FunCube Dongle HF Kit Convertor

Version 2.0

User Manual

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1 Introduction

FUNCUBE DONGLE HF CONVERTER

Funcube Dongle (FCD) is a powerful and small Software Defined Radio (SDR) which has the ability of covering the frequency range between 64 and 1700MHz. Since the beginning, the FCD has picked-up its owner's attention with its quality and performance. However, some remained reluctant with the lack of coverage bellow 64MHz. Hence, the need to provide this HF Converter KIT, that allows to use of the FCD in the HF bands, but also in the low VHF band of 6m (50MHz). Thus, interpolating this project, between the antenna and the receiver (FCD), the user is able to extend the coverage from DC to 1700MHz. Both the HF Converter topology and its assembly are very simple, as you can see in the next chapters.

2 KIT Schematic and Circuit Description

Fig. 1 presents the converter schematic, which is very simple. When looking to the schematic it is relatively easy and straightforward to identify the four main blocks of the circuit. That is to say: input filter; gain unit (Optional - not included in the Kit); the mixer; and the output filter (which since version 2.0 includes a notch filter for the broadcasts emissions).

Also, since version 2.0, the user has the ability to choose the power-supply source: either by an USB plug; or power directly by the FCD - (make sure your device is compatible with this function).

For advanced users there is place on the board to place a LNA device with minor changes to the circuit. Also, pay extra attention to the supply requirements of the device you choose to use, which may not be compatible with the FCD power supply capabilities.

Now let's look into the schematic in more detail.

2.1 Low Pass Filter (LPF)

This first stage of the signal is a LPF to extract the frequencies in the range of DC to 52MHz. It is a 9-pole butterworth LPF.

2.2 Gain Block - OPTIONAL

Advanced users can choose to populate this block with a good LNA device, in order to both, decrease the device's Noise Figure and increase its dynamic range, since the amplifier used on the FCD is a broadband unit which has very poor performance in these fields.

This is completely up to the users to use such approach and the respective planning of this stage.

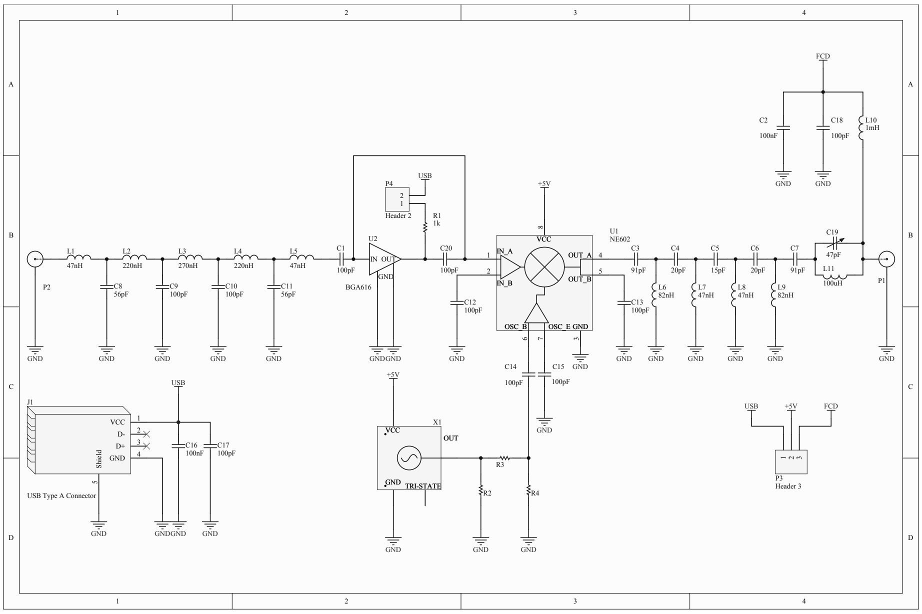

Figure 1: Circuit Schematic.

Several devices are plausible to be used, and in the circuit there is a footprint for devices like MAR-6 or BGA616, or similar.

