User Guide for

# FEBFMT1030_MEMS01

# Evaluation Board

# Motion Tracking Module with MT Software Suite

## Featured Fairchild Products:

## FEBFMT1030, FMT1030, FMT1020, FMT1010

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# Table of Contents

# 1. Introduction

This user guide describes the Evaluation Kit for the FMT1030. The FMT1030 Evaluation Kit is designed to support the evaluation of the FMT1000-series, in particular the FMT1030 Attitude and Heading Reference System.

## 1.1. Description

The FMT1000-series is a module outputting 3D orientation, 3D rate of turn, 3D acceleration and 3D magnetic field. It is specifically designed for industrial applications featuring vibration rejection, a robust sensor fusion algorithm and a high update rate. The FMT1000-series can be configured for any application.

The FMT1000-series Evaluation Kit is an excellent tool to start working with the FMT1000-series. It has a pre-mounted FMT1030 AHRS and comes with the extensive MT Software Suite and USB-cabling. The MT Software Suite is full-featured, with logging and visualization options, intuitive configuration windows and possibilities to export data for use in other programs. The Software Development Kit contains source code for communication and libraries for data processing.

The 24-pins header connects to all interfaces available on the FMT1000-series module. Connections with development platforms for Cortex-M processors of different brands can be made easy using the Fairchild examples on the mbed.org website.

Specifications of the FMT1000-series can be found in the FMT1000-series data sheet.

**Figure 1. FEBFMT1030_MEMS01 Development Board**

## 1.2. Features

- Easy to use Development Board
- Complete MT Software Suite
  - MT Manager Logging and Visualization GUI
    - Windows 7 and Linux
  - SDK for Windows, Linux
  - Source Code/Drivers (platform-independent)
  - Magnetic Field Mapper
- Drivers and Examples on ARM® mbed™
- Full Functionality
- Delivered with FMT1030 Mounted
- USB, RS232, UART, SPI, $I^2C$ Interfaces

## 1.3. Ordering Information

| Part Number | Description | Packing Method |
|---|---|---|
| FEBFMT1030_MEMS01 | Evaluation Kit for FMT1030 AHRS | Single unit |

## 2. Photographs

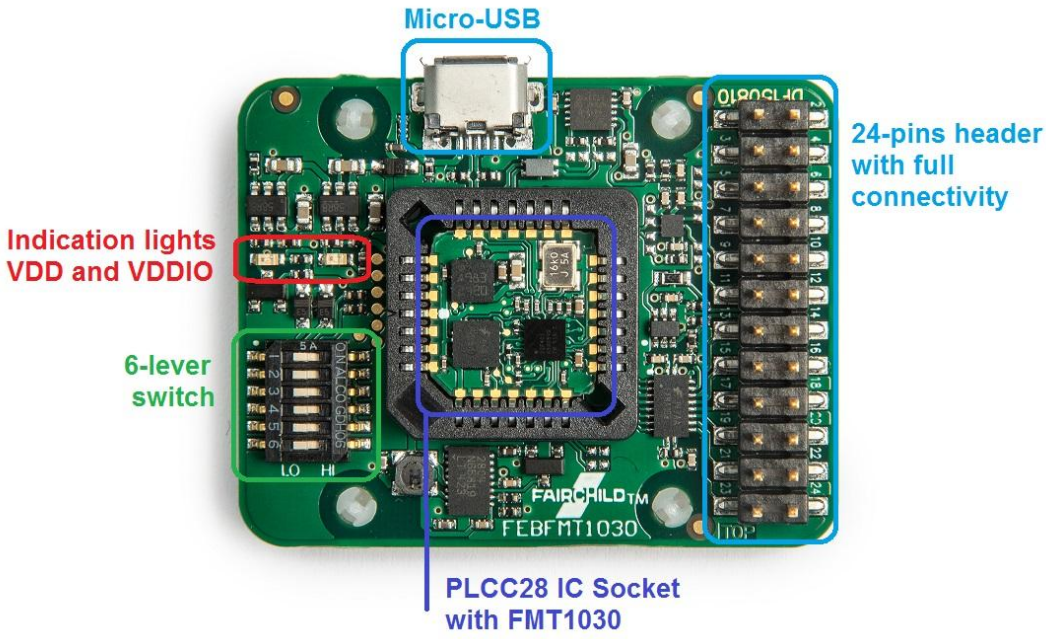



**Figure 2. Top View of the FMT1000-Series Evaluation Board with the Various Components**

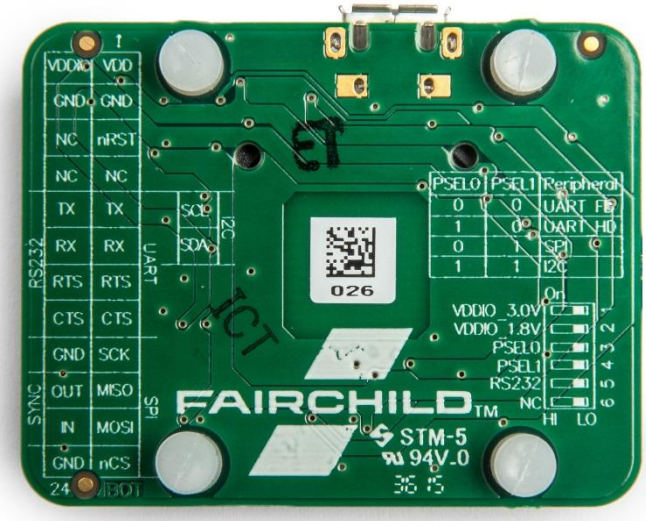



**Figure 3. Bottom View of the FMT1000-Series Evaluation Board with the description of the header and switch. Text is displayed as see-through.**

