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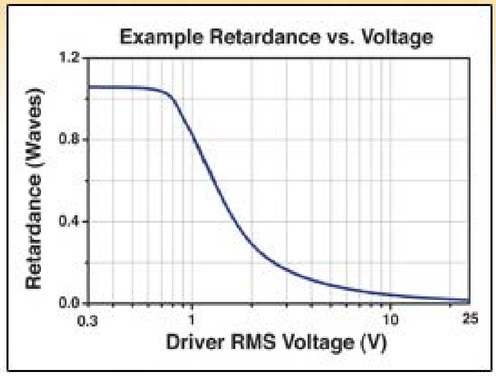
THORLABS

LCC1222-B - August 9, 2016

Item # LCC1222-B was discontinued on August 9, 2016. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

THREE-QUARTER-WAVE LIQUID CRYSTAL VARIABLE RETARDERS / WAVE PLATES

- **Nematic Liquid Crystal 3/4-Wave Variable Retarder**
- **Available with Ø10 mm or Ø20 mm Clear Aperture**
- **AR Coated for Visible, NIR, or IR Light**



Hide Overview

OVERVIEW

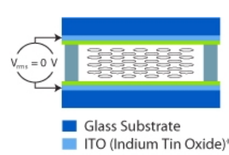
Features

- Variable Wave Plate to Actively Control the Polarization State of Light
- Retardance Range: ~30 nm to 3λ/4
- Clear Aperture: Ø10 mm or Ø20 mm
- Sufrace Quality: 20-10 Scratch-Dig
- Retardance Uniformity: < λ/50 Over the Entire Clear Aperture

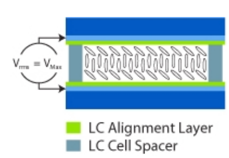
Thorlabs' Three-Quarter-Wave Liquid Crystal Variable Retarders (LCVR) use a nematic liquid crystal cell to function as a variable wave plate. The absence of moving parts provides quick switching times on the order of milliseconds (see the *Switching Time* tab for details). AR coatings are available for three wavelength ranges: 350 - 700 nm, 650 - 1050 nm, or 1050 - 1620 nm (see the *Performance* tab for transmission and retardance data). Our Ø10 mm retarders feature a 1" outer diameter, making them compatible with any of our Ø1" optics mounts for 8 mm thick optics. Our Ø20 mm retarders feature a 2" outer diameter, making them compatible with any of our Ø2" optics mounts for 13 mm thick optics.

These liquid crystal variable retarders provide excellent uniformity, low optical losses and

Operating Principle



High Retardance



Low Retardance

In their nematic phase, liquid crystal molecules have an ordered orientation, which together with the stretched shape of the molecules creates an optical anisotropy. When an electric field is applied, the molecules align to the field and the level of birefringence is controlled by the tilting of the LC molecules.

Selection Guide for LC Retarders	
Type	**Clear Aperture**
Half Wave	Ø10 mm or Ø20 mm
Half Wave, Thermally Stabilized	Ø10 mm
Three-Quarter Wave	Ø10 mm or Ø20 mm
Full Wave	Ø10 mm or Ø20 mm

low wavefront distortion. Our retarders also provide quick switching time, a broad operating temperature range, and a broad wavelength range. Please see the *Specs*, *Performance*, and *Switching Time* tabs for complete details.

Full Wave, Thermally Stabilized	Ø20 mm
Multi-Wave	Ø10 mm
Multi-Wave, Integrated Controller	Ø10 mm
Custom LC Retarders	

A Liquid Crystal Variable Retarder consists of a transparent cell filled with a solution of Liquid Crystal (LC) molecules and functions as a variable wave plate. Two parallel faces of the cell wall are coated with a transparent conductive film so that a voltage can be applied across the cell. The orientation of the LC molecules is determined by the alignment layer in the absence of an applied voltage. When an AC voltage is applied, the molecules will change from their default orientation based on the applied rms value of the voltage. Hence, the phase offset in a linearly polarized beam of light can be actively controlled by varying the applied voltage.

The LCC25 controller, sold below, provides active DC offset compensation, while applying an AC voltage (0 to 25 V_{rms}). The DC offset compensation automatically zeros the DC bias across the LC device in order to counteract the buildup of charges. It is fully compatible with all of the liquid crystal retarders sold by Thorlabs.

Hide Specs

SPECS

Ø10 mm Clear Aperture LC Retarders

Item #	LCC1112-A	LCC1112-C
Wavelength Range	350 - 700 nm[a]	1050 - 1620 nm
Liquid Crystal Material	Nematic Liquid Crystal	
Retardance Range	~30 nm to >3λ/4	
Clear Aperture	Ø10 mm	
Surface Quality	20-10 Scratch-Dig	
Switching Speed (Rise/Fall, Typical)[a]	11.2 ms / 155 µs @ 25.6 °C	20.9 ms / 1190 µs @ 25.6 °C
AR Coating	R_{avg} < 0.5% at all Air-to-Glass Surfaces for Specified Wavelength Range	
Wavefront Distortion	≤λ/4 (@635 nm)	
Retardance Uniformity	< λ/50 over the Entire Clear Aperture	
Housing Outer Diameter	Ø1"	
Storage Temperature	-30 to 70 °C	
Operation Temperature	-20 to 45 °C	
Compatible Mounts	RSP1 (RSP1/M), CRM1 (CRM1/M), CRM1P (CRM1P/M), KM100	

