Cohu Electronics

5930 Series Thermal Camera User's Manual

Figure 1 – 5935-1000/T100 Thermal Camera with 100mm Lens Installed

Technical Manual 6X-1060

January 3, 2006

Cohu Electronics

5930 Series Thermal Camera User's Manual

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Product Description

The Cohu 5930 series is a long wavelength (LWIR) Infrared microbolometer based camera system. The embeddable electronics provides the foundation for the processing and signal generation for the camera. Below is a description of all the different aspects that make up the complete camera assembly.

1.1 FPA Description

The FPA used in the 5930 is an uncooled 320 x 240 matrix or "staring" array of microbolometer detectors (51um square), sensitive in the 8.0-14.0 micron range. The FPA is enclosed in an all-metal evacuated dewar package, and is thermally stabilized by the electronics using a built in TE cooler. The FPA incorporates internal thermal reference detectors that provide compensation for thermal drift and noise.

1.2 Hardware Description

The camera electronics are comprised of four major circuit boards as described below.

1.2.1 FPA Support PCB

The FPA support PCB provides all the interface signals required to control the FPA. The FPA Support PCB supports all the FPA functions as listed in Table 1.

Table 1 - 5930 SERIES FPA Support Functions

Specifications	
FPA Clocks	**3**
FPA Biases (DAC adjustable)	**1**
FPA Adjustable Bias Resolution	**8 bit**
FPA Biases (Fixed)	**1**
FPA Power Supplies	**3**
FPA Video Outputs	**1**
FPA Video Offset Range	**0 to +3.25V**
FPA Video Offset Resolution	**8 bit**
FPA Video ADC Resolution	**14 bit**
FPA Video ADC Rate	**≤ 7.37500 MHz**
FPA TEC Setpoints	**2**
PCB Size	**2" x 2"**

1.2.2 Camera Controller PCB

The camera controller PCB provides all the video processing and control functions for the camera. The camera controller PCB provides all the functions listed in Table 2.

Table 2 – 5930 Series Camera Controller Functions

Specifications	
FPA Format	**320 x 240**
FPA Frame Rate	**NTSC: 59.94 Hz** **PAL: 50 Hz**
FPA Clock Generation	**≤ 6**
FPA Adjustable Bias Generation	**≤ 4**
Nonuniformity Correction	**2 point gain/offset**
NUC Gain Coefficient Precision	**16 bit**
NUC Gain Range	**0 to 2 – 2^{-15}**
NUC Offset Coefficient Precision	**16 bit**
NUC Offset Coefficient Range	**-16,384 to +16,383.5**
NUC Offset Refresh Precision	**16 bit**
NUC Offset Refresh Range	**-16,384 to +16,383.5**
NUC Tables Possible	**≤ 12**
Defective Pixel Replace Kernal	**5 lines / 7 columns**
Intensity Transformation Table	**Dual 14 in / 16 out**
Zone Statistic ROIs	**4 Zones**
Zone Statistical Computations	**Average, Sigma, Max., Min.**
Processed FPA Video Output Precision	**16 bit**
Processed FPA Video Output Selections	**Digitized FPA Video** **NUC Corrected Video** **Pixel Replaced Video** **Intensity Transform Video**
PCB Size	**2" x 2"**

1.2.3 Camera Support PCB

The camera support PCB provides all the power supply conditioning and camera interface functions. The camera support PCB provides all the functions listed in Table 3.

Table 3 - Camera Support Functions

Specifications	
Power Input Range	**+5.8V to +28.2V**
Smart Battery Pack Interface	**1 Wire**
+VhiM Output (Bias Power)	**+7.0V to +12V @ 300mA**
+5.XVM Output (Main Board Power)	**+5.0V to +5.5V @ 5.0A**
Video Encoder Formats	**NSTC or PAL**
Number of Analog Video Outputs	**2 Composite and SVID**
Digital Output Formats	**LVDS (Serialized 4 Pair)**
COM Port Interfaces	**2**
COM Port Formats	**RS232C** **RS422 (Differential Full Duplex)** **RS485 (Differential Half Duplex)**
Oscillator Frequency	**NTSC: 49.09090 MHz** **PAL: 59.00000 MHz** **NI: 80.00000 MHz**
External Clock Input Format	**LVDS**
External Sync Input Format	**LVDS**
Calibration Flag Reference Control	**Dual Temperature, "Heat Only"**
Calibration Flag Reference Setpoint	**8 bit DAC**
Calibration Flag Motor Control	**PWM**
Cooling Fan Interface	**PWM (+5V Level)**
Motorized Focus Interface	**+5V "H-Bridge"**
PCB Size	**2" x 2"**

