ARM® ARM926EJ-S Based
32-bit Microprocessor

N32903 Family
NuMaker NuEZcam
Hardware User Manual

For additional information or questions, please contact: Nuvoton Technology Corporation.

www.nuvoton.com

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1 OVERVIEW

Nuvoton's NuMaker NuEZcam solution is an open source hardware device supports video, audio recorder and camera snapshot that save video, audio and photo files to a micro SD card. It can be used for home security, aerial photography or PC CAM.

The NuEZcam integrates necessary functions such as CMOS sensor, voice microphone and SD interface. These functions make a cost effective solution for camera applications, it has an external connector that provides Arduino microcontroller based kit with TXD/RXD protocol of UART for communication, such as do some data sampling between mobile device and Arduino microcontroller or for Nuvoton's NuEdu-SDK-M451 development board to expand various possible applications.

1.1 NuEZcam System Block

Figure 1-1 shows the NuEZcam system architecture and peripheral interfaces for connecting external devices.

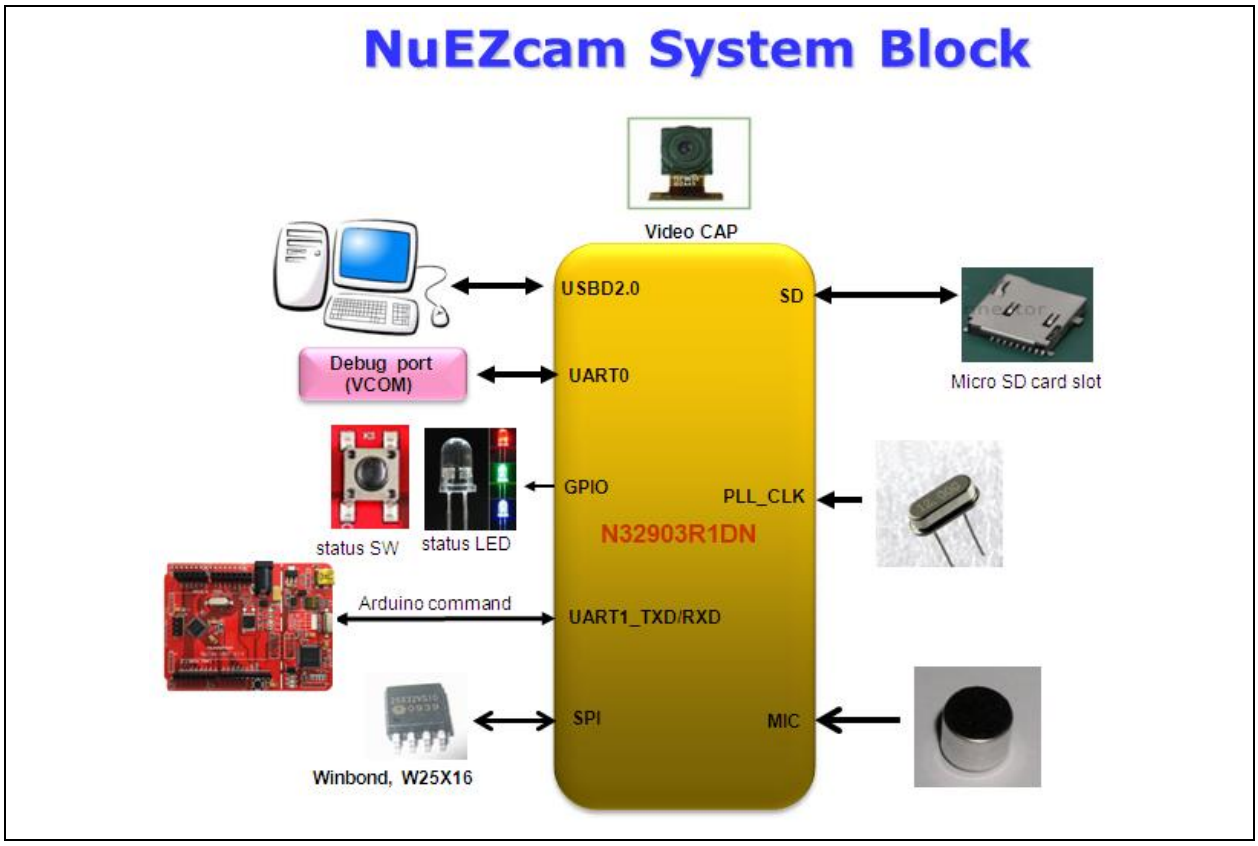


Figure 1-1 NuEZcam System Block

2 INTRODUCTION TO NUEZCAM

The NuEZcam uses an ARM926 SOC N32903R1DN as the SOC microcontroller (MCU). The N32903R1DN provides the SPI interface for SPI NOR Flash booting, a micro SD slot for memory storage, a video input interface to VGA/720P CMOS Sensor for photo picture or video studio with Motion JPEG, a differential microphone interface with ECM type for voice record, and an USB2.0 High-speed device port to PC for software development or SPI Flash program upgrade. It also provides two UART ports – the port 0 dedicated for debugging, and the UART port 1 for Arduino microcontroller based kit communication.

2.1 NuEZcam Features

- SOC: N32903R1DN (ARM926 at 192 MHz, 8 MB DDR2 with TQFP64 package)
- Main program with 2 MB SPI Flash (W25Q16FV, SO8)
- VGA/720P CMOS Image sensor input
- Video MJPG performance at VGA@30fps/720P@20fps
- Supports CMOS Image sensor list:
  - VGA COMS Image sensor: GC0308, NT99050.
  - 720P CMOS Image sensor: NT99141.
- Embedded electret condenser microphone
- Supports Arduino microcontroller communication based on TXD/RXD protocol
- One LED for status indication (GPA5), One SW for status control (GPB6).
- Wide power supply input range from 3.5V to 6V
- NuEZcam board PCB size: 25mm x 35mm
- NuWicam-Debug board PCB size: 2mm x 3mm
- NuWicam-Debug tools 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 recorder using VGA CMOS sensor of 120mA at 5V (typical)
  - Continuous working time 10 hours is possible with 1500mAH AA BAT x 4

2.2 N32903R1DN Features

- N32903R1DN: 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) or 1280x720 (720P) resolution for video MJPEG format
- DMA accelerate that SD data transfer with memory storage
- 10-bit Audio ADC with Microphone pre-Amp & AGC
- USB2.0 High speed, driver support MS (Mass Storage) Class
- Two UART ports support debugging and Arduino controller communication
- Package: TQFP-64 (MCP, stacked with 8MB DDR2@1.8V)

Please refer to Figure 2-1 for the N32903R1DN SOC outline.