Ø20 mm Clear Aperture LC Retarders

Item #	LCC1222-A	LCC1222-B	LCC1222-C
Wavelength Range	350 - 700 nm[a]	650 - 1050 nm	1050 - 1620 nm
Liquid Crystal Material	Nematic Liquid Crystal		
Retardance Range	~30 nm to >3λ/4		
Clear Aperture	Ø20 mm		
Surface Quality	20-10 Scratch-Dig		
Switching Speed (Rise/Fall, Typical)[a]	11.2 ms / 155 µs @ 25.6 °C	13.5 ms / 333 µs @ 25.6 °C	20.9 ms / 1190 µs @ 25.6 °C
AR Coating	R_{avg} < 0.5% at all Air-to-Glass Surfaces for Specified Wavelength Range		
Wavefront Distortion	≤λ/4 (@635 nm)		
Retardance Uniformity	< λ/50 over the Entire Clear Aperture		
Housing Outer Diameter	Ø2"		
Storage Temperature	-30 to 70 °C		
Operation Temperature	-20 to 45 °C		
Compatible Mounts	RSP2 (RSP2/M), LCRM2, LCRM2/M, KM200		

- Liquid crystal is more susceptible to damage when exposed to light sources close to UV wavelengths. Our tests show that the liquid crystal variable retarder can be deteriorated while exposed to a 395 nm, 6 W/cm^2 light source for four hours. With a 365 nm, 40 mW/cm^2 light source, the liquid crystal variable retarder can be damaged within 15 minutes. Therefore, it is recommended that the liquid crystal variable retarder be used with light sources of 400 nm or longer wavelength. If wavelengths of shorter than 400 nm are used, then the power must be lower along with a shorter exposure duration. The shorter the wavelength, the more susceptible the liquid crystal is to damage.

- Switching speed is highly dependent on several factors, including voltage change and cell temperature. See the *Switching Time* tab for more details.

Hide Performance

PERFORMANCE

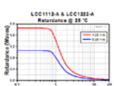
LC Retarder Performance

In their nematic phase, liquid crystals molecules have an ordered orientation, which together with the stretched shape of the molecules, creates an optical anisotropy. When an electric field is applied, the molecules align to the field and the level of birefringence is controlled by the tilting of the LC molecules. To minimize effects due to ions in the material, an LC device must be driven using an alternating voltage. Our LCC25 controller is designed to minimize the DC offset in the driving signal in the operating range of 0 V to 25 V. To accomplish this the LCC25 controller automatically zeros the DC bias across the LC device in order to counteract the buildup of charges. The LC material also exhibits some chromatic dispersion due to changes in the molecular polarizability. To account for this, we provide the retardation data below for two wavelengths in each wavelength range.

Additionally, the LC retardation also depends on the temperature of the device. As temperature increases the material density decreases and the retardation decreases with it (however as seen in the switching time tab, the switching speed of the LC improves at higher temperatures). Generally, the LC's refractive indices (both ordinary and extraordinary) change more drastically as temperature nears the LC's clearing temperature. As such, we choose to use materials with a high clearing temperature to minimize the temperature dependence when used at room temperature.

Click Here to Download Retardance Data
Click Here to Download Transmission Data

LCC1112-A & LCC1222-A (350 - 700 nm)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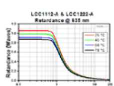
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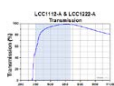
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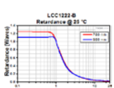
LCC1222-B (650 - 1050 nm)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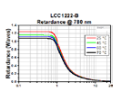
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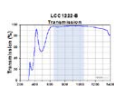
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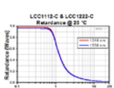
LCC1112-C & LCC1222-C (1050 - 1620 nm)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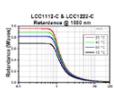
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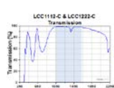
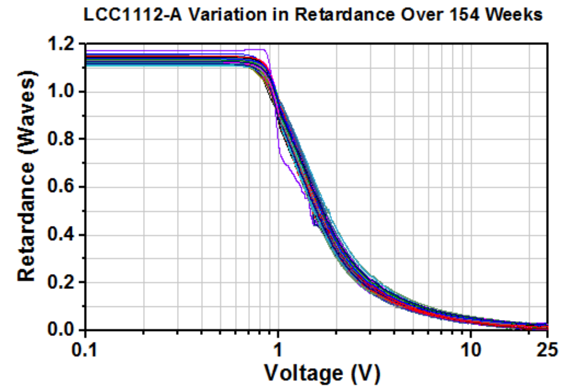

Click to Enlarge

Long-Term Stability

Our liquid crystal retarders exhibit consistent performance over time. The graph to the right shows the retardance vs. voltage for a single LCC1112-A three-quarter wave retarder, driven by our LCC25 liquid crystal controller over 154 weeks. The retardance was tested once per week and varied only slightly over the testing period. For the complete set of data from testing each week, please click below to download the full data file.

The graph below to the left shows that the retardance varies only slightly at a constant voltage, while the graph below to the right shows that the voltage varies only slightly at a constant retardance. Similar consistency in

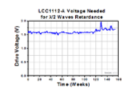


Click to Enlarge
Graph shows variation in retardance over a period of 154 weeks.

performance can also be expected for our other models of retarders. To maximize the long-term stability of our retarders, we recommend always using the LCC25 controller. It is specifically designed to reduce the DC voltage offset, thus minimizing charge buildup and maximizing stability.

Click Here to Download Long-Term Performance Data


Click to Enlarge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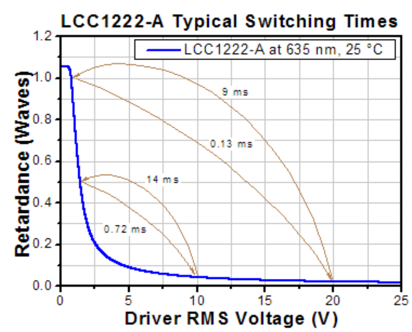
Hide Switching Time

SWITCHING TIME

LC Retarders Switching Time



Click to Enlarge
Switching Time Decreases with Higher Voltage Changes

Liquid crystal retarders feature a short switching time compared to mechanical variable wave plates due to the lack of moving parts. The switching time of a liquid crystal retarder depends on several variables, some of which are controlled in the manufacturing process, and some by the user.

In general liquid crystal retarders will always switch faster when changing from a high to a low birefringence value. Additionally, the higher the operating temperature is, the faster the retarder will switch from one state to another due to the decreased viscosity at the higher temperature.

