

**Digital Monochrome (b/w)
Line Scan Camera**

 System: **IEEE1394a**
Baumer FWL120

 Art. No: **OD106413**

- IEEE1394a (FireWire™) progressive scan CCD camera
- 2048 pixel
- Outstanding image quality
- High sensitivity
- Frame based image capture up to 8 MByte image data per frame
- Freely programmable true partial scan function (ROI)
- External synchronization (frame trigger / line sync)
- Encoder pulse divider register
- Integrated online 14 bit shading correction
- Automatic exposure control for stable image quality at web speed tolerances down to stand still
- Integrated 16 MByte RAM for temporarily image data buffering
- Compact robust aluminum housing
- Industrial IEEE1394a connector
- Camera parameter in real-time programmable
- Powerful Baumer FCAM1394 driver (OHCI standard compliant) / Software Development Kit for Windows / Linux
- System compatible to Baumer FireWire™ matrix cameras
- IEEE1394a interface
- User-friendly Baumer TWAIN compatible image capture and camera control software



shown lens needs to be ordered separately

1. Overview

| | |
|--------------------------------------|---|
| Sensor | interline progressive scan CCD |
| Shutter / readout mode | global shutter / progressive scan readout |
| Number of pixel | 2048 |
| Number of lines | up to 4095 *) |
| Pixel size | 14.0 µm x 14.0 µm |
| Color filter | no |
| Operation modes | |
| Frame trigger mode | yes, edge controlled / status controlled |
| Free running mode | yes (frame based) |
| Line sync mode | external encoder input / free running time controlled |
| Signal processing | real-time software programmable |
| Pixel clock | 6.5 MHz |
| Max. line rate | 2.8 kHz |
| A/D converter | 14 bit |
| Exposure control (t _{exp}) | total: 1 µsec .. 65 msec, step 1 µsec automatic exposure control |
| Gain control | 0 .. 10 dB |
| Offset (black level) | 0 .. 255 LSB (14 bit) |
| Shading correction | yes, online (14 bit) |
| Image data buffer | 16 MByte |
| Image acquisition | |
| Data format | raw image data from camera |

Technical specifications subject to change

| Camera image format modes (see item 3) | Format (pixel) | Bit per pixel | Pixel clock MHz | Lines per sec. (**) |
|--|---|---------------|-----------------|---------------------|
| Full frame | 2048 x 4095 | 8 | 6.5 | 2.8 KHz |
| Partial scan function | yes, format freely programmable | | | |
| | # pixel horizontal * lines + 256 < 8 million pixel | 8 | 6.5 | 2.8 KHz |
| Test pattern function | yes | | | |
| Data quality | at 20 °C, gain = 1, exposure time = 0.35 msec, | | | |
| Readout noise | $\sigma < 0.5$ (8 bit) typical | | | |
| Dynamic range | typical > 54 dB | | | |
| Optical interface | F-Mount | | | |
| Optical filter | no option : super polished, IR cut filter or no filter | | | |
| Process interface functions | | | | |
| Frame trigger | yes, edge trigger or status controlled | | | |
| Line sync | yes | | | |
| External line sync divider | encoder pulse divider (16 bit) | | | |
| Frame delay | yes, free programmable | | | |
| Software reset | yes, in free running mode, delay up to 32 msec | | | |
| Image data header | yes | | | |
| Electrical interface | | | | |
| Data / control / power | standard single cable IEEE1394a / 6 pins option: screw lock type connector | | | |
| Digital input | 1: frame trigger, opto decoupled, 5 V .. 30 V / 20 mA rising edge (***) min. trigger impulse length (t_{min}): 4 μ sec max. trigger delay (t_{delay}): 4 μ sec | | | |
| | 2: line sync, opto decoupled, 5 V .. 30 V / 20 mA rising edge (***) min. trigger impulse length (t_{min}): 4 μ sec max. trigger delay (t_{delay}): 4 μ sec | | | |
| Digital output | no | | | |
| LED | green: power on / image data transfer not active yellow: power on / image data transfer active yellow flashing: error | | | |
| Power consumption | < 6 Watt | | | |
| Environmental | | | | |
| Storage temperature | -10 °C .. +70 °C | | | |
| Operating temperature | +5 °C .. +50 °C | | | |
| Humidity | 10 % .. 90 % non condensing | | | |
| Housing | aluminum | | | |
| Dimensions | 73 x 56 x 93.9 mm ³ | | | |
| Weight | 370 g | | | |
| IEEE1394a interface | 400 Mbit / sec | | | |
| Software | Baumer FCAM1394 driver / SDK for Windows 2000 / Windows XP / Linux Kernel 2.4.>22, 2.6.xx Baumer TWAIN image capture and camera control software | | | |

