EagleRay 4K
Compact Cinema Camera
1000m / 6000m

USER MANUAL

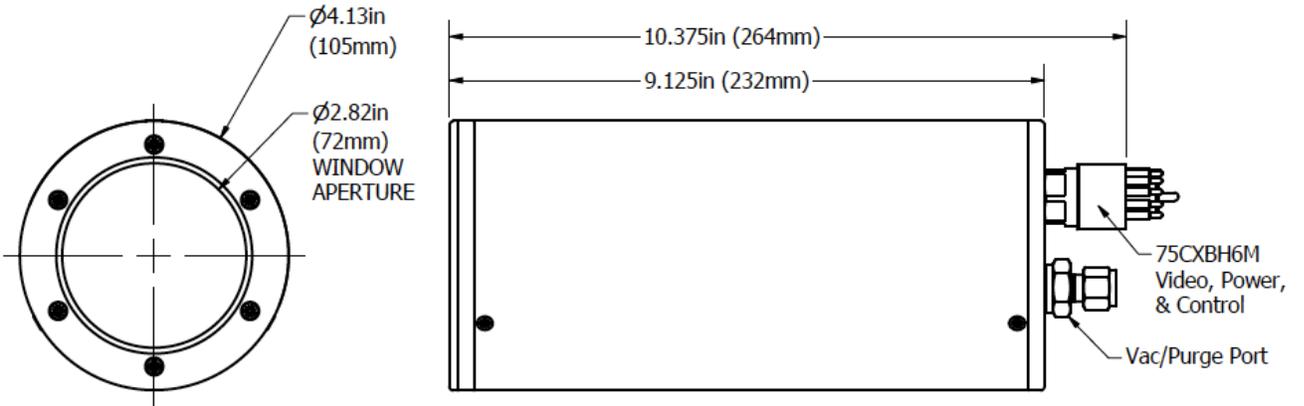*HW Rev.B - FW v2.0 - 10 April, 2020*

I.   INTRODUCTION:

The Arctic Rays EagleRay 4K is a compact, cinema-quality 4K "mini-camera" system for use down to 1000m (aluminum housing) or 6000m (titanium housing). The camera features a Micro-Four-Thirds (MFT) sensor, with motorized 12-50mm zoom lens.

Lens and camera control is provided via a handheld controller over RS-232. Real-time full-resolution 4K video (up to 2160p30) is output via 75ohm coaxial cable and can be converted to single-mode fiber optic for long-haul connections with an optional fiber-optic converter.
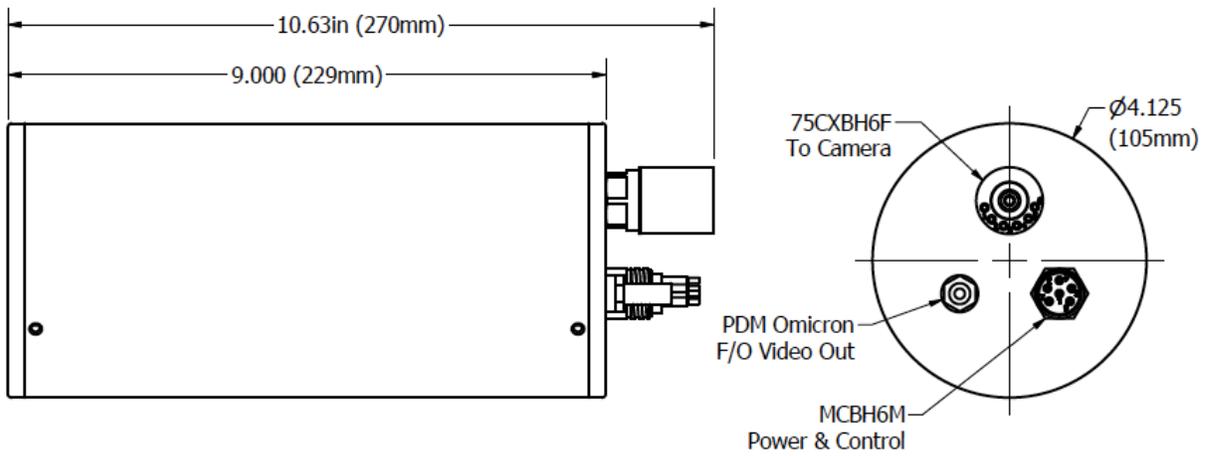
The fiber optic converter can be located in a separate housing, in order to minimize the size and weight of the camera, and provide a single flexible cable exit. This makes the EagleRay 4K camera head small enough for mounting on manipulator arms, small pan & tilt units, or positioning in tight spaces using a T-handle. Alternatively, the Fiber Optic converter can be incorporated into a single, larger camera bottle.

