UM2135
User manual

Discovery kit with STM32F413ZH MCU

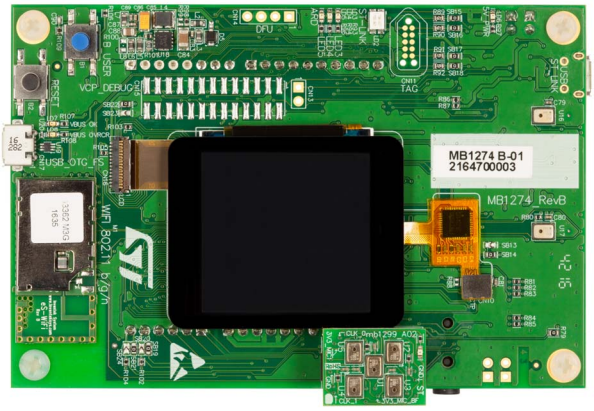
Introduction

The 32F413HDISCOVERY Discovery kit is a complete demonstration and development platform for the STMicroelectronics ARM® Cortex®-M4 core-based STM32F413ZHT6 microcontroller. This microcontroller features up to 18 timers, internal 320-Kbyte SRAM, 1.5-Mbyte Flash memory and the following interfaces: four I^2Cs, five I^2Ss two of which are full duplex, one SDIO, four USARTs, six UARTs, three CANs, one 12-bit ADC, two 12-bit DACs, one SAI, six digital filters for Sigma Delta Modulator, twelve PDMs with stereo microphone and beamforming support, one USB OTG FS, one FSMC interface, one Quad-SPI interface and one SWD debugging support. The 32F413HDISCOVERY Discovery kit offers everything required for users to get started quickly and develop applications easily.

The full range of hardware features of the 32F413HDISCOVERY Discovery kit helps users to evaluate almost all peripherals (USB OTG FS, microSD™ card, Wi-Fi® 802.11 b/g/n, I^2S Audio DAC stereo with audio jack, ST-MEMS digital microphones, PSRAM, Quad-SPI Flash memory, LCD parallel interface with capacitive multi-touch panel and others) and develop applications. The Arduino™ Uno V3 connectivity support provides unlimited expansion capabilities with a large choice of specialized add-on boards.The expansion connectors allow easy connection of a daughterboard for specific customer applications. The integrated ST-LINK/V2-1 provides an embedded in-circuit debugger and programmer for the STM32.

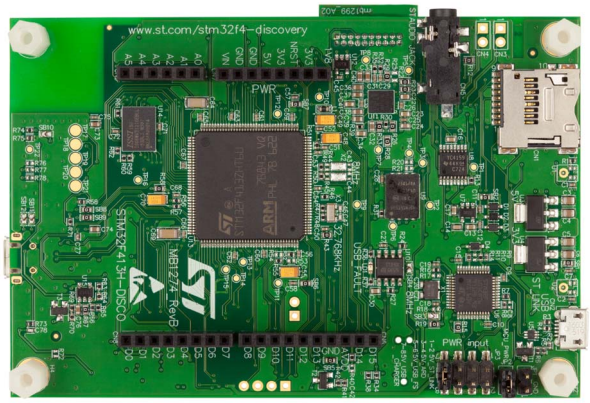
The 32F413HDISCOVERY Discovery kit comes with the comprehensive free software libraries and examples available with the STM32Cube package.

Figure 1. 32F413HDISCOVERY board



(Top view with LCD)

Figure 2. 32F413HDISCOVERY board



(Bottom view with STM32F413ZHT6)

1. Pictures are not contractual.

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- STM32F413ZHT6 microcontroller featuring 1.5 Mbytes of Flash memory and 320 Kbytes of SRAM, in LQFP144 package
- 240x240-pixel TFT LCD with touch screen
- 8-Mbit PSRAM; 512K word x 16bits
- 128-Mbit Quad-SPI Flash memory
- I^2S audio codec
- 2 on-board ST-MEMS microphones
- Integrated Wi-Fi® module compliant with 802.11 b/g/n
- 2 push-buttons (user and reset)
- 2 user LEDs: one green and one red
- Jack connector for Audio line with microphone input and stereo output
- Connector for microSD™ card
- USB OTG FS with Micro-AB connector
- Expansion connectors:
  - Audio daughterboard (5 ST-MEMS microphones)
  - Arduino Uno V3
- Flexible power supply options:
  - ST LINK USB V_{BUS} or external sources
- On-board ST-LINK/V2-1 debugger/programmer with USB re-enumeration capability: mass storage, virtual COM port, debug port
- Comprehensive free software libraries and examples available with the STM32Cube package
- Support of wide choice of Integrated Development Environments (IDEs) including IAR™, Keil®, GCC-based IDEs

2 Product marking

Evaluation tools marked as "ES" or "E" are not yet qualified and therefore they are not ready to be used as reference design or in production. Any consequences deriving from such usage will not be at ST charge. In no event, ST will be liable for any customer usage of these engineering sample tools as reference design or in production.

"E" or "ES" marking examples of location:

- On the targeted STM32 that is soldered on the board (for illustration of STM32 marking, refer to the section “Package characteristics” of the STM32 datasheet at *www.st.com*).
- Next to the evaluation tool ordering part number, that is stuck or silk-screen printed on the board.

3 System requirements

- Windows® OS (XP, 7, 8 and 10), Linux® or MacOS™
- USB Type-A to Micro-B cable

4 Development toolchains

- ARM® Keil®: MDK-ARM(a)
- IAR™: EWARM(a)
- GCC-based IDEs: free SW4STM32 from AC6

5 Demonstration software

The demonstration software is preloaded in the STM32F413ZH Flash memory for easy demonstration of the device peripherals in standalone mode. The latest versions of the demonstration source code and associated documentation can be downloaded from the www.st.com/stm32f4-discovery webpage.

a. On Windows® only.

6 Ordering information

To order the 32F413HDISCOVERY Discovery kit, refer to *Table 1*:

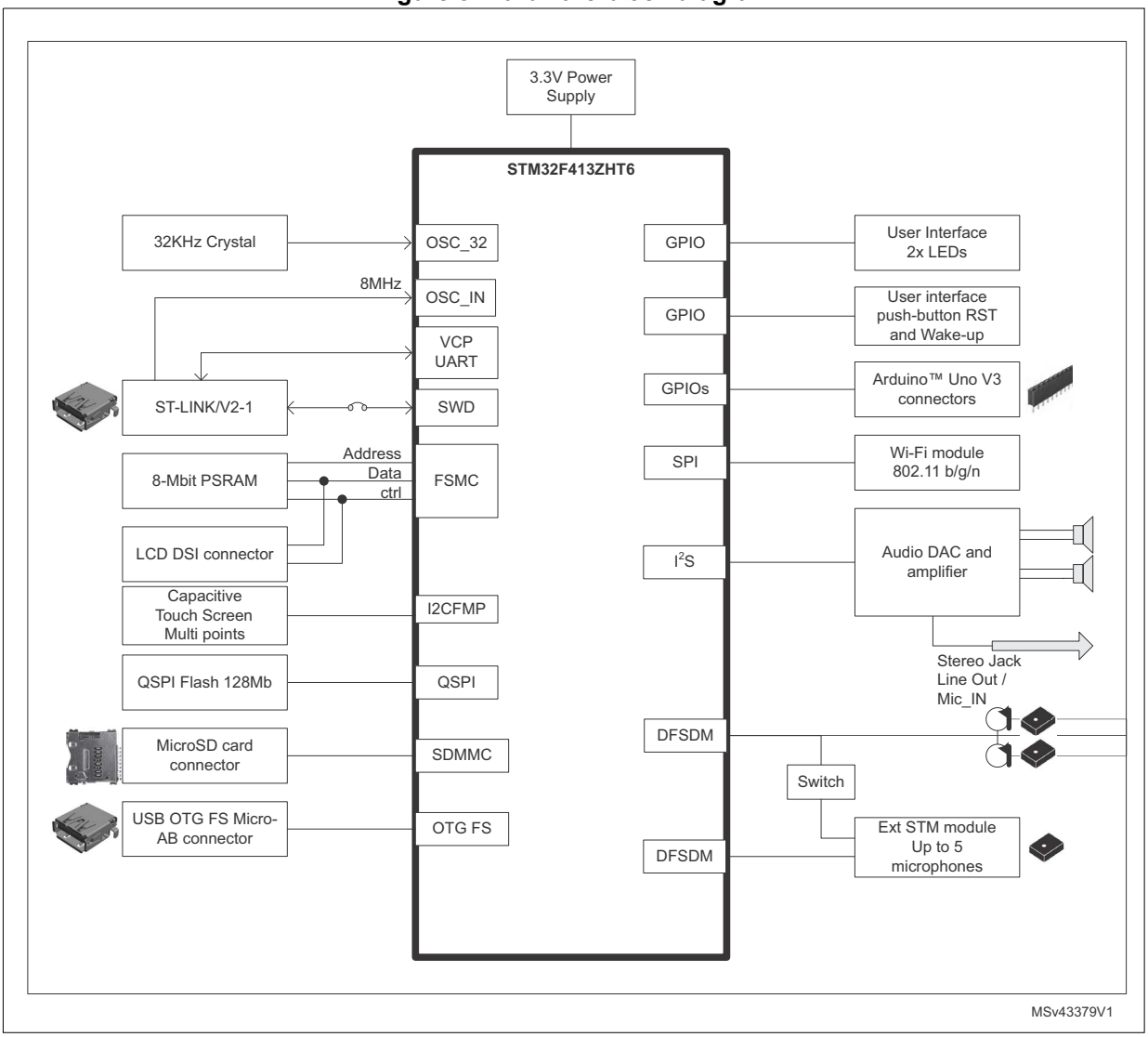
Table 1. Ordering information

Order code	Target STM32
STM32F413H-DISCO	STM32F413ZHT6

7 Hardware layout and configuration

The 32F413HDISCOVERY Discovery kit is designed around the STM32F413ZH (144-pin in LQFP package). The hardware block diagram (see *Figure 3*) illustrates the connection between the STM32 and the peripherals (PSRAM, Quad-SPI Flash memory, LCD connector, USB OTG connectors, USART, Audio, microSD™ card, Arduino™ Uno V3 shields and embedded ST-LINK/V2-1). Refer to *Figure 4* and *Figure 5* to locate these features on the 32F413HDISCOVERY board.

Figure 3. Hardware block diagram



7.1 32F413HDISCOVERY Discovery kit layout

Figure 4. 32F413HDISCOVERY Discovery kit (top side)

