A leading U.S. manufacturer of quality television products, Cohu, Inc., Electronics Division, is the oldest continuing manufacturer of closed circuit television cameras and systems in the world. We represent a single source for diverse CCTV products for the sciences, industry, and government. Applications include surveillance and security systems, high resolution cameras, miniature cameras, general purpose, environmental, low light level, machine vision, and many more.

This catalog represents our current line of CCTV cameras and equipment. Our unique model numbering system allows for specific cameras to be designated with a variety of options included. You will find this system explained under the ordering information for each camera series. If, however, you do not find a camera listed that describes your specific needs, you are encouraged to contact the factory and discuss your needs with one of our applications engineers. What you desire may already be available, or it may be possible to custom design a camera to fulfill your requirements.

Cohu is dedicated to satisfying our customer needs by bringing to the market high performance quality products which incorporate the very latest in technology and features—designed to provide years of satisfying service.
Thank you . . .

for your interest in Cohu video cameras and camera systems.

The enclosed literature will help you identify the exact Cohu camera or system for your requirement.

Should you need additional information, or if you wish to notify us of a change of address, please use the attached postage-paid reply card, or call us at (619) 277-6700.

We look forward to supporting you on your current project and with all your CCTV camera and system requirements.

Thank you,

Cohu, Inc., Electronics Division
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. 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. This warranty does not extend to Cohu equipment subjected to misuse, accident, neglect, or improper application, nor repaired or altered by other than Cohu or those authorized by Cohu in writing.

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 or implied. Cohu shall not be liable for any collateral or consequential damages. A Return Authorization Number (R.A.#) must be obtained from Cohu prior to returning any item for warranty repair or replacement.
There is a Cohu Representative Near You

ALABAMA, FLORIDA, GEORGIA, MISSISSIPPI, N CAROLINA, S CAROLINA, TENNESSEE
COHU - SOUTHEAST
Loren Whilley
880 Monarch Drive
Kershaw, SC 29067
Phone: (803) 475-4272
FAX: (803) 475-4274

ALASKA, HAWAII, IDAHO, UTAH, WASHINGTON
SCIENTIFIC SYSTEMS, INC.
Richard Eberle
P. O. Box 2636
Redmond, WA 98073-2636
Phone: (206) 868-4464
FAX: (206) 868-4468

ARIZONA, NEVADA/CLARK CO & SOUTH
PERSPECTIVE
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Kevin Conboy
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Henderson, NV 89014
Phone: (702) 456-5594
FAX: (702) 456-2199

CALIFORNIA/NORTHERN.
NEVADA/NORTH
COHU - N. CALIFORNIA
Gary Kuniz
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FAX: (510) 743-0463

CALIFORNIA/CENTRAL,
NORTH L.A. COUNTY
PERSPECTIVE
MEASUREMENTS
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San Dimas, CA 91773
Phone: (909) 592-3851
FAX: (909) 592-3078

CALIFORNIA/SOUTH L.A. AND
ORANGE COUNTITIES
PERSPECTIVE
MEASUREMENTS
Jerry Parish
3711 N Harbor Dr. Ste. K
Fullerton, CA 92635
Phone: (714) 525-3553
FAX: (714) 525-0703

CALIFORNIA/SAN DIEGO
AND IMPERIAL COUNTIES
PERSPECTIVE
MEASUREMENTS
Dick Sjoberg
1343 Stratford Court
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FAX: (619) 259-0257

COLORADO, MONTANA, NEW
MEXICO, TEXAS (EL PASO), WYOMING
SCIENTIFIC SYSTEMS, INC.
Bill Leavy
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FAX: (505) 883-5250

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COHU - NEW ENGLAND
Joe Barrett
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Portsmouth, NH 03801
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FAX: (603) 430-2807

DC, DELAWARE, MARYLAND, NEW JERSEY, VIRGINIA, PENNSYLVANIA/EAST
SUTTER & CO., INC.
Edwin J. Sutter
301 Maple Avenue, West
Bldg. 2 - Suite E
Vienna, VA 22183
Phone: (703) 938-0505
FAX: (703) 281-4266

EASTERN CANADA
INTEGRATED TELECOMMUNICATIONS SYSTEMS
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Phone: (613) 830-8329
800-487-8135
FAX: (613) 830-8274

ILLINOIS, N IOWA, MICHIGAN, WISCONSIN
COHU - MIDWEST
William H. Ritchie
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River Forest, IL 60305
Phone: (708) 488-0400
Fax: (708) 488-1318

WESTERN CANADA
COHU / San Diego
(619) 277-6700

P.O. Box 85623 San Diego, CA 92186-5623 • Telephone: (619) 277-6700 Fax: (619) 277-0221 TWX: 910-335-1244
The Cohu board-level CCD camera has been designed to fit the needs of OEM customers who require high performance video in a compact package. The 1100 Series features a resolution of 768 (H) x 494 (V) active pixels, internal crystal or external synchronization, and 2 to 16 field/8 step integration or shuttering to 1/10000.

Configuring the 1100 Series for custom purposes is quite easy. A flexible cable allows for virtually any orientation of the sensor with respect to the control board. Measuring less than 2" x 4", this feature/size combination is ideal for machine vision and image processing applications.

The 1100 Series cameras feature a 1/2"-format on-chip microlens sensor, which improves sensitivity and provides increased dynamic range while reducing lag, blooming and dark current. For video applications prone to streaking problems, a 1000:1 overload capability allows transmission of clear video signals even when bright incidental light is present in the scene.

Both RS-170 and CCIR cameras have 20 dB of AGC for high sensitivity in low light-level applications. This single board camera synchronizes from an internal crystal, or external horizontal/vertical source.

Asynchronous reset accepts an external trigger input to reset the camera to the beginning of the vertical interval (field 1, line 1). The first field of video information reads out 9.5 horizontal lines after triggering.

Four modes of operation can be selected: field (interlace and non-interlace), and frame (interlace and non-interlace). The integration time in the field mode is 16.6 ms for each field. Interlace mode sums two rows of pixels from each line, thus increasing the sensitivity. The non-interlace mode uses only field one, or one-half (242) the number of vertical pixels. The advantage of non-interlaced is using the same field of pixels every 1/60 second for repeatability. The integration time of each field in the frame (interlace) mode is 33.3 ms, for a vertical resolution of 485 pixels. Operating in the frame interlace mode and strobing will achieve full frame resolution of fast moving objects.

Cohu is ISO-9001 certified.

Cohu offers option boards that greatly expand the capabilities of the 1100 Series. These boards easily plug into the control board. Options include:

- Line Lock Sync - accepts 12 VAC reference input and synchronizes the camera to the phase of the line frequency.
- External Sync - accepts genlock input (composite horizontal/vertical sync) to synchronize the camera to the externally-supplied reference.
- Electronic Iris - automatically controls the integration of the sensor from 1/60 sec. to 1/15,000 sec. to compensate for changing scene illumination. This control smoothly steps through the entire range.
- Special Reset - allows resetting the camera and determining integration time with an external pulse. Integration time ranges from a minimum of 650 μS to a maximum limited only to the operator's subjective analysis of video information versus the rise in dark current.
- DC Iris - control auto iris lenses that do not have circuitry integral to the lens (aspherical).

Both RS-170 and CCIR cameras have 20 dB of AGC for high sensitivity in low light-level applications.

The Cohu 1100 Series Board Level Camera puts high performance in a small package.

FEATURES AND BENEFITS

- High Resolution — for better definition, error-free results
- 1/2" or 1/3" On-chip-microlens Interline Transfer Imager virtually eliminates overload streaking, improves dynamic range and sensitivity.
- Wide Dynamic Range permits operation over a broad range of light levels.
- High Signal-to-Noise Ratio for clear, noise-free video.
- Shutter 1/60 to 1/10000 (8 steps)
- Integration from 2 to 16 fields
- Field or Frame Modes
- 1000:1 Overload Capability permits incidental light overloads up to ten times that of other CCD cameras.
- Custom Mechanical Configurations to support your design.

APPLICATIONS

- Image Processing
- Machine Vision
- Process Control
- Quality Control
- Image Analysis

Cohu, Inc./Electronics Division
### ORDERING INFORMATION

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### SPECIFICATIONS

**ELECTRICAL**
- **Pick up Device**
  - 1/2" or 1/3" Interline transfer, microlens sensor
- **Active Picture Elements**
  - RS-170: 768 (H) x 494 (V)
  - CCIR: 752 (H) x 582 (V)
- **Pixel Cell Size - RS-170**
  - 1/2": 8.6 µm (H) x 9.8 µm (V)
  - 1/3": 6.35 µm (H) x 7.4 µm (V)
- **Pixel Cell Size - CCIR**
  - 1/2": 8.4 µm (H) x 8.3 µm (V)
  - 1/3": 6.5 µm (H) x 6.25 µm (V)
- **Total Pixel Elements**
  - 811 (H) x 508 (V)
- **Resolution**
  - RS-170: 580 horizontal TVL, 350 vertical TVL
  - CCIR: 560 horizontal TVL, 450 vertical TVL
- **Synchronization**
  - H & V
  - Crystal (RS-170A) or Asynchronous reset
- **Shutter**
  - 1/60 to 1/10000
- **AGC**
  - 20 dB range, auto or manual control
- **Signal-to-Noise**
  - >55 dB (Gain 0, Gamma 1)
  - 38 dB (Gain 20 dB, Gamma 1)
- **Gamma**
  - .45 to 1.0, continually variable

**Integration**
- 2 - 16 fields

**Lens Mount**
- C or CS (not included)

**Auto Lens Output**
- Reference video provided to control auto-iris lenses

**Sensitivity**
- 1/2" Full video, No AGC: .065 fc .087 fc
- 1/3" .65 lux .87 lux
- 80% Video, AGC on: .005 fc .006 fc
- .05 lux .06 lux
- 30% Video, AGC on: .002 fc .003 fc
- .02 lux .03 lux

**Power**
- 12 VDC, 3.6 W max. Standard: 115/230 VAC adapter optional

**MECHANICAL**
- **Dimensions**
  - See illustration
- **Weight**
  - 1.5 oz. (44 g) without lens
- **Ambient Operating Temperature Limits**
  - -20° to 60° C (4° - 140° F)
- **Relative Humidity**
  - to 95% non-condensing
- **Shock**
  - 15 g's any axis, non-operating condition, per MIL-E-5400T

**DIMENSIONS**

COHU RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.
This Cohu monochrome CCD camera has been designed to fit the needs of OEM customers who require high performance video in a compact package. The MS12 features a resolution of 768 (H) x 494 (V) active pixels, internal crystal or external horizontal and vertical synchronization, 2 to 16 field/8 step integration, or 1/60 - 1/10,000 shuttering in eight steps.

It measures only 2" (W) x 1.5" (H) x 3.75" (L). This feature/size combination is ideal for scientific and image processing applications.

The MS12 Series cameras feature a 1/2"-format on-chip microlens sensor, which dramatically improves sensitivity and dynamic range, and reduces dark current, lag, and blooming. For video applications prone to streaking problems, a 1000:1 overload capability allows transmission of clear video signals even when bright incidental light is present in the scene.

Both RS-170 and CCIR cameras have 20 dB of gain, manual or auto, for high sensitivity in low light-level applications.

The MS12 Series cameras synchronize from an internal crystal, or external horizontal/vertical source.

Asynchronous reset accepts an external trigger input to reset the camera to the beginning of the vertical interval (field 1, line 1). The first field of video information reads out 620 μS after triggering.

Four modes of operation are user-selectable: field (interlace and non-interlace), and frame (interlace and non-interlace). The integration time in the field mode is 16.6 ms for each field. Interlace mode sums two rows of pixels from each line, thus increasing the sensitivity.

The non-interlace mode uses only field one, or one-half (242) the number of vertical pixels, for repeatability. The integration time of each field in the frame (interlace) mode is 33.3 ms, for a vertical resolution of 485 pixels. Operating in the frame interlace mode and strobing will achieve full frame resolution of fast moving objects.

The MS12 is ideal for medical/microscopy and image processing applications.

The non-interlace mode uses only field one, or one-half (242) the number of vertical pixels, for repeatability. The integration time of each field in the frame (interlace) mode is 33.3 ms, for a vertical resolution of 485 pixels. Operating in the frame interlace mode and strobing will achieve full frame resolution of fast moving objects.

**APPLICATIONS**
- Image Processing
- Machine Vision
- Process Control
- Quality Control
- Image Analysis

**FEATURES AND BENEFITS**
- High Resolution — for better definition, error-free results
- 1/2" On-Chip-Microlens Interline Transfer Imager improves dynamic range and sensitivity and virtually eliminates overload streaking.
- Wide Dynamic Range permits operation over a broad range of light levels.
- High Signal-to-Noise Ratio for clear, noise-free video
- Shutter 1/60 to 1/10000 (8 steps)
- Integration from 2 to 16 fields
- Field or Frame Modes
- 1000:1 Overload Capability permits incidental light overloads up to ten times that of other CCD cameras
- Two Year Warranty
- Asynchronous Reset to capture random events

Designed and manufactured in U.S.A.

Cohu, Inc./Electronics Division
MS12/MS12E MONOCHROME CCD CAMERA

DIMENSIONS

SPECTRAL RESPONSE

SPECIFICATIONS

ELECTRICAL

Pick up Device
1/2" Interline transfer, micro lens sensor

Active Picture Elements
RS-170: 768 (H) x 494 (V)
CCIR: 752 (H) x 582 (V)

Pixel Cell Size
RS-170: 8.4 μm (H) x 9.8 μm (V)
CCIR: 8.6 mm (H) x 8.3 μm (V)

Resolution
RS170: 580 horizontal TVL, ≥350 vertical TVL
CCIR: 560 horizontal TVL, 450 vertical TVL

Synchronization
Internal: Crystal (RS-170A)
External: H & V
Asynchronous reset

Shutter
1/60 to 1/10000

AGC
20 dB range, auto or manual control

Signal-to-Noise
>55 dB (Gain 0, Gamma 1)
38 dB (Gain 20 dB, Gamma 1)

Gamma
0.45 to 1.0, continually variable, preset to 1.0

Integration
2 - 16 fields

Lens Mount
Standard: CS
Accessory: C (PN:2010695-001)

Auto Lens Output
Reference video provided to control auto-iris lenses;

Lens Voltage
11 VDC

Sensitivity
Full video, No AGC: .065 fc (0.65 lux)
80% Video, AGC on: .005 fc (.05 lux)
30% Video, AGC on: .002 fc (.02 lux)

Power
Standard: Regulated 12 VDC, 3.6 W max.;
Accessory: 115/230 VAC to 12 VDC adapter (PN: 8368-4)

MECHANICAL

Connectors
Video Out: BNC;
12 VDC In: Switchcraft TB3M;
External Async Reset In, Vertical Trigger In, Horizontal Trigger In,
Ground: Hirose SR30-10F-05S

Dimensions
See illustration

Ambient Temperature Limits
-20°C to 60°C (4°F - 140°F)

Relative Humidity
95% condensing

Shock
30 g's, 11 mS duration, 3 axes

Mounts
1/4-20 female thread top and bottom

ORDERING INFORMATION

MS12
Monochrome 1/2" CCD camera,
12 VDC, RS-170A

MS-12E
Monochrome 1/2" CCD camera,
12 VDC, CCIR

Lenses
Please consult factory or authorized Cohu representative for selection

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COHU
Cohu, Inc. Electronics Division

5755 Kearny Villa Road • San Diego, CA 92123
Telephone: (619) 277-6700 • FAX: (619) 277-0221 • TWX: 910-335-1244

ADVANCED VIDEO TECHNOLOGY
Made in the U.S.A.
NEW!

**MONOCHROME CCD SURVEILLANCE CAMERA**

**2100 SERIES**

High Performance 1/2" On-Chip-Microlens Interline Transfer Imager

The new Cohu 2100 Series camera has been designed for the surveillance professional who demands a small camera of unequaled performance at a competitive price. In a package measuring only 1.5"(H) x 3.75" (D) x 2" (W), you get 580 horizontal line resolution, microlens sensor technology for dramatic sensitivity and dynamic range, and a price comparable to cameras with only half the performance.

This feature/size combination makes it ideal for indoor surveillance installations, or for outdoor use when housed in a Cohu environmental enclosure.

The features of the 2100 Series give it versatility, reliability, and value. Rugged, solid state construction provides high resistance to shock and vibration. An electronic shutter allows the camera to track rapidly moving subjects.

Mounting holes on the top and bottom of its housing mean easy installation, while its neutral color allows it to unobtrusively blend into the surroundings.

### FEATURES AND BENEFITS

- **High Performance** — for clear images and positive identification
- **1/2" On-chip-microlens Interline Transfer Imager** dramatically improves dynamic range and sensitivity and virtually eliminates overload streaking
- **High Sensitivity** permits operation over a broad range of light levels.
- **High Signal-to-Noise Ratio** for clear, noise-free video.
- **"C" or "CS" Lens Mount** expands your choice of lenses.
- **Choice of RS-170 or CCIR Models**
- **1000:1 Overload Capability** permits incidental light overloads up to ten times that of other CCD cameras.
- **Two-Year Warranty**
- **Made in U.S.A. — direct factory support**
- **It's a Cohu CCTV camera** — your assurance of quality, dependability, industry recognition, customer service, and ISO-9001 certification.

### APPLICATIONS

- Surveillance
- Covert Installations
- Access Control
- Transportation Systems
- Gaming
- Robotic Vehicles
- Loss Prevention
- Image Processing

For size, features, and price, the Cohu 2100 Series is the ideal surveillance and security camera.

The 2100 Series camera features a 1/2"-format on-chip microlens sensor, which improves sensitivity and dynamic range, while reducing dark current, lag, and blooming. For video applications prone to streaking problems, a 1000:1 overload capability allows incidental light overloads up to 10 times that of other cameras.

RS-170 and CCIR models are available, and both have 20 dB of AGC for high sensitivity in low light-level applications.

Electronic iris provides eight f-stops of automatic light control. This electronic shutter provides control from 1/60 to 1/15,000 second. This is of particular importance when the images are fast-moving or the camera is mounted on a vibrating source.

From board-level design to its cast aluminum enclosure, you can expect the highest performance and value from the Cohu 2100 Series CCD camera.

Designed and manufactured in the U.S.A.
2100 SERIES MONOCHROME CCD SURVEILLANCE CAMERA

ORDERING INFORMATION

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<td>5 Elec. Iris (CCIR)</td>
</tr>
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</table>

The versatility of this camera allows for a wide selection of lenses. Consult your Cohu representative for the lens that best suits your application.

SPECIFICATIONS

Pick up Device
1/2" Interline transfer, enhanced sensitivity

Picture Elements
RS-170: 768 (H) X 494 (V)
CCIR: 752 (H) X 582 (V)

Resolution
RS-170: 580 horizontal TVL, 350 vertical TVL
CCIR: 560 horizontal TVL, 450 vertical TVL

Synchronization
Internal: Genlock, Crystal
External: H&V, Asynchronous reset

Electronic Shutter
1/60 to 1/15,000 with elec. iris
1/60 to 1/10,000 switch selectable

Signal-to-Noise
>55 dB (gain 0, gamma 1)
38 dB (gain 20 dB, gamma 1)

Gamma
.45 to 1.0 continually variable

AGC
20 dB range, auto or manual control

Integration
2-16 frames

Dimensions
See illustration

Lens Mount
C (CS adaptor provided)

Auto Lens Output
Reference video provided to control auto-iris lenses

Lens Voltage
11 VDC

Sensitivity
Full video, No AGC: 0.065 fc (.65 lux)
80% Video, AGC on: .005 fc (.05 lux)
30% Video, AGC on: .002 fc (.02 lux)

Power
12 VDC, 3.6 W max. Standard 115 VAC/60 Hz optional

Ambient Temperature Limits
-4°F (-20°C) to 140°F (60°C)

Relative Humidity
to 95% non-condensing

Shock
30 g’s, 11 mS duration, 3 axes

Mounts
1/4-20 female threads, top and bottom

DIMENSIONS

Unless otherwise noted all dimensions in inches and (mm)

P.O. Box 85623 • San Diego, CA 92186-5623
Telephone: (619) 277-6700 • FAX: (619) 277-0221

Advanced Video Technology
Made in the U.S.A.
**DIGITAL OUTPUT MONOCHROME CCD CAMERA**

**MODEL 4110**

COHU INC. ELECTRONICS DIVISION

Cohu's new Model 4110 Digital Video Camera is the first and only digital output CCD camera to combine a high-performance defect-free sensor and affordability in a single package. Designed to support both existing and future digital imaging applications, this exciting new camera is the culmination of close collaboration between Cohu and both users and manufacturers of image processing equipment.

The Model 4110 produces a digital output byte for each pixel and shares a pixel clock directly with the frame memory of the image processor board. The design eliminates the phase-lock-loop or genlock circuits usually employed with conventional analog to digital front end circuitry. This breakthrough allows an accurate digital reproduction of each pixel to be transferred to the processor and virtually eliminates pixel jitter. Imaging system noise is further reduced by moving the sensitive analog front end circuitry into the camera and away from the high-noise environment associated with the host computer's digital computing circuitry. The result is a much higher system Modulation Transfer Function (MTF) from the camera sensor to the image processor.

The new Model 4110 helps digitizer manufacturers conserve board space, providing room for additional functions and features.

**APPLICATIONS**

- Measurement
- Image Processing
- Machine Vision
- Pattern recognition
- Non-contact measurement
- Inspection
- Microscopy
- Medical Imaging
- Robotics
- Laboratory Research
- Remote Sensing

**FEATURES AND BENEFITS**

- Highly Accurate Measurements due to elimination of pixel jitter
- Improved System Efficiencies resulting from in-camera A/D conversion
- Noise Reduction resulting from advanced design features
- Preservation of Near-Perfect Array Geometry due to direct correspondence between sensor elements and processor memory
- No Audible Noise - no array movement, no electromechanical components
- Real Time, RS-170 Speed at 14.31818 MHz clock
- Maximzed Resolution due to improved MTF
- Cost Effective — priced well below cameras with similar capabilities
- 1/2" Format CCD 739x484 Frame Transfer Array, Blemish-Free Sensor
- Simultaneous Analog Video Output
- Electronic Shutter reduces blurring of fast-moving objects

**Cohu Model 4110 Digital Video Monochrome CCD Camera**

The Model 4110 is a vastly superior image acquisition camera for use with measurement systems. The virtual elimination of pixel jitter, the near perfect geometry of the CCD sensor array, and the optimum MTF efficiency make the 4110 the smart choice for dimensional measurement systems. The improved signal-to-noise ratio and broad dynamic range of true 8-bit precision, combined with the elimination of clamping, auto gain, post filtering, and auto black circuitry, make the Model 4110 the best choice for photometric purposes.

The Model 4110 uses a half-inch format, 739 x 484 sensor array. By using an image processing board with the same or greater processor memory, the Model 4110 will yield a higher system resolution than can be achieved with conventional analog cameras on similar systems.

Designed and manufactured in U.S.A., the rugged and highly reliable Model 4110 is backed by a two-year warranty.
## MODEL 4110 DIGITAL OUTPUT MONOCHROME CCD CAMERA

### ORDERING INFORMATION

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<tr>
<td>2</td>
<td>10 MHz Clock (Master)</td>
<td>14.3 MHz Master/Slave</td>
<td>02</td>
<td>44-pin to 25-pin interface cable, 10 ft.</td>
</tr>
<tr>
<td>3</td>
<td>10 MHz (Slave)</td>
<td>10 MHz (Slave)</td>
<td>14.3 MHz Master/Slave</td>
<td>03</td>
</tr>
<tr>
<td>4</td>
<td>Externally Selectable</td>
<td>14.3 MHz Master/Slave</td>
<td>14.3 MHz Master/Slave</td>
<td>04</td>
</tr>
</tbody>
</table>

**Clock Options**
- 1: 14.31818 MHz Clock (Master)
- 2: 10 MHz Clock (Master)
- 3: 14.3 MHz (Slave)
- 4: 10 MHz (Slave)
- 5: Externally Selectable 14.3 MHz Master/Slave

**Filter Options**
- 0: No I.R. Filter
- 1: With I.R. Filter

**Special Options**
- 00: No Camera Cable
- 01: 44-pin to 37-pin interface cable, 10 ft.
- 02: 44-pin to 25-pin interface cable, 10 ft.
- 03: 44-pin to 37-pin interface cable, 10 ft.

**Lens Options**
- 0000: None

### Lens Options
- AL04: 4.5mm, f/2.0 (2/3")
- AL06: 6.5mm, f/1.8 (2/3")
- AL08: 8mm, f/1.4 (2/3")
- AL12: 12.5mm, f/1.4 (1")
- AL16: 16mm, f/1.4 (2/3")
- AL26: 25mm, f/1.6 (2/3")
- AL51: 50mm, f/1.8 (2/3")
- AL75: 75mm, f/1.8 (1")

* Special pinouts and cable lengths can be specified by customer.

* Wide angle.

Please consult factory for other lens selections.

### COMPATIBLE IMAGE PROCESSING BOARDS

Compatible image processing boards are available from the following manufacturers, listed in alphabetical order:

- **Coreco**
  - Saint Laurent, Quebec
  - Phone: (800) 361-4914
  - From Canada: (514) 333-1301
- **Dipix**
  - Ottawa, Ontario
  - Phone: (800) 724-5929
  - From Canada: (613) 596-4942
- **Epix, Inc.**
  - Northbrook, IL
  - Phone: (708) 498-4002
- **Imaging Technology, Inc.**
  - Woburn, MA
  - Phone: (800) 532-3500
- **Imagraph**
  - Chelmsford, MA
  - Phone: (508) 256-4624
- **Matrox**
  - Dorval, Quebec
  - Phone: (514) 685-2630
- **Percoptics Corporation**
  - Knoxville, TN
  - Phone: (615) 966-9200
- **Recognition Concepts**
  - Carson City, NV
  - Phone: (800) 243-8724
- **Tecon**
  - Redmond, WA
  - Phone: (800) 232-5220
- **Univision Technologies, Inc.**
  - Burlington, MA
  - Phone: (617) 221-6700

* Wide angle.

Please consult factory for other lens selections.
Cohu's Model 4710 solid-state cameras now offer even better performance for applications requiring low noise, high resolution and high sensitivity. Improved signal-to-noise characteristics result in a quieter picture, and better immunity to potentially harmful noise disturbances. The new Model 4710 also makes high resolution pictures attainable without geometric distortion, lag or image retention. The blemish-free imager provides pixel-to-pixel contrast variation of less than 5%.

Closely matching the sensitivity of standard silicon target imaging tubes, the Model 4710 CCD (Charge Coupled Device) image sensor uses the frame transfer method with over 400,000 picture elements and an active imaging area of 6.4 mm by 4.8 mm (1/2-inch format). Automatic Gain Control (AGC) adds further sensitivity for use under widely varying light conditions.

In addition to its superior performance, the new Model 4710 represents the ultimate in quality construction. Designed and manufactured in the U.S.A., these rugged CCD cameras have become the international standard for performance and reliability.

Available with a wide range of options, the Model 4710 is compact, lightweight and energy efficient. It is the ideal CCD camera for machine vision, image processing, robotics, process control, microscopy, and many other scientific and industrial applications.

### FEATURES AND BENEFITS

- **High Resolution** for better definition of details, error-free results.
- **High Sensitivity** permits operation over a broad range of light levels.
- **Enhanced Signal-to-Noise Ratio** for clean, noise-free video.
- **Frame Transfer Imager** for minimized blooming characteristics.
- **No Lag or Image Retention** for fast, clean, precise images.
- **Zero Geometric Distortion** for consistent corner-to-corner linearity.
- **Low Power Consumption** for flexible system integration, energy savings, and minimal dissipation.
- **Adjustable C Mount** for maximum adaptability.
- **Quality, State-of-the-Art Design and Construction** for total, solid-state reliability and long life.
- **Wide Range of Options** for flexible system integration.
- **Auto Black** for maximum effective dynamic range.
- **AGC with Peak-Average Adjustment** for clear images in varying light level applications.
- **Blemish-Free Imager** for quality, blemish-free image.
- **IR Sensitive** for use in IR applications.

### APPLICATIONS

- **Machine Vision**
- **Pattern Recognition**
- **Non-Contact Measurement and Inspection**
- **Bar Code Reading**
- **Image Processing**
- **Robotics**
- **Automated Visual Control**
- **EMI Environments**
- **Subways**
- **High Voltage Areas**
- **Linear Accelerators**
- **NMR Units**
- **Remote Piloted Vehicles**
- **Land Based, Aircraft, Submersibles**
- **Microscopy**
- **Medical Imaging**

Designed and manufactured in U.S.A.
**MODEL 4710 CCIR SOLID-STATE MONOCROME CCD CAMERA**

### SPECIFICATIONS

#### ELECTRICAL

<table>
<thead>
<tr>
<th>Imager</th>
<th>Single CCD using frame transfer method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Area</td>
<td>6.4 x 4.8 mm (corresponding to 1/2&quot; tube)</td>
</tr>
<tr>
<td>Active Picture Elements</td>
<td>699(H) x 576(V)</td>
</tr>
<tr>
<td>Number of Picture Cells</td>
<td>732(H) x 290(V)</td>
</tr>
<tr>
<td>Cell Size</td>
<td>9.2 μm(H) x 16.8 μm(V)</td>
</tr>
<tr>
<td>Resolution</td>
<td>Horizontal 525 TV lines</td>
</tr>
<tr>
<td></td>
<td>Vertical &gt; 415 TV lines</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>See Table 1, below.</td>
</tr>
<tr>
<td>Contrast Variation @ 25°C</td>
<td>&lt;5% overall</td>
</tr>
<tr>
<td>Scanning System</td>
<td>CCIR, 2:1 interlaced</td>
</tr>
<tr>
<td>Video Output</td>
<td>1.0 Vp-p 75 ohms unbalanced</td>
</tr>
<tr>
<td>Gamma</td>
<td>0.5 or 1.0 jumper selectable</td>
</tr>
<tr>
<td>AGC</td>
<td>60dB variable gain (peak-average adjustable)</td>
</tr>
<tr>
<td></td>
<td>Jumper-selectable — on/off</td>
</tr>
<tr>
<td>Auto Lens Drive</td>
<td>Peak-average adjustable</td>
</tr>
<tr>
<td></td>
<td>(Separate auto lens video eliminates AGC/auto lens interaction)</td>
</tr>
<tr>
<td>Signal-to-Noise Ratio @ 25°C</td>
<td>56dB (gamma 1, gain 0 dB), unweighted, 8MHz bandwidth</td>
</tr>
<tr>
<td>Auto Black</td>
<td>Maintain set-up level at 7.5 ± 5 IRE units if picture contains at least 10% black</td>
</tr>
<tr>
<td>Power Options</td>
<td>AC or DC 12V ± 10%</td>
</tr>
<tr>
<td></td>
<td>AC or DC 24V ± 5% (optional)</td>
</tr>
<tr>
<td></td>
<td>AC or 220/240V ± 10%, 50Hz with wall transformer</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>4.2W</td>
</tr>
<tr>
<td>Grey Scale</td>
<td>Renders all shades of grey on EIA TV resolution chart, 1956</td>
</tr>
</tbody>
</table>

#### ENVIRONMENTAL

| Ambient Temperature Limits  | Operating: -10°C to 50°C (14°F to 122°F) |
|                            | Storage: -30°C to 70°C (-22°F to 157°F)   |
| Humidity                   | Up to 95% relative humidity               |
| Vibration                  | 5 to 60Hz with 0.208cm/0.082 inches total excursion (15 g's @ 60Hz); from 60 to 1,000Hz, 5 g's rms random vibration without damage |
| Shock                      | 30 g's in any axis under non-operating conditions per MIL-E-5400T, paragraph 3.2.24.6 |
| Altitude                   | Sea level to equivalent of 3,048m/10,000 feet (508mm/20 inches of mercury) |

#### MECHANICAL

| Dimensions                  | See Figure 1.                            |
| Weight (less lens)          | 450 grams/15 ounces                     |
| Camera Mount                | 1/4 - 20 threaded holes                  |
| Lens Mount                  | "C" Mount                               |
| Lens                        | See Ordering Information.               |
| Connectors                  | BNC Connector — Video out               |
|                            | Switchcraft TB4M — Lens Drive           |
|                            | Switchcraft TB3M — Power in             |
|                            | Hirose SR30-10R-6S (Auxiliary)          |

#### SENSITIVITY 2850K FACEPLATE ILLUMINATION

<table>
<thead>
<tr>
<th></th>
<th>With IR Filter</th>
<th>Without IR Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usable with AGC</td>
<td>0.2 Lux (.02 fc)</td>
<td>0.04 Lux (.004 fc)</td>
</tr>
<tr>
<td>Full Video, Non-AGC</td>
<td>1.5 Lux (.15 fc)</td>
<td>0.25 Lux (.025 fc)</td>
</tr>
<tr>
<td>Full Video, AGC</td>
<td>0.7 Lux (.07 fc)</td>
<td>0.12 Lux (.012 fc)</td>
</tr>
</tbody>
</table>

*Table 1*
**DIMENSIONS**

![Diagram of COHU Solid State Camera](image)

- **Optical T:**
  - Adjustable "C" Mount Lens Adapter

- **Front View**
  - Switchcraft Connector P/N TB4M
  - HIROSE Connector P/N SR30-10R-6S (Used with Sync/Genlock only)

- **Rear View**
  - Switchcraft Connector P/N TB3M

**NOTE:** ALL DIMENSIONS IN MM AND (INCHES)

**Figure 1**

---

**SPECTRAL RESPONSE**

![Spectral Response Graph](image)

- **Responsivity A/W**
- **Quantum Efficiency**

**MODULATION TRANSFER FUNCTION CURVE**

![MTF Curve](image)

- **MTF %**
- **Horizontal Resolution TV Lines**

**Shaded area indicates spectral response with faceplate removed or with a quartz faceplate installed. Please consult factory for prices.**
## ORDERING INFORMATION

<table>
<thead>
<tr>
<th>471X</th>
<th>X</th>
<th>XXX</th>
<th>/</th>
<th>XXXX</th>
</tr>
</thead>
</table>

### Power Options
1. 12V ac 50 Hz or dc
2. 220/240V ac, 50 Hz
3. 24V ac 50 Hz or dc

### Sync Options
1. Genlock, revert to crystal
2. Genlock, revert to linelock
3. CCIR Crystal
4. H & V Drive

### Optical Filter
- 000: None
- 100: IR Filter

### Lens Options
- 0000: None
- Manual Iris Lenses
  - A014: 12mm, f/1.2, 1/2"
  - AL04: 4.5mm, f/2.0, 2/3"
  - AL06: 6.5mm, f/1.8, 2/3"
  - AL08: 8mm, f/1.4, 2/3"
  - AL09: 9mm, f/1.3, 2/3"
  - AL16: 16mm, f/1.4, 2/3"
  - AL28: 25mm, f/1.6, 2/3"
  - AL51: 50mm, f/1.8, 2/3"
- Auto Iris Lenses
  - ES04: 4.2mm, f/1.8, 1/2"
  - ES06: 6mm, f/1.2, 1/2"
  - ES08: 8mm, f/1.4, 2/3"
  - ES13: 12mm, f/1.2, 1/2"
  - ES16: 16mm, f/1.4, 2/3"
  - EH35: 35mm, f/1.4, 2/3"

Please consult factory for other lens selections.

---

### SYNC OPTIONS

The standard sync board contains a crystal-controlled oscillator to generate a 13.375 MHz reference frequency. A sync generator IC shapes the repetitive timing pulses used to control the movement of charge frames on the sensor board. This board also contains circuits to generate blanking, clamp, and sync pulses. These signals combine with the video signal on the video board to produce composite CCIR monochrome video.

The genlock board contains additional circuits to receive external input signals, including composite video, composite sync, and horizontal and vertical drive. These inputs are processed and supplied as reference signals to the genlock oscillator. In the absence of an externally applied signal, the camera is either crystal-locked or line locked, depending on the position of the crystal/line lock jumper. In the Line Lock Mode, the camera synchronizes to an external 50 Hz reference derived from the AC power line. In the CCIR Crystal Mode, the internal crystal-controlled oscillator provides back-up. The H and V Drive Input option allows the camera to synchronize to externally supplied horizontal- and vertical-drive signals.

### POWER OPTIONS

The Model 4710 camera requires AC or DC 12V or 24V input power. For operation from a 220/240 VAC 50 Hz power source, an optional AC power pack is available.

### OPTICAL FILTER

The Model 4710 is designed to be IR sensitive. For use in applications with undesirable IR conditions, the optional IR filter will cut off at 650nm.

### LENS OPTIONS

In addition to the lenses listed above, Cohu provides a complete selection of lenses for specialized applications. Our applications engineers will help you determine the proper field-of-view, focal length, lens speed (f-stop), and size (image sensor format) for your application.

### SPECIAL FEATURES

Cohu welcomes the opportunity to provide special features to better serve your particular application. Some examples of special features already provided include custom painting, silk screen and logo; remote head with 6' cable; imager faceplate removal for laser applications; imager tilt with customer-specified degree; and special connector pin configurations. Please contact Cohu for other special features.

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Cohu reserves the right to change specifications without notice.

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87-04 (1/91)
January 1991

COHU RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.

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5755 Kearny Villa Road • San Diego, CA 92123 • P.O. Box 85623 • San Diego, CA 92186-5623
FAX: (619)277-0221 • Telephone: (619)277-6700 • TWX: 910-335-1244
Cohu's solid-state cameras now offer even better performance for security/surveillance applications requiring high resolution and high sensitivity. Exceeding the sensitivity of standard silicon target imaging tubes, Cohu's CCD (Charge Coupled Device) image sensor uses the frame transfer method with over 400,000 picture elements and an active imaging area of 6.4mm by 4.8mm (1/2-inch format). Automatic Gain Control (AGC) adds further sensitivity for use under widely varying light conditions. In addition, high resolution pictures are attainable without geometric distortion, lag, or image retention.

Cohu's CCD cameras are available in three different housings. The 4720 Series comes in a low profile enclosure for general purpose, indoor applications. The 4730 and 4760 Series are for harsh environment applications. The 4730 is housed in a 3-inch barrel to minimize size and weight. The 4760 is housed in a 6-inch barrel to accommodate a 6:1 or 10:1 zoom lens. A UL Classified explosion-proof housing is also available as an option.

Cohu's CCD cameras represent the ultimate in quality construction. Designed and manufactured in the U.S.A., these rugged, energy-efficient cameras have become the international standard for performance and reliability. Available with a wide range of options, the 4720/4730/4760 Series is the logical choice for trouble-free security/surveillance applications.

**FEATURES AND BENEFITS**

- **High Resolution** for better definition of details, error-free results.
- **High Sensitivity** permits operation over a broad range of light levels.
- **Enhanced Signal-to-Noise Ratio** for clean, noise-free video.
- **Frame Transfer Imager** for minimized blooming characteristics.
- **No Lag or Image Retention** for fast, clean, precise images.
- **Zero Geometric Distortion** for consistent corner-to-corner linearity.
- **Low Power Consumption** for flexible system integration, energy savings, and minimal dissipation.
- **Adjustable C Mount** for maximum adaptability.
- **Quality, State-of-the-Art Design and Construction** for total, solid-state reliability and long life.
- **Wide Range of Options** for flexible system integration.
- **Auto Black** for maximum effective dynamic range.
- **AGC with Peak-Average Adjustment** for clear images in varying light level applications.
- **Blemish-Free Imager** for quality, blemish-free image.
- **IR Sensitive** for use in IR applications.

