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IoT_ZTB-DK006 Development Kit User Guide

Rev.1.0 — 20 April 2020

Revision history

Rev	Date	Description
1V0	20200420	Initial release

Contact information

For more information, please visit: http://www.nxp.com

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1. Introduction

IoT_ZTB is designed for evaluation and development of K32W061 and JN5189 devices to conveniently evaluate the devices functions and performance. There are also some useful peripherals, like GPIOs, and Arduino interface. J-Link and J-Trace functions are all supported for debugging the devices. ISP download function is also contained and very easy to use.

1.1 Purpose

This document introduces all functions of IoT_ZTB DK. Descripts all parts of IoT_ZTB DK boards in detail.

1.2 Kit contents

IoT_ZTB DK includes the following three boards:

- Carrier Main Board
- K32W061 Module board
- JN5189 Module Board
- K32W061 USB Dongle
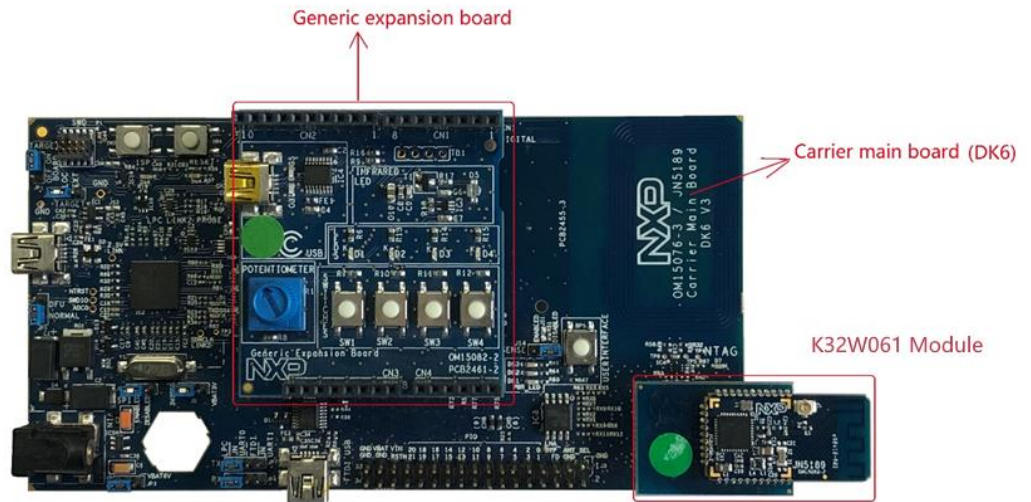- Generic expansion board
- Lighting expansion board

Figure 1 Board overview

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2. Carrier Main Board

The OM15076 also called DK6 carrier main board provides a flexible development system for NXP's K32W061 and JN5189 ultra-low power, high performance wireless microcontrollers. It can be used with a wide range of development tools, including NXP's MCUXpresso IDE. It has been developed by NXP to enable evaluation and prototyping with the K32W061/041 IEEE 802.15.4 and BLE 5.0 wireless microcontroller.

The carrier boards (part number: OM15076) supplied in the development kit are physically identical. They are all pre-fitted with an Arduino-compatible expansion board and a K32W061-based module with integrated antenna.
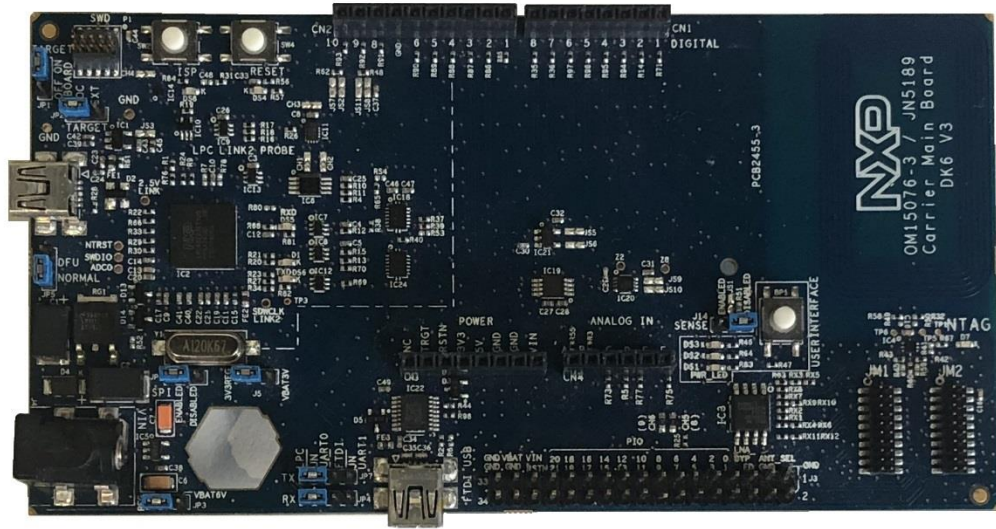

Figure 2 Carrier Main Board

2.1 Feature summary
The carrier main board includes the following features:
- K32W061 module site
- NFC Tag with printed antenna
- On-board, high-speed USB based, Link2 debug probe with ARM's CMSIS-DAP and SEGGER J-Link protocol options.
- Link2 probe can be used with on-board K32W061 or external target.
- Support for external debug probes.
- Power, Reset, ISP and UART Tx/Rx LEDs.

