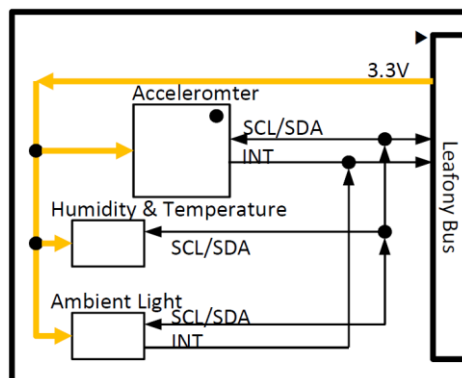# AI01 4-Sensors

1. 概要

温湿度センサー、照度センサー、加速度センサーを搭載したリーフである。MCU リーフとは I2C で接続される。

2. リーフ仕様

2-1. ブロック図
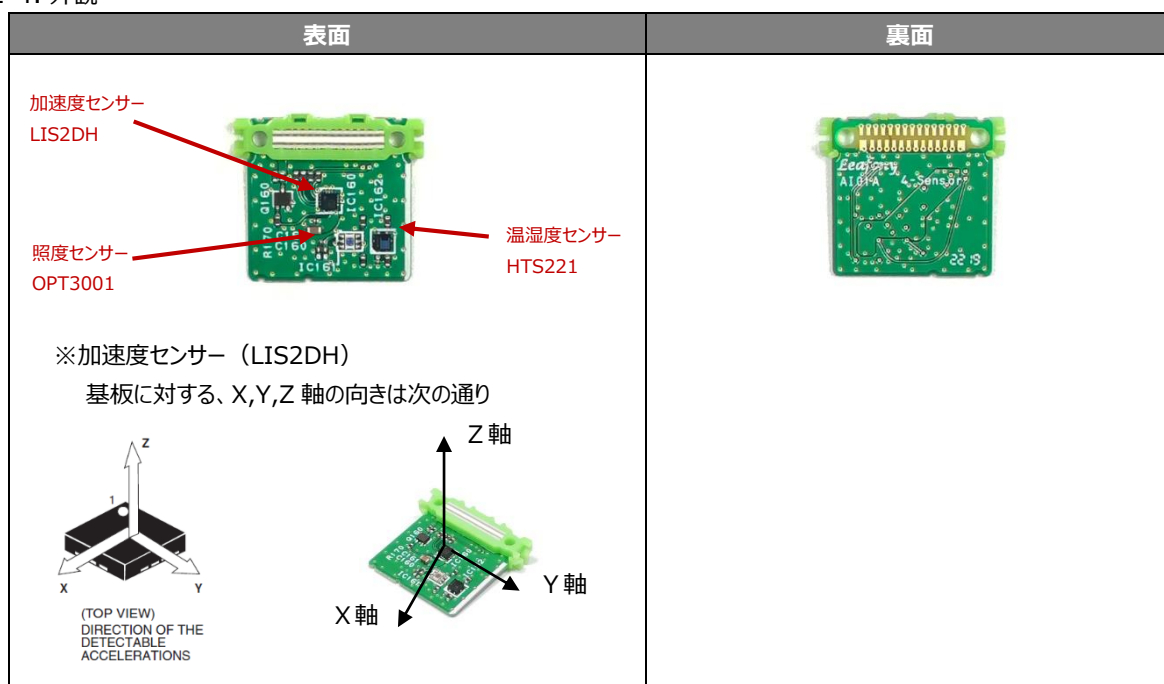

2-2. 電源仕様

Symbol	Parameter	Condition	Min.	Typ.	Max.
Vdd	Power Supply Voltage	–	1.71V	3.3V	3.6V
Idd	Operating current	Active	-	16uA	-
		Sleep	-	1.4uA	-

2-3. 主要部品

部品番号	部品名	型番	ベンダー名	備考
IC162	温湿度センサー	HTS221	ST Microelectronics	I2C アドレス：0x5F
IC161	照度センサー	OPT3001	Texas Instruments	I2C アドレス：0x45(チップ抵抗の付け替えにより 0x44 に変更可能)
IC160	加速度センサー	LIS2DH	ST Microelectronics	I2C アドレス：0x19

※I2C アドレスは 7bit で表記

2-4. 外観

表面	裏面
加速度センサー LIS2DH 照度センサー OPT3001 温湿度センサー HTS221 ※加速度センサー（LIS2DH） 基板に対する、X,Y,Z 軸の向きは次の通り Z軸 Y軸 X軸 (TOP VIEW) DIRECTION OF THE DETECTABLE ACCELERATIONS	

