SmartMotion Development Kit (DK)

DK-UNIVERSAL-I

Hardware User Guide

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1 OVERVIEW

The TDK SmartMotion DK-UNIVERSAL-I 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 DK-UNIVERSAL-I 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) DK-UNIVERSAL-I supports multiple types of TDK IMUs and pressure sensors.

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 Development Kit (DK) DK-UNIVERSAL-I is a hardware unit for TDK sensor product evaluation and algorithm software development. The platform offers flexible solutions for many different application developments.

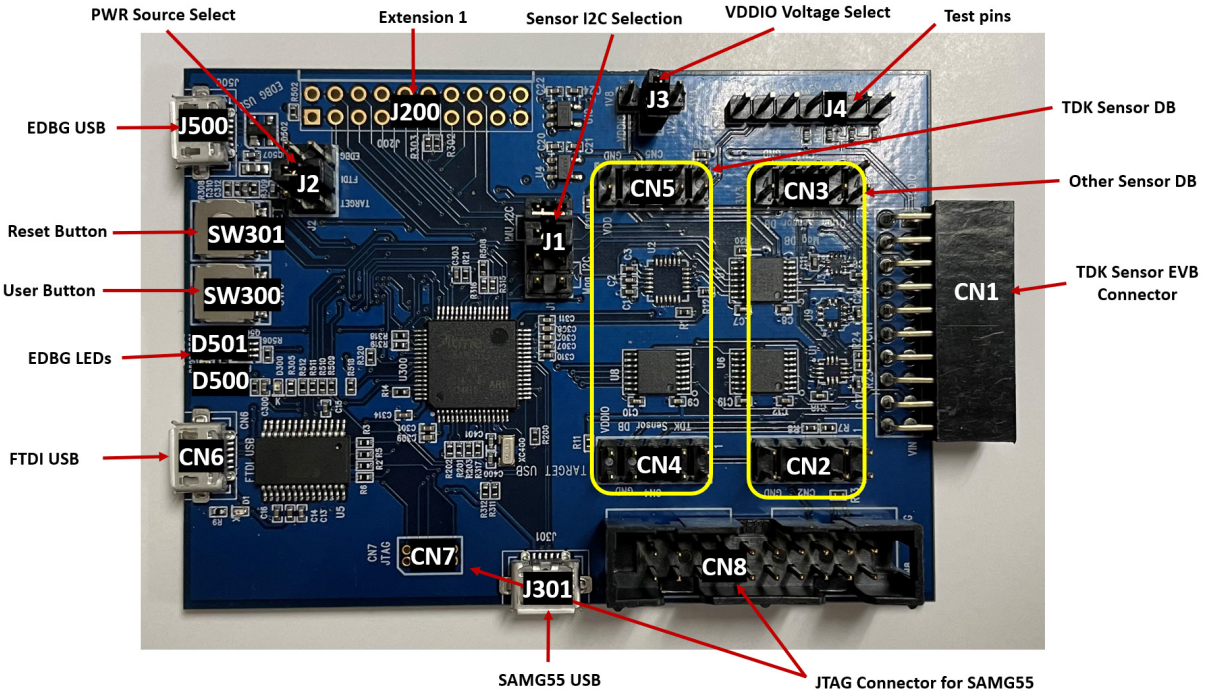


Figure 1. The SmartMotion DK-UNIVERSAL-I Board

3 QUICK SETUP

3.1. USING MOTIONLINK SOFTWARE

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.

