



MT7686 HDK V11 User's Guide

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Document Revision History

Revision	Date	Description
1.0	30 June 2017	Initial release

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1. Introduction

MediaTek LinkIt™ for real-time operating system (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 MT7686 hardware development kit (HDK). 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 MediaTek MT7686 chipset based on ARM Cortex-M4 with floating point unit in QFN48 package. It enables rich connectivity features, communication with cloud services and real-time control. The MT7686 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 MT7686 HDK has three binary files for bootloader, Wi-Fi connectivity and FreeRTOS. The MSD programmer enables to update the FreeRTOS binary file only.
- Coresight Debug Access Port ([CMSIS-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 a project on MT7686 HDK.

The front view of the HDK including a stamp module and main board is shown in Figure 1. MT7682 and MT7686 use the same HDK main board.

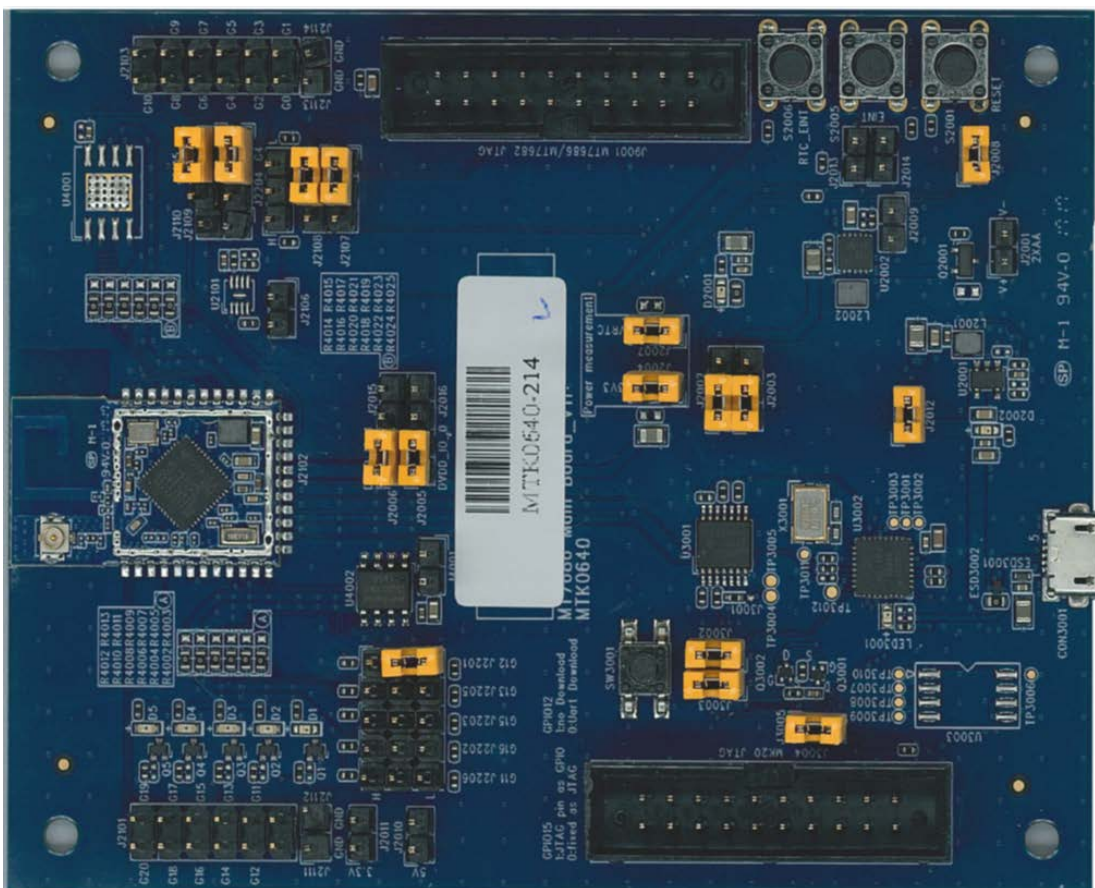


Figure 1. Front view of MT7686 HDK

2. Get started with the HDK

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

2.1. Configuring the MT7686 HDK

MT7686 HDK includes a main board (MT7686 Main Board_V11) and a MT7686 stamp module. The MT7686 stamp module is mounted on the main board. The top view of the main board is shown in Figure 2.

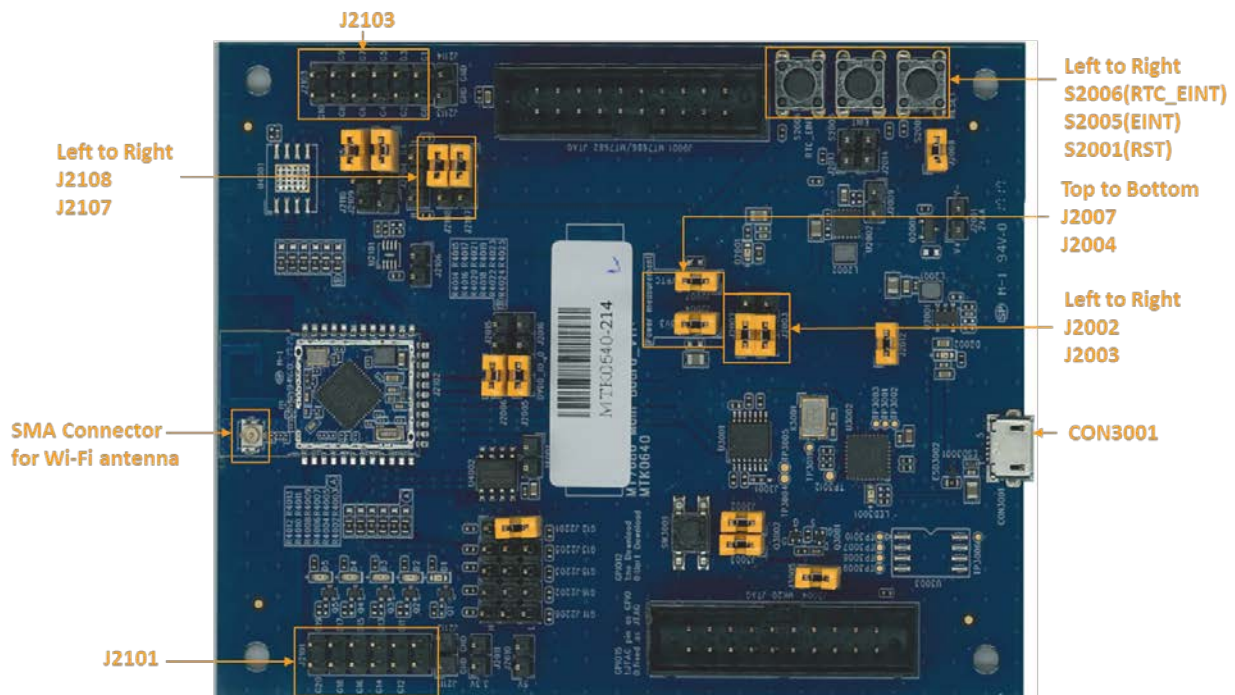


Figure 2. Jumpers and connectors on the MT7686 HDK

The description of pins (Figure 2) and their functionality is provided below.

