



# BeagleY-AI

Release 1.0.20240516-wip



# Table of contents

<b>1 Introduction</b>	<b>3</b>
1.1 Detailed overview	3
1.1.1 AM67A SoC	4
1.2 Board components location	4
1.2.1 Front components	4
1.2.2 Back components	5
<b>2 BeagleY-AI Quick Start</b>	<b>7</b>
2.1 What's included in the box?	7
2.2 Getting started	7
2.2.1 Boot Media	7
2.2.2 Power Supply	8
2.2.3 Board connection	9
2.2.4 USB Tethering	9
2.2.5 Using BeagleY-AI	10
2.2.6 Connecting to WiFi	13
<b>3 Design and specifications</b>	<b>15</b>
3.1 Block diagram and overview	15
3.2 SoC	15
3.3 Boot modes	25
3.4 Power sources	25
3.5 PMIC	25
3.6 General connectivity and expansion	25
3.7 Buttons and LEDs	25
3.8 Networking	25
3.9 Ethernet	25
3.10 Memory, media, and storage	25
3.11 Multimedia I/O	25
3.12 Debug ports	25
3.13 Mechanical Specifications	25
3.13.1 Dimensions & Weight	38
<b>4 Expansion</b>	<b>47</b>
<b>5 Demos and tutorials</b>	<b>49</b>
<b>6 Support</b>	<b>51</b>
6.1 Production board boot media	51
6.2 Certifications and export control	51
6.2.1 Export designations	51
6.2.2 Size and weight	51
6.3 Additional documentation	51
6.3.1 Hardware docs	51
6.3.2 Software docs	52
6.3.3 Support forum	52
6.3.4 Pictures	52
6.4 Change History	52

6.4.1 Board Changes . . . . . 52

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**Important:** This is a work in progress, for latest documentation please visit <https://docs.beagleboard.org/latest/>

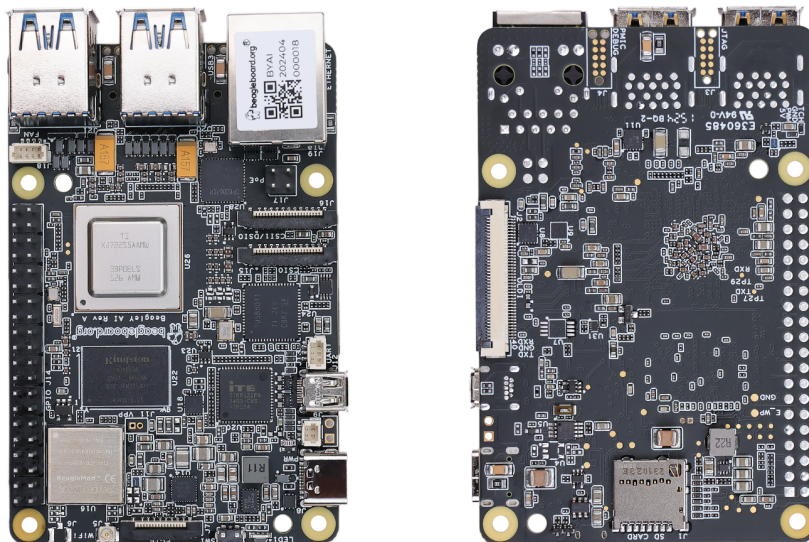
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BeagleY-AI is an open-source single board computer based on the Texas Instruments AM67A Arm-based vision processor.

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### License Terms

- This documentation is licensed under a [Creative Commons Attribution-ShareAlike 4.0 International License](#)
  - Design materials and license can be found in the [git repository](#)
  - Use of the boards or design materials constitutes an agreement to the [boards-terms-and-conditions](#)
  - Software images and purchase links are available on the [board page](#)
  - For export, emissions and other compliance, see [Support](#)
  - All support for BeagleY-AI design is through the BeagleBoard.org community at [BeagleBoard.org forum](#).
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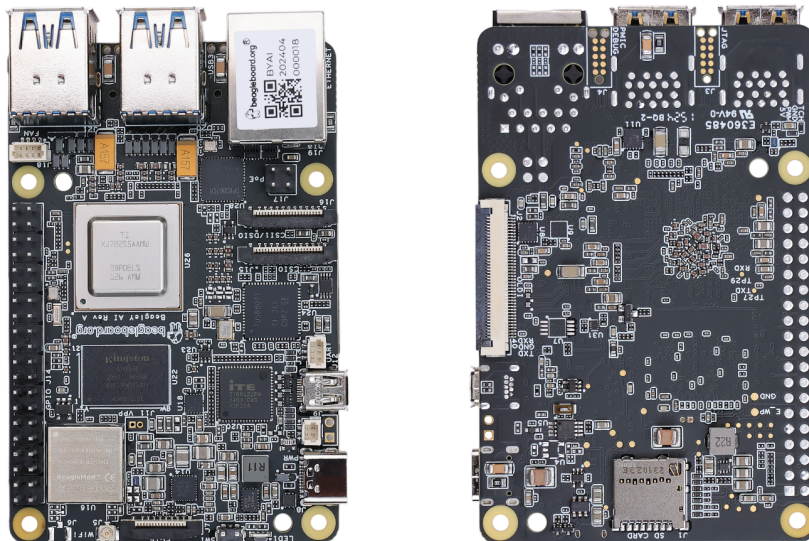




# Chapter 1

## Introduction

BeagleY-AI is an open-source single board computer designed for edge AI applications.



### 1.1 Detailed overview

BeagleY-AI is based on the Texas Instruments AM67A Arm-based vision processor. It features a quad-core 64-bit Arm®Cortex®-A53 CPU subsystem at 1.4GHz, Dual general-purpose C7x DSP with Matrix Multiply Accelerator (MMA) capable of 4 TOPs each, Arm Cortex-R5 subsystem for low-latency I/O and control, a 50 GFlop GPU, video and vision accelerators, and other specialized processing capability.

Table 1.1: BeagleY-AI features

Feature	Description
Processor	Texas Instruments AM67A, Quad 64-bit Arm® Cortex® -A53 @1.4 GHz, multiple cores including Arm/GPU processors, DSP, and vision/deep learning accelerators
RAM	4GB LPDDR4
Wi-Fi	Beagleboard BM3301, 802.11ax Wi-Fi
Bluetooth	Bluetooth Low Energy 5.4 (BLE)
USB Ports	4 x USB 3.0 TypeA ports supporting simultaneous 5Gbps operation, 1 x USB 2.0 TypeC, supports USB 2.0 device mode
Ethernet	Gigabit Ethernet, with PoE+ support (requires separate PoE HAT)
Camera/Display	2 x 4-lane MIPI camera connector (one connector muxed with DSI capability)
Display Output	1 x HDMI display, 1 x OLDI display, 1 x DSI MIPI Display
Real-time Clock (RTC)	Supports external coin-cell battery for power failure time retention
Debug UART	1 x 3-pin debug UART
Power	5V/3A DC power via USB-C
Power Button	On/Off included
PCIe Interface	PCI-Express® Gen3 x 1 interface for fast peripherals (requires separate M.2 HAT or other adapter)
Expansion Connector	40-pin header
Fan connector	1 x 4-pin fan connector, supports PWM control and fan speed measurement
Storage	microSD card slot with UHS-1 support
Tag Connect	1 x JTAG, 1 x External PMIC programming port

### 1.1.1 AM67A SoC

**Todo:** Add AM67A SoC details

## 1.2 Board components location

### 1.2.1 Front components

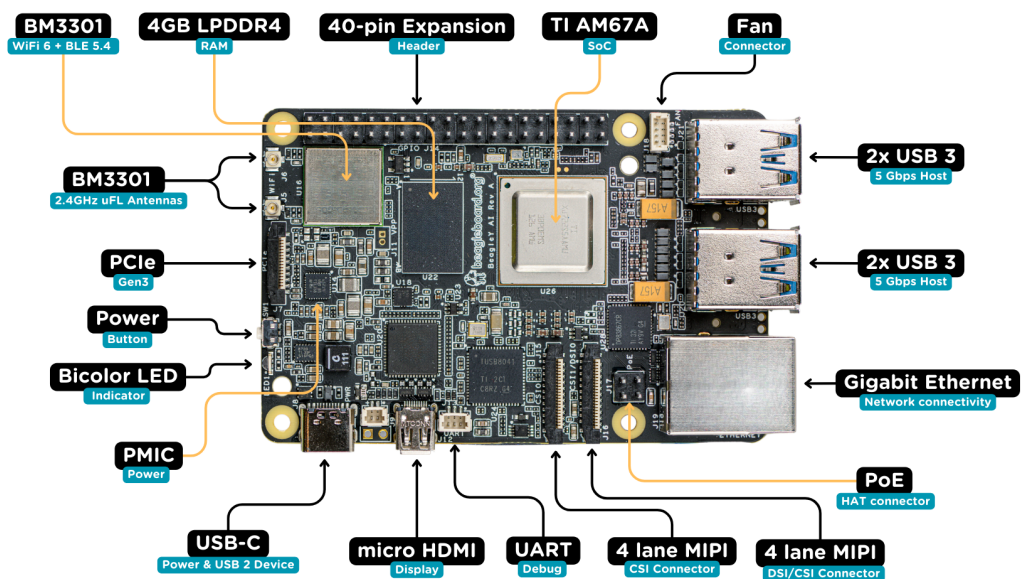


Table 1.2: BeagleY-AI board front components location

Feature	Description
WiFi/BLE	Beagleboard BM3301 with 802.11ax Wi-Fi & Bluetooth Low Energy 5.4 (BLE)
RAM	4GB LPDDR4
Expansion	40pin Expansion header compatible with HATs
SoC	TI AM67A Arm®Cortex®-A53 4 TOPS vision SoC with RGB-IR ISP for 4 cameras, machine vision, robotics, and smart HMI
Fan	4pin Fan connector
USB-A	4 x USB 3 TypeA ports supporting simultaneous 5Gbps operation host ports
Network Connectivity	Gigabit Ethernet
PoE	Power over Ethernet HAT connector
Camera/Display	1 x 4-lane MIPI camera/display transceivers, 1 x 4-lane MIPI camera
Debug UART	1 x 3-pin JST-SH 1.0mm debug UART port
Display Output	1 x HDMI display
USB-C	1 x Type-C port for power, and supports USB 2 device
PMIC	Power Management Integrated Circuit for 5V/5A DC power via USB-C with Power Delivery support
Bicolor LED	Indicator LED
Power button	ON/OFF button
PCIe	PCI-Express® Gen3 x 1 interface for fast peripherals (requires separate M.2 HAT or other adapter)

### 1.2.2 Back components

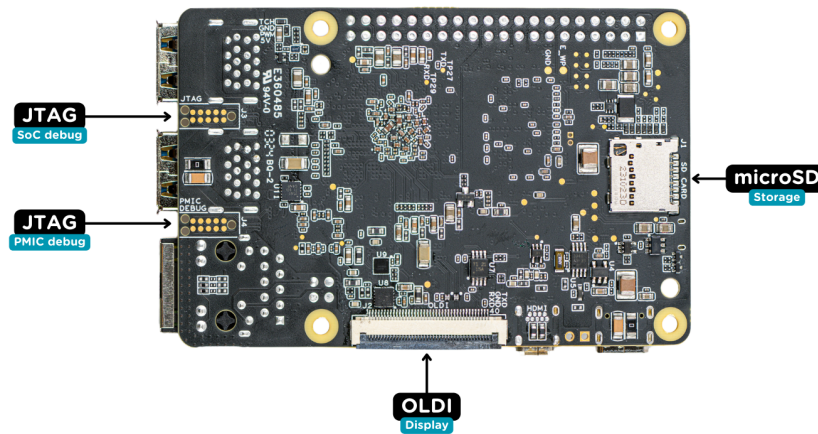


Table 1.3: BeagleY-AI board back components location

Feature	Description
Tag-Connect	1 x JTAG & 1 x Tag Connect for PMIC NVM Programming
Display output	1 x OLDI display
Storage	microSD card slot with support for high-speed SDR104 mode





## Chapter 2

# BeagleY-AI Quick Start

### 2.1 What's included in the box?

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**Todo:** Update BeagleY-AI what's included in the box section as per production release.

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When you purchase a BeagleY-AI, you'll get the following in the box:

1. BeagleY-AI
2. 2.4GHz antennas
3. Quick-start card

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**Tip:** For board files, 3D model, and more, you can checkout the [BeagleY-AI repository on OpenBeagle](#).

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**Todo:** Attaching antennas instructions for BeagleY-AI

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**Todo:** BeagleY-AI unboxing video

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### 2.2 Getting started

To get started you need the following:

1. USB type-A to type-C cable or type-C to type-C cable
2. 5V - 3A power supply
3. MicroSD Card
4. Boot media

#### 2.2.1 Boot Media

Download the boot media from <https://www.beagleboard.org/distros/beagle-y-ai-debian-xfce-12-5-2024-03-25> and flash it on a micro SD Card using using [Balena Etcher](#) following these steps:

1. Select downloaded boot media



### 2.2.3 Board connection

There is only one USB type-C port on board, if you choose to use a dedicated power supply for first time setup, you may access the board via one of the following methods:

1. Connection to HDMI display, Keyboard and Mouse
2. UART using RPi debug probe or similar
3. Ethernet network connection

Another direct and easy option is to connect the board directly to your PC or Laptop using a USB type-C cable.

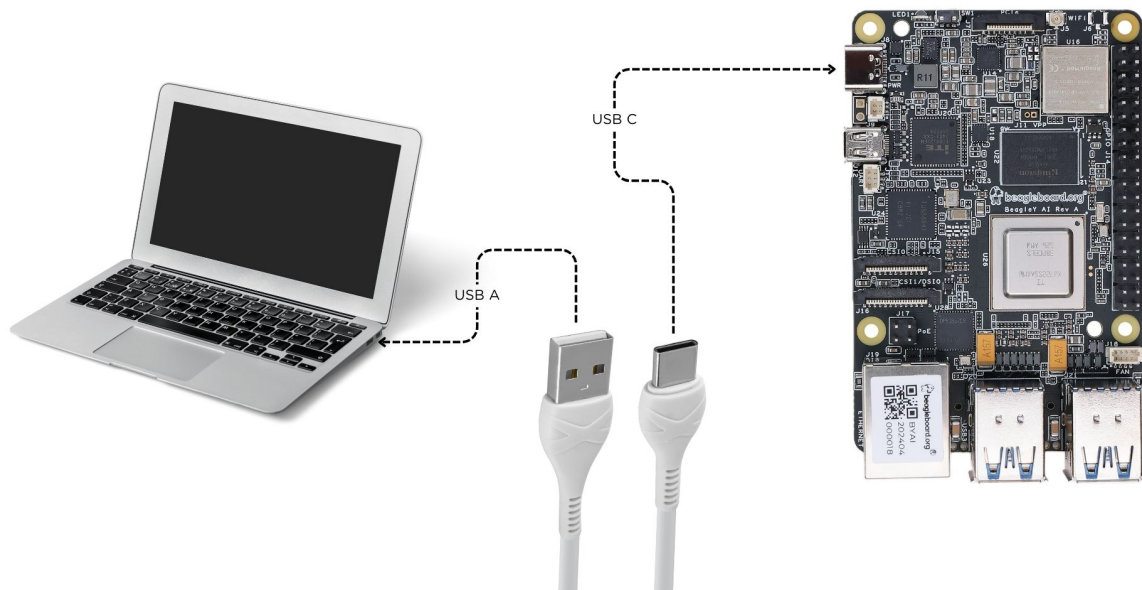
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**Note:** If you are using the board with a fan or running a heavy task you should always power the board with a dedicated power supply that can supply  $5V \geq 3A$ .

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### 2.2.4 USB Tethering

To initially test your board, you can connect the board directly to your computer using a type-A to type-C cable shown in the image below.



After connecting, you should see the power LED glow, and soon just like with other Beagles, you'll see a virtual wired connection on your computer. To access the board you can use SSH as shown below.

---

**Note:** Here you must update the default password to something safer.

---

```
[lorforlinux@fedora ~] $ ssh debian@192.168.7.2
Debian GNU/Linux 12

BeagleBoard.org Debian Bookworm Xfce Image 2024-03-25
Support: https://bbb.io/debian
default username is [debian] with a one time password of [tempwd]

debian@192.168.7.2's password:
You are required to change your password immediately (administrator enforced).
You are required to change your password immediately (administrator enforced).

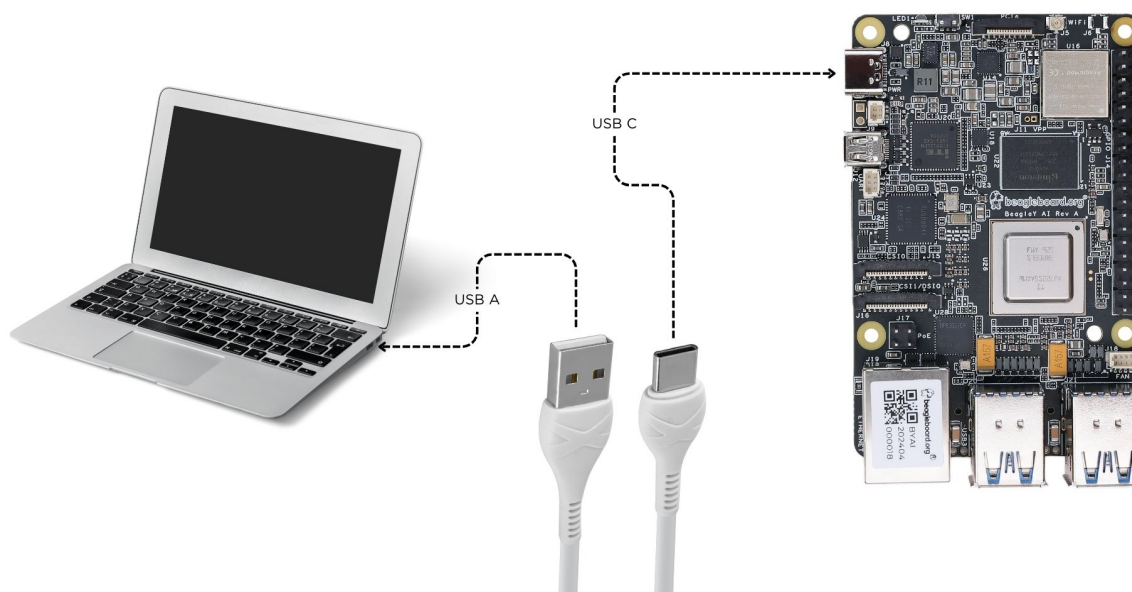
The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Mon Mar 25 06:56:39 2024 from 192.168.7.1
WARNING: Your password has expired.
You must change your password now and login again!
Changing password for debian.
Current password: █
```

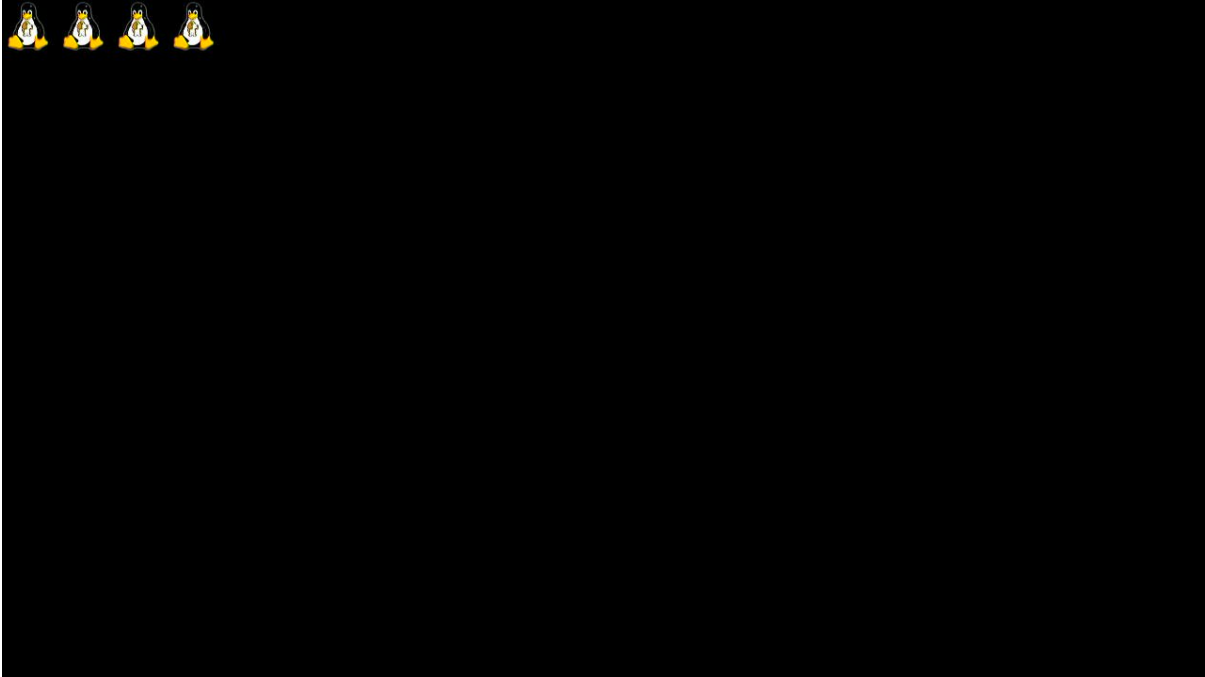
### 2.2.5 Using BeagleY-AI

To setup your BeagleY-AI for normal usage, connect the following:

1. 5V ≥ 3A power supply
2. HDMI monitor using micro HDMI to full-size HDMI cable
3. Ethernet cable from the board to your router
4. Wireless or wired keyboard & mice

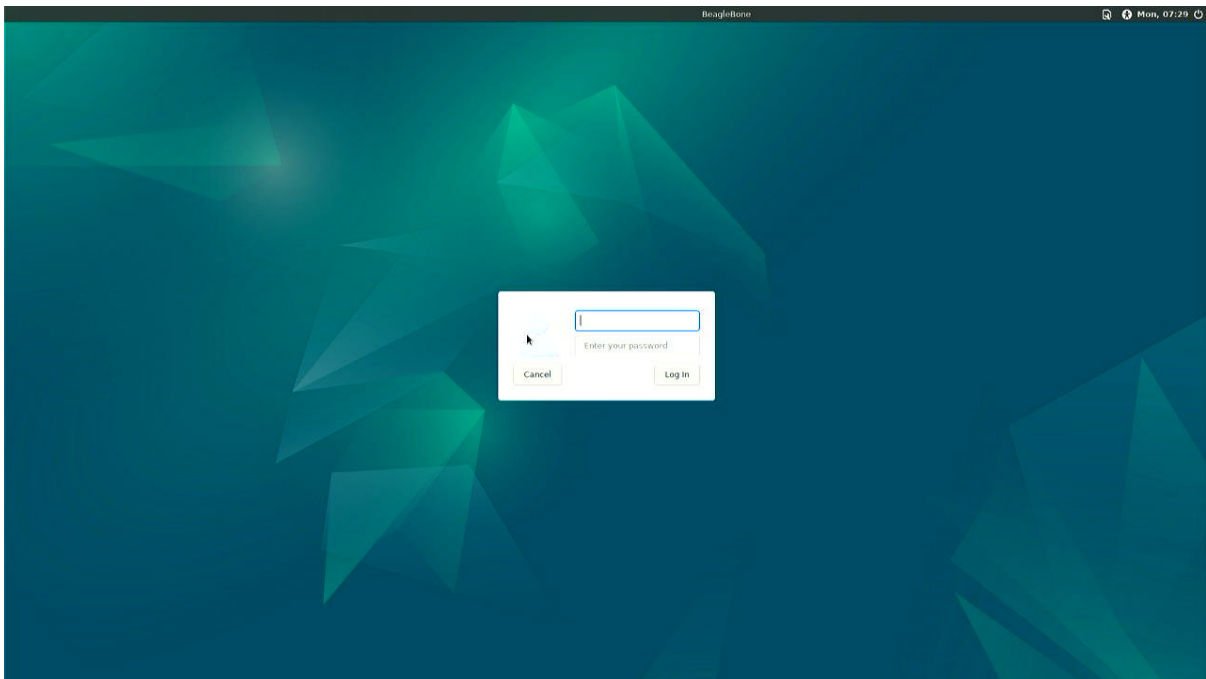


If everything is connected properly you should see four penguins on your monitor.

