

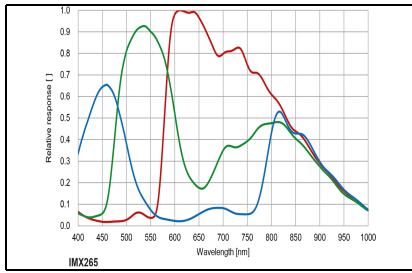
## Article Overview

Compute System (System on Module, SoM)	NVIDIA® Jetson Nano™
Camera Type	GeniCam standard, attached over USB3
Image Sensor	Sony IMX265 Gen2
Image Signal Processor (ISP)	FPGA based, suitable for machine vision
Hardware Trigger	FPGA based for high speed/accurate image triggering
LED/Flash Driver	FPGA based trigger for synchronisation at high speed, high power circuit, up to 2.5A @ 48 V
OS	Linux® based on Ubuntu 18.04 and NVIDIA® L4T 32.4.4
Installed Software	NVIDIA® Jetpack 4.4.1, Baumer GAPI & neoAPI SDK's, Camera Explorer preinstalled
Freely Programmable	All operating system and software can be customized as required. Compatible with many Linux® standard software products and programming languages
OS/FW Version	1.1

## Computing Information

SoM Model	NVIDIA® Jetson™ Nano
CPU	NVIDIA® ARM® Cortex A57 MPCore
CPU Instruction Set	NEON Technology
CPU Cores	4
CPU L1 Cache	48 KB
CPU L2 Cache	2 MB
CPU L3 Cache	-
CPU Max. Frequency	1.43 GHz
GPU	NVIDIA® Maxwell
GPU Interfaces	OpenGL 4.6, OpenGL ES 3.2, Vulkan 1.1, CUDA
GPU Cores	128 NVIDIA® CUDA Cores
GPU Max. Frequency	921 MHz
Deep Learning Accelerator (DLA)	-
Memory	Dual Channel, 4ch x 16-bit LPDDR4
Memory Capacity	4 GB
Memory Max. Frequency	1600 MHz
Memory Peak Bandwidth	25.6 GB/s
eMMC Storage Type	eMMC 5.1 Flash Storage
eMMC Storage Capacity	16 GB (shared with the OS and installed software), extendable via SD-card

Sensor Graph: Relative Response



## External Interfaces

Networking	10/100/1000 BASE-T Ethernet, Media Access Controller (MAC) over M12 connector
USB	2 x USB3 (max. bandwidth 5 GB, shared with camera, max. 900mA @ 5 V), 2 x MicroUSB for debug and recovery
HDMI	HDMI 2.0a/b (up to 6Gbps), maximum resolution 3840 x 2160 at 60Hz (up to 24bpp)
Inputs	1 x Hardware Trigger, opto-decoupled 1 x Input to NVIDIA SoM, opto-decoupled
Outputs	3 x PWM 48V/2.5A, 1 x synchronized for flash, 2 x non synchronized, opto-decoupled
UART	1 x RS232, Rx/Tx only

## Camera Details

Sensor Model Name	Sony IMX265 Gen2
Sensor Type	1/1.8" progressive scan CMOS
Shutter	Global Shutter
Resolution	2048 x 1536 pixels
Scan Area	7.06 mm x 5.29 mm
Pixel Size	3.45 $\mu\text{m}$ x 3.45 $\mu\text{m}$

## Camera Data Quality

@ 20 °C, gain = 1, exposure time = 4 msec

Dark Noise ( $\sigma$ )	2 e- typical
Saturation	9500 e- typical
Dynamic Range	71 dB typical
SNR	40 dB typical
Quantum efficiency $\eta$	48% @ 465 nm, 58% @ 536 nm, 54% @ 631 nm typical
Firmware	Revision 3.0