PARAMETER	SPECIFICATION
Model Number	AR201
Depth Rating	1,000m (3,300ft) or 6,000m (19,700ft)
Image Type	4K UHD Video (3840 x 2160p)
Lens	Olympus Zoom 12-50mm MFT (35mm Equivalent: 24-100mm)
Aperture	f/3.5-6.3 (Minimum f/22)
Angle of View	84-24° (in air), 60-18° (in water)
Output Resolution	3840 x 2160 @ 23.98, 24, 25, 29.97, 30p
Minimum Focus Distance	7.8in (200mm)
Remote Control Functions	Focus, zoom, iris, gain, white balance, shutter speed, frame rate, auto-focus, recording trigger, audio level (optional)
Power	12-40Vdc
Video Output Signal	6G-SDI (coax or fiber optic with optional converter)
Control Signal	RS232
Housing Materials	Aluminum/Acrylic (1,000m) or Titanium/Sapphire (6,000m)
Dimensions	9.125in (232mm) L x 4.125in (105mm) dia
Operating Temp.	0°C – 40°C
Digital Recorder / Monitor	Optional (Atomos Shogun or equivalent)
Pan & Tilt Interface	Optional connector on camera bottle for pass-thru connection to P&T
Fiber Optic Converter	Separate housing, same size as camera, or integrated into extended-length camera housing. One Impulse PDM Omicron single-mode fiber-optic connector, standard.

Overall Dimensions – EagleRay Camera (Coax Output):

Ø4.13in
(105mm)

Ø2.82in
(72mm)
WINDOW
APERTURE

10.375in (264mm)

9.125in (232mm)

75CXBH6M
Video, Power,
& Control

Vac/Purge Port

Overall Dimensions – EagleRay Fiber Optic Converter Bottle:

10.63in (270mm)

9.000 (229mm)

75CXBH6F
To Camera

Ø4.125
(105mm)

PDM Omicron
F/O Video Out

MCBH6M
Power & Control

II.   SETUP

The EagleRay 4K Camera System kit consists of the following components:

1. Camera Bottle
2. Fiber Optic Converter Bottle
3. Interconnect Cable (Coax+6)
4. Bench Cable (MCIL6F Pigtail)
5. Bench 24V power supply
6. Shogun Inferno DVR/Monitor with power supply
7. 1TB SSD Installed in Shogun drive caddy
8. SATA to USB Cable (for file download)
9. Blackmagic Design Fiber Optic to SDI converter with power supply
10. EagleRay hand controller
11. Hand controller cable (MXR-8 to RJ45) with RJ45 breakout
12. Dummy plugs (1ea MCDC6F, 75CXDC6M, 75CXDC6F)

