

# Lt Camera Series™

## Camera User's Manual

USB3 Vision® – Monochrome & Color Area Scan



**USB**™  
VISION

March 9, 2023  
P/N: LT-U00M-USR00  
Rev: 005  
[www.lumenera.com](http://www.lumenera.com)

 **TELEDYNE LUMENERA**  
Everywhereyoulook™

# Notice

## © 2019-2023 Teledyne Lumenera

All information provided in this manual is believed to be accurate and reliable. No responsibility is assumed by Teledyne Lumenera for its use. Teledyne Lumenera reserves the right to make changes to this information without notice. Reproduction of this manual in whole or in part, by any means, is prohibited without prior permission having been obtained from Teledyne Lumenera.

Microsoft and Windows are registered trademarks of Microsoft Corporation in the United States and other countries. Windows, Windows 10 are trademarks of Microsoft Corporation.

All other trademarks or intellectual property mentioned herein belong to their respective owners.

Document Date: March 9, 2023  
Document Number: LT-U00M-USR00

## **About Teledyne Lumenera — a business unit of Teledyne Digital Imaging Inc.**

Teledyne Lumenera, a business unit of Teledyne Digital Imaging Inc., is headquartered in Ottawa, Canada, and is a leading developer and manufacturer of high-performance digital cameras and custom imaging solutions. Teledyne Lumenera imaging solutions provide a unique combination of speed, resolution and sensitivity to meet the most demanding digital imaging requirements, and are deployed worldwide in a wide range of industrial and scientific applications.

Teledyne Imaging is an international high performance semiconductor and Electronics Company that designs, develops, manufactures, and markets digital imaging products and solutions, in addition to providing wafer foundry services.

Teledyne Digital Imaging offers the widest range of machine vision components in the world. From industry-leading image sensors through powerful and sophisticated cameras, frame grabbers, vision processors and software to easy-to-use vision appliances and custom vision modules.

**This document does not contain information whose export/transfer/disclosure is restricted by the Canadian Export Control regulation.**

# Contents

<b>SERIES OVERVIEW</b>	<b>1</b>
DESCRIPTION	1
MODEL PART NUMBERS	2
<i>Monochrome Cameras</i>	4
<i>Color Cameras</i>	6
<i>Optional Accessories</i>	8
SOFTWARE REQUIREMENTS	10
<i>Firmware Files for all Lt Models</i>	10
Firmware Update using Sopera LT	10
Firmware Update using Lumenera API	11
Switching Camera Modes	11
<b>SERIES SPECIFICATIONS</b>	<b>12</b>
COMMON SPECIFICATIONS	12
SENSOR COSMETIC SPECIFICATIONS	13
DYNAMIC RANGE & SIGNAL TO NOISE RATIO MEASUREMENT CONDITIONS	14
MEAN TIME BETWEEN FAILURE (MTBF)	14
<b>MODEL SPECIFICATIONS</b>	<b>16</b>
SPECIFICATIONS LT-M1610 / LT-C1610	16
<i>Spectral Response Curves Lt-M1610 / Lt-C1610</i>	17
SPECIFICATIONS LT-M1630 / LT-C1630	18
<i>Spectral Response Curves Lt-M1630 / Lt-C1630</i>	19
SPECIFICATIONS LT-C1900	20
<i>Spectral Response Curves Lt-C1900</i>	21
SPECIFICATIONS LT-M1950 / LT-C1950	22
<i>Spectral Response Curves Lt-M1950 / Lt-C1950</i>	23
SPECIFICATIONS LT-M1980 / LT-C1980	24
<i>Spectral Response Curves Lt-M1980 / Lt-C1980</i>	25
SPECIFICATIONS LT-M2020 / LT-C2020	26
<i>Spectral Response Curves Lt-M2020 / Lt-C2020</i>	27
SPECIFICATIONS LT-M2050 / LT-C2050	28
<i>Spectral Response Curves Lt-M2050 / Lt-C2050</i>	29
SPECIFICATIONS LT-M2420 / LT-C2420	30
<i>Spectral Response Curves Lt-M2420 / Lt-C2420</i>	31
SPECIFICATIONS LT-M2450 / LT-C2450	32
<i>Spectral Response Curves Lt-M2450 / Lt-C2450</i>	33
SPECIFICATIONS LT-M2470 / LT-C2470	34
<i>Spectral Response Curves Lt-M2470 / Lt-C2470</i>	35
SPECIFICATIONS LT-M3200 / LT-C3200	36
<i>Spectral Response Curves Lt-M3200 / Lt-C3200</i>	37
SPECIFICATIONS LT-M3840 / LT-C3840	38
<i>Spectral Response Curves Lt-M3840 / Lt-C3840</i>	39
SPECIFICATIONS LT-M4030 / LT-C4030	40
<i>Spectral Response Curves Lt-M4030 / Lt-C4030</i>	41
SPECIFICATIONS LT-M4060 / LT-C4060	42
<i>Spectral Response Curves Lt-M4060 / Lt-C4060</i>	43
SPECIFICATIONS LT-M4020 / LT-C4020	44
<i>Spectral Response Curves Lt-M4020 / Lt-C4020</i>	45

SPECIFICATIONS LT-M4040 / LT-C4040.....	46
<i>Spectral Response Curves Lt-M4040 / Lt-C4040</i> .....	47
SPECIFICATIONS LT-M5300 / LT-C5300.....	48
<i>Spectral Response Curves Lt-M5300 / Lt-C5300</i> .....	49
SPECIFICATIONS LT-M5470 / LT-C5470.....	50
<i>Spectral Response Curves Lt-M5470 / Lt-C5470</i> .....	51
SPECIFICATIONS LT-M4430 / LT-C4430.....	52
<i>Spectral Response Curves Lt-M4430 / Lt-C4430</i> .....	53
SPECIFICATIONS LT-M5500 / LT-C5500.....	54
<i>Spectral Response Curves Lt-M5500 / Lt-C5500</i> .....	55
SPECIFICATIONS LT-M4510 / LT-C4510.....	56
<i>Spectral Response Curves Lt-M4510 / Lt-C4510</i> .....	57
SPECIFICATIONS LT-M6480 / LT-C6480.....	58
<i>Spectral Response Curves Lt-M6480 / Lt-C6480</i> .....	59
GUIDE TO USING A ROLLING SHUTTER CAMERA.....	60
<i>Overview of Electronic Rolling Shutter (ERS) Exposures</i> .....	61
<i>Overview of Global Reset Release (GRR) Exposures</i> .....	62
<b>CONNECTING THE CAMERA</b> .....	<b>63</b>
USB3 VISION® OVERVIEW .....	63
CONNECTING POWER .....	63
<i>Connectors</i> .....	63
<i>LED Status Indicator</i> .....	66
PREVENTING OPERATIONAL FAULTS DUE TO ESD.....	66
<b>FEATURE REFERENCE</b> .....	<b>67</b>
LT SERIES FEATURES .....	67
CAMERA INFORMATION CATEGORY.....	68
<i>Camera Information Feature Descriptions</i> .....	68
<i>Power-up Configuration Dialog</i> .....	70
Camera Power-up Configuration .....	70
Load / Save Configuration .....	70
SENSOR CONTROL CATEGORY.....	71
<i>Sensor Control Feature Descriptions</i> .....	71
<i>High Gain Conversion Mode</i> .....	74
I/O CONTROL CATEGORY .....	75
<i>I/O Control Feature Descriptions</i> .....	75
Input and Output Line Details .....	78
Strobe and Flash Zone (Lt-3840, Lt-5500) .....	78
ADVANCED PROCESSING CATEGORY.....	80
<i>Advanced Processing Feature Descriptions</i> .....	81
LENS CONTROL (FOR LT-Ux0x-xxxxx SERIES).....	82
<i>Lens Control Feature Descriptions</i> .....	82
<i>F-stops vs. Exposure Overview</i> .....	82
IMAGE FORMAT CONTROL CATEGORY .....	84
<i>Image Format Control Feature Description</i> .....	84
<i>Width and Height Features for Partial Scan Control</i> .....	87
Vertical Cropping (Partial Scan) .....	87
Horizontal Cropping (Partial Scan) .....	88
<i>Horizontal and Vertical Flip</i> .....	88
<i>Using the Multiple ROI Mode</i> .....	89
Important Usage Details .....	90
Example: Two Horizontal ROI Areas (2x1).....	90
Example: Four ROI Areas (2x2) .....	91
Example: Actual Sample with Six ROI Areas (3x2) .....	91
ACQUISITION CONTROL CATEGORY .....	93
<i>Acquisition Control Feature Descriptions</i> .....	93

EVENT CONTROL CATEGORY .....	95
<i>Event Control Feature Descriptions</i> .....	96
TRANSPORT LAYER CONTROL CATEGORY .....	97
<i>Transport Layer Feature Descriptions</i> .....	97
TELEDYNE LUMENERA CONTROL CATEGORY .....	99
<i>Teledyne Lumenera Control Feature Descriptions</i> .....	99
FILE ACCESS CONTROL CATEGORY .....	100
<i>File Access Control Feature Descriptions</i> .....	100
<i>File Access via the CamExpert Tool (Quick Camera Firmware Upgrade)</i> .....	102
USB3 VISION HOST CONTROLS .....	103
<b>TECHNICAL SPECIFICATIONS</b> .....	<b>104</b>
IDENTIFICATION AND MECHANICAL NOTES .....	104
MECHANICAL SPECIFICATIONS .....	105
<i>Models Lt-Ux0x-xxxxx</i> .....	105
<i>Models Lt-xx1x-xxxxx</i> .....	106
<i>Models Lt-Ux20-xxxxx</i> .....	107
TEMPERATURE MANAGEMENT .....	108
SENSOR ALIGNMENT SPECIFICATION .....	108
CONNECTORS .....	109
<i>Connector Locations for Lt-Ux0x-xxxxx</i> .....	109
Side and Face View .....	109
I/O Connector Pinout Details (LT-Ux0x-xxxxx) .....	109
Optional I/O Connector Packages (LT-Ux0x-xxxxx) .....	110
<i>Connector Locations for Lt-xx1x-xxxxx</i> .....	111
I/O Connector Pinout Details (LT-xx1x-xxxxx) .....	111
<i>Connector Locations for Lt-Ux2x-xxxxx</i> .....	112
Connector Pinout Details (LT-Ux2x-xxxxx) .....	112
Optional I/O Connector Packages (LT-Ux2x-xxxxx) .....	113
<i>Bi-directional I/O DC Specifications</i> .....	115
<i>Optically-Isolated Input Specifications</i> .....	115
<i>Optically-Isolated Output Specifications</i> .....	118
COMPUTER REQUIREMENTS FOR LT CAMERAS .....	124
EC & FCC DECLARATIONS OF CONFORMITY .....	125
<b>ADDITIONAL REFERENCE INFORMATION</b> .....	<b>128</b>
CHOOSING A LENS WITH THE CORRECT IMAGE CIRCLE .....	128
<i>Lens Options for Lt-1900</i> .....	128
<i>Lens Options for Lt-1950</i> .....	129
<i>Lens Options for Lt-2020, Lt-2050, Lt-2470, Lt-3840</i> .....	129
<i>Lens Options for Lt-1980, Lt-2420, Lt-2450</i> .....	130
<i>Lens Options for Lt-1630</i> .....	130
<i>Lens Options for Lt-4030, Lt-4060, Lt-5500</i> .....	131
<i>Lens Options for Lt-1610, Lt-3200, Lt-4020, Lt-4040, Lt-5300, Lt-4510</i> .....	132
<i>Lens Options for Lt-4430, Lt-5470</i> .....	132
<i>Lens Options for Lt-6480</i> .....	133
<i>Additional Lens Parameters (application specific)</i> .....	134
OPTICAL CONSIDERATIONS .....	134
<i>Illumination</i> .....	134
<i>Light Sources</i> .....	135
<i>Monochrome Cameras with Anti-Reflection Filter</i> .....	135
AR/AR Filter Specification Highlights .....	135
<i>Color Camera with IR Cut-off Filter</i> .....	136
NIR/AR Filter Specification Highlights .....	136
Guidelines for Choosing IR Cut-off Filters .....	137
Back Focal Variance when using any Filter .....	138
LENS MODELING .....	139

<i>Magnification and Resolution</i> .....	139
SENSOR HANDLING INSTRUCTIONS.....	140
<i>Electrostatic Discharge and the Sensor</i> .....	140
<i>Protecting Against Dust, Oil and Scratches</i> .....	140
<i>Cleaning the Sensor Window</i> .....	140
RUGGEDIZED CABLE ACCESSORIES .....	141
<i>Cable Manufactures Contact Information</i> .....	141
<i>Long Passive Cables and Optical Cables</i> .....	141
<i>USB3 Long Distance Active Cables</i> .....	141
<b>TROUBLESHOOTING</b> .....	<b>143</b>
OVERVIEW .....	143
USB 3 CAMERA FAQ ITEMS .....	143
USING THE U3V DEVICE MANAGER TOOL.....	144
SWITCHING A TELEDYNE LUMENERA CAMERA FROM LUCAM MODE TO USB3 VISION MODE .....	145
<i>Using LtUpdater to Switch to USB3 Vision Mode</i> .....	145
SWITCHING A TELEDYNE LUMENERA CAMERA FROM USB3 VISION MODE TO LUCAM MODE .....	146
LUMENERA LUCAM API FOR LINUX OS.....	147
TROUBLESHOOTING FLOW CHARTS .....	148
<i>Chart 1</i> .....	148
<i>Chart 2</i> .....	149
<i>Chart 3</i> .....	150
<i>Chart 4</i> .....	151
<b>REVISION HISTORY</b> .....	<b>152</b>
<b>CONTACT INFORMATION</b> .....	<b>153</b>
SALES INFORMATION .....	153
TECHNICAL SUPPORT .....	153

# Series Overview

---

## Description

Teledyne Lumenera USB3@ Vision compliant cameras provide a quick and easy means of capturing high quality images on any USB 3.0 equipped desktop, laptop, or embedded computer. Because they are USB-based, there is no need for a frame grabber. Instead, a single cable provides full command control and data transfer at speeds of up to 380 MB/s (Lt series).

**Lt-Ux0x-xxxxx** and **Lt-xx1x-xxxxx** USB 3 cameras are powered via the USB 3 computer port and may optionally be powered through the external interface header. **Lt-Ux2x-xxxxx XL** USB 3 cameras must be powered through the external interface header. The external interface header also provides access for hardware input and output signals.

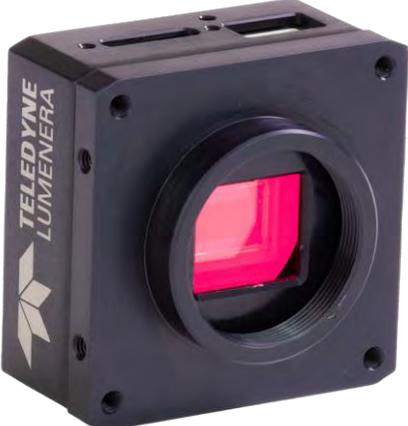
Some of the Lt Series feature highlights include:

- Compliant with third-party USB3 Vision application development software
- Color or monochrome Sony IMX series electronic global shutter CMOS sensors
- High-Speed USB 3.1 Gen 1 interface for fastest image delivery and simplified connectivity
- 128 MB / 256 MB (XL models) low-latency RAM frame buffer
- Transfer Burst Mode supported
- Region of Interest (ROI) option to provide higher frame rates
- Selectable 8 or 12-bit pixel data
- Multiple data rates supported, each optimized for lowest noise performance
- Compact, robust form factor
- Locking industrial micro USB (power / data) and General Purpose I/O connectors for control of peripherals and lighting synchronization
- P-Iris connector for support of precise iris lens control (available with **LT-Ux0x-xxxxx** series camera models)
- The **Lt-Ux0x-xxxxx** series with 4 GPI/O, the options are: 1 optically isolated output, 1 optically isolated input, and 2 configurable I/O ports controls for synchronization (trigger and strobe) of multiple cameras, peripherals, and lighting
- The **Lt-xx1x-xxxxx** series which uses a smaller case, has a reduced I/O signal set on a locking 9-pin connector
- The **Lt-Ux2x-xxxxx** series boasts up to 31 MP, is designed to support operating temperatures between 0°C–50°C and is suited for outdoor applications such as traffic monitoring.
- FCC Class B, CE Certified

---

# Model Part Numbers

This manual covers the monochrome and color models of USB3 Vision cameras summarized in the tables below. Specific camera model specifications follow this section.



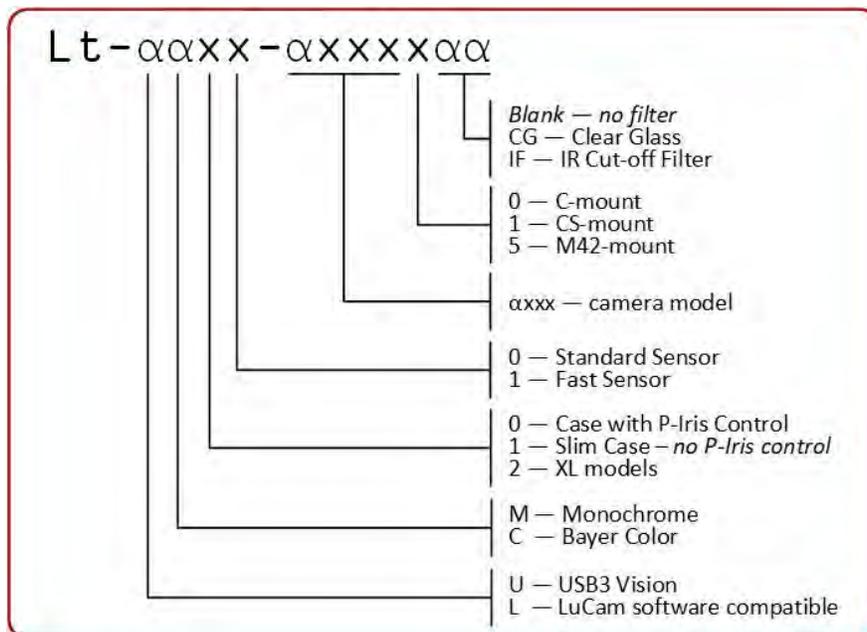
*Compact models (P/N: LT-xx1x-xxxxx)*



*Medium size models with P-Iris (P/N: LT-xx0x-xxxxx)*



XL models (P/N: LT-Ux2x-xxxx)



Part number description

# Monochrome Cameras

All models use Global Shutter sensors unless designated with **\*RS** for Rolling Shutter.

Lt Model Full Resolution	Sensor & Size	Lens Mount case version	Lens Image Circle	Lt Part Number	Notes
<a href="#">Lt-M1610</a> 1608 x 1104	<b>Sony 1.7M</b> (IMX432)	C-mount	1.1"	LT-UM11-M1610	
<a href="#">Lt-M1630</a> 1632 x 1248	<b>Sony 2.0M</b> (IMX430)	C-mount	1/1.7"	LT-UM11-M1630	
<a href="#">Lt-M1950</a> 1932 x 1216	<b>Sony 2.3M</b> (IMX392)	C-mount	1/2.3"	LT-UM10-M1950	
		CS-mount		LT-UM10-M1951	
<a href="#">Lt-M1980</a> 1944 x 1472	<b>Sony 2.9M</b> (IMX429)	C-mount	2/3"	LT-UM11-M1980	
<a href="#">Lt-M2020</a> 2064 x 1544	<b>Sony 3.2M</b> (IMX265)	C-mount	1/1.8"	LT-UM11-M2020	
		CS-mount		LT-UM11-M2021	
<a href="#">Lt-M2050</a> 2064 x 1544	<b>Sony 3.2M</b> (IMX252)	C-mount w/P-Iris	1/1.8"	LT-UM00-M2050	With Clear Glass
				LT-UM00-M2050CG	
<a href="#">Lt-M2420</a> 2464 x 2056	<b>Sony 5.1M</b> (IMX264)	C-mount	2/3"	LT-UM11-M2420	
		CS-mount		LT-UM11-M2421	
<a href="#">Lt-M2450</a> 2464 x 2056	<b>Sony 5.1M</b> (IMX250)	C-mount w/P-Iris	2/3"	LT-UM00-M2450	With Clear Glass
				LT-UM00-M2450CG	
<a href="#">Lt-M2470</a> 2472 x 2064	<b>Sony 5.1M</b> (IMX547)	C-mount	1/1.8"	LT-UM11-M2470	
		CS-mount		LT-UM11-M2471	
<a href="#">Lt-M3200</a> 3216 x 2208	<b>Sony 7.1M</b> (IMX428)	C-mount	1.1"	LT-UM11-M3200	
<a href="#">Lt-M3840</a> 3840 x 2160	<b>Sony 8.3M</b> (IMX334) <b>*RS</b>	C-mount	1/1.8"	LT-UM10-M3840	
		CS-mount		LT-UM10-M3841	
<a href="#">Lt-M4030</a> 4112 x 2176	<b>Sony 8.9M</b> (IMX267)	C-mount	1"	LT-UM11-M4030	
<a href="#">Lt-M4060</a> 4112 x 2176	<b>Sony 8.9M</b> (IMX255)	C-mount w/P-Iris	1"	LT-UM00-M4060	With Clear Glass
				LT-UM00-M4060CG	
<a href="#">Lt-M4020</a> 4112 x 3008	<b>Sony 12.4M</b> (IMX304)	C-mount	1.1"	LT-UM11-M4020	
<a href="#">Lt-M4040</a> 4112 x 3008	<b>Sony 12.4M</b> (IMX253)	C-mount w/P-Iris	1.1"	LT-UM00-M4040	With Clear Glass
				LT-UM00-M4040CG	
<a href="#">Lt-M5300</a> 5328 x 3040	<b>Sony 16.2M</b> (IMX542)	C-mount	1.1"	LT-UM11-M5300	
<a href="#">Lt-M5470</a> 5472 x 3084	<b>Sony 16.9M</b> (IMX387)	M42-mount	4/3"	LT-UM20-M5475	
<a href="#">Lt-M4430</a> 4432 x 4436	<b>Sony 19.7M</b> (IMX367)	M42-mount	4/3"	LT-UM20-M4435	

Lt Model Full Resolution	Sensor & Size	Lens Mount case version	Lens Image Circle	Lt Part Number	Notes
<u>Lt-M5500</u> 5472 x 3648	<b>Sony 20.0M</b> (IMX183) *RS	C-mount	1"	LT-UM10-M5500	
<u>Lt-M4510</u> 4512 x 4512	<b>Sony 20.4M</b> (IMX541)	C-mount	1.1"	LT-UM11-M4510	
<u>Lt-M6480</u> 6480 x 4860	<b>Sony 31.5M</b> (IMX342)	M42-mount	APS-C	LT-UM20-M6485	

## Color Cameras

All models use Global Shutter sensors unless designated with **\*RS** for Rolling Shutter.

Lt Model Full Resolution	Sensor & Size	Lens Mount case version	Lens Image Circle	Part Number	Notes
<u>Lt-C1610</u> 1608 X 1104	<b>Sony 1.7M</b> (IMX432)	C-mount	1.1"	LT-UC11-C1610IF	with IR Cut-off Filter
<u>Lt-C1630</u> 1632 x 1248	<b>Sony 2.0M</b> (IMX430)	C-mount	1/1.7"	LT-UC11-C1630IF	with IR Cut-off Filter
<u>Lt-C1900</u> 1944 x 1096	<b>Sony 2.1M</b> (IMX327) <b>*RS</b>	C-mount	1/2.8"	LT-UC10-C1900IF	with IR Cut-off Filter
		CS-mount		LT-UC10-C1901IF	with IR Cut-off Filter
<u>Lt-C1950</u> 1932 x 1216	<b>Sony 2.3M</b> (IMX392)	C-mount	1/2.3"	LT-UC10-C1950IF	with IR Cut-off Filter
		CS-mount		LT-UC10-C1951IF	with IR Cut-off Filter
<u>Lt-C1980</u> 1944 x 1472	<b>Sony 2.9M</b> (IMX429)	C-mount	2/3"	LT-UC11-C1980IF	with IR Cut-off Filter
<u>Lt-C2020</u> 2064 x 1544	<b>Sony 3.2M</b> (IMX265)	C-mount	1/1.8"	LT-UC11-C2020IF	with IR Cut-off Filter
		CS-mount		LT-UC11-C2021IF	with IR Cut-off Filter
<u>Lt-C2050</u> 2064 x 1544	<b>Sony 3.2M</b> (IMX252)	C-mount w/P-Iris	1/1.8"	LT-UC00-C2050	
				LT-UC00-C2050IF	with IR Cut-off Filter
<u>Lt-C2420</u> 2464 x 2056	<b>Sony 5.1M</b> (IMX264)	C-mount	2/3"	LT-UC11-C2420IF	with IR Cut-off Filter
		CS-mount		LT-UC11-C2421IF	with IR Cut-off Filter
<u>Lt-C2450</u> 2464 x 2056	<b>Sony 5.1M</b> (IMX250)	C-mount w/P-Iris	2/3"	LT-UC00-C2450	
				LT-UC00-C2450IF	with IR Cut-off Filter
<u>Lt-C2470</u> 2472 x 2064	<b>Sony 5.1M</b> (IMX547)	C-mount	1/1.8"	LT-UC11-C2470IF	with IR Cut-off Filter
		CS-mount		LT-UC11-C2471IF	with IR Cut-off Filter
<u>Lt-C3200</u> 3216 x 2208	<b>Sony 7.1M</b> (IMX428)	C-mount	1.1"	LT-UC11-C3200IF	with IR Cut-off Filter
<u>Lt-C3840</u> 3840 x 2160	<b>Sony 8.3M</b> (IMX334) <b>*RS</b>	C-mount	1/1.8"	LT-UC10-C3840IF	with IR Cut-off Filter
		CS-mount		LT-UC10-C3841IF	with IR Cut-off Filter
<u>Lt-C4030</u> 4112 x 2176	<b>Sony 8.9M</b> (IMX267)	C-mount	1"	LT-UC11-C4030IF	with IR Cut-off Filter
<u>Lt-C4060</u> 4112 x 2176	<b>Sony 8.9M</b> (IMX255)	C-mount w/P-Iris	1"	LT-UC00-C4060	
				LT-UC00-C4060IF	with IR Cut-off Filter
<u>Lt-C4020</u> 4112 x 3008	<b>Sony 12.4M</b> (IMX304)	C-mount	1.1"	LT-UC11-C4020IF	with IR Cut-off Filter
<u>Lt-C4040</u> 4112 x 3008	<b>Sony 12.4M</b> (IMX253)	C-mount w/P-Iris	1.1"	LT-UC00-C4040	
				LT-UC00-C4040IF	with IR Cut-off Filter
<u>Lt-C5300</u> 5328 x 3040	<b>Sony 16.2M</b> (IMX542)	C-mount	1.1"	LT-UC11-C5301IF	with IR Cut-off Filter
<u>Lt-C5470</u> 5472 x 3084	<b>Sony 16.9M</b> (IMX387)	M42-mount	4/3"	LT-UC20-C5475	

Lt Model Full Resolution	Sensor & Size	Lens Mount case version	Lens Image Circle	Part Number	Notes
<u>Lt-C4430</u> 4432 x 4436	<b>Sony 19.7M</b> (IMX367)	M42-mount	4/3"	LT-UC20-C4435	
<u>Lt-C5500</u> 5472 x 3648	<b>Sony 20.0M</b> (IMX183) *RS	C-mount	1"	LT-UC10-C5500IF	with IR Cut-off Filter
<u>Lt-C4510</u> 4512 x 4512	<b>Sony 20.4M</b> (IMX541)	C-mount	1.1"	LT-UC11-C4510IF	with IR Cut-off Filter
<u>Lt-C6480</u> 6480 x 4860	<b>Sony 31.5M</b> (IMX342)	M42-mount	APS-C	LT-UC20-C6485	

# Optional Accessories

Accessories & Cables for all camera series	Part Number	
USB 3.1 Cable A-Male to Micro-B male Locking (3m / 9.75ft)	La303ML	
Accessories & Cables for camera series LT-xx1x-xxxxx	Part Number	
GPIO Sync cable, 9-Pin with I/O lead (power & lead cable)	La4000PAFL	
Accessories & Cables for camera series LT-Ux0x-xxxxx	Part Number	
Locking 5V DC international power supply with GPIO cable (power & blunt lead cable)	La2000PIOK	
Hirose 8-Pin GPIO with I/O blunt lead	La2000PAFL	
Accessories & Cables for camera series LT-Ux2x-xxxxx	Part Number	
Generic 12 volt power supply for aux. connector (Samtec 10-Pin) – 4 meter length	G3-APWS-S10S04M	
<b>IR Cut-off Filter</b> M42 mount camera filter designed by Midopt to thread directly into our M42-mount camera between lens and sensor.	G3-AM42-SP644IF	
<b>Heatsink</b> 51mm x 28mm x 15mm (screws included)	G3-AHSK-51X28	

Accessories & Cables for camera series LT-Ux2x-xxxxx	Part Number	
<p><b>Lens adapter</b> M42 x 1mm to F-mount (Nikon)</p>	G2-AM42-MOUNT4	
<p><b>Cable (2M):</b> Camera Auxiliary Samtec ISDF-05-D connector to breakout Euroblock connector</p>	G3-AIOC-BRKOUT2M	
<p><b>Cable (2M):</b> Camera Auxiliary Samtec ISDF-05-D connector to flying Lead (open-ended) from pin 1 to 10</p>	G5-AIOC-BLUNT2M	
<p><b>Mounting Bracket Assembly</b> Including Hole for the Third Mounting position (1/4-20 Mounting Adapter) 35 mm of length 1/4 inch screw mount</p>	G3-AMNT-BRA02	

See section [Ruggedized Cable Accessories](#) cabling options available directly from our preferred cable sources.

# Software Requirements

Software required to configure and control the operation of the Lt-Series cameras is listed below.

SDK	OS	Supported Models
Teledyne DALSA <b>Sapera LT SDK</b> (USB3 Vision compliant)  Third-party USB3 Vision compliant SDK	Windows	All camera part numbers beginning with <b>Lt-Uxxx</b>
Teledyne Lumenera <b>LuCam Software</b> (not USB3 Vision compliant)  	Windows, Linux	All camera part numbers beginning with <b>Lt-Lxxx</b>  All camera part numbers beginning with <b>Lt-Ux2x*</b>  Specific models <b>Lt-2470, Lt-5300 and Lt-4510*</b>

\* **Lt-Ux2x-xxxxx Series Cameras and specific models Lt-2470, Lt-5300 and Lt-4510** may be used with either USB3 Vision SDK (Sapera LT/third-party) or LuCam SDK (version 6.9 and up) according to the driver that is used. See [Using the U3V Device Manager Tool](#) for details on selecting from drivers.

**Sapera LT SDK** provides everything you need to control image acquisition devices. It includes the CamExpert camera configuration tool, code examples, demos, and full documentation. Sapera LT is USB3 Vision compliant. It can be downloaded from the Teledyne DALSA [Sapera LT SDK](#) page.



**LuCam Software** includes device drivers and SDK to support the latest Lt series cameras, providing a comprehensive set of functions to control the operation of the cameras. LuCam software is not USB3 Vision compliant. It can be downloaded from Teledyne Lumenera, for [Windows](#) or for [Linux](#).

## Firmware Files for all Lt Models

The latest firmware files for all Lt Models are available on the Teledyne Lumenera Lt Series support web site (subject to change):

[www.lumenera.com/support/industrial-usb-ethernet/drivers-downloads/usb3-camera-firmware-updater.html](http://www.lumenera.com/support/industrial-usb-ethernet/drivers-downloads/usb3-camera-firmware-updater.html)

### **Firmware Update using Sapera LT**

When using Sapera LT, update the camera firmware using CamExpert (see [File Access via the CamExpert Tool \(Quick Camera Firmware Upgrade\)](#)). The Camera firmware can easily be upgraded within your own application via the API. The camera has a failsafe scheme which prevents unrecoverable camera errors even in the case of a power interruption.

## ***Firmware Update using Lumenera API***

When using Lumenera API, use the Lumenera Updater tool. See [Using LtUpdater](#) for details.

## ***Switching Camera Modes***

The camera can be switched between LuCam mode and USB3 Vision mode as required by the user. See **Switching a Teledyne Lumenera camera from LuCam mode to USB3 Vision mode** and **Switching a Teledyne Lumenera camera from USB3 Vision mode to LuCam mode** for details on the procedure.

# Series Specifications

## Common Specifications

Camera Controls	
Synchronization Modes	Free running, External triggered, Software Triggered
Exposure Control	Internal – Programmable via the camera API External – based on Trigger Width
Exposure Mode	Programmable with time increments that are camera model specific Minimum (in $\mu$ s) is model specific Pulse controlled via Trigger pulse width
Inputs/Outputs (Lt-Ux0x-xxxxx series)	4 GPIO options: 1 optically isolated output, 1 optically isolated input, and 2 configurable I/O ports controls for synchronization (trigger and strobe) of multiple cameras, peripherals, and lighting
Inputs/Outputs (Lt-xx1x-xxxxx series)	2 GPIO bi-directional terminals 1 optically isolated input 1 optically isolated output 3.3 Vdc output source (maximum 150 mA)
Inputs/Outputs (Lt-Ux2x-xxxxx series)	2 GP inputs 3 GP outputs
Features	
Flash memory	Non-volatile flash memory implemented
Image Buffer	128 MB (Lt-Ux0x-xxxxx and Lt-xx1x-xxxxx series) 256 MB (Lt-Ux2x-xxxxx series)
Gain	Manual and automatic control – Analog and Digital (sensor specific)
Auto-Exposure	Yes, with user set target luminance level
Color model output	Color cameras support BayerBG8 and BayerBG16 output modes
LUT	Programmable LUT (Look-up-table)
Timestamp	Timer to Timestamp images and events
Back Focal Distance	
Back Focal Distance	17.52 mm (C-mount) 12.52 mm (CS-mount) 12 mm (M42-mount)
Mechanical Interface	
Data Interface	USB 3.1, micro-b locking connector
I/O Interface	Locking Hirose MXR-8R-8SA(71) (Lt-Ux0x-xxxxx series) Locking 9-pin JST NSHR-09V-S for the (Lt-xx1x-xxxxx series) Locking 10-pin Samtec TFM-105-02-L-D-WT (Lt-Ux2x-xxxxx series)
Camera Dimensions (W x H x L) see <a href="#">Mechanical Specifications</a>	44 x 44 x 61 mm (Lt-Ux0x-xxxxx series) 45 x 45 x 28 to 36 mm (model dependent for Lt-xx1x-xxxxx series) 59 x 59 x 44 mm (Lt-Ux20-xxxxx series)
Mass	~ 140 g (approximate value for Lt-Ux0x-xxxxx series) ~ 88 g (approximate value for Lt-xx1x-xxxxx series) ~ 263 g (approximate value for Lt-Ux20-xxxxx series)
Electrical Interface	
Input Voltage	5 to 25 V via power over USB or via external interface connector (Lt-xx1x-xxxxx, Lt-Ux0x-xxxxx series) 10 to 28 V via external interface connector <b>only</b> (Lt-Ux2x-xxxxx series)
Power Dissipation (typical)	~ 4 W (Lt-Ux0x-xxxxxx series) ~ 2.3 to 3.6 W (Lt-xx1x-xxxxxx series) ~ 8 W (Lt-Ux20-xxxxx series)

Environmental Conditions	
Operating Temperature (at camera front plate)	All Models: 0°C to +50°C <i>Any metallic camera mounting provides heat sinking, which consequently reduces the internal temperature.</i>
Operating Relative Humidity	5% to 90% non-condensing
Storage	-30°C to +70°C
Conformity	FCC Class B & CE Certified, RoHS & WEEE Compliant
Shock / Vibration	IEC60721-4-7 Class 7M2 & IEC60068-2-27
Sinusoidal & Random Vibration	IEC60721-4-7 Class 7M2 & IEC60721-4-2 Class 2M2 IEC60068-2-6 & IEC60068-2-64
Case Protection Rating	IP50 (Optical Path) (Lt-Ux0x-xxxxx series) IP40 (Optical Path) (Lt-xx1x-xxxxx series) IP40 (Lt-Ux2x-xxxxx series)

## Sensor Cosmetic Specifications

After Factory Calibration and/or Corrections are applied (dependent on sensor)

Blemish Specifications	Maximum Number of Defects	Blemish Description
Hot/Dead Pixel defects	Typical 0.0025% Max 0.005%	Any pixel that deviates by $\pm 20\%$ from the average of neighboring pixels at 50% saturation including pixel stuck at 0 and maximum saturated value.
Spot defects	None	Grouping of more than 8 pixel defects within a sub-area of 3x3 pixels, to a maximum spot size of 7x7 pixels.
Clusters defects	None	Grouping of more than 5 single pixel defects in a 3x3 kernel.
Column defects	None	Vertical grouping of more than 10 contiguous pixel defects along a single column.
Row defects	None	Horizontal grouping of more than 10 contiguous pixel defects along a single row.

### Cleanliness Test conditions

- Nominal light = illumination at 60% of saturation
- Camera temperature  $\leq 55^\circ\text{C}$
- At exposures lower than 0.1 seconds
- At gain = 1

### Defective Pixel Correction Test conditions

- Gray: illumination at 60% of saturation, gain = 1
- Black: gain = 15
- Camera temperature =  $50^\circ\text{C} - 55^\circ\text{C}$

### Sony Sensor Limitation

- Max pixel saturated values: Max Pixel format bit depth – 4095 (12-bit)

---

# Dynamic Range & Signal to Noise Ratio Measurement Conditions

Specifications calculated according to EMVA-1288 standard, using white LED light.

## Dynamic Range Test Conditions

- Exposure 100  $\mu$ s for 0% Full Light Level
- Lt-x1610 exposure 6 ms, gain 1, variable light source from dark to saturation
- Lt-x1630 exposure 40 ms, gain 1, variable light source from dark to saturation
- Lt-x1900 exposure 17 ms, gain 1, variable light source from dark to saturation
- Lt-x1950 exposure 60 ms, gain 1, variable light source from dark to saturation
- Lt-x1980 exposure 75 ms, gain 1, variable light source from dark to saturation
- Lt-x2020 exposure 16 ms, gain 1, variable light source from dark to saturation
- Lt-x2050 exposure 45 ms, gain 1, variable light source from dark to saturation
- Lt-x2420 exposure 28 ms, gain 1, variable light source from dark to saturation
- Lt-x2450 exposure 33 ms, gain 1, variable light source from dark to saturation
- Lt-x2470 exposure 19 ms, gain 1, variable light source from dark to saturation
- Lt-x3200 exposure 38 ms, gain 1, variable light source from dark to saturation
- Lt-x3840 exposure 43 ms, gain 1, variable light source from dark to saturation
- Lt-x4030 exposure 150 ms, gain 1, variable light source from dark to saturation
- Lt-x4060 exposure 50 ms, gain 1, variable light source from dark to saturation
- Lt-x4020 exposure 150 ms, gain 1, variable light source from dark to saturation
- Lt-x4040 exposure 32 ms, gain 1, variable light source from dark to saturation
- Lt-x4430 exposure 3.5 ms, gain 1, variable light source from dark to saturation
- Lt-x4510 exposure 73 ms, gain 1, variable light source from dark to saturation
- Lt-x5300 exposure 63 ms, gain 1, variable light source from dark to saturation
- Lt-x5470 exposure 3.5 ms, gain 1, variable light source from dark to saturation
- Lt-x5500 exposure 10 ms gain 1, variable light source from dark to saturation
- Lt-x6480 exposure 3.5 ms, gain 1, variable light source from dark to saturation

## SNR Test Conditions

- Exposure 2000  $\mu$ s
- 80% saturation

---

# Mean Time between Failure (MTBF)

Teledyne Lumenera MTBF calculations use the Parts Count / Parts Stress method. Calculated assembly FIT values are rounded up with margin to provide adequate headroom and the final quoted MTBF is then rounded down to the nearest year.

In practice, MILSTD217F is used to model passive and simple active parts, such as diodes and transistors, because manufacturer data is unreliable. When MILSTD217F models are used to represent more than one physical part, worst case parameters are used. Manufacturer's data is used to model more complicated active parts, such as buffers and FPGAs, because the internal structures are not known, and the manufacturer data is more likely to be valid. When manufacturer data is used, it is modified to meet specific use conditions using the Arrhenius equation and the result is set to a 90% confidence level using the Chi-Squared Distribution Method. Again, when more than one of the same parts exist on an assembly, worst case parameters are used. Manufacturer data is either obtained from the manufacturer's website or provided directly from the manufacturer.

The calculated MTBF only considers electronic components. It does not include mechanical parts unless specified.

**MTBF assumptions**

- Fixed Ground Environment Readily Accessible for Maintenance
- Manufactured to Specification
- Proper Operating Conditions/Environment During Life Cycle

It is important to note that the MTBF result provided here is subject to change due to design changes or as new reliability/test data becomes available.

**Calculation Results**

Lt Series Product MTBF Results	Lt-Ux0x-xxxxx, Lt-xx1x-xxxxx	Lt-Ux2x-xxxxx
FIT Value	9500	11 400
MTBF Years	12	10

# Model Specifications

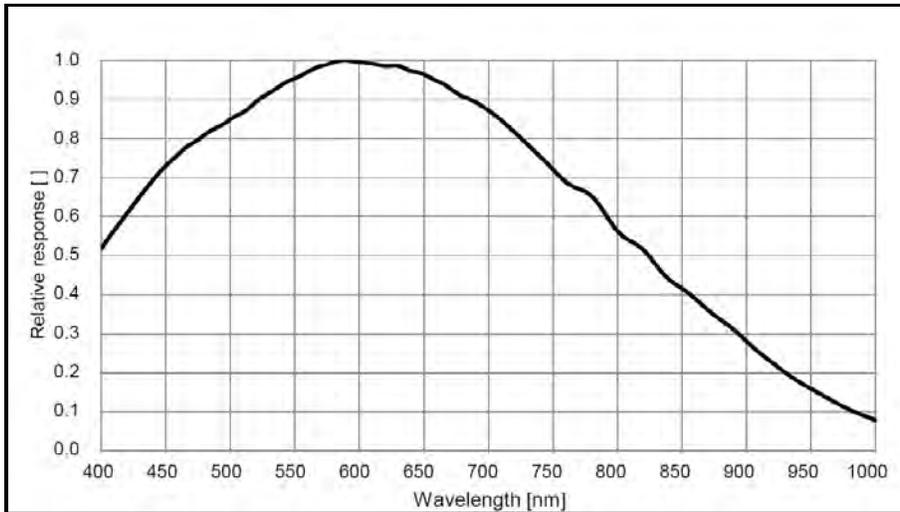
## Specifications Lt-M1610 / Lt-C1610

Supported Features	Lt-M1610 / Lt-C1610	
Resolution	1608 x 1104	
Sensor	Sony IMX432 (1.8 MP)	
Pixel Size	9.00 $\mu\text{m}$ x 9.00 $\mu\text{m}$	
Optical Format	1.1"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	100.4 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	96.3 fps (8-bit, 12-bit)	
Maximum Sustained Frame Rate Output	96.3 fps (8-bit)	
Exposure Time Range	5 $\mu\text{s}$ – 4295 s (triggered) 14 $\mu\text{s}$ – 9.2 s (continuous)	
Trigger to Exposure Minimum Delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	5.00 $\mu\text{s}$ (triggered) 13.81 $\mu\text{s}$ (continuous) Exposure time increment steps = Horizontal Line Time	
Min. Time from End of Exposure to Start of Next Exposure	105.7 $\mu\text{s}$	
Horizontal Line Time	8.81 $\mu\text{s}$	
Readout Time	10.36 ms (Horizontal Line Time) x (lines in frame + 72) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (256 max)	
Color Enhancement Support	Monochrome Model — No	Color Model — Yes (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes – On Sensor, Vertical and Horizontal	
Binning Support	No	
Multi-ROI Support	No	
Decimation Support	No	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	72.7 dB	
SNR	50.0 dB	

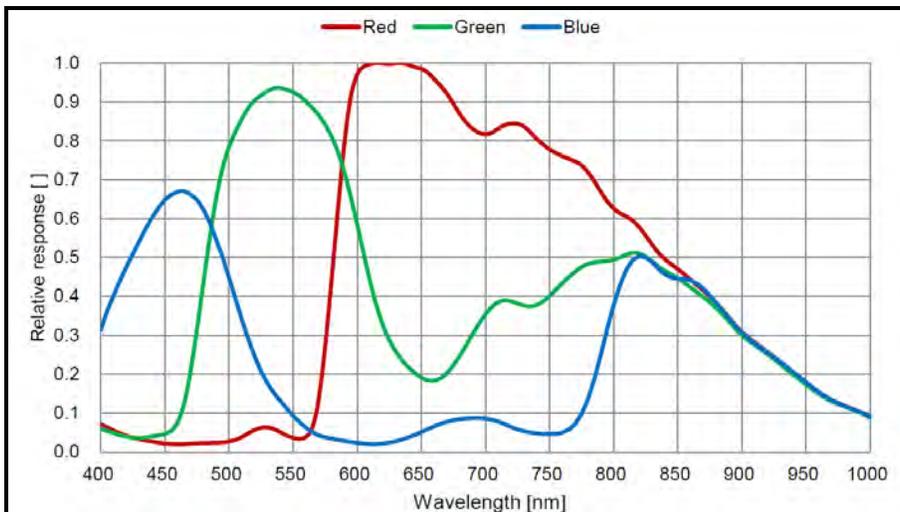
# Spectral Response Curves Lt-M1610 / Lt-C1610

Response curves from sensor datasheet.