# 3. Getting Started

## 3.1. Installing MT Software Suite

The MT Software Suite is available on the Fairchild Motion Tracking website: https://www.fairchildsemi.com/products/sensors/mems-motion-sensors/.

The installation procedure consists of a set of several installers and starts with this screen:


**Figure 4. MT Software Suite Installer Home Screen**

## 3.2. Displaying Data in MT Manager

When the FEBFMT1030 is connected (the FEBFMT1030 will automatically be installed), click the 3D View icon: . This shows the 3D box representation of the FMT.

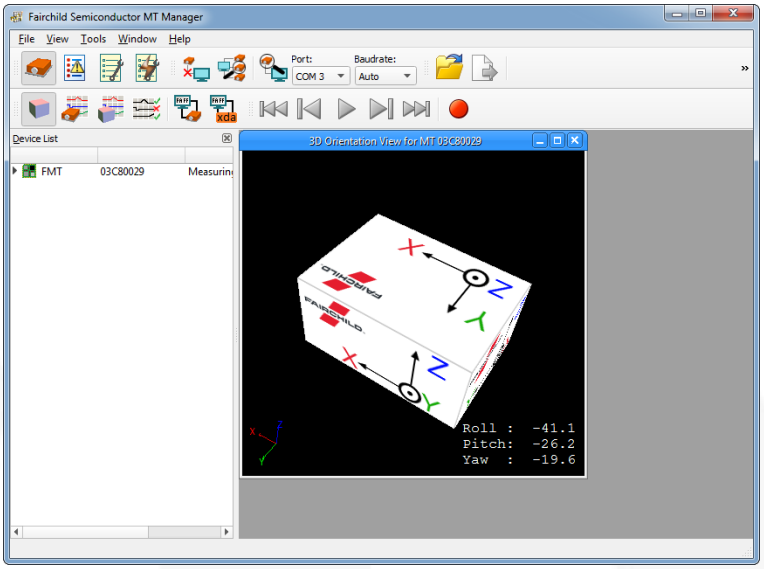



**Figure 5. The 3D Box View of the MT Manager**

The other visualizations can be opened using the windows toolbar: .

Refer to the MT Manager User Manual for more information on these graphs and their features. The MT Manager User Manual can be found via Help – Documentation

## 3.3. Configuring the FMT with MT Manager

MT Manager is an excellent tool to configure the FMT. Click the Output Configuration button: 

The following screen appears:

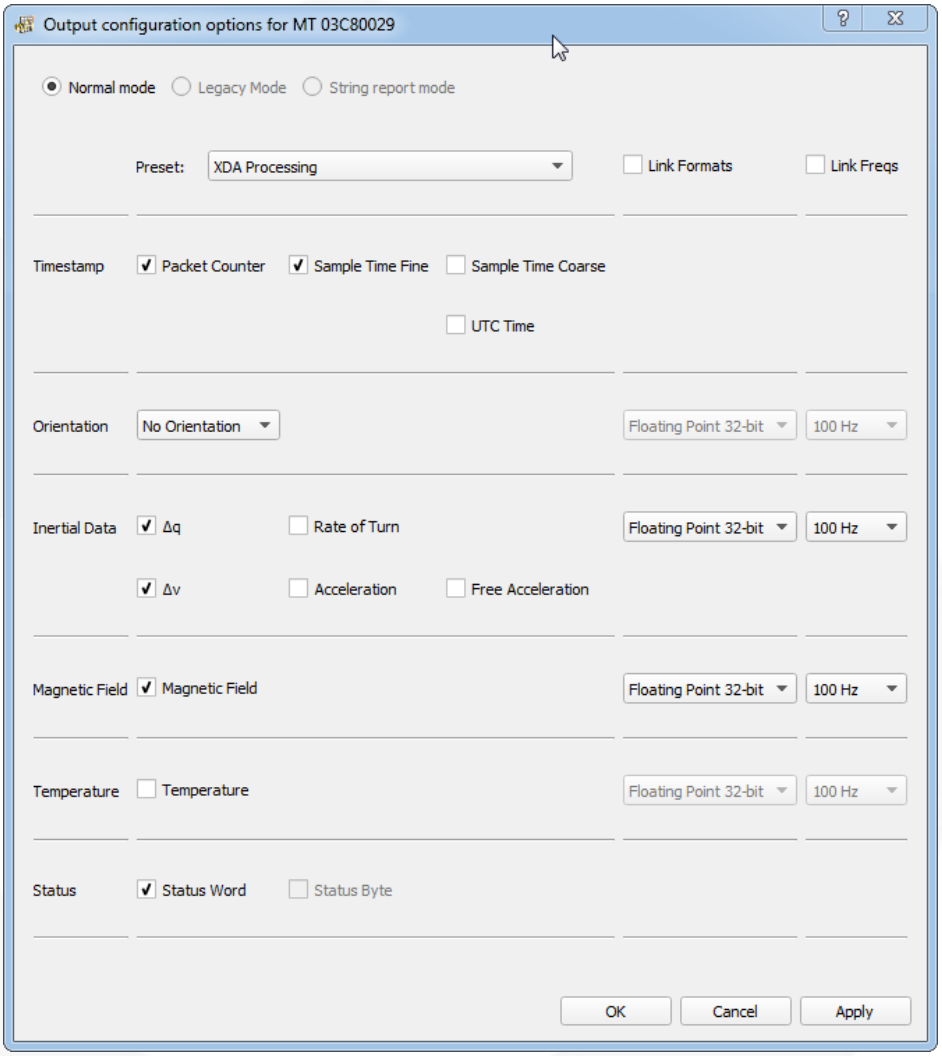



**Figure 6. Output Configuration Window of a FEBFMT1030**

By default, the output of the FMT is orientation only. Click “Inertial Data” (Δq/Δv or Rate of Turn/Acceleration) and “Magnetic Field” to be able to show this data in MT Manager.

## 3.4. Other Functionality of MT Manager

With the MT Manager, it is possible to record data and export that data for use in other programs, configure synchronization options and to review the test and calibration report.

More information on the functions in MT Manager can be found in the MT Manager User Manual.

## 3.5. Embedded Examples

The FMT is designed for easy integration in embedded systems. To aid in development example code is provided for the ARM mbed platform. An example implementation of the Xbus Low Level Communication Protocol is provided as generic C99 compliant source code[1], while an ARM mbed specific application demonstrates the use of the Xbus library to communicate with a FEBFMT1030 Evaluation Board using UART, SPI or $I^2C$ communications.

The example code has been tested with the following ARM mbed compatible boards:

- ST Nucleo F302R8 – Cortex M4
- FreeScale FRDM-KL46Z – Cortex M0+
- NXP EA LPC 4088 – Cortex M4

The example code is available at http://www.mbed.org/teams/Fairchild-Semiconductor. Documentation on how-to-use is provided on the description page and in the code. Note that these examples are provided as is and are not supported by the Fairchild support team. The examples are licensed under the Apache License version 2.0.

Several basic commands were used, it is easy to extend the program with commands from the Low-Level Communication Protocol (LLCP). This protocol is documented in detail in the MT Software Suite and in the Low-Level Communication Protocol Documentation.

## 3.6. Frames of Reference used in FMT

The FMT uses a right-handed coordinate system as the basis of the sensor of frame.

The following data is outputted in corresponding reference coordinate systems:

**Table 1. Reference frame in FMT**

| Data | Symbol | Reference Coordinate System |
|---|---|---|
| Acceleration | $a_x$, $a_y$, $a_z$ | Sensor-fixed |
| Rate of turn | $\omega_x$, $\omega_y$, $\omega_z$ | Sensor-fixed |
| Magnetic Field | $m_x$, $m_y$, $m_z$ | Sensor-fixed |
| Free Acceleration | a | Local Tangent Plane (LTP), default ENU |
| Velocity Increment | $\Delta v_x$, $\Delta v_y$, $\Delta v_z$ | Local Tangent Plane (LTP), default ENU |
| Orientation Increment | $\Delta q_0$, $\Delta q_1$, $\Delta q_2$, $\Delta q_3$ | Local Tangent Plane (LTP), default ENU |
| Orientation | Euler Angles, Quaternions or Rotation Matrix (DCM) | Local Tangent Plane (LTP), default ENU |

[1] Xbus example code is not specific to ARM processors and should be compatible with other embedded architectures.

Local Tangent Plane (LTP) is a local linearization of the Ellipsoidal Coordinates (Latitude, Longitude, and Altitude) in the WGS-84 Ellipsoid.

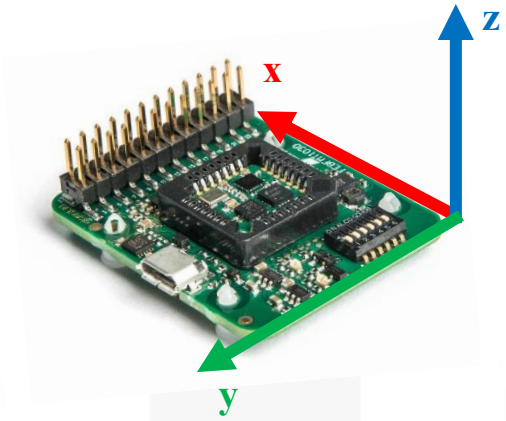



**Figure 7. Default Sensor Fixed System for the FMT**

It is straightforward to apply a rotation matrix to the FMT, so that the velocity and orientation increments, free acceleration and the orientation output are using that coordinate frame. The default reference coordinate system is East-North-Up (ENU) and the FMT1000-series has predefined outputs for North-East-Down (NED) and North-West-Up (NWU). Any arbitrary alignment can be entered. These orientation resets have effect on all outputs that are by default outputted with an ENU reference coordinate system.

