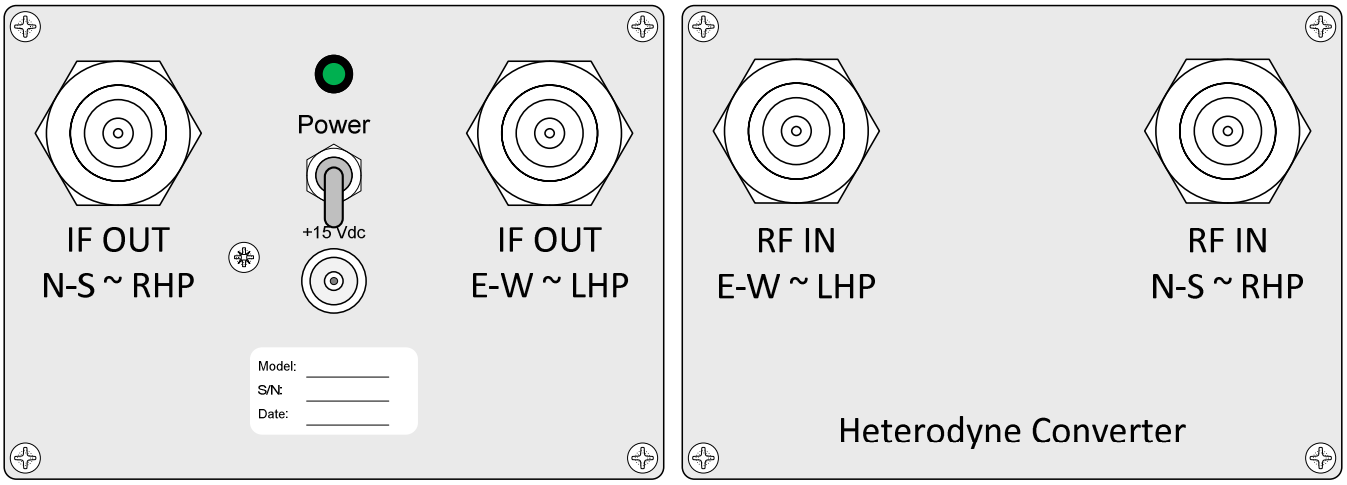
UPC-590L-M Up-Converter Installation and Operation

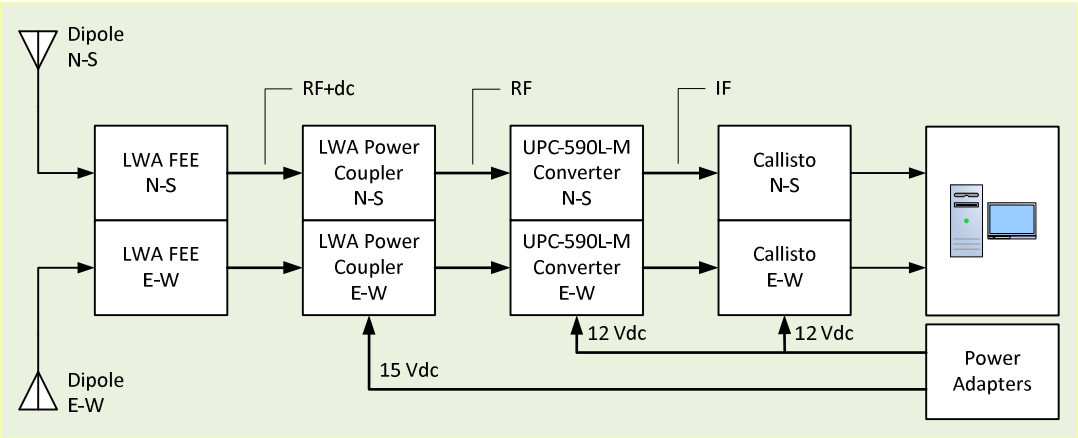
1. Description

The model UPC-590L-M consists of two identical heterodyne converters with 5 to 85 MHz RF input and 205 to 285 MHz IF output. It is designed for use with the Long Wavelength Array (LWA) Antenna and includes 15 dB of attenuation in each IF output path. The UPC-590L-M has the same dimensions and form factor as the LWA Power Coupler and Callisto instruments. Because the LWA Antenna has built-in front-end electronics with low noise figure and high gain, the UPC-590L-M has no RF input preamplification.

