HADRON™ 640R
ENGINEERING DATASHEET

Doc. # 102-2053-40, Revision 160
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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 a 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. Any video processing is performed outside the Hadron 640R.

1.1 References

DOCUMENT	LOCATION
Boson Engineering Datasheet	https://flir.netx.net/file/asset/52701/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

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
100	2022-04-13	First revision.
160	2024-01-18	Added camera alignment calibration information.

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, 0.701µm pitch, 4-lane MIPI
EO camera optics	EFL 4.8 mm, 67° HFOV, F/# 2.3, 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
Hadron 60Hz	70640AS32-6PMRXX	6A003.b.4.b

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, Qualcomm RB5, and Lantronix OpenQ 865 is provided.

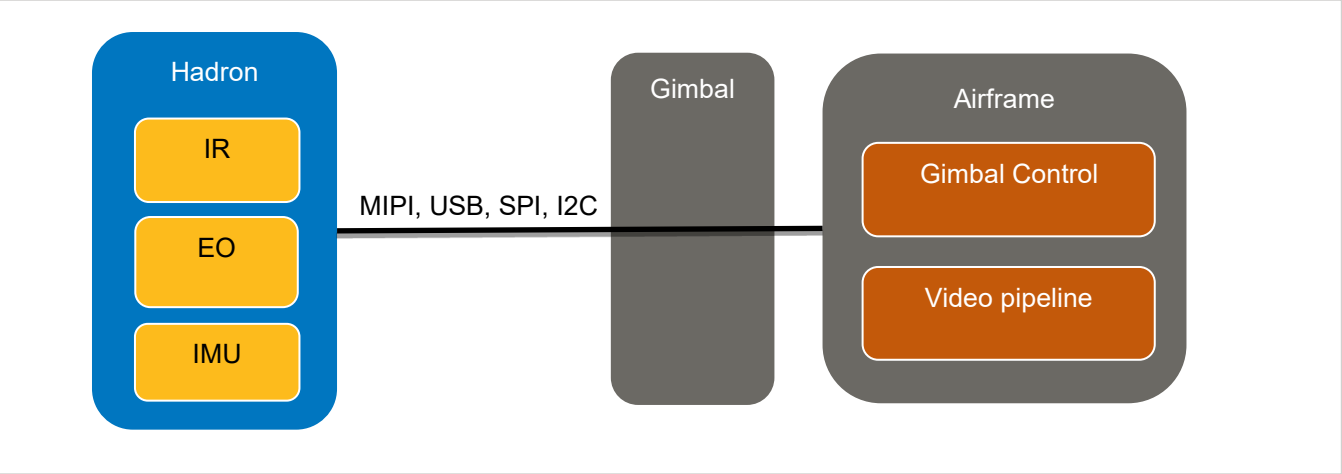

FIGURE 1. HADRON 640R ARCHITECTURE

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/2.3 lens.

2.5 Persistent Storage on the Payload

The EEPROMs 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 Identification and Calibration

Each Hadron 640R payload is calibrated for camera relative alignment. This alignment represents the angular offset between the optical axes of the two images. The alignment between each of the imagers and the mounting points on the frame is not calibrated (see Fig. 2).

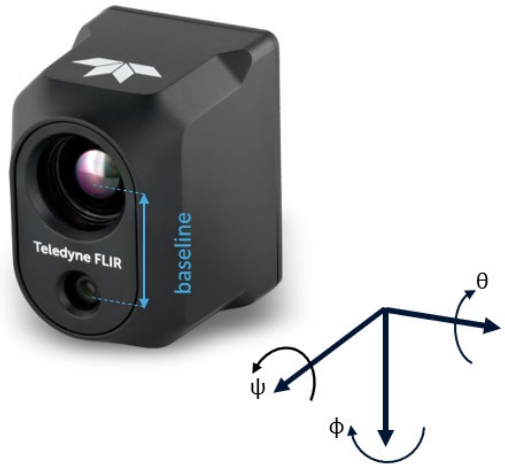

FIGURE 2: RELATIVE ALIGNMENT ANGLE AXIS DESCRIPTION

That data is stored in the Boson JFFS file system as a file called *calibration.csv* with the following format:

[Hadron Electrical Revision],[Hadron Serial Number],[Hadron Part Number],[HW Rev],[Boson Serial Number],[Boson Part Number],[Test Date],[EO IFOV (deg)],[IR IFOV (deg)],[Theta (deg)],[Phi (deg)],[Psi (deg)]

For example:

FLIR0001,R001276,70640AS32-6PMRXX,0001,225844,20640AS32-6PMRX,2022-11-4,+0.0087813,+0.0529178,-0.560,-0.441,-0.062

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. This provides ingress protection from the back of the payload. The Hadron 640R itself is IP54 rated provided that the rear of the payload is sealed. The Hadron 640R dissipates some heat through convection off the front surface but the primary heat path should be through the metal back plate to which the gimbal shall be mounted. Careful thermal design is important to guarantee the performance of the IR imager.

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 Figure 4.

3.1 Hadron 640R mechanical dimensions

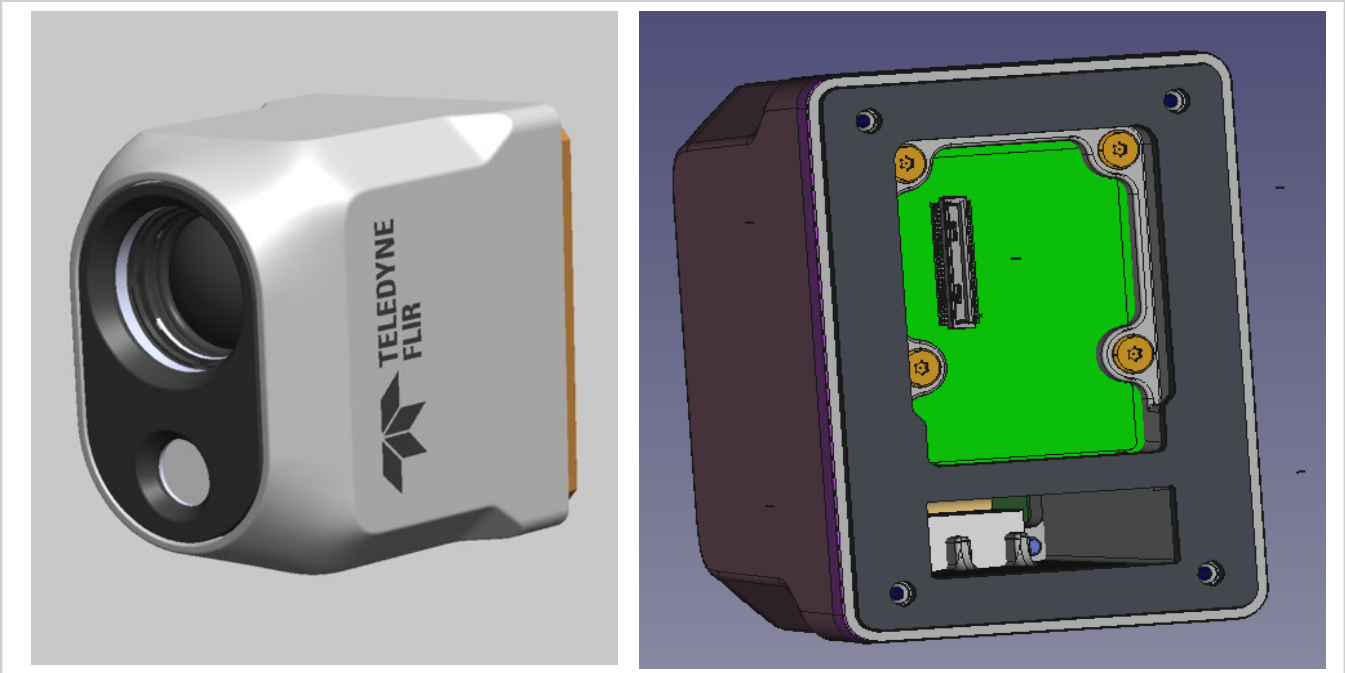

FIGURE 3. 3D RENDER OF HADRON 640R WITH PROTECTIVE HOUSING.

