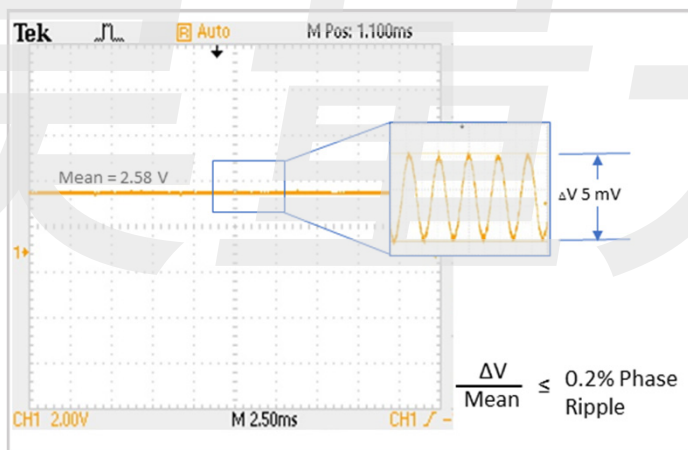


## Spatial Light Modulator – 1920 x 1152

**Meadowlark Optics** Liquid Crystal on Silicon (LCoS) Spatial Light Modulators (SLMs) are uniquely designed for pure phase applications and incorporate analog data addressing with high refresh rates. This combination provides users with the fastest response times and highest phase stabilities commercially available. Meadowlark offers both transmissive and reflective SLMs in either one- or two-dimensions. Phase-only SLMs can also be used for amplitude-only or a combination of both. The 1920 x 1152 SLM is good for applications requiring high speed, high diffraction efficiency, low phase ripple and high-power lasers.

**High Phase Stability** - Meadowlark Optics' SLMs are known for having the highest phase stability on the market. Our backplanes are custom designed with high refresh rates and direct analog drive schemes resulting in phase ripple as low as 0.2% (0.002  $\pi$  radians) for standard speed, and as low as 0.5% (0.005  $\pi$  radians) for high-speed. Phase ripple is quantified by measuring the 1<sup>st</sup> order ripple as compared to the mean intensity while writing a repeating linear phase ramp to the SLM.



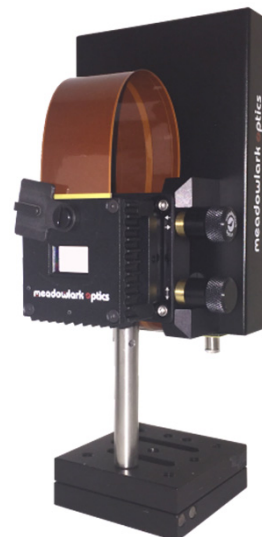
1<sup>st</sup> order Intensity when writing a phase ramp to the SLM

**Hardware Interface Options** - Meadowlark Optics' SLMs come with multiple hardware interface options. For customers that prefer the computer to view the SLM as a secondary monitor, we offer a HDMI controller with optional output trigger for synchronization. For customers that require high speed operation, we offer PCIe controllers with input and output triggers and low latency image transfers.



HDMI Controller

PCIe Controller to support high frame rates (up to 844 Hz)



### SLM Features

• • •

- High resolution
- High speed
- High Phase Stability
- Pure analog phase control
- High first order efficiency
- High reflectivity
- High power handling
- Compact design
- Wavelengths from 400-1650 nm

