OM-O2S / OM-O2SP

Onion Omega2S IoT compute modules

Hardware Design Guide

Version 1.0

Table of Contents

1. Using this Design Guide

Refer to this design guide when developing custom hardware that features the Omega2S modules.

1.1 Additional Resources

Use this guide in conjunction with the following documents:

1.1.1 Omega2S Datasheet

Refer to the Omega2S datasheet for in-depth details about the specifications, functionality, features, details on the pins, and much more. It is available online.

1.1.2 Omega2S Reference Design Schematics

The Omega2S reference design showcases the circuits required to make use of all of the functionality available on the Omega2S. It is a useful companion to this Hardware Design Guide and can be found online.

1.1.3 Omega2S Footprint CAD Files

CAD files for the Omega2S PCB Footprint can be used to speed up the creation of PCB layouts for custom hardware featuring the Omega2S modules. The CAD files are available online.

1.1.3 Omega2 Online Documentation

Extensive documentation for the Omega2 family is hosted online. This documentation also applies to the Omega2S.

It can be found here: http://docs.onion.io/

2. Schematic Design Guide

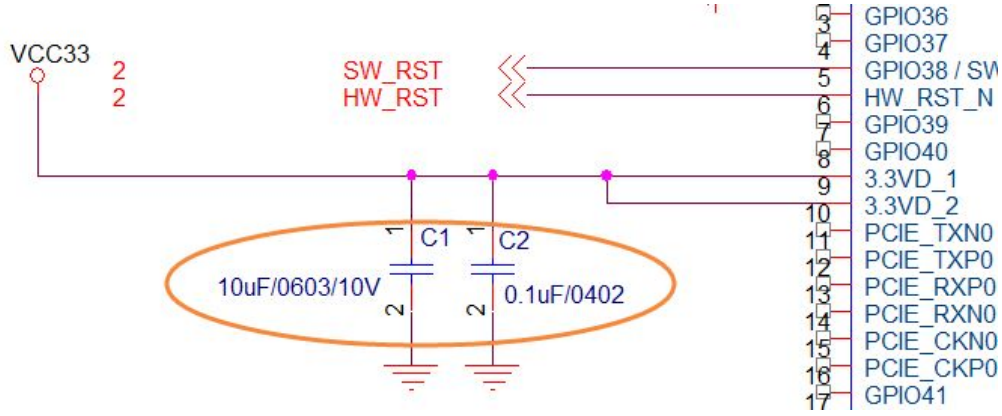
2.1 Power Supply Pins

The Omega2S has three (3) pins that must be supplied with 3.3V for the device to function:

Pin No	Name	I/O	Description
8	3.3VD_1	I	3.3V Power Supply
9	3.3VD_2	I	3.3V Power Supply
32	VDD_FLASH	I	3.3V FLASH Power Supply

2.1.1 Capacitors

For pins 8 and 9, we need to add 10uf and 0.1uf decoupling capacitors. The capacitors should be as close as possible to the pins:

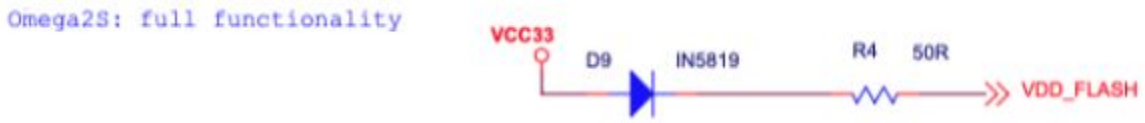


2.1.2 Considerations for the Flash Power Supply

The VDD_FLASH pin is the 3.3V power supply for the built-in flash storage of the Omega2S. This pin **must** be supplied with 3.3V in order for the Omega to boot and function properly.

