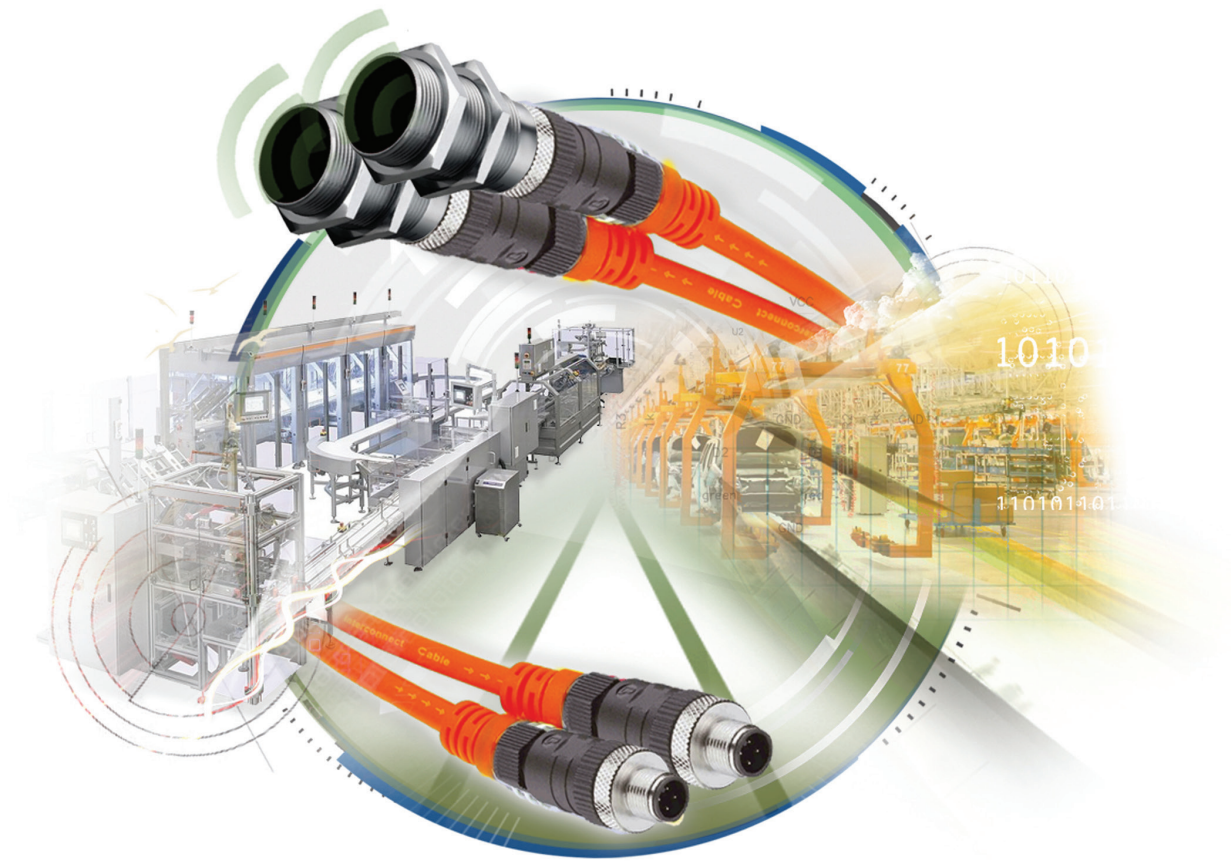RENESAS

Smart Sensor Solution
for Process Automation

Smart Analog

What is Smart Analog?

Enabling Next Generation Intelligent Sensors

Smart Analog (SA) brings design flexibility, extensive reusability, multi-sensor control in embedded-sensing applications for industrial and process automation. The technology enables small footprint implementation while maintaining low system cost. Smart Analog products are available as SAICs (Smart configurable Analog Front End ICs) or as SAMCUs with integrated intelligence (Smart Analog Microcontrollers).

Using the SA-Designer software GUI, configurable amplifier circuits can easily be tailored. Analog Front End circuits tuning and debugging can be performed on the fly The SAIC101 offers a 16-bit Delta-sigma A/D converter IC with a programmable gain instrumentation amplifier ideal for differential output sensors used in process automation instrumentation for measuring flow, temperature and pressure.

The SAMCU integrates an ultra-low-power 16-bit RL78 CPU core, and reconfigurable analog functions including, configurable operational amplifiers with adjustable gain, High-pass/Low-pass filters, 8-bit DACs, 12-bit ADCs.

