



VLF-LF-MF Up Converter

<5kHz-530kHz to

3.5MHz-4MHz model HS-350

4MHz-4.5MHz model HS-400

4MHz-4.5MHz model HS-400 GPS-REF

User manual. Rev 2024-01

Since many countries are allocating the 472 kHz to 479 kHz band for experimental use by Radio Amateurs, a growing number of them as well as listeners have become interested on VLF and LF bands.

The fact that few radios are available on the market covering properly frequencies from below 5kHz to 530kHz, convinced us to provide radio amateurs and listeners with the high-performance receiving VLF-LF Converter that we introduce here.

The VLF-LF Up-Converter extends the range of any shortwave receiver to below 5 kHz to 530 kHz.

The Converter is connected between the antenna and a shortwave radio receiver. When it is power-on the <5kHz to 530 kHz band segment is translate to 3.500MHz to 4.030MHz, Model-350 or 4.00MHz to 4.530MHz, Model 400, allowing the reception of VLF and LF bands.

For example, if a conversion frequency of 4.000MHz - 4.500MHz, Model 400, is used, and the receiver tuned on 4.135.500MHz, you are receiving on 135.500kHz, just ignoring the digit “4” on the dial.

Alternatively most SDR radio control software lets customise by the user the dial, in this regard see below PowerSDR configuration.

The VLF-LF Up-Converter enables reception of VLF mobile maritime communications, aviation and marine navigational aids such as LORAN, NDB and DGPS beacons, DGPS reference stations, NAVTEX, Standard Time & Frequency stations, LF Amateur bands, European LW broadcast stations, monitoring the sounds of nature created by planet Earth (Natural Radio) such as sferics, hiss, tweaks, whistlers, Dawn Chorus, other not well known VLF radio atmospheric sounds, and many more. It is advisable to use a variable attenuator in front of the converter in order to improve signal to noise ratio. Its use have more or less noticeable effects depending on local band conditions. If you are living in the country side far away from noise sources probably you do not need one.

In urban areas in presence of strong signals or noise a variable attenuator avoids saturating the IF receiver. Adjusting the attenuation to a proper value weak signals buried in the noise can be seen emerging.

In addition better energy transfer is achieved between antenna and converter due the broad impedance matching effect.

If the VLF-LF up-Converter is connected in line to a HF transceiver acting as IF receiver, take precautions to prevent transmitting any signal into the converter.

Input Filters

Referring to the functional block diagram, the 50 Ω antenna is connected to J1 ,BNC type connector; a Gas Discharge Tube protects the converter from transients that may come from the antenna.

Next the input filters section is a combination of a 110dB IF trap and a 7th order, 0.3dB insertion loss, Elliptic Low Pass Filter with a cut-off frequency of 520 kHz.

This section provides good performance right up to the start of the AM broadcast band with a sharp roll-off, giving a good rejection to MW broadcast signals avoiding introducing overload or intermodulation products in the receiver.

Local Oscillator (only models HS-400 and HS-350)

Low phase noise, crystal controlled oscillator provides +7dBm signal level to the mixer.

A good quality quartz crystal of 3.5MHz or 4MHz, according to the model of converter, is used.

A trimmer capacitor is accessible by the user if fine adjust of frequency is required in times.

A low noise linear fixed voltage IC regulates the voltage applied to the oscillator to enhance stability and avoid drift.

The oscillator is followed by a buffer stage to improve its stability. Next, an amplifier accommodates the signal to the required level. It connects to a 4 MHz, 7th order, Elliptic Low Pass Filter which cleans up any harmonics and assures that a pure signal applies to the mixer to minimise spurious responses.

Local Oscillator (only model HS-400 GPS-REF)

Although the performance of the models HS-350 and HS-400 is excellent for regular listening there are applications needed by advanced users that demand high accuracy reception parameters. In this regard from early 2023 we introduced a new VLF-LF-MF converter model, the HS-400 GPS-REF featuring the connection of an external frequency reference source such as GPS Disciplined Oscillator, GPSDO, Rubidium frequency reference or similar high accuracy instrument.

This kind of reference instruments can achieve frequency resolutions down to pHz (10-12 Hz) and low phase noise in the range of sub-picoseconds RMS jitter.

We recommend the cost-effective Leo Bodnar Low-jitter GPS-locked precision frequency reference:

https://www.leobodnar.com/shop/index.php?main_page=index&cPath=107

Notice that model HS-400 GPS-REF do not mount a local oscillator. A 4.00MHz external frequency reference is needed. (Not included)

Mixer

The mixer stage is designed around a Mini-Circuits SRA-8+ double balanced mixer. It is rated to operate from 500Hz, giving an excellent frequency coverage. Designed for +7 dBm of LO power, it has a conversion loss of less than 5 dB at VLF LF bands, which is compensated by the post-mixer amplifier. A double balanced mixer has the advantage of high port-to-port isolation, which keeps the strong LO signal from degrading the dynamic range of the IF receiver. Every effort has been made to terminate the ports of the mixer in a proper 50 Ω impedance to maximize its performance.

