

# T-REX

High-speed Intelligent FPGA-based camera family:

Real Time Vision Platform



Preliminary

Product Brief v1.1

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T-REX, highly customizable and user-programmable FPGA based high-speed smart cameras, is a high-end FPGA camera with a Xilinx Zynq FPGA and high speed imaging sensor and Gigabit Ethernet. It includes high-performance ARM system-on-chip (SoC) technology, combined with turbocharged industrial CMOSIS imaging sensor.

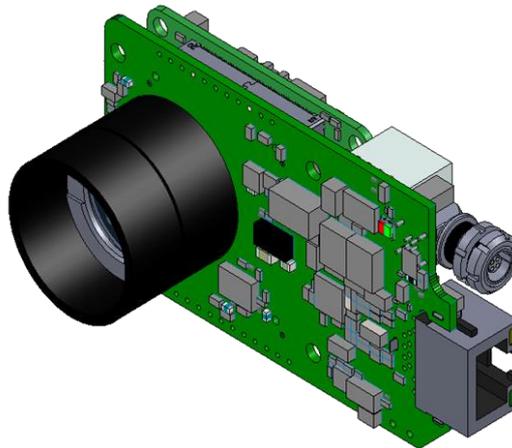
With high performance FPGA system-on-chip (SoC) technology, Velociraptor camera family opens new dimensions in computer vision. It is global shutter industrial camera with incredible frame rates and **open FPGA architecture**. With FPGA processing power the image processing algorithms can run in real time on the camera. Just add your imagination.

T-REX includes full customizable and user-programmable **open reference design** for high-speed FPGA based camera and application development system. Its emphasis is on an **open hardware-software development model**, **high-frame rates**, **real-time image processing on FPGA** and modern graphical user interface support.

A suite of intermediate, versatile **Xilinx Zynq 7020 FPGA**, is used to develop algorithms and **process data in real-time**. Images are acquired by **CMOSIS sensor**, **CMV2000** (2048x1088 pixels, 2/3" size) or **CMV4000** (2048x2048 pixels, 1" size). The sensor outputs 760 million pixels per second resulting in **331 FPS (CMV2000) and 175 FPS (CMV4000) at full frame**. The on-board 512MB LPDDR2 memory with 3.2GB/s of bandwidth enables usage of complex buffered image processing.

The reference design can be easily edited with standard Xilinx Vivado tools. OptoMotive's custom IP cores seamlessly integrate inside the Xilinx Vivado toolchain. Large portion of FPGA (PL) is **free for a programming and development of new algorithms, or implementation of additional IP cores**.

The 700MHz Dual Core ARM Cortex A9 Programmable Subsystem runs Linux OS with custom made EVO control and streaming stack. User applications or custom data post-processing can easily be added to existing design.



## Versatile and affordable, in all possible ways!

### Key camera features:

- Turbocharged industrial CMOSIS sensor, 2.2 and 4.2M pixel, Colour (Bayer filter), Monochrome and VIS-NIR
- User programmable and reconfigurable FPGA with dual ARM processor Zynq 7020
- 512 MB LPDDR2 SDRAM internal volatile memory
- User programmable imaging pipeline
- Gigabit Ethernet for fast data transmission
- Delivered in CNC housing or OEM version
- Firmware can be upgraded to add new features
- 3 general purpose user-programmable bidirectional I/Os

## Targeted to:

- **Laser triangulation:** with ready-made PEAK detector on-board image processing core
- **Motion capture:** with ready-made Blob detector or Running Length Encoder (RLE) on-board image processing core
- **Industrial process automation:** to count, detect, check, verify, read, inspect and test different products, levels, components, etc. at incredible speed
- **Industrial quality control:** to inspect defects, cracks or surface blemishes, size, position, dimension and colour, foreign objects, quality.
- **General R&D**

Specification table

Camera Family		T-REX					
Camera model		2.2M	2.2IR	2.2C	4.2M	4.2IR	4.2C
imaging sensor	Model (CMOSIS)	CMV2000			CMV4000		
		2E5M1 PP	E12M1 PP	2E5C1 PP	2E5M1 PP	E12M1 PP	2E5C1 PP
	Colour filter	None	None	Bayer	None	None	Bayer
	Diagonal	12.7 mm (2/3")			15,92 mm (1")		
	<b>Active pixels</b>	<b>2048 x 1088</b>			<b>2048 x 2048</b>		
	Pixel size	5.5 µm x 5.5 µm					
	Pixel data formats	MONO8 (M and IR), BAYER8 (C only)					
	Region of interest	YES, with 8 pixel increments					
	Pixel clock speed	760 MHz (8 pixels @ 95 MHz)					
	<b>Frame rate (Full frame)</b>	<b>333 FPS</b>			<b>178 FPS</b>		
	<b>RAW frame rate*</b>	<b>54 FPS</b>			<b>26 FPS</b>		
	<b>ADC resolution</b>	<b>10 bit</b>					
	Analogue Gain	1 - 1.6x					
	Shutter type	Electronic Global Shutter					
	Shutter time	2.4 us - 90 s					
	Exposure	Linear, 3Slope High Dynamic Range					
Dynamic range	60 dB						
Features	Pixel correction	Dead pixel correction and Programmable LUT					
	Trigger modes	Free running, trigger, overlap, pulse width					
	Trigger features	Delay 0 - 1000 ms LP Filter 1.5Hz - 100 kHz					
	Shutter resolution	21 ns					
Processing	FPGA	Zynq 7020					
	Free FPGA %	Up to 50%, most of 220 slices of DSP are free.					
	Volatile memory	512MB LPDDR2					
	Non-volatile memory	32MB QSPI flash, optional eMMC					
Mechanical	Lens mount	C-mount (1" 32G thread)					
	Temp range	0 - 50°C					
	Mass	50 g OEM / 290 g with housing					
	Protection	Up to IP67 with housing					
	Housing material	CNC-machined aluminium, anodized in a special OptoMotive blue colour					
	RoHS	RoHS compliant					
	Fixing holes	4 x M3 OEM / 5 x M6 on housing					
Electrical	<b>Input voltage</b>	<b>Power over Ethernet 42-57V or 5V (OEM)</b>					
	Consumption	up to 11W					
	IO	3x bidirectional 5V TTL					
	IO isolation	No, but camera has 1.5kV PoE isolation					
	Connectors	RJ45, 4 pin LEMO EXG 00 304					

