China Daheng Group, Inc. Beijing Image Vision Technology Branch

Mercury USB 3.0 Vision Cameras

User Manual

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Notice

Certifications

FCC

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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Preface

We really appreciate your choosing the product of DAHENG IMAGING.

Mercury USB 3.0 Vision series camera is DAHENG IMAGING's mature area scan digital camera, featuring mega pixels resolution, high definition, extremely low noise and perfect color conversion. The camera, which is equipped with a standard USB 3.0 Vision interface, is convenient for use and connection. It could be used in a wide and diverse range of applications including machine vision, high-definition imaging and surveillance, medical imaging, intelligent transportation systems, character recognition and documents processing, and any more.

The Mercury USB 3.0 Vision series camera is a compact camera that will be a good choice for the users who are demanding on the camera size. This manual describes in detail on how to install and use the Mercury USB 3.0 Vision digital cameras.

Contents

1. Introduction

1.1. Models

The current Mercury USB3.0 Vision camera models are listed in the top row of the specification tables on the next pages of this manual. The camera models are differentiated by their resolution, their maximum frame rate at full resolution, and whether the camera's sensor is mono or color.

1.2. General Specifications

1.2.1. MER-031-860U3x

Specifications	MER-031-860U3C	MER-031-860U3C-L
Resolution	640 x 480	
Sensor Type	Onsemi PYTHON 300, Global shutter CMOS	
Optical Size	1/4 inch	
Pixel Size	4.8μm × 4.8μm	
Frame Rate	860fps@ 640 × 480	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0dB ~16dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	48dB	
Definition	>479 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp.	0°C~45°C	
Storage Temp.	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	

Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 1: MER-031-860U3C (-L) General Specifications

Specifications	MER-031-860U3M	MER-031-860U3M-L
Resolution	640 x 480	
Sensor Type	Onsemi PYTHON 300, Global shutter CMOS	
Optical Size	1/4 inch	
Pixel Size	4.8μm × 4.8μm	
Frame Rate	860fps@ 640 × 480	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0dB ~16dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	34dB	
Definition	>601 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 2: MER-031-860U3M (-L) General Specifications

1.2.2. MER-031-860U3M NIR

Specifications	MER-031-860U3M NIR	MER-031-860U3M-L NIR
Resolution	640 x 480	
Sensor Type	Onsemi PYTHON 300, Global shutter CMOS	
Optical Size	1/4 inch	
Pixel Size	4.8μm × 4.8μm	
Frame Rate	860fps@ 640 × 480	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0dB ~16dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	32dB	
Definition	>527 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 3: MER-031-860U3M (-L) NIR General Specifications

1.2.3. MER-041-436U3x

Specifications	MER-041-436U3C	MER-041-436U3C-L
Resolution	720x540	
Sensor Type	Sony IMX287, Global shutter CMOS	
Optical Size	1/2.9 inch	
Pixel Size	6.9μm ×6.9μm	
Frame Rate	438fps@720x540	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0~24dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	43.19dB	
Definition	>541 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 4: MER-041-436U3C (-L) General Specifications

Specifications	MER-041-436U3M	MER-041-436U3M-L
Resolution	720x540	
Sensor Type	Sony IMX287, Global shutter CMOS	
Optical Size	1/2.9 inch	
Pixel Size	6.9μm ×6.9μm	
Frame Rate	438fps@720x540	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0~24dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	43.25dB	
Definition	>599 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 5: MER-041-436U3M (-L) General Specifications

1.2.4. MER-050-560U3x

Specifications	MER-050-560U3C	MER-050-560U3C-L
Resolution	800 x 600	
Sensor Type	Onsemi PYTHON 500, Global shutter CMOS	
Optical Size	1/3.6 inch	
Pixel Size	4.8μm × 4.8μm	
Frame Rate	560fps@ 800 × 600	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0dB ~16dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	47dB	
Definition	>585 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 6: MER-050-560U3C (-L) General Specifications

Specifications	MER-050-560U3M	MER-050-560U3M-L
Resolution	800 x 600	
Sensor Type	Onsemi PYTHON 500, Global shutter CMOS	
Optical Size	1/3.6 inch	
Pixel Size	4.8μm × 4.8μm	
Frame Rate	560fps@ 800 × 600	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0dB ~16dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	33dB	
Definition	>603 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 7: MER-050-560U3M (-L) General Specifications

1.2.5. MER-050-560U3M NIR

Specifications	MER-050-560U3M NIR	MER-050-560U3M-L NIR
Resolution	800 x 600	
Sensor Type	Onsemi PYTHON 500, Global shutter CMOS	
Optical Size	1/3.6 inch	
Pixel Size	4.8μm × 4.8μm	
Frame Rate	560fps@ 800 × 600	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0dB ~16dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	32dB	
Definition	>604 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 8: MER-050-560U3M (-L) NIR General Specifications

1.2.6. MER-051-120U3x

Specifications	MER-051-120U3C	MER-051-120U3C-L
Resolution	808 x 608	
Sensor Type	Onsemi PYTHON 480, Global shutter CMOS	
Optical Size	1/3.6 inch	
Pixel Size	4.8μm × 4.8μm	
Frame Rate	120fps@ 808 × 608	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	5μs~1s	
Gain	0dB ~16dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	41dB	
Definition	>530 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 9: MER-051-120U3C (-L) General Specifications

Specifications	MER-051-120U3M	MER-051-120U3M-L
Resolution	808 x 608	
Sensor Type	Onsemi PYTHON 480, Global shutter CMOS	
Optical Size	1/3.6 inch	
Pixel Size	4.8μm × 4.8μm	
Frame Rate	120fps@ 808 × 608	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	5μs~1s	
Gain	0dB ~16dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	41dB	
Definition	>563 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 10: MER-051-120U3M (-L) General Specifications

1.2.7. MER-131-210U3x

Specifications	MER-131-210U3C	MER-131-210U3C-L
Resolution	1280 x 1024	
Sensor Type	Onsemi PYTHON 1300, Global shutter CMOS	
Optical Size	1/2 inch	
Pixel Size	4.8μm × 4.8μm	
Frame Rate	210fps@ 1280 × 1024	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0dB ~16dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	47dB	
Definition	>1023 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 11: MER-131-210U3C (-L) General Specifications

Specifications	MER-131-210U3M	MER-131-210U3M-L
Resolution	1280 x 1024	
Sensor Type	Onsemi PYTHON 1300, Global shutter CMOS	
Optical Size	1/2 inch	
Pixel Size	4.8μm × 4.8μm	
Frame Rate	210fps@ 1280 × 1024	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0dB ~16dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	33dB	
Definition	>1107 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 12: MER-131-210U3M (-L) General Specifications

1.2.8. MER-131-210U3M NIR

Specifications	MER-131-210U3M NIR	MER-131-210U3M-L NIR
Resolution	1280 x 1024	
Sensor Type	Onsemi PYTHON 1300, Global shutter CMOS	
Optical Size	1/2 inch	
Pixel Size	4.8μm × 4.8μm	
Frame Rate	210fps@ 1280 × 1024	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0dB ~16dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	33dB	
Definition	>1014 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 13: MER-131-210U3M NIR (-L) General Specifications

1.2.9. MER-132-43U3x

Specifications	MER-132-43U3C	MER-132-43U3C-L
Resolution	1292 × 964	
Sensor Type	sharp RJ33J, Global shutter CCD	
Optical Size	1/3 inch	
Pixel Size	3.75μm × 3.75μm	
Frame Rate	43fps @ 1292 x 964	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 12bit	
Shutter Time	20μs ~ 1s	
Gain	0dB ~ 25dB	
Pixel Data Formats	Bayer RG8 / Bayer RG12	
Signal Noise Ratio	49dB	
Definition	>942 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp.	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 14: MER-132-43U3C (-L) General Specifications

Specifications	MER-132-43U3M	MER-132-43U3M-L
Resolution	1292 × 964	
Sensor Type	sharp RJ33J,Global shutter CCD	
Optical Size	1/3 inch	
Pixel Size	3.75μm × 3.75μm	
Frame Rate	43fps @ 1292 x 964	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 12bit	
Shutter Time	20μs ~ 1s	
Gain	0dB ~ 25dB	
Pixel Data Formats	Mono8 / Mono12	
Signal Noise Ratio	37.04dB	
Definition	>1060 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp.	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 15: MER-132-43U3M (-L) General Specifications

1.2.10. MER-133-54U3x

Specifications	MER-133-54U3C	MER-133-54U3C-L
Resolution	1280x960	
Sensor Type	Onsemi AR0135, Global shutter CMOS	
Optical Size	1/3 inch	
Pixel Size	3.75μm ×3.75μm	
Frame Rate	54fps@1280x960	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0 dB~31dB	
Pixel Data Formats	Bayer GR8/Bayer GR10	
Signal Noise Ratio	40dB	
Definition	>856 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 16: MER-133-54U3C (-L) General Specifications

Specifications	MER-133-54U3M	MER-133-54U3M-L
Resolution	1280x960	
Sensor Type	Onsemi AR0135, Global shutter CMOS	
Optical Size	1/3 inch	
Pixel Size	3.75μm ×3.75μm	
Frame Rate	54fps@1280x960	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0 dB~31dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	40dB	
Definition	>968 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 17: MER-133-54U3M (-L) General Specifications

1.2.11. MER-134-93U3x

Specifications	MER-134-93U3C	MER-134-93U3C-L
Resolution	1280x1024	
Sensor Type	Onsemi PYTHON 1300, Global shutter CMOS	
Optical Size	1/2 inch	
Pixel Size	4.8μm × 4.8μm	
Frame Rate	93fps @ 1280 × 1024	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	5μs~1s	
Gain	0 dB~16dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	39dB	
Definition	>921 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 18: MER-134-93U3C (-L) General Specifications

Specifications	MER-134-93U3M	MER-134-93U3M-L
Resolution	1280x1024	
Sensor Type	Onsemi PYTHON 1300, Global shutter CMOS	
Optical Size	1/2 inch	
Pixel Size	4.8μm × 4.8μm	
Frame Rate	93fps @ 1280 × 1024	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	5μs~1s	
Gain	0 dB~16dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	39dB	
Definition	>896 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 19: MER-134-93U3M (-L) General Specifications

1.2.12. MER-160-227U3x

Specifications	MER-160-227U3C	MER-160-227U3C-L
Resolution	1440x1080	
Sensor Type	Sony IMX273, Global shutter CMOS	
Optical Size	1/2.9 inch	
Pixel Size	3.45μm ×3.45μm	
Frame Rate	227fps@1440x1080	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0~24dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	41dB	
Definition	>983 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 20: MER-160-227U3C (-L) General Specifications

Specifications	MER-160-227U3M	MER-160-227U3M-L
Resolution	1440x1080	
Sensor Type	Sony IMX273, Global shutter CMOS	
Optical Size	1/2.9 inch	
Pixel Size	3.45μm × 3.45μm	
Frame Rate	227fps@1440x1080	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0~24dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	41dB	
Definition	>1132 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 21: MER-160-227U3M (-L) General Specifications

1.2.13. MER-230-168U3x

Specifications	MER-230-168U3C	MER-230-168U3C-L
Resolution	1920x1200	
Sensor Type	Sony IMX174, Global shutter CMOS	
Optical Size	1/1.2 inch	
Pixel Size	5.86μm ×5.86μm	
Frame Rate	168fps@1920x1200	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0 dB~24dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	54dB	
Definition	>1085 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 22: MER-230-168U3C (-L) General Specifications

Specifications	MER-230-168U3M	MER-230-168U3M-L
Resolution	1920x1200	
Sensor Type	Sony IMX174, Global shutter CMOS	
Optical Size	1/1.2 inch	
Pixel Size	5.86μm ×5.86μm	
Frame Rate	168fps@1920x1200	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0 dB~24dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	41dB	
Definition	>1185 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 23: MER-230-168U3M (-L) General Specifications

1.2.14. MER-231-41U3x

Specifications	MER-231-41U3C	MER-231-41U3C-L
Resolution	1920x1200	
Sensor Type	Sony IMX249, Global shutter CMOS	
Optical Size	1/1.2 inch	
Pixel Size	5.86μm ×5.86μm	
Frame Rate	41fps@1920x1200	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0 dB~24dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	54dB	
Definition	>1099 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 24: MER-231-41U3C (-L) General Specifications

Specifications	MER-231-41U3M	MER-231-41U3M-L
Resolution	1920x1200	
Sensor Type	Sony IMX249, Global shutter CMOS	
Optical Size	1/1.2 inch	
Pixel Size	5.86μm ×5.86μm	
Frame Rate	41fps@1920x1200	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0 dB~24dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	41dB	
Definition	>1154 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 25: MER-231-41U3M (-L) General Specifications

1.2.15. MER-301-125U3x

Specifications	MER-301-125U3C	MER-301-125U3C-L
Resolution	2048x1536	
Sensor Type	Sony IMX252, Global shutter CMOS	
Optical Size	1/1.8 inch	
Pixel Size	3.45μm ×3.45μm	
Frame Rate	125fps@2048x1536	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0 dB~24dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	50dB	
Definition	>1318 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 26: MER-301-125U3C (-L) General Specifications

Specifications	MER-301-125U3M	MER-301-125U3M-L
Resolution	2048x1536	
Sensor Type	Sony IMX252, Global shutter CMOS	
Optical Size	1/1.8 inch	
Pixel Size	3.45μm ×3.45μm	
Frame Rate	125fps@2048x1536	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0 dB~24dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	35dB	
Definition	>1275 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 27: MER-301-125U3M (-L) General Specifications

1.2.16. MER-302-56U3x

Specifications	MER-302-56U3C	MER-302-56U3C-L
Resolution	2048x1536	
Sensor Type	Sony IMX265, Global shutter CMOS	
Optical Size	1/1.8 inch	
Pixel Size	3.45μm ×3.45μm	
Frame Rate	56fps@2048x1536	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0~24dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	40dB	
Definition	>1328 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 28: MER-302-56U3C (-L) General Specifications

Specifications	MER-302-56U3M	MER-302-56U3M-L
Resolution	2048x1536	
Sensor Type	Sony IMX265, Global shutter CMOS	
Optical Size	1/1.8 inch	
Pixel Size	3.45μm ×3.45μm	
Frame Rate	56fps@2048x1536	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0~24dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	40dB	
Definition	>1328 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 29: MER-302-56U3M (-L) General Specifications

1.2.17. MER-500-14U3x

Specifications	MER-500-14U3C	MER-500-14U3C-L
Resolution	2592x1944	
Sensor Type	Onsemi MT9P006, Rolling shutter CMOS	
Optical Size	1/2.5 inch	
Pixel Size	2.2μm ×2.2μm	
Frame Rate	14fps@2592x1944	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	36μs~1s	
Gain	0 dB~17dB	
Pixel Data Formats	Bayer GR8/ Bayer GR10	
Signal Noise Ratio	48dB	
Definition	>1556 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 30: MER-500-14U3C (-L) General Specifications

Specifications	MER-500-14U3M	MER-500-14U3M-L
Resolution	2592x1944	
Sensor Type	Onsemi MT9P031, Rolling shutter CMOS	
Optical Size	1/2.5 inch	
Pixel Size	2.2μm ×2.2μm	
Frame Rate	14fps@2592x1944	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	36μs~1s	
Gain	0 dB~17dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	35dB	
Definition	>1408 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 31: MER-500-14U3M (-L) General Specifications

1.2.18. MER-502-79U3x

Specifications	MER-502-79U3C	MER-502-79U3C-L
Resolution	2448x2048	
Sensor Type	Sony IMX250, Global shutter CMOS	
Optical Size	2/3 inch	
Pixel Size	3.45μm ×3.45μm	
Frame Rate	79fps@2448x2048	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0 dB~24dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	50dB	
Definition	>1717 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 32: MER-502-79U3C (-L) General Specifications

Specifications	MER-502-79U3M	MER-502-79U3M-L
Resolution	2448x2048	
Sensor Type	Sony IMX250, Global shutter CMOS	
Optical Size	2/3 inch	
Pixel Size	3.45μm ×3.45μm	
Frame Rate	79fps@2448x2048	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0 dB~24dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	38dB	
Definition	>1839 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 33: MER-502-79U3M (-L) General Specifications

1.2.19. MER-502-79U3M POL

Specifications	MER-502-79U3M POL	MER-502-79U3M-L POL
Resolution	2448x2048	
Sensor Type	Sony IMX250, Global shutter CMOS	
Optical Size	2/3 inch	
Pixel Size	3.45μm ×3.45μm	
Frame Rate	79fps@2448x2048	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0 dB~24dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	41dB	
Definition	>1060 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 34: MER-502-79U3M (-L) POL General Specifications

1.2.20. MER-503-36U3x

Specifications	MER-503-36U3C	MER-503-36U3C-L
Resolution	2448x2048	
Sensor Type	Sony IMX264, Global shutter CMOS	
Optical Size	2/3 inch	
Pixel Size	3.45μm ×3.45μm	
Frame Rate	36fps@2448x2048	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0 dB~23.9dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	41dB	
Definition	>1672 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 35: MER-503-36U3C (-L) General Specifications

Specifications	MER-503-36U3M	MER-503-36U3M-L
Resolution	2448x2048	
Sensor Type	Sony IMX264, Global shutter CMOS	
Optical Size	2/3 inch	
Pixel Size	3.45μm ×3.45μm	
Frame Rate	36fps@2448x2048	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	20μs~1s	
Gain	0 dB~23.9dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	39dB	
Definition	>1867 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 36: MER-503-36U3M (-L) General Specifications

1.2.21. MER-630-60U3x

Specifications	MER-630-60U3C	MER-630-60U3C-L
Resolution	3088x2064	
Sensor Type	Sony IMX178,Rolling shutter CMOS	
Optical Size	1/1.8 inch	
Pixel Size	2.4μm ×2.4μm	
Frame Rate	60fps@3088x2064	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	8μs~1s	
Gain	0 dB~24dB	
Pixel Data Formats	Bayer RG8/ Bayer RG10	
Signal Noise Ratio	40dB	
Definition	>1624 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 37: MER-630-60U3C (-L) General Specifications

Specifications	MER-630-60U3M	MER-630-60U3M-L
Resolution	3088x2064	
Sensor Type	Sony IMX178, Rolling shutter CMOS	
Optical Size	1/1.8 inch	
Pixel Size	2.4μm ×2.4μm	
Frame Rate	60fps@3088x2064	
ADC Bit Depth	10bit	
Pixel Bit Depth	8bit, 10bit	
Shutter Time	8μs~1s	
Gain	0 dB~24dB	
Pixel Data Formats	Mono8/Mono10	
Signal Noise Ratio	40dB	
Definition	>1327 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 38: MER-630-60U3M (-L) General Specifications

1.2.22. MER-1070-14U3x

Specifications	MER-1070-14U3C	MER-1070-14U3C-L
Resolution	3840x2748	
Sensor Type	Onsemi MT9J003, Rolling shutter CMOS	
Optical Size	1/2.3 inch	
Pixel Size	1.67μm ×1.67μm	
Frame Rate	14fps@3840x2748	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 12bit	
Shutter Time	24μs~1s	
Gain	0 dB~25.9dB	
Pixel Data Formats	Bayer GR8/ Bayer GR12	
Signal Noise Ratio	46dB	
Definition	>2150 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 39: MER-1070-14U3C (-L) General Specifications

Specifications	MER-1070-14U3M	MER-1070-14U3M-L
Resolution	3840x2748	
Sensor Type	Onsemi MT9J003, Rolling shutter CMOS	
Optical Size	1/2.3 inch	
Pixel Size	1.67μm ×1.67μm	
Frame Rate	14fps@3840x2748	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 12bit	
Shutter Time	24μs~1s	
Gain	0 dB~25.9dB	
Pixel Data Formats	Mono8/Mono12	
Signal Noise Ratio	28dB	
Definition	> 1581 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 40: MER-1070-14U3M (-L) General Specifications

1.2.23. MER-1520-13U3C

Specifications	MER-1520-13U3C	MER-1520-13U3C-L
Resolution	4608x3288	
Sensor Type	Onsemi MT9F002, Rolling shutter CMOS	
Optical Size	1/2.3 inch	
Pixel Size	1.4μm ×1.4μm	
Frame Rate	13fps@4608x3288	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 12bit	
Shutter Time	22μs~1s	
Gain	0 dB~22.5dB	
Pixel Data Formats	Bayer GR8/ Bayer GR12	
Signal Noise Ratio	46dB	
Definition	>2368 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 41: MER-1520-13U3C (-L) General Specifications

1.2.24. MER-1810-21U3C

Specifications	MER-1810-21U3C	MER-1810-21U3C-L
Resolution	4912x3684	
Sensor Type	Onsemi AR1820, Rolling shutter CMOS	
Optical Size	1/2.3 inch	
Pixel Size	1.25μm ×1.25μm	
Frame Rate	21fps@4912x3684	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 12bit	
Shutter Time	20μs~1s	
Gain	0 dB~20dB	
Pixel Data Formats	Bayer GR8/ Bayer GR12	
Signal Noise Ratio	47dB	
Definition	>2521 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 42: MER-1810-21U3C (-L) General Specifications

1.2.25. MER-2000-19U3x

Specifications	MER-2000-19U3C	MER-2000-19U3C-L
Resolution	5496x3672	
Sensor Type	Sony IMX183,Rolling shutter CMOS	
Optical Size	1 inch	
Pixel Size	2.4μm ×2.4μm	
Frame Rate	19.6fps@5496x3672	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 12bit	
Shutter Time	12μs~1s	
Gain	0 dB~24dB	
Pixel Data Formats	Bayer RG8/ Bayer RG12	
Signal Noise Ratio	42dB	
Definition	>2367 lines	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 43: MER-2000-19U3C (-L) General Specifications

Specifications	MER-2000-19U3M	MER-2000-19U3M-L
Resolution	5496x3672	
Sensor Type	Sony IMX183,Rolling shutter CMOS	
Optical Size	1 inch	
Pixel Size	2.4μm ×2.4μm	
Frame Rate	19.6fps@5496x3672	
ADC Bit Depth	12bit	
Pixel Bit Depth	8bit, 12bit	
Shutter Time	12μs~1s	
Gain	0 dB~24dB	
Pixel Data Formats	Mono8/ Mono12	
Signal Noise Ratio	TBD	
Definition	TBD	
Synchronization	external trigger, software trigger	software trigger
I/O	1 opto-isolated input line and 1 opto-isolated output line,2 GPIOs	N/A
Operating Temp	0°C~45°C	
Storage Temp	-20°C~70°C	
Operating Humidity	10%~80%	
Power Consumption	<2.5W@5V	
Lens Mount	C	
Dimensions	29 mm×29 mm×29mm (without lens adapter or connectors)	
Weight	57g	53g
Software	Windows XP/Win7/Win8/Win10 32bit and 64bit OS	
Data Interface	USB3.0	
Programmable Control	Image size, gain, exposure time, trigger polarity, flash polarity, etc.	Image size, gain, exposure time, etc.
Regulations	CE, RoHS, FCC, USB3.0 Vision, GenICam	

Table 1- 44: MER-2000-19U3M (-L) General Specifications

1.3. Spectral Response

1.3.1. MER-031-860U3x / MER-050-560U3x / MER-131-210U3x

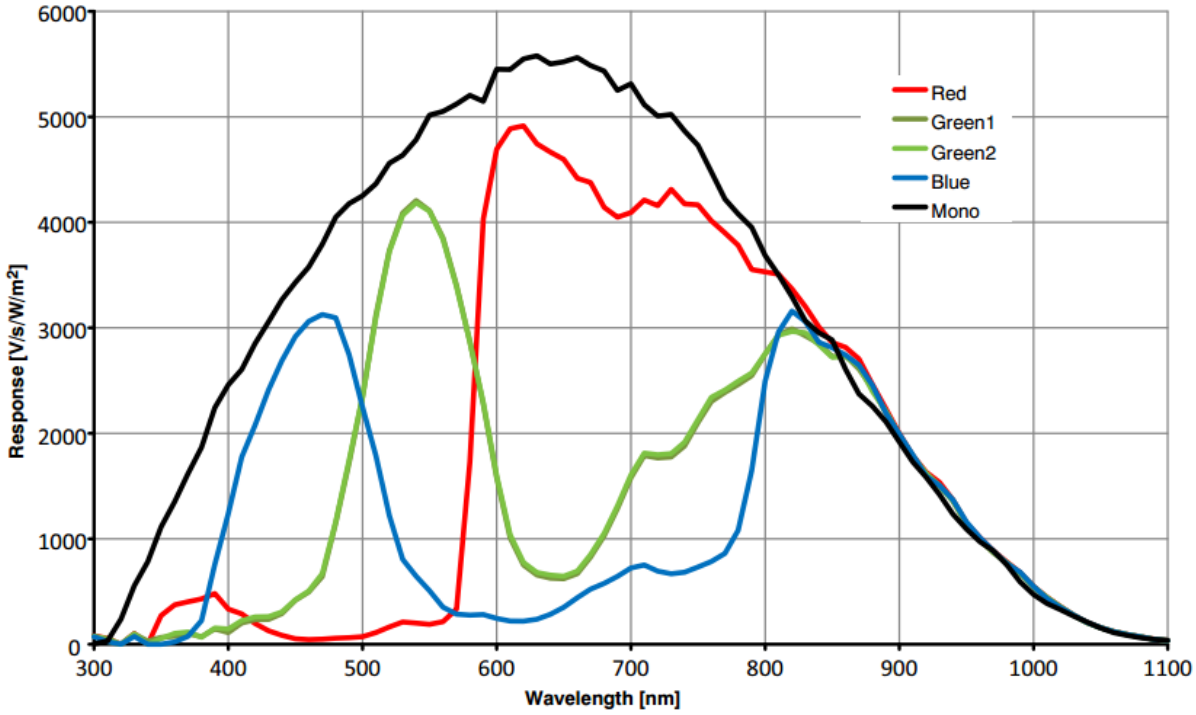


Figure1- 1: MER-031-860U3x / MER-050-560U3x / MER-131-210U3x Sensor Spectral Response

1.3.2. MER-031-860U3M NIR / MER-050-560U3M NIR / MER-131-210U3M NIR

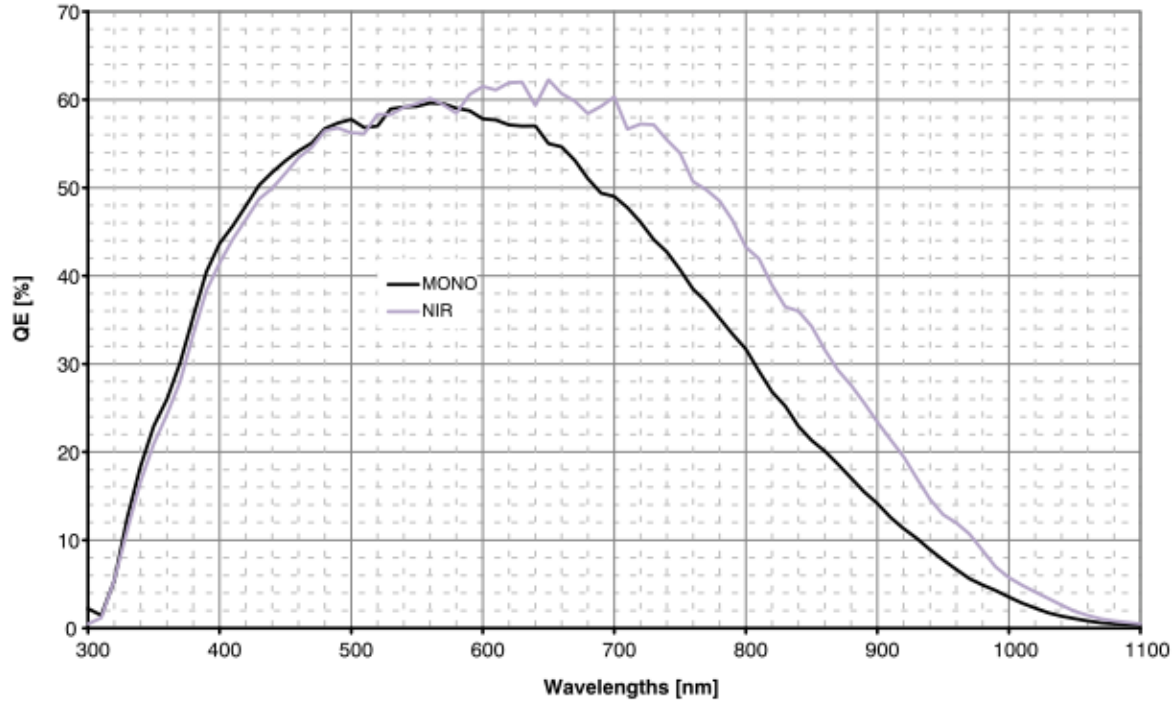


Figure1- 2: MER-031-860U3M NIR / MER-050-560U3M NIR / MER-131-210U3M NIR Sensor Spectral Response

