Controlling Filter Wheels and Stages from VPascal
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This document describes how filter wheels, stages, and other laboratory equipment can be controlled from VPascal.

Introduction
Many experiments involve the use of additional equipment with the camera, including devices like filter wheels and microscope stages. Most of these devices can be controlled by sending them commands from the computer.

Most devices can be considered as serial communications devices, although the actual physical connection on modern equipment is frequently via USB. If your equipment uses a USB connection, it most likely provides a "virtual serial port" that can be accessed using the VPascal serial communications functions.

Sample VPascal modules are provided on the Digital Optics web site for controlling devices manufactured by both LUDL and Sutter.

Serial Communications
Every device you may need to control via a serial connection has its own particular protocol and set of commands. To integrate such equipment into a V++ setup may require a VPascal module to send out the appropriate commands and act on any information that comes back from the device. Modules have already been written for some devices and are made available on the Digital optics web site for you to use "as is" or to modify for your own purposes.

It is assumed that you already know the basics of doing serial communications in VPascal. If not, then please read the Serial Communications overview in the V++ online help before continuing with this article.

To implement serial control for a device of your own you'll need to be able to transmit and receive serial data, correctly terminate commands, recognize incoming commands, flush the serial buffers, and wait while a device is busy. All of this is easily accomplished in VPascal and is illustrated in downloadable sample modules.

If you are using a LUDL filter wheel or z-axis motor then you can use the sample modules immediately. For other devices you may need to do some modifications first.

Filter Wheels
By mounting a selection of filters in a wheel it is possible to select them under software control by simply rotating the wheel. Often there is also an integrated shutter available which can be opened and closed by sending commands to the serial port.

The commands available typically include the following kinds of operations:

Home	Go to the "home" position (a known wheel orientation)
Set position n	Go to a specific filter position
Rotate	Rotate the wheel by a given number of filter positions
Open	Open the shutter
Close	Close the shutter

The Wheel.v module implements commands for a LUDL filter wheel. These are used to create a toolbar for the user to manually control the wheel. They are also shared via DDE so that you can

write your own modules that drive the wheel without having to re-implement the filter wheel commands.

The LUDL high-level commands are quite simple - for example, "ROTAT S M 2" moves the wheel to the second filter position and "ROTAT S M H" returns it to the home position. More notes about the LUDL devices are provided below.

The LambdaCtrl.v module implements a controller for a Sutter Lambda 10-2 filter wheel and also shares its procedures and variables via DDE.

Stage Controllers

Stage controllers are used to move samples under a microscope, in one or more axes. The commands you can send to an axis motor typically include operations like the following:

Home	Move the stage to the home position in this axis
Move	Move to an absolute position
Relative move	Move to a position relative to the current position

The LepZAxis.v module implements the commands for a LUDL z-axis controller but is very easily extended to cope with other axes or even multiple axes. It creates a toolbar for the user and also shares all commands via DDE so that simple client modules can also control the stage. The ZClient.v module illustrates how a few lines of code can call the "server" module to control the stage (the same principle applies to the sample filter wheel module).

Actual command strings for the LUDL axis motor include "move b=12" for an absolute move, "moverel b=-1" for a relative move and "joystick b+" to enable the user's joystick for manual movements. See the next section for more notes on controlling LUDL devices.

LUDL Notes

LUDL devices require a carriage-return character to terminate a command from the host and send back a line-feed character to terminate their own responses. This protocol can be handled automatically in VPascal by defining termination strings as follows:

```
SetTxEnd( chr( 13 ) ) ;
SetRxEnd( chr( 10 ) ) ;
```

Before sending any commands to the filter wheel or axis motor, you must also select the high-level protocol by sending a command as follows:

```
Transmit( chr( 255 ) + chr( 65 ) ) ;
```

As with all serial communications, it's also a good idea to flush the transmit and receive buffers before you start (use VPascal's TxFlush and RxFlush procedures).

If you have written a control module for a serial device and would be willing to share it with others on this web site then please contact us (details below).

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