**OPTIONS**

- Line-Lock or Genlock
- Phase Adjustable Line-Lock
- External H & V Drive
- Clock Output (13.375 MHz)
- IR Filter
- Bright Light Limiter
- Source ID Generator
- Remote Control
- Heater

**Designed and Manufactured in U.S.A.**
### 4720/4730/4760 CCIR SOLID-STATE CCD CAMERA

#### SPECIFICATIONS

<table>
<thead>
<tr>
<th>ELECTRICAL</th>
<th>4720 SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Imager</strong></td>
<td>Single CCD using frame transfer method</td>
</tr>
<tr>
<td><strong>Image Area</strong></td>
<td>6.4 x 4.8 mm (corresponding to 1/2&quot; tube)</td>
</tr>
<tr>
<td><strong>Active Picture Elements</strong></td>
<td>699(H) x 576(V)</td>
</tr>
<tr>
<td><strong>Number of Picture Cells</strong></td>
<td>732(H) x 290(V)</td>
</tr>
<tr>
<td><strong>Cell Size</strong></td>
<td>9.2 μm(H) x 16.8 μm(V)</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>Horizontal 525 TV lines, Vertical &gt; 415 TV lines</td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td>See Table 1, back cover</td>
</tr>
<tr>
<td><strong>Contrast Variation @ 25°C</strong></td>
<td>&lt; 10% overall</td>
</tr>
<tr>
<td><strong>Scanning System</strong></td>
<td>CCIR, 2:1 interlaced</td>
</tr>
<tr>
<td><strong>Gamma</strong></td>
<td>0.5 or 1.0 jumper selectable</td>
</tr>
<tr>
<td><strong>AGC</strong></td>
<td>6dB variable gain (peak-average adjustable), Jumper selectable — on/off</td>
</tr>
<tr>
<td><strong>Auto Lens</strong></td>
<td>Peak-average adjustable, Separate auto lens video eliminates AGC/auto lens interaction</td>
</tr>
<tr>
<td><strong>Signal-to-Noise Ratio @ 25°C</strong></td>
<td>52dB (gamma 1), gain 6dB, unweighted, 8MHz bandwidth, 58dB (gamma 1), gain 6dB, weighted, CCIR</td>
</tr>
<tr>
<td><strong>Auto Black</strong></td>
<td>Maintain set-up level at 7.5 + 5 IRE units if picture contains at least 10% black</td>
</tr>
<tr>
<td><strong>Power Requirements</strong></td>
<td>AC or DC 12V ± 10%, AC or DC 24V ± 5% (optional), AC 220/240V ± 10%, 50Hz with optional wall transformer</td>
</tr>
<tr>
<td><strong>Power Consumption</strong></td>
<td>4.2W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENVIRONMENTAL</th>
<th>4720 SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ambient Temperature Limits</strong></td>
<td>Operating: -10° to 50°C (14° to 122°F), Storage: -30° to 70°C (-22° to 157°F)</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>Up to 95% relative humidity</td>
</tr>
<tr>
<td><strong>Vibration</strong></td>
<td>5 to 60Hz with 0.208cm/0.082 inches total excursion (15 g's @ 60Hz), from 60 to 1,000Hz, 5 g's rms random vibration without damage</td>
</tr>
<tr>
<td><strong>Shock</strong></td>
<td>30 g's in any axis under non-operating conditions per MIL-E-5400T paragraph 3.2.24.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPECIFICATIONS</th>
<th>4720 SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Altitude</strong></td>
<td>Sea level to equivalent of 3,048m/10,000 feet (508mm/20 inches of mercury)</td>
</tr>
<tr>
<td><strong>Weight (less lens)</strong></td>
<td>450 grams/15 ounces</td>
</tr>
<tr>
<td><strong>Camera Mount</strong></td>
<td>1/4 - 20 threaded holes</td>
</tr>
<tr>
<td><strong>Lens Mount</strong></td>
<td>&quot;C&quot; Mount, 16mm format</td>
</tr>
<tr>
<td><strong>Type of Connector</strong></td>
<td>BNC Connector — Video out, Switchcraft TB4M — Lens Drive, Switchcraft TB3M — Power in, Hirose SR30-10R-6S (Auxiliary)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4730 &amp; 4760 SPECIFICATIONS</th>
<th>4720 SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ambient Temperature Limits</strong></td>
<td>Operating: -10° to 60°C (14° to 140°F), Storage: -30° to 70°C (-22° to 157°F)</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>Up to 100% relative humidity, MIL-E-5400T paragraph 3.2.24.4, equipped with standard Schrader tank valve (purge fitting) on camera housing to allow camera to be purged with dry nitrogen or other moisture eliminators, and to maintain housing interior at approximately 5 psi/.352 kg/cm²</td>
</tr>
<tr>
<td><strong>Ambient Air Pressure</strong></td>
<td>Sea level to equivalent of 3,048m/10,000 feet (508mm/20 inches of mercury)</td>
</tr>
<tr>
<td><strong>Air Contaminants</strong></td>
<td>Withstands exposure to sand, dust, fungus and salt atmosphere, per MIL-E-5400T paragraphs 3.2.24.7, 3.2.24.8, and 3.2.24.9</td>
</tr>
<tr>
<td><strong>Explosion</strong></td>
<td>MIL-E-5400T paragraph 3.2.24.10</td>
</tr>
<tr>
<td><strong>Acoustic Noise</strong></td>
<td>Operates in extremely high acoustic noise environment (150dB), e.g., close proximity to high-thrust rocket engine</td>
</tr>
<tr>
<td><strong>Underwater Operation</strong></td>
<td>Camera head operates to depth of 18.3m/60 feet with factory installed connector option available</td>
</tr>
<tr>
<td><strong>MECHANICAL</strong></td>
<td>Weight (less lens) 4732 — 1.36 kg/3 lbs, 4735 — 1.81 kg/4 lbs, 4760 — 6.35 kg/14 lbs, 7.71 kg/17 lbs (Z10D lens)</td>
</tr>
<tr>
<td><strong>Type of Lens</strong></td>
<td>A full range of C-mount fixed, auto-iris, and zoom lenses are available (see Ordering Information for Lens Options)</td>
</tr>
<tr>
<td><strong>Rear Plate Connector</strong></td>
<td>Bendix PT07C-14-18P, Bendix PT07C-20-39P (Mating connector supplied; all functions, video, power, and remote controls through single connector)</td>
</tr>
<tr>
<td><strong>Pressurized Fitting</strong></td>
<td>Standard Schrader Valve</td>
</tr>
<tr>
<td><strong>Purge/Relief Fitting</strong></td>
<td>Pressure relief valve (4760 only)</td>
</tr>
</tbody>
</table>
4720/4730/4760 CCIR SOLID-STATE CCD CAMERA

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>47X</th>
<th>X - X</th>
<th>X</th>
<th>XX / XXXX</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>Power Options</td>
<td>Sync Options</td>
<td>Optical Filter</td>
<td>Option Boards</td>
</tr>
<tr>
<td>0 None</td>
<td>0 None</td>
<td>2 Genlock/XTAL</td>
<td>0 None</td>
<td>00 None</td>
</tr>
<tr>
<td>2 General Purpose</td>
<td>2 12VAC or DC</td>
<td>3 Genlock/LL</td>
<td>1 IR Filter</td>
<td>*40 Bright Light</td>
</tr>
<tr>
<td>3 Environmental Housing</td>
<td>4 220/240VAC</td>
<td>4 Phase Adjust LL</td>
<td></td>
<td>L Filter</td>
</tr>
<tr>
<td>4 24VAC or DC</td>
<td>5 CCIR Crystal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Environmental Housing</td>
<td>6 Environmental Housing</td>
<td>7 UL Classified</td>
<td></td>
<td></td>
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<tr>
<td>7 UL Classified Explosion-Proof Housing CHX</td>
<td>7 UL Classified Explosion-Proof Housing CHX</td>
<td></td>
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</tr>
</tbody>
</table>

*4730/4760 only

COHU RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.

SPECTRAL RESPONSE

MODULATION TRANSFER FUNCTION

TYPICAL SENSITIVITY 2850K FACEPLATE ILLUMINATION

<table>
<thead>
<tr>
<th>With IR Filter</th>
<th>Without IR Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usable with AGC</td>
<td>0.2 Lux (.02 fc)</td>
</tr>
<tr>
<td>Full Video, Non-AGC</td>
<td>1.2 Lux (.12 fc)</td>
</tr>
<tr>
<td>Full Video, AGC</td>
<td>0.6 Lux (.06 fc)</td>
</tr>
</tbody>
</table>

Table 1
Cohu's Model 4750 solid state monochrome CCD cameras are cost effective general purpose cameras ideally suited for applications that require both high sensitivity and high resolution. High resolution pictures are attainable without geometric distortion, lag, or image retention. The 1/2" format CCD (charge coupled device) image sensor of the Model 4750 generates sensitivity that closely matches that of standard silicon target imaging tubes. These capabilities, along with its inherent rugged design and minimal maintenance, make this camera superior to many existing CCD or tube cameras.

Weighing just 450 grams, the Model 4750 is ideally suited for a broad range of security/surveillance applications. To provide high sensitivity in low-light areas, the Model 4750 features automatic gain control (AGC). The Model 4750 uses the frame transfer method and over 400,000 picture elements to generate a high-resolution image.

As with all Cohu CCD cameras, the Model 4750 is designed and manufactured in the U.S.A. A leading U.S. manufacturer of closed-circuit television cameras for over 40 years, Cohu is based in San Diego, California.

**FEATURES AND BENEFITS**

- **High Resolution** with 1/2-inch format sensor for sharper images
- **High Sensitivity** improves image in low light levels
- **Zero Geometric Distortion** for consistent corner-to-corner linearity
- **Frame Transfer Imager** for minimized blooming characteristics
- **No Lag or Image Retention** for fast, clean, precise images
- **Wide Range of Options** for flexible system integration
- **AGC with Peak-Average Adjustment** for clear images in varying light conditions.
- **Low Power Consumption**
- **High Signal-to-Noise Ratio** provides better dynamic range
- **Auto Black** for contrast enhancement
- **Quality, State-of-the-Art Design and Construction** for total, solid-state reliability and long life
- **IR Sensitive** for use in IR applications.

**APPLICATIONS**

- Perimeter Security
- General Surveillance
- Traffic Safety and Control

---

Designed and manufactured in U.S.A.
MODEL 4750 CCIR MONOCHROME CCD CAMERA

SPECIFICATIONS

ELECTRICAL

- **Pickup Area:** 6.4 x 4.8 mm (1/2-inch format)
- **Active Picture Elements:** 699(H) x 576(V) (frame transfer)
- **Number of Picture Cells:** 732(H) x 290(V)
- **Cell Size:** 9.2μm(H) x 16.8μm(V)
- **Resolution:** Horizontal 525 TV lines, Vertical >415 TV lines
- **Sensitivity:** 2850 K faceplate illumination.
- **Video Output:** 1.0 V p-p @75 ohms, unbalanced
- **Gamma:** 0.5 or 1.0 jumper selectable
- **AGC:** 6 dB variable gain, jumper selectable on/off, peak-average adjustable
- **Power Consumption:** 4.2W

<table>
<thead>
<tr>
<th>SENSITIVITY</th>
<th>With IR Filter</th>
<th>Without IR Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Video, AGC Off</td>
<td>0.12 fc (1.2 lux)</td>
<td>0.010 fc (0.10 lux)</td>
</tr>
<tr>
<td>Full Video, AGC On</td>
<td>0.06 fc (0.6 lux)</td>
<td>0.005 fc (0.05 lux)</td>
</tr>
<tr>
<td>Usable Picture, AGC On</td>
<td>0.02 fc (0.2 lux)</td>
<td>0.002 fc (0.02 lux)</td>
</tr>
</tbody>
</table>

Table 1

- **Auto Black:** Maintain set-up level at 7.5± 5 IRE units if picture contains at least 10% black
- **Signal-to-Noise Ratio:** 52 dB at gamma 1, 0 dB
  - 8 MHz bandwidth, unweighted
  - 58 dB at gamma 1, 0 dB weighted, CCIR
- **Auto Lens Drive Signal:** Peak-average characteristic tracks AGC adjustment to eliminate AGC/auto lens interaction.
- **Synchronization:**
  - CCIR crystal, 13.375 MHz clock output (standard)
  - Genlock, external sync with crystal zero crossing line lock back-up (jumper selectable)
  - External H & V drive
- **Power Requirements:**
  - AC 230V ±10%, 50 Hz (optional, with wall transformer)
  - AC/DC 12V ±10%
  - AC/DC 24V ±5% (optional)

ENVIRONMENTAL

- **Ambient Temperature Limits:**
  - Operating: -10 to 50 °C (14  to 122° F)
  - Storage: -30 to 70 °C (−22° to 157° F)
- **Humidity:** Up to 95% relative humidity
- **Vibration (less lens):** 5 to 60 Hz with 0.082 inch total excursion (15 g's @ 60 Hz). From 60 to 1000 Hz, 5 g's rms random vibration without damage
- **Shock (less lens):** Up to 15 g's in any axis under nonoperating conditions, MIL-E-5400T, paragraph 3.2.24.6
- **Altitude:** Sea level to equivalent of 3,048m/10,000 feet (508mm/20 inches of mercury)

MECHANICAL

- **Weight (less lens):** 450 grams (15 ounces)
- **Dimensions:**
  - Please see Figure 1.
- **Camera Mount:** 1/4 - 20 threaded holes
- **Lens Mount:**
  - 'C' mount, 16mm format
- **Connectors:**
  - BNC connector - Video Out
  - Switchcraft TB4M - Lens Drive
  - Switchcraft TB3M - Power In
  - Hirose SR30-10R-6S - Auxiliary
**DIMENSIONS**

**NOTE:** ALL DIMENSIONS IN MM AND (INCHES)

**FRONT VIEW**

**REAR VIEW**

**SPECTRAL RESPONSE**

**MODULATION TRANSFER FUNCTION CURVE**
### ORDERING INFORMATION

<table>
<thead>
<tr>
<th>475X</th>
<th>X</th>
<th>XXX</th>
<th>XXXX</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Options</strong></td>
<td><strong>Sync Options</strong></td>
<td><strong>Optical Filter</strong></td>
<td><strong>Lens Options</strong></td>
</tr>
<tr>
<td>2 12V AC/DC 50Hz</td>
<td>2 Genlock (Revert to crystal)</td>
<td>000 None</td>
<td>0000 None</td>
</tr>
<tr>
<td>3 230V AC, 50 Hz</td>
<td>3 Genlock (Revert to linelock)</td>
<td>100 IR Filter</td>
<td>Manual Iris Lenses</td>
</tr>
<tr>
<td>4 24V AC/DC</td>
<td>5 CCIR Crystal</td>
<td></td>
<td>AL04 4.5mm, f/2.0 (2/3&quot;)</td>
</tr>
<tr>
<td></td>
<td>7 External H &amp; V Drive</td>
<td></td>
<td>AL06 6.5mm, f/1.8 (2/3&quot;)</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>AL08 8mm, f/1.4 (2/3&quot;)</td>
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<td></td>
<td></td>
<td></td>
<td>AL09 9mm, f/1.3 (2/3&quot;)</td>
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<td></td>
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<td>AL16 16mm, f/1.4 (2/3&quot;)</td>
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<td>AL26 25mm, f/1.6 (2/3&quot;)</td>
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<td></td>
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<td></td>
<td>AL51 50mm, f/2.8 (2/3&quot;)</td>
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<td></td>
<td></td>
<td></td>
<td>AL75 75mm, f/1.8 (1&quot;)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Auto Iris Lenses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ES05 4.8mm, f/1.8 (2/3&quot;)</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>ES06 6mm, f/1.2 (1/2&quot;)</td>
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<td></td>
<td></td>
<td></td>
<td>ES08 8mm, f/1.4 (2/3&quot;)</td>
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<td></td>
<td></td>
<td></td>
<td>ES13 12mm, f/1.2 (1/2&quot;)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>ES16 16mm, f/1.4 (2/3&quot;)</td>
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<td></td>
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<td></td>
<td>ES28 28mm, f/1.2 (1/2&quot;)</td>
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<td></td>
<td></td>
<td></td>
<td>ES35 35mm, f/1.4 (2/3&quot;)</td>
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<td></td>
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<td></td>
<td>Please consult factory for other lens selections.</td>
</tr>
</tbody>
</table>

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### OPTIONAL FEATURES

#### SYNC OPTIONS
The genlock board contains circuits to receive external input signals, including composite video, composite sync, and horizontal and vertical drive. These inputs are processed and supplied as reference signals to the genlock oscillator. In the absence of an externally applied signal, the camera is either crystal-locked or line locked, depending on the position of the crystal/linelock jumper. In the Linelock Mode, the camera synchronizes to an external 50 Hz reference derived from the AC power line. In the CCIR Crystal Mode, the internal crystal-controlled oscillator provides back-up. The H & V Drive Input Option allows the camera to synchronize to externally supplied horizontal- and vertical-drive signals.

#### IR FILTER
The 4750 Series is designed to be IR sensitive. For use in applications with undesirable IR conditions, the optional IR filter will cut off at 650 nm.
Cohu's 4800 Series RS-170 Monochrome Frame Transfer CCD cameras are ideal for applications that require both high resolution and high sensitivity. Currently installed in thousands of sites around the world, they support a wide range of security/surveillance and electronic imaging applications.

4800 Series CCD cameras are available in three different housings. The 4810 Series housing is designed for non-environmental security/surveillance, image processing, and other scientific or industrial applications. The 4830 Series and 4860 Series Environmental CCD Cameras are designed for harsh environment applications. They consist of a 4810 Series camera and lens installed in either a three-inch-diameter or six-inch-diameter sealed and pressurized environment-resistant housing. The six-inch housing will accommodate virtually any size zoom lens. An explosion-proof housing is also available as an option.

4800 Series cameras provide high resolution pictures without geometric distortion, lag, or image retention. They provide sensitivity comparable to that of standard silicon target image tube cameras, and very low contrast variation. These capabilities, along with their reliable, rugged design and low maintenance, make 4800 Series cameras the ideal solution for high performance video requirements.

4800 Series cameras are designed and manufactured in U.S.A., and are backed by a full two-year warranty.

Cohu is uniquely positioned to respond quickly to special engineering requests for custom or modified products. We also offer complete system engineering services. A leading U.S. manufacturer of video cameras and systems for over 40 years, Cohu is based in San Diego, California.

**FEATURES AND BENEFITS**

- **Sealed, Pressurized Environmental Models** withstand exposure to extreme temperatures, sand, dust, fungus, and salt atmosphere.
- **High Resolution** with ½-inch format frame transfer image sensor for sharper images.
- **High Sensitivity** improves image in low light levels.
- **Zero Geometric Distortion** for consistent corner-to-corner linearity.
- **No Lag or Image Retention** for fast, clean, precise images.
- **Wide Range of Options** for flexible system integration.
- **Two-Year Warranty**
- **AGC with Peak-Average Adjustment** for clear images in varying light conditions.
- **High Signal-to-Noise Ratio** provides better dynamic range.
- **Auto Black** for contrast enhancement.
- **Quality, State-of-the-Art Design and Construction** for total, solid-state reliability and long life.
- **IR Sensitive** for use in IR applications.
- **Over 367,000 Picture Elements**
- **Made in U.S.A. — direct factory support, parts availability**
- **Adjustable "C" Mount** for maximum lens adaptability.

**APPLICATIONS**

- **Security/Surveillance**
  - Perimeter Security
  - Government and Military Facilities
  - Unmanned Storage Facilities
  - Nuclear Power Plants
  - Hazardous Waste Management
  - Correctional Facilities
- **EMI Environments**
  - Subways
  - High Voltage Areas
  - Linear Accelerators
  - NMR Units
- **Transportation Management**
  - Traffic Safety and Control
  - Bridges and Tunnels
  - Mass Transit
  - Airports and Train Stations
  - Fare Collection Points
- **Image Processing**
## 4800 SERIES MONOCHROME CCD CAMERAS

### ELECTRICAL

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Imager</strong></td>
<td>Single CCD using frame transfer method.</td>
</tr>
<tr>
<td><strong>Pickup Area</strong></td>
<td>8.8 x 6.6 mm (2½-inch format)</td>
</tr>
<tr>
<td><strong>Active Picture Elements</strong></td>
<td>754(H) x 244(V) (frame transfer)</td>
</tr>
<tr>
<td><strong>Cell Size</strong></td>
<td>11.5µm(H) x 27µm(V)</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>Horizontal 565 TV lines</td>
</tr>
<tr>
<td></td>
<td>Vertical &gt;350 TV lines</td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td>2850 K faceplate illumination, See Table 1 on back page.</td>
</tr>
<tr>
<td><strong>Contrast Variation @25°C</strong></td>
<td>&lt;5% overall</td>
</tr>
<tr>
<td><strong>Video Output</strong></td>
<td>1.0 V p-p @75 ohms, unbalanced</td>
</tr>
<tr>
<td><strong>Gamma</strong></td>
<td>0.5 or 1.0 jumper selectable</td>
</tr>
<tr>
<td><strong>Gray Scale</strong></td>
<td>Renders all shades of gray on EIA TV resolution chart, 1956</td>
</tr>
<tr>
<td><strong>AGC</strong></td>
<td>6 dB variable gain (peak-average adjustable)</td>
</tr>
<tr>
<td></td>
<td>Jumper selectable, On/Off.</td>
</tr>
<tr>
<td><strong>Auto Black</strong></td>
<td>Maintain set-up level at 7.5 ± 5 IRE units if picture contains at least 10% black</td>
</tr>
<tr>
<td><strong>Signal-to-Noise Ratio @25°C</strong></td>
<td>50 dB at gamma 1, 0 dB gain 8 MHz bandwidth, unweighted</td>
</tr>
<tr>
<td></td>
<td>55 dB at gamma 1, 0 dB gain, weighted</td>
</tr>
<tr>
<td><strong>Auto Lens Drive Signal</strong></td>
<td>Peak-average characteristic tracks AGC adjustment to eliminate AGC/auto lens interaction.</td>
</tr>
<tr>
<td><strong>Synchronization</strong></td>
<td>EIA RS-170 crystal, 14.31818 clock output (standard)</td>
</tr>
<tr>
<td></td>
<td>Genlock, external sync with crystal or line lock back-up (jumper selectable)</td>
</tr>
<tr>
<td></td>
<td>Phase adjustable line lock (4830/4860 Series only)</td>
</tr>
<tr>
<td></td>
<td>External H &amp; V drive</td>
</tr>
<tr>
<td><strong>Power Requirements</strong></td>
<td>AC/DC 12V ±10%</td>
</tr>
<tr>
<td></td>
<td>AC/DC 24V ±5%</td>
</tr>
<tr>
<td></td>
<td>AC 115/230V ±10%, 50/60 Hz with wall transformer for 4810</td>
</tr>
<tr>
<td><strong>Power Consumption</strong></td>
<td>4.2W</td>
</tr>
<tr>
<td></td>
<td>4830 Heater: 35W</td>
</tr>
<tr>
<td></td>
<td>4860 Heater: 50W</td>
</tr>
</tbody>
</table>

### ENVIRONMENTAL

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ambient Temperature Limits</strong></td>
<td>Operating: -10 to 50°C (14° to 122°F)</td>
</tr>
<tr>
<td></td>
<td>Storage: -30 to 70°C (-22° to 157°F)</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>Up to 95% relative humidity</td>
</tr>
<tr>
<td><strong>Vibration (less lens)</strong></td>
<td>5 to 60 Hz with 0.082 inch total excursion (15 g’s @ 60 Hz).</td>
</tr>
<tr>
<td></td>
<td>From 60 to 1000 Hz, 5 g’s rms random vibration without damage</td>
</tr>
<tr>
<td><strong>Shock (less lens)</strong></td>
<td>Up to 30 g’s in any axis under nonoperating conditions, MIL-E-5400T, paragraph 3.2.24.6</td>
</tr>
<tr>
<td><strong>Altitude</strong></td>
<td>Sea level to equivalent of 3,000m/10,000 feet (500mm/20 inches of mercury)</td>
</tr>
</tbody>
</table>

### MECHANICAL

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight (less lens)</strong></td>
<td>4830 — 3 lbs.</td>
</tr>
<tr>
<td></td>
<td>4835 — 4 lbs.</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td>4860 — 14 lbs.</td>
</tr>
<tr>
<td><strong>Camera Mount</strong></td>
<td>¼ - 20 threaded holes</td>
</tr>
<tr>
<td><strong>Lens Mount</strong></td>
<td>“C” mount, 16mm format</td>
</tr>
<tr>
<td><strong>Connectors</strong></td>
<td>BNC connector - Video Out</td>
</tr>
<tr>
<td></td>
<td>Switchcraft TB4M - Lens Drive</td>
</tr>
<tr>
<td></td>
<td>Switchcraft TB3M - Power In</td>
</tr>
<tr>
<td></td>
<td>Hirose SR30-10R-6S - Auxiliary</td>
</tr>
</tbody>
</table>

### 4830 & 4860 SPECIFICATIONS

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ambient Air Pressure</strong></td>
<td>Two atmospheres (sea level) to equivalent of 100,000 feet (3,000 meters), exceeding MIL-E-5400T paragraph 3.2.24.4.</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>Up to 100% relative humidity, MIL-E-5400T paragraph 3.2.24.4.</td>
</tr>
<tr>
<td><strong>Vibration — 4830</strong></td>
<td>50 to 60 Hz with 0.020 inches total excursion (3.5 g’s @ 60 Hz). From 60 to 1000 Hz, 3 g’s rms random vibration without damage</td>
</tr>
<tr>
<td><strong>Vibration — 4860</strong></td>
<td>0.03 inches total excursion from 5 to 30 Hz; peak random vibrations of 5 g’s from 30 to 1,000 Hz without damage or degradation</td>
</tr>
<tr>
<td><strong>Shock</strong></td>
<td>30 g’s in any axis under nonoperating conditions per MIL-E-5400T paragraph 3.2.24.6.</td>
</tr>
</tbody>
</table>

### Air Contaminants

Withstands exposure to sand, dust, fungus, and salt atmosphere, per MIL-E-5400T, paragraph 3.2.24.7, 3.2.24.8, and 3.2.24.9

### Explosion

MIL-E-5400T, paragraph 3.2.24.10

### Acoustic Noise

Operates in extremely high acoustic noise environment (150 dB), e.g., close proximity to high thrust rocket engine

### Underwater Operation

Camera operates to 60 feet in depth (18 meters) with factory installed connector option

### MECHANICAL

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight (less lens)</strong></td>
<td>4830 — 3 lbs.</td>
</tr>
<tr>
<td><strong>Type of Lens</strong></td>
<td>A full range of C-mount fixed, auto-iris, and zoom lenses is available.</td>
</tr>
<tr>
<td><strong>Purge/Relief Fitting</strong></td>
<td>Pressure relief valve (4860 only)</td>
</tr>
<tr>
<td><strong>Pressurized Fitting</strong></td>
<td>Standard Schrader Valve</td>
</tr>
<tr>
<td><strong>Rear Plate Connectors</strong></td>
<td>Bendix PT07C-14-18P</td>
</tr>
<tr>
<td><strong>(Mating Connector Supplied. All functions controlled through single connector.)</strong></td>
<td></td>
</tr>
</tbody>
</table>
### ORDERING INFORMATION

<table>
<thead>
<tr>
<th>48X</th>
<th>X — X</th>
<th>X</th>
<th>XX</th>
<th>XXXX</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing Options</td>
<td>Power Options</td>
<td>Sync Options</td>
<td>Optical Filter</td>
<td>Option Boards</td>
<td>Lens Options</td>
</tr>
<tr>
<td>1 General Purpose</td>
<td>2 12V ac/dc</td>
<td>2 Genlock</td>
<td>000 None</td>
<td>0000 None</td>
<td>L Low Temperature Operation</td>
</tr>
<tr>
<td>3 3' Environmental</td>
<td>4 24V ac/dc</td>
<td>(Revert to crystal)</td>
<td>100 IR Filter</td>
<td>Manual Iris Lens</td>
<td></td>
</tr>
<tr>
<td>5 6' Environmental</td>
<td>115V ac, 60 Hz (4810 Series supplied with ac wall adapter)</td>
<td>3 Genlock (Revert to line lock)</td>
<td></td>
<td>(4810 Series Only)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 Phase Adjustable Line Lock (4830 and 4860 ac models only)</td>
<td></td>
<td>AL12 12mm, f/1.4, 1&quot;</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>5 RS-170 Crystal</td>
<td></td>
<td>4860, use SS-522</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>7 External H &amp; V Drive</td>
<td></td>
<td>For Sunshields</td>
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<td>4830 use SS-300</td>
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<td></td>
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<td>4860 use SS-522</td>
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<td>For Remote Control</td>
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<td>Use 2380-090</td>
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<td>CA-246 (4830 cable)</td>
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<td></td>
<td></td>
<td></td>
<td>CA-294 (4960 cable)</td>
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</table>

### SENSITIVITY

<table>
<thead>
<tr>
<th>Sensor</th>
<th>With IR Filter</th>
<th>Without IR Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Video, AGC Off</td>
<td>0.2 fc (2 lux)</td>
<td>0.02 fc (0.2 lux)</td>
</tr>
<tr>
<td>80% Video, AGC On</td>
<td>0.07 fc (0.7 lux)</td>
<td>0.007 fc (0.07 lux)</td>
</tr>
<tr>
<td>30% Video, AGC On</td>
<td>0.02 fc (0.2 lux)</td>
<td>0.002 fc (0.02 lux)</td>
</tr>
</tbody>
</table>

* Available on 24V ac models only as an "ER". Please consult factory for other lens selections.

### SPECTRAL RESPONSE

![Spectral Response Graph](chart)

<table>
<thead>
<tr>
<th>UV</th>
<th>Visible Spectrum</th>
<th>Incident Wavelength-nm</th>
<th>IR</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>200</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>70%</td>
<td>70%</td>
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<tr>
<td>50%</td>
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<tr>
<td>3%</td>
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<tr>
<td>2%</td>
<td>2%</td>
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</tr>
</tbody>
</table>

### MODULATION TRANSFER FUNCTION

![Modulation Transfer Function Graph](chart)

<table>
<thead>
<tr>
<th>Horizontal Resolution TV Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

Cohu, Inc., Electronics Division
5755 Kearny Villa Road • San Diego, CA 92123
Phone: (619)277-6700 • FAX: (619)277-6700 • TWX: 910-335-1244
The Model 4810 solid-state cameras are ideal for applications that require both high resolution and high sensitivity. High resolution pictures are attainable without geometric distortion, lag or image retention. The 2/3-inch format CCD (Charge Coupled Device) image sensor of the Model 4810 generates sensitivity that closely matches standard silicon target imaging tubes. These capabilities, along with its inherent rugged design and minimal maintenance, make Cohu's Model 4810 superior to existing CCD or tube cameras.

Weighing just 15.5 ounces, the Model 4810 is suited for numerous applications including machine vision, image processing, robotics, process control and microscopy.

Automatic gain control (AGC) is incorporated in Cohu's Model 4810 to provide high sensitivity for use in low-light areas. The 4810 utilizes the frame transfer method and over 365,000 picture elements to generate a high resolution image with a contrast variation of <5%. Low power consumption allows flexible system integration and easy operation.

**OPTIONS**

- Synchronization
  - Genlock/Crystal
  - Genlock/Line Lock
  - Phase Adjust Line Lock
  - RS-170 Crystal
  - External H & V Drive
- IR Filter

**FEATURES**

- High Resolution
  - $754(H) \times 488(V)$ Picture Elements
- High Sensitivity
  - (to .007fc/.07 Lux)
- Auto Black for Wide Dynamic Range or Manual Adjustable
- AGC with Peak-Average Adjustment or Fixed Gain with Manual Adjustment
- Zero Geometric Distortion
- Selectable Gamma
- No Lag or Image Retention
- Low Power Consumption
- Blemish-Free Sensor
- Over 365,000 Picture Elements
- Adjustable C Mount

**APPLICATIONS**

- Machine Vision
  - Pattern Recognition
  - Non-Contact Measurement and Inspection
  - Bar Code Reading
  - Image Processing
- Robotics
  - Automated Visual Control
- EMI Environments
  - Subways
  - High Voltage Areas
  - Linear Accelerators
  - NMR Units
- Remote Piloted Vehicles
  - Land Based, Aircraft, Submersibles
- Microscopy
- Medical Imaging
- Security/Surveillance
### 4810 SERIES MONOCHROME CCD CAMERAS

#### ELECTRICAL

<table>
<thead>
<tr>
<th>Imager</th>
<th>Single CCD using frame transfer method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pickup Area</td>
<td>8.8 x 6.6 mm (3/4-inch format)</td>
</tr>
<tr>
<td>Active Picture Elements</td>
<td>754(H) x 488(V) (frame transfer)</td>
</tr>
<tr>
<td>Cell Size</td>
<td>11.5µm(H) x 27µm(V)</td>
</tr>
<tr>
<td>Resolution</td>
<td>Horizontal 565 TV lines, Vertical &gt;350 TV lines</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>2850 K faceplate illumination, See Table 1 below</td>
</tr>
<tr>
<td>Contrast Variation @25°C</td>
<td>&lt;5% overall</td>
</tr>
<tr>
<td>Video Output</td>
<td>1.0 V p-p @75 ohms, unbalanced</td>
</tr>
<tr>
<td>Gamma</td>
<td>0.5 or 1.0 jumper selectable</td>
</tr>
<tr>
<td>Gray Scale</td>
<td>Renders all shades of gray on EIA TV resolution chart, 1956</td>
</tr>
<tr>
<td>AGC</td>
<td>6 dB variable gain (peak-average adjustable), Jumper selectable, On/Off</td>
</tr>
<tr>
<td>Auto Black</td>
<td>Maintain set-up level at 7.5±5 IRE units if picture contains at least 10% black</td>
</tr>
<tr>
<td>Signal-to-Noise Ratio @25°C</td>
<td>50 dB at gamma 1, 0 dB gain, 8 MHz bandwidth, unweighted, 55 dB at gamma 1, 0 dB gain, weighted</td>
</tr>
<tr>
<td>Auto Lens Drive Signal</td>
<td>Peak-average characteristic tracks AGC adjustment to eliminate AGC/auto lens interaction</td>
</tr>
<tr>
<td>Synchronization</td>
<td>EIA RS-170 crystal, 14.31818 clock output (standard), Genlock, external sync with crystal or line lock back-up (jumper selectable), External H &amp; V drive</td>
</tr>
<tr>
<td>Power Requirements</td>
<td>AC/DC 12V ±10%, AC/DC 24V ±5%, AC 115/230V ±10%, 50/60 Hz, with wall transformer</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>4.2W</td>
</tr>
</tbody>
</table>

#### ENVIRONMENTAL

| Ambient Temperature Limits | Operating: -10 to 50 °C (14° to 122° F), Storage: -30 to 70 °C (~-22° to 157° F) |
| Humidity | Up to 95% relative humidity |
| Vibration (less lens) | 5 to 60 Hz with 0.082 inch total excursion (15 g's @ 60 Hz). From 60 to 1000 Hz, 5 g's rms random vibration without damage |
| Shock (less lens) | Up to 30 g's in any axis under nonoperating conditions, MIL-E-5400T, paragraph 3.2.24.6 |
| Altitude | Sea level to equivalent of 3,000m/10,000 feet (500mm/20 inches of mercury) |

#### MECHANICAL

| Weight (less lens) | 450 grams (15 ounces) |
| Dimensions | Please see dimensional drawings |
| Camera Mount | 1/4 - 20 threaded holes |
| Lens Mount | "C" mount, 16mm format |
| Connectors | BNC connector - Video Out, Switchcraft TB4M - Lens Drive, Switchcraft TB3M - Power In, Hirose SR30-10R-6S - Auxiliary |

#### SENSITIVITY

<table>
<thead>
<tr>
<th>With IR Filter</th>
<th>Without IR Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Video, AGC Off</td>
<td>0.2 fc (2 lux)</td>
</tr>
<tr>
<td>80% Video, AGC On</td>
<td>0.07 fc (0.7 lux)</td>
</tr>
<tr>
<td>30% Video, AGC On</td>
<td>0.02 fc (0.2 lux)</td>
</tr>
</tbody>
</table>

**Table 1**
NOTE: ALL DIMENSIONS IN INCHES AND (CM).

Figure 1

SPECTRAL RESPONSE

Shaded area indicates spectral response with faceplate removed or with a quartz faceplate installed. Please consult factory for prices.

MODULATION TRANSFER FUNCTION
MODEL 4810 SOLID-STATE MONOCHROME CCD CAMERA

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>481X</th>
<th>X</th>
<th>XXX</th>
<th>/</th>
<th>XXXX</th>
</tr>
</thead>
</table>

**Power Options**

2 12V ac/dc
4 24V ac/dc
5 115V ac, 60 Hz

Note: 12V and 24V models include power mating connector. Model 4815 is the same as Model 4812 with an external 12V dc power pack.

**Sync Options**

*2 Genlock (Revert to crystal)
*3 Genlock (Revert to line lock)
5 RS-170 Crystal
7 H & V Drive

* Includes Genlock, line lock, external H & V drive, and clock output

**Optical Filter**

000 None
100 IR Filter

**Lens Options**

0000 None
Manual Iris Lenses
AL09 9mm, f/1.4, 2/3"
AL12 12.5mm, f/1.4, 1"
AL16 16mm, f/1.4, 2/3"
AL25 25mm, f/1.4, 1"
AL50 50mm, f/1.4, 1"
AL75 75mm, f/1.8, 1"

Auto Iris Lenses*
ES08 8mm, f/1.4, 2/3"
ES12 12.5mm, f/1.4, 1"
ES16 16mm, f/1.4, 2/3"
ES25 25mm, f/1.4, 1"
ES50 50mm, f/1.8, 1"
EH75 75mm, f/1.8, 1"

* Auto iris lenses require lens connector P/N 1310356-104, which must be ordered separately when customer supplies own lens.

Warranty: Two years on CCD cameras; one year on lenses.

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OCTONAL FEATURES

**POWER OPTIONS**

The Model 4810 camera requires AC or DC 12V or 24V input power. For operation from a 115/230 VAC 50/60 Hz power source, an optional AC power pack is available.

**OPTICAL FILTER**

The Model 4810 is designed to be IR sensitive. For use in applications with undesirable IR conditions, the optional IR filter will cut off at 650nm.

**LENS OPTIONS**

In addition to the lenses listed above, Cohu provides a complete selection of lenses for specialized applications. Our applications engineers will help you determine the proper field-of-view, focal length, lens speed (f-stop), and size (image sensor format) for your application.

**SYNC OPTIONS**

The standard sync board contains a RS-170 crystal-controlled oscillator to generate a 14.31818 MHz reference frequency. A sync generator IC shapes the repetitive timing pulses used to control the movement of charge frames on the sensor board. This board also contains circuits to generate blanking, clamp, and sync pulses. These signals combine with the video signal on the video board to produce composite monochrome video.

The genlock board contains additional circuits to receive external input signals, including composite video, composite sync, and horizontal and vertical drive. These inputs are processed and supplied as reference signals to the genlock oscillator. In the absence of an externally applied signal, the camera is either crystal locked or line locked, depending on the position of the crystal/line lock jumper. In the Line-Lock Mode, the camera synchronizes to an external 60 Hz reference derived from the AC power line. In the RS-170 Crystal Mode, the internal crystal-controlled oscillator provides back-up. The H and V Drive Input option allows the camera to synchronize to externally supplied horizontal- and vertical-drive signals.

**SPECIAL FEATURES**

Cohu welcomes the opportunity to provide special features to better serve your particular application. Some examples of special features include a 10dB S/N increase for 60dB total signal-to-noise ratio; custom painting, silk screen and logo; remote head with 6' cable; imager faceplate removal for laser applications; imager tilt with customer-specified degree; and special connector pin configurations. Please contact Cohu for other special features.

COHU RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.
The 4910 Series High Performance Monochrome 1/2" CCD Cameras from Cohu offer high resolution and high sensitivity for use in a broad range of security/surveillance, scientific, and industrial video applications.

The 4910 Series cameras feature a 1/2"-format on-chip microlens sensor, which reduces dark current, lag, and blooming, while improving dynamic range and spectral characteristics. For video applications prone to streaking problems, a 1000:1 overload capability allows transmission of clear video signals even when bright incidental light is present in the scene.

The 4910 Series design also incorporates a removable trim plate for side panel access to controls such as gamma, electronic shutter, and gain.

Available in RS-170 and CCIR models, the 4910 Series cameras feature 26 dB of AGC for high sensitivity in low light-level applications. They are rugged, yet lightweight and compact, making them ideal for easy system integration. And 4910 Series cameras are backed by a full two-year warranty.

A leading U.S. manufacturer of closed circuit video cameras and systems for more than 40 years, we welcome requests for special products and complete CCTV systems.

FEATUES AND BENEFITS

- High Resolution — for better definition, error-free results
- Side-Panel Controls provide convenience and precision
- 1/2" On-chip-microlens Interline Transfer Imager virtually eliminates overload streaking, improves dynamic range
- Eight-Speed Electronic Shutter reduces blurred images of fast-moving objects
- High Sensitivity permits operation over a broad range of light levels
- Choice of Synchronization Options for greater versatility
- High Signal-to-Noise Ratio for clear, noise-free video
- Asynchronous Reset provides random vertical reset capability for production line applications
- Optional Electronic Iris automatically controls exposure from 1/60 sec. to 1/15,000 sec.
- Blemish-Free Imager — no dead pixels
- Made in U.S.A. — direct factory support
- 1000:1 Overload Capability permits incidental light overloads up to ten times that of other CCD cameras
- No Lag or Image Retention — provides fast, clean, precise images
- Zero Geometric Distortion for consistent corner-to-corner linearity
- 26 dB AGC for increased sensitivity at low light levels
- Optional IR Filter
- "C" or "CS" Lens Mount expands your choice of lenses
- Top or Bottom Mounting for easy installation
- State-of-the-Art Design and Construction for total, solid-state reliability and long life
- Choice of RS-170 or CCIR Models
- Two-Year Warranty
4910 HIGH PERFORMANCE MONOCHROME CCD CAMERA

**ELECTRICAL**

<table>
<thead>
<tr>
<th>Image Area</th>
<th>6.4 x 4.8 mm (corresponding to 1/2&quot; image tube)</th>
</tr>
</thead>
</table>
| Active Picture Elements | RS-170: 768H x 494V  
CCIR: 752H x 582V |
| Imager Type | On-chip microlens sensor interline transfer CCD |
| Cell Size | RS170: 8.4 x 9.8 microns  
CCIR: 8.6 x 8.3 microns |
| Resolution | RS170: 580 horizontal TVL,  
≥350 vertical TVL  
CCIR: 560 horizontal TVL  
450 vertical TVL |
| Sensitivity (faceplate) @2850 K | Please see Table 1. |

**Electronic Shutter**

- Eight steps from 1/50 or 1/60 to 1/4,000 second
- 1/50, 1/250, 1/500, 1/1,000, 1/2,000, 1/4,000, 1/10,000 second

**Integration**

- Integration period controllable through external input pulse
- External clock speeds
  - RS170: 28.6363 MHz
  - CCIR: 28.375 MHz

**Power Requirements**

- 12V ac or dc (standard)
- 24V ac or dc (optional)
- 115V ac (optional on RS-170 models, includes wall transformer and connector)
- 230V ac (optional on CCIR models, includes wall transformer and connector)

- 4.2 watts dc power consumption
- LED Power Indicator, Green

**Signal-to-Noise Ratio**

- ≥56 dB at gamma 1, gain 0 dB  
 38 dB at gamma 1, AGC On

**Auto Lens**

- Separate lens video ratio tracks
- AGC peak/average adjustment to eliminate AGC/auto lens interaction
- Power: +15V, 35 mA maximum

**Sync/Phase and Timing**

- Genlock, revert to variable phase line lock with zero crossing detector
- Crystal Lock
- Asynchronous Reset
- Internal Clock Speeds
  - RS170: 28.6363 MHz
  - CCIR: 28.375 MHz

**Gamma**

- Variable 0.45 to 1.0

**AGC**

- 26 dB, variable gain

**Sensitivity (faceplate) @2850 K**

Please see Table 1.

