

3-Axis Programmable Sense Amplifier IC with Built-in Nonvolatile Memory

MB42M102/103/104

A programmable sense amplifier IC that detects, amplifies, and corrects minute voltage changes with higher precision. It incorporates three detection circuits, three constant-current sources for sensor operation, a Flash memory, and a temperature sensor.

Introduction

At present, the market for sensors that measure acceleration and pressure is expanding in various fields including automotive devices, mobile devices, robots, games, and industrial devices. Due to advancements in sensor miniaturization such as MEMS^{*1}, the detection of sensor output with higher precision and a high amplification rate are demanded in sense amplifiers that amplify the sensor output. Furthermore, they must offer a function to correct the offset voltage and sensitivity in the sensor caused by fluctuation in manufacture and temperature changes.

In this context, FUJITSU has developed programmable sense amplifiers^{*2} IC “MB42M102”, “MB42M103”, and “MB42M104” that detect, amplify, and correct minute voltage changes with higher precision.

Overview

This product is a sense amplifier IC that detects and amplifies the minute differential voltage of bridge-resistance-type sensors, etc. at low-noise and high-gain. It incorporates three detection circuits, three constant-current (or constant-voltage) sources for sensor operation, a Flash memory, and a temperature sensor. It can be applied in the detection circuits

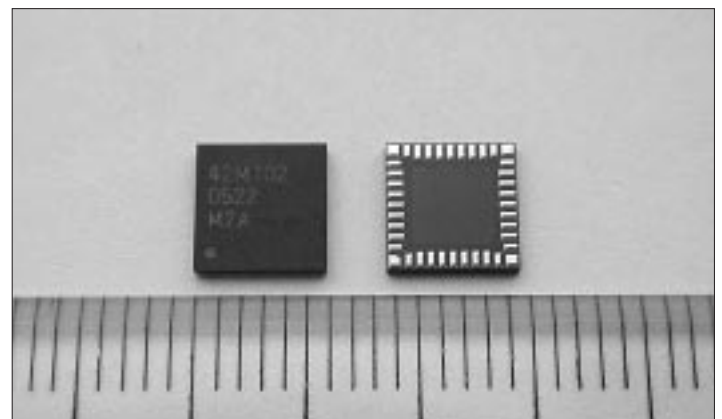
of three-axis piezoresistance-type acceleration sensors, pressure sensors, etc.

Fig.1 presents a schematic of the entire sensor.

By utilizing this product, it is possible to correct the offset voltage and sensitivity fluctuation generated by temperature changes by memorizing the correction coefficient in the built-in Flash memory (analog inclination correction); this enables the development of sensors with higher precision.

FUJITSU has been distributing the programmable sense amplifier IC “MB42M101”, which implements digital correction^{*3} by 10°C, since the year 2004. By adding three

Photo 1 External View



products with different temperature correction methods this time, our customers who manufacture sensor modules, etc. will be able to produce products with higher precision and higher yields in a wide range of applications.

Fig.2 presents the pin assignments.

Product Features

Fig.3 presents a block diagram of this product, which is composed of the following functional blocks:

