JP106
Weather Station Solution

January 2020

BIG IDEAS FOR EVERY SPACE **RENESAS**

Weather Station Solution

- **Overview**

  This solution supports smart home systems, where a master unit (indoor unit) aggregates weather data (temperature, humidity, CO_2 concentration) that is measured by a slave unit (outdoor unit). This data can then be sent wirelessly to the cloud, and accessed through a smartphone.

  It includes two RX-based systems (RX651 and RX23W), which utilize Bluetooth® Low Energy (BLE) to send various sensor data between each other, and also includes integrated Wi-Fi and Bluetooth® capabilities on the master unit for further wireless communication.

- **System Benefits**
  - Measures indoor comfort and real-time weather data by providing vital data through its sensors, allowing the user to easily monitor their environment
  - Highly efficient RX-based MCU with added security features suitable for cloud communication and dual-bank memory functionality for secure, remote firmware updates
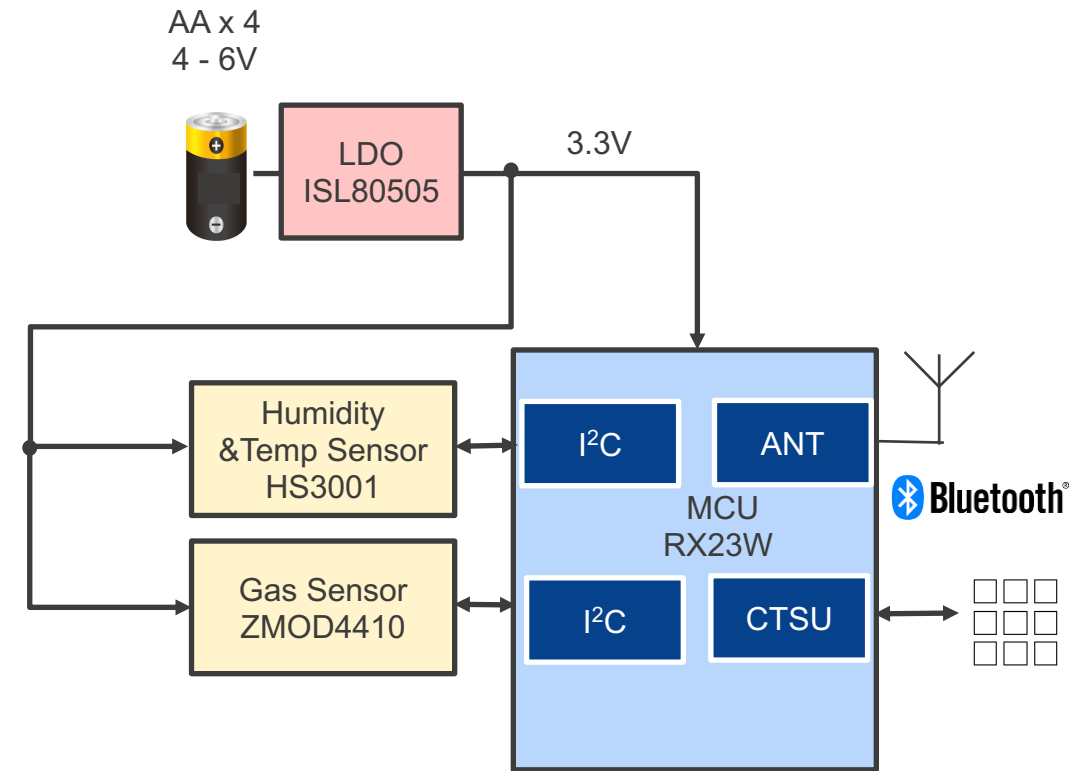
JP106

