



**TELEDYNE
FLIR**



HADRON™ ENGINEERING DATASHEET

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1 INTRODUCTION

This document is a detailed datasheet for Hadron 640R, a dual camera IR+EO core payload intended to be mounted on a small UAS gimbal. There are separate interfaces to the two cameras: the EO camera has raw 4-lane MIPI interface and the IR camera has 2-lane MIPI and USB 3.0 interfaces. Hadron 640R also has a built in IMU for gimbal stabilization. Video processing (compression, recording etc.) is performed outside the Hadron 640R.

1.1 References

DOCUMENT	LOCATION
Boson datasheet	https://flir.netx.net/file/asset/15754/original/attachment
Boson resources	https://www.flir.com/support/products/boson#Resources
OV64B Resources	https://www.ovt.com/products/ov64b40-ga5a-002a-z/
Bosch BHI160B datasheet	https://www.bosch-sensortec.com/media/boschsensortec/downloads/datasheets/bst-bhi160b-ds000.pdf
Hadron 640R mechanical IDD	TBD

1.2 Abbreviations and definitions

ABBREVIATION	DEFINITION
CCI	Command and Control Interface
EFL	Effective Focal Length
EO	Electro-Optical
(H)FOV	(Horizontal) Field of View
IDD	Interface Design Document
IMU	Inertial Measurement Unit
IR	Infrared
UAS	Unmanned Aircraft System
UVC	USB Video Class

1.3 Revision history

REVISION	DATE	COMMENT
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100	2022-04-13	First revision.
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2 SYSTEM OVERVIEW

2.1 Datasheet summary

All dimensions and weights are preliminary and nominal design values. They may be updated later with measured values.

Part number of complete Hadron 640R	60Hz: 70640AS32-6PMRXX 9Hz: 70640AS32-9PMRXX
Size (estimate)	36 x 50 x 43 mm
Weight (estimate)	56 g
Power (estimate)	5V supply voltage. Typical power dissipation < 1800 mW, Max < 3000 mW (during FFC)
Mechanical interface (estimate)	Screw mount to back plate
Electrical interface (estimate)	Hadron 640R connector: Hirose DF40C-50DP-0.4V(51) Example of mating connector: DF40HC(2.5)-50DS-0.4V(51)
IR camera sensor	Pass-through interface to Boson MIPI and USB
EO camera sensor	Omnivision OV64B, 9248x6944 pixels, 0.701 μ m pitch, 4-lane MIPI
EO camera optics	EFL 4.8 mm, 67° HFOV, F/# 1.85, 390nm to 640nm IR cut filter
EO camera video	Full resolution @ 60Hz See OV64B datasheet for more options
IMU	Bosch BHI160B, I2C
Operational and storage temperature	-20 °C to +60 °C
Tested EMI performance	FCC part 15 Class B
Environmental sealing	IP54 (with the rear interfaces sealed)

Product classification:

PART	PART NUMBER	ECCN	HTS
Hadron 60Hz	70640AS32-6PMRXX	6A003.b.4.b	9013.80.9000

2.2 Product architecture

The Hadron 640R is designed to be a UAS dual IR+EO camera payload with an integrated IMU for gimbal control. It provides raw (uncompressed) IR and EO video for further processing in the airframe. Mechanically, the back of the Hadron 640R can be mounted against the yoke of the gimbal. The electrical interface is a 60-pin connector for video and CCI for the two cameras as well as the IMU. As a part of the delivery, software reference code for NVIDIA Jetson Nano/TX2 and Lantronix OpenQ 865 is provided. The gimbal controller is not part of the delivery (hardware and software).

