MISTRAL

an AXISCADES company

MRD5165

EAGLE KIT LR Wi-Fi

Hardware *User Guide*

Revision History

Revision	Date	Description
1.0	May 22, 2024	Preliminary version

ABSTRACT

This technical user's guide describes the hardware architecture, configuration options and connectors details of the MRD5165 Eagle Kit LR Wi-Fi.

Note: Information in this document is subject to change. Contact us for the most updated version of this document.

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Abbreviations & Acronyms

Many acronyms and abbreviations are used throughout this manual. Use the table below to navigate unfamiliar terms used in this document.

Acronym	Definition
AI	Artificial Intelligence
BLE	Bluetooth Low Energy
BT	Bluetooth
CSI	Camera Serial Interface
DP	Display Port
DPU	Display Processing Unit
DSI	Display Serial Interface
DSP	Digital Signal Processing
FCU	Flight Control Unit
GPIO	General Purpose Input/Output
GPU	Graphics Processing Unit
HDMI	High-Definition Multimedia Interface
I2C	Inter Integrated Circuit
I2S	Integrated Inter-IC Sound Bus
IO	Input-Output
IoT	Internet of Things
ISP	Image Signal Processor
JTAG	Joint Test Action Group
LGA	Land Grid Array
LPDDR	Low Power Double Data Rate Memory
MIPI	Mobile Industry Processor Interface
PCIe	Peripheral Component Interconnect Express
PMIC	Power Management Integrated circuits
PoP	Package On Package
LR	Long Range
FPV	First Person View
IMU	Inertial Measurement Unit
UFS	Universal Flash Storage
VPU	Vision Processing Unit
LTE	Long Term Evolution
HDR	High Dynamic Range
UART	Universal Asynchronous Receiver Transmitter
SPI	Serial Peripheral Interface
PWM	Pulse Width Modulation
CAN	Controller Area Network
GPS	Global Position System
ADC	Analog to Digital Converter
HS	High Speed
LS	Low Speed

1. Introduction

Embark on the future of autonomous flight with our Drone Development Kit!!

Packed with cutting-edge technology, this kit empowers developers to create powerful drone solutions. Experience exceptional compute performance, seamless AI integration, and precision with computer vision capabilities. The kit supports 5G connectivity for real-time communication and leverages edge computing for on-the-fly data processing. Designed with power efficiency in mind, it ensures longer flight times without compromising performance. Explore the skies and revolutionize the drone industry with our optimized development kit – your gateway to a new era of airborne innovation.

The MRD5165 Eagle Kit LR Wi-Fi from Mistral is an advanced drone controller built around the Qualcomm QRB5165 SoC and CubePilot's Cube Orange+. The MRD5165 Eagle Kit LR Wi-Fi delivers high-speed wireless connectivity and high-accuracy artificial intelligence (AI) and machine-learning inferencing technology to facilitate accelerated development of innovative, power-efficient, high-computing robots and drones for enterprise, industrial, and professional service applications.

The MRD5165 SoM, the core of the MRD5165 Eagle Kit LR Wi-Fi, is a high-compute, AI-enabled, low-power processor with 8GB LPDDR5 PoP memory, 128GB UFS storage, a dedicated high-performance Computer Vision Engine for video analytics, on-board wireless connectivity, and multiple PMICs for power supplies. The MRD5165 Eagle Kit LR Wi-Fi integrates a powerful Image Signal Processor and provides various peripheral connections such as 6 MIPI CSI cameras, an HDMI Camera, USB 3.0 ports, a Micro USB port for debugging, and a Gigabit Ethernet port for wired connectivity. It also integrates an expandable SD card slot for additional storage.

The MRD5165 Eagle Board has the expansion connectors which integrates the MRD5165 LR Wi-Fi Board features the LR Wi-Fi, 5G, CAN and Low speed Peripherals.

The MRD5165 Eagle Kit LR Wi-Fi is highly integrated, modular form-factor design tailored for robotics developers, drone manufacturers, and system integrators, empowering users to build intelligent machines customized to their requirements. The kit is meticulously engineered for effortless integration directly into your designs!

This MRD5165 Eagle Kit LR Wi-Fi also includes multiple software options including support for embedded Linux and a reference Root File-System from Ubuntu. The kit supports Linux Kernel 5.4, Ubuntu, and ROS; and includes a suite of software packages for implementing various applications such as AI/ML, Neural Processing, Auto Pilot, Navigation, Machine Vision, Multimedia and User Interface among others.

1.1. Overview

The MRD5165 Eagle Kit LR Wi-Fi is a high performance, standalone development platform that allows users to evaluate the QRB5165 System-on-Chip (SoC).

Below are the MRD5165 Eagle Kit LR Wi-Fi key features:

- Solderable LGA MRD5165 SoM in modular form factor
  - 8GB of LPDDR5 PoP memory (Expandable up to 16GB)
  - 128GB UFS memory (Expandable up to 256GB)
  - 8x Kryo 585 CPU @2.84GHz, Adreno 650 GPU

  - Adreno 665 VPU, Adreno 995 DPU
  - Spectra 480 ISP, Hexagon 698 DSP
  - Neural Processing Unit
  - Accelerators for depth-map, HDR, Face-detection
  - Video encode of 4K120 / 8K30
  - Wi-Fi 6 & BT/BLE Connectivity
- 10/100/1000Mb/s Ethernet interface with IX connector
- All-Ways aware sensor technology (IMU, Barometer, Magnetometer Sensors)
- USB Type-C (with DP-ALT mode) and USB Host port
- Up to 6 cameras concurrently (6x MIPI CSI Ports ; 1x Main Camera, 1x TOF/HDMI Camera, 4x Tracking Cameras)
- HDMI Input camera support
- Supports 5G/LTE Connectivity
- Debug UART using USB to UART interfaces through the on board FTDI device
- JTAG interface
- User LED
- PMIC and DC-DC regulators are used to derive the required power for SoM and other on-board peripherals
- Four push-pull control switches and Boot configuration DIP Switch
- Micro SD card
- HS and LS Expansion connectors: PCIe, USB, UART, SPI, I2C, PWM, CAN & GPIOs
- Flight Control unit supports Cube Orange+ and Cube peripherals like CAN, USB, UART, GPS, ADC, PWM, Debug, I2C, Serial port, SPKT and FR sky
- LR Wi-Fi board supports LR Wi-Fi, 5G, 3xCAN & FPV IMU
- Input power: 12V-36V, (12V@5A (max))
- Dimensions: 138 x 92 x 58 mm
- Temperature range (Tj): -25° C to +80° C

1.2.MRD5165 Eagle Kit LR Wi-Fi Contents

The MRD5165 Eagle Kit LR Wi-Fi includes:

1. MRD5165 Eagle Board with embedded MRD5165 SoM
2. MRD5165 Flight Control Unit
3. MRD5165 Eagle Kit LR Wi-Fi Board
4. Basic Accessories Kit
5. Vision Accessories Kit**
6. Cable Accessories Kit**
7. 5G Connectivity Accessories Kit**
8. Quick Start Guide

The MRD5165 Eagle Kit LR Wi-Fi include pre-installed system software.
**Additional accessories to be ordered separately.

Following table identifies the various components in each Accessories Kit.

Table 1-1: Basic Accessories Kit

Sl. No	Accessories	Description	Qty
1	DC Adapter	AC/DC Adapter, 240V input, 12V, 60W, certified	1
2	Power Cord	Power cord for DC adapter	1
3	Custom Power cable	Custom power cable with DC Jack (2.10mm ID, 5.50mm OD)	1
4	I-PEX cable	Micro coaxial cable (100mm)	2
5	I-PEX Camera Adapter	I-PEX camera adapter with screws	1
6	USB Type-C Cable	Cable,USB3.0, Type-C (Male) to A (Male), 5Gbps, Shielded,1m	1
7	FCU Accessories Kit	Cable set for FCU (Details are explained in Table 1-2)	1

*Available 300 mm and 400mm variants of IPEX cable.

Table 1-2: FCU Accessories Kit (MRD5165-ACC-FCU-101)

Sl. No	Accessories	Description	Qty
1	I2C cable	4-pin cables (Can be used for CAN1, CAN2, I2C2 ports)	2
2	CAN cable	4-pin cables (Can be used for CAN1, CAN2, I2C2 ports)	2
3	P SENSE cable	3-pin cable (Used for P SENSE port)	1
4	Buzzer cable	6-pin cable with Micro USB (Can be used for USB port)	1
5	GPS1 cable	8-pin cable (Can be used for GPS1 port)	1
6	USB cable	Micro USB Cable (Can be used for Cube USB port)	1
7	Telemetry cable	6-Pin Cable (Can be used for FR-SKY, SERIAL 1, GPS2 ports)	2

Table 1-3: Vision Accessories Kit (MRD5165-ACC-VK-101)

Sl. No	Accessories	Description	Qty
1	IMX577 camera module	Main camera	1
2	OV9282 camera module	Tracking camera	1
3	IMX577 Camera Adapter	IMX577 Camera Adapter board	1
4	OV9282 Camera Adapter	OV9282 Camera Adapter Board	1

Table 1-4: Cable Accessories Kit (MRD5165-ACC-CK-101)

Sl. No	Accessories	Description	Qty
1	USB Micro-B Cable	USB 2.0 Micro-B to A cable	1
2	IX Ethernet cable	Ethernet IX Type A to RJ45 cable	1
3	HDMI cable	HDMI-A to HDMI Micro-D cable	1

Table 1-5: 5G Connectivity Accessories Kit (MRD5165-ACC-MK-101)

Sl. No	Accessories	Description	Qty
1	5G modem	5G /4G/3G FR1 Bands ,M.2 FF Module with screws	1
2	5G antenna kit	5G/4G Monopole Antennas	1
3	5G MHF4 to UFL cable	SMA to MHF4 cable	4

2. MRD5165 Eagle Kit LR Wi-Fi Specifications

The key features of MRD5165 Eagle Kit LR Wi-Fi are listed below,

Table 2-1 : MRD5165 Eagle Kit LR Wi-Fi Specifications

Category	Description
Platform	Octa Core Qualcomm® Kryo™ 585 CPU @ 2.84 GHz Qualcomm® Adreno™ 650 GPU Qualcomm® Hexagon™ 698 DSP Qualcomm® Spectra™ 480 Image Processing Engine Qualcomm® Adreno 665 VPU Qualcomm® Adreno 995 DPU
Memory Support	8GB LPDDR5 (Package on Package) 128GB UFS 3.1 SD v3.0 4-bit for SD card
Flight Control Unit	Flight Controller Unit (FCU) supported by Cube Orange+ Customizable to multitude of vehicles (air-borne, land and water) • 2x Telemetry Header • 2x GPS Header • 2x CAN Header • ADC Header • SPKT Header • I2C Header • HMI Header (USB2.0, Buzzer) • PWM Header • P SENSE Header
LR Wi-Fi Board	LR Wi-Fi Board supports • LR Wi-Fi • 5G • 3 x CAN • FPV IMU
Connectivity	On-Board Wi-Fi 6 (802.11a/b/g/n/ac 2.4/5GHz 2x2 MIMO) & BT 5.2/BLE Supports 5G/ LTE (with 2x Nano SIM support) Custom Wireless / RF modules (PCIe based)
Camera	Up to 6 concurrent cameras - 6 x MIPI CSI Ports • 1x 4-lane MIPI-CSI Main Camera • 4x Low Resolution Tracking Cameras • 1x MIPI CSI ToF Camera/1x Depth Camera/1x HDMI Input Camera Accelerators for depth-map, HDR, Face-detection Video-encode of 4K120/8K30
Sensors	IMU Barometer Magnetometer
Expansion Connectors	HS Expansion Connector • PCIe0 Gen3 1-lane • PCIe2 Gen3 2-lane • 2x USB 3.0/2.0 • 2x CSI C-PHY • GPIOs LS Expansion Connector

	• ADC, UART, I2C, GPIOs • SPI, CAN-FD
Debug Interface	Micro USB Debug Port to access QRB5165 JTAG Interface
Power	• 12V-36V (12V@5A Typ) - XT30 Power input • Discrete Power Protection circuits
Form factor	Dimensions: 138 x 92 x 58 mm
Weight	355 g
Temperature	Temperature range (Tj): -25° C to +80° C

3. Hardware Description

3.1. MRD5165 Eagle Kit LR Wi-Fi

The MRD5165 Eagle Kit LR Wi-Fi consists of MRD5165 SoM, MRD5165 Eagle Board and MRD5165 Flight Control Unit. The functional block diagram of each of the above is depicted below,

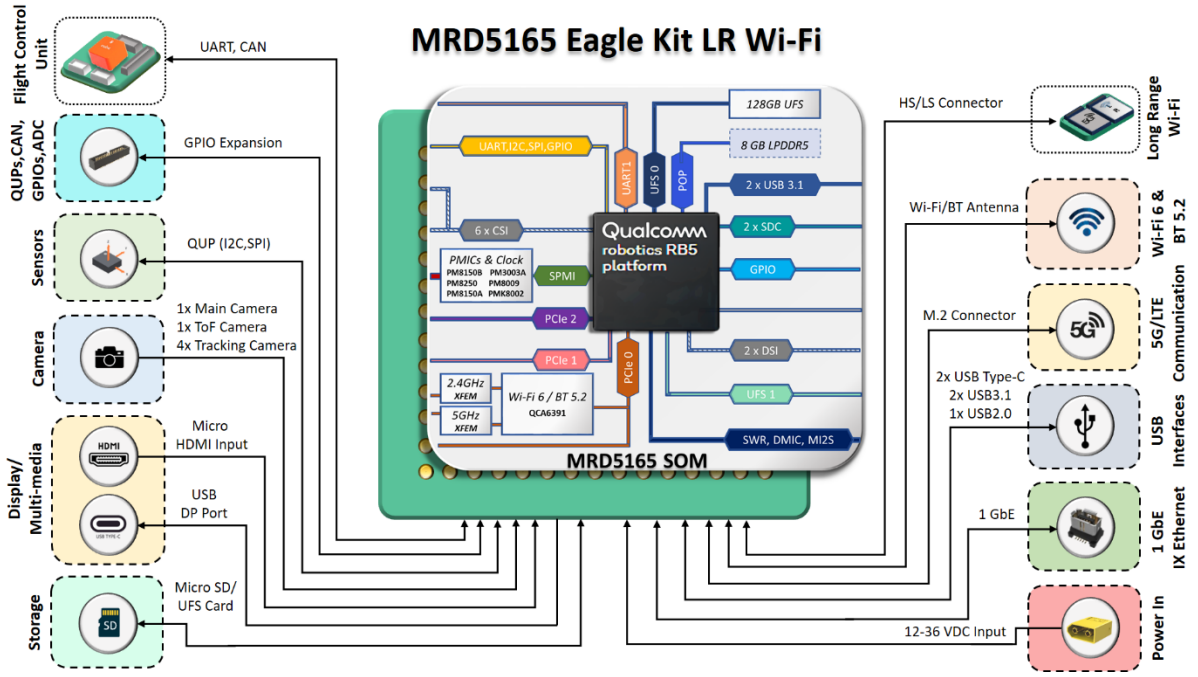

Figure 3-1: MRD5165 Eagle Kit LR Wi-Fi – Functional Block Diagram

3.1.1. MRD5165 SoM

The Mistral's MRD5165 SoM is a cutting-edge System on Module featuring the potent Qualcomm® premium tier QRB5165 processor, a core component of the Qualcomm Robotics RB5 platform.

The MRD5165 SoM offers wireless connectivity with Wi-Fi 6 and Bluetooth 5.1, using Qualcomm QCA6391 chip. It also possesses an array of 6x MIPI CSI ports and 2x MIPI DSI ports for versatile use, as well as multiple audio/video input/output interfaces. Moreover, the MRD5165 SoM supports 2x USB 3.1 ports, 3x PCIe 3.0 slots, I2S, various low-speed interfaces such as GPIOs, UART, SPI, I2C and more.

MRD5165 SoM has a form factor of 54 x 45mm comes with LGA pattern of 829 pins on the bottom side to interface with carrier boards.

