Intel® Aero Compute Board

Hardware Features and Usage

Rev 1.5.2

Contents

Revision History

Revision Number	Description	Revision Date
1.0	Initial release	February 2017
1.5	Updated the block diagram (Figure 1) • Corrected SPI1 chip-select assignments CS-0 and CS-1 • Added detail for Intel® Aero Flight Controller interfaces Updated the voltage input requirement section 3.6.1 Added CAN bus pin assignments to the table in section 3.7.1 Added a new section discussing the Intel® Aero Flight Controller which is assembled with the Intel® Aero Compute Board inside the Intel® Aero Ready to Fly Drone (section 6)	July 2017
1.5.1	Corrected reference to chip selects in body of text 3.7.1 to match the block diagram in Figure 1	February 2018
1.5.2	Corrected CPU kernel GPIO # and pin assignments in sections 3.7.1 and 3.7.2.2 Updated URL references throughout the document Eliminated one subsection in section 5 that was sufficiently addressed in 5.1 Corrected the pin numbering for the 80-pin IO Expansion Connector in Figure 2 and Figure 7	April 2018

1 Introduction

The Intel® Aero Compute Board is designed with ease and flexibility for connecting a broad variety of sensors and peripherals. In addition to several fixed-function interfaces: USB 3.0 OTG, micro-HDMI, CSI-2 (MIPI), M.2 for SSD, M.2 for LTE, micro-SD, and HSUART, the Compute Board is designed with an IO Expansion Connector (Section 3.7) that exposes 6 processor GPIOs, 28 FPGA GPIOs, and 5 FGPA analog sense inputs (ADC). Chapter 3 describes the pinout for both the fixed-function and programmable interface connectors as well as the method for accessing these interfaces via software. To access the IO Expansion Connector, developers can either use the supplied 80-pin Accessories Connector (Section 3.8) or build a custom expansion / breakout board to suit their needs. Mating connector part numbers are provided in Section 3.1.

This document also defines the function of the 8 LEDs found on the Intel® Aero Compute Board (Chapter 5) and how a developer can control the two LEDs that are user-programmable.

Lastly, some details about the Intel® Aero Flight Controller are captured in Chapter 6. The Intel® Aero Flight Controller is assembled as part of the Intel® Aero Ready to Fly Drone. The Flight Controller plugs directly into the Intel® Aero Compute Board using a dedicated connector. For developers using the Ready to Fly Drone, the block diagram and usage information provided in the referenced web article can be helpful when working with one of the supported autopilots: PX4* and ArduPilot*, or for custom flight control firmware.

