

『MMS101 SDK for Arduino』 User's Guide:

Instruction Manual

OUTLINE

This document is the instruction manual of "MMS101 SDK for Arduino".

"MMS101 SDK for Arduino" is a System Design Kit (SDK) consisting of a Shield which is connected to Arduino, a conversion board, the sample sketch, and an evaluation application. You can easily check the operation of the sensor by using the Sample Sketch. This kit is an expanded part of Arduino board and not operable alone.

For details on each sensor, refer to the applicable data sheet.

CAUTION

This kit is a design / sales promotion tool specifically for our products.

Therefore, we do not provide any guarantees for the performance, reliability, management of contained substances, export management, and others regarding this kit.

Please let us know that we will replace it if it is defective in its initial state.


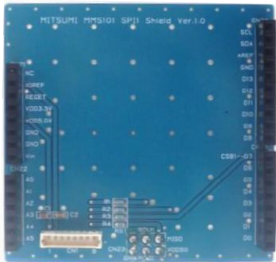

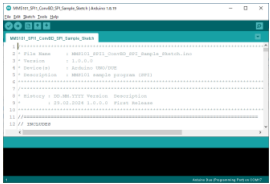
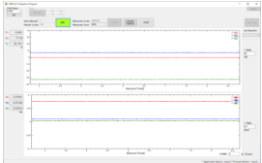

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1 Configuration

1-1 Kit Configuration

This kit consists of below:

Conversion Board	Expansion Board	Cable	Sample Sketch	Evaluation App.
 MMS10B1 SPI1 Conv.BD	 MMS101 SPI1 Shield	 PicoBlade(8p) Cable 300mm(*1)	 MMS101_SDK_for_Arduino _Sample_Sketch.ino	 ForceSensorEvaluation Program Ver.4.0.0.x
 MMS101C SPI1 Conv.BD + FPC Cable (*2)				

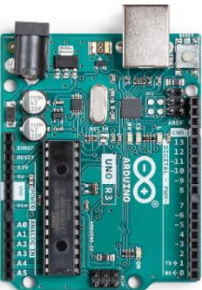


- (*1) The equivalent product is the Molex PicoBlade(8p) cable (Model No. 15134-0803).
If you need additional purchases of different lengths, please use commercially available FPC cable.
- (*2) The equivalent product is the Molex FPC cable (Model No. 15032-0215).
If you need additional purchases of different lengths, please use commercially available FPC cable.

Force Sensor Sample
 MMS101BXA
 MMS101C09

You can choose whether or not to include the force sensor sample by configuring your purchase set.
For details, please refer to "[Ordering information](#)".

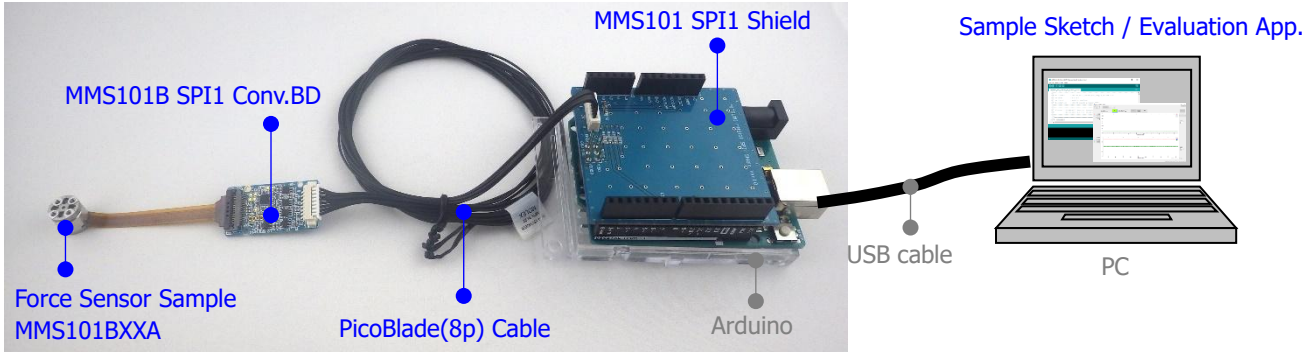
*Please use a conversion board that is compatible with each model.

This kit does not include the following items. Please prepare them yourself.

Arduino	USB cable	PC	Arduino IDE
	Please prepare a USB cable that can be used with Arduino.		






2 Usage form

Connect the evaluation kit as shown below.



3 Compatible Arduino models

This kit is applicable to UNO, LEONARDO, DUE, MEGA2560 and UNO R4.
If you're using the UNO R4, please refer to "[How to apply UNO R4](#)".

Model	UNO	LEONARDO	DUE	MEGA2560	UNO R4
View					
System Power Supply	5.0V	5.0V	3.3V	5.0V	5V
Limit (*1)	Data Rate > 1msec	Data Rate > 1msec	Data Rate >= 1msec	Data Rate > 1msec	Data Rate >= 1msec

(*1) The data rate is the execution period of the loop() function in the sample sketch. It depends on the capabilities of the Arduino's CPU.

4 Sample Sketch

4-1 File configuration

[MMS101_SDK_for_Arduino_Sample_Sketch]

└ MMS101_SDK_for_Arduino_Sample_Sketch.ino : Main Processing

4-2 Upload the sample sketch

(1) Download the Arduino IDE

The Arduino IDE is required to upload the Sample Sketch to the Arduino. Download the Arduino IDE from the URL below.

Download HP: <https://www.arduino.cc/en/software>

(2) Launch the Arduino IDE



(3) Make the Arduino IDE recognize the Arduino (in the case of DUE).

Select [Tools]

→ [Board: "Arduino Due (Programming Port)"]

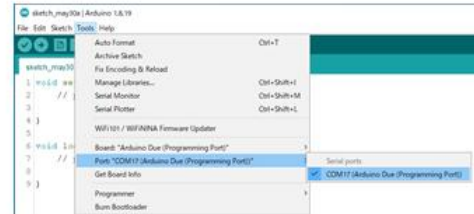
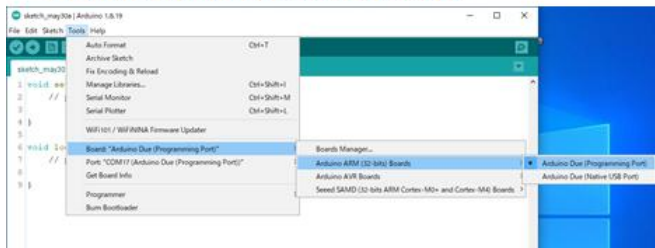
→ [Arduino ARM (32-bits) Boards]

→ [Arduino Due (Programming Port)]

Select [Tools]

→ [Port]

→ [COMxx(Arduino Due(Programming Port))]



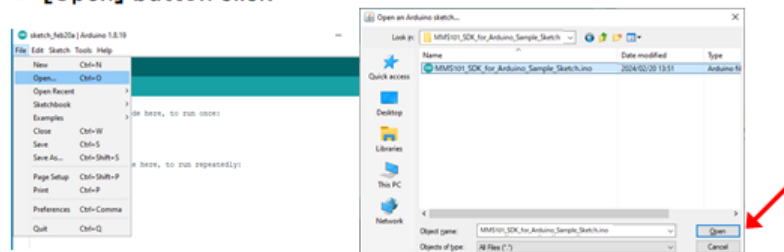
(4) Load the sample sketch on the Arduino IDE.

Select [File]

→ [Open...]

→ [MMS101_SDK_for_Arduino_Sample_Sketch.ino] file select

→ [Open] button click



(5) How to change Arduino model

In the sample sketch, the code for DUE is initially set. Change the code given below according to the Arduino model to use.

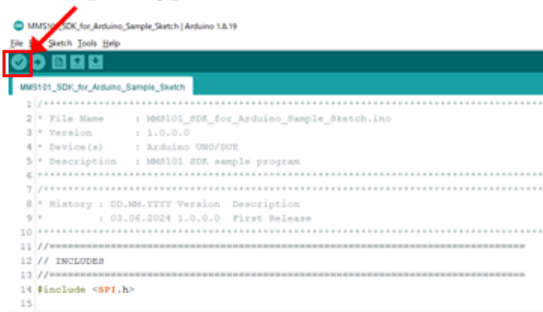
```

1 //=====
2 //
3 * File Name      : MMS101_SDK_for_Arduino_Sample_Sketch.ino
4 * Version       : 1.0.0.0
5 * Device(s)    : Arduino UNO/DUE
6 * Description   : MMS101 SDK sample program
7 //=====
8 * History      : DD.MM.YYYY Version  Description
9 *              : 03.04.2024 1.0.0.0  First Release
10 //=====
11 // INCLUDES
12 //=====
13 #include <SPI.h>
14
15 //=====
16 // Sample Board Version
17 //=====
18 #define _sketch_version_ "1","0","0" // Release version
19
20 //=====
21 // DEFINE AND INCLUDE for Arduino Settings
22 //=====
23 #define UNO           1
24 #define DUE           2
25 #define LEONARDO     3
26 #define MEGA2560     4
27 #define ARDUINO_VER  DUE // Set Arduino Board
  
```

- For use of UNO
30 #define ARDUINO_VER UNO
- For use of DUE
30 #define ARDUINO_VER DUE
- For use of LEONARDO
30 #define ARDUINO_VER LEONARDO
- For use of MEGA2560
30 #define ARDUINO_VER MEGA2560

(6) Verify the sample sketch and upload it to Arduino.

Click [Verify] button



Click [Upload] button



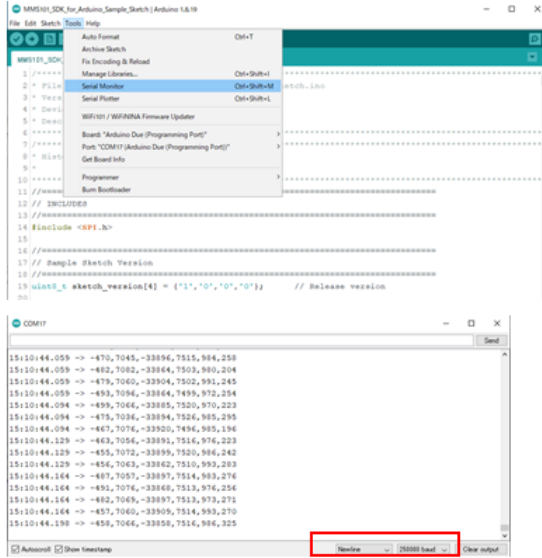
4-3 How to use the serial monitor / serial plotter

This kit allows you to monitor data using the serial monitor/serial plotter included with the Arduino IDE.

