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p o l a r i z a t i o n   s o l u t i o n s

Liquid Crystal Digital Controller Manual

Revision 3.1

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Quick Start Guide

Requires a computer running Microsoft® Windows® XP or later.

1) Place the included CD in the CD-ROM drive, wait for the CellDRIVE menu to appear and click on the "Install CellDRIVE …" button.

2) If you are using the USB interface, the USB driver will need to be installed prior to connecting the controller to the computer. The driver installers are on the CellDRIVE CD in the following directories:
   32 bit Windows® XP & newer: USB DRIVERS\32 bit\
   64 bit Windows® Vista & newer: USB DRIVERS\64 bit\

3) Plug either the USB or serial cable into the appropriate connector on the digital interface controller. Plug the other end into an appropriate USB or RS232 port on the computer.

4) Connect up to four Meadowlark Optics liquid crystal (LC) devices to appropriate connectors on the controller back panel. The D3060HV(high voltage) controller can control up to two Swift LC devices. If a liquid crystal device has the temperature control (TSC) option installed, connect the temperature control cable to the five-pin LEMO™ connector. The controller (including D3060HV) is capable of TSC on any single channel. If additional LC devices require TSC, please contact us to inquire about our TC3051, Stand-alone Temperature Control unit.

5) Plug the power supply into the appropriate connector on the controller back panel. Connect the power to a properly grounded outlet.

6) Turn on the controller power. (NOTE: The D3060HV controller also has a key interlock switch to enable the LC voltage outputs) The green POWER LED should illuminate and remain on until the power is turned off. The orange STATUS LED will flash a number of times, pause and then flash again, designating the firmware version for the controller. On the D3060HV, the HIGH VOLTAGE LED has three states: off = high voltage and outputs inactive (turn on key switch); orange = high voltage on, normal operation; red = high voltage circuitry overheated (turn off key switch and allow unit to cool – contact us if this happens regularly)

7) Start the CellDRIVE software by clicking Start ➔ All Programs ➔ Meadowlark Optics ➔ CellDRIVE 3100.

8) If using a D3060HV controller, turn the keyswitch on to enable the LC outputs.

1. Nematic Liquid Crystal Variable Retarder Basics

1.1 Physical architecture

Typical nematic Liquid Crystal Variable Retarders (LCVRs) such as Meadowlark Optics' LVR- and LRC- series are constructed using two optically flat fused silica windows coated with a transparent conductive coating. A thin dielectric layer is applied over this coating, which is the molecular alignment layer. The two windows are then assembled; creating a cavity that is filled with a birefringent nematic liquid crystal material. The Swift LC devices do not use an alignment layer; the alignment is accomplished by shearing the two substrates relative to each other. For more information, please visit our website, www.meadowlark.com, for an application note on the technology.

With no voltage applied, the liquid crystal molecules lie parallel to the glass substrates and maximum retardation is achieved.
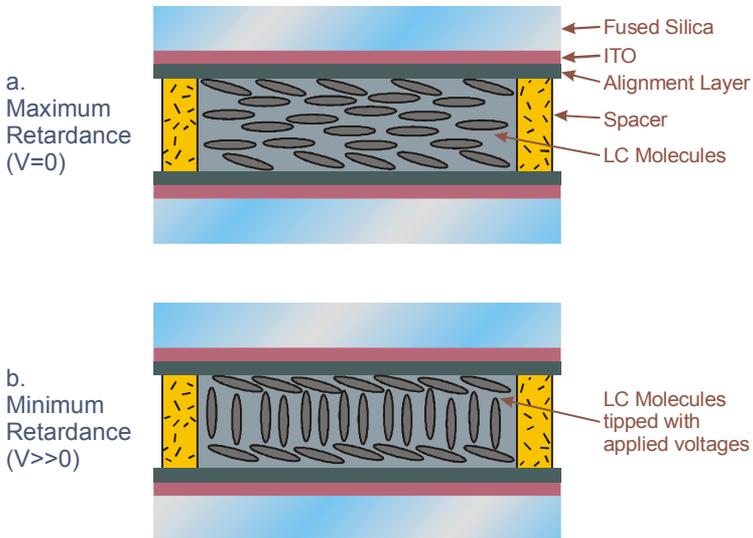
Figure 1 Liquid Crystal Variable Retarder showing molecular alignment (a) without and (b) with applied voltage (not to scale)

When voltage is applied, liquid crystal molecules begin to tip perpendicular and as voltage increases, molecules tip further causing a reduction in the effective retardance. Molecules at the surface, however, are unable to rotate freely because they are pinned at the alignment layer causing a residual retardance, even at higher voltage.

We compensate for this residual retardance with a subtractive, fixed polymer retarder, called a compensator, which is attached to the liquid crystal cell. Figure 2 illustrates typical retardance as a function of voltage for an LCVR with and without an attached compensator. We also have the ability to provide custom compensation to provide custom voltage operation.

The Swift LC devices use voltages up to 100V for operation, but the general shape of the curves is still applicable and the voltage axis can be scaled by a factor of 5 for a good approximation.
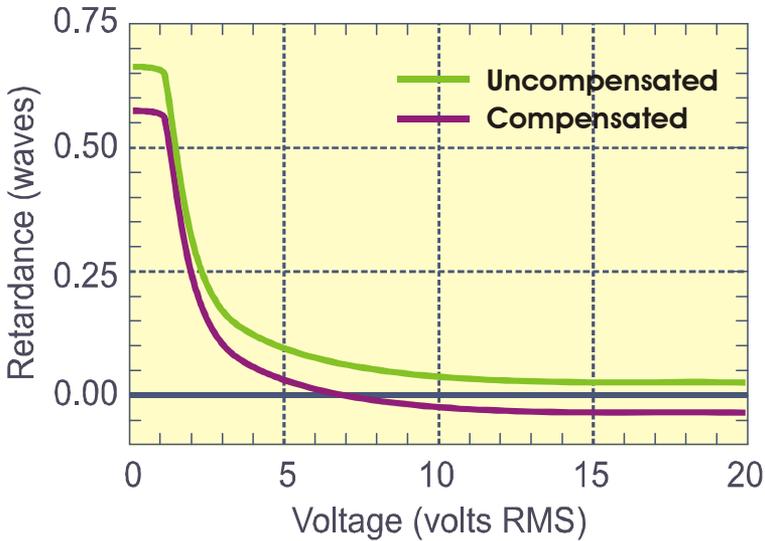
Figure 2 Liquid Crystal Variable Retarder with and without compensator

