EU080 Slave Actuator for Automatic Home or Building HVAC System

September 2020





Automatic Home or Building HVAC System Platform Slave Actuator Unit¹

Please see EU076 for problem definition with existing / retrofit buildings, complete solution proposal and benefits.

This is the **Slave Actuator Unit** as part of the proposed platform concept:

- -determines the optimum time, duration and air flow amount and direction out of the sensor data
- -includes HVAC / BLDC fan control
- -Bluetooth Mesh communication to Master Actuator Unit

Overall goals:

- -achieve optimum air quality in all rooms
- -avoid mold
- improve energy efficiency
- improve user experience and comfortability



NOTE ¹: Renesas does not have any plans to provide end products to the market; you, our customers are the experts in developing and providing such and Renesas does not claim to have the competency to do. Hence, this is just a proposal for a *potential* realization.

EU080





Slave Actuator for Automatic Home or Building HVAC System

Overview

The slave actuator unit(s) control a fan or HVAC in one room or section of a home or building by following instructions from the master actuator. This can be one or all of the following fan controls:

- RPM of a brushless DC (BLDC) fan motor
- Direction of flow, i.e. in/out (and optionally swipe up/down, left/right)
- Flow sensor (Liter/min)
- Electrical heater 0% 100%

If the actuator controls an HVAC rather than a simple fan, it may have additional sensors and outputs of its own to better control the HVAC, such as:

- RPM of BLDC compressor motor
- Compressor pressure sensor (bar)

An additional GUI using capacitive touch or simple push button(s) and/or an LCD can be used to display local values and enter data. A more sophisticated GUI may also be achieved via a master actuator, IP gateway or smartphone. A real-time clock (RTC) could easily be added to switch between different operation modes, depending on the day, time, holiday, etc. All RTCs could also be synchronized within the system.

System Benefits

- -Bluetooth® 5 Mesh communication enables communication with other sensors and the actuators. Advantages of Bluetooth 5 include:
 - Secure bidirectional packet data flow
 - Low power (can go down to µA average while being connected)
 - Additional wiring is not required
 - Automatic routing (with no setup for the routing itself)
 - Scalable speed vs. range (i.e. for four times range or a double speed option, depending on the location)
- For the power supply, mains will usually be needed (e.g. 230V_{ac} or 110V_{ac} or 24V_{dc}) from the building control system. Renesas has a comprehensive set of solutions available, depending on the exact use case.



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Slave Actuator for Automatic Home or Building HVAC System



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Automatic Home or Building HVAC System Platform

Major advantages of Bluetooth 5 Mesh

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- secure communication (Diffie-Hellmann Key Exchange, AES128 etc.)
- bidirectional packet data flow
- low power (can go down to µA average while being connected)
- no need for additional wiring
- automatic routing (with no setup for the routing itself)
- scalability of speed vs. range:
 - for four times range or
 - double speed option

depending on location.



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Slave Actuator for Automatic Home or Building HVAC System

| Device Category | P/N | Key Features | | | |
|--------------------|----------|---|--|--|--|
| | RX23W | Bluetooth 5.0 MCU w/ RX v2 core and BT Mesh functionality | | | |
| MCU | RX65N | CU with RX v2 core for communication | | | |
| | RX66T | CU with RX v3 core for motor control | | | |
| | FS2012 | Calibrated Gas Flow Sensor Module | | | |
| Analog | IPS2200 | Inductive position sensor IC | | | |
| | ZSSC3224 | High End 24-Bit Sensor Signal Conditioner IC | | | |
| Power | ISL85415 | 3-36V in, 0.6-34V / 500mA out Buck Regulator | | | |

EU080



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RX23W – 32-bit MCU for Bluetooth 5.0 Low Energy



54 MHz RXv2 Core with FPU, Low Power Design, RTC and Encryption Functions

Support for Multiple Communication Functions

- Bluetooth Low Energy (1Channel)
- An RF transceiver and link layer compliant with the Bluetooth 5.0 Low Energy specification, also supports Bluetooth 4.2
- LE 1M PHY, LE 2M PHY, LE Coded PHY (125 kbps and 500 kbps), and LE Advertising extension support
- On-chip Bluetooth-dedicated AES-CCM (128-bit blocks) encryption circuit
- USB 2.0 host/function/On-The-Go (OTG) (one channel), full-speed = 12 Mbps, low-speed = 1.5 Mbps, isochronous transfer, and Battery Charger supported
- CAN (one channel) compliant to ISO11898-1: Transfer at up to 1 Mbps
- Including many others