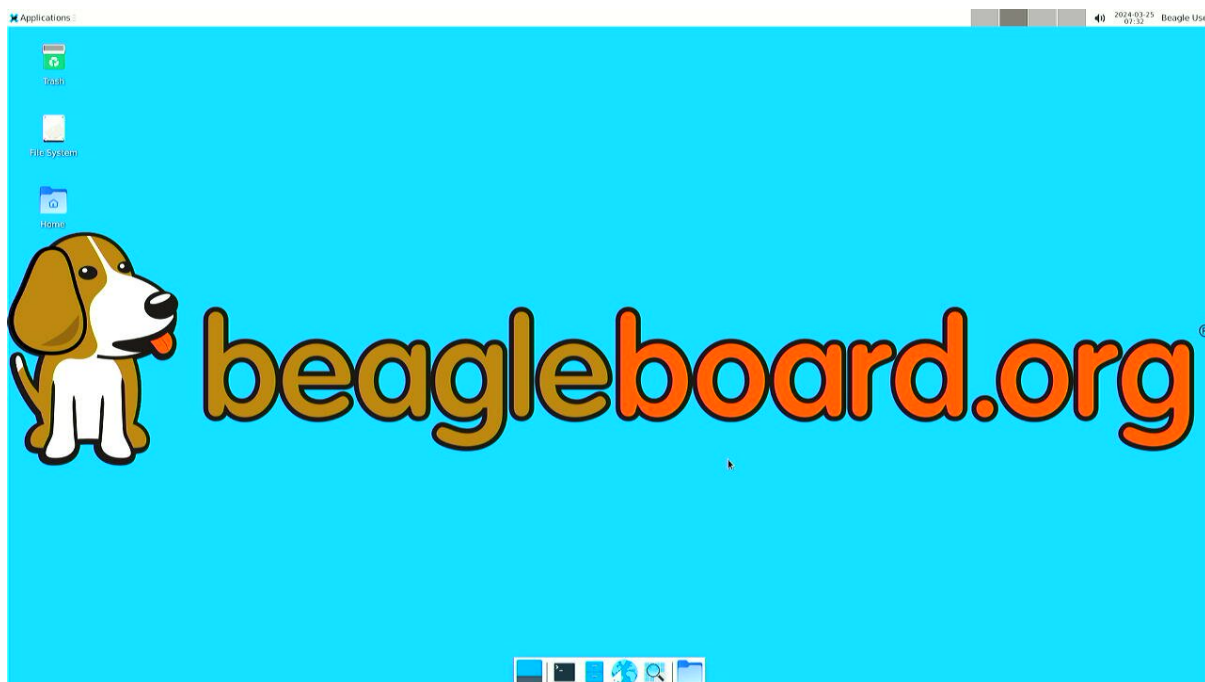


When prompted, log in using the updated login credentials you updated during the USB tethering step.

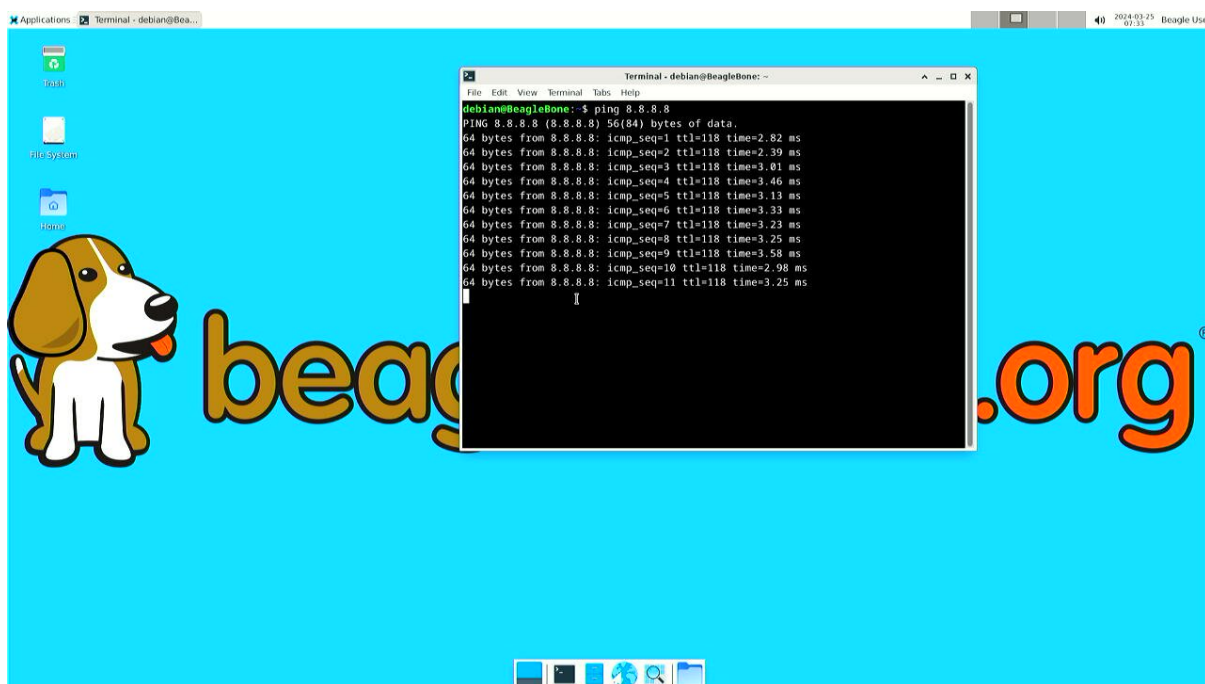
**Note:** You can not update login credentials at this step, you must update them during USB tethering step!



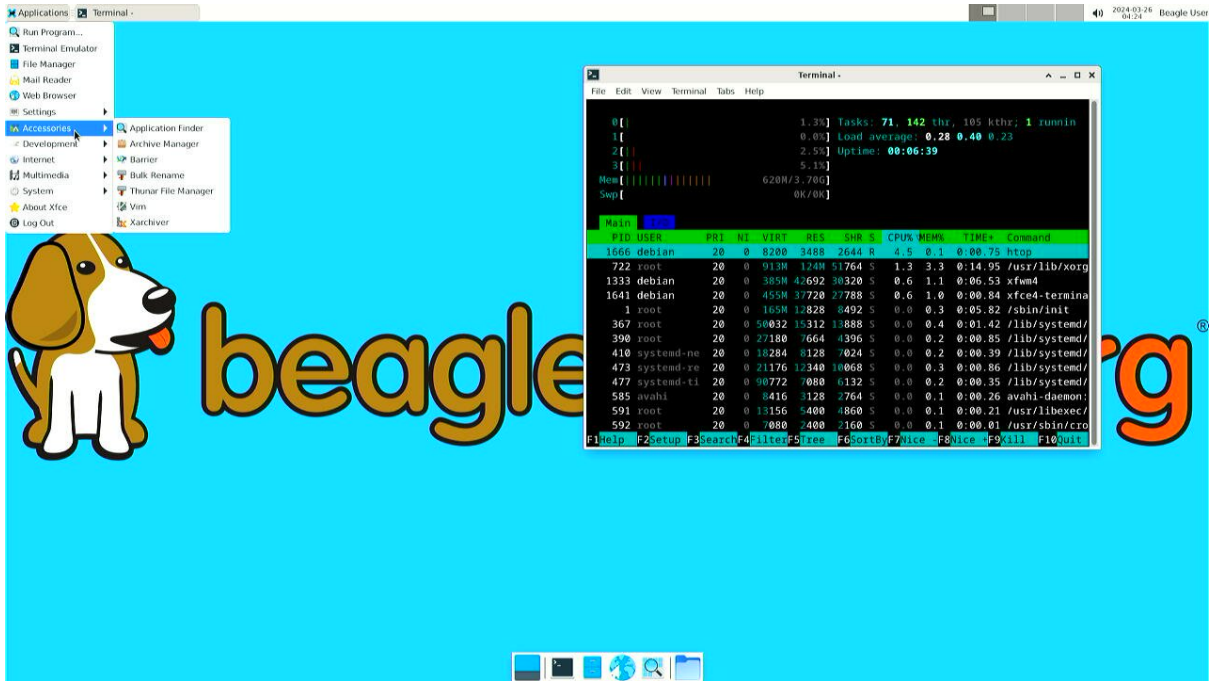
Once logged in you should see the splash screen shown in the image below:



Test network connection by running ping 8.8.8.8



Explore and build with your new BeagleY-AI board!



### 2.2.6 Connecting to WiFi

Connect 2x antennas to your BeagleY-AI board if not pre-attached.

After successfully attaching the antenna, power up the board. Once booted you can follow the commands below to connect to any WiFi access point,

- To list the wireless devices attached, (you should see wlan0 listed)

```
iwctl device list
```

- Scan WiFi using,

```
iwctl station wlan0 scan
```

- Get networks using,

```
iwctl station wlan0 get-networks
```

- Connect to your wifi network using,

```
iwctl --passphrase "<wifi-pass>" station wlan0 connect "<wifi-name>"
```

- Check wlan0 status with,

```
iwctl station wlan0 show
```

- To list the networks with connected WiFi marked you can again use,

```
iwctl station wlan0 get-networks
```

- Test connection with ping command,

```
ping 8.8.8.8
```



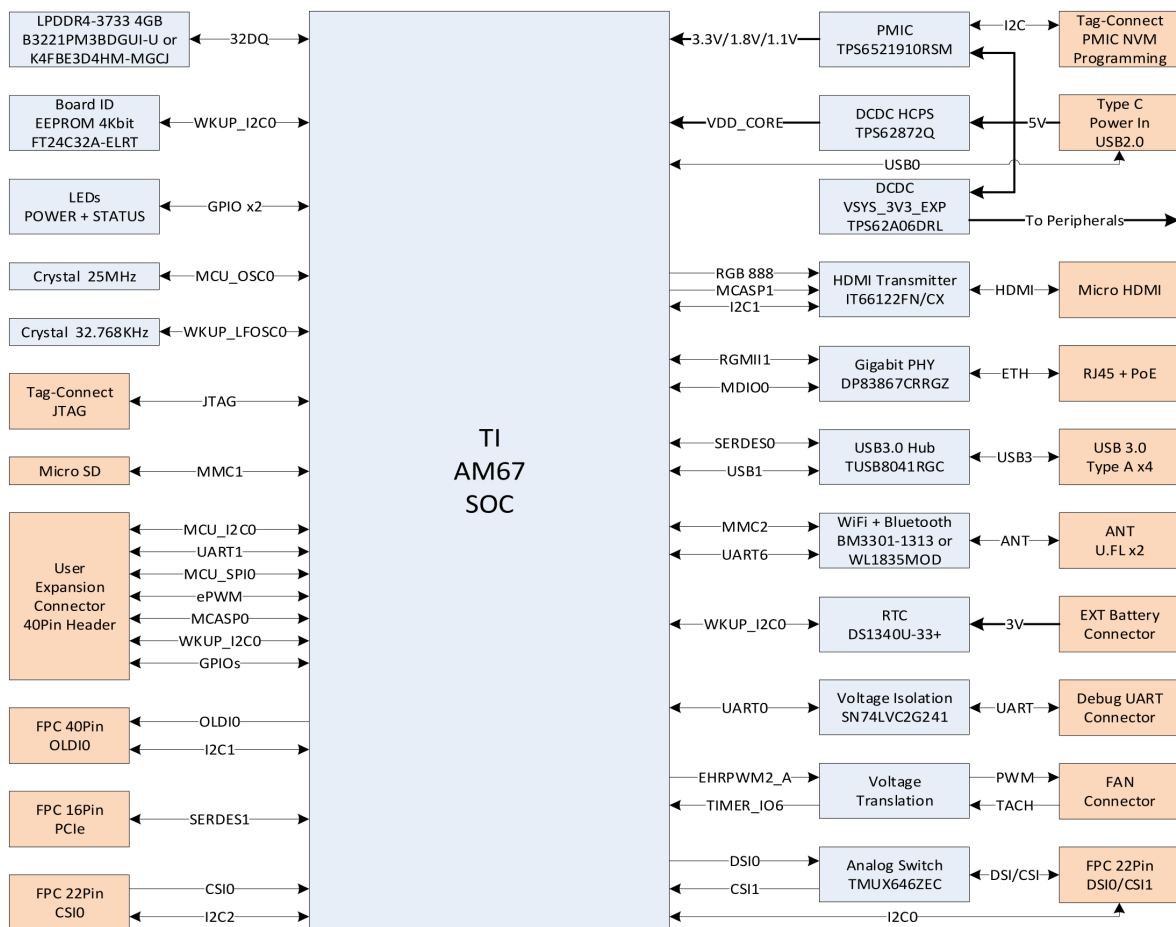


# Chapter 3

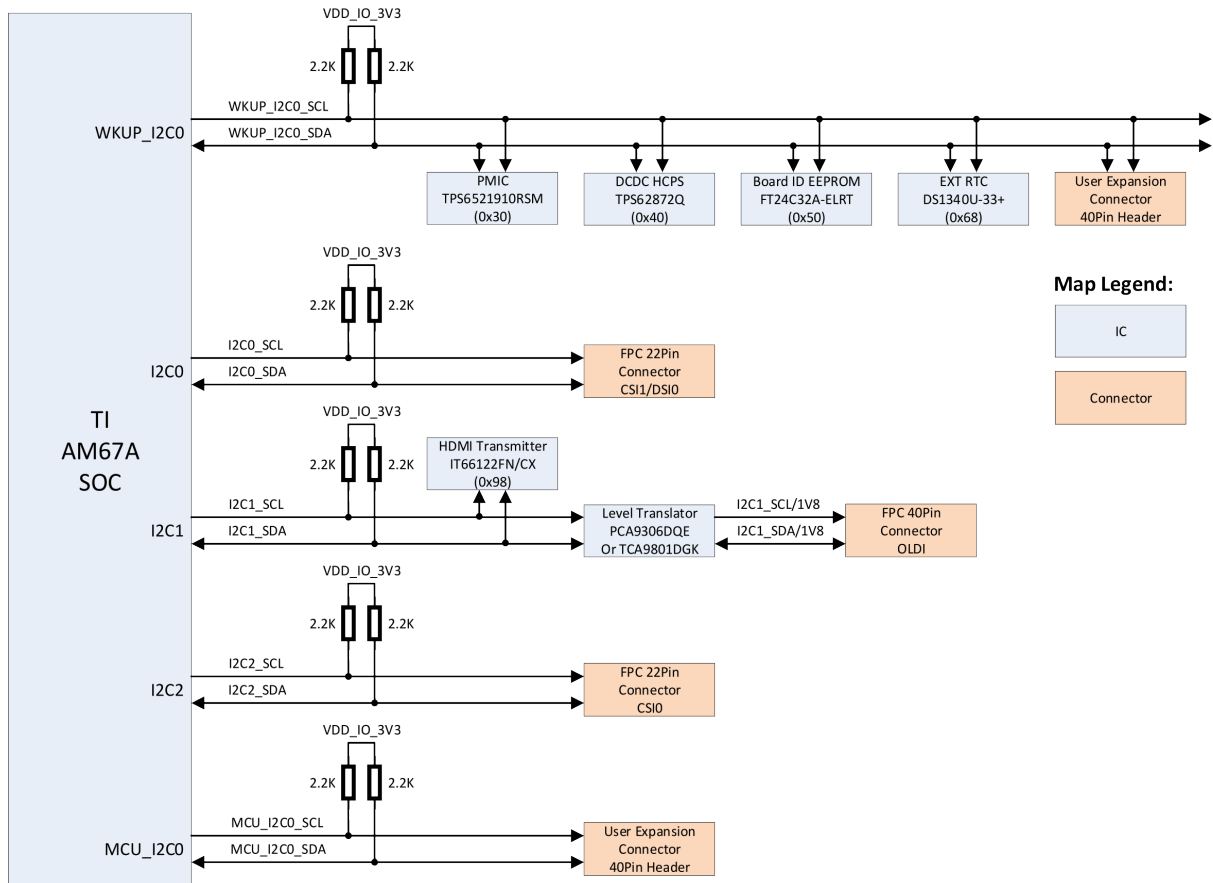
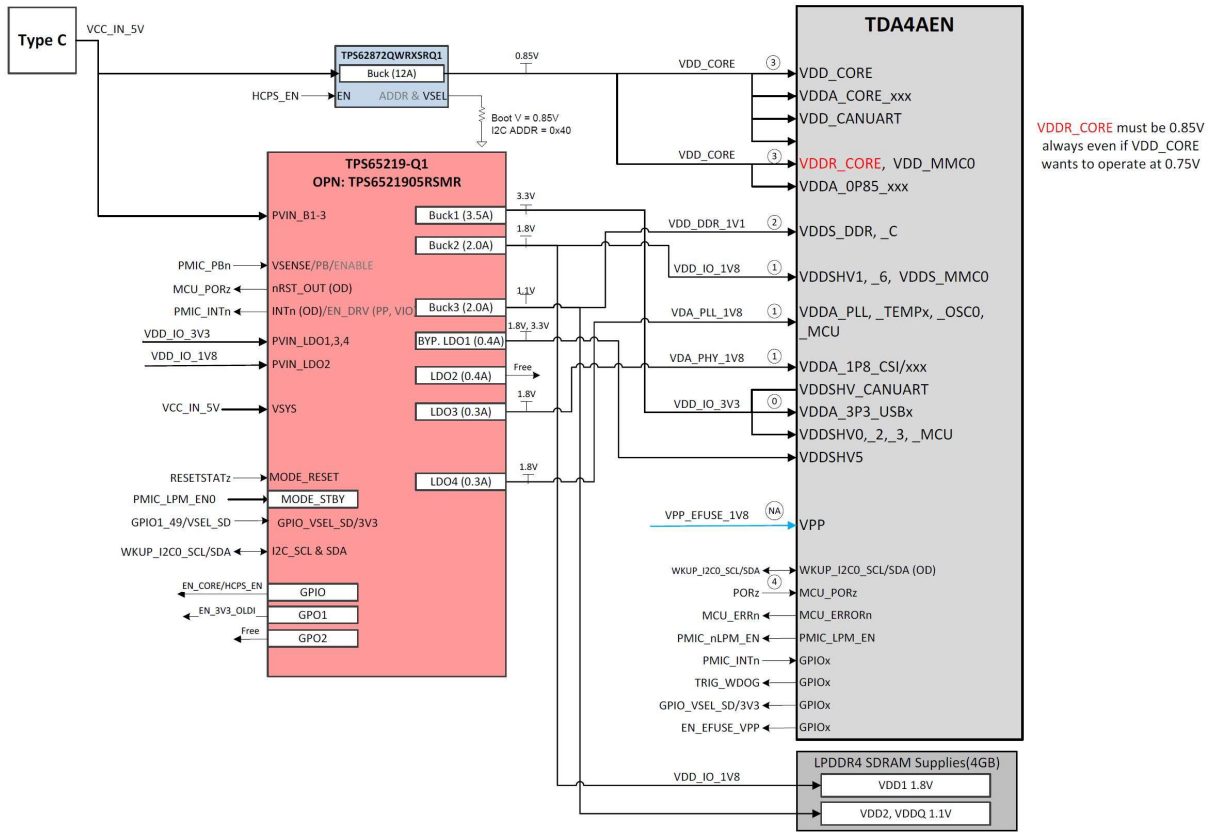
## Design and specifications

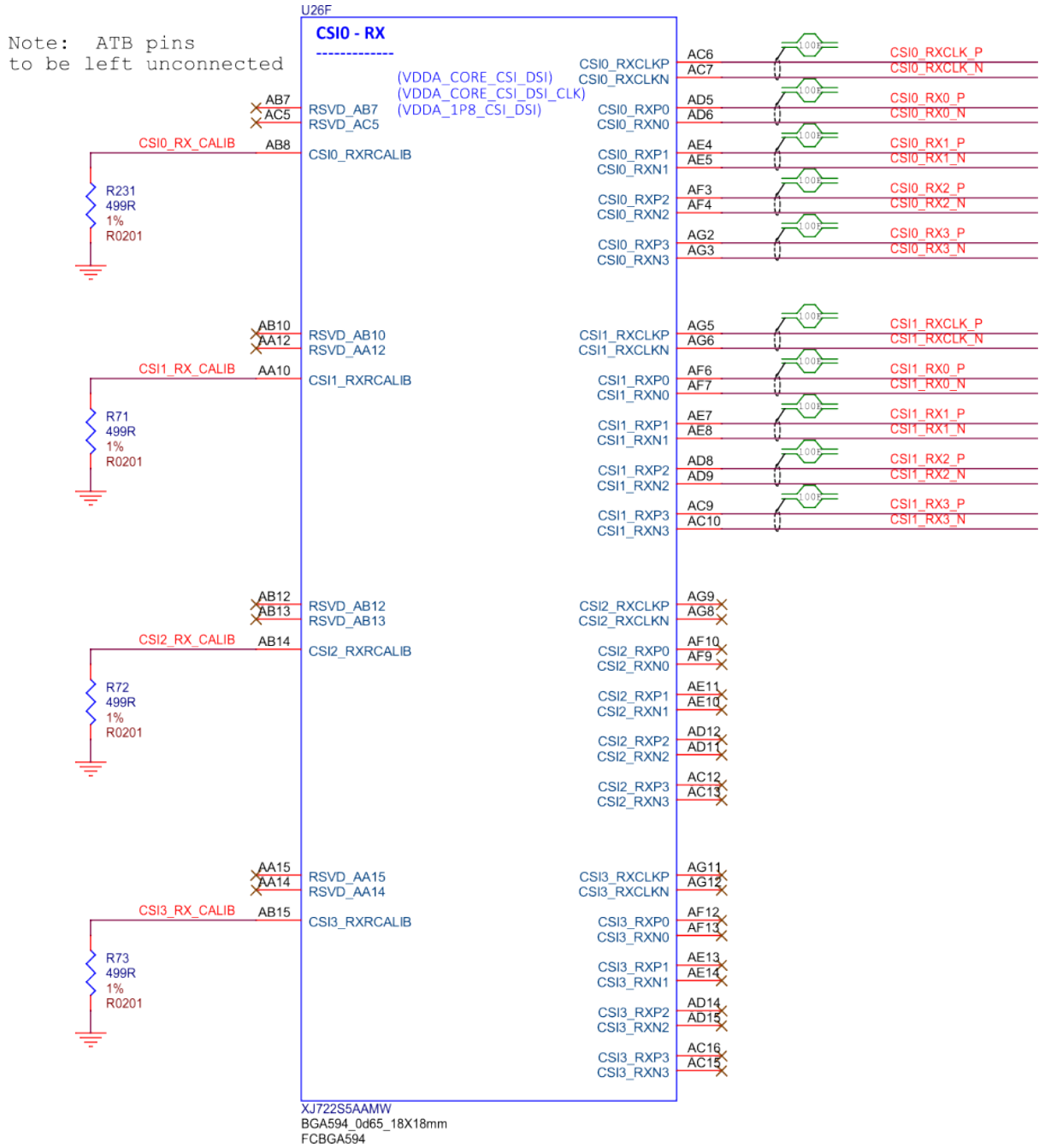
If you want to know how BeagleY-AI is designed and the detailed specifications, then this chapter is for you. We are going to attempt to provide you a short and crisp overview followed by discussing each hardware design element in detail.