1.2.4 Camera Power Supply PCB

The camera power supply PCB provides all the power conditioning and external interfaces for the camera. The camera power supply PCB provides the following functions:

- Configures the following power inputs based on model selection;
  - ✓ 5935 Series: 95-250VAC
  - ✓ 5934 Series: 20-28VAC
  - ✓ 5932 Series: 11-16VDC
- Input power conditioning.
- AC Power Fusing.
- Power illumination (internal LED).
- Configures COM port interface (RS422).
- External interface connectors (through cable assemblies) to main Camera electronics (includes power, COM, analog video and digital video).
- Expansion connectors for auxiliary camera functions (not used on base Camera model).

1.3 Camera Operation

This Camera has a multitude of operational and configuration settings which can be adjusted via software control. Typically only a few settings or adjustments require attention once the Camera is embedded into a specific application. A complete list of adjustable settings and software features can be found in Paragraph 3 of this Document.

Cohu Electronics provides a host software application (Camera Control Interface) that can be used for generic camera control and camera setup. For specific information on the capabilities of this application please refer to Cohu CCI manual. Cohu Electronics also sells a developer's software guide for end-users that intend on designing a custom software interface for their own application. Contact the Cohu's Product Manager for more information on how to develop you own application for this camera.

1.4 Lens Options

The camera is equipped with a lens mount with a specific internal thread to accept a series of watertight, fixed focus, f/1.4 Infrared lenses. See Table 4 for the f/1.4 lens options. The lenses are designed with the front lens element sealed for NEMA 4 and IP67 water resistance rating. All these lenses have the front lens element Diamond Carbon Coated for added resistance against weather and scratching.

Table 4 - Fixed Focus Lenses

Cohu Part Number	Focal Length	Minimum Focus Distance	Field of View (H x V)
T013	13mm	2 inches	69º x 53º
T025	25mm	12 inches	36º x 28º
T050	50mm	24 inches	18º x 14º
T075	75mm	30 inches	13.5º x 10.5º
T100	100mm	36 inches	9º x 7º
T200	200mm	120 inches	4.5º x 3.5º

The front lens plate has a machined groove designed specifically to interface to an O'Ring installed on the f/1.4 lenses to ensure the water resistance rating of the camera. See Figure 2 for lens mounting interface specifications.

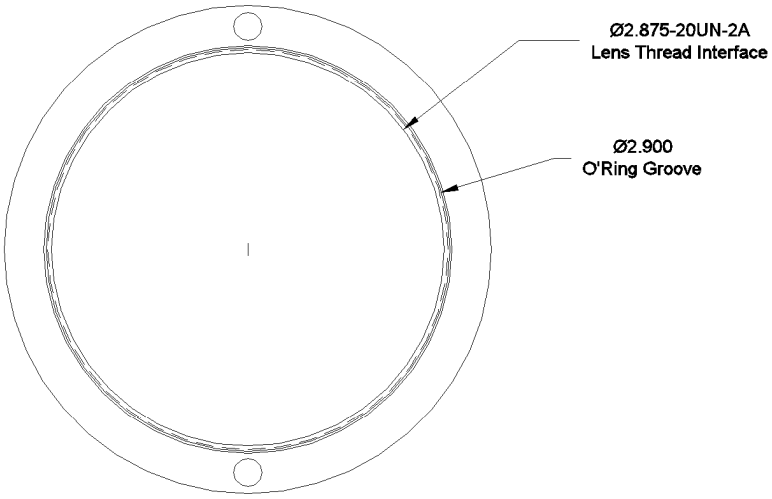

Figure 2 - Lens Mechanical Interface

1.5 Camera Performance

The Camera meets the performance parameters listed is Table 5.