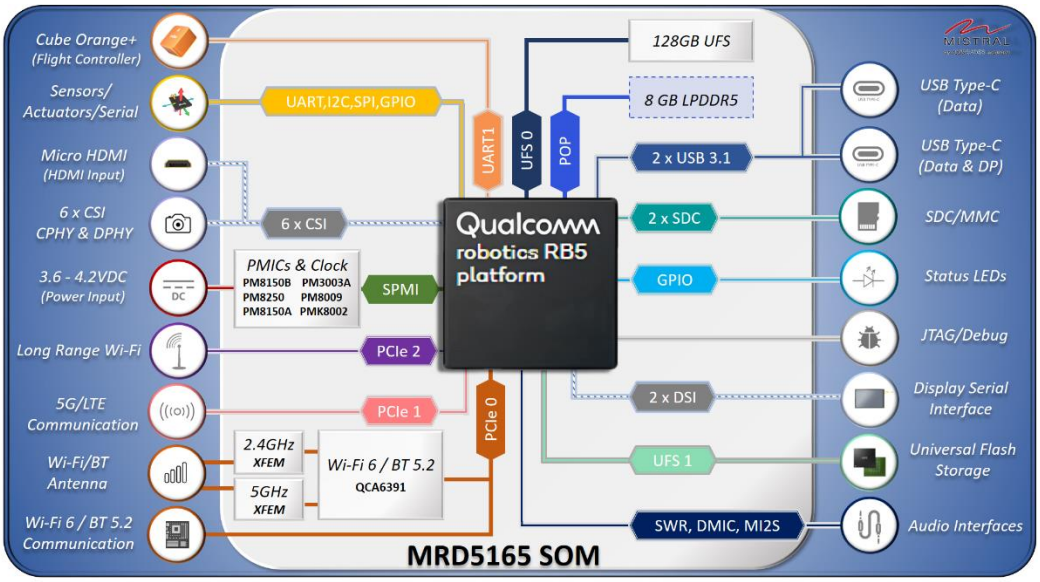

Figure 3-2 : MRD5165 SoM – Functional Block Diagram

3.1.2. MRD5165 Eagle Board

MRD5165 Eagle Board is designed to provide access to some of the most important features supported by the MRD5165 SoM. MRD5165 Eagle Board has a form factor of 115 x 62 mm.

A major part of the standard interfaces, which are supported by the MRD5165 SoM, are exposed on the solderable LGA pads. The connectors, LEDs, and push buttons are all placed on the board edge in MRD5165 Eagle Board in a way that easily allows for user access and integration.

A visual representation of the interfaces to subsystems, including the camera, display, and USB, is presented. This depiction facilitates a clear understanding of the port and interface specifications essential for device operations.

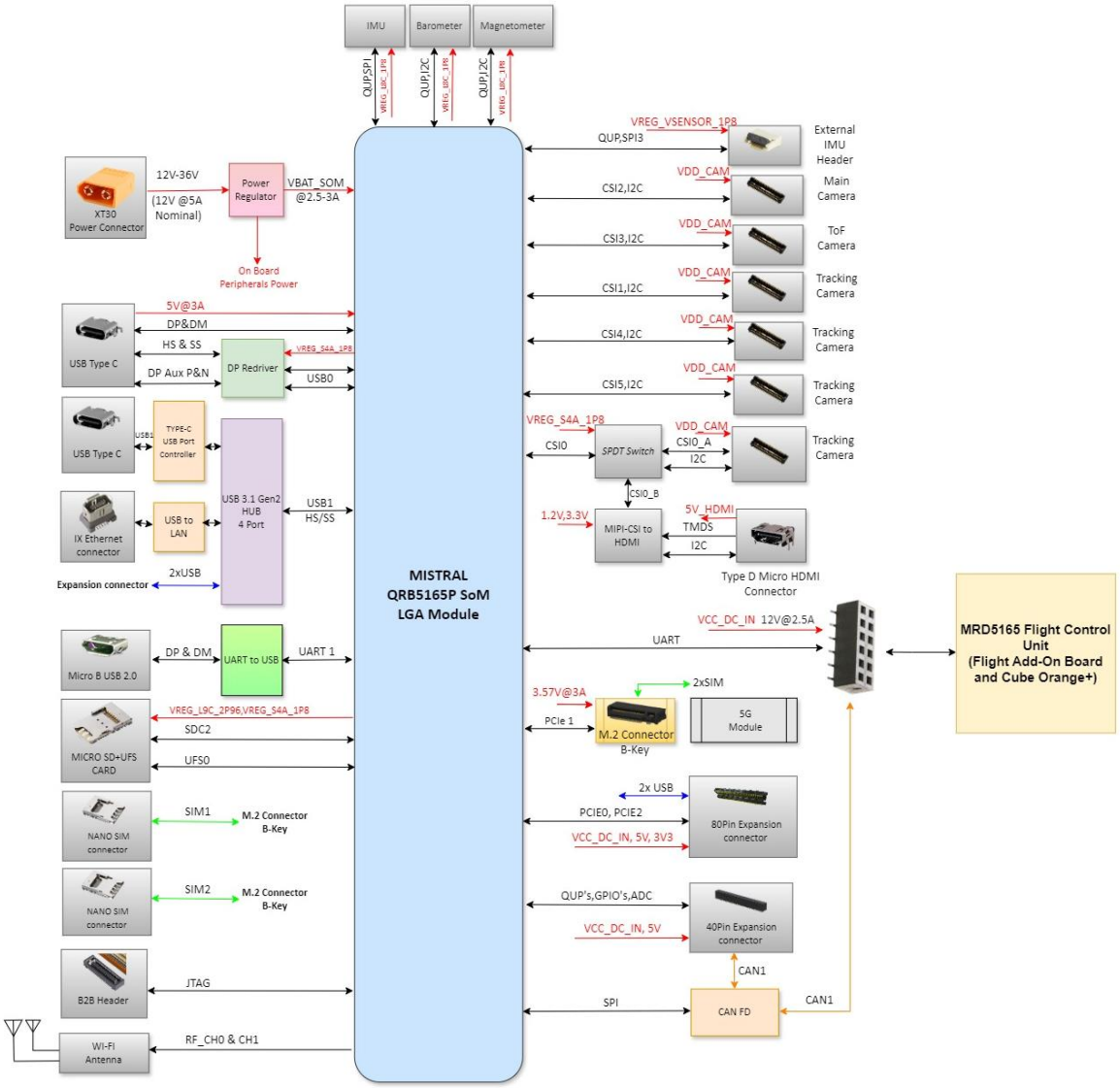

Figure 3-3: MRD5165 Eagle Board – Functional Block Diagram

3.1.3. MRD5165 Flight Control Unit

The MRD5165 Flight Control Unit facilitates seamless integration of flight control functionalities with the MRD5165 Eagle Board. The flight controller features are provided by the Cube Orange+ module from Cubepilot. The Cube Orange+ autopilot is the latest and most powerful model in the Cubepilot ecosystem. MRD5165 Flight Control Unit has a form factor of 93 x 62 mm.

The Flight control unit features Cube connector and peripheral B2B connectors. With MRD5165 Flight Control Unit, you will be able to connect GPS, CAN, I2C, Telemetry, FR-SKY, UART, USB, Battery monitor, PPM modules to Cube Orange+ Module. AUX monitor is reserved for future use.

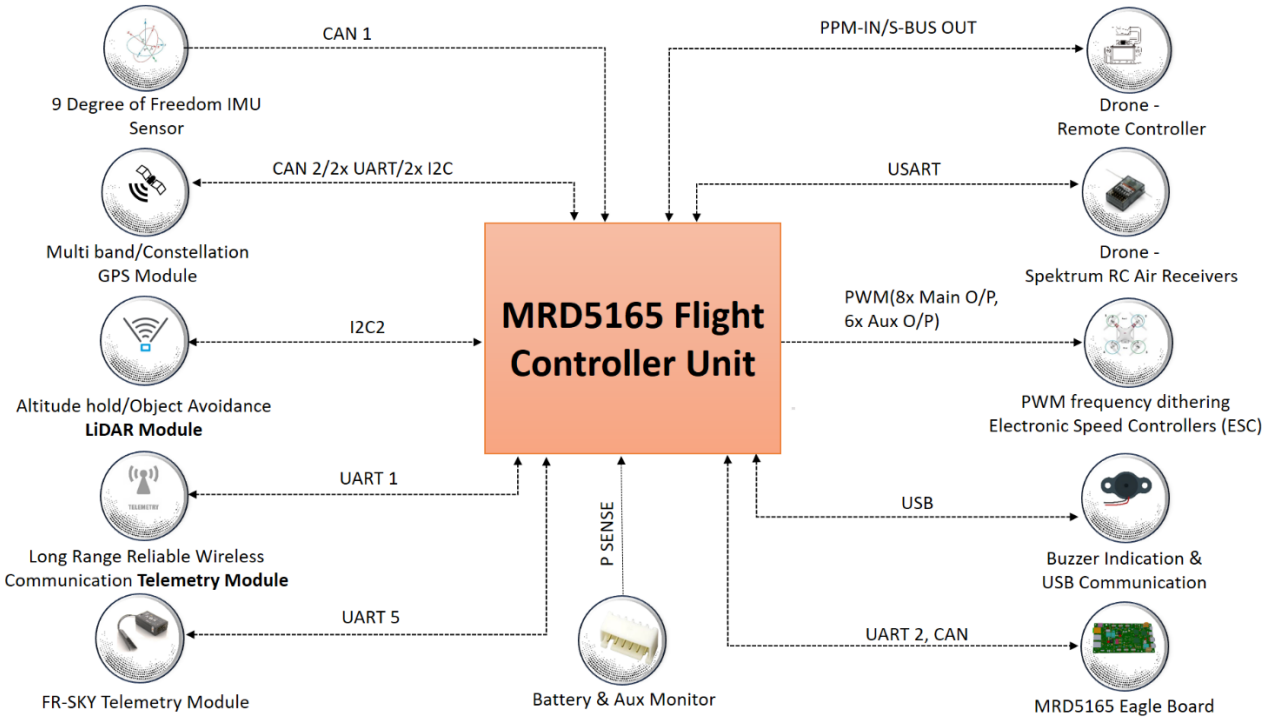

Figure 3-4: MRD5165 Flight Control Unit - Functional Block Diagram

Flight Control Unit is compatible with Cube Orange+ and other cube compatible modules.

3.1.4. MRD5165 LR Wi-Fi Board

The MRD5165 Eagle Board has the expansion connectors which integrates the MRD5165 LR Wi-Fi Board features the 5G, LR Wi-Fi and other peripherals.

MRD5165 LR Wi-Fi Board has a form factor of 115 x 62 mm.

