SENSIRION
THE SENSOR COMPANY

Application Note for I²C Flow and Differential Pressure Sensors

Reading scale factor, measurement unit and tracking information

Summary

Sensirion provides I²C sensors measuring flow or differential pressure. These sensors are based on the same thermal flow sensor chip, called SF04. The chip contains an EEPROM memory cell, where amongst others certain sensor information as scale factor, measurement unit and tracking information is stored. The present application note explains how to read out this sensor information.

1. Introduction

The output of sensors with a SF04 chip inside is a 16bit integer number provided by an I²C interface. To get the physical value of the measurement, one has to divide the output by a scale factor and the measurement unit has to be known. Scale factor and measurement unit are defined during calibration and cannot be changed later on. During calibration, the information about the used scale factor and measurement unit is written to the EEPROM, which can be read out by the user. Furthermore the serial numbers of the flow chip and the sensor as well as sensor name and item number are stored in the EEPROM. With this sensor information, the production process is fully traceable.

The following chapters describe how to read out sensor information as scale factor, measurement unit and serial number.

2. Read EEPROM

For basic sensor communication, please refer to the product datasheet or the user manual "Sensirion I2C Flow and Differential Pressure Sensors".

To dump the content of the EEPROM starting at a given EEPROM address, two steps have to be performed.

1st Step

The internal address register has to be set by invoking a set EEPROM address command.

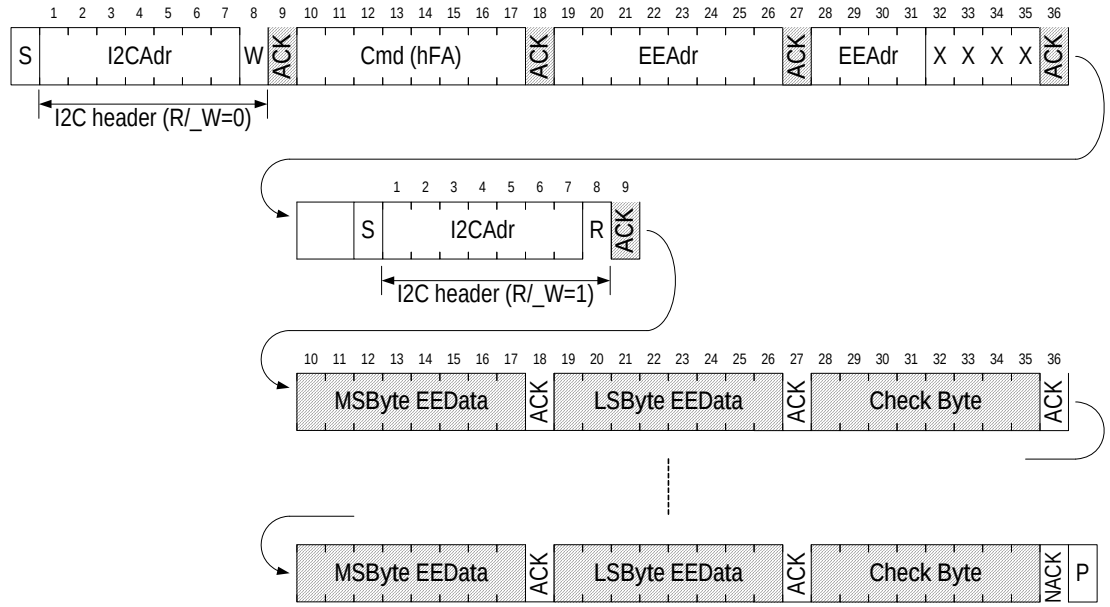
8 Bit Command Code	*Command*
hFA	set EEPROM address

Important: The EEPROM address is a 12-bit value followed by additional 4 bits which are not interpreted by the sensor (can be sent as 0). Example: To set the EEPROM address h2B6, the full command string is: 80 FA 2B 60. (hexadecimal, assuming the default I2C address)

2nd Step

Send an I2C header with R/_W=1. After the header with R/_W=1, the sensor system writes the EEPROM word at the actual address to the bus, followed by a CRC byte. The internal address register is automatically increased after each completed word write out. Therefore, if the master continues clocking the SCK line after the CRC byte, the next EEPROM word with corresponding CRC byte is written to the bus, and so on. The master can interrupt EEPROM dumping by not pulling down the DATA line during any acknowledge-related SCK pulse (NACK).

I2C Read EEPROM



3. Scaling of Measurement Signal and Unit

To get the physical information from the sensor reading, the scale factor and the measurement unit have to be known. For some standard sensors, this information can be found in the datasheet. For all other sensors it has to be read from the Sensor internal EEPROM memory.

A series of operations is needed for correct scaling and determination of the measurement signal.

The original calibrated signal read from the sensor is an integer number. The integer value can be converted to the original unit the sensor has been calibrated for. For this the number has to be divided by the sensors 'scale factor' which is stored in the EEPROM.

Again, the EEPROM address is composed of an EEPROM base address and an address offset. To determine the base EEPROM address for actual sensor information, bit <6:4> of User Register (called active configuration field) must be multiplied by h300. Then the Wordadr Offset of following table must be added to that address.