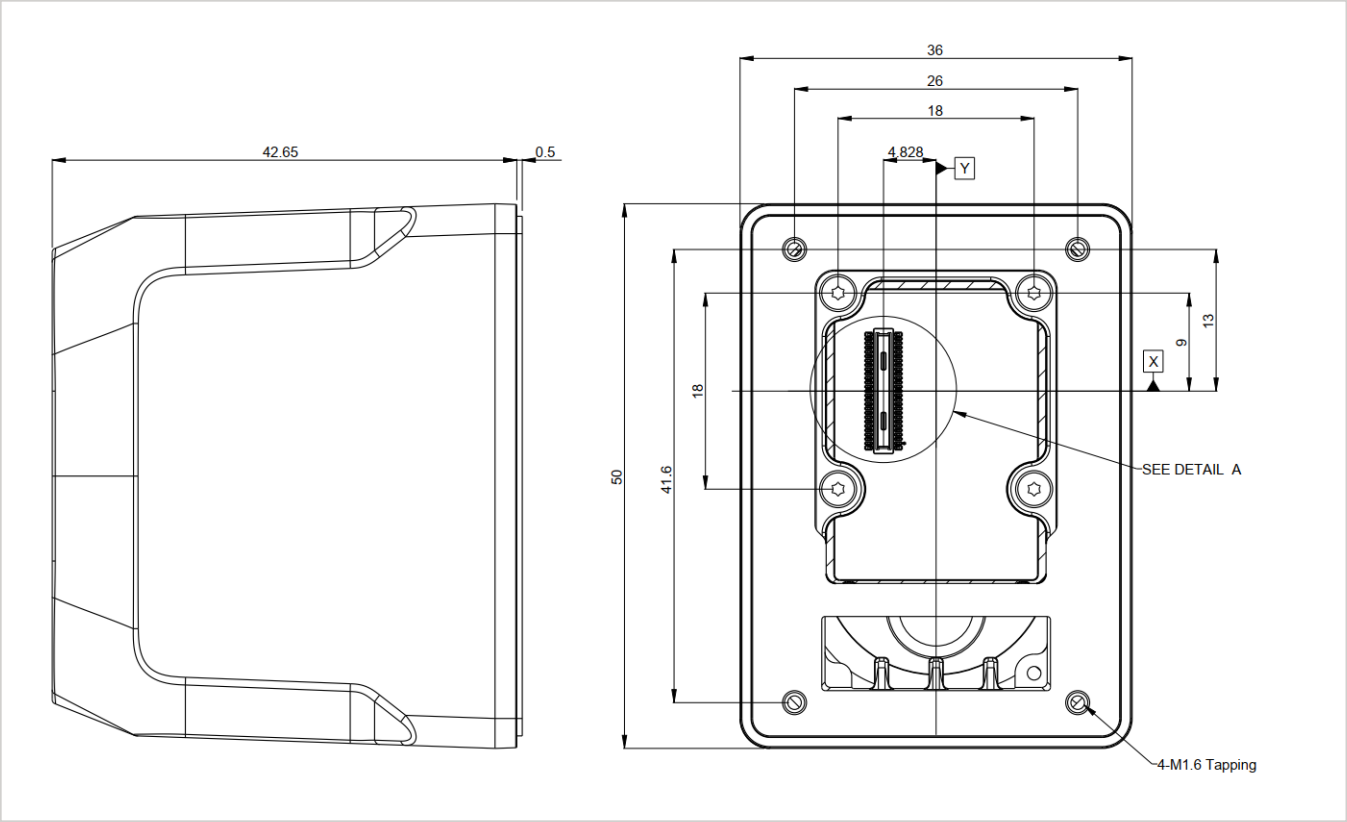

FIGURE 4. HADRON 640R EXTERNAL DIMENSIONS [MM] WITH PROTECTIVE HOUSING.

