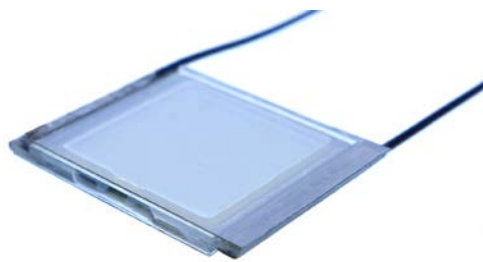


X-FOS(G2)-LAS

PRELIMINARY PRODUCT SPECIFICATION



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Disclaimer

All technical information concerning LC-Tec's X-FOS(G2)-LAS model is based on laboratory test results believed to be reliable at the time of press. The product is under development and the specification might change prior to official product release. The user should decide if the shutter is fit-for-purpose before using it. The user accepts all responsibility associated with such use.

1. Revision history

<i>Revision</i>	<i>Revision date</i>	<i>Revision content</i>
Initial release	2014-04-11	-
-	-	-

2. Product description

The X-FOS(G2)-LAS (Fast Optical Shutter - Laser Operation) is a polarizer-based nematic liquid crystal (LC) optical shutter that controls the light transmittance by an externally applied drive voltage. It provides broadband visual-near infrared (up to 1,000nm) operation with high open state transmittance optimized for wavelengths around 550nm. Compared to conventional mechanical shutters, LC shutters are completely vibration-free and contain no moving parts.

The shutter consists of a polarization modulator in the form of a LC cell positioned between crossed linear polarizers. Applying the drive voltage reorients the birefringent LC molecules, changing the phase retardation of light passing through the LC cell. This results in a change in transmittance of light passing through the full shutter structure. Analogue gray-scale operation between fully open and closed states is realized by voltage amplitude modulation.

3. Ordering information

<i>Product</i>	<i>Part number</i>
13x17_X-FOS(G2)-LAS	TBD, prototype only
LCC-230 Controller	LCT-030

To purchase or for more information, please contact us at: info@lc-tec.se.

4. Custom designing

Customers not finding their required shutter properties are advised that other FOS models are available and that further optimization and custom designing are possible, both in terms of electro-optical properties and mechanical dimensions (up to 14"x16" size).

Please note that the maximum open state transmittance of the X-FOS(G2)-LAS shutter can be optimized for any given wavelength in the 400 to 1,000nm interval.

5. General specifications

<i>X-FOS(G2)-LAS</i>	
Technology	Nematic LC
Mode of operation	Normally white
Side 1 polarizer transmission axis ¹	+45°
Side 2 polarizer transmission axis ¹	-45°
LC cell substrate material	Polished soda lime glass
Polarizer type and material	Reflective type metal
AR substrate material	N/A
Scratch resistance	N/A

6. Absolute maximum ratings²

<i>X-FOS(G2)-LAS</i>	
Operating temperature ³	-30°C to +70°C
Storage temperature ³	-30°C to +70°C
Drive voltage amplitude	≤18V
Drive voltage frequency	≤1kHz AC square waveform
Laser damage threshold	250mW/mm ² CW @ 450nm (72h continuous exposure)

7. Electro-optical specifications⁴

<i>X-FOS(G2)-LAS</i>	
Open state transmittance ⁵	60% @ 550nm Broadband 400-1,000nm operation, for other wavelengths refer to graphs in section 8.1
Contrast	130:1 @ V _D =18V and 550nm Broadband 400-1,000nm operation, for other wavelengths refer to graphs in section 8.1
Angular dependence	Normally or close to normally incident light only recommended
Closing time (T ₁₀₀ -T ₁₀)	100μs @ V _D =18V
Opening time (T ₀ -T ₉₀)	18ms @ V _D =18V

¹ Refer to drawing in section 10.

² Reliability tests performed over a range of environmental conditions according to standard IEC 61747-5.

