ASCOM EF Lens Controller

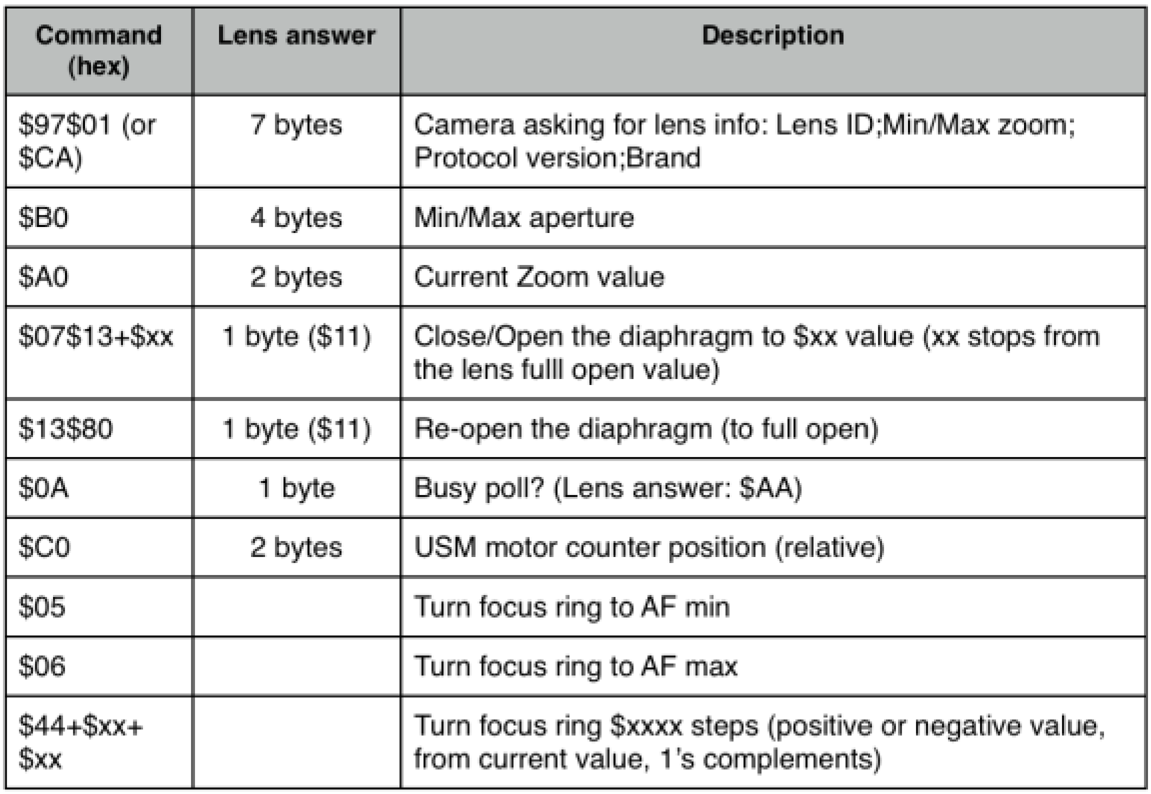
ASCOM EF Lens Controller – control unit for Canon EF/EF-S lenses. It allows you to control lens using the ASCOM platform tools.

Features (supported by driver):

- focus control;
- aperture value control;
- temperature measure (additional sensor required, e.g. popular DS18B20).

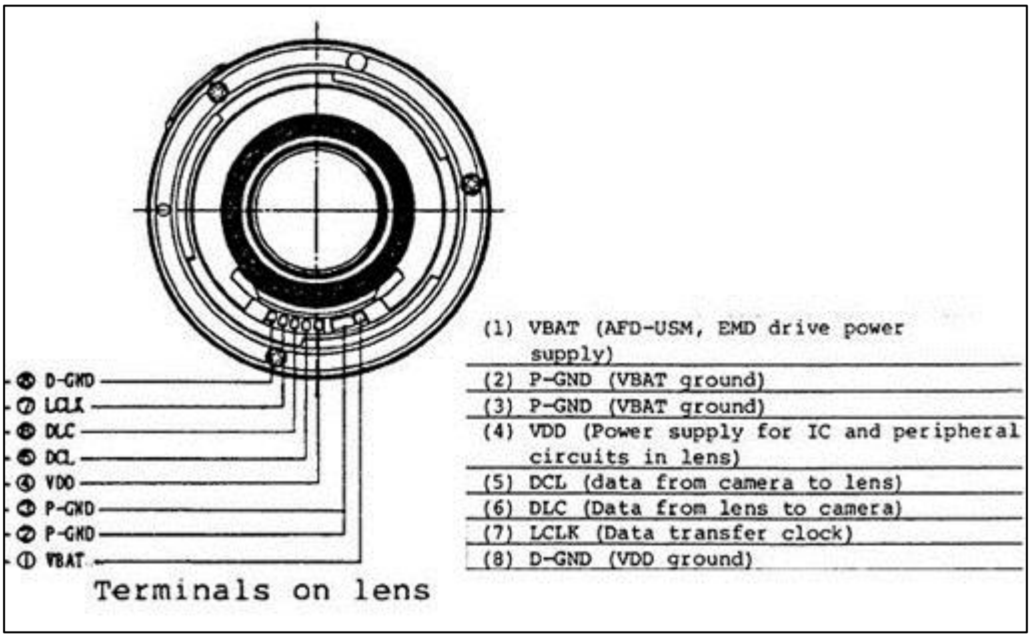
This device uses SPI interface. Description of lens commands were taken from published articles about reverse engineered internal Canon protocol.

