The Deep Space Systems WRA50X cameras are derived from a terrestrial machine vision camera. WRA502 is the Optical Navigation Camera for the Orion Multi Purpose Crew Vehicle.

Size, Weight and Power:
- Size: 3.2 x 2.5 x 3 in. (W x D x H)
- Weight ≤ 0.67 lbs.
- 5 VDC Power, 6.8 Watts Peak (Heater Mode) 3.8 W Average

Performance:
- 5.3 Megapixel (2592 x 2048) CMOS Image Sensor
- 75 fps at Full Resolution
- In Flight Commandable Manual Controls
- USB 3.0 Interface
  - Compatible with USB 2.0 at lower data rates
  - Qualifiable interfaces include FireWire and Ethernet

The capabilities added by Deep Space Systems’ installation of a Heater-Illumination-Power (HIP) board include:
- Built In Closed Loop Heater Control (enabled upon command)
- Over-temperature shutdown protection
- LED Illuminator with beam focusing lens
- Power supply diodes for over-voltage and electro-static discharge (ESD) protection

Environmental Qualification
- Qualified operational baseplate temperature range in vacuum: -40°F to 203°F (-40°C to 95°C)
- Radiation Tolerant (proton and heavy ion radiation tested)
- Random Vibration: 54.99 G_rms Qual for 730 seconds
- Shock: 10584 Gs, Qual Peak Gs
- Aluminum-to-aluminum and connector body to aluminum bonding < 2.5 milliohms
- 40 dB shielding attenuation from 30kHz to 40GHz

Lenses
- Lenses are ruggedized and space qualified (other custom optics are available upon request)
  - AZURE Photonics AZURE-06520ML5M (6.5mm, F2.0 - 22, HFOV = 89.1°)
  - Schneider Optics 21-1006219 APO-XENOPLAN (35mm, F2.0 - 22, HFOV = 22°)

Other Specifications
- Pixel Size: 4.8 x 4.8 microns
- Optical Formal: 1 in
- Peak Quantum Efficiency (QE): 53% at 550 nm
- Fixed-Pattern Noise (FPN) < 1% of signal
- Photo Response Non-Uniformity (PRNU) < 2% of signal
- Dynamic Range: 53 dB
- Bit depth: 8- or 10-bit
- Responsivity at 550 nm: 24 LSB10/in2/cm2, 4.6 V/lux.s
- Pipelined and Triggered Global Shutter
- MTF at center ≥ 20%
- MTF at specified angle from center ≥ 10% at 30°
- Flexible Region of Interest
- Windows and Linux API available
- High Dynamic Range (HDR)
- Auto & Manual Exposure
- Programmable Look-Up Table (LUT)
- Auto & Manual White Balance
- Monochrome or Color
- Manual control of:
  - Color Temperature
  - Gain
  - Gamma
  - Saturation
  - Binning and Decimation
  - Image Flip and Rotate
- Example Frame Rates:
  - 75 fps at 2592 x 2048
  - 183 fps at 1980 x 1020
  - 250 fps at 1280 x 1024
  - 813 fps at 640 x 480
DSS WRA501, WRA502, WRA503

DSS WRA502 Shown
(Optical Navigation Camera for the Orion Multi Purpose Crew Vehicle)
Optical Navigation Camera Location

Optical Navigation Camera Baffle Assembly
Custom Light Baffle Upon Request

OpNav Camera Baffle Bracket (OPNAVBB501-0xx)

OpNav Camera Flight (WRA502-0xx, Beneath Cover)

OpNav Camera Cover Flight (OPNAVCC501-0xx)

Part # WRA501 89° FOV Medium Field of View Lens w/ included Illuminator LEDs

Part # WRA502 OpNav Camera, 22° FOV

DSS WRA501, WRA502, WRA503
### Frequency Response Table

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>ASD (g^2/Hz)</th>
<th>dB</th>
<th># of Octaves</th>
<th>Slope (dB/Oct)</th>
<th>Area</th>
<th>g RMS</th>
<th>Slope (dB/Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0.040</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>25</td>
<td>0.050</td>
<td>0.97</td>
<td>0.02</td>
<td>0.31</td>
<td>0.02</td>
<td>0.47</td>
<td>0.19</td>
</tr>
<tr>
<td>70</td>
<td>1.995</td>
<td>16.02</td>
<td>1.49</td>
<td>10.79</td>
<td>30.43</td>
<td>5.52</td>
<td>0.36</td>
</tr>
<tr>
<td>95</td>
<td>1.995</td>
<td>0.00</td>
<td>0.44</td>
<td>0.00</td>
<td>80.30</td>
<td>8.96</td>
<td>0.00</td>
</tr>
<tr>
<td>130</td>
<td>13.965</td>
<td>8.45</td>
<td>0.45</td>
<td>18.68</td>
<td>306.00</td>
<td>17.49</td>
<td>0.24</td>
</tr>
<tr>
<td>200</td>
<td>13.965</td>
<td>0.00</td>
<td>0.62</td>
<td>0.00</td>
<td>1283.55</td>
<td>35.83</td>
<td>0.00</td>
</tr>
<tr>
<td>300</td>
<td>3.990</td>
<td>-5.44</td>
<td>0.58</td>
<td>-9.30</td>
<td>2047.30</td>
<td>45.25</td>
<td>-0.05</td>
</tr>
<tr>
<td>2000</td>
<td>0.080</td>
<td>-16.99</td>
<td>2.74</td>
<td>-6.21</td>
<td>3024.06</td>
<td>54.99</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

