LinkIt 7687 HDK V30 User's Guide

Version: 1.3

Release date: 30 June 2016

Document Revision History

Revision	Date	Description
1.0	31 March 2016	Initial version.
1.1	2 May 2016	Added power domain information. Refine the output binary file name.
1.2	17 May 2016	Added CMSIS-DAP firmware update procedure.
1.3	30 June 2016	Refine the Get started section and pull-up resister.

Table of contents

Lists of tables and figures

1. Introduction

Airoha IoT SDK for RTOS is a low-cost and easy to use Internet of Things (IoT) development platform to design, prototype, evaluate and implement IoT projects. The platform supports LinkIt™ 76x7 hardware development kit (HDK) by SAC. This user manual provides required knowledge on features of the HDK, including the pins, communication interfaces, core microcontroller unit (MCU) description, the networking capabilities and how to use them through the host driver. The HDK includes MT76x7 chipset which is based on ARM Cortex-M4 with floating point MCU in QFN68 package. It enables rich connectivity features, communication with cloud services and real-time control. LinkIt 76x7 HDK is pin compatible with Arduino UNO R3.

MT76x7 product portfolio includes MT7687F, MT7697, and MT7697D. The examples in the document are carried on MT7687F chipset and could be applied to any MT76x7 based HDK.

The LinkIt 7687 HDK supports ARM mbed IoT Device Platform for more convenient debugging and binary code download operations.

The following features are available:

- Mass storage device (MSD) programmer.
    - The LinkIt 7687 HDK has three binary files for bootloader, Wi-Fi and FreeRTOS. The MSD programmer enables to update the FreeRTOS binary file only.
- CMSIS-DAP (Coresight Debug Access Port (DAP)) Debug Interface.
    - A firmware debug interface similar to ST-link or J-link. It enables debugging a target project or downloading a binary to the flash storage of the device.
- Virtual Serial Port.
    - Supports UART functionality, such as transferring log information from the HDK.

These features are used to download and debug the project.

2. Get started with the HDK

Before commencing the application development, you need to configure the development platform.

2.1. Configuring the LinkIt 7687 HDK

LinkIt 7687 HDK includes a main board and a MT7687F stamp module. The MT7687F stamp module is mounted on the main board. The top view of the main board is shown in Figure 1.

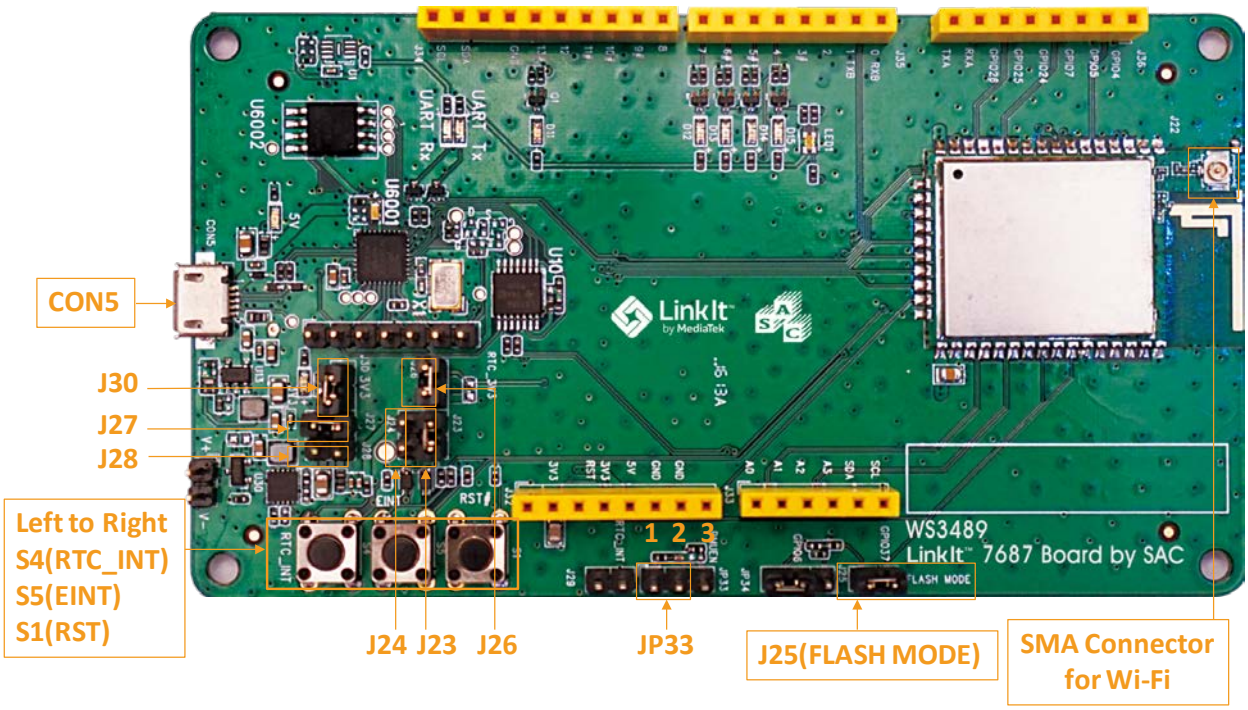


Figure 1. Top view of the LinkIt 7687 HDK

The description of pins (Figure 1) and their functionality is provided below.

1) **CON5** is a USB connector to debug through UART, transmit and receive a signal and supply power from the PC. The USB connectivity with the PC is supported by the on-board MK20DX128VFM5.
   - Set the jumpers **J23**, **J26**, **J27**and **J30** on, if the board is powered using the USB connector.
2) Press **S4** to wake up the system from the RTC mode.
3) **S5** enables the external interrupt (configured at **GPIO0**), see section 4.4, “Buttons” for more details.
4) Press **S1** to reset the system.
5) **JP33** enables the board to support RTC interrupt mode, if the jumper pins 1 and 2 are connected.
6) **J25** sets the flash mode (see section 2.3, “Configuring the HDK flash mode”).
7) **Wi-Fi Antenna** is a PCB antenna. MT7687F stamp module is by default connected to the PCB antenna to transmit and receive RF signals.

The default configuration of the LinkIt 7687 HDK support the following functionality:

1) Power supply - attach a micro-USB connector to the **CON5.**

2) Flash mode - **Recovery** mode.
3) Support RTC interrupt.
4) Clock source - 32.768kHz source crystal clock for the RTC mode or external clock operating on 32.768 kHz.
5) XTAL - 40MHz.
6) RTC mode - supported.

The hardware settings of the stamp module are shown below:

1) XTAL - 40MHz.
2) Clock source - 32.768kHz source crystal clock for the RTC mode or external clock operating on 32.768 kHz.
3) RTC mode - supported.
4) Flash mode - **Normal** mode.

