

Callisto-Lx ~ Supplement

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1. Introduction

This document applies to manufactured Callisto-Lx units and supplements the following general description and installation documents. All documents are available online:

- ⚙ **Callisto-Lx: Callisto on Raspberry Pi** ~ [{CIX-Rpi}](#)
- ⚙ **Callisto-Lx: Setup and Operation Guide** ~ [{CIX-Setup}](#)
- ⚙ **Callisto-Lx: Supplement** ~ [{CIX-Supp}](#)
- ⚙ **Install the Minicom Terminal Emulator for Use with Callisto-Lx** ~ [{CIX-MCom}](#)

Items supplied with manufactured units:

- ⚙ Callisto-Lx equipped with a Raspberry Pi platform (either Raspberry Pi model B+ or Raspberry Pi 2 model B) and preprogrammed Micro-SD memory card (a memory card adapter is supplied loose)
- ⚙ 2.1 x 5.5 mm locking dc coaxial plug for power cable
- ⚙ On first of multiple unit order: Spare preprogrammed Micro-SD memory card and adapter

Items required but not supplied:

- ⚙ Nominal 12.0 Vdc, 5 W power source
- ⚙ Callisto instrument
- ⚙ DB-9M to DB-9F straight-through EIA-232 interface cable (only pins 2, 3 and 5 required)
- ⚙ Ethernet cable for LAN access

2. Getting Started

1. Read this entire document before making any connections; important details are provided in the next section.
2. Obtain the documents mentioned in section 1 **Introduction** and become familiar with them.
3. A preprogrammed memory card is installed in Callisto-Lx. A spare preprogrammed memory card also is provided with the first unit of multiple unit order. The spare card may be used if the card equipped in the Callisto-Lx becomes corrupted; refer to the Maintenance section of this document for procedures to access and replace the internal card
4. Connect the 10/100BaseT Ethernet jack on the Callisto-Lx front panel to your LAN. The LAN must have a DHCP server to automatically supply an IP address to the Callisto-Lx.
5. Connect the Callisto-Lx EIA-232 serial port to the Callisto instrument serial port using a DB-9M to DB-9F straight-through cable.
6. Assemble a power cable using the supplied 2.1 x 5.5 mm locking coaxial plug, center positive.
7. Check that the power switch on the Callisto-Lx rear panel is in the OFF (down) position.
8. Connect the Callisto-Lx to your power source through the coaxial power jack on the rear panel. The Callisto-Lx power supply requirements are 8 to 16 Vdc at 5 W. A locking-type coaxial plug is supplied. It has a long

barrel and needs to be completely seated in the jack. Push it in until you hear and feel a click, then tighten the locking sleeve.

9. Turn the power switch ON (up). The green LED on the rear panel should light. The Callisto-Lx requires several tens of seconds to boot.
10. Wait about 1 minute and then find the Callisto-Lx IP address on your network. Your router or DHCP server may be used to discover the assigned IP address. Alternately, use a network scanner tool (for example, [{AngryIP}](#) or [{NetScan}](#)). The hostname is **Callisto-Lx** or **Callisto-Lx***, where a * is one or two numbers or letters such as 2, 3 or B2. The hostname is assigned during testing and may be changed by the user.
11. Using PuTTY or Tera Term terminal emulator program, access the Callisto-Lx command line interface (console). Edit the launcher shell script in Callisto-Lx as described in the [Appendix](#). The launcher shell controls file uploading and archiving. Callisto-Lx login details are in the next section below. For installing and using PuTTY see [{RPIBasic}](#).
12. Refer to section 4 of the **Callisto-Lx: Setup and Operation Guide** to setup the Callisto-Lx configuration files for your environment and then run the callisto service; this guide is available at [{CIX-Setup}](#). The files to be edited or replaced are located in the /etc/callisto/ directory. Similar configuration files may be located in the /home/pi/Callisto-Lx/ directory, but these are not used and may be deleted. Manufactured Callisto-Lx units include a few example configuration files in the /etc/callisto/ directory, including callisto.cfg, scheduler.cfg and frqxxxxx.cfg.
13. Refer to section 5 of the **Callisto-Lx: Setup and Operation Guide** for daily operation of Callisto-Lx. See [{CIX-Setup}](#).