2.1.2.1 Omega2S

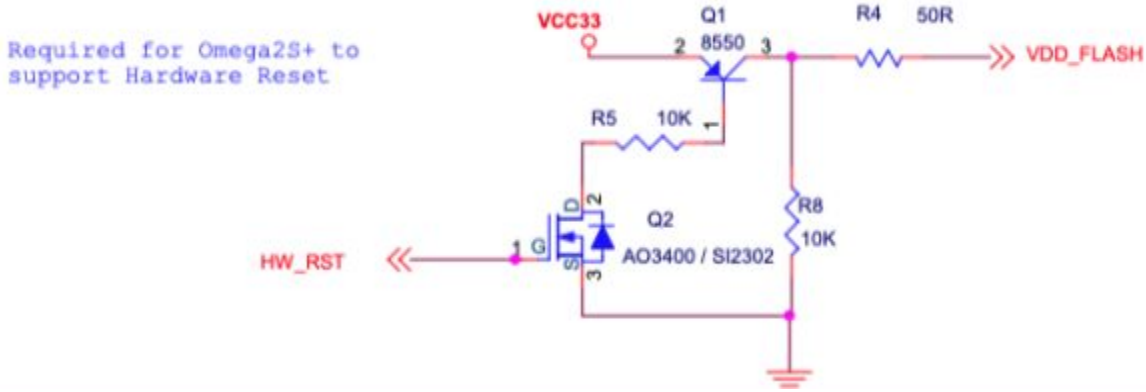
When using the **Omega2S**, the VDD_Flash pin should be pulled up to 3.3V.



2.1.2.2 Support for Hardware Reset with Omega2S+

When using the **Omega2S+**, there are some considerations that must be taken into account when it comes to the VDD_Flash pin.

In order for the HW_RST_N signal to properly power-cycle the CPU, the VDD_Flash pin must also be pulled down to Ground when the HW_RST_N is triggered. This is due to a limitation in the 32MB Flash Chip used in the Omega2S+. Reference circuit below:



2.1.2.3 No Support for Hardware Reset with Omega2S+

If there is no need to support hard-reset in your Omega2S+ design, VDD_Flash should be simply pulled up to 3.3V.

2.2 Special Pins

2.2.1 Pins affecting system boot

There are six (6) pins that affect the boot sequence of the device. The pins fall into two categories:

1. Pins that must be left **floating** at boot time. They cannot be pulled up or pulled down, or else the Omega cannot boot
2. Pins that must be **floating or pulled down** at boot time. They cannot be pulled up, or else the Omega cannot boot

Once the Omega has booted, these pins can be used normally.

No	Name	I/O	Description	Boot Time
2	GPIO_36 / PERST_N	I/O	General Purpose I/O / PCIe Device Reset - Active Low	Must be **floating**
20	GPIO_45 / UART_TXD1	I/O	General Purpose I/O / UART1 Lite TXD	Must be **floating**
27	GPIO_1 / I2S_SDO	I/O	General Purpose I/O / I2S Data Output	Must be **floating** or **pulled-down**
33	SPI_CS1	O	SPI Chip Select 1	Must be **floating**
34	SPI_CLK	O	SPI Clock	Must be **floating**
39	GPIO_12 / UART_TXD0	I/O	General Purpose I/O / Serial UART0 Lite TXD	Must be **floating** or **pulled-down**

2.2.2 SPI Pins

The SPI communication pins connected to the internal flash - CLK, MOSI, MISO, CS0 - pins 34, 35, 36, and 37 **cannot be used as regular GPIOs**. Connecting non-SPI circuitry to these pins may prevent your Omega from booting or cause other damage to your unit.

No	Name	I/O	Description
33	SPI_CS1	O	SPI Chip Select 1
34	SPI_CLK	O	SPI Clock Cannot be used as a regular GPIO
35	SPI_MISO	I	SPI Master Input/Slave Output Cannot be used as a regular GPIO
36	SPI_MOSI	O	SPI Master Output/Slave Input Cannot be used as a regular GPIO
37	SPI_CS0	O	SPI Chip Select 0 Cannot be used as a regular GPIO

2.2.3 Reset Pins

There are two reset pins:

No	Name	I/O	Description
4	GPIO_38 / SW_RST	I/O	General Purpose I/O / Default User Button - Programmed to trigger a reboot in Onion Firmware - Active High
5	HW_RST_N		Hardware Power On Reset - Active Low Performs hard reset (power-cycle) of the CPU

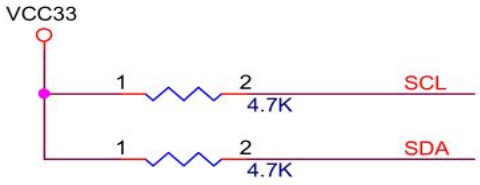
The **SW_RST** pin acts as the soft-reset on the Omega2S. It is **active-high**.