2 Intel® Aero Compute Board Block Diagram

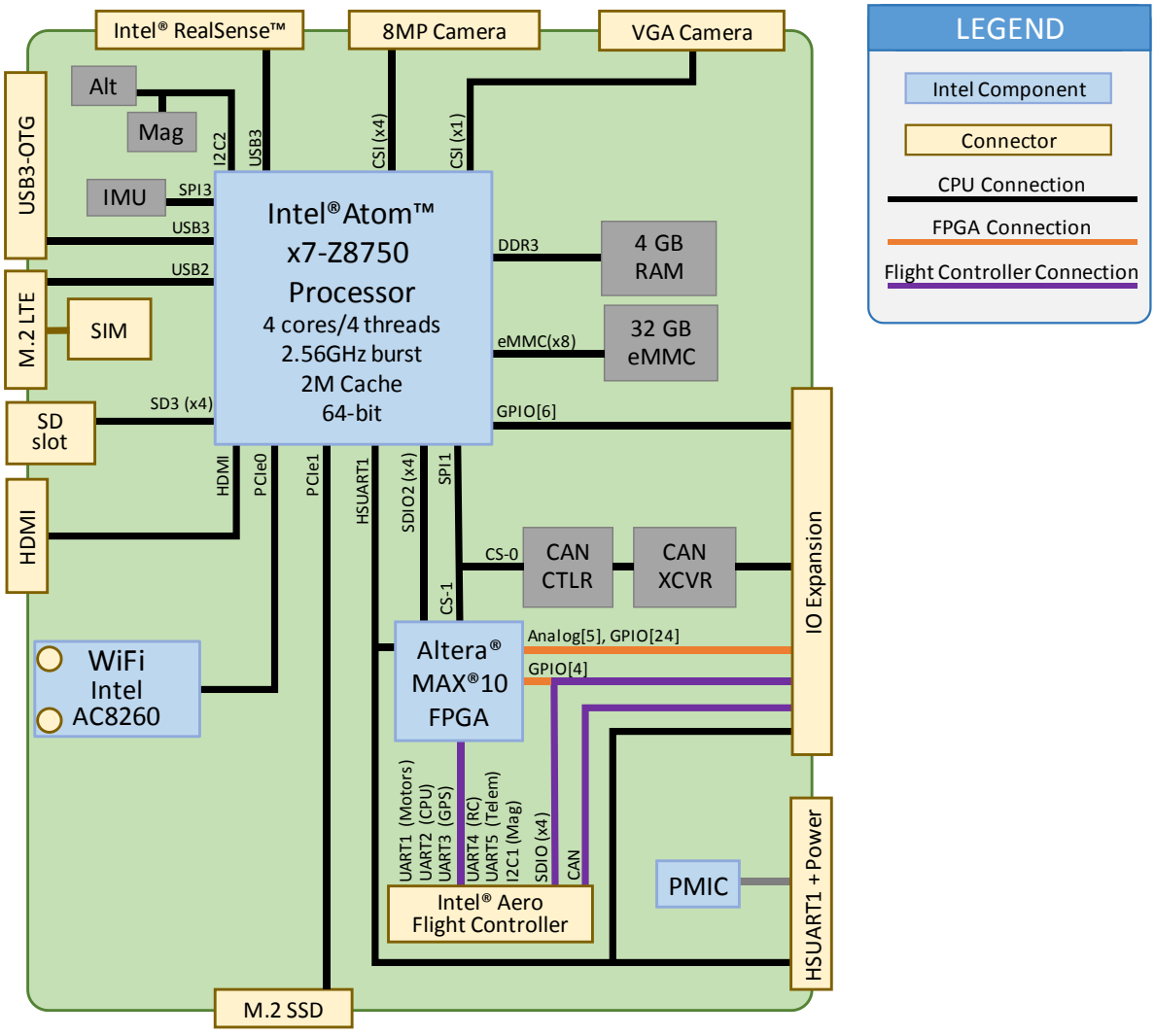

Figure 1. Intel® Aero Compute Board Block Diagram

Placement of connectors and components in this block diagram is representational only and does not reflect the physical placement on the printed circuit board.

3 Connector Specifications

Users may connect various devices to the Compute Board by building a custom cable using the connector information provided in Section 3.1 and the pin definitions captured in Chapter 3.

3.1 Connector Part Numbers

Connector	Manufacturer Name	Manufacturer Part Number	Mating Connector Part Number
Front Facing 8MP Camera	JAE Electronics	WP7A-S030VA1-R500	WP7-P030VA1-R500
Down Facing VGA Camera	Advanced Connectek	BBR43-24KB533	BBR13-24K6417
RealSense USB3.0 Camera	Dai-Ichi Seiko	20347-310E-12R	20347-310E-12R
Power and Console UART	Molex	53261-1071	51021-1000
IO Expansion	JST	80PS-JMDSS-G-1-TF	80R-JMDSS-G-1-TF