For any given retarder, the switching speed will always be faster at higher voltages. The graph to the right depicts examples of switching between different voltages. If trying to achieve faster switching speed, we recommend using the retarder together with a fixed waveplate, to use the variable retarder at a higher voltage.

In addition, the material's viscosity and hence the switching speed also depend on temperature of the LC material. As can be seen below, the switching speed can increase by as much as two times by heating the LC retarder. Our standard LC retarders are designed to work at temperatures of up to 50 °C, where they can still maintain the specified retardation. If additional speed is required, the retarders can work at temperatures up to 70 °C, but the maximum retardation value will be lower.

The switching speed also is directly proportional to the thickness of the LC retarder, the rotational viscosity of the LC material, and the dielectric anisotropy of the LC material. However, since each of those variables affects other operating parameters as well, our LC retarders are designed to optimize overall performance, with a special emphasis on switching time. We also offer custom and OEM LC retarders optimized for other parameters, as well as faster liquid crystal retarders. Contact techsupport@thorlabs.com for details.

Sample Switching Times at Various Temperatures

Switching times were tested by measuring the rise time from V_1 to V_2 and the fall time from V_2 to V_1 with the liquid crystal retarder being held at the specified temperature. V_1 is fixed at 10 V for all the tests, and V_2 is the voltage at which the retardation is the maximum specified value for the retarder (3/4 λ). Please note that switching times at lower voltages (for instance, if V_1=5 V) are longer than the switching times specified below.

LCC1222-A/LCC1112-A

Temperature	V_1	V_2	Rise Time (ms)	Fall Time (µs)
25.6 °C	10	1.56	11.245	155
45 °C	10	1.56	7.566	71
60 °C	10	1.56	4.875	46
70 °C	10	1.56	3.275	32

LCC1222-B

Temperature	V_1	V_2	Rise Time (ms)	Fall Time (µs)
25.6 °C	10	1.8	13.483	333
45 °C	10	1.8	9.202	204
60 °C	10	1.8	8.445	123
70 °C	10	1.8	6.741	97

LCC1222-C/LCC1112-C

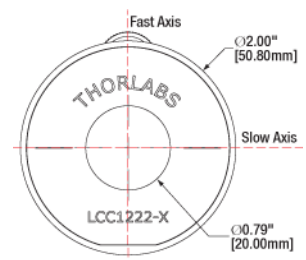
Temperature	V_1	V_2	Rise Time (ms)	Fall Time (µs)
25.6 °C	10	1.4	20.925	1190
45 °C	10	1.4	8.122	579
60 °C	10	1.4	5.140	260
70 °C	10	1.4	4.060	210

Hide Applications

APPLICATIONS

Alignment

In order to precisely align the axis of the liquid crystal cell, mount the retarder in an appropriate rotation mount (e.g. the RSP1 or the CRM1P for our Ø10 mm clear aperture retarders and RSP2 or the LCRM2 for our Ø20 mm clear aperture retarders). Then set up a detector or power meter to monitor the transmission of a beam through a pair of crossed linear polarizers. Next place the LC retarder between two crossed polarizers with the slow axis aligned with the transmission axis of the first polarizer. Then slowly rotate it until the transmitted intensity is minimized. In this configuration, the LC retarder is ready for phase modulation applications.



Drawing indicates the slow and fast axes

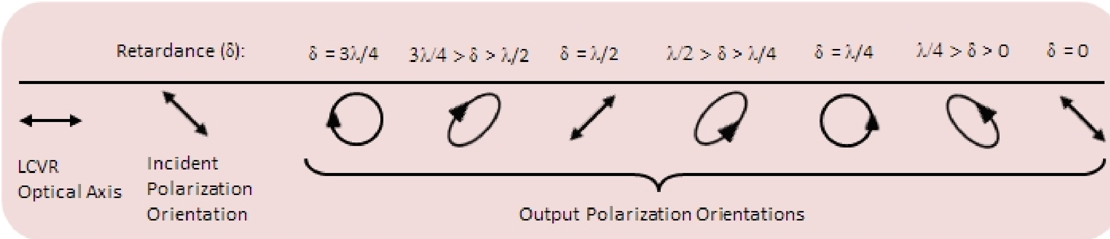
To operate as a light intensity modulator or shutter, again find the minimum transmitted intensity as prescribed above. Once the minimum is found, rotate the retarder by ±45°. This will maximize the transmitted intensity through the crossed polarizers for most LC retarders (e.g., zero-order quarter- or half-wave plates). However, this rule of thumb does not rigidly hold for multi-wave phase retarders using broadband sources due to the wavelength dependency of the retardation.

The slow (extraordinary) axis of the liquid crystal retarder corresponds to the orientation of the long axis of the liquid crystal molecules when no voltage is being applied. Applying a voltage will cause the orientation direction of the liquid crystal molecules to rotate out of the plane of the drawing, changing the retardation. Thorlabs LC retarders are nematic liquid crystal devices, which must be driven with an AC voltage in order to prevent the accumulation of ions and free charges, which degrades performance and can cause the device to burn out.

Applications

Polarization Control with a Liquid Crystal Variable Retarder

The LCVR can be effectively used as a variable zero-order wave plate over a broad spectrum of wavelengths. The optical axis of the LCVR is defined as the major axis of the liquid crystal molecules when no voltage is being applied to the cell, which are all aligned due to the LC alignment layer. When using the LCVR to control the polarization of a beam, the linearly polarized input beam should be aligned so that its polarization axis is oriented at an angle of 45° with respect to the optical axis of the LCVR in order to maximize the dynamic range of the optic. The schematic below shows how the output state of polarization will change as retardance is decreased (RMS voltage increased).