BIG IDEAS FOR EVERY SPACE

Weather Station Solution

RX651 Indoor Module
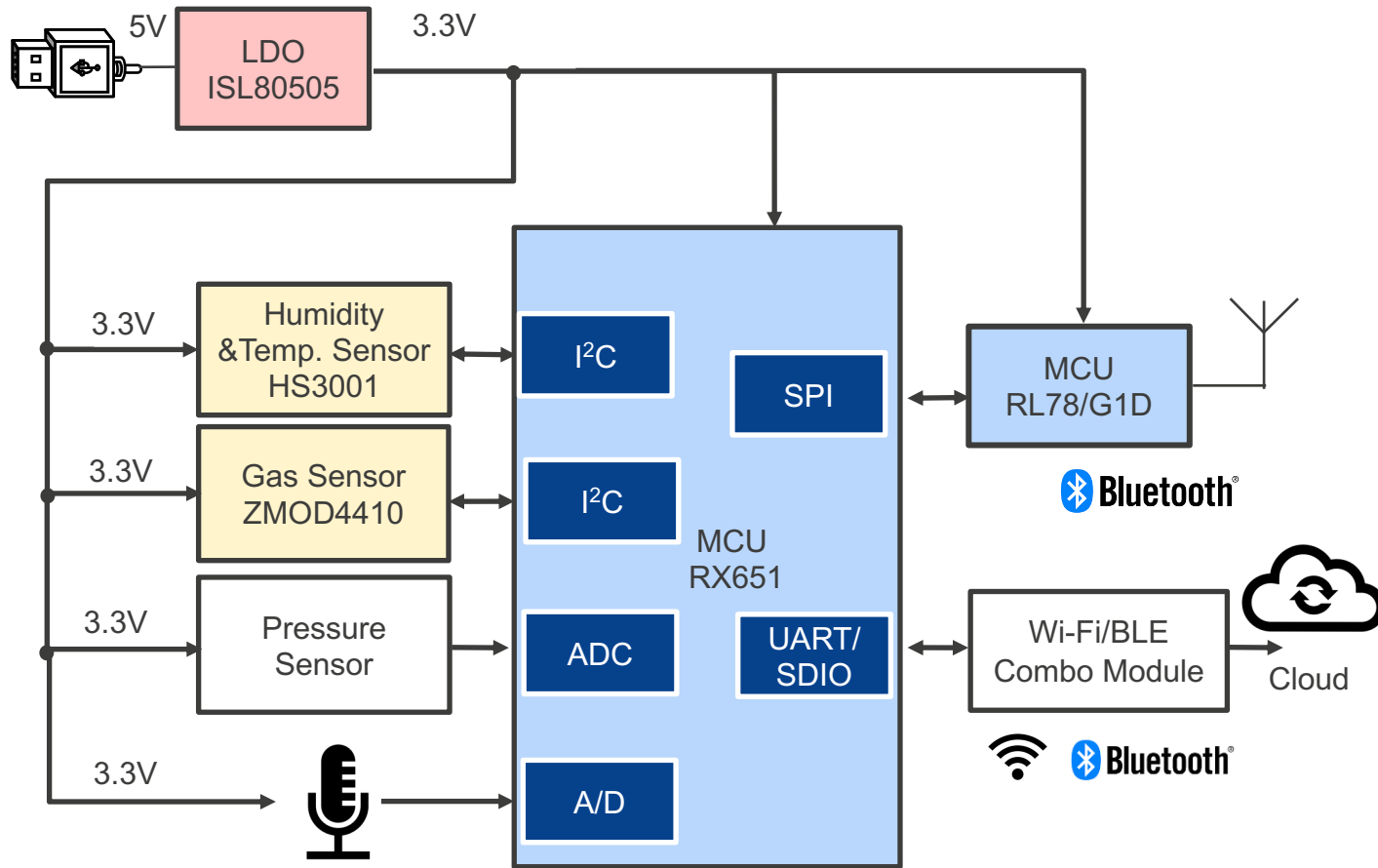
RX23W Outdoor Module (BLE ver.)

JP106

BIG IDEAS FOR EVERY SPACE   RENESAS

Weather Station Solution

Device Category	P/N	Key Features
MCU	RX651	32-bit highly-efficient 240 MHz MCU with large ROM/RAM capacity, enhanced security, connectivity and HMI. Capable of OTA firmware updates and dual bank memory swap.
	RX23W	54 MHz RXv2 core with FPU, low power design, RTC and encryption functions. Supports the latest BLE 5.0 standard and secure updates.
	RL78/G1D	Bluetooth® Low Energy MCU with the lowest level of current consumption in the industry
Analog	ZMOD4410	Highly reliable gas sensor for measuring TVOC gases and provide estimated CO_2 levels (eCO_2), which is compliant with UBA standards
	HS3001	Silicon carbide capacitive sensing element, excellent stability against aging, temperature sensor accuracy of $\pm 0.2°C$
Power	ISL80505	High performance 0.5A LDO

