DATA SHEET

Spatial Light Modulators

Key Features and Benefits

- Solid-state for rapid, vibrationless operation
- Single-mask or dual-mask liquid-crystal designs for phase, amplitude, or simultaneous phase/amplitude control
- VIS or NIR wavelength ranges
- Smaller SLM-128 enclosure for easier integration
- USB interface with free Software Developer's Kit (SDK) for efficient low-power operation and software integration

SLM-128 and SLM-640

Simultaneous phase and amplitude modulation of your VIS or NIR beam with no moving parts

These Spatial Light Modulators (SLMs) are based on proven industry-leading designs, and offer both single-mask and dual-mask configurations for phase, amplitude, or for simultaneous phase/amplitude pulse shaping.

Now part of PerkinElmer, Cambridge Research & Instrumentation, Inc. (CRi) collaborated with the Massachusetts Institute of Technology (MIT) on the initial development of modern liquid crystal (LC) SLMs, and is the exclusive worldwide licensee of MIT's technology for bonded optical masks for simultaneous phase and amplitude control in a single device.

Liquid Crystal Optical Modulation

Our SLM optics use nematic LC to alter the phase or the amplitude of light. The LC masks provide an electrically variable index of refraction for light that is polarized along the crystal's "extraordinary" axis. The refractive index of light that is polarized along the "ordinary" axis (also called the orthogonal axis), is not changed.

Depending on the orientation of the extraordinary axis of the LC mask and the placement of linear polarizers in front and/or behind the LC mask, a single-mask SLM can modulate a beam's phase or amplitude.

The dual-mask models use a patented arrangement where two LC masks are bonded together in precise registration and proximity. The masks are oriented orthogonal to one another and 45 degrees to the polarization of incident light. This arrangement enables the independent adjustment of both phase and amplitude. Removing the polarizers and driving both masks with the same patterns so the differential is zero allows the SLM to be used as a pure phase modulator for arbitrarily polarized light.

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An available and removable surface-coated mirror allows the beam to pass through the system twice. This so-called "double-pass" configuration doubles the optical modulation of the SLM and can result in faster time response when changing between different drive patterns.

SLM Available Configurations

SLM - xxx - m - ww

xxx = number of pixels per mask (128 or 640)
m = modulation mode (P = phase, A = amplitude, or D = dual)
ww = wavelength range (VN = 488 - 900 nm or NM = 900 - 1620 nm)

Examples

SLM-128-A-VN = Spatial light modulator with a single 128-pixel mask configured for amplitude modulation in the 488 - 900 nm wavelength range.

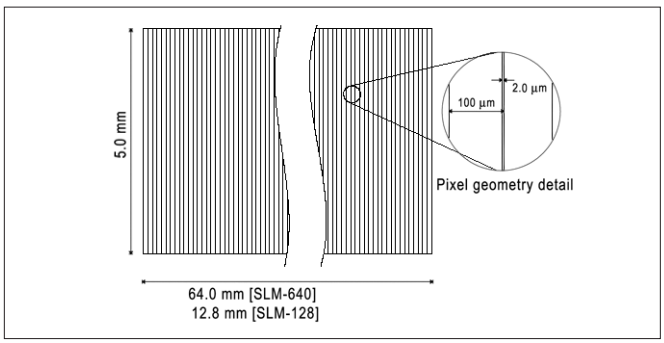
SLM-640-D-NM = Spatial light modulator with dual 640-pixel masks (640 pixels x 2 masks) configured for simultaneous phase and amplitude modulation in the 900 - 1620 nm wavelength range.

Standard items included with all models

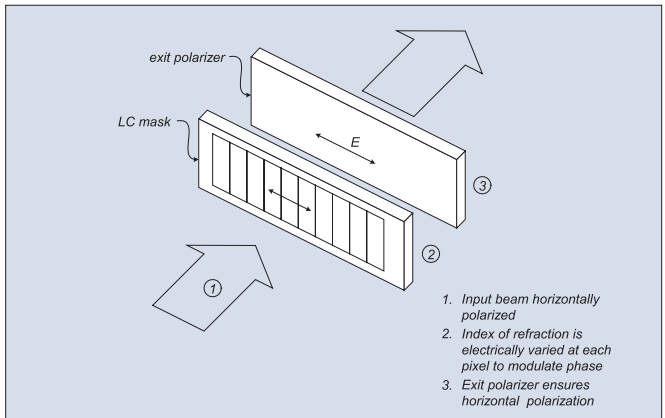
All SLM models include integral control electronics with USB 1.1 interface, cables, worldwide switching power transformer, and software drivers. Phase modulators include one removable polarizer. Amplitude and dual-mask modulators include two removable polarizers.

Accessories

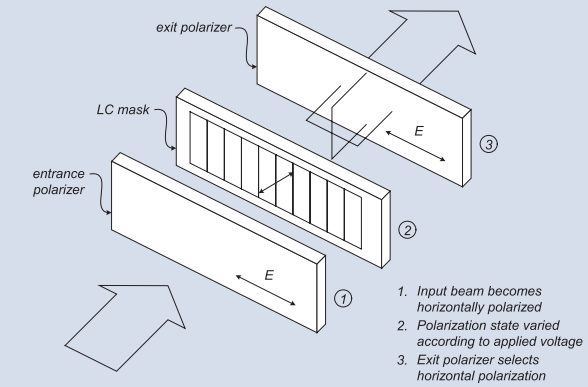
An optional and removable reflective surface is available to enable a reflective (double-pass) configuration.