1.3.3. MER-041-436U3x

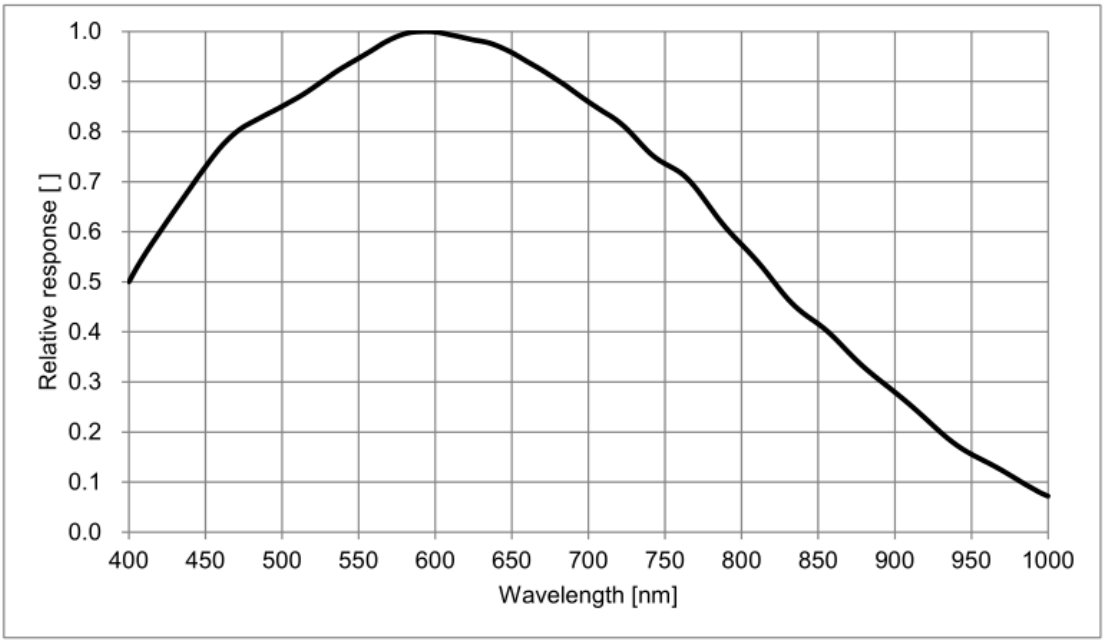


Figure1- 3: MER-041-436U3M Sensor Spectral Response

TBD

Figure1- 4: MER-041-436U3C Sensor Spectral Response

1.3.4. MER-051-120U3x

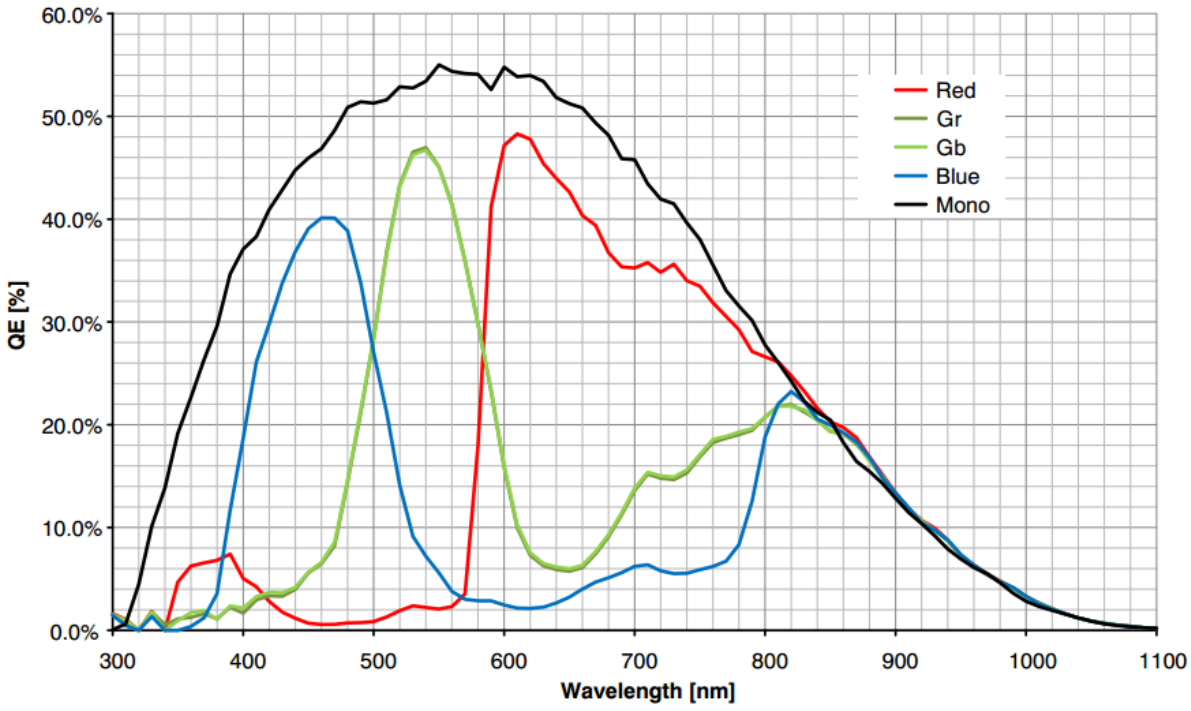


Figure1- 5: MER-051-120Ux Sensor Spectral Response

1.3.5. MER-132-43U3x

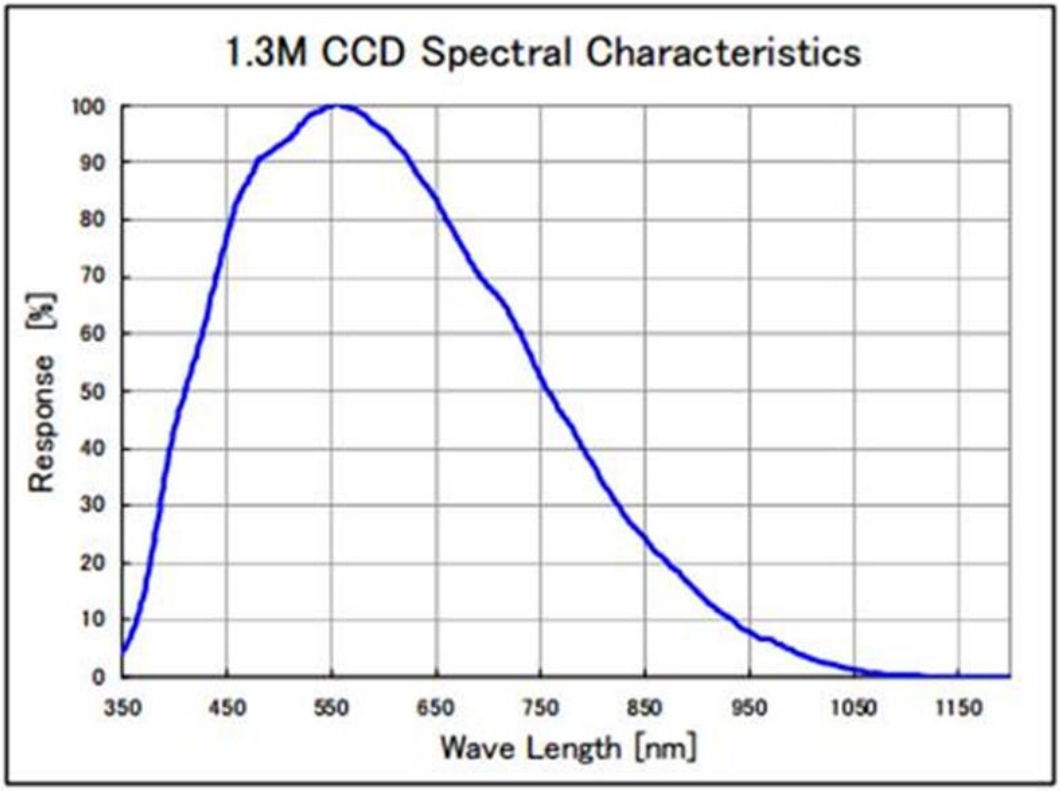


Figure1- 6: MER-132-43U3M Sensor Spectral Response

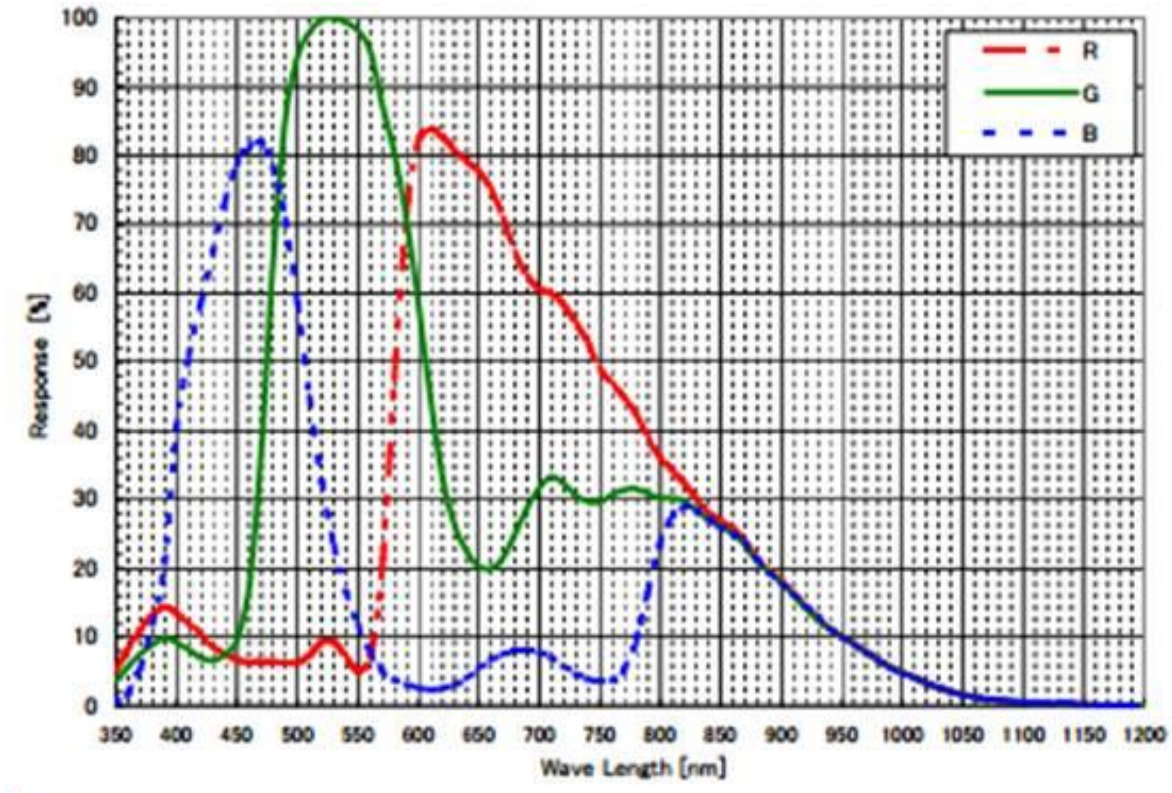


Figure1- 7: MER-132-43U3C Sensor Spectral Response

1.3.6. MER-133-54U3x

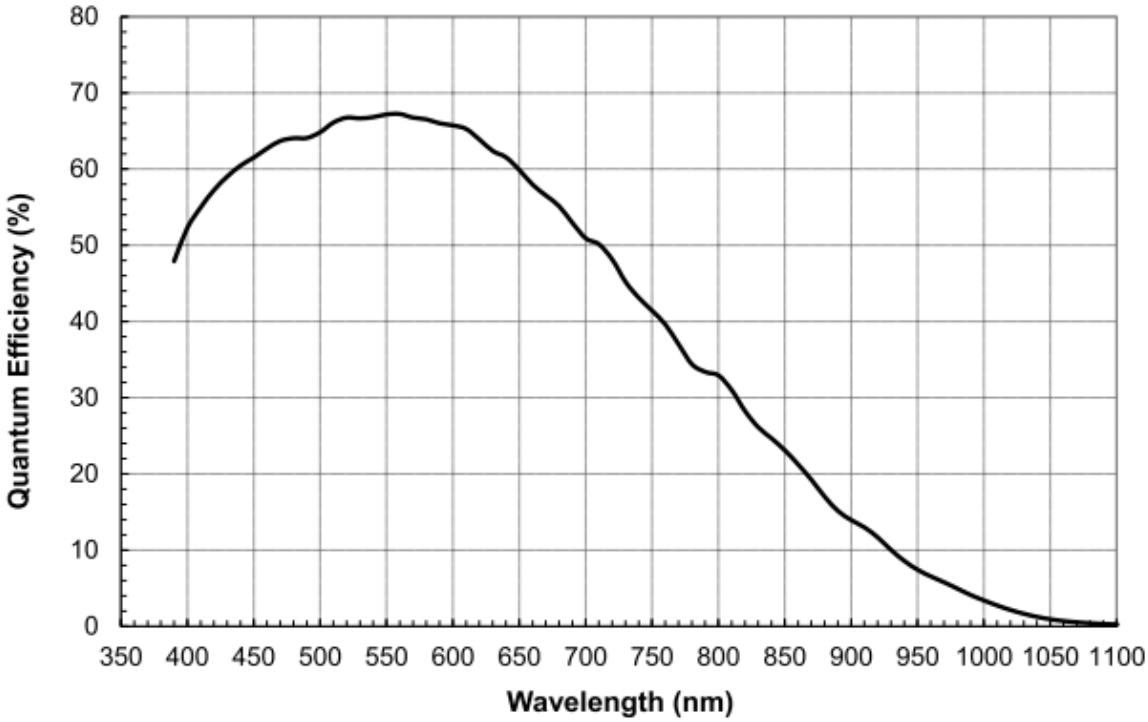


Figure1- 8: MER-133-54U3M Sensor Spectral Response

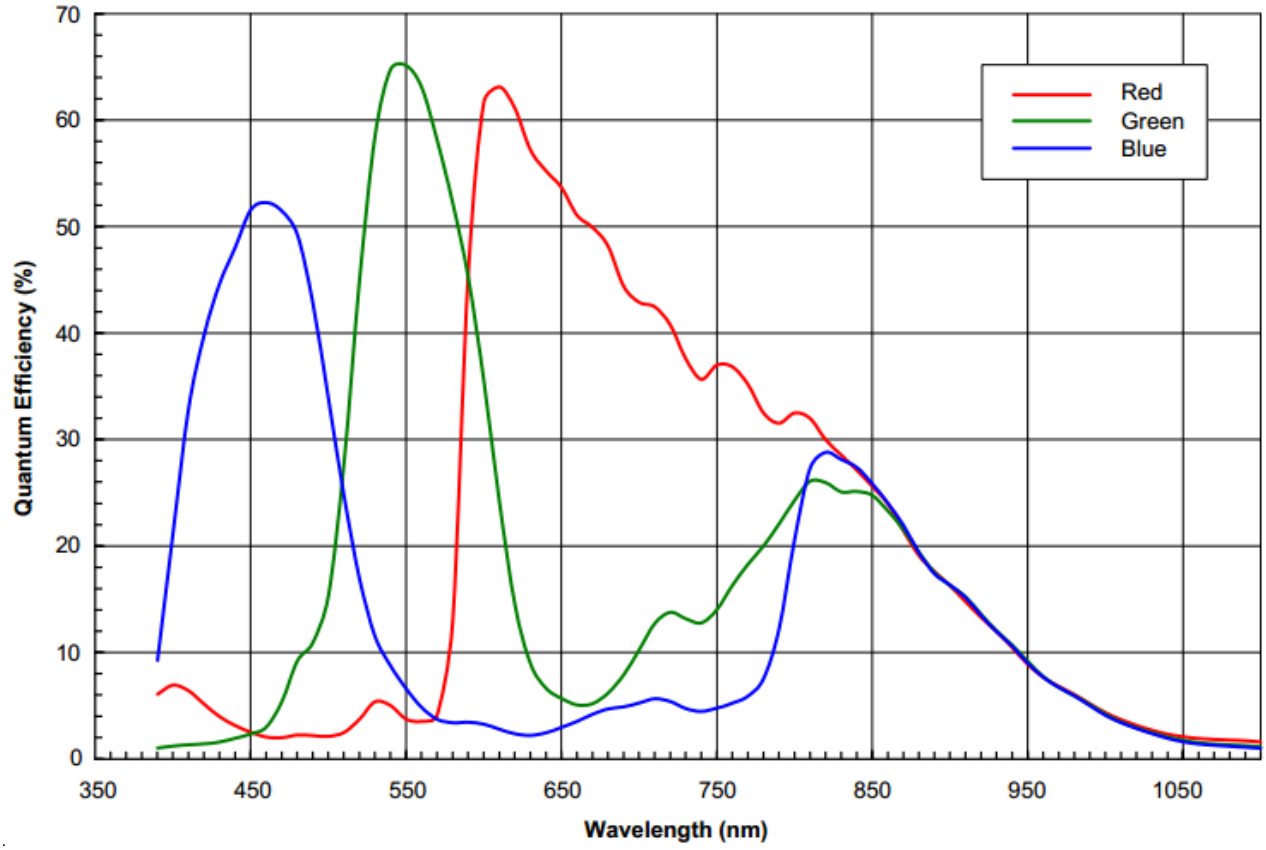


Figure1- 9: MER-133-54U3C Sensor Spectral Response

1.3.7. MER-134-93U3x

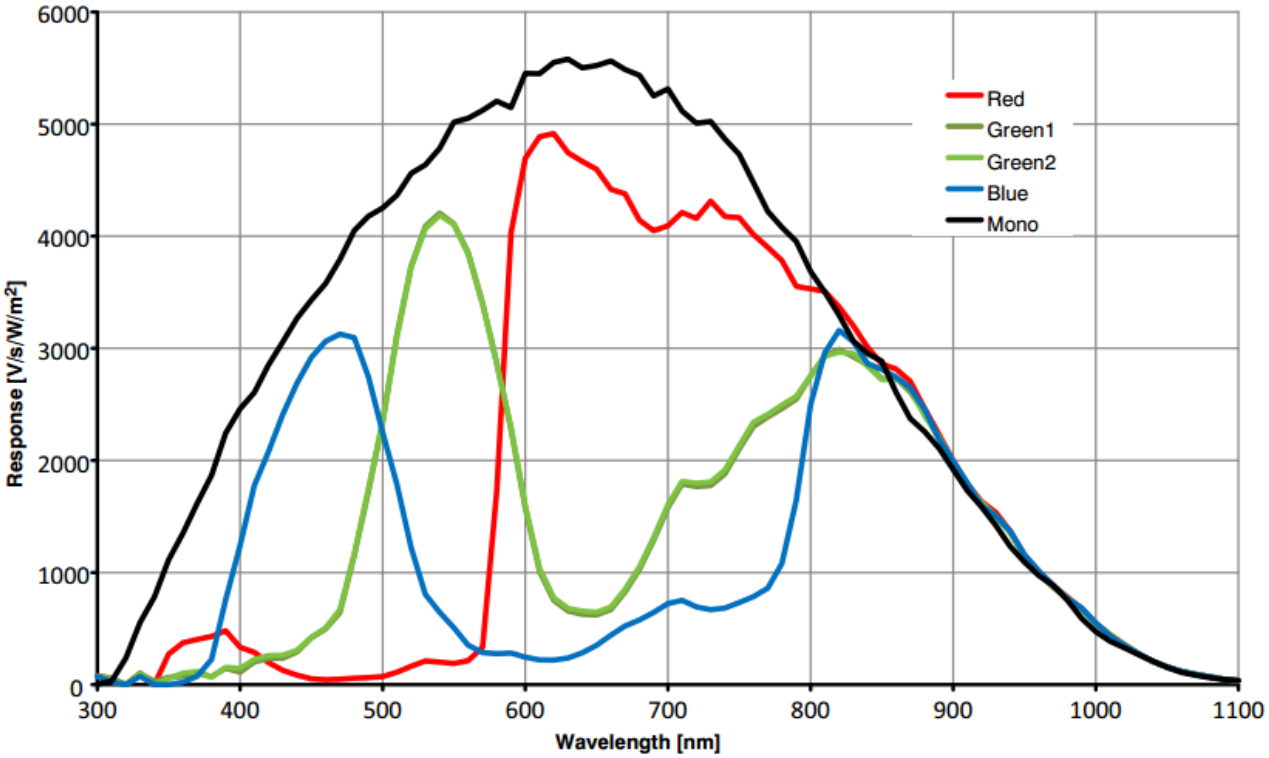


Figure1- 10: MER-134-93U3x Sensor Spectral Response

1.3.8. MER-160-227U3x

TBD

Figure1- 11: MER-160-227U3x Sensor Spectral Response

1.3.9. MER-230-168U3x

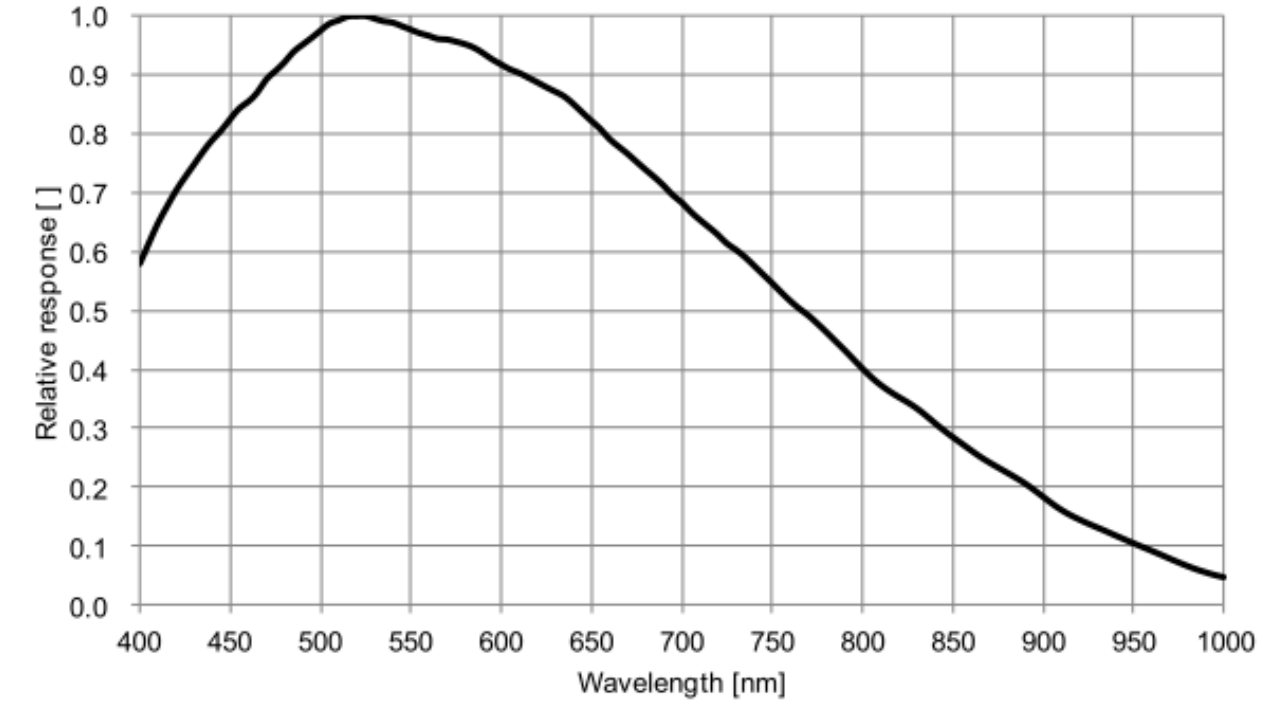


Figure1- 12: MER-230-168U3M Sensor Spectral Response

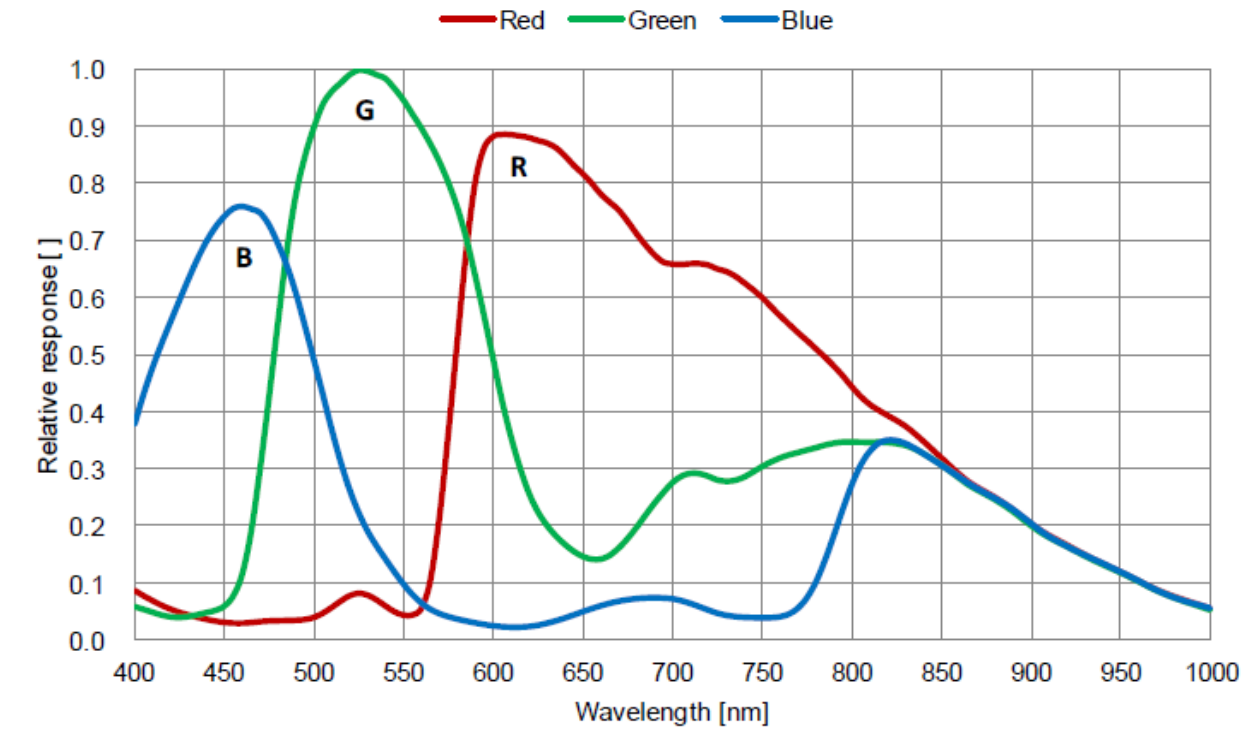


Figure1- 13: MER-230-168U3C Sensor Spectral Response

1.3.10. MER-231-41U3x

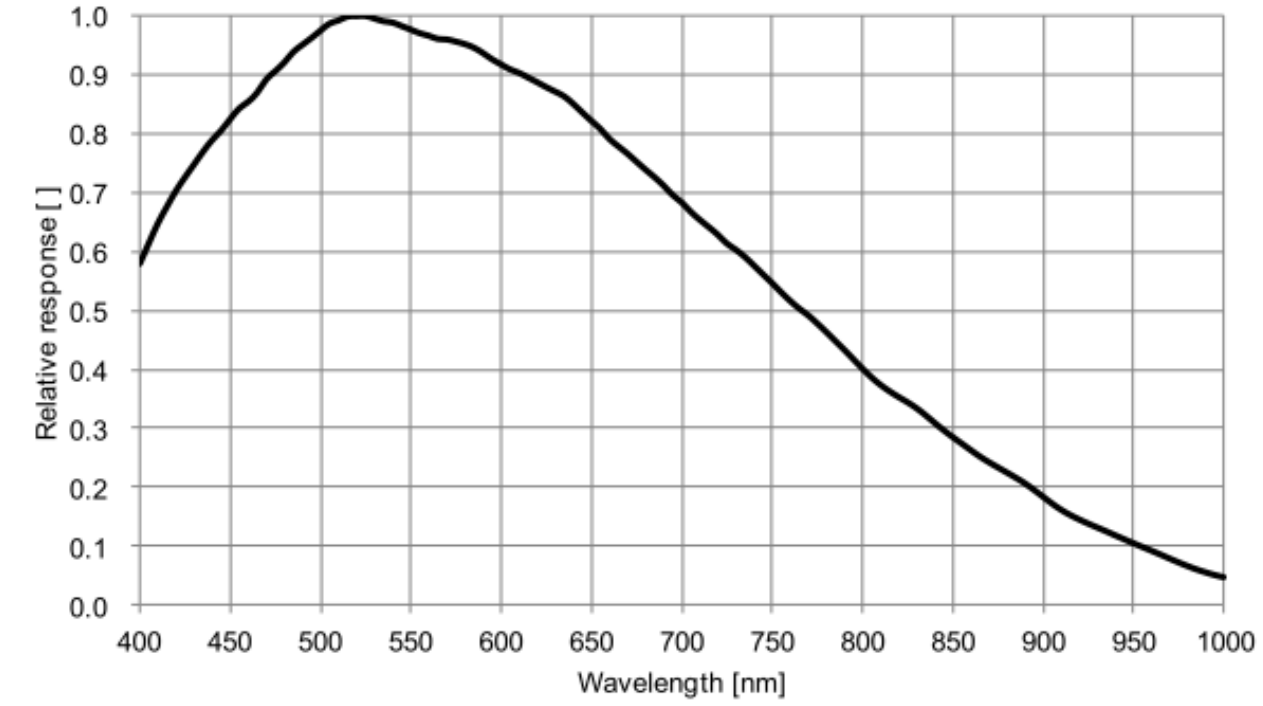


Figure1- 14: MER-231-41U3M Sensor Spectral Response

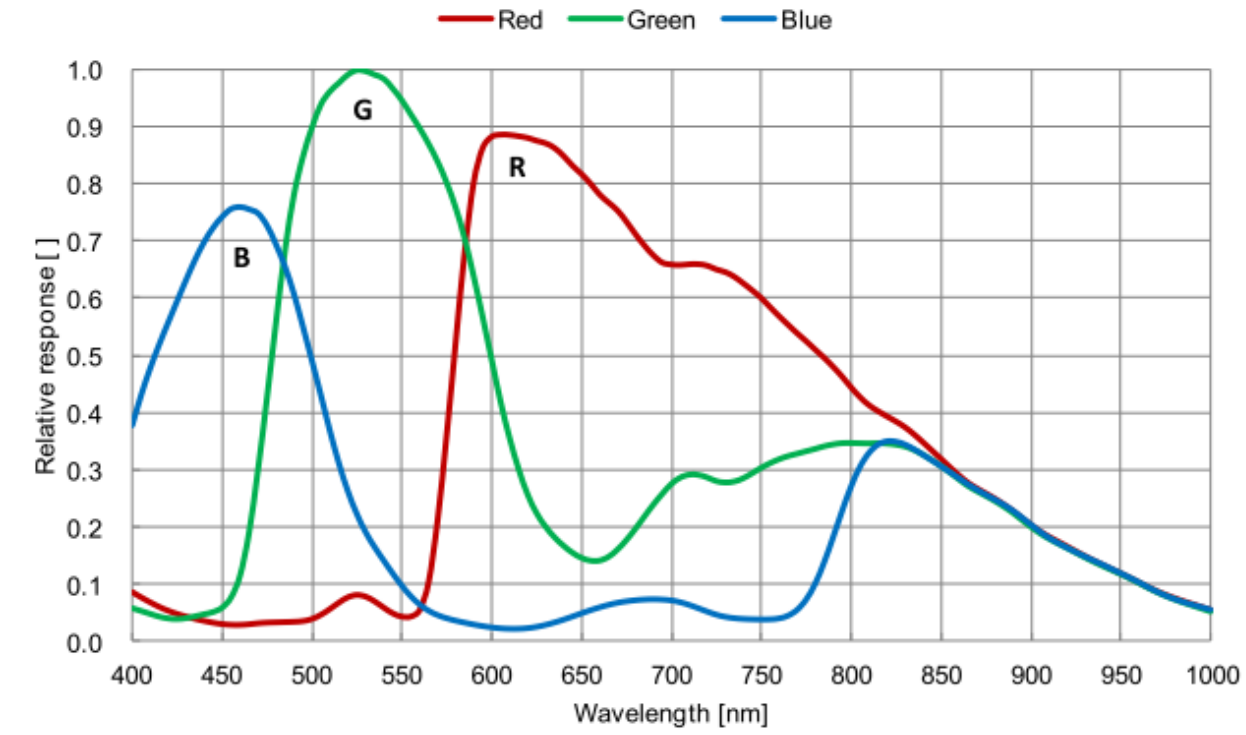


Figure1- 15: MER-231-41U3C Sensor Spectral Response

1.3.11. MER-301-125U3x

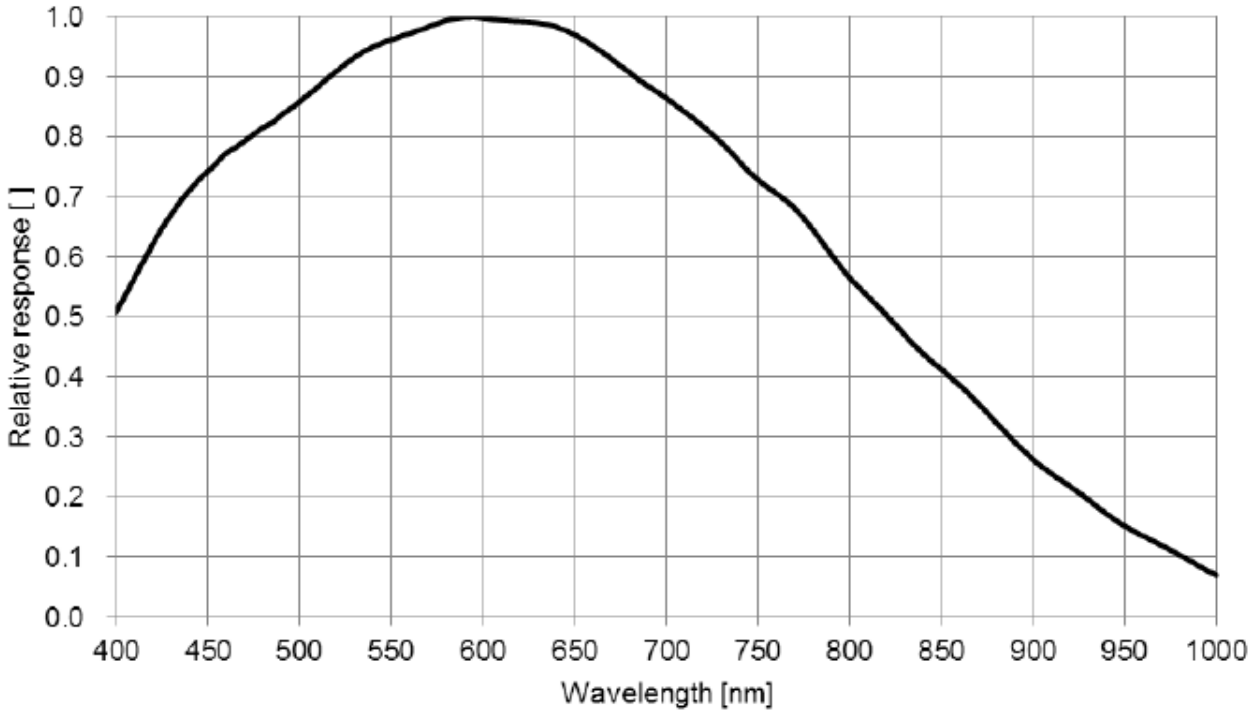


Figure1- 16: MER-301-125U3M Sensor Spectral Response

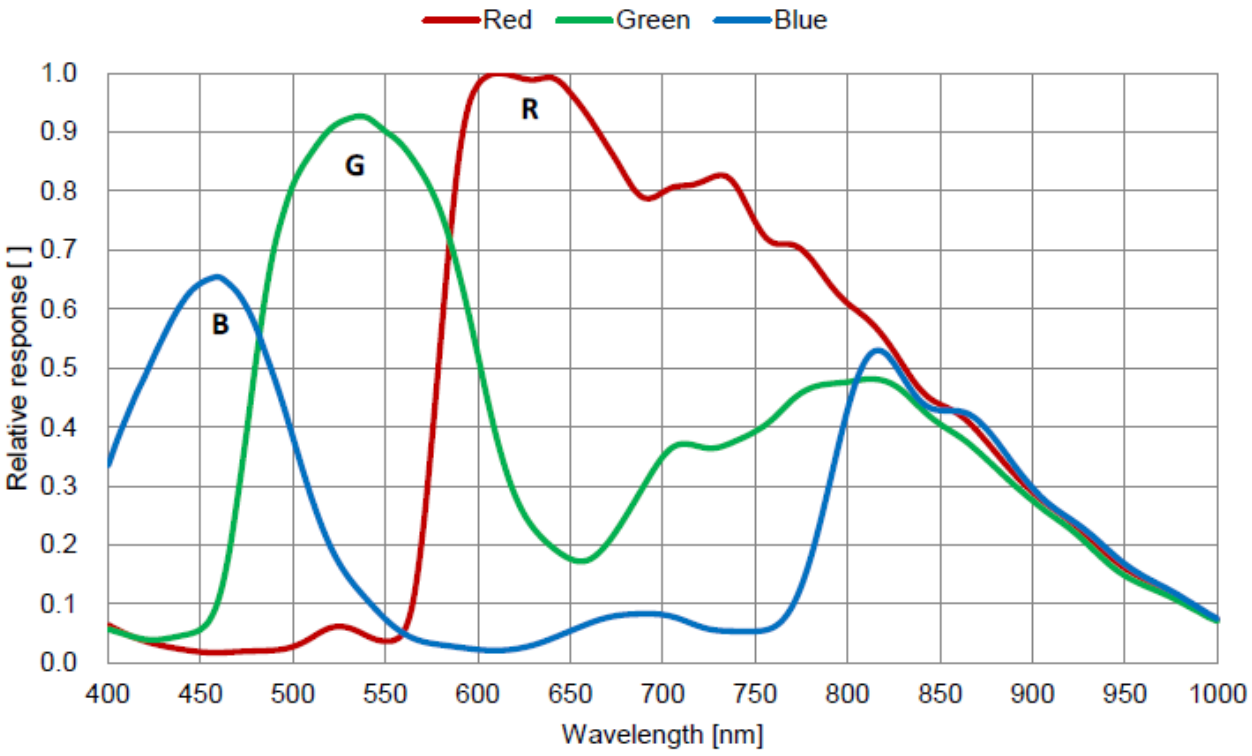