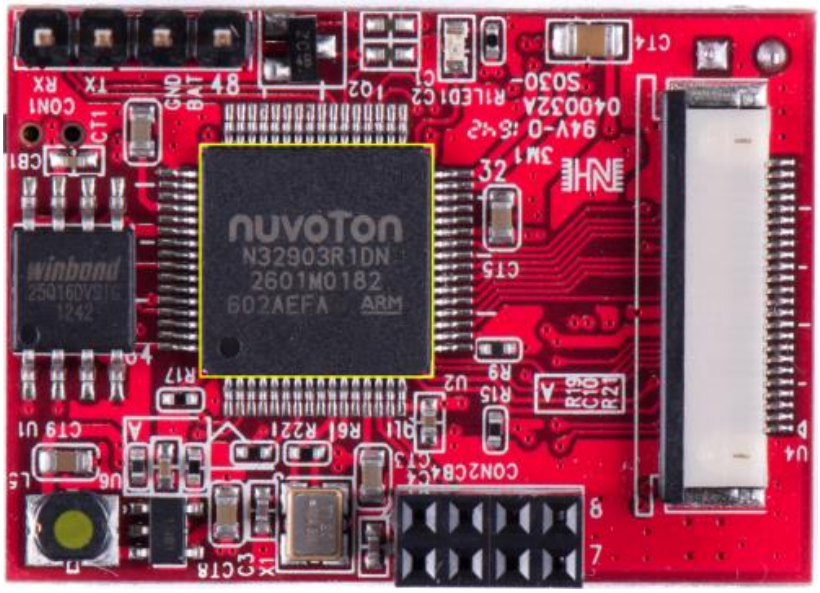


Figure 2-1 N32903R1DN SOC Outline

2.3 VGA (GC0308, NT99050) Features

- GC0308: GalaxyCore's CMOS image sensor with 1/6.5-inch optical format
- NT99050: NOVATEK's CMOS image sensor with 1/5-inch optical format
- Resolution 640V x 480H
- On-Chip ISP provides AE (Auto Exposure) and AWB (Auto White Balance) control
- AVI encoder operating at up to 30 frames per second at 24 MHz clock
- Output formats: YCbCr4:2:2
- Single power supply (3V)
- Supports Horizontal /Vertical mirror control

Please refer to Figure 2-2 for the GC0308/NT99050 CMOS sensor module outline.

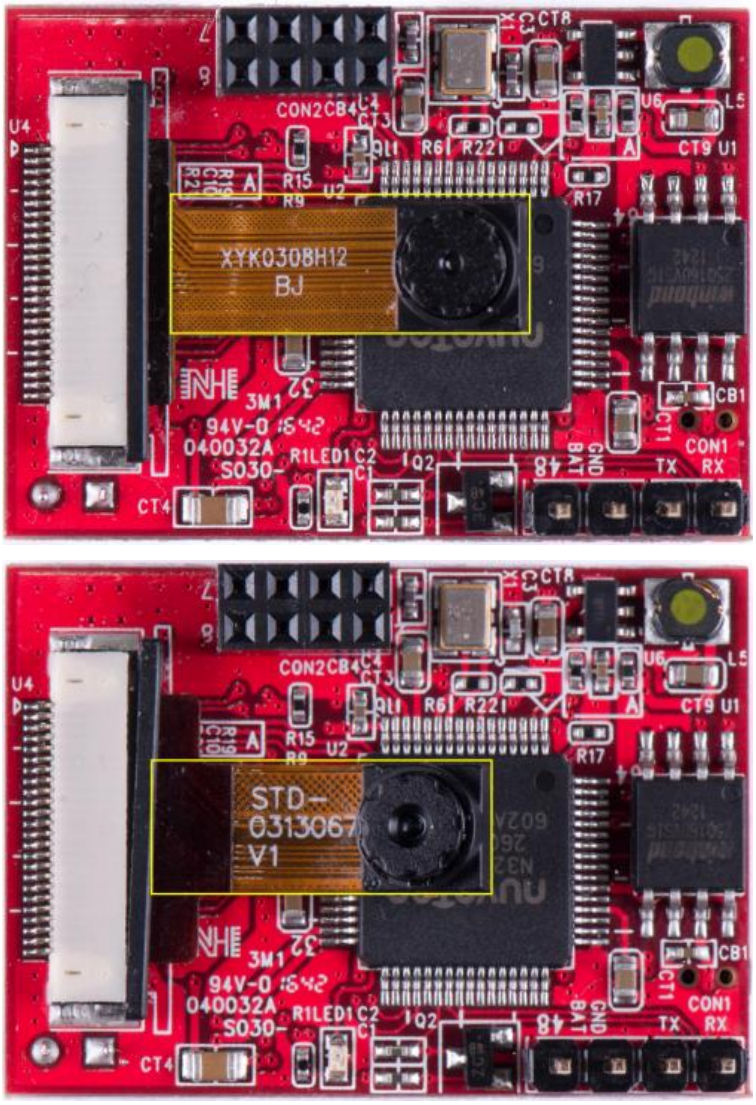


Figure 2-2 GC0308/NT99050 CMOS Sensor Module Outline

2.4 720P (NT99141) Features

- NT99141: NOVATEK's CMOS image sensor with 1/4-inch optical format
- Resolution 1280V x 720H
- On-Chip ISP provides AE (Auto Exposure) and AWB (Auto White Balance) control
- AVI encoder operating at up to 20 frames per second at 16 MHz clock
- Output formats: YCbCr4:2:2
- Single power supply (3V)
- Support Horizontal /Vertical mirror control

Please refer to Figure 2-3 for the NT99141 CMOS sensor module outline.