## Monochrome (Lt-M1610)



## Color (Lt-C1610)



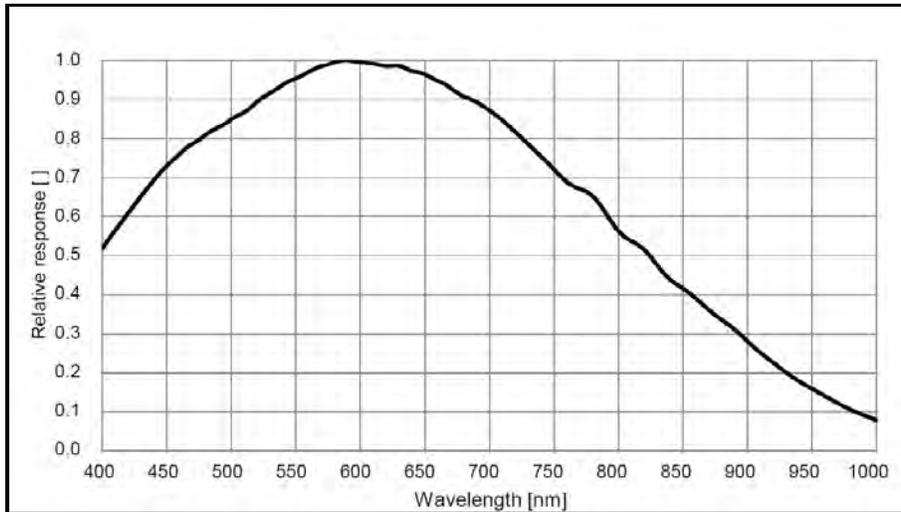
# Specifications Lt-M1630 / Lt-C1630

Supported Features	Lt-M1630 / Lt-C1630	
Resolution	1632 x 1248	
Sensor	Sony IMX430 (2.0 MP)	
Pixel Size	4.50 $\mu\text{m}$ x 4.50 $\mu\text{m}$	
Optical Format	1/1.7"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	25.1 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	85.7 fps (8-bit, 12-bit)	
Max. Sustained Frame Rate Output	85.7 fps (8-bit)	
Exposure Time Range	5 $\mu\text{s}$ – 4295 s (triggered) 14 $\mu\text{s}$ – 151.8 s (continuous)	
Trigger to Exposure Minimum Delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	5.00 $\mu\text{s}$ (triggered) 14.05 $\mu\text{s}$ (continuous) Exposure time increment steps = Horizontal Line Time	
Min. Time from End of Exposure to Start of Next Exposure	54.3 $\mu\text{s}$	
Horizontal Line Time	9.05 $\mu\text{s}$	
Readout Time	11.64 ms (Horizontal Line Time) x (lines in frame + 38) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (256 max)	
Color Enhancement Support	Monochrome Model – No	Color Model – Yes (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes – On Sensor, Vertical and Horizontal	
Binning Support	Yes, on sensor, monochrome model	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x Vertical and Horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	72.7 dB	
SNR	44.0 dB	

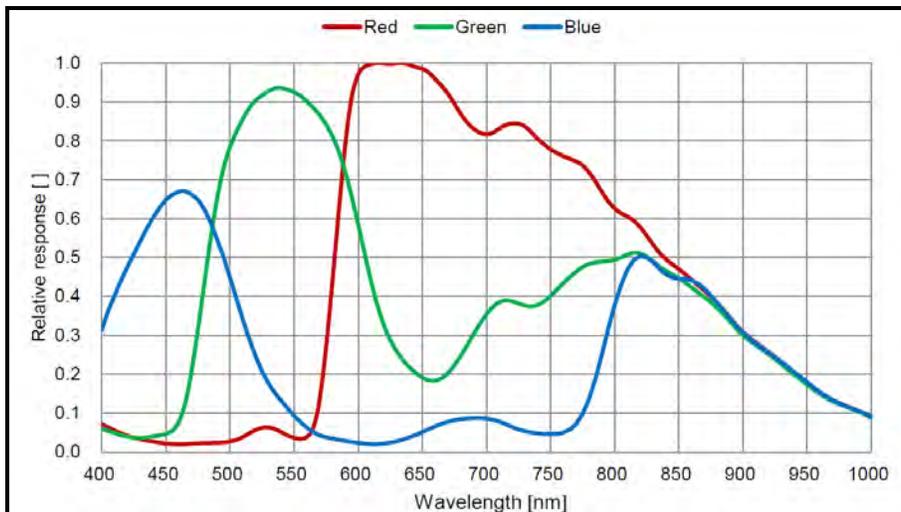
# Spectral Response Curves Lt-M1630 / Lt-C1630

Response curves from sensor datasheet.

## Monochrome (Lt-M1630)



## Color (Lt-C1630)



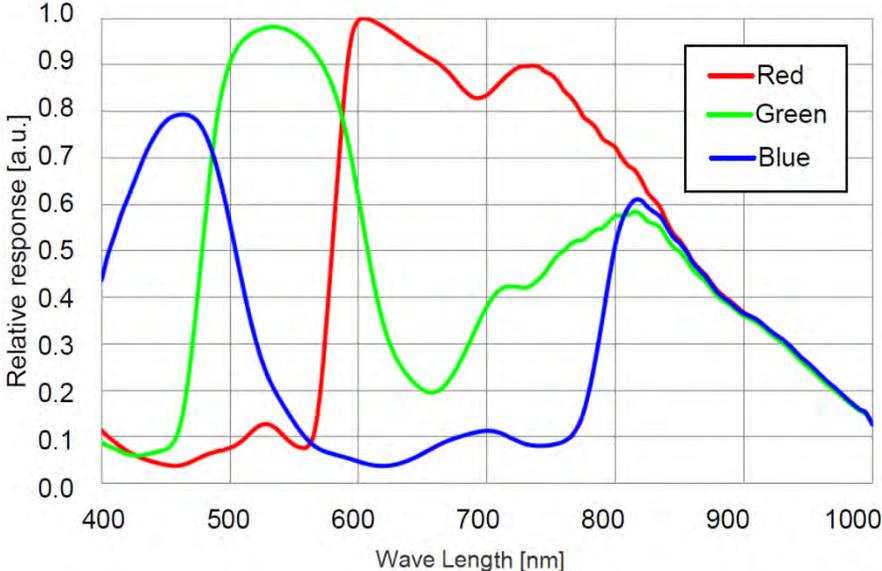
# Specifications Lt-C1900

Supported Features	C1900
Resolution	1944 x 1096
Sensor	Sony IMX327 (2.1 MP)
Pixel Size	2.90 $\mu\text{m}$ x 2.90 $\mu\text{m}$
Optical Format	1/2.8"
Shutter Type (see <a href="#">Guide to Using a Rolling Shutter Camera</a> )	Electronic Rolling Shutter function (ERS) (continuous) Global Reset Release (GRR) function (single exposure)
Full Well charge	11.2 ke (max)
Pixel Data Formats	Bayer 8-Bit or 12-Bit
Max. Internal Frame Rate Full resolution	60 fps (8-bit, 12-bit)
Max. Sustained Frame Rate Output	60 fps (8-bit)
Exposure Time Range	149 $\mu\text{s}$ – 1 s (triggered) 15 $\mu\text{s}$ – 1 s (continuous)
Trigger to Exposure Minimum Delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$
Actual Exposure Time Minimum	148.15 $\mu\text{s}$ (triggered) 14.81 $\mu\text{s}$ (continuous) Exposure time increment steps = Horizontal Line Time
Minimum Time from End of Exposure to Start of Next Exposure	118.5 $\mu\text{s}$
Horizontal Line Time	29.63 $\mu\text{s}$ (triggered) 14.81 $\mu\text{s}$ (continuous)
Readout Time	32.47 ms (Horizontal Line Time ) x (lines in frame) — in $\mu\text{s}$
Auto-Exposure	Yes, with Auto-Brightness Target (continuous only)
Black Offset control	Yes (in DN)
Gain Control	In-sensor gain (3715x digital max)
Color Enhancement Support	Yes – (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes
Image Correction	No
Image Flip Support	Yes, in-sensor, both vertical and horizontal
Binning Support	No
Multi-ROI Support	No
Decimation Support	No
On-board image memory	128 MB
Output Dynamic Range	72.7 dB
SNR	40.5 dB

# Spectral Response Curves Lt-C1900

Response curves from sensor datasheet.

## Color (Lt-C1900)



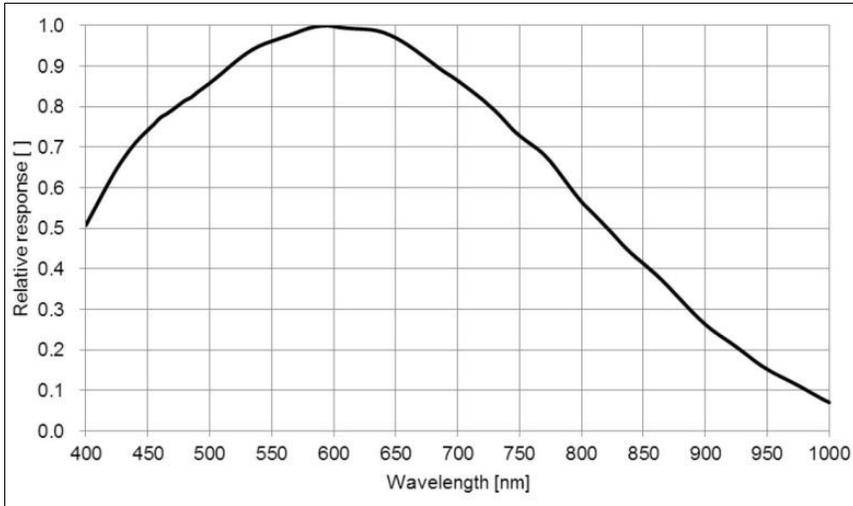
# Specifications Lt-M1950 / Lt-C1950

Supported Features	Lt-M1950 / Lt-C1950	
Resolution	1932 x 1216	
Sensor	Sony IMX392 (2.3 MP)	
Pixel Size	3.45 $\mu\text{m}$ x 3.45 $\mu\text{m}$	
Optical Format	1/2.3"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	10.5 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	162 fps (8-bit) 81 fps (12-bit)	
Maximum Sustained Frame Rate Output	162 fps (8-bit)	
Exposure Time Range	14 $\mu\text{s}$ – 4295 s (triggered) 25 $\mu\text{s}$ – 11.1 s (continuous)	
Trigger to Exposure Minimum Delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	13.73 $\mu\text{s}$ (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	31.7 $\mu\text{s}$	
Horizontal Line Time	3.96 $\mu\text{s}$	
Readout Time	4.91 ms (Horizontal Line Time) x (lines in frame + 23) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (max 256)	
Color Enhancement Support	Monochrome Model – No	Color Model – Yes (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes, In-Sensor, Vertical and Horizontal	
Binning Support	Yes, on sensor, monochrome model	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x, vertical and horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	73.4 dB	
SNR	40.2 dB	

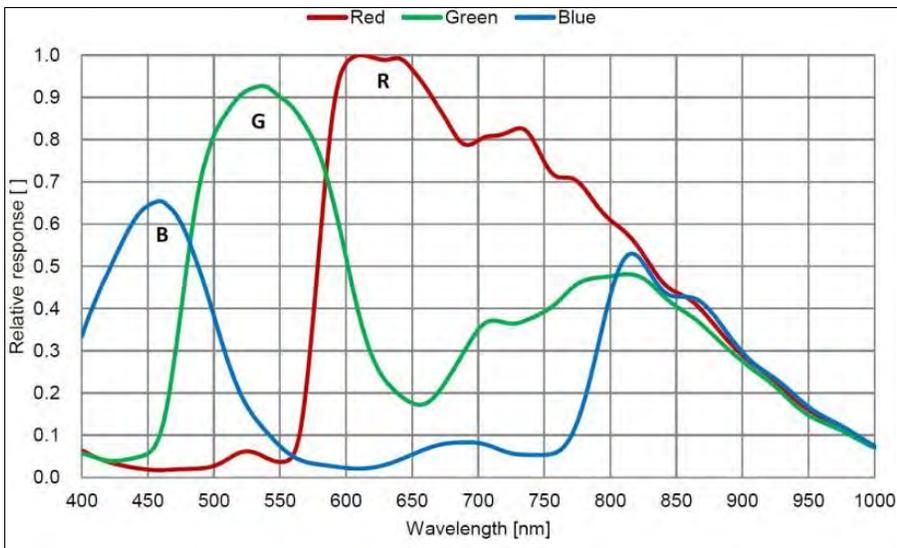
# Spectral Response Curves Lt-M1950 / Lt-C1950

Response curves from sensor datasheet.

## Monochrome (Lt-M1950)



## Color (Lt-C1950)



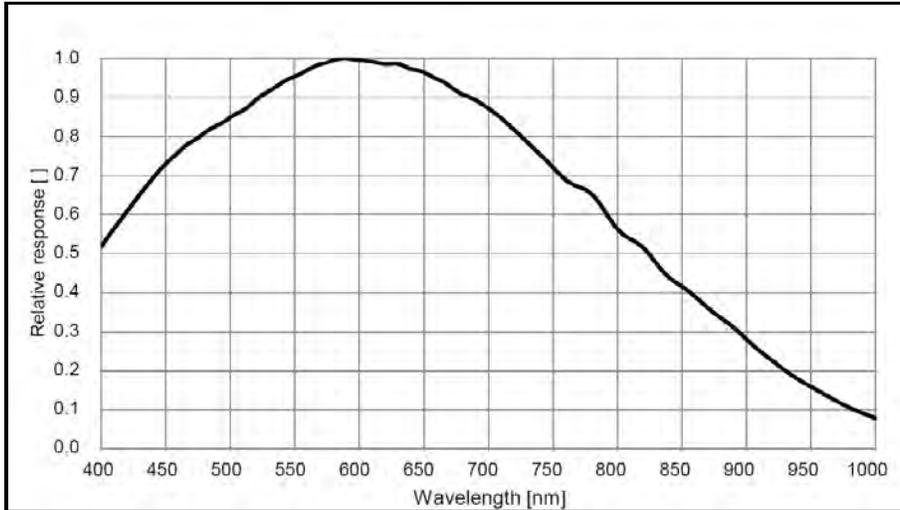
# Specifications Lt-M1980 / Lt-C1980

Supported Features	Lt-M1980 / Lt-C1980	
Resolution	1944 x 1472	
Sensor	Sony IMX429 (2.9 MP)	
Pixel Size	4.50 $\mu\text{m}$ x 4.50 $\mu\text{m}$	
Optical Format	2/3"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	24.9 ke	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	62.8 fps (8-bit, 12-bit)	
Maximum Sustained Frame Rate Output	62.8 fps (8-bit)	
Exposure Time Range	5 $\mu\text{s}$ – 4295 s (triggered) 16 $\mu\text{s}$ – 177.1 s (continuous)	
Trigger to Exposure Minimum Delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	5.00 $\mu\text{s}$ (triggered) 15.56 $\mu\text{s}$ (continuous) (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	42.2 $\mu\text{s}$	
Horizontal Line Time	10.56 $\mu\text{s}$	
Readout Time	15.92 ms (Horizontal Line Time) x (lines in frame + 36) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (256 max)	
Color Enhancement Support	Monochrome Model — No	Color Model — Yes (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes, on sensor, vertical and horizontal	
Binning Support	Yes, on sensor, monochrome model	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x, vertical and horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	72.0 dB	
SNR	43.9 dB	

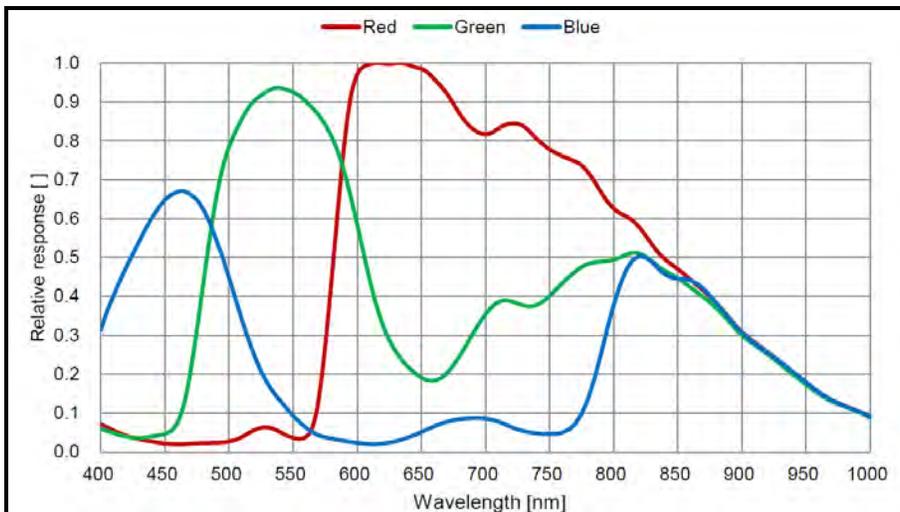
# Spectral Response Curves Lt-M1980 / Lt-C1980

Response curves from sensor datasheet.

## Monochrome (Lt-M1980)



## Color (Lt-C1980)



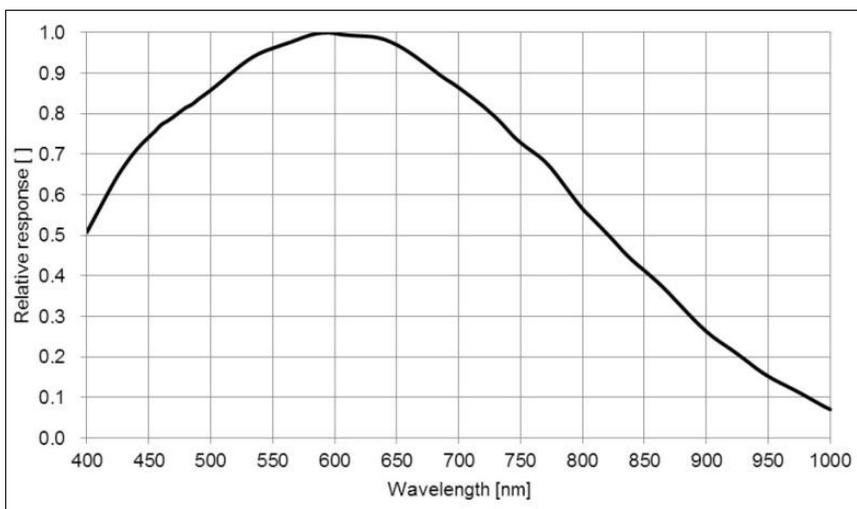
# Specifications Lt-M2020 / Lt-C2020

Supported Features	M2020	C2020
Resolution	2064 x 1544	
Sensor	Sony IMX265 (3.2 MP)	
Pixel Size	3.45 $\mu\text{m}$ x 3.45 $\mu\text{m}$	
Optical Format	1/1.8"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	10.9 ke (max)	
Pixel Data Formats	Mono 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	55 fps (8-bit, 12-bit)	
Maximum Sustained Frame Rate Output	55 fps (8-bit)	
Exposure Time Range	14 $\mu\text{s}$ – 4295 s (triggered) 14 $\mu\text{s}$ – 11.9 s (continuous)	
Trigger to Exposure Minimum delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	13.73 $\mu\text{s}$ (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	91.2 $\mu\text{s}$	
Horizontal Line Time	11.40 $\mu\text{s}$	
Readout Time	17.80 ms (Horizontal Line Time) x (lines in frame +17) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	In-sensor Gain (max 256)	
Color Enhancement Support	Monochrome Models – No	Color Models – Yes (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes, In-Sensor, Vertical and Horizontal	
Binning Support	No	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x, vertical and horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	73.8 dB	
SNR	41.1 dB	

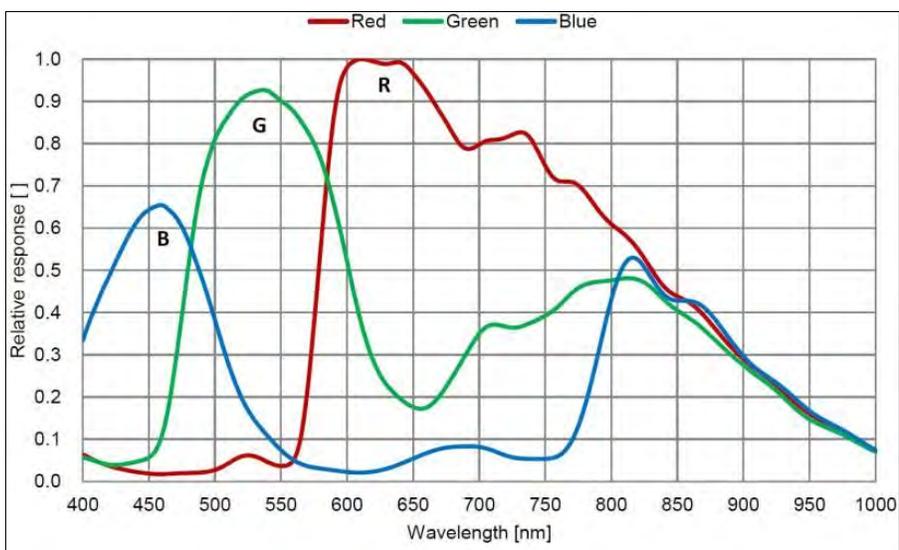
# Spectral Response Curves Lt-M2020 / Lt-C2020

Response curves from sensor datasheet.

## Monochrome (Lt-M2020)



## Color (Lt-C2020)



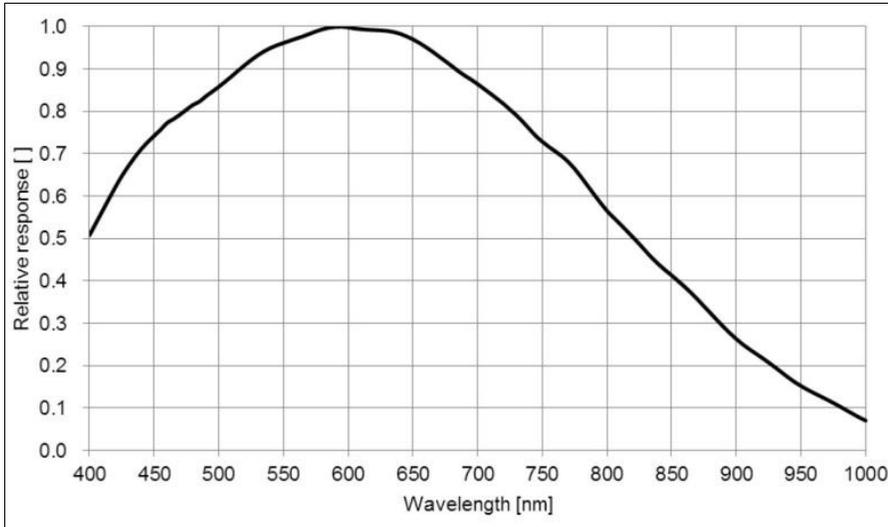
# Specifications Lt-M2050 / Lt-C2050

Supported Features	Lt-M2050 / Lt-C2050	
Resolution	2064 x 1544	
Sensor	Sony IMX252 (3.2 MP)	
Pixel Size	3.45 $\mu\text{m}$ x 3.45 $\mu\text{m}$	
Optical Format	1/1.8"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	10.7 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate (Full resolution)	151 fps (8-bit) 83 fps (12-bit)	
Maximum Sustained Frame Rate Output	120 fps (8-bit)	
Exposure Time Range	14 $\mu\text{s}$ – 4295 s (triggered) 14 $\mu\text{s}$ – 8.2 s (continuous)	
Trigger to Exposure Minimum delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	13.73 $\mu\text{s}$ (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	41.7 $\mu\text{s}$	
Horizontal Line Time	4.17 $\mu\text{s}$	
Readout Time	6.60 ms (Horizontal Line Time) x (lines in frame + 38) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (max 256)	
Color Enhancement Support	No – Monochrome Models	Yes – Color Models (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip	Yes, Horizontal and Vertical	
Binning Support	Yes, on sensor, monochrome model	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x vertical and horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	73.0 dB	
SNR	40.3 dB	

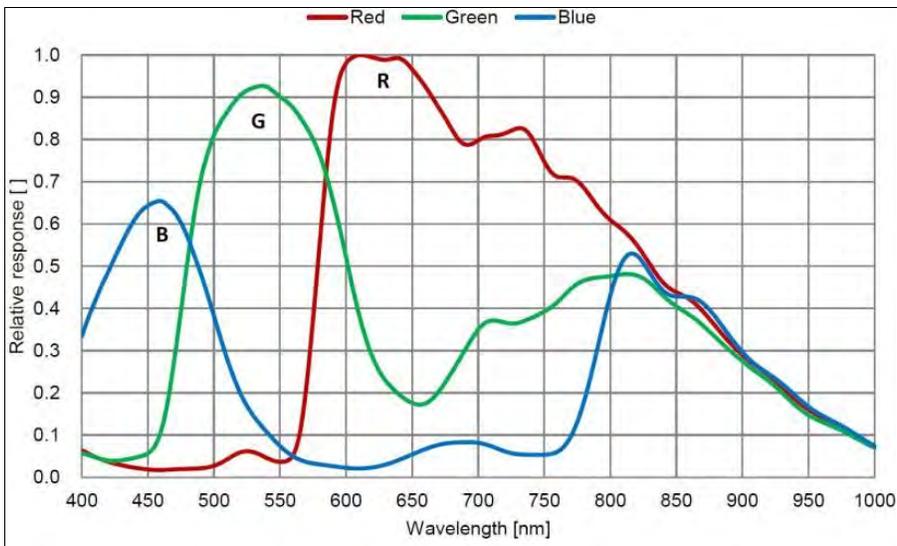
# Spectral Response Curves Lt-M2050 / Lt-C2050

Response curves from sensor datasheet.

## Monochrome (Lt-M2050)



## Color (Lt-C2050)



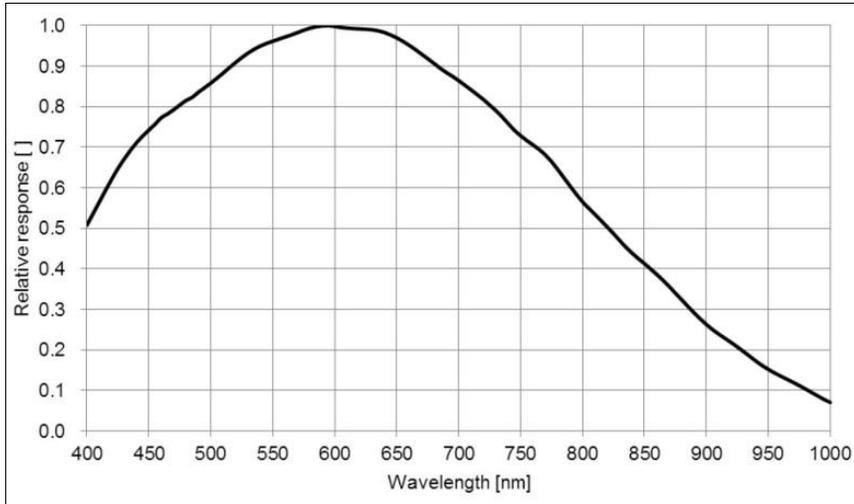
# Specifications Lt-M2420 / Lt-C2420

Supported Features	Lt-M2420 / Lt-C2420	
Resolution	2464 x 2056	
Sensor	Sony IMX264 (5.1 MP)	
Pixel Size	3.45 $\mu\text{m}$ x 3.45 $\mu\text{m}$	
Optical Format	2/3"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	10.4 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	35 fps (8-bit, 12-bit)	
Maximum Sustained Frame Rate Output	35 fps (8-bit)	
Exposure Time Range	14 $\mu\text{s}$ – 4295 s (triggered) 14 $\mu\text{s}$ – 14.1 s (continuous)	
Trigger to Exposure Minimum delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	13.73 $\mu\text{s}$ (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	107.3 $\mu\text{s}$	
Horizontal Line Time	13.40 $\mu\text{s}$	
Readout Time	27.78 ms (Horizontal Line Time) x (lines in frame + 17) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	In-sensor Gain (max 256)	
Color Enhancement Support	No – Monochrome Models	Yes – Color Models (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes, in sensor, Vertical and Horizontal	
Binning Support	No	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x, vertical and horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	73.0 dB	
SNR	40.2 dB	

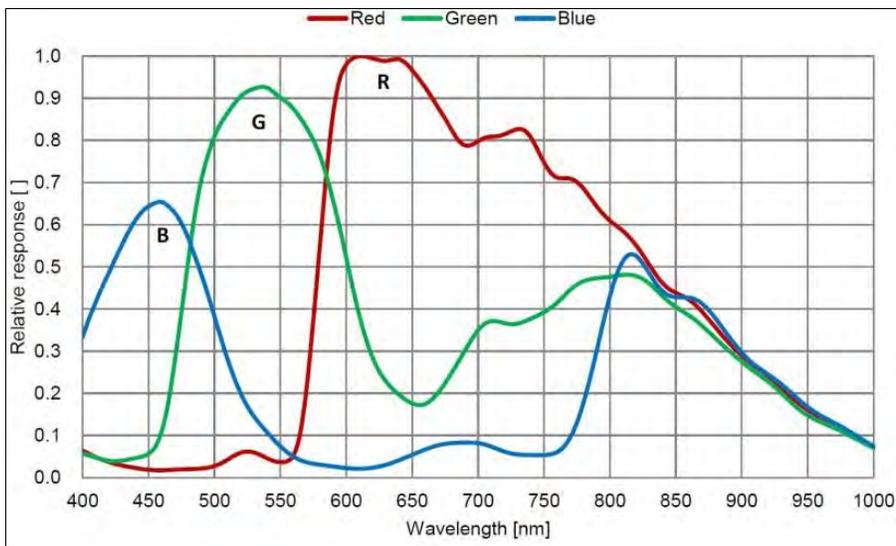
# Spectral Response Curves Lt-M2420 / Lt-C2420

Response curves from sensor datasheet.

## Monochrome (Lt-M2420)



## Color (Lt-C2420)



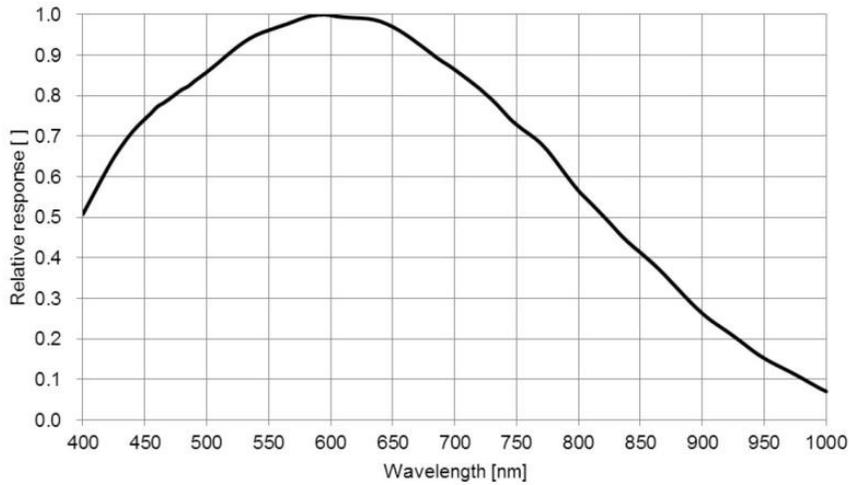
# Specifications Lt-M2450 / Lt-C2450

Supported Features	Lt-M2450 / Lt-C2450	
Resolution	2464 x 2056	
Sensor	Sony IMX250 (5.1 MP)	
Pixel Size	3.45 $\mu\text{m}$ x 3.45 $\mu\text{m}$	
Optical Format	2/3"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	10.8 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	99 fps (8-bit) 53 fps (12-bit)	
Maximum Sustained Frame Rate Output	75 fps (8-bit)	
Exposure Time Range	14 $\mu\text{s}$ – 4295 s (triggered) 14 $\mu\text{s}$ – 9.6 s (continuous)	
Trigger to Exposure Minimum delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	13.73 $\mu\text{s}$ (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	48.5 $\mu\text{s}$	
Horizontal Line Time	4.85 $\mu\text{s}$	
Readout Time	10.16 ms (Horizontal Line Time) x (lines in frame + 38) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (max 256)	
Color Enhancement Support	No – Monochrome Models	Yes – Color Models (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes, in sensor, Vertical and Horizontal	
Binning Support	Yes, on sensor, monochrome model	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x, vertical and horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	73.0 dB	
SNR	40.3 dB	

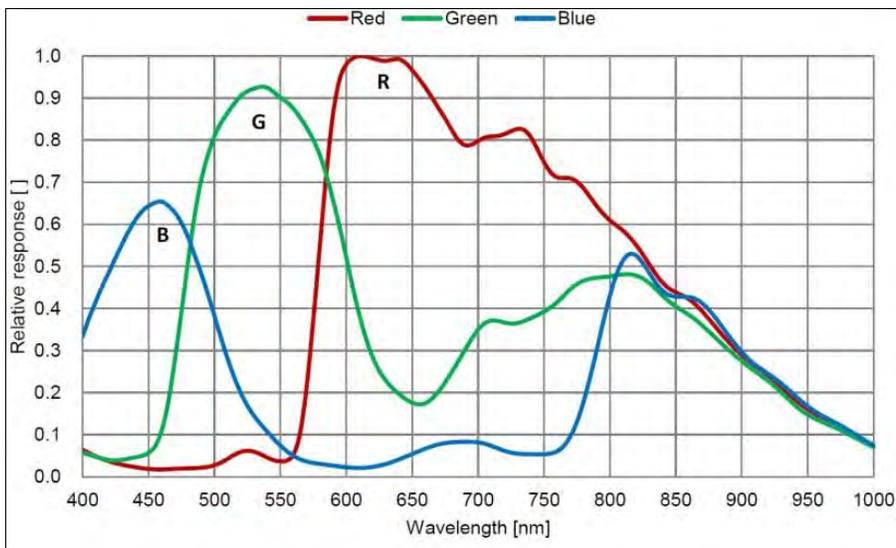
# Spectral Response Curves Lt-M2450 / Lt-C2450

Response curves from sensor datasheet.

## Monochrome (Lt-M2450)



## Color (Lt-C2450)



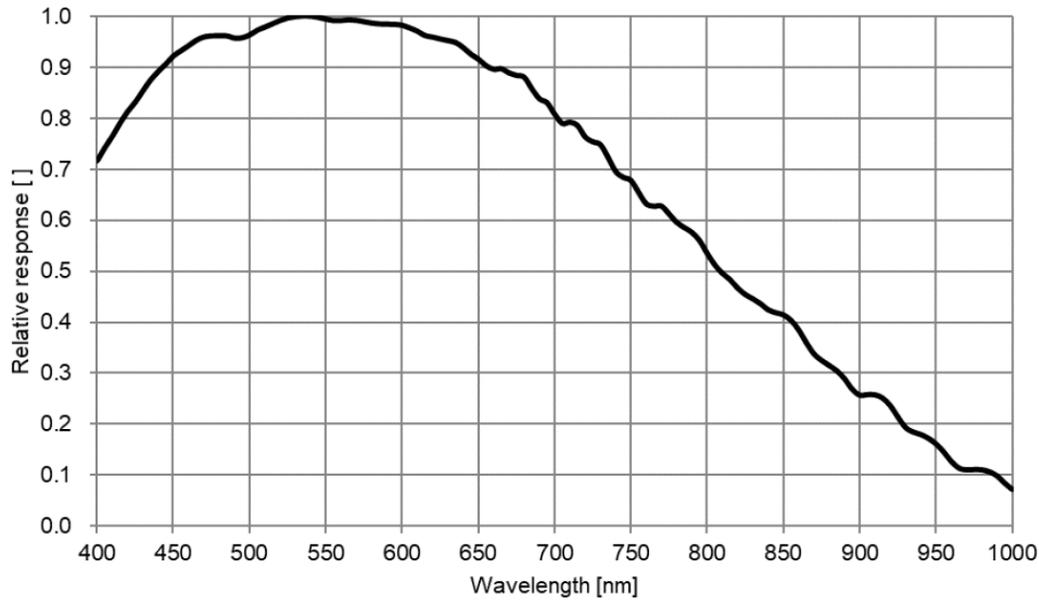
# Specifications Lt-M2470 / Lt-C2470

Supported Features	Lt-M2470 / Lt-C2470	
Resolution	2472 x 2064	
Sensor	Sony IMX547 (5.1 MP)	
Pixel Size	2.74 $\mu\text{m}$ x 2.74 $\mu\text{m}$	
Optical Format	1/1.8"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	9.4 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	92 fps (8-bit) 63 fps (12-bit)	
Max. Sustained Frame Rate Output	75 fps (8-bit)	
Exposure Time Range	2 $\mu\text{s}$ – 4295 s (triggered) 9 $\mu\text{s}$ – 102 s (continuous)	
Trigger to Exposure Minimum delay (fast trigger/reset exposure alignment)	0.1 $\mu\text{s}$	
Actual Exposure Time Minimum	2.47 $\mu\text{s}$ (triggered) 9 $\mu\text{s}$ (continuous) Exposure time increment steps = 1 $\mu\text{s}$	
Min. Time from End of Exposure to Start of Next Exposure	244 $\mu\text{s}$	
Horizontal Line Time	4.89 $\mu\text{s}$	
Readout Time	10.82 ms (Horizontal Line Time) x (lines in frame + 130) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes, on sensor (max 256)	
Color Enhancement Support	Monochrome – No	Color – Yes (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes, on sensor, Vertical and Horizontal	
Binning Support	Yes, on sensor, Monochrome Model	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x, Vertical and Horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	71.4 dB	
SNR	39.7 dB	

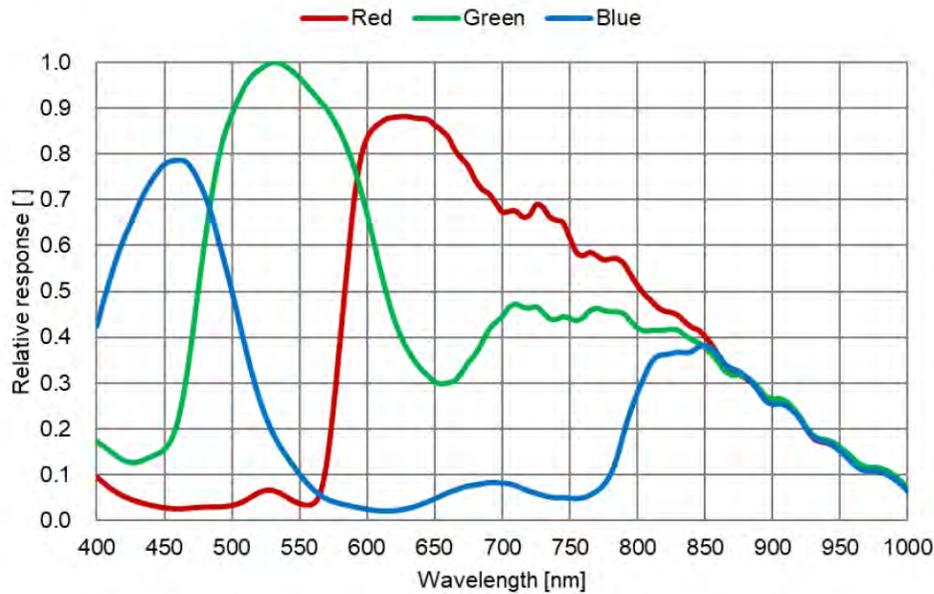
# Spectral Response Curves Lt-M2470 / Lt-C2470

Response curves from sensor datasheet.

## Monochrome (Lt-M2470)



## Color (Lt-C2470)



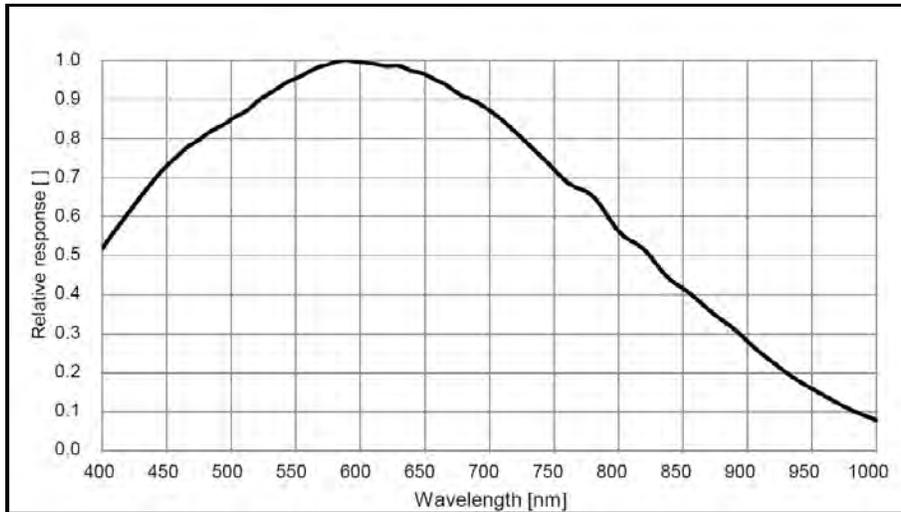
# Specifications Lt-M3200 / Lt-C3200

Supported Features	Lt-M3200 / Lt-C3200	
Resolution	3216 x 2208	
Sensor	Sony IMX428 (7.1 MP)	
Pixel Size	4.50 $\mu\text{m}$ x 4.50 $\mu\text{m}$	
Optical Format	1.1"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	25.2 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	50 fps (8-bit, 12-bit)	
Maximum Sustained Frame Rate Output	50 fps (8-bit)	
Exposure Time Range	5 $\mu\text{s}$ – 4295 s (triggered) 14 $\mu\text{s}$ – 9.2 s (continuous)	
Trigger to Exposure Minimum Delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	5.00 $\mu\text{s}$ (triggered) 13.81 $\mu\text{s}$ (continuous) (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	105.7 $\mu\text{s}$	
Horizontal Line Time	8.81 $\mu\text{s}$	
Readout Time	19.87 ms (Horizontal Line Time) x (lines in frame + 48) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (256 max)	
Color Enhancement Support	Monochrome Model – No	Color Model – Yes (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes, on sensor, vertical and horizontal	
Binning Support	Yes, on sensor, monochrome model	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x vertical and horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	72.4 dB	
SNR	44.0 dB	

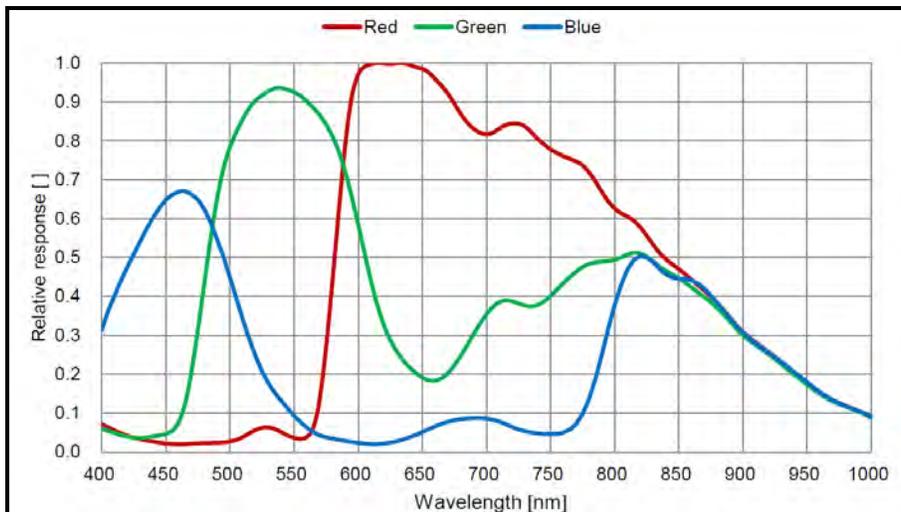
# Spectral Response Curves Lt-M3200 / Lt-C3200

Response curves from sensor datasheet.

## Monochrome (Lt-M3200)



## Color (Lt-C3200)



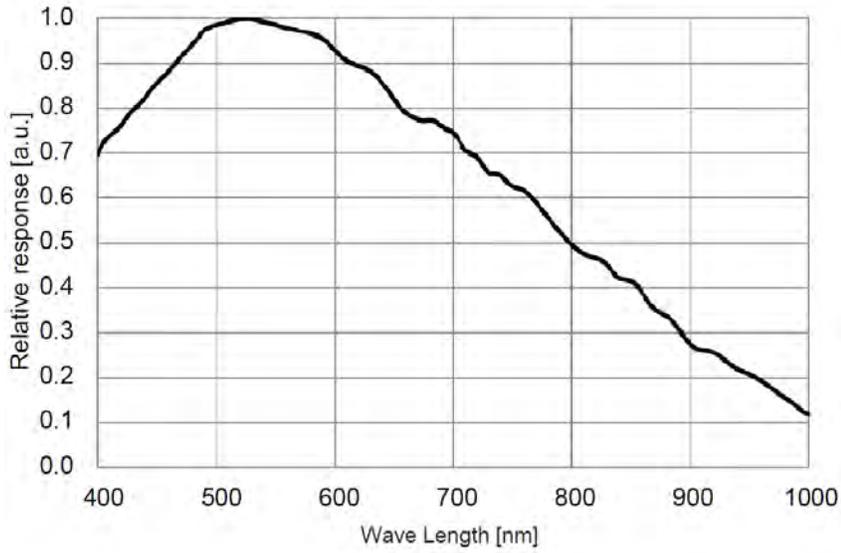
# Specifications Lt-M3840 / Lt-C3840

Supported Features	Lt-M3840 / Lt-C3840	
Resolution	3840 x 2160	
Sensor	Sony IMX334 (8.3 MP)	
Pixel Size	2 $\mu\text{m}$ x 2 $\mu\text{m}$	
Optical Format	1/1.8"	
Shutter type (see <a href="#">Guide to Using a Rolling Shutter Camera</a> )	Electronic Rolling Shutter function (ERS) (continuous) Global Reset Release (GRR) function (single exposure)	
Full Well charge	7.0 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	44 fps (8-bit, 12-bit)	
Maximum Sustained Frame Rate Output	44 fps (8-bit)	
Exposure Time Range	104 $\mu\text{s}$ – 1 s (triggered) 13 $\mu\text{s}$ – 1 s (continuous)	
Trigger to Exposure Minimum delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	103.70 $\mu\text{s}$ (triggered) 12.21 $\mu\text{s}$ (continuous) (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	29.6 $\mu\text{s}$	
Horizontal Line Time	14.81 $\mu\text{s}$ (triggered) 9.91 $\mu\text{s}$ (continuous)	
Readout Time	32.00 ms (Horizontal Line Time) x (lines in frame) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target (continuous only)	
Black offset control	Yes (in DN)	
Gain Control	Yes (max 3317)	
Color Enhancement Support	No – Monochrome Models	Yes – Color Models (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes in sensor, Vertical and Horizontal	
Binning Support	Yes, color model	
Multi-ROI Support	No	
Decimation Support	No	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	70.8 dB	
SNR	38.5 dB	

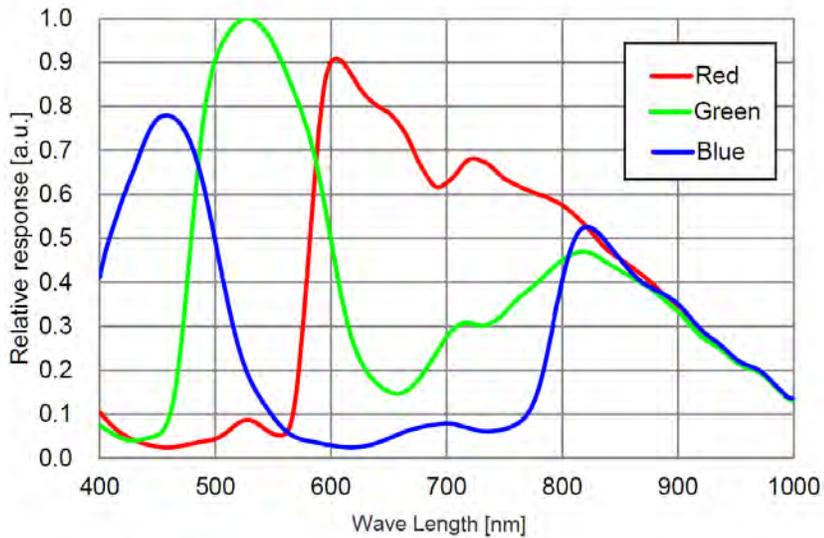
# Spectral Response Curves Lt-M3840 / Lt-C3840

Response curves from sensor datasheet.