Smart Analog Key Benefits

- Build optimized Op-amp based topologies in no time
- Change circuit and configuration of Analog Front End on the fly
- Eliminate time consuming trials and errors in rewiring of Op-Amp circuit
- Lower system cost
- High performance at reduced power consumption, and shorted development time
- Effectively reduce the need for external parts
- Enable Intelligent Auto-calibration control
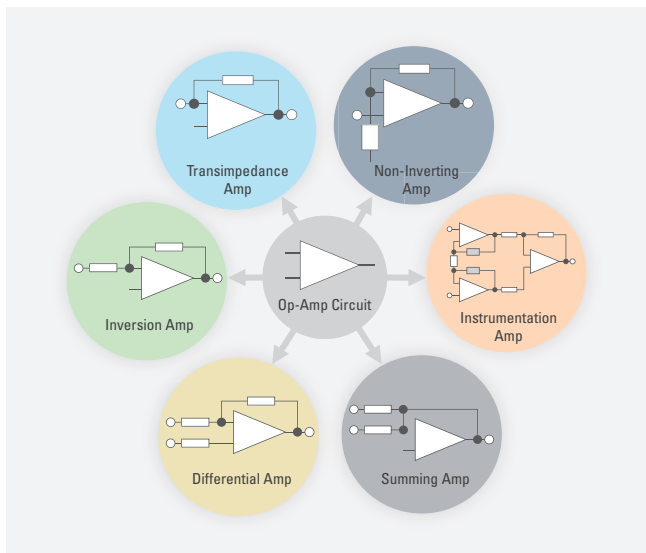

Topology Options

Smart Analog Designer Tool

- Intuitive and powerful GUI-based sensor configuration software tool
- Enables quick configuration of the Analog Front End, with easy gain values change or offset tuning.
- Source code generation for import in IDE workbench compiler
- Sensor calibration and debugging "on the fly" with Easy Starter
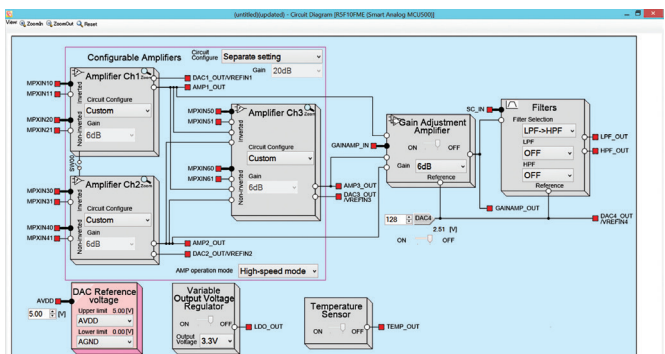
Significantly Reduce Development Time

Reduce overall design lead time between 3 to 8 months depending on complexity of design
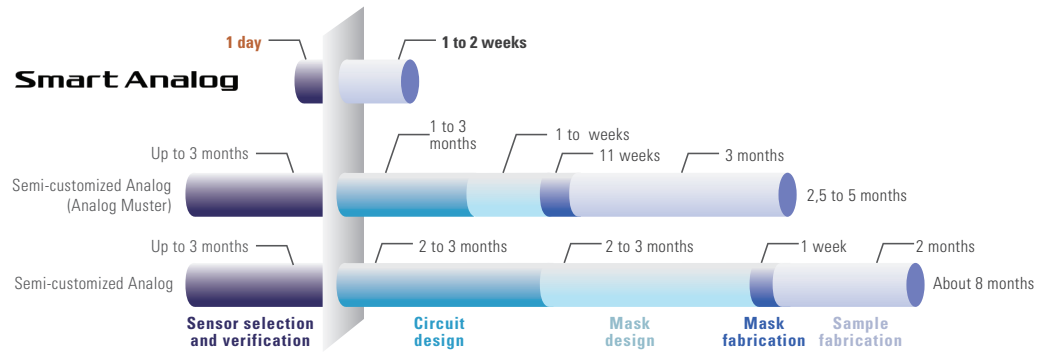
Smart Analog MCU (RL78/G1E) Features