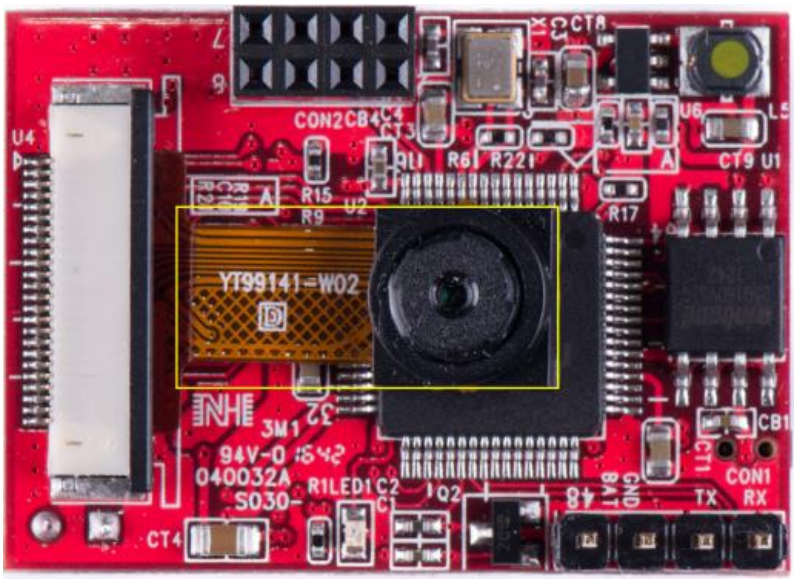


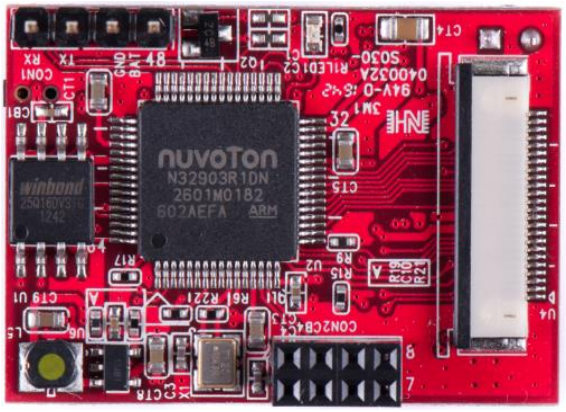
Figure 2-3 NT99141 CMOS Sensor Module Outline

2.5 Board Introduction

As shown in Figure 2-4, the NuEZcam solution contains one main boards and one common debug board, as described below:

- **NuEZcam board:** Camera main board
- **NuWicam-Debug board:** Debug tools board

NuEZcam board



NuWicam-Debug board

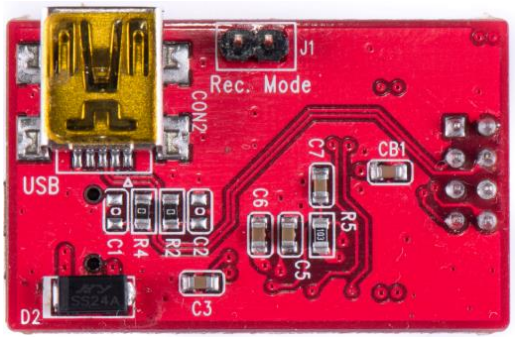


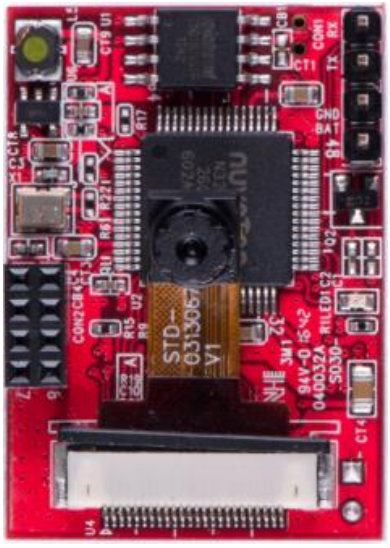
Figure 2-4 NuEZcam Solution PCB Outline

2.5.1 NuEZcam Board

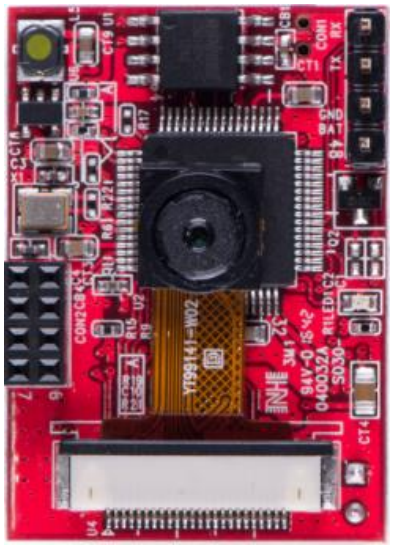
The NuEZcam board uses the GC0308/NT99050 VGA CMOS sensor or NT99141 720P CMOS sensor and provides a powerful JPEG Codec based on Nuvoton's N32903R1DN for encoding. NuEZcam firmware provides both audio and video data storage to micro SD card. The format of video is Motion-JPEG with VGA/720P resolution.

GC0308 CMOS Sensor Front View

NT99050 CMOS Sensor Front View



NT99141 CMOS Sensor Front View



Rear View

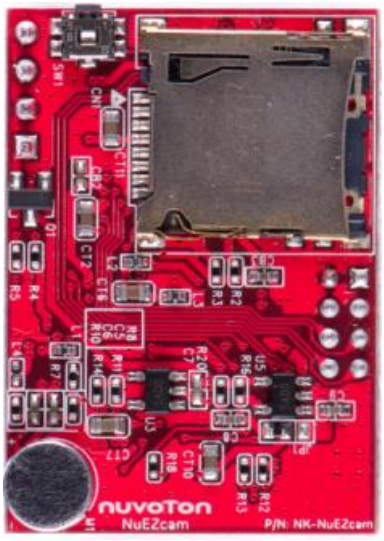


Figure 2-5 NuEZcam Board (Front View and Rear View)

2.5.2 NuWicam-Debug Board

The NuWicam-Debug board is connected to the NuEZcam main board for software development or SPI Flash program upgrade. User can also get the debugging message from the N32903R1DN UART port 0 through USB Virtual COM.