- 1) **CON3001** 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](#).
 - a) Set the jumpers **J2002** pin 1 and pin 2, **J2003** pin 1 and pin 2, **J2004** and **J2007** on, if the board is powered by a USB connector.
- 2) **S2005** enables the external interrupt (configured at **GPIO0**), see section 4.4, “Buttons”, for more details.
- 3) Press **S2001** to reset the system.
- 4) **Wi-Fi Antenna** is a PCB antenna. MT7686 stamp module is by default connected to the PCB antenna to transmit and receive RF signals.

The default configuration of the MT7686 HDK supports the following functionality:

- 1) Power supply. Attach a micro-USB connector to the **CON3001**.
- 2) Supports RTC interrupt.

- 3) Clock source — 32.768kHz source crystal clock for the RTC mode or external clock operating on 32.768 kHz.
- 4) XTAL at 26MHz.
- 5) Supports RTC mode.

The hardware settings of the stamp module are shown below:

- 1) XTAL at 26MHz.
- 2) Clock source — 32.768kHz source crystal clock for the RTC mode or external clock operating at 32.768kHz.
- 3) Supports RTC mode.

2.2. Installing the MT7686 HDK drivers on Microsoft Windows

To configure the MT7686 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**.
- 3) In **Device Manager**, navigate to **Ports (COM & LPT)** (see Figure 3).
- 4) A new **COM** device should appear under **Ports (COM & LPT)** in **Device Manager**, as shown in Figure 3. 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 **UART0** of the chipset, see section 4.5, “Extension connectors”. The **mbed Serial Port (UART0)** is applied to flash the board and log the outputs.

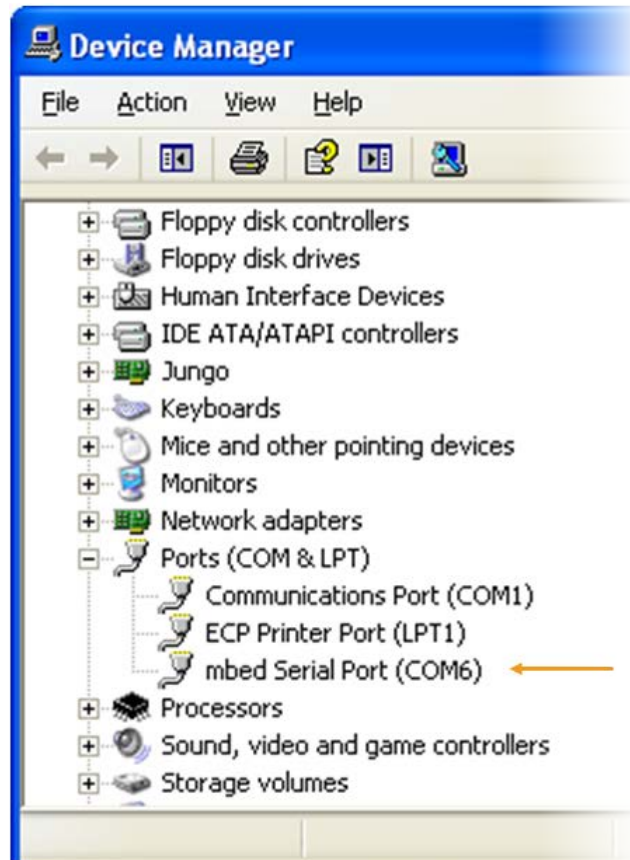


Figure 3. COM port associated with the MT7686 HDK

2.3. Configuring the HDK flash mode

The MT7686 HDK is embedded with 4MB flash memory. The boot options are either from the Flash memory or from the UART port.

To update the firmware on the MT7686 HDK:

- 1) Set the jumpers **J2002** pin 1 and pin 2, **J2003** pin 1 and pin 2, **J2004** and **J2007** 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 MT7686 Flash Tool's behavior on the PC. A message is sent to the **UART0** port of the chipset and the code is uploaded to the embedded flash memory through **UART0**.
- 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 2.

To run the project on the MT7686 HDK:

- 1) Set the jumpers **J2002** pin 1 and pin 2, **J2003** pin 1 and pin 2, **J2004** and **J2007** 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 2.

2.4. Downloading the image using the MT7686 HDK as a removable storage

To update the FreeRTOS binary only (example project binary: `mt7686_iot_sdk.bin`), use the HDK as a mass storage device according to the following steps:

- 1) Power up the board with a micro-USB cable.
- 2) Navigate to **Computer** on your PC to check if a new mass storage named **MT7686** is available under **Removable Disk**, as shown in Figure 4.
- 3) Open the **MT7686** removable storage, then drag and drop the binary `mt7686_iot_sdk.bin` to complete downloading the image.

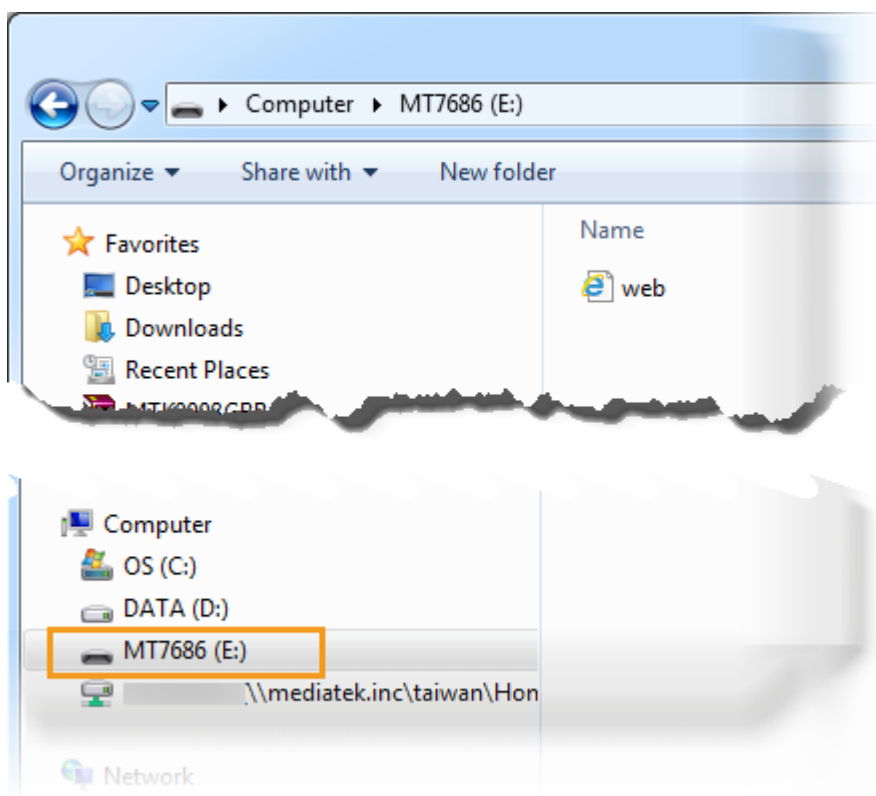


Figure 4. New removable storage detected

3. Hardware Features

This section provides the main supported features of the MT7686 HDK. The detailed description of the features is provided in the upcoming sections.

- IEEE 802.11bgn Wireless Connectivity Single Chip with QFN68 package.
- The IOs on MT7686 HDK are 3.3V compatible. MT7686 chip IO can support 3.3V, 2.8V and 1.8V.
- Support for [FreeRTOS](#).
- Flexible on-board power supply
 - [USB](#) with power (V_{BUS} , 5V).
 - External V_{IN} (1.8~3.2V).
- Ten LEDs
 - Power LEDs (**D2001, D2002**) and user LEDs (**D1, D2, D3, D4, D5**).
- Three push buttons
 - System Reset.
 - Real Time Clock (RTC) Interrupt.
 - External Interrupt.
- XTAL (Crystal Oscillator)
 - 26MHz 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

MT7686 features an ARM Cortex-M4 with floating point processor, which is the most energy efficient ARM processor available.