### Software Features

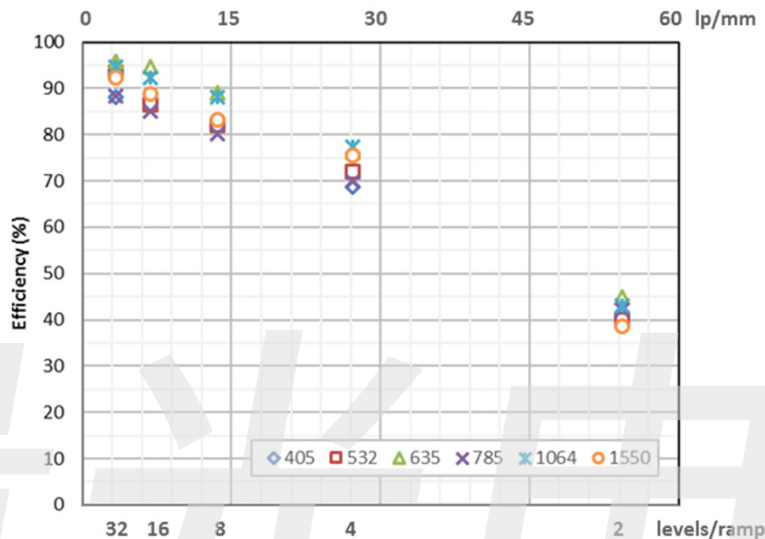
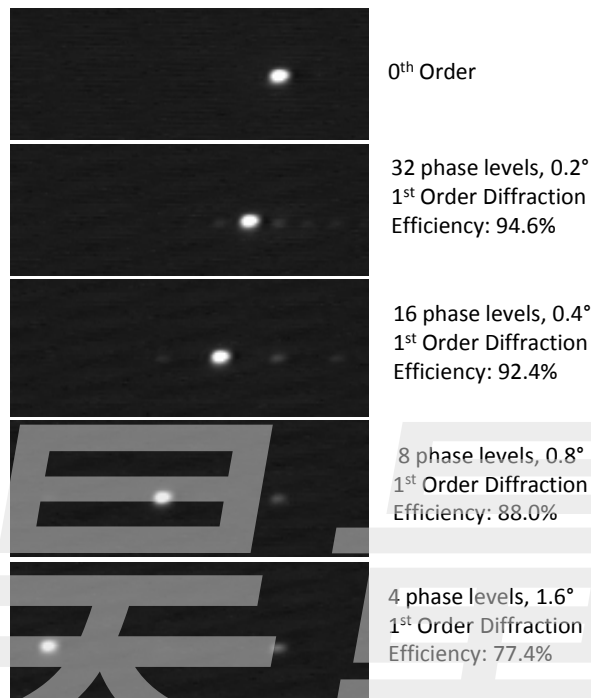
• • •

- Input and Output Triggers
- Image Generation
- Automated Sequencing
- Wavefront Calibration
- Global and Regional Look Up Tables



**Diffraction Efficiency (1st-order)** - This is the percentage of light measured in the 1st-order when writing a linear repeating phase ramp to the SLM as compared to the light in the 0<sup>th</sup> order when no pattern is written to the SLM. Diffraction efficiency varies as a function of the number of phase levels in the phase ramp. An example measurement, taken at 1064 nm is shown below left, for phase ramps with 4 to 32 phase levels between 0 and  $2\pi$ . The plot below right shows sample 1<sup>st</sup> order diffraction efficiency measurements, as a function of the phase ramp period, taken at various wavelengths.

**Measured 1<sup>st</sup> Order Diffraction Efficiency**

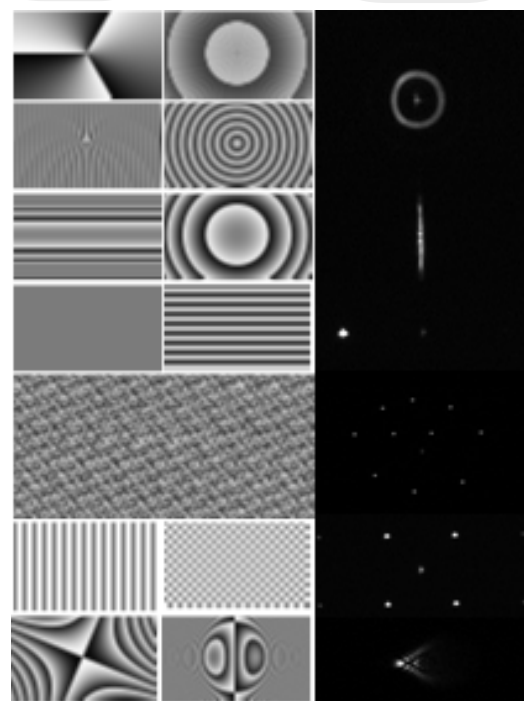


**Software** - Meadowlark Optics' SLMs are supplied with a GUI and software development kits that support LabVIEW, Matlab, and C++. The software allows the user to generate images, to correct aberrations, to calibrate the global and/or regional optical response over 'n' waves of modulation, to sequence at a user defined frame rate, and to monitor the SLM temperature.

