KR007
Air Duct System

May 2020

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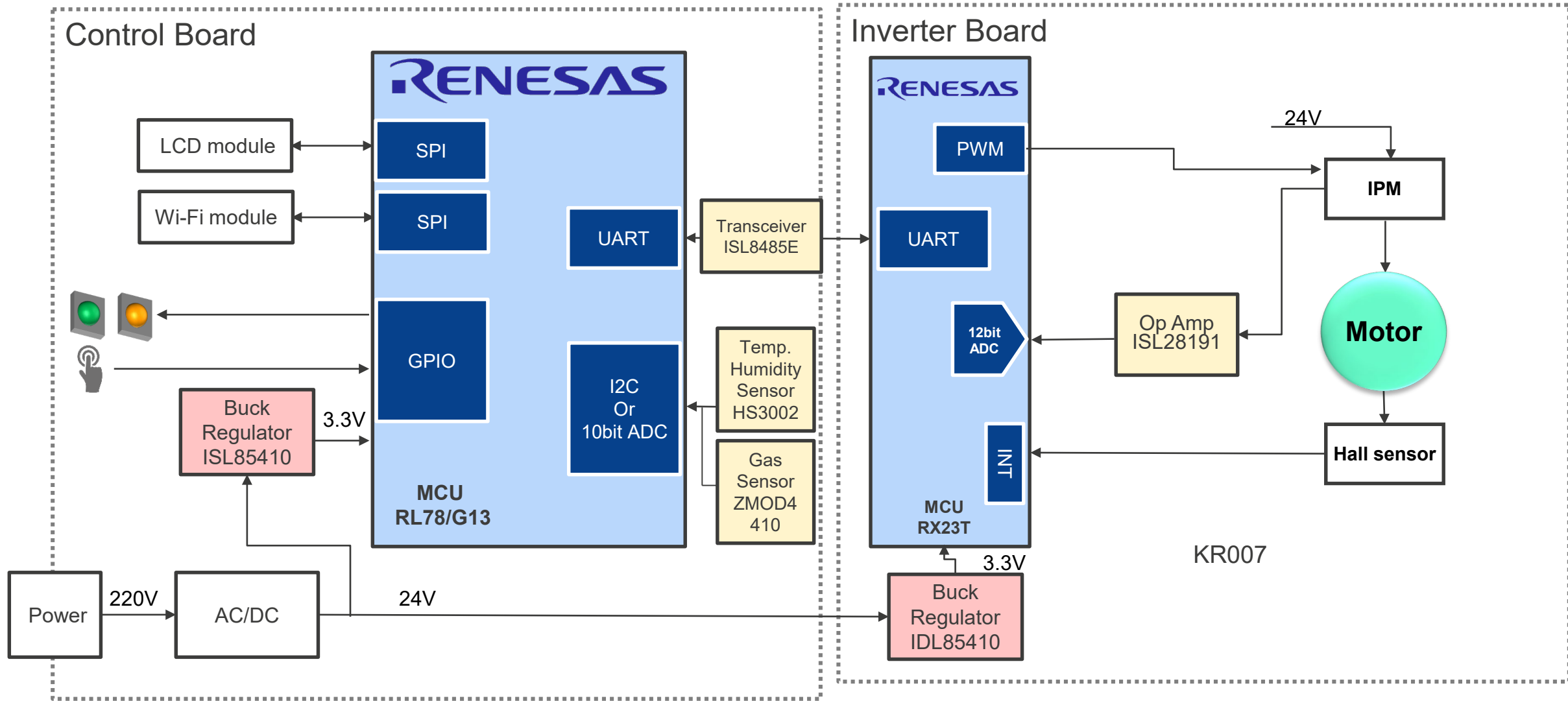
RENESAS

Air Duct System

- **Overview**
  This design demonstrates an air duct system that purifies the air inside homes by sensing the temperature, humidity and air quality. The RL78 microcontroller (MCU) series has a variety of functions and a wide lineup, as well as a standby function to reduce current consumption to minimize standby power. The RX23T MCU also enables efficient motor control.