This stage, for global use is (as you can see in the schematic) disabled. If you need further information on this please contact us.

2.3 Mixer

Mixing the RF signal and the IF signal is responsibility of the NE602 device. This device is a fairly good and robust device (also use by Elecraft in their equipments) adds the DC-64MHz signals to the 106.25MHz IF, which will be feed to the next stage.

2.4 High Pass Filter - HPF

The result of the mixer operation with the RF and IF signals enters this 9-pole filter, which then cuts the noise bellow 100MHz.

2.5 Clock Oscillator and Attenuator

The IF is generated by a Clock Oscillator module, which results in a 106.25MHz signal with 5Vpp. This voltage value is to high to be handled by the mixer, hence the need for an Attenuator, which in this case is of 6dB. Further information on this subject can be found on Table 2.

2.6 Power Supply Source

The KIT can be power either by an USB port or by a compatible FCD device. This decision is up to the user to make, and is done in the circuit by making a shunt. Further information is presented in Section 4.1

3 KIT Package

A list of the KIT content is presented bellow on Table 1.

Components	Value	Quantity
L1/L5/L7/L8	$47nH$	4
L2/L4	$220nH$	2
L3	$270nH$	1
L6/L9	$82nH$	2
L10	$1mH$	1
L11	$100uH$	1
R2	39Ω	1
R3/R4	150Ω	2
C1/C9/C10/C12/C13/C14/C15/C17/C18	$100pF$	9
C2/C16	$100nF$	2
C3/C7	$91pF$	2
C4/C6	$20pF$	2
C5	$15pF$	1
C8/C11	$56pF$	2
C19	$60pF\ trimmer$	1
P1/P2	$PanelSMA$	2
X1	$106.25MHz$	1
U1	$NE602AN$	1
J1	$USBPLUG$	1

Table 1: Kit Components.

4 Assembly

In the next paragraphs some assembly instructions are described with help of illustrative pictures. The rest of the steps is a basic an easy to assemble just match the components you receive with the KIT against the silkscreen on both sides of the board. Any information on the components label and/or value can be found on Section 3.

4.1 Power Supply Unit

Since version 2.0 the FCD Converter KIT gives the freedom, to the user, of choosing the supply source. Thus, the user can choose to power the converter from a USB port (like version 1.0), or use the ability of power the converter directly from the FCD device.

Please note, you need to make sure that your device is able to power external devices, this is an internal feature of the FCD devices that your device has to be able to provide.

If you want to use energy from a USB port you should make a shunt between the *USB* pin and the *PS* pin of component *P3*. An example of this can be seen on Figure 2.

In case, of wanting to power the device with the FCD you need to shunt the pins *FCD* and *PS*, again in the *P3* component. This is shown on Figure 3.

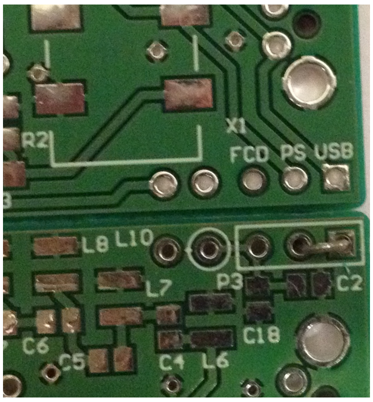

Figure 2: Power Supply Connection using a USB port.

To make the shunt you can use part of the coil *L10*, or if you prefer you can choose to use some kind of jumper, on your own.

Once again, please note that not all FCD devices support the ability to power external devices. So please make sure that yours does before using it!

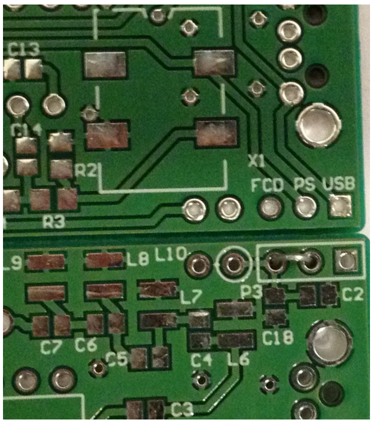

Figure 3: Power Supply Connection using the FCD.

