EU016
(Bio)Sensing
with wireless charging & Bluetooth

EMEA System Solutions Team (SST)
Sept. 2019 1v2

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(Bio)Sensing
with Wireless Charging & Bluetooth

- **Overview**
  - For Biosensing (or other use cases like Smart Home) multiple sensor data needs to be acquired and transferred via Bluetooth to a smartphone or the cloud. Sensors may be any combination of Pulse oxy / PPG, gyro, accelerometer, humidity, temperature, ambient light etc. Such acquisition devices are usually low power and mobile, like using a small Li-Ion cell, which needs to be recharged wirelessly to get rid of physical connection at all. Here we provide a complete, compact solution.
- **System benefits**
  - Multiple (Bio)Sensors, incl. very compact Pulse Oxy sensor
  - Wireless Charging
    - incl. Li-Ion (e.g. 100mAh) battery management, protection, automatic power control, DCDC
    - optimized for low power and very small size by high integration (“all-in-one” RX chip)
  - Bluetooth® (Low Energy) communication module

Block Diagram #EU016
Sept. 2019

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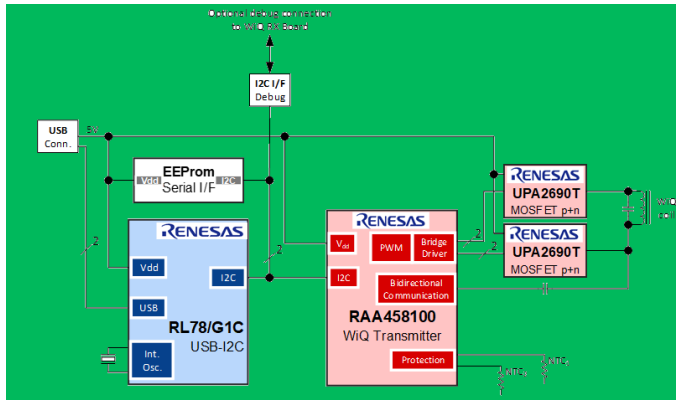
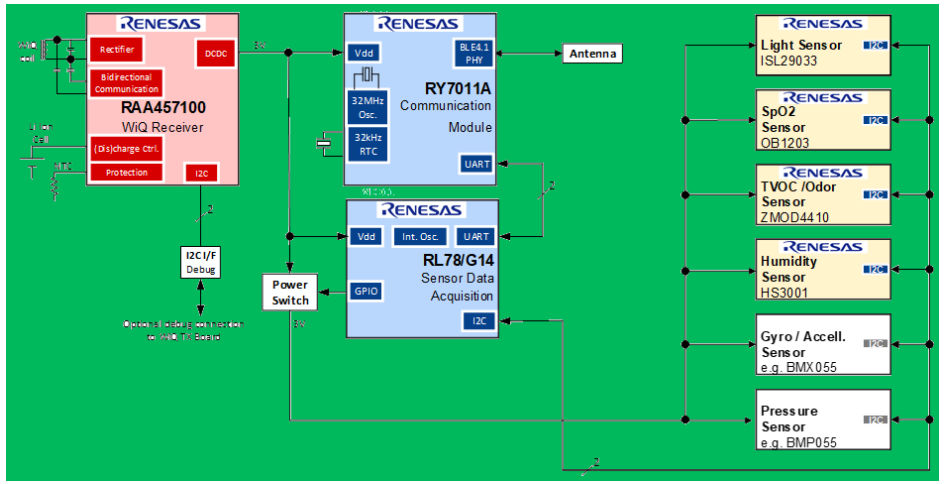
(Bio)Sensing
with Wireless Charging & Bluetooth // Overview



Stationary Device
(Wireless Charging Transmitter)



Portable Device
(Wireless Charging Receiver)

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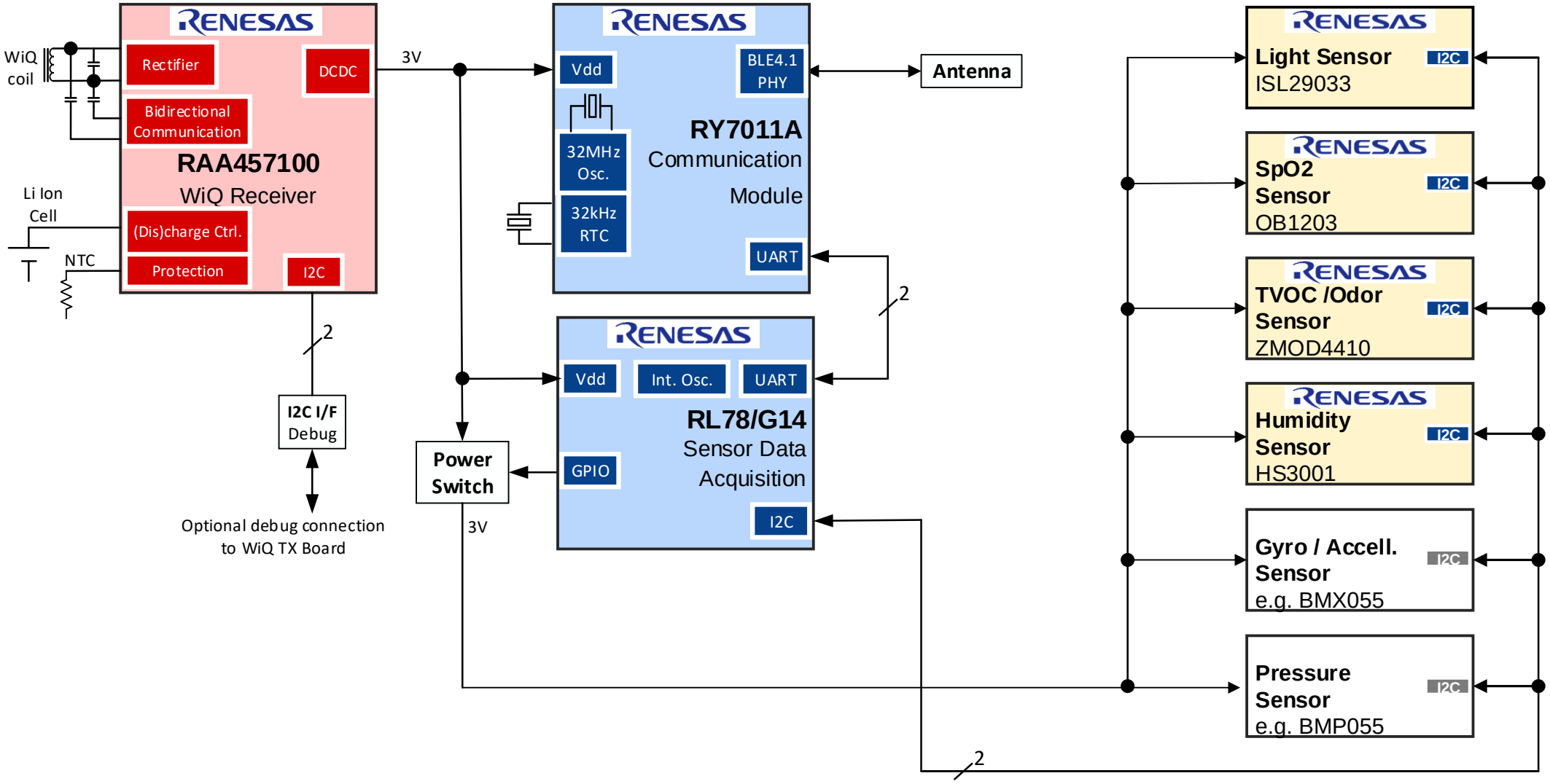
(Bio)Sensing
with Wireless Charging & Bluetooth // Charging Receiver (portable device)



