

FlexSpec1 Manual Arduino Control with PuTTY and Xming on Windows

Wayne Green

Friday 10th November, 2023 16:17:37 MT

This document covers using a Win1X machine to control a Raspberry Pi over the Internet.

As of October 2023 we are leaning to using the StellarMate¹ product together with PuTTY^{2,3}. These notes were developed for for our roll-your-own interface.

Stellarmate package has many support features already installed. Jasem Mutlaq, the author, is heavily involved with Kstars, libindi and Ekos – so the integration is very strong. We have successfully used the package in both stand-alone mode on the Raspberry Pi (RPi), with X-Windows Xming⁴ support, in its 'split' mode – where a basic interface is provided between a Win1X system and a remote libinbdi-server running on the RPi. As of October 2023 we tested between Boulder CO, Phoenix AZ, Portland OR and Newcastle upon Tyne, UK.

¹<https://stellarmate.com/>

²<https://www.putty.org/>

³`sudo apt install putty -y`

⁴<https://sourceforge.net/projects/xming/>

Service	Port	WAN/Internet Control
SSH	5624	Required for Flexspec
INDI Web Manager	8624	Not required
INDI Server	7624	Not required
EkosLive Server	3000	Not required
Web VNC	6080	Not required
VNC	5900	Not required
Serial	/dev/ttyS<n>	Arduino Serial1 pins on RPi
Serial	/dev/ttyACM0	Arduino Serial USB

Table 1: Stellarmate Wan Firewall Requirements

Contents

1.1	Remote Desktop PuTTY	3
1.2	Remote Desktop Xming	4
2	Raspberry Pi	5
2.1	SSH on Raspberry Pi	5
2.2	Non-StellarMate Raspberry Pi's	5
2.3	Raspberry Pi – Raspbian SSH	6
2.4	Serial Ports	6
2.5	Raspberry External Pin Functions	7
2.6	StellarMate	7
3	Using Putty from Linux Desktop	7
4	Linux Ports	8
5	Running the Arduino CLI on the Raspberry Pi	8
5.1	Additional Resources	8
5.2	More than One Win1X connection	8
5.2.1	Another approach to autostart with Win1X	9
6	Auditing	9
6.1	Windows	9
6.2	Linux	9
7	WAN Firewall	10
7.1	Handy Network Commands	12
7.2	ip vs ifconfig	13
7.3	Modem Configuration	13
8	RPi Serial Ports	13
8.1	Connecting FlexSpec1 via Serial Ports	14
9	Home Security	14
10	Stellarmate	14
10.1	Paramount	14
	References	14

List of Figures

1-1	Win1X use.	2
1-2	PuTTY screen snaps of the 4 configuration menu panels.	4
1-3	Xming screen snaps of the 4 configuration menu panels.	5
10-4	Raspberry Pi, Paramount packages to install.	14
10-5	TheSkyX preferences	15
10-6	Stellarmate paramount options	16

10-7 Stellarmate paramount connection 16

DRAFT

PuTTY and Xming on Windows

PuTTY running remotely on a Raspberry Pi uses X11 to share its interface with the remote user. This may require Xming for Win11, and XQuartz for Apple machines. It may require including a X11 desktop (in lieu of Wayland) on the remote Linux machines.

This article addresses executing PuTTY on a Raspberry Pi from a Win1X machine located elsewhere on the Internet. It addresses basic tactical aspects of network configuration. Direct X11 and port-to-port TCP methods sidestep the bandwidth overhead of VNC like environments. The office desktop is presumed to be a Win1X office desktop, but may be a Linux desktop with built-in native X11 protocols⁵⁶, or an Apple machine with a proper X11 Server support package like XQuartz. Linux is addressed in section 3.

Win1X requires an X11 Server support program. Here the Xming⁷ package is the only one discussed.

The typographic conventions used in these notes.

Here **k** means hit the “k” on the keyboard.

For the Win1X office desktop, it is important that you acquire and install:

1. Win1X office desktop
 - (a) Xming
 - (b) PuTTY
2. Raspberry Pi
 - (a) PuTTY
3. Optional Linux office desktop
 - (a) PuTTY

You need to configure Xming’s XLaunch program. You need to configure the Raspberry Pi’s configuration.

The PuTTY program provides a X11/ssh connection to remote machines. Here the machine’s hostname is **stellarmate.local**, the port is 22.

Xming is a X11 “server” (meaning is backwards from a data center’s client/server sense). X11 “serves” the graphics from a remote machine doing all the heavy computing on a light-weight machine that knows nothing about the remote application.

Grab Xming and install on a Win machine.

