SPECIFICATION SHEET

PLUTO - 0,7" HDTV LCOS Phase Only Kit

Modulator for phase displays VIS, NIR & TELCO
HES: 6010 xxx

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HOLOEYE Pioneers in Photonic Technology

Table of content:

1 Introduction

1.1 Description

The PLUTO kit is used to control an LCOS (Liquid Crystal-on-Silicon) active matrix reflective mode phase only LCD with 1920 X 1080 resolution and a 0.7" diagonal. The Pluto platform can control three different version of the high resolution phase only display that are optimized for different wavelength ranges. PLUTO-VIS is optimized for 420 - 850 nm, PLUTO-NIR for 850 - 1100 nm and PLUTO-TELCO for common telecommunication wavelength ranges up to 1550 nm.
The signal is addressed via a standard DVI (Digital Visual Interface) signal e.g. by a PC's graphics card. Basically the LCOS display works like an extended monitor, were all phase function (gratings, phase masks, holograms, etc.) are addressed via DVI. Hence this plug and play kit guaranties a quick start-up and easy usage.
The PLUTO kit is highly programmable and allows a tailored configuration according the specific requirements. Via the RS-232 interface and with the provided software one is able to perform gamma control to configure the modulator for different applications and wavelengths. Besides geometry and gamma corrections different sequences can also be addressed to the driver.

1.2 Deliverables

- High resolution phase display incl. flex cable
- Compact driver unit
- Power supply + cable
- DVI and RS-232 cable
- Dual head graphics card (VGA / DVI)
- Display mount
- CD with software package
  and documentation

Figure 1: PLUTO kit deliverables

1.3 General usage guidelines

- Due to transport reasons the display and the driver unit have to be connected on site. The connection has to be done on an antistatic workstation in order to avoid damages on the driver electronics and / or the display.
- All plugs of electrical interfaces especially the display to drive board connection has to be done without applied voltage.
- Even if the DVI is hot plug capable we recommend to boot the PC after connection.
- Do not use the kit outside buildings and in humid or dusty places and keep the kit away from extreme heat and coldness.
- Avoid touching the LCD because this might cause damages or reduce its optical quality.
- If you plan to illuminate the kit with powerful light sources, we strongly recommend consulting HOLOEYE services.

2 Phase Display Specifications

2.1 Display parameter

Part no.	HED 6010 xxx
Type:	LCOS (reflective), Active Matrix LCD
Drive scheme:	digital (pulse width modulation)
Mode :	ECB mode, nematic
Phase levels:	256 (8-bit) grey levels
Active Area:	15.36 mm x 8.64 mm
Weight:	12 grams
Resolution:	Nominal: 1920 H x 1080 V pixels Total: 1952 H x 1088 V pixels
Pixel Pitch:	8.0 µm
Fill Factor / Aperture ratio:	87%
Max. Image Frame Rate:	60 Hz
0^{th} order intensity	60%
Illumination (max.)	< 2 W / cm²
Operating temperature:	+10°C to +70°C
Operating Waveband:	UV irradiation shall be controlled via an absorption filter

Figure 2: HD phase display

2.2 Connecting the display

At first the driver unit and the display flex cable have to be connected. This has to be done under antistatic conditions and without applied voltage. Note that the ZIF connector is limited in the contact durability wherefore often connection and disconnection should be avoided.
First of all release the two screws on top of the driver unit and remove the cover. Open the brown connector flap by pulling it up until it becomes perpendicular to the driver board as shown in the left side of *Figure 3*. Take the display with face and golden pins up and align the flex straight to the connector. Then push the flex cable carefully into the connector until a you feel a resistance.