MT7686 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

MT7686 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 MT7686 HDK based on MT7686F, if the power is supplied from an on-board micro-USB connector **CON3001** (Figure 2). This supply can be isolated from the switching regulator using the jumpers. Note, that the jumpers **J2002** pin 1 and pin 2, **J2003** pin 1 and pin 2, **J2004** and **J2007** 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
J2002(1-2)	3.3V power supply	Use micro-USB connector supporting 3.3V power source.
J2004	Current measurement	Measures the current flow in MT7686F.
J2003(1-2)	AVDD33_VRTC power supply	Use micro-USB connector supporting RTC 3V3 power.
J2007	Current measurement in RTC mode	Measures the current flow in RTC mode for MT7686.

- 2) Power up using an AA or AAA battery.

- Connect an external AA battery to battery pin header (**J2001**) to supply power to the system, as shown in Figure 5. When using an AA battery, plug the USB to micro-USB connector **CON3001** (Figure 2). Note, that the jumpers **J2002** pin 2 and pin 3, **J2003** pin 2 and pin 3, **J2004**, and **J2007** are required to be set on. More details on the jumpers can be found in Table 2.

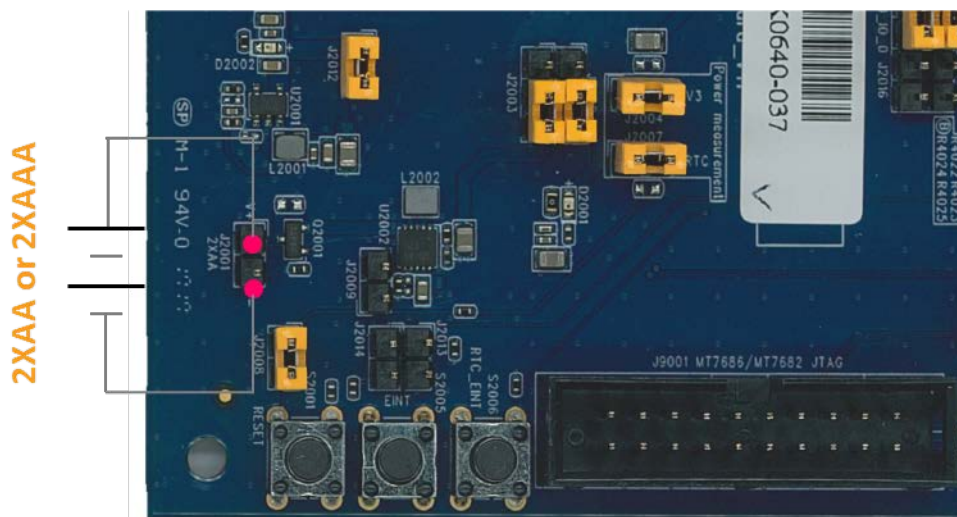


Figure 5. Power up the HDK using an AA or AAA Battery (J2001)

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

Jumper	Usage	Comments
J2002(2-3)	3.3V power supply	Use AA or AAA battery source supporting 3.3V power.
J2004	Current measurement	Measures the current flow in MT7686.
J2003(2-3)	AVDD33_VRTC power supply	Use AA or AAA battery source supporting RTC 3V3 power.
J2007	Current measurement in RTC mode	Measures the current flow in RTC mode for MT7686.

4.3. LEDs

The MT7686 HDK has onboard LEDs associated with different functionalities of the board (Figure 6).

- 1) **D2002** indicates the power rail 5V is on.
- 2) **D2001** indicates the power rail 3.3V is on.

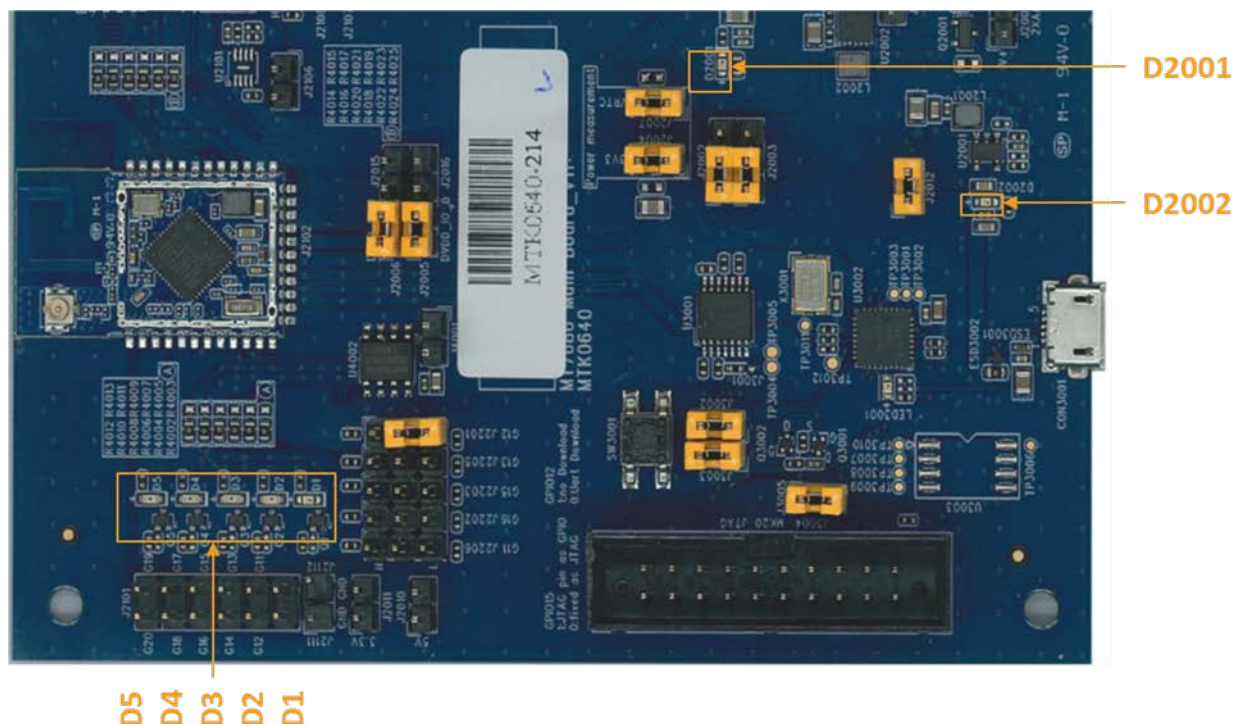


Figure 6. On-board LEDs

3) **D1, D2, D3, D4, and D5** are LEDs assigned for user interaction. All LEDs are high active (Figure 6). GPIO pins to activate the LEDs are shown in Table 3.

Table 3. GPIO pins to activate the LEDs

LED	GPIO
D1	GPIO11
D2	GPIO12
D3	GPIO13
D4	GPIO14
D5	GPIO15

4.4. Buttons

The MT7686 HDK is equipped with buttons with the following functionality. The push buttons are shown in Figure 2.

- 1) System reset button (**S2001**) resets the MT7686 HDK.
- 2) External interrupt button (**S2005**). Users can configure GPIO0 as an external interrupt pin. Press the button to wake up the system from the sleep mode.
- 3) RTC interrupt button (**S2006**). When the system is in RTC mode, push the button to wake up the system.