Figure1- 17: MER-301-125U3C Sensor Spectral Response

1.3.12. MER-302-56U3x

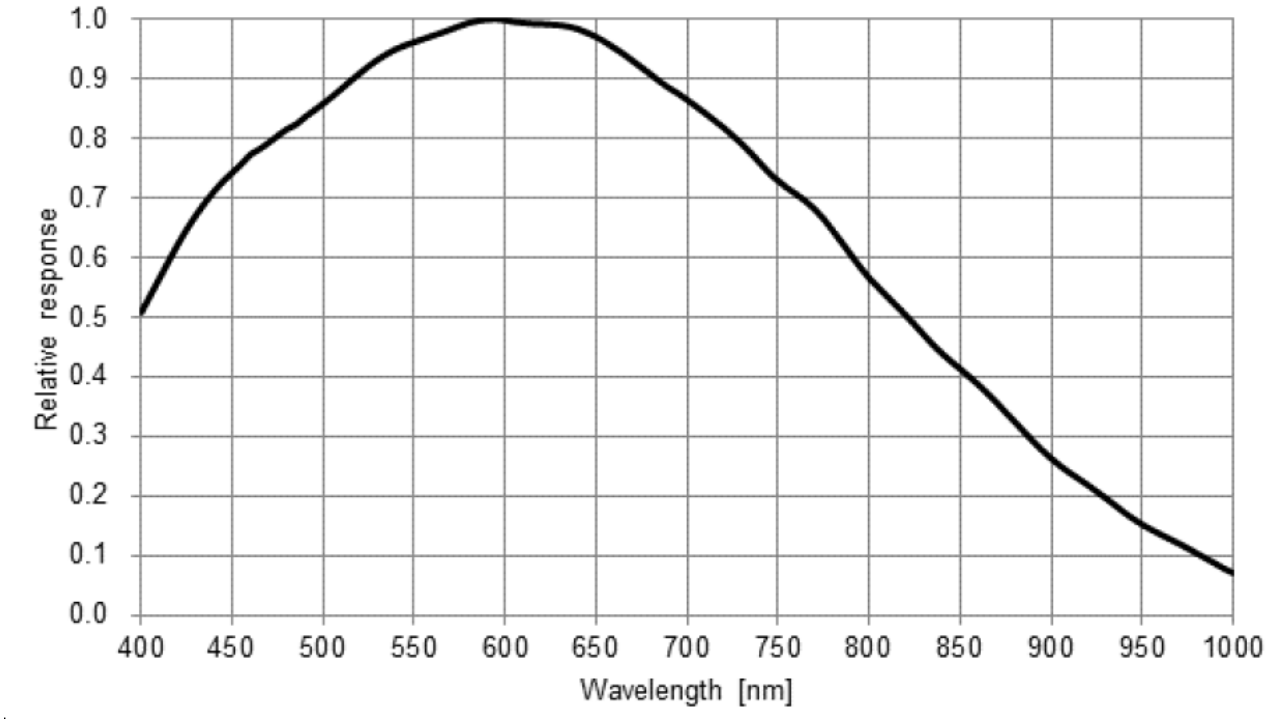


Figure1- 18: MER-302-56U3M Sensor Spectral Response

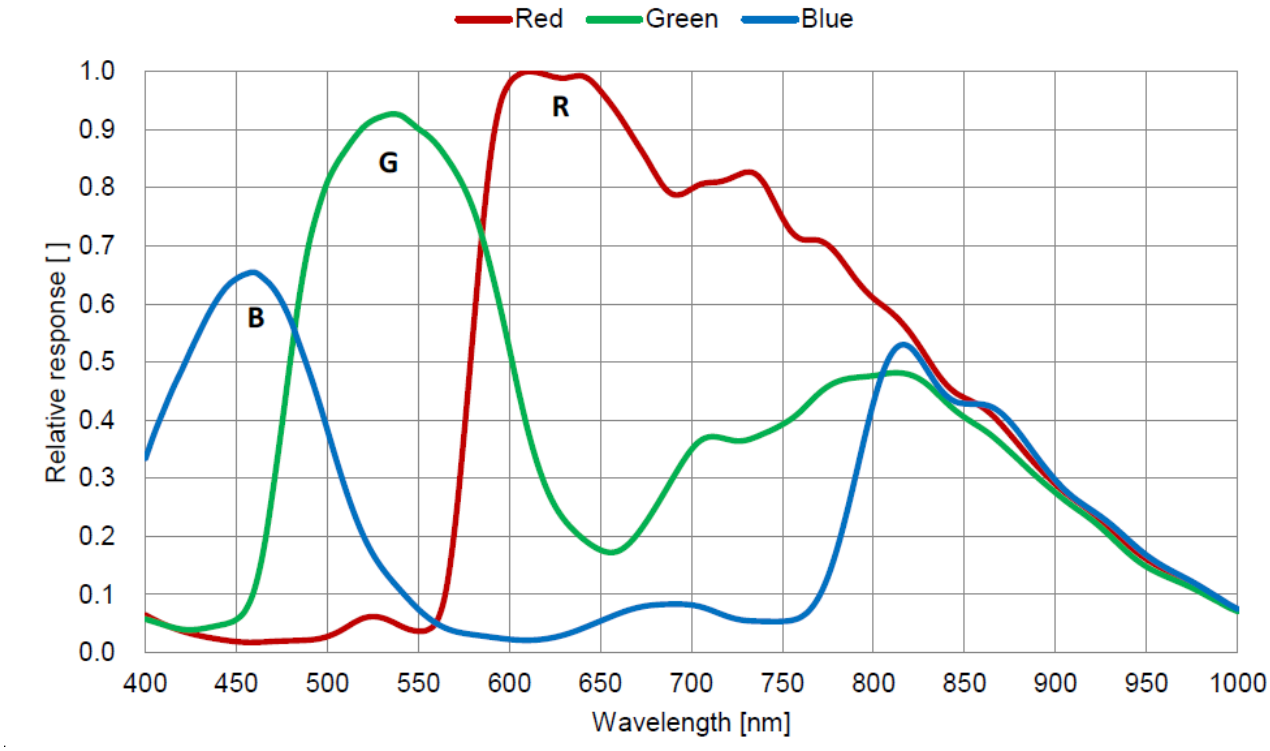


Figure1- 19: MER-302-56U3C Sensor Spectral Response

1.3.13. MER-500-14U3x

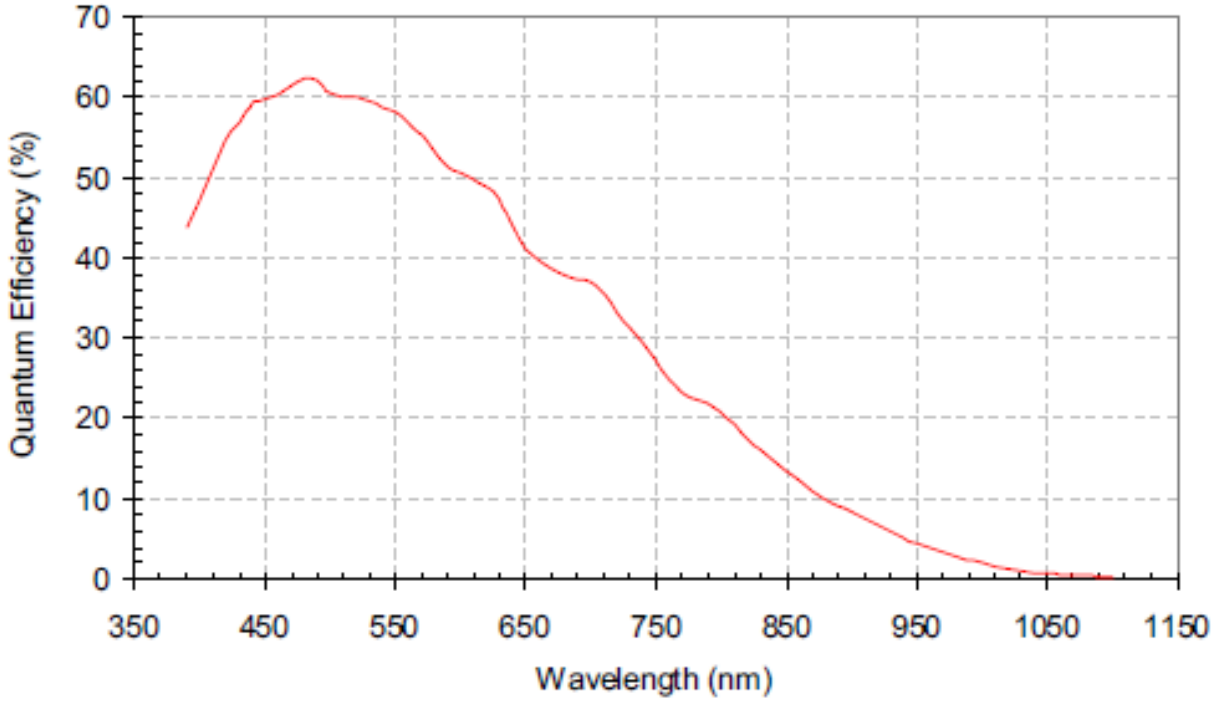


Figure1- 20: MER-500-14U3M Sensor Spectral Response

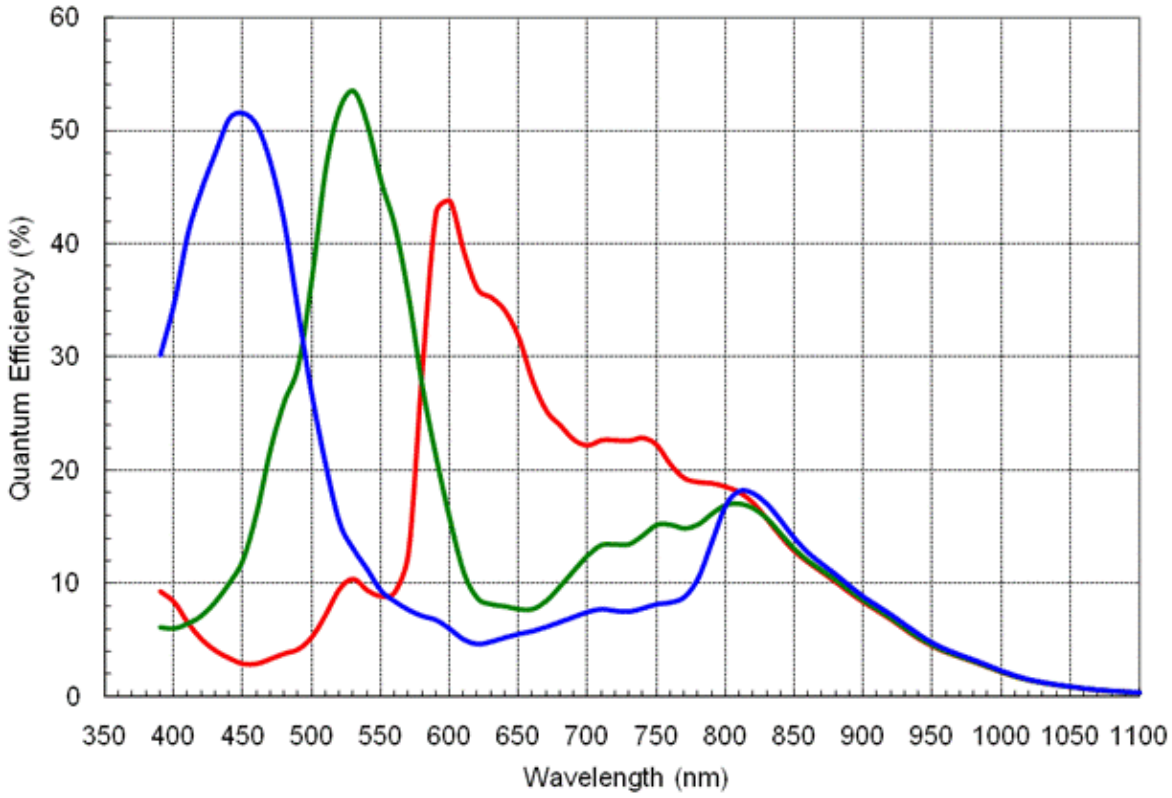


Figure1- 21: MER-500-14U3C Sensor Spectral Response

1.3.14. MER-502-79U3x

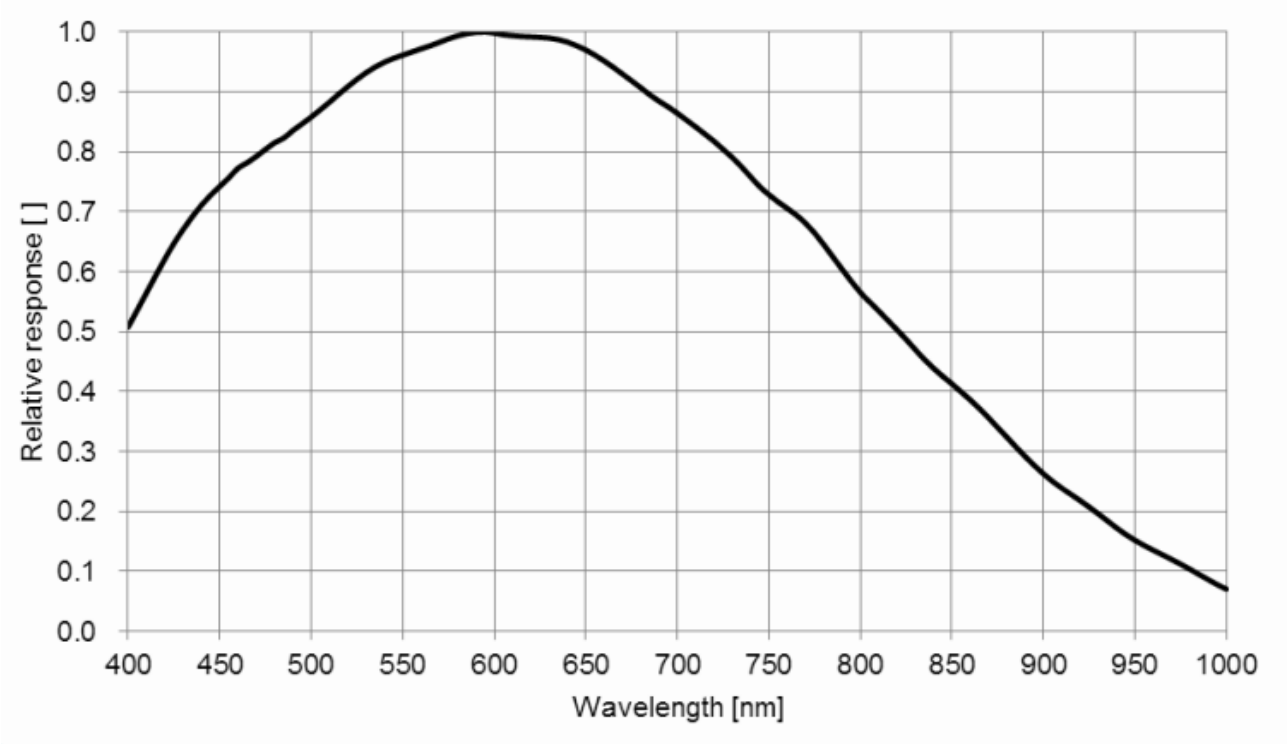


Figure1- 22: MER-502-79U3M Sensor Spectral Response

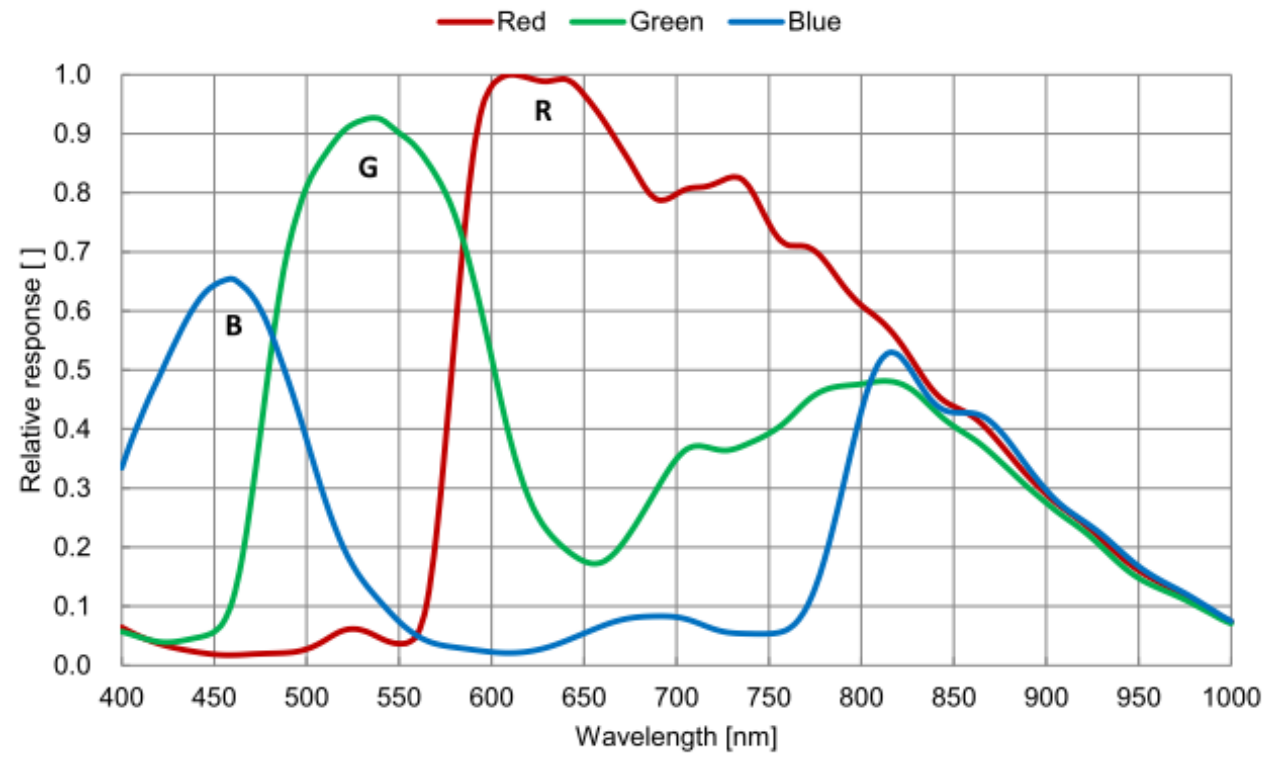


Figure1- 23: MER-502-79U3C Sensor Spectral Response

1.3.15. MER-502-79U3M POL

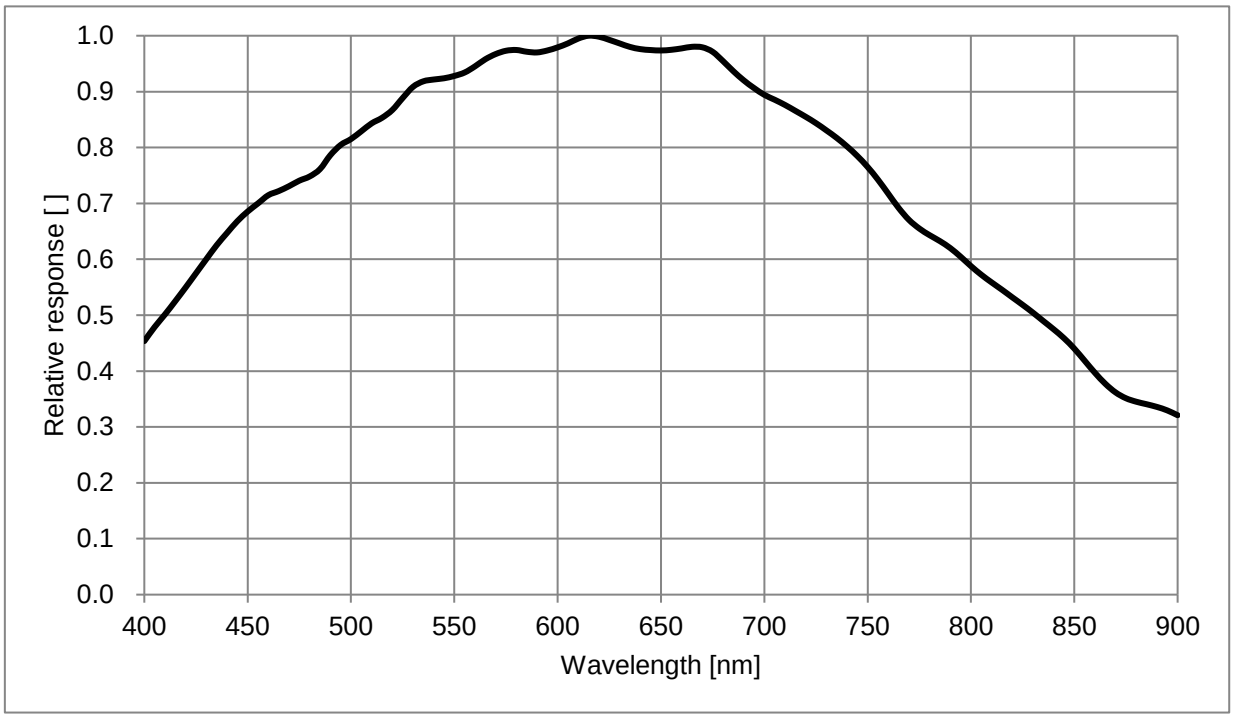


Figure1- 24 MER-502-79U3M POL Sensor Spectral Response

1.3.16. MER-503-36U3x

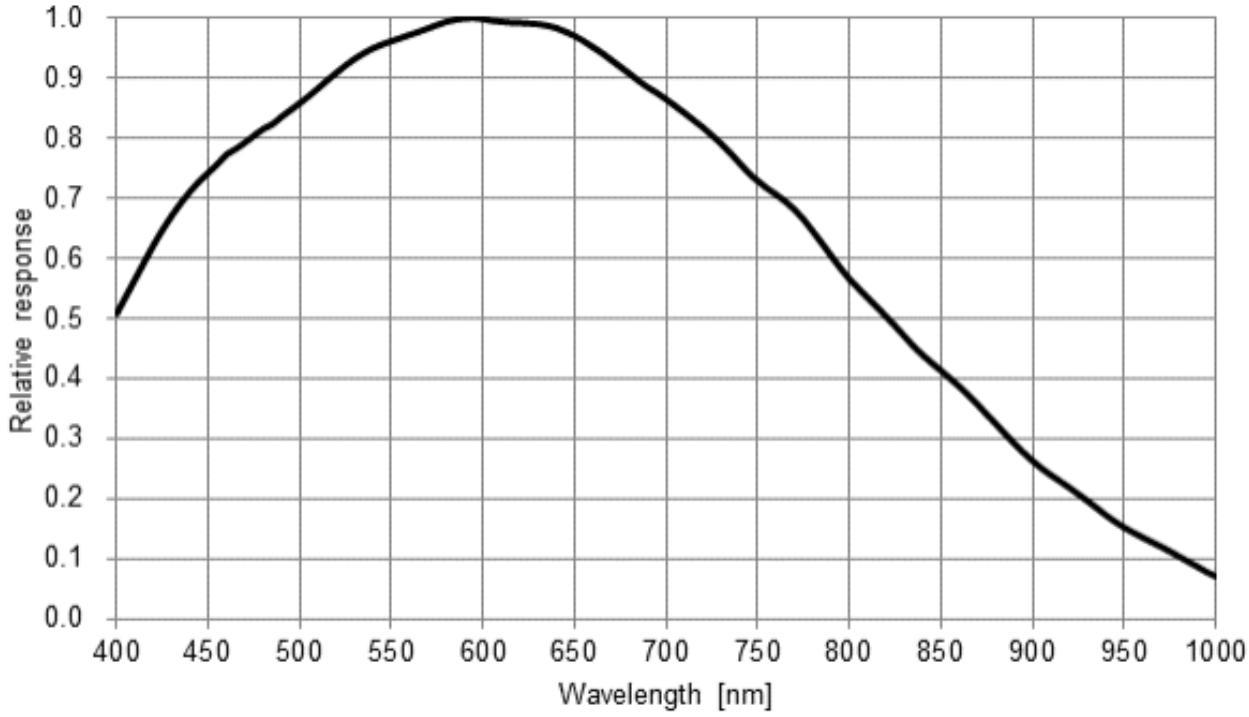


Figure1- 25: MER-503-36U3M Sensor Spectral Response

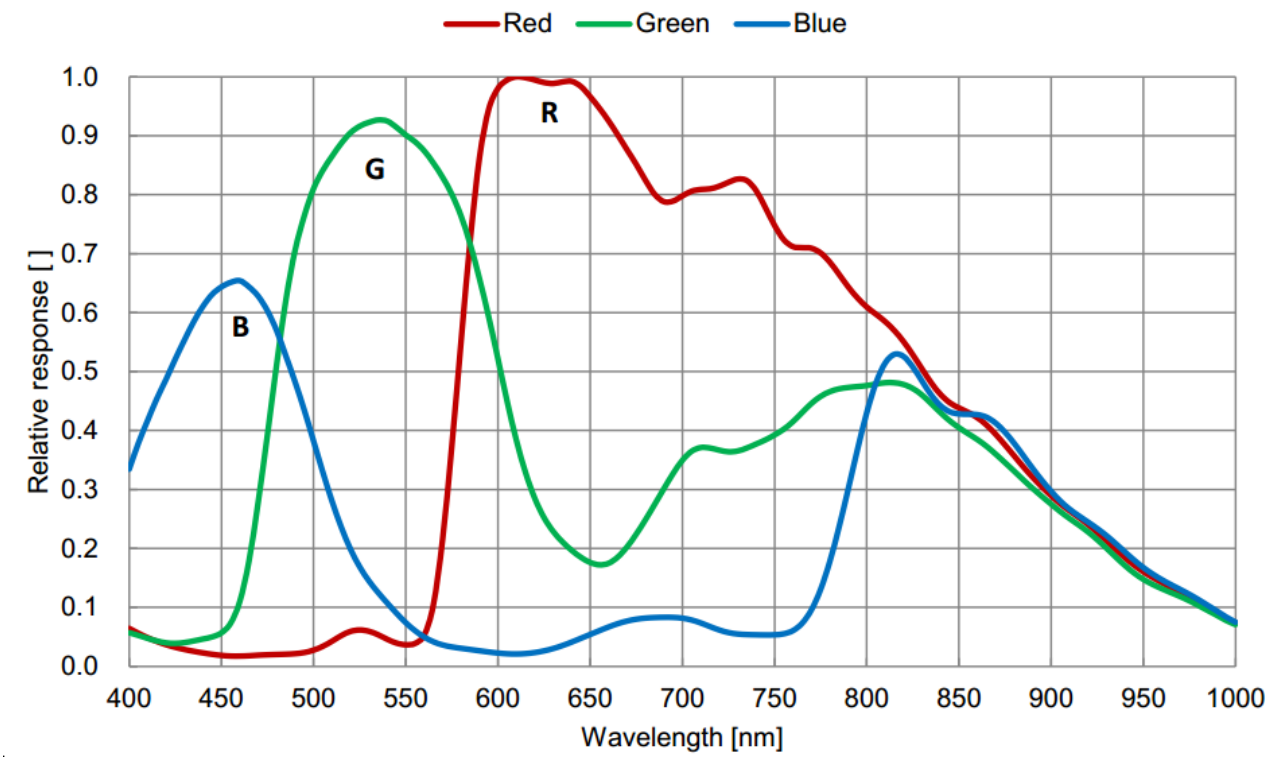


Figure1- 26: MER-503-36U3C Sensor Spectral Response

1.3.17. MER-630-60U3x

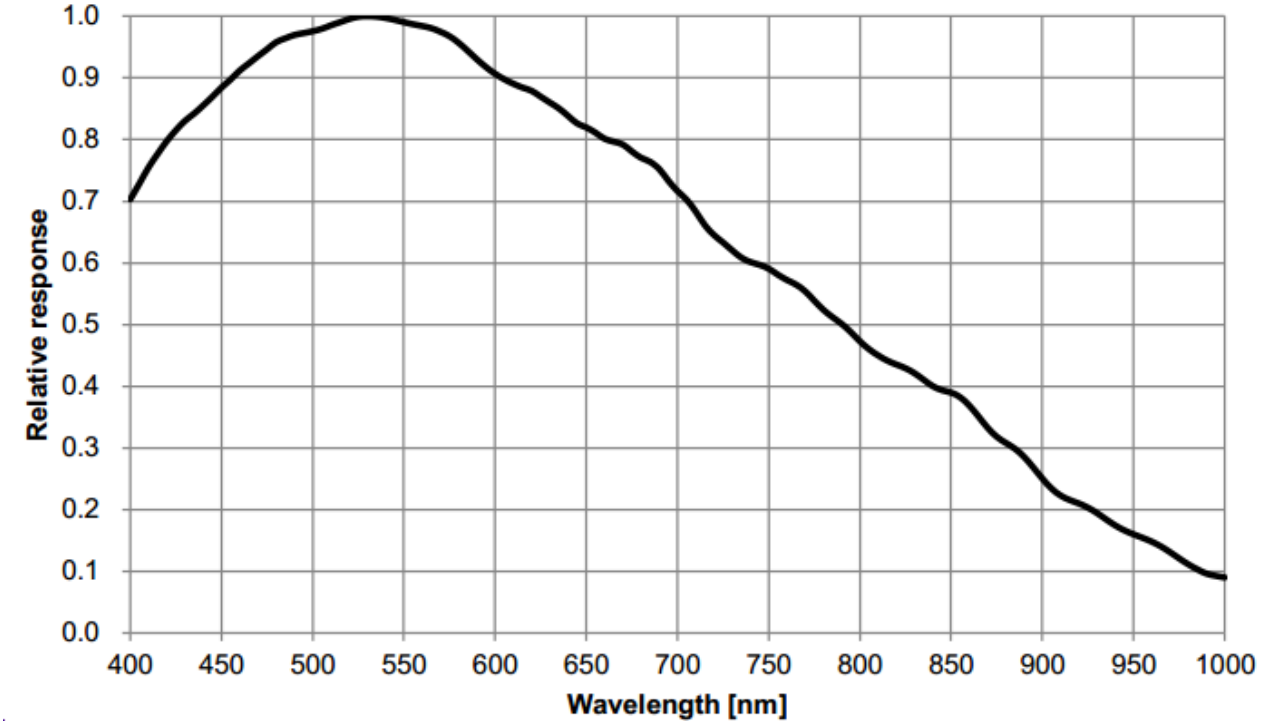


Figure1- 27: MER-630-60U3M Sensor Spectral Response

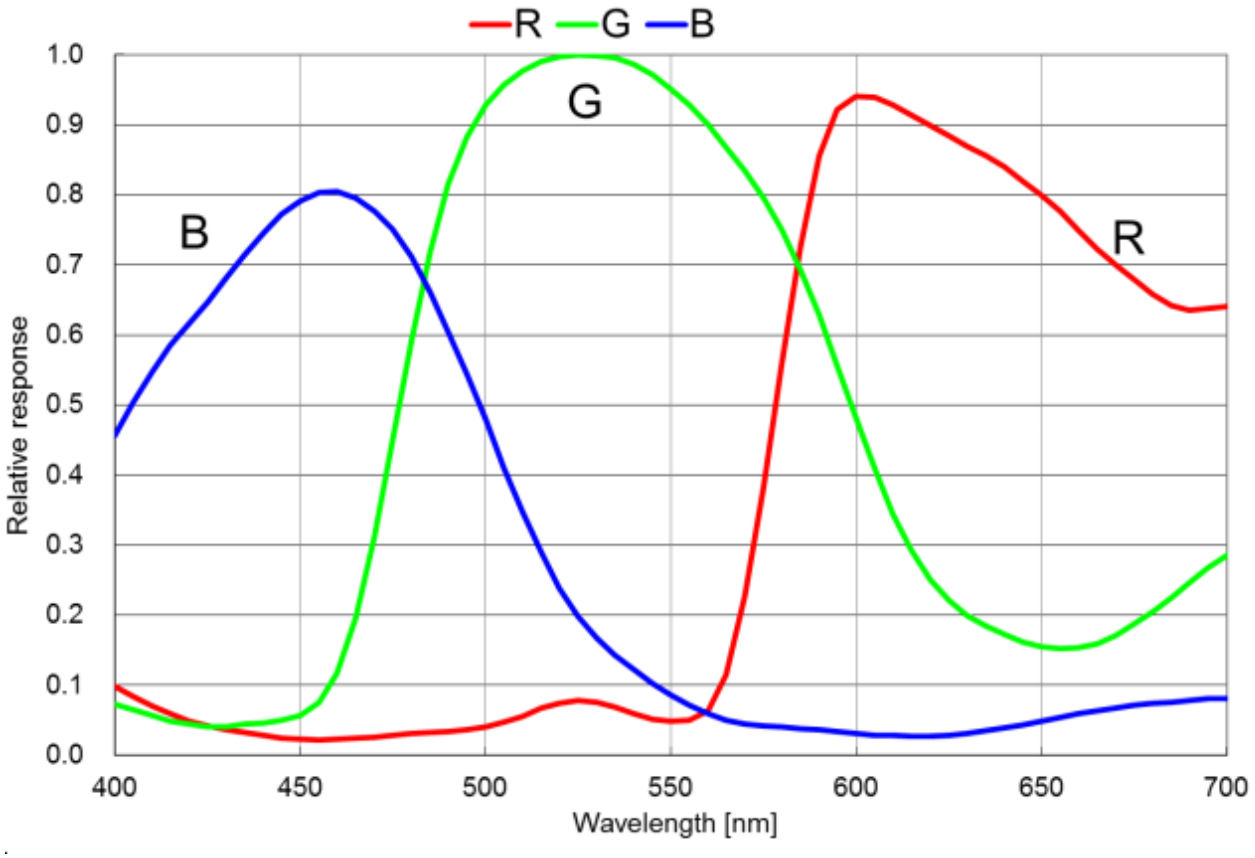


Figure1- 28: MER-630-60U3C Sensor Spectral Response

1.3.18. MER-1070-14U3x

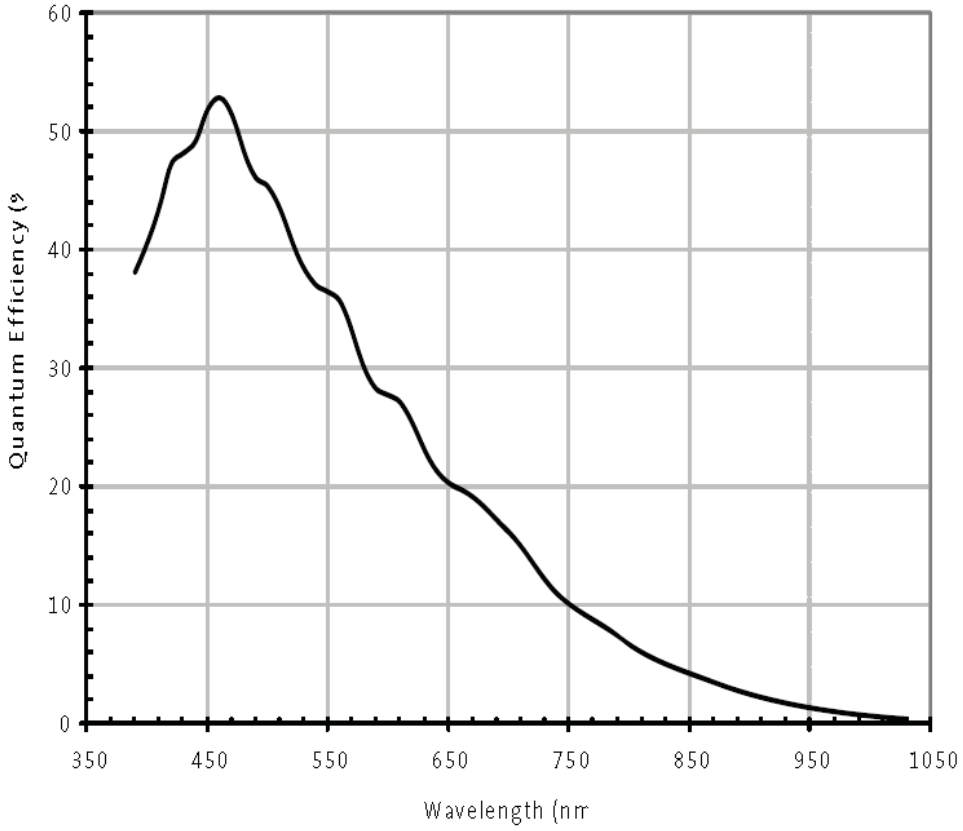


Figure1- 29: MER-1070-14U3M Sensor Spectral Response

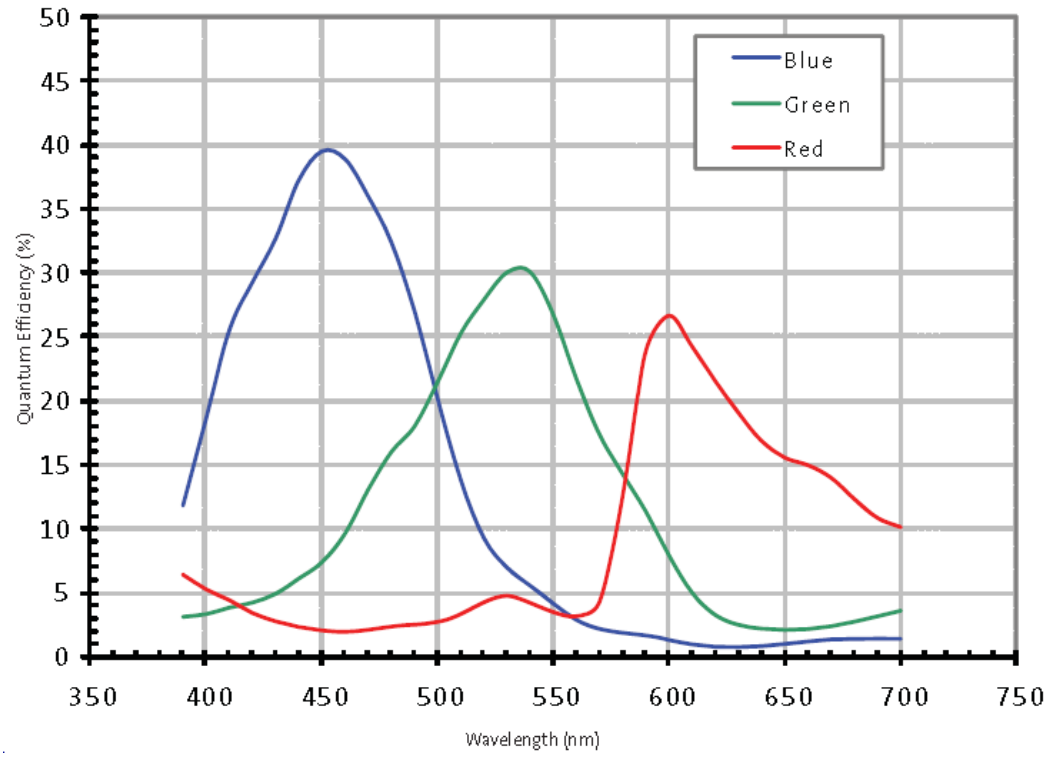


Figure1- 30: MER-1070-14U3C Sensor Spectral Response