# 4. Package and Handling

Note that this is a mechanical shock (g) sensitive device. Proper handling is required to prevent damage to the part.

Note that this is an ESD-sensitive device. Proper handling is required to prevent damage to the part.

Make sure not to apply force on the components of the MTi 1-series module, especially when placing the MTi 1-series module in an IC-socket.

## 4.1. Evaluation Kit

The FMT1000-series is available as an Evaluation Kit. An FMT1030 AHRS is mounted in a PLCC-28 socket and connects to USB, RS232, UART, I2C and SPI. The FEBFMT1030_MEMS01 comes with MT Manager, an intuitive GUI for Linux and Windows, example code and example applications.

The Development Board exposes the pins of the FMT on an easy to use 24-pins header allowing easy connectivity during prototyping.

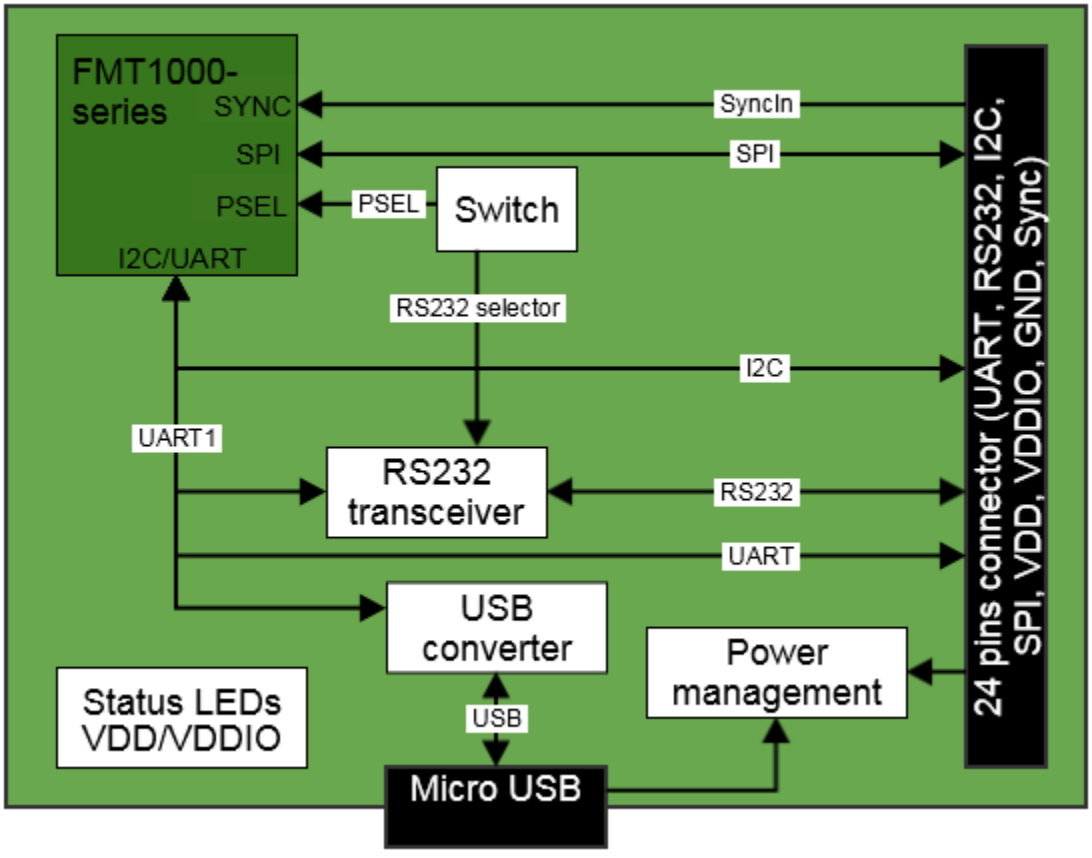



**Figure 8. Layout of the FEBFMT1030_MEMS01 Evaluation Board**

## Connections and Peripheral Switch

The MTi Development Board has the following connections and switches:

- 24-pins dual row header with a pitch of 2.54 mm: Table 2 shows the connections. For information on the connections, refer to the pin description in Table 5. Refer to 0 how to enable the various interfaces on the Evaluation Board.

