±2g、±4g、±6g、±8g（選択）3軸加速度センサー

KXSD9－2050モジュール

★チップ型３軸加速度センサーＫＸＳＤ９－２０５０を基板に半田付けし、使いやすくモジュール化しました。

★Ｉ２Ｃインターフェイスでマイコン等に接続します。（ＳＰＩでも使用できます）

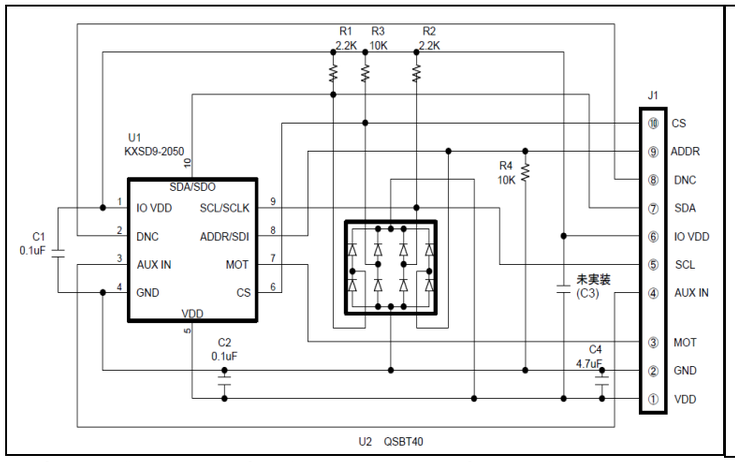
■ 測定レンジ　　±２ｇ、±４ｇ、±６ｇ、±８ｇから選択（デフォルトは±６ｇ）

■ 感度　　２７３カウント／ｇ（±６ｇ時）

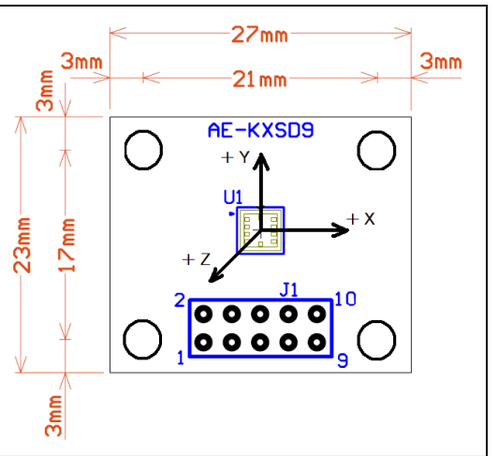
■ ０（ゼロ）ｇオフセット　　２０４８

■ 電源電圧　　１．８Ｖ～３．６Ｖ（標準３．３Ｖ）

■回路図■



■外形寸法とＸＹＺ方向■



※ピンヘッダは2×7(14)ピンが付属しています。ピンヘッダを使用する場合には、2×5(10)ピンとなるように加工してください。
2×2ピン分をニッパ等の工具を使ってカットします。

■各ピンの説明■

番号	名 称	接続・機能等
1	VDD	電源入力　　１．８Ｖ～３．６Ｖ（標準３．３Ｖ）
2	GND	ＧＮＤ
3	MOT	モーションウエークアップ出力
4	AUX IN	外部Ａ／Ｄ入力
5	SCL	Ｉ２Ｃシリアルクロック入力　　（IO VDDにプルアップ済み）
6	IO VDD	Ｉ／Ｏ電源入力　　１．７Ｖ～ＶＤＤ（標準３．３Ｖ）
7	SDA	Ｉ２Ｃシリアルデータ　　（IO VDDにプルアップ済み）
8	DNC	無接続（接続禁止）
9	ADDR	Ｉ２Ｃスレーブアドレスの下位ビット（GNDにプルダウン済み　LSB=0）
10	CS	Ｉ２Ｃ／ＳＰＩ切り替え　　（IO VDDにプルアップ済み　Ｉ２Ｃ選択）

SPIで使用する場合には、J1-⑩CSピンをLow(GND)に接続します。

■特性■

Mechanical
(specifications are for operation at 3.3V and T = 25C unless stated otherwise)

Parameters		Units	Min	Typical	Max
Operating Temperature Range		ºC	-40	-	85
Zero-g Offset		counts	1843	2048	2253
Zero-g Offset Variation from RT over Temp.		mg/ºC		0.5 (xy) 3 (z)	
Sensitivity	FS1=1, FS0=1 (± 2g)	counts/g	794	819	844
	FS1=1, FS0=0 (± 4g)		390	410	430
	FS1=0, FS0=1 (± 6g)		257	273	289
	FS1=0, FS0=0 (± 8g)		189	205	221
Sensitivity Variation from RT over Temp.		%/ºC		0.01 (xy) 0.04 (z)	
Offset Ratiometric Error (V_{dd} = 3.3V ± 5%)		%		0.3	
Sensitivity Ratiometric Error (V_{dd} = 3.3V ± 5%)		%		1.1 (xy) 0.6 (z)	
Self Test Output change on Activation		g	1.1 0.03	1.5 (xy) 0.5 (z)	1.9 1.1
Mechanical Resonance (-3dB)[2]		Hz		4000 (xy) 2000 (z)	
Non-Linearity		% of FS		0.1	
Cross Axis Sensitivity		%		2	
Noise Density (on filter pins)		µg / √Hz		750	