Table 5- Camera Performance

Performance Requirement	Specification
Non-Uniformity Correction	< 0.0025
Noise	< 3 Counts
NEDT (f/1.4 Optic and FPA)	< 100 mKelvin
Operability	>99.5%

1.6 Mechanical Characteristics

The Camera dimensions are as shown in Figure 3. These dimensions show the Camera without a lens or mating connector. The mating connector adds about 2.0" to the rear of the camera which includes room for the cable's bend radius. The different focal length lenses are larger as they go up in focal length. This will add to the length of the camera depending on the lens focal length.

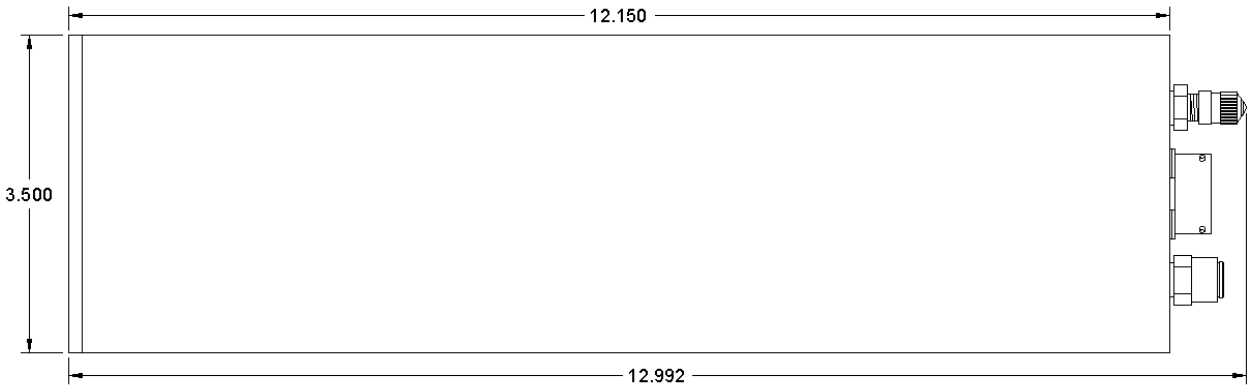

Figure 3 - Camera Dimensions

2. Installation

This section describes everything from removing the camera from the box to how to connect the camera to external devices.

2.1 Unpacking and Receiving Inspection.

The camera was tested and carefully packed at Cohu Electronics. Upon acceptance by the carrier, they should assume responsibility for its safe arrival. Should you receive this item in damaged condition, claims for shipping damage must be filed against the carrier.

To return the camera to the factory for any other service, please contact Cohu Electronics Customer Service Department for a Return Authorization Number.

2.2 Lens Cleaning.

The lens provided with this Camera has the front lens element diamond carbon coated. Even though this coating is very tough, the following cleaning procedures should be adhered to. A light dusting of air should be enough to dislodge most dust particles, although small amounts of dust should not affect camera performance. If necessary to clean the front surface, use 75% isopropyl alcohol and a lens tissue. Use a clean section of tissue with each swipe so as to not drag dirt back on the front lens surface.

2.3 Electrostatic Discharge (ESD) Precautions.

The installation procedures in this user's manual do not require entry into the Enclosure of the Camera. However in the event that the camera needs to be opened as directed by Cohu Electronics , the following ESD precautions should be followed:

- Use a conductive pad on whatever work space used.
- Connect the conductive pad to earth ground through a 1MΩ resistor.
- Use a wrist strap connected to earth ground through a 1MΩ resistor when working with the equipment.
- Maintain the relative humidity above 30%. Working on this circuitry with a relative humidity below 30% requires more extreme ESD precautions not specified in this document.
- Use antistatic bags to store and transport any electronic components or circuit board assemblies removed from this Camera. Use new antistatic bags as old antistatic bags can lose their static protection after use.