4.2 Notch Filter and Capacitor *C12*

4.2.1 Notch Filter

Version 1.0 of the Converter KIT had many good feedbacks, even in presence of broadcast emissions. Nevertheless, some users suggested that the broadcast emissions should be attenuated, and minimized on a future version. It was decided to incorporate a notch filter, which would cut the broadcast emissions on the input of the FCD device. The user should actuate in the trimmer *C19* when in the presence of a strong signal to remove or at least minimize its effect on the desired signals to be received. The trimmer is located immediately before the FCD input to remove the effects caught by all the devices (with are possible antennas) in the circuit.

4.2.2 Capacitor *C12*

If you notice that your device is affected by an high level of broadcast noise, instead of placing a shunt on the *C12*, you should populate it with the respective component - a 100pF capacitor. This component is included on the components provided.

Otherwise, you can just choose to place a shunt instead of *C12*.

4.3 Clock Level Attenuator

The output level of the clocks, can vary between 3.3V and 5V, which are values to high for the mixer, and would definitively produce spurious and non linear effects on the signal. To avoid this an attenuator of 6dB is intercalated between the clock oscillator and the mixer. Some users found the attenuator value to be somehow small, so if you think that there are some strange effects cause by an high level of the clock oscillator in your receiving spectrum, please increase the attenuator to 10dB or even 12dB.

		Attenuation		
		6dB	10dB	12dB
Resistor Values	R2	150Ω	100Ω	82Ω
	R3	39Ω	75Ω	91Ω
	R4	150Ω	100Ω	82Ω

Table 2: Resistor Values for the Clock Oscillator Attenuator.

4.4 Clock Oscillator Test

Fig. 4 shows the test point, where you can test your device, and understand if it is working correctly. Either using an oscilloscope like shown on Figure 5 or a frequency meter like is shown in Figure 6. Either way, you should obtain a signal with a frequency close to 106.25MHz.

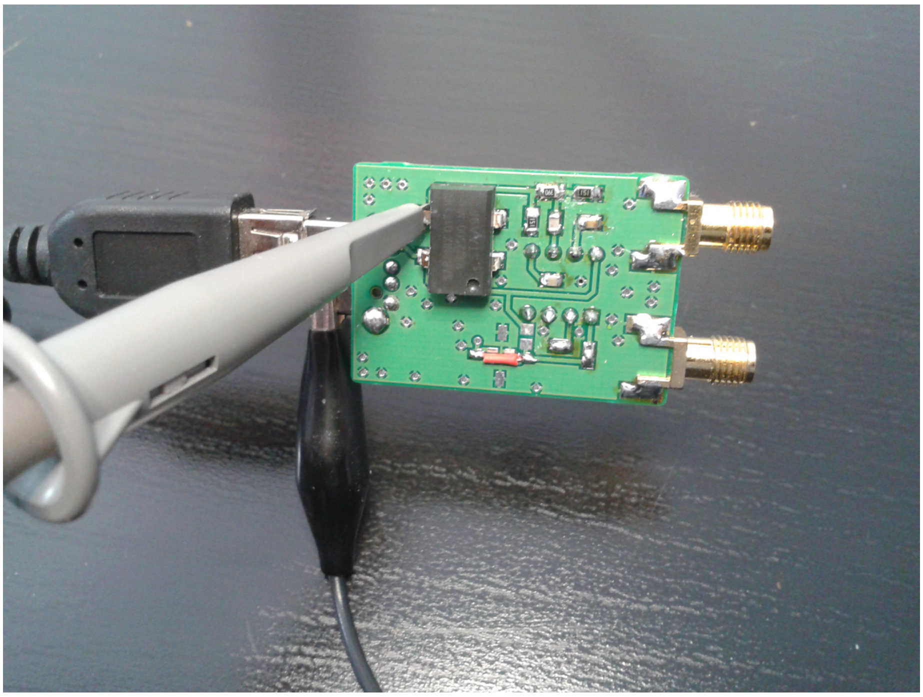

Figure 4: Clock Oscillator test point.