3.2 Connector Locations and Pin Orientation

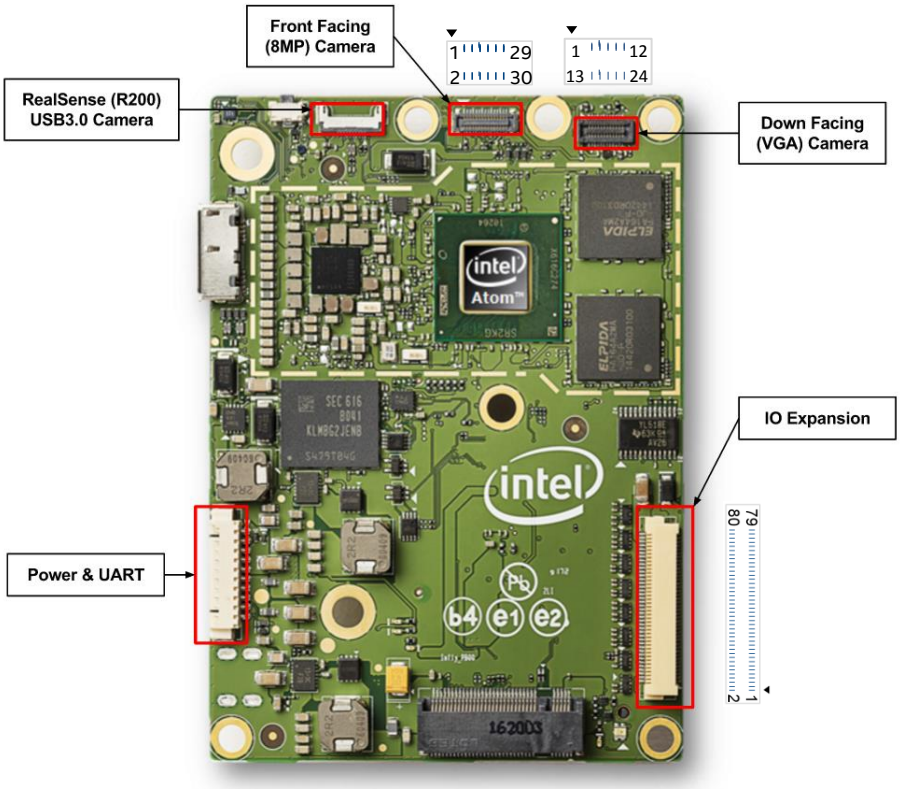

Figure 2. Connector Locations and Pin Orientation

3.3 8MP Camera Connector

This 4-lane CSI-2 (MIPI) interface is intended for connection with the 8MP RGB camera included in the optional Intel® Aero Vision Accessory Kit.

Refer to Figure 2. Connector Locations and Pin Orientation.

3.3.1 Connector Pin Definition

Pin Name	Pin #	Pin #	Pin Name
GND	1	2	+2.8V (AF MOTOR)
MIPI1_DATA1_DN	3	4	GND
MIPI1_DATA1_DP	5	6	I2C_SCL
GND	7	8	I2C_SDA
MIPI1_DATA0_DN	9	10	GND
MIPI1_DATA0_DP	11	12	CLOCK1
GND	13	14	GND
MIPI1_CLK_DN	15	16	VSYNC
MIPI1_CLK_DP	17	18	CAMERA_RESET_N
GND	19	20	GND
MIPI1_DATA2_DN	21	22	GND
MIPI1_DATA2_DP	23	24	+2.8V (ANALOG)
GND	25	26	+1.8V
MIPI1_DATA3_DN	27	28	+1.2V
MIPI1_DATA3_DP	29	30	GND

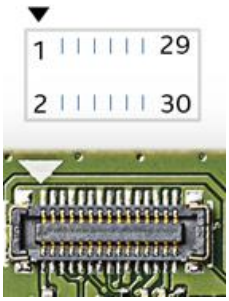

Figure 3. 8MP Camera Connector Pin Orientation

3.4 VGA Camera Connector

This single-lane CSI-2 (MIPI) interface is intended for connection to the VGA camera with global shutter, included in in the optional Intel® Aero Vision Accessory Kit.

Refer to Figure 2. Connector Locations and Pin Orientation.

3.4.1 Connector Pin Definition

Pin Name	Pin #	Pin #	Pin Name
GND	1	13	GND
+1.8V	2	14	NC
+1.5V	3	15	GND
GND	4	16	+2.8V
CLOCK2	5	17	GND
GND	6	18	INTERRUPT
MIPI2_DATA0_DP	7	19	GND
MIPI2_DATA0_DN	8	20	I2C_SDA
GND	9	21	I2C_SCL
MIPI2_CLK_DP	10	22	GND
MIPI2_CLK_DN	11	23	CAMERA_RESET_N
GND	12	24	GND

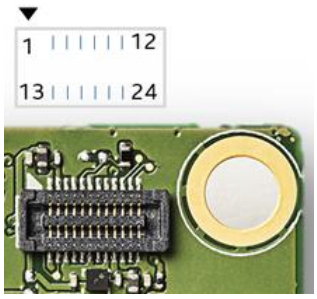

Figure 4. VGA Camera Connector Pin Orientation

3.5 RealSense USB 3.0 Camera Connector

The Intel® Aero Compute Board has a dedicated connector for the Intel® RealSense camera (R200) which is included in the optional Intel® Vision Accessory Kit. This low-profile custom connector interfaces directly to one of the processor's USB 3.0 ports.

Refer to Figure 2. Connector Locations and Pin Orientation

3.5.1 Connector Pin Definition

Pin #	Pin Name	
1	GND	
2	USB3_RXN3	*Input to Atom*
3	USB3_RXP3	*Input to Atom*
4	GND	
5	USB3_TXN3	*Output from Atom*
6	USB3_TXP3	*Output from Atom*
7	GND	
8	RESERVED	
9	+3.3V	
10	+3.3V	

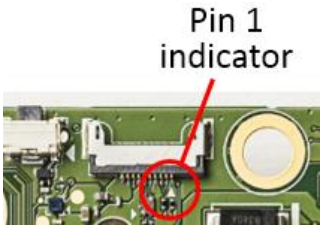

Figure 5. USB 3.0 Camera Connector Pin Orientation

3.5.2 Software Access

The Intel® RealSense™ camera (R200) supports Full HD color and IR depth sensing features. It connects to the Intel® Aero Compute Board through a USB 3.0 connector. For more details, please refer to the "Cameras and Video" article on the Wiki for the Intel® Aero Platform.