**Global or Regional Calibrations** - Regional calibrations provide the highest spatial phase fidelity commercially available by regionally characterizing the phase response to voltage and calibrating on a pixel by pixel basis.

**Image Generation Capabilities**

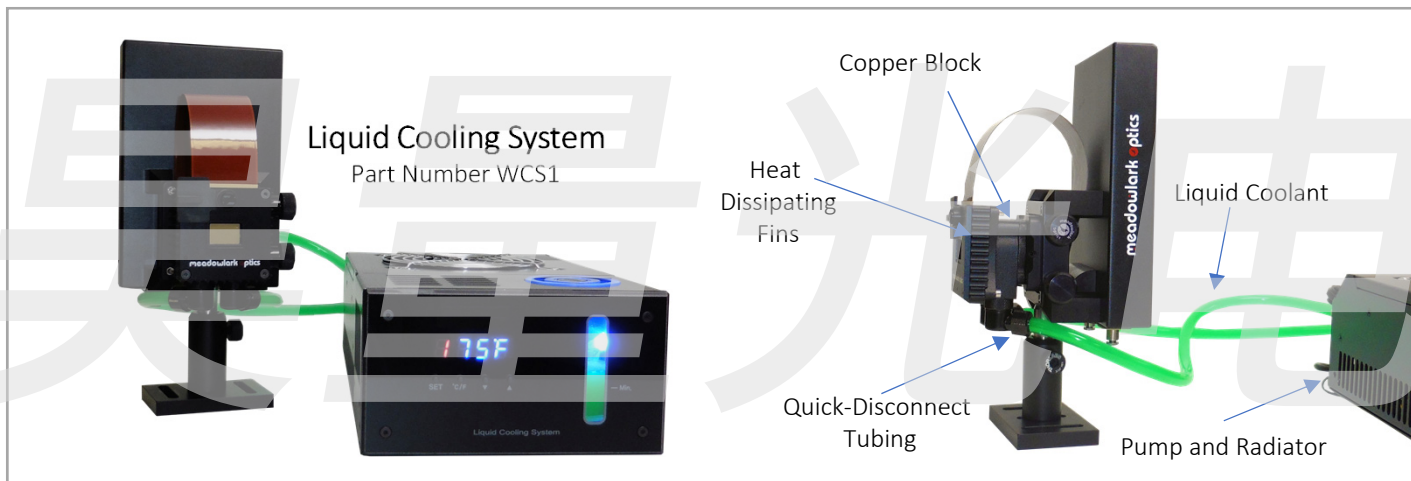
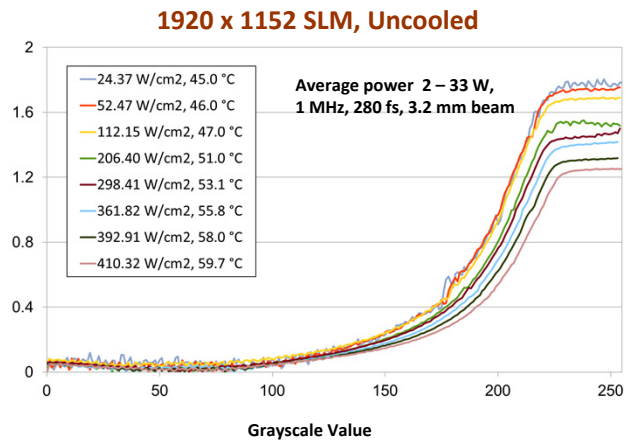
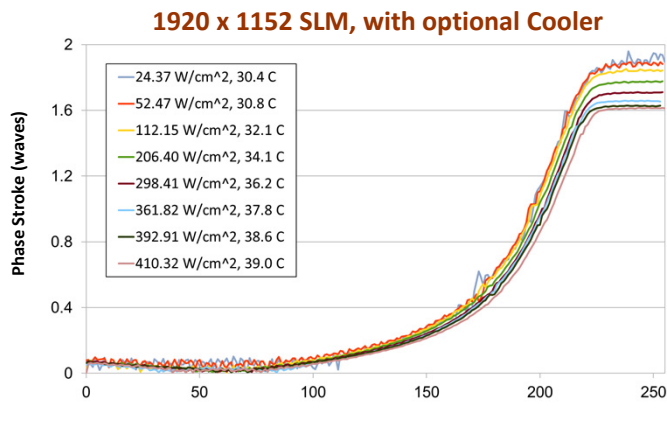
- Bessel Beams: Spiral Phase, Fork, Concentric Rings, Axicons
- Lens Functions: Cylindrical, Spherical
- Gratings: Blazed, Sinusoid
- Diffraction Patterns: Stripes, Checkerboard, Solid, Random Phase
- Holograms, Zernike Polynomials, Superimpose Images