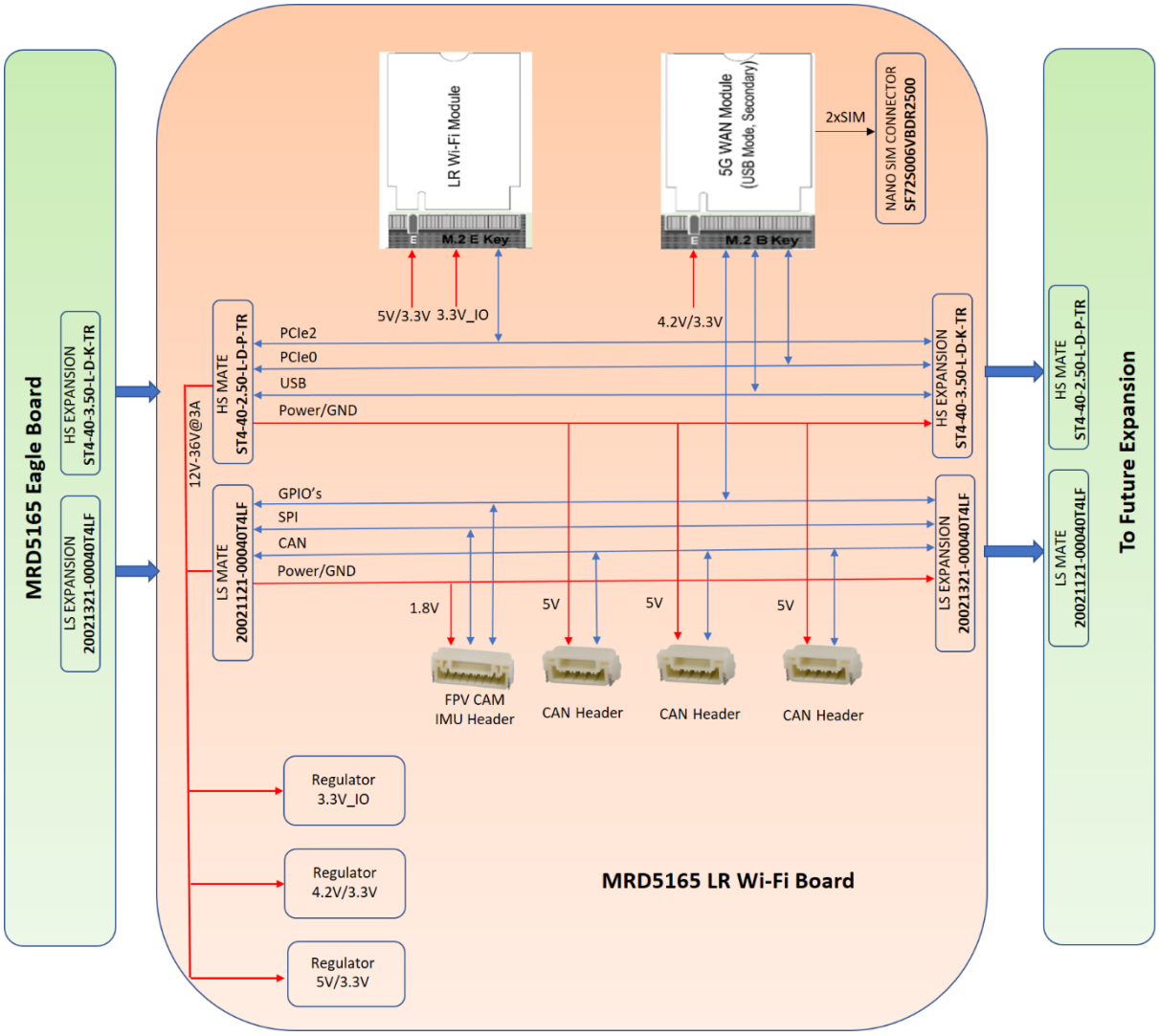

Figure 3-5: MRD5165 LR Wi-Fi Board – Functional Block Diagram

4. Board Placement Diagram

Various boards in the MRD5165 Eagle Kit LR Wi-Fi are explained below,

4.1. MRD5165 Eagle Kit LR Wi-Fi – Board location

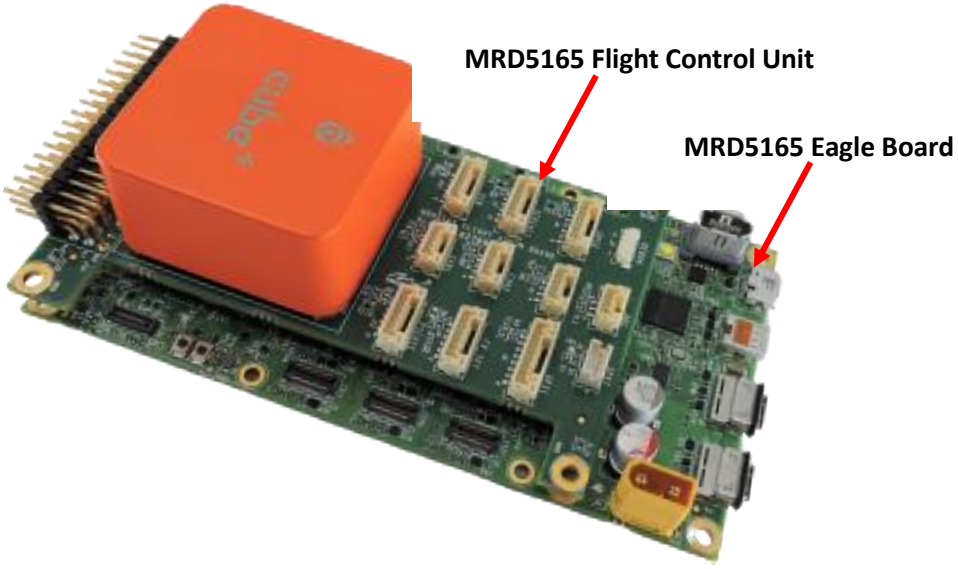

Figure 4-1: MRD5165 Flight Control Unit and MRD5165 Eagle Board - Top View

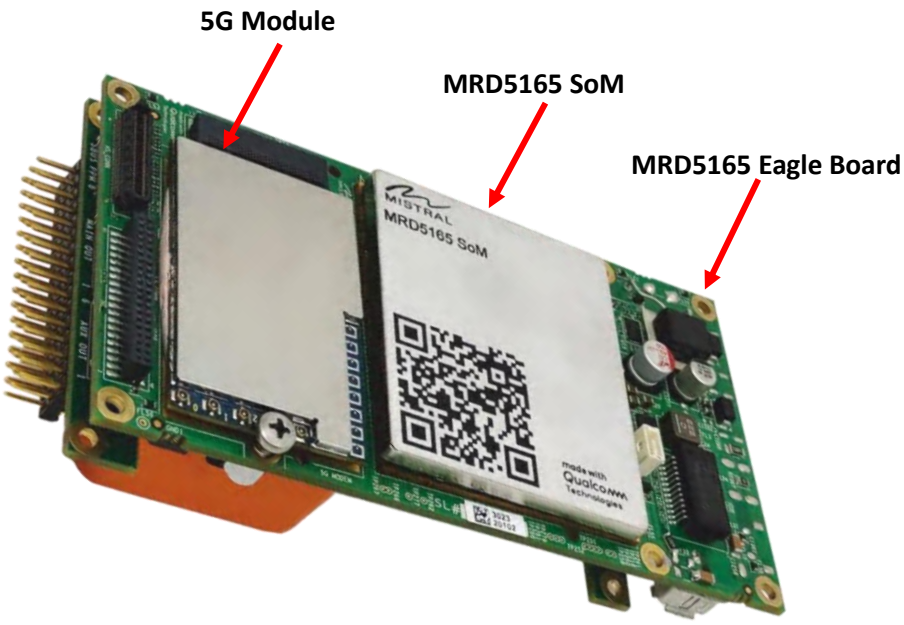

Figure 4-2: MRD5165 SoM and MRD5165 Eagle Board - Bottom View

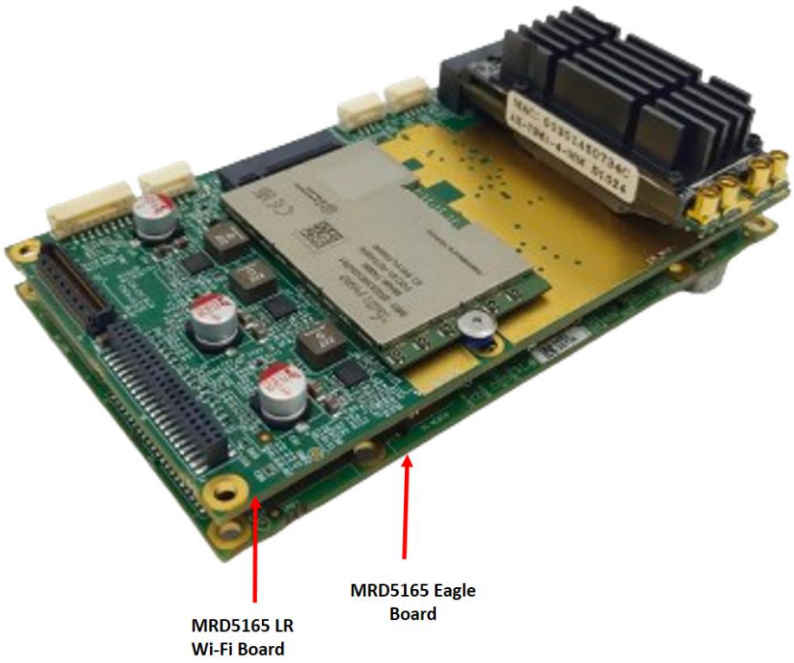

Figure 4-3: MRD5165 Eagle Board and MRD5165 LR Wi-Fi Board - Bottom View

4.2. MRD5165 Eagle Board Peripherals

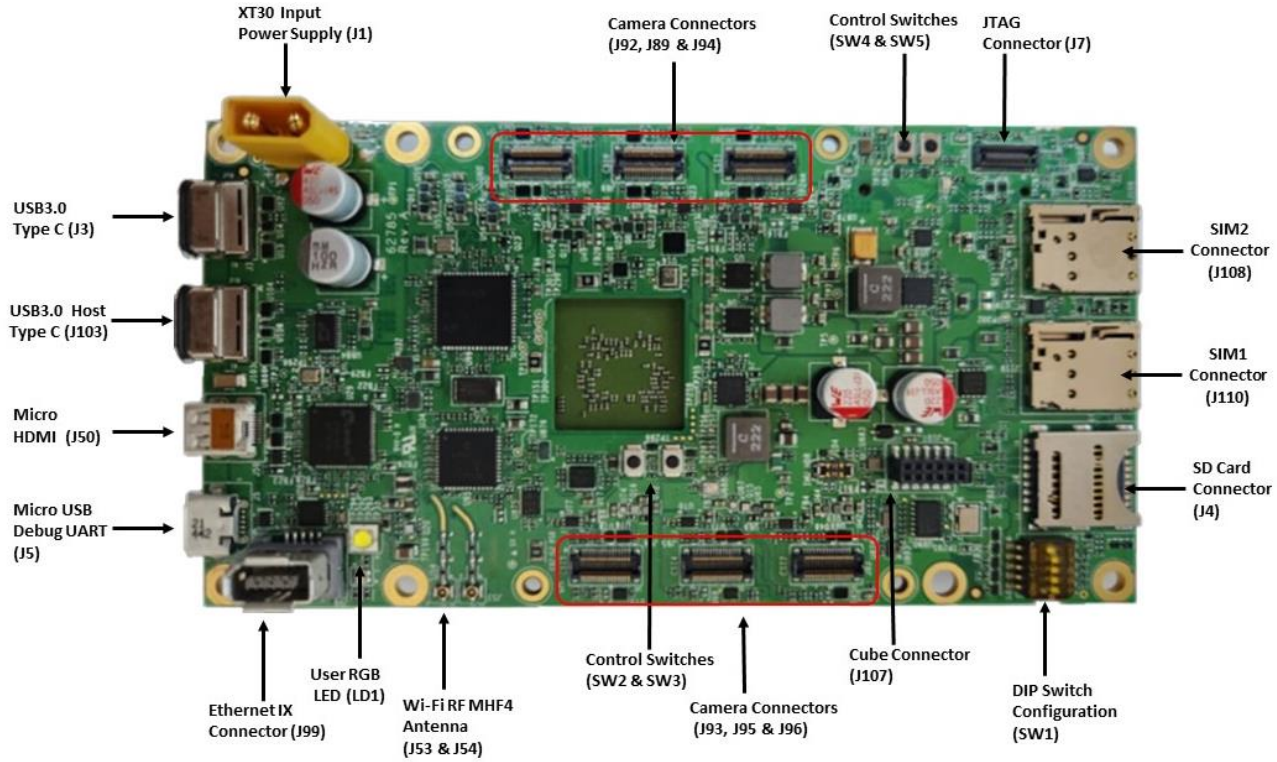

Figure 4-4: MRD5165 Eagle Board - Top View

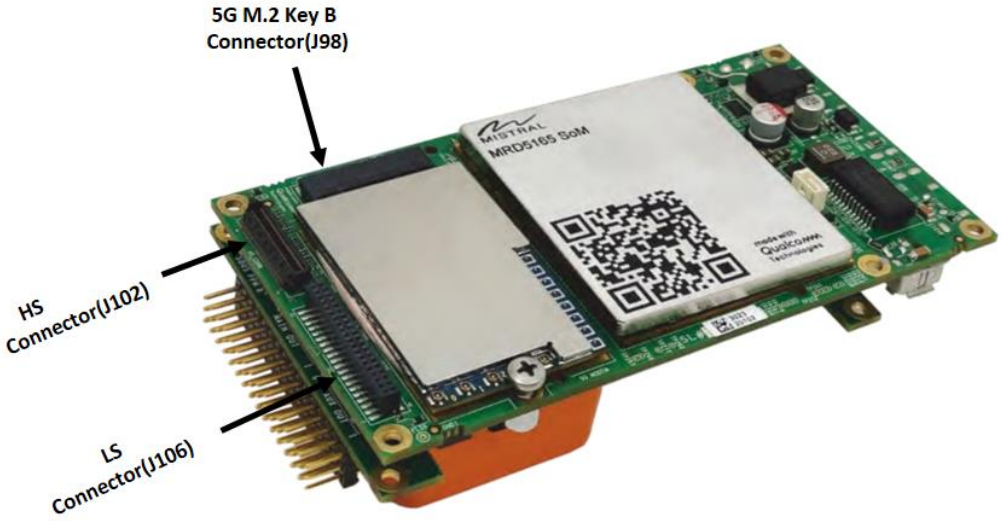

Figure 4-5: MRD5165 Eagle Board - Bottom View

4.3. MRD5165 Flight Control Unit Peripherals

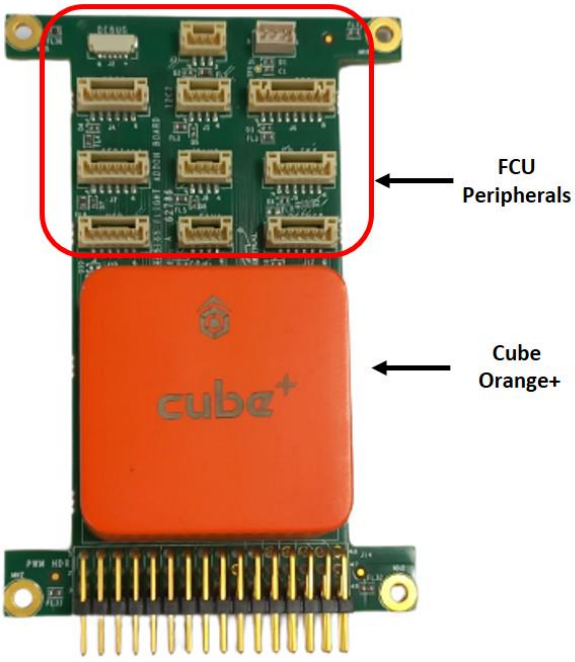

Figure 4-6: MRD5165 Flight Control Unit - Top View

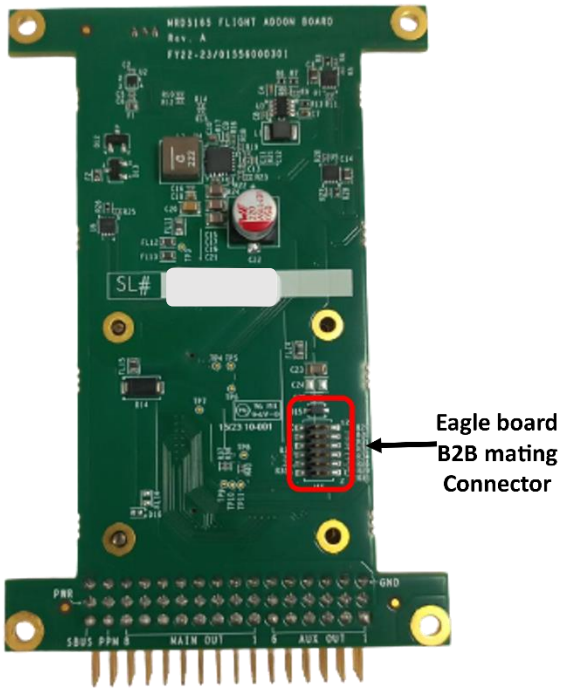

Figure 4-7: MRD5165 Flight Control Unit - Bottom View

4.4. MRD5165 LR- Wi-Fi Board Peripherals

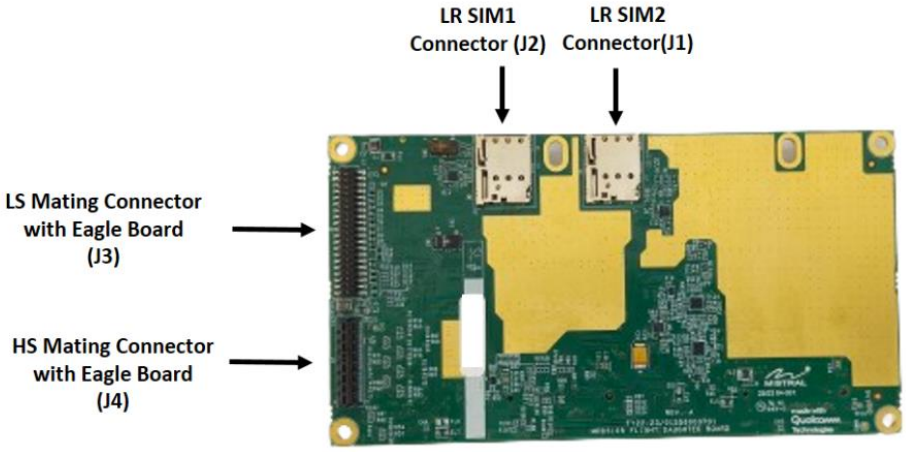

Figure 4-8: MRD5165 LR Wi-Fi Board- Top View

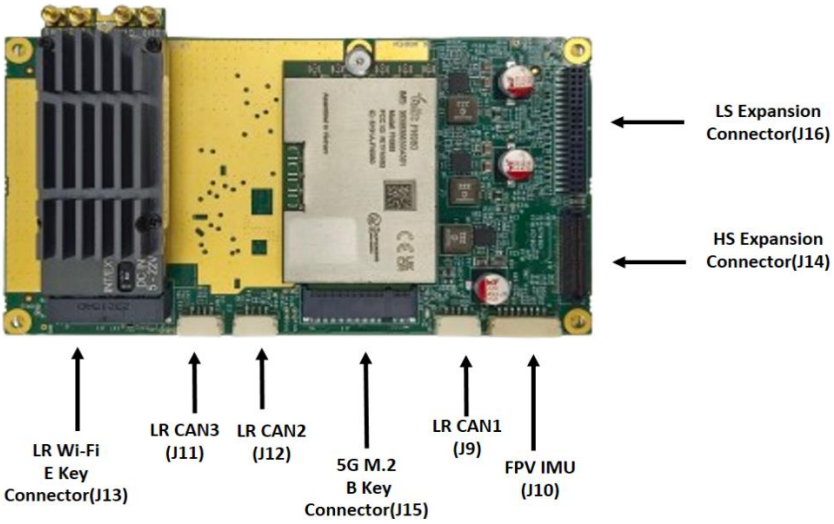

Figure 4-9: MRD5165 LR Wi-Fi Board – Bottom View

5. MRD5165 Eagle Board Interfaces

5.1.Power Input Connector

The MRD5165 Eagle Board supports a wide input range of 12V to 36V (12V@5A max). To power up the board, minimum 12V needs to be applied to the XT30 male connector (J1) using the custom power cable and the DC adapter. When the power is provided, power LED (LD2) glows, indicating that the board is powered on.

Boot up messages can be observed by viewing the boot message logs by plugging a micro-USB cable into the debug port (J5) using a serial terminal.

Table 5-1: Power Connector (J1)

Pin No	Signal	Description
1	Supply	12V - 36V Input
2	Ground	Ground

5.2.Ethernet port

The MRD5165 Eagle Board provides a Gigabit Ethernet port (via IX connector), supporting network speeds of 10/100/1000 Mbps, which connects to the MRD5165 SoM through the USB hub controller and USB to LAN chipset.

This port is utilized to transmit the captured data to the host PC over the network. The connector pin details can be found below table, with Figure 5-2 illustrating the Ethernet IX connector.

Table 5-2: Ethernet IX Connector (J99)

Pin No	Signal	Description
1	MDI_P_0_CONN	Gigabit Ethernet differential pair 0 positive
2	MDI_N_0_CONN	Gigabit Ethernet differential pair 0 negative
3	Ground	Shield Ground

4	MDI_P_2_CONN	Gigabit Ethernet differential pair 2 positive
5	MDI_N_2_CONN	Gigabit Ethernet differential pair 2 negative
6	MDI_P_1_CONN	Gigabit Ethernet differential pair 1 positive
7	MDI_N_1__CONN	Gigabit Ethernet differential pair 1 negative
8	MDI_P_3_CONN	Gigabit Ethernet differential pair 3 positive
9	MDI_N_3_CONN	Gigabit Ethernet differential pair 3 negative
10	Ground	Shield Ground

5.3.USB Type C (DP Alt mode) port

Dedicated USB0 super speed signals from MRD5165 SoM are connected to USB Type C connector (J3). This port used for ADB Programming and DP alt mode. This CC controller supports Dual Role Port (DRP).

Table 5-3: USB Type C (DP alt mode) Connector (J3)

Pin No	Signal	Description
A1	Ground	Ground
A2	USB0_SSTX_C1_P_CON	SuperSpeed Transmit+
A3	USB0_SSTX_C1_M_CON	SuperSpeed Transmit-
A4	USB_VBUS_TYPEC	Power
A5	USB_CC1	Configuration Channel 1
A6	USB_HS0_D_P	USB Data Signal Positive
A7	USB_HS0_D_M	USB Data Signal Negative
A8	USB_SBU1	Side Band Use 1
A9	USB_VBUS_TYPEC	Power
A10	USB0_SSRX_C2_M_CON	SuperSpeed Receive-
A11	USB0_SSRX_C2_P_CON	SuperSpeed Receive+
A12	Ground	Ground
B1	Ground	Ground
B2	USB0_SSTX_C2_P_CON	SuperSpeed Transmit+
B3	USB0_SSTX_C2_M_CON	SuperSpeed Transmit-
B4	USB_VBUS_TYPEC	Power
B5	USB_CC2	Configuration Channel 2
B6	USB_HS0_D_P	USB Data Signal Positive
B7	USB_HS0_D_M	USB Data Signal Negative
B8	USB_SBU2	Side Band Use 2
B9	USB_VBUS_TYPEC	Power
B10	USB0_SSRX_C1_M_CON	SuperSpeed Receive-
B11	USB0_SSRX_C1_P_CON	SuperSpeed Receive+
B12	Ground	Ground

5.4.Host USB port

The MRD5165 Eagle Board support another USB Type C host. It is interfaced with MRD5165 SoM with a Dual Role Port (DRP) Controller and USB hub controller. This port can support a maximum current (Source) of 5V @900mA.

