

Spatial Light Modulators

HOLOEYE's Spatial Light Modulator (SLM) systems are based on translucent or reflective liquid crystal microdisplays. These devices can modulate light spatially in amplitude or phase, so they act as a dynamic optical element. The optical function or information to be displayed can be taken directly from the optic design software or an image source and can be transferred by a computer interface.

Implementation is accomplished using the HDMI port of a standard PC graphics card. The SLM can be used just like an external plug & play monitor.

SLM Software Features

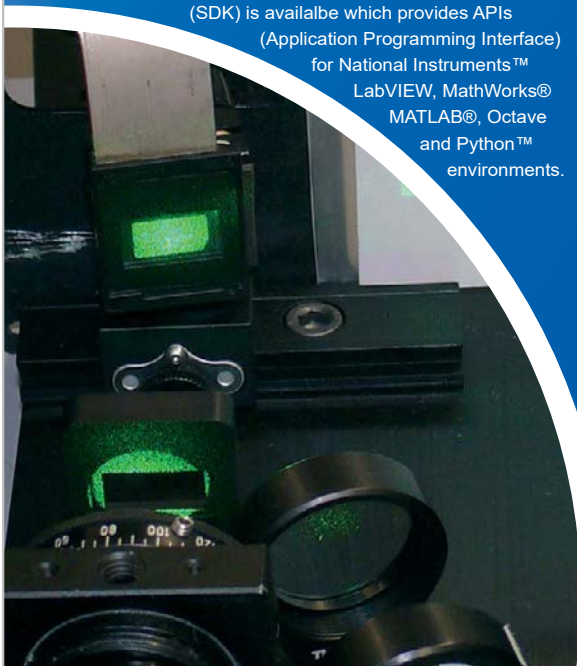
All HOLOEYE Spatial Light Modulators can be controlled by a Configuration Manager (Windows). This software gives the opportunity to control all relevant image parameters and provides an easy gamma control to configure the device for different applications and wavelengths.

Additionally an SLM Pattern Generator Software is delivered with the SLM. Key features are:

- computation of computer generated holograms (CGH) from user defined images
- generation of SLM signals representing basic optical functions such as lenses, gratings, axicon and vortex functions
- superposition of CGH's with basic optical functions to combine functionalities

For easy display of images and image sequences on the Spatial Light Modulator an SLM Slideshow Player software is also delivered with the kit.

Besides that an SLM Display Software Development Kit (SDK) is available which provides APIs (Application Programming Interface) for National Instruments™ LabVIEW, MathWorks® MATLAB®, Octave and Python™ environments.



PLUTO-2 - Phase Only Spatial Light Modulator Series



The PLUTO-2 phase modulator models are based on reflective LCOS microdisplays with 1920 x 1080 pixel resolution and 8.0 μm pixel pitch.

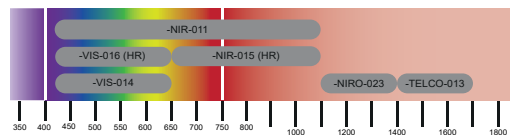
Display Type	Reflective LCOS
Resolution	1920 x 1080 Pixel
Pixel Pitch	8.0 μm
Active Area / Diagonal	15.36 x 8.64 mm / 0.7"
Fill Factor	93%
Addressing Bit Depth	8 Bit
Input Frame Rate	60 Hz / (180 Hz)
Signal Format	HDMI - HDTV Res.

The PLUTO-2 series covers different versions optimized for different applications and wavelength ranges from 350 nm up to 1700 nm. Furthermore high retardation display panels are available (VIS and NIR) which enable a modulo 4π or 6π encoding of optical functions depending on the wavelength.

The pulse code modulation for digitally addressed devices leads to a slight superimposed phase flicker. For some applications a stable phase response is required. This can be accomplished driving the high retardation display versions with low voltage settings for 2π phase retardation, however compromising the response time.

All different phase display versions can be driven with the same PLUTO-2 driver units. This provides you the flexibility to upgrade / adapt the SLM device to another version for different applications without the need to purchase a complete new SLM kit.

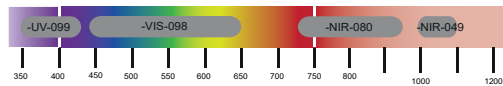
The PLUTO-2 driver also features a dual-core ARM® Cortex™-A9 processor which includes on-chip memory. This enables the user to program additional functionality which is directly processed on the PLUTO-2 device. The dual-core system runs an embedded Linux™ SMP operating system and includes a library which provides full control and supervision of the display and driver board.