- **System benefits**
  - Minimize standby power with the RL78 MCU series
  - Efficient motor control with the RX23T MCU
  - Temperature/Humidity and gas sensors protect air quality and supports filter exchange detection

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Air Duct System

Control Board

- LCD module ↔ SPI
- Wi-Fi module ↔ SPI
- GPIO
- UART
- I2C Or 10bit ADC
- Buck Regulator ISL85410 → 3.3V
- MCU RL78/G13
- Transceiver ISL8485E
- Temp. Humidity Sensor HS3002
- Gas Sensor ZMOD4 410
- Power → 220V → AC/DC → 24V

Inverter Board

- PWM
- UART
- 12bit ADC
- INT
- MCU RX23T
- Buck Regulator IDL85410 → 3.3V
- 24V
- IPM
- Op Amp ISL28191
- Motor
- Hall sensor
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Air Duct System

Device Category	P/N	Key Features
MCU	RX23T	32-bit MCU for motor control incorporating a multifunctional timer, high-speed 12-bit A/D converter, and 10-bit A/D converter
	RL78/G13	16-bit MCU for general-purpose applications with low power, high function, and abundant lineup
Power	ISL85410	Wide VIN 1A Synchronous Buck Regulator
Analog	ZMOD4410	Indoor Air Quality Sensor Platform
	HS3002	High-Performance Relative Humidity and Temperature Sensor
	ISL8485E	ESD Protected to ±15kV, 5V, Low Power, High SpeedRate Limited, RS-485/RS-422 Transceivers
	ISL28191	Single Supply Ultra-Low Noise, Low Distortion Rail-to-Rail Output, Op Amp

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RX23T – 32-bit FPU MCU for Controlling a Single Inverter
40 MHz RX v2 Core with FPU, 5V Power Supply and Highly Accurate 12-Bit ADC
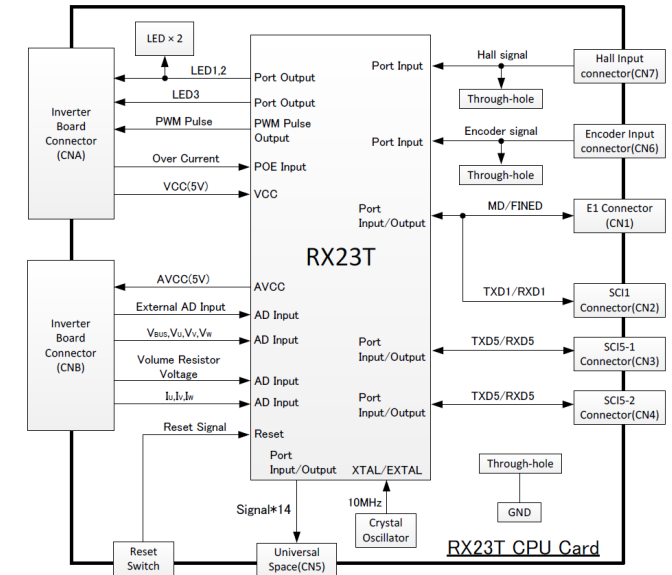
High Performance and Low Power Design
- Max. operating frequency: 40MHz
- Enhanced DSP: 32-bit multiply-accumulate and 16-bit multiply-subtract instructions
- Built-in FPU: 32-bit single-precision floating point(compliant to IEEE754)
- Divider, fast interrupt, CISC Harvard architecture with 5-stage pipeline
- Variable-length instructions, ultra-compact code
- 3 low power consumption modes, software standby mode(with RAM retention) < 0.45 µA

Suitable for Inverter Control
- Enhanced DSP and FPU modules
- 40MHz PWM (three-phase complementary output x 2ch)

Rich Peripheral Functions
- Up to 4 communications channels
- Up to 12 extended-function timers
- 12-bit ADC: 10ch
- Useful functions for IEC60730 compliance