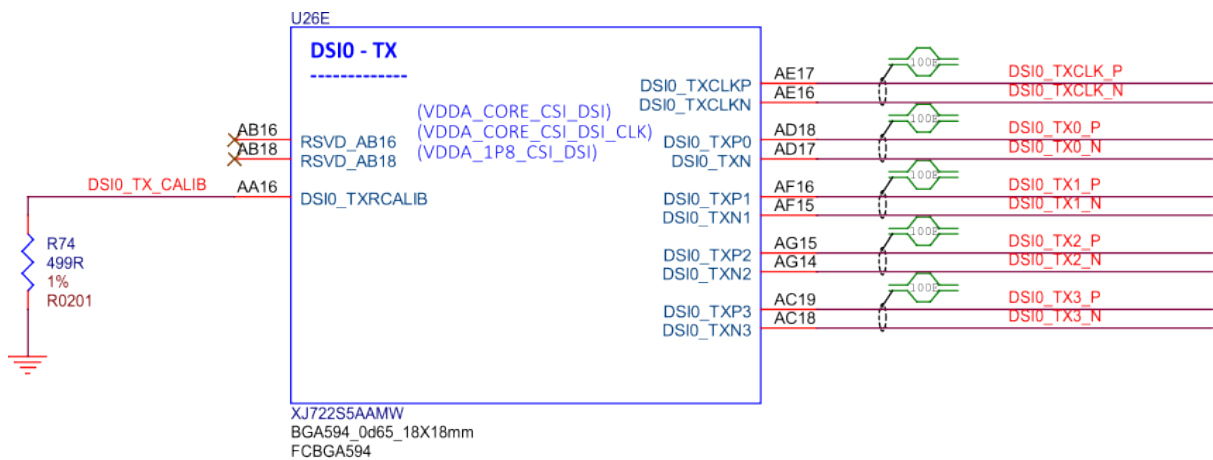
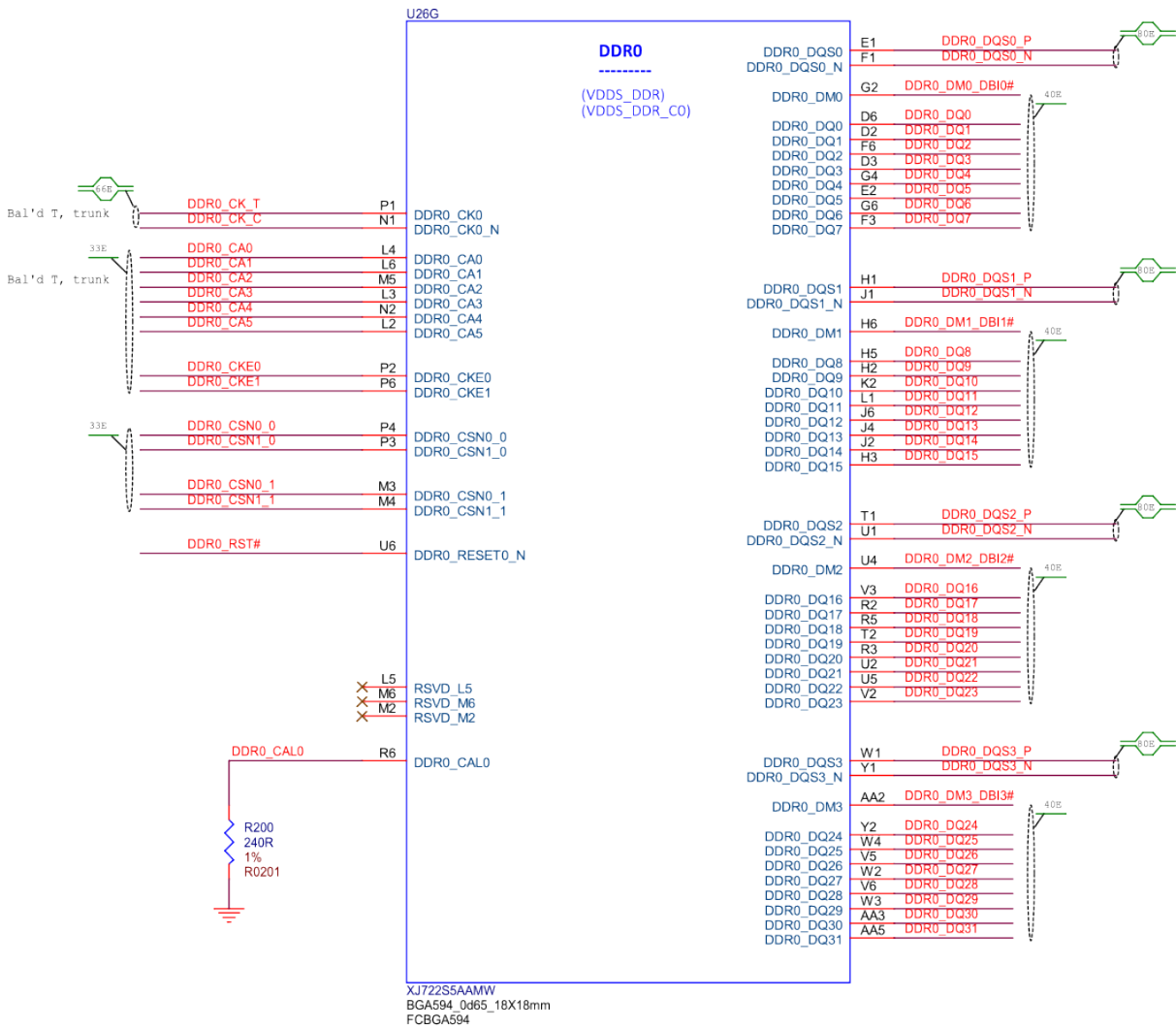
### 3.1 Block diagram and overview



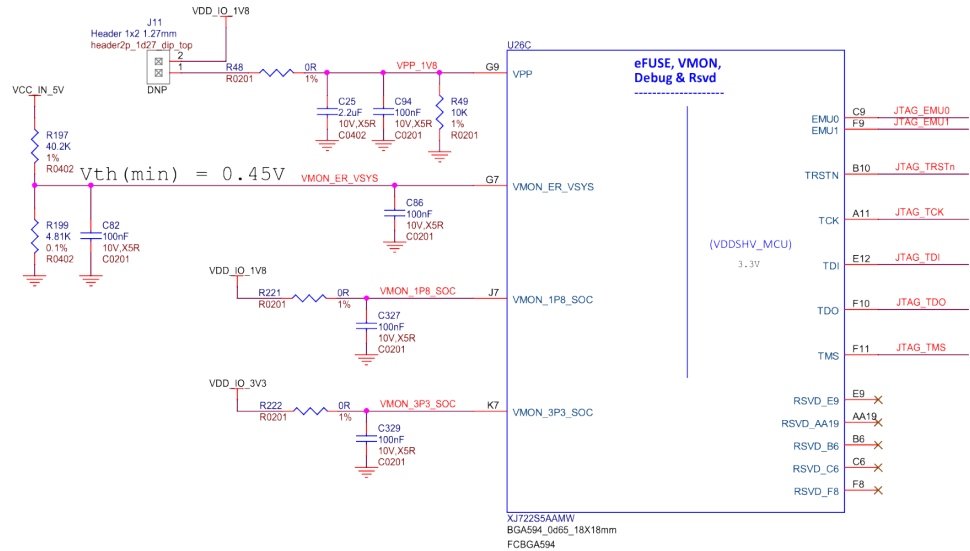
### 3.2 SoC



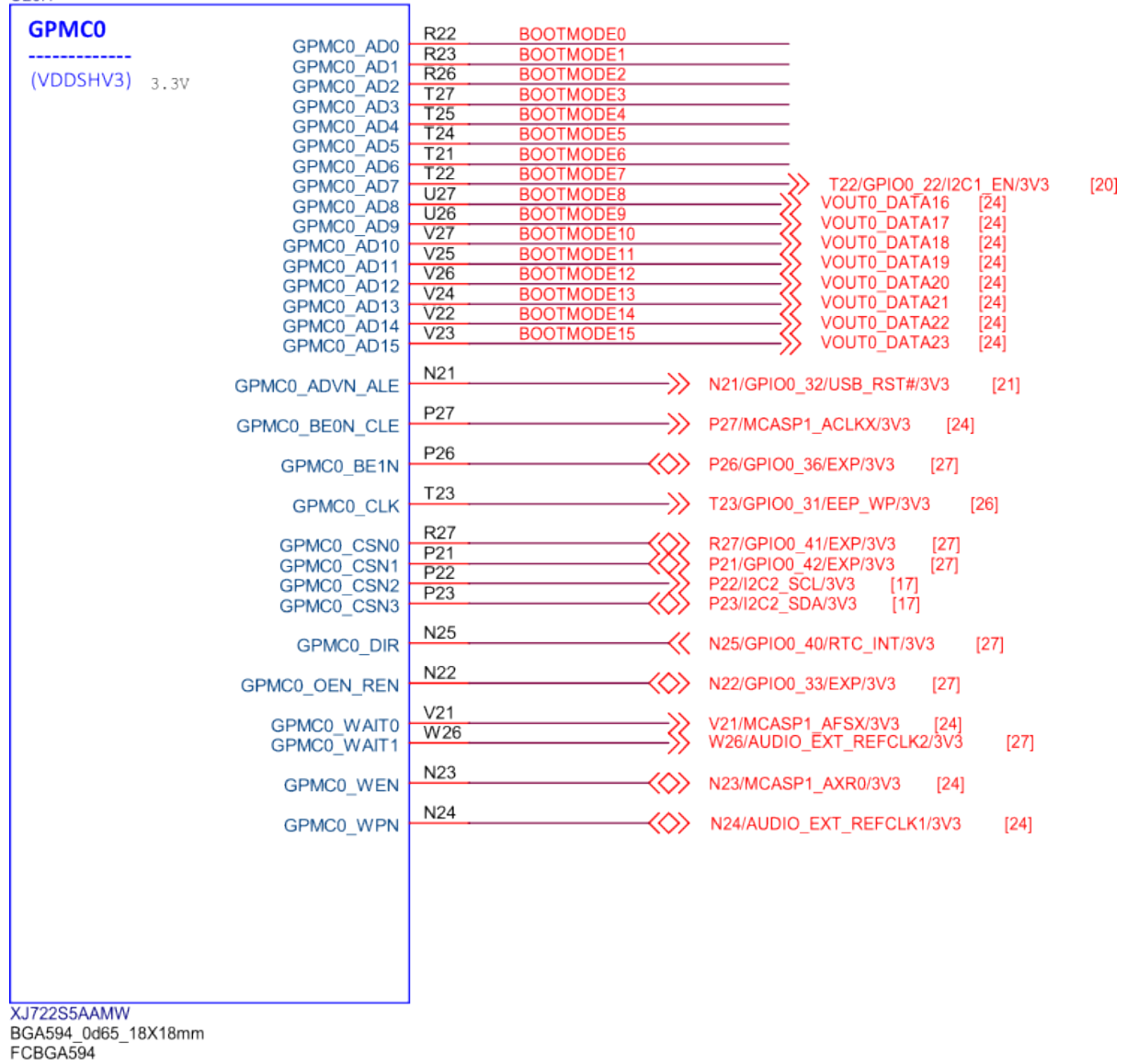


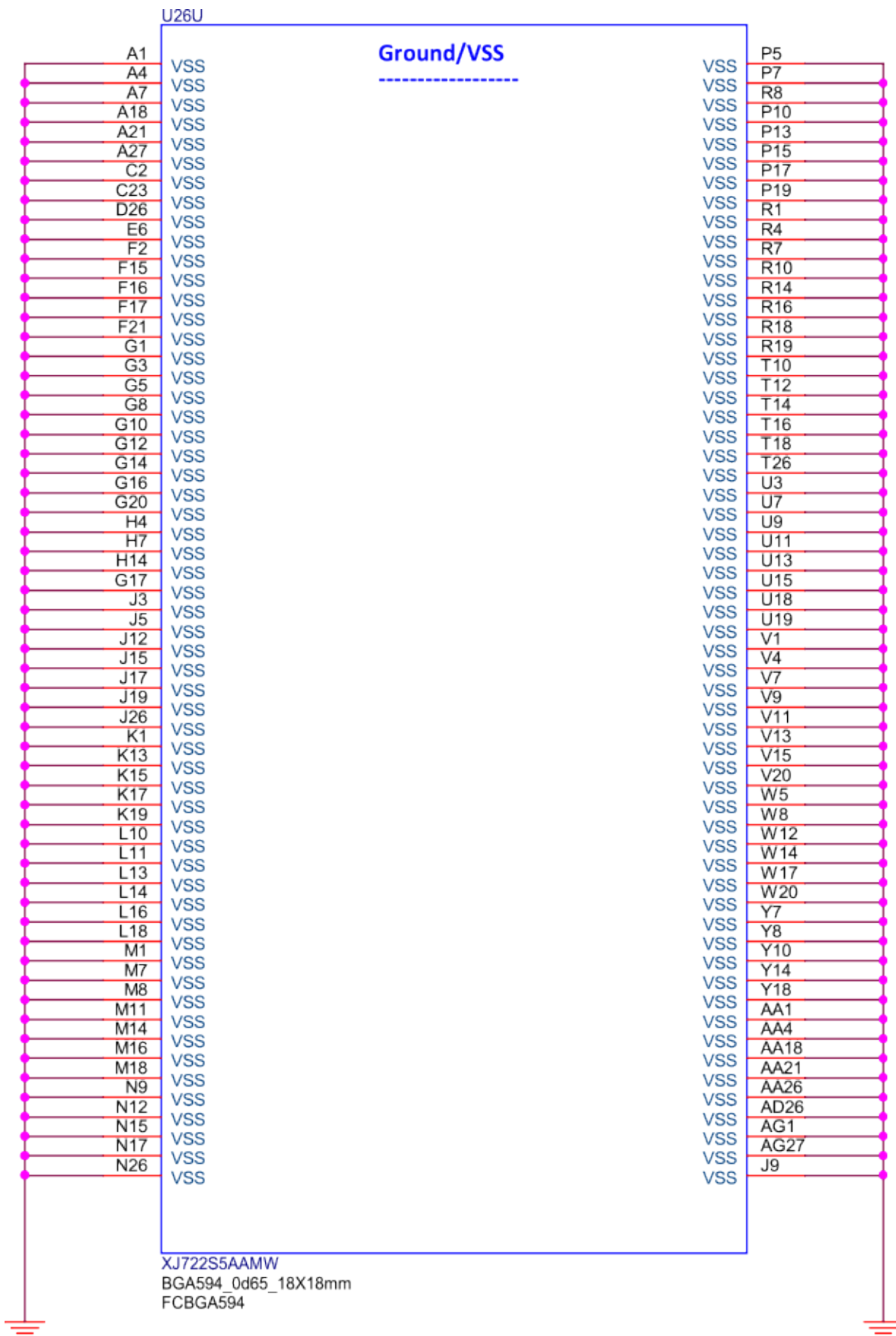


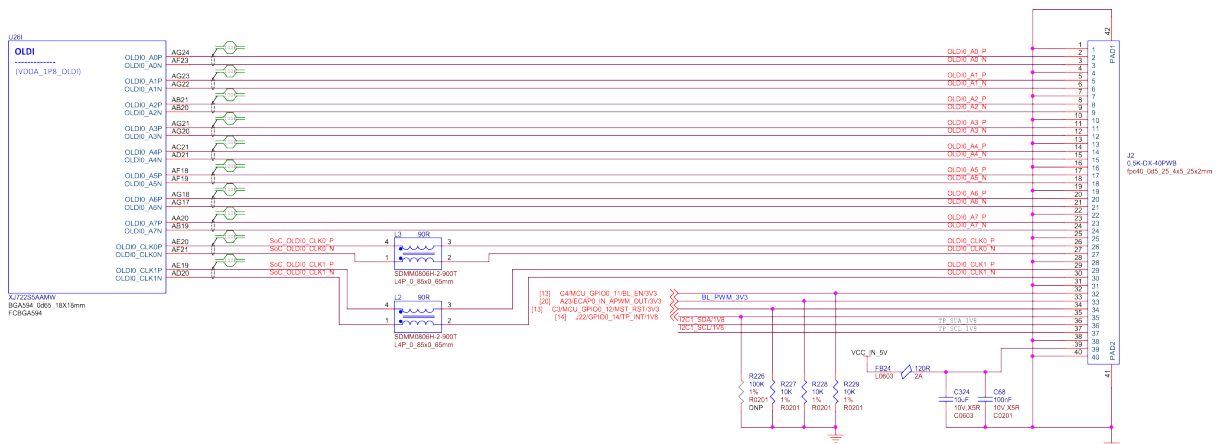
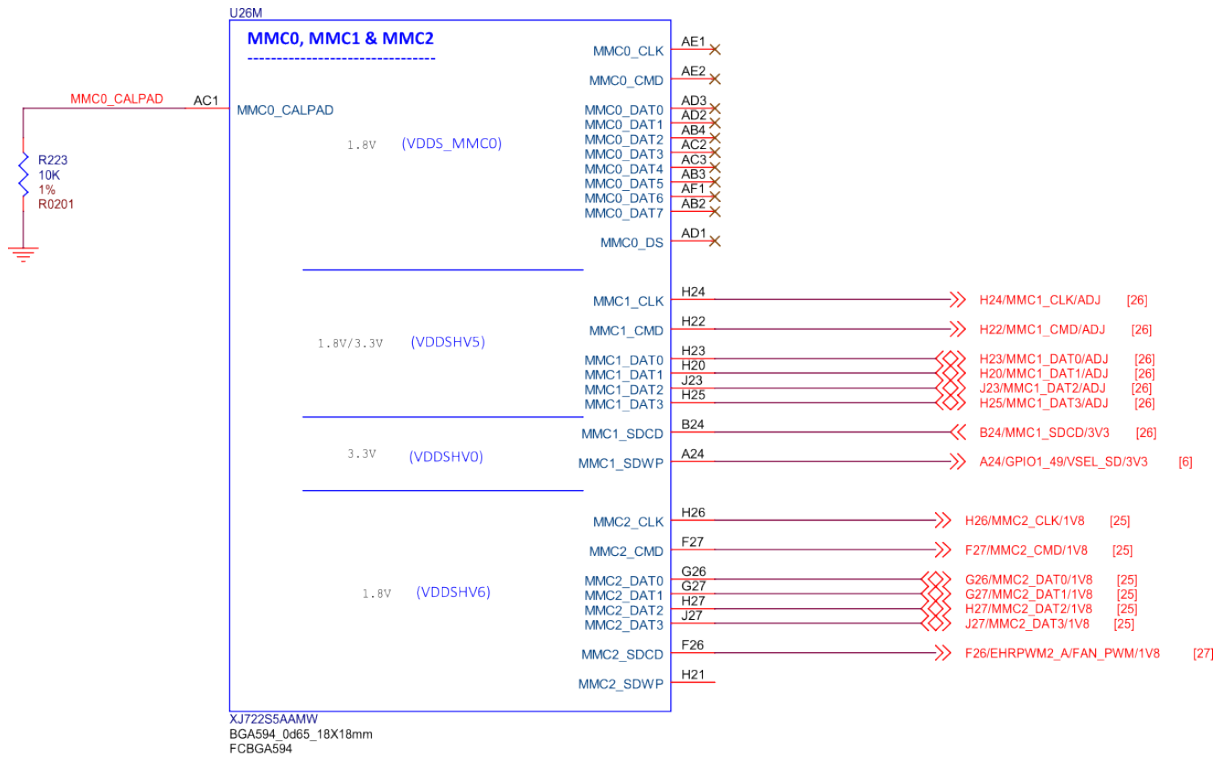
monitoring VCC\_IN 5V, to protect SoC from 1st stage power fault.