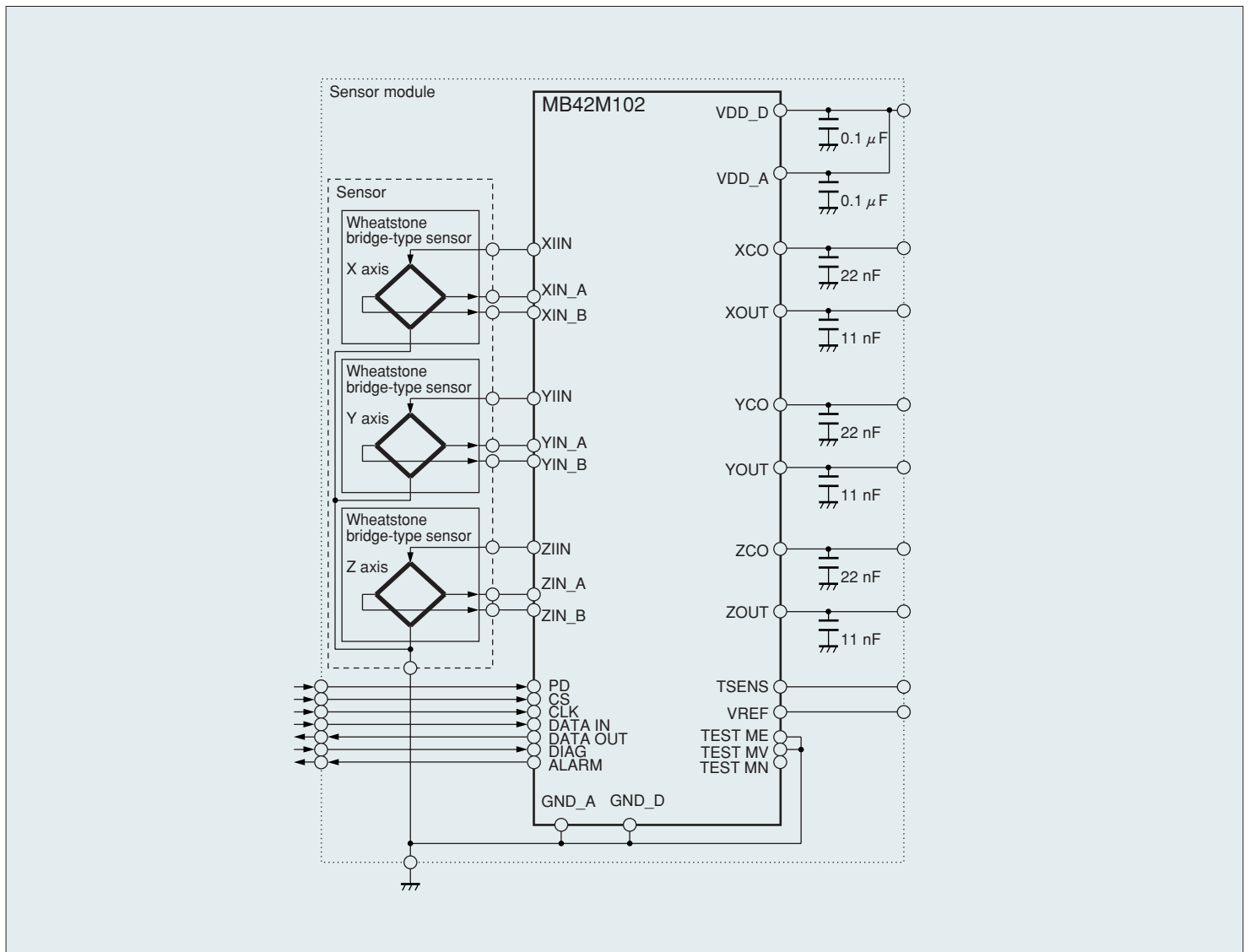
- Detection circuit

- Flash memory
- Correction function
- Failure detection circuit
- Temperature sensor
- Constant-current/constant-voltage sources for sensor operation

Detection of three-dimensional changes possible on one chip

This product incorporates three independent sense amplifier circuits that can detect, amplify, and correct minute voltage changes of Wheatstone bridge-type sensors, etc. Errors

Figure 1 Schematic of the Entire Sensor



memory and corrects offset voltage and sensitivity fluctuation in the sensor caused by temperature changes.

Offset voltage is corrected by giving coefficients in both directions of high temperature and low temperature from optimal temperature points given in the 5°C step setup in between -20°C and 55°C.

Sensitivity fluctuation is corrected by giving a coefficient to the constant-current (or constant-voltage) source for operating the sensor.

Fig.4 presents an image drawing for temperature correction.

Failure detection circuit

This product transmits signals from an alarm terminal when a sudden failure occurs in the IC or sensor element structure in use after sensor construction and an operation status that is considerably different from the normal status. This enables early repair, replacement, etc.

Temperature sensor circuit

This product contains a temperature sensor capable of analog voltage output for various controls.

Constant-current source for sensor operation

This is a constant-current (or constant-voltage) source circuit that operates the external Wheatstone bridge-type sensors.

Three circuits are included; their simultaneous adjustment is possible.

It is also possible to carry out a rough adjustment from 50 to 400 μA in 50 μA steps. As a minute adjustment, ±30% of the rough adjustment can be adjusted in 2% steps. It is possible to select the optimal current value from a maximum of 248 levels.