1.2 Response time

For a standard nematic LC device switching response time depends on several parameters: layer thickness, viscosity, temperature, variations in drive voltage, surface treatment and the direction of the retardance change. Typical response time for a standard visible LCVR is shown in Figure 3. It takes about 5 ms to switch from one-half to zero waves (low to high voltage) and about 20 ms to switch from zero to one-half wave (high to low voltage). The Swift LC devices have a more symmetric switching profile with switching speeds on the order of 150 µsec. At higher temperature, LC material viscosity decreases, contributing to a faster response.
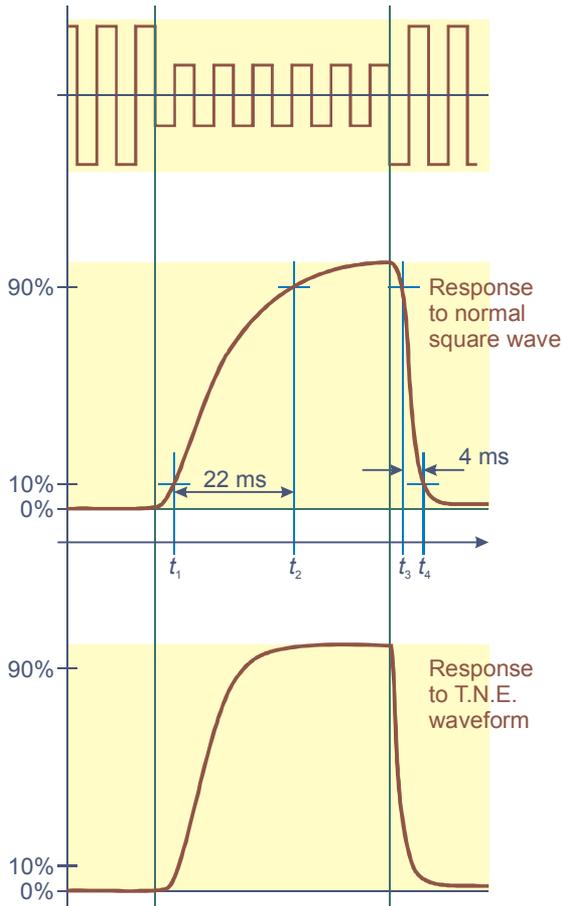
Figure 3 Transient response of standard LCVR

Another control technique involves the Transient Nematic Effect (TNE) to improve response times. This technique uses a very short duration high voltage spike to accelerate the molecular alignment parallel to the applied field. Voltage is then reduced to achieve the desired retardance. When switching from low to high retardance, all voltage is momentarily removed allowing the liquid crystal molecules to undergo natural relaxation.   Due to the technology involved, TNE is not useful for switching Swift LC devices.

2. Hardware Setup and Configuration

2.1 Laboratory and computer requirements
- One to four voltage-controlled liquid crystal cells with SMA-to-SMB cables to connect the LC cells. (D3060HV controller can interface with up to two Swift LC devices, which are hardwired and terminated with FAKRA SMB connector.) Please note that LC cells are not included with the controller.
- 100-240 VAC, 47-63 Hz 500 mA power.
- A computer with an available USB or serial port.
- Minimum computer system requirements to run the included CellDRIVE 3100 software are 256 MB RAM, 250 MB hard drive space, 800x600 pixel, 16-bit color graphics display, a CD-ROM drive, and Microsoft® Windows® XP, Vista, Windows® 7 or Windows® 8. A Microsoft® HyperTerminal configuration is also included (HyperTerminal is a component of Microsoft® Windows® XP and earlier).
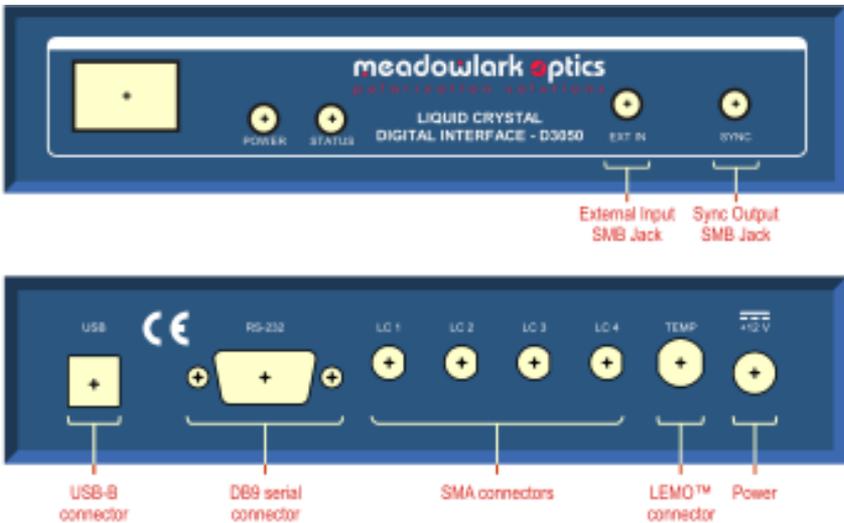

Figure 4 - D3050 Front and back panel connections

2.2 Using the digital controller
1. Unpack controller and cables from shipping container. Please verify that your shipment included:
   - Controller
   - Controller to LCVR cable (not included with D3060HV)
   - +12V power supply and power cables

- USB cable or Serial cable
- Temperature sensing/control cable
- CellDRIVE software CD
- User's manual

2. Install the CellDRIVE 3100 software.
   - Place the CellDRIVE CD in the CD-ROM drive.
   - Wait for the CellDRIVE menu to appear, and then click on the "Install CellDRIVE …" button. (If autorun doesn't work, double click on setup.exe on the CD.)