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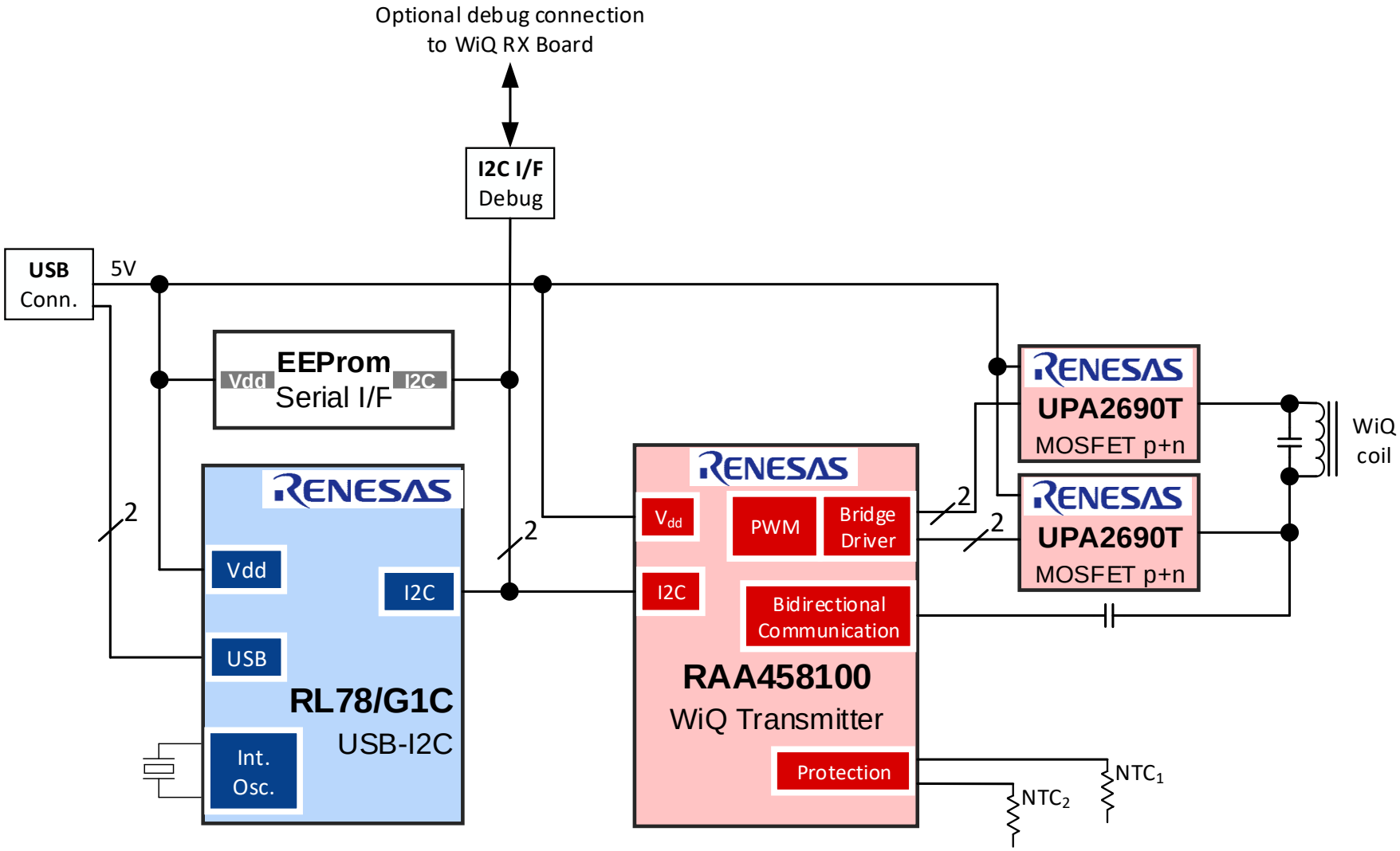
BIG IDEAS FOR EVERY SPACE

(Bio)Sensing
with Wireless Charging & Bluetooth // Charging Transmitter (stationary device)



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(Bio)Sensing
with Wireless Charging & Bluetooth

Device Category	P/N	Key Features
MCU	RY7011A	Compact Bluetooth 4.1 module (based on RL78/G1D)
	RL78/G1C	Low power 16bit MCU, 24MHz, USB2.0, I2C and further I/F
	RL78/G14	Low power 16bit MCU, 32MHz, General Purpose
Power	RAA457100	Wireless Charging Transmitter, Automatic Transmission Power Control (reducing heat and losses), multiple overtemperature protection, wireless communication
	RAA458100	Wireless Charging Receiver, up to 70mA charge current, integrated 100mA DCDC, LiIon battery protection (OT/UT, OV/UV, OC), wireless communication
	UPA2690	Dual MOSFET (half-)bridge, n- plus p-channel to drive Charging coil
Analog	HS300x	Humidity sensor with industry-leading accuracy, response time, and excellent stability
	OB1203	Digital RGB + IR / Ambient Light, Proximity, Pulse Oximeter and Heart-Rate Sensor
	ISL29033	Integrated Digital Ambient Light Sensor: Ultra-Low Lux, Low Power, I2C I/F
	ZMOD4410	Indoor Air Quality (TVOC, eCO_2) / Odor Sensor

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RY7011 – Bluetooth® Low Energy Module

Compact Module with Built-in 32 MHz Crystal Resonator for RF and Antenna

High Integration

- The RL78/G1D module (RY7011) contains the RL78/G1D, a 32 MHz crystal resonator for RF chip, and an antenna, all in a compact (8.95 x 13.35 x 1.7 mm) module.
- GPIO 24 pins mounted, These can use the UART,I2C, SPI, Timer, ADC.
- RF transceiver is certified with Bluetooth v4.2 Specification (Low Energy Single mode)

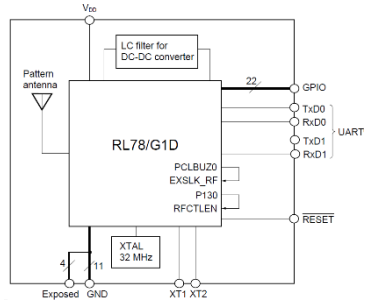
Easy to Develop and Use

- The module has been tested and found to comply with global regulatory certification for Japan, FCC, IC, and CE as well as Bluetooth SIG certification
- The module inherits the functional pins of the RL78/G1D, so not only can you use it for modem configuration, but you can also leverage the strengths of the microcontroller for embedded configuration

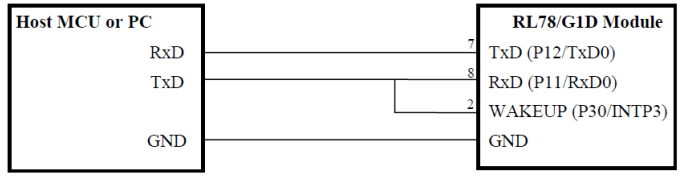
Low Power Consumption

- RL78/G1D module support Bluetooth® Low Energy and achieved the lowest level of current consumption in the industry.
  - RF transmitter active normal mode: 4.3 mA, Low power mode:2.6 mA
  - RF receiver active normal mode: 3.5 mA
  - Average current: 9.1 µA (1-second intervals, connection maintained, CC-RL compiler)

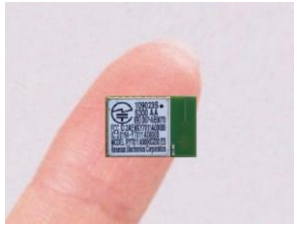
Part #	Flash ROM	RAM	Package
RY7011A000DZ00	256KB	20KB	42-pin LGA (8.95 × 13.35mm)



RL78/G1D module (RY7011) Block Figure



Connections to the host microcontroller



RL78/G1D module (RY7011)
（RY7011A000DZ00）
Size: 8.95 × 13.35 × 1.7 mm

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RL78/G1D – Bluetooth® Low Energy MCU

Bluetooth® Low Energy MCU with the lowest level of current consumption in the industry.

