# S-5611A Trimming adjustment method via serial interface communication

**Rev. 2_1_00**

## ■ Application Note Overview

This application note describes the following:

・S-5611A communication interface

・How to enter serial communication operation mode

・Trimming adjustment flow and register mapping

**S-5611A communication interface**

**■Communication interface overview**

The S-5611A has a built-in EEPROM and a volatile register, and can be programmed by sending commands from an external controller.
Can be written/read.
The S-5611A can be powered on by applying a specific voltage (VREF>VDD×0.8) to the VREF/SCL pin.
You can enter serial communication operation mode.
When the S-5611A is put into serial communication operation mode, the VOUT/SDA pin and the VREF/SCL pin are used
The 2-wire serial interface is enabled, allowing bidirectional communication between the S-5611A and an external controller.

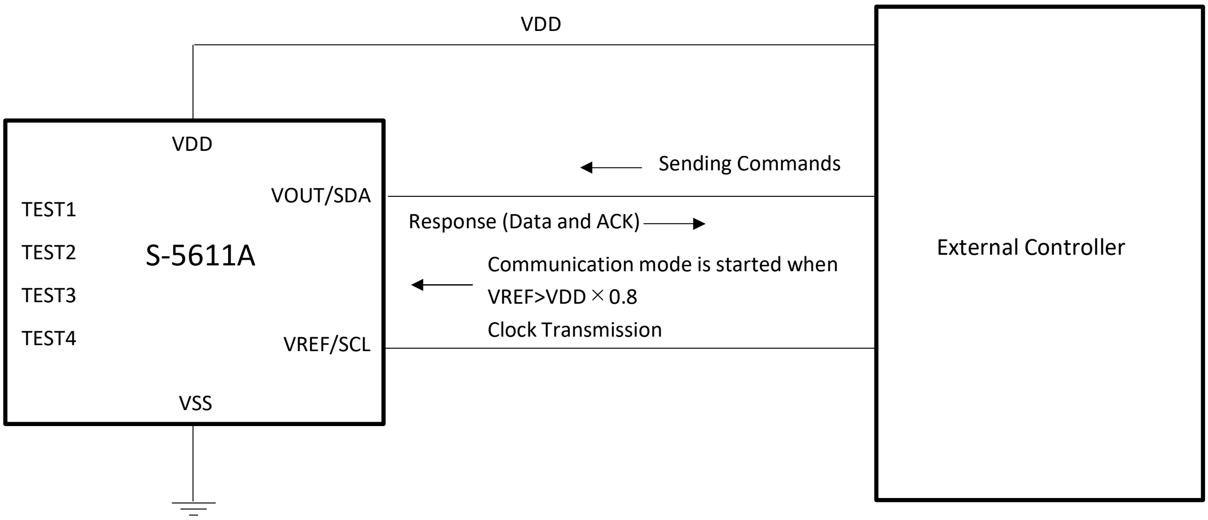



**Figure 1 Connection in communication mode**

### How to enter serial communication operation mode

**■How to start communication**

The timing chart below shows the power-on and keyword writing timing for putting the S-5611A into the serial communication operation mode.

When VREF > VDD x 0.8, VDD is raised to enable register access from the external controller.

Perform the initial communication (write keyword register).

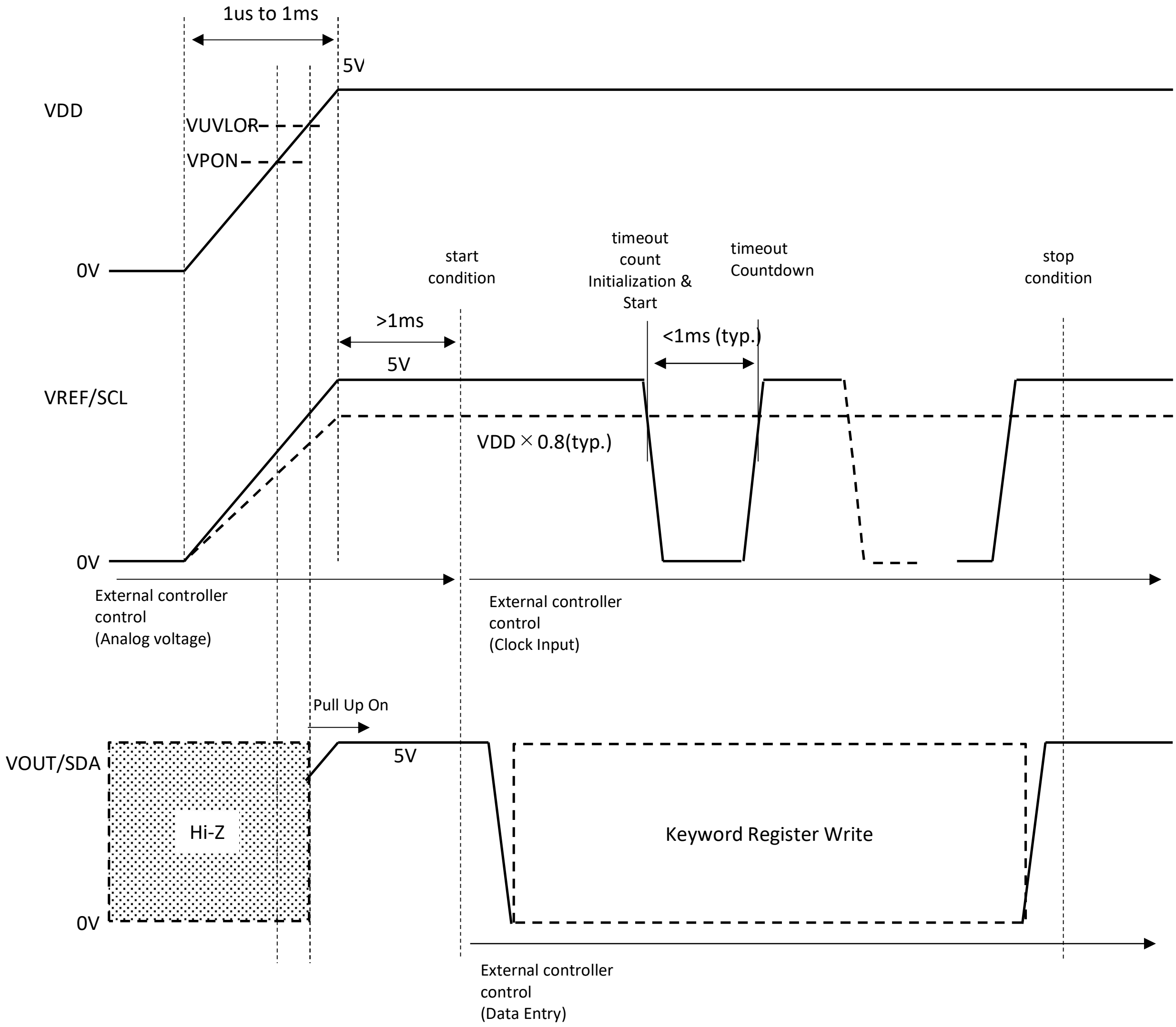



**Figure 2 Timing chart for power-on and keyword writing**

## ■ Capability required to drive the SDA pin and SCL pin during serial communication

In serial communication operation mode, the VOUT/SDA pin is pulled up to VDD by the resistor built into the S-5611A.
Therefore the external controller must have sink capability.

The VREF/SCL pin is in a Hi-Z state.
However, in order to re-enter the communication mode (described later), the linear hall sensor operation mode
The voltage of the VREF/SCL pin must be VDD x 0.8 or higher.
In the linear Hall sensor operation mode, the VREF/SCL pin is not Hi-Z,
so the external controller needs source capability.

Sink current required to drive the SDA pin > VDD÷RPU_SDA *15.63mA (max.)
Source current required to drive the SCL pin > IREF_SNK *14mA (max.)

・The sink current IREF_SNK of the VREF pin in the linear hall sensor operation mode is
Please refer to "1.4 Reference Voltage Characteristics" in the data sheet.
For the pull-up resistor RPU_SDA, refer to "2.3 DC Electrical Characteristics" in the data sheet.
・The above are DC current conditions. In terms of AC, please make sure to meet the conditions in "2.4 AC Electrical Characteristics" of the data sheet.

## ■Basic communication format

The basic format of data sent from an external controller during serial communication is as shown in Figure 3.

Command transmission begins by inputting a start condition from an external controller to the S-5611A.
The device address is sent first, and the read/write is determined by the 0/1 at the end of the device address.
If the IC receives the device address correctly, it will return an ACK as a response the next time the clock goes high.
In the case of a write, the controller sends a pointer and data, and in the case of a read, the S-5611A outputs data.
Finally, a stop condition is input from the controller to the S-5611A to end the command transmission.

*For details on serial communication operation, please refer to the data sheet.

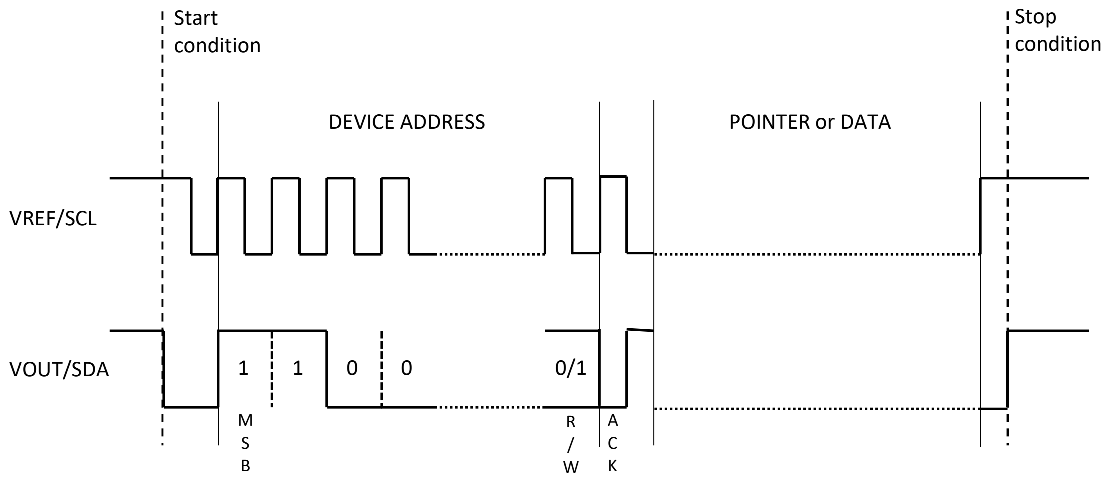



**Figure 3 Basic communication format**

## ■ Write keywords

The initial communication begins with writing a specific keyword to the keyword register.
After that, you will be able to access other registers, and you will be able to change the operation mode of the S-5611A, adjust the trimming, etc.

- The address of the keyword register is CFh.
・The data (keyword) to be sent is CDh.

**Data to send to the keyword register (CFh)**

Ch (B7–B4), Dh (B3–B0)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CFh | CFh | CFh | CFh | CFh | CFh | CFh | CFh |
| B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |

keyword

## ■How to exit communication mode

To exit communication mode, set the VREF pin to a voltage of VDD × 0.8 or less after the stop condition.
The serial communication operation mode is exited and then the linear hall sensor operation mode is entered.

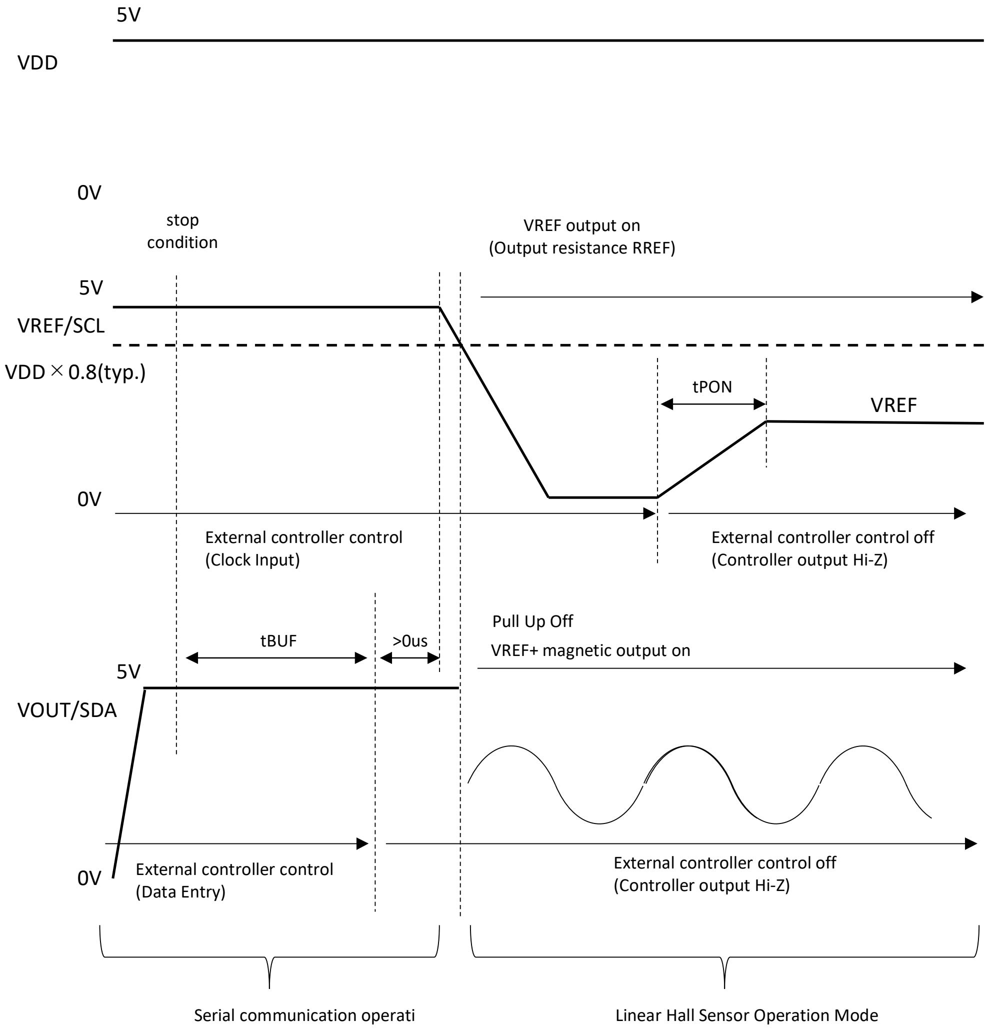



**Figure 4 Timing chart for leaving serial communication mode**

## ■How to re-enter communication mode

If the keyword CDh is written to the keyword register CFh, the linear hall sensor operation mode
Apply voltage to the VREF pin from an external controller and set VREF ≥ VDD × 0.8
to switch to serial communication operation mode.
You can reinject it.
By turning the power back on, the trimming adjustment can be performed with the linear hall sensor operation mode and the serial communication operation mode.
Register changes can be made while switching between operating modes without turning off the power.

