



# CAM MASTER 3D : EMBEDDED VISION REFERENCE DESIGN BOARD

**A POWERFUL PLATFORM READY-TO-CUSTOMIZE FOR ROBOTIC APPLICATIONS**



## OVERVIEW

- Modular reference design
- Nexvision's most powerful computer vision unit for robotic market
- 2x NVIDIA® Jetson™ TX2 Module + FPGA video processing
- On-board video analytics (object tracking, deep learning)

## HIGHLIGHTS

- On-board dedicated video enhancement image pipe (HDR, FPN, 3D noise reduction, HOG, stabilization), Nexvision's IP : NEXIP™
- Video : 3G-SDI in/out, HDMI output + optical fiber link (Quad Tx/Rx: up to 56 GT/s max, full duplex)
- Gigabit Ethernet, USB 3.1 Gen 1, SATA 2, SPI, I2C, PCIe Gen 2
- Onboard video recording and meta data storage (SSD on M.2)
- Onboard streaming server based on our NexStream™

## APPLICATIONS



Robotics



Industrial inspection  
Machine vision



Deep learning  
for healthcare



Cinema video camera



Multispectral embedded  
vision systems



UAV - UGV - UUV



Situational awareness  
for autonomous vehicle

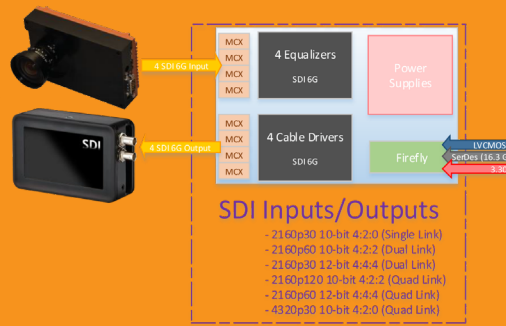
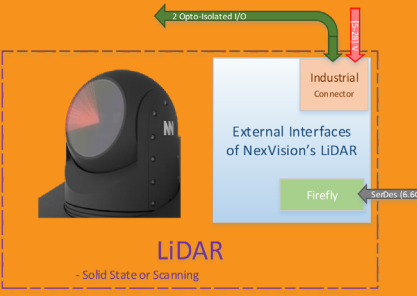
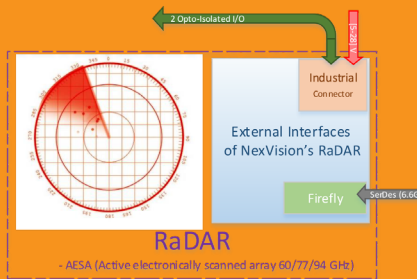