2.2. Installing the LinkIt 7687 HDK drivers on Microsoft Windows

To configure the LinkIt 7687 HDK:

1) Connect the HDK to the computer using a micro-USB cable.
2) Download and install mbed Windows serial port driver from here. Open Windows **Control Panel** then click **System** and:
   - On Windows 7 and 8, click **Device Manager**.
   - On Windows XP, click the **Hardware** tab and then **Device Manager**.
3) In **Device Manager**, navigate to **Ports (COM & LPT)** (see Figure 2).
4) A new **COM** device should appear under **Ports (COM & LPT)** in **Device Manager**, as shown in Figure 2. Note the **COMx** port number of the serial communication port, this information is needed to send command and receive logs from the COM port. Virtual COM port is connected to the board through the **UART1** of the chipset, see section 4.5, " Extension connectors". The **mbed Serial Port** (**UART1)** is applied to flash the board and log the outputs.

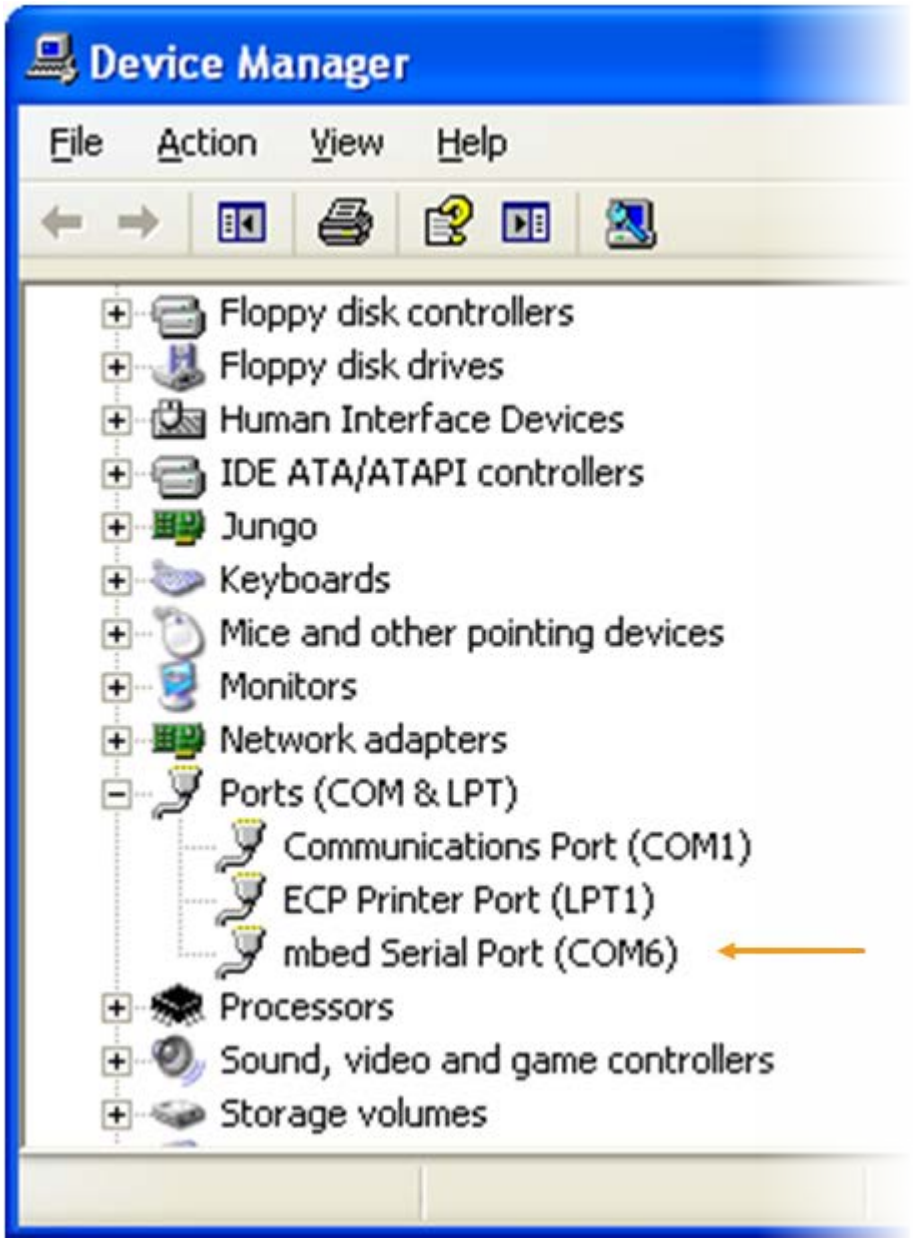


Figure 2. COM port associated with the LinkIt 7687 HDK

2.3. Configuring the HDK flash mode

The LinkIt 7687 HDK is embedded with 2MB flash memory. The boot options are either from the Flash memory or from the UART port.

To update the firmware on the LinkIt 7687 HDK:

1) Set the jumper **J25** to **FLASH Recovery** mode, as shown in Figure 1. The jumpers **J23**, **J26**, **J27** and **J30** should be on.

- In this mode, if the power is on, the board will load ROM code and start the **ATE Daemon** or **Firmware Upgrade Daemon** according to the MT76x7 Flash Tool's behavior on the PC. A message **"ccc"** is sent

to the **UART1** port of the chipset and the code is uploaded to the embedded flash memory through **UART1**.

2) Connect the board to the computer using a micro-USB cable.

The development board should now be connected to the PC, as shown in Figure 1.

To run the project on the LinkIt 7687 HDK:

1) Set the jumper **J25** off to switch to **FLASH Normal** mode. The jumpers **J23**, **J26**, **J27** and **J30** should be on.
   - In this mode, if the power is on, the board will load firmware from the flash and reboot.
2) Connect the board to a computer using a micro-USB cable.

The development board should now be connected to the PC, as shown in Figure 1.

2.4. Downloading the image using the LinkIt 7687 HDK as a removable storage

To update the FreeRTOS binary only (example project binary: `mt7687_iot_sdk.bin`), use the HDK as a mass storage device according to the following steps:

1) Set the HDK to **FLASH Recovery** mode.
2) Power up the board with a micro-USB cable.
3) Navigate to **Computer** on your PC to check if a new mass storage named **MT76x7** is available under **Removable Disk**, as shown in Figure 3.
4) Open the **MT76x7** removable storage, then drag and drop the binary `mt7687_iot_sdk.bin` to complete downloading the image.
5) Disconnect, set the jumper to **FLASH Normal** mode, and then reconnect the board to run your application.