The UPC-590L-M panel layouts are shown below. The front panel (left) has connectors for power (2.1 x 5.5 mm coaxial jack, center positive), a power switch and power indicator and two output connectors for the IF to the receivers (type N-female). The rear panel (right) has two input connectors for the RF from the LWA Power Coupler (type N-female).



The basic configuration is shown below. The Converter is inserted between the LWA Power Coupler and the Callistos instrument or other receivers.



2. Installation

Equipment location

The Converter should be placed in an indoor environmentally controlled location with a reliable source of power. It is recommended that the Converter be collocated with the Callisto instrument and connected to it with a short coaxial jumper cable.

Signal levels

The LWA Antenna is an active antenna. The Front-End Electronics (FEE) gain is 35 dB. The UPC-590L-M has a 15 dB attenuator in the IF output path and its mixer has a conversion loss of approximately 6 dB. Internal filters, coaxial cables and connectors introduce approximately 1 dB of additional loss, giving a total loss of 22 dB through the converter. To maintain a 0 dB Transmission Level Point at the RF input to the Callisto instrument or other receiver, additional attenuation will need to be inserted in the RF circuit between the LWA Power Coupler and the receiver. The value of this attenuator will depend on the additional losses introduced by external coaxial cables and splitters (if equipped). Ordinary RF circuit engineering principles can be used to determine these losses.

Power supply

The UPC-590L-M requires 12 Vdc input voltage. Nominal load current is 100 mA. The power supply should be regulated such that the voltage at the UPC-590L-M power input connector never drops below 8 V under all anticipated input and output conditions. The power supply should be high quality. It is recommended that ferrite beads be placed on the power supply lead at both the Converter end and power supply end. Clamshell beads will allow several windings of the power leads to be wrapped around the cores.

Coaxial cable transmission lines and connectors

Coaxial cables can build up a static charge that, if allowed to discharge by connecting to equipment, may damage sensitive input circuits. To avoid such damage, it is recommended that static charges be dissipated by momentarily shorting the cable connector center pin and shield before connecting to the converter. This should be done carefully to avoid damaging the connector center pin. Also, all coaxial cable connections must be made before power is applied to any of the components.

All coaxial cables and connectors used with the UPC-590L-M converter must be 50 ohms impedance.

The LWA Antenna requires a power coupler (for example, the LWAPC or LWAPC-Q) and has a built-in preamplifier called Front End Electronics (FEE). The coaxial cable that connects the LWA Antenna FEE to the power coupler may be 5 or 6 mm diameter and its length is not critical within reasonable limits. Refer to the LWA Antenna and LWA Power Coupler documentation for specific details on installing those components.

The coaxial cable that connects the LWA Power Coupler to the UPC-590L-M Converter generally should be 5 to 10 mm diameter and ≤ 50 m long. If a longer cable is required, an intermediate amplifier may be needed. Similarly, the cable between the UPC-590L-M Converter and Callisto instrument or receiver should be 5 to 10 mm diameter and ≤ 50 m long, and an intermediate amplifier used with longer cables. Use only the best possible quality RF connectors and cables.

3. Software Setup

Before attempting to setup the Converter, refer to the Callisto ***Software Setup Guide*** for detailed instructions on using the Callisto software and the Frequency Genie software tool. Setup the UPC-590L-M Converter according to the steps below, while referring to the screenshots immediately following:

1. Connect all equipment; double-check all coaxial cable and power connections and power supply voltages. Refer to the LWA Antenna and LWA Power Coupler instruction manuals for connection and powering details;

2. Apply power to LWA Power Coupler, UPC-590L-M Converter, and Callisto instrument;

3. Open callisto.exe and obtain a spectral overview (OVS) of the sky. This records the relative sky noise power at each frequency within Callisto's frequency range 45 to 870 MHz with 62.5 kHz resolution. This range includes frequencies within the up-converter IF output range and also includes frequencies outside the range. When finished with this step close callisto.exe;