3. Additional Details

Login: Manufactured Callisto-Lx units use the following default user and password (users should change the password, see [{RPIBasic}](#)):

User: **pi**

Password: **Callisto-Lx_RPi-!**

Note: Only change the password for user: pi as instructed above – DO NOT enter `sudo passwd`

Shutdown: DO NOT remove power from Callisto-Lx without first shutting down the software. To shutdown Callisto-Lx, first login to the command line interface. Once logged in enter at the prompt:

```
sudo halt
```

or

```
sudo shutdown -h now
```

Wait at least 1 minute before turning off or removing power from Callisto-Lx.

Raspberry Pi power and activity LEDs: The power and CPU activity LEDs on the Raspberry Pi printed circuit board are not visible in the Callisto-Lx.

Power Input: Power is connected through a 2.1 x 5.5 mm coaxial dc power jack on the rear panel. The corresponding plug supplied with the Callisto-Lx is a locking type and it must be soldered to a 2-conductor power cable by the user. The plug will accept up to 18 AWG stranded wire and must be wired center positive.

The power On/Off switch and power indicating LED also are on the rear panel. Voltage range is 8 to 16 Vdc and the power supply should be rated ≥ 5 W.

Power cycle: Never cycle, turn off or remove power to the Callisto-Lx without first shutting down the software as described above. If the software becomes corrupted by improper shutdown, it will have to be reloaded onto the micro-SD card and reconfigured. See section 4 **Maintenance** below for access to the micro-SD memory card on the Raspberry Pi platform. See also {[RPIBasic](#)} and {[RPIBackup](#)}.

Identification: The Callisto-Lx rear panel has a label that includes the serial number and date of manufacture. The serial number prefix for all Callisto-Lx units is “CLX”.

Network connection: All manufactured Callisto-Lx are setup for a wired LAN with DHCP via the 10/100BaseT Ethernet connector on the front panel. The user’s LAN router or DHCP server should be setup to reserve an IP address for the Callisto-Lx. Alternately, the Callisto-Lx can be setup to use a static IP address (see next item). A reserved or static IP address will prevent the address from being inadvertently changed by the router or DHCP server. Using IP reservation is the preferred method.

Static IP: To setup the Callisto-Lx with a static IP address, see **Setup Static IP Address on Raspberry Pi** {[RPIStatic](#)}.

Wireless LAN: The user can add wireless LAN access to the Callisto-Lx by installing a WiFi USB adapter. It is suggested that the Callisto-Lx initially be used in its original configuration (wired LAN) for familiarization and to verify operation. After operation has been verified, then changes can be made. See **Setup Wireless LAN (WLAN) on Raspberry Pi** {[RPIWAN](#)}.

Timekeeping: All manufactured Callisto-Lx use NTP for timekeeping and have been setup to use four NTP server pools in the USA. If server pools in other countries or specific NTP servers or local NTP servers are to be used, the NTP configuration file ntp.conf must be edited. Additional information on editing the configuration file for different NTP servers can be found in {[GpsNtp-Pi](#)}. To add a local NTP server

```
sudo nano /etc/ntp.conf
```

Scroll down to find:

```
server 0.us.pool.ntp.org iburst
server 1.us.pool.ntp.org iburst
server 2.us.pool.ntp.org iburst
server 3.us.pool.ntp.org iburst
```

Just below the server pools add the following lines:

```
# Use specific NTP servers
server aaa.bbb.ccc.ddd iburst
```

where aaa.bbb.ccc.ddd is the IP address of the local NTP server. Add as many local servers as desired, one on each line. Generally, the original server pools should be retained (not deleted or commented out) unless redundant time server are provided locally. This way, if the local time server fails, the Callisto-Lx can still keep very good time by using the pool. NTP always will use the best server available. When above changes are completed restart the NTP service

```
sudo service ntp restart
```