4.5. Extension connectors

The MT7686 HDK provides similar pin-out extension connectors (**J2101** and **J2103**) for various sensor and device connectivity, as shown in Figure 2 and described in Table 4.

The board has 21 GPIOs multiplexed with other interfaces. Depending on the use case, user can configure each I/O functionality.

Table 4. GPIO pin-out extension connectors

Connector Pin Number	Signal Name	Connector Pin Number	Signal Name
J2101.1	GPIO20	J2103.1	GPIO1
J2101.2	GPIO19	J2103.2	GPIO0
J2101.3	GPIO18	J2103.3	GPIO3
J2101.4	GPIO17	J2103.4	GPIO2
J2101.5	GPIO16	J2103.5	GPIO5
J2101.6	GPIO15	J2103.6	GPIO4
J2101.7	GPIO14	J2103.7	GPIO7
J2101.8	GPIO13	J2103.8	GPIO6
J2101.9	GPIO12	J2103.9	GPIO9
J2101.10	GPIO11	J2103.10	GPIO9
		J2103.11	x
		J2103.12	GPIO10

Table 5. GPIO pin multi-function definition

Pin alias	Name	Direction	Description
GPIO0	GPIO[0]	I/O	General purpose input, output
	UART1_RTS	O	UART1 RTS
	PWM[0]	I/O	Pulse-width-modulated output
	EINT[0]	I	External interrupt
	I2C1_CLK	I/O	I2C1 CLK
	I2S_RX	I	I2S slave RX
GPIO1	GPIO[1]	I/O	General purpose input, output
	UART1_CTS	O	UART1 CTS
	PWM[1]	O	Pulse-width-modulated output
	EINT[1]	I	External interrupt
	I2C1_CLK	I/O	I2C1 CLK
	I2S_TX	O	I2S slave TX
GPIO2	GPIO[2]	I/O	General purpose input, output
	UART1_RX	I	UART1_RX
	PWM[0]	O	Pulse-width-modulated output

GPIO3	EINT[2]	I	External interrupt
	I2S_WS	O	I2S slave TX
	GPIO[3]	I/O	General purpose input, output
	UART1_TX	O	UART1_TX
	PWM[1]	O	Pulse-width-modulated output
	EINT[3]	I	External interrupt
GPIO4	I2S_CK	O	I2S slave TX
	GPIO[4]	I/O	General purpose input, output
	SPI_A_SIO2_M	I/O	SPI_A master SIO2
	PWM[1]	O	Pulse-width-modulated output
	EINT[4]	I	External interrupt
	SPI_A_SIO2_S	I/O	SP_A I slave SIO2
GPIO5	I2S_MCK	O	I2S master MCK
	GPIO[5]	I/O	General purpose input, output
	SPI_A_SIO3_M	I/O	SPI_A master SIO3
	UART0_RX	I	UART0 RX
	EINT[5]	I	External interrupt
	SPI_A_SIO3_S	I/O	SP_A I slave SIO3
	TDM_RX	I	TDM_RX
	I2C0_CLK	O	I2C0 CLK
GPIO6	UART3_RX_N9	I	N9_UART3 RX
	GPIO[6]	I/O	General purpose input, output
	SPI_A_CS_M	O	SPI_A master CS
	UART0_TX	I	UART0 TX
	EINT[6]	I	External interrupt
	SPI_A_CS_S	O	SPI_A slave CS
	TDM_TX	O	TDM_RX
	I2C0_SDA	I/O	I2C0 SDA
GPIO7	UART3_RX_N9	I	N9_UART3 RX
	GPIO[7]	I/O	General purpose input, output
	SPI_A_CSK_M	I/O	SPI_A master CSK
	UART0_TX	O	UART0 TX
	EINT[7]	I	External interrupt
	SPI_A_CSK_S	I/O	SPI_A slave CSK
	TDM_WS	O	TDM_WS
	CLKO1	O	Clock output source_1
GPIO8	GPIO[8]	I/O	General purpose input, output
	SPI_A_SIO0_M	I/O	SPI_A master SIO0
	UART0_RTS	I	UART0 RTS
	EINT[8]	I	External interrupt

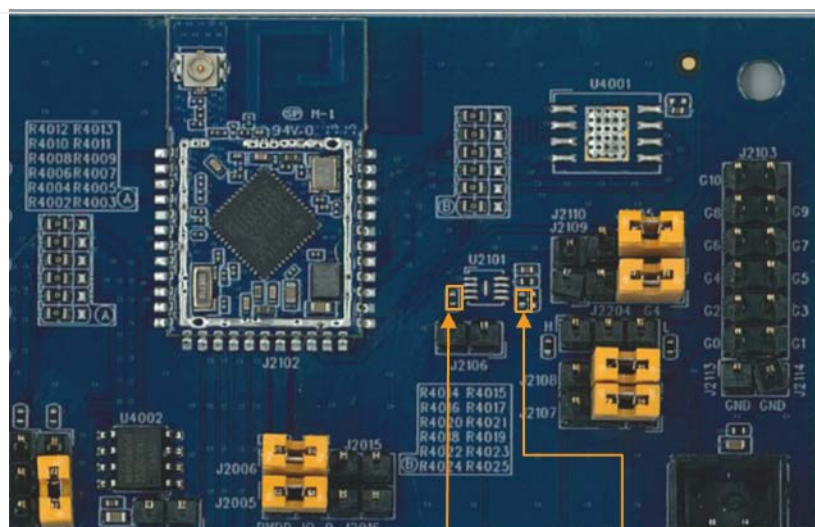
GPIO9	SPI_A_SIO0_S	I/O	SPI_A slave SIO0
	TDM_CK	O	TDM_CK
	I2C0_CLK	O	I2C0 CLK
	GPIO[9]	I/O	General purpose input, output
	SPI_A_SIO1_M	I/O	SPI_A master SIO1
	UART0_CTS	I	UART0 CTS
	EINT[9]	I	External interrupt
	SPI_A_SIO1_S	I/O	SPI_A slave SIO1
GPIO10	TDM_MCLK	O	TDM_MCLK
	I2C0_SDA	O	I2C0 SDA
	GPIO[10]	I/O	General purpose input, output
	PWM[2]	O	Pulse-width-modulated output
GPIO11	UART2_CTS	I	UART2 CTS
	EINT[10]	I	External interrupt
	GPIO[11]	I/O	General purpose input, output
	MC0_CK_M	O	SDIO master CK
	PWM[3]	O	Pulse-width-modulated output
	EINT[11]	I	External interrupt
	MC0_CK_S	O	SDIO slave CK
GPIO12	CLK02	O	Clock output source_2
	I2S_RX	I	I2S RX
	GPIO[12]	I/O	General purpose input, output
	SPI_B_SIO3_M	I/O	SPI_B master SIO3
	UART0_RTS	I	UART0 RTS
	EINT[12]	I	External interrupt
	SPI_A_SIO3_S	I/O	SPI_B slave SIO3
	UART2_TX	O	UART2 TX
	I2S_TX	O	I2S TX
	MC0_CMD_M	O	SDIO master CMD
GPIO13	MC0_CMD_S	O	SDIO slave CMD
	GPIO[13]	I/O	General purpose input, output
	SPI_B_SIO2_M	I/O	SPI_B master SIO2
	UART0_RTS	I	UART0 RTS
	EINT[13]	I	External interrupt
	SPI_A_SIO2_S	I/O	SPI_B slave SIO2
	UART2_RTS	I	UART2 RTS
	I2S_WS	O	I2S WS
	MC0_DA0_M	I/O	SDIO master DA0
	MC0_DA0_S	I/O	SDIO slave DA0
	CLK04	O	Clock output source_4

