

## Description

The FS1012 MEMS mass flow sensor module measures the flow rate using the thermo-transfer (calorimetric) principle. The FS1012 is capable of measuring a gas or liquid medium.

The FS1012 offers key advantages over resistor-based flow solutions. The sensor utilizes thermopile sensing, which provides an excellent signal-to-noise ratio. The sensor comprises a “solid” thermal isolation technology and silicon-carbide coating to protect it from abrasive wear and provides robustness and long-term reliability. In comparison, other sensors typically contain a fragile membrane above an etched cavity for the thermal isolation base.

The FS1012 features the sensor fully assembled and wire-bonded out to a 6-pin header. Wetted materials consist of a glass fiber reinforced PA66 resin, epoxy, and silicon carbide.

## Features

- Gas or liquid mediums
- Robust “solid” isolation technology
- Resistant to surface contamination
- No cavity to cause clogging
- Resistant to vibration and pressure shock
- Low power application
- Sensitive at low flow rates and differential pressure levels
- Fast response: <5ms
- Millivolt output
- Supply voltage: 3V to 5V
- Module operating temperature range: 0°C to +85°C

## Typical Applications

- Process controls and monitoring
- Oil and gas leak detection
- HVAC and air control systems
- CPAP and respiratory devices
- Liquid dispensing system

## FS1012 Flow Sensor Module



## Basic Application Circuits

Figure 1. Single-Ended Circuit Example

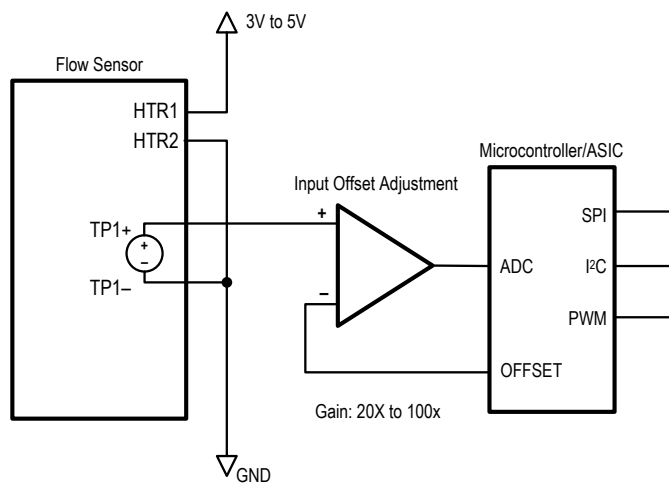
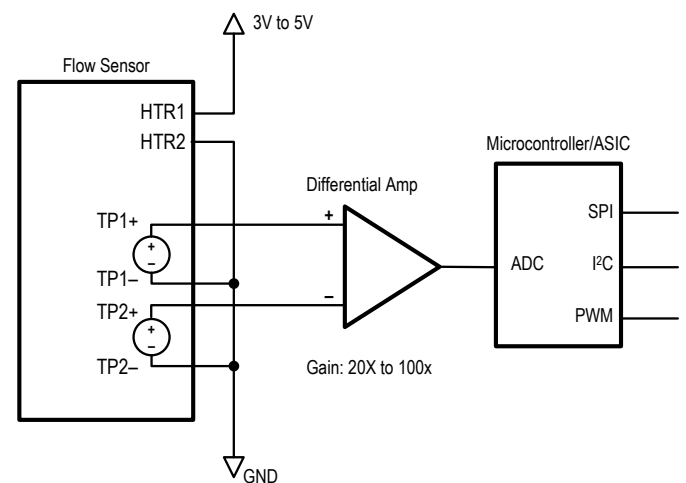
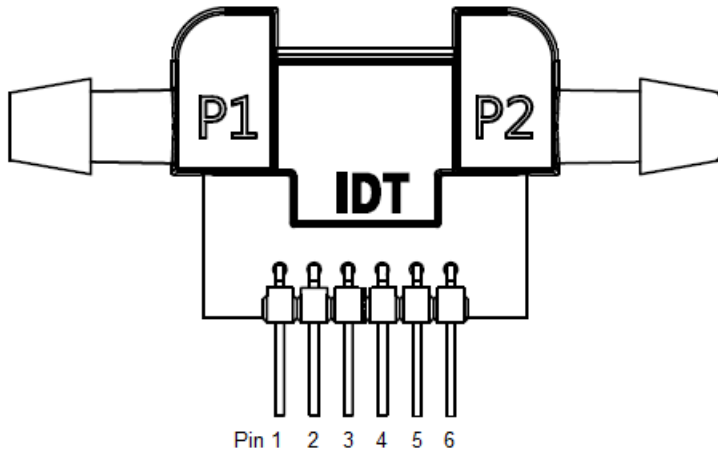


