

ARM® ARM926EJ-S Based 32-bit Microprocessor

N32905 Family NuMaker NuWicam Hardware User Manual

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1 OVERVIEW

Nuvoton's NuMaker NuWicam is an open source hardware device supports P2P that transmits a video and audio data to a wireless receiver through Wi-Fi.

The NuWicam integrates necessary functions such as CMOS sensor or TV video (NTSC/PAL) decoder, voice microphone, SDIO host controller for connecting with Wi-Fi module. These functions make a cost effective solution for Wi-Fi camera applications.

The NuWicam can be used for home security or monitoring the elders, babies or pets at home remotely. The NuWicam provides an App supports iOS and Android that allows users to set up the Wi-Fi camera easily and connect to it from everywhere through a smartphone or tablet.

The NuWicam has an external connector that provides Arduino microcontroller based kit with TXD/RXD protocol of UART for communication, or for Nuvoton's NuEdu-SDK- M451 development board to expand various possible applications.

1.1 NuWicam System Block

Figure 1-1 shows the NuWicam system architecture and peripheral interfaces for connecting external devices. Key part features in NuWicam are also listed.

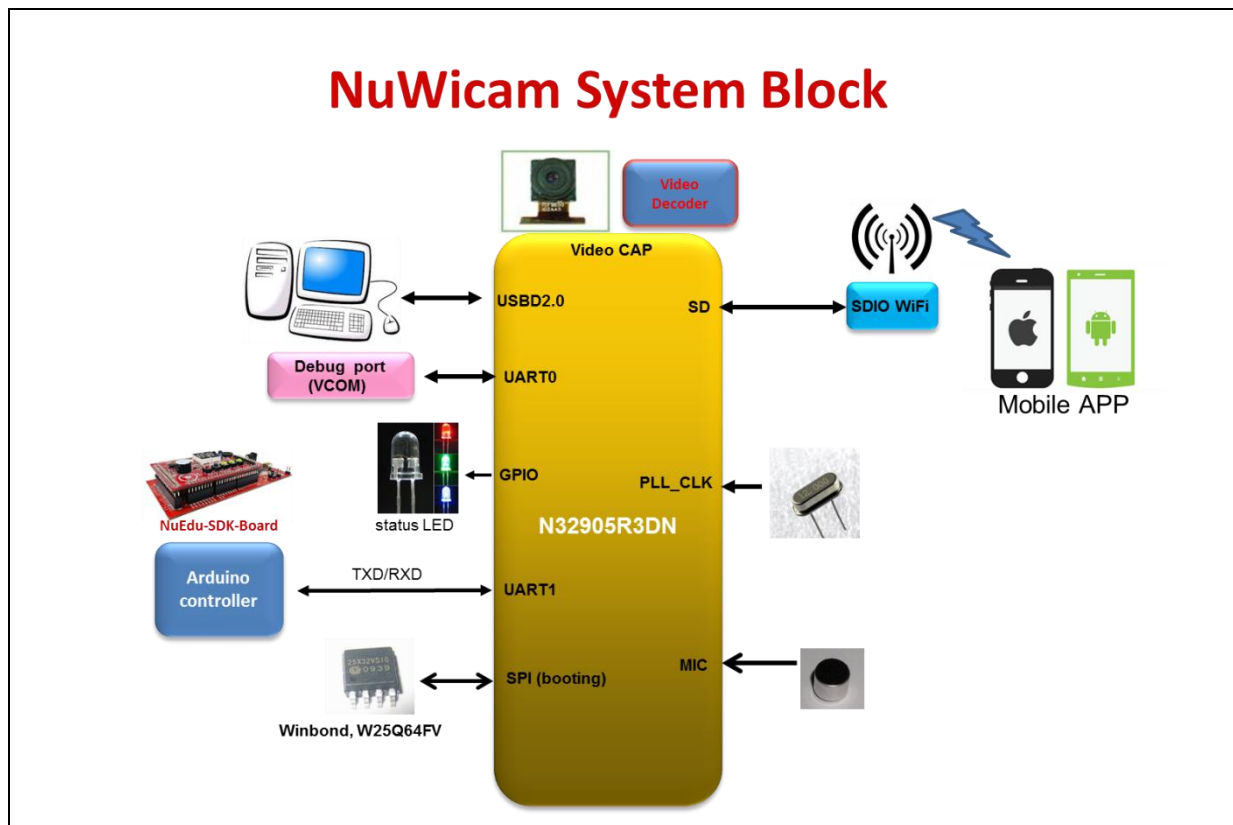


Figure 1-1 NuWicam System Block

2 INTRODUCTION TO NUWICAM

The NuWicam uses an ARM926 SOC which N32905R3DN as the SOC microcontroller, N32905R3DN provides the SPI interface for SPI NOR flash booting, provides a SD interface to SDIO Wi-Fi module for wireless network connection, provides a video input interface to VGA CMOS sensor or TV video (NTSC/PAL) decoder for Motion JPEG video streaming, provides a differential microphone interface with ECM type for audio streaming, provides an USB2.0 Hi speed device port to PC for software development or SPI flash's program upgrade. It also provide two UART ports, port 0 is dedicated for debugging and the UART port 1 for Arduino microcontroller based kit communication.

2.1 NuWicam Features

- SOC: N32905R3DN (ARM926 at 192 MHz, 32 MB DDR2 with TQFP64 package)
- Main program with 8 MB SPI Flash (W25Q64FV, SO8)
- VGA CMOS Image Sensor (GC0308)
- Alternative video with TV video decoder, TVP5150/ GM7150 (NTSC/PAL support)
- Video streaming achieves MJPG performance at VGA@30fps
- SDIO Wi-Fi module with RTL8189FTV, software AP mode support and easy to configure
- Embedded Electret Condenser Microphone
- Supports Arduino microcontroller communication based on TXD/RXD protocol
- 3 LEDs for status indication, Program Ready, Wi-Fi Link & App running
- Wide power supply input range from 3.5V to 6V
- System operation in Linux OS 3.4.35
- Main PCB size: 25mm x 50mm
- Debug tooling board, which is used for:
 - Software development or SPI flash program updated by the utility of PC through USB port
 - Message debugging with UART port 0 through USB virtual COM
- Power consumption
 - A/V streaming running up to 200mA at 5V (typical)
 - Working time of 6 hours is possible with 1500mAh AA BAT x 4

2.2 N32905R3DN on NuWicam Features

- N32905R3DN: Nuvoton's ARM9 family based on the ARM926EJ-S core
- CPU operated at 192 MHz, 1.8V with 8KB I-Cache & 8KB D-Cache
- SRAM@8K and Internal Booting ROM, IBR@16K
- System booting with SPI NOR flash
- CCIR601 & CCIR656 interfaces for CMOS image sensor
- Resolution up to 2M pixel for Still Image Capture, 640x480 (VGA) resolution for MJPEG video streaming
- DMA accelerate that SD data transfer with SDIO Wi-Fi module
- 10-bit Audio ADC with Microphone pre-Amp & AGC
- USB2.0 Hi speed, driver support MS (Mass Storage) Class
- Two UART ports support debugging and Arduino controller communication
- Package, TQFP-64 (MCP, stacked with 32MB DDR2 @1.8V)

Please refer to Figure 2-1 for the N32905R3DN SOC outline.