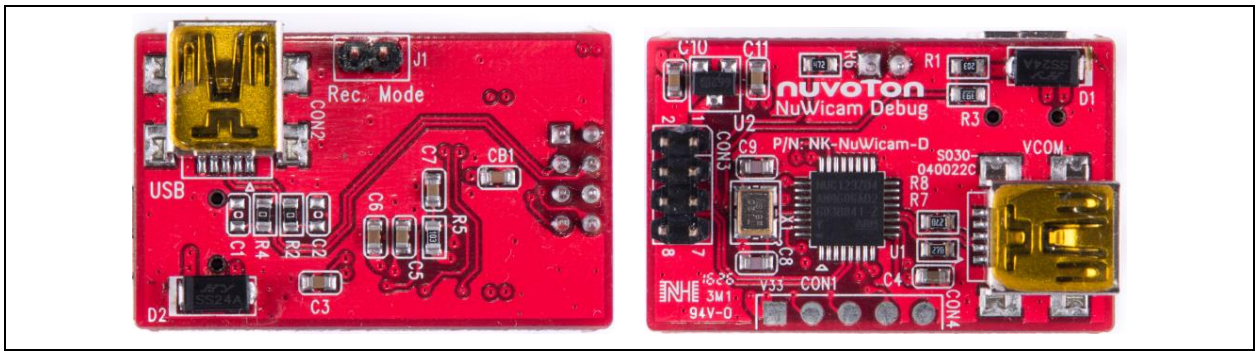


Figure 2-6 NuWicam-Debug Board (Front View and Rear View)

2.6 NuEZcam Power Scheme

Figure 2-7 shows the NuEZcam system power scheme. User should follow the power distribution requirement to provide the correct power voltage to NuEZcam to prevent incorrect voltage caused board damage or broken.

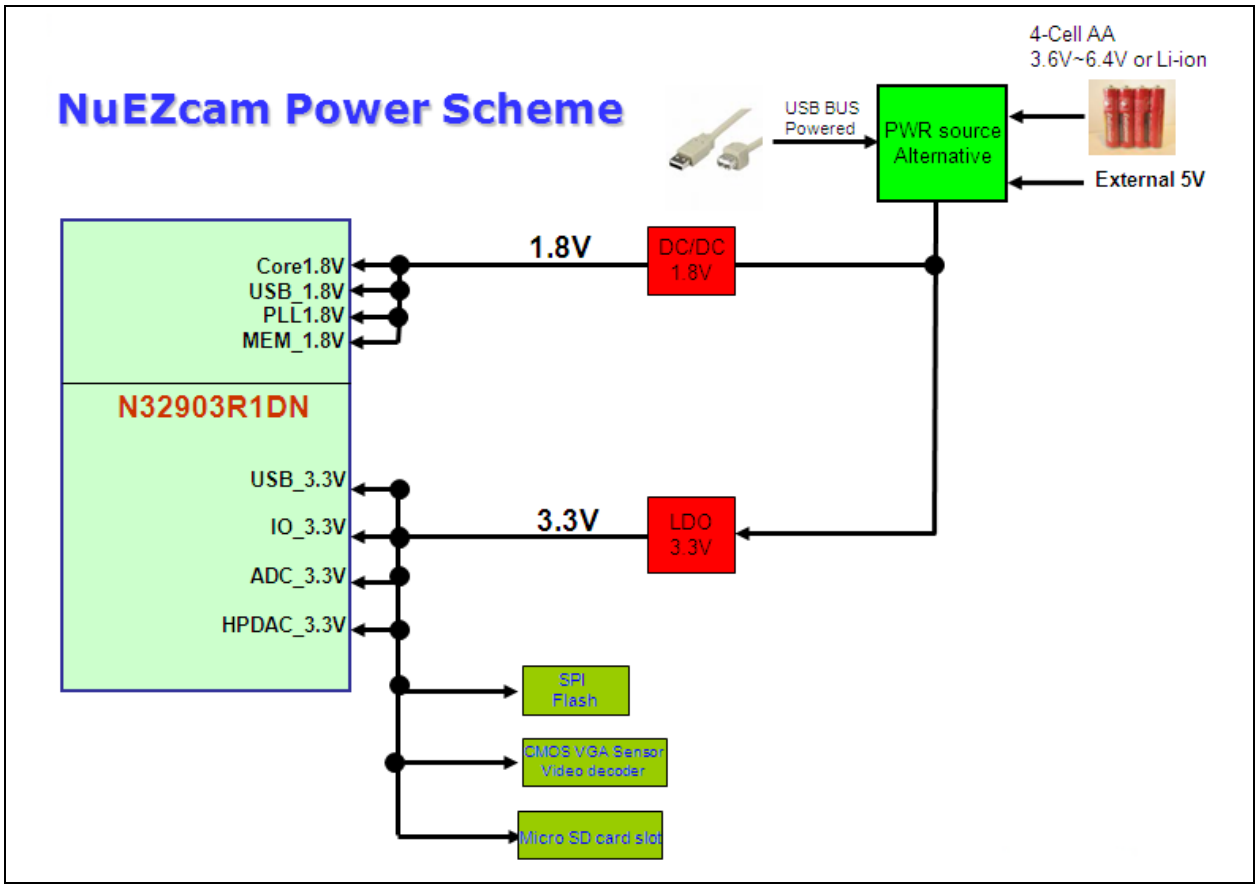


Figure 2-7 NuEZcam Power Scheme

2.7 NuEZcam Jumper and Connector

2.7.1 NuEZcam Board Jumper Description

Figure 2-8 shows the front and rear view of NuEZcam Board & NuWicam-Debug Board.