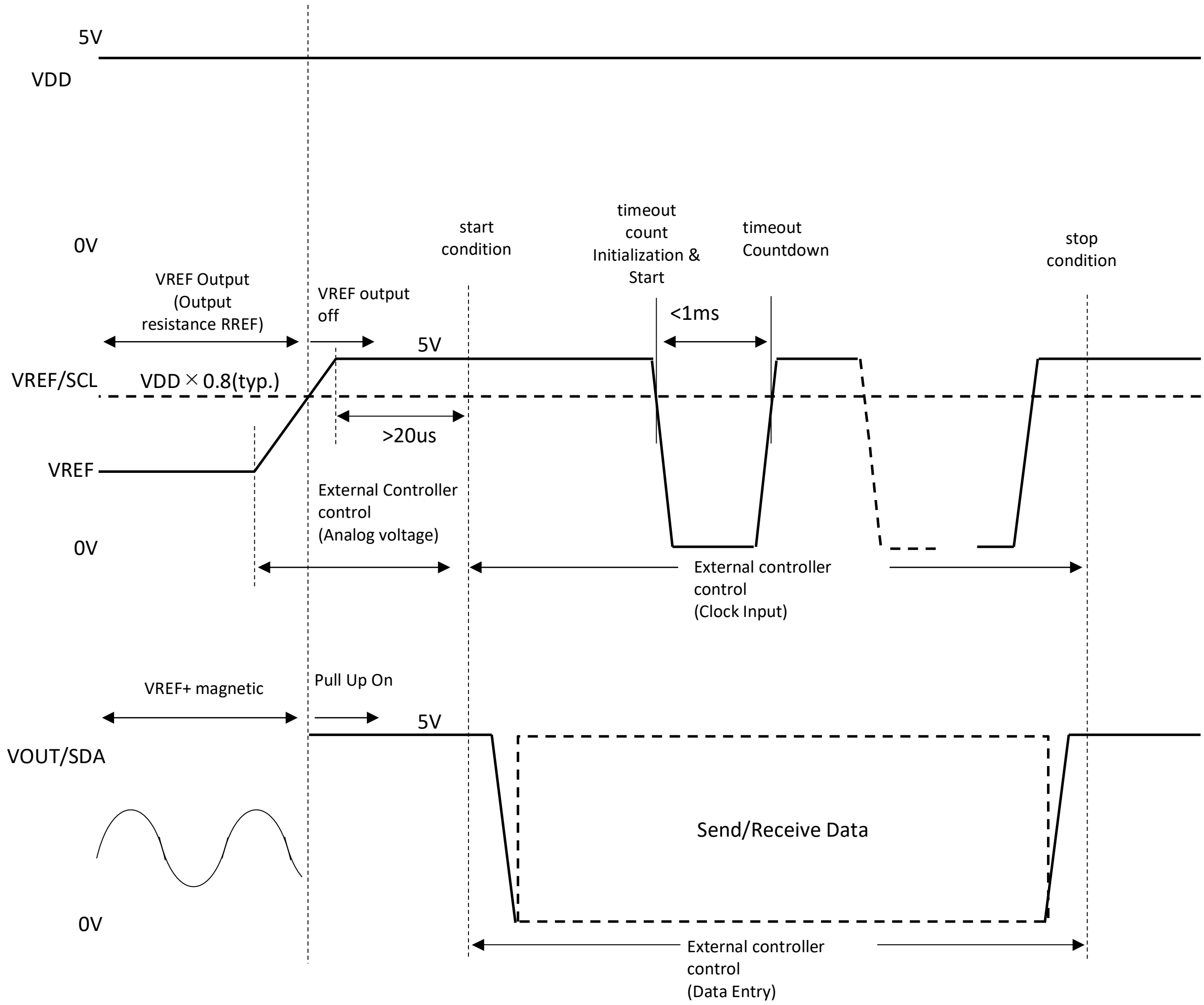



**Figure 5. Timing chart when re-entering communication mode**

## ■ Flowchart for initial communication

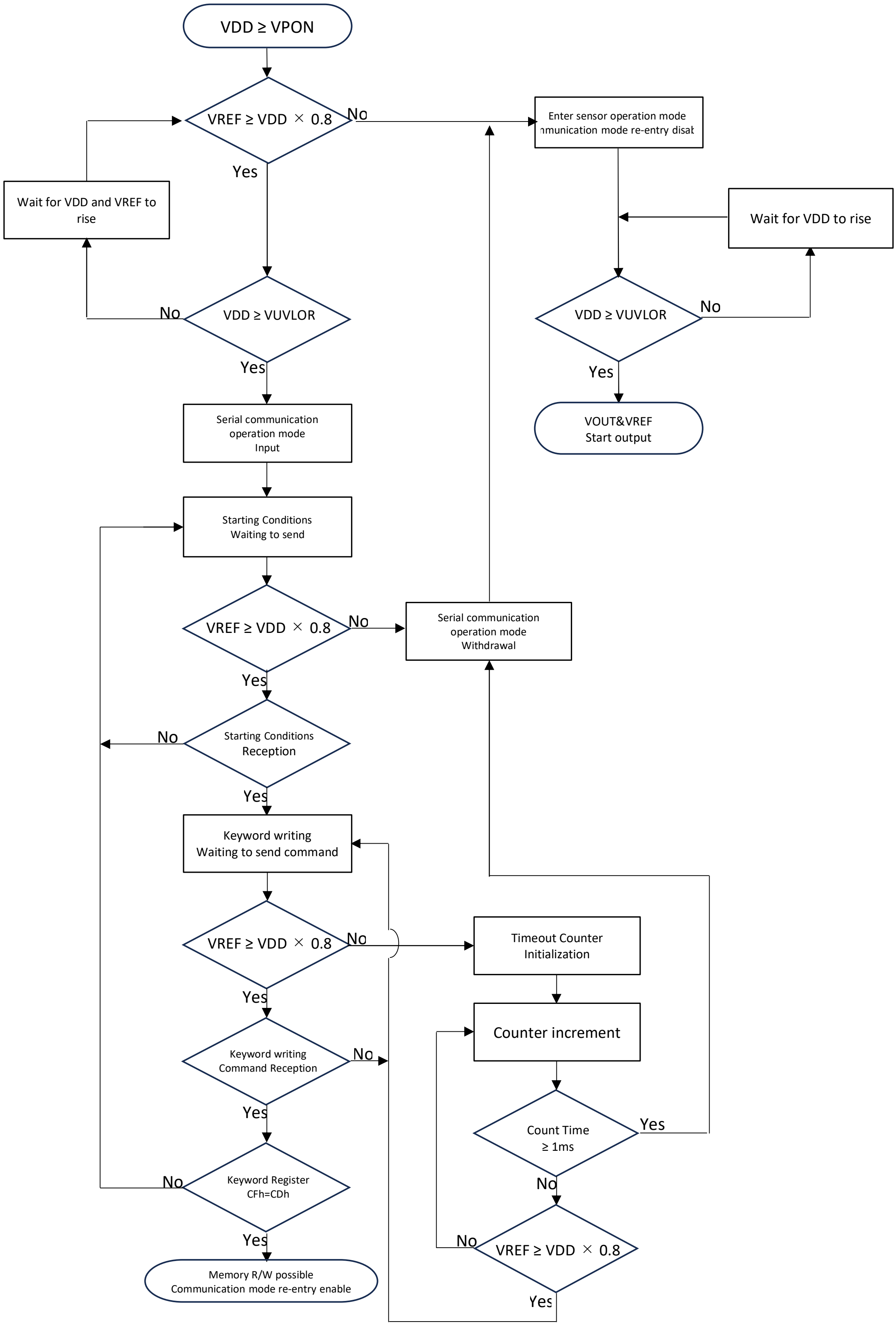



**Figure 6 Flowchart of initial communication to enable memory R/W**

## Trimming adjustment flow

### ■ How to proceed with trimming and memory configuration

The trimming adjustment of the S-5611A is done by writing to the register
in serial communication operation mode and
We will now proceed back and forth between measurements in the Linear Hall Sensor operating mode.

The memory of the S-5611A consists of a combination of non-volatile and volatile areas.

00h to 3Fh: Non-volatile memory area
40h to CFh: Volatile memory area

The trimming adjustment data for the S-5611A is stored in addresses 10h to 1Ah and 50h to 5Ah.
Addresses 10h to 1Ah are non-volatile areas, and any content written
therein is retained even if the power is restarted.
Addresses 50h to 5Ah are volatile areas, and any content written therein will be lost when the power is restarted.
When the power is turned on, the contents of 10h to 1Ah are stored in addresses 50h to 5Ah.

The characteristics of the S-5611A are adjusted by registers 50h to 5Ah, without referring
to the contents of registers 10h to 1Ah.
In trimming adjustment, we basically write from 50h to 5Ah.
When the finalized trimming results are stored, write to 10h to 1Ah.

Normally, tBUF in Figure 5 described in "2.4 AC Electrical Characteristics" of the data sheet is restricted
to min. 13 ms as described in Table 14.
When writing to registers 50h~5Ah, communication is possible with tBUF of min. 1300ns only.
Therefore, by using 50h to 5Ah, the time required for adjustment can be shortened.

## ■ Overview of the trimming process

The trimming process consists of steps 0 to 10 below.
Each step will be explained in detail below.

Step 0 Load Disable Enable
↓
Step 1 Setting the function switching register
↓ - Thermal shutdown enable/disable
↓ ・Output signal polarity
↓ Reference voltage
↓ - Frequency bandwidth
↓
Step 2 Adjustment of magnetic sensitivity temperature drift (not measured)
↓ *Here, adjust the sensitivity without measuring the temperature characteristic.
↓ If you want to adjust the sensitivity temperature characteristic
↓ with even higher accuracy, perform steps 7a or 7b.
↓
Step 3 VREF Adjustment
↓ *No adjustment is required when using reference voltage input mode.
↓
Step 4 Magnetic sensitivity coarse adjustment
↓
Step 5 Output offset voltage temperature drift adjustment
↓
Step 6 Magnetic Sensitivity Adjustment
↓
Step 7 7a. Magnetic sensitivity temperature drift adjustment or 7b. Magnetic sensitivity temperature
↓ drift adjustment (with adjustment step measurement)
↓ *Step 7 involves actually measuring and adjusting the temperature drift.
↓ This is done when you want to adjust the temperature drift with higher accuracy.
↓
↓ *7a is calculated by leading the temperature characteristic adjustment steps recorded
↓ at the time of shipment.
↓
↓ *7b is calculated by measuring the actual temperature adjustment steps.
↓ Since there are more measurement steps, the adjustment time increases, but
↓ Sensitivity and temperature characteristics can be adjusted with higher precision than 7a
↓
Step 8 Offset Adjustment
↓
Step 9 Write trimming results to non-volatile address
↓
Step 10 Write Protect
*Once write protection is enabled, it cannot be disabled again.
Please do as necessary.

■ Register mapping

The register mapping of the S-5611A is shown below.

Please refer to the trimming flow for how to calculate the data to be written to each register.

<table>
<tr><th></th><th>B7</th><th>B6</th><th>B5</th><th>B4</th><th>B3</th><th>B2</th><th>B1</th><th>B0</th></tr>
<tr><td>00h<br>～08h</td><td colspan="8">Unused</td></tr>
<tr><td>09h</td><td colspan="3">Unused</td><td colspan="5">VOUT_OFF_TC_ADJ1</td></tr>
<tr><td>0Ah</td><td colspan="8">VOUT_OFF_TC_ADJ2</td></tr>
<tr><td>0Bh</td><td colspan="8">VOUT_OFF_TC_ADJ3</td></tr>
<tr><td>0Ch</td><td colspan="3">Unused</td><td colspan="5">VOUT_OFF_TC_ADJ1</td></tr>
<tr><td>0Dh</td><td colspan="8">VOUT_OFF_TC_ADJ2</td></tr>
<tr><td>0Eh</td><td colspan="8">VOUT_OFF_TC_ADJ3</td></tr>
<tr><td>0Fh</td><td colspan="3">Unused</td><td colspan="5">SENSE_TC_TABLE</td></tr>
<tr><td></td><td>B7</td><td>B6</td><td>B5</td><td>B4</td><td>B3</td><td>B2</td><td>B1</td><td>B0</td></tr>
<tr><td>10h</td><td colspan="8">VOUT_OFF[8:1]</td></tr>
<tr><td>11h</td><td colspan="3">Unused</td><td colspan="5">SENSE_COARSE(11h)</td></tr>
<tr><td>12h</td><td colspan="7">Fixed to "0" ("1" write prohibited)</td><td>SENSE_COARSE(12h)</td></tr>
<tr><td>13h</td><td colspan="7">Unused</td><td>TSD_EN</td></tr>
<tr><td>14h</td><td colspan="8">SENSE_FINE[7:0]</td></tr>
<tr><td>15h</td><td>Unused</td><td colspan="6">SENSE_TC</td><td>SENSE_REV</td></tr>
<tr><td>16h</td><td colspan="3">Unused</td><td>VREF_SEL</td><td>VREF_EXT</td><td>Unused</td><td colspan="2">VREF_SEL</td></tr>
<tr><td>17h</td><td colspan="2">Unused</td><td colspan="6">VREF</td></tr>
<tr><td>18h</td><td colspan="8">Unused</td></tr>
<tr><td>19h</td><td>VOUT_OFF [0]</td><td>Adjustment Range Expansion</td><td>Unused</td><td colspan="5">VOUT_OFF_TC</td></tr>
<tr><td>1Ah</td><td colspan="2">FBW_SEL</td><td colspan="3">Fixed to "0" ("1" write prohibited)</td><td colspan="3">SENSE_FINE[9:8]</td></tr>
<tr><td>1Bh<br>~1Eh</td><td colspan="8">Unused</td></tr>
<tr><td>1Fh</td><td colspan="7">Unused</td><td>Write Protect</td></tr>
<tr><td>20h<br>～3Fh</td><td colspan="8">No access</td></tr>
<tr><td></td><td>B7</td><td>B6</td><td>B5</td><td>B4</td><td>B3</td><td>B2</td><td>B1</td><td>B0</td></tr>
<tr><td>40h<br>~4Eh</td><td colspan="8">Unused</td></tr>
<tr><td>4Fh</td><td colspan="7">Unused</td><td>LOAD_DIS</td></tr>
<tr><td>50h<br>～5Ah</td><td colspan="8">Same mapping as 10h to 1Ah<br>LOAD_DIS=0b When the linear hall sensor is in operation, the contents of 10h to 1Ah are loaded.<br>LOAD_DIS=1b Do not load when linear hall sensor is in operation.</td></tr>
<tr><td>5Bh<br>～5Fh</td><td colspan="8">Unused</td></tr>
<tr><td>60h<br>~CEh</td><td colspan="8">No access</td></tr>
<tr><td>CFh</td><td colspan="8">Keyword Register</td></tr>
</table>

- About "unused" areas

Data can be written to the unused areas, but it will not affect the operation of the S-5611A.

・About 4Fh

4Fh can be written to, but when read, all bits are set to "0" regardless of the current register value.

- About "No Access" Areas

An inaccessible area is an area where reading/writing is not possible.

If you send a Read/Write command specifying this address, the IC will return a NACK.

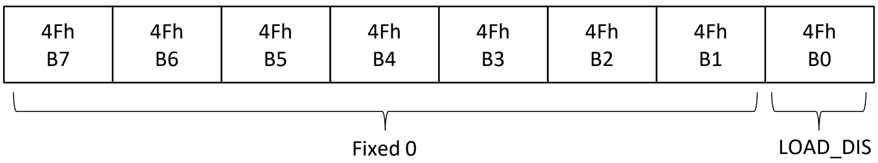
## ■ Enable Load Disable

Immediately after power-on, the contents of 50h to 5Ah are overwritten with the same contents as 10h to 1Ah each time the serial communication operation mode is exited.
By enabling the load disable function, the contents of 50h to 5Ah can be maintained when leaving the mode.
Enable load disable before starting trimming.
The load disable function can be enabled/disabled by the LOAD_DIS register (4Fh B0).

| Address | bit | Register Name | Register Function |
|---|---|---|---|
| 4Fh | B0 | LOAD_DIS | Load Disable Enable/Disable |

| Load disable function enable/disable | LOAD_DIS |
|---|---|
| invalid | 0 |
| valid | 1 |

**Data to send to the load disable register (4Fh)**




* When address 4Fh is read, all bits are output as "0" regardless of the current register value.

Please write LOAD_DIS=1 before starting trimming.