- How to move Canon EF Lenses (pdf);
- Canon EF-S Protocol and Electronic Follow Focus.



Command (hex)	Lens answer	Description
$97$01 (or $CA)	7 bytes	Camera asking for lens info: Lens ID;Min/Max zoom; Protocol version;Brand
$B0	4 bytes	Min/Max aperture
$A0	2 bytes	Current Zoom value
$07$13+$xx	1 byte ($11)	Close/Open the diaphragm to $xx value (xx stops from the lens fulll open value)
$13$80	1 byte ($11)	Re-open the diaphragm (to full open)
$0A	1 byte	Busy poll? (Lens answer: $AA)
$C0	2 bytes	USM motor counter position (relative)
$05		Turn focus ring to AF min
$06		Turn focus ring to AF max
$44+$xx+ $xx		Turn focus ring $xxxx steps (positive or negative value, from current value, 1's complements)

Connection to lens is easy. It is only necessary to know pinout of its contacts. This information is available on the Web. Just «google» *canon ef pinout.* I recommend to use a scheme, shown below.

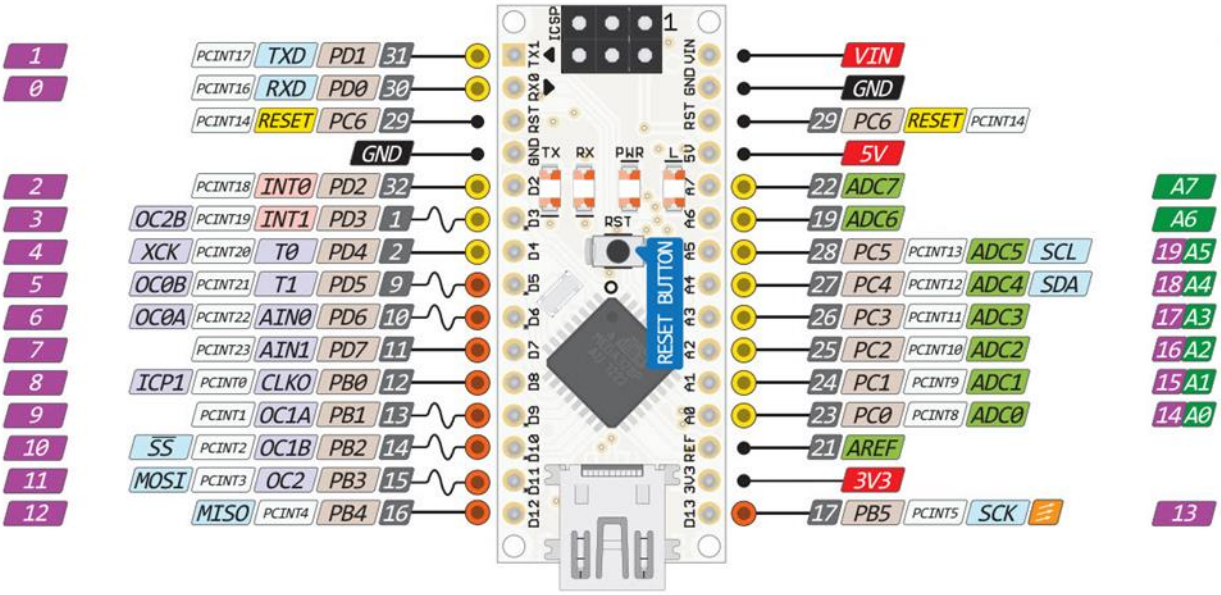


(1) VBAT (AFD-USM, EMD drive power supply)
(2) P-GND (VBAT ground)
(3) P-GND (VBAT ground)
(4) VDD (Power supply for IC and peripheral circuits in lens)
(5) DCL (data from camera to lens)
(6) DLC (Data from lens to camera)
(7) LCLK (Data transfer clock)
(8) D-GND (VDD ground)

This picture describes electric pins on lens or special macro-adapter which is suitable for soldering wires. You can buy adapters in any photo shop or on web stores such as EBay. It looks something like this.