The camera system general connection diagram is shown below:
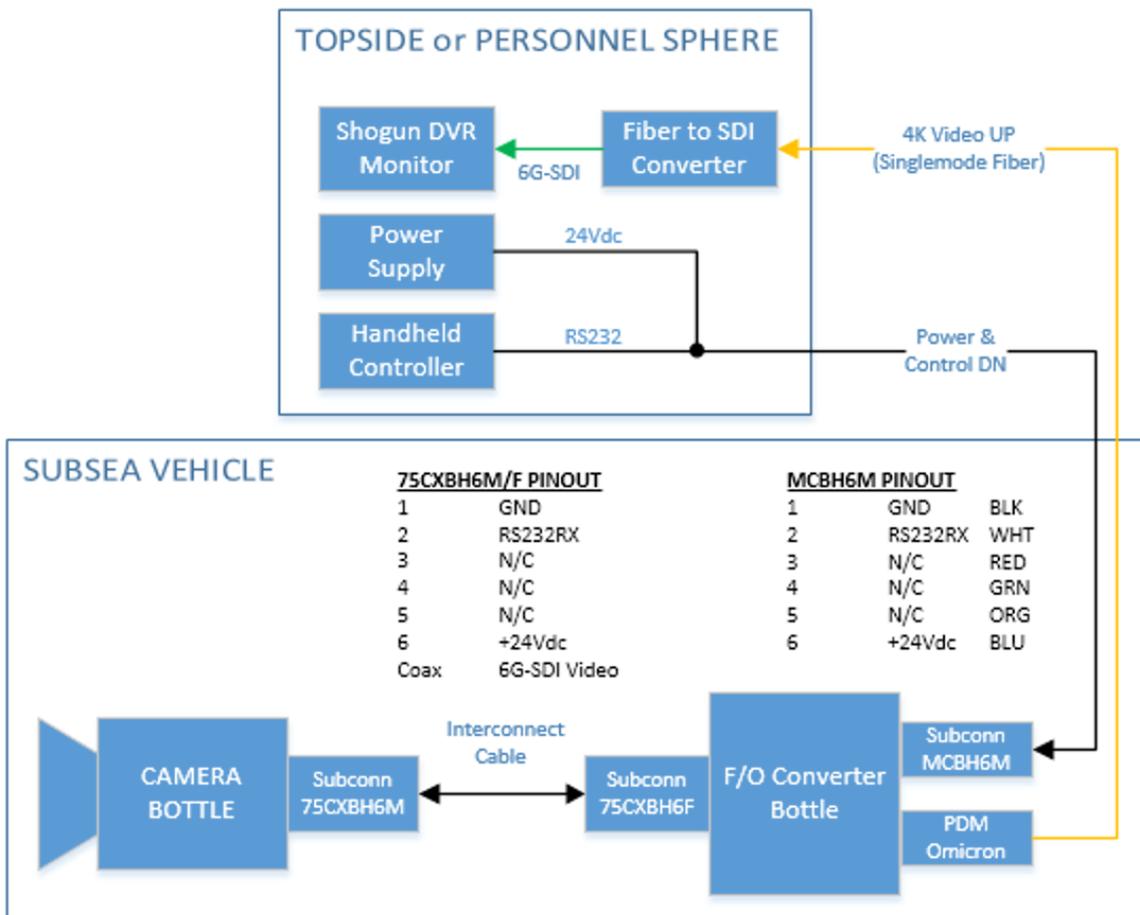
Mechanical: The Eagle Ray bottles should be held on their diameters and provided good contact with water for cooling. Bottles may be clamped in any orientation, but do not clamp to the connectors. Do not operate for extended periods of time in air.

1000m systems use hard anodized 6061-T6 Aluminum housings with acrylic windows. 6000m systems use 6AL-4V (Grade5) Titanium housings with Sapphire windows. Take care when cleaning windows. No incompatible solvents or abrasives should be used.

Connectors: Rubber-moulded connectors should be lubricated with Dow Corning #4 Silicone Grease or equivalent, prior to mating. *WARNING: Do not lubricate coaxial or fiber-optic mating surfaces or signal degradation could result. Do not use spray lubricants.* Maximize bend radii on all cabling, particularly coax (interconnect cable) and fiber optics. Consult connector manufacturers' manuals for specifications.

O-ring seals: Eagle Ray cameras utilize several o-ring seals: One for each bottle endcap, one for the camera window, and one on each connector bulkhead and vacuum/fill port. In addition, 6000m units utilize an Amber Kapton (Polyimide) ring, which acts as a window seat and high-pressure seal. None of these seals should be serviced by the user. The unit should be sent to the factory for seal replacement every 1-2 years, depending on use.

Power: The EagleRay should be powered from a 24Vdc nominal power supply. Both the camera and fiber optic converter bottles contain their own independent voltage regulators, so any clean DC supply in the range of 12-40Vdc is acceptable.

Communications: EagleRay uses the Futaba S.Bus serial control protocol over RS232, for control of the camera and its lens. The RS232 port operates at 100,000bps 8E2N. This is a non-standard RS232 configuration. Consult Arctic Rays if you are not using a direct cable connection and/or your telemetry system cannot support this setting. NOTE: The RS232 control signal is NOT multiplexed with the 4K video feed by default. This is a copper-based control signal.

