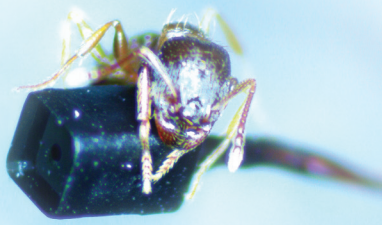
DATA SHEET



minnieCam™ -XS; up to 1Mpixel resolution, under 1.35mm OD for medical or industrial applications

introduction:

With a package footprint of less than 0.95mmx0.95mm, the minnieCam™ -XS is the world's smallest imaging sensor with up to 1Mpixel output resolution when used with Enable's Video Processing Units (VPUs).

It is an ideal solution for imaging applications that require good image quality within less than 1.35mm outside diameter at the distal end: For example medical devices where clinical use could be greatly enhanced with the addition of embedded real-time, low-cost, miniature size optical imaging. Or industrial applications for accessing narrow conduits or passages without compromising image quality or mechanical flexibility.

The minnieCam™ -XS assembly includes the CMOS image sensor, imaging optics (µObjective™ lens), a highly-flexible and miniature multi-conductor cable, and a proximal electrical connector; all in an incredibly compact footprint.

Still images or live video can be captured by connecting the proximal electrical connector into the company's proprietary VPU hardware. The hardware is available with HDMI or USB3.0 output for displaying an image on a monitor or a computer.

The unique architecture of the minnieCam™ -XS design allows for combined ultra-low power consumption with high sensitivity rolling shutter pixel and large full-well capacity, for applications where high SNR is mandatory.

product features:

- Up to 1Mpixel resolution in an extremely small footprint.
- highly-flexible and miniature cabling.
- ready for integration into existing products.
- sterilizable design.
- low-cost for use with disposable products, yet durable enough to withstand multiple sterilization cycles for re-usable devices.
- custom optical designs for different imaging needs.
- custom cable sizes and designs also available.
- video outputs include HDMI/DVI or USB 3.0.
- 360 degree steerable conduits with single-hand operation in the smallest possible OD profile are also available. Ideal for demanding endoscopic procedures.

In order to address a broad array of imaging needs, Enable, Inc., can provide a custom optical design and procurement of the µObjective™ lens, without compromising the miniature footprint of the sensor. Same customization goes for the electrical conductors.

Patented steering conduits are also available. They can provide full 360 degree steerability with single hand operation, in the smallest possible shaft profile, in a varying array of sizes and stiffness.

Custom arrangements can be made based on project and volume requirements.

Contact us to discuss your imaging needs.

product specifications: ENA-10002-AS

camera specifications:	
native resolution	160,000
effective pixels	400H x 400V
frame rate	60 fps full resolution
electrical connector	Mini-B USB, 5pin
color mosaic	RGB Bayer pattern
scan mode	progressive
optical size	1/25.7”
field of view (diagonal in air)[1]	90 deg or 100 deg[2]
device profile (LxWxH[3]) mm	0.95x0.95x2.0mm
including optics	<1.35mm OD

electrical cable:	
diameter	<0.56mm to <0.79mm[2, 4]
length	2.0 m typ. - 5.0 m max[5]
video processing unit (VPU):[6]	
voltage input	12VDC typ. 400mA max
signal output	HDMI/DVI (1080p/60fps)
	400x400 to 1000x1000[7]
	or
	USB 3.0 (400x400)

1 Custom optics with specific FOV values can be designed and manufactured on demand and adapted to the minnieCam™ -XS assembly.

2 There is a combination of electrical wire size (EC4) and lens type (L02) that are standard for the minnieCam™ -XS product line. See in the “part number and configuration ordering section” for more details.

3 The H dimension is perpendicular to the image plane of the sensor and is defined predominantly by the length of the micro-objective. This dimension can vary depending on the specific customer imaging requirements.