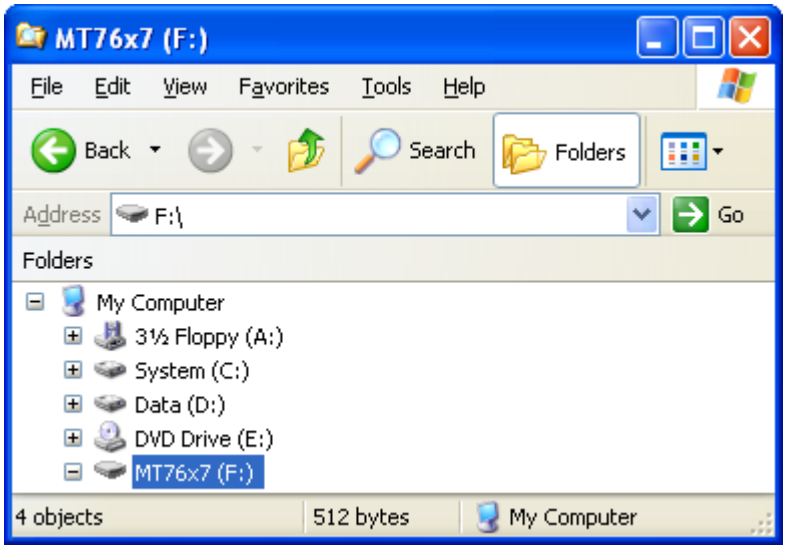


Figure 3. New removable storage detected

3. Hardware Features

This section provides the main supported features of the LinkIt 7687 HDK. The detailed description of the features is provided in the upcoming sections.

- IEEE 802.11bgn Wireless Connectivity Single Chip with QFN68 package.
- Arduino UNO Revision 3 pin compatible and an eight pin extension connector.
- The I/Os on MT7687F are 3.3V compatible.
- Support for FreeRTOS.
- Flexible on-board power supply
  - USB with power (V_{Bus}, 5V).
  - External V_{IN} (1.8~3.2V).
- Ten LEDs
  - UART communication LEDs (**D9, D10**), power LEDs (**D6, D5**), user LEDs (**D11, D12, D13**, **D14**, **D15**).
- Three push buttons
  - System Reset.
  - Real Time Clock (RTC) Interrupt.
  - External Interrupt.
- XTAL (Crystal Oscillator)
  - 40MHz source clock support with low power consumption in idle mode.
  - 32.768kHz clock for the RTC mode or external 32.768kHz mode.
- USB re-enumeration capability: two different interfaces supported on the same USB.
  - CMSIS-DAP USB.
  - Virtual COM port UART through USB on PC.
- On-board chip antenna with U.FL for conducted testing.
- Micro USB connector for power and debug connections.
- Headers for current measurement.

4. Hardware Feature Configuration

4.1. Microcontroller

MT7687F features an ARM Cortex-M4 with floating point processor, which is the most energy efficient ARM processor available.

MT7687F provides low power consumption embedded architecture and it's optimized for various types of applications in home automation, smart grid, handheld devices, personal medical devices and industrial control that have lower data rates, and transmit or receive data on an infrequent basis.

4.2. Power supply

LinkIt 7687 HDK supports two types of power supply.

1) Power up with a micro-USB connector.

An on-board switching regulator provides voltage of 3.3V for the LinkIt 7687 HDK based on MT7687F, if the power is supplied from an on-board micro-USB connector **CON5** (Figure 1). This supply can be isolated from the switching regulator using the jumpers. Note that the jumpers **J27**, **J30**, **J23** and **J26** are required to be set on. More details on the jumpers can be found in Table 1.

Table 1. Jumper settings for system power input through USB connection

Jumper	Usage	Comments
J27	3.3V power supply	Use micro-USB connector supporting 3.3V power source.
J30	Current measurement	Measures the current flow in MT7687F.
J23	RTC3V3 power supply	Use micro-USB connector supporting RTC 3V3 power.
J26	Current measurement in RTC mode	Measures the current flow in the MT7687F RTC mode.

2) Power up using an AA or AAA battery.

- Connect an external AA battery to battery pin header (**J21**) to supply power to the system, as shown in Figure 4. When use AA battery ,please plug the USB to micro-USB connector CON5 (Figure 1).Note that the jumpers **J28**, **J30**, **J24** and **J26** are required to be set on. More details on the jumpers can be found in Table 2.

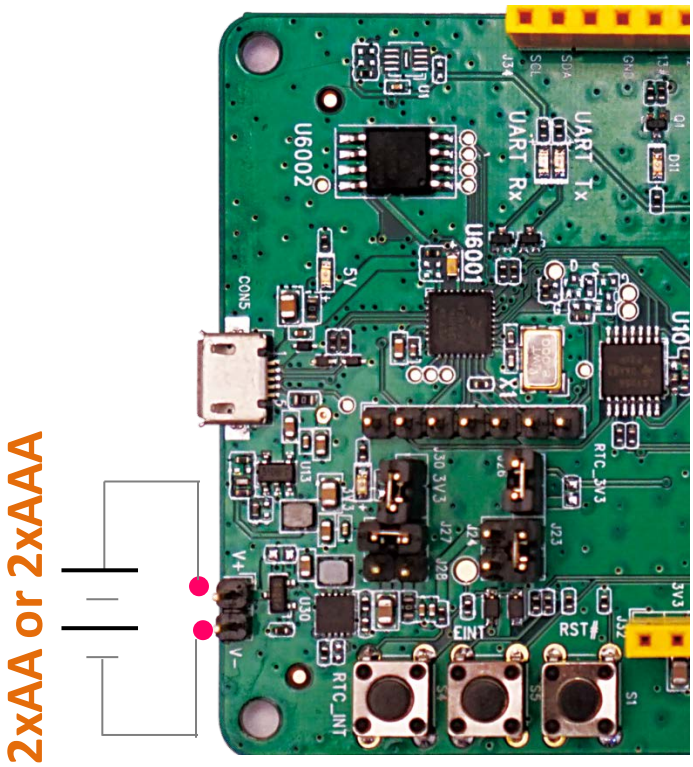


Figure 4. Power up the HDK using an AA or AAA Battery (J21)

Table 2. System power input from AA or AAA battery jumpers

Jumper	Usage	Comments
J28	3.3V power supply	Use AA or AAA battery source supporting 3.3V power.
J30	Current measurement	Measures the current flow in MT7687F.
J24	RTC 3V3 power supply	Use AA or AAA battery source supporting RTC 3V3 power.
J26	Current measurement in RTC mode	Measures the current flow in the MT7687F RTC mode.

4.3. LEDs

The LinkIt 7687 HDK has onboard LEDs associated with different functionalities of the board (Figure 5).

1) **D6** indicates the power rail 5V is on.
2) **D5** indicates the power rail 3.3V is on.
3) **D9 (UART Tx)** indicates the UART1 transmission is in use (blink, if there is traffic).
4) **D10 (UART Rx)** indicates the UART1 receiving is in use (blink, if there is traffic).