- High Performance
  - 41 DMIPS at 32 MHz
  - Multiplier and Divider/Multiply accumulator
  - Direct Memory Access controllers
- Ultra-Low Power Technology
  - 1.6 V to 5.5 V operation from a single supply
  - Operating as low as 88.4 µA/MHz
    - (MCU:65.6 µA/MHz + AFE: 22.84 µA/MHz)
  - Multiple Low power saving mode: Halt, Stop, Snooze
- High-speed On-chip Oscillator
  - 1 MHz to 32 MHz multiple Pre-configured settings
  - ±1% accuracy over voltage and temperature range
- Built-in Safety Features
  - Illegal memory access, guard
  - Temperature sensor
- Analog
  - 12-bit High speed and High accuracy SAR ADC
  - Reconfigurable Amplifier Analog Front End
- Operating Ambient Temperature
  - −40 °C to +85 °C
- Serial Communication Interfaces
  - CSI
  - UART/ UART (LIN-Support)
  - I²C communication
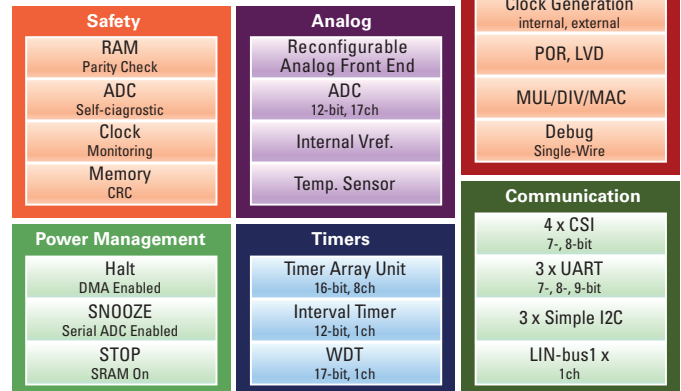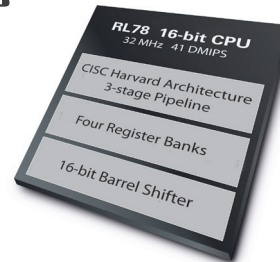
Fully Reconfigurable Smart Analog Front End

- Settings specification via SPI control registers
- Power-off function on each configurable analog block
- Variable Output regulator: 2-3.3 V/15 mA
- Reference Voltage output: 1.21 V (Typ)
- Temperature sensor: Output voltage coefficient= -5 mV/°C
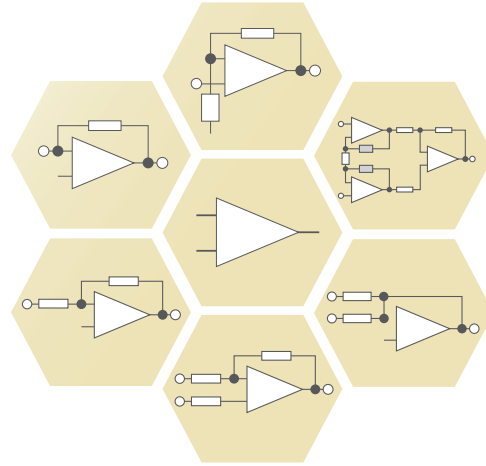
OP-Amp based Topology

- Four operating modes are available
  - High Speed, Mid-speed 1 and 2, Low Speed
- Single-channel operation:
  - Non-inverting, Inverting, Differential,Transimpedance
  - Adjustable gain from 6 dB to 40 dB in 18 steps of 2 dB
- Multiple-channel operation: Instrumentation
  - Adjustable gain from 20 dB to 40 dB in 18 steps
- 8-bit Resolution D/A signal conversion
 - OP-Amps and filters reference voltage control

Butterworth characteristic Filters

- Low Pass filter with adjustable fc range: 9 Hz to 4.5 KHz
- High Pass filter with adjustable fc range: 8 Hz to 800 Hz

Reconfigurable Analog Front End	
Configurable Amp 3ch	Temp Sensor
Gain adjustment Amp 1ch	Low Pass Filter SC 1ch
8-bit DAC 4ch	High Pass Filster SC 4ch
Variable Output Voltage Regulator	Voltage Reference