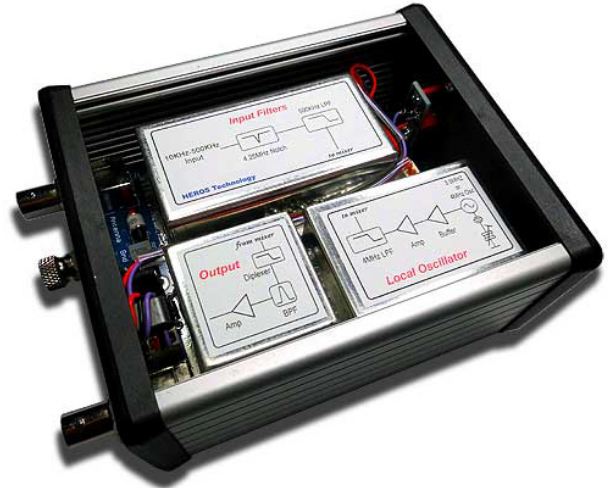
The mixer IF port is most critical in terms of proper termination, for so, a diplexer circuit provides a 50 Ω resistive load to the mixer while passing the desired signal to the IF amplifier, with minimum loss.

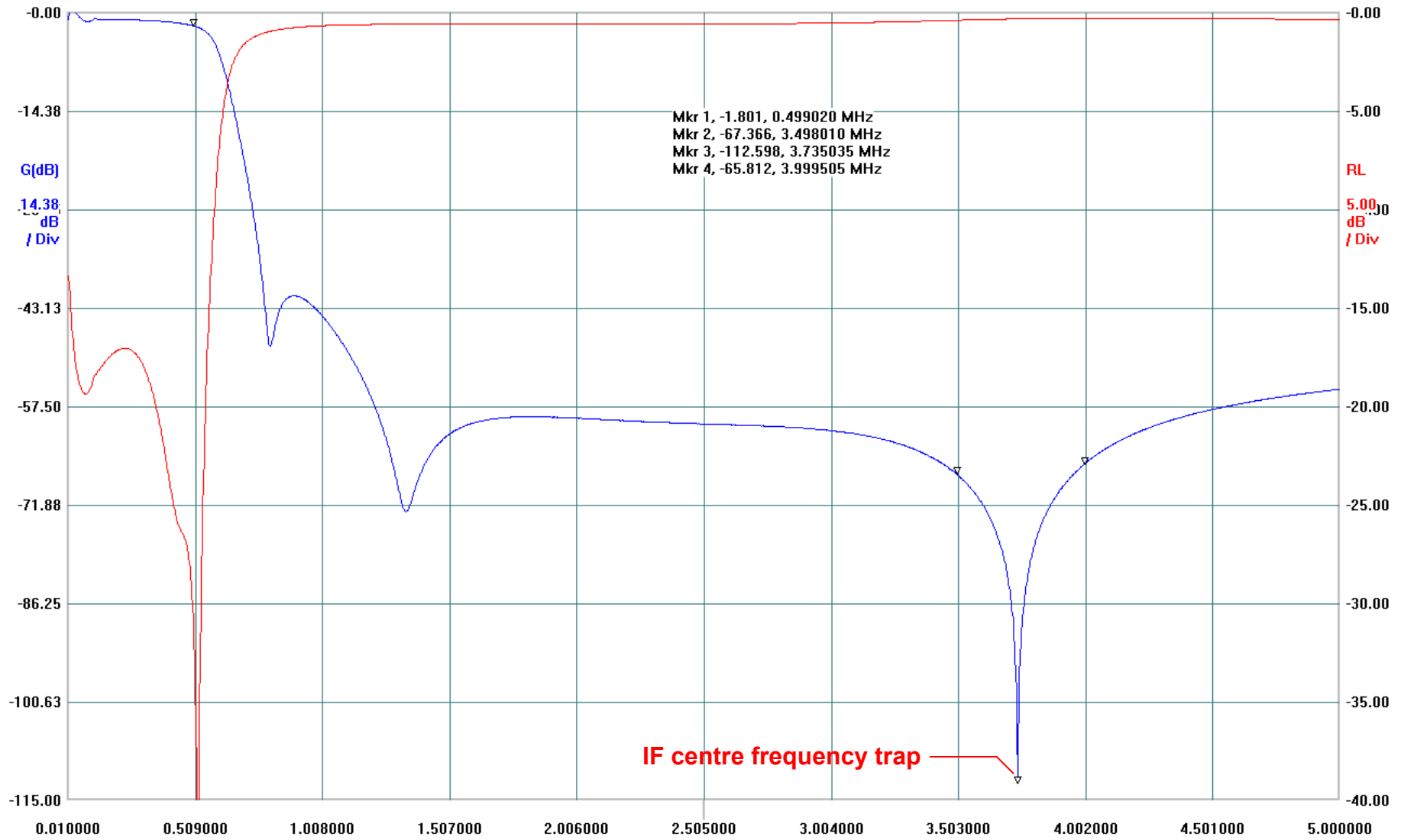
Next, a Band Pass filter at IF frequency connects to a Low Noise Amplifier to compensate losses, delivering around 5dB of gain to the output, necessary to overcome losses from external cable tails, relays and connectors.