High Performance and Low Power Design

- Operation from single 1.8 to 3.6V supply
- Up to 512KB Flash and 64KB RAM
- IEC60730 Compliant
- Capacitive Touch Sensing Unit: 12Keys (Self), 36 Keys (Mutual)
- Max. operating frequency: 54 MHz, Capable of 88.56 DMIPS in operation at 54 MHz
- Enhanced DSP and FPU modules
- RTC capable of operating on the battery backup power supply
- Security: 128- or 256-bit key length of AES for ECB, CBC, GCM, others. TRNG and Safe management of Keys.

| Part # | ROM (Kbytes) | RAM (Kbytes) | Security Functions | Package |
|-----------------|-----------------|-----------------|--------------------|------------|
| R5F523W8ADNG#30 | 512 | 64 | N/A | QFN/56/0.4 |
| R5F523W7ADNG#30 | 384 | 64 | N/A | QFN/56/0.4 |
| R5F523W8BDNG#30 | 512 | 64 | Available | QFN/56/0.4 |
| R5F523W7BDNG#30 | 384 | 64 | Available | QFN/56/0.4 |



Low Cost System Block



Target Board for RX23W – RTK5RX23W0C00000B





RX65N – 120MHz RXv2 Core MCU

Large ROM/RAM, Enhanced Security, Connectivity and HMI

High Performance and Wide Product Lineup

- RXv2 Core 120 MHz operation (34 CoreMark/mA), on-chip FPU
- Up to 2M ROM / 640K RAM, supportive of the dual bank funciton
- Wide package lineup : 64-pin (4.5mm x 4.5mm, BGA) to 176-pin

Rich Peripheral/Security Functions

- 16-bit TPUa, MTU3a, 8-bit TMRa (4ch), 16-bit CMT(4ch), 32-bit CMTW(2ch)
- 12-bit A/D (8 ch for unit 0, 21ch for unit 1), 12-bit D/A (2ch)
- DMACAa (8ch), DTCb (1ch), EXDMAC(2ch), DMAC for Ethernet controller(1ch)
- Various communication peripheral such as Ethernet, USB, CAN, SD host/slave interface, and quad SPI
- Security: AES、TRNG、TDES、RSA、SHA

Low Power Design and Architecture

- Operation from a single 2.7- to 3.6-V supply
- Low power consumption: A product that support all peripheral functions draws only 0.19mA/MHz(Typ.)
- RTC is capable of operation from a dedicated power supply
- Four low-power modes

| Part # | ROM | RAM | Data Flash | Package |
|--------------|------|------|---------------|---|
| R5F565N4xDxx | 512K | 256k | None | 64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA |
| R5F565N7xDxx | 768K | 256K | None | 64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA |
| R5F565N9xDxx | 1M | 256K | None | 64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA |
| R5F565NCxDxx | 1.5M | 640K | 32K | 64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145- TFLGA,176-LFQFP,176-LPBFA,177-TFLGA |
| R5F565NExDxx | 2M | 640K | 32K | 64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145- TFLGA,176-LFQFP,176-LPBFA,177-TFLGA |