# Configurable Amplifier Operation Modes

By specifying settings in the SPI control registers, the configurable amplifiers can be used in Single-channel or Multiple-channel operation mode
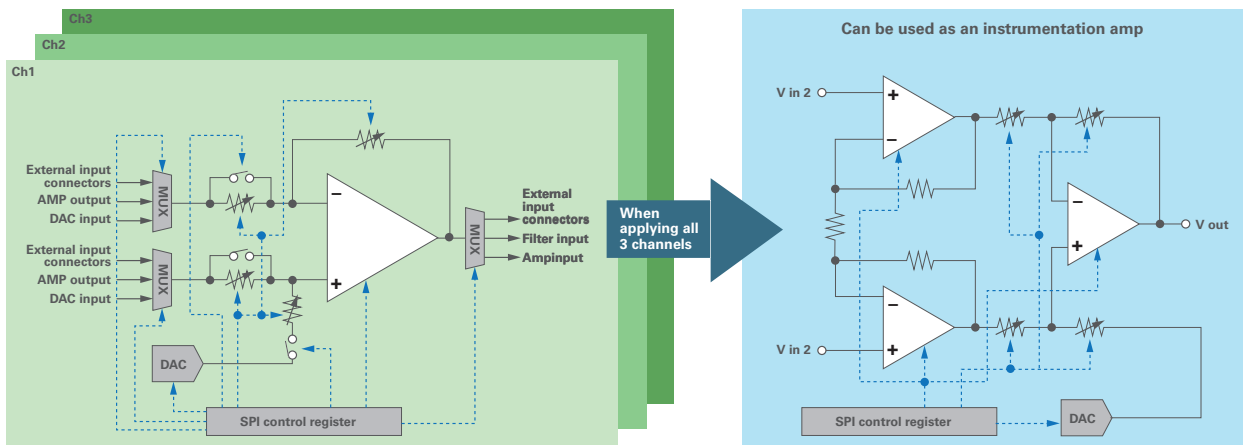
Programmable Analog Front End for Bridge type Sensors

Smart Analog IC101 Features

- Highly Integrated Analog Front End
  - Programmable Gain Instrumentation Amplifier
  - Gain adjustment from x 1 to x 32
  - Adjustable of offset voltage
- 16-bit Delta-Sigma AD Converter
- 4 analog inputs Mux:
  - Single-ended/Diffenrential mode selectable
- Integrated AFE Voltage reference interlock with Sensor BIAS voltage
- 5-bit D/A Converters for sensor offset adjustment
- On-chip Temperature sensor
- Integrated SINC3 digital filter.
- 256-bytes of Flash memory for AFE calibration and system configuration storage
- Selectable SPI or UART. MCU digital interface
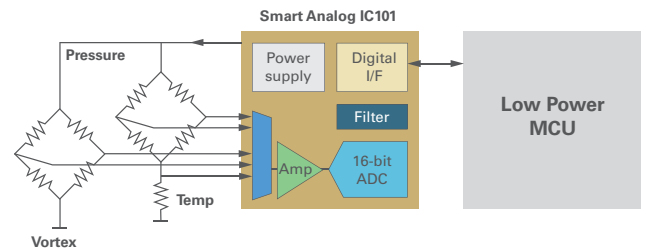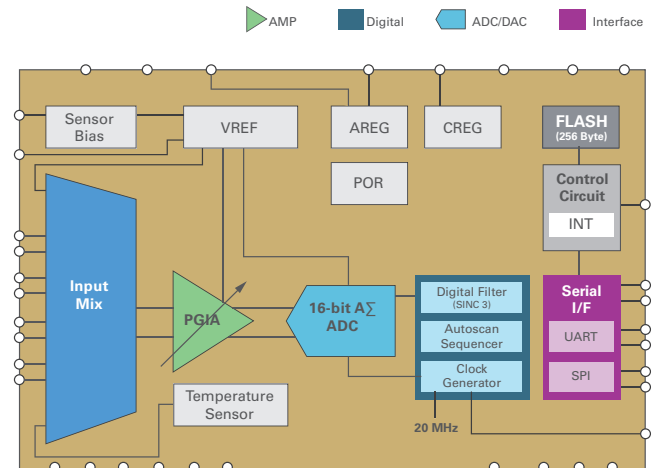
Vortex Flow, Pressure, Temperature example
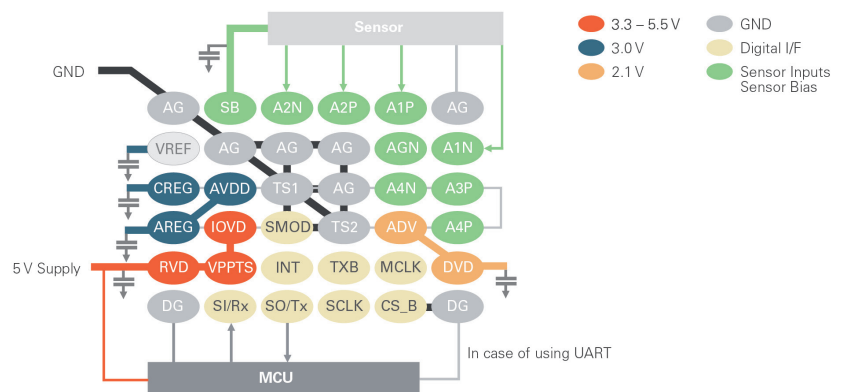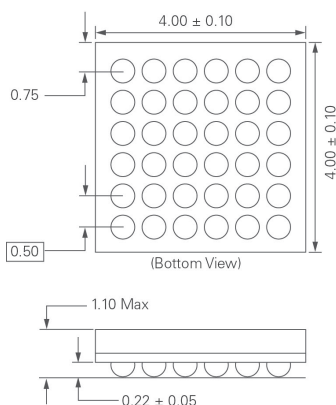
Integrated Power Management Unit

