＠TDK InvenSense

SmartMotion

Development Kit (DK) Ver. B

Hardware User Guide

TABLE OF CONTENTS

1 OVERVIEW

The TDK SmartMotion Platform Ver. B is a comprehensive development system for TDK InvenSense Motion Sensor devices. The platform designed around the Microchip SAM G55 MCU can be used by customers for rapid evaluation and development of InvenSense sensor-based solutions. The platform integrates an on-board Embedded Debugger so external tools are not required to program or debug with the SAM G55 MCU. Each InvenSense motion sensor has its own unique development kit (DK).

The TDK SmartMotion platform Ver. B comes with the necessary software including an InvenSense Motion Link, a GUI-based development tool, and embedded Motion Drivers (eMD) for InvenSense motion sensors.

Embedded Motion Drivers (eMD) consists of a set of APIs to configure various aspects of the platform including motion sensor parameters such as full-scale range (FSR), output data rate (ODR), low-power or low-noise mode, and sensor interface to host (I^2C, SPI). eMDs will also provide the following enhanced motion functions that run on the MCU:

- Sensor Fusion

- Accelerometer and Gyroscope Calibration

- Android Functions: Game Rotation Vector, Gravity, Linear Acceleration

Motion Link is a GUI-based development tool included with the platform. It can be used to capture and visualize the sensor data from the motion sensor.

The platform supports Atmel Studio and is compatible with Microchip Xplained Pro Extension boards. The Xplained Pro extension series evaluation kits offer additional peripherals to extend the features of the board and ease the development of customer designs.

The TDK SmartMotion Development Kit (DK) Ver. B supports multiple types of TDK IMUs. Table 1 lists the TDK Sensor Development Kit (DK) ordering information. This user guide applies to the following development kits. Refer to section 3.1 for more information.

SUPPORTED SENSOR	DK PART NUMBER	MOUNTED ON U#
IAM-20680HT	DK-20680HT	U1
IAM-20680HP	DK-20680HP	U1
IAM-20680	DK-20680A	U1
ICM-20602	DK-20602	U1
ICM-20648	DK-20648	U2
ICM-40609-D	DK-40609-D	U2
ICM-40605	DK-40605	U3
ICM-42605	DK-42605	U3

Table 1. Sensors and DKs

2 INTRODUCTION

2.1. FEATURES OVERVIEW

- Integrated TDK InvenSense motion sensor
- Support for a magnetic sensor with plug in daughter boards (DB)
- Microchip SAM G55 microcontroller with 512 KB flash
- On-board Embedded debugger (EDBG) for programming and debugging
- Built in FTDI USB to UART interface for fast motion sensor data transfer
- USB connectors for host interface to software debug and data logging
- Board power supply through USB