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- Target Reset, and User buttons.
- Expansion options based on Arduino R3, plus additional expansion port pins.
- On-board 3.3V from USB port, 4xAAA batteries, 2xAAA batteries (low-power mode) or external power supply options.
- Built-in power consumption measurement.
- UART, I2C and SPI port bridging from LPC4233 target to USB via the on-board debug probe.
- 8Mb Macronix MX25R QSPI flash.
- FTDI USB connector.

2.2 Board layout and settings

This section provides a quick reference guide to the main board components, configurable items, visual indicators and expansion connectors. The layout of the components on the OM15076 Carrier Main Board is shown in Figure 3.
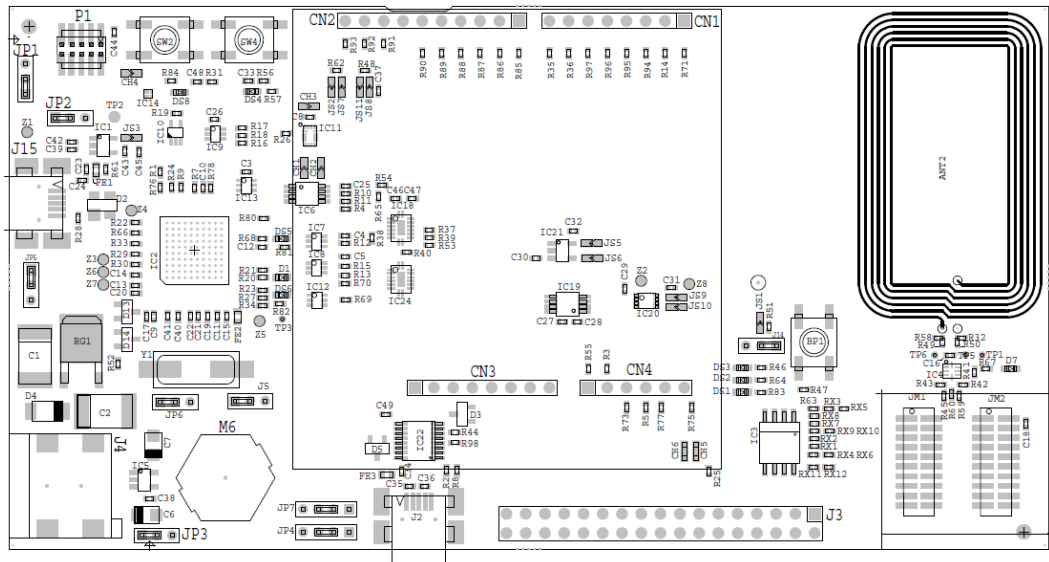

Figure 3 Carrier board layout

The function of each identified component is listed in Table 1

Table 1. Table Board interface components

Circuit ref	Description
D1	Link2 LPC4322 BOOT0_LED indicator. Reflects the state of LPC43xx Link2 MCU P1_1. When the boot process fails, D1 will toggle at a 1 Hz rate for 60 seconds. After 60 seconds, the LPC4322 is reset.
DS1	K32W061 Power LED
DS2, DS3	2x Red debug LEDs connected respectively to K32W061 PIO_0 (DS2) and PIO_3 (DS3). LEDs are on anytime the PIO is low.
DS4	K32W061 Reset LED – LED is on anytime the Target RESET is pulled low.

