FS-B2KU7CL
FS-B4KU7CL
FS-B4KU35CL
FS-B8KU7CL
FS-B8KU35CL
FS-B16KU35CL
Monochrome Line Scanning Camera Link Camera
Safety Precautions

The lightning flash with arrowhead symbol, within an equilateral triangle, is intended to alert the user to the presence of uninsulated “dangerous voltage” within the product’s enclosure that may be of sufficient magnitude to constitute a risk of electric shock to persons.

The exclamation point within an equilateral triangle is intended to alert the user to the presence of important operating and maintenance (servicing) instructions in the literature accompanying the appliance.

Product Precautions

- Handle the camera with care. Do not abuse the camera. Avoid striking or shaking it. Improper handling or storage could damage the camera.
- Do not pull or damage the camera cable.
- During camera use, do not wrap the unit in any material. This will cause the internal temperature of the unit to increase.
- Do not expose the camera to moisture, or do not try to operate it in wet areas.
- Do not operate the camera beyond its temperature, humidity and power source ratings.
- While the camera is not being used, keep the lens or lens cap on the camera to prevent dust or contamination from getting in the CCD or filter area and scratching or damaging this area.
- Do not keep the camera under the following conditions:
  - In wet, moist, and high humidity areas
  - Under hot direct sunlight
  - In high temperature areas
  - Near an object that releases a strong magnetic or electric field
  - Areas with strong vibrations
- Use a soft cloth to clean the camera. Use pressured air spray to clean the surface of the glass. DO not scratch the surface of the glass.

For U.S.A.

Warning:
This equipment generates and uses radio frequency energy and if not installed and used properly, i.e., in strict accordance with the instruction manual, may cause harmful interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment.

For Canada

Warning:
This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

WARNING:
TO PREVENT FIRE OR SHOCK HAZARD, DO NOT EXPOSE THIS APPLIANCE TO RAIN OR MOISTURE.
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<th>FS-B8KU7CL</th>
<th>FS-B8KU35CL</th>
<th>FS-B4KU7CL</th>
<th>FS-B4KU35CL</th>
<th>FS-B2KU7CL</th>
</tr>
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<tbody>
<tr>
<td>Image Sensor</td>
<td>16k CMOS</td>
<td>8k CMOS</td>
<td>8k CMOS</td>
<td>4k CMOS</td>
<td>4k CMOS</td>
<td>2k CMOS</td>
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<td>image sensor</td>
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<td>DR-16k-3.5</td>
<td>DR-8k-7</td>
<td>DR-8k-3.5</td>
<td>DR-4k-7</td>
<td>DR-4k-3.5</td>
<td>DR-2k-7</td>
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<td>(AWAIBA)</td>
<td>(AWAIBA)</td>
<td>(AWAIBA)</td>
<td>(AWAIBA)</td>
<td>(AWAIBA)</td>
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<tr>
<td>Active Pixels</td>
<td>16,384 pixels</td>
<td>8,192 pixels</td>
<td>4,096 pixels</td>
<td>2,048 pixels</td>
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<td></td>
</tr>
<tr>
<td>Pixel Size</td>
<td>3.5 (H) x 3.5 (V) um (3.5 um pitch)</td>
<td>7 (H) x 7 (V) um (7 um pitch)</td>
<td>3.5 (H) x 3.5 (V) um (3.5 um pitch)</td>
<td>7 (H) x 7 (V) um (7 um pitch)</td>
<td>3.5 (H) x 3.5 (V) um (3.5 um pitch)</td>
<td>7 (H) x 7 (V) um (7 um pitch)</td>
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<tr>
<td>Photo Array Length</td>
<td>57.344 mm</td>
<td>28.672 mm</td>
<td>14.336 mm</td>
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<tr>
<td>Total Data Rate</td>
<td>Camera Link</td>
<td>85MHz x 8 TAP</td>
<td>680 MHz</td>
<td>640 MHz</td>
<td>400 MHz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Full</td>
<td>80MHz x 8 TAP</td>
<td>640 MHz</td>
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<tr>
<td></td>
<td>Medium</td>
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<td>400 MHz</td>
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<tr>
<td>Camera Link</td>
<td>Camera Link</td>
<td>85MHz x 4 TAP</td>
<td>340 MHz</td>
<td></td>
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<tr>
<td></td>
<td>Full</td>
<td>80MHz x 4 TAP</td>
<td>320 MHz</td>
<td></td>
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<td></td>
<td>Medium</td>
<td>50MHz x 4 TAP</td>
<td>200 MHz</td>
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<tr>
<td>Camera Link</td>
<td>Camera Link</td>
<td>85MHz x 2 TAP</td>
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<td></td>
<td>Full</td>
<td>80MHz x 2 TAP</td>
<td>160 MHz</td>
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<td>Full</td>
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<td>Maximum Line Rate</td>
<td>Camera Link</td>
<td>85MHz x 8 TAP</td>
<td>40kHz</td>
<td>80kHz</td>
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<tr>
<td></td>
<td>Full</td>
<td>80MHz x 8 TAP</td>
<td>38.5kHz</td>
<td>75kHz</td>
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<td>Medium</td>
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<td>24kHz</td>
<td>47kHz</td>
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<tr>
<td>Camera Link</td>
<td>Camera Link</td>
<td>85MHz x 4 TAP</td>
<td>20.5kHz</td>
<td>40kHz</td>
<td>80kHz</td>
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<tr>
<td></td>
<td>Full</td>
<td>80MHz x 4 TAP</td>
<td>19kHz</td>
<td>38kHz</td>
<td>75kHz</td>
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<tr>
<td>Camera Link</td>
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<td>12kHz</td>
<td>24kHz</td>
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<td>9.5kHz</td>
<td>19kHz</td>
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<td>75kHz</td>
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<td>Video Output</td>
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<td></td>
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<tr>
<td></td>
<td>Camera Link Medium</td>
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<td>8 bit / 10 bit</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Camera Link Base</td>
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<td>8 bit / 10 bit</td>
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<tr>
<td>Power</td>
<td>Input Voltage</td>
<td>+12 Vdc to +24 Vdc</td>
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<tr>
<td></td>
<td>Consumption</td>
<td>7.2W (TYP)</td>
<td>4.3W (TYP)</td>
<td>2.8W (TYP)</td>
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<td>Optical Specifications</td>
<td>Communication</td>
<td>RS232 via Camera Link connector</td>
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### Optical Specifications

<table>
<thead>
<tr>
<th>Product</th>
<th>FS-B16KU35CL</th>
<th>FS-B8KU7CL</th>
<th>FS-B8KU35CL</th>
<th>FS-B4KU7CL</th>
<th>FS-B4KU35CL</th>
<th>FS-B2KU7CL</th>
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<tr>
<td>Fill Factor</td>
<td>100%</td>
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<td>Responsivity (except opck=11)</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>gbdt=1</td>
<td>9DN/nj/cm2</td>
<td>19DN/nj/cm2</td>
<td>9DN/nj/cm2</td>
<td>19DN/nj/cm2</td>
<td>9DN/nj/cm2</td>
<td>19DN/nj/cm2</td>
</tr>
<tr>
<td>(@8bit)</td>
<td>(@8bit)</td>
<td>(@8bit)</td>
<td>(@8bit)</td>
<td>(@8bit)</td>
<td>(@8bit)</td>
<td>(@8bit)</td>
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<tr>
<td>Responsivity (except opck=11)</td>
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</tr>
<tr>
<td>gbdt=0</td>
<td>38DN/nj/cm2</td>
<td>77DN/nj/cm2</td>
<td>38DN/nj/cm2</td>
<td>77DN/nj/cm2</td>
<td>38DN/nj/cm2</td>
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<tr>
<td>(@8bit)</td>
<td>(@8bit)</td>
<td>(@8bit)</td>
<td>(@8bit)</td>
<td>(@8bit)</td>
<td>(@8bit)</td>
<td>(@8bit)</td>
</tr>
<tr>
<td>Responsivity (opck=11) gbdt=1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>19DN/nj/cm2</td>
<td>38DN/nj/cm2</td>
<td>19DN/nj/cm2</td>
<td>38DN/nj/cm2</td>
<td>19DN/nj/cm2</td>
<td>38DN/nj/cm2</td>
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<tr>
<td>(@8bit)</td>
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<td>(@8bit)</td>
<td>(@8bit)</td>
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<td>(@8bit)</td>
</tr>
<tr>
<td>Responsivity (opck=11) gbdt=0</td>
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<tr>
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<td>77DN/nj/cm2</td>
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<td>77DN/nj/cm2</td>
<td>155DN/nj/cm2</td>
<td>77DN/nj/cm2</td>
<td>155DN/nj/cm2</td>
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<td>(@8bit)</td>
<td>(@8bit)</td>
<td>(@8bit)</td>
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<td>(@8bit)</td>
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</table>
Monochrome Camera Link Line Scan