Table 5-4: Host USB Connector (J103)

Pin No	Signal	Description
A1	Ground	Ground
A2	USB0_SSTX_C1_P_CON	SuperSpeed Transmit+
A3	USB0_SSTX_C1_M_CON	SuperSpeed Transmit-
A4	USB_VBUS_TYPEC	Power
A5	USB_CC1	Configuration Channel 1

A6	USB_HS0_D_P	USB Data Signal Positive
A7	USB_HS0_D_M	USB Data Signal Negative
A8	NC	Not Connected
A9	USB_VBUS_TYPEC	Power
A10	USB0_SSRX_C2_M_CON	SuperSpeed Receive-
A11	USB0_SSRX_C2_P_CON	SuperSpeed Receive+
A12	Ground	Ground
B1	Ground	Ground
B2	USB0_SSTX_C2_P_CON	SuperSpeed Transmit+
B3	USB0_SSTX_C2_M_CON	SuperSpeed Transmit-
B4	USB_VBUS_TYPEC	Power
B5	USB_CC2	Configuration Channel 2
B6	USB_HS0_D_P	USB Data Signal Positive
B7	USB_HS0_D_M	USB Data Signal Negative
B8	NC	Not Connected
B9	USB_VBUS_TYPEC	Power
B10	USB0_SSRX_C1_M_CON	SuperSpeed Receive-
B11	USB0_SSRX_C1_P_CON	SuperSpeed Receive+
B12	Ground	Ground

5.5.Debug serial console port

The standard micro-B USB connector is used as the debug port using USB to UART FTDI chipset. This provides access to the QRB5165 SoC through UART, using any serial console application with a baud rate of 115200 bps.

To detect the FTDI and emulate the UART host bus, connect a micro-USB cable to J5 on the MRD5165 Eagle Kit LR Wi-Fi.

Table 5-5: Debug USB Connector (J5)

Pin No	Signal	Description
1	VCC	5V input supply
2	DM	USB Data Signal Negative
3	DP	USB Data Signal Positive
4	ID	Not Connected
5	GND	Ground

5.6.HDMI-IN port

Dedicated CSI0 Interface from QRB5165 is connected HDMI IN Type-D connector (J50) through SPDT switch and MIPI-CSI to HDMI converter. This is the default configuration for HDMI IN camera module.

Table 5-6: HDMI Connector (J50)

Pin No	Signal	Description
1	LT6911_HPD	Hot plug detect
2	NC	Not Connected
3	HDMI_RX2_P_CONN	Data Pair 2+
4	Ground	Ground
5	HDMI_RX2_N_CONN	Data Pair 2-
6	HDMI_RX1_P_CONN	Data Pair 1+
7	Ground	Ground
8	HDMI_RX1_N_CONN	Data Pair 1-
9	HDMI_RX0_P_CONN	Data Pair 0+
10	Ground	Ground
11	HDMI_RX0_N_CONN	Data Pair 0-

12	HDMI_RXC_P_CONN	Data Pair +
13	Ground	Ground
14	HDMI_RXC_N_CONN	Data Pair-
15	NC	Not Connected
16	Ground	Ground
17	LT6911_DDC_SCL	SCL clock
18	LT6911_DDC_SDA	SDA Data
19	HDMI_IN_5P0	5V supply

5.7.Camera ports

The MRD5165 Eagle Board can support six cameras through CAM0, CAM1, CAM2, CAM3, CAM4 and CAM5 connectors.

All camera connectors are 30-pins B2B connector (Part number: AXF5G3012A, Mating Part number: AXF6G3012A)

Note: To use the MRD5165 Eagle Board Camera connectors, user shall use the I-PEX Camera Adapter (Please refer section: 8-2), which connects to the camera module connector as shown in Figure 8-2.

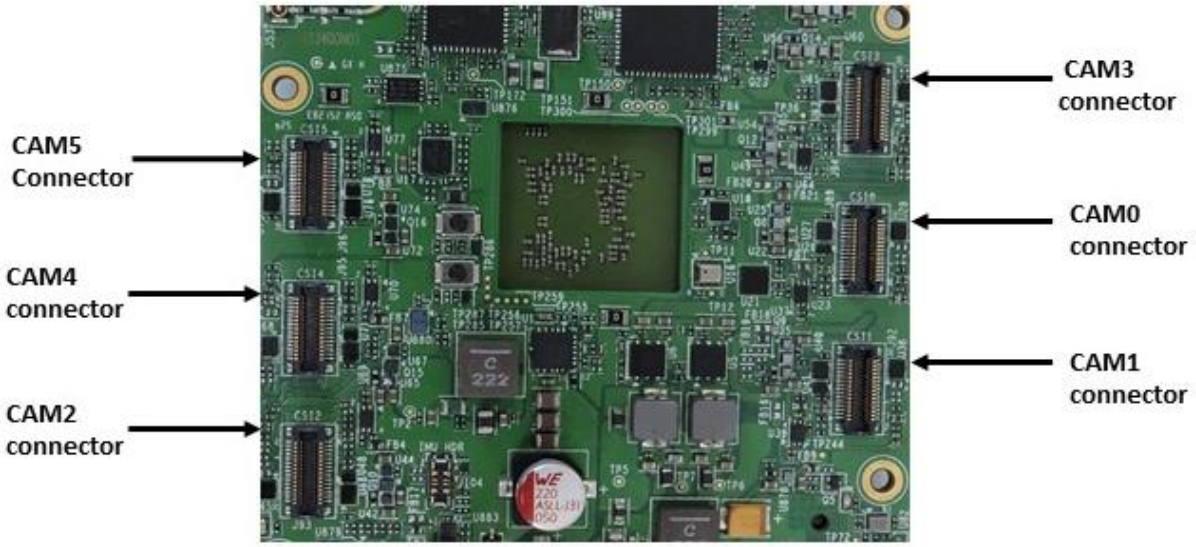

Figure 5-1: MRD5165 Eagle Board Camera Connectors

5.8.CAM0 Connector

Dedicated CSI0 Interface from QRB5165 is connected to the CAM0 connector (J89).

Note:

1) To use the MRD5165 Eagle Board Camera connectors, user shall use the I-PEX Camera Adapter, which connects to the camera module connector as shown in Figure 8-2.
2) At any given time, either CAM0 or HDMI can be active, but not both simultaneously.

Table 5-7: CAM0 Connector (J89)

Pin No	Signal	Description
1	GPIO-X	Strobe Pin
2	CAM0_DVDD_1V1_1V2	1.1V/1.2V supply voltage
3	GPIO-W	Spare Pin
4	CAM5V0	5V supply voltage
5	CAM0_AVDD_2V8	2.8V supply voltage
6	CAM_DOVDD_1V8	1.8V supply voltage
7	VSYNC	Vertical synchronization pin
8	GPIO-Z	Camera Power Down
9	GPIO140	Camera reset
10	CCI_I2C_SDA0	I2C Data
11	Ground	Ground
12	CCI_I2C_SCL0	I2C Clock
13	CAM0_D2_M	MIPI Data Lane 2 Differential Pair -
14	Ground	Ground
15	CAM0_D2_P	MIPI Data Lane 2 Differential Pair +
16	CLK0/CSI0MCLK	MIPI Master Clock
17	Ground	Ground
18	Ground	Ground
19	CAM0_D0_M	MIPI Data Lane 1 Differential Pair -
20	CAM0_CLK_P	MIPI Clock Lane Differential Pair +
21	CAM0_D0_P	MIPI Data Lane 1 Differential Pair +
22	CAM0_CLK_M	MIPI Clock Lane Differential Pair -
23	Ground	Ground
24	Ground	Ground
25	CAM0_D3_M	MIPI Data Lane 3 Differential Pair -
26	CAM0_D1_P	MIPI Data Lane 1 Differential Pair +
27	CAM0_D3_P	MIPI Data Lane 3 Differential Pair +
28	CAM0_D1_M	MIPI Data Lane 1 Differential Pair -
29	CAM0_PWR_SWITCH	1V1/1V2 Supply Selection Switch
30	Ground	Ground

5.9.CAM1 Connector

Dedicated CSI1 Interface from QRB5165 is connected to the CAM1 connector (J92).

Note: To use the MRD5165 Eagle Board Camera connectors, user shall use the I-PEX Camera Adapter, which connects to the camera module connector as shown in Figure 8-2.

Table 5-8: CAM1 Connector (J92)

Pin No	Signal	Description
1	GPIO-V	Strobe Pin
2	CAM1_DVDD_1V1_1V2	1.1V/1.2V supply voltage
3	GPIO-T	Spare Pin
4	CAM_5V0	5V supply voltage
5	CAM1_AVDD_2V8	2.8V supply voltage
6	CAM_DOVDD_1V8	1.8V supply voltage
7	VSYNC	Vertical synchronization pin
8	GPIO_155	Camera Power Down
9	PCM_D	Camera reset
10	CCI_I2C_SDA1	I2C Data
11	Ground	Ground
12	CCI_I2C_SCL1	I2C Clock
13	CAM1_D2_M	MIPI Data Lane 2 Differential Pair -
14	Ground	Ground

15	CAM1_D2_P	MIPI Data Lane 2 Differential Pair +
16	CLK1/CSI1_MCLK	MIPI Master Clock
17	Ground	Ground
18	Ground	Ground
19	CAM1_D0_M	MIPI Data Lane 1 Differential Pair -
20	CAM1_CLK_P	MIPI Clock Lane Differential Pair +
21	CAM1_D0_P	MIPI Data Lane 1 Differential Pair +
22	CAM1_CLK_M	MIPI Clock Lane Differential Pair -
23	Ground	Ground
24	Ground	Ground
25	CAM1_D3_M	MIPI Data Lane 3 Differential Pair -
26	CAM1_D1_P	MIPI Data Lane 1 Differential Pair +
27	CAM1_D3_P	MIPI Data Lane 3 Differential Pair +
28	CAM1_D1_M	MIPI Data Lane 1 Differential Pair -
29	CAM1_PWR_SWITCH	1V1 & 1V2 Supply Selection Switch
30	Ground	Ground

5.10. CAM2 Connector

Dedicated CSI2 Interface from QRB5165 is connected to CAM2 connector (J93).

Note: To use the MRD5165 Eagle Board Camera connectors, user shall use the I-PEX Camera Adapter, which connects to the camera module connector as shown in Figure 8-2.

Table 5-9: CAM2 Connector (J93)

Pin No	Signal	Description
1	GPIO-KK	Strobe Pin
2	CAM2_DVDD_1V1_1V2	1.1V/1.2V supply voltage
3	QRB_GPIO_62	Spare Pin
4	CAM_5V0	5V supply voltage
5	CAM2_AVDD_2V8	2.8V supply voltage
6	CAM_DOVDD_1V8	1.8V supply voltage
7	VSYNC	Vertical synchronization pin
8	QRB_GPIO_63	Camera Power Down
9	GPIO-II	Camera reset
10	CCI_I2C_SDA2	I2C Data
11	Ground	Ground
12	CCI_I2C_SCL2	I2C Clock
13	CAM2_D2_M	MIPI Data Lane 2 Differential Pair -
14	Ground	Ground
15	CAM2_D2_P	MIPI Data Lane 2 Differential Pair +
16	CLK2/CSI2_MCLK	MIPI Master Clock
17	Ground	Ground
18	Ground	Ground
19	CAM2_D0_M	MIPI Data Lane 1 Differential Pair -
20	CAM2_CLK_P	MIPI Clock Lane Differential Pair +
21	CAM2_D0_P	MIPI Data Lane 1 Differential Pair +
22	CAM2_CLK_M	MIPI Clock Lane Differential Pair -
23	Ground	Ground
24	Ground	Ground
25	CAM2_D3_M	MIPI Data Lane 3 Differential Pair -
26	CAM2_D1_P	MIPI Data Lane 1 Differential Pair +
27	CAM2_D3_P	MIPI Data Lane 3 Differential Pair +
28	CAM2_D1_M	MIPI Data Lane 1 Differential Pair -
29	CAM2_PWR_SWITCH	1V1 & 1V2 Supply Selection Switch
30	Ground	Ground

5.11. CAM3 Connector

Dedicated CSI3 Interface from QRB5165 is connected to CAM3 connector (J94).

Note: To use the MRD5165 Eagle Board Camera connectors, user shall use the I-PEX Camera Adapter, which connects to the camera module connector as shown in Figure 8-2.

Table 5-10: CAM3 Connector (J94)

Pin No	Signal	Description
1	GPIO-LL	Strobe Pin
2	CAM3_DVDD_1V2-TOF_5V	1.2V/5V supply voltage
3	PCM_FS	Spare Pin
4	CAM_5V0	5V supply voltage
5	CAM3_AVDD_2V8-TOF_5V	2.8V/5V supply voltage
6	CAM3_DVDD_1V8-TOF_5V	1.8V/5V supply voltage
7	VSYNC	Vertical synchronization pin
8	GPIO-S	Camera Power Down
9	GPIO-U	Camera reset
10	CCI_I2C_SDA3	I2C Data
11	Ground	Ground
12	CCI_I2C_SCL3	I2C Clock
13	CAM3_D2_M	MIPI Data Lane 2 Differential Pair -
14	Ground	Ground
15	CAM3_D2_P	MIPI Data Lane 2 Differential Pair +
16	CLK3/CSI3_MCLK	MIPI Master Clock
17	Ground	Ground
18	Ground	Ground
19	CAM3_D0_M	MIPI Data Lane 1 Differential Pair -
20	CAM3_CLK_P	MIPI Clock Lane Differential Pair +
21	CAM3_D0_P	MIPI Data Lane 1 Differential Pair +
22	CAM3_CLK_M	MIPI Clock Lane Differential Pair -
23	Ground	Ground
24	Ground	Ground
25	CAM3_D3_M	MIPI Data Lane 3 Differential Pair -
26	CAM3_D1_P	MIPI Data Lane 1 Differential Pair +
27	CAM3_D3_P	MIPI Data Lane 3 Differential Pair +
28	CAM3_D1_M	MIPI Data Lane 1 Differential Pair -
29	CAM3_PWR_SWITCH	1V1/1V2 Supply Selection Switch
30	CAM3_PWR_SWITCH2	1V1,1V2,1V8,2V8 & 5V Supply Selection Switch

5.12. CAM4 Connector

Dedicated CSI4 Interface from QRB5165 is connected to CAM4 connector (J95).

Note: To use the MRD5165 Eagle Board Camera connectors, user shall use the I-PEX Camera Adapter, which connects to the camera module connector as shown in Figure 8-2.

Table 5-11: CAM4 Connector (J95) Information

Pin No	Signal	Description
1	GPIO-TT	Strobe Pin
2	CAM4_DVDD_1V1_1V2	1.2V/5V supply voltage
3	GPIO_153	Spare Pin
4	CAM_5V0	5V supply voltage
5	CAM4_AVDD_2V8	2.8V/5V supply voltage
6	CAM_DOVDD_1V8	1.8V/5V supply voltage
7	VSYNC	Vertical synchronization pin

8	GPIO_145	Camera Power Down
9	GPIO-AA	Camera reset
10	CCI_I2C_SDA2	CCI I2C Data
11	Ground	Ground
12	CCI_I2C_SCL2	CCI I2C Clock
13	CAM4_D2_M	MIPI Data Lane 2 Differential Pair -
14	Ground	Ground
15	CAM4_D2_P	MIPI Data Lane 2 Differential Pair +
16	CLK4/CSI4_MCLK	MIPI Master Clock
17	Ground	Ground
18	Ground	Ground
19	CAM4_D0_M	MIPI Data Lane 1 Differential Pair -
20	CAM4_CLK_P	MIPI Clock Lane Differential Pair +
21	CAM4_D0_P	MIPI Data Lane 1 Differential Pair +
22	CAM4_CLK_M	MIPI Clock Lane Differential Pair -
23	Ground	Ground
24	Ground	Ground
25	CAM4_D3_M	MIPI Data Lane 3 Differential Pair -
26	CAM4_D1_P	MIPI Data Lane 1 Differential Pair +
27	CAM4_D3_P	MIPI Data Lane 3 Differential Pair +
28	CAM4_D1_M	MIPI Data Lane 1 Differential Pair -
29	CAM4_PWR_SWITCH	1V1/1V2 Supply Selection Switch
30	Ground	Ground

5.13. CAM5 Connector

Dedicated CSI5 Interface from QRB5165 is connected to CAM5 connector (J96).

Note: To use the MRD5165 Eagle Board Camera connectors, user shall use the I-PEX Camera Adapter, which connects to the camera module connector as shown in Figure 8-2.