## Image Acquisition

Resolution	2048 px x 1536 px		
Interface Frame Rate (depends on used interface performance)	Format	Resolution	max. Frame Rate (@ Trigger Mode) <sup>2)</sup>
	Full Frame	2048 x 1536	55 fps
	Binning 2x2	1024 x 768	55 fps
	Binning 2x1	1024 x 1536	55 fps
	Binning 1x2	2048 x 768	55 fps
Acquisition Frame Rate <sup>1)</sup>	55 fps   $t_{\text{readout}} = 18.1 \text{ msec}$ (max. Res. Full Frame) @ 12 bit		
Pixel Formats	BayerRG8, BayerRG10, BayerRG12, BayerRG12p Mono8, Mono10, Mono12, Mono12p, RGB8, BGR8		
Partial Scan	True Partial Scan with increasing Frame Rate on Y direction, Region of Interest (ROI) arbitrary Width: minimum 16, increment 16 Height: minimum 2, increment 2		
Acquisition Frame Rate	Off or 0.01 ... 65535 Hz		
Acquisition Mode	Continuous, Single Frame and Multi Frame		
Acquisition Status	AcquisitionActive, AcquisitionTrigger Wait		
Exposure Mode	Timed		
Shutter Mode	Global		
Readout Mode	Overlapped, Sequential		

<sup>1)</sup> Sensor readout, different from pixel format    <sup>2)</sup> depends on the used interface

## Image Pre-Processing (FPGA-Based)

Analog Controls	Exposure Time (1 µsec ... 60 sec   Step Size 1 µsec) Gain (0...48 dB), Offset (0 ... 255 LSB   12 bit)
Auto Function	ExposureAuto and GainAuto with BrightnessAutoPriority based on BrightnessAuto ROI BalanceWhiteAuto and ColorTransformationAuto based on BalanceWhiteAuto ROI
Gamma Correction	Gamma (0.1 ... 2   available if LUT is enabled)
LUT	Luminance (12 bit)
Color Models	Mono, Raw Bayer, RGB and BGR
Color Processing	Integrated color processor for high quality color calculation
Color Enhancement	Color Transformation to sRGB color space by optimized Matrix for 3000 K, 5000 K, 6500 K and 9500 K Lightsource or User defined Matrix
Color Tolerance	-
Binning Horizontal	1 or 2
Binning Vertical	1 or 2
Fix Pattern Noise Correction	yes

## Camera Process Synchronization

Trigger Mode	Off (Free Running), On (Trigger)
Trigger Overlap Type	Readout
Trigger Sources	Hardware (Line1), Software, Counter, End, All or Off fixed Trigger Delay out of $t_{readout}$ : <sup>1)</sup> 67 µsec @ 12 bit max. Trigger Delay during $t_{readout}$ : <sup>1)</sup> 73.7 µsec @ 12 bit
Trigger Delay	0 ... 2 sec, Tracking and buffering of up to 256 triggers
External Flash Sync	via Exposure Active $t_{delay\ flash} \leq 3\ \mu\text{sec}$ , $t_{duration} = t_{exposure}$
Encoder Function	yes, via Counter and Trigger Source

## Camera Digital I/Os

Lines	Input: Line 1, Output: Line 2, (Line 0/3 not usable)
Output Sources	Off, ExposureActive, Timer1, ReadoutActive, UserOutput 1-3 and TriggerReady
Line Debouncer	Low and high signal separately selectable Debouncing Time 0 ... 5 msec, Step Size: 1 µsec

## USB 3 Vision® Features

Events Transmission via Asynchronous Message Channel	DeviceTemperatureStatusChanged, EventLost, ExposureEnd, ExposureStart, FrameEnd, FrameStart, FrameTransferSkipped, GigEVisionError, GigEVisionHeartbeatTimeOut, PrimaryApplicationSwitch, Line0..7 FallingEdge, Line0..7 RisingEdge, TransferBufferFull, TransferBufferReady, TriggerOverlapped, TriggerReady, TriggerSkipped
Frame Counter	up to 2 <sup>32</sup>
Payload Size	0 ... 9437408 Byte
Timestamp	64 bit, resolution in nsec, increment = 10
USB Vision	v1.0.1

<sup>1)</sup> Sensor readout, different from pixel format



## Electrical Data

Digital Output	Isolated, short-circuit protected $U_{ext}$ : 12 .. 48 V DC (Power IO) (See documentation for guidelines when using > 30 V) $I_{out}$ : Continuously: max. 1.5 A PWM $t_{on}$ max. 1s / Duration max. 40% max. 2.5 A (Max. current can be used on one output or as a sum of all outputs)
----------------	--

