MT7686 HDK V11 User's Guide

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Document Revision History

Revision	Date	Description
1.0	30 June 2017	Initial release
1.1	30 Oct 2017	1. Correct the number of LED 2. Add description for LED 3. Add jumpers setting at chapter 2.4
1.2	5 Jan 2018	Add chapter 2.5 for entering IAR and GCC interface
1.3	21 May 2018	Updated HDK picture for jumper settings

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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 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 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.

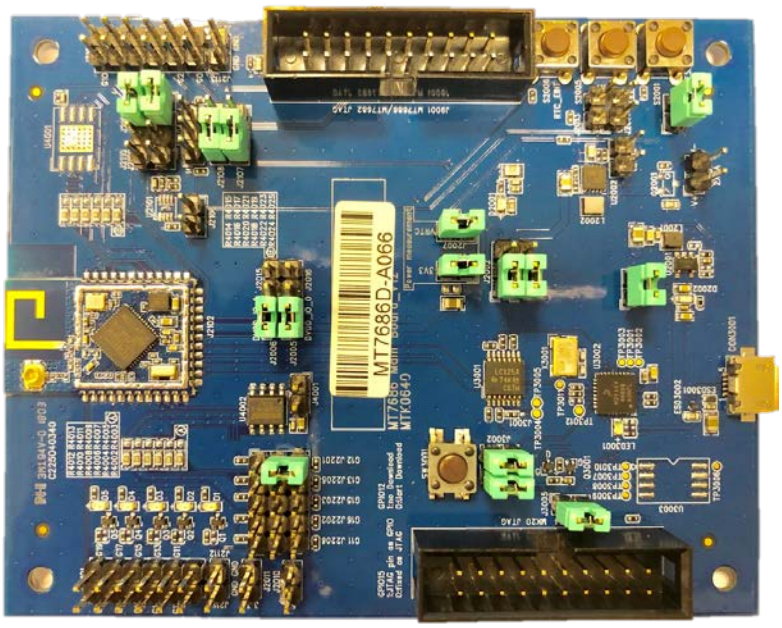


Figure 1. Front view of MT7686 HDK

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.

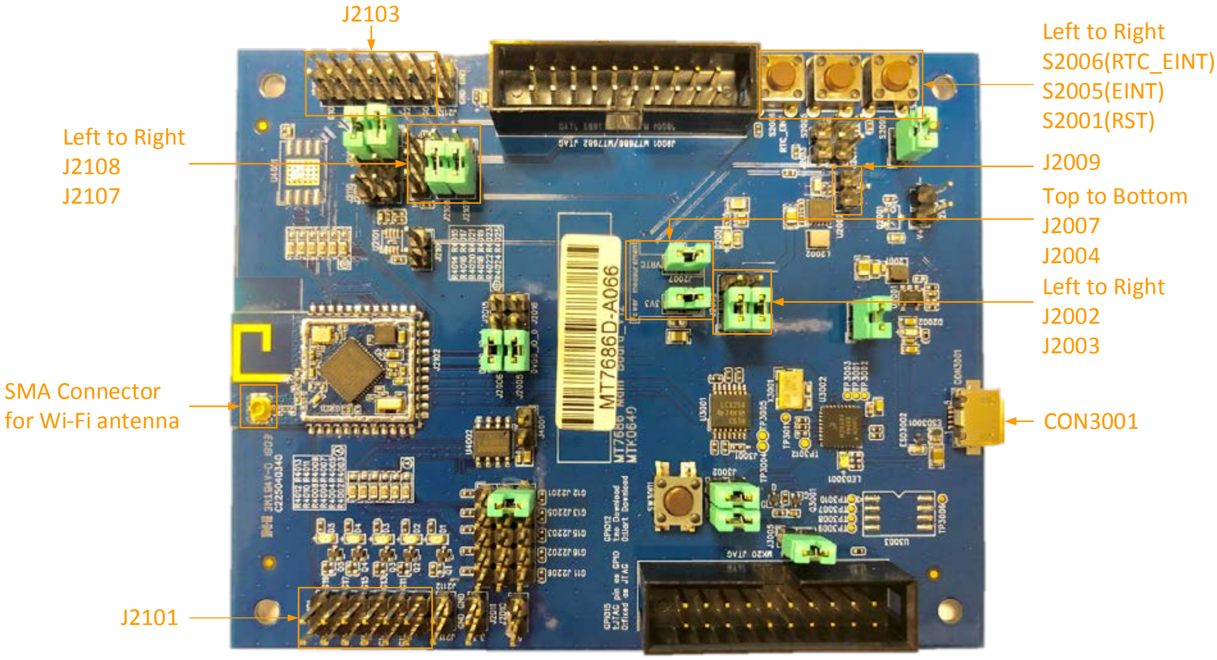


Figure 2. Jumpers and connectors on the MT7686 HDK

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 MT7686, 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.
2) To enable the chipset to UART download mode, set the jumper **J2201** pin 2 and pin 3 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**.

3) 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.
2) Remove J2201 jumper, to set the board into a flash mode.

- In this mode, if the power is on, the board will load firmware from the Flash and reboot.

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

The development board should now be connected to the PC, as shown inFigure 4.

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) Set the jumpers J2107 pin 2 and pin 3, J2108 pin2 and pin 3 on.
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 **MT7686** is available under **Removable Disk**, as shown in Figure 4.
4) Open the **MT7686** removable storage, then drag and drop the binary `mt7686_iot_sdk.bin` to complete downloading the image.

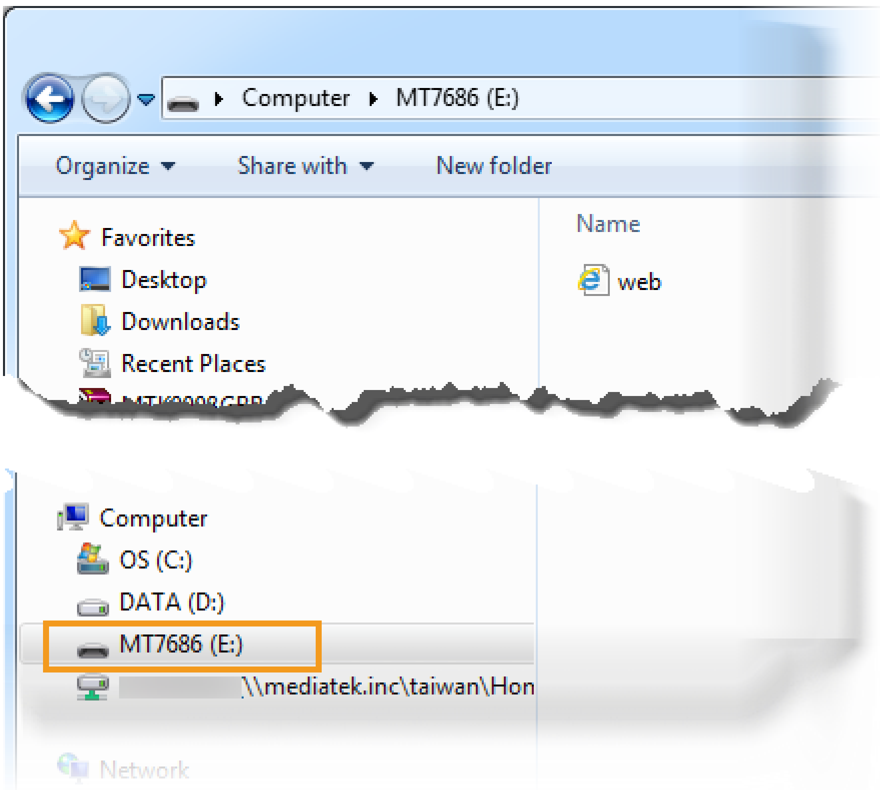


Figure 4. New removable storage detected

2.5. Enter IAR and GCC development interface

MT7686 HDK support IAR and GCC development interface to design or debug.