3. Hardware configuration of the controller:
   - Connect the +12VDC supply to the controller. Plug the power supply into a properly grounded AC outlet.
   - For USB interface: attach USB cable to USB connector on rear of controller and connect other end to USB port on computer.
     For serial interface: attach serial cable to DB9 connector on controller and connect other end to serial port on computer.
   - Connect cables to attach up to four liquid crystal cells to controller (D3060HV can control up to two Swift LC devices).
   - If applicable, connect temperature sensing and control (TSC) cable to the five-pin LEMO$^®$ connector on the temperature-enabled controller. The controller (including the D3060HV) is capable of TSC on any single channel. If additional LC devices require TSC, please contact us to inquire about our TC3051, Stand-alone Temperature Control unit.

4. Turn on the front panel switch and observe the LEDs. The green power LED remains illuminated as long as the controller is powered on. The yellow status LED flashes the firmware version number and then remains off. On the D3060HV, the HIGH VOLTAGE LED has three states: off = high voltage and outputs inactive (turn on key switch); orange = high voltage on, normal operation; red = high voltage circuitry overheated (turn off key switch and allow unit to cool – contact us if this happens regularly)

5. If using USB, the USB driver must be installed prior to connecting controller to the computer. The installers are located in the USB drivers directory of the CD. Please choose the 32 bit or 64 bit installer, as appropriate for your Windows$^®$ version. Windows$^®$ XP, Vista, 7 and 8 are all available in either 32 bit or 64 bit versions.

3. Computer Control

There are several computer-based methods by which to control the amplitude of the 2-kHz square wave (13-kHz for D3060HV) output signals. Therefore, signals and waveforms in this manual refer to an amplitude envelope about a 2-kHz or 13-kHz square wave. For instance, a driver signal described as "invariant" actually refers to a square wave with a steady amplitude; the envelope is unchanging in time but the signal itself (if measured with an oscilloscope) oscillates about the zero-voltage axis. It is important to note that the square wave is always symmetric about the zero-voltage axis; thus "time-invariant" does not actually mean that a DC voltage is applied to a liquid crystal cell. As previously mentioned, zero-offset is critical for nematic liquid crystal cells.

> **!** Voltage levels herein refer to the amplitude envelope of a 2-kHz (13-kHz for D3060HV) square wave with near-zero DC offset. Applying any significant DC component to a liquid crystal cell may significantly decrease lifetime of the device.

The most common methods of interfacing to the controller are:
1. Using CellDRIVE 3100 nematic liquid crystal driver software package from Meadowlark Optics (or using the external input capability).
2. Typing command-line ASCII control codes through a terminal interface (Microsoft® HyperTerminal, for example).
3. Using a C/C++ program that communicates with the controller via USB
4. Developing a custom LabVIEW™ application using sub-VIs included on the CellDRIVE CD.

3.1 CellDRIVE 3100

CellDRIVE 3100 provides for internal or external waveform generation (amplitude modulation of the square wave) and temperature sensing and control options. A closed-loop proportional feedback control circuit in the digital interface controller implements the temperature control feature with a user entered set point and measured temperature monitoring through the user interface. Active heating and passive cooling of the liquid crystal cell achieve temperature control. The user interface, Figure 5, consists of a control section (left-hand side) and a waveform display section (right-hand side). Clicking the Meadowlark Optics logo displays the software and firmware version numbers.
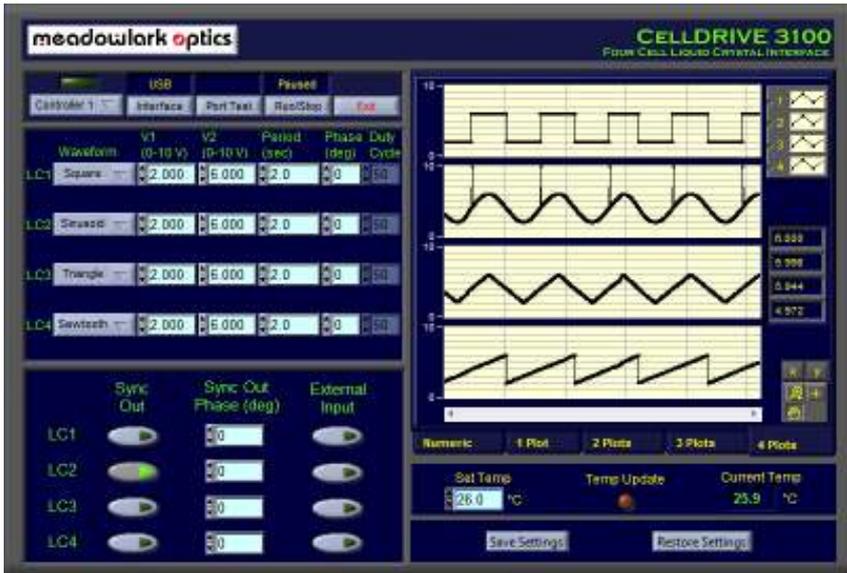
Figure 5 CellDRIVE 3100 User Interface

3.1.1 Control Panel

Along the top of the control section are buttons and indicators that operate as follows:

- **Controller *n* (USB interface selected):** Selects between multiple controllers connected to the same computer. This control does not appear when a serial interface is used.

<p align="center">**– OR –**</p>

  I/O COM *n* (Serial interface selected): Selects COM port to which the controller is connected. Note that although "LPT *n*" options appear on this pull down menu, the controller is not configured for connection to a parallel port.

- **Status Light:** Illuminates as follows (also see Port Test below):
  Green (waveforms "on") - Port status OK when last checked
  Green (waveforms "off") - Last user-initiated port test passed
  Yellow (waveforms "off") - User-initiated port test underway
  Red (waveforms "off") - Last user-initiated port test failed

- **Interface:** Selects between USB and serial interface.