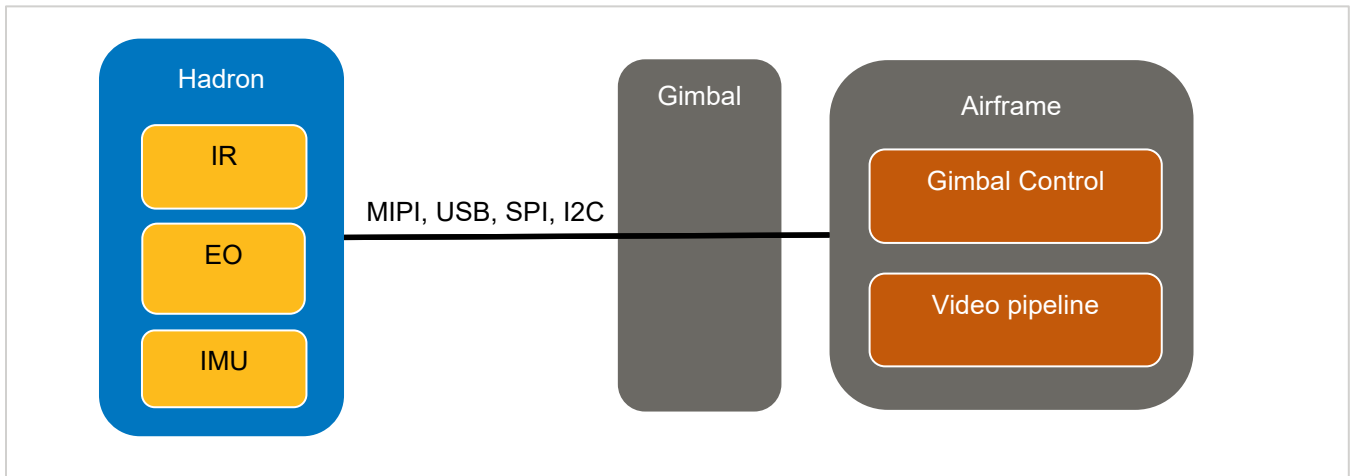


FIGURE 1. HADRON 640R ARCHITECTURE

2.3 IR camera

The IR camera is a MIPI Boson® 640x512 with 32° HFOV (PN 20640AS32-6PMRX 60Hz, or 20640AS32-9PMRX 9Hz). It has a built-in shutter for non-uniformity corrections.

The hyper-focal distance is given by the table below where c is the circle of confusion (2x the pixel pitch), f is the focal length, N is the F# number and H ($H = f^2/Nc + f$) is the hyper-focal distance.

CAMERA	C [MM]	F [MM]	N = F/#	H [MM]
IR	2*0.012	13.6	1.0	7720
EO	2*0.0007	4.8	2.3	7160

2.4 EO camera

The EO camera uses an Omnivision OV64B 64MP sensor and a 67° HFOV f/1.85 lens.

2.5 EEPROM

The EEPROM on the EO sensor board and the main board can be read and written by the user. FLIR reserves the first 2048 bytes on each EEPROM for production data. Notice that the EEPROMs are not write protected – the user must take care to not overwrite the first 2048 bytes!

2.5.1 Rev FLIR0001

2.5.1.1 EO EEPROM flash map

BYTE NUMBER	EXAMPLE DATA	TYPE	COMMENT
0 – 7	FLIR0001	ASCII	Revision of EO EEPROM flash map
8 – 15	H0000123	ASCII	EO sensor serial number (same as Hadron 640R SW unless the sensor is replaced)
16 – 19	0000	ASCII	EO sensor hardware revision (same as Hadron 640R revision unless it is replaced)
20 – 36	2019-08-15_142154	ASCII	Date and time of production

2.5.1.2 IMU EEPROM flash map

BYTE NUMBER	EXAMPLE DATA	TYPE	COMMENT
0 – 7	FLIR0001	ASCII	Revision of IMU EEPROM flash map
8 – 15	H0000123	ASCII	Hadron 640R serial number
16 – 33	70320A034-6C-12080	ASCII	Hadron 640R part number
34 – 37	0000	ASCII	Hadron 640R hardware revision
38 – 47	0000047721	ASCII	Boson serial number
48 – 62	20320A034-6CAAX	ASCII	Boson part number
63 – 80	2019-08-15_142154	ASCII	Date and time of production

3 MECHANICAL

The Hadron 640R has an IR and EO camera intended to be mounted vertically. The payload frame serves as an external mechanical interface. A gimbal yoke can be screwed onto the back and host a cable harness leading from the Hadron 640R to the airframe. That way, ingress protection from the back can be handled by the gimbal design. The Hadron 640R itself is IP54 rated as long as the back is sealed. The thermal heat path from the Hadron 640R is through convection off the surface and the through the metal back plate to which the gimbal is mounted (if no gasket is used on the back).