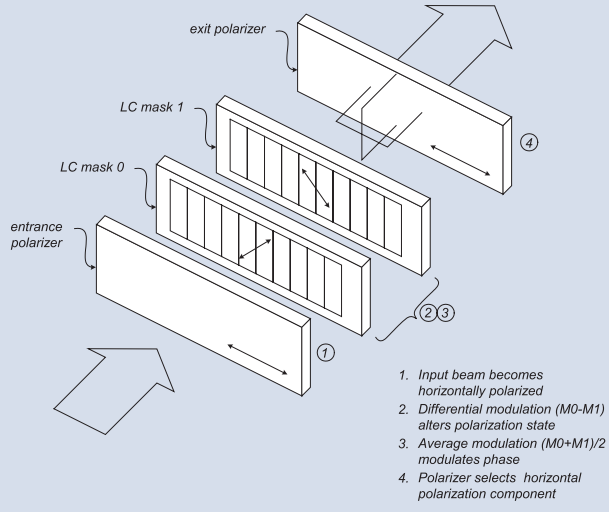
Spatial Light Modulators utilize liquid crystal (LC) masks manufactured in our own state-of-the-art fabrication facility in the U.S. Dual-mask models feature precisely aligned optical masks providing simultaneous phase and amplitude control in a single device.



Phase Modulation Transmissive Mode



Amplitude Modulation Transmissive Mode



Phase & Amplitude Modulation Transmissive Mode

The three choices for transmissive mode are shown above. (The SLM can also be used in reflective mode).

Specifications

	SLM-128-P/ SLM-128-A	SLM-128-D	SLM-640-P/ SLM-640-A	SLM-640-D
LC optics masks	1	2	1	2
Pixels per mask	128		640	
Pixel height	5000 µm (5 mm)			
Pixel pitch	100 ± 0.005 µm			
Interpixel gap[1]	2.0 µm			
Intermask alignment[2, 3]	n/a ± 2.0 µm n/a ± 2.0 µm			
Intermask separation[2,4]	n/a	1.03 mm	n/a	1.03 mm
Spectral range[5]	488 - 900 nm (VN models), 900 nm - 1620 nm (NM models)			
Transmission (VN)[13]	> 88%	> 85%	> 88%	> 85%
Transmission (NM)[13]	> 92%	> 90%	> 92%	> 90%
Pulse damage threshold	100 µJ/cm^2 (490 nm, 50 fs, 1 kHz), 200 µJ/cm^2 (890 nm, 50 fs, 1 kHz)			
Maximum modulation[6,7]	3π radians at longest wavelength			
Modulation temperature coefficient[8]	-0.3% modulation per °C			
Response time[9-12]	35 ms (2π radians at 900 nm, VN models), 70 ms (2π radians at 1620 nm, NM models)			
Drive waveform	Bipolar 3.3 kHz square wave			
Drive resolution	12-bit, 2.44 mV per step			
Frame buffers	128		32	
Interfaces	USB 1.1, 5V / 3.3V logic trigger (TTL compatible)			
Power	+24V DC via worldwide switching transformer (4 plugs included)			
Mechanical mounting	3 x ¼"–20 and 2 x M6 threaded holes			
Overall size	5.29" x 6.90" x 0.98"		7.2" x 12.8" x 1.54"	
Operating temperature	18 - 35 °C			
Storage temperature	-15 - 50 °C			

Notes

1. Median size of the photolithographic gap between adjacent pixel electrodes. Actual optical response within this gap and in the adjacent region is determined by electrostatics and the liquid crystal material properties.
2. Applies to dual-mask models only.
3. Lateral misalignment between pixel 0 of the first and second mask.
4. Separation along the optical path between first and second mask, in medium (n = 1.51).
5. For standard models. Operation over the range of 400 - 1650 nm is possible with derated performance due to reduced coating and polarizer efficiency outside the optimal range.
6. Used single-pass, (i.e. in transmission). Modulation is doubled when the SLM is used in reflection, since the light traverses the optics twice.
7. Specified at the longest wavelength in the operating range. Maximum modulation is greater at shorter wavelengths.
8. Properties of liquid crystal vary with temperature which, in turn changes the modulation response of the SLM. The temperature coefficient is typically decreased in 0.3% modulation per increase in 1 °C.
9. All response times are measured at 25 °C, and improve at higher temperatures.
10. Settling time to 95% for step from minimum modulation to listed modulation.
11. Settling is faster for transition in the opposite direction, (i.e., from stated modulation to minimum modulation).
12. Includes the electronic circuitry response from trigger pulse or P (frame-select) command.
13. Without polarizers.

For more information, please visit www.perkinelmer.com/SLM

Email: slm@perkinelmer.com

PerkinElmer, Inc.
940 Winter Street
Waltham, MA 02451 USA
P: (800) 762-4000 or
(+1) 203-925-4602
www.perkinelmer.com

PerkinElmer®

For a complete listing of our global offices, visit www.perkinelmer.com/ContactUs

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