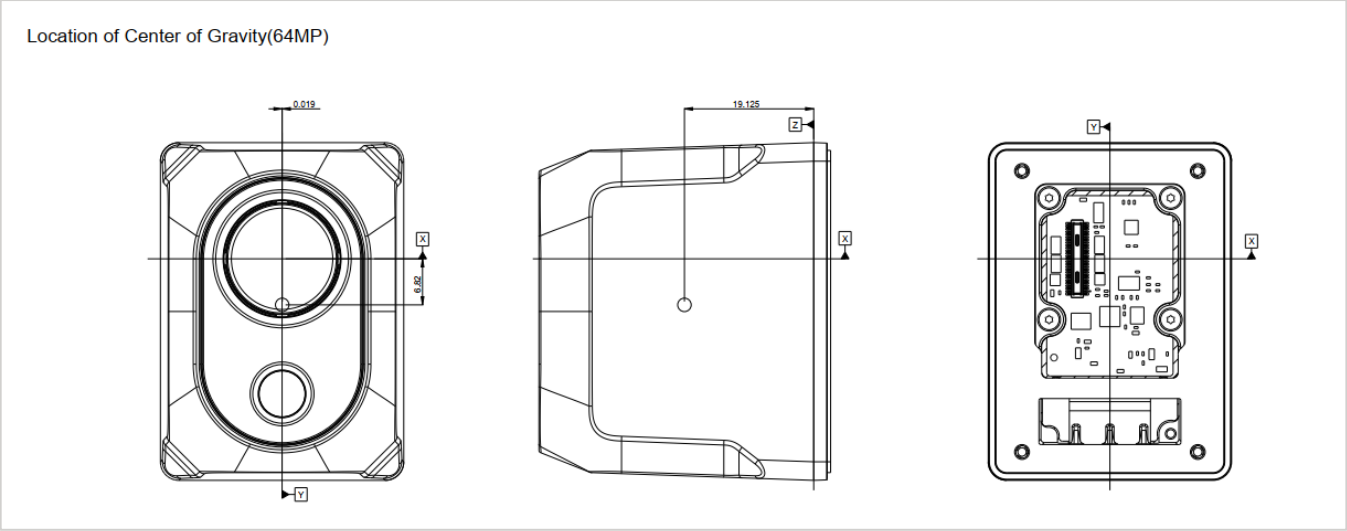

FIGURE 5: ESTIMATED COG FOR THE PAYLOAD

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 Figure 6 for the IMU intrinsic coordinate system (different from the Hadron 640R coordinate system).