Figure 2. Differential Circuit Example



## Pin Assignments

**Figure 3. Pin Assignments for Module – Top View**



## Pin Descriptions

**Table 1. Pin Descriptions**

Pin Number	Pad Name	Type	Description
1	TP1+	Output	Thermopile 1 (+)
2	TP1-	Output	Thermopile 1 (-)
3	HTR1	Input	Heater
4	HTR2	Input	Heater
5	TP2-	Output	Thermopile 2 (-)
6	TP2+	Output	Thermopile 2 (+)

## Absolute Maximum Ratings

The absolute maximum ratings are stress ratings only. Stresses greater than those listed below can cause permanent damage to the device. Functional operation of the FS1012 at absolute maximum ratings is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

**Table 2. Absolute Maximum Ratings**

Symbol	Parameter	Conditions	Minimum	Maximum	Units
V <sub>H</sub>	Heater Voltage Supply			5.6	V
T <sub>STOR</sub>	Storage Temperature		-50	130	°C
P <sub>BURST</sub>	Burst Pressure			10	bar

## Recommended Operating Conditions

**Table 3. Recommended Operating Conditions**

Symbol	Parameter	Minimum	Typical	Maximum	Units
T <sub>AMB</sub>	Ambient Operating Temperature <sup>[a]</sup>	0		85	°C
I <sub>HTR_CC</sub>	Heater Driving Current – Constant Current <sup>[a]</sup>		10	20	mA
V <sub>HTR_CV</sub>	Heater Driving Voltage – Constant Voltage <sup>[a]</sup>		3	5.6	V

[a] Sensor specifications are tested at the wafer die level.

## Electrical Characteristics

**Table 4. Electrical Characteristics**

Note: See important notes at the end of the table.

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
R <sub>H</sub>	Heater Resistor <sup>[a]</sup>		230	290	400	Ω
α <sub>HTR</sub>	Heater Temperature Coefficient of Resistance <sup>[a]</sup>			300		ppm/°C
V <sub>TP_OUT</sub>	Thermopile Output <sup>[a]</sup>	3V driving voltage, in air, 20°C, no flow	30	35	60	mV
R <sub>TP</sub>	Thermopile Resistance <sup>[a]</sup>	20°C	100	210	300	KΩ
V <sub>TP_OUTDIFF</sub>	Thermopile Differential Output <sup>[a]</sup>	3V driving voltage, in air, 20°C, no flow	-1	0	1	mV
t <sub>RESP</sub>	Response Time			5		ms

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
<b>Standard Gas Flow Range<sup>[b], [c]</sup></b>						
	Gas Flow	FS1012-1020-NG	0		2 (2000)	SLPM (SCCM)
		FS1012-1100-NG	0		10 (10000)	SLPM (SCCM)
<b>Standard Liquid Flow Range<sup>[b], [c]</sup></b>						
	Liquid Flow	FS1012-1001-LQ	0		0.5 (500)	SLPM (SCCM)
		FS1012-1002-LQ	0		1.0 (1000)	SLPM (SCCM)

[a] Sensor specifications are tested at the wafer die level.

[b] SLPM: Standard liter per minute.