## Monochrome (Lt-M3840)



## Color (Lt-C3840)



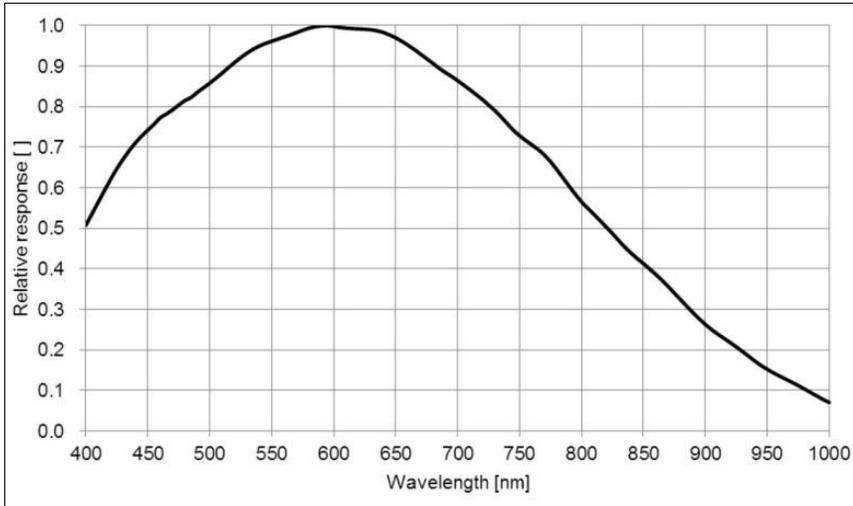
# Specifications Lt-M4030 / Lt-C4030

Supported Features	Lt-M4030 / Lt-C4030	
Resolution	4112 x 2176	
Sensor	Sony IMX267 (8.9 MP)	
Pixel Size	3.45 $\mu\text{m}$ x 3.45 $\mu\text{m}$	
Optical Format	1"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	10.6 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	31 fps (8-bit) 21 fps (12-bit)	
Maximum Sustained Frame Rate Output	31 fps (8-bit)	
Exposure Time Range	14 $\mu\text{s}$ – 4295 s (triggered) 14 $\mu\text{s}$ – 22.8 s (continuous)	
Trigger to Exposure Minimum delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	14.26 $\mu\text{s}$ (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	115.5 $\mu\text{s}$	
Horizontal Line Time	14.40 $\mu\text{s}$	
Readout Time	31.61 ms (Horizontal Line Time) x (lines in frame + 19) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (max 256)	
Color Enhancement Support	No – Monochrome Models	Yes – Color Models (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes in sensor, Vertical and Horizontal	
Binning Support	No	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x vertical and horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	73.3 dB	
SNR	40.1 dB	

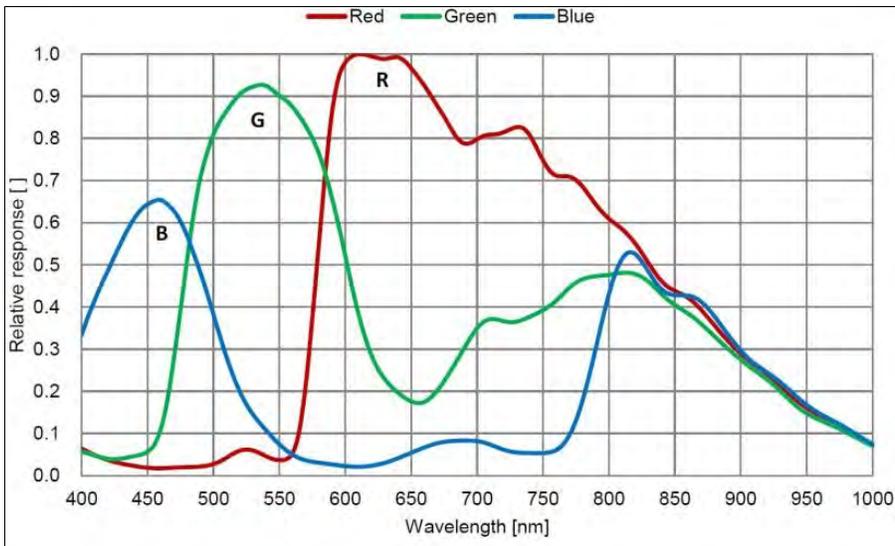
# Spectral Response Curves Lt-M4030 / Lt-C4030

Response curves from sensor datasheet.

## Monochrome (Lt-M4030)



## Color (Lt-C4030)



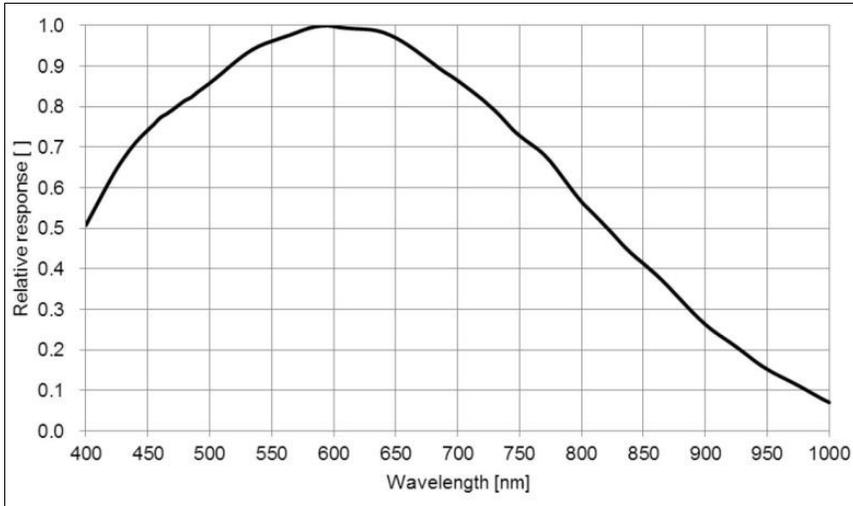
# Specifications Lt-M4060 / Lt-C4060

Supported Features	Lt-M4060 / Lt-C4060	
Resolution	4112 x 2176	
Sensor	Sony IMX255 (8.9 MP)	
Pixel Size	3.45 $\mu\text{m}$ x 3.45 $\mu\text{m}$	
Optical Format	1"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	10.5 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	57 fps (8-bit) 30 fps (12-bit)	
Maximum Sustained Frame Rate Output	42 fps (8-bit)	
Exposure Time Range	14 $\mu\text{s}$ – 4295 s (triggered) 14 $\mu\text{s}$ – 15.5 s (continuous)	
Trigger to Exposure Minimum delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	14.26 $\mu\text{s}$ (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	156 $\mu\text{s}$	
Horizontal Line Time	7.80 $\mu\text{s}$	
Readout Time	17.39 ms (Horizontal Line Time) x (lines in frame + 54) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (max 256)	
Color Enhancement Support	No – Monochrome Models	Yes – Color Models (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes in sensor, Vertical and Horizontal	
Binning Support	Yes, on sensor, monochrome model	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x, vertical and horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	73.0 dB	
SNR	40.3 dB	

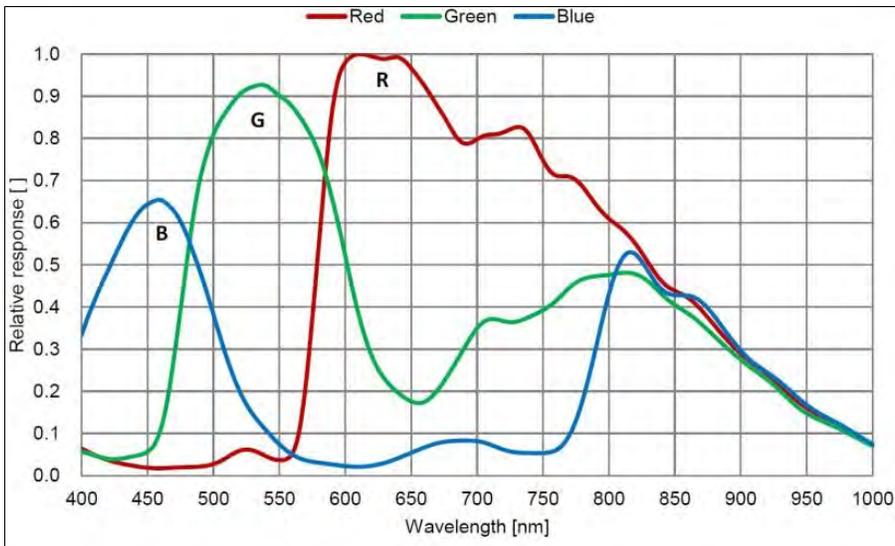
# Spectral Response Curves Lt-M4060 / Lt-C4060

Response curves from sensor datasheet.

## Monochrome (Lt-M4060)



## Color (Lt-C4060)



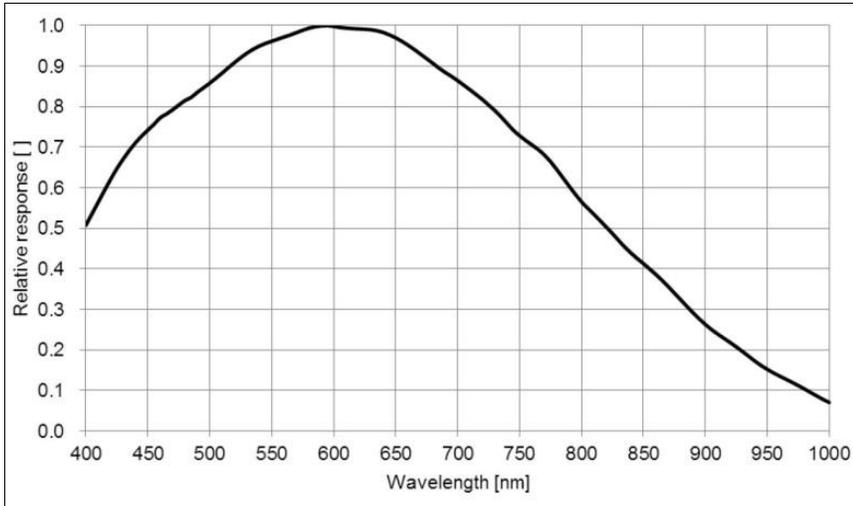
# Specifications Lt-M4020 / Lt-C4020

Supported Features	Lt-M4020 / Lt-C4020	
Resolution	4112 x 3008	
Sensor	Sony IMX304 (12.4 MP)	
Pixel Size	3.45 $\mu\text{m}$ x 3.45 $\mu\text{m}$	
Optical Format	1.1"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	10.6 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	22 fps (8-bit, 12-bit)	
Maximum Sustained Frame Rate Output	22 fps (8-bit)	
Exposure Time Range	14 $\mu\text{s}$ – 4295 s (triggered) 14 $\mu\text{s}$ – 22.8 s (continuous)	
Trigger to Exposure Minimum delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	14.26 $\mu\text{s}$ (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	115.5 $\mu\text{s}$	
Horizontal Line Time	14.40 $\mu\text{s}$	
Readout Time	43.59 ms (Horizontal Line Time) x (lines in frame + 19) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (max 256)	
Color Enhancement Support	No – Monochrome Models	Yes – Color Models (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes in sensor, Vertical and Horizontal	
Binning Support	No	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x, vertical and horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	73.0 dB	
SNR	40.1 dB	

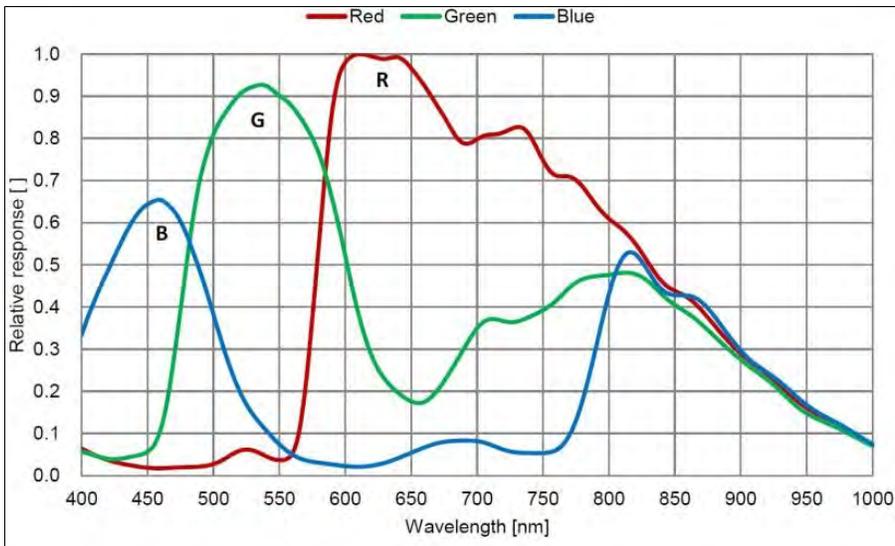
# Spectral Response Curves Lt-M4020 / Lt-C4020

Response curves from sensor datasheet.

## Monochrome (Lt-M4020)



## Color (Lt-C4020)



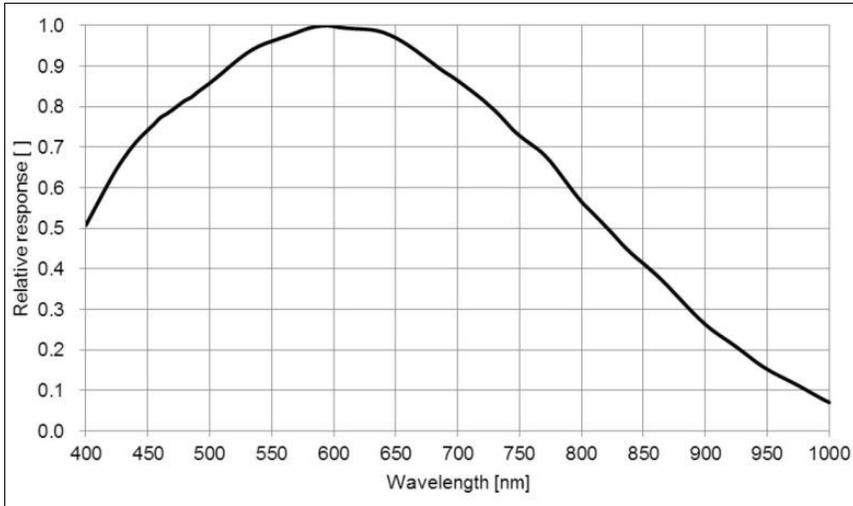
# Specifications Lt-M4040 / Lt-C4040

Supported Features	Lt-M4040 / Lt-C4040	
Resolution	4112 x 3008	
Sensor	Sony IMX253 (12.4 MP)	
Pixel Size	3.45 $\mu\text{m}$ x 3.45 $\mu\text{m}$	
Optical Format	1.1"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	10.5 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	42 fps (8-bit) 22 fps (12-bit)	
Maximum Sustained Frame Rate Output	30 fps (8-bit)	
Exposure Time Range	14 $\mu\text{s}$ – 4295 s (triggered) 14 $\mu\text{s}$ – 15.5 s (continuous)	
Trigger to Exposure Minimum delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	14.26 $\mu\text{s}$ (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	156 $\mu\text{s}$	
Horizontal Line Time	7.80 $\mu\text{s}$	
Readout Time	23.88 ms (Horizontal Line Time) x (lines in frame + 54) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (max 256)	
Color Enhancement Support	No – Monochrome Models	Yes – Color Models (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes, on sensor, Vertical and Horizontal	
Binning Support	Yes, on sensor, monochrome model	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x, vertical and horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	73.0 dB	
SNR	40.4 dB	

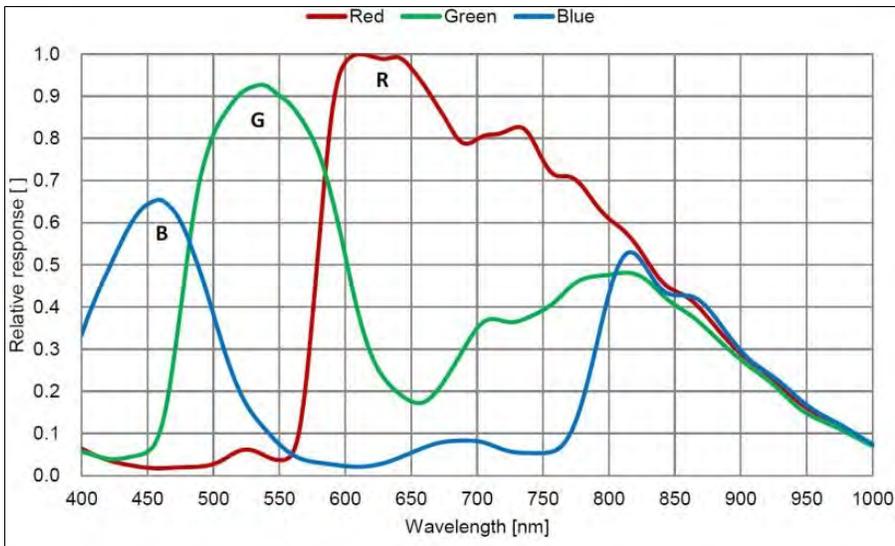
# Spectral Response Curves Lt-M4040 / Lt-C4040

Response curves from sensor datasheet.

## Monochrome (Lt-M4040)



## Color (Lt-C4040)



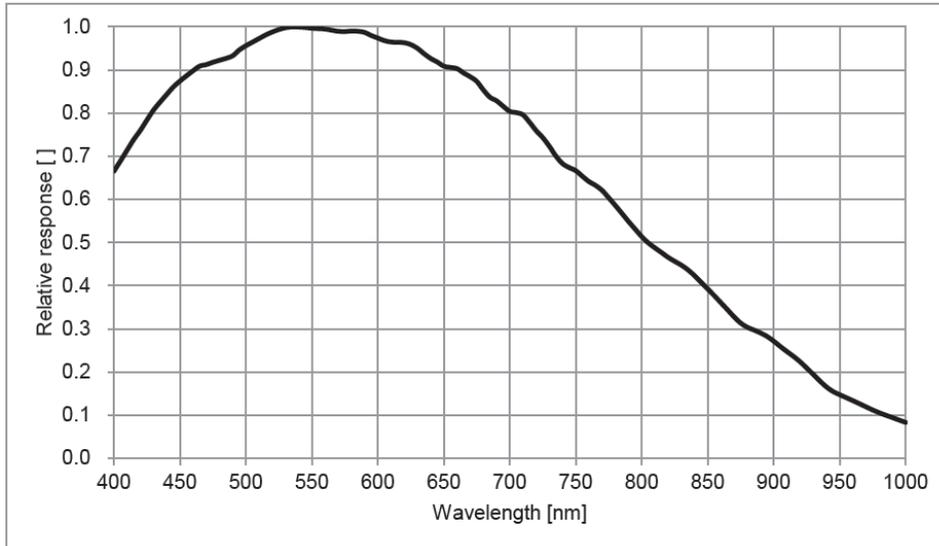
# Specifications Lt-M5300 / Lt-C5300

Supported Features	Lt-M5300 / Lt-C5300	
Resolution	5328 x 3040	
Sensor	Sony IMX542 (16.2 MP)	
Pixel Size	2.74 $\mu\text{m}$ x 2.74 $\mu\text{m}$	
Optical Format	1.1"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	8.5 ke (max)	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	33 fps (8-bit) 22 fps (12-bit)	
Max. Sustained Frame Rate Output Full resolution	24 fps (8-bit)	
Exposure Time Range	2 $\mu\text{s}$ – 4295 s (triggered) 25 $\mu\text{s}$ – 196 s (continuous)	
Trigger to Exposure Minimum Delay (fast trigger/reset exposure alignment)	0.1 $\mu\text{s}$	
Actual Exposure Time Minimum	2.46 $\mu\text{s}$ (triggered) 25 $\mu\text{s}$ (continuous) Exposure time increment steps = 1 $\mu\text{s}$	
Min. Time from End of Exposure to Start of Next Exposure	135 $\mu\text{s}$	
Horizontal Line Time	9.64 $\mu\text{s}$	
Readout Time	30.36 ms (Horizontal Line Time) x (lines in frame + 108)	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (max 256)	
Color Enhancement Support	Monochrome – No	Color – Yes (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes, on sensor, Vertical and Horizontal	
Binning Support	Yes, on sensor, Monochrome Model	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x, Vertical and Horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	71.5 dB	
SNR	39.3 dB	

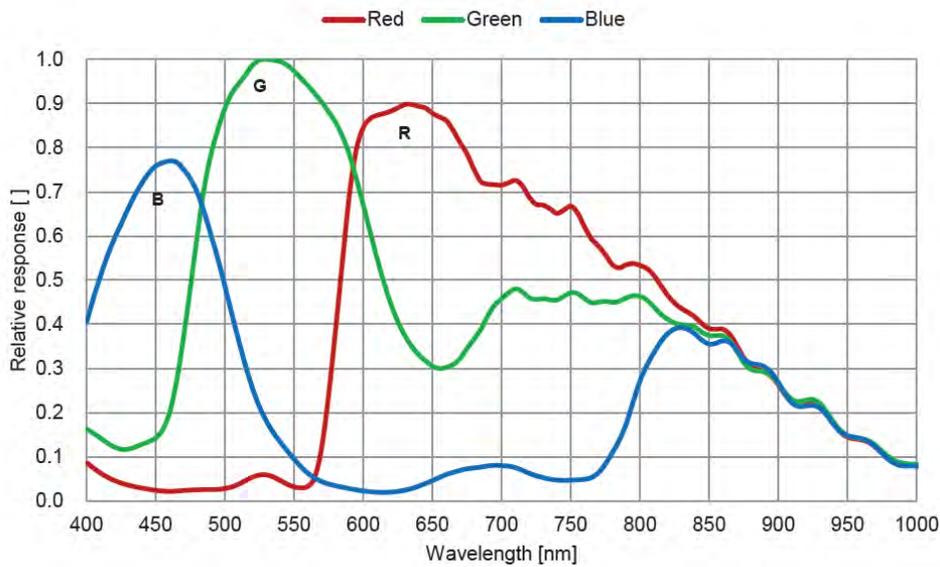
# Spectral Response Curves Lt-M5300 / Lt-C5300

Response curves from sensor datasheet.

## Monochrome (Lt-M5300)



## Color (Lt-C5300)



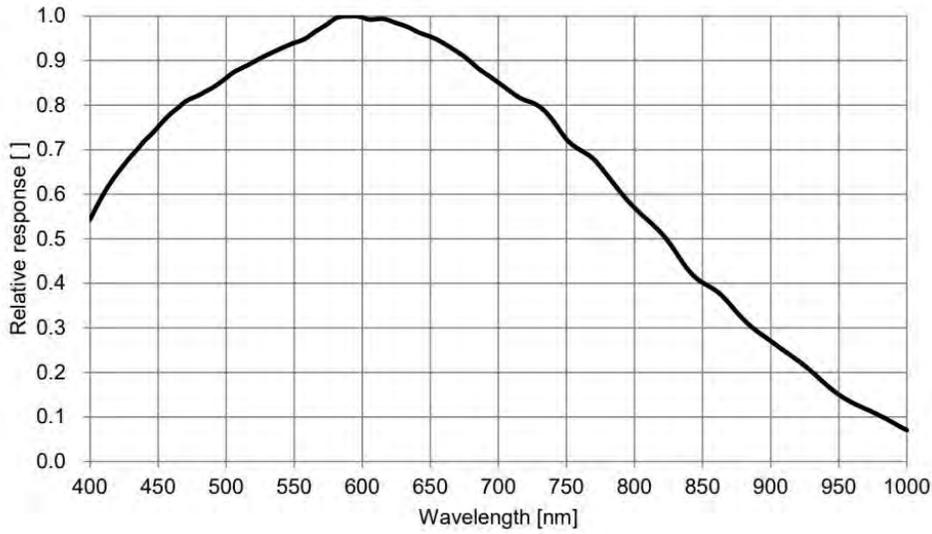
# Specifications Lt-M5470 / Lt-C5470

Supported Features	Lt-M5470 / Lt-C5470	
Resolution	5472 x 3084	
Sensor	Sony IMX387 (16.9 MP)	
Pixel Size	3.45 $\mu\text{m}$ x 3.45 $\mu\text{m}$	
Optical Format	4/3"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	10.5 ke (max)	
Pixel Data Formats	Monochrome 8-bit, 10-bit or 12-bit	Bayer 8-bit, 10-bit or 12-bit
Max. Internal Frame Rate Full resolution	32 fps (8-bit) 22 fps (12-bit)	
Maximum Sustained Frame Rate Output	27 fps (8-bit)	
Exposure Time Range	30 $\mu\text{s}$ – 12.15 s (triggered) 40 $\mu\text{s}$ – 12.15 s (continuous)	
Trigger to Exposure Minimum Delay (fast trigger/reset exposure alignment)	8 $\mu\text{s}$	
Actual Exposure Time Minimum	30.06 $\mu\text{s}$ (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	236.6 $\mu\text{s}$	
Horizontal Line Time	9.86 $\mu\text{s}$	
Readout Time Full resolution	31.00 ms (Horizontal Line Time) x (lines in frame + 60) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (max 256)	
Color Enhancement Support	Monochrome – No	Color – No
Defective Pixel Replacement	No	
Image Correction	No	
Image Flip Support	Yes, on sensor, vertical and horizontal	
Binning Support	Yes, on sensor, monochrome model	
Multi-ROI Support	Yes	
Decimation Support	Yes, 1/2x, vertical and horizontal	
On-Board Image Memory	256 MB	
Output Dynamic Range (dB)	69.1 dB	
SNR	40.2 dB	

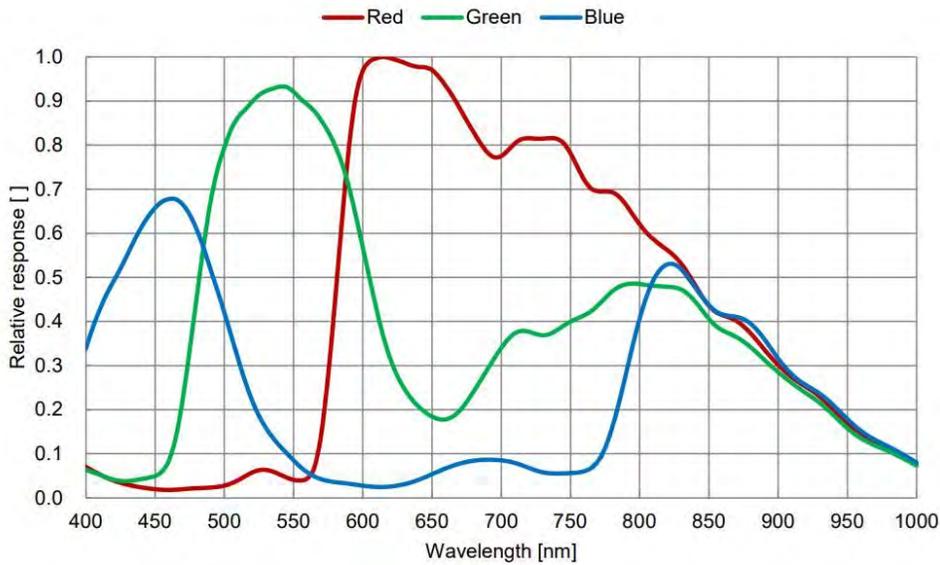
# Spectral Response Curves Lt-M5470 / Lt-C5470

Response curves from sensor datasheet.

## Monochrome (Lt-M5470)



## Color (Lt-C5470)



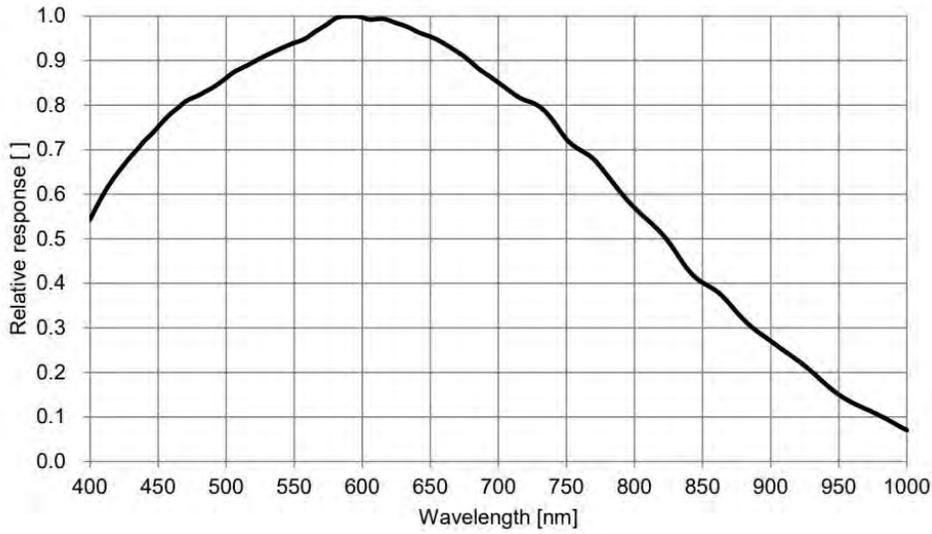
# Specifications Lt-M4430 / Lt-C4430

Supported Features	Lt-M4430 / Lt-C4430	
Resolution	4432 x 4436	
Sensor	Sony IMX367 (19.7 MP)	
Pixel Size	3.45 $\mu\text{m}$ x 3.45 $\mu\text{m}$	
Optical Format	4/3"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	10.5 ke (max)	
Pixel Data Formats	Monochrome 8-bit, 10-bit or 12-bit	Bayer 8-bit, 10-bit or 12-bit
Max. Internal Frame Rate Full resolution	27 fps (8-bit) 19 fps (12-bit)	
Maximum Sustained Frame Rate Output	19 fps (8-bit)	
Exposure Time Range	30 $\mu\text{s}$ – 12.15 s (triggered) 38 $\mu\text{s}$ – 12.15 s (continuous)	
Trigger to Exposure Minimum Delay (fast trigger/reset exposure alignment)	8 $\mu\text{s}$	
Actual Exposure Time Minimum	30.06 $\mu\text{s}$ (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	242.4 $\mu\text{s}$	
Horizontal Line Time	8.08 $\mu\text{s}$	
Readout Time	36.41 ms (Horizontal Line Time) x (lines in frame + 70) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (max 256)	
Color Enhancement Support	Monochrome – No	Color – No
Defective Pixel Replacement	No	
Image Correction	No	
Image Flip Support	Yes, on sensor, vertical and horizontal	
Binning Support	Yes, on sensor, monochrome model	
Multi-ROI Support	Yes	
Decimation Support	Yes, 1/2x, vertical and horizontal	
On-Board Image Memory	256 MB	
Output Dynamic Range (dB)	69.1 dB	
SNR	40.2 dB	

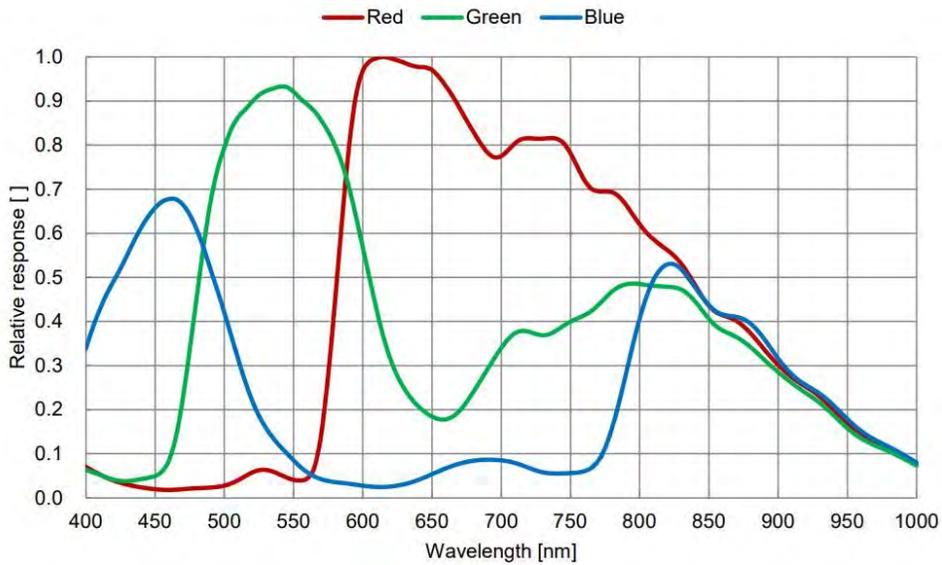
# Spectral Response Curves Lt-M4430 / Lt-C4430

Response curves from sensor datasheet.

## Monochrome (Lt-M4430)



## Color (Lt-C4430)



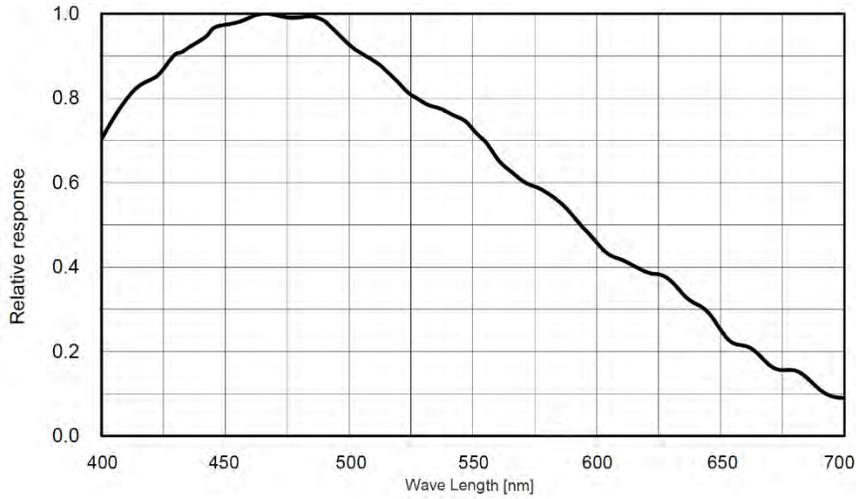
# Specifications Lt-M5500 / Lt-C5500

Supported Features	Lt-M5500 / Lt-C5500	
Resolution	5472 x 3648	
Sensor	Sony IMX183 (20.0 MP)	
Pixel Size	2.40 $\mu\text{m}$ x 2.40 $\mu\text{m}$	
Optical Format	1"	
Shutter type	Electronic Rolling Shutter function (ERS) (continuous) Global Reset Release (GRR) function (single exposure)	
Full Well charge	14.6 ke	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	20 fps (8-bit, 12-bit)	
Maximum Sustained Frame Rate Output	20 fps (8-bit)	
Exposure Time Range	1773 $\mu\text{s}$ – 10 s (triggered) 57 $\mu\text{s}$ – 1 s (continuous)	
Trigger to Exposure Minimum Delay (fast trigger/reset exposure alignment)	1 $\mu\text{s}$	
Actual Exposure Time Minimum	1772.44 $\mu\text{s}$ (triggered) 57.44 $\mu\text{s}$ (continuous) (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	13.6 $\mu\text{s}$	
Horizontal Line Time	13.61 $\mu\text{s}$	
Readout Time	49.65 ms (Horizontal Line Time) x (lines in frame) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (max 180)	
Color Enhancement Support	Monochrome – No	Color – Yes (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes, on sensor, vertical and horizontal	
Binning Support	Yes, on sensor, continuous	
Multi-ROI Support	No	
Decimation Support	No	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	71.7 dB	
SNR	41.7 dB	

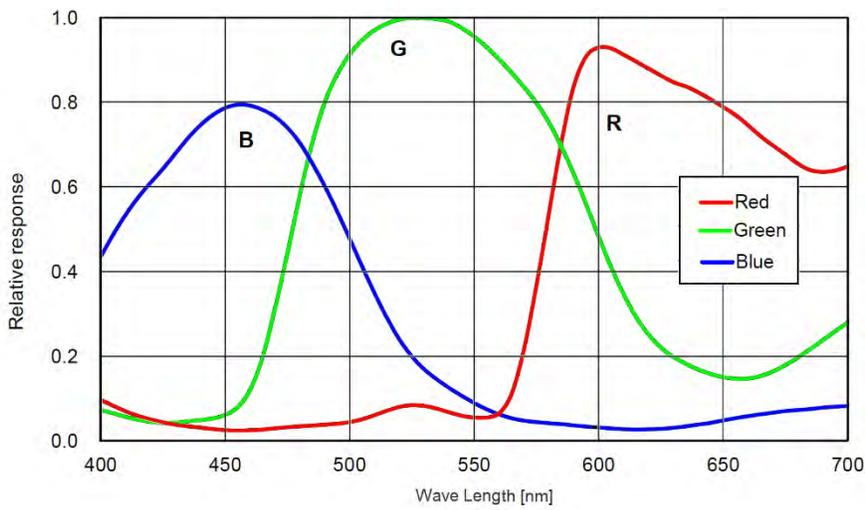
# Spectral Response Curves Lt-M5500 / Lt-C5500

Response curves from sensor datasheet.

## Monochrome (Lt-M5500)



## Color (Lt-C5500)



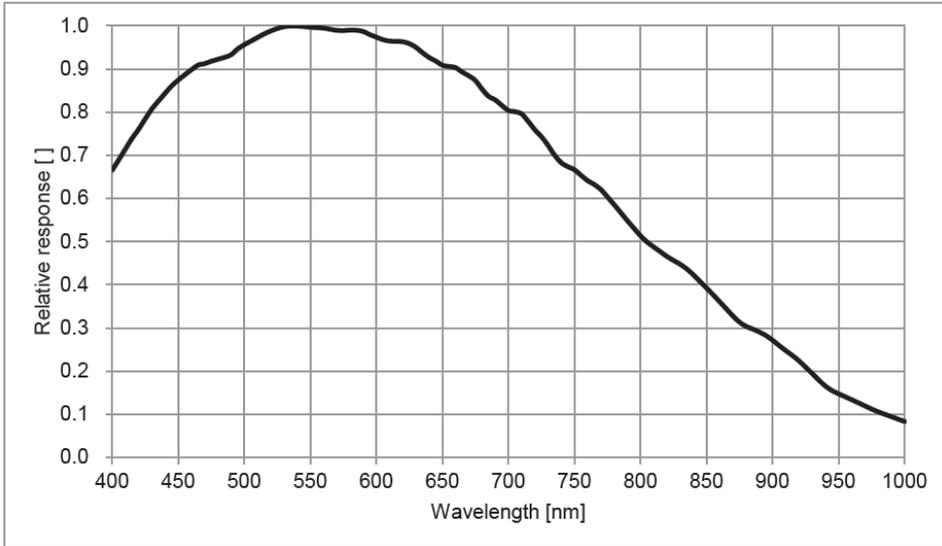
# Specifications Lt-M4510 / Lt-C4510

Supported Features	Lt-M4510 / Lt-C4510	
Resolution	4512 X 4512	
Sensor	Sony IMX541 (20.4 MP)	
Pixel Size	2.74 $\mu\text{m}$ x 2.74 $\mu\text{m}$	
Optical Format	1.1"	
Shutter type	Full frame electronic global shutter function	
Full Well charge	9.2 ke	
Pixel Data Formats	Monochrome 8-bit or 12-bit	Bayer 8-bit or 12-bit
Max. Internal Frame Rate Full resolution	26 fps (8-bit) 18 fps (12-bit)	
Max. Sustained Frame Rate Output Full resolution	19 fps (8-bit)	
Exposure Time Range	2 $\mu\text{s}$ – 4295 s (triggered) 22 $\mu\text{s}$ – 160 s (continuous)	
Trigger to Exposure Minimum Delay (fast trigger/reset exposure alignment)	0.1 $\mu\text{s}$	
Actual Exposure Time Minimum	2.46 $\mu\text{s}$ (triggered) 22 $\mu\text{s}$ (continuous) Exposure time increment steps = 1 $\mu\text{s}$	
Min. Time from End of Exposure to Start of Next Exposure	132 $\mu\text{s}$	
Horizontal Line Time	8.27 $\mu\text{s}$	
Readout Time	38.22 ms (Horizontal Line Time) x (lines in frame + 110)	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	Yes (max 256)	
Color Enhancement Support	Monochrome – No	Color – Yes (Brightness, Contrast, Gamma)
Defective Pixel Replacement	Yes	
Image Correction	No	
Image Flip Support	Yes, on sensor, vertical and horizontal	
Binning Support	Yes, on sensor, monochrome model	
Multi-ROI Support	No	
Decimation Support	Yes, 1/2x, vertical and horizontal	
On-Board Image Memory	128 MB	
Output Dynamic Range (dB)	72.4 dB	
SNR	39.6 dB	

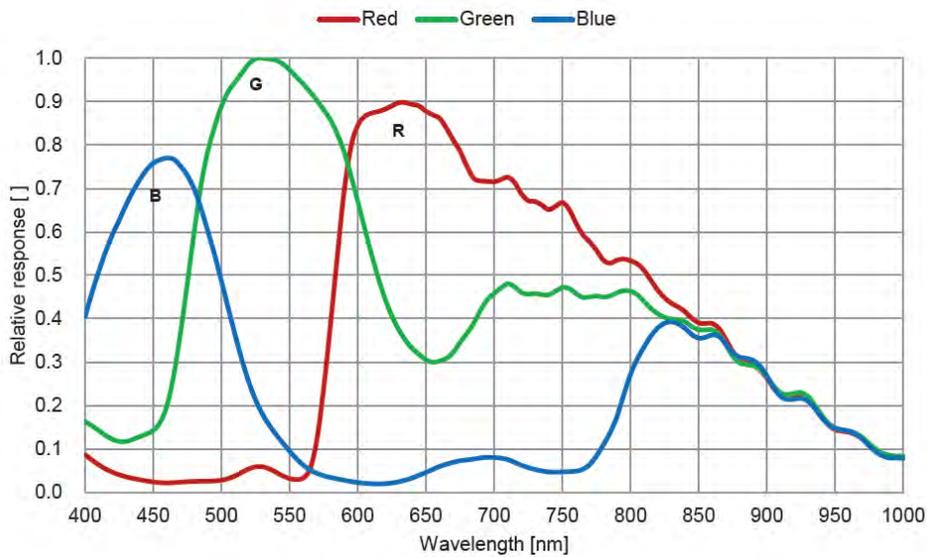
# Spectral Response Curves Lt-M4510 / Lt-C4510

Response curves from sensor datasheet.