4-3-1 How to launch the serial monitor/serial plotter

For the serial monitor

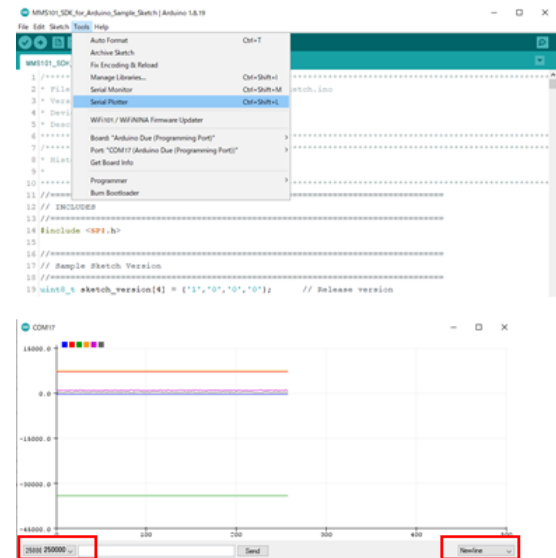
Select [Tools]
-> [Serial Monitor]



- Delimiter: Newline
- Baud rate: 250,000

For the serial plotter

Select [Tools]
-> [Serial Plotter]

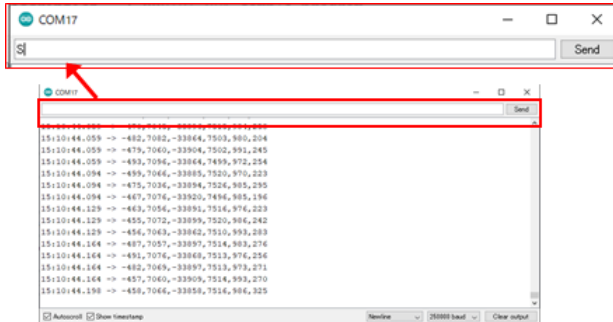


- Delimiter: Newline
- Baud rate: 250,000

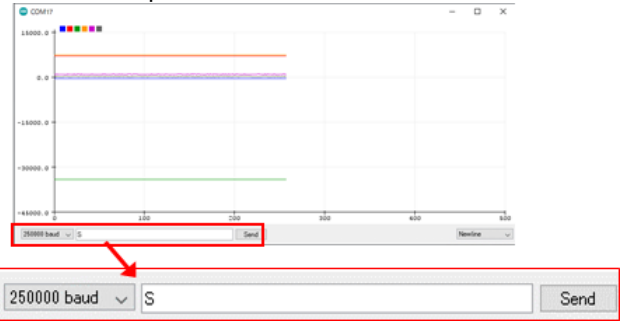
4-3-2 Evaluation procedure

(1) START: input [S] or [s]

For the serial monitor

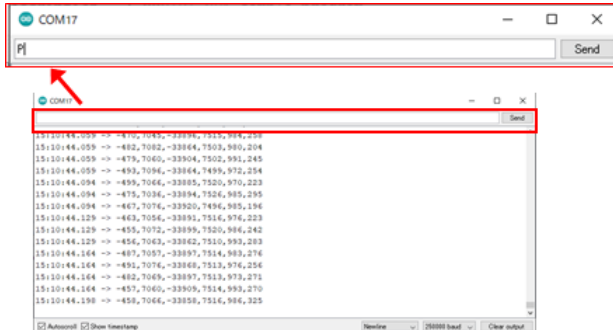


For the serial plotter



(2) STOP: input [P] or [p]

For the serial monitor




For the serial plotter



4-4 How to change the Arduino model settings

In the sample sketch, the code for DUE is initially set. Change the code given below according to the Arduino model to use.



•For use of UNO
 30 #define ARDUINO_VER UNO

•For use of DUE
 30 #define ARDUINO_VER DUE

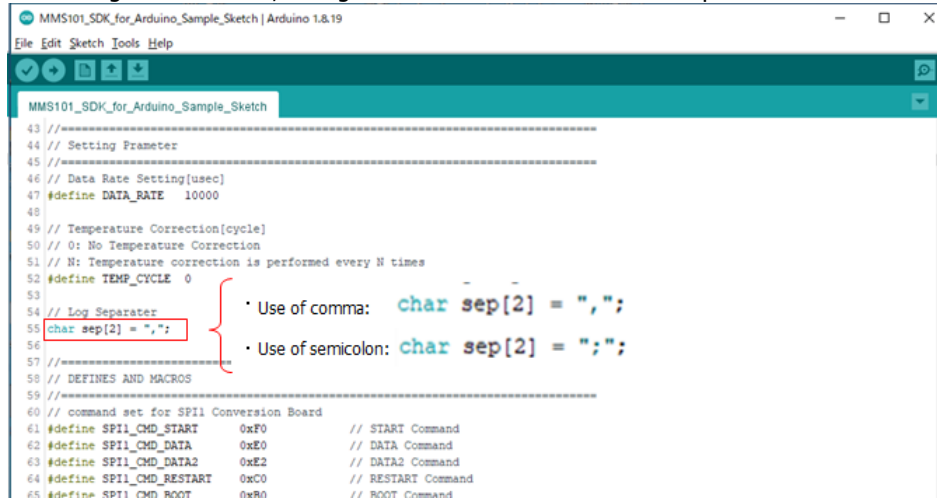
•For use of LEONARDO
 30 #define ARDUINO_VER LEONARDO

•For use of MEGA2560
 30 #define ARDUINO_VER MEGA2560

4-5 How to change the delimiter

Data output of the Sample Sketch is initially comma-separated.

To change the delimiter, change the character between double quotations to the desired character as shown below.



• Use of comma: char sep[2] = ",";

• Use of semicolon: char sep[2] = ";";

4-6 How to apply UNO R4

If you are using the UNO R4 when the sample sketch is not yet compatible with it, please apply the following code to the sample sketch.

4-6-1 SPI communication

Modify the code in the setup() function as follows;

• Please delete the code below

```
149 SPI.setDataMode(SPI_MODE3);           // SPI Mode:3
150 SPI.setBitOrder(MSBFIRST);           // MSB first
151 SPI.setClockDivider(SPI_CLOCK_DIV8);  // SCLK=2MHz
```

• Please add the code below

```
152 SPI.beginTransaction(SPISettings(2000000, MSBFIRST, SPI_MODE3));
```

• Example of modification

```
147 // Initialize SPI
148 SPI.begin();
149 // SPI.setDataMode(SPI_MODE3);           // SPI Mode:3
150 // SPI.setBitOrder(MSBFIRST);           // MSB firstS
151 // SPI.setClockDivider(SPI_CLOCK_DIV8);  // SCLK=2MHz
152 SPI.beginTransaction(SPISettings(2000000, MSBFIRST, SPI_MODE3));
```

4-6-2 Serial communication

If you are using the application, please add "Serial.dtr();" to the setup() function.

```
137 void setup() {
138     uint8_t axis;
139     uint8_t count;
140
141     Serial.begin(250000);           // serial boudrate: 250000bps
142     Serial.dtr();
```

5 Evaluation application

5-1 File configuration

The file configuration of the evaluation application is as follows.

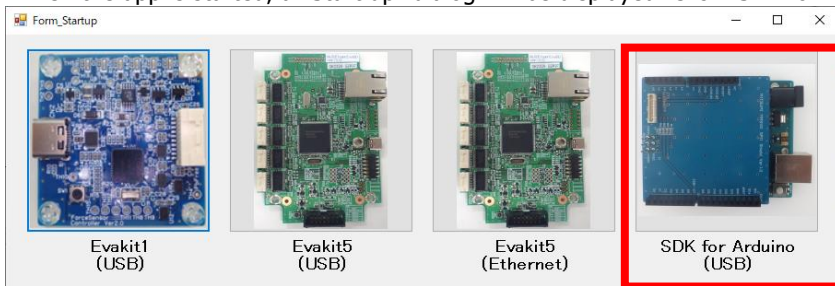
[ForceSensor_EvaluationProgram_ver.3.0.0.x]

- └ ForceSensor_EvaluationProgram.exe: Application
- └ NPlot.dll: Library for drawing graphs
- └ OpenTK.dll: Library for drawing graphs
- └ OpenTK.GLControl.dll: Library for drawing graphs
- └ [Settings]: Settings storage folder
- └ [UserData]: Data storage folder

5-2 How to use the evaluation application

5-2-1 Launch the evaluation application

When the app is started, a "Start up" dialog will be displayed. Click "SDK for Arduino(USB)".



This app has been confirmed to work on Windows 10, and 11

This app requires .NET Framework 4.8. An installation guide is available on the Microsoft website (URL below), so please install it according to your environment.

Microsoft .NET Framework install guide homepage URL:

<https://learn.microsoft.com/ja-jp/dotnet/framework/install/>

5-2-2 Display screen

Initiation button
(Read matrix correction coefficient from the AFE IC
Inside the sensor. Then the sensor operation is started.
The button turns light green while sensor is operating.)

Logging start button

Offset cancel button
(Change to light green when ON state)

Data acquisition interval setting
*The setting is 1-10000msec (1msec step)

Number of measurement setting
Number of measurement times

Logging stop button

Data save button
(Continuous measurement data is output as a CSV file)

COM Selection

MMS101 Evaluation Program

Interval[msec] 1

Restart Times 100

INIT.

Measuring Cycles 3600000

Measuring Count 0

START

OFFSET CANCEL

STOP

Save Log

Log Separator Selection
(select the delimiter
format for log data)

Log Separator [,]Comma

Fx, Fy, Fz measurement value

Fx, Fy, Fz measurement graph

Y Width 70 [N]

Fx, Fy, Fz measurement graph
Y-axis scale setting
(Set around 0 N)

Offset temperature correction update setting
(Offset temperature correction is performed for each set number of data acquisitions.)

Mx, My, Mz measurement value

Mx, My, Mz 測定グラフ

Y Width 0.2 [Nm]

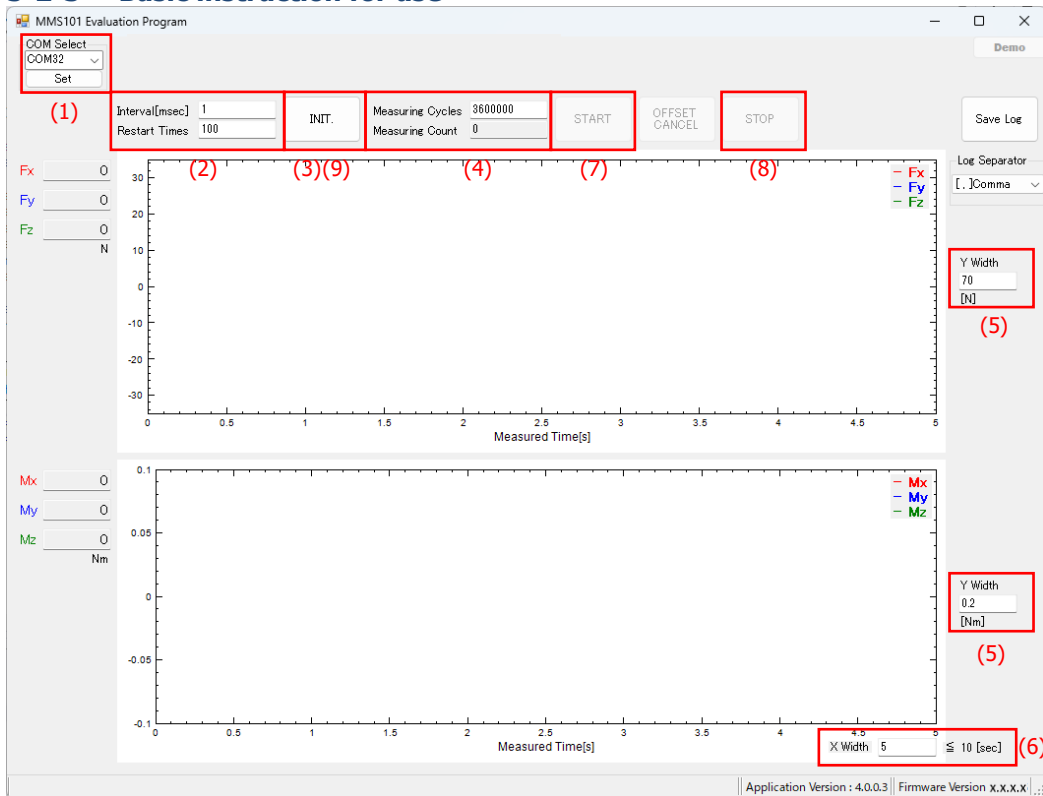
Mx, My, Mz measurement graph
Y-axis scale setting
(Set around 0 Nm)

Measurement graph
X-axis scale setting
(The maximum value that can be set changes depending value of interval)

X Width 5 ≤ 10 [sec]