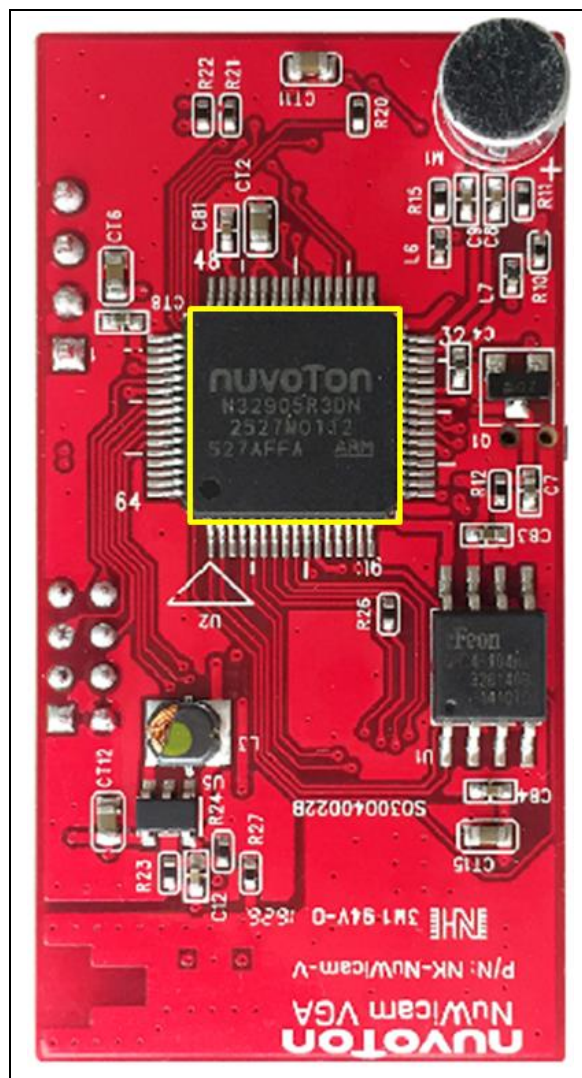


Figure 2-1 N32905R3DN SOC Outline

2.3 GC0308 on NuWicam Features

- GC0308: GalaxyCore's CMOS image sensor
- Resolution 640V x 480H with 1/6.5-inch optical format
- On-Chip ISP provides AE (Auto Exposure) and AWB (Auto White Balance) control
- Operating at up to 30 frames per second at 24 MHz clock in VGA mode
- Output formats: YCbCr4:2:2
- Single power supply (3V)
- Support Horizontal /Vertical mirror control

Please refer to Figure 2-2 for the GC0308 CMOS sensor module outline.

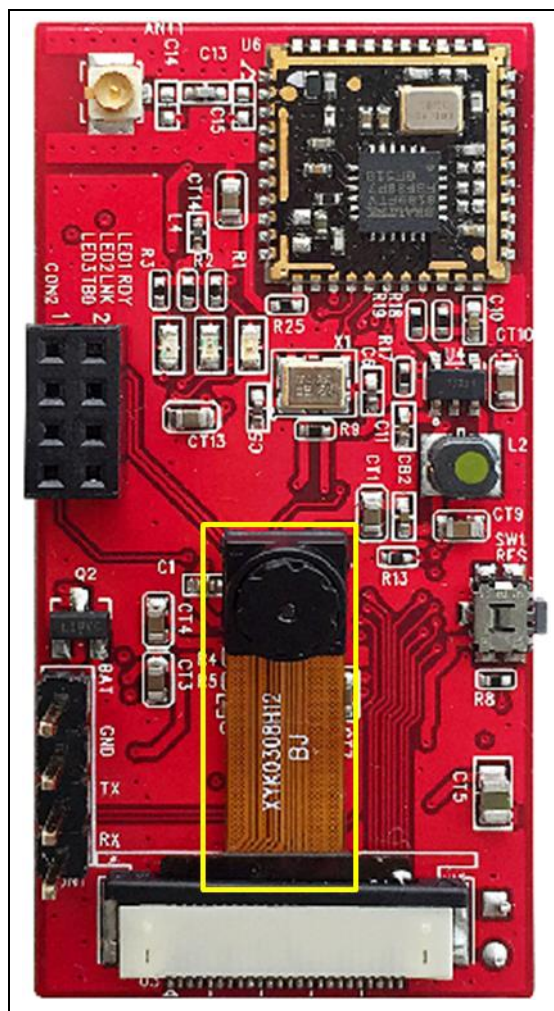


Figure 2-2 GC0308 CMOS Sensor Module Outline

2.4 TVP5150/GM7150 on NuWicam Features

- TVP5150: Ti's NTSC/PAL video decoder
- GM7150 is Chengdu GoldTel (成都国腾) NTSC/PAL video decoder
- Both video decoders are pin out compatible
- Support NTSC (N, 4.43), PAL (B, D, G, H, I, M, N) Video data source
- The output formats can be 8-bit 4:2:2 or 8-bit ITU-R BT.656
- Single 14.318-MHz Crystal for all standards
- Support power-on reset
- NTSC/PAL detection
 - TVP5150 can support auto detection
 - GM7150, detection by jumper setting
- TVP5150 PKG is LQFP32
- GM7150 PKG is QFN32

Please refer to Figure 2-3 for the TVP5150/ GM7150 TV video decoder outline.

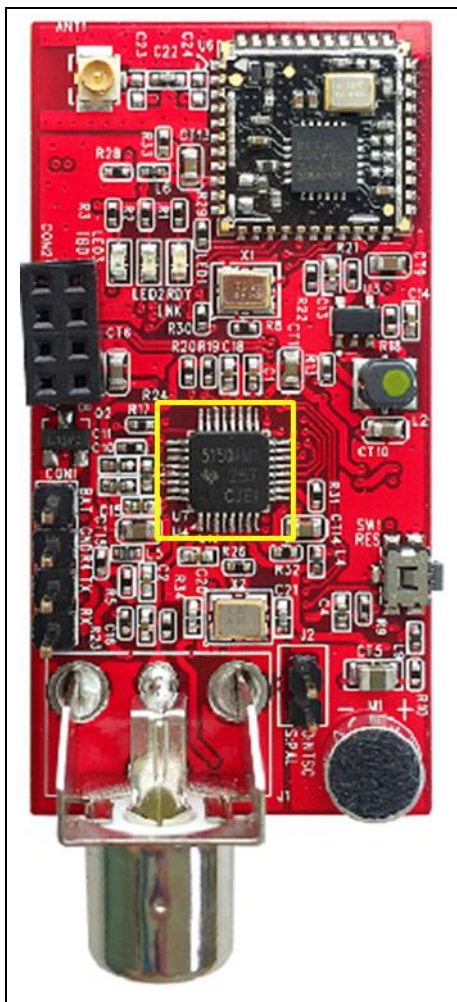
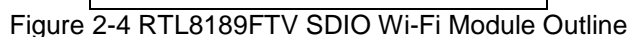


Figure 2-3 TVP5150/ GM7150 TV video decoder outline

- RTL8189FTV: Realtek's Wi-Fi chip
- Operated at 802.11n Wi-Fi LGA Module
- Module size is 12.0 mm x 12.0 mm x 1.6mm, 3.3V at SDIO Interface
- Operate at ISM 2.4GHz frequency bands
- Security can apply WPA/WPA2 certification for Wi-Fi.
- 1T (transmitter) and 1R (receiver) allow data rates supporting up to 150 Mbps downstream and 150 Mbps upstream PHY rates
- NuWicam Network Architecture working at software AP mode



2.6 Board Introduction

As shown in Figure 2-5, the NuWicam solution contains two kinds of main boards and one common debug board, as described below:

- **NuWicam-VGA:** Wi-Fi camera main board with VGA CMOS sensor
- **NuWicam-TVP:** Wi-Fi camera main board with TV video decoder
- **NuWicam-Debug:** Debug board

