EU079 Master Actuator for Automatic Home or Building HVAC System

September 2020





Automatic Home or Building HVAC System Platform Master Actuator Unit¹

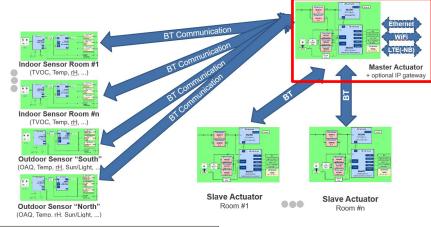
Please see EU076 for problem definition with existing / retrofit buildings, complete solution proposal and benefits.

This is the Master 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 Slave Actuator Unit(s), Indoor and Outdoor Sensor Unit(s)
- -further improvement by using eAI instead of fixed algorithms

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.

EU079



Master Actuator for Automatic Home or Building HVAC System



EU079

Overview

The master actuator unit(s) is the brain of the system. It fulfils all the functions of a slave actuator unit and includes other capabilities, such as:

- Collection of all sensors data from indoor sensor unit(s), outdoor sensor unit(s) and slave actuator unit(s)
- Additional weather information may be collected from the internet, if an IP gateway is implemented in the master actuator or separately (see IP Gateway for Automatic Home or Building HVAC System <u>Automatic Home or Building HVAC System, EU081</u>)
- Calculation/Determination of the set points for each slave actuator unit, like flow direction (in/out), temperature, etc., using an algorithm or the latest embedded artificial intelligence (AI) technology
- Provision of the set points for each slave actuator and the master itself
- Local (graphical) GUI of the whole system, which may also be mirrored by a Bluetooth® or web interface
- Real-time clock (RTC) and its distribution to sensor/actuator units for different operation modes, depending on the day, time, holiday, etc.

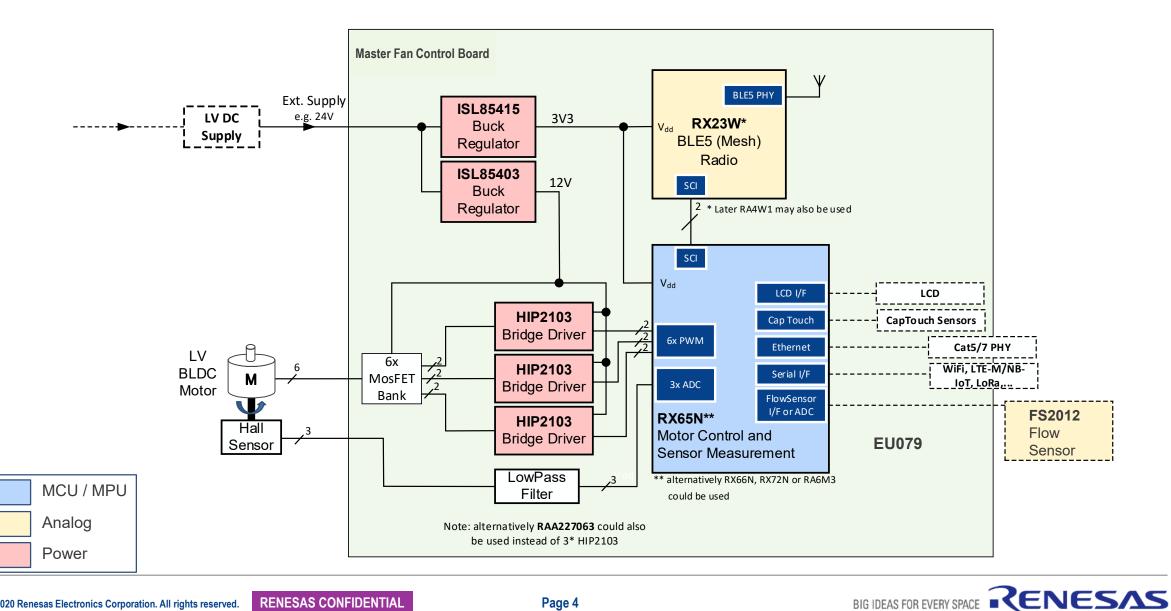
From a system perspective, the master and slave actuator can have the same hardware and software. In this case, the master is a role rather than a certain device and it would not represent a single-point-of-failure, as another slave actuator could take over the master role in case the original master fails. However, there must be only one master, per system, at a time.