### AVTs in Qual. Duration (Sec/Axis)

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Duration (Sec/Axis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>735</td>
</tr>
<tr>
<td>4</td>
<td>675</td>
</tr>
<tr>
<td>3</td>
<td>615</td>
</tr>
<tr>
<td>2</td>
<td>555</td>
</tr>
<tr>
<td>1</td>
<td>495</td>
</tr>
</tbody>
</table>

### WRA501 Random Vibration Qualification Levels

- **Frequency (Hz)**: 20, 25, 70, 95, 130, 200, 300, 2000
- **ASD (g^2/Hz)**: 0.040, 0.050, 1.995, 1.995, 13.965, 13.965, 3.990, 0.080
- **dB**: 0.97, 0.02, 0.44, 0.00, 0.45, 0.00, -5.44, -16.99
- **# of Octaves**: 3.01, 0.00, 0.44, 0.00, 18.68, 0.00, 0.58, 2.74
- **Slope (dB/Oct)**: 0.22, 0.00, 0.00, 17.49, 0.00, 0.00, 45.25, -6.21
- **Area**: 30.43, 80.30, 306.00, 1283.55, 2047.30, 3024.06, 3024.06, 3024.06
- **g RMS**: 0.47, 8.96, 17.49, 35.83, 45.25, 54.99, 54.99, 54.99
- **Slope (dB/Hz)**: 0.19, 0.00, 0.24, 0.00, 0.24, 0.00, 0.00, 0.00

### CCA501 Camera Controller

- **(WiGig, WiFi, 4 X USB3.0, 1000T Ethernet, HDMI, 480GB)**
- **Enveloped MPE and Proqualification/Qualification (MPE + 3dB) Shock Test Levels**

### WRA501 Shock Qualification Levels

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>G</th>
<th>dB</th>
<th># of Octaves</th>
<th>Slope (dB/Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>150</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>1600</td>
<td>6735</td>
<td>33.06</td>
<td>4.00</td>
<td>8.27</td>
</tr>
<tr>
<td>3510</td>
<td>17791</td>
<td>8.44</td>
<td>1.13</td>
<td>7.44</td>
</tr>
<tr>
<td>10000</td>
<td>17791</td>
<td>0.00</td>
<td>1.51</td>
<td>0.00</td>
</tr>
</tbody>
</table>

### Video and Imaging Camera System for The Orion Multipurpose Crew Vehicle

- **Orion Full EDU Ship Set (Less OpNav Camera)**
- **DSS WRA501, WRA502, WRA503**
- **CCA501 Camera Controller**

- **WRA501 Wireless Camera**
  - 4K Video at 30 fps (recording)
  - 1080P Video at 120 fps (recording)
  - 720P Video at 240 fps (recording)
  - 12 MpfFull resolution stills
  - Up to 720P Live Streaming via WiFi
  - Auto and Manual Shutter Control and Exposure
  - Manual control of White Balance, Color, ISO Limit, Sharpness, Shutter, and Exposure Value Compensation
  - .jpg and .mp4 files stored in internal 128 GB MicroSD Card
  - HTML and FTP file transfer via WiFi
  - LED “Head Light” Illuminator
  - Internal Autonomous Heater Control When in Sleep Mode
  - Electrical Isolation from Chassis and Thermal Grounding to Chassis
  - 5.8 GHz WiFi as Client in Assigned (Static) Frequency Channel
  - Powered via single 5V twisted pair (5W average 6 W peak)
  - Power via External Battery/Solar Cells is optional (totally wireless)
  - Internal Auto Sequence Execution, Reconfigurable In Flight via WiFi
  - 3 Ruggedized and qualified lenses (many optional lenses available)
  - Patch and Monopole 5.8GHz antenna options (patch shown above)
  - May be operated in a fully wired mode (no RF emissions)
  - Built in closed loop heater control when in sleep mode

### Other Deep Space Systems Products

- **WLA501 5.8 GHz WiFi Camera**
  - 4K Video at 30 fps (recording)
  - 1080P Video at 120 fps (recording)
  - 720P Video at 240 fps (recording)
  - 12 MpfFull resolution stills
  - Up to 720P Live Streaming via WiFi
  - Auto and Manual Shutter Control and Exposure
  - Manual control of White Balance, Color, ISO Limit, Sharpness, Shutter, and Exposure Value Compensation
  - .jpg and .mp4 files stored in internal 128 GB MicroSD Card
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  - Power via External Battery/Solar Cells is optional (totally wireless)
  - Internal Auto Sequence Execution, Reconfigurable In Flight via WiFi
  - 3 Ruggedized and qualified lenses (many optional lenses available)
  - Patch and Monopole 5.8GHz antenna options (patch shown above)
  - May be operated in a fully wired mode (no RF emissions)
  - Built in closed loop heater control when in sleep mode

### System Features

- **WLA501 Random Vibration Qualification Levels**
  - Frequency (Hz): 100, 1600, 3510, 10000
  - G: 12.25, 7.15, 3.87
  - Size (of UV): 11.25 x 7.15 inches
  - Weight: 8 lbs (not incl. WiFi)
  - Power: 150 watts (max input power)
  - Power supply: 5V/1.5A
  - Efficiency: 22.25% (total efficiency)
  - COTS: Yes
  - Shock: 120 Gs peak/Go

### Video and Imaging Camera System

- **Video and Imaging Camera System for The Orion Multipurpose Crew Vehicle**

- **CCA501 Camera Controller**

- **Video and Imaging Camera System for The Orion Multipurpose Crew Vehicle**

- **WLA501 Wireless Camera**

- **Other Deep Space Systems Products**

- **WLA501 5.8 GHz WiFi Camera**

- **Video and Imaging Camera System for The Orion Multipurpose Crew Vehicle**

- **WLA501 Wireless Camera**

- **Other Deep Space Systems Products**

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