| Memory | | RXv2 32-bit CPU | | | | |
|--|--|---|-------------------------------------|--|--|--|
| Program Flash w/DualBank Function 2 MB | Floa | -bit | | | | |
| SRAM | | DSP Instructions | | | | |
| Data Flash 32 KB | Register Indirect Multiply-and-Accumulate (Result: 80-bit) Register Direct Multiply-and-Accumulate (Result: 72-bit) | | | | | |
| | | Barrel Shifter: 32-bit | | | | |
| System | Timers | Communication | Security and Safety | | | |
| Data Transfer Controller ExDMA Controller × 2 ch DMA Controller × 8 ch | Multi-Function Timer Pulse Unit 16-bit x 8 ch | RX651 RX65N | Encryption Modules AES, TRNG | | | |
| Interrupt Control | Timer Pulse Unit | Ethernet Controller | Trusted Secure IP | | | |
| Clock Generation Circuit | Programmable Pulse | US82.0 Full Speed Host/Function Module | Trusted Memory Function | | | |
| High-speed On-Chip Oscillator Low-speed On-Chip Oscillator | Generator | CAN × 2 ch | Memory Protection Unit | | | |
| Power-On Reset Voltage Detection Circuit | 8-bit Timer × 4 ch | x 3 ch | Register Write | | | |
| Event Link Controller | Compare Match Timer 16-bit x 4 ch 32-bit x 2 ch | Interface x 13 ch Serial Peripheral Interface × 3 ch | Clock Frequency Accuracy Measure | | | |
| | Real-Time Clock Calendar | | CRC | | | |
| Analog | Function | Quad Serial Peripheral Interface | Data Operation | | | |
| 12-bit A/D x 8ch (with 3 ch S&H) | | (Quad SPI) x 1 dh | Circuit | | | |
| 12-bit A/D × 21 ch | | SD Host Interface x 1 ch | Watchdog Timer 14-bit × 1 ch | | | |
| 12-bit D/A × 2 cb | | SD Slave Interface x 1 ch | Independent Watchdog Timer | | | |
| 12-01 014 - 2 01 | | MMC Host Interface x 1 ch | 14-bit × 1 ch | | | |
| Temperature Sensor | | | HMI | | | |
| *The Maximum specifications for | Parallel Data Capture | | | | | |
| | | | LCDC | | | |
| | | | | | | |

System Block



Renesas Starter Kit for RX65N



RX66T – 32-bit MCU for Motor Control

160MHz RXv3 Core for Motor Control Applications

Key Features

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- RXv3 Core 160 MHz operation (5.8 CoreMark/MHz)
- 2.7 to 5.5 V operation
- Operating Temperature -40 to 105 °C
- Program Flash up to 1 MB, SRAM up to 128 KB
- Enhanced Analog:
 - 12-bit A/D Converter x 3 units , 12-bit D/A Converter x 2 channels
 - 6-channel Comparators
 - 6-channel Pseudo-Differential PGA
- 160 MHz PWM
 - 4 channels for 3-phase complementary switching, 2 channels for 5-phase complementary switching, 10 channels for single-phase complementary switching
 - 4-channel high-resolution PWM enables minimum 195 ps timing adjustment
- Trusted Secure IP Lite (AES/TRNG)

| Part # | ROM (kB) | RAM (kB) | Data Flash (kB) | Package |
|--------------|-------------|-------------|--------------------|--------------|
| R5F566TKADFP | 1024 | 128 | 32 | PLQP0100KB-B |
| R5F566TEBDFP | 512 | 63 | 32 | PLQP0100KB-B |
| R5F566TABDFP | 256 | 64 | 32 | PLQP0100KB-B |

| Memory | | RXv3 32-bit CPU | | | | |
|--|--|--|---|--|--|--|
| Code Flash 1 MB | Floa | 160 MHz ting-Point Operation Unit: 32 | -bit | | | |
| SRAM | DSP Instructions | | | | | |
| 128 KB Data Flash | Register Indi Register Dir | rect Multiply-and-Accumulate | e (Result: 80-bit) (Result: 72-bit) | | | |
| SRAM with ECC | | Barrel Shifter: 32-bit | · · · | | | |
| iona | | | | | | |
| System | Timers | Communication Functions | Security and Safety | | | |
| DMA Controller x 8 ch | Fiea Register Indi Register Dir Timer Pulse Unit 16-bit x 9 ch General-Purpose 32-bit x 10 ch 8-bit Timer 4 unit (2 ch x 4) Compare Match Timer 16-bit x 4 ch 14-bit Independent Watchdog Timer 14-bit Independent Watchdog Timer * This kit can build evaluation envir * This board picture is prototype ve | USB2.0 Full Speed Host/Function Module | Trusted Secure IP (AES/TRNG) Key management, Access management | | | |
| 16 level 16 pin + NMI | | CAN x 1ch | Code Protect | | | |
| On-Grip Oscillator | | Serial Communication | (Flash access limited) | | | |
| Power-on Reset (POR) | | Interface x 7 ch | Unique ID | | | |
| Voltage Detection Circuit (LVD) | | I ² C Bus Interface x 1 ch | Memory Protection Unit | | | |
| Event Link Controller | 14-bit Watchdog Timer | Serial Peripheral Interface x 1 ch | Register Write Protection Unit | | | |
| Analog | 14-bit Independent Watchdog Timer | 8/16-bit External Bus | Clock Frequency Accuracy Measurement Circuit | | | |
| 12-bit A/D Converter 3 units (8 ch, 8 ch, 14 ch) | | | Data Operation Circuit (RAM test assist) | | | |
| Pseudo-Differential Programmable Gain Amplifier x 6 ch | | | A/D Self-Diagnostics | | | |
| 12-bit D/A Converter x 2 ch | | | A/D Disconnection Detection | | | |
| Temperature Sensor | | | CRC32 Calculator | | | |
| Comparator x 6 ch | * This kit can build evaluation envir | onment by Web Installer. | Trusted Memory (flash access limited) | | | |
| | * This board picture is prototype ve | rsion. | Port Output Enable | | | |
| | I Himistrerkit | S John State | Oscillation-stop Detection | | | |
| | RENESAS Start Compatible Color LCD board | er Ki E2 Lite CPU Board | | | | |

