

CN192

Smart IoT Air Purifier

October 2019

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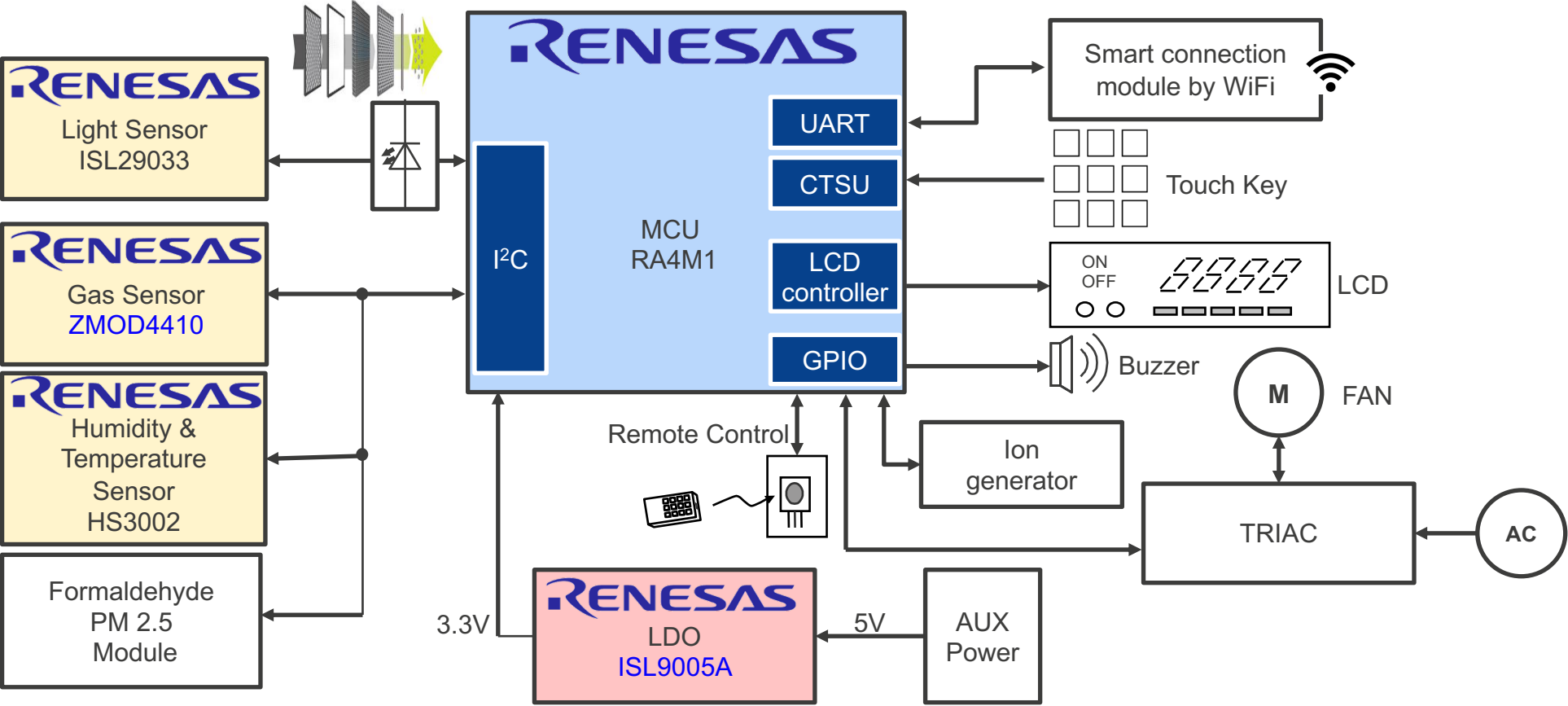
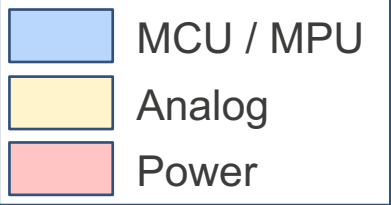
■ Overview

With the rapid growth of the air purifier market, Renesas highlights a reference design that features different user interaction experiences via the capability of the RA4 MCU series. This design is based around a main control MCU (RA4M1), which features built-in touch sensor capabilities, high-performance ADCs, displays, USB and security modules. This platform allows easy expansion and support through the Arm® ecosystem, as well as a secure cloud connection. The design also features ambient sensing solutions, which include a temperature and humidity sensor (HS3003), gas sensor ([ZMOD4410](#)), and automatic filter replacement through the light sensor (ISL29033) with automatic inspection. The system can be remotely monitored and controlled through the secure cloud connection.

