FC3 Frequency Counter

This is a project by FoxDelta Project Team
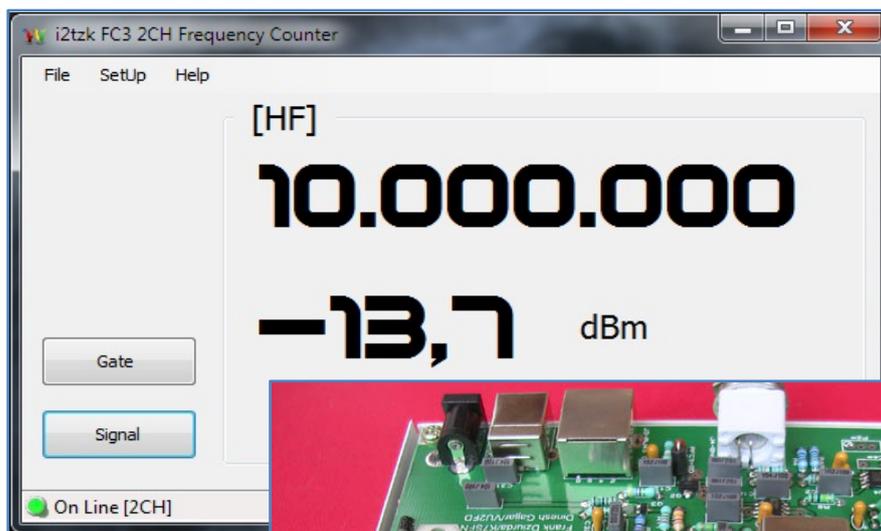
September, 2012

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1 FC3 project's notes

Fc3 is designed and developed for Radio Amateurs looking for economical frequency counter for their hobby work and wish to measure RF signal Level at the same time.

Analog Device's AD8307 is used to measure RF level very accurately in dBm, Vpp, Vpeak or Vrms.

Counter works with PC or as a stand-alone. PC Connection is auto detected and so is stand-alone mode.

Front panel push buttons are provided for RF Meter Mode and HF to VHF Frequency measurement modes.

A PC program Windows based specially designed for FC3 by Tony/I2TZK is provided for configuration of IF Off-sets and AD8307 related parameter configuration thru USB interface.

Program reflects also the LCD panel frequency readout and the two pushbutton.

Complete KIT uses AD8307, ADA4789 and MC12080 in SMT package and are supplied pre-soldered on PCB for those who do not like to solder these tiny devices.

Assembled FC3 may also be available, refer to FoxDelta web site for any detail about FC3 kit.

FC3 Frequency Counter main features are:

- USB and DC12V Powered
- Measure RF Level using AD8307
- Display signal level in dBm, Vpp, Vpeak and Vrms
- Count frequency up to 500MHZ.
- HF, VHF and autorange modes.
- 2 x 16 LCD Display with backlight control
- 50 ohms input impedance for both ranges
- Frequency "off-sets" set by PC program.
- Calibration and other parameters set by PC program

2   Modes and signal level

FC3 allows 3 operative modes:

- HF
- VHF
- AUTO

```
432.350.00
-2.8   dBm      VHF
```

```
35.650.450
-13.4 dBm      HF
```
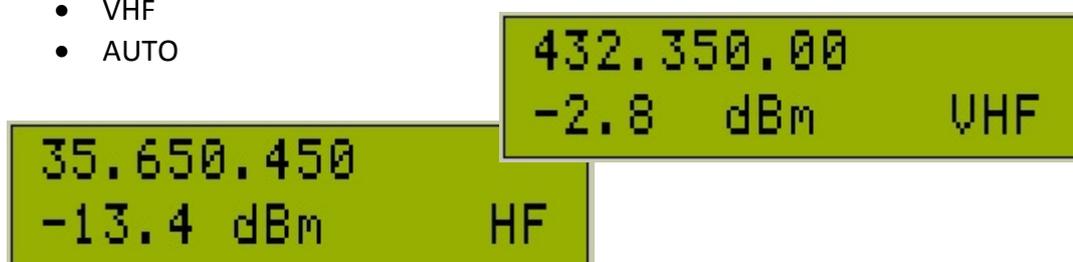
To select a mode push the right button on the
LCD front panel or click the pushbutton "Gate"
of the Windows program.

```
144.125.00   AUTO
-5.8   dBm      VHF
```

HF mode can read frequencies up to 60 MHz, VHF uses an MC12080 prescale to divide by 10
the input frequency. AUTO will automatically select, when needed, the prescale usage.