First some X11 magic:

You will open a **ssh -X** connection to the Raspberry Pi. This allows linux to display a console window on the Win1X office desktop monitor. In that window (remember will start programs on the Raspberry Pi) you will start a PuTTY program running on the Raspberry Pi that causes its window to appear on the Win1X office desktop.

Check the files in the /etc/X11 directory:
/etc/X11/xinit/xserverrc

⁵In X11, the XClient is the program with all the builtin domain/control logic – like a spreadsheet, that offers up a GUI connection. An XServer, with all the logic for window creation, managing user interaction and ‘serving’ back graphics etc ties the user to the XClient’s logic. The XServer may be elsewhere on the network from the running program. The protocol is very light-weight compared to remote-desktop (VNC) methods.

⁶Note: The Wayland X11-Replacement may introduce X11 issues.

⁷Get Xming: <https://sourceforge.net/projects/xming/>

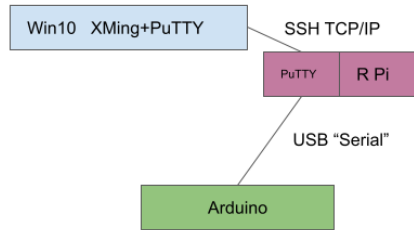


Figure 1-1: Win1X office desktop monitor uses TCP/IP and SSH with the -X switch to open a connection to Raspberry Pi. A PuTTY instance is started on the Raspberry Pi, configured for the USB port for the Arduino displays the PuTTY window on the remote desktop vi SSH -X working with Xming

```

36  ~/.xinitrc
37  ~/.xsession  -- start programs when the login is complete
38  ~/.profile
39
40  ssh-keygen -t ed25519 -C "your_email@example.com"
41
42  If there is no /etc/X11
43  xmodmap -pke > ~/.Xmodmap # make a .Xmodmap upon which to hack
44  This varies with new modern keyboards, there is massive confusion over what a key is called and what code
45  corresponds to the key among keyboard vendors.
46  To use the caps lock key as a spare control key find the code for the caps lock key using the xev program.
47  Xev will show keycodes when a key changes state, like shift down, then shift up etc...
48  Hit the the "caps" key and note its code. Then edit the ~/.Xmodmap file and change:
49  keycode 37 = Control_L NoSymbol Control_L

```

1.1 Remote Desktop PuTTY

On the remote desktop, configure the remote PuTTY:

1. Session:

- (a) Select the **Serial** radio button
- (b) Serial Line to **/dev/ttyACM0**
- (c) Speed **9600**
- (d) Close window on exit → **Only on clean exit**

2. Terminal

- (a) In the **Line discipline options**:
 - i. Local echo to **Force on**
 - ii. Local line editing to **Force on**

3. Window

- (a) Columns: **120** Rows: **50**
- (b) scrollbar 200
- (c) display scrollbar

4. Connection → Data

- (a) login name can be set to **stellarmate** for stellarmate, or the remote user's name.
- (b) Terminal-type string xterm
- (c) Terminal Speed 38400, 38400

5. SSH

- (a) Remote Command to **/home/stellarmate/bin/flex.py**

6. SSH→X11

- (a) Enable X11 forwarding
- (b) localhost:0.0
- (c) MIT-Magic-Cookie-1
- (a) Serial
 - i. Baud to 9600
 - ii. Data bits 8
 - iii. Stop bits 1
 - iv. Parity None
 - v. Flow Control None.