Electrical
(specifications are for operation at 3.3V and T = 25C unless stated otherwise)

Parameters		Units	Min	Typical	Max
Supply Voltage (V_{dd})	Operating	V	1.8	3.3	3.6
I/O Pads Supply Voltage (V_{IO})		V	1.7		V_{dd}
Current Consumption	Operating (full power)	µA	120	220	320
	Motion Wake Up 15Hz Mode			40	75
	Standby			0.1	
Output Low Voltage		V	-	-	0.3 * V_{io}
Output High Voltage		V	0.9 * V_{io}	-	-
Input Low Voltage		V	-	-	0.2 * V_{io}
Input High Voltage		V	0.8 * V_{io}	-	-
Input Pull-down Current		µA		0	
Power Up Time	LPF (-3dB) = 50Hz	ms		15.9	
	LPF (-3dB) = 100Hz			8.0	
	LPF (-3dB) = 500Hz			1.6	
	LPF (-3dB) = 1,000Hz			0.8	
	LPF (-3dB) = 2,000Hz			0.4	
A/D Conversion time		µs		200	
SPI Communication Rate		MHz			1
I^2C Communication Rate		KHz			400
Bandwidth (-3dB)		Hz	40	50	60

Parameter	Specification	Test Conditions
Zero-g Offset @ RT	2048 +/- 205 counts	25C, Vdd = 3.3 V
Sensitivity @ RT	819 +/- 25 counts/g	25C, Vdd = 3.3 V
Current Consumption -- Operating	120 <= Idd <= 320 uA	25C, Vdd = 3.3 V

■Ｉ２Ｃ設定■

このモジュールは、KXSD9-9050の(SCL/SCLK)と(SDA/SDO)をＩ２Ｃインターフェイス用にプルアップしてあります。
またアドレス設定ピンの(ADDR/SDI)をプルダウン(０に設定）し、(CS)をプルアップしてあります。
キットのＪ１の９番ピン（ADDR)、10番ピン（CS)を無接続（どこにも接続しない）にした場合、Ｉ２Ｃインターフェイスが選択され、Ｉ２Ｃのスレーブアドレスは,
ライト時0x30(00110000), リード時0x31(00110001)になります。

■Ｉ２Ｃシーケンス■

Sequence 1. The Master is writing one byte to the Slave.

Master	S	SAD + W		RA		DATA		P
Slave			ACK		ACK		ACK	

Sequence 2. The Master is writing multiple bytes to the Slave.

Master	S	SAD + W		RA		DATA		DATA		P
Slave			ACK		ACK		ACK		ACK	

Sequence 3. The Master is receiving one byte of data from the Slave.

Master	S	SAD + W		RA		Sr	SAD + R			NACK	P
Slave			ACK		ACK			ACK	DATA		

Sequence 4. The Master is receiving multiple bytes of data from the Slave.

Master	S	SAD + W		RA		Sr	SAD + R			ACK		NACK	P
Slave			ACK		ACK			ACK	DATA		DATA		

Sequence 5. The Master is receiving acceleration bytes from the Slave (ADDR = 0, CLKhld = 1).

Master	S	0x30h		0x00h	200µS	Sr	0x31h			ACK	
Slave			ACK		ACK	CLKhld			ACK	XOUT_H		XOUT_L

Master	ACK		ACK		ACK		ACK		NACK	P
Slave		YOUT_H		YOUT_L		ZOUT_H		ZOUT_L		

■Ｉ２Ｃレジスタマップ■

Register Name	Type Read/Write	Address Hex	Address Binary
XOUT_H	R	0x00	0000 0000
XOUT_L	R	0x01	0000 0001
YOUT_H	R	0x02	0000 0010
YOUT_L	R	0x03	0000 0011
ZOUT_H	R	0x04	0000 0100
ZOUT_L	R	0x05	0000 0101
AUXOUT_H	R	0x06	0000 0110
AUXOUT_L	R	0x07	0000 0111
-	-	xxxx	xxxx xxxx
-	-	xxxx	xxxx xxxx
Reset_write	W	0x0A	0000 1010
-	-	xxxx	xxxx xxxx
CTRL_REGC	R/W	0x0C	0000 1100
CTRL_REGB	R/W	0x0D	0000 1101
CTRL_REGA	R	0x0E	0000 1110

■レジスタ■

XOUT_H
X-axis accelerometer output most significant byte

R	R	R	R	R	R	R	R
XOUTD11	XOUTD10	XOUTD9	XOUTD8	XOUTD7	XOUTD6	XOUTD5	XOUTD4
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

I²C Address: 0x00h
SPI Read Address: 0x80h

XOUT_L
X-axis accelerometer output least significant byte

R	R	R	R	R	R	R	R
XOUTD3	XOUTD2	XOUTD1	XOUTD0	X	X	X	X
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

