

## Key Features

- Large active area up to 10 x 15 cm
- Up to 10 lp/mm resolution
- Gigabit Ethernet interface (Camera Link optional)
- 14-bit digital video output
- Energy range 10 - 225 kV
- Ready-to-run software and drivers

## Applications

- Industrial inspection, biomedical and scientific

# Shad-o-Box High Speed Industrial X-Ray Detectors

## Overview

Teledyne DALSA's *Shad-o-Box HS* product family of digital x-ray cameras offers users a high-speed, high-performance x-ray imaging detector with a fast, reliable Gigabit Ethernet interface. The cameras in this product line are capable of frame rates up to 66 fps (even higher in 2 x 2 binned mode), and communicate via a standard Cat6e data cable over lengths up to 100 m. The detectors are available with different scintillator options to address a range of resolution and sensitivity requirements, making this camera an ideal choice for industrial inspection, biomedical and scientific x-ray imaging applications.

The Shad-o-Box HS product line leverages Teledyne DALSA's advanced CMOS image sensing technology, which enables the delivery of low-dose x-ray images and yields higher image quality than a-Si flat panels and image intensifier devices. Camera features include: (1) large active area of up to 10 x 15 cm; (2) several different resolution (pixel size) options; (3) fast, real-time image transfer via Gigabit Ethernet interface; (4) 14-bit digitization of images; and (5) SDK's, drivers and programming support. The camera interface allows easy access to features such as adjusting the frame rate, single and multiple frame acquisitions, and control of advanced timing modes. Each camera ships with our ShadoCam Imaging application and Teledyne DALSA's CamExpert software, which provide simple, user-friendly tools for communicating with the camera and acquiring images.

# Shad-o-Box HS Product Family Datasheet

## Description

Shad-o-Box HS cameras contain a large-area, high-resolution CMOS detector with a photodiode pixel array featuring four standard size options of approximately 2x2, 3x4, 4x6 and 5x5 inches. The cameras are available in different resolution models featuring either a 135µm, 99/100µm or 49.5µm pixel size. All detectors are capable of real-time, full-resolution imaging at frame rates up to 66 fps.

The detector array consists of a single CMOS die (no tiling) that contains multiple output taps to enable high frame rates. The video signal is digitized to 14 bits, reassembled (deinterlaced) within the camera's FPGA, and then transferred directly to the host memory via a high-speed Gigabit Ethernet interface. An optional Camera Link interface is also available (contact your sales representative for details).<sup>(1)</sup>

The CMOS sensor inside the Shad-o-Box HS camera contains a direct-contact Gd<sub>2</sub>O<sub>2</sub>S scintillator such as Carestream Min-R<sup>®</sup> 2190 or Mitsubishi Chemical DRZ (a CsI option is also available – please contact us for details). The scintillator converts x-ray photons into visible light that is sensed by the CMOS photodiodes. A thin graphite cover protects the sensor from accidental damage as well as ambient light. The Shad-o-Box HS camera also contains lead and steel shielding to protect the camera electronics from the x-ray radiation. The cameras are sensitive to x-ray energies as low as 15 keV, and may be used with generators up to 225 kVp. Please refer to our application notes for additional information.

<sup>(1)</sup> Max. cable length for CameraLink models is 7 m.

## Shad-o-Box HS Camera Options

Device	Number of Pixels	Active Area	Resolution	Max. Frame Rate
<b>Shad-o-Box 512 HS</b>	768 x 512	10.4 x 6.9 cm	135 µm	35 fps
<b>Shad-o-Box 1024 HS</b>	768 x 1024	10.4 x 13.8 cm	135 µm	35 fps
<b>Shad-o-Box 1280 HS</b>	1280 x 1280	12.8 x 12.8 cm	100 µm	30 fps
<b>Shad-o-Box 688 HS</b>	1032 x 688	10.2 x 6.8 cm	99 µm	66 fps
<b>Shad-o-Box 1548 HS</b>	1032 x 1548	10.2 x 15.3 cm	99 µm	30 fps
<b>Shad-o-Box 1K HS</b>	1152 x 1300	5.7 x 6.4 cm	49.5 µm	20 fps
<b>Shad-o-Box 3K HS</b>	2304 x 1300	11.4 x 6.4 cm	49.5 µm	20 fps
<b>Shad-o-Box 6K HS</b>	2304 x 2940	11.4 x 14.6 cm	49.5 µm	9 fps