Device	λ Range	Maximum Phase	Average Refl.
PLUTO-2-VIS-014	420-650 nm	2.7π @ 633 nm	65 %
PLUTO-2-VIS-016	420-650 nm	5.4π @ 633 nm	65 %
PLUTO-2-VIS-020	530-640 nm	6.3π @ 633 nm	75 - 80 %
PLUTO-2-NIR-011	420-1100 nm	2.0π @ 1064nm	65 - 75 %
PLUTO-2-NIR-015	650-1100 nm	3.7π @ 1064nm	65 - 75 %
PLUTO-2-NIRO-023	1100-1400 nm	4.1π @ 1300 nm	74 %
PLUTO-2-TELCO-013	1400-1700 nm	3.5π @ 1550 nm	80 %

PLUTO-2 - High Reflectivity Versions

Some PLUTO-2 SLM display versions are equipped with a dielectric mirror coating to increase the reflectivity. Due to the increased reflectivity less absorption occurs and these display versions can be used with higher incident laser power compared to the standard versions.



Device	λ Range	Maximum Phase	Average Refl.
PLUTO-2-UV-099	350-420 nm	2.3 π @ 405 nm	90 %
PLUTO-2-VIS-098	450-650 nm	2 π @ 650 nm	93 %
PLUTO-2-NIR-080	730-950 nm	4.8 π @ 800 nm	95 %
PLUTO-2-NIR-049	1000-1100 nm	2 π @ 1064 nm	93 %

LETO - Phase Only Spatial Light Modulator Series



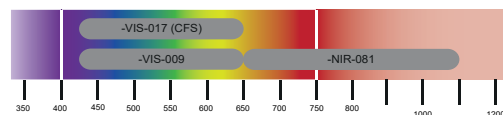
The LETO phase modulator is based on reflective LCOS microdisplays with 1920 x 1080 pixel resolution. With a pixel pitch of only 6.4 μm and small interpixel gaps of 0.2 μm the LETO SLM provides a high fill factor of 93% and

thereby high light efficiency.

Display Type	Reflective LCOS
Resolution	1920 x 1080 Pixel
Pixel Pitch	6.4 μm
Active Area / Diagonal	12.5 x 7.1 mm / 0.55"
Fill Factor	93 %
Addressing Bit Depth	8 Bit
Input Frame Rate	60 Hz / 180 Hz
Signal Format	HDMI - HDTV Res.

The LETO is also prepared to work in color-field-sequential (CFS) mode. For operation with color-switchable LASER the LED connector can be used to synchronize the light source with the device.

The LETO series covers a version for the visible (420-650 nm), a version for version for the near IR (650 -1100 nm) and a fast version for Color Sequential (CFS) operation in the visible.



Device	λ Range	Maximum Phase	Average Refl.
LETO-VIS-017	420-650 nm	min. 2 π (CFS)	75%
LETO-VIS-009	450-650 nm	2.8 π @ 650 nm	75 %
LETO-NIR-081	650-1100 nm	2.4 π @ 1064 nm	62-70 %

GAEA-2 Phase Only Spatial Light Modulator Series



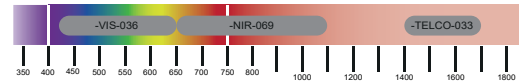
The GAEA-2 phase modulators are based on reflective LCOS microdisplays with 4160 x 2464 pixel resolution and 3.74 μm pixel pitch. The phase displays can be

addressed at 3840x2160 pixel or 4000x2464 pixel resolution at 60 Hz. The full physical resolution of 4160 x 2464 pixel can be used at 58 Hz frame rate.

Display Type	Reflective LCOS
Resolution	max . 4160 x 2464 Pixel
Pixel Pitch	3.74 μm
Active Area / Diagonal	15.32 x 9.22 mm / 0.7"
Fill Factor	90 %
Addressing Bit Depth	8 Bit
Input Frame Rate	3840 x 2160 Pixel @ 60 Hz 4000 x 2464 Pixel @ 60 Hz 4160 x 2464 Pixel @ 58 Hz
Signal Format	HDMI

The small pixel pitch of 3.74 μm enables high diffraction angles with high effective spatial resolution of 133.5 lp/mm.

The GAEA series covers a version for the visible (420 - 650 nm), the near IR (650-1100 nm) and a version for the area of 1400-1700 nm.



Device	λ Range	Maximum Phase	Average Refl.
GAEA-VIS-036	420-650 nm	3 π @ 633 nm	62 %
GAEA-NIR-069	650-1100 nm	2.4 π @ 1064 nm	60 %
GAEA-TELCO-033	1400-1700 nm	2.6 π @ 1550 nm	72 %

LC 2012 Translucent Spatial Light Modulator



The LC 2012 is a basic Spatial Light Modulator system based on a translucent liquid crystal microdisplay with a resolution of 1024 x 768 pixel (XGA). The device can be used for phase or amplitude modulation in the

visible range (however, phase shift may be limited, e.g. $\sim 2 \pi$ at 450 nm, $\sim 1.8 \pi$ at 532 nm). The LC 2012 is addressed by a standard HDMI interface.

Display Type	Translucent LC
Resolution	1024 x 768 Pixel
Pixel Pitch	36 μm
Active Area / Diagonal	36.9 x 27.6 mm / 1.8"
Fill Factor	55 %
Addressing Bit Depth	8 Bit
Input Frame Rate	60 Hz
Signal Format	HDMI - XGA Res.