2-5. ピンアウト

Name	Function
SCL	I2C 通信クロック
SDA	I2C 通信データ
D3	INT：割り込み出力信号　L：割り込み
3V3	3.3V 入力
GND	GND

3. 温湿度センサー(HTS221)仕様

3-1. 概要

項目	内容
温度計測範囲	-40〜120℃
Temperature accuracy	±0.5°C (15 to +40°C)
Relative humidity range	0 to 100%
Humidity accuracy	3.5% rH (20 to +80% rH)
Interfaces	I2C

3-2. 電気的特性

・　最大定格

Parameter	Value
Operating Temperature	-40℃ to +120℃
Maximum Operation Voltage	4.8V

- 定格

Symbol	Parameter	Condition	Min.	Typ.	Max.
Vdd	supply voltage	Internal Oscillator	1.71V	2.5V	3.6V
Idd	Normal mode	1Hz, 2.5V	-	2uA	-
	Power down mode	2.5V	-	0.5uA	-

3-3. データシートリンク先

https://www.st.com/ja/mems-and-sensors/hts221.html

3-4. 主な関数とライブラリ

3-4-1. ユニファイドセンサードライバー

include file:Adafruit_Sensor.h

https://github.com/adafruit/Adafruit_Sensor

関数	概要
－	Adafruit のセンサーライブラリを使用するために必要。

3-4-2. 温湿度センサーデータ取得

include file:HTS221.h

https://github.com/ameltech/sme-hts221-library

関数	概要
smeHumidity.begin()	温湿度センサーを初期化。 【パラメータ】 なし 【戻り値】 true: 成功 false:失敗
smeHumidity.readTemperature()	温湿度センサーから温度を読み込む。 【パラメータ】 なし 【戻り値】 温度データ
smeHumidity.readHumidity()	温湿度センサーから湿度を読み込む。 【パラメータ】 なし 【戻り値】 湿度データ
smeHumidity.deactivate()	省電力モードに移行。 【パラメータ】 なし 【戻り値】 true: 成功

smeHumidity.activ ate()	省電力モードから復帰。 【パラメータ】 なし 【戻り値】 true: 成功

3-5. レジスタ

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
WHO_AM_I	0Fh	1	0	1	1	1	1	0	0

WHO_AM_I description

WHO_AM_I[7:0]	Device identification=BCh(読み出し専用)

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
AV_CONF	10h	Reserved	Reserved	AVGT2	AVGT1	AVGT0	AVGH2	AVGH1	AVGH0

WHO_AM_I description

AV_CONF[7:6]	Reserved
AV_CONF[5:3]	AVGT2-0: To select the numbers of averaged temperature samples (2 - 256).
AV_CONF[2:0]	AVGH2-0: To select the numbers of averaged humidity samples (4 - 512).

Humidity and temperature average configuration

AVGx2:0	Nr. internal average		Noise (RMS)		I_{DD} 1 Hz
	Temperature (AVGT)	Humidity (AVGH)	Temp (°C)	rH %	µA
000	2	4	0.08	0.4	0.80
001	4	8	0.05	0.3	1.05
010	8	16	0.04	0.2	1.40
011	16	32	0.03	0.15	2.10
100	32	64	0.02	0.1	3.43
101	64	128	0.015	0.07	6.15
110	128	256	0.01	0.05	11.60
111	256	512	0.007	0.03	22.50

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
CTRL_REG1	20h	PD	Reserved	Reserved	Reserved	Reserved	BDU	ODR1	ODR0

CTRL_REG1 description

CTRL_REG1[7]	PD: power-down control (0: power-down mode; 1: active mode)
CTRL_REG1[6:3]	Reserved
CTRL_REG1[2]	BDU: block data update (0: continuous update; 1: output registers not updated until MSB and LSB reading)
CTRL_REG1[1:0]	ODR1, ODR0: output data rate selection

Output data rate configuration

ODR1	ODR0	Humidity (Hz)	Temperature (Hz)
0	0	One-shot	
0	1	1 Hz	1 Hz
1	0	7 Hz	7 Hz
1	1	12.5 Hz	12.5 Hz

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
CTRL_REG2	21h	BOOT	Reserved	Reserved	Reserved	Reserved	Reserved	Heater	ONE_SHOT

CTRL_REG2 description

CTRL_REG2[7]	BOOT: Reboot memory content (0: normal mode; 1: reboot memory content)
CTRL_REG2[6:2]	Reserved
CTRL_REG2[1]	Heater (0: heater disable; 1: heater enable)
CTRL_REG2[0]	One-shot enable (0: waiting for start of conversion; 1: start for a new dataset)