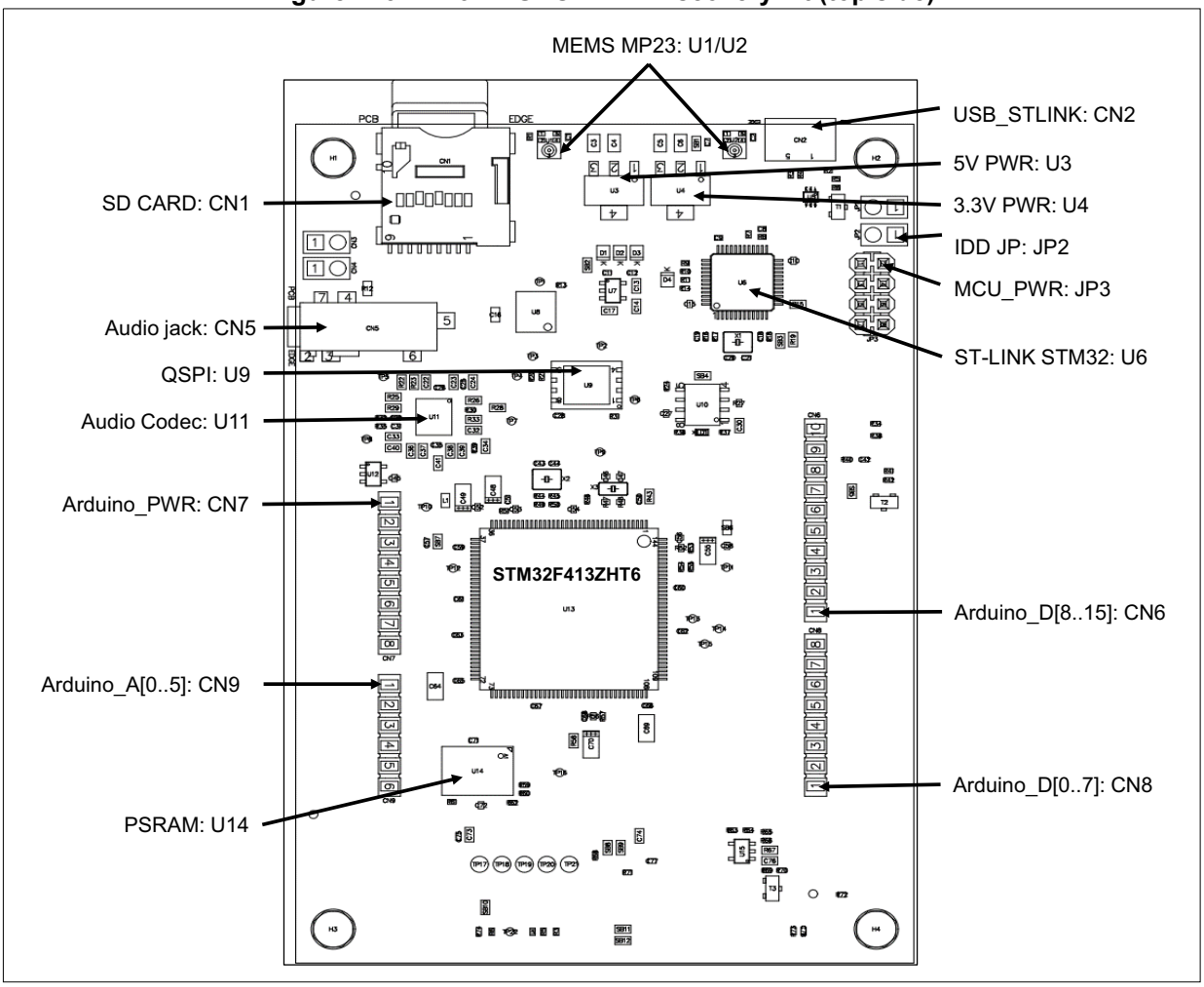
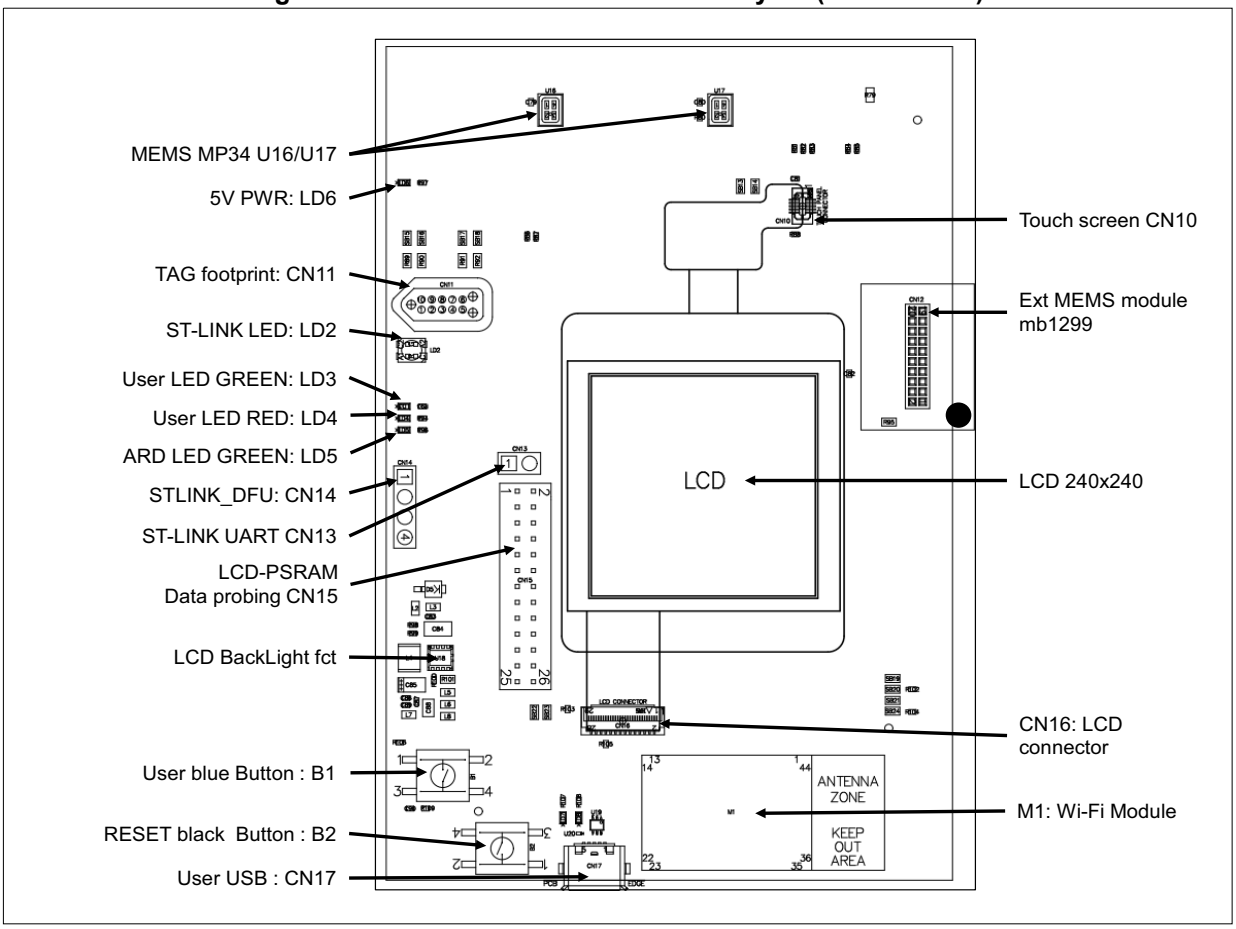


Figure 5. 32F413HDISCOVERY Discovery kit (bottom side)



7.2 Embedded ST-LINK/V2-1

The ST-LINK/V2-1 programming and debugging tool is integrated on the 32F413HDISCOVERY Discovery kit. The new features supported on ST-LINK/V2-1 and not present on ST-LINK/V2 are listed below:

- USB software re-enumeration
- Virtual COM port interface on USB
- Mass storage interface on USB
- USB power management request for more than 100 mA power on USB

These features are no more supported on ST-LINK/V2-1:

- SWIM interface
- Application voltage lower than 3 V

For all general information concerning debugging and programming features common between V2 and V2-1 versions, refer to *ST-LINK/V2 in-circuit debugger/programmer for STM8 and STM32* User manual (UM1075) at the *www.st.com* website.

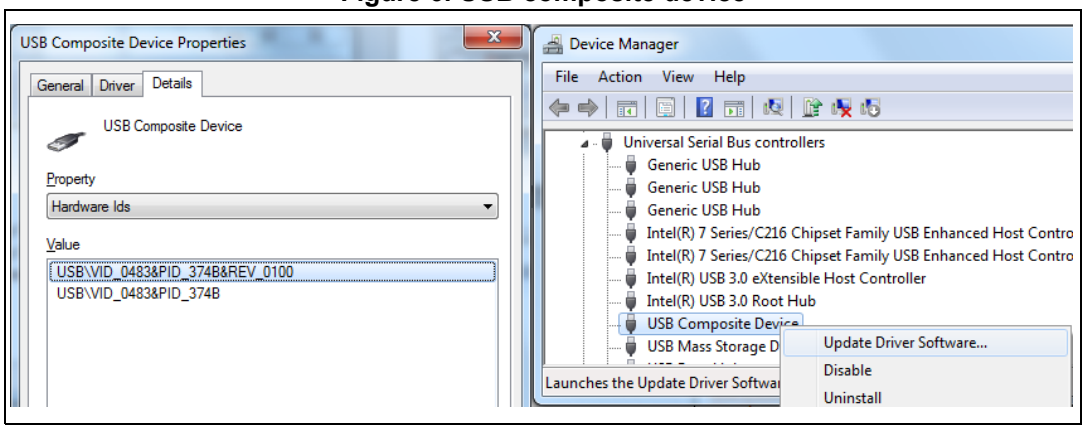
7.2.1 Drivers

Before connecting the 32F413HDISCOVERY Discovery kit to a Windows® PC (XP, 7, 8 or 10) through a USB, a driver for the ST-LINK/V2-1 must be installed. It is available at the *www.st.com* website.

In case the 32F413HDISCOVERY Discovery kit is connected to the PC before the driver is installed, some 32F413HDISCOVERY interfaces may be declared as "unknown" in the PC device manager. To recover from this situation the user must install the driver files, and update the driver of the connected device from the device manager (see *Figure 6*).

Note: Prefer using the "USB Composite Device" handle for a full recovery.

Figure 6. USB composite device



7.2.2 ST-LINK/V2-1 firmware upgrade

The ST-LINK/V2-1 embeds a firmware upgrade mechanism for in-situ upgrade through the USB port. As the firmware may evolve during the life time of the ST-LINK/V2-1 product (for example new functionalities, bug fixes, support for new microcontroller families), it is recommended to visit *www.st.com* before starting to use the 32F413HDISCOVERY Discovery kit and periodically, to stay up-to-date with the latest firmware version.

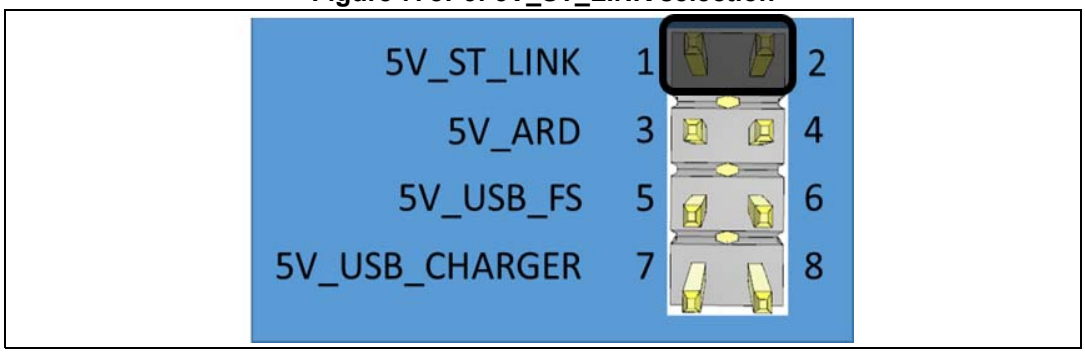
7.2.3 Power supply

The 32F413HDISCOVERY Discovery kit is designed to be powered by 5 V DC power supply. It is possible to configure the 32F413HDISCOVERY board to use any of the following four sources for the power supply:

- **5V_ST_LINK**: DC power from USB ST-LINK connector.The power source is the USB Micro-B connector of the ST-LINK/V2-1 (CN2). A jumper needs to be placed on pins 1 and 2 of JP3 (5V_ST_LINK on silkscreen) to enable this power source (see *Figure 7*). It is the default setting. In this configuration only the ST-LINK MCU is powered before the USB enumeration, because the host PC only provides 100 mA to the board at that time. During the USB enumeration, the 32F413HDISCOVERY board asks for the 500 mA power to the host PC. If the host is able to provide the required power, the enumeration succeeds and, the power transistor ST890 (U10) is switched ON, the entire board is powered and the LED LD1 remains turned OFF, thus the 32F413HDISCOVERY board consumes up to 500 mA current, but no more. If the host is not able to provide the requested current, the enumeration fails. Therefore the ST890 remains OFF and the MCU part including the extension board is not powered. As a

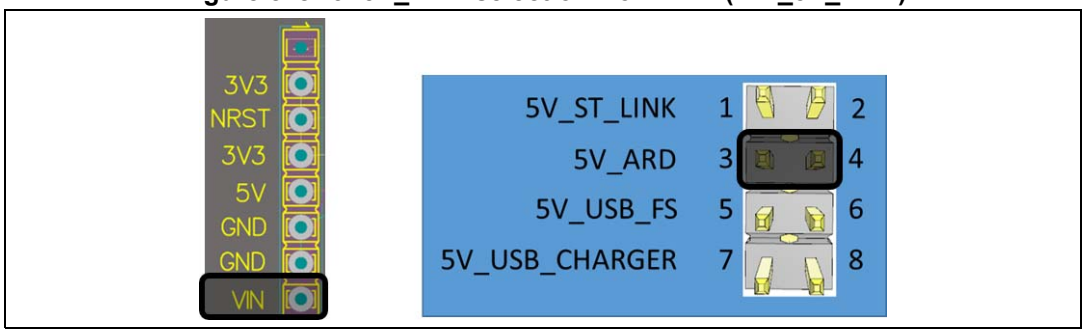
consequence the red LED LD1 is turned ON. In this case it is mandatory to use an external power supply.

Figure 7. JP3: 5V_ST_LINK selection



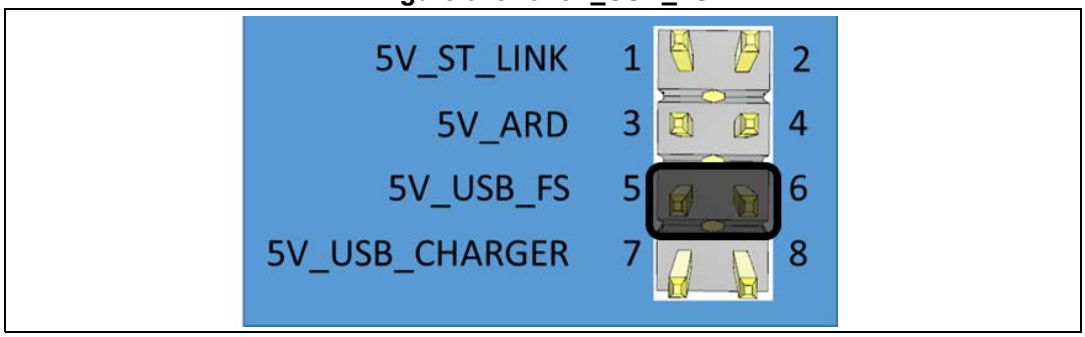
- **5V_ARD**: 7-12V DC power from Arduino Uno V3 connector. The power source is CN7 pin 8 named V_{IN} on Arduino connector silkscreen. A jumper needs to be placed on pins 3 and 4 of JP3 (5V_ARD on silkscreen) to enable this power source (see *Figure 8*).

Figure 8. JP3: 5V_ARD selection from CN7 (VIN_5V_ARD)



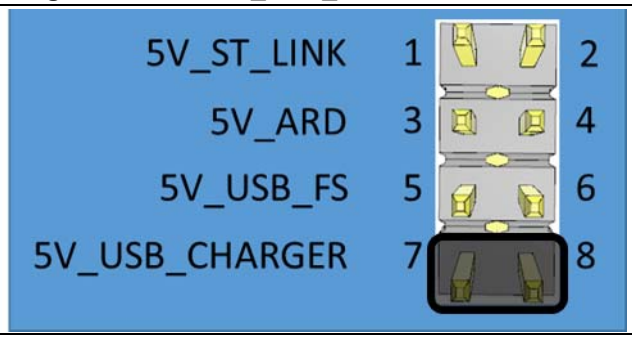
- **5V_USB_FS**: DC power from USB user connector.The power source is the USB Micro-AB connector (CN17). In this case, the 32F413HDISCOVERY board is powered by an external USB host without current limitation on board. A jumper needs to be placed on pins 5 and 6 of JP3 (5V_USB_FS on silkscreen) to enable this power source (see *Figure 9*).

Figure 9. JP3: 5V_USB_FS



- **5V_USB_CHARGER**: DC power charger from USB ST-LINK. The power source is the USB Micro-B connector of the ST-LINK/V2-1 (CN2). In this case, if the 32F413HDISCOVERY Discovery kit is powered by an external USB charger the debug is not available. If the PC is connected instead of the charger, the limitation is no more effective, in this case the PC could be damaged. A jumper has to be placed on pins 7 and 8 of JP3 (5V_USB_CHARGER on silkscreen) to enable this power source (see *Figure 10*).