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DS5, DS6	Green LEDs connected respectively to UART0_Tx (DS5) and UART0_Rx (DS6).
DS8	In System Programming (ISP) LED indicator. LED is ON when SW2 button is pressed.
IC2	Link2 MCU
J2	FTDI serial header. In addition to provide a serial output from K32W061, the Target side of the board can be powered from the FTDI header. The K32W061 supports serial ISP boot from the FTDI header.
J5	32 pins Expansion header connector for debug. All the K32W061 IOs from modules and more are available here.
J14	K32W061 VBAT current monitor V sense measurement. The V sense can be measured with a volt meter. Pin 1 (square pad) is positive and pin 2 is negative. K32W061 current is calculated by dividing the measured voltage at J14 by the V sense resistance value of 3.3Ω.
J15	Link2 mini USB B-type connector. Powers both the Link2 side of the board and depending on the JP3, J5 configuration, the K32W061 Target side of the board. Power the board from this connector when using the on-board debug probe to debug the K32W061 Target MCU.
J1	K32W061 Target SWD disable – 2-position jumper pins. 1. Jumper "ON" (default) the K32W061 Target SWD interface enabled. Normal operating mode where the Target SWD is connected to either the on-board 2. Link2 debug probe or an external debug probe. Jumper "OFF", the K32W061 Target SWD interface is disabled. Use this setting only when the on-board Link2 debug probe is used to debug an off-board Target K32W061.
J2	SWD interface buffer power selection
J3	K32W061 power source selection 1. Jumper fitted in position pin 1 - 2 (default -5V REG). Power source is either 5V from mini USB connector or FTDI connector, or 4.5V from 3xAAA batteries or 5V from a 7-12V DC power supply connected on J4. 2. Jumper fitted in position pin 2 - 3 (BAT 6V). Power source is 4xAAA batteries. See details on Board power diagram Figure 5
J4	Jumper to route LPC or FTDI to UART RX0 K32W061 (to change in pair with JP7)
J5	Link2 (LPC4322) force DFU boot – 2 position jumper pins. 1. Jumper open (default) or shunted to boot mode for Link2 to follow the normal boot sequence. The Link2 will boot from internal flash if image is found there. With the internal flash erased the Link2 normal boot sequence will fall through to DFU boot. 2. Jumper shunted to force the Link2 to DFU boot mode. Use this setting to reprogram the Link2 internal flash with a new image or to use the MCUXpresso IDE with CMSIS-DAP protocol.
J6	JP6 is used to isolate the Link2 debug probe (SPI bridge function) from the K32W061 target to prevent leakage current in power critical applications / current consumption analysis. JP6 needs to be fitted in position 1 - 2 to use the SPI bridging function between the K32W061 and Link2. This jumper is not fitted by default
J7	Jumper to shunt LPC to K32W061 or FTDI to UART TX0 K32W061 (to change in pair with JP4)
CN1, CN2, CN3, CN4	Expansion connectors, including Arduino Uno rev3 compatible connectivity.
JM1, JM2	K32W061 module headers

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P1	10-pin SWD connector – The SWD connector is used to debug the K32W061 Target from an external debug probe. The same SWD connector can also be used to connect the on-board Link2 debug probe to an off-board target MCU (for this JP1 must be shunted).
BP1	User Interface button connected to IO1. Used in some Applications Notes.
SW2	In System Programming (ISP) button. K32W061 will enter ISP mode when SW2 is pressed during hardware reset.
SW4	K32W061 Reset pushbutton.

To ease the board usage and any debug the connectors serigraphy is also copied on PCB bottom. J7, J13, J12 & J11 battery slots are also here.
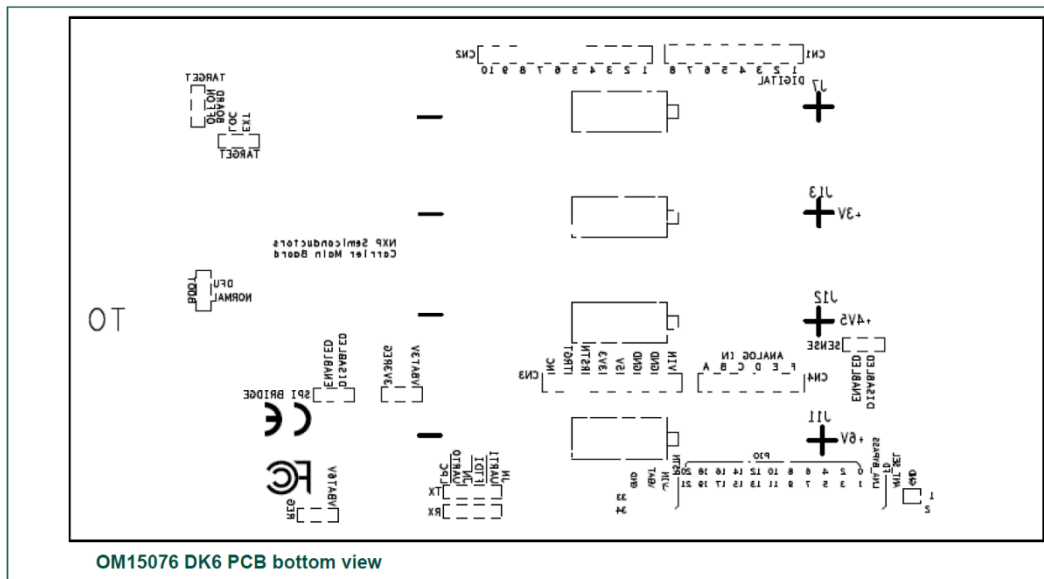

Figure 4 OM15076 DK6 PCB bottom view

2.3 LED indicators

The DK6 board LED location are shown in Figure 3. A description of each on-board LED indicator is shown in next table.