## ■ Setting the function switching register

Before fine-tuning VREF, magnetic sensitivity, and output offset voltage,
Set the other register contents to the values you would normally use as a sensor.

| Address | bit | Register Name | Register Function |
|---|---|---|---|
| 53h | B0 | TSD_EN | Thermal shutdown enable/disable |
| 55h | B0 | SENSE_REV | Output signal polarity selection |
| 56h | B4, B1~B0 | VREF_SEL | Reference Voltage Selection |
| 56h | B3 | VREF_EXT | Reference voltage operating mode selection |
| 5Ah | B7~B6 | FBW_SEL | Frequency Band Selection |

**- Thermal shutdown enable/disable setting**

Thermal shutdown can be enabled or disabled using the TSD_EN register.

| Thermal shutdown enable/disable | TSD_EN |
|---|---|
| invalid | 0 |
| valid | 1 |

| 53h B7 | 53h B6 | 53h B5 | 53h B4 | 53h B3 | 53h B2 | 53h B1 | 53h B0 |
|---|---|---|---|---|---|---|---|
| Unused | | | | | | | TSD_EN |

**- Output signal polarity setting**

The polarity of the output signal can be switched using the SENSE_REV register.
The magnetic sensitivity and output offset voltage are affected by the SENSE_REV setting, so set this first.

| Output signal polarity | SENSE_REV |
|---|---|
| Positive electrode | 0 |
| The opposite extreme | 1 |

| 55h B7 | 55h B6 | 55h B5 | 55h B4 | 55h B3 | 55h B2 | 55h B1 | 55h B0 |
|---|---|---|---|---|---|---|---|
| Unused | SENSE_TC | | | | | | SENSE_REV |

*The method for determining SENSE_TC will be shown in step 2 below.

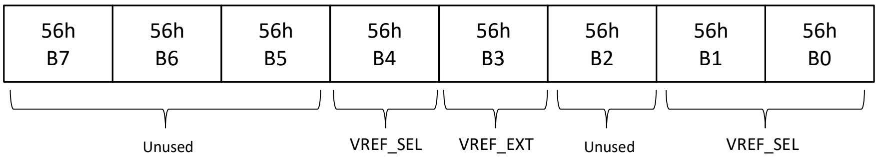
**・Reference voltage setting**

Reference voltage input mode enable/disable. Can be set in VREF_EXT register (address 56h B3)

| eference Voltage Operation Mod | VREF_EXT |
|---|---|
| Reference Voltage Output Mode | 0 |
| Reference Voltage Input Mode | 1 |

In reference voltage output mode, the magnitude of the reference voltage to be output can be selected by the VREF_SEL register (address 56h B4, B1 to B0).

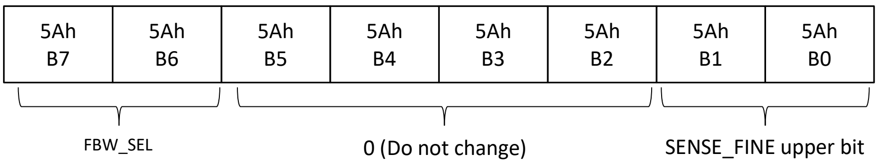
| Reference Voltage | VREF_SEL(B4) | VREF_SEL(B1~B0) |
|---|---|---|
| 2.50 | 0b | 00b |
| 1.65 | 0b | 01b |
| 1.50 | 1b | 10b |
| 0.50 | 1b | 11b |




**・Frequency bandwidth setting**

The frequency bandwidth can be changed using the FBW_SEL register (address 5Ah B7~B6).

| Frequency Bandwidth | FBW_SEL |
|---|---|
| 400kHz | 00b |
| 200kHz | 01b |
| 100kHz | 10b |



1 Determine and write TSD_EN

*Write 0 to B7 to B1 of address 53h and TSD_EN to B0.

| 53h B7 | 53h B6 | 53h B5 | 53h B4 | 53h B3 | 53h B2 | 53h B1 | 53h B0 |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | TSD_EN |

2 Determine SENSE_REV and write

*Write 0 to B7 to B1 of address 55h and SENSE_REV to B0.

| 55h B7 | 55h B6 | 55h B5 | 55h B4 | 55h B3 | 55h B2 | 55h B1 | 55h B0 |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | SENSE_REV |

3 Determine VREF_SEL and VREF_EXT and write

| 56h B7 | 56h B6 | 56h B5 | 56h B4 | 56h B3 | 56h B2 | 56h B1 | 56h B0 |
|---|---|---|---|---|---|---|---|
| 0 | | | n the table below according to yo | | | | |

*Select a setting from the table below and determine the value to write to register 56h.

| Reference Voltage Operation Mode | Reference Voltage | Input Reference Voltage | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Reference Voltage Output Mode | 2.50V | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1.65V | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 1.50V | | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| | 0.50V | | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| Reference Voltage Input Mode | | 1.65V≦V≦2.65V | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | | 0.5V≦V<1.65V | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |

4 Read address 5Ah

The contents of B1 to B0 are read with the purpose of retransmitting them as is in the next "5"

5 Determine FBW_SEL and write

| 5Ah B7 | 5Ah B6 | 5Ah B5 | 5Ah B4 | 5Ah B3 | 5Ah B2 | 5Ah B1 | 5Ah B0 |
|---|---|---|---|---|---|---|---|
| FBW_SEL | | 0 | | | | SENSE_FINE upper bit<br>Send pre-read content | |

## ■ Adjustment of magnetic sensitivity temperature drift (not measured)

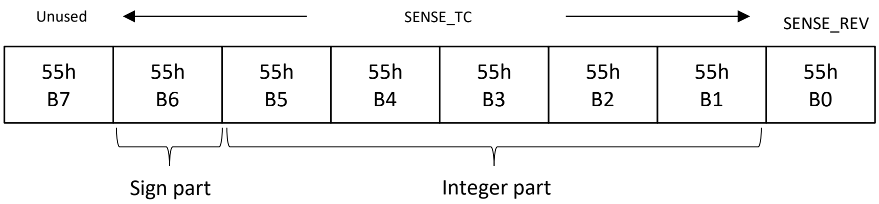
Before fine-tuning VREF, magnetic sensitivity, and output offset voltage,
Adjust magnetic sensitivity temperature drift

| Address | bit | Register Name | Feature Name |
|---|---|---|---|
| 55h | B6~B1 | SENSE_TC | Magnetic Sensitivity Temperature Drift Adjustment |

**- Setting magnetic sensitivity temperature drift**

The magnetic sensitivity temperature drift can be set in the SENSE_TC register (address 55h).

The SENSE_TC register is a total of 6 bits, B6 to B1, at address 15h (55h).
・The format of SENSE_TC is a signed integer (-31 to 31). Integer part: B5 to B1 Sign part: B6 (1=positive 0=negative)




The adjustment step when changing the SENSE_TC register by 1 varies between individual devices.
The adjustment steps for each unit are recorded in the SENSE_TC_TABLE (address 0Fh) before shipping.

SENSE_TC_TABLE is a 5-bit unsigned integer (0 to 31).
By reading SENSE_TC_TABLE, the correspondence between the value
and the temperature drift adjustment amount can be understood in a table.

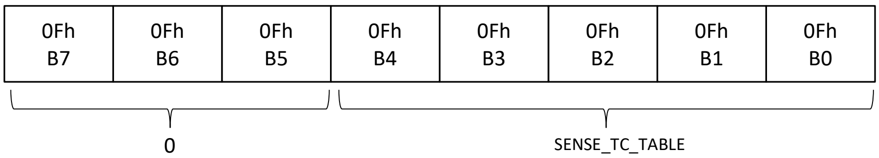


Table SENSE_TC_TABEL and temperature drift adjustment steps

| SENSE_TC_TABLE | Temperature drift adjustment step (ppm/°C) |
|---|---|
| 0 | 16.80 |
| 1 | 17.55 |
| 2 | 18.29 |
| 3 | 19.04 |
| 4 | 19.78 |
| 5 | 20.53 |
| 6 | 21.27 |
| 7 | 22.02 |
| 8 | 22.76 |
| 9 | 23.51 |
| 10 | 24.25 |
| 11 | 25.00 |
| 12 | 25.74 |
| 13 | 26.49 |
| 14 | 27.23 |
| 15 | 27.98 |
| 16 | 28.72 |
| 17 | 29.47 |
| 18 | 30.21 |
| 19 | 30.96 |
| 20 | 31.70 |
| 21 | 32.45 |
| 22 | 33.19 |
| 23 | 33.94 |
| 24 | 34.68 |
| 25 | 35.43 |
| 26 | 36.17 |
| 27 | 36.92 |
| 28 | 37.66 |
| 29 | 38.41 |
| 30 | 39.15 |
| 31 | 39.90 |

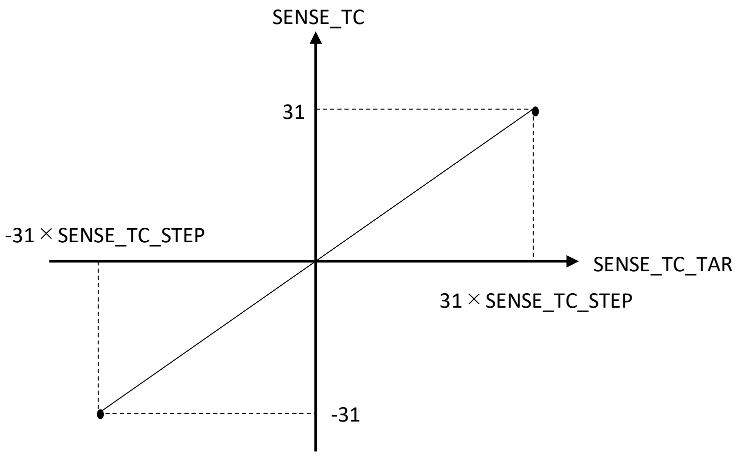
**・Adjustment flow for magnetic sensitivity temperature drift**

| Variable Name | Variable type | explanation |
|---|---|---|
| SENSE_TC_TABLE | Shipment record value | An integer number corresponding to the adjustment step of the magnetic sensitivity temperature drift |
| SENSE_TC_STEP | Shipment record value | Adjustment steps for magnetic sensitivity temperature drift corresponding to SENSE_TC_TABLE |
| SENSE_TC_TAR | Adjustment target value | Adjustment target value for magnetic sensitivity temperature drift |
| SENSE_TC_SET | Register setting value | Optimal value of SENSE_TC |

1 Read the SENSE_TC_TABLE

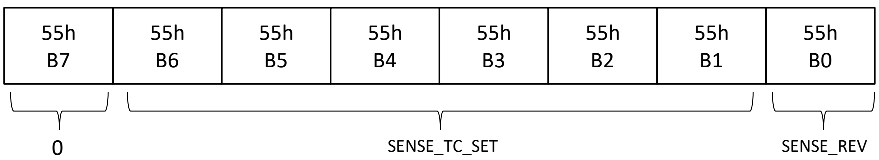
2 Calculate SENSE_TC_SET
・The target magnetic sensitivity temperature drift (ppm/°C) is SENSE_TC_TAR
・The temperature characteristic adjustment step (ppm/°C) corresponding to SENSE_TC_TABEL is set to SENSE_TC_STEP

SENSE_TC_SET = SENSE_TC_TAR ÷ SENSE_TC_STEP
*SENSE_TC_SET is rounded off to an integer.




3 Write SENSE_TC
Write SENSE_TC=SENSE_TC_SET

* Write 0 to B7 of address 55h, SENSE_TC_SET to B6 to B1, and the SENSE_REV determined in step 1 to B0.



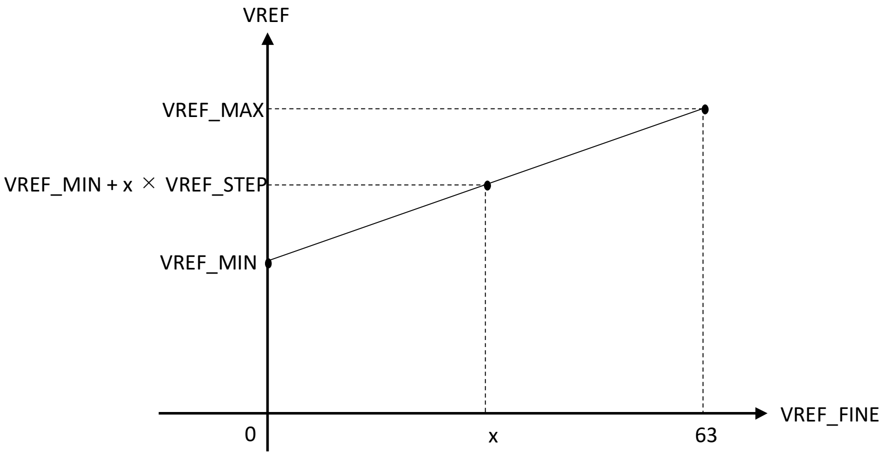
## ■ VREF adjustment

**・How to use the VREF_FINE register**

・B5 to B0 are treated as unsigned integers (0 to 63).

・When writing, the specified integer (0 to 63) is converted to a 6-digit binary number, and B5 to B0 of the transmission data are set, and B7 to B6 are set to 00b.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 57h<br>B7 | 57h<br>B6 | 57h<br>B5 | 57h<br>B4 | 57h<br>B3 | 57h<br>B2 | 57h<br>B1 | 57h<br>B0 |
| Unused (00b) | | VREF_FINE | | | | | |




**Adjustment amount of VREF relative to VREF_FINE**

・**VREF_FINE adjustment flow**

**<Explanation of variables in the flow>**

| Variable Name | Variable type | explanation |
|---|---|---|
| VREF_FINE_INI | Register setting value | VREF_FINE before adjustment |
| VREF_INI | Measurements | VREF pin voltage before adjustment |
| VREF_MAX | Measurements | VREF pin voltage when VREF_FINE=63 |
| VREF_MIN | Measurements | VREF pin voltage when VREF_FINE=0 (measured value) |
| VREF_STEP | Calculated value | The amount of change in the VREF pin voltage when VREF_FINE changes by +1 |
| VREF_TAR | Adjustment target value | VREF adjustment target value |
| VREF_FINE_TRM1 | Register setting value | VREF_FINE after adjustment (1st time) |
| VREF_TRM | Measurements | VREF pin voltage after the first adjustment |
| VREF_FINE_TRM2 | Register setting value | VREF_FINE after adjustment (2nd time) |
| VREF_TRM2 | Measurements | VREF pin voltage after second adjustment |

1 Read the VREF_FINE (57h) register.
The read result is VREF_FINE_INI.

2 Measure the VREF voltage and set the measured value as VREF_INI.

3 Write 63 to VREF_FINE(57h)

4 Measure the VREF voltage and set the measured value as VREF_MAX.

5 Write 0 to VREF_FINE(57h)

6 Measure the VREF voltage and set the measured value as VREF_MIN.

7 Calculate the new VREF_FINE
VREF_STEP=(VREF_MAX-VREF_MIN)÷63
VREF_TAR = VREF target voltage
VREF_FINE_TRM1=(VREF_TAR-VREF_INI)÷VREF_STEP+VREF_FINE_INI
*VREF_FINE_TRM1 should be rounded off to the nearest integer.

8 Write VREF_FINE_TRM1 to VREF_FINE(57h)

9 Measure the VREF voltage and set it as VREF_TRM.
Determine whether the following conditions are met.
-VREF_STEP÷2 < ( VREF_TRM - VREF_TAR ) < VREF_STEP÷2

If it is met, proceed to coarse magnetic sensitivity adjustment.
If not, perform an additional trimming in the steps from "10" onwards.

10 Calculate VREF_FINE_TRM2=(VREF_TAR - VREF_TRM)÷VREF_STEP+VREF_FINE_TRM1
*VREF_FINE_TRM2 should be rounded off to the nearest integer.

