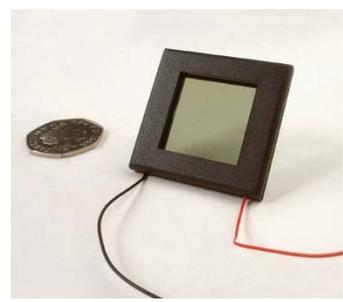


LCS2 –G

Single element, Fast switching Liquid crystal shutter



Features

- Single element – active area 25.5mm x 25.5mm
- Fast switching Ferroelectric Liquid Crystal (FLC)
- Contrast ratio >1000:1 (with appropriate external polariser alignment)
- Transmission 80% (without polarisers)
- Plastic housing to prevent physical damage to the cell
- Supplied with and without polarisers
- Lightweight and portable
- Large volume supply availability
- Solid state device with no moving parts

Applications

- 3D glasses
- Simulation (projection)
- Printing
- Ophthalmic equipment
- Metrology measurement systems
- Optical switching
- Beam steering
- Imaging
- Camera shuttering
- Laser modulation

Description

CRL Opto LCS2-G shutter is optimised for use at 540nm to modulate transmitted light. Other visible wavelengths can be used but the contrast ratio and transmittance will differ from the values shown in this datasheet. It is not designed for use with <400nm light.

The LCS2-G shutter is constructed using transmissive conductive glass components that sandwich a fast switching liquid crystal material. When square wave voltages are supplied to the shutter, the liquid crystal material switches very quickly from a light to a dark state.

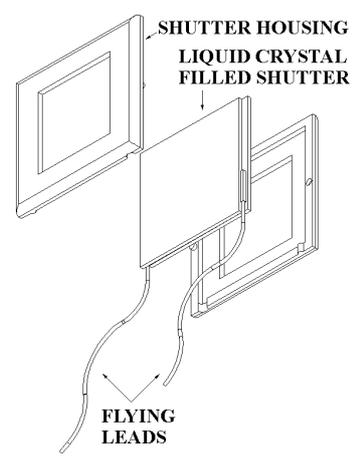
The shutter is surrounded by a black rectangular plastic housing and can be connected via two unterminated flying leads. Whilst the lightweight plastic housing provides strain relief for the flying leads, it also eases integration of the shutter into the users application and helps prevent physical damage to the glass cell.

The LCS2 is supplied with two main polariser options:

- fixed factory set crossed polarisers bonded to the shutter (part no: LCS2-G)
- polarisers supplied separately to the shutter (part no: LCS2N-G)

The LCS2-G has factory fitted polarisers that are positioned for use at 25C and 10V p/p (Volts peak to peak) 500Hz drive. Under different conditions this may not give the best contrast ratio (CR).

Polarisers can be supplied separately from the shutter, this allows the shutter to be optimally positioned relative to the polarisers which should be crossed at 90°. The shutter can then be used under a wider range of temperature and voltage conditions.



Shutter mode and specifications

Mode of operation

The FLC shutter can be considered as a switchable half-wave plate. The axes of the plate are rotated between two fixed positions by the application of the drive voltage. The front polariser selects one polarisation state of the input light. In the shutter dark state the axes of the liquid crystal are aligned with the polariser axes so the liquid crystal does not affect the state of polarisation. Because the polarisers are crossed the output polariser absorbs the light. In the light state the axes of the liquid crystal are rotated (ideally by 45 degrees) so the polarisation state of the light is altered (ideally, effectively rotated by 90 degrees) and some of the light is transmitted by the output polariser.

If the polarisers are rotated from the optimum crossed position the contrast ratio is reduced. The shutter no longer effectively blocks the light and the detector receives a constant illumination with the switched waveform superimposed.