**Mechanical**

<table>
<thead>
<tr>
<th>Dimensions (less lens)</th>
<th>Please see Figure 1.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (less lens)</td>
<td>18.5 ounces (0.52 kg)</td>
</tr>
</tbody>
</table>
| Lens Mount             | "CS" mount, 16mm format  
"C" mount with adapter (furnished) |
| Camera Mounts          | 1/4 - 20 threaded holes, top and bottom |
| Connectors             | Video (BNC)  
Power (2 circuit screw terminal)  
Lens (3 pin Mini-DIN)  
External Sync (8 pin DIN) |
| Pin 1. External Vertical Trigger In  
Pin 2. External Sync/Horizontal Trigger In  
Pin 3. Grab Pulse Out (-)  
Pin 4. Ground  
Pin 5. Ground  
Pin 6. Vertical Reset In  
Pin 7. Grab Pulse Out (+)  
Pin 8. Integrate Input |

**Environmental**

| Ambient Temperature Limits | Operating: -20 to 60°C (-4 to 140°F)  
Storage: -30 to 70°C (-22 to 187°F) |
| Humidity                 | Up to 95% relative humidity |
| Vibration                | Sine vibration from 10 to 2,000 Hz,  
5G peak, all 3-axis, 1/2 hour per axis per MIL-E-5407, para.  
3.2.24.5.1.2, fig. 2, curve IIIA.  
Random vibration from 10-2,000 Hz, 11G RMS all 3-axis, 1/2 hour per axis, meets MIL-E-5407T, para.  
3.2.24.5.1.2A, category 6. |
| Shock                    | Up to 15 G in any axis under nonoperating conditions. |

**Sensitivity**

<table>
<thead>
<tr>
<th>Full Spectrum</th>
<th>With IR Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Video. No AGC</td>
<td>0.065 fc (.65 lux)</td>
</tr>
<tr>
<td>50% Video. AGC On (20 dB)</td>
<td>0.002 fc (.02 lux)</td>
</tr>
<tr>
<td>30% Video. AGC On</td>
<td>0.0004 fc (0.004 lux)</td>
</tr>
</tbody>
</table>

Table 1

This model has been tested and found to comply with the FCC limits for Class "B."
SIDE PANEL CONTROLS

An easily removable trim plate allows access to the following side-panel controls:

- Electronic Iris ON/OFF
- Eight-Step Shutter Timing
- AGC Peak/Average
- Gain
- AGC ON/OFF
- Gamma
- Black Level
### 4910 SERIES HIGH PERFORMANCE MONOCHROME CCD CAMERA

#### ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Power Options</th>
<th>Sync Options</th>
<th>Optical Filters</th>
<th>Options</th>
<th>Module Options</th>
<th>Lens Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 12V ac or dc</td>
<td>2 Genlock* (revert to crystal) RS-170</td>
<td>0 None</td>
<td>0 None (Standard TV Rate)</td>
<td>0 None.</td>
<td>Manual Iris, CS Mount</td>
</tr>
<tr>
<td>3 230V ac, 50 Hz, with ac wall adapter (CCIR Models)</td>
<td>3 Genlock* (revert to variable phase line lock) RS-170</td>
<td>1 IR Filter (Non-removable)</td>
<td>1 Frame Mode</td>
<td></td>
<td>A003 3.7mm, f/1.6, 1/2&quot;</td>
</tr>
<tr>
<td>4 24V ac or dc</td>
<td>4 Asynchronous Reset RS-170</td>
<td></td>
<td>3 Electronic Iris*</td>
<td></td>
<td>A006 6mm, f/1.4, 1/2&quot;</td>
</tr>
<tr>
<td>5 115V ac, 60 Hz, with ac wall adapter (RS-170 Models)</td>
<td>5 Genlock* (revert to crystal) CCIR</td>
<td></td>
<td></td>
<td></td>
<td>A013 12mm, f/1.4, 1/2&quot;</td>
</tr>
<tr>
<td></td>
<td>6 Genlock* (revert to variable phase line lock) CCIR</td>
<td></td>
<td></td>
<td></td>
<td>Manual Iris, C Mount</td>
</tr>
<tr>
<td></td>
<td>7 Asynchronous Reset CCIR</td>
<td></td>
<td></td>
<td></td>
<td>*AL04 4.5mm, f/2.0, 2/3&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>* Electronic Iris option is designed for use with manual iris lenses only. With this option, the camera operates in the field integration mode. Use of the electronic iris defeats electronic shutter positions</td>
<td></td>
<td>A018 8mm, f/1.4, 2/3&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>*Wide Angle</td>
<td></td>
<td>AL16 16mm, f/1.4, 2/3&quot;</td>
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<td>AL25 25mm, f/1.4, 1&quot;</td>
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<td></td>
<td>AL50 50mm, f/1.4, 1&quot;</td>
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<td>AL75 75mm, f/1.8, 1&quot;</td>
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<td></td>
<td>Auto Iris, CS Mount</td>
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<td></td>
<td></td>
<td></td>
<td>EH04 3.7mm, f/1.6, 1/2&quot;</td>
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<td>EH06 6mm, f/1.4, 1/2&quot;</td>
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<td></td>
<td>EH13 12mm, f/1.4, 1/2&quot;</td>
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<td></td>
<td>Auto Iris, C Mount</td>
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<td>ES04 4.2mm, f/1.8, 1/2&quot;</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>ES05 4.8mm, f/1.8, 2/3&quot;</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>ES08 8mm, f/1.4, 2/3&quot;</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>ES12 12.5mm, f/1.4, 2/3&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ES16 16mm, f/1.4, 2/3&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ES25 25mm, f/1.4, 1&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>EH35 35mm, f/1.4, 2/3&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ES50 50mm, f/1.4, 1&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>EH75 75mm, f/1.8, 1&quot;</td>
</tr>
</tbody>
</table>

* Please consult factory for other lens selections.

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### SPECTRAL RESPONSE

![Spectral Response Graph](image-url)

**Relative Response** vs **Wavelength**

---

5755 Kearny Villa Road • San Diego, CA 92123

Cohu, Inc/Electronics Division

Printed in U.S.A. 91-07 (7/93) July 1993
The 4940 Series High Performance Monochrome Environmental CCD Cameras from Cohu combine advanced video technology and rugged reliability for peak performance in harsh-environment security/surveillance applications.

The 4940 Series cameras feature a high-sensitivity on-chip microlens interline transfer imager, which reduces dark current, lag, and blooming while improving dynamic range and spectral characteristics. For video applications prone to streaking problems, a 1000:1 overload capability allows transmission of clear video signals even when bright incidental light is present in the scene.

The 4940 Series High Performance Monochrome CCD Cameras' 4.5" sealed and pressurized environmental housing provides maximum protection against rain, snow, dust, humidity, chemical pollutants, extreme temperatures, and other hazards.

Optional features include a fiber optic transmitter and a programmable source ID generator. An internal heater for low temperature operation is standard on all 115V models.

The 4940 Series High Performance CCD cameras are backed by a full two-year warranty. Cohu welcomes requests for special products and complete CCTV systems.

**APPLICATIONS**

- Intelligent Vehicle-Highway Systems/Traffic Management
- Mass Transit Systems
- Security/Surveillance
- Military Installations
- Airports
- Industrial Process Monitoring
- Nuclear Power Plants
- Hazardous Waste Management
- Radar Tracking Systems

**FEATURES AND BENEFITS**

- **Sealed, Pressurized Environmental Housing** protects against harsh environmental conditions
- **On-Chip Microlens Interline Transfer Imager** improves sensitivity, virtually eliminates overload streaking, and improves dynamic range.
- **High Resolution** — for better definition, error-free results
- **High Sensitivity** permits operation over a broad range of light levels.
- **Choice of Synchronization Options** for greater versatility
- **High Signal-to-Noise Ratio** for clear, noise-free video
- **Optional Fiber Optic Transmitter and Source I.D. Generator**
- **Made in U.S.A. —** direct factory support
- **Two-Year Warranty**
- **Internal Heater** for low temperature operation
- **1000:1 Overload Capability** permits incidental light overloads up to ten times that of other CCD cameras.
- **No Lag or Image Retention** — provides fast, clean, precise images
- **Zero Geometric Distortion** for consistent corner-to-corner linearity
- **26 dB AGC** for increased sensitivity at low light levels
- **Optional IR Filter**
- "C" or "CS" Lens Mount expands your choice of lenses.
- **State-of-the-Art Design and Construction**

Cohu 4940 Series High Performance Monochrome Environmental CCD Camera
**ELECTRICAL**

<table>
<thead>
<tr>
<th>Image Area</th>
<th>6.4 x 4.8 mm (corresponding to 1/2&quot; image tube)</th>
</tr>
</thead>
</table>
| Active Picture Elements | RS170: 768x494V  
CCIR: 525x582V |
| Imager Type         | On-chip microlens sensor interline transfer CCD |
| Cell Size           | RS170: 8.4 x 9.8 microns  
CCIR: 8.6 x 8.3 microns |
| Resolution          | RS170: 580 horizontal TVL, 350 vertical TVL  
CCIR: 560 horizontal TVL, 450 vertical TVL |
| Sensitivity (faceplate) @2850 K | Please see Table 1. |
| Electronic Shutter* | Eight steps from 1/50 or 1/60 to 1/10,000 second (1/50 or 1/60, 1/125, 1/250, 1/500, 1/1,000, 1/2,000, 1/4,000, 1/10,000 second) |
| Video Output        | 1.0 V p-p @75 ohms, unbalanced |
| Gamma               | Variable 0.45 to 1.0 |

**AGC**

26 dB, variable gain

**Signal-to-Noise Ratio**

≥56 dB at gamma 1, gain 0 dB  
38 dB at gamma 1, AGC On

**Auto Lens**

Separate lens video ratio tracks  
AGC peak/average adjustment to eliminate AGC/auto lens interaction  
Power: +15V, 100 mA maximum

**Synchronization**

Genlock, revert to variable phase adjustable line lock with zero crossing detector  
Genlock, revert to crystal  
Crystal Lock  
Internal Clock Speeds  
RS170: 28.6363 MHz  
CCIR: 28.375 MHz

**Power Requirements**

12V ac, 50/60 Hz  
24V ac, 50/60 Hz  
115V ac, 50/60 Hz  
230V ac, 50/60 Hz

**Power Consumption (by module)**

4.2 watts camera  
40 watts heater  
1.5 watts lens

**SENSITIVITY**

<table>
<thead>
<tr>
<th></th>
<th>Full Spectrum</th>
<th>With IR Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Video, No AGC</td>
<td>0.065 fc (0.65 lux)</td>
<td>0.25 fc (2.5 lux)</td>
</tr>
<tr>
<td>80% Video, AGC On</td>
<td>0.002 fc (0.02 lux)</td>
<td>0.01 fc (0.1 lux)</td>
</tr>
<tr>
<td>30% Video, AGC On</td>
<td>0.0004 fc (0.004 lux)</td>
<td>0.0015 fc (0.015 lux)</td>
</tr>
</tbody>
</table>

*Please see “Standard Features” box on back cover

<table>
<thead>
<tr>
<th>MECHANICAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
</tr>
<tr>
<td>Weight (less lens)</td>
</tr>
</tbody>
</table>
| Lens Mount | "CS" mount, 16mm format  
"C" mount with adapter (furnished) |
| Housing Mount | 1/4-20 threaded holes |
| Connectors | Please see Figure 1. |

**ENVIRONMENTAL**

<table>
<thead>
<tr>
<th>Ambient Temperature Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating: -20 to 60 °C (-4 to 140 °F); -40 to 60 °C (-40 to 140 °F) with heater</td>
</tr>
<tr>
<td>Storage: -30 to 70 °C (-22 to 157 °F)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 100% relative humidity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sine vibration from 5 to 60 Hz with 0.082 inches total excursion (15 g's @ 60 Hz). Random vibration from 60 to 1,000 Hz, 5 g's rms (0.027g7Hz without damage.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shock (less lens)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 15 g's, 11ms, in any axis under nonoperating conditions, MIL-E-5400T, paragraph 3.2.24.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Altitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea level to equivalent of 3,000m/10,000 feet (508mm/20 inches of mercury)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Air Contaminants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Withstands exposure to sand, dust, fungus, and salt atmosphere, per MIL-E-5400T, paragraph 3.2.24.7, 3.2.24.8, and 3.2.24.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Explosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIL-E-5400T, paragraph 3.2.24.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acoustic Noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can withstand environments greater than 150 dB continuously for 30 minutes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCC rules, Part 15, Subpart J, for Class A devices</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 15 g's in any axis under nonoperating conditions, MIL-E-5400T, paragraph 3.2.24.6</td>
</tr>
</tbody>
</table>

This model has been tested and found to comply within the FCC limits for Class ‘B.’
**CONNECTOR CONFIGURATIONS**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12/24V ac in</td>
</tr>
<tr>
<td>B</td>
<td>Reserved for Position Reference Return</td>
</tr>
<tr>
<td>C</td>
<td>75 Ω Sync Termination</td>
</tr>
<tr>
<td>D</td>
<td>Reserved for Focus Position</td>
</tr>
<tr>
<td>J</td>
<td>Video Ground</td>
</tr>
<tr>
<td>K</td>
<td>Video Out</td>
</tr>
<tr>
<td>L</td>
<td>Ground (Overall Cable Shield)</td>
</tr>
<tr>
<td>M</td>
<td>External Sync In</td>
</tr>
<tr>
<td>N</td>
<td>Ground (Sync Coax Shield)</td>
</tr>
<tr>
<td>P</td>
<td>Ground (Lens Conductors Shield)</td>
</tr>
<tr>
<td>R</td>
<td>Zoom In</td>
</tr>
<tr>
<td>S</td>
<td>Focus In</td>
</tr>
<tr>
<td>T</td>
<td>Iris In</td>
</tr>
<tr>
<td>U</td>
<td>Ground (Zoom, Focus, Iris Common)</td>
</tr>
<tr>
<td>V</td>
<td>115V ac Camera Power, 60 Hz, Low</td>
</tr>
<tr>
<td>W</td>
<td>115V ac Camera Power, High</td>
</tr>
<tr>
<td>X</td>
<td>AC Ground</td>
</tr>
<tr>
<td>Y</td>
<td>Reserved for Zoom Position</td>
</tr>
<tr>
<td>Z</td>
<td>Ground</td>
</tr>
<tr>
<td>b</td>
<td>Reserved for Position Reference</td>
</tr>
<tr>
<td>c</td>
<td>Auto/Manual Iris Select</td>
</tr>
<tr>
<td>d</td>
<td>12/24V ac in</td>
</tr>
<tr>
<td>e</td>
<td>RXD (Programmable ID Generator)</td>
</tr>
<tr>
<td>f</td>
<td>Ground</td>
</tr>
<tr>
<td>h</td>
<td>TXD (Programmable ID Generator)</td>
</tr>
<tr>
<td>i</td>
<td>TXD (Programmable ID Generator)</td>
</tr>
<tr>
<td>k</td>
<td>Ground (Programmable ID Generator)</td>
</tr>
<tr>
<td>m</td>
<td>Heater Power, 115V ac Low</td>
</tr>
<tr>
<td>n</td>
<td>RXD (Programmable ID Generator)</td>
</tr>
<tr>
<td>r</td>
<td>Heater Power, 115V ac High</td>
</tr>
</tbody>
</table>

**PROGRAMMABLE SOURCE ID GENERATOR**

The optional Programmable Source ID Generator is a built-in electronic circuit which allows written messages to be superimposed over images displayed on CCTV monitors. Using a computer and RS-422 serial communication, a user types messages that will then appear on the monitor. Text is made up of block letters 28 horizontal TV lines in height. The letters are white with a black outline for maximum legibility. There are two modes of operation, as follows:

1. ID Mode: Up to two lines of text (24 characters per line, including spaces) can be stored in non-volatile memory. Text can be placed at the top or bottom of the monitor screen, and can be updated from a computer or a dumb terminal, making this a real-time updatable programmable ID generator. Stored text, which typically provides information such as the location of individual cameras in multi-camera systems, will be continuously displayed until it is updated.

2. Menu Mode: In this mode, up to 12 lines of 24 characters can be entered into volatile memory without affecting data stored in the ID Mode. A computer is required to enter data in this mode.

Special cables or connectors are available for programming the Programmable Source ID Generator. Please consult factory for details.
# 4940 SERIES HIGH PERFORMANCE MONOCHROME CCD CAMERA

## Ordering Information

<table>
<thead>
<tr>
<th>Power Options*</th>
<th>Sync Options &amp; Video Format</th>
<th>Optical Filters</th>
<th>Camera Options</th>
<th>Module Options</th>
<th>Lens Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 12V ac, 50/60 Hz</td>
<td>2 RS-170 Genlock (revert to crystal)</td>
<td>0 None</td>
<td>0 None</td>
<td>0 None</td>
<td>Auto Iris, CS Mount</td>
</tr>
<tr>
<td>3 230V ac, 50/60 Hz**</td>
<td>3 RS-170 Genlock (revert to phase adjustable line lock)</td>
<td>1 IR Filter (non-removable)</td>
<td>1 Fiber Optic Transmitter</td>
<td>1 Programmable ID. Generator</td>
<td>EH04 3.7mm, f/1.6, 1/2&quot;</td>
</tr>
<tr>
<td>4 24V ac, 50/60 Hz</td>
<td>5 CCIR Genlock (revert to crystal)</td>
<td>2 Programmable ID. Generator and Fiber Optic Transmitter (See notes on page 3.)</td>
<td>3 Programmable ID. Generator and Fiber Optic Transmitter (See notes on page 3.)</td>
<td></td>
<td>EH06 6mm, f/1.4, 1/2&quot;</td>
</tr>
<tr>
<td>5 115V ac, 50/60 Hz</td>
<td>6 CCIR Genlock (revert to phase adjustable line lock)</td>
<td></td>
<td></td>
<td></td>
<td>EH13 12mm, f/1.4, 1/2&quot;</td>
</tr>
</tbody>
</table>

* Heater for Low Temperature Operation is standard on 115V models. Heater on 12V and 24V models is a special order feature. Please consult factory.

**Please consult factory for availability.

COHU RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.

## Notes on Standard Features

**Electronic Shutter:** Internal switches select shutter speeds or the number of integration fields, and enable or disable the external ON/OFF control of the internally-selected shutter or integration mode. These switches are set at the factory prior to sealing and pressurizing the environmental housing. The standard factory settings disable the external ON/OFF control and provide 1/60 second shutter speed. The switches can be set differently at the factory to customer specifications, or in the field by removing the camera from the housing.

**AGC Peak/Average** adjustment is made via an internal control, which is set at 0.45 at the factory prior to sealing and pressurizing the environmental enclosure. Customer may specify different setting.

## Spectral Response

![Sensor Spectral Response](image-url)

**Spectral Response**

- **Wavelength (nm)**: 400 to 1000
- **Relative Response**: 0 to 5

COHU RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.
FIRST GENERATION INTENSIFIED MONOCHROME CCD CAMERA

5510 SERIES

High Reliability, High Sensitivity, For Low Light Level Applications

Designed for reliable, long-life operation in applications characterized by low light levels, the 5510 Series first generation intensified CCD camera provides a number of advantages over SIT cameras traditionally used for LLL applications.

The 5510 Series Intensified CCD (ICCD) camera uses a first generation image intensifier which is fiber-optically coupled to the CCD image sensor to provide clear images, even when a scene illumination is extremely limited.

When compared to high-maintenance SIT cameras, the 5510 Series ICCD camera offers significantly greater dependability because the camera employs a solid-state CCD image sensor. The camera is also smaller, consumes less power, and exhibits less lag than an SIT camera.

The 5510 camera is available in standard, as well as in sealed, pressurized environmental housings.

Designed and manufactured in the U.S.A., the 5510 Series is the ideal camera for economical, reliable, low light level video requirements.

FEATURES AND BENEFITS

- **High Sensitivity** improves image in low light levels.
- **Low Lag** for fast, clean, precise images.
- **High Signal-to-Noise Ratio** provides better dynamic range.
- **Low Power Consumption** for flexible system integration, energy savings, and minimal dissipation.
- **Selectable AGC** allows better control under varying light conditions.
- **Made in U.S.A.** - direct factory support.
- **High Resolution** for sharper images.
- **Auto Black** for contrast enhancement.
- **Adjustable C Mount** for maximum adaptability.
- **Suitable Replacement for SIT Cameras**
- **RS-170 and CCIR Models**
- **Solid State Design** for long life and reliability.
- **Available in sealed, pressurized environment-resistant housings** for use in outdoor and hostile environments.

APPLICATIONS

- **Security/Surveillance**
  - Airports
  - Mass Transit
  - Power Plants
  - Military Installations
- **Microscopy**
- **Medical Imaging**
- **Machine Vision**
- **Image Processing**

Designed and manufactured in U.S.A.
## Specifications

### Electrical

<table>
<thead>
<tr>
<th>Image Intensifier</th>
<th>18 mm, Gen 1, electrostatic demagnifying 1&quot; input image format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geometric Distortion</td>
<td>≤ 6% within a circle not to exceed picture height</td>
</tr>
<tr>
<td>Spectral Response</td>
<td>S 25</td>
</tr>
</tbody>
</table>

### Imager

<table>
<thead>
<tr>
<th>Frame Transfer CCD</th>
<th>1/2&quot; format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Picture Elements</td>
<td>RS-170: 739(H) x 484(V)</td>
</tr>
<tr>
<td></td>
<td>CCIR: 699(H) x 576(V)</td>
</tr>
<tr>
<td>Cell Size</td>
<td>RS-170: 8.5µm(H) x 19.5µm(V)</td>
</tr>
<tr>
<td></td>
<td>CCIR: 9.2µm(H) x 16.8µm(V)</td>
</tr>
</tbody>
</table>

### General

<table>
<thead>
<tr>
<th>Resolution (TV lines)</th>
<th>RS-170: 480 horizontal, 350 vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CCIR: 460 horizontal, 400 vertical</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>2854 K faceplate illumination. 80% video: 0.00005 fc. No AGC: 5 x 10^-4. With 6dB gain: 2.5 x 10^-4. Usable picture: 0.000015 fc at 30% video</td>
</tr>
<tr>
<td>Gamma</td>
<td>0.5 or 1.0 jumper selectable</td>
</tr>
<tr>
<td>Auto Black</td>
<td>Maintain set-up level at 7.5± 5 IRE units if picture contains at least 10% black</td>
</tr>
</tbody>
</table>

### Spectral Response

- 25°C

### Ordering Information

<table>
<thead>
<tr>
<th>55X</th>
<th>X — X</th>
<th>X</th>
<th>X</th>
<th>X</th>
<th>/</th>
<th>XXXX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holding</td>
<td>Power Options</td>
<td>Sync Options</td>
<td>Optical Filter</td>
<td>Option Boards</td>
<td>Format</td>
<td>Lens Options</td>
</tr>
<tr>
<td>1 General Purpose</td>
<td>1 2V at 100k HZ</td>
<td>3 Spot</td>
<td>1 25V at 100k HZ</td>
<td>4 25V at 100k HZ</td>
<td>5</td>
<td>0000 None</td>
</tr>
<tr>
<td>11</td>
<td>12V at 100k HZ</td>
<td>3 Spot</td>
<td>1 25V at 100k HZ</td>
<td>4 25V at 100k HZ</td>
<td>5</td>
<td>0000 None</td>
</tr>
<tr>
<td>CS</td>
<td>12V at 100k HZ</td>
<td>3 Spot</td>
<td>1 25V at 100k HZ</td>
<td>4 25V at 100k HZ</td>
<td>5</td>
<td>0000 None</td>
</tr>
</tbody>
</table>

Cohu reserves the right to change specifications without notice.

### Optional Features

#### Sync Options

The genlock board contains circuits to receive external input signals, including composite video, composite sync, and horizontal and vertical drive. These inputs are processed and supplied as reference signals to the genlock oscillator. In the absence of an externally applied signal, the camera is either crystal-locked or line locked, depending on the position of the crystal/linelock jumper. In the Linelock Mode, the camera synchronizes to an external 50 or 60 Hz reference derived from the AC power line. In the Crystal Mode, the internal crystal-controlled oscillator provides back-up. The H & V Drive Input Option allows the camera to synchronize to externally supplied horizontal and vertical-drive signals.

### Spectral Response

- 25°C

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**Printed in U.S.A.**

9/30/91 (LR91)

May 1993

5755 Kearny Villa Road • San Diego, CA 92123

FAX: (619)277-0221 • Telephone: (619)277-6700 • TWX: 910-335-1244

Cohu, Inc./Electronics Division
Cohu’s 6310 Series Monochrome CCD cameras are high performance cameras which employ a unique high resolution frame transfer imager to provide an economical alternative to comparably priced cameras with much lower resolution and sensitivity. They provide high resolution pictures without geometric distortion, lag, or image retention, and sensitivity comparable to that of standard silicon target image tube cameras. These performance features, along with rugged design and low maintenance, make 6310 Series cameras an excellent value for a wide range of security/surveillance applications.

Weighing just 15 ounces, 6310 Series cameras feature 20 dB Automatic Gain Control (AGC) to provide high sensitivity in varying light conditions.

As with all Cohu CCD cameras, 6310 Series cameras are designed and manufactured in the U.S.A. and are backed by a two-year warranty. For assistance in selecting the proper camera for your application, please call Cohu at (619) 277-6700 and ask to speak with one of our experienced Applications Engineers.

**FEATURES AND BENEFITS**

- **High Resolution** with 1/2" format frame transfer image sensor with over 350,000 active picture elements
- **High Sensitivity** improves image in low light levels
- **Zero Geometric Distortion** for consistent corner-to-corner linearity
- **No Lag or Image Retention** for fast, clean, precise images
- **Wide Range of Options** for flexible system integration
- **Low Power Consumption** for flexible system integration, energy savings, and minimal dissipation
- **20 dB AGC with Peak-Average Adjustment** for clear images in varying light conditions
- **High Signal-to-Noise Ratio** provides better dynamic range
- **Auto Black** for contrast enhancement
- **Quality, State-of-the-Art Design and Construction** for total, solid-state reliability and long life
- **IR Sensitive** for use in IR applications
- **Over 350,000 picture elements**
- **Made in U.S.A. — direct factory support, parts availability**
- **Two-Year Warranty**

**APPLICATIONS**

- **Security/Surveillance**
  - Government Facilities
  - Environmental Monitoring
  - Power Plants
  - Banks
  - Retail Stores
  - Unmanned Storage Facilities
  - Parking Garages
  - Office Buildings
  - Correctional Facilities
- **Transportation Safety and Control**
  - Bridges and Tunnels
  - Mass Transit
  - Airports and Train Stations
  - Fare Collection Points
- **Teleconferencing**
- **Image Processing**

Designed and manufactured in U.S.A.
## ELECTRICAL

- **Imager**
  - Single CCD using frame transfer method
- **Pickup Area**
  - 6.4 x 4.8 mm (1/2-inch format)
- **Active Picture Elements**
  - 739(H) x 484(V) (frame transfer)
- **Cell Size**
  - 8.5μm(H) x 19.5μm(V)
- **Resolution**
  - Horizontal 550 TV lines
  - Vertical >350 TV lines
- **Sensitivity**
  - 2850 K faceplate illumination. See Table 1.
- **Contrast Variation @ 25°C**
  - <15%
- **Video Output**
  - 1.0 V p-p @75 ohms. unbalanced
- **Gamma**
  - 0.5 or 1.0 jumper selectable
- **AGC**
  - Peak average adjustable, 20 dB
- **Power Consumption**
  - 4.2W

### Auto Black
Maintain set-up level at 7.5± 5 IRE units if picture contains at least 10% black

### Signal-to-Noise Ratio
- 56 dB at gamma 1, AGC off
- 8 MHz bandwidth, unweighted

### Auto Lens Drive Signal
Peak-average characteristic tracks AGC adjustment to eliminate AGC/auto lens interaction.

### Synchronization
- EIA RS-170 crystal, 14.31818 clock output (standard)
- Genlock, external sync with crystal line lock back-up (jumper selectable)
- External H & V drive

### Power Requirements
- AC/DC 12V ±10%

## ENVIRONMENTAL

- **Ambient Temperature Limits**
  - Operating: -10 to 50 °C
  - (14° to 122° F)
  - Storage: -30 to 70 °C
  - (−22° to 158° F)
- **Humidity**
  - Up to 95% relative humidity
- **Vibration (less lens)**
  - 5 to 60 Hz with 0.082 inch total excursion (15 g’s @ 60 Hz). From 60 to 1000 Hz, 5 g’s rms random vibration without damage
- **Shock (less lens)**
  - Up to 30 g’s in any axis under nonoperating conditions,
  - MIL-E-5400T, paragraph 3.2.24.6
- **Altitude**
  - Sea level to equivalent of 3,000m/10,000 feet (500mm/20 inches of mercury)

## MECHANICAL

- **Weight (less lens)**
  - 425 grams (15 ounces)
- **Dimensions**
  - Please see Figure 1.
- **Camera Mount**
  - 1/4 - 20 threaded holes
- **Lens Mount**
  - "C" mount
- **Connectors**
  - BNC connector - Video Out
  - Switchcraft TB4M - Lens Drive
  - Switchcraft TB3M - Power In
  - Hirose SR30-10R-6S - Auxiliary

## SENSITIVITY

<table>
<thead>
<tr>
<th>With IR Filter</th>
<th>Without IR Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Video, AGC Off</td>
<td>0.40 fc (4.0 lux)</td>
</tr>
<tr>
<td>90% Video, AGC On</td>
<td>0.036 fc (0.36 lux)</td>
</tr>
<tr>
<td>Usable Picture (30%) Video, AGC On</td>
<td>0.0012 fc (0.012 lux)</td>
</tr>
</tbody>
</table>

Table 1
**DIMENSIONS**

**FRONT VIEW**

**REAR VIEW**

**NOTE:** ALL DIMENSIONS IN INCHES AND (CM).

---

**Figure 1.**

Cohu 6310 Monochrome CCD Camera

---

**SPECTRAL RESPONSE**

**MODULATION TRANSFER FUNCTION**

![Graphs showing spectral response and modulation transfer function.](image-url)
6310 SERIES RS-170 MONOCHROME 1/2" CCD CAMERA

ORDERING INFORMATION

631X — X — X — XXXX

Power Options  Sync Options  Optical Filter  Option Boards  Video Format  Lens Options
2  12V ac/dc
5  115V ac, 60 Hz
(with ac wall adapter)
2  Genlock
   (Revert to crystal)
3  Genlock
   (Revert to linelock)
5  RS-170 Crystal
7  External H & V Drive
   (Revert to crystal)
0  None
1  IR Filter
   (See IR transmission curve, below.)
0  None
1  RS-170
*AL04 4.5mm, f/2.0, 1/2"
*AL06 6.5mm, f/1.8, 1/2"
*AL08 8mm, f/1.4, 1/2"
AL04 12mm, f/1.2, 1/2"
AL16 16mm, f/1.4, 2/3"
AL26 25mm, f/1.6, 2/3"
AL51 50mm, f/2.8, 2/3"
** Auto iris lens mating connectors supplied with lens. Those customers supplying their own auto iris lenses must order connector separately.
Please consult factory for other lens selections.

COHU RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.

OPTIONAL FEATURES

SYNC OPTIONS
The genlock board contains circuits to receive external input signals, including composite video, composite sync, and horizontal and vertical drive. These inputs are processed and supplied as reference signals to the genlock oscillator. In the absence of an externally applied signal, the camera is either crystal-locked or line locked, depending on the position of the crystal/linelock jumper. In the Linelock Mode, the camera synchronizes to an external 60 Hz reference derived from the AC power line. In the Crystal Mode, the internal crystal-controlled oscillator provides back-up. The H & V Drive Input Option allows the camera to synchronize to externally supplied horizontal- and vertical-drive signals.

IR FILTER
The 6310 Series is designed to be IR sensitive. For use in applications with undesirable IR conditions, the optional IR filter will cut off at 650 nm.

TRANSMISSION OF IR FILTER

COHU INC.
ELECTRONICS DIVISION

Pu-lh-.T. in U.S.A.
91 04;10,"3'.)
Ocioyfi 1M1
5755 Kearny Villa Road • San Diego, CA 92123 • P.O. Box 85623 • San Diego, CA 92186-5623
FAX. (619)277-0221 • Telephone: (619)277-6700 • TWX: 910-335-1244
The 8410 and 8420 Series are full-frame frame-transfer RS-170 monochrome video cameras which provide ultra-high-resolution images for a broad range of scientific, industrial, and security/surveillance applications. They employ a unique blemish-free image sensor which provides true interlace video output for exceptional picture quality.

Because the 8410 and 8420 Series' image sensor has two independently addressable field memories, the camera can be operated in several different modes. In addition, the frame transfer imager has contiguous pixels. A high-bandwidth video-processing circuit makes full use of the resolution of the imager, while allowing options such as Automatic Gain Control and Auto Black Control.

Independent addressing of each field memory provides flexibility for different modes of operation. In the normal mode, the camera provides true interlace with 486 lines per frame and 1134 pixels per line. After a 1/60-second exposure of the 486 active lines in the imaging area, one field of 243 lines becomes video; the other 243 lines are discarded. A subsequent 1/60-second exposure produces the additional lines to complete the frame.

The low-light sensitivity mode utilizes pseudo interlace by summing two adjacent lines after a 1/60-second exposure time. The alternate summing of lines provides two different fields for each frame, with a 2:1 gain in light sensitivity.

In the dual field mode, both fields are exposed simultaneously for 1/30 second and stored on-chip. This results in a frame with the higher vertical resolution associated with true interlace but without the time-dependent image offset that occurs with normal-mode operation. In this mode, higher sensitivity is achieved at the expense of greater lag.

**FEATURES AND BENEFITS**

- High Resolution — 850 horizontal TV lines for sharper images
- Over 550,000 Active Picture Elements — 1134 x 486 array
- High Sensitivity permits operation over a wide range of light levels
- Two Independently Addressable Field Memories allow full-frame vertical resolution in all modes of operation
- True Interlace Operation for true high-resolution images
- Built-In Blooming Protection eliminates "washed-out" images caused by bright incidental light
- Low Power Consumption
- Two Year Warranty
- Auto Black for contrast enhancement
- 2/3" Format Blemish-Free Frame Transfer Sensor with Contiguous Pixels
- Virtual Phase Sensor Technology provides high blue response, low dark signal, uniformity and single-phase clocking
- 20 dB AGC with Peak-Average Adjustment for clear images in varying light level applications
- Made in U.S.A. — rugged, reliable design, quality components, direct factory support.

**APPLICATIONS**

- Scientific Microscopy
- Image Processing
- Machine Vision
- Robotics
- Mapping
- Industrial Security/Surveillance
- Aerial Reconnaissance
- Transportation Management

Designed and Manufactured in U.S.A.
## Specifications

<table>
<thead>
<tr>
<th>Electrical</th>
<th>Environmental</th>
<th>Mechanical</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Imager</strong></td>
<td><strong>Ambient Temperature Limits</strong></td>
<td><strong>Dimensions</strong></td>
</tr>
<tr>
<td>Full-frame frame transfer CCD</td>
<td>Operating: $-20$ to $50^\circ$ C ($-4^\circ$ to $122^\circ$ F)</td>
<td>Please see dimensional drawings.</td>
</tr>
<tr>
<td><strong>Image Area</strong></td>
<td>Storage: $-30$ to $70^\circ$ C</td>
<td><strong>Weight (less lens)</strong></td>
</tr>
<tr>
<td>8.8 x 6.6 mm (2/3&quot; format)</td>
<td>($-22^\circ$ to $157^\circ$ F)</td>
<td>Less than 48 ounces (12 V model)</td>
</tr>
<tr>
<td><strong>Active Picture Elements</strong></td>
<td><strong>Humidity</strong></td>
<td><strong>Lens mount</strong></td>
</tr>
<tr>
<td>1134(H) x 486(V)</td>
<td>Up to 95% relative humidity</td>
<td>&quot;C&quot; mount adapter furnished</td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td><strong>Vibration (less lens)</strong></td>
<td><strong>Connectors</strong></td>
</tr>
<tr>
<td>(Full Video, AGC Off)</td>
<td>5 to 60 Hz with 0.082 inch total</td>
<td>BNC connector—Video Out</td>
</tr>
<tr>
<td>Normal Mode: 0.035 lux</td>
<td>excursion (15 g's @ 60 Hz). From</td>
<td>Switchcraft TB5M—Power In</td>
</tr>
<tr>
<td>Low-Light Mode: 0.013 lux</td>
<td>60 to 1000 Hz, 5 g's rms random</td>
<td>Hirose SR30-10R-6S—Remote</td>
</tr>
<tr>
<td>Dual-Field Mode: 0.013 lux</td>
<td>vibration without damage</td>
<td>Switchcraft TB4M—Lens Drive</td>
</tr>
<tr>
<td><strong>S/N Ratio</strong></td>
<td><strong>Shock (less lens)</strong></td>
<td>(8410 only)</td>
</tr>
<tr>
<td>45 dB (gamma 1, gain 0 dB, aperture flat)</td>
<td>Up to 15 g's in any axis under</td>
<td>Hirose SR30-10R-7S—Auxiliary</td>
</tr>
<tr>
<td><strong>Horizontal Resolution</strong></td>
<td><strong>Altitude</strong></td>
<td>Output (8420 only)</td>
</tr>
<tr>
<td>850 TV lines</td>
<td>Sea level to equivalent of</td>
<td></td>
</tr>
<tr>
<td><strong>Vertical Resolution</strong></td>
<td>3,048m/10,000 feet (508mm/20 inches of mercury)</td>
<td></td>
</tr>
<tr>
<td>Normal Mode: 486 lines true interface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual-Field Mode: 486 lines true interface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-Light Mode: 350 lines pseudo interface</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Exposure</strong></td>
<td><strong>Power Requirements</strong></td>
<td><strong>Dimensions</strong></td>
</tr>
<tr>
<td>Normal Mode: 1/60 second</td>
<td>+15V dc, 285 mA steady state,</td>
<td>Please see dimensional drawings.</td>
</tr>
<tr>
<td>Low Light Mode: 1/60 second</td>
<td>800 mA startup (100ms)</td>
<td><strong>Weight (less lens)</strong></td>
</tr>
<tr>
<td>Dual Field Mode: 1/30 second</td>
<td>-15V dc, 140 mA steady state,</td>
<td>Less than 48 ounces (12 V model)</td>
</tr>
<tr>
<td><strong>Video Output</strong></td>
<td>800 mA startup (100 ms)</td>
<td><strong>Lens Mount</strong></td>
</tr>
<tr>
<td>1.0 V p-p, 75 ohm, unbalanced</td>
<td>5V dc, 205 mA steady state</td>
<td>&quot;C&quot; mount adapter furnished</td>
</tr>
<tr>
<td><strong>Contrast Variation</strong></td>
<td>2500mA startup (100 ms)</td>
<td><strong>Connectors</strong></td>
</tr>
<tr>
<td>&lt;5 %</td>
<td>(For line lock, 12V ac, 60 Hz,</td>
<td>BNC connector—Video Out</td>
</tr>
<tr>
<td><strong>Gamma</strong></td>
<td>&lt;1 mA steady state, 1 mA startup)</td>
<td>Switchcraft TB5M—Power In</td>
</tr>
<tr>
<td>0.5 to 1</td>
<td>115V ac, ± 10%, 60 Hz, with</td>
<td>Hirose SR30-10R-6S—Remote</td>
</tr>
<tr>
<td><strong>AGC</strong></td>
<td>external power supply</td>
<td>Switchcraft TB4M—Lens Drive</td>
</tr>
<tr>
<td>20 dB, peak/average adjustable</td>
<td></td>
<td>(8410 only)</td>
</tr>
<tr>
<td><strong>Manual Gain</strong></td>
<td>20 dB variable</td>
<td>Hirose SR30-10R-7S—Auxiliary</td>
</tr>
<tr>
<td><strong>Auto Black</strong></td>
<td>Maintain setup level at 7.5 ±5 IRE units if picture contains at least 10% black</td>
<td>Output (8420 only)</td>
</tr>
<tr>
<td><strong>Synchronization</strong></td>
<td>Crystal lock (21.477 MHz), Genlock, line lock</td>
<td></td>
</tr>
</tbody>
</table>
## Ordering Information

<table>
<thead>
<tr>
<th>Housing Options</th>
<th>Power Options</th>
<th>Sync Options</th>
<th>Optical Filter</th>
<th>Video Format</th>
<th>Lens Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Indoor Industrial</td>
<td>0 Requires external ±15V dc, ±5V dc (12V ac for line lock)</td>
<td>2 Genlock (revert to crystal)</td>
<td>0 None</td>
<td>10 RS-170 (EIA)</td>
<td>0000 None</td>
</tr>
<tr>
<td>2 Indoor Scientific</td>
<td>5 115V ac with external power supply</td>
<td>3 Genlock (revert to phase adjustable line lock)</td>
<td>1 I.R. Filter (for general use)</td>
<td></td>
<td>Manual Iris Lenses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 Phase adjustable line lock</td>
<td>2 I.R. Filter (for microscope use)</td>
<td></td>
<td>AL09 9mm, f/1.3 (2/3')</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AL12 12.5mm, f/1.4 (1')</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AL16 16mm, f/1.4 (2/3')</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AL25 25mm, f/1.4 (1')</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AL50 50mm, f/1.4 (1')</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AL75 75mm, f/1.8 (1')</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Auto Iris Lenses (for use on 8415 Series only)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ES08 8mm, f/1.4 (2/3')</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ES12 12.5mm, f/1.4 (1')</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ES16 16mm, f/1.4 (2/3')</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ES25 25mm, f/1.4 (1')</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ES50 50mm, f/1.4 (1')</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ES75 75mm, f/1.8 (1')</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Please consult factory for other lens selections.</td>
</tr>
</tbody>
</table>

## Special Features

Cohu welcomes the opportunity to provide special features to better serve your particular application. Some examples of special features are: custom painting, silk screen and logo; special filters; and special lens supports and mounting configurations. Please contact Cohu concerning these or other special features.