Design

A carefully PCB and shielding design keep feed through signals of the HF receiving frequency down to a very low level; therefore, weak LF signals will not be interfered by strong HF signals on the same frequency.

The HF receiver used should have strong rejection of HF signals through paths other than the antenna connector. Most HF transceivers and receivers have good performance in this respect, but some SWL receivers do not and may be used with the addition of filters and shielding.





Converter class: Superheterodyne. IF output mirrored up.

Type: Double balanced mixer

Frequency range: Below 5kHz to 530kHz.

IF output:

- 4MHz-4.530MHz; model HS-400 and model HS-400GPS-REF

- 3.5MHz-4.030MHz, model HS-350.

Input/output impedance: 50 Ω

IF rejection: 110dB typical.

MW band rejection: >80dB

Local Oscillator (Only models HS-350 and HS-400)

- Frequency: 3.500MHz or 4.000MHz, fundamental. According to the converter model

- Quartz crystal. Low phase noise.

- Operating temperature: -10°C to +60°C

- Ageing ± 3 ppm typical per year or ± 12 Hz.

- Frequency Stability ± 5.00 ppm or ± 20 Hz @ room temp (25°C)

External Master Oscillator (Only model HS-400 GPS-REF)

Model HS-400 GPS-REF do not mount a local oscillator. A 4.00MHz external frequency reference is needed. (Not included)

- Frequency: 4.00MHz Recommended a GPS Disciplined Oscillator, GPSDO. Not included

- Input Signal Level: 1V (+13dBm max)/50 Ω .

- Input Signal Connector SMA

General (All models)