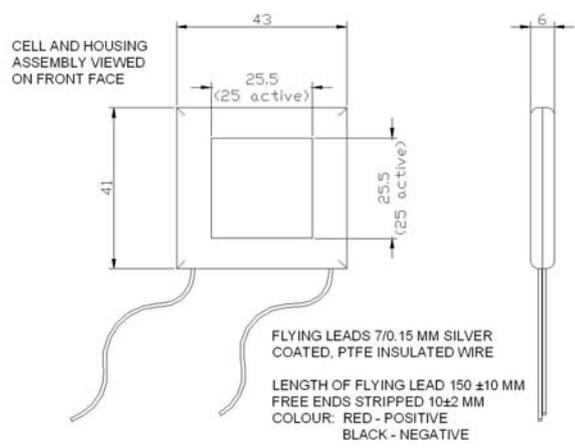


Figure 1. Shutter dimensions

Specifications/Product	LCS2-G	LCS2N-G	Notes
Overall dimensions (mm)	43 x 41 x 6	43 x 41 x 6	Parallel configuration
Active area dimensions (mm)	25.5 x 25.5	25.5 x 25.5	Single switching element
Continuous drive voltage (V) peak to peak (p/p)	5-20	5-20	Factory set up value 10V and must be DC balanced
Operating wavelength (nm)	400 - 700	400 - 700	Optimum 540nm
Average current (µA) at 20V p/p, 1kHz	30	30	
Optical response time (µs) at 25°C ON – 90%	110-120 µs	110-120 µs	10V pp 500Hz
Switching rise time (µs) at 25°C 10 – 90%	60-70 µs	60-70 µs	10V pp 500Hz
Light transmission (%) at 500nm	>37*	80	
Contrast ratio with a photopic filter, 10V p/p 500 Hz @ 25°C	>300:1	>1000:1	Using CRL supplied polarisers
Operating temperature range (°C)	optimal at 25 10 to 50	10 to 50	Range with reduced performance, -10 to 60
Storage temperature range (°C)	-10 to 60	-10 to 60	

*with both entry and exit polarisers

Shutter mode and specifications continued...

Contrast Ratio

The contrast ratio is affected by a number of interdependent variables; these include the type and alignment of the polariser, the voltage and frequency applied and temperature.

Contrast ratio is measured as:

$$\frac{\text{Transmission through shutter (clear state)}}{\text{Transmission through shutter (dark state)}}$$

Transmission of light through the shutter as a percentage is calculated as:

$$\frac{\text{Transmission through shutter (clear state)}}{\text{Transmission with no shutter}} \times 100$$

Figure 2 illustrates the effect of different frequencies and voltages on the contrast ratio. At low frequency (<500Hz) a 10V p/p drive voltage is adequate. At higher frequency it is necessary to use a slightly higher voltage 15V p/p for 1-2kHz. It is important to drive at the lowest acceptable voltage otherwise damage to the cell will occur with a consequent loss in contrast ratio. In particular do not use high voltage and low frequency.