2.4 Tripod Mounting Interface

The camera has a tripod mounting plate clamped to the bottom of the Camera. The Tripod mount has five mounting threads (0.250-20UNC-2B) separated as shown in Figure 4. This provides two center-to-center mountings, being 1.75” and 1” bolt patterns. Insure the mounting arm/fixture supports one of these mounting bolt patterns.

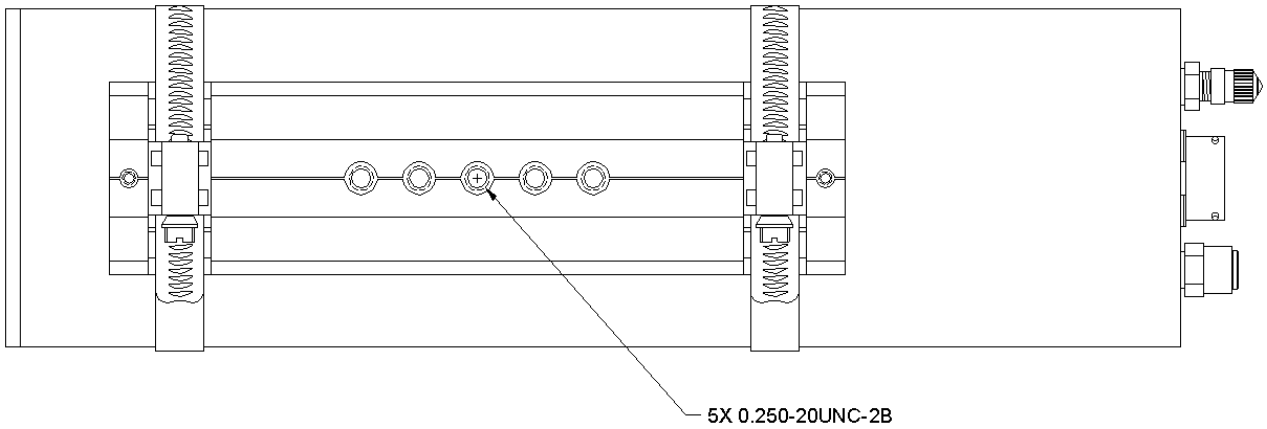

Figure 4 - Tripod Mounting Locations

2.5 Main Rear Panel Signal Connector

The main signal input/output connector is located on the rear panel of the Camera as shown in Figure 5.