- **Port Test (active when waveforms are "off"):** Initiates a read/write test of controller. The status light illuminates yellow during the test, then green or red upon completion. A green light indicates

proper communication between the controller and the computer and a red light indicates unsuccessful communication.
<u>In the event of a red light:</u>
  1. Check the cable connections.
  2. Exit CellDRIVE, turn the controller off and back on, wait for the status LED on the controller to stop flashing, then restart CellDRIVE.
  3. Try a different USB or serial cable.
  4. Try running the unit with a different computer.
  5. If all else fails, contact Meadowlark Optics for assistance.
- **Run/Stop:** Toggles waveform generation between the on (Run) and off (Stop) states. In "Stop" mode the port test may be executed.
- **Exit:** Quits CellDRIVE. The last voltages generated by CellDRIVE will remain on the controller outputs until the controller is powered off. The temperature will also be maintained until the controller is powered off.

3.1.2 Waveform Control

In addition to the time-invariant setting, CellDRIVE 3100 provides the capability to select from and configure a variety of CellDRIVE-generated waveforms for each individual output channel. Table 1 lists configuration parameters available with each waveform.

3.1.2.1 More on T.N.E. (Not useful with Swift LC devices)

The CellDRIVE 3100 user interface with T.N.E. mode configured on channel 4 ($V_{TNE} = 10V$ and $T_{TNE} = 150$ msec) is shown in Figure 6. An example T.N.E. output envelope is shown in Figure 7; the 2-kHz square wave is shown within the envelope (the shaded region).

By considering positive-voltage (top half) of the signal shown in Figure 7, one can distinguish a square wave varying between +3 and +7 volts. Immediately preceding the positive-going transition a 10-volt spike is observed. Similarly, immediately following the negative-going transition, a zero-volt spike is observed. The purpose of these spikes is to drive the state change in the liquid crystal faster than what would otherwise occur. When the T.N.E. waveform is selected, the user may specify the duration of the T.N.E. spikes as well as the magnitude of the positive-transition spike (the negative-transition spike is always zero).
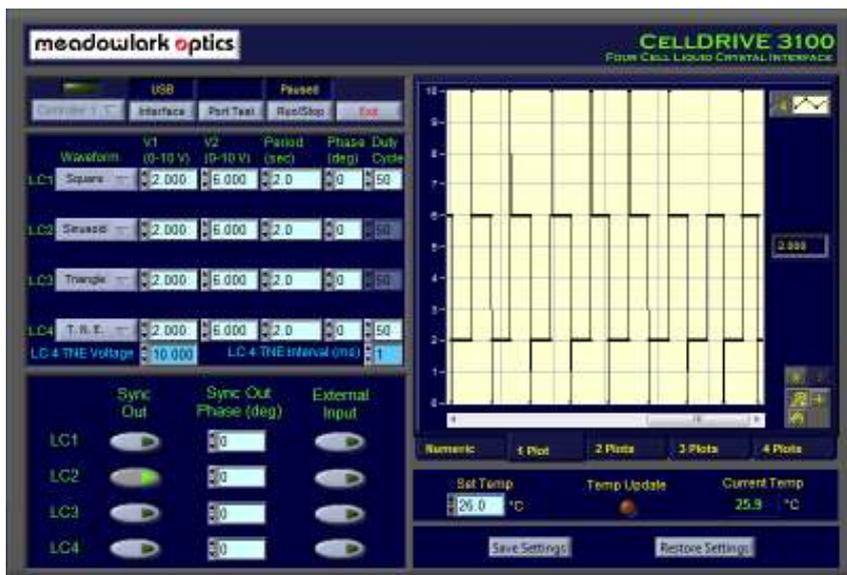
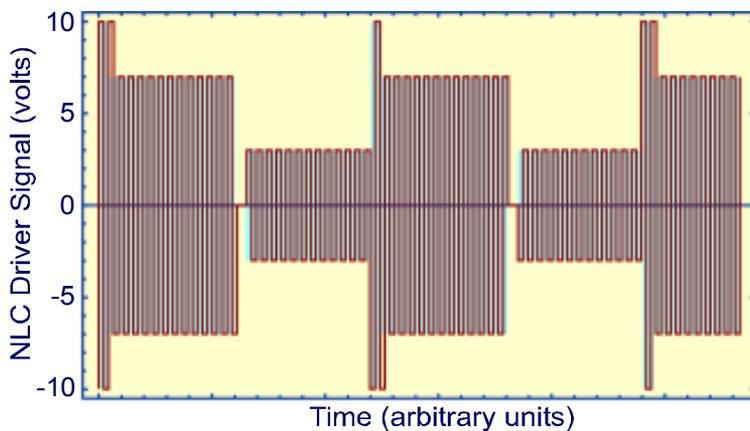**Figure 6 T.N.E. Waveform on LC channel 4**

Figure 7 T.N.E. envelope

Table 1 CellDRIVE 3100 waveform options

Waveform	Available Parameters and Allowable Ranges		Description
Off	(*None*)		Output is 0.0 V
Invariant	V_1	0 – 10 V	Output is time-invariant square wave with user-specified amplitude.
Sinusoid	V_1 V_2 T Φ	0 – 10 V 0 – 10 V 0.5 – ∞ sec -360° – 360°	Output is a square wave within envelope that varies sinusoidally between V_1 and V_2 over user-specified period. Phase relative to other output channels can also be varied.
Triangle	V_1 V_2 T Φ	0 – 10 V 0 – 10 V 0.5 – ∞ sec -360° – 360°	Output is a square wave within an envelope that varies linearly from V_1 to V_2 and back to V_1 over a user-specified period. The phase relative to the other output channels can also be varied.
Square	V_1 V_2 T φ % Duty Cycle	0 – 10 V 0 – 10 V 0.5 – ∞ sec -360° – 360° 0 – 100 %	Output is a square wave within an envelope that varies instantly between V_1 and V_2 over user-specified period. The phase relative to the other output channels and duty cycle (ratio of positive-voltage duration to total period, expressed as percent) can also be varied.
Sawtooth	V_1 V_2 T Φ	0 – 10 V 0 – 10 V 0.5 – ∞ sec -360° – 360°	Output is a square wave within an envelope that rises linearly to V_1 or V_2 (whichever is greater) over user-specified period, and then drops instantly to lower voltage. The phase relative to the other output channels can also be varied.
T.N.E.	V_1 V_2 T φ % Duty Cycle V_{TNE} T_{TNE}	0 – 10 V 0 – 10 V 0.5 – ∞ sec -360° – 360° 0 – 100 % 0 – 10 V 0 – 255 ms	*Transient Nematic Effect.* Identical in behavior to square wave with the following exception: a voltage spike occurs for a brief interval immediately following a positive transition, and similarly the voltage drops to zero for a brief interval immediately following a negative transition.

