UM1979
User manual

Getting started with sound terminal expansion board based on STA350BW for STM32 Nucleo

Introduction

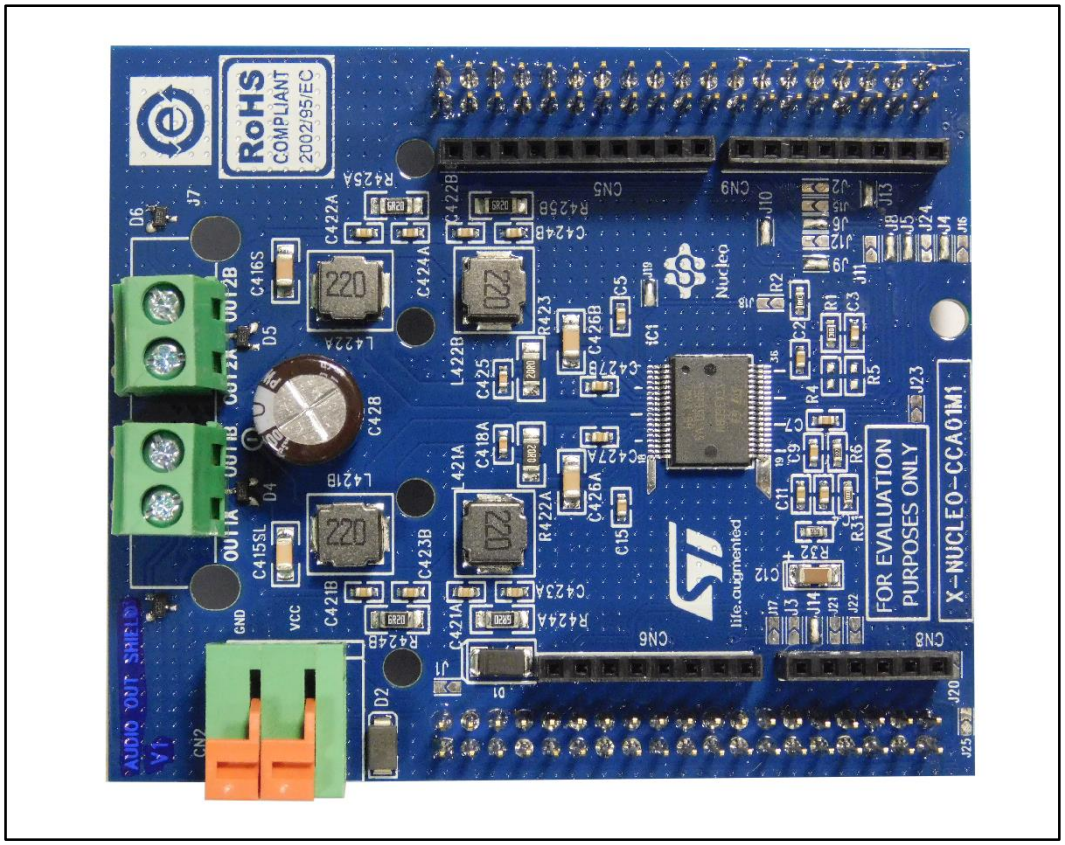
The X-NUCLEO-CCA01M1 is an expansion board based on the STA350BW Sound Terminal® 2.1-channel high-efficiency digital audio output system.

It can be plugged on top of an STM32 Nucleo board and is compatible with the ST morpho connector layout, enabling the output of digital audio streams to speaker pairs connected directly to the board so users can evaluate the STMicroelectronics STA350BW digital audio output component. Up to two X-NUCLEO-CCA01M1 expansion boards can be plugged on the same STM32 Nucleo host for a four-channel digital audio output system.

Communication between the STM32 MCU and the STA350BW device is handled via the I²C bus for setup and control and the I²S or SAI buses for digital audio transmission.

The board has a dedicated connector to supply power for the output stage.