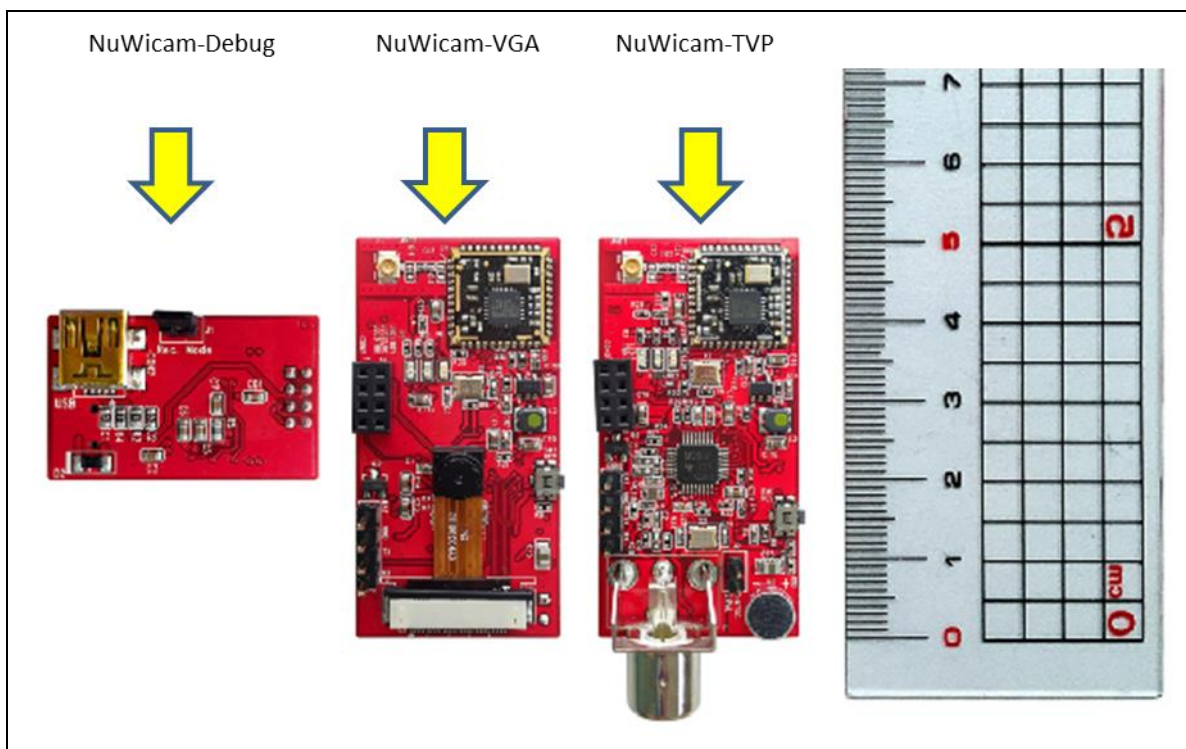


Figure 2-5 NuWicam PCB Outline

2.6.1 NuWicam-VGA Board

The NuWicam-VGA board uses GC0308 VGA CMOS sensor and provides a powerful JPEG codec based on Nuvoton's N32905R3DN for encoding. NuWicam firmware provides both audio and video streaming over Wi-Fi network with RTSP server. The format of video stream is Motion-JPEG with VGA resolution.



Figure 2-6 NuWicam-VGA Board (Front View and Rear View)

2.6.2 NuWicam-TVP Board

The NuWicam-TVP board uses TVP5150 or GM7150 TV video decoder for connecting NTSC or PAL analog camera and based on Nuvoton's N32905R3DN to provide a powerful JPEG codec for video encoding. NuWicam firmware provides both audio and video streaming over Wi-Fi network with RTSP server. The format of video stream is Motion-JPEG with VGA resolution.



Figure 2-7 NuWicam-TVP Board (Front View and Rear View)

2.6.3 NuWicam-Debug Board

The NuWicam-Debug board is connected to the NuWicam-VGA or NuWicam-TVP main board for software development or SPI flash's program upgrade. User can also get the debugging message from the N32905R3DN UART port 0 through USB Virtual COM.

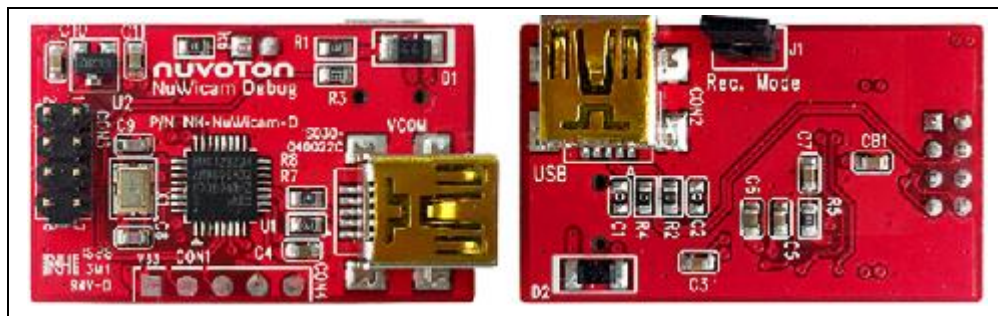


Figure 2-8 NuWicam-Debug Board (Front View and Rear View)

2.7 NuWicam Power Scheme

Figure 2-9 shows the NuWicam system power scheme, user should follow the power distribution requirement to provide that correct power voltage to NuWicam to prevent incorrect voltage caused board damaged or broken.

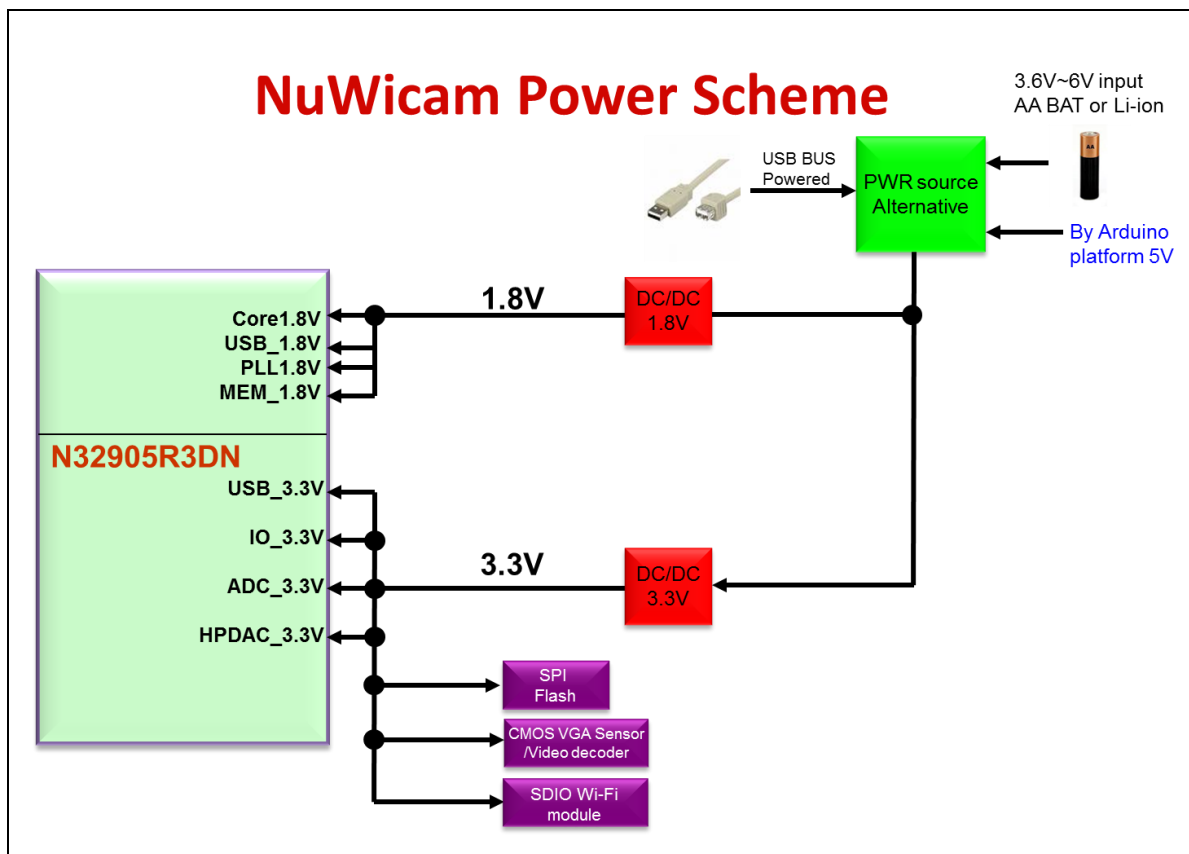


Figure 2-9 NuWicam Power Scheme

2.8 NuWicam Jumper and Connector

2.8.1 NuWicam-VGA Board Jumper Description

Figure 2-10 shows the front and rear view of NuWicam-VGA Board & NuWicam-Debug Board.