BIG IDEAS FOR EVERY SP

FS2012 – High Performance Flow Sensor Module



Applications for Process Controls, Oil and Gas Leak Detection, CPAP and Respirator Devices

High Accuracy and Fully Calibrated Output

- Accuracy error down to 2% of reading (typical)
- Full calibrated output

High Performance and Easy to Use

- Robust solid isolation technology
- Resistant to surface contamination
- No cavity to cause clogging
- Resistant to vibration and pressure shock
- Support analog output: 0V to 5V, digital output: I²C
- Supply voltage: 5V(Typ)
- Module operating temperature range: 0°C to +85°C

| Part # | Parameter | Description |
|----------------|-------------------------------------|--|
| FS2012-1020-NG | Gas Flow | 0 to 2 SLPM |
| FS2012-1100-NG | Gas Flow | 0 to 10 SLPM |
| FS2012-1001-LQ | Liquid Flow | 0 to 0.5(500) SLPM(SCCM) |
| FS2012-1002-LQ | Liquid Flow | 0 to 1.0(1000) SLPM(SCCM) |
| | SLPM: Standard li SCCM: Standard | iter per minute. cubic centimeter per minute. |



Analog Output Example



FS2012 Module (front)





IPS2200 – Inductive Positive Sensor IC

Magnet-free, Inductive Positive Sensor IC for High Speed Absolute Position Sensing

High Performance and Low Cost

- High accuracy : $\leq 0.2\%$ full scale, adaptable to any full-scale angle range
- Rotation sensing up to 360° angle range
- Cost effective, no magnet required, single IC support on-axis and off-axis rotation, liner motion, and arc motion sensing

Flexible Usage and Safety Functions

- Differential and single-ended sine and cosine outputs
- Nonvolatile user-configurable memory, programmable via I2C or SPI, Supply voltage programmable for 3.0V to 3.6V or 4.5V to 5.5V
- Fast diagnostic alarm trough interrupt pin, ±18V over-voltage and reversepolarity protection on output pins

Immunity and Wide Operating Temperature Range

- Immune to magnetic stray fields, no shielding required, suitable for harsh environments and extreme temperature
- Wide operation temperature: -40°C to 125°C

| Part # | Carrier Type | Temp Range (°C) | Package |
|-------------|---------------------------|--------------------|----------------------|
| IPS2200BI1W | 7" Reel, 500 parts/reel | -40 to +125 | 16-TSSOP 4.4 x 5.0mm |
| IPS2200BI1R | 13" Reel, 4000 parts/reel | -40 to +125 | 16-TSSOP 4.4 x 5.0mm |



Block Diagram



IPS2-COMBOARD and IPS2200MROT4x90001 Application Module

BIG IDEAS FOR EVERY SPACE RENESAS

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ZSSC3224 – Sensor Signal Conditioner High End 24-Bit Sensor Signal Conditioner IC

Features

- Flexible, programmable analog front-end design; up to 24-bit analog-to-digital converter (ADC)
- Fully programmable gain amplifier for optimizing sensor signals: gain range 6.6 to 216 (linear)
- Internal auto-compensated temperature sensor
- Digital compensation of individual sensor offset; 1st and 2nd order digital compensation of sensor gain as well as 1st and 2nd order temperature gain and offset drift
- Programmable interrupt operation
- High-speed sensing: e.g. 18-bit conditioned sensor signal measurement rate >200s-1
- Typical sensor elements can achieve an accuracy of better than ±0.10% FSO** at -40 to 85°C