11 Write VREF_FINE_TRM2 to VREF_FINE(57h)

12 Measure the VREF voltage and set it as VREF_TRM2.
Make sure the final VREF voltage meets the required accuracy.

## ■ Magnetic sensitivity coarse adjustment

### ・How to use the SENSE_COARSE register

SENSE_COARSE is a total of 6 bits, B4 to B0 of address 11h (51h) and B0 of address 12h (52h)

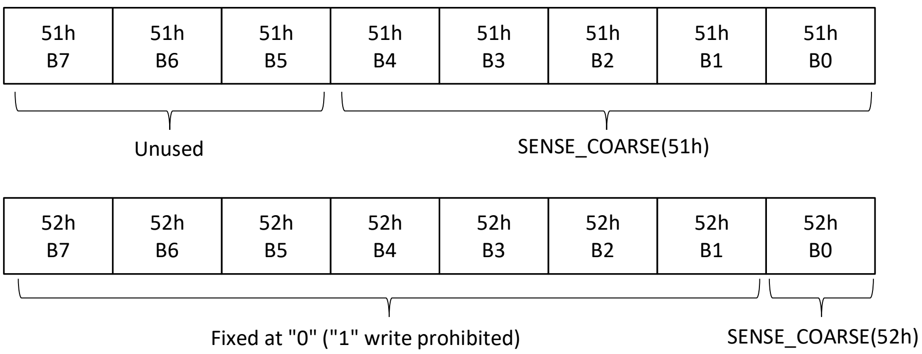
・When writing to address 11h (51h), B4 to B0 of the send data should be a 5-bit binary number corresponding to the dB value to be set, and B7 to B5 should be 000b.

・Even if you want to change only SENSE_COARSE,
you must send the data of the other bits (B7 to B1) in address 12h (52h).
Please set B7 to B1 to 0.

・Refer to the table below and write the binary number that corresponds to the SENSE_CORASE setting.

Relationship between dB value and binary number to be written

| Setting SENSE_COARSE | Magnetic Sensitivity | SENSE_COARSE(51h) | SENSE_COARSE(52h) |
|---|---|---|---|
| RG1 | Factory coarse adjustment settings x 2 | 0 0000b | 0b |
| RG2 | Factory coarse adjustment | 0 0000b | 1b |
| RG3 | Factory coarse adjustment setting divided by 2 | 0 0100b | 1b |
| RG4 | Factory coarse adjustment setting ÷ 4 | 0 0110b | 1b |
| RG5 | Factory coarse adjustment setting ÷8 | 0 0111b | 1b |
| RG6 | Factory coarse adjustment setting ÷ 16 | 1 0111b | 1b |
| RG7 | Factory coarse adjustment setting ÷ 32 | 1 1111b | 1b |



**・How to use the SENSE_FINE register**

SENSE_FINE is divided into two addresses, B1 to B0 at address 1Ah (5Ah) and B7 to B0 at address 14h (54h), for a total of 10 bits.

・The calculation is performed with B1 to B0 of address 1Ah (5Ah) as the upper bits and B7 to B0 of address 14h (54h) as the lower bits.

・The format of SENSE_FINE is an unsigned integer (0 to 1023).

| MSB | | | | | | | | | LSB |
|---|---|---|---|---|---|---|---|---|---|
| 5Ah B1 | 5Ah B0 | 54h B7 | 54h B6 | 54h B5 | 54h B4 | 54h B3 | 54h B2 | 54h B1 | 54h B0 |

Integer part (unsigned)

・Even if you want to change only SENSE_FINE, you need to send the data of other bits (B7 to B2) in address 1Ah (5Ah).

If you do not want to rewrite B7 to B2, read them in advance and send the values read out.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 54h B7 | 54h B6 | 54h B5 | 54h B4 | 54h B3 | 54h B2 | 54h B1 | 54h B0 |

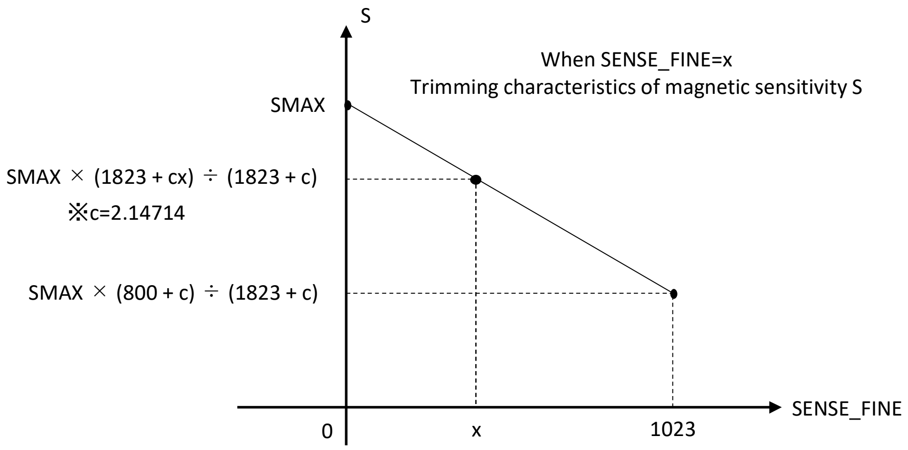
SENSE_FINE lower bit

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5Ah B7 | 5Ah B6 | 5Ah B5 | 5Ah B4 | 5Ah B3 | 5Ah B2 | 5Ah B1 | 5Ah B0 |
| FBW_SEL | | 0 (Do not change) | | | | SENSE_FINE upper bit | |

*If you do not want to rewrite FBW_SEL, send the contents that you read in advance.

The relationship between magnetic sensitivity S and SENSE_FINE is relative, and calculations are based on the magnetic sensitivity when SENSE_FINE=0.
Using the magnetic sensitivity SMAX when SENSE_FINE=0 as a reference, the adjustment result can be calculated using the following formula.

Magnetic sensitivity S=SMAX×(1823+c-SENSE_FINE)÷(1823 ※c=2.14714



・**SENSE_COARSE Adjustment flow selection**

Two types of flow can be selected for magnetic sensitivity adjustment

Adjustment flow 1: Apply the maximum magnetic field that will be applied during actual use,
and set the sensor output voltage at that time as the target. Adjust it to exceed the voltage.

Adjustment flow 2 ⇒ Apply the magnetic field you want to sense accurately during actual use,
and check the magnetic sensitivity at that time. Adjust to exceed the target value.

If the applied magnetic field range and the sensor output at that time are important, select adjustment flow 1.
When there is a magnetic field within the applied magnetic field range that needs to be sensed
with particular accuracy, or when the applied magnetic field range is If not specified, select Adjustment Flow 2.

・**SENSE_COARSE adjustment flow 1**

| Variable Name | Variable type | explanation |
|---|---|---|
| BFS | Test conditions | Magnetic field range used as sensor |
| VSIGFS_TAR | Adjustment target va | Sensor output target for BFS |
| VOUT0_M31 | Measurements | VOUT pin voltage in no magnetic field when SENSE_TC=-31 is set |
| VOUT0_P31 | Measurements | VOUT pin voltage in no magnetic field when SENSE_TC=31 is set |
| VOUTFS_M31 | Measurements | VOUT pin voltage for magnetic field BFS when SENSE_TC=-31 is set |
| VOUTFS_P31 | Measurements | VOUT pin voltage for magnetic field BFS when SENSE_TC=31 is set |
| VSIGFS_M31 | Calculated value | Sensor output for BFS when SENSE_TC=-31 is set |
| VSIGFS_P31 | Calculated value | Sensor output for BFS when SENSE_TC=31 is set |
| SENSE_TC_SET2 | Register setting valu | Optimal SENSE_TC_SET setting after adjusting SENSE_CORSE |
| SENSE_TC_TAR | Adjustment target va | Adjustment target value for magnetic sensitivity temperature drift |
| C_SENSE_TC | Calculated value | Correction value of SENSE_TC_SET2 according to SENSE_CORSE |
| SENSE_TC_STEP | Calculated value | Adjustment target value for magnetic sensitivity temperature drift |

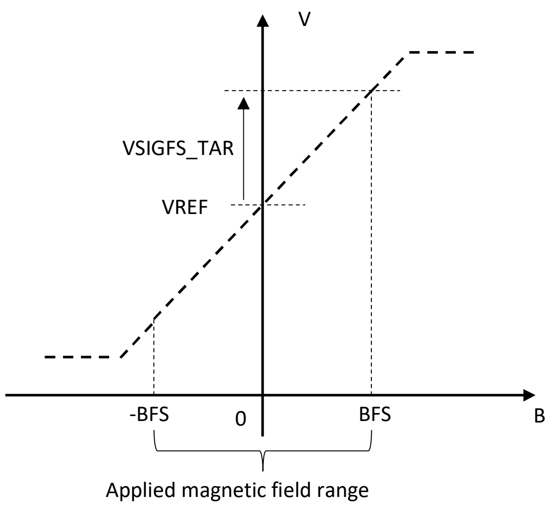
In the following explanation, SENSE_FINE reads/writes to 5Ah and 54h.
SENSE_COARSE is read and written to 51h and 52h.

1 Definition of maximum magnetic flux density (BFS)

Even if a magnetic field larger than the maximum magnetic flux density BMAX that can be applied
to the S-5611A is applied, VOUT cannot change in response to a magnetic field.
Therefore, depending on the specifications of the product (such as a current sensor) that incorporates the S-5611,
Determine the range of magnetic flux densities over which VOUT must change.
And the maximum magnetic flux density in that range is called BFS.

2 Definition of target maximum output voltage VSIGFS_TAR

The target for adjusting the magnetic sensitivity is the maximum magnetic flux density (BFS) applied.
Define the target maximum output voltage VSIGFS_TAR



3 Set SENSE_FINE to maximum sensitivity

・Write SENSE_FINE=0. Please send data according to the diagram below, except for SENSE_FINE.

| 54h<br>B7 | 54h<br>B6 | 54h<br>B5 | 54h<br>B4 | 54h<br>B3 | 54h<br>B2 | 54h<br>B1 | 54h<br>B0 |
|---|---|---|---|---|---|---|---|
| SENSE_FINE lower bit | | | | | | | |

| 5Ah<br>B7 | 5Ah<br>B6 | 5Ah<br>B5 | 5Ah<br>B4 | 5Ah<br>B3 | 5Ah<br>B2 | 5Ah<br>B1 | 5Ah<br>B0 |
|---|---|---|---|---|---|---|---|
| FBW_SEL | | 0 | | | | SENSE_FINE upper bit | |

*In this flow, the FBW_SEL determined in step 1 is written to FBW_SEL.

*Please repeat steps 4 to 9 below for i=0 to 6.

4 Write SENSE_COARSE=RG7-i

| 51h<br>B7 | 51h<br>B6 | 51h<br>B5 | 51h<br>B4 | 51h<br>B3 | 51h<br>B2 | 51h<br>B1 | 51h<br>B0 |
|---|---|---|---|---|---|---|---|
| 0 | | | SENSE_COARSE(51h) | | | | |

| 52h<br>B7 | 52h<br>B6 | 52h<br>B5 | 52h<br>B4 | 52h<br>B3 | 52h<br>B2 | 52h<br>B1 | 52h<br>B0 |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | SENSE_COARSE(52h) |

5 Write SENSE_TC=-31

After that, measure VOUT without applying a magnetic field, and let the measurement result be VOUT0_M31.

| 55h<br>B7 | 55h<br>B6 | 55h<br>B5 | 55h<br>B4 | 55h<br>B3 | 55h<br>B2 | 55h<br>B1 | 55h<br>B0 |
|---|---|---|---|---|---|---|---|
| 0 | SENSE_TC | | | | | | SENSE_REV |

*In this flow, write the SENSE_REV determined in step 1 to SENSE_REV.

*For the following "6", "7", "8", and "11", write in the same way, changing only the SENSE_TC.

6 Write SENSE_TC=31

After that, measure VOUT without applying a magnetic field, and set the measurement result as VOUT0_P31.

7 Write SENSE_TC=-31

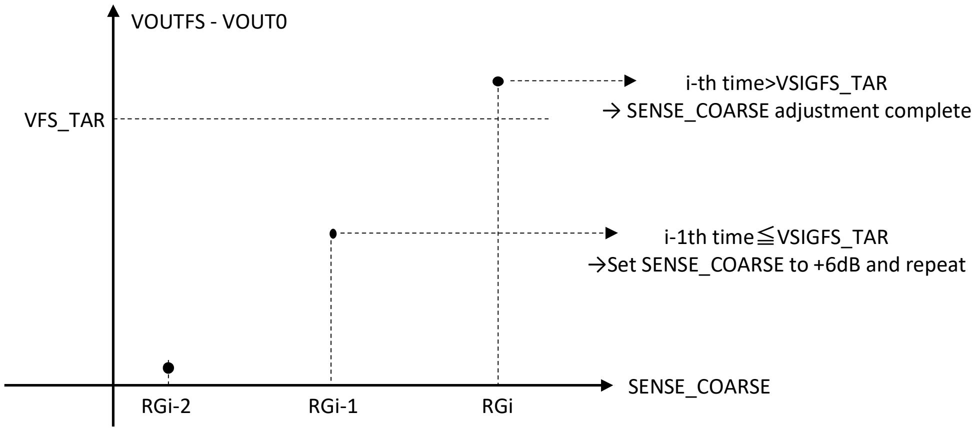
Then, measure VOUT with BFS applied, and set the measurement result as VOUTFS_M31.

8 Write SENSE_TC=31

Then, measure VOUT with BFS applied, and set the measurement result as VOUTFS_P31.

9 VSIGFS_M31=VOUTFS_M31-VOUT0_M31
VSIGFS_P31=VOUTFS_P31-VOUT0_M31

If VSIGFS_P31>VSIGFS_TAR and VSIGFS_M31>VSIGFS_TAR, end the loop and proceed to "10" below.
If the above termination condition is not met and i<6, recalculate i=i+1 and return to "4".
If the above termination condition is not met and i=6, the VFS cannot be adjusted.




10 Calculate SENSE_TC_SET2=(SENSE_TC_TAR+CSENSE_TC)÷SENSE_TC_STEP
* SENSE_TC_TAR is the value defined in "1. Setting the function switching register"
*SENSE_TC_SET2 is rounded off to an integer.
*Select C_SENSE_TC from the table below to correct the change in sensitivity temperature characteristic due to SENSE_COARSE.

| Setting SENSE_COARSE | C_SENSE_TC |
|---|---|
| RG1 to RG5 | 0 |
| RG6 | -257 |
| RG7 | -342 |

11 Write SENSE_TC=SENSE_TC_SET2

**・SENSE_COARSE adjustment flow 2**

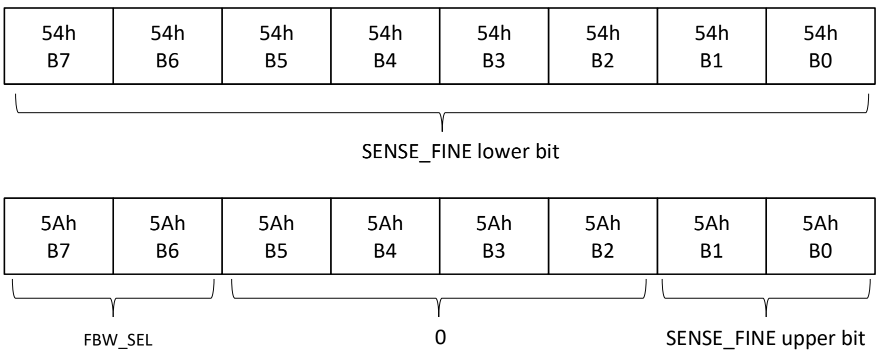
| Variable Name | Variable type | explanation |
|---|---|---|
| BNOM | Test conditions | Magnetic field that needs to be sensed accurately |
| S_TAR | Adjustment target va | Magnetic sensitivity target for BNOM |
| VOUT0_M31 | Measurements | VOUT pin voltage in no magnetic field when SENSE_TC=-31 is set |
| VOUT0_P31 | Measurements | VOUT pin voltage in no magnetic field when SENSE_TC=31 is set |
| VOUTFS_M31 | Measurements | VOUT pin voltage for magnetic field BFS when SENSE_TC=-31 is set |
| VOUTFS_P31 | Measurements | VOUT pin voltage for magnetic field BFS when SENSE_TC=31 is set |
| S_M31 | Calculated value | Magnetic sensitivity to BNOM when SENSE_TC=-31 is set |
| S_P31 | Calculated value | Magnetic sensitivity for BNOM when SENSE_TC=31 is set |
| SENSE_TC_SET2 | Register setting valu | Optimal SENSE_TC_SET setting after adjusting SENSE_CORSE |
| SENSE_TC_TAR | Adjustment target va | Adjustment target value for magnetic sensitivity temperature drift |
| C_SENSE_TC | Calculated value | Correction value of SENSE_TC_SET2 according to SENSE_CORSE |
| SENSE_TC_STEP | Calculated value | Adjustment target value for magnetic sensitivity temperature drift |

In the following explanation, SENSE_FINE reads/writes to 5Ah and 54h.
SENSE_COARSE is read and written to 51h and 52h.