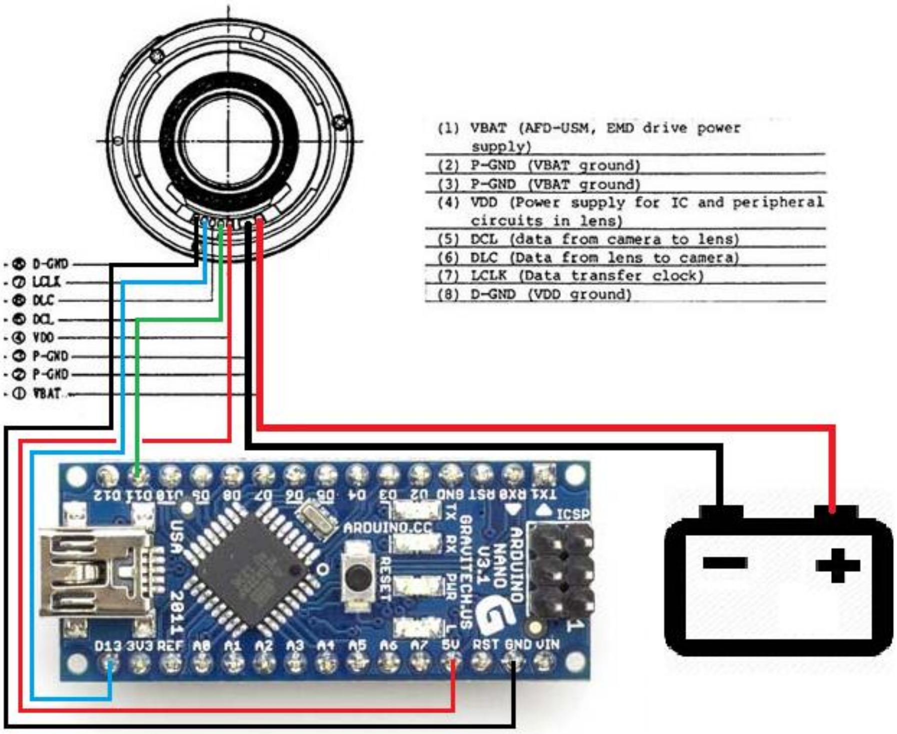
Next component – microcontroller, which support SPI interface. It may be ATmega, STM32, PIC or board, based on its controllers. Factory PCB has all required components and will be easy for beginners while simple microcontroller allows you to make own custom device.

I used Arduino Nano based on ATmega328P controller. Its performance is enough for our purpose. Small size and low cost - its advantage.



Pinout diagram above shows the designations of Arduino Nano contacts. So we need:

Digital logic		
Controller	**Lens**	**Description**
5V	VDD	Power supply for digital circuit in lens
GND	D-GND	VDD ground
MOSI (pin 11)	DCL	Data from camera to lens
SCK (pin 13)	LCLK	Data transfer clock
External power supply		
VCC	VBAT	AFD-USM, EMD drive power supply
GND	P-GND	V-BAT ground



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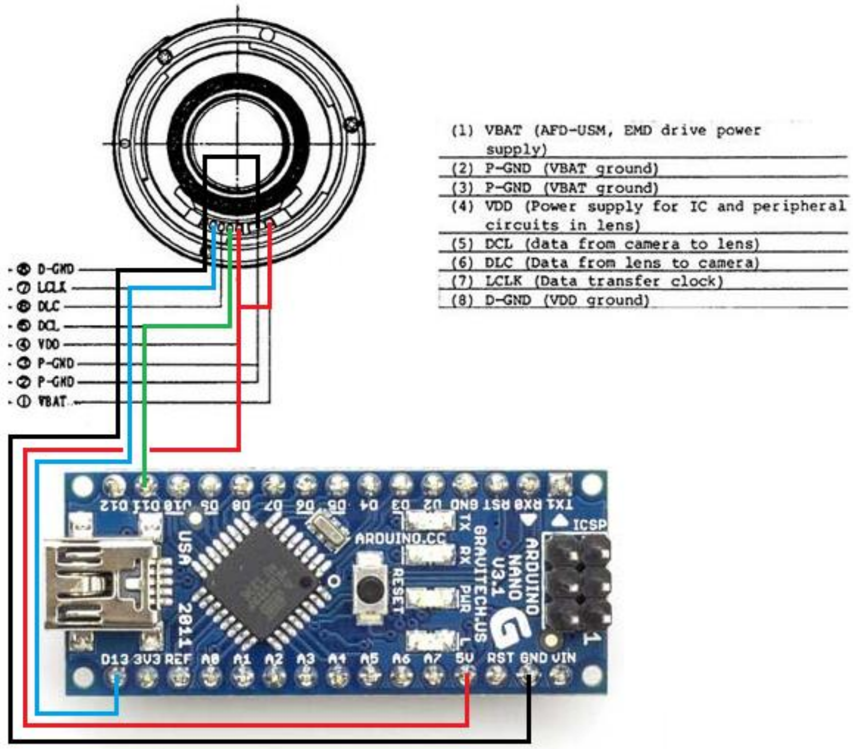
Note: only huge lenses may require external power supply. I tested my lenses (EF-S 18-55, EF 50/1.8, EF200/2.8L) and measured their current consumption. It was less than 200 mA. It means that these lenses can be powered directly from 5V Arduino pin. Entire system will be powered from USB, and there is no need for additional wires.