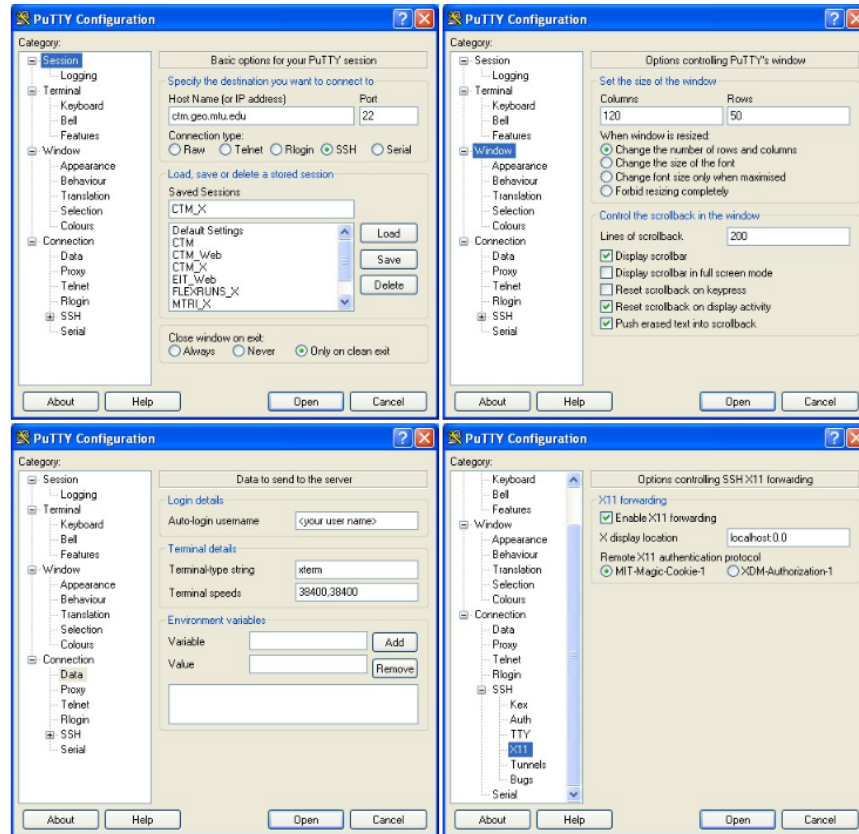


Figure 1-2: PuTTY screen snaps of the 4 configuration menu panels.

1.2 Remote Desktop Xming

On the Windows pane, enter a new configuration for this machine.

1. Page 1 - Set Multiple windows (Each remote application gets its own Win1X office desktop window).
2. Page 2 - Start no client. The clients are started with the Win1X PuTTY's SSH -X session.
3. Page 3 - Clipboard (handy)
4. Page 4 - Save the configuration. This sets the policy for all machines, Xming does not care about the remote machines business – any remote may connect if firewall permissions are set.

Details for the Raspberry Pi.

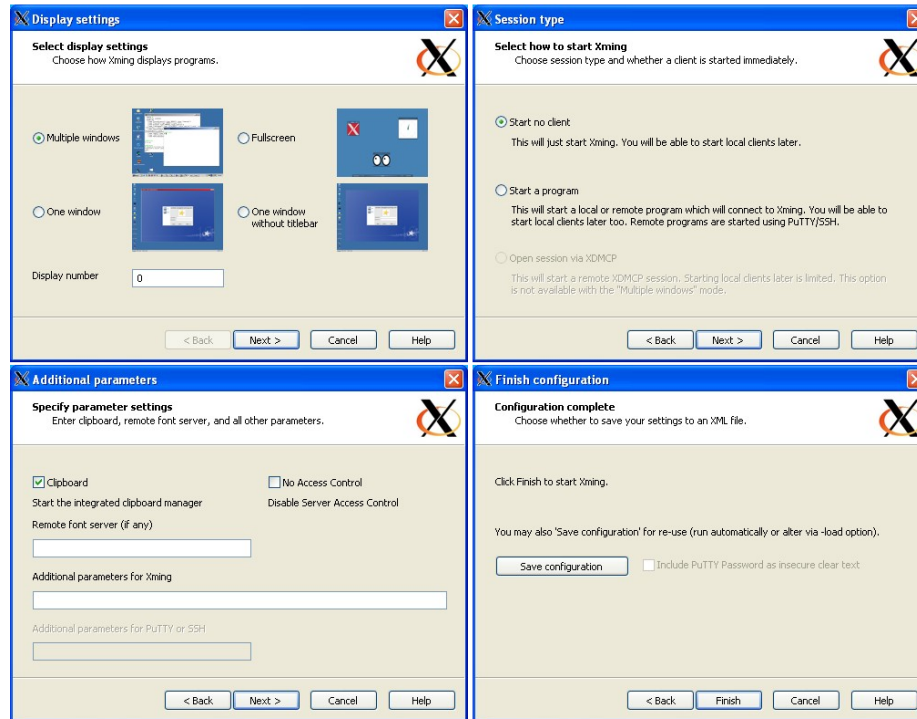


Figure 1-3: Xming screen snaps of the 4 configuration menu panels.

2 Raspberry Pi

Details related to the Raspberry Pi.

2.1 SSH on Raspberry Pi

The StellarMate image has all necessary ports open and ready for use. The firewall has been set to pass all relevant ports.

See subsection 2.6 below.

2.2 Non-StellarMate Raspberry Pi's

Note: this section is complicated by the details needed to open home firewalls to the internet using the local Telco's interface routers. Each router is different, and the Telco changes its mind frequently.

This command will list the full name for hosts that are on the network. Here we're looking for our machine **pier15** that will appear as **pier15.hsd1.co.comcast.net**:

```
{sudo nmap -sP 10.1.10.0/24 | awk -e '/^Nmap/ {print $5;}}'
```

If ssh issues a:

ssh: connect to host <machine>.local port 22: Connection refused

use the keyboard/mouse for the raspbian machine and run the command **sudo raspi-config**, then under Interface options, **I2 SSH** **TAB**, enable.