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## Specifications

Detector Specifications	Value	Units
Typ. dark current (23°C) <sup>(1)(4)</sup>	12	ADU/s <sup>(2)</sup>
Read noise (rms)	4-8	ADU
Typ. dynamic range	3000:1	
Digitization	14	bits
Image lag	<0.1	%
Non-linearity (10..90% FS)	<1.5	%
Readout period <sup>(3)(4)</sup>	22	ms
Max. frame rate (full res.) <sup>(4)</sup>	30	fps
Output data rate	40	MHz

<sup>(1)</sup> dark current doubles approx. every 8°C

<sup>(2)</sup> ADU = Analog-Digital Unit = 1 LSB (Least Significant Bit)

<sup>(3)</sup> time required to transfer image from sensor to camera memory

Camera Specifications	512 HS 1024 HS	All Others	Units
Typical supply voltage	6.5	12.0	Volts
Supply voltage range	6.0 to 8.0	11 to 13	Volts
Maximum supply current <sup>(4)</sup>	1.5	1.0	Amps
Typical power dissipation	< 10		Watts
Camera interface	Gigabit Ethernet		
Trigger connector	TTL		

General Specifications	Value	Units
Operating temperature	10 to 40	°C
Storage temperature	-10 to +55	°C
Humidity (non-condensing)	10 to 80	% R.H.
Weight <sup>(4)(5)</sup>	< 3.5	kg

<sup>(4)</sup> depends on detector model

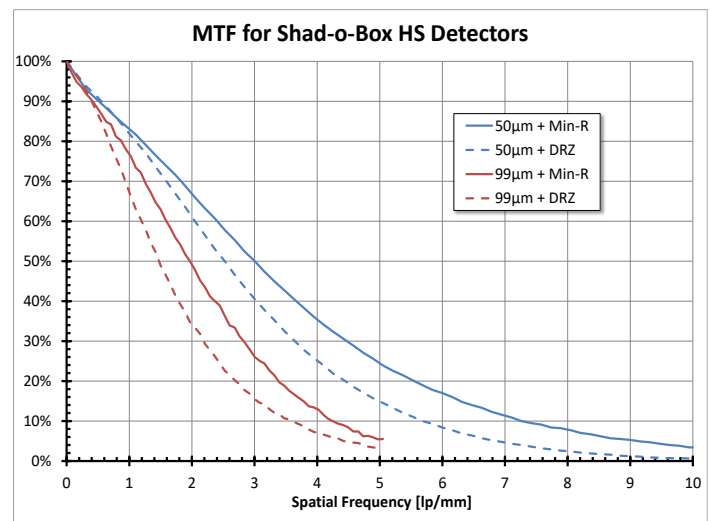
<sup>(5)</sup> Shad-o-Box 1K HS < 1 kg

## Resolution & Sensitivity

The Shad-o-Box HS cameras are designed to work with x-ray sources operating at a wide range of kVp settings. X-ray energies as low as 10-15 keV can be detected. The cameras can be used with x-ray energies as high as 225kV, although we recommend the use of additional shielding and/or collimation at higher energies in order to protect the sensor element and electronics from damage.

The pixel spacing of each camera model determines the limiting resolution of the sensor. The actual Modulation Transfer Function (MTF) of the detector depends on the type of scintillator that is installed. A thicker phosphor screen will produce more signal, but at the expense of high-frequency contrast. Typical MTF curves for the two standard scintillator options are shown in the graph below.