⑧ D-GND
⑦ LCLK
⑥ DLC
⑤ DCL
④ VDD
③ P-GND
② P-GND
① VBAT
(1) VBAT (AFD-USM, EMD drive power supply)
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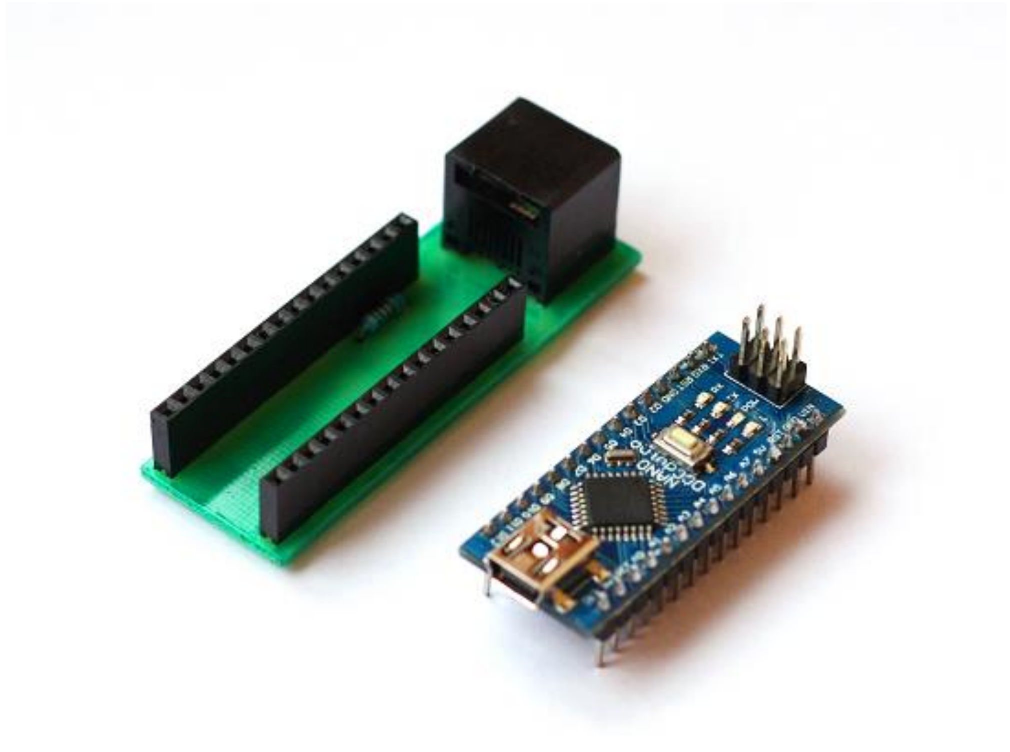
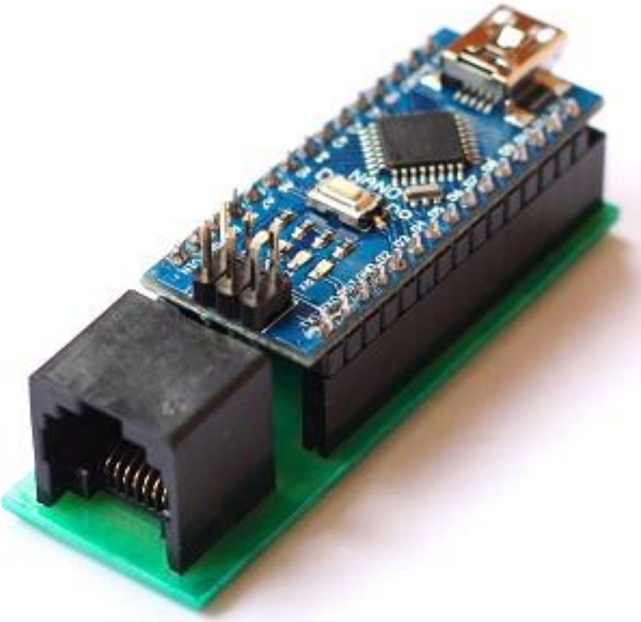
D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 GND RST RX0 TX1
D13 3V3 REF A0 A1 A2 A3 A4 A5 A6 A7 5V RST GND VIN
ARDUINO NANO V3.1
ICSP

You can experiment on the breadboard but for the final design it is better to use a more respectable solution.