**Table 2. Connections on 24-Pins Header**

| Pin# | Name | Pin# | Name |
|---|---|---|---|
| 1 | VDD | 2 | VDDIO |
| 3 | GND | 4 | GND |
| 5 | nRST | 6 | NC |
| 7 | NC | 8 | NC |
| 9 | UART TX or I2C SCL | 10 | RS232-TX |
| 11 | UART RX or I2C SDA | 12 | RS232-RX |
| 13 | UART-RTS | 14 | RS232-RTS |
| 15 | UART-CTS or DRDY | 16 | RS232-CTS |
| 17 | SPI-SCK | 18 | GND |
| 19 | SPI-MISO | 20 | RESERVED |
| 21 | SPI-MOSI | 22 | SYNC_IN |
| 23 | SPI-nCS | 24 | GND |

- Micro USB: the Evaluation Board has a micro USB connection that can be used to connect directly to a USB port on a PC or laptop. To enable the communication via USB, make sure to have the peripheral selection set to UART (full duplex).
- Peripheral switch: This switch sets the interface configuration of the 12.1 x 12.1 mm module in the socket of the Evaluation Board.

**Table 3. Settings for Switch**

<table>
<tr><th>Lever nr</th><th>Name</th><th>Description</th></tr>
<tr><td>1</td><td>VDDIO_3.0V</td><td>Sets the VDDIO of UART, SPI and I2C to 3.0 V, if VDDIO is not supplied to pin #2 of the 24-pins connector. Setting a VDDIO, either external or with this lever, is required to properly define the voltage levels of SYNC_IN.</td></tr>
<tr><td>2</td><td>VDDIO_1.8V</td><td>Sets the VDDIO of UART, SPI and I2C to 1.8 V, if VDDIO is not supplied to pin #2 of the 24-pins connector. When VDDIO_3.0 V is selected as well, VDDIO will be 3.0 V. Setting a VDDIO, either external or with this lever, is required to properly define the voltage levels of SYNC_IN.</td></tr>
<tr><td>3</td><td>PSEL0</td><td rowspan="2"><table><tr><th>PSEL0</th><th>PSEL1</th><th>Peripheral(1)</th></tr><tr><td>0</td><td>0</td><td>UART_FD</td></tr><tr><td>1</td><td>0</td><td>UART_HD</td></tr><tr><td>0</td><td>1</td><td>SPI</td></tr><tr><td>1</td><td>1</td><td>I2C</td></tr></table></td></tr>
<tr><td>4</td><td>PSEL1</td></tr>
<tr><td>5</td><td>RS232</td><td>Set this lever to 1 (high) to enable RS232 communication. Also, PSEL0 and PSEL1 must be set to UART. This lever must be set to 0 to enable I2C</td></tr>
<tr><td>6</td><td>NC</td><td>N/A</td></tr>
</table>

**Note:**

1. The values for the peripheral selection on the switch are inverted with respect to the values on the module.

Table 4. Switch Positions to Enable Interfaces on Development Board

| Interface | PSEL0 | PSEL1 | RS232 | Comments |
|---|---|---|---|---|
| UART FD | 0 | 0 | 0 | When USB is detected, interface is USB |
| UART HD | 1 | 0 | 0 | |
| USB | 0 | 0 | 0 | When USB is detected, interface is USB |
| I2C | 1 | 1 | 0 | |
| SPI | 0 | 1 | 0 | |
| RS232 | 0 | 0 | 1 | When USB is detected, interface is USB |