3.6 Power & UART Connector

This connector supplies all the power for the Compute Board. It also provides access to the processor's high-speed UART (HSUART).

Refer to Figure 2. Connector Locations and Pin Orientation.

3.6.1 Connector Pin Definition

Pin #	Pin Name	
1	+VIN	
2	+VIN	
3	GND	
4	GND	
5	GND	
6	+VIN	
7	+VIN	
8	GND	
9	HSUART_TX	*Output from Aero*
10	HSUART_RX	*Input to Aero*

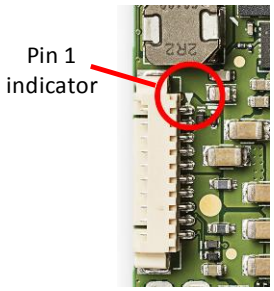

Figure 6. Power & UART Connector Pin Orientation

Notes:

- The acceptable input voltage for +VIN is +5V DC.
- The UART interface is 3.3V tolerant. Signal voltage should not exceed 3.6 V.

3.6.2 Software Access to the Processor HSUART

The UART available on this 10-pin connector can be used for other purposes such as connecting an external flight controller. Please refer to Connecting an External Flight Controller to the Intel® Aero Compute Board.

3.7 IO Expansion Connector

3.7.1 Connector Pin Definition

The Intel® Aero Compute Board has a configurable 80-pin IO Expansion Connector. In addition to power and ground pins, this connector provides access to the processor GPIOs and processor HSUART. The on-board Altera® MAX® 10 FPGA provides an additional 24 FPGA GPIOs and 5 FPGA analog inputs (ADC). The FPGA is accessible using the processor SPI1 interface (chip select 1).

A dedicated CAN bus is also available and accessible using the same SPI1 bus (chip select 0).

The IO Expansion Connector pin definition and pin mapping to the FPGA are captured in the table below.

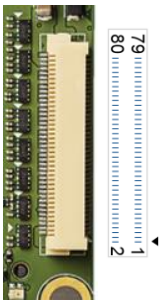

Figure 7. IO Expansion Connector Pin Orientation

FPGA Pin #	Pin Name	Pin#	Pin#	Pin Name	FPGA Pin #
	+3.3V	1	2	+3.3V	
	+3.3V	3	4	+3.3V	
	GND	5	6	GND	
	GND	7	8	GND	
	GND	9	10	AERO_RTF_FC_SDIO / FGPA_GPIO_25	M5

FPGA Pin #	Pin Name	Pin#	Pin#	Pin Name	FPGA Pin #
G5	FPGA_ADC_1	11	12	AERO_RTF_FC_SDIO / FGPA_GPIO_26	M4
F5	FPGA_ADC_2	13	14	AERO_RTF_FC_SDIO / FGPA_GPIO_27	R3
B1	FPGA_ADC_3	15	16	AERO_RTF_FC_SDIO / FGPA_GPIO_28	P3
	GND	17	18	GND	
C2	AERO_RTF_DRONE_VBATSENSE / FPGA_ADC_4	19	20	FPGA_GPIO_01	P15
D2	FPGA_ADC_5	21	22	FPGA_GPIO_02	R14
	GND	23	24	FPGA_GPIO_03	M9
	CPU_GPIO_05	25	26	FPGA_GPIO_04	L9
	CPU_GPIO_06	27	28	GND	
	GND	29	30	FPGA_GPIO_05	N1
	CPU_GPIO_01	31	32	FPGA_GPIO_06	P2
	CPU_HSUART0_TX	33	34	FPGA_GPIO_07	L4
	CPU_HSUART0_RX	35	36	FPGA_GPIO_08	L5
	GND	37	38	GND	
	CPU_GPIO_02	39	40	FPGA_GPIO_09	K4
	CPU_GPIO_03	41	42	FPGA_GPIO_10	K5
	GND	43	44	FPGA_GPIO_11	J4
	CPU_GPIO_04	45	46	FPGA_GPIO_12	B13
	CPU_GPIO_07	47	48	GND	
	GND	49	50	FPGA_GPIO_13	A14
M14	FPGA_GPIO_21	51	52	FPGA_GPIO_14	D12
L15	FPGA_GPIO_22	53	54	FPGA_GPIO_15	A5
	GND	55	56	FPGA_GPIO_16	C8
R11	FPGA_GPIO_23	57	58	GND	
P12	FPGA_GPIO_24	59	60	FPGA_GPIO_17	E9
	FC_CAN_L	61	62	FPGA_GPIO_18	E11
	FC_CAN_H	63	64	FPGA_GPIO_19	P1
	GND	65	66	FPGA_GPIO_20	R2
	RESERVED	67	68	GND	
	RESERVED	69	70	CPU_CAN_H	
	GND	71	72	CPU_CAN_L	
	RESERVED	73	74	GND	
	RESERVED	75	76	+VBAT	
	GND	77	78	+VBAT	
	RESERVED	79	80	RESERVED	

3.7.2 Software Access

Software access to each of the interface signals available through the IO Expansion Connector is described below.