Functionalities	On-board image processing	As an option (if an IP Core is integrated)
	Open reference design	Yes
	Open architecture	Yes
	Software	Compatible with OptoMotive EVO software (full source included)
	Operating system	Windows XP, Windows 7, 64bit or 32bit
	Development tools	Xilinx ISE/EDK version 13.3 or later. Microsoft Visual Studio 2010
Standards		EN55022, class A EN61000-4-2 EN61000-4-3 EN61000-4-4 EN61000-4-6
	FCC	Part 15, class A
	RoHS	Compliancy as per European directive 2002/95/EC

NOTE: Gigabit Ethernet connection limits a speed of RAW video frame rate streaming to 55 FPS at full resolution. To harness full sensor speed the on-board image processing is needed.

**Each camera is supplied with:**

- Software: EVO software: API, filter driver, examples, GUI for image capturing and recording  
FPGA Reference Design
- Cable: 2x Ethernet Cable CAT5E
- Power Supply: 100-240V single port PoE injector

## Specification: Resolution / FPS

Specifications of resolutions and maximum frame rates are shown in Table 1.

The following equation is used for calculating a theoretical maximum acquisition speed (FPS) refers to a given resolution:

$$FPS = \frac{47500000}{129 \times Y + 2000}$$

where: Y        Number of lines

where: FPS     Frames per second

### STANDARD RESOLUTIONS

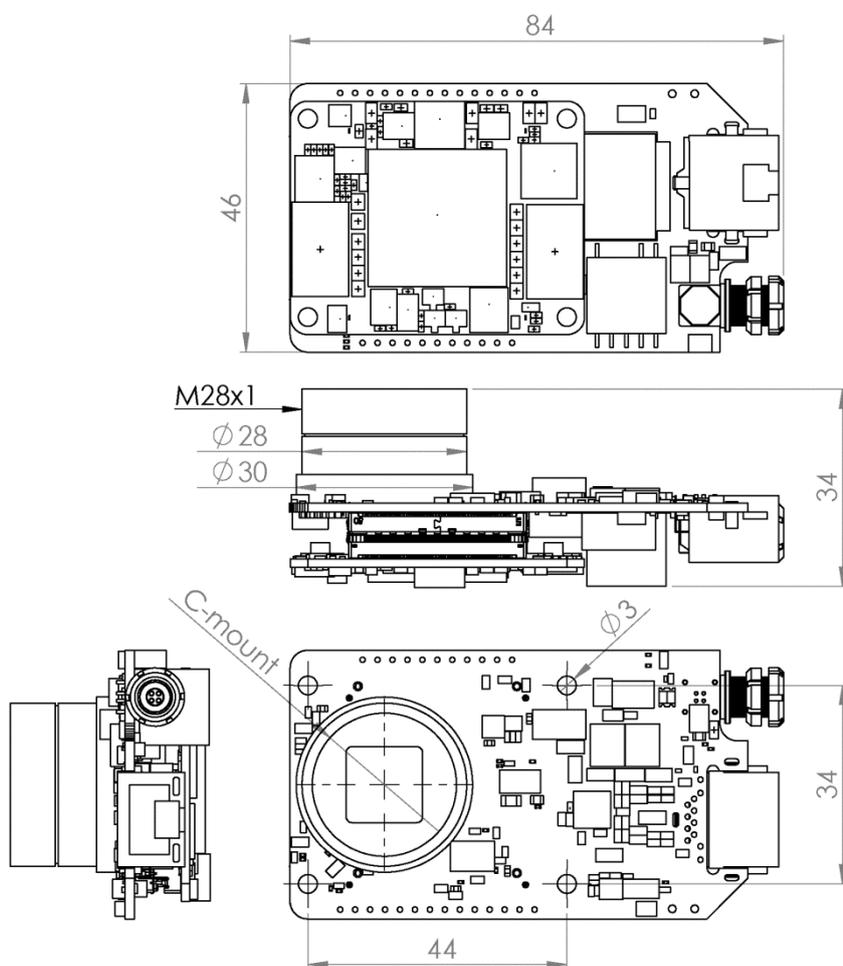
Resolution	Active pixels	MAX. FRAME RATE	MAX. FRAME RATE
Full frame 4.2M	2048 x 2048	N/A	176 FPS
Full frame 2.2M	2048 x 1088	331 FPS	325 FPS
2K	2048 x 1080	334 FPS	327 FPS
HD 1080	1920 x 1080	334 FPS	327 FPS
SXGA	1280 x 1024	352 FPS	344 FPS
HD 720	1280 x 720	466 FPS	453 FPS
XGA	1024 x 768	495 FPS	481 FPS
SVGA	800 x 600	591 FPS	571 FPS
PAL	768 x 576	615 FPS	593 FPS
WVGA	752 x 480	733 FPS	702 FPS
VGA	640 x 480	733 FPS	702 FPS
QVGA	320 x 240	1405 FPS	1296 FPS

The resolutions are scaled to standard sizes for easier comparison; the frame rate depends on the number of lines only.

## Mechanical drawings

### T-REX, OEM

STEP 3D model available on request



## T-REX in housing (IP67 optional)