## Connector Configurations

### Lens (8410 Only)

<table>
<thead>
<tr>
<th>1</th>
<th>Lens Video</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Chassis Ground</td>
</tr>
<tr>
<td>3</td>
<td>Power</td>
</tr>
<tr>
<td>4</td>
<td>Ground</td>
</tr>
</tbody>
</table>

### Remote

<table>
<thead>
<tr>
<th>1</th>
<th>Composite Sync Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Select C (Future)</td>
</tr>
<tr>
<td>3</td>
<td>Vertical Reset (Future)</td>
</tr>
<tr>
<td>4</td>
<td>Horizontal Reset (Future)</td>
</tr>
<tr>
<td>5</td>
<td>Select Low-Light Mode</td>
</tr>
<tr>
<td>6</td>
<td>Select Dual-Field Mode</td>
</tr>
<tr>
<td>7</td>
<td>Ground</td>
</tr>
</tbody>
</table>

### Power

<table>
<thead>
<tr>
<th>1</th>
<th>-15V</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>+15V</td>
</tr>
<tr>
<td>3</td>
<td>60 Hz</td>
</tr>
<tr>
<td>4</td>
<td>+5V</td>
</tr>
<tr>
<td>5</td>
<td>Ground</td>
</tr>
</tbody>
</table>

### AUX (8420 Only)

<table>
<thead>
<tr>
<th>1</th>
<th>Pixel Clock Output (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Pixel Clock Output (+)</td>
</tr>
<tr>
<td>3</td>
<td>Blanking (+)</td>
</tr>
<tr>
<td>4</td>
<td>Blanking (-)</td>
</tr>
<tr>
<td>5</td>
<td>Composite Sync Out (+)</td>
</tr>
<tr>
<td>6</td>
<td>Composite Sync Out (-)</td>
</tr>
</tbody>
</table>
Cohu's new 1310 Series High Performance Color Cameras offers the ultimate in color vibrancy, picture clarity, and reliability. With a resolution of 460 horizontal lines (450 PAL), and a size measuring only 4" x 2" x 2", the 1300 Series combines the performance edge with a compact size for critical applications such as security, surveillance, and traffic management.

Special on-chip microlens sensor technology dramatically increases sensitivity while reducing blooming. Conveniently located adjustment pots make set up easy and fast. Gain, color balance, and externally-controlled integration setting are available on the back panel. An optional electronic iris feature is available that eliminates the need for an auto iris lens under most lighting conditions.

Designed and manufactured in the U.S.A., the 1300 Series cameras pack traditional Cohu engineering and technology excellence into a small and affordable enclosure. Cohu, Inc./Electronics Division is ISO-9001 certified.

**APPLICATIONS**
- Surveillance
- Perimeter Security
- Access Control
- Traffic Surveillance
- Bridges and Tunnels
- Inspection and Toll Plaza
- Transportation
- Mass Transit Systems

The Cohu 1300 Series features high performance color video in an exceptionally small enclosure.

**FEATURES AND BENEFITS**
- On Chip Microlens Interline Transfer Sensor provides high sensitivity and reduces blooming and transfer smear
- High Resolution - up to 460 horizontal TV lines (NTSC) for sharper images
- Small Size - only 4" x 2" x 2"
- Integration - externally controllable for low light imaging
- Standard Auto Iris - Electronic iris and DC iris optional
- Convenient Rear Panel Function Controls for precision adjustment
- High Signal-to-Noise Ratio provides clear, noise-free images
- 1000:1 Overload Capability prevents light overloads that cause blooming
- AGC for clear images in varying light conditions
- Optional crystal genlock or phase adjustable linelock synchronization
- C and CS lens mounts
- Optional top mounting accessory
- Made in U.S.A. - direct factory support
- Two Year Warranty
- Meets FCC Class B requirements

Designed and manufactured in U.S.A.
# 1300 HIGH PERFORMANCE COLOR CCD CAMERA

## SPECIFICATIONS

### ELECTRICAL

<table>
<thead>
<tr>
<th>Property</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Imager</strong></td>
<td>Single interline transfer CCD with matrix filter (cyan, yellow, magenta, green)</td>
</tr>
<tr>
<td><strong>Image Area</strong></td>
<td>6.4 x 4.8 mm (1/2&quot; format)</td>
</tr>
</tbody>
</table>
| **Active Picture Elements** | NTSC: 768 (H) x 494 (V)  
PAL: 752 (H) x 582 (V) |
| **Resolution** | NTSC: 460 horizontal TV lines  
350 vertical TV lines  
PAL: 450 horizontal TV lines  
415 vertical TV lines |
| **Sensitivity** | (3200K faceplate illumination)  
6.5 lux at full video, AGC off  
0.3 lux at 80% video, AGC on  
0.8 lux at 30% video, AGC on |
| **Shutter** | Internal DIP switch, 1/60 to 1/10,000, 8 steps  
Electronic Shutter (Optional)  
1/60 to 1/15,000 sec. auto-compensates for scene illumination |
| **Integration** | Externally controllable 1/60 to 16 sec. |
| **Gamma** | 0.6 |
| **AGC** | 0-20 dB (on/off), selectable (local/remote) |
| **Signal-to-Noise Ratio** | 46 dB (AGC off, NTSC with 4.5 MHz filter) |
| **Video Output** | Encoded NTSC and PAL, 1 V p-p @ 75 ohms, unbalanced composite, |
| **Auto Lens Output** | Controls auto iris lens  
DC Iris Option  
Controls aspherical lens |
| **Color Balance** | Automatic, through-the-lens type, less than 10 IRE units unbalance from 2850 to 5600 K;  
Local/Remote Manual White Balance |
| **Synchronization Options** | NTSC or PAL, crystal, genlock, or phase adjust lutelock |
| **Power Requirements** | 12 VDC or 12 VAC |
| **Power Consumption** | 7.5 W |

### ENVIRONMENTAL

<table>
<thead>
<tr>
<th>Property</th>
<th>Details</th>
</tr>
</thead>
</table>
| **Ambient Temperature Limits** | Operating: -20° to 50°C, -4° to 122°F  
Storage: -30° to 70°C, -22° to 157°F |
| **Humidity** | Up to 95% relative, non condensing |
| **Vibration (less lens)** | Per Mil-STD-810(E), Method 514.4, Categories 1, 4, 5, 8, 9, 10 |
| **Shock (less lens)** | No damage to 30 g, 11 ms duration  
No crush hazard to 75 g, 11 ms duration |

**NEW!** This camera is available in 3" and 4½" sealed and pressurized environmental enclosures. Contact your Cohu representative for full information.

### MECHANICAL

<table>
<thead>
<tr>
<th>Property</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight (less lens)</strong></td>
<td>10 oz., (280 g.)</td>
</tr>
<tr>
<td><strong>Lens Mount</strong></td>
<td>C/CS standard</td>
</tr>
<tr>
<td><strong>Camera Mounts</strong></td>
<td>1/4-20 female, top and bottom</td>
</tr>
</tbody>
</table>
| **Connectors (NTSC and PAL)** | Video Out: BNC  
Lens Drive: 4 pin  
Power In: 3 pin connector  
Remote: 8 pin mini-DIN |
| **Rear Panel Adjustments** | AGC on/off/remote  
Manual Gain Control  
Auto/Manual/Remote White Balance select  
Manual White Balance adjust |

### DIMENSIONS

#### MECHANICAL

- **Weight (less lens):** 10 oz., (280 g.)
- **Lens Mount:** C/CS standard
- **Camera Mounts:** 1/4-20 female, top and bottom
- **Connectors (NTSC and PAL):**
  - Video Out: BNC
  - Lens Drive: 4 pin
  - Power In: 3 pin connector
  - Remote: 8 pin mini-DIN
- **Rear Panel Adjustments:**
  - AGC on/off/remote
  - Manual Gain Control
  - Auto/Manual/Remote White Balance select
  - Manual White Balance adjust

### ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Power Option</th>
<th>Sync</th>
<th>Iris Options</th>
<th>Lens Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 - NTSC (60 Hz)</td>
<td>2 - 12 VDC</td>
<td>1 - NTSC XTAL</td>
<td>0 - Auto Iris</td>
<td>0000 None</td>
</tr>
<tr>
<td>5 - PAL (50 Hz)</td>
<td>7 - 12 VAC</td>
<td>2 - NTSC Genlock</td>
<td>3 - Elec. Iris NTSC</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3* - NTSC Phase Adjust LL</td>
<td>4 - DC Iris</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 - PAL XTAL</td>
<td>5 - Elec. Iris PAL</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 - PAL Genlock</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Requires Power Option 7*

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P.O. Box 85623 • San Diego, CA 92186-5623  
Phone (619) 277-6700 • FAX (619) 277-0221

Cohu, Inc./Electronics Division

Printed in U.S.A. 1300 Series 2/95
Cohu’s 8210 and 8310 Series High Performance Color CCD Cameras offer the ultimate in color vibrancy, picture clarity and reliability. They employ a half-inch interline transfer sensor with on-chip microlenses for exceptional sensitivity and minimal blooming. Y-C video outputs on NTSC and PAL models let you do high resolution recordings on Super VHS media. RGB models are also available.

8210 and 8310 Series cameras feature convenient side-panel access to electronic shutter, integration, gain, and other camera controls. And an optional electronic iris eliminates the need for an auto iris lens in most lighting conditions.

Designed and manufactured in the U.S.A., 8210 and 8310 Series High Performance Color CCD Cameras are backed by a two-year warranty. They are available with a wide range of optional features. OEM engineering requests are welcome.

**FEATURES AND BENEFITS**

- On-Chip-Microlens Interline Transfer Sensor provides high sensitivity and reduces blooming and transfer smear.

- High Resolution — up to 460 horizontal TV lines (NTSC) for sharper images.

- High Sensitivity — permits operation over a wide range of light levels.

- NTSC/Y-C and PAL/Y-C Models provide S-VHS output for high-resolution VCR recordings.

- Selectable Integration for microscopy and low-light video.

- Optional Electronic Iris automatically controls exposure, eliminating need for auto iris lens.

- Side Panel Access to Function Controls — for convenient, precision control.

- NTSC/Y-C and PAL/Y-C Models Feature Color Lock for consistent color rendition in multi-camera applications.

- High Signal-to-Noise Ratio provides better dynamic range.

- Eight-Speed Electronic Shutter reduces blurring of fast-moving objects.

- 1000:1 Overload Capability permits incidental light overloads up to ten times that of other CCD cameras.

- AGC with Peak-Average Adjustment for clear images in varying light levels.

- Choice of “C” or “CS” Lens Mounts.

- Made in U.S.A. — direct factory support.

- Two Year Warranty

**APPLICATIONS**

- Security/Surveillance
  - Perimeter Security
  - Traffic Safety and Control
  - General Surveillance

- Microscopy

- Image Processing
  - Medical and Industrial

- Machine Vision
  - Pattern Recognition
  - Non-Contact Measurement
  - 3-D Imaging
  - Inspection

- Robotics

Designed and manufactured in U.S.A.
### SPECIFICATIONS

#### ELECTRICAL — NTSC/Y-C AND PAL/Y-C MODELS

<table>
<thead>
<tr>
<th>Imager</th>
<th>Single interline transfer CCD with matrix filter (cyan, yellow, magenta, green)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Area</td>
<td>6.4 x 4.8 mm (1/2&quot; format)</td>
</tr>
</tbody>
</table>
| Active Picture Elements | NTSC/Y-C: 768(H) x 494(V)  
PAL/Y-C: 752(H) x 582(V) |
| Resolution | NTSC/Y-C: Horizontal 460 TV lines  
Vertical 350 TV lines  
PAL/Y-C: Horizontal 450 TV lines  
Vertical 415 TV lines |
| Sensitivity | 3200 K faceplate illumination.  
6.5 lux at full video, AGC Off.  
0.5 lux at 80% video, AGC On. |
| Electronic Shutter | Switch selectable, 1/100 second (off) to 1/10,000 second (8 steps) |
| Integration | Switch selectable, 2 to 16 fields (8 steps); grab pulse available |
| Gamma | 0.5 |
| AGC | 0-20 dB  
Peak-average adjustable |
| Signal-to-Noise Ratio (AGC Off) | 48 dB (NTSC with 4.5 MHz filter)  
48 dB (Y output with 6 MHz filter) |
| Video Outputs | Encoded: NTSC and PAL  
1 V p-p @75 ohms, unbalanced, composite |
| S Video | Y: 1 V p-p @75 ohms, unbalanced, composite  
C: 0.285 V p-p |
| Auto Lens Output | Peak-average characteristic tracks  
AGC adjustment to eliminate  
AGC/auto lens interaction |
| Color Lock | Burst phase adjustment  
Horizontal phase adjustment |
| Color Balance | Through-the-lens type  
Less than 10 IRE units unbalance from 2850 to >5800 K |
| Synchronization | NTSC or PAL crystal, color lock standard |
| Power Requirements | 12V ac or dc (standard)  
115V ac, 60 Hz for NTSC models (optional, with wall transformer)  
230V ac, 50 Hz for PAL models (optional, with wall transformer) |
| Power Consumption | 4.5W |

#### ELECTRICAL — RGB MODELS

<table>
<thead>
<tr>
<th>Imager</th>
<th>Single interline transfer CCD with matrix filter (cyan, yellow, magenta, green)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Area</td>
<td>6.4 x 4.8 mm (1/2&quot; format)</td>
</tr>
</tbody>
</table>
| Active Picture Elements | RGB/60: 768(H) x 494(V)  
RGB/50: 752(H) x 582(V) |
| Resolution | RGB/60: Horizontal 450 TV lines  
Vertical 350 TV lines  
RGB/50: Horizontal 430 TV lines  
Vertical 415 TV lines |
| Sensitivity | 3200 K faceplate illumination.  
13 lux at full video, AGC Off.  
1.1 lux at 80% video, AGC On. |
| AGC | 0-20 dB  
Peak-average adjustable |
| Gamma | 0.5 or 1.0 |

### ENVIRONMENTAL

| Ambient Temperature Limits | Operating: -20 to 50 °C  
(-4° to 122° F)  
Storage: -30 to 70 °C  
(-22° to 157° F) |
| Humidity | Up to 95% relative humidity |
| Vibration (less lens) | Sine vibration from 5 to 2,000 Hz.  
5 g's peak, all 3-axis, 1/2 hr. per axis per MIL-E-5400T, para 3.2.24.5.1.2, fig. 2, curve IIIa.  
Random vibration from 10 to 2,000 Hz.  
11 g's rms, all 3-axis, 1/2 hr. per axis, per MIL-E-5400T, para 3.2.24.5.1.2, category 6. |
| Shock (less lens) | Up to 15 g's in any axis under nonoperating conditions, MIL-E-5400T, paragraph 3.2.24.6 |

### MECHANICAL

| Dimensions | Please see dimensional drawings. |
| Weight (less lens) | 23 ounces (.65 kg) (12 V model) |
| Lens Mount | "CS" mount standard, "C" mount adapter furnished |
| Connectors (NTSC/Y-C and PAL/Y-C Models Only) | BNC connector — Video Out  
4 Circuit MINI-DIN — Y-C  
3 Circuit MINI-DIN — Lens Drive  
2 Circuit Terminal Strip — Power In  
8 Circuit MINI-DIN — Remote |
| Connectors (RGB Models) | BNC connector — Video Out  
8 Circuit MINI-DIN — Remote 1  
7 Circuit MINI-DIN — Sync  
2 Circuit Terminal Strip — Power In  
9 Circuit D-Sub — RGB Out |
| NTSC/Y-C and PAL/Y-C Side Panel Adjustments | Shutter/Off/Integrate Selection  
8-position Shutter/Integrate Switch  
AGC On/Off Selection  
AGC Peak/Average Adjustment  
Auto/Manual/Remote White Balance Selection  
White Balance Adjustment |
| RGB Side Panel Adjustments | Shutter/Off/Integrate Selection  
8-position Shutter/Integrate Switch  
AGC Peak/Average Adjustment  
AGC/Manual/Remote Selection  
Gain Adjustment  
Vertical Phase Adjustment  
Horizontal Phase Adjustment |
**DIMENSIONS OF NTSC/Y-C AND PAL/Y-C MODELS**

![Diagram of NTSC/Y-C and PAL/Y-C Models]

**DIMENSIONS OF RGB MODELS**

![Diagram of RGB Models]

**TYPICAL f/STOP VS. SHUTTER**

![Graph of Typical f/Stop vs. Shutter]

**MATRIX FILTER COLOR RESPONSES**

![Graph of Matrix Filter Color Responses]

Note: Unless otherwise designated, all dimensions in mm and inches.
**8X1** | **Power Options** | **Video Format** | **Module Options** | **Lens Options**
---|---|---|---|---
2 NTSC Format (60 Hz) | 2 12V ac/dc, 50/60Hz | 1 NTSC/Y-C or PAL/Y-C | 000 None | 0000 None
3 PAL Format (50 Hz) | 3 230V ac, 50 Hz, with wall transformer and connector (8310 Series only) | 2 RGB/60 or RGB/50 | 300 Electronic Iris* | Manual Iris, CS Mount
4 24/26 V ac/dc, 50/60 Hz | 4 115V ac, 60 Hz, with wall transformer and connector (8210 Series only) | | | AE03 3.7mm, f/1.6, 1/2"
5 | | | | AEO6 6mm, f/1.4, 1/2"

*Electronic Iris option is designed for use with manual iris lenses only. When enabled, this option defeats electronic shutter and integration positions.

**PLEASE NOTE:** Cohu welcomes the opportunity to provide special features to better serve your particular requirement. For example, custom painting, silkscreen and logo for OEM customers and special connector pin configurations can be ordered. Please contact Cohu for details.

---

**NTSC, PAL CONNECTOR CONFIGURATIONS**

**LENS**

| 1 | Power |
| 2 | Lens Video |
| 3 | Ground |

**Y-C**

| 1 | Y—Ground |
| 2 | C—Ground |
| 3 | Y |
| 4 | C |

**REMOTE**

| 1 | Auto/Man White Balance |
| 2 | White Balance |
| 3 | Sync/Video In (color lock) |
| 4 | Shutter On/Off |
| 5 | +5 |
| 6 | Ground |

**RGB CONNECTOR CONFIGURATIONS**

**REMOTE**

| 1 | Blue Level |
| 2 | Red Level |
| 3 | Sync/Horizontal In |
| 4 | Shutter On/Off |
| 5 | +5 |
| 6 | Vertical In |
| 7 | Ground |
| 8 | External Gain |

**SYNC**

| 1 | Grab Pulse |
| 2 | Vertical Drive Out |
| 3 | Horizontal Drive Out |
| 4 | Clock Out |
| 5 | Ground |

**RGB**

| 1 | Ground |
| 3 | R |
| 4 | G |
| 5 | B |
| 6 | NC |
| 7 | Sync |
| 8 | NC |
| 9 | NC |
Cohu's new 2200 Series High Performance Color Cameras offers the ultimate in flexibility, features, color vibrancy, picture clarity, and reliability. With a resolution of 460 horizontal lines (450 PAL), and a size measuring only 4" x 2" x 2", the 2200 Series combines the performance edge with a compact size for industrial and scientific applications such as machine vision, medical analysis, and metrology.

The Model 2200 can offer simultaneous NTSC (or PAL), Y-C, and RGB outputs to simplify image processing and display. Special on-chip microlens sensor technology dramatically increases sensitivity while reducing blooming.

Gain, asynchronous reset, color balance, and externally-controlled integration setting are easily accessed. Optional features include RGB, genlock, electronic iris, and automatic or sample and hold white balance.

All Cohu cameras are manufactured in the U.S.A. and come with a two-year warranty and the support of experienced Applications Engineers to help make sure you achieve everything you expect from your camera.

Cohu is ISO-9001 certified.

APPLICATIONS
- Machine Vision
- Medical Analysis
- Portrait Studio
- Agricultural Processing
- Microscopy (low light)
- Inspection
- Optical Measurement

FEATURES AND BENEFITS
- On Chip Microlens Interline Transfer Sensor provides high sensitivity and reduces blooming and transfer smear
- High Resolution - up to 460 horizontal TV lines for sharper images
- Small Size - only 4" x 2" x 2"
- Integration - externally controllable for low light imaging
- Asynchronous Reset
- Rear Panel Controls for precision adjustment
- High Signal-to-Noise Ratio provides clear, noise-free images
- 1000:1 Overload Capability prevents light overloads that cause blooming
- Manual Gain and Color Balance
- Optional crystal genlock
- C lens mount standard, CS optional
- Optional top or bottom mounting accessory
- Made in U.S.A. - direct factory support
- Two Year Warranty
- Meets FCC Class B and VDE Class B requirements

Designed and manufactured in U.S.A.

Cohu, Inc./Electronics Division
**ELECTRICAL**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Imager</strong></td>
<td>Single interline transfer CCD with matrix filter (cyan, yellow, magenta, green)</td>
</tr>
<tr>
<td><strong>Image Area</strong></td>
<td>6.4 x 4.8 mm (1/2&quot; format)</td>
</tr>
<tr>
<td><strong>Active Picture Elements</strong></td>
<td>NTSC and RGB/60: 768 (H) x 494 (V) PAL and RGB/50: 752 (H) x 582 (V)</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>NTSC/Y-C: 460 horizontal TV lines RGB/60: 350 vertical TV lines</td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td>6.5 lux at full video, AGC off 0.3 lux at 80% video, AGC on 0.8 lux at 30% video, AGC on</td>
</tr>
<tr>
<td><strong>Shutter</strong></td>
<td>Internal DIP switch, 1/60 to 1/10,000, 8 steps</td>
</tr>
<tr>
<td><strong>Electronic Iris (Optional)</strong></td>
<td>1/60 to 1/15,000 sec. auto-compensates for scene illumination</td>
</tr>
<tr>
<td><strong>Integration</strong></td>
<td>1/60 to 16 fields (active high)</td>
</tr>
<tr>
<td><strong>Gamma</strong></td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Gain AGC/Manual</strong></td>
<td>0-20 dB (on/off), selectable (local/remote)</td>
</tr>
<tr>
<td><strong>Signal-to-Noise Ratio</strong></td>
<td>46 dB (AGC off @ 6.5 lux 4.5 MHz filter)</td>
</tr>
<tr>
<td><strong>Video Output</strong></td>
<td>Encoded NTSC and PAL: 1 V p-p @ 76 ohms, unbalanced composite; S Video Y: 1 V p-p @ 75 ohm S Video C: 285 V p-p RGB (per channel): 0.714 V p-p @ 75 ohms, unbalanced; sync on green, 0.4 V p-p @ 75 ohms unbalanced</td>
</tr>
<tr>
<td><strong>Auto Lens Output</strong></td>
<td>Non-AGC video, DC iris drive optional</td>
</tr>
<tr>
<td><strong>Color Balance</strong></td>
<td>Automatic, through-the-lens type, less than 10 IRE units unbalanced from 2850 to 5800 K; Local/Remote Manual White Balance</td>
</tr>
<tr>
<td><strong>Synchronization Options</strong></td>
<td>NTSC or PAL: crystal, asynchronous reset RGB: Genlock, H&amp;V drive (optional)</td>
</tr>
<tr>
<td><strong>Power Requirements</strong></td>
<td>12 VDC ±10%</td>
</tr>
<tr>
<td><strong>Power Consumption</strong></td>
<td>6 W</td>
</tr>
</tbody>
</table>

**ENVIRONMENTAL**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ambient Temperature Limits</strong></td>
<td>Operating: -20° to 50°C, -4° to 122°F Storage: -30° to 70°C, -22° to 157°F</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>Up to 95% relative, non condensing</td>
</tr>
<tr>
<td><strong>Vibration (less lens)</strong></td>
<td>Per MIL-STD.-810(E), Method 514.4, Categories 1, 4, 5, 8, 9, 10</td>
</tr>
<tr>
<td><strong>Shock (less lens)</strong></td>
<td>No damage to 30 g, 11 ms duration No crash hazard to 75 g, 11 ms duration</td>
</tr>
</tbody>
</table>

**MECHANICAL**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight</strong></td>
<td>10 oz., (280 g.)</td>
</tr>
<tr>
<td><strong>Lens Mount</strong></td>
<td>C/CS standard</td>
</tr>
<tr>
<td><strong>Camera Mounts</strong></td>
<td>1/4-20 female, top and bottom</td>
</tr>
<tr>
<td><strong>Connectors</strong></td>
<td>Video Out: BNC; Y-C/RGB: 12 pin Aux Lens Drive: 4 pin connector Power In: 3 pin connector Aux: 12 pin connector</td>
</tr>
</tbody>
</table>

**DIMENSIONS**

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-40 THREADS FOR AUXILIARY MOUNT (TOP)</td>
<td>(4.00 (102.4)</td>
</tr>
<tr>
<td>AUXILIARY MOUNT (BOTTOM)</td>
<td>(1.37 (34.8)</td>
</tr>
<tr>
<td>1/4-20 THROES FOR AUXILIARY MOUNT (3 PLACES)</td>
<td>(2.00 (50.8)</td>
</tr>
</tbody>
</table>

**ORDERING INFORMATION**

- **22X**
  - **Format**
    - 2 - NTSC/Y-C
    - 5 - PAL/Y-C
  - **Power Option**
    - 2 - 12 VDC
  - **Iris Options**
    - 0 - Auto Iris
    - 3 - Elec. Iris NTSC
  - **Color**
    - 0 - Manual white bal.
    - 2 - Auto white bal.
  - **Unassigned**
    - 1 - RGB output

- **X**
  - **Color**
    - 0 - Manual white bal.
    - 2 - Auto white bal.
  - **Iris Options**
    - 0 - Auto Iris
    - 3 - Elec. Iris NTSC
  - **Sync**
    - 1 - NTSC XTAL
    - 2 - NTSC Genlock
  - **Format**
    - 2 - NTSC/Y-C
    - 5 - PAL/Y-C

- **XXXX**
  - **Lens Options**
    - 0000 None

**Cohu, Inc. • Electronics Division**

P.O. Box 85623 • San Diego, CA 92186-5623
Phone (619) 277-6700 • FAX (619) 277-0221
Cohu's 8240 Series is the leader in high resolution, environmentally secure CCD cameras. Special on-chip microlens sensor technology dramatically increases sensitivity while offering excellent color vibrancy, picture clarity, and reliability. The rugged, 4.5" diameter environmental housing is designed to stand up to even the harshest weather conditions.

The 8240 Series cameras provide 460 TV lines of horizontal resolution - a significant performance edge for critical applications such as security, surveillance, and traffic management.

For video applications prone to streaking problems, the microlens sensor provides a 1000:1 overload capability, which allows transmission of clear video signals, even when bright, incidental light is present in the scene.

The 8240 Series High Performance CCD cameras' sealed and pressurized environmental enclosure provides maximum protection against rain, snow, dust, humidity, chemical pollutants, extreme temperatures, and other environmental hazards.

**FEATURES AND BENEFITS**

- **Superior Resolution** - 460 horizontal TV lines for sharper images
- **On-Chip Microlens Interline Transfer** dramatically increases sensitivity and virtually eliminates blooming
- **Sealed, Pressurized Environmental Housing** protects against harsh weather conditions
- **Internal Heater** allows camera to be installed in the coldest of climates
- **Selectable Integration** for low light video
- **Zero Geometric Distortion** ensures precision measurement
- **Color Lock** for consistent color rendition in multi-camera applications
- **Two Year Warranty**
- **Made In U.S.A.** for direct factory support
- **High Signal-to-Noise Ratio** provides better dynamic range

**OPTIONS**

- **Programmable Source ID Generator** permits incorporation of detailed messages on monitor screens
- **Fiber Optic Transmitter** for transmission of the video signal over long distances without interference or signal loss
- **Choice of Voltages**
- **Two-Digit Source ID Generator**
- **Special Engineering Revisions**

The Cohu 8240 Series offers high performance in a rugged housing.

Designed and manufactured in U.S.A.
### ELECTRICAL

<table>
<thead>
<tr>
<th>Spec</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Imager</strong></td>
<td>Single interline transfer CCD with matrix filter (cyan, yellow, magenta, green)</td>
</tr>
<tr>
<td><strong>Image Area</strong></td>
<td>6.4 x 4.8 mm (1/2-inch format)</td>
</tr>
<tr>
<td><strong>Active Picture Elements</strong></td>
<td>768(H) x 493(V)</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>Horizontal 460 TV lines, Vertical &gt;350 TV lines</td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td>3200 K faceplate illumination, 6.5 lux at full video, AGC Off, 0.5 lux at 80% video, AGC On.</td>
</tr>
<tr>
<td><strong>Electronic Shutter</strong></td>
<td>External switch selectable, on/off, internal switch selectable, 1/60 second (On) to 1/10,000 second in 8 steps</td>
</tr>
<tr>
<td><strong>Integration</strong></td>
<td>External switch selectable, on/off, internal switch selectable, 2 to 16 fields (8 steps)</td>
</tr>
<tr>
<td><strong>Gamma</strong></td>
<td>0.5</td>
</tr>
<tr>
<td><strong>AGC</strong></td>
<td>0-20 dB</td>
</tr>
<tr>
<td><strong>Auto Lens Operation</strong></td>
<td>Peak-average characteristic tracks AGC adjustment to eliminate AGC/auto lens interaction</td>
</tr>
<tr>
<td><strong>Color Lock</strong></td>
<td>Burst phase adjustment, horizontal phase adjustment</td>
</tr>
<tr>
<td><strong>Color Balance</strong></td>
<td>Through-the-lens type, less than 10 IRE units unbalance from 2850 to &gt;5800 K</td>
</tr>
<tr>
<td><strong>Synchronization</strong></td>
<td>EIA RS-170 crystal, color lock standard</td>
</tr>
<tr>
<td><strong>Power Requirements</strong></td>
<td>12V ac or dc (standard), 115V ac</td>
</tr>
<tr>
<td><strong>Power Consumption</strong></td>
<td>4.5W, camera only, 54.5 W, camera with heater</td>
</tr>
</tbody>
</table>

*Please see Standard Features section on back cover.*

### ENVIRONMENTAL

<table>
<thead>
<tr>
<th>Spec</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ambient Temperature Limits</strong></td>
<td>Operating: -20 to 50 °C (4° to 122°F), -40 to 50 °C (40° to 122°F) with optional heater</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>Up to 100% relative humidity</td>
</tr>
<tr>
<td><strong>Vibration (less lens)</strong></td>
<td>Sine vibration from 5 to 60 Hz with 0.082 inch total excursion (15 g’s @ 60 Hz). Random vibration from 60 to 1000 Hz, 5 g’s rms (0.027g^2/Hz) without damage</td>
</tr>
<tr>
<td><strong>Shock (less lens)</strong></td>
<td>Up to 15 g’s, 11ms, in any axis under nonoperating conditions, MIL-E-5400T, paragraph 3.2.24.6</td>
</tr>
<tr>
<td><strong>Altitude</strong></td>
<td>Sea level to equivalent of 3,000m/10,000 feet (508mm/20 inches of mercury)</td>
</tr>
<tr>
<td><strong>Air Contaminants</strong></td>
<td>Withstands exposure to sand, dust, fungus, and salt atmosphere, per MIL-E-5400T, paragraph 3.2.24.7, 3.2.24.8, and 3.2.24.9</td>
</tr>
<tr>
<td><strong>Explosion</strong></td>
<td>MIL-E-5400T, paragraph 3.2.24.10</td>
</tr>
<tr>
<td><strong>Acoustic Noise</strong></td>
<td>Can withstand environments greater than 150 dB continuously for 30 minutes</td>
</tr>
<tr>
<td><strong>EMI</strong></td>
<td>FCC rules, Part 15, Subpart J, for Class A devices</td>
</tr>
</tbody>
</table>

### MECHANICAL

<table>
<thead>
<tr>
<th>Spec</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensions</strong></td>
<td>Please see dimensional drawings.</td>
</tr>
<tr>
<td><strong>Weight (Including 10:1 zoom lens)</strong></td>
<td>11 pounds, 2 ounces (115V model)</td>
</tr>
<tr>
<td><strong>Lens Mount</strong></td>
<td>“CS” or “C” mount</td>
</tr>
<tr>
<td><strong>Housing Mount</strong></td>
<td>1/4–20 threaded holes, allows enclosure to be rotationally oriented in 90° increments</td>
</tr>
<tr>
<td><strong>Purge/Relief Fitting</strong></td>
<td>Schrader purge fitting, 20 psi relief valve</td>
</tr>
</tbody>
</table>
The optional Programmable Source ID Generator is a built-in electronic circuit which allows written messages to be superimposed over images displayed on CCTV monitors. Using a computer and RS-422 serial communication, a user types messages that will then appear on the monitor. Text is made up of block letters 28 horizontal TV lines in height. The letters are white with a black outline for maximum legibility. There are two modes of operation, as follows:

1. ID Mode: Up to two lines of text (24 characters per line, including spaces) can be stored in non-volatile memory. Text can be placed at the top or bottom of the monitor screen, and can be updated from a computer or a dumb terminal, making this a real-time updatable programmable ID generator. Stored text, which typically provides information such as the location of individual cameras in multi-camera systems, will be continuously displayed until it is updated.

2. Menu Mode: In this mode, up to 12 lines of text can be entered into volatile memory without affecting data stored in the ID Mode. A computer is required to enter data in this mode.
### 8240 SERIES HIGH PERFORMANCE COLOR CCD CAMERAS

#### ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Power Options</th>
<th>Configuration</th>
<th>Module Options</th>
<th>Lens Options</th>
<th>Special Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 12V ac, 50/60 Hz</td>
<td>1 NTSC</td>
<td>000 None</td>
<td>0000 None</td>
<td>L Low Temperature Operation</td>
</tr>
<tr>
<td>4 24V ac, 50/60 Hz</td>
<td>(Note: Y-C, RGB and PAL configurations available as engineering revisions. Please consult factory.)</td>
<td>010 Fiber Optic Transmitter</td>
<td>Auto Iris, CS Mount EH04 3.7mm, f/1.6, 1/2&quot; EH06 6mm, f/1.4, 1/2&quot; EH13 12mm, f/1.4, 1/2&quot;</td>
<td>SS-425 Sunshield</td>
</tr>
<tr>
<td>5 115V ac, 50/60 Hz</td>
<td>052 Programmable Source ID Generator</td>
<td></td>
<td>Auto Iris, C Mount ES05 4.8mm, f/1.8, 2/3&quot; ES08 8mm, f/1.4, 2/3&quot; ES16 16mm, f/1.4, 2/3&quot; ES25 25mm, f/1.4, 1&quot;</td>
<td>For remote control and other accessories, please consult the factory.</td>
</tr>
<tr>
<td></td>
<td>053 Programmable Source ID Generator &amp; Fiber Optic Transmitter</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### NOTES ON STANDARD FEATURES

**Electronic Shutter/Integration:** Internal switches select shutter speeds or the number of integration fields, and enable or disable the external ON/OFF control of the internally-selected shutter or integration mode. These switches are set at the factory prior to sealing and pressurizing the environmental housing. The standard factory settings disable the external ON/OFF control and provide 1/60 second shutter speed. The switches can be set differently at the factory, or in the field by removing the camera from the housing.

**AGC Peak/Average** adjustment is made via an internal control, which is set at the factory prior to sealing and pressurizing the environmental enclosure. Customer may specify different setting upon ordering.

#### SPECIAL FEATURES

Cohu welcomes the opportunity to provide special features to better serve your particular requirement. Some examples of special features are:

- **Y-C (S-VHS) Output** for VCR compatibility
- **RGB and PAL formats**
- **Custom painting, silkscreen, and logo**
- **Special filters, lens supports, and mounting solutions**
- **Special adjustment of AGC peak/average control**
- **Customer-specified setting of Electronic Shutter or Integration mode switches**
Cohu's new 4980 Series High Performance Monochrome Remote-Head CCD Cameras are the perfect solution for video applications requiring high performance in a compact package. The lightweight mini-remote head is easily incorporated into microscopes, medical instruments, and machine vision systems, and is ideal for specialized security/surveillance applications.

Available in RS-170 and CCIR models, these high resolution cameras employ a half-inch format interline transfer imager with on-chip microlenses for unparalleled sensitivity and minimal blooming. For additional sensitivity in low-light conditions, they provide 26 dB AGC and variable field/frame integration capabilities.

For video applications prone to streaking problems, the sensor provides a 1000:1 overload capability, which allows transmission of clear video signals even when bright incidental light is present in the scene.

4980 Series cameras are backed by a full two-year warranty. They're rugged, yet lightweight and compact — ideal for easy system integration. For easy access to camera controls, they have a removable trim plate on the camera control unit.

This camera is available in color models. Please request literature on Cohu's 8280 Series. We welcome requests for special products and complete CCTV systems.