High Integration

- Power-efficient low-end microcontrollers with Bluetooth® Low Energy
- 2.4 GHz RF transceiver
  - Compliant with Bluetooth® v4.2 Low Energy (Master/Slave) specification
  - Reception sensitivity: –90 dBm
  - Max. transmission output power: 0 dBm

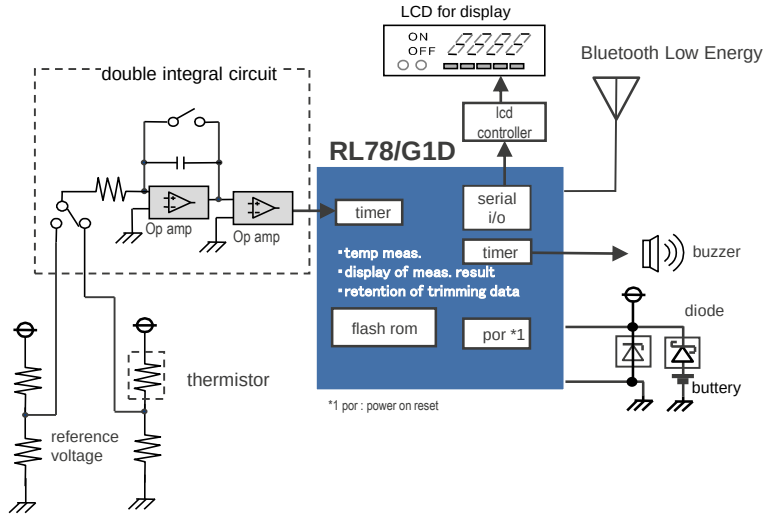
Easy to Develop and Use

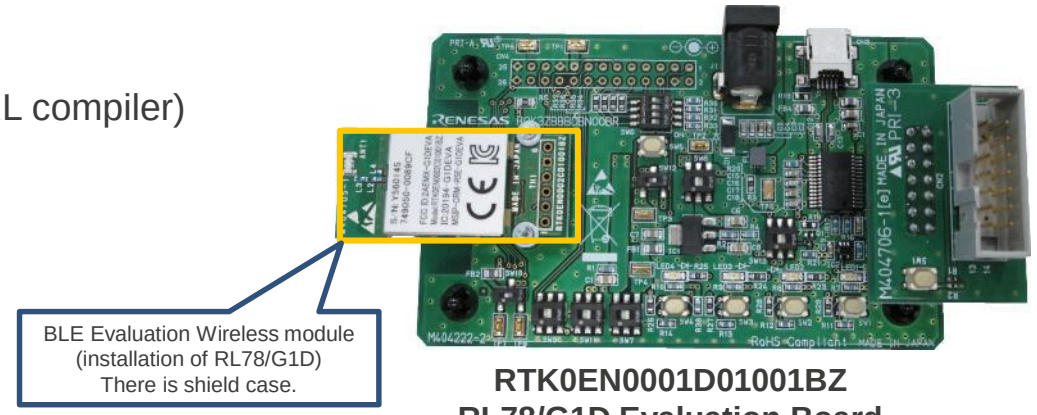
- Since circuit elements necessary for connecting an antenna are built in, not only does this simplifies circuit design for the antenna connection, but also reduce BOM and overall costs.
- Software stack supports wireless updating, helping to make maintenance of user software more efficient.

Low Power Consumption

- Achieved the lowest level of current consumption in the industry (3 V operation)
  . RF transmitter active normal mode: 4.3 mA, Low power mode:2.6 mA
  . RF receiver active normal mode: 3.5 mA
  . Average current: 9.1 µA (1-second intervals, connection maintained, CC-RL compiler)
- Different standby mode for MCU:HALT, STOP, SNOOZE
- Low power saving mode with 6 setting (min. 0.1 µA) for RF part

Part #	Flash ROM	RAM	Package
R5F11AGG	128KB	12KB	48-pin HWQFN (6 × 6) (0.4mm pitch)
R5F11AGH	192KB	16KB	
R5F11AGJ	256KB	20KB	





RTK0EN0001D01001BZ
RL78/G1D Evaluation Board

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RL78/G1C – USB MCU

USB communications and rapid charging (USB 2.0, BC 1.2 compliant)

High Integration

- In addition to two USB 2.0 (full speed) host channels or one function channel, suitable for PC connectivity and a wide variety of communication and interfaces applications
- The RL78/G1C microcontrollers are compliant with Battery Charging Specification 1.2 (BC 1.2) for high-speed battery charging.

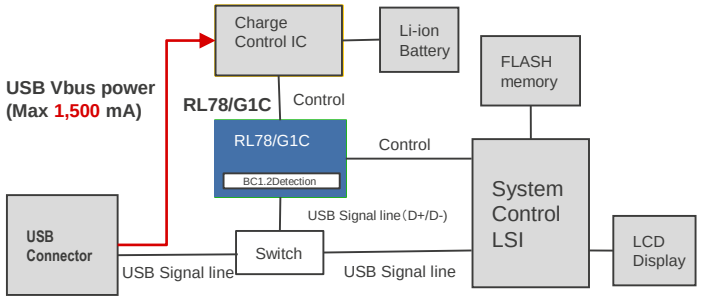
Easy to Develop and Use

- USB sample firmware is available free of charge. This simplifies development for customers, reduces costs and significantly shortens time to market.
- All application notes are available for download on the Renesas website
  - HID (Human Interface Device Class), CDC (Communication Device Class), MSC (Mass Storage Class), USB Host Android Open Accessory, USB Peripheral Firmware Update

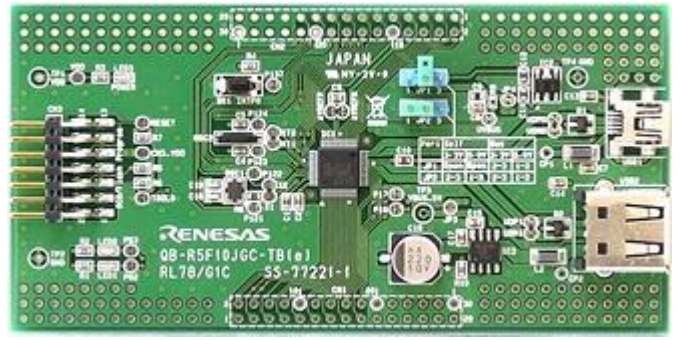
Low Power Consumption

- The lowest level of current consumption in the industry.
  - USB operation: 8 mA
  - USB operation(No-communication of only SOF receiving): 4 mA