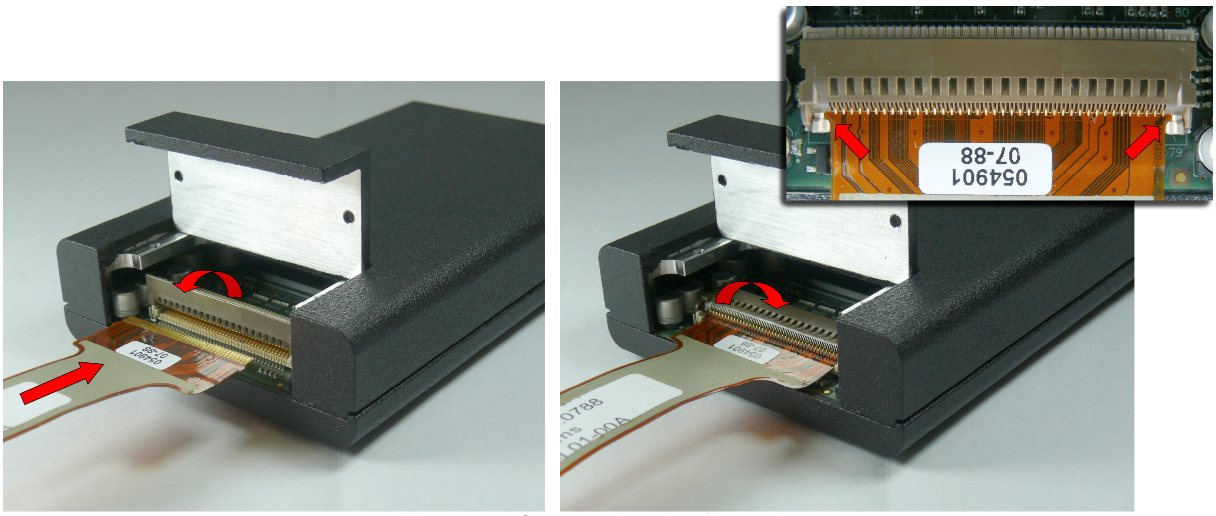


Figure 3: Connecting the flex cable

Now fix the connector by pressing down the brown plastic flap. If the display is connected correctly, the interface stopper on both sides of the display flex will be interlocked by two tiny white plastic spikes from the connector. (see close-up in *Figure 3*) Finally close the cover of the housing and fit it with the two screws.

2.3 Mounting the display

The standard landscape type phase display comes with a polymer border. The packaging allows a stable holding in the supplied display mount what has a M4 thread. When mounting the display with locking screws, avoid strong forces affecting the display. The metallic back side of the display offers the possibility of a magnetic mounting.

2.4 Dimensions of display and mount

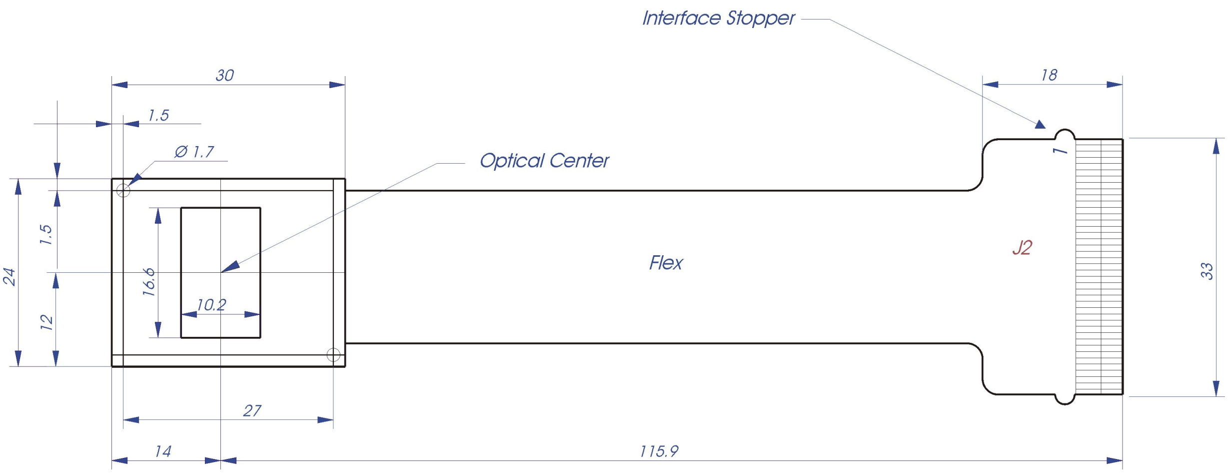


Figure 4: Display dimensions (unit: mm)

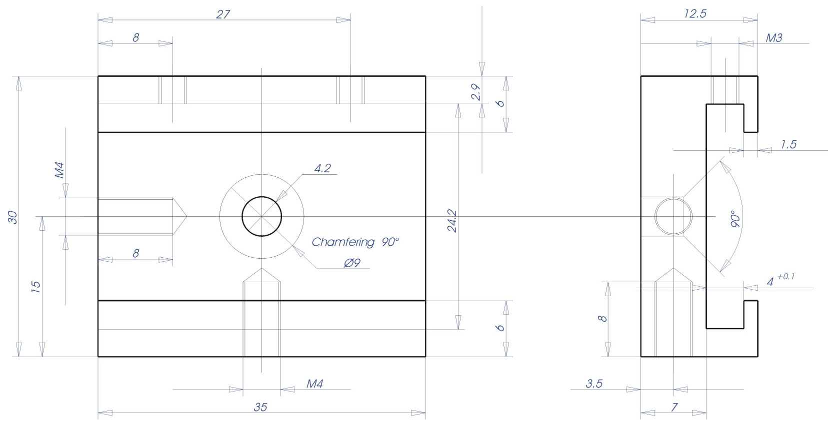


Figure 5: Display and display mount dimensions (unit: mm)

3 PLUTO Driver Unit

The compact electronics drives one LCOS phase display. It requires only a single voltage (5V) supply. Signal input is standard DVI and the 8 Bit data from the green color channel will be used to address the LCOS display. The PLUTO kit is highly programmable and the RS-232 connector enables the user to do various display adjustments like gamma correction, geometrical settings and even different sequences can be loaded to the driver.