Raspberry Pi platform: The Callisto-Lx software has been successfully used with the Raspberry Pi model B+, Raspberry Pi 2 model B and Raspberry Pi 3. The Raspberry Pi 3, which has built-in wireless LAN capability, works in both wired and wireless modes. However, because manufactured Callisto-Lx units are supplied in an aluminum enclosure, that built-in capability cannot be used. Also, the built-in Bluetooth capability on the RPi 3 is disabled.

Hostname: If more than one Callisto-Lx is used on a network the hostname on each one may be changed to a unique identifier. To change the hostname see [{RPIBasic}](#).

Software: All software used on Callisto-Lx is open source, used under their respective licenses and provided at no charge. In particular, the callisto application software was originally developed for Unix by Juha Aatrokoski at Metsähovi Radio Observatory in Finland. It is licensed under the General Public License (GPL) version 3.

Memory card: All Callisto-Lx units use an 8 GB or larger micro-SD memory card. There are wide variations in the actually storage capacity of memory cards, and some 8 GB cards will not hold the Callisto-Lx image. It is known that Polaroid 8 GB MicroSDHC UHS-I Class 10 cards do have enough capacity. If the card supplied with Callisto-Lx requires replacement it is recommended that Class 10 or higher be used, and it may be necessary to use a 16 GB card.

Partition expansion: The amount of memory required for Callisto-Lx file system is less than the memory card capacity. Some units may be shipped without the file system partition expanded to fill the memory card or the card may have been replaced later with a larger one. To expand the file system, use the Expand Filesystem option in Raspi-Config – Advanced Options; see [{RPIBasic}](#). It will be necessary to reboot the Raspberry Pi afterward. Note that there is no confirmation – selecting the option immediately expands the filesystem partition.

Data storage: The Callisto-Lx does not have unlimited data storage so it is necessary to routinely move or delete the *.fit data files. As supplied, the Callisto-Lx has about 5 GB available storage capacity, estimated to be about 4 to 5 months of data assuming 12 hour/day observations. It is recommended that the /home/pi/Callisto-Lx/Archive/ and /home/pi/Callisto-Lx/OVS directories be purged at regular intervals not exceeding 3 to 4 months. To determine the amount of free memory card storage enter

```
df -h
```

Files may be easily copied to a Windows PC or deleted using WinSCP (see [{RPIBasic}](#)). Generally, do not delete the files before the Callisto-Lx data have been archived.

Troubleshooting: Serial communication between Callisto-Lx and the Callisto instrument can be tested and verified by using the Minicom software tool (this tool is already installed on Callisto-Lx). See [{CIX-MCom}](#).

4. Maintenance

The Callisto-Lx requires no regular maintenance other than to clean dust from the enclosure.

Cleaning: Use a soft damp cloth with special care around the panel labels; never use chemicals.

Memory card access: If it is necessary to access the Raspberry Pi (RPI) micro-SD memory card inside the enclosure follow these procedures:

Tools required: Torx T10 screwdriver and No. 1 phillips screw driver

1. Place the Callisto-Lx on a shop cloth on the workbench. The enclosure is a tubular aluminum extrusion and the RPi printed circuit is accessed through the ends
2. Turn the enclosure upside down and remove the four front panel screws. All manufactured Callisto-Lx use self-threading Torx T10 screws on the front and rear panels. The DB-9M connector on the front panel is connected by an internal serial cable to the RPi assembly. After the panel screws have been removed do not pull on the panel or cable; allow the panel to sit loosely on the workbench
3. Using a No. 1 phillips screwdriver, remove the four M2.5 x 6 mm screws and lockwashers that hold the RPi to the enclosure bottom near the enclosure front. Reach inside and hold the RPi to prevent it falling inside the enclosure. In addition to the serial cable the RPi has a connectorized cable to the power supply near the enclosure rear. Do not pull on this cable
4. Carefully move the RPi toward the enclosure opening and rotate far enough to access the micro-SD memory card on its rear underside. Do not stress the cables connected to the RPi. Depending on the RPi model, the card is push to insert/push to eject or push to insert and pull to eject. When removing the card, note its orientation and be sure to replace it with the same orientation. Do not force the card
5. If it is necessary to reload the software image, follow the procedures in **Raspberry Pi Backup and Restore Procedures** {[RPIBackup](#)}
6. After reinserting the memory card in the RPi, reassemble the enclosure in the reverse order. Carefully move the RPi printed circuit board to line-up the screw holes on the enclosure bottom and replace the screws. To prevent cross-threading, insert the M2.5 screw and lockwasher and slowly turn it counter-clockwise until you hear a click. The threads are now engaged. Carefully turn the screw clockwise until snug against the enclosure. After replacing the four screws holding the RPi printed circuit board, put the front panel in position and replace the screws using the same procedure: Insert the screw and slowly turn it counter-clockwise until you hear a click, then carefully turn the screw clockwise until snug against the panel

5. References

{ AngryIP }	http://angryip.org/download/#windows
{ CIX-Rpi }	http://www.reeve.com/Documents/Articles%20Papers/Reeve_Callisto-LxRPI.pdf
{ CIX-Setup }	http://www.reeve.com/Documents/Articles%20Papers/Reeve_Callisto-Lx_Setup.pdf
{ CIX-MCom }	http://www.reeve.com/Documents/CALLISTO/Reeve_MinicomSetup.pdf
{ CIX-Supp }	http://www.reeve.com/Documents/Articles%20Papers/Reeve_Callisto-Lx_Supplement.pdf
{ GpsNtp-Pi }	http://www.reeve.com/Documents/Articles%20Papers/Reeve_GpsNtp-Pi_Setup.pdf
{ NetScan }	https://www.softperfect.com/products/networkscanner/
{ RPIBackup }	http://www.reeve.com/Documents/Articles%20Papers/Reeve_RPi_BackupRestore.pdf
{ RPIBasic }	http://www.reeve.com/Documents/Articles%20Papers/Reeve_RPi_BasicSetup.pdf

Appendix ~ Callisto-Lx Launcher Shell

The launcher shell script manages all data file transfers, first by determining if a new FITS file has been placed in the Data directory and then copying it to various destinations including the FHNW server in Switzerland, an optional local NAS or USB drive and finally to an /home/pi/Callisto-Lx/Archive directory on the Callisto-Lx. After these actions successfully complete, the launcher.sh deletes the file from the Data directory. If an FTP transfer is not successful, the file remains in the Data directory for attempted transfer in the next data transfer cycle (5 minute intervals).

To edit the launcher.sh, at the PuTTY command line prompt enter

```
sudo nano launcher.sh
```

When the nano editor opens, edit the information for your setup as described in the four steps following. A copy of the basic file is shown in the box below. Be sure to change the usernames, passwords and paths to correspond to actual requirements. When finished, save the edited launcher.sh file and exit the editor (CTRL-X, Y, Enter). Note: For reference, the launcher.sh file is located in the /home/pi/ directory.

1. Data file upload to FHNW: To upload Callisto FITS file data to the FHNW server in Switzerland, uncomment the 10 lines that immediately follow the text

```
# upload *.fit to FHNW web server IP 147.86.8.73 (passive mode by default)
```

Important: Replace **xxxxx**\$xxx in the FHNW upload section with the actual password but retain the back-slash character ****. The password is of the form **xxxxx\$xxx**, and the backslash character **** must be inserted before the **\$** as shown (so that it is not confused with a variable). The password may be obtained by sending an email inquiry to Christian Monstein: monstein@astro.phys.ethz.ch .