Application Version : 4.0.0.3 | Firmware Version X.X.X.X

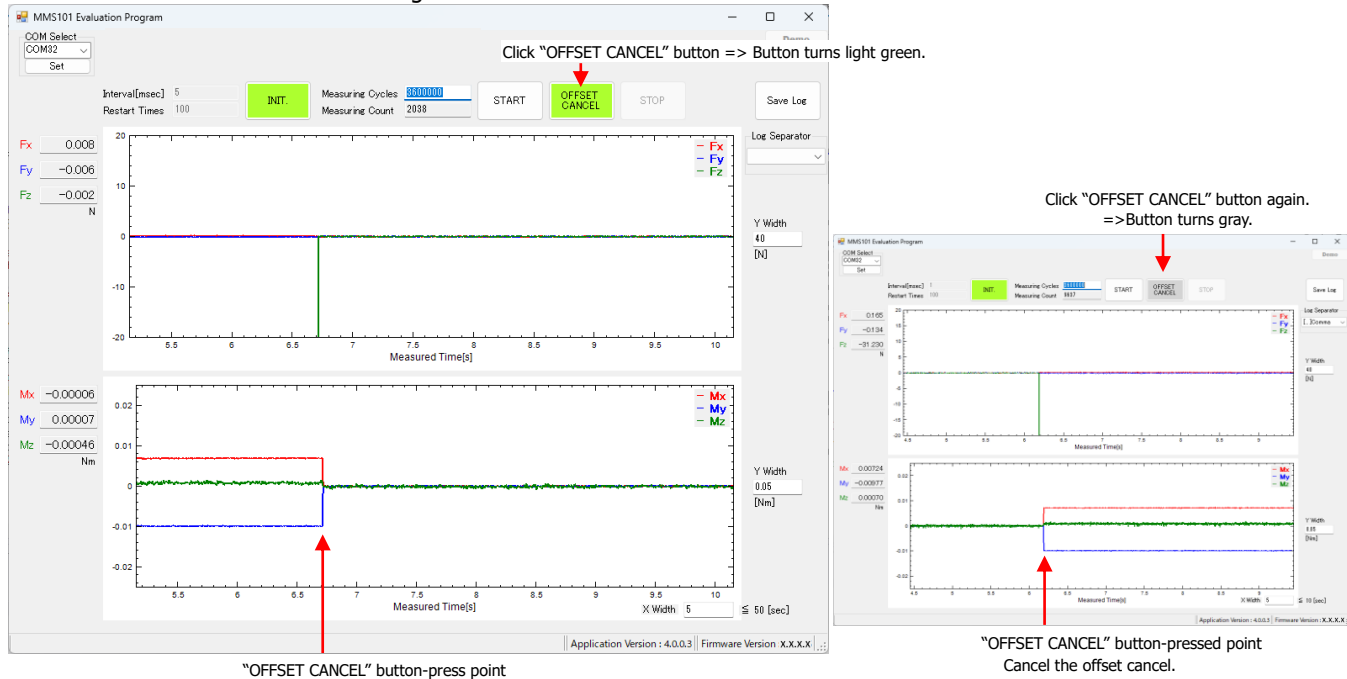
5-2-3 Basic instruction for use



- (1) Select the COM port on the evaluation board. Click the “Set” button.
The COM port depends on the PC.
- (2) Enter Interval[msec] and Restart Times.
The temperature sensor value for offset/temperature control is updated every number of times the numerical value set in Restart Cycles is acquired.
e.g. Restart Times=0 : Temperature sensor value acquisition is the first time only. No temperature value updating is performed thereafter.
Restart Times=1 : Update temperature sensor value every time
Restart Times=10 : Temperature sensor value updated once every 10 data acquisitions
- (3) Click the “INIT.” button.
The sensor operation is started.
The “INIT.” button turns light green while the sensor is operating.
Click it again to stop the sensor operation.
- (4) Enter Measuring Cycles.
The settable number of measurements is 2,147,483,647 at the maximum.
Since the number of measurements depend on the PC specification, it should be set so that "the number of measurements x 64 bytes" is less than "available PC memory".
- (5) Enter Y Width. (Value can be changed even during measurement)
- (6) Enter X Width. (Value can be changed even during measurement)
- (7) Click the “START” button. => The data logging starts.
- (8) Click the “STOP” button. => The data logging stops.
The logging process will stop automatically once the data for the “Measuring Cycles” count has been acquired, even without clicking the “STOP” button.
- (9) Click the “INIT.” button => The sensor operation stops.
The sensor operation is stopped.
The “INIT.” button turns gray after the sensor operation stops.

5-2-4 Offset cancel procedure

The sensor output has an initial offset. Offset also occurs in the mounted condition or in gravity. It is possible to cancel the offset deviation with the "OFFSET CANCEL" button. Click the "OFFSET CANCEL" button again to cancel the offset cancel.

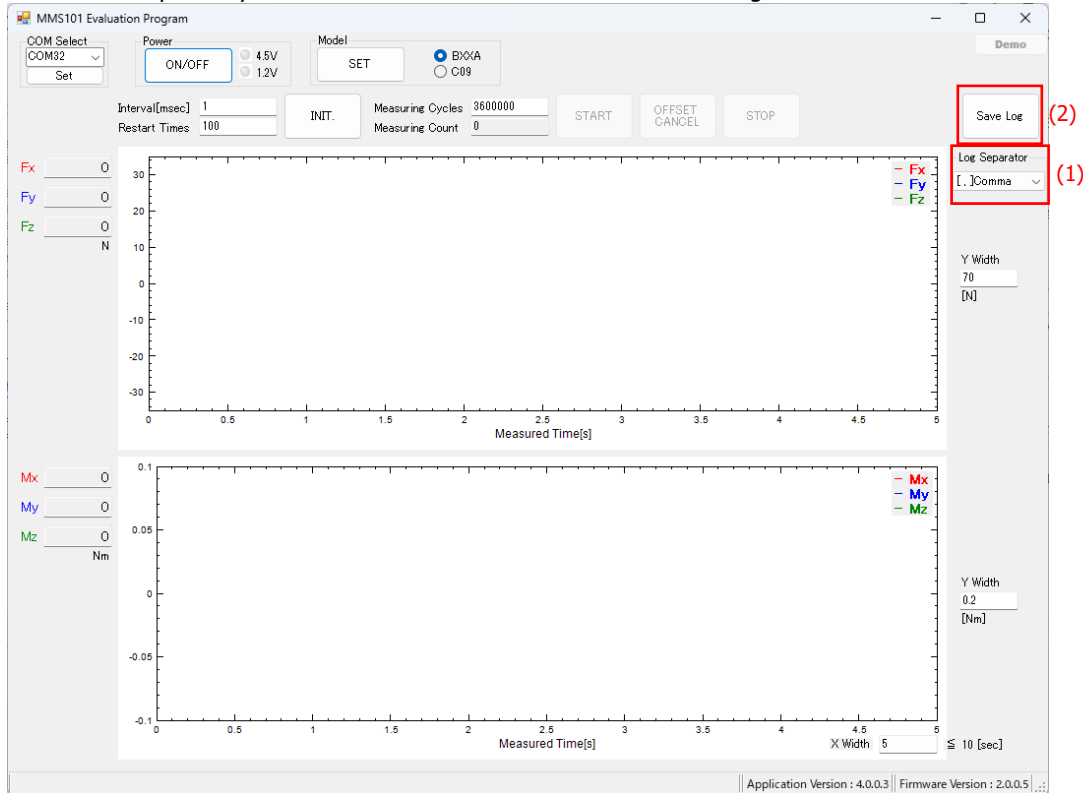


Please click the "OFFSET CANCEL" button after more than 5min has elapsed since sensor operation started to use.

*It is recommended that the output (initial-drift) stabilization wait time after sensor activation be equal to or greater than 5min.

5-2-5 Measurement data saving procedure

The data acquired by measurement can be saved with the “Save Log” button.

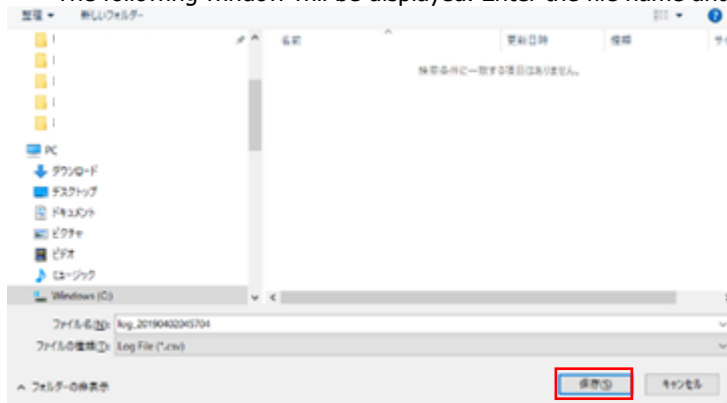


(1) Select the log separator.

[,]Comma
[;]Semicolon
[]Tab

(2) Click the “Save Log” button.

The following window will be displayed. Enter the file name and click the “Save” button

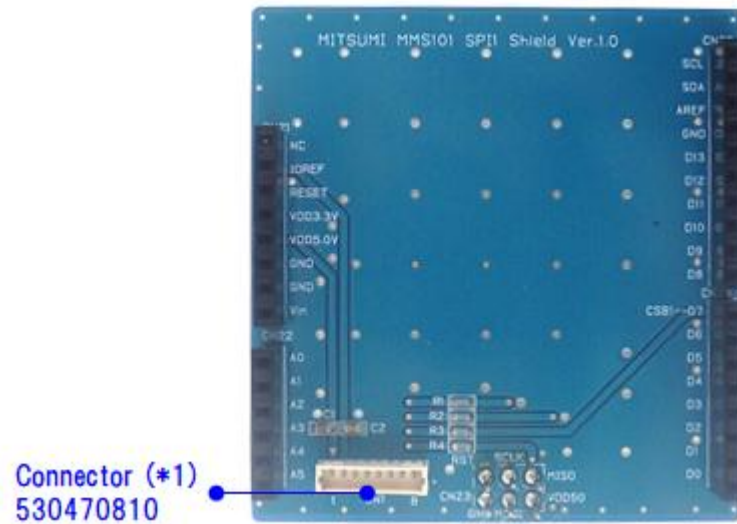


The data will be saved in the following format.

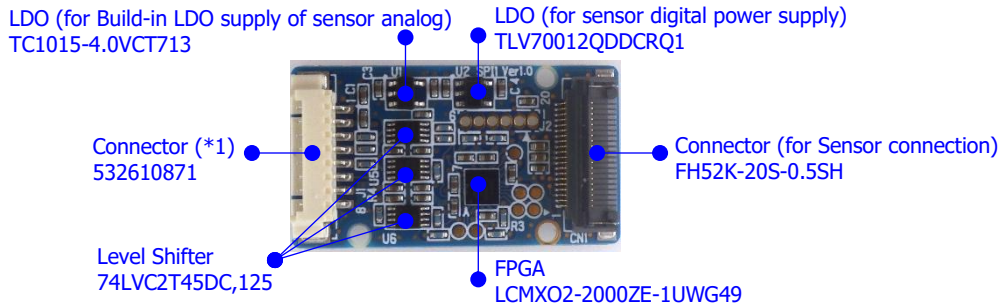
#	A	B	C	D	E	F	G	H
1	2019/4/3 14:20							
2	count[times]	Measured Time[s]	Fx Value[N]	Fy Value[N]	Fz Value[N]	Mx Value[Nm]	My Value[Nm]	Mz Value[Nm]
3	1	0.00244	0.014	-0.095	-1.537	0.00095	-0.00067	-0.00027
4	2	0.003681	0.013	-0.12	-1.318	0.00121	-0.00062	-0.00087
5	3	0.004922	0.009	-0.125	-1.214	0.00113	-0.00081	-0.00121
6	4	0.006161	-0.011	-0.106	-1.052	0.00119	-0.00085	-0.00088
7	5	0.0074	0.003	-0.111	-0.961	0.00093	-0.00067	-0.00131
8	6	0.008641	0.005	-0.133	-0.837	0.0012	-0.00091	-0.00124
9	7	0.009882	0.003	-0.099	-0.743	0.0009	-0.00081	-7.00E-05

6 Board configuration

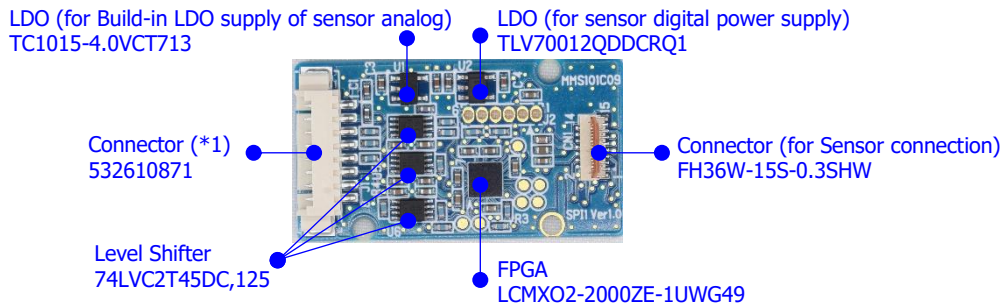
6-1 Expansion Board: MMS101 SPI1 Shield Ver.1.0