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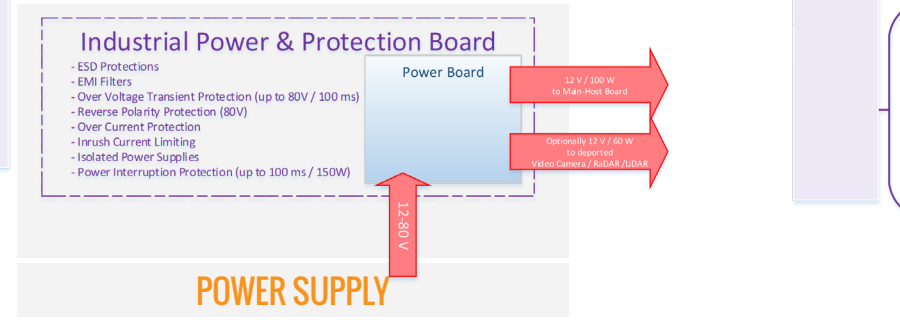
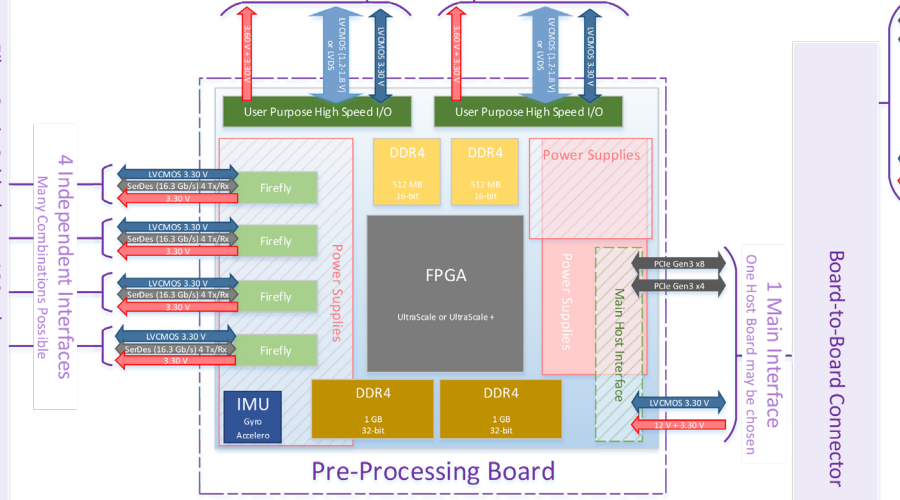
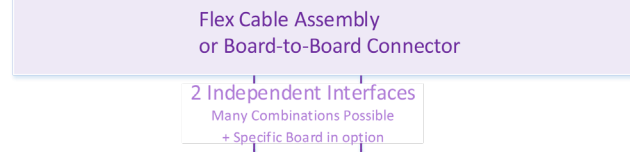
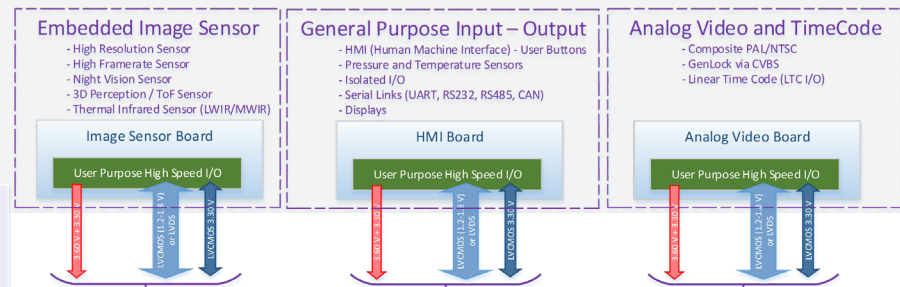
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# CAM MASTER 3D ECOSYSTEM : EMBEDDED SITUATIONAL AWARENESS PORTFOLIO

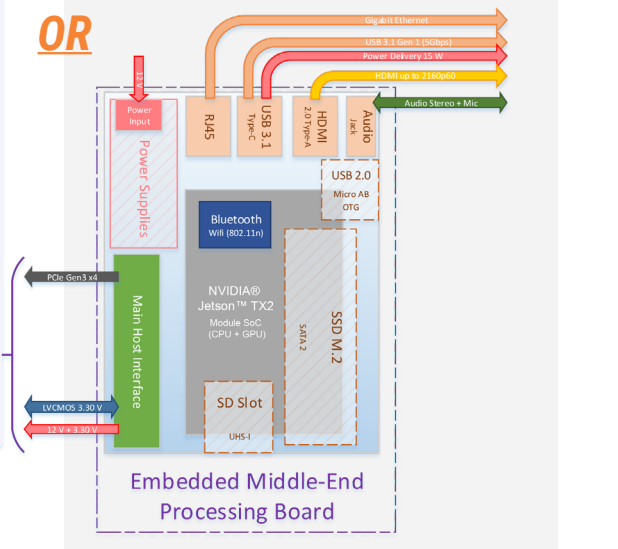
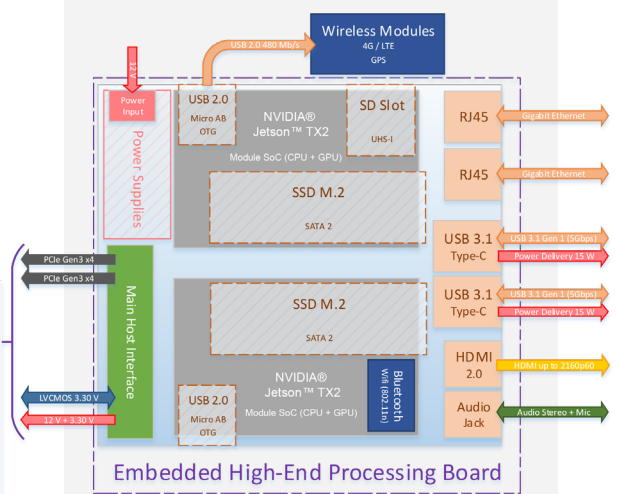
## REMOTE SENSORS