According to the following steps to enter these interfaces:

1) Set the jumpers J2107 pin 2 and pin 3, J2108 pin2 and pin 3 on.
2) Set the jumpers J2201 pin1 and pin2 on.

3) Power up the board with a micro-USB cable.

4) Use computer to enter the IAR and GCC software.

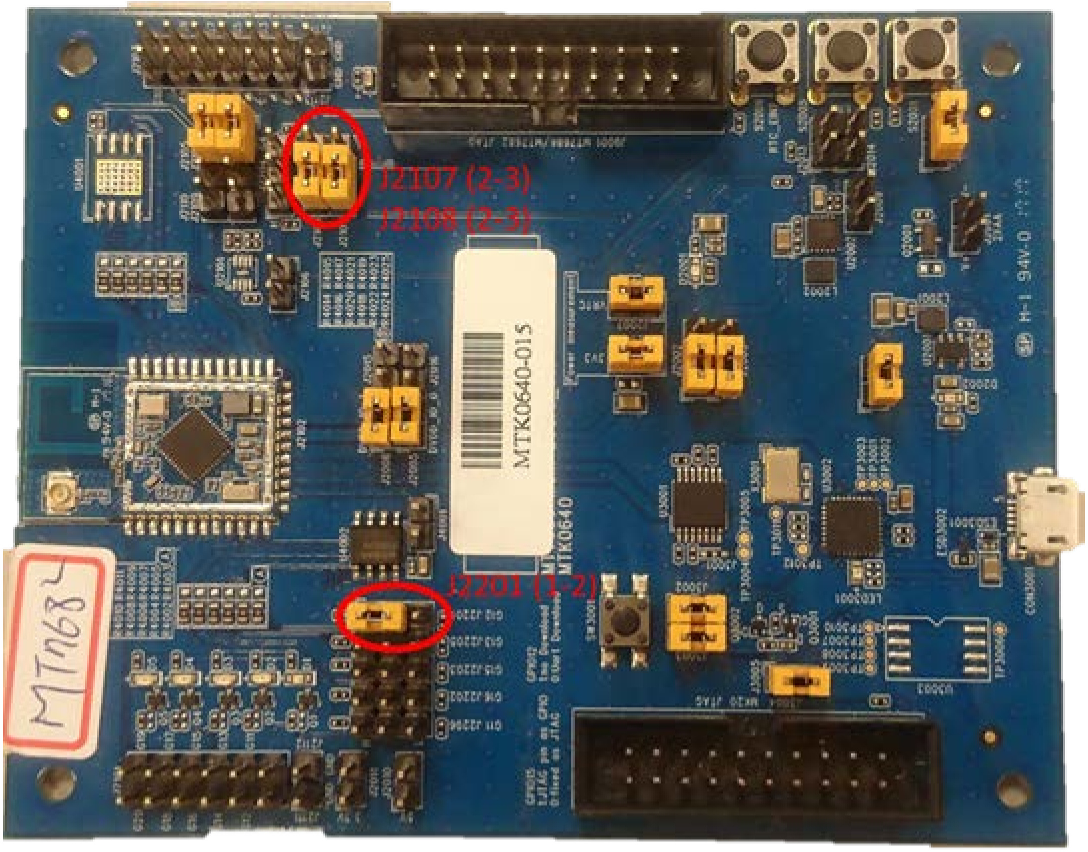


Figure 5. Switch j2107, j2108 and j2201 to enter IAR and GCC interface.

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} (1.8~3.63V).
- Eight LEDs
  - Power LEDs (**D2001, D2002**)
  - User LEDs (**D1, D2, D3**, **D4**, **D5**).
  - UART communication LEDs(**LED3001**)
- 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 6. 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**, **J2007**, and **J2009** are required to be set on. More details on the jumpers can be found in Table 2.

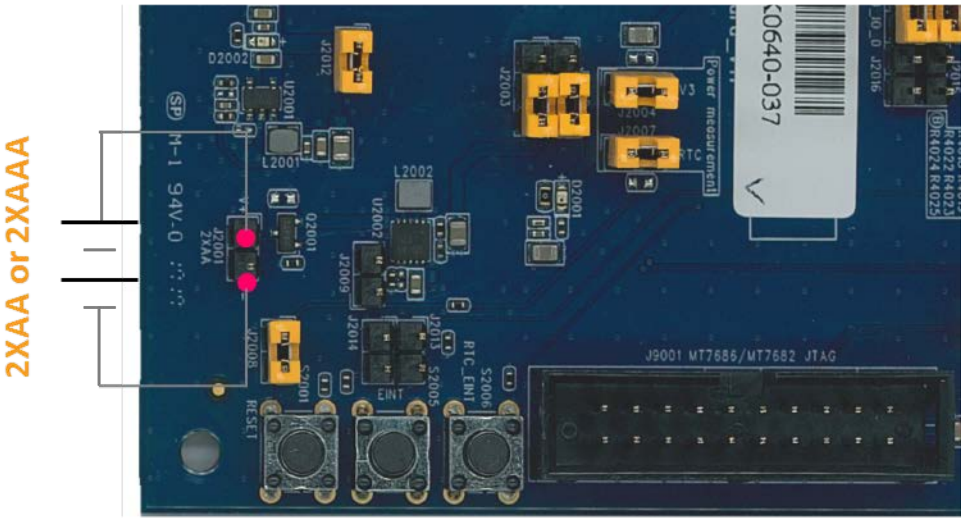


Figure 6. Power up the HDK using an AA or AAA Battery (J2001)

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.
J2009	Enables booster	Connects MT7686 EXT_PWR_EN (pin 21) to booster enabling pin

4.3. LEDs

The MT7686 HDK has onboard LEDs associated with different functionalities of the board (Figure 7).

1) **D2002** indicates the power rail 5V is on.
2) **D2001** indicates the power rail 3.3V is on.
3) Blinking **LED3001** indicates communication between MK20 UART and MT7682 UART0.
4) **D1**, **D2**, **D3**, **D4**, and **D5** are LEDs assigned for user interaction. All LEDs are high active (Figure 7).