3.1 Dimensions of driver unit

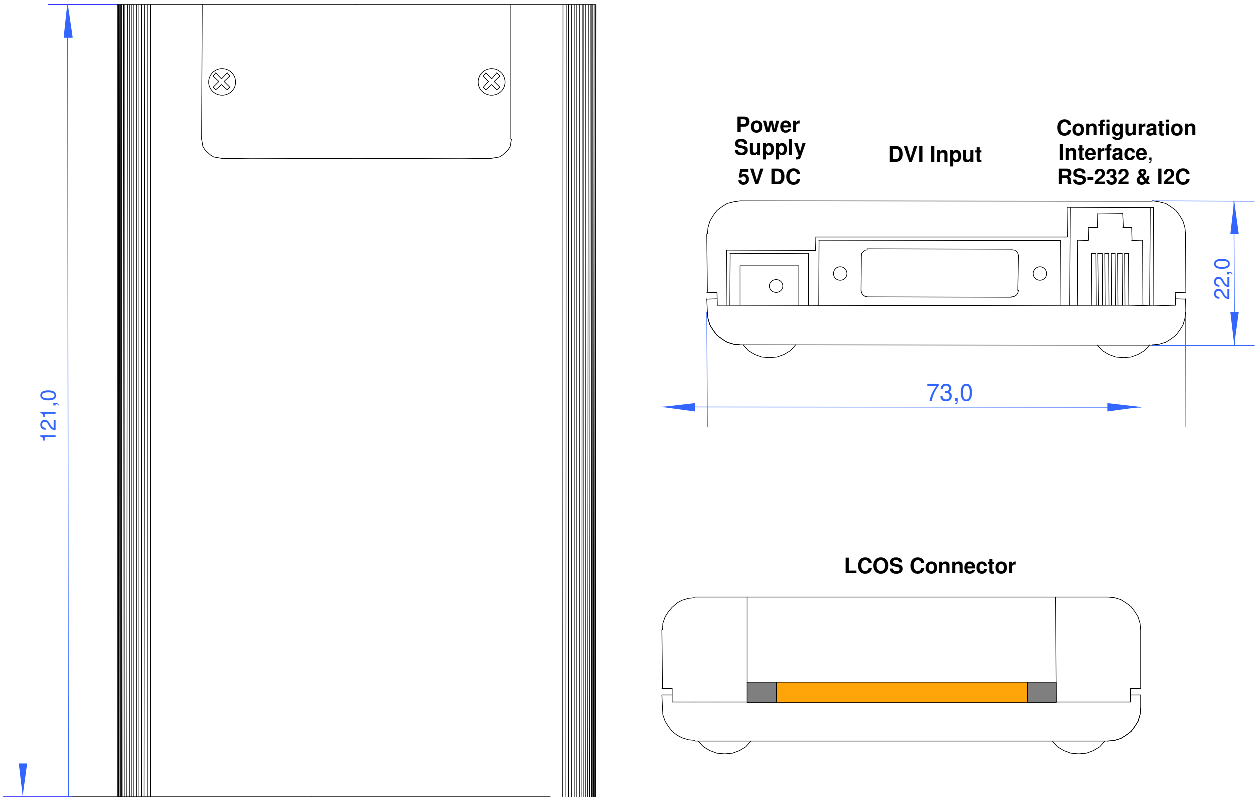


Figure 6: Driver interfaces and dimensio

3.2 Power supply

Switching power supply

Input:	100 - 240V AC	
	47 - 63 Hz	0.4 A
Output:	5V --- 2.4A max.	

Power applies directly by plugging the power supply cable into the unit.

3.3 Power up sequence

- Connect all components:
  - Microdisplay to driver unit (see chapter 2.2)
  - DVI cable to PC and driver unit
  - RS-232 cable to PC's COM port and driver unit
    (only necessary for advanced optical settings, not for normal operation)

- Second monitor for use with double head graphics card with native resolution of 1920x1080 at 60 Hz vertical refresh rate or above is recommended for easy maneuver.

- The DVI output of the graphics card needs to be activated, e.g. by using the „Clone"-Function. This can be normally done under „Advanced"-settings under the menu point „Display-Properties"

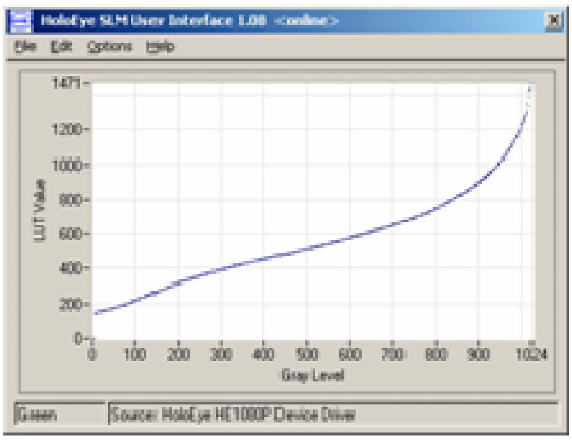
- Turn on the device by connecting the power cable.