Applications

- Barometric altitude measurement for portable navigation or emergency call systems; altitude measurement for car navigation
- Weather forecast
- Fan control
- Industrial, pneumatic, and liquid pressure
- High-resolution temperature measurements
- Object-temperature radiation (via thermopile)

| Part # | rt # Operation Condition | | Package |
|--------------|-----------------------------|----------------|---|
| ZSSC3224BI3R | 1.68-3.6V –40°C to +85°C | MSL1 | 24-PQFN |
| ZSSC3224BI1B | (see above) | Not applicable | die, thickness 304µm |
| ZSSC3224BI2B | (see above) | Not applicable | die, thickness 725µm (without backlapping) |



ZSSC3224 Block Diagram





ISL85415 – 0.5A Regulator with Integrated High Side FET Support 3V-36V Input Voltage Range for Buck Output

Wide Working Range

- Power input voltage range from 3V to 36V
- The device provides an easy-to-use high-efficiency, low BOM-count solution for a variety of applications.
- Up to 0.5A load over full temperature range

High Efficiency and Performance (Low Board Space)

- Synchronous operation for high efficiency
- No compensation required
- Integrated High-side and Low-side NMOS devices
- Selectable PFM or forced PWM mode at light loads
- Internal fixed (500kHz) or adjustable switching frequency 300kl to 2MHz

| Part # | V _{IN} Range(V) | Temp.(°C) | Package |
|-------------|-----------------------------|------------|---------------|
| ISL85415FRZ | 3 to 36 | -40 to 125 | 12 Ld DFN 4x3 |







FIGURE 1. FRONT OF EVALUATION BOARD ISL85415DEM022



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ALTERNATIVE SLAVE ACTUATOR FOR FAN CONTROL



Smart Home HVAC System Slave Actuator Unit // Fan Control

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BIG IDEAS FOR EVERY SPACE



Smart Home HVAC System Slave Actuator – Fan Control // Major BOM list

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| Device Category | P/N | Key Features | | | |
|--------------------|----------|---|--|--|--|
| MCU | RX23W | Bluetooth 5.0 MCU w/ RX v2 core and BT Mesh functionality | | | |
| IVICO | RX65N | ICU with RX v2 core for communication | | | |
| | HIP2103 | Half Bridge Driver 60V, 1A/2A peak | | | |
| FS2012 | | Calibrated Gas Flow Sensor Module | | | |
| Dowor | ISL85415 | 3-36V in, 0.6-34V / 500mA out Buck Regulator | | | |
| Fower | ISL85403 | 3-36V in, 0.8-24V / 2.5A out Buck Regulator | | | |



RX23W – 32-bit MCU for Bluetooth 5.0 Low Energy 54 MHz RXv2 Core with FPU, Low Power Design, RTC and Encryption functions

Support for Multiple Communication Functions

- Bluetooth Low Energy (1Channel)
- An RF transceiver and link layer compliant with the Bluetooth 5.0 Low Energy specification, also supports Bluetooth 4.2
- LE 1M PHY, LE 2M PHY, LE Coded PHY (125 kbps and 500 kbps), and LE Advertising extension support
- On-chip Bluetooth-dedicated AES-CCM (128-bit blocks) encryption circuit
- USB 2.0 host/function/On-The-Go (OTG) (one channel), full-speed = 12 Mbps, low-speed = 1.5 Mbps, isochronous transfer, and Battery Charger supported
- CAN (one channel) compliant to ISO11898-1: Transfer at up to 1 Mbps
- Including many others

High Performance and Low Power Design

- Operation from single 1.8 to 3.6V supply
- Up to 512KB Flash and 64KB RAM
- IEC60730 Compliant
- Capacitive Touch Sensing Unit: 12Keys (Self), 36 Keys (Mutual)
- Max. operating frequency: 54 MHz, Capable of 88.56 DMIPS in operation at 54 MHz.
- Enhanced DSP and FPU modules
- RTC capable of operating on the battery backup power supply
- Security: 128- or 256-bit key length of AES for ECB, CBC, GCM, others. TRNG and Safe management of Keys.

| Part # | ROM (Kbytes) | RAM (Kbytes) | Security Functions | Package |
|-----------------|-----------------|-----------------|--------------------|------------|
| R5F523W8ADNG#30 | 512 | 64 | N/A | QFN/56/0.4 |
| R5F523W7ADNG#30 | 384 | 64 | N/A | QFN/56/0.4 |
| R5F523W8BDNG#30 | 512 | 64 | Available | QFN/56/0.4 |
| R5F523W7BDNG#30 | 384 | 64 | Available | QFN/56/0.4 |