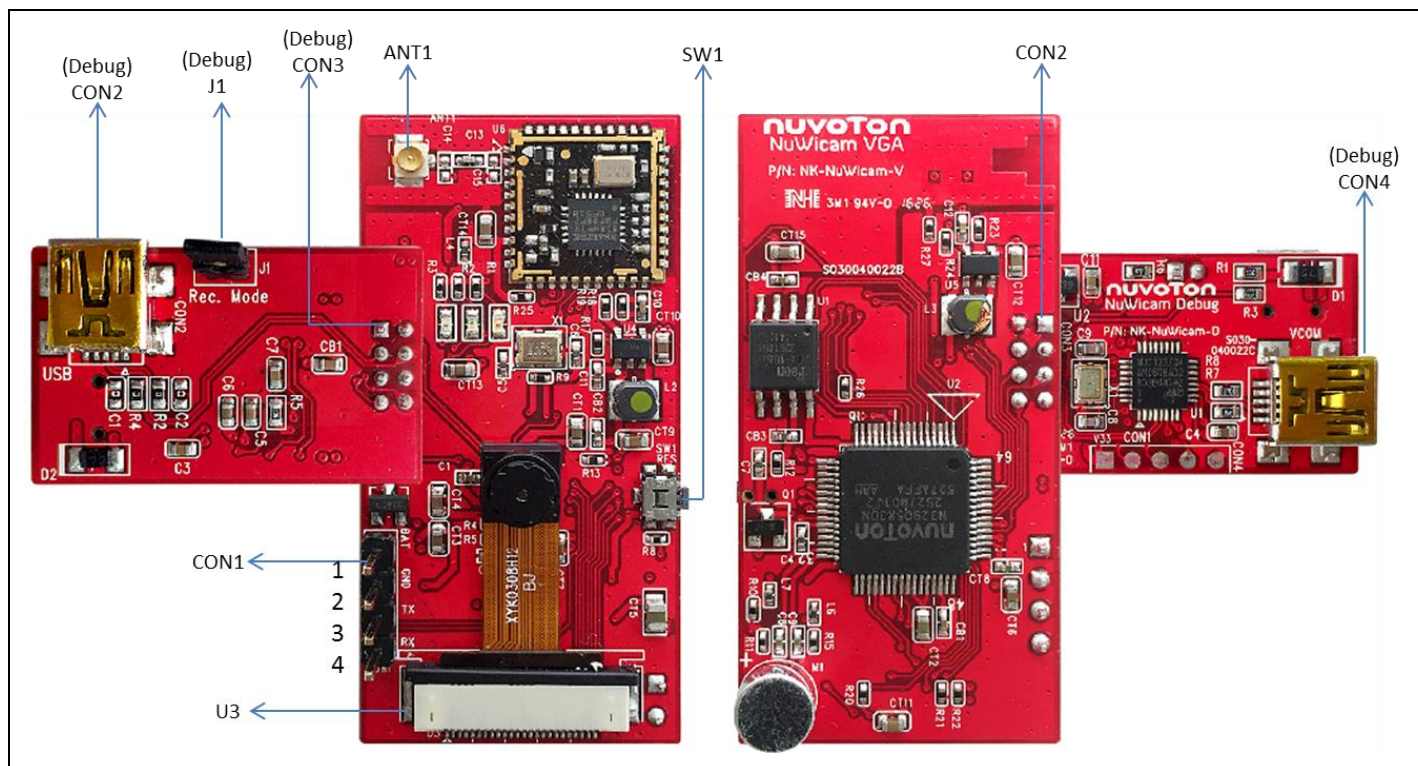
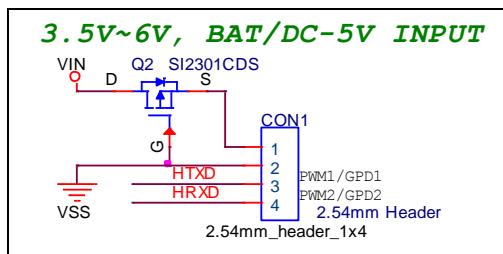


Figure 2-10 NuWicam-VGA Board & NuWicam-Debug Board (Front View and Rear View)

- CON1: This connector is an expanded connector for connecting to Arduino microcontroller based kit
 - CON1. pin 1-2, it is for power supply or BAT connection
 - ◆ PIN 1, input voltage range from +3.5V to +6V
 - ◆ PIN 2, connect it to GND

Note: The pin 1-2 of CON1 is connected to power supply or BAT, NuWicam can run Wi-Fi camera function with an independent power supply without NuWicam debug board's USB power, about voltage request is from 3.5V (Min.) to 6V (max.), typical DC 5V is prefer and recommended.

- CON1. Pin 3 & 4, UART protocol of interface with TXD/RXD for Arduino communication



- CON2: This connector is for connecting with NuWicam-Debug board's CON3
- SW1: RESET KEY
 - System re-start when the button is pressed

2.8.2 NuWicam-TVP Board Jumper Description

Figure 2-11 shows the front view and rear view of NuWicam-TVP Board & NuWicam-Debug Board.

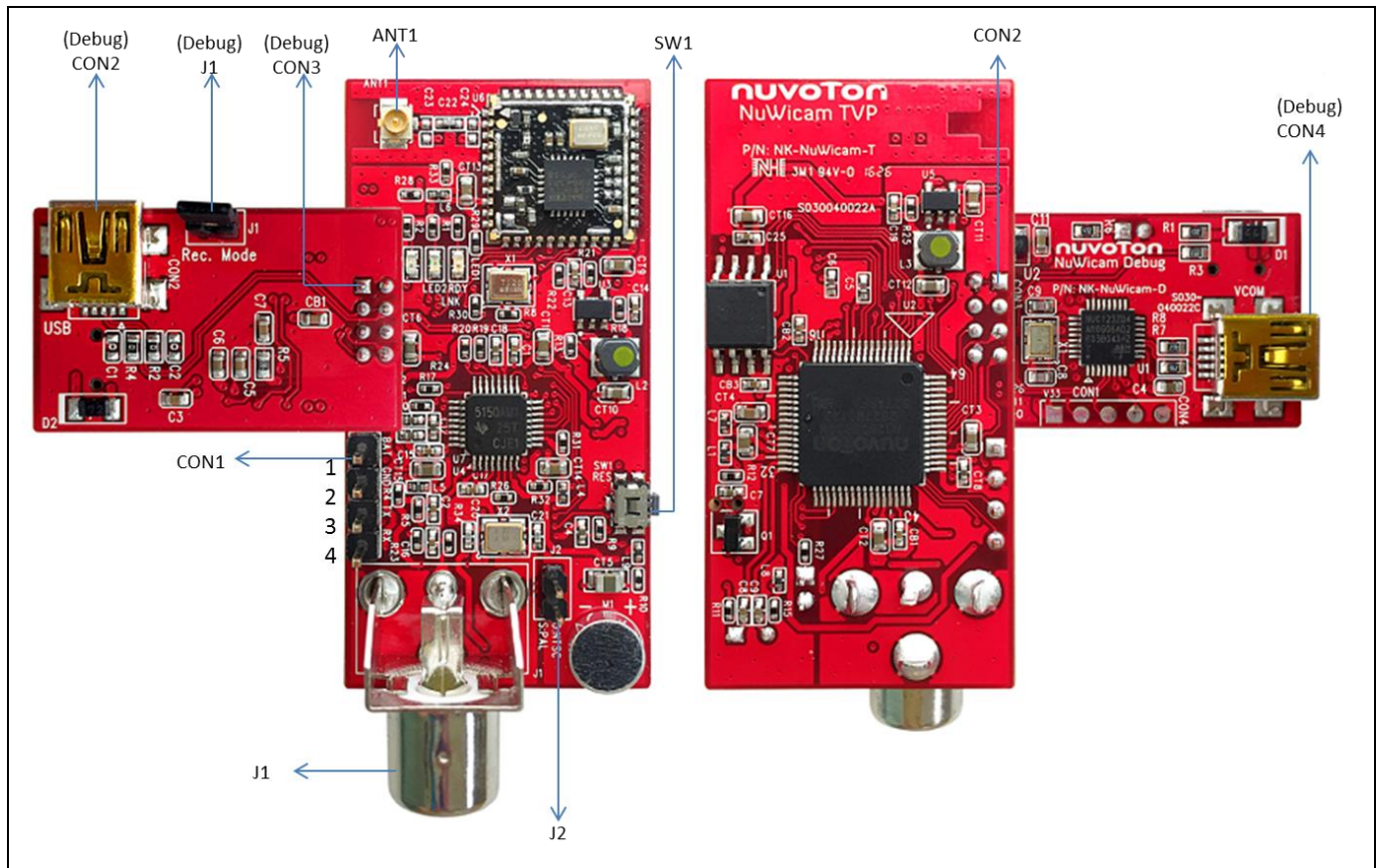


Figure 2-11 NuWicam-TVP Board & NuWicam-Debug Board (Front View and Rear View)