The Hadron 640R has an external protective housing that secures ingress protection and protects it from impact. It also helps against image non-uniformities in the IR image caused by wind cooling the lens holder.

For a mechanical specification of the interface, see drawing in the mechanical IDD (section 1.1).

3.1 Hadron 640R mechanical dimensions

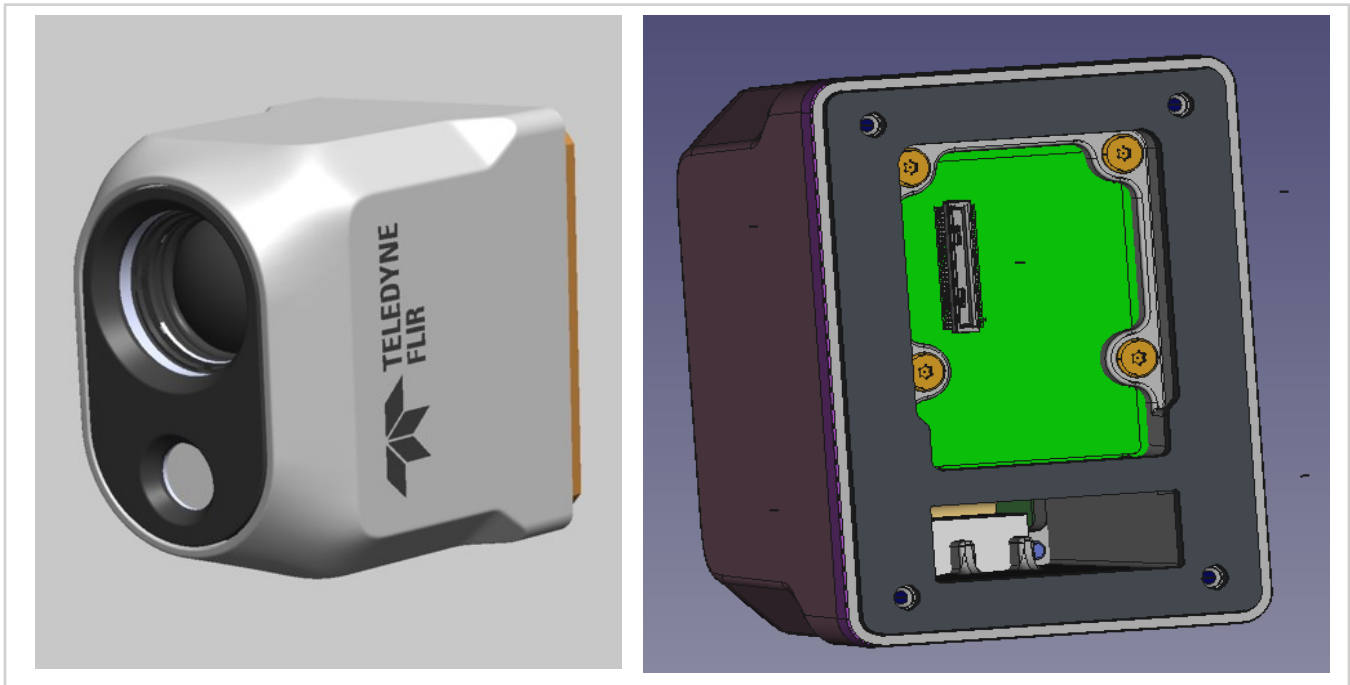


FIGURE 2. 3D RENDITION OF HADRON 640R WITH PROTECTIVE HOUSING.