3.7.2.1 IO Configurable via the FPGA

The on-board Altera® MAX® 10 FPGA allows user-configurable IO that are routed to the 80-pin IO Expansion Connector. An FPGA sample configuration file is provided

which contains implementations of several standard electrical interfaces. These include PWM, ADC, I²C, UART, and digital GPIO. All are accessible via the Intel® Atom™ processor using its SPI1 bus. Refer to the "FPGA Sample Configuration" article on the Wiki for the Intel® Aero Platform for the register mapping and software access instructions. A sample binary and source code are also provided.

Features supported in the FPGA sample configuration file:

- SPI bus (*connects to the processor, refer to the block diagram in Chapter 2*)
- General Purpose digital IO (GPIO)
- 5 analog sense inputs (ADC, 12 bits, voltage range 0 ~ 3 Volts)
- Up to 12 PWMs (16 bits) limited to the accessible FPGA IOs
- 1 UART up to 115.2Kbps (no hardware flow control)
- 1 I²C Bridge
- 1 I²C Bus (100KHz)

3.7.2.2 Processor GPIOs

The following Intel® Atom™ processor GPIOs (digital) are accessible via software as described in the "Processor GPIOs" article on the Wiki for the Intel® Aero Platform.

Processor GPIO Name	SW Kernel #
CPU_GPIO_01	GPIO-350
CPU_GPIO_02	GPIO-481
CPU_GPIO_03	GPIO-485
CPU_GPIO_04	GPIO-348
CPU_GPIO_05	GPIO-487
CPU_GPIO_06*	Power Off
CPU_GPIO_07	GPIO-319

* Grounding this pin for 3 seconds will initiate shutdown on the Compute Board. This is hardcoded in the BIOS. It cannot be re-purposed by the user.

3.7.2.3 Processor CAN Bus

The Intel® Aero Compute Board includes a CAN Bus interface (MCP2515 CAN Controller and a MCP2562 CAN Transceiver) that is connected to the Intel® Atom™ processor's SPI bus. (see block diagram in Chapter 2).

For usage information, refer to the "CAN Controller" article on the Wiki for the Intel® Aero Platform.

3.7.2.4 Processor HSUART

The Intel® Aero Compute Board drives a high speed serial interface (HSUART) that can be used to connect to a system flight controller or other peripheral device.

The HSUART can be accessed through Linux sysfs at node /dev/ttyS1.

For more information, refer to the article under the "Connecting an External Flight Controller" topic in the Wiki for the Intel® Aero Platform.

3.8 80-pin Accessories Connector Pinout Definition

The 80-pin Accessories Connector is a flexible circuit board with five Hirose DF13 connectors that is packaged with the Intel® Aero Compute Board. This Accessories Connector plugs into the IO Expansion Connector (Section 3.7). Signal routing for each of the five connectors, labeled J1 through J5, is defined in the pin definition tables below. Developers can repurpose / reconfigure the connector pin assignments using the processor (CPU) and FPGA GPIO pin mapping information provided in the same tables.

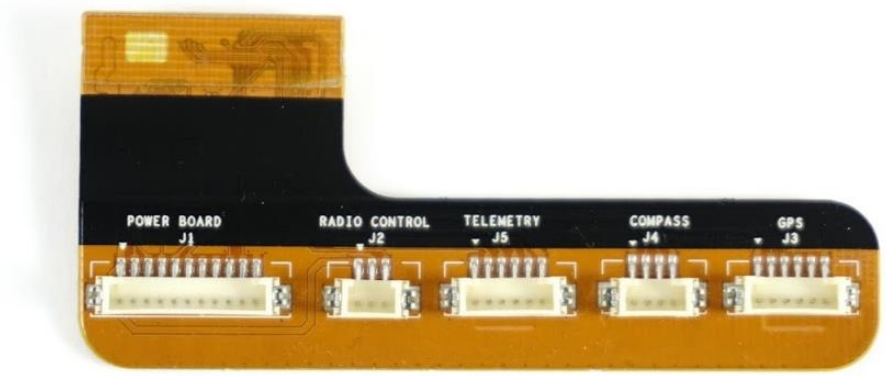

Figure 8. 80-pin Accessories Connector

Note: Pin 1 on each connector is indicated by the white triangle silkscreen marking.