Table 5-12: CAM5 Connector (J96)

Pin No	Signal	Description
1	GPIO-UU	Strobe Pin
2	CAM5_DVDD_1V1_1V2	1.2V/5V supply voltage
3	GPIO-PP	Spare Pin
4	CAM_5V0	5V supply voltage
5	CAM4_AVDD_2V8	2.8V/5V supply voltage
6	CAM_DOVDD_1V8	1.8V/5V supply voltage
7	VSYNC	Vertical synchronization pin
8	QRB_GPIO_111	Camera Power Down
9	GPIO-DDD	Camera reset
10	CCI_I2C_SDA3	I2C Data
11	Ground	Ground
12	CCI_I2C_SCL3	I2C Clock
13	CAM5_D2_M	MIPI Data Lane 2 Differential Pair -
14	Ground	Ground
15	CAM5_D2_P	MIPI Data Lane 2 Differential Pair +
16	CLK5/CSI5_MCLK	MIPI Master Clock
17	Ground	Ground
18	Ground	Ground
19	CAM5_D0_M	MIPI Data Lane 1 Differential Pair -
20	CAM5_CLK_P	MIPI Clock Lane Differential Pair +

21	CAM5_D0_P	MIPI Data Lane 1 Differential Pair +
22	CAM5_CLK_M	MIPI Clock Lane Differential Pair -
23	Ground	Ground
24	Ground	Ground
25	CAM5_D3_M	MIPI Data Lane 3 Differential Pair -
26	CAM5_D1_P	MIPI Data Lane 1 Differential Pair +
27	CAM5_D3_P	MIPI Data Lane 3 Differential Pair +
28	CAM5_D1_M	MIPI Data Lane 1 Differential Pair -
29	CAM5_PWR_SWITCH	1V1/1V2 Supply Selection Switch
30	Ground	Ground

5.14. RF Antennas

MRD5165 Eagle Kit LR Wi-Fi uses two dual-band, 2.4/5 GHz, WLAN/Bluetooth technology antennas on the Eagle board.

- QCA6391 supports 2 × 2 MIMO with 2x Wi-Fi antenna ports and 1x Bluetooth technology antenna port (Bluetooth technology antenna can be dedicated or shared with one of the Wi-Fi antennas).
- Current system-on-module uses a shared Wi-Fi/Bluetooth technology approach on RF chain 0.

5.15. Micro SD Card Connector

Dedicated SDC2 interface of the QRB5165 processor is made available at SD card connector (J4) in MRD5165 Eagle Board. The card-detect pin from the SD card connector is connected to the GPIO77 to detect the presence of SD card.

Table 5-13: Micro SD Card Connector (J4)

Pin No	Signal	Description
1	Ground	Ground
2	NC	Intended for Future Use
3	NC	Intended for Future Use
4	Ground	Ground
5	NC	Intended for Future Use
6	NC	Intended for Future Use
7	Ground	Ground
8	NC	Intended for Future Use
9	VREG_S4A_1P8	Power supply 1.8V
10	Ground	Ground
11	Ground	Ground
12	VREG_L9C_2P96	Power supply 2.96V
13	SDC2_DATA_1	Data line 1
14	SDC2_DATA_0	Data line 0
15	SDC2_CLK_CONN	SD card Clock
16	SDC2_CMD	SD card command
17	SDC2_DATA_3	Data line 3
18	SDC2_DATA_2	Data line 2
19	SD_UFS_CARD_DET_N	SD Card detection

5.16. Nano SIM Connectors

The MRD5165 Eagle Board has 2x Nano SIM connector for 5G Module connectivity.

Table 5-14: Nano SIM Connector (J110 - USIM1)

Pin No	Signal	Description
C1	USIM1_VDD	Power supply 1.8V
C2	RST_SIM	Reset signal
C3	CLK_SIM	Clock signal
C5	Ground	Ground
C6	NC	Not Connected
C7	DATA_SIM	Data signal
CSW	Ground	Ground
DSW	USIM1_DET_M2	SIM card detection pin

Table 5-15: Nano SIM Connector (J108 - USIM2)

Pin No	Signal	Description
C1	USIM2_VDD	Power supply 1.8V
C2	RST_SIM2	Reset signal
C3	CLK_SIM2	Clock signal
C5	Ground	Ground
C6	NC	Not Connected
C7	DATA_SIM2	Data signal
CSW	Ground	Ground
DSW	SIM2_CARD_DETECT	SIM card detection pin

5.17. 5G M.2 Connector

PCIe1 interface from QRB5165 is connected to M.2 B key connector for interfacing off-the-shelf 5G/LTE solutions in the MRD5165 Eagle Board.

Table 5-16: 5G M.2 Connector (J98)

Pin No	Signal	Description
1	CONFIG_3	Based on the state of the configuration pins on the module, being tied to GND or left NC
2	VCC_5G	5G Module Power supply
3	Ground	Ground
4	VCC_5G	5G Module Power supply
5	Ground	Ground
6	MODULE_PWRKEY	Module On/Off High - Default on condition Low - Power OFF condition
7	USB_HS_DP_DN2_5G	USB 2.0 Data Plus
8	MODULE_W_DISABLED_N	RF disable
9	USB_HS_DM_DN2_5G	USB 2.0 Data Minus
10	MODULE_STATUS	LED control
11	Ground	Ground
12	NC	Not connected
13	NC	Not connected
14	NC	Not connected
15	NC	Not connected
16	NC	Not connected
17	NC	Not connected
18	NC	Not connected
19	NC	Not connected

20	PCM_CLK	Switch Host Interface High: USB Low: PCIe (default)
21	CONFIG_0	Based on the state of the configuration pins on the module, being tied to GND or left NC
22	PCM_DIN	Not connected
23	WAKE_ON_WAN_N	Coexistence transmit/Wake Host
24	PCM_DOUT	Not connected
25	DYN_PWR_CTRL	Dynamic power control
26	GPS_DISABLE_N	RF function can also be enabled or disabled through AT commands
27	Ground	Ground
28	PCM_SYNC	Not connected
29	M2_MODULE_PIN29	USB 3.1 super-speed receive - Minus
30	USIM1_RST	Reset output to an external UIM1 card
31	M2_MODULE_PIN31	USB 3.1 super-speed receive - Plus
32	USIM1_CLK	Clock output to an external UIM1 card
33	Ground	Ground
34	USIM1_DATA	Data connection with an external UIM1 card
35	M2_MODULE_PIN35	USB 3.1 super-speed transmit - Minus
36	USIM1_VDD	Supply output for an external UIM1 card
37	M2_MODULE_PIN37	USB 3.1 super-speed transmit - Plus
38	DEVSLP	Test Point
39	Ground	Ground
40	5G_GPIO_0	SIM card detection signal for SIM connector 2
41	PCIE1_RX0_M	PCIe 1 Receive 0 – minus
42	5G_GPIO_1	Data signal for SIM connector 2
43	PCIE1_RX0_P	PCIe 1 Receive 0 – plus
44	5G_GPIO_2	Clock signal for SIM connector 2
45	Ground	Ground
46	5G_GPIO_3	Reset signal for SIM connector 2
47	PCIE1_TX0_M	PCIe1 Transmit 0 – minus
48	5G_GPIO_4	Power supply for SIM connector 2
49	PCIE1_TX0_P	PCIe 1 Transmit 0 – plus
50	PCIE1_RST_N_3V3	Functional reset to the PCIe bus: Active LOW
51	Ground	Ground
52	PCIE1_CLK_REQ_3V3	PCIe 1 reference clock request signal: Active LOW
53	PCIE1_REFCLK_M	PCIe 1 differential reference clock – minus
54	PCIE1_WAKE_N_3V3	PCIe1 wake-up: Active LOW
55	PCIE1_REFCLK_P	PCIe 1 differential reference clock – plus
56	NC	Not connected
57	Ground	Ground
58	NC	Not connected
59	WL_XFEM_CTRL_LAA_TXEN _GPIO	General Purpose I/O
60	WL_XFEM_CTRL_WL_TXEN _GPIO	General Purpose I/O
61	ANTCTL1	Test Point
62	COEX_TXD_GPIO	General Purpose I/O
63	ANTCTL2	Test Point
64	COEX_RXD_GPIO	General Purpose I/O
65	RFFE_VIO_1V8	Reference Voltage
66	USIM1_DET_M2_MOD	UIM1 Card Present Detect
67	MODULE_RESET_N	Reset Input: Active high signal
68	SUSCLK	Not connected
69	CONFIG_1	Based on the state of the configuration pins on the module, being tied to GND or left NC
70	VCC_5G	5G Module Power supply

71	Ground	Ground
72	VCC_5G	5G Module Power supply
73	Ground	Ground
74	VCC_5G	5G Module Power supply
75	CONFIG_2	Based on the state of the configuration pins on the module, being tied to GND or left NC

Mistral tested and validated the following 5G Modules,

Table 5-17: 5G Modules

Sl. No	Manufacturer	Part Number	Power supply	Slide Switch Position for Supply(SW2)	SIM Slot Support
1	Telit	FN980	3.5V	Pin 1 (Default)	USIM1
2	Telit	FN990	3.5V	Pin 1 (Default)	USIM1 and USIM2
3	Quectel	RM502Q	4.2V	Pin 3	USIM1

The mode selection of 5G M.2 Pin 20 is detailed in the following table,

Table 5-18: Mode Selection

Sl. No	Mode	M.2 Pin 20 Configuration
1	PCIe mode	Low (Default Hardware configuration)
2	USB mode	High

5.18. Expansion Connectors

PCIe0, USB Interface and few QUPs from QRB5165 are connected to two expansion connectors on the MRD5165 Eagle Board.

- High speed (HS) connector: PCIE0, USB1 and few GPIOs are terminated to the 80-pin expansion connector.
- Low speed (LS) connector: QUP GPIOs are terminated to the 40-pin low speed expansion connector.

Table 5-19: High Speed (HS) Expansion Connector (J107)

Pin No	Signal	Description
1	Ground	Ground
2	Ground	Ground
3	USB_HS_DP_DN2	USB high speed data - plus
4	USB1_SS_RX_P_DN2	USB super speed 1 receive - plus
5	USB_HS_DM_DN2	USB high speed data - minus
6	USB1_SS_RX_M_DN2	USB super speed 1 receive – minus
7	Ground	Ground
8	Ground	Ground
9	USB1_SS_TX_P_DN2	USB super speed 1 transmit - plus
10	USB1_SS_RX_P_DN3	USB super speed 1 receive - plus
11	USB1_SS_TX_M_DN2	USB super speed 1 transmit - minus
12	USB1_SS_RX_M_DN3	USB super speed 1 receive - minus
13	Ground	Ground
14	Ground	Ground
15	USB_HS_DP_DN3	USB high speed data - plus
16	PCIE0_TX0_M_WLAN_LGA	PCIe 0 Gen 3 transmit 0 - minus
17	USB_HS_DM_DN3	USB high speed data - minus
18	PCIE0_TX0_P_WLAN_LGA	PCIe 0 Gen 3 transmit 0 - plus

19	Ground	Ground
20	Ground	Ground
21	USB1_SS_TX_P_DN3	USB super speed 1Transmit - plus
22	PCIE0_RX0_M_WLAN_LGA	PCIe 0 Gen 3 receive 0 - minus
23	USB1_SS_TX_M_DN3	USB super speed 1 transmit - minus
24	PCIE0_RX0_P_WLAN_LGA	PCIe 0 Gen 3 receive 0 - plus
25	Ground	Ground
26	Ground	Ground
27	PCIE0_REFCLK_M_WLAN_LGA	PCIe 0 Gen 3 reference clock - minus
28	PCIE2_TX0_M	PCIe 2 Gen 3 transmit 0 - minus
29	PCIE0_REFCLK_P_WLAN_LGA	PCIe 0 Gen 3 reference clock - plus
30	PCIE2_TX0_P	PCIe 2 Gen 3 transmit 0 - plus
31	Ground	Ground
32	Ground	Ground
33	PCIE2_REFCLK_M	PCIe 2 Gen 3 reference clock - minus
34	PCIE2_RX0_M	PCIe 2 Gen 3 receive 0 - minus
35	PCIE2_REFCLK_P	PCIe 2 Gen 3 reference clock - plus
36	PCIE2_RX0_P	PCIe 2 Gen 3 receive 0 - plus
37	Ground	Ground
38	Ground	Ground
39	CSI3_LN0_A	MIPI CSI3 CPHY single lane 0 - A
40	PCIE2_TX1_M	PCIe 2 Gen 3 transmit 1 - minus
41	CSI3_LN0_B	MIPI CSI3 CPHY single lane 0 - B
42	PCIE2_TX1_P	PCIe 2 Gen 3 transmit 1 - plus
43	CSI3_LN0_C	MIPI CSI3 CPHY single lane 0 - C
44	Ground	Ground
45	CSI3_LN0_NC	MIPI CSI3 CPHY single lane 0 - NC
46	PCIE2_RX1_M	PCIe 2 Gen 3 receive 1 - minus
47	Ground	Ground
48	PCIE2_RX1_P	PCIe 2 Gen 3 receive 1 - plus
49	SLEEP_CLK	sleep clock is input to the Wi-Fi module
50	Ground	Ground
51	GPIO_91	USB ID
52	CSI4_LN0_A	MIPI CSI4 CPHY single lane 0 - A
53	GPIO-MM	GPIO for PCIe
54	CSI4_LN0_B	MIPI CSI4 CPHY single lane 0 - B
55	PM_AMUX3	ADC pin
56	CSI4_LN0_C	MIPI CSI4 CPHY single lane 0 - C
57	PCIE0_CLK_REQ_N_LGA	PCIe 0 Gen 3 clock - minus
58	CSI4_LN0_NC	MIPI CSI4 CPHY single lane 0 - NC
59	PCIE0_WAKE_N_LGA	PCIe 0 Gen 3 wake - minus
60	Ground	Ground
61	PCIE0_RST_N_LGA	PCIe 0 Gen 3 reset - minus
62	VCC_5V0	Power supply 5V
63	USB1_PWRCTL2	Load switch enable for the second port for the USB hub
64	DMIC_CLK3	I2S2 data1 for Wi-Fi module
65	USB1_OVERCUR2z	Load switch interrupt for second port for USB hub
66	DMIC_DATA3	I2S2 data0 for Wi-Fi module
67	USB1_PWRCTL3	Load switch enable for the third port for the USB hub
68	WSA_SWR_CLK	I2S2 clock for Wi-Fi module
69	USB1_OVERCUR3z	Load switch interrupt for third port for USB hub
70	WSA_SWR_DATA	I2S2 word select for Wi-Fi module
71	GPIO_138	General Purpose I/O
72	QRB_GPIO_11	GPIO for PCie2
73	GPIO-GG	PCIe clock request
74	VCC_3V3	Power supply 3.3V
75	GPIO-HH	PCIe wake

76	VCC_DC_IN	Power supply 12V-36V
77	GPIO-FF	PCIe reset
78	VCC_DC_IN	Power supply 12V-36V
79	VREG_S4A_1P8	Power supply 1.8V
80	VCC_DC_IN	Power supply 12V-36V

Table 5-20: Low Speed (LS) Expansion Connector (J106)

Pin No	Signal	Description
1	Ground	Ground
2	Ground	Ground
3	VCC_3V3	3.3V supply
4	VCC_DC_IN	12V supply
5	VREG_S4A_1P8	1V8 supply
6	GPIO-G	General Purpose I/O
7	AP_LS_EXP_UART0_TX	UART TX Provision (3V3 Logic Level)
8	GPIO-K	General Purpose I/O
9	AP_LS_EXP_UART0_RX	UART RX Provision (3V3 Logic Level)
10	GPIO-I	General Purpose I/O
11	GPIO-E	General Purpose I/O
12	GPIO-B	General Purpose I/O
13	GPIO-D	General Purpose I/O
14	GPIO-J	General Purpose I/O
15	AP_LS_EXP_SPI0_MISO	SPI0 Data input
16	GPIO-L	General Purpose I/O
17	AP_LS_EXP_SPI0_MOSI	SPI0 Data output
18	GPIO-F	General Purpose I/O
19	AP_LS_EXP_SPI0_SCLK	SPI0 Clock input
20	GPIO_116	General Purpose I/O
21	AP_LS_EXP_SPI0_CS0	SPI0 Chip select
22	GPIO-A	General Purpose I/O
23	SPI1_MISO	SPI1 Data output
24	GPIO-C	General Purpose I/O
25	SPI1_MOSI	SPI1 Data output
26	CAN_H	CAN high level I/O voltage
27	SPI1_CLK	SPI1 Clock input
28	CAN_L	CAN low level I/O voltage
29	SPI1_CS	SPI1 Chip select
30	SSC_LS_EXP_I2C0_SDA	I2C0 Data
31	SDM_FAST_BOOT_1	General Purpose I/O
32	SSC_LS_EXP_I2C0_SCL	I2C0 Clock
33	SPI2_MISO	SPI2 Data input
34	SSC_LS_EXP_I2C1_SDA	I2C1 Data
35	SPI2_MOSI	SPI2 Data output
36	SSC_LS_EXP_I2C1_SCL	I2C1 Clock
37	SPI2_CLK	SPI2 Clock input
38	SERIAL2_CTS	UART CTS Signal (3V3 Logic Level)
39	SPI2_CS1	SPI2 Chip select
40	SERIAL2_RTS	UART RTS Signal (3V3 Logic Level)

5.19. Cube B2B Connector

The MRD5165 Flight Control Unit is mating to the MRD5165 Eagle Board using a B2B Connector (J107). Cube Orange+ is interfaced to QRB5165 through UART0.