Detector	Typical Sensitivity <sup>(1)</sup>
512/1024 HS (with DRZ-Std)	24.0 ADU/μR @ 50kVp 33.6 ADU/μR @ 80kVp
688/1548 HS (with Min-R 2190)	3.8 ADU/μR @ 50kVp 5.0 ADU/μR @ 80kVp
688/1548 HS (with DRZ-Std)	9.7 ADU/μR @ 50kVp 13.7 ADU/μR @ 80kVp
1280 HS (with Min-R 2190)	4.1 ADU/μR @ 50kVp 5.2 ADU/μR @ 80kVp
1280 HS (with DRZ-Std)	10.5 ADU/μR @ 50kVp 14.5 ADU/μR @ 80kVp
1K/3K/6K HS (with Min-R 2190)	0.8 ADU/μR @ 50kVp



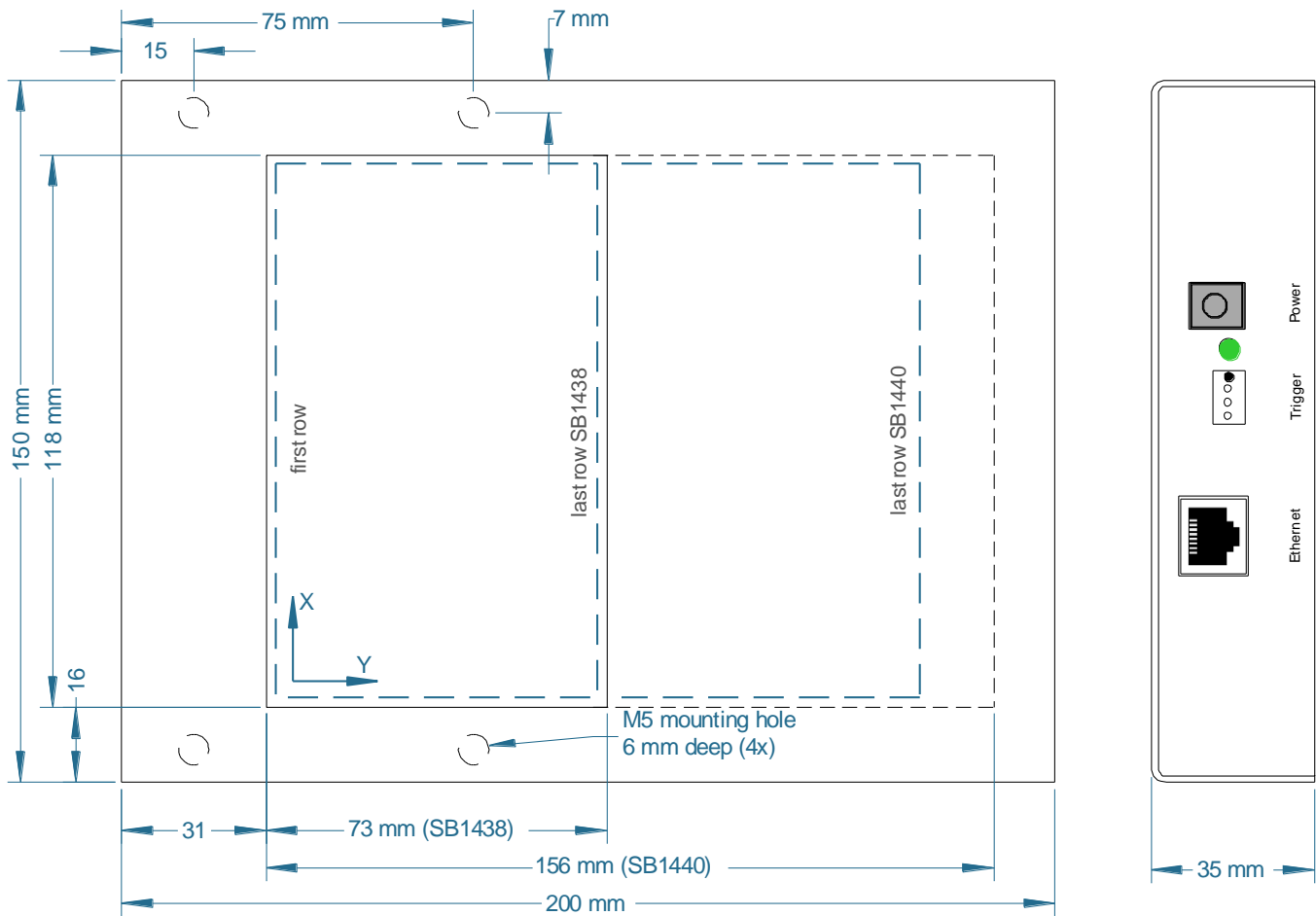
<sup>(1)</sup> W target, 2 mm glass window, no filtration