## Conformity

Conformity	CE, RoHS, REACH
KC Registration No. / Date	- /
MTBF	53 years @ T = 45 °C / 36 years @ T = 60 °C T = Measurement Point

## Camera GenICam™ Features

Timer	Timer Selector: Timer Selector: Timer 1 TimerTriggerSource: Line1, SoftwareTrigger, ExposureStart, ExposureEnd, FrameTransferSkipped, TriggerSkipped, Off TimerDelay: 0 µsec ... 2 sec, Step Size: 1 µsec TimerDuration: 4 µsec ... 2 sec, Step Size: 1 µsec
Counter	Counter Selector: Counter 1, Counter 2 CounterValue: 0 ... 65535 Counter Event Source: Counter1End or Counter2End, ExposureActive, FrameTransferSkipped, FrameTrigger, TriggerSkipped, Line0..3 and Off Counter Reset Source: Counter1End, Counter2End, Line0..3 and Off
Sequencer	Sequencer Characteristics: up to 128 sets, up to 4 possible pathes for triggered set transitions, 6 trigger sources: Counter1End, Counter2End, ExposureActive, Line0..3, ReadoutActive, Timer1End Sequencer Parameters for Exposure, Gain, Trigger, ROI and Output: ExposureTime, CounterDuration, CounterEventActivation, CounterEventSource, CounterResetSource, ExposureMode, ExposureTime, Gain, Height, OffsetX, OffsetY, TriggerMode, UserOutputValue, UserOutputValueAll, Width
User Sets	Factory Settings: UserSet0 (read only) Freely Programmable: UserSet1, UserSet2, UserSet3 Parameters: any user definable Parameter
Acquisition Abort	Delay up to 18.1 msec
Chunk Data	yes, Chunk Selector: Binning, BlackLevel, CounterValue, DeviceTemperature, ExposureTime, FrameID, Gain, Height, Image, ImageControl, LineStatusAll, OffsetX, OffsetY, PixelFormat, SequencerSetActive, Timestamp, Width
Device Temperature	InHouse Event generation for Normal to High, High to Exceeded and Exceeded to Normal Exceeded (no image transfer) = max. internal temperature sensor + 1 °C
Device Link Throughput Limit	yes, up to max. Device Link Speed
Custom Data	yes, 128 Byte
SFNC Version	v2.4

## Camera Factory Settings after Start-Up

Trigger Mode	Off (Free Running)
Analog Controls	Exposure Time: 4 msec, Gain: 0 dB, Offset: 0
Pixel Format	BayerRG8
Partial Scan	Off
Acquisition Frame Rate	Off
Timer/Counter/Sequencer	Off
Defect Pixel Correction	On
Fixed Pattern Noise Correction	-
Digital Input	Line0, invert = false
Digital Output	Line3, invert = false, line source = Off
GPIO 1/2	Line1, Line2, invert = false, LineMode = Input
TriggerSource	All

## Camera Partial Scan Framerates

@ FullFrame, min Exposure, Mono8 (monochrome camera) or BayerRG8 (color camera)

	Resolution	max. fps acquisition	max. fps interface <sup>2)</sup>
Full HD	1920 x 1080	77	77
SXGA	1280 x 1024	82	82
HD720	1280 x 720	114	114
XGA	1024 x 768	107	107
SVGA	800 x 600	136	136
VGA	640 x 480	167	167
CIF	352 x 288	264	264
QVGA	320 x 240	308	308
QCIF	176 x 144	466	466
LineScan	2048 x 1024	82	82
	2048 x 512	157	157
	2048 x 256	292	292
	2048 x 128	510	510
	2048 x 64	814	814
	2048 x 32	1159	1159
	2048 x 16	1471	1471
	2048 x 8	1699	1699
	2048 x 4	1842	1842
	2048 x 2	1923	1923
	2048 x 1	-	-

<sup>2)</sup> depends on the used interface