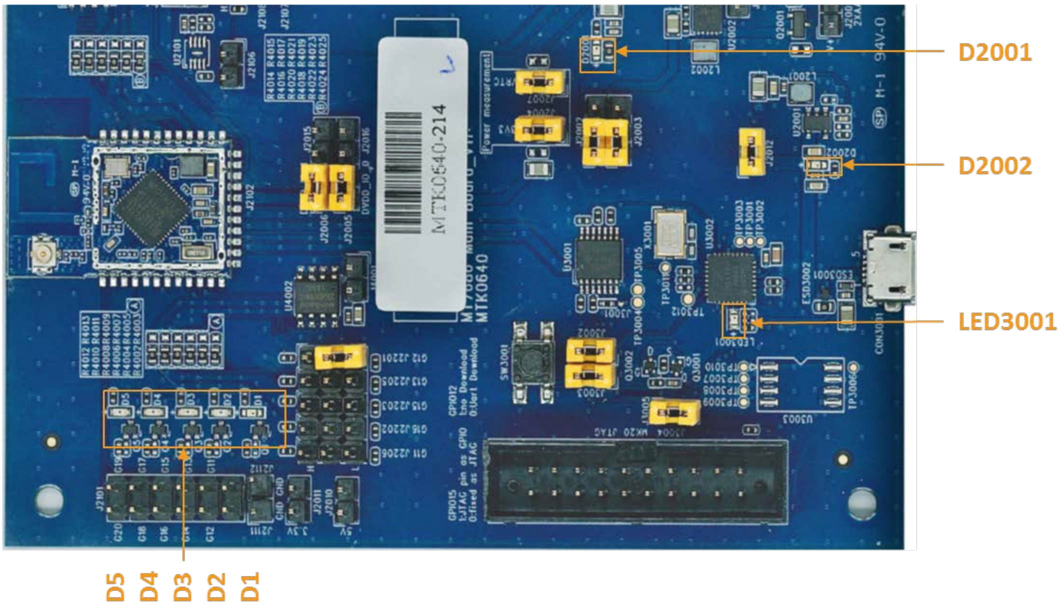


Figure 7. On-board LEDs

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) CMSIS-DAP Firmware update button (**SW3001**). Press the button to enter upload mode and upload the latest CMSIS-DAP Firmware to MK20.

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**	GPIO8
J2101.11	X **	**J2103.11**	x
J2101.12	RTC_EINT	**J2103.12**	GPIO10

Table 5. GPIO pin multi-function definition

Pin alias	Name	Description
GPIO0	GPIO0	General purpose input, output
	EINT0	External interrupt
	U1RTS	UART RTS
	SCL1	I2C CLK
	I2S_RX	I2S RX
	JTDI	JTAG Debug port
	WIFI_ANT_SEL0	External frontend control
	BT_PRI1	Wi-Fi and Bluetooth coexistence control signal
	PWM0	Pulse-width-modulated output
GPIO1	GPIO1	General purpose input, output
	EINT1	External interrupt
	U1CTS	UART CTS
	SDA1	I2C Data
	I2S_TX	I2S TX

	JTMS	JTAG Debug port
	WIFI_ANT_SEL1	External frontend control
	BT_PRI3	Wi-Fi and Bluetooth coexistence control signal
	PWM1	Pulse-width-modulated output
GPIO2	GPIO2	General purpose input, output
	EINT2	External interrupt
	URXD1	UART RX
	PWM0	Pulse-width-modulated output
	I2S_WS	I2S WS
	JTCK	JTAG Debug port
	CLKO0	Clock out port
	BT_PRI0	Wi-Fi and Bluetooth coexistence control signal
	WIFI_ANT_SEL4	External frontend control
GPIO3	GPIO3	General purpose input, output
	EINT3	External interrupt
	UTXD1	UART TX
	PWM1	Pulse-width-modulated output
	I2S_CK	I2S bit clock
	JTRST_B	JTAG Debug port
	WIFI_ANT_SEL2	External frontend control
	I2S_CK	I2S bit clock
GPIO4	GPIO4	General purpose input, output
	SPISLV_A_SIO2	SPI slave SIO2
	SPIMST_A_SIO2	SPI master SIO2
	EINT4	External interrupt
	I2S_MCK	I2S MCLK
	JTDO	JTAG Debug port
	WIFI_ANT_SEL3	External frontend control
	I2S_MCK	I2S MCLK
GPIO5	GPIO5	General purpose input, output
	SPISLV_A_SIO3	SPI slave SIO3
	SPIMST_A_SIO3	SPI master SIO3
	EINT5	External interrupt
	URXD0	UART RX
	WIFI_ANT_SEL0	External frontend control
	TDM_RX	TDM RX
	SCL0	I2C CLK
	PMU_RGU_RSTB	PMU Control Signal

GPIO6	GPIO6	General purpose input, output
	SPISLV_A_CS	SPI slave CS
	SPIMST_A_CS	SPI master CS
	EINT6	External interrupt
	UTXD0	UART TX
	WIFI_ANT_SEL1	External frontend control
	TDM_TX	TDM TX
	SDA0	I2C DATA
GPIO7	GPIO7	General purpose input, output
	SPISLV_A_SCK	SPI slave CLOCK
	SPIMST_A_SCK	SPI master CLOCK
	EINT7	External interrupt
	CLKO1	Clock out port
	WIFI_ANT_SEL2	External frontend control
	TDM_WS	TDM WS
	BT_PRI3	Wi-Fi and Bluetooth coexistence control signal
GPIO8	GPIO8	General purpose input, output
	SPISLV_A_SIO0	SPI slave SIO0
	SPIMST_A_SIO0	SPI master SIO0
	EINT8	External interrupt
	SCL0	I2C CLK
	U0RTS	UART RTS
	TDM_CK	TDM CK
	BT_PRI0	Wi-Fi and Bluetooth coexistence control signal
GPIO9	GPIO9	General purpose input, output
	SPISLV_A_SIO1	SPI slave SIO1
	SPIMST_A_SIO1	SPI master SIO1
	EINT9	External interrupt
	SDA0	I2C DATA
	U0CTS	UART CTS
	TDM_MCLK	TDM MCLK
	WIFI_ANT_SEL3	External frontend control
	BT_PRI1	Wi-Fi and Bluetooth coexistence control signal
GPIO10	GPIO10	General purpose input, output
	EINT10	External interrupt
	U2CTS	UART CTS
	PWM2	Pulse-width-modulated output

	PMU_RGU_RSTB	PMU Control Signal
	PMU_GOTO_SLEEP	PMU Control Signal
	WIFI_ANT_SEL4	External frontend control
	SDA0	I2C DATA
GPIO11	GPIO11	General purpose input, output
	EINT11	External interrupt
	PWM3	Pulse-width-modulated output
	URXD2	UART RX
	MA_MC0_CK	SDIO master clock
	SLV_MC0_CK	SDIO slave clock
	CLKO2	Clock out port
	WIFI_ANT_SEL0	External frontend control
	I2S_RX	I2S RX
GPIO12	GPIO12	General purpose input, output
	SPISLV_B_SIO3	SPI slave SIO3
	SPIMST_B_SIO3	SPI master SIO3
	UTXD2	UART TX
	MA_MC0_CM0	SDIO master command
	SLV_MC0_CM0	SDIO slave command
	EINT12	External interrupt
	WIFI_ANT_SEL1	External frontend control
	I2S_TX	I2S TX
GPIO13	GPIO13	General purpose input, output
	SPISLV_B_SIO2	SPI slave SIO2
	SPIMST_B_SIO2	SPI master SIO2
	U2RTS	UART RTS
	MA_MC0_DA0	SDIO mater Data0
	SLV_MC0_DA0	SDIO slave Data0
	CLKO4	Clock out port
	EINT13	External interrupt
	I2S_WS	I2S WS
GPIO14	GPIO14	General purpose input, output
	SPISLV_B_SIO1	SPI slave SIO1
	SPIMST_B_SIO1	SPI master SIO1
	TDM_RX	TDM RX
	MA_MC0_DA1	SDIO master Data1
	SLV_MC0_DA1	SDIO slave Data1
	PWM4	Pulse-width-modulated output
	EINT14	External interrupt
	CLKO4	Clock out port