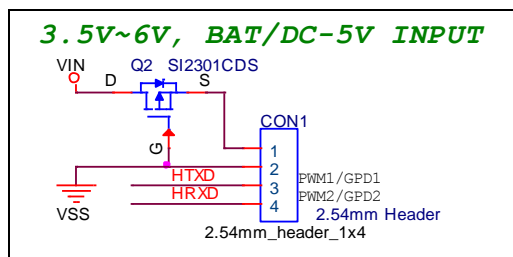
- **J1:** NTSC/ PAL analog camera input connector
- **J2:** NTSC/ PAL video source selection (this jumper function only for GM7150 use)
 - Jumper J2 open expresses video source is NTSC
 - Jumper J2 close expresses Video source is PAL

Note: TVP5150 can automatically identify NTSC/PAL signals by firmware itself without jumper J2 setting.

- **CON1:** This is an expanded connector for connecting to Arduino microcontroller based kit
 - CON1. pin 1-2, is for power supply or BAT connection
 - ◆ **PIN 1:** input voltage range from +3.5V to +6V
 - ◆ **PIN 2:** connect it to GND

Note: The pin 1-2 of CON1 is connected to power supply or BAT, NuWicam can run Wi-Fi camera function with an independent power supply without NuWicam debug board's USB power, about voltage request is from 3.5V (Min.) to 6V (max.), typical DC 5V is prefer and recommended.

- CON1. Pin 3 & 4, UART protocol of interface with TXD/RXD for Arduino communication



- **CON2:** This connector is for connecting with NuWicam-Debug board's CON3
- **SW1: RESET KEY**
 - System re-starts when the button is pressed.

2.8.3 NuWicam-Debug Board Jumper Description

Figure 2-12 shows the front view and rear view of NuWicam-Debug Board.

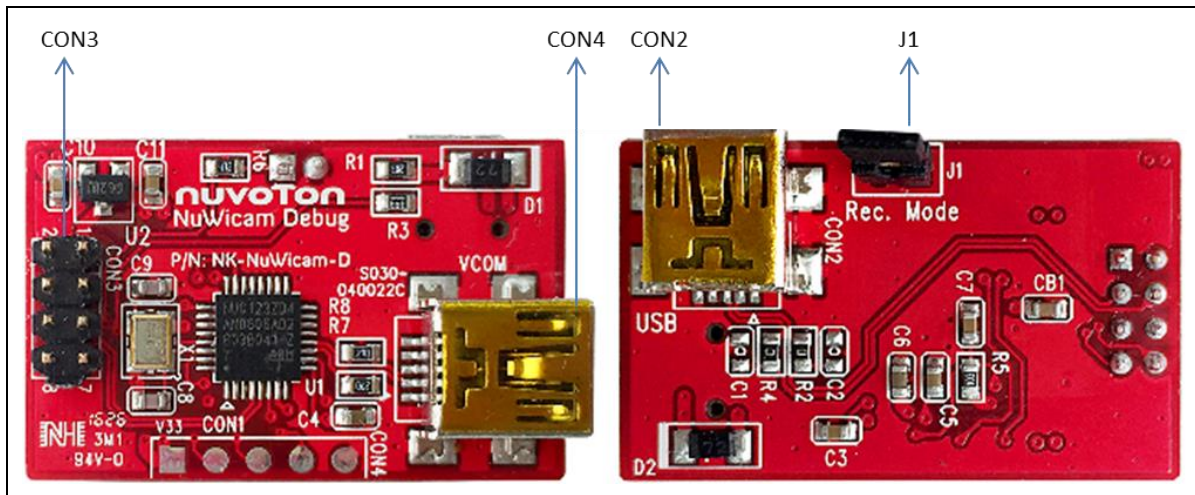


Figure 2-12 NuWicam-Debug Board (Front and Rear View)

- J1: USB recovery mode selection
 - J1 jumper open, for normal operation
 - J1 jumper close, N32905R3DN enter USB recovery mode, this case only for SPI Flash program upgrade in AutoWriter program.

Note: For AutoWriter program operation, please refer to the “Nuvoton NuWicam User Guide.pdf”.

- CON2: USB connector
 - Used for USB application or SPI Flash program upgrades, for this purpose, user must connect USB cable through CON2 to PC for getting USB communication.
- CON3:
 - Connected to NuWicam-VGA or NuWicam-TV main board's CON2
- CON4: VCOM connector
 - User can get that debugging message from N32905R3DN UART port 0 through USB Virtual COM

Note: For Virtual COM driver installation and operation, please refer to the “Nuvoton NuWicam User Guide.pdf”.

2.9 N32905R3DN Pin Assignment for Connectivity

The NuWicam uses N32905R3DN (TQFP64 with EPAD) as SOC. All pin definitions are listed in the following table.

PKG No.#	Pin Name	Function	Connectivity	Type
1	GPD[13]	SPI0_CS0_	SPI Flash	IOU
2	GPD[14]	SPI0_DI	SPI Flash	IOU
3	GPD[15]	SPI0_DO	SPI Flash	IOU
4	GPE[4]	SDDAT[2]	SDIO WI-FI	IOU
5	GPE[5]	SDDAT[3]	SDIO WI-FI	IOU
6	GPE[6]	SDCMD	SDIO WI-FI	IOU
7	GPE[7]	SDCLK	SDIO WI-FI	IOU
8	GPE[2]	SDDAT[0]	SDIO WI-FI	IOU
9	GPE[3]	SDDAT[1]	SDIO WI-FI	IOU
10	XIN	XIN	12 MHz	A
11	XOUT	XOUT	12 MHz	A
12	MVREF	MVREF	0.9V	P
13	U_PLL_VDD18	U_PLL_VDD18	1.8V	P
14	UD_DM	UD_DM	USB	A
15	UD_DP	UD_DP	USB	A
16	UD_VDD33	UD_VDD33	3.3V	P
17	UD_REXT	UD_REXT	12.1K	A
18	VSS	GND	GND	G
19	GPC[15]	SPDATA[7]	VGA / TVP5150	IOU
20	GPC[14]	SPDATA[6]	VGA / TVP5150	IOU
21	GPC[13]	SPDATA[5]	VGA / TVP5150	IOU
22	GPC[12]	SPDATA[4]	VGA / TVP5150	IOU
23	GPC[11]	SPDATA[3]	VGA / TVP5150	IOU
24	GPC[10]	SPDATA[2]	VGA / TVP5150	IOU

25	GPC[9]	SPDATA[1]	VGA / TVP5150	IOU
26	GPC[8]	SPDATA[0]	VGA / TVP5150	IOU
27	VDD18	1.8V	1.8V	P
28	VDD33	3.3V	3.3V	P
29	ADC_VSS33	ADC_VSS33		G
30	ADC_VDD33	ADC_VDD33	3.3V	P
31	ADC_AIN[0]	MIC+	MIC	A
32	ADC_AIN[1]	MIC-	MIC	A
33	ADC_AIN[2]	NC	NC	A
34	GPA[5]	TBD	reserved	IOU
35	GPA[4]	SW_SCK	I ² C	IOU
36	GPA[3]	SW_SDA	I ² C	IOU
37	GPA[1]	TBD	reserved	IOU
38	RST_	RST_	RESET	IU
39	GPD[1]	HUR_TXD	to Arduino RX	IOU
40	GPD[2]	HUR_RXD	to Arduino TX	IOU
41	UD_CDET	UD_CDET	USB	I
42	VDD18	1.8V	1.8V	P
43	MVREF	MVREF	0.9V	P
44	VDDQ	VDDQ	1.8V	P
45	ADAC_HPVS33	ADAC_HPVS33	GND	G
46	ADAC_HPVD33	ADAC_HPVD33	3.3V	P
47	ADAC_HPOUT_L	NC		A
48	ADAC_HPOUT_R	NC		A
49	ADAC_AVSS33	ADAC_AVSS33	GND	G
50	ADAC_VREF	NC		A
51	ADAC_AVDD33	ADAC_AVDD33	3.3V	P
52	VDD18	1.8V	1.8V	P