The **HW_RST_N** pin acts as the hard-reset on the Omega2S. This input is **active-low**.

On the Omega2S+, note that a specific circuit is required to enable the hard-reset. See the Support for Hardware Reset with Omega2S+ section above.

2.3 I2C Pull-Up Resistors

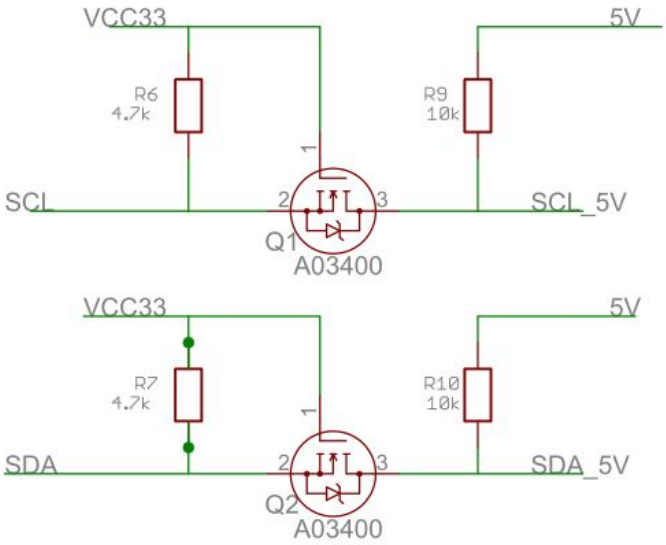
If the end-device requires use of the I2C bus, pull-up resistors should be added to the I2C lines. The resistor value can be 4.7K.



2.3.1 5V Compatible I2C

If the end-device needs to use Omega2S's I2C to communicate with 5V I2C devices, a logic level shifting circuit should be added to the I2C lines.

Reference circuit below:



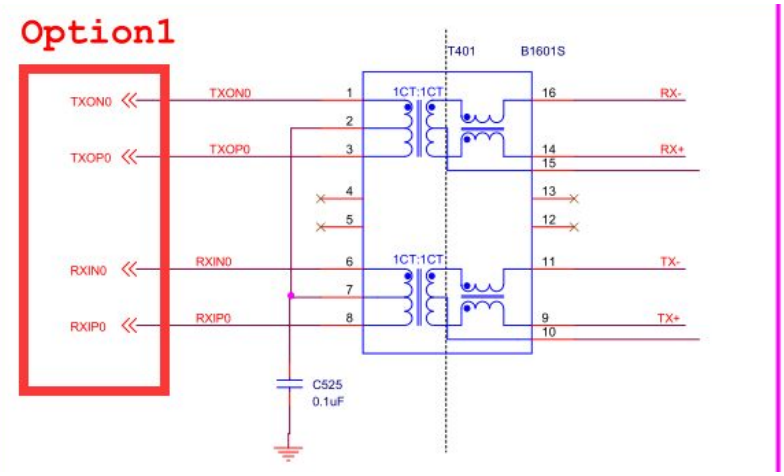
2.4 Ethernet Port

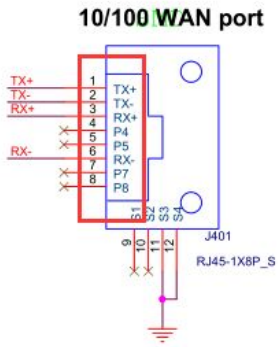
There are two Ethernet circuit options:

1. Using a Network transformer - *the recommended option, good for all transmissions*
2. Capacitive coupling - *cost-effective solution for short distance Ethernet usage (5m or less)*

Regardless of which option is selected, please make sure the final connection follows the below:

Omega2S Pin	RJ45 Port
Pin 41: RXI_P0	PIN 1 TX+
Pin 42: RXI_N0	PIN 2 TX-
Pin 43: TXO_P0	PIN 3 RX+
Pin 44: TXO_N0	PIN 6 RX-





2.5 Two Antenna Design

Having a single PCB layout to serve two antenna use cases is definitely possible.

