JP132
Ticket Vending Machine

June 2020

BIG IDEAS FOR EVERY SPACE

RENESAS

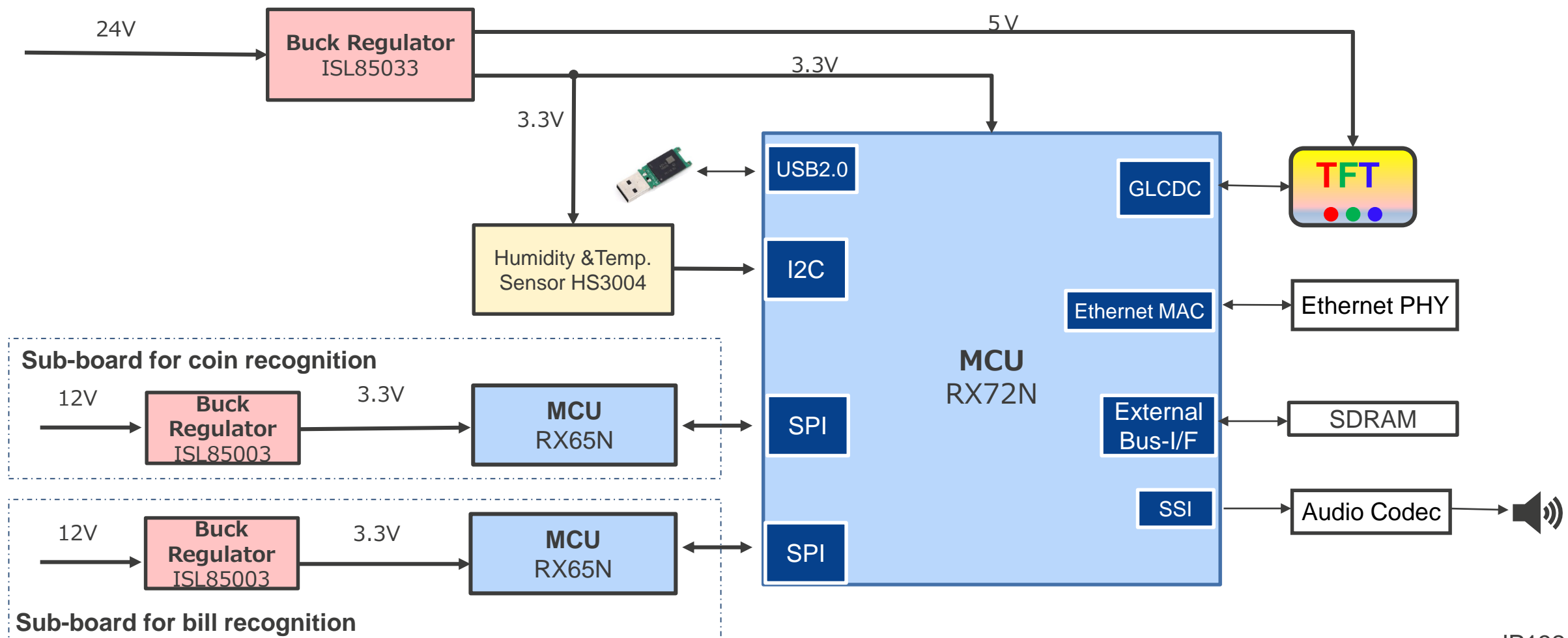# Ticket Vending Machine

- **Overview**
  This reference design is used for a ticket machine used in train stations and utilizes a thin-film transistor (TFT) display for customers to purchase tickets. The reference design also features voice guidance via a speaker and is able to detect abnormalities inside the device with a temperature sensor. When updating the firmware of this application, you can rewrite it using a USB. Two RX65N 32-bit microcontrollers (MCUs) are used to recognize bills and coins.