GPIO15	GPIO15	General purpose input, output
	SPISLV_B_SIO0	SPI slave SIO0
	SPIMST_B_SIO0	SPI master SIO0
	TDM_TX	TDM TX
	MA_MC0_DA2	SDIO mater Data2
	SLV_MC0_DA2	SDIO slave Data2
	SCL1	I2C Clock
	EINT15	External interrupt
	PWM3	Pulse-width-modulated output
GPIO16	GPIO16	General purpose input, output
	SPISLV_B_SCK	SPI slave clock
	SPIMST_B_SCK	SPI master clock
	TDM_WS	TDM WS
	MA_MC0_DA3	SDIO master Data3
	SLV_MC0_DA3	SDIO slave Data3
	SDA1	I2C data
	EINT16	External interrupt
GPIO17	GPIO17	General purpose input, output
	SPISLV_B_CS	SPI slave CS
	SPIMST_B_CS	SPI master CS
	TDM_CK	TDM CK
	CLKO3	Clock out port
	AUXADC0	AUX ADC
	EINT17	External interrupt
	BT_PRI0	Wi-Fi and Bluetooth coexistence control signal
GPIO18	GPIO18	General purpose input, output
	PMU_GOTO_SLEEP	PMU Control Signal
	TDM_MCLK	TDM MCLK
	CLKO4	Clock out port
	SDA1	I2C data
	ZCV (SW set AUXADC1)	AUX ADC
	EINT18	External interrupt
	CLKO3	Clock out port
	PMU_RGU_RSTB	PMU Control Signal
GPIO19	GPIO19	General purpose input, output
	URXD0	UART RX
	EINT19	External interrupt
	SCL1	I2C Clock
	PWM5	Pulse-width-modulated output

	AUXADC2	AUX ADC
GPIO20	GPIO19	General purpose input, output
	UTXD0	UART TX
	EINT20	External interrupt
	AUXADC3	AUX ADC

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 8. 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).

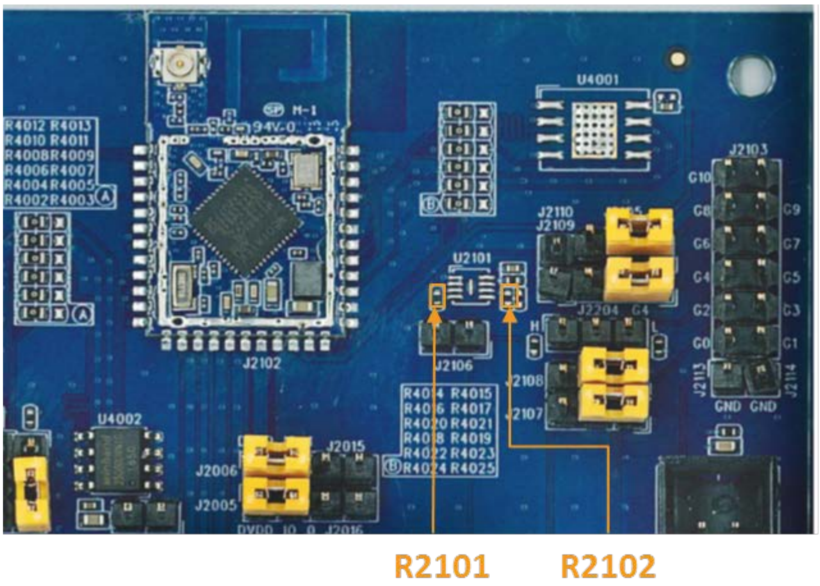


Figure 8. Locations of I2C pull-up resistors

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 retention mode, the PMU is turned off while the RTC module remains powered on. The RTC module only consumes 3µA in retention 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**.