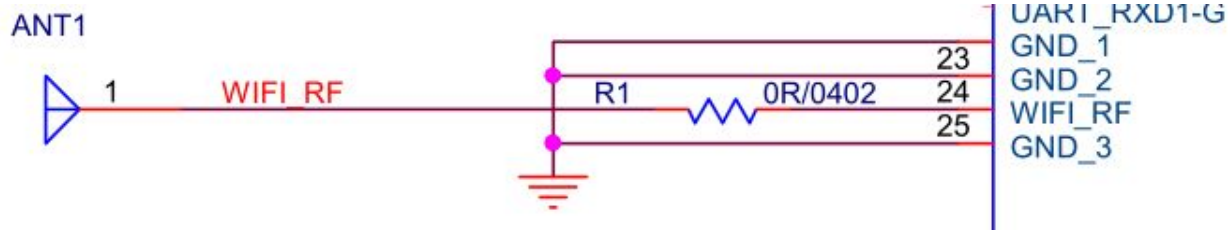
Use Case 1) Use onboard U.FL connector to connect external antenna.

Use Case 2) Connect a chip antenna (or other conenctor) to Pin 24 (WIFI_RF).

To serve both use cases with a single design, a 0 ohm resistor connected to Pin 24 (WIFI_RF) will do the trick:

Use Case 1) Use Omega2S onboard u.FL connector, leave 0R resistor unpopulated.

Use Case 2) Populate 0R, connect chip antenna or other connector to pin 24 (WIFI_RF).



Note 1: only one of pin 24 or the u.FL connector should be active in a design. If both pin 24 and the u.FL connector are connected to antennae, the transmission power will be split between the two.

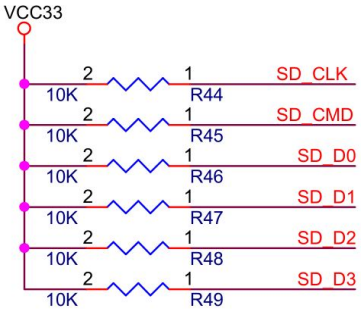
Note 2: With this design, the U.FL connector can be detuned by the pin 24 to 0R trace. The longer the trace connected to pin 24, the more it will affect the u.fl tuning. We recommend putting the 0R as close as possible to pin 24. To guarantee no U.FL detuning in your design, fall back to a single-antenna use-case design.

2.6 Extended Storage

The Omega2S has one SDIO interface. It can support one an SD/Micro-SD card, SD NAND Flash, and eMMC to extend the available amount of storage.

The SDIO interface supports the SDXC specification for SD cards, with a maximum capacity of 2 TB and a maximum transfer speed of 300 MB/s, and the eMMC5.1 interface for eMMC storage.

Each SDIO pin should have a pull-up resistor, the resistor value can be 10K.

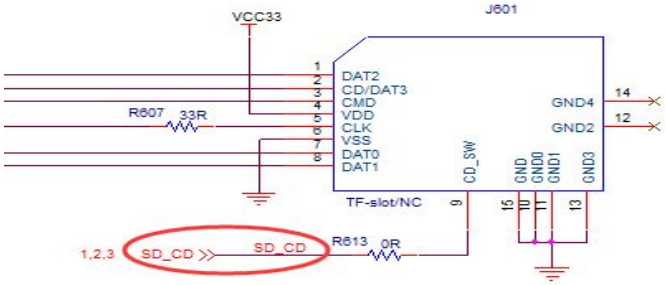


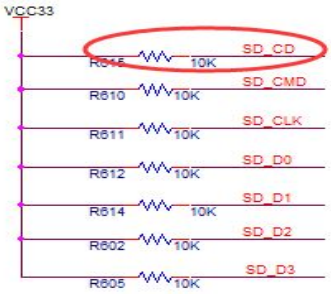
2.6.1 Micro SD Card Usage

There is an SD detect pin (pin 54: SD_CD) to check whether an SD Card is detected in the slot. The pin is active-low:

- 0 : SD Card detected
- 1: No Card detected

This pin should have a pull-up resistor, the resistor value can be 10K.