3.1.3 Sync Pulse Controls

CellDRIVE 3100 provides the capability to output a TTL sync pulse (high for approximately 1 μsec) on the front panel sync connector at specified points in the CellDRIVE generated waveform. This sync pulse may be used for purposes such as triggering external lab equipment at specific times.

- **Sync Out:** Toggles sync pulse generation on and off for the specified channel. A visual indicator of sync pulse generation is shown as a brief spike on the graph of the generated waveform whenever a sync pulse is output (see waveform 2 in Figure 5). Sync pulse generation may be enabled for any combination of channels. It is up to the user to determine which sync pulses are associated with which channels. [**NOTE**: The sync pulse is no t an actual volatge spike being sent to the LC device.]

- **Sync Out Phase:** Specifies at which point in the waveform the sync pulse is generated, and is additive to any phase specified in the respective waveform control.

3.1.4 External Input Controls

CellDRIVE 3100 provides the capability to drive the channel outputs via an externally generated signal applied to the front panel "external input" connector. The input DC signal must be between 0V (corresponds to a square wave of 0V amplitude on the output channel) and 5V (corresponds to a square wave varying between –10V and +10V amplitude on the output channel). As an example, if the user desires a sinusoid on the output channel that varies between 0 V_{p-p} and 8 V_{p-p} then the externally applied signal must be a sinusoid that varies between 0 V and +2 V amplitude.

- **External Input:** Applying a signal to the front panel external input connector and selecting an external input button configures the controller to periodically sample the signal voltage, generate the appropriate amplitude square wave and output it to the selected channel. The externally applied signal will drive the output of every channel that has been selected by clicking on an external input button. Sync out and waveform controls will be disabled for each channel that has external inputs active (generation of sync out pulses is not possible if using external inputs). Any channel that has not been selected may be controlled normally through the software, including generation of sync pulses.

3.1.5 Waveform display

The right-hand side of the user interface consists of waveform display options, which include the row of tabs along the bottom of the display section. The tabs provide choices for numeric or graphic display modes and the user-controlled display options are:

- **Numeric:** Shows the instantaneous voltage for each channel, and status lights that indicate updated voltages on each channel.
- *n* **Plot(s):** Specifies number of channels to plot on the displayed waveform. For instance, if only three channels are being used, one might select "3 Plots". If two channels are driven by time-invariant values while a third is driven in T.N.E. mode, one might choose to plot only the T.N.E. channel. The choice of display has no effect on output to the LC channel - choosing to display channel 2 does not affect the signal output of channel 3.
- **Legend:** The waveform plotted on a particular graph is selected by clicking left of the number on the plot legend. Clicking right of the number on the plot legend gives a menu of options for displaying a plot.
- **Y:** This button auto-scales the vertical axis or axes to a range of 0-10 V.
- **X:** This button auto-scales the horizontal axis to show the most recent 5000 voltage values, or to all of the voltage values if less than 5000 have been acquired.
- **Zoom/Pan:** Includes a variety of zoom and pan features for viewing the graph.
- **Horizontal Scroll bar:** Enables scrolling back to review 5000 most recent voltage values.
- **Vertical Axis Values:** These may be double-clicked and "edited" to change the vertical axis range.

3.1.6 Temperature Sensing and Control
The temperature control interface includes the following:
- **Set Temp:** Allows user to set the temperature (°C) at which a temperature-controlled LC is to be maintained.
- **Temp Update:** Flashes when temperature measurement displayed on the screen is updated.
- **Current Temp:** Displays present temperature of a temperature-controlled LC. If the temperature is within ±1 degree of the set point the number will be in green text, otherwise it will be red.

NOTE: If more than one device requires TSC operation, please contact us to inquire about our TC3051, Stand-alone Temperature Control unit.

3.1.7 Save/Restore Controls
The settings may be saved and restored using the save and restore buttons.
- **Save Settings:** Allows user to specify a file into which present waveform, sync out, external input and set temperature values will be saved.

- **Restore Settings:** Allows user to specify a file from which waveform, sync out, external input and set temperature values will be loaded.

3.2 Additional Digital Interface Control Options

The user has several other digital interface control options; via a HyperTerminal session, a user created program to communicate with the controller via USB, or by using custom LabVIEW VIs supplied by Meadowlark Optics. Table 2 details a complete list of ASCII firmware commands that may be used when performing USB or HyperTerminal control. Note that all commands are lower case.

3.2.1 HyperTerminal Command Line Control

The HyperTerminal interface is available only through a COM port (RS-232) connection. After initiating a HyperTerminal session (see Appendix A for details), text commands are issued directly to the controller and responses are printed to the HyperTerminal screen.

3.2.2 USB Control via C/C++ Program

The user can write a program that communicates directly with the controller through a USB connection. Included on the CellDRIVE CD (Source Code folder) is a source code file (usb_ver.cpp) that initializes a USB connection to the controller, sends a *ver:?* command and reads the status response (after sending any command, status must be read before another command can be sent). This program may be used as a starting point and modified as necessary to perform the desired task(s). Header file usbdrvd.h must be included in the source code and the library file usbdrvd.dll (both included on the CellDRIVE CD) must be linked in the final program. If a user developed or modified application program is to be distributed in any way, please contact Meadowlark Optics for licensing and copyright details.