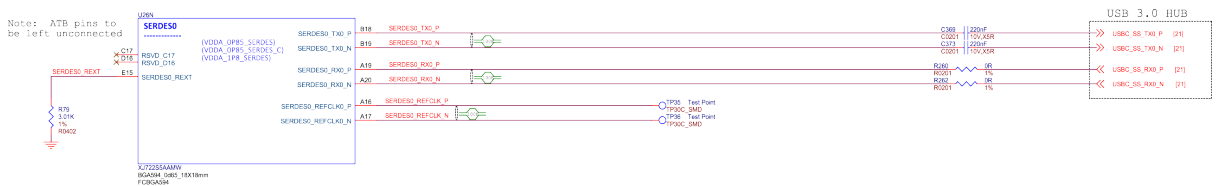
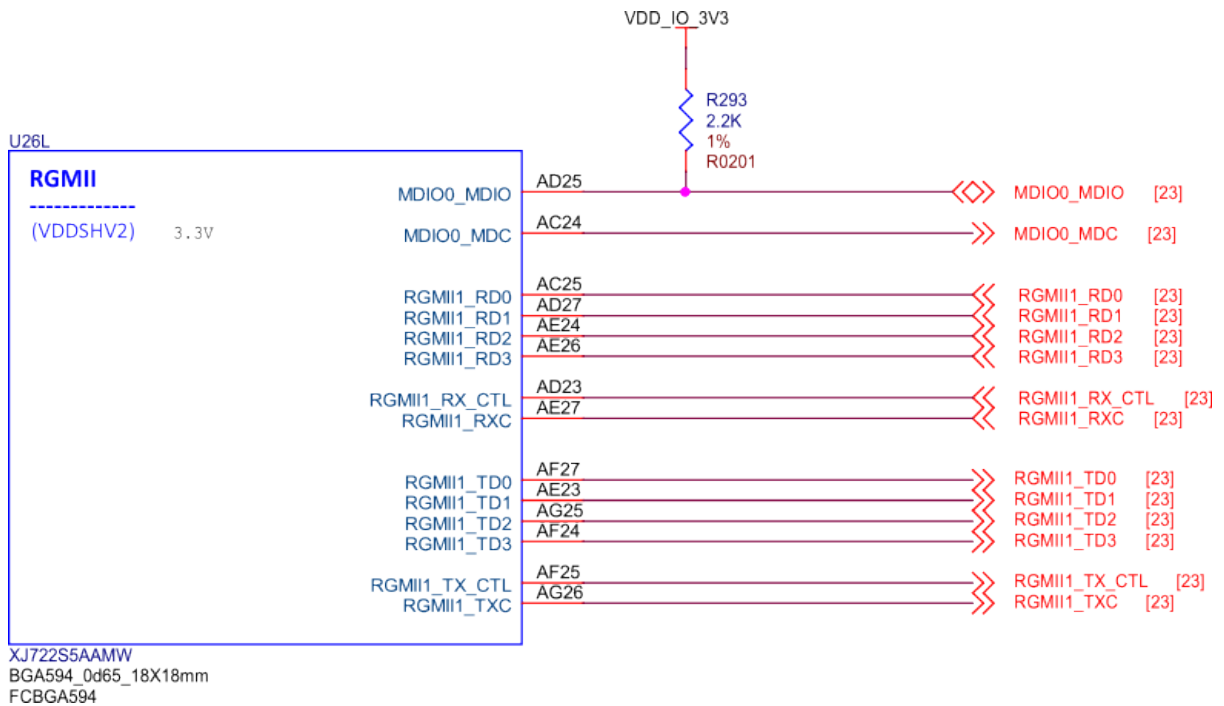
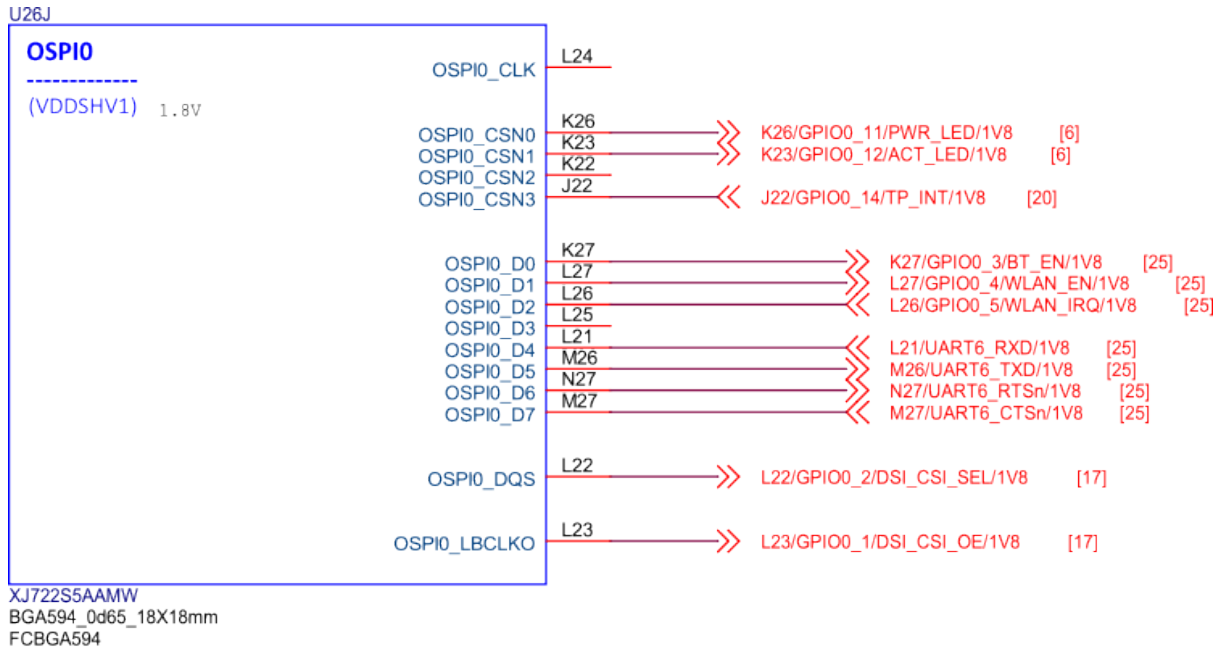
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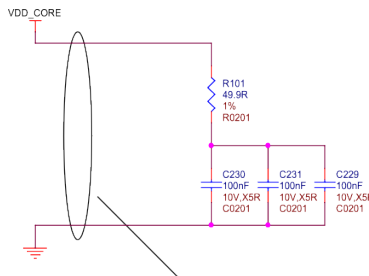
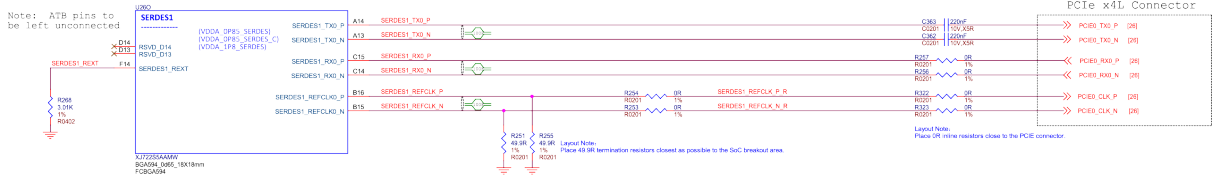




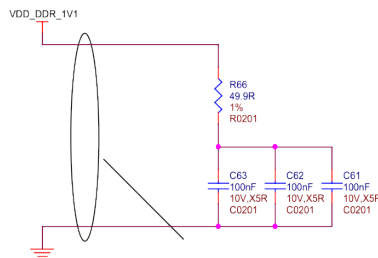




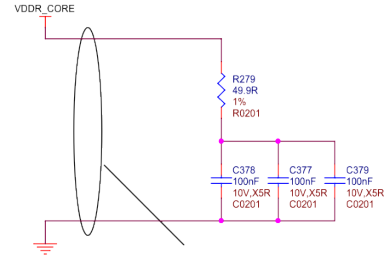




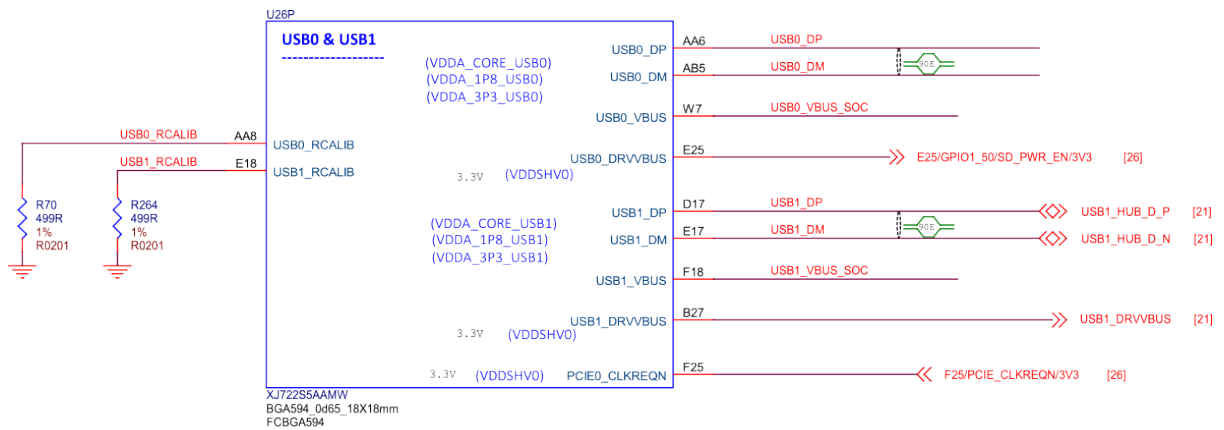
Route supply & Gnd connections from SoC Pol as a pseudo differential pair to TPs near R & C termination for easy access



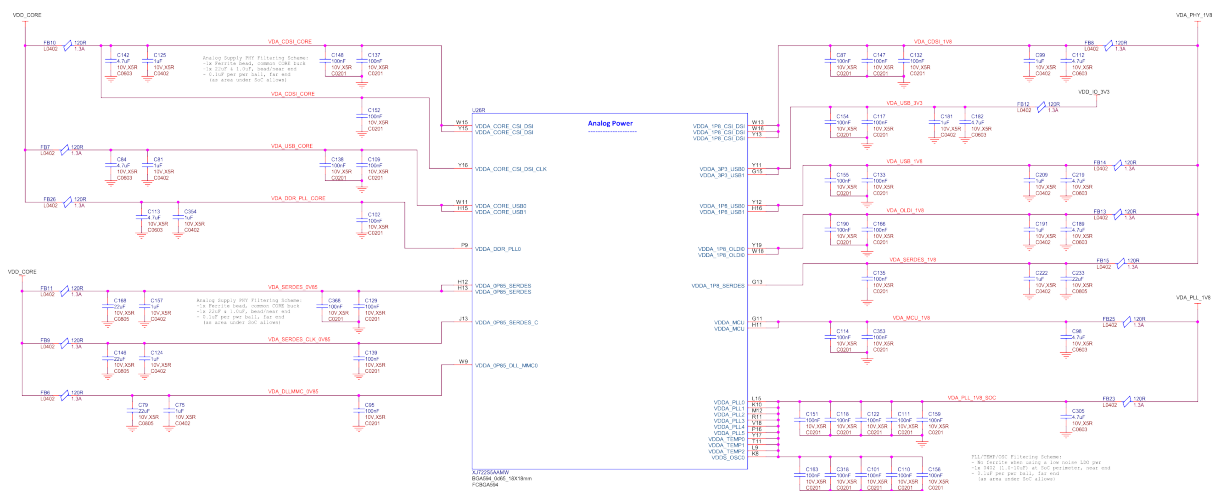
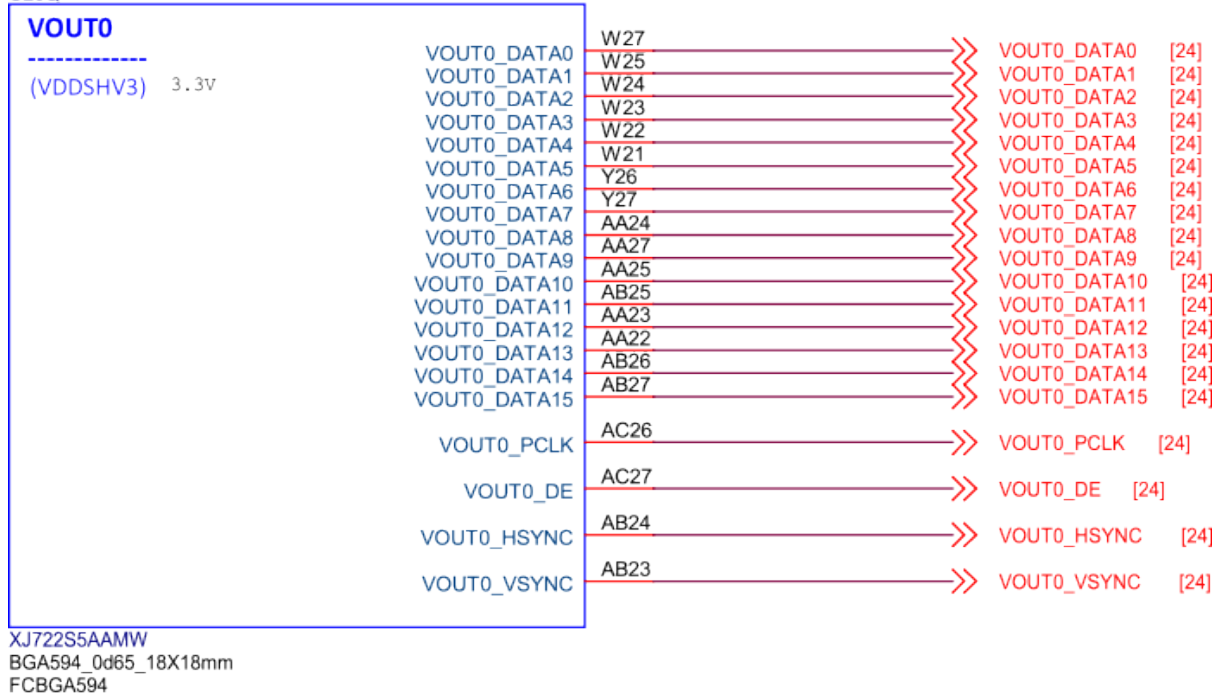
Route supply & Gnd connections from SoC Pol as a pseudo differential pair to TPs near R & C termination for easy access

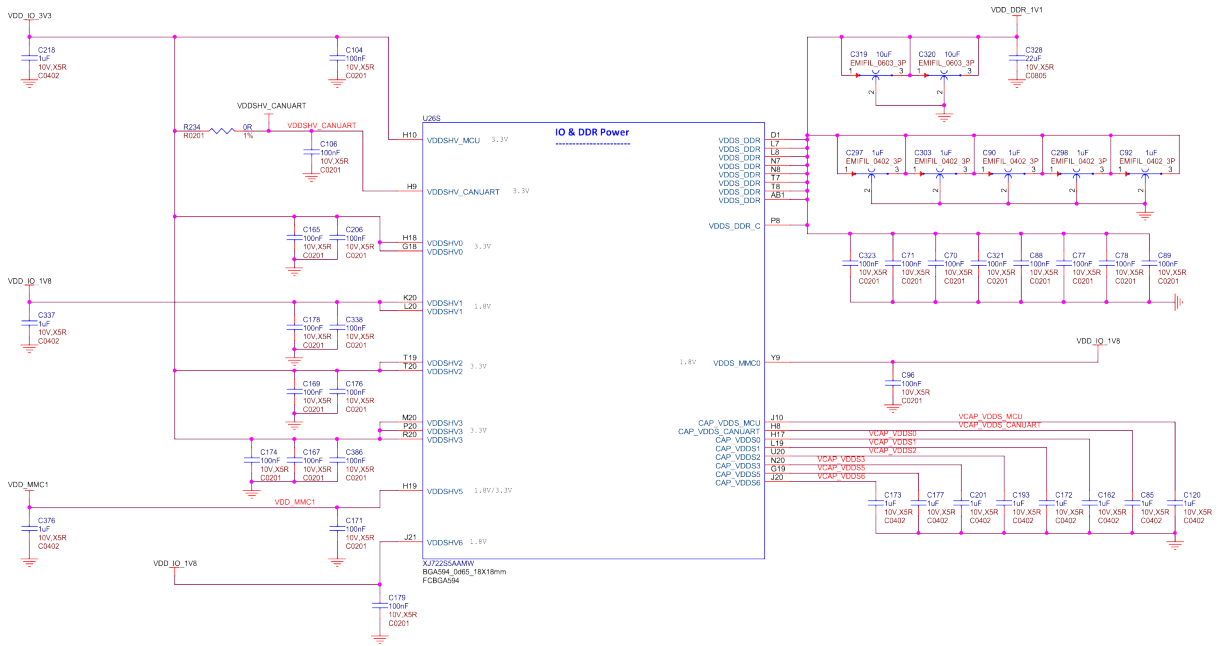


Route supply & Gnd connections from SoC Pol as a pseudo differential pair to TPs near R & C termination for easy access



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### 3.3 Boot modes

### 3.4 Power sources

### 3.5 PMIC

### 3.6 General connectivity and expansion

### 3.7 Buttons and LEDs

### 3.8 Networking

### 3.9 Ethernet

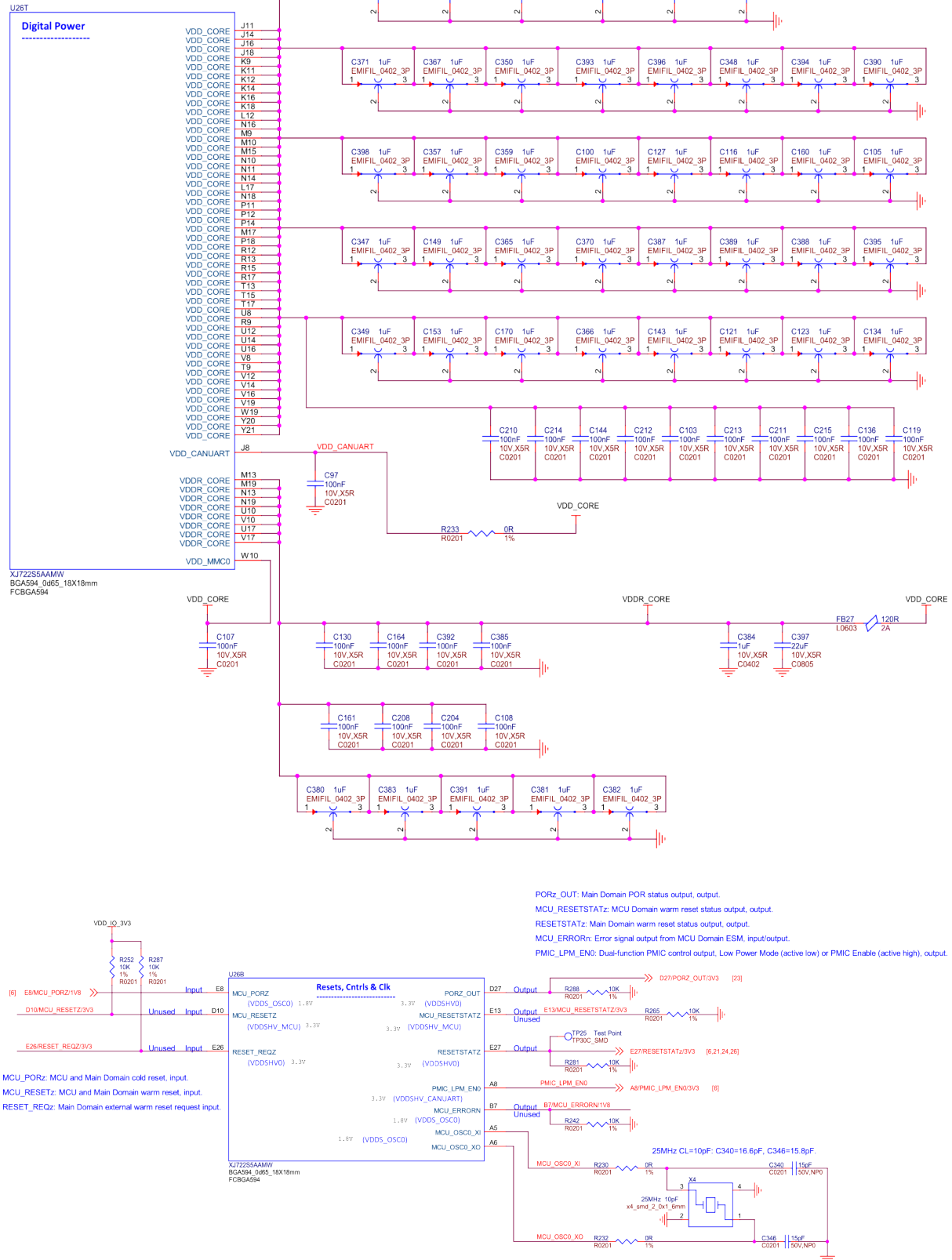
### 3.10 Memory, media, and storage

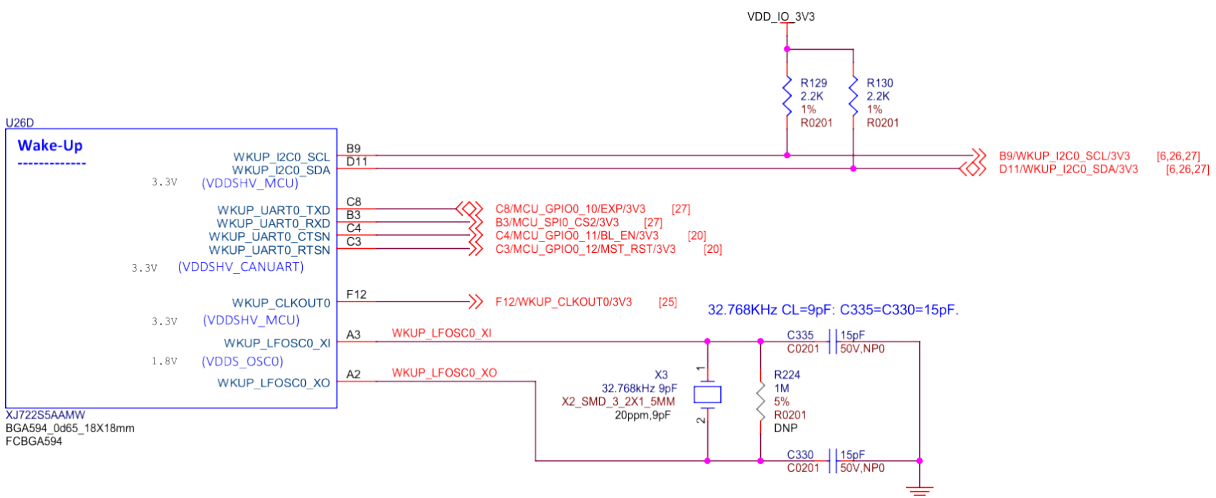
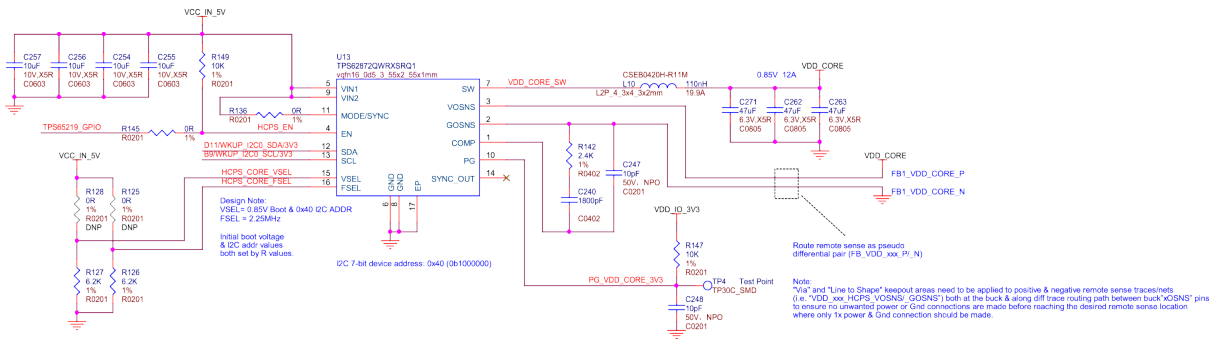
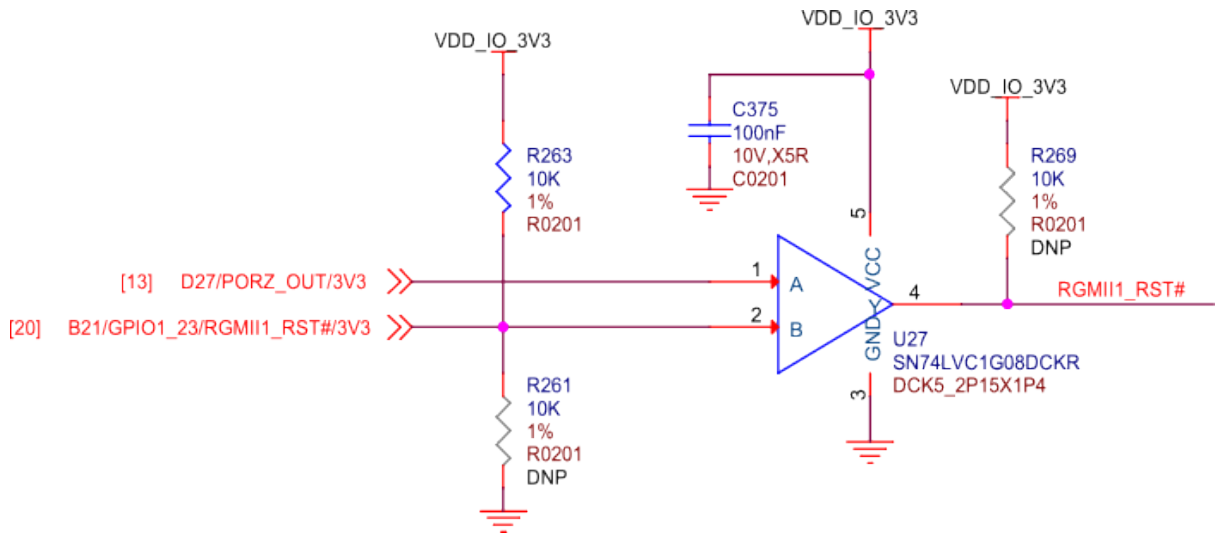
### 3.11 Multimedia I/O