6-2 Conversion Board: MMS101B SPI1 Conv.BD Ver.1.0



6-3 Conversion Board: MMS101C SPI1 Conv.BD Ver.1.0

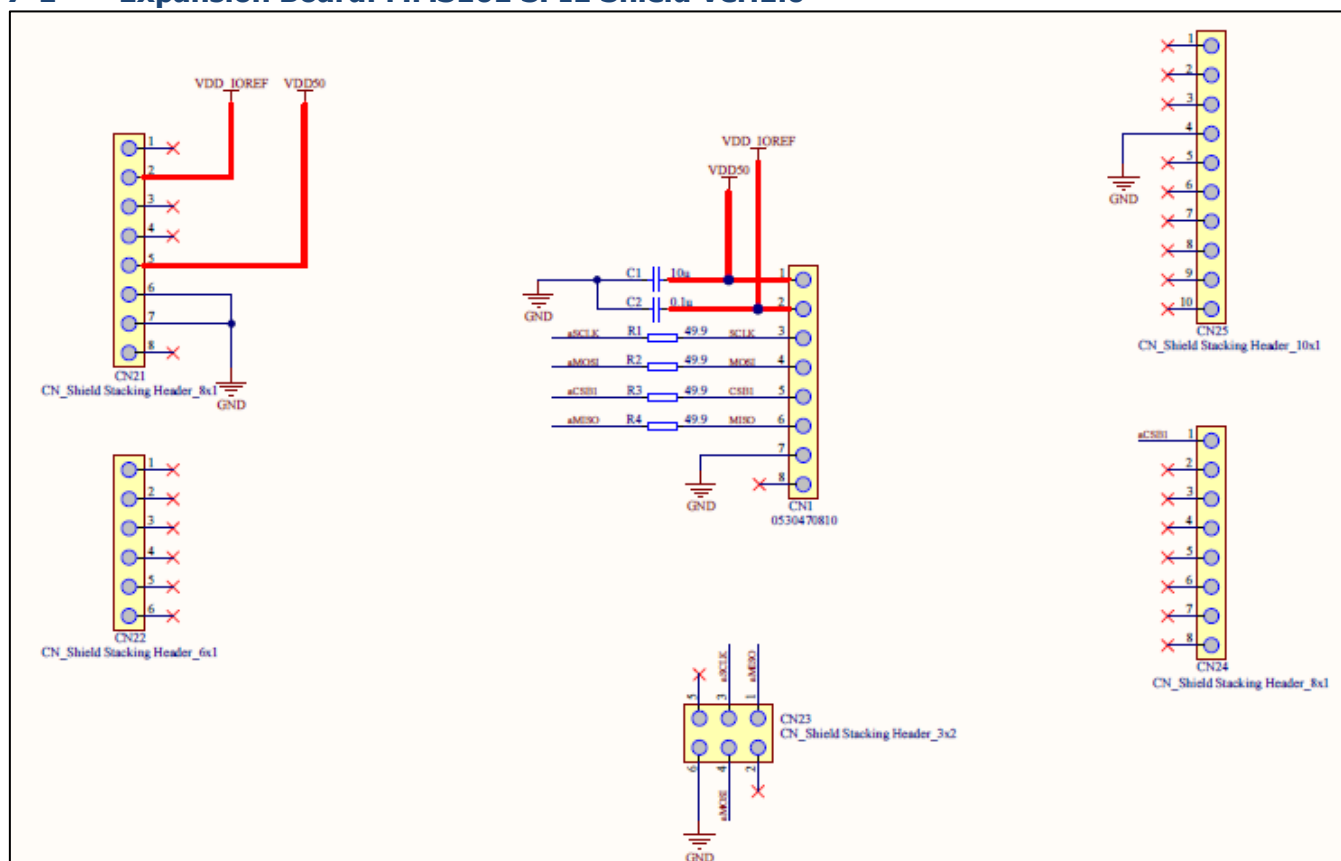


Pin assign: Connector(*1)

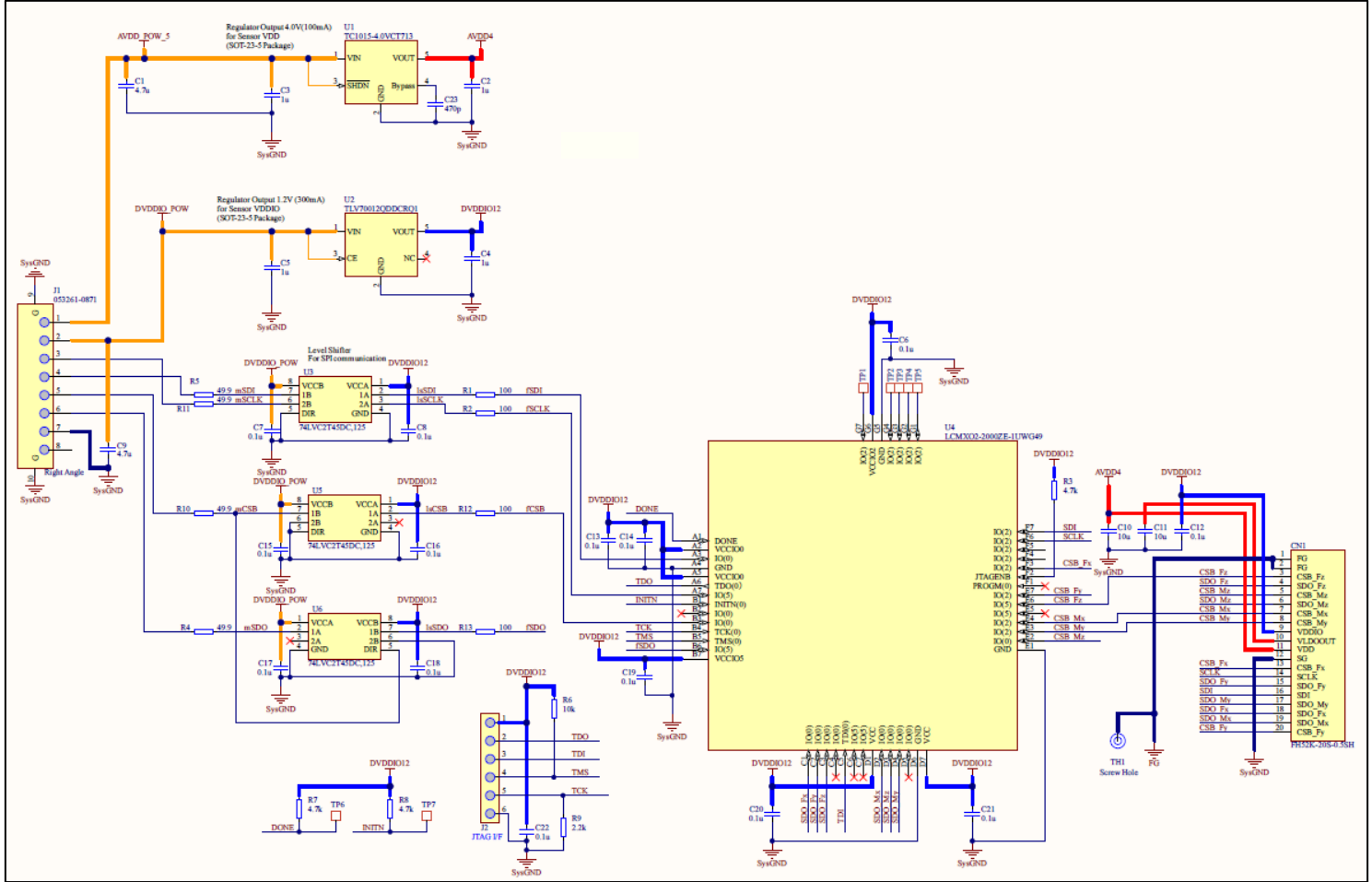
No.	Pin Name	Function
1	VDD	Analog power supply (4.5 ~ 6.0V)
2	VDDIO	Digital I/O power supply (2.0 ~ 5.5V)
3	SCLK	Serial clock for SPI
4	SDI	Serial Data Input for SPI (MOSI)
5	CSB	Chip select for SPI (negative logic)
6	SDO	Serial Data Output for SPI (MISO)
7	GND	Ground
8	NC	-

7 Schematic circuit diagram

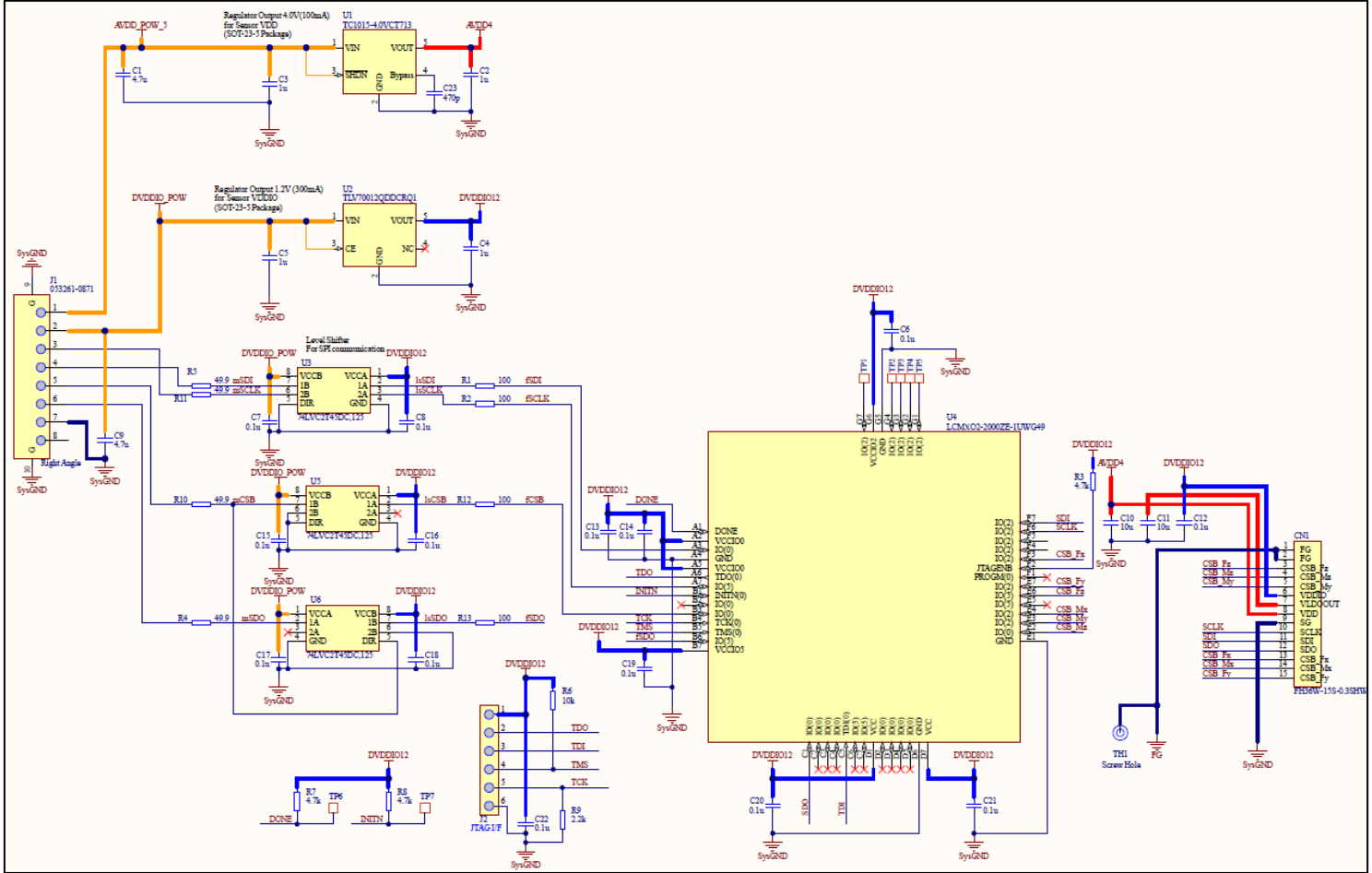
7-1 Expansion Board: MMS101 SPI1 Shield Ver.1.0