- Internal reference voltage generator
- Integrated Sensor Bias generator: 1.2 V to 2.2 V
- Operating voltage range: 2.7 V ≤ VDD ≤ 5.5 V
- Industrial grade (-40 to +125 °C)
- Small 4 mm x 4 mm 36-pin FPGA package

Small Package & Ideal Pin Assignment for Easy PCB Layout
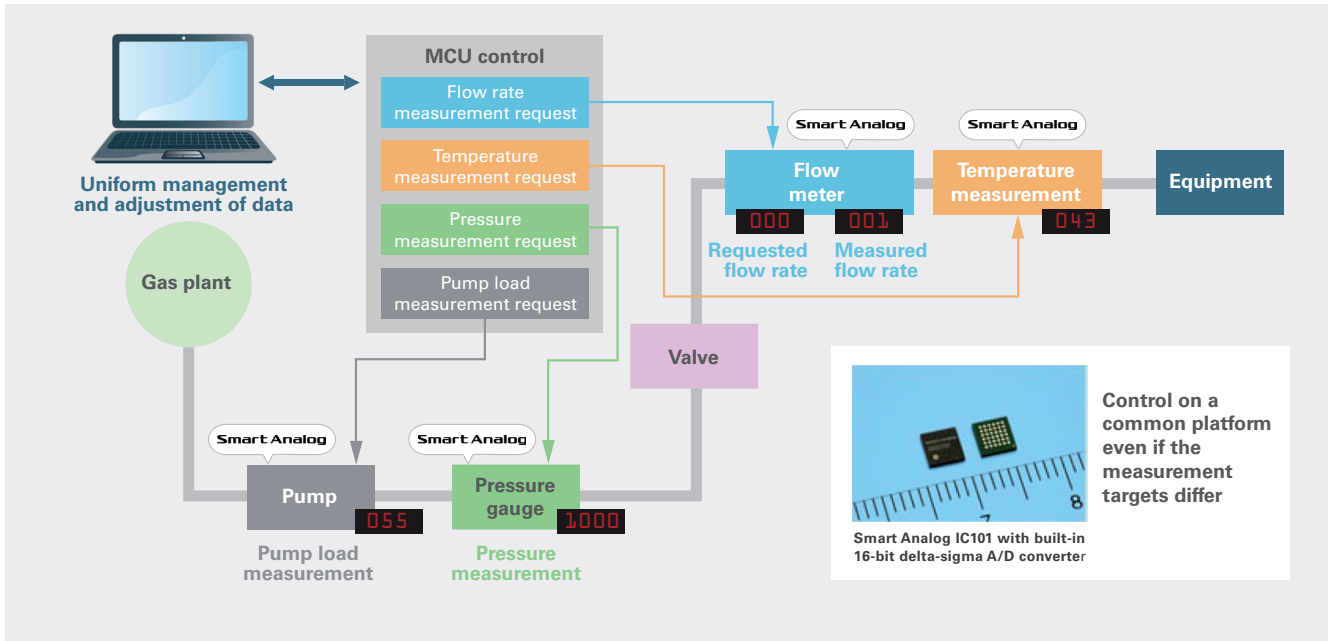