Low Cost System Block



Target Board for RX23W – RTK5RX23W0C00000B







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RX65N – 120MHz RXv2 Core MCU

Large ROM/RAM, Enhanced Security, Connectivity and HMI

High Performance and Wide Product Lineup

- RXv2 Core 120 MHz operation (34 CoreMark/mA), on-chip FPU
- Up to 2M ROM / 640K RAM, supportive of the dual bank funciton
- Wide package lineup : 64-pin (4.5mm x 4.5mm, BGA) to 176-pin

Rich Peripheral/Security Functions

- 16-bit TPUa, MTU3a, 8-bit TMRa (4ch), 16-bit CMT(4ch), 32-bit CMTW(2ch)
- 12-bit A/D (8 ch for unit 0, 21ch for unit 1), 12-bit D/A (2ch)
- DMACAa (8ch), DTCb (1ch), EXDMAC(2ch), DMAC for Ethernet controller(1ch)
- Various communication peripheral such as Ethernet, USB, CAN, SD host/slave interface, and quad SPI
- Security: AES、TRNG、TDES、RSA、SHA

Low Power Design and Architecture

- Operation from a single 2.7- to 3.6-V supply
- Low power consumption: A product that support all peripheral functions draws only 0.19mA/MHz(Typ.)
- RTC is capable of operation from a dedicated power supply
- Four low-power modes

| Part # | ROM | RAM | Data Flash | Package |
|--------------|------|------|---------------|---|
| R5F565N4xDxx | 512K | 256k | None | 64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA |
| R5F565N7xDxx | 768K | 256K | None | 64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA |
| R5F565N9xDxx | 1M | 256K | None | 64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA |
| R5F565NCxDxx | 1.5M | 640K | 32K | 64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145- TFLGA,176-LFQFP,176-LPBFA,177-TFLGA |
| R5F565NExDxx | 2M | 640K | 32K | 64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145- TFLGA,176-LFQFP,176-LPBFA,177-TFLGA |

| Memory | | RXv2 32-bit CPU | | | | |
|--|---|---|-------------------------------------|--|--|--|
| Program Flash w/DualBank Function 2 MB | Floating-Point Operation Unit: 32-bit | | | | | |
| SRAM 640 KB | | DSP Instructions | DSP Instructions | | | |
| Data Flash 32 KB | Register Indir Register Dire | sct Multiply-and-Accumulate (Result: 80-bit) ct Multiply-and-Accumulate (Result: 72-bit) | | | | |
| | Barrel Shifter: 32-bit | | | | | |
| System | Timers | Communication | Security and Safety | | | |
| Data Transfer Controller ExDMA Controller × 2 ch DMA Controller × 8 ch | Multi-Function Timer Pulse Unit 16-bit x 8 ch | RX851 RX85N | Encryption Modules AES , TRNG | | | |
| Interrupt Control | 32-bit x 1 ch | Ethernet Controller | Trusted Secure IP | | | |
| Clock Generation Circuit | Programmable Pulse | USB2.0 Full Speed Host/Function Module | Trusted Memory Function | | | |
| High-speed On-Chip Oscillator Low-speed On-Chip Oscillator | Generator | CAN × 2 ch I2C Bus Interface | Memory Protection Unit | | | |
| Power-On Reset Voltage Detection Circuit | 8-bit Timer × 4 ch | x 3 ch Serial Communications | Register Write Protection | | | |
| Event Link Controller | Compare Match Timer 16-bit x 4 ch 32-bit x 2 ch | Interface × 13 ch Serial Peripheral Interface × 3 ch | Clock Frequency Accuracy Measure | | | |
| | Real-Time Clock Calendar | | CRC | | | |
| Analog | Pulluuli | Quad Serial Peripheral Interface | Data Operation | | | |
| 12-bit A/D x 8ch (with 3 ch S&H) | | (Coldo SPI) X T on | Circuit | | | |
| 12-bit A/D × 21 ch | | x 1 ch | Watchdog Timer 14-bit × 1 ch | | | |
| 12-bit D/A × 2 ch | | SD Slave Interface x 1 ch | Independent Watchdog Timer | | | |
| | | x 1 ch | 14-DIC × 1 ch | | | |
| Temperature Sensor | | | HMI | | | |
| *The Maximum specifications for | or the group are shown | | Parallel Data Capture | | | |
| | | | LCDC | | | |
| | | | 2D Graphics | | | |