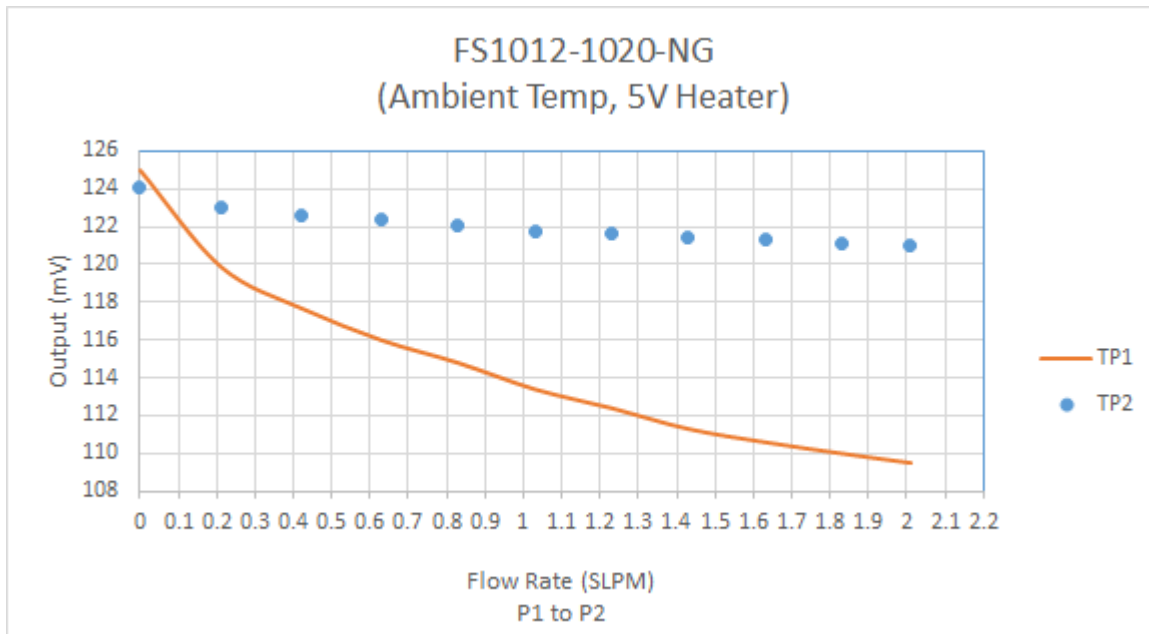
[c] SCCM: Standard cubic centimeter per minute.

## Flow Curves

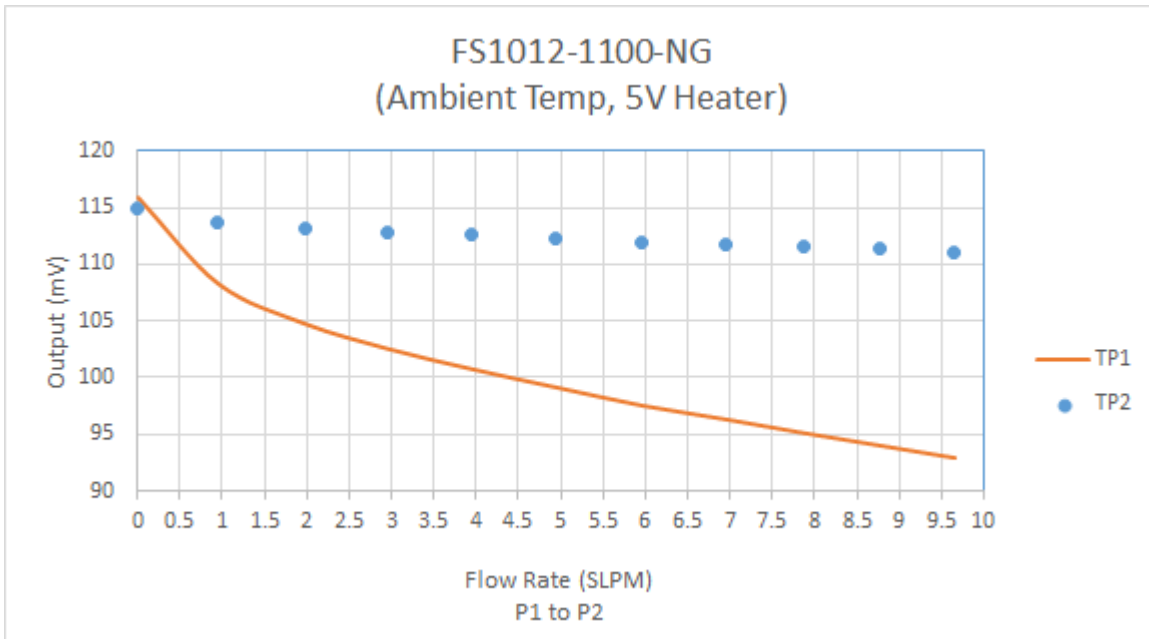
The flow output curves are typical values at room conditions. The heater voltage is set at 5VDC. Flow input is from P1 to P2 out.