1.3.19. MER-1520-13U3C

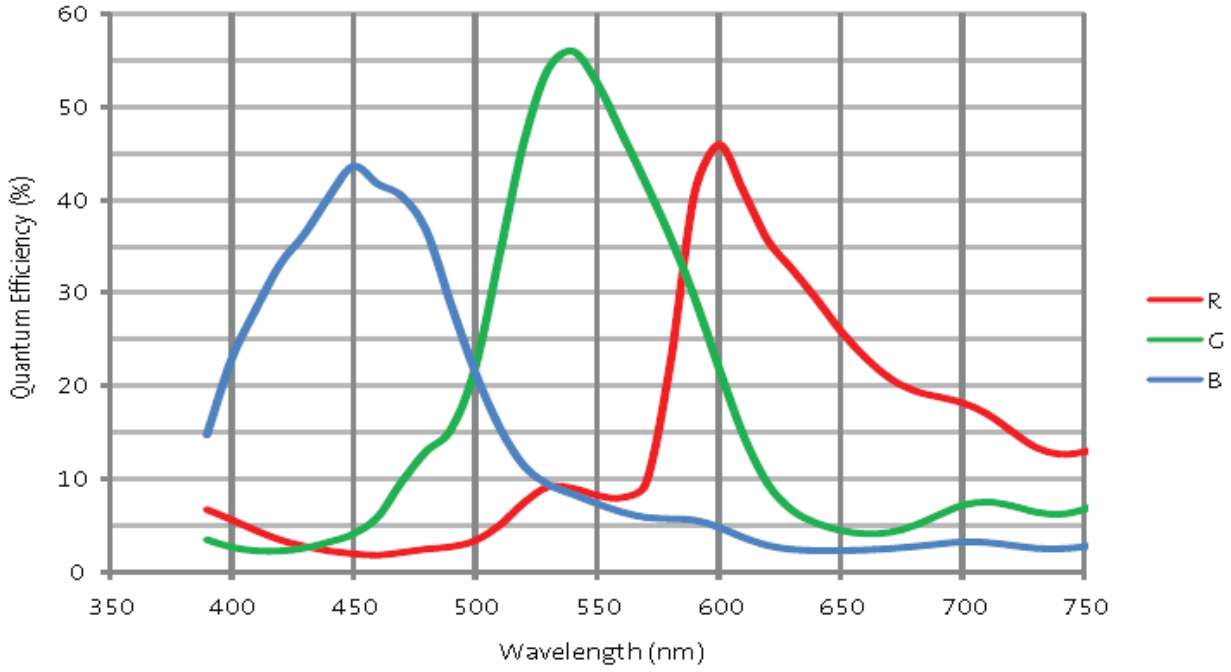


Figure1- 31: MER-1520-13U3C Sensor Spectral Response

1.3.20. MER-1810-21U3c

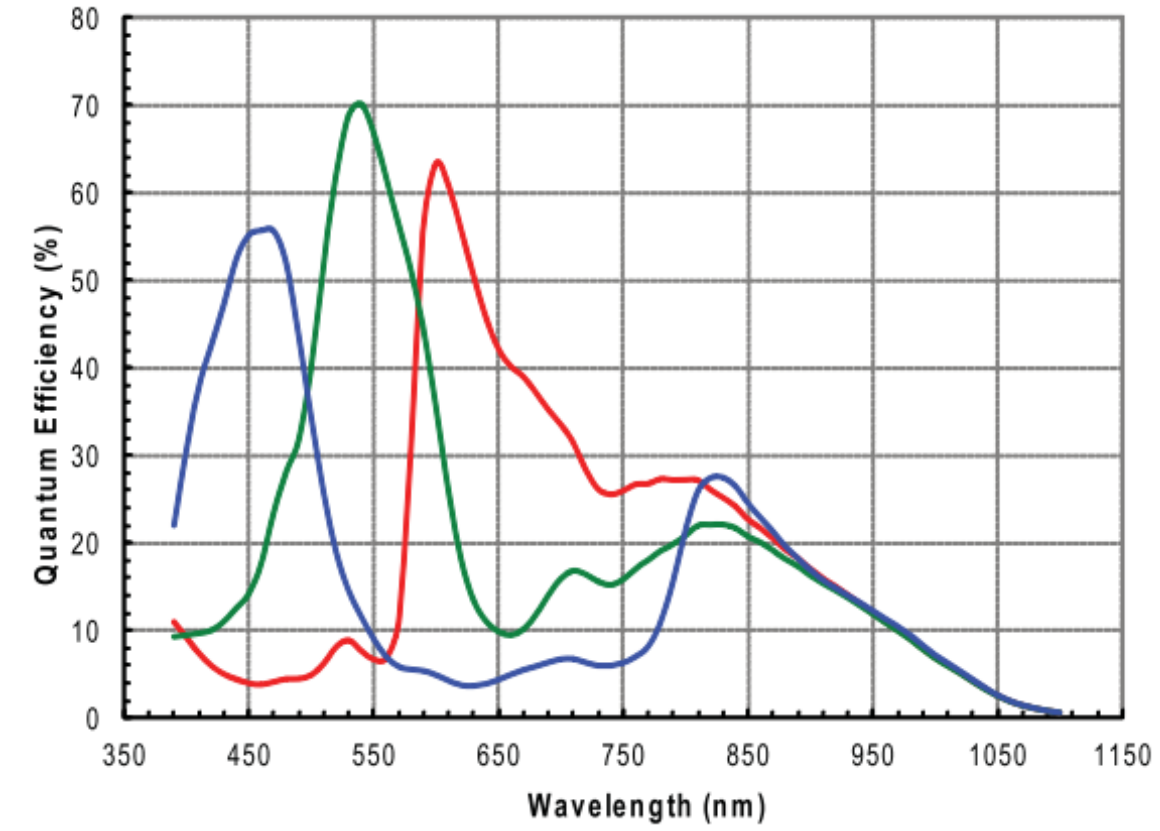


Figure1- 32: MER-1810-21U3C Sensor Spectral Response

1.3.21. MER-2000-19U3x

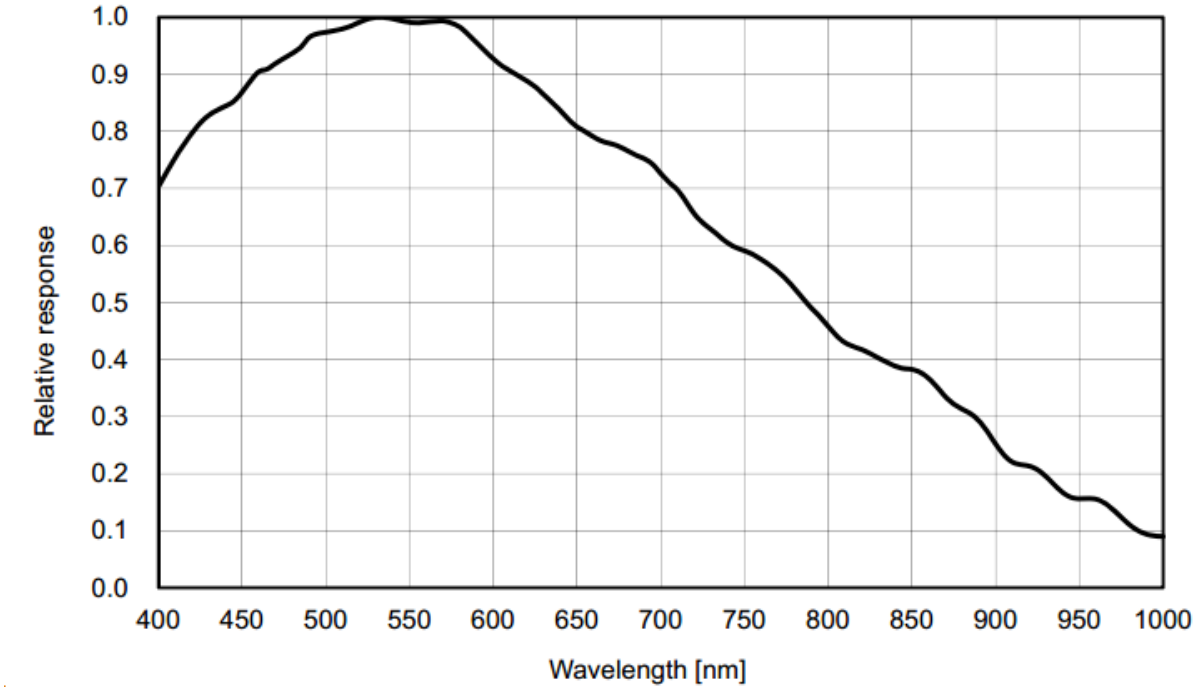


Figure1- 33: MER-2000-19U3M SENSOR 响应曲线

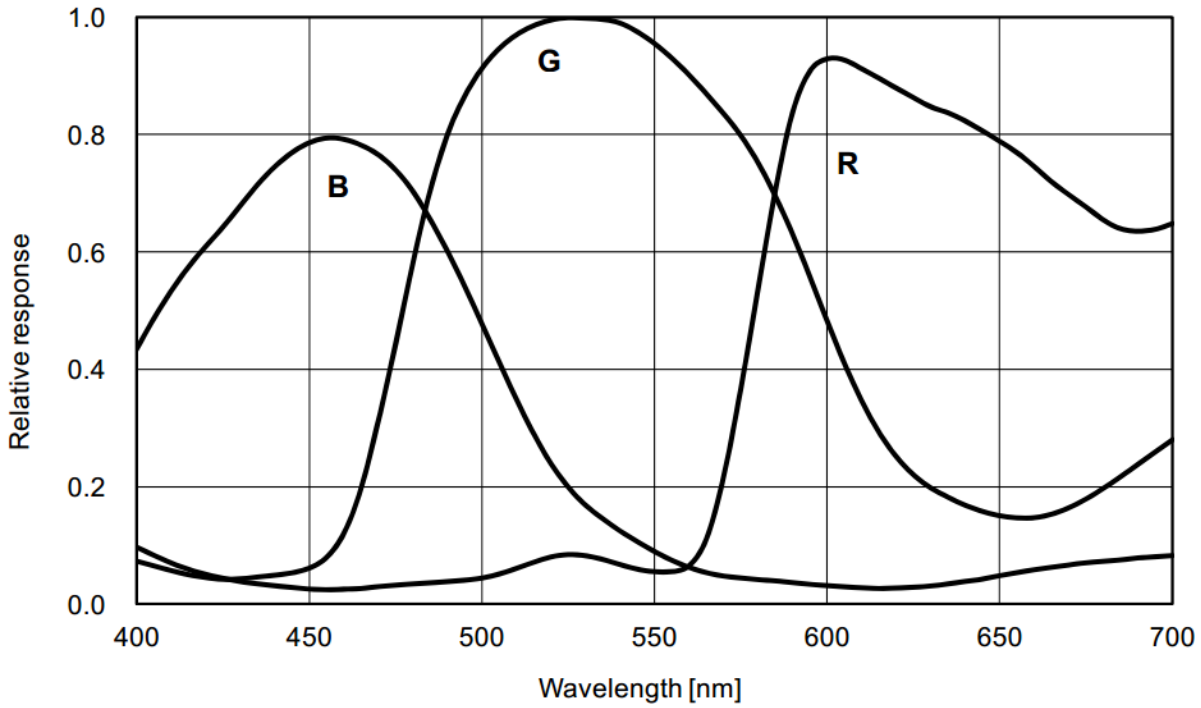


Figure1- 34: MER-2000-19U3C SENSOR 响应曲线

1.3.22. Filters

Each Mercury color camera is equipped with an additional infrared cut-Off filter, and each monochrome camera is equipped with a transparent piece of anti-reflection glass, the following are their specifications and spectral response.

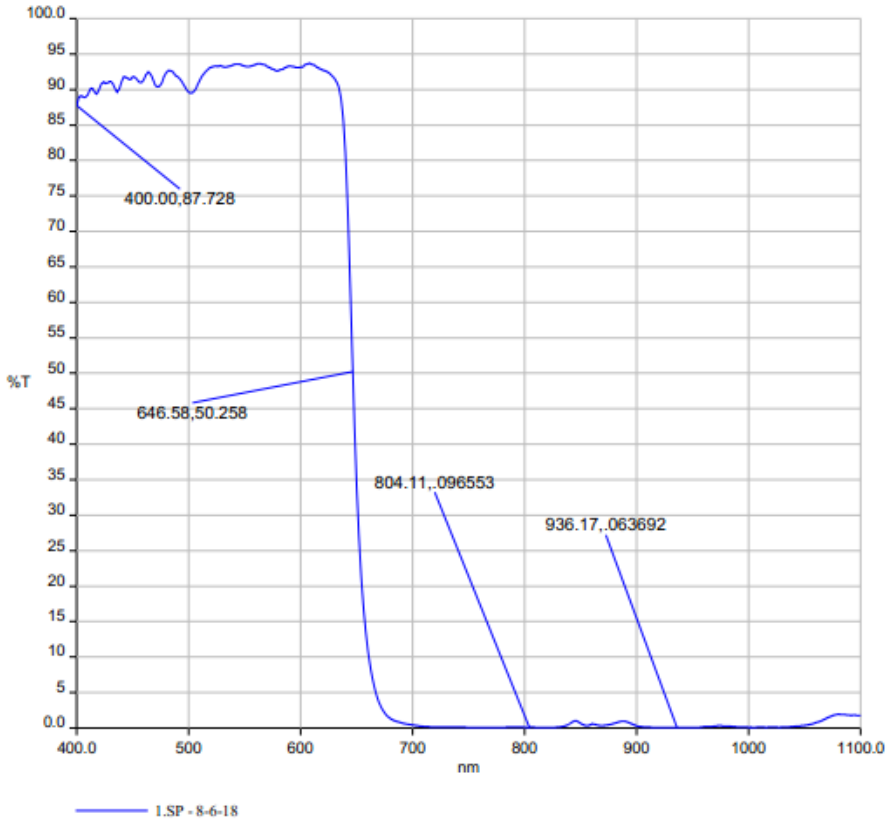


Figure1- 35: Infrared Cut-Off Filter Spectral Response for MER Series Color Camera

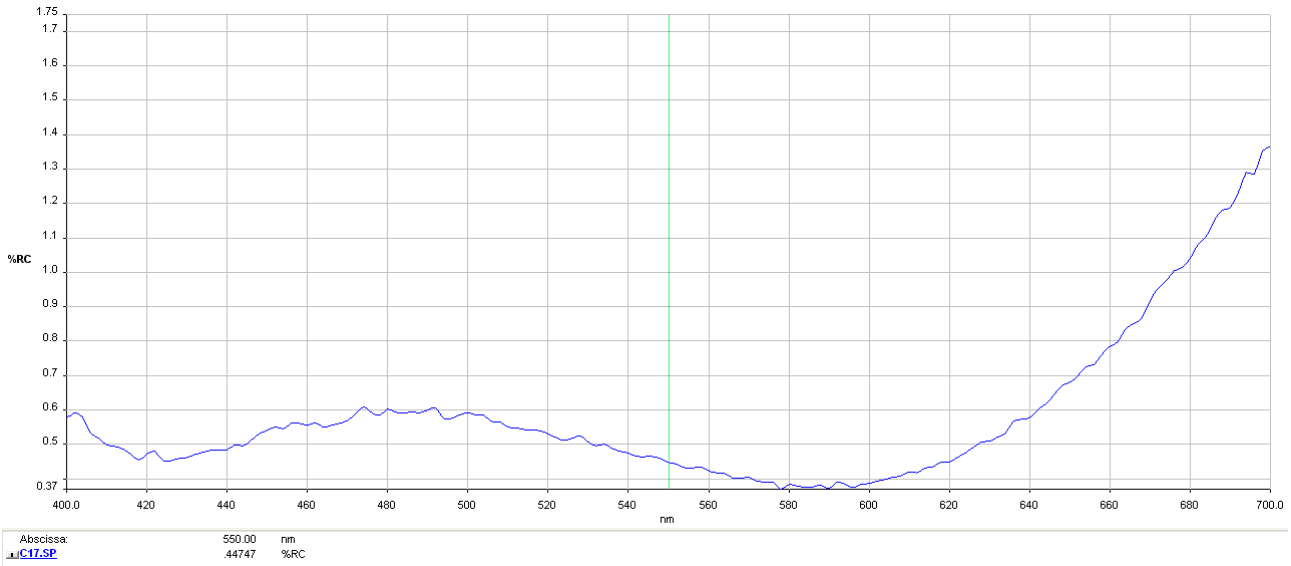


Figure1- 36: Transparent Glass Spectral Response for MER Series Mono Camera

1.4. Mechanical interface

1.4.1. Mechanical dimensions

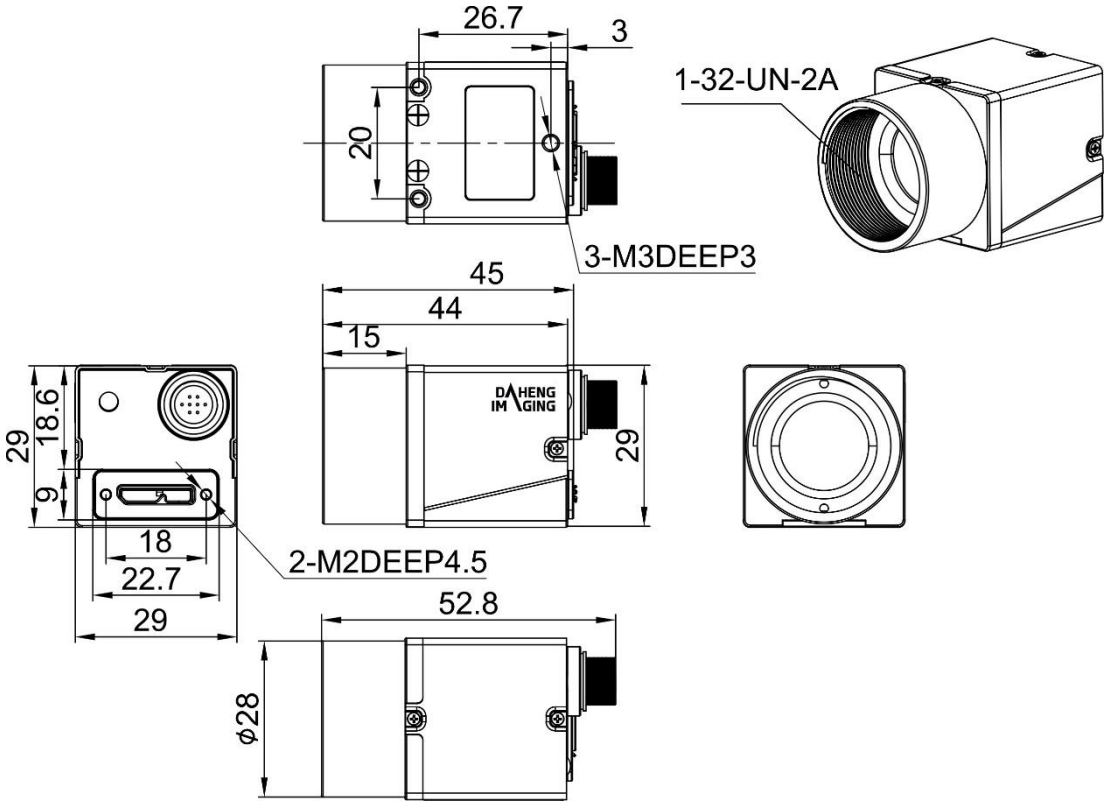


Figure1- 37: MER-U3x series Mechanical dimensions

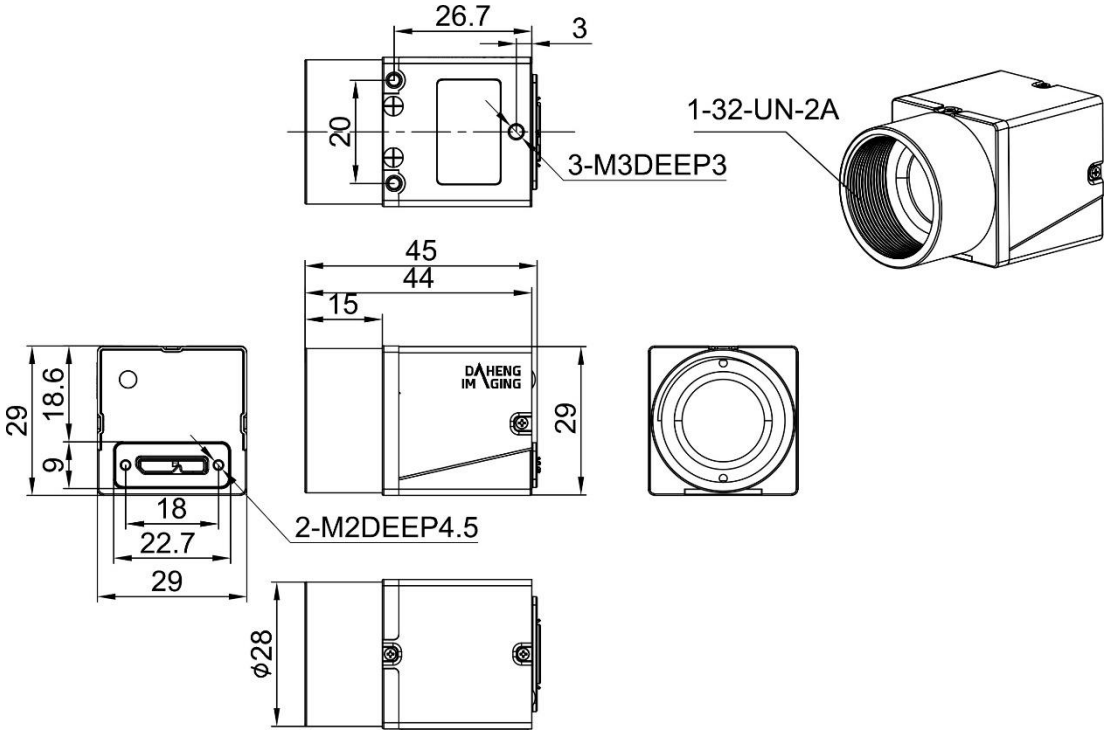


Figure1- 38: MER-U3x-L series Mechanical dimensions

1.4.2. Optical interface

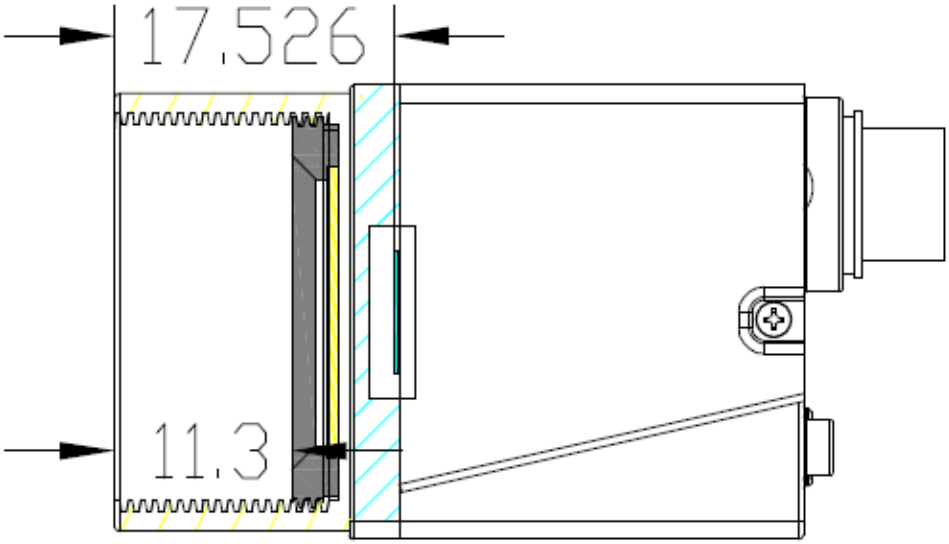


Figure1- 39: Optical interface

Mercury cameras are equipped with C-mount lens adapters. The back flange distance is 17.526 mm (in the air). The maximum allowed thread length of lens is 11.3mm, as shown in Figure1- 39. A longer lens thread will damage camera.