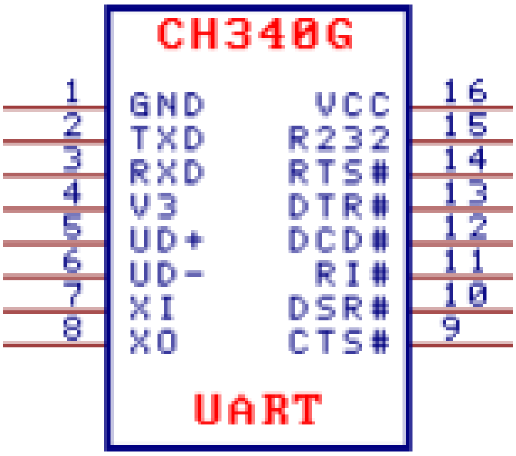


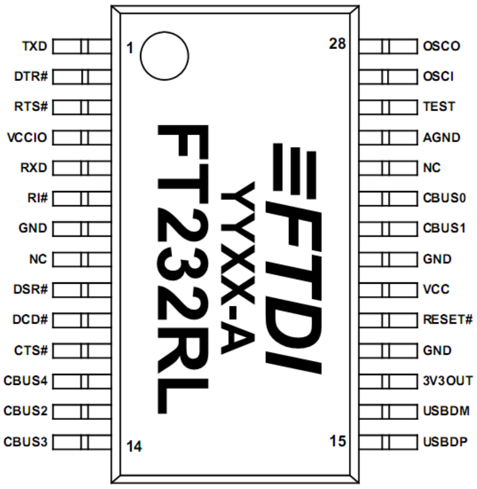


I want to point out one feature associated with Arduino. Now, these boards use the Automatic (Software) Reset, which is convenient for firmware upload but do not really need us. The fact is that:

> One of the hardware flow control lines (DTR) of the FT232RL is connected to the reset line of the ATmega168 or ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip.

This means that each connection («Connect» button in MaximDL or FocusMax) to the device will cause it to reboot. Result is 3-5 sec delay. If you are not satisfied, simplest solution is to unsolder DTR pin to prevent transfer of reboot signal. I used «ChinaDuino», it has CH340G as UART chip. Original Arduino uses FT232RL.





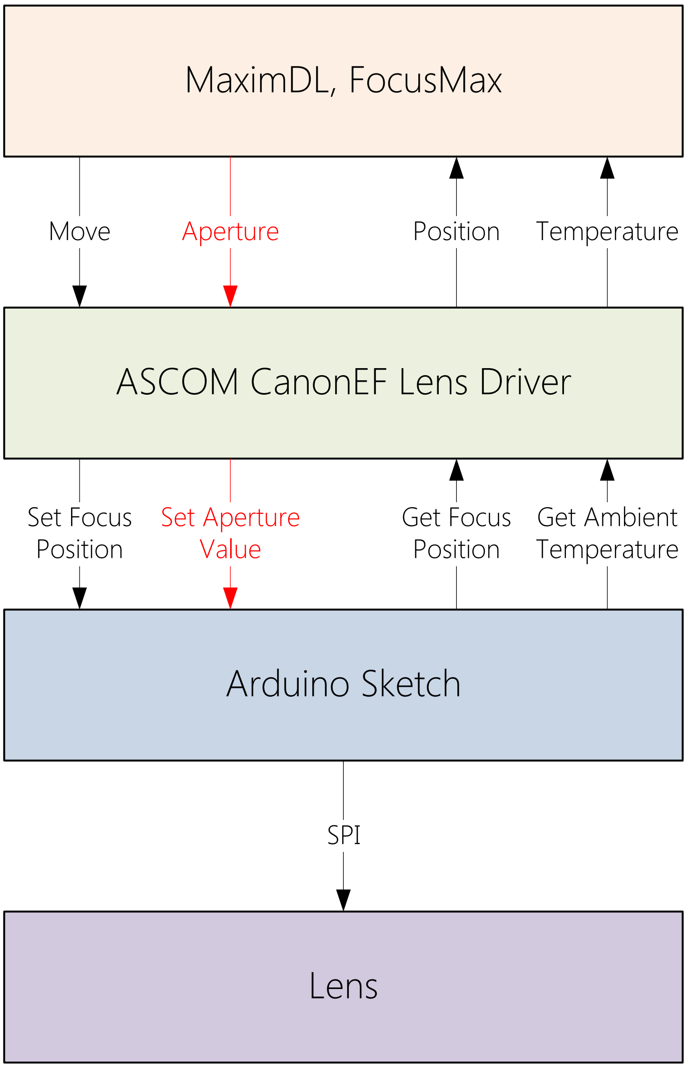
These schemes allow you to easily find the DTR pin. After making these changes, device connects immediately.

Software

Software consists of two main parts:

- Arduino sketch (firmware) is responsible for interaction with lens;
- ASCOM device driver.