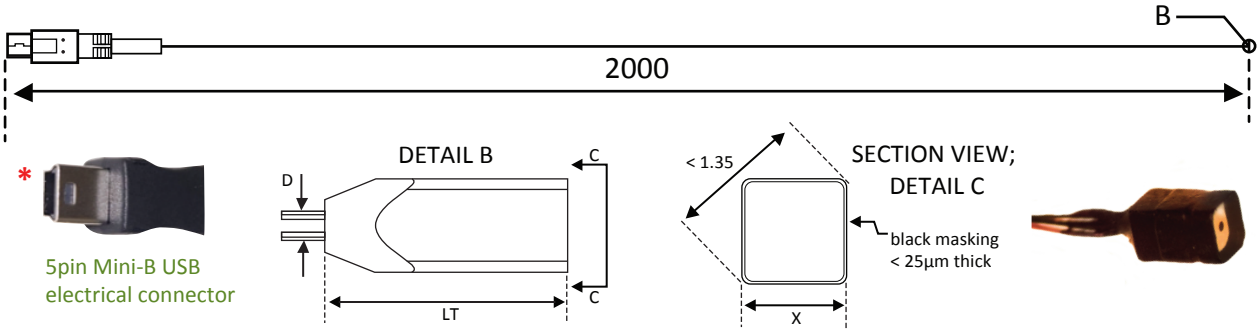
4 minnieCam™ -XS is available with 4 different sizes of electrical cables. Smallest one is < 0.56mm OD.

5 Shielded cable wire must be selected for applications that require electrical cable longer than 2m in length (EC1 or EC3 style wire from the configuration table).

6 Enable Inc VPUs ARE REQUIRED to get an image out of the minnieCam™ -XS sensor. Two different types of VPUs are available: ENA-10017-AS (HDMI output only) and ENA-10011 (HDMI and USB 3.0 output).

7 Interpolation algorithms allow increasing the output resolution of the HDMI output port of the VPU from half-VGA to XGA+ while maintaining sharp images and suppressing pixilation of the enlarged image. Both VPU models can step the resolution of the output image from 400x400 to 1,000x1,000 pixels in steps of 200 pixels. The USB3.0 output remains unchanged and always equal to 400x400.

mechanical dimensions (all dimensions in mm):



* MUST connect electrical connector to either ENA-10017-AS or ENA-10011-AS Video Processing Unit to get signal.

electrical connector wiring instructions:

CIB pin assignment[1]	EC2 or EC4 cable wires	EC1 or EC3 cable wires
1	brown	brown+outside shield[2]
2	red	red
3	white coax core (trim back cable shielding)	white coax core (trim back cable shielding)
4	black coax core (trim back cable shielding)	black coax core (trim back cable shielding)

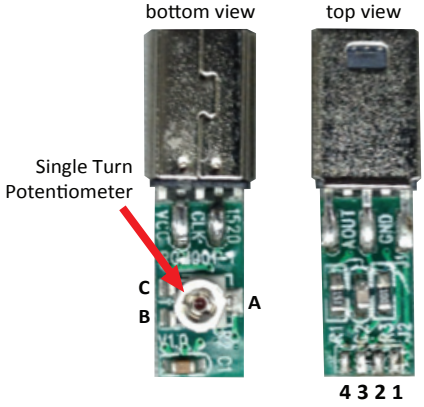


Figure 1: CIB board assembly, ENA-10004-AS

1 See **Figure 1** for pin numbering assignment of the CIB board.
2 Outside shield refers to the overall outside shield of the multiconductor cable.

The resistance value between terminals A-C in the CIB board (see Figure 1 above) is a function of the length of the electrical cable assembly. For the standard 2m long unshielded EC4 type cable (see configuration information at the end of this document for cable type details) this value is typically set at:

A-C ≈ 90 Ω.

NOTE: The actual resistance of a given assembly may be slightly different from the above value.