Figure 10. JP3: 5V_USB_CHARGER selection



Note: In case the board is powered by a USB charger, there is no USB enumeration, so the led LD1 remains set to OFF permanently and the board is not powered. In this specific case only, the jumper JP3 should be set in position 7-8, to allow the board to be powered anyway.

Caution: Do not connect the PC to the ST-LINK (CN2) when R45 is soldered. The PC may be damaged or the board may not be powered correctly.

STM32F413ZH IDD current measurement: JP2

The STM32F413ZH current measurement can be done on JP2. By default a jumper is placed on JP2.

For current measurement configuration, the jumper on JP2 should be removed and an amp meters should be place on JP2.

Note: The 32F413HDISCOVERY *Discovery kit must be powered by a power supply unit or by an auxiliary equipment complying with the standard EN-60950-1: 2006+A11/2009, and must be Safety Extra Low Voltage (SELV) with limited power capability.*

7.3 Programming/debugging when the power supply is not from ST-LINK/V2-1

It is mandatory to power the 32F413HDISCOVERY Discovery kit first using CN7 (V_{IN}) or CN17 (USB_FS_OTG), then connecting the USB cable to the PC. Proceeding this way ensures that the enumeration succeeds thanks to the external power source.

The following power sequence procedure must be respected:

1. Connect the jumper JP3 on (5V_ARD) or (5V_USB_FS)
2. Connect the external power source to CN7 in case of an Arduino shield or CN17 in case of an USB FS host interface

3. Check that the GREEN LED LD6 is turned ON
4. Connect the PC to USB connector CN2

If this order is not respected, the board may be powered by V_{BUS} first from ST-LINK, and the following risks may be encountered:

1. If more than 500 mA current is needed by the board, the PC may be damaged or current can be limited by the PC. As a consequence the board is not powered correctly.
2. 500 mA is requested at the enumeration, so there is a risk that the request is rejected and enumeration does not succeed if the PC cannot provide such current.

7.4 Clock sources

Three clock sources are described below:

- MCO, 8 MHz clock from ST-LINK MCU for the STM32F413ZHT6
- X2, 8 MHz oscillator for the STM32F413ZHT6
- X1, 32.768 KHz crystal for the STM32F413ZHT6 embedded RTC

7.5 Reset sources

The reset signal of the 32F413HDISCOVERY Discovery kit is active low and the reset sources include:

- Reset button B2
- Arduino Uno V3 shield board from CN7
- Embedded ST-LINK/V2-1

7.6 Audio

An audio codec WM8994ECS/R from CIRRUS with four DACs and two ADCs is connected to the I^2S interface of the STM32F413ZH. It communicates with the STM32 via the I^2C bus shared with the touch panel of the FRIDA LCD.

- The analog-line output is connected to the DAC of WM8994ECS/R via audio jack CN5.
- The microphone input is connected from the audio jack to the input line of WM8994ECS/R
- Two optional external speakers can be connected to WM8994ECS/R through CN3 for left speaker and through CN4 for right speaker.
- Two digital microphones (ST-MEMS microphone) MP34DT01TR-M are on 32F413HDISCOVERY Discovery kit. They are connected to the digital input microphones of the STM32F413ZH and are managed by the DFSDM functionality.
- The connector CN12 offers the possibility to connect a microphone module with up to five ST-MEMS microphones (see *Figure 26: Audio*). They are connected to the digital input microphones of the STM32F413ZH and are managed by the DFSDM functionality.

7.7 USB OTG FS

The 32F413HDISCOVERY Discovery kit supports the USB OTG FS communication via a USB Micro-AB connector.

A USB power switch (U15) is also connected on V_{BUS} and provides power to CN17. The green LED LD7 is lit when either:

- Power switch is ON and the 32F413HDISCOVERY works as a USB host
- V_{BUS} is powered by another USB host when the32F413HDISCOVERY works as a USB device.

The red LED LD8 is lit when an overcurrent occurs.

Note:1 When the 32F413HDISCOVERY board is powered by the ST-LINK, the OTG function provides up to 100 mA.

Note:2 When the 32F413HDISCOVERY board is powered by an external power supply, the OTG function can provide more than 100 mA, according to the external power supply capability.

Note:3 When the 32F413HDISCOVERY board is powered by an external power supply through the USB FS connector (CN17), in device mode, do not use a PC as power source.

7.8 microSD card

The 32F413HDISCOVERY Discovery kit supports the microSD card connected to the SDIO port of the STM32F413ZH.

The microSD card has to be compatible with the MMC 4.1 specification, or with the microSD card memory specification version 2.0

7.9 PSRAM memory

The 8-Mbit PSRAM (IS66WV51216EBLL-55BLI from ISSI: Integrated Silicon Solution Inc) is connected to the FSMC interface of the STM32F413ZH. This memory is organize as 512K words by 16 bits.

7.10 Quad-SPI NOR Flash memory

The 128-Mbit Quad-SPI NOR Flash memory (N25Q128A13EF840F from MICRON) is connected to the Quad-SPI interface of the STM32F413ZH.

7.11 Virtual COM port

The serial interface USART6 is directly available as a virtual COM port of the PC connected to the ST-LINK/V2-1 USB connector CN13. The virtual COM port settings are configured as:

- 115200 b/s
- 8 bits data
- no parity
- 1 stop bit
- no flow control

7.12 LCD

The 240x240-pixel TFT LCD (FRD154BP2902 from Frida) is connected to the FSMC data interface of the STM32F413ZH.

It uses the Sitronix ST7789H2 controller for 262K-color and TFT-LCD graphic type. Display data are stored into the on-chip display data RAM of 240x320x18 bits. It performs display data RAM read/write operation with no external operation clock, to minimize power consumption.

An external SRAM is also used to store display data.

LCD_RS signal is used to determine whether the bus is carrying data or control/command registers.

7.13 Capacitive control touch panel

The Capacitive Control Touch Panel (Frida LS015GF614A) is controlled by the STM32F413ZH through the I2CFMP shared with audio codec.

7.14 Wi-Fi 802.11 b/g/n module

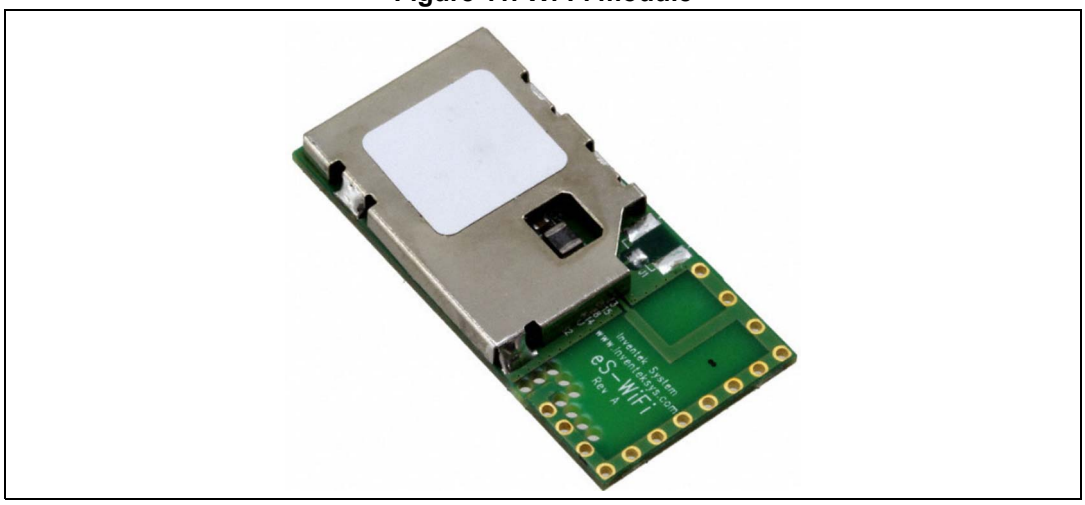
A Wi-Fi module from INVENTEK Systems ISM43362_M3x_l44 is integrated in the 32F413HDISCOVERY Discovery kit (see *Figure 11*).

The Inventek ISM43362-M3G-L44 is an embedded (eS-WiFi) wireless Internet Connectivity device. The Wi-Fi hardware module consists of an ARM®-M3 Cortex® host processor, an integrated antenna and a Broadcom Wi-Fi device.

The module is driven by an SPI interface enabling the connection to the STM32F413ZH.

The Wi-Fi module requires no operating system and has a completely integrated TCP/IP stack that only requires AT commands to establish connectivity.

Figure 11. Wi-Fi module



7.15 Buttons and LEDs

The black button B2 located on LCD side, is the reset of the microcontroller STM32F413ZH (refer to the *Figure 4: 32F413HDISCOVERY Discovery kit (top side)*).

When the button is depressed the logic state is "0", otherwise the logic state is "1".

The blue button B1, located on the LCD side, is available to be used as a digital input or as alternate function Wake-up.

When the button is depressed the logic state is "1", otherwise the logic state is "0".

Two LEDs (LD4 red and LD3 green) located on the LCD side, are available for the user (refer to the *Figure 5: 32F413HDISCOVERY Discovery kit (bottom side)*). To light a LED a high logic state "1" should be written in the corresponding GPIO register.

Table 2 gives the assignment of the control ports to the LED indicators.

Table 2. Assignment of the control ports to the LED indicators

LED	Color	Name	Comment
B1	BLUE	USER_B	Alternate function Wake-up PA0
B2	BLACK	RESET	NRST
LD1	RED	Fault Power	Current upper than 750 mA
LD2	RED/GREEN	ST-LINK COM	Green when communication
LD3	GREEN	LED2_GREEN	PC5
LD4	RED	LED1_RED	PE3
LD5	GREEN	ARDUINO	PB12
LD6	GREEN	5 V Power	5 V available
LD7	GREEN	V_{BUS} OK	5 V USB available
LD8	RED	V_{BUS} OCRCR	PG7

8 Connectors

8.1 Arduino Uno V3 connectors

CN6, CN7, CN8 and CN9 are female connectors compatible with Arduino Uno V3. Most shields designed for Arduino Uno V3 are also supported by the 32F413HDISCOVERY Discovery kit.

Since the I/Os of the STM32F413ZH microcontroller are 5 V tolerant, there is no issue for Arduino compatibility.

Example for the connector references (see *Figure 12*):

- CN6: Fisher BL 1-10 G
- CN7: Fisher BL 1-8 G
- CN8: Fisher BL 1-8 G
- CN9: Fisher BL 1-6 G

Figure 12. Arduino connector (top view)

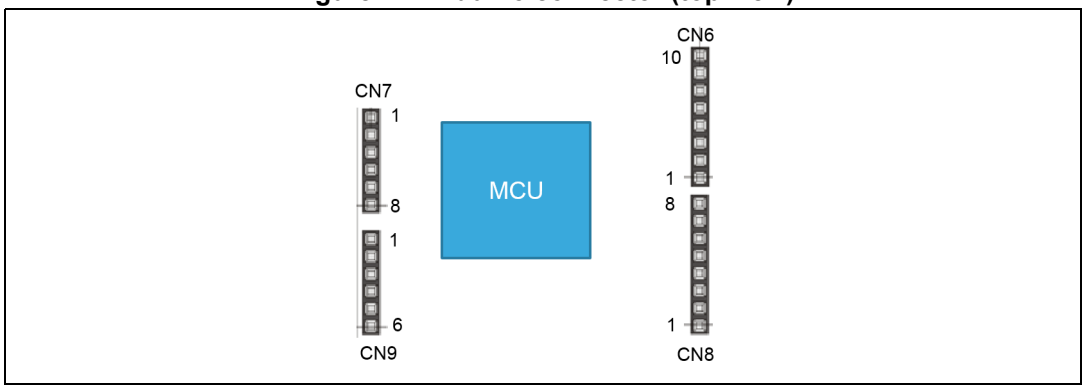


Table 3. Pinout of the Arduino connector

Connector	Pin number	Pin name	Signal name	STM32 pin	Function
CN7	1	NC	-		-
	2	IOREF	-		3.3 V reference
	3	NRST	NRST	NRST	RESET
	4	3.3 V	-		3.3 V input/output
	5	5 V	-		5 V output
	6	GND	-		GND
	7	GND	-		GND
	8	V_{IN}	-		Power input

Table 3. Pinout of the Arduino connector (continued)

Connector	Pin number	Pin name	Signal name	STM32 pin	Function
CN9	1	A0	ADC	PC0	ADC1_IN10
	2	A1	ADC	PA1	ADC1_IN1
	3	A2	ADC	PA2	ADC1_IN2
	4	A3	ADC	PA5	ADC1_IN5
	5	A4	ADC	PB1	ADC1_IN9
	6	A5	ADC	PC4	ADC1_IN14
CN6	10	SCL/D15	ARD_D15	PB10	I2C2_SCL
	9	SDA/D14	ARD_D14	PB11	I2C2_SDA
	8	A_{VDD}	V_{REF}	-	V_{REF}
	7	GND	-	-	Ground
	6	SCK/D13	ARD_D13	PB12	SPI3_SCK
	5	MISO/D12	ARD_D12	PB4	SPI3_MISO
	4	PWM/MOSI/ D11	ARD_D11	PB5	TIM3_CH2/SPI3_ MOSI
	3	PWM/CS/D10	ARD_D10	PA15	TIM2_CH1/SPI3_N SS
	2	PWM/D9	ARD_D9	PB8	TIM4_CH3
	1	D8	ARD_D8	PA4	IO
CN8	8	D7	ARD_D7	PC13	IO
	7	PWM/D6	ARD_D6	PB0	TIM3_CH3
	6	PWM/D5	ARD_D5	PE6	TIM9_CH2
	5	D4	ARD_D4	PB6	EXT_IT_6
	4	PWM/D3	ARD_D3	PF10	TIM5_CH4
	3	D2	ARD_D2	PG13	I/O
	2	TX/D1	ARD_D1	PF7	UART7_TX
	1	RW/D0	ARD_D0	PF6	UART7_RX

8.2 USB OTG FS Micro-AB connector CN17

Example of connector reference (see *Figure 13*):

- Molex 475900001

Figure 13. USB OTG FS Micro-AB connector (front view)