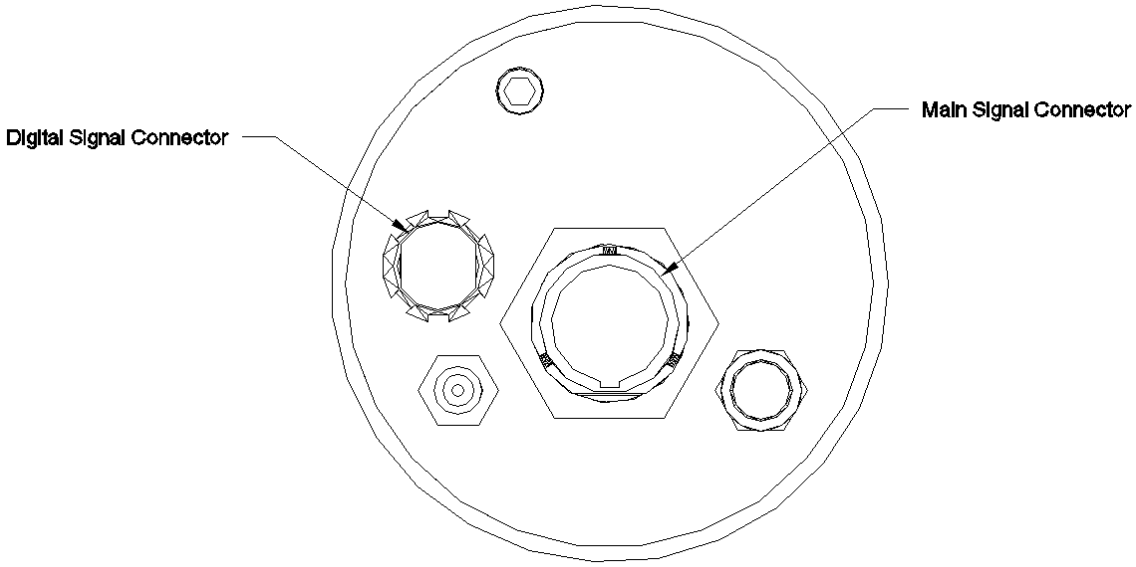

Figure 5 - Camera Rear Panel

2.5.1 Camera Main Signal Connector

The main signal connector that is mounted to the rear panel of the Camera is manufactured by Amphenol and the part number is PT07H-14-18P. This connector is hermetically sealed which means it is gastight therefore exceeds the NEMA 4 and IP67 water resistance rating of the Camera. This connector is equipped with 18 contacts. See Table 6 for main signal pin descriptions.

Table 6 - Main Signal Pin Descriptions

Pin Number(s)	Direction	Signal Name	Signal Description
G	Input	Chassis	Chassis Ground
U	Input	AC Line	AC Line high side power input. Camera will function on voltage inputs of 90-250VAC, 47-63Hz.
T	Input	AC Neutral/24VAC Lo	AC Line and 24VAC return (Neutral).
B	Input	24VAC Hi	24VAC high side power input. Camera will function on voltage inputs of 20-28VAC, 47-63Hz.
C	Input	+12VDC	DC Camera positive power input. The Camera can function on voltage inputs of 11-16VDC.
K	Input	-12VDC	DC Camera power common.
M	Input	RX+	RS422: Camera receive data positive (+).
N	Input	RX-	RS422: Camera receive data negative (-).
S	Output	TX+	RS422: Camera transmit data positive (+).
R	Output	TX-	RS422: Camera transmit data negative (-).
P	Input	Ground	Data/Power Ground
L	Output	Video	Video
A	Output	Video Ground	Video Ground

2.5.2 Mating Rear Panel Connector

The connector that mates with the main signal connector of the Camera is manufactured by Amphenol and the part number is a PT06A-14-18S-SR. This connector must be manufactured to the assembly procedure provided by Amphenol.

2.6 Main Rear Panel Digital Signal Connector

The main digital signal connector is located on the rear panel of the Camera as shown in Figure 5.

2.6.1 Camera Digital Signal Connector

The digital signal connector that is mounted to the rear panel of the Camera is manufactured by fischer and the part number is DBPE 1031 A019-139. This connector is hermetically sealed which means it is gastight therefore exceeds the NEMA 4 and IP67 water resistance rating of the Camera. This connector is equipped with 19 contacts. See Table 7 for digital signal pin descriptions.

Table 7 - Digital Signal Pin Descriptions

Pin Number(s)	Direction	Signal Name	Signal Description
6	Input	ExtClk+	Positive (+) LVDS external clock input. NTSC: 49.09090 MHz. PAL: 59.00000 MHz.
7	Input	ExtClk-	Negative (-) LVDS external clock input. NTSC: 49.09090 MHz. PAL: 59.00000 MHz.
8	Input	ExtSync+	Positive (+) LVDS external sync input.
9	Input	ExtSync-	Negative (-) LVDS external sync input.
10	Input	ExtClkEn_n	External clock enable. This input determines whether the Camera boots with an external or internal clock. Low (tied to PGND): external clock, Open: internal clock.
11	Input	PGND	Power Ground.
12	Output	SprcFpaVid0+	Positive (+) LVDS serialized 16 bit processed FPA video data bits 0-7.
13	Output	SprcFpaVid0-	Negative (-) LVDS serialized 16 bit processed FPA video data bits 0-7.
14	Output	SprcFpaVid1+	Positive (+) LVDS serialized 16 bit processed FPA video data bits 8-15.
15	Output	SprcFpaVid1-	Negative (-) LVDS serialized 16 bit processed FPA video data bits 8-15.
16	Output	SprcFpaVidSync+	Positive (+) LVDS serialized digital processed FPA video sync.
17	Output	SprcFpaVidSync-	Negative (-) LVDS serialized digital processed FPA video sync.
18	Output	SprcFpaVidClk+	Positive (+) LVDS serialized digital processed FPA video clock.
19	Output	SprcFpaVidClk-	Negative (-) LVDS serialized digital processed FPA video clock.