Pure Phase Retarder with Liquid Crystal Variable Retarder

In order to only effect the phase of the incident beam, the linearly polarized input beam must have its polarization axis aligned with the optical axis of the liquid crystal retarder. As V_{rms} is increased, the phase offset in the beam is decreased. Pure phase retarders are often used in interferometers to alter the optical path length of one arm of the interferometer with respect to the other. With an LCVR, this can be done actively.

Hide LC Controller

LC CONTROLLER

The LCC25 liquid crystal variable retarder controller produces a 2000 Hz square wave output with an amplitude that can be varied from 0 to 25 V_{rms}. The output amplitude can be set via the front panel controls, the USB interface, and the external input. Both the front panel and USB interface allow the user to select two voltage levels, Voltage 1 and Voltage 2. When the LCC25 is operated in the constant voltage mode, the output of the controller will be a 2000 Hz square wave with an amplitude equal to either of the two set voltage levels (Figure A). If the LCC25 controller is operating in the modulation mode, the output 2000 Hz square wave will be modulated in amplitude between the two voltage settings with a modulation frequency that can be set by the user to be between 0.5 and 150 Hz (Figure B).

The modulated mode can be used to measure the response time of the LC retarder.

External or remote control of the LCC25 is possible using the external input or the USB interface. The external input accepts a 0 to 5 VDC TTL signal that modulates the 0 to 25 V_{rms} output of the LCC25 between the two set voltages. The USB interface can be used to send line commands to the controller so that the LCC25 can be used in automated lab sequences.

LCC25 Specifications	
Electrical Specs	
Adjustable Output Voltage	± 25 V
External Input Voltage	0 to 5 VDC Square Wave
Voltage Resolution	1.0 mV
Adjustable Internal Modulation Frequency	0.5 to 150 Hz @ 50% Duty Cycle
Switching Frequency	2,000 ± 5 Hz, 50% Duty Cycle
Slew Rate	10 V/ms
DC offset	±10 mV
Max Output Current	15 mA
AC Power	85 – 264 VAC, 47 – 63 Hz, 25 VA
Fuse Rating	125 mA, 5 x 20 mm SLO-BLO
Warm Up Time	30 Minutes
Physical Specs	More [+]

In order to prevent the separation and build up of charges in the liquid crystal layer, the LCC25 will automatically detect and correct any DC offset in real time to within ±10 mV.

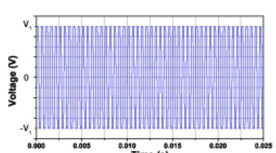


Figure A. A plot of the output voltage of the LCC25 Liquid Crystal Controller when it is being operated in the constant voltage mode.

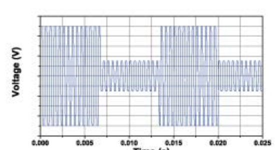


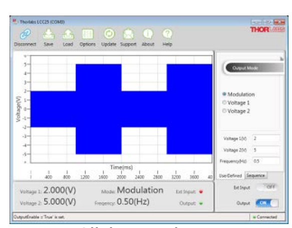
Figure B. A plot of the output voltage of the LCC25 Liquid Crystal Controller when the ouptput voltage is being modulated between the two set voltages.

Software for the LCC25 Controller

Software

Version 3.0.0

GUI Interface for controlling the Liquid Crystal Retarder Controller via a PC. To download, Click the button below.



Click to Enlarge

Screen shot of the GUI interface in Modulation Mode.

Software

GUI Interface

The GUI interface included with the software provides access to all of the settings of the liquid crystal retarder controller. For example, the user can select one of two user-defined voltages or a modulation mode that oscillates between these two voltages at a user-defined frequency. As shown in the above screen shot, the applied voltage is shown in a plot with respect to time. Both the output and external input can be turned on and off via the GUI. In addition, advanced features allow the user to define a custom waveform by specifying the starting voltage, ending voltage, the voltage step size, and the dwell time. The waveform may be previewed on the screen before it is output to the retarder, and it may be saved so that the LCC25 can be restarted quickly in the future. The GUI is available as a stand-alone or LabVIEW based version for flexibility in implementation.

Custom Software Development

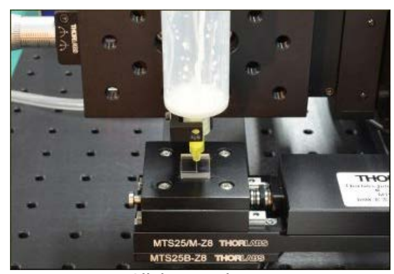
Users may also use the provided C/C++ and LabVIEW software development kits for implementing the liquid crystal retarder controller with other instruments. Sample C++ code and LabVIEW programs help to illustrate how the C commands and LabVIEW VIs can be utilized. Full documentation on the available commands is provided with the software.

Hide Custom Capabilities

CUSTOM CAPABILITIES

Thorlabs' Custom Liquid Crystal Capabilities

Thorlabs offers a large variety of liquid crystal retarders from stock, including 1/2-, 3/4-, and full-wave models with a Ø10 mm or Ø20 mm clear aperture as well as 1/2-wave temperature-controlled models. However, we also offer OEM and custom retarders. The retardance range, coating, rubbing angle, temperature stabilization, and size can be customized to meet many unique optical designs. We also offer other custom liquid crystal devices, such as empty LC cells, polarizaton rotators, and noise eaters. For more information about ordering a custom liquid crystal device, please contact Thorlabs' technical support.



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Liquid Crystal Cell Seal Application

Our engineers work directly with our customers to discuss the specifications and other design aspects of a custom liquid crystal retarder. They will analyze both the design and feasibility to ensure the custom products are manufactured to high-quality standards and in a timely manner.

Polyimide (PI) Coating and Rubbing - Custom Alignment Angle

In their nematic phase, liquid crystal molecules naturally align to an average orientation, which together with their stretched shape, creates an optical anisotropy, or direction-dependent optical effect. The orientation of the LC molecules in an LC cell, in the absence of an applied voltage, is determined by the alignment layer, created by the polyimide (PI) coating and rubbing angle. Rubbing creates grooves, which the liquid crystal molecules will align to. Users can choose any initial orientation of LC molecules by specifying the rubbing angle.