Part #	ROM (Kbytes)	RAM (Kbytes)	Temp.(°C)	Package
R5F523T5ADFM	128	12	-40 to 85	LFQFP64/0.50
R5F523T3ADFD	64	12	-40 to 85	LQFP52/0.65
R5F523T5AGFM	128	12	-40 to 105	LFQFP64/0.50
R5F523T3AGFL	64	12	-40 to 105	LFQFP48/0.50

System Block

Evaluation Kits

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RL78/G13 – Standard Functions MCU

Low Power and Abundant Lineup for General Purpose Applications

High Performance Peripheral Functions

- 43.2 DMIPS(32 MHz)
- On-chip oscillator, data flash, 10-bit A/D converter
- Built-in safety features enable support for the household appliance safety standard

(IEC/UL 60730)

Low Power

- CPU: 66 µA/MHz, standby (STOP): 230 nA
- 0.57 µA (RTC_LVD,HALT mode)

Abundant Lineup

- 16-512KB ROM / 2-32KB RAM
- 20-128 pin package

| Part #	Flash ROM	RAM	Package(mm)
R5F1006/7/8x R5F1016/7/8x	16 ~ 64 KB	2 ~ 4 KB	20-LSSOP,24-HWQFN(4 x 4),25-WFLGA(3 x 3)
R5F100A/B/Cx R5F101A/B/Cx	16 ~ 128 KB	2 ~ 12 KB	20-LSSOP,32-HWQFN(5 x 5), 36-WFLGA(4 x 4)
R5F100Ex R5F101Ex	16 ~ 192 KB	2 ~ 16 KB	40-HWQFN(6 × 6)
R5F100F/Gx R5F101F/Gx	16 ~ 512 KB	2 ~ 32 KB	44-LQFP(10 × 10), 48-LFQFP(7 × 7), 48-HWQFN(7 x 7)
R5F100J/Lx R5F101J/Lx	32 ~ 512 KB	2 ~ 32 KB	52-LQFP(10 × 10), 64-LQFP(12 × 12), 64-LFQFP(10 × 10), 64-VFBGA(4 × 4),
R5F100M/Px R5F101M/Px	96 ~ 512 KB	8 ~ 32 KB	80-LQFP(14 × 14), 80-LFQFP(12 × 12), 100-LQFP(14 × 20), 100-LFQFP(14 × 14),
R5F100Sx R5F101Sx	192 ~ 512 KB	16 ~ 32 KB	128-LFQFP(14 × 20)
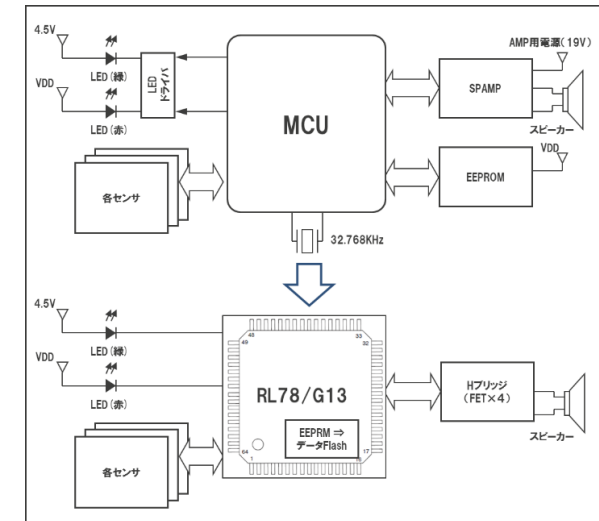
BOM Cost Reduction Use Case

Renesas Starter Kit for RL78/G13
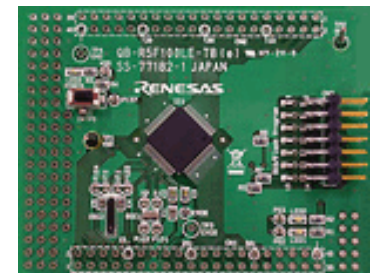
QB-R5F100LE-TB Easy Evaluation Kit

