

## TDK-InvenSense Motion Evaluation Guide

### INTRODUCTION

This TDK-InvenSense Motion Evaluation Guide provides direction for starting an evaluation of TDK-InvenSense motion sensor devices such as ICM20602, ICM20648, and ICM20948. TDK-InvenSense provides evaluation boards (EVB) and software with which one can evaluate the device hardware, as well as any corresponding motion fusion algorithms. This is a getting-started guide for customers to ensure the correct hardware and software are procured to support their objectives in motion testing.

### STEP 1 – GET THE HARDWARE

To evaluate TDK-InvenSense’s motion products, customers must first acquire the following hardware

#### MCU EVALUATION BOARD

All current TDK-InvenSense evaluation software runs on an ST Nucleo ARM M4 evaluation board, specifically the Nucleo-F411RE. This board is a standard MCU evaluation board, and is sold in multiple distribution channels. Table 1 lists where it can be purchased.

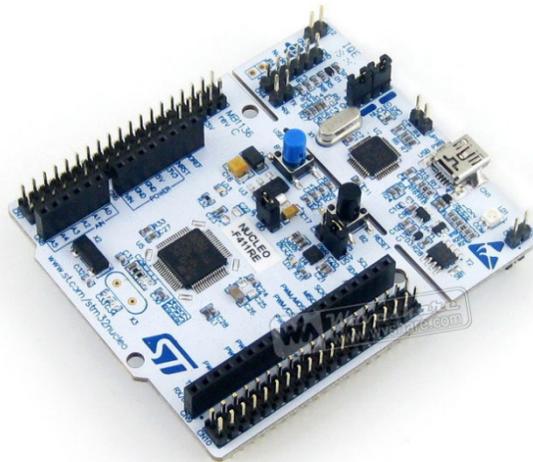


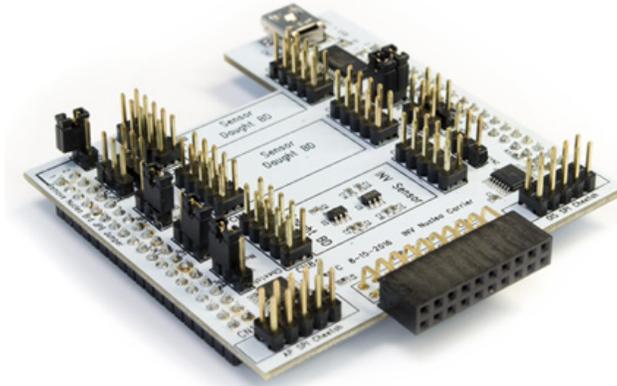
Figure 1. St Nucleo ARM M4 evaluation board

Distribution	Link
DigiKey	<a href="https://www.digikey.com/products/en?keywords=ST%20Nucleo%20F411RE">https://www.digikey.com/products/en?keywords=ST%20Nucleo%20F411RE</a>
Mouser	<a href="http://www.mouser.com/ProductDetail/STMicroelectronics/NUCLEO-F411RE/?qs=%2fha2pyFaduhS8dDgizqVU9%2fK%252bppALHhCfu2Nc0ySD4UJquYmZ5Y3Q%3d%3d">http://www.mouser.com/ProductDetail/STMicroelectronics/NUCLEO-F411RE/?qs=%2fha2pyFaduhS8dDgizqVU9%2fK%252bppALHhCfu2Nc0ySD4UJquYmZ5Y3Q%3d%3d</a>
AVNET	<a href="https://www.avnet.com/shop/us/p/kits-and-tools/development-kits/stmicroelect/nucleo-f411re-3074457345626133151/">https://www.avnet.com/shop/us/p/kits-and-tools/development-kits/stmicroelect/nucleo-f411re-3074457345626133151/</a>

Table 1. ST Nucleo ARM M4 evaluation board distribution channels

#### TDK-INVENSENSE CARRIER BOARD

The Carrier Board is an interface board between the ST Nucleo MCU board and TDK-InvenSense Motion EVB boards, and provides easy and stable connections.