## EMBEDDED SENSORS / PERIPHERAL INTERFACES



## PROCESSING



Board-to-Board Connector

1 Main Interface  
One Host Board may be chosen

## POWER SUPPLY

# CAM MASTER 3D : A READY-TO-CUSTOMIZE PLATFORM WITH HIGH-END SOFTWARE LIBRARY

## IMAGE PROCESSING : NEXIP™

### FPGA (Image Pre-Processing)

- Video enhancement and advanced video processing : temporal noise filtering and contrast enhancement
- Multiple exposure blending provides realtime HDR for high details retention in low and over exposed area
- Multispectral band image sensor fusion (Visible, SWIR, Thermal IR)
- Feature point extraction, image stabilization, denoising

### GPU (Image analysis and codec)

- Detection, recognition, tracking
- Machine learning / AI
- 3D perception / SLAM / 360° vision
- Full framerate, high quality video encoding

## SOFTWARE DEVELOPMENT

### Dedicated embedded Linux BSP based on buildroot, including:

- U-boot bootloader
- Custom Linux kernel based on NVIDIA® sources
- Integration of NVIDIA® Jetson™ specific frameworks: CUDA®, OpenCV, OpenGL TensorRT™, cuDNN, NVIDIA DIGITS™ Workflow, NVIDIA VisionWorks™, Camera Imaging, Video CODEC
- Customizable failsafe update system (FPGA, Software)
- Embedded debugging and profiling tools: quadd, nvprof, cuda-gdb, gdb, LTTng

### External debugging and profiling tools:

- Tegra system profiler, NVIDIA® NSight

### Specific drivers:

- FPGA: PCIe based, video acquisition, video display, Xilinx IPs (UART, SPI, I2C, XADC, ...), high speed inter SoCs communication channel, generic data transfer to/from SoC modules

### Nexvision's Middleware:

- Video analysis framework
- Embedded video recording: H264, H265, MP4, MKV, AAC
- Video streaming: RTSP/RTCP/RTP, H264, H265, AAC
- ONVIF NVT profile support

# SYSTEM SPECIFICATIONS

## MAIN BOARD (PRE PROCESSING + I/O)

### Front-end image processor (FPGA)

Xilinx Kintex Ultrascale (KU025 / 035 / 040 / 060 / 095) or Ultrascale + (KU11P or KU15P)