Typical power consumption with heater ON

V_{DD} [V]	I [mA]
3.3	33
2.5	22
1.8	12

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
CTRL_REG3	22h	DRDY_H_L	PP_OD	Reserved	Reserved	Reserved	DRDY	Reserved	Reserved

CTRL_REG3 description

CTRL_REG3[7]	DRDY_H_L: Data Ready output signal active high, low (0: active high - default;1: active low)
CTRL_REG3[6]	PP_OD: Push-pull / Open Drain selection on pin 3 (DRDY) (0: push-pull - default; 1: open drain)
CTRL_REG3[5:3]	Reserved
CTRL_REG3[2]	DRDY_EN: Data Ready enable (0: Data Ready disabled - default;1: Data Ready signal available on pin 3)
CTRL_REG3[1:0]	Reserved

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
STATUS_REG	27h	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	H_DA	T_DA

STATUS_REG description

STATUS_REG[7:2]	Reserved
STATUS_REG[1]	H_DA: Humidity data available. (0: new data for humidity is not yet available; 1: new data for humidity is available)

STATUS_REG[0]	T_DA: Temperature data available. (0: new data for temperature is not yet available; 1: new data for temperature is available) H_DA is set to 1 whenever a new humidity sample is available. H_DA is cleared anytime HUMIDITY_OUT_H (29h) register is read. T_DA is set to 1 whenever a new temperature sample is available. T_DA is cleared anytime TEMP_OUT_H (2Bh) register is read.

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
HUMIDITY_OUT_L	28h	HOUT7	HOUT6	HOUT5	HOUT4	HOUT3	HOUT2	HOUT1	HOUT0

HUMIDITY_OUT_L description

HUMIDITY_OUT_L[7:0]	HOUT7 - HOUT0: Humidity data LSB

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
HUMIDITY_OUT_H	29h	HOUT14	HOUT13	HOUT12	HOUT11	HOUT10	HOUT9	HOUT8	HOUT7

HUMIDITY_OUT_H description

HUMIDITY_OUT_H[7:0]	HOUT15 - HOUT8: Humidity data MSB

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
TEMP_OUT_L	2Ah	TOUT7	TOUT6	TOUT5	TOUT4	TOUT3	TOUT2	TOUT1	TOUT0

TEMP_OUT_L description

TEMP_OUT_L[7:0]	TOUT7 - TOUT0: Temperature data LSB

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
TEMP_OUT_H	2Bh	TOUT15	TOUT14	TOUT13	TOUT12	TOUT11	TOUT10	TOUT9	TOUT8

TEMP_OUT_H description

TEMP_OUT_H[15:8]	TOUT15 - TOUT8: Temperature data MSB.

3-6. 省電力制御

センサー値を取得する場合には、MCU が定時間毎に Sleep モードから Wakeup することで行える
温湿度センサーを低消費電力にするには温湿度センサーのチップにある Power-down モードを使用する。
電源投入時は Power-down モードとなっている。

Power-down モードへの移行に必要な関数
    smeHumidity.deactivate()

Active への移行に必要な関数
    smeHumidity.activate()

4. 照度センサー(OPT3001)仕様

4-1. 概要

項目	内容
Measurement range	0.01 lux to 83 k lux
IR Rejects	> 99% (typ)
Interfaces	I2C

4-2. 電気的特性

・ 最大定格

Parameter	Value
Operating Temperature	-40℃ to +85℃
Maximum Operation Voltage	6V

・ 定格

Symbol	Parameter	Condition	Min.	Typ.	Max.
Vdd	supply voltage	Internal Oscillator	1.6V	-	3.6V
Vdd_IO	IO pin supply voltage	−	1.6V	-	5.5V
Idd	Active	Dark,VDD=3.6V	-	1.8uA	2.5uA
		Full-scale lux,VDD=3.6V	-	3.7uA	-
	Shutdown	Dark,VDD=3.6V	-	0.3uA	0.47uA
		Full-scale lux,VDD=3.6V	-	0.4uA	-

4-3. データシートリンク先

http://www.tij.co.jp/product/jp/OPT3001

4-4. 主な関数とライブラリ

4-4-1. ユニファイドセンサードライバー

include file:Adafruit_Sensor.h

https://github.com/adafruit/Adafruit_Sensor

関数	概要
−	Adafruit のセンサーライブラリを使用するために必要。

4-4-2. 照度センサーデータ取得

include file:ClosedCube_OPT3001.h

https://github.com/closedcube/ClosedCube_OPT3001_Arduino

関数	概要
light.begin(address)	温湿度センサーを初期化。 【パラメータ】 address：7 ビットの I2C スレーブアドレス。 【戻り値】 Error Code

light.writeConfig(newConfig)	照度センサーのコンフィグレーションレジスターにデータを書き込む。 【パラメータ】 newConfig：設定データ 【戻り値】 Error Code
light.readConfig()	照度センサーのコンフィグレーションレジスターを読み出します。 【パラメータ】 なし 【戻り値】 レジスタ値
light.readResult()	照度センサーデータを読みます。 【パラメータ】 なし 【戻り値】 　　輝度、測定値生値、エラーコード