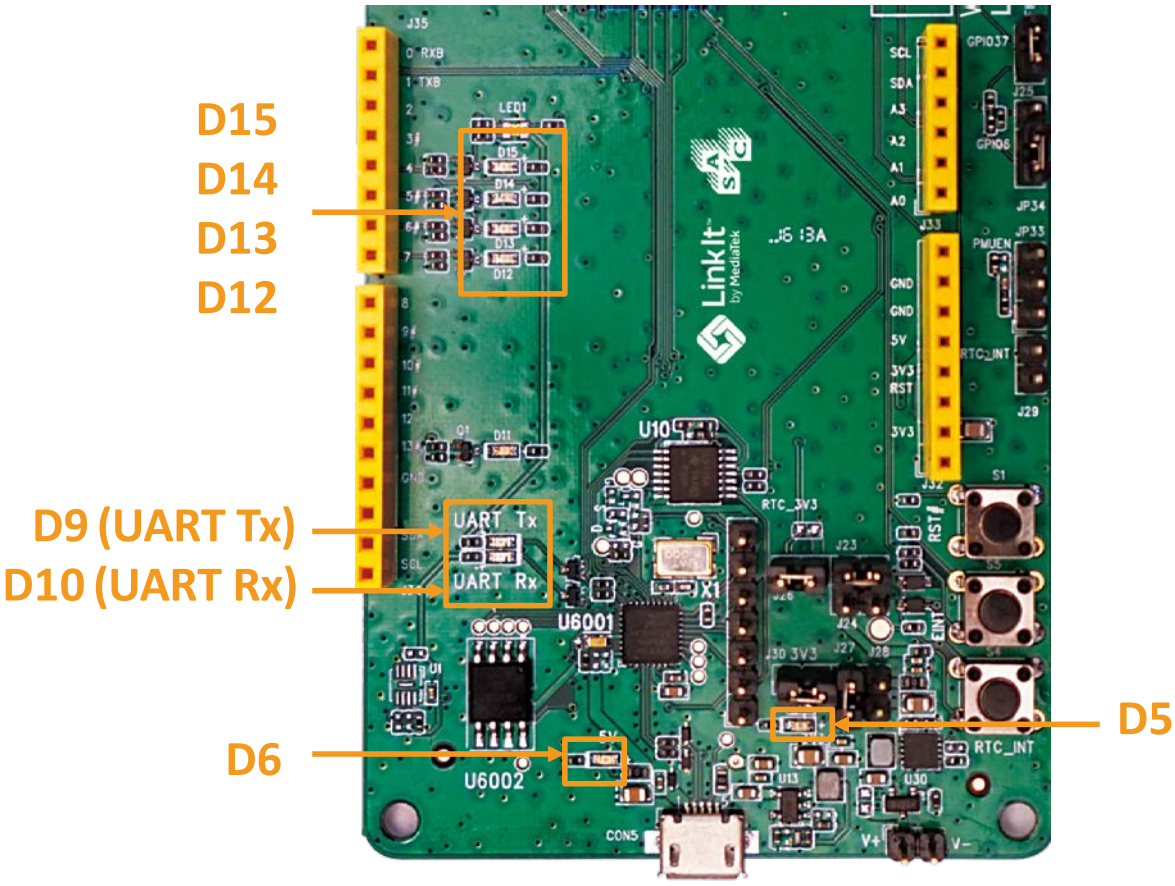


Figure 5. On-board LEDs

5) **D11**, **D12**, **D13**, **D14**, and **D15** are LEDs assigned for user interaction. All LEDs are high active (Figure 5). GPIO pins to activate the LEDs are shown in Table 3.

Table 3. GPIO pins to activate the LEDS

LED	GPIO
D11	GPIO31
D12	GPIO35
D13	GPIO34
D14	GPIO33
D15	GPIO6

4.4. Buttons

The LinkIt 7687 HDK is equipped with buttons with the following functionality. The push buttons are shown in Figure 1.

1) System reset button (**S1**) resets the LinkIt 7687 HDK.

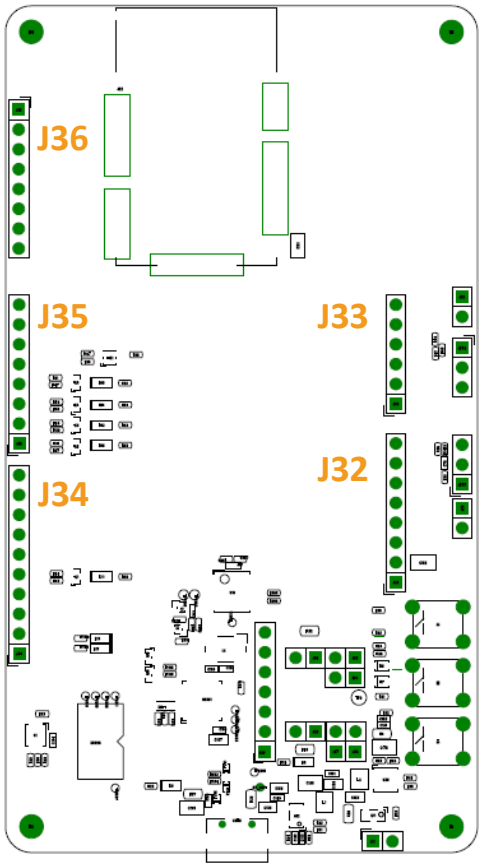
2) RTC interrupt mode button (**S4**). When the system is in the RTC mode, push the button to wake up the system.

3) External interrupt button (**S5**). Users can configure GPIO0 as an external interrupt pin. Press the button to wake up the system from the sleep mode.

4.5. Extension connectors

The LinkIt 7687 HDK provides similar pin-out to Arduino UNO with extension connectors (**J32** to **J36**) for various sensor and device connectivity, as shown in Figure 6.

Ref	J36 Signal	J35 Signal	J34 Signal
1	GPIO4	GPIO35	GPIO27
2	GPIO5	GPIO34	GPIO28
3	GPIO7	GPIO33	NA
4	GPIO24	GPIO6	GND
5	GPIO25	GPIO1	GPIO31
6	GPIO26	GPIO0	GPIO30
7	GPIO2	GPIO37	GPIO29
8	GPIO3	GPIO36	GPIO32
9			GPIO39
10			GPIO38



Ref	J32 Signal	J33 Signal
1	NA	GPIO60
2	3.3V	GPIO59
3	Reset	GPIO58
4	3.3V	GPIO57
5	5V	GPIO28
6	GND	GPIO27
7	GND	
8	NA	

Figure 6. Arduino and 8-pin extension connector

The board has 28 GPIOs multiplexed with other interfaces. Depending on the use case, user can configure each I/O functionality.