2.6.2 Mating Digital Signal Connector

The connector that mates with the digital signal connector of the Camera is manufactured by fischer and the part number is S 1031 A019-150+. All the signals in this connector are Low Voltage Differential (LVDS) which requires a mating cable that uses 100Ω twisted pairs. Belden cable 9808 (7 100Ω twisted pair with overall foil/braided shield) will work for this application or any equivalent cable.

This connector requires a mating environmental clamp set sold by fischer to ensure the sealing between the connector and cable used. See Table 8 for fischer environmental cable clamp part numbers for corresponding cable diameter ranges. The connector and environmental cable clamp must be assembled as described on page N2 in the fischer General Catalogue, Edition 5.

Table 8 - Environmental Cable Clamps

Fischer Part Number:	Cable Diameter Range (mm)
E3 1031.2/2.7	**2.2-2.7mm**
E3 1031.2/3.2	**2.7-3.2mm**
E3 1031.2/3.7	**3.2-3.7mm**
E3 1031.2/4.2	**3.7-4.2mm**
E3 1031.2/4.7	**4.2-4.7mm**
E3 1031.2/5.2	**4.7-5.2mm**
E3 1031.2/5.7	**5.2-5.7mm**
E3 1031.2/6.2	**5.7-6.2mm**
E3 1031.2/6.7	**6.2-6.7mm**

2.7 Power Input Selection

The camera input power is specified by model configuration when originally ordered from Cohu Electronics, and is delivered to accept the specified voltage configuration of 120VAC, or 24VAC or 12VDC. Refer to Table 6 for connector pin assignments.

Cohu Electronics offers a suite of field cable assemblies for providing connections from the camera to the users control/monitoring system or transmission backbone. Refer to Cohu Electronics CA290 series data sheet for selection of the proper cable to meet specific requirements.

2.7.1 AC Line Input Voltage Connections

The Camera is delivered to accept 120VAC or 24VAC Line voltage. If it is determined the ordered/delivered voltage format of the camera system is not the desired voltage level, the input voltage can be changed. A connector should be plugged into header J1 or J2 located as shown in Figure 6 (Figure 6 is drawn without Transformer Support Plate and mating connectors for clarity).

Warning: Never power the Camera up with a connector plugged into headers J1 and J2 simultaneously. This may provide a risk of electric shock on the main rear panel connector.

2.7.2 24VAC Input Voltage Connections

The Camera can be configured to accept 24VAC instead of AC Line voltage. To accomplish this, the connector plugged into header J1 should be unplugged. The two position connector that is

lying inside the Camera must be plugged into header J2 as shown in Figure 6 (Figure 6 is drawn without Transformer Support Plate and mating connectors for clarity).

Warning: Never power the Camera up with a connector plugged into headers J1 and J2 simultaneously. This may provide a risk of electric shock on the main rear panel connector.