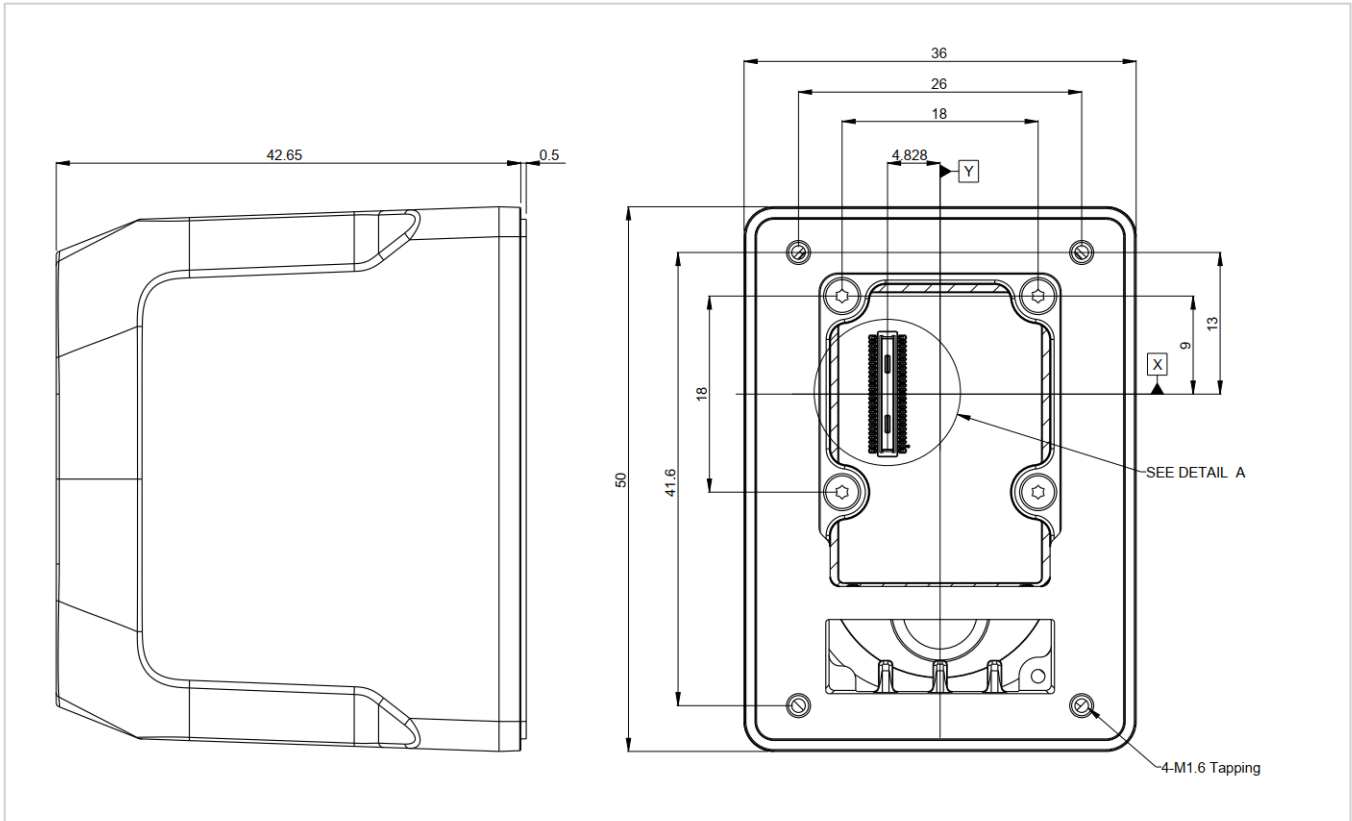


FIGURE 3. HADRON 640R EXTERNAL DIMENSIONS [MM] WITH PROTECTIVE HOUSING.