Power: DC 12volts/40mA

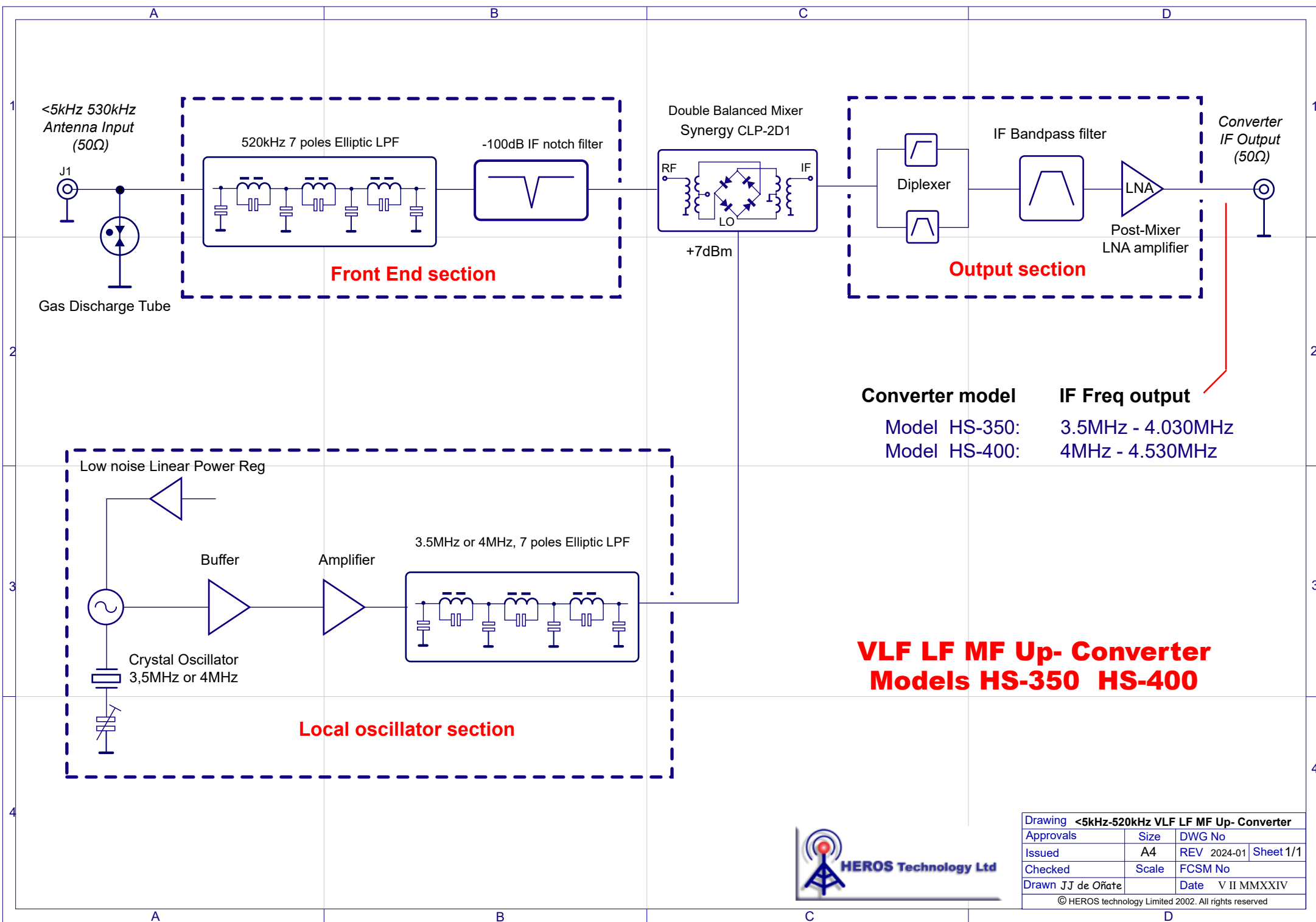
Enclosure: Aluminium

Size: 125mmx105mmx55mm (4.921x4.133x2.165in)