The color models are equipped with an IR filter and the cut-off frequency is 700nm. The mono models are equipped with a transparent glass. Remove IR-filter or transparent glass will defocus the image plane. Contact our technical support when the glass need to be removed.

1.5. Software Interface

1.5.1. Software Package

The Software package of DAHENG IMAGING MERCURY series that is used to control the MERCURY series camera, is to provide a stable, real-time image transmission, and provide a free SDK and abundant development example source code. The package is composed of the following modules:

1) Driver Package (Driver): This package provides the MERCURY series camera driver program, such as: the USB3.0 cameras' driver program.

2) Interface library (API): This package provides the camera control interface library and the image processing interface library, supports the user for secondary development.

3) Demonstration program (GalaxyView.exe): This demonstration program is used to display the camera control, image acquisition and image processing functions, the user can control the camera directly by the demonstration program, and also the user can develop their own control program based on the camera interface library.

4) Sample: The sample demonstrates the camera functions, the user can easily use these samples to control cameras, and also can refer to the samples to develop their own control program.

5) Programmer's Manual: This manual is the users programming guide that instructs the users how to configure the programming environment and how to control camera and acquisition images through the camera interface library.

You can download the latest camera package from the website: www.daheng-imaging.com/downloads.

1.5.2. Application Programming Interface

After installing the MERCURY series camera software package, the user can use the demonstration program and the samples to control the camera, also the user can control the camera by the program which is written by the user themselves. The software package provides three kinds of program interface, the user can select the suitable one for use according to their own requirements:

1) API Interface

In order to simplify the users' programming complexity, the package provides the general C programming interface GxIAPI.dll and image processing algorithm interface DxImageProc.dll for the user to control the camera, and also provides the samples and software development manual which are based on these interfaces.

2) GenTL Interface

This interface is developed according to the standard of general transport layer in Gen<i>Cam standard, daheng follows the Gen<i>Cam standard and provides the GenTL interface for the user, the user can use the GenTL interface directly to develop their own control program. The definition and usage of GenTL interfaces can be downloaded from the website of EMVA.

In addition, users can use some third-party software that supports Gen <i > Cam standard to control the camera, such as HALCON.

3) USB3.0 Vision interface

The MERCURY series USB3.0 camera is compatible with the USB3.0 Vision protocol, which allows the user to control the camera directly through the USB3.0 Vision protocol. In addition, the user can use some third-party software that supports the USB3.0 Vision protocol to control the camera, such as HALCON.

Note:

GEN<i>CAM standard: GEN<i>CAM is administered by the European Machine Vision Association (EMVA). GenICam provides a generic programming interface for all kinds of cameras and devices. It provides a standard application programming interface (API), no matter what interface technology is being used. It mainly includes the following modules:

- GenAPI: an XML description file format defining how to capture the features of a device and how to access and control these features in a standard way.
- GenTL: a generic Transport Layer Interface, between software drivers and libraries, that transports the image data from the camera to the application running on a PC.
- SFNC: common naming convention for camera features, which promotes interoperability between products from different manufacturers.

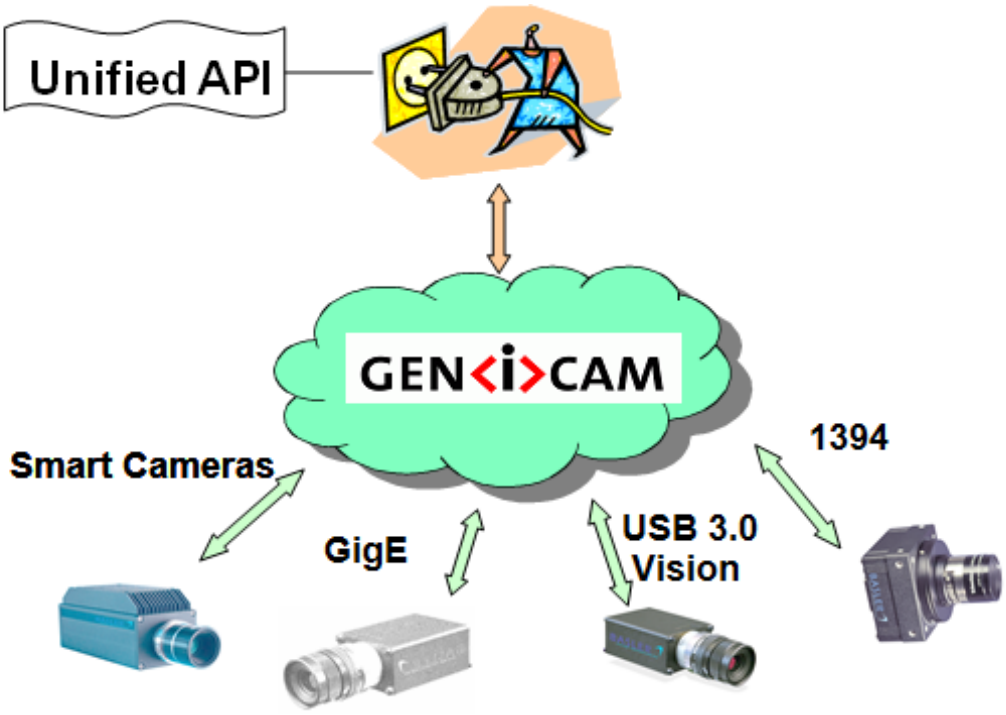


Figure1- 40: GEN<i>CAM standard schematic diagram

1.6. Guideline for Avoiding EMI

You should consider the EMI(Electro Magnetic Interference) and ESD(Electro-Static discharge) problem in the process of using the camera, to guarantee the camera to work in a relatively good electromagnetic environment. The main measures are as follows:

1) USB cable certificated by USB-IF with lock screw is recommended.

2) Connect I/O cable shield conductor to ground.Try to use camera cables that are the correct length. Avoid coiling camera cables. If the cables are too long, use a meandering path rather than coiling the cables.

3) Keep your cameras away from equipments with high voltage, or high current (as motor, inverter,relay, etc.). If necessary, use additional shielding.

4) ESD (electro-static discharge)may damage cameras permanently, so use suitable clothing (cotton) and shoes, and touch the metal to discharge the electro-static before operating cameras.

1.7. Environment Requirement

1) Housing temperature during operation: 0°C ~ 45°C,Humidity during operation: 10% ~ 80% (relative , non-condensing);Storage temperature: -20°C ~ 70°C.

2) To avoid collecting dust inthe optical filter, always keep the plastic cap on cameraswhen no lens is mounted.

3) Pc requirement: Intel Core 2 Duo, 2.4Ghzor above, and more than 2GB memory.

4) USB3.0 host controller requirement: Intel controller integrated in mainboard is recommend. Select Renesas controller if external frame grabber is needed.

5) The cables should be fastened with fastening screw at the end of the device.

6) Make sure that cameras are transported in the original factory packages.

1.8. Standards and Regulations

DAHENG IMAGING's cameras are compliant with CE, RoHS and FCC regulations.

2. Features

2.1. I/O control

2.1.1. Input Mode Operation

1) Configuring Line as Input

The MER-U3x series camera has three input signals: Line0, Line2, and Line3. In which the Line0 is a uni-directional opto-isolated input I/O, Line2 and Line3 are bi-directional line which can be configured as input or output I/Os.

The camera's default input is Line0 when the camera is powered on. Line2 and Line3 are input by default, which can be configured to be input or output by LineMode.

2) Input Debouncer

In order to suppress the interference signals from external trigger, the MER-U3x series camera has the external trigger filtering function, including rising edge filtering and falling edge filtering. The user can set the trigger filter function by setting the “TriggerFilterRaisingEdge” and the “TriggerFilterFallingEdge”. The range of the trigger filter function is [0, 5000] μs, step: 1μs.

Example 1: Setting the rising edge filter width is 1ms, the pulse width less than 1ms in the rising edge will be filtered out, as shown in Figure2- 1:

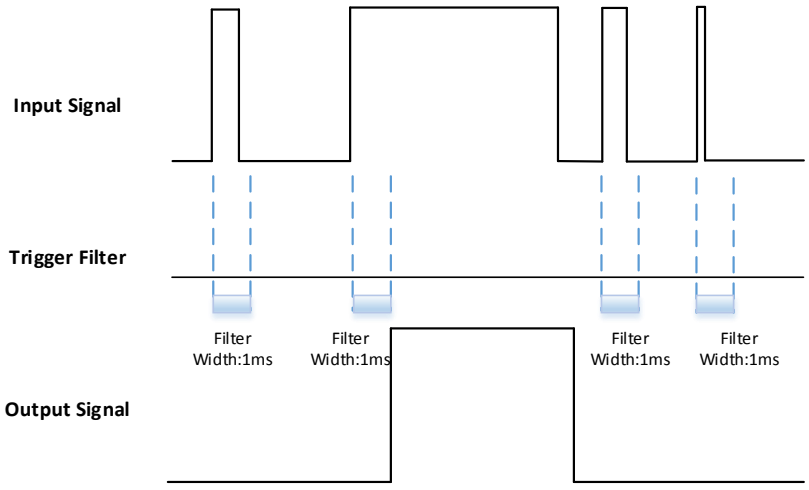


Figure2- 1: Input signal filter schematic diagram

3) Trigger Delay

The MER-U3x series camera has trigger delay function. The user can set the trigger delay function by setting “TriggerDelay”. The range of the trigger delay function is [0, 3000000] μs, step: 1μs.

Example 1: Setting the trigger delay value to be 1000ms, and the trigger signal will be valid after 1000ms delay, as shown in Figure2- 2:

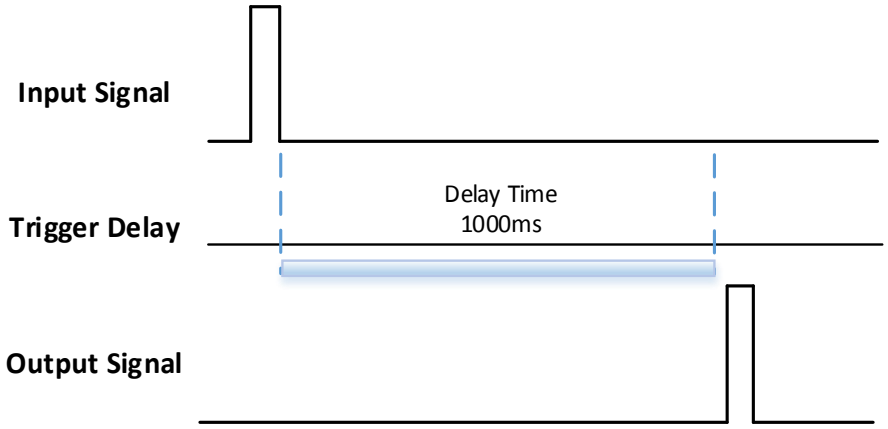


Figure2- 2: Trigger delay schematic diagram

4) Input Inverter

The signal level of input lines is configurable for the MER-U3x series camera. The user can select whether the input level is reverse or not by setting “LineInverter”.

For the MER-U3x series camera, the default input line level is false when the camera is powered on, indicating that the input line level is not reversed. If it is set as true, indicating that the input line level is reversed. As shown in the Figure2- 3:

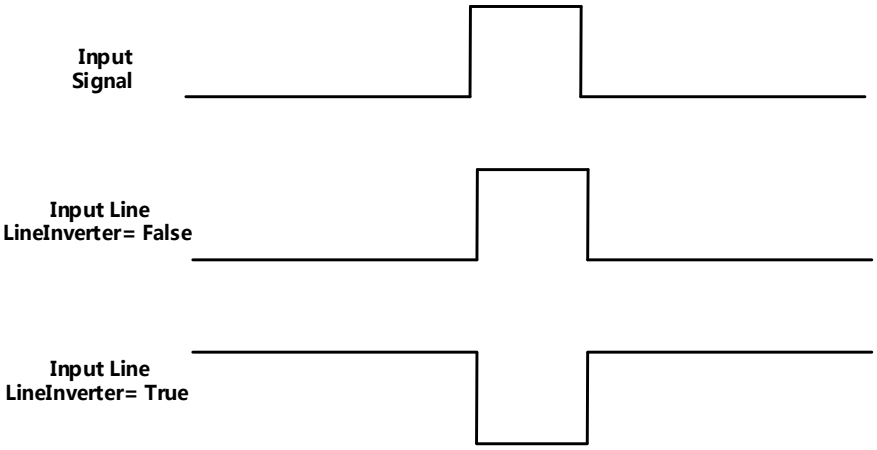


Figure2- 3: Setting input line reverse

2.1.2. Output Mode Operation

1) Configuring line as output

The MER-U3x series camera has three output signals: Line1, Line2, and Line3. In which the Line1 is a uni-directional opto-isolated output I/O, Line2 and Line3 are bi-direction configurable I/Os.

The camera's default output is Line1 when the camera is powered on. Line2 and Line3 can be configured to be output by changing the “LineMode” of this line.

Each output source of the three output lines can be configurable, and the output source includes: Strobe, UserOutput0, UserOutput1, and UserOutput2.

The default output source of the camera is UserOutput0 when the camera is powered on.

2) Setting the user-defined status for the output lines

The MER-U3x series camera can select the user-defined output by setting “LineSource”, by setting “UserOutputValue” to configure the output signal.

By setting “UserOutputSelector” to select the output UserOutput0, UserOutput1, UserOutput2.

By setting “UserOutputValue” to set the user-defined output value, and the default value is false when the camera is powered on.

3) Output Inverter

In order to facilitate the camera IO configuration and connection, the MER-U3x series camera has the function of configurable output signal level. The user can select whether the output level is reverse or not by setting “LineInverter”.

The default output signal level is false when the camera is powered on, indicating that the output line level is not reversed. If it is set as true, indicating that the output line level is reversed. As shown in the Figure2- 4:

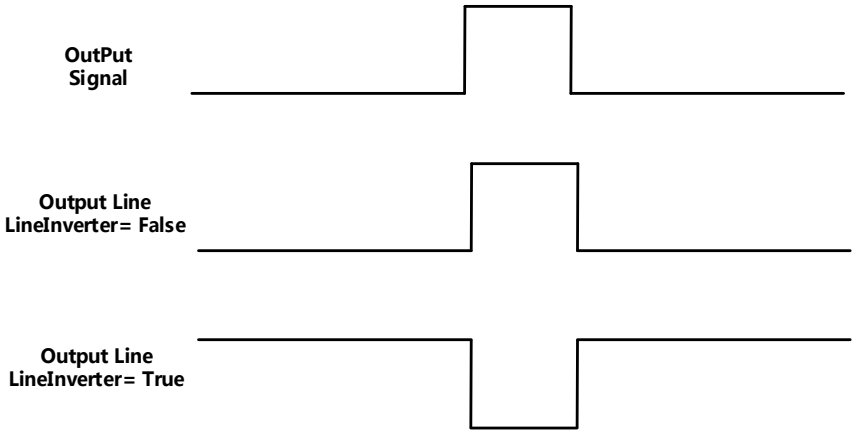


Figure2- 4: Set output line reversion

2.1.3. Read the LineStatus

1) Read the level of single line

The MER-U3x series camera can get the line’s signal status. When the device is powered on, the default status of Line0 and Line1 is false, and the default status of Line2 and Line3 is true.

2) Read all the lines level

The MER-U3x series camera can get the current status of all lines. On the one hand, the signal status is the status of the external IO after the reversal of the polarity. On the other hand, signal status level can reflect the external IO level.

All the lines level status bit of the MER-U3x series camera are shown in Table2- 1. The default polarity does not reverse, and the default value is oxC.

Line3	Line2	Line1	Line0
1	1	0	0

Table2- 1: Camera line status bit

2.2. Image Acquisition Control

2.2.1. Acquisition Start and Stop

2.2.1.1. Acquisition Start

It is allowed to send **Acquisition Start** command immediately after opening the camera. The acquisition process in continuous mode is illustrated in Figure2- 5, and the acquisition process in trigger mode is illustrated in Figure2- 6.

- **Continuous Acquisition:**

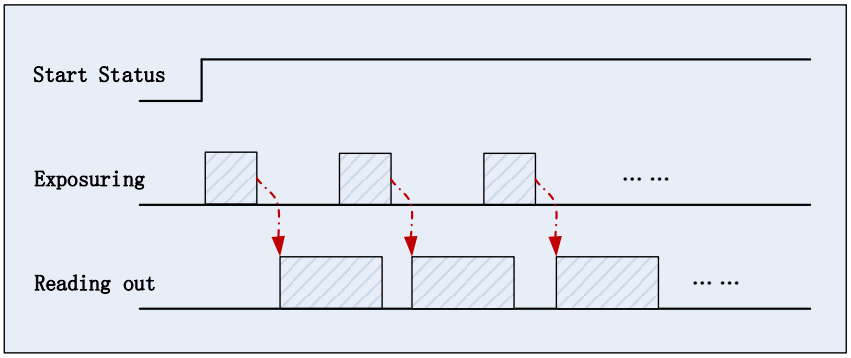


Figure2- 5: Continuous acquisition process

In continuous mode, a camera starts to expose and read out after receiving the **AcquisitionStart** command. The frame rate is determined by the exposure time, ROI and some other parameters.

- **Trigger Acquisition:**

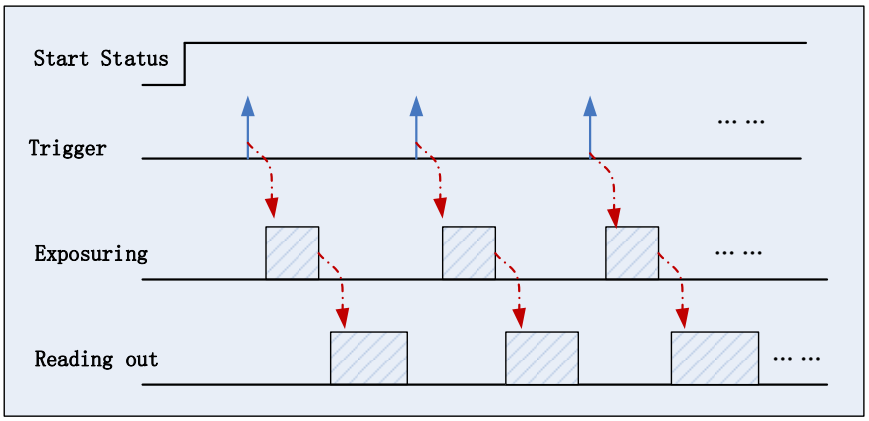


Figure2- 6: Trigger acquisition process

In trigger mode, sending **AcquisitionStart** command is not enough, a trigger signal is also needed. Each time a frame trigger is applied (including software trigger and external trigger), the camera will acquire and transmit a frame. The maximum frame rate in trigger mode is depended on the exposure time, ROI and some other parameters.

2.2.1.2. Acquisition Stop

It is allowed to send **AcquisitionStop** command to camera at any time. The acquisition stop process is irrelevant to acquisition mode. But different stop time will result in different process, as shown in Figure2- 7 and Figure2- 8.

- **Acquisition stop during reading out:**

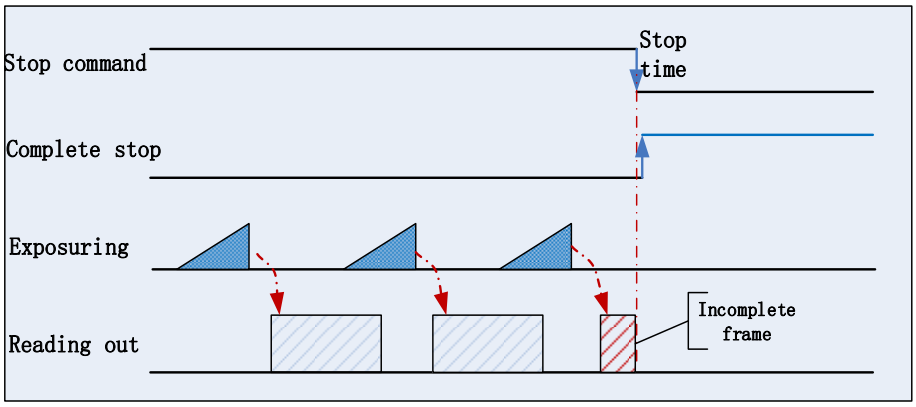


Figure2- 7: Acquisition stop during reading out

As shown in Figure2- 7, when the camera receives an acquisition stop command during reading out, it stops transferring frame data immediately. The currently transferred frame data is regarded as incomplete frame and will be discarded.

- **Acquisition stop during blanking:**

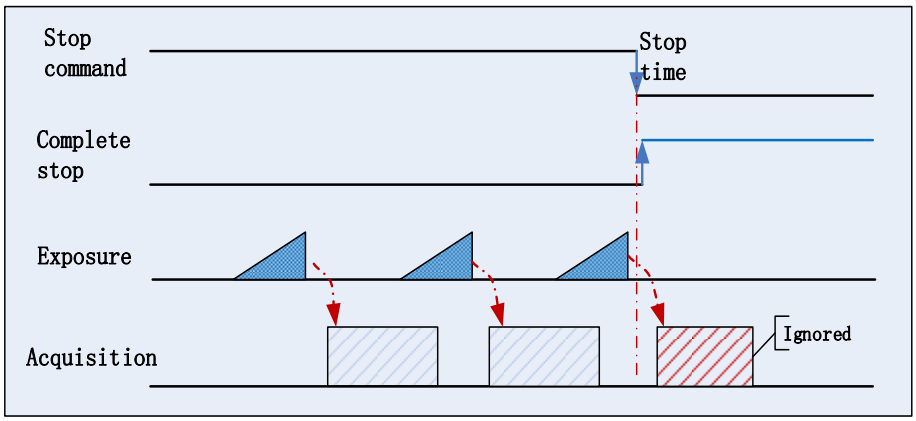


Figure2- 8: Acquisition stop during blanking

After the camera transferred a whole frame, the camera goes into wait state. When user sends an Acquisition Stop command in wait state, the camera will return to stop-finished state. The camera won't send any frames even if it is just going to start the next exposing.

2.2.2. RegionSendMode

MER-134-93U3x camera supports SingleROISendMode and MultiROISendMode, any other cameras only support SingleROISendMode. MultiROISendMode means the camera sends several images after one exposure as shown in Figure2- 9 while SingleROISendMode means the camera sends only one image after one exposure as shown in Figure2- 10.

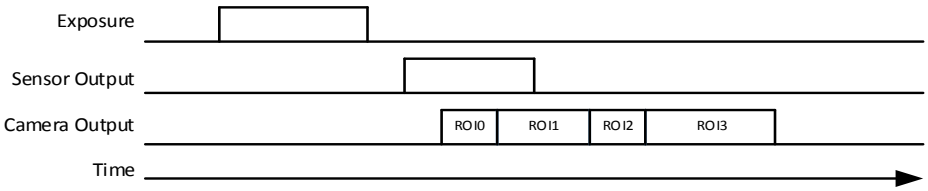


Figure2- 9: MultiROISendMode

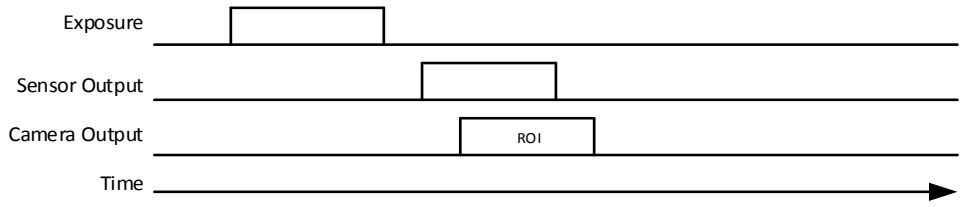


Figure2- 10: SingleROISendMode

In the single ROI mode, the image sensor of the MER-134-93U3x camera outputs only the image of the corresponding region of the ROI. In the multi-ROI mode, the camera will calculate the multi-ROI parameters that are set by the user and the equivalent ROI parameters, then the image sensor will output the image of the corresponding region of the equivalent ROI parameters.

- The calculation method of the equivalent ROI parameters

Equivalent Width: The equivalent width is the minimum width that can include all ROIs which are projected on horizontal axis.

Equivalent Height: The equivalent height is the sum of all ROI projections on the vertical axis.

As shown in Figure2- 11, the equivalent width is width, and the equivalent height is the sum of height1, height2, and height3.

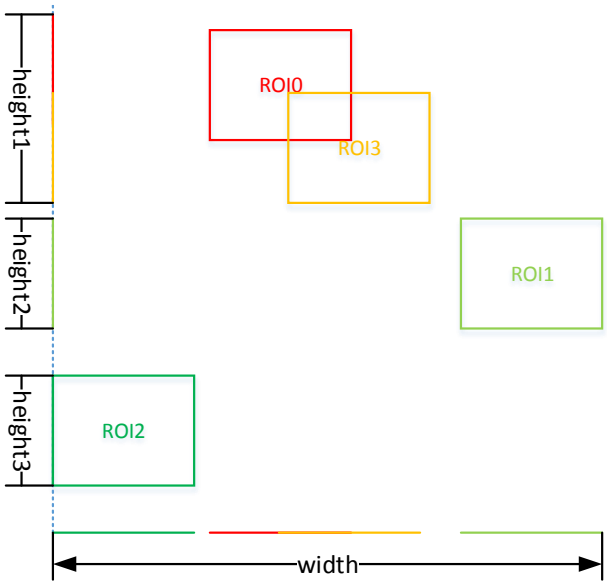


Figure2- 11: Equivalent width and equivalent height

Multi-ROI camera can be switched between multiple ROI mode and single ROI mode, it can be switched only in stop acquisition mode.

2.2.2.1. Single ROI mode and Configuration

In the demonstration program (GalaxyView.exe), if the user wants to use the single ROI mode, sets like this: in the "image format control" option and" ROI output mode" menu, select "SingleROISendMode". The Multi-ROI camera works in single ROI mode by default when the camera is powered on.

In single ROI mode, the user can only set Region0. If the user wants to change the parameters of Region0, in the "image format" option and pull-down menu of "Region selection", select the "Region0", then change the image width, image height, horizontal offset and vertical offset.

2.2.2.2. Multi-ROI mode and Configuration

In the demonstration program (GalaxyView.exe), if the user wants to use the multi-ROI mode, sets like this: in the "image format control" option and” ROI output model” menu, select "MultiROISendMode".

In multi-ROI mode, the MER-134-94U3x camera supports up to 4 ROIs, Region0, Region1, Region2 and Region3, which means one exposure can output 4 frame images. The height, width, horizontal offset and vertical offset of the ROI can be modified.

- Region0 setting

The Region0 cannot be closed. If the user wants to change the parameters of the Region0, in the “image format” option and pull-down menu of “Region selection”, select the “Region0”, then change the image width, image height, horizontal offset and vertical offset.

- Region1 setting

The Region1 can be set as open or close. If the user wants to close the Region1, just select “Region1” in the pull-down menu of “Region selection” in the “image format” option, and select “Off” in the pull-down menu of “Region Switch”. When the Region1 is closed, setting the image width, image height, horizontal offset and vertical offset will not have any effects.

If the user wants to open Region1, just select "Region1" in the ”image format” option, select "Region1" in the pull-down menu of " Region selection ", and select "On" in the pull-down menu of "regional switches". When the Region1 is opened, setting the image height, image width, and horizontal offset and vertical offset will enable the MER-134-93U3x camera to output the image of the corresponding region.

- Region2 setting

The Region2 can be set as open or close. If the user wants to close the Region2, just select “Region2” in the pull-down menu of “Region selection” in the “image format” option, and select “Off” in the pull-down menu of “Region Switch”. When the Region2 is closed, setting the image width, image height, horizontal offset and vertical offset will not have any effects.

If the user wants to open Region2, just select "Region2" in the ”image format” option, select "Region2" in the pull-down menu of " Region selection ", and select "On" in the pull-down menu of "regional switches". When the Region2 is opened, setting the image height, image width, and horizontal offset and vertical offset will enable the MER-134-93U3x camera to output the image of the corresponding region.

- Region3 setting

The Region3 can be set as open or close. If the user wants to close the Region3, just select “Region3” in the pull-down menu of “Region selection” in the “image format” option, and select “Off” in the pull-down menu of “Region Switch”. When the Region3 is closed, setting the image width, image height, horizontal offset and vertical offset will not have any effects.

If the user wants to open Region3, just select "Region3" in the ”image format” option, select "Region3" in the pull-down menu of " Region selection ", and select "On" in the pull-down menu of "regional switches". When the Region3 is opened, setting the image height, image width, and horizontal offset and vertical offset will enable the MER-134-93U3x camera to output the image of the corresponding region.

2.2.3. Switching Acquisition Mode

Trigger mode supports two options: **ON** and **OFF**. When trigger mode is set **OFF**, the camera works in continuous mode; when trigger mode is set **ON**, the camera works in trigger mode. It can be switched between **ON** and **OFF** any time after the camera is opened.

As shown below, switching the acquisition mode at different positions will have different results.

- **Switch acquisition mode during frame reading out**

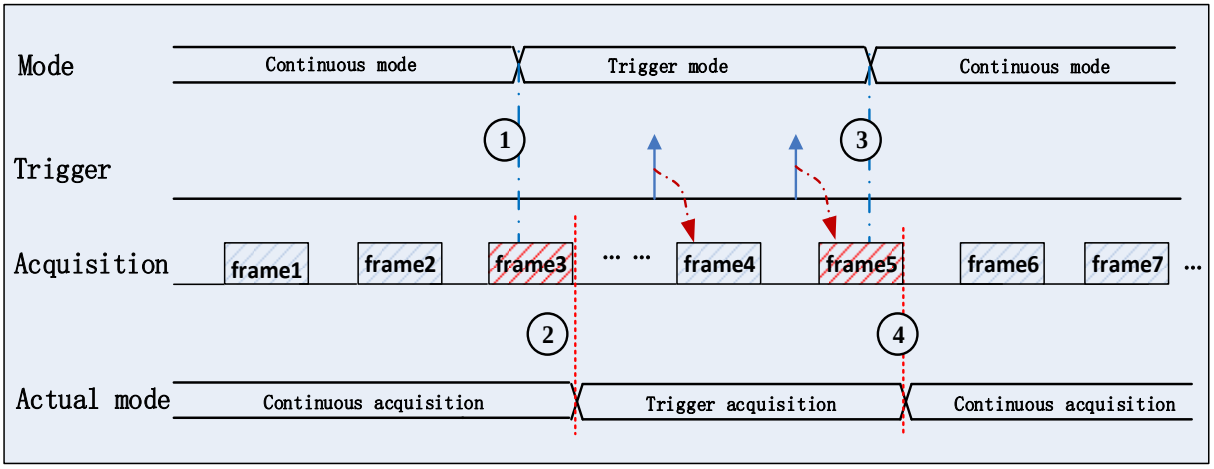


Figure2- 12: Switch acquisition mode during reading out

As shown in Figure2- 12, the camera starts with trigger mode **OFF** after receiving acquisition start command.