**Figure 2. TDK-InvenSense carrier board**

Distribution	Link
DigiKey	<a href="https://www.digikey.com/product-detail/en/tdk-invensense/BRD_CARRIER/BRD_CARRIER-ND/7319728">https://www.digikey.com/product-detail/en/tdk-invensense/BRD_CARRIER/BRD_CARRIER-ND/7319728</a>
CDI	<a href="https://www.cdiweb.com/ProductDetail/BRDCARRIER-TDK-InvenSense/607644/">https://www.cdiweb.com/ProductDetail/BRDCARRIER-TDK-InvenSense/607644/</a>
Mouser	<a href="http://www.mouser.com/ProductDetail/TDK/BRD_CARRIER/?qs=%2fha2pyFaduit3XXy0xMtTOUH3PDBN%252bsSYHn3Yjg4Pb4SvTzpVPC6hXvFH6qFxSZl">http://www.mouser.com/ProductDetail/TDK/BRD_CARRIER/?qs=%2fha2pyFaduit3XXy0xMtTOUH3PDBN%252bsSYHn3Yjg4Pb4SvTzpVPC6hXvFH6qFxSZl</a>
AVNET	<a href="https://www.avnet.com/shop/us/p/uncategorized/invensense-ivs--1/brd-carrier-3074457345632869188/">https://www.avnet.com/shop/us/p/uncategorized/invensense-ivs--1/brd-carrier-3074457345632869188/</a>

**Table 2. TDK-InvenSense carrier board distribution channels**

### TDK-INVENSENSE MOTION EVB

Every TDK-InvenSense motion sensor device has an EVB board which can be purchased. Each EVB has similar pin outs and size, which allows the same Nucleo + Carrier board combination to support many different motion EVBs. The following is a list of our main motion EVB products and corresponding links to facilitate purchase:



**Figure 3. TDK-InvenSense Motion EVB**

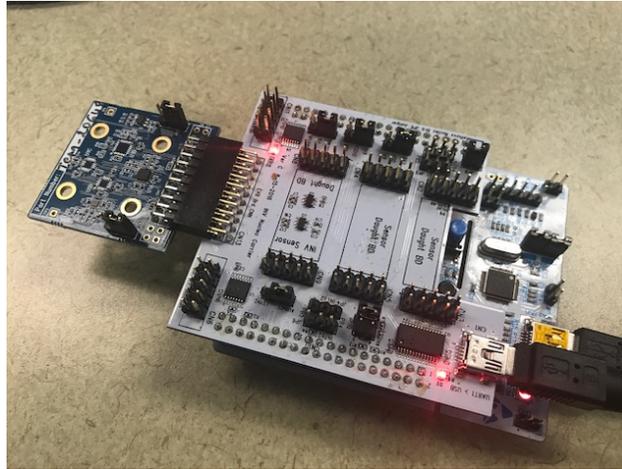
Motion Product	Distribution	Link
ICM-20948	DigiKey	<a href="https://www.digikey.com/products/en/development-boards-kits-programmers/evaluation-boards-sensors/795?k=ICM20948">https://www.digikey.com/products/en/development-boards-kits-programmers/evaluation-boards-sensors/795?k=ICM20948</a>
	CDI	<a href="https://www.cdiweb.com/ProductDetail/EVICM20948-TDK-InvenSense/597422/">https://www.cdiweb.com/ProductDetail/EVICM20948-TDK-InvenSense/597422/</a>
	Mouser	<a href="http://www.mouser.com/ProductDetail/TDK/ICM-20948/?qs=%2fha2pyFadughVsku%252b8C%252bNL7InjnNTxzOcxDHnsnuieU%3d">http://www.mouser.com/ProductDetail/TDK/ICM-20948/?qs=%2fha2pyFadughVsku%252b8C%252bNL7InjnNTxzOcxDHnsnuieU%3d</a>
	AVNET	<a href="https://www.avnet.com/shop/us/p/sensors-and-transducers/sensors-and-transducers-misc/invensense-ivs--1/icm-20948-3074457345628252494/">https://www.avnet.com/shop/us/p/sensors-and-transducers/sensors-and-transducers-misc/invensense-ivs--1/icm-20948-3074457345628252494/</a>
ICM-20648	DigiKey	<a href="https://www.digikey.com/product-detail/en/tdk-invensense/EV_ICM-20648/1428-1069-ND/6140301">https://www.digikey.com/product-detail/en/tdk-invensense/EV_ICM-20648/1428-1069-ND/6140301</a>
	CDI	<a href="https://www.cdiweb.com/ProductDetail/EVICM20648-TDK-InvenSense/597419/">https://www.cdiweb.com/ProductDetail/EVICM20648-TDK-InvenSense/597419/</a>
	Mouser	<a href="http://www.mouser.com/ProductDetail/TDK/ICM-20648/?qs=%2fha2pyFaduh3gxMKGYZFdfPMu32Ke4lflHHZVUt7FCU%3d">http://www.mouser.com/ProductDetail/TDK/ICM-20648/?qs=%2fha2pyFaduh3gxMKGYZFdfPMu32Ke4lflHHZVUt7FCU%3d</a>
	AVNET	<a href="https://www.avnet.com/shop/us/p/uncategorized/invensense-ivs--1/icm-20648-evb-3074457345630142190/">https://www.avnet.com/shop/us/p/uncategorized/invensense-ivs--1/icm-20648-evb-3074457345630142190/</a>
ICM-20602	DigiKey	<a href="https://www.digikey.com/product-detail/en/tdk-invensense/EV_ICM-20602/1428-1068-ND/6140300">https://www.digikey.com/product-detail/en/tdk-invensense/EV_ICM-20602/1428-1068-ND/6140300</a>
	CDI	<a href="https://www.cdiweb.com/ProductDetail/EVICM20602-TDK-InvenSense/597416/">https://www.cdiweb.com/ProductDetail/EVICM20602-TDK-InvenSense/597416/</a>
	Mouser	<a href="http://www.mouser.com/ProductDetail/TDK/ICM-20602/?qs=%2fha2pyFadiuyCH0%252bf5atPw9boPC8ZqJMb3VMsqeoyis%3d">http://www.mouser.com/ProductDetail/TDK/ICM-20602/?qs=%2fha2pyFadiuyCH0%252bf5atPw9boPC8ZqJMb3VMsqeoyis%3d</a>
	AVNET	<a href="https://www.avnet.com/shop/us/p/uncategorized/invensense-ivs--1/icm-20602-evb-3074457345630142191/">https://www.avnet.com/shop/us/p/uncategorized/invensense-ivs--1/icm-20602-evb-3074457345630142191/</a>