System Block



Renesas Starter Kit for RX65N





HIP2103/4 – 60V, 1A/2A, Half-Bridge Driver

High Voltage Drivers for Industrial Motor Control

Optimized Half-Bridge Drivers

- Supports half bridge, full bridge configurations
- Enables DC and 3 phase BLDC motors

Independent High/Low Inputs

- Reduces connections to MCU and lowers cost
- Supports 3.3V and 5V signals

Sleep Mode

- Low quiescent current (5uA) with unique sleep mode
- Allows direct connection to battery without disconnect switch

Integrated LDO (HIP2104)

- Option with integrated 12V & 3.3V LDO (HIP2014)
- Provides bias to external MCU

| Part # | UVLO | VCC Reg | VDD Reg | Package |
|-----------------|------|---------|---------|-------------|
| HIP2103FRTAAZ-T | 4.0V | N/A | N/A | 8L 3x3 TDF |
| HIP2104FRTAAZ-T | 4.0V | 3.3V | 12V | 12L 4x4 DFN |





BIG IDEAS FOR EVERY SPACE RENESAS

FS2012 – High Performance Flow Sensor Module



Applications for Process Controls, Oil and Gas Leak Detection, CPAP and Respirator Devices

High Accuracy and Fully Calibrated Output

- Accuracy error down to 2% of reading (typical)
- Full calibrated output

High Performance and Easy to Use

- Robust solid isolation technology
- Resistant to surface contamination
- No cavity to cause clogging
- Resistant to vibration and pressure shock
- Support analog output: 0V to 5V, digital output: I²C
- Supply voltage: 5V(Typ)
- Module operating temperature range: 0°C to +85°C

| Part # | Parameter | Description | | |
|----------------|-------------------------------------|--|--|--|
| FS2012-1020-NG | Gas Flow | 0 to 2 SLPM | | |
| FS2012-1100-NG | Gas Flow | 0 to 10 SLPM | | |
| FS2012-1001-LQ | Liquid Flow | 0 to 0.5(500) SLPM(SCCM) | | |
| FS2012-1002-LQ | Liquid Flow | 0 to 1.0(1000) SLPM(SCCM) | | |
| | SLPM: Standard li SCCM: Standard | iter per minute. cubic centimeter per minute. | | |



Analog Output Example



FS2012 Module (front)





ISL85415 – 0.5A Regulator with Integrated High Side FET Support 3V-36V Input Voltage Range for Buck Output

Wide Working Range

- Power input voltage range from 3V to 36V
- The device provides an easy-to-use high-efficiency, low BOM-count solution for a variety of applications.
- Up to 0.5A load over full temperature range

High Efficiency and Performance (Low Board Space)

- Synchronous operation for high efficiency
- No compensation required
- Integrated High-side and Low-side NMOS devices
- Selectable PFM or forced PWM mode at light loads
- Internal fixed (500kHz) or adjustable switching frequency 300kl to 2MHz

| Part # | V _{IN} Range(V) | Temp.(°C) | Package |
|-------------|-----------------------------|------------|---------------|
| ISL85415FRZ | 3 to 36 | -40 to 125 | 12 Ld DFN 4x3 |







FIGURE 1. FRONT OF EVALUATION BOARD ISL85415DEM022



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ISL85403 – 2.5A Regulator with Integrated High Side FET

Support 3V-40V Input Voltage Range for Buck or Boost-Buck Output

Wide Working Range

- Power input voltage range from 3V to 40V
- Support both step down (buck) or boost+buck outputs
- Up to 2.5A load over full temperature range

High Efficiency

- Optional external low side FET for higher efficiency
- Selectable PWM / PFM modes
- 300uA input quiescent PFM mode current
- Less than 5uA shutdown current

High Performance

- 200KHz to 2.2MHz frequency range
- +/- 1% voltage regulation accuracy

| Part # | V _{IN} Range(V) | Temp.(°C) | Package |
|---------------|-----------------------------|------------|---------------|
| ISL85403FRZ-T | 3 to 40 | -40 to 125 | 20 Ld 4x4 QFN |







ISL85403EVAL1Z Evaluation Board



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RESERVE



Smart Home HVAC System Slave Actuator Unit // Fan Control (Alternative MCUs)