Figure 1: X-NUCLEO-CCA01M1 expansion board



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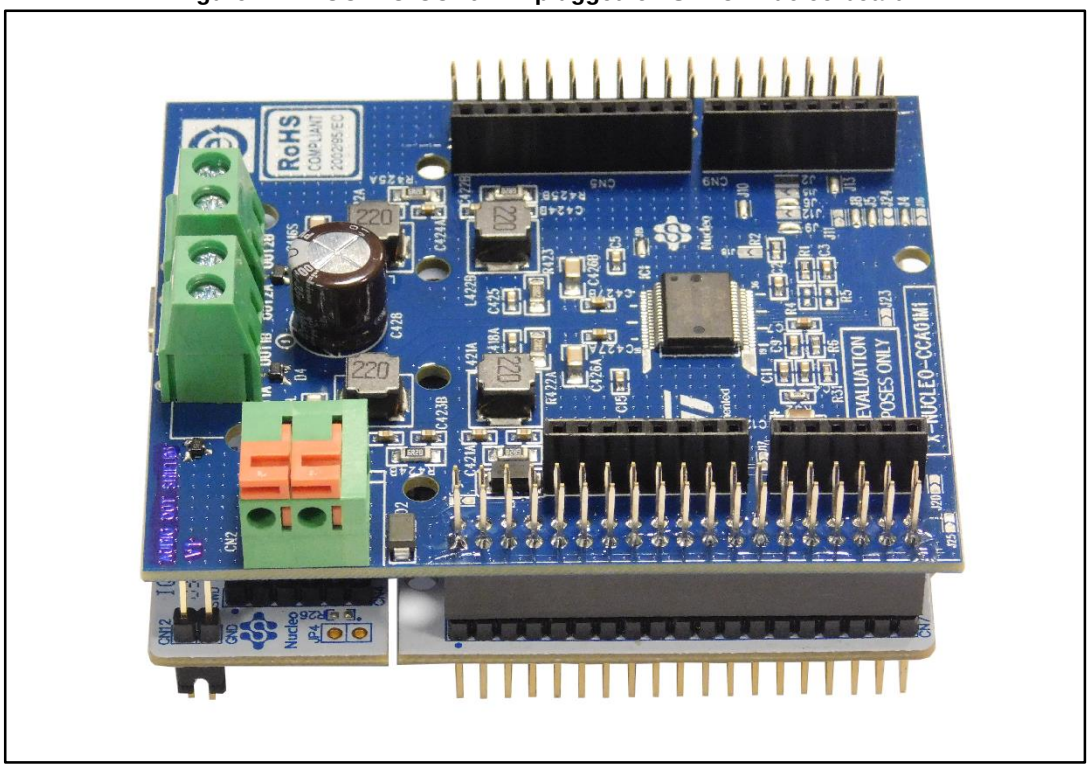
1 Getting started

This section describes the hardware requirements for the X-NUCLEO-CCA01M1 expansion board for STM32 Nucleo.

1.1 Hardware Requirements

The X-NUCLEO-CCA01M1 is an expansion board for use with STM32 Nucleo boards (please refer to UM1724 on www.st.com for further information). To function correctly, the STM32 Nucleo board must be connected to the X-NUCLEO-CCA01M1 expansion board, as shown in the figure below.

Figure 2: X-NUCLEO-CCA01M1 plugged on STM32 Nucleo board



When mounting the X-NUCLEO-CCA01M1 on the STM32 Nucleo main board, ensure that all the pins are aligned with their corresponding connector. It is very important to handle both boards carefully during this operation to avoid damaging or bending the male/female pins and connectors.

You must also implement all the ESD prevention measures necessary to avoid damaging any X-NUCLEO-CCA01M1 expansion board components.

An additional external power source fed through a dedicated connector on the board supplies the audio output stage (see *Section 5.1: "Nucleo 144 support"*).

2 System requirements

Using the STM32 Nucleo boards with the X-NUCLEO-CCA01M1 expansion board requires the following software and hardware:

- a Windows® (XP, Vista, 7, 8) PC with the following minimum characteristics:
  - at least 128 MB of RAM
  - 40 MB of available hard disk space
- a USB type A to Mini-B USB cable to connect your PC to the STM32 Nucleo board for installation of the board firmware package (order code: X-CUBE-SOUNDTER1)
- at least one 8 Ω passive speaker to be connected to the X-NUCLEO-CCA01M1 expansion board (two are required for stereo audio reproduction)
- an external power supply from +5 V to +26 V

3 Hardware description

This section describes the X-NUCLEO-CCA01M1 features and provides information that could be useful for understanding the board schematics.