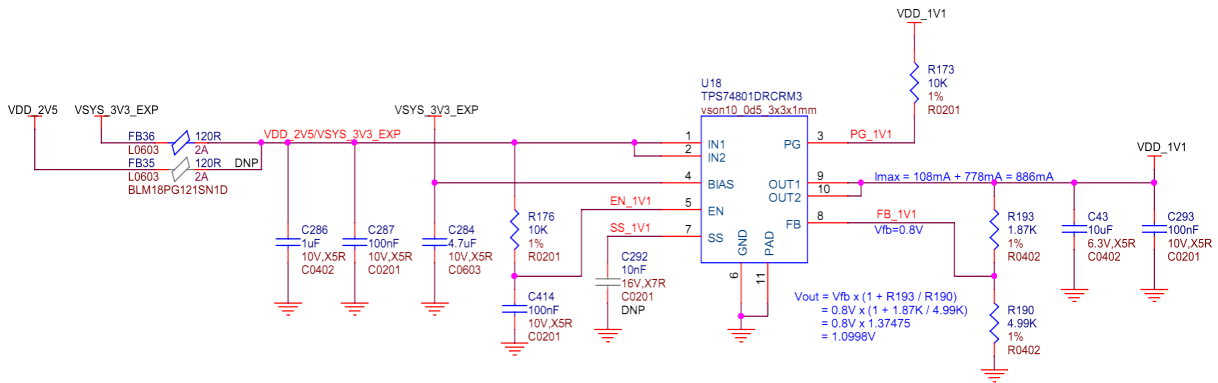
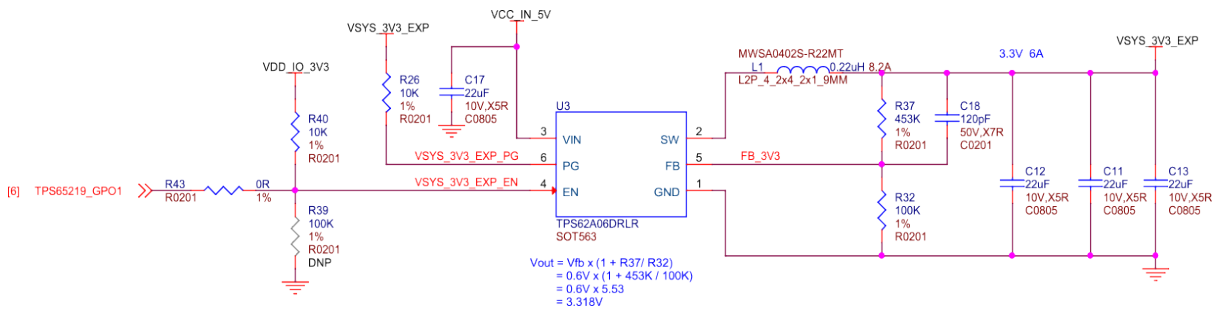
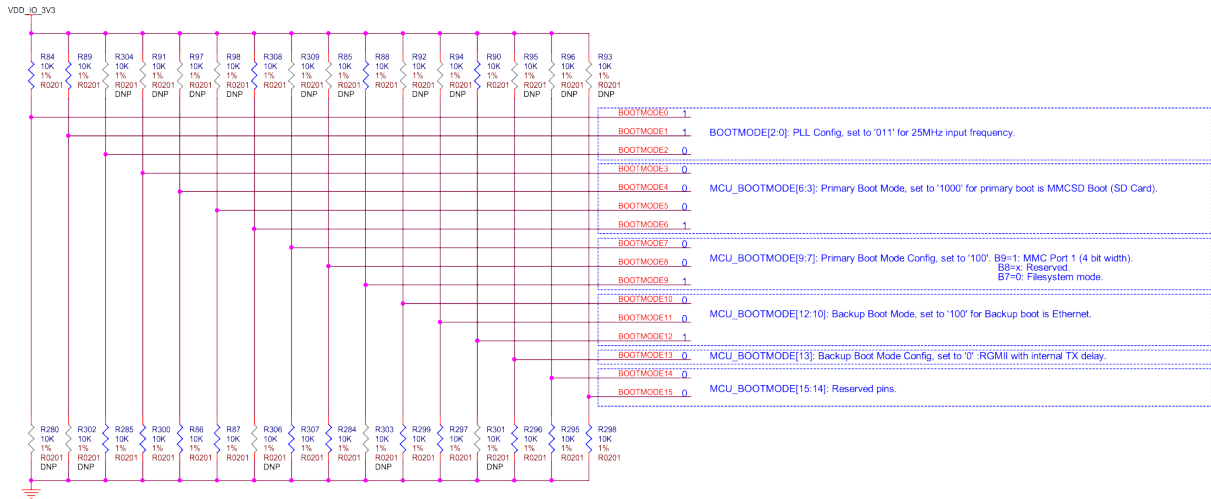
### 3.12 Debug ports

### 3.13 Mechanical Specifications

# DIGITAL POWER 3

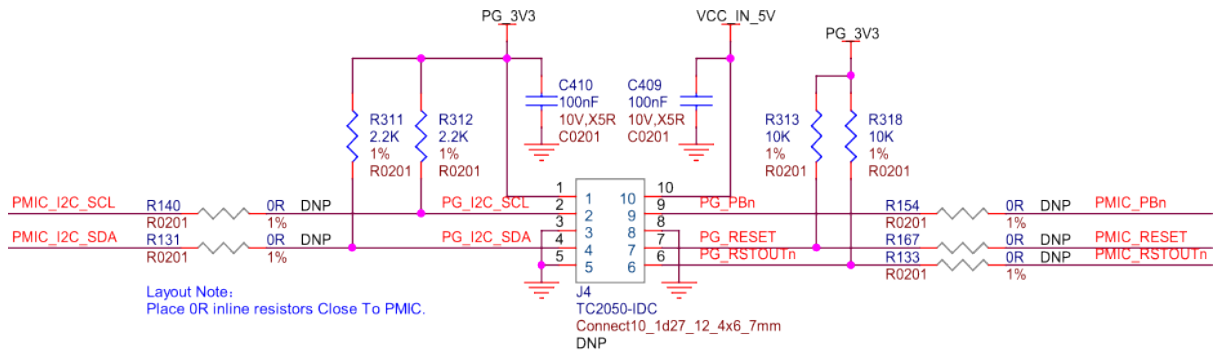


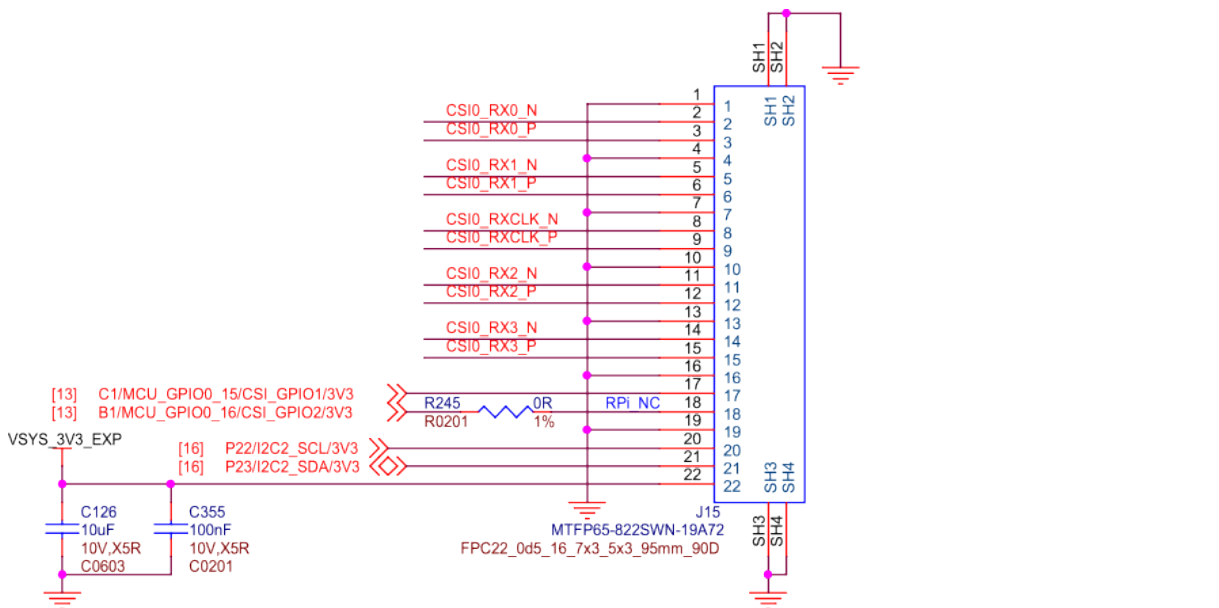
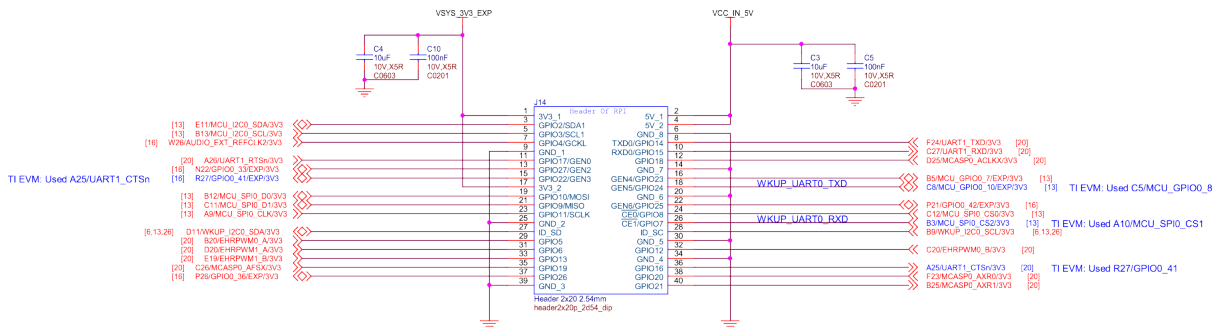
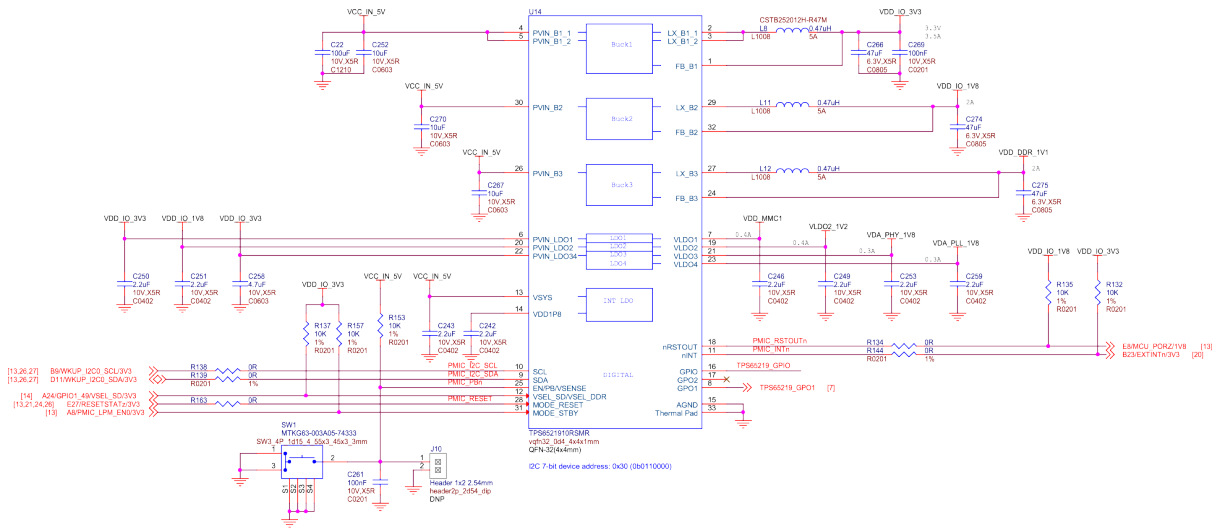




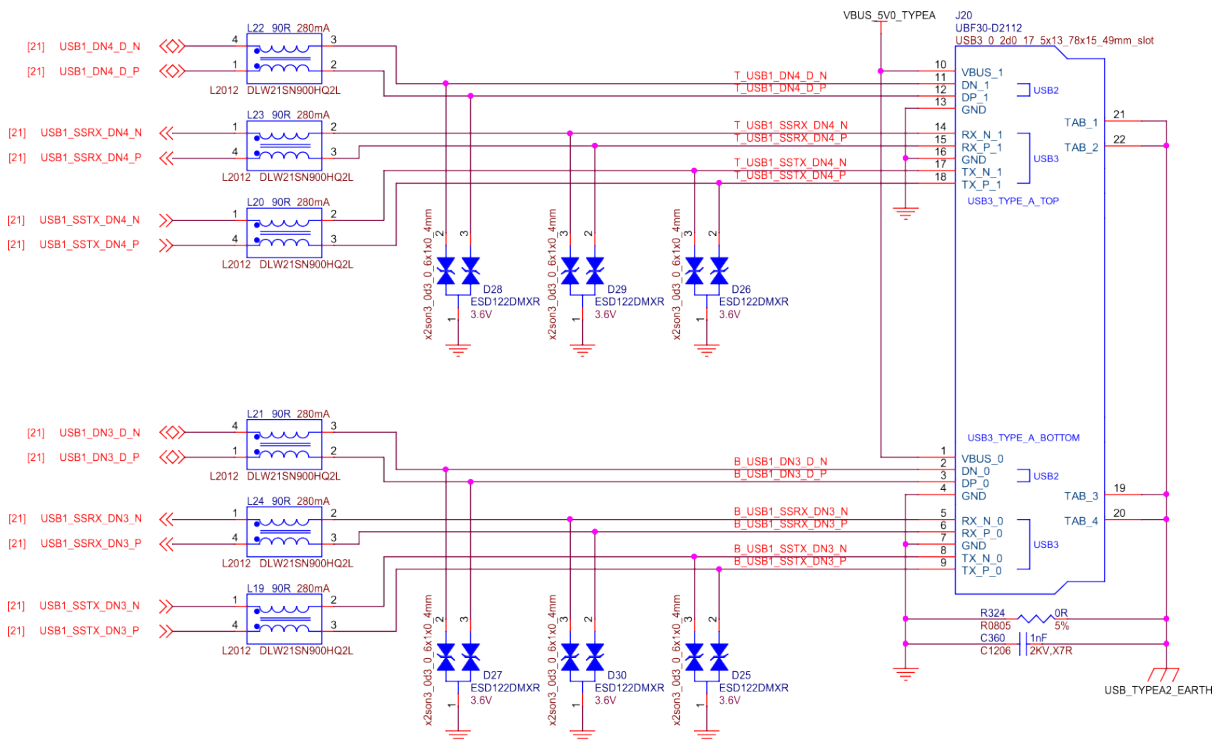
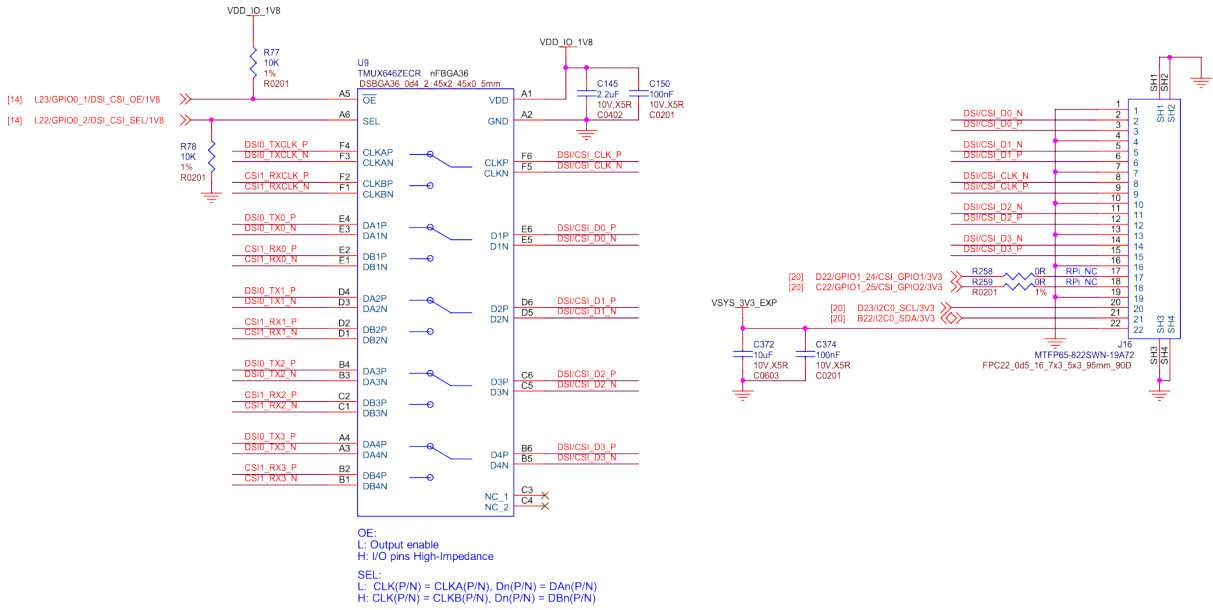
Ethernet PHY: VDD1P0=1.1V, Imax=108mA  
 USB3.0 HUB: VDD=1.1V, Imax=778mA  
 Total: Imax = 108mA + 554mA = 886mA  
 Option 1: VIN\_2V5/3V3 = 3.3V

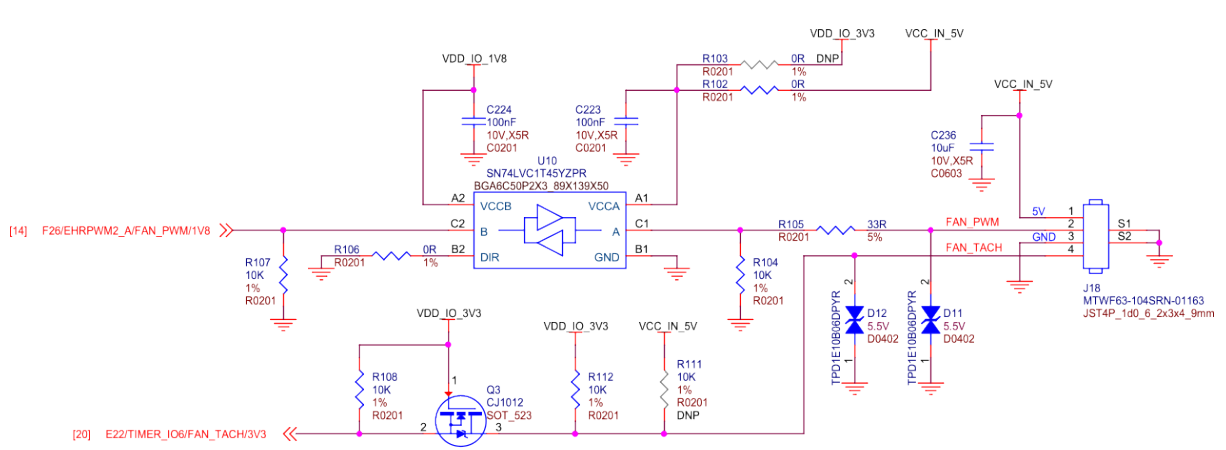
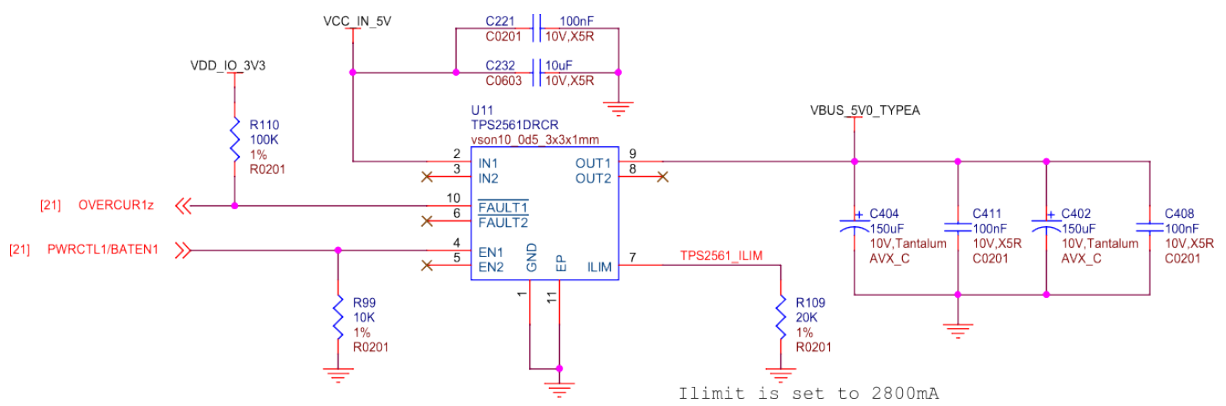
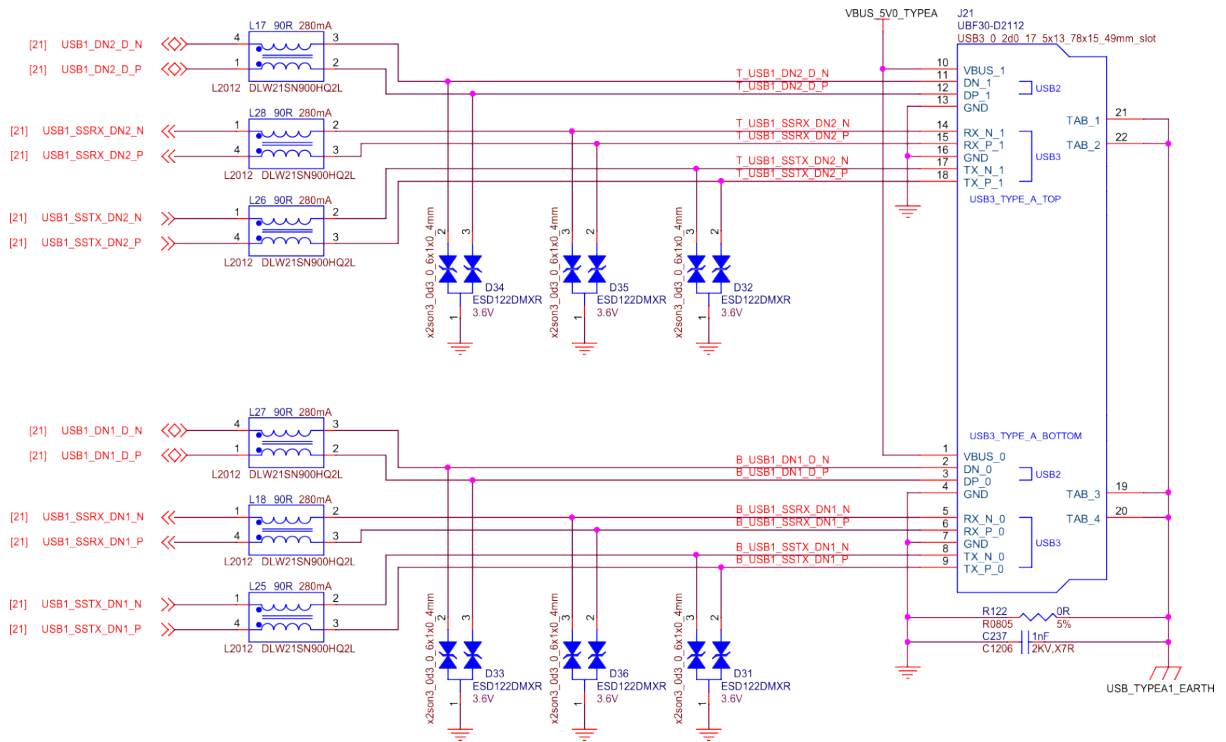
Power Consumption: (3.3V-1.1V) \* 0.886A = 1.9492W  
 Thermal Junction-to-ambient: 1.9492W \* 44.2°C/W=86.15°C  
 Option 2: VIN\_2V5/3V3 = 2.5V  
 Power Consumption: (2.5V-1.1V) \* 0.886A = 1.2404W  
 Thermal Junction-to-ambient: 1.2404W \* 44.2°C/W=54.83°C