■ System Benefits

- The RA4 MCU supports 16-bit ADC, high-performance CTSU and a full Arm® ecosystem
- Full analog sensor portfolio and high-performance power system

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Block Diagram #CN192
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Device Category	P/N	Key Features
MCU	RA4M1	High efficiency 48-MHz Arm® Cortex®-M4 core, 256-KB code flash memory, 32-KB SRAM, Segment LCD Controller, Capacitive Touch Sensing Unit, USB 2.0 Full-Speed Module, 14-bit A/D Converter, 12-bit D/A Converter, security and safety features.
Power	ISL9005A	300mA high performance LDO, very low quiescent current: 50µA . Low output noise.
Analog	ZMOD4410	Gas sensor with high sensitivity and long term stability, software-upgradeable platform, internationally-accepted definition of Indoor Air Quality (IAQ), calculation of estimated Carbon Dioxide (eCO ₂)
	HS3002	Silicon-carbide capacitive sensing element, excellent stability against aging, temperature sensor accuracy of $\pm 0.2^{\circ}$ C
	ISL29033	Light sensor close to human eye response

RA4M1 – High Efficiency 48-MHz Arm® Cortex®-M4 Core

For Applications Needing HMI/Control/ Security/Graphical and Capacitive Touch

High Performance

- 48MHz Arm® Cortex®-M4 CPU

Highly Integrated Capabilities

- 256KB Flash and 32KB SRAM
- 14-Bit ADC (25 ch.)
- 12-Bit DAC (1 ch.)/ 8-Bit DAC (2 ch.)

Communication Interfaces

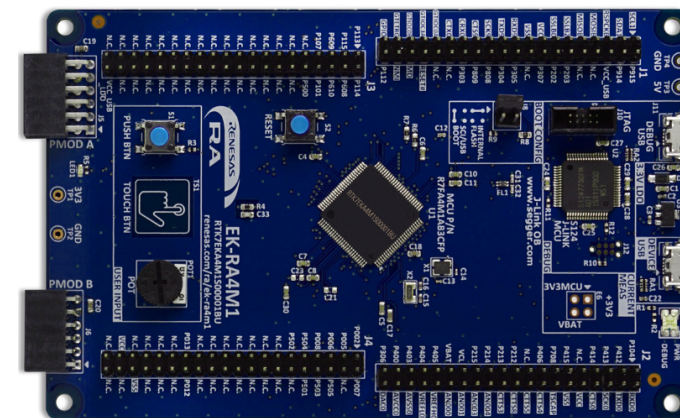
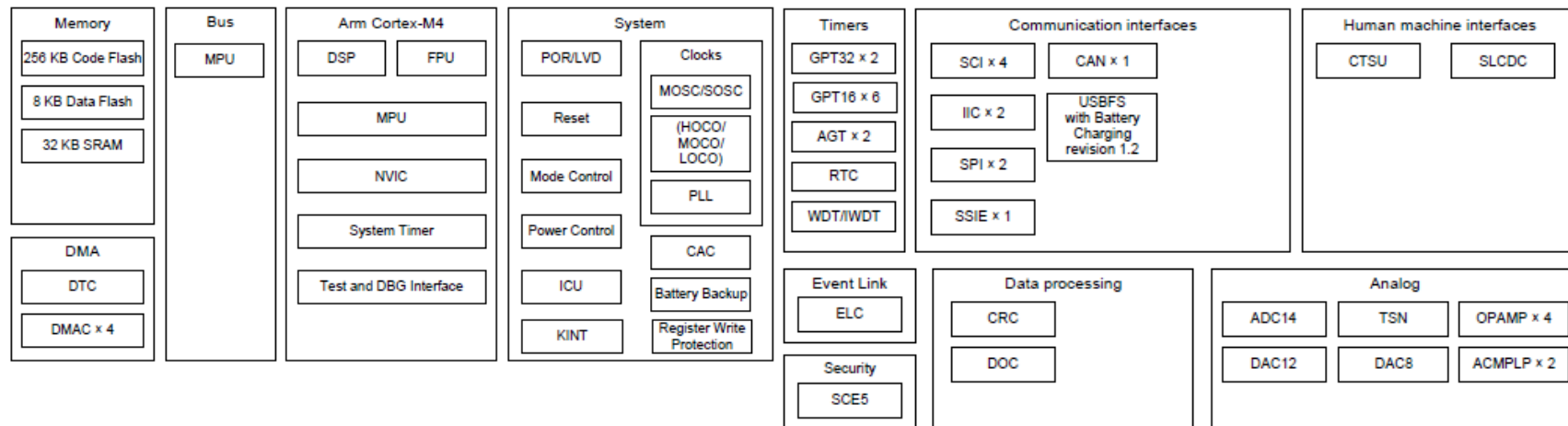
- USB 2.0 (Full Speed)
- CAN
- SCI x4/SPIx2/IICx2