System Benefits

- The RX23W MCU enables Bluetooth 5 mesh communication
- The master actuator can (but does not need to) have an integrated gateway to the intranet/internet using a secure communication mechanism like HTTPS or MQTT, if not achieved externally (see IP Gateway for <u>Automatic Home or Building HVAC System, EU081</u>). For these cases, one or multiple of the following technologies are available:
 - Wi-Fi (based on IEEE 802.11), Thread or Zigbee (based on IEEE 802.15.4), Ethernet (based on IEEE 802.3), LTE-M/-NB (depending on geographical region and available providers), or LoRaWAN

*Note: For the power supply, the mains will usually be needed for the fan/HVAC (e.g. $230V_{ac}$ or $110V_{ac}$; or $24V_{dc}$ from the building control system).

Master Actuator for Automatic Home or Building HVAC System



WINNING COMBOS

BIG IDEAS FOR EVERY SPACE

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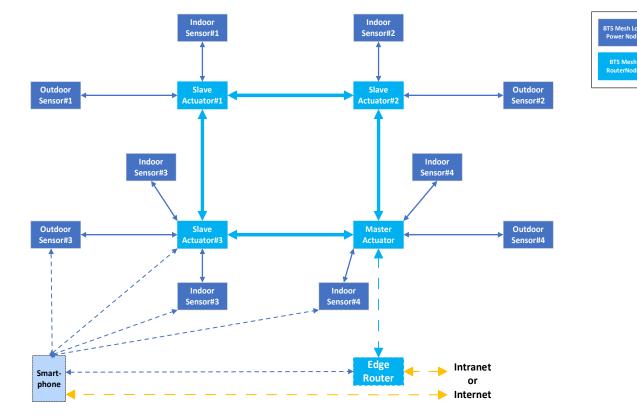
Automatic Home or Building HVAC System Platform

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.



EU079





Master Actuator for Automatic Home or Building HVAC System

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



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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

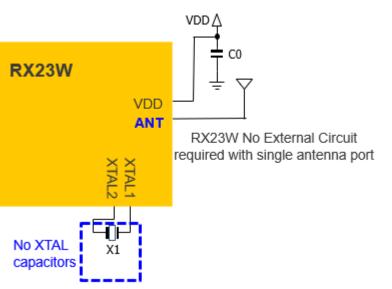
Support for Multiple Communication Functions

- 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

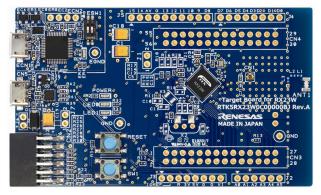
High Performance and Low Power Design

- 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

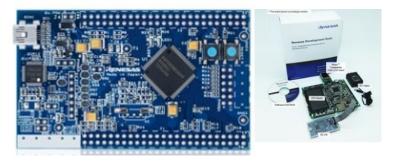
Low Power Design and Architecture

- 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 120 MHz					
Program Flash w/DualBank Function 2 MB	Floating-Point Operation Unit: 32-bit						
SRAM 640 KB		DSP Instructions					
Data Flash		irect Multiply-and-Accumulate rect Multiply-and-Accumulate					
32 KB	Barrel Shifter: 32-bit						
0	-	a					
System	Timers Multi-Function	Communication Functions	Security and Safety				
Data Transfer Controller ExDMA Controller × 2 ch DMA Controller × 8 ch	Timer Pulse Unit 16-bit x 8 ch 32-bit x 1 ch	RX651 RX65N	Encryption Modules AES, TRNG				
Interrupt Control	Timer Pulse Unit	Ethernet Controller	Trusted Secure IP				
16 levels, 16 pins	16-bit × 6 ch	US82.0 Full Speed Host/Function Module	Trusted Memory Function				
PL tigh-speed On-Chip Oscillator iow-speed On-Chip Oscillator Power-On Reset Voltage Detection Circuit	Programmable Pulse Generator	CAN × 2 ch	Memory Protection				
	8-bit Timer × 4 ch Compare Match Timer	I2C Bus Interface x 3 ch	Unit				
		Serial Communications	Register Write Protection				
Event Link Controller	16-bit x 4 ch 32-bit x 2 ch	x 13 ch Serial Peripheral	Clock Frequency Accuracy Measure				
	Real-Time Clock Calendar Function	Interface × 3 ch	CRC				
Analog		Quad Serial Peripheral Interface	Data Operation				
12-bit A/D x 8ch (with 3 ch S&H)		(Quad SPI) x 1 ch	Circuit				
12-bit A/D × 21 ch		SD Host Interface x 1 ch	Watchdog Timer 14-bit × 1 ch				
12-bit D/A × 2 ch		SD Slave Interface x 1 ch	Independent Watchdog Timer				
12-0it U/A × 2 ch		MMC Host Interface x 1 ch	14-bit × 1 ch				
Temperature Sensor			HMI				
The Maximum specifications fo	r 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