The X-NUCLEO-CCA01M1 expansion board allows the user to test the functions of the STMicroelectronics STA350BW Sound Terminal® device.

The STA350BW is an integrated 2.1-channel high-efficiency digital audio output system which handles digital audio processing, digital amplifier control, and FFX-power output stage. It therefore represents a high-power single-chip FFX™ solution encompassing high-quality, high-efficiency, and all-digital amplification. It is a complete solution for the digital audio power amplifier and comes with a full assortment of digital processing features, including up to 8 programmable biquadratic filters (EQ) per channel. Special digital signal processing techniques are available to manage low-frequency quantization noise in case of very low frequency cutoff filter thresholds. Visit *www.st.com* for further information regarding the STA350BW device.

On the X-NUCLEO-CCA01M1 expansion board, the STA350BW component is specifically configured for 2.0 BTL channels, releasing up to 2 x 40 W (@THD=10%) in 8 Ω of power output at 24 V supply voltage using reduced components. A dedicated power connector on the board is used to feed the power output stage, while the digital control section is powered by the 3.3 V source from the STM32 Nucleo board via the ST morpho connector. Search for application note AN3383 (STA350BW 2.0-channel demonstration board) at *www.st.com* for further information regarding hardware configuration for the Sound Terminal® device.

The board routes signals between microcontrollers on the STM32 Nucleo board and Sound Terminal device via:

- I²C to setup and control the STA350BW device parameters
- I²S (or SAI) for standard audio streaming.

Up to two X-NUCLEO-CCA01M1 expansion boards can be plugged onto the same STM32 Nucleo host in order to build a four-channel digital audio output system.

3.1 Nucleo 144 support

In order to accept Nucleo-144 boards, morpho header connectors must be soldered on the relevant footprint available on the Nucleo.

A pair of 2 x 38 pin stripline is enough to plug the expansion board, so it is not necessary to solder the whole 2 x 80 pin header.

3.2 Powering the board

We suggest reading UM1724, available on www.st.com, before proceeding with power connection.

As previously mentioned, two power sources are required for the board to function properly:

1. to power the digital/control part of the component; this 3.3 V source is routed by the board via the ST morpho connector to the component when the X-NUCLEO-CCA01M1 is connected to a STM32 Nucleo host.
2. for the power output stage; this 5 V to 26 V power source must be connected to the CN2 connector on the board.

The two viable strategies for powering the system are described below.

3.2.1 Powering the whole system

The whole STM32 Nucleo host plus X-NUCLEO-CCA01M1 board system can be powered through the VIN pin on the Arduino UNO R3 or ST morpho connector.