JP106

BIG IDEAS FOR EVERY SPACE **RENESAS**

RX651 – 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 function
- 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)
- Various communication peripheral such as 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
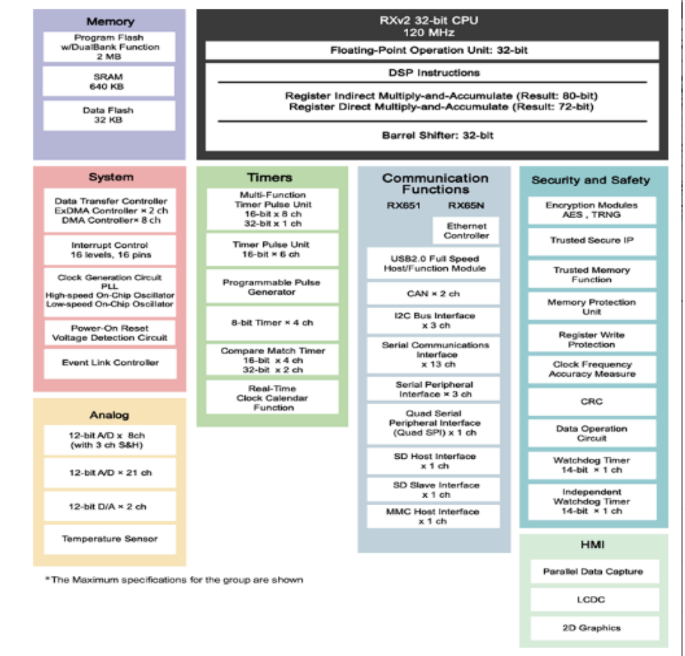
Part #	ROM	RAM	Data Flash	Package
R5F56514xxxx	512K	256k	None	64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA
R5F56517xxxx	768K	256K	None	64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA
R5F56519xxxx	1M	256K	None	64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA
R5F5651Cxxxx	1.5M	640K	32K	64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA,176-LFQFP,176-LPBFA,177-TFLGA
R5F5651Exxxx	2M	640K	32K	64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA,176-LFQFP,176-LPBFA,177-TFLGA

System Block
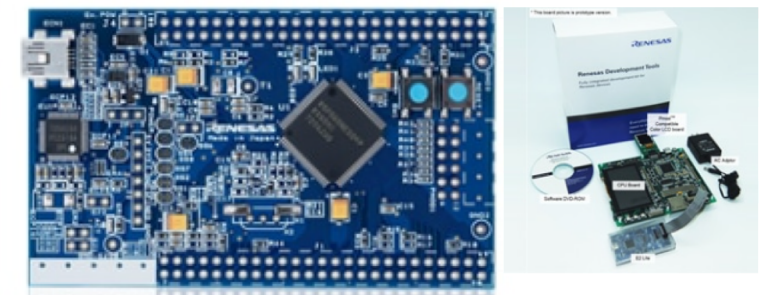
Renesas Starter Kit for RX65N/1

BIG IDEAS FOR EVERY SPACE **RENESAS**

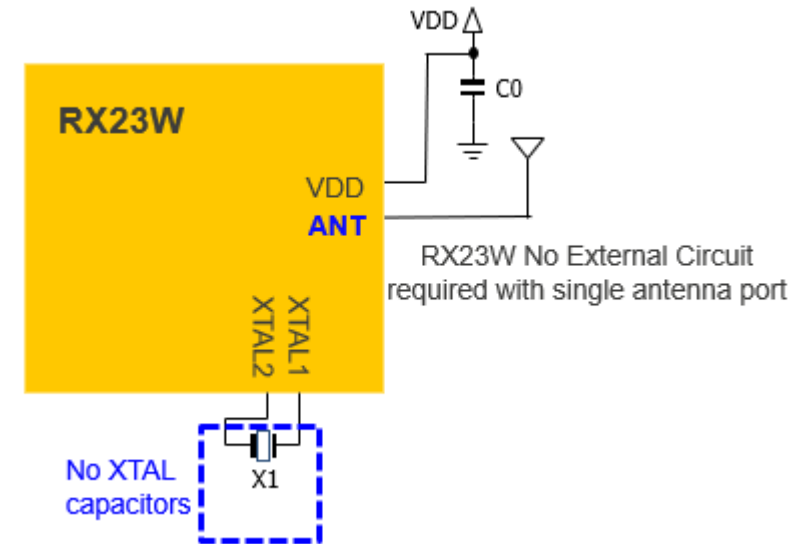# RX23W – 32-bit MCU for Bluetooth® 5.0 Low Energy