*) full frame mode

**) maximum line rate depending on set exposure time

***) can be inverted via software

2. Camera Factory Settings after Camera Start-Up

| Camera factory settings after camera start-up | |
|---|-------------------|
| Operation modes | free running mode |
| Signal processing | |
| Exposure control | 0.35 msec |
| Gain control | 0 dB |
| Offset (black level) | 0 |
| Shading correction | off |
| Image acquisition | |
| Camera image format mode | full frame |
| Partial scan function | not active |
| Electrical interface | |
| Digital output | - |

3. SDK Supported Image Formats

| Camera name | FWL120 | | | | |
|-------------|----------------|-------------|----------------|------------------|-------------------|
| Camera mode | SDK image mode | | | | |
| | Mode ID | Description | Image format | Color coding | Functions / State |
| Full Frame | 0 | Full Frame | 2048 x 4095 *) | RawMono8, Mono8, | PS, FT, LS, Mono |

*) Partial scan: for calculation of the maximum image size see item 1

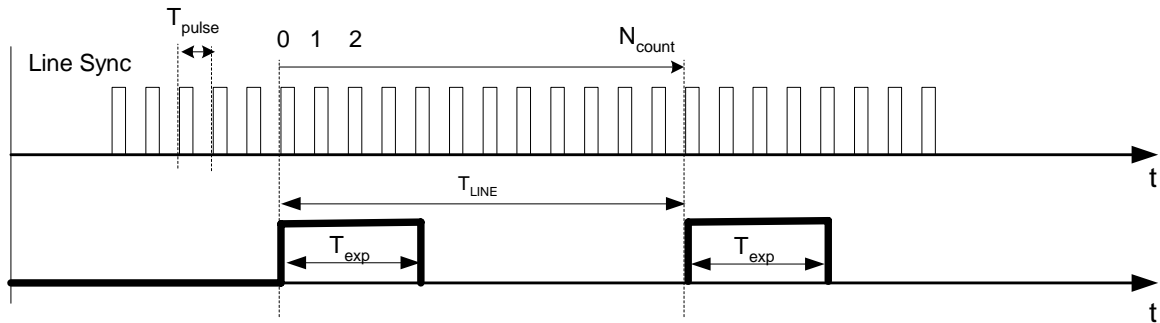
SDK - Software Development Kit
 PS - partial scan
 FT - frame trigger
 LS - line sync
 Mono - monochrome mode

RawMono8 - unmanipulated pixel data for monochrome camera modes in 8 bit
 Mono8 - software corrected image data for monochrome camera modes in 8 bit

4. Timing, Operation

4.1 Line Synchronization Mode

4.1.1 External Synchronization (Encoder)



T_{exp} = Exposure time

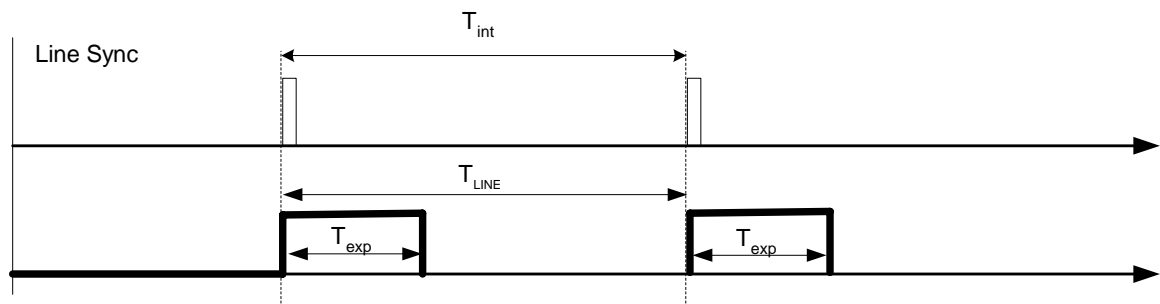
T_{pulse} = Time between two encoder pulses