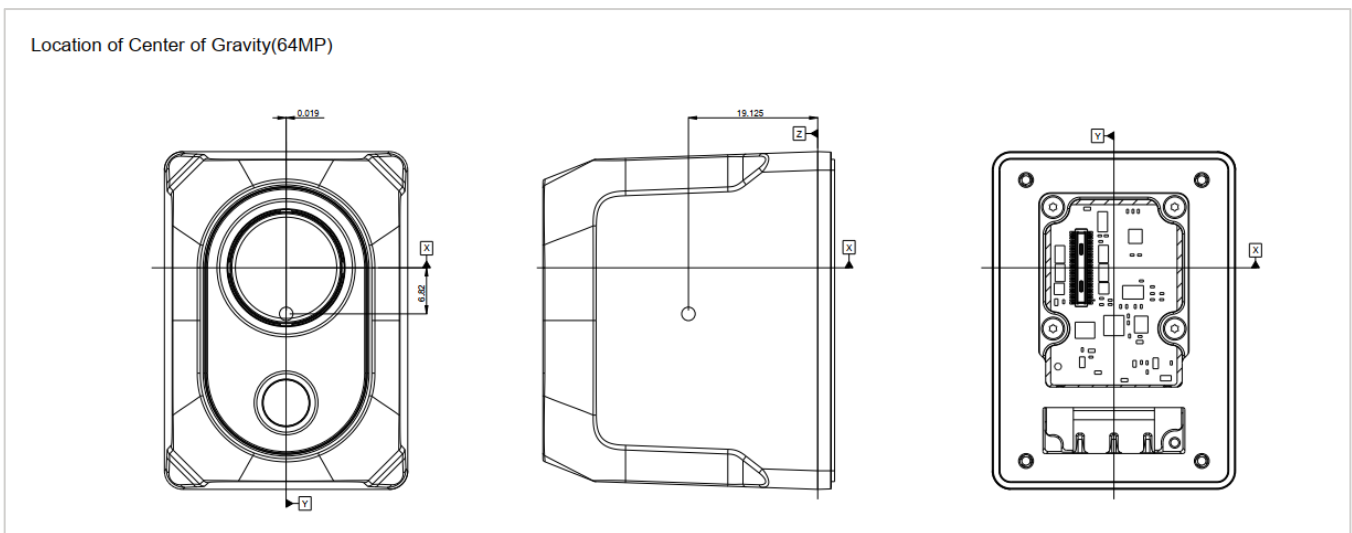


FIGURE 4: ESTIMATED COG FOR THE PAYLOAD

3.2 IMU location

The IMU is located on the main board close to the center of the gravity and in the Hadron 640R x and y direction. See **Error! Reference source not found.** 4 for the IMU intrinsic coordinate system (different from the Hadron 640R coordinate system).