## Monochrome (Lt-M4510)



## Color (Lt-C4510)



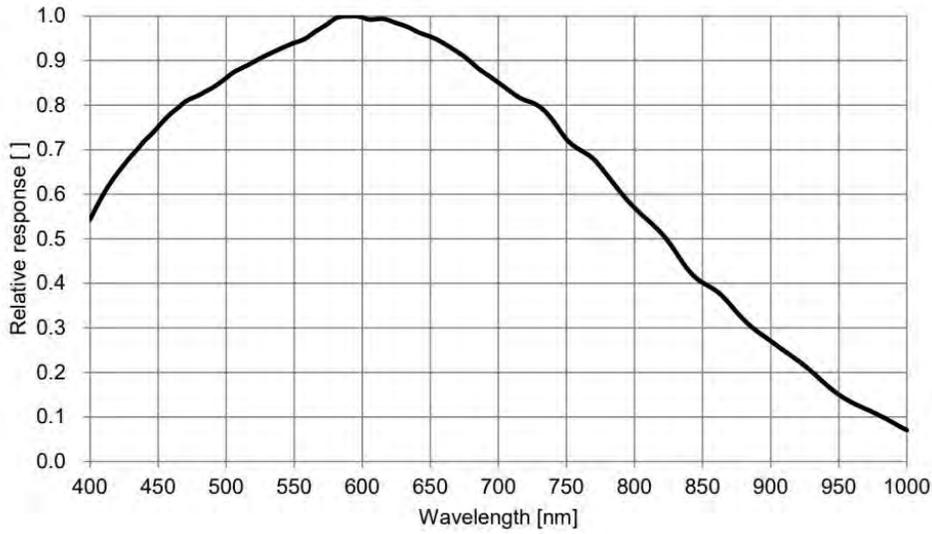
# Specifications Lt-M6480 / Lt-C6480

Supported Features	Lt-M6480 / Lt-C6480	
Resolution	6480 x 4860	
Sensor	Sony IMX342 (31.5 MP)	
Pixel Size	3.45 $\mu\text{m}$ x 3.45 $\mu\text{m}$	
Optical Format	APS-C	
Shutter type	Full frame electronic global shutter function	
Full Well charge	10.5 ke (max)	
Pixel Data Formats	Monochrome 8-bit, 10-bit or 12-bit	Bayer 8-bit, 10-bit or 12-bit
Max. Internal Frame Rate Full resolution	18 fps (8-bit) 12 fps (12-bit)	
Maximum Sustained Frame Rate Output	15 fps (8-bit)	
Exposure Time Range	56 $\mu\text{s}$ – 2147.48 s (triggered) 42 $\mu\text{s}$ – 12.15 s (continuous)	
Trigger to Exposure Minimum Delay (fast trigger/reset exposure alignment)	8 $\mu\text{s}$	
Actual Exposure Time Minimum	30.06 $\mu\text{s}$ (Exposure time increment steps = Horizontal Line Time)	
Min. Time from End of Exposure to Start of Next Exposure	231.6 $\mu\text{s}$	
Horizontal Line Time	11.58 $\mu\text{s}$	
Readout Time	56.92 ms (Horizontal Line Time) x (lines in frame + 54) — in $\mu\text{s}$	
Auto-Exposure	Yes, with Auto-Brightness Target	
Black offset control	Yes (in DN)	
Gain Control	256 (max)	
Color Enhancement Support	Monochrome – No	Color – No
Defective Pixel Replacement	No	
Image Correction	No	
Image Flip Support	Yes, on sensor, vertical and horizontal	
Binning Support	Yes, on sensor, monochrome model	
Multi-ROI Support	Yes	
Decimation Support	Yes, 1/2x vertical and horizontal	
On-Board Image Memory	256 MB	
Output Dynamic Range (dB)	69.1 dB	
SNR	40.2 dB	

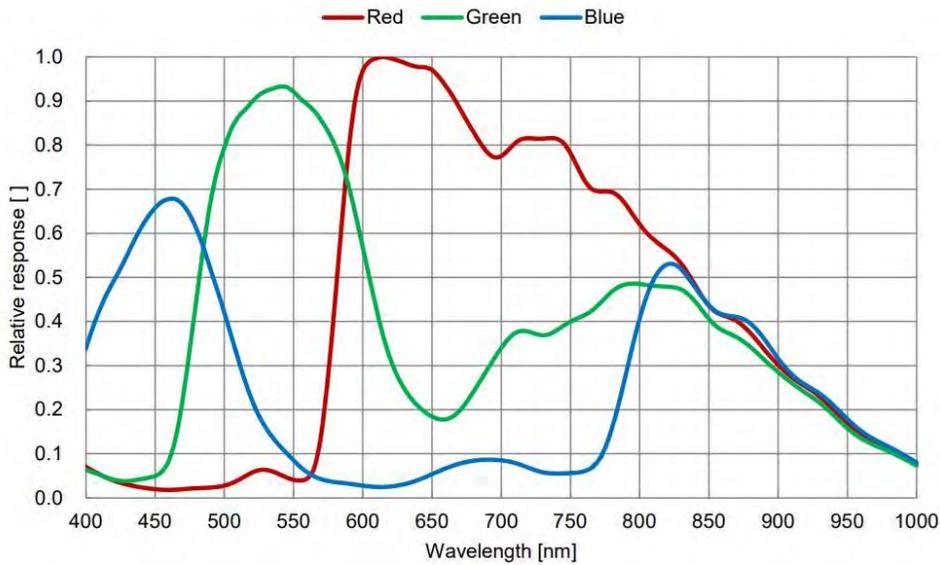
# Spectral Response Curves Lt-M6480 / Lt-C6480

Response curves from sensor datasheet.

## Monochrome (Lt-M6480)



## Color (Lt-C6480)



---

# Guide to Using a Rolling Shutter Camera

A few Lt Series cameras implement Sony rolling shutter sensors to achieve a high pixel density –low cost solution for a number of imaging implementations. These sensors have different usage characteristics and thus provide different application solutions compared to the Lt Series global shutter models. The following points highlight those differences:

## Simpler Sensor Design Attributes

- Rolling shutter cameras have a simpler design with smaller pixels, allowing higher resolutions for a given sensor physical area. As an example, mobile phones use rolling shutter sensors.
- Depending on the imaging requirements, the higher density pixel array may require a higher quality lens. Lens specifications define the resolution and contrast/modulation attributes that must be considered. This commonly used gauge is the Modulation Transfer Function (MTF), which is extensively covered by lens suppliers to qualify their products. Consider reading <https://www.edmundoptics.com/resources/application-notes/optics/introduction-to-modulation-transfer-function/> as an initial start to understanding MTF.
- A rolling shutter sensor exposes, samples, and reads out sequentially, as part of the design criteria to achieve a higher pixel density via simplified circuitry.
- Rolling shutter sensors generate less heat, which translates to a lower noise level.
- Global shutter CMOS sensors require more complicated circuit architecture, thus limiting the pixel density for a given physical size.

## Rolling Shutter Trade-offs

When selecting a rolling shutter camera, the user needs to understand that the camera is not suitable for all machine vision applications. Limitation examples are:

- A rolling shutter camera is unsuitable for applications like barcode scanning, machine vision, or automated inspection systems, which require the imaging of rapidly moving objects.
- Moving objects are subject to temporal distortions best described as positional errors (shifts) from the top of an object to its bottom, due to how individual lines are exposed (detailed below).
- Rolling shutter cameras using global reset release mode (GRR) are not suitable for moving objects in well-lit environments.
- Degree of distortions change as exposure time is increased or decreased.
- Use of a strobe flash with a controlled duration, in a dark imaging environment, is required to eliminate positional distortions.
- Many examples of visual distortions due to rolling shutter sensors can be found on Internet, mostly for cell phones and consumer cameras, for instance <https://www.youtube.com/watch?v=dNVtMmLInoE> *Rolling Shutter Explained (Why Do Cameras Do This?)*.

The guidelines that follow will permit the successful usage of rolling shutter cameras in machine vision applications.

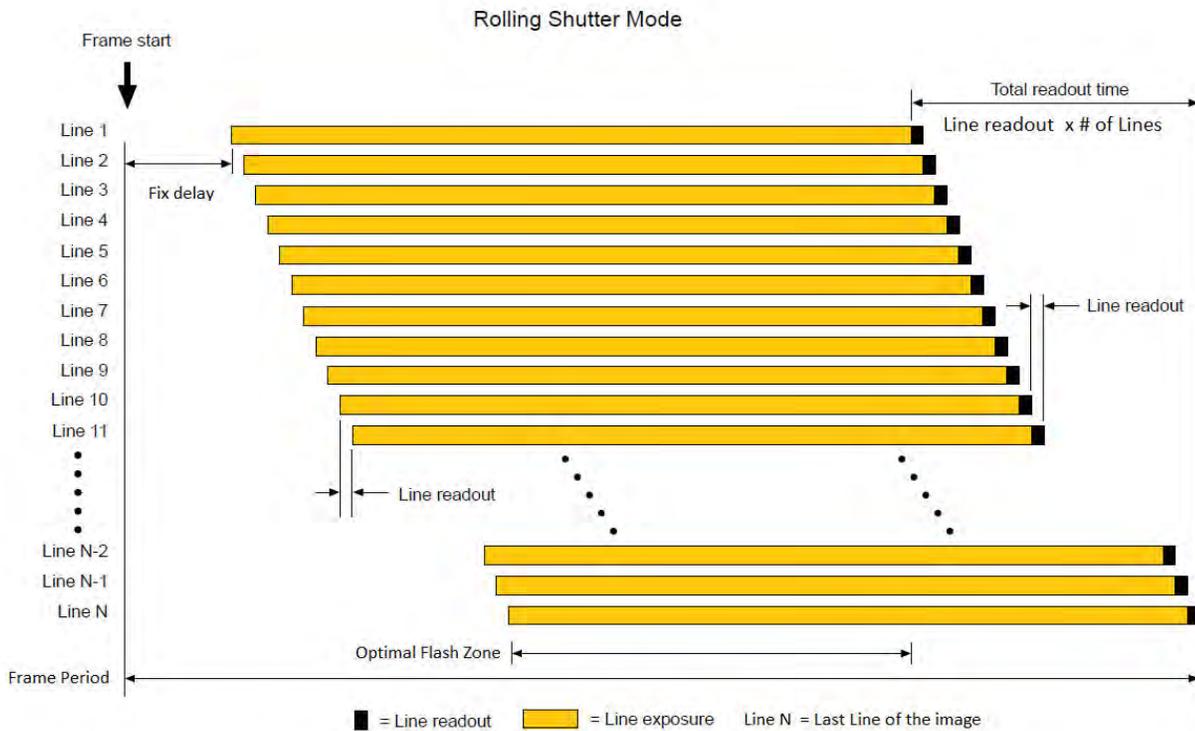
## Guide to ERS or GRR Exposure Modes

The following two subsections provide overviews and constraints on using either the typical *Electronic Rolling Shutter (ERS) Exposures* or *Global Reset Release (GRR) Exposures* modes.

# Overview of Electronic Rolling Shutter (ERS) Exposures

Referring to the following graphic:

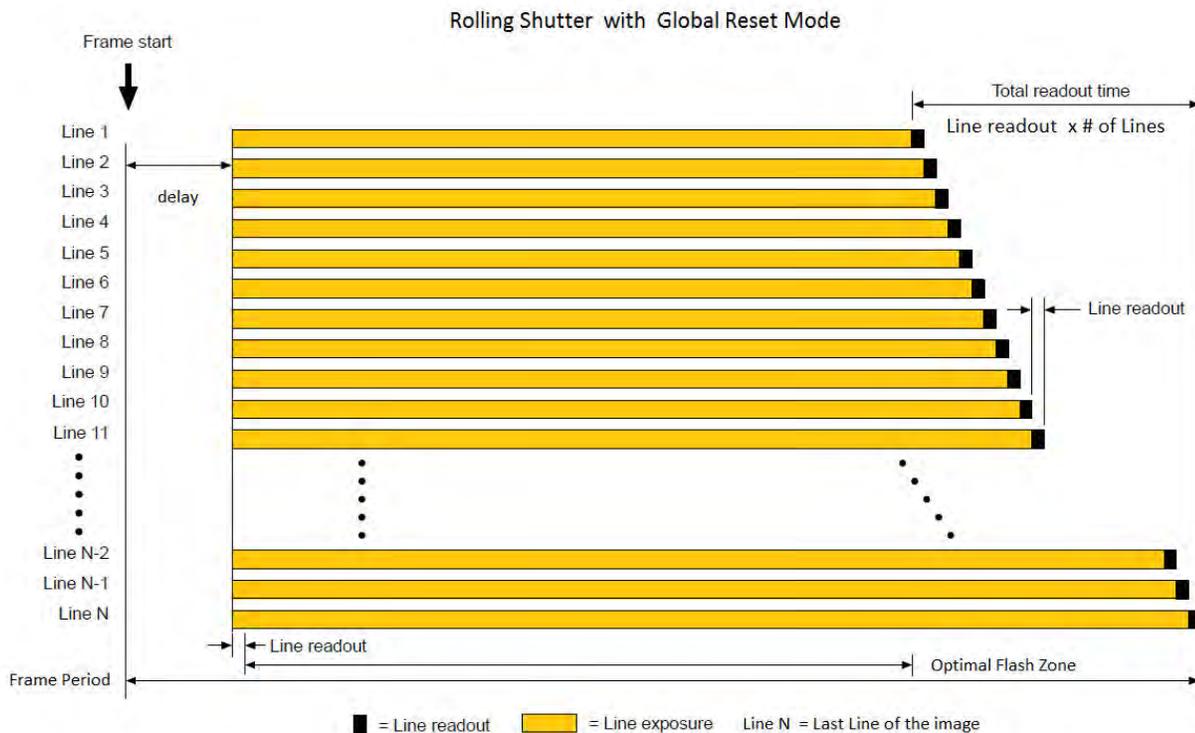
- Each sensor line is exposed for the programmed time integration period.
- Exposures start with Line 1. The sensor design uses a shared line readout circuit. Due to this simplified circuitry, only a single line of pixel data can be readout at any given time. Therefore, the line 2 exposure (integration period) is delayed by the required readout time of line 1.
- This delayed line exposure is repeated from the sensor's first line to its last sensor line.
- This sequence allows the common readout circuit to read the data from each row. This results in an exposure start time delay between the first to last row – thus the name rolling shutter.
- To avoid motion artifacts the user needs to freeze motion using flash lighting of suitable length in a dark environment. The flash is triggered at the start of the last line's exposure and stops at the end of the first line's exposure. The flash must maintain a constant light output during this period.
  - To control the flash device, use the Lt output signal with these feature selections: *outputLineSource=PulseOnStartofExposure*, *outputLinePulseDelay=flashZoneDelay* (delay to the start of the last line exposure), *outputLinePulseDuration=flashZoneDuration* (optimal flash zone time as shown in the graphic below).
  - The two new features mentioned, *flashZoneDelay* and *flashZoneDuration*, automatically provide the optimal flash zone time values no matter the exposure duration and any vertical cropping/offset settings. The user is free to use any delay or duration as required. See **Strobe and Flash Zone (Lt-3840, Lt-5500)** for settings.
- The dark environment illumination ensures minimal exposure (and thus minimal motion artifacts) during the sensor lines integration time occurring before and after the flash period.



# Overview of Global Reset Release (GRR) Exposures

Referring to the following graphic:

- All sensor lines start integrating at the same time, therefore GRR mode is also known as Global Start Mode.
- The first sensor line (Line 1) only is exposed for the programmed time integration period.
- The sensor design uses a shared line readout circuit. Therefore again, only a single line of pixel data can be readout at any given time.
- With each sensor line starting exposure integration at once, each following line's exposure is increased by the readout time required by the previous row.
- In a well-lit environment with static objects, there is a visible exposure increase from the top sensor row to the bottom sensor row.
- With moving objects in a well-lit environment, there is motion blurring from top to bottom.
- Therefore, as described previously, flash lighting in a dark environment is used to freeze motion. The flash period matches the integration period for line 1. The increasing exposures for the other sensor lines will not be visible without any other illumination source.



# Connecting the Camera

---

## USB3 Vision® Overview

Ratified in 2013, the [USB3 Vision®](#) standard is a popular interface for industrial cameras connected to computer systems. Teledyne Lumenera USB 3 cameras comply with the standard as defined by the USB3 Vision Technical Committee.

The USB3 Vision implementation uses the programming interface (API) previously defined by the [GenICam™](#) standard for access and control features in compliant imaging products, which simplifies applications design and integration (device discovery, device control, event handling, data streaming, etc.) for camera and system manufacturers.

For viability in real world machine vision environments, the standard also specifies locking USB 3 compliant connectors such as the USB 3.0 Standard-B and USB 3.0 Powered-B connector.

See **Switching a Teledyne Lumenera camera from LuCam mode to USB3 Vision** mode to use cameras with the Sopera LT development environment.

---

## Connecting Power

**Lt-Ux0x-xxxxx** and **Lt-xx1x-xxxxx** USB 3 cameras may be powered directly by the USB 3 computer port. This method provides a cabling solution for testing or for imaging installations where camera acquisitions are only software controlled and require no external I/O.

**Lt-Ux2x-xxxxx XL series cameras must be powered through the external interface header.** The external interface header also provides access for hardware input and output signals.

See section **I/O Connector Pinout Details** for the I/O connector and power supply specifications.

When the camera receives power, the status LED will indicate that the camera has initialized and is ready:

- **Lt-Ux0x-xxxxx** and **Lt-xx1x-xxxxx**: steady green
- **Lt-Ux2x-xxxxx**: steady blue

## Connectors

Depending on model, the camera has two or three connectors:

- **USB 3** – USB 3 connection to a computer
  - **Lt-Ux0x-xxxxx** and **Lt-xx1x-xxxxx**: data and power
  - **Lt-Ux2x-xxxxx**: data only

- **External Interface Header** – Used for external signal connections and for camera power
  - Lt-Ux0x-xxxxx and Lt-xx1x-xxxxx: optional power
  - Lt-Ux2x-xxxxx: required power
- **Iris Control (LT-Ux0x-xxxxx Series only)** – Standard 4 pin iris control for lenses with a motorized iris.

The following figures of the camera back side shows connector and LED locations. See **Mechanical Specifications** for details on the connectors and camera mounting dimensions.



*Teledyne Lumenera LT-Ux0x-xxxxx Series*



*Teledyne Lumenera LT-xx1x-xxxxx Series*



*Teledyne Lumenera LT-Ux2x-xxxxx Series*

## LED Status Indicator

The Lt Series has one multicolor LED located on the back panel, to provide a simple visible indication of camera state, as described below.

Lt-Ux0x-xxxxx, Lt-xx1x-xxxxx	Lt-Ux2x-xxxxx	Description
LED is off	LED is off	No power to the camera
	Flashing red	Initialization sequence
Steady orange		Device driver failed to load
Flashing orange few times per second	Steady red	Firmware failed to load
Flashing orange once per 2 seconds	Steady red	FPGA failed to load
Steady green	Steady blue	Camera ready / operational
Dimmer green	Flashing green	Camera is streaming or fast frames mode is enabled
Dimmer green (snapshot)	Flashing green	LED will be dimmer green for duration of exposure/LED will flash on frame acquisition
Flashing orange/green		(case 1) Camera is connected to USB 2.0 ports and does not have external power connected (case 2) USB 3 port is not supplying enough camera power
	Steady red and flashing blue	Fatal Error. If the camera does not reboot itself contact Technical Support

## Preventing Operational Faults due to ESD

	<p>Camera installations which do not protect against ESD (electrostatic discharge) may exhibit operational faults. Problems such as random camera resets and random loss of connections may all be solved by proper ESD management.</p> <p>The camera, when used with USB 3 power or a simple power supply, is not properly connected to earth ground and therefore is susceptible to ESD caused problems.</p>
---	--

Teledyne Lumenera has performed ESD testing on cameras using an 8 kilovolt ESD generator without any indication of operational faults. The two following methods, either individually or together will prevent ESD problems.

- Method 1: Use a shielded/grounded power supply that connects to the ground pin of the I/O connector. The camera body is now properly connected to earth ground and can withstand ESD of 8 kilovolts.
- Method 2: Mount the camera on a metallic platform with a good connection to earth ground.

# Feature Reference

---

## Lt Series Features

The following sections describe the Teledyne Lumenera Lt Camera Series feature set in detail.

Features (parameters) are grouped in functional categories for easier reference. USB3 GenICam control tools, such as CamExpert, enable the user to read or modify the features as required to explore the camera operation in the user's imaging setup.

At the start of each section, a screen capture of CamExpert presents the features of the category. Many of the features shown may be changed directly in CamExpert or programmatically via an imaging application. The availability of a feature may depend on the setting of other features, and while some features are read only, others may be changed even during acquisition. Note that features shown may vary with different Lt-Series models, that is, a specific camera model may not support the full feature set defined in a category.

The feature description table lists the features and their possible values, as displayed in CamExpert (display name) and as defined in the .xml file. The last column of the table contains other important information associated with the feature:

- **Device version** in which the feature was introduced. The device version number identifies the supported software functional package (different from the firmware revision number). As Lt-Series capabilities evolve, the device version increases. New features included in a major device version release are indicated in **green text** for easy identification. For each feature, the device version may differ for each camera sensor available.
- **View**. The visibility level of the feature: beginner, expert, guru, or invisible. Note that features tagged as invisible are usually for Teledyne DALSA or third party software usage—not typically needed by end user applications.
- **Naming Convention**. A DFNC tag indicates that the feature is a member of the DALSA Features Naming Convention. Otherwise, the feature is a member of the GenICam Standard Features Naming Convention (SFNC tag not shown).

# Camera Information Category

Camera information can be retrieved via a controlling application. Parameters such as camera model, firmware version, etc., are read to uniquely identify the connected Lt-Series device. These features are typically read-only.

Category	Parameter	Value
Camera Information	Family Name	LT Family
Sensor Control	Device Vendor Name	Teledyne DALSA
I/O Control	Device Model Name	LT-C6480
Advanced Processing	Device Version	1.00
Image Format Control	Manufacturer Part Number	
Metadata Controls	Device Manufacturer Info	Standard Design
Acquisition Control	Device Firmware Version	0
Event Control	Device Serial Number	8675309
Transport Layer Control	Device User ID	8675309
Teledyne Lumenera Control	Device Reset	Press...
File Access Control	Device Temperature Selector	Sensor
USB3 Vision Host Controls	Device Temperature (in C)	33.816002
	Device Built-In Self Test	Press...
	Device Built-In Self Test Status	Passed
	Device Built-In Self Test Status All	0
	Power-up Configuration	Setting...

<< Less

## Camera Information Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
Family Name <i>(Lt-Ux20-xxxx models only)</i>	DeviceFamilyName	Displays the device family name.	1.00 Beginner
Device Vendor Name	DeviceVendorName	Name of the manufacturer of the device.	1.00 Beginner
Device Model Name	DeviceModelName	Model of the device.	1.00 Beginner
Device Version	DeviceVersion	Version of the device.	1.00 Beginner
Manufacturer Part Number	deviceManufacturerPartNumber	Displays the device manufacturer part number.	1.00 DFNC Beginner
Device Manufacturer Info	DeviceManufacturerInfo	Manufacturer information about the device.	1.00 Beginner
Device Firmware Version	DeviceFirmwareVersion	Version of the firmware in the device.	1.00 Expert
Device Serial Number	DeviceSerialNumber	Device's serial number. This string is a unique identifier of the device.	1.00 Beginner

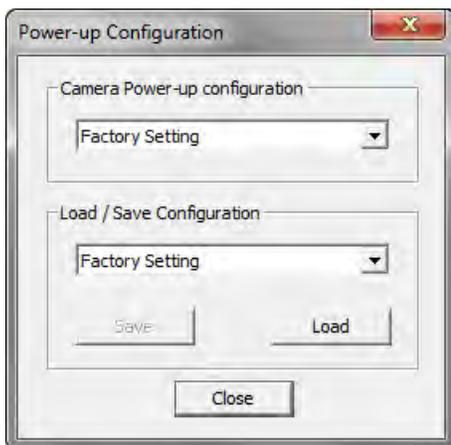
Display Name	Feature & Values	Description	Device Version & View
Device User ID	DeviceUserID	User-programmable device identifier.	1.00 Beginner
Device Reset	DeviceReset	Resets the device to its power up state. After reset, the device must be rediscovered.	1.00 Beginner
Device Temperature Selector (Lt-Ux20-xxxx models only)	DeviceTemperatureSelector	Select the source where the temperature is read.	1.00 Beginner
<i>Sensor</i>	<i>Sensor</i>	<i>Temperature read from image sensor.</i>	
<i>Processor</i>	<i>Processor</i>	<i>Temperature read from device core.</i>	
Device Temperature (in C)	DeviceTemperature	Device's sensor temperature in degrees Celsius (C).	1.00 Expert
Device Built-In Self Test (Lt-Ux20-xxxx models only)	deviceBIST	Command to perform an internal test which will determine the device status.	1.00 Beginner DFNC
Device Built-In Self Test Status (Lt-Ux20-xxxx models only)	deviceBISTStatus	Return the status of the device Built-In Self test. Possible return values are device-specific.	1.00 Beginner DFNC
<i>Passed</i>	<i>Passed</i>	<i>No failure detected.</i>	
Device Built-In Self Test Status All (Lt-Ux20-xxxx models only)	deviceBISTStatusAll	Return the status of the device Built-In Self Test as a bit field. The meaning for each bit is device-specific.	1.00 Beginner DFNC
Power Up configuration (Lt-Ux20-xxxx models only)			
Power-up Configuration Selector	UserSetDefaultSelector	Specify the camera configuration set to load and make active on camera power-up or reset. The camera configuration sets are stored in camera non volatile memory.	1.00 Beginner
<i>Factory Setting</i>	<i>Default</i>	<i>Select the Factory Setting values as the Power-up Configuration.</i>	
<i>User Set 1</i>	<i>UserSet1</i>	<i>Select the user defined configuration UserSet 1 as the Power-up Configuration.</i>	
<i>User Set 2</i>	<i>UserSet2</i>	<i>Select the user defined configuration UserSet 2 as the Power-up Configuration.</i>	
User Set Selector	UserSetSelector	Selects the camera configuration set to load feature settings from or save current feature settings to. The Factory set contains default camera feature settings. User camera configuration sets contain feature settings previously saved by the user.	1.00 Beginner
<i>Factory Setting</i>	<i>Default</i>	<i>Select the default camera feature settings saved by the Factory.</i>	
<i>UserSet 1</i>	<i>UserSet1</i>	<i>Select the User defined Configuration space UserSet1 to save to or load from features settings previously saved by the user.</i>	
<i>UserSet 2</i>	<i>UserSet2</i>	<i>Select the User defined Configuration space UserSet2 to save to or load from features settings previously saved by the user.</i>	
Load Configuration	UserSetLoad	Loads the camera configuration set, specified by the User Set Selector feature, to the camera and makes it active.	1.00 Beginner
Save Configuration	UserSetSave	Saves the current camera configuration to the user set specified by the User Set Selector feature. The user sets are located on the camera in non volatile memory.	1.00 Beginner
Device Gen CP Version Major	DeviceGenCPVersionMajor	Major version of the GenCP specification.	1.00 Invisible
Device Gen CP Version Minor	DeviceGenCPVersionMinor	Minor version of the GenCP specification.	1.00 Invisible

Display Name	Feature & Values	Description	Device Version & View
Device Manifest XML Major Version	DeviceManifestXMLMajorVersion	Indicates the major version number of the GenICam XML.	1.00 Invisible
Device Manifest XML Minor Version	DeviceManifestXMLMinorVersion	Indicates the minor version number of the GenICam XML.	1.00 Invisible
Device Manifest XML Sub Minor Version	DeviceManifestXMLSubMinorVersion	Indicates the subminor version number of the GenICam XML.	1.00 Invisible

## Power-up Configuration Dialog

CamExpert provides a dialog box for selecting the camera power-up configuration and for loading or saving a user-defined camera power-up configuration.

Note that power-up configuration is only available with Lt-Ux20 cameras.



### Camera Power-up Configuration

The **Camera Power-up Configuration** list allows the user to select the camera configuration state to load on power-up (see feature *UserSetDefaultSelector*). The user chooses from the factory data set, or one of two possible user saved states.

### Load / Save Configuration

The **Load / Save Configuration** list allows the user to change the camera configuration any time after a power-up (see feature *UserSetSelector*). To reset the camera to the factory configuration, select *Factory Setting* and click **Load**. To save a current camera configuration, select User Set 1 or 2 and click **Save**. Select a saved user set and click **Load** to restore a saved configuration.

# Sensor Control Category

The Sensor Control category includes sensor's specific characteristics such as width, height, and pixel size, as well as parameters related to frame rate, exposure, gain, etc.

Category	Parameter	Value
Camera Information	Device Scan Type	Areascan
Sensor Control	Sensor Color Type	Bayer Sensor
I/O Control	Input Pixel Size	8 Bits/Pixel
<input checked="" type="checkbox"/> <b>Advanced Processing</b>	Sensor Width	6480
Image Format Control	Sensor Height	4860
<input checked="" type="checkbox"/> <b>Metadata Controls</b>	Sensor Shutter Mode	Global
Acquisition Control	Auto-Brightness Target	152
<input checked="" type="checkbox"/> <b>Event Control</b>	Acquisition Frame Rate Control Mode	Maximum Speed
Transport Layer Control	Acquisition Frame Rate (in Hz)	17.569752
Teledyne Lumenera Control	Exposure Time (in us)	30000.0
File Access Control	Actual Exposure Time (in us)	30000.0
USB3 Vision Host Controls	Exposure Auto	Off
	Auto-Exposure Time Max Value (in us)	100000.0
	Exposure Mode	Timed
	Exposure Alignment	Synchronous
	Exposure Delay (in us)	Not Enabled
	Gain Selector	All
	Gain	1.0
	Gain Auto	Off
	Black Level Selector	Analog
	Black Level (in DN)	5.0

<< Less

## Sensor Control Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
Device Scan Type	DeviceScanType	Defines the scan type of the device's sensor.	1.00 Beginner
Sensor Color Type	sensorColorType	Defines the camera sensor color type.	1.00 Beginner DFNC
<i>Monochrome Sensor</i>	<i>Monochrome</i>	<i>Sensor color type is monochrome</i>	
<i>Bayer Sensor</i>	<i>CFA_Bayer</i>	<i>Sensor color type is Bayer Color Filter Array (CFA).</i>	

Display Name	Feature & Values	Description	Device Version & View
Input Pixel Size	pixelSizeInput	Size of the image input pixels, in bits per pixel.	1.00 Guru DFNC
8 Bits/Pixel	Bpp8	Sensor output data path is 8 bits per pixel.	
10 Bits/Pixel	Bpp10	Sensor output data path is 10 bits per pixel.	
12 Bits/Pixel	Bpp12	Sensor output data path is 12 bits per pixel.	
Sensor Width (see Image Format Control Category)	SensorWidth	Effective width of the sensor in pixels.	1.00 Expert
Sensor Height (see Image Format Control Category)	SensorHeight	Effective height of the sensor in pixels.	1.00 Expert
Sensor Shutter Mode	SensorShutterMode	States or selects the supported shutter mode of the device.	1.00 Beginner
Global	Global	The shutter exposes all pixels at the same time.	
Global Reset	GlobalReset	The shutter opens at the same time for all pixels but ends in a line sequential manner.	
Rolling	Rolling	The shutter opens and closes sequentially for groups (typically lines) of pixels.	
Auto-Brightness Target	autoBrightnessTarget	Sets the target image grayscale value in DN, for the auto-brightness algorithm. Features that use auto-brightness include ExposureAuto and GainAuto.	1.00 DFNC Expert
Acquisition Frame Rate Control Mode	acquisitionFrameRateControlMode	Set the frame control method used in free running mode.	1.00 DFNC Guru
Programmable	Programmable	The camera frame rate is controlled by the AcquisitionFrameRate feature.	
Maximum Speed	MaximumSpeed	The camera operates at its maximum frame rate using the current exposure (time and delay) configuration.	
Acquisition Frame Rate (in Hz)	AcquisitionFrameRate	Controls the acquisition rate (in Hertz) at which the frames are captured.	1.00 Beginner
Exposure Time (in us)	ExposureTime	Sets the Exposure time. This controls the duration where the photosensitive cells are exposed to light.	1.00 Beginner
Exposure Auto	ExposureAuto	Sets the automatic exposure mode. The exact algorithm used to implement this control is device-specific.	1.00 Beginner
Off	off	Exposure duration is user controlled using ExposureTime.	
Continuous	Continuous	Exposure duration is constantly adapted by the device to maximize the dynamic range.	
Auto-Exposure Time Max Value (in us)	exposureAutoMaxValue	Sets the maximum exposure time value allowed by the user in microseconds for the Auto-Exposure function.	1.00 DFNC Expert
Exposure Mode	ExposureMode	Sets the operation mode for the camera exposure (or electronic shutter).	1.00 Beginner
Timed	Timed	The exposure duration time is set using the Exposure Time feature and the exposure starts with a FrameStart event.	
Trigger Width (All models except Lt-C1900 and Lt-M/C3840)	TriggerWidth	Uses the width of the trigger signal pulse to control the exposure duration. Use the Trigger Activation feature to set the polarity of the trigger. The Trigger Width setting is applicable with Trigger Selector = Single Frame Trigger(Start). Note that the Line Inverter feature setting may affect the polarity of the trigger signal and is only available when exposureAlignment = Reset.	

Display Name	Feature & Values	Description	Device Version & View
Exposure Alignment	exposureAlignment	Exposure Alignment specifies how the exposure is executed in relationship to the sensor capabilities and current frame trigger.	1.00 DFNC Beginner
<i>Synchronous</i>	<i>Synchronous</i>	<i>Exposure is synchronous to the internal timing of the sensor. The readout is concurrent to the exposure for the fastest possible frame rate. When a valid trigger is received and the ExposureTime is shorter than the readout period, the ExposureStart event is latched in the previous frame's readout. That is; the ExposureStartEvent is delayed and is initiated when the actual exposure starts such that the exposure ends and readout begins as soon as the previous readout has completed.</i>	
<i>Reset</i>	<i>Reset</i>	<i>Sensor timing is reset to initiate exposure when a valid trigger is received. Readout is sequential to exposure, reducing the maximum achievable frame rates. That is, a trigger received during exposure or readout is ignored since data would be lost by performing a reset.</i>	
Exposure Delay (in us)	exposureDelay	Specifies the delay in microseconds to apply after the FrameStart event before starting the ExposureStart event.	1.00 Beginner DFNC
Gain Selector	GainSelector	Selects which gain is controlled when adjusting gain features.	1.00 Beginner
<i>All</i>	<i>All</i>	<i>Gain will be applied to all channels or taps.</i>	
High Gain Conversion Mode	HighGainConversionMode	Sets the high gain conversion mode.	1.01 DFNC Guru (model dependent)
<i>Off</i>	<i>Off</i>	<i>High gain conversion mode is disabled.</i>	
<i>Active</i>	<i>Active</i>	<i>High gain conversion mode is enabled.</i>	
Gain	Gain	Controls the selected gain as an amplification factor.	1.00 Beginner
Gain Auto	GainAuto	Sets the automatic gain control (AGC) mode. The exact algorithm used to implement AGC is device-specific.	1.00 Beginner
<i>Off</i>	<i>Off</i>	<i>Gain is User controlled using Gain.</i>	
<i>Continuous</i>	<i>Continuous</i>	<i>Gain is constantly adjusted by the device.</i>	
Auto-Gain Max Value	gainAutoMaxValue	Sets the maximum gain multiplier value for the automatic gain algorithm. The automatic gain function is an amplification factor applied to the video signal to obtain the auto-brightness target value.	1.00 DFNC Guru
Auto-Gain Min Value	gainAutoMinValue	Sets the minimum gain multiplier value for the automatic gain algorithm. The automatic gain function is an amplification factor applied to the video signal to obtain the auto-brightness target value.	1.00 DFNC Guru
Black Level Selector	BlackLevelSelector	Selects which Black Level to adjust using the Black Level features.	1.00 Expert
<i>Analog</i>	<i>AnalogAll</i>	<i>Sensor Dark Offset</i>	
Black Level (in DN)	BlackLevel	Controls the black level as an absolute physical value. This represents a DC offset applied to the video signal, in DN (digital number) units. The Black Level Selector feature specifies the channel to adjust.	1.00 Expert

Display Name	Feature & Values	Description	Device Version & View
Black Level Auto	BlackLevelAuto	Sets the automatic black level control mode.	1.00 Expert
<i>Off</i>	<i>Off</i>	<i>Black Level is User controlled using Black Level.</i>	
<i>Continuous</i>	<i>Continuous</i>	<i>Black level is programmed automatically from other settings.</i>	

## High Gain Conversion Mode

High gain conversion mode is used to improve image quality in low light environments.

When high gain conversion is enabled (**High Gain Conversion Mode = Active**), read noise is minimized, which yields a lower absolute sensitivity threshold better suited for detecting weak signals with short exposures. This mode is therefore ideal when light levels are low.

In normal to very bright lighting conditions, the saturation capacity of the sensor pixels should be maximized to provide the highest dynamic range. In this case, the high gain conversion mode should be disabled (**High Gain Conversion Mode = Off**).

# I/O Control Category

The I/O control category groups features used to configure external trigger, line inputs and strobe output.

Category	Parameter	Value
Camera Information	Trigger Selector	Single Frame Trigger(Start)
Sensor Control	Trigger Mode	Off
I/O Control	Trigger Software	Press...
Advanced Processing	Trigger Source	Software
Color Processing	Trigger Activation	Rising Edge
Image Format Control	Trigger Delay (in us)	0.0
Acquisition Control	Trigger Frames Count	1
Event Control	Strobe Mode	Off
Event Info	Strobe Delay (in us)	0
Test Data	Strobe Duration (in us)	41
Exposure End Data	Strobe Source	Line 1
Transport Layer Control	Line Selector	Line 0
Teledyne Lumenera Control	Line Name	GPI1 Opto
File Access Control	Line Mode	Input
USB3 Vision Host Controls	Line Inverter	Not Enabled
	Line Status	False
	Output Line Source	Not Enabled
	Output Line Value	Not Enabled
	Line Status All	0x0000000000000000C

## I/O Control Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
Trigger Selector	TriggerSelector	Selects which type of trigger to configure with the various Trigger features.	1.00 Beginner
Single Frame Trigger(Start)	FrameStart	Selects a trigger starting the capture of a single frame. Frame size is determined by image format feature "Height".	
MultiFrame Trigger(Start)	FrameBurstStart	Selects a trigger to capture multiple frames. The number of frames is specified by the triggerFrameCount feature.	
Trigger Mode	TriggerMode	Controls if the selected trigger is active.	1.00 Beginner
Off	Off	Disables the selected trigger.	
On	On	Enable the selected trigger.	

Display Name	Feature & Values	Description	Device Version & View
Trigger Software	TriggerSoftware	Generates an internal trigger. TriggerSource must be set to Software.	1.00 Beginner
Trigger Source	TriggerSource	Specifies the internal signal or physical input Line to use as the trigger source. The selected trigger must have its TriggerMode set to On.	1.00 Beginner
Software	Software	<i>Specifies that the trigger source will be generated by software using the TriggerSoftware command.</i>	
Line 0	Line0	<i>Specifies which physical line (or pin) and associated I/O control block to use as external source for the trigger signal.</i>	
Line 1	Line1	<i>Specifies which physical line (or pin) and associated I/O control block to use as external source for the trigger signal.</i>	
Line 2	Line2	<i>Specifies which physical line (or pin) and associated I/O control block to use as external source for the trigger signal.</i>	
Line 3	Line3	<i>Specifies which physical line (or pin) and associated I/O control block to use as external source for the trigger signal.</i>	
Trigger Activation	TriggerActivation	Specifies the activation mode of the trigger.	1.00 Beginner
Rising Edge	RisingEdge	<i>Specifies that the trigger is considered valid on the rising edge of the source signal.</i>	
Falling Edge	FallingEdge	<i>Specifies that the trigger is considered valid on the falling edge of the source signal.</i>	
Trigger Delay	TriggerDelay	Specifies the delay in microseconds to apply after receiving the trigger and before activating the triggerEvent.	1.00 Beginner
Trigger Frames Count	triggerFrameCount	Sets the maximum number of frames to acquire when a valid trigger is received. This feature is available when Trigger Selector = MultiFrame Trigger(Start).	1.00 Beginner
Strobe Mode	StrobeMode	Enables/disables the strobes in snapshot mode.	1.00 Beginner
Off	Off	<i>Strobe Is Off</i>	
On Trigger	OnTrigger	<i>Strobe fires on the trigger.</i>	
Strobe Delay	StrobeDelay	Trigger to strobe delay	1.00 Beginner
Strobe Duration	StrobeDuration	Strobe length	1.00 Beginner
Strobe Source	StrobeSource	Output physical line (pin) used to generate the strobe signal.	1.00 Guru
Line 1	Line1	<i>Line 1</i>	
Line 2	Line2	<i>Line 2</i>	
Line 3	Line3	<i>Line 3</i>	
Line Selector	LineSelector	Selects the physical line (or pin) of the external device connector to configure.	1.00 Beginner
Line 0	Line0	<i>Index of the physical line and associated I/O control block to use.</i>	
Line 1	Line1	<i>Index of the physical line and associated I/O control block to use.</i>	
Line 2	Line2	<i>Index of the physical line and associated I/O control block to use.</i>	
Line 3	Line3	<i>Index of the physical line and associated I/O control block to use.</i>	
Line 4	Line4	<i>Index of the physical line and associated I/O control block to use.</i>	

Display Name	Feature & Values	Description	Device Version & View
Line Name	lineName	Description of the physical Pin associated with the logical line.	1.00 DFNC Beginner
<i>GPI1 Opto</i>	<i>Gpi1Opto</i>	<i>Associated with the logical line GPI1 Opto</i>	
<i>GPO1 Opto</i>	<i>Gpo1Opto</i>	<i>Associated with the logical line GPO1 Opto</i>	
<i>GPIO2</i>	<i>Gpio2</i>	<i>Associated with the logical line GPIO2</i>	
<i>GPIO3</i>	<i>Gpio3</i>	<i>Associated with the logical line GPIO3</i>	
<i>VCC3.3</i>	<i>VCC3.3</i>	<i>Associated with the logical line VCC3.3</i>	
Line Mode	LineMode	Reports if the physical Line is an Input or Output signal.	1.00 Expert
<i>Input</i>	<i>Input</i>	<i>The line is an input line.</i>	
<i>Output</i>	<i>Output</i>	<i>The line is an output line.</i>	
Line Inverter	LineInverter	Control to invert the polarity of the selected input or output line signal.	1.00 Beginner
Line Status	LineStatus	Returns the current status of the selected input or output line.	1.00 Expert
Output Line Source	outputLineSource	Selects which internal signal or event driven pulse or software control state to output on the selected output line.	1.00 DFNC Beginner
<i>Software Controlled</i>	<i>SoftwareControlled</i>	<i>The OutputLineValue feature changes the state of the output.</i>	
<i>Strobe on Trigger</i>	<i>Strobe</i>	<i>Generate a pulse on the Trigger event.</i>	
<i>Pulse on: Start of Readout</i>	<i>PulseOnStartofReadout</i>	<i>Generate a pulse on the ReadoutStart event.</i>	
<i>Exposure Active</i>	<i>ExposureActive</i>	<i>Generate a signal that is active when the Exposure is active.</i>	
<i>Ready For Trigger</i>	<i>ReadyForTrigger</i>	<i>Generate a signal that is active when the camera is ready for a frame trigger.</i>	
Output Line Pulse Delay	outputLinePulseDelay	Sets the delay (in $\mu$ s) before the output line pulse signal. Applicable for the OutputLineSource feature.	1.00 Beginner DFNC
Output Line Pulse Duration	outputLinePulseDuration	Sets the width (duration) of the output line pulse in microseconds.	1.00 Beginner DFNC
Output Line Value	outputLineValue	Sets the output state of the selected Line if the outputLineSoftwareLatchControl = OFF. OutputLineSource must be SoftwareControlled. If the outputLineSoftwareLatchControl = Latch, the state of the pin will change with the outputLineSoftwareCmd command.	1.00 Beginner
<i>Active</i>	<i>Active</i>	<i>Sets the Output circuit to close</i>	
<i>Inactive</i>	<i>Inactive</i>	<i>Sets the Output circuit to open</i>	
Flash Zone Delay	flashZoneDelay	Returns the recommended output pulse delay, corresponding to the delay of the last line exposure start of a rolling shutter sensor, when the Output Line Source = <i>Pulse on Start of Exposure</i> . (RO)	1.01 Guru DFNC Lt-M/C3840, Lt-M/C5500 models
Flash Zone Duration	flashZoneDuration	Returns the recommended output pulse duration for controlling a flash device for the optimal flash zone time. (RO)	1.01 Guru DFNC Lt-M/C3840, Lt-M/C5500 models
Line Status All	LineStatusAll	Returns the current status of all available line signals, at time of polling, in a single bit field. The order is Line1, Line2, ...	1.00 Expert

Display Name	Feature & Values	Description	Device Version & View
Line Pinout	linePinAssociation	Enumeration of the physical line (or pin) on the I/O device connector.	1.00 Invisible
<i>Pin6-7=Opto Input</i>	<i>GpiOptoPin6and7</i>	<i>Pin 6 is the negative opto input and Pin 7 is the positive opto input on the I/O connector.</i>	
<i>Pin2-3=Opto Output</i>	<i>GpoOptoPin2and3</i>	<i>Pin 2 is the positive opto output and Pin 3 is the negative opto output on the I/O connector.</i>	
<i>Pin4=Signal - Pin8=Gnd - Pin1=Pwr</i>	<i>Pin4Signal_Pin8Gnd_Pin1Pwr</i>	<i>Pin 4 is the Signal, Pin 8 is the ground and Pin 1 is the common output Power on the I/O connector.</i>	
<i>Pin5=Signal - Pin8=Gnd - Pin1=Pwr</i>	<i>Pin5Signal_Pin8Gnd_Pin1Pwr</i>	<i>Pin 5 is the Signal, Pin 8 is the ground and Pin 1 is the common output Power on the I/O connector.</i>	
<i>Pin9-7=Opto Input</i>	<i>GpiOptoPin9and7</i>	<i>Pin 9 is the positive opto input and Pin 7 is the negative opto input on the I/O connector.</i>	
<i>Pin8-7=Opto Output</i>	<i>GpoOptoPin8and7</i>	<i>Pin 8 is the positive opto output and Pin 7 is the negative opto output on the I/O connector.</i>	
<i>Pin4=Signal - Pin2,6=Gnd - Pin1=Pwr</i>	<i>Pin4Signal_Pin2or6Gnd_Pin1Pwr</i>	<i>Pin 4 is the Signal, Pin 2 and 6 are the ground and Pin 1 is the common output Power on the I/O connector.</i>	
<i>Pin5=Signal - Pin2,6=Gnd - Pin1=Pwr</i>	<i>Pin5Signal_Pin2or6Gnd_Pin1Pwr</i>	<i>Pin 5 is the Signal, Pin 2 and 6 are the ground and Pin 1 is the common output Power on the I/O connector.</i>	
<i>Pin3=3.3V</i>	<i>Pin3Power</i>	<i>Pin 3 is the 3.3V optional output Power on the I/O connector.</i>	

## Input and Output Line Details

The general purpose I/O line signals are on the GPIO connector located on the back or edge (dependent of model series) of the cameras. See section **Connectors** for details on connector pinout and I/O signal specifications.

## Strobe and Flash Zone (Lt-3840, Lt-5500)

In the case of rolling shutter cameras, to help with settings when using a strobe light, the camera provides optimal values for the **Output Line Pulse Delay** and **Output Line Pulse Duration** features, which are found, respectively, in the **Flash Zone Delay** and **Flash Zone Duration** read-only features.

### IT IS UP TO THE USER TO INPUT THOSE VALUES.

Note that these optimal values depend on camera settings, so that modifying the settings may induce changes to the flash zone values. Again, it is up to the user to re-enter the **Output Line Pulse Delay** and **Output Line Pulse Duration** values when necessary.

See section Overview of Electronic Rolling Shutter (ERS) Exposures for details.

### To Use Strobe and Flash Zone in Video/Free Running Mode (Electronic Rolling Shutter)

1. Set **Line Selector** to *Line 3* (only option for video).
2. Set **Line Mode** to *Output*.
3. Set **Output Line Source** to *Pulse on: Start of Exposure*.
4. Set **Output Line Pulse Delay** to the value found in **Flash Zone Delay**.
5. Set **Output Line Pulse Duration** to the value found in **Flash Zone Duration**.

### To Use Strobe and Flash Zone in Still/Triggered Single Frame Mode (Global Reset Release Shutter)

1. Set **Trigger Mode** to *On* to set the camera to still/single frame.
2. Set **Line Selector** to *Line 1, 2, or 3*.
3. Set **Line Mode** to *Output*.
4. Set **Output Line Source** to *Pulse on: Start of Exposure*.
5. Set **Output Line Pulse Delay** to the value found in **Flash Zone Delay**.
6. Set **Output Line Pulse Duration** to the value found in **Flash Zone Duration**.