7-2 Conversion Board: MMS101B SPI1 Conv.BD Ver.1.0

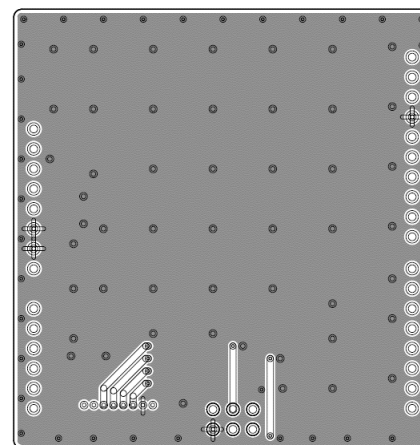
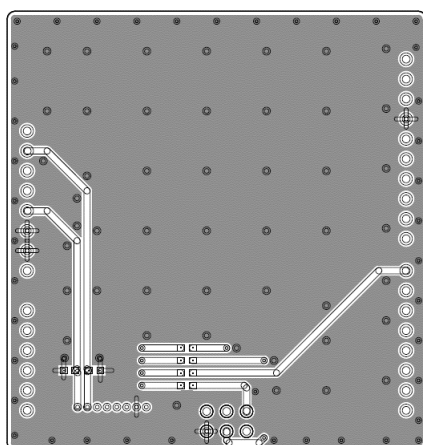
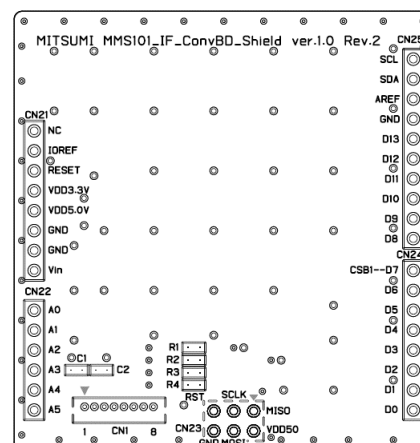
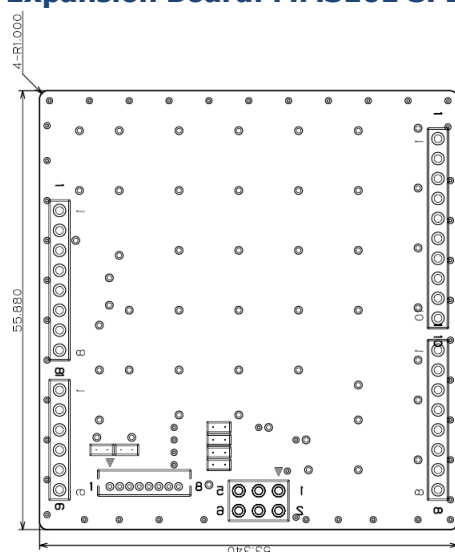


7-3 Conversion Board: MMS101C SPI1 Conv.BD Ver.1.0



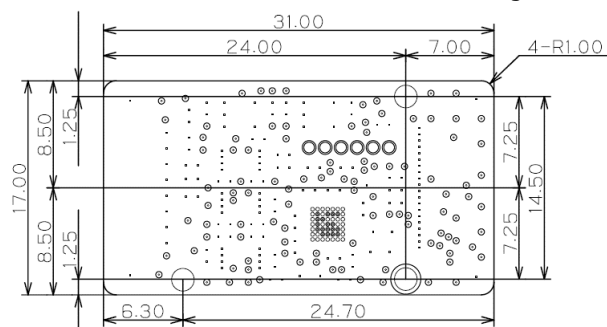
8 Layout diagram

8-1 Expansion Board: MMS101 SPI1 Shield Ver.1.0

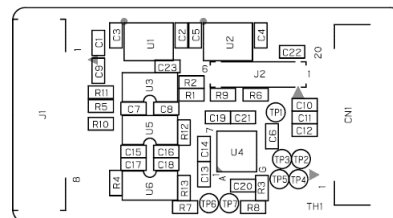


8-2 Conversion Board: MMS101B SPI1 Conv.BD Ver.1.0

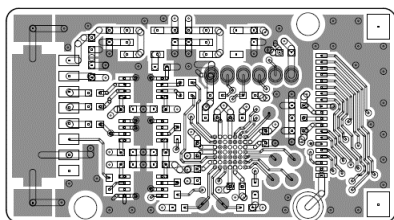
Mounting hole: $\Phi 1.8$



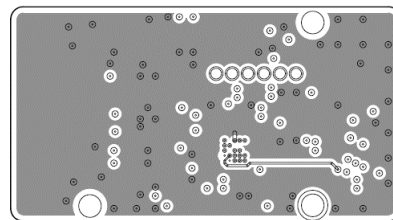
Dimensions (Unit: mm)



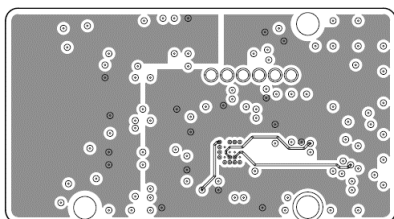
Component placement



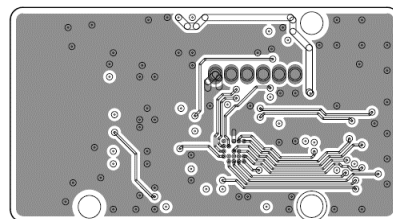
Pattern (Component side)



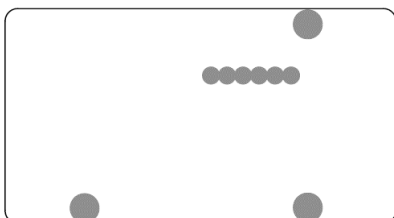
Pattern (L2)



Pattern (L3)



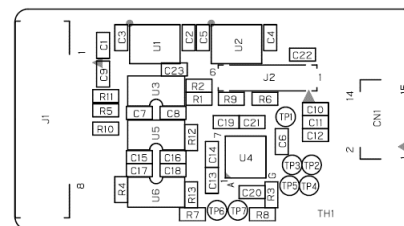
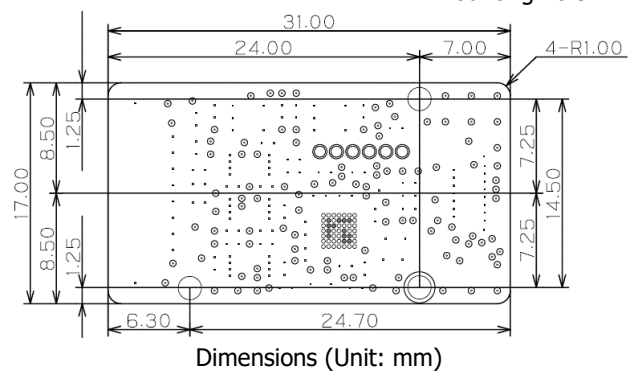
Pattern (L4)



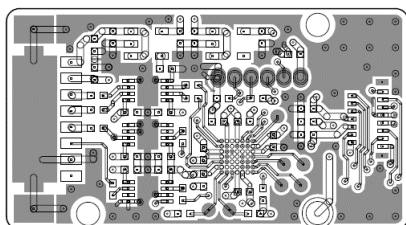
Pattern (Solder side)

8-3 Conversion Board: MMS101C SPI1 Conv.BD Ver.1.0

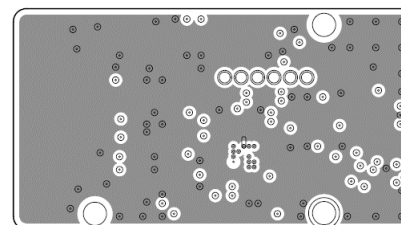
Mounting hole: $\Phi 1.8$



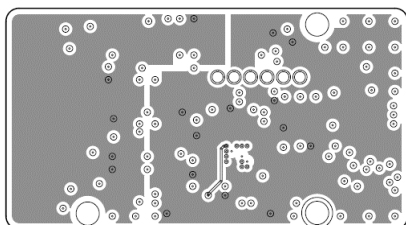
Component placement



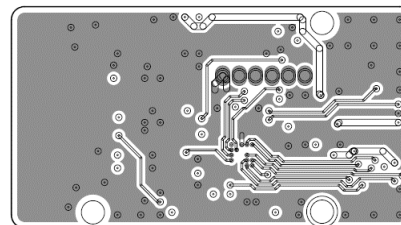
Pattern (Component side)



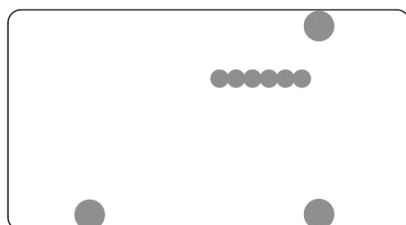
Pattern (L2)



Pattern (L3)



Pattern (L4)



Pattern (Solder side)

9 BOM list

9-1 Expansion Board: MMS101 SPI1 Shield Ver.1.0

Designator	Model	Maker	Parts name	Value	Q'ty
C1	GRM188R61E106KA73D	muRata	Capacitor	10u	1
C2	CGA3E2X7R1H104K080AA	TDK	Capacitor	0.1u	1
CN1	530470810	Molex	Connector	8pin	1
CN21, CN24	85	Adafruit Industries	Pin header	8pin	2
CN22	85	Adafruit Industries	Pin header	6pin	1
CN23	85	Adafruit Industries	Pin header	6pin	1
CN25	85	Adafruit Industries	Pin header	10pin	1
R1, R2, R3, R4	RK73H1JTDD49R9F	KOA	Resistor	49.9	4

9-2 Conversion Board: MMS101B SPI1 Conv.BD Ver.1.0

Designator	Model	Maker	Parts name	Value	Q'ty
C1, C9	GRM155R61A474KE15D	muRata	Capacitor	4.7u	2
C2, C3, C4, C5	GRM155R61E105KA12D	muRata	Capacitor	1u	4
C6, C7, C8, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22	GCM155R71C104KA55D	muRata	Capacitor	0.1u	14
C10, C11	GRM155R61A106ME11D	muRata	Capacitor	10u	2
C23	GCM1555C1H471JA16D	muRata	Capacitor	470p	1
CN1	FH52K-20S-0.5SH	Hirose Electric	Connector	20pin	1
J1	532610871	Molex	Connector	8pin	1
J2	XB-1-3 6pin	Mac8	Pin header	OPEN	1
R1, R2, R12, R13	RK73H1ETTP1000	KOA	Resistor	100	4
R3, R7, R8	RMC1/16SK472FTH	KAMAYA	Resistor	4.7k	3
R4, R5, R10, R11	RK73H1ETTP49R9F	KOA	Resistor	49.9	4
R6	RMC1/16SK103FTH	KAMAYA	Resistor	10k	1
R9	RK73H1ETTP2201F	KOA	Resistor	2.2k	1
TH1	-	-	Through hole	Φ1.8	1
TH2	-	-	None TH	Φ1.8	1
TP1, TP2, TP3, TP4, TP5, TP6, TP7	-	-	Test land	Φ1.0	7
U1	TC1015-4.0VCT713	Microchip Technology	LDO	4.0V,100mA	1
U2	TLV70012QDDCRQ1	Texas Instruments	LDO	1.2V,300mA	1
U3, U5, U6	74LVC2T45DC,125	Nexperia USA Inc.	Level shifter	-	3
U4	LCMX02-2000ZE-1UWG49	Lattice Semiconductor	FPGA	-	1