1 Determine the target magnetic sensitivity.
Define the target magnetic sensitivity as S_TAR [V/T].

2 Determine the magnetic field for adjustment.
The magnetic field for which we want to adjust the sensitivity most precisely is defined as BNOM[T].

3 Write SENSE_FINE=0
・Write SENSE_FINE=0. Please send data according to the diagram below, except for SENSE_FINE.




*In this flow, the FBW_SEL determined in step 1 is written to FBW_SEL.

*Please repeat steps 4 to 9 below for i=0 to 6.

4 Write SENSE_COARSE=RG7-i

| 51h B7 | 51h B6 | 51h B5 | 51h B4 | 51h B3 | 51h B2 | 51h B1 | 51h B0 |
|---|---|---|---|---|---|---|---|
| 0 | | | SENSE_COARSE(51h) | | | | |

| 52h B7 | 52h B6 | 52h B5 | 52h B4 | 52h B3 | 52h B2 | 52h B1 | 52h B0 |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | SENSE_COARSE(52h) |

5 Write SENSE_TC=-31
After that, measure VOUT without applying a magnetic field, and let the measurement result be VOUT0_M31.

| 55h B7 | 55h B6 | 55h B5 | 55h B4 | 55h B3 | 55h B2 | 55h B1 | 55h B0 |
|---|---|---|---|---|---|---|---|
| 0 | SENSE_TC | | | | | | SENSE_REV |

*In this flow, write the SENSE_REV determined in step 1 to SENSE_REV.
*For the following "6", "7", "8", and "11", write in the same way, changing only the SENSE_TC.

6 Write SENSE_TC=31
After that, measure VOUT without applying a magnetic field, and set the measurement result as VOUT0_P31.

7 Write SENSE_TC=-31
Then, measure VOUT with BNOM applied, and set the measurement result as VOUTNOM_M31.

8 Write SENSE_TC=31
After that, measure VOUT with BNOM applied, and set the measurement result as VOUTNOM_P31.

9 The magnetic sensitivity is calculated from the measurement results.
S_P31=(VOUTNOM_P31-VOUT0_P31)÷BNOM
S_M31=(VOUTNOM_M31-VOUT0_M31)÷BNOM

If S_P31>S_TAR and S_M31>S_TAR, end the loop and proceed to "10" below.
If the above termination condition is not met and i<6, recalculate i=i+1 and return to "4".
If the above termination condition is not met and i=6, then S_TAR cannot be adjusted.

10 Select C_SENSE_TC from the table below to compensate for the change in sensitivity temperature characteristic due to SENSE_COARSE. Calculate SENSE_TC_SET2=(SENSE_TC_TAR+CSENSE_TC)÷SENSE_TC_STEP
* SENSE_TC_TAR is the value defined in "1. Setting the function switching register"
*SENSE_TC_SET2 is rounded off to an integer.

| Setting SENSE_COARSE | C_SENSE_TC |
|---|---|
| RG1 to RG5 | 0 |
| RG6 | -257 |
| RG7 | -342 |

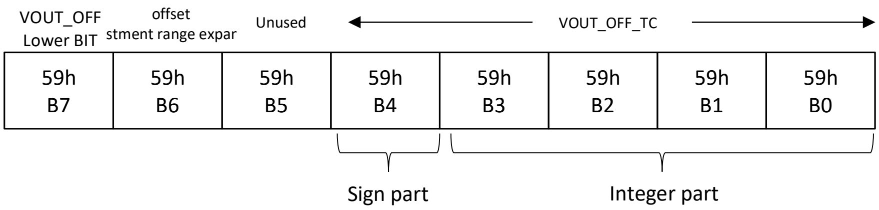
11 Write SENSE_TC=SENSE_TC_SET2

## ■ Output offset voltage temperature adjustment

### ・How to use the VOUT_OFF_TC register

The output offset voltage temperature drift TCVOFF can be adjusted using the VOUT_OFF_TC register.
VOUT_OFF_TC is set to the optimum value at the factory.
TCVOFF changes depending on the values of the SENSE_COARSE and SENSE_REV registers.
After determining the values of the above two registers, you need to recalculate the optimal values.

The VOUT_OFF_TC register is a total of 5 bits, B4 to B0, at address 19h (59h).
・VOUT_OFF_TC format is a signed integer (-15 to 15). Integer part: B3 to B0 Sign part: B4 (1=positive 0=negative)

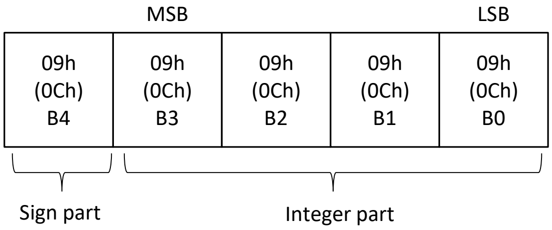



### ・VOUT_OFF_TC optimum value setting flow

**<Explanation of variables in the flow>**

| Variable Name | Variable type | explanation |
|---|---|---|
| VOUT_OFF_TC_ADJ1 | Shipment record value | Optimal code for RG1 (Use when output signal polarity is positive) |
| VOUT_OFF_TC_ADJ1R | Shipment record value | Optimal code for RG1 (used when output signal polarity is reversed) |
| VOUT_OFF_TC_ADJ2 | Shipment record value | Values for calculating the optimum code for RG2 (used when output signal polarity is positive) |
| VOUT_OFF_TC_ADJ2R | Shipment record value | Values for calculating the optimum code for RG2 (used when output signal polarity is reversed) |
| VOUT_OFF_TC_ADJ3 | Shipment record value | Values for calculating the optimum code for RG3 to RG7 (used when output signal polarity is positive) |
| VOUT_OFF_TC_ADJ3R | Shipment record value | Values for calculating the optimum code for RG3 to RG7 (used when output signal polarity is reversed) |

1 Read VOUT_OFF_TC_ADJ1 (or VOUT_OFF_TC_ADJ1R)
・It is stored as a signed integer (-15 to 15) in B4 to B0 of address 09h (0Ch).
Integer part: B3 to B0 Sign part: B4 (1 = positive, 0 = negative)
・If SENSE_REV=0 (positive), read VOUT_OFF_TC_ADJ1 (address 09h).
・If SENSE_REV=1 (reverse polarity), read VOUT_OFF_TC_ADJ1R (address 0Ch).



2 Read VOUT_OFF_TC_ADJ2 (or VOUT_OFF_TC_ADJ2R)

・It is stored as a signed integer (-127 to 127) in B7 to B0 of address 0Ah (0Dh).

Integer part: B6 to B0 Sign part: B7 (1=positive, 0=negative)

・If SENSE_REV=0 (positive polarity), read VOUT_OFF_TC_ADJ2 (address 0Ah).

・If SENSE_REV=1 (reverse polarity), read VOUT_OFF_TC_ADJ2R (address 0Dh).

MSB LSB

| 0Ah (0Dh) B7 | 0Ah (0Dh) B6 | 0Ah (0Dh) B5 | 0Ah (0Dh) B4 | 0Ah (0Dh) B3 | 0Ah (0Dh) B2 | 0Ah (0Dh) B1 | 0Ah (0Dh) B0 |
|---|---|---|---|---|---|---|---|
| Sign part | Integer part | | | | | | |

3 Read VOUT_OFF_TC_ADJ3 (or VOUT_OFF_TC_ADJ3R)

・It is recorded as a signed integer (-127 to 127) in B7 to B0 of address 0Bh (0Eh).

Integer part: B6 to B0 Sign part: B7 (1=positive 0=negative)

・If SENSE_REV=0 (positive polarity), read VOUT_OFF_TC_ADJ3 (address 0Bh).

・If SENSE_REV=1 (reverse polarity), read VOUT_OFF_TC_ADJ3R (address 0Eh).

MSB LSB

| 0Bh (0Eh) B7 | 0Bh (0Eh) B6 | 0Bh (0Eh) B5 | 0Bh (0Eh) B4 | 0Bh (0Eh) B3 | 0Bh (0Eh) B2 | 0Bh (0Eh) B1 | 0Bh (0Eh) B0 |
|---|---|---|---|---|---|---|---|
| Sign part | Integer part | | | | | | |

4 Calculate the optimum value of VOUT_OFF_TC

The calculation formula for the value to be set in the VOUT_OFF_TC register changes depending on the setting of SENSE_COARSE.

Also, the variables used in the calculation formula change depending on the SENSE_REV setting.

When SENSE_REV=0

| Setting SENSE_COARSE | VOUT_OFF_TC calculation formula |
|---|---|
| RG1 | VOUT_OFF_TC_ADJ1 |
| RG2 | VOUT_OFF_TC_ADJ2 ÷ 8 |
| RG3~RG7 | (VOUT_OFF_TC_ADJ2 - C_ADJ3×VOUT_OFF_TC_ADJ3) ÷ 8 |

When SENSE_REV=1

| Setting SENSE_COARSE | VOUT_OFF_TC calculation formula |
|---|---|
| RG1 | VOUT_OFF_TC_ADJ1R |
| RG2 | VOUT_OFF_TC_ADJ2R ÷ 8 |
| RG3~RG7 | (VOUT_OFF_TC_ADJ2R - C_ADJ3×VOUT_OFF_TC_ADJ3R) ÷ 8 |

VOUT_OFF_TC_ADJ1: An integer between -15 and 15

VOUT_OFF_TC_ADJ2: Integer between -127 and 127

VOUT_OFF_TC_ADJ3: Integer between -127 and 127

VOUT_OFF_TC_ADJ1R: An integer between -15 and 15

VOUT_OFF_TC_ADJ2R: Integer between -127 and 127

VOUT_OFF_TC_ADJ3R: Integer between -127 and 127

C_ADJ3: Real number between 1 and 1.938

*For coefficient C_ADJ3, substitute the value in the table below for each SENSE_COARSE setting.

| Setting SENSE_COARSE | Coefficient C_ADJ3 |
|---|---|
| RG3 | 1 |
| RG4 | 1.5 |
| RG5 | 1.75 |
| RG6 | 1.875 |
| RG7 | 1.938 |

*The calculation result of VOUT_OFF_TC should be rounded off to an integer.

5 Set VOUT_OFF_TC to the optimum value

- Read address 5Ah to get the contents of B7 to B5.

Write the VOUT_OFF_TC calculated in "4". Please send the data according to the diagram below.

| 59h B7 | 59h B6 | 59h B5 | 59h B4 | 59h B3 | 59h B2 | 59h B1 | 59h B0 |
|---|---|---|---|---|---|---|---|
| Write the previously read value | | | VOUT_OFF_TC | | | | |

## ■ Magnetic sensitivity fine adjustment

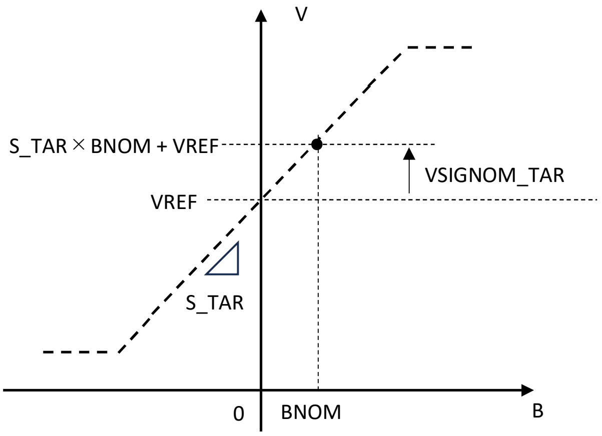
**・How to use the SENSE_FINE register**

Please refer to the contents described in Step 4 Coarse magnetic sensitivity adjustment.

**・Define VSIGNOM_TAR and BNOM**

In the S-5611, the sensitivity is fine-tuned by applying a magnetic field BNOM for sensitivity adjustment.
BNOM is calculated from the target magnetic sensitivity S_TAR and standard output VSIGNOM_TAR.

VSIGNOM_TAR=0.8
BNOM = VSIGNOM_TAR ÷ S_TAR *Please define S_TAR within the scope of the product specifications.




**・Select SENSE_FINE adjustment flow**

Two types of flow can be selected for magnetic sensitivity adjustment

・Adjustment flow 1 ⇒ The magnetic sensitivity adjustment will be completed in 1 to 2 times.
The optimum value is calculated using a formula based on the initial measurements.

・Adjustment flow 2 ⇒ The magnetic sensitivity needs to be adjusted 10 times.
The contents of the register are determined bit by bit, gradually approaching the optimal value.

Adjustment flow 1 is the standard flow.
Adjustment flow 2 requires more measurements, but because the register is determined one bit at a time while measuring, it allows for more precise adjustment.

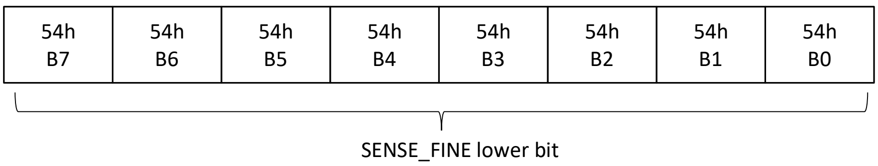
**・SENSE_FINE adjustment flow 1**

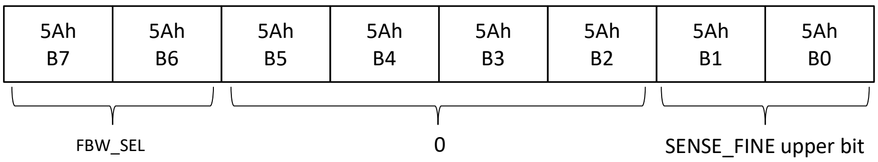
| Variable Name | Variable type | explanation |
|---|---|---|
| VSIGNOM_TAR | Adjustment target value | Sensor output voltage (0.8V) adjustment target value when BNOM is applied |
| S_TAR | Adjustment target value | Magnetic sensitivity adjustment target value |
| BNOM | Test conditions | Magnetic field where the sensor output is 0.8V when S_TAR |
| VOUT0 | Measurements | VOUT pin voltage in no magnetic field |
| VOUTNOM | Measurements | VOUT pin voltage when BNOM is applied |
| VSIGNOM | Calculated value | Sensor output for BNOM |
| SENSE_FINE_TRM | Register setting value | Optimal setting for SENSE_FINE (first adjustment) |
| VOUT02 | Measurements | VOUT pin voltage in no magnetic field (after magnetic sensitivity adjustment) |
| VOUTNOM2 | Measurements | VOUT pin voltage when BNOM is applied (after magnetic sensitivity adjustment) |
| VSIGNOM2 | Calculated value | Sensor output for BNOM (after magnetic sensitivity adjustment) |
| SENSE_FINE_TRM2 | Register setting value | Optimal setting for SENSE_FINE (2nd adjustment) |
| VOUT03 | Measurements | VOUT pin voltage in no magnetic field (after magnetic sensitivity adjustment) |
| VOUTNOM3 | Measurements | VOUT pin voltage when BNOM is applied (after magnetic sensitivity readjustment) |
| VSIGNOM3 | Calculated value | Sensor output for BNOM (after magnetic sensitivity readjustment) |

*In the following explanation, SENSE_FINE reads/writes to 5Ah and 54h.