	KU025	KU035	KU040	KU060	KU095	KU11P	KU15P	
System logic cells	318 K	444 K	530 K	726 K	1176 K	653 K	1143 K	
CLB Flip-Flops	290 K	406 K	485 K	663 K	1075 K	597 K	1045 K	
CLB LUTs	145 K	203 K	242 K	331 K	537 K	299 K	523 K	
Block RAM	12.7 Mb	19.0 Mb	21.1 Mb	38 Mb	59.1 Mb	26.2 Mb	34.6 Mb	
UltraRAM	/	/	/	/	/	22.5 Mb	36 Mb	
DSP	1152	1700	1920	2760	768	2928	1968	
Main host interface capability (one of the following)	<ul style="list-style-type: none"> <li>&gt; 1x Jetson™ TX2</li> <li>&gt; Gen3 x4 slot</li> <li>&gt; Gen3 x8 slot</li> </ul>		<ul style="list-style-type: none"> <li>&gt; 1x Jetson™ TX2</li> <li>&gt; 2x Jetson™ TX2</li> <li>&gt; Gen3 x4 slot + Gen3 x8 slot</li> <li>&gt; Gen3 x4 slot + Gen3 x4 slot</li> </ul>			<ul style="list-style-type: none"> <li>&gt; 1x Jetson™ TX2</li> <li>&gt; Gen3 x4 slot</li> <li>&gt; Gen3 x8 slot</li> </ul>		<ul style="list-style-type: none"> <li>&gt; 1x Jetson™ TX2</li> <li>&gt; 2x Jetson™ TX2</li> <li>&gt; Gen3 x4 slot + Gen3 x8 slot</li> <li>&gt; Gen3 x4 slot + Gen3 x4 slot</li> </ul>
Number of Firefly group / PCIe capable	1x / 0	2x / 1x PCIe Gen3 x8 (or x4)		4x / 1x PCIe Gen3 x8 (or x4)		<ul style="list-style-type: none"> <li>&gt; 4x / 2x PCIe Gen3 x8 (or x4)</li> <li>&gt; 4x / 3x PCIe Gen3 x4</li> </ul>		
Number of user purpose high speed I/O group	1x	2x				1x	2x	
DDR4 banks @2400 Mb/s	1x 512 Mb 16 bit 1x 1Gb 32 bit	2x 512 Mb 16 bit 2x 1 Gb 32 bit			2x 512 Mb 16 bit 2x 1 Gb 32 bit			

#### One memory configuration :

- 512 Mb NOR flash
- R/W access via SoC (over-the-air update via Ethernet)

#### Memory banks on FPGA

- Up to 2x 512MB 16-bit DDR4@2400Mb/s (6.4 GB/s)
- Up to 2x 1 GB 32-bit DDR4@2400 Mb/s (19.2 GB/s)

#### EEPROM storage:

- 1x I2C 128 kb EEPROM

#### Development tools

- 8-bit dedicated I/O (DSIO) LVCMOS 3.30V to FPGA
- 1x JTAG port for FPGA configuration
- 2x LED for FPGA

#### Environment management

- 4x temperature sensors
- 1x FAN drive by PWM 12V
- Inertial sensors (3D accelerometer, 3D gyroscope, 3D magnetometer)

# SYSTEM SPECIFICATIONS

## One main host interface

- PCI Express
  - 1x PCIe Gen3 x8
  - 1x PCIe Gen3 x4
- 12V and 3.30V Input supply voltage (75 W max)
- LVDS and LVCMOS (3.30 V)

## Processing board

### 1) Daughter board with two parallel NVIDIA® Jetson™ TX2 Modules

#### 2x SoC modules

	NVIDIA® Jetson™ TX2 Module
CPU	HMP Dual Denver 2 (2 MB L2) + Quad ARM® A57 (2 MB L2)
GPU	NVIDIA Pascal™, 256 CUDA® cores
Video capabilities	4K x 2K 60 Hz Encode (HEVC) 4K x 2K 60 Hz Decode (12-Bit Support)
Embedded memory	8 GB 128 bit LPDDR4 58.3 GB/s
Embedded storage	32 GB eMMC
FPGA link	PCIe Gen 2 x4 (up to 16 Gb/s)

#### Display

- 1x HDMI (Type A connector):
  - HDMI 2.0 (4096x2160 at 60 Hz)

#### Ethernet

- Up to 2x Gigabit slot RJ45 (limited to 1 per SoC)
  - 10/100/1000 BASE-T

#### Audio

- Audio jack 3.5mm TRRS : analog stereo output + microphone

#### Wireless links

- Embedded Bluetooth 4.0 / Wifi (802.11 a/b/g/n/ac)
- 4G/LTE modules or GPS via micro USB port

#### Storage

- Up to 2x SSD up to 2 TB (M.2 slot key B connector) (limited to 1 per SoC)
  - Single/double sided SSD compatible (2260/2280 format)
  - SATA 2 (3 Gb/s)
- Up to 2x external SD card slot (limited to 1 per SoC)
  - Protocol SDIO 4.0 (UHS-I only) => Up to 104 MB/s
  - Backward compatible with all SD standard (Default Speed/High Speed/SDR12/SDR25/DDR50/SDR50/SDR104)