### FEATURES AND BENEFITS

- **Compact, Lightweight Mini-Remote Head** — only 1.125" diameter means maximum flexibility for end users or OEMs
- **Variable length cable** up to 100 feet between head and CCU
- **Camera Head Connector** for complete interchangeability better definition, error-free results
- **High Resolution** — for better definition, error-free results
- **On-Chip-Microlens Interline Transfer Imager** dramatically increases sensitivity and virtually eliminates streaking and blooming.
- **Eight-Speed Electronic Shutter** reduces blurred images of fast-moving objects.
- **Choice of Synchronization Options** — Asynchronous reset, genlock, H & V drive, line lock, or crystal
- **High Signal-to-Noise Ratio** for clear, noise-free video
- **Optional Electronic Iris** automatically controls exposure.
- **Asynchronous Reset** provides random vertical reset capability for production line applications.
- **Made in U.S.A.** — direct factory support
- **1000:1 Overload Capability** permits incidental light overloads up to ten times that of other CCD cameras.
- **No Lag or Image Retention** — provides fast, clean images
- **Zero Geometric Distortion** for consistent corner-to-corner linearity
- **26 dB AGC** for increased sensitivity at low light levels
- **Optional IR Filter**
- **Field or Frame Integration** — for added sensitivity in low-light-level imaging applications
- **Choice of RS-170 & CCIR Models**
- **Two-Year Warranty**
- **Special Configurations** for OEMs and end users

**APPLICATIONS**

- Image Processing
- Machine Vision
- Microscopy
- Endoscopy
- Process Control
- Quality Control
- Image Analysis
- Security/Surveillance

**NEW! HIGH PERFORMANCE REMOTE-HEAD MONOCHROME CCD CAMERA**

**4980 SERIES**

Cable Length to 100 Feet
On-Chip-Microlens Imager

The mini-remote head can be separated from the CCU by up to 100 feet of cable.
## Specifications

### Electrical

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Area</td>
<td>6.4 x 4.8 mm (corresponding to 1/3&quot; image tube)</td>
</tr>
<tr>
<td>Active Picture Elements</td>
<td></td>
</tr>
<tr>
<td>RS-170: 768H x 494V CCIR: 752H x 582V</td>
<td></td>
</tr>
<tr>
<td>Imager Type</td>
<td>Interline transfer CCD with on-chip microlenses</td>
</tr>
<tr>
<td>Cell Size</td>
<td>RS170: 8.4 x 9.8 microns</td>
</tr>
<tr>
<td></td>
<td>CCIR: 8.6 x 8.3 microns</td>
</tr>
<tr>
<td>Resolution</td>
<td>RS170: 580 horizontal TVL, 350 vertical TVL</td>
</tr>
<tr>
<td></td>
<td>CCIR: 560 horizontal TVL, 450 vertical TVL</td>
</tr>
<tr>
<td>Sensitivity (faceplate) @2850 K</td>
<td>0.016 lux at 30% video, AGC on</td>
</tr>
<tr>
<td></td>
<td>0.65 lux at full video, AGC off</td>
</tr>
<tr>
<td></td>
<td>0.02 lux at 80% video, AGC on</td>
</tr>
<tr>
<td></td>
<td>0.016 lux at 30% video, AGC on</td>
</tr>
<tr>
<td>Electronic Shutter</td>
<td>Eight steps from 1/50 or 1/60 to 1/10,000 second (1/50 or 1/60, 1/25, 1/50, 1/100, 1/200, 1/400, and 1/100,000 second)</td>
</tr>
<tr>
<td>Integration</td>
<td>Integration period controllable through external input pulse</td>
</tr>
<tr>
<td></td>
<td>Grab pulse output</td>
</tr>
<tr>
<td></td>
<td>Field (1/50 or 1/60 second) or Frame (1/50 or 1/60 second) integration selected by internal jumper</td>
</tr>
</tbody>
</table>

### Power Requirements

- 12V ac or dc (standard) 115V ac (optional on RS-170 models, includes wall transformer and connector) 230V ac (optional on CCIR models, includes wall transformer and connector)
- 4.2 watts dc power consumption
- LED Power Indicator, Green

### Video Output

- 1.0 V p-p @75 ohms, unbalanced
- AGC: 26 dB, variable gain
- Signal-to-Noise Ratio: 50 dB at gamma 1, gain 0 dB
- Auto Lens: Separate lens video signal tracks AGC peak/average adjustment to eliminate AGC/auto lens interaction
- Power: +15V, 35 mA maximum

### Synchronization

- Genlock, revert to variable phase line lock with zero crossing detector
- Genlock, revert to crystal
- Crystal Lock
- H & V Drive
- Asynchronous Reset
- Internal Clock Speeds
  - RS170: 28.6363 MHz
  - CCIR: 28.375 MHz

### Power Requirements

- AGC On/Off
- AGC peak/average
- Manual Gain
- Gamma
- Sharpness

### Options

- Genlock (revert to crystal CCIR)
- 0 Field Mode
- 1 IR Filter (Non-removable)
- 0 Frame Integration Mode
- 3 Electronic Iris
- * Electronic Iris option is designed for use with manual iris lenses only. With this option, the camera operates in the field integration mode. Use of the electronic iris defeats electronic shutter positions.

### Ordering Information

<table>
<thead>
<tr>
<th>498X</th>
<th>X</th>
<th>X</th>
<th>X</th>
<th>X</th>
<th>Cable</th>
<th>Lens</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
<td>Genlock (revert to crystal)</td>
<td>0</td>
<td>Field Mode</td>
<td>10 Feet</td>
<td>Manual Iris, C Mount</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Genlock (revert to line lock)</td>
<td>0</td>
<td>Frame Integration Mode</td>
<td>25 Feet</td>
<td>*AL04 4.5mm, 1/2.0, 2/3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Asynchronous Reset RS-170</td>
<td>0</td>
<td>Electronic Iris*</td>
<td>50 Feet</td>
<td>*AL08 8mm, 1/4, 2/3</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>Genlock (revert to crystal CCIR)</td>
<td>0</td>
<td></td>
<td>100 Feet</td>
<td>AL16 16mm, 1/4, 2/3</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>Genlock (revert to line lock CCIR)</td>
<td>0</td>
<td></td>
<td></td>
<td>AL25 25mm, 1/4, 1</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>Asynchronous reset (CCIR)</td>
<td>0</td>
<td></td>
<td></td>
<td>AL50 50mm, 1/4, 1</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>Line lock or variable phase adjustable</td>
<td>0</td>
<td></td>
<td></td>
<td>* Wide Angle</td>
</tr>
</tbody>
</table>

### Mechanical

- Dimensions (less lens/cable):
  - Camera Head: 1.125" dia. x 2.00" length (28.57 x 50.8 mm)
  - CCU: 4.7" x 5.0"(W) x 6.9"(D)
  - 432 x 127 x 175.3 mm
- Weight:
  - Camera Head: 4 ounces (113 grams)
  - CCU: 27.5 ounces (780 grams)
- Lens Mount:
  - Adjustable "C" mount
- CUC Controls:
  - Electronic Shutter
  - AGC peak/average
  - Manual Gain
  - Gamma
  - Sharpness
- CUC Connectors:
  - Video (BNC)
  - Power (2 circuit screw terminal)
  - Lens (3 pin Mini-DIN)
- External Sync (8 pin DIN)
  - Pin 1. Ext. Vertical Trigger In
  - Pin 2. Ext. Sinc/HORIZONTAL Trigger In
  - Pin 3. Grab Pulse Out (-)
  - Pin 4. Ground
  - Pin 5. Ground
  - Pin 6. Vertical Reset In
  - Pin 7. Grab Pulse Out (+)
  - Pin 8. Integrates input

### Environmental

- Ambient Temperature Limits
  - Operating: -20 to 60 °C (-4° to 140° F)
  - Storage: -30 to 70 °C (-22° to 157° F)
- Humidity
  - Up to 95% relative humidity
- Vibration
  - Sine vibration from 5 to 2,000 Hz, 5 g's peak, all 3-axis, 1/2 hr, peak per axis per MIL-E-5400T, para 3.2.24.5.1.2, fig. 2, curve Illa.
  - Random vibration from 10 to 2,000 Hz, 11 g's rms, all 3-axis, 1/2 hr, peak per axis, per MIL-E-5400T, para 3.2.24.5.1.2, category 6.
- Shock
  - Up to 15 g's in any axis under nonoperating conditions
Cohu's new 4990 Series High Performance Monochrome Remote-Head CCD Cameras are the perfect solution for video applications requiring high performance in a compact package. The lightweight remote head is easily incorporated into microscopes, medical instruments, and machine vision systems, and is ideal for specialized security/surveillance applications.

Available in RS-170 and CCIR models, these high resolution cameras employ a half-inch format HAD interline transfer imager with on-chip microlenses for unparalleled sensitivity and minimal blooming. For additional sensitivity in low-light conditions, they provide 26 dB AGC and variable field/frame integration capabilities.

For video applications prone to streaking problems, the sensor provides a 1000:1 overload capability, which allows transmission of clear video signals even when bright incidental light is present in the scene.

4990 Series cameras are backed by a full two-year warranty. They're rugged, yet lightweight and compact — ideal for easy system integration. For easy access to camera controls, they have a removable trim plate on the camera control unit.

Cohu has been a leading U.S. manufacturer of closed circuit video cameras and systems for over 40 years. We welcome requests for special products and complete CCTV systems.

**APPLICATIONS**

- Image Processing
- Machine Vision
- Microscopy
- Endoscopy
- Process Control
- Quality Control
- Image Analysis
- Security/Surveillance

**FEATURES AND BENEFITS**

- Compact, Lightweight Remote Head — maximum flexibility for end users or OEMs
- High Resolution — for better definition, error-free results
- On-Chip-Microlens Interline Transfer Imager dramatically increases sensitivity and virtually eliminates streaking and blooming.
- Eight-Speed Electronic Shutter reduces blurred images of fast-moving objects.
- High Sensitivity permits operation over a broad range of light levels.
- Choice of Synchronization Options for greater versatility
- High Signal-to-Noise Ratio for clear, noise-free video
- Asynchronous Reset provides random vertical reset capability for production line applications.
- Optional Electronic Iris automatically controls exposure
- Made in U.S.A. — direct factory support
- 1000:1 Overload Capability permits incidental light overloads up to ten times that of other CCD cameras.
- No Lag or Image Retention — provides fast, clean images
- Zero Geometric Distortion for consistent corner-to-corner linearity
- 26 dB AGC for increased sensitivity at low light levels
- Optional IR Filter
- Field or Frame Integration — for added sensitivity in low-light-level imaging applications
- State-of-the-Art Design and Construction for total, solid-state performance

Designed and Manufactured in U.S.A.
4990 SERIES HIGH PERFORMANCE REMOTE-HEAD CCD CAMERA

SPECIFICATIONS

**ELECTRICAL**

- **Image Area**: 6.4 x 4.8 mm (corresponding to 1/2" image tube)
- **Active Picture Elements**: RS-170: 768H x 494V  
  CCIR: 752H x 582V
- **Imager Type**: Had interline transfer CCD with on-chip microlenses
- **Cell Size**: RS170: 8.4 x 9.8 microns  
  CCIR: 8.6 x 8.3 microns
- **Resolution**: RS170: 580 horizontal TVL, 350 vertical TVL  
  CCIR: 560 horizontal TVL, 450 vertical TVL
- **Sensitivity (faceplate) @2850 K**: 0.05 lux at 80% video, AGC on  
  0.65 lux at full video, AGC off
- **Video Output**: 1.0 V p-p @75 ohms, unbalanced
- **AGC**: 20 dB, variable gain
- **Signal-to-Noise Ratio**: ≥56 dB at gamma 1, gain 0 dB  
  ≥38 dB at gamma 1, AGC On
- **Auto Lens**: Separate lens video signal tracks AGC  
  peak/average adjustment to eliminate AGC/auto lens interaction  
  Power: +15V, 35 mA maximum
- **Gamma**: Variable 0.45 to 1.0
- **Synchronization**: Genlock, revert to variable phase line lock with zero crossing detector  
  Genlock, revert to crystal  
  Crystal Lock  
  H & V Drive  
  Asynchronous Reset  
  Internal Clock Speeds  
  RS170: 28.6363 MHz  
  CCIR: 28.375 MHz
- **Power Requirements**: 12V ac or dc (standard)  
  115V ac (optional on RS-170 models, includes wall transformer and connector)  
  230V ac (optional on CCIR models, includes wall transformer and connector)  
  4.2 watts dc power consumption

**MECHANICAL**

- **Dimensions (less lens)**: Camera Head: 1.50" dia. x 2.00" length (38.1 x 50.8 mm)  
  CCU: 1.7"(H) x 5.0"(W) x 6.9"(D) (43.2 x 127 x 175.3 mm)
- **Weight**: Camera Head (less lens and cable): 4 ounces (113 grams)  
  15' Remote Cable: 17 ounces (483 grams)  
  CCU: 27.5 ounces (780 grams)
- **Lens Mount**: Adjustable “C” mount
- **CCU Controls**: Electronic Shutter  
  AGC peak/average  
  AGC On/Off  
  Manual Gain  
  Gamma  
  Sharpness
- **Connectors**: Video (BNC)  
  Lens (3 pin Mini-DIN)  
  External Sync (8 pin DIN)  
  Pin 1: External Vertical Trigger In  
  Pin 2: External Sync/Horizontal Trigger In  
  Pin 3: Grab Pulse Out ( )  
  Pin 4: Ground  
  Pin 5: Ground  
  Pin 6: Vertical Reset In  
  Pin 7: Grab Pulse Out (+)  
  Pin 8: Integrate Input
- **Camera Head (15 pin “D” subminiature)**

**ORDERING INFORMATION**

- **Power Options**: 12V ac or dc  
  230V ac, 50 Hz, with ac wall adapter (CCIR models)
- **Sync Options**:  
  Genlock* (revert to crystal)  
  Genlock* (revert to phase adjustable line lock)
- **Optical Filters**: None (Standard TV Rate)  
  Fade Integration Mode  
  Electronic Iris*  
  Adjustable “C” mount  
  Manual Iris, C Mount  
  *Wide Angle
- **Lens Filters**: Sharpness
- **Format**: RS-170 (EIA)  
  CCIR
- **Lens Options**:  
  Manual Iris, C Mount  
  *Wide Angle

**ENVIRONMENTAL**

- **Ambient Temperature Limits**: Operating: -20 to 60°C  
  (-4° to 140°F)  
  Storage: -30 to 70°C  
  (-22° to 157°F)
- **Humidity**: Up to 95% relative humidity
- **Vibration**: Sine vibration from 5 to 2.000 Hz,  
  5 g’s peak, all 3-axes, 1/2 hr. per axis per MIL-E-5404T, para 3.2.24.5.1.2. fig. 2, curve Ila.  
  Random vibration from 10 to 2.000 Hz,  
  11 g’s rms, all 3-axes, 1/2 hr. per axis, per MIL-E-5404T, para 3.2.24.5.1.2. category 6.
- **Shock**: Up to 15 g’s in any axis under nonoperating conditions

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COHU, Inc./Electronics Division

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Cohu's Monochrome Remote-Head Frame-Transfer CCD Cameras offer all the outstanding performance characteristics of Cohu's 4800 and 4700 Series standard monochrome frame-transfer cameras, with the added benefits of a two-piece configuration, electronic shutter, and enhanced signal-to-noise characteristics. The lightweight remote camera head is ideally suited for mounting on microscopes, robots, and other equipment with size and weight limitations.

Both the 6400 Series RS-170 and the 6700 Series CCIR cameras provide high resolution and high sensitivity. The blemish-free CCD sensor provides pixel-to-pixel contrast variation of less than 5%, with zero geometric distortion and no lag or image retention.

Connected to the camera control unit by an integral 15-foot cable, the remote camera head weighs only 113 grams, and measures only 38mm in diameter and 51mm in length.

As with all Cohu CCD cameras, the 6400 and 6700 Series cameras are designed and manufactured in U.S.A., and are backed by a full two-year warranty.

**APPLICATIONS**
- Microscopy
- Machine Vision
- Medical Imaging
- Process Control
- Quality Control
- Image Analysis
- Security/Surveillance

**FEATURES AND BENEFITS**
- **Compact, Lightweight Remote Head** — maximum flexibility for end users or OEMs
- **High Resolution** — for better definition, error-free results
- **Two-Speed Electronic Shutter** reduces blurred images of fast-moving objects.
- **High Sensitivity** permits operation over a broad range of light levels.
- **Genlock, H & V Drive, Pixel Clock Outputs** for machine vision interface
- **High Signal-to-Noise Ratio** for better dynamic range.
- **Auto Black** for contrast enhancement.
- **100% Blemish-Free Frame-Transfer Image Sensor** — no dead pixels.
- **Made in U.S.A.** — direct factory support
- **No Lag or Image Retention** — provides fast, clean images
- **Zero Geometric Distortion** for consistent corner-to-corner linearity
- **Selectable AGC Ranges** for better control under varying light conditions
- **Optional IR Filter**
- **State-of-the-Art Design and Construction** for high performance, reliability and long life
- **Choice of RS-170 & CCIR Models**
- **Two-Year Warranty**
- **15" Remote Cable** facilitates system design and installation.
- **Special Configurations** for OEMs and end users

Cohu, Inc./Electronics Division

Designed and Manufactured in U.S.A.
### ELECTRICAL

<table>
<thead>
<tr>
<th>Specification</th>
<th>RS-170</th>
<th>CCIR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Imager Type</strong></td>
<td>Single CCD using frame-transfer method</td>
<td></td>
</tr>
<tr>
<td><strong>Image Area</strong></td>
<td>6.4 x 4.8 mm (corresponding to 1/2” image tube)</td>
<td>9.2(H) x 16.8(V) microns</td>
</tr>
</tbody>
</table>
| **Active Picture Elements**   | RS-170: 755 H x 242 V  
CCIR: 699 H x 288 V |                            |
| **Cell Size**                 | RS-170: 8.5(H) x 19.5 (V) microns | CCIR: 9.2(H) x 16.8(V) microns |
| **Resolution**                | RS-170: 550 horizontal TV lines, 350 vertical TV lines  
CCIR: 525 horizontal TV lines, 415 vertical TV lines |                            |
| **Sensitivity (faceplate)**   | 0.25 lux at full video, AGC off  
0.009 lux at 80% video, AGC on |                            |
| **Contrast Variation**        | < 5% overall at gamma 1, gain 0 dB |                            |
| **Electronic Shutter**        | Switch selectable, 1/1,000 second, 1/2,000 second, and Off |                            |
| **Video Output**              | 1.0 V p-p @75 ohms, unbalanced |                            |
| **AGC**                       | Switch selectable, Off/Low Gain/High Gain  
Peak-average adjustable  
Low Gain: 0 - 6 dB  
High Gain: 0 - 20 dB |                            |
| **Auto Black**                | Maintain set-up level at 7.5 ±5 IRE units if picture contains at least 10% black |                            |
| **Signal-to-Noise Ratio**     | ≥ 56 dB at gamma 1, gain 0 dB  
38 dB at gamma 1, AGC On |                            |
| **Auto Lens**                 | Separate lens video signal tracks  
AGC peak/average adjustment to eliminate AGC/auto lens interaction  
Power: +9V, 100 mA maximum |                            |
| **Gamma**                     | 0.5 or 1.0 jumper selectable |                            |
| **Synchronization**           | Genlock, revert to crystal  
Genlock, revert to phase adjustable line lock  
External H & V Drive  
Internal Clock Speeds  
RS-170: 14.31818 MHz  
CCIR: 14.375 MHz |                            |
| **Power Requirements**        | 4.5 watts dc (without lens) |                            |

### MECHANICAL

<table>
<thead>
<tr>
<th>Specification</th>
<th>RS-170</th>
<th>CCIR</th>
</tr>
</thead>
</table>
| **Dimensions (less lens)**    | Camera Head: 1.50” dia. x 2.00” length (38.1 x 50.8 mm)  
Cable: 15 feet (4.57 meters)  
CCU: 1.7”(H) x 5.0”(W) x 7.3”(D) (43.7 x 127 x 189 mm) |                            |
| **Weight**                    | Camera Head (less lens and cable): 4 ounces (113 grams)  
Remote Cable: 17 ounces (483 grams)  
CCU: 29 ounces (822 grams) |                            |
| **Lens Mount**                | Adjustable "C" mount, 16mm format |                            |
| **Connectors**                | BNC connector — Video Out  
Switchcraft TB4M — Lens Drive  
Switchcraft TB3M — Power In  
Hirose SR30-10R-7S — Auxiliary |                            |

### ENVIRONMENTAL

<table>
<thead>
<tr>
<th>Specification</th>
<th>RS-170</th>
<th>CCIR</th>
</tr>
</thead>
</table>
| **Ambient Temperature Limits**| Operating: -10 to 50°C (14 to 122°F)  
Storage: -30 to 70 °C (-22 to 157°F) |                            |
| **Humidity**                  | Up to 95% relative humidity |                            |
| **Vibration**                 | 5 to 60 Hz with 0.082 inch total excursion (15 g’s @ 60 Hz). From 60 to 1,000 Hz, 5 g’s rms random vibration without damage. |                            |
| **Shock (less lens)**         | Remote head: Up to 30 g’s.  
CCU: Up to 15 g’s in any axis under nonoperating conditions, MIL-E-5400T, paragraph 3.2.24.6 |                            |
| **Altitude**                  | Sea level to the equivalent of 3,000 meters or 10,000 feet (508mm/20 inches of mercury) |                            |

### ORDERING INFORMATION

<table>
<thead>
<tr>
<th>6X Video Format</th>
<th>1X Power Options</th>
<th>X Sync Options</th>
<th>XXX Optical Filters</th>
<th>XXX / XXXX Lens Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 RS-170 (EIA)</td>
<td>2 12 V ac or dc</td>
<td>2 Genlock (revert to crystal)</td>
<td>000 None</td>
<td>Manual Iris, C Mount</td>
</tr>
<tr>
<td>7 CCIR</td>
<td>3 230V ac, 50 Hz, with ac wall adapter (CCIR models)</td>
<td>3 Genlock (revert to phase adjustable line lock)</td>
<td>100 IR Filter (non-removable)</td>
<td></td>
</tr>
</tbody>
</table>
| 5 115V ac, 60 Hz, with ac wall adapter (RS-170 models) | 7 External H & V Drive (revert to crystal) | | | *AL04 4.5 mm, f/2, 0, 2/3"
*AL08 8 mm, f/1.4, 2/3"
AL09 9 mm, f/1.4, 2/3"
AL16 16 mm, f/1.4, 2/3"
AL26 25 mm, f/1.6, 2/3"
AL51 50 mm, f/1.8, 2/3"
* Wide Angle |

Auto Iris, C Mount
ES04 4.2 mm, f/1.6, 1/2"
ES06 6 mm, f/1.2, 1/2"
ES08 8 mm, f/1.4, 2/3"
ES13 12 mm, f/1.2, 1/2"
ES16 16 mm, f/1.4, 2/3"
ES25 25 mm, f/1.4, 1"
EH35 35 mm, f/1.4, 2/3"

NOTE: Auto iris lenses require auto iris cable assembly 8352-1, to be ordered separately.

COHU RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.
Cohu's new 8280 and 8380 Series High Performance Color Mini-Remote-Head CCD Cameras are the perfect solution for remote-head camera applications requiring extended cable lengths and reduced head size. The mini-remote camera head connects to the camera control unit with a fully detachable cable, which can be ordered in lengths of 10, 25, 50, or 100 feet. The lightweight remote head is easily incorporated into microscopes, medical imaging systems, and machine vision systems.

Available in NTSC/Y-C, PAL/Y-C, and RGB models, these high resolution cameras use on-chip microlens technology, which dramatically increases sensitivity by placing an individual lens on each pixel of the sensor.

Designed and manufactured in the U.S.A., 8280 and 8380 Series High Performance Color Mini-Remote-Head CCD Cameras are backed by a two-year warranty.

FEATURES AND BENEFITS

- **Compact, Lightweight Mini-Remote Head** — 1.125" diameter facilitates camera operation and integration
- **Selective Cable Lengths** — up to 100 feet
- **On-Chip Microlens Sensor** enhances sensitivity and dynamic range, reduces vertical smear
- **High Resolution** — 460 horizontal TV lines for sharper images
- **High Sensitivity** — permits operation over a wide range of light levels
- **Convenient External Adjustments** for shutter speed, integration period, AGC, white balance controls
- **Two Year Warranty**
- **Eight-Speed Electronic Shutter** reduces blurring of fast-moving objects or provides electronic iris capability
- **Selecteable Integration Periods with Grab Pulse** — for low light level microscopy applications,
- **1000:1 Overload Capability** permits incidental light overloads up to ten times that of other CCD cameras
- **AGC with Peak-Average Adjustment** for clear images in varying light level applications
- **Made in U.S.A.** — direct factory support, quality design and construction

APPLICATIONS

- **Microscopy**
- **Image Processing** Medical and Industrial
- **Machine Vision** Pattern Recognition Non-Contact Measurement 3-D Imaging Inspection
- **Robotics**
- **Computer Graphics**
- **Remote Sensing**
- **Mapping**
- **Teleradiology**
- **Quality Control**
- **Teleconferencing**
- **Security/Surveillance**

Designed and manufactured in U.S.A.
### Specifications

#### Electrical — NTSC and PAL Models

- **Imager**
  - Single interline transfer CCD with matrix filter (cyan, yellow, magenta, green)

- **Image Area**
  - 6.4 x 4.8 mm (1/2" format)

- **Active Picture Elements**
  - NTSC/Y-C: 768(H) x 493(V)
  - PAL/Y-C: 752(H) x 582(V)

- **Resolution**
  - NTSC/Y-C: Horizontal 460 TV lines
  - Vertical 350 TV lines
  - PAL/Y-C: Horizontal 450 TV lines
  - Vertical 415 TV lines

- **Sensitivity**
  - 3200 K faceplate illumination.
  - 6.5 lux at full video, AGC Off.
  - 0.5 lux at 80% video, AGC On.

- **Electronic Shutter**
  - Switch selectable, 1/60 second (off) to 1/10,000 second (8 steps)

- **Integration**
  - Switch selectable, 2 to 16 fields (8 steps). Grab pulse available

- **Gamma**
  - 0.6

- **AGC**
  - 0-20 dB
  - Peak-average adjustable

- **Signal-to-Noise Ratio (AGC Off)**
  - 48 dB (NTSC with 4.5 MHz filter)
  - 45 dB (PAL with 5 MHz filter)

- **Video Outputs**
  - NTSC and PAL
  - 1 V p-p @75 ohms, unbalanced, composite

- **S Video**
  - Y: 1 V p-p @75 ohms, unbalanced, composite
  - C: 0.285 V p-p

- **Auto Lens Output**
  - Peak-average characteristic tracks AGC adjustment to eliminate AGC/auto lens interaction

- **Color Lock**
  - Burst phase adjustment
  - Horizontal phase adjustment

- **Color Balance**
  - Through-the-lens type
  - Less than 10 IRE units unbalance from 2850 to >5800 K

- **Synchronization**
  - NTSC or PAL crystal, color lock standard

- **Power Requirements**
  - 12V ac or dc (standard)
  - 115V ac, 60 Hz for NTSC models
  - 230V ac, 50 Hz for PAL models
  - (optional, with wall transformer)

- **Power Consumption**
  - 4.5W

#### Environmental

- **Ambient Temperature Limits**
  - Operating: -20 to 50 °C
  - Storage: -30 to 70 °C

- **Humidity**
  - Up to 95% relative humidity, non-condensing

- **Vibration (less lens)**
  - 5 to 60 Hz with 0.082 inch total excursion (15 g's @ 60 Hz). From 60 to 1000 Hz, 5 g's rms random vibration without damage

- **Shock (less lens)**
  - Up to 15 g's in any axis under nonoperating conditions, MIL-E-5400T, paragraph 3.2.24.6

- **Altitude**
  - Sea level to equivalent of 3,000m/10,000 feet (508mm/20 inches of mercury)

#### Mechanical

- **Dimensions (less lens/cable)**
  - Camera Head: 1.125" dia. x 2.41" length (38.1 x 60 mm)
  - CCU: 2.63" (H) x 5.75" (W) x 7.75"(D) (65 mm x 148 mm x 200mm)

- **Weight**
  - Camera Control Unit (12 V model): 36 ounces (1000 grams)
  - Camera Head (less lens and cable): 1.75 ounces (49 grams)
  - 10' Remote Cable: 7.5 ounces (205 grams)

- **Lens Mount**
  - "CS" mount standard, "C" mount adapter furnished

- **Connectors (NTSC and PAL Models)**
  - BNC connector — Video Out
  - 4 Circuit MINI-DIN — Y-C
  - 3 Circuit MINI-DIN — Lens Drive
  - 2 Circuit Terminal Strip — Power In
  - 15 Circuit "D" — Camera Head
  - 8 Circuit MINI-DIN — Remote

- **Power Options**
  - "Auto/Man White Balance
  - White Balance
  - Sync/Video In
  - Shutter On/Off
  - Grab Pulse

#### Ordering Information

<table>
<thead>
<tr>
<th>8X8</th>
<th>Video Format</th>
<th>Power Options</th>
<th>Configuration Options</th>
<th>Board Options</th>
<th>Cable Options</th>
<th>Lens Options</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>NTSC/C</td>
<td>12V ac, 60 Hz</td>
<td>1 NTSC or PAL</td>
<td>00 None</td>
<td>10 feet</td>
<td>Manual Iris, CS Mount</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>PALY-C</td>
<td>230V ac</td>
<td>2 RGB*</td>
<td>30 Electronic Iris**</td>
<td>25 feet</td>
<td>Manual Iris, C Mount</td>
<td>A003 3.7m, 11.6, 1/2</td>
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<tr>
<td></td>
<td></td>
<td>24V dc</td>
<td></td>
<td>40 50 feet</td>
<td>50 feet</td>
<td>AL04 4.5mm, 1/2, 2/3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>115V ac, 60 Hz</td>
<td>(3380 Series only)</td>
<td>100 feet</td>
<td>100 feet</td>
<td>AL06 6.5mm, 1/8, 2/3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>with wall</td>
<td></td>
<td></td>
<td></td>
<td>AL08 9mm, 1/4, 2/3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>transformer</td>
<td></td>
<td></td>
<td></td>
<td>AL12 12.5mm, 1/4, 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(8280 Series only)</td>
<td></td>
<td></td>
<td></td>
<td>AL16 16mm, 1/4, 2/3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>AL26 25mm, 1/6, 2/3</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>AL51 50mm, 1/6, 2/3</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>AL75 75mm, 1/3, 1</td>
<td></td>
</tr>
</tbody>
</table>

*Contact factory prior to placing order.

---

**Contact Cohu, Inc. Electronics Division P.O. Box 85623 San Diego, CA 92186-5623 Phone: 619/277-6700 FAX: 619/277-0221**

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`COHU
Cohu, Inc.Electronics Division

ADVANCED
TECHNOLOGY
Made in the U.S.A.`
**NEW! On-Chip Microlens Sensor**

**HIGH PERFORMANCE COLOR REMOTE-HEAD CCD CAMERAS**

8290 & 8390 SERIES

Cohu’s new 8290 and 8390 Series High Performance Color Remote-Head CCD Cameras are the perfect solution for applications requiring high performance in a compact package. The lightweight remote head is easily incorporated into microscopes and machine vision systems, and is ideal for specialized security/surveillance applications.

Available in NTSC/Y-C, PAL/Y-C, and RGB models, these high resolution cameras use on-chip microlens HAD sensor technology, which enhances dynamic range and sensitivity while reducing vertical smear.

An easily removable trim plate on the camera control unit provides convenient access to electronic shutter timing, integration, AGC, and white balance controls.

Designed and manufactured in the U.S.A., 8290 and 8390 Series High Performance Color Remote-Head CCD Cameras are backed by a two-year warranty. OEM engineering requests are welcomed.

**FEATURES AND BENEFITS**

- Compact, Lightweight Remote Head — for easy installation and operation
- On-Chip Microlens Sensor enhances sensitivity and dynamic range, reduces vertical smear
- High Resolution — 460 horizontal TV lines for sharper images
- High Sensitivity — permits operation over a wide range of light levels
- Convenient External Adjustments for control of shutter speed, integration period, AGC, and other critical parameters
- Zero Geometric Distortion ensures precision measurement.
- Two Year Warranty
- Choice of Video Formats — including Y-C and RGB outputs for specialized applications
- Eight-Speed Electronic Shutter reduces blurring of fast-moving objects
- Selectable Integration Periods with Grab Pulse — for low light level microscopy applications.
- 1000:1 Overload Capability permits incidental light overloads up to ten times that of other CCD cameras
- AGC with Peak-Average Adjustment for clear images in varying light level applications
- Made in U.S.A. — direct factory support, quality design and construction.

**APPLICATIONS**

- Microscopy
- Image Processing
- Medical and Industrial
- Machine Vision
- Pattern Recognition
- Non-Contact Measurement
- 3-D Imaging
- Inspection
- Robotics
- Computer Graphics
- Remote Sensing
- Mapping
- Teleradiology
- Quality Control
- Teleconferencing
- Security/Surveillance

Designed and manufactured in U.S.A.
### Electrical — NTSC and PAL Models

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Imager</strong></td>
<td>Single interline transfer CCD with matrix filter (cyan, yellow, magenta, green)</td>
</tr>
<tr>
<td><strong>Image Area</strong></td>
<td>6.4 x 4.8 mm (1/2&quot; format)</td>
</tr>
</tbody>
</table>
| **Active Picture Elements** | NTSC/Y-C: 768(H) x 493(V)  
PAL/Y-C: 752(H) x 582(V) |
| **Resolution**| NTSC/Y-C: Horizontal 460 TV lines  
Vertical 350 TV lines  
PAL/Y-C: Horizontal 460 TV lines  
Vertical 415 TV lines |
| **Sensitivity**| 3200 K faceplate illumination.  
6.5 lux at full video, AGC Off.  
0.55 lux at 80% video, AGC On. |
| **Electronic Shutter** | Switch selectable, 1/60 second (off) to 1/10,000 second (8 steps) |
| **Integration** | Switch selectable, 2 to 16 fields (8 steps). Grab pulse available |
| **Gamma** | 0.5 |
| **AGC** | 0-20 dB  
Peak-average adjustable |
| **Signal-to-Noise Ratio (AGC Off)** | 48 dB (NTSC with 4.5 MHz filter)  
45 dB (PAL with 5 MHz filter) |
| **Video Outputs** | Encoded: NTSC and PAL  
1 V p-p @75 ohms, unbalanced, composite |
| **S Video:** | Y: 1 V p-p @75 ohms, unbalanced, composite  
C: 0.286 V p-p |
| **Auto Lens Output** | Peak-average characteristic tracks  
AGC adjustment to eliminate  
AGC/auto lens interaction |
| **Color Lock** | Burst phase adjustment  
Horizontal phase adjustment |
| **Color Balance** | Through-the-lens type  
Less than 10 IRE units unbalance from 2850 to >5800 K |
| **Synchronization** | NTSC or PAL crystal, color lock standard |
| **Power Requirements** | 12V ac or dc (standard)  
115V ac, 60 Hz for NTSC models (optional, with wall transformer)  
230V ac, 50 Hz for PAL models (optional, with wall transformer) |
| **Power Consumption** | 4.5W |

### Electrical — RGB Models

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Imager</strong></td>
<td>Single interline transfer CCD with matrix filter (cyan, yellow, magenta, green)</td>
</tr>
<tr>
<td><strong>Image Area</strong></td>
<td>6.4 x 4.8 mm (1/2-inch format)</td>
</tr>
</tbody>
</table>
| **Active Picture Elements** | RGB/60: 768(H) x 493(V)  
RGB/50: 752(H) x 582(V) |
| **Resolution**| RGB/60: Horizontal 460 TV lines  
Vertical 350 TV lines  
RGB/50: Horizontal 460 TV lines  
Vertical 415 TV lines |
| **Sensitivity**| 3200 K faceplate illumination.  
6.5 lux at full video, AGC Off.  
0.55 lux at 80% video, AGC On. |
| **AGC** | 0-20 dB  
Peak-average adjustable |
| **Gamma** | 0.5 or 1.0 |
| **Electronic Shutter** | Switch selectable, 1/60 second (off) to 1/10,000 second (8 steps) |
| **Integration** | Switch selectable, 2 to 16 fields (8 steps). Grab pulse available |
| **Power Requirements** | 12V ac or dc (standard)  
115V ac, 60 Hz (optional, with wall transformer)  
230V ac, 50 Hz (optional, with wall transformer) |
| **Power Consumption** | 4.5W |

### Environmental

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
</table>
| **Ambient Temperature Limits** | Operating: -20 to 50 °C  
(-4° to 122° F)  
Storage: -30 to 70 °C  
(-22° to 157° F) |
| **Humidity** | Up to 95% relative humidity, non-condensing |
| **Vibration (less lens)** | 5 to 60 Hz with 0.082 inch total excursion (15 g's @ 60 Hz). From 60 to 1000 Hz, 5 g's rms random vibration without damage |
| **Shock (less lens)** | Up to 15 g's in any axis under nonoperating conditions, MIL-E-5400T, paragraph 3.2.24.6 |
| **Altitude** | Sea level to equivalent of 3,000m/10,000 feet (508mm/20 inches of mercury) |

### Mechanical

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dimensions</strong></td>
<td>Please see dimensional drawings</td>
</tr>
</tbody>
</table>
| **Weight** | Camera Control Unit (12 V model): 36 ounces (1000 grams)  
Camera Head (less lens and cable): 4 ounces (113 grams)  
15' Remote Cable: 17 ounces (483 grams) |
| **Lens Mount** | Adjustable "C" mount |
| **Connectors** | Please see dimensional drawings |
| **Top Panel Adjustments** | Shutter/Off/Integrate  
8-Position Shutter/Integrate Switch  
AGC On/Off  
AGC Peak/Average Adjustment  
Auto/Manual/Remote White Balance Switch  
White Balance Adjustment  
Horizontal Phase/Color Lock  
SC Phase Switch  
SC Phase Adjustment  
AGC/Manual/Remote Gain  
Vertical Phase Adjustment  
Horizontal Phase Adjustment |
| **Gain** |  * NTSC/Y-C and PAL/Y-C Models Only  
** RGB Models Only |
8290 AND 8390 SERIES REMOTE-HEAD COLOR CCD CAMERAS

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Format Options</th>
<th>Power Options</th>
<th>Configuration Options</th>
<th>Lens Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 NTSC Format (50 Hz)</td>
<td>12V ac/dc</td>
<td>1000 NTSC/Y-C or PAL/Y-C</td>
<td>0000 None</td>
</tr>
<tr>
<td>3 PAL Format (50 Hz)</td>
<td>230V ac, 50/60 Hz, with wall transformer (8390 Series only)</td>
<td>2000 RGB/60 or RGB/50</td>
<td></td>
</tr>
<tr>
<td>4 24V ac/dc, 50/60 Hz</td>
<td>5 115V ac, 50/60 Hz, with wall transformer (8290 Series only)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PLEASE NOTE: Cohu welcomes the opportunity to provide special features to better serve your particular requirement. For example, custom painting, silkscreen and logo for OEM customers and special connector pin configurations can be ordered. Please contact Cohu for details.

**NTSC & PAL CONNECTOR CONFIGURATIONS**

**LENS**
1. Power
2. Lens Video
3. Ground

**Y-C**
1. Y—Ground
2. C—Ground
3. Y
4. C

**REMOTE**
1. Auto/Man
2. White Balance
3. Sync/Video In
4. Shutter On/Off
5. +5
6. Ground
7. Ground
8. Grab Pulse

**RGB CONNECTOR CONFIGURATIONS**

**REMOTE 1**
1. Blue Level
2. Red Level
3. Sync/Horizontal In
4. Shutter On/Off
5. +5
6. Vertical In
7. Ground
8. External Gain
9. NC

**SYNC**
1. Grab Pulse
2. V Drive Out
3. H Drive Out
4. Clock Out
5. Ground
6. NC
7. Sync
8. NC
9. NC

NOTE: The RGB connector layout is directly compatible with Targa Vista* and other image capture boards.

COHU RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.
Cohu’s new 6800 Series Remote-Head Monochrome CCD Camera offers excellent performance characteristics in a compact, two-piece configuration. The small, lightweight remote imager and choice of RGB, Y-C, or NTSC outputs offer optimum capability to both OEM design engineers and end users across a broad range of scientific and industrial applications.

The 6800 Series Remote-Head CCD Camera features state-of-the-art frame transfer technology with an RGB stripe filter for reliable, high-sensitivity true color video. Cohu’s unique, 1/2-inch format blemish-free image sensor provides over 357,000 picture elements for greater resolution. The high signal-to-noise ratio ensures excellent dynamic range, while the two-speed electronic shutter greatly reduces problems associated with blurred images of fast-moving objects.

The compact, rugged 6800 Series consists of the remote camera head with integral 15-foot control cable, and the camera control unit. The remote head weighs a mere 4 ounces, and measures only 1.5 inches in diameter and two inches in length with standard C-mount adapter.

As with all Cohu CCD cameras, the new 6800 Series is designed and manufactured in the U.S.A., and comes with a two-year warranty.

**FEATURES AND BENEFITS**

- **Small, Lightweight Remote Imager** ensures maximum flexibility in system design and installation.
- **Electronic Shutter** reduces blurring of fast-moving objects.
- **Separate RGB, NTSC, and Y-C outputs** to support a wide range of applications. For S-VHS recording applications, Y-C outputs permit a minimum of 300 TV lines horizontal resolution.
- **Horizontal and Vertical Aperture Correction** for sharper pictures.
- **100% Blemish-Free Sensor** - no dead pixels.
- **High Resolution with 1/2-inch format sensor**
- **High, 50 dB Signal-to-Noise Ratio** provides better dynamic range.
- **Color Lock** provides consistent color rendition in multi-camera applications.
- **15’ Remote Cable** facilitates system design and installation.
- **Auto/Manual White Balance** enhances color control.
- **Selectable AGC Ranges** for better control under varying light conditions.