3.8.1 "J1" Power Board

Pin #	Pin Name	FPGA or CPU Pin Name†
1	+3.3V	
2	CPU_GPIO_01	CPU_GPIO_01
3	RESERVED	
4	ANALOG_INPUT	FPGA_ADC_4
5	LED CTRL	CPU_GPIO_03
6	FAN CTRL	CPU_GPIO_04
7	NC	
8	NC	
9	UART_RX	FPGA_GPIO_20
10	UART_TX	FPGA_GPIO_19
11	GND	

† Refer to the IO Expansion Connector pin definition table in Section 3.7.

NC: No Connect

3.8.2 "J2" Radio Control

Pin #	Pin Name	FPGA Pin Name†
1	+3.3V	
2	GND	
3	RC_RX	FPGA_GPIO_18

† Refer to the IO Expansion Connector pin definition table in Section 3.7.

3.8.3 "J3" GPS

Pin #	Pin Name	FPGA Pin Name†
1	+VBAT	
2	GPS_TX	FPGA_GPIO_15
3	GPS_RX	FPGA_GPIO_16
4	NC	
5	NC	
6	GND	

† Refer to the IO Expansion Connector pin definition table in Section 3.7.

NC: No Connect

CAUTION: +VBAT is equivalent to +VIN (Section 3.6.1) and could potentially exceed the input voltage limit of some GPS devices. Limit +VBAT to meet the GPS device requirements.

3.8.4 "J4" Compass

Pin #	Pin Name	FPGA Pin Name†
1	GND	
2	MAG_SDA	FPGA_GPIO_13
3	MAG_SCL	FPGA_GPIO_14
4	+VBAT	

† Refer to the IO Expansion Connector pin definition table in Section 3.7.

CAUTION: +VBAT is the same as +VIN (Section 3.6.1) and could potentially exceed the input voltage limit of some Compass devices. Limit +VBAT to meet the Compass device requirements.

3.8.5 "J5" Telemetry

Pin #	Pin Name	FPGA Pin Name†
1	GND	
2	CTS	FPGA_GPIO_05
3	RTS	FPGA_GPIO_06
4	RX	FPGA_GPIO_07
5	TX	FPGA_GPIO_08
6	+5V	

† Refer to the IO Expansion Connector pin definition table in Section 3.7.

4 On-Board Sensors

The Intel® Aero Compute Board is designed with a 6 Degree of Freedom IMU (BMI160), a magnetometer (BMM150), and an altimeter (MS5611). The sensors are connected to the processor SPI bus and I2C bus.

Full details how to access each sensor can be found in the article "Onboard Sensors" on the Wiki for the Intel® Aero Platform.

5 LED Definition and Usage

5.1 Compute Board LEDs

The Intel® Aero Compute Board has a total of 8 LEDs. Four are located on the top side of the board. The other Four LEDs are located on the bottom side. Refer to Figure 9 and Figure 10

The table below describes each LED and its function. Two of the LEDs can be programmed via software as described in the "LEDs" article on the Wiki for the Intel® Aero Platform.

LED Color	LED "ON" Function	Software controlled GPIO?
Green	FPGA Program Loaded LED	No
Green	PMIC Power OK	No
Green	Processor Power On LED	No
Green	M.2 SSD Active LED	No
Green	M.2 Power On LED	No
Green	Flight Controller Connected LED	No
Orange	User Programmable	Yes Processor GPIO # 507
Tricolor	Red	Yes Processor GPIO # 437
	Green	Yes Processor GPIO # 341
	Blue	Yes Processor ISH GPIO # 347

Note that the "Flight Controller Connected LED" is used only with the Intel® Aero Flight Controller which is assembled with the Intel® Aero Ready to Fly Drone.

