

DFM 72BUC02-ML

Technical Reference Manual



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1 Quick Facts

General	
Dynamic Range	8 bit
Resolution	2592x1944
Frame Rate at Full Resolution	7
Pixel Formats	8-Bit Bayer (GR)

Optical Interface	
IR-Cut filter	No
Sensor Type	Aptina MT9P006
Shutter Type	Rolling
Sensor Format	1/2.5 inch
Pixel Size	2.2 μm
Lens Mount	M12x0.5

Electrical Interface	
Interface	USB 2.0
Supply voltage	4.75 VDC to 5.25 VDC
Current consumption	approx 250 mA @ 5 VDC

Mechanical Data	
Dimensions	H: 30 mm, W: 30 mm, L: 15 mm
Mass	7 g

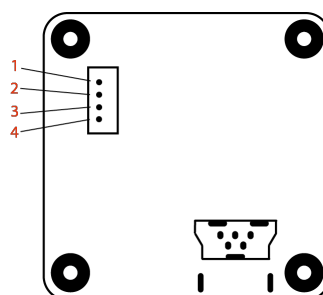
Adjustments	
Shutter	100 μs to 30 s
Gain	4 to 63



Environmental	
Temperature (operating)	-5 °C to 45 °C
Temperature (storage)	-20 °C to 60 °C
Humidity (operating)	20 % to 80 % (non-condensing)
Humidity (storage)	20 % to 95 % (non-condensing)

3 I/O Connector

3.1 4-pin I/O Connector



Rear view of camera

Pin	Signal	I/O	Remarks	Characteristics			
				Min	Typ	Max	Unit
1	TRIGGER_IN (-)	I ³	Optocoupler ground	-	-	-	-
2	TRIGGER_IN (+)	I ³	Optocoupler signal	3.3 ²	-	24.0 ²	V
3	GND_I/O	G ³	External Ground	-	-	-	-
4	STROBE_OUT	O ³	Open drain	-	-	24.0 ¹	V

¹ max. 0.2A (ID) for open drain MOSFET!

² min. 3.5 mA driver strength required!

³ G: Ground O: Output I: Input

The part number of this PicoBlade connector is Molex-53047-0410. To create an I/O cable, a PicoBlade connector (Molex-51021-0400) or a PicoBlade cable assembly (e.g. Molex-15134-0400) are required.

3.1.1 TRIGGER_IN

The *TRIGGER_IN* line can be used to synchronize the start of the exposure time with external events. The [Trigger](#) section describes in detail how the image sensor's behavior can be controlled.

The current input signal can also be read directly through the [General Purpose Input](#) feature.

3.1.2 STROBE_OUT

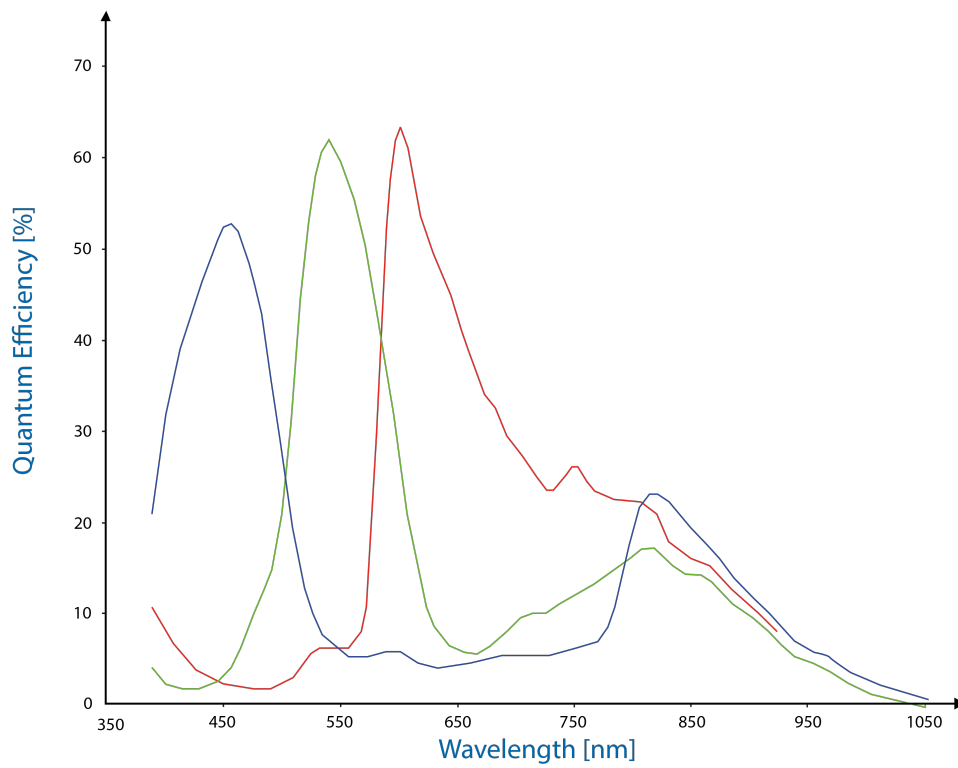
The *STROBE_OUT* line's main usage is to indicate the integration time of the image sensor which allows flashes, strobes or other light sources to be synchronized with camera operation. The line's behavior can be controlled through the [Strobe](#) controls.