**APPLICATIONS**

- Image Processing
- Microscopy
- Borescopes
- Machine Vision
- Pattern Recognition
- Non-contact measurement
- Inspection
- Medical Imaging
- Robotics
- Security/Surveillance
**SPECIFICATIONS**

### ELECTRICAL

<table>
<thead>
<tr>
<th>Imager</th>
<th>Single CCD using frame transfer method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Area</td>
<td>6.4 x 4.8 mm (1/2-inch format)</td>
</tr>
<tr>
<td>Active Picture Elements</td>
<td>739 x 484 (frame transfer)</td>
</tr>
<tr>
<td>Cell Size</td>
<td>8.5μm(H) x 19.75μm(V)</td>
</tr>
<tr>
<td>Resolution</td>
<td>(RGB or NTSC)</td>
</tr>
<tr>
<td></td>
<td>Horizontal &gt;300 TV lines</td>
</tr>
<tr>
<td></td>
<td>Vertical &gt;350 TV lines</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>Please see Table 1, below.</td>
</tr>
<tr>
<td>Contrast Variation</td>
<td>&lt;5% overall at gamma 1, gain 0 dB</td>
</tr>
<tr>
<td>Video Output Levels</td>
<td>(Note 1)</td>
</tr>
<tr>
<td>NTSC:</td>
<td>1.0 V p-p @75 ohms, unbalanced, composite</td>
</tr>
<tr>
<td>Y-C:</td>
<td>1.0V p-p @75 ohms, unbalanced, composite</td>
</tr>
<tr>
<td>C: .258 V p-p @ 75 ohms</td>
<td></td>
</tr>
<tr>
<td>Component (RGB):</td>
<td></td>
</tr>
<tr>
<td>R: 0.714 V p-p @75 ohms, unbalanced</td>
<td></td>
</tr>
<tr>
<td>G: 0.714 V p-p @75 ohms, unbalanced</td>
<td></td>
</tr>
<tr>
<td>B: 0.714 V p-p @75 ohms, unbalanced</td>
<td></td>
</tr>
<tr>
<td>Sync: 4V p-p @75 ohms, unbalanced</td>
<td></td>
</tr>
<tr>
<td>Gamma</td>
<td>0.5 or 1.0 jumper selectable</td>
</tr>
<tr>
<td>Aperture Correction</td>
<td>Jumper selectable in or out</td>
</tr>
</tbody>
</table>

**Signal to Noise Ratio**
50 dB at gamma 1, AGC Off, encoded output

**Color Lock**
Burst phase adjustment
Horizontal phase adjustment

**Color Balance**
Through-the-lens type.
Less than 10 IRE units unbalance from 2850 to 6400 K

**Electronic Shutter**
Switch selectable, 1/1000 second, 1/2000 second, or Off

**AGC**
Switch selectable.
Off/Low Gain, High Gain
Low Gain: 0 - 12 dB
High Gain: 8 - 20 dB

**Auto Lens Output**
Peak/Average ratio tracks AGC adjustment

**Synchronization**
RS-170 crystal, 14.31818 MHz clock output, with color lock standard

**Remote**
White Balance
Auto/Manual White Balance
Shutter On/Off
Sync/Horizontal Trigger In
Vertical Trigger In
Master Clock Output 14.31818 MHz

**Power Requirements**
AGC 115V ±10%, 60 Hz
Fuse protected
12V ac/dc, 60 Hz

**Power Consumption**
4.2W

NOTE: 1. Simultaneous output of all video signals is provided. Up to four outputs may be terminated at one time.

### ENVIRONMENTAL

<table>
<thead>
<tr>
<th>Ambient Temperature Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating: -10 to 50 °C</td>
</tr>
<tr>
<td>(14° to 122° F)</td>
</tr>
<tr>
<td>Storage: -30 to 70 °C</td>
</tr>
<tr>
<td>(-22° to 157° F)</td>
</tr>
</tbody>
</table>

**Humidity**
Up to 95% relative humidity

**Vibration**
5 to 60 Hz with 0.082 inch total excursion (15 g’s @ 60 Hz). From 60 to 1000 Hz, 5 g’s rms random vibration without damage

**Shock (less lens)**
Up to 15 g’s in any axis under nonoperating conditions.

**Altitude**
Sea level to equivalent of 3,048m/10,000 feet (508mm/20 inches of mercury)

### MECHANICAL

**Camera Control Unit**
Dimensions: See Figure 1.
Weight: 29 ounces

**Camera Head**
Dimensions: See Figure 1.
Weight: 4 ounces
Cable Length: 15 feet

**Lens Mount**
"C" mount, 16mm format

**Connectors**
BNC Connector - Video Out
Switchcraft TB3M - Power In
3 Pin Mini-Din - Lens Drive
4 Pin Mini-Din - Y-C output (Industry Standard Configuration)
7 Pin Mini-Din - R-G-B-Sync Output
8 Pin Mini-Din - Remote

### SENSITIVITY, 3200 K ILLUMINATION

<table>
<thead>
<tr>
<th>Faceplate Illumination</th>
<th>Minimum Scene Illumination, f/1.4 lens</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGC Off, 100% video</td>
<td>1.7 fc (17 lux)</td>
</tr>
<tr>
<td>Lo AGC, 12 dB, 70% video</td>
<td>0.35 fc (3.5 lux)</td>
</tr>
<tr>
<td>Hi AGC, 20 dB, 70% video</td>
<td>0.1 fc (1 lux)</td>
</tr>
<tr>
<td>Useable picture, 35% video</td>
<td>0.05 fc (0.5 lux)</td>
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<tr>
<td></td>
<td>17 fc (170 lux)</td>
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<tr>
<td></td>
<td>3.5 fc (35 lux)</td>
</tr>
<tr>
<td></td>
<td>1.0 fc (10 lux)</td>
</tr>
<tr>
<td></td>
<td>0.5 fc (5 lux)</td>
</tr>
</tbody>
</table>

**Table 1**
DIMENSIONS

Front View

Bottom View

Side View

NOTF: ALL DIMENSIONS IN MM AND (INCHFS).

Figure 1

CONNECTOR CONFIGURATIONS

LENS
3-Pin Mini-Din

REMOTE
8-Pin Mini-Din

(BNC - Encoded Video)

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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</thead>
<tbody>
<tr>
<td>Power</td>
<td>Lens</td>
<td>Ground</td>
<td>Y-Y</td>
<td>Blue</td>
<td>Green</td>
<td>Ground</td>
<td>Clock Out</td>
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<tr>
<td>Y-C</td>
<td>C-Ground</td>
<td>SYNC</td>
<td>C</td>
<td>Red</td>
<td>Ground</td>
<td>Auto/Manual</td>
<td>White Balance</td>
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<tr>
<td>4-Pin Mini-Din</td>
<td>Vertical Trigger In</td>
<td>Shutter ON/OFF</td>
<td>+5</td>
<td>Vertical Trigger In</td>
<td>Ground</td>
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</table>

NOTF: ALL DIMENSIONS IN MM AND (INCHFS).
# 6800 SERIES REMOTE-HEAD COLOR CCD CAMERA

## ORDERING INFORMATION

<table>
<thead>
<tr>
<th>681X</th>
<th>2100</th>
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<tbody>
<tr>
<td><strong>Power Options</strong></td>
<td><strong>Standard Configuration</strong></td>
<td><strong>Lens Options</strong></td>
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<tr>
<td>2 12 VAC/DC, 60 Hz</td>
<td></td>
<td>0000 None</td>
</tr>
<tr>
<td>5 115 VAC, 60 Hz</td>
<td></td>
<td>Manual Iris Lenses</td>
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<tr>
<td></td>
<td></td>
<td>AL04 4.5mm, f/2.0 (2/3&quot;)</td>
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<td>AL06 6.5mm, f/1.8 (2/3&quot;)</td>
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<td></td>
<td>AL08 8mm, f/1.4 (2/3&quot;)</td>
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<td></td>
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<td>AL09 9mm, f/1.4 (2/3&quot;)</td>
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<td>AL12 12mm, f/1.4 (1&quot;)</td>
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<td>AL16 16mm, f/1.4 (2/3&quot;)</td>
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<td>AL26 25mm, f/1.6 (2/3&quot;)</td>
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<td>AL51 50mm, f/2.8 (2/3&quot;)</td>
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<td>AL75 75mm, f/1.8 (1&quot;)</td>
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<td></td>
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<td>Auto Iris Lenses</td>
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<td>ES05 4.8mm, f/1.8 (2/3&quot;)</td>
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<td>ES06 6mm, f/1.2 (1/2&quot;)</td>
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<td>ES08 8mm, f/1.4 (2/3&quot;)</td>
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<td>ES13 12mm, f/1.2 (1/2&quot;)</td>
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<td>ES16 16mm, f/1.4 (2/3&quot;)</td>
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<td>ES28 28mm, f/1.2 (1/2&quot;)</td>
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<td>ES35 35mm, f/1.4 (2/3&quot;)</td>
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<td>ES50 50mm, f/1.4 (1&quot;)</td>
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<tr>
<td></td>
<td></td>
<td>ES75 75mm, f/1.8 (1&quot;)</td>
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</tbody>
</table>

**NOTE:** Auto iris lenses require auto iris cable assembly 8307-8, to be ordered separately.

Please consult factory for other lens selections.

---

**SPECIAL FEATURES**

Cohu welcomes the opportunity to provide special features to better serve your particular requirement. For example, the remote camera head can be sealed to allow immersion in liquids for sterilization or other purposes. Other special features include custom painting, silk screen and logo for OEM customers and special connector pin configurations. Please contact Cohu for other special features.
NEW! With Surge Protection!

MICROPROCESSOR CAMERA CONTROL SYSTEM

MPC SERIES

For Color or Monochrome CCTV Systems

The Microprocessor Camera Control System is designed and manufactured to reduce the cost of CCTV system installations and improve operation and control for security and surveillance applications.

The MPC can reduce total equipment and installation costs by up to 25% for systems that exceed 1,000 feet in distance (cameras to monitors). For systems that reach 5,000 feet, the savings are 50% or more compared to traditional multiple-conductor cable systems. This is accomplished by installing fewer, or individual video and control cables and by eliminating signal conversion losses.

The MPC is offered in two versions: monochrome and color, to meet users' custom needs. All standard mini-systems of the camera site controls are expandable to 223 camera sites, 32 monitors, and 32 multi-operator Master and Remote stations. Larger system configurations are available upon request.

The MPC utilizes a microprocessor CPU and controls the following: camera and monitor selection (camera and monitor selection, camera and monitor selection, and camera and monitor selection); and all pan/tilt, zoom, and focus functions. Digital control signals are transmitted from the MPC by one or more of three formats: RS-422 serial-data bi-directional line, RS-232 serial-data line, or DTMF signals over a twisted pair. The MPC transmitter is compatible with existing systems where receivers utilize one of those transmitter formats.

The MPC transmitter is equipped with a shielded twisted-pair protection device to protect camera and monitor signals against cable surges caused by lightning and other phenomena.

Options available to the user are the Preset Control and Camera Switching Option. The Preset Control option allows manual switching or random camera sequencing of up to 10 preset positions for each camera. The camera video switching option allows manual switching or random camera sequencing of up to 16 cameras per monitor for as long as 8 seconds per camera. In addition to these, autoscan, color, and highlight limiter control options are also available. For additional information on options and capabilities options, consult the Cohu Applications Engineering Group in San Diego or your local Cohu representative.

FEATURES

- Controls up to 223 camera sites
- Expand to 31 remote operator stations
- Compatible with RS-422, RS-232, DTMF
- Operator control of pan/tilt, lens functions
- Digitized control signals
- Operator programmable
- Distances up to 5 miles (8 km) with shielded twisted pair
- Power and data line surge protection

OPTIONS

- Preset control for up to 10 positions
- Autoscan, color, and highlight limiter controls
- Video switching/sequencing
- RS-422 balanced-line service
- Multiple RS-232 ports

Typical MPC System Components: Camera on Pan/Tilt Unit, Microprocessor Control Unit, Preset Panel, CPU Receiver Box, RS422 Distribution Unit

Designed and manufactured in U.S.A
THE MPC SYSTEM

The Coni microprocessor control (MPC) system provides the latest technology in a computer-controlled system. Programming and operating the MPC system is simple and requires no special training.

The MPC control system includes master control panels, remote control panels, preset control panels, control receivers, and RS-422 distribution units. Commands to the control receivers at the camera site are via a single twisted pair cable (shielded if preferred) using RS-422 digital data or optional DTMF or other communication channels if RS-232. All of the units in the system may be connected in a "daisy chain," or by the use of an RS-422 distribution unit, in a "star" pattern with up to ten legs.

Cameras, monitors and limited camera selection access can be assigned to a specific MPC station with our unique systems approach.

The standard control priority is first call to priority. When the camera site is in use, a busy indicator is illuminated on the numeric display readout.

THE MPC MASTER CONTROL PANEL

The MPC master control panel functions as the system CPU.

The functions performed include:
1) polling remote control panels for command/camera selection input. 2) routing operator commands to correct control receiver. 3) controlling video switches. 4) implementing commands received via RS-232. 5) implementing control priority. 6) setting system parameters such as the RS-422 baud rate. 7) non-volatile storage of camera sequence and camera selection data. 8) selection of data transfer (RS-422 2-way, RS-422 1-way, or DTMF) for each camera site. 9) implementing functions unique to a particular system (such as priority lockout or camera/monitor access assignment) that may be defined to implement non-standard requirements on a system basis. 10) RS-232 interface or DTMF interface.

Other system options may be selected as appropriate for any user system.

THE MPC CONTROL PANEL

The MPC master control panel and MPC remote control panels serve as operator control units. The MPC control panel is designed for fast, efficient use with little operator training. The layout and clearly designated functions provide the operator quick command and control.

A digital keypad is used to enter monitor/camera selection, sequence programming, sequence/hold commands, and system parameter programming (master only). A numeric display indicates the camera and monitor selection. The busy LED indicator illuminates if the camera is already under control by another operator.

A joystick is used for pan/tilt control, toggle switches for zoom, focus and iris, and push button switches and LED status indicators for camera power, lens speed, and automatic/manual iris select.

Up to three auxiliary push buttons and LED indicators are also available as options for control of bright light limit on/off, peak/avg adjust, auto color balance on/off, manual white balance, or other user-defined controls.

**COMMAND/CONTROL FOR SELECTED CAMERA SITE**

1. NUMERIC DISPLAY
   CAMERA
   Indicates camera site selected
   BUSY
   Indicates camera site in use
   MONITOR
   Indicates which monitor is under control
   ENTER KEY
   Completes the selection function

2. PUSHBUTTON KEYPAD
   Provides selection of:
   CAMERA SELECT KEY
   Activates camera selection function
   MONITOR SELECT KEY
   Activates monitor select function
   ENTER KEY
   Completes the selection function

3. SEQUENTIAL/HOLD KEY
   Starts and stops sequence
   CLEAR KEY
   Clears the selection function
   0-9 KEYS
   Numeric input for selection function

4. CAMERA POWER
   Selects power on/off. Lamp indicates power on.

5. BRIGHT LIGHT LIMITER/ AUTO WHITE BALANCE
   B&W—turns bright light limiter on/off. Lamp indicates bright light limiter on.
   Color—select auto or manual white balance.
   Lamp indicates auto.

6. PEAK/BLUE
   B&W—adjusts peak average toward peak.
   Color—adjusts more blue in manual white balance.

7. MANUAL
   Selects manual control mode
   Lamp indicates manual control mode

8. AVERAGE/RED
   B&W—adjusts average toward average.
   Color—adjusts more red in manual white balance.

9. IRIS OPEN-CLOSE
   Opens and closes lens iris when MANUAL mode is activated

10. FOCUS NEAR-FAR
    Controls lens focus

11. COMM ERR LAMP
    Communication error—indicates communication failure with camera control receiver

12. RESET SWITCH
    Restarts the microprocessor

13. ZOOM IN-OUT
    IN brings subject closer on monitor; OUT moves it further away.

14. POWER LAMP
    Green indicates the control panel has power (On-Off switch is on rear panel).

15. PAN/TILT JOYSTICK
    Moving joystick to any position through a full 360° activates the panning (right-left) and/or tilting (up-down)
**MPC CONTROL RECEIVER**

The MPC control receiver receives command data from the MPC master control panel and decodes the command data, performs error checking, and acts on valid data to drive the pan/tilt unit if applicable and camera controls.

**MPC PRESET CONTROL PANEL**

The preset control panel installed near the MPC control panel provides push buttons for operator call-up and programming of preset locations. LEDs display status of preset positions.

**MPC RS-422 DISTRIBUTION UNIT**

The RS-422 distribution unit provides for ten twisted pair connections for MPC system data communication to control receivers and remote control panels if a single daisy chain is not convenient.

---

**SPECIFICATIONS**

**ELECTRICAL**

- **Input Voltage**
  - 105-135V ac, 50-60 Hz
  - 200-265V ac, 50-60 Hz
- **Input Power**
  - Control Panel: 20 Watts
  - Receiver: 25 Watts, exclusive of camera heater and camera power
  - Preset Panel: 0.25 Watts
  - RS-422 Dist Unit: 15 Watts
- **Surge Protection**
  - Power Line Surge (peak current): 1500 amps
  - Data Line: 100 amps for 1 ms half value pulse width

**ENVIRONMENTAL**

- **Ambient Temperature Limits**
  - Operating: Control Panel 0 to 50 °C (-40 to 122 °F)
  - Receiver -40 to 60 °C (-40 to 140 °F)
  - Preset Panel -10 to 50 °C (14 to -22 °F)

**IEEE-422 Distribution Unit**

- Receiver: 20 to 80 °C (-29 to 176 °F)
  - 100°C (392°F)
- **Humidity**
  - Control Panel, relative Receiver: 100% relative
- **Vibration**
  - 5 to 30 Hz with 0.03 inches total excursion. From 30 to 1000 Hz with peak random vibrations of 5 g, without damage or degradation.
- **Shock**
  - 5 g in any axis under non-operating conditions

**Mechanical**

- **Dimensions**
  - Control Panel: 15.5" x 5.5" x 9.0" (39.4cm x 14.0cm x 22.9cm)
  - Receiver: 5.4" x 10.0" x 13.5" (13.7cm x 25.4cm x 34.3cm)
  - Preset Panel: 7.2" x 8.2" x 19.0" (18.3cm x 21.0cm x 48.3cm)
- **Weight**
  - Control Panel: 10.4 lbs (4.7 kg)
  - Receiver: 17.3 lbs (7.8 kg)
  - Preset Panel: 2.3 lbs (1.02 kg)
  - RS-422 Distribution Unit: 4.2 lbs (1.9 kg)
- **Enclosure**
  - Control Panel: NEMA 4 weatherproof box
  - Receiver: NEMA 4 weatherproof box

**TYPICAL MPC SYSTEM**

[Diagram of typical MPC system with master station, remote stations, and control distribution unit.]
### MPC — MICROPROCESSOR CAMERA CONTROL SYSTEM

#### ORDERING INFORMATION

### CONTROL PANEL

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<tr>
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<tbody>
<tr>
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<td>Panel Configuration</td>
<td>Input Power</td>
<td>Front Panel Options (*)</td>
<td>System Options (As required)</td>
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<tr>
<td>MPC</td>
<td>M Master</td>
<td>R Remote</td>
<td>0 None</td>
<td>1 115 VAC, 50/60 Hz</td>
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<td>2 230 VAC, 50/60 Hz</td>
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<td></td>
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<td>00 Basic MPC (0)</td>
<td>51 Preset</td>
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<td>01 Bright Light Limiter (1)</td>
<td>52 RS-232, Single*</td>
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<td>02 BLL/Peak Avg (3)</td>
<td>53 RS-232, Dual*</td>
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<td>03 Auto Scan (1)</td>
<td>54 Video Switcher, Parallel*</td>
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<td>04 White Balance (13)</td>
<td>56 DTMF*</td>
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<td>05 BLL/Peak Avg/White Balance (13)</td>
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* NUMBER OF OPTIONS REQUIRED FOR FUNCTION — 3 Positions Max

** Master Only

### CONTROL RECEIVER

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<tr>
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<td>Input Power</td>
<td>Camera Power</td>
<td>Pan/Tilt Power</td>
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<td>1 115 VAC</td>
<td>0 None</td>
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<tr>
<td></td>
<td>2 230 VAC, 50/60 Hz</td>
<td>2 230 VAC</td>
<td>1 115 VAC</td>
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<td></td>
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<td>4 12 VAC</td>
<td>2 230 VAC</td>
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<td>5 12 VDC</td>
<td>3 115 VDC</td>
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<td></td>
<td></td>
<td>6 24 VAC</td>
<td>6 24 VAC</td>
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<tr>
<td></td>
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<td>7 24 VDC</td>
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### AUXILIARY EQUIPMENT & CABLES

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<td>CA Cable</td>
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CCTV MOUNTING EQUIPMENT

MOUNTS AND ACCESSORIES

Cohu offers a selection of light-, medium-, and heavy-duty mountings for CCTV cameras and monitors. Indoor and outdoor versions are available to suit the environment of the intended application. Each unit has been designed for dependability and long life.

Where an adjustable head is required, be sure to include its separate model number when ordering the basic mount.

If you need assistance in determining the proper accessories for your particular CCTV installation, please call your Cohu representative, or call the factory and ask to speak with one of our experienced applications engineers.

---

**PM2000, WM2000, AH2000, and ST1 DIMENSIONS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Dimensions</th>
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<tbody>
<tr>
<td>PM2000</td>
<td>8.50&quot; DIA / 3.80&quot; DIA / 7.00&quot; B.C.</td>
</tr>
<tr>
<td>WM2000</td>
<td>22.50&quot; / 3.00&quot; DIA</td>
</tr>
<tr>
<td>AH2000</td>
<td>36° DIA / 4.75&quot; B.C.</td>
</tr>
<tr>
<td>ST1</td>
<td>3.00&quot; DIA.</td>
</tr>
</tbody>
</table>

**SPECIFICATIONS**

**WM2000 WALL MOUNT**

The WM2000 is a universal wall arm mount designed for wall mounting medium- to heavy-duty pan/tilts or heavy-duty camera enclosures. The WM2000 will support loads of up to 75 lbs. When used with an optional ST1 support strut, maximum load capacity is increased to 150 lbs.

**PM2000 PEDESTAL MOUNT**

The PM2000 is a universal pedestal mount designed for use with all medium- and heavy-duty pan/tilts. Its aluminum construction ensures load capacity up to 125 lbs. ST1 struts can be used to increase horizontal stability in windy areas. The PM2010 is the same as the PM2000 except it is 10" high.

**AH2000 HEAD ADAPTER**

The AH2000 adjustable head adapter is designed for use with WM2000 and PM2000 mounts. It provides 360° horizontal movement. For certain installation applications, the AH2000 can be used alone.

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Designed and manufactured in U.S.A.
INDOOR/OUTDOOR MOUNTS AND ACCESSORIES

PEDESTAL AND WALL MOUNTS

CM1700 LIGHT-DUTY MOUNT
The CM1700 is a light-duty low-cost universal mount primarily designed for ceiling or pedestal mounting. It can also be used as a wall mount. The CM1700 features an easily adjustable ball/swivel head for camera positioning and is finished in black anodized and beige enamel. Its 6.75" stem supports up to 10 lbs.

CM1400/PM14 WALL MOUNT
Designed for interior use in banks, offices and similar installations, the CM1400/PM14 will easily accommodate light-duty cameras and other equipment up to 20 lbs. This economical mount measures 9.75" from the base to its mounting point, and is made of die-cast aluminum. The CM1400 features an easily adjustable ball/swivel head which allows unlimited pan rotation and 90° tilt down angle. The PM14 is identical to the CM1400 except that it has an adapter plate in place of the ball/swivel head.

EM1400 WALL MOUNT
This light-duty wall mount is designed for use with light- to medium-weight cameras and camera enclosures up to 20 lbs. It features a 9.71" die-cast aluminum arm with an adjustable positioning of the camera or enclosure.

EM22 and MM22 ENCLOSURE MOUNTS
For loads up to 40 lbs., the EM22 Wall Mount and the MM22 Pedestal/Ceiling Mount are economical solutions. Both mounts have fully adjustable swivel heads and are made of sturdy cast aluminum. The EM22 measures 16.50" from base to mounting point; the MM22 measures 6.86" in height.

MOUNTING ACCESSORIES

PAN/TILT ADAPTER PLATES
The PA2000 is the adapter plate for medium-duty pan/tilts and scanners and the PA2010 will adapt to all heavy-duty pan/tilts. Both are for use with the WM2000 Universal Wall Mount.

POLE MOUNT ADAPTERS
The PA100 Series Pole Mount Adapters permit the use of a standard wall mount when installation of CCTV equipment is required on a pole. Lightweight and easily installed, the rugged one-piece aluminum construction provides a strong, stable mounting surface for the accessory equipment. The Model PA100 is designed for use with CM1400, EM22, and EM1400 mounts. Minimum pole diameter is 1.5". Model PA102 is for use with WM2000 mounts, and requires a pole with a 3" minimum diameter. The SPA102 Pole Mount Adapter is for use with the ST1 Support Strut in installations requiring additional support: minimum pole diameter is 3 inches.

PARAPET MOUNT ADAPTER
Model PP100 Parapet Mount Adapter eliminates the expense and hazards of installing and servicing CCTV equipment mounted on parapets. Supporting up to 175 lbs., the PP100 fastens to the inside of the parapet and is rotatable a full 360° so the equipment can be installed and serviced in safety from the rooftop. It can be installed on any parapet wall at least 18" high, and is compatible with most wall mounts.

CORNER MOUNT ADAPTERS
Model CM100 Corner Mount Adapters are compatible with WM2000 Wall Mounts. In installations requiring the addition of an ST1 Support Strut, a Model SCM100 Corner Mount Strut Adapter must also be used.

COHU RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.
CCTV REMOTE POSITIONING DEVICES

PAN AND TILT UNITS

Cohu offers a selection of pan and tilt units for a wide array of applications and environmental conditions. Outdoor units are built to withstand harsh conditions such as rain, snow, and extreme temperatures. Some indoor applications may require environmental pan and tilt units due to extreme conditions.

In selecting the proper unit for your application, the most important consideration is weight. Be sure to include the total weight of the camera/lens package. Also, be sure to factor in high winds and other conditions that might put additional strain on the unit.

For assistance in determining the correct equipment for your application, please call your Cohu representative, or call the factory and ask to speak with one of our experienced applications engineers.

### PT175-24P LIGHT DUTY
- Indoor/Outdoor Operation
- Inverted Operation
- External Limit Adjustment
- Pan 0—355° movement in horizontal plane at 9°/second ±1° (No-load condition)
- Tilt ±90° movement in vertical plane at 3°/sec. ±0.5° (No-load condition)
- Maximum Load 20 lbs. at 5' from tilt table surface to center of gravity
- Gearing Chain and sprocket pan drive; worm gear tilt drive
- Input Voltage 24V ac. 50/60 Hz
- Power Requirements Running: 0.47 amp, 30.8 VA Starting: 1.81 amps, 43.5 VA
- Construction Aluminum casting and plate, all internal parts corrosion protected
- Temperature -10°F to 140°F (-23°C to 60°C)
- Weight 18 lbs (8.1 kg)

### PT270P MINI PAN/TILT
- For Indoor Operation
- Inverted Operation
- External Limit Adjustment
- Pan 0—355° movement in horizontal plane at 9°/second ±1° (No-load condition)
- Tilt ±90° movement in vertical plane at 3°/sec. ±0.5° (No-load condition)
- Maximum Load 15 lbs. at 5' from tilt table surface to center of gravity
- Gearing Chain and sprocket final drive
- Input Voltage 115V ac, 50/60 Hz or 24V ac, 50/60 Hz (Model PT270-24P)
- Power Requirements 24V units: 0.74 amp (running) 115V units: 0.13 amp (running)
- Construction Aluminum plate, all internal parts corrosion protected
- Temperature -10°F to 140°F (-23°C to 60°C)
- Weight 9 lbs (4 kg)

### PT550P MEDIUM DUTY
- For Outdoor Operation
- Easy Servicability
- Inverted Operation
- Dynamic Braking for Instantaneous Stopping
- Adjustable Worm Gear Final Drive to Prevent Drift and Minimize Backlash
- Pan 0—355° movement in horizontal plane at 6°/second ±1° (No-load condition)
- Tilt ±90° movement in vertical plane at 3°/sec ±0.5° (No-load condition)
- Maximum Load 40 lbs. at 5' from tilt table surface to center of gravity
- Gearing Chain and sprocket final drive
- Input Voltage 115V dc
- Power Requirements 0.88 amp, 102 VA maximum
- Construction Aluminum plate, all internal parts corrosion protected
- Temperature -10°F to 140°F (-23°C to 60°C)
- Weight 22 lbs (9.9 kg)
- Preset Position Option

Model PT550P Medium Duty Outdoor Pan and Tilt Unit

Designed and manufactured in the U.S.A.
# PAN AND TILT UNITS

## SPECIFICATIONS

### PT570P MEDIUM DUTY
- For Outdoor Operation
- Easy Serviceability
- Inverted Operation
- External Limit Adjustment
- Adjustable Worm Gear Final Drive to Prevent Drift and Minimize Backlash
- Pan: 0—355° movement in horizontal plane at 6°/second ±1° (No-load condition)
- Tilt: ±90° movement in vertical plane at 3°/sec. ±0.5° (No-load)
- Maximum Load: 40 lbs. at 5" from tilt table surface to center of gravity
- Input Voltage: 115V ac. 50/60 Hz or 24V ac, 50/60 Hz (Model PT570-24P)
- Power Requirements: 24V units: 1.8 amps running, 2.70 amps maximum
  115V units: 0.36 amps running
- Construction: Aluminum plate, all internal parts corrosion protected
- Temperature: -10°F to 140°F (-23°C to 60°C)
- Weight: 22 lbs (9.9 kg)
- Preset Position Option

### PT1250P HEAVY DUTY
- Outdoor/Outdoor Operation
- Easy Serviceability
- Rugged Construction
- Explosion-Proof Models
- External Limit Adjustment
- Adjustable Worm Gear Final Drive to Prevent Drift and Minimize Backlash
- Pan: 0—355° movement in horizontal plane at 6°/second ±1° (No-load condition)
- Tilt: ±90° movement in vertical plane at 3°/sec. ±0.5° (No-load)
- Maximum Load: 100 lbs. at 5" from tilt table surface to center of gravity
- Input Voltage: 115V ac. 50/60 Hz; 220V ac option for Explosion-Proof Models; 115V dc (Model PT1250DC)
- Power Requirements: Standard 115V ac models: 0.70 amps running, 1.20 amp
  Explosion-Proof Models: 1.0 amp running, 1.48 amp maximum
  115V dc models: 0.66 amps running, 1.0 amp maximum
- Construction: Aluminum casting and plate, all internal parts corrosion protected
- Temperature: -10°F to 140°F (-23°C to 60°C)
- Weight: 55 lbs (25 kg)
- Preset Position Option

### PT2000L EXTRA HEAVY DUTY
- Outdoor Operation
- Dynamic Braking for Instantaneous Stopping
- Rugged Construction
- External Limit Adjustment
- Adjustable Worm Gear Final Drive to Prevent Drift and Minimize Backlash
- Pan: 0—355° movement in horizontal plane at 6°/second ±1° (No-load condition)
- Tilt: ±90° movement in vertical plane at 6°/sec. ±0.5° (No-load)
- Maximum Load: 150 lbs. at 5" from tilt table surface to center of gravity
- Input Voltage: 115V dc
- Power Requirements: Running: 2.4 amps. 276 VA
  Starting: 3.6 amps. 414 VA
- Construction: Aluminum casting and plate, all internal parts corrosion protected
- Temperature: -10°F to 140°F (-23°C to 60°C)
- Weight: 110 lbs (50 kg)
- Preset Position Option

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**Preset Position Option**

The Preset Position Option is a position feedback modification which allows pan and tilt to be automatically positioned to various preset positions. This feature requires the use of a Cohu MPC Microprocessor Control System or related equipment.
Cohu's Model SID-100 Source ID Generator is designed to provide positive identification of the source of the video signal displayed on a monitor screen. The more cameras utilized in a closed-circuit television system, the more desirable it is to be certain you know which camera view is being observed. Typical applications include security/surveillance, airport ground traffic control, penal institutions, mass transit facilities, and other complex monitoring operations.

A 16-character alphanumeric display is produced by each SID-100 Source ID Generator and superimposed on the appropriate video image. Each character is 28 TV lines high and is derived from a standard 5x7 dot matrix. The particular display information is programmed into an erasable EPROM using a PROM programmer. This information is inserted into the video signal by raising the appropriate portions of the signal to whiter-than-white voltage levels without overdriving the monitor. Vertical position of the display is determined by jumper selection and horizontal position is determined by the potentiometer. Once installed, the programmed ID is automatically displayed with its associated video signal.

EPROMs are installed in the appropriate SID-100 Source ID Generator boards which are, in turn, installed into an 18-board capacity Model UDC-111 rackmountable display chassis. EPROMs may be erased with an ultra-violet light EPROM eraser. Programming of EPROMs is available from Cohu. In addition, Cohu can provide, as a special ER feature, a PROM programmer and PC-compatible software to enable user programming.

**ELECTRICAL**

Each Source ID Generator board separates the composite sync from the video input for use in providing timing for its digital logic and memory circuits. Display information is inserted into the video output without distorting any other signal characteristics. Any Source ID Generator board may be removed without disturbing the video signal. The SID-100 is compatible with all closed-circuit television systems utilizing either EIA standard RS-170 or CCIR specifications.

**MECHANICAL**

Up to 18 individual SID-100 boards may be installed in a Cohu Model UDC-111 rackmountable chassis, which fits in a standard 19" rack with a 3.5" panel height. Video is cabled to and from the chassis through 36 BNC connectors located on the back panel.

**FEATURES**

- Video source identification at a glance
- 16-character white alphanumeric display
- Field programmable
- Display location on monitor screen, jumper selectable
- Capable with EIA RS-170 and CCIR specifications
- Up to 18 separate Source ID Generator boards in a single 19" rackmount chassis

*Designed and manufactured in U.S.A.*
## SPECIFICATIONS

### ELECTRICAL

**Input Power**
115 VAC/20 W (18 modules installed)

**Input Signal Level**
-4 dB; nominal 1.0 V p-p composite video, EIA RS-170 (CCIR special order only)

**Characters**
Alphanumeric; 28 lines high; white

**Number of Characters**
16 per module, including blanks

### MECHANICAL

**Chassis Dimensions**
19.0" x 13.0" x 3.5"
(48.26 cm x 33.02 cm x 8.89 cm)

**Chassis Connectors**
36 BNC Type Connectors

**Number of ID Generator Modules per Chassis**
Up to 18, maximum

### ENVIRONMENTAL

**Ambient Temperature Limits**
- Operating: 0° to 50°C (32° to 122°F)
- Storage: -40° to 85°C (-40° to 185°F)

**Ambient Air Pressure**
Sea level to equivalent of 10,000 feet (3,048 m) above sea level (24.4 cm of mercury)

**Humidity**
95% relative humidity (without condensation)

**Shock**
15 g's in any axis under non-operating conditions, MIL-E-5400R, para. 3.2.24.6.

## ORDERING INFORMATION

<table>
<thead>
<tr>
<th>MODEL NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>SID-100</td>
<td>Source ID Generator Module (specify EPROM programmed or unprogrammed)</td>
</tr>
<tr>
<td>UDC-111</td>
<td>Display Chassis, with power supply</td>
</tr>
</tbody>
</table>

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COHU RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.

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5755 Kearny Villa Road • San Diego, CA 92123
P.O. Box 85623 • San Diego, CA 92186-5623
Telephone: (619) 277-6700 • FAX: (619) 277-0221 • TWX: 910-335-1244

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Printed in U.S.A.

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![Diagram showing video input, UDC-111, SID-100, MONITOR, SWITCHER, and video output connections]
The Cohu 9800 Series Video Distribution Amplifier is a solid-state, side-band video amplifier that amplifies and distributes video signals from one input to four output channels. The input may be composite or noncomposite, monochrome or color video. Each amplifier has an integral power supply; AC on-off switch and indicator; front panel test points for input, output and power supply; and a video gain adjustment on the front panel. Individual connector panels, one for each amplifier, fasten to the rear of the enclosure and have six BNC or UHF connectors, one connector for each output and two for the bridging (loop-thru) input.

**FEATURES**

- Modular Construction With Total Solid-State Active Circuitry
- Choice of Vertical or Horizontal Configuration
- Fits Standard 19-inch Rack or Cabinet
- Integral Power Supply on Each Module
**SPECIFICATIONS**

**ELECTRICAL**

<table>
<thead>
<tr>
<th>Type of Input</th>
<th>Video, composite or noncomposite (monochrome or color)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Level</td>
<td>Composite: 1V p-p or 1.4V p-p (nominal)</td>
</tr>
<tr>
<td></td>
<td>Noncomposite: 0.7V p-p or 1V p-p (nominal)</td>
</tr>
<tr>
<td>Number of Inputs</td>
<td>One</td>
</tr>
<tr>
<td>Input Characteristics</td>
<td>Bridging greater than 50K ohms at 1 KHz. (Provision for loop-through of 75-ohm line. Less than 2 nanoseconds delay.)</td>
</tr>
<tr>
<td>Reflection Coefficient</td>
<td>Less than 2%</td>
</tr>
<tr>
<td>Output Level</td>
<td>Composite: 1V p-p or 1.4V p-p (nominal)</td>
</tr>
<tr>
<td></td>
<td>Noncomposite: 0.7V p-p or 1V p-p (nominal)</td>
</tr>
<tr>
<td>Number of Outputs</td>
<td>Four</td>
</tr>
</tbody>
</table>

- **Output Impedance**: 75-ohm source-terminated
- **Isolation Between Outputs**: Greater than 35 dB at 3.58 MHz
- **Isolation Between Amplifiers**: Greater than 60 dB to 10 MHz, greater than 50 dB to 20 MHz
- **Video Gain**: 20 MHz ± 0.25 dB (can be adjusted for 30 MHz ± 1 dB)
- **Differential Gain**: Less than 0.2% at 10%, 50% and 90% APL (average picture level)
- **Differential Phase**: Less than 0.2° at 10%, 50% and 90% APL
- **Tilt**: Less than 1% (to all-white picture)
- **Noise**: Less than 0.5mV rms, 20 Hz to 20 MHz
- **Delay Time**: 15 nanoseconds at 3.58 MHz

**ENVIRONMENTAL**

| Power Requirements | 105-125V, 50-60 Hz, 3W max. per PDA, 4W max. per VDA or 5W max. per SDA |
| Operating Temperature | -20°C to +50°C |
| Humidity | To 95% |

**MECHANICAL**

| Dimensions | Amplifiers: 1¼"W x 4¾"H x 10¼"D |
| Vertical-CHassis: 19"W x 5¾"H x 16"D |
| Horizontal-CHassis: 19"W x 1¼"H x 16½"D |
| Weight | Amplifiers: 1 lb. 6 oz. net, 3 lb. shipping max |
| Vertical-CHassis: 12 lbs. net, 25 lbs. shipping |
| Horizontal-CHassis: 5 lbs. net, 10 lbs. shipping |

**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>VIDEO DA MODEL NO.</th>
<th>ENCLOSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>9850-000</td>
<td>Vertical Chassis Holds 10 DAs</td>
</tr>
<tr>
<td>9860-000</td>
<td>Horizontal Chassis Holds 3 DAs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DISTRIBUTION AMPLIFIERS</th>
<th>ENCLOSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>9800-152</td>
<td>For Horizontal Chassis With BNC connector assembly, 1 input (with loop-thru) and 4 outputs</td>
</tr>
<tr>
<td>9800-352</td>
<td>For Horizontal Chassis With UHF connector assembly, 1 input (with loop-thru) and 4 outputs</td>
</tr>
<tr>
<td>9800-151</td>
<td>For Vertical Chassis With BNC connector assembly, 1 input (with loop-thru) and 4 outputs</td>
</tr>
<tr>
<td>9800-351</td>
<td>For Vertical Chassis With UHF connector assembly, 1 input (with loop-thru) and 4 outputs</td>
</tr>
</tbody>
</table>

Two types of enclosures are available for mounting in a standard 19-inch rack or cabinet. The vertical chassis accommodates up to ten vertically plugged-in amplifiers and the horizontal chassis holds up to three amplifiers. The line cord and fuse are attached to the rear of the chassis and power distribution to all amplifiers is via interconnection board. The vertical chassis requires 5¼" of rack space and the horizontal chassis requires 1¼" of space.
The Cohu 9800 Series Video Cable Equalizer compensates for high frequency losses due to long runs. Equalization is sufficient for up to 6000 feet of RG-11/U foam dielectric cable. Longer distances can be equalized by using polyfoam dielectric cables having even lower losses.

The equalizer is a self-contained, plug-in module, having its own integral regulated power supply. All circuitry is contained on an etched, glass epoxy circuit board. All components, test points and adjustments are prominently marked.

Equalization to 30 dB at 10 MHz is provided by three convenient front panel controls, variable RESPONSE control, a variable GAIN control, and a fixed +15 dB toggle switch. Equalization of 0 to 15 dB is made using the RESPONSE control. Equalization above 15 dB requires activating the +15 dB toggle switch and using the variable RESPONSE control. Activating the +15 dB of equalization to which the variable RESPONSE control will add the necessary signal for up to a total of 30 dB equalization at 10 MHz. Should low frequency gain compensation be necessary, the variable GAIN control will provide from -4 dB to +6 dB adjustment, which shifts the entire equalization curve, low frequency to high frequency.

The Cohu 9800 Series Equalizer, when used at the receiving end of a cable, provides excellent results with both color and monochrome video signals. The equalizer will accept either a 75-ohm unbalanced or 124-ohm balanced input, producing an equalized 75-ohm unbalanced output. Differential input provides rejection of hum caused by ground loops. The equalizer may also be used at the transmitting end with similar excellent performance.

**FEATURES**

- Up to 30 dB Equalization at 10 MHz
- Dependable Operation Over a Wide Environmental Range
- Front Panel Variable Equalization Adjustments
- Total Solid State Active Circuitry
- Exceptional Low Hum and Noise Level
- Integral, Regulated Power Supply on Each Module

Shown clockwise from left: The Cohu 9800 series Video Cable Equalizer, Portable Cabinet, Horizontal Frame and Vertical Frame.
# SPECIFICATIONS

## ELECTRICAL

### Video Inputs
One 75-ohm coaxial input, grounded or differential alternate, one 124-ohm balanced input.

### Video Output
1V p-p maximum, 75-ohm source-terminated.

### Compensation at 10 MHz
30 dB total, 0 to 15 dB adjustable, 15 dB fixed.

### Frequency Response (Amplifier plus Cable)
Gain increase shall be proportional to the square root of the frequency to within ±0.5 dB, ±0.1 dB per MHz up to 10 MHz.