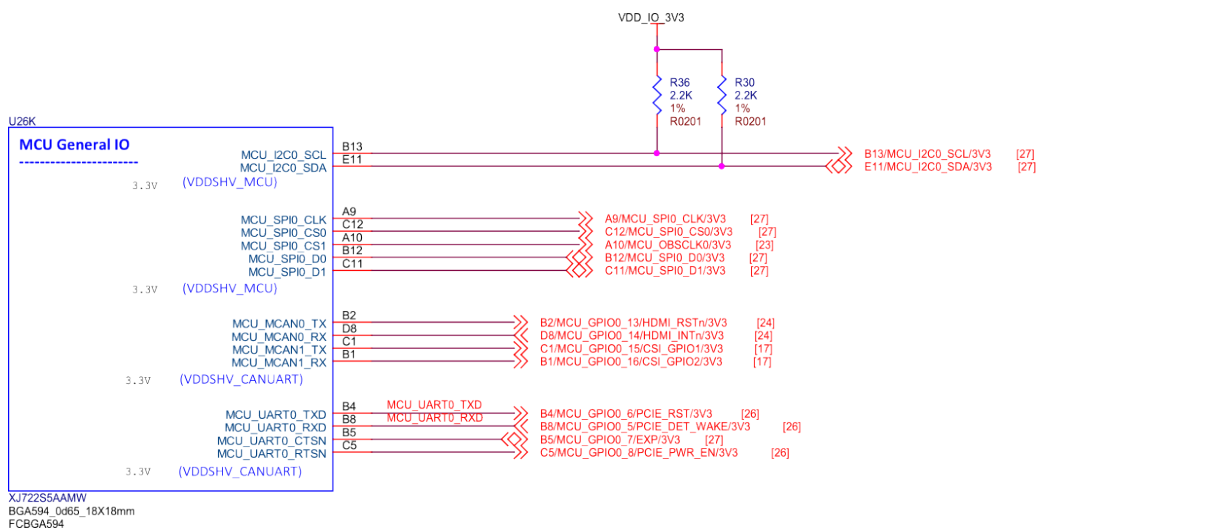
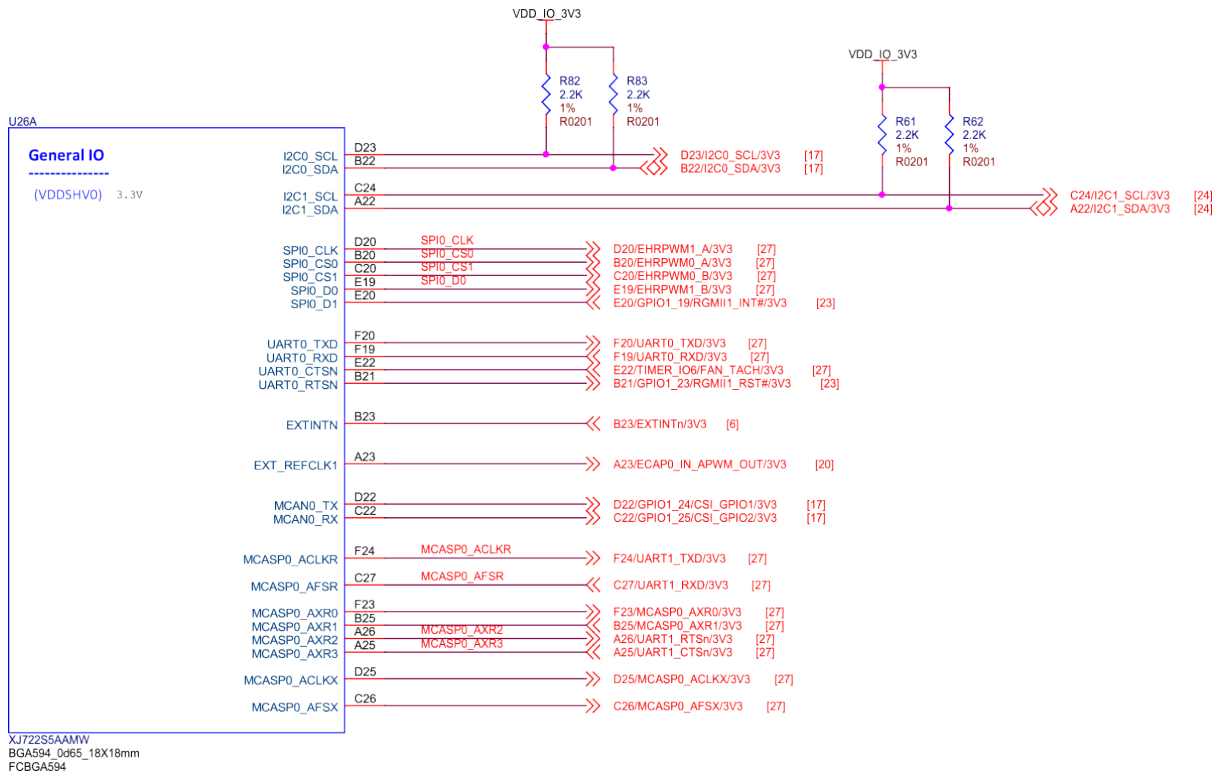


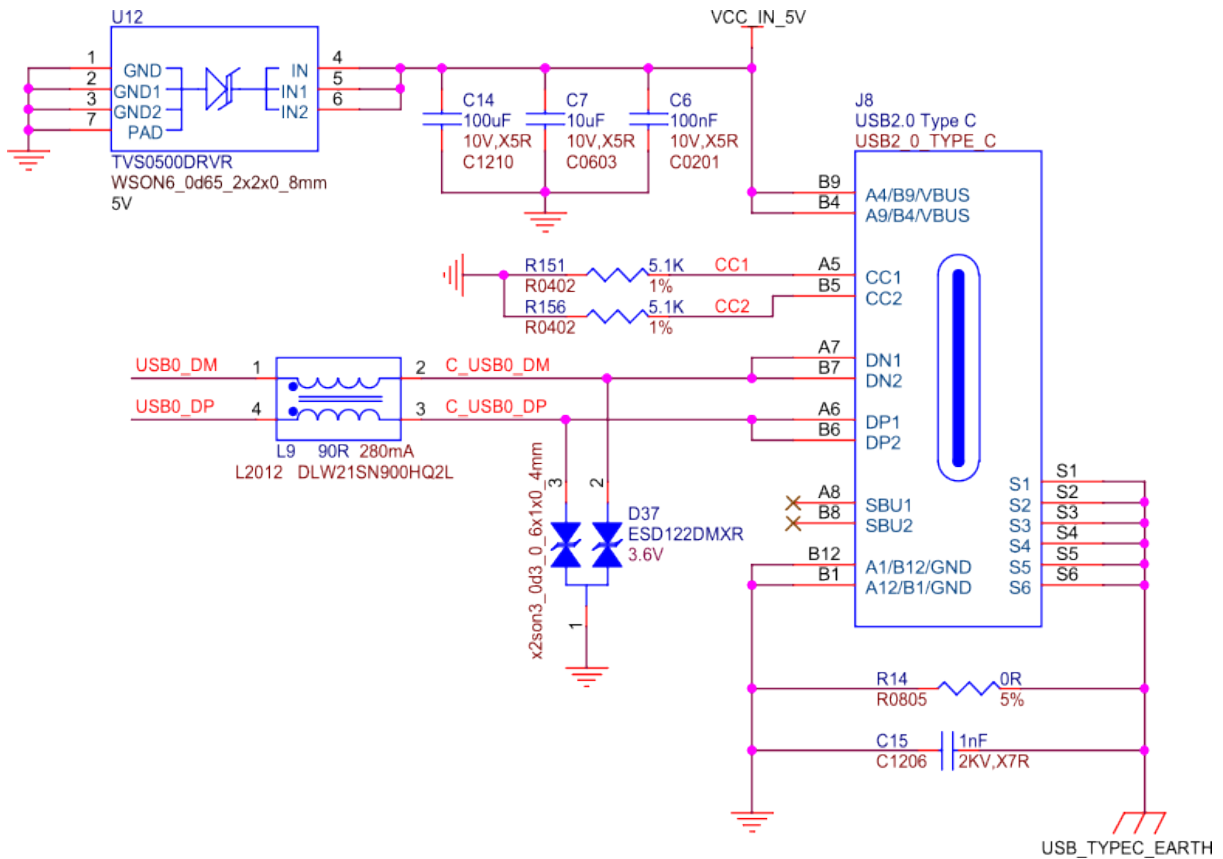
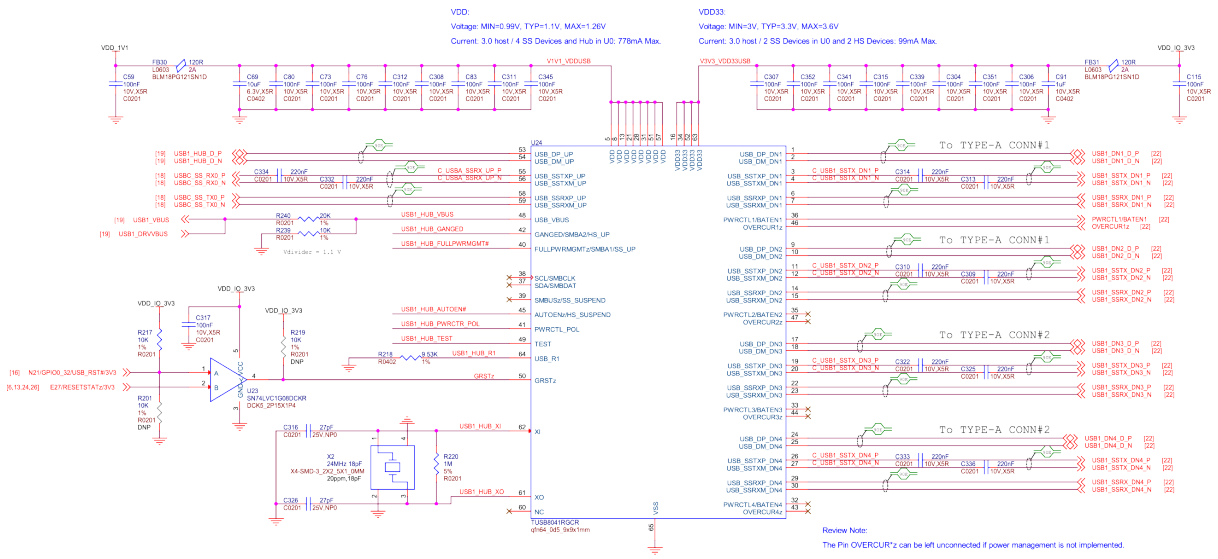


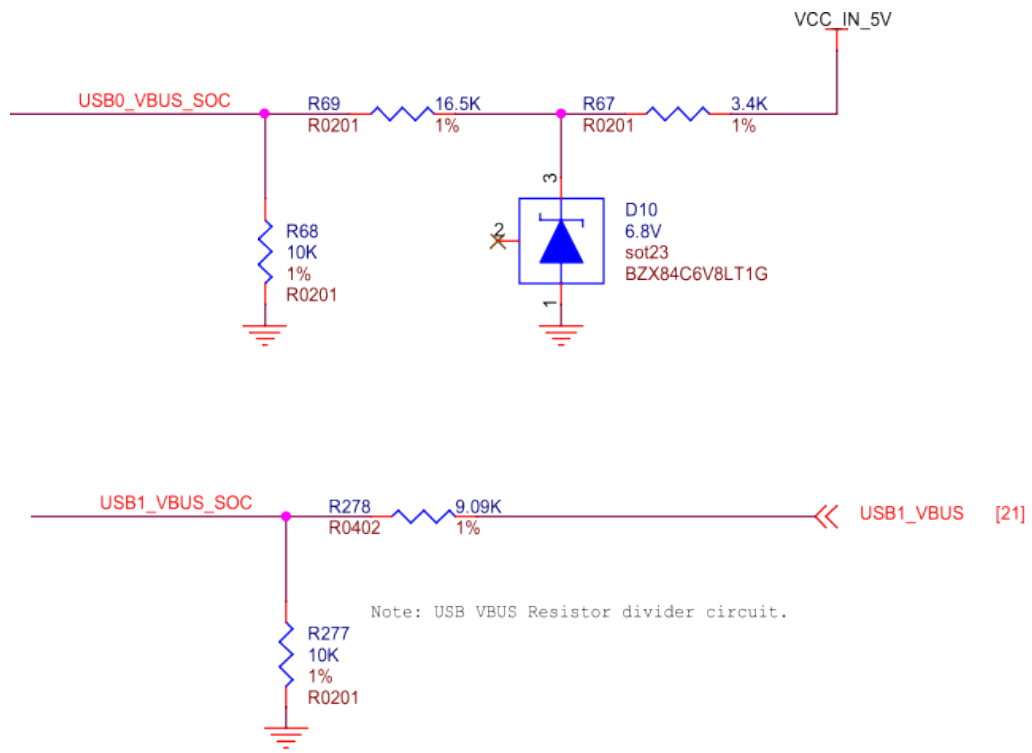
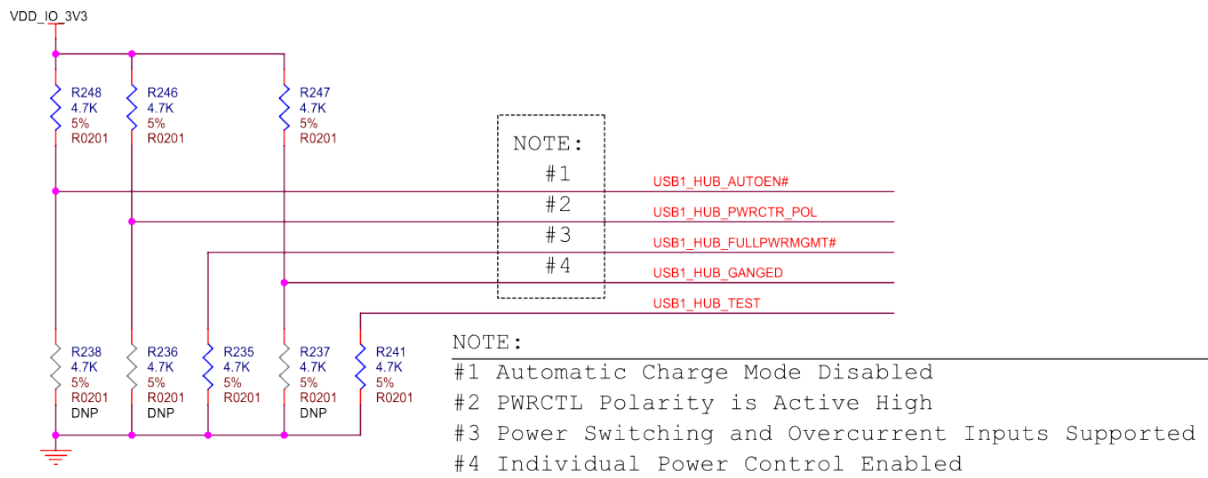


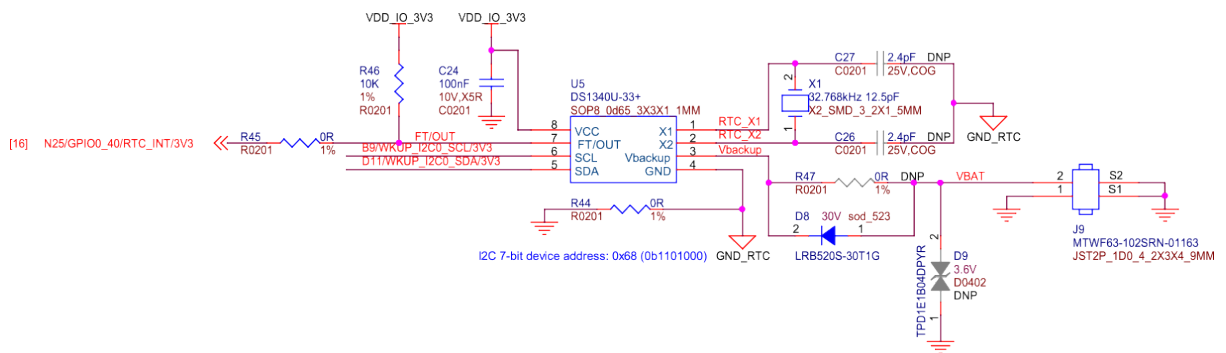
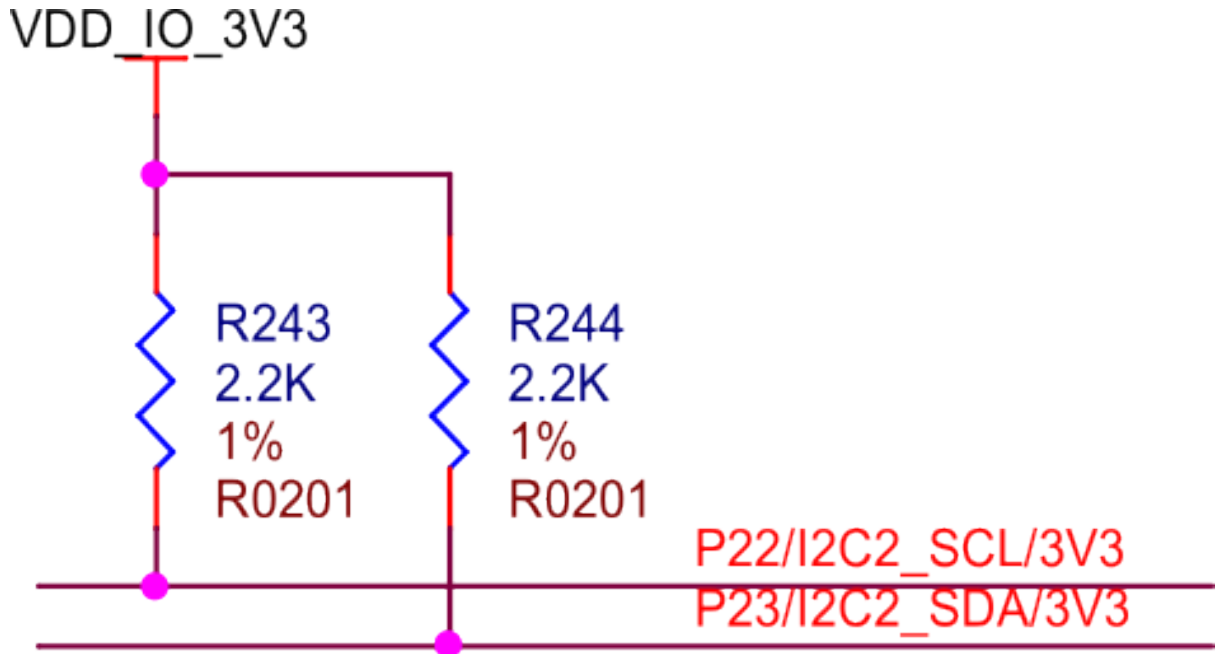