Table 2. LED indicator functions

LED reference	Description
D1	Link2 MCU BOOT0_LED indicator. Reflects the state of Link2 MCU P1_1. When the boot process fails, D1 will toggle at a 1 Hz rate for 60 seconds. After 60 seconds, the Link2 MCU is reset. It will be ON when the Link2 MCU is Booting using DFU (See description for JP5).
DS1	K32W061 Power LED. This LED is on any time power is applied to the K32W061 wireless MCU.
DS2, DS3	2x Red debug LEDs connected respectively to K32W061 PIO_0 (DS2) and PIO_3 (DS3). LEDs are on anytime the respective PIOs from the K32W061 are pulled low.
DS4	K32W061 Reset LED – LED is on anytime the Target RESET is pulled

	low.
DS5, DS6	2x Green LEDs connected respectively to UART0_Tx (DS5) and UART0_Rx (DS6). LEDs will flash any time there is activity on the UART0.
DS8	In System Programming (ISP) LED indicator. LED is ON when IO5_ISP is pulled low and when SW2 button is pressed.

2.4 ARDUINO connectors

ARDUINO compatible connectors are based on Arduino R3.

References on the DK6 board are CN1, CN2, CN3, CN4.

The Generic expansion board OM15082 can be plugged into these connectors.

2.5 Buttons

2.5.1 Reset button

This button (SW4) is used to reset the K32W061 (note that the Link2 is NOT reset by this button)

2.5.2 ISP button

This button connects the K32W061_PIO5 (ISP_Entry) pin to ground. This should be used to set the K32W061 in ISP mode to program a binary file into the chip memory.

To force entry into this ISP mode, hold down the ISP button (SW2), press and release the Reset button (SW4), then release the ISP button (SW2). This is done automatically when using the DK6 Production Flash programmer with J2 (FTDI USB interface).

2.6 User Interface button

This button (BP1) is connected to K32W061_PIO_1 and should be used as an input.

2.7 K32W061 Serial port

The K32W061 UART0 can also be connected through a virtual communication port (VCOM) UART bridge Link2 function either to a host computer connected to the J2 USB FTDI or to J15 USB Link2. By default, the DK 6 is configured to use the FTDI USB.

For Link2 USB: The factory default CMSIS-DAP Link2 image includes UART bridge functionality (VCOM support), and this firmware is also available with the LPCScrypt utility, available at https://www.nxp.com/design/microcontrollers-developer-resources/lpc-microcontroller-utilities:LPC-UTILITIES power connections and measurements.

For the USB FTDI, the PC driver is available on FTDI website (the FTDI chip is already configured before the carrier board release).

2.8 Board power connections

A block diagram of the board power tree is shown in Figure 5. When the K32W061 Target is to be debugged from the on board Link2 probe, the USB mini B-type connector

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(J15) must connected to a Host computer. When the K32W061 Target is to be debugged from an external debug probe, instead of the on-board debug probe, the Link USB connector (J15) must be disconnected.

The K32W061 Target VBAT selection is made at JP3, J5, with 3.3V from on-board LDO set as the default.

Figure 5 Board power diagram

2.9 Debug Configurations

The DK6 board has a built-in debug probe referred to as "Link2". The K32W061 target wireless MCU can be debugged by the Link2 debugging probe, or from an external debug probe installed at P1. On-board jumpers JP1 and JP2 must be correctly positioned for each mode. The on-board Link2 debug probe is capable of debugging target MCU's with a VDDIO range of 1.6V to 3.6V. Check the sections below for the appropriate jumper settings and how to properly power the board.

2.9.1 Debug using on-board debug probe

To use the on-board Link debug probe:

- The jumper JP2 must be fitted in position pin 1 - 2 (Local Target).
- Jumper JP1 must be open or fitted in position 2 – 3 to enable the target K32W061.
- Connecting the mini USB J15 to a host computer will power the Link and according JP3, J5 position, the K32W061 sections of the board and provide the USB link to the debug tool software.

2.9.2 Debug using external debug probe

To use an external debug probe:

- connect the probe to the SWD (P1) connector

- power the K32W061 Target section of the board from the FTDI header (J1) or the Jack connector (J4)
- and fit a jumper to JP2 across pin 1 - 2 (Local Target).
- Jumper JP1 must be open or fitted across pin 2 – 3 to enable the target K32W061.
- The on-board Link2 debug probe must be unpowered, by leaving USB mini (J15) unconnected.