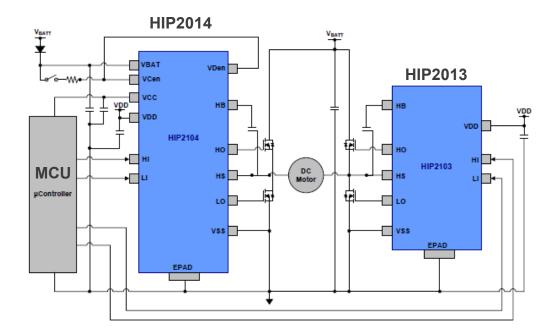
Sleep Mode

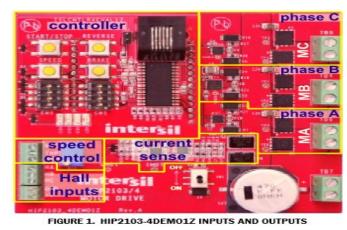
- Low quiescent current (5uA) with unique sleep mode
- Allows direct connection to battery without disconnect switch

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

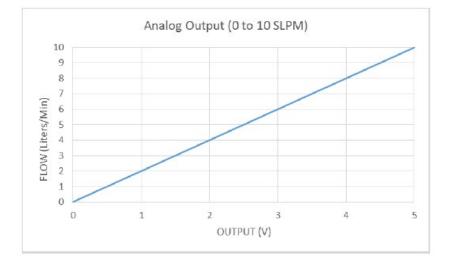
High Accuracy and Fully Calibrated Output

- 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 liter per minute. SCCM: Standard 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

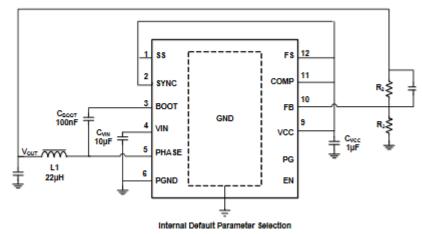
Wide Working Range

- 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



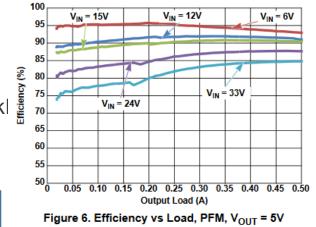




FIGURE 1. FRONT OF EVALUATION BOARD ISL85415DEM022





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

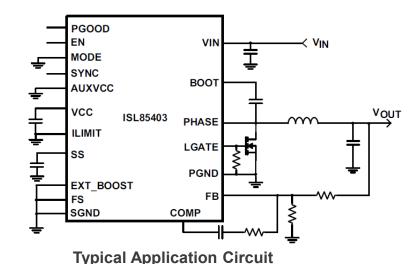
High Efficiency

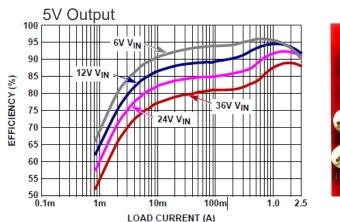
- Optional external low side FET for higher efficiency
- Selectable PWM / PFM modes
- 300uA input quiescent PFM mode current
- Less than 5uA shutdown current