5.2 Compute Board Top Side LED Locations

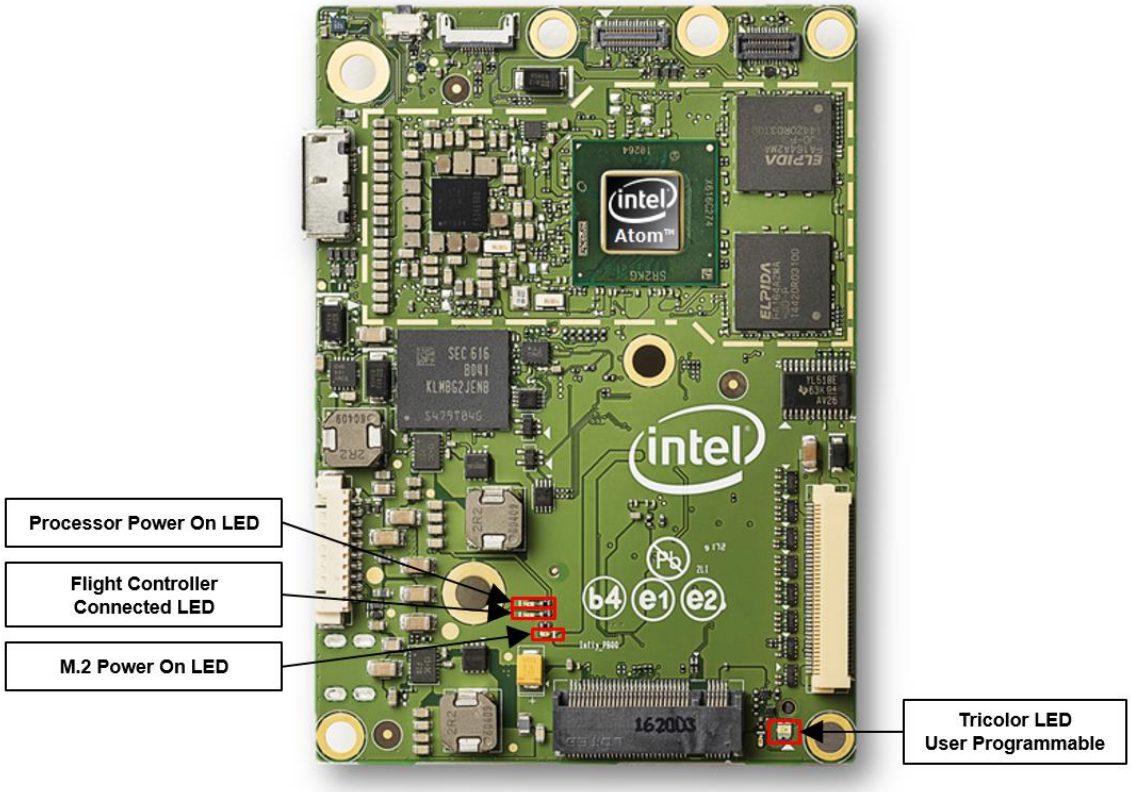

Figure 9. LEDs on Top Side of Compute Board

5.3 Compute Board Bottom Side LED Locations

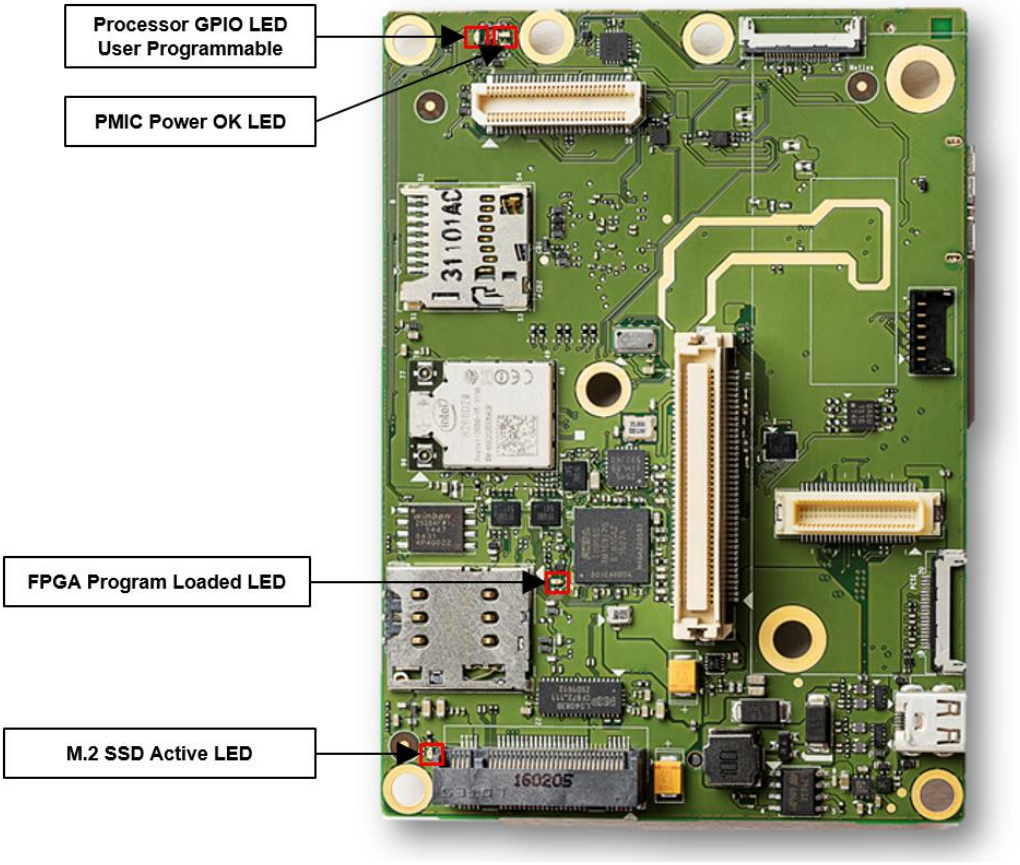

Figure 10. LEDs on Bottom Side of Compute Board

6 Intel® Aero Flight Controller

The Intel® Aero Flight Controller ships with the Intel® Aero Ready to