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

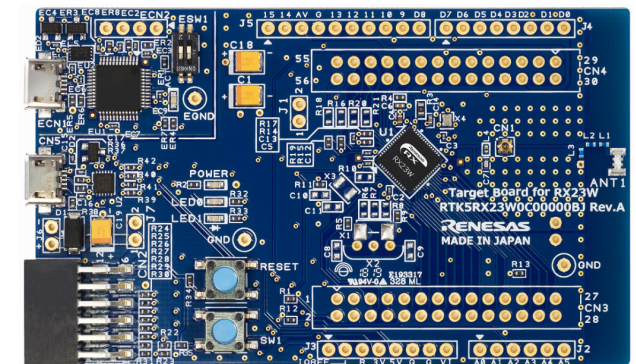**Support for Multiple Communication Functions**
- Bluetooth Low Energy (1-Channel)
- An RF transceiver and link layer compliant with the Bluetooth 5.0 Low Energy specification, also supports Bluetooth 4.2
- LE 1M PHY, LE 2M PHY, LE Coded PHY (125 kbps and 500 kbps), and LE Advertising extension support
- 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

RX23W No External Circuit required with single antenna port

Low Cost System Block

Target Board for RX23W – RTK5RX23W0C00000B

BIG IDEAS FOR EVERY SPACE

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 simplify circuit design for the antenna connection, but also reduces 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	
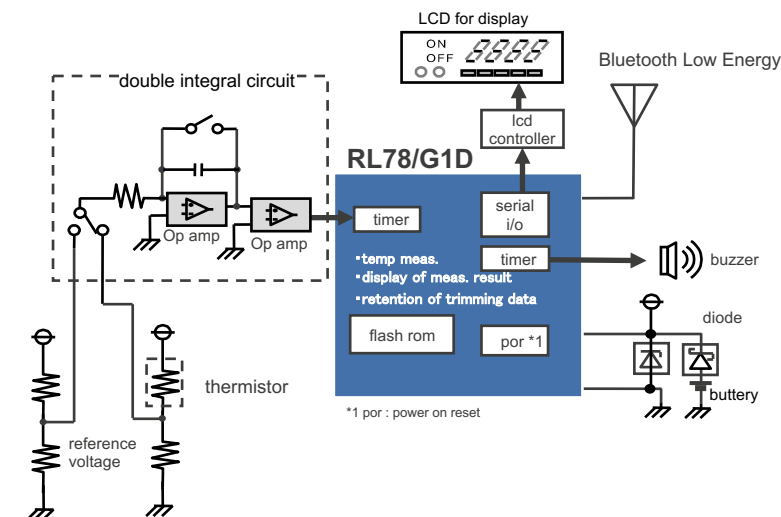
BLE Evaluation Wireless module (installation of RL78/G1D) There is shield case.
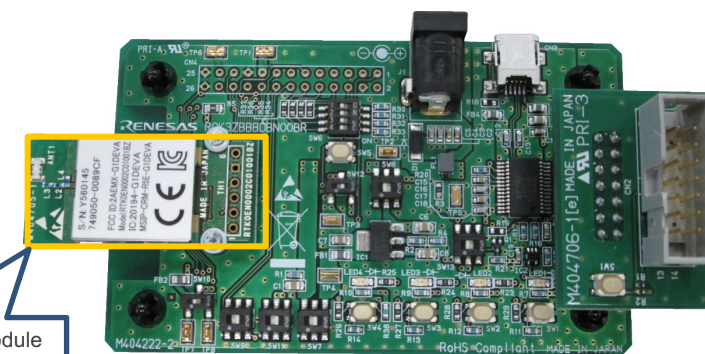
RTK0EN0001D01001BZ
RL78/G1D Evaluation Board

BIG IDEAS FOR EVERY SPACE

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 (eCO$_2$)
- 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