2.2. PLATFORM OVERVIEW

The TDK SmartMotion Platform Ver. B is a hardware unit for TDK sensor product evaluation and algorithm software development. The platform offers flexible solutions for many different application developments. The board shown in Figure 1 is the DK-20680HT board (with TDK sensor in slot U1).
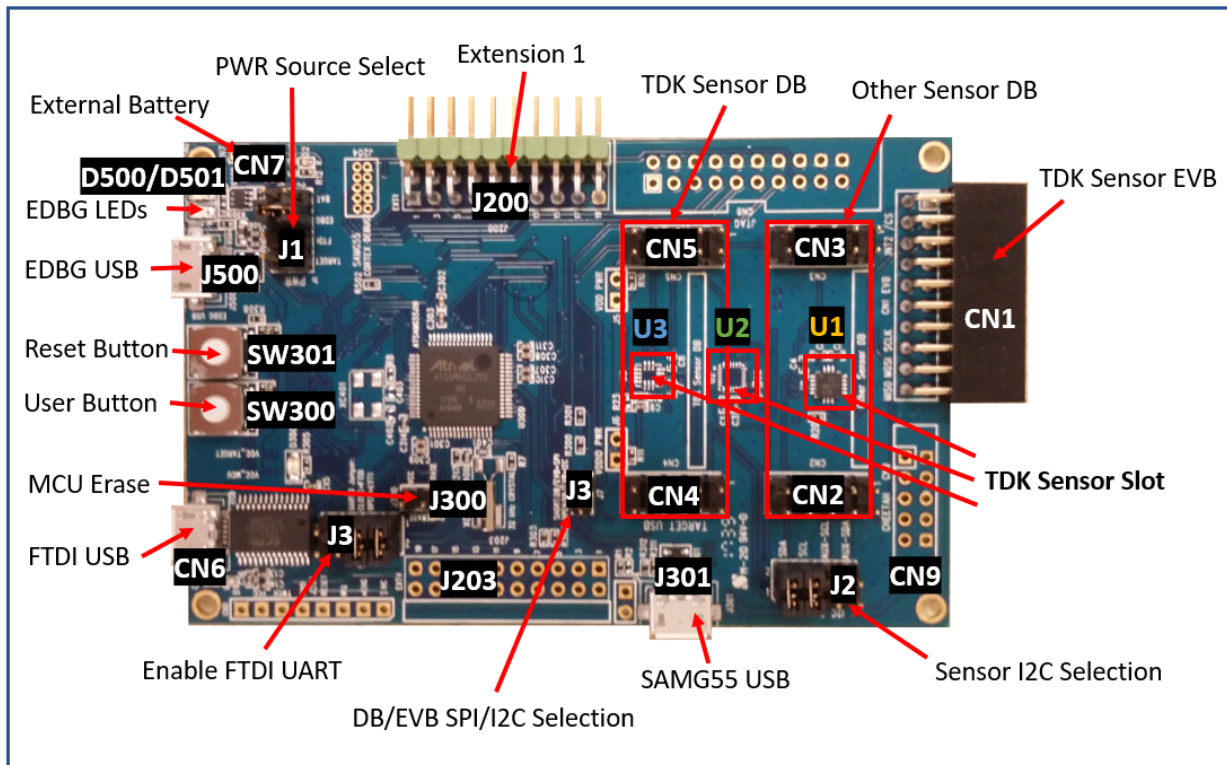

Figure 1. The SmartMotion Platform Overview

Table 2 details the TDK SmartMotion Platform Ver. B connector and header reference names and descriptions.

CONNECTOR NAME	CONNECTOR REF #	CONNECTOR FUNCTION DESCRIPTIONS
TDK Sensor Slot	U1	Populated for the following DK boards: DK-20680HT DK-20680HP DK-20680A DK-20602

CONNECTOR NAME	CONNECTOR REF #	CONNECTOR FUNCTION DESCRIPTIONS
TDK Sensor Slot	U2	Populated for the following DK boards: DK-20648 DK-40609-D
TDK Sensor Slot	U3	Populated for the following DK boards: DK-40605 DK-42605
TDK Sensor EVB	CN1	External TDK sensor EVB connector
Other Sensor DB	CN2/CN3	Daughter board connector for Mag sensor. I^2C interface only.
TDK Sensor DB	CN4/CN5	Daughter board connector for TDK sensor. I^2C and SPI interfaces.
External Battery	CN7	External battery
	CN9	Not mounted. Used for internal testing
FTDI USB	CN6	USB connector for FTDI USB to serial UART interface
EDBG LEDs	D500/D501	EDBG LEDs. D500 is green and D501 is yellow
PWR Source Select	J1	Board power source selection
Sensor I^2C Selection	J2	Select host I^2C connections, for IMU and mag.
Enable FTDI UART	J3	Assign UART0 for FTDI or for use on J200 extension header
DB/EVB SPI/I^2C Selection	J7	Assign DB/EVB communication bus protocol, I^2C or SPI
Extension 1	J200	Extension header 1. Has same function as J200 on Microchip's Xplained-Pro board. Refer to http://www.atmel.com/Images/Atmel-42389-SAM-G55-Xplained-Pro_User-Guide.pdf for more details
	J203	Not mounted. Extension header 2. Has same function as J203 on Microchip's Xplained-Pro board
MCU Erase	J300	MCU Erase is used to clear flash on the MCU SAM G55
SAMG55 USB	J301	MCU SAM G55 USB connector
EDBG USB	J500	EDBG MCU USB connector
User Button	SW300	User Button is connected to MCU GPIO, function is defined by the user
Reset Button	SW301	RESET Button: Hardware Reset for the Target MCU and EDBG MCU.