# Advanced Processing Category

The Advanced Processing category includes features related to image and color processing.

Category	Parameter	Value
Camera Information	Gamma Correction	1.0
Sensor Control	Contrast Correction	1.0
I/O Control	Brightness Correction	0.0
<b>Advanced Processing</b>	LUT Mode	Off
Color Processing	LUT Index	0
Image Format Control	LUT Value	
Acquisition Control	LUT Value All	
<b>Event Control</b>	<< Less	
Transport Layer Control		
Teledyne Lumenera Control		
File Access Control		
USB3 Vision Host Controls		

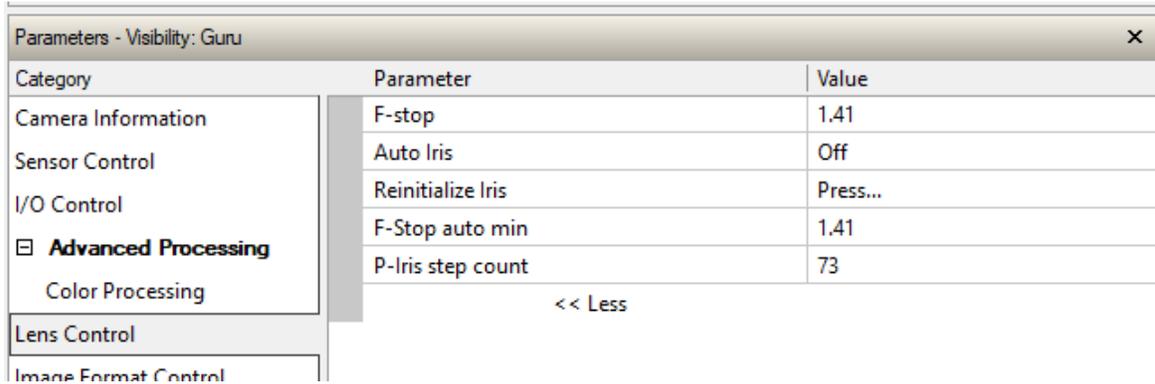
Category	Parameter	Value
Camera Information	Balance White Auto	Off
Sensor Control	Balance Ratio Selector	Red
I/O Control	Balance Ratio	1.25
<b>Advanced Processing</b>	<< Less	
Color Processing		
Image Format Control		
Acquisition Control		
<b>Event Control</b>		
Transport Layer Control		
Teledyne Lumenera Control		
File Access Control		
USB3 Vision Host Controls		

## Advanced Processing Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
Gamma Correction	gammaCorrection	Sets the gamma correction factor. The gamma correction is applied as an inverse exponent to the original pixel value.	1.00 DFNC Expert
Contrast Correction	contrastCorrection	Sets the contrast correction factor.	1.00 DFNC Expert
Brightness Correction	brightnessCorrection	Sets the brightness correction as a percentage.	1.00 DFNC Expert
LUT Mode	lutMode	Sets the enable state of the LUT module (Lookup Table).	1.00 DFNC Expert
<i>Off</i>	<i>Off</i>	<i>Disables the LUT.</i>	
<i>Active</i>	<i>Active</i>	<i>Enables the LUT module.</i>	
LUT Index	LUTIndex	Selects the index (offset) of the coefficient to access in the selected LUT.	1.00 Guru
LUT Value	LUTValue	Returns the value at specified LUT index entry of the LUT selected by the LUT Selector feature.	1.00 Guru
LUT Value All	LUTValueAll	Accesses all the LUT coefficients in a single access without using individual LUT indices. This feature accesses the LUT values in the currently active LUT table set by the LUT Current Active Set feature.	1.00 Guru
Balance White Auto	BalanceWhiteAuto	Controls the mode for automatic white balancing between the color channels. The white balancing ratios are automatically adjusted.	1.00 Expert
<i>Off</i>	<i>Off</i>	<i>White balancing is user controlled using BalanceRatioSelector and BalanceRatio.</i>	
<i>Continuous</i>	<i>Continuous</i>	<i>White balancing is constantly adjusted by the device.</i>	
Balance Ratio Selector	BalanceRatioSelector	Selects which color gain is controlled with the BalanceRatio feature.	1.00 Expert
<i>Red</i>	<i>Red</i>	<i>RED gain is controlled by Balance Ratio.</i>	
<i>Green</i>	<i>Green</i>	<i>GREEN gain is controlled by Balance Ratio.</i>	
<i>Blue</i>	<i>Blue</i>	<i>BLUE gain is controlled by Balance Ratio.</i>	
Balance Ratio	BalanceRatio	Sets the digital gain of the selected color component (BalanceRatioSelector).	1.00 Expert

# Lens Control (for LT-Ux0x-xxxxx series)

The Lens Control category is used to configure features controlling motorized iris lens. It applies to LT-Ux0x-xxxxx Series only.



## Lens Control Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
F-stop	iris	F-number setting. The larger the number the smaller the aperture.	1.00 DFNC Expert
Auto Iris	irisAuto	Iris's automatic mode	1.00 DFNC Beginner
<i>Off</i>	<i>Off</i>		
<i>Continuous</i>	<i>Continuous</i>		
Reinitialize Iris	irisInit	Initializes the iris	1.00 DFNC Beginner
F-Stop auto min	irisAutoMax	Minimum f-number when Auto Iris is enabled.	1.00 DFNC Expert
P-Iris step count	irisStepsCount	Number of positions in the P-Iris stepping motor. Users must consult their lens's manual and set it correctly before accessing their lens.	1.00 DFNC Guru

## F-stops vs. Exposure Overview

The Lt Series Lens F-stop control allows adjusting the lens iris with small incremental steps. It is important to remember that full stop increases will half the incoming illumination and requires doubling the exposure time to compensate.

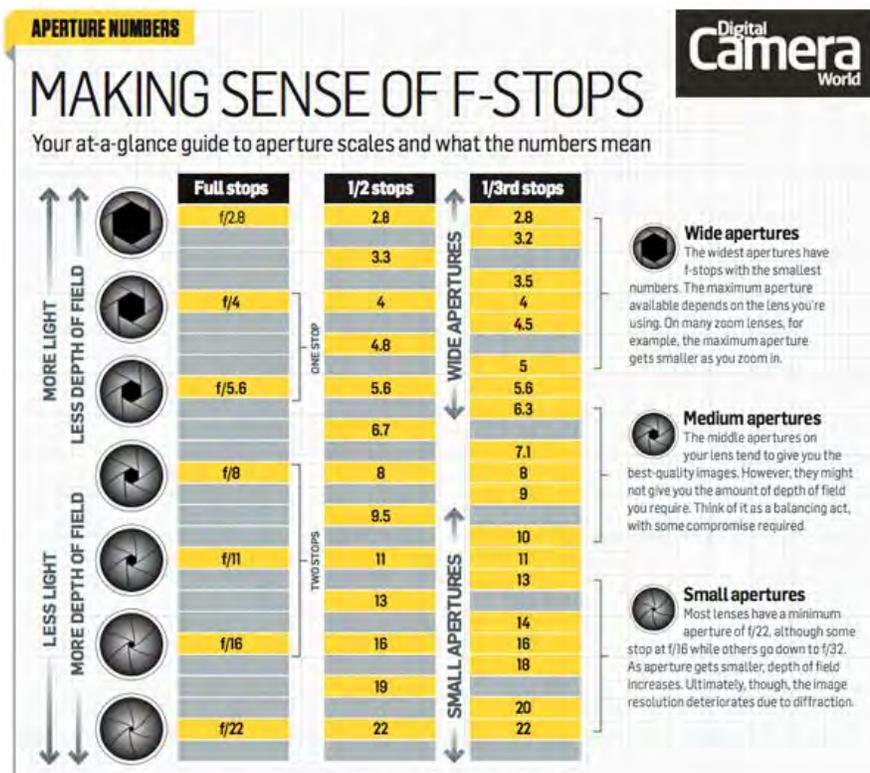
The common aperture scale is as follows:

f/1.4	(large opening of aperture – a lot of light)
f/2.0	(half as much light as f/1.4)
f/2.8	(half as much light as f/2.0)
f/4.0	(half again)
f/5.6	(half again)
f/8.0	(half again)
f/11.0	(half again)
f/16.0	(half again)
f/22.0	(half again)
f/32.0	(very small aperture, lets in little light)

For users unfamiliar with lens iris controls (F-stops), the following photography site has a good explanation of this subject and along with a handy table of standard F-stop values.

Digital Camera World's web site

<https://www.digitalcameraworld.com/tutorials/cheat-sheet-how-to-understand-f-stops>



(Courtesy of Digital Camera World)

# Image Format Control Category

The Image Format Control category groups parameters used to configure camera pixel format, image cropping, decimation, and others.

Category	Parameter	Value
Camera Information	Sensor Width	2464
Sensor Control	Sensor Height	2056
I/O Control	Width	2464
<input checked="" type="checkbox"/> <b>Advanced Processing</b>	Height	2056
Color Processing	Binning Horizontal	1
Lens Control	Binning Vertical	1
<b>Image Format Control</b>	Decimation Horizontal	1
Acquisition Control	Decimation Vertical	1
<input checked="" type="checkbox"/> <b>Event Control</b>	Offset X	0
Transport Layer Control	Offset Y	0
Teledyne Lumenera Control	Pixel Format	Mono8
File Access Control	Horizontal Flip	False
	Vertical Flip	False

## Image Format Control Feature Description

Display Name	Feature & Values	Description	Device Version & View
Sensor Width	SensorWidth	Effective width of the sensor in pixels.	1.00 Expert
Sensor Height	SensorHeight	Effective height of the sensor in pixels.	1.00 Expert
<u>Width</u>	Width	Width of the Image provided by the device (in pixels).	1.00 Beginner
<u>Height</u>	Height	Height of the Image provided by the device (in lines).	1.00 Beginner
Binning Horizontal	BinningHorizontal	Number of horizontal pixels to combine together. This reduces the horizontal resolution of the image.	1.00 Beginner
Binning Vertical	BinningVertical	Number of vertical pixels to combine together. This reduces the vertical resolution of the image.	1.00 Beginner
Decimation Horizontal	DecimationHorizontal	Horizontal sub-sampling of the image. This reduces the horizontal resolution (width) of the image by the specified horizontal decimation factor.	1.00 Beginner
Decimation Vertical	DecimationVertical	Vertical sub-sampling of the image. This reduces the vertical resolution (height) of the image by the specified vertical decimation factor.	1.00 Beginner
Offset X	OffsetX	Horizontal offset from the origin to the region of interest (in pixels).	1.00 Beginner
Offset Y	OffsetY	Vertical offset from the origin to the region of interest (in pixels).	1.00 Beginner

Display Name	Feature & Values	Description	Device Version & View
Pixel Format	PixelFormat	Format of the pixels provided by the device. It represents all the information provided by PixelSize, PixelColorFilter combined in a single feature.	1.00 Beginner
	<i>Mono8</i>	<i>Mono8</i>	<i>Monochrome 8-bit</i>
	<i>Mono16</i>	<i>Mono16</i>	<i>Monochrome 16-bit</i>
	<i>BayerGR8</i>	<i>BayerGR8</i>	<i>Bayer Green-Red 8-bit</i>
	<i>BayerGR16</i>	<i>BayerGR16</i>	<i>Bayer Green-Red 16-bit</i>
	<i>BayerGB8</i>	<i>BayerGB8</i>	<i>Bayer Green-Blue 8-bit</i>
	<i>BayerGB16</i>	<i>BayerGB16</i>	<i>Bayer Green-Blue 16-bit</i>
	<i>BayerBG8</i>	<i>BayerBG8</i>	<i>Bayer Blue-Green 8-bit</i>
	<i>BayerBG16</i>	<i>BayerBG16</i>	<i>Bayer Blue-Green 16-bit</i>
	<i>BayerRG8</i>	<i>BayerRG8</i>	<i>Bayer Red-Green 8-bit</i>
	<i>BayerRG16</i>	<i>BayerRG16</i>	<i>Bayer Red-Green 16-bit</i>
	<i>Mono10p</i> <i>(Lt-Ux20-xxxx models only)</i>	<i>Mono10p</i> <i>Monochrome 10-bit packed</i> <i>(Image width must be set to a multiple of 32.)</i>	
	<i>BayerRG10p</i> <i>(Lt-Ux20-xxxx models only)</i>	<i>BayerRG10p</i> <i>Bayer Red-Green 10-bit packed</i> <i>(Image width must be set to a multiple of 32.)</i>	
	<i>BayerGR10p</i> <i>(Lt-Ux20-xxxx models only)</i>	<i>BayerGR10p</i> <i>Bayer Green-Red 10-bit packed</i> <i>(Image width must be set to a multiple of 32.)</i>	
	<i>BayerGB10p</i> <i>(Lt-Ux20-xxxx models only)</i>	<i>BayerGB10p</i> <i>Bayer Green-Blue 10-bit packed</i> <i>(Image width must be set to a multiple of 32.)</i>	
	<i>BayerBG10p</i> <i>(Lt-Ux20-xxxx models only)</i>	<i>BayerBG10p</i> <i>Bayer Blue-Green 10-bit packed</i> <i>(Image width must be set to a multiple of 32.)</i>	
	<i>Mono12p</i>	<i>Mono12p</i>	<i>Monochrome 12-bit packed</i>
	<i>BayerRG12p</i>	<i>BayerRG12p</i>	<i>Bayer Red-Green 12-bit packed</i>
	<i>BayerGR12p</i>	<i>BayerGR12p</i>	<i>Bayer Green-Red 12-bit packed</i>
	<i>BayerGB12p</i>	<i>BayerGB12p</i>	<i>Bayer Green-Blue 12-bit packed</i>
	<i>BayerBG12p</i>	<i>BayerBG12p</i>	<i>Bayer Blue-Green 12-bit packed</i>
<u>Horizontal Flip</u>	ReverseX	Horizontal image flip function.	1.00 Expert
<u>Vertical Flip</u>	ReverseY	Vertical image flip function.	1.00 Expert
Horizontal Offset	OffsetX	Horizontal offset from the Sensor Origin to the Area Of Interest (in pixels).	1.00 Beginner
Vertical Offset	OffsetY	Vertical offset from the Sensor Origin to the Area Of Interest (in pixels).	1.00 Beginner
Multiple ROI Mode <i>(Lt-Ux20-xxxx models only)</i>	multipleROI Mode	Enable the Multiple ROI (Region of Interest) per image feature. The ROI Count is set by the Multiple ROI Count feature.	1.00 Expert DFNC
	<i>Off</i>	<i>Off</i>	<i>Single ROI per image.</i>
	<i>Active</i>	<i>Active</i>	<i>The ROI per image feature is active.</i>
ROI Count Horizontal	multipleROICountHorizontal	Specifies the number of ROI (Region of Interest) available for the X axis.	1.00 Expert DFNC
ROI Count Vertical	multipleROICountVertical	Specifies the number of ROI (Region of Interest) available for the Y axis.	1.00 Expert DFNC
ROI Count	multipleROICount	Specifies the number of possible ROI (Region of Interest) available in an acquired image. Two is minimum, while the maximum is device specific.	1.00 Expert DFNC

Display Name	Feature & Values	Description	Device Version & View
ROI Selector	multipleROISelector	Select an ROI (Region of Interest) when Multiple ROI Mode is enabled. Selector range is from 1 to the Multiple ROI Count value.	1.00 Expert DFNC
<i>ROI (x1, y1)</i>	<i>roi1_1</i>	<i>ROI (x1, y1)</i>	
<i>ROI (x2, y1)</i>	<i>roi2_1</i>	<i>ROI (x2, y1)</i>	
<i>ROI (x3, y1)</i>	<i>roi3_1</i>	<i>ROI (x3, y1)</i>	
<i>ROI (x4, y1)</i>	<i>roi4_1</i>	<i>ROI (x4, y1)</i>	
<i>ROI (x5, y1)</i>	<i>roi5_1</i>	<i>ROI (x5, y1)</i>	
<i>ROI (x6, y1)</i>	<i>roi6_1</i>	<i>ROI (x6, y1)</i>	
<i>ROI (x7, y1)</i>	<i>roi7_1</i>	<i>ROI (x7, y1)</i>	
<i>ROI (x8, y1)</i>	<i>roi8_1</i>	<i>ROI (x8, y1)</i>	
<i>ROI (x1, y2)</i>	<i>roi1_2</i>	<i>ROI (x1, y2)</i>	
<i>ROI (x1, y3)</i>	<i>roi1_3</i>	<i>ROI (x1, y3)</i>	
<i>ROI (x1, y4)</i>	<i>roi1_4</i>	<i>ROI (x1, y4)</i>	
<i>ROI (x1, y5)</i>	<i>roi1_5</i>	<i>ROI (x1, y5)</i>	
<i>ROI (x1, y6)</i>	<i>roi1_6</i>	<i>ROI (x1, y6)</i>	
<i>ROI (x1, y7)</i>	<i>roi1_7</i>	<i>ROI (x1, y7)</i>	
<i>ROI (x1, y8)</i>	<i>roi1_8</i>	<i>ROI (x1, y8)</i>	
...	...	...	
ROI Offset X	multipleROIOffsetX	Horizontal offset (in pixels) from the origin to the selected ROI (Region of Interest).	1.00 Expert DFNC
ROI Offset Y	multipleROIOffsetY	Vertical offset (in pixels) from the origin to the selected ROI (Region of Interest).	1.00 Expert DFNC
ROI Width	multipleROIWidth	Width of the selected ROI (Region of Interest) provided by the device (in pixels).	1.00 Expert DFNC
ROI Height	multipleROIHeight	Height of the selected ROI (Region of Interest) provided by the device (in pixels).	1.00 Expert DFNC
Test Image Selector <i>(Lt-Ux20-xxxx models only)</i>	TestImageSelector	Selects the type of test image that is sent by the camera. Choices are either as defined by the GeniCam standard and/or as provided by the device manufacturer.	1.00 Guru
<i>Off</i>	<i>Off</i>	<i>Image is from the camera sensor.</i>	
<i>Grey Horizontal Ramp</i>	<i>GreyHorizontalRamp</i>	<i>Image is filled horizontally with an image that goes from the darkest possible value to the brightest.</i>	
Width Max	WidthMax	Maximum width of the image (in pixels). The dimension is calculated after horizontal binning, decimation or any other function changing the horizontal dimension of the image.	1.00 Invisible
Height Max	HeightMax	Maximum height of the image (in pixels). This dimension is calculated after vertical binning, decimation or any other function changing the vertical dimension of the image.	1.00 Invisible
Pixel Color Filter	PixelColorFilter	Indicates the type of color filter applied to the image.	1.00 Invisible
<i>None</i>	<i>None</i>	<i>No color filter.</i>	
<i>BayerRG</i>	<i>BayerRG</i>	<i>Bayer Red Green filter.</i>	
<i>BayerGB</i>	<i>BayerGB</i>	<i>Bayer Green Blue filter.</i>	
<i>BayerGR</i>	<i>BayerGR</i>	<i>Bayer Green Red filter.</i>	
<i>BayerBG</i>	<i>BayerBG</i>	<i>Bayer Blue Green filter.</i>	

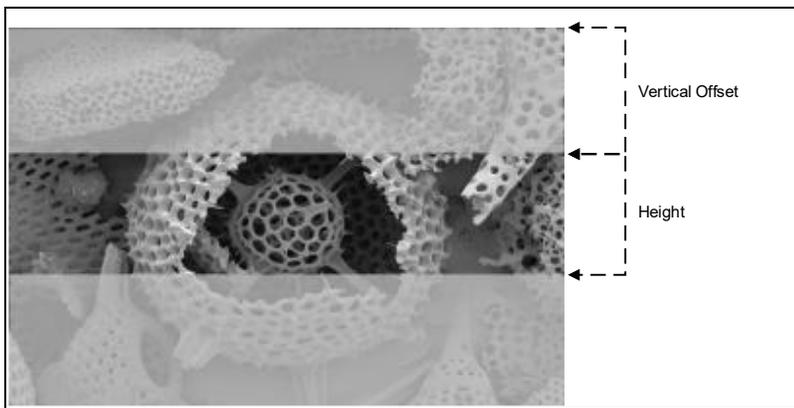
# Width and Height Features for Partial Scan Control

Width and Height controls, along with their respective offset settings, allow the camera to grab a region of interest (ROI) within the full image frame. Besides eliminating post acquisition image cropping done by software in the host computer, a windowed ROI grab reduces the transfer bandwidth required since less pixels are transmitted.

## Vertical Cropping (Partial Scan)

The Height and Vertical Offset features, used for vertical cropping, reduce the number of video lines grabbed for a frame. By not scanning the full height of the sensor, the maximum possible acquisition frame rate is proportionately increased, up to the Lt Camera maximum.

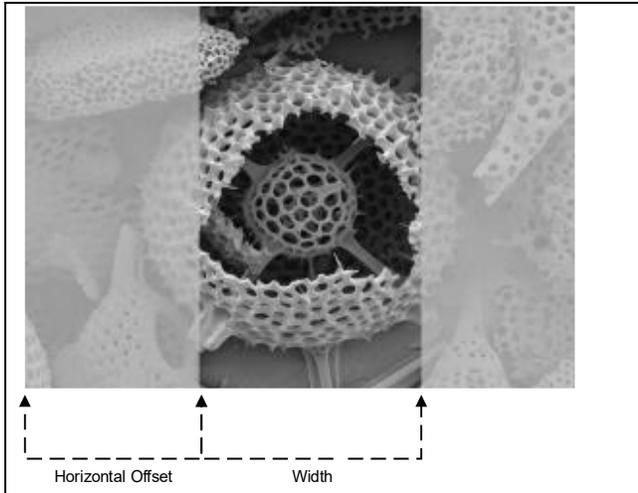
The following figure is an example of a partial scan acquisition using both Height and Vertical Offset controls. The Vertical Offset feature defines at what line number from the sensor origin to acquire the image. The Height feature defines the number of lines to acquire (to a maximum of the remaining frame height). Note that only the partial scan image (ROI) is transmitted to the host computer.



In general, using short exposures at high frame rates will exceed the maximum bandwidth transfer speed, when the camera buffer memory is filled. The tables below (for different models) describe frame rate maximums written to internal memory that can be sustained during continuous acquisition. Increase the exposure time, decrease the frame rate, or acquire a limited number of frames, so as to not exceed the transfer bandwidth.

## Horizontal Cropping (Partial Scan)

Lt Series cameras support cropping the acquisition horizontally by grabbing fewer pixels on each horizontal line. Horizontal offset defines the start of the acquired video line while horizontal width defines the number of pixels per line.

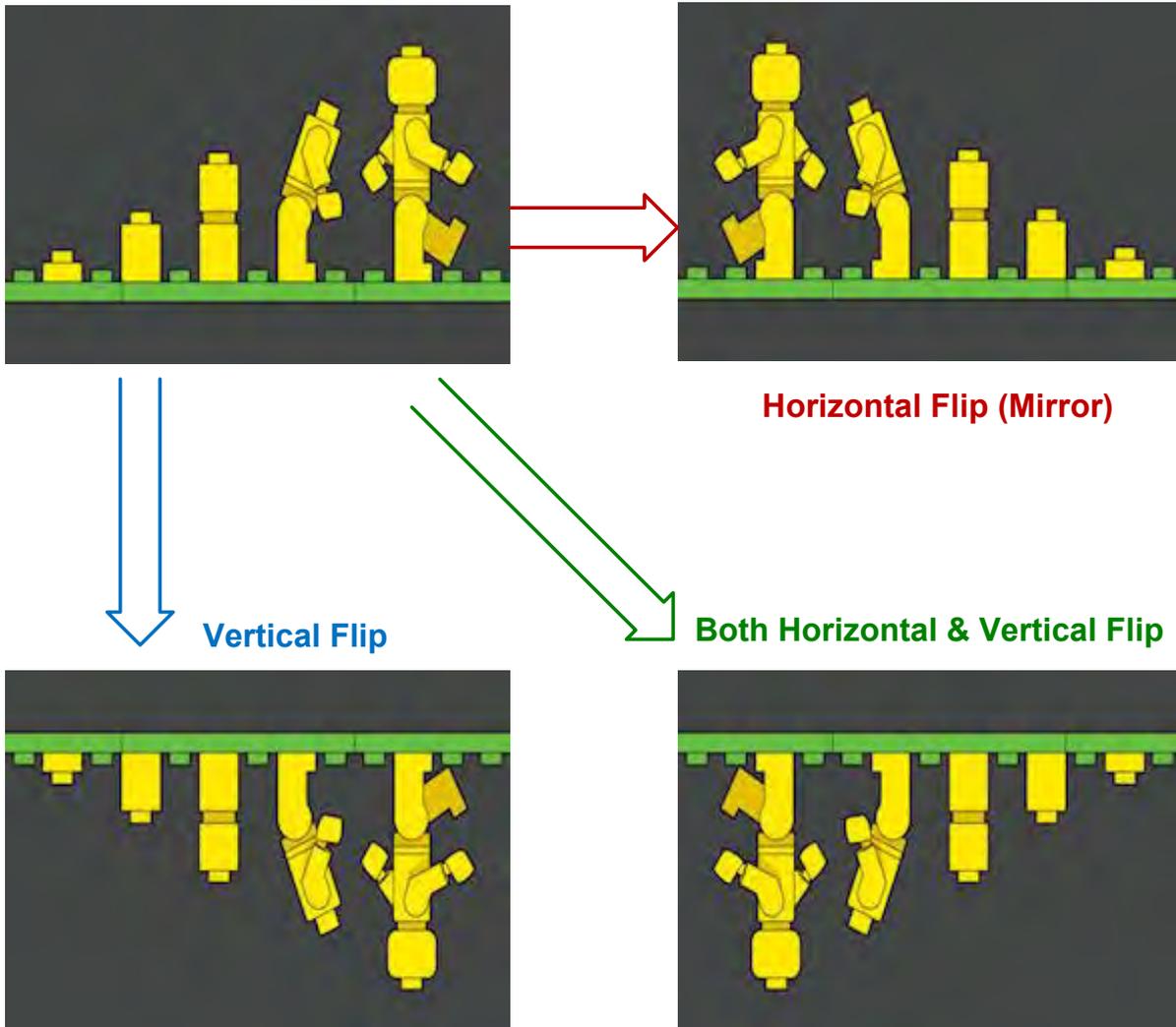


## Horizontal and Vertical Flip

The Image Flip features activate image acquisition with horizontal and/or vertical inversion.

- Support of one or both functions is camera model specific since it is a function of sensor data readout, not post sensor processing.
- When image flip is supported directly at the sensor, activation of the flip function does not reduce the maximum frame rate possible from that model.
- The horizontal and/or vertical image flip functions acquire images as expected.

## Acquisition Flip Features



## Using the Multiple ROI Mode

Lumenera Lt-Ux20 cameras implement the Multiple ROI (region of interest) features, which allow defining from 2 to 64 smaller image ROI areas versus the single ROI area possible with vertical and horizontal crop functions.

Multiple ROI Mode	Active
ROI Count Horizontal	2
ROI Count Vertical	2
ROI Count	4
ROI Selector	ROI (x1, y2)
ROI Offset X	32
ROI Offset Y	1024
ROI Width	512
ROI Height	640
Decimation Horizontal	1
Decimation Vertical	1
Test Image Selector	Off

These multiple areas are combined as one output image, reducing transfer bandwidth requirements. In addition, any reduction of the number of vertical lines output results in a greater acquisition frame rate.

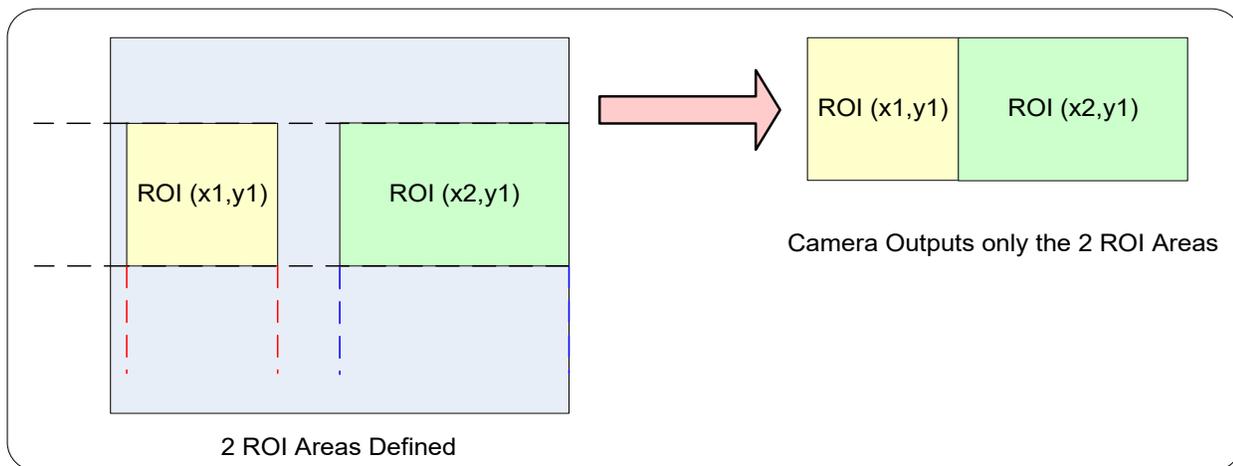
### Important Usage Details

- The Lt-Ux20 supports from 2 to 64 ROI areas (8 ROIs x 8 ROIs matrix maximum). Each ROI is identified as ROI( $x_i, y_j$ ), where  $i$  and  $j$  refer to the row and column of the ROI.
- For any selected ROI, the Offset X/Offset Y features define the upper left corner of the ROI.
- Offset, Width, and Height features have individual increment values (step size) to consider.
- The first ROI of any row sets the height value for any other ROI in that row.
- The first ROI of any column sets the width value of any other ROI in that column.

The following examples show the multi-ROI function (2x1 and 2x2 areas), the resultant camera output, and the constraints when configuring the ROI areas.

### Example: Two Horizontal ROI Areas (2x1)

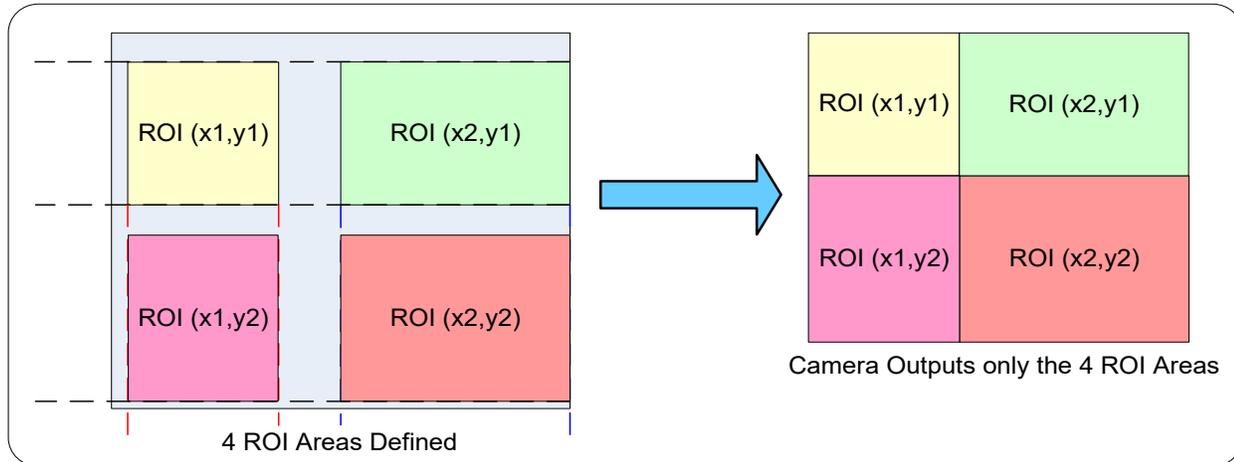
This example shows 2 ROIs on the same row.



- ROI( $x_1, y_1$ ) defines the height of any ROI in that row.
- ROI( $x_2, y_1$ ) can have a different width.

- The camera output image frame consists only of the two ROI areas. The user must account for the change between ROI data for each output image row.
- The output image being smaller, bandwidth requirements are reduced.

### **Example: Four ROI Areas (2x2)**

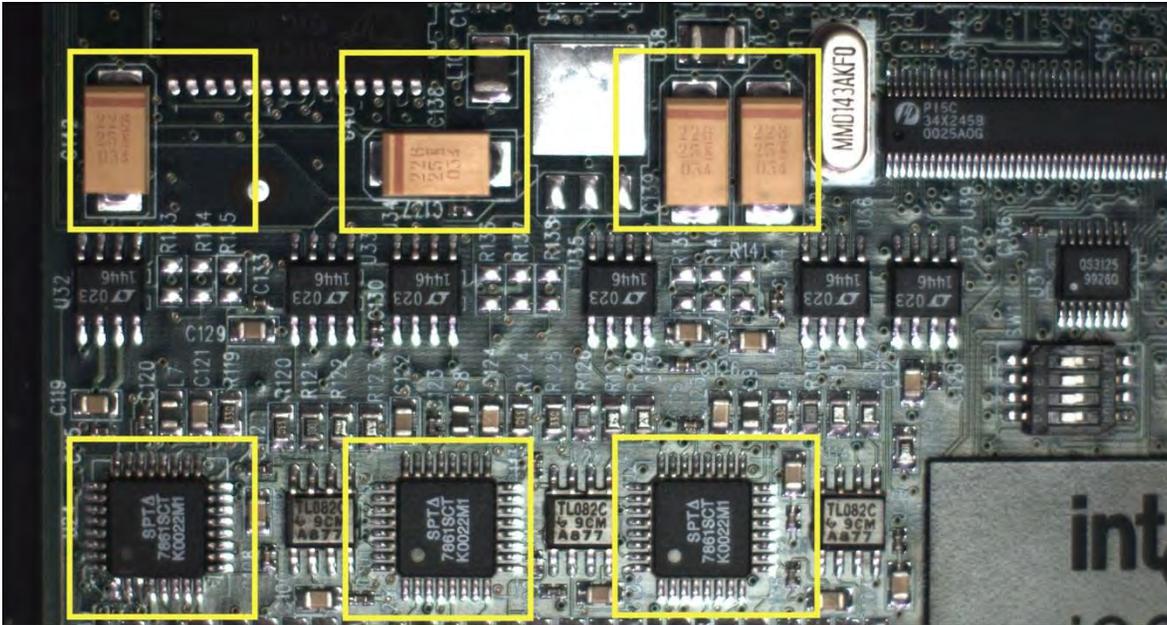


- ROI(x1, y1) defines the height of any ROI in the first row, and the width of any ROI in the first column.
- ROI(x2, y1) defines the width of any ROI in the second column.
- ROI(x1, y2) defines the height of any ROI in the second row.
- The camera output image frame consists only of the 4 ROI areas, in the same order as the ROI rows and columns. The user must account for the change between ROI data for each output image row.
- The output image being smaller, bandwidth requirements are reduced.

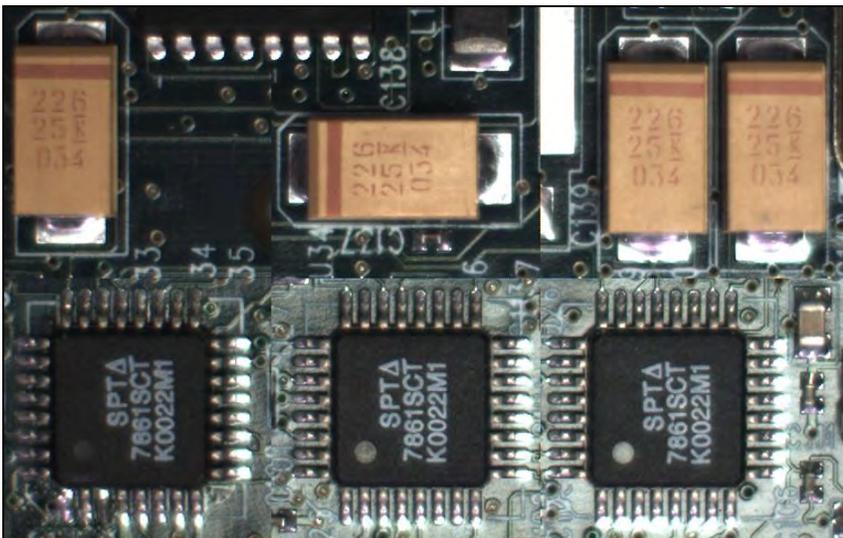
### **Example: Actual Sample with Six ROI Areas (3x2)**

This example uses the example problem of solder inspection of certain components on a PCB. The image below of a sample PCB shows 6 ROI areas highlighted by the yellow overlay graphics (manually added to this example).

Note how the top row ROI areas may be larger than ideal due to height and width requirements of ROI areas in the second row; constraints and interdependencies as defined in the preceding ROI descriptions.

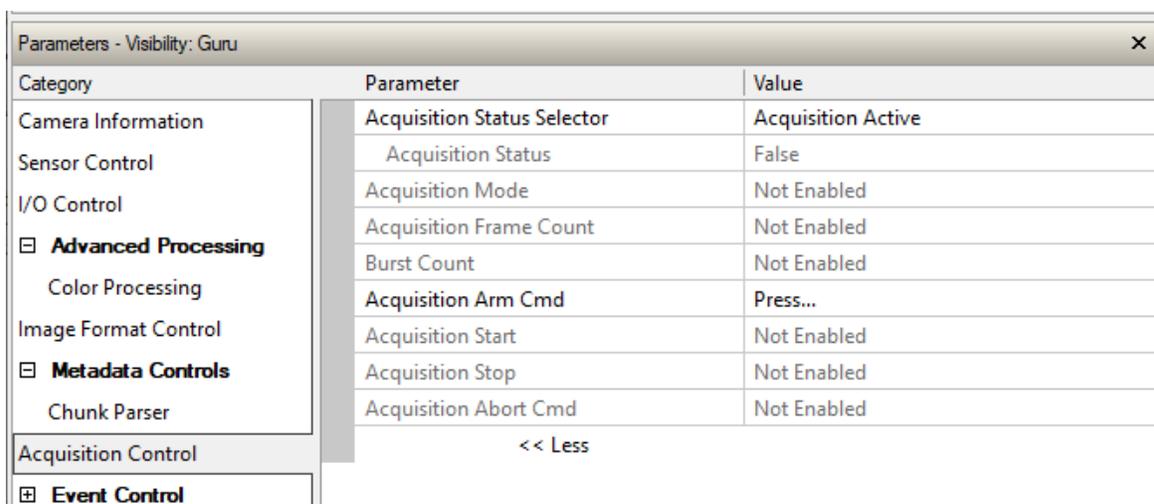


With the ROI areas defined, the camera outputs an image consisting only of data within those ROI areas, as shown below. Such data reduction improves transfer bandwidth and also reduces image processing time for the host system imaging application.



# Acquisition Control Category

The Acquisition Control category includes controls for acquisition management of the device.



## Acquisition Control Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
Acquisition Status Selector	AcquisitionStatusSelector	Selects the internal acquisition signal to read using AcquisitionStatus.	1.00 Expert
<i>Acquisition Active</i>	<i>AcquisitionActive</i>	<i>Device is currently doing an acquisition of one or many frames.</i>	
Acquisition Status	AcquisitionStatus	Reads the state of the internal acquisition signal selected using the Acquisition Status Selector feature.	1.00 Expert
Acquisition Mode	AcquisitionMode	Sets the acquisition mode of the device. It defines mainly the number of frames to capture during an acquisition and the way the acquisition stops.	1.00 Beginner
<i>Continuous</i>	<i>Continuous</i>	<i>Frames are captured continuously until stopped with the AcquisitionStop command.</i>	
<i>Single Frame</i>	<i>SingleFrame</i>	<i>One frame is captured for each AcquisitionStart Command. An AcquisitionStop occurs at the end of the Active Frame.</i>	
<i>Multi-Frame</i>	<i>MultiFrame</i>	<i>A sequence of frames is captured for each AcquisitionStart Command. The number of frames is specified by AcquisitionFrameCount feature. An AcquisitionStop occurs at the end of the Active Frame(s).</i>	
Acquisition Frame Count	AcquisitionFrameCount	Number of frames to be acquired in MultiFrame acquisition mode.	1.00 Beginner
Burst Count	AcquisitionBurstFrameCount	Number of consecutive snapshots to acquire on cameras that support fast multiple snapshots.	1.00 Guru

Display Name	Feature & Values	Description	Device Version & View
Acquisition Arm Cmd	AcquisitionArm	Arms the device before an AcquisitionStart command. This optional command validates all the current features for consistency and prepares the device for a fast start of the acquisition. If not used explicitly, this command is automatically executed at the first AcquisitionStart but will not be repeated for subsequent ones unless a data transfer related feature is changed in the device.	1.00 Guru
Acquisition Start	AcquisitionStart	Starts the Acquisition of the device. The number of frames captured is specified by AcquisitionMode.	1.00 Beginner
Acquisition Stop	AcquisitionStop	Stops the Acquisition of the device at the end of the current Frame.	1.00 Beginner
Acquisition Abort Cmd	AcquisitionAbort	Aborts the acquisition immediately. This will end the capture without completing the current frame or aborts waiting on a trigger. If no acquisition is in progress, the command is ignored.	1.00 Beginner
Device Registers Streaming Start	DeviceRegistersStreamingStart	Announces the start of registers streaming without immediate checking for consistency.	1.00 Invisible
Device Registers Streaming End	DeviceRegistersStreamingEnd	Announces end of registers streaming and performs validation for registers consistency before activating them.	1.00 Invisible
Device Feature Streaming Start	DeviceFeaturePersistenceStart	Announces the start of feature streaming without immediate checking for consistency.	1.00 Invisible
Device Feature Streaming End	DeviceFeaturePersistenceEnd	Announces end of feature streaming and performs validation for feature consistency before activating them.	1.00 Invisible
Register Check	DeviceRegistersCheck	Performs an explicit register set validation for consistency.	1.00 Invisible
Registers Valid	DeviceRegistersValid	States if the current register set is valid and consistent.	1.00 Invisible

# Event Control Category

This category includes features related to event management.

Parameters - Visibility: Guru

Category	Parameter	Value
Camera Information	Timestamp Latch Value (in ns)	0
Sensor Control	Timestamp Latch	Press...
I/O Control	Timestamp Increment	10
Advanced Processing	Timestamp Tick Frequency (in Hz)	100000000
Color Processing	Event Selector	End of Exposure
Image Format Control	Event Notification	Off
Metadata Controls	<< Less	
Chunk Parser		
Acquisition Control		
Event Control		
Event Info		
Test Data		

Parameters - Visibility: Guru

Category	Parameter	Value
Event Control	Test Event ID	20479
Event Info	<< Less	
Test Data		
Exposure End Data		

Parameters - Visibility: Guru

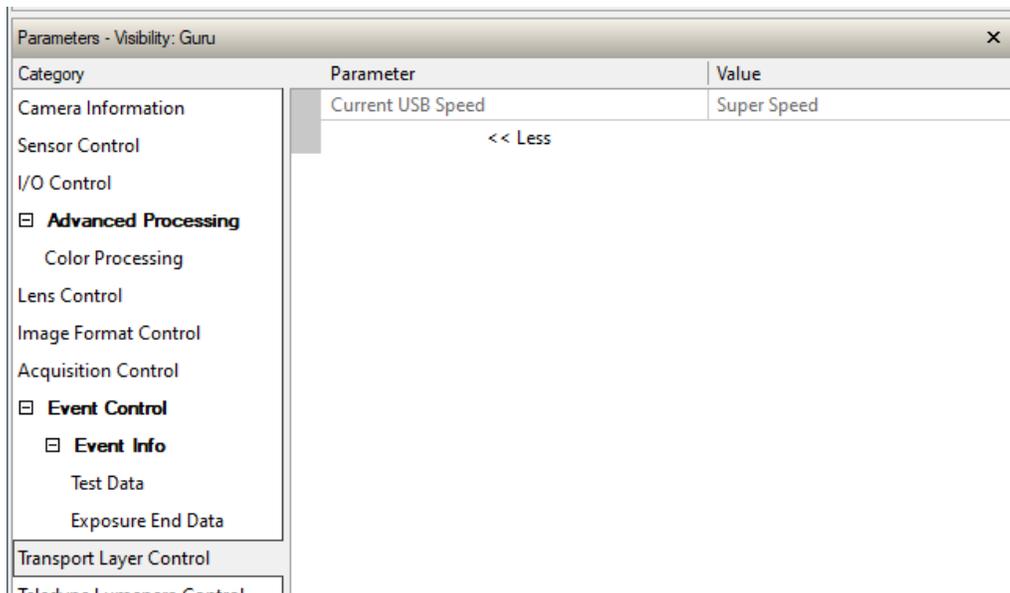
Category	Parameter	Value
Event Control	Exposure End Event ID	40006
Event Info	<< Less	
Test Data		
Exposure End Data		

## Event Control Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
Timestamp Latch Value	TimestampLatchValue	Returns the latched value of the timestamp.	1.00 Expert
Timestamp Latch	TimestampLatch	Latches the current Timestamp in the TimestampLatchValue feature.	1.00 Expert
Timestamp Tick Frequency (in Hz)	timestampTickFrequency	Indicates the number of Timestamp ticks (or increments) during 1 second (frequency in Hz). This features changes depending on the Timestamp Source.	1.00 DFNC Expert
Event Selector	EventSelector	Select the Event to enable/disable with the EventNotification feature.	1.00 Expert
<i>End of Exposure (All models except Lt-1900, Lt-3840 and Lt-5500)</i>	<i>ExposureEnd</i>	<i>Event sent on control channel on end of exposure.</i>	
Event Notification	EventNotification	Enable Events for the event type selected by the EventSelector feature.	1.00 Expert
<i>Off</i>	<i>Off</i>	<i>The selected event is disabled.</i>	
<i>On</i>	<i>On</i>	<i>The selected event will generate a software event.</i>	
Test Event ID	EventTest	Represents the event ID to identify the EventTest software Event.	1.00 Guru
Test Data	EventTestData	Data of the U3V test event	1.00 Guru
Test Event Timestamp	EventTestTimestamp	Timestamp of the Test event.	1.00 Guru
Exposure End Event ID	EventExposureEnd	Represents the event ID to identify the EventExposureEnd software Event.	1.00 Guru
Exposure End Data	EventExposureEndData	Data of the exposure end event	1.00 Guru
Exposure End Event Timestamp	EventExposureEndTimestamp	Timestamp of the EventExposureEnd event.	1.00 Guru

# Transport Layer Control Category

The Transport Layer control category includes parameters related to USB3 Vision specification.