3.2.3 ASCII Command Conversions

To convert the 16-bit integer (i) and 14-bit integer (t) values in Table 2, use the following conversion formulae:

Convert to voltage: $V = i / 6553.5$

Convert **Set-point** to temperature (°C): $T = (t*500/16384) - 273.15$

Convert **Set-point** from temperature (°C): $t = (°C + 273.15) * 16384/500$

Table 2 ASCII commands for the Digital Interface Controller

Firmware Command	Description	Notes
ld:n,i<CR>	Sets the modulation voltage on the specified LC channel. Converts integer i to a square-wave amplitude voltage.	n = LC channel (1,2,3,4) i = 16-bit integer (0-65535)
ld:n,?<CR>	Query voltage setting on channel n.	n = LC channel (1,2,3,4) Controller returns 16-bit integer (i)
ldd:i_1, i_2, i_3, i_4<CR>	Simultaneously sets modulation voltages on all LC channels. Converts each integer i to square-wave amplitude voltage.	each i = 16-bit integer (0-65535)
ldd:?<CR>	Query voltage settings on all channels.	Controller returns four 16-bit integers (i)
ldx: i_1 i_2 i_3 i_4<CR>	Simultaneously sets modulation voltages on all LC channels. Converts each binary integer i to square-wave amplitude voltage.	each i = 16-bit binary integer (0x0000 – 0xFFFF) (no comma and leading zeroes must be inserted for values < 0x1000) ldx is the only command that takes binary data as input parameters
tne: n,t,i<CR>	Activate TNE switching on channel n.	t = duration of TNE pulse (0-255 ms, t = 0 turns off TNE feature) i = 16-bit integer specifying amplitude of TNE pulse
tne: n,?<CR>	Query the TNE duration and amplitude voltage setting on channel n.	TNE pulse duration (in ms) and 16-bit integer (i)
sout:<CR>	Produces sync pulse (high-low) on front panel sync connector.	No parameters

extin:i<CR>	Enables output channels to be driven by signal applied to front panel external input connector.	i = integer (0 – 15) specifies output channel(s) enabled for external input
		    bit 0 set: channel 1 enabled
		    bit 1 set: channel 2 enabled
		    bit 2 set: channel 3 enabled
		    bit 3 set: channel 4 enabled
		any combination is valid

tmp:?<CR>	Query current temperature of temperature controlled LC.	Controller returns **16-bit** integer i converted to temperature by T (ºC) = (i*500/65535) - 273.15
tsp:t<CR>	Sets temperature setpoint for temperature control.	t is **14-bit** integer
tsp:?<CR>	Query current temperature setpoint.	Controller returns **14-bit** integer (t)
ver:?<CR>	Query firmware version.	Controller returns firmware version and copyright string

3.2.4 Custom LabVIEW VI Control

Several VIs are included in a library file on the CellDRIVE 3100 CD in the LabVIEW folder.

LabVIEW VIs that interface with the controller via the serial port are:
- Meadowlark Serial IO Example.VI
- Meadowlark Serial.LLB
    - o Meadowlark Serial Com.VI
    - o Meadowlark Serial Read Voltage.VI
    - o Meadowlark Serial Set Voltage.VI

LabVIEW VIs that interface with the controller by the USB port are:
- Meadowlark USB IO Example.VI
- Meadowlark USB.LLB
    - o Meadowlark USB Com.VI
    - o Meadowlark USB Easy Close.VI
    - o Meadowlark USB Easy Open.VI
    - o Meadowlark USB Read Voltage.VI
    - o Meadowlark USB Set Voltage.VI

The serial and USB files are similar in that each includes a LabVIEW library file containing fundamental VIs and an example that implements them in a program that sets and reads controller voltages. The LabVIEW back panels of the *IO Example* VIs are user accessible to facilitate independent development. Programmers are encouraged to open and examine the *IO Example* diagram screens. Please note that the LabVIEW development suite from National Instruments is required to use the included VIs, and is not provided with any version of CellDRIVE software. It is assumed that the customer has experience programming in LabVIEW and understands good programming practices. Meadowlark Optics cannot offer customer support for LabVIEW application development. If a developed or modified LabVIEW application is to be distributed in any way, please contact Meadowlark Optics for licensing and copyright details.

4. Frequently Asked Questions

Q: The controller is not working.
A: Check the power supply is plugged in, front panel switch is on and the green power light is steady. If using a USB interface, check the status of the controller under Windows® Device Manager by looking for a Meadowlark Optics USB Device. If using a serial interface, double check RS232 connection and attempt a HyperTerminal session. Occasionally it helps to turn off the controller, wait a few seconds, and then turn it back on.

Q: I started the CellDRIVE software and then turned on the controller, and now the software is behaving erratically. What is happening?
A: The controller must be turned on and have completed its power-on self-test *before* starting the CellDRIVE software.

Q: HyperTerminal commands do not seem to have any effect.
A: Confirm that HyperTerminal is properly configured as outlined in Appendix A. **NOTE:** HyperTerminal commands are only available through a COM (RS-232) port. A controller connected to a USB port will not respond to a HyperTerminal session.

Q: Liquid crystal cells are not changing state.
A: Check SMA connections and measure LC cell end of the cable with an AC (true-RMS) voltmeter or oscilloscope. Default values after power up (before running either of the CellDRIVE applications) are 555mV (5.55V for Swift LC devices). An oscilloscope will show a 2-kHz (13-kHz for Swift LC devices) square wave with 1.12V peak-to-peak amplitude (11.2V for Swift LC devices). **ALTERNATELY**: Double check optical alignment of cell. Some cell orientations won't affect polarization if they happen to align with an Eigen axis (fast or slow axis of the liquid crystal retarder).

Q: I can't use the SMA connectors on the back of the device, I need BNC.
A: BNC jack to SMA plug adapters are available from Meadowlark Optics. Meadowlark Optics can also provide (SMA to SMB) custom cable adapters to attach Meadowlark Optics LC cells.