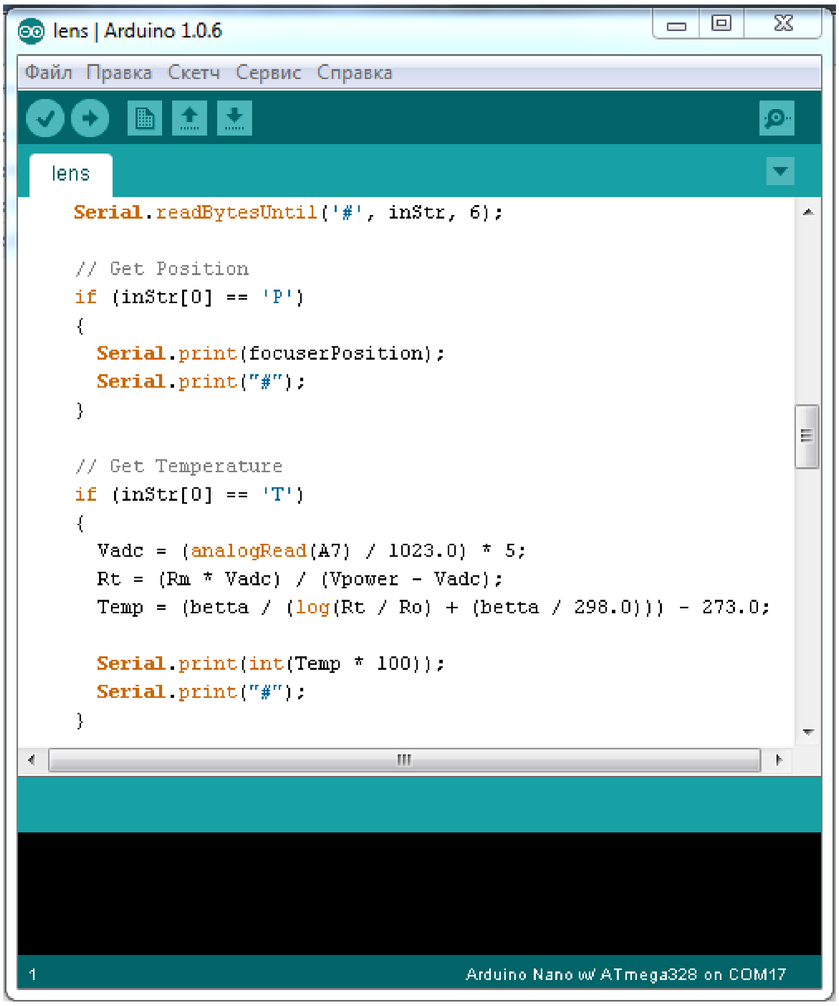
Unit relations shown in the figure below:



The red highlighted functionality implemented in addition to the main functions realized in driver pattern. Focuser driver has no iris control functions by default. But aperture value control is important feature.

Using the driver

1. Install Arduino drivers (FT232RL chip). Usually Arduino IDE installer already has appropriate driver. If you have Arduino clone based on another UART chip – search drivers on the Web.
2. Download and install Arduino IDE. This programming environment allows you to create, edit and upload sketches.

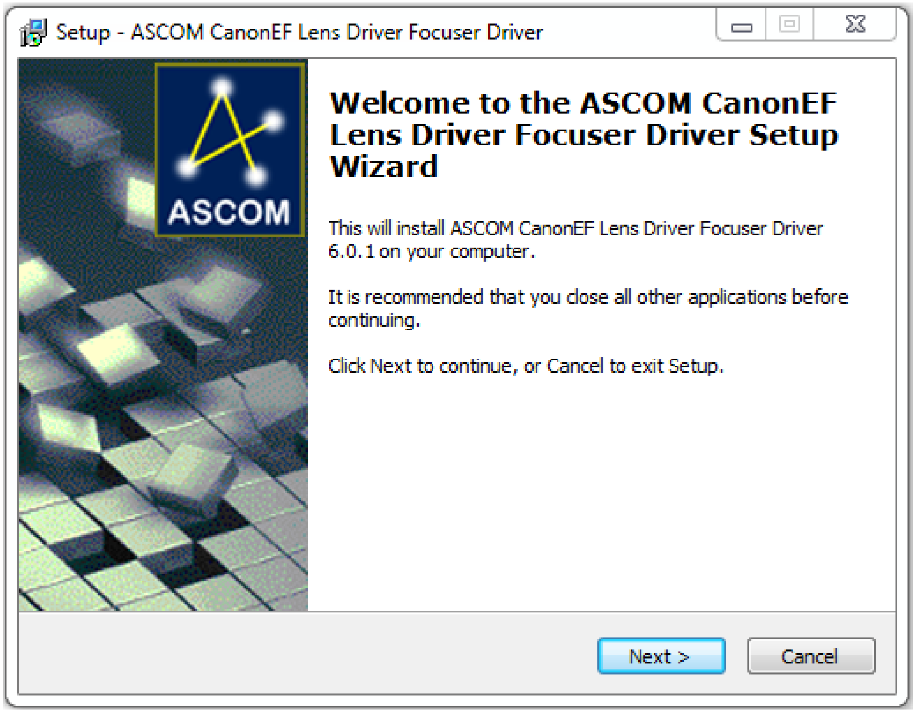

lens | Arduino 1.0.6
Файл Правка Скетч Сервис Справка
lens
1
Arduino Nano w/ ATmega328 on COM17

```
  Serial.readBytesUntil('#', inStr, 6);

  // Get Position
  if (inStr[0] == 'P')
  {
    Serial.print(focuserPosition);
    Serial.print("#");
  }

  // Get Temperature
  if (inStr[0] == 'T')
  {
    Vadc = (analogRead(A7) / 1023.0) * 5;
    Rt = (Rm * Vadc) / (Vpower - Vadc);
    Temp = (betta / (log(Rt / Ro) + (betta / 298.0))) - 273.0;

    Serial.print(int(Temp * 100));
    Serial.print("#");
  }
```