Figure 5: Clock Oscillator test with an Oscilloscope.

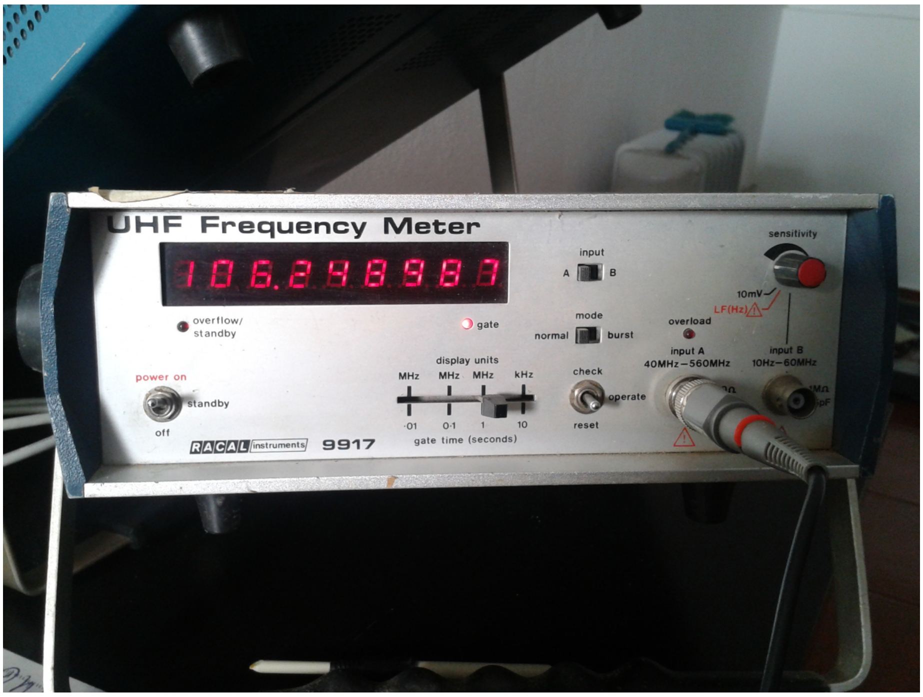

Figure 6: Clock Oscillator test with a Frequency Meter.

5 Software

In a general way, all the softwares compatible with the FCD device are plausible of being used with this KIT. Though, there are some that support the transverter functionality and let you introduce the offset frequency (106.25MHz). To make users life easier we show twos examples.

5.1 SDR-Radio by Simon Brown

First of all let us thank for the wonderful job done by Simon with SDR-Radio, and the support he gave us to our KIT.

That said, let's go the configuration:

1. Open the SDR-Radio Console;
2. Go to Console Tab;
3. Select Frequency Offset;
4. Enter the offset - 106.25MHz;
5. Enjoy...

The above described process is shown on Figure 7.