Q: I need a particular waveform generated.
A: Use HyperTerminal and a text file editor to generate a piecewise approximation using `ld:` or `ldd:` commands. Transfer text file through HyperTerminal to the controller. Or, develop code using LabVIEW™ development suite and VIs included on the CellDRIVE CD. We can custom-program any waveform into CellDRIVE 3100; please contact us for details. ALTERNATIVELY: Use a signal generator with the external input capability of CellDRIVE 3100.

Q: How do I uninstall the CellDRIVE software?

A: Use the Add/Remove Programs option in the Windows® control panel. ALTERNATIVELY: Insert the CellDRIVE CD into the CD drive on the computer. Once the menu appears, click on the "Install CellDRIVE…" button. The software uninstaller will then run.

Q: Can I use multiple controllers to control more than four LC cells?

A: Yes. The CellDRIVE 3100 program is designed to handle up to four controllers connected to USB ports, giving a total of 16 channels of control. Waveform generation is limited to four channels (one controller) at a time.

Q: In TNE mode, the graphical display shows that TNE spikes are sometimes missing from the waveform.

A: Extremely short TNE spikes are occasionally misrepresented on the CellDRIVE 3100 interface, but viewing the output with an oscilloscope will verify that they are consistently produced and delivered to the LC cell.

Q: What are the power-on default voltage and temperature values?

A: After powering on the controller each LC channel will have a 2-kHz (13-kHz for Swift LC devices), 555mV (5.55V for Swift LC devices) [zero-to-peak amplitude] square wave. The temperature set-point is initialized to 0ºC so the cell will not heat. Once CellDRIVE 3100 Advanced is started, the temperature set-point (on units equipped with temperature sensing and control) is initialized to the LC temperature detected when the controller was powered on.

Appendix A: Configuring HyperTerminal

The interface between the host computer and controller consists of ASCII commands issued from the computer, and ASCII responses issued by the controller. When the RS-232 interface is used, ASCII commands and responses can be respectively issued by and read from a terminal application. HyperTerminal is a terminal application that is included with the Microsoft® Windows® operating system and can be installed from any Windows® CD. Note that HyperTerminal supports only communication over the COM ports; USB communication is not supported through HyperTerminal.

A HyperTerminal configuration file that configures the terminal interface for use with the controller is included on the CellDRIVE CD. In this appendix, the configuration parameters for ASCII terminal communications are detailed so that users may configure alternative terminal programs. If HyperTerminal has already been configured for use with a controller on a given computer, or if the HyperTerminal configuration file from the CD is used, these steps do not need to be followed.

1. Confirm that a controller is connected to one of the COM ports of the computer, powered on, and the computer is booted into with Windows® XP or newer. Launch the HyperTerminal program from: Start|Programs|Accessories|Communications|HyperTerminal.

2. The HyperTerminal title screen will appear briefly, and then the "Connection Description" dialog box will appear. The dialog will prompt you for a name and an icon for the new connection to be created. Type an appropriately descriptive name such as `Digital Interface Controller` in the "Name:" field. Click on one of the icons displayed to choose a connection icon. Click on the OK button to continue.

3. The "Connection Description" dialog box will close, and the "Connect To" dialog box will open. There are four fields in this dialog box, three of which refer to dial-up modem connections and are therefore not relevant. Click on the bottom-most field labeled "Connect using:" and select the COM port to which the controller is connected. Click the OK button to proceed.

4. The "Connect To" dialog box will close and a dialog box labeled "COMn Properties" (where n is the COM port number selected in the previous step) will appear. The COM port connection parameters (illustrated below) are:

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- Bits per second: 38400
- Data bits: 8
- Parity: None
- Stop Bits: 1
- Flow Control: None

When the port settings are complete, click the OK button to proceed.

A HyperTerminal screen will now open. At this point, the terminal connection has been established and properly typed commands issued from the COMPUTER will be detected and appropriately followed by the controller. The steps that follow are necessary to correctly display the ASCII commands and responses in the HyperTerminal window.

5. Click File|Properties and a dialog "Properties" box will open. The dialog box will have two tabs at the top: "Connect To" and "Settings". Click the "Settings" tab. Click the button called "ASCII Setup…".

6. In the "ASCII Setup…" page, the following settings must be enabled:

- ✓ Echo typed characters locally
- ✓ Wrap lines that exceed terminal width

These settings are activated by placing a "check" in the appropriate boxes as shown in the below figure. Click OK to close the "ASCII Setup…" screen, and click OK again to exit the "Properties" dialog box.
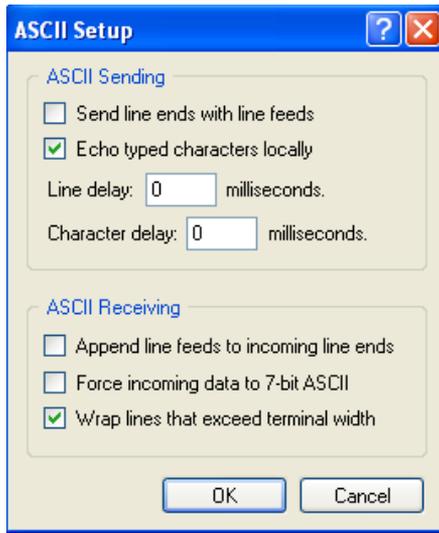
7. To save this configuration for future terminal sessions, click File|Save As…
Select a location and filename that will be convenient to remember.

8. Test the connection by typing `ver:?` and pressing the RETURN key. The
controller should generate a response that includes the version number and
copyright information.

Once the configuration is complete, commands listed in Table 2 can be used to
initiate controller functions.

Appendix B: Firmware Updater

The user can reprogram the internal firmware when new versions are released. Update is accomplished by using the firmware updater program included on the CellDRIVE CD. In order to use the firmware updater program the controller must be powered on and connected to an available USB port on the host computer.

Perform the following steps to reprogram the controller firmware:

1. Install firmware updater software on a computer running Microsoft® Windows® (XP or later). Place CellDRIVE CD in the CD-ROM drive, wait for the CD menu to appear and click on the "Install Firmware Updater" button.