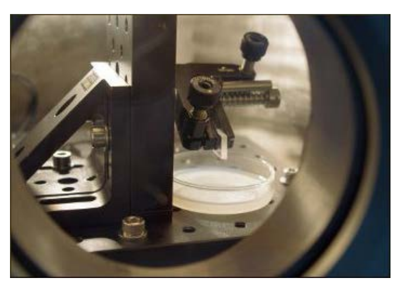
Click to Enlarge
Custom Liquid Crystal Cell Without Case

Custom Cell Spacing

The wall spacing inside of the liquid crystal cell, which determines the thickness of LC material, can be customized during the manufacturing process. The retardance range of an LC cell is dependent on the LC material thickness:

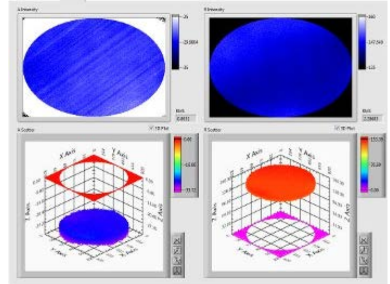
$$\delta = \frac{2\pi d\Delta n}{\lambda_\nu}$$

Here, δ is the retardance in waves, d is the thickness of the LC material, λ_v is the wavelength of light, and Δn is the birefringence of the LC material used. Thus, for a given wavelength, the retardance is determined by the wall spacing inside the LC cell (i.e., the thickness of LC layer). We offer standard retardance ranges of λ/2 to 30 nm, 3λ/4 to 30 nm, and λ to 30 nm, but higher retardance ranges may also be ordered.



Click to Enlarge
Liquid Crystal Cell Filling in a Vacuum Chamber

Click to Enlarge
Custom Liquid Crystal Cell Test Setup



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Custom Liquid Crystal Cell Test Result

Custom Liquid Crystal Material
Customers can also provide their own liquid crystal material, and Thorlabs will use it to fill the liquid crystal cell. Since different liquid crystal materials have different birefringence values, varying the material enables a different retardance range.

Temperature Control/Switching Time
A temperature sensor can also be integrated into the LC variable retarder. Using a temperature controller, the temperature of the retarder can be actively stabilized to within ±0.1 °C. The viscosity of the liquid crystal material is lowered at higher temperatures, allowing the retarder to switch from one state to another due to the decreased viscosity. An active temperature control system can be used to heat the retarder, allowing it to operate at higher switching speeds.

Assembly / Housing
If desired, we can manufacture custom liquid crystal retarders without housings.

Testing
Each LC retarder is tested for birefringence, uniformity, and fast axis angle, using the measurement setup shown in the photo to the left. The equipment measures the 2-dimensional birefringence distribution using wave plates and a CCD camera. The image to the right shows a sample test result of a liquid crystal retarder, showing excellent uniformity.

For More Information
Contact Thorlabs' technical support for more information about our custom liquid crystal device options or to place an order.

Hide Patterned Retarders

PATTERNED RETARDERS

Features

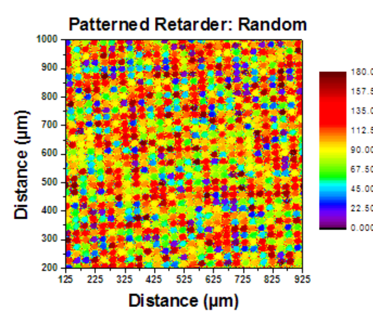
- Build a Custom Microretarder
- Customize Size, Shape, and Substrate Material
- Retardance Range: 50 - 550 nm
- Fast Axis Resolution: <1º
- Retardance Fluctuations Under 30 nm

Applications

- 3D Displays
- Polarization Imaging
- Diffractive Optical Applications: Polarization Gratings, Polarimetry, and Beam Steering

Custom Capability	Custom Specification
Patterned Retarder Size	Ø100 µm to Ø2"
Patterned Retarder Shape	Any
Microretarder Size	≥Ø30 µm
Microretarder Shape	Round, Square, Hexagon, or Polygon
Retardance Range @ 632.8 nm	50 to 550 nm
Substrate	N-BK7, UV Fused Silica, or Other Glass
Substrate Size	Ø5 mm to Ø2"
AR Coating	-A: 350 - 700 nm -B: 650 - 1050 nm -C: 1050 - 1700 nm

Thorlabs offers customizable patterned retarders, available in any pattern size from Ø100 µm to Ø2" and any substrate size from Ø5 mm to Ø2". These custom retarders are composed of an array of microretarders, each of which has a fast axis aligned to a different angle than its neighbor. The size and shape of the microretarders are also customizable. They can be as small as 30 µm and in shapes including circles, squares, and polygons. This control over size and shape of the individual microretarders allows us to construct a large array of various patterned retarders to meet nearly any experimental or device need.



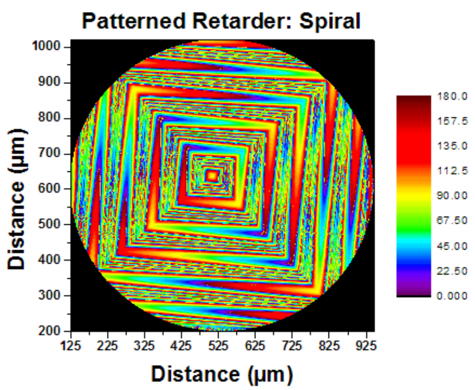
These patterned retarders are constructed from our liquid crystals and liquid crystal polymers. Using photo alignment technology, we can secure the fast axis of each microretarder to any angle within a resolution of <1°. Figures 1 - 3 show examples of our patterned retarders. The figures represent measured results of the patterned retarder captured on an imaging polarimeter and demonstrate that the fast axis orientation of any one individual microretarder can be controlled deterministically and separately from its neighbors.