4. Open the Frequency Genie software tool and load the spectral overview from step 3;

5. For the UPC-590 up-converter, setup Frequency Genie as follows:

Channel selection method:	Minimum detection (see Note)
Type of converter:	Upconverter (IF=RF+LO)
Sweeplength:	200
RF Startfrequency (MHz):	5
RF Stopfrequency (MHZ):	85
LO (converter)(MHz):	200
Filenumber FRQxxxxx.cfg:	00000 to 99999 (example, 00585)

   Note: To prepare a frequency list based only on equal spacing of the channels, select Equally Spaced; however, strong radio frequency interference (RFI) may exist on some channels and the frequency list with equal spacing may require manual editing.

6. To view the frequency range on the Spectral Overview, click the Preview FrqPrg button on lower-right of the Frequency Genie main window. The programmed frequency range will be shown as a green slanted line;

7. Click the Save Program button on the upper-right of the main window to generate the frequency list;

8. Move or copy the frequency list file to the same folder as callisto.exe;

9. Edit callisto.cfg parameter [frqfile] to use the frequency file from step 7. It may be necessary to reduce the Callisto gain parameter [agclevel] due to the gain of the LWA FEE. A new setting will have to be found experimentally. See section 2. Installation – Signal levels for additional information.

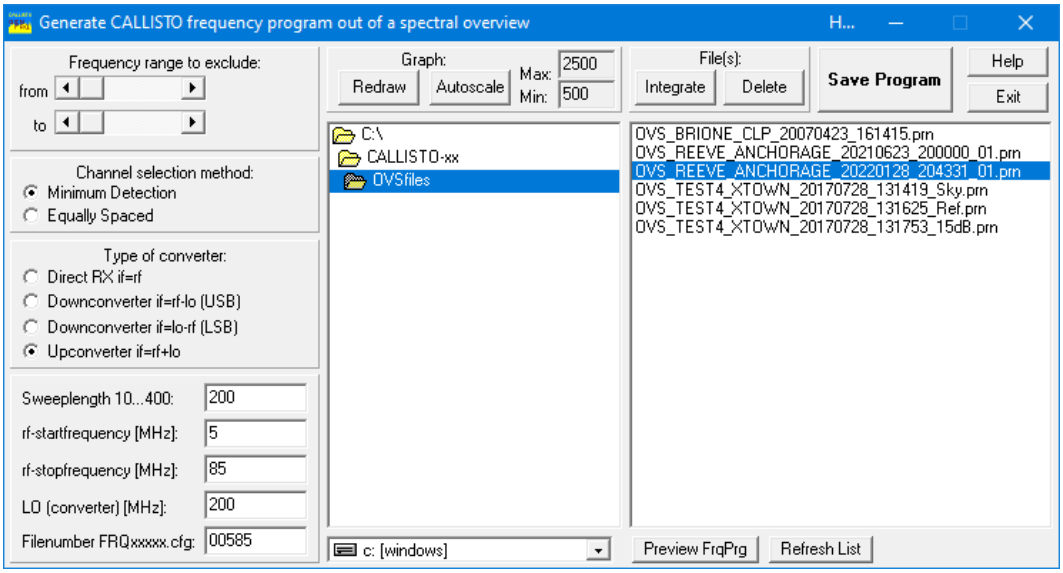
10. Change the focus code parameter [focuscode] in callisto.cfg. The recommended code is 62 for right-hand circular polarization (RHCP) and 63 for left-hand circular polarization (LHCP). When the LWA Antenna is configured for linear polarizations, the recommended focus codes are 58 and 59. The focus code number is not critical but must be different for each polarization;