Weight: 480g

Shipping Weight: 800g

Country of origin: United Kingdom

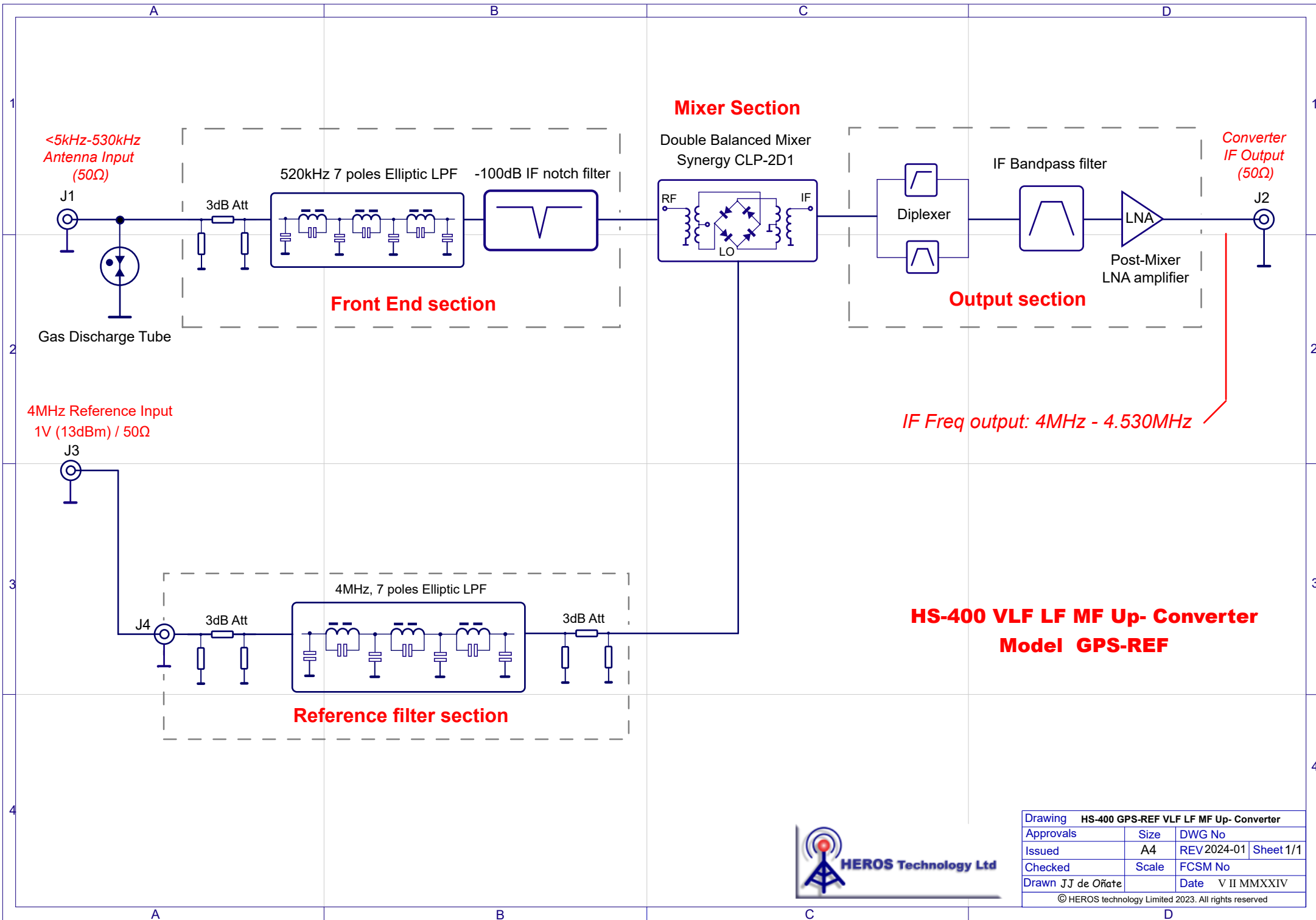


Converter model	IF Freq output
Model HS-350:	3.5MHz - 4.030MHz
Model HS-400:	4MHz - 4.530MHz

VLF LF MF Up- Converter Models HS-350 HS-400



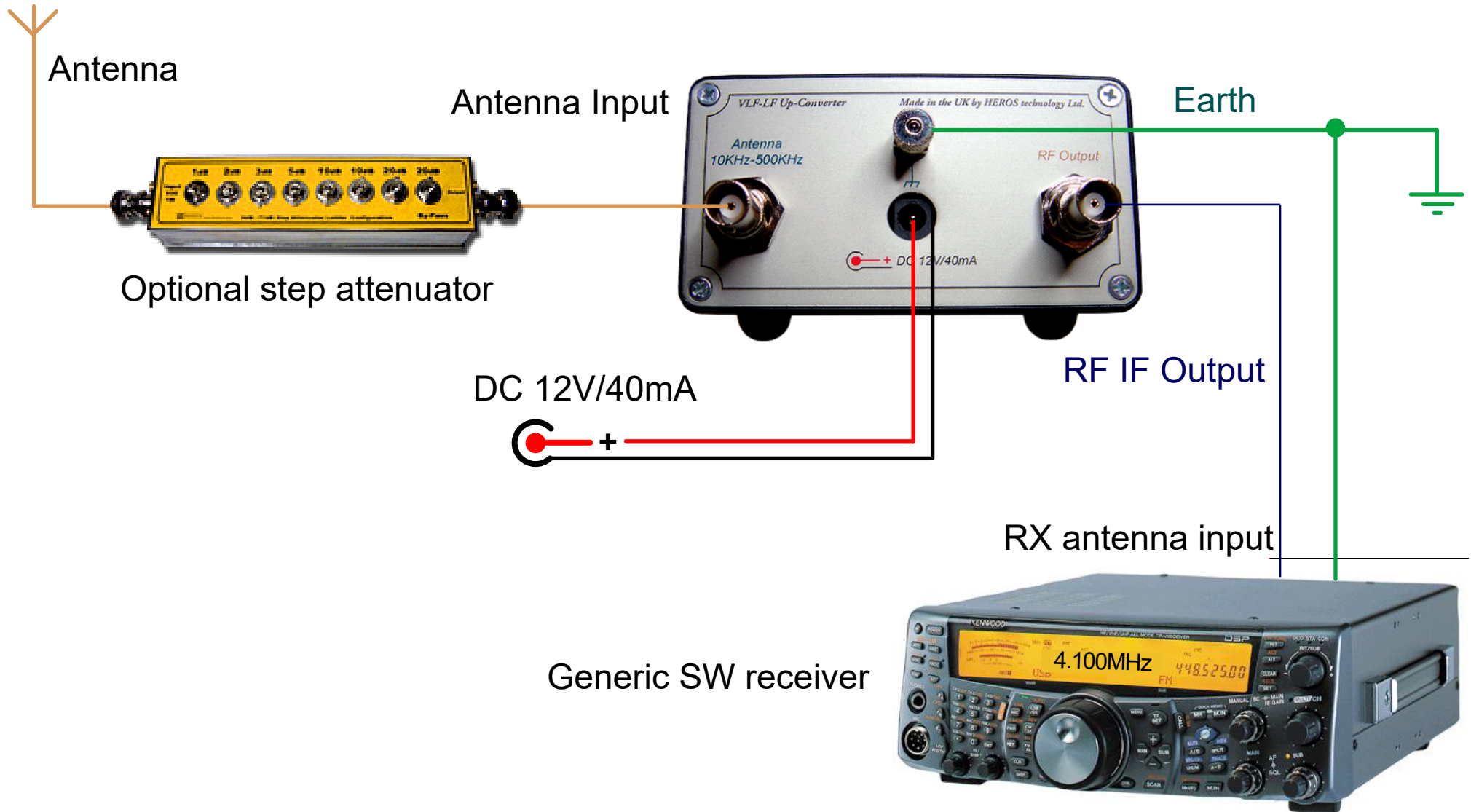
Drawing <5kHz-520kHz VLF LF MF Up- Converter			
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**HS-400 VLF LF MF Up- Converter
Model GPS-REF**