2.9.3 On-Board Link2 flash programming

To program the Link2 Flash the Link2 MCU must be in DFU mode. If the Link2 already has a valid image in the flash, you will need to force it into DFU mode by placing a jumper shunt on JP5 across pin 1 - 2, then power the board by connecting the mini USB J15 to a host computer. Link2 MCU programming is performed using the LPCScrypt utility (see https://www.nxp.com/design/microcontrollers-developer-resources/lpc-microcontroller-utilities:LPC-UTILITIES). Instructions for using the tool are located at the same web page.

2.9.4 Using the DK6 to debug an off-board target

The DK6 board's Link2 debug probe may be used to debug an off-board target MCU. The on-board Link2 debug probe is capable of debugging target MCU's with a VDDIO range of 1.6V to 3.6V. To keep the on-board target K32W061 MCU from interfering with the SWD interface:

- JP1 must be fitted across pin 1 - 2.
- The Link2 debug probe SWD is connected by a ribbon cable between the P1 connector to the off-board target MCU SWD interface.
- Power the DK6 board from the Link USB connector J15,
- Fit jumper JP2 across pins 2 - 3 (External Target).

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3. K32W061 Modules

K32W061 Module board is the K32W061 minimum system board. The module should be mounted to carrier board as the target. There is a RF connector on this board, which can be used to RF signal testing.
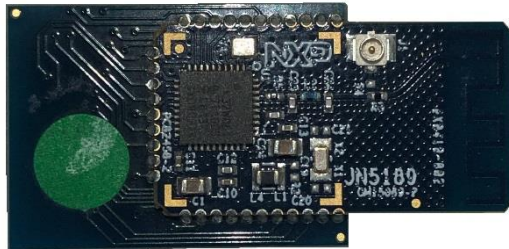

Figure 6 K32W061 module board

4. JN5189 Modules

The JN5189 Module board is identical to the K32W061 modules but with a JN5189 fitted.

Generic expansion board

This expansion board is available in the development kit and is compatible with Arduino shields. They are supplied pre-fitted with Arduino-compatible header of Carrier Boards in the development kit.

The Generic Expansion Board has the following features:

- Arduino-compatible expansion header (in four parts, CN1-CN4)
- 4 user-input buttons (SW1, SW2, SW3, SW4) connected to DIOs on the K32W061 module on the Carrier Board:
  - SW1 is connected to IO19
  - SW2 is connected to IO15
  - SW3 is connected to IO7
  - SW4 is connected to IO4
- 4 LEDs (D1, D2, D3, D4) connected to DIOs on the K32W061 module on the Carrier Board:
  - D1 is connected to IO16
  - D2 is connected to IO6 (same as for the PWM output used on the Lighting/Sensor Expansion Board to drive the three white LEDs)
  - D3 is connected to IO3
  - D4 is an optional LED which is not fitted on the supplied board and shares IO4 with button SW1
- Potentiometer connected to K32W061 ADC0, with a 0-1.8V DC voltage swing

- Infrared Emitting LED Vishay VSMB2948SL connected to K32W061 IO20_IR_Blaster
- USB Mini B port to provide access to K32W061 UART1 via IO11 and IO10 of K32W061 module (connected via FTDI FT230X driver device)
- PCB pads for 4-way GPIO header (3V3, VCC, IO11, IO10), where IO11 and IO10 can be used to access K32W061 UART1 (in this case, the FTDI driver chip for the USB port must be isolated by removing resistors R9 and R16).
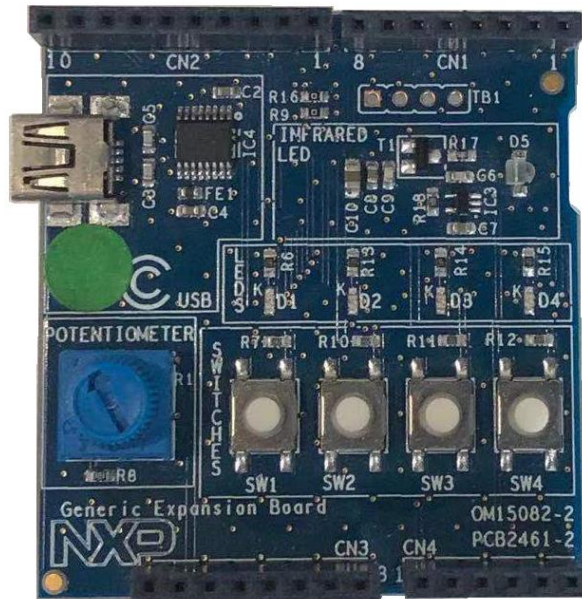

Figure 7 Generic expansion board

5. Light expansion board

This expansion board is available in the development kit and is compatible with Arduino shields. They are supplied pre-fitted with Arduino-compatible header of Carrier Boards in the development kit.