Mechanical Specifications

<table>
<thead>
<tr>
<th>Product</th>
<th>FS-B16KU35CL</th>
<th>FS-B8KU7CL</th>
<th>FS-B8KU35CL</th>
<th>FS-B4KU7CL</th>
<th>FS-B4KU35CL</th>
<th>FS-B2KU7CL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>80 (W) x 100 (H) x 38.1 (D) mm (excluding connector)</td>
<td>56 (W) x 58 (H) x 26.5 (D) mm</td>
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<td></td>
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<tr>
<td>Lens Mount</td>
<td>M72, P=0.75 mm</td>
<td>F Mount</td>
<td>F Mount</td>
<td>F Mount, C Mount</td>
<td></td>
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</tr>
<tr>
<td>Weight</td>
<td>Approx. 453 g</td>
<td>Approx. 250g</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Interface Connectors</td>
<td>Camera Link connector (MDR) x 2</td>
<td>Power connector (6pin connector)</td>
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Environmental Specifications

<table>
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<tr>
<th>Product</th>
<th>FS-B16KU35CL</th>
<th>FS-B8KU7CL</th>
<th>FS-B8KU35CL</th>
<th>FS-B4KU7CL</th>
<th>FS-B4KU35CL</th>
<th>FS-B2KU7CL</th>
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<tr>
<td>RoHS</td>
<td>RoHS compliant</td>
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<tr>
<td>Operating Temperature</td>
<td>0 to 40 deg. C</td>
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<tr>
<td>Storage Temperature</td>
<td>-30 to 65 deg. C</td>
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II. Product Numbering

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<th>B</th>
<th>16K</th>
<th>U35</th>
<th></th>
<th>CL</th>
<th>M72</th>
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<tr>
<td>(2) BW / Color</td>
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<td></td>
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<tr>
<td>B: Black and White</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>C: Color</td>
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<td></td>
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<td>8: 8K</td>
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<tr>
<td>4: 4K</td>
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<td>U35: 35um</td>
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<td>None: 1 line (single)</td>
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<tr>
<td>D: 2 lines (dual)</td>
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<td></td>
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<td>Q: 4 lines (Quad)</td>
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<td>(6) Output type</td>
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<td>CL: Camera link</td>
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<tr>
<td>GE: GigE Vision</td>
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<tr>
<td>CX: CoaXPress</td>
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<td>(7) Mount type</td>
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<td>C: C mount</td>
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<td>F: F mount</td>
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Order Number

FS-B16KU35CL-M72
FS-B8KU7CL-M72
FS-B8KU35CL-F
FS-B4KU7CL-F
FS-B4KU35CL-F
FS-B2KU7CL-F
FS-B2KU7CL-C
III. Connector Specifications

A. FS-B2KU7CL
   C. Power connector

   LED

   B. Don’t use

   A. Camera Link (Base)

   A. Camera Link connector (Base):
      MDR Receptacle (3M)
   B. Don’t Use
   C. Power Connector
      HR10A-7R-6PB (Hirose)

This connector is for 12Vdc power input.
The RED LED light indicates that the camera is powered-on.

B. FS-B8KU35CL, FS-B4KU7CL, FS-B4KU35CL
   C. Power connector

   LED

   B. Camera Link (Full/Medium)
   A. Camera Link (Base)

   A. Camera Link connector (Base):
      MDR Receptacle (3M)
   B. Camera Link connector (Medium/Full):
      MDR Receptacle (3M)
   C. Power Connector
      HR10A-7R-6PB (Hirose)

This connector is for 12Vdc power input.
The RED LED light indicates that the camera is powered-on.
C. FS-B8KU7CL, FS-B16KU35CL

A. Camera Link connector (Base): MDR Receptacle (3M)
B. Camera Link connector (Medium/Full): MDR Receptacle (3M)
C. Power Connector
   This connector is for 12Vdc power input.
   The RED LED light indicates that the camera is powered-on.

D. Pin Assignment of the Connectors

1. Camera Link connector (Base): MDR Receptacle (3M)

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Signal name</th>
<th>Pin No.</th>
<th>Signal name</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>14</td>
<td>GND</td>
</tr>
<tr>
<td>2</td>
<td>X0-</td>
<td>15</td>
<td>X0+</td>
</tr>
<tr>
<td>3</td>
<td>X1-</td>
<td>16</td>
<td>X1+</td>
</tr>
<tr>
<td>4</td>
<td>X2-</td>
<td>17</td>
<td>X2+</td>
</tr>
<tr>
<td>5</td>
<td>Xclk-</td>
<td>18</td>
<td>Xclk+</td>
</tr>
<tr>
<td>6</td>
<td>X3-</td>
<td>19</td>
<td>X3+</td>
</tr>
<tr>
<td>7</td>
<td>SerTC+</td>
<td>20</td>
<td>SerTC-</td>
</tr>
<tr>
<td>8</td>
<td>SerTFG-</td>
<td>21</td>
<td>SerTFG+</td>
</tr>
<tr>
<td>9</td>
<td>CC1- (for the external sync signal input)</td>
<td>22</td>
<td>CC1+ (for the external sync signal input)</td>
</tr>
<tr>
<td>10</td>
<td>CC2+</td>
<td>23</td>
<td>CC2-</td>
</tr>
<tr>
<td>11</td>
<td>CC3-</td>
<td>24</td>
<td>CC3+</td>
</tr>
<tr>
<td>12</td>
<td>CC4+</td>
<td>25</td>
<td>CC4-</td>
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<tr>
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<td>GND</td>
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2. Camera Link connector (Medium): MDR Receptacle (3M)

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<th>Signal name</th>
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<td>2</td>
<td>Y0-</td>
<td>15</td>
<td>Y0+</td>
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<td>3</td>
<td>Y1-</td>
<td>16</td>
<td>Y1+</td>
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<tr>
<td>4</td>
<td>Y2-</td>
<td>17</td>
<td>Y2+</td>
</tr>
<tr>
<td>5</td>
<td>Yclk-</td>
<td>18</td>
<td>Yclk+</td>
</tr>
<tr>
<td>6</td>
<td>Y3-</td>
<td>19</td>
<td>Y3+</td>
</tr>
<tr>
<td>7</td>
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<td>100 Ohm terminated</td>
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<td>21</td>
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<td>9</td>
<td>Z1-</td>
<td>22</td>
<td>Z1+</td>
</tr>
<tr>
<td>10</td>
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</tr>
<tr>
<td>11</td>
<td>Zclk-</td>
<td>24</td>
<td>Zclk+</td>
</tr>
<tr>
<td>12</td>
<td>Z3-</td>
<td>25</td>
<td>Z3+</td>
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### Power Connector

3. Power Connector: HR10A-7R-6PB (Hirose or equivalent) (Cable connector: HR10A-7P-6S or equivalent)

<table>
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<th>Voltage</th>
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<td>IN</td>
<td>+12 V</td>
</tr>
<tr>
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<td>IN</td>
<td>+12 V</td>
</tr>
<tr>
<td>3</td>
<td>+12 V</td>
<td>IN</td>
<td>+12 V</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
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<td></td>
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<td>6</td>
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#### Signal Details

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<th>I/O</th>
<th>explanation</th>
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<td>I</td>
<td>Ext TRG. Refer to section 5.</td>
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<td>CC2</td>
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<td>Spare</td>
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<tr>
<td>CC3</td>
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<td>Spare</td>
</tr>
<tr>
<td>CC4</td>
<td></td>
<td>Spare</td>
</tr>
<tr>
<td>SerTC</td>
<td>I</td>
<td>Serial communication from the frame grabber.</td>
</tr>
<tr>
<td>SerTFG</td>
<td>O</td>
<td>Serial communication to the frame grabber.</td>
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E. Bit Assignment

1. “Full Configuration”

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<th>Port/bit</th>
<th>8-bit x8</th>
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<td>Port C0</td>
<td>C0</td>
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</tr>
<tr>
<td>Port A1</td>
<td>A1</td>
<td>Port C1</td>
<td>C1</td>
<td></td>
</tr>
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<td>A2</td>
<td>Port C2</td>
<td>C2</td>
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</tr>
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<td>Port A3</td>
<td>A3</td>
<td>Port C3</td>
<td>C3</td>
<td></td>
</tr>
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<td>Port A4</td>
<td>A4</td>
<td>Port C4</td>
<td>C4</td>
<td></td>
</tr>
<tr>
<td>Port A5</td>
<td>A5</td>
<td>Port C5</td>
<td>C5</td>
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<td>Port C6</td>
<td>C6</td>
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</tr>
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<td>Port A7</td>
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<td>Port C7</td>
<td>C7</td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
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<tr>
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<td>B5</td>
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<tr>
<td>Port B6</td>
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<th>8-bit x 8</th>
<th>Port/bit</th>
<th>8-bit x8</th>
<th>Port/bit</th>
<th>8-bit x8</th>
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<td>F0</td>
<td>Port H0</td>
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<td>Port F1</td>
<td>F1</td>
<td>Port H1</td>
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<td>D2</td>
<td>Port F2</td>
<td>F2</td>
<td>Port H2</td>
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<td>D3</td>
<td>Port F3</td>
<td>F3</td>
<td>Port H3</td>
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<tr>
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<td>Port F4</td>
<td>F4</td>
<td>Port H4</td>
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<td>F7</td>
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<td>E1</td>
<td>Port G1</td>
<td>G1</td>
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<td>Port E3</td>
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<td>Port G3</td>
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<td></td>
</tr>
<tr>
<td>Port E4</td>
<td>E4</td>
<td>Port G4</td>
<td>G4</td>
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<td>E5</td>
<td>Port G5</td>
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<td>Port G6</td>
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| Port F0       | F0       |           |          |
| Port F1       | F1       |           |          |
| Port F2       | F2       |           |          |
| Port F3       | F3       |           |          |
| Port F4       | F4       |           |          |
| Port F5       | F5       |           |          |
| Port F6       | F6       |           |          |
| Port F7       | F7       |           |          |
| Port G0       | G0       |           |          |
| Port G1       | G1       |           |          |
| Port G2       | G2       |           |          |
| Port G3       | G3       |           |          |
| Port G4       | G4       |           |          |
| Port G5       | G5       |           |          |
| Port G6       | G6       |           |          |
| Port G7       | G7       |           |          |
2. "Medium Configuration"