## Transport Layer Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
Current USB Speed	US3VCurrentSpeed	Current Speed of the USB link.	1.00 Beginner
	<i>Low Speed</i>	<i>LowSpeed</i>	
	<i>Full Speed</i>	<i>FullSpeed</i>	
	<i>High Speed</i>	<i>HighSpeed</i>	
	<i>Super Speed</i>	<i>SuperSpeed</i>	
Payload Size	PayloadSize	Provides the number of bytes transferred for each image or chunk on the stream channel.	1.00 Invisible
U3VVersionMajor	U3VVersionMajor	Major version of the specification.	1.00 Invisible
U3VVersionMinor	U3VVersionMinor	Minor version of the specification.	1.00 Invisible
U3VCpCapability	U3VCpCapability	Indicates additional features on the control channel	1.00 Invisible
U3VCpConfiguration	U3VCpConfiguration	Configures additional features on the control channel	1.00 Invisible
U3VMaxCommandTransferLength	U3VMaxCommandTransferLength	Specifies the maximum supported command transfer length of the device	1.00 Invisible
U3VMaxAcknowledgeTransferLength	U3VMaxAcknowledgeTransferLength	Specifies the maximum supported acknowledge transfer length of the device	1.00 Invisible
U3VNumberStreamChannels	U3VNumberStreamChannels	Number of Stream Channels and the corresponding Streaming Interface Register Maps (SIRM)	1.00 Invisible

Display Name	Feature & Values	Description	Device Version & View
U3VSirmAddress	U3VSirmAddress	Pointer to the first Streaming Interface Register Map	1.00 Invisible
U3VSirmLength	U3VSirmLength	Specifies the length of each Streaming Interface Register Map	1.00 Invisible
U3VEirmAddress	U3VEirmAddress	Pointer to the Event Interface Register Map	1.00 Invisible
U3VEirmLength	U3VEirmLength	Specifies the length of the EIRM	1.00 Invisible

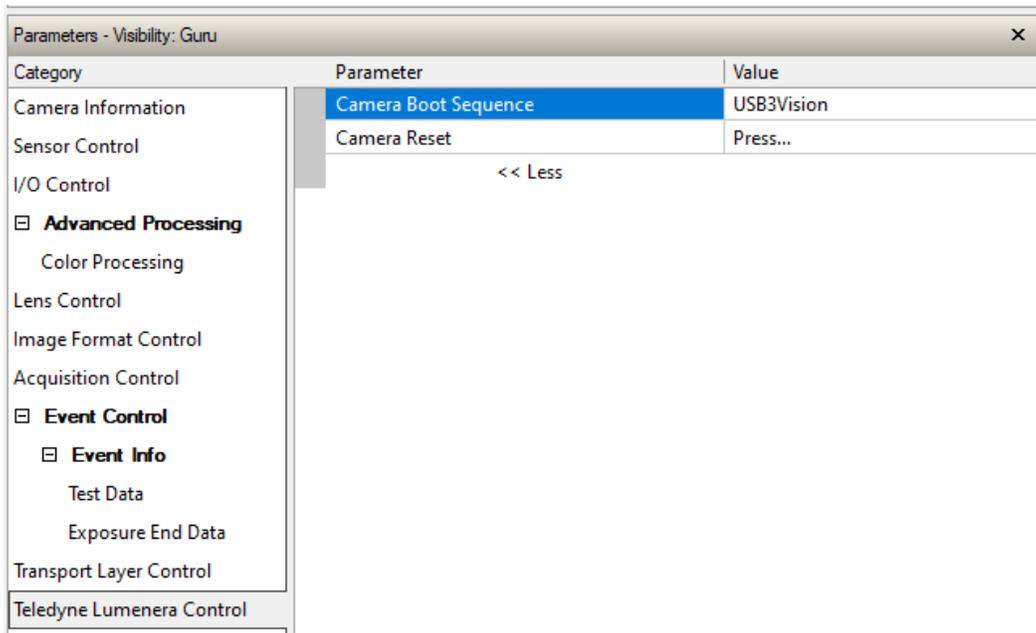
# Teledyne Lumenera Control Category

This category contains manufacturer-specific control features.



Setting the **cameraBootSequence** feature to Lucam and resetting the camera will disable access to the camera via USB3 Vision. The LuCam mode protocol is required for use of the Lumenera LuCam API – not Sapera LT API.

If the **cameraBootSequence** feature is not visible, the mode may be changed by selecting the appropriate driver; see section [Using the U3V Device Manager Tool](#) for details. See **Switching a Teledyne Lumenera camera from LuCam mode to USB3 Vision mode** and **Switching a Teledyne Lumenera camera from USB3 Vision mode to LuCam mode** for information and methods required to switch a camera mode.

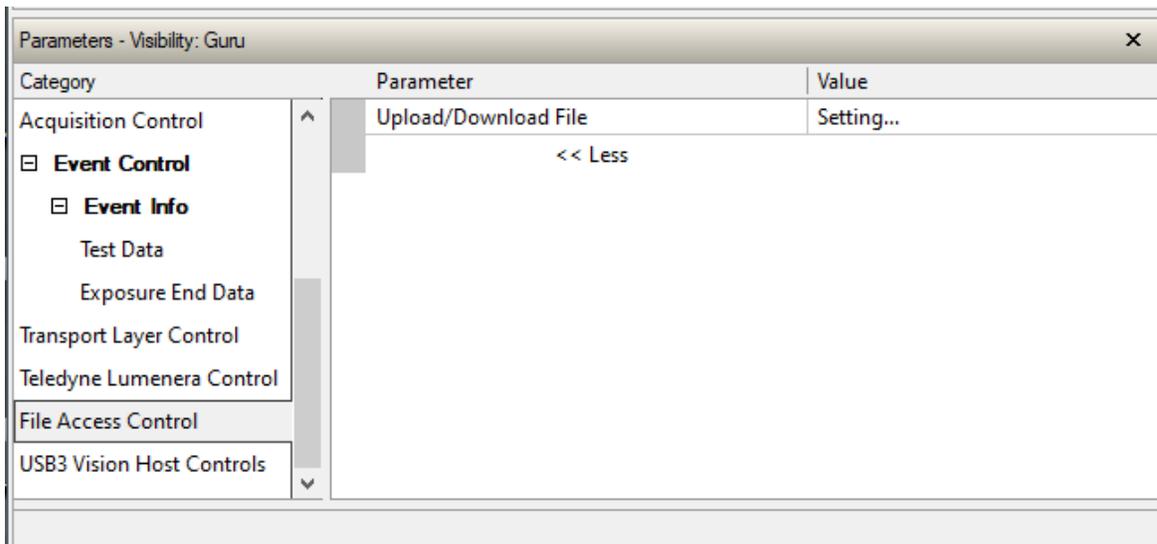


## Teledyne Lumenera Control Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
Camera Boot Sequence	cameraBootSequence	Boot camera as USB3 Vision or LuCam.	1.00 DFNC Guru
<i>Lucam</i>	<i>Lucam</i>	<i>Lucam protocol. (applicable when using the Teledyne Lucam API software)</i>	
<i>USB3Vision</i>	<i>USB3Vision</i>	<i>USB3Vision protocol (compatible with Genicam and USB3 Vision software API)</i>	
Camera Reset	CameraReset	Resets the camera features to its power-on default state but does not do a hardware camera reset.	1.00 DFNC Beginner

# File Access Control Category

File Access Control in CamExpert allows the user to quickly upload or download camera firmware and other data to the Lt Series device.



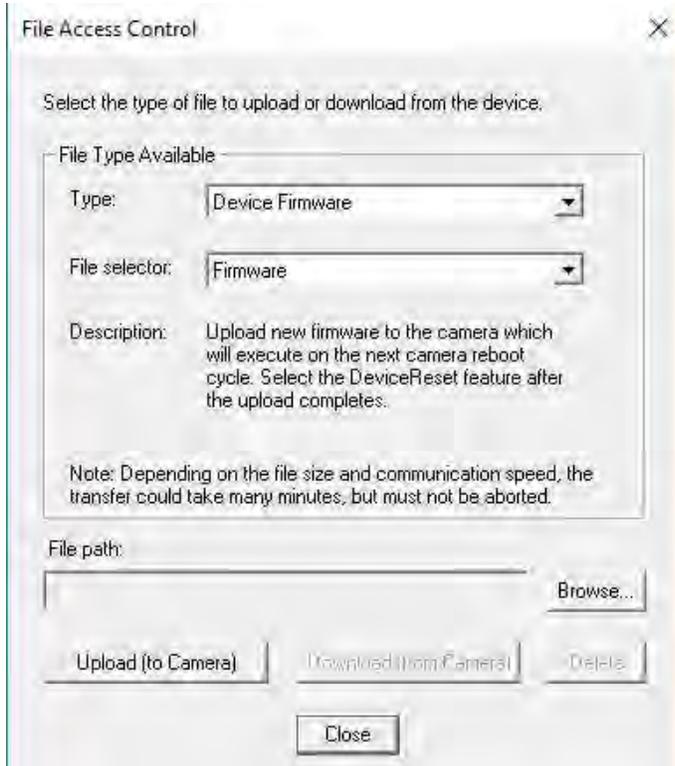
## File Access Control Feature Descriptions

Display Name	Feature & Values	Description	Device Version & View
File Selector	FileSelector	Selects the file to access. The file types which are accessible are device-dependent.	1.00 Guru
<i>Firmware</i>	<i>Firmware</i>	<i>Upload new firmware to the camera which will execute on the next camera reboot cycle. Select the DeviceReset feature after the upload completes.</i>	
<i>Image</i>	<i>Image</i>	<i>Sample image taken with this unit.</i>	
<i>Firmware</i>	<i>Firmware1</i>	<i>Uploads new firmware to the camera which will install and run after the upload. The camera will disconnect and reconnect.</i>	
<i>User Defined saved Image</i>	<i>userDefinedSavedImage</i>	<i>Upload and download an image in the camera.</i>	
File Operation Selector	FileOperationSelector	Selects the target operation for the selected file in the device. This operation is executed when the File Operation Execute feature is called.	1.00 Guru
<i>Open</i>	<i>Open</i>	<i>Select the Open operation - executed by FileOperationExecute.</i>	
<i>Close</i>	<i>Close</i>	<i>Select the Close operation - executed by FileOperationExecute</i>	
<i>Read</i>	<i>Read</i>	<i>Select the Read operation - executed by FileOperationExecute.</i>	
<i>Write</i>	<i>Write</i>	<i>Select the Write operation - executed by FileOperationExecute.</i>	
<i>Delete</i>	<i>Delete</i>	<i>Select the Delete operation - executed by FileOperationExecute.</i>	
File Operation Execute	FileOperationExecute	Executes the operation selected by File Operation Selector on the selected file.	1.00 Guru

Display Name	Feature & Values	Description	Device Version & View
File Open Mode	FileOpenMode	Selects the access mode used to open a file on the device.	1.00 Guru
	<i>Read</i>	<i>Select read-only open mode</i>	
	<i>Write</i>	<i>Select write-only open mode</i>	
File Access Offset	FileAccessOffset	Controls the mapping offset between the device file storage and the file access buffer.	1.00 Guru
File Access Length	FileAccessLength	Controls the mapping length between the device file storage and the file access buffer.	1.00 Guru
File Access Buffer	FileAccessBuffer	Defines the intermediate access buffer that allows the exchange of data between the device file storage and the application.	1.00 Guru
File Operation Status	FileOperationStatus	Displays the file operation execution status.	1.00 Guru
	<i>Success</i>	<i>The last file operation has completed successfully.</i>	
	<i>Failure</i>	<i>The last file operation has completed unsuccessfully for an unknown reason.</i>	
	<i>File Unavailable</i>	<i>The last file operation has completed unsuccessfully because the file is currently unavailable.</i>	
	<i>File Invalid</i>	<i>The last file operation has completed unsuccessfully because the selected file is not present in this camera model.</i>	
	<i>File Application Error</i>	<i>The selected file transferred correctly but the device found something wrong with it.</i>	
	<i>File Is Read Only</i>	<i>The selected file cannot be uploaded, just downloaded.</i>	
	<i>File Is Write Only</i>	<i>The selected file cannot be downloaded, just uploaded.</i>	
File Operation Result	FileOperationResult	Displays the file operation result. For Read or Write operations, the number of successfully read/written bytes is returned.	1.00 Guru
File Size	FileSize	Represents the size of the selected file in bytes.	1.00 Guru

## File Access via the CamExpert Tool (Quick Camera Firmware Upgrade)

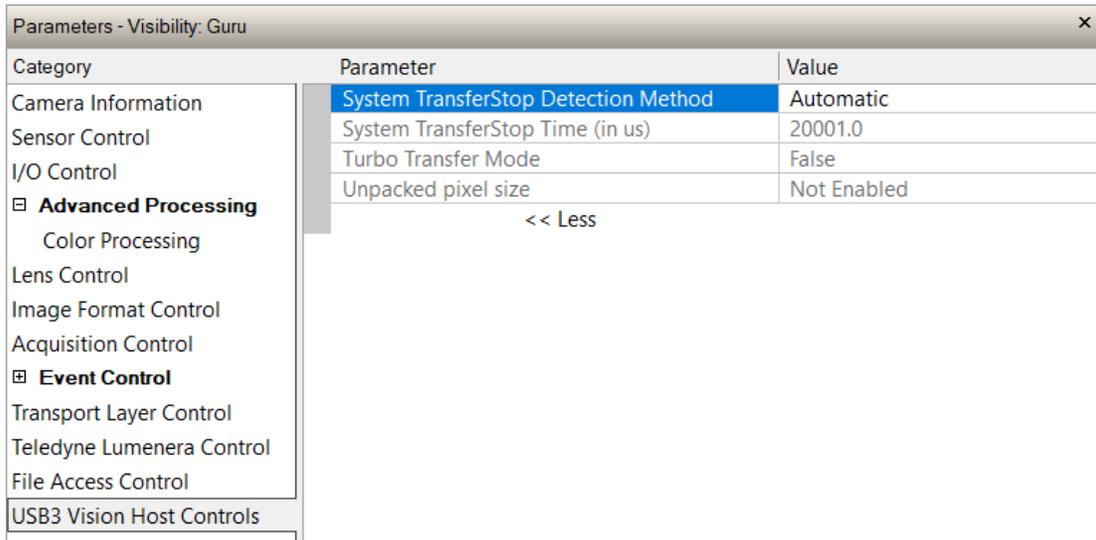
- In the **File Access Control** category, click **Setting** to open the File Access Control dialog.



- From the **Type** list, choose the type of file to upload to the camera.
- From the **File selector** list, choose *Firmware*.
- Click **Browse** to open Windows Explorer.
- Select the .cbf firmware file to upload.
- Click **Upload (to Camera)** to execute the file transfer to the camera.

# USB3 Vision Host Controls

The USB3 Vision Host Controls parameters are used to configure the host computer system features used for camera communication management. None of the parameters are stored in the camera. The features allow optimizing the configuration for maximum bandwidth.



The screenshot shows a software window titled "Parameters - Visibility: Guru" with a close button (X) in the top right corner. The window is divided into two main sections: a left-hand navigation pane and a right-hand main content area. The navigation pane lists various control categories, with "USB3 Vision Host Controls" selected at the bottom. The main content area displays a table of parameters for the selected category.

Category	Parameter	Value
Camera Information	System TransferStop Detection Method	Automatic
Sensor Control	System TransferStop Time (in us)	20001.0
I/O Control	Turbo Transfer Mode	False
<input checked="" type="checkbox"/> <b>Advanced Processing</b>	Unpacked pixel size	Not Enabled
Color Processing	<< Less	
Lens Control		
Image Format Control		
Acquisition Control		
<input checked="" type="checkbox"/> <b>Event Control</b>		
Transport Layer Control		
Teledyne Lumenera Control		
File Access Control		
USB3 Vision Host Controls		

# Technical Specifications

---

## Identification and Mechanical Notes

### Identification Label

	Teledyne Lumenera LT cameras have an identification label applied to the bottom side, with the following information:	
	Model Part Number Serial number Barcode FCC and CE logo Made in Canada	

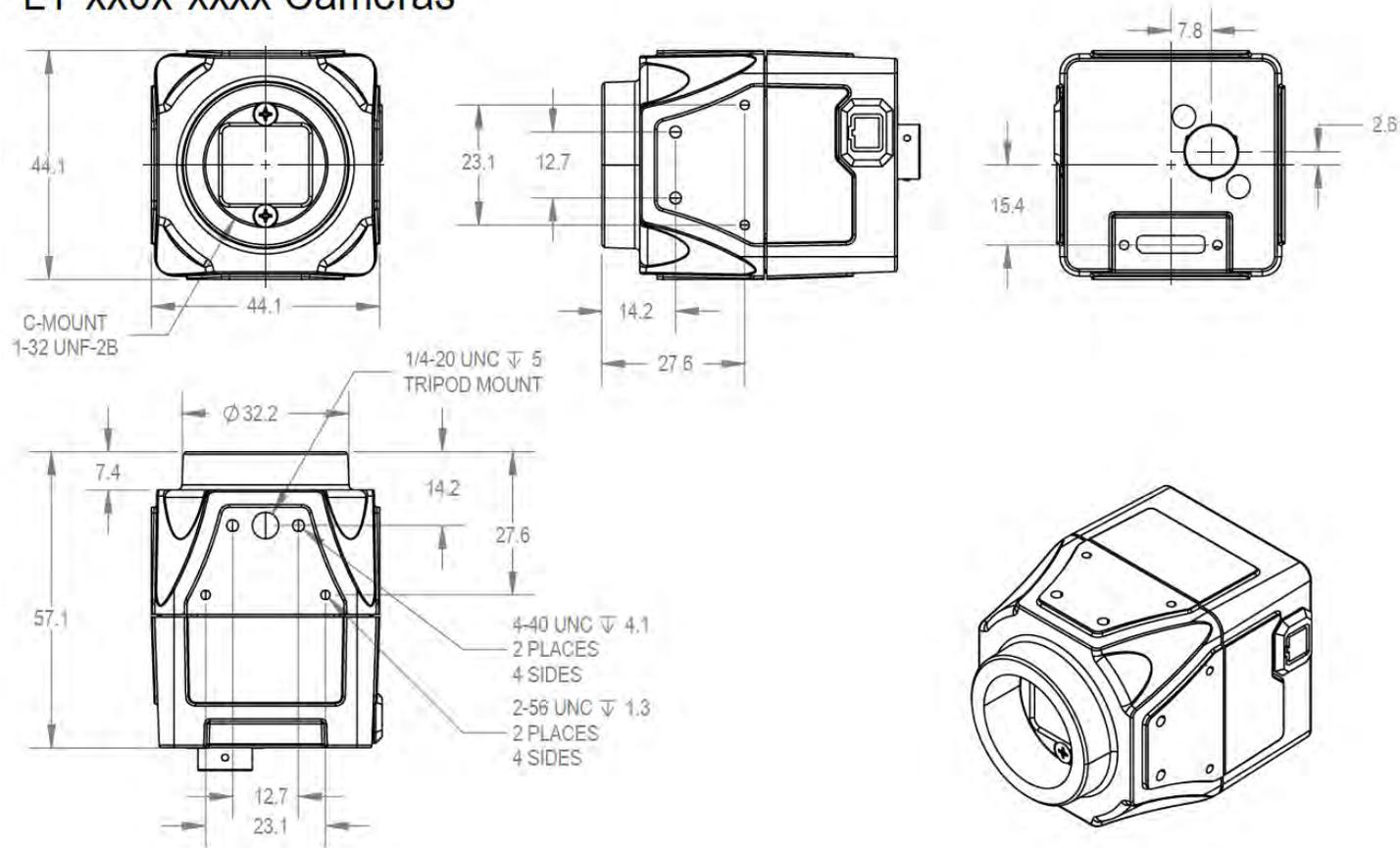
### Additional Mechanical Notes

	Lt camera series supports a screw lock USB 3 cable as described in <a href="#">Ruggedized Cable Accessories</a> . For information on lens requirements see <a href="#">Choosing a Lens with the Correct Image Circle</a> . Each camera side has mounting holes providing good grounding capabilities. Overall height or width tolerance is $\pm 0.05\text{mm}$ .
---	---

# Mechanical Specifications

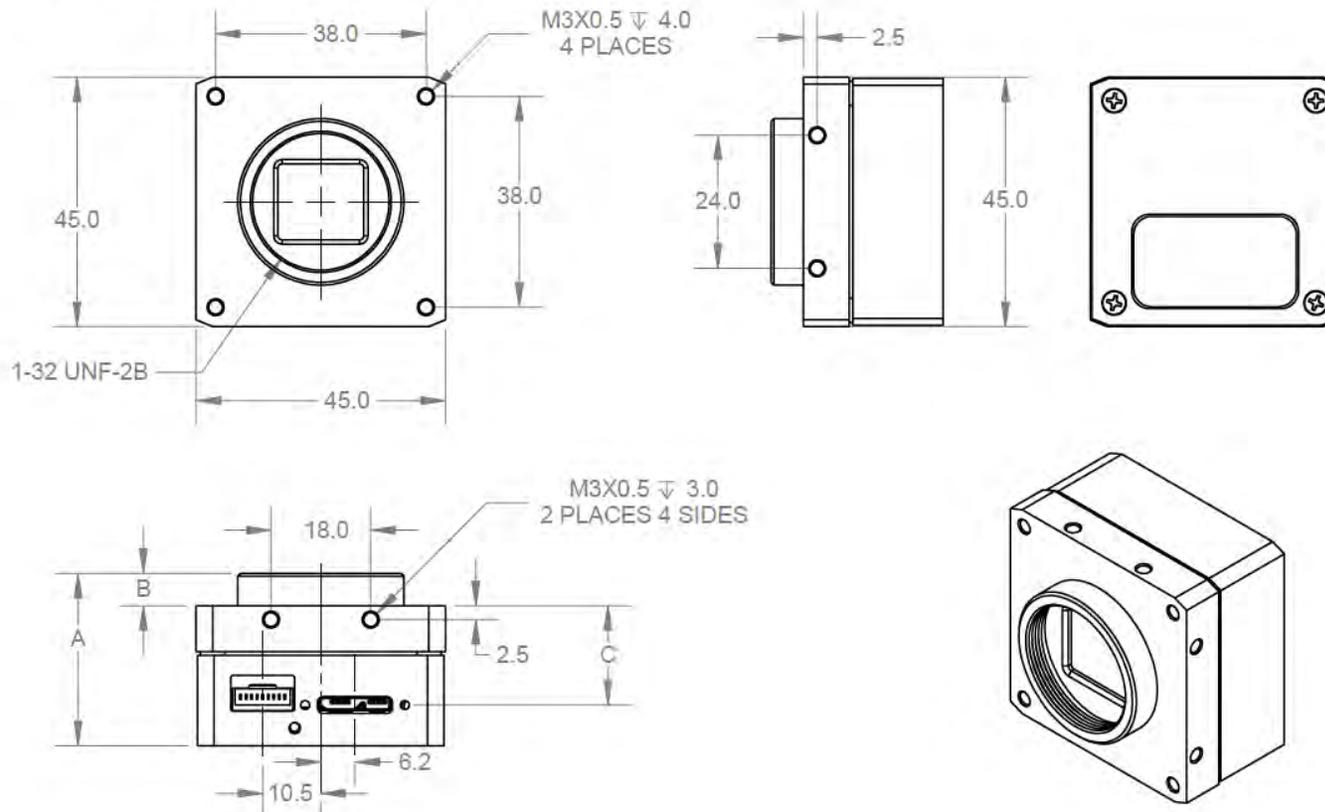
## Models Lt-Ux0x-xxxxx

### LT-xx0x-xxxx Cameras



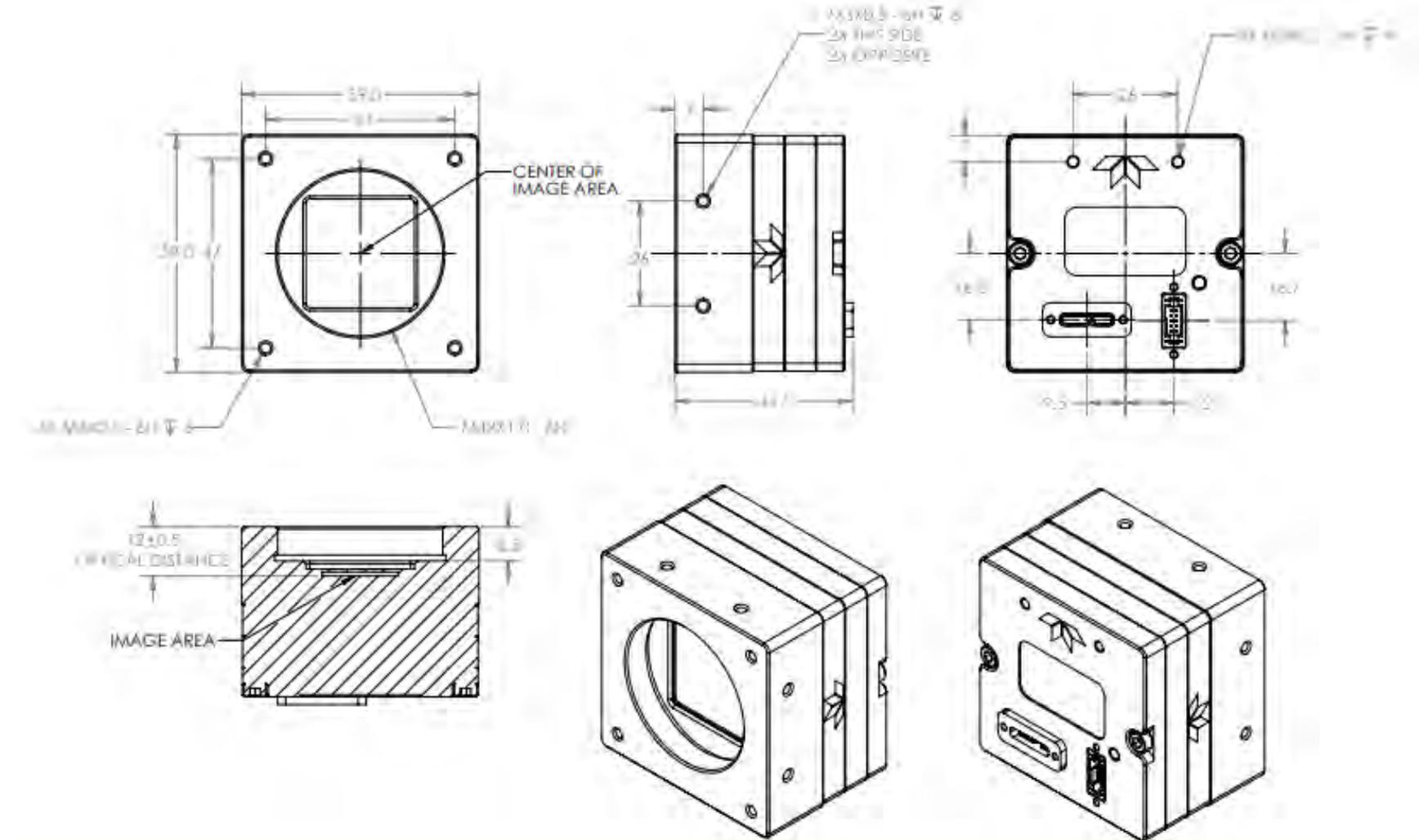
## Models Lt-xx1x-xxxx

### LT-xx1x-xxxx Cameras



MODELS	MOUNT	DIMENSION		
		A	B	C
Lt-1610				
Lt-1630				
Lt-1950				
Lt-1980				
Lt-2020				
Lt-2420	C-	36.1	10.8	17.7
Lt-2470				
Lt-3200				
Lt-4020				
Lt-4030				
Lt-4510				
Lt-5300				
Lt-5500				
Lt-1611	CS-	31.1	5.8	17.7
Lt-1631				
Lt-1981				
Lt-1951				
Lt-2021				
Lt-2421				
Lt-2471				
Lt-3201				
Lt-4021				
Lt-4031				
Lt-1900	C-	32.8	10.8	14.5
Lt-3840				
Lt-1901	CS-	27.8	5.8	14.5
Lt-3841				

# Models Lt-Ux20-xxxxx



# Temperature Management

Lt Series cameras are designed to optimally transfer internal component heat to the outer metallic body. If the camera is free standing (i.e., not mounted) it will be very warm to the touch.

Basic heat management is achieved by mounting the camera onto a metal structure via its mounting screw holes. Heat dissipation is improved by using thermal paste between the camera body (not the front plate) and the metal structure.

# Sensor Alignment Specification

The following figure specifies sensor alignment for the Lt Series where all specifications define the absolute maximum tolerance allowed for production cameras. Dimensions X, Y, Z are in microns and referenced to the mechanical body or the optical focal plane (for the Z-axis dimension). Theta specifies the sensor rotation relative to the sensor's center and mechanical body.

		Lt-Ux0x-xxxxx Lt-xx1xx-xxxxx	Lt-Ux2x-xxxxx	
<b>X variance</b>	0 mm nominal	+/- 0.97 mm	+/-0.50 mm	
<b>Y variance</b>	0 mm nominal	+/- 0.97 mm	+/-0.50 mm	
<b>Z lens mount to sensor</b>	nominal per lens mount	+ .21 mm to -.42 mm	+/-0.42 mm	
<b>Theta variance</b>		+/- 2 degree	+/- 2 degree	

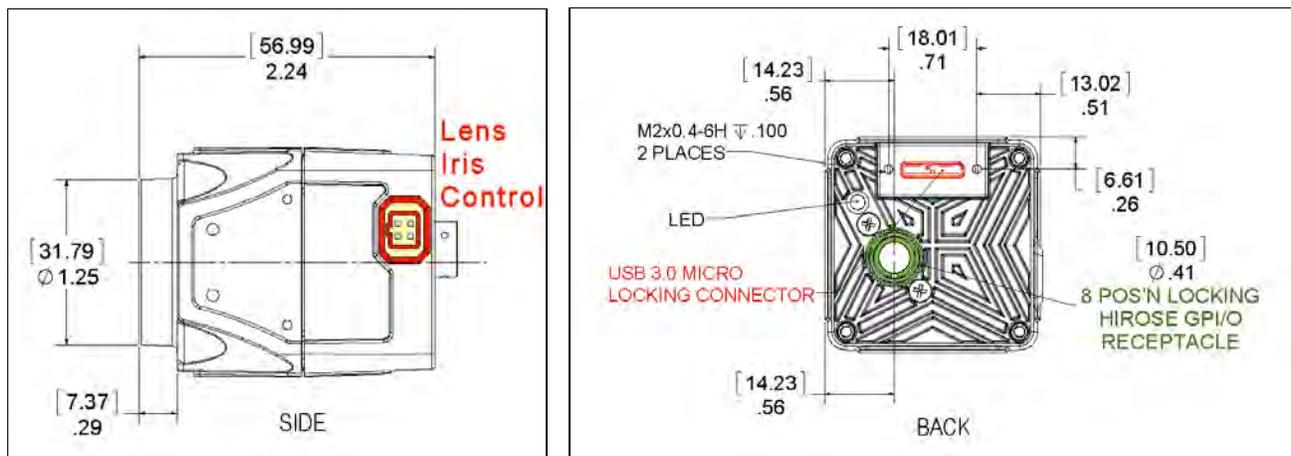
# Connectors

## Connector Locations for Lt-Ux0x-xxxxx

The camera has three connectors: data, I/O signals and alternate power, and iris control. Descriptions and specifications are provided below.

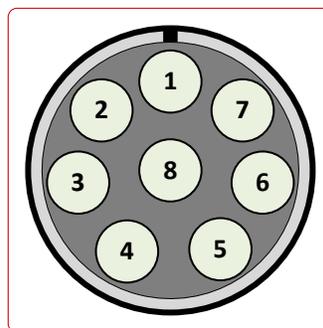
- **USB 3:** The standard USB 3 connection to a computer provides the control and data transfer interface while also typically supplying the camera 5 Volt power. The camera is designed for a USB 3.0 Type Micro B with screw lock cable assembly. See [USB3 Long Distance Active Cables](#) for a suggested cable type.
- **I/O signals and alternative power:** Used for external signal connections and for camera power if the USB 3 connection cannot supply the camera.
- **Iris control:** Standard 4 pin P-Iris control for lenses with a motorized iris.

### Side and Face View



LT-Ux0x-xxxxx connector locations highlighted

### I/O Connector Pinout Details (LT-Ux0x-xxxxx)



I/O connector MXR-8PIN pin numbers as viewed by user

Digi-Key Part Number HR1824-ND connector can be used as a mating connector.

Pin Number	Function	Description
1	V-External	External power input terminal (5-25 VDC)
2	GPO1+	Optically isolated output - positive terminal
3	GPO1-	Optically isolated output - negative terminal
4	GPIO2	Bi-directional general purpose I/O #2 terminal
5	GPIO3	Bi-directional general purpose I/O #3 terminal
6	GPI1-	Optically isolated input - negative terminal
7	GPI1+	Optically isolated input - positive terminal
8	GND	External power ground reference terminal

### Optional I/O Connector Packages (LT-Ux0x-xxxxx)

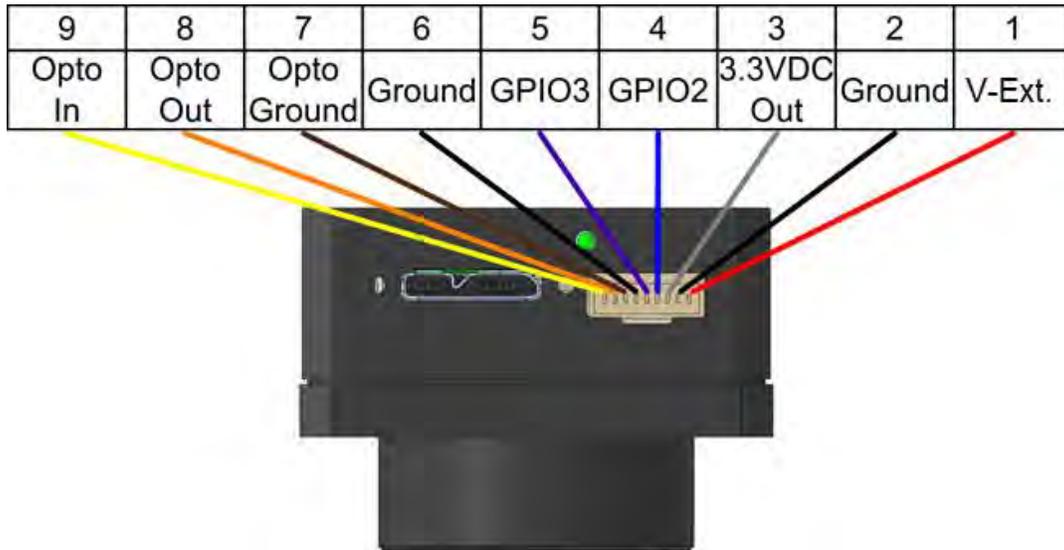
Two optional connector packages are available from Teledyne Lumenera:

- La2000PK — provides a 5 V power adapter and the Digi-Key Part HR1824-ND connector for external power usage.
- La2000PIOK — which combines a 5 V power adapter and the Hirose connector with blunt end wire assembly for easy access to the GPIO signal lines. The following figure lists the wiring color mapping.

Pin #	Function	Wire color	Description
1	V-External	<b>RED</b>	External power input terminal (+5Vdc)
2	GPO1+	<b>GREEN</b>	Optically isolated output positive terminal
3	GPO1-	<b>ORANGE</b>	Optically isolated output negative terminal
4	GPIO2	<b>BLUE</b>	Bi-directional general purpose I/O
5	GPIO3	<b>BROWN</b>	Bi-directional general purpose I/O
6	GPI1-	<b>YELLOW</b>	Optically isolated input negative terminal
7	GPI1+	<b>GREY</b>	Optically isolated input positive terminal
8	GND	<b>BLACK</b>	External power ground reference terminal

*La2000PIOK optional connector and wire color information*

## Connector Locations for Lt-xx1x-xxxxx



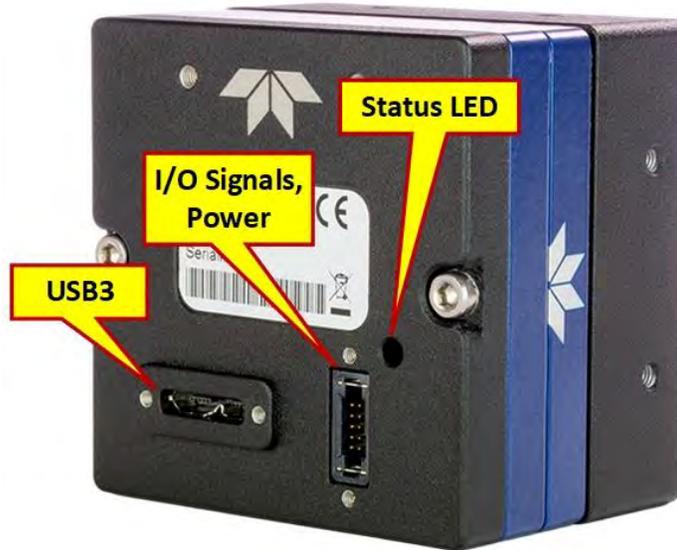
*I/O Connector Pin Numbers as Viewed by User*

### ***I/O Connector Pinout Details (LT-xx1x-xxxxx)***

Mating connector JST NSHR-09V-S is available at Digi-Key (ref: 455-2785-ND)

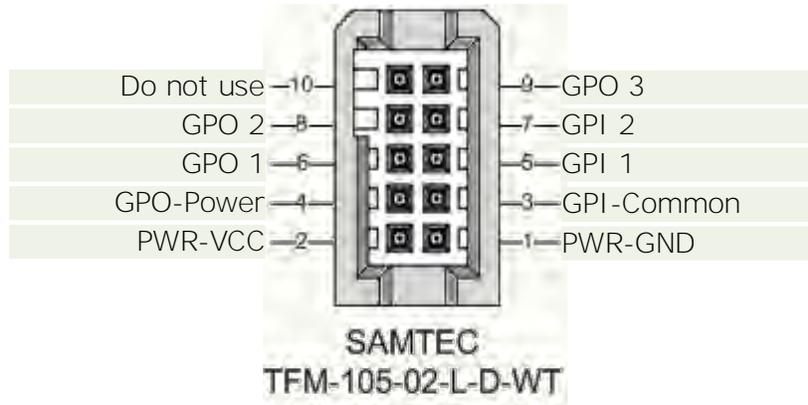
Pin Number	Function	Description
1	V-External	External power input terminal (5–25 VDC) Takes priority over USB 3 power
2	GND	External power ground reference terminal
3	3.3 Vdc output	Output supplying a maximum of 150 mA
4	GPIO2	Bi-directional general purpose I/O #2 terminal
5	GPIO3	Bi-directional general purpose I/O #3 terminal
6	GND	External power ground reference terminal
7	Opto GND	External ground reference for Opto signal
8	Opto Output	Optically isolated output
9	Opto Input	Optically isolated input

## Connector Locations for Lt-Ux2x-xxxxx



Location of connectors and status LED for Lt-Ux2x-xxxxx models

## Connector Pinout Details (LT-Ux2x-xxxx)



I/O connector for LT-Ux2x-xxxxx models

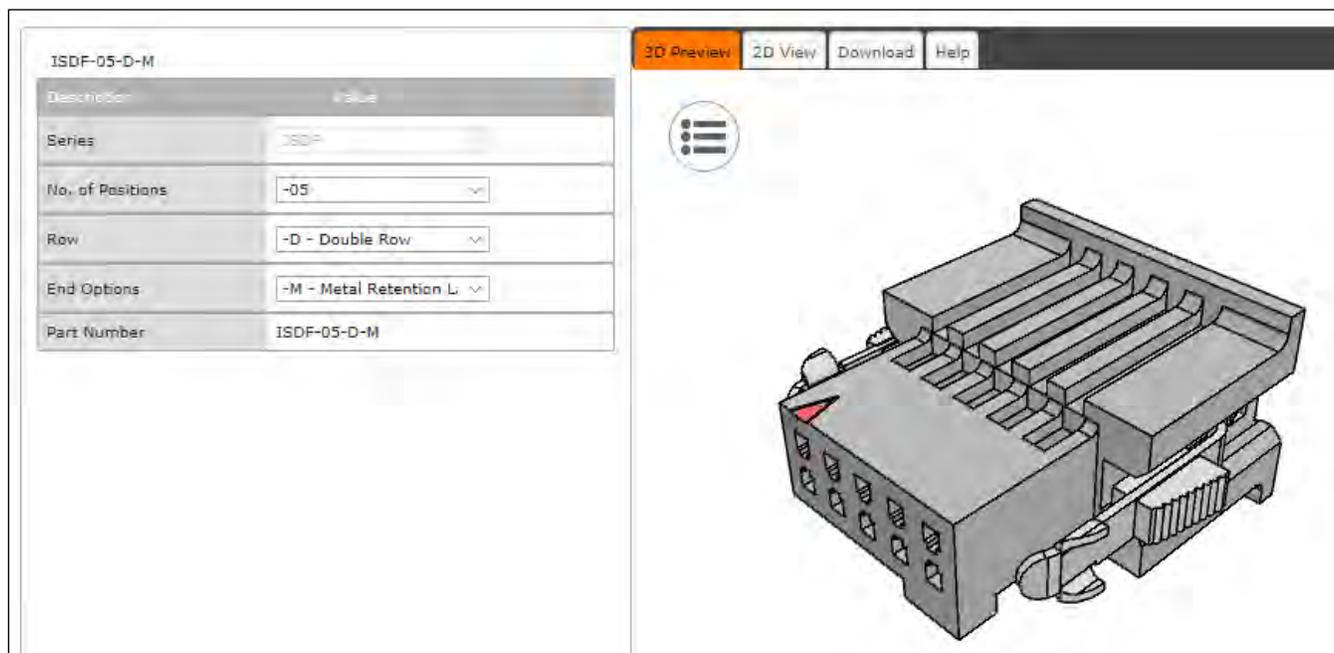
Pin Number	Lt-Ux2x series	Direction	Definition
1	PWR-GND	—	Camera Power – Ground
2	PWR-VCC	—	Camera Power – DC +10 to +28 Volts
3	GPI-Common	—	General Input Common Ground
4	GPO-Power	—	General Output Common Power
5	GPI 1	In	General External Input 1
6	GPO 1	Out	General External Output 1
7	GPI 2	In	General External Input 2
8	GPO 2	Out	General External Output 2
9	GPO 3	Out	General External Output 3
10	—	—	Do not use.

## Optional I/O Connector Packages (LT-Ux2x-xxxxx)

For users wishing to build their own custom I/O cabling, the following product information is provided to expedite your cable solutions. Samtec web information for the discrete connector and a cable assembly with retention clips follows the table.

MFG	Part #	Description	Data Sheet
Samtec	ISDF-05-D ISDF-05-D-M (see image below)	Discrete Connector (see example below)	<a href="https://www.samtec.com/products/isdf">https://www.samtec.com/products/isdf</a>
Samtec	SFSD-05-[WG]-G-[AL]-DR-[E2O] WG : Wire Gauge AL : Assembled Length E2O : End 2 Option	Discrete Cable Assembly (see example below)	<a href="https://www.samtec.com/products/sfsd">https://www.samtec.com/products/sfsd</a>
<b>ISDF-05-D-M Connector Availability On-Line</b>			
North America (specific country can be selected)		<a href="http://www.newark.com/samtec/isdf-05-d-m/connector-housing-receptacle-10/dp/06R6184">http://www.newark.com/samtec/isdf-05-d-m/connector-housing-receptacle-10/dp/06R6184</a>	
Europe (specific country can be selected)		<a href="http://uk.farnell.com/samtec/isdf-05-d-m/receptacle-1-27mm-crimp-10way/dp/2308547?ost=ISDF-05-D-M">http://uk.farnell.com/samtec/isdf-05-d-m/receptacle-1-27mm-crimp-10way/dp/2308547?ost=ISDF-05-D-M</a>	
Asia-Pacific (specific country can be selected)		<a href="http://sg.element14.com/samtec/isdf-05-d-m/receptacle-1-27mm-crimp-10way/dp/2308547?ost=ISDF-05-D-M">http://sg.element14.com/samtec/isdf-05-d-m/receptacle-1-27mm-crimp-10way/dp/2308547?ost=ISDF-05-D-M</a>	
<b>Important: Samtec ISDF-05-D-S is not compatible with the Lt-Ux2x-xxxxx</b>			

### Samtec ISDF-05-D-M mating connector for customer-built cables with retention clips .050 Tiger Eye™ Discrete Wire Socket Housing



**Samtec connector-cable assembly SFSD-05-28-H-03.00-SR with retention clips  
 .050 Tiger Eye™ Double Row Discrete Wire Cable Assembly, Socket**

SFSD-05-28-H-03.00-SR	
Description	Value
Series	SFSD
No. of Positions	-05
Wire Gauge	-28 AWG
Wire Color Code	All Black Wire
Plating Options	-H - 30µ" Heavy Gold
Assembly Length	3.00 INCH
End Option	-SR - Single Ended wit
Notch Option	Not Available
Part Number	SFSD-05-28-H-03,00-SR
Cable Type Option	PVC Cable

3D Preview
2D View
Download
Help

# Bi-directional I/O DC Specifications

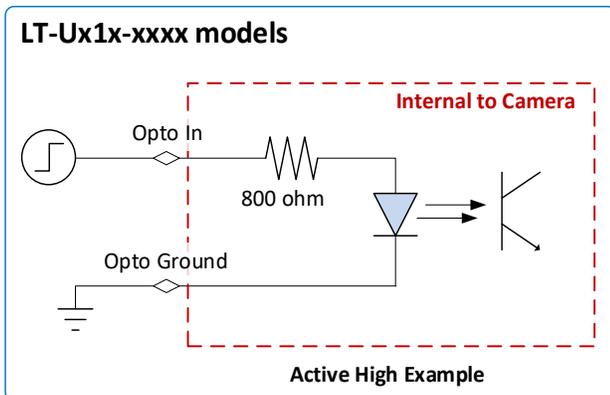
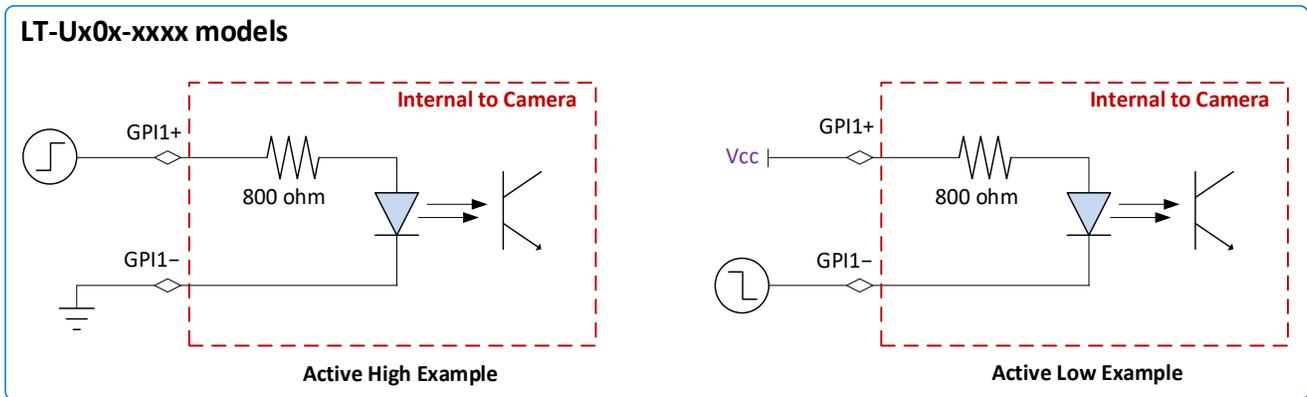
Lt-Ux0x-xxxxx and Lt-xx1x-xxxxx only

GPO Operating Characteristics (GPIO2 & GPIO3 as outputs)		
LOW value: 0.0 to 0.6 V	HIGH value: 2.65 to 3.3 V	Typical output current: 24 mA
GPI Operating Characteristics (GPIO2 & GPIO3 as inputs)		
LOW input voltages: 0.0 to 0.8 V	HIGH input voltages: 2.0 to 5.0 V	

## Optically-Isolated Input Specifications

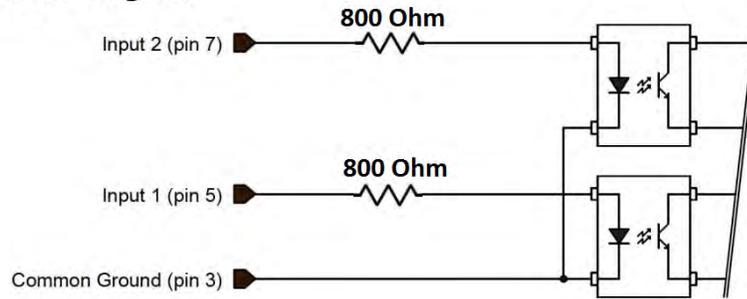
The optically-isolated input pins are designed to operate from 3.3 V to 24 V at a typical current of 20 mA (maximum 50 mA, minimum 5 mA @ 3.3 V). Greater input voltages are supported with use of an external voltage dropping resistor. The opto-isolated internal current limiting resistor is 800 Ω.