105 SSH (Secure SHell), originates on port 22. The port needs to be allowed through the Raspbian's "uncom-
106 plicated firewall" **ufw** task. Root permissions are required.

```
107 sudo ufw list      # see all the current ports
108 sudo ufw allow ssh # allow the port to work.
```

109 **2.3 Raspberry Pi – Raspbian SSH**

110 Enable SSH through the Raspberry Pi Configuration menu: **Preferences → Raspberry Pi Configuration** Click
111 on "Interfaces": and select **Enabled** next to SSH.

112 Use the command **sudo nano /etc/ssh/sshd_config** find and **X11Forwarding** set the value to yes

113 **X11Forwarding yes.**

114 Save.

115 **sudo systemctl restart ssh**

116 **2.4 Serial Ports**

117 At end of file:

```
118 dtoverlay=disable-bt
119 dtoverlay=uart1
120 dtoverlay=uart2
121 droverlay=uart3
122 dtoverlay=uart4
123 dtoverlay=uart5
```

124 Pinouts:

125	0/1	14/15	Same Uart
126	2	0/1	
127	3	4/5	
128	4	8/9	
129	5	12/13	

130 To disable the Bluetooth

131 **sudo systemctl disable hciuart**

132 **/boot/cmdline.txt:**

133 add **console=ttyS0,115200** to the main line.

2.5 Raspberry External Pin Functions

	ALT0	ALT1	ALT2	ALT3	ALT4	ALT5
0	SDA0	SA5	PCLK	SPI3_CE0_N	TXD2	SDA6
1	SCL0	SA4	DE	SPI3_MISO	RXD2	SCL6
2	SDA1	SA3	LCD_VSYNC	SPI3_MOSI	CTS2	SDA3
3	SCL1	SA2	LCD_HSYNC	SPI3_SCLK	RTS2	SCL3
4	GPCLK0	SA1	DPI_D0	SPI4_CE0_N	TXD3	SDA3
5	GPCLK1	SA0	DPI_D1	SPI4_MISO	RXD3	SCL3
6	GPCLK2	SOE_N	DPI_D2	SPI4_MOSI	CTS3	SDA4
7	SPI0_CE1_N	SWE_N	DPI_D3	SPI4_SCLK	RTS3	SCL4
8	SPI0_CE0_N	SD0	DPI_D4	—	TXD4	SDA4
9	SPI0_MISO	SD1	DPI_D5	—	RXD4	SCL4
10	SPI0_MOSI	SD2	DPI_D6	—	CTS4	SDA5
11	SPI0_SCLK	SD3	DPI_D7	—	RTS4	SCL5
12	PWM0	SD4	DPI_D8	SPI5_CE0_N	TXD5	SDA5
13	PWM1	SD5	DPI_D9	SPI5_MISO	RXD5	SCL5
14	TXD0	SD6	DPI_D10	SPI5_MOSI	CTS5	TXD1
15	RXD0	SD7	DPI_D11	SPI5_SCLK	RTS5	RXD1
16	FL0	SD8	DPI_D12	CTS0	SPI1_CE2_N	CTS1
17	FL1	SD9	DPI_D13	RTS0	SPI1_CE1_N	RTS1
18	PCM_CLK	SD10	DPI_D14	SPI6_CE0_N	SPI1_CE0_N	PWM0
19	PCM_FS	SD11	DPI_D15	SPI6_MISO	SPI1_MISO	PWM1
20	PCM_DIN	SD12	DPI_D16	SPI6_MOSI	SPI1_MOSI	GPCLK0
21	PCM_DOUT	SD13	DPI_D17	SPI6_SCLK	SPI1_SCLK	GPCLK1
22	SD0_CLK	SD14	DPI_D18	SD1_CLK	ARM_TRST	SDA6
23	SD0_XMD	SD15	DPI_D19	SD1_CMD	ARM_RTCK	SCL6
24	SD0_DAT0	SD16	DPI_D20	SD1_DAT0	ARM_TDO	SPI3_CE1_N
25	SD0_DAT1	SD17	DPI_D21	SD1_DAT1	ARM_TCK	SPI4_CE1_N
26	SD0_DAT2	TE0	DPI_D22	SD1_DAT2	ARM_TDI	SPI5_CE1_N
27	SD0_DAT3	TE1	DPI_D23	SD1_DAT3	ARM_TMS	SPI6_CE1_N

2.6 StellarMate

You need to `sudo apt update`, then `sudo apt install putty -y` to install PuTTY.

