

# Shad-o-Box HS Product Family Datasheet



## 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 - 240 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 (5) 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.

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## Description

Shad-o-Box HS cameras contain a large-area, high-resolution CMOS detector with a photodiode pixel array featuring five standard size options of approximately 2x2, 2x6, 3x4, 4x6 and 5x5 inches. The cameras are available in different resolution models featuring either a 99µm 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.

The CMOS sensor inside the Shad-o-Box HS camera contains a direct-contact Gd<sub>2</sub>O<sub>2</sub>S or CSI scintillator.

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 10 keV and may be used with generators up to 240 kVp (depending on models). Please refer to our application notes for additional information.

## Shad-o-Box HS Camera Options

Device	Number of Pixels	Active Area	Resolution	Max. Frame Rate
<b>Shad-o-Box 1280 HS</b>	1280 x 1280	12.8 x 12.8 cm	99 µm	40 fps <sup>1</sup>
<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	30 fps
<b>Shad-o-Box 2K HS</b>	1152 x 2940	5.7 x 14.6 cm	49.5 µm	10 fps
<b>Shad-o-Box 3K HS</b>	2304 x 1300	11.4 x 6.4 cm	49.5 µm	30 fps <sup>1</sup>
<b>Shad-o-Box 6K HS</b>	2304 x 2940	11.4 x 14.6 cm	49.5 µm	15 fps <sup>1</sup>
<b>Shad-o-Box 3K HS 5GigE</b>	2304 x 1254	11.4 x 6.2 cm	49.5 µm	50 fps
<b>Shad-o-Box 6K HS 5GigE</b>	2304 x 2930	11.4 x 14.5 cm	49.5 µm	20 fps

<sup>1</sup> Turbo Drive enabled.

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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	Value	Units
Typical supply voltage	12.0	Volts
Supply voltage range	11 to 13	Volts
Maximum supply current <sup>(4)</sup>	<3.0	Amps
Typical power dissipation	< 20	Watts
Camera interface	(5) 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

# Shad-o-Box HS Product Family Datasheet

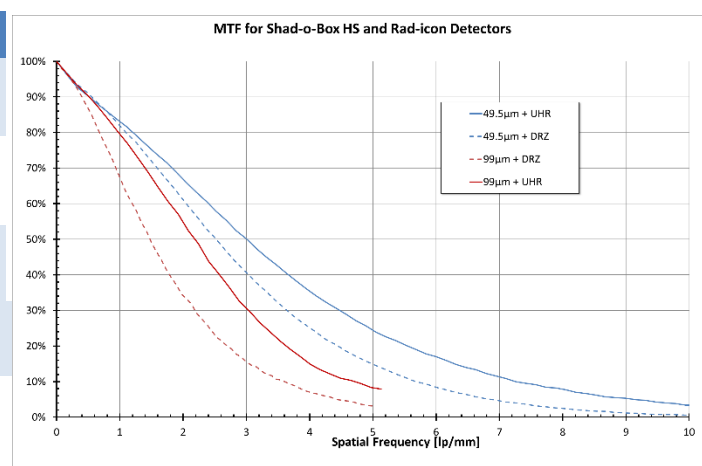
## Resolution & Sensitivity

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 (for some models), 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>
688/1548 HS (with UHR)	3.8 ADU/μR @ 50kVp 5.0 ADU/μR @ 80kVp
688/1548/1280 HS (with DRZ-Std)	9.7 ADU/μR @ 50kVp 13.7 ADU/μR @ 80kVp
1K/2K/3K/6K HS (with UHR)	0.8 ADU/μR @ 50kVp
3K/6K HS 5GigE (with UHR)	2.5 ADU/μR @ 50kVp