Fly Drone. It is pre-loaded with Dronecode* PX4* autopilot flight control firmware. The Flight Controller plugs directly into the Intel® Aero Compute Board through a dedicated connector.

Software access details are provided on the Wiki for the Intel® Aero Platform.

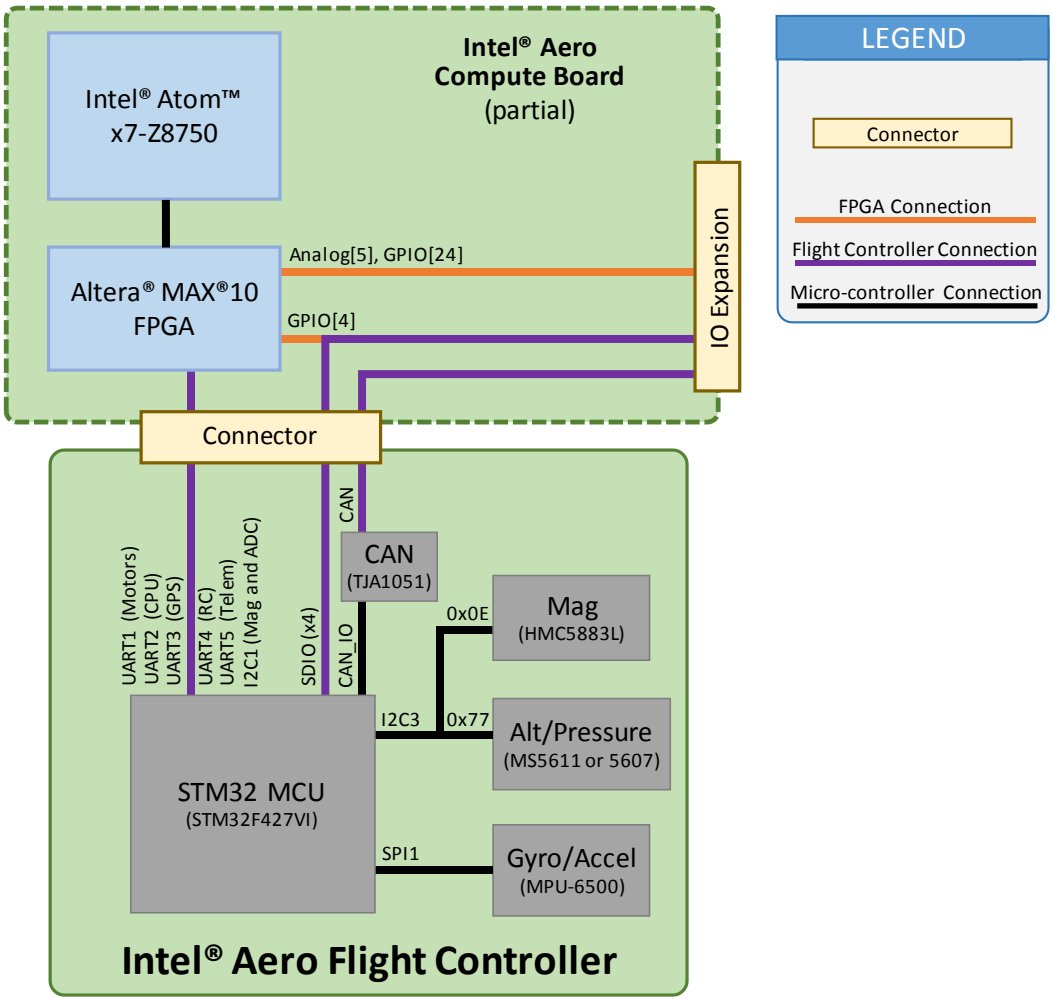

Figure 11. Hardware Block Diagram – Aero Flight Controller