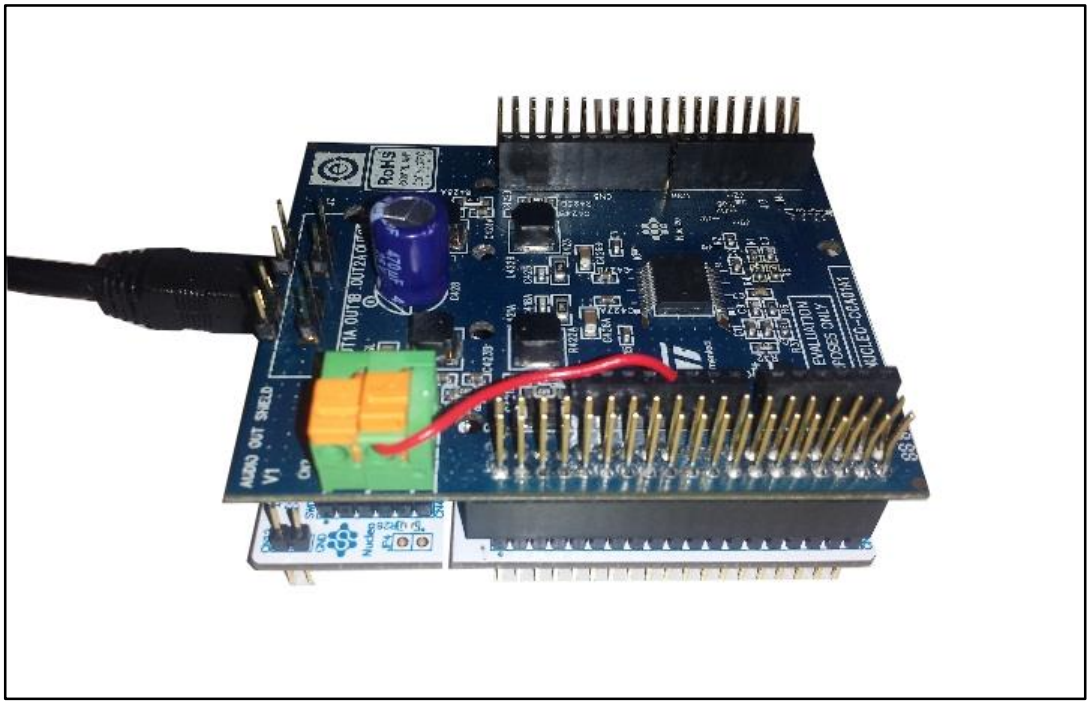
- voltage range 7 V to 12 V
- the STM32 Nucleo JP5 connector must be placed in the “E5V” position
- The 3.3V source is generated by the STM32 Nucleo voltage regulator and routed to the correct ST morpho pin
- the USB cable can be used for debug purposes, but you must first supply the board via VIN and then connect the USB cable to the PC.

3.2.2 Using the +5V pin as a voltage source

The +5V pin can be used as an output voltage source for the power stage of the X-NUCLEO-CCA01M1.

- the STM32 Nucleo board is connected and powered by USB as you would normally
- the JP5 connector on the STM32 Nucleo board must be placed in the “U5V” position
- the 3.3 V source functions normally
- a wire can be used to connect +5V pin on the ST morpho or Arduino UNO R3 connector with the VS signal, pin 1 on the CN2 as shown in the figure below
- the ground connection to CN2.2 is not required as the “gnd” signal is already in common with the STM32Nucleo board.

Figure 3: +5V pin used as a voltage source



3.3 I²C interface

The STA350BW device allows selection of the LSB of the I²C address by pulling the SA pin low or high. The expansion board uses solder bridges J18 and J19 to control the SA level.

In the default configuration, SA is set to LOW.

The following table gives the possible configurations with resulting I²C addresses:

Table 1: I²C address setup

J18 status	J19 status	SA level	I²C address
OPEN	CLOSE	LOW	0x38
CLOSE	OPEN	HIGH	0x3A

Do not close both J18 and J19 at the same time as it will result in a short between 3.3 V and GND.

I²C bus lines must be pulled up for the peripheral to work properly. External resistor footprints (R4 and R5) are provided on the board in order to allow the user to solder pull-up resistors. Suggested resistor values are 4.7 kΩ. In the default configuration, these resistors are not mounted.

A valid alternative for I²C bus pull-up is to use MCU internal pull-up capabilities.

3.3.1 Solder bridge configurations

The various possible configurations depend on actual use circumstances. The X-NUCLEO-CCA01M1 expansion board is designed to route I²S signals to several ST morpho pins that expose several I²S (or SAI) peripherals, depending on the adopted MCU. You can therefore plug up to two expansion boards on the one STM32 Nucleo host to create a 4-channel digital audio output system using two separate I²S peripherals of the same MCU.

Solder bridges can be modified to switch from one configuration to another. The actual configuration together with the MCU used defines whether the X-NUCLEO-CCA01M1 expansion board is designated as:

- device number 1, when connected to the default I²S (or SAI)
- device number 2, when linked to a different I²S (or SAI) instance

Note that for each hardware configuration, the correct firmware initialization parameters must be used.