GPIO14	GPIO[14]	I/O	General purpose input, output
	SPI_B_SIO1_M	I/O	SPI_B master SIO1
	UART0_RTS	I	UART0 RTS
	EINT[14]	I	External interrupt
	SPI_A_SIO1_S	I/O	SPI_B slave SIO1
	UART2_RTS	I	UART2 RTS
	TDM_RX	I	TDM RX
	MC0_DA1_M	I/O	SDIO master DA1
	MC0_DA1_S	I/O	SDIO slave DA1
	CLKO4	O	Clock output source_4
	PWM[4]	O	Pulse-width-modulated output
GPIO15	GPIO[15]	I/O	General purpose input, output
	SPI_B_SIO0_M	I/O	SPI_B master SIO0
	UART0_RTS	I	UART0 RTS
	EINT[15]	I	External interrupt
	SPI_A_SIO0_S	I/O	SPI_B slave SIO0
	UART2_RTS	I	UART2 RTS
	TDM_TX	I	TDM TX
	MC0_DA2_M	I/O	SDIO master DA2
	MC0_DA2_S	I/O	SDIO slave DA2
	I2C1_SCL	O	I2C1 SCL
	PWM[3]	O	Pulse-width-modulated output
GPIO16	GPIO[16]	I/O	General purpose input, output
	SPI_B_SCK_M	O	SPI_B master SCK
	UART0_RTS	I	UART0 RTS
	EINT[16]	I	External interrupt
	SPI_A_SCK_S	I/O	SPI_B slave SCK
	UART2_RTS	I	UART2 RTS
	TDM_WS	I	TDM WS
	MC0_DA3_M	I/O	SDIO master DA3
	MC0_DA3_S	I/O	SDIO slave DA3
	I2C1_SDA	I/O	I2C1 SDA
	UART3_TX_N9	I	N9_UART3 TX
GPIO17	GPIO[17]	I/O	General purpose input, output
	SPI_B_CS_M	O	SPI_B master CS
	EINT[16]	I	External interrupt
	SPI_B_CS_S	I/O	SPI_B slave CS
	UART2_RTS	I	UART2 RTS
	TDM_CK	I	TDM CK
	PWM[5]	O	Pulse-width-modulated output

GPIO18	CLKO3	O	Clock output source_3
	ADC_IN0	I	Auxiliary ADC input
	GPIO[18]	I/O	General purpose input, output
	EINT[18]	I	External interrupt
	TDM_MCLK	I	TDM_MCLK
	CLKO4	O	Clock output source_4
	CLKO3	O	Clock output source_3
	ADC_IN1	I	Auxiliary ADC input
GPIO19	I2C1_SDA	I/O	I2C1 SDA
	GPIO[19]	I/O	General purpose input, output
	EINT[19]	I	External interrupt
	UART0_RX	I	UART0 RX
	PWM[5]	O	Pulse-width-modulated output
	ADC_IN2	I	Auxiliary ADC input
GPIO20	I2C1_SDA	I/O	I2C1 SDA
	GPIO[20]	I/O	General purpose input, output
	EINT[20]	I	External interrupt
	UART0_TX	I	UART0 TX
	ADC_IN3	I	Auxiliary ADC input

Note, to use the GPIO8 and GPIO9 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 R2101 is for adding the pull-up resistor for I2C0_SDA (GPIO9). The location of R2102 is for adding the pull-up resistor for I2C0_CLK (GPIO8).



R2101

R2102

Figure 7. Locations of I2C pull-up resistors

4.6. RTC

The MT7686 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 mode, the PMU is turned off while the RTC module remains powered on. The RTC module only consumes 3 μ A in hibernate mode. The RTC has a dedicated PMU control pin EXT_PWR_EN (pin 21) 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 **C17** to **C18**.