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



## Software

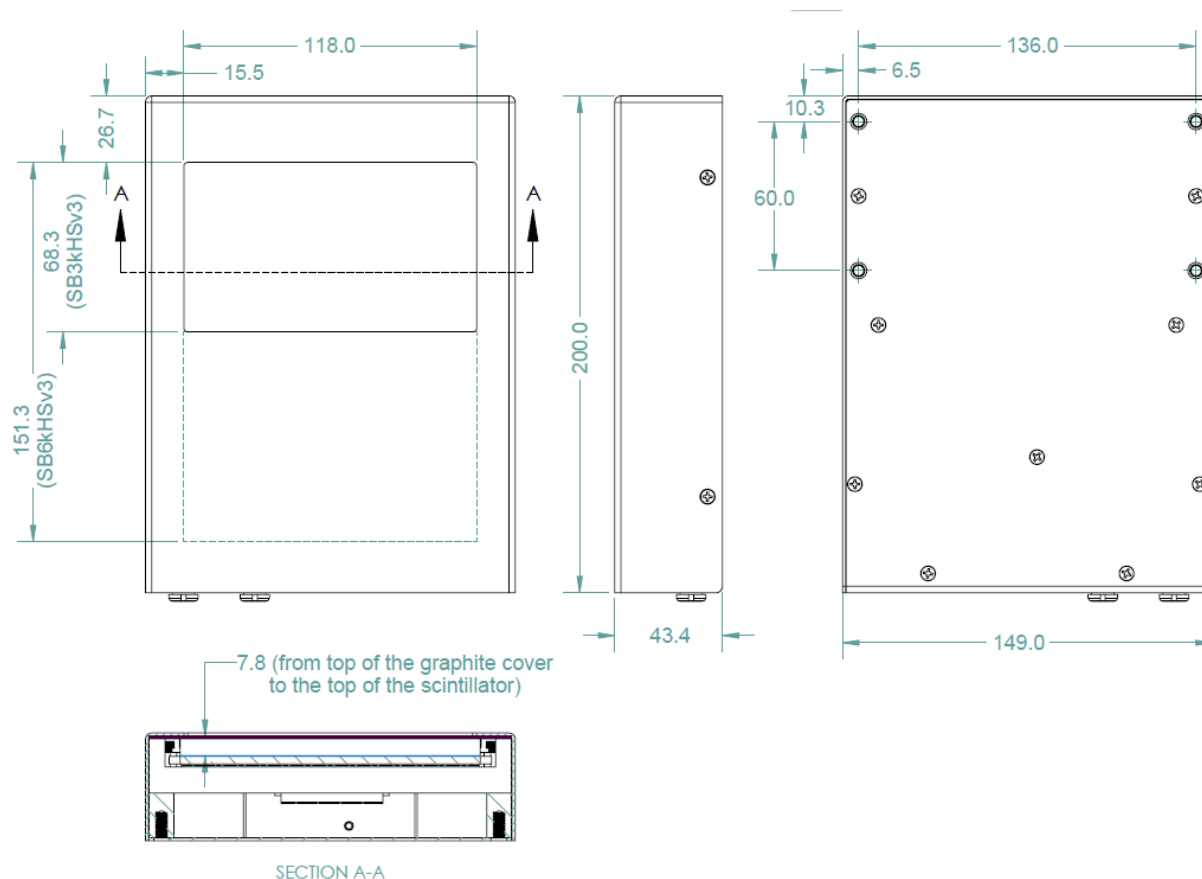
Each Shad-o-Box HS camera ships with our ShadoCam Imaging application, Teledyne DALSA's CamExpert software and a Gigabit Ethernet driver. The software is compatible with Windows 7, 8, 10 and 11. Check with your sales representative for compatibility with other Windows versions or with the Linux operating 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/>).



# Shad-o-Box HS Product Family Datasheet

## Mechanical Drawing: Shad-o-Box 3K/6K HS 5GigE

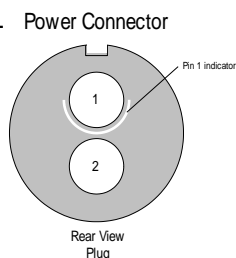


### Data Connector:

RJ45 HALO HFJ11-1G16E-L12RL Power Connector

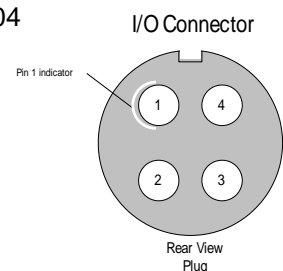
### Power Connector:

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



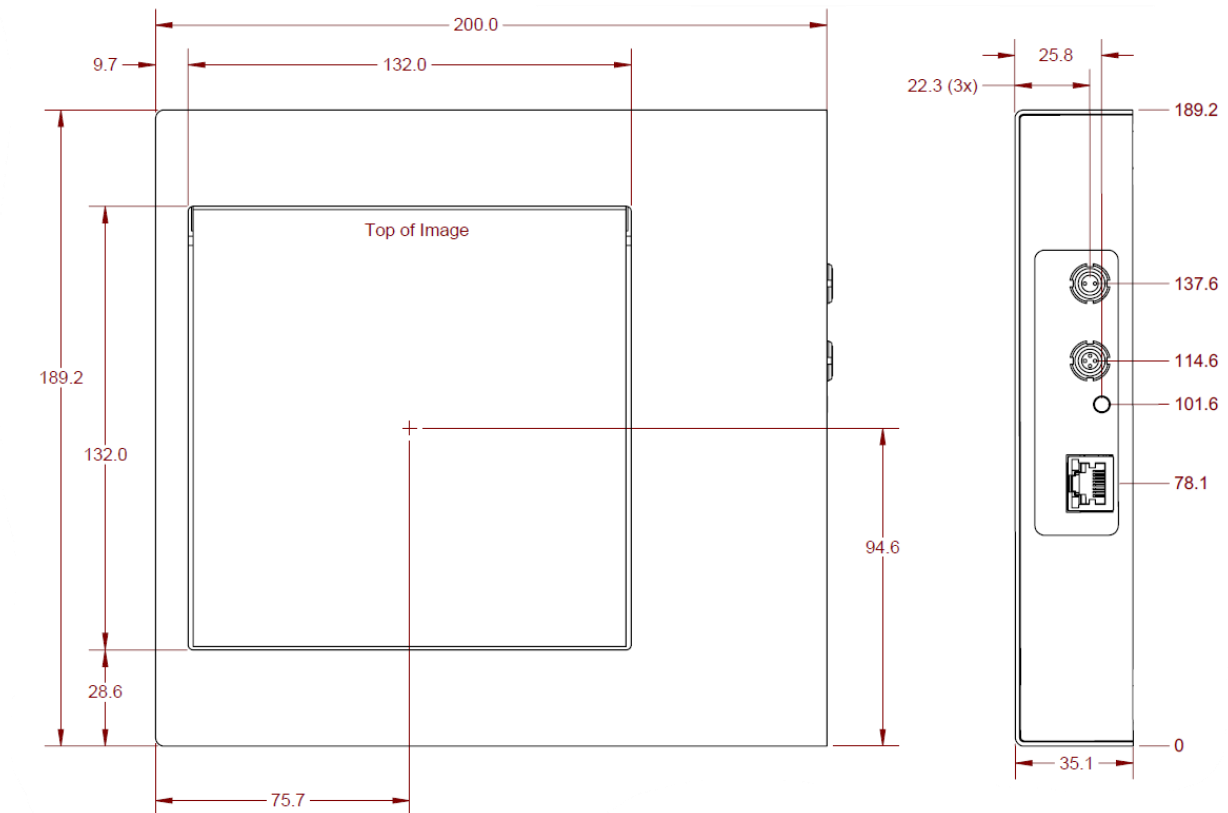
### Trigger I/O Connector:

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-



# Shad-o-Box HS Product Family Datasheet

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



### Data Connector:

RJ45 HALO HFJ11-1G16E-L12RL

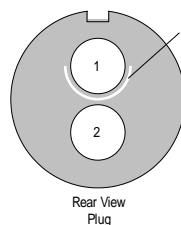
### Power Connector:

2-pin LEMO EGG.0B.0302

Pin 1 +12 VDC

Pin 2 ground

Power Connector



### Trigger I/O Connector:

4-pin LEMO EGG.0B.0304

TTL (open collector), opto-isolated

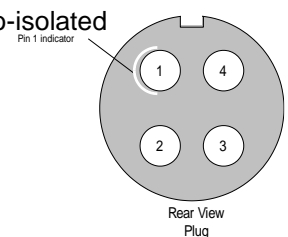
Pin 1 Trig out+

Pin 2 Trig out-

Pin 3 Trig in+

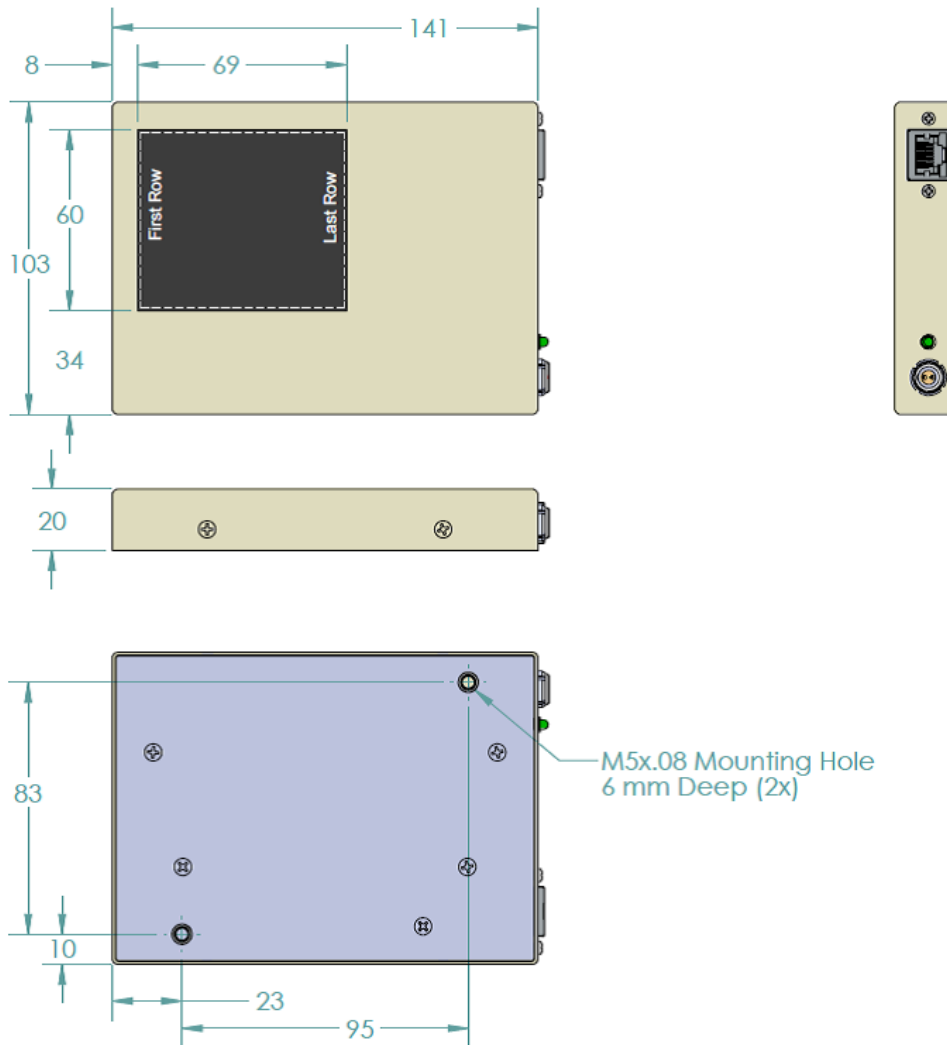
Pin 4 Trig in-

I/O Connector



# Shad-o-Box HS Product Family Datasheet

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



### Data Connector:

RJ45 HALO HFJ11-1G16E-L12RL

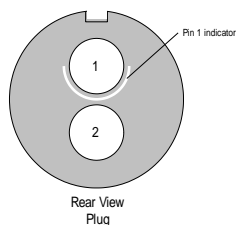
### Power Connector

### Power Connector:

2-pin LEMO EGG.0B.0302

Pin 1 +12 VDC

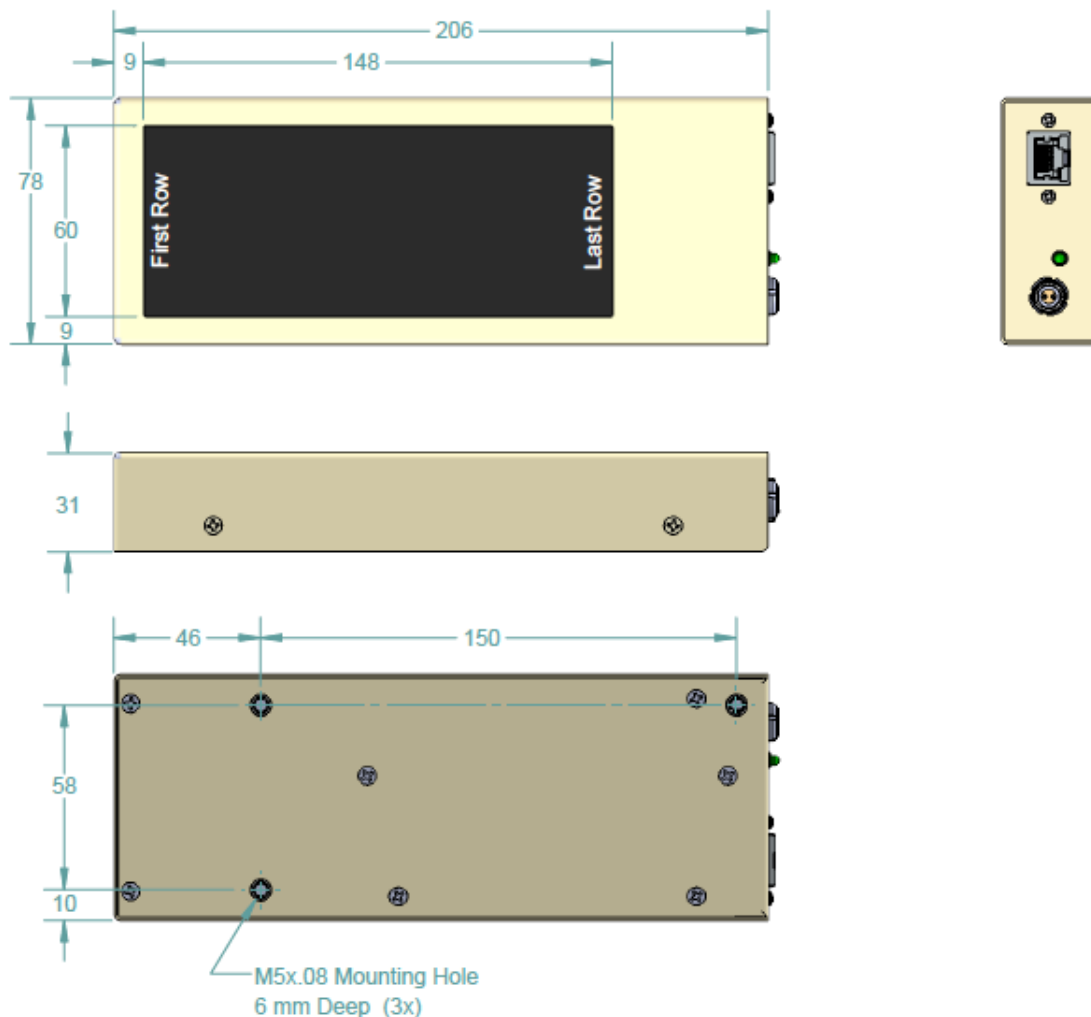
Pin 2 ground





# Shad-o-Box HS Product Family Datasheet

## Mechanical Drawing: Shad-o-Box 2K HS



### Data Connector:

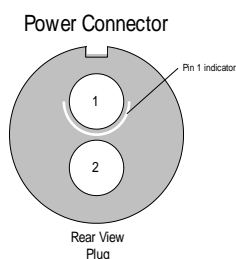
RJ45 HALO HFJ11-1G16E-L12RL

### 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 UHR scintillator, or option -02 for a Mitsubishi Chemical DRZ-Std (99  $\mu\text{m}$  models) or DRZ-Fine (49.5  $\mu\text{m}$  models) scintillator. Additional scintillator options may be available by request.

All cameras ship with a universal input power supply (100-264V, 50-60Hz), power cord, Ethernet cable. For international orders, please specify the type of power cord you require.