- **Lt-Ux0x-xxxxx / Lt-xx1x-xxxxx** – The external signal is applied to the GPI1+/Opto In input and the GPI1–/Opto Ground is connected to ground. When the external signal goes positive relative to ground and current flows through the input pins, the camera receives an active high trigger signal.
- **Lt-Ux0x-xxxxx models only** – The external signal is applied to the (–) input and the (+) is connected to a positive voltage (Vcc). When the external signal goes negative relative to Vcc and current flows through the GPI input pins, the camera receives an active high trigger signal.
- **Lt-xx1x-xxxxx** models only allow for active high configuration.

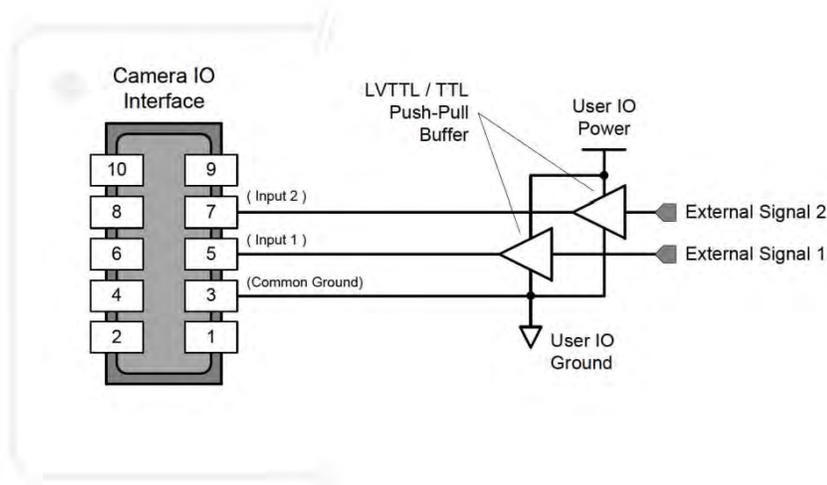


# Input Signals Electrical Specifications

## External Inputs Block Diagram

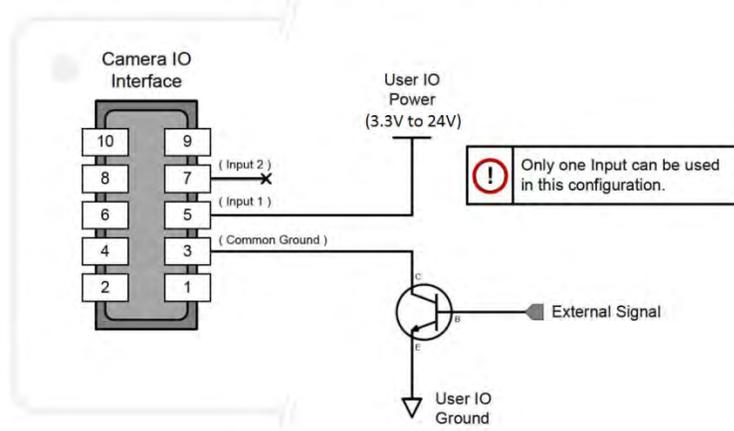


## External Inputs: Using TTL/LVTTL Drivers

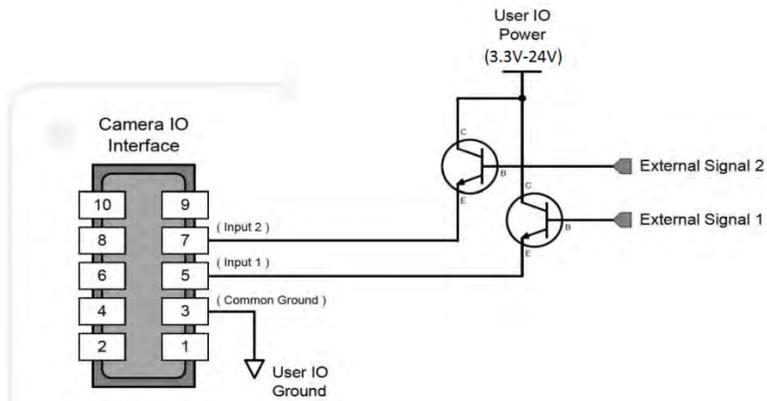


### External Inputs: Using Common Emitter NPN Driver

- Warning: Only one External Signal can be used (input 1 or input 2).

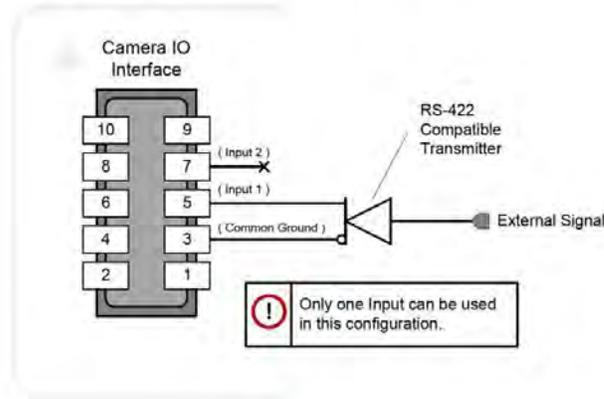


### External Inputs: Using Common Collector NPN Drivers



### External Inputs: Using a Balanced Driver

- Warning: Only one External Signal can be used (input 1 or input 2).

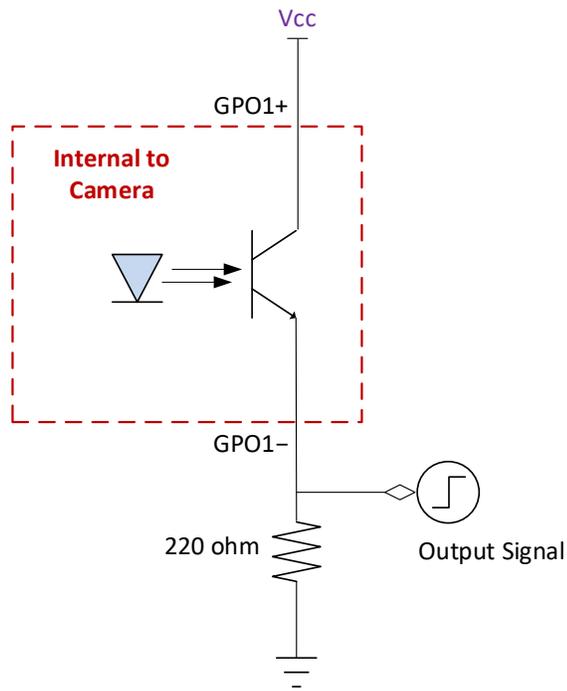


## Optically-Isolated Output Specifications

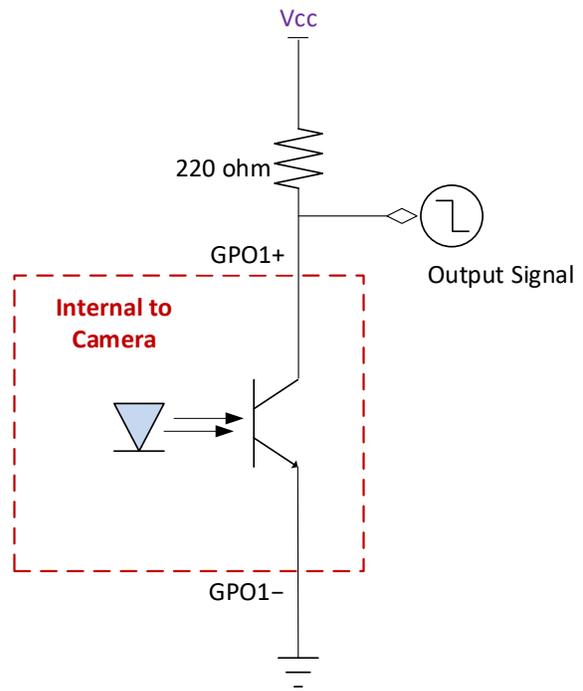
The optically-isolated output requires an external resistor and biasing current. The current flow through the signal output transistor should nominally be 20 mA and must not exceed 50 mA.

- **Lt-Ux0x-xxxxx / Lt-xx1x-xxxxx** – As shown in the following simplified circuit diagrams, two methods for connecting the output to an external circuit are used dependent on choosing an active high or low signal. The two examples use a 5 V bias supply (output referenced to 5 V) and a 220  $\Omega$  series resistor.
  - When using a 12 V bias supply (for  $V_{cc}$ ) a 560  $\Omega$  resistor is suggested.
  - For either active high or low configurations, the output signal swings between  $V_{cc}$  and ground.
- **Lt-xx1x-xxxxx** models only allow for active low configuration.

### LT-Ux0x-xxxx models

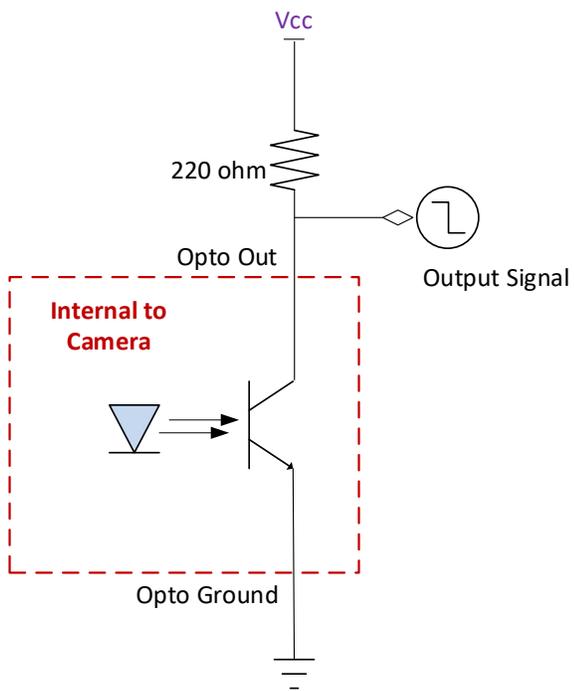


Active High Output Example



Active Low Output Example

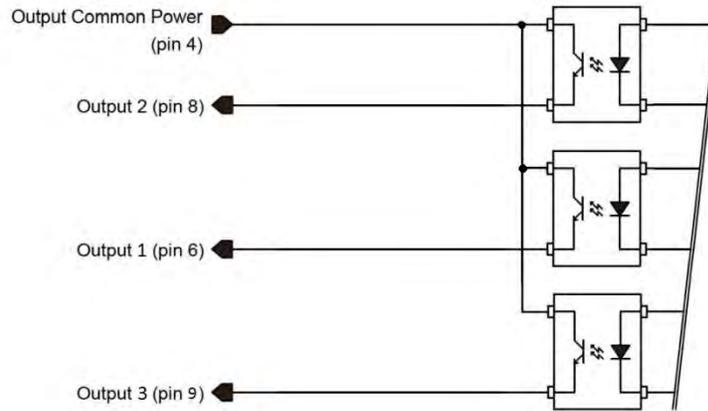
### LT-xx1x-xxxx models



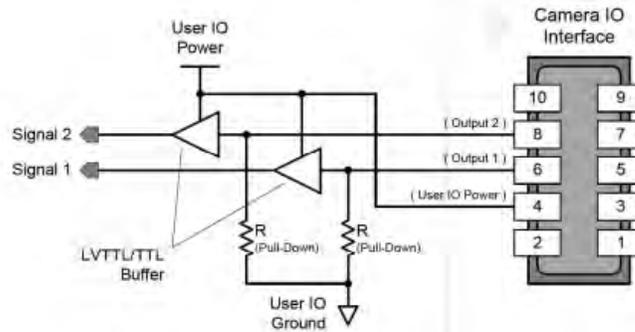
Active Low Output Example

## Output Signals Electrical Specifications

### External Outputs Block Diagram

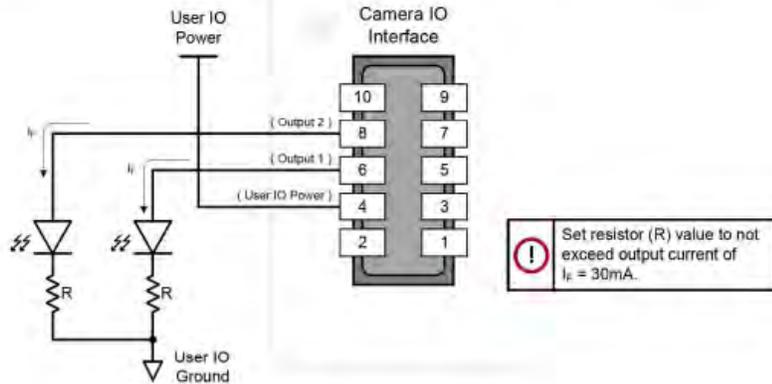


### External Outputs: Using External TTL/LVTTL Drivers



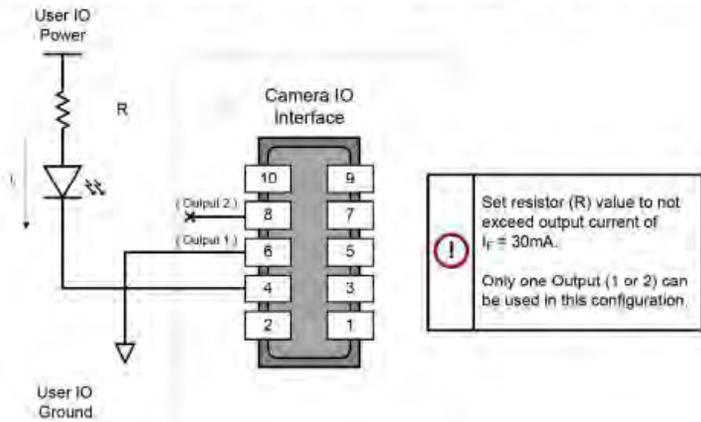
### External Outputs: Using External LED Indicators

- Two external LEDs can be connected in the Common Cathode configuration.



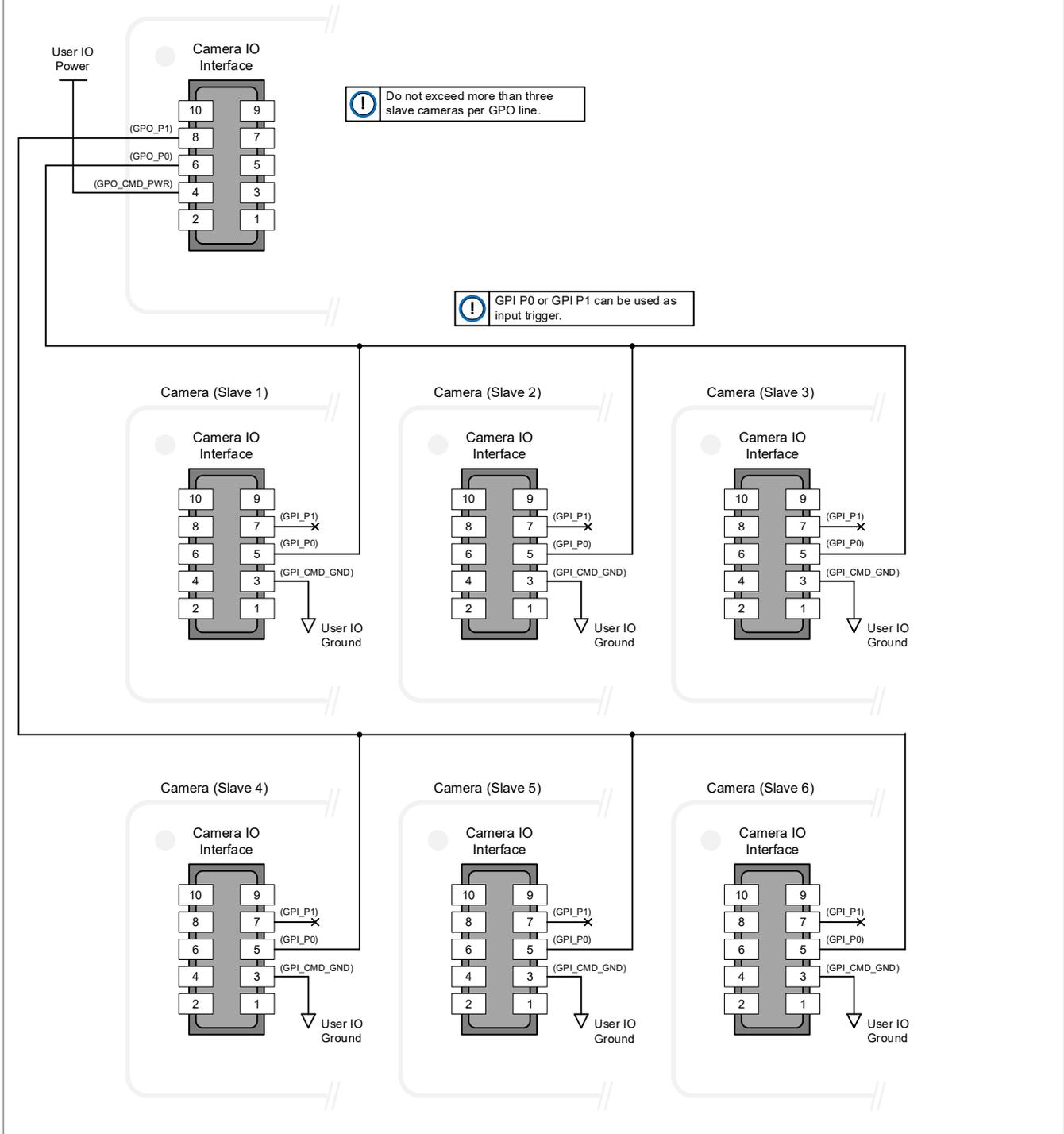
⚠ Set resistor (R) value to not exceed output current of  $I_L = 30\text{mA}$ .

- Alternatively one external LED can be connected in the Common Anode configuration.



### Using camera outputs to drive other camera inputs

- A synchronization method where one camera signals other cameras.
- Note: One camera output can drive a maximum of three inputs, as illustrated below.



---

# Computer Requirements for Lt Cameras

- A USB 3.0 equipped desktop, laptop or embedded computer will have the 5 volt power supply required by the Lt Series cameras.
- The computer requires the Windows 10 or Linux operating system.
- Teledyne DALSA Sopera LT development package or LuCam SDK.
- Alternatively refer to your USB3 Vision compliant SDK for computer requirements.

# EC & FCC Declarations of Conformity

Certificate 1 of 3



## EC Declaration of Conformity

**Products:** Lt-C2050, Lt-M2050, Lt-C2450, Lt-M2450, Lt-C4060, Lt-M4060, Lt-C4040, Lt-M4040

Note: These cameras are identical to the camera model variants listed in the test reports.

Model Variants	Equivalent Listed Model Variants
Lt-C2050, Lt-M2050	Lt345RC, Lt345RM
Lt-C2450, Lt-M2450	Lt545RC, Lt545RM
Lt-C4060, Lt-M4060	Lt945RC, Lt945RM
Lt-C4040, Lt-M4040	Lt1245RC, Lt1245RM

**Directives:** 2014/30/EU (Electromagnetic Compatibility Directive)  
2011/65/EU (Restriction of Hazardous Substances Directive)

**Standards to which conformity is declared:**

EN55024: 2010  
EN55032: 2012  
EN61000-3-2:2014  
EN61000-3-3:2013  
EN50581: 2012

**Manufacturer's Name and Address:**

Teledyne Lumenera Corporation  
7 Capella Court  
Ottawa, Ontario  
K2E 8A7  
Canada

**Type of Equipment:** Digital Camera

This is to certify that the Teledyne Lumenera Cameras meet or exceed the standards for CE compliance per the Council Directives noted above. All equipment is assembled at Teledyne Lumenera Corporation.

**Authorization Signature:**

Doug Sanderson  
VP Engineering

3/18/2020

Date



## EC Declaration of Conformity

**Products:**

Lt-C1610, Lt-C1630, Lt-C1900, Lt-C1950, Lt-C1980, Lt-C2020, Lt-C2420, Lt-C2470, Lt-C3200, Lt-C3840, Lt-C4020, Lt-C4030, Lt-C4510, Lt-C5300, Lt-C5500, Lt-M1610, Lt-M1630, Lt-M1950, Lt-M1980, Lt-M2020, Lt-M2420, Lt-M2470, Lt-M3200, Lt-M3840, Lt-M4020, Lt-M4030, Lt-M4510, Lt-M5300, Lt-M5500

**Directives:** 2014/30/EU (Electromagnetic Compatibility Directive)  
2011/65/EU (Restriction of Hazardous Substances Directive)

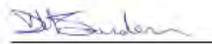
**Standards to which conformity is declared:**  
EN 55032:2015/A11:2020 (Lt-C5500 and Lt-M5500 only)  
EN 55032:2012/AC:2013  
EN 55035:2017

**Manufacturer's Name and Address:**  
Teledyne Lumenera Corporation  
7 Capella Court  
Ottawa, Ontario  
K2E 8A7  
Canada

**Type of Equipment:** Digital Camera

This is to certify that the Teledyne Lumenera Cameras meet or exceed the standards for CE compliance per the Council Directives noted above. All equipment is assembled at Teledyne Lumenera Corporation.

**Authorization Signature:**

  
\_\_\_\_\_  
Doug Sanderson  
VP Engineering

July 26, 2022  
Date



## EC Declaration of Conformity

**Products:**

Lt-C4430, Lt-C5470, Lt-C6480, Lt-M4430, Lt-M5470, Lt-M6480

**Directives:** 2014/30/EU (Electromagnetic Compatibility Directive)

2011/65/EU (Restriction of Hazardous Substances Directive)

**Standards to which conformity is declared:**

EN 55032:2015/A11:2020

EN 55035:2017/A11:2020

EN 50581:2012

**Manufacturer's Name and Address:**

Teledyne Lumenera Corporation  
7 Capella Court  
Ottawa, Ontario  
K2E 8A7  
Canada

**Type of Equipment:** Digital Camera

This is to certify that the Teledyne Lumenera Cameras meet or exceed the standards for CE compliance per the Council Directives noted above. All equipment is assembled at Teledyne Lumenera Corporation.

**Authorization Signature:**

Doug Sanderson  
VP Engineering

Oct / 20 / 2021

Date

# Additional Reference Information

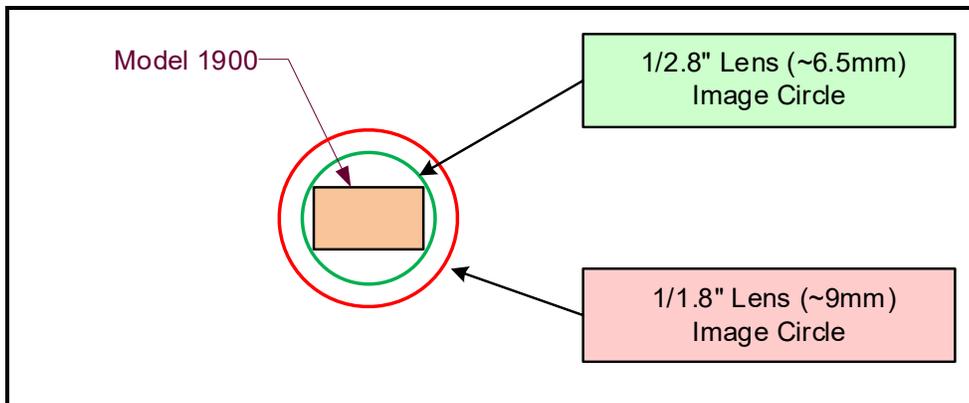
---

## Choosing a Lens with the Correct Image Circle

Each Lt Series model requires a lens with an image circle specification to fully illuminate the sensor. The following section graphically shows the minimum lens image circle for each model family along with alternative lens types. Brief information on other lens parameters to consider follows those sections.

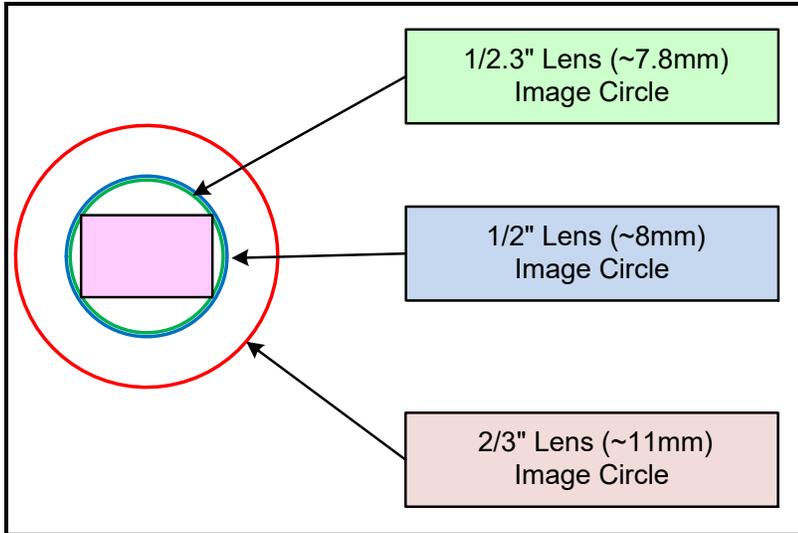
### Lens Options for Lt-1900

- The following figure shows the lens image circles relative to this model, in color or monochrome versions.
- A 1/2.8" lens can be used with this model.



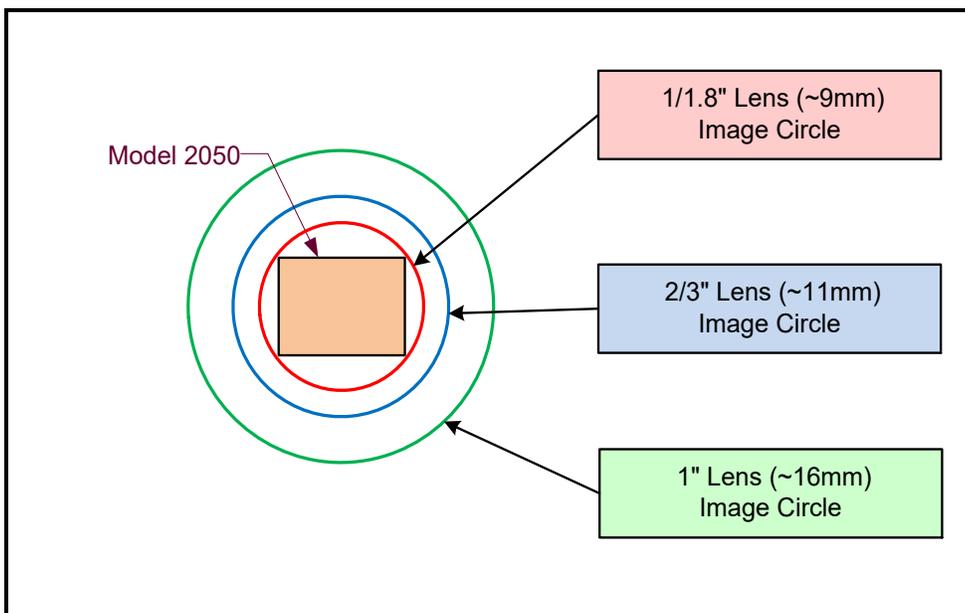
## Lens Options for Lt-1950

- The following figure shows the lens image circles relative to this model, in color or monochrome versions.
- A 1/2.3" lens can be used with these models.



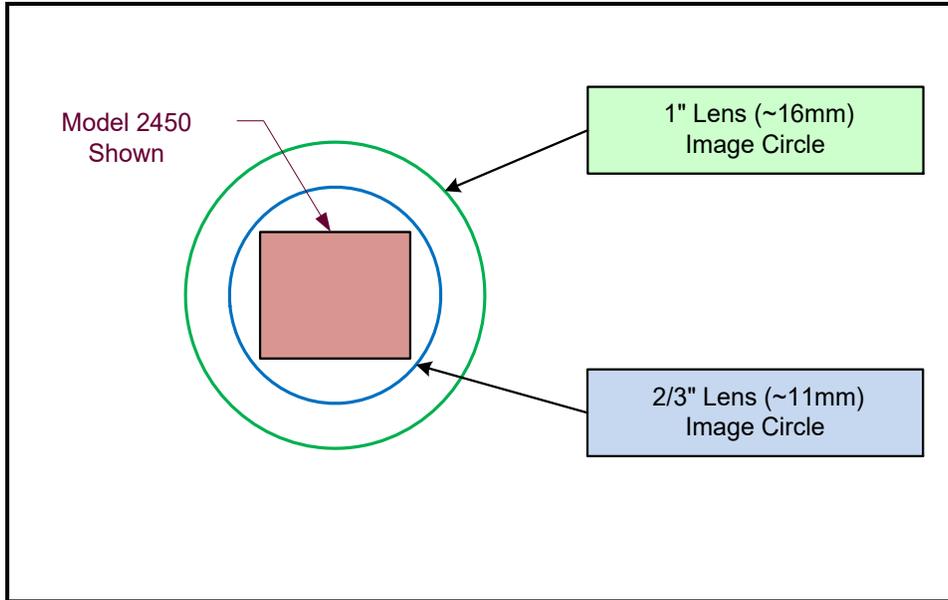
## Lens Options for Lt-2020, Lt-2050, Lt-2470, Lt-3840

- The following figure shows the lens image circles relative to these models, in color or monochrome versions.
- A 1/1.8" lens can be used with these models.



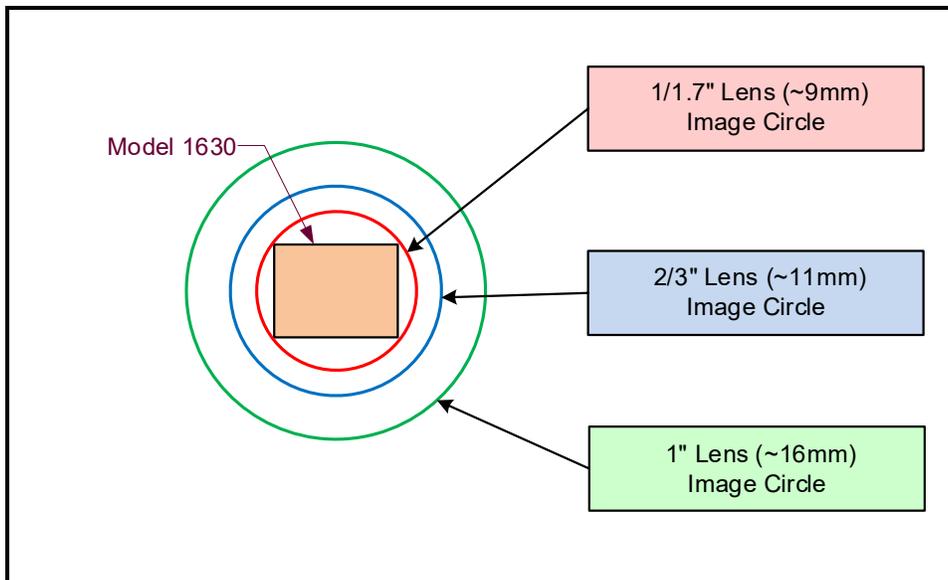
## Lens Options for Lt-1980, Lt-2420, Lt-2450

- The following figure shows the lens image circles relative to these models, in color or monochrome versions.
- A typical 2/3" lens will fully illuminate these sensors.



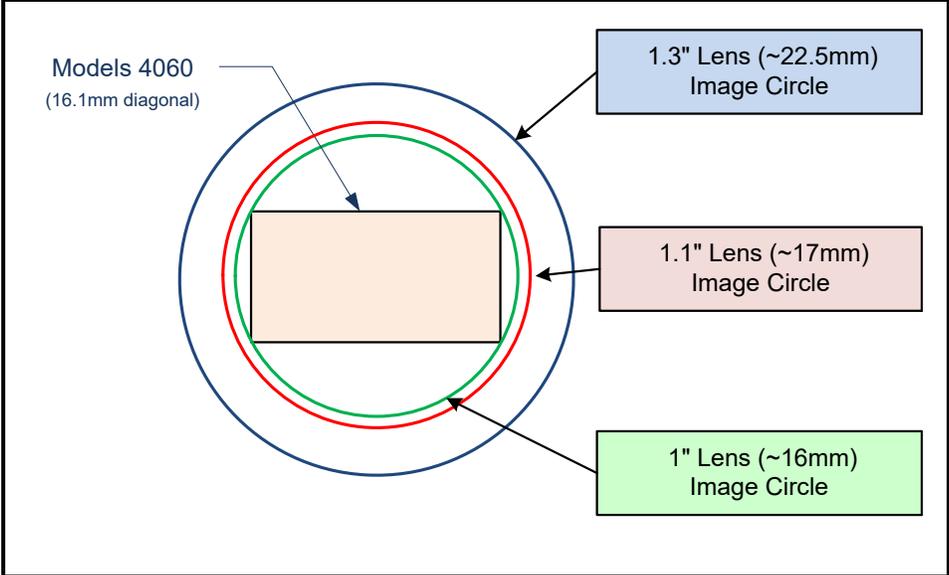
## Lens Options for Lt-1630

- The following figure shows the lens image circles for this model, in color or monochrome versions.
- A 1/1.7" lens can be used with this model.



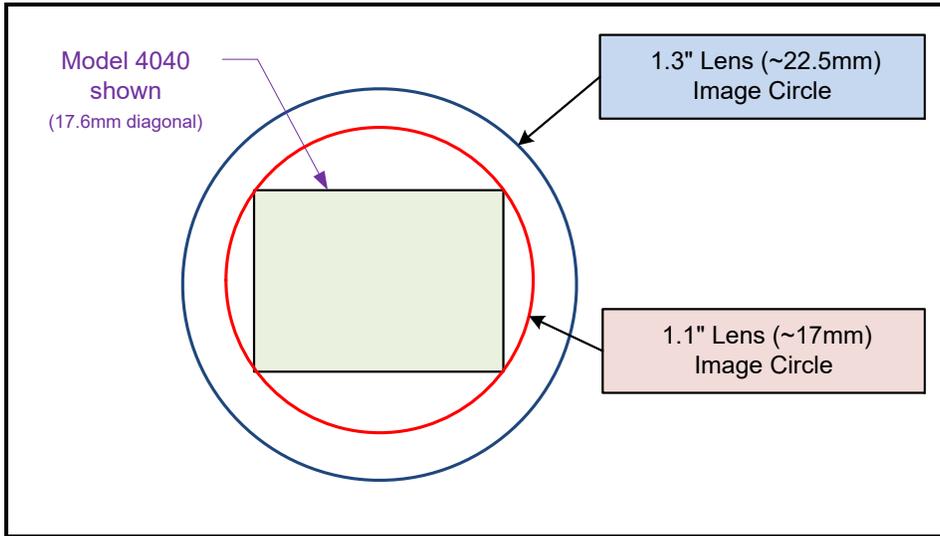
# Lens Options for Lt-4030, Lt-4060, Lt-5500

- The following figure shows the lens image circles relative to these models, in color or monochrome versions.
- A typical 1" lens will just illuminate these sensors while larger image circle lens will avoid any corner shading.



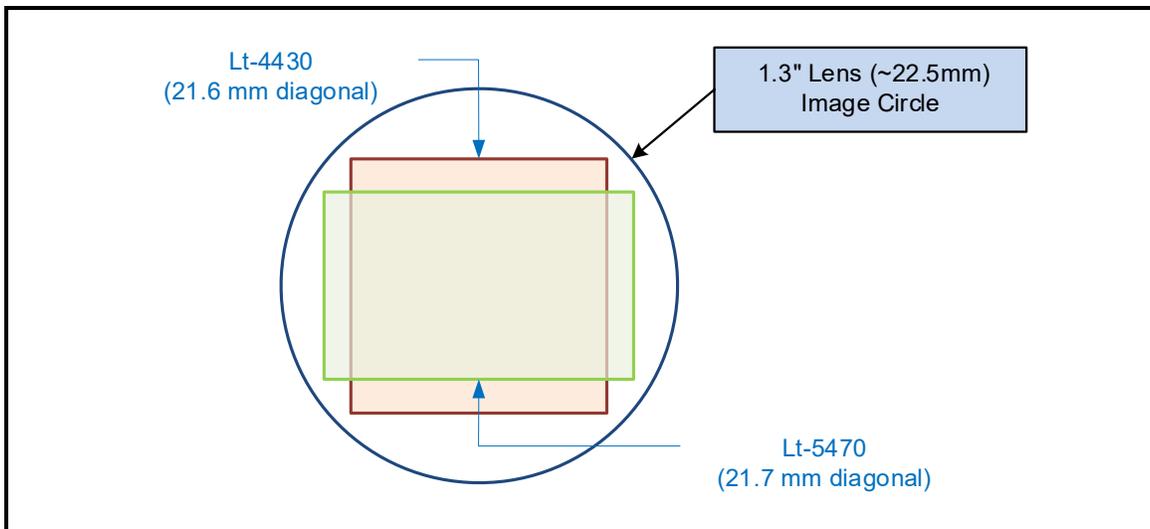
## Lens Options for Lt-1610, Lt-3200, Lt-4020, Lt-4040, Lt-5300, Lt-4510

- The following figure shows the lens image circles relative to these models, in color or monochrome versions.
- A typical 1.1" lens will illuminate these sensors.



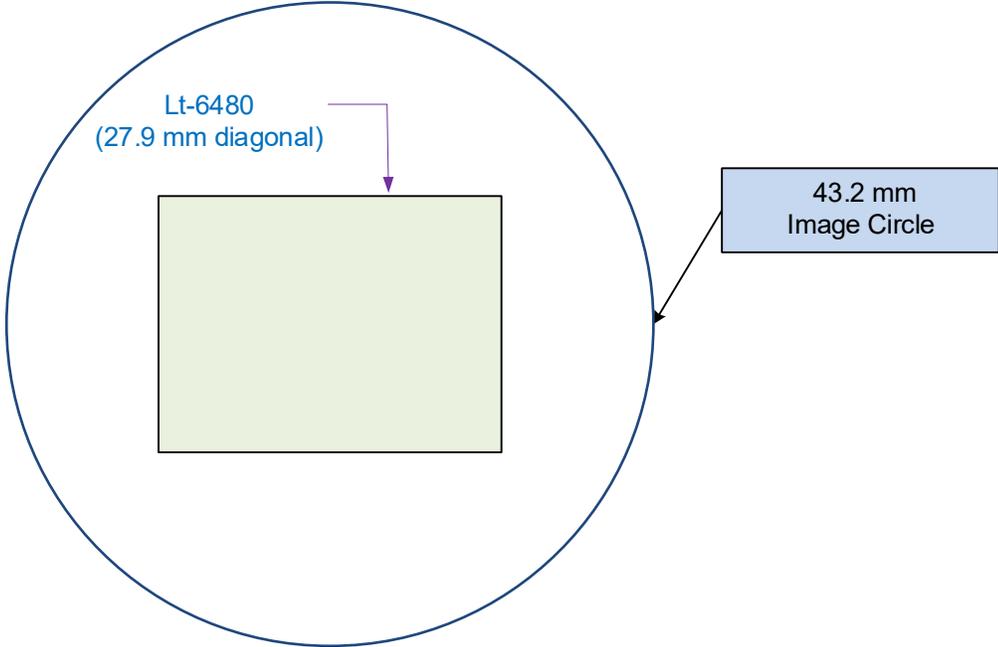
## Lens Options for Lt-4430, Lt-5470

- The following figure shows the lens image circles relative to these models, in color or monochrome versions.
- A typical 4/3" lens will illuminate these sensors.



# Lens Options for Lt-6480

- The following figure shows a 43.2 mm lens image circle relative to Lt-6480 sensors. This model is APS-C format.



## Additional Lens Parameters (application specific)

There are other lens parameters that are chosen to meet the needs of the vision application. These parameters are independent of the Lt Model (assuming that the Lens Mount and Lens Sensor Size parameters are correct, as previously covered in this section). A vision system integrator or lens specialist should be consulted when choosing lenses since there is a trade-off between the best lenses and cost. An abridged list of lens parameters follows – all of which need to be matched to the application.

- **Focal Length:** Defines the focus point of light from infinity. This parameter is related to the Lt Mount (C, CS, M42 mount). See [Back Focal Variance when using any Filter](#).
- **Field of View:** A lens is designed to image objects at some limited distance range, at some positive or negative magnification. This defines the field of view.
- **F-Number (aperture):** The lens aperture defines the amount of light that can pass. Lenses may have fixed or variable apertures. Additionally, the lens aperture affects Depth of Field which defines the distance range which is in focus when the lens is focus at some specific distance.
- **Image Resolution and Distortion:** A general definition of image quality. A lens with poor resolution seems to never be in focus when used to image fine details.
- **Aberrations (defect, chromatic, spherical):** Aberrations are specific types of lens faults affecting resolution and distortion. Lens surface defects or glass faults distort all light or specific colors. Aberrations are typically more visible when imaging fine details.
- **Spatial Distortions:** Describes non-linear lens distortions across the field of view. Such distortion limits the accuracy of measurements made with that lens.

---

## Optical Considerations

This section provides an overview to illumination, light sources, filters, lens modeling and lens magnification. Each of these components contributes to the successful design of an imaging solution.

### Illumination

The amount and wavelengths of light required to capture useful images depend on the application. Factors include the nature, speed and spectral characteristics of objects being imaged, exposure times, light source characteristics, environmental and acquisition system specifics, and more. The Teledyne DALSA Web site provides an introduction to this potentially complicated issue, along with many other application notes and guides on machine vision. Start with this Knowledge Center article: [www.teledynedalsa.com/en/learn/knowledge-center/machine-vision-101-an-introduction/](http://www.teledynedalsa.com/en/learn/knowledge-center/machine-vision-101-an-introduction/)

It is often more important to consider exposure than illumination. The total amount of energy (which is related to the total number of photons reaching the sensor) is more important than the rate at which it arrives. For example, 5  $\mu\text{J}/\text{cm}^2$  can be achieved by exposing 5  $\text{mW}/\text{cm}^2$  for 1 ms just the same as exposing 5  $\text{W}/\text{cm}^2$  for 1  $\mu\text{s}$ .

# Light Sources

Keep these guidelines in mind when selecting and setting up light source:

- LED light sources are relatively inexpensive; provide a uniform field, and longer life span compared to other light sources. However, they also require a camera with excellent sensitivity.
- Halogen light sources generally provide very little blue relative to infrared light (IR).
- Fiber-optic light distribution systems generally transmit very little blue relative to IR.
- Some light sources age such that over their life span they produce less light. This aging may not be uniform—a light source may produce progressively less light in some areas of the spectrum but not others.

## Monochrome Cameras with Anti-Reflection Filter

Lt-Ux0x-xxxxx and Lt-xx1x-xxxxx series monochrome models are available with AR/AR coated glass filters, factory installed for optimized imaging solutions. See section **Monochrome Cameras** for ordering information.