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ISL85410 – 1A Synchronous Buck with Integrated FETs
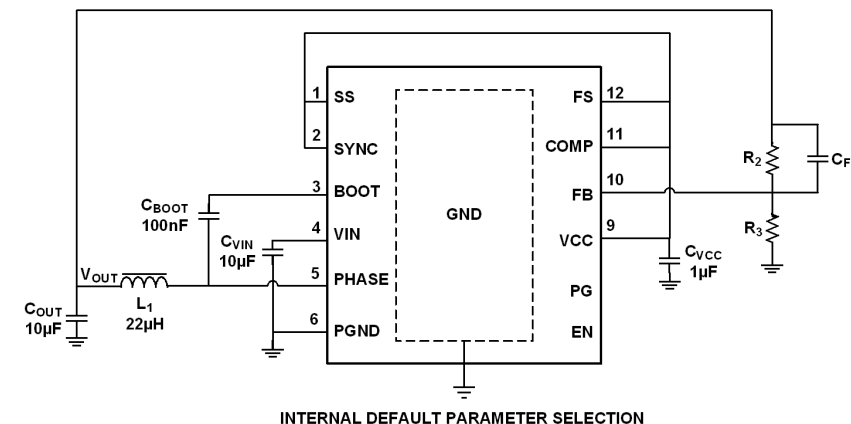## Support 3V-40V Input Voltage Range for Buck Output

Wide Working Range and Space-Limited Applications

- Power input voltage range from 3V to 40V
- Up to 1A load over full temperature range
- 4mm x 3mm DFN package
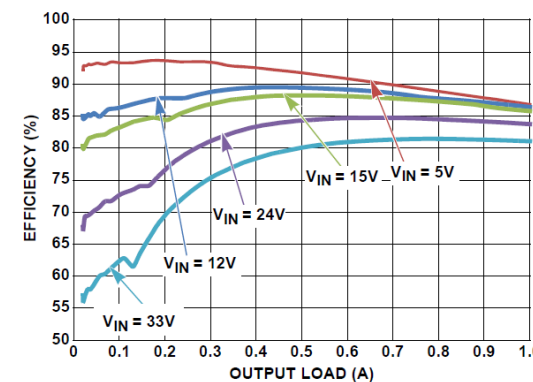- Minimal external components required

High Efficiency and Performance

- 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 300kHz to 2MHz

Typical Application Circuit

Efficiency vs Load, PFM, V_{OUT} = 3.3V

ISL8541xDEMO1Z Evaluation Board

Part #	V_{IN} Range(V)	Temp.(℃)	Package
ISL85410FRZ	3 to 40	-40 to 125	12 Ld DFN 4x3

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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 (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
- 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
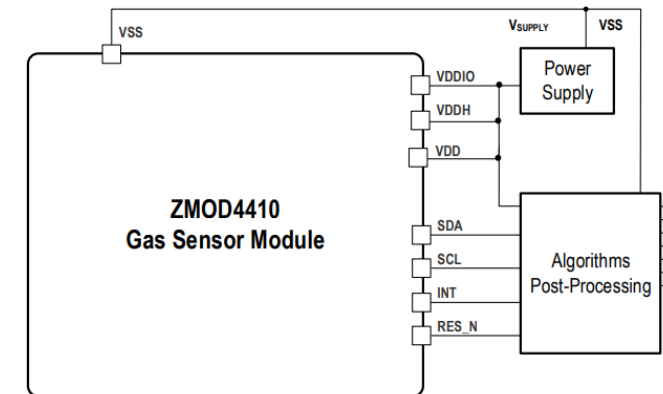
ZMOD4410 typical application
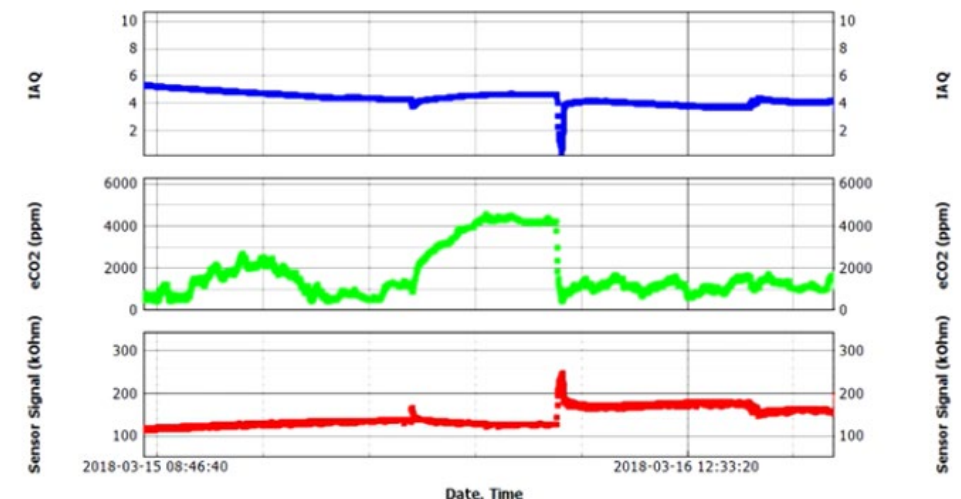
Measuring IAQ and Est CO$_2$ level with ZMOD4410