4-5. レジスタ

Name	Add	D15	D14	D13	D12	D11	D10	D9	D8
Result	00h	E3	E2	E1	E0	R11	R10	R9	R8
		D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
		R7	R6	R5	R4	R3	R2	R1	R0

Result Register Field Descriptions

Field	Description
E[3:0]	**Exponent.** These bits are the exponent bits. Full-Scale Range and LSB Size as a Function of Exponent Level provides further details.
R[11:0]	**Fractional result.** These bits are the result in straight binary coding (zero to full-scale).

Full-Scale Range and LSB Size as a Function of Exponent Level

E3	E2	E1	E0	FULL-SCALE RANGE (lux)	LSB SIZE (lux per LSB)
0	0	0	0	40.95	0.01
0	0	0	1	81.90	0.02
0	0	1	0	163.80	0.04
0	0	1	1	327.60	0.08
0	1	0	0	655.20	0.16
0	1	0	1	1310.40	0.32
0	1	1	0	2620.80	0.64
0	1	1	1	5241.60	1.28
1	0	0	0	10483.20	2.56
1	0	0	1	20966.40	5.12
1	0	1	0	41932.80	10.24
1	0	1	1	83865.60	20.48

Name	Add	D15	D14	D13	D12	D11	D10	D9	D8
Configuration	01h	RN3	RN2	RN1	RN0	CT	M1	M0	OVF
		D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
		CRF	FH	FL	L	POL	ME	FC1	FC0

Configuration Register Field Descriptions

Field	Description
RN[3:0]	**Range number field (read or write).** The range number field selects the full-scale lux range of the device. The format of this field is the same as the result register exponent field (E[3:0]). When RN[3:0] is set to 1100b (0Ch), the device operates in automatic full-scale setting mode. In this mode, the automatically chosen range is reported in the result exponent (register 00h, E[3:0]). The device powers up as 1100 in automatic full-scale setting mode. Codes 1101b, 1110b, and 1111b (0Dh, 0Eh, and 0Fh) are reserved for future use.

CT	**Conversion time field (read or write).** The conversion time field determines the length of the light to digital conversion process. The choices are 100 ms and 800 ms. A longer integration time allows for a lower noise measurement. The conversion time also relates to the effective resolution of the data conversion process. The 800-ms conversion time allows for the fully specified lux resolution. The 100-ms conversion time with full-scale ranges above 0101b for E[3:0] in the result and configuration registers also allows for the fully specified lux resolution. The 100-ms conversion time with full-scale ranges below and including 0101b for E[3:0] can reduce the effective result resolution by up to three bits, as a function of the selected full-scale range. Range 0101b reduces by one bit. Ranges 0100b, 0011b, 0010b, and 0001b reduces by two bits. Range 0000b reduces by three bits. The result register format and associated LSB weight does not change as a function of the conversion time. 0 = 100 ms 1 = 800 ms
M[1:0]	**Mode of conversion operation field (read or write).** The mode of conversion operation field controls whether the device is operating in continuous conversion, single-shot, or low-power shutdown mode. The default is 00b (shutdown mode), such that upon power-up, the device only consumes operational level power after appropriately programming the device. When single-shot mode is selected by writing 01b to this field, the field continues to read 01b while the device is actively converting. When the single-shot conversion is complete, the mode of conversion operation field is automatically set to 00b and the device is shut down. When the device enters shutdown mode, either by completing a single-shot conversion or by a manual write to the configuration register, there is no change to the state of the reporting flags (conversion ready, flag high, flag low) or the INT pin. These signals are retained for subsequent read operations while the device is in shutdown mode. 00 = Shutdown (default) 01 = Single-shot 10, 11 = Continuous conversions