Table 4. GPIO pin multi function definition

Pin alias	Name	Direction	Description
GPIO0	UART1_RTS_CM4	O	UART1 RTS (Cortex-M4)
	GPIO[0]	I/O	General purpose input, output
	PWM[0]	I/O	Pulse-width-modulated output
	EINT[0]	I	External interrupt
GPIO1	UART1_CTS_CM4	I	UART1 CTS (Cortex-M4)
	GPIO[1]	I/O	General purpose input, output

	PWM[1]	O	Pulse-width-modulated output
	EINT[1]	I	External interrupt
GPIO2	UART1_RX_CM4	I	UART1 RX (Cortex-M4)
	SWD_CLK	O	Cortex-M4 SWD debug port
	GPIO[2]	I/O	General purpose input, output
	PWM[23]	O	Pulse-width-modulated output
	WIC[0]	I	External interrupt
GPIO3	UART1_TX_CM4	O	UART1 TX (Cortex-M4)
	SWD_DIO	I/O	Cortex-M4 SWD debug port
	GPIO[3]	I/O	General purpose input, output
	PWM[24]	O	Pulse-width-modulated output
	EINT[2]	I	External interrupt
	PULSE_CNT	I	Pulse counter
GPIO4	SPI_DATA0_EXT *	I/O	External flash interface
	GPIO[4]	I/O	General purpose input, output
	PWM[2]	O	Pulse-width-modulated output
	EINT[3]	I	External interrupt
GPIO5	SPI_DATA1_EXT *	O	External flash interface
	GPIO[5]	I/O	General purpose input, output
	PWM[3]	O	Pulse-width-modulated output
	EINT[4]	I	External interrupt
GPIO6	SPI_CS_1_M_CM4	O	SPI master chip select 1
	GPIO[6]	I/O	General purpose input, output
	PWM[4]	O	Pulse-width-modulated output
	EINT[5]	I	External interrupt
GPIO7	SPI_CS_0_M_CM4	O	SPI master chip select 0
	SPI_CS_EXT *	O	External flash interface
	GPIO[7]	I/O	General purpose input, output
	PWM[5]	O	Pulse-width-modulated output
	EINT[6]	I	External interrupt
GPIO24	SPI_MOSI_M_CM4	O	SPI master MOSI
	SPI_DATA2_EXT *	I/O	External flash interface
	I2C1_CLK	I/O	I2C1 CLK
	GPIO[24]	I/O	General purpose input, output
	PWM[25]	O	Pulse width modulation
GPIO25	SPI_MISO_M_CM4	I	SPI master MISO
	SPI_DATA3_EXT *	I/O	External flash interface
	I2C1_DATA	I/O	I2C1 DATA
	GPIO[25]	I/O	General purpose input, output
	PWM[26]	O	Pulse width modulation

	FRAME_SYNC *	I	3DD synchronization
	WIC[1]	I	External interrupt
GPIO26	SPI_SCK_M_CM4	O	SPI master SCK
	SPI_CLK_EXT *	O	External flash interface
	I2S_TX	O	I2S master TX
	GPIO[26]	I/O	General purpose input, output
	PWM[27]	O	Pulse width modulation
GPIO27	SWD_DIO	I/O	Cortex-M4 SWD debug port
	I2C0_CLK(1)	O	I2C0 CLK
	GPIO[27]	I/O	General purpose input, output
	PWM[28]	O	Pulse width modulation
	PULSE_CNT	I	Pulse counter input
	WIC[2]	I	External interrupt
GPIO28	SWD_CLK	I	Cortex-M4 SWD debug port
	I2C0_DATA(1)	O	I2C0 DATA
	GPIO[28]	I/O	General purpose input, output
	PWM[29]	O	Pulse width modulation
GPIO29	I2S_MCLK_S	O	I2S MCLK slave
	SPI_MOSI_S_CM4	I	SPI slave MOSI (Cortex-M4)
	SPI_MOSI_M_CM4	O	SPI master MOSI
	GPIO[29]	I/O	General purpose input, output
	PWM[30]	O	Pulse width modulation
	WIC[3]	I	External interrupt
GPIO30	SPI_MISO_S_CM4	O	SPI slave MISO (Cortex-M4)
	SPI_MISO_M_CM4	I	SPI master MISO
	I2S_FS	I	I2S slave FS
	GPIO[30]	I/O	General purpose input, output
	PWM[31]	O	Pulse width modulation
GPIO31	I2S_TX	O	I2S TX
	SPI_SCK_S_CM4	I	SPI slave SCK (Cortex-M4)
	SPI_SCK_M	O	SPI master SCK
	I2S_RX	I	I2S slave RX
	GPIO[31]	I/O	General purpose input, output
	PWM[32]	O	Pulse width modulation
GPIO32	SPI_CS_0_S_CM4	I	SPI slave CS (Cortex-M4)
	SPI_CS_0_M	O	SPI master CS
	I2S_BCLK	I	I2S BCLK slave
	GPIO[32]	I/O	General purpose input, output
	PWM[33]	O	Pulse width modulation

	WIC[4]	I	External interrupt
GPIO33	SWD_DIO	I/O	Cortex-M4 SWD debug port
	IR_TX	O	IrDA TX
	GPIO[33]	I/O	General purpose input, output
	PWM[34]	O	Pulse width modulation
	PULSE_CNT	I	Pulse counter
	WIC[5]	I	External interrupt
GPIO34	SWD_CLK	I	Cortex-M4 SWD debug port
	IR_RX	I	IrDA RX
	GPIO[34]	I/O	General purpose input, output
	PWM[35]	O	Pulse width modulation
	FRAME_SYNC *	I	3DD synchronization
	WIC[6]	I	External interrupt
GPIO35	UART_DBG_CM4	O	UART DBG TX (Cortex-M4)
	GPIO[35]	I/O	General purpose input, output
	PWM[18]	O	Pulse-width-modulated output
GPIO36	UART2_RX_CM4	I	UART2 RX (Cortex-M4)
	GPIO[36]	I/O	General purpose input, output
	PWM[19]	O	Pulse-width-modulated output
	WIC[7]	I	External interrupt
GPIO37	UART2_TX_CM4	O	UART2 TX (Cortex-M4)
	GPIO[37]	I/O	General purpose input, output
	PWM[20]	O	Pulse-width-modulated output
	EINT[20]	I	External interrupt
GPIO38	UART2_RTS_CM4	O	UART2 RTS (Cortex-M4)
	GPIO[38]	I/O	General purpose input, output
	PWM[21]	O	Pulse-width-modulated output
	EINT[21]	I	External interrupt
	SWD_DIO	I/O	Cortex-M4 SWD debug port
GPIO39	UART2_CTS_CM4	O	UART2 CTS (Cortex-M4)
	[Reserved]		[Reserved]
	GPIO[39]	I/O	General purpose input, output
	PWM[22]	O	Pulse-width-modulated output
	PULSE_COUNT *	I	Pulse counter
	EINT[22]	I	External interrupt
	SWD_CLK	I	Cortex-M4 SWD debug port
GPIO57	PCM_CLK	I/O	PCM interface for Bluetooth
	GPIO[57]	I/O	General purpose input, output
	PWM[36]	O	Pulse-width-modulated output
	WIC[8]	I	External interrupt