Part #	Operation Condition	Package
ZMOD4410AI1V ZMOD4410AI1R	1.7-3.6V -40° to +65° Est. CO2 400-5000ppm Ethanol in air 0-1000ppm	3.0 × 3.0 × 0.7mm, 12-LGA
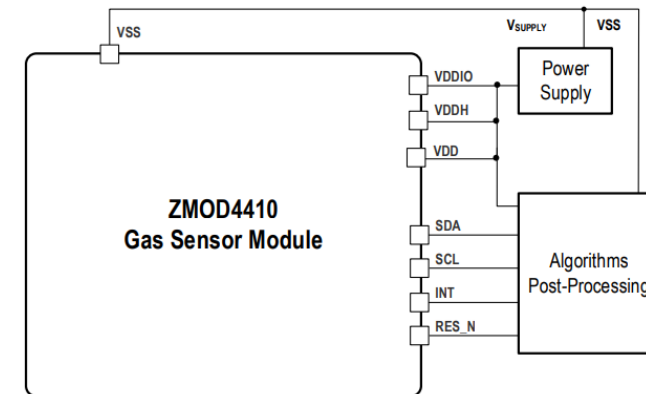
ZMOD4410 typical application
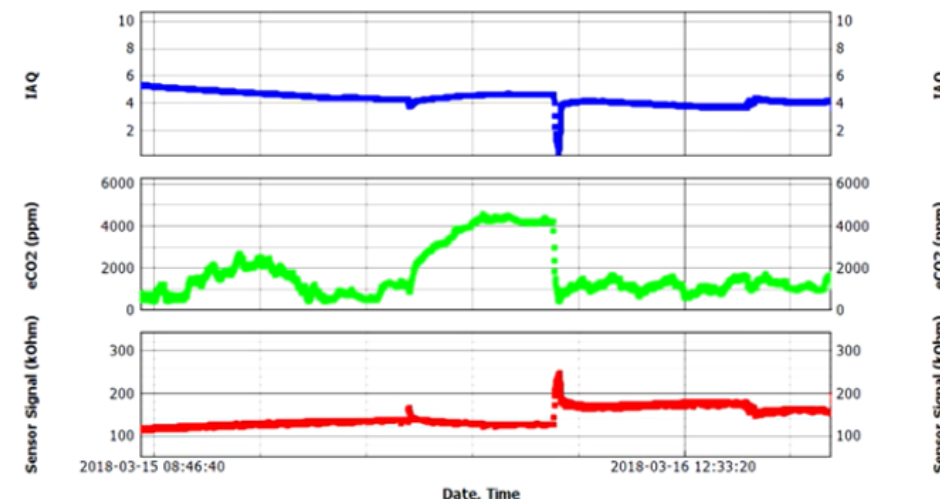
Measuring IAQ and Est CO$_2$ level with ZMOD4410

BIG IDEAS FOR EVERY SPACE

RENESAS

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

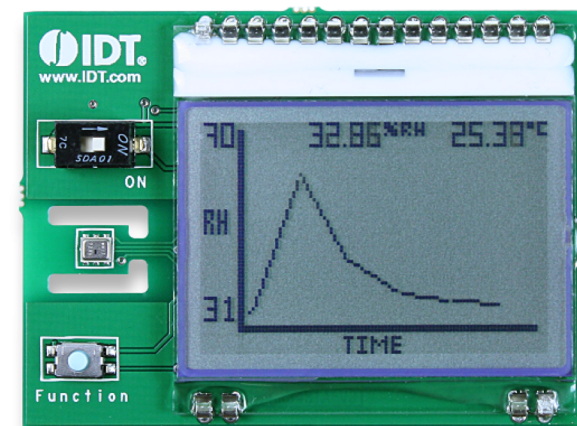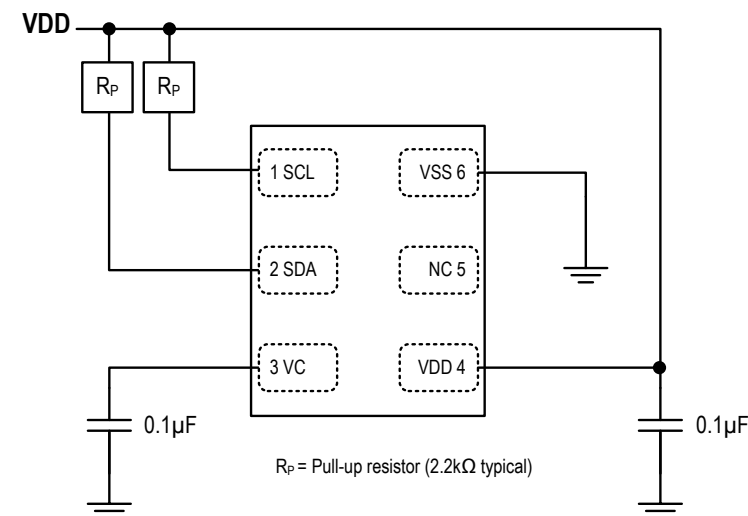- 0.1%RH per year drift
- MEMS silicon-carbide sensor technology