OVF	**Overflow flag field (read-only).** The overflow flag field indicates when an overflow condition occurs in the data conversion process, typically because the light illuminating the device exceeds the programmed full-scale range of the device. Under this condition OVF is set to 1, otherwise OVF remains at 0. The field is reevaluated on every measurement. If the full-scale range is manually set (RN[3:0] field < 1100b), the overflow flag field can be set while the result register reports a value less than full-scale. This result occurs if the input light has a temporary high spike level that temporarily overloads the integrating ADC converter circuitry but returns to a level within range before the conversion is complete. Thus, the overflow flag reports a possible error in the conversion process. This behavior is common to integrating-style converters. If the full-scale range is automatically set (RN[3:0] field = 1100b), the only condition that sets the overflow flag field is if the input light is beyond the full-scale level of the entire device. When there is an overflow condition and the full-scale range is not at maximum, the OPT3001 aborts its current conversion, sets the full-scale range to a higher level, and starts a new conversion. The flag is set at the end of the process. This process repeats until there is either no overflow condition or until the full-scale range is set to its maximum range.
CRF	**Conversion ready field (read-only).** The conversion ready field indicates when a conversion completes. The field is set to 1 at the end of a conversion and is cleared (set to 0) when the configuration register is subsequently read or written with any value except one containing the shutdown mode (mode of operation field, M[1:0] = 00b). Writing a shutdown mode does not affect the state of this field.
FH	**Flag high field (read-only).** The flag high field (FH) identifies that the result of a conversion is larger than a specified level of interest. FH is set to 1 when the result is larger than the level in the high-limit register (register address 03h) for a consecutive number of measurements defined by the fault count field (FC[1:0]).
FL	**Flag low field (read-only).** The flag low field (FL) identifies that the result of a conversion is smaller than a specified level of interest. FL is set to 1 when the result is smaller than the level in the low-limit register (register address 02h) for a consecutive number of measurements defined by the fault count field (FC[1:0]).

L	**Latch field (read or write).** The latch field controls the functionality of the interrupt reporting mechanisms: the INT pin, the flag high field (FH), and flag low field (FL). This bit selects the reporting style between a latched window-style comparison and a transparent hysteresis-style comparison. 0 = The device functions in transparent hysteresis-style comparison operation, where the three interrupt reporting mechanisms directly reflect the comparison of the result register with the high- and low-limit registers with no user-controlled clearing event. 1 = The device functions in latched window-style comparison operation, latching the interrupt reporting mechanisms until a user-controlled clearing event.
POL	**Polarity field (read or write).** The polarity field controls the polarity or active state of the INT pin. 0 = The INT pin reports active low, pulling the pin low upon an interrupt event. 1 = Operation of the INT pin is inverted, where the INT pin reports active high, becoming high impedance and allowing the INT pin to be pulled high upon an interrupt event.
ME	**Mask exponent field (read or write).** The mask exponent field forces the result register exponent field (register 00h, bits E[3:0]) to 0000b when the full-scale range is manually set, which can simplify the processing of the result register when the full-scale range is manually programmed. This behavior occurs when the mask exponent field is set to 1 and the range number field (RN[3:0]) is set to less than 1100b. Note that the masking is only performed to the result register. When using the interrupt reporting mechanisms, the result comparison with the low-limit and high-limit registers is unaffected by the ME field.
FC[1:0]	**Fault count field (read or write).** The fault count field instructs the device as to how many consecutive fault events are required to trigger the interrupt reporting mechanisms: the INT pin, the flag high field (FH), and flag low field (FL). The fault events are described in the latch field (L), flag high field (FH), and flag low field (FL) descriptions. 00 = One fault count (default) 01 = Two fault counts 10 = Four fault counts 11 = Eight fault counts

4-6. 省電力制御

センサー値を取得する場合には、MCU が定時間毎に Sleep モードから Wakeup することで行える。

照度センサーを低消費電力にするには Shutdown モードを使用する。

電源投入時は Shutdown モードとなっている。

Configuration Register Field の Mode of conversion operation field を変更することで Active モード と Shutdown モードを切替できる

    00 = Shutdown モード (default)

    01 = Single-shot

    10, 11 = Continuous conversions

ライブラリからは以下の様に設定する。

1)Active モード

```
newConfig.ModeOfConversionOperation = B11;
light.writeConfig(newConfig);
```

ただし Active モードにするときにそのほかの Configuration Register の内容も書き変わるため
以下のように設定する。

```
newConfig.RangeNumber = B1100;            //automatic full scale
newConfig.ConvertionTime = B1;           //convertion time = 800ms
newConfig.ModeOfConversionOperation = B11;   //continous conversion
newConfig.Latch = B1;                    //latch window styl

light.writeConfig(newConfig);
```

2)Shutdown モード

```
ClosedCube_OPT3001 light;
OPT3001_Config newConfig;

newConfig.ModeOfConversionOperation = B00;
light.writeConfig(newConfig);
```