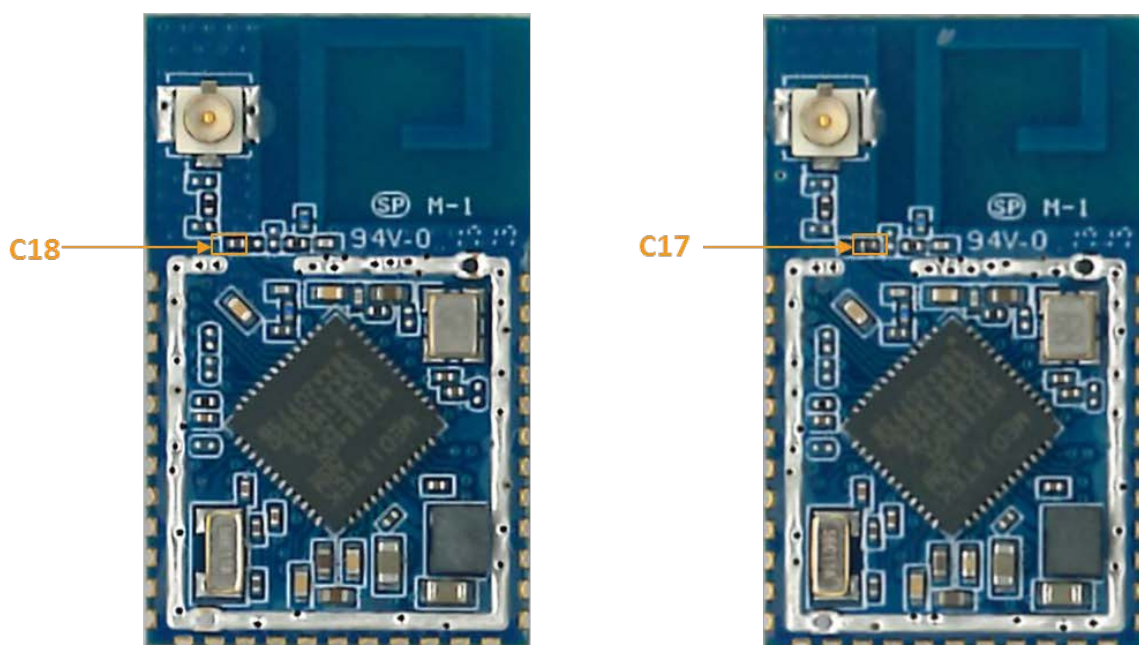


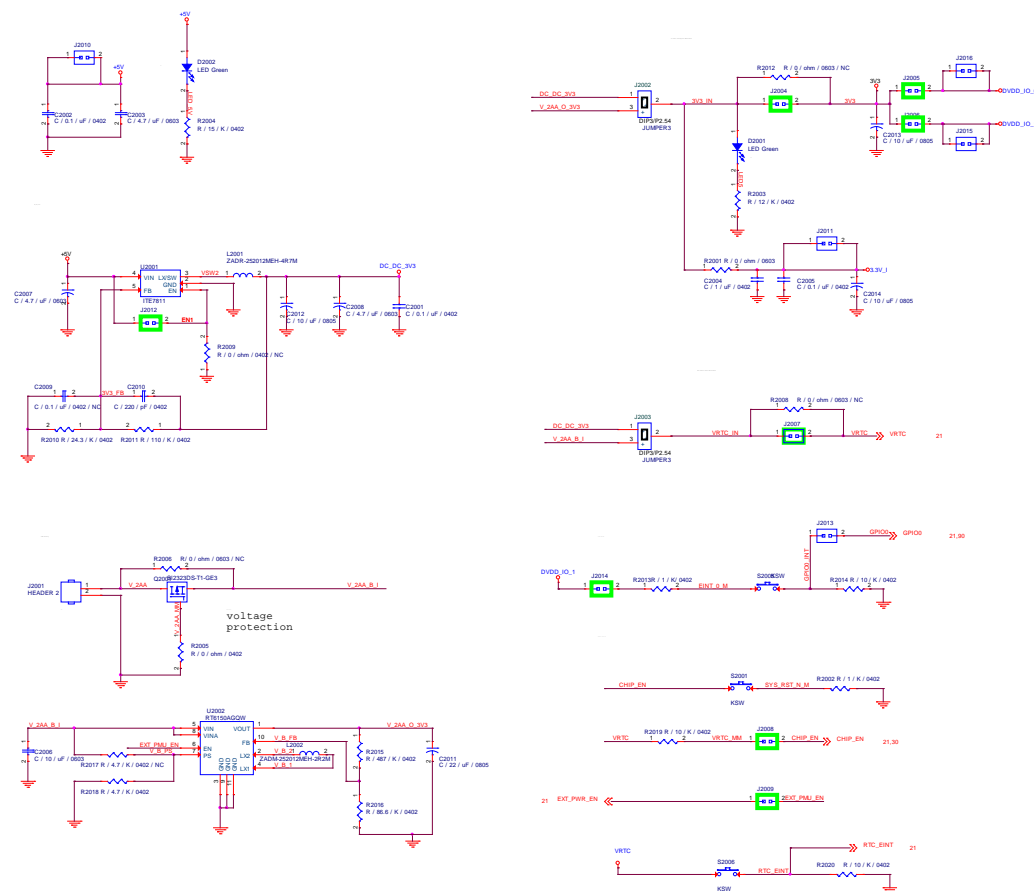
Figure 8. Location of the components C17 and C18

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 **SW3001**, then plug-in the USB cable to **CON3001**, release the button **SW3001** 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 (V11)