At this point you can already use the device. For advanced optical settings and changing the electro-optical response you can use the HOLOEYE GUI (Graphical User Interface) software.

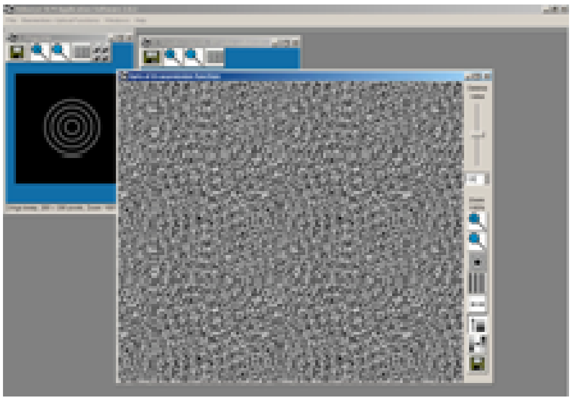
4 Software Package

The software package includes a device driver with graphical user interface (GUI) as well as an application software.

The GUI software can be used to change geometrical settings, brightness, contrast and the electro-optical response by applying a new gamma curve or the digital drive schemes. This requires RS-232 communication via COM port of the computer. There are also USB to COM adapter available. For further support by creating and loading new gamma curves etc. feel free to contact HOLOEYE



The Application software allows the computation of computer generated holograms (CGH) from user defined signals as well as the generation of elementary optical functions like different kind of gratings etc. as well as the superposition of different CGH's.



4.1 Hardware and software requirements

- IBM PC or compatible
- Operating System Windows2000 or Windows XP
- Serial port (COM port) or USB to RS-232 adapter

4.2 Installing the GUI software and device driver

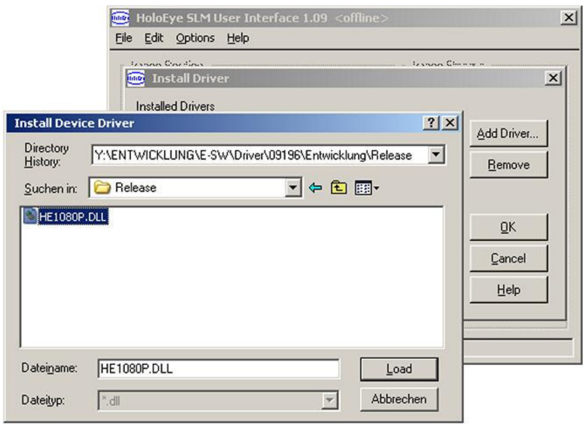
Basically there are three steps in order to get the GUI software incl. device driver running.

1. Installation of the GUI
2. Installation of the device driver
3. Integration of the device driver into the GUI

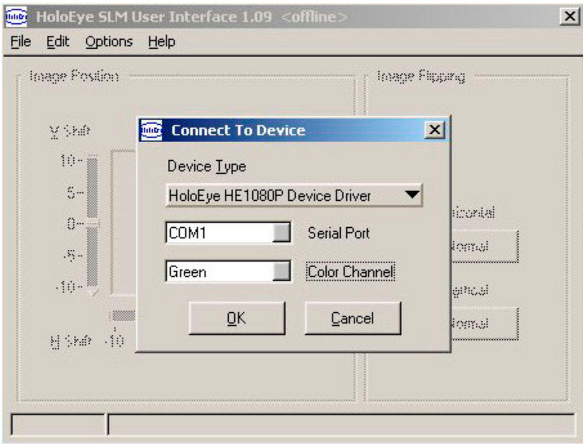
Install the GUI by starting the setup.exe from the directory "Setup SLM_GUI_109" and follow the instruction.

After completing this, install the HE1080P device driver by starting the setup.exe from the directory "Setup_HE1080P_109". This will install the driver on your hard disk to the path "C:\Program Files\HE1080P" (Changes can be done in the dialog). Start the software from the start menu and use also the descriptions which can be found at help button.

Run the Holoeye GUI from start menu and select *Add / Remove Driver* from the *Options* menu.
Use the "Add Driver" Button and choose the driver "HE1080P.dll" from the file list. The path was defined one step before. Default path: "C:\Program Files\HE1080P



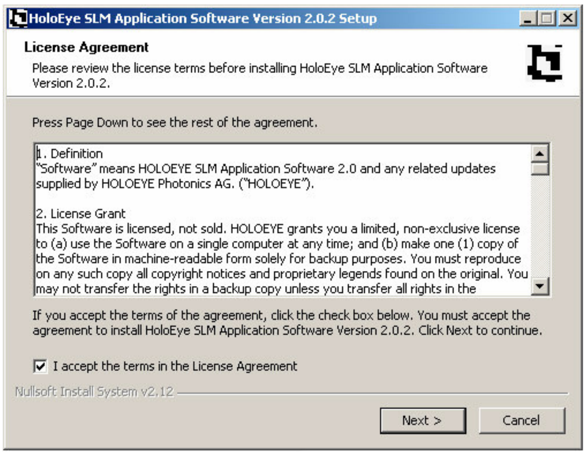
To establish a communication with the device, go to menu point “File” and click “Connect To Device”. Choose the Port and select the “Green” color channel.