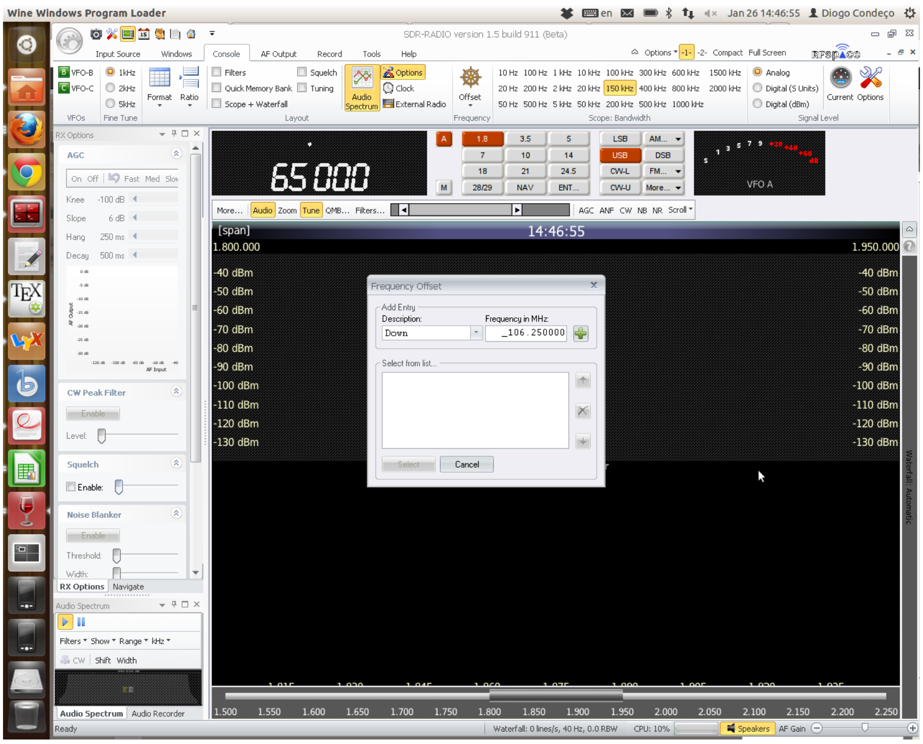

Figure 7: SDR-Radio configuration window.

5.2 HDSDR and similar

In HDSDR and similar programs you should look for the option *ExtIO LO Frequency Options*, and set it up like is shown in Figure 8.

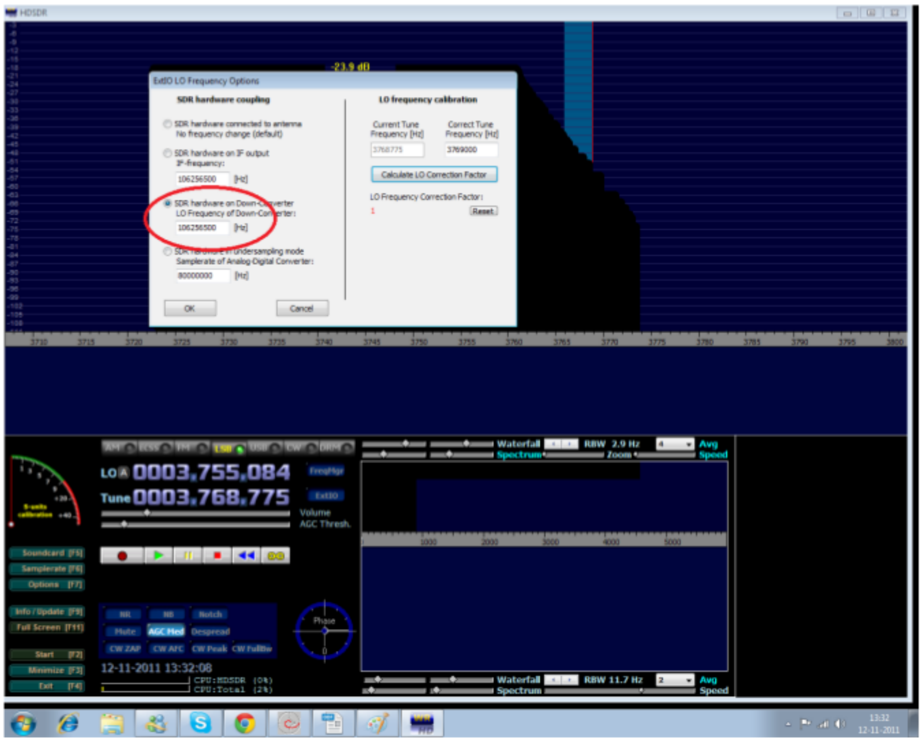

Figure 8: HDSDR and similar configuration window.