I²C Address: 0x01h
SPI Read Address: 0x81h

YOUT_H
Y-axis accelerometer output most significant byte

R	R	R	R	R	R	R	R
YOUTD11	YOUTD10	YOUTD9	YOUTD8	YOUTD7	YOUTD6	YOUTD5	YOUTD4
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

I²C Address: 0x02h
SPI Read Address: 0x82h

YOUT_L
Y-axis accelerometer output least significant byte

R	R	R	R	R	R	R	R
YOUTD3	YOUTD2	YOUTD1	YOUTD0	X	X	X	X
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

I²C Address: 0x03h
SPI Read Address: 0x83h

ZOUT_H
Z-axis accelerometer output most significant byte

R	R	R	R	R	R	R	R
ZOUTD11	ZOUTD10	ZOUTD9	ZOUTD8	ZOUTD7	ZOUTD6	ZOUTD5	ZOUTD4
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

I²C Address: 0x04h
SPI Read Address: 0x84h

ZOUT_L
Z-axis accelerometer output least significant byte

R	R	R	R	R	R	R	R
ZOUTD3	ZOUTD2	ZOUTD1	ZOUTD0	X	X	X	X
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

I2C Address: 0x05h

AUXOUT_H
Auxiliary output most significant byte

R	R	R	R	R	R	R	R
AUXOUTD11	AUXOUTD10	AUXOUTD9	AUXOUTD8	AUXOUTD7	AUXOUTD6	AUXOUTD5	AUXOUTD4
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

I²C Address: 0x06h
SPI Read Address: 0x86h

AUXOUT_L
Auxiliary output least significant byte

R	R	R	R	R	R	R	R
AUXOUTD3	AUXOUTD2	AUXOUTD1	AUXOUTD0	X	X	X	X
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

I2C Address: 0x07h
SPI Read Address: 0x87h

Reset_write
When the key (11001010) is written to this register the offset, sensitivity and temperature correction values will be loaded into RAM and used for all further measurements. This is also accomplished at power-up by an internal power-up reset circuit.

W	W	W	W	W	W	W	W
1	1	0	0	1	0	1	0
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

I²C Address: 0x0Ah

CTRL_REGC
Read/write control register: Factory programmed power up/reset default value (0xE1h)

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
LP2	LP1	LP0	MOTLev	MOTLat	0	FS1	FS0	11100001
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	

I²C Address: 0x0Ch
SPI Read Address: 0x8Ch SPI Write Address: 0x0Ch

FS1	FS0	Full Scale Range	12-bit Sensitivity
0	0	+/-8 g	205 counts/g
0	1	+/-6 g	273 counts/g
1	0	+/-4 g	410 counts/g
1	1	+/-2 g	819 counts/g

MOTLev	FS1	FS0	Motion Wake Up Threshold
0	0	0	+/-6 g
0	0	1	+/-4.5 g
0	1	0	+/-3 g
0	1	1	+/-1.5 g
1	0	0	+/-4 g
1	0	1	+/-3 g
1	1	0	+/-2 g
1	1	1	+/-1 g

LP2	LP1	LP0	Filter Corner Frequency
0	0	0	No Filter
0	0	1	2000 Hz
0	1	0	2000 Hz
0	1	1	2000 Hz
1	0	0	1000 Hz
1	0	1	500 Hz
1	1	0	100 Hz
1	1	1	50 Hz

CTRL_REGB
Read/write control register: Factory programmed power up/reset default value (0x40h)

R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	Reset Value
CLKhld	ENABLE	ST	0	0	MOTIen	0	0	01000000
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	

I²C Address: 0x0Dh
SPI Read Address: 0x8Dh SPI Write Address: 0x0Dh

MOTIen *enables the motion wakeup feature.*
MOTIen = 1 – the KXSD9 will run in a low power mode until a motion event occurs that causes MOTI in CTRL_REGA and the MOT pin (7) to go high. The part then enters normal operation if MOTLat = 1 or remains in low power mode if MOTLat = 0.
MOTIen = 0 – the KXSD9 is in normal operating mode

ST *activates the self-test function for the sensor elements on all three axes. A correctly functioning KXSD9 will increase all channel outputs when Self test = 1 and Enable = 1. This bit can be read or written.*

Enable *powers up the KXSD9 for operation.*
Enable = 1 – normal operation
Enable = 0 – low-power standby

CLKhld *allows the KXSD9 to hold the serial clock, SCL, low in I²C mode to force the transmitter into a wait state during A/D conversions.*

CLKhld = 1 – SCL held low during A/D conversions
CLKhld = 0 – SCL unaffected

CTRL_REGA
Read-only status register

R	R	R	R	R	R	R	R
X	X	X	X	X	X	MOTI	X
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

I²C Address: 0x0Eh
SPI Read Address: 0x8Eh SPI Write Address: 0x0Eh

MOTI *reports the status of the motion wakeup interrupt. Reading CTRL_REGA clears the MOTI bit and MOT pin (7).*
MOTI = 1 - a motion wake up event has occurred and the MOT pin (7) is high.
MOTI = 0 - a motion wake up event has not occurred and the MOT pin (7) is low.