The output signal can also be directly controlled through the [General Purpose Output](#) feature.

4 Spectral Characteristics

4.1 Spectral Sensitivity - MT9P006





5 Camera Controls

This section describes the parameters available for the DFM 72BUC02-ML camera.

The actual name of the parameter depends on the driver technology used to access the camera. Parameter names are listed for the most common ways to access the cameras:

- UVC/V4L2 (on Linux, via `uvcdvideo`)
- *IC Imaging Control* (on Windows, via *Device Driver for USB Cameras*)

5.1 Sensor Readout Control

5.1.1 Pixel Format

The pixel format defines the data type of the pixels transmitted to the computer. The bits per pixel needed for a particular pixel format influence the required bandwidth.

The driver technology used to access the camera significantly impacts the way the pixel format is controlled:

- When using the `uvcdvideo` driver on Linux, the pixel format is defined by `video4linux2`.
- When using *IC Imaging Control*, the pixel format is part of the video format - a parameter which combines pixel format, resolution and readout mode. For more information, refer to the *IC Imaging Control* documentation sections on `VideoFormat` and `VideoFormatDesc`.

The DFM 72BUC02-ML color camera supports multiple pixel formats with variable bits-per-pixel settings. The names of the pixel formats and the way to select them depends on the driver used to control the camera. The following table contains a short overview of all possible formats followed by a more detailed description.

Pixel Format	Bits Per Pixel	UVC	TIS UVC Driver
8-Bit Bayer (GR)	8	GRBG	RGB32, Y800

5.1.1.1 8-Bit Bayer Raw

This format transmits data using one byte for each pixel.

UVC drivers see it with the *FourCC* GRBG, RGGB, GBRG or BA81.

The *Device Driver for USB Cameras* simplifies this variety of possible pixel formats and offers two video formats instead: RGB32 and Y800. The RGB32 format results from the driver's automatic debayering of the raw image data, while the Y800 format contains the raw data which is reinterpreted as monochrome.

5.1.2 Readout Modes

The DFM 72BUC02-ML camera offers different sensor readout modes.

By default, the camera outputs all pixels of the image sensor.



In *skipping* modes, the image sensor regularly skips a number of rows and/or columns during readout. The resulting output image is smaller but contains the same field of view than the image produced by default readout mode.

In *binning* modes, a number of neighboring pixels is merged into one output pixel during readout. The nature of this merge operation is sensor-specific, most sensors either add the pixel values or average them.

Generally, binning modes provide better image quality than skipping modes. However, skipping modes usually provide a higher maximum frame rate.

The way the readout modes are controlled depends greatly upon which driver technology is used to access the camera:

- Selecting readout modes is currently not supported through UVC in Linux.
- When using *IC Imaging Control*, the readout mode is part of the video format - a parameter that which combines pixel format, resolution and readout mode. For more information, refer to the *IC Imaging Control* documentation sections on `VideoFormat` and `VideoFormatDesc`.

The following readout modes are supported:

- Default
- Binning 2X
- Binning 4X

5.1.3 Frame Rate

The frame rate is specified in frames per second and determines the camera's operating speed.

The way the frame rate is controlled depends greatly upon which driver technology is used to access the camera:

- When using `uvcdm` on Linux, the frame rate is selected from a list of available frame rates.
- When using *IC Imaging Control*, the frame rate is selected from a list of available frame rates through APIs such as `Grabber::setFPS` or `ICImagingControl.DeviceFrameRate`.

The range of available frame rates depends upon other camera settings such as well, pixel format, resolution and readout modes.

Parameter	Frame Rate
Minimum	Depending on Pixel Format, Resolution, and Readout Mode
Maximum	Depending on Pixel Format, Resolution, and Readout Mode



The following tables show the maximum frame rate for some combinations of pixel format and resolution.