9-3 Conversion Board: MMS101C SPI1 Conv.BD Ver.1.0

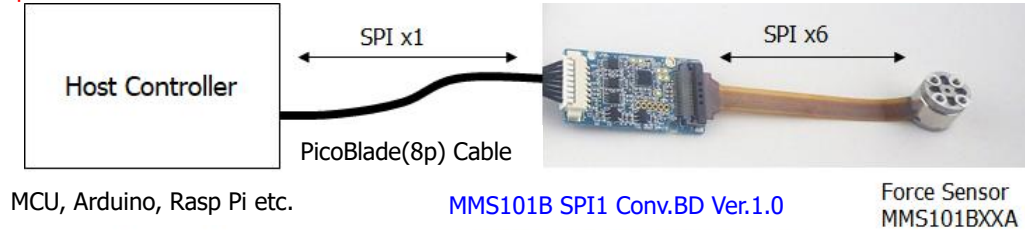
Designator	Model	Maker	Parts name	Value	Q'ty
C1, C9	GRM155R61A474KE15D	muRata	Capacitor	4.7u	2
C2, C3, C4, C5	GRM155R61E105KA12D	muRata	Capacitor	1u	4
C6, C7, C8, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22	GCM155R71C104KA55D	muRata	Capacitor	0.1u	14
C10, C11	GRM155R61A106ME11D	muRata	Capacitor	10u	2
C23	GCM1555C1H471JA16D	muRata	Capacitor	470p	1
CN1	FH36W-15S-0.3SHW	Hirose Electric	Connector	15pin	1
J1	532610871	Molex	Connector	8pin	1
J2	XB-1-3 6pin	Mac8	Pin header	OPEN	1
R1, R2, R12, R13	RK73H1ETTP1000	KOA	Resistor	100	4
R3, R7, R8	RMC1/16SK472FTH	KAMAYA	Resistor	4.7k	3
R4, R5, R10, R11	RK73H1ETTP49R9F	KOA	Resistor	49.9	4
R6	RMC1/16SK103FTH	KAMAYA	Resistor	10k	1
R9	RK73H1ETTP2201F	KOA	Resistor	2.2k	1
TH1	-	-	Through hole	Φ1.8	1
TH2	-	-	None TH	Φ1.8	1
TP1, TP2, TP3, TP4, TP5, TP6, TP7	-	-	Test land	Φ1.0	7
U1	TC1015-4.0VCT713	Microchip Technology	LDO	4.0V,100mA	1
U2	TLV70012QDDCRQ1	Texas Instruments	LDO	1.2V,300mA	1
U3, U5, U6	74LVC2T45DC,125	Nexperia USA Inc.	Level shifter	-	3
U4	LCMXO2-2000ZE-1UWG49	Lattice Semiconductor	FPGA	-	1

10 MMS101B SPI1 Conv.BD Ver.1.0 Communication Specification

10-1 Description

The conversion board MMS101B SPI1 Conv.BD Ver.1.0 (hereafter referred to as SPI1 Conv.BD) consolidates the six SPI wires of the force sensor MMS101BXXA into one SPI wire to communicate with the host controller.

The communication specifications for the conversion board MMS101C SPI1 Conv.BD Ver.1.0 are also the same.



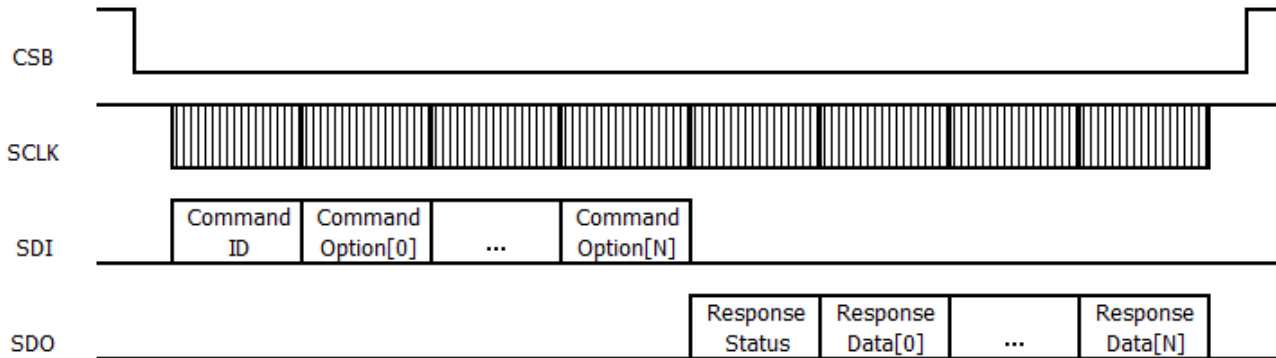
10-2 SPI communication settings

Host controller and SPI1 Conv.BD communicate using SPI. SPI communication settings are as follows.

Item	Settings
Mode	Mode3(CPOL=1,CPHA=1)
Baud rate	~ 2MHz
Data length	8 bit
Data transmission direction	MSB First
Byte order	Big Endian

10-3 Communication data format

SPI1 Conv.BD always returns a response to the received command. The basic communication format is as follows.



Command format

Byte	Name	Details
0	Command ID	Indication code of the command instructed to SPI1 Conv.BD. Refer to " Command list ".
1	Command Option[0]	If there is a parameter associated with Command ID, it is appended. For multiple byte data, the byte order is big-endian.
:	:	
N+2	Command Option[N]	

Response format

Byte	Name	Details
0	Response Status	This is the result of executing the command. Refer to " Status Code list ".
1	Response Data[0]	If there is anything order than the response status, it is appended. For multiple byte data, the byte order is big-endian.
:	:	
N+2	Response Data[N]	

10-4 Command list

The command to instruct SPI Conv.BD is as follows.

Name	Command ID	Operation
START	0xF0	Command to start measurement for SPI1 Conv.BD
DATA2(*1)	0xE2	Command to read ADC data from SPI1 Conv.BD
RESTART	0xC0	Command to update temperature sensor value for offset temperature correction of MMS101
BOOT	0xB0	Command to read and hold the matrix correction coefficient from MMS101 by SPI1 Conv.BD
STOP	0xB2	Command to stop measurement for SPI1 Conv.BD
RESET	0xB4	Command to reset SPI1 Conv.BD and MMS101
STATUS	0x80	Command to read status of SPI1 Conv.BD
VERSION	0xA2	Command to read version of SPI1 Conv.BD
COEFF	0x30(*2)	Command to read the matrix correction coefficient held by SPI1 Conv.BD
INTERVAL	0x44	Command to update temperature sensor value for offset temperature correction of MMS101 at set cycle

(*1) Please execute the matrix operation by user's system.

(*2) Command ID is different for each axis. (Fx=0x30, Fy=0x32, Fz=0x34, Mx=0x36, My=0x38, Mz=0x3A)

10-4-1 START command

Command to start measurement for SPI1 Conv.BD. SPI1 Conv.BD acquires ADC data from MMS101 at 1msec intervals and holds the latest data. Please execute this command when in READY state.

Command format

Byte	Data	Details
0	Command ID=0xF0	

Response format

Byte	Data	Details
0	Status Code	Refer to " Status Code list "

10-4-2 DATA2 command

Command to read ADC data (before the matrix operation) from SPI1 Conv.BD. To obtain force data, perform matrix operation on the ADC data. Obtain the matrix correction coefficients in advance with COEFF command. Please execute this command when in MEASURE state.

Command format

Byte	Data	Details
0	Command ID=0xE2	

Response format

Byte	Data	Details
0	Status Code	Refer to " Status Code list ".
1-2	Measure Status	Refer to " Measure Status list ".
3-5	FxADC	ADC data for each axis.
6-8	FyADC	
9-11	FzADC	
12-14	MxADC	
15-17	MyADC	
18-20	MzADC	

Matrix operation formula:

$$FxMD = A1 * FxADC + A2 * FyADC + A3 * FzADC + A4 * MxADC + A5 * MyADC + A6 * MzADC$$

...

$$MzMD = F1 * FxADC + F2 * FyADC + F3 * FzADC + F4 * MxADC + F5 * MyADC + F6 * MzADC$$

Unit conversion formula:

$$Fx = FxMD / 2^{11} [*0.001 \text{ N}]$$

...

$$Mz = MzMD / 2^{11} [*0.00001 \text{ Nm}]$$

For details, please refer to "Matrix operation" in the data sheet.

10-4-3 RESTART command

Command to update temperature sensor value for offset temperature correction of MMS101. Please execute this command when in MEASURE state.

It is also possible to set the automatic update cycle of temperature sensor value using INTERVAL command.

Command format

Byte	Data	Details
0	Command ID=0xC0	

Response format

Byte	Data	Details
0	Status Code	Refer to " Status Code list ".

10-4-4 BOOT command

Command to read and hold the matrix correction coefficients from MMS101. Please execute this command when in STANDBY state.

Command format

Byte	Data	Details
0	Command ID=0xB0	

Response format

Byte	Data	Details
0	Status Code	Refer to " Status Code list "

10-4-5 STOP command

Command to stop measurement for SPI1 Conv.BD. Please execute this command when in MEASURE state.

Command format

Byte	Data	Details
0	Command ID=0xB2	

Response format

Byte	Data	Details
0	Status Code	Refer to " Status Code list "

10-4-6 RESET command

Command to reset the internal information and the matrix correction coefficients in SPI1 Conv.BD. Execute reset on MMS101. After executing this command, it changes to STANDBY state.

Command format

Byte	Data	Details
0	Command ID=0xB4	

Response format

Byte	Data	Details
0	Status Code	Refer to " Status Code list "

10-4-7 STATUS command

Command to read status of SPI1 Conv.BD. This command can be executed in any state.

Command format

Byte	Data	Details
0	Command ID=0x80	

Response format

Byte	Data	Details
0	Status Code	Refer to " Status Code list "
1-2	Measure Status	Refer to " Measure Status list "
3	State ID	Refer to " State ID list "

10-4-8 VERSION command

Command to read the hardware version and firmware version of SPI1 Conv.BD. This command can be executed in any state.

Command format

Byte	Data	Details
0	Command ID=0xA2	

Response format

Byte	Data	Details
0	Status Code	Refer to " Status Code list "
1-2	Hardware version	Indicates the two-digit hardware version
3	Firmware version	Indicates the four-digit firmware version

10-4-9 COEFF command

Command to read the matrix correction coefficients held by SPI1 Conv.BD. It is necessary to obtain the matrix correction coefficients from MMS101 in advance using the BOOT command. Command ID is different for each axis. Please execute this command when in READY state.

Command format

Byte	Data	Details
0	Command ID=0x30	0x30 = Fx, 0x32 = Fy, 0x34 = Fz, 0x36 = Mx, 0x38 = My, 0x3A = Mz

Response format

Byte	Data	Details
0	Status Code	Refer to " Status Code list "
1-3	Coefficient Data1	matrix correction coefficient 1 (A1 ~ F1)
4-6	Coefficient Data2	matrix correction coefficient 2 (A2 ~ F2)
7-9	Coefficient Data3	matrix correction coefficient 3 (A3 ~ F3)
10-12	Coefficient Data4	matrix correction coefficient 4 (A4 ~ F4)
13-15	Coefficient Data5	matrix correction coefficient 5 (A5 ~ F5)
16-18	Coefficient Data6	matrix correction coefficient 6 (A6 ~ F6)

10-4-10 INTERVAL command

Command to update temperature sensor value for offset temperature correction of MMS101. When the number of data acquisitions reaches the Interval value, the temperature sensor value for offset temperature correction is updated and the number of data acquisitions is reset. The temperature sensor value is automatically updated at the interval of the Interval value. This command can be executed in any state.

The number of data acquisitions will also be reset when RESTART command is executed.

Command format

Byte	Data	Details
0	Command ID=0x44	
1-3	Interval = 0~10,000,000	0: Temperature updates are not performed automatically. N(>0): The temperature sensor value is updated after data is acquired N times.

Response format

Byte	Data	Details
0	Status Code	Refer to " Status Code list "

10-5 Status Code list

The execution result of the received command is shown below.

Status Code	Details	
0x00	OK	No error
0x01	Busy	Access denied (Respond to on illegal state)
0x81	Not Support	Respond to an illegal Command ID
0x82	Illegal Command	Respond to an illegal command format
0x83	Illegal Parameter	Respond to an illegal parameter (out of range)

10-6 Measure Status list

When an error occurs in SPI1 Conv.BD, the corresponding bit becomes 1. If there are no errors, all bits are 0.

(Example) If a communication error with the Fx axis occurs during BOOT processing, b0 and b6 will be 1.