HMI Interface

- Capacitive Touch Sensing Unit (27 ch.)
- Segment LCD Controller - up to 34 segments x 8 commons

Wide Voltage and Low Power Consumption

- Wide operating voltage range of 1.6V to 5.5V
- Various Low Power Modes



RTK7EKA4M1S00001BU

Part #	Flash Memory	RAM	Temp	Package
R7FA4M1AB3CFP	256KB	32KB	40 ~ 105°C	100 LQFP
R7FA4M1AB3CFM	256KB	32KB	40 ~ 105°C	64 LQFP

ISL9005A – LDO with Low ISUPPLY, High PSRR

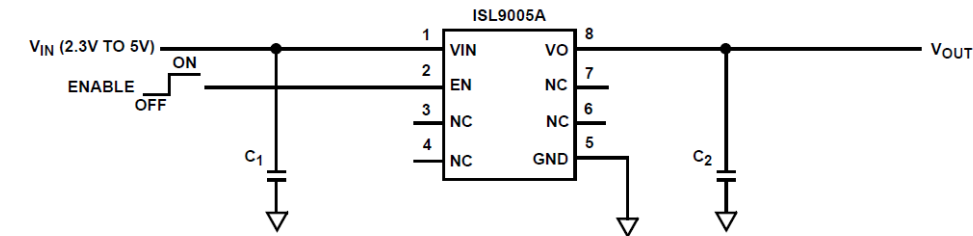
Wide Input Voltage: 2.3V to 6.5V with 300mA Current Output

High Performance

- LDO with 300mA continuous output
- Excellent transient response to large current steps
- Excellent load regulation: <0.1% voltage change across full range of load current
- High PSRR: 75dB @ 1kHz
- Wide input voltage capability: 2.3V to 6.5V

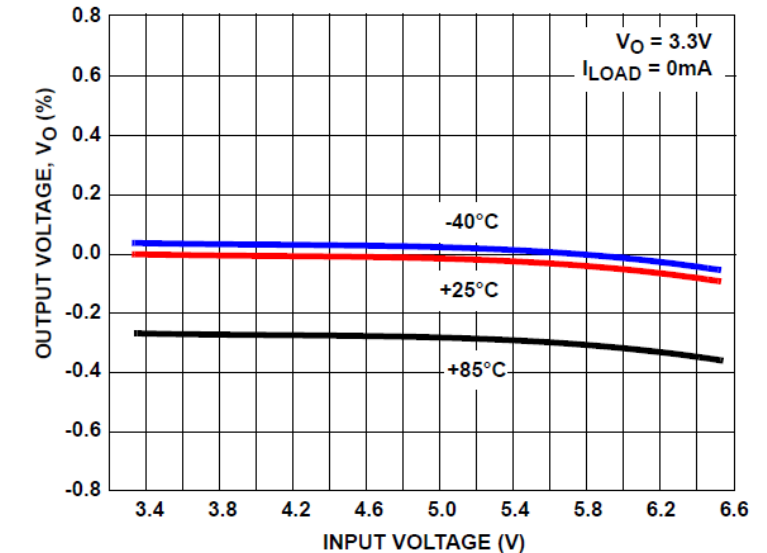
High Efficiency in a Small Package

- Very low quiescent current: 50μA
- Low dropout voltage: typically 200mV at 300mA
- Low output noise: typically 45μVRMS at 100μA (1.5V)
- Tiny 2mmx3mm 8 Ld DFN package



C₁, C₂: 1μF X5R CERAMIC CAPACITOR

Typical Application Circuit



Output voltage vs Input voltage (3.3V Output)