Add the `x11-utils` package to pick up the rather silly command keys. This displays two white eyeballs and the pupils track the mouse movement. While small and cute, it does a rather deep test of the X11 capability including managing the event manager. This is helpful to debug X11 connections.

```
sudo apt install -y x11-utils
```

Other programs:

```
sudo apt install -y saoimage-ds9
```

```
sudo apt install -y iraf
```

```
sudo apt install -y python3-pyraf
```

The ssh connect to StellarMate is made to an alternate port:

```
ssh -X -p 5624 stellarmate@stellarmate.local
```

The username is `stellarmate` and the password is the usual StellarMate password.

3 Using Putty from Linux Desktop

PuTTY on a linux desktop machine in the office has all the Xming features built-in and does not require additional X-windows code.

4 Linux Ports

devices such as serial ports, USB ports etc appear simply as filenames. For example the Arduino often identifies as `/dev/ttyACM0`. By making no distinction using devices becomes very easy but drives Win1X people nuts.

See section 8 for details about the Raspberry Pi.

The ports you are interested in:

1. `/dev/serial0` - the serial port pins on the Raspberry Pi. This requires special action to enable the GPIO pins. This is recognized by the Arduino on its Serial1 device.
2. `/dev/ttyAMC0` - the USB port recognized by the Arduino on its Serial device.

5 Running the Arduino CLI on the Raspberry Pi

The Raspberry Pi will run the Arduino CLI, which in turn may run a serial port connection. Using the magic of X11, discussed above, the Arduino CLI windows will appear on the Win1X office desktop monitor or Linux office desktop monitor.

From the Win1X machine:

1. Use XLaunch with multiple windows.
 2. Then make a PuTTY connection to the RPi. (Call this Win1X/Rpi)
 - (a) this opens a Win1X cmd window, and prompts for the password into the RPi machine.
 - (b) A Rpi prompt will appear.
 3. In the Win1X/Rpi window (now a shell on the RPi)
 - (a) enter the command `putty --display=$DISPLAY` (two dashes)
 - (b) This causes a PuTTY configuration window from the RPi to appear on the Win1X desktop.
 - (c) Configure for the serial connection desired `/dev/ttyAM0` for the Arduino.
- (a) Run
 - (b) This causes a PuTTY serial console (as you configured it) to appear on the Win1X desktop.
 - (c) Interact with the Arduino, at the end of a UART serial connection, with the FlexSpec1 instrument – as though you were at the Rpi.

You may wish to install `xeyes` program on the RPi. Xeyes is a rather simplistic X11 program that causes a little window to pop-up with two “eyeballs” where the “eyes” will watch the mouse move around. This tests mouse and graphics in on go. To do so – in the Win1X/Rpi console enter:

```
sudo apt install x11-utils
```

5.1 Additional Resources

http://www.straightrunning.com/xmingnotes/IDH_PROGRAM.htm

5.2 More than One Win1X connection

Make Desktop Icon's for unique connections:

1. Run XLaunch.exe and save the configuration to file `config.xlaunch`.
2. Create a shortcut of XLaunch.exe under Startup directory.
3. Modify the target field of the shortcut to `"C:\ZZH\software\Xming\XLaunch.exe" -run "config.xlaunch"`.

5.2.1 Another approach to autostart with Win1X

1. Search for Xming in the Start Menu
2. Right click on the shortcut and select Open file location
3. Copy the selected Xming shortcut
4. Press Ctrl-I to move the cursor to the Explorer location input
5. type shell:startup and then Enter
6. Paste the Xming shortcut in the Startup directory.

6 Auditing

It is possible to save the and/or share the configuration parameters for PuTTY.

6.1 Windows

PuTTY on Win1X records its configuration(s) into the Registry. It requires the dangerous step of using Regedit to recover. The steps are:

1. Find HKEY_CURRENT_USER\Software\SimonTatham\PuTTY Note: The “SimonTatham” is the name of the author of the package not you, the “CURRENT_USER”.
2. Right click and export, the resulting file is a text file suitable for sharing and archiving.

6.2 Linux

The configuration file is in **\$HOME/.putty** deep.

7 WAN Firewall

Never open a large range of ports. Stellarmate uses ports 5624-8624, that includes (Internet Relay Chat RFC-1469) at 6667.

DRAFT

Service	Port	WAN/Internet Control
SSH	5624	Required for Flexspec
INDI Web Manager	8624	Not required
INDI Server	7624	Not required
EkosLive Server	3000	Not required
Web VNC	6080	Not required
VNC	5900	Not required
Serial	/dev/ttyS<n>	Arduino Serial1 pins on RPi
Serial	/dev/ttyACM0	Arduino Serial USB

Table 2: Stellarmate Wan Firewall Requirements

7.1 Handy Network Commands

The original program to manage and display information about networks was called `ifconfig` for “interface configuration”. This has been replaced recently with the newer `ip` to “show / manipulate routing, network devices, interfaces and tunnels”.

command	action
arp	address resolution protocol
dig	DNS lookup
netstat	Print network connections, routing tables, interface statistics, masquerade connections, and multicast memberships
nslookup	lookup DNS information
ping	see if path to machine exists
tcpdump	view traffic on local machine
tracert	tracert to a remote machine: eg: <code>tracert google.com</code>

Table 3: A few of many tools for network tracing.