Arduino IDE also has COM port monitor, which help you to debug code and quickly check main functions of the controller.

Use P# to get current focus position (5000 by default)
Use Mxxxx# to move focus, e.g. M5270#
Use Axx# to change aperture value, where xx – count of steps (1/3 EV). 0 – wide open on your lens.

3. Download lens control sketch. Open it with Arduino IDE and upload to your board.
4. Download and install ASCOM focuser driver. Follow instructions shown on your screen.



Setup - ASCOM CanonEF Lens Driver Focuser Driver

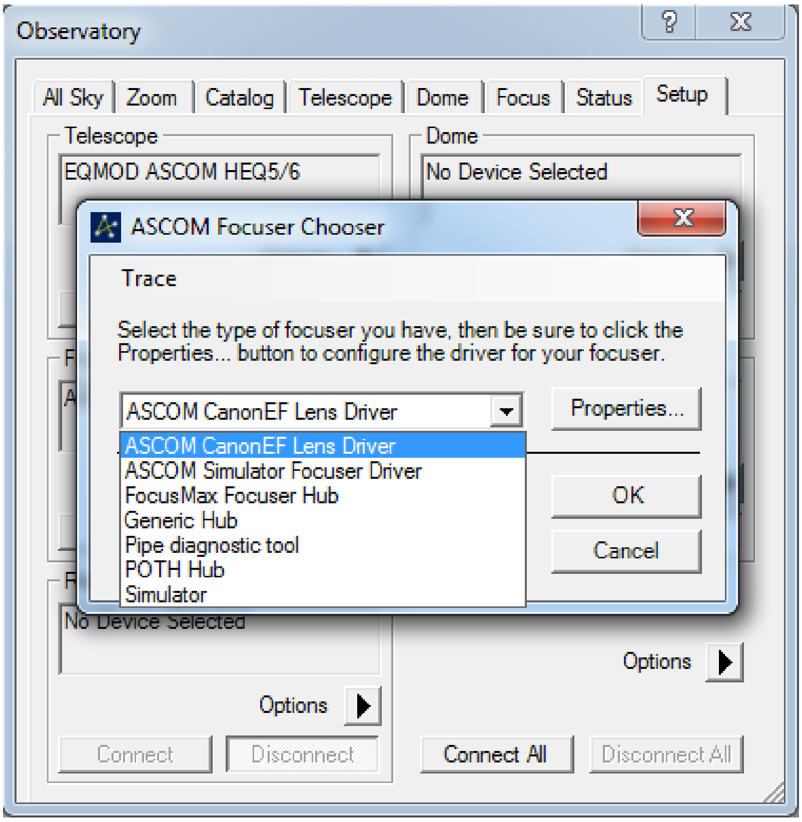
Welcome to the ASCOM CanonEF Lens Driver Focuser Driver Setup Wizard

This will install ASCOM CanonEF Lens Driver Focuser Driver 6.0.1 on your computer.

It is recommended that you close all other applications before continuing.

Click Next to continue, or Cancel to exit Setup.

5. Select driver in ASCOM Focuser Chooser.



Observatory

Telescope: EQMOD ASCOM HEQ5/6

Dome: No Device Selected

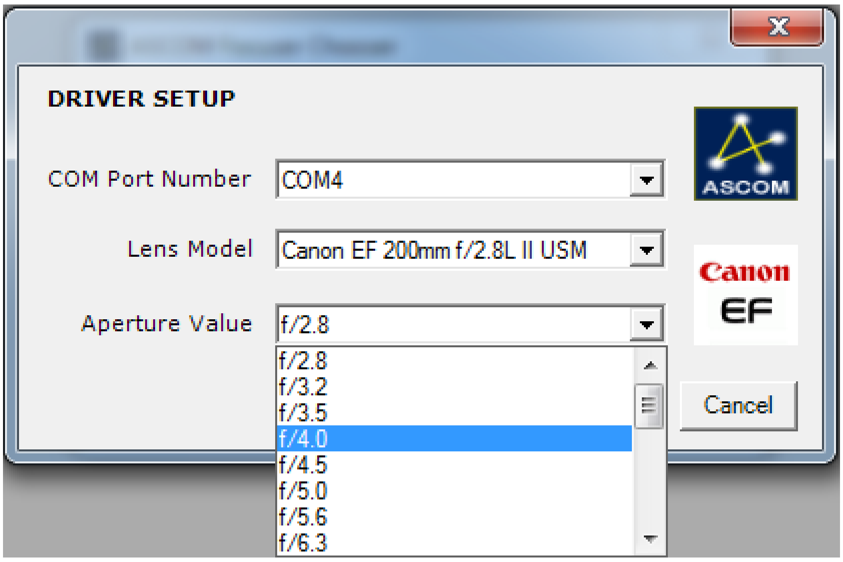
ASCOM Focuser Chooser

Select the type of focuser you have, then be sure to click the Properties... button to configure the driver for your focuser.