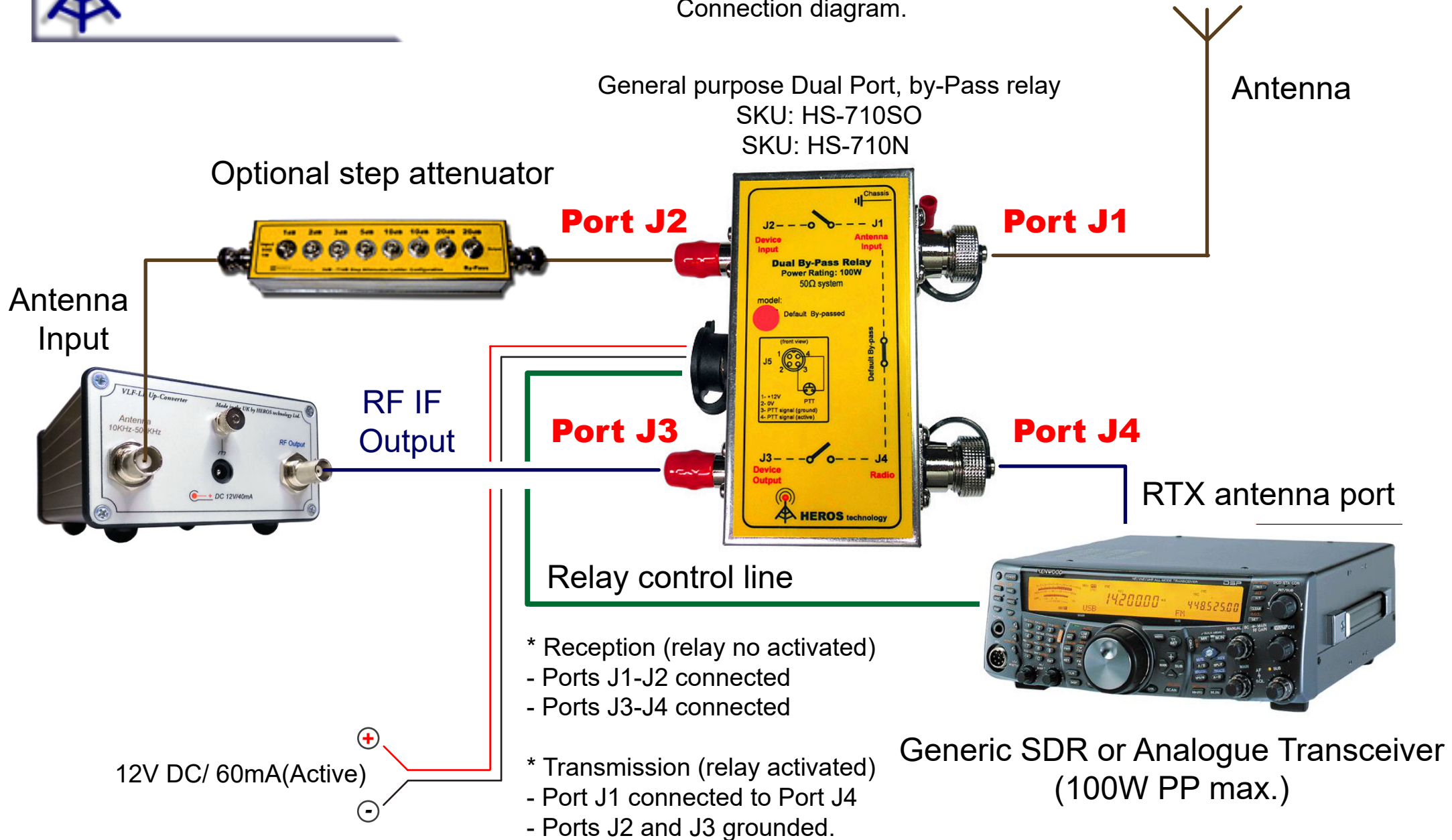


Drawing HS-400 GPS-REF VLF LF MF Up- Converter			
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VLF-LF-MF <5KHz - 530KHz Up Converter

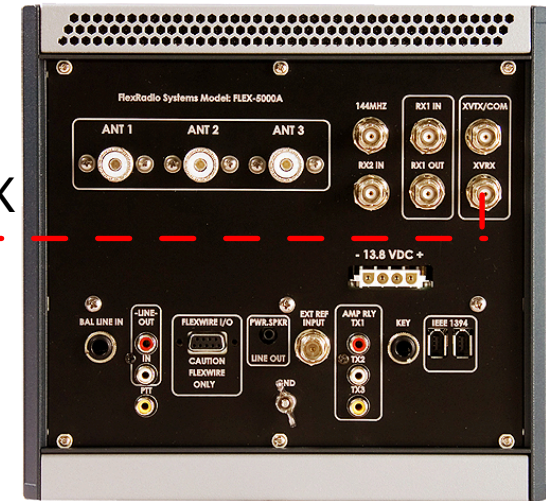
By-passing the Converter on transmission switch-over
Connection diagram.