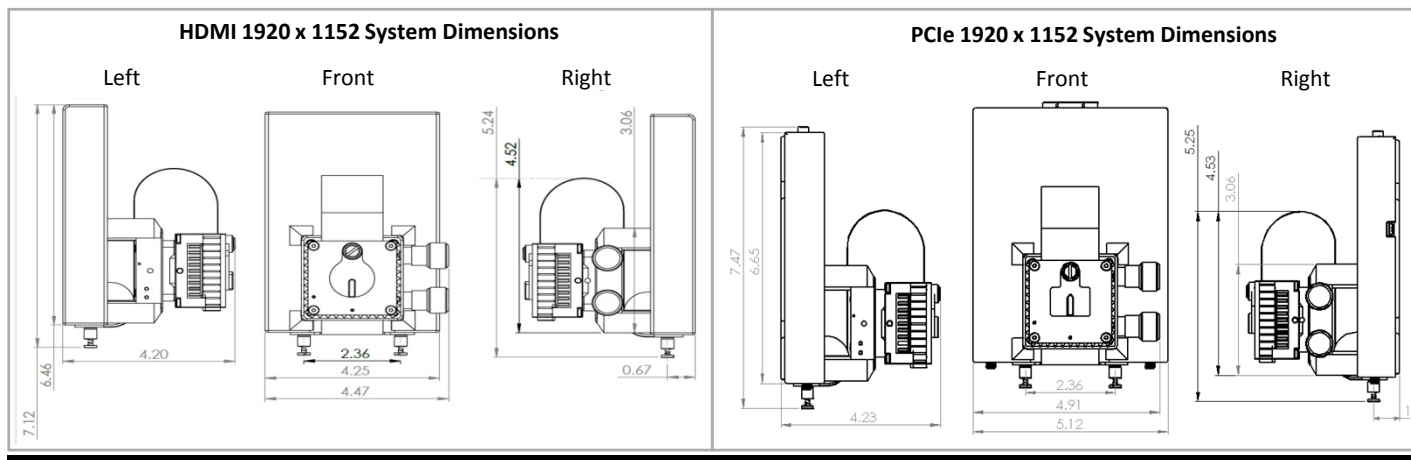


**High Power Capability** - Meadowlark Optics' Spatial Light Modulators have been tested for compatibility with high power pulsed and CW lasers. In the graphs below, the optical response of the 1920 x 1152 pixel SLM with and without liquid cooling was measured as the incident power was incremented up to 15 GW/cm<sup>2</sup> peak power or 410 W/cm<sup>2</sup> average power.