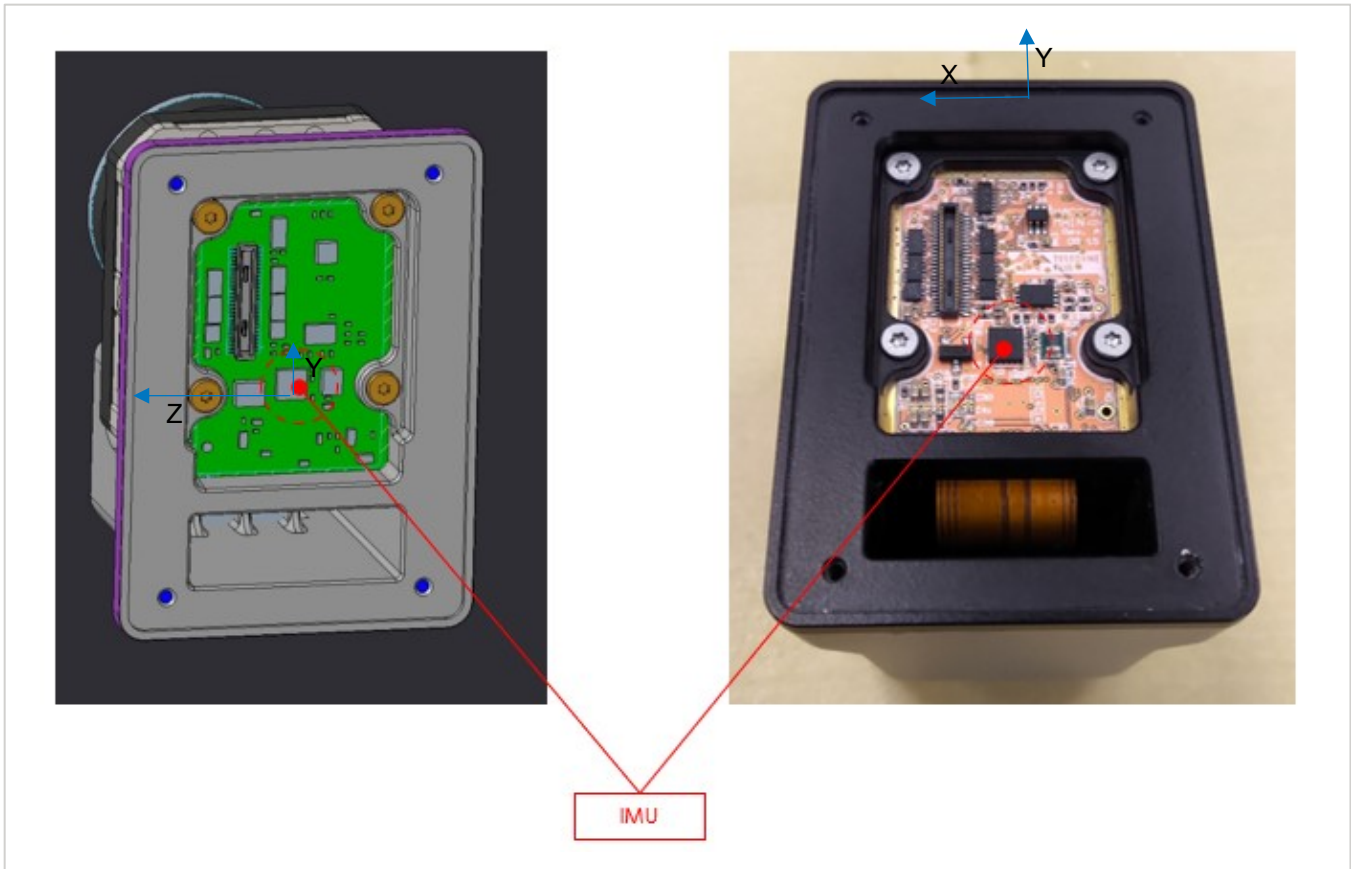


FIGURE 5. APPROXIMATE LOCATION OF THE IMU SEE MECHANICAL IDD FOR EXACT NOMINAL LOCATION OF IMU.

3.3 Example of gimbal integration

The gimbal is not part of Hadron 640R, but the design is intended to be integrated with a gimbal.

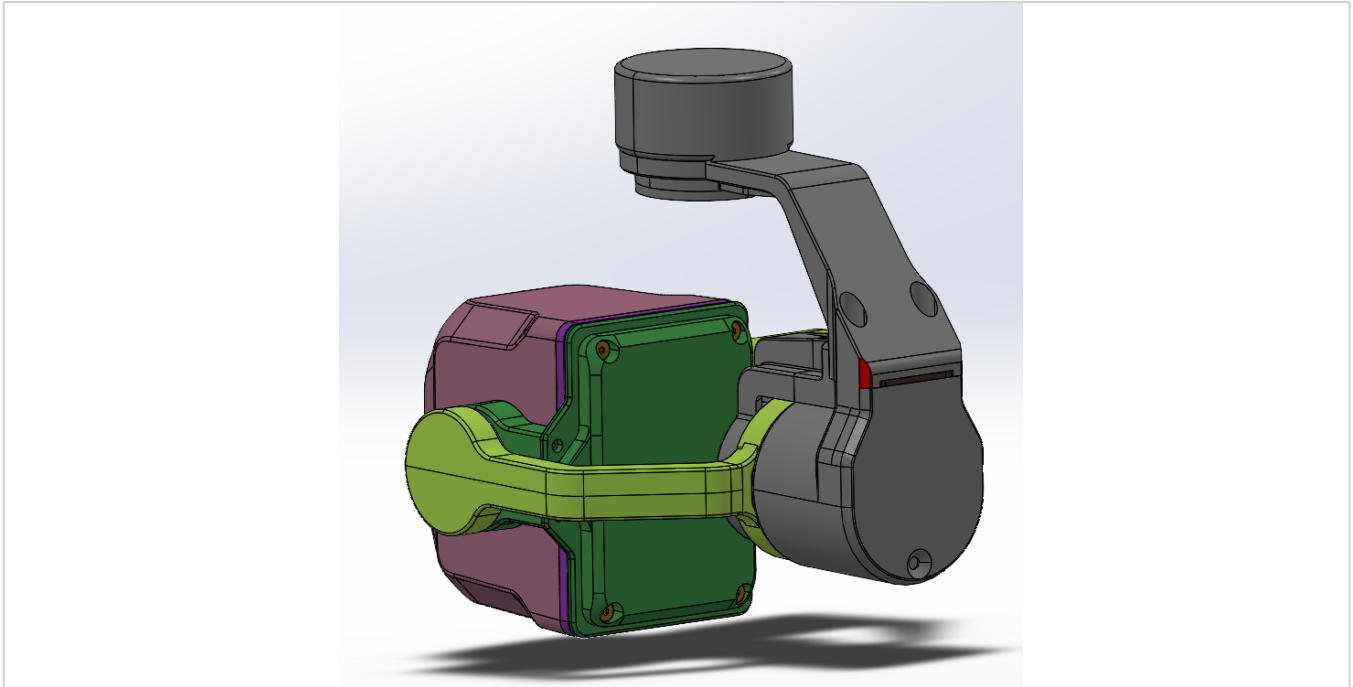


FIGURE 6. EXAMPLE OF HOW HADRON 640R CAN BE MOUNTED TO A GIMBAL YOKE.