**Table 3. TDK-InvenSense Motion EVB distribution channels**

## MISC

Other hardware that customers will need are two mini-USB male to USB 2.0 male cables and a PC running Win 7.

Connecting the hardware is fairly simple. The boards can only be connected in a specific logical fashion. There might be some jumper setting changes which specific software tool documents will specify.



**Figure 4. Connecting the Hardware**

## HARDWARE SUMMARY

To summarize, customers will need the following

- ST Nucleo F411RE MCU Evaluation Board
- TDK-InvenSense Carrier Board
- TDK-InvenSense Motion EVB Board
- Two mini-USB cables
- PC/Laptop with Win7

## STEP 2 – SELECTING THE RIGHT SOFTWARE EVALUATION TOOL

There are currently two different software packages available for customers to download and use to evaluate motion hardware: MotionLink and the Embedded Motion Drivers (eMDs). Each serves a different purpose and has a different degree of complexity in bringing-up. All software is available for free to download in the TDK-InvenSense Developer's Corner. You will need to sign up for an account to access

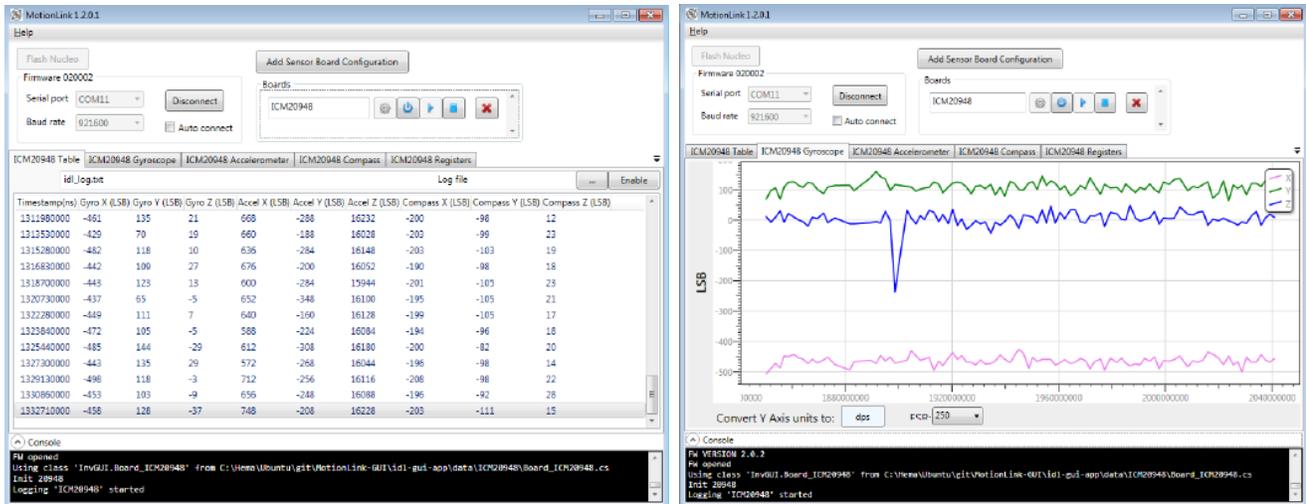
<https://www.invensense.com/developers/software-downloads/>