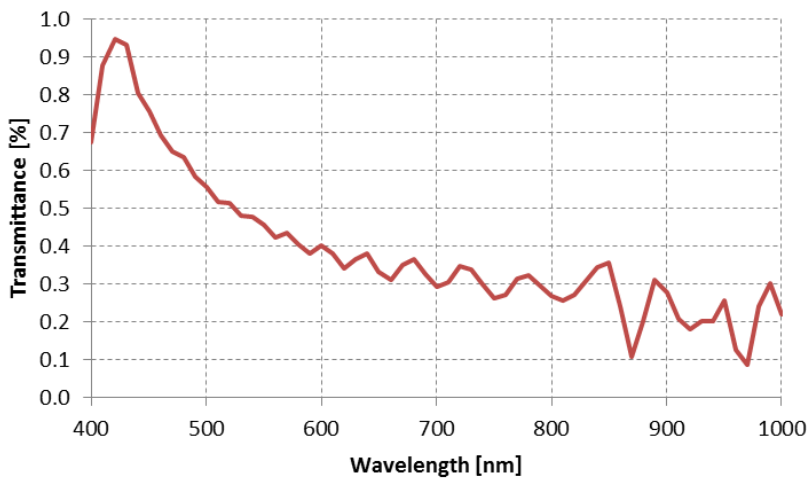
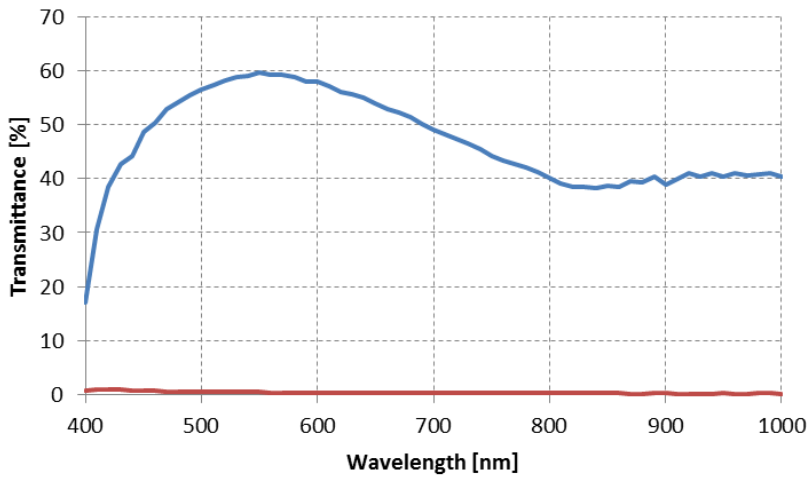
³ Dry, no condensation.

⁴ The specified values are valid for the 13x17mm size and measured at room temperature (23°C ± 3°C).

⁵ Refers to linearly polarized incident light oriented parallel to the entrance polarizer transmission axis.

8. Graphs (typical values for polarized light @ room temperature and $V_D=18V$ unless other specified)

8.1. Open and closed state transmittance vs. wavelength



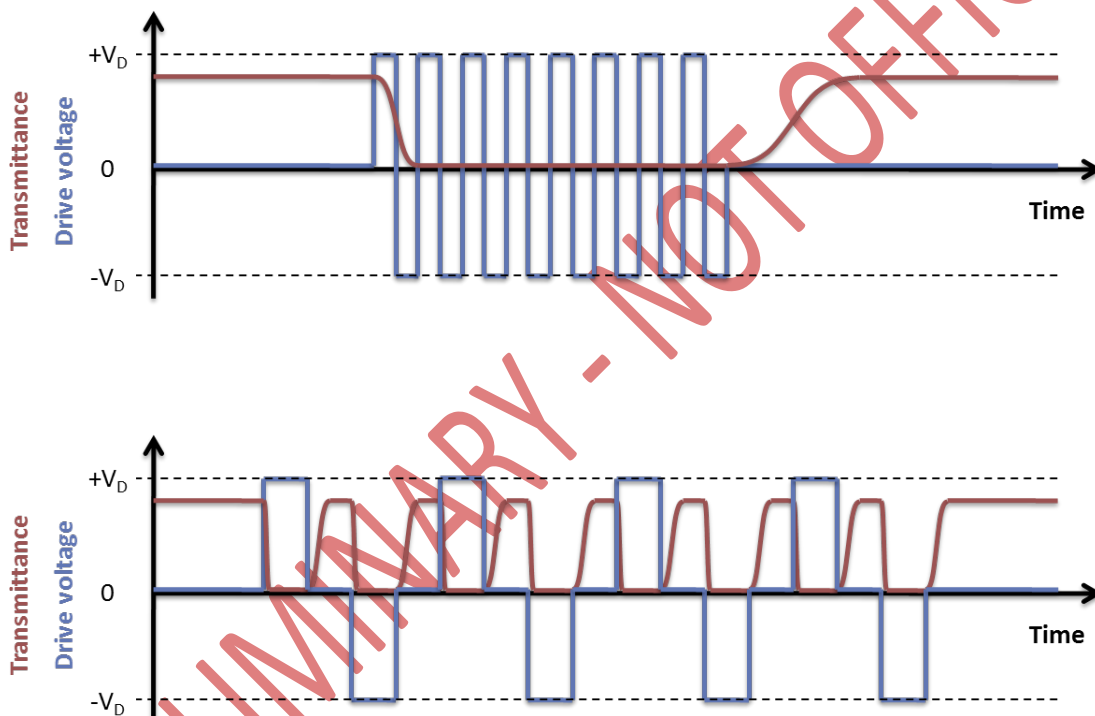
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9. Drive voltage and recommended controller