1 Write SENSE_FINE=0

・Write SENSE_FINE=0. Please send data according to the diagram below, except for SENSE_FINE.




*In this flow, the FBW_SEL determined in step 1 is written to FBW_SEL.

*In this flow, when writing SENSE_FINE, please change only the contents of SENSE_FINE and write as shown in the figure above.

2 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT0.

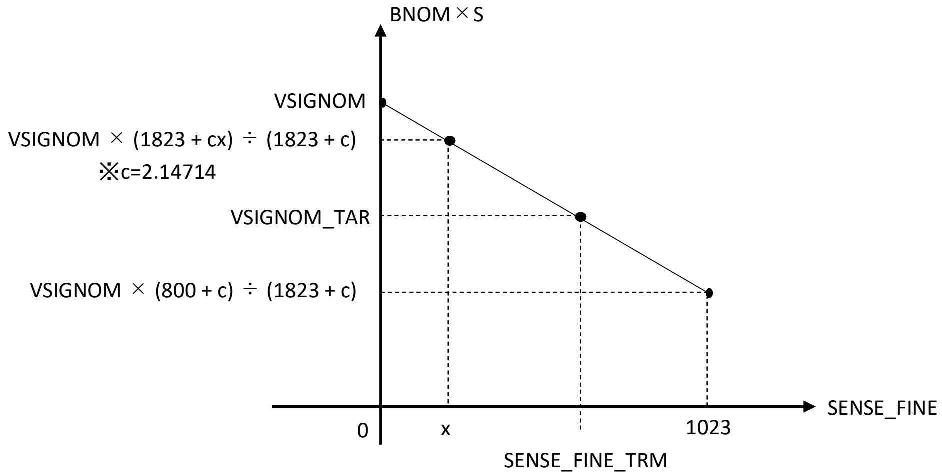
3 With BNOM applied, measure VOUT and let VOUTNOM be it.

4 VSIGNOM=VOUTNOM-VOUT0

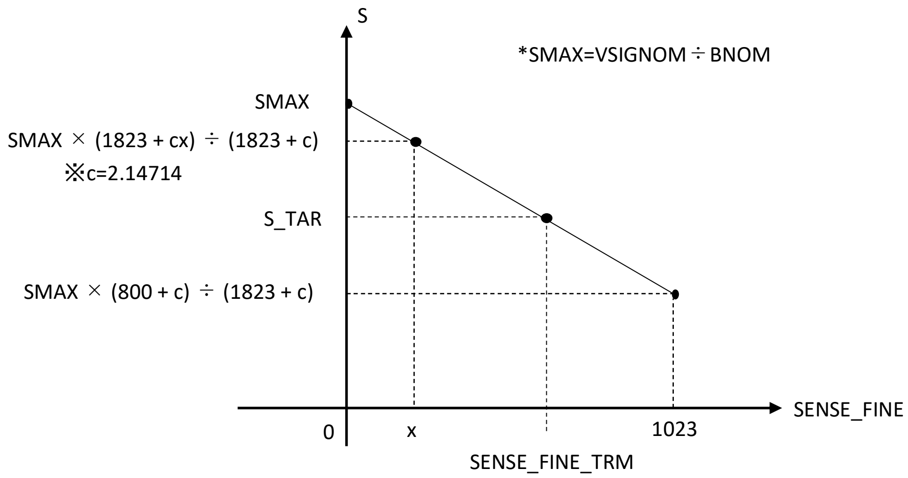
Calculate SENSE_FINE_TRM=(1823+c)×(1-VSIGNOM_TAR÷VSIGNOM) ※c=2.14714

*SENSE_FINE_TRM is an integer rounded off to the nearest whole number.

5 Write SENSE_FINE=SENSE_FINE_TRM




*The adjustment of magnetic sensitivity S corresponds to the above figure as shown below.




6 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT02.

7 Measure VOUT with BNOM applied and call it VOUTNOM2.

8 VSIGNOM2=VOUTNOM2-VOUT02
Determine whether the following conditions are met.
-SSTEP ÷2＜ (VSIGNOM2-VSIGNOM_TAR)÷VSIGNOM_TAR＜SSTEP÷2

*SSTEP is determined as the Max (0.30%) of "Formula B" among the values listed in "1.2 Magnetic Properties" of the data sheet.

If it is met, proceed to the next adjustment flow.
If not, perform an additional trim in the following steps.

9 Calculate SENSE_FINE_TRM2
=(1823+c)×(1-VSIGNOM_TAR÷VSIGNOM2)+SENSE_FINE_TRM×VSIGNOM_TAR÷VSIGNOM2
*SENSE_FINE_TRM2 is rounded off to the nearest integer.

10 Write SENSE_FINE=SENSE_FINE_TRM2

11 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT03.

12 Measure VOUT with BNOM applied and call it VOUTNOM3.

13 VSIGNOM3=VOUTNOM3-VOUT03
Check that the final magnetic sensitivity S=VSIGNOM3÷BNOM meets the required accuracy.

**・SENSE_FINE adjustment flow 2**

| Variable Name | Variable type | explanation |
|---|---|---|
| VSIGNOM_TAR | Adjustment target value | Sensor output voltage (0.8V) adjustment target value when BNOM is applied |
| S_TAR | Adjustment target value | Magnetic sensitivity adjustment target value |
| BNOM | Test conditions | Magnetic field where the sensor output is 0.8V when S_TAR |
| VOUT0 | Measurements | VOUT pin voltage in no magnetic field |
| VOUTNOM | Measurements | VOUT pin voltage when BNOM is applied |
| VSIGNOM | Calculated value | Sensor output for BNOM |
| SENSE_FINE_TRM | Register setting value | Optimal setting for SENSE_FINE (first adjustment) |
| VOUT02 | Measurements | VOUT pin voltage in no magnetic field (after magnetic sensitivity adjustment) |
| VOUTNOM2 | Measurements | VOUT pin voltage when BNOM is applied (after magnetic sensitivity adjustment) |
| VSIGNOM2 | Calculated value | Sensor output for BNOM (after magnetic sensitivity adjustment) |

*In the following explanation, SENSE_FINE reads/writes to 5Ah and 54h.

1 Set SENSE_FINE_TRM=0
Let i=0

*Please repeat steps 2 to 5 below for i=0 to 9.

2 Write SENSE_FINE=SENSE_FINE_TRM+2^(9-i)
・For all data types other than SENSE_FINE, please send data according to the diagram below.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 54h B7 | 54h B6 | 54h B5 | 54h B4 | 54h B3 | 54h B2 | 54h B1 | 54h B0 |

SENSE_FINE lower bit (54h B7–B0)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5Ah B7 | 5Ah B6 | 5Ah B5 | 5Ah B4 | 5Ah B3 | 5Ah B2 | 5Ah B1 | 5Ah B0 |

FBW_SEL (5Ah B7–B6) 0 (5Ah B5–B2) SENSE_FINE upper bit (5Ah B1–B0)

*In this flow, the FBW_SEL determined in step 1 is written to FBW_SEL.

3 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT0.

4 With BNOM applied, measure VOUT and let VOUTNOM be it.

VSIGNOM=VOUTNOM-VOUT0
(i) If VSIGNOM ≥ VSIGNOM_TAR
Recalculate SENSE_FINE_TRM=SENSE_FINE_TRM+2^(9-i)

(ii) VSIGNOM
In this case, SENSE_FINE_TRM is not recalculated.

5 If i<9, recalculate i=i+1 and return to "2" above.
If i=9, end the loop and proceed to "6" below

6 Write SENSE_FINE=SENSE_FINE_TRM

7 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT02.

8 Measure VOUT with BNOM applied and call it VOUTNOM2.

9 VSIGNOM2=VOUTNOM2-VOUT02
Check that the final magnetic sensitivity S=VSIGNOM2÷BNOM meets the required accuracy.

## ■Magnetic sensitivity temperature drift adjustment

### ・When magnetic sensitivity temperature drift adjustment is required

The magnetic sensitivity temperature drift is adjusted using the SENSE_TC register in "Step 2. Adjustment of magnetic sensitivity temperature drift (without measurement)".
The magnetic sensitivity temperature drift when using this method varies within the range of "Magnetic Sensitivity Temperature Drift" described in "1.2 Magnetic Characteristics" on the datasheet.
If you want to adjust the temperature drift more precisely, you can measure the actual temperature drift and then adjust it.

### ・SENSE_TC adjustment flow

| Variable Name | Variable type | explanation |
|---|---|---|
| BNOM | Test conditions | Step 6. Magnetic field of the magnitude determined by fine-tuning the magnetic sensitivity |
| VOUT0_P25C | Measurements | VOUT pin voltage in no magnetic field (at 25° C) |
| VOUT_NOM_P25C | Measurements | VOUT pin voltage when BNOM is applied (at 25° C) |
| VSIGNOM_P25C | Calculated value | Sensor output for BNOM (at 25° C) |
| TLT | Test conditions | The lowest temperature in the desired temperature range |
| VOUT0_LT | Measurements | VOUT pin voltage in no magnetic field (LT) |
| VOUTNOM_LT | Measurements | VOUT pin voltage when BNOM is applied (LT) |
| VSIGNOM_LT | Calculated value | Sensor output for BNOM (LT) |
| THT | Test conditions | The highest temperature in the desired temperature range |
| VOUT0_HT | Measurements | VOUT pin voltage in no magnetic field (HT) |
| VOUTNOM_HT | Measurements | VOUT pin voltage when BNOM is applied (HT) |
| VSIGNOM_HT | Calculated value | Sensor output for BNOM (HT) |
| SENSE_TC_INI | Calculated value | Magnetic sensitivity temperature drift before adjustment |
| SENSE_TC_TAR | Adjustment target value | Step 2. Adjustment of magnetic sensitivity temperature drift (without measurement) Same value |
| SENSE_TC_STEP | Shipment record value | Step 2. Adjustment of magnetic sensitivity temperature drift (without measurement) Same value |
| SENSE_TC_SET2 | Calculated value | Step 4. Same value as magnetic sensitivity coarse adjustment |
| SENSE_TC_TRM | Register setting value | Optimal setting for SENSE_TC |

1 The ambient temperature (Ta) of the S-5611A is set to 25° C.
2 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT0_P25C.
3 Measure VOUT with BNOM applied, and set the measurement result as VOUTNOM_P25C.
4 VSIGNOM_P25C=VOUTNOM_P25C-VOUT0_P25C
5 Set the ambient temperature (Ta) of the S-5611A to the lowest temperature TLT [°C] in the desired temperature range.
6 Measure VOUT without applying a magnetic field, and let the measurement result be VOUTNOM_LT.
7 Measure VOUT with BNOM applied, and let the measurement result be VOUTNOM__LT.
8 VSIGNOM_LT=VOUTNOM_LT-VOUT0_LT
9 Set the ambient temperature (Ta) of the S-5611A to the highest temperature THT [°C] within the desired temperature range.
10 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT0_HT.

11 Measure VOUT with BNOM applied, and let the measurement result be VOUTNOM_HT.

12 VSIGNOM_HT=VOUTNOM_HT-VOUT0_HT

13 SENSE_TC_INI=(VSIGNOM_HT-VSIGNOM_LT)÷VSIGNOM_P25C÷(THT-TLT)×1e6 [ppm/°C]

14 Calculate SENSE_TC_TRM=(SENSE_TC_TAR-SENSE_TC_INI)÷SENSE_TC_STEP+SENSE_TC_SET2.
*SENSE_TC_TRM is rounded off to an integer.

Write SENSE_TC=SENSE_TC_TRM

| 55h<br>B7 | 55h<br>B6 | 55h<br>B5 | 55h<br>B4 | 55h<br>B3 | 55h<br>B2 | 55h<br>B1 | 55h<br>B0 |
|---|---|---|---|---|---|---|---|
| 0 | SENSE_TC=SENSE_TC_TRM | | | | | | SENSE_REV |

*In this flow, write the SENSE_REV determined in step 1 to SENSE_REV.

15 Set the ambient temperature (Ta) of the S-5611A to 25° C and perform fine sensitivity adjustment again.
Please re-perform part of the contents of "6. Fine-tuning the magnetic sensitivity"

If you selected Adjustment Flow 1 in "6. Magnetic Sensitivity Fine Tuning"
→ Please repeat steps 5 to 13 in Adjustment Flow 1

If you selected Adjustment Flow 2 in "6. Magnetic Sensitivity Fine Tuning"
→ Please repeat steps 1 to 9 in Adjustment Flow 2

**■Magnetic sensitivity temperature drift adjustment (adjustment step measurement included)**

**・About adjustment step measurement**

SENSE_TC_STEP, the adjustment step for magnetic sensitivity temperature drift, is
In addition to using the value read in "1. Setting the function switching register",
You can also use actual measured adjustment steps.
Although this increases the number of measurement steps, it allows for even more precise tuning of the sensitivity-temperature characteristics.

**・SENSE_TC adjustment flow**

| Variable Name | Variable type | explanation |
|---|---|---|
| BNOM | Test conditions | Step 6. Magnetic field of the magnitude determined by fine-tuning the magnetic sensitivity |
| VOUT0_P25C | Measurements | VOUT pin voltage in no magnetic field (at 25° C) |
| VOUT_NOM_P25C | Measurements | VOUT pin voltage when BNOM is applied (at 25° C) |
| VSIGNOM_P25C | Calculated value | Sensor output for BNOM (at 25° C) |
| VOUT0_P25C_P31 | Measurements | VOUT pin voltage in no magnetic field when SENSE_TC=31 (at 25° C) |
| VOUT_NOM_P25C_P31 | Measurements | VOUT pin voltage when BNOM is applied at SENSE_TC=31 (at 25°C) |
| VSIGNOM_P25C_P31 | Calculated value | Sensor output for BNOM when SENSE_TC=31 (at 25° C) |
| VOUT0_P25C_M31 | Measurements | VOUT pin voltage in no magnetic field when SENSE_TC=-31 (at 25° C) |
| VOUT_NOM_P25C_M31 | Measurements | VOUT pin voltage when BNOM is applied at SENSE_TC=-31 (at 25°C) |
| VSIGNOM_P25C_M31 | Calculated value | Sensor output for BNOM at SENSE_TC=-31 (at 25° C) |
| TLT | Test conditions | The lowest temperature in the desired temperature range |
| VOUT0_LT | Measurements | VOUT pin voltage in no magnetic field (LT) |
| VOUTNOM_LT | Measurements | VOUT pin voltage when BNOM is applied (LT) |
| VSIGNOM_LT | Calculated value | Sensor output for BNOM (LT) |
| VOUT0_LT_P31 | Measurements | VOUT pin voltage (TLT) with no magnetic field when SENSE_TC=31 |
| VOUT_NOM_LT_P31 | Measurements | VOUT pin voltage when BNOM is applied (TLT) at SENSE_TC=31 |
| VSIGNOM_LT_P31 | Calculated value | Sensor output for BNOM at SENSE_TC=31 (at TLT) |
| VOUT0_LT_M31 | Measurements | VOUT pin voltage (TLT) with no magnetic field when SENSE_TC=-31 |
| VOUT_NOM_LT_M31 | Measurements | VOUT pin voltage when BNOM is applied (at TLT) at SENSE_TC=-31 |
| VSIGNOM_LT_M31 | Calculated value | Sensor output for BNOM at SENSE_TC=-31 (at TLT) |
| THT | Test conditions | The highest temperature in the desired temperature range |
| VOUT0_HT | Measurements | VOUT pin voltage in no magnetic field (at THT) |
| VOUTNOM_HT | Measurements | VOUT pin voltage when BNOM is applied (at THT) |
| VSIGNOM_HT | Calculated value | Sensor output for BNOM (at THT) |
| VOUT0_HT_P31 | Measurements | VOUT pin voltage (at THT) with no magnetic field when SENSE_TC=31 |
| VOUT_NOM_HT_P31 | Measurements | VOUT pin voltage when BNOM is applied (at THT) at SENSE_TC=31 |
| VSIGNOM_HT_P31 | Calculated value | Sensor output for BNOM at SENSE_TC=31 (at THT) |
| VOUT0_HT_M31 | Measurements | VOUT pin voltage (at THT) with no magnetic field when SENSE_TC=-31 |
| VOUT_NOM_HT_M31 | Measurements | VOUT pin voltage when BNOM is applied (at THT) at SENSE_TC=-31 |
| VSIGNOM_HT_M31 | Calculated value | Sensor output for BNOM at SENSE_TC=-31 (at THT) |
| SENSE_TC_INI | Calculated value | Magnetic sensitivity temperature drift before adjustment |
| SENSE_TC_TAR | Adjustment target value | Step 2. Adjustment of magnetic sensitivity temperature drift (without measurement) Same value |
| SENSE_TC_STEP_M | Calculated value | Magnetic sensitivity temperature drift adjustment step calculated from measured value |
| SENSE_TC_SET2 | Calculated value | Step 4. Same value as magnetic sensitivity coarse adjustment |
| SENSE_TC_TRM | Register setting valu | Optimal setting for SENSE_TC |

1 The ambient temperature (Ta) of the S-5611A is set to 25° C.

2 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT0_P25C.