53	GPA[7]	S_RESET/RECOVERY	video device RESET/ USB recovery mode	IOU
54	VDD33	3.3V	3.3V	P
55	GPA[10]	URTXD	VCOM debug	IOU
56	GPA[11]	URRXD	VCOM debug	IOU
57	GPB[6]	LED3_TBD	status LED, low active	IOU
58	GPB[5]	LED2_LINK	status LED, low active	IOU
59	GPB[4]	LED1_REDAY	status LED, low active	IOU
60	GPB[3]	SVSYNC	VGA / TVP5150	IOU
61	GPB[2]	SHSYNC	VGA / TVP5150	IOU
62	GPB[1]	SPCLK	VGA / TVP5150	IOU
63	GPB[0]	SCLKO/ NTSC or PAL SEL	VGA SCLK / TVP5150 CAM source selection	IOU
64	GPD[12]	SPI0_CLK	SPI FLASH	IOU
65	GND	GND	GND	E_PAD

2.10 NuWicam PCB Placement

Figure 2.14, Figure 2.15 and Figure 2.16 show the front and back NuWicam PCB placement.

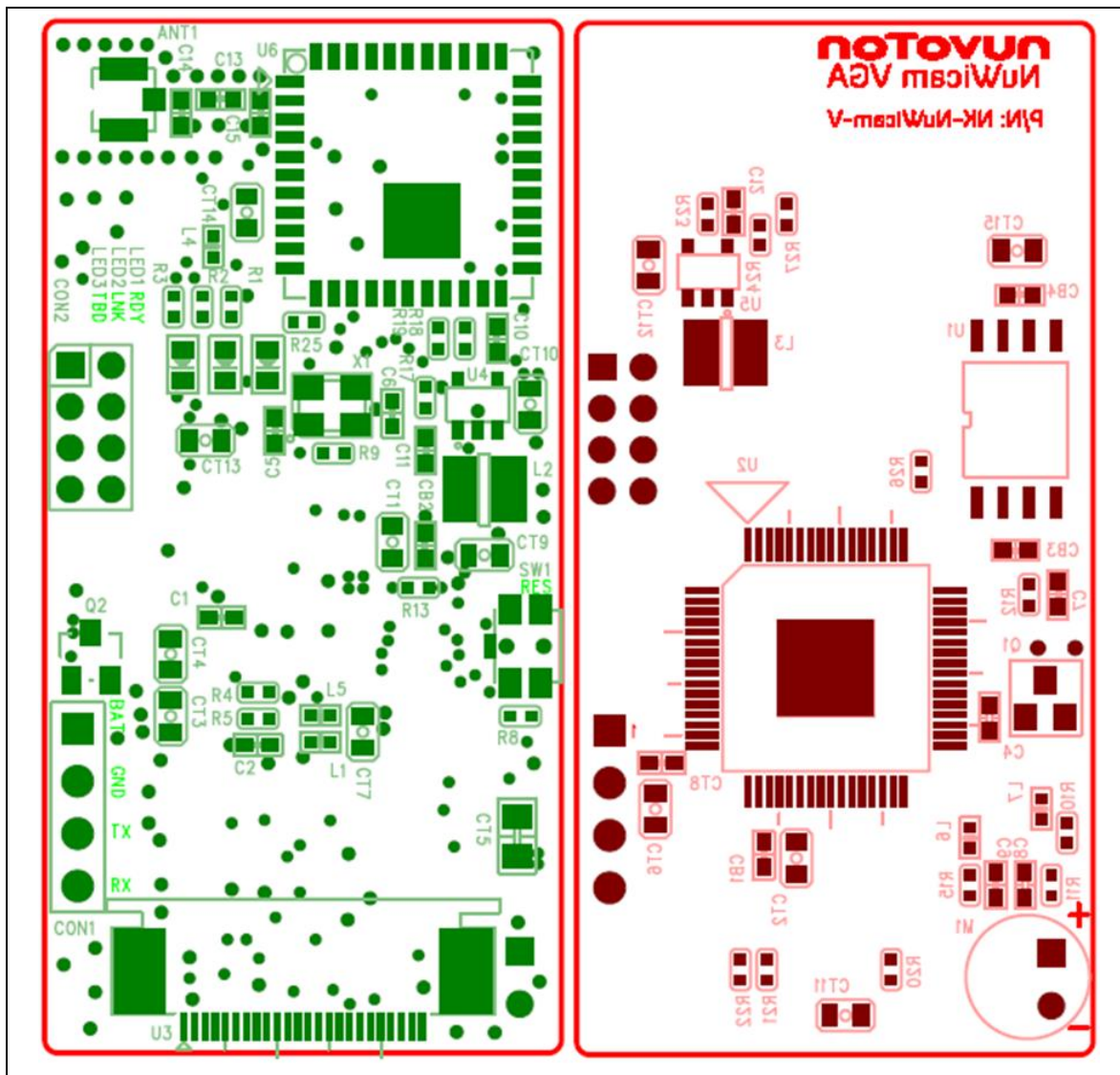


Figure 2-13 Front and Back NuWicam-VGA PCB Placement

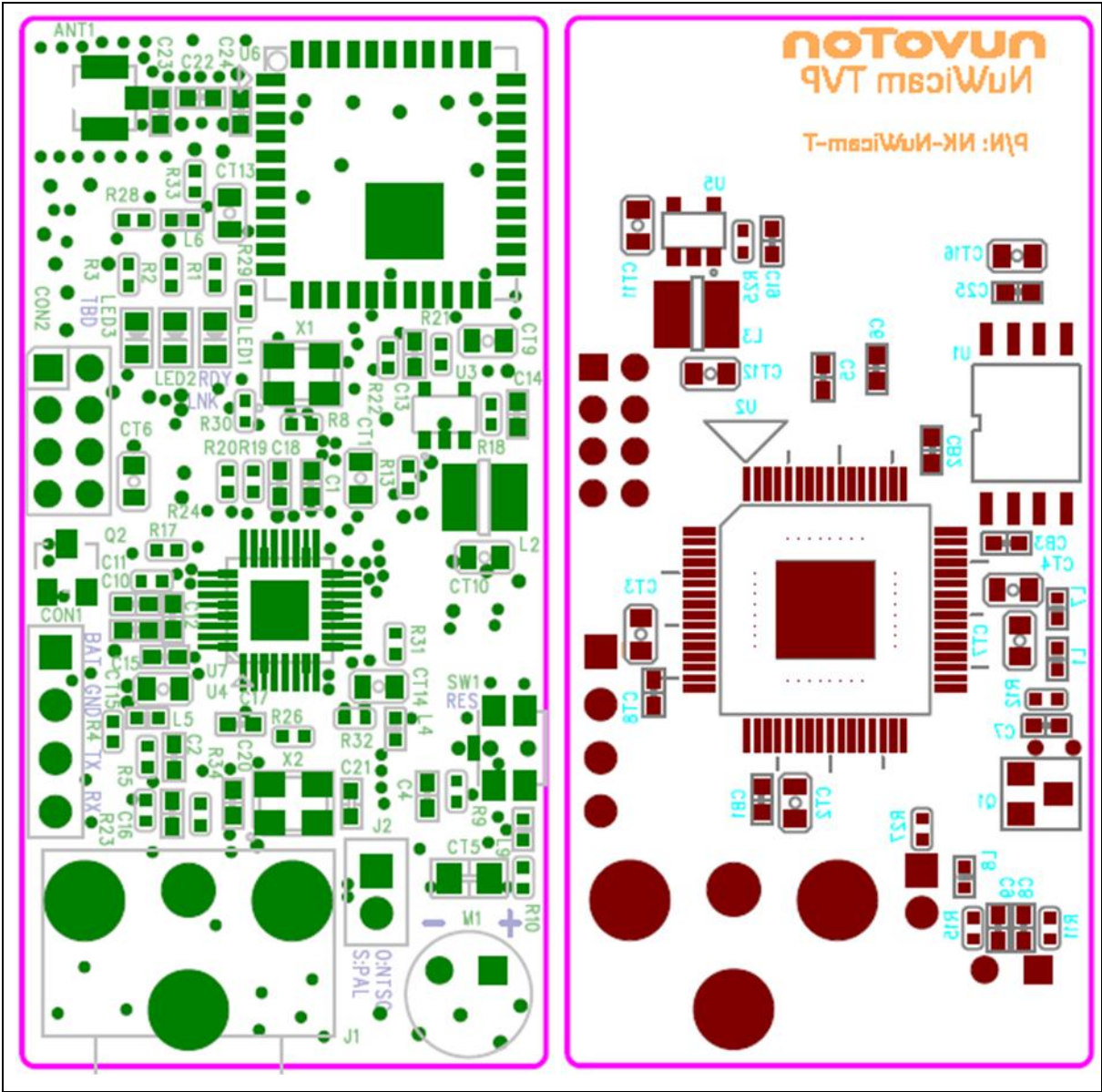


Figure 2-14 Front and Back NuWicam-TVP PCB Placement

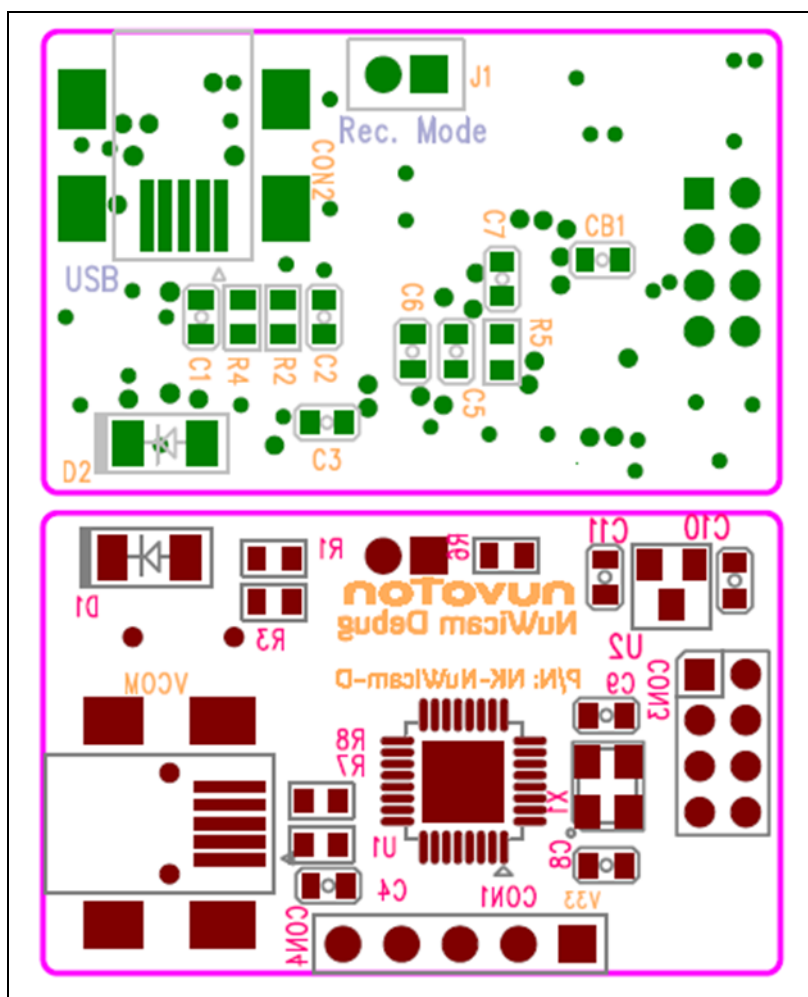
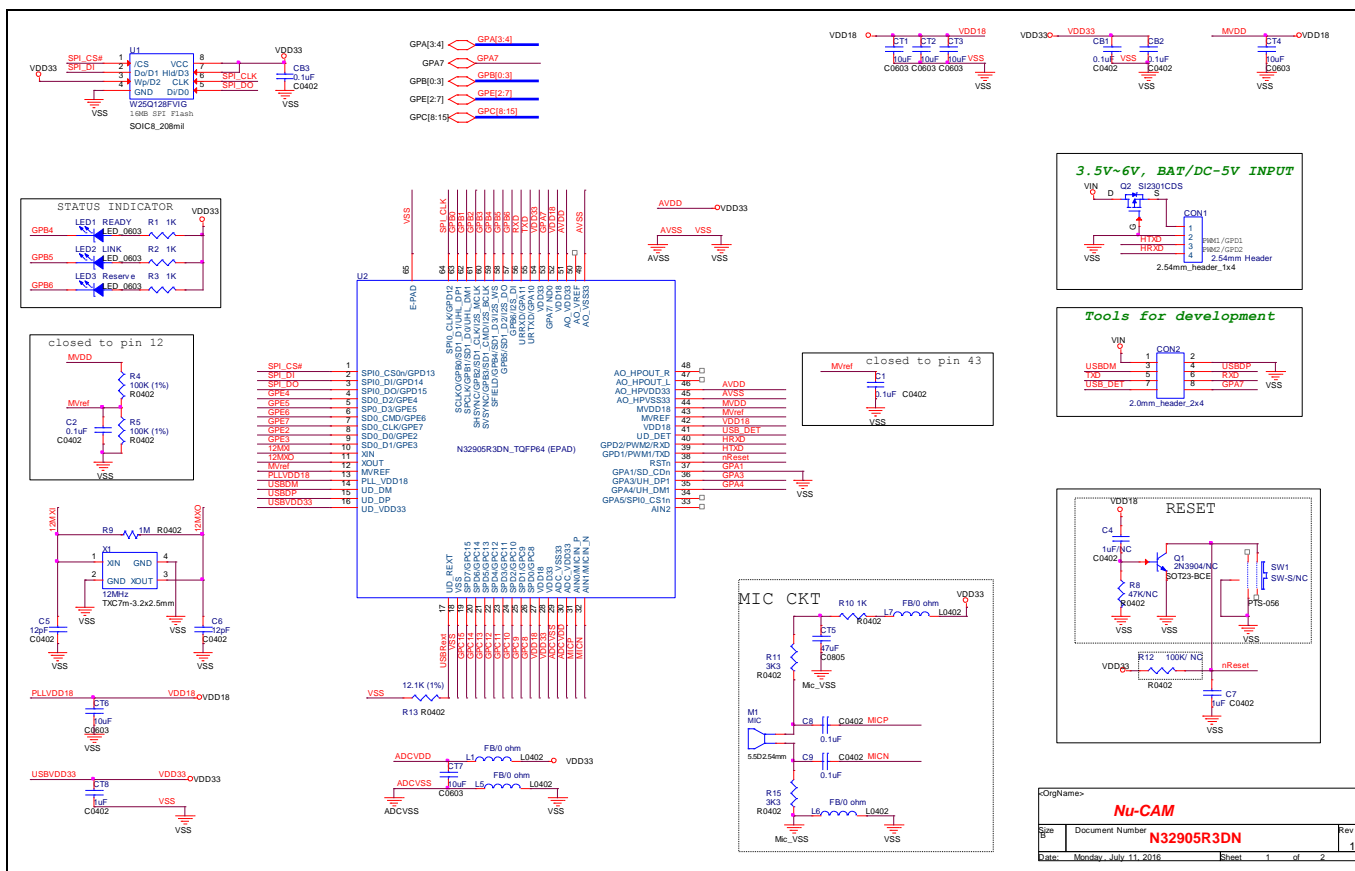