10 bit mode

<table>
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<tr>
<th>Port</th>
<th>10-bit x 4taps</th>
<th>Port</th>
<th>10-bit x 4taps</th>
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<td>B0</td>
</tr>
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<td>A1</td>
<td>A1</td>
<td>Port C1</td>
<td>B1</td>
</tr>
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<td>A2</td>
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<td>B8</td>
<td>Port C4</td>
<td>B4</td>
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8 bit mode

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3. “Base Configuration”

10 bit mode

### Base connector

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<th>10-bit x 2taps</th>
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<tbody>
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<tr>
<td>Port A1</td>
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<td>B2</td>
</tr>
<tr>
<td>Port A3</td>
<td>A3</td>
<td>Port C3</td>
<td>B3</td>
</tr>
<tr>
<td>Port A4</td>
<td>A4</td>
<td>Port C4</td>
<td>B4</td>
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<td>Port A5</td>
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8 bit mode

### Base connector

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<th>Port/bit</th>
<th>8-bit x 2taps</th>
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</thead>
<tbody>
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<td>Port C0</td>
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</tr>
<tr>
<td>Port A1</td>
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<td>B1</td>
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<tr>
<td>Port B4</td>
<td>B4</td>
<td>Port B5</td>
<td>B5</td>
</tr>
<tr>
<td>Port B6</td>
<td>B6</td>
<td>Port B7</td>
<td>B7</td>
</tr>
</tbody>
</table>
IV. Timing Chart

Caution: Camera does not accept any commands without sync signal. When External Trigger Mode (limd=1) is used through the Hyper Terminal, please send the commands on Internal Sync mode. And send the next command after receiving OK.

A. Exposure Time

**EXT LINE**

External sync (CC1)

---

**EXT FIX MODE**

CC1

---

**PULSE MODE**

CC1

---

**INTERNAL MODE**

---

Product Specifications

14

Ver 1.11
**Parameter A, B and C are different for each camera model. Please refer to the actual number on the table below.**

*Intu, intl and opck are camera control ASCII commands. For details please refer to the Command Descriptions.*

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
<th>Value [us]</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Line interval</td>
<td>External sync : CC1 line period</td>
</tr>
<tr>
<td>T2</td>
<td>Sync rise to exposure end</td>
<td>(6 x B) + 1</td>
</tr>
<tr>
<td>T3</td>
<td>Sync rise to exposure start</td>
<td>B16K : (18 x B) + 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Except B16K : (18 x B) + 1</td>
</tr>
<tr>
<td>T5</td>
<td>Exposure time (EXT_LINE)</td>
<td>B16K : T1 – (12 x B) – 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Except B16K : T1 – (12 x B) – 2</td>
</tr>
<tr>
<td>T6</td>
<td>CC1 rise to exposure start (EXT_FIX)</td>
<td>(6 x B) + 2</td>
</tr>
<tr>
<td>T7</td>
<td>Exposure time (EXT_FIX)</td>
<td>B16K : ((intu x 256 + intl) x C) + 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Except B16K : ((intu x 256 + intl) x C) + 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min setting : intu = 0, intl = 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum Exposure Time : Line period – 3us</td>
</tr>
<tr>
<td>T9</td>
<td>CC1 rise to exposure start PULSE)</td>
<td>(5 x B) + 2</td>
</tr>
<tr>
<td>T10</td>
<td>CC1 fall to exposure end PULSE)</td>
<td>(5 x B) + 1</td>
</tr>
<tr>
<td>T12</td>
<td>Exposure time (PULSE)</td>
<td>Pulse width of CC1(High) – 1</td>
</tr>
<tr>
<td>T13</td>
<td>Line interval (INTERNAL)</td>
<td>((intu x 256 + intl) x C) + A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A : Minimum line period</td>
</tr>
<tr>
<td>T14</td>
<td>Exposure time (INTERNAL)</td>
<td>B16K : T13 – 3 – (12 x B)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Except B16K : T13 – 2 – (12 x B)</td>
</tr>
</tbody>
</table>

*The min and max of T12 follows. The min of T12=3us The max of T12= the line period – 2us

A: Minimum line period [us]

<table>
<thead>
<tr>
<th>opck</th>
<th>FS-B16KU35CL</th>
<th>FS-B8KU35CL, FS-B8KU7CL</th>
<th>FS-B4KU7CL, FS-B4KU35CL</th>
<th>FS-B2KU7CL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25.4 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
</tr>
<tr>
<td>1</td>
<td>41.6 us</td>
<td>21.1 us</td>
<td>21.1 us</td>
<td>21.1 us</td>
</tr>
<tr>
<td>2</td>
<td>48.6 us</td>
<td>24.5 us</td>
<td>24.5 us</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>82.6 us</td>
<td>41.6 us</td>
<td>41.6 us</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>96.8 us</td>
<td>48.6 us</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>164.5 us</td>
<td>82.6 us</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>26 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
</tr>
<tr>
<td>9</td>
<td>51.6 us</td>
<td>25 us</td>
<td>25 us</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>102.8 us</td>
<td>51.6 us</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>25 us</td>
<td>12.5 us</td>
<td>12.5 us</td>
<td>12.5 us</td>
</tr>
<tr>
<td>23</td>
<td>25.4 us</td>
<td>13.2 us</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>24</td>
<td>26 us</td>
<td>13.2 us</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>41.6 us</td>
<td>21.1 us</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>26</td>
<td>25.4 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
</tr>
<tr>
<td>27</td>
<td>26 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
</tr>
<tr>
<td>28</td>
<td>41.6</td>
<td>21.1 us</td>
<td>21.1 us</td>
<td>21.1 us</td>
</tr>
</tbody>
</table>
### B: CLK period

<table>
<thead>
<tr>
<th>Model</th>
<th>Value [us]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS-B16KU35CL</td>
<td>0.0235</td>
</tr>
<tr>
<td>Except for FS-B16KU35CL</td>
<td>0.0117</td>
</tr>
</tbody>
</table>

### C: Amount of change time per step

<table>
<thead>
<tr>
<th>Model</th>
<th>Value [us]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS-B16KU35CL</td>
<td>0.4</td>
</tr>
<tr>
<td>Except for FS-B16KU35CL</td>
<td>0.2</td>
</tr>
</tbody>
</table>
V. Output mode

A. FS-B2KU7CL

Four rate modes can be selected using command: opck.

<table>
<thead>
<tr>
<th>opck</th>
<th>Maximum line rate</th>
<th>Total data rate</th>
<th>Camera Link Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>75kHz</td>
<td>170MHz (85MHzx2TAP)</td>
<td>Base</td>
</tr>
<tr>
<td>1</td>
<td>47kHz</td>
<td>100MHz (50MHzx2TAP)</td>
<td>Base</td>
</tr>
<tr>
<td>2–7</td>
<td></td>
<td>Don’t use</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>75kHz</td>
<td>160MHz (80MHzx2TAP)</td>
<td>Base</td>
</tr>
<tr>
<td>9–10</td>
<td></td>
<td>Don’t use</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>80kHz</td>
<td>170MHz (85MHzx2TAP)</td>
<td>Base</td>
</tr>
<tr>
<td>12–25</td>
<td></td>
<td>Don’t use</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>75kHz</td>
<td>170MHz (85MHzx2TAP)</td>
<td>AOI mode (Base)</td>
</tr>
<tr>
<td>27</td>
<td>75kHz</td>
<td>160MHz (80MHzx2TAP)</td>
<td>AOI mode (Base)</td>
</tr>
<tr>
<td>28</td>
<td>47kHz</td>
<td>100MHz (50MHzx2TAP)</td>
<td>AOI mode (Base)</td>
</tr>
<tr>
<td>29–255</td>
<td></td>
<td>Don’t use</td>
<td></td>
</tr>
</tbody>
</table>

1. Output Timing “Base”

Image output
CH1(portA)

Image output
CH2(portB)

LVAL

1,024 pixels

2. Output Timing “AOI Mode (BASE)”

Image output
CH1(portA)

Image output
CH2(portB)

LVAL

(riwu*256+riwl) pixels

N= (risu * 256 + risl) * 2+1
B. FS-B4KU35CL

Seven Data rate modes can be selected using command: opck.