- **System Benefits**
  - The RX72N 32-bit MCU is a high-performance product that operates at 240MHz with a line up max of 224 pins, so you can use many functions without duplicating pins
  - Not only can you perform TFT display processing that requires high performance, you can also achieve high-quality audio through the synchronous serial interface (SSI) with one chip
  - The HS3004 sensor measures the temperature inside the equipment and helps detect abnormalities

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Device Category	P/N	Key Features
MCU	RX72N	RX Flagship MCU with the Highest Performance RXv3 Core and the High-performance Operate at 240MHz
	RX65N	120MHz RXv2 Core MCU Large ROM/RAM, Enhanced Security, Connectivity and HMI
Power	ISL85033	Dual Standard Buck Regulator Wide VIN Dual Standard Buck Regulator With 3A/3A Continuous Output Current
	ISL85003	Efficient 3A Synchronous Buck Regulator Network and communication equipment, Industrial control, Point-of-load regulators
Analog	HS3004	Relative Humidity and Temperature Sensor High Accuracy Humidity and Temperature Measurement for Environmental Monitoring

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RX72N – RX Flagship MCU with the Highest Performance
RXv3 Core and the High-performance Operate at 240MHz

High Performance and Built-in Functions
- 240MHz RXv3 core, double-precision FPU, and register bank save function
- Up to 4MB ROM with dual-bank structure / 1MB SRAM
- Up to 29 extended-function timers (MTU3a x 9 ch), 182 general I/O ports
- SCI x 13/RIICa x 3
- DMACAa x 8 ch/DTCb x 1ch/EXDMAC x 2ch/ DMAC for the Ethernet x 3
- 12-bit ADC: 29ch in 2 units, 12-bit DAC: 2ch
- Encryption engines (AES, 3DES, RSA, ECC, SHA, TRNG), key management, flash memory protection
- Useful functions for IEC60730 compliance
- Trigonometric calculators (sin, cos, arctan, hypot) to speed up motor vector control
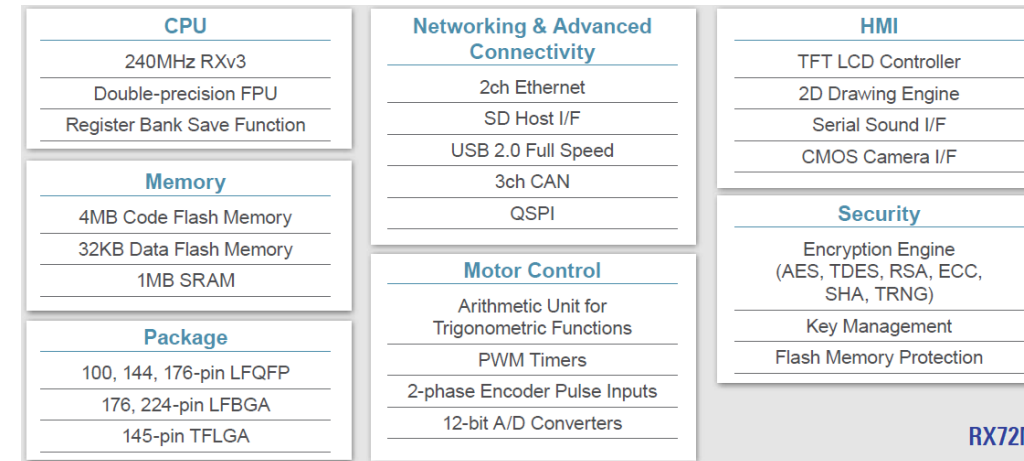
High-end HMI Function
- Graphic-LCD controller (GLCDC)
- 2D drawing engine
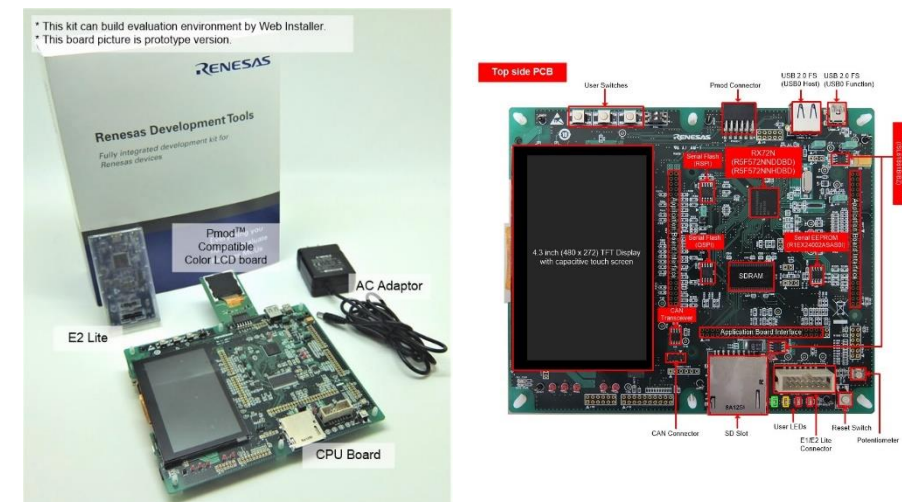- Serial sound interface and CMOS camera interface