	ADC_IN0	I	Auxiliary ADC input
GPIO58	PCM_SYNC	I/O	PCM interface for Bluetooth
	GPIO[58]	I/O	General purpose input, output
	PWM[37]	O	Pulse-width-modulated output
	WIC[9]	I	External interrupt
	ADC_IN1	I	Auxiliary ADC input
GPIO59	PCM_OUT	O	PCM interface for Bluetooth
	SWD_DIO	I/O	Cortex-M4 debug port
	GPIO[59]	I/O	General purpose input, output
	PWM[38]	O	Pulse-width-modulated output
	WIC[10]	I	External interrupt
	ADC_IN2	I	Auxiliary ADC input
GPIO60	PCM_IN	I	PCM interface for Bluetooth
	SWD_CLK	I	Cortex-M4 SWD debug port
	GPIO[60]	I/O	General purpose input, output
	PWM[39]	O	Pulse-width-modulated output
	PULSE_CNT	I	Pulse counter input
	WIC[11]	I	External interrupt
	ADC_IN3	I	Auxiliary ADC input

Note, to use the GPIO27 and GPIO28 pins as I2C0, add pull-up resistors on the HDK or on the I2C0 daughterboard. To add pull-up resistors on the HDK, refer to the resistor locations in Figure 7. The location of R23 is for adding the pull-up resistor for I2C0_SDA (GPIO28). The location of R25 is for adding the pull-up resistor for I2C0_CLK (GPIO27). Similarly, the pull-up resistors are also needed in order to use GPIO24 (I2C1_CLK) and GPIO25 (I2C1_DATA) pins as I2C1. Due to the space limitation on the HDK, these pull-up resistors for GPIO24 and GPIO25 need to be added on the I2C1 daughterboard.

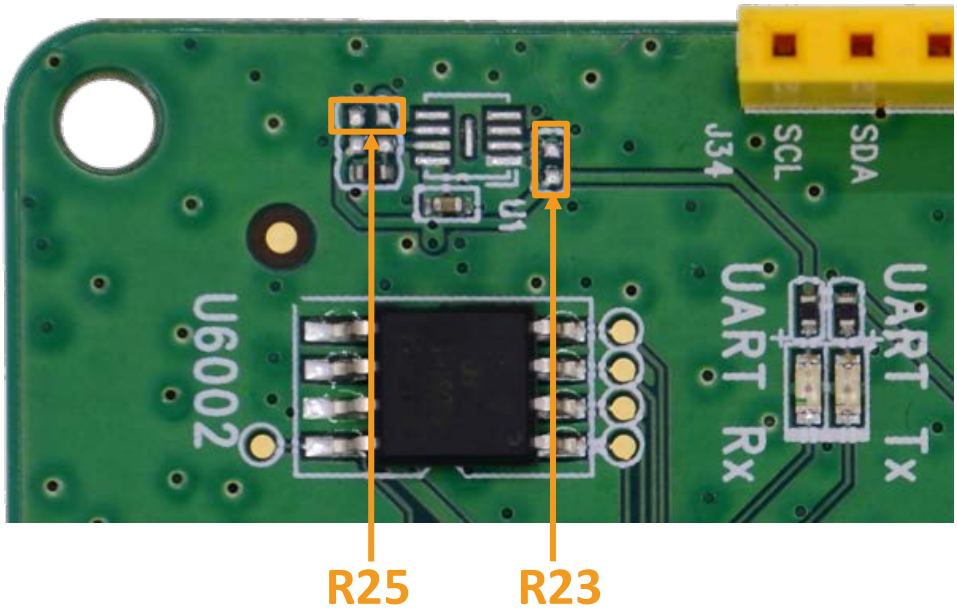


Figure 7. Locations of I2C pull-up resistors

4.6. RTC

The LinkIt 7687 HDK features an RTC module. The clock source operates at 32.768kHz crystal oscillator or an external clock source. The RTC has built-in accurate timer to wake up the system when the user defined timer expires. The RTC uses a different power source from the Power Management Unit (PMU). In hibernate or sleep mode, the PMU is turned off while the RTC module remains powered on. The RTC module only consumes 3µA in hibernate mode. The RTC has a dedicated PMU control pin PMU_EN_RTC (pin 23) used to turn the power on when the RTC timer expires and turn the power off when it intends to enter the hibernate mode.

4.7. RF connections

By default, the board ships with RF signals routed to the on-board circuit antenna. An on-board U.FL, a conductive test component, (I-PEX) connector enables to test the signals using a compatible cable. If a user wants to perform the testing, the user needs to solder the capacitor from the location **C93** to **C94**.