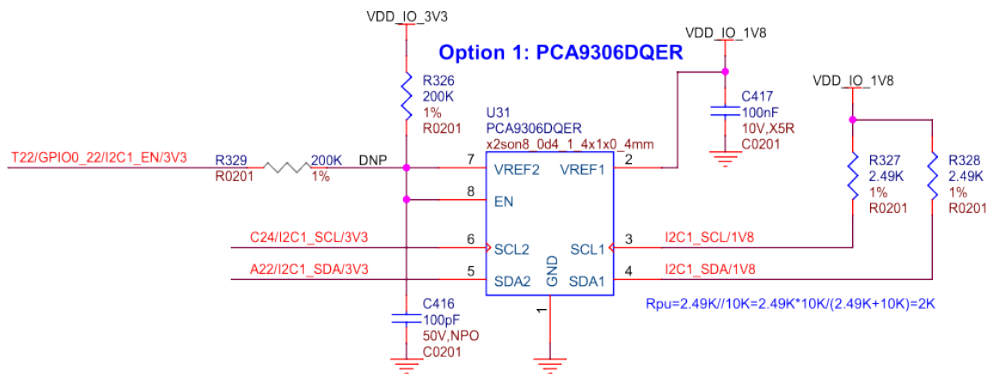








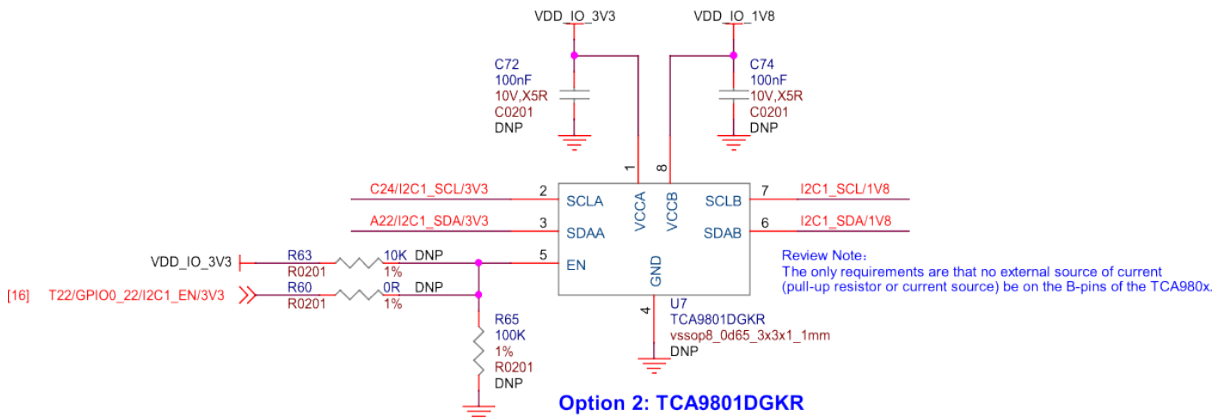


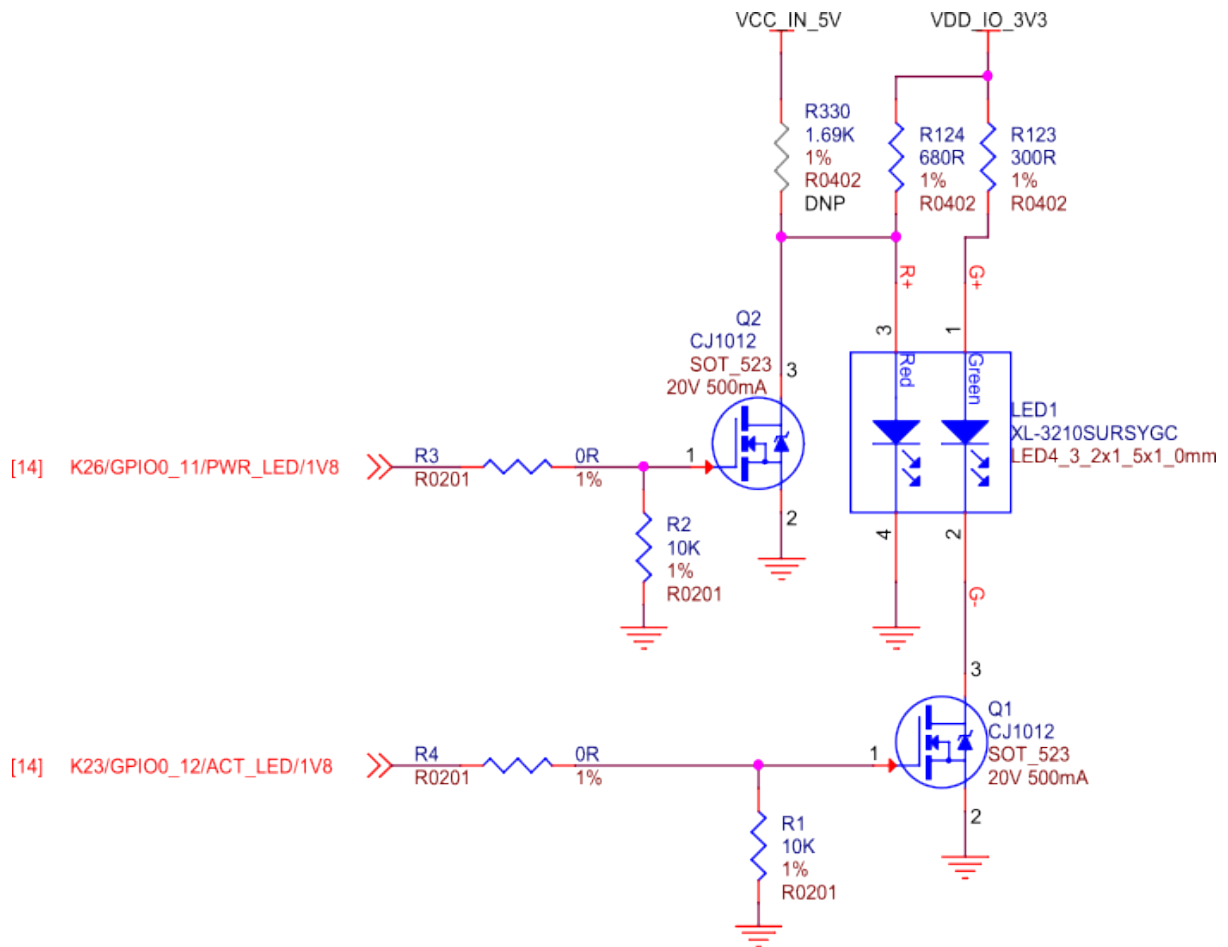


IIC voltage-level translator:

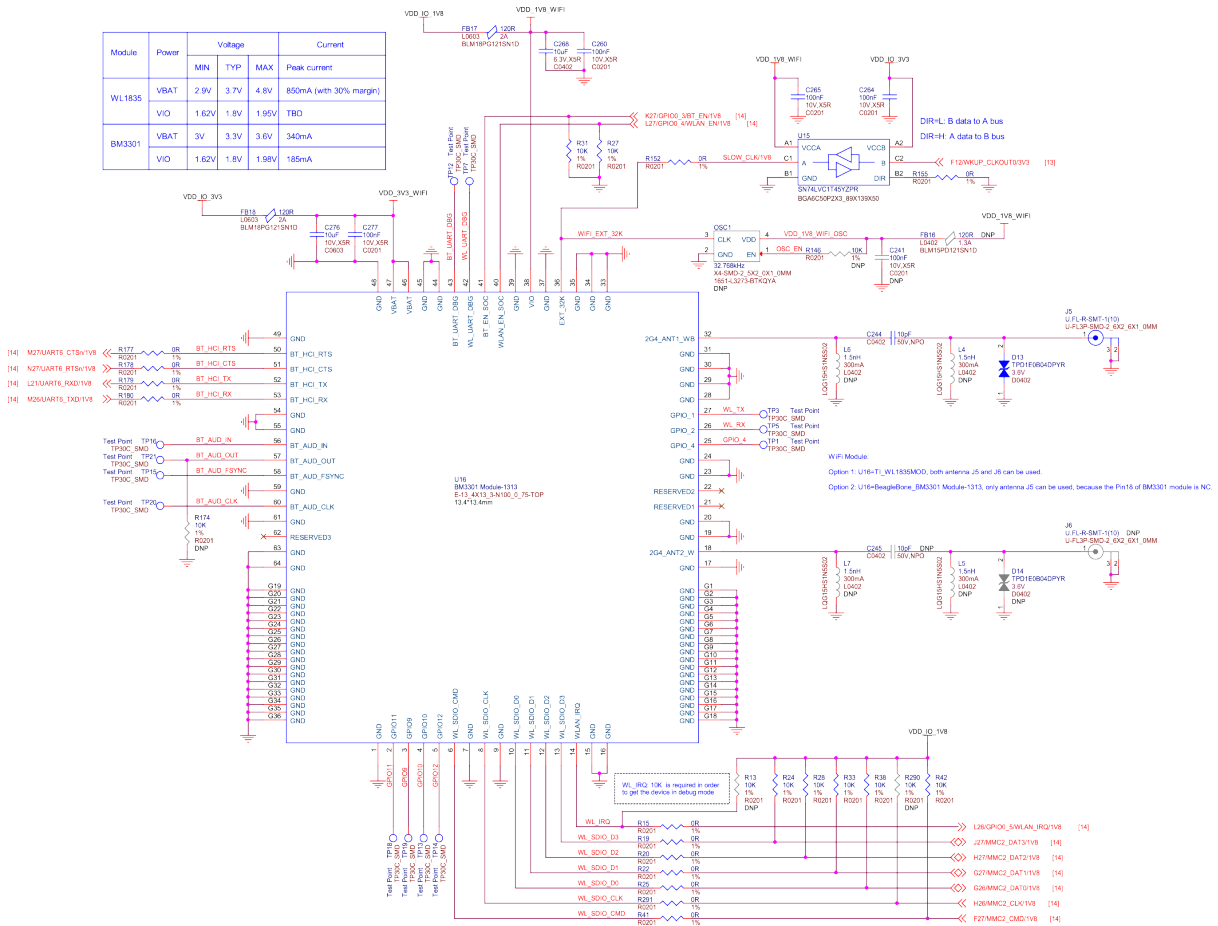
Option 1: TI\_PCA9306DQER, if there are pull-up resistors on the OLDI LCD, must install U31.  
As there are 10K pull-up on the OLDI LCD, so install U31 default.

Option 2: TI\_TCA9801DGKR, if there are no pull-up resistors or current source on the OLDI LCD, can install U7.





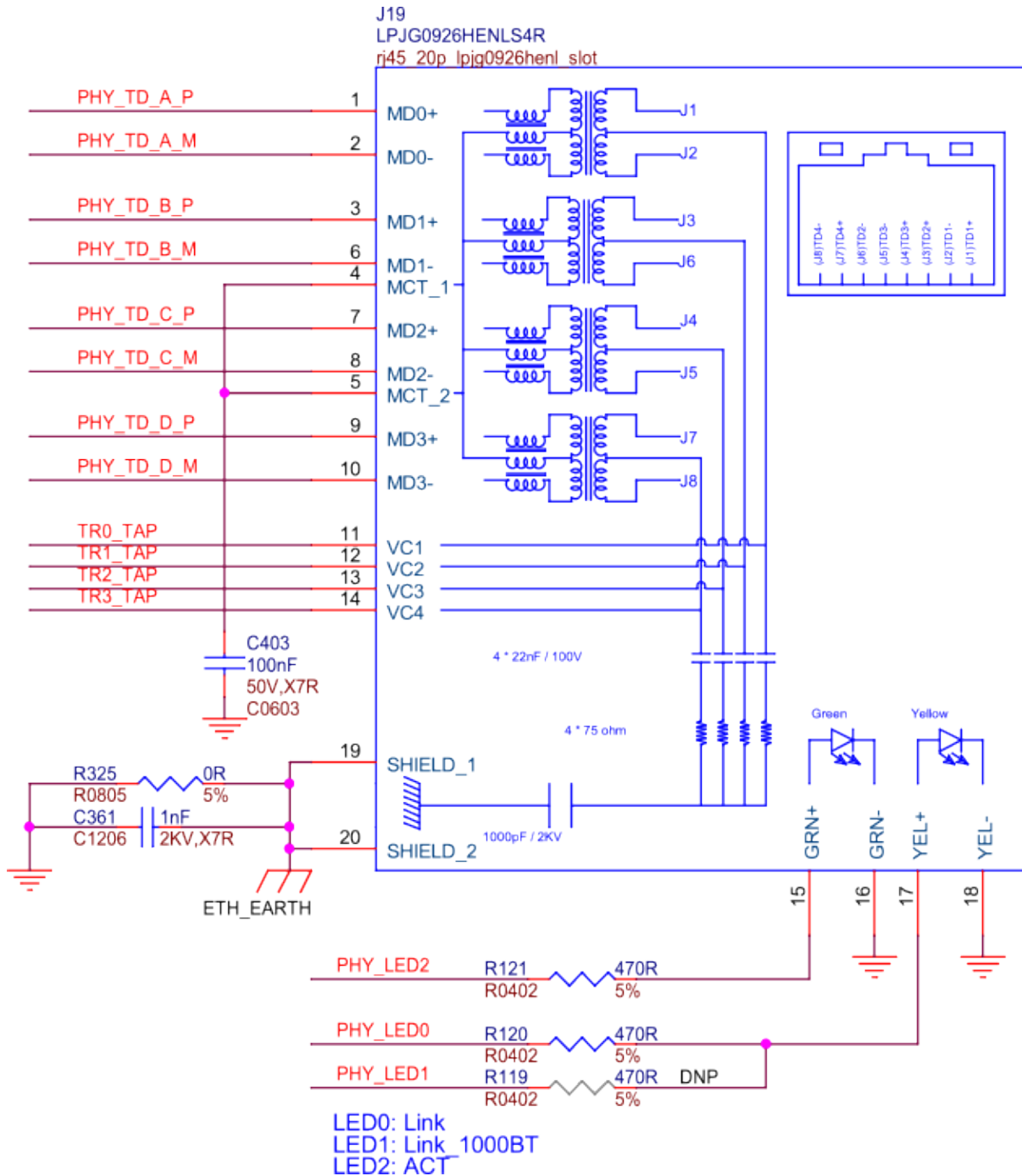


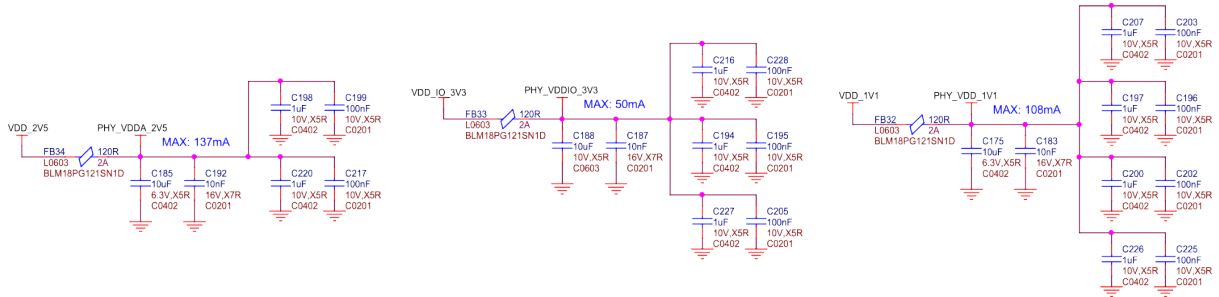
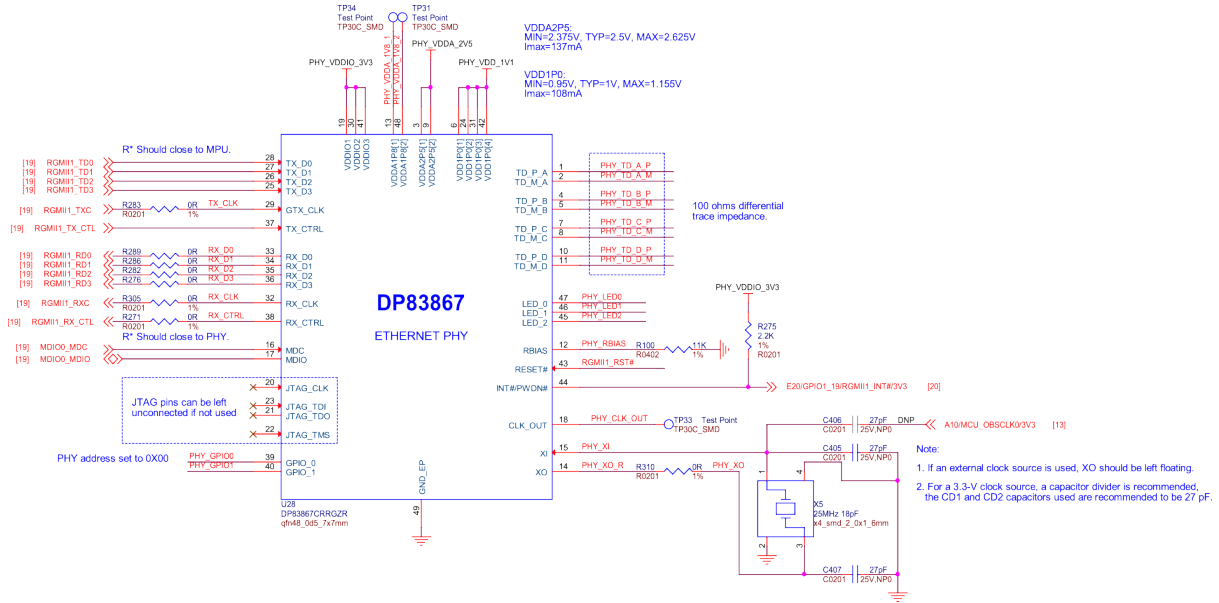


### 3.13.1 Dimensions & Weight

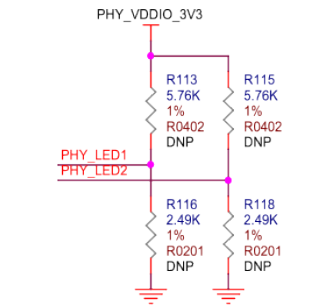
Table 3.1: Dimensions & weight

Parameter	Value
Size	85 x 56 x 20 mm
Max height	20mm
PCB Size	85 x 56 mm
PCB Layers	14 layers
PCB Thickness	1.6mm
RoHS compliant	Yes
Gross Weight	110 g
Net Weight	50 g

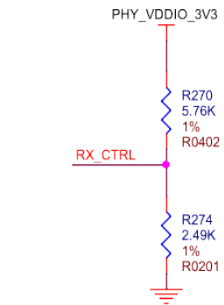




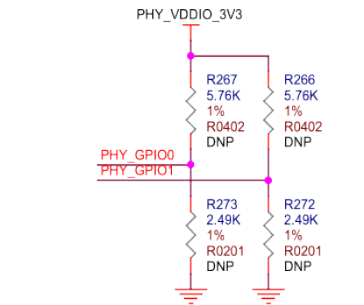
LED\_0: MODE 1  
Mirror Enable=[0]  
For Enabling Mount R114, R117



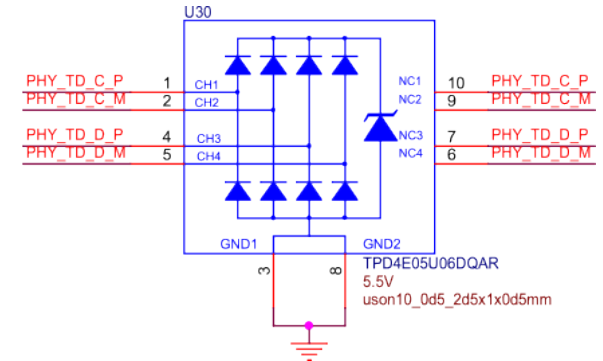
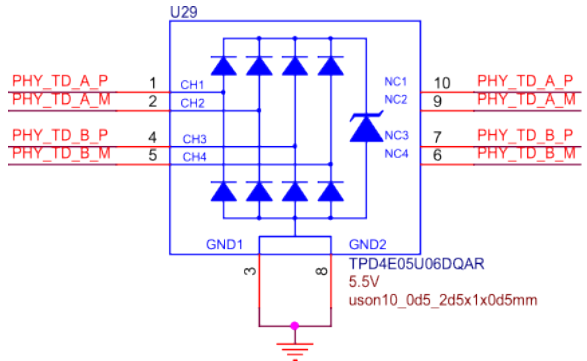
LED1 & LED2: MODE1  
RGMII Clock Skew TX[0:2]=[000]  
ANEG\_SEL(Auto-negotiation)=[0]  
PHY\_LED[0:2] CANT CONFIGURE IN MODE4

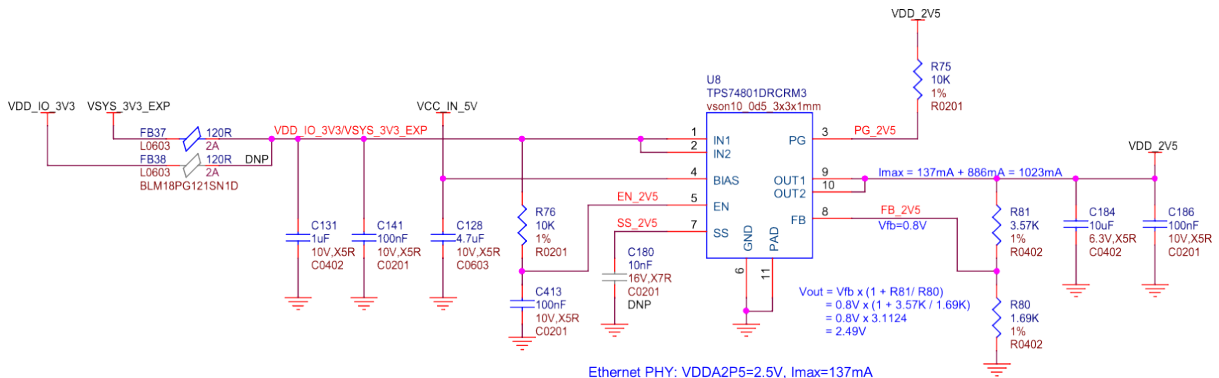


Autoneg enable. For Disabling  
R270=2.49K, R274=NI

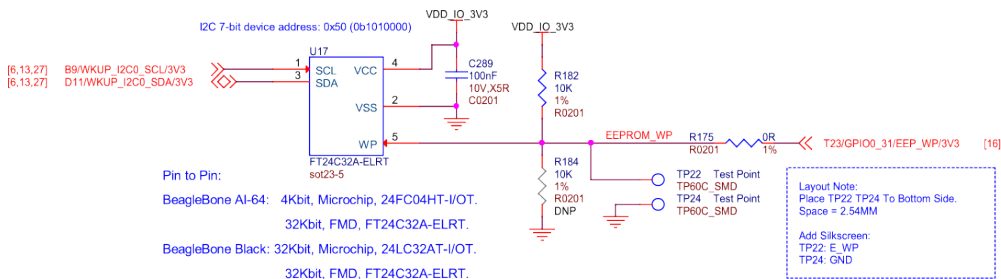
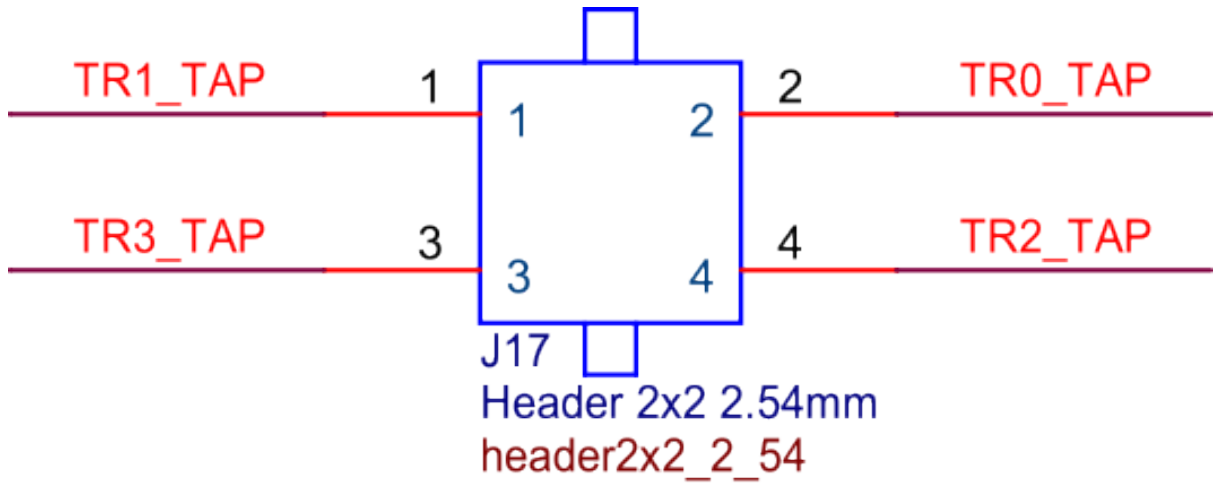