POLARIZERS • SPATIAL LIGHT MODULATORS • WAVEPLATES • LIQUID CRYSTAL DEVICES • OTHER CAPABILITIES



A copper block is attached to the back of the SLM to draw heat out of the SLM. The copper block is attached with 2 meters of quick-disconnect tubing to cooling unit containing an external pump, radiator, and fan to cool the liquid down to ambient temperature. Includes one bottle of liquid coolant.





# 1920 x 1152 Analog Spatial Light Modulator Specifications

**Resolution:** 1920 x 1152  
**Fill Factor:** 95.7%

**Array Size:** 17.6 x 10.7 mm  
**Pixel Pitch:** 9.2 x 9.2  $\mu\text{m}$

**Zero-Order Diffraction Efficiency\*:** 88%  
**Controller:** HDMI 8/12-bit, PCIe 8/12-bit

## Standard Speed System - Standard Liquid Crystal with HDMI Controller



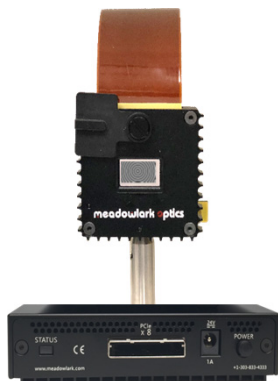
Specify Calibration Wavelength	Wavefront Distortion	LC Response Time / System Frame Rate	AR Coatings (Ravg <1%)	Reference this Model Number when Ordering
405 nm	$\lambda/3$	6 ms / 31 Hz	400 – 800 nm	Model P1920-400-800-HDMI
532 nm	$\lambda/5$	9 ms / 31 Hz	400 – 800 nm	
635 nm	$\lambda/6$	12 ms / 31 Hz	400 – 800 nm	
785 nm	$\lambda/7$	19 ms / 31 Hz	600 – 1300 nm	Model P1920-600-1300-HDMI
1064 nm	$\lambda/10$	25 ms / 31 Hz	600 – 1300 nm	
1550 nm	$\lambda/12$	33 ms / 31 Hz	850 – 1650 nm	Model P1920-850-1650-HDMI

## Mid Speed System - Standard Liquid Crystal with High Speed PCIe Controller



Specify Calibration Wavelength	Wavefront Distortion	LC Response Time / System Frame Rate	AR Coatings (Ravg <1%)	Reference this Model Number when Ordering
405 nm	$\lambda/3$	3.0 ms / 281.6 Hz	400 – 800 nm	Model MSP1920-400-800-HSP8
532 nm	$\lambda/5$	4.5 ms / 211.1 Hz	400 – 800 nm	
635 nm	$\lambda/6$	5.9 ms / 169.0 Hz	400 – 800 nm	
785 nm	$\lambda/7$	10.0 ms / 93.7 Hz	600 – 1300 nm	Model MSP1920-600-1300-HSP8
1064 nm	$\lambda/10$	13.0 ms / 76.8 Hz	600 – 1300 nm	
1550 nm	$\lambda/12$	24.8 ms / 40.2 Hz	850 – 1650 nm	Model MSP1920-850-1650-HSP8

## High Speed System – High Speed Liquid Crystal with High Speed PCIe Controller



Specify Calibration Wavelength	Wavefront Distortion	LC Response Time / System Frame Rate	AR Coatings (Ravg <1%)	Reference this Model Number when Ordering
532 nm	$\lambda/5$	1.4 ms / 422.4 Hz	488 – 800 nm	Model HSP1920-488-800-HSP8
635 nm	$\lambda/6$	1.8 ms / 422.4 Hz	488 – 800 nm	
785 nm	$\lambda/7$	2.3 ms / 422.4 Hz	600 – 1300 nm	Model HSP1920-600-1300-HSP8
1064 nm	$\lambda/10$	3.3 ms / 281.6 Hz	600 – 1300 nm	
1550 nm	$\lambda/12$	4.7 ms / 211.2 Hz	850 – 1650 nm	Model HSP1920-850-1650-HSP8

\*Silicon backplane, performance varies as a function of wavelength.