#### USB

- Up to 2x USB downstream (limited to 1 per SoC)
  - USB 3.1 Gen 1 (5 Gb/s)
  - Type-C type connector + power delivery 15 W
- Up to 2x USB (limited to 1 per SoC)
  - USB 2.0 (480 Mbps)
  - Micro AB type connector
  - On-The-Go (OTG)
  - Power usage (2.5 W)

#### Serial

- Up to 2x UART (Limited to 1 per SoC)
  - 1.80 V signalling
  - Embedded flow control

#### EEPROM storage

- 1 x I2C 128 kb EEPROM per SoC

### 2) Daughter board with one NVIDIA® Jetson™ TX2 Module

Refer to above with only one Jetson™ TX2 Module and one instance of each interface

### 3) Daughter board: edge board connector

- Configure as a root complex
  - Subject to be a master on a backplane
  - Compatible with NexVision's switch 4x PCUO (up to 4x Gen3 4-lanes) (Host/Target/Non transparent port)
- Configure as a legacy endpoint
  - Subject to be a slave on a PC (or a Server)

## Up to 4x Firefly interface [ Serial high speed ]

- 4 Lanes SerDes full duplex
  - Up to 16.6 GT/s per lane
- Provide 3.30V supply voltage
- 8x LVCMOS 3.30V control I/O

### Main application purpose - could be a combination of :

#### Fiber Link

- MTP optical standard:
  - 14 GT/s per lane [0 ; 70 ] °C
  - 10.3 GT/s per lane [-40 ; +85] °C
- Proprietary fiber optic protocol up to 54 Gbps practical data throughput (64B/66B)
- Example application :
  - Long distance camera head unit with SerDes (Embedded FPGA)
  - Video processing cluster

#### Copper Link

- Firefly
  - 16.6 GT/s per lane
- Proprietary protocol up to 64 Gbps practical data throughput (64B/66B)
- Example application :
  - Very short distance camera head unit with SerDes (Embedded FPGA)
  - Video processing cluster

#### Digital Video Interface via mezzanine

- Up to 4x Input/ Output per Firefly
- 6G-SDI or Coaxpress :
  - SMPTE ST-2081
  - Example video format:
    - > 2160p30 10-bit 4:2:0
  - Backward compatible with SMPTE 424M and SMPTE 292M
- Dual link and quad link 6G-SDI option
  - Example video format:
    - > 4320p30 10-bit 4:2:0
    - > 2160p120 10-bit 4:2:0
    - > 2160p60 12-bit 4:4:4

#### PCIe Link

- Gen3 x4 (or x8 via 2x Firefly)
- Backward compatible Gen2 and Gen1
- Physical interface
  - Fiber optic direct link (1x MTP optical standard)
  - Copper direct link
  - Edge slot standard via mezzanine
    - > Compatible with NexVision's switch 4x PCUO (Up to 4x Gen3 4-lanes) (Host/Target/Non transparent port)
  - SSD Connector (M.2 / NGFF) or (U.2 / SFF-8639) via mezzanine
    - > NVMe SSD solution

## SYSTEM SPECIFICATIONS

### Up to 2x independant user purpose interface [ parallel high speed and low speed ]

- Board-to-Board interface or flex cable
- Provide main 3.60V supply voltage and low power 3.30V voltage
- Level voltage signalling referenced by the targeted board, support :
  - Up to 24 LVDS pairs
  - Up to 52 LVCMOS flexible (1.20-1.80 V)
  - Up to 18 LVCMOS fixed 3.30V

### Application examples

- Short distance image sensor board:
  - High resolution color or monochrome sensors
  - High framerate sensors
  - Night vision sensor
  - 3D perception / ToF sensors
  - Thermal infrared sensor (LWIR/MWIR)
- General purpose input/output:
  - HMI (Human Machine Interface) - User buttons
  - Pressure sensor and temperature sensor
  - Isolated I/O
  - Serial low speed links (UART, RS232, RS485, CAN)
- Analog video and time code:
  - Composite analog video PAL/NTSC (I/O)
  - GenLock via CVBS (I/O)
  - Linear time code (LTC I/O)