Table 2: Solder bridge descriptions

Function	Solder bridge	Default
Exclude D1 diode	J1	open
STA350BW Reset PIN	J2	open
STA350BW I2S bit clock (BICKI)	J3	open
STA350BW I2S master clock (MCLK)	J4	open
STA350BW I2S LR clock (LRCKI)	J5	closed
STA350BW I2S Serial Data (SDI1)	J6	closed
STA350BW I2S bit clock (BICKI)	J8	closed
STA350BW I2C SCL	J9	closed
STA350BW I2C SDA	J10	closed
STA350BW I2S bit clock (BICKI)	J11	open
STA350BW I2S Serial Data (SDI1)	J12	open
STA350BW Reset PIN	J13	closed
STA350BW Power down PIN	J14	open
STA350BW I2S Serial Data (SDI1)	J15	open
STA350BW I2S master clock (MCLK)	J16	open
STA350BW I2S LR clock (LRCKI)	J17	open
STA350BW I2C SA pull-up	J18	open
STA350BW I2C SA pull-down	J19	closed
STA350BW I2S Serial Data (SDI1)	J20	open
STA350BW I2S LR clock (LRCKI)	J21	open
STA350BW Power down PIN	J22	open
STA350BW I2S master clock (MCLK)	J23	open
STA350BW I2S master clock (MCLK)	J24	open
STA350BW I2S Serial Data (SDI1)	J25	open

Table 3: Solder bridge settings for device-1 board

Jumper	STM32F401RE, STM32F746ZG or STM32L476RG	STM32F072RB	STM32L053R8
J1	open	open	open
J2	open	open	open
J3	open	open	open
J4	closed	open	open
J5	closed	closed	closed
J6	closed	closed	closed
J8	close	close	closed
J9	closed	closed	closed
J10	closed	closed	closed
J11	open	open	open
J12	open	open	open
J13	closed	closed	closed
J14	closed	closed	closed
J15	open	open	open
J16	open	open	open
J17	open	open	open
J18	open	open	open
J19	closed	closed	closed
J20	open	open	open
J21	open	open	open
J22	open	open	open
J23	open	closed	closed
J24	open	open	open
J25	open	open	open

Table 4: Solder bridge settings for device-2 board

Jumper	STM32F401RE or STM32F746ZG	STM32F072RB	STM32L053R8	NUCLEO-L476RG
J1	open	open	NOT SUPPORTED	open
J2	closed	closed		closed
J3	closed	open		closed
J4	open	open		open
J5	open	open		open
J6	open	open		open
J8	open	open		open
J9	closed	closed		closed
J10	closed	closed		closed
J11	open	closed		open
J12	open	closed		open
J13	open	open		open
J14	open	open		open
J15	open	open		open
J16	closed	open		closed
J17	open	open		closed
J18	closed	closed		closed
J19	open	open		open
J20	open	open		open
J21	closed	closed		open
J22	open	open		closed
J23	open	open		open
J24	open	closed		open
J25	closed	open		open

4 Connectors

The pin assignments for the ST morpho and the Arduino UNO R3 connectors are shown in the following tables.

Table 5: ST morpho connector pin assignments

Connector	Pin	Signal	Remarks
CN7	1	BICKI	If J1 is closed
	3	SDI1	If J3 is closed
	6	E5V	
	12	3V3	
	16	3V4	
	17	LRCKI	If J17 is closed
	18	5V	
	20	GND	
	22	GND	
	24	V_IN, +VS	D1 diode between, excluded if J1 is closed
	28	PWRDN	If J14 is closed
	32	LRCKI	If J21 is closed
	34	PWRDN	If J22 is closed
	35	MCLK	If J23 is closed
	37	SDI1	If J20 is closed
CN10	3	SCL	
	4	MCLK	If J4 is closed
	5	SDA	
	11	BICKI	If J11 is closed
	13	MCLK	If J24 is closed
	15	SDI1	If J12 is closed
	16	LRCKI	If J5 is closed
	19	MCLK	If J16 is closed
	23	RESET	If J2 is closed
	26	SDI1	If J6 is closed
	29	SDI1	If J15is closed
	30	BICKI	If J8 is closed
	33	RESET	If J13 is closed