N_{count} = Encoder Divider Register

$T_{readout}$ = Readout time = 0.35 msec

$$T_{LINE} = \text{Max} (T_{exp} , T_{pulse} * (N_{count} + 1) , T_{readout})$$

4.1.2 Free Running Time controlled Synchronization



T_{exp} = Exposure time

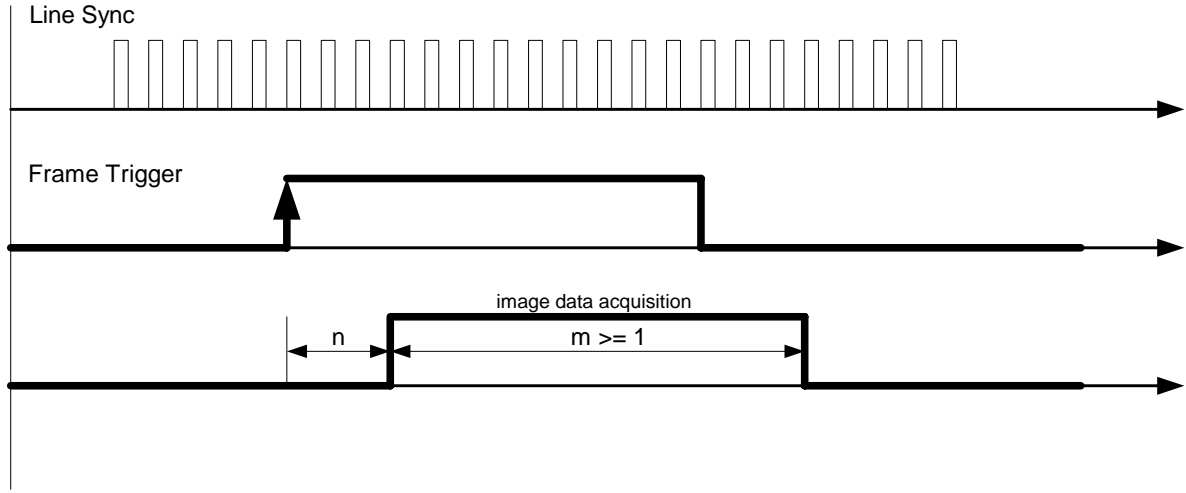
T_{int} = Timerregister = 0.35 msec

$T_{readout}$ = Readout time = 0.35 msec

$$T_{LINE} = \text{Max} (T_{exp} , T_{int} , T_{readout})$$

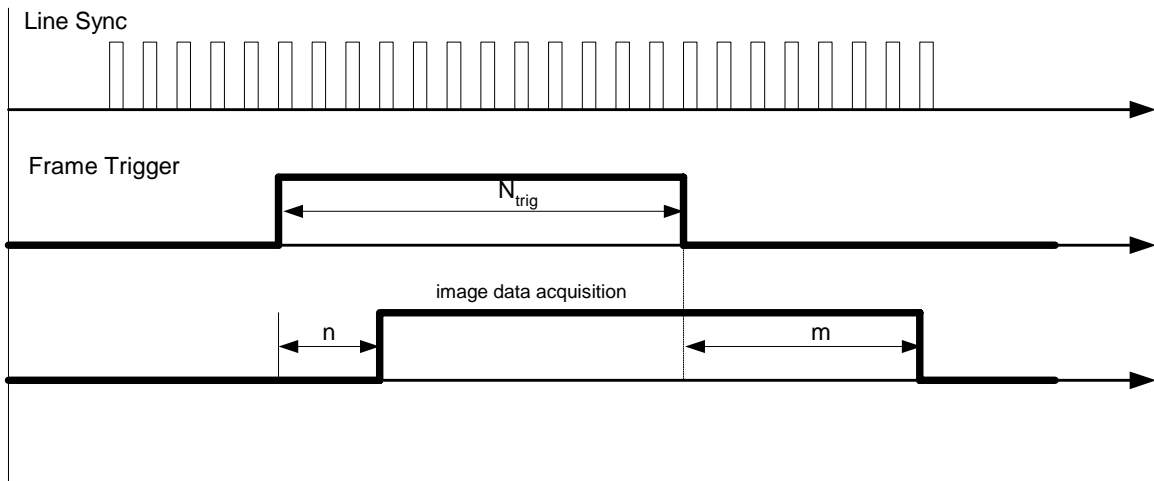
4.2 Frame Trigger Mode

4.2.1 Edge Controlled



n – start of acquisition delay in # of lines, programmable (FrameBeginRegister)
 m – acquisition in # of lines, programmable (FrameLengthRegister)