<table>
<thead>
<tr>
<th>opck</th>
<th>Maximum line rate</th>
<th>Total data rate</th>
<th>Camera Link Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>75kHz</td>
<td>340MHz (85MHzx4TAP)</td>
<td>Medium</td>
</tr>
<tr>
<td>1</td>
<td>47kHz</td>
<td>200MHz (50MHzx4TAP)</td>
<td>Medium</td>
</tr>
<tr>
<td>2</td>
<td>40kHz</td>
<td>170MHz (85MHzx2TAP)</td>
<td>Base</td>
</tr>
<tr>
<td>3</td>
<td>24kHz</td>
<td>100MHz (50MHzx2TAP)</td>
<td>Base</td>
</tr>
<tr>
<td>4-7</td>
<td></td>
<td></td>
<td>Don't use</td>
</tr>
<tr>
<td>8</td>
<td>75kHz</td>
<td>320MHz (80MHzx4TAP)</td>
<td>Medium</td>
</tr>
<tr>
<td>9</td>
<td>38kHz</td>
<td>160MHz (80MHzx2TAP)</td>
<td>Base</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>Don't use</td>
</tr>
<tr>
<td>11</td>
<td>80kHz</td>
<td>340MHz (85MHzx4TAP)</td>
<td>Medium</td>
</tr>
<tr>
<td>12-25</td>
<td></td>
<td></td>
<td>Don't use</td>
</tr>
<tr>
<td>26</td>
<td>75kHz</td>
<td>170MHz (85MHzx2TAP)</td>
<td>AOI mode (Base)</td>
</tr>
<tr>
<td>27</td>
<td>75kHz</td>
<td>160MHz (80MHzx2TAP)</td>
<td>AOI mode (Base)</td>
</tr>
<tr>
<td>28</td>
<td>47kHz</td>
<td>100MHz (50MHzx2TAP)</td>
<td>AOI mode (Base)</td>
</tr>
<tr>
<td>29-255</td>
<td></td>
<td></td>
<td>Don't use</td>
</tr>
</tbody>
</table>

1. Output Timing “Medium configuration”

Image output  
CH1(portA)

Image output  
CH2(portB)

Image output  
CH3(portC)

Image output  
CH4(portD)

LVAL

1,024 pixels
2. Output Timing “Base configuration”

Image output CH1(portA)

Image output CH2(portB)

LVAL

2,048 pixels

3. Output Timing “AOI Mode (Base)”

Image output CH1(portA)

Image output CH2(portB)

LVAL

(riwu*256+riwl) pixels

<table>
<thead>
<tr>
<th>Product number</th>
<th>The start pixel output</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS-B4KU35CL</td>
<td>N= (risu* 256 + risl)*4+1</td>
</tr>
<tr>
<td>FS-B4KU7CL</td>
<td>N= (risu* 256 + risl)*2+1</td>
</tr>
</tbody>
</table>
### C. FS-B8KU35CL, FS-B8KU7CL

You can change ten modes of data rate by `opck` command.

<table>
<thead>
<tr>
<th>opck</th>
<th>Maximum line rate</th>
<th>Total data rate</th>
<th>Camera Link Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>75kHz</td>
<td>680MHz (85MHzx8TAP)</td>
<td>Full Format1</td>
</tr>
<tr>
<td>1</td>
<td>47kHz</td>
<td>400MHz (50MHzx8TAP)</td>
<td>Full Format1</td>
</tr>
<tr>
<td>2</td>
<td>40kHz</td>
<td>340MHz (85MHzx4TAP)</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
<td>24kHz</td>
<td>200MHz (50MHzx4TAP)</td>
<td>Medium</td>
</tr>
<tr>
<td>4</td>
<td>20kHz</td>
<td>170MHz (85MHzx2TAP)</td>
<td>Base</td>
</tr>
<tr>
<td>5</td>
<td>12kHz</td>
<td>100MHz (50MHzx2TAP)</td>
<td>Base</td>
</tr>
<tr>
<td>6-7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>75kHz</td>
<td>640MHz (80MHzx8TAP)</td>
<td>Full Format1</td>
</tr>
<tr>
<td>9</td>
<td>38kHz</td>
<td>320MHz (80MHzx4TAP)</td>
<td>Medium</td>
</tr>
<tr>
<td>10</td>
<td>19kHz</td>
<td>160MHz (80MHzx2TAP)</td>
<td>Base</td>
</tr>
<tr>
<td>11</td>
<td>80kHz</td>
<td>680MHz (85MHzx8TAP)</td>
<td>Full Format1</td>
</tr>
<tr>
<td>12-22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>75kHz</td>
<td>680MHz (85MHzx8TAP)</td>
<td>Full Format2</td>
</tr>
<tr>
<td>24</td>
<td>75kHz</td>
<td>640MHz (80MHzx8TAP)</td>
<td>Full Format2</td>
</tr>
<tr>
<td>25</td>
<td>47kHz</td>
<td>400MHz (50MHzx8TAP)</td>
<td>Full Format2</td>
</tr>
<tr>
<td>26</td>
<td>75kHz</td>
<td>170MHz (85MHzx2TAP)</td>
<td>AOI mode (Base)</td>
</tr>
<tr>
<td>27</td>
<td>75kHz</td>
<td>160MHz (80MHzx2TAP)</td>
<td>AOI mode (Base)</td>
</tr>
<tr>
<td>28</td>
<td>47kHz</td>
<td>100MHz (50MHzx2TAP)</td>
<td>AOI mode (Base)</td>
</tr>
</tbody>
</table>
1. Output Timing “Full Configuration Format1”

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH1(portA)</th>
<th>1,024 pixels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH2(portB)</th>
<th>1,024 pixels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH3(portC)</th>
<th>1,024 pixels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,024 pixels</td>
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<tr>
<td></td>
<td>1,024 pixels</td>
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<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH4(portD)</th>
<th>1,024 pixels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH5(portE)</th>
<th>1,024 pixels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
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</tr>
<tr>
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<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH6(portF)</th>
<th>1,024 pixels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
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<tr>
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<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH7(portG)</th>
<th>1,024 pixels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH8(portH)</th>
<th>1,024 pixels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
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<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,024 pixels</td>
<td></td>
</tr>
</tbody>
</table>

LVAL

1,024 pixels
### 2. Output Timing "Full Configuration Format2"

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH1 (portA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>LVAL</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH2 (portB)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH3 (portC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH4 (portD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH5 (portE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH6 (portF)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH7 (portG)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Image output</th>
<th>CH8 (portH)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
</tr>
</tbody>
</table>

1,024 pixels
3. Output Timing “Medium Configuration”

Image output CH1(portA)

Image output CH2(portB)

Image output CH3(portC)

Image output CH4(portD)

LVAL

2,048 pixels

4. Output Timing “Base Configuration”

Image output CH1(portA)

Image output CH2(portB)

LVAL

4,096 pixels
5. Output Timing “AOI Mode (Base)"

<table>
<thead>
<tr>
<th>Product number</th>
<th>The start pixel output</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS-B8KU35CL</td>
<td>N = (risu × 256 + risl) × 4 + 1</td>
</tr>
<tr>
<td>FS-B8KU7CL</td>
<td>N = (risu × 256 + risl) × 2 + 1</td>
</tr>
</tbody>
</table>

Image output
CH1(portA)
N
N+2
N+4

Image output
CH2(portB)
N+1
N+3
N+5

LVAL
(riwu × 256 + riwl) pixels
You can change nine modes of data rate by opck command.

<table>
<thead>
<tr>
<th>opck</th>
<th>Maximum line rate</th>
<th>Total data rate</th>
<th>Camera Link Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>39kHz</td>
<td>680MHz (85MHzx8TAP)</td>
<td>Full Format 1</td>
</tr>
<tr>
<td>1</td>
<td>24kHz</td>
<td>400MHz (50MHzx8TAP)</td>
<td>Full Format 1</td>
</tr>
<tr>
<td>2</td>
<td>20.5kHz</td>
<td>340MHz (85MHzx4TAP)</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
<td>12kHz</td>
<td>200MHz (50MHzx4TAP)</td>
<td>Medium</td>
</tr>
<tr>
<td>4</td>
<td>10kHz</td>
<td>170MHz (85MHzx2TAP)</td>
<td>Base</td>
</tr>
<tr>
<td>5</td>
<td>6kHz</td>
<td>100MHz (50MHzx2TAP)</td>
<td>Base</td>
</tr>
<tr>
<td>6–7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>38.5kHz</td>
<td>640MHz (80MHzx8TAP)</td>
<td>Full Format 1</td>
</tr>
<tr>
<td>9</td>
<td>19kHz</td>
<td>320MHz (80MHzx4TAP)</td>
<td>Medium</td>
</tr>
<tr>
<td>10</td>
<td>9.5kHz</td>
<td>160MHz (80MHzx2TAP)</td>
<td>Base</td>
</tr>
<tr>
<td>11</td>
<td>40kHz</td>
<td>680MHz (85MHzx8TAP)</td>
<td>Full Format 1</td>
</tr>
<tr>
<td>12–22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>39kHz</td>
<td>680MHz (85MHzx8TAP)</td>
<td>Full Format 2</td>
</tr>
<tr>
<td>24</td>
<td>38.5kHz</td>
<td>640MHz (80MHzx8TAP)</td>
<td>Full Format 2</td>
</tr>
<tr>
<td>25</td>
<td>24kHz</td>
<td>400MHz (50MHzx8TAP)</td>
<td>Full Format 2</td>
</tr>
<tr>
<td>26</td>
<td>20kHz</td>
<td>170MHz (85MHzx2TAP)</td>
<td>AOI mode (Base)</td>
</tr>
<tr>
<td>27</td>
<td>16.5kHz</td>
<td>160MHz (80MHzx2TAP)</td>
<td>AOI mode (Base)</td>
</tr>
<tr>
<td>28</td>
<td>24kHz</td>
<td>100MHz (50MHzx2TAP)</td>
<td>AOI mode (Base)</td>
</tr>
<tr>
<td>29–255</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Output Timing “Full Configuration Format1”

Image output CH1(portA)

| 1 | 3 | 5 | 4089 | 4045 | 4093 | 4091 |...............................