In general, use TP1 to measure gas flow and TP2 for liquid flow.

**Figure 4. FS1012-1020-NG Flow Curve**



**Figure 5. FS1012-1100-NG Flow Curve**



**Figure 6. FS1012-1001-LQ Flow Curve**

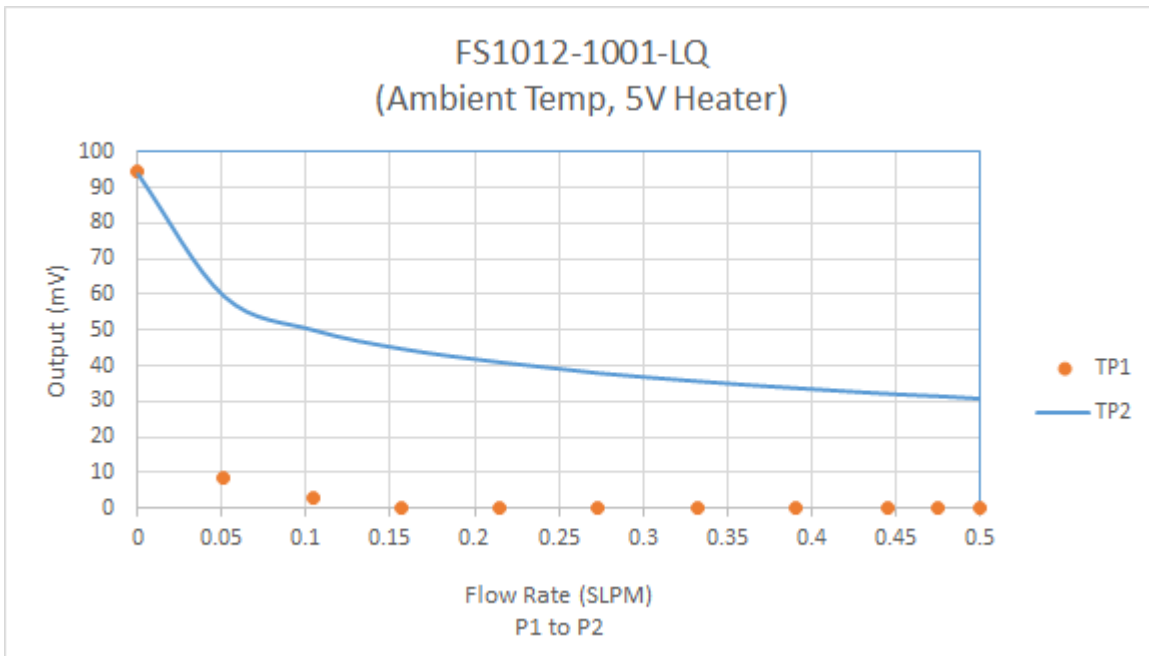
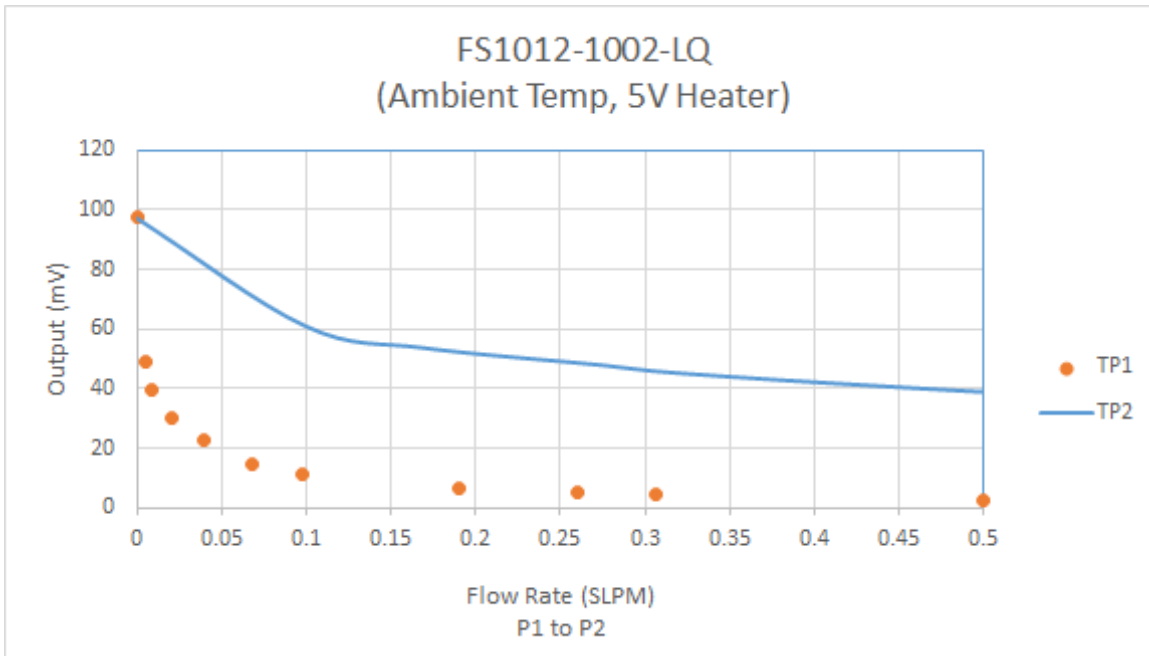
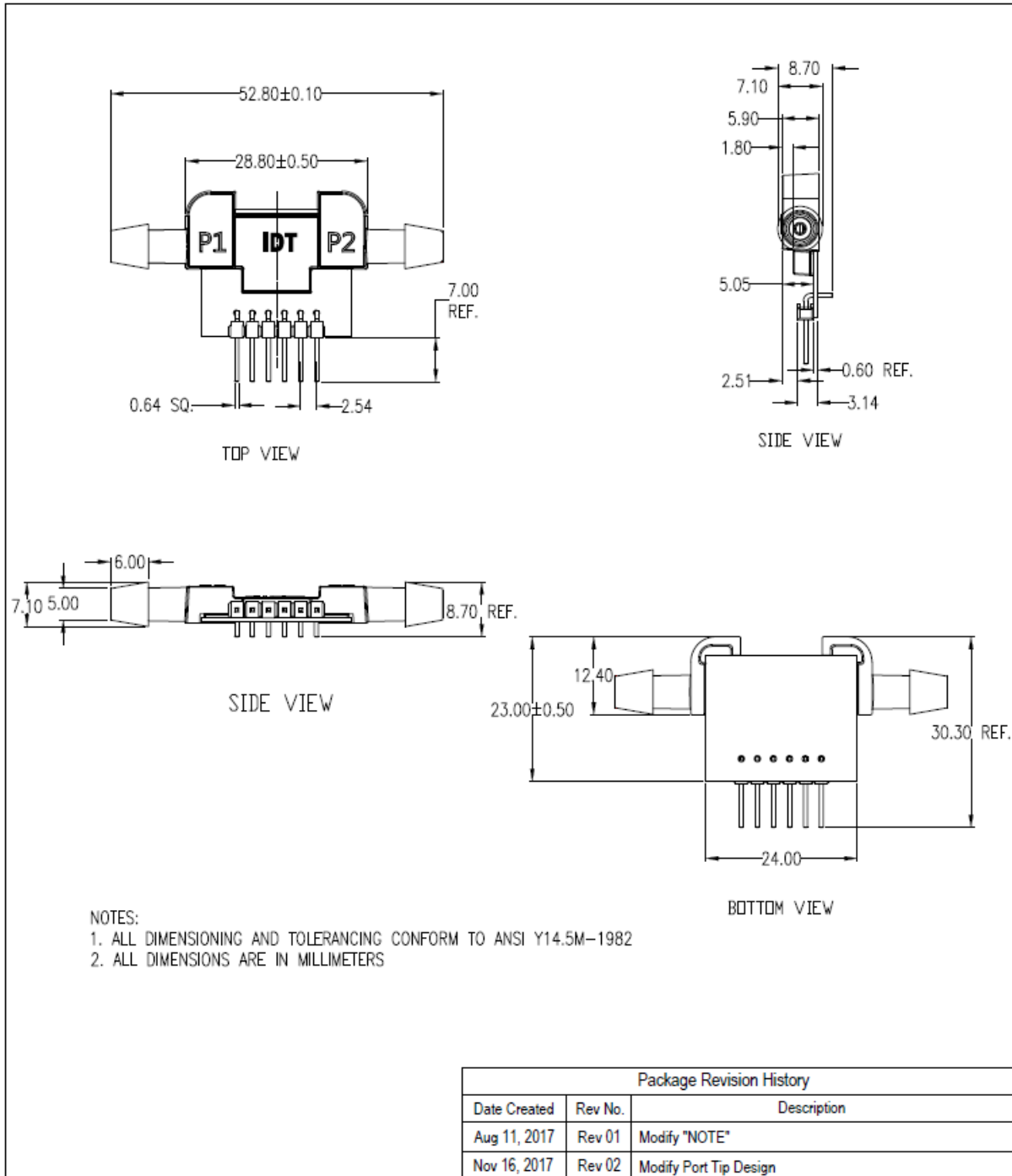