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

R_P = Pull-up resistor (2.2kΩ typical)

Typical Operating Circuit

SDAH02 Evaluation Kit

BIG IDEAS FOR EVERY SPACE

ISL80505/510 – High Performance 0.5A/1A LDO
High PSRR for Instrumentation, Industrial, and Medical Applications

Stable Output Voltage

- ±1.8% V_{OUT} accuracy guaranteed over line, load
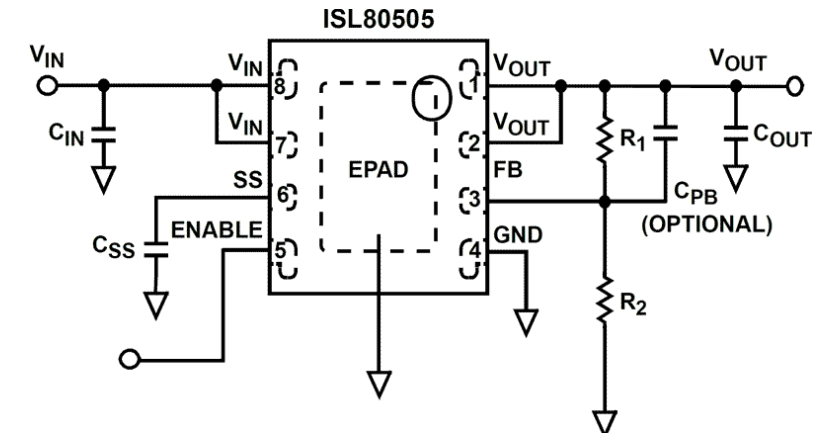- Stable with a 4.7µF output ceramic capacitor

High Efficiency

- Very low 45mV dropout voltage at V_{OUT} = 2.5V
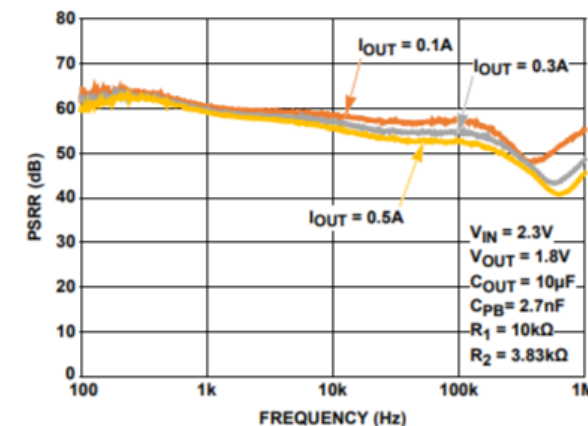- Very fast transient response

High Performance

- Excellent PSRR over wide frequency range
- Programmable output soft-start time
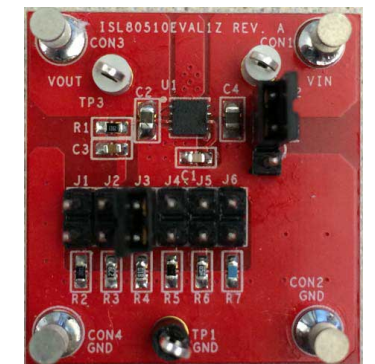
Excellent Safety

- Current limit protection
- Thermal shutdown function

Typical Application Circuit

PSRR (power supply rejection ratio)

ISL80510EVAL1Z 1A LDO Eval Board

Part #	Vin (V)	Iout (A)	Package
ISL80505IRAJZ	1.8V to 6V	0.5	3x3 DFN
ISL80510IRAJZ	2.2V to 6V	1	3x3 DFN

BIG IDEAS FOR EVERY SPACE

RENESAS

Renesas.com

BIG IDEAS FOR EVERY SPACE