10. Edit scheduler.cfg for the desired observing schedule;

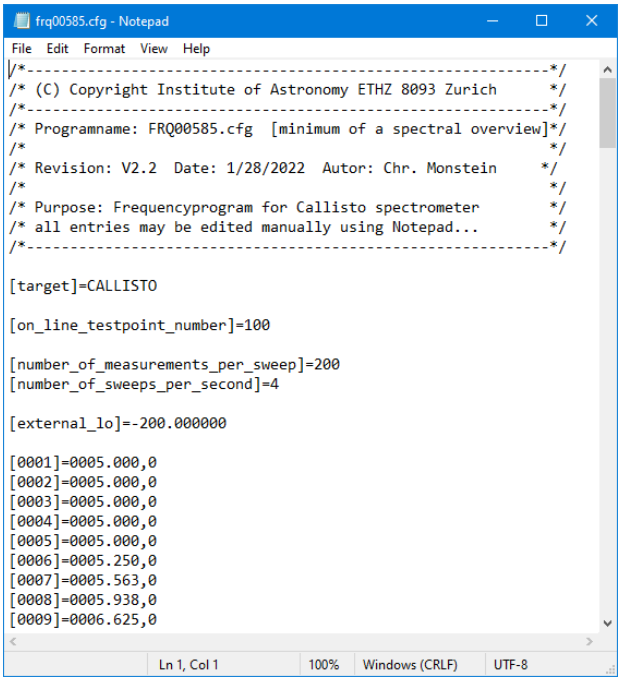
11. Open callisto.exe. It will automatically load the new frequency file;

12. If callisto.cfg is not setup for automatic execution, manually start the new observation. When the Automatic radio button is selected, Callisto will observe according to the scheduler.cfg file setup in step 10;

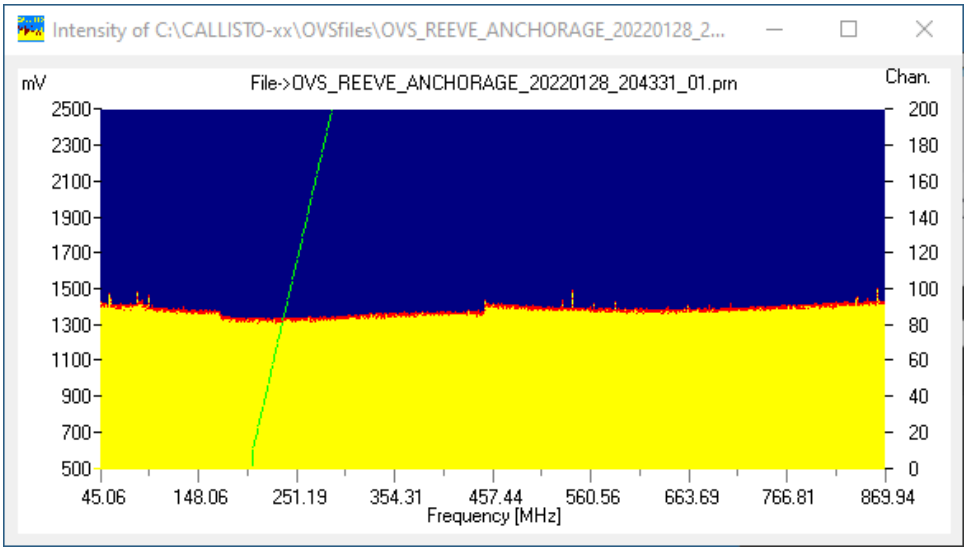
13. On the callisto.exe main window, click on Spectrum y(f) to view the spectrum of the programmed frequency range.



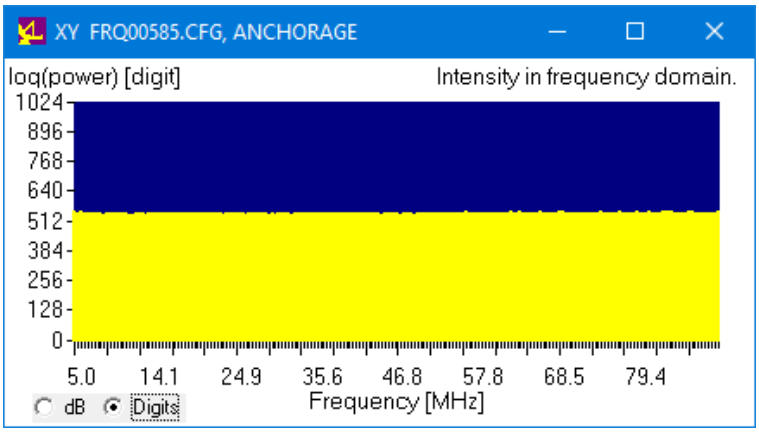
Frequency Genie main window showing setup for an up-converter with 200 MHz LO and 5 to 85 MHz RF input. The output filename (Filenumber) is 00585.



