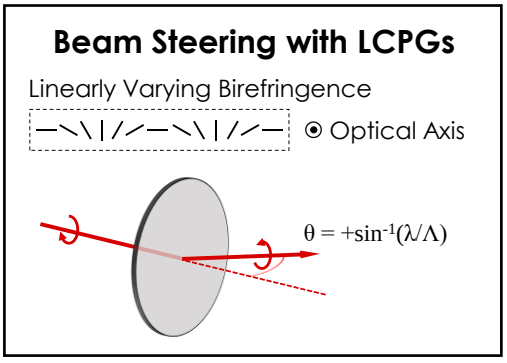
meadowlark optics

Nonmechanical Beam Steering with Liquid Crystal Polarization Gratings (LCPG)

Meadowlark Optics' Liquid Crystal Polarization Gratings utilize spatially varying birefringence to create highly efficient polarization-sensitive gratings. Circularly polarized light can be directed into either the + 1 or - 1 order depending on the handedness of the incident light. By using a stack of N LCPGs and half-waveplate switches, it is possible to steer to 2^N discrete angles in 1D or 2D arrays.

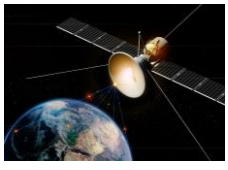
Liquid crystal polarization gratings are also known as geometric phase gratings, Pancharatnam-Berry phase gratings, and diffractive waveplates. These transmissive gratings efficiently (> 99.5 %) diffract circularly polarized light to either the first positive or negative order, based on the handedness of the incident light. By incorporating fast electro-optic half-wave polarization retarders to control the handedness of polarization, Meadowlark can develop custom LCPG devices and systems with a range of leading capabilities:

- Wide-angle beam steering > 100°
- Large apertures > 20 cm
- Sub-millisecond switching times
- Dramatically reduced size, weight, and power (SWaP) requirements
- Random-access and inertia-less beam steering
- Dynamic focusing also available

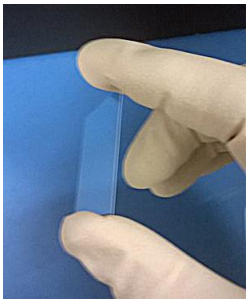


Applications of LCPG Beam Steering

Wind Sensing, Laser Communications, Autonomous Driving, Active Imaging





Benefits of LCPG Beam Steering

- Low size, weight, and power
- Random-access scanning
- Robust non-mechanical operation
- Large apertures possible (>15cm)
- Diffraction-limited wavefront quality
- High diffraction efficiency (>99%)
- Up to 80°×80° steering demonstrated
- Demonstrated in VIS to MWIR

Liquid Crystal Suite

Variable Retarders
Liquid Crystal Variable Retarder
UV Variable Retarder
MWIR Variable Retarder
OEM LCVR

Rotators
Achromatic High-Speed Rotator
Binary Rotator
Polarization Rotator

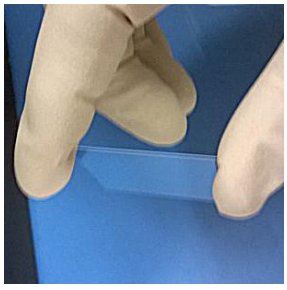
Shutters / Attenuators
Achromatic High-Speed Shutter
High Contrast Shutter
Variable Attenuator

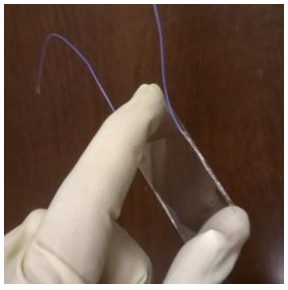
Controllers
Analog Controller
FLC Controller
LC Digital Interface Controller
Temperature Controller
Two Channel High Voltage Controller

ORDERING INFORMATION

Meadowlark can provide custom systems to meet your needs using the patented liquid crystal polarization grating (LCPG) beam steering technology. When contacting us for a quote, please provide:

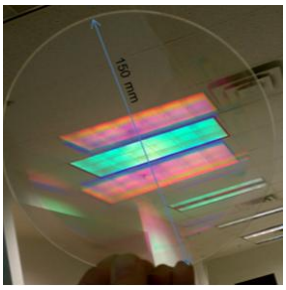
- Clear Aperture (mm)
- Operating Wavelength (nm)
- 1D or 2D Steering
- Number of Angles
- Maximum Steering Angle (°)
- Response Time/Switching Speed (ms)
- Housing/Mechanical Interface Requirements
- Description of Application & Additional Details





LCPG (left) and LC half-wave switch (right) on 200 µm glass.

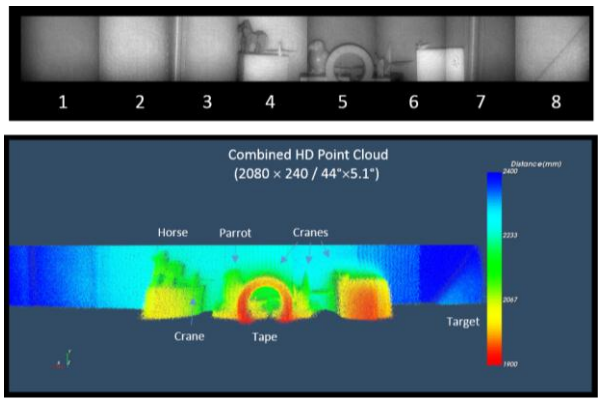




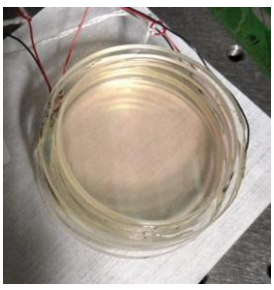
A 2-mm LCPG-based variable optical attenuator (left) and a 15-cm diameter LCPG (right).

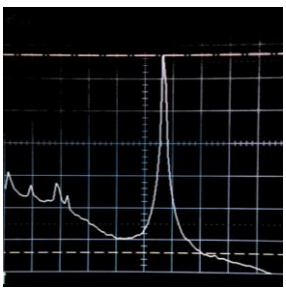
Non-Mechanical Steering for a Range of Aperture Sizes

Meadowlark can build LCPGs and LC switches using thin 200 µm glass and with apertures ranging from 2 mm to 200 mm. Thin glass enables discrete steering to > 1,000 revolvable angles with transmissive assemblies < 1 cm thick. Meanwhile the ability to steer large beams over large angles makes this approach unique among non-mechanical steering technologies for replacing large gimbals or steering large collection apertures in optical receiver paths.



LCPG steering used to stitch 8 fields of view in flash lidar.





A 5 cm aperture LCPG steering system (left) used to steer coherent Doppler lidar. System had 1 dB insertion loss, 29 dB CNR on target (right) and no measurable contribution from side-lobes or leakage.

LCPG Steering for Lidar

LCPG technology excels at non-mechanical beam steering for many narrowband sensors including lidar. To date, we have demonstrated LCPG beam steering for both coherent and direct detection lidars and both monostatic and bistatic architectures. Due to the ability to steer light in discrete steps over large angles, LCPG beam steering is particularly well suited to steering flash lidar systems and coherent doppler lidar wind sensing systems.

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