### Power supply options

	Standard	Industrial power & protection board
Voltage range	12 V <sub>DC</sub>	12-80 V <sub>DC</sub>
Power consumption <ul style="list-style-type: none"> <li>▪ Light process               <ul style="list-style-type: none"> <li>&gt; 1 SoC (40% load)</li> <li>&gt; Ambient T°C: 25°C</li> </ul> </li> <li>▪ Maximum process               <ul style="list-style-type: none"> <li>&gt; 2 SoC (100% load)</li> <li>&gt; Ambient T°C: 85°C</li> </ul> </li> </ul>	15W  60W	20W  70W
ESD protection	X	X
EMI filters	X	X
Over voltage transient protection		80 V / 100ms
Reverse polarity protection		80 V
Over current protection		X
Inrush current limiting		X
Power interruption protection (for 150W power consumption)		Up to 100 ms
Power management of FPGA/SoC supplies <ul style="list-style-type: none"> <li>▪ Sequence</li> <li>▪ Trim</li> <li>▪ Margin</li> <li>▪ Supervise</li> <li>▪ Manage faults</li> </ul>		X

# MECHANICAL

		Dimensions (L x l x h) in mm	Weight in grams
Main FPGA board without extension boards		110x90x5	200
Main host interface expansion	SoC daughter board (One Jetson™ TX2 module + heatsink)	110x80x20	110
	SoC daughter board (Two Jetson™ TX2 module + heatsink)	110x110x20	190
	High speed interface to a pc (PCIe edge board edge connector)	110x100x5	30
	High speed data storage (2 slots SSD NVMe M.2)	110x60x10	40
Firefly expansion	MOOVICAM video camera ecosystem <ul style="list-style-type: none"> <li>High resolution sensor</li> <li>High framerate sensor</li> <li>Night vision sensor</li> <li>3D perception / ToF sensor</li> <li>Thermal infrared sensor (LWIR/MWIR)</li> </ul>	88x75x61	380 w/o lens
	RaDAR AESA (Active Electronically Scanned Array 66/77/94 GHz)	25x30x20 / module	50
	LiDAR (solid state or scanning)	120x80x40	180
	Mezzanine 6G-SDI (4 inputs / 4 outputs)	40x60x10	30
	Mezzanine CoaxPress (4 inputs / 4 outputs)	40x60x10	70
	High speed data storage mezzanine (1 SSD NVMe M.2)	30x90x10	30

## Environment

	Standard	Optional
Operating temperature	Commercial 0 to +50 °C	Extended -20 °C to 80 °C
Humidity resistance	10-90% non-condensing	Tropicalized

		Dimensions (L x l x h) in mm	Weight in grams
User purpose high speed I/O expansion	Embedded image sensor <ul style="list-style-type: none"> <li>High resolution sensor</li> <li>High framerate sensor</li> <li>Night vision sensor</li> <li>3D perception / ToF sensor</li> <li>Thermal infrared sensor (LWIR/MWIR)</li> </ul>	70x70x10	30
	General purpose input/output <ul style="list-style-type: none"> <li>HMI (Human Machine Interface – user buttons)</li> <li>Pressure and temperature sensors</li> <li>Isolated I/O</li> <li>Serials links (UART, RS232, RS485, CAN)</li> <li>Displays</li> </ul>	70x70x10	50
	Analog video and time code <ul style="list-style-type: none"> <li>Composite PAL/NTSC</li> <li>GenLock via CVBS</li> <li>Linear Time Code (LTC I/O)</li> </ul>	70x70x10	40
Industrial power board		300x160	670
Options	SSD NVMe U.2	70x100x9	125
	SSD NVMe M.2	22x80x2.4	10
	SSD SATA M.2	22x80x2.4	10
	SD Card UHS-I	24x32x2.1	2
	Transceiver fiber optic proprietary protocol to MTP (4 Tx/Rx)	-	-
	Transceiver fiber optic PCIe protocol to MTP [Gen3 (x4 or x8)]	-	-
	Copper proprietary protocol (4 Tx/Rx)	-	-
	Copper equalized cable (4 Tx/Rx)	-	-
	Copper PCIe protocol [Gen3 (x4 or x8)]	-	-

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