The Generic Expansion Board has the following features:

- Arduino-compatible expansion header (in four parts, CN1-CN4)
- 3 White LEDs (D1, D2, D3) connected to IO6 on the module on the Carrier Board:
  - D4 is an optional LED which is not fitted on the supplied board and shares IO4 with button SW1
- RGB LED controlled by I2C
- 2 Digital Microphones connected to DMIC interface in the module

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- 1 Temperature Sensor (IC8) connected by I2C
- 1 gyroscope (IC6) connected by I2C
- 1 Light Sensor (G1) connected by I2C
- 1 Accelerometer & Magnetometer (IC9) connected by I2C

Figure 8 Lighting expansion board

6. K32W061 USB Dongle

The OM15080-K32W can be used as a node in a Zigbee as a Zigbee Control Bridge, Zigbee Coordinator or packet sniffer. It can also be used in Thread wireless network, typically dongle for Border Router, Network/Radio Co-Processor (NCP/RCP) and is compatible with the NXP QTool for BLE.

Figure 9 K32W061 USB Dongle

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7. Current measurement on the DK6

The device current can be measured:

1. Using the on-board current measurement circuit with MCUXpresso.
2. Measuring the voltage across a sense resistor (R51) in series with the supply,
3. A current meter on a modified DK6 board or a stand-alone module,

Each of these methods will be described in subsections below. When a board is attached, attempting to measure the lowest possible power, the IO pins must be configured by software configuration to avoid any extra current from the IO ports that have external pull-up or pull-down resistors enabled. JP6 should be opened to avoid leakage to the Link2 via the I2C and SPI connections between it and the device.

7.1 Current measurement with MCUXpresso

The DK6 board has an on-board current measurement circuit consisting of a MAX9634T (IC21) current monitor chip and a 12-bit ADC (ADC122S021, IC19) with a 12-bit sample at 50k to 200ksps. The on-board MAX9634T current monitor measures the voltage across the K32W061 VBAT Vsense resistor of 3.3Ω. The MAX9634 multiplies the sense voltage by 25 to provide a voltage range suitable for the ADC to measure. The current measurement circuit is controlled by the debug processor and is not user programmable. Power measurement utilities to use this feature are available in the MCUXpresso IDE installation.

Due to input offset voltage variations in the MAX9634, the current measurement circuit is not recommended for measuring current below 150uA.

7.2 Vsense resistor measurement

The voltage across a series 3.3Ω resistor with the target VBAT can be manually measured at J14 on the PCB. The voltmeter positive probe is applied to J14 pin 1 (square pad) and negative probe to J14 pin 2. Use Ohm's law to calculate the current (device current = measured voltage / 3.3Ω). As an example, if the measured voltage is 10mV, then 10e-3 / 3.3Ω = 3.03mA. Note that the input current to the MAX9634 used in the on-board current measurement will be included in the voltage measured across this resistor.

7.3 Current measurement with a multimeter

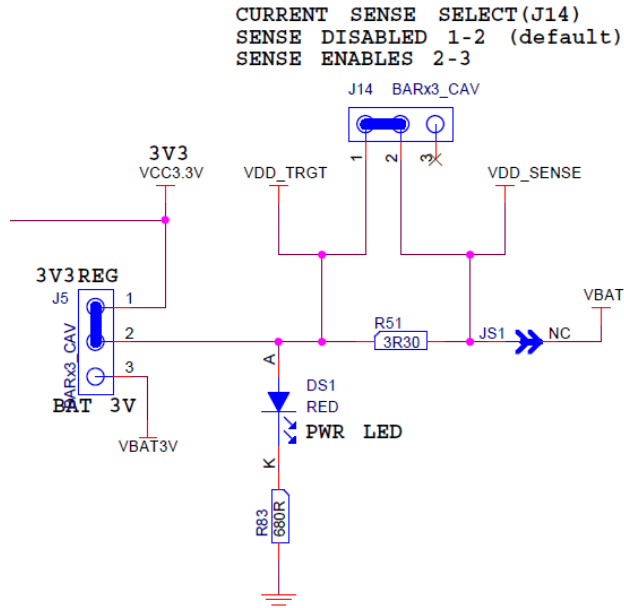Figure 10 is the circuit for the power supply to the module. The signal VBAT is used to power the module

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Figure 10 Power Sensing Circuit