2. NAS server: If data files are to be copied to a Network Attached Storage (NAS) server, be sure a directory is setup on the NAS to receive the files. To copy data files to a NAS server, uncomment the lines in launcher.sh that apply to the NAS. The lines are shown in the example below. First, uncomment by removing the # character, and then enter the IP address, login details and path to the NAS directory. The address is represented in the example below by **aa.bb.cc.dd**. The **user** and **password** are represented by **yyyyyyyyyy zzzzzzzzzz**. This example assumes the directory to be used on the NAS is **array1/Callisto-Lx** and it should be changed to the actual path to be used. After removing the hash character #, the commands should look like:

```
# uncomment the next 10 lines to upload *.fit to NAS if equipped
ftp -n -i aa.bb.cc.dd <<EOCSB
user yyyyyyyyyy zzzzzzzzzz
binary
cd array1/Callisto-Lx
put $line
EOCSB
if [ $? -ne 0 ]; then
    echo "FTP To NAS failed. Exiting..."
    exit 1
fi
```

3. USB hard drive or USB flash drive: If a USB hard drive or flash drive is to be used with Callisto-Lx, the line in launcher.sh that copies the files to those drive types should be uncommented, as in

```
# uncomment the next line to copy *.fit to USB drive if equipped
cp $line /media/Callisto-Lx/
```

Note: There is no harm in enabling a USB drive by uncommenting the line even though a drive is not plugged into the RPi. When plugged in the data files should appear in the Callisto-Lx directory on the USB hard drive or flash drive.

Launcher.sh file in box below. Edit as described above.

```
#!/bin/bash

# exit shell script if copy is already running
pids=$(pgrep -f $(basename $0))
for pid in $pids;
do
    if [ $pid -ne $$ ]; then
        echo "$0 is already running. Exiting."
        exit 7
    fi
done

cd ~/Callisto-Lx/Data/

# loop through the files in the directory..
find . -type f -name "*.fit" -mmin +15 | while read line
do

    # upload *.fit to FHNW web server IP 147.86.8.73 (passive mode by default)
    # ftp -n -i ftpexchange.cs.technik.fhnw.ch <<EOCSA
    #user solarradio xxxxx\${xxx}
    #binary
    #put $line
    #quit
    #EOCSA
    # if [ $? -ne 0 ]; then
    #     echo "FTP to FHNW failed. Exiting..."
    #     exit 1
    # fi

    # uncomment the next 10 lines to upload *.fit to NAS if equipped
    # ftp -n -i aa.bb.cc.dd <<EOCSB
    #user user yyyyyyyyyy zzzzzzzzzz
    #binary
    #cd array1/Callisto-Lx
    #put $line
    #EOCSB
    # if [ $? -ne 0 ]; then
    #     echo "FTP To NAS failed. Exiting..."
    #     exit 1
    # fi

    # copy *.fit to archive directory
    cp $line ~/Callisto-Lx/Archive/

    # uncomment the next line to copy *.fit to USB drive if equipped
    # cp $line /media/Callisto-Lx/

    # delete *.fit and start over
    rm $line
done
```

4. Callisto-Pi spectrum images: If Callisto-Pi is to be used to produce spectrum images from Callisto-Lx data, it is necessary to add instructions in launcher.sh to send the data to the Callisto-Pi platform. Simply place the following command lines immediately after the commands for the NAS server. In this case, aa.bb.cc.dd is the Callisto-Pi IP address. The Callisto-Pi login is anonymous and anything. The example below assumes the directory on Callisto-Pi is /Callisto-Lx and it should be changed to the actual directory to be used. To activate the commands, simply remove the hash character # from the beginning of the last 10 lines:

```
        # uncomment the next 10 lines to upload *.fit to Callisto-Pi if equipped
#      ftp -n -i aa.bb.cc.dd <<EOCSB
#user anonymous anything
#binary
#cd /Callisto-Lx
#put $line
#EOCSB
#  if [ $? -ne 0 ]; then
#      echo "FTP To Callisto-Pi failed. Exiting..."
#      exit 1
#  fi
```


Document information

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