## Software

Each Shad-o-Box HS camera ships with our ShadoCam Imaging application, Teledyne DALSA's CamExpert software and a Gigabit Ethernet driver. The software is compatible with Windows 7, 8 and 10. Check with your sales representative for compatibility with other Windows versions or with the Linux operating system. The camera can be connected on a network, but for optimal performance a dedicated network adapter is highly recommended.

For writing custom applications to acquire images from the camera, we recommend using Teledyne DALSA's Sopera Essential, or the Sopera LT SDK (free download available at <http://www.teledynedalsa.com/imaging/products/software/sopera/lt/>).

## Mechanical Drawing: 512 & 1024 HS Models



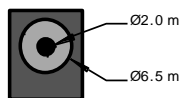
### Data Connector:

RJ45 HALO HFJ11-1G16E-L12RL

### Power Connector:

DC power jack, 2 mm center pin

center pin:  
6.5 VDC  
outside:  
ground



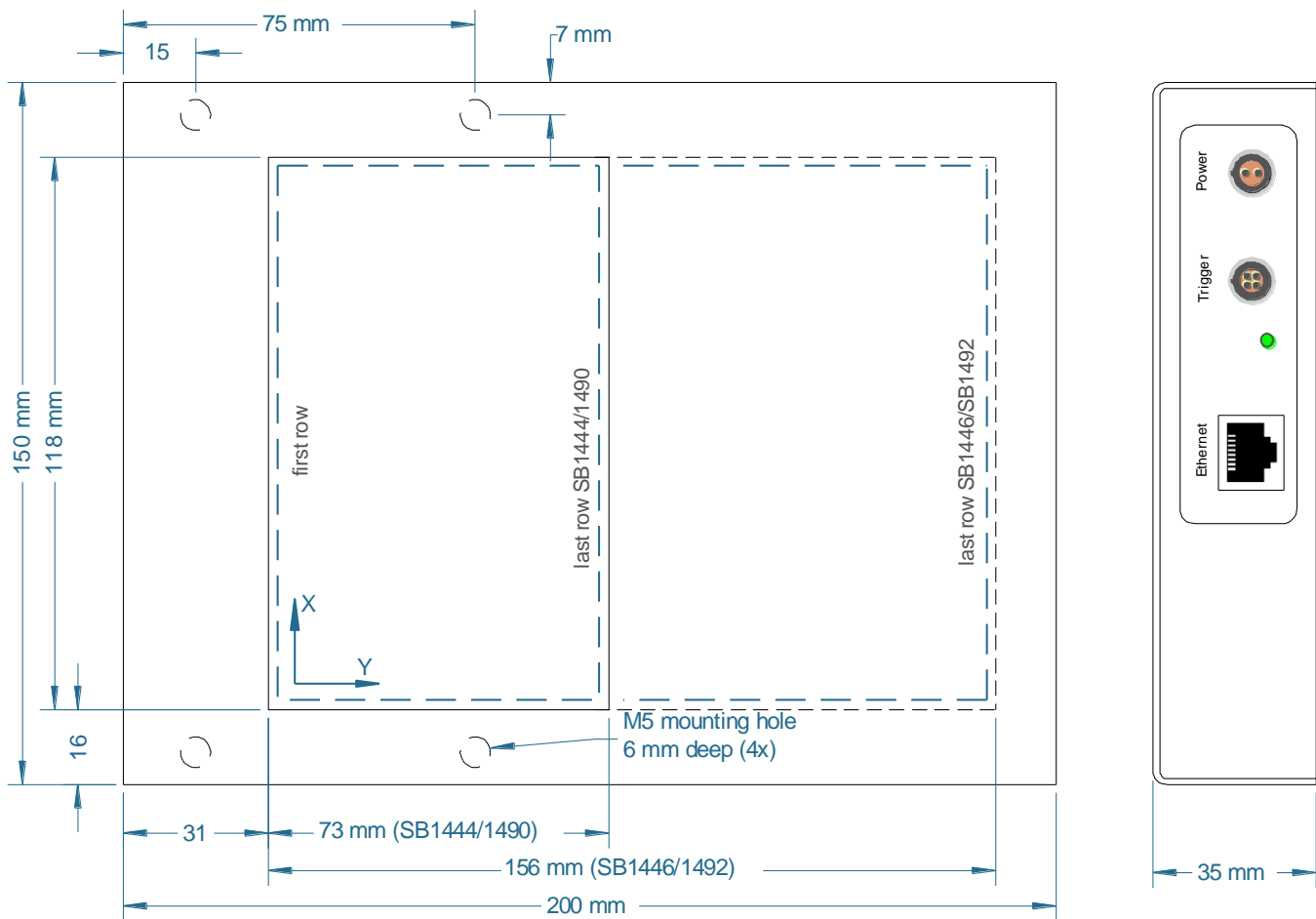
### Trigger I/O Connector:

4-pin FCI 78208-104HLF  
Mates with FCI 78211-004LF  
TTL (open collector), opto-isolated

Pin 1 Trig out+  
Pin 2 Trig out-  
Pin 3 Trig in+  
Pin 4 Trig in-



## Mechanical Drawing: 688/1548/3K/6K Models

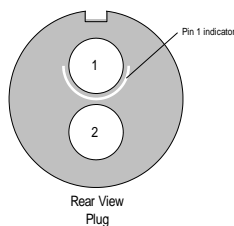


### Data Connector:

RJ45 HALO HFJ11-1G16E-L12RL Power Connector

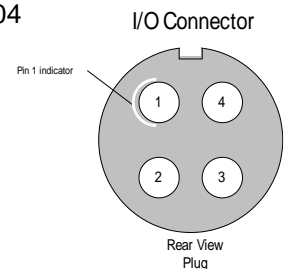
### Power Connector:

2-pin LEMO EGG.0B.0302  
 Pin 1 +12 VDC  
 Pin 2 ground

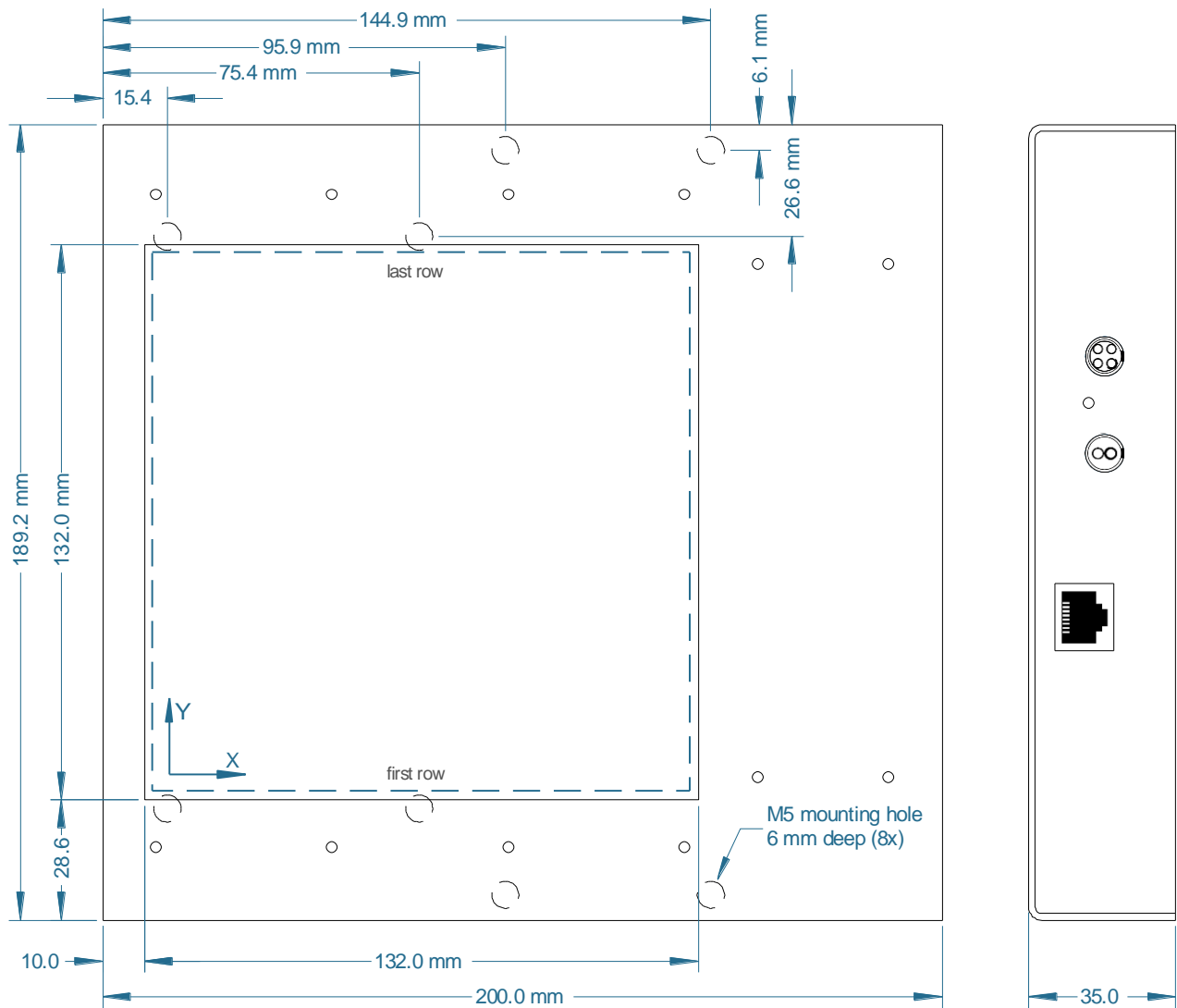


### Trigger I/O Connector:

4-pin LEMO EGG.0B.0304  
 TTL (open collector),  
 opto-isolated  
 Pin 1 Trig out+  
 Pin 2 Trig out-  
 Pin 3 Trig in+  
 Pin 4 Trig in-