At point 1, the camera gets a command of setting trigger mode **ON** while transferring the 3rd frame in trigger mode OFF. The trigger mode is not active until the 3rd frame is finished, that is point 2, and then the trigger signal is also allowed. At point 3, the camera gets a command of switching back to **OFF**. It is also not active until the 5th frame is finished, it should wait a complete reading out. The camera actually switches from trigger mode to continuous mode at point 4, and then the camera works in continuous mode.

- **Switch acquisition mode during blanking (or expositing)**

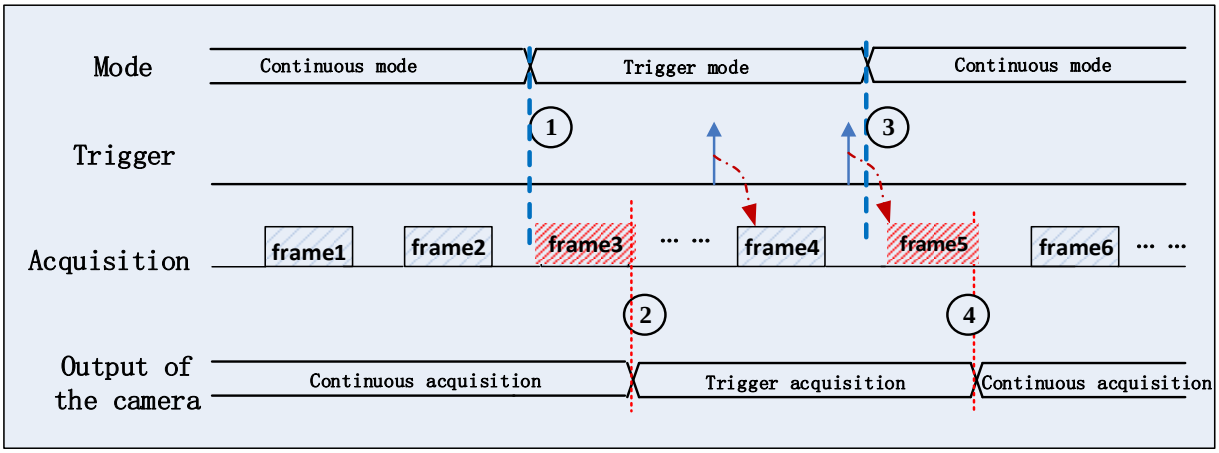


Figure2- 13: Switch acquisition mode in waiting time

As shown in Figure2- 13, the camera with trigger mode **OFF** begins after receiving an **AcquisitionStart** command.

At point 1, the camera gets a command of setting trigger mode **ON** while it is in wait state. The trigger mode is not active until the 3rd frame is finished (including exposure and reading out), i.e., point 2. Please note that the 3th frame does not belong to trigger mode. All trigger frames need trigger signals or soft-trigger commands. At point 3, the camera gets a command of switching back to continuous mode. It is also not active until the 5th frame is finished, it should wait a complete frame. The camera switches from trigger mode to continuous mode at point 4 actually, and then the camera works in continuous mode.

When switching from continuous mode to trigger mode, the trigger signal is blocked in the first 100ms after switching mode. Please make sure to send the trigger signal after 100ms. This is only required for the MER-1520-13U3c, MER-1070-14U3x and MER-1810-21U3c, not for all other models.

2.2.4. Continuous Mode and Configuration

- Continuous mode configuration

The default value of **TriggerMode** is **OFF** in default user set. If the camera is opened with default user set, the camera works in continuous mode directly. Otherwise, user can set **Trigger Mode OFF** to use continuous mode.

Other parameters also can be changed in **Trigger Mode OFF**.

- Continuous mode features

In continuous acquisition mode, the camera captures and transfers images according to camera parameter settings.

In continuous mode, ROI size, bandwidth limitation and exposure time may have effects on frame rate.

2.2.5. Software Trigger Acquisition and Configuration

- Software trigger acquisition configuration

The camera support software trigger acquisition mode. Three steps followed should be ensured.

Set the **Trigger Mode** to **ON**.

Set the **Trigger Source** to **Software**.

Send **Software Trigger** command.

All the software trigger commands are sent by the host through the USB bus, to trigger the camera to capture and transmission images.

- Software trigger acquisition features

In software trigger acquisition mode, the camera begins to acquire one image after receiving software trigger commands. In general, the number of frames is equal to the number of software trigger commands. The relative features are illustrated below:

1) In software trigger acquisition mode, if the trigger frequency is lower than permissible maximal FPS (Frame per Second) of the camera, the current frame rate is trigger frequency. If the trigger frequency is higher than permissible maximal FPS (Frame per Second) of the camera, some software triggers are ignored and the current frame rate is lower than trigger frequency.

2) The trigger delay function can control the delay interval between your triggers and the camera acquiring frames. The default value of trigger delay time is zero.

2.2.6. External Trigger Acquisition and Configuration

- External trigger acquisition configuration

The camera support external trigger acquisition mode. Three steps followed should be ensured.

Set the **Trigger Mode** to **ON**.

Set the **Trigger Source** to **Line0**.

Connect external trigger signal to Line0

If the Trigger Source is set by Line2 or Line3, it should be ensured that the corresponding Line is set as Input.

Please refer to **2.1.1** for more information of the programmable GPIO interfaces.

- Trigger acquisition features

The relative feathers about the camera's trigger signal process are illustrated below:

1) The polarity of lines can be set by **inverted** or **not inverted**; the default setting is **not inverted**.

2) Improper signal can be filtered by setting appropriate value to trigger filter. Raising edge filter and falling edge can be set separately. The range is from 0 to 5000μs. The default configuration is not use trigger filter.

3) The time interval between trigger and exposure can be through the trigger delay function. The range of time interval covers from 0 to 3000000μs. The default value of trigger delay time is zero.

The functions, like trigger polarity, trigger delay and trigger filter, can be selected in the Galaxy View.

The camera's trigger source Line0 use opto-isolated circuit to isolate signal. Its internal circuit delay trigger signal, and rising edge's delay time is longer than falling edge's. There are a dozen clock cycles delay of rising edge and dozens clock cycles delay of falling edge. If you use Line0 to trigger the camera, the positive pulse signal's positive width will be wider (about 20-40μs) and the negative pulse signal's negative width will be narrower (about 20-40μs). You can adjust filter parameter to accurately filter trigger signal.

There is small difference among there models of MER-U3x camera. These camera's different time intervals are shown below:

Camera model	GPIO delay time	opto-coupler delay time
MER-031-860U3x	Non-overlap/Overlap: 4μs	Non-overlap/Overlap: 8-12μs
MER-031-860U3M NIR	Non-overlap/Overlap: 4μs	Non-overlap/Overlap: 8-12μs
MER-041-436U3x	Non-overlap: 0.16μs Overlap: (0.16~4.08) μs	Non-overlap: 4.16~8.16μs Overlap: (4.16~12.08) μs
MER-050-560U3x	Non-overlap/Overlap: 4μs	Non-overlap/Overlap: 8-12μs
MER-050-560U3M NIR	Non-overlap/Overlap: 4μs	Non-overlap/Overlap: 8-12μs
MER-051-120U3x	Non-overlap: 4μs Overlap: 16.3-29.4μs	Non-overlap: 8-12μs Overlap: 20.3-37.4μs
MER-131-210U3x	Non-overlap: 4μs Overlap: 25-32μs	Non-overlap: 8-12μs Overlap: 30-40μs
MER-131-210U3M NIR	Non-overlap: 4μs Overlap: 25-32μs	Non-overlap: 8-12μs Overlap: 30-40μs
MER-132-43U3x	Non-overlap: 0.55μs Overlap: (0.55~24.1) μs	Non-overlap: 4.55~8.55μs Overlap: (4.55~32.1) μs
MER-133-54U3x	183μs	187μs ~191μs
MER-134-93U3x	Non-overlap: 4μs Overlap: 27.6-37.9μs	Non-overlap: 8-12μs Overlap: 31.6-45.9μs
MER-160-227U3x	Non-overlap: 0.16μs Overlap: (0.16~8) μs	Non-overlap: 4.16~8.16μs Overlap: (4.16~16) μs
MER-230-168U3x	Non-overlap: 0.16μs Overlap: (0.16~9.76) μs	Non-overlap: 4.16~8.16μs Overlap: (4.16~17.76) μs
MER-231-41U3x	Non-overlap: 0.16μs Overlap: (0.16~20) μs	Non-overlap: 4.16~8.16μs Overlap: (4.16~28) μs
MER-301-125U3x	Non-overlap: 0.16μs Overlap: (0.16~10.29) μs	Non-overlap: 4.16~8.16μs Overlap: (4.16~18.29) μs
MER-302-56U3x	Non-overlap: 0.16μs Overlap: (0.16~11.44) μs	Non-overlap: 4.16~8.16μs Overlap: (4.16~19.44) μs
MER-500-14U3x	Non-overlap: 292μs Overlap: 292±36μs	Non-overlap: 296-300μs Overlap: 296-300±36μs
MER-502-79U3x	Non-overlap: 0.16μs Overlap: (0.16~12.27) μs	Non-overlap: 4.16~8.16μs Overlap: (4.16~20.27) μs
MER-502-79U3M POL	Non-overlap: 0.16μs Overlap: (0.16~12.27) μs	Non-overlap: 4.16~8.16μs Overlap: (4.16~20.27) μs
MER-503-36U3x	Non-overlap: 0.16μs Overlap: (0.16~13.44) μs	Non-overlap: 4.16~8.16μs Overlap: (4.16~21.44) μs
MER-630-60U3x	BayerRG8/Mono8:2357us BayerRG10/Mono10:2707us	BayerRG8/Mono8:2361-2365us BayerRG10/Mono10:2711-2715us
MER-1070-14U3x	5250±25μs	5254-5258±25μs
MER-1520-13U3c	5800±150μs	5804-5808±150μs
MER-1810-21U3c	BayerGR8:2.7ms BayerGR12:3.3ms	BayerGR8:2.7ms BayerGR12:3.3ms
MER-2000-19U3x	BayerRG8/Mono8:800us BayerRG12/Mono12:1550us	BayerRG8/Mono8:804-808us BayerRG12/Mono12:1554-1558us

Table2- 2: Different time intervals of MER-U3x series Camera

2.2.7. Set Exposure

- Global Shutter

Model	Sensor Type
MER-031-860U3X/MER-031-860U3M NIR/ MER-041-436U3x/MER-050-560U3x/ MER-050-560U3M NIR/ MER-051-120U3x/MER-131-210U3x/ MER-131-210U3M NIR/ MER-132-43U3x/MER-133-54U3x/ MER-134-93U3x/ MER-160-227U3x/MER-230-168U3x/ MER-231-41U3x/MER-301-125U3x/MER-302-56U3x/ MER-502-79U3x//MER-502-79U3M POL/MER-503-36U3x	Global Shutter

Table2- 3: Global Shutter camera models

The implementation process of global shutter sensor is as shown in Figure2- 14, all the lines of the sensor are exposed at the same time, and then the sensor will read out the image date one by one.

The advantage of the global shutter sensor is that all the lines are exposed at the same time, and the images do not appear offset and distortion when capturing moving objects.

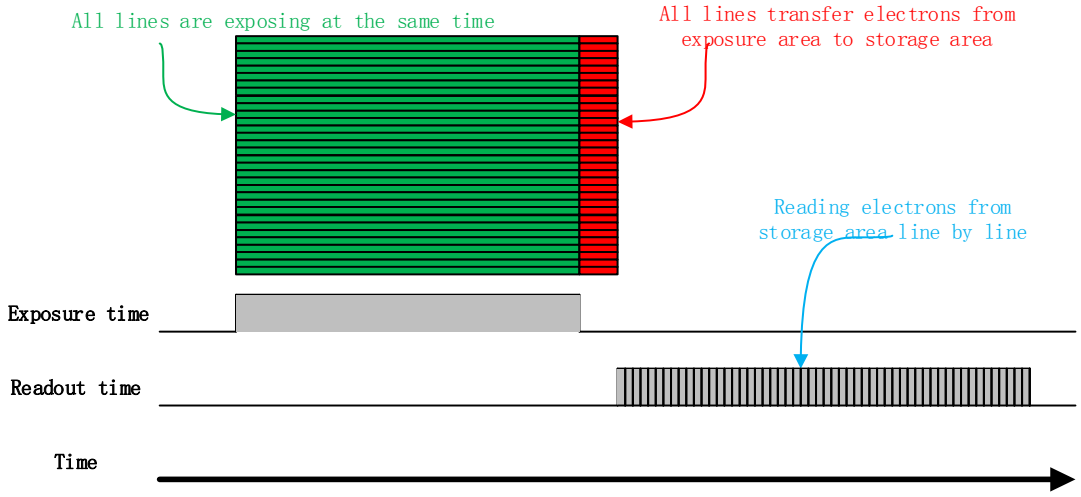


Figure2- 14: Global Shutter

- Electronic Rolling Shutter

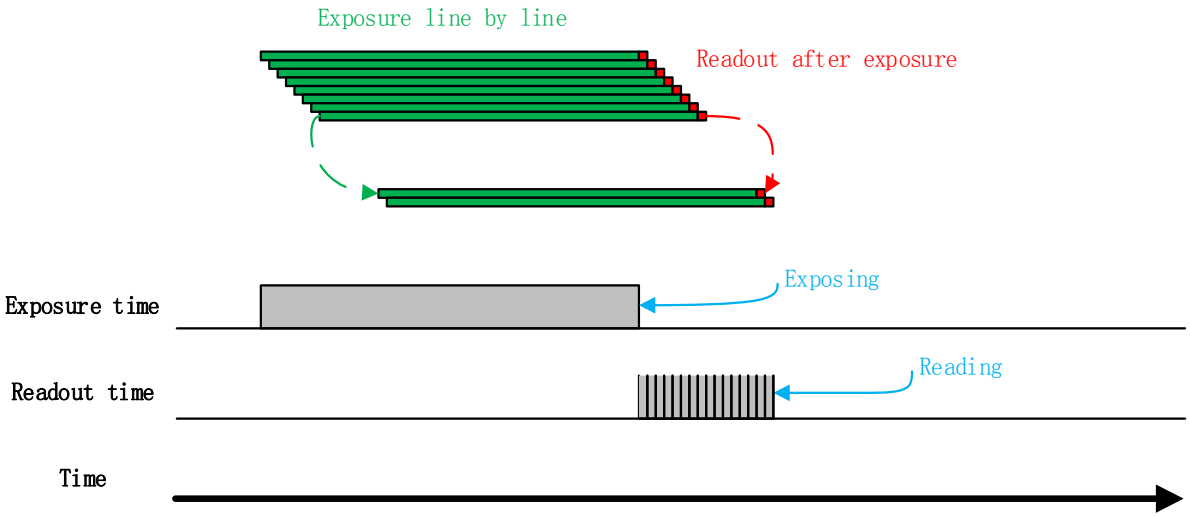


Figure2- 15: Electronic rolling shutter

Model	Sensor Type
MER-500-14U3x/MER-1070-14U3x/ MER-1520-13U3c/MER-1810-21U3c MER-630-60U3x/MER-2000-19U3x	Electronic rolling shutter

Table2- 4: Electronic rolling shutter camera models

The implementation process of electronic rolling shutter sensor is as shown in Figure2- 15, different from the global shutter, electronic rolling shutter exposures from the first line, and starts the second line exposure after a row period. And so on, after N-1 line, the N line starts exposing. When the first line exposure ends, it begins to read out the data, and it need a row period time to read out one line (including the line blanking time). When the first line reads out completely, the second line just begins to read out, and so on, when the n-1 line is read out, the N line begins to read out, until the whole image is read out completely.

- Setting the exposure time

The MER-U3x series camera supports setting the exposure time, step: 1μs. The exposure time is shown as follows:

Model	Exposure Mode	Exposure Time Range(μs)	Steps(μs)
MER-031-860U3X	Global Shutter	20-1000000	1
MER-031-860U3M NIR	Global Shutter	20-1000000	1
MER-041-436U3X	Global Shutter	20-1000000	1
MER-050-560U3X	Global Shutter	20-1000000	1
MER-050-560U3M NIR	Global Shutter	20-1000000	1
MER-051-120U3x	Global Shutter	5-1000000	1
MER-131-210U3X	Global Shutter	20-1000000	1
MER-131-210U3M NIR	Global Shutter	20-1000000	1
MER-132-43U3X	Global Shutter	20-1000000	1

MER-133-54U3x	Global Shutter	20-1000000	1
MER-134-93U3x	Global Shutter	5-1000000	1
MER-160-227U3x	Global Shutter	20-1000000	1
MER-230-168U3X	Global Shutter	20-1000000	1
MER-231-41U3X	Global Shutter	20-1000000	1
MER-301-125U3X	Global Shutter	20-1000000	1
MER-302-56U3X	Global Shutter	20-1000000	1
MER-500-14U3X	Electronic Rolling Shutter	36-1000000	1
MER-502-79U3X	Global Shutter	20-1000000	1
MER-502-79U3M POL	Global Shutter	20-1000000	1
MER-503-36U3X	Global Shutter	20-1000000	1
MER-630-60U3x	Electronic Rolling Shutter	8-1000000	1
MER-1070-14U3X	Electronic Rolling Shutter	24-1000000	1
MER-1520-13U3C	Electronic Rolling Shutter	22-1000000	1
MER-1810-21U3C	Electronic Rolling Shutter	20-1000000	1
MER-2000-19U3X	Electronic Rolling Shutter	12-1000000	1

Table2- 5: Exposure Time of MER-U3x series camera

When the external light source is sunlight or direct current (DC), the MER series USB interface camera has no special requirements for the exposure time. When the external light source is alternating current (ac), the exposure time must synchronize with the external light source (under 50Hz light source, the exposure time must be a multiple of 1/100s, under 60Hz light source, the exposure time must be a multiple of 1/120s), to ensure better image quality. You can set the exposure time that is synchronized with the external light source by using the demo or interface function.

The MER-U3x series camera supports automatic exposure function. If the automatic exposure function is enabled, the camera can adjust the exposure time automatically according to the environment brightness. See 0 section for more details.

2.2.8. Overlap exposure and Non-overlap exposure

There are two stages in image acquisition of the MER-U3x series camera: exposure and readout. Once the camera is triggered, it begins to integrate and when the integration is over, the image data will be read out immediately.

The MER-U3x series camera supports two exposure modes: overlap exposure and non-overlap exposure. The user cannot assign the overlap exposure or non-overlap exposure directly, it depends on the frequency of trigger signal and the exposure time. The two exposure mode are described as below:

- Non-overlap exposure

In non-overlap exposure mode, after the exposure and readout of the current frame are completed, the next frame will expose and read out. As shown in the Figure2- 16, the N frame is read out, after a period of time, the N+1 frame to be exposed.

The computational formula of non-overlap exposure frame period:

non-overlap exposure frame period > exposure time + readout time

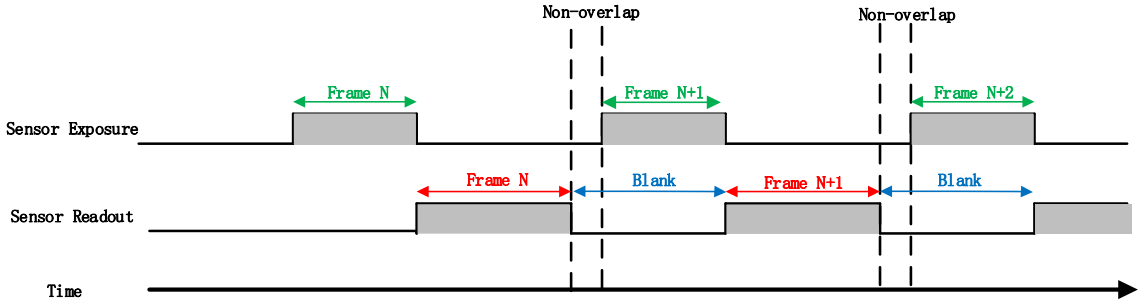


Figure2- 16: The exposure sequence diagram in non-overlap exposure mode

- Trigger acquisition mode in non-overlap exposure mode

If the trigger delay is greater than the sum of the exposure time and readout time, it will not occur overlap exposure, as shown in Figure2- 17.

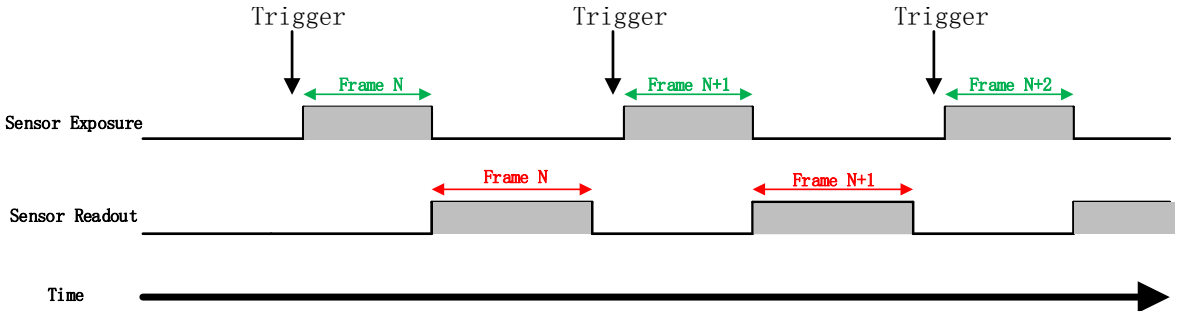


Figure2- 17: The trigger acquisition exposure sequence diagram in non-overlap exposure mode

- Overlap exposure

In overlap exposure mode, the current frame image exposure process is overlap with the readout of the previous frame. That is, when the previous frame is reading out, the next frame image has been started exposure. As shown in the Figure2- 18, when the N frame image is reading out, the N+1 frame image has been started exposure.

The computational formula of overlap exposure frame period:

overlap exposure frame period ≤ exposure time + readout time

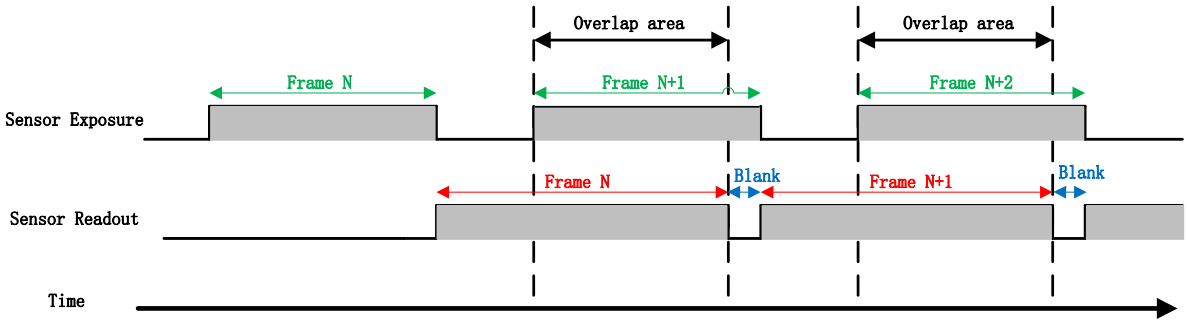


Figure2- 18: The exposure sequence diagram in overlap exposure mode

- Continuous acquisition mode

If the exposure time is greater than the frame blanking time, the exposure time and the readout time will be overlapped. As shown in the Figure2- 18.

- Trigger acquisition mode in overlap exposure mode

When the interval between two triggers is less than the sum of exposure time and the readout time, it will occur overlap exposure, as shown in Figure2- 19.

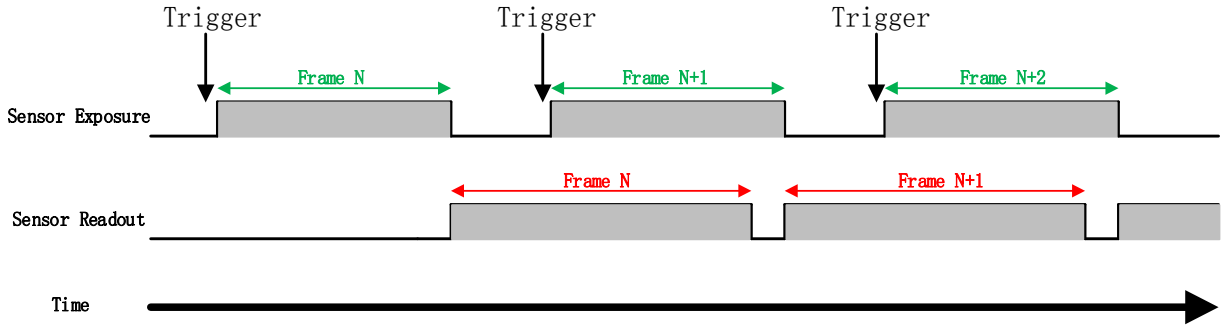


Figure2- 19: The trigger acquisition exposure sequence diagram in overlap exposure mode

Compared with non-overlap exposure mode, in overlap exposure mode, the camera can obtain higher frame rate.

MER-133-54U3x,MER-630-60U3x, MER-1070-14U3x, MER-1520-13U3c, MER-1810-21U3c, MER-2000-19U3x,these cameras only support non-overlap exposure in trigger mode. When the trigger delay is less than the frame period, some trigger signals will be shield.

2.2.9. Strobe

Strobe is one of the ways to adjust the brightness of the image, which is a lot different from a global shutter camera and an electronic rolling shutter camera, especially in strobe control.

All the lines of the global shutter camera are exposed at the same time, and it is simple to supplement light, and the camera can get the same brightness images as long as the strobe is light during the exposure of the camera.

The Global shutter sensors of MER-U3x series camera are as follows models:

Model	Sensor Type
MER-031-860U3X/MER-031-860U3M NIR/ MER-041-436U3x/MER-050-560U3x/ MER-050-560U3M NIR/ MER-051-120U3x/MER-131-210U3x/ MER-131-210U3M NIR/MER-132-43U3x/MER-133-54U3x/ MER-134-93U3x// MER-160-227U3x MER-230-168U3x/ MER-231-41U3x/MER-301-125U3x/MER-302-56U3x /MER-502-79U3x/ MER-502-79U3M POL/MER-503-36U3x	Global Shutter

Table2- 6: Global Shutter camera models

Because all the lines of Electronic rolling shutter camera are exposed not at the same time, it is difficult to use flash light. The strobe is light only during all the lines at the same time exposure and no photons into the sensor at the other time, the camera can get consistent brightness image. If the strobe is light too early, the image above will be bright, if the strobe is delay to extinguish, the image below will brighter.

The following figure identifies the moment when the MER-500-14U3x electronic rolling shutter camera exposing:

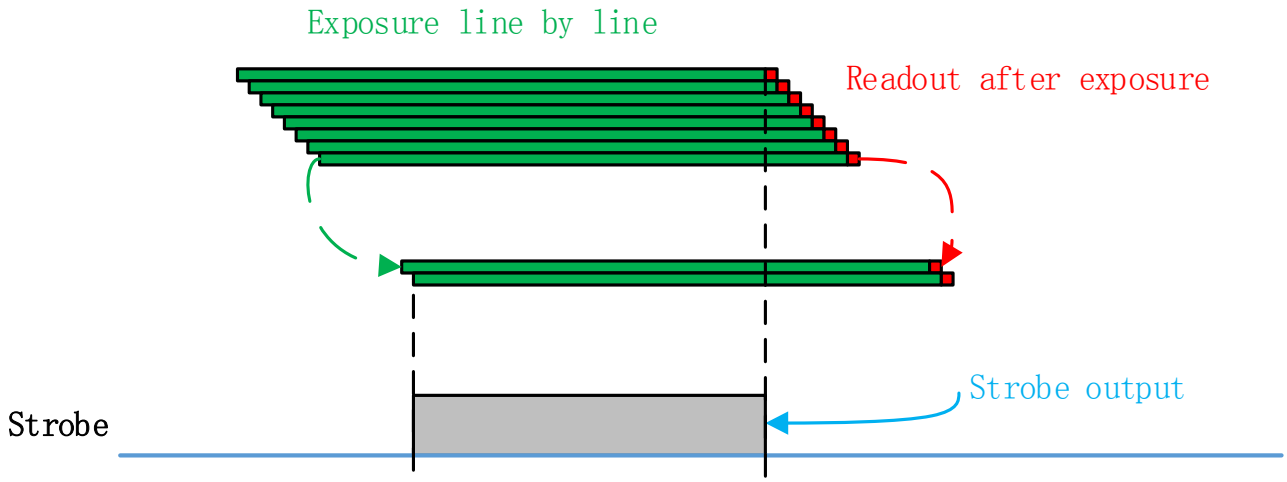


Figure2- 20: The exposing moment of MER-500-14U3x camera

The MER-500-14U3x camera output a strobe signal when all the lines are exposed at the same time, and does not output the strobe signal at other stages. Therefore, when the exposure time is less than the preset frame period (approximately equal to readout time), there is no strobe output, and the flash light is off.

Example:

When the camera is at the full resolution, the bandwidth limit is closed, if set the exposure time as 100ms, then the preset frame period is about 71.5ms, the signal width of strobe is 28.5ms, if change the exposure time to 70ms, then no strobe signal output, because all the lines are not exposed at the same time.

2.3. Basic Features

2.3.1. Gain

The MER-U3x series camera can adjust the analog gain, and the range of analog gain is as follows:

Model	Adjustment range	Default/Steps
MER-031-860U3x	0-16dB	0dB, 0.1dB
MER-031-860U3M NIR	0-16dB	0dB, 0.1dB
MER-041-436U3x	0-24dB	0dB, 0.1dB
MER-050-560U3x	0-16dB	0dB, 0.1dB
MER-050-560U3M NIR	0-16dB	0dB, 0.1dB
MER-051-120U3x	0-16dB	0dB, 0.1dB
MER-131-210U3x	0-16dB	0dB, 0.1dB
MER-131-210U3M NIR	0-16dB	0dB, 0.1dB
MER-132-43U3x	0-25dB	0dB, 0.1dB
MER-133-54U3x	0-31dB	0dB, 0.1dB
MER-134-93U3x	0-16dB	0dB, 0.1dB
MER-160-227U3x	0-24dB	0dB, 0.1dB
MER-230-168U3x	0-24dB	0dB, 0.1dB
MER-231-41U3x	0-24dB	0dB, 0.1dB
MER-301-125U3x	0-24dB	0dB, 0.1dB
MER-302-56U3x	0-24dB	0dB, 0.1dB
MER-500-14U3x	0-17dB	0dB, 0.1dB
MER-502-79U3x	0-24dB	0dB, 0.1dB
MER-502-79U3M POL	0-24dB	0dB, 0.1dB
MER-503-36U3x	0-24dB	0dB, 0.1dB
MER-630-60U3x	0-24dB	0dB, 0.1dB
MER-1070-14U3x	0-25.9dB	0dB, 0.1dB
MER-1520-13U3c	0-22.5dB	0dB, 0.1dB
MER-1810-21U3c	0-20dB	0dB, 0.1dB
MER-2000-19U3x	0-24dB	0dB, 0.1dB

Table2- 7: Analog gain of MER-U3x series camera

When the analog gain changes, the response curve of the camera changes, as shown in Figure2- 21. The horizontal axis represents the output signal of the sensor in the camera, and the vertical axis represents the gray value of the output image. When the amplitude of the sensor output signal remains constant, increasing the gain makes the response curve steeper, and that makes the image brighter. For every 6dB increases of the gain, the gray value of the image will double. For example, when the camera has a gain of 0dB, the image gray value is 126, and if the gain is increased to 6dB, the image gray will increase to 252. Note that increasing the analog gain or digital gain will amplify the image noise.