Networking and Advanced Connectivity
- Ethernet MAC compliant with IEEE 1588 (2ch)
- SD host interface, quad SPI, RSPIc, MMCIF, USB 2.0 full speed and CAN x 3

Part #	ROM	RAM	Temp.(°C)	Package
R5F572NxxxFP	2/4MB	1MB	-40 to 85/105	LFQFP/100/0.5
R5F572NxxxFB	2/4MB	1MB	-40 to 85/105	LFQFP/144/0.5
R5F572NxxxLK	2/4MB	1MB	-40 to 85/105	TFLGA/100/0.5
R5F572NxxxFC	2/4MB	1MB	-40 to 85/105	LFQFP/176/0.5
R5F572NxxxBG	2/4MB	1MB	-40 to 85/105	LFBGA/176/0.8
R5F572NxxxBD	2/4MB	1MB	-40 to 85/105	LFBGA/244/0.8

CPU
- 240MHz RXv3
- Double-precision FPU
- Register Bank Save Function

Memory
- 4MB Code Flash Memory
- 32KB Data Flash Memory
- 1MB SRAM

Package
- 100, 144, 176-pin LFQFP
- 176, 224-pin LFBGA
- 145-pin TFLGA

Networking & Advanced Connectivity
- 2ch Ethernet
- SD Host I/F
- USB 2.0 Full Speed
- 3ch CAN
- QSPI

Motor Control
- Arithmetic Unit for Trigonometric Functions
- PWM Timers
- 2-phase Encoder Pulse Inputs
- 12-bit A/D Converters

HMI
- TFT LCD Controller
- 2D Drawing Engine
- Serial Sound I/F
- CMOS Camera I/F

Security
- Encryption Engine (AES, TDES, RSA, ECC, SHA, TRNG)
- Key Management
- Flash Memory Protection

RX72N

RX72N Block Diagram

RX72N Start Kit

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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