The software functions are described in the help function.

4.3 Installing the Application software

Install the Application Software by starting the “HoloeyeSLMAppSoft_HEO1080_2.1.2_Installer.exe” from the directory “Application Software”. Follow the instructions within the dialog window. It’s recommended to install all components. After successful installation start the application software from the start menu.



All functions of this software are described in the manual witch can be opened from the start menu.

5 Phase Modulation Properties

5.1 Measurement set up

The following figure shows the experimental set up for phase and amplitude modulation measurements.

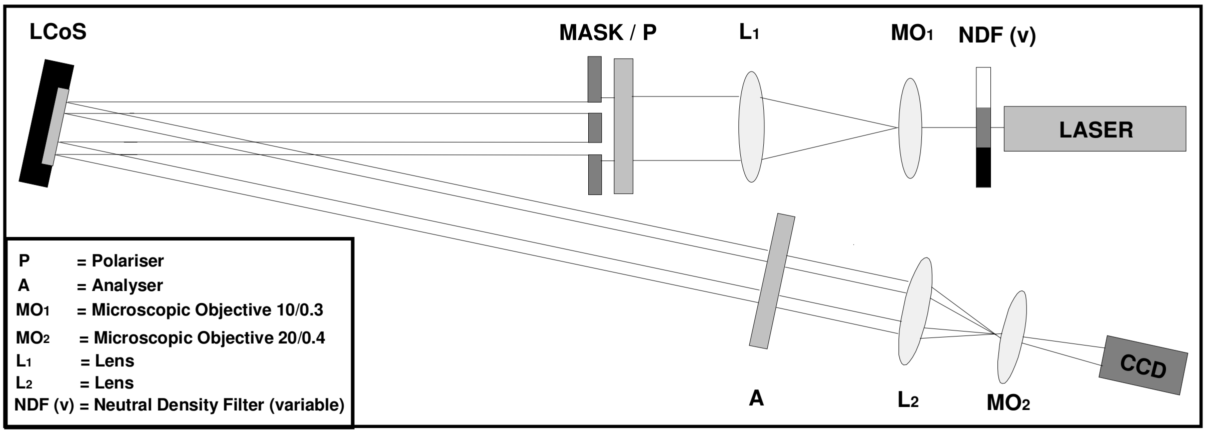


Figure 7: Experimental setup for phase modulation measurements

This two beam interference set-up consists of a neutral density filter, 2 polariser, a double hole mask, 4 lenses and a CCD camera. The polarisation of the expanded and collimated laser beam can be adjusted by a polariser or a λ/2 wave plate in case of a pre polarised source. The mask creates 2 coherent beams which are guided to the LCOS display that is separated into two parts (one part gets a stable signal and the other part is successively addressed by gray level from 0 to 255). These two beams will be reflected under a small angle whereas one beam is modulated by the LCOS display. The analyser chooses the output polarisation and the lenses let the beams interfere and image the interference pattern onto the CCD.
A software written by HOLOEYE evaluates the phase shift introduced by the changing gray level of one display half (this software can be downloaded with a instruction manual from the download area of our homepage www.holoeye.com).
If the un modulated beam is blocked and the CCD camera is replaced by an intensity meter one can easily measure the intensity modulation of the SLM for certain polariser/analyser settings.

5.2 Polariser settings

The polarizer used for the HeNe-laser and the analyzer are calibrated in such manner that the 0° position blocks horizontally polarized light and transmits vertically polarized light. The direction of polarizer rotation is mathematically positive.

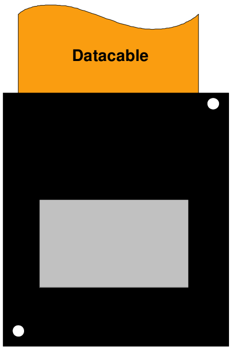


Figure 8: Phase LCoS

5.3 Complex Modulation Measurement Data

The phase modulation was measured relative to a linear polarized reference beam by using a Michelson-Interferometer as described in the setup sketch. The intensity modulation was measured with the same setup but with a blocked reference beam.

The left side graph shows the phase shift properties of the display with the default settings, measured at 633nm. The graph at the right side shows that there is almost no coupled amplitude modulation during phase modulation.