## MOTIONLINK

The MotionLink software is primarily used to evaluate the raw sensor hardware. What this means is that there are no motion algorithms or filters such as calibration or sensor fusion involved. MotionLink's main features and capabilities include

- Register map and values
- Simple I<sup>2</sup>C writes and reads
- Display raw sensor data on console including a timestamp with maximum sample rate at 1 kHz
- Log data to file
- Display line graph of the raw sensor data

MotionLink is simple to use and supports the latest of TDK-InvenSense's motion sensor hardware including all the ICM product lines. Typically, MotionLink is a customer's first method of evaluation.



**Figure 5. MotionLink GUI**

For installation details please read the MotionLink User Manual that comes with the installation package.

### THE EMBEDDED MOTION DRIVER (EMD)

The eMDs are a full-featured Motion software package which includes motion fusion, gesture tracking, DMP features, and automatic sensor calibration. Customers will use the eMDs as an evaluation vehicle if they are interested in TDK-InvenSense’s motion fusion algorithms.

Because each eMD is customized to the motion hardware, an eMD for ICM20602 (high performance 6-axis only) would be very different compared to an eMD for the ICM20948 (9-axis with embedded DMP). In general, current eMDs have the following features

- Raw Accelerometer
- Raw Gyroscope
- Raw Magnetometer
- Dynamically Calibrated Accelerometer
- Dynamically Calibrated Gyroscope
- Dynamically Calibrated Magnetometer
- Game Rotation Vector – Accel and Gyro based RV
- Rotation Vector – Accel, Gyro, and Mag based RV
- Geomagnetic Rotation Vector – Accel and Mag based RV
- BAC (Basic Activity Classifier) – Android-based activity detection of Walking, Standing, Running, Biking, and Transport
- Step Detector
- Step Counter (Pedometer)
- SMD (Significant Motion Detection)
- Pickup Detection
- Tilt Detection
- Gravity
- Linear acceleration
- Orientation
- B2S (Bring to See) Detection
- Heading
- Euler Angles
- Quaternion generation

Each eMD has a Software Guide which elaborates on details of that release.

Due to complexity of the algorithms, an eMD’s development cycle and release tend to be later than MotionLink’s support for new products. Please contact your local sales representative if an eMD for a motion part is not available on the TDK-InvenSense Developer’s Corner.

## OTHER REQUIRED SOFTWARE

Because both the MotionLink and eMD run on a Nucleo MCU evaluation board, to flash or download the Nucleo firmware requires Nucleo USB and ST-Link drivers. There is also an FTDI driver used for the TDK-InvenSense Carrier Board which needs to be installed.

- Nucleo Board USB Drivers - [http://www.st.com/content/st\\_com/en/products/embedded-software/development-tool-software/stsw-link009.html](http://www.st.com/content/st_com/en/products/embedded-software/development-tool-software/stsw-link009.html)
- Nucleo ST-LINK Utility - <http://www.st.com/en/embedded-software/stsw-link004.html>
- Carriers Board's FTDI Driver - <http://www.ftdichip.com/Drivers/VCP.htm>

Because the eMDs are a full-featured software products with source code, the developmental toolchain IAR is required to run the application. Also, a terminal application like Tera Term or Putty is required to retrieve the traces from the firmware application.

eMD specific software requirements

- IAR ARM Workbench IDE - <https://www.iar.com/iar-embedded-workbench/>
- RS232 terminal emulator –
  - Putty - <http://www.putty.org/>
  - Tera Term - [http://download.cnet.com/Tera-Term/3000-2094\\_4-75766675.html](http://download.cnet.com/Tera-Term/3000-2094_4-75766675.html)

## SOFTWARE SUMMERY

To summarize, after obtaining all the hardware, a customer will find all TDK-InvenSense motion software available for download at the Developer's Corner. The customer can use MotionLink and eMDs for evaluation.

MotionLink – evaluation tool for the motion hardware

eMDs – software drivers for full-featured motion algorithms including sensor fusion and gesture detection

## FURTHER HELP

Email any additional questions to:

Technical Support North America - [techsupport\\_NorthAmerica@invensense.com](mailto:techsupport_NorthAmerica@invensense.com)

**REVISION HISTORY**

REVISION DATE	REVISION	DESCRIPTION
07/12/2017	1.0	Initial Release

## **DECLARATION DISCLAIMER**

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