241 7.2 ip vs ifconfig

242 The mapping from old ifconfig commands to new ip commands.

ifconfig command	New ip command
arp -a	ip neigh
arp -v	ip -s neigh
arp -s 192.168.1.1 1:2:3:4:5:6	ip neigh add 192.168.1.1 lladdr 1:2:3:4:5:6 dev eth1
arp -i eth1 -d 192.168.1.1	ip neigh del 192.168.1.1 dev eth1
ifconfig -a	ip addr
ifconfig eth0 down	ip link set eth0 down
ifconfig eth0 up	ip link set eth0 up
ifconfig eth0 192.168.1.1	ip addr add 192.168.1.1/24 dev eth0
ifconfig eth0 netmask 255.255.255.0	ip addr add 192.168.1.1/24 dev eth0
ifconfig eth0 mtu 9000	ip link set eth0 mtu 9000
ifconfig eth0:0 192.168.1.2	ip addr add 192.168.1.2/24 dev eth0
iptables	show and manipulate IPTABLES iptables -S
netstat	ss
netstat -neopa	ss -neopa
netstat -g	ip maddr
route	ip route

Table 4: A ifconfig vs ip command quick summary.

243 7.3 Modem Configuration

244 Each model model will use a different scheme to enable Network Address Translation (NAT) to connect the
245 port from the WAN side to a “server” within the LAN. Information usually includes:

246 Start Port

247 End Port

248 Server IP4 Address

249 Server IP6 Address

250

251 8 RPi Serial Ports

252 The Raspberry Pi has 6 serial ports, available in various ways, including over BlueTooth connections. The
253 ports use GPIO pins, and may be disabled to allow secondary functions for the GPIO pins to be permitted.

Name	Type	Models	Enabled	GPIO (TX)	GPIO (RX)	CTS/RTS
UART0	PL011	All	Yes	14,32,36	15,33,37	
UART1	mini-UART	All	No	14,32,40	15,33,41	
UART2	PL011	Pi4 Only	No	0	3	2,3
UART3	PL011	Pi4 Only	No	4	7	6,7
UART4	PL011	Pi4 Only	No	8	11	10,11
UART5	PL011	Pi4 Only	No	12	15	14,15

Table 5: Stellarmate WAN Firewall Ports

8.1 Connecting FlexSpec1 via Serial Ports

The Serial Ports for the RPi are 3.3V and require a level shifter to be on the safeside. The FlexSpec1 design calls for a 5-wire cable between the RPi and the Arduino SBC. These include:

RPi	RPi
+5 V	Power
GND	Signal/Electrical Ground
Tx	Commands
Rx	Response
Reset	Reboot FlexSpec1

Table 6: The Cable has a footprint on the FlexSpec PCBA. Pins are shown for programming clarity. The pins on the Arduino are labels and NOT traditional pin numbers. Be careful.

9 Home Security

Adding MAC address filters to your ISP modem is a decent and easy way to add security for to keep unauthorized people out of the observing sessions!

ACTION:
MAC Security¹

10 Stellarmate

10.1 Paramount

This page helps with installation for Paramount: <https://www.indilib.org/devices/mounts/bisque-paramount.html>

```
# if using a Paramount
apt-add-repository ppa:mutlaqja/ppa
apt-get update
sudo apt-get install libindi

cat >> /home/stellarmate/help.txt <<EOF
Paramount: In TheSkyX preferences, make sure to turn off TCP Responses close socket.
EOF
```

Figure 10-4: Raspberry Pi, Paramount packages to install.

Stellarmate uses the TCP connection for the mount. Needs port address of the mount's PC.