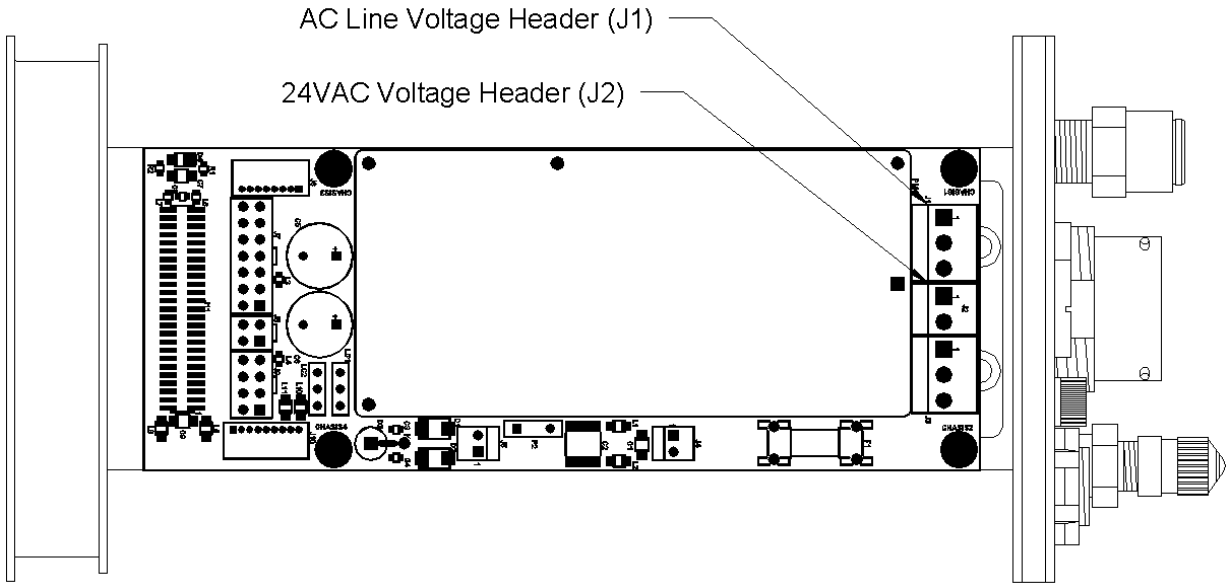

Figure 6 - Voltage Input Selection

3. Camera Software Features

The Camera is equipped with a multitude of operational and configuration settings. See Table 9 for all the software features available in this Camera.

Table 9 -Software Features

Camera Software Feature	Host Application Control (C) or Monitor (M)	Notes
Selection of up to 8 Operational Modes	C	**Configured at factory.**
Selection of up to 16 NUC Modes	C	**Configured at factory.**
Automatic Refresh on Operational Mode or NUC Mode Switch	C	
Automatic Refresh on Camera Boot	C	
Automatic Refresh on Timer	C	
Automatic Refresh on Camera Internal Temperature Change	C	
Commanded Refresh	C	
Selection of up to 16 Video Color Palettes	C	**Configured at factory but user can create custom palettes. Contact**

Camera Software Feature	Host Application Control (C) or Monitor (M)	Notes
		Lumitron for specific information.
Video Color Bar Enable	C	
Video Polarity Invert	C	
Video Color Gamma Boost	C	**Gamma boost built into color palette.**
Video Zoom	C	
Video Freeze	C	
Video Disable	C	
Selection of up to 8 Video Overlay Palettes	C	**Configured at factory but user can create custom palettes. Contact Lumitron for specific information.**
Commanded Overlay Refresh	C	
Overlay Mode Selection	C	
Foreground and Background Color Selection	C	
Two Standard Reticles with Intensity Readout	C	
One Range Reticle	C	**Designed for use with 100mm lens.**
Configured Lens Select	C	**Based on factory configuration.**
Focus Control	C	**If hardware is present.**
Zoom Control	C	**Not yet implemented.**
Sync Mode Selection	C	
Frame Counter Reset	C	**Resets frame header value.**
FPA Temperature	M	**Contact Lumitron for ADC to temperature equation.**
FPA Support Board Temperature	M	**Contact Lumitron for ADC to temperature equation.**
Two Available Internal Remote Temperatures	M	**Contact Lumitron for ADC to temperature equation.**
Calibration Flag Temperature	M	**Contact Lumitron for ADC to temperature equation.**
Fan Mode	C	
Camera Power	M	**Contact Lumitron for ADC to voltage equation.**
Two (AGC/ALC) Automatic Gain and Level Control Modes	C	**Linear and Histogram equalization. Can be disabled.**
Up to 8 Region of Interest Areas	C	**First ROI reserved for full frame.**
AGC/ALC Brightness	C	**Reported in automatic mode, can be set in manual mode.**
AGC/ALC Contrast	C	**Reported in automatic mode, can be set in manual mode.**
AGC/ALC Low and High Limit Settings	C	
Four AGC/ALC Lag Filter Rates	C	
Multiple Linear AGC/ALC Mapping Settings	C	
Automatic NUC Switching Capability	C	**Not yet implemented.**
Reticle Size and Position	C	
Radiometric Capability	C/M	**Requires custom OEM software.**
Built-In Tests	C	
Camera Operation Statistics	M	
Field Upgradeable Operational Software	C	**Contact Lumitron before upgrading camera operational software.**
Field Upgradeable FPGA Configuration	C	**Contact Lumitron before upgrading Xilinx FPGA configuration file.**
Production and Manufacturing Information	C/M	**Modification of stored production/manufacturing data reserved for specific OEM's.**