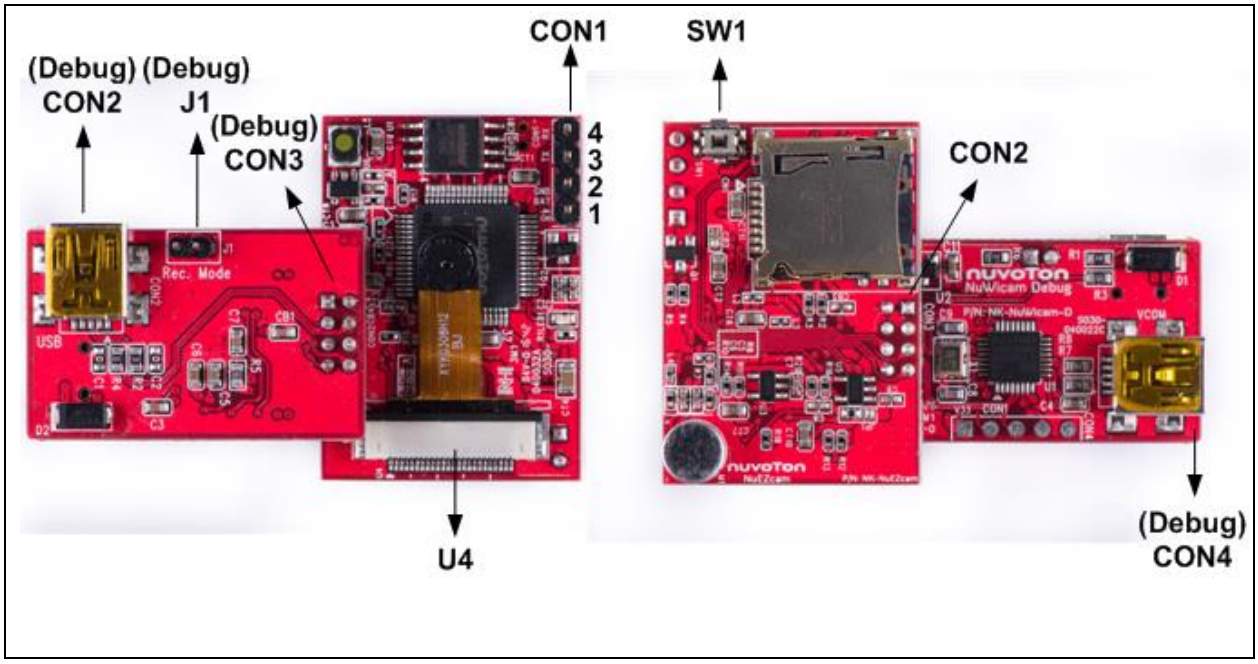
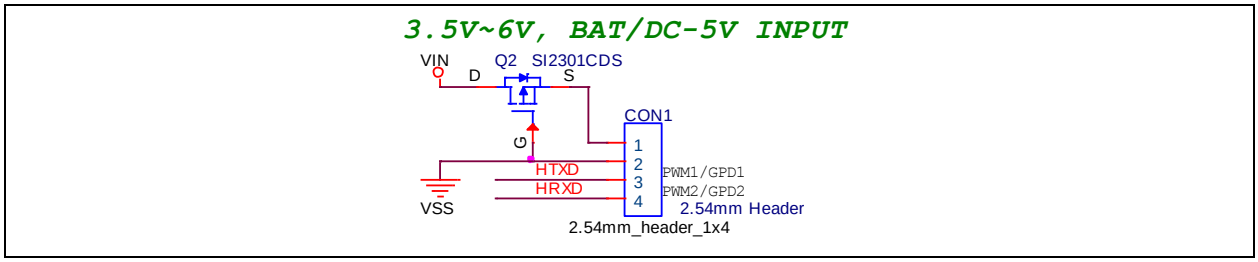


Figure 2-8 NuEZcam Board & NuWicam-Debug Board (Front View and Rear View)

- 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, NuEZcam can run 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: for status control (GPB6).

2.7.2 NuWicam-Debug Board Jumper Description

Figure 2-9 shows the front view and rear view of NuWicam-Debug Board.

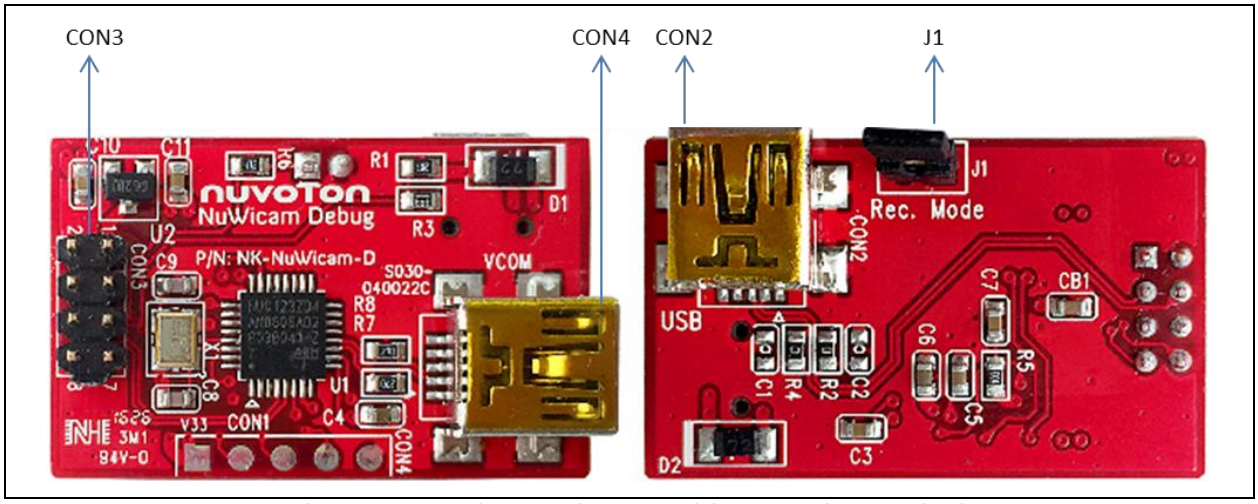


Figure 2-9 NuWicam-Debug Board (Front and Rear View)

- J1: USB recovery mode selection
  - J1 jumper open, for normal operation
  - J1 jumper close, N32903R1DN 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 NuMaker NuEZcam 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 NuEZcam main board’s CON2.
  .
- CON4: VCOM connector
  - User can get that debugging message from N32903R1DN UART port 0 through USB Virtual COM

N**ote:** For Virtual COM driver installation and operation, please refer to the “NuvoTon NuMaker NuEZcam User Guide.pdf”.

2.8 N32903R1DN Pin Assignment for Connectivity

The NuEZcam uses the N32903R1DN (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	GPD14]	SPI0_DI	SPI Flash	IOU
3	GPD[15]	SPI0_DO	SPI Flash	IOU
4	GPE[4]	SDDAT[2]	Micro SD	IOU
5	GPE[5]	SDDAT[3]	Micro SD	IOU
6	GPE[6]	SDCMD	Micro SD	IOU
7	GPE[7]	SDCLK	Micro SD	IOU
8	GPE[2]	SDDAT[0]	Micro SD	IOU
9	GPE[3]	SDDAT[1]	Micro SD	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]	CMOS Sensor	IOU
20	GPC[14]	SPDATA[6]	CMOS Sensor	IOU
21	GPC[13]	SPDATA[5]	CMOS Sensor	IOU
22	GPC[12]	SPDATA[4]	CMOS Sensor	IOU