Function Pins are located in outside 2 row
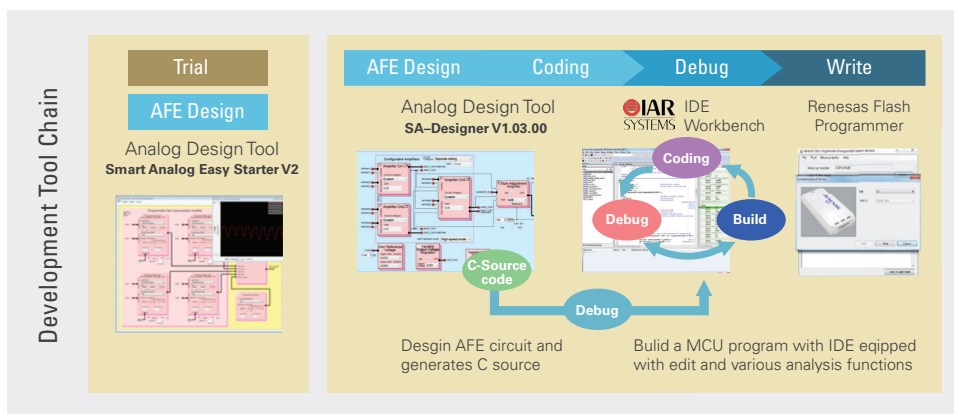

Pin Assignment (Top View)

Application Cases

Smart Analog IC101's flexible analog front-end is ideal for industrial instrumentation equipment, process automation sensors, pressure, temperature, and flow metering sensors.

Uniform management and adjustment of data

Gas plant

MCU control
- Flow rate measurement request
- Temperature measurement request
- Pressure measurement request
- Pump load measurement request

Smart Analog — **Flow meter** `000` `001`
Requested flow rate / Measured flow rate

Smart Analog — **Temperature measurement** `043`

Equipment

Valve

Smart Analog — **Pump** `055`
Pump load measurement

Smart Analog — **Pressure gauge** `1000`
Pressure measurement

Control on a common platform even if the measurement targets differ

Smart Analog IC101 with built-in 16-bit delta-sigma A/D converter

Intuitive Workflow

The Smart Analog development environment includes a powerful and easy-to-use GUI-based software that covers all aspects of analog front-ends design, dramatically reducing the amount of time needed to develop sensor applications and bring products faster to market.

Development Tool Chain

Trial
AFE Design
Analog Design Tool
Smart Analog Easy Starter V2

AFE Design — Coding — Debug — Write

Analog Design Tool
SA–Designer V1.03.00

IAR SYSTEMS IDE Workbench
Coding — Build — Debug

Renesas Flash Programmer

Desgin AFE circuit and generates C source

Bulid a MCU program with IDE eqipped with edit and various analysis functions

IO-Link Description file for Smart Analog Sensor board

Development Tools

The Sense-IT kit is a reference platform for industrial sensors and Smart Analog. It offers a complete hardware/software platform for in-depth Smart Analog devices testing and prototyping of intelligent sensor applications, including IO-Link Industrial sensors.

Package content:

- Smart Analog Sensor board
- IO-Link Daughter board
- USB Connection cable
- Quick Start Guide
- E1 Debugger
- CD-ROM (User Manual, Tutorial, IDE, Flash Memory Programmer)

Analog Design Tool:

- Smart Analog Easy Starter V2
  – On the fly configuration of RL78/G1E
- SA Designer
  – Configuration of SA devices: SAIC 101, RL78/G1E

Additional Software:

- An evaluation version of the TMG GmbH IO-Link Device Stack is included for integration into Industrial Automation network setups

Part Number:
YSENSE – IT – RL78
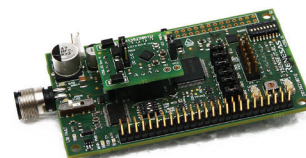
Ordering Information

RL78/G1E Part Number		Flash ROM	RAM	Data Flash
9 mm x 9 mm WQFN 64-pin	12 mm x 12 mm LQFN 80-pin			
R5F10FLC	R5F10FMC	32 KB	2 KB	4 KB
R5F10FLD	R5F10FMD	48 KB	3 KB	4 KB
R5F10FLE	R5F10FME	64 KB	4 KB	4 KB

SAIC Part Number	Package	Operating Temperature range
RAA7301013CBG	36-pin plastic FBGA (4 x 4)	-40 °C ≤ TA ≤ 105 °C
RAA7301014CBG		-40 °C ≤ TA ≤ 125 °C

Order Number	Boards size
YSENSE-IT-RL78	Smart Industrial Sensor platform = 90 x 55 mm

For further information on Renesas Electronics Smart Analog solutions, visit our European website at www.renesas.eu/smartanalog

Smart Sensor Solution for Process Automation

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