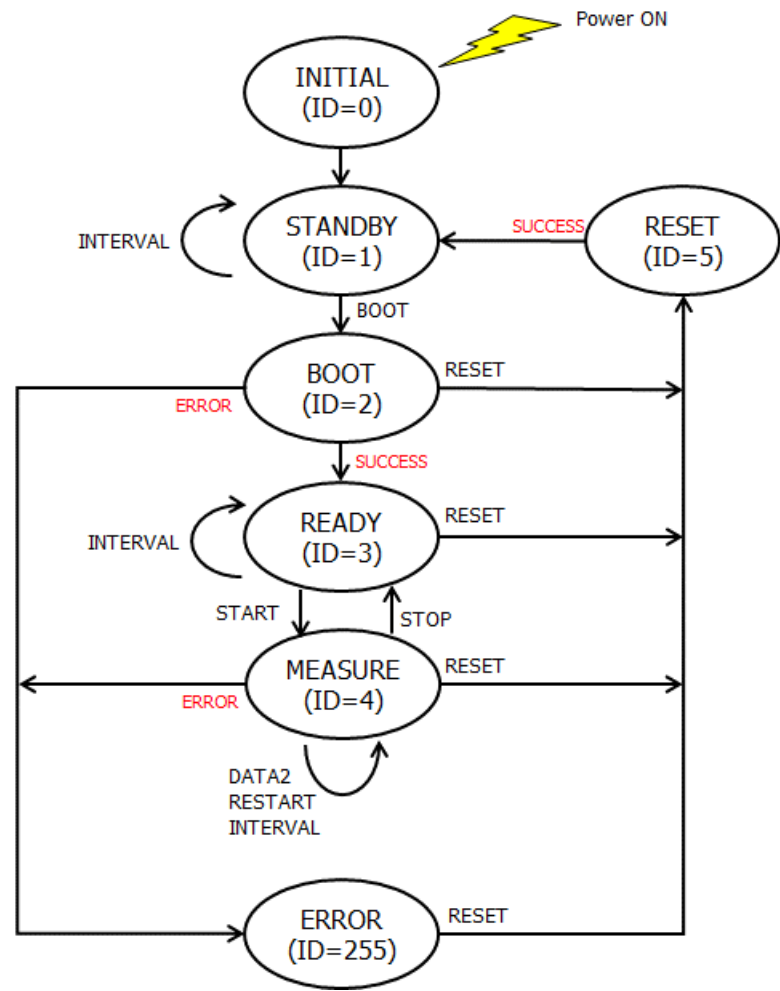
Bit	Details	
b0	Fx NACK	Communication error when accessing the corresponding axis of MMS101 (MMS101 responded NACK)
b1	Fy NACK	
b2	Fz NACK	
b3	Mx NACK	
b4	My NACK	
b5	Mz NACK	
b6	BOOT Error	Communication error during BOOT processing
b7	START Error	Communication error during START processing
b8	MEASURE Error	Communication error during MEASURE processing
b9	Not Update	New data is not ready
b10	RESTART Error	Communication error during RESTART processing
b11	STOP Error	Communication error during STOP processing
b12	RESET Error	Communication error during RESET processing
b13-b15	Reserved	-

10-7 State ID list

The state of SPI1 Conv.BD is shown below.

状態	ID	Operation
INITIAL	0	Internal initialization after power-on
STANDBY	1	Waiting state for BOOT command after internal initialization is completed
BOOT	2	Acquisition operation of the matrix correction coefficients from MMS101
READY	3	Holds the matrix correction coefficients and waits for START command
MEASURE	4	Updated sensor data at 1msec intervals Output the latest data held by DATA2 command
RESET	5	Execute reset command to MMS101 Initialize the internal information and the matrix correction coefficients of SPI1 Conv.BD
ERROR	255	Transitions when an Error occurs Wait until the RESET command is executed from host

10-8 State transition diagram

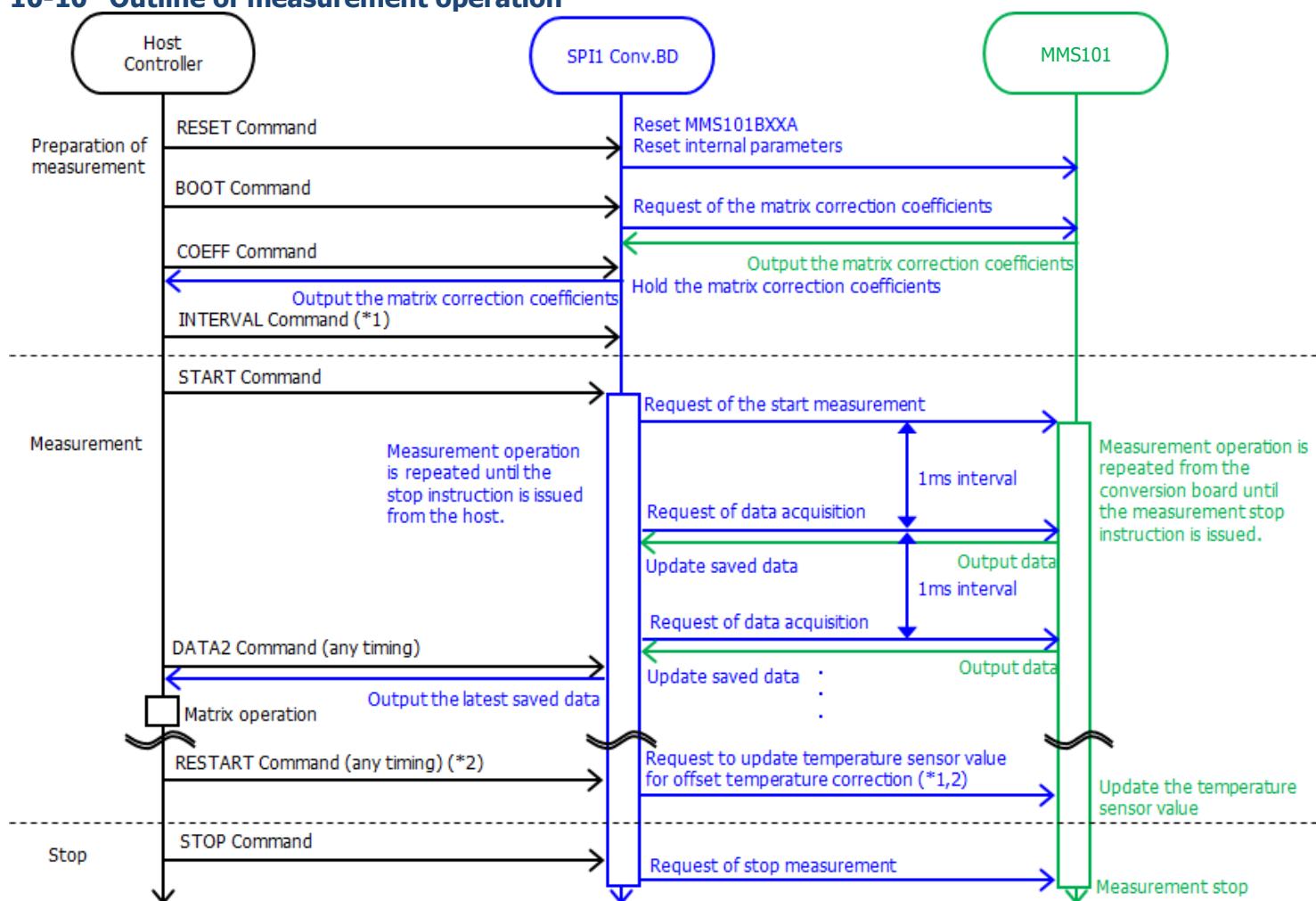


10-9 State transition table

		State						
		INITIAL	STANDBY	BOOT	READY	MEASURE	RESET	ERROR
Command	START	/	/	/	->MEASURE	/	/	/
	DATA2	/	=	=	=	=	=	=
	RESTART	/	/	/	/	=	/	/
	BOOT	/	->BOOT	/	/	/	/	/
	STOP	/	/	/	/	->READY	/	/
	RESET	/	->RESET	->RESET	->RESET	->RESET	/	->RESET
	STATUS	/	=	=	=	=	=	=
	VERSION	/	=	=	=	=	=	=
	COEFF	/	=	=	=	=	/	/
	INTERVAL	/	=	=	=	=	/	/

[>-] Transmission state [=] Keep state [/] Ignore (Return Busy)

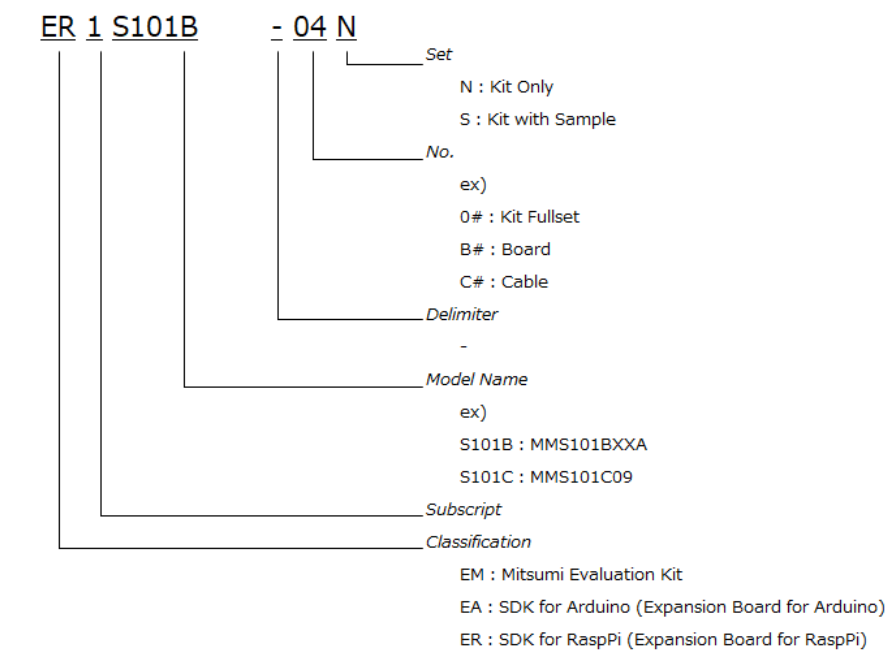
10-10 Outline of measurement operation



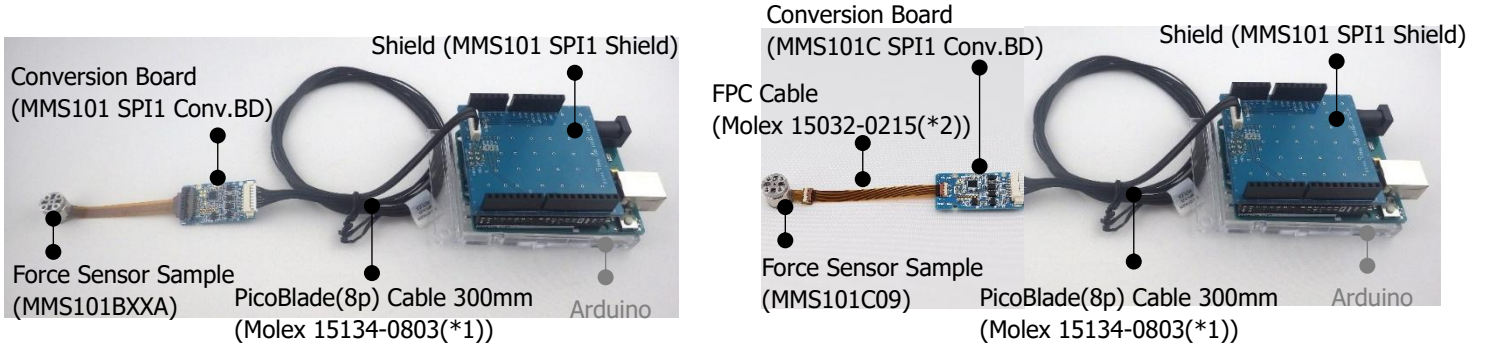
(*1)(*2) The temperature sensor value for offset temperature correction is updated according to the INTERVAL Command and RESTART Command.