Table 2. Connectors

2.3. QUICK SETUP

1. Download and install MotionLink software.
2. Connect the FTDI USB (CN6) to PC and open MotionLink for quick testing, as shown in the block diagram in Figure 2.
3. Click on Start MotionLink to get to the GUI window.
4. Refresh COM and if needed, connect EDBG USB (J500) to PC and Flash MCU Firmware.
5. Click on Select and Configure Sensor Board and find the correct part number.
6. Connect to the serial port and power on the board.

For further help, click on the Help button on the top bar for the MotionLink user manual or troubleshooting help.
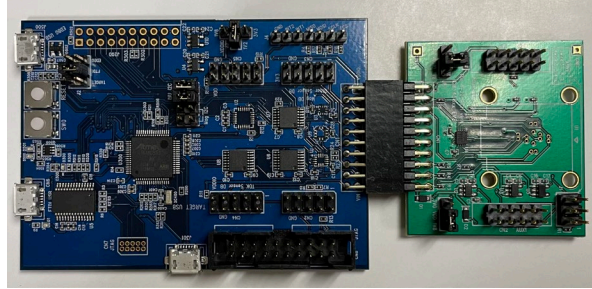

Figure 2. Block diagram

Figure 3. DK-UNIVERSAL-I connected to EVB

2.4. UPDATING SAMG55 FIRMWARE HARDWARE USER GUIDE

The TDK SmartMotion Platform Ver. B is compatible with Microchip's SAM G55 Xplained Pro for updating and flashing the firmware. Follow this link to download the Atmel Xplained Pro user guide, starting from page 5:

http://www.atmel.com/Images/Atmel-42389-SAM-G55-Xplained-Pro_User-Guide.pdf

Connect the EDBG (Atmel Embedded Debugger) USB port with USB cable to PC. To set up the board, click on Device Programming (Ctrl + Shift + P): and select EDBG as the Tool.

3 SENSORS AND DEVELOPMENT KITS

3.1. TDK SENSOR TO SAM G55 MCU CONNECTION

3.1.1. DK-20680HT

The DK-20680HT is the development kit for TDK IAM-20680HT.

The IAM-20680HT is a 6-axis MotionTracking™ for Automotive non-safety applications that combines a 3-axis gyroscope and a 3-axis accelerometer in a thin 3x3x0.75mm^3 (16-pin LGA) package.

Please refer to the datasheet for the sensor details.

The IAM-20680HT sensor can be connected to SAMG55 MCU I^{2}C or SPI.

The sensor I^{2}C slave address is 0x69, and its SPI /CS = NPCS1.

The VDDIO voltage level ranges from 1.71V to 3.6V.

3.1.2. DK-20680HP

The DK-20680HP is the development kit for TDK IAM-20680HP.

The IAM-20680HP is a 6-axis MotionTracking™ for Automotive non-safety applications that combines a 3-axis gyroscope and a 3-axis accelerometer in a thin 3x3x0.75mm^3 (16-pin LGA) package.

Please refer to the datasheet for the sensor details.

The IAM-20680HP sensor can be connected to SAMG55 MCU I^{2}C or SPI.

The sensor I^{2}C slave address is 0x69, and its SPI /CS = NPCS1.

The VDDIO voltage level ranges from 1.71V to 3.6V.

3.1.3. DK-20680A

The DK-20680A is the development kit for TDK IAM-20680.

The IAM-20680 is a 6-axis MotionTracking™ for in-cabin Automotive applications that combines a 3-axis gyroscope and a 3-axis accelerometer in a small 3x3x0.75mm^3 (16-pin LGA) package.

Please refer to the datasheet for the sensor details.

The ICM-20602 sensor can be connected to SAMG55 MCU I^{2}C or SPI.

The sensor I^{2}C slave address is 0x69, and its SPI /CS = NPCS1.

The VDDIO voltage level ranges from 1.71V to 3.6V.

3.1.4. DK-20602

The DK-20602 is the development kit for TDK ICM-20602.

The ICM-20602 is a 6-axis MotionTracking™ device that combines a 3-axis gyroscope and a 3-axis accelerometer in a small 3x3x0.75mm^3 (16-pin LGA) package.

Please refer to the datasheet for the sensor details.

The ICM-20602 sensor can be connected to SAMG55 MCU I^{2}C or SPI.

The sensor I^{2}C slave address is 0x69, and its SPI /CS = NPCS1.

The VDDIO voltage level ranges from 1.71V to 3.45V.