Figure 7. FS1012-1002-LQ Flow Curve



## Package Outline Drawings

Figure 8. FS1012 Module Outline Drawings



## Ordering Information

Note: The part code depends on the application. In the part code, NG refers to “non-corrosive gas” and LQ refers to “liquid.”

Orderable Part Number	Description and Package	Shipping Packaging	Temperature
FS1012-1020-NG	0 to 2 SLPM gas flow sensor mounted on a circuit board with a flow housing	Box	0°C to +85°C
FS1012-1100-NG	0 to 10 SLPM gas flow sensor mounted on a circuit board with a flow housing	Box	0°C to +85°C
FS1012-1001-LQ	0 to 0.5 SLPM (500 SCCM) liquid flow sensor mounted on a circuit board with a flow housing	Box	0°C to +85°C
FS1012-1002-LQ	0 to 1.0 SLPM (1000 SCCM) liquid flow sensor mounted on a circuit board with a flow housing	Box	0°C to +85°C

## Revision History

Revision Date	Description of Change
November 19, 2018	Update module dimensions drawing, change Table 2 spec, added flow curves.
September 8, 2017	Updated module dimensions drawing.
July 20, 2017	Initial release of the datasheet.



## IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES (“RENESAS”) PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers skilled in the art designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only for development of an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising out of your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Rev.1.0 Mar 2020)

### Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,  
Koto-ku, Tokyo 135-0061, Japan  
[www.renesas.com](http://www.renesas.com)

### Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:  
[www.renesas.com/contact/](http://www.renesas.com/contact/)

### Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.