3 Measure VOUT with BNOM applied, and set the measurement result as VOUTNOM_P25C.

4 VSIGNOM_P25C=VOUTNOM_P25C-VOUT0_P25C

5 Write SENSE_TC=31

| 55h B7 | 55h B6 | 55h B5 | 55h B4 | 55h B3 | 55h B2 | 55h B1 | 55h B0 |
|---|---|---|---|---|---|---|---|
| 0 | SENSE_TC | | | | | | SENSE_REV |

*In this flow, write the SENSE_REV determined in step 1 to SENSE_REV.
*When writing to the SENSE_TC register thereafter, write in the same way, changing only SENSE_TC.

6 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT0_P25C_P31.

7 Measure VOUT with BNOM applied, and set the measurement result as VOUTNOM_P25C_P31.

8 VSIGNOM_P25C_P31 = VOUTNOM_P25C_P31 - VOUT0_P25C_P31

9 Write SENSE_TC=-31

10 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT0_P25C_M31.

11 Measure VOUT with BNOM applied, and set the measurement result as VOUTNOM_P25C_M31.

12 VSIGNOM_P25C_M31 = VOUTNOM_P25C_M31 - VOUT0_P25C_M31

13 Write SENSE_TC=SENSE_TC_SET2

14 Set the ambient temperature (Ta) of the S-5611A to the lowest temperature TLT [°C]
in the desired temperature range.

15 Measure VOUT without applying a magnetic field, and let the measurement result be VOUTNOM_LT.

16 Measure VOUT with BNOM applied, and let the measurement result be VOUTNOM_LT.

17 VSIGNOM_LT=VOUTNOM_LT-VOUT0_LT

18 Write SENSE_TC=31

19 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT0_LT_P31.

20 Measure VOUT with BNOM applied, and set the measurement result as VOUTNOM_LT_P31.

21 VSIGNOM_LT_P31=VOUTNOM_LT_P31-VOUT0_LT_P31

22 Write SENSE_TC=-31

23 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT0_LT_M31.

24 Measure VOUT with BNOM applied, and set the measurement result as VOUTNOM_LT_M31.

25 VSIGNOM_LT_M31=VOUTNOM_LT_M31-VOUT0_LT_M31

26 Write SENSE_TC=SENSE_TC_SET2

27 Set the ambient temperature (Ta) of the S-5611A to the highest temperature THT [°C] within the desired temperature range.

28 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT0_HT.

29 Measure VOUT with BNOM applied, and let the measurement result be VOUTNOM_HT.

30 VSIGNOM_HT=VOUTNOM_HT-VOUT0_HT

31 Write SENSE_TC=31

32 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT0_HT_P31.

33 Measure VOUT with BNOM applied, and set the measurement result as VOUTNOM_HT_P31.

34 VSIGNOM_HT_P31 = VOUTNOM_HT_P31 - VOUT0_HT_P31

35 Write SENSE_TC=-31

36 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT0_HT_M31.

37 Measure VOUT with BNOM applied, and set the measurement result as VOUTNOM_HT_M31.

38 VSIGNOM_HT_M31 = VOUTNOM_HT_M31 - VOUT0_HT_M31

39 Write SENSE_TC=SENSE_TC_SET2

40 Calculate SENSE_TC_INI=(VSIGNOM_HT - VSIGNOM_LT)÷VSIGNOM_P25C÷(HLT-TLT)×1e6 [ppm/°C]

41 Calculate SENSE_TC_P31
= (VSIGNOM_HT_P31 - VSIGNOM_LT_P31) ÷ VSIGNOM_P25C_P31 ÷ (THT-TLT) × 1e6 [ppm/°C]

42 Calculate SENSE_TC_M31
= (VSIGNOM_HT_M31 - VSIGNOM_LT_M31) ÷ VSIGNOM_P25C_M31 ÷ (THT-TLT) × 1e6 [ppm/°C]

43 Calculate SENSE_TC_STEP_M = (SENSE_TC_P31-SENSE_TC_M31)÷62 [ppm/°C]

44 Calculate SENSE_TC_TRM=(SENSE_TC_TAR-SENSE_TC_INI)÷SENSE_TC_STEP_M+SENSE_TC_SET2
*SENSE_TC_TRM is rounded off to an integer.

Write SENSE_TC=SENSE_TC_TRM

| 55h<br>B7 | 55h<br>B6 | 55h<br>B5 | 55h<br>B4 | 55h<br>B3 | 55h<br>B2 | 55h<br>B1 | 55h<br>B0 |
|---|---|---|---|---|---|---|---|
| 0 | SENSE_TC=SENSE_TC_TRM | | | | | | SENSE_REV |

*In this flow, write the SENSE_REV determined in step 1 to SENSE_REV.

45 Set the ambient temperature (Ta) of the S-5611A to 25° C and perform fine sensitivity adjustment again.
Please re-perform part of the contents of "6. Fine-tuning the magnetic sensitivity"

If you selected Adjustment Flow 1 in "6. Magnetic Sensitivity Fine Tuning"
→ Please repeat steps 5 to 13 in Adjustment Flow 1

If you selected Adjustment Flow 2 in "6. Magnetic Sensitivity Fine Tuning"
→ Please repeat steps 1 to 9 in Adjustment Flow 2

## ■ Offset adjustment

### ・How to use the VOUT_OFF register

The offset voltage VOFF of the VOUT pin voltage is adjusted using the VOUT_OFF register. The VOUT_OFF register is divided into two addresses, B7 to B0 at address 10h (50h) and B7 at address 19h (59h), for a total of 9 bits.

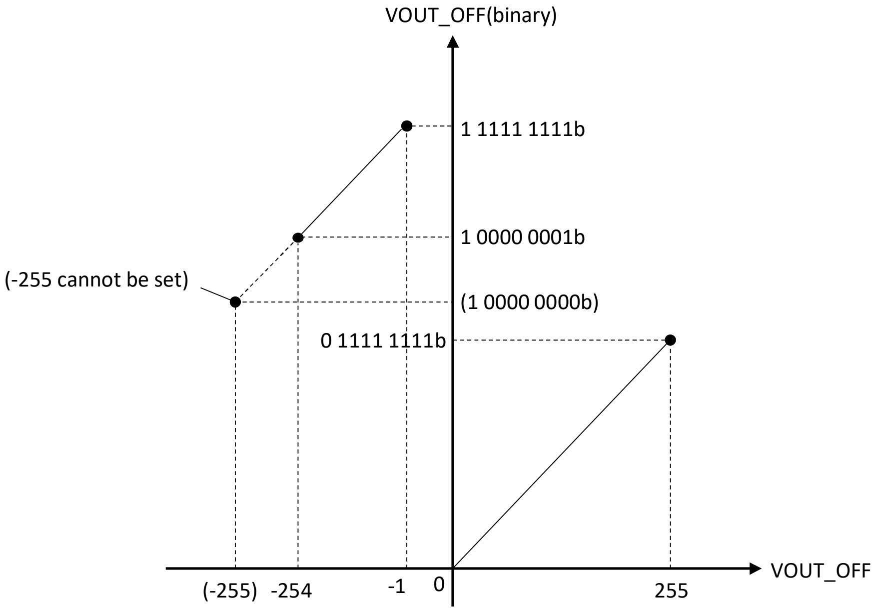
・The calculation is performed with B7 to B0 at address 10h (50h) as the upper bits and B7 at address 19h (59h) as the lower bit.

・VOUT_OFF is a two's complement integer (-255 to 255).

・The values that can be set for VOUT_OFF are -254 to 255. -255 is not possible.

| MSB | | | | | | | | LSB |
|---|---|---|---|---|---|---|---|---|
| 50h B7 | 50h B6 | 50h B5 | 50h B4 | 50h B3 | 50h B2 | 50h B1 | 50h B0 | 59h B7 |

Integer part (two's complement format)




**Correspondence between VOUT_OFF and 9-bit binary number**

・Even if you want to change only VOUT_OFF, you must send the data of other bits (B6 to B0) in address 19h (59h). If you do not want to rewrite B6 to B0, read them in advance and send the values read.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 50h B7 | 50h B6 | 50h B5 | 50h B4 | 50h B3 | 50h B2 | 50h B1 | 50h B0 |

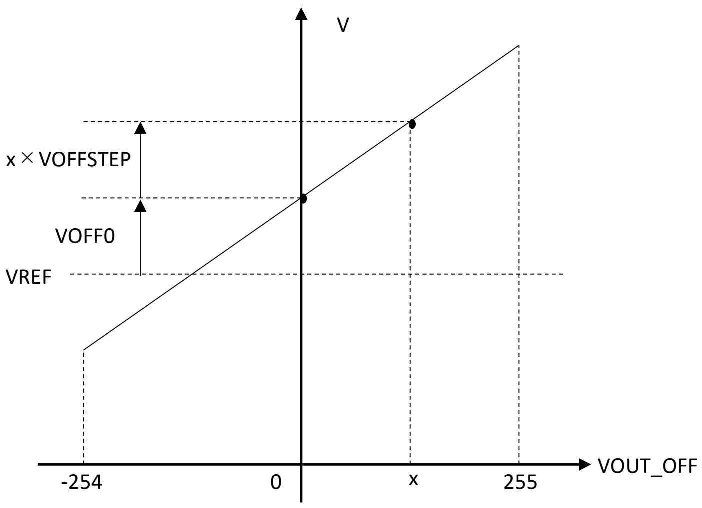
VOUT_OFF upper bit

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 59h B7 | 59h B6 | 59h B5 | 59h B4 | 59h B3 | 59h B2 | 59h B1 | 59h B0 |
| VOUT_OFF Lower BIT | offset Adjustment range expansion | Unused | VOUT_OFF_TC | | | | |

**・Offset adjustment amount by VOUT_OFF register**

Setting the VOUT_OFF register value to +x from the current value will increase VOUT by x×VOFFSTEP, and setting it to -x will decrease VOUT by x×VOFFSTEP.
If VOFF when the VOUT_OFF register is 0 is VOFF0, the relationship between VOUT, VOFF and VOUT_OFF is expressed by the following equation.

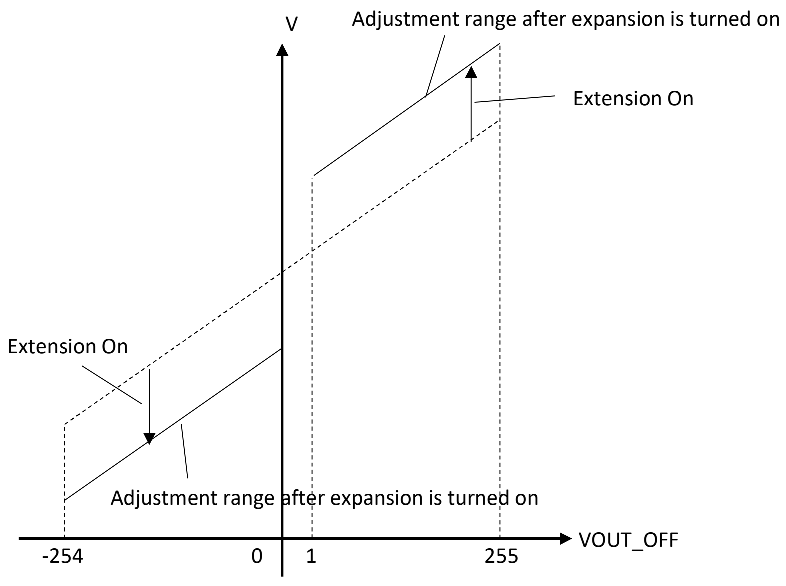
VOUT=VOFF0+VREF+VOUT_OFF×VOFFSTEP
VOFF=VOFF0+VOUT_OFF×VOFFSTEP ※VOFF=VOUT-VREF




**- Expanded offset adjustment range**

If you need to widen the offset adjustment range, set B6 of address 19h (59h) to "1".
The adjustment range can be expanded.

When the extended on state is entered, VOUT increases by 128×VOFFSTEP when VOUT_OFF is in the range of 1 to 255.
On the other hand, when VOUT_OFF is in the range of -254 to 0, it decreases by 128×VOFFSTEP.



**・VOUT_OFF adjustment flow selection**

Two types of flow can be selected for offset adjustment

・Adjustment flow 1 ⇒ The offset adjustment will be completed in 1 to 2 times.
The optimum value is calculated using a formula based on the initial measurements.

・Adjustment flow 2 ⇒ The offset needs to be adjusted 8 times.
The contents of the register are determined bit by bit, gradually approaching the optimal value.

Adjustment flow 1 is the standard flow.
Adjustment flow 2 requires more measurements, but since the register is determined one bit at a time while measuring, This allows for more accurate alignment.

**・VOUT_OFF adjustment flow 1**

| Variable Name | Variable type | explanation |
|---|---|---|
| VOFF_TAR | Adjustment target va | Offset adjustment target value |
| VREF | Measurements | Measured VREF pin voltage |
| VOUT_P255 | Measurements | VOUT pin voltage when VOUT_OFF=255 |
| VOFF_P255 | Calculated value | Offset when VOUT_OFF=255 |
| VOUT_M254 | Measurements | VOUT pin voltage when VOUT_OFF=-254 |
| VOFF_M254 | Calculated value | Offset when VOUT_OFF=-254 |
| VOFFSTEP | Calculated value | Calculated offset adjustment step |
| VOUT_PM0 | Measurements | VOUT pin voltage when VOUT_OFF=0 |
| VOUT_P255E | Measurements | VOUT pin voltage when VOUT_OFF=255 |
| VOUT_M254E | Measurements | Offset when VOUT_OFF=-254 |
| VOFF_TRM | Register setting valu | Optimal VOUT_OFF setting (first adjustment) |
| VOUT_TRM | Measurements | VOUT pin voltage after VOUT_OFF adjustment |
| VOFF_TRM2 | Register setting valu | Optimal VOUT_OFF setting (2nd adjustment) |
| VOUT_TRM2 | Measurements | VOUT pin voltage after VOUT_OFF adjustment |

*If the text specifies that VOUT_OFF should be read/written, this is done for addresses 50h and 59h.

1 Determine the offset target value VOFF_TAR.
Adjusting VOFF The target VOFF_TAR does not necessarily have to be 0mV.
In the procedure described in this document, VOFF can be adjusted appropriately regardless of the value of VOFF_TAR.