LVAL
2,048 pixels

Image output CH2(portB)

| 7 | 2 | 4 | 6 | 4090 | 4096 | 4094 | 4092 |...............................

| 7 | 2 | 4 | 6 | 4097 | 4099 | 4097 | 4095 |...............................

| 7 | 2 | 4 | 6 | 4098 | 4012 | 8186 | 8192 |8190 |8188 |...............................

| 7 | 2 | 4 | 6 | 4103 | 4098 | 4100 | 4100 | 8193 | 8195 | 8197 | 8199 |...............................

Image output CH3(portC)

| Image output CH4(portD) |

| 8193 | 8195 | 8197 | 8199 |...............................

| 8 | 12288 | 12286 | 12284 | 12282 | 12280 | 12278 | 16384 | 16382 | 16380 | 16378 | 16383 | 16381 | 16379 | 12296 | 12290 | 12292 | 12294 | 12296 | 12290 | 12292 | 12294 |

LVAL
2,048 pixels
2. Output Timing “Full configuration Format2”

- Image output CH1(portA)
- Image output CH2(portB)
- Image output CH3(portC)
- Image output CH4(portD)
- Image output CH5(portE)
- Image output CH6(portF)
- Image output CH7(portG)
- Image output CH8(portH)

LVAL: 2,048 pixels
3. Output Timing “Medium Configuration”

Image output
CH1(portA)

Image output
CH2(portB)

Image output
CH3(portC)

Image output
CH4(portD)

LVAL

4. Output Timing “Base Configuration”

Image output
CH1(portA)

Image output
CH2(portB)

LVAL

8,192 pixels
5. Output Timing “AOI Mode (Base)”

Image output
CH1(portA)

Image output
CH2(portB)

LVAL

\[ N = (\text{risu} \times 256 + \text{risl}) \times 2 + 1 \]
VI. Communication Specifications

-Communication format

   Baud Rate: 9600bps
   Data Length: 8 bit
   Start Bit: 1 bit
   Stop Bit: 1 bit
   Parity: None
   Xon/Xoff Control: None

-Communication

  usid?<CR>       Reads the camera ID from the Camera
  limd=1<CR>      Sets the external sync system to the camera