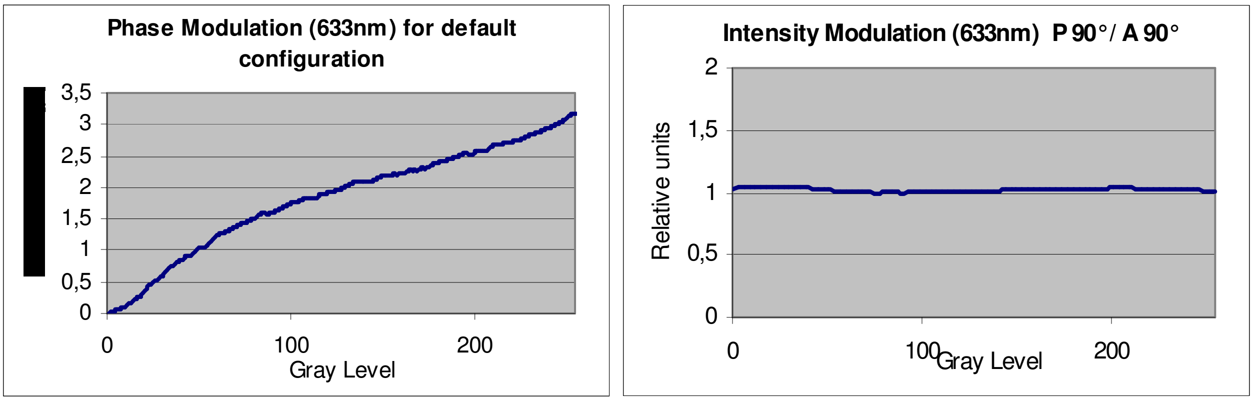


Figure 9: Phase- and intensity modulation with default configuration and gamma table @ 633nm

5.4 Phase Measurement with Gamma Correction

The phase only kit is highly programmable and with the GUI software the user is able to load customized gamma tables in order to achieve a linear optical response from 0-2π for the used wavelength. This influences the voltage to gray level Look up Table (LUT).

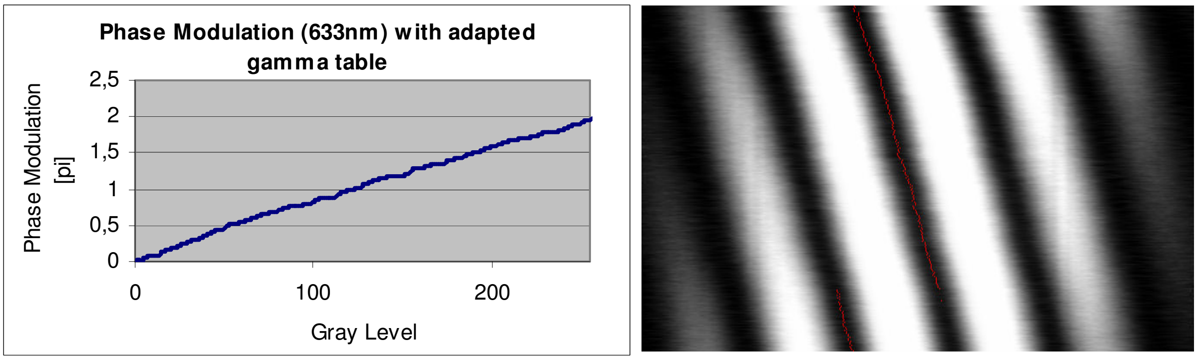


Figure 10: Phase modulation creating a linear optical response over one complete wave

The graph shows a linear phase response after loading a new gamma table into the device. The right figure is a screenshot of the corresponding measurement result, taken with the provided software "Phase Cam" showing the shift of the interference pattern as a function of the applied gray level (y - axis).

6 Phase Only Display for NIR Applications

6.1 NIR - Phase only display (800-1100nm)

HOLOEYE provides further display types for the near infra red spectrum. While the standard phase only display (VIS) has a broadband AR (anti reflection) coating from 420 – 810 nm, the VIS version features an AR coating from 800-1100. Moreover a thicker LC layer guarantees a phase modulation of 2π still at 1064nm.