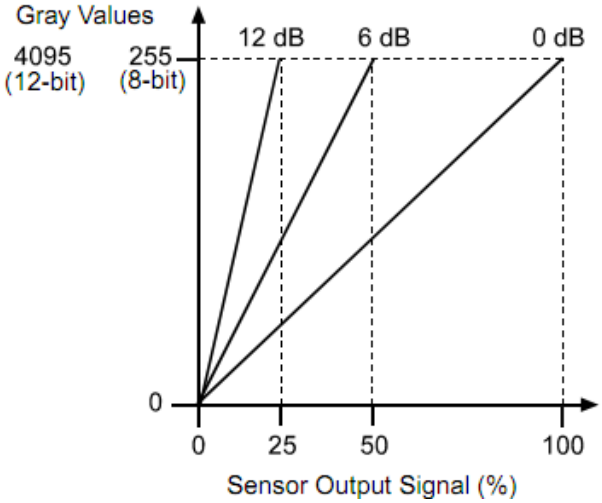


Figure2- 21: The cameras response curve

2.3.2. Pixel Format

By setting the pixel format, the user can select the format of output image data. The available pixel formats depend on the camera model and whether the camera is monochrome or color. The following table shows the pixel format supported by the camera.

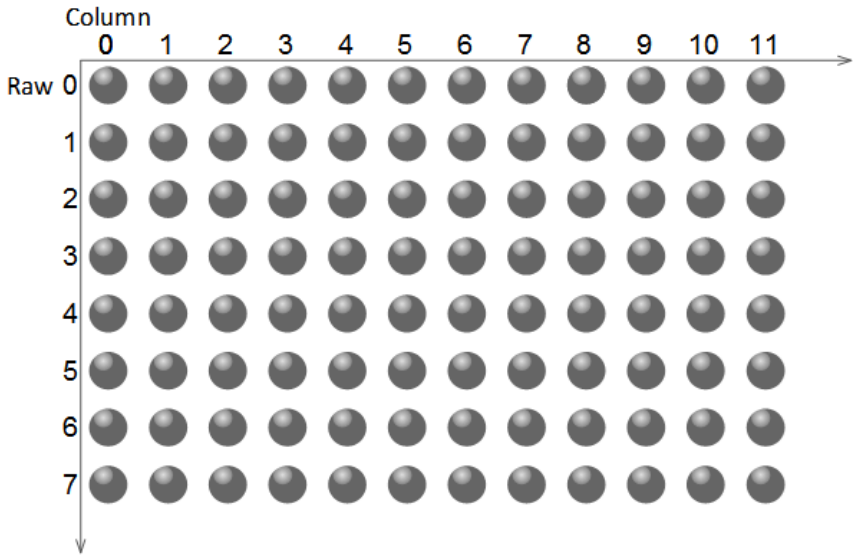
Model	Pixel Format
MER-031-860U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-031-860U3M NIR	Mono8, Mono10
MER-041-436U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-050-560U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-050-560U3M NIR	Mono8, Mono10
MER-051-120U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-131-210U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-131-210U3M NIR	Mono8, Mono10
MER-132-43U3x	Mono8, Mono12, BayerRG8, BayerRG12
MER-133-54U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-134-93U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-160-227U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-230-168U3x	Mono8, Mono10, BayerRG8, BayerRG10

MER-231-41U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-301-125U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-302-56U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-500-14U3x	Mono8, Mono10, BayerGR8, BayerGR10
MER-502-79U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-502-79U3M POL	Mono8, Mono10
MER-503-36U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-630-60U3x	Mono8, Mono10, BayerRG8, BayerRG10
MER-1070-14U3x	Mono8, Mono12, BayerGR8, BayerGR12
MER-1520-13U3c	BayerGR8, BayerGR12
MER-1810-21U3c	BayerGR8, BayerGR12
MER-2000-19U3x	Mono8, Mono12, BayerRG8, BayerRG12

Table2- 8: Pixel Format that the MER-U3x series camera supported

The image data starts from the upper left corner, and each pixel outputs the brightness value of each pixel line from left to right and from top to bottom.

- Mono8



When the pixel format is set to Mono8, the brightness value of each pixel is 8bits. The format in the memory is as follows:

Y00	Y01	Y02	Y03	Y04	……
Y10	Y11	Y12	Y13	Y14	……
……					

Among them Y00, Y01, Y02 … are the gray value of each pixel that starts from the first row of the image. Then the gray value of the second row pixels of the images is Y10, Y11, and Y12…

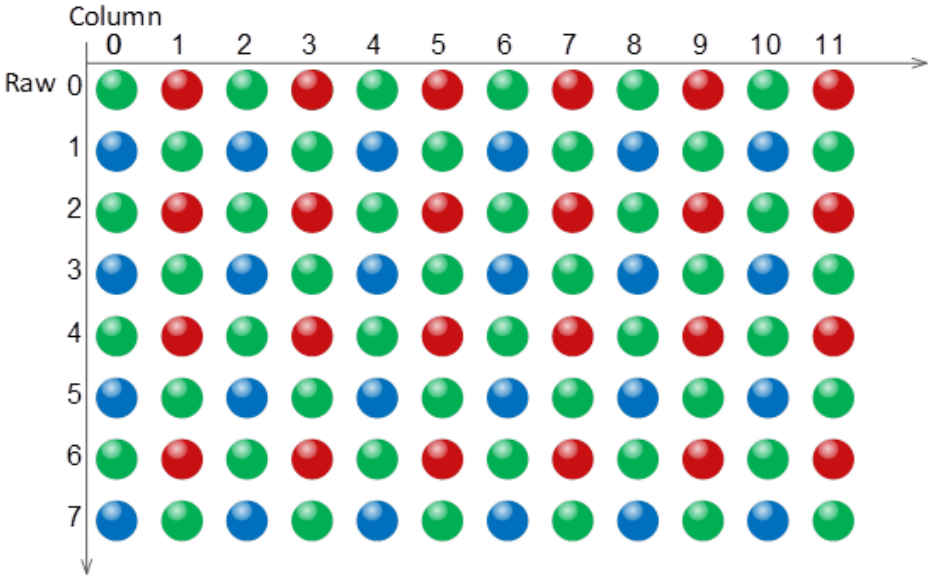
- Mono10/12

When the pixel format is set to mono10/12, each pixel value in the output image of the camera is 16bits, and the effective data of the mono10/12 format is 10/12bits, and the high 6/4 bit is complemented with 0. Note that the brightness value of each pixel contains two bytes, arranged in little-endian mode. The format is as follows:

Y00	Y01	Y02	Y03	Y04	……
Y10	Y11	Y12	Y13	Y14	……
……					

Among them Y00, Y01, Y02…are the gray value of each pixel that start with the first line of the image. The first byte of each pixel is low 8bits of brightness, and the second byte of each pixel is high 8bits of brightness.

- BayerGR8



When the pixel format is set to BayerGR8, the value of each pixel in the output image of the camera is 8bits. According to the location difference, the three components of red, green and blue are respectively represented. The format in the memory is as follows:

G00	R01	G02	R03	G04	……
B10	G11	B12	G13	B14	……
……					

Where G00 is the first pixel value of the first row (for the green component), R01 represents the second pixel value (for the red component), and so on, so that the first row pixel values are arranged. B10 is the first pixel value of the second row (for the blue component), the G11 is the second pixel value (for the green component), and so on, and the second row of pixel values are arranged.

- BayerGR10/12

When the pixel format is set to BayerGR10/12, the value of each pixel in the output image of the camera is 16bits. The effective data of BayerGR10/12 format is 10/12bits, and the high 6/4 bit is complemented

with 0. According to the location difference, the three components of red, green and blue are respectively represented. The format in the memory is as follows:

G00	R01	G02	R03	G04	……
B10	G11	B12	G13	B14	……
……					

Each pixel is the same as BayerGR8, the difference is that each pixel is made up of two bytes, the first byte is the low 8bits of the pixel value, and the second byte is the high 8bits of the pixel value.

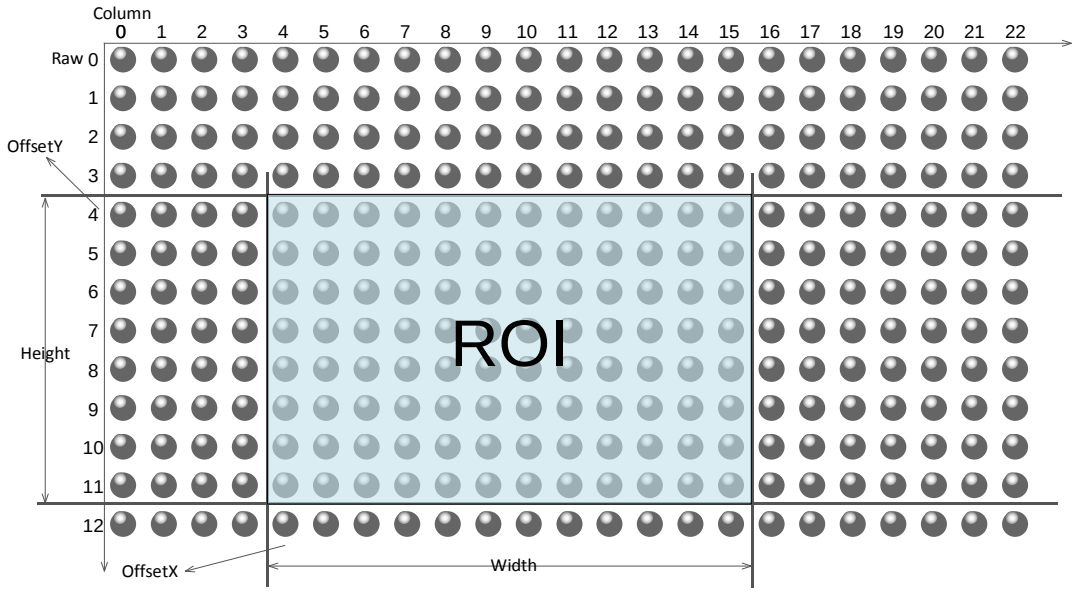
When changing the pixel format, the device should stop acquisition.

2.3.3. ROI

By setting the ROI of the image, the camera can transmit the specific region of the image, and the output region's parameters include horizontal offset, vertical offset, width and height of the output image. The camera only reads the image data from the sensor's designated region to the memory, and transfer it to the host, and the other regions' image of the sensor will be discarded.

By default, the image ROI of the camera is the full resolution region of the sensor. By changing the horizontal offset, vertical offset, width and height, the location and size of the image ROI can be changed. The horizontal offset refers to the starting column of the ROI, and the vertical offset refers to the starting row of the ROI. The step length of horizontal offset and width is 4, and the step length of vertical offset and height is 2.

The coordinates of the ROI of the image are defined as the 0th line and 0th column as the origin of the upper left corner of the sensor. As shown in the figure, the horizontal offset of the ROI is 4, the vertical offset is 4, the height is 8 and the width is 12.



When reducing the height of the ROI, the maximum frame rate of the camera will be raised. Please refer to section 2.4.1 for specific effects on the acquisition frame rate.

When setting the ROI of the image, the device should stop acquisition.

2.3.4. Auto Exposure/Auto Gain

2.3.4.1. ROI setting of Auto Exposure/Auto Gain

For auto exposure and auto gain, you can specify a portion of the sensor array and only the pixel data from the specified portion will be used for auto function control.

AAROI is defined by the following way:

AAROIOffsetX: The offset of the X axis direction.

AAROIOffsetY: The offset of the Y axis direction.

AAROIWidth: The width of ROI.

AAROIHeight: The height of ROI.

Offset is the offset value that relative to the upper left corner of the image. The step length of X axis direction offset and width is 4, the step length of Y axis direction offset and height is 2. The ROI setting depends on the current image size and cannot exceed the current image range. That is to say, assuming the current image width is Width, the image height is Height, then the ROI setting need to meet the condition 1:

$$\mathrm{AAROIWidth} + \mathrm{AAROIOffsetX} \leq \mathrm{Width}$$

$$\mathrm{AAROIHeight} + \mathrm{AAROIOffsetY} \leq \mathrm{Height}$$

If not meet the condition 1, the user cannot set the ROI.

The default value of ROI is the entire image, you can set the ROI as your need. Where the minimum value of can be set to 16, and the maximum value is equal to the current image width. The minimum value of can be set to 16, and the maximum value is equal to the current image height, they are all need to meet the condition1.

For example: the current image width is 1024, the height is 1000, and then the ROI setting is:

$$\mathrm{AAROIOffsetX} = 100\ ;$$

$$\mathrm{AAROIOffsetY} = 50\ ;$$

$$\mathrm{AAROIWidth} = 640\ ;$$

$$\mathrm{AAROIHeight} = 480\ ;$$

The relative position of the ROI and the image is shown in Figure2- 22.

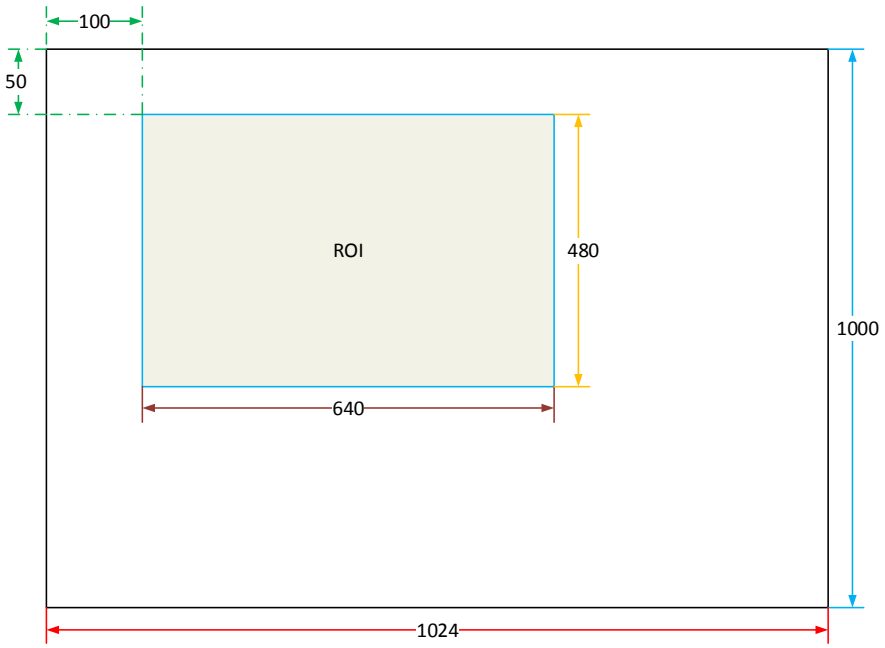


Figure2- 22: An example for the relative position between the ROI and the current image

2.3.4.2. Auto Gain

The auto gain function can adjust the camera's gain automatically, so that the average gray value in AAROI is achieved to the expected gray value. The auto gain can be controlled by "Once" and "Continuous" mode.

When using the "Once" mode, the camera adjusts the image data in the AAROI to the expected gray value once, then the camera will turn off the auto gain function. When using the "Continuous" mode, the camera will continuous adjust the gain value according to the data of the AAROI, so that the data in the AAROI is kept near to the expected gray level.

The expected gray value is set by the user, and it is related to the data bit depth. For 8bit pixel data, the expected gray value range is 0-255, and for 10bit pixel data, the expected gray value range is 0-1023.

The camera adjusts the gain value in the range [minimum gain value, maximum gain value] which is set by the user.

The auto gain function can be used with the auto exposure at the same time, at this moment, the exposure is adjusted first, that is: when the exposure time reaches the maximum which is set by the user, then the gain starts to adjust.

2.3.4.3. Auto Exposure

The auto exposure function can adjust the camera's exposure time automatically, so that the average gray value in AAROI can achieve to the expected gray value. The auto exposure can be controlled by "Once" and "Continuous" mode.

When using the "Once" mode, the camera adjusts the image data in the AAROI to the expected gray value once, then the camera will close the auto exposure function. When using the "Continuous" mode, the camera will continuous adjusting the exposure time according to the data of the AAROI, so that the data in the ROI is kept near to the expected gray level.

The expected gray value is set by the user and it is related to the data bit depth. For 8bit pixel data, the expected gray value range is 0-255, for 10bit pixel data, the expected gray value range is 0-1023, and for 12bit pixel data, the expected gray value range is0-4095.

The camera adjusts the exposure time within the range [minimum exposure time, maximum exposure time] which is set by the user.

The auto exposure function can be used with the auto gain at the same time, at this moment, the exposure is adjusted first, that is: when the exposure time reaches the maximum which is set by the user, then the gain starts to adjust.

2.3.5. Auto White Balance

2.3.5.1. Auto White Balance ROI

Auto White Balance function use the image data of the “white dot” area (ROI) to calculate the white balance coefficient, and then use the coefficient to handle the components of the image, in order to make the R/G/B component the same in the ROI.

ROI is defined in the following way:

AWBROIOffsetX: The offset of the X axis direction.

AWBROIOffsetY: The offset of the Y axis direction.

AWBROIWidth: The width of ROI.

AWBROIHeight: The height of ROI.

Offset is the offset value that relative to the upper left corner of the image. Where the step length of X axis direction offset and width is 4, the step length of Y axis direction offset and height is 2. The ROI setting depends on the current image and cannot exceed the current image range. That is to say, assuming the current image width is Width, the image height is Height, then the ROI setting need to meet the following condition 2:

$$\mathrm{AWBROIWidth} + \mathrm{AWBROIOffsetX} \leq \mathrm{Width}$$

$$\mathrm{AWBROIHeight} + \mathrm{AWBROIOffsetY} \leq \mathrm{Height}$$

If not meet the condition 2, the user cannot set the ROI.

The default value of ROI is the entire image, you can set the “white dot” area (ROI) according to your need. Where the minimum value of AWBROIWidth can be set is 16, the maximum value is equal to the current image width; the minimum value of AWBROIHeight can be set is 16, the maximum value is equal to the current image height, they are all need to meet the condition2.

Assuming the current image width is 1024, the height is 1000, and then the “white dot” area ROI setting is:

$$\mathrm{AWBROIOffsetX} = 100;$$

$$\mathrm{AWBROIOffsetY} = 50;$$

$$\mathrm{AWBROIWidth} = 640;$$

$$AWBROIHeight = 480;$$

The relative position of the ROI and the image is shown in Figure2- 23.

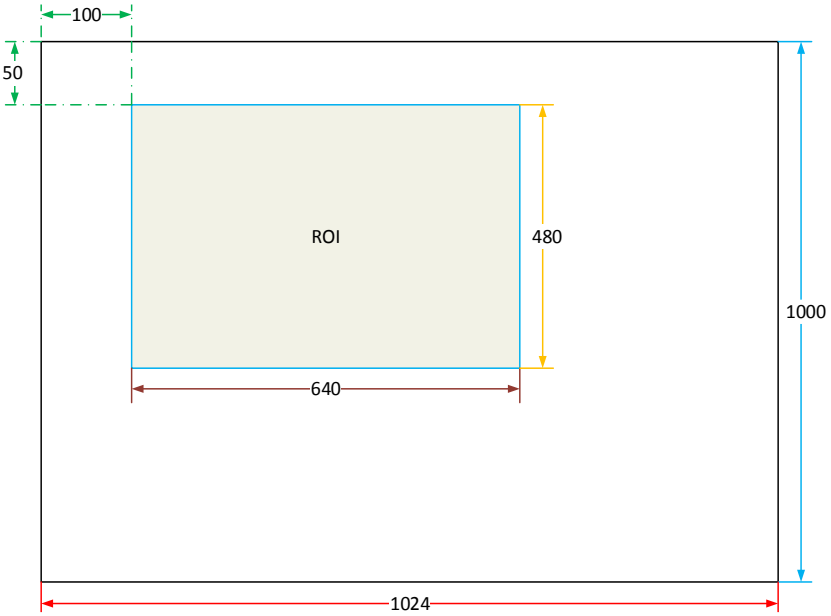


Figure2- 23: An example for the relative position between the ROI and the current image

2.3.5.2. Auto White Balance

Auto White Balance function use the image data of the “white dot” area (ROI) to calculate the white balance coefficient, and then use the coefficient to handle the components of the image, in order to make the R/G/B component the same in the ROI. The auto white balance function is only available on color sensors.

The auto white balance can be controlled by “Once” and “Continuous” mode.

When using the “Once” mode, the camera just adjusts the white balance once, when using the “Continuous” mode, the camera continuously adjusts the white balance coefficient based on the data in ROI.

The auto white balance function can also select the color temperature. When the color temperature of the selection is “Adaptive”, the data in ROI always adjusting the red, green and blue to the same. When selecting the specific color temperature, the camera will adjust the coefficient according to the light source, so that the hue of the ROI is the same as the hue of the light source. That is, high temperature is cold, low color temperature is warm.

2.3.6. TestPattern

The MER-U3x series camera supports three test images: gray gradient test image, moving diagonal gray gradient test image, and static diagonal gray gradient test image. When the camera captures in 10bit mode, the gray value of test image is: the pixel gray value in 8bit mode multiplies by 4, as the output of pixel gray value in 10bit mode.

The following three test images are illustrated in the 8bit mode.

- GrayFrameRampMoving

In the gray gradient test image, all the pixels' gray values are the same in the frame. In the adjacent frame, the gray value of the next frame increases by 1 compared to the previous frame, until to 255, and then the next frame gray value returns to 0, and so on. A printscreen of a single frame is shown in Figure2- 24:

Figure2- 24: Gray gradient test image

- SlantLineMoving

In the moving diagonal gray gradient test image, the first pixel value of adjacent row in each frame increases by 1, until the last row. When the pixel gray value increases to 255, the next pixel gray value returns to 0. The first pixel gray value of adjacent column increases by 1, until the last column. When the pixel gray value increases to 255, the next pixel gray value returns to 0.

In the moving diagonal gray gradient test image, in the adjacent frame, the first pixel gray value of the next frame increases by 1 compared to the previous frame. So, in the dynamic image, the image is scrolling to the left. A printscreen of the moving diagonal gray gradient test image is shown in Figure2- 25.

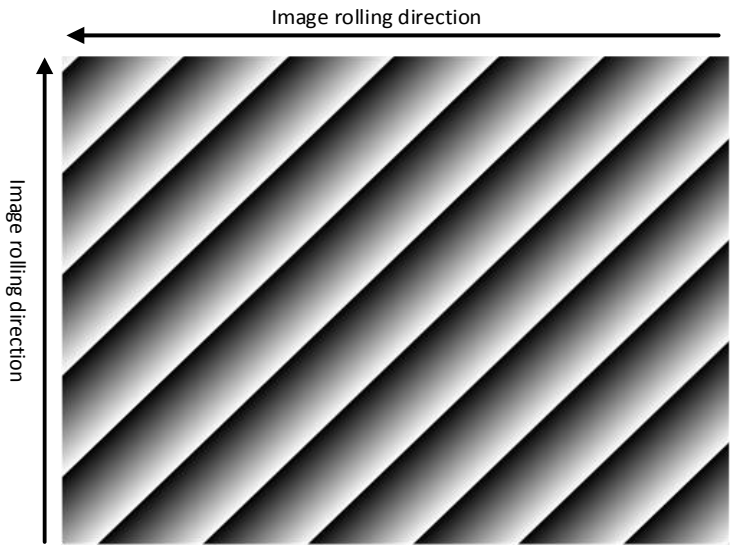


Figure2- 25: Moving diagonal gray gradient test image

- SlantLine

In the static diagonal gray gradient test image, the first pixel gray value is 0, the first pixel gray value of adjacent row increases by 1, until the last row. When the pixel gray value increases to 255, the next pixel gray value returns to 0. The first pixel gray value of adjacent column increases by 1, until the last column. When the pixel gray value increases to 255, the next pixel gray value returns to 0.

Compared to the moving diagonal gray gradient test image, in the adjacent image of the static diagonal gray gradient test image, the gray value in the same position remains unchanged. A printscreen of the static diagonal gray gradient test image is shown in Figure2- 26.

Figure2- 26: Static diagonal gray gradient test image

2.3.7. User Set Control

By setting various parameters of the camera, the camera can perform the best performance in different environments. There are two ways to set parameters: one is to modify the parameters manually, and the other is to load parameter set. In order to save the specific parameters of the users, avoiding to set the parameters every time you open the camera, the MER-U3x series camera provides a function to save the parameter set, can easily save the parameters that the user use, including the control parameters that the camera needed. There three types of configuration parameters: the currently effective configuration parameters, the vendor default configuration parameters (Default), and the user configuration parameters (UserSet0).

Three operations can be performed on the configuration parameters, including save parameters (UserSetSave), load parameters (UserSetLoad), and set the startup parameter set (UserSetDefault). The UserSetSave is to save the effective configuration parameters to the user configuration parameter set which is set by the user. The UserSetLoad is to load the vendor default configuration parameters (Default) or the user configuration parameters (UserSet0) to the current effective configuration parameters. UserSetDefault is refer to the user can specify a set of parameters which to be loaded into the effective configuration parameters automatically when the camera is reset or powered on. And the camera can work under this set of parameters. This set of parameters can be a vendor default configuration parameters (Default) or a user configuration parameters (UserSet0).

1) The type of configuration parameters

The type of configuration parameters includes: the current effective configuration parameters, vendor default configuration parameters (Default), user configuration parameters (UserSet0).

The currently effective configuration parameters: Refers to the current control parameters used by the camera. Using API function or Demo program to modify the current control parameters of the camera is to modify the effective configuration parameters. The effective parameters are stored in volatile memory of the camera, so when the camera is reset or powered on again, the effective configuration parameters will be lost.

The vendor default configuration parameters (Default): Before the camera leaves the factory, the camera manufacturer will test the camera to assess the camera's performance and optimize the configuration parameters of the camera. The manufacturer' default configuration parameters are the camera configuration parameters optimized by the manufacture in a particular environment, these parameters are stored in the non-volatile memory of the camera, so when the camera is reset or powered on again, the effective configuration parameters will not be lost, and these parameters cannot be modified.

The user configuration parameters (UserSet0): The effective parameters are stored in volatile memory of the camera, so when the camera is reset or powered on again, the effective configuration parameters will be lost. You can store the effective configuration parameters to the user configuration parameters, the user configuration parameters are stored in the non-volatile memory of the camera, so when the camera is reset or powered on again, the user configuration parameters will not be lost. The MER-U3x series camera can store a set of user configuration parameters.

2) The operation of configuration parameters

The operations for configuration parameters include the following three types: save parameters (UserSetSave), load parameters (UserSetLoad) and set the startup parameter set (UserSetDefault).

Save parameters (UserSetSave): Save the current effective configuration parameters to the user configuration parameters. The storage steps are as follows:

a) Modify the camera's configuration parameters, until the camera runs to the user's requirements.

b) Execute the save parameters command and save the effective configuration parameters to the user parameter set.

The camera's configuration parameters which are saved in the user parameter set include:

- DeviceLinkThroughputLimitMode, DeviceLinkThroughputLimit
- OffsetX, OffsetY, Width, Height
- PixelFormat
- TestPattern
- TriggerMode, TriggerSource, TriggerPolarity, TriggerDelay
- TriggerFilterRisingEdge, TriggerFilterFallingEdge
- ExposureTime
- ExposureAuto, AutoExposureTimeMax, AutoExposureTimeMin
- AAROIOffsetX, AAROIOffsetY, AAROIWidth, AAROIHeight

- ExpectedGrayValue
- LineMode, LineInverter, LineSource, UserOutputValue
- Gain
- GainAuto, AutoGainMax,AutoGainMin
- BalanceRatio
- BalanceWhiteAuto, AWBLampHouse
- AWBROIOffsetX, AWBROIOffsetY, AWBROIWidth, AWBROIHeight
- DeadPixelCorrect
- ChunkModeActive, ChunkEnable

Load parameters (UserSetLoad): Load the vendor default configuration parameters or the user configuration parameters into the effective configuration parameters. After this operation is performed, the effective configuration parameters will be covered by the loaded parameters which are selected by the user, and the new effective configuration parameters are generated. The operation steps are as follows:

1) Select the function options of the load parameters.

2) Select the parameter set to be loaded and load the parameters.

Change startup parameter set (UserSetDefault): The user can use UserSetDefault to select Default or UserSet0 as the startup parameter set. When the camera is reset or powered on again, the parameters in the startup parameter set will be loaded into the effective configuration parameters.

2.3.8. DeviceUserID

The MER-U3x series camera provides programmable user-defined name function, the user can set a unique identification for the camera and can open and control the camera by the unique identification.

The user-defined name is a string which maximum length is 64bytes, the user can set it by the following ways:

1) Set by the GalaxyView software:

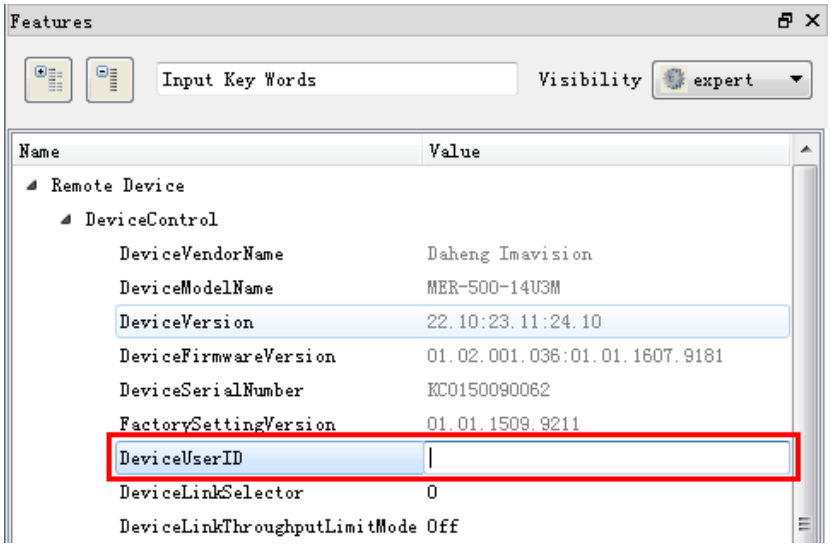


Figure2- 27: GalaxyView software

2) Set by calling the software interface, for details please see the Programmer's Guide.

When using multi-cameras at the same time, it is necessary to ensure the uniqueness of the user-defined name of each camera, otherwise, a positioning device exception will occur when the camera is opened.

2.4. Image Transmission

2.4.1. Calculate frame rate

1) Frame Period

You can calculate the frame period of the MER-U3x series camera by the following formula:

$$T_f = \mathrm{Max}\left(\frac{\mathrm{ImageSize} * 10^6}{\mathrm{BandWidth_{USB}}}, \frac{\mathrm{ImageSize} * 10^6}{\mathrm{DeviceLinkThroughputLimit}}, \mathrm{T_{acq}}, \mathrm{T_{exp}}\right)$$

Among them:

$$\mathrm{ImageSize} = \mathrm{Width} * \mathrm{Height} * \mathrm{PixelSize} + 84$$

T_f: The camera's frame period, unit: μs.

Width: The current image width.

Height The current image height.

PixelSize: The size of the pixel, in 8bit mode, the value is 1, and in 10bit/12bit mode, the value is 2.

$\mathrm{BandWidth_{USB}}$: The bandwidth of the USB interface, unit: Bps, for details please see 2.4.2 section.

DeviceLinkThroughputLimit: The limit of the device link bandwidth, unit: Bps, for details please see 2.4.3 section.

T_{acq}: The acquisition time of the camera, unit: μs, for details please see 2.4.4 section.

T_{exp}: The exposure time of the camera, unit: μs.

2) Frame rate (Unit: fps)

$$F = \frac{10^6}{T_f}$$

It is commended to use the frame rate calculate tool, the frame rate will be calculated automatically after the configuration parameters are filled.

2.4.2. USB Interface Bandwidth

The theory bandwidth of the USB interface of MER-U3x series camera is 400MBps, but actually the value decreases with the type of the USB3.0 host controller, the version of the host controller driver, the wastage of the HUB and the host performance. The user can refer the test result of the interface bandwidth in < TN-USB3.0 host controller bandwidth and CPU utilization> document.

2.4.3. DeviceLinkThroughputLimit

The MER-U3x series camera provides bandwidth limit function, in order to control the upper limit bandwidth of single device. When the DeviceLinkThroughputLimit is greater than the current device acquisition bandwidth, the current device acquisition bandwidth will not change, when the DeviceLinkThroughputLimit is less than the current device acquisition bandwidth, the current device acquisition bandwidth will be reduced to the limit of the DeviceLinkThroughputLimit, the current device acquisition bandwidth can be read from the camera.

When the camera is working in trigger mode, the bandwidth limit will restrict the maximum trigger frequency.