-Glossary

  []     Omissible
  <CR>   Carriage Return

-Notes

  1. The command name has to be lower-case. Upper case characters are invalid.
  2. The command has to be a one byte character. Double byte characters are invalid.
  3. A blank space (spacebar) is invalid.
  4. The newline code is indicated by “CR(0x0D)”. LF(0x0A) and CR + LF are usable for the newline code.
     However, the newline code at the returning command is always as “CR”.
  5. Retyping the command is necessary when using the hyper terminal and a command input error is received.
     (The command corrects by the cursor moving is invalid)
  6. Descriptions of exceptional cases:
     - “NG” is returned when a non-exist command is input or an input error is received.
       e.g. A command input error (Gain A level number is not designated)
            Input command:  ga01=96
            Returned command: NG
       e.g. A none-exist command is input
            Input command:  ff
            Returned command: NG
     - “NE” is returned when a numeric value input error is received.
       e.g. The numeric value input error (Input value is out of the setting range)
            Input command:  galv=96
            Returned command: NE
       e.g. The numeric value input error (Input value is out of the setting range)
            Input command:  ga01=2000
            Returned command: NE
<table>
<thead>
<tr>
<th>Command Name</th>
<th>Format</th>
<th>Argument</th>
<th>Return value</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Get ID (Note.1)</td>
<td>usid[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>ID (Default: 0)</td>
<td>Get the camera ID (For multiple camera management)</td>
</tr>
<tr>
<td>Set ID (Note.1)</td>
<td>usid=N&lt;CR&gt;</td>
<td>N: 0-255</td>
<td>OK</td>
<td>Set the camera ID (For multiple camera management)</td>
</tr>
<tr>
<td>Get Sync</td>
<td>limd[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>1: Ext Sync</td>
<td>Get the sync system of the camera</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2: Int Sync</td>
<td></td>
</tr>
<tr>
<td>Set Sync</td>
<td>limd=N&lt;CR&gt;</td>
<td>N=1: Ext Sync</td>
<td>OK</td>
<td>Set the sync system of the camera</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=2: Int Sync</td>
<td></td>
<td>CC1 is the external sync pulse</td>
</tr>
<tr>
<td>Get Exposure Control</td>
<td>inmd[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>0: Line cycle</td>
<td>Get the exposure control status</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1: Fixed Time Exposure</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2: Pulse Width Exposure</td>
<td></td>
</tr>
<tr>
<td>Set Exposure Control</td>
<td>inmd=N&lt;CR&gt;</td>
<td>N=0: Line cycle</td>
<td>OK</td>
<td>Set the exposure control status</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=1: Fixed Time Exposure</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=2: Pulse Width Exposure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get Exposure Time</td>
<td>intu[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>1-255 (Default: 0)</td>
<td>Get the exposure time</td>
</tr>
<tr>
<td></td>
<td>intl[?]&lt;CR&gt;</td>
<td>0-255 (Default: 0)</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Set Exposure Time</td>
<td>intu=N&lt;CR&gt;</td>
<td>N=1-255</td>
<td>OK</td>
<td>Set the exposure time</td>
</tr>
<tr>
<td></td>
<td>intl=N&lt;CR&gt;</td>
<td>N=0-255</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get width of output</td>
<td>opbt&lt;CR&gt;</td>
<td>N/A</td>
<td>8: 8bit</td>
<td>Get width of video output.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10: 10bit</td>
<td></td>
</tr>
<tr>
<td>Set width of output</td>
<td>opbt=N&lt;CR&gt;</td>
<td>N=8: 8bit</td>
<td>OK</td>
<td>Set width of video output.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=10: 10bit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check</td>
<td>cmck&lt;CR&gt;</td>
<td>N/A</td>
<td>OK</td>
<td>Communication test</td>
</tr>
<tr>
<td>Save</td>
<td>cmsv&lt;CR&gt;</td>
<td>N/A</td>
<td>OK</td>
<td>Save settings to the EEPROM</td>
</tr>
<tr>
<td>Load</td>
<td>cmld&lt;CR&gt;</td>
<td>N/A</td>
<td>OK</td>
<td>Load settings from the EEPROM</td>
</tr>
<tr>
<td>Version</td>
<td>fivr&lt;CR&gt;</td>
<td>N/A</td>
<td>CPU Version</td>
<td>Get the version number of the program for the microcomputer control</td>
</tr>
<tr>
<td>Model</td>
<td>cmmo&lt;CR&gt;</td>
<td>N/A</td>
<td>Model</td>
<td>Get the camera model</td>
</tr>
<tr>
<td>Revision</td>
<td>fpvr&lt;CR&gt;</td>
<td>N/A</td>
<td>FPGA Revision</td>
<td>Get the version number of FPGA</td>
</tr>
<tr>
<td>config</td>
<td>cmcf&lt;CR&gt;</td>
<td>N/A</td>
<td>(Data output)</td>
<td>Get the all current settings</td>
</tr>
<tr>
<td>clear</td>
<td>cmcl&lt;CR&gt;</td>
<td>N/A</td>
<td>OK</td>
<td>Clear current command settings of EEPROM</td>
</tr>
<tr>
<td>Command list</td>
<td>ccmcm&lt;CR&gt;</td>
<td>N/A</td>
<td>command list</td>
<td>active command list</td>
</tr>
<tr>
<td>Get Data Rate Mode</td>
<td>opck[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>0-255 (Default: 0)</td>
<td>Get Data Rate Mode</td>
</tr>
<tr>
<td>Set Data Rate Mode</td>
<td>opck=N&lt;CR&gt;</td>
<td>0-255</td>
<td>OK</td>
<td>Set Data Rate Mode</td>
</tr>
<tr>
<td>Command Name</td>
<td>Format</td>
<td>Argument</td>
<td>Return value</td>
<td>Explanation</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------</td>
<td>----------</td>
<td>--------------</td>
<td>------------------------------------------------------------------</td>
</tr>
<tr>
<td>FFC Control</td>
<td>ffmd=N&lt;CR&gt;</td>
<td>N=0: OFF</td>
<td>OK</td>
<td>Shade control mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=1: ON</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=2: Data out (Note.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=3: Data in (by pixel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=4: Data in (all)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=5: Auto shade for gain</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=6: Auto shade for offset</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ffmd[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>0: OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1: ON</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2: Data out (Note.2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3: Data in (by pixel)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4: Data in (all)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5: Auto shade for gain</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6: Auto shade for offset</td>
<td></td>
</tr>
<tr>
<td>Select Gain/Offset</td>
<td>ffgo=N&lt;CR&gt;</td>
<td>N=0: OFF</td>
<td>OK</td>
<td>Setting target value reference/setting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=1: Gain</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=2: Offset</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ffgo[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>0: OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1: Gain</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2: Offset</td>
<td></td>
</tr>
<tr>
<td>Lower Pixel Address</td>
<td>ffpl=N&lt;CR&gt;</td>
<td>N: 0-255</td>
<td>OK</td>
<td>Correction target pixel (The lower rank address) value reference/setting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ffpl[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>0-255 (Default: 0)</td>
<td></td>
</tr>
<tr>
<td>Upper Pixel Address</td>
<td>fpu=N&lt;CR&gt;</td>
<td>N: 0-255</td>
<td>OK</td>
<td>Correction target pixel (The upper rank address) value reference/setting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>fpu[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>0-255 (Default: 0)</td>
<td></td>
</tr>
<tr>
<td>FFC Coeff</td>
<td>ffdo=N&lt;CR&gt;</td>
<td>N: 0-255</td>
<td>OK</td>
<td>Set the upper 8bit data of FFC coefficients (12bit).</td>
</tr>
<tr>
<td></td>
<td>ffdtl=N&lt;CR&gt;</td>
<td>N: 16-240</td>
<td>OK</td>
<td>Set the lower 4bit data of FFC coefficients (12bit).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>This value has to be a multiple of 16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The remainder of N divided by 16 is ignored</td>
</tr>
<tr>
<td></td>
<td>ffdo[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>0-255 (Default: 0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ffdtl[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>16-240 (Default: 16)</td>
<td>Get the lower 4bit data of FFC coefficients (12bit).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>This value is multiple of 16</td>
</tr>
<tr>
<td>Black Level Target</td>
<td>fflo=N&lt;CR&gt;</td>
<td>N: 0-255</td>
<td>OK</td>
<td>Correction target level value reference/setting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>for black level</td>
</tr>
<tr>
<td></td>
<td>fflo[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>0-255 (Default: 3)</td>
<td></td>
</tr>
<tr>
<td>Gray Level Target</td>
<td>ffgo=N&lt;CR&gt;</td>
<td>N: 0-255</td>
<td>OK</td>
<td>Correction target level value reference/setting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>for gray level</td>
</tr>
<tr>
<td></td>
<td>ffgo[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>0-255 (Default: 200)</td>
<td></td>
</tr>
<tr>
<td>Set Data</td>
<td>ffd&lt;CR&gt;</td>
<td>N/A</td>
<td>OK</td>
<td>Set data</td>
</tr>
<tr>
<td>Get Selected Output</td>
<td>ffu&lt;CR&gt;</td>
<td>N/A</td>
<td>0: upper 8 bits</td>
<td>Select upper 8 bits or lower 4 bits of the shade correction value to be put</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1: lower 4 bits</td>
<td></td>
</tr>
<tr>
<td>Set Selected Output</td>
<td>ffu=N&lt;CR&gt;</td>
<td>0: upper 8 bits</td>
<td>OK</td>
<td>on the video output line when ffmd=4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: lower 4 bits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EEPROM Load From User Bank</td>
<td>ffd&lt;CR&gt;</td>
<td>N/A</td>
<td>OK</td>
<td>Load shade data (Gain and Offset) from EEPROM user bank</td>
</tr>
<tr>
<td>EEPROM Save To User Bank</td>
<td>ffs&lt;CR&gt;</td>
<td>N/A</td>
<td>OK</td>
<td>Save shade data (Gain and Offset) to EEPROM user bank</td>
</tr>
<tr>
<td>EEPROM Load From Factory Bank</td>
<td>ffl&lt;CR&gt;</td>
<td>N/A</td>
<td>OK</td>
<td>Load shade data (Gain and Offset) from EEPROM factory bank</td>
</tr>
<tr>
<td>RAM clear</td>
<td>ffcl&lt;CR&gt;</td>
<td>Non</td>
<td>OK</td>
<td>Clear shade data (Gain) to 0</td>
</tr>
<tr>
<td></td>
<td>ffco&lt;CR&gt;</td>
<td>Non</td>
<td>OK</td>
<td>Clear shade data (Offset) to 3200 (12bit)</td>
</tr>
<tr>
<td>Command Name</td>
<td>Format</td>
<td>Argument</td>
<td>Return value</td>
<td>Explanation</td>
</tr>
<tr>
<td>--------------</td>
<td>--------</td>
<td>----------</td>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Get User Mode</td>
<td>ffum[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>0:user mode OFF</td>
<td>User BANK mode ON/OFF</td>
</tr>
<tr>
<td>Set User Mode</td>
<td>ffum=N&lt;CR&gt;</td>
<td>0:user mode OFF</td>
<td>OK</td>
<td><strong>ON</strong>: save/load FFC coefficient to User BANK</td>
</tr>
<tr>
<td>Get FFC coefficient bank</td>
<td>ffsb[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>0-7 (Default: 0)</td>
<td>Get User BANK</td>
</tr>
<tr>
<td>Set FFC coefficient bank</td>
<td>ffsb=N&lt;CR&gt;</td>
<td>0-7 (Default: 0)</td>
<td>OK</td>
<td>Set User BANK</td>
</tr>
<tr>
<td>Get Test Pattern</td>
<td>tsmd[?]&lt;CR&gt;</td>
<td>N/A</td>
<td>0: OFF</td>
<td>Get test pattern mode</td>
</tr>
<tr>
<td>Set Test Pattern</td>
<td>tsmd=N&lt;CR&gt;</td>
<td>N=0: OFF</td>
<td>OK</td>
<td>Set test pattern mode</td>
</tr>
<tr>
<td>Get Gain A Data</td>
<td>gadt&lt;CR&gt;</td>
<td>N/A</td>
<td>0-255 (Default: 0)</td>
<td>Get Digital Gain Data</td>
</tr>
<tr>
<td>Set Gain A Data</td>
<td>gadt=N&lt;CR&gt;</td>
<td>N: 0-255</td>
<td>OK</td>
<td>Set Digital Gain Data</td>
</tr>
<tr>
<td>Get Gain B Mode</td>
<td>gbdt&lt;CR&gt;</td>
<td>N/A</td>
<td>0 or 1 (Default: 0)</td>
<td>Get Gain B Mode</td>
</tr>
<tr>
<td>Set Gain B Mode</td>
<td>gbdt=N&lt;CR&gt;</td>
<td>N=0: OFF</td>
<td>OK</td>
<td>Set Gain B Mode</td>
</tr>
<tr>
<td>Get Anti Blooming Mode</td>
<td>abmd&lt;CR&gt;</td>
<td>N/A</td>
<td>0 or 1 (Default: 0)</td>
<td>Get Anti Blooming Mode</td>
</tr>
<tr>
<td>Set Anti Blooming Mode</td>
<td>abmd=N&lt;CR&gt;</td>
<td>N=0: OFF</td>
<td>OK</td>
<td>Set Anti Blooming Mode</td>
</tr>
<tr>
<td>Get start pixel of AOI</td>
<td>risu&lt;CR&gt;</td>
<td>N/A</td>
<td>0-255 (Default: 0)</td>
<td>Get start pixel of AOI (The upper rank address)</td>
</tr>
<tr>
<td>Set start pixel of AOI</td>
<td>risu=N&lt;CR&gt;</td>
<td>N=0-255 (Default: 0)</td>
<td>OK</td>
<td>Set start pixel of AOI (The lower rank address)</td>
</tr>
<tr>
<td>Get the length of LVAL</td>
<td>riwu&lt;CR&gt;</td>
<td>N/A</td>
<td>0-255 (Default: 4)</td>
<td>Get the length of LVAL (The upper rank)</td>
</tr>
<tr>
<td>Set the length of LVAL</td>
<td>riwu=N&lt;CR&gt;</td>
<td>N=0-255 (Default: 4)</td>
<td>OK</td>
<td>Set the length of LVAL (The upper rank)</td>
</tr>
</tbody>
</table>

Note 1: The camera ID can be saved in the user area of the EEPROM, but cannot be cleared by a clear command.

Note 2: Gain or offset value (coeff) will be put on the video output instead of the image data.

Note 3: Gain or Offset must be set prior to "Set Data".

Note 4: Correction target pixel address = ffpu x 256 + ffpl.
VII. Command Description

A. Sync / Exposure Control (limd / inmd)
   limd: Change sync control mode.
   inmd: Change exposure control mode.

B. Sync and Exposure Mode
   Four operating modes can be selected using limd in Sync Selection and inmd in Exposure Control.