Part #	USB	Flash ROM	RAM	Package
R5F10JBC	Host/Function	32KB	5.5KB	32-pin HWQFN (5 × 5) (0.5mm pitch) 32-pin LQFP (7 × 7) (0.8mm pitch)
R5F11KBC	Function only	32KB	5.5KB	
R5F11JGC	Host/Function	32KB	5.5KB	48-pin HWQFN (7 × 7) (0.5mm pitch) 48-pin LQFP (7 × 7) (0.5mm pitch)
R5F11KGC	Function only	32KB	5.5KB	



USB BC1.2 Supporting



CPU Board: QB-R5F10JGC-TB

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RL78/G14 – Advanced Functions MCU

Suitable for motor control as well as industrial and metering applications

Added instruction functions to CPU core

- Added multiply, divide, and multiply-accumulate instructions that enable high-speed operation by direct execution without needing to utilize library functions
- High calculation performance: 51.2 DMIPS(32 MHz)

High performance peripheral functions

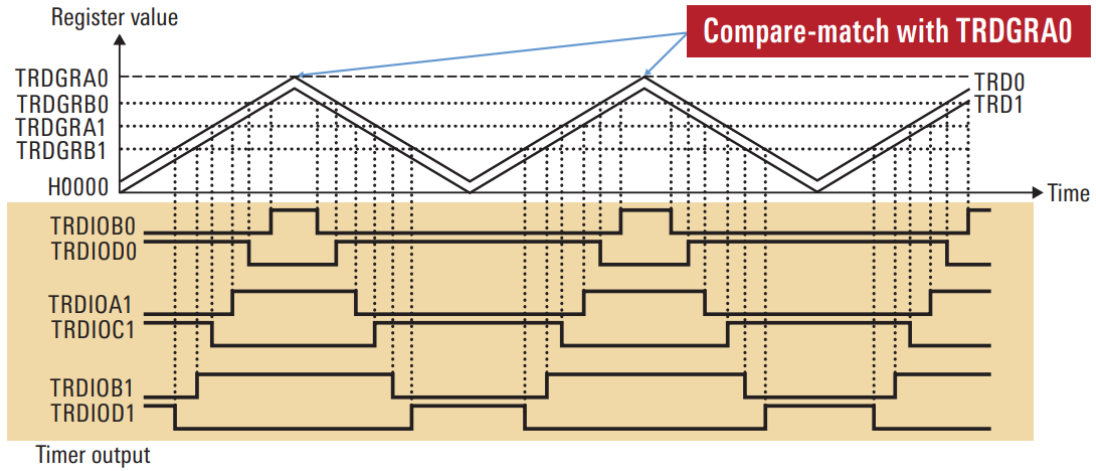
- Timer RD(Complementary PWM Mode for brushless DC motor control), Timer RG (Phase Count Mode), Timer RJ (asynchronous timer)
- Data Transfer Controller (DTC); Event Link Controller (ELC)
- Comparator, 8bit Digital Analog Converter

Easy to Develop and Use

- Scalable lineup packages, pin-counts and Flash ROM, RAM
- Released Starter Kit and Motor Solution Evaluation Kit

Part #	Flash ROM	RAM	Package(mm)
R5F104A	16 ~ 128 KB	2.5 ~ 16 KB	30-LSSOP(7.62)
R5F104B			32-HWQFN(5 × 5), 32-LQFP(7 × 7)
R5F104C			36-WFLGA(4 × 4)
R5F104E	16 ~ 192 KB	2.5 ~ 20 KB	40-HWGFN(6 × 6)
R5F104F	16 ~ 256 KB	2.5 ~ 24 KB	44-LQFP(10 × 10)
R5F104G	16 ~ 512 KB	2.5 ~ 48 KB	48-LFQFP(7 × 7), 48-HWQFN(7 × 7)
R5F104J	32 ~ 256 KB	4 ~ 24 KB	52-LQFP(10 × 10)
R5F104L	32 ~ 512 KB	4 ~ 48 KB	64-LFQFP(10 × 10), 64-LQFP(12 × 12), 64-LQFP(14 × 14)*, 64-WFLGA(5 × 5)
R5F104M	96 ~ 512 KB	12 ~ 48 KB	80-LFQFP(12 × 12), 80-LQFP(14 × 14)
R5F104P			100-LFQFP(14× 14), 100-LQFP(14 ×20)

*This product do not exist 384KB/512KB.



Complementary PWM mode operation example

Renesas Starter Kit for RL78/G14

RL78 Family Motor Solution Evaluation Kit

24V Motor Control Evaluation System for RX23T

RL78/G14 CPU Card for Motor Control

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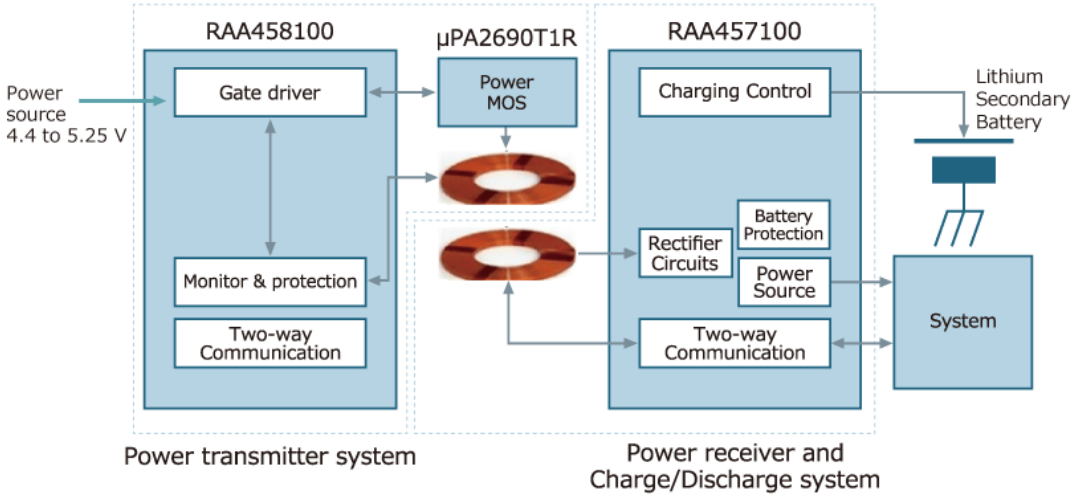
RAA457100

Wireless charging Receiver, Li Ion charge / discharge and protection, DCDC

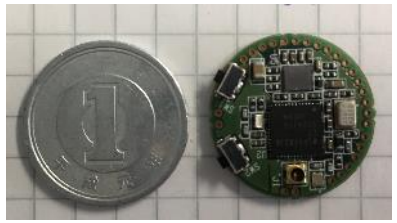
Much smaller than Qi charger + DCDC + full protection

- using very small coils (much smaller than Qi standard)
- solution can fit on one yen coin PCB (20mm)
- Evaluation kit with PC based GUI available



Rich Features, all-in-one chip

- Integrated Rectifier, bidirectional communication, Li-Ion Battery Charger, DCDC converter
- For single Li Ion cell, I_{charge} up to 70mA
- Up to 100mA DCDC out @ 1.2, 1.5, 1.8 or 3.0V
- Full battery protection: UV/OV, UT/OT, OC
- Wireless data transfer for Automatic Transmission Power Control
- 2 wire serial I/F for debug
- -20..+50°C