5. 加速度センサー(LIS2DH)仕様

5-1. 概要

項目	内容
Measurement range	±2g/±4g/±8g/±16g (selectable)
Function	6D/4D orientation detection
	Freefall detection
	Motion detection
Interfaces	I2C

5-2. 電気的特性

5-2-1. 最大定格

Parameter	Value
Operating Temperature	-40℃ to +85℃
Maximum Operation Voltage	4.8V

5-2-2. 定格

Symbol	Parameter	Condition	Min.	Typ.	Max.
Vdd	supply voltage	Internal Oscillator	1.71V	2.5V	3.6V
Vdd_IO	IO pin supply voltage	−	1.71V	-	Vdd+0.1V
Idd	Current consumption	normal mode 50Hz	-	11uA	-
		normal mode 1Hz	-	2uA	-
		low power mode 50Hz	-	6uA	-
IddPdn	Current consumption	Power down mode	-	0.5uA	-

5-3. データシートリンク先

https://www.st.com/ja/mems-and-sensors/lis2dh.html

5-4. 主な関数とライブラリ
5-4-1. ユニファイドセンサードライバー

include file:Adafruit_Sensor.h

https://github.com/adafruit/Adafruit_Sensor

関数	概要
−	Adafruit のセンサーライブラリを使用するために必要。

5-4-2. 加速度センサーデータ取得

Adafruit_LIS3DH.h

https://github.com/adafruit/Adafruit_LIS3DH

関数	概要
Adafruit_LIS3DH accel = Adafruit_LIS3DH();	Adafruit_LIS3DH ライブラリのインスタンスを作成と通信モードの設定 【パラメータ】 accel：インスタンス名(accel) = 通信モード（Adafruit_LIS3DH()）
accel.begin(address)	加速度センサーの初期化 【パラメータ】 address: 7 ビットの I2C スレーブアドレス。 【戻り値】 true: 成功 false:失敗
accel.writeRegister8(register_address, value)	加速度センサーのレジスタに値を書き込む 【パラメータ】 register_address : 　LIS3DH_REG_CTRL1 CTRL_REG1 (20h) 　LIS3DH_REG_CTRL2 CTRL_REG2 (21h) 　LIS3DH_REG_CTRL3 CTRL_REG3 (22h) 　LIS3DH_REG_CTRL4 CTRL_REG4 (23h) 　LIS3DH_REG_CTRL5 CTRL_REG5 (24h) 　LIS3DH_REG_CTRL6 CTRL_REG5 (25h) 　LIS3DH_REG_INT1CFG INT1_CFG (30h) 　LIS3DH_REG_INT1THS INT1_THS (32h) 　LIS3DH_REG_INT1DUR INT1_DURATION (33h) 【戻り値】 なし

accel.setDataRate(value)	加速度センサーのデーターレートを設定。
	【パラメータ】
	value :
	LIS3DH_DATARATE_400_HZ 400Hz
	LIS3DH_DATARATE_200_HZ 200Hz
	LIS3DH_DATARATE_100_HZ 100Hz
	LIS3DH_DATARATE_50_HZ 50Hz
	LIS3DH_DATARATE_25_HZ 25Hz
	LIS3DH_DATARATE_10_HZ 10 Hz
	LIS3DH_DATARATE_1_HZ 1 Hz
	【戻り値】
	なし
accel.read()	加速度センサーの値を読み込む。
	【パラメータ】
	なし
	【戻り値】
	なし
	測定結果は以下の変数に保存される
	accel.x_g X 軸の値
	accel.y_g Y 軸の値
	accel.z_g Z 軸の値

5-5. レジスタ

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
CTRL_REG1	20h	ODR3	ODR2	ODR1	ODR0	LPen	Zen	Yen	Xen

CTRL_REG1 description

ODR[3:0]	Data rate selection. Default value:
	(0000:Power Down mode; Others: Refer to "Data Rate Configuration")
LPen	Low power mode enable. Default value: 0
	(0: Normal mode, 1: Low power mode)
Zen	Z axis enable. Default value: 1
	(0: Z axis disabled; 1: Z axis enabled)
Yen	Y axis enable. Default value: 1
	(0: Y axis disabled; 1: Y axis enabled)
Xen	X axis enable. Default value: 1
	(0: X axis disabled; 1: X axis enabled)