System Block
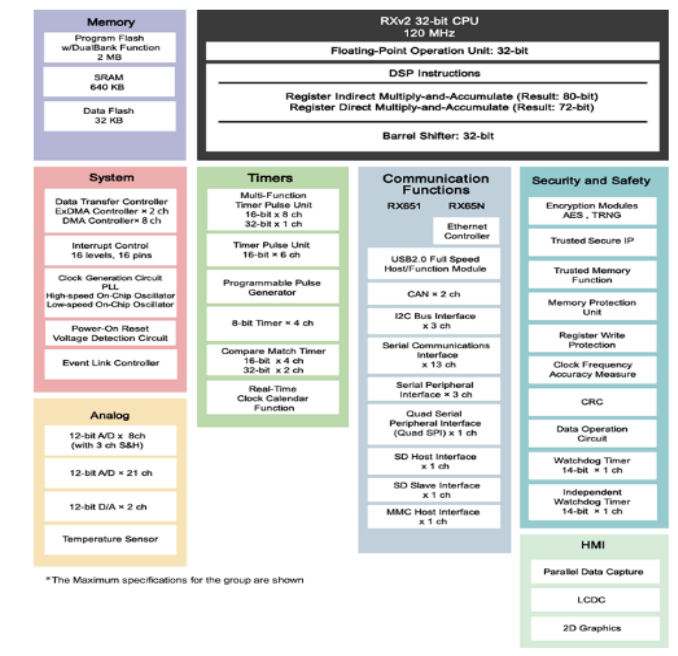
Part #	ROM	RAM	Data Flash	Package
R5F565N4xDxx	512K	256k	None	64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA
R5F565N7xDxx	768K	256K	None	64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA
R5F565N9xDxx	1M	256K	None	64-LFQFP,64-LFBGA,100-LFQFP,100-TFLGA, 144-LFQFP, 145-TFLGA
R5F565NCxDxx	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
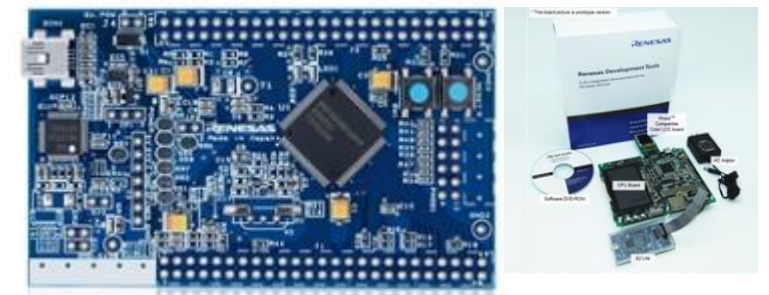
Renesas Starter Kit for RX65N

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ISL85033 – Dual Standard Buck Regulator
Wide V_{IN} Dual Standard Buck Regulator With 3A/3A Continuous Output Current

Wide Working Range

- Wide input voltage range: 4.5V to 28V
- Wide output voltage range: 0.6V to 5.5V

High Efficiency and Low Supply Current

- Dual 3A high efficiency synchronous buck regulator
- Iq (1.2mA), shutdown current(20µA)

System Safe Design and Flexible Usage

- Current mode control，Adjustable switching frequency from 300kHz to 2MHz
- Selectable in-phase or out-of-phase PWM operation
- Independent, sequential, ratiometric or absolute tracking between outputs
- Overcurrent/short circuit protection, thermal overload protection,
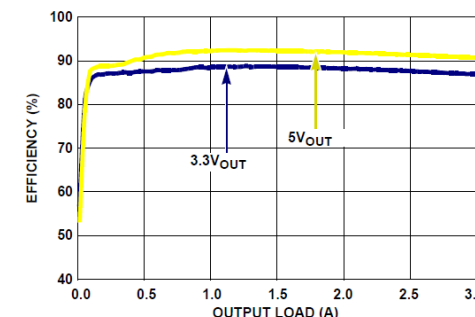- Boot undervoltage detection