Click to Enlarge
Figure 1: Patterned Retarder with Random Distribution

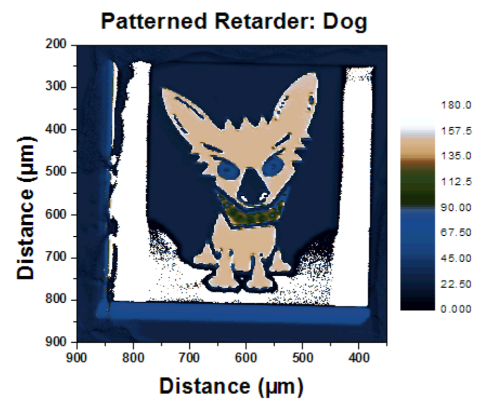
The manufacturing process for our patterned retarders is controlled completely in house. It begins by preparing the substrate, which is typically N-BK7 or UV fused silica (although other glass substrates may be compatible as well). The substrate is then coated with a layer of photoalignment material and placed in our patterned retarder system where sections are exposed to linearly polarized light to set the fast axis of a microretarder. The area of the exposed sections depends on the desired size of the microretarder; the fast axis can be set between 0° and 180° with a resolution <1°. Once set, the liquid crystal cell is constructed by coating the device with a liquid crystal polymer and curing it with UV light.

Thorlabs' LCP depolarizers provide one example of these patterned retarders. In principle, a truly randomized pattern may be used as a depolarizer, since it scrambles the input polarization spatially. However, such a pattern will also introduce a large amount of diffraction. For our depolarizers, we designed a linearly ramping fast axis angle and retardance that can depolarize both broadband and monochromatic beams down to diameters of 0.5 mm without introducing additional diffraction. For more details, see the webpage for our LCP depolarizers.

By supplying Thorlabs with a drawing of the desired patterned retarder or an excel file of the fast axis distribution, we can construct almost any patterned retarder. We can also produce variable retardance patterned retarders. For more information on creating a patterned retarder, please contact Tech Support.



Click to Enlarge
Figure 2: Patterned Retarder with a Spiral Distribution



Click to Enlarge
Figure 3: Patterned Retarder with a Pictoral Distribution

Hide Ø10 mm Three-Quarter-Wave Liquid Crystal Retarders

Ø10 mm Three-Quarter-Wave Liquid Crystal Retarders

- Ø10 mm Clear Aperture
- 1" Outer Diameter
- 2 Standard AR Coatings Available

Thorlabs' Ø10 mm clear aperture, 3/4-wave liquid crystal retarders are available with AR coatings for 350 - 700 nm (LCC1112-A) or 1050 - 1620 nm (LCC1112-C) light. These retarders have an outer diameter of 1", making them compatible with any of our Ø1" optic mounts for 8 mm thick optics. The RSP1 mount provides precise rotational adjustment and post mounting capability, while the CRM1P adds 30 mm cage-mounting versatility.

Part Number	Description	Price	Availability
LCC1112-A	3/4-Wave Liquid Crystal Retarder, Ø10 mm CA, ARC 350 - 700 nm	$750.00	Lead Time
LCC1112-C	3/4-Wave Liquid Crystal Retarder, Ø10 mm CA, ARC 1050 - 1620 nm	$750.00	Today

Hide Ø20 mm Three-Quarter-Wave Liquid Crystal Retarders

Ø20 mm Three-Quarter-Wave Liquid Crystal Retarders

- Ø20 mm Large Clear Aperture
- 2" Outer Diameter
- 3 Standard AR Coatings Available

Thorlabs' Ø20 mm clear aperture, 3/4-wave liquid crystal retarders are available with AR coatings for 350 - 700 nm (LCC1222-A), 650 - 1050 nm (LCC1222-B), or

1050 - 1620 nm (LCC1222-C) light. These retarders have an outer diameter of 2", making them compatible with any of our Ø2" optic mounts for 13 mm thick optics. The RSP2 mount provides precise rotational adjustment and post mounting capability, while the LCRM2 adds 60 mm cage-mounting versatility.

Part Number	Description	Price	Availability
LCC1222-A	**3/4-Wave Liquid Crystal Retarder, Ø20 mm CA, ARC 350 - 700 nm**	**$970.00**	**Lead Time**
LCC1222-C	**3/4-Wave Liquid Crystal Retarder, Ø20 mm CA, ARC 1050 - 1620 nm**	**$970.00**	**Today**