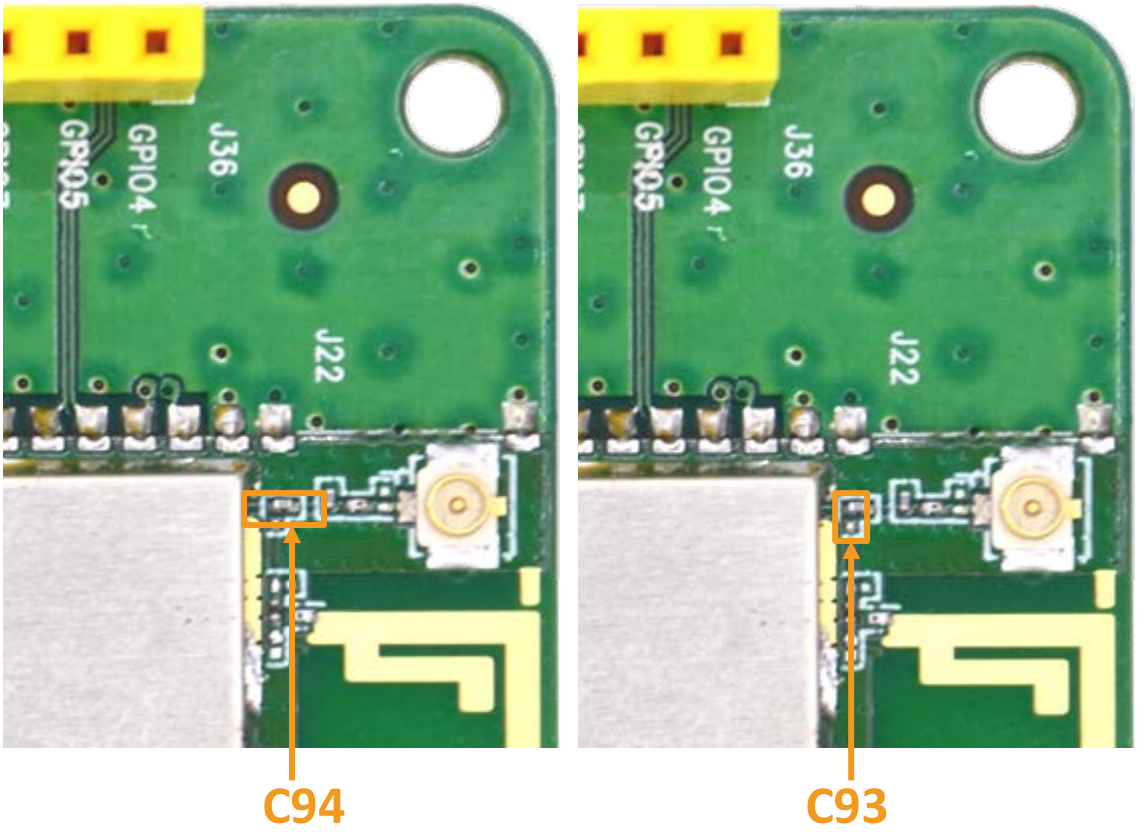


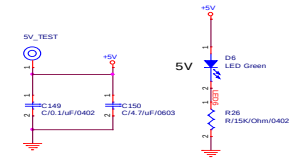
Figure 8. Location of the components C93 and C94

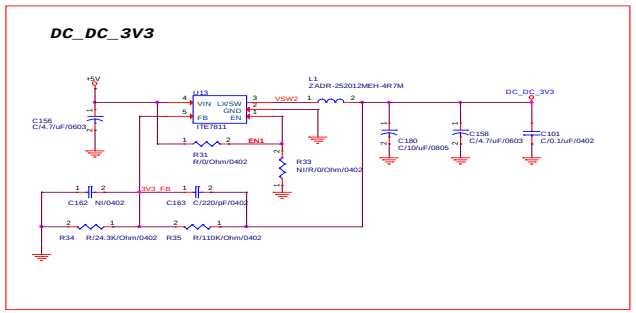
4.8. CMSIS-DAP Firmware update procedure

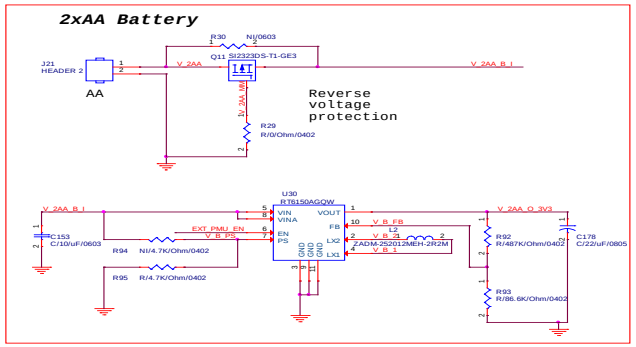
The latest firmware from OpenSDA platform can be downloaded from the mbed official website. To update the binary firmware of CMSIS-DAP, press and hold the **S1**, then plug-in the USB cable to **CON5**, release the button **S1** once the mass storage is shown, and then drag and drop in the binary code. After the mass storage disappears, keep the power connected for 10 seconds, and then reboot the system again to finish the firmware update.

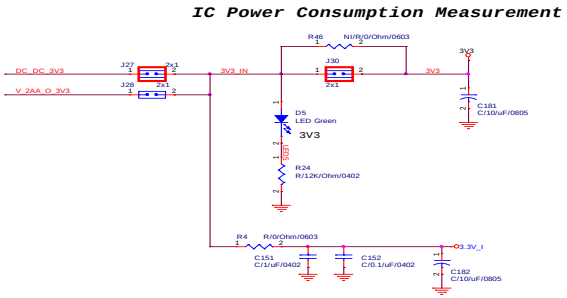
5. Schematics (V30)

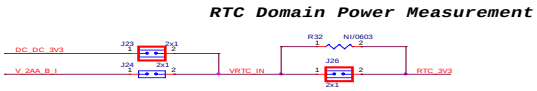
Main board schematic-1

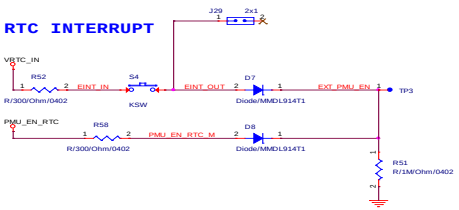


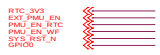


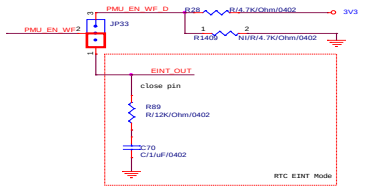


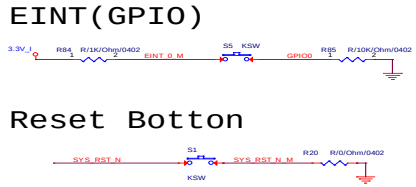




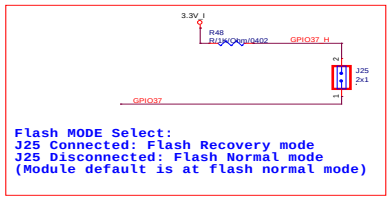


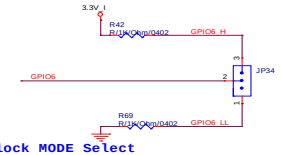




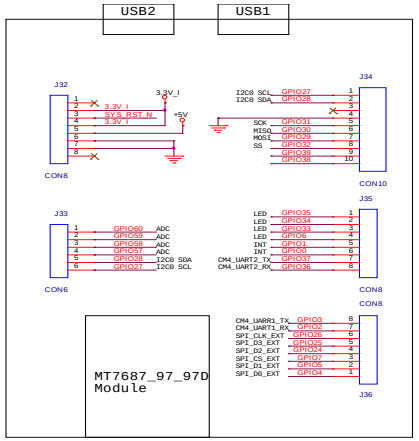


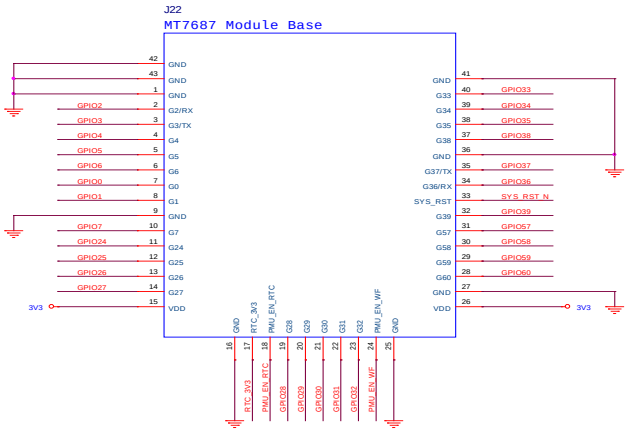
Main board schematic-2

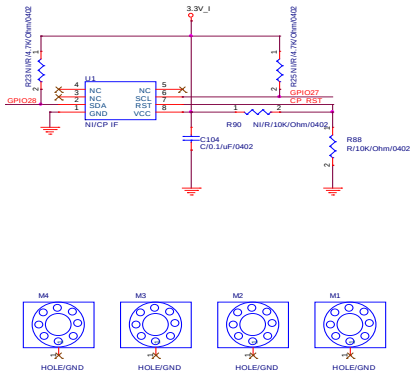




Sub-Function	Pin	Value	Description
Flash mode (when SIP_MODE=1)	GPIO37	0	Flash normal mode
		1	Flash recovery mode
rtc_mode/external 32KHz	GPIO6	0	ext 32KHz clock disable
		1	ext 32KHz clock enable