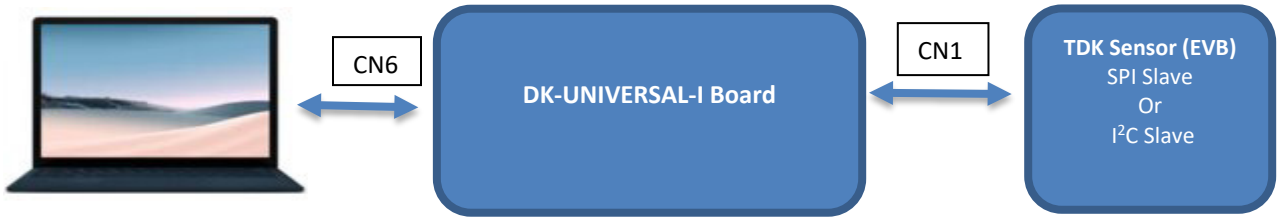


Figure 2. Block diagram

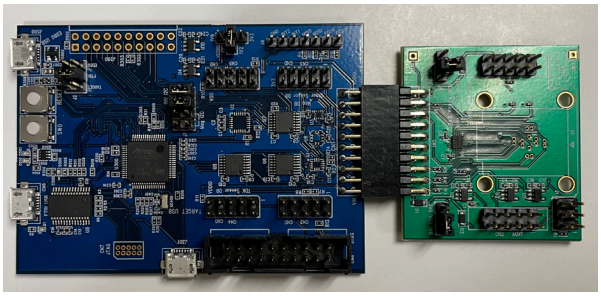


Figure 3. DK-UNIVERSAL-I connected to EVB

3.2. CONNECTORS

Table 1 details the TDK SmartMotion Platform Ver. I connector and header reference names and descriptions.

CONNECTOR NAME	CONNECTOR REF #	CONNECTOR FUNCTION DESCRIPTIONS
TDK Sensor EVB Connector	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
FTDI USB	CN6	USB connector for FTDI USB to serial UART interface
JTAG Connector for SAMG55	CN7/CN8	JTAG Connector for SAMG55 debugging
EDBG LEDs	D500/D501	EDBG LEDs. D500 is green and D501 is yellow
Sensor I^2C Selection	J1	Select host I^2C connections, for IMU sensor and other sensors
PWR Source Select	J2	Board power source selection
VDDIO Voltage Select	J3	Selects voltage level between 3.3V, 1.8V, 1.2V for VDDIO
Test pins	J4	Digital signal test pins
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
SAMG55 USB	J301	MCU SAM G55 USB connector

CONNECTOR NAME	CONNECTOR REF #	CONNECTOR FUNCTION DESCRIPTIONS
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 1. Connectors

3.3. JUMPER SETTINGS

JUMPER	DESCRIPTION
J1	The J1 is used to select which sensor will be connected to the SAMG55 master I2C. Only two jumper shunts are allowed. Jumper shunts on pin-1/2 and 3/4: IMU Sensor primary I2C is connected to SAMG55 I2C master Jumper shunts on pin-5/6 and 7/8: Other Sensor I2C is connected to SAMG55 I2C master. In this configuration TDK IMU Sensor is connected to SAMG55 SPI master.
J2	The J2 is for board power source selection. Only one jumper shunt is allowed. Jumper shunt on pin-1/2: board power is from EDBG USB on J500 Jumper shunt on pin-3/4: board power is from FTDI USB on CN6 Jumper shunt on pin-5/6: board power is from SAMG55 USB on J30
J3	J3 is for system VDDIO level selection. Jumper shunts on pin-1/2: VDDIO=3V3 Jumper shunts on pin-3/2: VDDIO=1V8 Jumper shunts on pin-4/2: VDDIO=1V2
J4	J4 have digital signals as test points. Pin-1: SPI /CS Pin-2: SPI SCLK, I2C SCL Pin-3: SPI MOSI, I2C SDA Pin-4: SPI MISO, I2C AD0 Pin-5: INT1 Pin-6: INT2 Pin-7: GND

Table 2. Jumper Settings

4 ADVANCED INFORMATION

4.1. UPDATING SAMG55 FIRMWARE HARDWARE USER GUIDE

The TDK SmartMotion Development Kit DK-UNIVERSAL-I is compatible with Microchip's SAMG55 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.