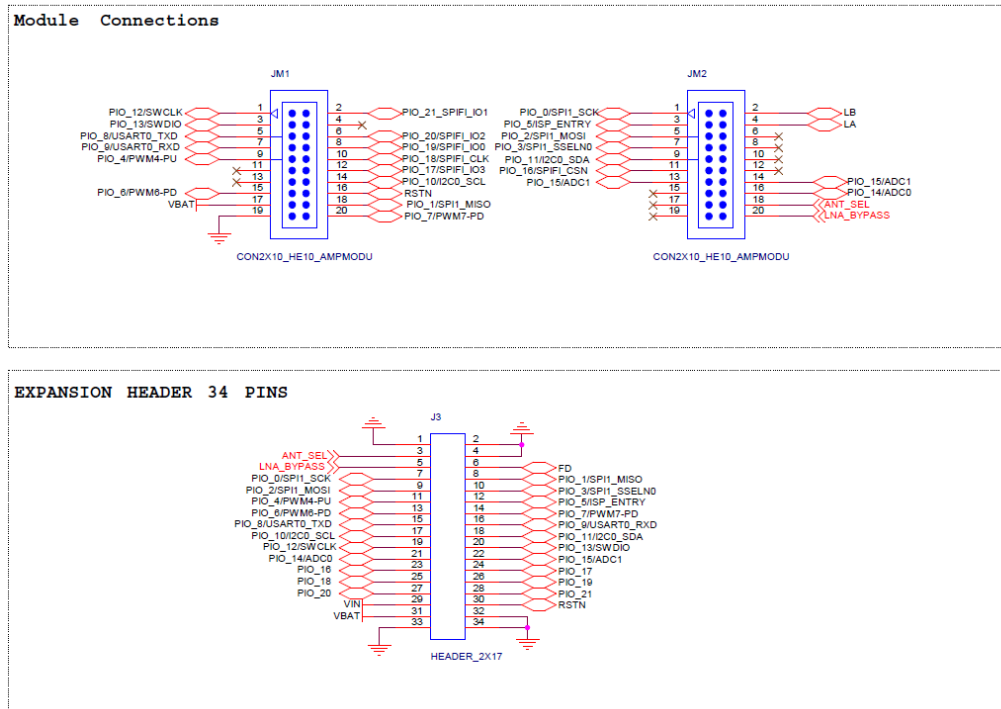This signal goes to the module (JM1.17) and the expansion connector (J3.31)

Figure 11 VBAT Connections

To measure the current using multimeter, remove R51 and place the multimeter across J14 pins 1 and 2.

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Figure 12 R51 Location

The multimeter will also measure the current take by the VSENSE line. This signal is used the measure the voltage drop across the 3R3 resistor so that the current consumption results can be shown from with MCUXpresso. The current taken from this signal is negligible but can be removed by cutting JS6.

Figure 13 Voltage Sense Circuit

7.4 IO Considerations

If an expansion board is not fitted then the following IO lines are connected on the DK6 board. Setting IOs incorrectly in the software will cause current to be consumed and this should be taken into consideration when measurement current. The following IOs are connected.

Function	PIOs Affected	Schematic Page number	Comment
NTAG	10, 11	4	Not connected by default. R45 and R59 are not fitted by default
User Interface Button	1	4	Leave signal high and do not press switch
DS2 LED	0	4	Leave signal high
DS3 LED	3	4	Leave signal high
QSPI	16, 17, 18, 19, 20, 21	4	Negligible affect if QSPI is not used. To completely remove any current consumption either remove IC3 or remove RX1, 3, 4, 7, 9 and RX11 to disconnect all PIOs
Bridge SPI	0, 1, 2, 3, 7	7	Negligible effect. Remove IC18 and IC24
UART	8,9 (UART 0) 0,1 (UART 1)	7	Remove jumpers on JP4 and JP7
IC2 interface to LPC	10, 11	5	Disabled by default. No current draw if DIOS 10 and 11 are high. Cut JS2 and JS11 to remove completely
Debug Interface	12, 13, 14	6	Negligible effect. Cut CH4 to disconnect
RESET and ISP buttons	5, RST	7	Negligible current drawn if not pressed. See Table for Sleep current measurement

For sleep current measurements, the following additional changes are required to achieve the datasheet value otherwise the result is typically 600nA high.