When integrating with a gimbal, the back of Hadron 640R has to be sealed in a water and dust proof way in order for the system to meet IP54. In doing so, a waterproof airpath must be kept open to equilibrate pressure as temperature changes.

4 ELECTRICAL

4.1 Overview

Hadron 640R has 3 main internal components:

- **Boson IR camera:** The self-contained IR camera.
- **EO camera:** An OV64B sensor with optics, an EEPROM for EO sensor calibration data.
- **Hadron 640R main board:** The board that connects the Boson and EO camera. It also holds the IMU and an EEPROM with IMU calibration parameters.

The input power is $5 \pm 0.25V$ on 3 pins. Each pin can sustain 0.3A. Internal 3.3V and 1.8V power rails are generated on the main board.

- Typical power consumption while streaming: <1800mW
- Maximum power consumption (peak when Boson shutter is activated): <3000mW

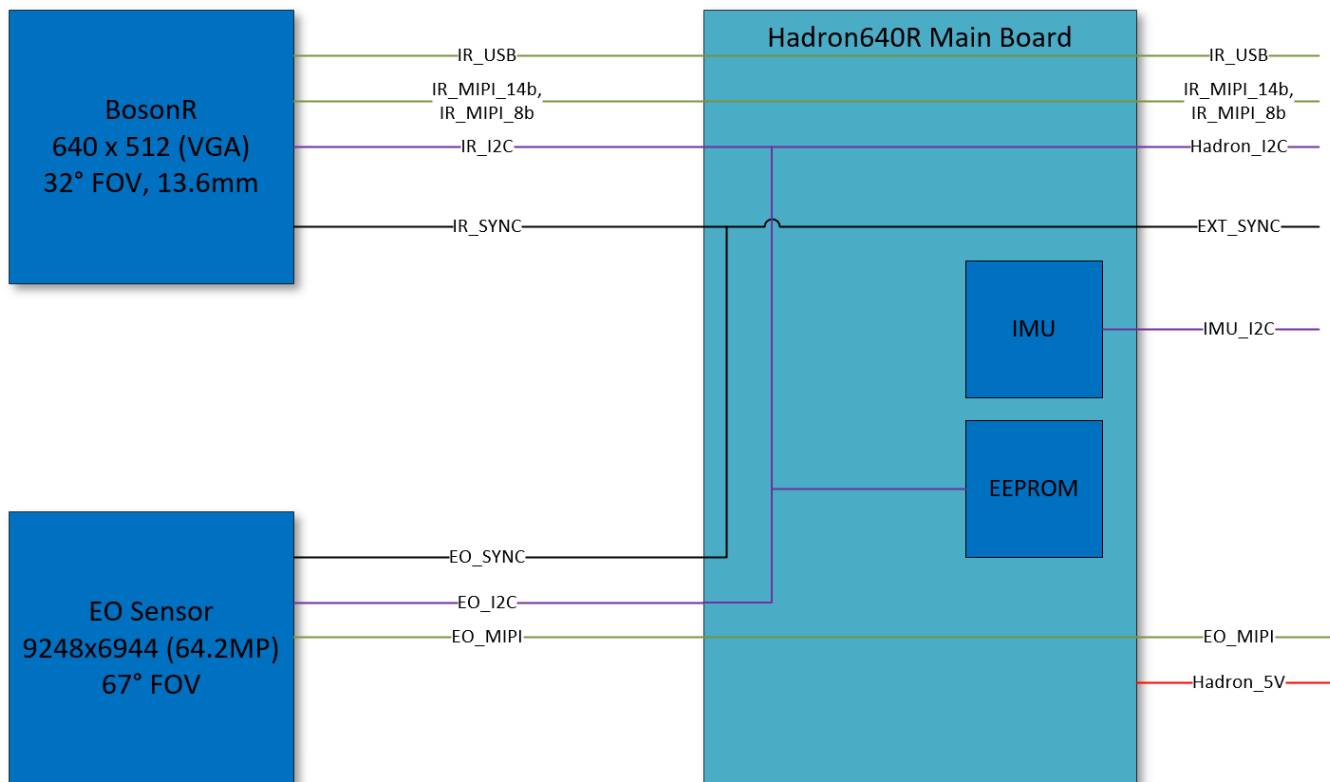


FIGURE 7. HADRON 640R INTERNAL AND EXTERNAL SIGNALS.

4.2 Hadron 640R external signals

Error! Reference source not found. below lists all external signals. The buses from the components to the main connector are described below. The main connector on Hadron 640R is DF40C-50DP-0.4V(51) and an example of a mating connector is DF40HC(2.5)-50DS-0.4V(51).

PIN	NAME	PIN	NAME
1	USB_VBUS	2	5V
3	USB_ID	4	5V
5	GND	6	5V
7	IR_USB_D_N	8	5V
9	IR_USB_D_P	10	/HADRON_RST
11	GND	12	GND
13	IR_USB_TX_N	14	EO_MIPI_D3_P
15	IR_USB_TX_P	16	EO_MIPI_D3_N
17	GND	18	GND
19	IR_USB_RX_N	20	EO_MIPI_D1_P
21	IR_USB_RX_P	22	EO_MIPI_D1_N
23	GND	24	GND
25	IR_MIPI_D1_N	26	EO_MIPI_C_P
27	IR_MIPI_D1_P	28	EO_MIPI_C_N
29	GND	30	GND
31	IR_MIPI_D0_N	32	EO_MIPI_D0_P
33	IR_MIPI_D0_P	34	EO_MIPI_D0_N