Main board schematic-1

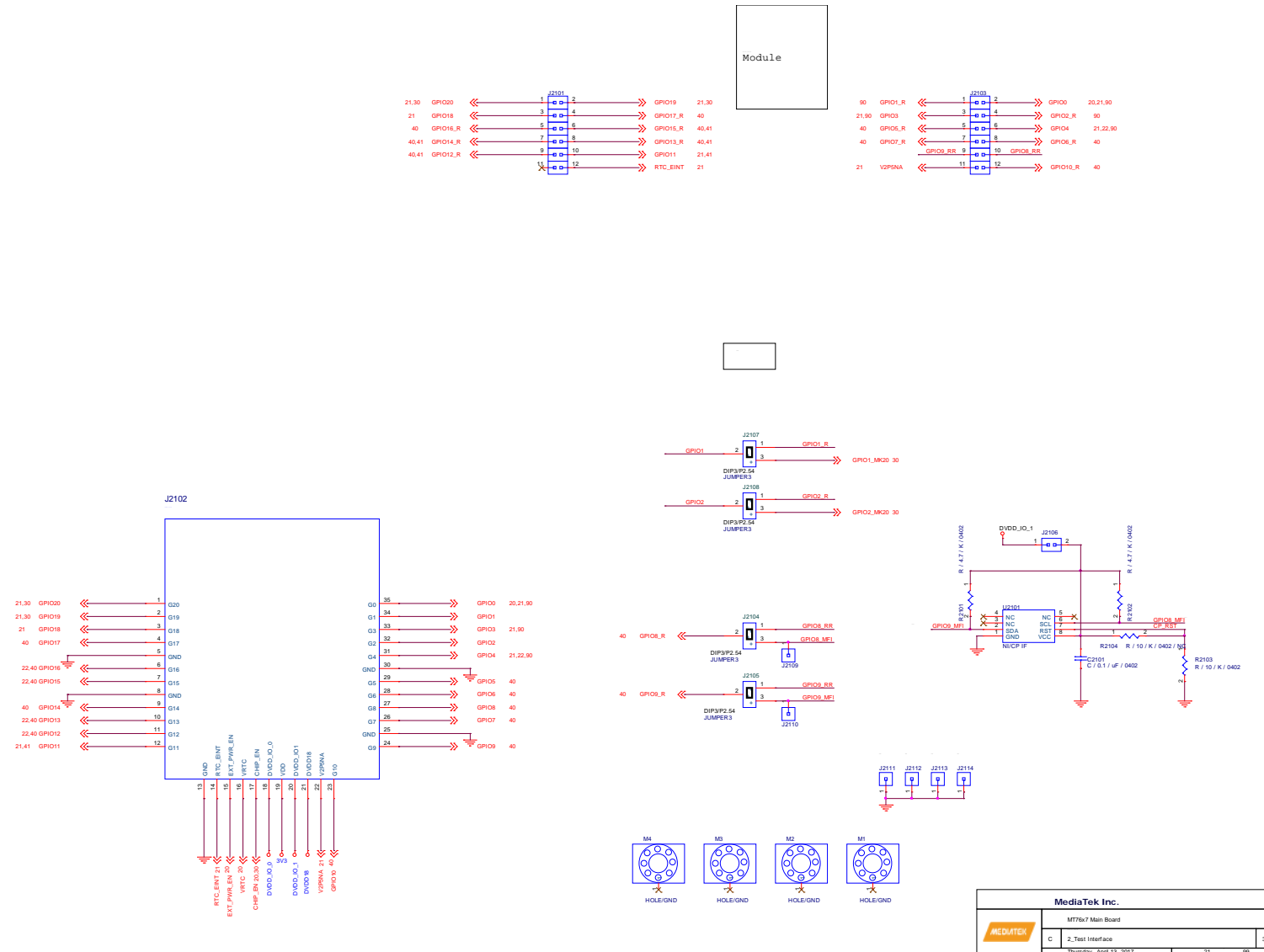


		/REDIRECT	
		20_Power Tree	
C			



MT7686 HDK V11 User's Guide

Main board schematic-2

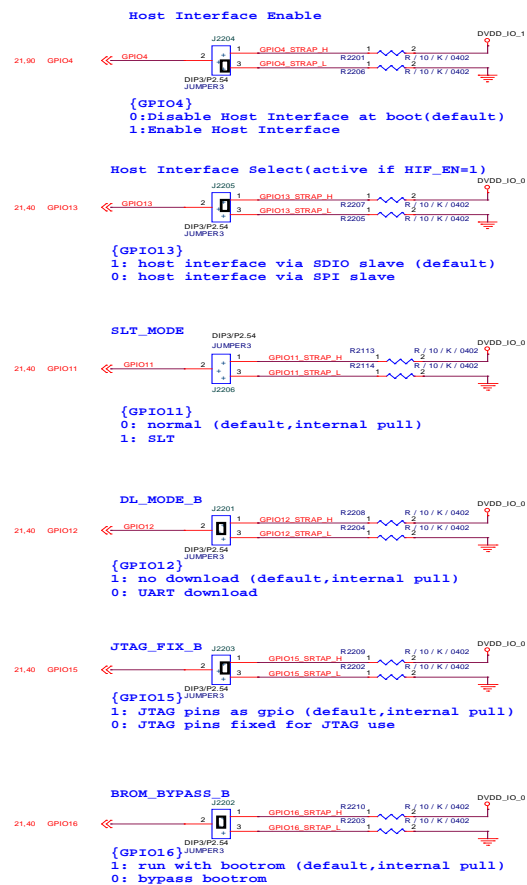


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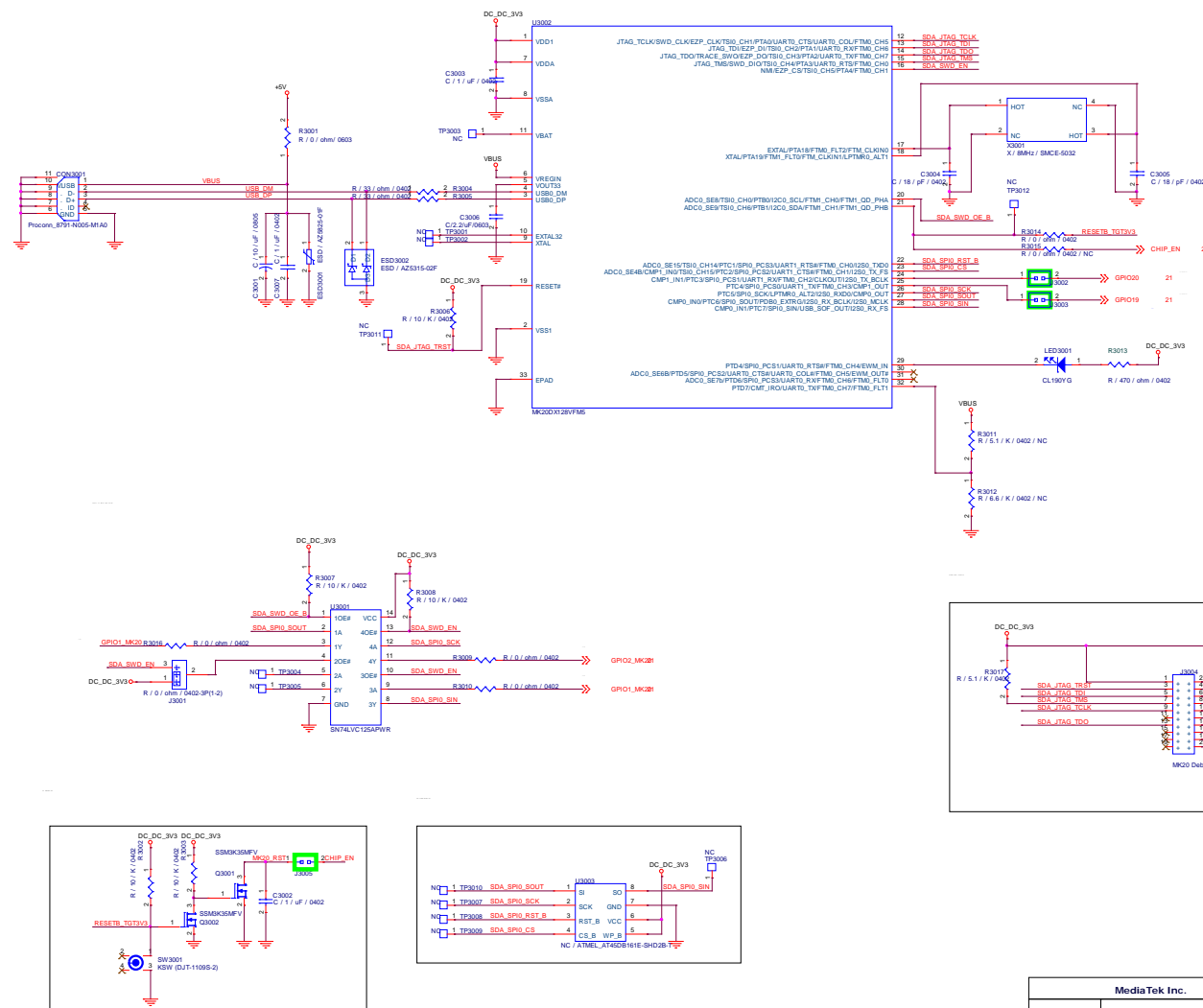


Main board schematic-3

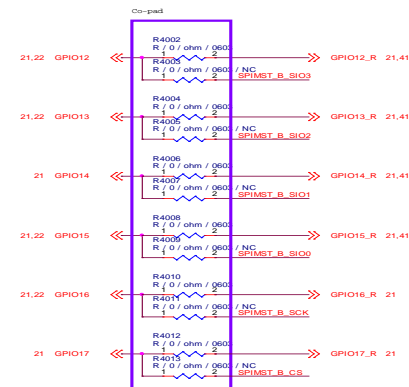
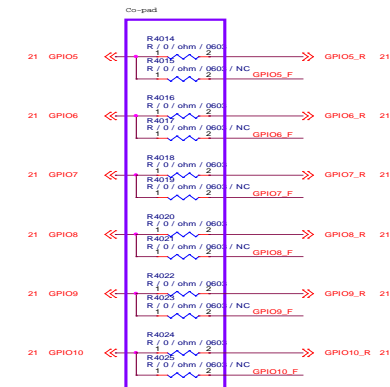
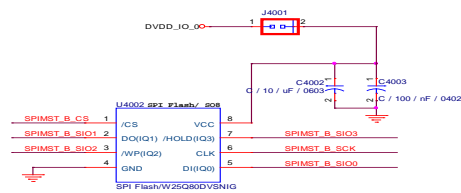
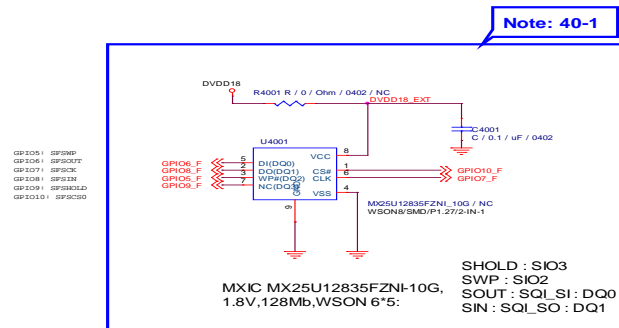


22_Strapping Option	
File	MTK Confidential
Date	Tuesday, February 07, 2017
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Main board schematic-4