8-Bit Bayer Raw

Width	Height	Maximum Frame Rate
2592	1944	7
1920	1080	15
640	480	60

5.1.4 Partial Scan Offset

If the selected resolution is smaller than the sensor size, the part of the sensor that is actually read out can be specified by the *Partial Scan Offset X* and *Partial Scan Offset Y* parameters. By default, the camera automatically positions the offsets so that the center of the sensor is used.

Parameter	Partial Scan Offset X
Minimum	0
Maximum	2560
Video4Linux2	X Offset
VCD Property	VCDID_PartialScanOffset \VCDElement_PartialScanOffsetX

Parameter	Partial Scan Offset Y
Minimum	0
Maximum	1944
Video4Linux2	Y Offset
VCD Property	VCDID_PartialScanOffset \VCDElement_PartialScanOffsetY

5.2 Image Sensor Control

5.2.1 Exposure Time

The *Exposure Time* parameter defines the time the camera opens its (electronic) shutter when it is taking an image.

Parameter	Exposure Time
Minimum	100 μ s
Maximum	30 s
Default	auto
Video4Linux2	Exposure (Absolute)
	The V4L2 Exposure (Absolute) control is using 100 μ s units
VCD Property	VCDID_Exposure\VCDElement_Value

5.2.2 Gain

The *Gain* parameter defines the amplification that is applied to the image at sensor level.

Parameter	Gain
Minimum	4
Maximum	63
Default	auto
Video4Linux2	Gain
VCD Property	VCDID_Gain\VCDElement_Value

5.3 Trigger

The trigger mode can be used to take images at very specific points in time which are specified by an electrical signal connected to the [TRIGGER_IN](#) pin of the I/O connector of the camera.

5.3.1 Trigger Mode

The *Trigger Mode* parameter enables the trigger mode.

Parameter	Trigger Mode
On	Enable Trigger Mode
True	
Off	Disable Trigger Mode
False	
Video4Linux2	Trigger Mode
VCD Property	VCDID_Trigger\VCDElement_Value



5.3.2 Software Trigger

The *Software Trigger* function can be used to simulate a trigger pulse, in turn causing one image to be exposed and delivered to the host computer.

Parameter	Software Trigger
Execute	Simulate one trigger pulse
Video4Linux2	Software Trigger
VCD Property	VCDID_Trigger\VCDElement_SoftwareTrigger

5.4 Digital I/O

The One4All series has one digital input and one digital output. The digital input can be used as a [Trigger](#) input but the current status can also be examined directly.

The digital output can be configured as a [Strobe](#) output to signal the exact moment when the image sensor is sensitive to light so that external light sources can be synchronized to its operation cycle.

5.4.1 General Purpose Input

The *General Purpose Input* parameter allows the current status of the [TRIGGER_IN](#) pin.

Parameter	General Purpose Input
True	TRIGGER_IN line status is low
1	
False	TRIGGER_IN line status is high
0	
Video4Linux2	ExtIO[1]
VCD Property	VCDID_GPIO\VCDElement_GPIORead VCDID_GPIO\VCDElement_GPIOIn

5.4.2 General Purpose Output

The *General Purpose Output* parameter controls the status of the [STROBE_OUT](#) pin.



Parameter	General Purpose Output
True	Drive the STROBE_OUT line high
1	
False	Drive the STROBE_OUT line low
0	
Video4Linux2	ExtIO[0]
VCD Property	VCDID_GPIO\VCDElement_GPIOWrite VCDID_GPIO\VCDElement_GPIOOut

5.5 Strobe

The strobe function controls the automatic generation of output pulses on the [STROBE_OUT](#) pin which is synchronized to the image sensor's exposure time.

5.5.1 Strobe Enable

The *Strobe Enable* parameter enables the automatic generation of strobe pulses.

Parameter	Strobe Enable
On	Strobe enabled
True	
Off	Strobe disabled
False	
Video4Linux2	Strobe[0]
VCD Property	VCDID_Strobe\VCDElement_Value

5.5.2 Strobe Polarity

The *Strobe Polarity* parameter can be used to invert the strobe pulse output.

Parameter	Strobe Polarity
ActiveHigh	The STROBE_OUT pin is logically high during the exposure time
True	
ActiveLow	The STROBE_OUT pin is logically low during the exposure time
False	
Video4Linux2	Strobe[1]
VCD Property	VCDID_Strobe\VCDElement_StrobePolarity



6 Revision History

Date	Version	Description
2018/12/07		Initial release of this document



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All weights and dimensions are approximate. Unless otherwise specified, the lenses shown in the context of cameras are not shipped with these cameras.

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