4.2. TDK SENSOR TO SAM G55 MCU CONNECTION

The DK-UNIVERSAL-I is the development kit for DB (sensor daughter board) and EVB (sensor evaluation board). There is no sensor mounted on the DK-UNIVERSAL-I board. CN1 for EVB and CN4/CN5 for DB are mounted on board for people to evaluate sensors (on EVB, DB, or standalone) separately. Figure 4 shows the pin out for CN1, where an external EVB can be mounted.

Figure 4. Pin out of CN1 (Connector to EVB)

4.3. CONNECTING OTHER SENSORS

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

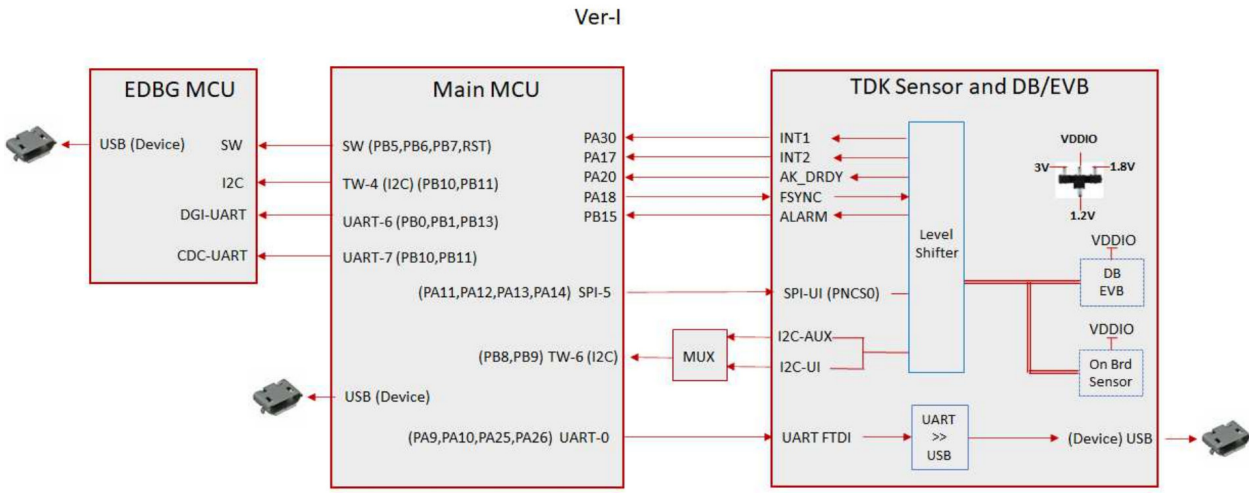
CN2/CN3 are designed for other sensor DB plug in. It only supports I^2C, not SPI.

5 THE SMARTMOTION SYSTEM DESIGN

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

5.1. 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 5 shows the system block diagram.



SPI-5 PNCS0 (PA11)	SPI-5 NPCS1 (PA05)	TW-6 (I2C)	UART-0	PA30	PA17	PA20	PA18	PB15
On brd sensor and DB/EVB	J200 EXT CNN	On brd sensor and DB/EVB sensor = 0x68	FTDI or J200 EXT CNN	On brd sensor and DB/EVB sensor INT1	On brd sensor and DB/EVB sensor INT2_FSYNC_CLKIN	AKM DB AK_DRDY	For IMUs with dedicated FYSYNC	For IMUs with ALARM

Figure 5. System Block Diagram

5.2. 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^2C) (PB8/9)	TDK sensor is connected to this master I^2C. 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 5.
TW4 (I^2C)	The master I^2C communicates with EDBG MCU slave I^2C.
UART6	The UART6 is used for EDBG DGI-UART interface.
UART7	The UART7 is used for EDBG CDC-UART interface.

Table 1. SAM G55 Resource Allocation

6 REVISION HISTORY

REVISION DATE	REVISION	DESCRIPTION
05/27/2022	1.0	Initial Release

7 DECLARATION DISCLAIMER

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