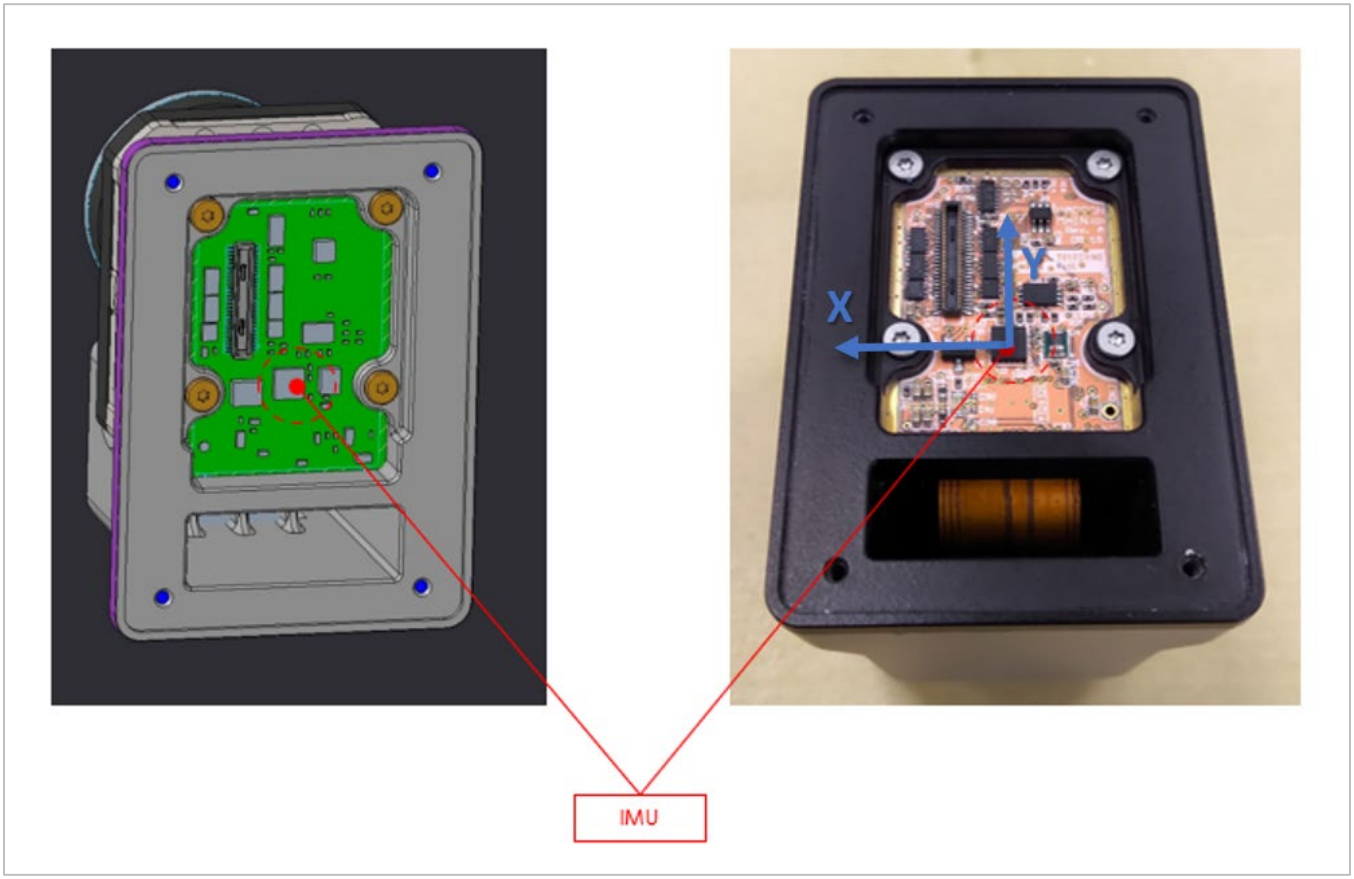

FIGURE 6. APPROXIMATE LOCATION OF THE IMU AND DESIGNATION OF THE IMU COORDINATE AXIS

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.

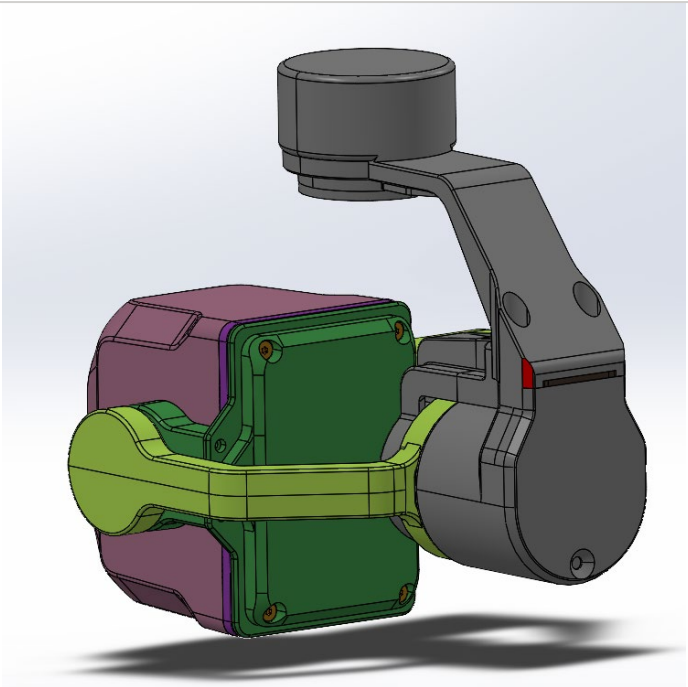

FIGURE 7. EXAMPLE MOUNTING APPLICATION OF THE HADRON 640R ON A 3-AXIS GIMBAL.

When integrating with a gimbal, the read of Hadron 640R must be against the metal frame to ensure that the system meets IP54.