Camera Software Feature	Host Application Control (C) or Monitor (M)	Notes
Static Configuration Data	C/M	**Modification of factory static configuration data reserved for specific OEM's.**
Individual Operational Mode Configuration	C/M	**Modification of factory operational mode data reserved for specific OEM's.**
Individual NUC Mode Configuration	C/M	**Modification of factory NUC mode data reserved for specific OEM's.**
Motorola DSP Register Settings	C/M	**Modification of any DSP registers is not suggested except for advanced users. Changes may prevent camera from operating properly.**
Xilinx FPGA Register Settings	C/M	**Modification of any FPGA registers is not suggested except for advanced users. Changes may prevent camera from operating properly.**
Access to DSP Memory	C/M	**Read/Write access reserved for specific OEM's.**
Access to SPI FLASH Memory	C/M	**Read/Write access reserved for specific OEM's.**
Access to NUC FLASH Memory	C/M	**Read/Write access reserved for specific OEM's.**
Access to NVM RAM	C	**Camera operational state is stored in NVM via operational software. Do not modify directly.**
Access to Real Time Clock	C	
Access to operational software configuration variables/settings.	C	**Contact Lumitron for specific information.**

4. Environmental Specifications

4.1 Temperature

The storage temperature range is -40ºC to 85 ºC.

The operating temperature range is -40ºC to 60 ºC.

4.2 Water Resistance

The Camera as shipped from factory with Lens meets or exceeds the NEMA4 and IP67 water resistance rating.

4.3 Relative Humidity

The Camera as shipped from factory with Lens meets a relative humidity of 10% to 95%, non-condensing.

4.4 Shock and Vibration

NEMA TS-2 Compliance;

Vibration: 5-30 Hz with 0.5G applied in three perpendicular planes.
Shock: 10G applied in three perpendicular planes

COHU ELECTRONICS WARRANTY

Cohu, Inc., Electronics Division warrants equipment manufactured to be free from defects of material and workmanship. Any part or parts will be repaired or replaced when proven by Cohu examination to have been defective within two years from date of shipment to the original purchaser for standard CCD cameras and one year from date of shipment to the original purchaser for intensified CCD cameras and all other Cohu manufactured products.

Pressurized Housings: Pressurized camera products include a lifetime pressurization warranty. Cohu will re-pressurize at no charge returned environmental cameras not exhibiting evidence of physical damage due to misuse. All warranty repairs will be performed at the factory or as otherwise authorized by Cohu in writing. Transportation charges to Cohu shall be prepaid by purchaser.

Extended IR Cameras: Cameras utilizing extended infrared (extended IR) sensors found to exceed acceptable white blemish specifications within one month of delivery shall be repaired without charge.

This warranty does not extend to Cohu equipment subjected to misuse, accident, neglect, improper application, or repaired or altered by other than Cohu or those authorized by Cohu in writing. Cameras utilizing extended IR sensors are not warranted for use in areas of elevated levels of cosmic radiation. Television image pickup tubes, image intensifiers, lenses, and products manufactured by companies other than Cohu are warranted by the original manufacturer.

This warranty is in lieu of all other warranties, express, implied, or statutory, including warranties of fitness for a particular purpose and merchantability, and sets forth buyers sole remedy in connection with such warranties. Cohu, in no event, whether as a result of breach of contract or warranty, tort (including negligence) or otherwise, shall be liable for any penalties regardless of reason; collateral, consequential, incidental, or exemplary damages, including without limitation, any loss of profit or revenues, loss of use of any equipment or goods, or removal or re-installation of equipment without prior written approval.

A Return Authorization (RA) Number must be obtained from Cohu prior to returning any item for warranty repair or replacement.

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