2. Start the firmware updater software by clicking Start|Programs|Meadowlark Optics/Firmware updater. The following screen will appear:

3. Cycle power on the controller to ensure the USB connection is properly made. Wait until the front panel status LED is done flashing before clicking OK. If the power is not cycled or the OK button is clicked before the front panel status LED is done flashing, the following error will be displayed. If this error appears, close the firmware updater program and re-run it.
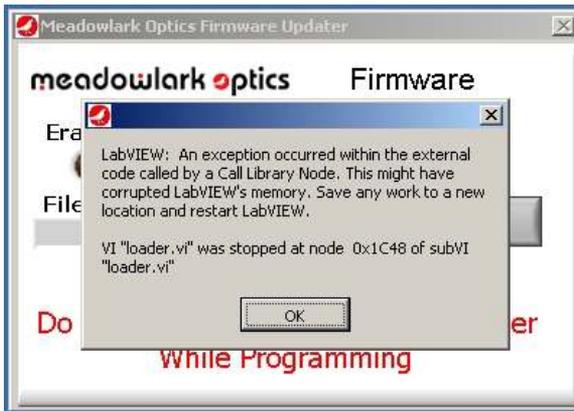
4. The following screen will appear after the USB connection is made.
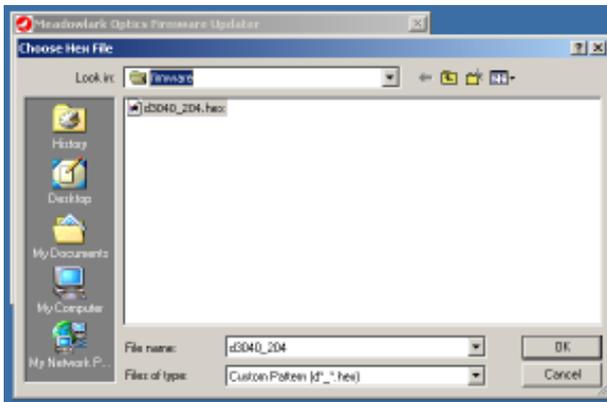
5. Choose the new hex file and click "OK". The program will check if the new firmware file is valid for the controller, if not, the following error screen will appear. At this point the user may elect to choose a different file or go ahead and program the controller with the chosen file.

Extreme caution should be exercised when deciding whether to program the controller with a file that may not be compatible. If there are questions about choosing the appropriate file, please contact Meadowlark Optics at 303-833-4333.
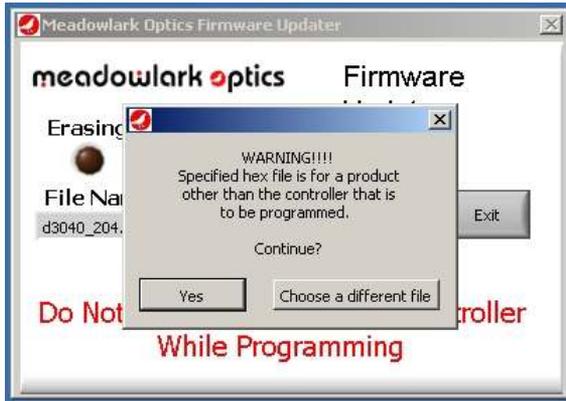
6. After the hex file is loaded and passes validity tests, the ready screen appears. Click the Program button to reprogram the controller firmware. If a final check is desired before reprogramming the firmware, the Meadowlark Optics logo may be clicked to display a screen showing the old and new firmware versions.

7. As the firmware is being erased and reprogrammed the status will be displayed as shown. ***DO NOT* disturb power to the controller while it is erasing or reprogramming.** If power is disturbed the controller's memory will be corrupted, requiring the unit to be returned to Meadowlark Optics for reprogramming.
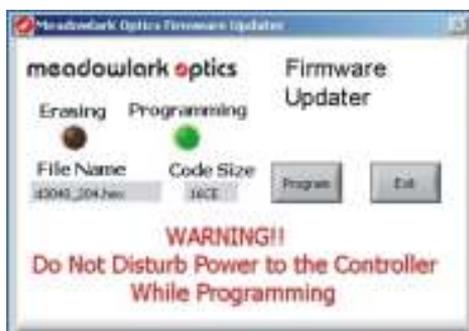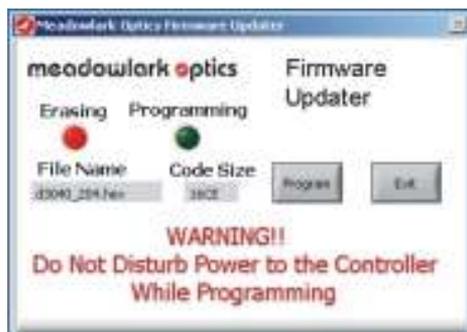
8. After programming is complete, the following screen appears. When the controller power is cycled, the status light should flash a pattern corresponding to the version number of the new firmware. The new firmware version may also be determined by clicking the Meadowlark Optics logo in the upper left corner of CellDRIVE.
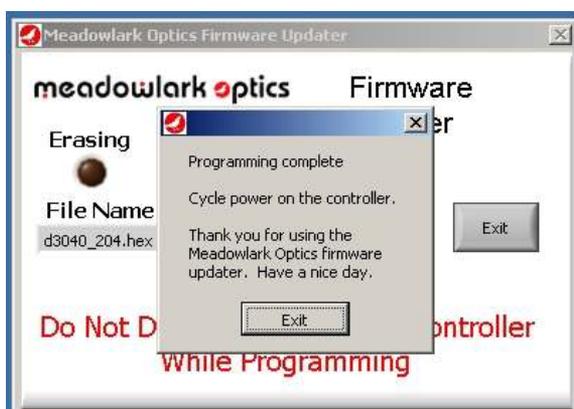
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meadowlark optics

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5964 Iris Parkway
P.O. Box 1000 (US Mail)
Frederick, Colorado 80530
303-833-4333

sales@meadowlark.com

www.meadowlark.com