Table 5-21: B2B Connector (J107)

Pin No	Signal	Description
1	Ground	Ground
2	Ground	Ground
3	CANL_CUBE	CANL Signal
4	SERIAL2_RTS	UART RTS Signal
5	CANH_CUBE	CANH Signal
6	SERIAL2_CTS	UART CTS Signal
7	Ground	Ground
8	AP_LS_EXP_UART0_TX	UART TX Signal
9	VCC_DC_IN	12V-36V DC Input Power Supply
10	AP_LS_EXP_UART0_RX	UART RX
11	VCC_DC_IN	12V-36V DC Input Power Supply
12	Ground	Ground

5.20. Control Switches

The MRD5165 Eagle Board supports multiple user Push button control switches for providing different modes and functions like fast boot and EDL mode to the processor.

Table 5-22: Control Switch

Pin No	Push button	Signal	Description
1	SW2	KYPD_VOLP_N	Volume Up button
2	SW3	PM_RESIN_N	Volume Down and EDL mode button
3	SW4	PHONE_ON_N	Power On button
4	SW5	SDM_FORCE_USB_BOOT	Fast boot mode & Forced USB Boot

Figure 5-2: Control Switches

5.21. Boot switch

The DIP switch can be used to control the Boot modes. Default state of the various pins are mentioned in the below table,

Table 5-23: DIP Switch setting

Sl No	Signal	Function	Default Condition
1	SDM_FAST_BOOT_0	Boot configuration(1)	OFF
2	SDM_FAST_BOOT_1	Boot configuration(2)	OFF
3	SD_DAT0	Boot configuration(3)	OFF
4	GPIO-P	Boot configuration(0)	OFF
5	CBL_PWR_N	CBL power for SOM	ON

The MRD5165 Eagle Kit LR Wi-Fi supports booting from UFS0 as default option. The boot modes shall be selected by configuring the boot pins as stated below,

Note: The current platform supports booting from UFS, while other options can be evaluated in future.

Table 5-24 : MRD5165 SoM Boot Modes

FAST_BOOT GPIO [3:0]	GPIO no.				Boot device
	90	**76**	**47**	**27**	
0000	0	0	0	0	Default: UFS0 -> eDL (USB0)
0001	0	0	0	1	SDC2 -> UFS0 -> eDL (USB0)
0010	0	0	1	0	SDC2 ->eDL (USB0)
0011	0	0	1	1	UFS0 -> eDL (SDC2 -> USB0)
0110	0	1	1	0	UFS0 -> USB0 -> eDL (USB0)
0111	0	1	1	1	Same as Fastboot [3:0] = 0000 UFS0 -> SDC2 -> USB0 -> eDL (USB0)
Others					Reserved

5.22. External IMU Connector

The MRD5165 Eagle Board supports external IMU.

Note: To validate the external IMU, require modification on Eagle board to disable the On Board IMU with resistor DNI option (Future use)

On-Board Connector Part number: **5054730810**

Table 5-25: IMU Connector(J104)

Pin No	Signal	Description
A1	Ground	Ground
A2	Ground	Ground
P1	VREG_VSENSOR_1P8	Power supply 1.8V
P2	Ground	Ground
1	SPI2_CLK	SPI1 Clock input
2	SPI2_ACCEL_CS	SPI1 Chip select
3	ACCEL_INT	Interrupt
4	SPI2_MISO	SPI1 Data input
P3	GYRO_INT	Interrupt
P4	SPI2_MOSI	SPI1 Data output
B1	Ground	Ground
B2	Ground	Ground

6. MRD5165 Flight Control Unit Peripherals

The MRD5165 Flight Control Unit which provides provision for connecting the Flight control unit peripherals is mating to the MRD5165 Eagle Board using a B2B Connector.

Various peripherals of the MRD5165 Flight Control Unit are depicted below.

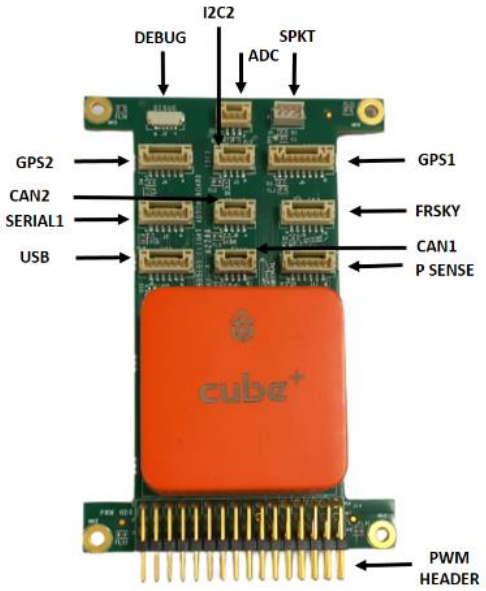

Figure 6-1: MRD5165 Flight control unit Peripherals

6.1.Cube B2B Connector

The MRD5165 Flight Control Unit has a B2B connector (J13) for mounting the Cube pilot's Cube Orange+ module.

Table 6-1: Cube B2B connector(J13)

Pin No	Signal	Description
1	FMU_SWDIO	FMU serial wire debug I/O
2	FMU_LED_AMBER	Boot error LED (drive only, controlled by FET)
3	FMU_LED_AMBER	FMU serial wire debug clock
4	I2C2_SDA	I2C Serial Data Tx/Rx (3V3)
5	EXTERN_CS	Chip select for external SPI (NC, just for debugging)
6	I2C2_SCL	I2C Serial Clock Signal (3V3)
7	FMU_RESETn	Reset pin for the FMU
8	NC	Not connected
9	VDD_SERVO_IN	5V Power Supply
10	NC	Not connected
11	EXTERN_DRDY	Interrupt pin for external SPI (NC, just for debugging)
12	SERIAL5_RX	UART 5 RX (Receive Data) (3V3)
13	GROUND	System GND
14	SERIAL5_TX	UART 5 TX (Transmit Data) (3V3)
15	GROUND	System GND
16	SERIAL4_RX	UART 4 RX (Receive Data) (3V3)
17	SAFETY	Safety button input
18	SERIAL4_TX	UART 4 TX (Transmit Data) (3V3)
19	VDD_3V3_SPEKTRUM_EN	Enable for the Spektrum voltage regulator
20	SERIAL3_RX	UART 3 RX (Receive Data) (3V3)

21	PRESSURE_SENS_IN	Analogue Signal port, for pressure sensor, Laser range finder, or Sonar
22	SERIAL3_TX	UART 3 TX (Transmit Data) (3V3)
23	AUX_BATT_VOLTAGE_SENS	Voltage sense for Aux battery input
24	ALARM	Buzzer PWM Signal
25	AUX_BATT_CURRENT_SENS	Current sense for Aux battery input
26	IO_VDD_3V3	Not connected
27	VDD_5V_PERIPH_EN	Enable voltage supply for Peripherals
28	IO_LED_SAFET_PORT	IO-LED_SAFETY (safety LED) pinned out for IRIS
29	VBUS	USB VBus (VDD)
30	SERIAL2_RTS	UART 2 RTS (Request To Send)
31	OTG_DP1	USB Data+ (D)
32	SERIAL2_CTS	UART 2 CTS (Clear To Send)
33	OTG_DM1	USB Data- (M)
34	SERIAL2_RX	UART 2 RX (Receive Data)
35	I2C1_SDA	I2C Serial Data Tx/Rx
36	SERIAL2_TX	UART 2 TX (Transmit Data)
37	I2C1_SCL	I2C Serial Clock Signal
38	SERIAL1_RX	UART 1 RX (Receive Data)
39	CAN2_L	FMU CAN bus Low Signal Driver
40	SERIAL1_TX	UART 1 TX (Transmit Data)
41	CAN2_H	FMU CAN bus High Signal Driver
42	SERIAL1_RTS	UART 1 RTS (Request To Send)
43	VDD_5V_PERIPH_OC	Error state message from Peripheral power supply
44	SERIAL1_CTS	UART 1 CTS (Clear To Send)
45	VDD_5V_HIPOWER_OC	Error state message from High power Peripheral power supply
46	IO_USART1_TX	I/O USART 1 TX
47	BATT_VOLTAGE_SENS_PORT	Voltage sense from main battery
48	IO_USART1_RX_SPKT_DSM	Signal from Spectrum receiver
49	BATT_CURRENT_SENS_PORT	Current sense from main battery
50	FMU_CH1_PORT	FMU PWM output channel 1
51	SPI_EXT_MOSI	External SPI, for debug only
52	FMU_CH2_PORT	FMU PWM output channel 2
53	VDD_SERVO	VDD_Servo, for monitoring servo bus
54	FMU_CH3_PORT	FMU PWM Output Channel 3
55	VDD_BRICK_VALID	Main Power valid signal
56	FMU_CH4_PORT	FMU PWM Output Channel 4
57	VDD_BRICK_VALID	Backup Power valid Signal
58	FMU_CH5_PORT	FMU PWM Output Channel 5
59	VBUS_VALID	USB bus valid signal
60	FMU_CH6_PORT	FMU PWM Output Channel 6
61	VDD_5V0_IN_PORT	Main power (5V) into FMU from power selection
62	PPM_SBUS_PORT	PPM / S.Bus Signal Input
63	VDD_5V0_IN_PORT	Main power (5V) into FMU from power selection
64	SBUS_OUT	S.Bus Signal Output
65	IO_VDD_5V5	Not connected
66	IO_CH8_PORT	I/O PWM Output Channel 8
67	SPI_EXT_MISO	External SPI, for Debug only
68	IO_CH7_PORT	I/O PWM Channel 7
69	IO_SWDIO	I/O serial wire debug
70	IO_CH6_PORT	I/O PWM Output Channel 6
71	IO_SWCLK	I/O Serial Wire Debug Clock
72	IO_CH5_PORT	I/O PWM Output Channel 5
73	SPI_EXT_SCK	External SPI, for Debug only
74	IO_CH4_PORT	I/O PWM Output Channel 4
75	IO_RESETn	I/O Reset Pin

76	IO_CH3_PORT	I/O PWM Output Channel 3
77	CAN1_L	FMU CAN bus Low Signal Driver
78	IO_CH2_PORT	I/O PWM Output Channel 2
79	CAN1_H	FMU CAN bus High Signal Driver
80	IO_CH1_PORT	I/O PWM Output Channel 1

Figure 6-2: Cube B2B Connector

6.2. P Sense Connector

The MRD5165 Flight Control Unit has a P Sense connector to sense the current and voltage. The power supply 5.35V is coming from the flight control unit.

On-Board Connector Part number: BM06B-GHS-TBT(LF)(SN)(N)

Mating Connector Part number: GHR-06V-S

Table 6-2: Psense Connector (J12)

Pin No	Signal	Description
1	VDD_5V0_IN_PORT	5V35 Power supply (Out)
2	BATT_VOLTAGE_SENS_PORT	Battery Voltage Sense Connecter (3.3V)
3	BATT_CURRENT_SENS_PORT	Battery Current Sense Connecter (3.3V)
4	AUX_BATT_VOLTAGE_SENS	Auxiliary Battery Voltage Connecter (3.3V)
5	AUX_BATT_CURRENT_SENS	Auxiliary Battery Current Connecter (3.3V)
6	GROUND	Ground

P Sense Mating Cable Details: We can sense the voltage and Current using 3-pin P Sense cable by connecting with Power Brick Mini (PBM). The cable will have 3 pin connection (2,3,6), it have two markings at each corner. Connect the PBM side to Power Brick Module and connect the other end which is mentioned as FCU side to the P Sense connector located on the FCU board.

6.3. CAN1 Connector

The MRD5165 Flight Control Unit has a CAN1 connector for connecting the device supports CAN like GPS.

On-Board Connector Part number: BM04B-GHS-TBT(LF)(SN)(N)

Mating Connector Part number: GHR-04V-S

Table 6-3: CAN1 Connector(J11)

Pin No	Signal	Description
1	VDD_5V_PERIPH	5V Power supply
2	CAN1_H	CAN High
3	CAN1_L	CAN Low
4	GROUND	Ground

6.4. USB Connector

The MRD5165 Flight Control Unit has a USB connector for connecting device supports USB.

On-Board Connector Part number: BM06B-GHS-TBT(LF)(SN)(N)

Mating Part number: GHR-06V-S

Table 6-4: USB Connector(J10)

Pin No	Signal	Description
1	VBUS	5V Power supply
2	OTG_DP1	USB Data Positive (D+)
3	OTG_DM1	USB Data Minus (D-)
4	GROUND	Ground
5	BUZZER_OUT	Buzzer Output
6	FMU_LED_AMBER	Boot / Error LED (FW updates)

6.5. FR SKY Connector

The MRD5165 Flight Control Unit has a FR SKY connector for connecting device supports serial UART.

On-Board Connector Part number: BM06B-GHS-TBT(LF)(SN)(N)

Mating Connector Part number: GHR-06V-S

Table 6-5: FR SKY Connector(J9)

Pin No	Signal	Description
1	VDD_SERVO	5V35 Power supply
2	SERIAL5_TX	TX of AP FMU_uart5 TX(3.3V)
3	SERIAL5_RX	RX of AP FMU_uart5 RX (3.3V)
4	FMU_SWDIO	Serial wire debug I/O(3.3V)
5	FMU_SWCLK	Serial wire Clock(3.3V)
6	GROUND	Ground

6.6. CAN2 Connector

The MRD5165 Flight Control Unit has a CAN2 connector for connecting the device supports CAN like GPS.

On-Board Connector Part number: BM04B-GHS-TBT(LF)(SN)(N)

Mating Connector Part number: GHR-04V-S

Table 6-6: CAN2 Connector(J8)

Pin No	Signal	Description
1	VDD_5V_PERIPH	5V35 Power supply
2	CAN2_H	CAN2 High
3	CAN2_L	CAN2 Low
4	GROUND	Ground

6.7.Serial1 Connector

The MRD5165 Flight Control Unit has a Serial1 connector for connecting telemetry serial devices.

On-Board Connector Part number: BM06B-GHS-TBT(LF)(SN)(N)

Mating Connector Part number: GHR-06V-S

Table 6-7: SERIAL1 Connector(J7)

Pin No	Signal	Description
1	VDD_5V_HIPOWER	5V35 Power supply
2	SERIAL1_TX	UART1 TX (Transmit Data) (3.3V)
3	SERIAL1_RX	UART 1 RX (Receiver Data) (3.3V)
4	SERIAL1_CTS	UART 1 CTS (Clear To Send) (3.3V)
5	SERIAL1_RTS	UART 1 RTS (Request To Send) (3.3V)
6	GROUND	Ground

6.8.GPS1 Connector

The MRD5165 Flight Control Unit has a GPS1 connector for connecting the GPS device like Here3+ to track the location.

On-Board Connector Part number: BM08B-GHS-TBT(LF)(SN)(N)

Mating Connector Part number: GHR-08V-S

Table 6-8: GPS1 Connector(J6)

Pin No	Signal	Description
1	VDD_5V_PERIPH	5V35 Power supply
2	SERIAL3_TX	UART3 TX (Transmit Data) (3.3V)
3	SERIAL3_RX	UART 3 RX (Receiver Data) (3.3V)
4	I2C1_SCL	I2C1 Clock(3.3V)
5	I2C1_SDA	I2C1 Data(3.3V)
6	SAFETY	Signal shorted to GND on press
7	IO_LED_SAFET_PORT	LED Driver For Safety Button(12V)
8	GROUND	Ground

6.9. I2C2 Connector

The MRD5165 Flight Control Unit has an I2C2 connector for connecting the I2C support devices.

On-Board Connector Part number: BM04B-GHS-TBT(LF)(SN)(N)

Mating Connector Part number: GHR-08V-S

Table 6-9: I2C2 Connector(J5)

Pin No	Signal	Description
1	VDD_5V_PERIPH	5V35 Power supply
2	I2C2_SCL	I2C2 Clock(3.3V)
3	I2C2_SDA	I2C2 Data(3.3V)
4	GROUND	Ground

6.10. GPS2 Connector

The MRD5165 Flight Control Unit has a GPS2 connector for connecting the GPS devices like Here3+ to track the location.