2 Read address 59h
In the future, when writing VOUT_OFF, please send B5 to B0 of the 59h transmission data as the results of reading B5 to B0 here.

3 Measure VREF without applying a magnetic field, and let the measurement result be VREF.

4 Write VOUT_OFF=255

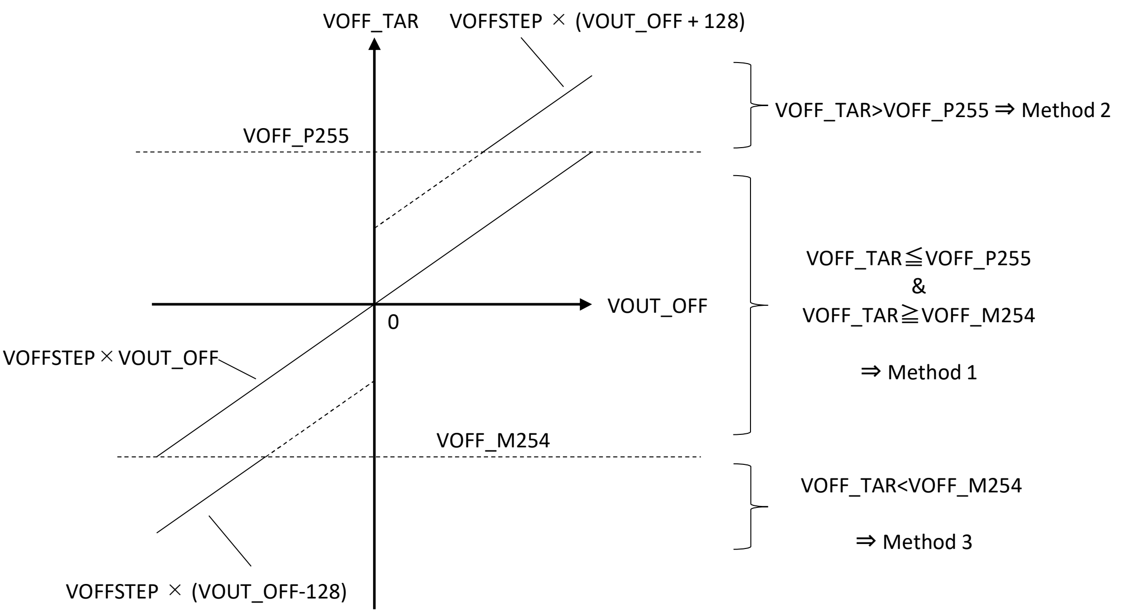
5 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT_P255.
At that time, calculate the offset voltage VOFF_P255=VOUT_P255-VREF.

6 Write VOUT_OFF=-254

7 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT_M254.
At that time, calculate the offset voltage VOFF_M254=VOUT_M254-VREF.

8 Calculate the VOFF adjustment step VOFFSTEP
VOFFSTEP=(VOUT_P255-VOUT_M254)÷509

9 To set the VOUT_OFF register appropriately, it is necessary to determine whether to expand the adjustment range based on the VOFF_P255 and VOFF_M254 values.
Depending on the result, the register setting method is divided into 1 to 3.



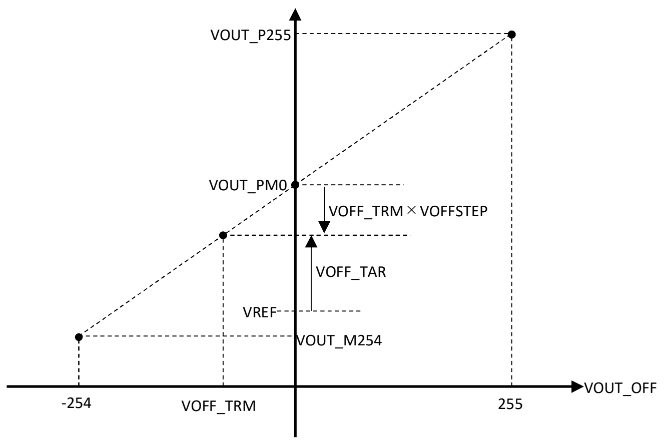

**Method 1: When VOUT_P255≧VOFF_TAR and VOUT_M254≦VOFF_TAR**

10 Write VOUT_OFF=0

11 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT_PM0.
VOFF_TRM=-(VOUT_PM0-VREF-VOFF_TAR)÷VOFFSTEP
*VOFF_TRM is an integer rounded off to the nearest whole number.

12 Write VOUT_OFF=VOFF_TRM

13 Perform "Additional trimming (common to methods 1 to 3)" described below.




**Method 2 VOFF_P255**

10 Adjustment range extension on

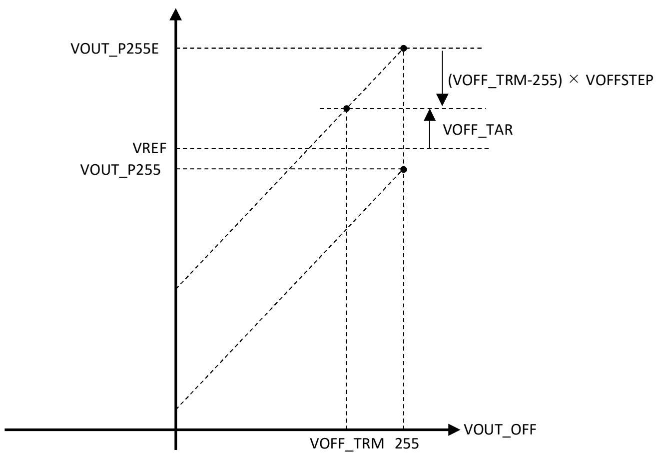
11 Write VOUT_OFF=255

12 Measure VOUT without applying a magnetic field, and the measurement result is VOUT_P255E.

13 VOFF_TRM=255-(VOUT_P255E-VREF-VOFF_TAR)÷VOFFSTEP
*VOFF_TRM is an integer rounded off to the nearest whole number.

14 Write VOUT_OFF=VOFF_TRM

15 Perform "Additional trimming (common to methods 1 to 3)" described below.



**Method 3: If VOFF_M254>VOFF_TAR**

10 Adjustment range extension on

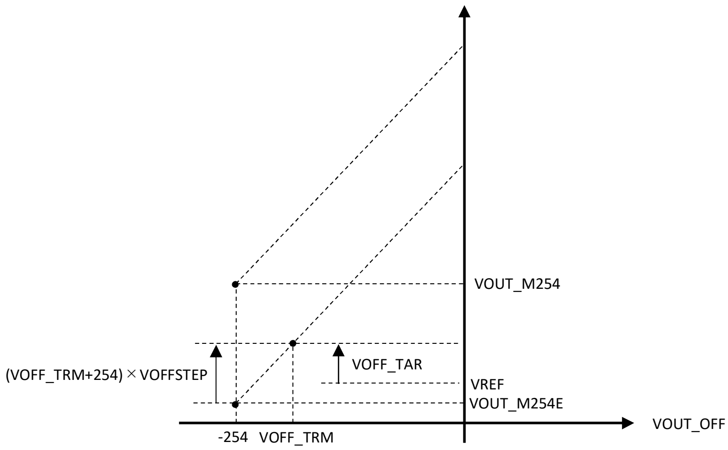
11 Write VOUT_OFF=-254

12 Measure VOUT without applying a magnetic field, and the measurement result is VOUT_M254E.

13 VOFF_TRM=-254-(VOUT_M254E-VREF-VOFF_TAR)÷VOFFSTEP
*VOFF_TRM is an integer rounded off to the nearest whole number.

14 Write VOUT_OFF=VOFF_TRM

15 Perform "Additional trimming (common to methods 1 to 3)" described below.




**Additional trimming (common to methods 1 to 3)**

Add 1 VOUT measurement, VOUT_TRM

Add 2 Determine whether the following conditions are met.
-VOFFSTEP÷2 < (VOUT_TRM-VREF-VOFF_TAR) < VOFFSTEP÷2

Add 3 If it is satisfied, proceed to writing the trimming result to the non-volatile address.
If not, perform an additional trim in the following steps.

Add 4 VOFF_TRM2=VOFF_TRM-(VOUT_TRM-VREF-VOFF_TAR)÷VOFFSTEP
*VOFF_TRM2_TRM2 is an integer rounded off to the nearest whole number.

Add 5 Write VOUT_OFF=VOFF_TRM2

Add 6 VOUT measurement, VOUT_TRM2
Check that the error from the final target, VOUT_TRM2-VREF-VOFF_TAR, meets the required accuracy.

**・VOUT_OFF adjustment flow 2**

| Variable Name | Variable type | explanation |
|---|---|---|
| VOFF_TAR | Adjustment target va | Offset adjustment target value |
| VREF | Measurements | Measured VREF pin voltage |
| VOUT0 | Measurements | VOUT pin voltage when VOUT_OFF=0 |
| VOFF0 | Calculated value | Offset when VOUT_OFF=0 |
| VOUT_P255 | Measurements | VOUT pin voltage when VOUT_OFF=255 |
| VOFF_P255 | Calculated value | Offset when VOUT_OFF=255 |
| VOUT_M254 | Measurements | VOUT pin voltage when VOUT_OFF=-254 |
| VOFF_M254 | Calculated value | Offset when VOUT_OFF=-254 |
| VOUTX | Measurements | Adjustment process offset |
| VOFF_TRM | Register setting valu | Optimal VOUT_OFF setting |
| VOUT_TRM | Measurements | VOUT pin voltage after VOUT_OFF adjustment |

*If the text specifies that VOUT_OFF should be read/written, this is done for addresses 50h and 59h.

1 Determine the offset target value VOFF_TAR.
Adjusting VOFF The target VOFF_TAR does not necessarily have to be 0mV.
In the procedure described in this document, VOFF can be adjusted appropriately regardless of the value of VOFF_TAR.

2 Read address 59h
In the future, when writing VOUT_OFF, please send B5 to B0 of the 59h transmission data as the results of reading B5 to B0 here.

3 Measure VREF without applying a magnetic field, and let the measurement result be VREF.

4 Write VOUT_OFF=0

5 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT0.
At that time, calculate the offset voltage VOFF0=VOUT0-VREF.

4 Write VOUT_OFF=255

5 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT_P255.
At that time, calculate the offset voltage VOFF_P255=VOUT_P255-VREF.

6 Write VOUT_OFF=-254

7 Measure VOUT without applying a magnetic field, and set the measurement result as VOUT_M254.
At that time, calculate the offset voltage VOFF_M254=VOUT_M254-VREF.

8 To set the VOUT_OFF register appropriately, it is necessary to determine whether to expand the adjustment range based on the VOFF_P255 and VOFF_M254 values. Depending on the result, decide whether to extend the adjustment range or not.

(i) When VOUT_P255 ≧ VOFF_TAR and VOUT_M254 ≦ VOFF_TAR
In this case, the adjustment range extension is not turned on.

(ii) In any other case
Turns on extended adjustment range.

9 The next step branches depending on which of VOFF0 and VOFF_TAR is larger.

***(i) If VOFF0≦VOFF_TAR***

Set VOFF_TRM=0
Let i=0

*Please repeat steps 10 to 12 below for i=0 to 7.

10 Write VOUT_OFF=VOFF_TRM+(2^(7-i))

11 Measure VOUT without applying a magnetic field, and let the measurement result be VOUTX.

(i) When VOUTX-VREF≦VOFF_TAR
Recalculate VOFF_TRM=VOFF_TRM+(2^(7-i))

(ii) When VOUTX-VREF>VOFF_TAR
In this case, VOFF_TRM is not recalculated.

12 If i<7, recalculate i=i+1 and return to "10" above.
If i=7, end the loop and proceed to "13" below

13 Write VOUT_OFF=VOFF_TRM

14 Measure VOUT without applying a magnetic field, and let the measurement result be VOUT_TRM.
Check that the error VOUT_TRM-VREF-VOFF_TAR from the final target meets the required accuracy.

***(ii) If VOFF0＞VOFF_TAR***

Set VOFF_TRM=0
Let i=0

※Please repeat steps 10 to 12 below 8 times for i=0 to 7.

10 Write VOUT_OFF=VOFF_TRM-(2^(7-i))

11 Measure VOUT without applying a magnetic field, and let the measurement result be VOUTX.

(i) When VOUTX-VREF≧VOFF_TAR
Recalculate VOFF_TRM=VOFF_TRM-(2^(7-i))

(ii) VOUTX - VREF
In this case, VOFF_TRM is not recalculated.

12 If i<7, recalculate i=i+1 and return to "10" above.
If i=7, end the loop and proceed to "13" below

13 Write VOUT_OFF=VOFF_TRM

14 Measure VOUT without applying a magnetic field, and let the measurement result be VOUT_TRM.
Check that the error VOUT_TRM-VREF-VOFF_TAR from the final target meets the required accuracy.

## ■Writing trimming results to non-volatile addresses

The final trimming adjustment code is written to a non-volatile area.
Please write from 10h to 1Ah as shown in the table below.

For multi-byte write, 11 bytes from 10h to 1Ah are sent.
*When writing a single byte, there is no need to send data to the unused register 18h.

**Address and transmission data to be written after trimming**

<table>
<tr><th></th><th>B7</th><th>B6</th><th>B5</th><th>B4</th><th>B3</th><th>B2</th><th>B1</th><th>B0</th></tr>
<tr><td>10h</td><td colspan="8">VOUT_OFF[8:1]</td></tr>
<tr><td>11h</td><td colspan="3">0</td><td colspan="5">SENSE_COARSE(51h)</td></tr>
<tr><td>12h</td><td colspan="7">0</td><td>SENSE_COARSE(52h)</td></tr>
<tr><td>13h</td><td colspan="7">0</td><td>TSD_EN</td></tr>
<tr><td>14h</td><td colspan="8">SENSE_FINE[7:0]</td></tr>
<tr><td>15h</td><td>0</td><td colspan="6">SENSE_TC</td><td>SENSE_REV</td></tr>
<tr><td>16h</td><td colspan="3">0</td><td>VREF_SEL</td><td>VREF_EXT</td><td>0</td><td colspan="2">VREF_SEL</td></tr>
<tr><td>17h</td><td colspan="2">0</td><td colspan="6">VREF</td></tr>
<tr><td>18h</td><td colspan="8">0</td></tr>
<tr><td>19h</td><td>VOUT_OFF [0]</td><td>Adjustment Range Expansion</td><td>0</td><td colspan="5">VOUT_OFF_TC</td></tr>
<tr><td>1Ah</td><td colspan="2">FBW_SEL</td><td colspan="4">0</td><td colspan="2">SENSE_FINE[9:8]</td></tr>
</table>

## ■ Write protection

By enabling the write protect function, you can prevent the contents of the non-volatile memory from being rewritten.
Once the write protect function is enabled, it cannot be disabled again.
Therefore, please do as necessary.

### ・Write protection activation flow

1 Write the keyword for write-protect mode to the keyword register.

The data (keyword) to be sent is 5Eh

**Data to send to the keyword register (CFh)**

5h (B7–B4) Eh (B3–B0)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CFh<br>B7<br>0 | CFh<br>B6<br>1 | CFh<br>B5<br>0 | CFh<br>B4<br>1 | CFh<br>B3<br>1 | CFh<br>B2<br>1 | CF0h<br>B1<br>1 | CFh<br>B0<br>0 |

keyword

2 By writing the write protect mode keyword,
It becomes possible to write to the write protect register (1Fh B0).

Write "1" to the write protect register.

| Write protect function enable/disable | Write Protect Register |
|---|---|
| invalid | 0 |
| valid | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1Fh<br>B7 | 1Fh<br>B6 | 1Fh<br>B5 | 1Fh<br>B4 | 1Fh<br>B3 | 1Fh<br>B2 | 1Fh<br>B1 | 1Fh<br>B0 |

0 (B7–B1) Write Protect Register (B0)

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