Part #	Output Voltage (V)	Package
SL9005AIRNZ-T	3.3	8 Ld 2mmx3mm DFN
SL9005AIRKZ-T	2.85	8 Ld 2mmx3mm DFN
SL9005AIRJZ-T	2.8	8 Ld 2mmx3mm DFN
SL9005AIRFZ-T	2.5	8 Ld 2mmx3mm DFN
SL9005AIRCZ-T	1.8	8 Ld 2mmx3mm DFN
SL9005AIRBZ-T	1.5	8 Ld 2mmx3mm DFN

ZMOD4410 – Indoor Air Quality Sensor Platform

TVOC Sensor for Indoor Air Quality Applications

Flexible Measure Target

- Measurement of total volatile 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

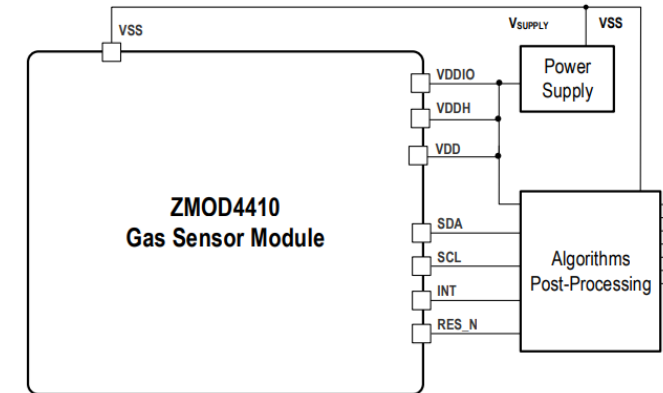
Low Power

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

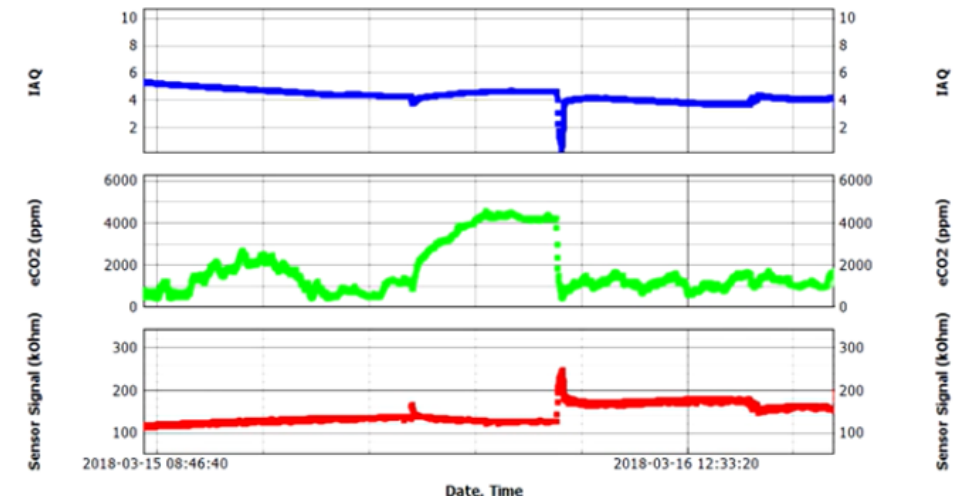
Easy to Use:

- [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

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



ZMOD4410 Typical Application



Measuring IAQ and Est CO2 level with ZMOD4410

HS300x – Relative Humidity and Temperature Sensor

High Accuracy Humidity and Temperature Measurement for Environmental Monitoring

High Accuracy

- $\pm 1.5\%$ RH accuracy (HS3001)
- $\pm 0.2^{\circ}\text{C}$ temperature accuracy (HS3001, HS3002)