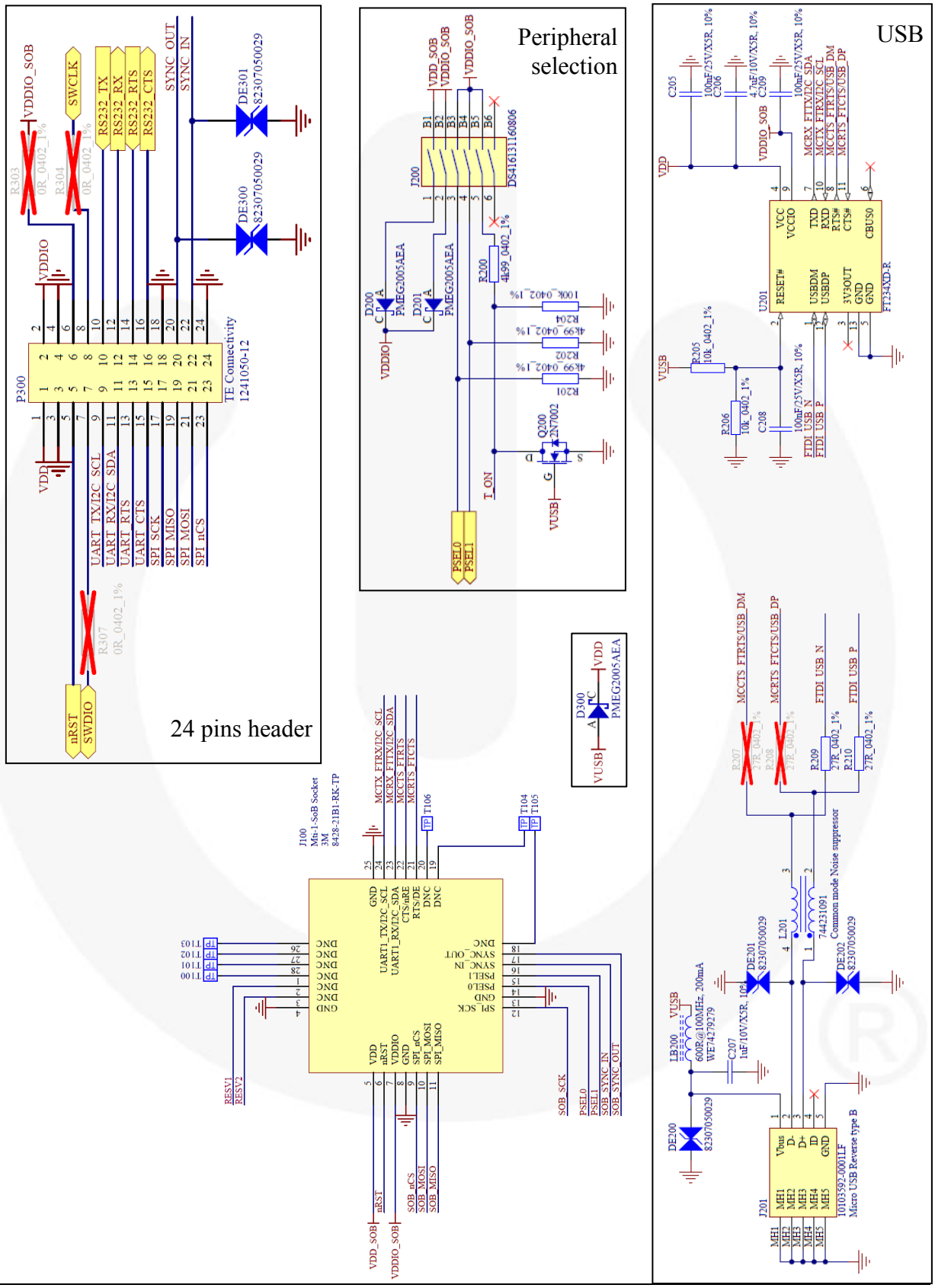

Figure 9. Switch to $I^2C$ Interface and VDDIO of 3.0 V

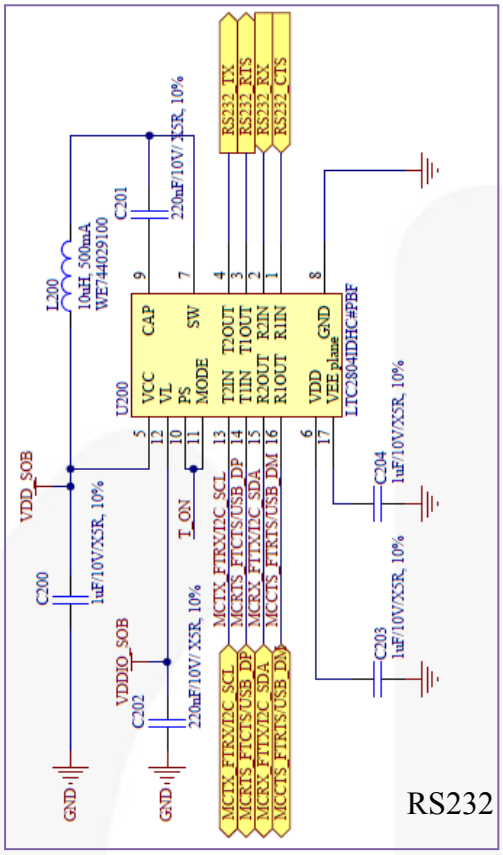
## 4.1. Pin Descriptions

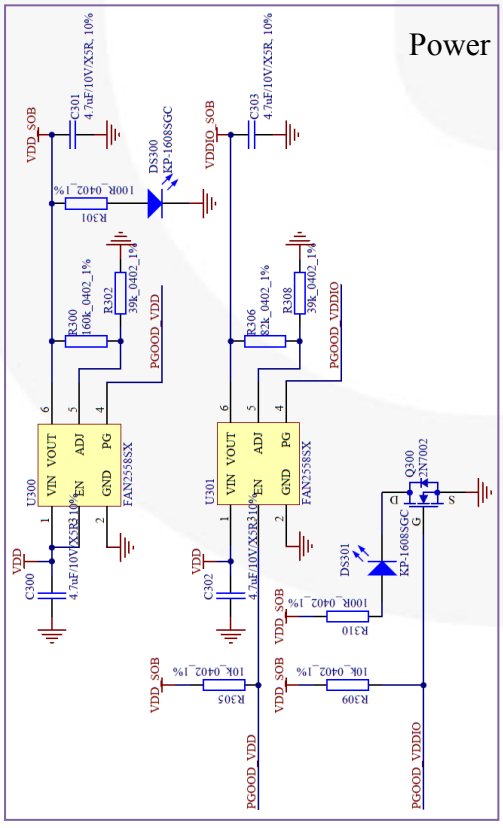
**Table 5. Pin Descriptions of the FEBFMT1030_MEMS01**