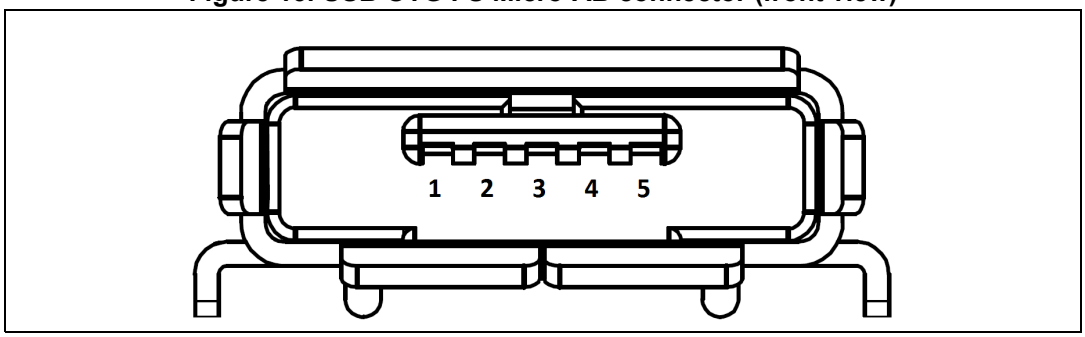


Table 4. USB OTG Micro-AB pinout (front view)

Connector	Pin number	Pin names	Signal name	STM32 pin	Function
CN15	1	V_{BUS}	USB_OTG_5V_VBUS	PA9	5V power and detection
	2	DM (D-)	USB_OTG_FS_N	PA11	USB diff pair M
	3	DP (D+)	USB_OTG_FS_P	PA12	USB diff pair P
	4	ID	USB_OTG_FS_ID	PA10	USB Identification
	5	GND	-	-	GND

Table 5. USB OTG FS power management

Pin number	Pin names	Signal names	STM32 pin	Function
U12-3	FAULTn	USB_OTG_FS_OVRCR	PG7	Over Current IT
U12-4	ENn	USB_OTG_FS_PWR_EN	PG8	USB Power enable

8.3 LCD FRIDA connector CN16

Example of connector reference (see *Figure 14*):

- Hirose FH26-29S-0.3SHW

Figure 14. LCD connector

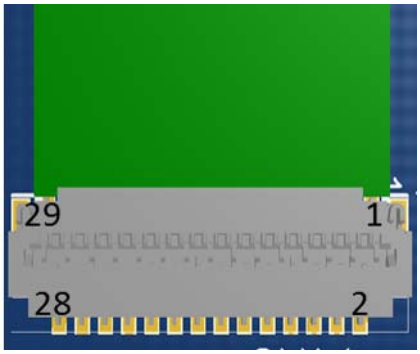


Table 6. Pinout of the LCD connector

Connector	Pin number	Pin name	Signal name	STM32 pin	Function
CN16	1	GND	-	-	Ground
	2	FMARK	LCD_TE	PB14	Tearing Effect
	3	DB15	LCD-PSRAM_D15	PD10	FSMC_D15
	4	DB14	LCD-PSRAM_D14	PD9	FSMC_D14
	5	DB13	LCD-PSRAM_D13	PD8	FSMC_D13
	6	DB12	LCD-PSRAM_D12	PE15	FSMC_D12
	7	DB11	LCD-PSRAM_D11	PE14	FSMC_D11
	8	DB10	LCD-PSRAM_D10	PE13	FSMC_D10
	9	DB9	LCD-PSRAM_D9	PE12	FSMC_D9
	10	DB8	LCD-PSRAM_D8	PE11	FSMC_D8
	11	DB7	LCD-PSRAM_D7	PE13	FSMC_D7
	12	DB6	LCD-PSRAM_D6	PE9	FSMC_D6
	13	DB5	LCD-PSRAM_D5	PE8	FSMC_D5
	14	DB4	LCD-PSRAM_D4	PE7	FSMC_D4
	15	DB3	LCD-PSRAM_D3	PD1	FSMC_D3
	16	DB2	LCD-PSRAM_D2	PD0	FSMC_D2
	17	DB1	LCD-PSRAM_D1	PD15	FSMC_D1
	18	DB0	LCD-PSRAM_D0	PD14	FSMC_D0
	19	/RD	LCD-PSRAM_NOE	PD4	FSMC_NOE
	20	/WR	LCD-PSRAM_NWE	PD5	FSMC_NWE
	21	RS	LCD-RS_A0	PF0	FSMC_RS

Table 6. Pinout of the LCD connector (continued)

Connector	Pin number	Pin name	Signal name	STM32 pin	Function
CN16	22	/CS	LCD_NE3	PG10	FSMC_NE
	23	RESET	LCD-CTP_RST	PB13	RESET
	24	IM	-	-	8/16 bit mode select
	25	IOVCC	3.3 V	-	Power
	26	VCI	3.3 V	-	Power
	27	GND	GND	-	Ground
	28	LEDA	LEDA	-	LED anode
	29	LEDK	LEDK	-	LED cathode

The *Table 7* shows LCD connection for Backlight management:

Table 7. Backlight power management

Pin number	Pin name	Signal name	STM32 pin	Function
U18-7	EN	LCD_BL_CTRL	PE5	Backlight enable

8.4 Touch panel connector CN10

Example of connector reference (see *Figure 15*):

- Hirose DF37NB-10DS-0.4V

Figure 15. Touch panel connector pinout

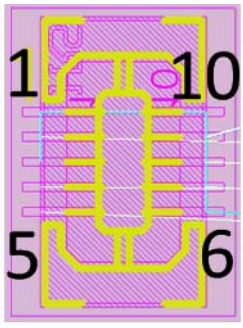


Table 8. Pinout of the touch panel

Connector	Pin number	Pin name	Signal name	STM32 pin	Function
CN10	1	GND	-	-	Ground
	2	INT	CTP_INT	PC1	Interrupt
	3	GND	-	-	Ground
	4	SDA	I2CFMP1_SDA	PC7	I2CFMP1_SDA
	5	SCL	I2CFMP1_SCL	PC6	I2CFMP1_SDA
	6	GND	-	-	Ground
	7	RESET	LCD-CTP_RST	PB13	RESET
	8	GND	-	-	Ground/ V_{CC} for rev2
	9	VDD	3.3 V	-	Power
	10	GND	-	-	Ground

8.5 microSD connector CN1

Example of connector reference (see *Figure 16*):

- Yamaichi PJS008-2003-1

Figure 16. microSD connector (front view)

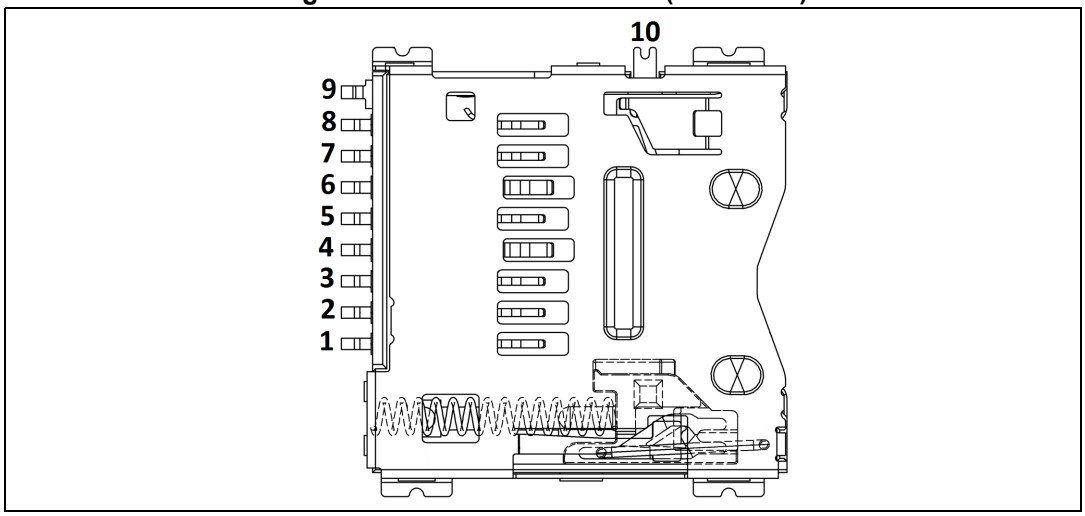


Table 9. Pinout of the microSD connector

Connector	Pin number	Pin name	Signal name	STM32 pin	Function
CN1	1	SDIO_D2	SD_D2	PC10	SD DATA 2
	2	SDIO_D3	SD_D3	PC11	SD DATA 3
	3	SDIO_CMD	SD_CMD	PA6	SD CMD
	4	3.3 V		-	POWER
	5	SD_CLK	SD_CLK	PC12	SD CLOCK
	6	GND		-	GND
	7	SDIO_D0	SD_D0	PC8	SD DATA 0
	8	SDIO_D1	SD_D1	PC9	SD DATA 1
	9	SW2 / GND		-	GND
	10	SW1	SD_Dectect	PF11	SD CARD DETECT

8.6 ST-LINK/V2-1 USB Micro-AB connector CN2

The USB connector is used to connect the embedded ST-LINK/V2-1 to a PC for programming and debugging of the STM32F413ZH microcontroller.

Example of connector reference (see *Figure 17*):

- Molex 1050170001

Figure 17. USB Micro-AB connector (front view)

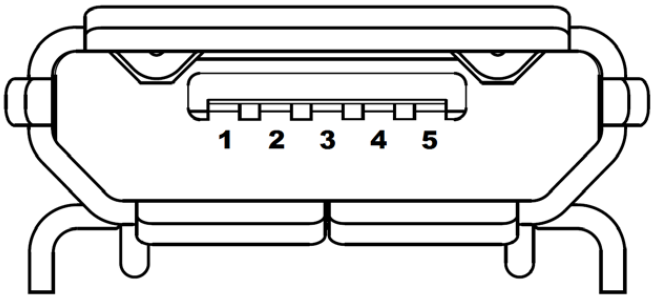


Table 10. USB Micro-AB connector

Connector	Pin number	Pin name	Signal name	STM32F103 pin	Function
CN2	1	V_{BUS}	5V_USB_ST_LINK	-	5 V power and detection
	2	DM (D-)	USB_STLK_N	PA11	USB diff pair M
	3	DP (D+)	USB_STLK_P	PA12	USB diff pair P
	4	ID	USB_STLK_ID	-	USB Identification
	5	GND	-	-	GND

8.7 TAG connector CN11

The TAG connector is implemented on the 32F413HDISCOVERY Discovery kit. The TAG connector is a 10-pin footprint supported by the SWD mode. It shares the same signals with the ST-LINK (see *Figure 18*).

The TC2050-IDC-NL cable is used to link ST-LINK and the TAG connector on the 32F413HDISCOVERY, so that users can easily program and debug the STM32F413ZH (see *Figure 19*).

Figure 18. TAG connector

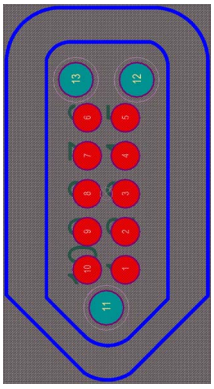


Figure 19. TC2050-IDC-NL cable

Table 11. Pinout of the TAG connector

Connector	Pin number	Pin name	Signal name	STM32 pin	Function
CN11	1	3.3 V	3V3_ST_LINK	-	Power
	2	SWD	STLINK_JTMS_SWDIO	PA13	SW DATA
	3	GND	-	-	Ground
	4	SWCLK	STLINK_JTCK_SWCLK	PA14	SW CLOCK
	5	GND	-	-	Ground
	6	SWO	STLINK_JTDO_SWO	PB3	SWO

Table 11. Pinout of the TAG connector (continued)

Connector	Pin number	Pin name	Signal name	STM32 pin	Function
CN11	7	NC	-	-	-
	8	NC	-	-	-
	9	NC	-	-	-
	10	NRST	NRST	NRST	RESET

8.8 Audio line output (green jack) connector CN5

A 3.5 mm stereo audio green jack output is available to support the headphone.

Example of connector reference (see *Figure 20*):

- PJ3028B-3_4P

Figure 20. Audio jack connector (front view)

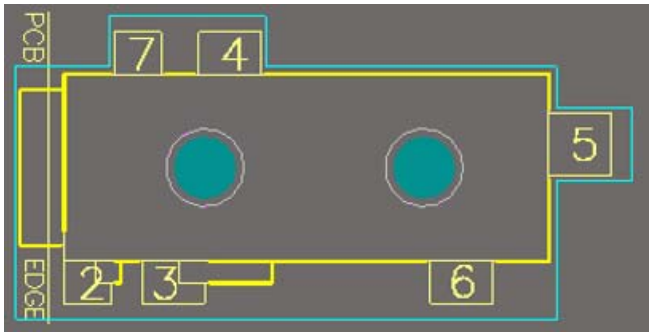


Table 12. Audio jack connector

Connector	Pin number	Pin name	Signal name	Audio codec pin	Function
CN5	1	1	NA	NA	NA
	2	2	MIC_IN	MICBIAS1	Microphone
	3	3	GND	HPOUT1FB/GND	GND
	4	4	HP_OUT_R	HPOUT1R	HP right
	5	5	NA	NA	NA
	6	6	HP_OUT_L	HPOUT1L	HP left

8.9 Extension microphone connector CN12

Example of connector reference (see *Figure 21*):

- Amphemol-FCI 20021311-00020T4LF

Figure 21. Extension microphone connector (front view)

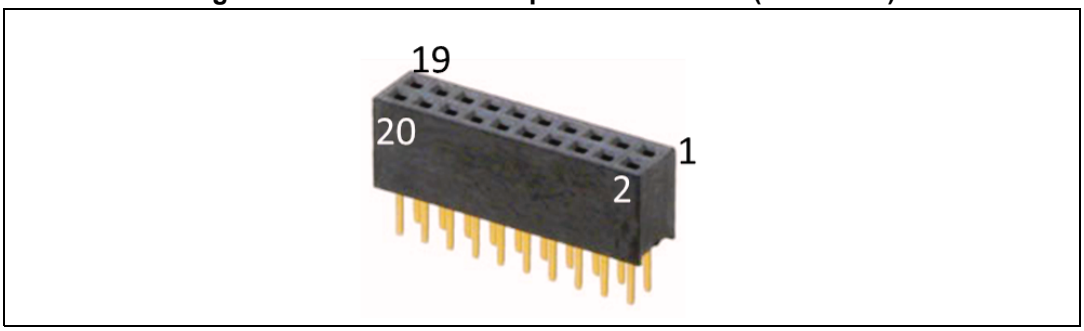


Table 13. Extension microphone connector

Connector	Pin number	Pin name	Signal name	STM32 pin	Function
CN12	1	GND	GND	-	Power
	2	V_{CC_0}	3.3 V	-	Ground
	3	CLK_1	EXT_DFSDM2_CKOUT	PD2	DFSDM2 CLOCK
	4	CLK_0	EXT_DFSDM1_CKOUT	PA8	DFSDM1 CLOCK
	5	DATA_1	EXT_DFSDM2_DATIN1	PA7	DFSDM2 DATA1
	6	DATA_0	EXT_DFSDM1_DATIN1	PD6	DFSDM1 DATA1
	7	DATA_3	EXT_DFSDM2_DATIN7	PB7	DFSDM2 DATA7
	8	-		-	-
	9	-	-	-	-
	10	DETECTN	DETECTN	-	-
	11	-	-	-	-
	12	MEMS_LED	MEMS_LED	PE4	-
CN12	13	-	-	-	-
	14	-	-	-	-
	15	-	-	-	-
	16	-	-	-	-
	17	-	-	-	-
	18	-	-	-	-
	19	V_{CC_1}	3.3 V	-	Power
	20	GND	GND	-	Ground

8.10 Optional audio stereo speakers CN3 and CN4

The stereo audio outputs are available to support stereo speakers (CN3 for left channel and CN4 for right channel).