11 Ordering Information

11-1 PO No. Description



11-2 Lineup



PO No.	Details			Contents			
	Product Name	Kit Name	Set	Main Contents	Sample	Accessory1	Accessory2
MMS101B							
EA1S101B-04N	MMS101BXXA	MMS101B SDK for Arduino	Kit Only	MMS101 SPI1 Shield	no	MMS101B SPI1 Conv.BD	PicoBlade(8p) Cable 300mm (*1)
EA1S101B-04S	MMS101BXXA	MMS101B SDK for Arduino	Kit with Sample	MMS101 SPI1 Shield	MMS101BXXA	MMS101B SPI1 Conv.BD	PicoBlade(8p) Cable 300mm (*1)
EA1S101B-B1	MMS101BXXA	MMS101B SPI1 Conv.BD	Accessory	MMS101B SPI1 Conv.BD	-	-	-

PO No.	Details			Contents			
	Product Name	Kit Name	Set	Main Contents	Sample	Accessory1	Accessory2
MMS101C							
EA1S101C-04N	MMS101C09	MMS101C SDK for Arduino	Kit Only	MMS101 SPI1 Shield	no	MMS101C SPI1 Conv.BD + FPC Cable(*2)	PicoBlade(8p) Cable 300mm (*1)
EA1S101C-04S	MMS101C09	MMS101C SDK for Arduino	Kit with Sample	MMS101 SPI1 Shield	MMS101C09	MMS101C SPI1 Conv.BD + FPC Cable(*2)	PicoBlade(8p) Cable 300mm (*1)
EA1S101C-B1	MMS101C09	MMS101C SPI1 Conv.BD	Accessory	MMS101C SPI1 Conv.BD	-	-	-

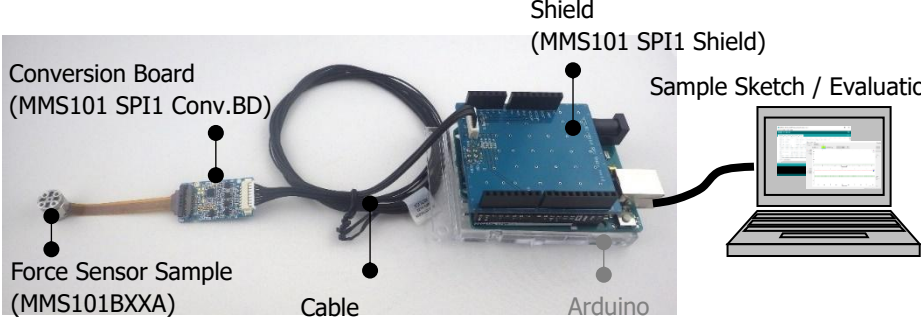
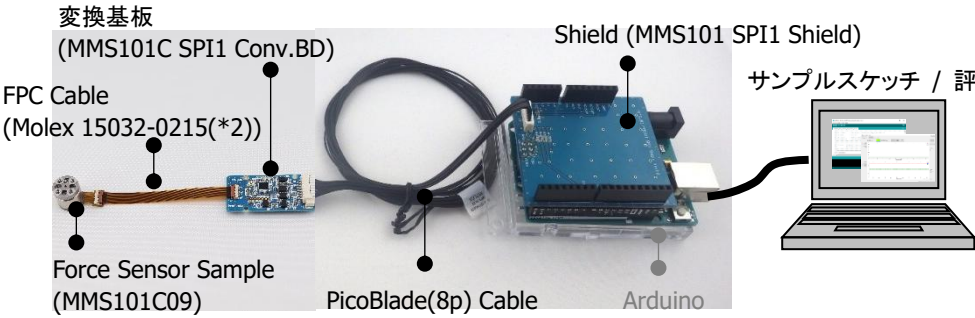
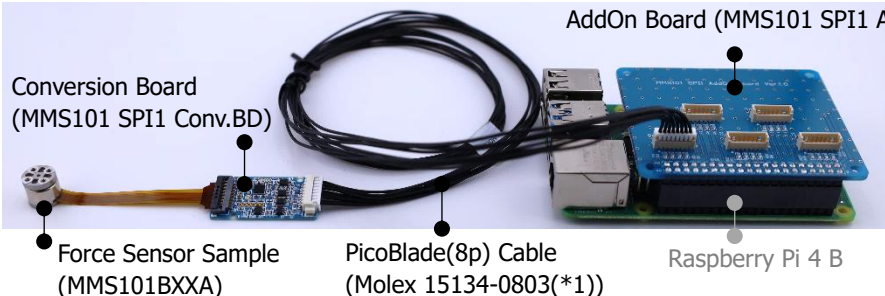
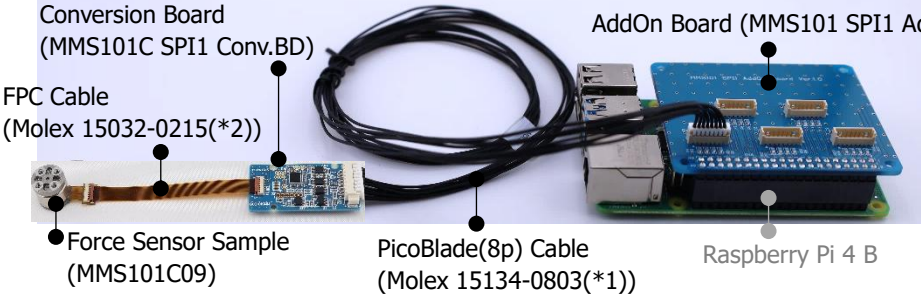
(*1) The equivalent product is the Molex PicoBlade(8p) cable (Model No. 15134-0803).

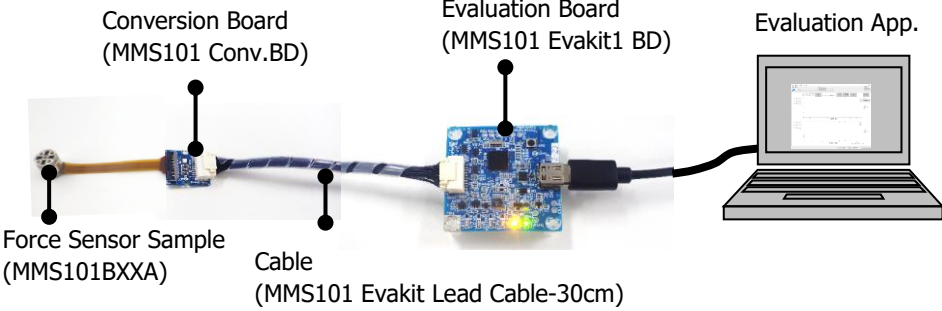
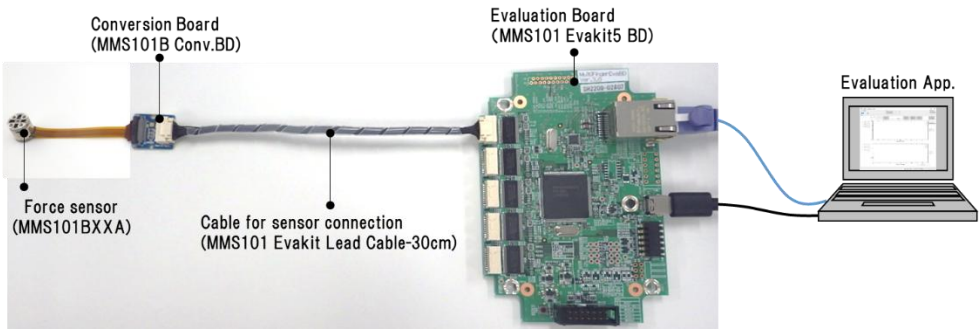
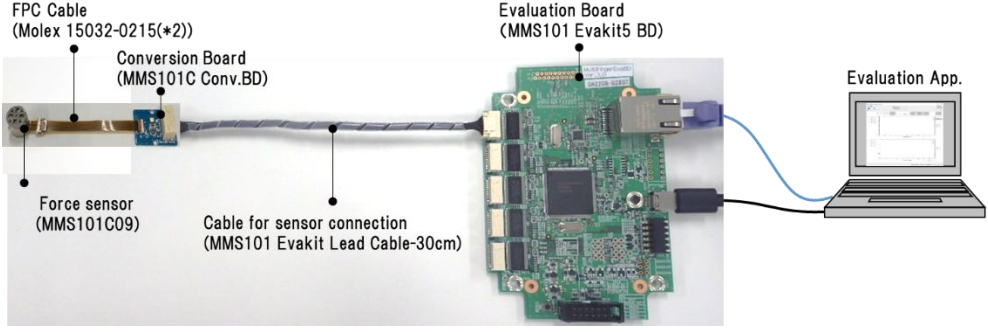
If you need additional purchases of different lengths, please use commercially available FPC cable.

(*2) The equivalent product is the Molex FPC cable (Model No. 15032-0215).

If you need additional purchases of different lengths, please use commercially available FPC cable.

11-3 Evaluation Kit List

Evaluation Kit Name	Configuration / Features
MMS101 SDK for Arduino	 <p>Conversion Board (MMS101 SPI1 Conv.BD)</p> <p>Force Sensor Sample (MMS101BXXA)</p> <p>Cable (MMS101 SPI1 Cable-300)</p> <p>Shield (MMS101 SPI1 Shield)</p> <p>Sample Sketch / Evaluation App.</p> <p>Arduino</p> <p>◆External Communication : USB</p> <p>◆Arduino is not included.</p>
	 <p>変換基板 (MMS101C SPI1 Conv.BD)</p> <p>FPC Cable (Molex 15032-0215(*2))</p> <p>Force Sensor Sample (MMS101C09)</p> <p>PicoBlade(8p) Cable (Molex 15134-0803(*1))</p> <p>Shield (MMS101 SPI1 Shield)</p> <p>サンプルスケッチ / 評価アプリ</p> <p>Arduino</p> <p>◆External Communication : USB</p> <p>◆Arduino is not included.</p>
MMS101 SDK for Raspberry Pi	 <p>Conversion Board (MMS101 SPI1 Conv.BD)</p> <p>Force Sensor Sample (MMS101BXXA)</p> <p>PicoBlade(8p) Cable (Molex 15134-0803(*1))</p> <p>AddOn Board (MMS101 SPI1 AddOn Board)</p> <p>Raspberry Pi 4 B</p> <p>◆Up to five sensors can be connected.</p> <p>◆Raspberry Pi is not included.</p>
	 <p>Conversion Board (MMS101C SPI1 Conv.BD)</p> <p>FPC Cable (Molex 15032-0215(*2))</p> <p>Force Sensor Sample (MMS101C09)</p> <p>PicoBlade(8p) Cable (Molex 15134-0803(*1))</p> <p>AddOn Board (MMS101 SPI1 AddOn Board)</p> <p>Raspberry Pi 4 B</p> <p>◆Up to five sensors can be connected.</p> <p>◆Raspberry Pi is not included.</p>

MMS101 Evakit1	 <p>Conversion Board (MMS101 Conv.BD)</p> <p>Evaluation Board (MMS101 Evakit1 BD)</p> <p>Evaluation App.</p> <p>Force Sensor Sample (MMS101BXXA)</p> <p>Cable (MMS101 Evakit Lead Cable-30cm)</p> <p>◆ External communication : USB</p>
MMS101 Evakit5	 <p>Conversion Board (MMS101B Conv.BD)</p> <p>Evaluation Board (MMS101 Evakit5 BD)</p> <p>Evaluation App.</p> <p>Force sensor (MMS101BXXA)</p> <p>Cable for sensor connection (MMS101 Evakit Lead Cable-30cm)</p> <p>◆ External communication : Ethernet / USB</p> <p>◆ Up to five sensors can be connected (Only in Ethernet).</p>
MMS101 Evakit5	 <p>FPC Cable (Molex 15032-0215(*2))</p> <p>Conversion Board (MMS101C Conv.BD)</p> <p>Evaluation Board (MMS101 Evakit5 BD)</p> <p>Evaluation App.</p> <p>Force sensor (MMS101C09)</p> <p>Cable for sensor connection (MMS101 Evakit Lead Cable-30cm)</p> <p>◆ External communication : Ethernet / USB</p> <p>◆ Up to five sensors can be connected (Only in Ethernet).</p>

(*1) The equivalent product is the Molex PicoBlade(8p) cable (Model No. 15134-0803).

If you need additional purchases of different lengths, please use commercially available PicoBlade(8p) cable.

(*2) The equivalent product is the Molex FPC cable (Model No. 15032-0215).

If you need additional purchases of different lengths, please use commercially available FPC cable.

[Contact]

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