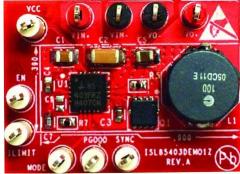
High Performance

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

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







ISL85403EVAL1Z Evaluation Board

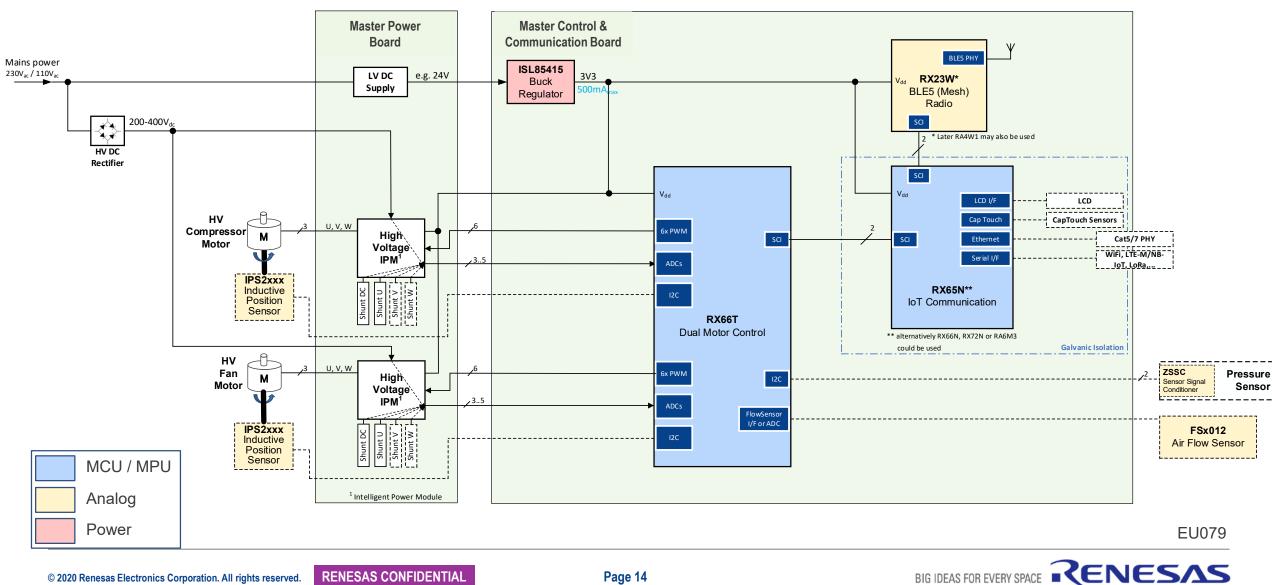


ALTERNATIVE MASTER ACTUATOR FOR HVAC / COMPRESSOR CONTROL





Smart Home HVAC System Master Actuator Unit // HVAC / Compressor Control



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RENESAS CONFIDENTIAL



Smart Home HVAC System Master Actuator – HVAC Compressor Control // Major BOM list

Device Category	P/N	Key Features				
	RX23W	Bluetooth 5.0 MCU w/ RX v2 core and BT Mesh functionality				
MCU	RX65N	ICU with RX v2 core for communication				
	RX66T	ICU with RX v3 core for motor control				
Analog	FS2012	Calibrated Gas Flow Sensor Module				
	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				

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54 MHz RXv2 Core with FPU, Low Power Design, RTC and Encryption functions Support for Multiple Communication Functions

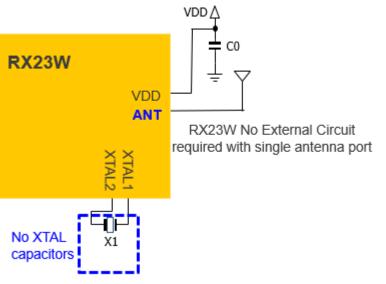
RX23W – 32-bit MCU for Bluetooth 5.0 Low Energy

- 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

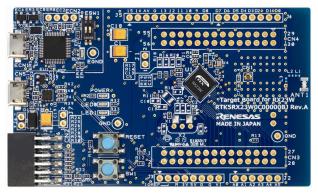
High Performance and Low Power Design

- 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

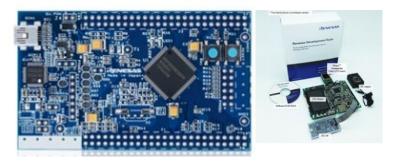
Low Power Design and Architecture

- 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
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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 120 MHz						
Program Flash w/DualBank Function 2 MB	Floating-Point Operation Unit: 32-bit							
SRAM 640 KB	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 32-bit x 1 ch	Functions RX851 RX85N	Encryption Modules AES, TRNG					
Interrupt Control 16 levels, 16 pins	32-bit x 1 ch Timer Pulse Unit 16-bit × 6 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	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 x 13 ch	Clock Frequency Accuracy Measure					
	Real-Time Clock Calendar Function	Serial Peripheral Interface × 3 ch	CRC					
Analog 12-bit A/D x 8ch	1 010001	Quad Serial Peripheral Interface (Quad SPI) x 1 ch	Data Operation Circuit					
(with 3 ch S&H)		SD Host Interface	Watchdog Timer 14-bit × 1 ch					
12-bit A/D × 21 ch		SD Slave Interface x 1 ch	Independent					
12-bit D/A × 2 ch		MMC Host Interface x 1 ch	Watchdog Timer 14-bit × 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