On-Board Connector Part number: BM06B-GHS-TBT(LF)(SN)(N)

Mating Connector Part number: GHR-06V-S

Table 6-10: GPS2 Connector(J4)

Pin No	Signal	Description
1	VDD_5V_PERIPH	5V35 Power supply
2	SERIAL4_TX	Universal asynchronous transmit 4(3.3V)
3	SERIAL4_RX	Universal asynchronous receiver 4(3.3V)
4	I2C2_SCL	I2C Clock(3.3V)
5	I2C2_SDA	I2C Data(3.3V)
6	GROUND	Ground

6.11. SPKT Connector

The MRD5165 Flight Control Unit has a SPKT connector for spektrum satellite receivers to connect with FCU using serial protocol for transferring the control signals and telemetry data.

On-Board Connector Part number: B3B-ZR(LF)(SN)

Mating Connector Part number: ZHR-3

Table 6-11: SPKT Connector(J1)

Pin No	Signal	Description
1	VDD_3V3_SPEKTRUM	Power supply 3.3V
2	GROUND	Ground
3	IO_USART1_RX_SPKT_DSM	Universal synchronous/asynchronous receiver(3.3V)

6.12. ADC Connector

The MRD5165 Flight Control Unit has an ADC connector for measuring pressure sense value.

On-Board Connector Part number: BM03B-GHS-TBT(LF)(SN)(N)

Mating Connector Part number: GHR-03V-S

Table 6-12: ADC Connector(J3)

Pin No	Signal	Description
1	VDD_5V_PERIPH	5V35 Power supply
2	PRESSURE_SENS_IN	Pressure sense(6V max)
3	GROUND	Ground

6.13. DEBUG Connector

The MRD5165 Flight Control Unit has I/O connector for debugging.

On-Board Connector Part number: SM06B-SURS-TF(LF)(SN

Mating Connector Part number: SUHR-06V-S-B

Table 6-13: DEBUG Connector(J2)

Pin No	Signal	Description
1	VDD_5V_PERIPH	Power supply 5V
2	IO_USART1_TX	Universal asynchronous transmit(3.3V)
3	IO_USART1_RX_SPKT_DSM	Universal asynchronous receiver(3.3V)
4	IO_SWDIO	Serial Wire Debug data(3.3V)
5	IO_SWCLK	Serial Wire Debug clock(3.3V)
6	GROUND	Ground

6.14. PWM Header

The MRD5165 Flight Control Unit has a PWM header for connecting motors/servos for running vehicle in the airframe.

Table 6-14: PWM Header(J14)

Pin No	Signal	Description
1	FMU_CH1_PORT	3.3 V Servo Signal, Servo Rail Power
2	GROUND	Ground
3	GROUND	Ground
4	FMU_CH2_PORT	3.3 V Servo Signal, Servo Rail Power
5	GROUND	Ground
6	GROUND	Ground
7	FMU_CH3_PORT	3.3 V Servo Signal, Servo Rail Power
8	GROUND	Ground
9	GROUND	Ground
10	FMU_CH4_PORT	3.3 V Servo Signal, Servo Rail Power
11	GROUND	Ground
12	GROUND	Ground
13	FMU_CH5_PORT	3.3 V Servo Signal, Servo Rail Power
14	GROUND	Ground
15	GROUND	Ground
16	FMU_CH6_PORT	3.3 V Servo Signal, Servo Rail Power
17	GROUND	Ground
18	GROUND	Ground
19	IO_CH1_PORT	3.3 V Servo Signal, Servo Rail Power
20	GROUND	Ground
21	GROUND	Ground
22	IO_CH2_PORT	3.3 V Servo Signal, Servo Rail Power
23	GROUND	Ground

24	GROUND	Ground
25	IO_CH3_PORT	3.3 V Servo Signal, Servo Rail Power
26	GROUND	Ground
27	GROUND	Ground
28	IO_CH4_PORT	3.3 V Servo Signal, Servo Rail Power
29	GROUND	Ground
30	GROUND	Ground
31	IO_CH5_PORT	3.3 V Servo Signal, Servo Rail Power
32	GROUND	Ground
33	GROUND	Ground
34	IO_CH6_PORT	3.3 V Servo Signal, Servo Rail Power
35	GROUND	Ground
36	GROUND	Ground
37	IO_CH7_PORT	3.3 V Servo Signal, Servo Rail Power
38	GROUND	Ground
39	GROUND	Ground
40	IO_CH8_PORT	3.3 V Servo Signal, Servo Rail Power
41	GROUND	Ground
42	GROUND	Ground
43	PPM_SBUS_PORT	3.3 V / 4.5 V Powered
44	GROUND	Ground
45	GROUND	Ground
46	SBUS_OUT	Serial bus out
47	GROUND	Ground
48	GROUND	Ground

7. MRD5165 Eagle Kit LR Wi-Fi Board Interfaces

7.1. LR Wi-Fi M.2 Connector

PCIe2 interface from QRB5165 is connected to M.2 E key connector for interfacing off-the-shelf LR Wi-Fi module.

Table 7-1: LR Wi-Fi M.2 Connector(J13)

Pin No	Signal	Description
1	Ground	Ground
2	VCC_3V3_LR	Power supply 3.3V
3	NC	Not Connected
4	VCC_3V3_LR	Power supply 3.3V
5	NC	Not Connected
6	TP7	Test Point
7	Ground	Ground
8	TP6	Test Point
9	NC	Not Connected
10	TP5	Test Point
11	NC	Not Connected
12	NC	Not Connected
13	NC	Not Connected
14	NC	Not Connected
15	VCC_LR_XPA	Power supply 5V
16	NC	Not Connected
17	VCC_LR_XPA	Power supply 5V
18	Ground	Ground
19	VCC_LR_XPA	Power supply 5V
20	NC	Not Connected
21	VCC_LR_XPA	Power supply 5V
22	NC	Not Connected

23	VCC_LR_XPA	Power supply 5V
24	NC	Not Connected
25	NC	Not Connected
26	NC	Not Connected
27	NC	Not Connected
28	NC	Not Connected
29	NC	Not Connected
30	NC	Not Connected
31	NC	Not Connected
32	NC	Not Connected
33	Ground	Ground
34	NC	Not Connected
35	PCIE2_TX0_LR_P	PCIe 2 Gen 3 transmit 0 - plus
36	NC	Not Connected
37	PCIE2_TX0_LR_M	PCIe 2 Gen 3 transmit 0 - minus
38	TP9	Test Point
39	Ground	Ground
40	TP8	Test Point
41	PCIE2_RX0_LR_P	PCIe 2 Gen 3 receive 0 - plus
42	TP13	Test Point
43	PCIE2_RX0_LR_M	PCIe 2 Gen 3 receive 0 - minus
44	TP12	Test Point
45	Ground	Ground
46	TP17	Test Point
47	PCIE2_REFCLK_LR_P	PCIe 2 Gen 3 reference clock - plus
48	TP16	Test Point
49	PCIE2_REFCLK_LR_M	PCIe 2 Gen 3 reference clock - minus
50	NC	Not Connected
51	Ground	Ground
52	PCIE2_RST_N_3V3	PCIe 2 Gen 3 reset - minus
53	PCIE2_CLK_REQ_3V3	PCIe 2 Gen 3 clock
54	NC	Not Connected
55	PCIE2_WAKE_N_3V3	PCIe 2 Gen 3 wake
56	NC	Not Connected
57	Ground	Ground
58	NC	Not Connected
59	PCIE2_TX1_LR_P	PCIe 2 Gen 3 transmit 1 - plus
60	NC	Not Connected
61	PCIE2_TX1_LR_M	PCIe 2 Gen 3 transmit 1 - minus
62	NC	Not Connected
63	Ground	Ground
64	NC	Not Connected
65	PCIE2_RX1_LR_P	PCIe 2 Gen 3 receive 1 - plus
66	NC	Not Connected
67	PCIE2_RX1_LR_M	PCIe 2 Gen 3 receive 1 - minus
68	NC	Not Connected
69	Ground	Ground
70	NC	Not Connected
71	NC	Not Connected
72	VCC_3V3_LR	Power supply 3.3V
73	NC	Not Connected
74	VCC_3V3_LR	Power supply 3.3V
75	Ground	Ground

Mistral tested and validated the following LR Wi-Fi Modules,

Table 7-2: LR Wi-Fi Module

Sl. No	Manufacturer	Part Number	Power supply
1	Doodle Labs	AX-TB6S-4-MM	3.3V

7.2. 5G M.2 Connector

PCIe0/USB_DN3 interface from QRB5165 is connected to M.2 B key connector for interfacing off-the-shelf 5G/LTE solutions in the MRD5165 LR Wi-Fi Board.

Note: By default 5G module will be accessed via USB mode. To validate the 5G PCIe0 mode, require modification on SoM board to disable the On Board Wi-Fi with resistor DNI option (Future use)

Table 7-3: 5G Module Connector (J98)

Pin No	Signal	Description
1	CONFIG_3	Based on the state of the configuration pins on the module, being tied to GND or left NC
2	VCC_5G	5G Module Power supply
3	Ground	Ground
4	VCC_5G	5G Module Power supply
5	Ground	Ground
6	MODULE_PWRKEY	Module On/Off High - Default on condition Low - Power OFF condition
7	USB_HS_5G_DP	USB 2.0 Data Plus
8	MODULE_W_DISABLED_N	RF disable
9	USB_HS_ 5G_DM	USB 2.0 Data Minus
10	MODULE_STATUS	LED control
11	Ground	Ground
12	NC	Not connected
13	NC	Not connected
14	NC	Not connected
15	NC	Not connected
16	NC	Not connected
17	NC	Not connected
18	NC	Not connected
19	NC	Not connected
20	PCM_CLK	Switch Host Interface High: USB Low: PCIe (default)
21	CONFIG_0	Based on the state of the configuration pins on the module, being tied to GND or left NC
22	PCM_DIN	Not connected
23	WAKE_ON_WAN_N	Coexistence transmit/Wake Host
24	PCM_DOUT	Not connected
25	DYN_PWR_CTRL	Dynamic power control
26	GPS_DISABLE_N	RF function can also be enabled or disabled through AT commands
27	Ground	Ground
28	PCM_SYNC	Not connected
29	USB3_SS_RX_5G_M	USB 3.1 super-speed receive - Minus
30	USIM1_RST	Reset output to an external UIM1 card
31	USB3_SS_RX_5G_P	USB 3.1 super-speed receive - Plus
32	USIM1_CLK	Clock output to an external UIM1 card

33	Ground	Ground
34	USIM1_DATA	Data connection with an external UIM1 card
35	USB3_SS_TX_5G_M	USB 3.1 super-speed transmit - Minus
36	USIM1_VDD	Supply output for an external UIM1 card
37	USB3_SS_TX_5G_P	USB 3.1 super-speed transmit - Plus
38	DEVSLP	Test Point
39	Ground	Ground
40	5G_GPIO_0	SIM card detection signal for SIM connector 2
41	PCIE0_RX0_5G_M	PCIe 1 Receive 0 – minus
42	5G_GPIO_1	Data signal for SIM connector 2
43	PCIE0_RX0_5G_P	PCIe 1 Receive 0 – plus
44	5G_GPIO_2	Clock signal for SIM connector 2
45	Ground	Ground
46	5G_GPIO_3	Reset signal for SIM connector 2
47	PCIE0_TX0_5G_M	PCIe1 Transmit 0 – minus
48	5G_GPIO_4	Power supply for SIM connector 2
49	PCIE0_TX0_5G_P	PCIe 1 Transmit 0 – plus
50	PCIE0_RST_N_3V3	Functional reset to the PCIe bus: Active LOW
51	Ground	Ground
52	PCIE0_CLK_REQ_3V3	PCIe 1 reference clock request signal: Active LOW
53	PCIE0_REFCLK_5G_M	PCIe 1 differential reference clock – minus
54	PCIE0_WAKE_N_3V3	PCIe1 wake-up: Active LOW
55	PCIE0_REFCLK_5G_P	PCIe 1 differential reference clock – plus
56	NC	Not connected
57	Ground	Ground
58	NC	Not connected
59	WL_XFEM_CTRL_LAA_TXEN_GPIO	General Purpose I/O
60	WL_XFEM_CTRL_WL_TXEN_GPIO	General Purpose I/O
61	ANTCTL1	Test Point
62	COEX2	General Purpose I/O
63	ANTCTL2	Test Point
64	COEX1	General Purpose I/O
65	RFFE_VIO_1V8	Reference Voltage
66	USIM1_DET_M2_MOD	UIM1 Card Present Detect
67	MODULE_RESET_N	Reset Input: Active high signal
68	SUSCLK	Not connected
69	CONFIG_1	Based on the state of the configuration pins on the module, being tied to GND or left NC
70	VCC_5G	5G Module Power supply
71	Ground	Ground
72	VCC_5G	5G Module Power supply
73	Ground	Ground
74	VCC_5G	5G Module Power supply
75	CONFIG2	Based on the state of the configuration pins on the module, being tied to GND or left NC

Mistral tested and validated the following 5G Modules,

Table 7-4: 5G Modules

Sl. No	Manufacturer	Part Number	Power supply	Slide Switch Position for Supply(SW2)	SIM Slot Support
1	Telit	FN980	3.3V	Pin 1 (Default)	USIM1
2	Telit	FN990	3.3V	Pin 1 (Default)	USIM1 and USIM2
3	Quectel	RM502Q	4.2V	Pin 3	USIM1

The mode selection of 5G M.2 Pin 20 is detailed in the following table,

Table 7-5: Mode Selection

Sl. No	Mode	M.2 Pin 20 Configuration
1	PCIe mode	Low
2	USB mode	High (Default Hardware configuration)

7.3. Nano SIM Connectors

The MRD5165 Eagle Kit LR Wi-Fi has 2x Nano SIM connector for 5G Module connectivity.

Table 7-6: LR SIM1 Connector (J2 - USIM1)

Pin No	Signal	Description
C1	USIM1_VDD	Power supply 1.8V
C2	RST_SIM	Reset signal
C3	CLK_SIM	Clock signal
C5	Ground	Ground
C6	TP	Test Point
C7	DATA_SIM	Data signal
CSW	Ground	Ground
DSW	USIM1_DET_M2	SIM card detection pin

Table 7-7: LR SIM2 Connector (J1 - USIM2)

Pin No	Signal	Description
C1	USIM2_VDD	Power supply 1.8V
C2	RST_SIM2	Reset signal
C3	CLK_SIM2	Clock signal
C5	Ground	Ground
C6	TP	Test Point
C7	DATA_SIM2	Data signal
CSW	Ground	Ground
DSW	SIM2_CARD_DETECT	SIM card detection pin

7.4. FPV IMU Header

The MRD5165 Eagle Kit LR Wi-Fi has a FPV IMU connector for connecting the device supports SPI interface. These connectors are reserved for future use.

Table 7-8: FPV IMU Connector (J10)

Pin No	Signal	Description
1	VREG_S4A_1P8	Power supply 1.8V
2	SPI2_CS1_FPV	Chip select signal

3	SPI2_MOSI_FPV	Master output slave input signal
4	SPI2_MISO_FPV	Master Input slave output signal
5	SPI2_CLK_FPV	Clock Signal
6	IMU_INT1_FPV	Interrupt1 signal
7	IMU_INT2_FPV	Interrupt2 signal
8	Ground	Ground

7.5. CAN Header

The MRD5165 Eagle Kit LR Wi-Fi has a 3 CAN (LR CAN1, LR CAN2 & LR CAN 3) connector for connecting the device supports CAN interface. These connectors are reserved for future use.

Table 7-9: LR CAN1 Connector (J9)

Pin No	Signal	Description
1	VCC_5V0	Power supply 5V
2	CAN_1_H	CAN1 High Signal
3	CAN_1_L	CAN1 Low signal
4	Ground	Ground

Table 7-10: LR CAN2 Connector (J12)

Pin No	Signal	Description
1	VCC_5V0	Power supply 5V
2	CAN_2_H	CAN2 High Signal
3	CAN_2_L	CAN2 Low signal
4	Ground	Ground

Table 7-11: LR CAN3 Connector (J13)

Pin No	Signal	Description
1	VCC_5V0	Power supply 5V
2	CAN_3_H	CAN3 High Signal
3	CAN_3_L	CAN3 Low signal
4	Ground	Ground

7.6. LR HS & LS Expansion Connector

PCIe, USB Interface and few QUPs from QRB5165 are connected to two expansion connectors on the MRD5165 Eagle Board. MRD5165 Eagle Kit LR Wi-Fi Board is mated with MRD5165 Eagle Board through HS LS Mating connector.

- High speed (HS) connector: PCIE0, USB1 and few GPIOs are terminated to the 80-pin expansion connector.
- Low speed (LS) connector: QUP GPIOs are terminated to the 40-pin low speed expansion connector.