PKG No.#	Pin Name	Function	Connectivity	Type
23	GPC[11]	SPDATA[3]	CMOS Sensor	IOU
24	GPC[10]	SPDATA[2]	CMOS Sensor	IOU
25	GPC[9]	SPDATA[1]	CMOS Sensor	IOU
26	GPC[8]	SPDATA[0]	CMOS Sensor	IOU
27	VDD18	1.8V	1.8V	P
28	VDD33	3.3V	3.3V	P
29	ADC_VSS33	ADC_VSS33	GND	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]	LED	Status LED	IOU
35	GPA[4]	SW_SCK	I²C	IOU
36	GPA[3]	SW_SDA	I²C	IOU
37	GPA[1]	SDCD	Micro SD	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_HPVSS33	ADAC_HPVSS33	GND	G

PKG No.#	Pin Name	Function	Connectivity	Type
46	ADAC_HPVDD33	ADAC_HPVDD33	3.3V	P
47	ADAC_HPOUT_L	NC	NC	A
48	ADAC_HPOUT_R	NC	NC	A
49	ADAC_AVSS33	ADAC_AVSS33	GND	G
50	ADAC_VREF	NC	NC	A
51	ADAC_AVDD33	ADAC_AVDD33	3.3V	P
52	VDD18	1.8V	1.8V	P
53	GPA[7]	RECOVERY	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]	SW	Status SW	IOU
58	GPB[5]	S_RESET	CMOS Sensor	IOU
59	GPB[4]	S_Power_Down	CMOS Sensor	IOU
60	GPB[3]	SVSYNC	CMOS Sensor	IOU
61	GPB[2]	SHSYNC	CMOS Sensor	IOU
62	GPB[1]	SPCLK	CMOS Sensor	IOU
63	GPB[0]	SCLKO]/ NTSC or PAL SEL	CMOS Sensor	IOU
64	GPD[12]	SPI0_CLK	SPI FLASH	IOU
65	GND	GND	GND	E_PAD

2.9 NuEZcam/NuWicam-Debug PCB Placement

Figure 2.10 and Figure 2.11 show the front and back NuEZcam/NuWicam-Debug PCB placement.