Part #	Feature	Package
RAA457100	All-In-One Wireless Receiver	WLBGA41 package 3.22 x 2.77 mm

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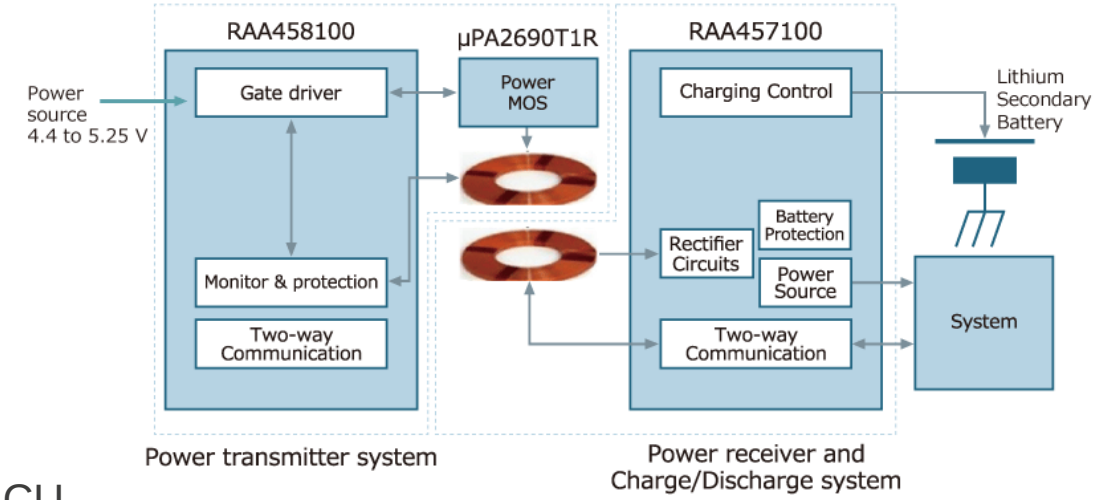
RAA458100

Wireless charging Transmitter, ATPC mode, integrated protection

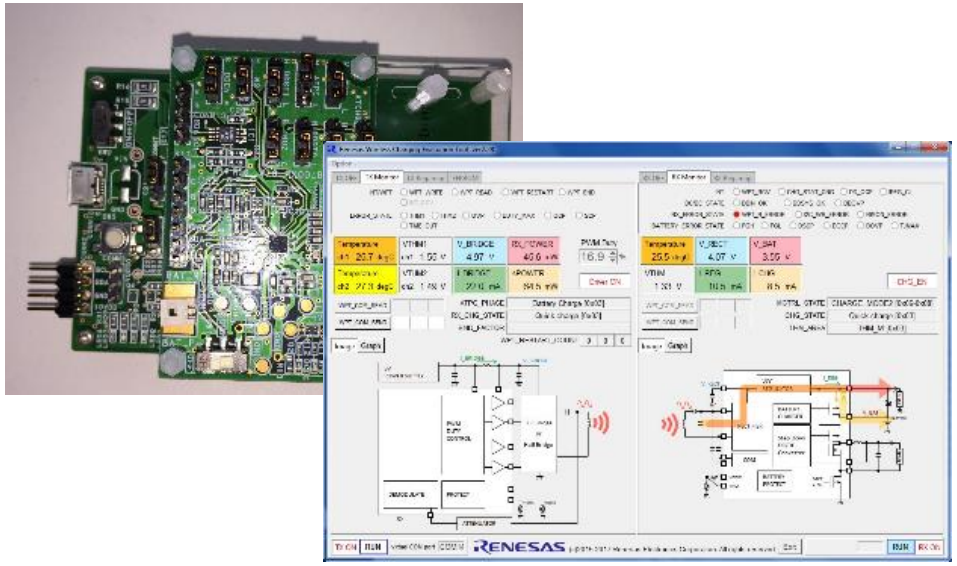
Much smaller and colder than Qi charger

- Using very small coils and package
- Lower losses = heat due to ATPC* and lower power
- Evaluation kit with PC based GUI available



Rich Features, quick start with evaluation kit

- Multiple operation modes: ATPC*, MCU or stand-alone
- charge parameters setable by small external EEProm or by MCU
- Integrated gate drivers for full or half-bridge mode
- Integrated Protection: Dual OT for coil & drivers + OC
- Wireless data transfer with RAA457100 for ATPC* avoids excessive heat in coils and increases efficiency
- 2 wire serial debug I/F
- Single 5V supply (e.g. from USB)
- -20..+60°C



Part #	Feature	Package
RAA458100	All-In-One Wireless Transmitter	UQFN40 package 5 x 5 x 0.65mm

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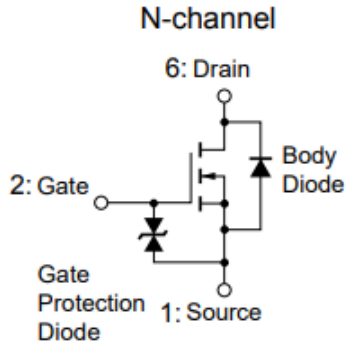
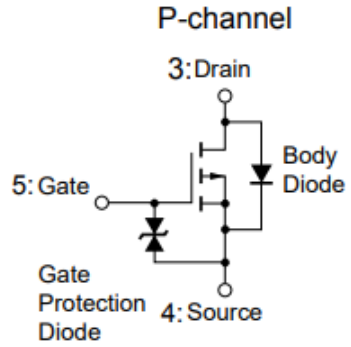
UPA2690T1R

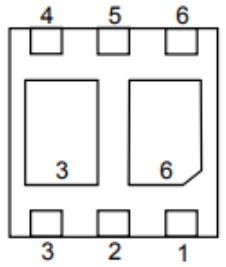
Dual, i.e. n- plus p-channel MOSFET (half) Bridge

Features

- Ideal for small, low power bridge drive applications
- Dual n- and p-channel MOSFET pair
- Compact package
- Low on-resistance
- High-speed switching and High-robustness
- Built-in gate protection diode

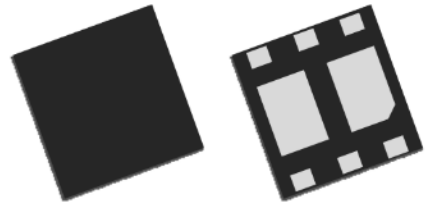






Most relevant data

- V_{dds} up to +/-20V
- DC current up to 4A (n-ch) / 3A (p-ch)
- Pulse current up 16A (n-ch) / 12A (p-ch)
- $R_{ds,on}$ down to 42mOhm (n-ch) / 79mOhm (p-ch)
- Power dissipation up to 1.5W
- Up to 150°C



6pinHUSON2020(Dual)

Part #	Feature	Package
UPA2690T1R	Dual n-ch / p-ch MOSFET	HUSON 6pin 2 x 2 x 0.7mm

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OB1203 All-In-One Bio and Light sensor

Fully integrated clinical grade calibrated module

Fully integrated module

- Color, Ambient Light, Proximity and Biosensor in a single module
- No external components needed
- Factory calibrated to clinical grade accuracy