VLF-MF <5KHz - 500KHz Up Converter

Set-up connection to SDR radios.

Flex 5000



XVRX

Antenna

Optional
step attenuator

Antenna
input



RF IF
output

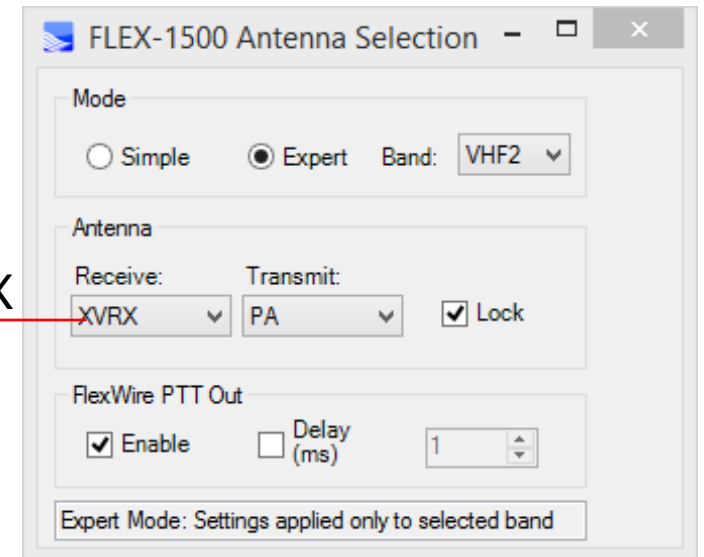
Flex 1500



XVRX



XVRX





VLF--MF <5KHz - 530KHz Up Converter

PowerSDR configuration.

FLEX-1500 Antenna Selection

Mode: Simple Expert Band: VHF2

Antenna: Receive: XVRX Transmit: PA Lock

FlexWire PTT Out: Enable Delay (ms) 1

Expert Mode: Settings applied only to selected band

Dial lower frequency
(0 KHz in the picture)

Local oscillator correction
(if any)

Local oscillator offset:
Negative value (-)
- 3.5 for Converter model 350
- 4 for Converter model 400

Dial upper frequency
(500 KHz in the picture)

XVTR Setup

Enabled	Band Button	UCB Address	Button Text	LO Offset (MHz)	LO Error (kHz)	Begin Freq (MHz)	End Freq (MHz)	RX Gain (dB)	RX Only	Power	XVTR RF TX	IF Gain	PA Enable
VHF/UHF Module Not Present													
<input type="checkbox"/>	0	0	2m	1.0	2.000	3.000000	4.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/>	1	1	70cm	6.0	7.000	8.000000	9.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	2	2	LF	-3.5	0.000	0.000000	0.500000	0.0	<input checked="" type="checkbox"/>	100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	3	3	3	0.0	0.000	0.000000	0.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	4	4	4	0.0	0.000	0.000000	0.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	5	5	5	0.0	0.000	0.000000	0.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	6	6	6	0.0	0.000	0.000000	0.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	7	7	7	0.0	0.000	0.000000	0.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	8	8	8	0.0	0.000	0.000000	0.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	9	9	9	0.0	0.000	0.000000	0.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	10	10	10	0.0	0.000	0.000000	0.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	11	11	11	0.0	0.000	0.000000	0.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	12	12	12	0.0	0.000	0.000000	0.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	13	13	13	0.0	0.000	0.000000	0.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>		14		0.0	0.000	0.000000	0.000000	0.0	<input type="checkbox"/>	100	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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Use XVTR PWR for Tune

Design

A carefully PCB and shielding design keep feed through signals down to a very low level.

The HFRX used as IF should have strong rejection of HF signals through paths other than the antenna connector

Most HF transceivers and receivers have good performance in this respect, but some SWL receivers do not and may be used with the addition of filters and shielding.

Operating

The VLF-LF Up Converter is suitable to work with SDR or Analogue radios.

It can work together active antennas, loop antennas and preamplifiers providing an output impedance of 50 Ω . Beverage antennas, 450 Ω characteristic impedance need a matching device.

WARNING!