2.6.2 eMMC Usage

When selecting an eMMC chip, Omega2S has success with chips that have the following:

- **eMMC 5.1 Interface**
- **FBGA153 Packaging**
- **11.5mm x 13mm Dimensions**

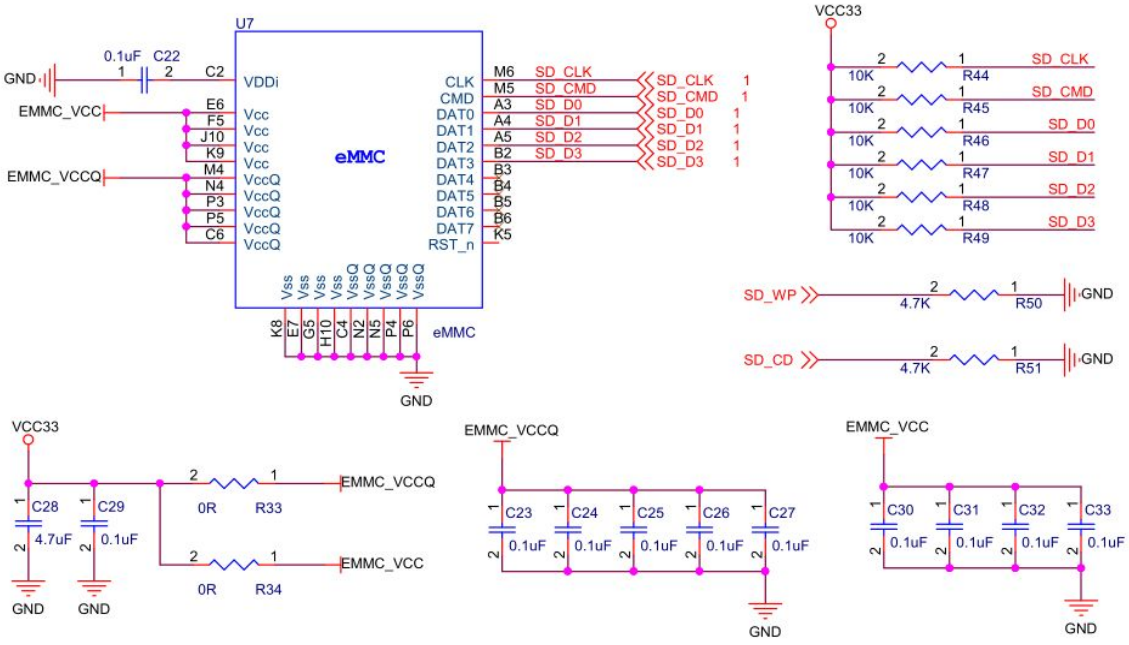
The Omega2S has successfully tested with the following chips:

Brand	Part No	Storage Size
Sandisk	SDINBDG4-8G	8 GB
Kingston	EMMC08G-T227-A01	8 GB
Samsung	KLM8G1WEPD-B031	8 GB
Toshiba	THGBMBG6D1KBAIL	8 GB

2.6.2.1 eMMC Circuit Design

- The SD detect pin (pin 54: SD_CD) should be connected to a pull-down resistor.
- It's not necessary to connect pins 49 - 52 (GPIO18-21) to the eMMC chip

Reference design:



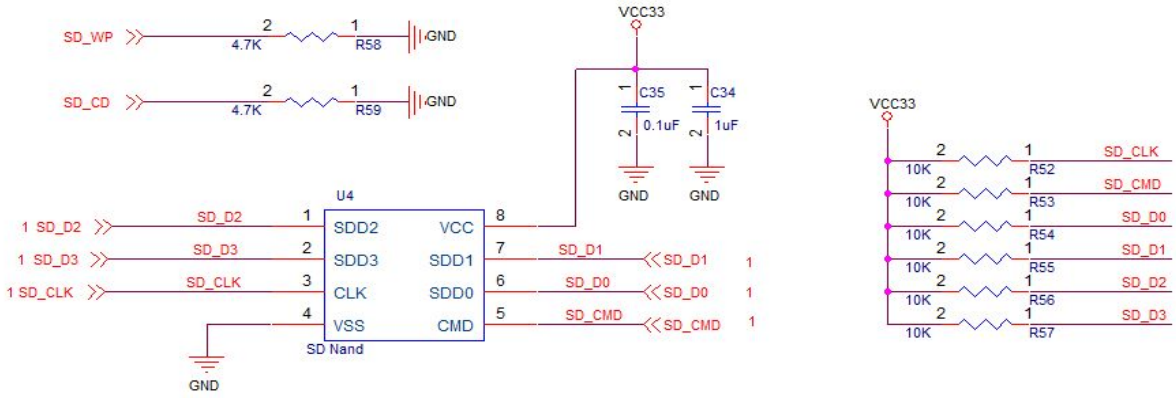
2.6.3 SD Nand Flash Usage

SD Nand Flash is embedded storage based on NAND Flash and SD controller. It is LGA-8 package (WSON), the size is 8mm x 6mm x0.75mm.