### Tilt
None (direct coupling).

### Amplifier Voltage Gain
Adjustable from -4 dB to +6 dB.

### Common Mode Rejection
55 dB at 50 to 60 Hz up to 3 volts peak-to-peak.

### Differential Gain
2% maximum, 10%, 50%, 90% APL.

### Differential Phase
±1° maximum, 10%, 50%, 90% APL.

### Hum and Noise
50 dB RMS below 0.7V p-p.

### Power Requirements
100/130, 200/260Vac, 50-60 Hz, 10W max.

### Connectors
Input 75-ohm UHF, 124-ohm twin UHF; Output 75-ohm BNC.

## ENVIRONMENTAL

### Operating Temperature
-20° to +60°C (-4° to +140°F).

### Humidity
To 90%, noncondensing.

### Shock Limits
15 g's on any axis under non-operating conditions per MIL-E-5400R, para. 3.2.24.6.

### Vibration Limits
0.03 inches total excursion from 5 to 30 Hz and peak random vibration of 5 g's from 30 to 1,000 Hz.

## MECHANICAL

### Dimensions
Equalizer: 1.1"W x 4.4"H x 10.75"D (2.79 x 11.17 x 20.30 cm).

### Power Requirements
Vertical Frame: 19.9"W x 5.25"H x 14.1"D (48.26 x 13.33 x 35.82 cm).

### Connectors
Horizontal Frame: 19.0"W x 1.74"H x 13.8"D (48.26 x 4.44 x 35.05 cm).

### Weight
Portable Cabinet: 5.6"W x 5.4"H x 13.5"D (14.22 x 13.71 x 34.29 cm).

### Model Numbers

<table>
<thead>
<tr>
<th>ENCLOSURE DESCRIPTION</th>
<th>MODEL NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Module Vertical Frame</td>
<td>9850-000</td>
</tr>
<tr>
<td>3 Module Horizontal Frame</td>
<td>9860-000</td>
</tr>
<tr>
<td>3 Module Portable Cabinet</td>
<td>9870-000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VIDEO CABLE EQUALIZER</th>
<th>AMPLIFIERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Amplifier</td>
<td>9800-855</td>
</tr>
<tr>
<td>Horizontal Amplifier</td>
<td>9800-856</td>
</tr>
</tbody>
</table>

COHU RESERVES THE RIGHT TO CHANGE SPECIFICATIONS WITHOUT NOTICE.
Cohu 9600C Series monochrome monitors are high quality, high performance raster scan displays built to international performance standards. They give stable and reliable performance for virtually every surveillance, industrial, medical, or educational CCTV application. They are extremely rugged, with exceptional geometry, and an average MTBF of 60,000 hours.

Cohu 9600C monitors are offered in 9", 12", 15", 17", and 23" (diagonal) models with P4 white phosphor anti-glare faceplate standard and feature a minimum center resolution of 1000 TV lines.

A full selection of rack, ceiling, and wall mounts is available.

**STANDARD FEATURES**

- Variable scanning to ensure signal reliability
- High resolution linear grey scale (16 discernible levels of black and white)
- Rugged metal case construction
- Easy access front panel controls
- BNC connectors for loop through of multiple monitors
- UL, FCC, and CSA listed for 120 V models
- 4:3 aspect ratio
- Switchable picture size from 105% to approx. 85%
- Composite Input compatible with any EIA standard RS-170 input (0.5 - 2 V p-p)
- Differential Input Amplifier provides increased common mode rejection better than 40 dB up to 6 V p-p
- Switchable Power Supply for 110/220/240 V operation; 50/60 Hz 525/60 NTSC and 625/50 CCIR scan operations
9" AND 12" HIGH RESOLUTION MONOCHROME MONITORS

Maximum Resolution
- 1050 TV lines at 31.5 KHz
- 1024 pixels at 36 KHz

Bandwidth
- 30 MHz -3 dB @ 25 V

Horizontal Frequency
- 15.5 - 40.0 KHz

Vertical Frequency
- 40-90 Hz

Power
- 90-264 VAC, 50/60 Hz

User Controls
- On/Off
- Horizontal Centering
- Vertical Centering
- Brightness
- Contrast
- Vertical Linearity
- Vertical Size
- Horizontal Size
- Focus
- Sub-brightness

Interfaces
- 1. One BNC input, 75 ohm terminated
- 2. Two BNC inputs, with loopthrough
- A/B switchable from front panel.

Weight
- 9": 12 lb. (5.45 kg)
- 12": 19 lb. (8.64 kg)

Dimensions
- As illustrated

15" AND 17" HIGH RESOLUTION MONOCHROME MONITORS

Maximum Resolution
- 1000 TV lines at center
- 800 TV lines at corner

Bandwidth
- 30 MHz

Horizontal Frequency
- 15.5 - 16 KHz

Vertical Frequency
- 50-70 Hz

Power
- 90-270 VAC, 50/60 Hz

User Controls
- On/Off
- Horizontal Centering
- Vertical Centering
- Brightness
- Contrast
- Vertical Size
- VTR Switch
- A/B Switch

Interfaces
- A/B BNC inputs, with loopthrough, auto terminating

Weight
- 15": 10.8 lb. (14 kg)
- 17": 37.5 lb. (17 kg)

Dimensions
- As illustrated

23" HIGH RESOLUTION MONOCHROME MONITORS

Maximum Resolution
- 1000 TV lines at center

Bandwidth
- 30 MHz

Horizontal Frequency
- 15 - 40 KHz

Vertical Frequency
- 45-90 Hz

Power
- 90-270 VAC, 50/60 Hz

User Controls
- Same as above

Interfaces
- A/B BNC inputs, with loopthrough, auto terminating

Weight
- 66 lb. (30 kg)

Dimensions
- As illustrated

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>96</th>
<th>XXC</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>9600 C Series</td>
<td>09</td>
<td>9&quot; Tube</td>
</tr>
<tr>
<td>12</td>
<td>12&quot; Tube</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>15&quot; Tube</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>17&quot; Tube</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>23&quot; Tube</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Mounted in standard cabinet</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>19&quot; rack mount assembly</td>
<td></td>
</tr>
<tr>
<td>2R</td>
<td>Dual rack mount for 9&quot; monitor</td>
<td></td>
</tr>
<tr>
<td>RBL</td>
<td>Rackmount with blank left panel</td>
<td></td>
</tr>
<tr>
<td>RBR</td>
<td>Rackmount with blank right panel</td>
<td></td>
</tr>
<tr>
<td>YC</td>
<td>Yoke mount for ceiling installation (17&quot; and 23&quot; only)</td>
<td></td>
</tr>
<tr>
<td>YW</td>
<td>Yoke mount for wall installation (17&quot; and 23&quot; only)</td>
<td></td>
</tr>
</tbody>
</table>
Horizontal fields of view using three different lenses at three distances.
Security System Sees Color In The Dark

SUMMARY: There are many video systems that see in the dark. Here’s a low-cost system that does it in color.

By Glen Southworth

---

**The Combination** of a single-chip color TV camera, timer, and solid state memory have made possible a 1,000-to-one improvement in the ability to see color images at very low light levels.

Applying a technique long used in astronomy, that of making time exposures through the use of special television camera tubes, a new generation of CCTV cameras have made low-cost video systems with exceptional sensitivity practical.

The secret is in allowing the light entering the camera lens to build up a charge on the camera sensor over an extended period of time, as opposed to continually scanning and destroying the charge image at a rate of 30 times per second, as is the case in normal operation. By delaying the scanning process for a number of frames, the sensor charge will continue to build up and deliver a dramatic increase in sensitivity.

This process is very similar to making time exposures with photographic film, and has much the same limitations in that the subject viewed by either type of camera must be stationary and that care must be taken to avoid overexposure.

A major difference, however, is that in the case of the television system, the time-exposure readout consists of a single field or frame of video with the need for a means of capturing and displaying the brief image produced.

A frame counter can be incorporated into a high-quality solid state video memory and be used to control the interval during which the camera sensor remains unscanned. At the end of a preset time, the sensor readout signal is released and the resulting single field or frame of video is scanned out. At the same time scanning commences, a high-speed analog-to-digital converter digitizes the image from the camera. From there it is stored in a Colorado Video Model 4-0 memory for continuous viewing.

An example of the effectiveness of such a system is shown in the nighttime photograph, which is an off-the-screen shot (which accounts for the scanning lines and the soft-appearing resolution) of a time exposure captured by a single-chip COHU model 8215 color camera. Obviously, if the video camera had been a two- or three-chip low-light camera, the picture would have been even better. The system described here, however, can be put together for less than $5,000.

The exposure time was set at 34 seconds with a lens opening of f1.8. The scene was shot at approximately 10:15 PM on a cloudy evening, with the only unnatural illumination being a small light bulb about 120 feet to the right of Santa.

A striking aspect of this video system arrangement is the ability to reproduce vivid color images under conditions where a human observer would see only a dim black and white picture. This technique also allows detection of faint fluorescence in biological specimens, rocks, or other materials when illuminated by ultraviolet light. This takes the camera’s greatly improved sensitivity almost into infrared capabilities.

**Contact:** InfoCard #80, Glen Southworth, Colorado Video, Box 928, Boulder, CO 80306; (303) 530-9580; Fax: (303) 530-9569.

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A striking aspect of this video system arrangement is the ability to reproduce vivid color images under conditions where a human observer would see only a dim black and white picture.
ABSTRACT

The system developed is an enhancement of an existing video system for process control and observation. It was developed to work within a nuclear radiation environment to identify locations and volumes of accumulated in-cell solids and to inspect the interior and exterior of the process vessel. It also performs remote integrity assessments of tanks and pipes routings that are required by regulatory agencies. System highlights are: operation in a highly radioactive environment; microwave transmission of video and control signals; low cost; low maintenance, and; modular design to enable future enhancements. Microwave transmission resolves the complications of a wired system while increasing reliability and safety. The video image is transmitted via microwave out of the cell to TV monitors at consoles in non-radiation zones.

INTRODUCTION

This remote TV inspection system has been developed as an enhancement to an earlier modular unit serving the same general purpose. The previous systems were designed and shipped by Cohu, Inc/Electronics Division and Broadcast Microwave Services (BMS), and are
primarily used as a process observation tool for identifying locations and volume of accumulated in-cell solids. Due to the modular design of the basic unit, new modules are interfaced to the basic unit to add additional capability for the process vessel interior/exterior inspection tasks. The new accessory module will allow insertion of the camera into 3" (75 mm) (ID) vertical process nozzles. The accessory is a 20' (6 m) stainless steel tube, consisting of four hinged sections, with a tilting TV camera and light assembly at the end of the tube. The accessory's flexible hinged sections will allow it to pass through congested piping arrangements before reaching the process vessel nozzle. The accessory will be attached to the original pan/tilt assembly with the tilt function disabled. The tilting of the camera head at the end of the tube is accomplished by a tilt motor mechanism at the camera end and is capable of tilting the camera head section ±95° from vertical.

Assembled from standard and modified standard components, the system creates a previously unavailable microwave-linked remote-control TV inspection system. Figure 1 shows the three major equipment groups of the original system without the accessory. At the top-side operator's location are the control panel, TV monitor, and video receiver unit with its microwave horn antenna. It receives video from and also sends control telemetry to the in-cell unit. These signals are relayed through the passive horn antenna assembly. The in-cell unit hangs from a cable. The pan/tilt unit is bottom mounted, allowing the camera and light a full range of movement for observation.

The accessory described above is attached to the pan/tilt mechanism of the in-cell unit. Figures 5 through 9 show the accessory for the process interior/exterior vessel inspection.

Remotely controlled functions are pan, tilt, zoom, camera on/off, light on/off, auto/manual white balance, and an auxiliary function for control of a film-camera shutter. The reserve capacity of the system allows for other functions to be controlled, too.

**MODULAR DESIGN**

The system is packaged largely from modules selected from standard catalog equipment. Primary components are a Cohu Color CCD Camera and microwave equipment supplied by the sister division of Cohu Inc., Broadcast Microwave Services (BMS).

Other components include various standard lens combinations packaged inside radiation shielded housings, a remotely controlled pan/tilt unit, a standard microwave transmitter/receiver, and other signal processing equipment for the telemetry control and video signals.

The accessory module consists of a 20' (6 m) long, four-section, stainless steel hinged assembly, measuring 1.5" (38 mm) outer diameter (OD), with a tilting housing at the end. On this housing is mounted a 2.5" (64 mm) OD remote head camera and lights.

Figure 2 shows the major components of the original video inspection system: microprocessor control panel, in-cell unit, and top-side unit. Figure 3 shows the accessory module interface to the original in-cell camera. Figures 4 through 6 show the complete vessel interior camera with tilting camera and light head.
WIRELESS TRANSMISSION

Microwave transmission solves the complications inherent in a wired system while also increasing reliability and safety in the hazardous environment. Video images generated by the remote color TV camera are transmitted by microwave to TV monitors in non-radiation zone consoles and office spaces.

The in-cell unit includes a video transmitter, a telemetry receiver, horn antenna, diplex coupler, power supply, and interconnecting cables. All components mount in a standard environmentally sealed aluminum enclosure modified to meet system requirements.

The top-side video receiving unit consists of a video receiver, diplexer, FSK modem, telemetry transmitter, horn antenna, and 115 V ac to 28 V dc power supply mounted in a sealed enclosure.

Signals are relayed via back-to-back microwave horn antennas that target the radio frequency signals.

RADIOACTIVE ENVIRONMENT

The camera unit is designed to operate in a radiation field of $2 \times 10^8$ rad cumulative dose (with occasional exposure to 200 rad/hr to 1,000 rad/hour). To provide radiation shielding, the camera head and lens are housed in a sealed aluminum housing containing lead-shielding. The housing is constructed from 6061-T6 aluminum tubing with 4.5 inch (114 mm) outside diameter and 0.25 inch (6.4 mm) wall thickness. It has a 0.23 inch (5.8 mm) optical-quality glass window.

Inside the housing, the camera head is shielded by 0.25 inch (6.4 mm) of lead. Special radiation tolerant materials are used for various gaskets and seals in the environmental housing.

ACCESSORY MODULE FOR VESSEL INTERIOR INSPECTION CAMERA SYSTEM (VIICS)

The following is a description of the accessory module for the Vessel Interior Inspection Camera System (VIICS) Figures 3 through 6. With minor modification to the original in-cell inspection camera system, the VIICS will attach and detach easily and provide video of the process vessel interior and exterior.

Vessel Inspection Accessory Cover Panel Assembly: The vessel inspection accessory cover panel assembly (Figure 3) contains the new camera control unit (CCU). The cover panel is compatible
with the original in-cell inspection camera when it is desirable to detach the accessory and use only the in-cell camera.

Vessel Interior Inspection Camera System (VIICS): The VIICS Assembly is attached to the original in-cell inspection camera system pan/tilt unit (figure 3). The VIICS assembly is folded into position (figure 4) for storage after disconnecting from the original in-cell inspection camera system pan/tilt unit. The VIICS accessory camera head is shown in figures 5 & 6.

The VIICS camera head assembly is a Cohu model 8280, consisting of a color video camera and auto iris lens, lead shielded housing, two (2) nuclear-grade sealed halogen lights, radiation resistant window glass, and necessary cables and connectors.

The housing end has a rounded centering aide to facilitate easy passage through congested piping arrangements. The centering aide is designed such that it will be at the bottom of the video display and will remain at the bottom during all tilt evolution. The lights provide a minimum of 50% video at a distance of 10' (3 m) with no thermal complications.

The original system to which the above accessory is attached consists of these components: Cohu 6800 series two-piece solid-state color camera:

Cohu Micro Processor Control (MPC) master control unit: 6061-T6 aluminum housing for remote unit: 12 V dc power supply; 15 V ac 13-inch color monitor: 15 V ac pan/tilt unit: 150 W. 20 lumens/watt environmentally sealed light and mating assembly: sealed and lead-shielded housing for remote camera head: Zoom lenses and auto iris lenses: Housing for external crane cab unit enclosing telemetry transmitter, video receiver, horn antenna, diplexer, 115 V ac to 28
V dc power supply, and FSK modem;
Environmentally sealed aluminum enclosure for
in-cell video transmitting unit enclosing video
transmitter, telemetry receiver, diplexer, pan/tilt
board, 115 V ac to 28 V dc power supply,
camera control, and MPC power supply; Video
receiver 2450 MHz. BMS model BMR-50; Horn
Antenna. BMS model BMA-10H; Telemetry
transmitter. BMS model TBT-50-TL; Video
Transmitter. BMS model TBT-50-VS;
Telemetry Receiver. BMS model BMR-50-TL;
BMS FSK Modem; Diplex Coupler, BMS
model TDS-100; 115 V ac to 28 V dc power
supply; Custom modified interconnection cables
for video. RF and power.

REMOTE HEAD COLOR CAMERA
The Cohu compact, rugged 6800 Series
camera consists of the remote camera head with
integral 15-foot (4.6 m) control cable and the
camera control unit (CCU). The CCU was
mounted separately in a sealed enclosure with
the power supply and microwave components of
the system. The assembly containing the camera
head and lens can be replaced without the
necessity for any adjustments. This offers an
easy method of changing to a different type lens
when required.

PAN/TILT UNIT
The mini pan/tilt mechanism is a standard
product that was specifically modified to
accommodate the lighter, smaller
new-generation cameras. The camera head
housing and supplemental light mount next to
each other on the pan/tilt unit moving platform.

SUPPLEMENTAL LIGHT
The supplemental light is an off-the-shelf
unit designed for applications such as
inspection, workbench illumination, and TV
lighting. The light has a broad uniform
color-balanced beam pattern ideal for color TV
and photographic applications.

HORN ANTENNA
The Horn antenna is a standard BMS model
BMA-10H. This is a
circularly-polarized horn
constructed with micro
strip techniques.

The gain of the horn is
a nominal 10 dB at 2 GHz
with 30 degree beam width.
With reflector attached to
the horn, gain is 16 dB
with 20 degree of beam
width. Isolation between
feeds is 25 dB. minimum.

TELEMETRY
TRANSMITTER
The BMS model
TBT-50 telemetry
transmitter is a portable
remote controlled
transmitter available with
operation at any frequency
between 2 and 2.5 GHz.
Power output is selectable
from 2 to 12 watts. For this
system the selected power
output is 5 watts.
TELEMETRY RECEIVER
This B.MS model BMR-50 is a standard-product single-channel receiver designed to receive and demodulate television broadcast signals at any designated operating frequency between 2 and 2.5 GHz. The receiver provides a standard video signal output and two independent audio outputs. An internal frequency-lock light indicates on-frequency conditions.

CONCLUSION
Although the system was developed for a specific application at Westinghouse Hanford in a high radiation environment, its adaptability for other uses at nuclear plants with similar requirements easily could be achieved. The low-cost modular design using off-the-shelf components provides relative ease in modifying the system.

APPRECIATION
The author wishes to thank Westinghouse-Hanford for allowing the use of system details for this paper. The author is grateful to the following persons of Cohu Inc., Electronics Division, for their help in coordinating, editing, reviewing, and preparing the final draft for this paper: Gary Holmes of Publications; Jim Walrod and Eric Hilsen of Engineering; and Ronn Rohe of Marketing.

REFERENCES

Figure 6
Video Sensors:
Picking a Solid-State Sensor Technology Depends on the Application

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Understanding the technology and capability of image sensors and video cameras allows identifying appropriate device solutions for measurement applications. This article examines CCD video camera technologies (frame, interline, progressive scan and charge-injection device) from an operational viewpoint.

The application of video in measurement solutions increases yearly. Understanding the features and benefits associated with video cameras allows a user to select the best technology to achieve the desired result.

Charge-coupled devices (CCDs) are two-dimensional fixed-geometry area arrays of photosites. Array sizes that are available for production-line applications (vs. scientific measurement) typically have 244, 485 and 1000 vertical lines of resolution. Each line has a specific number (typically 510, 768 or 1000) of pixels (picture elements). The greater the pixel count in each line, the higher the horizontal resolution.

Photons striking the silicon pixel generate a charge. This voltage level is referred to as a charge packet. The difference between sensor technologies is the method of construction and the path by which charge packets are transferred from the active array of the sensor chip to the camera circuits.

Frame transfer
A frame-transfer sensor may contain a field or a full frame of pixels on the active imaging area. A second array, called the storage register, also contains either a field or full frame of pixels. As photons strike the active array, a charge potential of electrons is built up in the pixel well. Clocking transfer pulses move the charge packets from the active register to the storage register (Figure 1). The time required to transfer the image from the active array to the storage register is dependent upon array size and clock speed.

A disadvantage of this transfer technique occurs when bright highlights are present. As each line of pixels moves through a bright point, the value of that pixel is altered. In an extreme case, streaking appears as a white vertical line.

The advantage of frame-transfer technology is near-100-percent fill factor: the ratio of active array area to total array area. In addition, these sensors incorporate a thicker surface substrate on each pixel, allowing their spectral response to extend into the near-infrared region (1100 nm).

Laser applications requiring a wide range of spectral response from 400 to 1100 nm are appropriate for this technology.

Progressive scan
In this technology, the lines of video on the sensor are read sequentially, rather than alternately.
as in interlaced cameras. The problem with interlaced cameras is that an object that is moving through the field of view will change positions between field 1 and field 2 relative to its speed of travel during the 16-ms time period. This movement can produce a blurred image.

Progressive-scan cameras such as those using the Eastman Kodak KAI-0370 Interline sensor can solve the problem. However, few monitors are available to directly view progressive scan, and progressive-scan output has not been standardized, so additional consideration is necessary when selecting hardware.

This is a high-cost solution (about $1400), which is appropriate in machine-vision applications requiring a full frame of vertical resolution per integration period.

Interline transfer

The interline-transfer sensor's active pixel area and storage register are both contained within the active imaging area (Figure 2). The active array of this device contains a full frame of pixels (494). Each column of active pixels is separated by a column of storage elements that can store one field. This configuration reduces size and cost in manufacturing the sensor but limits the ability to acquire full-frame vertical resolution, so a strobe or electro-optical/mechanical shutter is necessary for high-speed production lines.

Interline technology offers several advantages. The transfer of charge packets from active image pixels to the storage register happens in a fraction (6.5 μs) of the time required by frame transfer, reducing the probability of highlight smearing. In addition, an effective antialiasing gate inhibits charges spilling over to adjacent pixels.

The disadvantages of this technology are that its spectral response peaks at 550 nm and falls off sharply before reaching the near-infrared region, and its fill factor is only about 35 percent. Placing microlenses above each pixel to focus the light onto the active portion of the sensor raises the fill factor to 70 percent or more (Figure 3). This increases the light accumulating on the sensor by a factor of two.

This low-cost solution (about $800) is ideal for fluorescence microscopy and applications requiring extended integration (multiple frames) for additional sensitivity, or for asynchronous capture of random events.

Charge-injection devices

The development of charge-injection devices (CIDs) focused on two features that were not available with CCDs: addressable pixels and nondestructive readout. The CID imager allows users to select individual pixels by accessing row and column electrodes (Figure 4).

Nondestructive read is achieved when the charge potential is shifted between the electrodes of a single pixel. The difference between the two potentials is representative of the stored signal charge. The sensed potential is converted to a voltage for readout, not shifted to a transfer register.

The user or image-processing algorithm then makes a decision: Either use this value and clear the pixel to prepare for a fresh integration period, or resume collection on top of the previous charge.

This unique feature provides the means to image very bright objects and dim areas within the same scene by reading the highlights before they saturate and allowing additional integration time for dim areas.

This device also has a near-100-percent fill factor and responsiveness out to near-infrared (1100 nm). Machine vision inspection of glass bottles, where bright light can cause bright reflections, is an ideal use of the anti-blooming feature of this technology.

The future

Sensor engineering, manufacturing and quality continuously improve. Smaller-format imagers are fast becoming the norm. Smaller size allows higher yields and lower cost, with additional on-board gain and microlens technology compensating for the smaller pixel size. □
Selecting the Correct Video Camera for Test and Measurement Applications

Joe Barrett

ABSTRACT—Understanding the technology and capability of image sensors and video cameras allows identifying appropriate device solutions for measurement applications. This paper examines CCD video camera technologies (Frame, Interline, Progressive Scan, Charge injection Device) from an operational viewpoint. Video timing (RS-170) and camera features (resolution, sensitivity, shuttering, integration, asynchronous reset) are presented in a non-engineering format.

The application of video in measurement solutions increases yearly. Understanding the features and benefits associated with video cameras allows a user to select the best technology to achieve the desired result.

The goal of this paper is to deliver specific information on camera technologies that allows making an informed decision on integrating the camera into a vision system. Provided is a basic understanding of television and video cameras for optical measurement applications, including information on costs, design features, and benefits associated with using a video camera as a measurement tool. Advantages/disadvantages of the different technology options will be addressed. Information is presented in an operational/applications format rather than a design/engineering research format.

Topics covered include: television timing, technology of image sensors, including CCD and CID devices, operation of Frame Transfer, Interline Transfer, Progressive Scan and Addressable Arrays; Resolution, Modulation Transfer Function/Aliasing; Signal-to-Noise Ratio and Sensitivity (thermal noise); and Explanation of Basic Camera Variables — Gamma, Black Level, Gain, Sharpness, Integration, and Shuttering. Digital video and emerging camera technologies will close the discussion.

BACKGROUND

CCD image sensors were developed in the early 1970's by Bell Laboratories. The technology has progressively improved, resulting in higher yields, better performance, and lower cost. During the mid 1980's solid state technology surpassed video tubes as the primary means of acquiring video images. Chip size has progressively down-scaled in format from 2/3" to 1/2", and recently 1/3". Better manufacturing methods and innovative
485 ACTIVE LINES PER FRAME

FIGURE 1. MONITOR RASTER
designs are preserving the sensitivity and resolution, as well as improving signal-to-noise ratio.

The basic video system requires an illumination source, scene or object to view, and a lens or point source of light. The sensor will convert photons of light to electrons, the camera electronics develop a signal that is output to a monitor for viewing, or image processing system for analysis.

The television timing format was defined by the EIA (Electronics Industries Association) for the purpose of standardization during the 1950's. This work resulted in television specification RS-170, defining the United States standard (525 line format). Certain technology limitations (transformer flyback time) during those years required greater separation between lines of video information. It takes 33.3ms to create a single frame of video; 20% of this time is consumed with synchronization pulses. If the standard were to be created using today's technology this percentage would be greatly reduce. So why do we chose this format for measurement? The answer lies in the availability of inexpensive hardware, off-the-shelf practical solutions, and adequate performance in image processing measurement applications.

BASIC TELEVISION

Standard television timing (RS-170) was optimized for viewing on a monitor by the human eye. The construction of the image onto the monitor is an interesting and important step in understanding video timing.

The television image is developed on the monitor by scanning an electron beam across the face of a monitor phosphor screen. The beam moves from left to right tracing one line at a time. Each beam trace slopes slightly downward from left to right as it paints a line (figure 1). 262½ lines of video will be completed when the beam reaches the bottom of the screen. The beam is reset to the top and proceeds to trace another 262½ lines in between the previous ones. (If 262½ lines are contained in each field, why are only 242½ shown on the monitor? The remaining 20 lines are consumed with synchronization pulses and do not contain visual information.) This is called 2:1 interlaced video. Field 1 is composed of lines 1, 2, 3, ...262½. Field 2 contains lines 1, 2, 3, ... 262½. Two fields are required to produce a single frame of information (262¼ x 2 = 525 lines). The CCTV industry consensus is to refer to field 1 as the odd field, and field 2 as the even field. This is indexed to the last line in the field. Since field one ends in a half-line it is referred to as the odd field.

Phosphors have a specific decay time from excitation to discharge. This fact, plus the desire to reduce the "flicker effect" (appearance of a monitor flashing), deemed the 2:1 interlace as advantageous. 2:1 interlace was selected because it was the most cost effective method that produced a flicker-free image. Another option, progressively scanning all 525 lines in 1/60s would have required twice the bandwidth. The 2:1 interlace solution presents a picture each 1/60s. This greatly reduces the flash effect when compared to updating each picture one 1/30s. This advantage for the human eye is not a benefit in the image processing
BEGINNING OF FIELD 2, END OF FIELD 1

V-DRIVE

V-BLANKING

FIGURE 2. VERTICAL INTERVAL, BEGINNING FIELD 2

BEGINNING OF FIELD 1, END OF FIELD 2

V-DRIVE

V-BLANKING

FIGURE 3. VERTICAL INTERVAL, BEGINNING FIELD 1

ONE HORIZONTAL PERIOD

714 mV PEDESTAL LEVEL 53.5 mV

288 mV SYNC BLANKING LEVEL

H. BLANK 11.1 µS ACTIVE VIDEO 52.4 µS

ONE VIDEO LINE 63.5 µS

FIGURE 4. VIDEO LINE
environment where each image capture (one field) yields only fifty percent of the vertical information. A field is presented each 1/60s and it takes two fields (one frame) to acquire full vertical resolution. The imaging system’s throughput is lowered by a constraint of this standard. Choosing to operate with only one field means the vertical resolution is cut in half (262.5 lines), however, if 50% vertical resolution is sufficient, a benefit exists by processing at twice the rate.

**TIMING SIGNALS**

Video cameras use timing signals at both horizontal (line) and vertical (field) rates. Each vertical interval (1/60s) contains one field of information. Field 1 begins with a line and ends with a half-line (figure 2). Field 2 begins with a half-line and ends with a full line (figure 3). The half lines complete the picture on the top and bottom of the monitor. When referring to the line numbering system, two conditions prevail. If referring to monitor or image processor video, the first line of active video is called line 1. When discussing camera video, line 1 represents the beginning of the vertical interval, and the first line of active video starts at line 21. Twenty lines from each field are consumed by synchronization pulses. A full frame of video — 525 lines — contains 40 lines of synchronization signals. This leaves 485 active lines with video information. Standard 525-line monitors are designed to display these lines on the raster. Higher frame rates (875, 1023, 1125) require special cameras and multi-sync monitors.

**Vertical drive is the signal that separates individual fields and is the monitor’s indication to return the beam to the top of the raster. Vertical blanking separates active lines of video from one field to the next and is used by the monitor to blank (turn-off) the electron beam during non-video time.**

**HORIZONTAL RATE (LINE RATE)**

The duration of one video line (1 H period) is 63.5μs (525 lines occur in 33.3ms, thus 33.3ms divided by 525 = 63.5μs). Each line is composed of synchronization and active video information (figure 4). 17.5 percent (11.1μs) of the line is blanked. This horizontal blanking signal separates the active video of adjacent lines and is used by the monitor to blank the beam during retrace. Horizontal drive separates each line, and in the monitor is the signal that begins retrace. Active video time is equal to the horizontal period (63.5μs) minus horizontal blanking (11.1μs), or 52.4μs.

**RS-170 VIDEO TIMING**

Composite video is the combination of horizontal and vertical synchronization signals and active video information. This is normally provided as an output over a single 75-ohm coaxial cable. The synchronization information allows the receiving device to decode/display the information.

RS-170 timing specifications:
Frame = 33.3ms  525 H Lines  1/30s
Field = 16.6ms  262.5 H Lines  1/60s  
V Blanking = 1.24ms  20 H Lines  
V Drive = 666µs  10.5 H Lines  
H Line = 63.5µs  15.750 Hz  
Active video = 52.4µs  
H Blanking = 11.1µs  
H Drive = 6.35µs  

**VIDEO FORMAT**

Outputs are frequently specified in IRE (Institute of Radio Engineers) units. 140 IRE units is equivalent to a 1 Vp-p composite video signal. This is further sub-divided — 100 IRE (714mV) above blanking for active video and 40 IRE (286mV) below blanking for synchronization. A pedestal level is established above blanking at 53.5mV. This establishes a black reference and prevents video information from sinking below blanking. Increases in amplitude represent progressively lighter shades of gray until white is achieved at 714mV.

To determine actual video output in millivolts when given IRE units:

\[
mV \text{ of Video} = \frac{714mV}{100 \text{ IRE}} \times \text{IRE Units}
\]

Camera manufacturers sometimes specify video output with automatic gain control (AGC) in IRE units (i.e., 80% video with 12dB of AGC).

This equates to: 80 IRE \(\times\) \(\frac{714mV}{100 \text{ IRE}}\) = 571mV

**CCD IMAGE SENSORS**

CCD's are two-dimensional fixed geometry area arrays of photosites. The array contains 485 vertical lines, each line having a specific number of pixels (picture elements). The greater the pixel count in each line, the higher the horizontal resolution. The pixels convert light to an electrical charge. Photons striking the silicon pixel generate a charge proportional to the amount of light present during the integration period. This voltage level is referred to as a charge packet. The difference between sensor technologies is determined by the method of construction and the path by which the charge packets are transferred from the active array of the sensor chip to the camera circuits. The efficiency with which charge packets of electrons can be transferred from pixel of origin to the output without loss makes this technology an excellent measurement device.

Clocking of the charge packets contained within the pixels is at a rate sufficient to read a line (52.4µs) of pixel information while maintaining RS-170 timing. The greater the number of pixels per line the higher the clock speed. Moving the charge packets out of the
FIGURE 5. CCD SENSOR FRAME TRANSFER

FIGURE 6. FRAME TRANSFER
sensor generates lines of analog information that are read serially one line at a time. The camera circuits will merge the video information with synchronization signals.

**DARK SIGNAL**

One of the noise characteristics is Dark Signal, which is produced by the image sensor independent of light input. It is a function of all semiconductor devices. Thermal energy causes a release of electron-hole pairs. The Dark Signal is one of the factors limiting the low end of sensitivity and maximum signal-to-noise ratio. Dark signal is random in distribution across the surface of the array and is a function of design and manufacturing tolerances. Typically, Dark Signal doubles for each 9°C increase in temperature. When integrated over time, or subjected to heat, the Dark Signal will increase and become an artifact of the output, observable as fixed pattern noise. The performance of the CCD can be enhanced by thermo-electrically cooling the sensor.

**FRAME TRANSFER**

RCA pioneered the development of the Frame Transfer CCD in the early 1980's. A Frame Transfer sensor contains two arrays of pixels (figure 5), one for active imaging, and a second to store the field previously collected during the 16ms integration period. Both arrays contain the same number of pixels. The storage register is covered with an opaque material to prevent stray light from changing the contents of any individual pixel during storage or readout. The name "Frame Transfer" seems to suggest that this technology provides complete frames (525 lines) each transfer or integration period. This is not true in most cases. The capacity of most frame transfer sensor storage registers is only one field (243 lines). If a storage register can hold the full 485 lines from the frame, then two fields integrated over an identical period of time can be imaged onto the sensor, stored, and readout.

**Operation.** As photons strike the silicon, a charge potential of electrons is built up in the pixel well. After 16mSec (one field) of integration, a series of clocking transfer pulses move the charge packets from the active register to the storage register (figure 6). During the vertical interval the active array is used as a shift register, moving each row of stored charges vertically one line at a time from the active area into the storage register. Each line moves down sequentially until the entire field (244 lines of pixels) is contained in the storage register. The time required for this transfer is approximately 180μs (for Texas Instruments TC-241 sensor).

A disadvantage of this transfer technique occurs when bright highlights are present. If a pin-point highlight source is impinging on a single pixel location or cluster of pixels, then as each line of pixels moves through the bright point, the value of that pixel will be altered. In an extreme case, streaking appears as a white vertical line on the monitor. Possible solutions are to inhibit imaging during transfer time with a mechanical shutter, or controlled lighting of the target.

When one field is in the storage register, the next field is being integrated onto the
FIGURE 7. FRAME TRANSFER PSEUDO-INTERLACE
active array. The video information in the storage register is clocked into the horizontal readout register one line at a time. The readout rate for 768(H) pixel sensor is 14 Mhz.

The Texas Instruments Frame Transfer chip contains 244 pixels in the vertical direction. This is equivalent to one field. Providing full-frame resolution necessitates an interesting solution called pseudo-interlace. A proprietary technology called Virtual Phase was developed by Texas Instruments to increase the vertical resolution. Each pixel is composed of a Virtual Well and a Clocked Well (figure 7). This divides the pixels in half vertically. Changing the bias voltage to the pixels shifts the centroid by one-half pixel vertically during alternate fields, thus it is possible to increase the vertical resolution. A fifty percent overlap exists vertically between the two fields.

Advantages. Frame Transfer technology exhibits contiguous pixels (near 100% fill factor). Fill factor is the ratio of active area to total area on the surface of the sensor. Each pixel attaches to its neighbor vertically to facilitate the transfer process. Horizontally, thin channel stops separate each pixel to reduce bleed over. Large pixel size increases sensitivity.

The spectral response extends into the near IR region (1100nm). Frame Transfer sensors incorporate a thicker surface substrate on each pixel. The longer wavelengths of light penetrate deeper into the silicon and are still within the well of the pixel generating electrons proportional to the photon input.

The camera can be operated in the non-interlaced mode. The same pixels (no shift) are used for each field. The sensor exhibits 50% less noise under these conditions. Measurement repeatability is then directly tied to the same pixels.

Texas Instruments TC-241
Picture Elements: 780(H) x 244(V)
Active Picture Elements: 754(H) x 488(V)
Pixel Size: 11.5µm(H) x 27µm(V)
Dynamic Range: 60dB
Dark Signal: 20mV @ 45°C
Typical Frame Transfer Camera Cost: $1,500

PROGRESSIVE SCAN

This technology does not operate to the RS-170 standard of 2 interlaced fields combined to form a single frame. Instead the lines of video on the sensor are read progressively (sequentially), i.e., 1, 2, 3, 4, ... 525.

Full vertical resolution during the same period of integration is advantageous. Interlaced cameras have a separation of 16ms between the two fields. Processing at higher speeds or viewing objects in motion, standard RS-170 cameras deliver 1/2 vertical resolution (one field). An object that is moving through the field of view will change positions between field 1 and field 2 relative to its speed of travel during the 16ms time period. RS-170 2:1
FIGURE 8. CCD SENSOR INTERLINE TRANSFER
interlace will produce a blurred image.

Progressive Scan cameras are suited to answer this application. Presently, few monitors are available to directly view Progressive Scan. Some frame grabber (image processing) equipment accept the sequential image and can convert it to interlaced if viewing on a standard monitor is required. The progressive scan output has not been standardized so additional consideration is necessary when selecting hardware.

**Kodak KAI-0370 Interline.**
- Picture elements: 780 (H) x 489 (V)
- Active picture elements: 768 (H) x 484 (V)
- Pixel size: 11.6μm (H) x 13.6μm (V)
- Well depth: 60,000 electrons = saturation 600mV
- Dynamic Range: 60dB
- Dark Signal: 1mV @ 40°C
- Typical Progressive Scan Camera Cost: $1,400

**INTERLINE TRANSFER CCD**

The Interline Transfer sensor presents a different approach to pixel design, transfer, and readout of the video information. The sensors active pixel area and storage register are both contained within the active imaging area (figure 8). Active imaging pixels are not used as transfer pixels as was the case with Frame Transfer technology. The active array of this device contains a full frame of pixels (494). When viewing the imager, each column of pixels is separated by a column of storage elements that are covered with an opaque material. The storage elements have the capacity to store one field. After completion of the 16ms integration time, the charge packets from each pixel are transferred to the storage register. While the next field is gathering charge, the charge packets in the storage register are clocked to a horizontal output register one line at a time.

A sensor configured with a full frame of active pixels in the light sensitive area and only a field of capacity in the storage array reduces size and cost. It also limits the flexibility to acquire full vertical resolution where both fields are captured during identical integration periods.

The storage register is integral to the active image area. Thus the photon sensitive area of each pixel is smaller in size (relative to Frame Transfer). Less light is accumulated and a greater possibility of aliasing exists if detail of information in the field of view falls upon the opaque area. The percentage of fill (active image area to total image area) is approximately 35%. The spectral response peaks in the photopic area at 550nm and falls-off sharply before reaching the near IR region.

**Advantages.** Several advantages are offered with Interline technology. The transfer of charge packets from the active image pixels to the storage register happens in a fraction (5ns) of the time required by Frame Transfer. Thus the probability of highlight smearing is reduced. An effective anti-blooming gate inhibits charges spilling over to adjacent pixels.
FIGURE 9. INTERLINE CCD SHUTTERING

ONE VERTICAL INTERVAL

MICROLENS LIGHT GATHER/FILL-FACTOR

FIGURE 10A. MICROLENS TECHNOLOGY

INDIVIDUAL PIXEL WITH MICROLENS

FIGURE 10B. MICROLENS INTERLINE PIXEL
Individual pixels have a lower dark signal and a greater ability to gate away excess charge build-up into the substrate, providing wider dynamic range.

The Sony IXC038 Interline design is shutterable at the pixel level. The Frame Transfer device required $180\mu s$ to clear the array. Interline clears the contents of each pixel once every $63\mu s$ (during horizontal blanking). The actual clear time is only a few nanoseconds. During shuttering the active array is cleared each horizontal period until the time remaining in the field equals desired integration time (figure 9), then shuttering ceases, and normal charge accumulation begins.