<table>
<thead>
<tr>
<th>inmd</th>
<th>limd</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>LINE</td>
<td>External</td>
<td>Internal</td>
</tr>
<tr>
<td>1</td>
<td>FIX</td>
<td>EXT_FIX</td>
<td>Internal</td>
</tr>
<tr>
<td>2</td>
<td>PLS</td>
<td>Pulse</td>
<td>Don’t use</td>
</tr>
</tbody>
</table>

1. EXT_LINE mode

SYNC: External Sync
EXPOSURE TIME: Line Cycle (Refer to III-A)

Exposure time [us] = Line period – (2 + (12 x B))

B: CLK period (different by model)

<table>
<thead>
<tr>
<th>Model</th>
<th>Value [us]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS-B16KU35CL</td>
<td>0.0235</td>
</tr>
<tr>
<td>Except for FS-B16KU35CL</td>
<td>0.0117</td>
</tr>
</tbody>
</table>

2. EXT_FIX mode

SYNC: External Sync
EXPOSURE TIME: Programmable with intu and intl (refer to III-A)

Exposure time [us] = (( intu x 256 + intl) x C) + 2

C: Amount of change time per step

<table>
<thead>
<tr>
<th>Model</th>
<th>Value [us]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS-B16KU35CL</td>
<td>0.4</td>
</tr>
<tr>
<td>Except for FS-B16KU35CL</td>
<td>0.2</td>
</tr>
</tbody>
</table>
3. INTERNAL mode

SYNC: Internal Sync Only

**EXPOSURE TIME:** Line Cycle (Refer to III-A)

Exposure time [us] = (( intu x 256 + intl) x C) + A – (2 + (12 x B))

Line period [us] = (( intu x 256 + intl) x C) + A

A: Minimum line period (different by model).

<table>
<thead>
<tr>
<th>opck</th>
<th>FS-B16KU35CL</th>
<th>FS-B8KU35CL, FS-B8KU7CL</th>
<th>FS-B4KU7CL, FS-B4KU35CL</th>
<th>FS-B2KU7CL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
</tr>
<tr>
<td>1</td>
<td>41.6 us</td>
<td>21.1 us</td>
<td>21.1 us</td>
<td>21.1 us</td>
</tr>
<tr>
<td>2</td>
<td>48.6 us</td>
<td>24.5 us</td>
<td>24.5 us</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>82.6 us</td>
<td>41.6 us</td>
<td>41.6 us</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>96.8 us</td>
<td>48.6 us</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>164.5 us</td>
<td>82.6 us</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>26 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
</tr>
<tr>
<td>9</td>
<td>51.6 us</td>
<td>25 us</td>
<td>25 us</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>102.8 us</td>
<td>51.6 us</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>25 us</td>
<td>12.5 us</td>
<td>12.5 us</td>
<td>12.5 us</td>
</tr>
<tr>
<td>23</td>
<td>25.4 us</td>
<td>13.2 us</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>24</td>
<td>26 us</td>
<td>13.2 us</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>41.6 us</td>
<td>21.1 us</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>26</td>
<td>25.4 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
</tr>
<tr>
<td>27</td>
<td>26 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
<td>13.2 us</td>
</tr>
<tr>
<td>28</td>
<td>41.6 us</td>
<td>21.1 us</td>
<td>21.1 us</td>
<td>21.1 us</td>
</tr>
</tbody>
</table>

B: CLK period (different by model).

<table>
<thead>
<tr>
<th>Model</th>
<th>Value [us]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS-B16KU35CL</td>
<td>0.0235</td>
</tr>
<tr>
<td>Except for FS-B16KU35CL</td>
<td>0.0117</td>
</tr>
</tbody>
</table>

C: Amount of change time per step.

<table>
<thead>
<tr>
<th>Model</th>
<th>Value [us]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS-B16KU35CL</td>
<td>0.4</td>
</tr>
<tr>
<td>Except for FS-B16KU35CL</td>
<td>0.2</td>
</tr>
</tbody>
</table>

4. PULSE mode

SYNC: External Sync

**EXPOSURE TIME:** Pulse Width

Exposure time [us] = Pulse width of CC1 (High) – 1
C. Exposure Time Setting (intu / intl)

When the exposure control mode is programmable, set the exposure time. When sync control is internal, exposure time becomes a Line period, so you can change the Line period of camera by this setting value of "exposure time". The calculation of the exposure time is different from Sync / Exposure control mode, which is described in the Sync / Exposure control section.

intu: Change the upper byte of exposure time. The valid values are 0-255.

intl: Change the lower byte of exposure time. The valid values are 0-255.

The setting value of exposure time = (intu x 256) + intl

D. Data Rate Control (opck)

opck;

Change Camera Link clock speed and the Camera Link output format (Full/Medium/Base). The number and variation of active modes depends on the camera model. See each model's active modes in the following list.

<table>
<thead>
<tr>
<th>Camera Link Configure</th>
<th>Maximum Line rate</th>
<th>Data rate</th>
<th>Camera Link Configure</th>
<th>Maximum Line rate</th>
<th>Data rate</th>
<th>Camera Link Configure</th>
<th>Maximum Line rate</th>
<th>Data rate</th>
<th>Camera Link Configure</th>
<th>Maximum Line rate</th>
<th>Data rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Format 1 (9)</td>
<td>38kHz</td>
<td>85MHz x 8tap</td>
<td>Full Format 1 (9)</td>
<td>75kHz</td>
<td>85MHz x 8tap</td>
<td>Medium</td>
<td>75kHz</td>
<td>85MHz x 8tap</td>
<td>Base</td>
<td>75kHz</td>
<td>85MHz x 2tap</td>
</tr>
<tr>
<td>Medium</td>
<td>10.5kHz</td>
<td>85MHz x 8tap</td>
<td>Medium</td>
<td>47kHz</td>
<td>85MHz x 8tap</td>
<td>Base</td>
<td>47kHz</td>
<td>85MHz x 2tap</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base</td>
<td>10kHz</td>
<td>85MHz x 8tap</td>
<td>Base</td>
<td>12kHz</td>
<td>85MHz x 2tap</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*1...The output width of the CMOS sensor is 9 bit when opck = 11 (denoted by [opck=11]), and it is 10 bit when opck # 11 (denoted by [except 11]). If opck is changed from [11] to [except 11] and vice-versa, the correction value of the FFC will be loaded from EEPROM automatically each time as the behavior of the CMOS sensor is different between [opck=11] and [except 11].

*2...There are several clock speeds and output formats. A user can select clock speed and output format depending on the length of a camera link cable, the speed of a grabber-board, and the total cost.

E. Digital Gain Control (gadt)

gadt;

Set the digital gain.
The possible values are 0-255.
The maximum magnification is four time the gain (in gadt=255).
This is a function of the FPGA.

Digital gain formula is the following.

\[ Yw' = (1 + \text{gadt} / 64) \times (Yw - \text{ffto}) + \text{ffto} \]

Yw': Level after the digital gain
Yw: Level before the digital gain
ffto: "Offset" target level of FFC
F. Analog Gain Control (gbdt)

    gbdt:
    This sets the analog gain
    On: 4-fold
    Off: 1-fold
    This is a function of the CMOS sensor. The value will be sent to the corresponding CMOS sensor register.

G. Output bit setting (opbt)

    opbt:
    This sets the width of the video output.
    8: 8 bit
    10: 10 bit

H. Check Communication Establishment

    cmck:
    This checks that the RS232 communication is running.
    If you have received the message “OK” the RS232 communication is working.

I. Save / Load / Clear Camera Settings ( cmsv / cmld / cmcl )

    cmsv: The “CPU RAM” settings stored in the user area of the “CPU EEPROM”
    cmld: Load the “CPU EEPROM” settings of the user area into the “CPU RAM”
    cmcl: Reset the user area of the “CPU EEPROM”. The “CPU RAM” is set to the factory default.

J. To see the “Model”, “Firm / FPGA Version” ( cmmo / fivr / fpvr )

    cmmo: You can see the model number of the camera that is currently connected.

<table>
<thead>
<tr>
<th>Model number</th>
<th>Product number</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>FS-B2KU7CL</td>
</tr>
<tr>
<td>39</td>
<td>FS-B4KU35CL</td>
</tr>
<tr>
<td>36</td>
<td>FS-B4KU7CL</td>
</tr>
<tr>
<td>35</td>
<td>FS-B8KU35CL</td>
</tr>
<tr>
<td>34</td>
<td>FS-B8KU7CL</td>
</tr>
<tr>
<td>33</td>
<td>FS-B16KU35CL</td>
</tr>
</tbody>
</table>

    fivr: You can see the CPU version of the camera that is currently connected.
    fpvr: You can see the FPGA version of the camera that is currently connected.

K. To see active commands ( only HyperTerminal ) ( cmcm )

    cmcm;
    A list of the active commands will be displayed on the HyperTerminal
    Please use only when you communicate with HyperTerminal
    Inspection software commands will not be displayed.
L. To see all camera settings (only HyperTerminal) (cmcf)

  cmcf:
  A list of all the settings will be displayed in HyperTerminal.
  Please use only when you communicate with HyperTerminal.
  Inspection software commands will not be displayed.