Virtually Invisible

- Sensor works behind IR-ink
- Improved Industrial Design

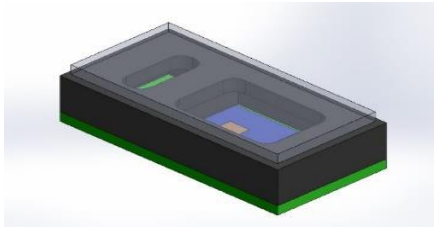
Smallest Form Factor

- Smallest biosensor module – 4.2 x 2 x 1.2mm
- Optimized optical package with low cross talk

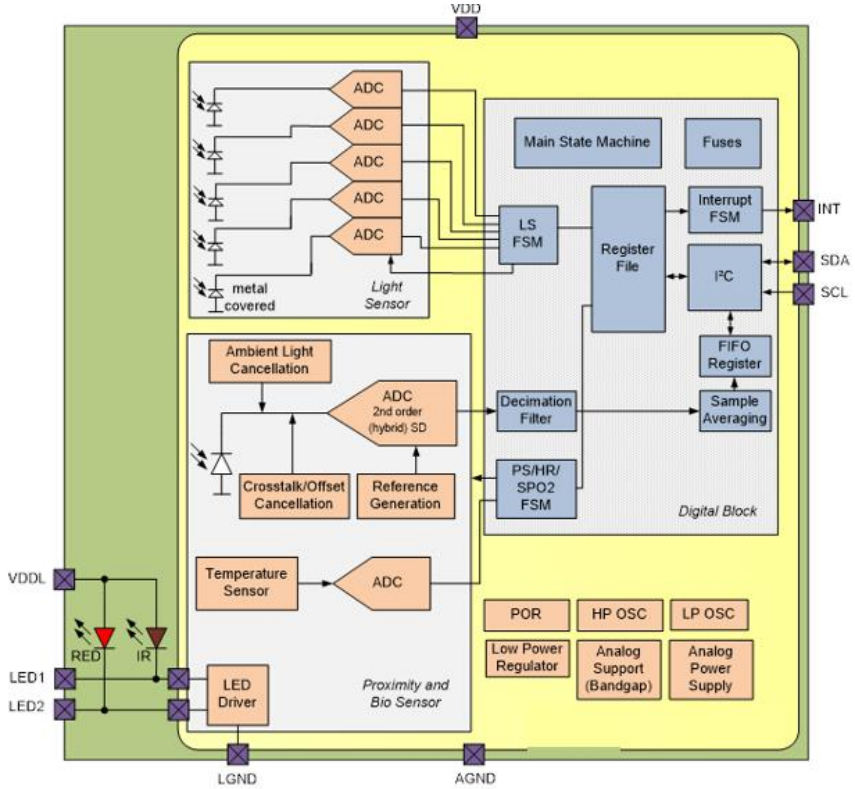
Complete solution

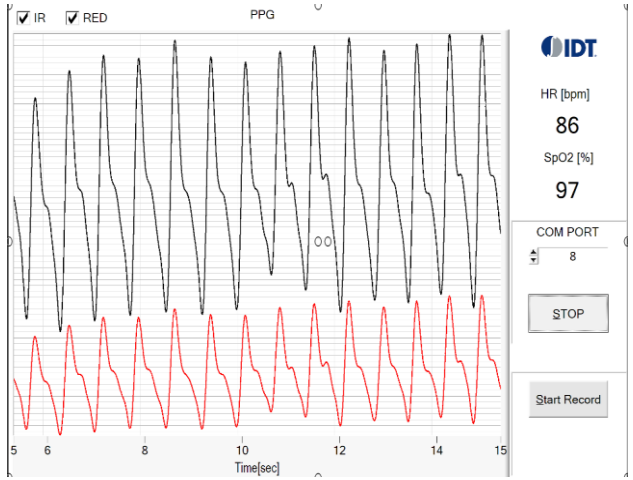
- Includes PulsOx algorithm
- Other algorithms can be added

Part #	Feature	Package
OB1203SD-C4	All-In-One Biosensor	14 pin, 4.2 x 2.0 x 1.2mm



Package 4.2 x 2 x 1.2mm





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HS300x – Relative Humidity and Temperature Sensor

High Accuracy Humidity and Temperature Measurement for Environmental Monitoring

High Accuracy

- ±1.5%RH accuracy (HS3001)
- ±0.2°C temperature accuracy (HS3001, HS3002)

Excellent Stability

- 0.1%RH per year drift
- MEMS silicon-carbide sensor technology

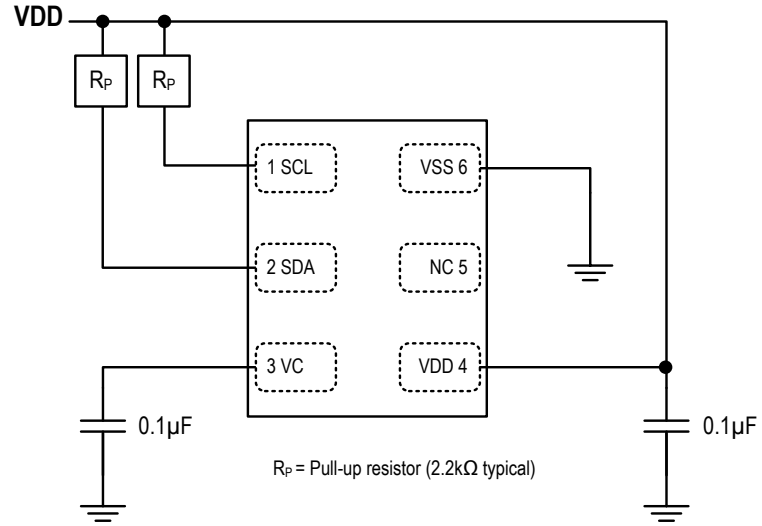
Fast Response

- Less than 6 seconds humidity response, in still air
- Less than 2 seconds temperature response

Extended Supply Voltage

- 2.3V to 5.5V, 24.4µA at 3.3V (one RH+Temp per second)
- 1.8V custom order

Part #	Feature	Package
HS3001	±1.5%RH	3×2.41×0.8 LGA
HS3002	±1.8%RH	3×2.41×0.8 LGA
HS3003	±2.8%RH	3×2.41×0.8 LGA
HS3004	±3.8%RH	3×2.41×0.8 LGA



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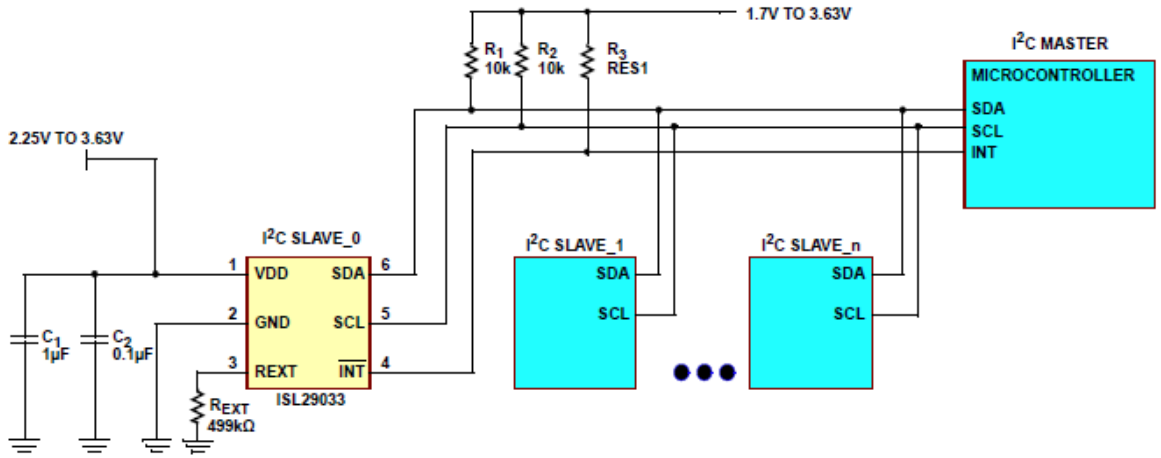
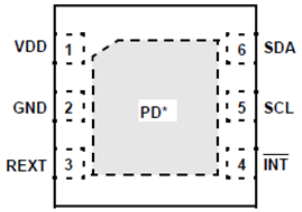
ISL29033 - Integrated Digital Ambient Light Sensor