The shutter mode steps in increments. Each change cuts the light in half as the integration period is halved. Shuttering is accomplished across its full range in 8 steps ($1/60s$ to $1/10,000s$). Modifying the camera to externally control the shutter circuit with a TTL pulse provides discrete steps at 242 levels, effectively stepping one line at a time.

A disadvantage of shuttering is the inability to obtain full frame (vertical) resolution. If two fields can be integrated during the same period, effectively stored, and then readout, true full frame resolution is achieved. Since the transfer register is designed to hold and readout only one field at a time, the information contained in the second field remains on the active array and is clocked into the substrate drain during the horizontal blanking period at the beginning of the next field. Clearing of the pixels happens across the entire array, not for selected fields. The inherent characteristics built into the sensor chip structure are the driving factors toward what features are available in cameras.

The interline chip can be asynchronously reset. A reset pulse input will initiate the vertical interval and clearing of the array nine lines ($571\mu s$) later. If the illumination to the sensor is controlled and/or a strobe is used, it is possible to quickly capture and readout a field of information. Asynchronously resetting the sensor and strobing in coincidence with reset, or before the transfer time (9 lines later), provides a quick capture time to readout ($571\mu s$ to $16.6ms$). The first field begins readout $571\mu s$ after reset and completes $16.6ms$ after reset. The second field, still on the active array, follows the first and begins reading out. This operation takes $16.6ms$. Acquiring RS-170 full-frame (vertical) resolution requires $33.3ms$.

An alternative to asynchronous operation is start-stop mode. By configuring the camera to shutter each H period, pixel charge accumulation will be dumped every $63.5\mu s$ (H period) until an external control pulse is received. This pulse commands the shutter to cease, and begins active integration. The duration of integration is equal to the pulse width plus $9$ H lines. At the conclusion of the input pulse, transfer takes place $9$ H later. Field 1 will have integrated for the input pulse width "x" plus $571\mu s$. Field 2 has integrated for "x" plus $571\mu s$ plus $16.6ms$. The reason field 2 has integrated for an additional vertical interval resides in the limitation of the storage register to hold only one field at a time. In this mode shutter is inhibited for one field after reset to avoid destroying the second field.

A recent development is the addition of micro-lenses placed above each pixel to focus the light onto the active portion of the sensor (figure 10a). Typical Interline sensors have a
FIGURE 11. CHARGE INJECTION DEVICE SENSOR (CID SENSOR)

FOUR STATES OF THE CID PIXEL

A. ++•++
   SENSE ELECTRODE     COLLECTION ELECTRODE
   COLLECTION STATE

B. ++++
   FLOAT
   FIRST READ

D. ••++
   INJECT TO SUBSTRATE

C. ++++
   READ
   NON-DESTRUCTIVE READ

FIGURE 12. CID SENSOR PIXEL MODES
fill factor of 35%. These focusing micro-lenses increase light gathering ability and reduce aliasing (figure 10b). Depending on the quality of the lens and precise placement, fill factor is raised to 70% or more, and the light falling on the sensor is increased by a factor of two (6dB, 1-f stop).

Low Dark Signal and wide dynamic range make this technology a good candidate for integration. Integration is extending the time that photons strike the pixels to longer than the standard 16.6ms. This mode requires the target to be stationary, or the image will be blurred. The longer the integration time the greater the charge build-up on the pixels, and increasing the ability to image in low light. Sensitivity increases by a factor of two when the field integration period is doubled (i.e., 2, 4, 8, 16 fields). Pixel non-uniformities will be exaggerated as integration time increases. A fixed pattern noise will eventually appear at the output. It shows on the monitor as a "starfield" pattern (like looking through a telescope at the stars). The amount of noise will be partially dependent on ambient temperature. Cooling the sensor extends integration without this artifact. Imaging still objects provides sensitivities equal to or greater than intensified cameras with this CCD technology.

Sony ICX-038.
Total Pixels: 811(H) x 508(V)
Active Pixels: 768(H) x 494(V)
Cell Size: 8.4μm(H) x 9.8μm(V)
1/2" format 8.4(H) x 768 = 6.4mm 494(V) x 9.8 = 4.8mm
Dark Signal 2mV @ 60 °C
Dynamic Range: 80dB
Typical Interline Transfer Camera Cost: $800

CID-CHARGE INJECTION DEVICE

CID imagers were developed in the early 1970's by General Electric for Aerospace applications. The development focused on two features that were not available with standard CCD's: addressable pixels and non-destructive readout.

The CID imager allows the user to select individual pixels by accessing row and column electrodes (a simple X-Y address; figure 11). The pixel value can be read non-destructively because the charge is not shifted out. These two unique features separate the CID imager from other sensor technologies.

Non-destructive read is achieved when the charge potential is shifted between the electrodes of two capacitors of a single pixel. The difference between the two potentials is representative of the stored signal charge. The sensed potential is converted to a voltage for readout as opposed to shifting a charge packet into a transfer register.

Photons striking the silicon of the collection electrode will accumulate holes during the integration period (figure 12a). To determine the amount of charge accumulated the pixel is "read." The sense electrode is allowed to float, the collection electrode is supplied a negative, then the potential is read (12b). Next a negative potential is supplied to the sense
electrode and a positive potential to the collection electrode (12c). The accumulated charge packet of holes will shift to the sense electrode where another read is performed. The difference in the two potentials represents the voltage equivalent of the amount of light striking the pixel during the integration time.

The user or image processing algorithm makes a decision: either use this value and clear (12d) the pixel to prepare for a fresh integration period, or resume collection on top of the previous charge (12a). Clearing a pixel is accomplished by supplying a positive potential to both electrodes forcing the holes into the substrate (12d).

This unique feature provides the means to image very bright objects and dim areas within the same scene by reading the highlights before they saturate and allowing additional integration time for dim areas. CID chip technology has deeper pixel wells than Frame or Interline Transfer (typically 300,000 vs. 80,000 electrons, respectively), thus providing wider dynamic range. The sensitivity of CID’s is about half that of Frame or Interline devices.

Advantages. Near 100% fill factor, the entire active image area is sensitive to light. No separate storage register is required. There are no opaque areas on the imager. The isolation of each individual pixel and lack of transfer/storage registers provides greater resistance to blooming and smearing. Since the user controls the readout, the following reads are possible: progressive, partial area, or individual pixels. This can increase the information output rate if less than a full frame is desired. The fewer lines of readout desired the faster the update rate (non RS-170).

Asynchronous reset provides capture of fast events by operating the camera in the Charge Inject mode (not allowing a charge to build on the pixels). Switching to "collect" upon receipt of an input control pulse starts integration time. Objects entering the field of view randomly can be captured in the center of the frame. The external trigger can activate a strobe and/or transition the camera into collect mode.

CIDTEC 2710 RS-170.
Sensor Picture Elements: 776H x 512V
Active Picture Elements: 755H x 484V
Pixel size: 12.0μm x 12.7μm
Format: 2/3"
Typical CID Camera Cost: $2,900

IMAGE FORMAT
The size of the sensor's active imaging area is defined as image format. The most widely available and economic sensors are 2/3", 1/2", and 1/3" RS-170 devices. CCTV sensors have an aspect ratio of 4 x 3, meaning that the ratio of horizontal width to vertical height is four to three, respectively.

Sensor engineering, manufacturing, and quality continuously improve. The smaller format imagers are fast becoming the norm. Smaller size allows higher yields and lower
COMBINATION OF CAMERA AND MONITOR GAMMA = 1.0

FIGURE 13. GAMMA CORRECTION
Recent camera entries into the market with 1/2" and 1/3" imagers present equal resolution and comparable sensitivity at less cost. One might think that sensitivity must be lower due to the smaller pixel size. While it is true that less area means fewer photons, sensor manufacturers have compensated by adding additional gain on the sensor chip and incorporating micro-lens technology. When replacing existing cameras or seeking new solutions it is very likely that a smaller format sensor will be selected due to availability and price. Changing from a larger format to smaller and maintaining the same optics have the effect of magnifying the image.

The image format approach to identifying the size of the active image area began with tubes. The diameter was chosen as the specific identification criteria. Typical tubes have diameters of 1", or 2/3". This designation was carried forward and applied to sensor chips. The following dimensions represent the aspect ratio of the three most common RS-170 image sensors:

- 2/3" sensor 6.6mm(V) x 8.8mm(H) x 11mm Diagonal
- 1/2" sensor 4.8mm(V) x 6.4mm(H) x 8mm Diagonal
- 1/3" sensor 3.6mm(V) x 4.8mm(H) x 6mm Diagonal

**MECHANICAL INTERFACE**

Standard CCTV cameras are equipped with C-Mounts (specific thread and pitch) for attachment of CCTV lenses. Lenses are available from a variety of manufacturers with the thread type defined as C-Mount. Microscopes with trinocular ports also have C adapters. Recently, CS-mount lenses have been introduced in tandem with camera manufacturers' new 1/2" and 1/3" format sensors. The difference between C and CS is the back focal distance. Back Focal is the distance between the center of the rear lens element and the sensor image plane. C lenses require a back focal length of 17.5mm; CS lenses only require 12.5mm, meaning that the CS type lens is mounted closer to the image array. This allows for using smaller and fewer optical elements, which in turn results in smaller mechanical size and lower cost. Optically the quality of better CS lenses is equal to C lenses. Apertures are proportionally smaller and the lens uses fewer elements. Light transmission is equal to, or better than C type.

**GAMMA**

Gamma correction is a result of non-linear phosphor coating on picture tubes. Picture tubes consistently compress black signals and stretch whites. Gamma defines the slope of the curve representing the difference between linear input and actual output. The sensor is a linear output device. If the camera is viewing a scene that changes linearly from left to right (with left representing black and right representing white), the display of this information on the monitor will appear as a slope of a curve that is shallow in the dark region and steep in the white areas (figure 13). For a given increase in illumination, a corresponding linear increase in millivolts is generated at the output of the sensor. The picture tube (monitor) will not accurately represent this information. During the infancy (1950's) of television it was decided to incorporate gamma correction into the camera since at that time far fewer cameras existed than monitors. Today gamma correction still resides in the camera.
FIGURE 14. LOGARITHMIC RESPONSE
HUMAN EYE

FIGURE 15. HUMAN EYE EDGE DETECTION
When desiring to view the output of a camera directly on a monitor, a gamma of 0.45 is selected. This will stretch the black and compress the whites. Since monitor picture tubes have a gamma factor of approximately 2.2, applying the camera correction of 0.45 yields a linear ratio \(2.2 \times 0.45 = 1\).

Measurement applications, inputs to frame grabbers, and image processing require the camera be operated in a gamma of 1.0, providing a linear output.

**HUMAN EYE RESPONSE**

The response of the human eye to illumination is also not linear. It is actually a logarithmic response, where the steepness of the curve is greatest in the darker regions (figure 14). The curve flattens out in the white region. This makes incremental changes of the same magnitude easy to identify in the black area and difficult in the white region. By darkening images, we increase our ability to discern contrast changes.

Another anomaly of the human visual system is the apparent sharpening of edges. An edge enhancement mechanism is built into our human imaging system. Viewing black and white rectangles placed horizontally in a row, the white areas appear to be whiter just prior to the transition to black (figure 15). Equally, it would appear as if the black areas become a little blacker just before transition to white.

Camera circuits can be altered to provide a similar sharpening of edges. Most cameras include a filtering operation to smooth pixel-to-pixel transitions. Changing the filter's parameters creates sharpness at the expense of adding ringing (Oscillations).

**RESOLUTION**

The ability of a sensor to reproduce the detail of a viewed image is called resolution. Vertical line resolution is 485 for a 525-line raster. This is the total number of active video lines. When reading the image on a monitor using the EIA test chart or another wedge pattern, historical experimental research has lead to a kell factor of 0.7 times the active lines equal to vertical resolution on the monitor. Thus vertical resolution displayed on a monitor is 350TVL \((485 \times 0.7)\) for RS-170 525-line systems.

A limitation to reproducing an image spatially is stated as the Nyquist Sampling Theory. To clearly resolve a given frequency, the sample rate must be a minimum of two times the frequency being sampled. Aliasing occurs if the sample rate is less than twice the original signal frequency to be imaged.

**Modulation Transfer Function.** Modulation transfer function represents the contrast between black and white information at differing resolutions. When the camera is viewing a black and white target with a converging wedge pattern, the lower resolution detail will be presented as having a much higher modulation (figure 16). Higher resolution details appear as only slight changes in gray level at the limiting resolution of the sensor. Camera circuit rise time and bandwidth limitation create this condition.
FIGURE 16. MODULATION TRANSFER FUNCTION (MTF)
**Horizontal Resolution.** Horizontal resolution is the number of black and white lines that are discernible across a video line equal to the height of the raster. Each line is counted, as opposed to line pairs which are used in photography and image intensifiers.

To find pixel resolution:

\[
\text{Number of Pixels} \times \frac{3H}{4W} = \text{Resolution per picture height}
\]

To find line pairs per millimeter:

\[
\text{Lp/mm} = \frac{\text{HTVL}}{2} \times \frac{4}{3} \times \frac{1}{\text{PW}}
\]

H = height
W = Width
HTVL = horizontal TV lines
PW = picture width

Resolution can also be directly read off a monitor when the camera is focused onto an EIA resolution test pattern. Attention needs to be paid to the variables associated with the system to ensure the result is not limited by another system component (e.g., monitor, lens).

The greater the horizontal detail or number of pixels, the faster the clock speed required if RS-170 timing is maintained and higher resolution is desired. The total number of horizontal pixels clocked out during the active video time (52μs) for a 768-element sensor equates to a pixel clock frequency of 14Mhz.

\[
\frac{52\mu s}{768 \text{ Pixels}} = 67\text{ns/pixel} \quad \frac{1}{67\text{ns}} = 14\text{Mhz}
\]

Higher resolution cameras (1134 H-pixels) operating at the RS-170 line rate increase the pixel clock frequency:

\[
\frac{52\mu s}{1134 \text{ Pixels}} = 45.8\text{ns/pixel} \quad \frac{1}{45.8\text{ns}} = 21\text{Mhz}
\]

**ANALOG TO DIGITAL.**

An RS-170 signal input to an A-D converter is sampled or chopped into segments, each one representing a specific location on the original sensor array. A phase locked loop is used by the frame grabbing device to arrive at a close approximation of pixel spatial location. Some pixel jitter or uncertainty is inherent in this process. Using the camera pixel clock achieves a better result. Each sample or pixel is given a brightness value based on the
number of bits, where 8-bit depth equals 256 shades of gray.

The Nyquist sampling theorem again applies. To fully represent the rate of brightness change in the original image we must sample at a rate at least two times the highest spatial frequency. This ensures a re-creation of the detail.

Aliasing is the erroneous representation of high frequency information from the original image. Aliasing occurs when scene details have a spatial frequency greater than half the sampling frequency. If under sampling is happening, the result is transference of the high frequency information to a lower frequency which appears as a moiré pattern.

APPLICATIONS OF VIDEO CAMERAS


FUTURE POSSIBILITIES FOR VIDEO CAMERAS

Active Pixel Sensors, down-scaling format, image processing in the camera, alternative formats, HDTV, Digital output, camera on a chip.
Bibliography


RIDERS OF THE MARTA rail transit network in Atlanta have at least one extra level of safety, thanks to a surveillance camera system installed at its stations.

"Back in the mid-1970s, in the original design concept, it was decided that a camera system would be installed in the rail transit system," recalls MARTA police chief Gene Wilson. Since then, the Metropolitan Atlanta Rapid Transit Authority has put in more than 360 surveillance cameras, adding them as new stations are brought on line.

"On occasion, the cameras will help us with crime problems, but their primary function is as an aid to customer service," he says.

Cameras have been placed inside the paid areas of the stations, offering essentially full coverage. Each rail station has between 12 and 14 cameras, and these are monitored from one of five "zone centers." Each zone center has about 95 monitors, and the operator who runs the cameras can start recording whenever he sees something unusual, or if he gets a request to do so from a "help phone," a handicap door access, a fare gate, or any other location he's alerted to.

The main advantage of the camera system is customer service, as Wilson explains. "Many times it has proven itself helpful in controlling crowds on a waiting platform. If we see a potential problem building, we'll send a transit police officer to the spot. Once there, the officer will make sure the people don't get too close to the rail or the tracks."

Police officers and emergency crews are dispatched to a scene because of the cameras. In some cases, the cameras spot workers who need help. But the cameras also serve as an effective deterrent to crime. This is true for serious crimes as well as for catching those who try to avoid paying their tokens at the fare gate.

The MARTA police force includes some 220 sworn officers, and this must also be factored in as a meaningful crime deterrent for the rail system.

The MARTA has put in more than 360 surveillance cameras.

The Best Equipment For the Job

The MARTA cameras are not recording all the time, but if the camera operators at the zone centers see something unusual, they hit the record button immediately. "We've looked at putting in an enhanced system, one that records continuously, but I don't know if we'll ever do that," Wilson says.

During the past decade, the MARTA system has relied heavily on surveillance equipment from Cohu's Electronics Division. The first cameras installed in 1985 were 3100 series tube models, including both fixed and zoom lenses. In 1990, more stations were added, so newer 4800 series cameras were added.

According to Laura Sallee, a Cohu applications engineer, the Cohu 3100 series is the predecessor of the 4800 series CCD cameras. "The 4800 series is ideal for applications that require both high resolution and high sensitiv-
Transit police officers benefit from the added assistance video gives.

ity, she says. "These cameras are installed at thousands of sites around the world and support a wide range of security/surveillance and electronic imaging applications."

Specifically for the MARTA setup, the 4800 series works well because of the large areas covered by camera surveillance. They're placed in both indoor and outdoor locations and each camera is encased in a sealed pressurized environment-resistant housing. Cohu 9-inch 9600 series monitors are used in the zone centers.

Atlanta has become one of the leading transportation centers in the U.S. In 1837, when the community was originally laid out, it was named Terminus, and it was set up to be the southern end of a proposed railroad from Chattanooga, Tennessee. By the time of the Civil War, it had been renamed Atlanta, and had a population some 15,000. Of course it had become a major railroad hub. Because of its strong growth of businesses and city facilities, the city also has attracted many major conventions, including the National Association of Broadcasters (NAB).

Providing cameras for transportation centers is not new. But the sheer size and scope of the MARTA system has presented some unique security and surveillance challenges. These challenges continue to be met with the opening of every new station, keeping the flow of rapid rail passengers moving in and around the Atlanta metro area.

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ENVIRONMENTAL CAMERAS FOR TRAFFIC SURVEILLANCE
by Tim Jones
Senior Applications Engineer

Cohu Inc./Electronics Division, tends to use the "no nonsense" approach in supplying video for traffic applications.

One of the most unique features Cohu offers for the traffic industry is its variety of ruggedized camera enclosures. These rugged enclosures are sealed and pressurized, and are offered in either 3", 4.5" or 6" outside diameter. They are purged of oxygen and pressurized with 5 psi of dry nitrogen. Why take these measures? One word: reliability. This insures that the internal circuits of the camera and the lens remain free from contaminates, e.g.: humidity, salt, dust and debris normally associated with all traffic applications.

In addition to the controlled internal environment for the camera, Cohu installs desiccant bags to insure that no residual humidity is retained in the camera. The environmental enclosures can be equipped with thermostatically-controlled heaters and sunshields as a standard configuration. The lens offered in most traffic applications has an auto/manual iris that can be controlled at either the master or remote/local control receivers. Other options available include wiper washer assemblies, low pressure alarm switches, fiber optics and 24-character programmable alphanumeric generators.

The environmental housing is made of aluminum and painted with a polyurethane paint as a standard.
The sealed camera enclosure is widely used throughout traffic surveillance systems and is especially useful in areas where humidity is high. By creating a controlled environment for cameras mounted in the great outdoors, the camera has an increased life which will decrease maintenance costs. *Cameras sealed in Cohu environmental housings simply cost less to maintain and are more reliable than those without the environmental housing.* The specific maintenance costs associated with non-environmental housings are: bucket truck rental, lane closures, and actual replacement costs of camera, lens, and associated hardware.

Cohu also features a local/remote Camera Control Receiver (CCR), designed specifically for use in the traffic market. The CCR is designed for installation in a 19\" rack frame, (for use in Nema or 330-type enclosures) and is featured with several useful controls.

The CCR can interface with either RS-232 or RS-422 communications and features a local/remote control switch. The CCR is equipped with dual RS-232 ports for drop and insert applications. In the remote control mode the CCR will interface with the MPC Master Control Panel via RS-422 or a PC via RS-232 located at the Traffic Operations Center (TOC). In the local mode, the CCR can operate the camera pan/tilt from the site for maintenance, repair and local control when an incident occurs. This eliminates the need for two way radio communications to the TOC. The CCR includes a BNC video output on the front panel to allow a local operator to view a monitor while performing tests, as well as a rear BNC connection for standard system operation. In addition to the standard camera pan/tilt functions, the CCR can be easily modified for use with a variety of communication modems and specific system configurations to meet the particular needs of the customer. Additionally, fiber optics transceivers for communications and video can be added.

The MPC Master Control Panel will interface via RS-422 over shielded twisted pair to the CCR and will interface with a PC or various other equipment via RS-232. The MPC Master can control most brands of matrix switchers and will interface with several different graphic user interface modules. In a standard configuration the MPC Master Control Panel provides the communication "Back Bone" for up to 223 separate camera sites and 32 remote stations.

These are just a few of the many reasons Cohu has maintained a high standard of quality throughout the more than four decades of operation.

For more information call the Traffic Experts at Cohu or your nearest Cohu sales representative.
Image Sensors, the Input Device for
Machine Vision Applications

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ABSTRACT—Understanding the technology and capability of image sensors and video cameras allows identifying appropriate imager solutions for measurement applications. This paper examines area array CCD (RS-170) video camera technologies (Frame, Interline) from an operational viewpoint. Camera features (field vs. frame resolution, shuttering, integration, asynchronous reset) are presented in a non-engineering format.

INTRODUCTION

The application of video in measurement solutions increases yearly. Understanding the features and benefits associated with video cameras allows a user to select the best technology to achieve the desired result.

The goal of this paper is to deliver specific information on camera technologies that allows making an informed decision on integrating the camera into a vision system. Provided is a basic understanding of video cameras for Machine Vision measurement applications. Advantages/disadvantages of the different technology options will be addressed. Information is presented in an operational/applications perspective rather than a design/engineering format.

Topics covered include: Technology of area array image sensors, including operation of (Texas Instruments) Frame Transfer, and (Sony) Interline Transfer devices. Field/Frame Resolution, Integration, Asynchronous Reset, and Shuttering as applied to the differing sensor technologies.

BACKGROUND

CCD image sensors were developed in the early 1970's by Bell Laboratories. The technology has progressively improved, resulting in higher yields, better performance, and lower cost. During the mid 1980's solid state technology surpassed tubes as the primary means of acquiring video images for most applications. Better manufacturing methods and innovative designs are enhancing sensitivity, resolution, and improving signal-to-noise ratio.
FIGURE 1. CCD SENSOR FRAME TRANSFER
The basic video system requires an illumination source, scene or object to view, lens, video camera, and monitor/image processing equipment. The scene is focused onto the imager by the lens, the CCD image sensor will convert photons of light to electrons, camera electronics process the image and add timing signals which are output to a monitor for viewing, or image processing system for analysis.

**CCD IMAGE SENSORS**

**Definition.** CCD's are two-dimensional fixed geometry area arrays of photosites. The array contains lines (242 to 485, typical) of pixels (picture elements). Each line contains 510 to 1K pixels, the greater the pixel count in each line, the higher the horizontal resolution. The greater the number of lines the higher the vertical resolution. RS-170 video standard limits the maximum number of active video lines to 485. The total number of lines for RS-170 is 525, yet only 485 contain image information, the balance of 40 lines are consumed with synchronization signals.

Each pixel converts light to an electrical charge. Photons striking the silicon pixel generate a charge proportional to the amount of light present during the integration period (16.6ms, typical). This potential is referred to as a charge packet. Sensitivity is a function of the number of photons striking the sensor, integration time, and the efficiency of the pixel to convert photons of light to electrons. This process is analog and yields a representative analog voltage output from the imager.

The difference between sensor technologies is determined by the method of construction, and the path by which the charge packets are transferred from the active array of the sensor chip to the camera circuits. The efficiency with which charge packets of electrons can be transferred (.99995) from pixel of origin to the output without loss makes this technology an excellent measurement device.

**Timing.** Clocking of the charge packets contained within the pixels is at a rate sufficient to read a line (52.4μs) of pixel information while maintaining RS-170 timing. The greater the number of pixels per line the higher the clock speed. (e.g., 768 horizontal pixels; 52.4μs/768 = 68.2ns/pixel, or 14Mhz clock rate). The charge packets are clocked out of the sensor serially one pixel at a time, line by line. The camera circuits will merge the video information with synchronization signals, providing composite video (RS-170) to a monitor or frame grabber.

**FRAME TRANSFER**

RCA pioneered the development of the Frame Transfer CCD in the early 1980's. A Frame Transfer sensor contains two arrays of pixels (fig. 1), one for active imaging, and a second to store the field previously collected during the 16.6ms integration period. Both arrays contain the same number of pixels. The storage register is covered with an opaque material to prevent stray light from changing the contents of any individual pixel during storage or readout.
FIGURE 2. FRAME TRANSFER

FIGURE 3. FRAME TRANSFER

FIGURE 4. FRAME TRANSFER PSEUDO-INTERLACE
Several columns of pixels in the active image area are also covered with an opaque material. Referred to as "Dark Reference Pixels", their values are used by the camera to provide DC restoration by clamping the video line to a known level. This compensates for changes in temperature.

The name "Frame Transfer" seems to suggest that this technology provides complete frames (485 active video lines) each transfer or integration period. This is not true in many cases. The Texas Instruments TC-245 has only a field of video capacity on the active image array and storage register, thus full frame resolution will always contain two fields that are separated by a 16.6ms time separation. If the active image array and storage register could hold the full 485 lines of a frame, then two fields integrated over an identical period of time can be imaged onto the sensor, stored, and readout. Imagers that have the capability to transfer two fields at a time into a full frame storage register are available, yet, significantly more expensive.

**Operation.** As photons strike the silicon of the sensor pixels, a charge potential of electrons is accumulated in the pixel well. After 16.6ms (one field) of integration, a series of clocking pulses transfers the charge packets from the active register to the storage register (fig. 2). During the vertical interval the active array is used as a shift register, each row of charges moves vertically one line at a time from the active area into the storage register. Each line moves down sequentially until the entire field (242 lines of pixels) is contained in the storage register. The time required for this transfer is approximately 130μs (TC-245). When one image (field) is in the storage register, the next image (field) is being integrated onto the active array. The video information in the storage register is clocked to the horizontal readout register one line at a time, then moved out at the 14Mhz rate.

The Texas Instruments Frame Transfer chip contains 242 pixels in the vertical direction. This is equivalent to one field. Providing full-frame resolution necessitates an interesting solution called pseudo-interlace. A proprietary technology called Virtual Phase was developed by Texas Instruments to increase the vertical resolution without adding more rows of pixels to the array. Each pixel is composed of a Clocked Well and a Virtual Well (fig. 3). A Virtual Barrier provides separation between each pixel well to prevent bleedover. The Antiblooming Gate provides means to discharge excess electrons, thus reducing saturation and blooming. The wells are both equally sensitive to light. The purpose behind two wells per pixel is to provide means to divide the pixel in-half. Changing the bias voltage to the active image array shifts the center (centroid) by one-half pixel vertically (fig. 4) during alternate fields, thus it is possible to increase the vertical resolution and decrease aliasing (loss of detail due to under sampling). A fifty percent overlap exists vertically between the two fields. The positioning of a line of pixels is such that for field 1, lines 1, 2, and 3 are adjacent. The pixels used for field 2, line 1 use 50% of the pixel from field 1, line 1, and 50% of the pixel from field 1, line 2. This sequence repeats for the entire second field.

**Shuttering.** Photons of illumination are normally allowed to integrate on the image sensor for 16.6ms before transfer to the storage register. Shuttering decreases the integration period to either 1/1000sec (1ms), or 1/2000sec (500μs). This feature provides a stop action effect for objects in the field of view that are in motion. The shorter integration period also
FIGURE 5. SHUTTER TIMING

FRAME TRANSFER

SYNC

CLEAR ARRAY PULSES

SHUTTER TRANSFER PULSE

VIDEO OUTPUT

FIGURE 6. ASYNCHRONOUS RESET

FRAME TRANSFER

TRIGGER PULSE

TRANSFER PULSE

SENSOR INTEGRATING STROBE PERIOD

VIDEO OUTPUT

X = INTEGRATION PERIOD, ranges from 4 ms to 16.6 ms
Maximum triggering repetition rate = 240 Hz
decreases sensitivity; four f-stops for 1ms, and five f-stops for 500μs. Since each f-stop effectively cuts the electron accumulation in-half, shuttering may require additional illumination.

**Timing.** Achieving an electronic shuttering effect on the image sensor requires additional pulses. No mechanical device is used to stop light from reaching the sensor, thus a way must be provided to clear the sensor of undesired charge accumulation. This is accomplished with Clear Pulses (fig. 5). Two clear pulses in rapid succession initiate transfer of the image accumulated on the active array to the storage register. The first pulse shifts an undesirable image that has accumulated for the previous 15ms. The second pulse, a few microseconds later ensures the array is emptied of any residual accumulated charge. Then the sensor is allowed to integrate for the desired 1ms, or 500μs period. A transfer pulse initiates the movement of the captured video image into the storage register for readout.

**Asynchronous Reset (option).** Allows external control of the vertical interval by supplying a trigger pulse from another source to synchronize the camera to external events. Upon receipt of the trigger pulse (fig. 6); the vertical interval is initiated, and the previously accumulated charge on the active array will be transferred to the storage register within 200μs. This field of information will contain an image that integrated on the sensor immediately prior to receiving the trigger. The duration of integration on field A will be random (the trigger pulse can occur anytime during the vertical period), resulting in an unpredictable output. Thus, field A is not used. After the 200μs period, the active array is now ready to integrate the desired image by strobing the subject. Integration on the array will continue until the next vertical sync pulse (16.6ms), or next reset pulse, whichever occurs first. Then the cameras internal transfer pulse will move the information to the storage register and begin readout. If the repetition rate of the trigger pulses is increased, the vertical pixel count will decrease.

Examples:
60Hz = 242 vertical lines
120Hz = 121 vertical lines
240Hz = 61 vertical Lines

The readout from the storage register is limited to a fixed RS-170 rate, thus increasing the frequency of the trigger pulses will not allow sufficient time to read the entire field out of the storage register before the next image is clocked from the active array to the storage register.

**Advantages.** Frame Transfer technology exhibits contiguous pixels (near 100% fill factor). Fill factor is the ratio of active image area to total image area on the surface of the sensor. Each pixel attaches to its neighbor vertically to facilitate the transfer process. Thin channel stops (barriers) separate each column of pixels to reduce bleed over. Large pixel size increases sensitivity.

The spectral response ranges from 250nm (UV) with the faceplate removed, through the
Figure 7. CCD Sensor Interline Transfer
photopic (visible) to a peak at 800nm, and extending into the near infrared (IR) region up to 1100nm. Frame Transfer sensors incorporate a thicker surface substrate on each pixel. The infrared wavelengths of light penetrate deeper into the silicon and are still within the well of the pixel generating electrons proportional to the photon input. The same IR input to an interline device will pass completely through the thinner Interline technology without registering a signal.

This sensor can be operated in the non-interlaced mode. The same pixels (no Virtual Phase shift) are used for each field. The sensor exhibits 50% less noise, and 50% less vertical resolution in this mode. Measurement repeatability is then directly tied to the same pixels.

Disadvantage. When bright highlights are present, or a pin-point source light is impinging on a single pixel location or cluster of pixels, then as each line of pixels moves through the bright point during transfer, the value of that pixel will be altered. In an extreme case, streaking appears as a white vertical line on the monitor. Possible solutions are to inhibit imaging during transfer time with a mechanical shutter, or controlled lighting of the target.

Frame Transfer Sensor: TC-245.
Picture Elements: 768(H) x 242(V)
Active Picture Elements: 755(H) x 242(V)
Pixel Size: 8.5μm(H) x 19.75μm(V)
Dynamic Range: 50dB
1/2" Format: 8.5μ(H) x 755 = 6.4mm, 19.75μ(V) x 242 = 4.8mm
Dark Signal: 6mV @ 45°C
Typical Frame Transfer Camera Cost:
  Remote Head (Cohu 6410) $2,300. Self-contained (Cohu 4810) $1,500.

INTERLINE TRANSFER CCD

An initial goal in designing the Interline Transfer CCD technology was to solve an inherent difficulty of Frame Transfer technology, streaking, which is caused by the combination of bright point-sources of light and the method of transferring the charge packets of electrons from the active array to the storage register one line at a time.

Operation. The Interline Transfer sensor presents a different approach to pixel design, transfer, and storage of the video information. The sensors active pixel area and storage register are both contained within the active imaging area (fig. 7). Active imaging pixels are not used as transfer pixels as was the case with Frame Transfer technology. The active array of this device contains a full frame of pixels, 485 (Sony ICX-0387). On the imager, each column of pixels is separated by a column of storage elements that are covered with an opaque material. The storage elements have the capacity to hold only one field. Each two active vertical pixels share a single storage pixel. After completion of the 33.2ms integration time (frame mode), the charge packets from each pixel of a single field are transferred to the
FIGURE 8. INTERLINE CCD SHUTTERING
storage register. While the next field is gathering charge, the charge packets in the storage register are clocked to a horizontal readout register one line at a time, and readout at a 28Mhz rate. The higher clock rate seems to suggest the information is moving-out faster. In fact this is not true, while the Frame Transfer unit is using a two phase clocking solution, the Interline is based on four phase clocking. Twice the clock rate as compared to Virtual Phase is required to accomplish the same task.

A sensor configured with a full frame of active pixels (485) in the light sensitive area and only a field (242) of capacity in the storage array reduces size, complexity, and cost. It also limits the ability to acquire full vertical resolution where both fields are captured during identical integration periods (possible using a strobe, or mechanical shutter).

The storage register is integral to the active image area. Thus the photon sensitive area of each pixel is smaller in size (relative to Frame Transfer). Less light is accumulated and a greater possibility of aliasing exists if a detail of information in the field of view falls upon the opaque area. The percentage of fill factor (active image area to total image area) is approximately 35%\(^4\). The spectral response peaks in the photopic area at 550nm and falls-off sharply (750nm) before reaching the near IR region.

**Shuttering.** The Sony ICX038 Interline design is shutterable at the pixel level. The Frame Transfer device required 130\(\mu\)s to clear the array. Interline clears the contents of each pixel in the active image array once every 63.5\(\mu\)s (during horizontal blanking). When shuttering, the active array is cleared each horizontal period until the time remaining in the field equals desired integration time (fig. 8), then shuttering ceases, and normal charge accumulation begins.

The shutter mode steps in increments. If the illumination is constant, each change cuts the charge accumulation by 50% as the integration period is halved. Shuttering is accomplished across its full range in 8 steps (1/60s to 1/10,000s). Modifying the camera to externally control the shutter circuit with a TTL pulse provides discrete steps at 242 levels, effectively stepping one line (H period) at a time.

A disadvantage of shuttering is the inability to obtain full frame (vertical) resolution. If two fields can be integrated during the same period, effectively stored, and then readout, true full frame resolution is achieved. Since the storage register is designed to hold only one field at a time, the information contained in the second field remains on the active array and is clocked into the substrate drain of the sensor at the beginning of the next field. Clearing the pixels happens across the entire array, not for selected fields. this is an example where inherent characteristics built into the sensor chip architecture drive the features that are available in cameras. Full vertical resolution and shuttering are mutually exclusive in this mode.

**Asynchronous Reset.** The interline chip can be asynchronously reset. A reset trigger input will initiate the vertical interval and transfer one field of the array 9.5 lines (614\(\mu\)s) later (fig. 9). If the illumination to the sensor is controlled and/or a strobe is used, it is possible to quickly capture and readout the image. Asynchronously resetting the sensor, and
INTERLINE SENSOR
(Quick Capture)

EXTERNAL TRIGGER

INTERNAL VERTICAL DRIVE

STROBE WINDOW

VIDEO OUTPUT

FIELD 1

FIELD 2

INTERLINE SENSOR

START/STOP TRIGGER

SPECIAL RESET TRIGGER

GRAB PULSE OUTPUT

INTEGRATION TIME

FIELD 1

INT. TRIGGER + 614 us

FIELD 2

INT. TRIGGER + 614 us + 16.6 ms

VIDEO OUTPUT

FIELD 1

FIELD 2

FIGURE 9. ASYNCHRONOUS RESET

FIGURE 10. START/STOP RESET

INDIVIDUAL PIXEL WITH MICROLENS

FIGURE 11. MICROLENS INTERLINE PIXEL
strobing in coincidence with reset, or before the transfer time (9.5 lines later), provides quick capture time to readout (614μs-capture to 16.6ms-readout). The first field begins readout 614μs after reset and completes 16.6ms later. The second field, still on the active array, follows the first and begins readout, this operation takes an additional 16.6ms. Acquiring RS-170 full-frame (vertical) resolution requires 33.3ms. The quality of the image is dependent upon controlling the light source such that no illumination is impinging on the imager during the time the first field is being readout and the second field is awaiting transfer.

**Start/Stop.** An alternative to asynchronous operation is start-stop mode. Configuring the camera to electronically shutter each H-period, pixel charge accumulation will be dumped every 63.5μs (H-period) until an external control pulse is received. This pulse commands the shutter to cease, and begins active integration (fig. 10). The duration of integration is equal to the input pulse width, plus 9.5-H (614μs) lines. Field 1 will have integrated for the input pulse width "x", plus 614μs. Field 2 has integrated for "x", plus 614μs, plus 16.6ms. The reason field 2 has integrated for an additional vertical interval resides in the limitation of the storage register to hold only one field at a time. The storage register must be readout completely (16.6ms) before a transfer is initiated and field 2 is shifted from the active image area to the storage register. In this mode electronic shuttering is inhibited for one field after reset to avoid destroying the second field.

**Sensitivity.** A development by Sony Imager Group is the addition of micro-lenses placed above each pixel to focus the light onto the active portion of the sensor (fig. 11). Typical Interline Sensors have a fill factor of 35%. These focusing micro-lenses increase light gathering ability and reduce aliasing. The quality of the lens and precise placement, raise the fill factor to 70% or more, the light falling on the sensor is increased by a factor of two (6dB, 1-f stop).

**Integration.** Low noise and wide dynamic range make this technology a good candidate for extended integration. Extended integration increases the time that photons strike the pixels beyond the standard 16.6ms. This mode requires the target to be stationary, or the image will be blurred. The longer the integration time the greater the charge accumulation on the pixels, thus increasing the ability to image in lowlight. Sensitivity increases by a factor of two when the frame integration period is doubled (e.g., 2, 4, 8, 16 frames). Pixel non-uniformities will be exaggerated as integration time increases. A fixed pattern noise will eventually appear at the output as a "starfield" pattern (like looking through a telescope at the stars). The amount of noise will be partially dependent on ambient temperature. Cooling the sensor extends integration without this artifact. Imaging still objects provides sensitivities equal to or greater than intensified cameras with this CCD technology. Full vertical resolution is possible, the difference between the integration time of the first field and second field will always be 16.6ms. The second field will remain on the active image area for an additional vertical period awaiting transfer to the storage register. This difference becomes a progressively smaller percentage as integration time increases.
Example: 4 frame integration

field A = 4 x 33.2ms = 132.8ms
field B = 4 x 33.2ms + 16.6ms = 149.4ms, 12.5% longer.

Example: 30 frame integration

field A = 30 x 33.2ms = 996ms
field B = 30 x 33.2ms + 16.6ms = 1,012ms, 1.6% longer.

Advantages. Several advantages are offered with Interline technology. The transfer of charge packets from the active image pixels to the storage register happens in a fraction (6.5μs) of the time required by Frame Transfer, this lowers the probability of highlight smearing. Effective pixel to pixel isolation inhibits charges spilling over to adjacent pixels (perceived as blooming). Individual pixels have lower noise and a greater ability to gate away excess charge accumulation into the substrate, providing wider dynamic range. Shuttering at the pixel level allows faster shutter speeds and greater flexibility for imaging high-speed operations.

Interline Transfer: ICX-038.
Total Pixels: 811(H) x 508(V)
Active Pixels: 768(H) x 494(V)
Pixel Size: 8.4μm(H) x 9.8μm(V)
Dynamic Range: 56dB
1/2" format 8.4(H) x 768 = 6.4mm, 494(V) x 9.8 = 4.8mm
Dark Signal: 2mV @ 60 ° C
Typical Interline Transfer Camera Cost:
  Remote Head (Cohu 4980) $1,700. Self-contained (Cohu 4910) $800

Feature Summary for Machine Vision Cameras

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Asynchronous Field/Frame</th>
<th>Shuttering</th>
<th>Integration Field/Frame</th>
<th>cost $ Budgetary</th>
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<td>Fixed</td>
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<td></td>
</tr>
<tr>
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<td>$1,500</td>
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<tr>
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<td>Yes/Yes</td>
<td>to 1/10,000</td>
<td>$850</td>
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</table>

Key:
FT= Frame Transfer
IT= Interline Transfer
Reference


Bibliography