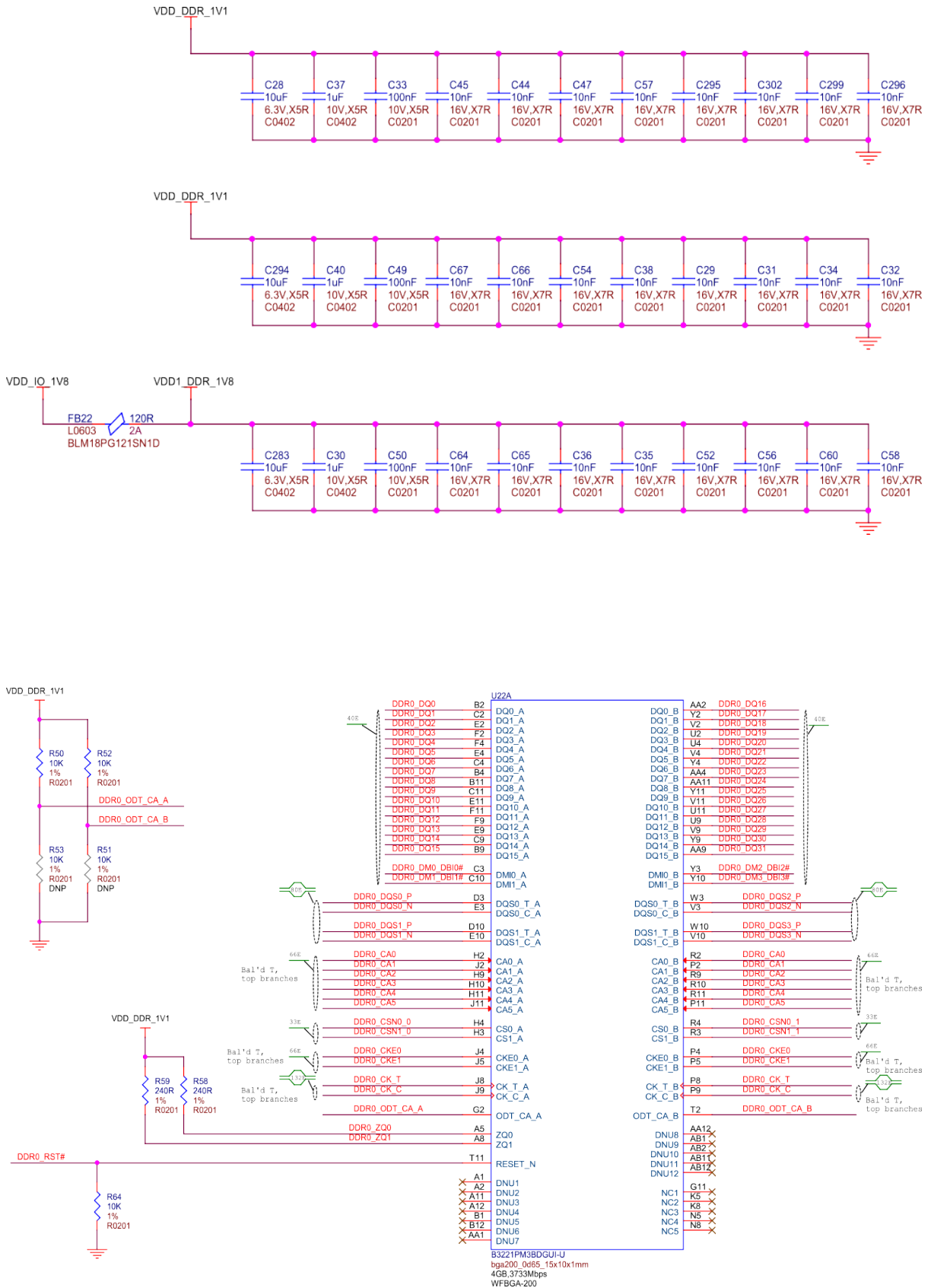
RGMII Clock Skew RX[0:2]=[000]

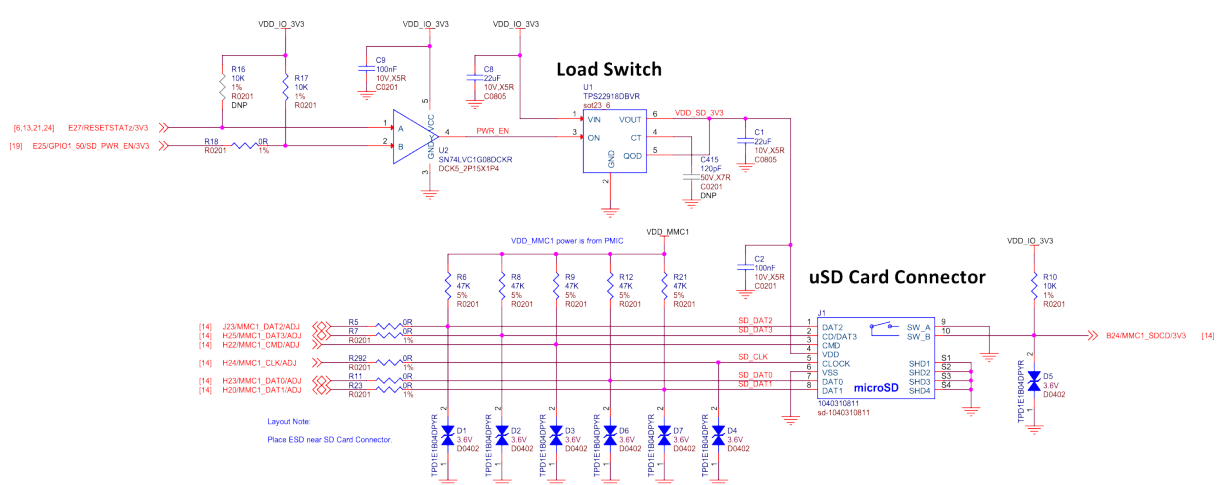
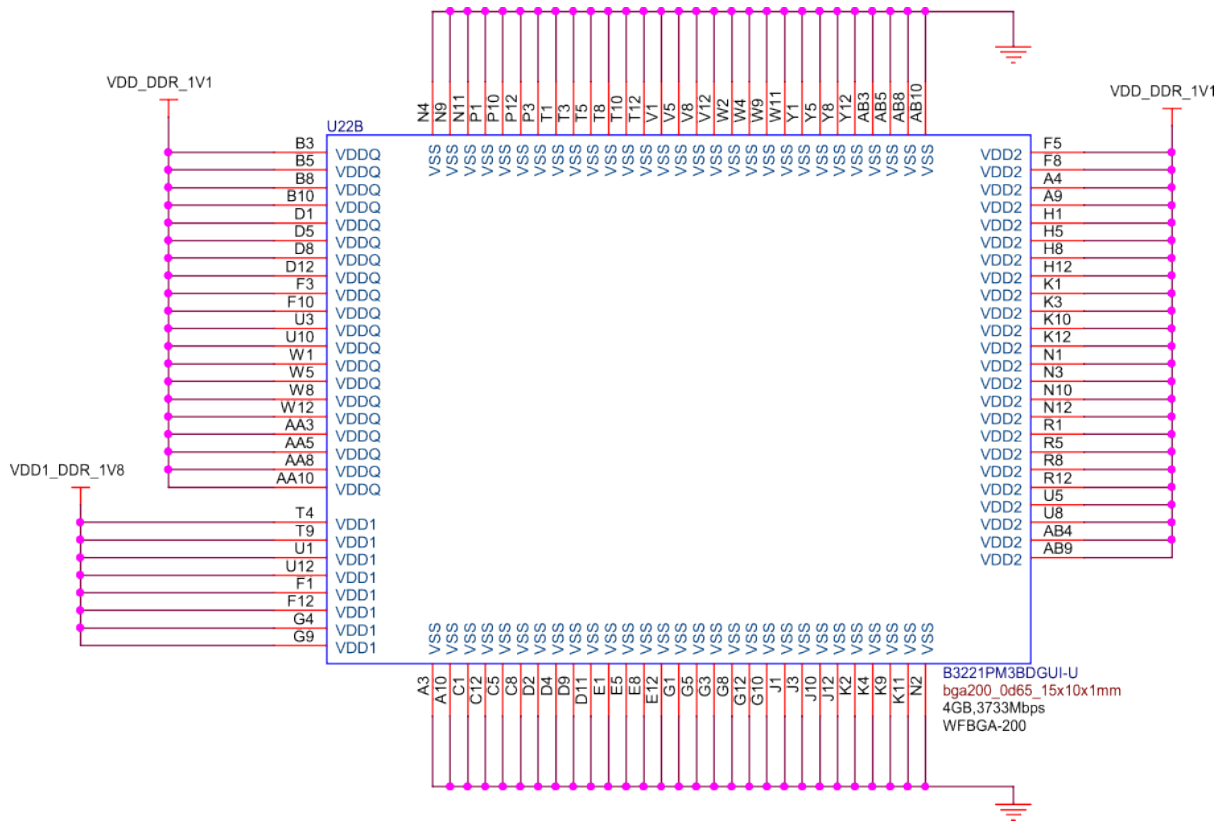


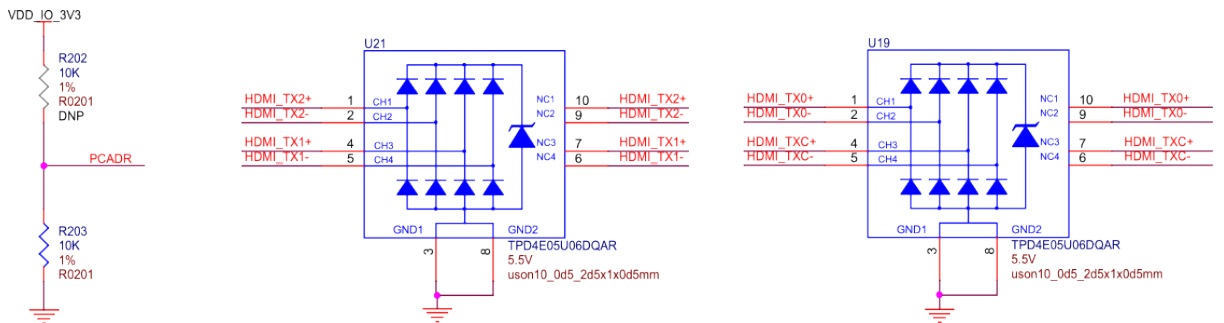
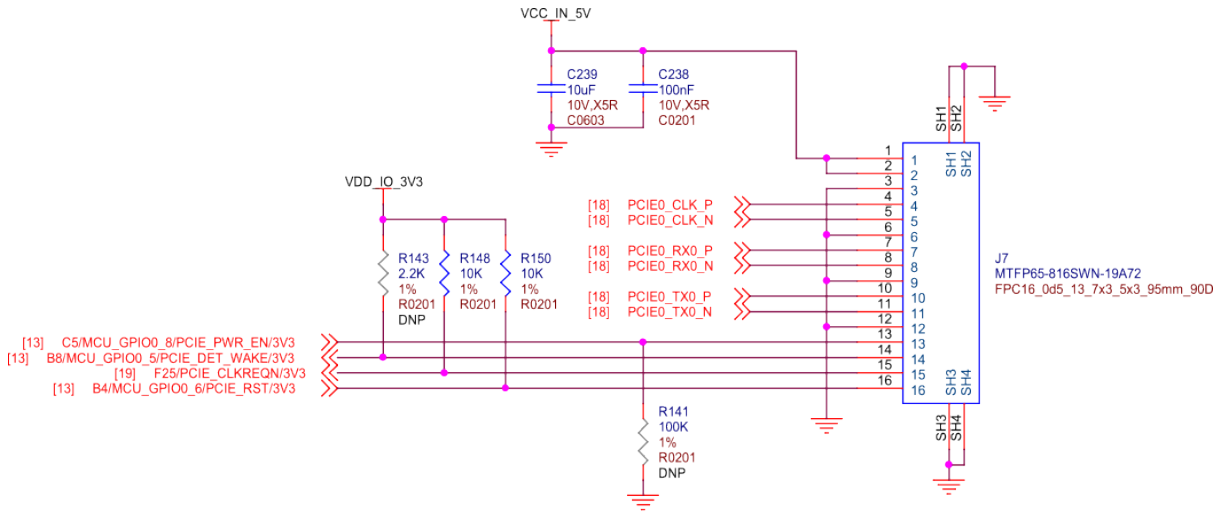


Ethernet PHY: VDDA2P5=2.5V, I<sub>max</sub>=137mA  
 LDO U18 Power In=2.5V, I<sub>max</sub>=886mA  
 Total: I<sub>max</sub>= 137mA + 886mA = 1023mA  
 Power Consumption: (3.3V-2.5V) \* 1.023A = 0.8184W  
 Thermal Junction-to-ambient: 0.8184W \* 44.2°C/W=36.17°C

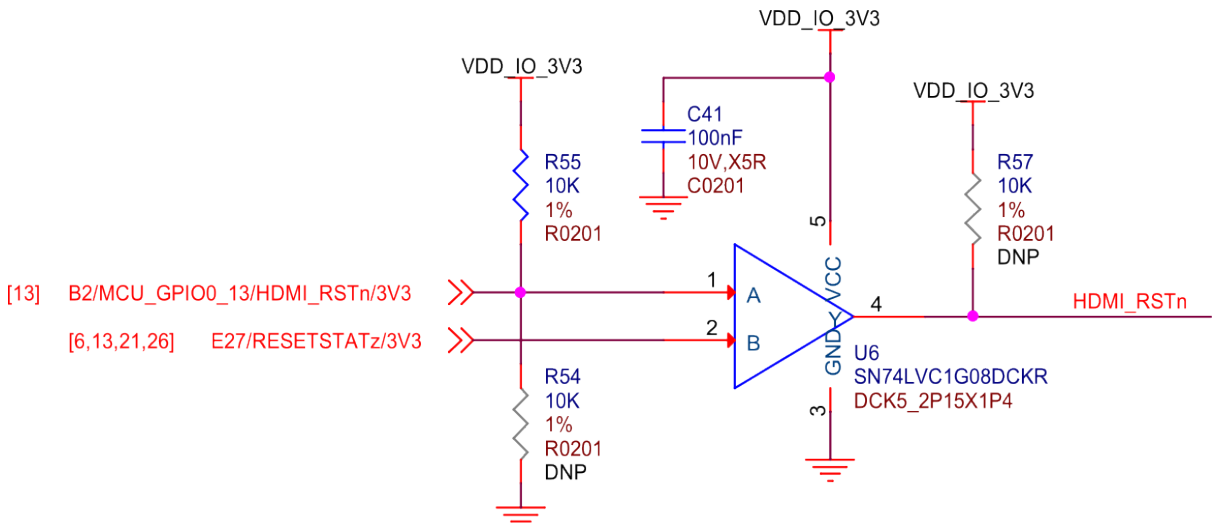
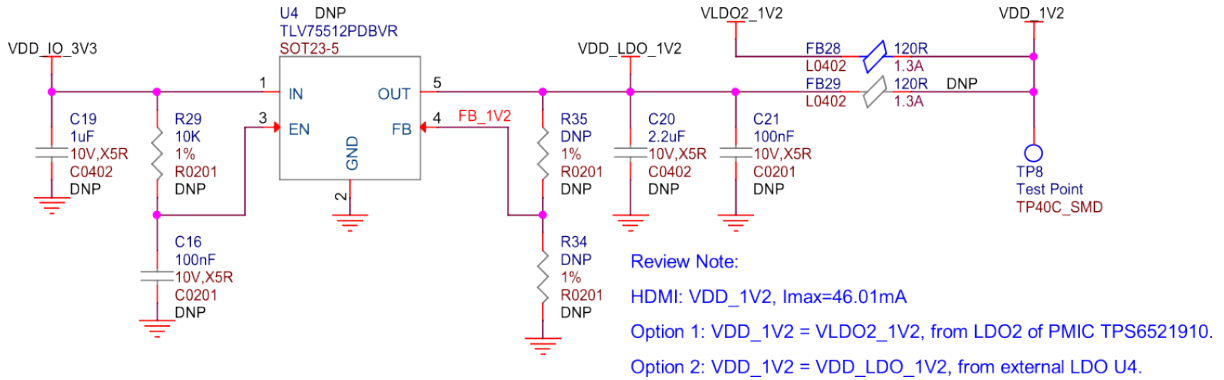


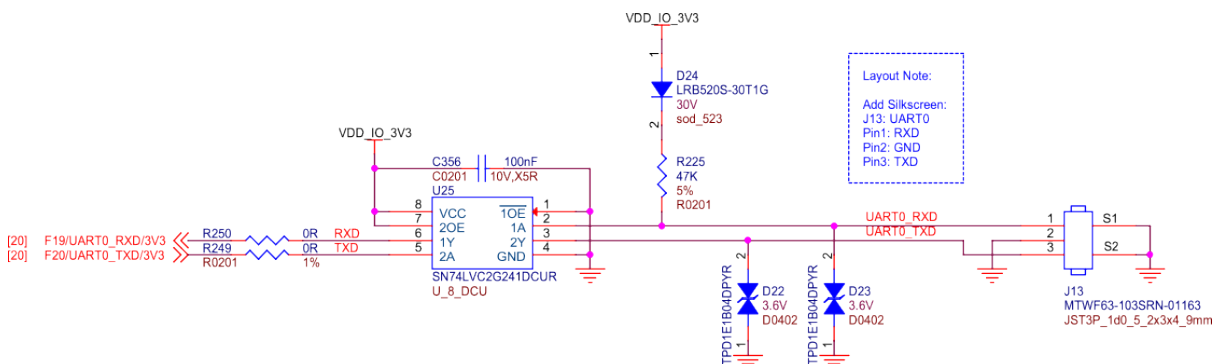
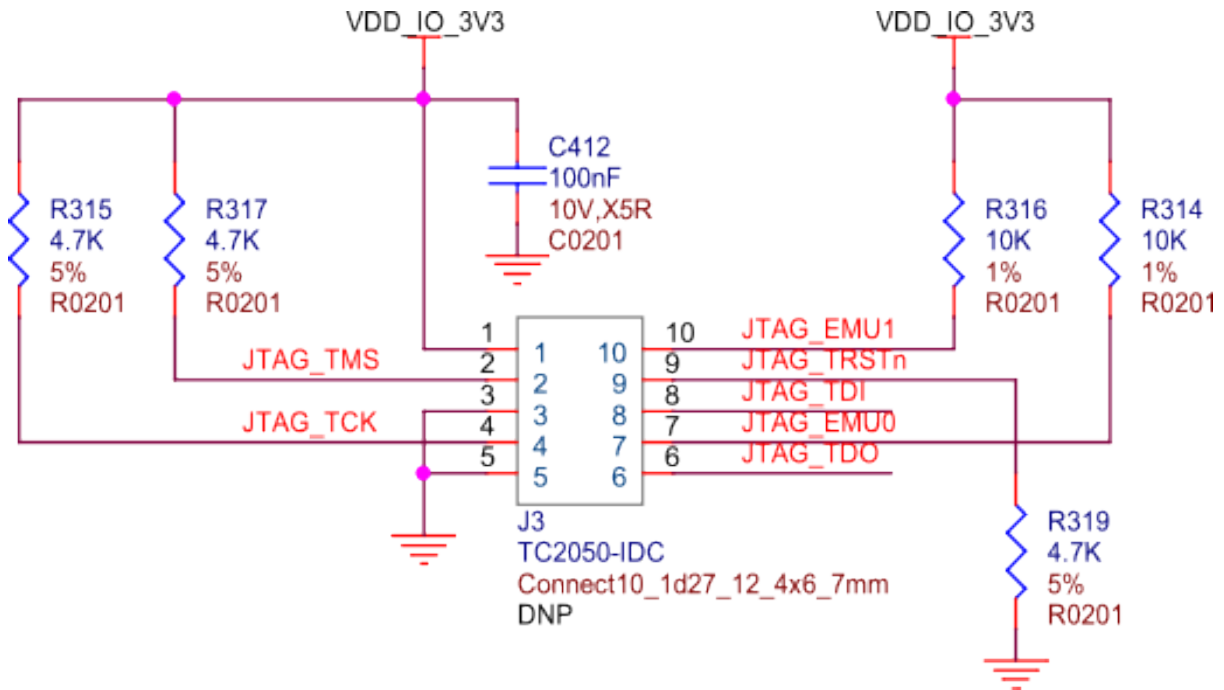
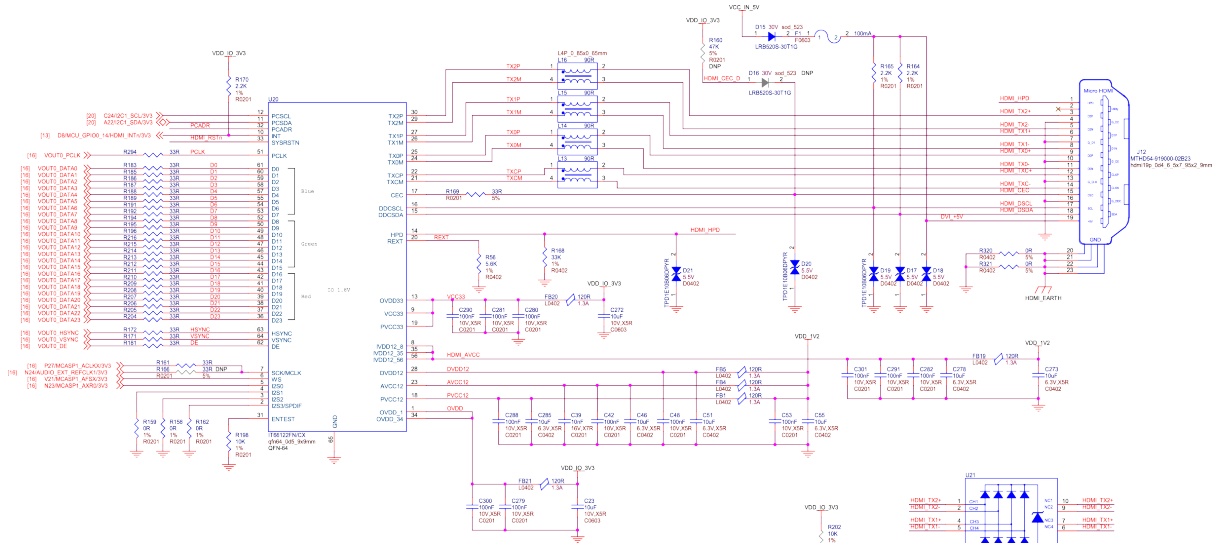






I2C 7-bit device address: 0x98









## **Chapter 4**

# **Expansion**



## **Chapter 5**

### **Demos and tutorials**



# Chapter 6

## Support

All support for BeagleY-AI design is through BeagleBoard.org community at [BeagleBoard.org](https://beagleboard.org/forum) forum.

### 6.1 Production board boot media

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**Todo:** Add production boot media link in `_static/epilog/production.image` and reference it here.

---

### 6.2 Certifications and export control

#### 6.2.1 Export designations

- HS: 8471504090
- US HS: 8543708800
- UPC: 640265311062
- EU HS: 8471707000
- COO: CHINA

#### 6.2.2 Size and weight

- Bare board dimensions: 85 x 56 x 20 mm
- Bare board weight: 50 g
- Full package dimensions: 140 x 100 x 40 mm
- Full package weight: 110g

### 6.3 Additional documentation

#### 6.3.1 Hardware docs

For any hardware document like schematic diagram PDF, EDA files, issue tracker, and more you can checkout the [BeagleY-AI design repository](#).

### 6.3.2 Software docs

For BeagleY-AI specific software projects you can checkout all the [BeagleY-AI project repositories group](#).

### 6.3.3 Support forum

For any additional support you can submit your queries on our forum, <https://forum.beagleboard.org/tag/beagle-y-ai>

### 6.3.4 Pictures

## 6.4 Change History

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**Note:** This section describes the change history of this document and board. Document changes are not always a result of a board change. A board change will always result in a document change.

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### 6.4.1 Board Changes

For all changes, see <https://openbeagle.org/beagle-y-ai/beagle-y-ai>. Versions released into production are noted below.

Table 6.1: BeagleY-AI board change history

Rev	Changes	Date	By