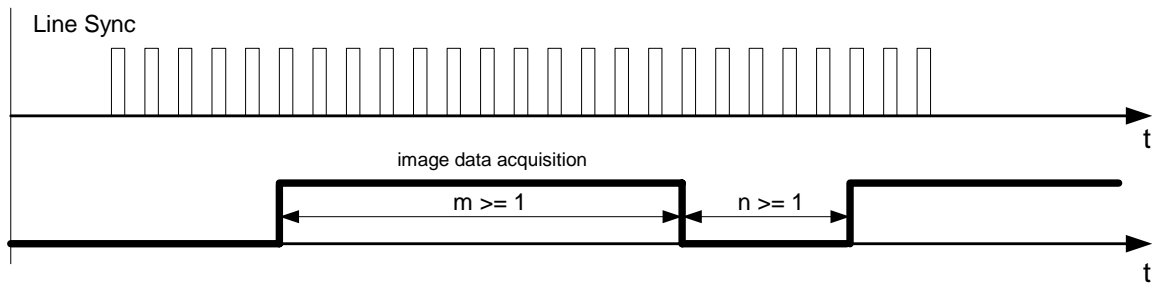
4.2.2 Status Controlled



n – start of acquisition delay in # of lines, programmable (FrameBeginRegister)
 $n < N_{trig}$ delay n must be set to a lower value than the trigger impulse length N_{trig}
 m – end of acquisition delay in # of lines, programmable (FrameLengthRegister)

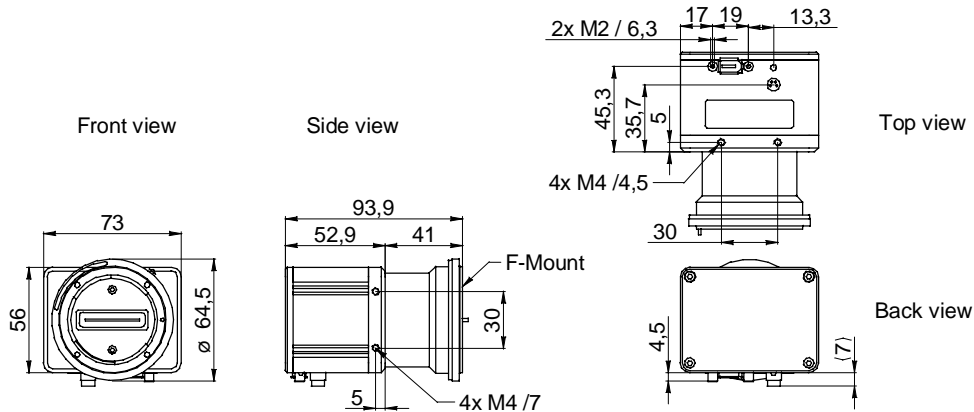
| | acquired # of lines |
|-------------------|---------------------|
| Edge controlled | m |
| Status controlled | $N_{trig} - n + m$ |

4.3 Frame Free Running Mode

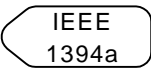



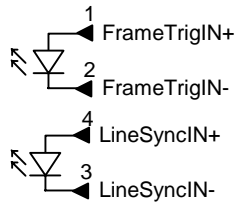
n – gap between two image data acquisitions in # of lines, programmable (FrameBeginRegister)
 m – acquisition in # of lines, programmable (FrameLengthRegister)

5. Housing



6. Connectors / Electrical Interfaces

| IEEE1394a | Pin |
|--|--|
|  IEEE 1394a | 1: Power 2: GND 3: TPB- 4: TPB+ 5: TPA- 6: TPA+ |

| Frame Trigger / Line Sync | Typ: Lumberg RSMESD 4pin. |
|---|--|
|  |  |
| | Trigger cable wires color *): 1 = brown 2 = white 3 = blue 4 = black |

*) shielded trigger / flash cable needs to be used and ordered separately

7. Application Notes

Because of the current used CCD line camera please note the following:

- For the best performance of the line scan camera predefined correction values are internally applied. This automatic correction of the digital offset of the ADC can not be influenced by the user. It might be expected that the loading of the correction values takes slightly longer than normally appearing with Baumer cameras.
- The used CCD line scan sensor operates without limitations as long as an illumination unit is used which avoids that the sensor is over exposed. When the sensor is over exposed some of the generated electrons may drift to adjacent pixels, resulting in a so called smear. This performance of the sensor can not be influenced by Baumer Optronic and need to be avoided by creating optimal illumination conditions.
- The design of the CCD line scan sensor does not allow the use of infrared-illumination units. This performance of the sensor can not be influenced by Baumer Optronic and need to be considered when designing the illumination units.

Baumer Optronic can not be hold responsible neither is reliable for any lack in image quality due to reasons described under item 7. Application Notes.

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