35	GND	36	GND
37	IR_MIPI_C_N	38	EO_MIPI_D2_P
39	IR_MIPI_C_P	40	EO_MIPI_D2_N
41	GND	42	GND
43	EXT_VSYNC	44	/IMU_CS
45	IMU_INT	46	IMU_SCK_SCL
47	CAM_I2C_SCL	48	IMU_MOSI_SDA
49	CAM_I2C_SDA	50	IMU_MISO

PIN / SIGNAL	VOLTAGE
Power 5V	5V \pm 0.25V
1.8V logic (I2C)	V high: 1.26 to 2.1V V low: -0.3 to 0.54V
USB	According to USB2 and USB3 standards
MIPI	According to CSI-2 version 1.2 and MIPI D-PHY version 1.2

4.2.1 Data buses

PIN / SIGNAL	VOLTAGE
IR_USB	<ul style="list-style-type: none"> Boson has a USB interface for video (UVC) and CCI. It supports both USB 2.0 and USB 3.0. The video format options are described in the Boson datasheet (see section 1.1).
IR_MIPI	<ul style="list-style-type: none"> The Boson supports 2-lane MIPI. The associated CSI-2 I2C interface (IR_I2C) is shared with the EO camera, the EO and IMU EEPROM on I2C bus I2C_CAM.
EO_MIPI	<ul style="list-style-type: none"> The OV64B EO sensor has a 4-lane MIPI interface. The EO MIPI trace lengths from the sensor to the external connector are 55 \pm 0.5 mm.
IMU_I2C (1.8V)	<ul style="list-style-type: none"> The IMU has an I2C interface. The I2C bus is separate from the other devices on I2C_CAM. IMU I2C address: 1101001
I2C_CAM (1.8V)	<ul style="list-style-type: none"> EO_I2C <ul style="list-style-type: none"> The EO sensor I2C bus with registers for image control. EO sensor I2C address: 110 1100 EO_IMU_I2C <ul style="list-style-type: none"> The IMU EEPROM I2C bus. IMU EEPROM I2C address: 101 0001 I2C_IR <ul style="list-style-type: none"> Boson CCI part of CSI-2. Boson CCI I2C address: 1101010
RESET_N	<ul style="list-style-type: none"> The Boson and the EO sensor can be reset by holding RESET_N low.