Excellent Stability

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

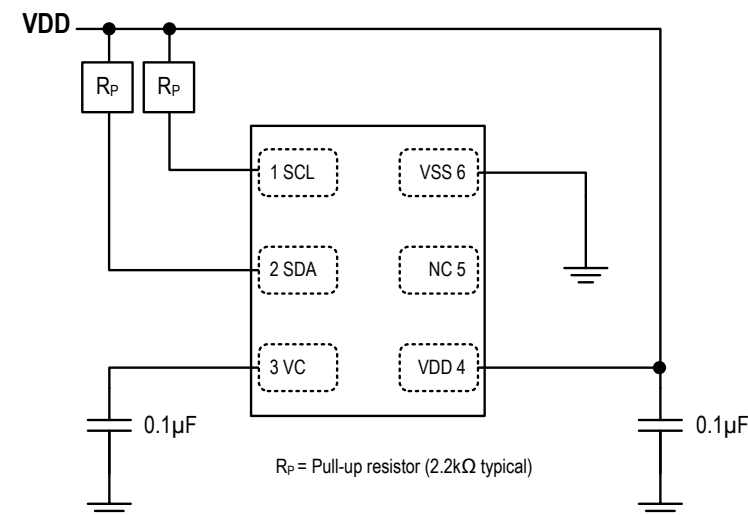
Fast Response

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

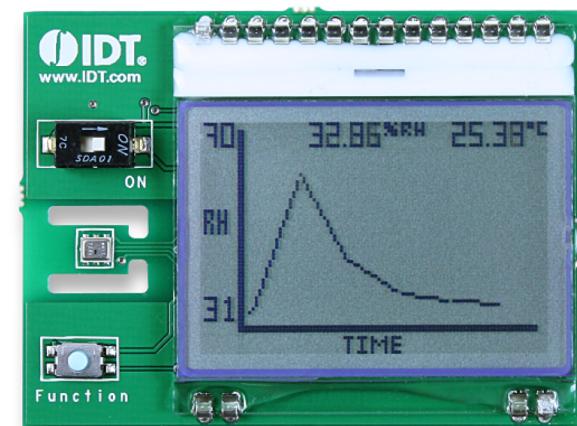
Extended Supply Voltage

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

Part #	Feature	Package
HS3001	$\pm 1.5\%$ RH	3 \times 2.41 \times 0.8 LGA
HS3002	$\pm 1.8\%$ RH	3 \times 2.41 \times 0.8 LGA
HS3003	$\pm 2.8\%$ RH	3 \times 2.41 \times 0.8 LGA
HS3004	$\pm 3.8\%$ RH	3 \times 2.41 \times 0.8 LGA



Typical Operating Circuit



SDAH02 Evaluation Kit

ISL29033 – Integrated Digital Ambient Light Sensor

Ultra-Low Lux, Low Power, Integrated Ambient and Infrared Light-to-Digital Converter

Integrated Functions and Small Package

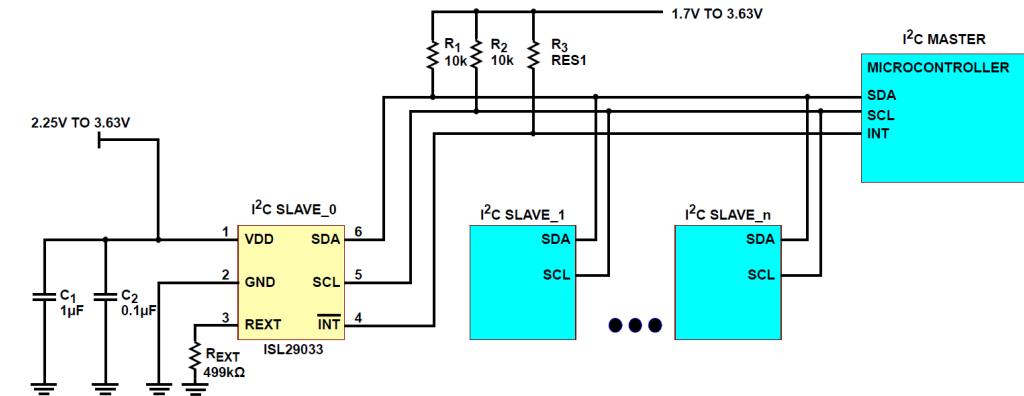
- 6 pin 2.0mmx2.1mm ODFN
- On-chip 16-bit ADC
- I²C(SMBus compatible) Interface

High Performance

- Adjustable sensitivity up to 520 counts per lux
- Measurement range: 0.0019 to 8,000lux with four selectable ranges
- Close to human eye response with excellent IR/UV rejection
- Operation across -40 to +85°C

Low Power Design

- Normal operation 57uA
- 0.3uA maximum shutdown current



Typical Operating Circuits



ISL290xxIROZ-EVALZ evaluation board

Part #	ALS Sensing	Interrupt Pin	Package
ISL29033IROZ-T7	Yes	Yes	6 Ld 2x2.1 ODFN

[Renesas.com](https://www.renesas.com)