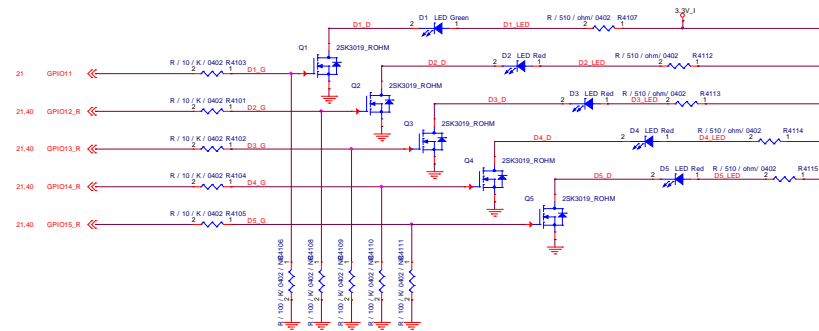


Main board schematic-5





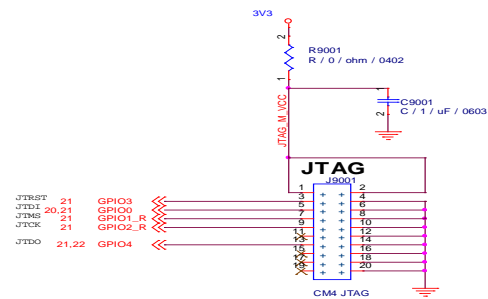
Main board schematic-6



MediaTek Inc.			
MT7686 Main Board			
C	4.LED		3.0
Thursday, April 13, 2017			



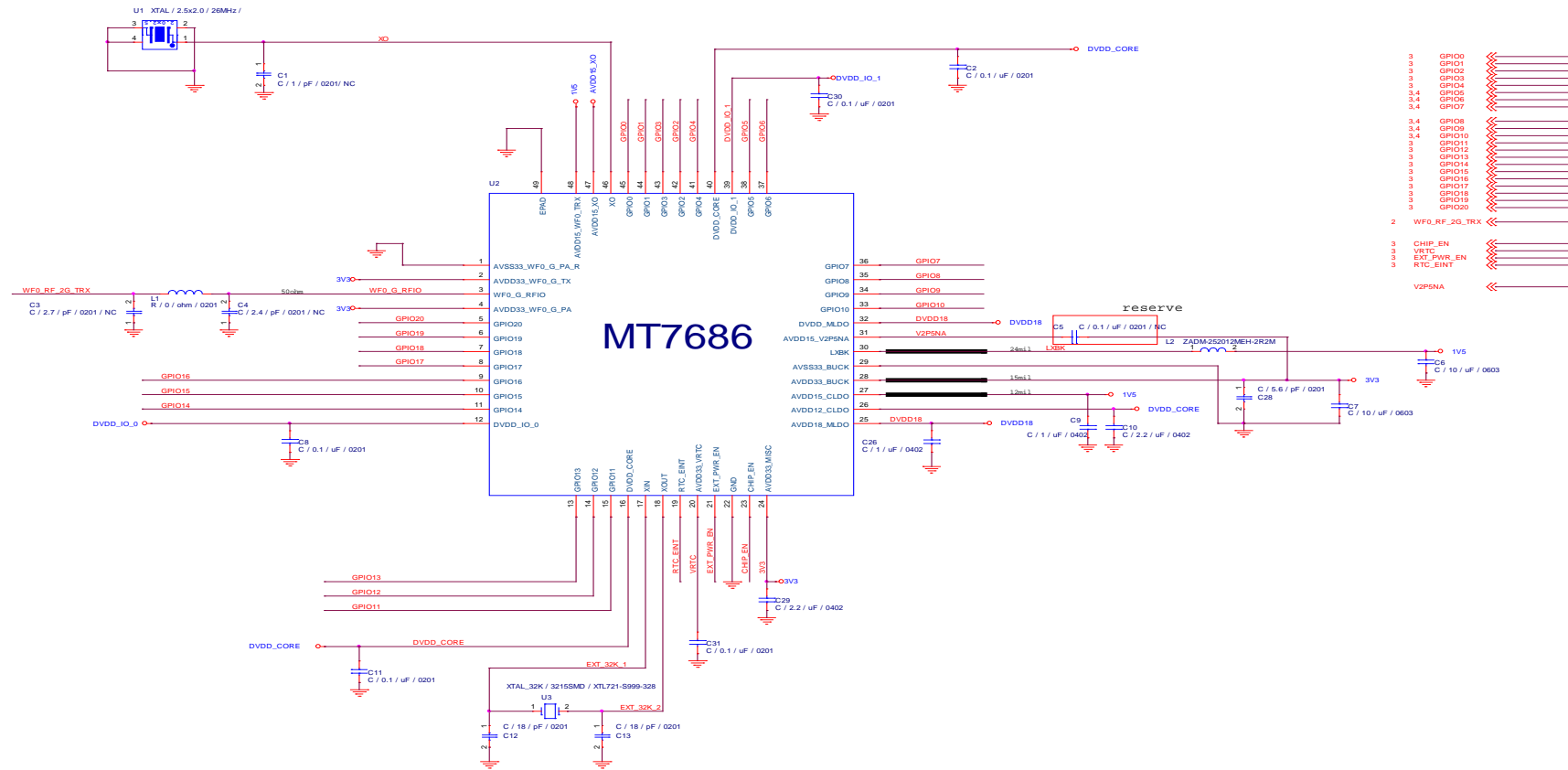
Main board schematic-7



MT7686 HDK V11 User's Guide

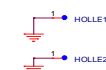
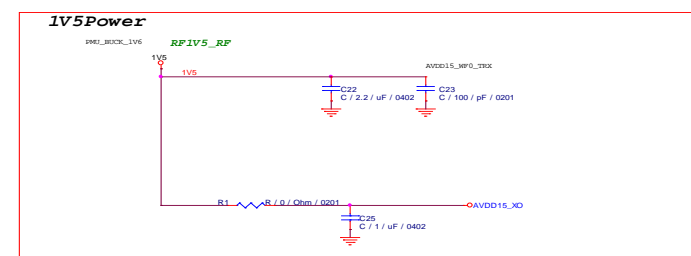
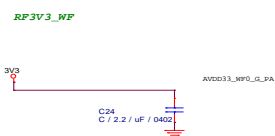
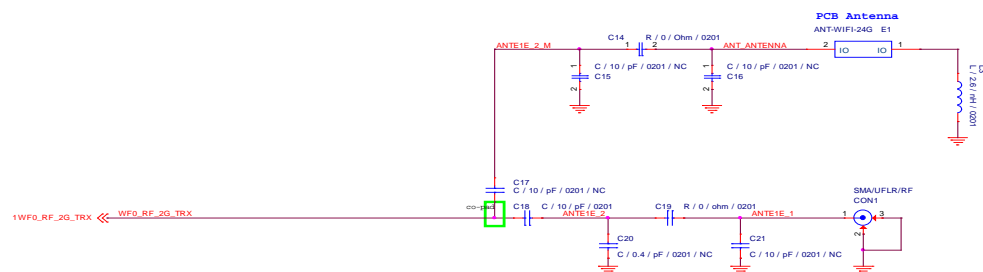
MEDIATEK	
Title	90_Debug Interface
Size	MTK Confidential
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MT7686_STAMP_MODULE_V10 schematic-1



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COMPRESSED IMAGE	File	MT7686 Stamp Module	
	Size	Document Number	Rev
	C	10_BB_RF	0.1
Date: Friday, January 13, 2017		Sheet	1 of 4

MT7686_STAMP_MODULE_V10 schematic-2



MT7686_STAMP_MODULE_V10 schematic-3

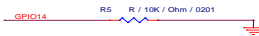
Strap Pin

XTAL Select



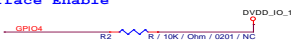
```
{GPIO17}
0:26MHz (default)
1:40MHz
```

SLOW_SRC_B



```
{GPIO14}
0:External
1:Internal (from 26/40MHz clock) (default)
```

Host Interface Enable



```
{GPIO4}
0:Disable Host Interface at boot(default)
1:Enable Host Interface
```

Host Interface Select(active if HIF_EN=1)

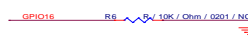


```
{GPIO13}
1: host interface via SDIO slave (default)
0: host interface via SPI slave
```

JTAG_FIX_B

```
{GPIO15}
1: JTAG pins as gpio (default)
0: JTAG pins fixed for JTAG use
```

BROM_BYPASS_B



```
{GPIO16}
1: run with bootrom (default)
0: bypass bootrom
```

SLT_MODE

```
{GPIO11}
0: normal (default)
1: SLT
```

DL_MODE_B

```
{GPIO12}
1: no download (default)
0: UART download
```