III. **VIDEO DISPLAY AND RECORDING**
The EagleRay system outputs a real-time 4K video feed over 6G-SDI. There is no on-board recording. To display and record video, an external DVR/Monitor such as the Atomos Shogun may be used. Setup is as follows:

    A. If using fiber-optics, connect the F/O feed to the input on the topside Fiber Optic to SDI converter.
       WARNING: When testing on the bench using short fiber optic jumper cables, be sure to add at least 5dB of attenuation to the system, so as to avoid overdriving the fiber optic receiver.
    B. Power the fiber optic converter as specified. In the case of the Blackmagic Design 12G converter, external 6-36Vdc is acceptable.
    C. Connect the SDI output of the converter (or camera if not using fiber optics) to the DVR/Monitor. In the case of the Atomos Shogun, not all SDI inputs support 6G-SDI (4K) video feeds. Be sure that the input used is correct.
    D. Power the DVR/Monitor as specified. In the case of the Atomos Shogun, batteries or external 6.2-16.8Vdc may be used.
    E. Make sure that the input of the DVR/Monitor is set to "SDI"

F. Make sure that the recording trigger is enabled, and set to "Red Epic". This will allow the REC button on the hand controller to start/stop the DVR recording remotely.

G. Make sure that the SSD is inserted, formatted, and recognized by the DVR.

H. The video feed from the camera is a CLEAN FEED (no On-screen Display). Any DVR features, such as focus peaking, timecode, histogram, etc. will not be recorded.

IV. **HAND CONTROLLER**

The EagleRay hand controller provides all of the functionality needed for general camera operation. The camera sensor has been setup at the factory for optimal performance in the EagleRay system. More obscure settings and firmware upgrades require direct access to the camera module inside (see Section V).

Power Switch: The hand controller can be turned on and off with the rocker switch on the side. The red LED indicates if it is powered ON. Power can be provided from its internal 9V battery, or externally through the interface cable. The battery and the external supply are internally diode OR'ed, so whichever has the highest voltage will power the handbox.

Interface Connector: This connector (Hirose MXR-8) carries RS232 control out to the camera, and can be used for externally powering the handbox.   The pinout is as follows:

HANDBOX PINOUT (Hirose MXR-8)
1   GND
2   +6-40Vdc (IN)
3   RS232 RX (IN)
4   RS232 TX (OUT)
5   RS232 GND
6   N/C
7   N/C
8   N/C

Record: The red REC button toggles record start/stop. When pressed, it passes a trigger to the DVR (Shogun or equivalent). The DVR must be properly configured to accept this trigger in order for this button to work. On the Atomos Shogun, the trigger should be enabled and set to "Red Epic".

Focus/Iris/Zoom: The FIZ controls provide absolute position control over focus and aperture, and speed control over zoom. The aperture position is dependent on the zoom location. Maximum apertures at tele and wide zoom are listed in the parameter table. *NOTE: The lens uses built-in stepper motors for iris and focus. Thus, focus control will have some granularity, and iris control is restricted to a finite number of fixed f-stops. See the camera parameter table for details.

Auto Focus: The AF button provides instantaneous autofocus upon press. As soon as the focus knob is moved, the lens will revert back to manual focus

Gain: Use this switch to toggle the gain up and down.

White Balance (WBAL): Use this switch to select up and down between several preset color temperatures.

Frame Rate (FRM): Toggle this switch UP to change the video output format.

Shutter Speed (S.SPD): Toggle this switch up or down to change the shutter speed setting.

V.   CAMERA SETTINGS:

The 4K video output from the EagleRay camera is a "clean feed". That is to say, no on-screen display (OSD) or readout of camera parameters is provided. Furthermore, the serial control protocol does not provide parameter feedback (e.g. aperture, white balance, etc.). As a result, the user will have to keep track of these parameters manually if they require specific settings. The table below lists all of the possible values supported by the hand controller. It is recommended that this table be printed out for quick reference.