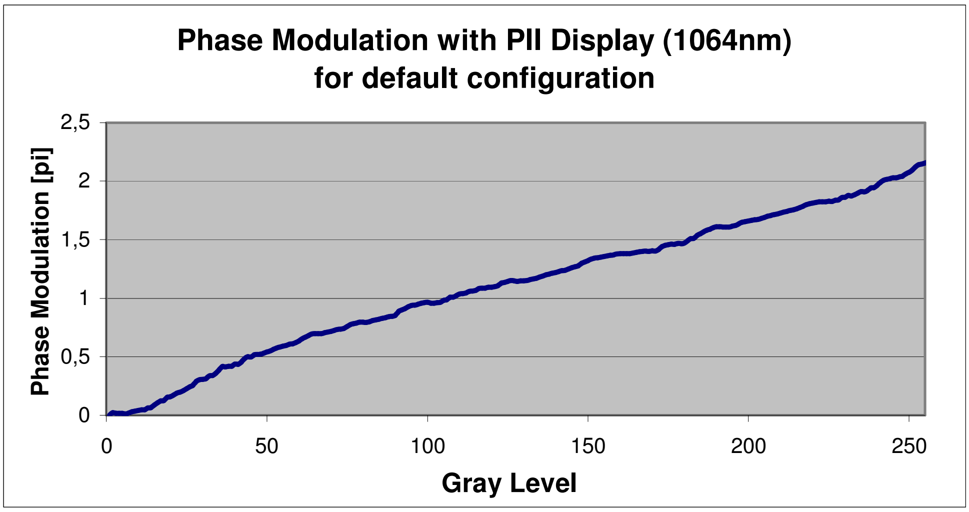


Figure 11: Phase modulation with NIR display at 1064nm

6.2 TELCO - Phase only display (1550nm)

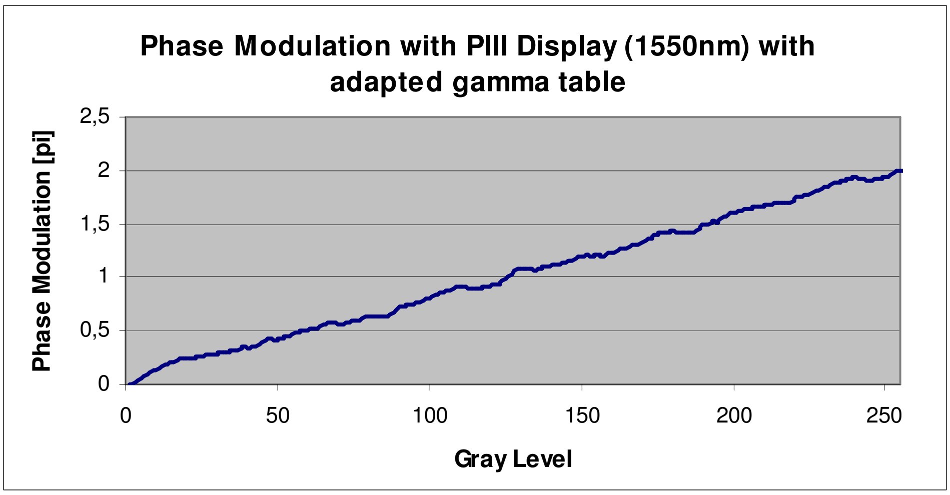


Figure 12: Phase modulation with TELCO display at 1550nm

7 Diffraction Efficiency

The lattice structure of the LCoS display itself, caused by the pixelation, leads to diffraction into higher orders. The 0^{th} order of the non-addressed display is around 60%.
The diffraction efficiency values see the 0^{th} order intensities as a reference (100%). For the total light efficiency definition of the phase panel this needs to be considered.

Diffraction efficiency values in table 2 have been determined for binary (lattice parameter 3 pixel), 8 level and 16 level blazed gratings at 633nm with a 5:5 sequenze configuration and linearised electro optical response of 2π.

Grating	I_{+1st}	I_{0th}	I_{-1st}
Binary (horizontal)	40%	1,8%	40%
8 level blaze	75%	2,2%	0,8%
16 level blaze	83%	1,6%	0,85%

Diffraction efficiency of different grating structures

8 Optical flatness of the panel

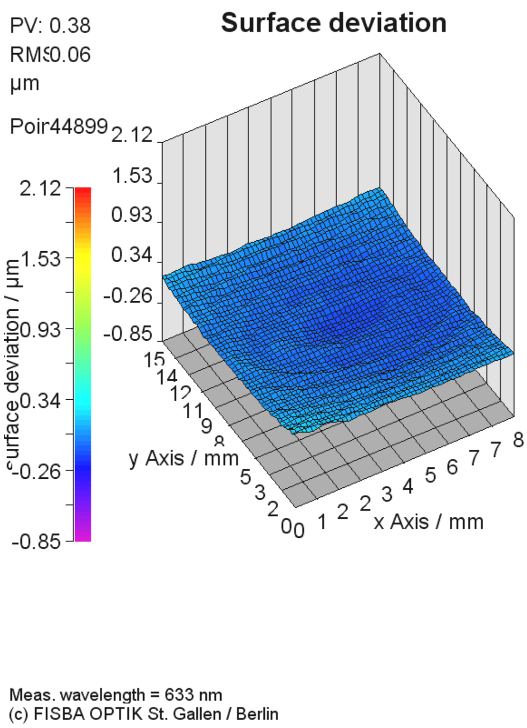
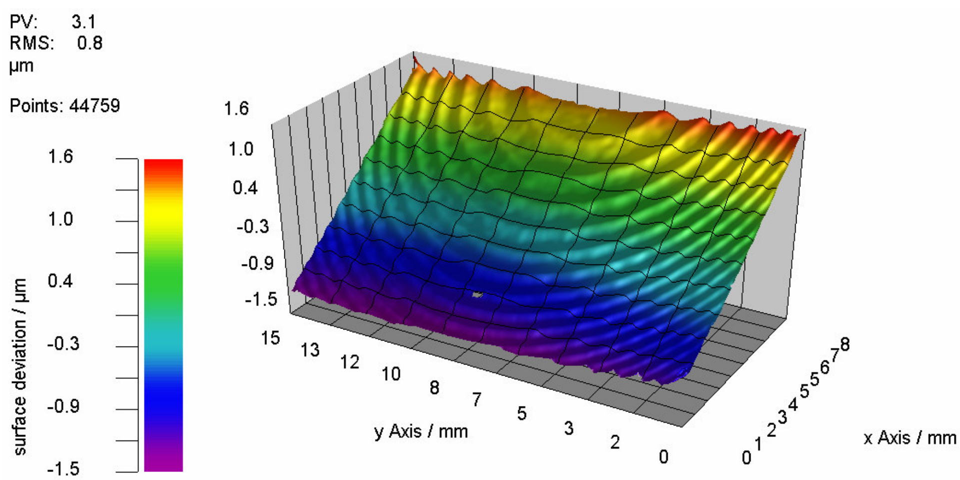