NOTE: **The output image can be completely lost or appear severely noisy and unstable if the potentiometer has been changed OR if the cable length has been modified from its factory setting.** If you need to shorten the length of the electrical cable from the factory-shipped standard length, do so from the proximal end by un-soldering the wire from the CIB board first. After you re-solder the wires back onto the CIB board (as per table above) adjust the potentiometer of the CIB board in the middle of a range for which you get a good stable image.

part number and configuration ordering information:

minnieCam™ -XS ordering Part Number: ENA-10002-AS

electrical cable specifications

Code A	Shield	D (mm)
EC1	Yes	0.79 ± 0.10
EC2	No	0.66 ± 0.10
EC3	Yes	0.69 ± 0.10
EC4	No	0.56 ± 0.10

D: defined in mechanical drawing

µObjective™ lens specifications

Code B	FOV	F#	DF (mm)	LT (mm)	X (mm)
L01	90	4.0	3-20	1.7	<1.05
L02	90	4.0	5-80	1.7	<1.05
L03	100	3.6	5-100	1.8	<1.00

FOV: Field of View; **DF:** Depth of Field; **LT** and **X** defined in drawing

Custom cable sizes and lenses can be designed and manufactured upon customer's request.

Indicates the standard product configuration.

configuration: MCXS - EC□ - L□□ (Code A, Code B)

For example when you order Part Number **ENA-10002-AS** with configuration **MCXS-EC3-L02**: It is a minnieCam™ -XS assembly with a 0.69mm OD multiconductor cable with outside shielding and a 90deg FOV, F#4 micro objective lens.

ENA-10001-PP: Is the plastic connector shell for the mini-B USB electrical connector. If the connector shell needs to be opened to gain access to the potentiometer, shown in Figure 1, the tabs that hold it together may get broken. **That is why an extra ENA-10001-PP is shipped with every minnieCam™ -XS order.** This way if you need to modify the length of the electrical cable or need to change the resistance between terminals A-C in the CIB board (see Figure 1), you can use the extra connector shell to cover back up the CIB board.

accesories:

ENA-10001-PP: Mini-B USB connector shell.
ENA-10004-AS: CIB PC board assembly (inside connector shell).
ENA-10017-AS: VPU-HDMI-XS; HDMI only output Video Processing Unit for all minnieCam™ -XS configurations.
ENA-10011-AS: VPU-USB3-HDMI-XS; USB3 and HDMI output Video Processing Unit for all minnieCam™ -XS configurations.
ENA-10020-AS: is the ENA-10017-AS without the chassis. Just the PC board assemblies for direct integration into your products.
ENA-10021-AS: is the ENA-10011-AS without the chassis. Just the PC board assemblies for direct integration into your products.

maintenance, cleaning, and handling instructions:

Harsh chemicals such as acetone will permanently damage the distal tip and lens. The black masking at the distal tip must be handled very carefully. It is water-soluble and can scratch off easily. The electrical wires are sensitive and are attached "softly" to the back end of the CMOS sensor. Handle the assembly with great care, especially near the sensor.

After some use, debris may attach onto the distal surface of the µObjective™ at the distal end of the minnieCam™ -XS assembly and impede the view or degrade the image quality. Ensure that you blow-off the distal end first with clean air BEFORE you rub it with soft tissue. Use ONLY soft tissue (such as lens tissue paper) to rub debris off of the distal tip of the assembly, making sure that you do not come in contact with the black masking coating.

NOTE: The contrast of the image can be greatly reduced if the black masking coating is compromised in any way from the distal end. **NOTE:** Always ware a grounding strap when handling the minnieCam™ -XS while not connected to a VPU. **NOTE:** The distal end-face of the assembly may get permanently damage if harsh tissue is used or is rubbed hard (even with soft tissue). **NOTE:** The distal surface of the µObjective™ as well as the distal tip of the scope may get permanently damaged if the above instructions are not followed correctly.

disclosures:

All units are tested 100% at the factory for image quality and functionality before shipping. Enable Inc. is not responsible for any damage or malfunction of the minnieCam™ -XS assembly as a result of mishandling after shipping to the customer. Shipping cost of all returns is the customer's responsibility.