Component	Action	Schematic Page	Comment
R51	Remove	2	Allow connection of a Multimeter across J14
IC22	Remove 3V3OUT	7	See Section 5.5 below
D5	Remove	7	Disconnect ISPEN from FTDI device
C33	Remove	7	Remove capacitor from Reset Line
R64	Remove	7	Remove Pullup Resistor from ISPEN
IC21 or cut JS5-6	Remove	6	Disconnect current sense amplifier
IC11	Remove	6	Disconnect control lines from LPC debug interface

7.5 Running the DK6 board at different voltages

In order to run the DK6 at different voltages, it is necessary to disconnect the FTDI 3V3OUT signal otherwise this will continue to supply 3.3V to the board. The circuit is shown below in **Figure 14**
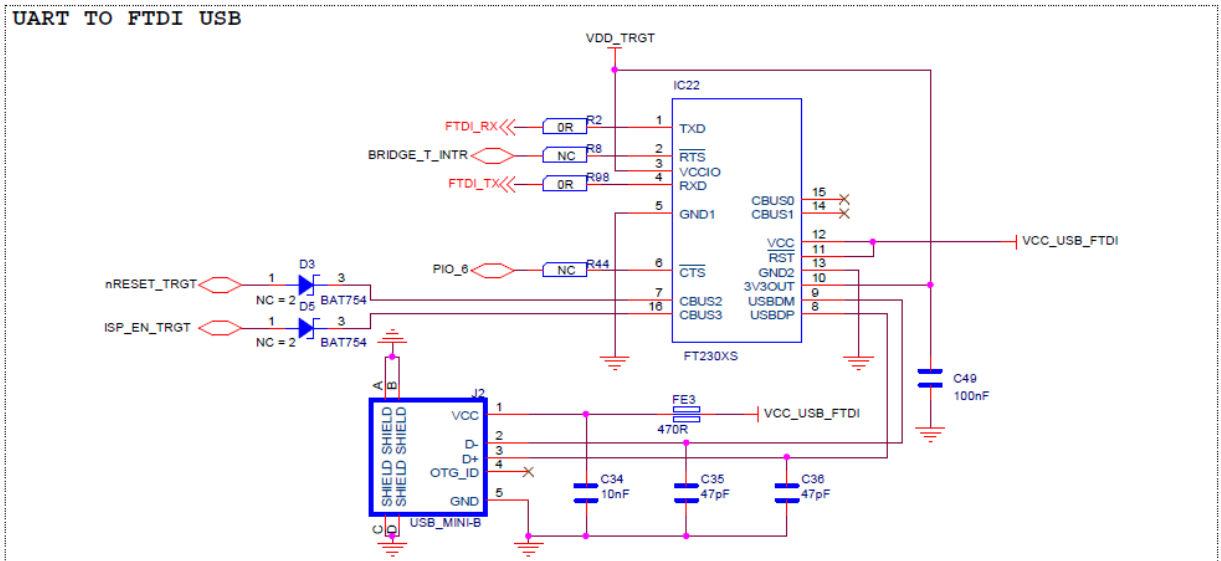

Figure 14 FTDI Interface

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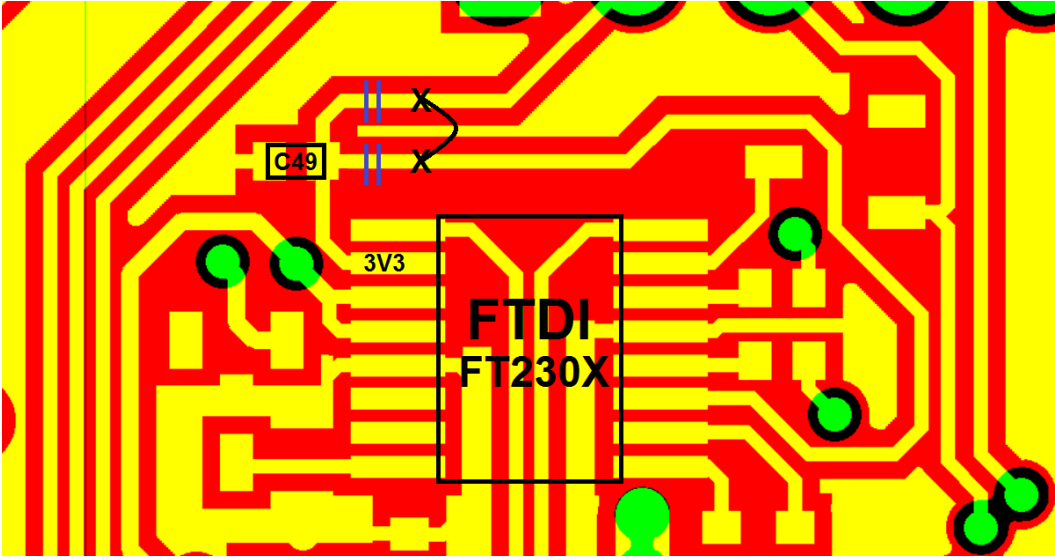It is important to leave C49 connected to Pin10 of the FT230A. To achieve this modify the boards as shown in Figure 15

Figure 15 3V3OUT modification

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