P/N	Description
SB1644	Shad-o-Box 1280 HS Camera (13 x 13 cm, 99 $\mu\text{m}$ pixel)
SB1444	Shad-o-Box 688 HS Camera (7 x 10 cm, 99 $\mu\text{m}$ pixel)
SB1446	Shad-o-Box 1548 HS Camera (10 x 15 cm, 99 $\mu\text{m}$ pixel)
SB1573	Shad-o-Box 1K HS Camera (7 x 6 cm, 49.5 $\mu\text{m}$ pixel)
SB1586	Shad-o-Box 2K HS Camera (6 x 15 cm, 49.5 $\mu\text{m}$ pixel)
SB1490	Shad-o-Box 3K HS Camera (7 x 11 cm, 49.5 $\mu\text{m}$ pixel)
SB1492	Shad-o-Box 6K HS Camera (11 x 15 cm, 49.5 $\mu\text{m}$ pixel)
SB1804	Shad-o-Box 3K HS 5 GigE Camera (7 x 11 cm, 49.5 $\mu\text{m}$ pixel)
SB1777	Shad-o-Box 6K HS 5 GigE Camera (11 x 15 cm, 49.5 $\mu\text{m}$ pixel)

## Contact Information

Teledyne Rad-icon Imaging,  
A BU of Teledyne Digital Imaging US, Inc.  
765 Sycamore Drive, Milpitas, CA 95035  
(408) 736-6000  
[sales.rad-icon@teledynedalsa.com](mailto:sales.rad-icon@teledynedalsa.com)  
[www.teledynedalsa.com/ndt](http://www.teledynedalsa.com/ndt)

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