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BIG IDEAS FOR EVERY SPACE

F

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Smart Home HVAC System Slave Actuator // Major BOM list

F

| Device Category | P/N | Key Features | | | | |
|--|----------|--|--|--|--|--|
| MCU | RA4W1 | Bluetooth 5.0 MCU w/ Arm® Cortex®-M4 and BT Mesh functionality | | | | |
| RA6M3 120-MHz Arm [®] Cortex [®] - M4 Core | | 120-MHz Arm [®] Cortex [®] - M4 Core | | | | |
| | HIP2103 | 03 Half Bridge Driver 60V, 1A/2A peak | | | | |
| | FS2012 | Calibrated Gas Flow Sensor Module | | | | |
| Dowor | ISL85415 | 3-36V in, 0.6-34V / 500mA out Buck Regulator | | | | |
| Fower | ISL85402 | 3-36V in, 0.8-24V / 2.5A out Buck Regulator | | | | |





RA4W1 – 48-MHz Arm[®] Cortex[®]- M4 for BLE 5.0

Bluetooth® 5.0 Low Energy Single Chip MCU for IoT Applications

High Performance

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- 48MHz 32-bit Arm[®] Cortex[®]-M4 core with FPU
- 512KB Flash,96KB SRAM and 8KB Data Flash

Full Functionality of Bluetooth 5.0 Low Energy

- 2.4 GHz radio with Bluetooth 5.0 Low Energy
- LE 1M, 2M, Coded PHY, and LE advertising extension
- Secure Crypto Engine (AES128 / 256, GHASH, TRNG)

Highly Integrated Capabilities

- 14-Bit ADC (8 ch.)
- 12-Bit DAC (1 ch.) and temperature sensor
- Low power analog comparator(2 ch), OPAMP x 1
- USB 2.0(Full Speed)/CAN/SCI x 4/SPI x 2 /IIC x 2
- GPT 32-bit(4 ch)/GPT 16-bit(3 ch)/AGT 16-bit(2 ch)/WDT/RTC

HMI Interface and Small Package

- Capacitive Touch Sensing Unit (11 ch.)
- Segment LCD Controller up to 9 segments x 4 commons
- 7x7mm QFN 56 pin package

| Part # | Flash Memory | RAM | Temp | Package |
|---------------|--------------|------|---------|---------|
| R7FA4W1AD2CNG | 512KB | 96KB | 40∼85°C | 56 QFN |





EK-RA4W1



RA6M3 – Ultra-Low Power 120-MHz Arm® Cortex®- M4 Core



Full Featured for Applications needing HMI/Control/ Security/Graphical and Capacitive Touch

High Performance

120MHz Arm[®] Cortex[®]-M4 CPU

Highly Integrated Capabilities

- 1MB-2MB Flash Memory and 640kB SRAM
- 128-bit unique ID
- 12-Bit ADC (x2)
- 12-Bit DAC

Communication Interfaces

- USB 2.0 (Full Speed/ High Speed)
- Ethernet Controller with DMA
- SCI x10/SPIx2/IICx3

HMI Interface

- Capacitive Touch Sensing Unit (18ch.)
- Graphics LCD Controller

Security and Encryption

- AES128/192/256, 3DES/ARC4, SHA1/SHA224/SHA256/MD5, GHASH, RSA/DSA/ECC
- True Random Number Generator (TRNG)

| Part # | Flash Memory | RAM | Temp | Package |
|-------------------|-----------------|-------|----------|----------|
| R7FA6M3AH3CFC#AA0 | 2MB | 640KB | 40~105°C | 176 LQFP |
| R7FA6M3AF3CFC#AA0 | 1MB | 640KB | 40~105°C | 176 LQFP |

| FLASH / | 2MB / 640kB | RA6M3 | RA6M3 | RA6M3 | RA6M3 | RA6M3 |
|---------------------------------------|----------------|----------------------------------|----------------------------------|-------------------------------|----------------------------------|---------------------------------|
| RAM | 1MB / 640kB | RA6M3 | RA6M3 | RA6M3 | RA6M3 | RA6M3 |
| Pin Count Package Size Pitch | | 100pin LQFP 14x14 0.5mm | 144pin LQFP 20x20 0.5mm | 145pin LGA 7x7 0.5mm | 176pin LQFP 24x24 0.5mm | 176pin BGA 13x13 0.8mm |

Flash/ RAM/ Package Table



RTK7EKA6M3S00001BU