Appendix A 32F413HDISCOVERY I/O assignment

Table 14. 32F413HDISCOVERY I/O assignment

Pin No.	Pin Name	Signal or Label	Feature / Comment
1	PE2	QSPI_BK1_IO2	QSPI
2	PE3	LED1_RED	User LED
3	PE4	MEMS_LED	Microphones MEMS Module
4	PE5	LCD_BL_CTRL	LCD and CTP
5	PE6	ARD_D5	ARD_TIM9_CH2
6	V_{BAT}	V_{BAT}	3.3V
7	PC13-ANTI_TAMP	ARD_D7	ARD_IO
8	PC14-OSC32_IN	OSC_32K_IN	RTC CLK
9	PC15-OSC32_OUT	OSC_32K_OUT	RTC CLK
10	PF0	PSRAM_A0/LCD-RS_A0	Shared between LCD and PSRAM
11	PF1	PSRAM_A1	PSRAM
12	PF2	PSRAM_A2	PSRAM
13	PF3	PSRAM_A3	PSRAM
14	PF4	PSRAM_A4	PSRAM
15	PF5	PSRAM_A5	PSRAM
16	V_{SS_5}	V_{SS_5}	GND
17	V_{DD_5}	V_{DD_5}	3.3 V
18	PF6	ARD_D0_URX	ARD_UART7
19	PF7	ARD_D1_UTX	ARD_UART7
20	PF8	QSPI_BK1_IO0	QSPI
21	PF9	QSPI_BK1_IO1	QSPI
22	PF10	ARD_D3_PWM	ARD_TIM5_CH4
23	PH0-OSC_IN	HSE_OSC_IN	8 MHz clock
24	PH1-OSC_OUT	WIFI_RST	Wi-Fi
25	NRST	NRST_BUTTON	RESET
26	PC0	ARD_A0	ARD_ADC1_IN10
27	PC1	CTP_INT	Touch Panel INT
28	PC2	CODEC_I2Sext_SD	I2S2
29	PC3	CODEC_I2S_SD	I2S2
30	V_{DD_12}	V_{DD_12}	3.3 V
31	V_{SSA}	V_{SSA}	GND
32	V_{REF+}	V_{REF}	3.3 V

Table 14. 32F413HDISCOVERY I/O assignment (continued)

Pin No.	Pin Name	Signal or Label	Feature / Comment
33	V_{DDA}	V_{DDA}	3.3 V
34	PA0-WKUP	B_USER	USER BUTTON
35	PA1	ARD_A1	ARD_ADC1_IN1
36	PA2	ARD_A2	ARD_ADC1_IN2
37	PA3	CODEC_I2S_MCLK	AUDIO_I2S2
38	V_{SS_4}	V_{SS_4}	GND
39	V_{DD_4}	V_{DD_4}	3.3 V
40	PA4	ARD_D8_IO	ARD
41	PA5	ARD_A3	ARD_ADC1_IN5
42	PA6	SD_CMD	SD CARD
43	PA7	DFSDM2_DATIN1	ST-MEMS microphones
44	PC4	ARD_A5	ARD_ADC1_IN14
45	PC5	LED2_GREEN	User LED
46	PB0	ARD_D6_PWM	ARD_TIM3_CH3
47	PB1	ARD_A4	ARD_ADC1_IN9
48	PB2	QSPI_CLK	QSPI
49	PF11	SD_Detect	SD CARD_IT_11
50	PF12	PSRAM_A6	PSRAM
51	V_{SS_6}	V_{SS_6}	GND
52	V_{DD_6}	V_{DD_6}	3.3 V
53	PF13	PSRAM_A7	PSRAM
54	PF14	PSRAM_A8	PSRAM
55	PF15	PSRAM_A9	PSRAM
56	PG0	PSRAM_A10	PSRAM
57	PG1	PSRAM_A11	PSRAM
58	PE7	LCD-PSRAM_D4	LCD-PSRAM
59	PE8	LCD-PSRAM_D5	LCD-PSRAM
60	PE9	LCD-PSRAM_D6	LCD-PSRAM
61	V_{SS_7}	V_{SS_7}	GND
62	V_{DD_7}	V_{DD_7}	3.3 V
63	PE10	LCD-PSRAM_D7	LCD-PSRAM
64	PE11	LCD-PSRAM_D8	LCD-PSRAM
65	PE12	LCD-PSRAM_D9	LCD-PSRAM
66	PE13	LCD-PSRAM_D10	LCD-PSRAM
67	PE14	LCD-PSRAM_D11	LCD-PSRAM

Table 14. 32F413HDISCOVERY I/O assignment (continued)

Pin No.	Pin Name	Signal or Label	Feature / Comment
68	PE15	LCD-PSRAM_D12	LCD-PSRAM
69	PB10	ARD_D15_SCL	ARD_I2C2
70	PB11	ARD_D14_SDA	ARD_I2C2
71	V_{CAP1_0}	V_{CAP1_0}	PWR
72	$V_{DD\_1\_0}$	$V_{DD\_1\_0}$	3.3 V
73	PB12	ARD_D13_SCK	SPI3 (ARD & WIFI)
74	PB13	LCD-CTP_RST	LCD-CTP
75	PB14	LCD_TE	LCD
76	PB15	WIFI_WKUP	Wi-Fi
77	PD8	LCD-PSRAM_D13	LCD-PSRAM
78	PD9	LCD-PSRAM_D14	LCD-PSRAM
79	PD10	LCD-PSRAM_D15	LCD-PSRAM
80	PD11	PSRAM_A16	PSRAM
81	PD12	PSRAM_A17	PSRAM
82	PD13	QSPI_BK1_IO3	QSPI
83	V_{SS_8}	V_{SS_8}	GND
84	V_{DD_8}	V_{DD_8}	3.3 V
85	PD14	LCD-PSRAM_D0	LCD-PSRAM
86	PD15	LCD-PSRAM_D1	LCD-PSRAM
87	PG2	PSRAM_A12	PSRAM
88	PG3	PSRAM_A13	PSRAM
89	PG4	PSRAM_A14	PSRAM
90	PG5	PSRAM_A15	PSRAM
91	PG6	QSPI_BK1_NCS	QSPI
92	PG7	USB_OTG_FS_OVRCR	USB_INT_7
93	PG8	USB_OTG_FS_PWR_EN	USB
94	V_{SS_9}	V_{SS_9}	GND
95	$V_{DD\_2\_USB33}$	$V_{DD\_2\_USB33}$	3.3 V
96	PC6	CTP_I2C_SCL	CTP_I2CFMP1
97	PC7	CTP_I2C_SDA	CTP_I2CFMP1
98	PC8	SD_D0	SD CARD
99	PC9	SD_D1	SD CARD
100	PA8	DFSDM1_CKOUT	ST-MEMS microphones
101	PA9	USB_OTG_FS_VBUS	USB
102	PA10	USB_OTG_FS_ID	USB

Table 14. 32F413HDISCOVERY I/O assignment (continued)

Pin No.	Pin Name	Signal or Label	Feature / Comment
103	PA11	USB_OTG_FS_DM	USB
104	PA12	USB_OTG_FS_DP	USB
105	PA13	DBG_SWDIO	STLINK
106	V_{CAP2_0}	V_{CAP2_0}	PWR
107	$V_{SS\ 2\_0}$	$V_{SS\ 2\_0}$	GND
108	$V_{DD\_2\_0}$	$V_{DD\_2\_0}$	3.3 V
109	PA14	DBG_SWCLK	ST-LINK
110	PA15	ARD_D10_PWM_CS	ARD_TIM2_CH1_SPI3
111	PC10	SD_D2	SD CARD
112	PC11	SD_D3	SD CARD
113	PC12	SD_CLK	SD CARD
114	PD0	LCD-PSRAM_D2	LCD-PSRAM
115	PD1	LCD-PSRAM_D3	LCD-PSRAM
116	PD2	DFSDM2_CKOUT	Microphones MEMS
117	PD3	CODEC_I2S_CK	AUDIO_I2S2
118	PD4	LCD-PSRAM_NOE	LCD-PSRAM
119	PD5	LCD-PSRAM_NWE	LCD-PSRAM
120	V_{SS_10}	V_{SS_10}	GND
121	V_{DD_10}	V_{DD_10}	3.3 V
122	PD6	DFSDM1_DATIN1	ST-MEMS microphones
123	PD7	PSRAM_NE1	PSRAM
124	PG9	UART_VCP_RX	STLINK_UART6
125	PG10	LCD_NE3	LCD
126	PG11	WIFI_SPI_CSN	WIFI_SPI_CS
127	PG12	WIFI_DRDY	Wi-Fi
128	PG13	ARD_D2_IO	ARD
129	PG14	UART_VCP_TX	STLINK_UART6
130	VSS_11	V_{SS_11}	GND
131	VDD_11	V_{DD_11}	3.3 V
132	PG15	CODEC_INT	AUDIO_INT15
133	PB3	DBG_SWO	ST-LINK
134	PB4	ARD_D12_MISO	SPI3 (ARD & WIFI)
135	PB5	ARD_D11_PWM_MOSI	SPI3 (ARD & WIFI)
136	PB6	ARD_D4_INT	ARD_INT_6
137	PB7	DFSDM2_DATIN7	ST-MEMS microphones

Table 14. 32F413HDISCOVERY I/O assignment (continued)

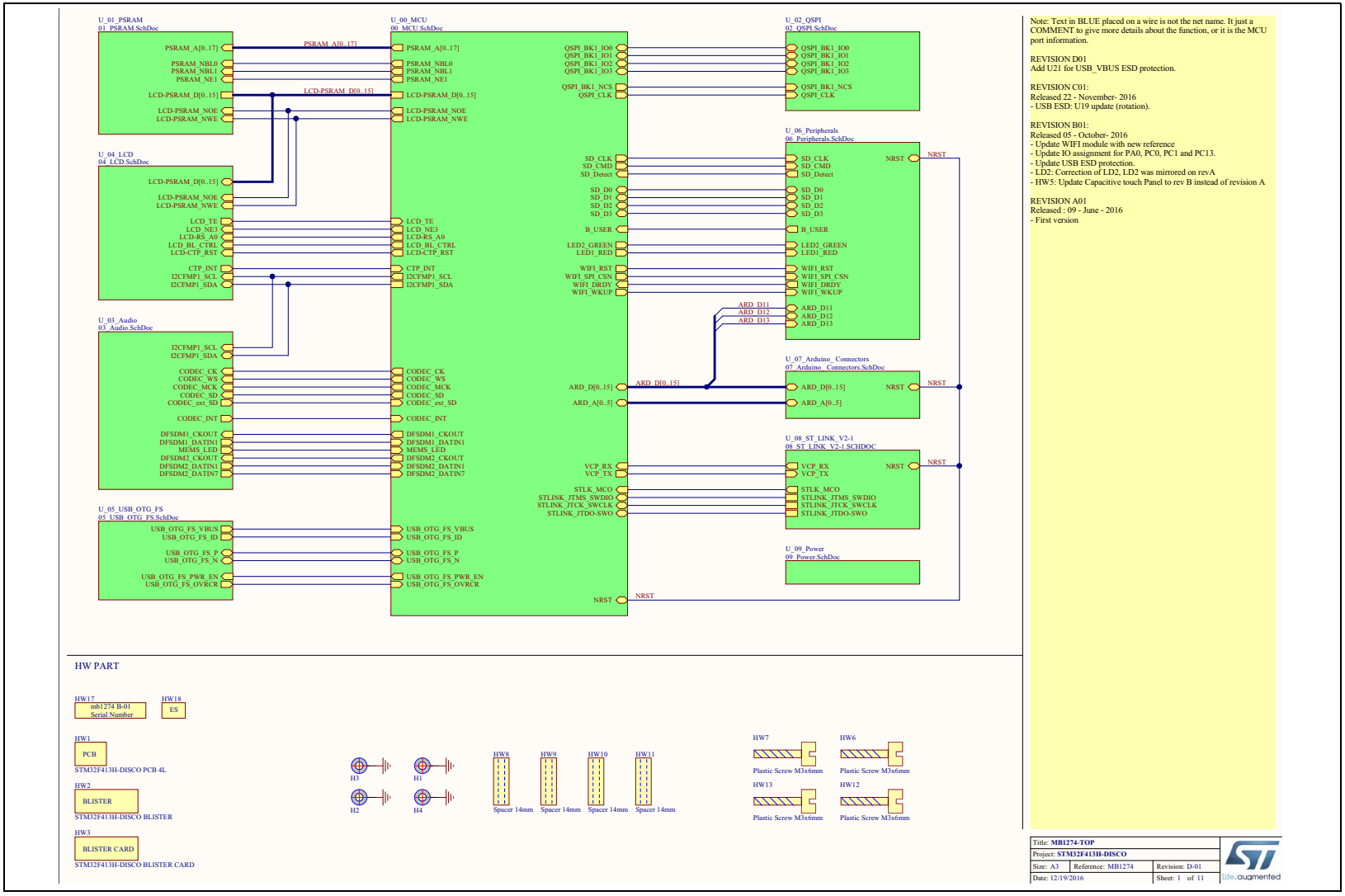
Pin No.	Pin Name	Signal or Label	Feature / Comment
138	BOOT0	BOOT0	BOOT
139	PB8	ARD_D9_PWM	ARD_TIM4_CH3
140	PB9	CODEC_I2S_WS	AUDIO_I2S2
141	PE0	PSRAM_NBL0	PSRAM
142	PE1	PSRAM_NBL1	PSRAM
143	PDR_ON	PDR_ON	PDR
144	V_{DD_3}	V_{DD_3}	3.3 V

Appendix B Schematics

This section provides the design schematics for the 32F413HDISCOVERY Discovery kit:

- Overall schematics for the 32F413HDISCOVERY, see *Figure 22*
- 32F413HDISCOVERY MCU, see *Figure 23*
- PSRAM, see *Figure 24*
- Quad-SPI, see *Figure 25*
- Audio, see *Figure 26*
- LCD, see *Figure 27*
- USB OTG FS, see *Figure 28*
- Peripherals, see *Figure 29*
- Arduino Uno V3 connector, see *Figure 30*
- ST-LINK with support of SWD only, see *Figure 31*
- Power, see *Figure 32*

Figure 22. Top



Note: Text in BLUE placed on a wire is not the net name. It just a COMMENT to give more details about the function, or it is the MCU port information.