The Omega2S has successfully tested with the following chips:

Brand	Part No	Storage Size
Longsto	CSNP1GCR01-AMW	1Gbit (128MB)
Longsto	CSNP4GCR01-AMW	4Gbit(512MB)

Reference design:

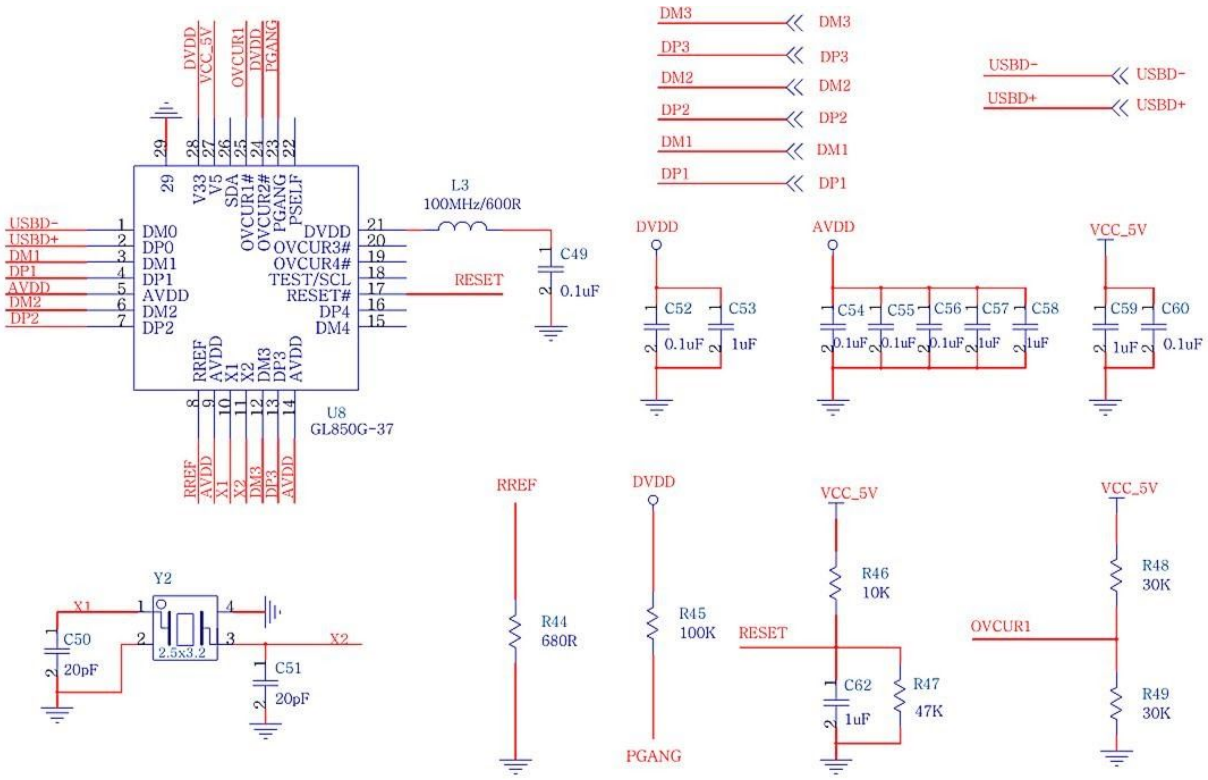


2.7 USB Hub

Omega2S has one USB interface, it can be connected to a USB hub to support additional USB ports.

The Omega2S has successfully tested with the **GL850G-OHY37** (QFN28 package) USB Hub IC.