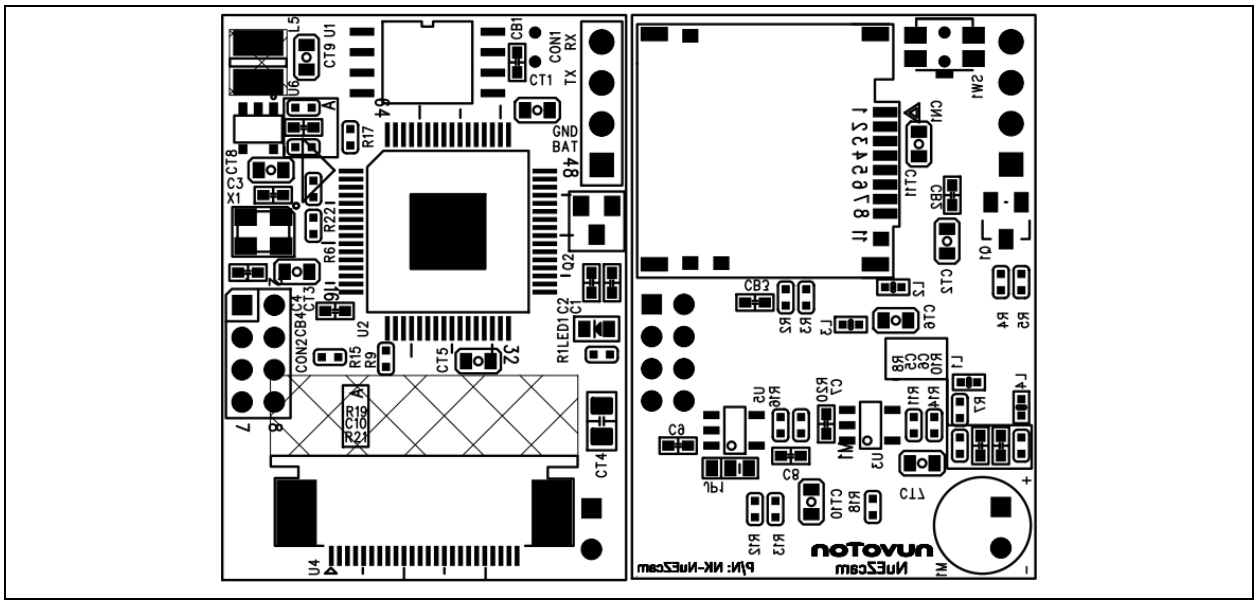


Figure 2-10 Front and Back NuEZcam PCB Placement

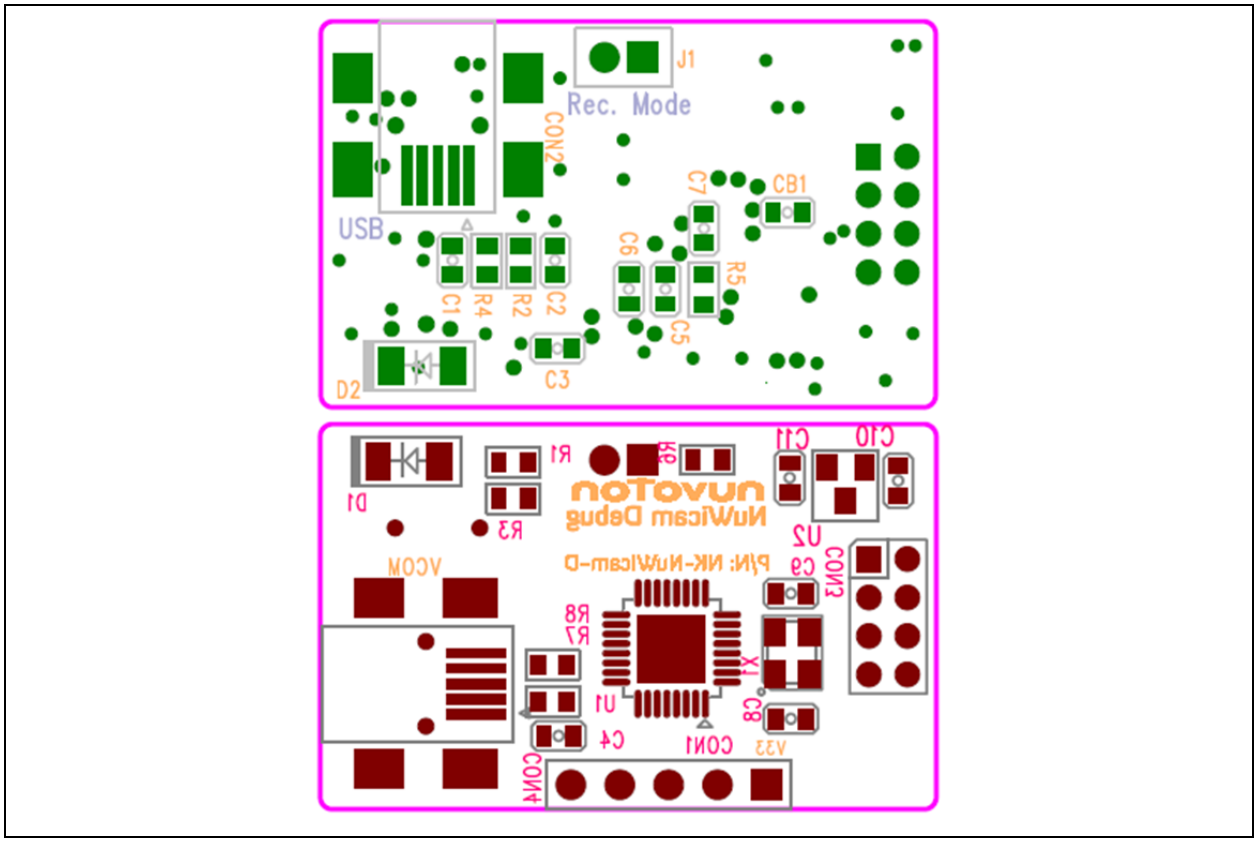
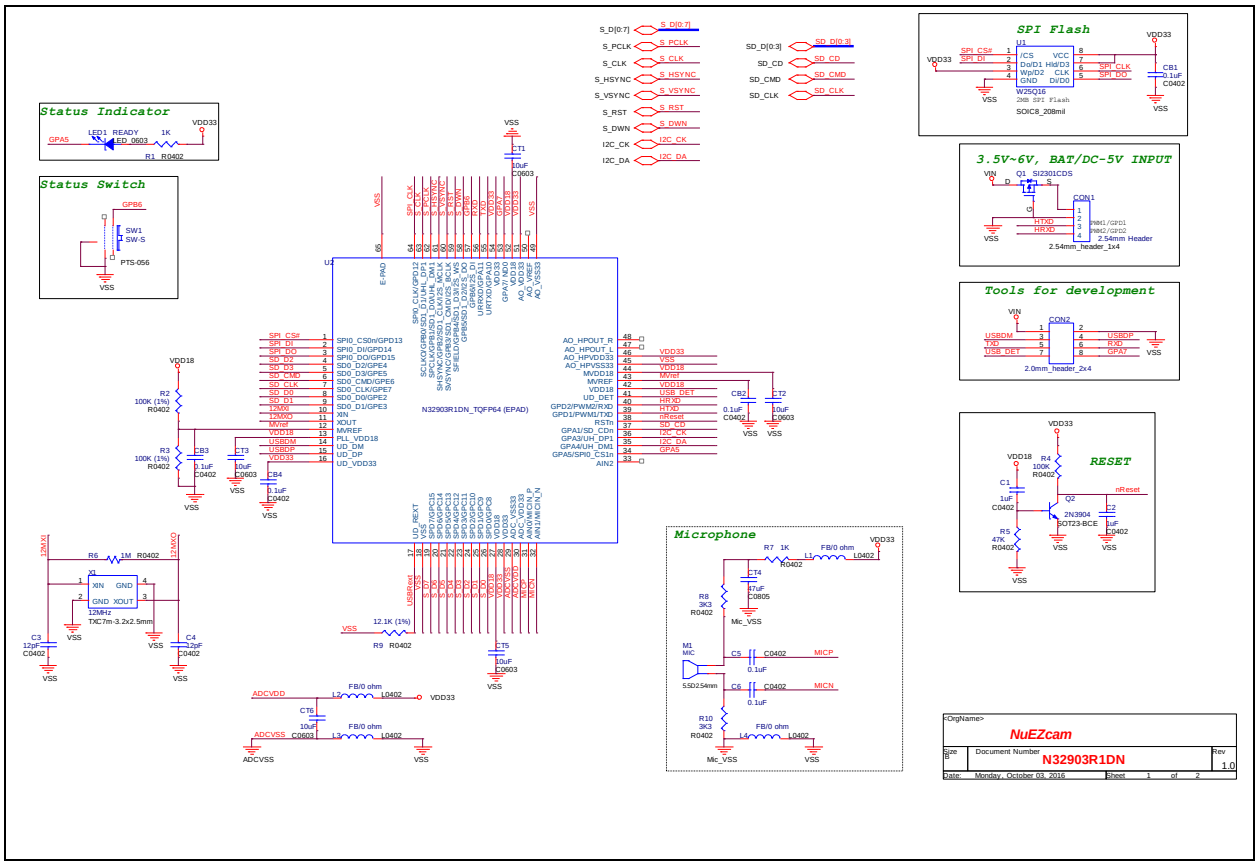