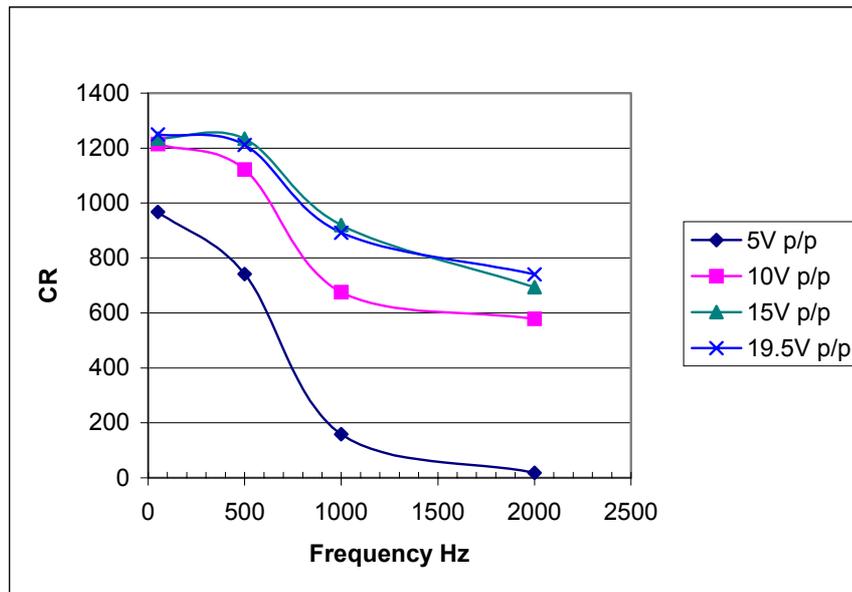


Figure 2. Frequency vs contrast ratio vs voltage for LCS2N-G

Similar curves, but at a lower CR, are found for LCS2-G shutter in which the cell may not be optimally positioned relative to the polarisers for all applications.

Response times

When a drive voltage is applied to the shutter the liquid crystal material switching rise time is defined as: *the time taken for the liquid crystal material to switch between 10% and 90% of its full switched position.* Optical response time is defined as:

- *the time between the switching trigger and 90% of the fully switched transmission (see Figure 3).*

Shutter mode and specifications continued...

A typical example of optical response can be seen in Figure 3 below:

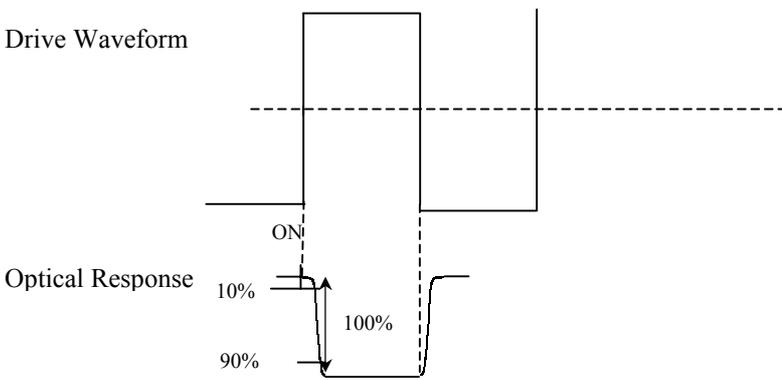


Figure 3. Typical optical response of the shutter when driven with a square wave form

When different voltages are applied to the shutter, the response time varies significantly in line with the voltage being used. As shown in Figure 4, when using a frequency of 1kHz a 10V p/p the response time for the LCS2-G (with polarisers) is 60-70µs. (Note - below 10V p/p the cell does not fully switch – see Figure 2). As the voltage increases the rise time shortens significantly. If this time becomes a significant portion of time during which the field is held on the cell per cycle, the contrast ratio is severely reduced. This limits the frequency at which the cell can be used (see Figure 2).

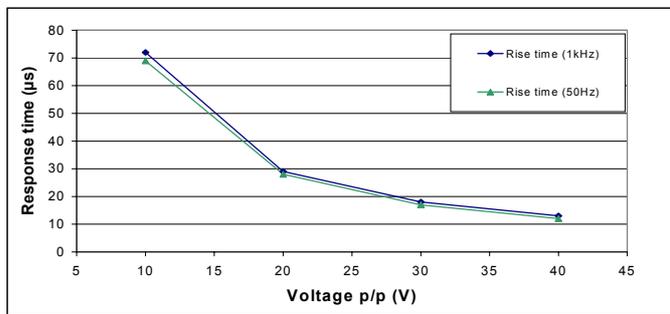


Figure 4. Effect of voltage on response times (10-90%) for LCS2-G

Coming soon:

LCS2-R/LCS2N-R (optimised for 640nm-700nm).

LCS2-B/LCS2N-B (optimised for 450nm-520nm).

To place an order for either the LCS2-G or the LCS2N-G please refer to the product ordering section below.

Product ordering

- LCS2-G Standard shutter with polarisers
- LCS2N-G Standard shutter without polarisers

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