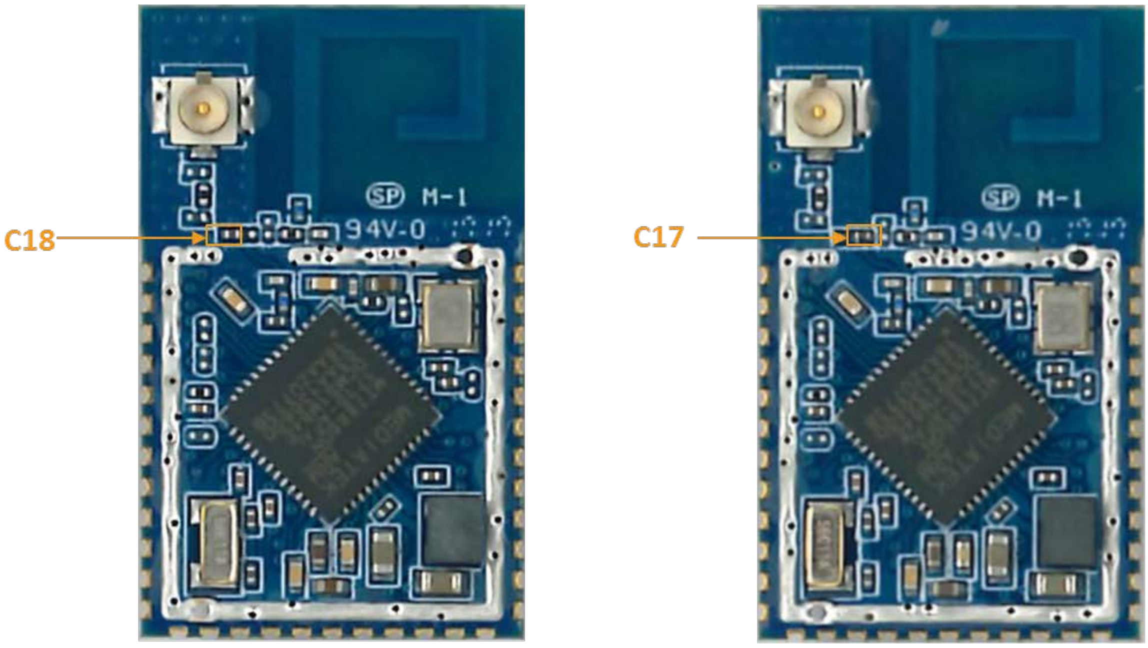


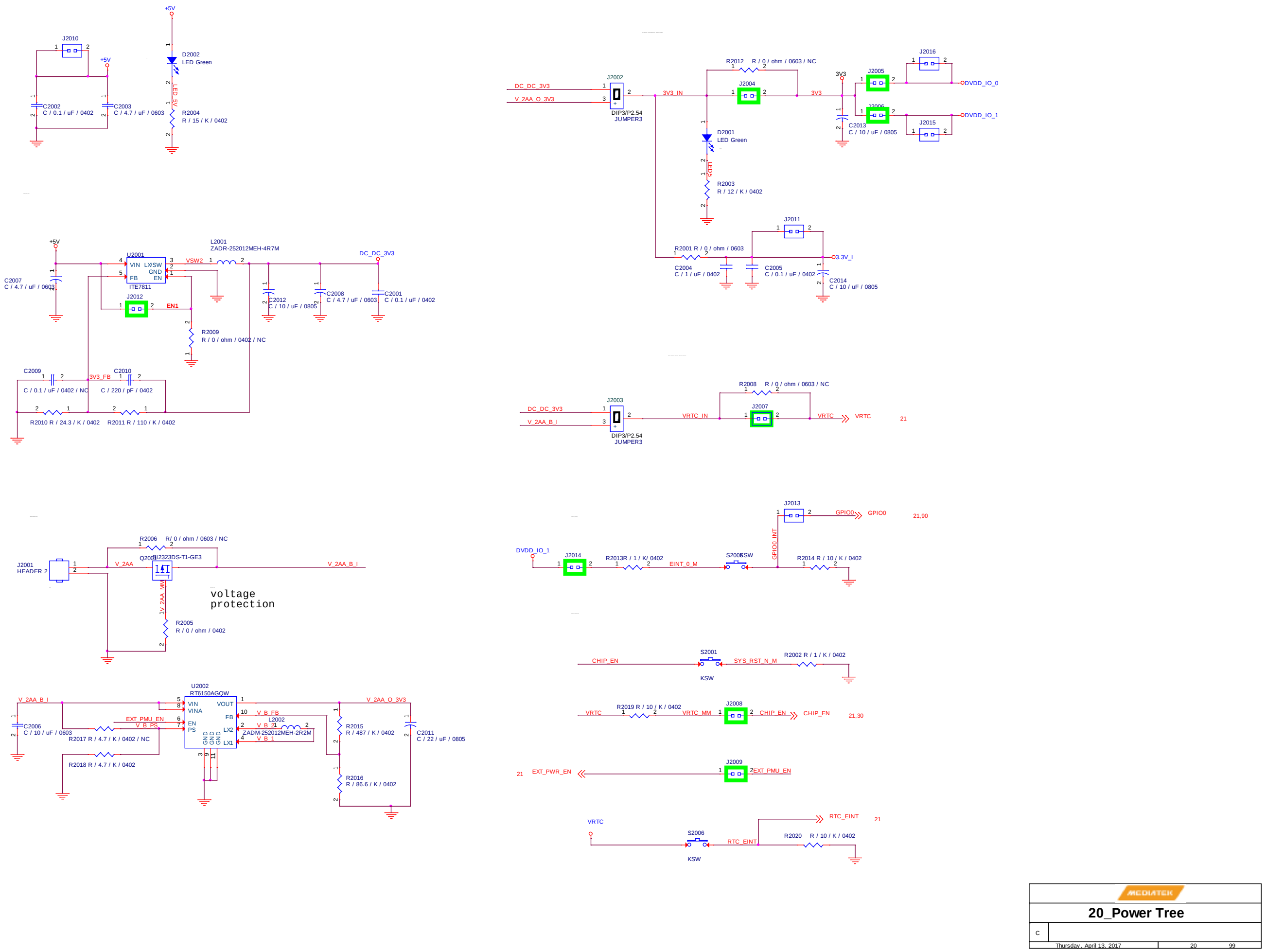
Figure 9. Location of the components C17 and C18

4.8. CMSIS-DAP firmware update procedure

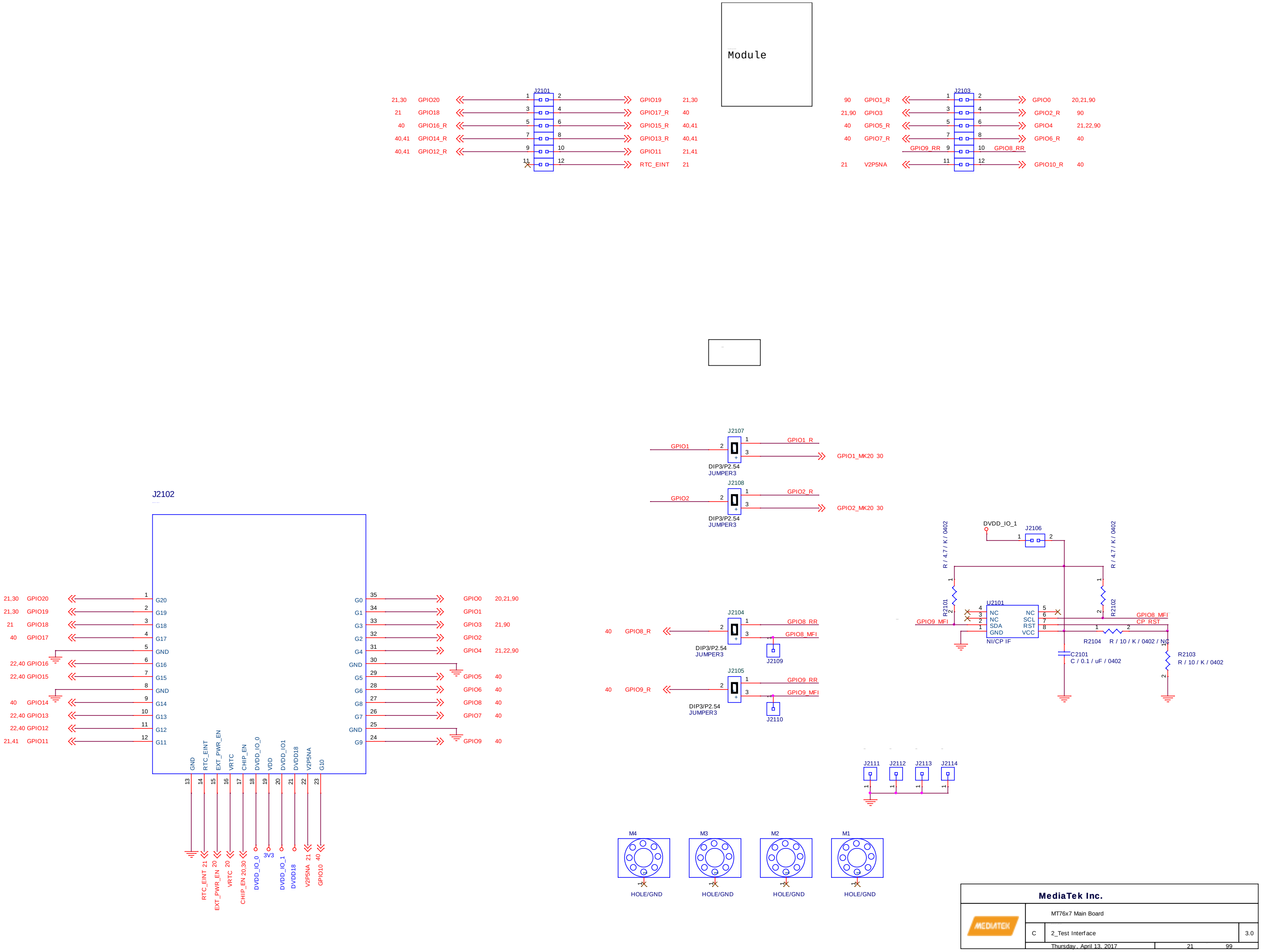
The latest firmware from OpenSDA platform can be downloaded from the mbed official website. To update the binary firmware of CMSIS-DAP, press and hold the **SW3001**, then plug-in the USB cable to **CON3001**, release the button **SW3001** once the mass storage is shown, and then drag and drop in the 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)