The shutter possesses mono-stable normally white operation, meaning that without voltage applied the shutter is in its fully open, light-transmitting state. Applying the drive voltage, V_D , switches it to a closed, light-absorbing state. This voltage must be kept throughout the duration of the time the shutter is required to be in the closed state. In general, increasing the drive voltage amplitude increases the contrast and shortens the closing time.

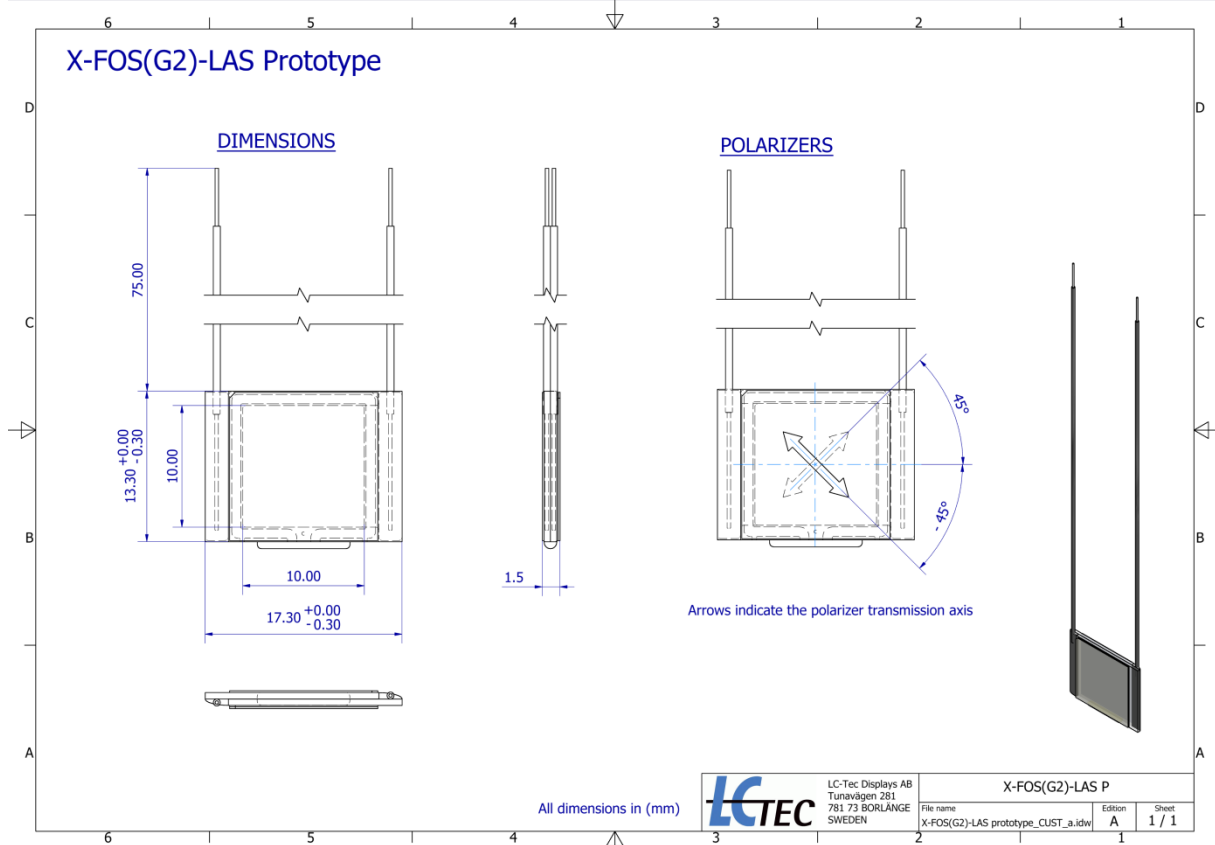
The transmittance of the shutter reacts to the RMS voltage. In order to prevent ion migration within the LC layer that might impair shutter performance and lifetime, it is recommended to ensure that there is no net DC bias present in the drive signal. This is best achieved via use of one of the two AC square waveforms illustrated below. When the top one is used, the recommended minimum frequency is 60Hz if visual flicker is to be avoided. The bottom option is suitable when cycled operation between open and closed states is desired.