Hide Liquid Crystal Controller

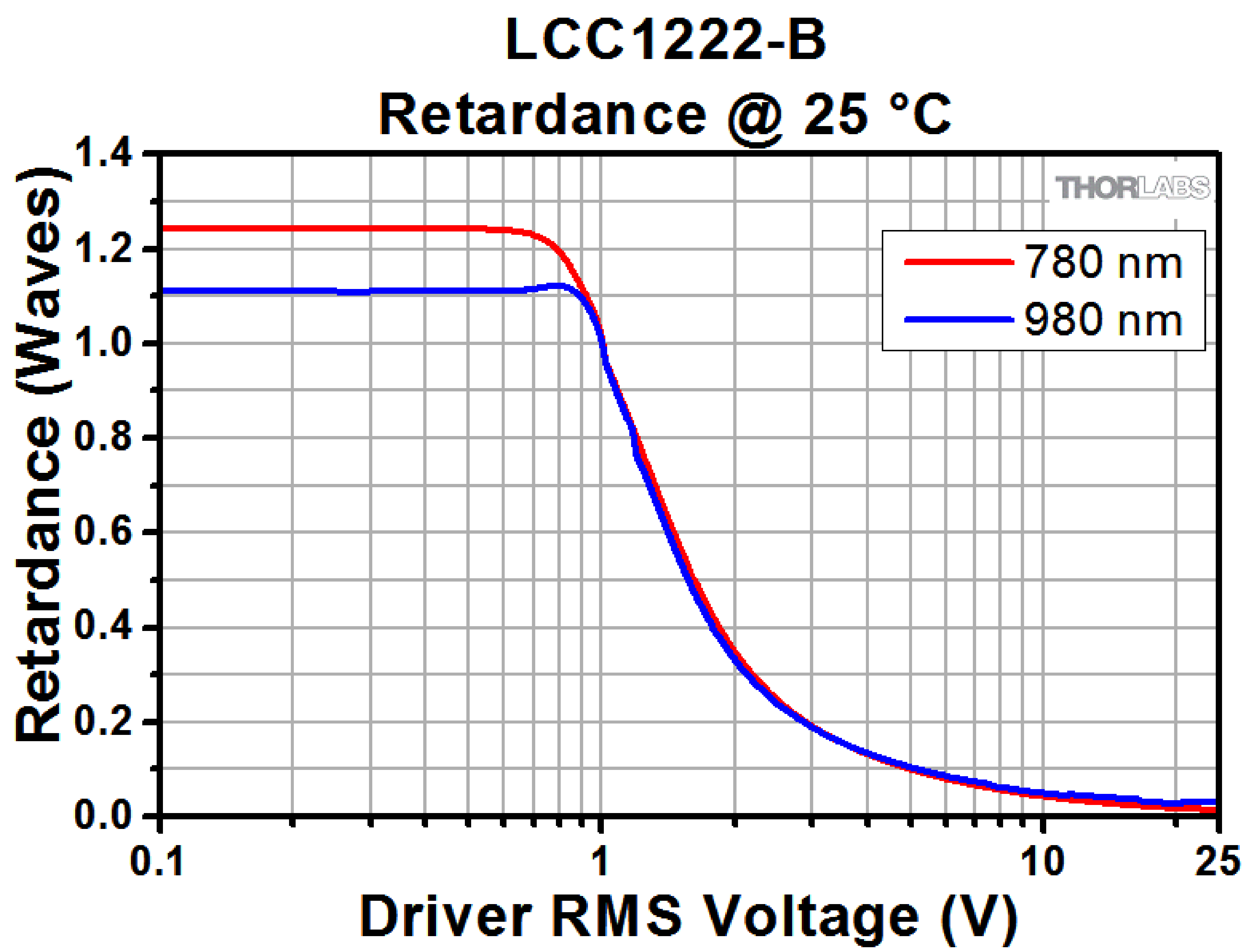
Liquid Crystal Controller

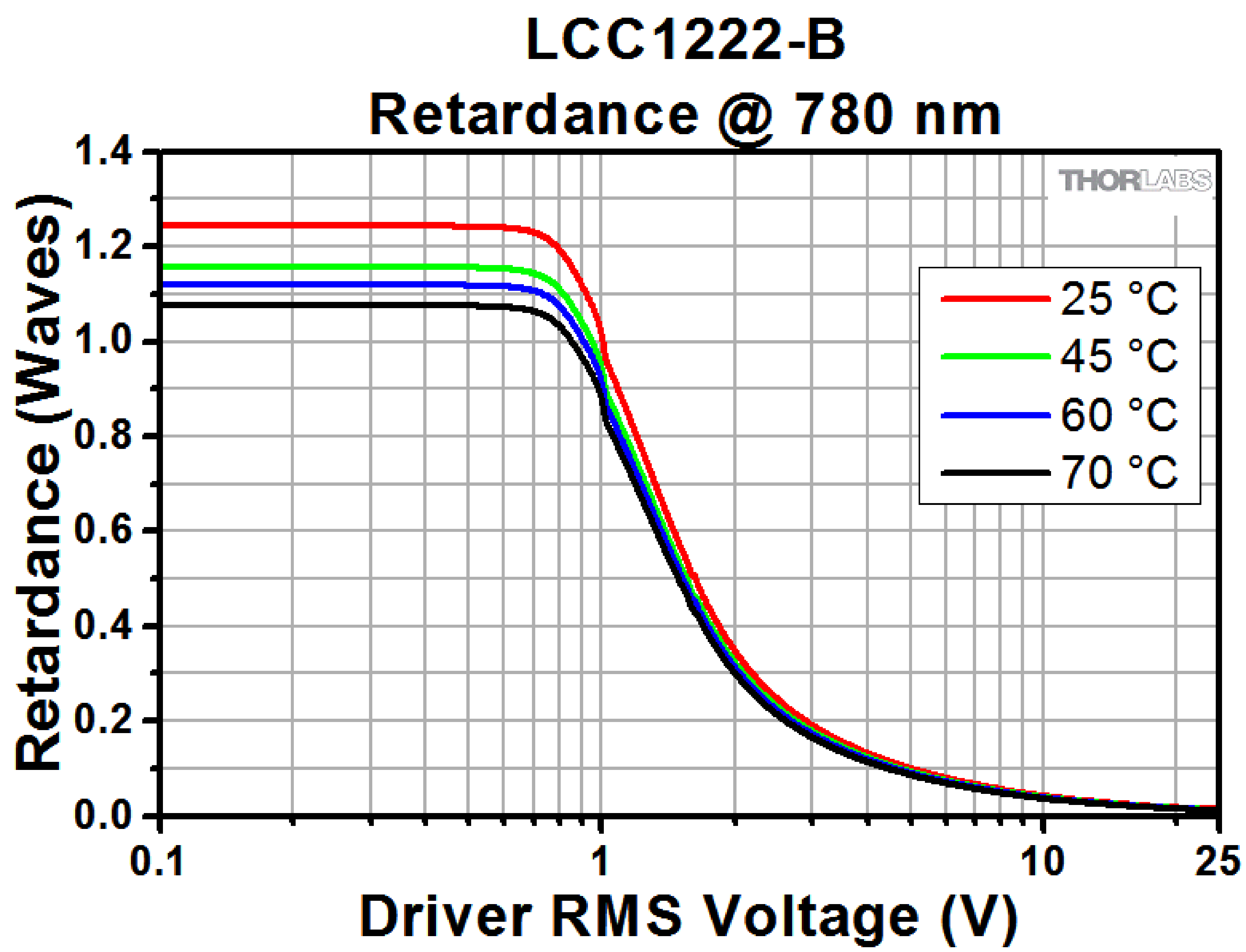
- Output Voltage Adjustment Range: ± 25 VAC (f = 2000 ± 5 Hz)
- Max Output Current: 15 mA
- Output Connector: BNC
- AC Power Requirements: 85 - 264 VAC, 47 - 63 Hz, 25 VA
- See the *LC Controller* Tab Above for More Information