Table 6: Arduino UNO R3 connector pin assignments

Connector	Pin	Signal	Remarks
CN6	2	3V3	
	4	3V3	
	5	5V	
	6	GND	
	7	GND	
	8	V_IN, +VS	D1 diode between, excluded if J1 is closed
CN5	10	SCL	
	9	SDA	
	6	BICKI	If J11 is closed
	5	MCLK	If J24 is closed
	4	SDI1	If J12 is closed
	2	MCLK	If J16 is closed
CN8	1	PWRDWN	If J14 is closed
	3	LRCKI	If J21 is closed
	4	PWRDWN	If J22 is closed
CN9	8	RESET	If J2 is closed
	5	SDI1	If J15 is closed
	3	RESET	If J13 is closed

5 Board schematics

Figure 4: X-NUCLEO-CCA01M1 schematic (1/2)

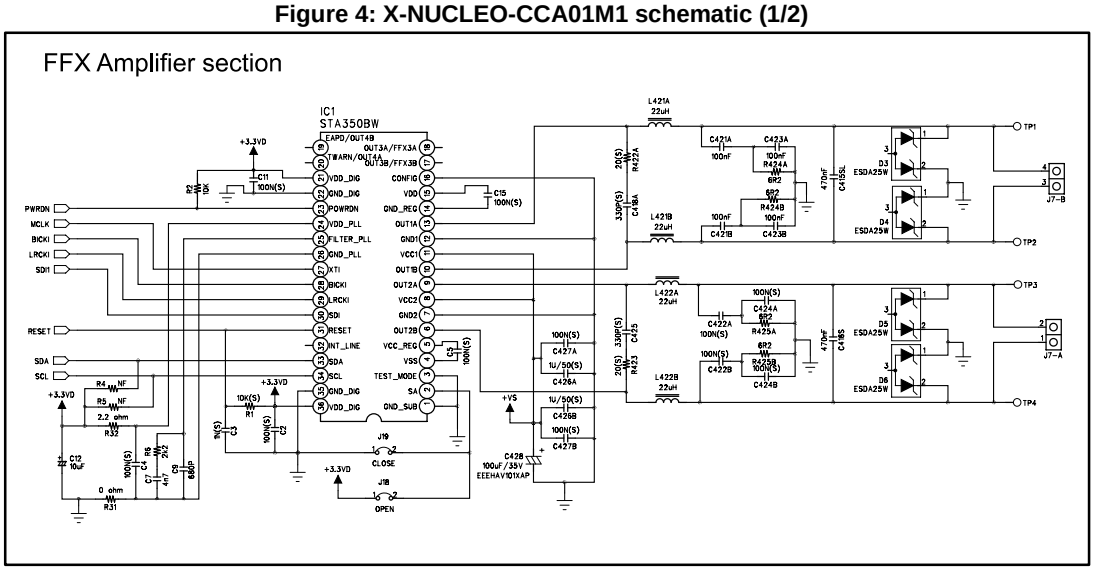
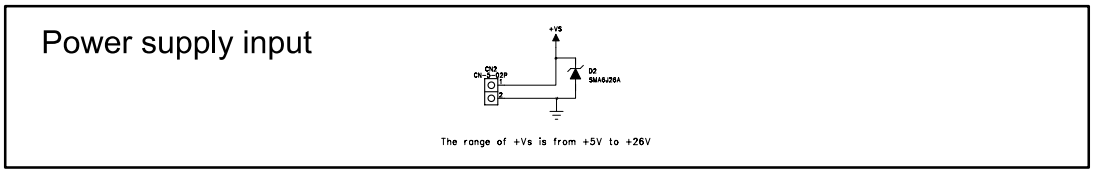


Figure 5: X-NUCLEO-CCA01M1 schematic (2/2)



6 Bill of materials

Table 7: BOM (1/2)