The LCC-230 (LC-Tec Part number LCT-030) is a flexible, full-featured liquid crystal controller specifically designed to drive all FOS, X-FOS, and PolarSpeed® models. The LCC-230 incorporates two independent LC channels, each with $30V_{RMS}$ of range and fully short-circuit protected. The controller is operated by the LCDriver2 application via a full-speed USB 2.0 compliant interface. LCDriver2 permits dynamic editing of programs up to 96 lines in length. Three trigger modes (internal, line, program) determine how program lines are executed. Up to nine programs may also be pre-stored on the LCC-230 for stand-alone operation. See user manual for further information.

Note: Customer-developed LC drive stages must be able to deliver at least the peak current of the specific FOS device to be driven. Output-stage ballast capacitors with a maximum ripple current rating at least three times the peak current is recommended.

10. Mechanical dimensions and polarizer transmission axis⁶



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⁶ Refers to available standard size. Custom designing up to 14"x 16" size is offered.

11. Handling precautions

The following provides recommendations for handling of this product.

LC shutter handling and cleaning precautions

- A protective film is supplied on both sides of the shutter and should be left in place until the shutter is required for operation.
- The polarizers do not have any hard-coating on the outer surface, please guard against scratching, do not rub with abrasives.
- Keep the shutter surface clean. Do not touch without protective gloves.
- Should the surface become contaminated, wipe lightly with a soft cloth moistened with solvent (isopropyl alcohol or ethyl alcohol) in order to clean the shutter surface.
- Do not wipe the shutter surface with dry or hard materials that may damage the surface. Do not use the following solvents for cleaning: water, aromatics, acetone or other ketone.
- Since this shutter contains glass substrates, avoid applying mechanical shock or pressure. Do not drop, bend, twist or press on the shutter.

Storage

- Avoid exposure to direct sunlight or high temperature and humidity. Recommended storage conditions: temperature range +5°C to +45°C with humidity <60%RH.
- Do not store the shutter near organic solvents or corrosive gases.
- Keep the shutter protected from vibration, shock and pressure.

Operating precautions

- It is important to operate the shutter within the specified voltage limits; higher voltages may significantly reduce the lifetime of the shutter.
- The use of direct current drive (DC voltage) should be avoided since a reaction stimulated by such current significantly reduces the lifetime of the shutter.
- The switching speed of the shutter will be reduced at lower temperatures, and the optical-shutter will show a dark color at higher temperatures. However, the shutter will revert to normal operation once the temperature conditions return to the range for normal operation.

Safety

- Should the shutter become damaged and the skin is exposed to liquid crystal material, it is recommended to immediately wash off the liquid crystal material using soap and water.
- If the liquid crystal material should come into contact with the eye, flush the eye using running water for at least five minutes. Seek medical advice.
- **Note: The polarizers are of reflective type. In the open state approximately half of the incident light is reflected back (for unpolarized incident light), while almost all of the light is reflected back in the closed state. Be aware of back-reflections.**