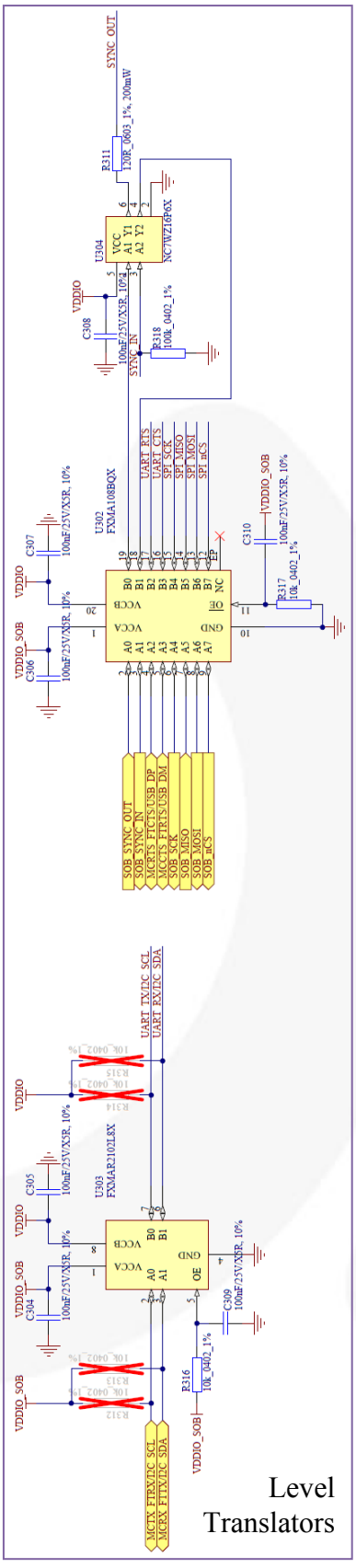
| Name | Type | Description |
|---|---|---|
| **Power Interface** | | |
| VDD | Power | Power supply voltage for sensing elements |
| VDDIO | Power | Digital I/O supply voltage |
| **Controls** | | |
| PSEL0 | Selection pins | These pins determine the signal interface. See 0. Note that when the PSEL0/PSEL1 is not connected, its value is 1. When PSEL0/PSEL1 is connected to GND, its value is 0 |
| PSEL1 | | |
| nRST | | Active low reset pin, connect to VDDIO if not used |
| **Signal Interface** | | |
| I2C_SDA | $I^2C$ interface | $I^2C$ serial data |
| I2C_SCL | | $I^2C$ serial clock |
| SPI_nCS | SPI interface | SPI chip select |
| SPI_MOSI | | SPI serial data input (slave) |
| SPI_MISO | | SPI serial data output (slave) |
| SPI_SCK | | SPI serial clock |
| RTS | UART interface | Hardware flow control in UART full duplex mode (Ready-to-Send) |
| CTS | | Hardware flow control in UART full duplex mode (Clear-to-Send) |
| nRE | | Receiver control signal in UART half duplex mode |
| DE | | Transmitter control signal in UART half duplex mode |
| UART-RX | | Receiver data input |
| UART-TX | | Transmitter data output |
| RS232-TX | RS232 interface | Receiver data input |
| RS232-RX | | Transmitter data output |
| RS232-RTS | | Hardware flow control in RS232 mode (Ready-to-Send) |
| RS232-CTS | | Hardware flow control in RS232 mode (Clear-to-Send) |
| SYNC_IN | Sync interface | SYNC_IN accepts a trigger which has the following functionality, depending on the configuration set in the firmware:<br>▪ It sends out the latest available data message, or<br>▪ It adjusts the bias of the clock onboard the MTi |
| DRDY | Data ready | Data ready pin indicates that data is available (SPI / $I^2C$) |

## 4.2. Schematics




RS232
U200
LTC2804IDHC#PBF
L200
10uH 500mA
WE744029100
C200
1uF/10V/X5R, 10%
C201
220nF/10V/X5R, 10%
C202
220nF/10V/X5R, 10%
C203
1uF/10V/X5R, 10%
C204
1uF/10V/X5R, 10%
VDD_SOB
VDDIO_SOB
T_ON
RS232_TX
RS232_RTS
RS232_RX
RS232_CTS
MCTX_FTRXI2C_SCL
MCRTS_FTCTSUSB_DP
MCRX_FTTXI2C_SDA
MCCTS_FTRTSUSB_DM


Power
U300
FAN2558SX
U301
FAN2558SX
Q300
2N7002
DS300
KP-1608SGC
DS301
KP-1608SGC
C300
4.7uF/10V/X5R, 10%
C301
4.7uF/10V/X5R, 10%
C302
4.7uF/10V/X5R, 10%
C303
4.7uF/10V/X5R, 10%
R300
160k_0402_1%
R301
100R_0402_1%
R302
39k_0402_1%
R303
EK_0402_1%
R305
10K_0402_1%
R308
39k_0402_1%
R309
10K_0402_1%
R310
100R_0402_1%
VDD_SOB
VDDIO_SOB
PGOOD_VDD
PGOOD_VDDIO