REVISION D01
Add U21 for USB_VBUS ESD protection.

REVISION C01:
Released 22 - November- 2016
- USB ESD: U19 update (rotation).

REVISION B01:
Released 05 - October- 2016
- Update WIFI module with new reference
- Update IO assignment for PA0, PC0, PC1 and PC13.
- Update USB ESD protection.
- LD2: Correction of LD2, LD2 was mirrored on revA
- HW5: Update Capacitive touch Panel to rev B instead of revision A

REVISION A01
Released : 09 - June - 2016
- First version

Title: **MB1274-TOP**		
Project: **STM32F413H-DISCO**		
Size: A3	Reference: MB1274	Revision: D-01
Date: 12/19/2016		Sheet: 1 of 11

life.augmented

Figure 23. MCU

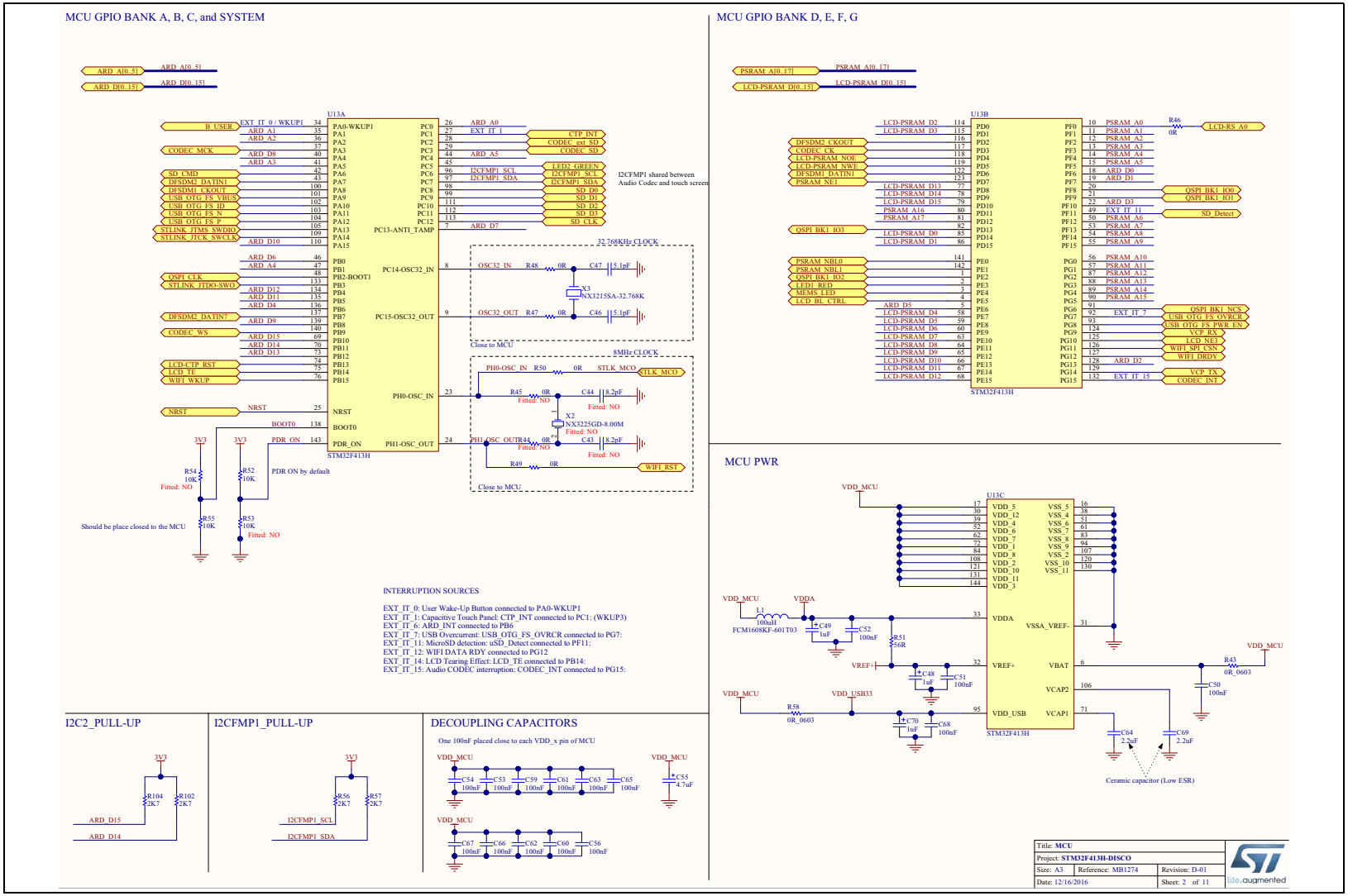


Figure 24. PSRAM

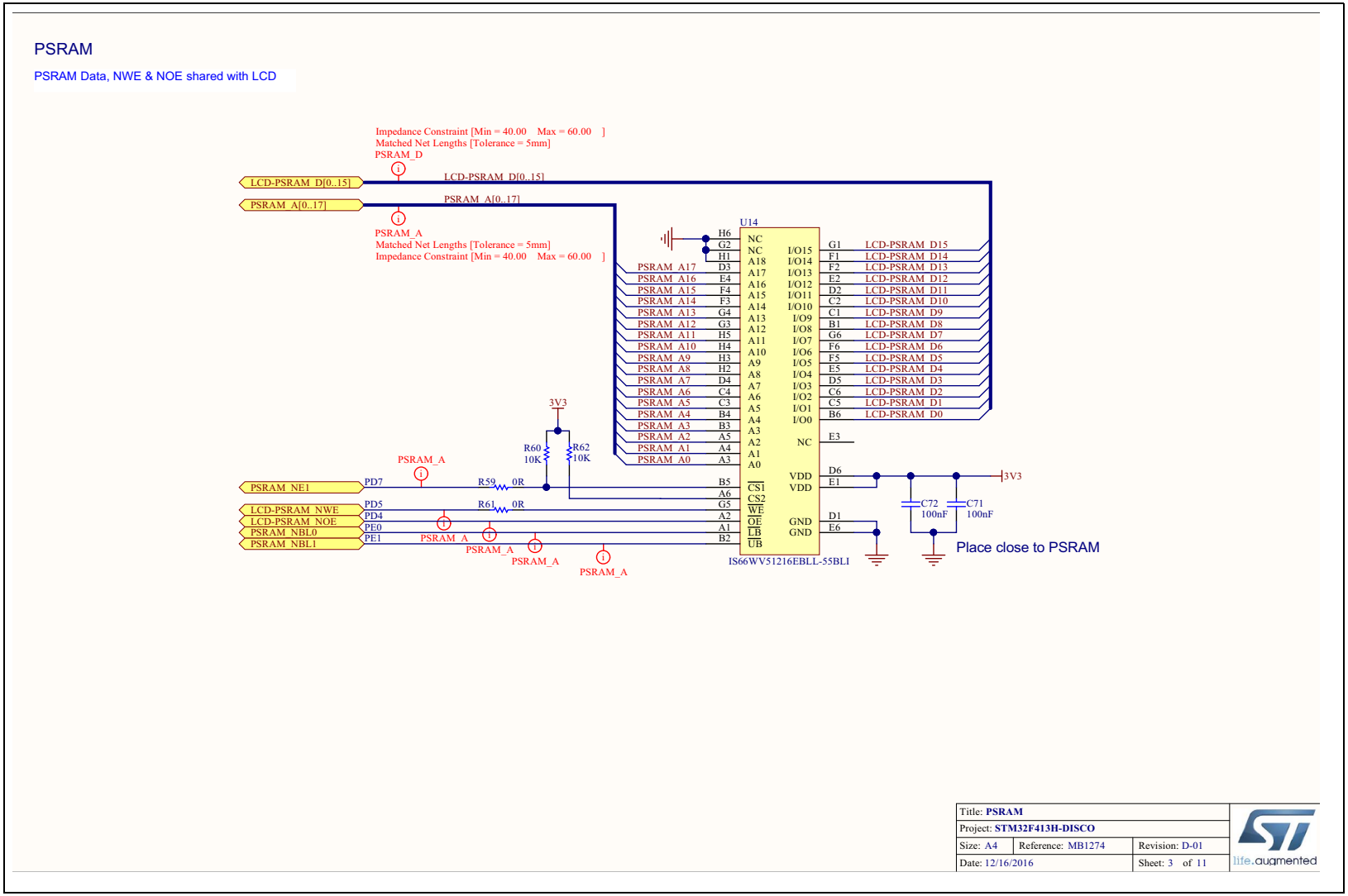


Figure 25. Quad-SPI

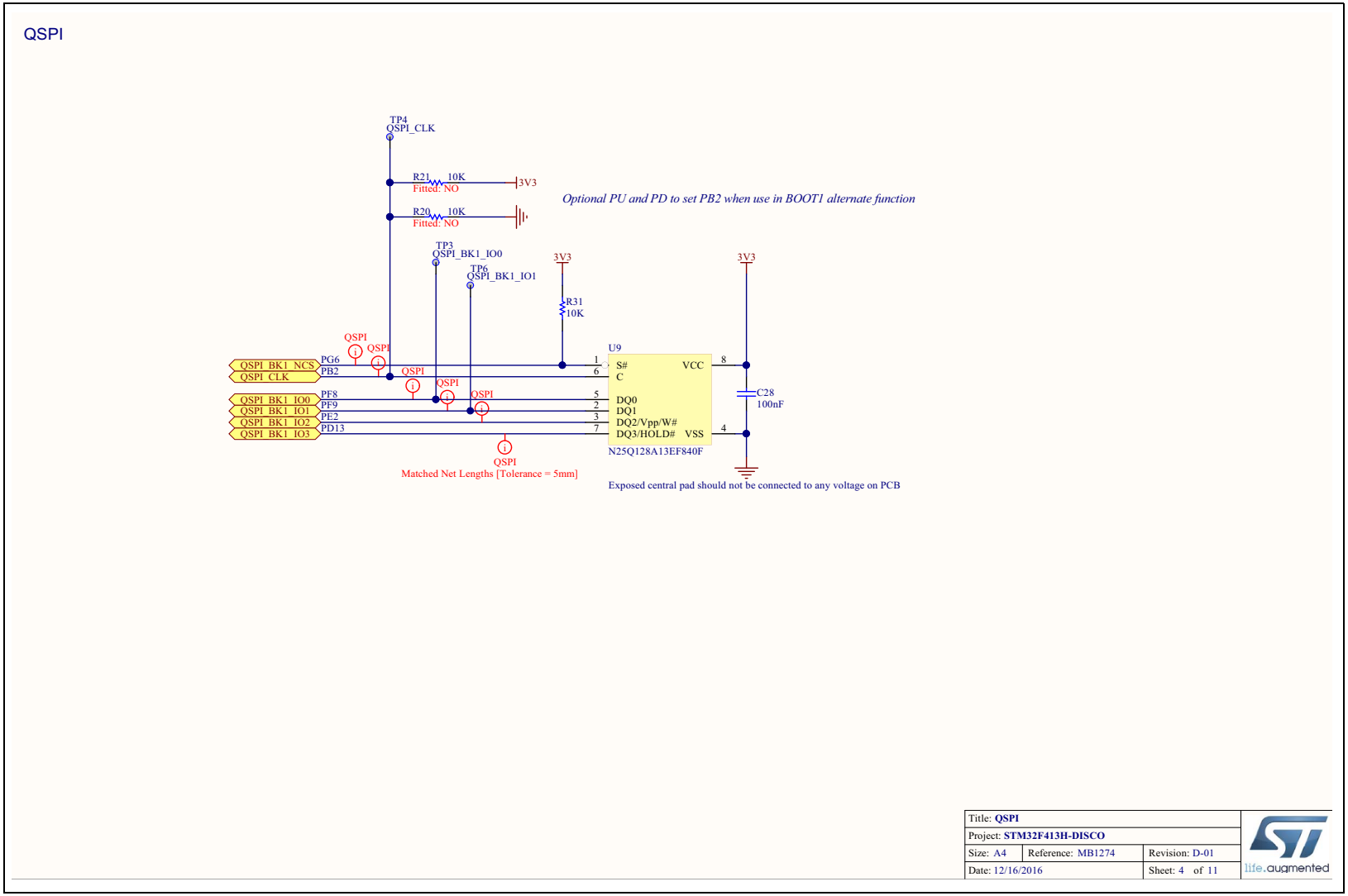


Figure 26. Audio

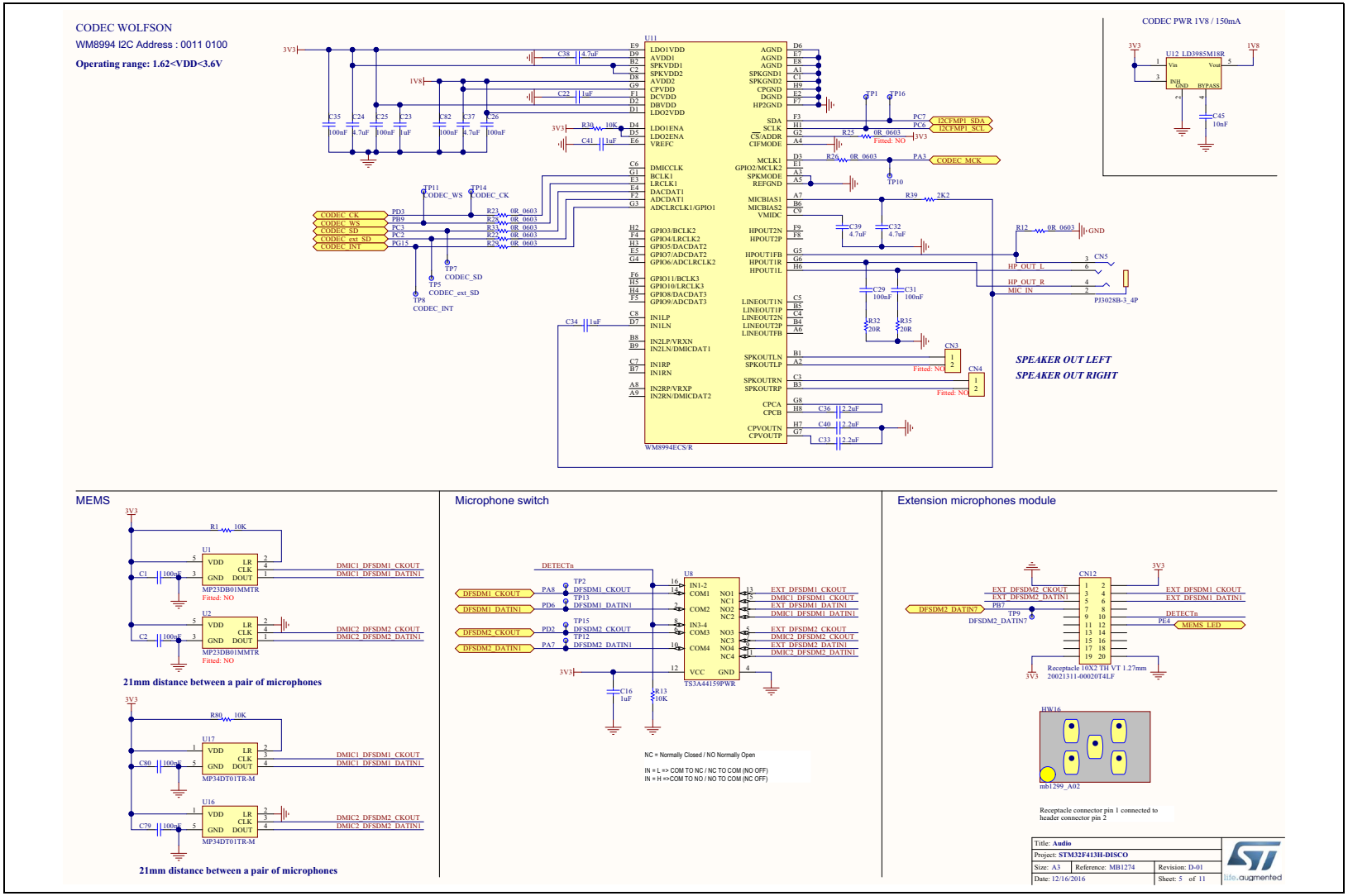


Figure 27. LCD

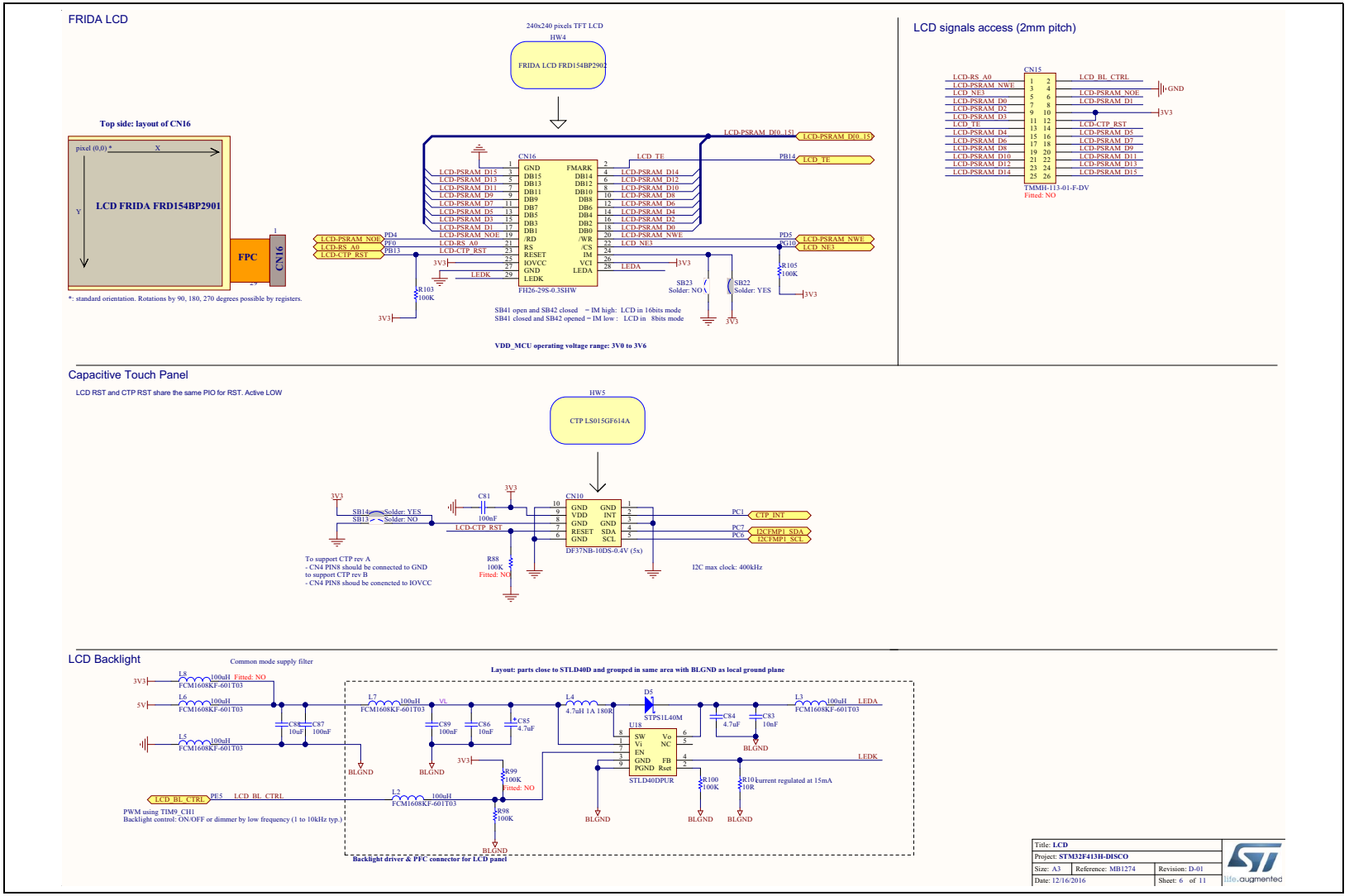


Figure 28. USB OTG FS