### AR/AR Filter Specification Highlights

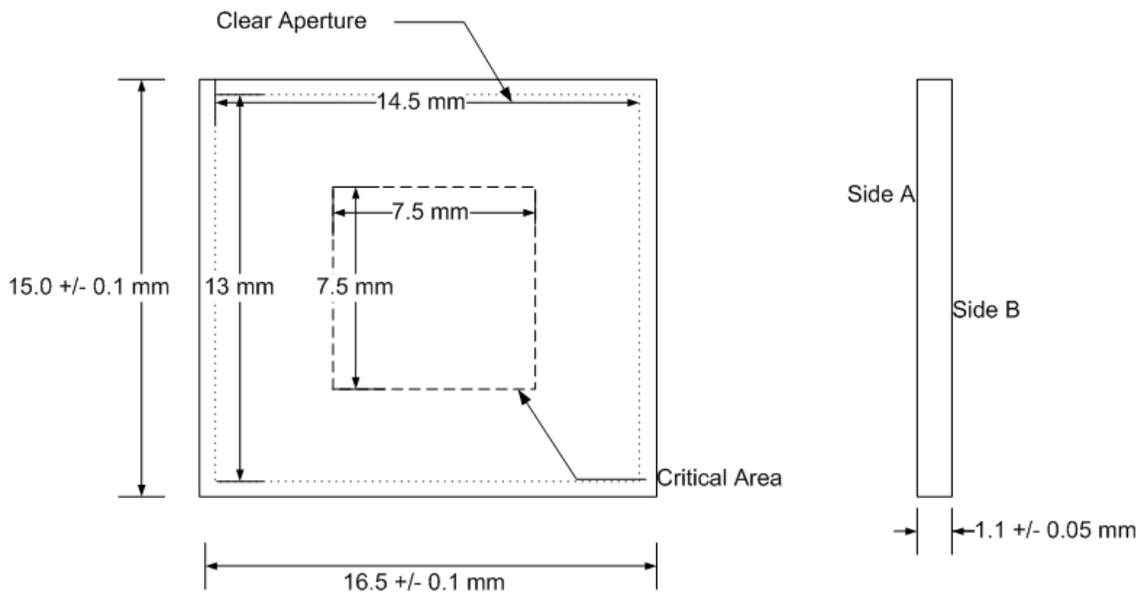
#### Spectral Performance

Parameter	Value	Unit	Comment
Reflectance 380nm – 399nm	< 4	%	Maximum
Reflectance 400nm – 700nm	< 2	%	Maximum
Reflectance 701nm - 1100nm	< 4	%	Maximum

#### Coating Uniformity

There will be less than  $\pm 1$ nm variation in the transmittance of any wavelength when measured across the clear aperture area of one filter

#### Dimensions



# Color Camera with IR Cut-off Filter

Lt Series color cameras are responsive to near infrared (IR) wavelengths, meaning that they have a spectral response that extends into near IR wavelengths (as defined for each sensor model in the sensor specification descriptions). Images captured will have washed out color if the sensor response is not limited to the visible light band

To prevent infrared from distorting the color balance of visible light acquisitions, use a “hot mirror” or IR cut-off filter that transmits visible wavelengths but does not transmit near infrared wavelengths and above.

Lt Camera color models are available with NIR/AR coated glass filters, factory installed for optimized imaging solutions. See **Color Cameras** for ordering information.

## NIR/AR Filter Specification Highlights

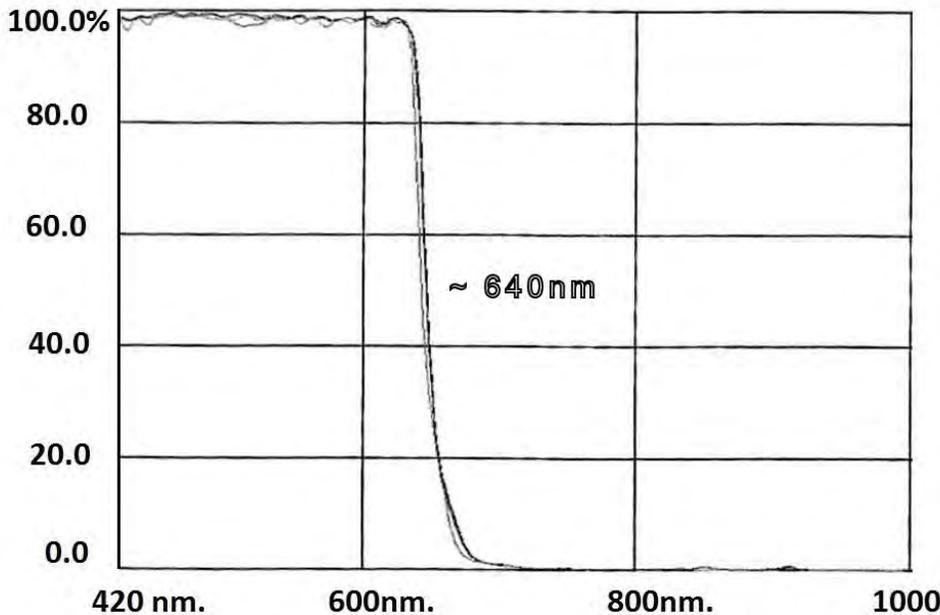
### Spectral Performance

Parameter	Value	Unit	Comment
Transmittance 400nm – 620nm	≥ 91	%	Minimum
Transmittance 400nm – 620nm	≥ 96	%	Average
Cutoff wavelength T=50%	640	nm	± 5 nm
Transmittance 700nm – 1100nm	≤ 1	%	Average
Transmittance 700nm – 1100nm	≤ 2	%	Maximum

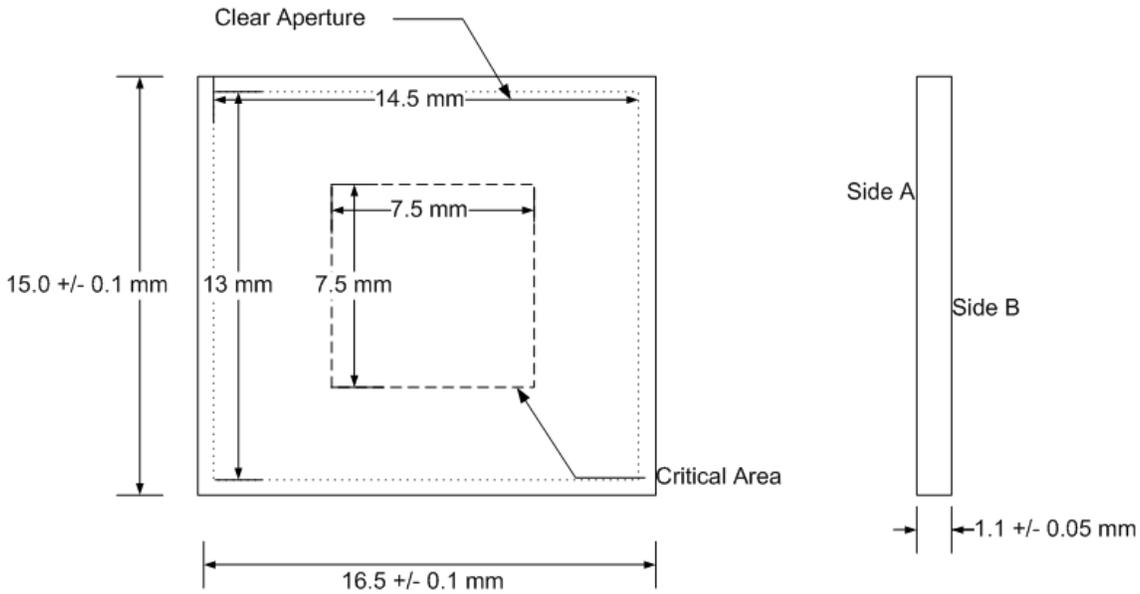
### Coating Uniformity

There will be less than ± 1 nm variation in the upper cutoff wavelength (640 nm) when measured across the clear aperture area of one filter.

### NIR Filter Response Graphic

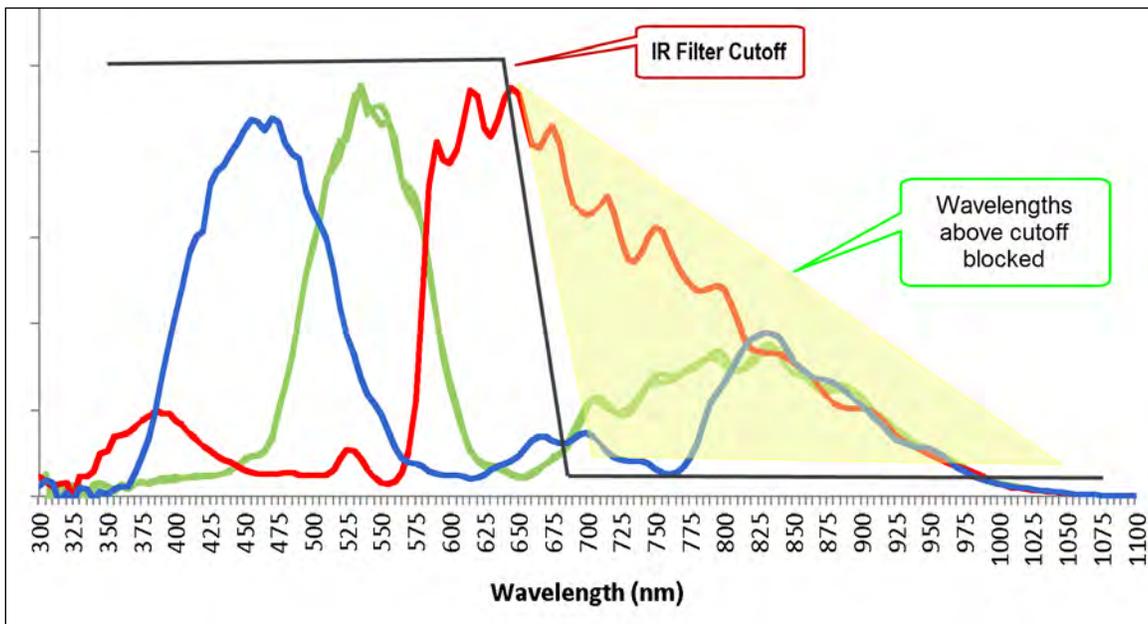


## Dimensions



## Guidelines for Choosing IR Cut-off Filters

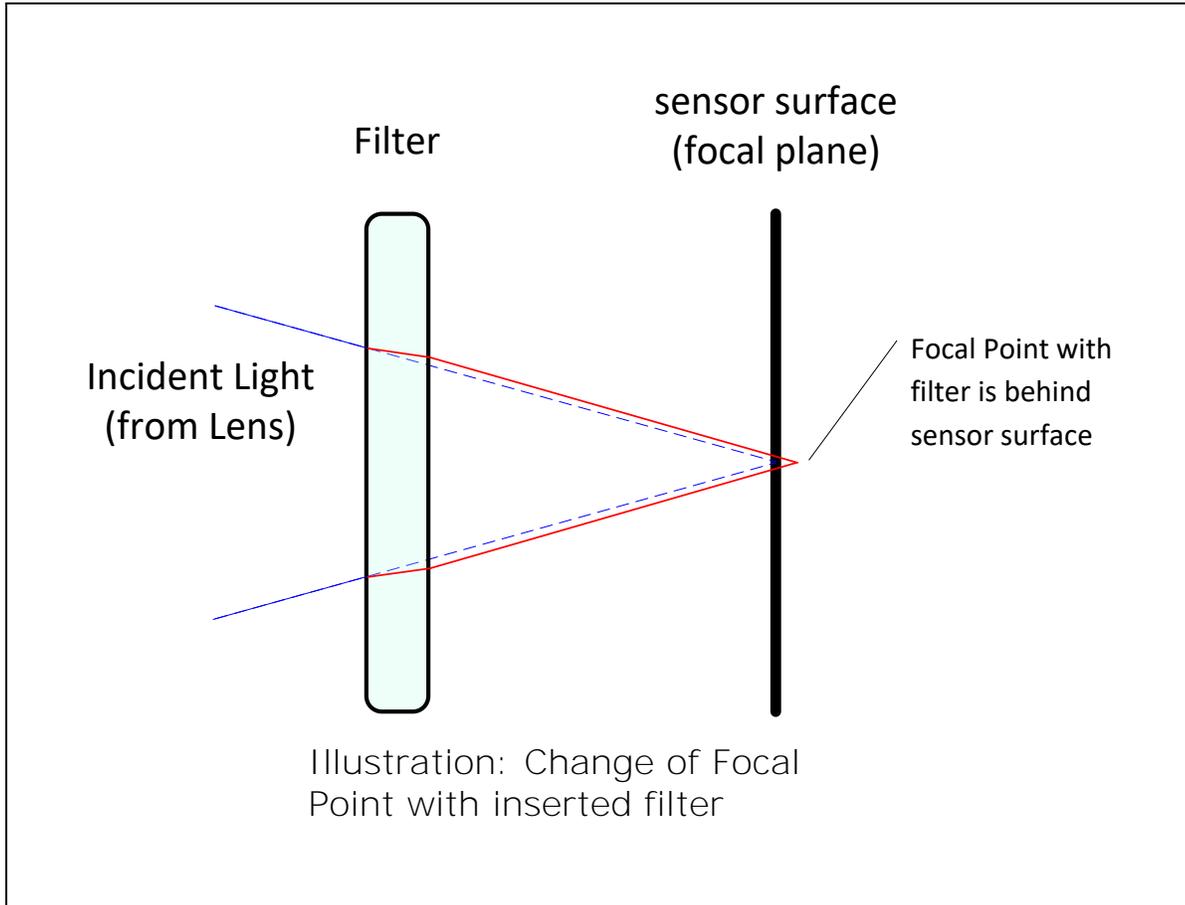
The following graphic, using a color sensor response spectrum, shows the transmission response of typical filters designed for CMOS sensor cameras. When selecting an IR cut-off filter, choose a near infrared blocking specification of  $\sim 650$  nm. Filters that block at  $700$  nm or longer wavelengths, designed for CCD cameras, are not recommended for Lt color cameras.



## Back Focal Variance when using any Filter

Inserting a filter between a lens and sensor changes the back focal point of the lens used. A variable focus lens simply needs to be adjusted, but in the case of a fixed focus lens, the changed focal point needs correction.

The following simplified illustration describes this but omits any discussion of the optics, physics, and math behind the refraction of light through glass filter media.



In this example when a glass filter is inserted between the lens and the camera sensor, the focal point is now about 1/3 of the filter thickness behind the sensor plane. Filters are typically specified as 1 mm thick.

For Lt Series models normally shipped without filters, when a filter is installed a fixed focus lens requires a 1/3 mm C-mount shim (spacer) added to move the lens focal point back to the sensor surface. Such shims are available from filter and lens suppliers. Alternatively use a variable focus lens and secure its focus ring after adjustment.

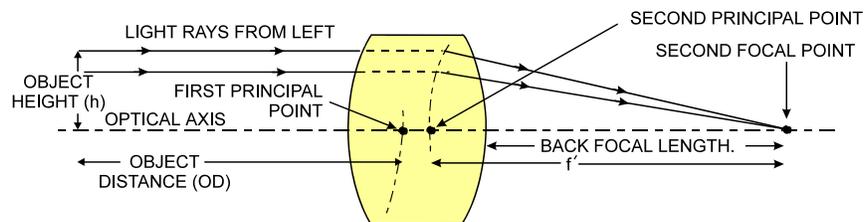
Lt-Ux00 cameras are *designed* to include a glass filter in their back focal distance. If the part number does not include the CG or IF suffix, the camera may need an adjustable lens to achieve satisfactory focus.

# Lens Modeling

Any lens surrounded by air can be modeled for camera purposes using three primary points: the first and second principal points and the second focal point. The primary points for a lens should be available from the lens data sheet or from the lens manufacturer. Primed quantities denote characteristics of the image side of the lens. That is,  $h$  is the object height and  $h'$  is the image height.

The focal point is the point at which the image of an infinitely distant object is brought to focus. The effective focal length ( $f'$ ) is the distance from the second principal point to the second focal point. The back focal length (BFL) is the distance from the image side of the lens surface to the second focal point. The object distance (OD) is the distance from the first principal point to the object.

## Primary Points in a Lens System



## Magnification and Resolution

The magnification of a lens is the ratio of the image size to the object size:

$m = \frac{h'}{h}$	Where $m$ is the magnification, $h'$ is the image height (pixel size) and $h$ is the object height (desired object resolution size).
--------------------	--

By similar triangles, the magnification is alternatively given by:

$m = \frac{f'}{OD}$
---------------------

These equations can be combined to give their most useful form:

$\frac{h'}{h} = \frac{f'}{OD}$	This is the governing equation for many object and image plane parameters.
--------------------------------	--

**Example:** An acquisition system has a 512 x 512 element, 10  $\mu\text{m}$  pixel pitch area scan camera, a lens with an effective focal length of 45 mm, and requires that 100  $\mu\text{m}$  in the object space correspond to each pixel in the image sensor. Using the preceding equation, the object distance must be 450 mm (0.450 m).

$\frac{10\mu\text{m}}{100\mu\text{m}} = \frac{45\text{mm}}{OD}$	OD=450 mm
---	-----------

---

# Sensor Handling Instructions

This section reviews proper procedures for handling, cleaning, or storing the Lt camera. Specifically, the Lt sensor needs to be kept clean and away from static discharge to maintain design performance.

## Electrostatic Discharge and the Sensor

Cameras sensors containing integrated electronics are susceptible to damage from electrostatic discharge (ESD).

Electrostatic charge introduced to the sensor window surface can induce charge buildup on the underside of the window that cannot be readily dissipated by the dry nitrogen gas in the sensor package cavity. With charge buildup, problems such as higher image lag or a highly non-uniform response may occur. The charge normally dissipates within 24 hours and the sensor returns to normal operation.



**Important:** Charge buildup will affect the camera's flat-field correction calibration. To avoid an erroneous calibration, ensure that you perform flat-field correction only after a charge buildup has dissipated over 24 hours.

## Protecting Against Dust, Oil and Scratches

The sensor window is part of the optical path and should be handled like other optical components, with extreme care.

Dust can obscure pixels, producing dark patches on the sensor response. Dust is most visible when the illumination is collimated. The dark patches shift position as the angle of illumination changes. Dust is normally not visible when the sensor is positioned at the exit port of an integrating sphere, where the illumination is diffuse.

Dust can normally be removed by blowing the window surface using a compressed air blower, unless the dust particles are being held by an electrostatic charge, in which case either an ionized air blower or wet cleaning is necessary.

Oil is usually introduced during handling. Touching the surface of the window barehanded will leave oily residues. Using rubber finger cots and rubber gloves can prevent oil contamination. However, the friction between the rubber and the window may produce electrostatic charge that may damage the sensor.

Scratches can be caused by improper handling, cleaning or storage of the camera. When handling or storing the camera without a lens, always install the C-mount protective cap. Scratches diffract incident illumination. When exposed to uniform illumination, a sensor with a scratched window will normally have brighter pixels adjacent to darker pixels. The location of these pixels changes with the angle of illumination.

## Cleaning the Sensor Window

Even with careful handling, the sensor window may need cleaning. The following steps describe various cleaning techniques to clean minor dust particles to accidental finger touches.

- Use compressed air to blow off loose particles. This step alone is usually sufficient to clean the sensor window. Avoid moving or shaking the compressed air container and use short bursts of air while moving the camera in the air stream. Agitating the container will cause condensation to form in the air stream. Long air bursts will chill the sensor window causing more condensation. Condensation, even when left to dry naturally, will deposit more particles on the sensor.
- When compressed air cannot clean the sensor, Teledyne Lumenera recommends using lint-free ESD-safe cloth wipers that do not contain particles that can scratch the window. The Anticon Gold 9"x 9" wiper made by Milliken is both ESD safe and suitable for class 100 environments. Suitable wipers are also available from Texwipe.
- An alternative to ESD-safe cloth wipers is Transplex swabs that have desirable ESD properties. There are several varieties available from Texwipe. Do not use regular cotton swabs, since these can introduce static charge to the window surface.
- Wipe the window carefully and slowly when using these products.

---

## Ruggedized Cable Accessories

Teledyne provides optional I/O cable assemblies for Lt series cameras. Users wishing to build their I/O cabling by starting from available cable packages should consider these popular assemblies described below. Contact Sales for pricing and delivery.

Users also may order cable assembly quantities directly from Alysium-Tech or Components Express. In such cases use the manufacturer's part number shown on the cable assembly engineering drawing.

## Cable Manufactures Contact Information

<p><b>For information contact:</b> (see their web site for worldwide offices)</p>	<p>Components Express, Inc. (CEI) 10330 Argonne Woods Drive, Suite 100 Woodridge, IL 60517-4995 Phone: 630-257-0605 / 800.578.6695 (outside Illinois) Fax: 630-257-0603 <a href="http://www.componentsexpress.com/">http://www.componentsexpress.com/</a></p>
<p><b>For information contact:</b> (see their web site for worldwide offices)</p>	<p>Alysium-Tech 101 Montgomery Street, Suite 2050 San Francisco, CA 94104 Phone: 415 248 7807 Fax: 415 248 7800 <a href="https://www.alysium.com/">https://www.alysium.com/</a></p>

## Long Passive Cables and Optical Cables

Contact Alysium-Tech for information on these cabling choices.

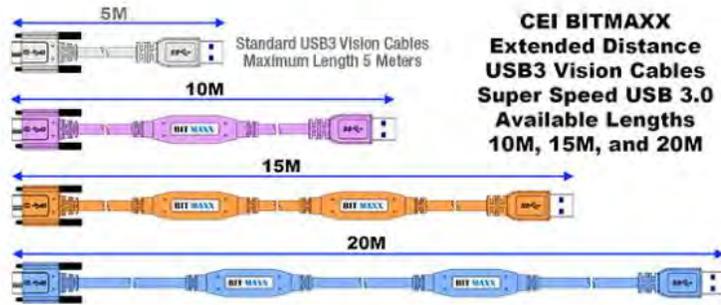
## USB3 Long Distance Active Cables

CEI's USB3 BitMaxx cables offer Plug & Play active cable solutions for USB Vision. Please visit the website for Components Express to review their cable options.



**COMPONENTS EXPRESS, INC.**  
INDUSTRY LEADING PERFORMANCE

Machine Vision  
**Long distance USB3 Cables**



# Troubleshooting

---

## Overview

This section provides information for troubleshooting camera installation problems. A few important items from the web site FAQ are repeated here, followed by troubleshooting flow charts enabling the user to pinpoint the problem type.

Teledyne Lumenera Troubleshooting FAQ on the web:

[www.lumenera.com/support/industrial-usb-ethernet/usb-faqs.html#Troubleshooting](http://www.lumenera.com/support/industrial-usb-ethernet/usb-faqs.html#Troubleshooting)

---

## USB 3 Camera FAQ Items

### **My USB camera is not recognized by the system and not listed in Device Manager**

If the camera does not show up in the Windows Device Manager, the cause could be one of the following:

- If the camera LED remains dark (off), verify that the USB 3 cable is not faulty. The camera is normally powered by the USB 3 port 5 volt power. Test the camera with another USB 3 cable.
- Test the camera by connecting it into another USB 3 port, or on another PC. When the camera is detected by host, an entry will appear in the Windows Device Manager – regardless of whether the device driver is loaded on the computer.

### **Windows Device Manager incorrectly lists the camera, or displays an exclamation mark beside the device**

This describes the situation that occurs when the correct device drivers are not loaded to the camera by the operating system. It may occur if the camera is connected to the PC before the software and device drivers have been installed. Teledyne Lumenera camera device drivers are signed and compliant with Microsoft requirements, so device drivers should load automatically whenever the camera is connected to a PC where the device drivers are resident.

### **My image is darker in the corners**

This issue known as vignetting happens when the lens image circle used is too small for the camera sensor. Make sure that you use the proper lens/optics for the camera. Your camera's datasheet will state the size of the sensor used so that you can properly match your lens/optics.

Also see Choosing a Lens with the Correct Image Circle for additional details.

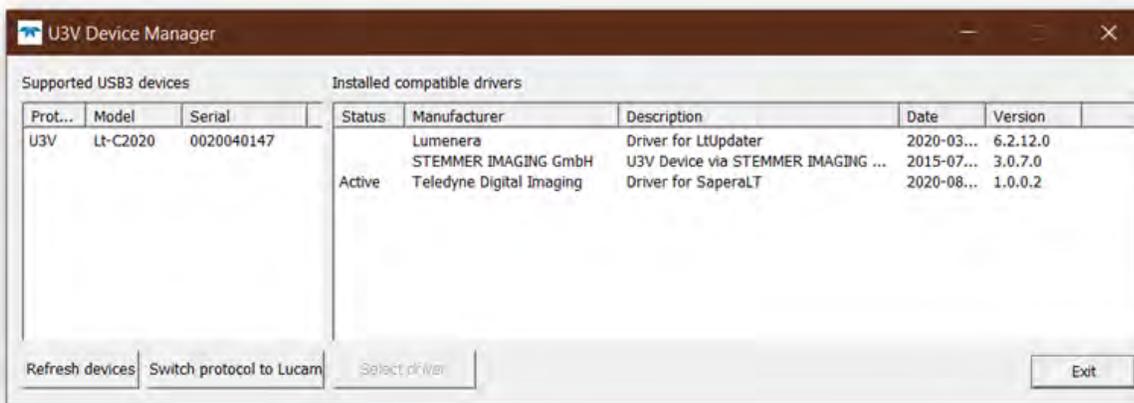
### **Settings which have an impact on the camera frame rate**

There are a few reasons why you cannot get the advertised frame rate.

- The selected exposure time can limit the frame rate. Make sure that the exposure time is  $fps < 1/desired\ frame\ rate$ .
- There are not enough computer resources to keep up with the current camera data rate. You will need to minimize the resource usage or operate the camera on a faster computer which easily handles the continuous video stream on the USB 3 port.

## Using the U3V Device Manager Tool

The Teledyne Lumenera U3V Device Manager, included with Spera LT since version 8.60, allows quick changes between multiple installed camera drivers. Select the connected camera. The mode may then be switched, and the driver may be selected from a list of installed drivers.



Alternatively, drivers may be selected with Windows Device Manager.

# Switching a Teledyne Lumenera camera from LuCam mode to USB3 Vision mode

## Using LtUpdater to Switch to USB3 Vision Mode

- Go to the Teledyne Lumenera web site and register your name and password to login and access the download area. [ [www.lumenera.com](http://www.lumenera.com) ]
- Go to */Home/Support/Industrial (USB & Ethernet)/Drivers & Downloads*
- Read the **Important Notes** and use Firefox or Chrome as recommended.
- Download the following three files:

1	LuCam Software and Software Development Kit	
2	USB 3.0 Camera Firmware and Updater	
3	Latest Firmware ZIP file or CBF file for your camera model	<b>NOTE: DO NOT</b> uncompress the zip file

**Important:** DO NOT connect the camera to the USB 3 port before the two software installations that follow.

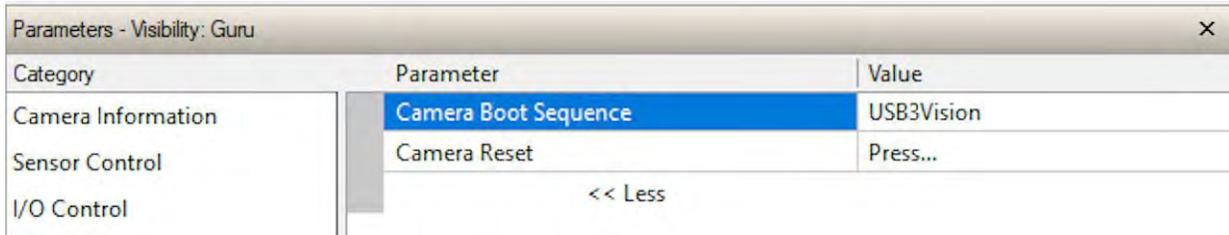
- Install the **LuCam Software and Software Development kit** first (file 1). This is required to run the LtUpdater tool.
- Install the **USB 3.0 Camera Firmware and Updater** tool (file 2).
- Connect the Teledyne Lumenera camera to a USB 3 port.
- Run the Teledyne Lumenera **LtUpdater.exe** tool from the desktop shortcut or from the typical path "*C:\Program Files\Teledyne Lumenera\LtUpdater\LtUpdater.exe*".  
The LtUpdater tool window will show that there is a camera connected in LuCam Mode. If all fields are grayed out, then either the camera is not connected to the computer, is unpowered or is already in USB3 Vision mode.
- Click **Select Packages** and select the camera firmware .zip or .cbf file you have downloaded for your camera model. The LtUpdater tool will automatically show the components within the zip file that will update the camera.
- Click **Update** and wait for confirmation of each updated component. The camera has been programmed with the latest firmware version.
- From the LtUpdater tool Camera Mode field, switch the camera from LuCam mode to USB3 Vision mode.
- Close the LtUpdater tool.
- Cycle the camera power to reset the camera into USB3 Vision Mode.
- Start the Spera LT CamExpert application to work with the Teledyne Lumenera camera as a Spera device.

---

# Switching a Teledyne Lumenera camera from USB3 Vision mode to LuCam mode

This procedure describes how to change mode with Sopera Lt CamExpert. You can also change it with a USB3 Vision compliant third-party tool using the same features.

- Run CamExpert and select the **Teledyne Lumenera Control** category.



- Change the **Camera Boot Sequence** value from *USB3Vision* to *LuCam*.
- Click *Press...* next to **Camera Reset**.
- Cycle the camera power.

The camera is now in LuCam mode. Sopera LT CamExpert cannot access the camera.

To return the camera to USB3 Vision mode, follow the procedure from section Switching a Teledyne Lumenera camera from LuCam mode to USB3 Vision mode.

---

# Lumenera LuCam API for Linux OS

The Linux LucamSDK provides a LucamAPI-compatible driver and example applications.

## To install the driver and compile the sample applications

1. Download the LucamSDK software package and untar it.
2. Unplug any Lumenera devices from the system.
3. Change to the SDK directory:

```
cd lucam-sdk_<version>
```

4. Compile the driver and install it:

```
sudo make install ALL_DRVS=1
```

5. Compile the example applications:

```
make examples
```

6. Plug a supported Teledyne Lumenera camera into a USB 3.x port.
7. Confirm that the driver is functional, and communicate with the camera by running the 'helloCamera' example program:

```
./examples/helloCamera/helloCamera
```

8. You should see the following output:

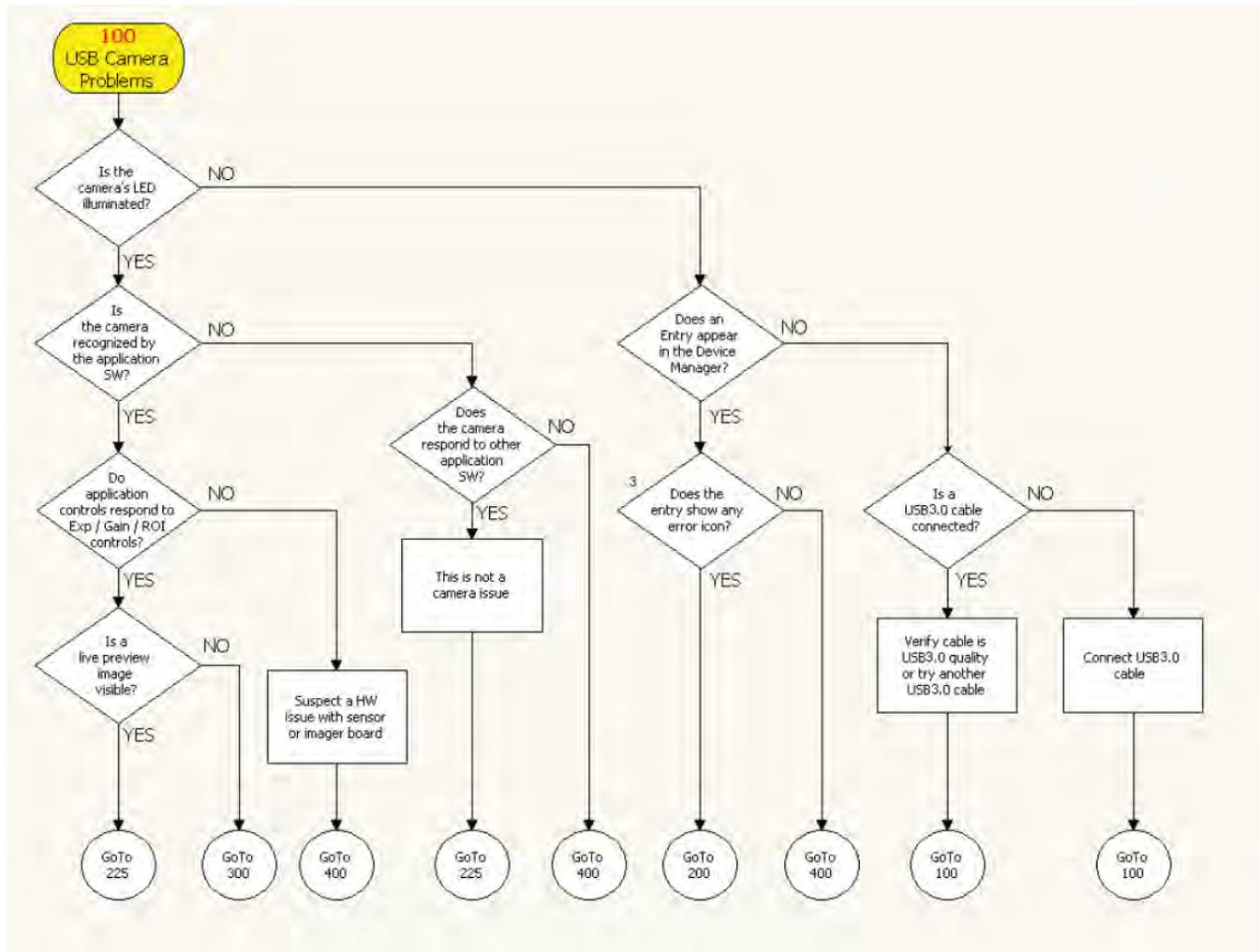
```
Hello camera!
```

In the `doc/` directory of the LinuxSDK, you will find the Lumenera USB Camera API Reference Manual if you need more information on using the API to communicate with the camera with your own applications.

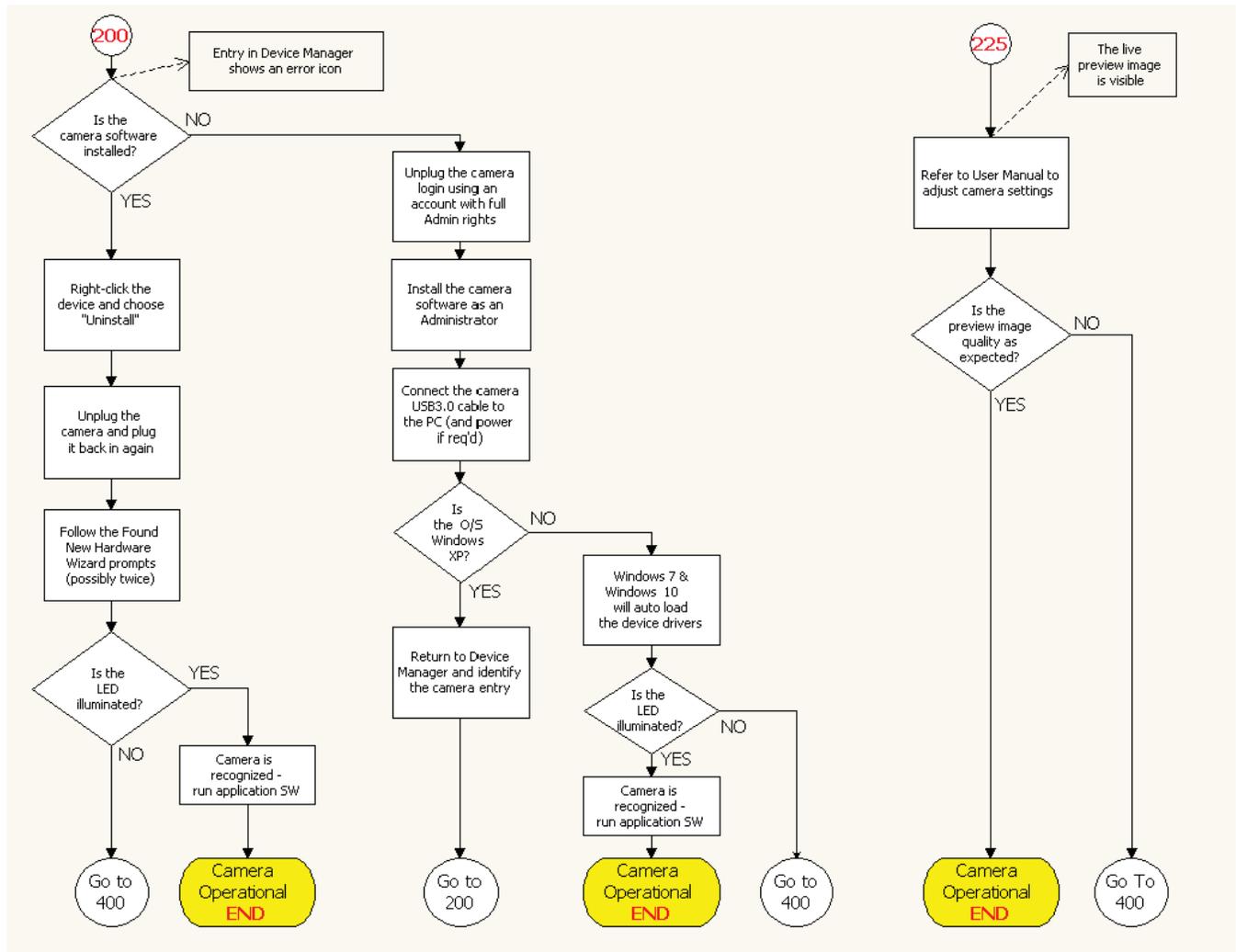
# Troubleshooting Flow Charts

Use the following flowchart to help identify problem with a Teledyne Lumenera Lt camera.

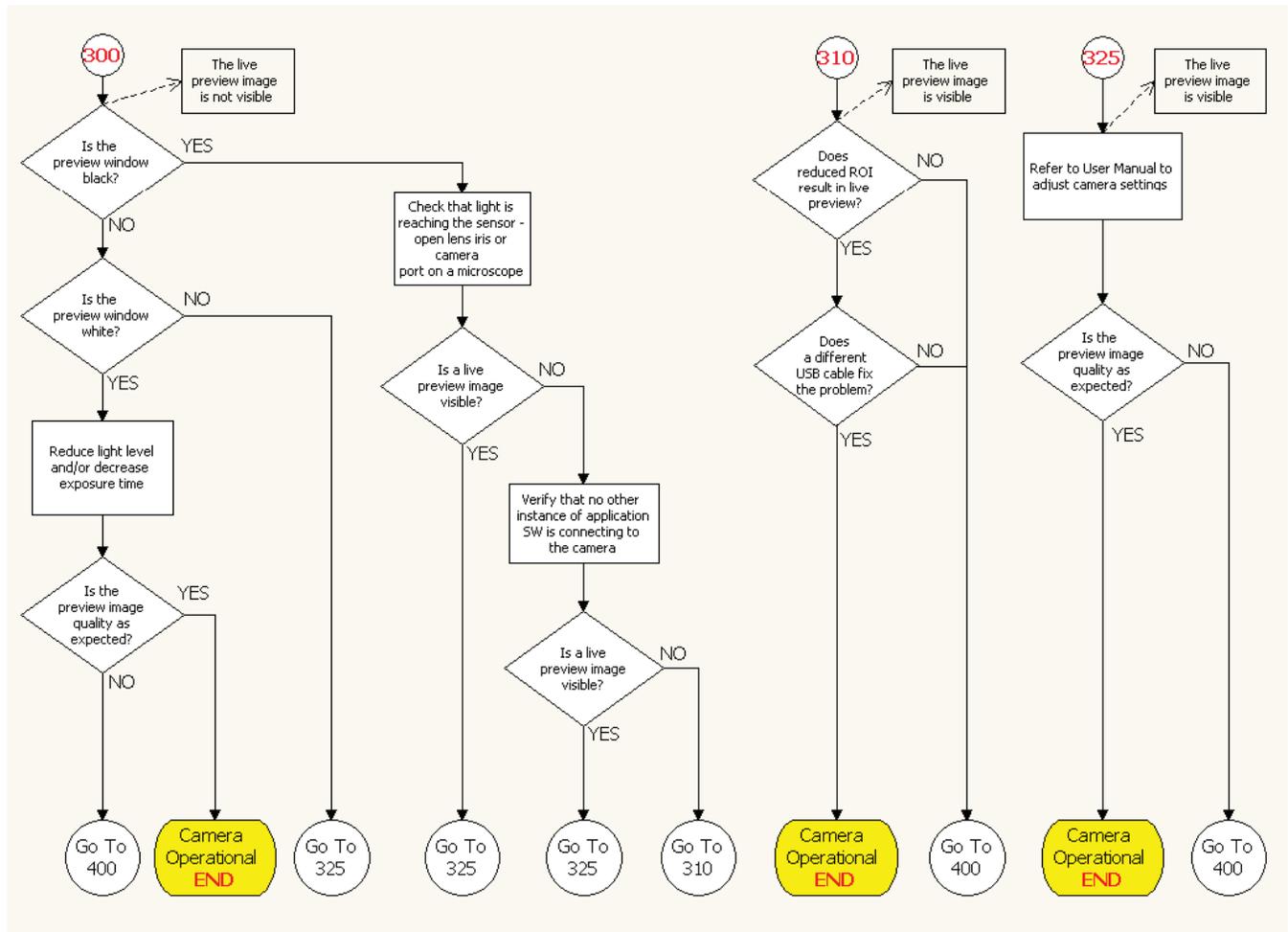
## Chart 1



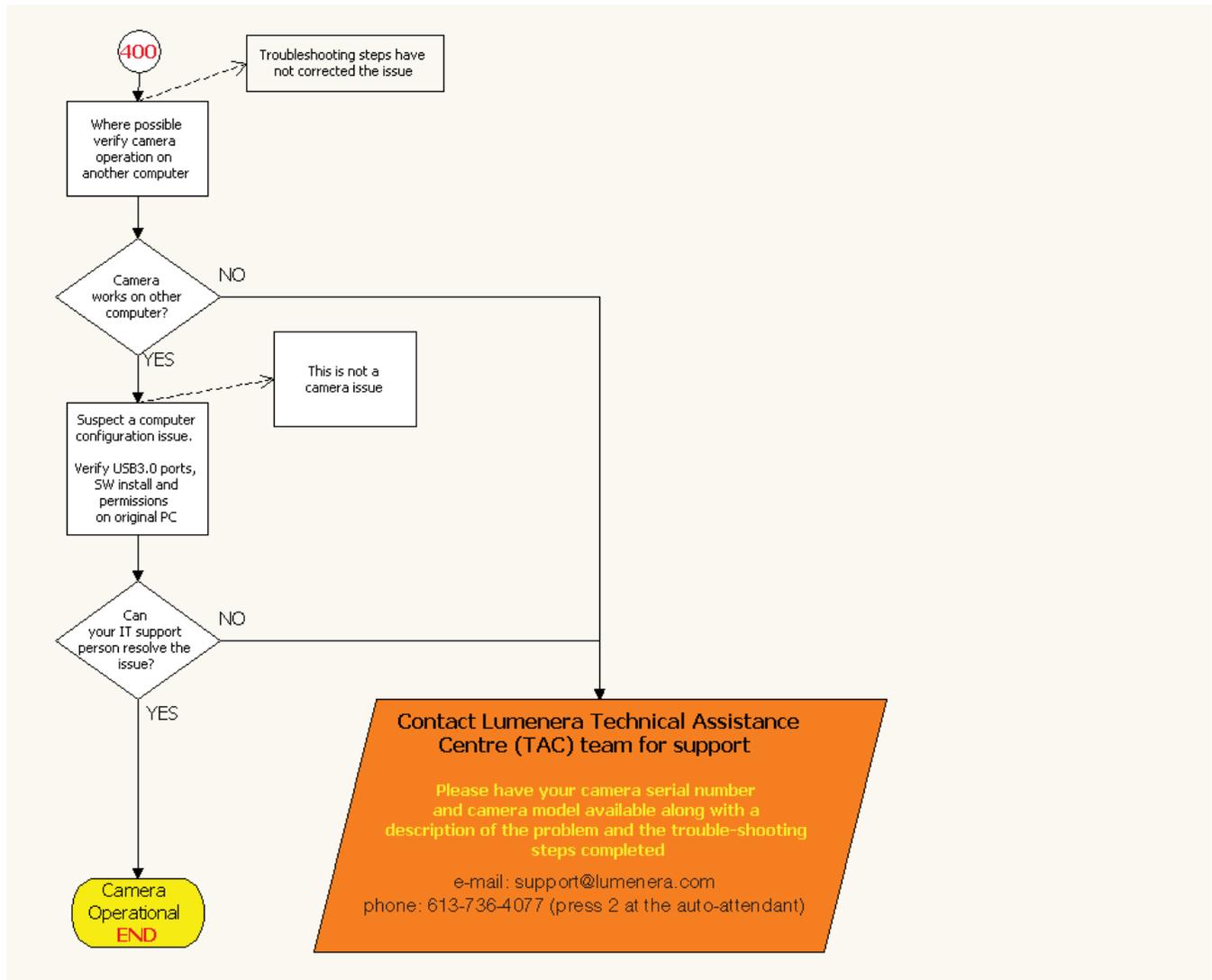
# Chart 2



# Chart 3



# Chart 4



# Revision History

Revision	Date	Major Change Description
001	April 9, 2020	Preliminary Internal Version
002	February 1, 2021	Support for USB3 Vision and Sopera LT
003	June 11, 2021	Addition of new models and related updates. Improvements targeting uniformity of specifications for the different models. A few corrections to model specifications.
004	November 1, 2021	Added Lt-Ux20-xxxxx series cameras
005	March 9, 2023	Addition of new models Lt-M/C2470, Lt-M/C5300, Lt-M/C4510 and related updates. New Multiple ROI Mode for Lt-Ux20 cameras. Correction of non-functional links. Update to the LtUpdater section.

# Contact Information

---

## Sales Information

Visit our web site:

<https://www.lumenera.com/>

### Sales

Teledyne Lumenera  
7 Capella Crt.  
Ottawa, Ontario  
Canada K2E 8A7  
Tel : 1.613.736.4077  
Fax: 1.613.736.4071  
Email: [info@lumenera.com](mailto:info@lumenera.com)

---

## Technical Support

Submit any support question or request via our web site:

Technical support form via our web page:  
Support requests for imaging product installations,  
Support requests for imaging applications

<https://www.lumenera.com/support/about-technical-support.html>

Camera support information

[lumenera.support@teledyne.com](mailto:lumenera.support@teledyne.com)

Product literature and driver updates