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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

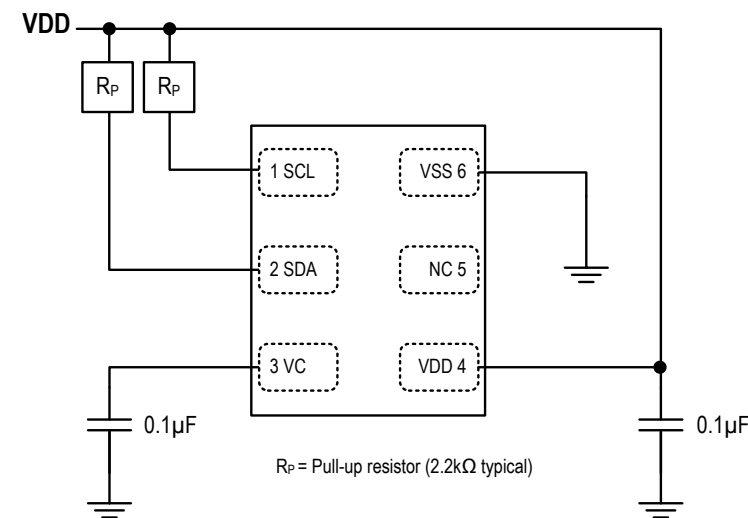- 0.1%RH per year drift
- MEMS silicon-carbide sensor technology

Fast Response

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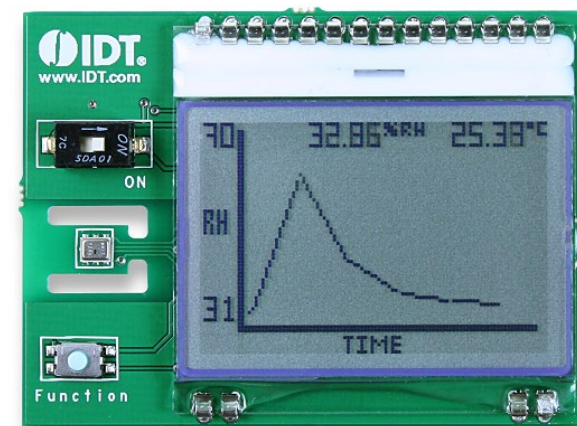- Less than 2 seconds temperature response

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

R_P = Pull-up resistor (2.2kΩ typical)

Typical Operating Circuit

SDAH02 Evaluation Kit

ISL8485E – Dual Protocol (RS-232/485) Transceivers
ESD Protected to ±15kV, 5V, Low Power, High Speed

High Speed
- Fast data rate up to 10Mbps

High Performance and Reliability
- 5V powered, RS-485/RS-422 interface port
- ±15kV (HBM) ESD protected bus (RS-485 I/O pins) Other pins Class 3 ESD >7kV HBM
- 30ns propagation delays, 5ns skew
- Current limiting and thermal shutdown for driver overload
- protection

Low Power and Small Package
- Low quiescent current: 500uA
- 8Ld SOIC for small footprint

Part #	Temp. Rang	Package
ISL8485EIBZ-T	-40 to +85	8 Ld SOIC
ISL8485EIBZ	-40 to +85	8 Ld SOIC
ISL8485ECBZ-T	0 to +70	8 Ld SOIC
ISL8485ECBZ	0 to +70	8 Ld SOIC

Typical Operating Circuits

Skew vs Temperature

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ISL28x91 – Single/Dual Ultra-Low Noise RRIO Op Amps
Applications for Low Noise Signal Processing, Low Noise Microphones, ADC Buffers ,etc.