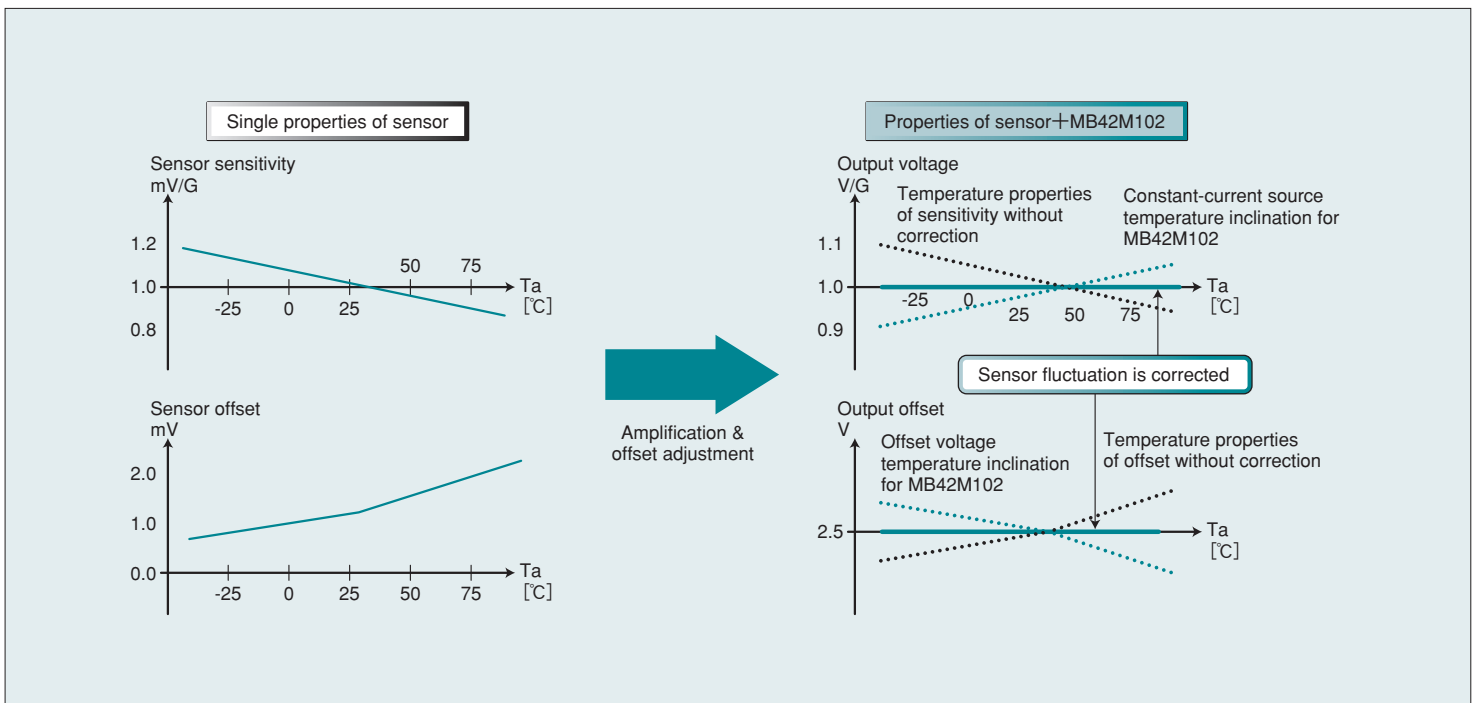
Specifications

Table 1 provides the major specifications of this product and the conventional product, MB42M101.

Future Development

FUJITSU plans to develop a group of products using this product as the basic form for lower power consumption, further miniaturization, and improved functions. We are also discussing the development of a density-detection-type sensor amplifier circuit, which is often used in gyrosensors, etc. In this way, we hope to rejuvenate the sensor amplifier IC series that supports various MEMS sensors. *

Figure 4 Image Drawing for Temperature Correction



NOTES

*1: MEMS (Micro Electro Mechanical System): A system that integrates an electric circuit and minute mechanical structure. It is also called a “micromachine”.

*2: Programmable sense amplifier: A circuit utilized to amplify extremely weak signals.

*3: Digital correction: A correction method utilized at a certain temperature point in steps of a certain temperature range.

Table 1 Comparison of Major Specifications

	Conventional product		New product	
	MB42M101		MB42M102	MB42M103
Process technology	COMS 0.50 μ m			
Power-supply voltage	3.0 to 5.5V		4.5 to 5.5V	
Bridge operation method	Current operation			Voltage operation
Selection range for constant current for sensor operation	35 to 520 μ A (with power-supply voltage: 5V)			
Gain (input/output)	240- to 2,860-times		48- to 572-times	240- to 2,860-times
Temperature correction method	Digital correction in 10°C step		Analog inclination correction	
Offset inclination correction range	—		Set temperature for offset switching: -20°C to 55°C (5°C step) Temperature inclination selection: Every $^{\circ}\text{C}$ -40.8 to 40.8mV (every $^{\circ}\text{C}$ 0.16mV step) (with power-supply voltage: 5V)	
Constant-current inclination correction range	—		Temperature inclination selection: every $^{\circ}\text{C}$ -0.022 to 0.233% (every $^{\circ}\text{C}$ 0.017% step) (with power-supply voltage: 5V)	
Sense amplifier offset adjustment	Input	2.20 to 2.90V (7-bit)		
	Output	2.18 to 2.78V (4-bit)		
Amplifier operation band	DC to 10,000Hz		DC to 700Hz	
Output noise	10mV (peak-to-peak value) (with setting of amplification rate: 1,008-times [other than MB42M103])			
Operation temperature range	-40°C to 85°C			
Shipment form	Plastic BCC-32-pins		Plastic BCC-40-pins	