ARCTIC RAYS
EagleRay 4K Camera
HANDBOX CONTROL PARAMETER TABLE

Camera Module: Blackmagic Design Micro Studio 4K
Lens: Olympus M.Zuiko Digital ED 12-50mm 1:3.5-6.3 EZ (Micro 4/3)

IRIS (23 discrete stops)	WHITE BALANCE (18 discrete color temps)	SHUTTER SPEED (16 discrete settings)
1. f/3.5 (max at full wide)	1. 2500K (bluest)	1. 1/30 sec (brightest)
2. f/3.7	2. 2800K	2. 1/50 sec
3. f/4.0	3. 3000K	3. 1/60 sec
4. f/4.5	4. 3200K	4. 1/75 sec
5. f/4.8	5. 3400K	5. 1/90 sec
6. f/5.2	6. 3600K	6. 1/100 sec
7. f/5.6	7. 4000K	7. 1/120 sec
8. f/6.2 (max at full tele)	8. 4500K	8. 1/150 sec
9. f/6.7	9. 4800K	9. 1/180 sec
10. f/7.3	10. 5000K	10. 1/250 sec
11. f/8.0	11. 5200K	11. 1/360 sec
12. f/8.7	12. 5400K	12. 1/500 sec
13. f/9.5	13. 5600K	13. 1/725 sec
14. f/10	14. 6000K	14. 1/1000 sec
15. f/11	15. 6500K	15. 1/1450 sec
16. f/12	16. 7000K	16. 1/2000 sec
17. f/14	17. 7500K	
18. f/15	18. 8000K	
19. f/16		
20. f/17		
21. f/19		
22. f/21		
23. f/22		
GAIN (5 discrete levels)	**FRAME RATE** (5 output formats)	
1. -12dB (least noise)	4Kp23.98	
2. -6dB	4Kp24	
3. 0 dB (default)	4Kp25	
4. +6dB	4Kp29.97	
5. +12dB (brightest)	4Kp30	

Other Settings / Camera Firmware Upgrades: Less-frequently used settings, lower resolution frame rates, and firmware upgrades are performed at the factory prior to delivery. If any changes need to be made, the camera module must be accessed directly. The module is a modified version of the Blackmagic Design Micro Studio 4K camera. To modify settings other than those available on the hand controller, follow these steps:

1. Open the camera bottle and slide out the chassis.
2. Connect power to the camera bottle endcap.
3. Connect an HDMI cable to the camera's HDMI output. The HDMI feed is 1080p only, but provides an OSD that allows you to see all of the camera's internal menus and settings.
4. Use the buttons on the camera body to navigate through the menus and settings.

   *NOTE: Do not alter the S.Bus channel mapping, or the handbox controller may not work properly.

5. If a camera firmware upgrade is required, connect a USB cable to the bottom of the camera through the hole in the mounting rail. Follow the instructions on the Blackmagic Design website for upgrading firmware in Micro Studio 4K cameras.
6. Once complete, verify that the SDI output and handbox controller work properly.
7. Inspect the o-ring seals, replace dessicant packs if needed, and close the camera bottle.
8. Verify a proper seal using the vacuum/purge port, and back-fill with dry nitrogen (optional).

VI. OPENING THE CAMERA HOUSING

The camera housing may be opened for window cleaning, camera setting change, or repair, by removing the three set screws holding the endcap in place. Perform the following steps for re-assembly of the housing:

1. Check o-ring seal(s) for cracks, flat spots, or debris. Clean o-ring(s) and grease with Dow Corning #4 or equivalent.
2. Check dessicant pack(s). If indicator color is pink or green, replace dessicants.
3. Re-assemble housing, careful to damage o-ring(s).
4. Attach fitting to vacuum/purcge port. 1000m cameras use a ¼" Swagelok tube fitting. 6000m cameras use a Prevco PRV fitting. Be sure to use the correct mating fitting for your camera.
5. Pull vacuum to -15 inHg (-500mbar). Wait 5 minutes and verify that the vacuum is holding.
6. If possible, back-fill/purge housing with dry nitrogen gas through the vacuum port. This, plus the dessicants, will ensure that condensation does not form on the window, ruining the image, or on the walls of the housing, posing risk of dripping onto electronics. Do not exceed 1ATM absolute internal pressure on housing.

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