(Example: address of article code
- bit<6:4> of User Register = '010'
-> EEPROM base address = 2 * h300 = h600
-> EEPROM address = h600 + h2E8 = h8E8
-> article code can be found at addresses h8E8 to h8F7)

Wordadr Offset	*#Words*	*Description/Format*
h2B6	1	scale factor
h2B7	1	measurement unit (for coding see below)

Note: The scale factor and the measurement unit were written to the EEPROM during calibration as information about the used calibration parameters. Scale factor and measurement unit cannot be changed after calibration.

4. Measurement Unit Coding

The 16bit flow unit code includes different types of information:

1. dimensions (e.g. milli, 0.001) (16 possibilities)
2. time base (e.g. per second) (16 possibilities)
3. unit (e.g. standard liter) (32 possibilities)
4. reserved (8 possibilities)

*Bit <3:0> (x*1)*	*Dimension*	*Prefix*
0 – 2	t.b.d.	
3	1e-9	n
4	1e-6	u
5	0.001	m
6	0.01	c
7	0.1	d
8	1	1
9	10	-
10	100	h
11	1000	k
12	1e6	M
13	1e9	G
14 – 15	t.b.d.	

*Bit <7:4> (x*16)*	*Time Base*	*Comment*
0	no time base	e.g. pressure / totalized flow
1	per microsecond	us
2	per millisecond	ms
3	per second	s
4	per minute	min
5	per hour	h
6	per day	day
7 – 15	t.b.d.	

*Bit <12:8> (x*256)*	*Volume / Pressure*	*Comment*
0	norm liter (0°C, 1013 hPa)	nl, typically for gas flow
1	standard Liter (20°C, 1013 hPa)	sl, typ. gas flow
2 – 7	t.b.d.	
8	liter (liquid)	l, typ. liquid flow
9	gram	g, typ. liquid flow
10 – 15	t.b.d.	
16	pascal	Pa, pressure
17	bar	bar, pressure
18	meter H_2O	m H_2O, pressure
19	inch H_2O	in H_2O, pressure
20 – 31	t.b.d.	

*Bit <15:13> (x*8192) are not defined*

Examples:

Unit	*Code*
nl/s	8*256 + 3*16 + 3 = 2099
m^3/s	8*256 + 3*16 + 11 = 2107
mln/min	0*256 + 4*16 + 5 = 69
hPa	16*256 + 0*16 + 10 = 4106

5. Tracking information

Some tracking information can be read out from the EEPROM, as the serial number, part name and item number of the sensor.

The EEPROM address is composed of an EEPROM base address and an address offset. To determine the base EEPROM address for general sensor information, bit <2:0> of Read-Only Register 2 (called active configuration field at boot time) must be multiplied by h300. Than the Wordadr Offset of the following table must be added to that address.

(Example: address of article code
- bit<2:0> of Read-Only Register 2 = '010'
-> EEPROM base address = 2 * h300 = h600
-> EEPROM address = h600 + h2E8 = h8E8
-> article code can be found at addresses h8E8 to h8F7)

Wordadr Offset	*#Words (16 bit)*	*Description/Format*
h2E4-h2E7	4	serial number chip (h2E4: MSB, h2E7: LSB)
h2E8-h2F1	10	Part name
h2F2-h2F7	6	Item number
h2F8-h2F9	2	serial number product

6. Revision history

Date	*Version*	*Changes*
June 2009	V1.0	Initial Release

Headquarter and Sales Offices

SENSIRION AG
Laubisruetistr. 50
CH-8712 Staefa ZH
Switzerland

Phone: + 41 (0)44 306 40 00
Fax: + 41 (0)44 306 40 30
info@sensirion.com
www.sensirion.com

SENSIRION Inc
Westlake Pl. Ctr. I, suite 204
2801 Townsgate Road
Westlake Village, CA 91361
USA

Phone: +1 805-409 4900
Fax: +1 805-435 0467
michael.karst@sensirion.com
www.sensirion.com

SENSIRION Japan
Sensirion Japan Co. Ltd.
Shinagawa Station Bldg. 7F
4-23-5 Takanawa
Minato-ku, Tokyo, Japan

phone: +81 3-3444-4940
fax: +81 3-3444-4939
info@sensirion.co.jp
www.sensirion.co.jp

SENSIRION Korea Co. Ltd.
#1414, Anyang Construction Tower B/D,
1112-1, Bisan-dong, Anyang-city,
Gyeonggi-Province, South Korea

Phone: +82-31-440-9925~27
Fax: +82-31-440-9927
info@sensirion.co.kr
www.sensirion.co.kr

SENSIRION China Co. Ltd.
Room 2411, Main Tower
Jin Zhong Huan Business Building,
Postal Code 518048
Futian District, Shenzhen, PR China

Phone: +86 755 8252 1501
Fax: +86 755 8252 1580
info@sensirion.com.cn/
www.sensirion.com.cn

Find your local representative at: http://www.sensirion.com/reps