Part #	No. of Outputs	Vin Range(V)	Iout (max)(A)	Package
ISL85033IRTZ	Dual (2)	4.7- 28	3 & 3 6(single output)	28 Ld TQFN
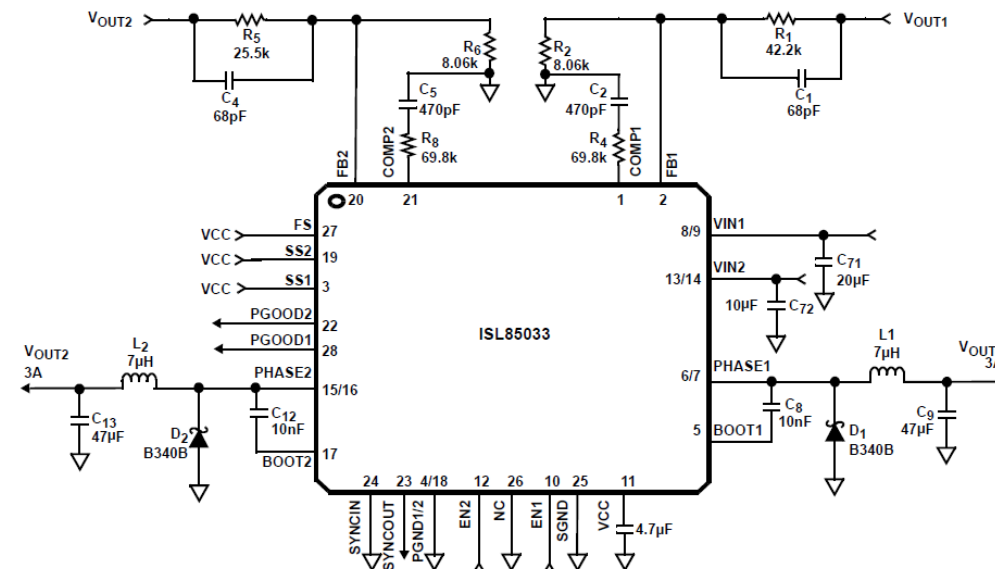
Typical Operation Circuits
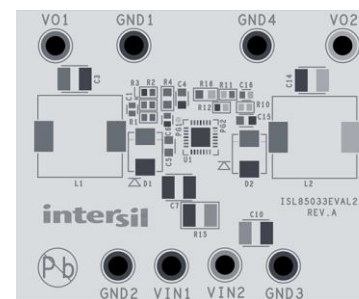
ISL85033EVAL2Z Evaluation Board

EFFICIENCY vs LOAD, TA = +25°C, fSW = 500kHz,VIN = 12V

ISL85003 – Efficient 3A Synchronous Buck Regulator
Network and communication equipment, Industrial control, Point-of-load regulators

Flexible Power

- Input voltage range 4.5V to 18V
- Adjustable output voltage as low as 0.8V
- DCM/CCM

High Efficiency and Accuracy

- Efficiency up to 95%
- High-side NFET Rds(on) of 65mΩ and low-side NFET Rds(on) of 45mΩ
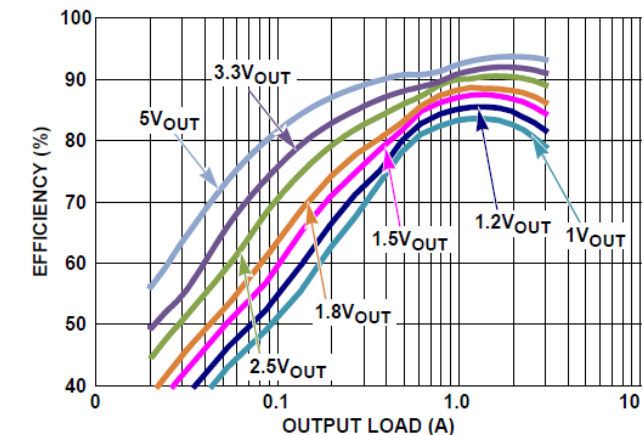- Precision 0.8V, ±1% accurate voltage reference

Built-in protection

- Positive and negative overcurrent protection
- Overvoltage and thermal protection