From <https://www.indilib.org/devices/mounts/bisque-paramount.html>

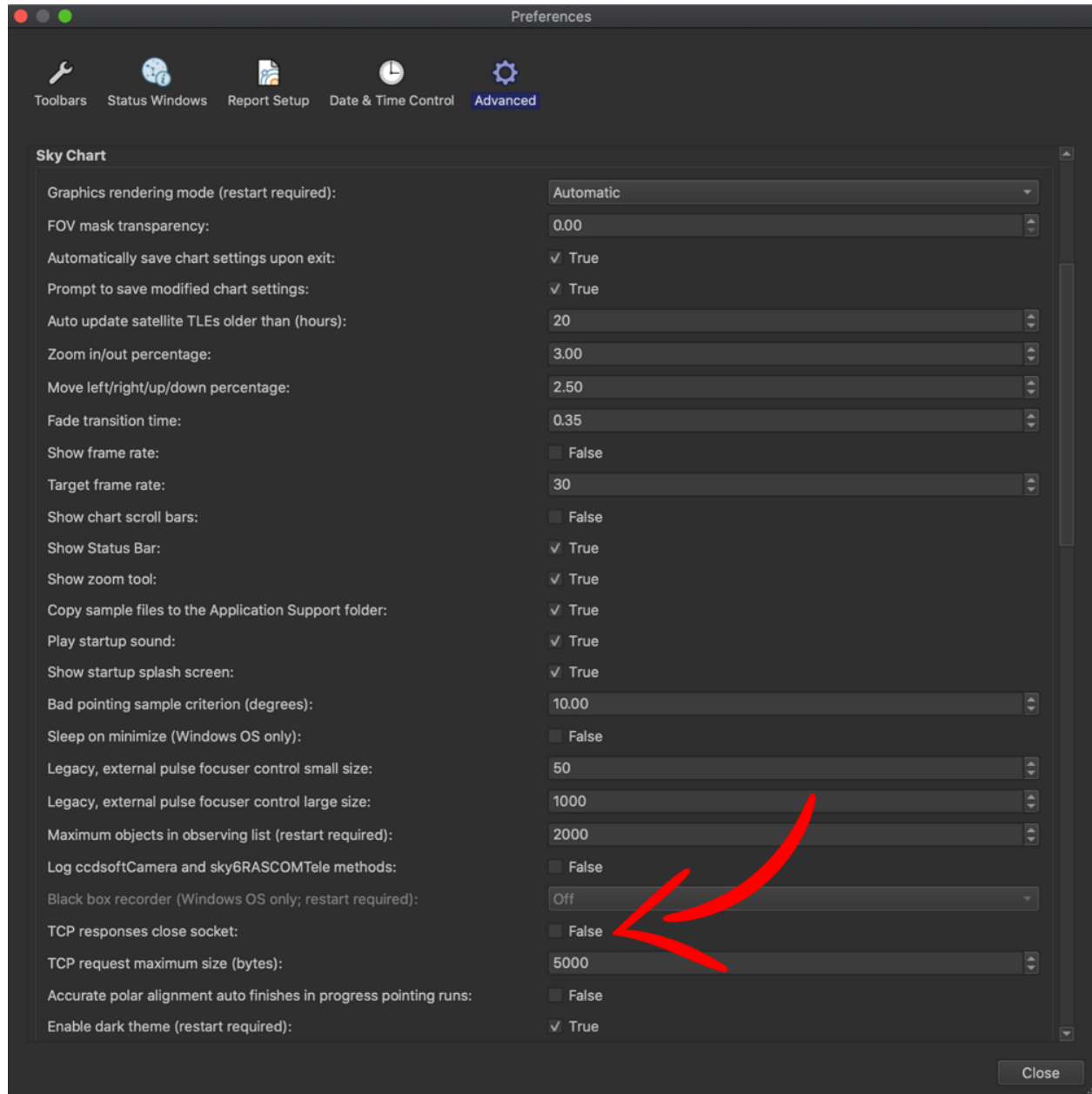


Figure 10-5: In TheSkyX preferences, make sure to turn off TCP Responses close socket