Item	Quantity	Reference	Part / value	Voltage / Watt / Ampere
1	1	CN2	connector	Screw Connector 2 Poles
2	1	CN5	HEADER 10	connector 10 pins, p. 2.54, female (socket) strip
3	2	CN6,CN9	HEADER 8	connector 8 pins, p. 2.54 female (socket) strip
4	2	CN7,CN10	HEADER 19x2	connector 38 pins (2X19) p. 2.54
5	1	CN8	HEADER 6	connector 6 pins, p. 2.54, female (socket) strip
6	15	C2,C4,C5,C11,C15,C421A,C421B,C422A, C422B,C423A,C423B, C424A,C424B,C427A,C427B	100 nF	35 V
7	2	C418A, C425	330 pF	35 V
8	1	C9	680 pF	16 V
9	1	C3	1 nF	16 V
10	1	C7	4.7 nF	16 V
11	2	C415SL, C416S	470 nF	35 V
12	2	C426A, C426B	1 uF	35 V
13	1	C12	10 uF	5 V
14	1	C428	100 uF	35 V
15	1	IC1	STA350BW	
16	4	TP1, TP2, TP3, TP4	HEADER 1	
17	2	J7 (OUT1A-OUT1B, OUT2A-OUT2B)	Screw Connector 2 poles, Vertical Mount PCB Terminal Blocks	3 A
18	1	R31	0 Ω	
19	1	R32	2R2	1/16 W
20	2	R1,R2	10 kΩ	1/16 W
21	1	R6	2.2 kΩ	1/16 W

Item	Quantity	Reference	Part / value	Voltage / Watt / Ampere
22	2	R4, R5	not mounted	
23	4	R424A, R424B, R425A, R425B	6R2	0.5 W
24	2	R422A, R423	20R	0.5 W
25	9	J4, J5, J6, J8, J9, J10, J13, J14, J19	soldered	
26	15	J1, J2, J3, J11, J12, J15, J16, J17, J18, J20, J21, J22, J23, J24, J25	not soldered	
27	1	D1	B240	
28	1	D2	SMA6J26A	
29	4	L421A, L421B, L422A, L422B	22uH COIL	
30	4	D3, D4, D5, D6	ESDA25W	

Table 8: BOM (2/2)

Item	Type / technology information	Tolerance	Package	Manufacturer	Manufacturer ordering code / Orderable part number	Additional notes
1			Through hole 5 mm			
2					HARWIN M20-7821046 or equivalent	Female on Top
3					HARWIN M20-7820846 or equivalent	Female on Top
4						Female on Bottom, Male on Top
5					HARWIN M20-7820646 or equivalent	Female on Top
6			0603			
7			0603			
8			0603			
9			0603			
10			0603			
11			1206			
12			1206			
13		10%	1206			
14		20%	SMT	PANASONIC	EEEHAV101XAP or equivalent	
15			PSSO36	ST	STA350BW	

Item	Type / technology information	Tolerance	Package	Manufacturer	Manufacturer ordering code / Orderable part number	Additional notes
16			not mounted			not mounted
17			Through hole 5 mm	Any		
18			0603			
19		1%	0603			
20		1%	0603			
21		1%	0603			
22			NOT MOUNTED			
23		1/%	1206			
24		1/%	1206			
25						
26						
27			SMD	diodes incorporated	B240	
28			SMD	ST	SMA6J26A	
29			SMD	SUNLORD	SWPA6045S220MT	
30			SOT323-3L	ST	ESDA25W	