Example 1:

The MER-500-14U3x is working in continuous mode, the DeviceLinkCurrentThroughput is 35000000Bps, the DeviceLinkThroughputLimit is 40000000Bps, and then the DeviceLinkCurrentThroughput is still 35000000Bps, if the DeviceLinkCurrentThroughput is 70000000Bps, the DeviceLinkThroughputLimit is 40000000Bps, and then the DeviceLinkCurrentThroughput will be 40000000Bps.

Example 2:

The MER-500-14U3x is working in trigger mode, the DeviceLinkCurrentThroughput is 400000000Bps, the maximum trigger frequency is 14Hz @ full resolution (8bit), when the DeviceLinkCurrentThroughput is 35000000Bps, the maximum trigger frequency is 7Hz @ full resolution (8bit).

Model	Min. of DeviceLinkThroughputLimit	Max. of DeviceLinkThroughputLimit	step of DeviceLinkThroughputLimit
MER-031-860U3x	35000000Bps(8bit)	400000000 Bps	1000000Bps
	70000000Bps(10bit)		
MER-031-860U3M NIR	35000000Bps(8bit)	400000000 Bps	1000000Bps
	70000000Bps(10bit)		

MER-041-436U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-050-560U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-050-560U3M NIR	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-051-120U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-131-210U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-131-210U3M NIR	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-132-43U3x	35000000Bps(8bit) 70000000Bps(12bit)	400000000 Bps	1000000Bps
MER-133-54U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-134-93U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-160-227U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-230-168U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-231-41U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-301-125U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-302-56U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-500-14U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-502-79U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-502-79U3M POL	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-503-36U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps
MER-630-60U3x	35000000Bps(8bit) 70000000Bps(10bit)	400000000 Bps	1000000Bps

MER-1070-14U3x	35000000Bps(8bit)	400000000 Bps	1000000Bps
	70000000Bps(12bit)		
MER-1520-13U3c	35000000Bps(8bit)	400000000 Bps	1000000Bps
	70000000Bps(12bit)		
MER-1810-21U3c	35000000Bps(8bit)	400000000 Bps	1000000Bps
	70000000Bps(12bit)		
MER-2000-19U3x	35000000Bps(8bit)	400000000 Bps	1000000Bps
	70000000Bps(12bit)		

Table2- 9: MER-U3x camera bandwidth control

When setting the DeviceLinkThroughputLimitMode or change the DeviceLinkThroughputLimit, some devices need to be stopped acquisition. The models are as follows:

Model	Support setting device's bandwidth limit when acquiring images?
MER-031-860U3x/ MER-031-860U3x NIR MER-050-560U3x/ MER-050-560U3x NIR MER-131-210U3x/MER-131-210U3x NIR MER-132-43U3x/MER-230-168U3x MER-231-41U3x/MER-500-14U3x MER-1070-14U3x/MER-1520-13U3C	No
The Other Models of MER-U3x Series Camera	Yes

Table2- 10: The models which support setting device 's bandwidth control function when acquiring images

2.4.4. Camera Acquisition Time

The acquisition time of the camera is related to the horizontal offset, vertical offset, width, and height of the image ROI.

The formula is as follows:

1) For MER-031-860U3x (NIR) camera:

Row period (unit: μs)

$$\mathrm{T_{row}} = 13889 * \max\left(\left(\frac{(Width)}{4} + 4\right), 84\right) * 10^{-6}$$

The acquisition time (unit: μs)

$$\mathrm{T_{acq}} = (Height) * \mathrm{Trow} + 85.5$$

2) For MER-041-436U3x camera:

Row period (unit: μs)

$$\mathrm{T_{row}} = \frac{147}{37.5} = 3.92$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 42) * Trow$$

3) For MER-050-560U3x (NIR) camera:

Row period (unit: μs)

$$T_{row} = 14706 * (74 + width) * 10^{-6}$$

The acquisition time (unit: μs)

$$T_{acq} = (Height) * Trow + 78.2$$

4) For MER-051-120U3x camera:

Row period (unit: μs)

$$T_{row} = 13889 * \max\left(\left(\frac{(Width)}{4} + 4\right), 84\right) * 10^{-6}$$

The acquisition time (unit: μs)

$$T_{acq} = (Height) * Trow + 19.8$$

5) For MER-131-210U3x (NIR) camera:

Row period (unit: μs)

$$T_{row} = 13889 * \max\left(\left(\frac{(Width)}{4} + 4\right), 84\right) * 10^{-6}$$

The acquisition time (unit: μs)

$$T_{acq} = (Height) * Trow + 11.4$$

6) For MER-132-43U3x camera:

Row period (unit: μs)

$$T_{row} = 1532 * 15.384 * 10^{-3} = 23.569$$

The acquisition time (unit: μs)

$$T_{acq} = (\text{int}\left(\frac{996 - (\text{height} + 102\text{ffset} + 16)}{8}\right) + \text{int}\left(\frac{102\text{ffset} + 16}{8}\right) + (102\text{ffset} + 16) - ((\text{int}\left(\frac{102\text{ffset} + 16}{8}\right) - 1) * 8) + \text{height} + 1) * T_{row}$$

7) For MER-133-54U3x camera:

In continuous mode, the row period (unit: μs)

$$T_{row} = \frac{1388}{74.25} = 18.69$$

In trigger mode, the row period (unit: μs)

$$T_{row} = \frac{1650}{74.25} = 22.222$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 30) * Trow$$

8) For MER-134-93U3x camera:

Row period (unit: μs)

$$T_{row} = \frac{86 + \frac{Width}{2} + 10}{72}$$

The acquisition time (unit: μs)

$$T_{acq} = Height * Trow + 149.5$$

When using a single ROI, the width and height represent the image width and image height of the Region0, when using multi-ROI, the width and height represent the equivalent width and equivalent height which are calculated by the Region0, Region1, Region2, and Region3. The specific calculate method can see 2.2.2 section.

9) For MER-160-227U3x camera:

When the pixel format is Mono8 or BayerRG8, the row period (unit: μs)

$$T_{row} = \frac{147}{37.5} = 3.92$$

When the pixel format is Mono10 or BayerRG10, the row period (unit: μs)

$$T_{row} = \frac{394}{37.5} = 7.84$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 42) * Trow$$

10) For MER-230-168U3x camera:

When the pixel format is Mono8 or BayerRG8, the row period (unit: μs)

$$T_{row} = \frac{180}{37.5} = 4.8$$

When the pixel format is Mono10 or BayerRG10, the row period (unit: μs)

$$T_{row} = \frac{360}{37.5} = 9.6$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 38) * Trow$$

11) For MER-231-41U3x camera:

Row period (unit: μs)

$$T_{row} = \frac{746}{37.5} = 19.89$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 38) * Trow$$

12) For MER-301-125U3x camera:

When the pixel format is Mono8 or BayerRG8, the row period (unit: μs)

$$T_{row} = \frac{190}{37.5} = 5.07$$

When the pixel format is Mono10 or BayerRG10, the row period (unit: μs)

$$T_{row} = \frac{380}{37.5} = 10.13$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 38) * Trow$$

13) For MER-302-56U3x camera:

Row period (unit: μs)

$$T_{row} = \frac{423}{37.5} = 11.28$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 32) * Trow$$

14) For MER-500-14U3x camera:

Row period (unit: μs)

$$T_{row} = 20832 * \max\left(\left(\frac{(Width + 1)}{2} + 450\right), 487\right) * 10^{-6}$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 19) * Trow$$

15) For MER-502-79U3x (POL)camera:

When the pixel format is Mono8 or BayerRG8, the row period (unit: μs)

$$T_{row} = \frac{227}{37.5} = 6.053$$

When the pixel format is Mono10 or BayerRG10, the row period (unit: μs)

$$T_{row} = \frac{454}{37.5} = 12.107$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 38) * Trow$$

16) For MER-503-36U3x camera:

Row period (unit: μs)

$$T_{row} = \frac{498}{37.5} = 13.28$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 32) * Trow$$

17) For MER-630-60U3x camera:

When the pixel format is Mono8 or BayerRG8, the row period (unit: μs)

$$T_{row} = \frac{420}{54} = 7.78$$

When the pixel format is Mono10 or BayerRG10, the row period (unit: μs)

$$T_{row} = \frac{420x2}{54} = 15.56$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 78) * Trow$$

18) For MER-1070-14U3x camera:

Row period (unit: μs)

$$T_{row} = 24.7$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 143) * Trow$$

19) For MER-1520-13U3C camera:

Row period (unit: μs)

$$T_{row} = \frac{246}{11} = 22.4$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 146) * Trow$$

20) For MER-1810-21U3C camera:

When the pixel format is BayerGR8, the row period (unit: μs)

$$T_{row} = \frac{5568}{55x8} = 12.655$$

When the pixel format is BayerGR12, the row period (unit: μs)

$$T_{row} = \frac{5568x2}{55x8} = 25.3$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 77) * Trow$$

21) For MER-2000-19U3x camera:

When the pixel format is Mono8 or BayerRG8, the row period (unit: μs)

$$T_{row} = \frac{900}{72} = 12.5$$

When the pixel format is Mono12 or BayerRG12, the row period (unit: μs)

$$T_{row} = \frac{900x2}{72} = 25$$

The acquisition time (unit: μs)

$$T_{acq} = (Height + 38) * Trow$$

3. Electrical Interface

There are three parts in the electrical interface: USB3.0 interface, LED light and I/O interface. By the USB3.0 interface, the camera can exchange data with the host and can power the camera; and the I/O interface can control the input and output of the signal; the LED light can indicate the camera's status.

3.1. USB Port

Recommend to use the cables officially recognized by USB IF.

3.2. LED Light

An LED light is set on the back cover of camera which indicates camera's status, as shown in Table3- 1. LED light can display 3 colors---red, yellow and green.

LED status	Camera status
Off	The camera is powered off
Red constant light	The camera is not boot-loaded.
Red flash	The camera is in low power mode
Green constant light	The camera has been boot-loaded, but no data is being transmitted.
Green flash	Data is being transmitted.
Yellow flash	The camera's initialization failed.

Table3- 1: Camera status

3.3. IO Port

IO port is implemented by Hirose 8-pin receptacle (part No. HR25-7TR-8PA (73)), and the corresponding plug is HR25-7TP-8S.

Diagram	Pin	Definition	color	Description
	1	Line0+	green	Opto-isolated input +
	2	GND	blue	GPIO GND
	3	Line0-	gray	Opto-isolated input -
	4	NC	purple	NC
	5	Line2	orange	GPIO input/output
	6	Line3	pink	GPIO input/output
	7	Line1-	white green	Opto-isolated output -
	8	Line1+	white blue	Opto-isolated output +

Table3- 2: IO port definition (back sight of camera)

The polarity of GPIO pins cannot be reversed, otherwise, camera or other peripherals could burn out.

3.3.1. Line0 (Opto-isolated input) circuit

Hardware schematics of opto-isolated input circuit is shown in Figure3- 1 and the dashed box is external.

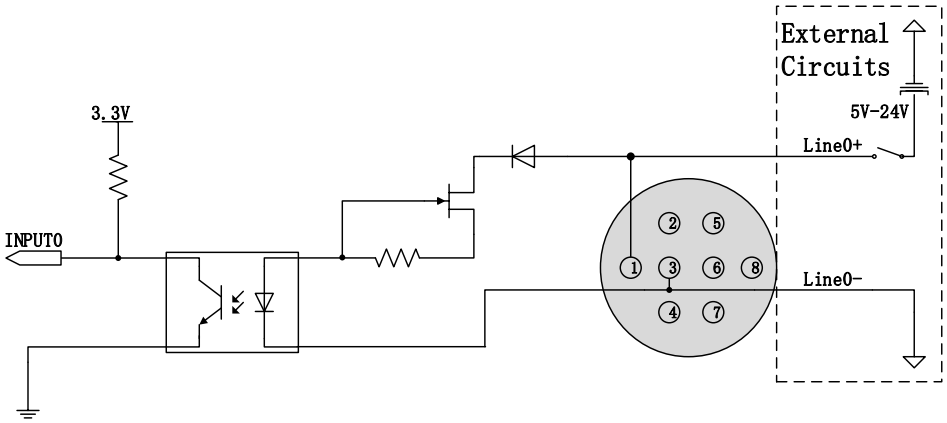


Figure3- 1: Opto-isolated input circuit

- Logic 0 input voltage: 0V~+2.5V (Line0+ voltage)
- Logic 1 input voltage: +5V~+24V (Line0+ voltage)
- Maximum input current: 7mA
- The status is unstable when input voltage is between 2.5V and 5V, which should be avoided.
- When peak voltage of input signal over 9V, a current limiting resistor is recommended to protection the input line.

Line0+ Input Voltage	Current-limiting resistance Rlimit
9V	680Ω
12V	1kΩ
24V	2kΩ

Table3- 3: Current limit resistor value

- Rising edge delay: <50μs (0°C~45°C), parameter description is shown in Figure3- 2
- Falling edge delay: <50μs (0°C~45°C), parameter description is shown in Figure3- 2.
- Different environment temperature and input voltage have influence on delay time of opto-isolated input circuit. Delay time in typical application environment (temperature is 25°C) is shown in Table3- 4.

Parameter	Test condition	Value (us)		
Rising edge delay	VIN=5V	3.02	~	6.96
	VIN=12V	2.46	~	5.14
Falling edge delay	VIN=5V	6.12	~	17.71
	VIN=12V	8.93	~	19.73

Table3- 4: Delay time of opto-isolated input circuit in typical application environment

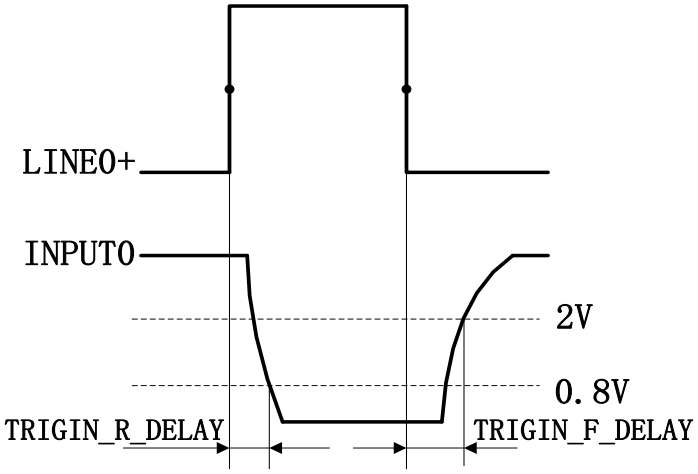


Figure3- 2: Parameter of opto-isolated input circuit

- Rising time delay (TRIGIN_R_DELAY): the time required for the response to the decrease to 0.8V of INPUT0 from 50% rising of LINE0+.
- Falling time delay (TRIGIN_F_DELAY): the time required for the response to the rise to 2V of INPUT0 from 50% falling of LINE0+.

3.3.2. Line1 (opto-isolated output) circuit

Hardware schematics of opto-isolated output circuit is shown in Figure3- 3 and the dashed box is application.

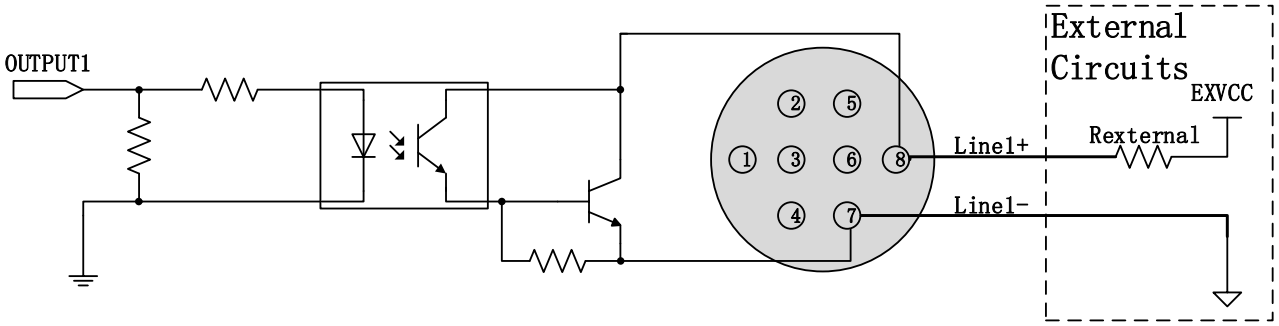


Figure3- 3: Opto-isolated output circuit

- Range of external voltage (EXVCC) is 5~24V.
- Maximum output current of Line1 is 25mA.
- Output voltage and output current of opto-isolated output circuit in typical application environment (temperature is 25°C) is as shown in Table3- 5.

External voltage EXVCC	External resistance Rexternal	Output voltage (V)	Output current (mA)
5V	1kΩ	0.90	4.16
12V	1kΩ	0.97	11.11
24V	1kΩ	1.04	23.08

Table3- 5: Output voltage and output current of opto-isolated output circuit in typical application environment

- Rising time delay = tr+td: <50μs (0°C~45°C) (parameter description as shown in Figure3- 4).
- Falling time delay = ts+tf: <50μs (0°C~45°C)(parameter description as shown in Figure3- 4).
- Delay time in typical application conditions (environment temperature is 25°C) is as shown in Table3- 6.

Parameter	Test Condition	Value (us)		
Storage time (ts)	External power is 5V, pull-up resistor is 1kΩ	6.16	~	13.26
Delay time (td)		1.90	~	3.16
Rising time (tr)		2.77	~	10.60
Falling time (tf)		7.60	~	11.12
Rising time delay = tr+td		4.70	~	13.76
Falling time delay = tf+ts		14.41	~	24.38

Table3- 6: Delay time of opto-isolated output circuit in typical application environment

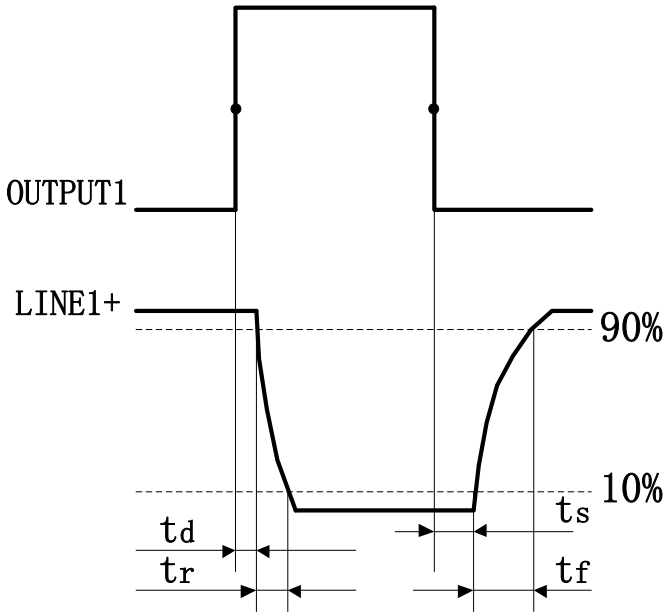


Figure3- 4: Parameter of opto-isolated output circuit

- Delay time (td): the time required from 50% rising of OUTPUT1 to the decrease to 90% of the maximum value of LINE1+.
- Falling time (tf): the time taken for the amplitude of LINE1+ to decrease from 90% to 10% of the maximum value.
- Storage time (ts): the time required from 50% falling of OUTPUT1 to the rise to 10% of the maximum value of LINE1+.
- Rising time (tr): the time for the response of LINE1+ to rise from 10% to 90% of its final value.

3.3.3. GPIO2/3 (bidirectional) Circuit

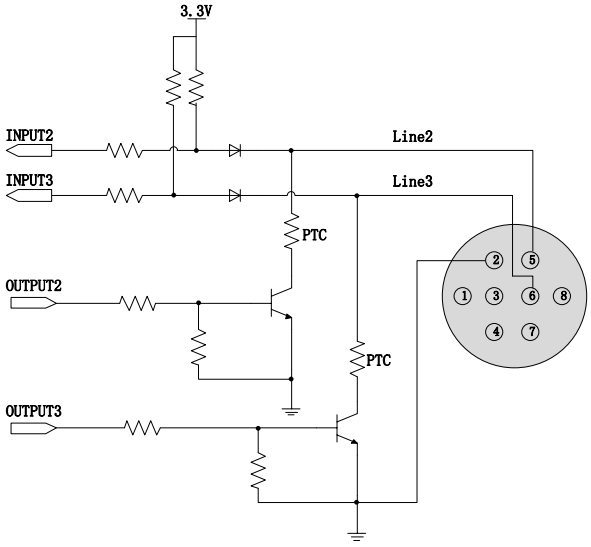


Figure3- 5: GPIO 2/3 (bidirectional) circuit

Line2/3 is configured as input:

- Logic 0 input voltage: 0V~+0.6V(Line2/3 voltage).
- Logic 1 input voltage: +1.9V~+24V(Line2/3 voltage).
- The status is unstable when input voltage is between 0.6V and 1.9V, which should be avoided.
- When input of Line2/3 is high, input current is lower than 100uA; when input of Line2/3 is low , input current is lower than -1mA.
- When LINE2/3 is configured as input, if the corresponding output device is common-anode connected, pull-down resistor over 1K should not be used, otherwise the input voltage of LINE2/3 will be over 0.6V and logic 0 cannot be recognized stably.
- Input rising time delay: 2μs (0°C~45°C), parameter description as shown in Figure3- 2.
- Input falling time delay: <2μs (0°C~45°C), parameter description as shown in Figure3- 2.
- When Line2/3 is configured as input, internal equivalent circuit of camera is shown as Figure3- 6, for Line2 as an example.

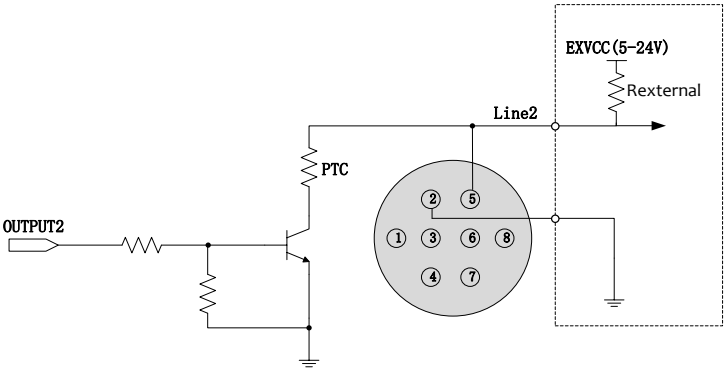


Figure3- 6: Internal equivalent circuit of camera when Line2 is configured as input

To avoid the damage of GPIO pins, please connect GND pin before supplying power to Line2/3.

Line2/3 is configured as output:

- Range of external voltage (EXVCC) is 5~24V.
- Maximum output current of Line2/3 is 25mA, output impedance is 40Ω.
- Output voltage and output current in typical application conditions (temperature is25°C) are shown in Table3- 7.

External voltage EXVCC	External resistance Rexternal	Line2/3 voltage (V)	Output current (mA)
5V	1kΩ	0.19	4.8
12V		0.46	11.6
24V		0.92	23.1

Table3- 7: Voltage and output current of Line2/3 in typical conditions

- Rising time delay = tr+td: <20μs (0°C~45°C) (parameter description as shown in Figure3- 4).
- Falling time delay = ts+tf: <20μs (0°C~45°C) (parameter description as shown in Figure3- 4).
- Delay parameters are affected greatly by external voltage and resistance, but little by temperature. Output delays in typical application conditions (temperature is 25°C) are shown in Table3- 8.

Parameter	Test Conditions	Value (us)		
Storage time (ts)	External power is 5V, pull-up resistor is 1kΩ	0.17	~	0.18
Delay time (td)		0.08	~	0.09
Rising time (tr)		0.11	~	0.16
Falling time (tf)		1.82	~	1.94
Rising time delay = tr+td		0.19	~	0.26
Falling time delay = tf+ts		1.97	~	2.09

Table3- 8: Delay time when GPIO is configured as output in typical conditions

- When Line2/3 is configured as output, internal equivalent circuit of camera is shown as Figure3- 7, for Line2 as an example.

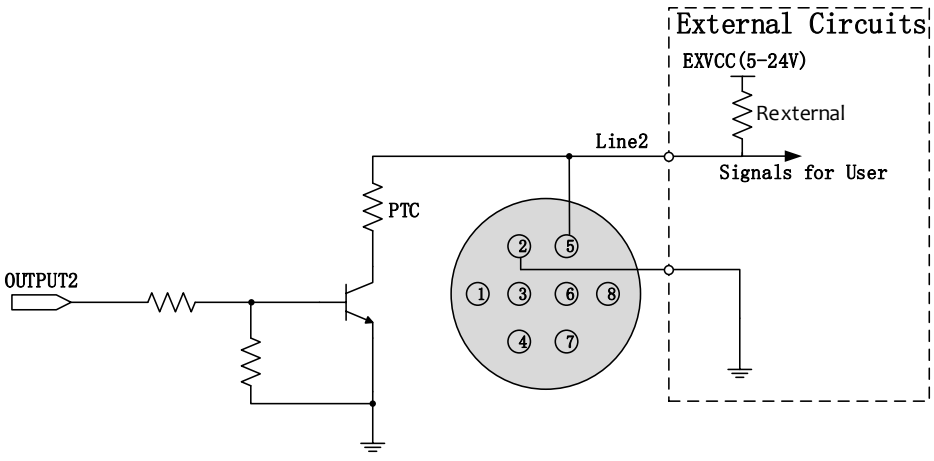


Figure3- 7: Internal equivalent circuit of camera when Line2 is configured as output

4. Installation and use

4.1. Setup Guide

The installation of Daheng Imaging Camera Software Suite is very simple, but you have to take attention to the following matters.

1) The path of installation can only be ASCII characters; otherwise you will not start the applications successfully.

2) When you are installing the setup suit, antivirus will ask you whether to allow some operations, then you must allow these operations.

3) If you are using USB3.0 Vision Cameras in Windows XP, and you have installed the Daheng Imaging Camera Software Suite without cameras connected to your PC, you must run **MER-Series UpdateDriver** firstly.

USB3.0 Vision Cameras can’t work in USB2.0 mode, if you connect a USB3.0 Vision Camera to a USB2.0 controller, you will not open the USB3.0 Vision Camera successfully.

5. FAQ

No.	General Question	Answer
1	If the installation package has been installed in a PC with an inactive Win7 64 bits OS, the demo may not be opened.	1) Please uninstall the software after activating the OS and reinstall the installation package.
2	Cannot find cameras.	1) Please check whether the LED indicator is green. 2) Please check whether the connection of cable is ok. 3) Please check whether the driver of host controller works well, and whether the camera displays as “USB3 Vision Digital Camera”, if not, try to reinstall the setup driver.
3	Fail to open device, it shows “Load XML failed”.	1) Please use the upgrade tool to update the device, after this, reopen the device. You can ask the upgrade tool from our technical support.
4	Fail to open device, it shows that “The device has been opened”.	1) Please close the software which has opened the camera.
5	Fail to open device, it shows that “this device can only be operated on an USB3.0 Port”.	1) Please check that whether the camera is connected to USB2.0 port or USB2.0 hub. Be sure to connect the camera to USB3.0 interface.
6	No image after acquisition start.	1) Please load the default setting, reopen the demo, acquisition start again, and check the frame rate. 2) Open the demo, switch to stream features page, and decrease the number of StreamTransferNumberUrb to 10. Then try to execute the command AcquisitionStart again and check the frame rate. 3) Open the demo, switch to stream features page, check the statistic information, and check if any packet has been received. If there are some incomplete frames, please refer to the section 1.7.
7	The frame rate is not up to the maximum value.	1) Change another PC with high performance. 2) It’s recommended to use Intel host controller (especially z77 chipset). 3) Be sure the main board support PCIE2.0. 4) If you have any other questions, please contact us.
8	Frames are lost during multiple cameras are acquiring images at the same time.	1) The bandwidth of the camera is more than the bandwidth of the host controller. You can decrease the bandwidth through the DeviceLinkThroughputLimit function. 2) Connect the camera to the host controller separately.
9.	Camera crashes on Advantech AIIS-1440 IPC.	1) Be sure the driver version of AMD USB controller is later than 2.20.

6. Revision History

No.	Version	Changes	Date
1	V1.0.0	Initial release	2016-05-25
2	V1.0.1	Update to MER-133-54U3M	2016-07-04
3	V1.0.2	Update to MER-301-125U3X	2016-07-15
4	V1.0.3	add SNR and definition to MER-133-54U3M	2016-07-28
5	V1.0.4	add SNR and definition to MER-502-79U3x	2016-08-24
6	V1.0.5	Update to MER-1810-21U3C	2016-08-30
7	V1.0.6	add SNR and definition to MER-1810-21U3C	2016-10-12
8	V1.0.7	Update to MER-031-860U3M NIR MER-050-560U3M NIR MER-131-210U3M NIR	2016-11-08
9	V1.0.8	Update to MER-503-36U3x	2016-11-11
10	V1.0.9	Update chapter 1.2 and 1.3	2016-12-02
11	V1.0.10	Update MER-XXX-XXXU3M NIR-L to MER-XXX-XXXU3M-L NIR	2016-12-26
12	V1.0.11	Update table 4-2, Update SNR and definition NIR camera, MER- MER-1810-21U3C, MER-301-125U3x	2017-01-12
13	V1.0.12	Update FAQ	2017-04-01
14	V1.0.13	Add chapter 3.2, update table 1-16 and table 1-17, update to MER-133-54U3x	2017-04-05
15	V1.0.14	Change MER-503-36U3X ADC bit width to 12bit	2017-05-11
16	V1.0.15	Update SNR and definition to MER-133-54U3C and MER-133-54U3M	2017-05-25
17	V1.0.16	Update to MER-302-56U3x, except Gain SNR Definition Add GPIO delay time and opto-isolated delay time of the MER-134-93U3x Rename MER-133-54U3m and MER-134-93U3m to MER-133-54U3x and MER-134-93U3x	2017-06-15
18	V1.0.17	Unify Sensor Type	2017-06-21
19	V1.0.18	Revise MER-1520-13U3C frame rate	2017-06-22
20	V1.0.19	Update section 1.5 Update chapter 2	2017-07-27
21	V1.0.20	Modify some descriptive languages and some minor bugs.	2017-09-05
22	V1.0.21	Update SNR and definition to MER-302-56U3x	2017-09-19
23	V1.0.22	Update to MER-051-120U3x	2017-10-11
24	V1.0.23	Modify sales Tel., delete MER-132-30U3X, specify sensor type for MER-132-43U3x	2017-10-24

25	V1.0.24	Update SNR and definition to MER-134-93U3C and MER-134-93U3M	2017-11-08
26	V1.0.25	Update definition to MER-1810-21U3C	2017-11-10
27	V1.0.26	Update gain to MER-051-120U3x	2017-12-22
28	V1.0.27	Add MER-630-60U3x	2017-12-29
29	V1.0.28	Update SNR to MER-051-120U3x Change the company's logo	2018-01-25
30	V1.0.29	Change the E-mail Update definition to MER-051-120U3C and MER-051-120U3M	2018-02-26
31	V1.0.30	Modify chapter 2.2.2.2，since MER-630-60U3x doesn't support Multi-ROI	2018-03-05
32	V1.0.31	Fix error for table 1-33 Update SNR and definition to MER-630-60U3x	2018-03-19
33	V1.0.32	Fix error for table 2-2 Add MER-2000-19U3x	2018-04-18
34	V1.0.33	Fix error for table 1-32 and table 1-33	2018-04-18
35	V1.0.34	Fix error for chapter 1.3.18	2018-04-18
36	V1.0.35	Change the frame rate of MER-200-19U3x to 19.6fps	2018-04-25
37	V1.0.36	Update SNR and definition to MER-2000-19U3x	2018-05-10
38	V1.0.37	Add FCC Certifications	2018-05-23
39	V1.0.38	Add MER-041-436U3x	2018-08-12
40	V1.0.39	Add MER-502-79U3M POL	2018-08-30
41	V1.0.40	Update SNR and definition to MER-502-79U3M POL Update SNR and definition to MER-041-436U3x	2018-09-07
42	V1.0.41	Update Figure1- 25 to MER-502-79U3M POL Add MER-160-227U3x	2018-09-21
43	V1.0.42	Update SNR and definition to MER-160-227U3x Update SNR and definition to MER-301-125U3M	2018-10-26