ASCOM CanonEF Lens Driver

Click «Properties», you can see driver setup dialog. Set required parameters:

- COM Port Number – controller connection port;
- Lens Model – choose your lens from drop-down list. In fact you can use any lens. Just add it to lens.txt which is in driver installation folder and insert all aperture values of lens;
- Aperture Value – select required aperture value. Changes will be saved in EEPROM of Arduino chip.



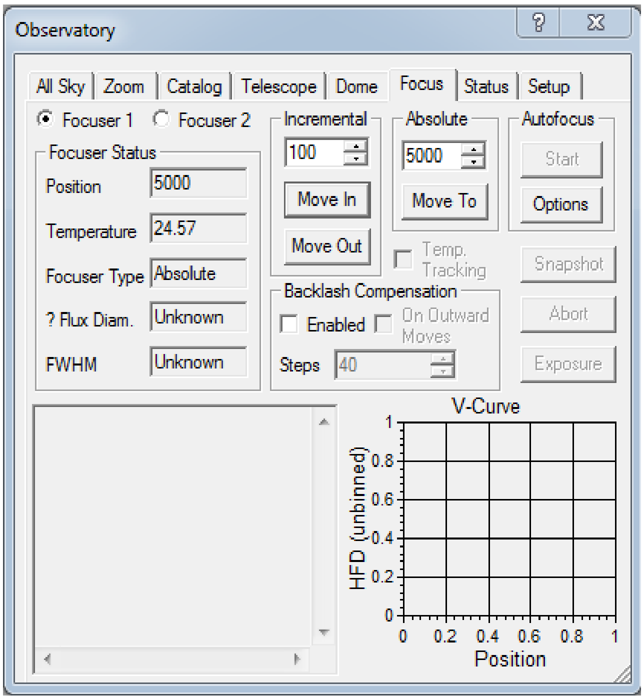
DRIVER SETUP

COM Port Number: COM4

Lens Model: Canon EF 200mm f/2.8L II USM

Aperture Value: f/2.8

After all changes are saved, you can connect to the controller.



Observatory

● Focuser 1 ○ Focuser 2

Focuser Status

Position: 5000

Temperature: 24.57

Focuser Type: Absolute

? Flux Diam.: Unknown

FWHM: Unknown

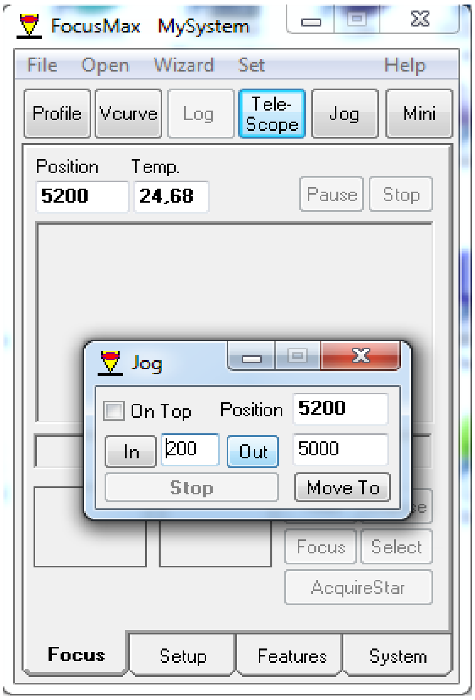
Incremental: 100

Absolute: 5000

Backlash Compensation: □ Enabled □ On Outward Moves

Steps: 40

□ Temp. Tracking



FocusMax MySystem

Position: 5200

Temp.: 24,68

Jog

□ On Top

Position: 5200

200

5000

Temperature will be displayed only if you connect a sensor. I used analog KTS-1 sensor. *GET TEMPERATURE* section in my sketch work with this sensor. You can use any other. Do not forget to correct your sketch. If you do not need to measure temperature just comment this strings.

Lenses were tested on 2 computers and 1 laptop, Windows 7 x32 / x64, ASCOM Platform v6 SP1.

Lenses:

- Canon EF-S 18-55 mm f/3.5-5.6 IS II;
- Canon EF 50 mm f/1.8 II;
- Canon EF 200 mm f/2.8 L II.

Software

- MaximDL v5.23, MaximDL v6.08;
- FocusMax v 3.8.0.20.

All lenses are work properly.