Part of an example frequency list generated by Frequency Genie with 200 channels per sweep, 4 sweeps per second, frequency range 5 to 85 MHz and local oscillator of 200 MHz. Note: The start frequency is repeated five times to allow the tuner synthesizer to stabilize when starting a new sweep. The amount of repetition is set by the `[nonlinchans]` parameter in `params.cfg` file of the Frequency Genie.



Spectrum plot from Frequency Genie showing spectrum for the OVS. The slanted green line is the programmed frequency range of the receiver RF input/up-converter IF output.

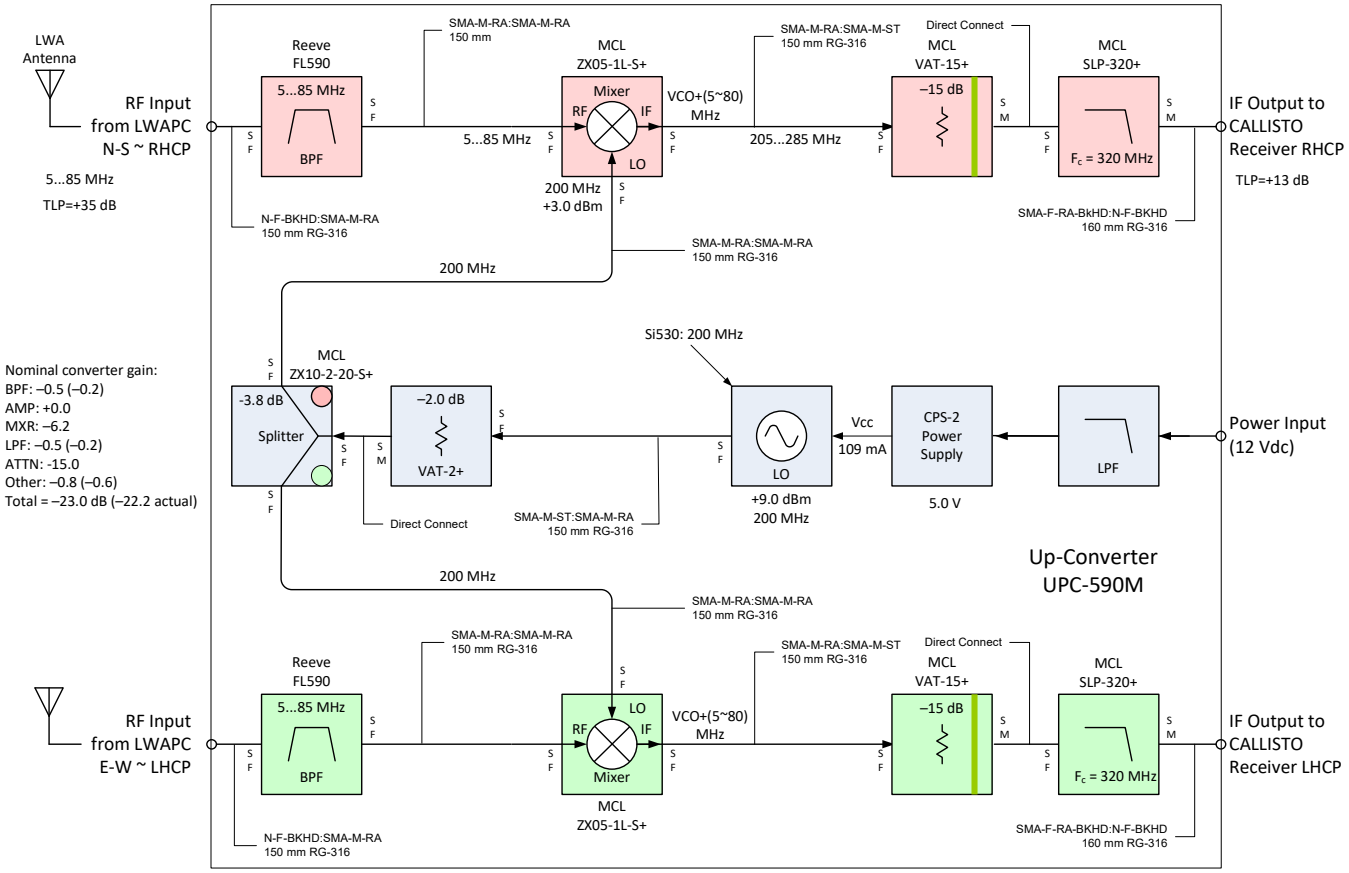


Spectrum Y(f) plot from callisto.exe showing the frequency range 5 to 85 MHz for the UPC-590L-M up-converter with no signal input. This plot was made with a 50 ohm termination on the RF input.

4. UPC-590L-M Up-Converter Description

Block diagram

The UPC-590L-M up-converter consists of two identical assemblies that share a common local oscillator. The following describes one of the assemblies. The RF input is first applied to a 5 to 85 MHz bandpass filter and then to the double-balanced mixer. A 200 MHz local oscillator is mixed with the filtered RF input to provide an IF output range of 205 to 285 MHz. The mixer conversion loss is approximately 8 dB. The mixer IF output is applied to a 20 dB attenuator and lowpass filter with a corner frequency of 320 MHz. The lowpass filter reduces the 2nd and higher harmonics of the oscillator leakage through the mixer. A power supply printed circuit board (model CPS-3) uses a linear low noise, low dropout voltage regulator to provide regulated 5.0 Vdc to the oscillator.



Specifications (all values nominal)

- Architecture: Single stage heterodyne converter
- Configuration: Dual converters with common local oscillator
- RF input frequency range: 5 to 85 MHz
- RF input connector: Type N-female
- IF output frequency range: 205 to 285 MHz
- IF output connector: Type N-female
- Input voltage: 12 Vdc
- Input current: 120 mA maximum
- Input power connector: 2.1x5.5 mm coaxial jack (center positive +)
- Gain: –22 dB (with internal 20 dB attenuator in each channel)