High Accuracy Humidity and Temperature Measurement for Environmental Monitoring

Integrated ambient and infrared light-to-digital converter with I²C (SMBus Compatible) interface

- Measurement range: 0.0019 to 8,000lux
- Program interrupt feature
- Excellent light sensor IR and UV rejection
- 75µA maximum operating current
- 0.3µA maximum shutdown current
- 6 Ld 2.0x2.1x0.7mm ODFN package
- -40°C to +85°C ambient operating temperature range.





Part #	Description
ISL29033IROZ-EVALZ	ISL29033IROZ-EVALZ EVALUATION BOARD
ISL29033IROZ-T7	ISL29033IROZ Ultra Low Lux Digital ALS

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ZMOD4410 – Indoor Air Quality Sensor Platform

TVOC Sensor for Indoor Air Quality Application

Flexible measure target:

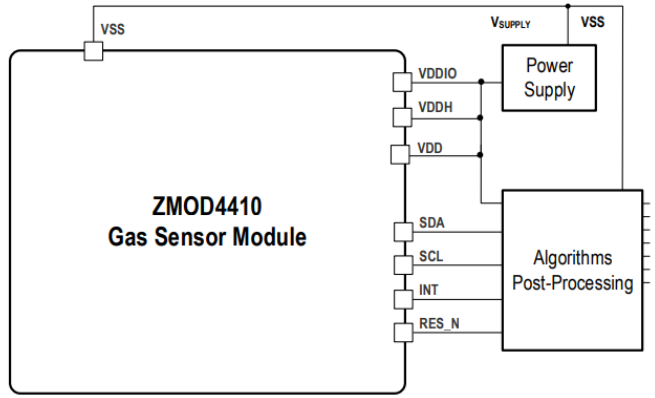
- Measurement of total organic compounds (TVOC)
- concentrations and indoor air quality (IAQ)
- Module algorithm estimates carbon dioxide level (eCO2)
- Algorithm to set a control signal to trigger an external action based on IAQ and odor change
- Configurable alarm/interrupt output with static and adaptive Levels

Low Power

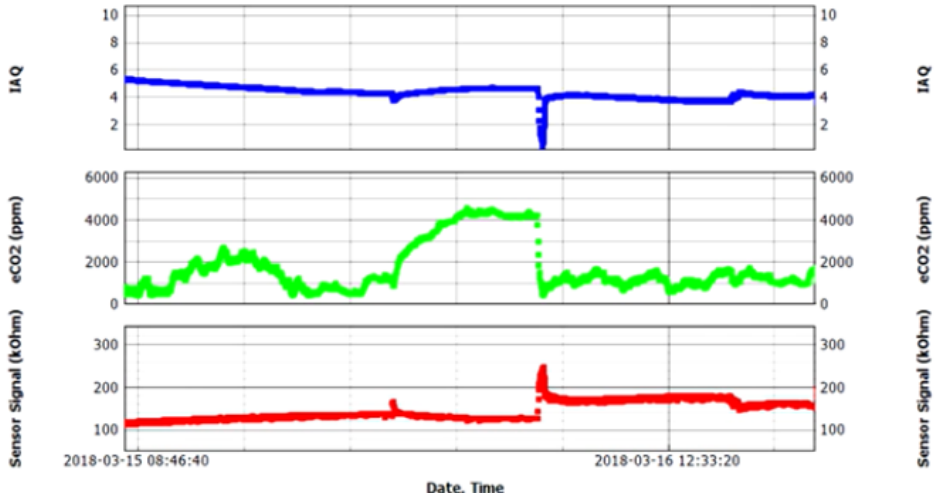
- Very low average power consumption down to 1mW
- Excellent for low-voltage and low-power battery applications

Easy to Use:

- ZMOD4410 Evaluation Kit
- Manuals, application notes, blog, and white papers
- Instructional videos
- Programming libraries, example codes, and
- algorithm support to optimize performance
- Third-party certification for compliance with well-accepted international IAQ standards



ZMOD4410 typical application



Measuring IAQ and Est CO2 level with ZMOS4410

Part #	Operation Condition	Package
ZMOD4410	1.7-3.6V -40° to +65° Est. CO2 400-5000ppm Ethanol in air 0-1000ppm	3.0 × 3.0 × 0.7mm, 12-LGA

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ALTERNATIVE

USING RL78/I1E INSTEAD OF OB1203

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(Bio)Sensing
with Wireless Charging & Bluetooth

- **Overview**
  - For Biosensing (or other use cases like Smart Home) multiple sensor data needs to be acquired and transferred via Bluetooth to a smartphone or the cloud. Sensors may be any combination of heart rate, gyro, accelerometer, humidity, temperature, ambient light etc. Such acquisition devices are usually low power and mobile, like using a small Li-Ion cell, which needs to be recharged wirelessly to get rid of physical connection at all. Here we provide a complete, compact solution.
- **System benefits**
  - Multiple (Bio)Sensors, incl. heartrate sensor Algorithm SW-library w/ noise cancelation
  - Wireless Charging
    - incl. Li-Ion (e.g. 50mAh) battery management, protection, automatic power control, DCDC
    - optimized for low power and very small size by high integration (“all-in-one” RX chip)
  - Bluetooth® (Low Energy) communication module