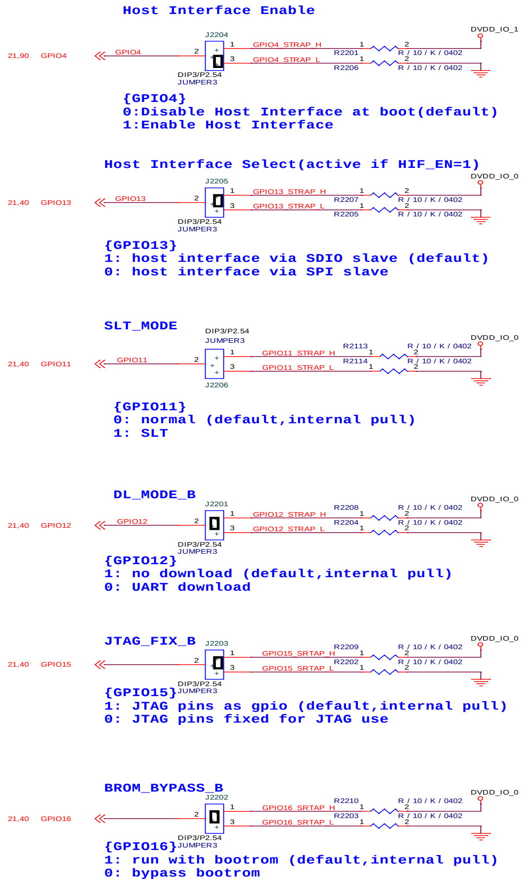
Main board schematic-1



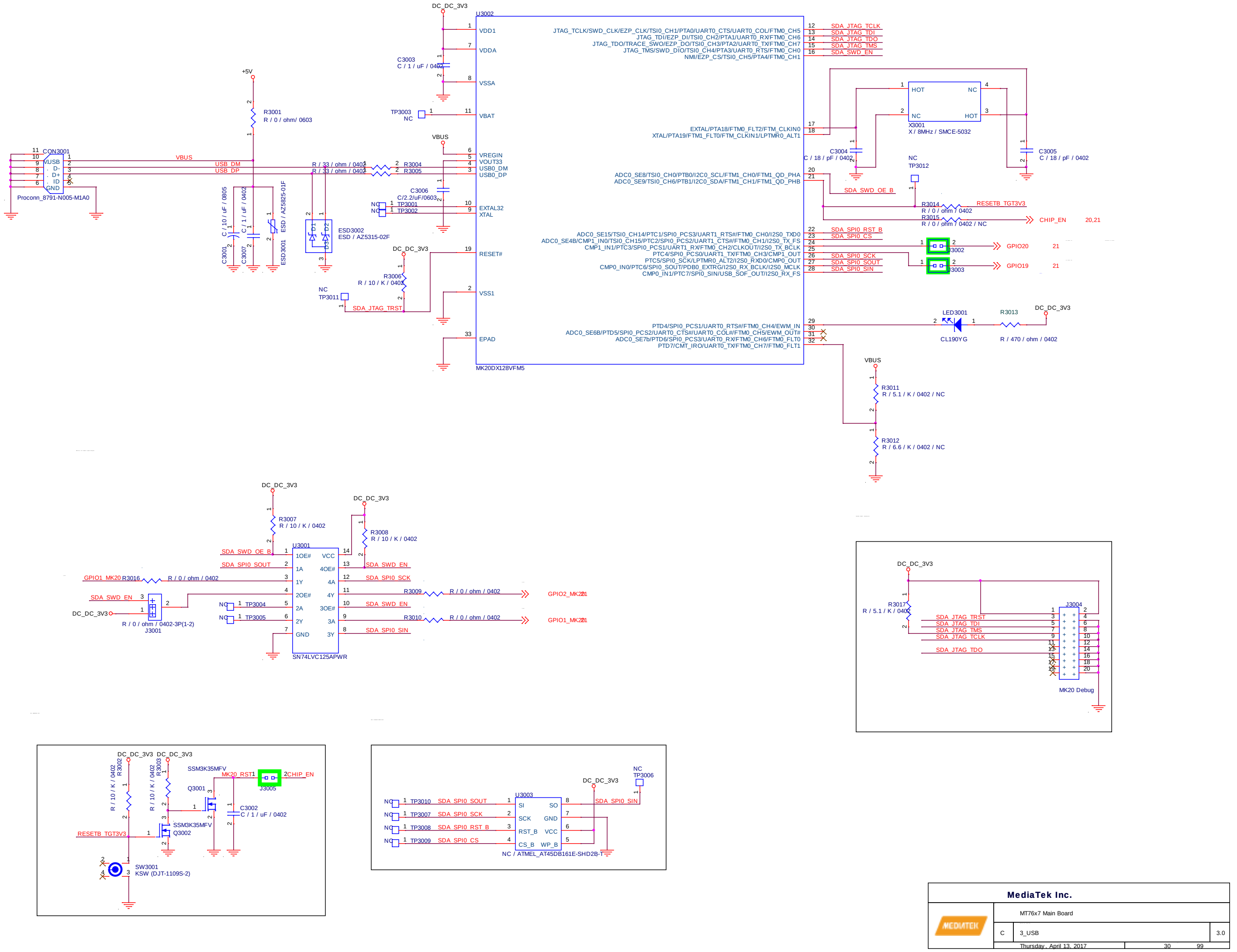
Main board schematic-2



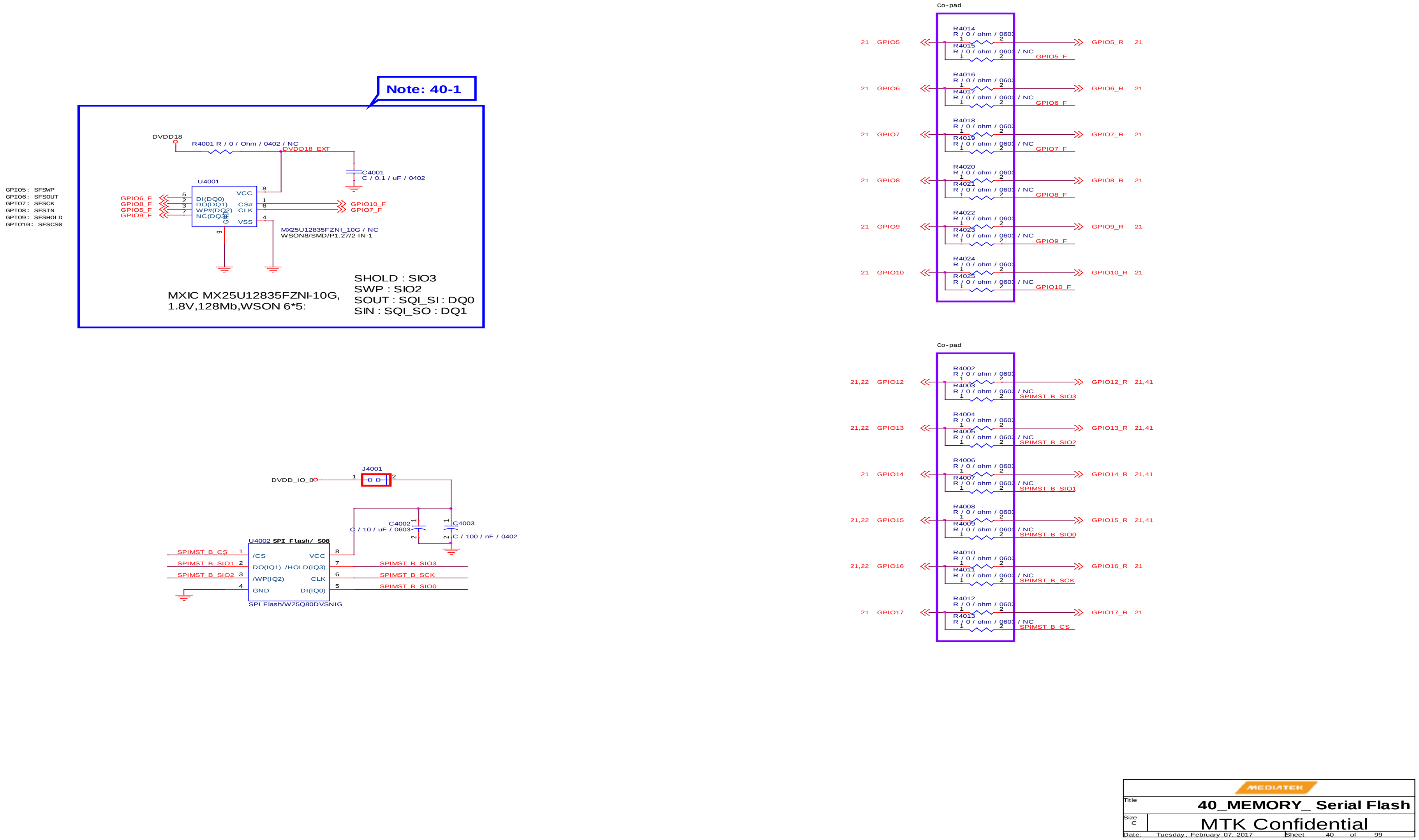
Main board schematic-3



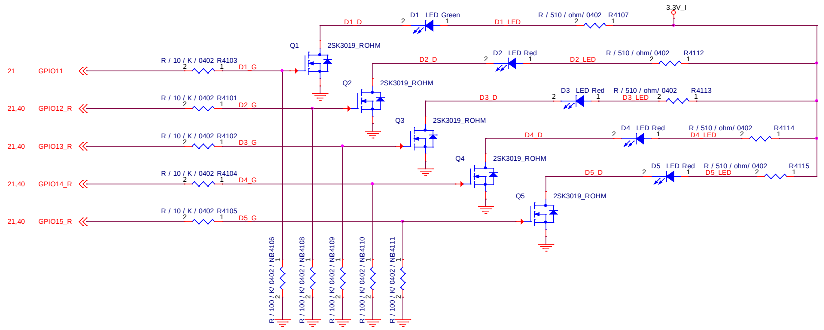
Main board schematic-4



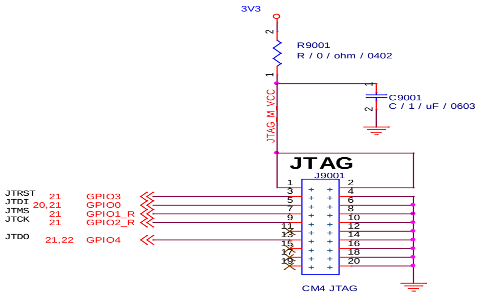
Main board schematic-5



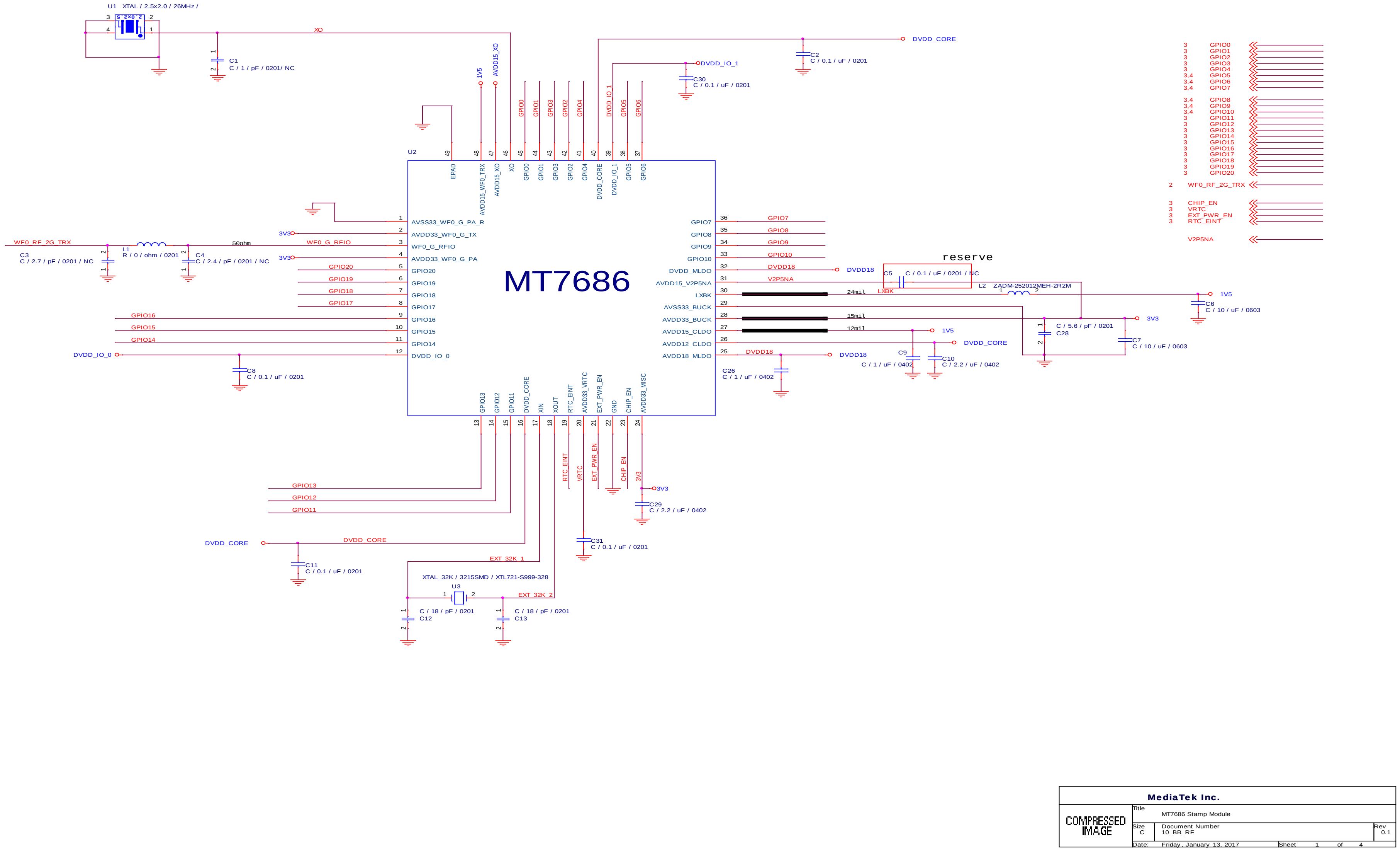
Main board schematic-6



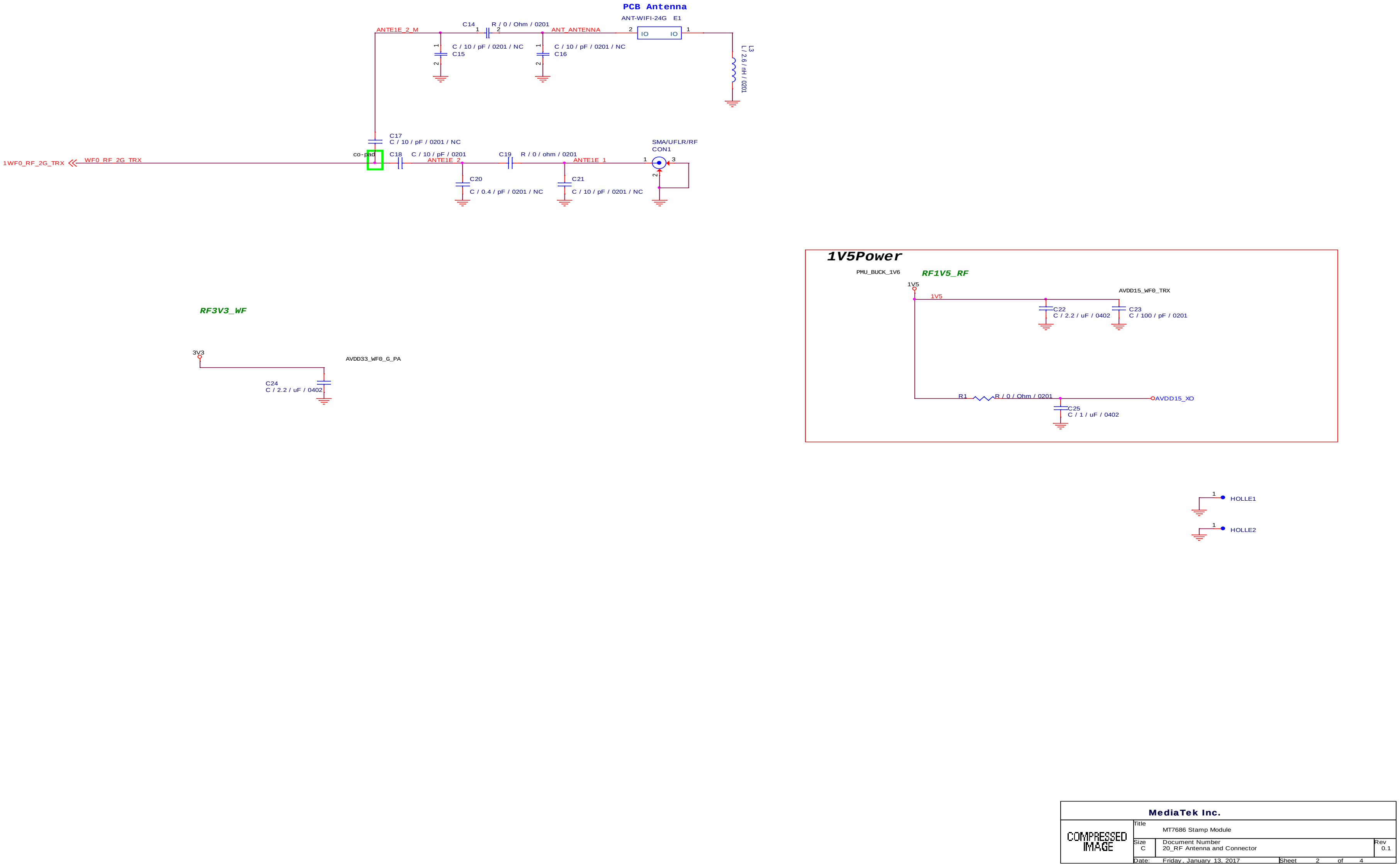
Main board schematic-7



MT7686_STAMP_MODULE_V10 schematic-1



MT7686_STAMP_MODULE_V10 schematic-2