Data Rate Configuration

ODR3	ODR2	ODR1	ODR0	Power mode selection
0	0	0	0	Power down mode
0	0	0	1	HR / normal / Low power mode (1 Hz)
0	0	1	0	HR / normal / Low power mode (10 Hz)
0	0	1	1	HR / normal / Low power mode (25 Hz)
0	1	0	0	HR / normal / Low power mode (50 Hz)
0	1	0	1	HR / normal / Low power mode (100 Hz)
0	1	1	0	HR / normal / Low power mode (200 Hz)
0	1	1	1	HR/ normal / Low power mode (400 Hz)
1	0	0	0	Low power mode (1.620 kHz)
1	0	0	1	HR/ normal (1.344 kHz); Low power mode (5.376 kHz)

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
CTRL_REG2	21h	HPM1	HPM0	HPCF2	HPCF1	FDS	HPCLICK	HPIS2	HPIS1

CTRL_REG2 description

HPM[1:0]	High Pass filter Mode Selection. Default value: 00 Refer to "High pass filter mode configuration"
HPCF[2:1]	High Pass filter Cut Off frequency selection
FDS	Filtered Data Selection. Default value: 0 (0: internal filter bypassed; 1: data from internal filter sent to output register and FIFO)
HPCLICK	High Pass filter enabled for CLICK function. (0: filter bypassed; 1: filter enabled)
HPIS2	High Pass filter enabled for AOI function on Interrupt 2, (0: filter bypassed; 1: filter enabled)
HPIS1	High Pass filter enabled for AOI function on Interrupt 1, (0: filter bypassed; 1: filter enabled)

High pass filter mode configuration

HPM1	HPM0	High Pass filter Mode
0	0	Normal mode (reset reading)
0	1	Reference signal for filtering
1	0	Normal mode
1	1	Autoreset on interrupt event

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
CTRL_REG3	22h	I1_CLICK	I1_AOI1	I1_AOI2	I1_DRDY1	I1_DRDY2	I1_WTM	I1_OVERRUN	--

CTRL_REG3 description

I1_CLICK	CLICK interrupt on INT1 pin. Default value 0. (0: Disable; 1: Enable)
I1_AOI1	AOI1 interrupt on INT1 pn. Default value 0. (0: Disable; 1: Enable)

I1_AOI2	AOI2 interrupt on INT1 pin. Default value 0.
	(0: Disable; 1: Enable)
I1_DRDY1	DRDY1 interrupt on INT1 pin. Default value 0.
	(0: Disable; 1: Enable)
I1_DRDY2	DRDY2 interrupt on INT1 pin. Default value 0.
	(0: Disable; 1: Enable)
I1_WTM	FIFO Watermark interrupt on INT1 pin. Default value 0.
	(0: Disable; 1: Enable)
I1_OVERRUN	FIFO Overrun interrupt on INT1 pin. Default value 0.
	(0: Disable; 1: Enable)

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
CTRL_REG4	23h	BDU	BLE	FS1	FS0	HR	ST1	ST0	SIM

CTRL_REG4 description

BDU	Block data update. Default value: 0
	(0: continuos update; 1: output registers not updated until MSB and LSB have been read)
BLE	Big/Little Endian data selection. Default value:0;
	(0: data LSb at lower address; 1: data MSb at lower address)
	The BLE function can be activated only in High Resolution mode
FS[1:0]	Full Scale selection. Default value: 00
	(00: +/- 2G; 01: +/- 4G; 10: +/- 8G; 11: +/- 16G)
HR	Operating mode selection
ST[1:0]	Self Test Enable. Default value: 00
	(00: Self Test Disabled; Other: See Table)
SIM	SPI Serial Interface Mode selection. Default value: 0
	(0: 4-wire interface; 1: 3-wire interface).

Self test mode configuration

ST1	ST0	Self test mode
0	0	Normal mode
0	1	Self test 0
1	0	Self test 1
1	1	--

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
CTRL_REG5	24h	BOOT	FIFO_EN	--	--	LIR_INT1	D4D_INT1	LIR_INT2	D4D_INT2

CTRL_REG5 description

BOOT	Reboot memory content. Default value: 0
	(0: Normal mode; 1: reboot memory content)
FIFO_EN	FIFO enable. Default value: 0
	(0: FIFO disable; 1: FIFO Enable)

LIR_INT1	Latch interrupt request on INT1_SRC register, with INT1_SRC register cleared by reading INT1_SRC itself. Default value: 0. (0: interrupt request not latched; 1: interrupt request latched)
D4D_INT1	4D enable: 4D detection is enabled on INT1 pin when 6D bit on INT1_CFG is set to 1.
LIR_INT2	Latch interrupt request on INT2_SRC register, with INT2_SRC register cleared by reading INT2_SRC itself. Default value: 0. (0: interrupt request not latched; 1: interrupt request latched)
D4D_INT2	4D enable: 4D detection is enabled on INT2 pin when 6D bit on INT2_CFG is set to 1.