Block Diagram #EU016
August, 2019

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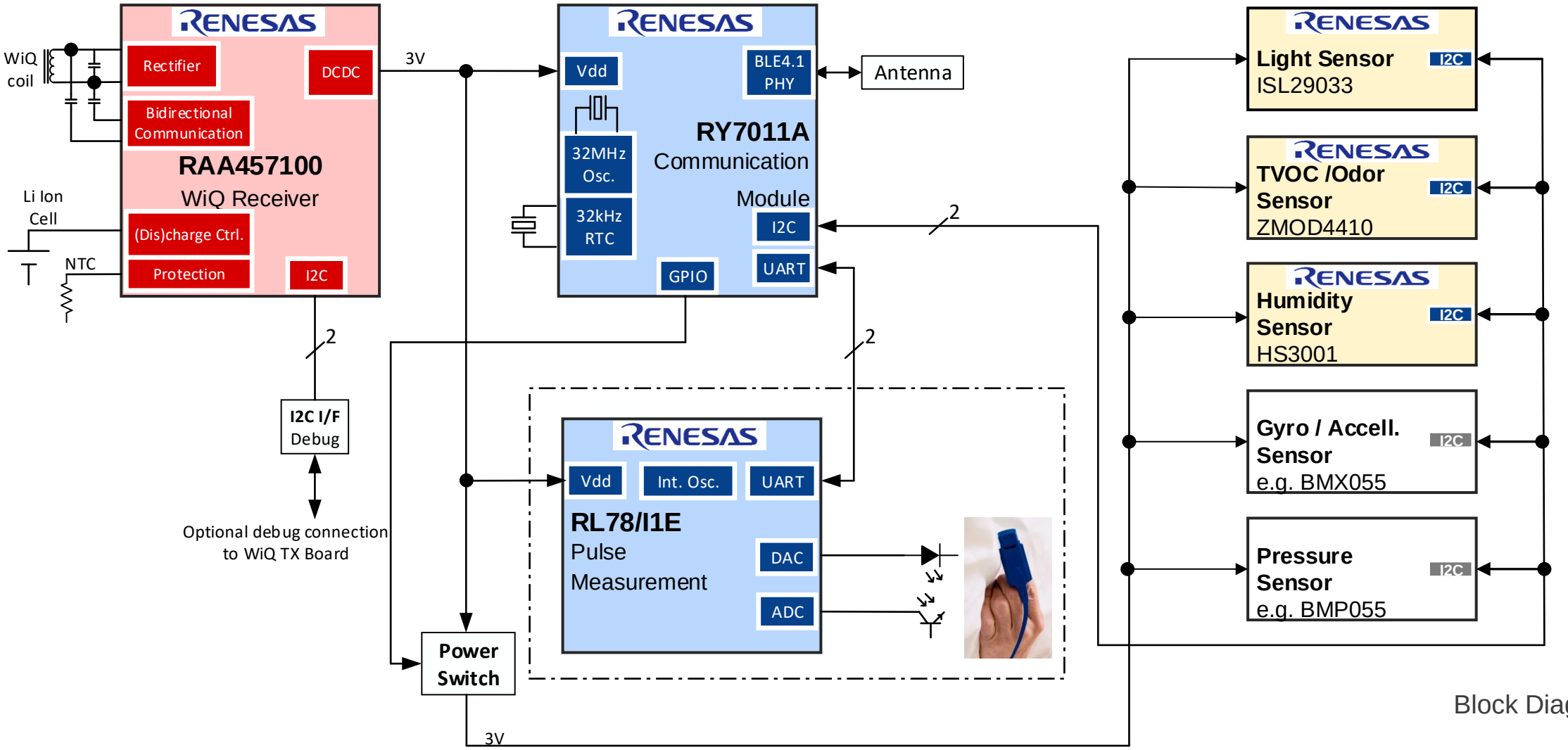
(Bio)Sensing
with Wireless Charging & Bluetooth // alternative Charging Receiver using RL78/I1E



Block Diagram #EU016
Sept. 2019

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(Bio)Sensing
with Wireless Charging & Bluetooth

Device Category	P/N	Key Features
MCU	RY7011A	Compact Bluetooth 4.1 module (based on RL78/G1D)
	RL78/I1E	Low power 16bit MCU, 32MHz with rich Analog Front End
	RL78/G1C	Low power 16bit MCU, 24MHz, USB2.0, I2C and further I/F
	RL78/G14	Low power 16bit MCU, 32MHz, General Purpose
Power	RAA457100	Wireless Charging Transmitter, Automatic Transmission Power Control (reducing heat and losses), multiple overtemperature protection, wireless communication
	RAA458100	Wireless Charging Receiver, up to 70mA charge current, integrated 100mA DCDC, LiIon battery protection (OT/UT, OV/UV, OC), wireless communication
	UPA2690	Dual MOSFET (half-)bridge, n- plus p-channel to drive Charging coil
Analog	HS300x	Humidity sensor with industry-leading accuracy, response time, and excellent stability
	ISL29033	Integrated Digital Ambient Light Sensor: Ultra-Low Lux, Low Power, I2C I/F
	ZMOD4410	Indoor Air Quality (TVOC, eCO_2) / Odor Sensor

Block Diagram #EU016
Sept. 2019

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RL78/I1E – High-precision Analog MCU

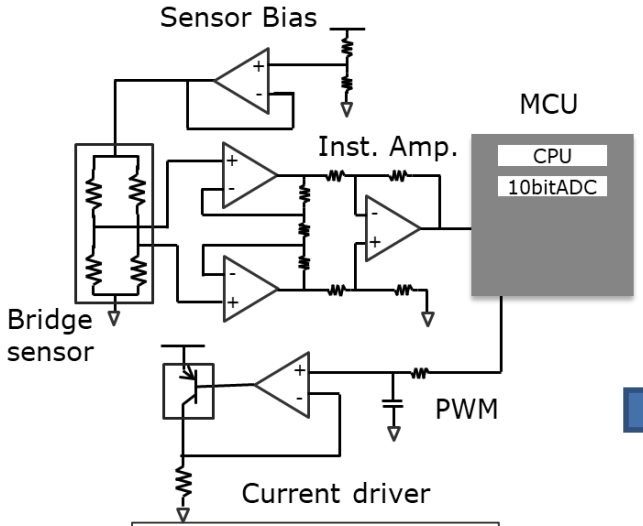
Integrate analog front end and MCU of system configuration commonly used in industry and environmental / infrastructural monitoring.

Small package
- Integration of Analog Front End(AFE) and MCU
- 4mm² small package line up
- Enables small sensor module

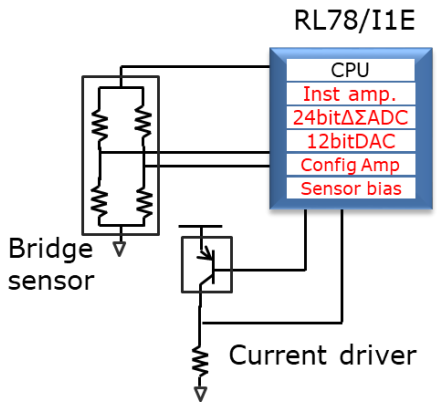
BOM cost reduction
- High integration of peripherals
- Reduce external parts
- Decreased complexity thank to high integration

Platform
- Easy to configure AFE with MCU by software
- Easy to add/change sensors by software
- Reduce time to market in expanding models

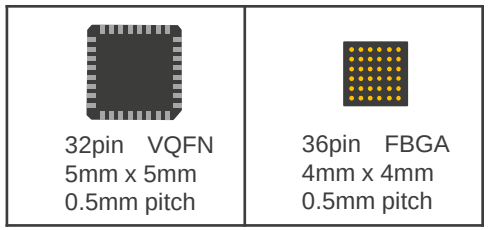
High temperature support
- T_A = -40 to +105℃ (G: Industrial applications)
- T_A = -40 to +125℃ (M: Industrial applications)



Nominal circuit diagram of nominal sensor module



Circuit diagram in using RL78/I1E



Part #	Flash ROM	Data Flash	RAM	PGA+24bitΔΣADC	10bitSAR-ADC	12bit-DAC	Package
R5F11CBC	32KB	4KB	8KB	3ch	8ch	1ch	32-pin VQFN (5 × 5) (0.5mm pitch)
R5F11CCC	32KB	4KB	8KB	4ch	10ch	1ch	36-pin FBGA (4 × 4) (0.5mm pitch)

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