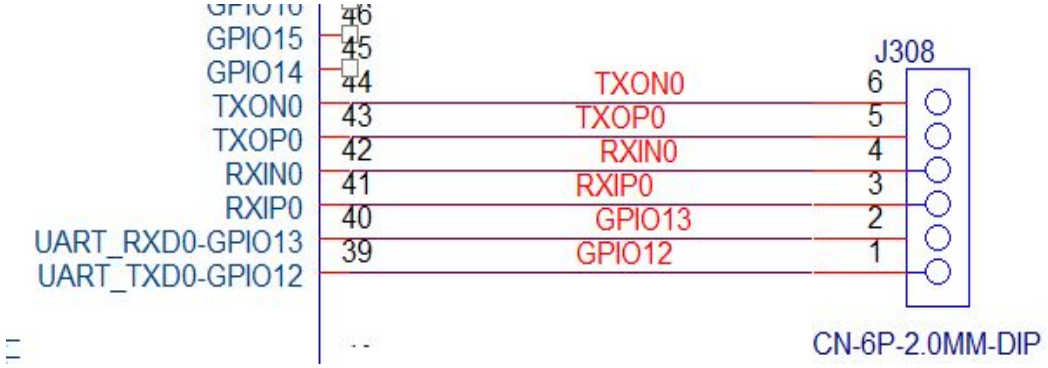
Reference design:



2.8 Test points

If the end-device doesn't use the SW_RST, UART0, or Ethernet port pins, it is recommended to reserve test points for these pins. The test points can be used for easy testing during manufacturing or upgrading the firmware or bootlaoder of the Omega2S module.

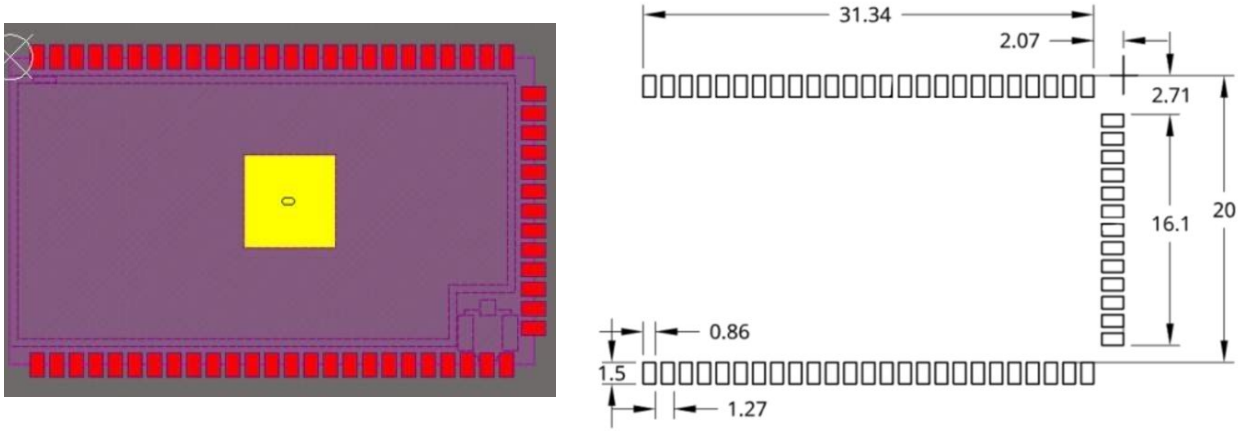
Note : if the product needs to pass FCC/CE certification, these pins must be available



3. PCB Layout Guide

3.1 Omega2S Footprint

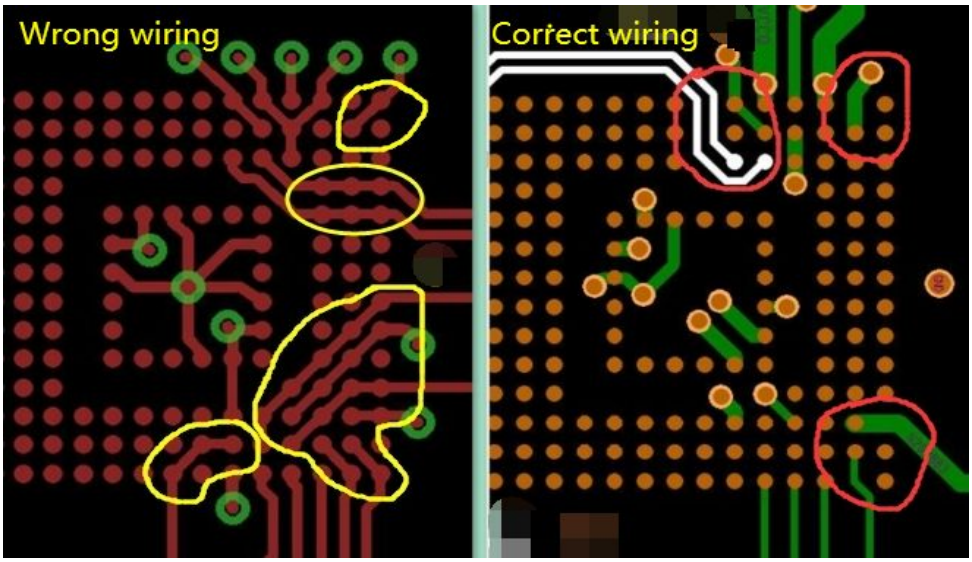
The middle ground pad on the bottom of the Omega2S should not be soldered.