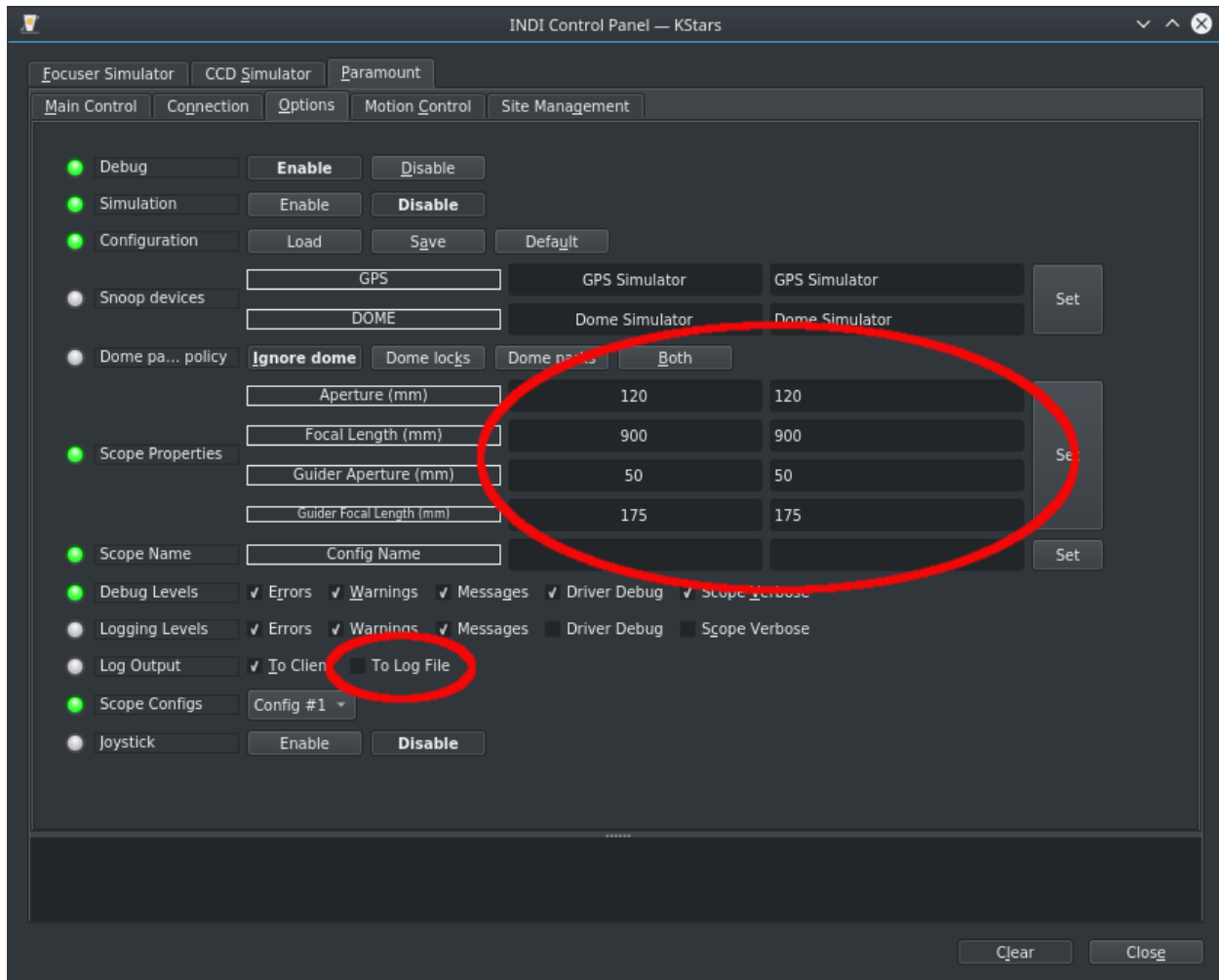


Figure 10-6: Fill in the telescope parameters, and set up to record to a log file.

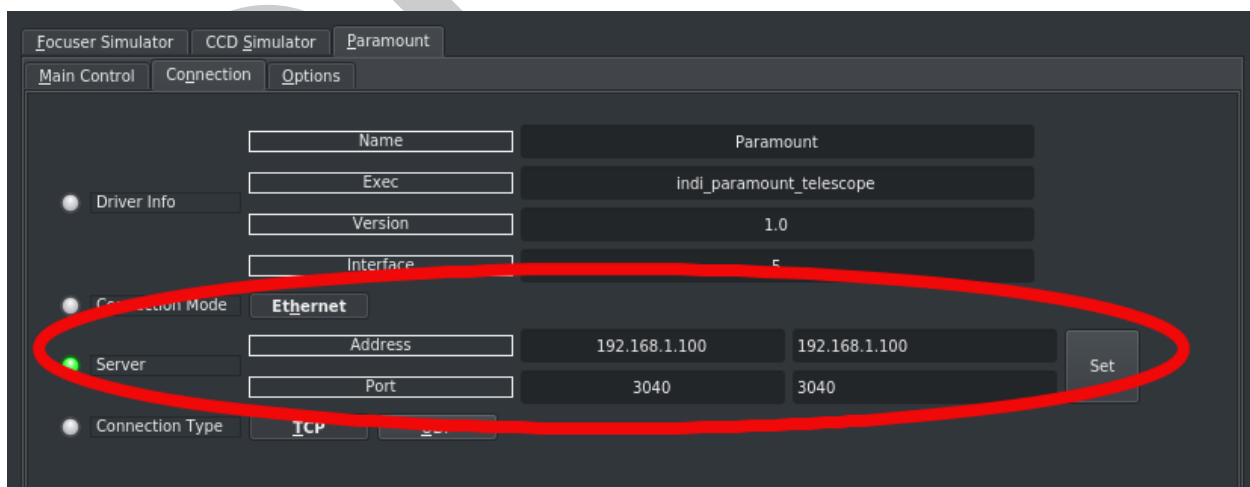


Figure 10-7: Stellarmate paramount connection, this is the IP address of the Sky X Computer, default port (3040) for TCP control.

es