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

			IC COMPO	
Code Flash	RXv3 32-bit CPU 160 MHz			
1 MB	Floating-Point Operation Unit: 32-bit			
SRAM 128 KB	DSP Instructions			
Data Flash 32 KB	Register Indirect Multiply-and-Accumulate (Result: 80-bit) Register Direct Multiply-and-Accumulate (Result: 72-bit)			
SRAM with ECC 16 KB		Barrel Shifter: 32-bit		
System	Timers	Communication Functions	Security and Safety	
Data Transfer Controller DMA Controller x 8 ch	Multi-Function Timer Pulse Unit 16-bit x 9 ch	USB2.0 Full Speed	Trusted Secure IP (AES/TRNG)	
Interrupt Controller 16 level 16 pin + NMI	General-Purpose PWM Timer	Host/Function Module	Key management, Access management	
On-Chip Oscillator	32-bit x 10 ch 8-bit Timer	CAN x 1ch	Code Protect (Flash access limited)	
Power-on Reset (POR)	4 unit (2 ch x 4)	Serial Communication Interface x 7 ch	Unique ID	
Voltage Detection Circuit (LVD)	Compare Match Timer 16-bit x 4 ch	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	Trusted Memory (flash access limited)		
	* This board picture is prototype ve	ersion.	Port Output Enable	
	tarterkit	S Jonation Contraction	Oscillation-stop Detection	
	RENESAS Start Compatible Color LCD board	E2 Lite CPU Board		

FS2012 – HIGH PERFORMANCE FLOW SENSOR MODULE

APPLICATIONS FOR PROCESS CONTROLS, OIL AND GAS LEAK DETECTION, CPAP AND RESPIRATOR DEVICES

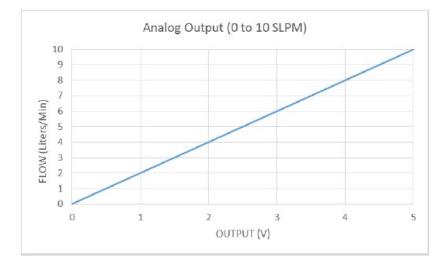
High accuracy and Fully Calibrated Output:

- 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 liter per minute. SCCM: Standard cubic centimeter per minute.		



WINNING COMBOS

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

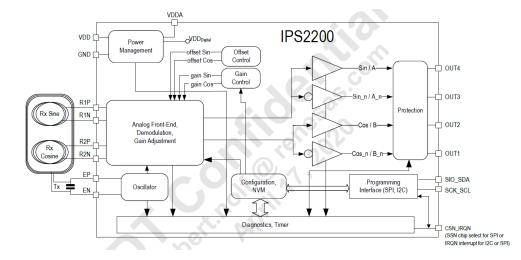
Flexible Usage and Safety Functions

- 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

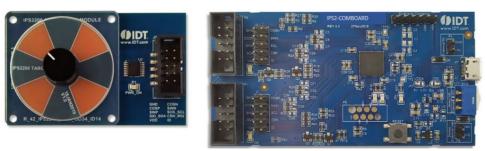
Immunity and Wide Operating Temperature Range

- 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
IPC2200BI1W	7" Reel, 500 parts/reel	-40 to +125	16-TSSOP 4.4 x 5.0mm
IPC2200BI1R	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



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

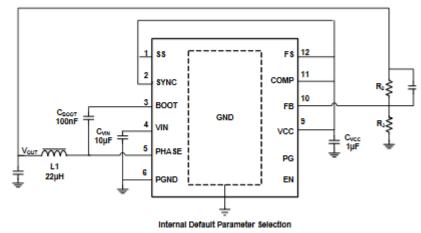
Wide Working Range

- 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



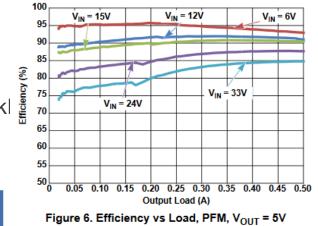




FIGURE 1. FRONT OF EVALUATION BOARD ISL85415DEM022





RENESAS

ZSSC3224 – SENSOR SIGNAL CONDITIONER HIGH END 24-BIT SENSOR SIGNAL CONDITIONER IC

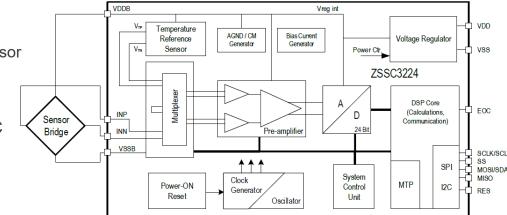
Features

- 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 #	Operation Condition	MSL Rating	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

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