M. Flat Field Correction (FFC)

  Shade correction is used for correcting non-uniformity of image brightness resulting from the lens or the imager.
  In using this camera, Shade Correction should be used because the imager has fixed pattern noise.
  In addition, default setting of the shade correction is ON (ffmd=1)
  When we ship this camera, we have shade coefficients in ROM.
  The coefficients are automatically loaded at power on.

1) Auto Shade Correction Procedure

ffto=A
Set target level to A in a light-shield condition (8 bit)

ffmd=6
Correct offset level of each pixel in a light-shielding condition in order to make a flat line.
(Offset correction value will be calculated only once when ffmd is set to 6 from other value).

fftg=B
Set target level to B in a light-receiving condition (8 bit).
(The light brightness level must be lower than the target level).

ffmd=5
Correct offset level of each pixel in a light-receiving condition in order to make a flat line.
(Fain correction value will be calculated only once when ffmd is set to 5 from other value).

ffmd=1
Confirm.
2) Manual Shade Correction Procedure (by pixel)

ffgo=Y  
Select gain or offset correction value.  
1: Gain Correction Value  2: Offset Correction Value

ffdt=C  
Set correction value.

ffdtl=D  
value = D/16 x 256 + C x 16  
Note: D should be multiples of 16

ffmd=4  
Set correction mode to “all pixels”. 
Apply

ffmd=1  
Confirm

3) Manual Shade Correction Procedures (all pixels)

ffgo=Y  
Select gain or offset correction value.  
1: Gain Correction Value  2: Offset Correction Value

ffpl=A  
Set a pixel address.

ffpu=B  
addr = B x 256 + A

ffdt=C  
Set correction value.

ffdtl=D  
value = D/16 x 256 + C x 16  
Note: D should be multiples of 16

ffmd=3  
Set correction mode to “by pixel”. 
Apply

ffmd=1  
Confirm

N. Save correction value (FFC)

ffsv:  
Save correction value of FFC (Gain and Offset). Transfer the data from the RAM to the EEPROM.  
(For more information, please refer to the outline on the camera memories-related FFC).

O. Load Correction Value (FFC)

ffld:  
Load correction value of FFC (Gain and Offset). Transfer from EEPROM to RAM.  
(For more information, please refer to the Outline on the camera memories-related FFC).

P. Clear FFC RAM (FFC)

If you want to clear the RAM of only offset or of only gain, use these commands.

ffcq: Clear “FFC RAM” of gain.

ffco: Clear “FFC RAM” of offset.
Q. Anti-blooming setting (abmd)

abmd:
Sets Anti-blooming ON/OFF
0: OFF
1: ON
This is a function of the CMOS sensor. You are sending a registry to the CMOS Sensor.

R. User ID (usid)

usid:
When using multiple cameras, you can set the ID for each camera.
The camera ID can be saved by a save command (cmsv) in the user area of the “CPU EEPROM”, but cannot be cleared by a clear command.
The possible values are 0-255.

S. Area of Interest (AOI)

AOI is the function that only the specific portion of 1 line is output from the camera.
The start pixel output can be set by using the risu and risl.

<table>
<thead>
<tr>
<th>Product number</th>
<th>AOI mode (Base)</th>
<th>AOI mode (Full)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS-B2KU7CL</td>
<td>N= (risu* 256 + risl)*2+1</td>
<td>-</td>
</tr>
<tr>
<td>FS-B4KU35CL</td>
<td>N= (risu* 256 + risl)*4+1</td>
<td>-</td>
</tr>
<tr>
<td>FS-B4KU7CL</td>
<td>N= (risu* 256 + risl)*2+1</td>
<td>-</td>
</tr>
<tr>
<td>FS-B8KU35CL</td>
<td>N= (risu* 256 + risl)*4+1</td>
<td>N= (risu* 256 + risl)*8+1</td>
</tr>
<tr>
<td>FS-B8KU7CL</td>
<td>N= (risu* 256 + risl)*2+1</td>
<td>N= (risu* 256 + risl)*8+1</td>
</tr>
<tr>
<td>FS-B16KU35CL</td>
<td>N= (risu* 256 + risl)*2+1</td>
<td>-</td>
</tr>
</tbody>
</table>

The width of LVAL can be set by using the command riwu and riwl
The width of LVAL = (riwu * 256 + riwl) pixels
Please set the width of LVAL shorter than the line rate. If the width of LVAL is longer than the line rate, the image isn’t output from the camera.

The output format, which is only base configuration, follows:

Image output
CH1(portA)
N
N+2
N+4
...............................
LVAL
(riwu*256+riwl) pixels
Image output
CH2(portB)
N+1
N+3
N+5
...............................

Product Specifications 40 Ver 1.11
A. Outline on the camera memories-related CPU

There are several non-volatile (EEPROM) and volatile (RAM) memories loaded in a camera. Please see the diagram below. This section describes the memory related CPU.

1. CPU RAM
   The setting is sent via RS232 communication and is stored in the “CPU RAM”. If a user wants to use the setting of “CPU RAM” later, the data must be saved from “CPU RAM” into “CPU EEPROM” before the power is turned off.

2. CPU EEPROM
   “CPU EEPROM” is divided into two areas; “User area” and “Factory area”
   - Factory area:
     Factory setting data is stored here. This is read only and cannot be accessed directly.
   - User area:
     User setting data is stored here. This can be accessed with the commands cmsv / cmld.

3. To set factory settings
   If a user wants to set the “CPU RAM” settings to the factory default, please send the Clear command (cmcl). The user area of the “CPU EEPROM” is reset when the Clear command (cmcl) is sent, factory setting will then be loaded into “CPU RAM”.

4. Behavior of Power
   When the power is turned on, Factory settings are loaded into the “CPU RAM” first. User settings will be loaded afterwards.
   Therefore, if nothing is saved in the user settings, “CPU RAM” is set to the factory default.
B. Outline on the camera memories-related FFC

There are several non-volatile (EEPROM) and volatile (RAM) memories loaded in a camera. See the block diagram below. This section describes the memory related FFC.

1. FFC RAM

“FFC RAM” is for storing a correction data of the Offset and Gain of FFC. When you transfer data between “FFC RAM” and “FFC EEPROM”, data of Gain and Offset is set. FFC will be corrected with the data of “FFC RAM”. If a user wants to use the data of “FFC RAM” later, please save the data of “FFC RAM” into “FFC EEPROM” before the power is turned off.

2. FFC EEPROM

“FFC EEPROM” is divided into three separate areas; “Standard user”, “Bank user”, and “Factory-set”.

Factory Set
Factory setting data is stored here. This is a read only area. Factory-set is accessible with the command fflf. The area “Factory-set” is divided into two areas: opck=11 and opck=all except 11 as the behavior of the CMOS sensor is different between opck=11 and opck=all except 11. When you send “FFC EEPROM” the acces command (fflf), the accessing area will change depending on the state of the opck automatically.

Standard User
This area is for a single bank user. When ffum=0, then Standard User should be accessed. Standard User is accessible with the commands ffsv / ffld. The area “Standard user” is divided into two areas; opck=11 and opck=all except 11, as the behavior of the CMOS sensor is different between opck=11 and opck=all except 11. When the “FFC EEPROM” is sent an access command (ffsv / ffld), the accessing area will change depending on the opck.

Bank user
You can store several patterns of correction data. When ffum=1, then Bank user should be accessed. Bank user is accessed with the commands (ffsv / ffld). The Bank user area is divided into eight areas. The area is switched by the command ffsb. Note that the areas cannot be switched depending on opck.

3. Behavior of Power

When the power is turned on, the “FFC EEPROM” will be loaded into “FFC RAM” from a predetermined area of the “FFC EEPROM” by the state of ffum / ffsb / opck.
IX. Test Patterns

A. FS-B2KU7CL-C, FS-B2KU7CL-F

Test Pattern 1 (tsmd=1)

Test Pattern 2 (tsmd=2)

Test Pattern 3 (tsmd=3)

Test Pattern 4 (tsmd=4)
B. FS-B4KU7CL-C / FS-B4KU7CL-F, FS-B4KU35CL-C / FS-B4KU35CL-F

- Test Pattern 1 (tsmd=1)

- Test Pattern 2 (tsmd=2)

- Test Pattern 3 (tsmd=3)

- Test Pattern 4 (tsmd=4)
C. FS-B8KU35CL-F, FS-B8KU7CL-M72

Test Pattern 1 (tsmd=1)

Test Pattern 2 (tsmd=2)

Test Pattern 3 (tsmd=3)

Test Pattern 4 (tsmd=4)

D. FS-B16KU35CL-M72

Test Pattern 1 (tsmd=1)

Test Pattern 2 (tsmd=2)

Test Pattern 3 (tsmd=3)

Test Pattern 4 (tsmd=4)
X. Quantum Efficiency
XI. Dimension

A. FS-B2KU7CL-C

Unit: mm

Unit: mm
C. FS-B16KU35CL-M72, FS-B8KU7CL-M72

Unit: mm

Cross section A - A

19.55 (from M72 frange to image plate)

10 (M72 thread depth)

15 (Max. lens insert depth)

Product Specifications

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Ver 1.11
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<td>June 19, 2012</td>
<td>Added AOI</td>
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