Level
Translators
U302
FXMA108BQX
U303
FXMAR2102L8X
U304
NC7WZ16P6X
C305
100nF/25V/X5R, 10%
C306
100nF/25V/X5R, 10%
C307
100nF/25V/X5R, 10%
C308
100nF/25V/X5R, 10%
C309
100nF/25V/X5R, 10%
C310
100nF/25V/X5R, 10%
R311
120R_0603_1%, 200mW
R312
10K_0402_1%
R313
10K_0402_1%
R314
10K_0402_1%
R315
10K_0402_1%
R316
10k_0402_1%
R317
10k_0402_1%
R318
100k_0402_1%
SYNC_OUT
SYNC_IN
VDDIO
VDDIO_SOB
UART_RTS
UART_CTS
SPI_SCK
SPI_MISO
SPI_MOSI
SPI_nCS
SOB_SYNC_OUT
SOB_SYNC_IN
SOB_SCK
SOB_MISO
SOB_MOSI
SOB_nCS
UART_TXI2C_SCL
UART_RXI2C_SDA
MCTX_FTRXI2C_SCL
MCRX_FTTXI2C_SDA

## 4.3. Physical Dimensions

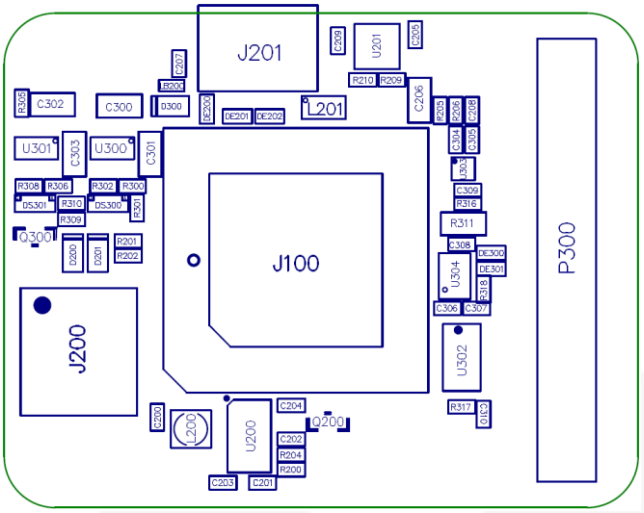



**Figure 10. Physical Location of Components**

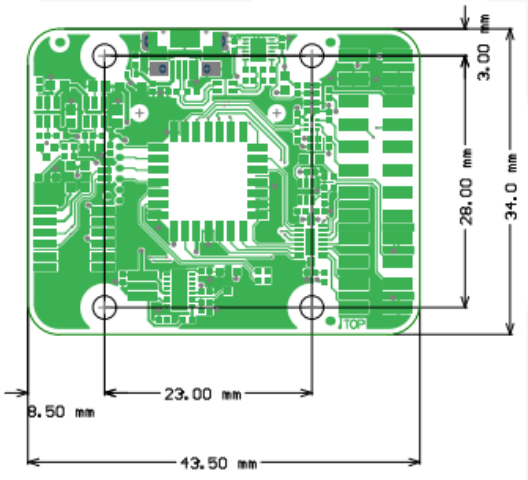



**Figure 11. Outer Dimensions of the FEBFMT Board (PCB spacers are placed).**

## 4.4. Electrical Specifications

The FEBFMT1030 Evaluation Board has the same communication protocol as the FMT1000-series module. Table 6 shows the electrical specifications for the Development Board.

**Table 6. System Specifications Evaluation Board**

| Input | Description | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| VDD | | 3.3 | | 5.5 | V |
| VDDIO | | 1.6 | | 5.5 | V |
| SyncIn | $V_{IH}$ | 0.75 * VDDIO | | | V |
| | $V_{IL}$ | | | 0.25 * VDDIO | V |

## 4.5. Absolute Maximum Ratings

**Table 7. Absolute Maximum Ratings FEBFMT1030**

| Parameter | Min. | Max. | Unit | Comments |
|---|---|---|---|---|
| Storage Temperature | -40 | +125 | °C | |
| Operating Temperature | -30 | +85 | °C | |
| VDD | 0.3 | 6.0 | V | |
| VDDIO | 0.3 | VDD + 0.5 | V | |
| $V_{SYNC\_IN}$ | | 7.0 | V | |
| Acceleration(2) | | 10,000 | g | Any axis, unpowered, for 0.2 ms |
| ESD Protection(3) | | ±2000 | V | Human Body Model |

**Notes:**

2. △This is a mechanical shock (g) sensitive device. Proper handling is required to prevent damage to the part.
3. ↯This is an ESD-sensitive device. Proper handling is required to prevent damage to the part.

# 5. Revision History

| Rev. | Date | Description |
|---|---|---|
| 1.0 | October 2015 | Initial Release |
| | | |
| | | |
| | | |

## WARNING AND DISCLAIMER

Replace components on the Evaluation Board only with those parts shown on the parts list (or Bill of Materials) in the Users' Guide. Contact an authorized Fairchild representative with any questions.

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