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 ± 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

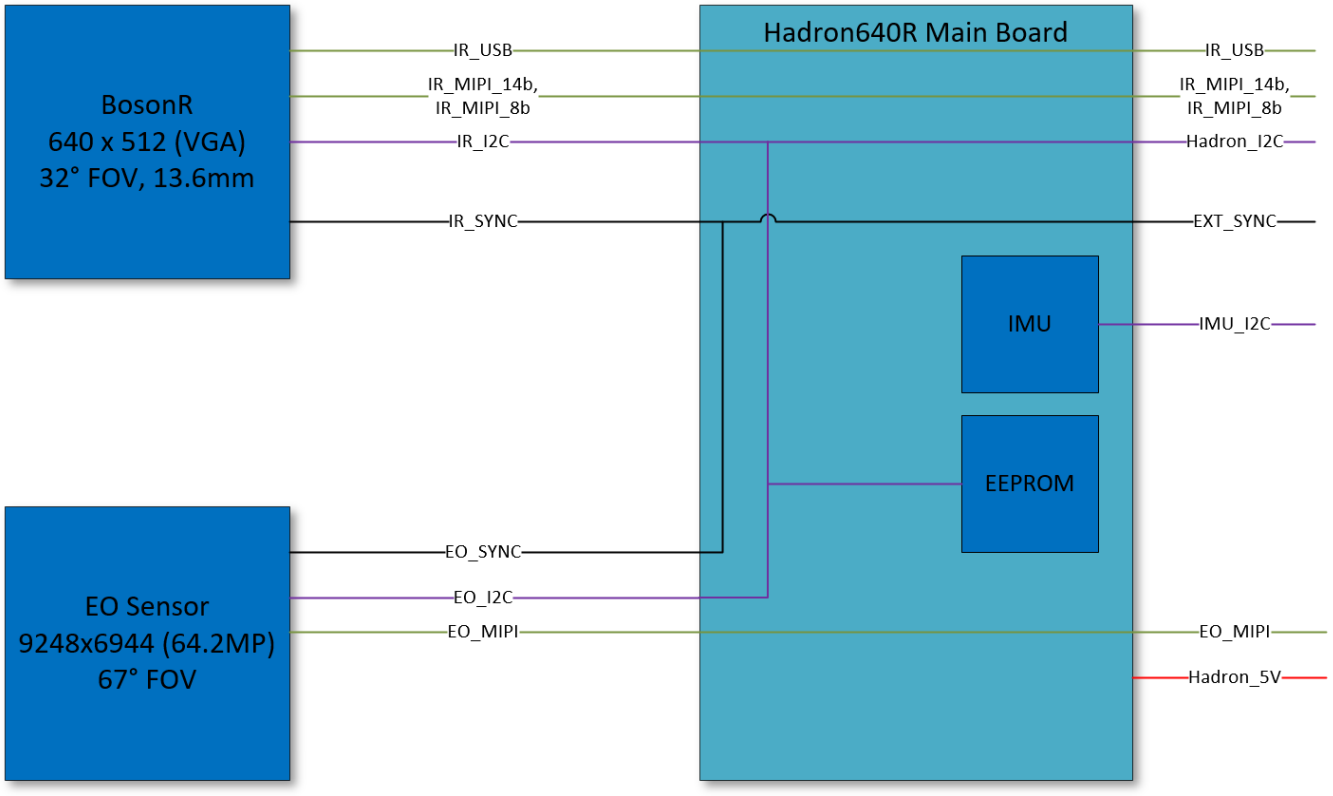

FIGURE 8. HADRON 640R INTERNAL AND EXTERNAL SIGNALS.

4.2 Hadron 640R external signals

Table 1 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

TABLE 1: HADRON 640R MAIN CONNECTOR PINOUT

PIN / SIGNAL	VOLTAGE
Power 5V	5V ± 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	• 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	• 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	• The OV64B EO sensor has a 4-lane MIPI interface. • The EO MIPI trace lengths from the sensor to the external connector are 55 ± 0.5 mm.
IMU_I2C (1.8V)	• 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)	• EO_I2C
	  • The EO sensor I2C bus with registers for image control.
	  • EO sensor I2C address: 110 1100
	• EO_IMU_I2C
	  • The IMU EEPROM I2C bus.
	  • IMU EEPROM I2C address: 101 0001
	• I2C_IR
	  • Boson CCI part of CSI-2.
	  • Boson CCI I2C address: 1101010

RESET_N	• The Boson and the EO sensor can be reset by holding RESET_N low.