Part #	External clock synchronization	Programmable soft start	Package
ISL85003FRZ	Yes	No	12L 3x4mm DFN
ISL85003AFRZ	No	Yes	12L 3x4mm DFN
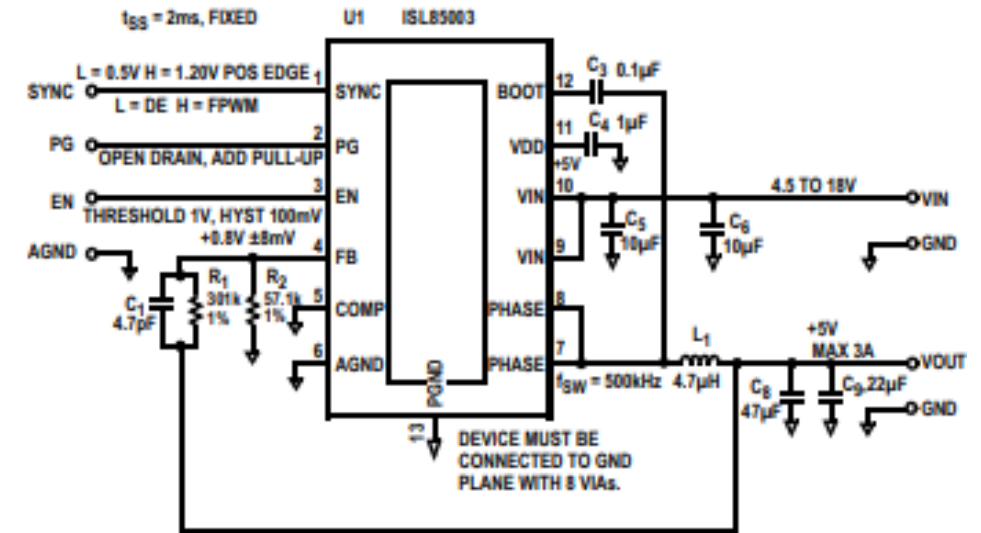
Typical Operation Circuits

Efficiency vs Load, 12V$_{IN}$ DCM

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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
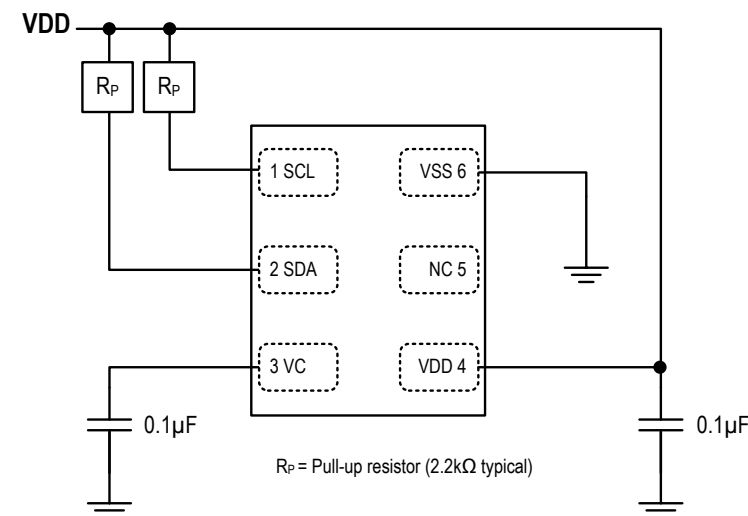- MEMS silicon-carbide sensor technology

Fast Response

- Less than 4 seconds humidity response, in still air
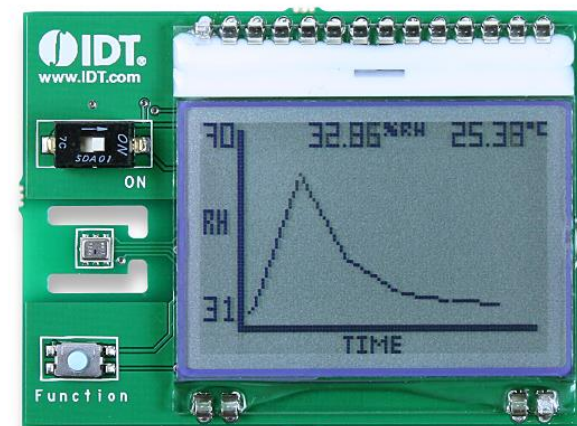- Less than 2 seconds temperature response

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

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