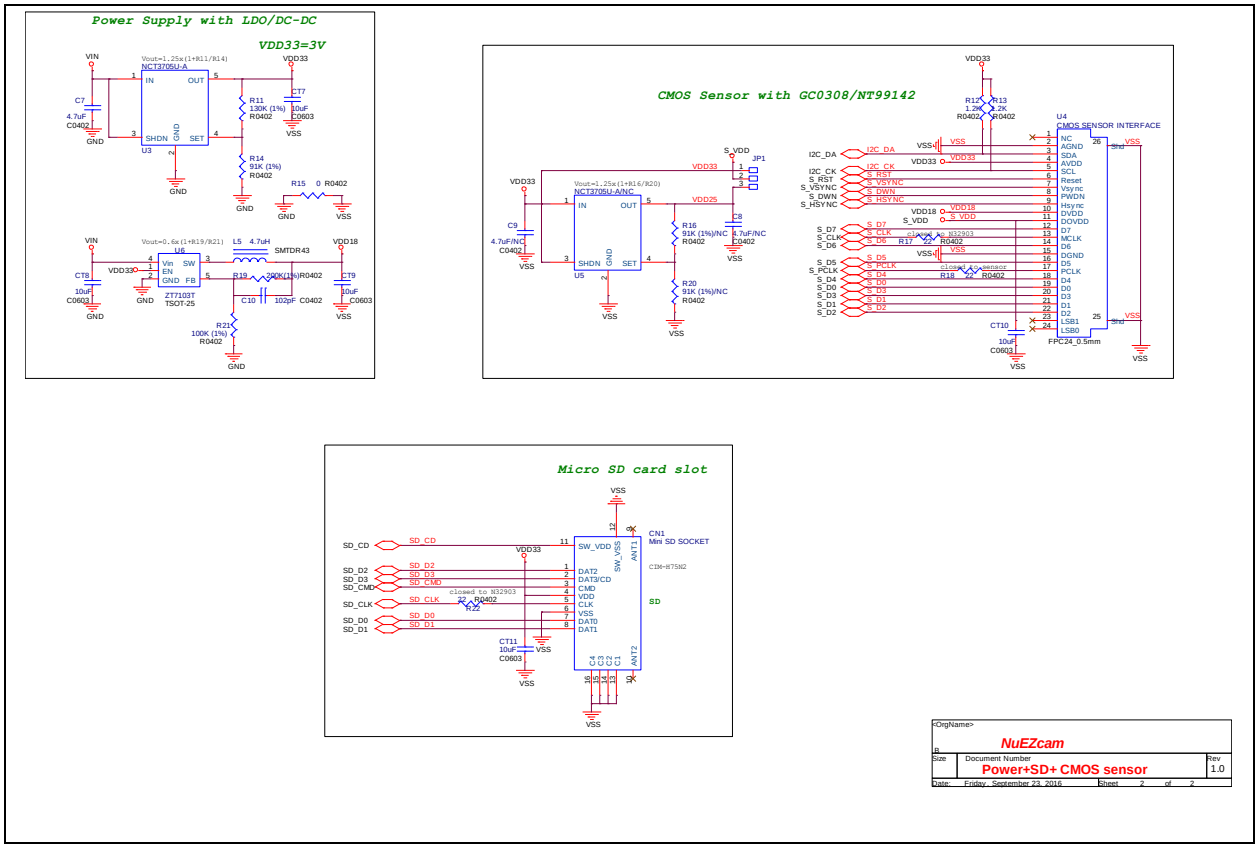
Figure 2-11 Front and Back NuWicam-Debug PCB Placement

3 NUEZCAM SCHEMATICS

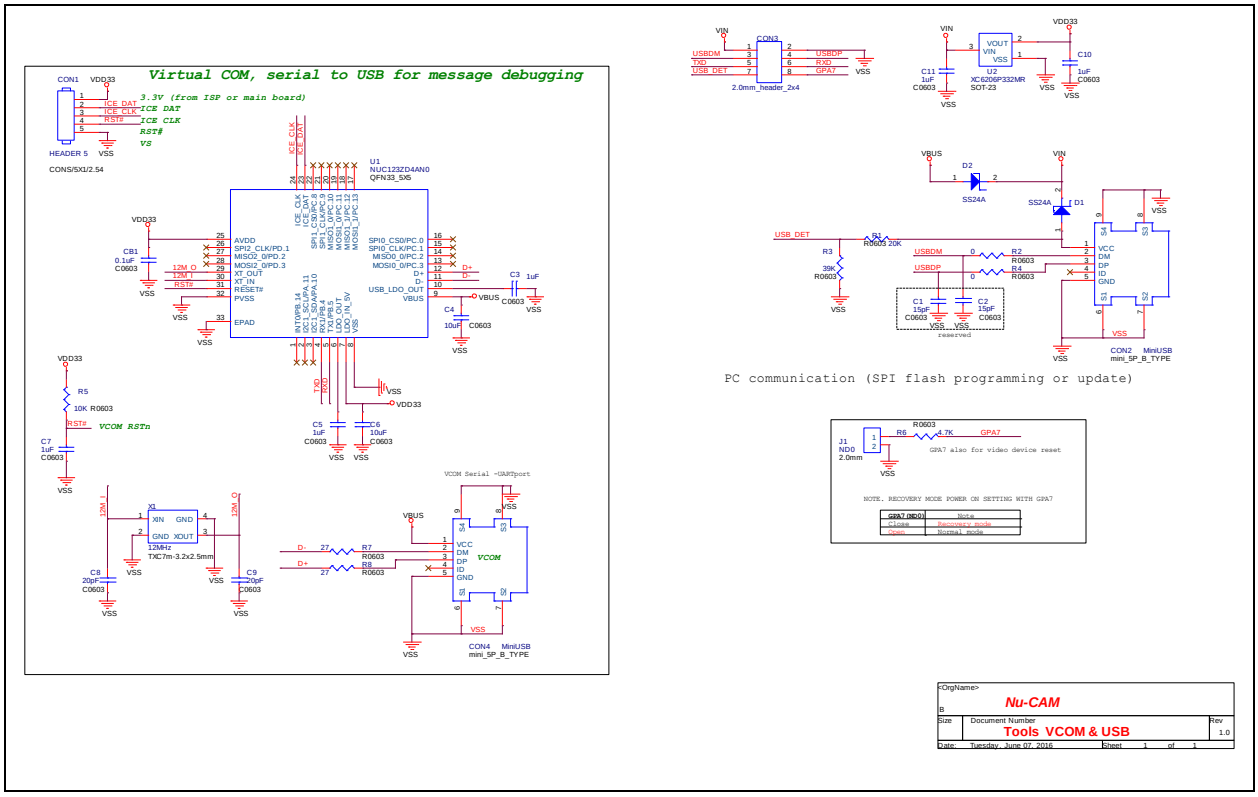
3.1 NuEZcam Schematic (1/2)



3.2 NuEZcam Schematic (2/2)



3.3 NuWicam-Debug Schematic (1/1)



4 STARTING TO USE NUEZCAM

To use NuEZcam, please refer to the "*Nuvoton NuMaker NuEZcam User Guide.pdf*" to get Hardware connectivity, Firmware programming, Virtual COM driver installation information.

5 EXAMPLE CODE

Please refer to the "*NuvoTon NuMaker NuEZcam Samples.pdf*" to get HTTP server configuration and A/V example code.

6 REVISION HISTORY

Date	Revision	Description
2016.11.17	1.00	1. Initially issued.

Important Notice

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