Figure 13: Optical flatness of the display

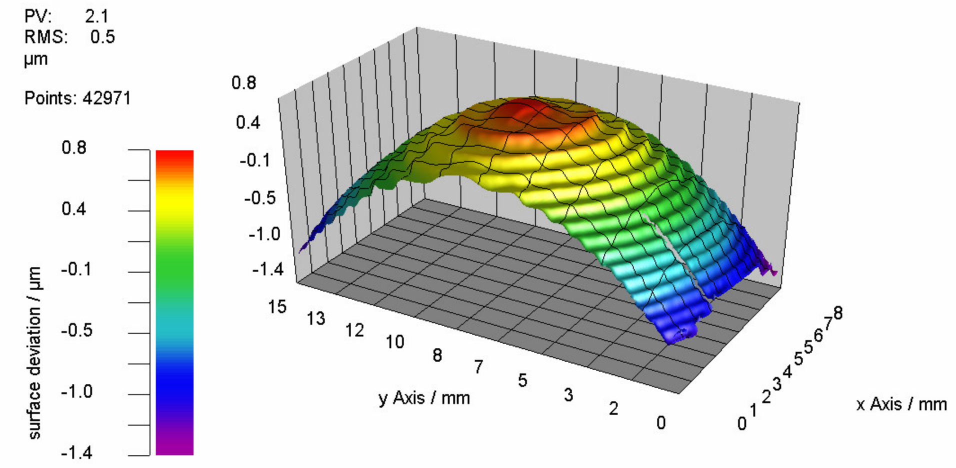
All of the micro display technologies are not ideally optical flat. Translucent displays as well as reflective LCoS displays (nematic and ferroelectric) show a slight curvature.
This in general not more than up to 3-4 waves at 633nm. For most of the applications this does not matter at all, since the deformation is almost spherical and superimposes a very weak lens function to the addressed optical function.
Due to fabrication also our HDTV phase LCoS-panel surface is not optically flat. The surface deformation is in general a spherical function. Depending on the application this has a minor effect which can be completely compensated due to the phase-only modulation properties.
A compensation function can be superimposed to all addressed optical function to compensate this deformation (see left side figure).
With this compensation function, one is able to flatten the reflected wave front and superimpose all optical function to this compensation function.
This has been proved by various customers already with HOLOEYE previous systems.
We could achieve a flatness of Lambda/2 – Lambda/4 for the HDTV-phase displays central area.

Examples of addressed phase functions with superimposed correction function

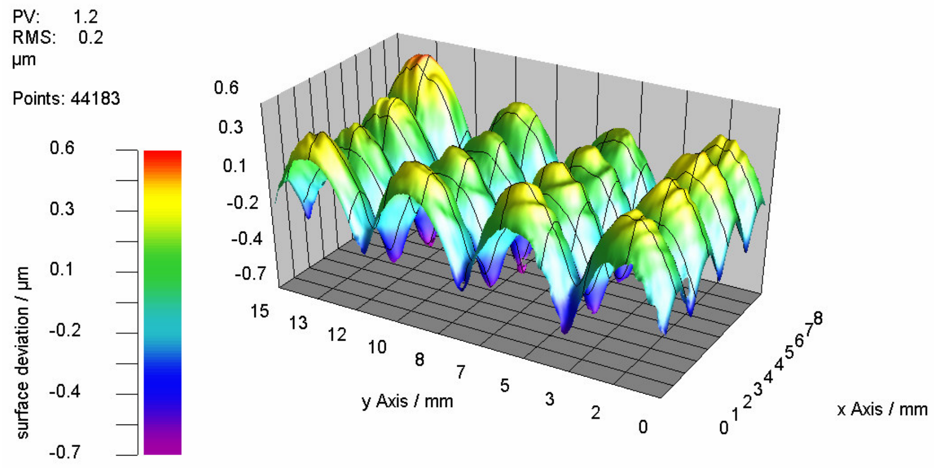
Linear phase ramp



Spherical phase function (lens)



Array of 16 spherical phase functions (lenses)



9 Start-up

- Display has to be connected under zero voltage conditions
- DVI-connector should be plugged before booting the PC
- The graphic card settings have to be checked and changed if necessary (1920x1080, 60 Hz, second monitor (DVI) activated)
- Connecting power supply
- Initial testing can be done by placing a polarizer directly on the display. It has to be turned until the addressed image is to see (note that this is not a crisp image since this is a phase display).

With further questions please get in contact with HOLOEYE:

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