Note: The default configuration is assigned to On Board LR Wi-Fi, 5G and other peripherals. To access the LR HS & LS expansion connector, need to make a necessary hardware modifications (Future use)

Table 7-12: HS Expansion Connector (J14)

Pin No	Signal	Description
1	Ground	Ground
2	Ground	Ground
3	USB_HS_DP_DN2	USB high speed data - plus
4	USB1_SS_RX_P_DN2	USB super speed 1 receive - plus
5	USB_HS_DM_DN2	USB high speed data - minus
6	USB1_SS_RX_M_DN2	USB super speed 1 receive – minus
7	Ground	Ground
8	Ground	Ground
9	USB1_SS_TX_P_DN2	USB super speed 1 transmit - plus
10	USB1_SS_RX_P_DN3	USB super speed 1 receive - plus
11	USB1_SS_TX_M_DN2	USB super speed 1 transmit - minus
12	USB1_SS_RX_M_DN3	USB super speed 1 receive - minus
13	Ground	Ground
14	Ground	Ground
15	USB_HS_DP_DN3	USB high speed data - plus
16	PCIE0_TX0_M_WLAN_LGA	PCIe 0 Gen 3 transmit 0 - minus
17	USB_HS_DM_DN3	USB high speed data - minus
18	PCIE0_TX0_P_WLAN_LGA	PCIe 0 Gen 3 transmit 0 - plus
19	Ground	Ground
20	Ground	Ground
21	USB1_SS_TX_P_DN3	USB super speed 1Transmit - plus
22	PCIE0_RX0_M_WLAN_LGA	PCIe 0 Gen 3 receive 0 - minus
23	USB1_SS_TX_M_DN3	USB super speed 1 transmit - minus
24	PCIE0_RX0_P_WLAN_LGA	PCIe 0 Gen 3 receive 0 - plus
25	Ground	Ground
26	Ground	Ground
27	PCIE0_REFCLK_M_WLAN_LGA	PCIe 0 Gen 3 reference clock - minus
28	PCIE2_TX0_M	PCIe 2 Gen 3 transmit 0 - minus
29	PCIE0_REFCLK_P_WLAN_LGA	PCIe 0 Gen 3 reference clock - plus
30	PCIE2_TX0_P	PCIe 2 Gen 3 transmit 0 - plus
31	Ground	Ground
32	Ground	Ground
33	PCIE2_REFCLK_M	PCIe 2 Gen 3 reference clock - minus
34	PCIE2_RX0_M	PCIe 2 Gen 3 receive 0 - minus
35	PCIE2_REFCLK_P	PCIe 2 Gen 3 reference clock - plus
36	PCIE2_RX0_P	PCIe 2 Gen 3 receive 0 - plus
37	Ground	Ground
38	Ground	Ground
39	CSI3_LN0_A	MIPI CSI3 CPHY single lane 0 - A
40	PCIE2_TX1_M	PCIe 2 Gen 3 transmit 1 - minus
41	CSI3_LN0_B	MIPI CSI3 CPHY single lane 0 - B
42	PCIE2_TX1_P	PCIe 2 Gen 3 transmit 1 - plus
43	CSI3_LN0_C	MIPI CSI3 CPHY single lane 0 - C
44	Ground	Ground
45	CSI3_LN0_NC	MIPI CSI3 CPHY single lane 0 - NC
46	PCIE2_RX1_M	PCIe 2 Gen 3 receive 1 - minus
47	Ground	Ground
48	PCIE2_RX1_P	PCIe 2 Gen 3 receive 1 - plus
49	SLEEP_CLK	sleep clock is input to the Wi-Fi module
50	Ground	Ground
51	GPIO_91	USB ID
52	CSI4_LN0_A	MIPI CSI4 CPHY single lane 0 - A
53	GPIO-MM	GPIO for PCIe
54	CSI4_LN0_B	MIPI CSI4 CPHY single lane 0 - B
55	PM_AMUX3	ADC pin
56	CSI4_LN0_C	MIPI CSI4 CPHY single lane 0 - C
57	PCIE0_CLK_REQ_N_LGA	PCIe 0 Gen 3 clock - minus

58	CSI4_LN0_NC	MIPI CSI4 CPHY single lane 0 - NC
59	PCIE0_WAKE_N_LGA	PCIe 0 Gen 3 wake - minus
60	Ground	Ground
61	PCIE0_RST_N_LGA	PCIe 0 Gen 3 reset - minus
62	VCC_5V0	Power supply 5V
63	USB1_PWRCTL2	Load switch enable for the second port for the USB hub
64	DMIC_CLK3	I2S2 data1 for Wi-Fi module
65	USB1_OVERCUR2z	Load switch interrupt for second port for USB hub
66	DMIC_DATA3	I2S2 data0 for Wi-Fi module
67	USB1_PWRCTL3	Load switch enable for the third port for the USB hub
68	WSA_SWR_CLK	I2S2 clock for Wi-Fi module
69	USB1_OVERCUR3z	Load switch interrupt for third port for USB hub
70	WSA_SWR_DATA	I2S2 word select for Wi-Fi module
71	GPIO_138	General Purpose I/O
72	QRB_GPIO_11	GPIO for PCie2
73	GPIO-GG	PCIe clock request
74	VCC_3V3	Power supply 3.3V
75	GPIO-HH	PCIe wake
76	VCC_DC_IN	Power supply 12V-36V
77	GPIO-FF	PCIe reset
78	VCC_DC_IN	Power supply 12V-36V
79	VREG_S4A_1P8	Power supply 1.8V
80	VCC_DC_IN	Power supply 12V-36V

Table 7-13: LS Expansion Connector (J16)

Pin No	Signal	Description
1	Ground	Ground
2	Ground	Ground
3	VCC_3V3	3.3V supply
4	VCC_DC_IN	12V supply
5	VREG_S4A_1P8	1V8 supply
6	GPIO-G	General Purpose I/O
7	AP_LS_EXP_UART0_TX	UART TX Provision (3V3 Logic Level)
8	GPIO-K	General Purpose I/O
9	AP_LS_EXP_UART0_RX	UART RX Provision (3V3 Logic Level)
10	GPIO-I	General Purpose I/O
11	GPIO-E	General Purpose I/O
12	GPIO-B	General Purpose I/O
13	GPIO-D	General Purpose I/O
14	GPIO-J	General Purpose I/O
15	AP_LS_EXP_SPI0_MISO	SPI0 Data input
16	GPIO-L	General Purpose I/O
17	AP_LS_EXP_SPI0_MOSI	SPI0 Data output
18	GPIO-F	General Purpose I/O
19	AP_LS_EXP_SPI0_SCLK	SPI0 Clock input
20	GPIO_116	General Purpose I/O
21	AP_LS_EXP_SPI0_CS0	SPI0 Chip select
22	GPIO-A	General Purpose I/O
23	SPI1_MISO	SPI1 Data output
24	GPIO-C	General Purpose I/O
25	SPI1_MOSI	SPI1 Data output
26	CAN_H	CAN high level I/O voltage
27	SPI1_CLK	SPI1 Clock input
28	CAN_L	CAN low level I/O voltage
29	SPI1_CS	SPI1 Chip select
30	SSC_LS_EXP_I2C0_SDA	I2C0 Data

31	SDM_FAST_BOOT_1	General Purpose I/O
32	SSC_LS_EXP_I2C0_SCL	I2C0 Clock
33	SPI2_MISO	SPI2 Data input
34	SSC_LS_EXP_I2C1_SDA	I2C1 Data
35	SPI2_MOSI	SPI2 Data output
36	SSC_LS_EXP_I2C1_SCL	I2C1 Clock
37	SPI2_CLK	SPI2 Clock input
38	SERIAL2_CTS	UART CTS Signal (3V3 Logic Level)
39	SPI2_CS1	SPI2 Chip select
40	SERIAL2_RTS	UART RTS Signal (3V3 Logic Level)

8. System Setup

Figure 8-1: MRD5165 Eagle Kit LR Wi-Fi - System setup

8.1. Pre-requisites

- The power input shall be connected through power cable in BATT-IN (J1) connector and the supplied DC Adapter.
- The MRD5165 Eagle Board shall be connected to the host PC through an Ethernet IX cable for the data transfer.
- The MRD5165 Eagle Board shall be connected to a host PC through a USB Type C cable for ADB access of the board.
- The HDMI Micro Type-D to Type-A cable shall be connected to host PC for data transfer.
- The USB Micro-B cable shall be connected in debug port for verifying the boot logs.
- Pre-install any serial console application (say Tera term, Minicom, Putty) in the host PC.
- Connect the MRD5165 Flight Control Unit peripherals.
- Connect the I-PEX Camera Adapter to the MRD5165 Eagle Board camera port.
- Connect the antenna Kit to the LR Wi-Fi module to establish LR Wi-Fi connectivity.
  (Note: This antenna kit is part of LR Wi-Fi accessories kit)
- The DIP switch setting shall be set as per the instructions in Section 5-20.

8.2. Camera integration & Testing

Follow below steps for camera integration and testing,

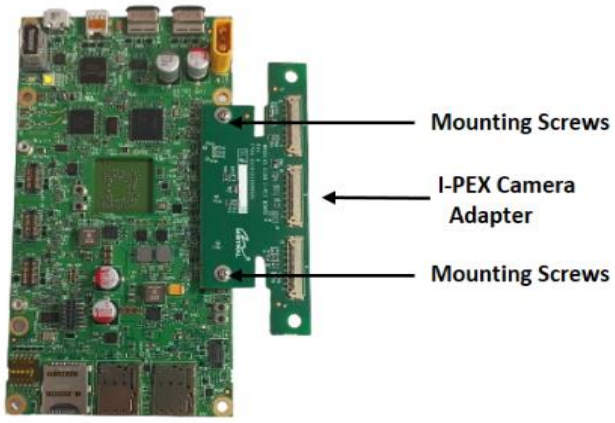

Figure 8-2 : MRD5165 Eagle Board camera connector with I-PEX Camera Adapter

- Connect the I-PEX Camera Adapter as shown above. Align the I-PEX Camera Adapter with mounting hole.
- Fit the adapter with screws provided by mistral.
- Connect the IPEX cable provided by Mistral in I-PEX Camera Adapter
- Connect the IMX577 Camera Adapter or OV9282 Camera Adapter at the other end of IPEX cable provided by Mistral
- Connect the IMX577 or OV9282 camera provided by Mistral.

Note: I-PEX Camera Adapter can be connected either to CSI0, CSI1 & CSI3 port or to CSI2, CSI4 & CSI5 port. For six camera support, we need two I-PEX camera adapter.

9. Mechanical Specifications

9.1.Device Physical Dimensions – 138 x 92 x 59 mm

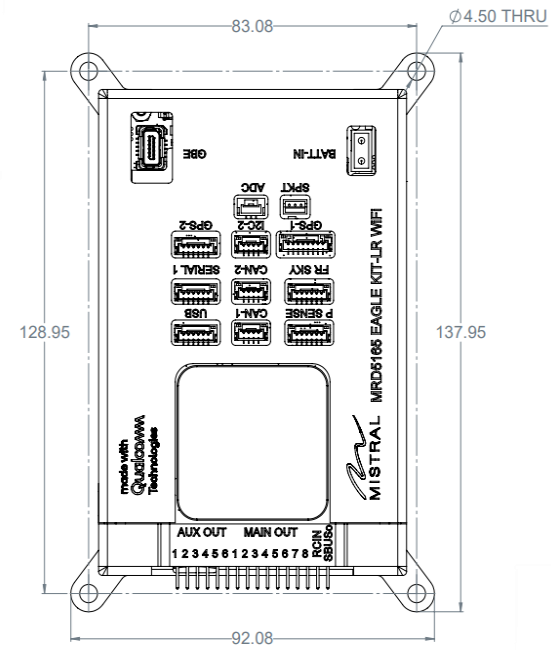

Figure 9-1 : Top View -1

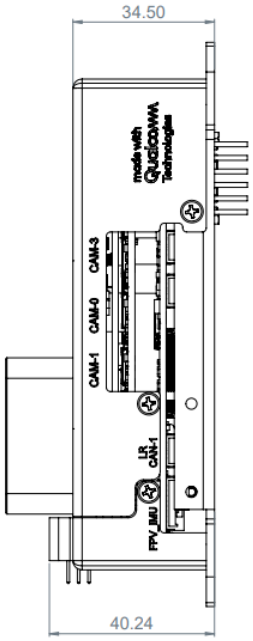

Figure 9-2: Side View-1

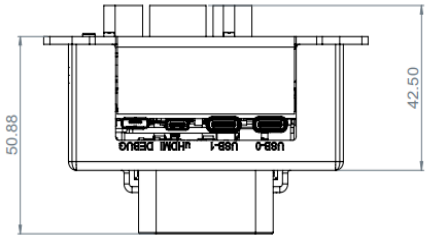

Figure 9-4: Side View - 2

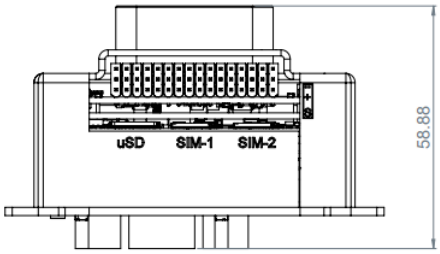

Figure 9-3 : Side View - 3

9.2.Exploded view – MRD5165 Eagle Kit LR Wi-Fi

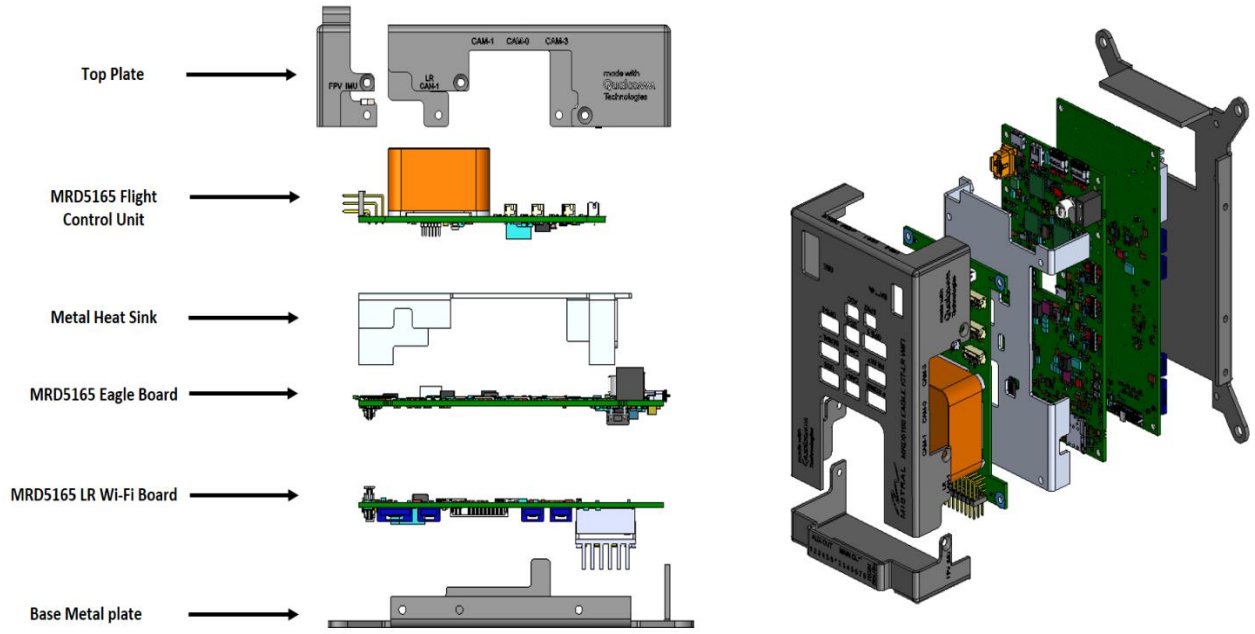

Figure 9-5: MRD5165 Eagle Kit LR Wi-Fi - Exploded view

10. Thermal Management

The standard MRD5165 Eagle Kit LR Wi-Fi comes with Metal enclosure for mechanical stability and thermal management.

Please contact Mistral Solutions for more technical information.

11. Environmental specification

Please contact Mistral Solutions for more information.

12. Ordering information

12.1. Orderable PN

Table 12-1: Orderable Part Number

Sl. No	Order Model	Orderable PN#
1	MRD5165 Eagle Kit LR Wi-Fi + Basic Accessories Kit	MRD5165-EGLR-BK-101
2	Vision Accessories Kit	MRD5165-ACC-VK-101
3	Cable Accessories Kit	MRD5165-ACC-CK-101
4	5G Connectivity Accessories Kit	MRD5165-ACC-MK-101

13. Additional Assistance

Please contact our support team for further assistance:

Phone: India: +91-80-4562 1100

Email: info@mistralsolutions.com

Web: https://mistralsolutions.com/MRD5165

Note: Information contained in this document is subject to change