3.1.5. DK-20648

The DK-20648 is the development kit for TDK ICM-20648.

The ICM-20648 is a 6-axis MotionTracking™ device that combines a 3-axis gyroscope, 3-axis accelerometer, and a Digital Motion Processor™ (DMP™) in a 3x3x0.9mm^3 (24-pin QFN) package.

Please refer to the datasheet for the sensor details.

The ICM-20602 sensor can be connected to SAMG55 MCU I^{2}C or SPI.

The sensor I^{2}C slave address is 0x69, and its SPI /CS = NPCS1.

The VDDIO voltage level ranges from 1.71V to 3.6V.

3.1.6. DK-40609-D

The DK-40609-D is the development kit for TDK ICM-40609-D.

The ICM-40609-D is a 6-axis MotionTracking™ device that combines a 3-axis gyroscope and a 3-axis accelerometer in a small $3x3x0.91mm^3$ (24-pin LGA) package.

Please refer to the datasheet for the sensor details.

The ICM-40609-D sensor can be connected to SAMG55 MCU I^{2}C or SPI.

The sensor I^{2}C slave address is 0x69, and its SPI /CS = NPCS1.

The VDDIO voltage level ranges from 1.71V to 3.6V.

3.1.7. DK-40605

The DK-40605 is the development kit for TDK ICM-40605.

The ICM-40605 is a 6-axis MotionTracking™ device that combines a 3-axis gyroscope and a 3-axis accelerometer in a small $2.5x3x0.91mm^3$ (14-pin LGA) package.

Please refer to the datasheet for the sensor details.

The ICM-20602 sensor can be connected to SAMG55 MCU SPI.

The sensor I^{2}C slave address is 0x69, and its SPI /CS = NPCS1.

The VDDIO voltage level ranges from 1.71V to 3.6V.

3.1.8. DK-42605

The DK-42605 is the development kit for TDK ICM-42605.

The ICM-40605 is a 6-axis MotionTracking™ device that combines a 3-axis gyroscope and a 3-axis accelerometer in a small $2.5x3x0.91mm^3$ (14-pin LGA) package.

Please refer to the datasheet for the sensor details.

The ICM-42605 sensor can be connected to SAMG55 MCU I^{2}C, SPI, or I3C.

The sensor I^{2}C slave address is 0x69, and its SPI /CS = NPCS1.

The VDDIO voltage level ranges from 1.71V to 3.6V.

3.2. MAGNETIC SENSORS CONNECTION

Third party magnetic sensors can be connected to the same SAM G55 MCU I^{2}C bus with TDK sensor through DB, assuming it has a different slave address.

CN2/CN3 are designed for the magnetic sensor DB plug in. It only supports I^{2}C, not SPI.

4   THE SMARTMOTION SYSTEM DESIGN

This section is a system design overview and addresses MCU SAM G55 resource allocation.

4.1. SYSTEM BLOCK DIAGRAM

The on-board EDBG MCU AT32UC3A4256HHB-C1UR allows the user to do main MCU SAM G55 debug, trace, and programming without using external tools. Figure 4 shows the system block diagram.
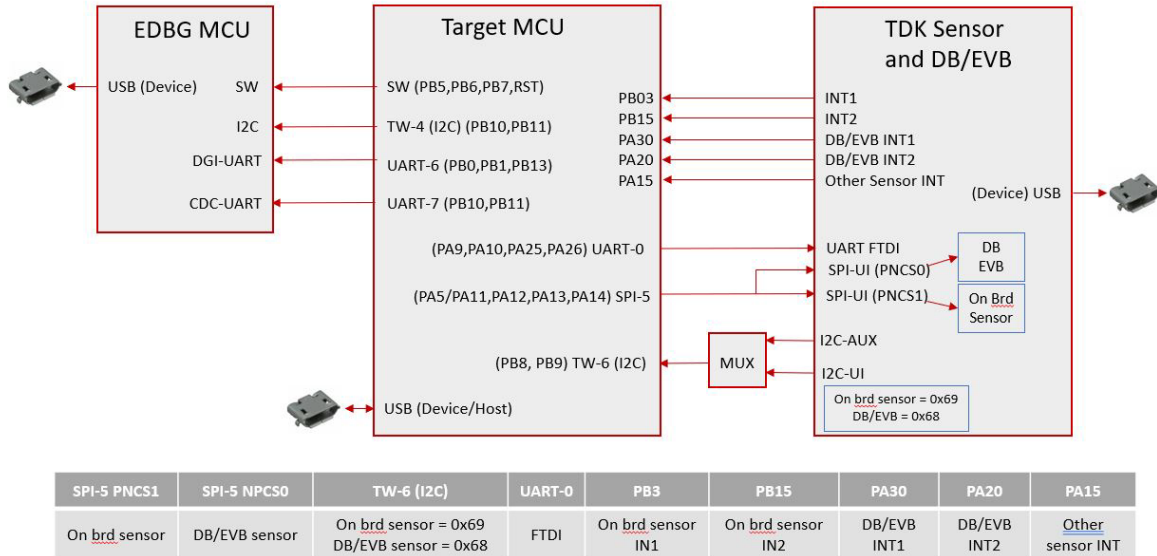