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
CTRL_REG6	25h	I2_CLICKen	I2_INT1	I2_INT2	BOOT_I2	P2_ACT	--	H_LACTIVE	--

CTRL_REG6 description

I2_CLICKen	Click interrupt on INT2 pin. Default value: 0 (0: disable; 1: enable)
I2_INT1	Interrupt 1 function enabled on INT2 pin. Default value: 0 (0: function disable; 1: function enable)
I2_INT2	Interrupt 2 function enabled on INT2 pin. Default value: 0 (0: function disable; 1: function enable)
BOOT_I2	Boot on INT2 pin enable. Default value: 0 (0: disable; 1:enable)
P2_ACT	Activity interrupt enable on INT2 pin. Default value: 0. (0: disable; 1:enable)
H_LACTIVE	interrupt active. Default value: 0. (0: interrupt active high; 1: interrupt active low)

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
INT1_CFG	30h	AOI	6D	ZHIE/ ZUPE	ZLIE/ ZDOWNE	YHIE/ YUPE	YLIE/ YDOWNE	XHIE/ XUPE	XLIE/ XDOWNE

INT1_CFG description

AOI	And/Or combination of Interrupt events. Default value: 0. Refer to "Interrupt mode"
6D	6 direction detection function enabled. Default value: 0. Refer to "Interrupt mode"
ZHIE/ ZUPE	Enable interrupt generation on Z high event or on Direction recognition. Default value: 0 (0: disable interrupt request;1: enable interrupt request)
ZLIE/ ZDOWNE	Enable interrupt generation on Z low event or on Direction recognition. Default value: 0 (0: disable interrupt request;1: enable interrupt request)
YHIE/ YUPE	Enable interrupt generation on Y high event or on Direction recognition. Default value: 0 (0: disable interrupt request; 1: enable interrupt request.)

YLIE/ YDOWNE	Enable interrupt generation on Y low event or on Direction recognition. Default value: 0
	(0: disable interrupt request; 1: enable interrupt request.)
XHIE/ XUPE	Enable interrupt generation on X high event or on Direction recognition. Default value: 0
	(0: disable interrupt request; 1: enable interrupt request.)
XLIE/XDOWNE	Enable interrupt generation on X low event or on Direction recognition. Default value: 0
	(0: disable interrupt request; 1: enable interrupt request.)

Interrupt mode

AOI	6D	Interrupt mode
0	0	OR combination of interrupt events
0	1	6 direction movement recognition
1	0	AND combination of interrupt events
1	1	6 direction position recognition

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
INT1_THS	32h	0	THS6	THS5	THS4	THS3	THS2	THS1	THS0

INT1_THS description

THS[6:0]	Interrupt 1 threshold. Default value: 000 0000
	1LSb = 16mg @FS=2g
	1LSb = 32 mg @FS=4g
	1LSb = 62 mg @FS=8g
	1LSb = 186 mg @FS=16g

Name	Add	D7	D6	D5	D4	D3	D2	D1	D0
INT1_DURATION	33h	0	D6	D5	D4	D3	D2	D1	D0

INT1_DURATION description

D[6:0]	Duration value. Default value: 000 0000 1 LSb = 1/ODR

5-6. 省電力制御

センサー値を取得する場合には、MCU が定時間毎に Sleep モードから Wakeup することで行えるが、加速度センサーの場合は Sleep 状態でも常時振動を取得し続け、ある大きさ以上の振動発生時に割り込みして Wakeup することも出来る。

加速度センサーを低消費電力にするには加速度センサーのチップにある Power-down モードを使用する。

電源投入時は Power-down モードとなっている。

Power-down モードと Active モードの移行は以下の関数によって行うことが出来る。

関数

　　　lis3dh.setDataRate(パラメータ)　　　　：　Data Rate 設定関数(パラメータ)

ライブラリの呼び出し

　　　#include < Adafruit_LIS3DH.h >

Data Rate パラメータ	処理内容
LIS3DH_DATARATE_50_HZ	normal mode 50Hz：Data rate 50Hz で動作する
LIS3DH_DATARATE_1_HZ	normal mode 1Hz：Data rate 1Hz で動作する
LIS3DH_DATARATE_POWERDOWN	Power Down mode：動作しない

スケッチの例

```
#include <Adafruit_LIS3DH.h>
Adafruit_LIS3DH lis3dh = Adafruit_LIS3DH();
void setup() { }
void loop() {
    lis3dh.setDataRate (LIS3DH_DATARATE_POWERDOWN);
}
```

6. 変更履歴
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