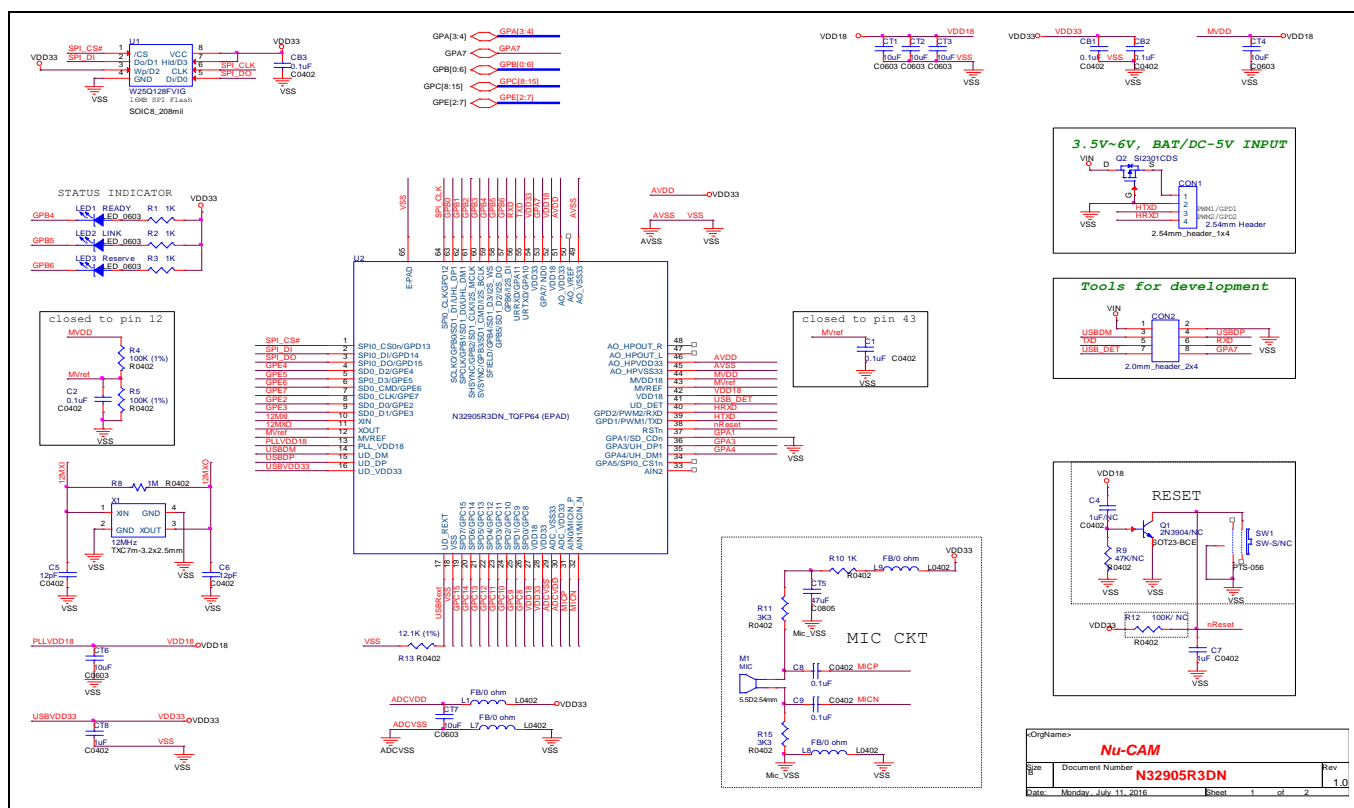
Figure 2-15 Front and Back NuWicam-Debug PCB Placement

3 NUWICAM SCHEMATICS

3.1 NuWicam-VGA Schematic (1/2)



3.3 NuWicam-TVP Schematic (1/2)



Power Supply with DC-DC

The RF trace and the copper ground (via, per 1.5mm) is 1.5X the trace width the trace with the please layout 6 mil core and 12 mil trace width if the RF trace keep 50 ohm characteristic impedance

SDIO WiFi with RTL8189FTV module

The RF trace and the copper ground (via, per 1.5mm) is 1.5X the trace width the trace with the please layout 6 mil core and 12 mil trace width if the RF trace keep 50 ohm characteristic impedance

NTSC/PAL CAM input source selection

Dual body layout (QFN32)

NTSC/PAL CAM input source selection

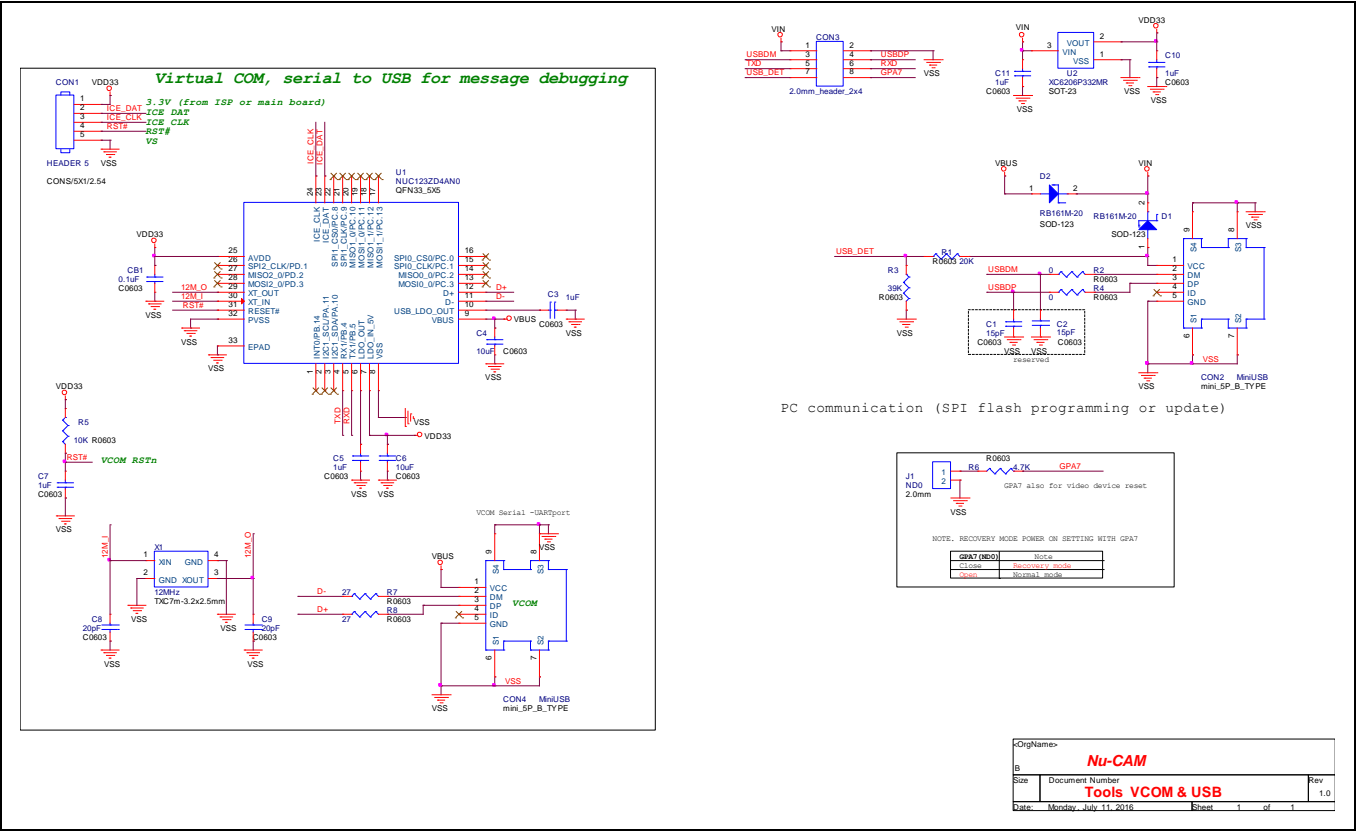
Input source

Input source	Output
Open	REFL
Close	REFL

Size Document Number **Rev** 1.0

Date Monday, July 11, 2016 **Sheet** 2 of 2

3.5 NuWicam-Debug Schematic (1/1)



4 STARTING TO USE NUWICAM

To use NuWicam, please refer to the “NuWicam User Guide.pdf” to get Hardware connectivity, Firmware programming, Mobile App installation and Virtual COM driver installation information.

5 EXAMPLE CODE

As to NuWicam example program, please refer to the “NuWicam programming guide.pdf” to get HTTP server configuration and A/V Streaming over RTSP information example code.

6 REVISION HISTORY

Date	Revision	Description
2016.07.27	1.00	1. Initially issued.

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