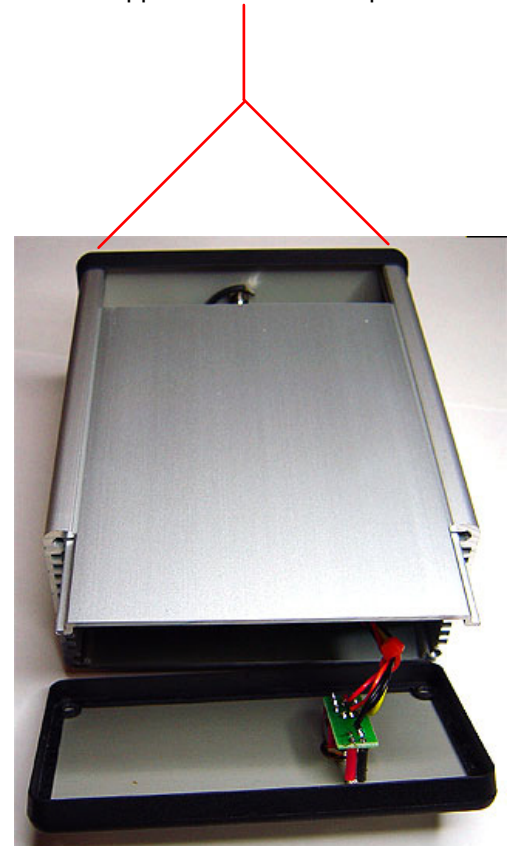
Using an active antenna, a DC block device must be used .

If the VLF-LF up-Converter is connected in line to a HF transceiver acting as IF receiver, take precautions to prevent transmitting any signal into the converter.

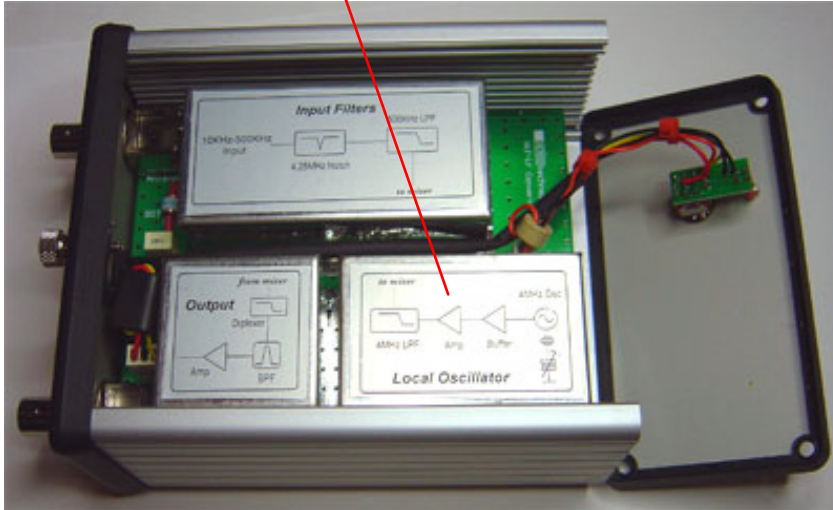
Oscillator calibration (Only models HS-350 and HS-400)

The VLF-LF Up-converter comes calibrated from factory after a burn test of 24 hours. If for any reason you need to re-calibrate the local oscillator proceed as follows:

Remove the four front panel screws and slide gently the lid. You may untie the two upper screws on rear panel.



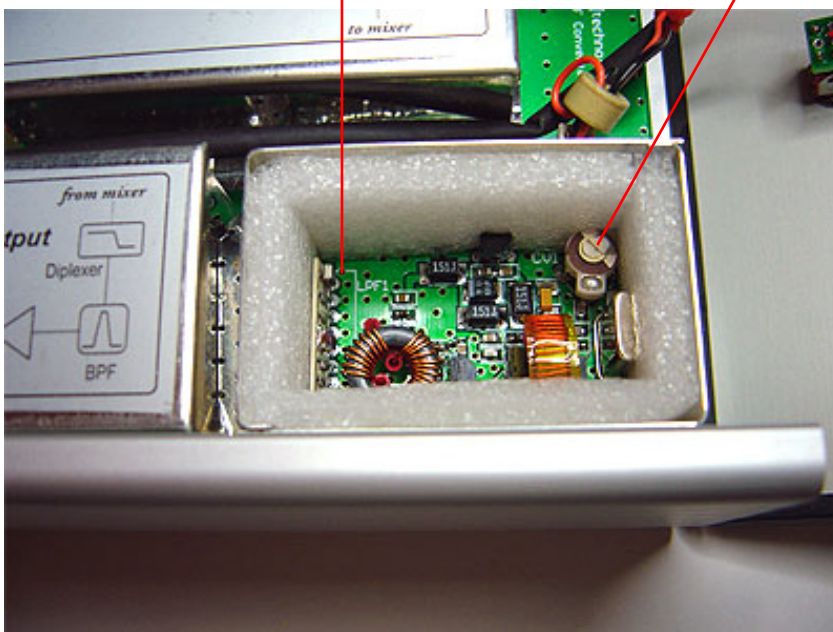
Remove the lid from the local oscillator section.



Switch ON the converter. Allow at least 30 minutes of warming time before adjusting at room temperature.

Measurement point

Adjusting trimmer





NOTES:

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