- Dimensions: 168 mm long x 110 mm wide x 79 mm high

- Weight: 3.8 kg

5. Operation and Maintenance

Operation:
All RF connections should be made to the Converter and Receiver before the power supply is connected and turned on. Power is applied by toggling the power switch on the front panel to the UP position. Power is removed by toggling the power switch to the DOWN position.

IMPORTANT: After the Converter has been in operation and if the coaxial cables need to be disconnected, the power switch should be turned off and the power cable removed before disconnecting the coaxial cables. If the Converter is used with the LWA Power Coupler (LWAPC), follow the instructions associated with the power coupler before applying or removing power from either unit.

Maintenance:
The Converter requires very little periodic maintenance. Converter maintenance described below should be performed when performing regular maintenance on the Callisto instrument, other receiver or power coupler.

A. Monthly Preventative Maintenance
   - ☼ Brush dust off the instrument being careful to not disturb the connections
   - ☼ If additional cleaning of the enclosure and panels is required, use a damp cloth; DO NOT use any chemicals (or else the silkscreen may dissolve)
   - ☼ Check condition of all cables and connectors

B. Annual Preventative Maintenance
   - ☼ Check power supply voltage, 12 Vdc
   - ☼ Check local oscillator frequency, 200 MHz ± 20 kHz (measure at IF Output with a frequency counter) after > 2 h warmup. The oscillator is not tunable; it is recommended that the unit be returned to the factory if the LO frequency is out of specification.

C. Internal RF connectors
   - ☼ If the internal type SMA RF connectors are loose or removed and replaced, torque them to 45 N-cm (4 in-lb).

Document information

Author: Whitham D. Reeve

Revision: 0.0 (Original draft started, 19 Dec 2020)
0.1 (Updated block diagrams, 19 Sep 2021)
0.2 (Highlighted images to be replaced, 21 Sep 2021)
0.3 (Updated IF frequencies to match -M oscillator, 27 Jan 2022)
0.4 (Replaced all images with current, 28 Jan 2022)