MT7686_STAMP_MODULE_V10 schematic-3

Strap Pin

XTAL Select

GPIO17 R4 R / 10K / Ohm / 0201 / NC DVDD_IO_0

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

JTAG_FIX_B

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

SLOW_SRC_B

GPIO14 R5 R / 10K / Ohm / 0201

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

BROM_BYPASS_B

GPIO16 R6 R / 10K / Ohm / 0201 / NC

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

Host Interface Enable

GPIO4 R2 R / 10K / Ohm / 0201 / NC DVDD_IO_1

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

SLT_MODE

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

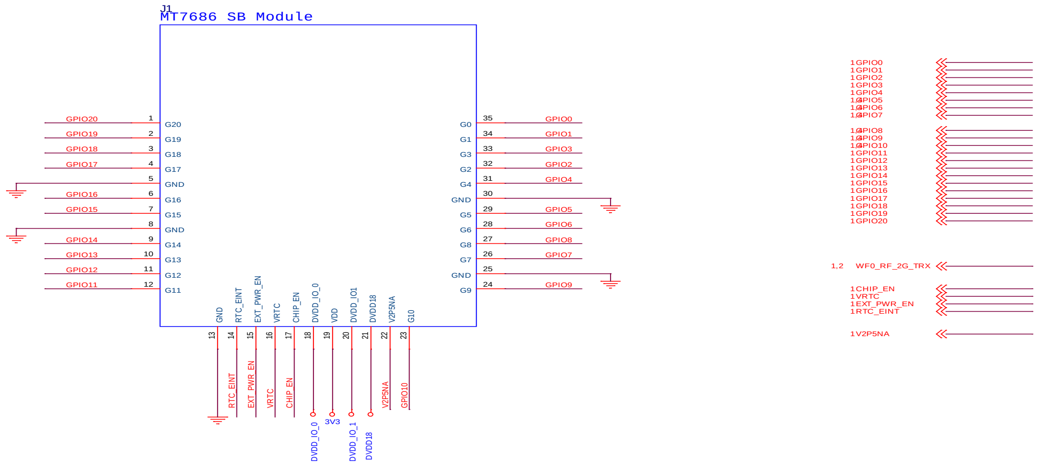
Host Interface Select(active if HIF_EN=1)

GPIO13 R7 R / 10K / Ohm / 0201 / NC

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

DL_MODE_B

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



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COMPRESSED IMAGE	Title: MT7686 Stamp Module	
	Size: C — Document Number: 21_Strap and Module	Rev: 0.1
	Date: Friday, January 13, 2017	Sheet 3 of 4