## Mechanical Drawing: Shad-o-Box 1280 HS



### Data Connector:

RJ45 HALO HFJ11-1G16E-L12RL

### Power Connector:

2-pin LEMO EGG.0B.0302

Pin 1 +12 VDC

Pin 2 ground

### Trigger I/O Connector:

4-pin LEMO EGG.0B.0304

TTL (open collector), opto-isolated

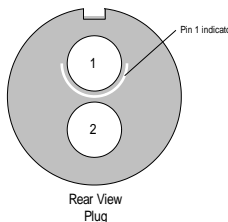
Pin 1 Trig out+

Pin 2 Trig out-

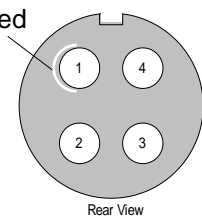
Pin 3 Trig in+

Pin 4 Trig in-

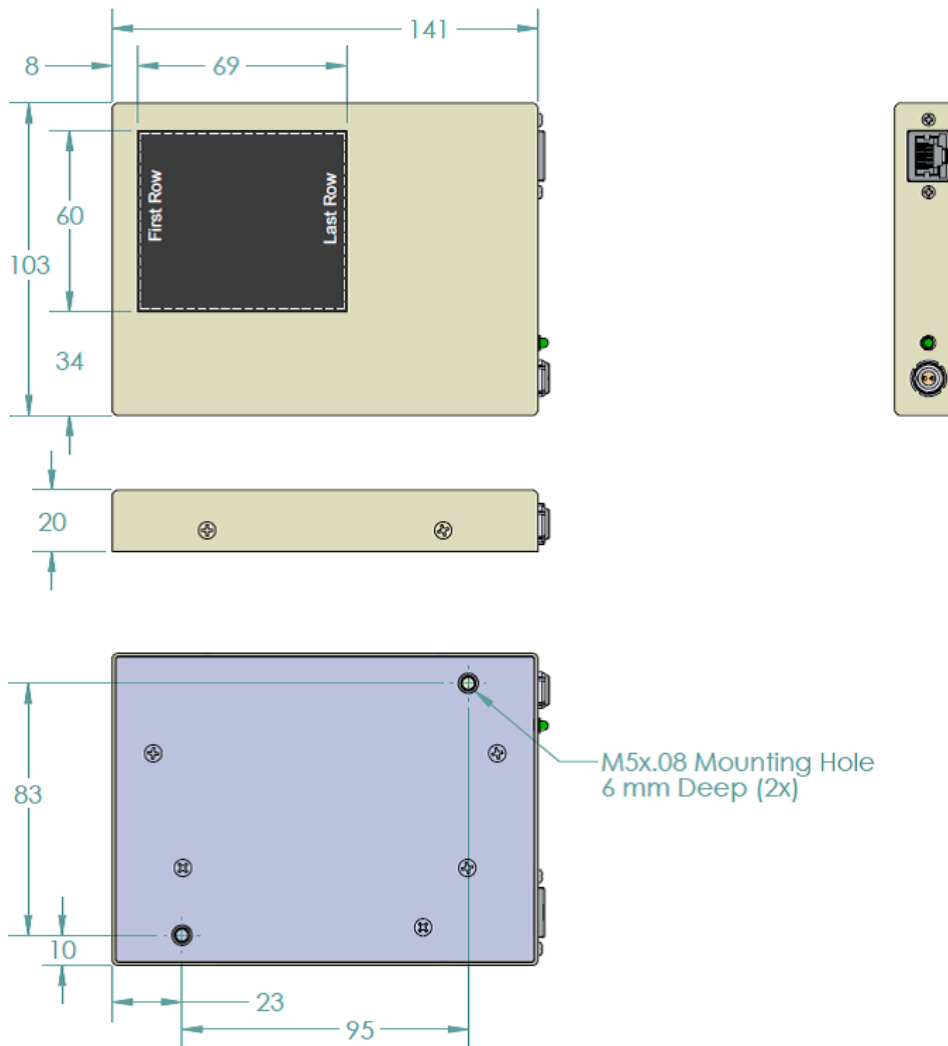
Power Connector



I/O Connector



## Mechanical Drawing: Shad-o-Box 1K HS

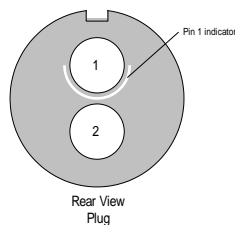


### Data Connector:

RJ45 HALO HFJ11-1G16E-L12RL Power Connector

### Power Connector:

2-pin LEMO EGG.0B.0302  
 Pin 1 +12 VDC  
 Pin 2 ground





# Shad-o-Box HS Product Family Datasheet

## Ordering Information

Shad-o-Box HS cameras are available in a single, industrial image quality grade (blemish specification available on request). Specify option -01 for the Carestream Min-R<sup>®</sup> 2190 scintillator, or option -02 for a Mitsubishi Chemical DRZ-Std (99/100 µm & 135 µm models) or DRZ-Fine (49.5 µm models) scintillator. Additional scintillator options may be available by request.

All cameras ship with a universal input power supply (90-264V, 50-60Hz), power cord, Ethernet cable, software CD and User's Manual. For international orders, please specify the type of power cord you require.

P/N	Description
SB1438	Shad-o-Box 512 HS Camera (7 x 10 cm, 135 µm pixel)
SB1440	Shad-o-Box 1024 HS Camera (10 x 14 cm, 135 µm pixel)
SB1350	Shad-o-Box 1280 HS Camera (13 x 13 cm, 100 µm pixel)
SB1444	Shad-o-Box 688 HS Camera (7 x 10 cm, 99 µm pixel)
SB1446	Shad-o-Box 1548 HS Camera (10 x 15 cm, 99 µm pixel)
SB1573	Shad-o-Box 1K HS Camera (7 x 6 cm, 49.5 µm pixel)
SB1490	Shad-o-Box 3K HS Camera (7 x 11 cm, 49.5 µm pixel)
SB1492	Shad-o-Box 6K HS Camera (11 x 15 cm, 49.5 µm pixel)

## Contact Information

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