The LCC25 is a liquid crystal controller compatible with all Thorlabs LC Variable Retarders and is ideal for driving most other nematic liquid crystal devices. Nematic LC retarders must be driven with an AC voltage in order to prevent the separation and build up of charge, which can cause the device to burn out. In addition to the 2000 Hz AC drive voltage, the LCC25 controller automatically zeros the DC bias across the LC device in order to counteract the buildup of charges. The AC output voltage of the LCC25 controller can be adjusted using the front panel controls, an external 0 - 5 VDC TTL input, and via the USB interface. For more information about the LCC25 controller and for a complete list of its specifications, please see the *LC Controller* tab.

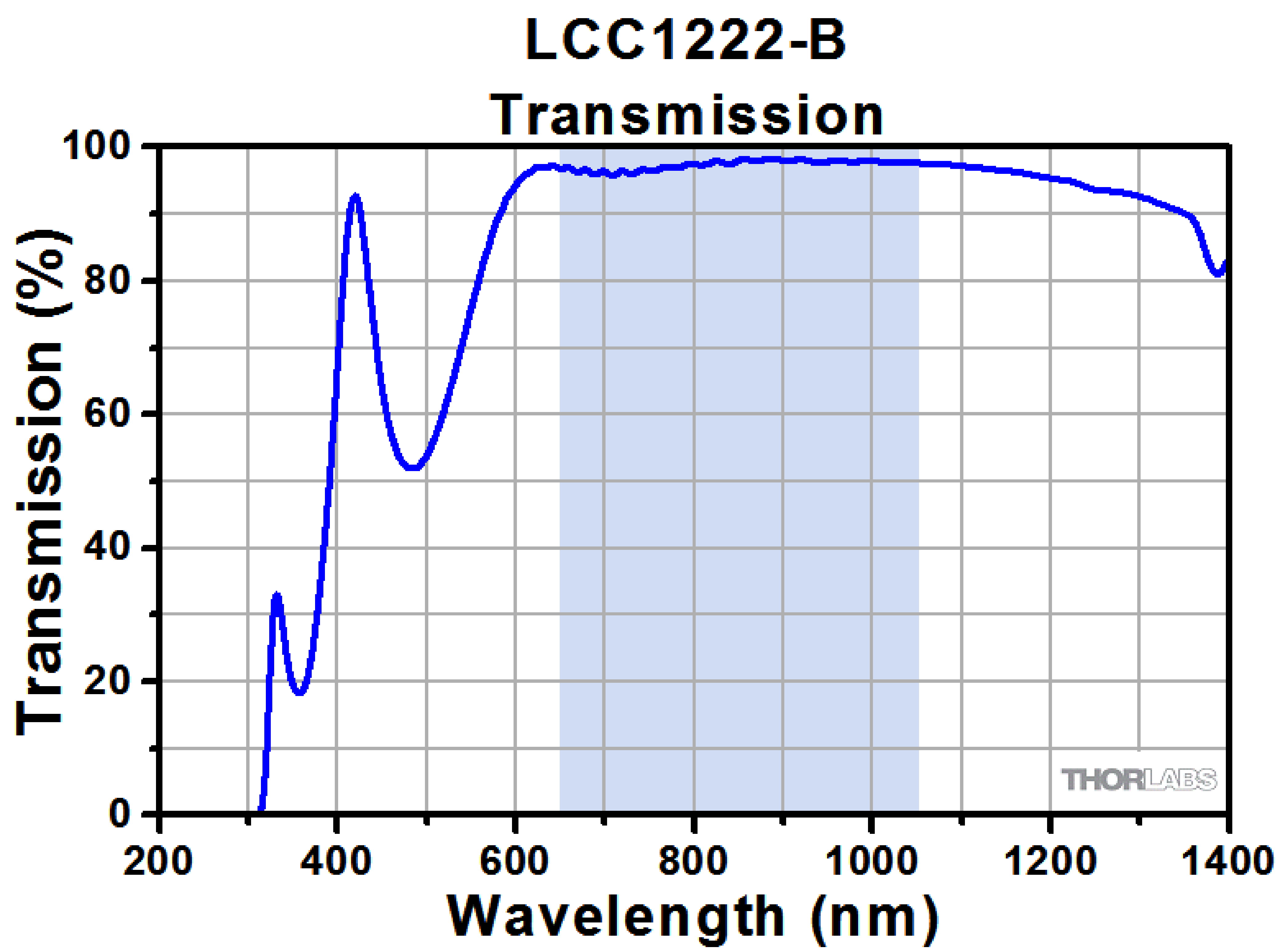
Part Number	Description	Price	Availability
LCC25	**Liquid Crystal Controller, 0-25 VAC, Square Wave, 50% Duty Cycle**	**$1,270.00**	**Today**

Visit the *Three-Quarter-Wave Liquid Crystal Variable Retarders / Wave Plates* page for pricing and availability information:
https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=6338


LCC1222-B
Retardance @ 25 °C
Retardance (Waves)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.1
1
10
25
Driver RMS Voltage (V)
780 nm
980 nm
THORLABS



LCC1222-B
Retardance @ 780 nm
Retardance (Waves)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.1
1
10
25
Driver RMS Voltage (V)
THORLABS
25 °C
45 °C
60 °C
70 °C



LCC1222-B
Transmission
Transmission (%)
Wavelength (nm)
0
20
40
60
80
100
200
400
600
800
1000
1200
1400
THORLABS