SPI-5 PNCS1	SPI-5 NPCS0	TW-6 (I2C)	UART-0	PB3	PB15	PA30	PA20	PA15
On brd sensor	DB/EVB sensor	On brd sensor = 0x69 DB/EVB sensor = 0x68	FTDI	On brd sensor IN1	On brd sensor IN2	DB/EVB INT1	DB/EVB INT2	Other sensor INT

Figure 4. System Block Diagram

4.2. MAIN MCU SAM G55 RESOURCE ALLOCATION

SAM G55 RESOURCE	USAGE
UART 0 (PA9/10/25/26)	The UART0 is connected to FTDI input by default. In the use case of Extension-1 on J200, the UART0 to FTDI connection can be disconnected through jumper J3.
TW6 (I^{2}C) (PB8/9)	TDK sensor is connected to this master I^{2}C. On board sensor slave address = 0x69. Sensors on DB and EVB have slave address = 0x68.
SPI5 (PA05/PA11/12/13/14)	The SPI5 master is connected to TDK IMU sensor. On board IMU /CS = PNCS1, EVB/DB IMU /CS = PNCS0.
GPIO (INTs) PB03/PB15/PA30/PA20/PA15	The GPIOs are used for sensor interrupt inputs and other intelligent functions. Refer to the table in Figure 3.
TW4 (I^{2}C)	The master I^{2}C communicates with EDBG MCU slave I^{2}C.
UART6	The UART6 is used for EDBG DGI-UART interface.
UART7	The UART7 is used for EDBG CDC-UART interface.

Table 3. SAM G55 Resource Allocation

4.3. JUMPER SETTINGS

JUMPER	DESCRIPTION
J1	J1 is used for board power source selection. Only one jumper is allowed to be closed 1. Pin 1/2: Closed – board power from external battery (CN7) 2. Pin 3/4: Closed – board power from EDBG USB connector (J500) 3. Pin 5/6: Closed – board power from FTDI USB connector (CN6) 4. Pin 7/8: Closed – board power from SAM G55 USB connector (J301)
J2	J2 is used to assign SAM G55 master I^2C to slave devices 1. 1/2 and 3/4: Closed – SAM G55 I^2C master for onboard IMU Sensor 2. 5/6 and 7/8: Closed – SAM G55 I^2C master for other sensors daughter boards connected via CN2 and CN3 (e.g., Magnetic sensor, etc.)
J3	J3 is used to choose UART0 for FTDI or the extension 1 headers (J200) 1. Close all 4 jumpers (1/2, 3/4, 5/6 and 7/8) (Default) – SAM G55 UART0 for FTDI 2. Open all 4 jumpers – SAM G55 UART0 for extension 1 header (J200)
J7	J7 is used for I^2C or SPI selection for DB/EVB communication 1. Short: SPI 2. Open: I^2C

Table 4. Jumper Settings

5 REVISION HISTORY

REVISION DATE	REVISION	DESCRIPTION
10/22/2021	1.0	Initial Release
08/30/2022	1.1	Additional Automotive products support included. Following sections reviewed: Table 1, 3.1.2, 3.1.3, 3.1.4, 3.1.5
10/05/2022	1.2	Added DK-20602, DK-20648, DK-20680A, DK-20680HP, DK-40605, DK-42605, DK-40609-D Updated figure, connection labels, and hardware guide instructions for clarity; removed schematics

6   DECLARATION DISCLAIMER

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