Refer to the Omega2S PCB Footprint CAD files for exact measurements. The files are available online.

3.2 eMMC Layout

As the eMMC BGA package has 153 balls, routing the PCB lines can become tricky. When routing and wiring the PCBs lines, make sure not to connect the trace to unnecessary (or unused) eMMC pins - see yellow circles in the diagram below.
The trace should only be connected to the single intended BGA pin - see red circles in diagram below.



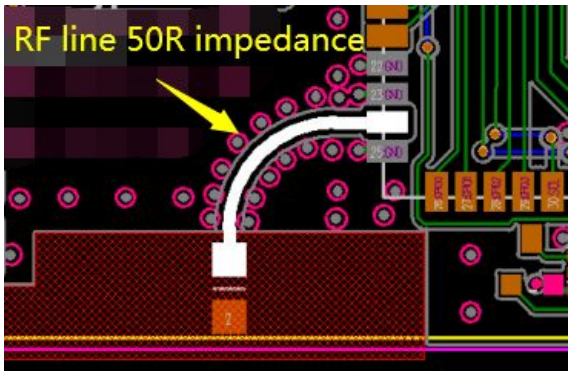
3.3 Impedance of PCB Lines

For better performance, it is recommended to set an impedance on the WIFI RF signal (pin 24) and USB Data lines (pins 61 and 62).

3.3.1 WiFi RF Impedance

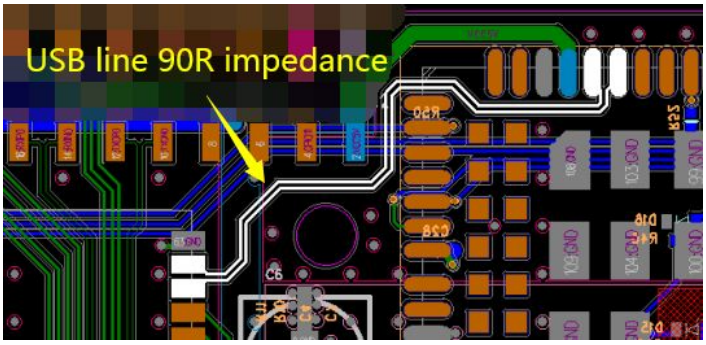
WiFi RF (pin 24) PCB line: it is recommended to set a 50R impedance.

Note: there should be GND vias around the RF PCB line



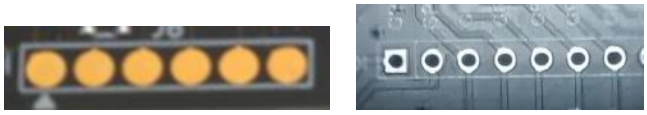
3.3.2 USB Data Lines

USB data lines (pins 61 and 62): these two lines carry a high-speed differential signal, it is recommended the lines are the same length and impedance matched to 90R.



3.4 Test Points

If the your custom PCB board has enough space, the test points can be exposed through a 2.0mm or 2.54mm pitch PCB via.



4. Suggestions & Feedback

We are always open to improving our documentation, so if there is something that is unclear or missing, please let us know.

Click the Give Feedback link and you will be directed to GitHub where you can create a new issue to outline your suggestions.

Note that you'll need a GitHub account.

5. Revision History

Revision	Date	Description
1.0	October 20, 2020	Initial release