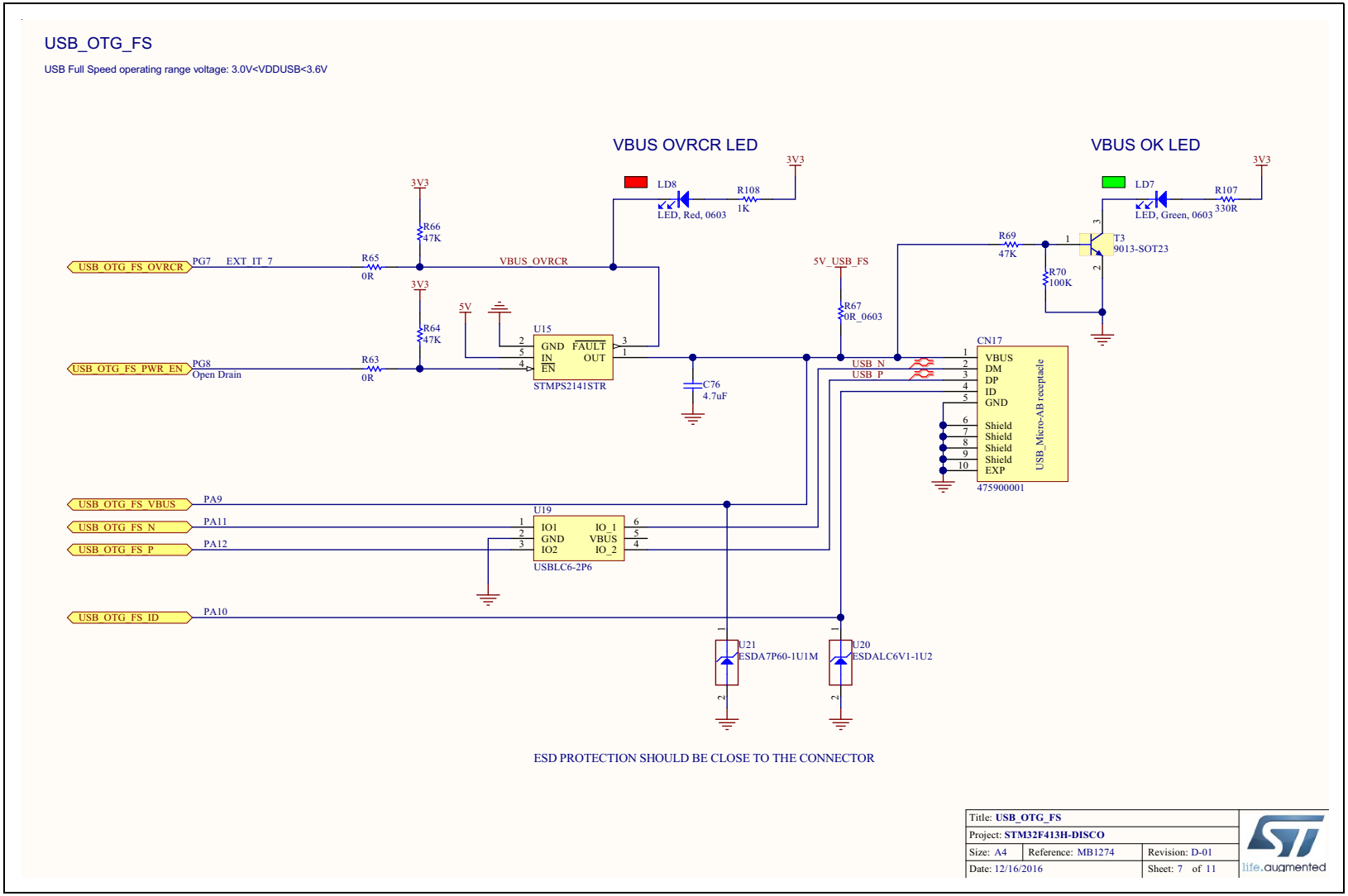


Figure 29. Peripherals

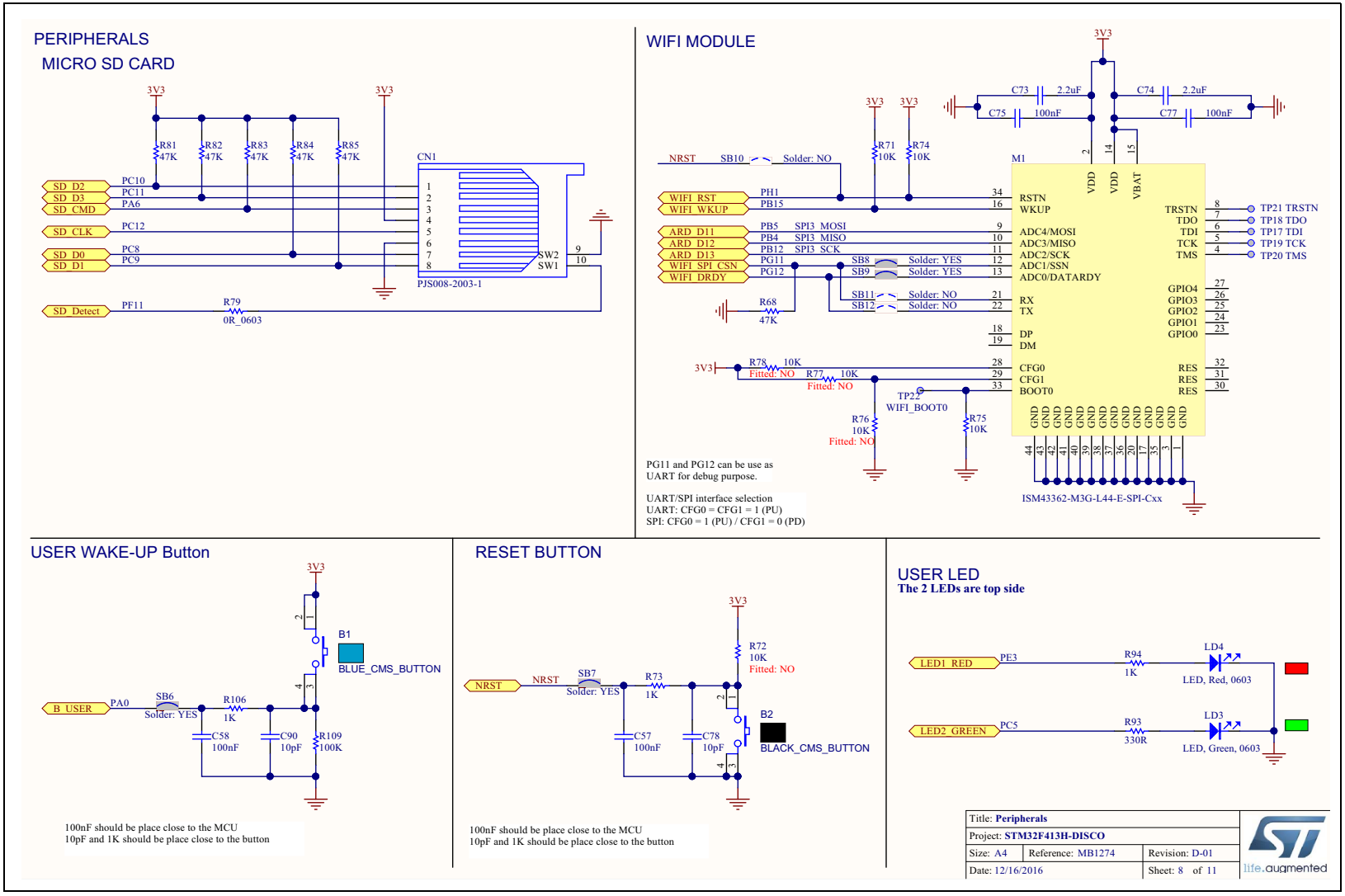


Figure 30. Arduino Uno V3 connector

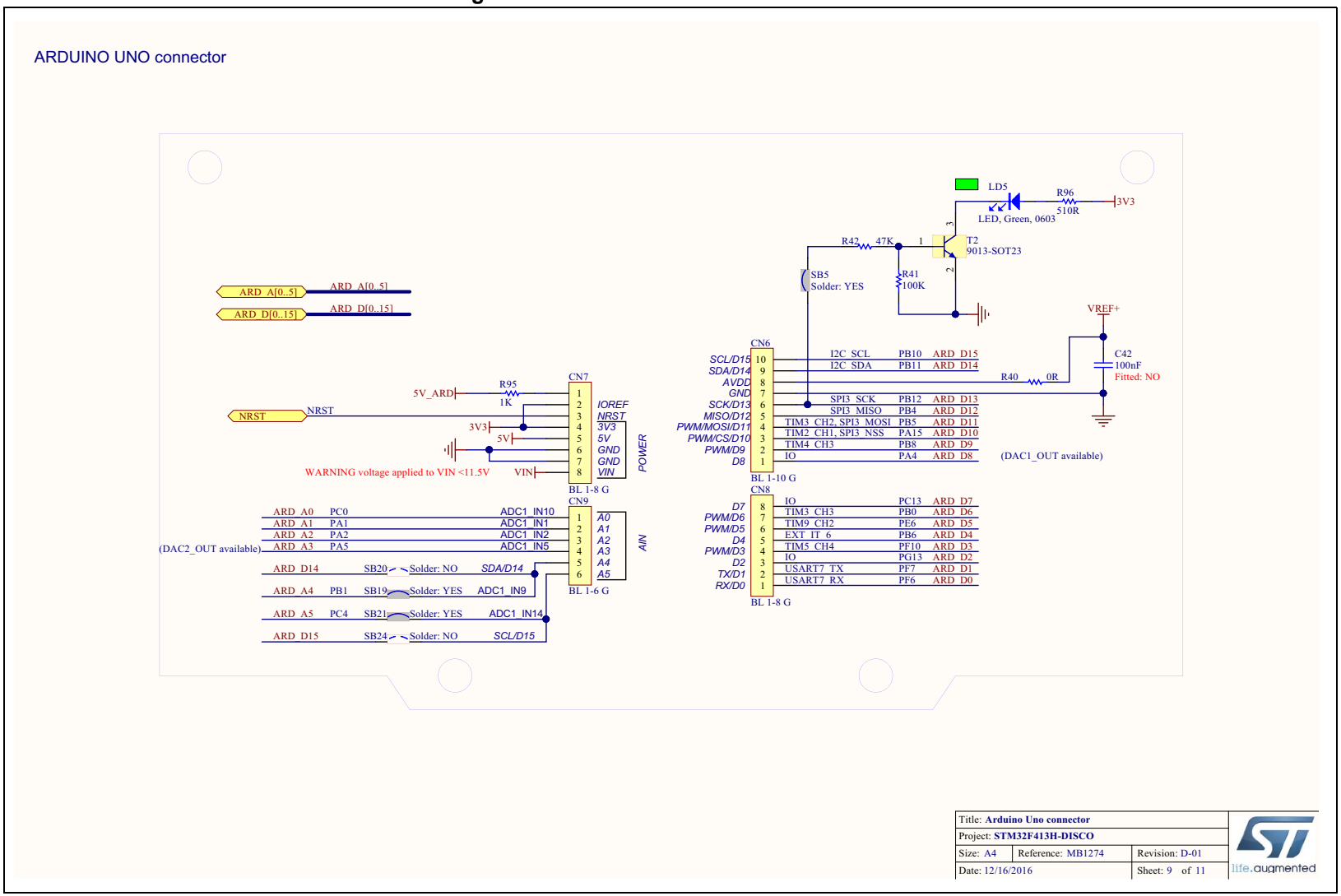


Figure 31. ST-LINK with support of SWD only

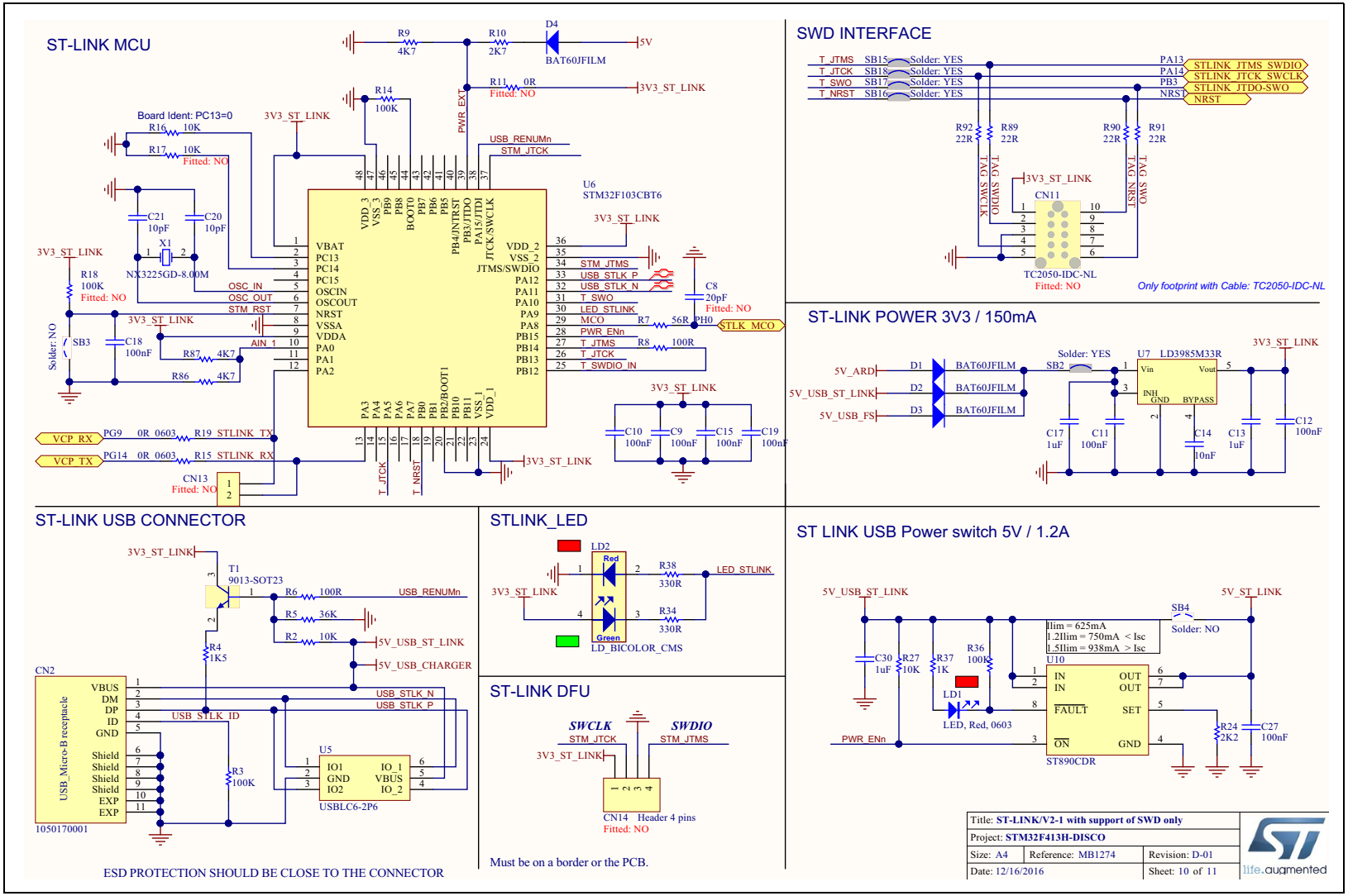
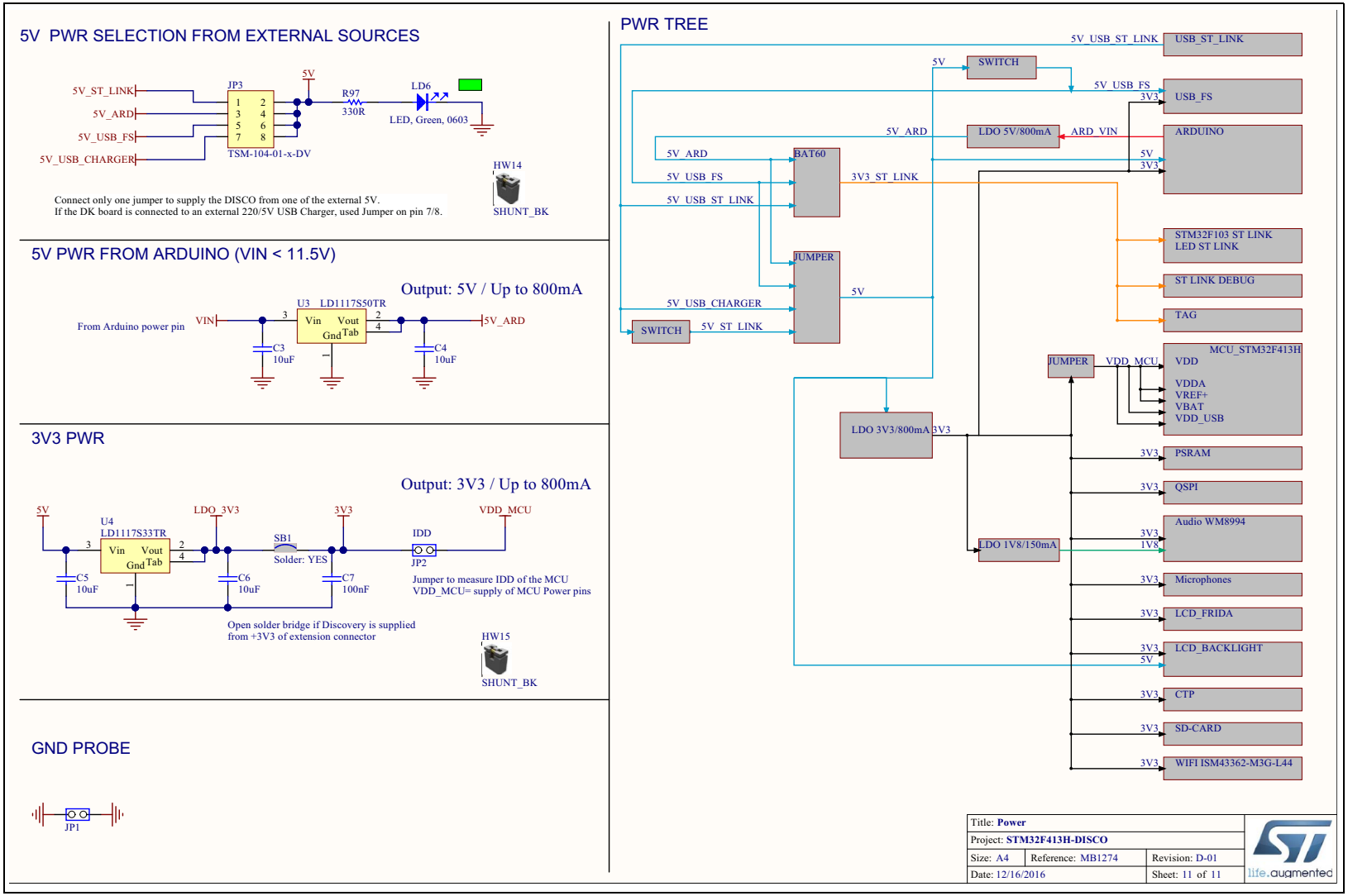


Figure 32. Power



Appendix C Federal Communications Commission (FCC) and Industry Canada (IC) Compliance

C.1 FCC Compliance Statement

Contains FCC ID: O7P-362

C.1.1 Part 15.19

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

C.1.2 Part 15.105

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

C.1.3 Part 15.21

Any changes or modifications to this equipment not expressly approved by STMicroelectronics may cause harmful interference and void the user's authority to operate this equipment.

C.2 IC Compliance Statement

Contains/Contient IC: 10147A-362

This device complies with FCC and Industry Canada RF radiation exposure limits set forth for general population for mobile application (uncontrolled exposure). This device must not be collocated or operating in conjunction with any other antenna or transmitter.

C.2.1 Compliance Statement

Notice: This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Industry Canada ICES-003 Compliance Label: CAN ICES-3 (A)/NMB-3(A)

C.2.2 Déclaration de conformité

Avis: Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement

Étiquette de conformité à la NMB-003 d'Industrie Canada : CAN ICES-3 (A)/NMB-3(A)

Appendix D CISPR32

D.1 Warning

Warning: This device is compliant with Class A of CISPR32. In a residential environment, this equipment may cause radio interference.

Avertissement: Cet équipement est conforme à la Classe A de la CISPR 32. Dans un environnement résidentiel, cet équipement peut créer des interférences radio.

Revision history

Table 15. Document revision history

Date	Revision	Changes
05-Apr-2017	1	Initial version