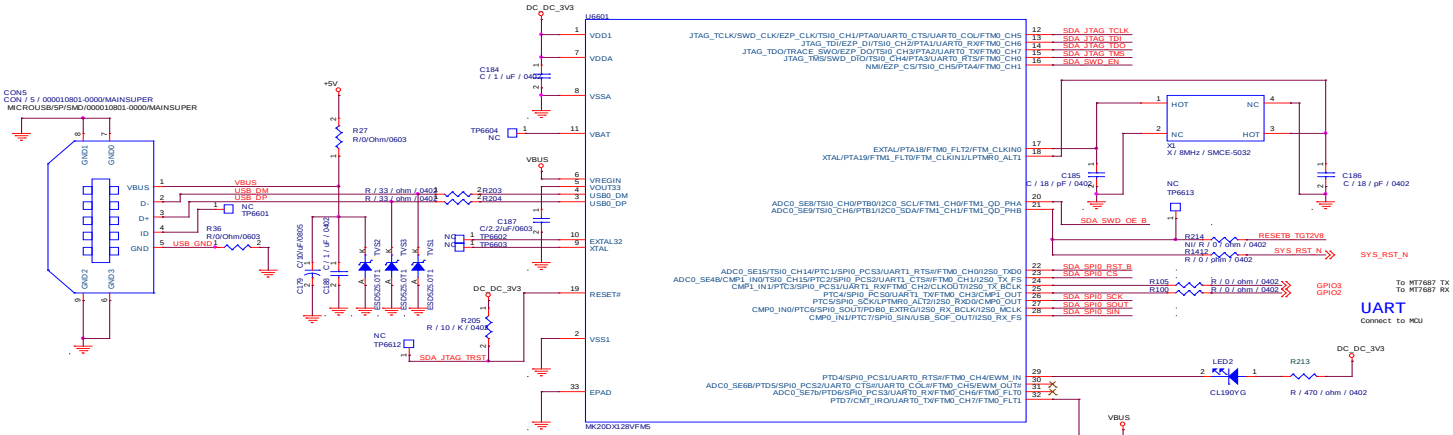




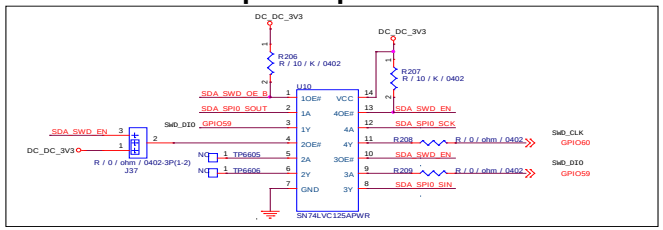


MediaTek Inc.		
MCDIATCK	Title: MT76x7 Main Board	
	Size: C; Document Number: 2_Test Interface	Rev: 3.0
	Date: Monday, March 07, 2016; Sheet 2 of 4	

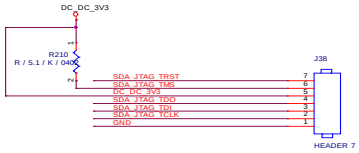
Main board schematic-3



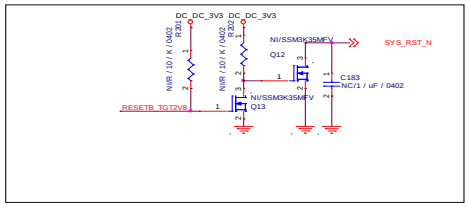
Buffer for SWD input/output



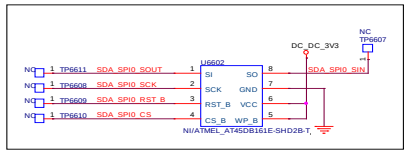
MK20 JTAG connector

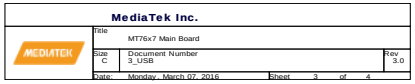


For RESETB LVS



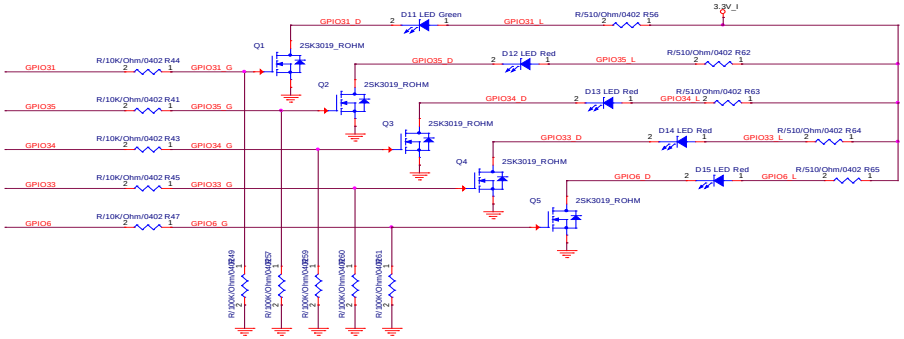
SPI FLASH MEMORY

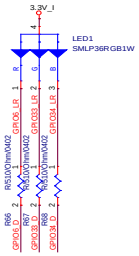




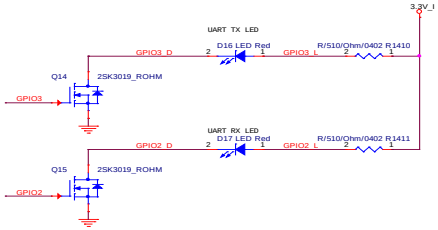
Main board schematic-4

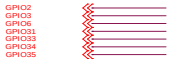
USER LED





UART1 LED





MediaTek Inc.			
MEDIATEK	Title: MT76x7 Main Board		
	Size: C	Document Number: 4_LED	Rev: 3.0
	Date: Monday, March 07, 2016	Sheet 4 of 4	