

# ARCOptix

## Variable attenuator

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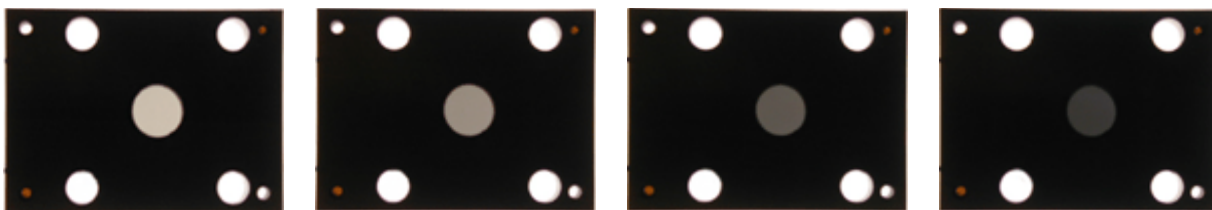
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The arcoptix variable attenuator functions as a variable gray filter from 350nm to 700nm. The attenuator can be continuously tuned by setting the amplitude (between 0 and 20V) of a square wave signal (at least 50Hz and with polarity change).

The device offers several advantages:

- **voltage tunable**
- **no moving parts**
- **limited wavelength dependency**
- **functions over the whole visible spectrum**
- **polarization independent**
- **polarization maintaining**
- **compact**

The Arcoptix variable attenuator is based on a combination of the LC cells with perpendicular optical axes. The LC cells are filled with a special mixture of liquid crystal and dichroic molecules. The two cells act as a polarizer and analyzer with a kind of variable dichroicity (or specific polarization absorption). By applying a bias the optical axes on these two cells can be tilted and the absorption of the light that propagate normally to the cells is reduced. The pictures below shows the white light transmission of the VA65 for increasing applied voltages:

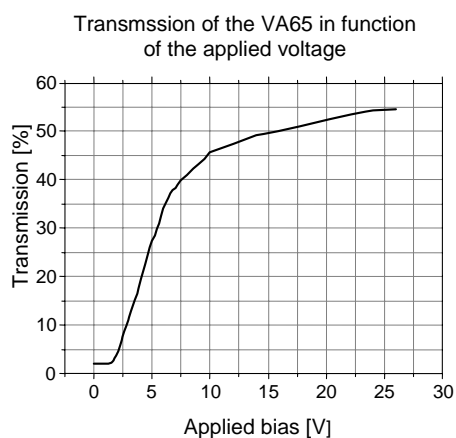
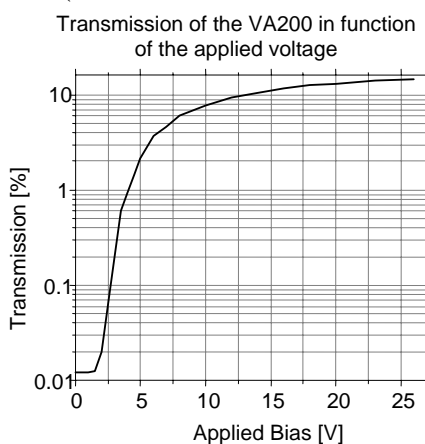


## Specifications

For an attenuator with a 10mm aperture the specs are given by the table below:

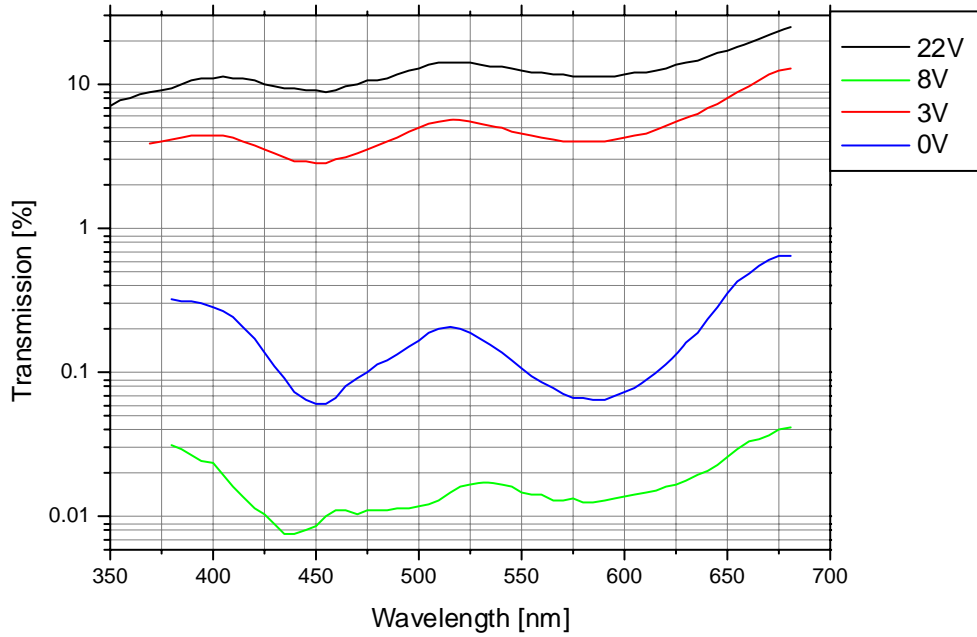
Useable aperture	10 mm
Transmission for Model VA200 Model VA65	From 0.1 to $10^{-4}$ (at 633nm) From 0.5 to $1.5 \cdot 10^{-2}$ (at 633nm)
Transmission uniformity	Better than 0.3%
Voltage range	0-20 V (square wave)
Wavelength range	350-700 nm (optimal performances between 400 and 650nm)
Temperature range	10°-50° C
Cell size	27x27x5mm
Total size with housing	40 x 55x8mm

The transmission in function of the driving voltage is given below for the two standard models (custom

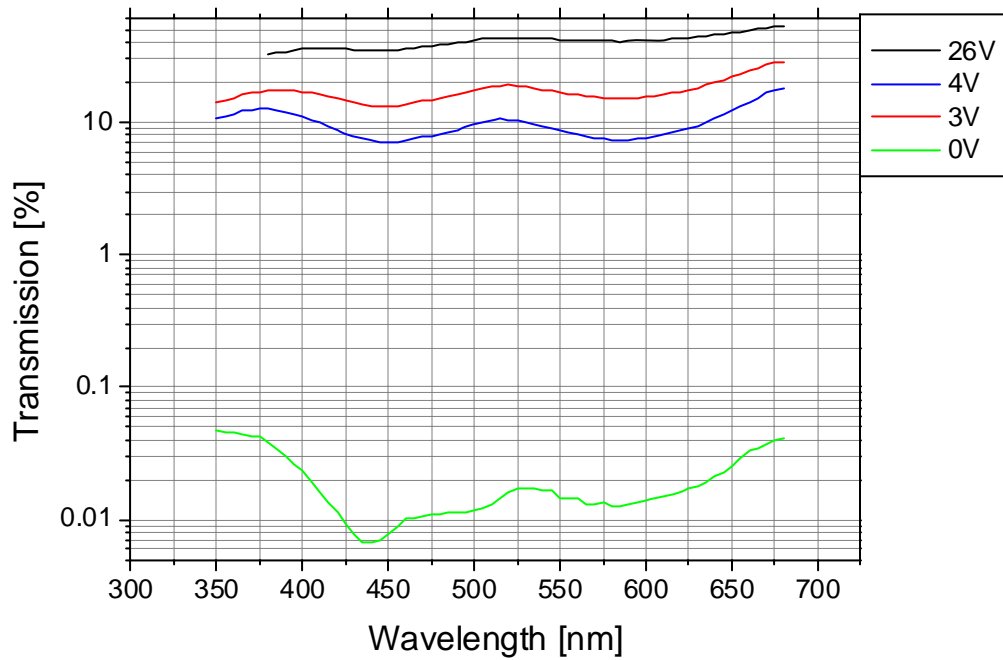


The transmission curves of our two standard models VA200 and VA65 are given below:

Transmission of the variable attenuator VA200



Transmission of the variable attenuator VA65

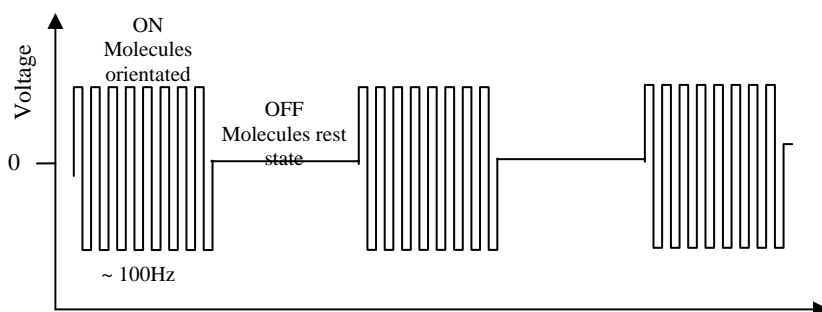


## Electrical driving

In principle the phase shifter can be adjusted by simply applying a DC bias on both sides of the cell. Unfortunately this will in practice not work very well. Impurity ions present in the LC material such as alkaline-earth metals cause a leakage current to flow across the cell gap when a voltage is applied to the cell. This ion migration may destroy the helical stacking structure and initiate irreversible degradation chemical reactions. If driven with a DC voltage, impurity ions present may migrate towards the alignment layers under the action of the electric field and become embedded at the cell surfaces. Upon removal of the applied voltage thereafter, an electrical field across the liquid crystal may persist due to the captured charges and hence hinder cell switching.

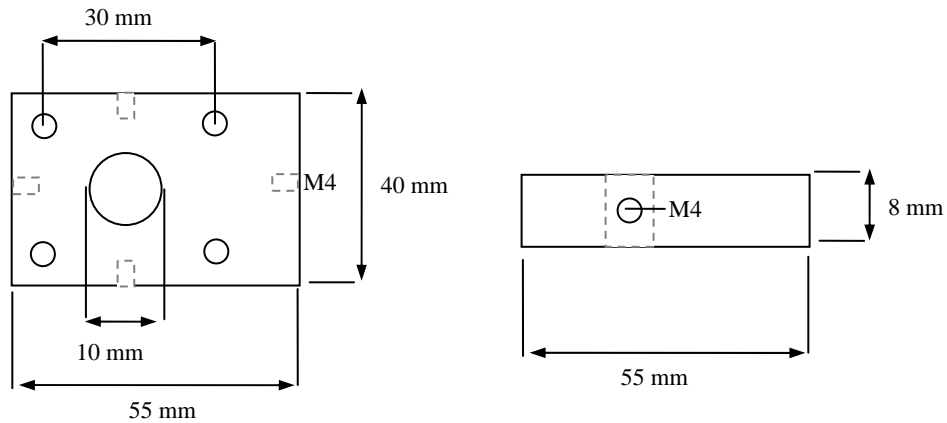
For this reason, LC cells are usually driven with AC square-wave voltages of between  $\pm 3.0$  and  $\pm 10$  volt whereby the polarity is rapidly switched at speeds of up to 1KHz (the frequency is not very important, typically more than 10Hz) in order to prevent impurity ion migration from occurring. A priori, it may be expected that activation of the LC cell with AC voltage might cause the molecules to rotate. However in practice interactions between the LC molecules themselves hinder this and if the polarity change is rapid enough (which is generally the case for a square wave) the molecules "do not have enough time to react". Polarity reversal (when it is performed quickly) of the driving electronics will therefore have no effect upon the alignment of the molecules and the performance of the device is only dependent upon the root-mean-squared (rms) voltage and not on the polarity of the external field.

Notice that the attenuation stays constant when applying a square shaped function because of the slow reaction time of the LC molecules. Only slowly varying applied voltages below 100Hz may change the phase shift.



## Housing

The Housing is made of anodized aluminum. It has an M4 thread on every side and it is compatible with spider&hoyer components.



## Custom Design

Design and quotes for custom specifications such as attenuation range, switching time, active area, , total size, housing can directly be asked by sending us an email at [info@arcoptix.com](mailto:info@arcoptix.com).