Ultra-Low Noise and Ultra-Low Distortion

- 1.7nV/√Hz input voltage noise at 1kHz
- 1kHz THD+N typical 0.00018% at $2V_{P-P}$ V_{OUT}
- Harmonic Distortion -76dBc, -70dBc, fo = 1MHz
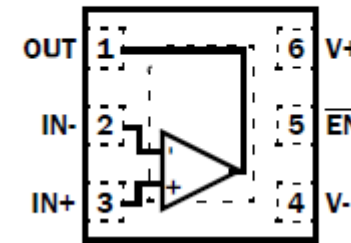
Good Dynamic Performance

- Rail-to-rail input and output
- Gain-bandwidth: 5MHz
- 61MHz -3dB bandwidth
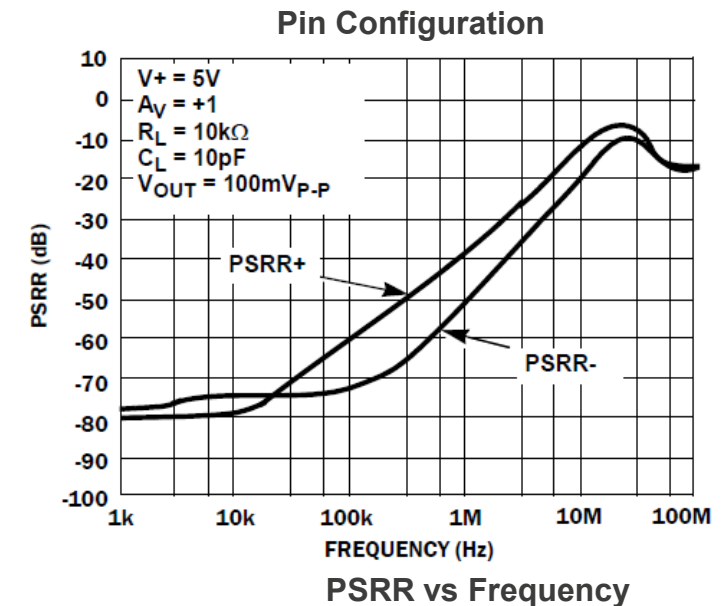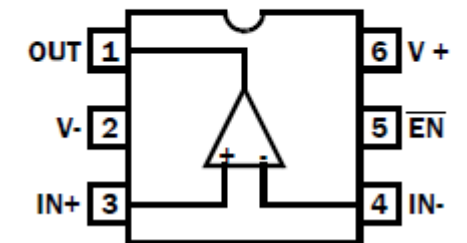
High Performance and Space-Saving Package

- 630µV maximum offset voltage
- 3µA input bias current
- 100dB typical CMRR
- Ground Sensing and enable pin
- 6 Ld UTDFN(1.6mmx1.6mm) and 6 Ld SOT-23 packages are available in ISL28191

Part #	Channel	Supply Voltage(V)	Package
ISL28191FHZ-T7	Single	3 to 5.5	6 Ld SOT-23
ISL28191FRUZ-T7	Single	3 to 5.5	6 Ld UTDFN
ISL28291FUZ	Dual	3 to 5.5	10 Ld MSOP
ISL28291FBZ	Dual	3 to 5.5	8 Ld SOIC
ISL28291FRUZ-T7	Dual	3 to 5.5	10 Ld UTQFN

ISL28191
(6 LD 1.6X1.6X0.5 UTDFN)
TOP VIEW

ISL28191
(6 LD SOT-23)
TOP VIEW

Pin Configuration

PSRR vs Frequency

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