7 Layout

Figure 6: X-NUCLEO-CCA01M1 top layer

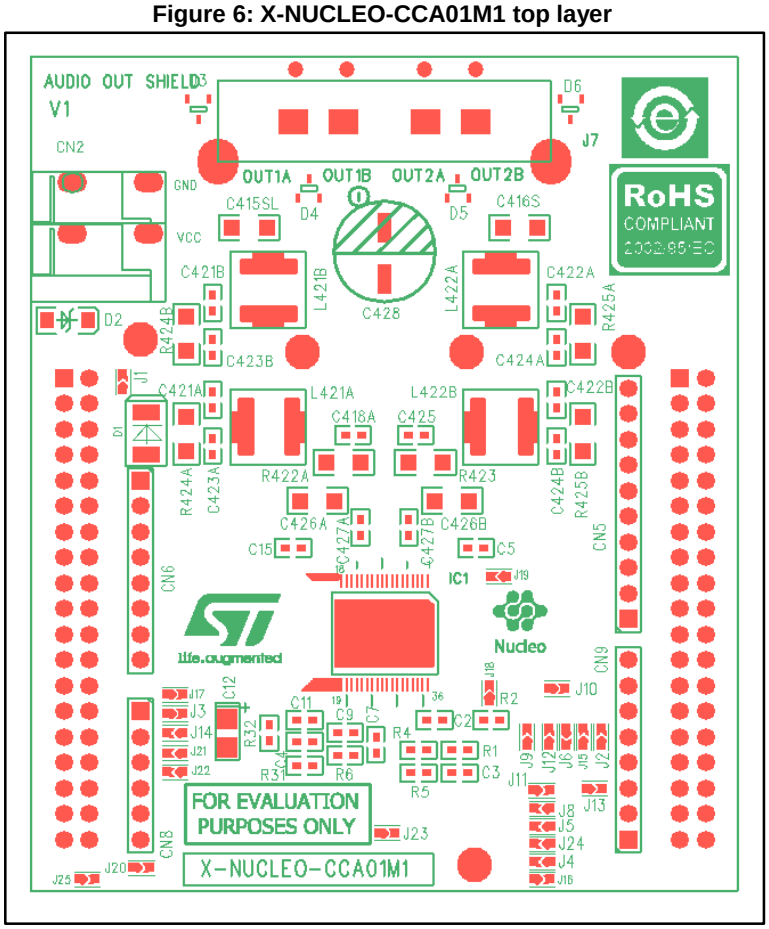
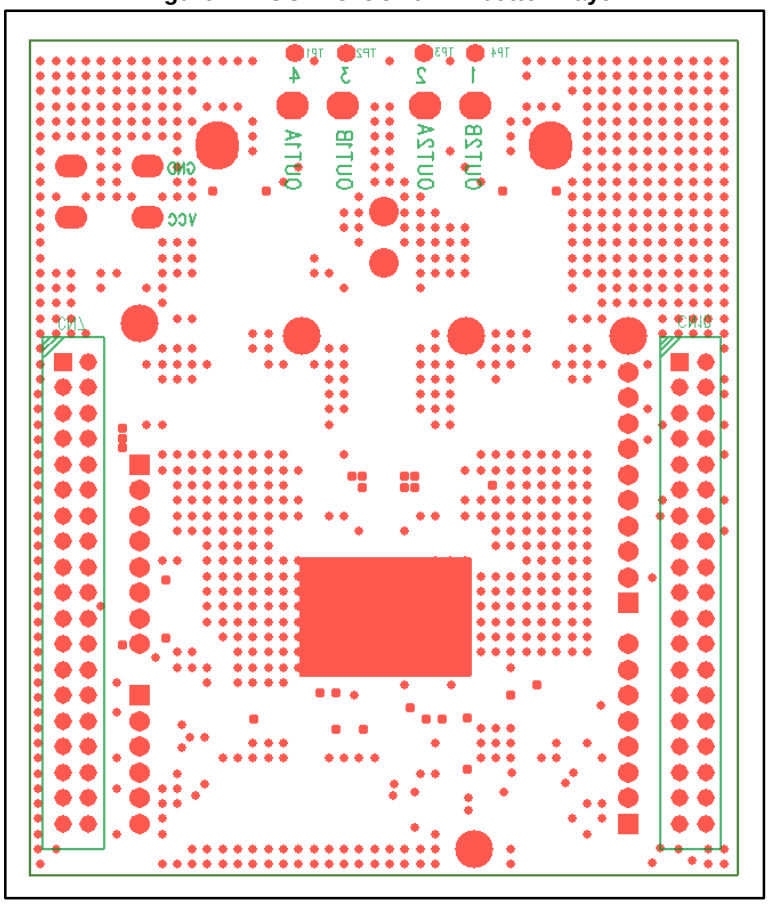


Figure 7: NUCLEO-CCA01M1 bottom layer



8 Revision history

Table 9: Document revision history

Date	Version	Changes
10-Nov-2015	1	Initial release.
11-Jul-2016	2	Text changes throughout document Updated Nucleo compatibility information Changed *Table 3: "Solder bridge settings for device-1 board"* Changed *Table 4: "Solder bridge settings for device-2 board"* Added *Section 5.1: "Nucleo 144 support"*

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