4 differents units are available to measure the input signal level:

- dBm
- Vpeak
- Vpp
- Vrms

```
25.000.000
0.0    dBm      HF
```

```
25.000.000
0.224 Vrms     HF
```

```
25.000.000
0.63   Vpp     HF
```
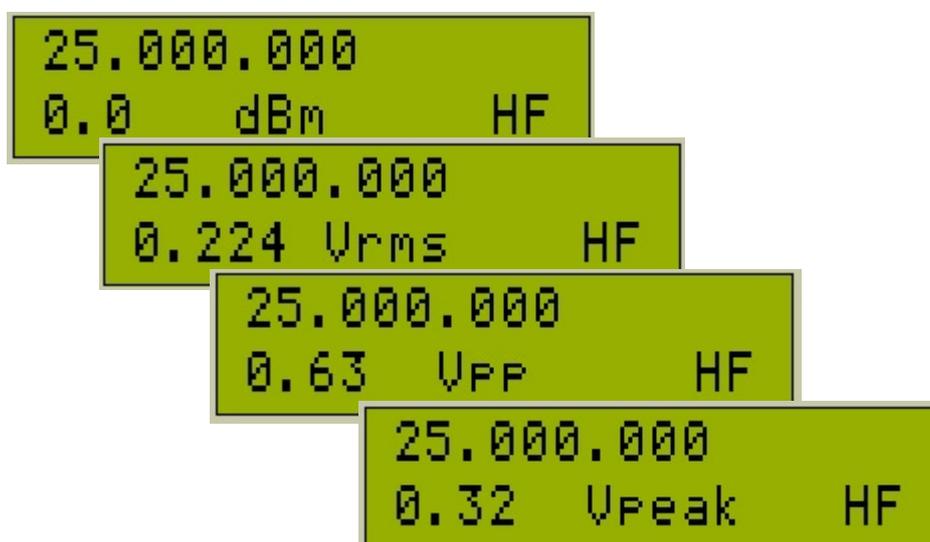
Select the unit pushing the
left button on the LCD front
panel or click the "Signal"
pushbutton of the Windows
program.

```
25.000.000
0.32   Vpeak    HF
```

3 Connect FC3 to a PC

Although FC3 can work stand-alone **without a permanent PC link**, the USB connection to the PC is needed to customize and fine calibrate the unit.

Connect FC3 to the PC using a standard USB cable (printer cable), the LCD lights on and starts to initialize.

Plugged in the cable, you should listen to the Windows announcement sound that indicates a new device has been detected and the corresponding driver is loading.

The LCD shows the sequence:

FC3 is waiting to be recognized by Windows and needed drivers are installed.

Windows is searching drivers
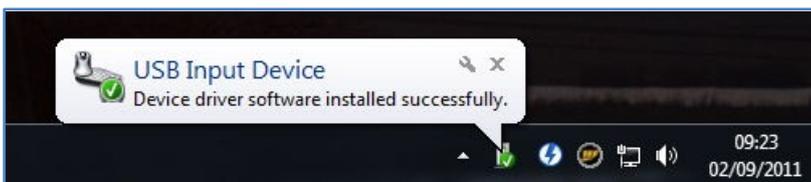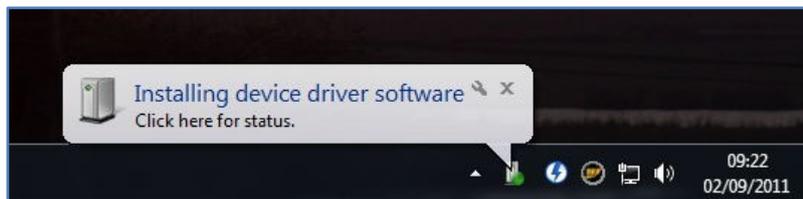
Driver successfully found and installed

After a while, as soon as Windows has installed the drivers, the LCD will show the message "ON LINE".

FC3 now is ready to be linked by the PC program. **This operation can take several seconds** depending on the time needed by Windows to find the right drivers.

If this is the first time you attach this device, Windows will start to search and install the required drivers. To communicate with Windows, FC3 uses the USB port embedded into the microcontroller PIC18F4550, so **drivers are the standard ones developed by Microchip and Windows Microsoft.**
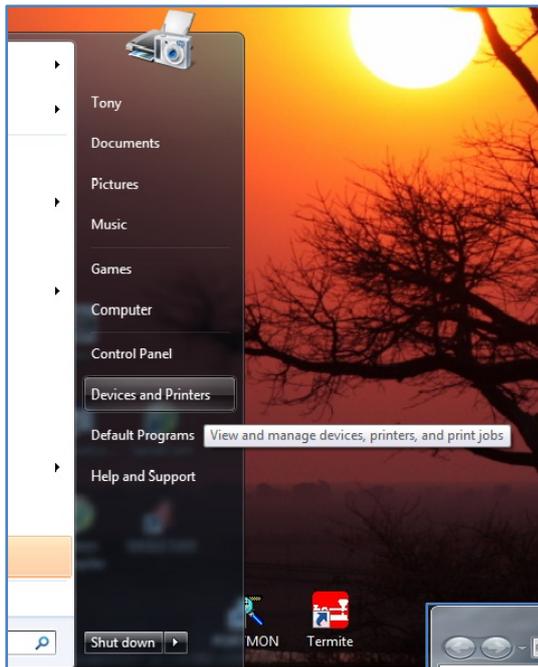
Driver installed can be verified selecting "Device and Printers" from the "Start" menu or from the "Control Panel" (pictures refer to Windows7).
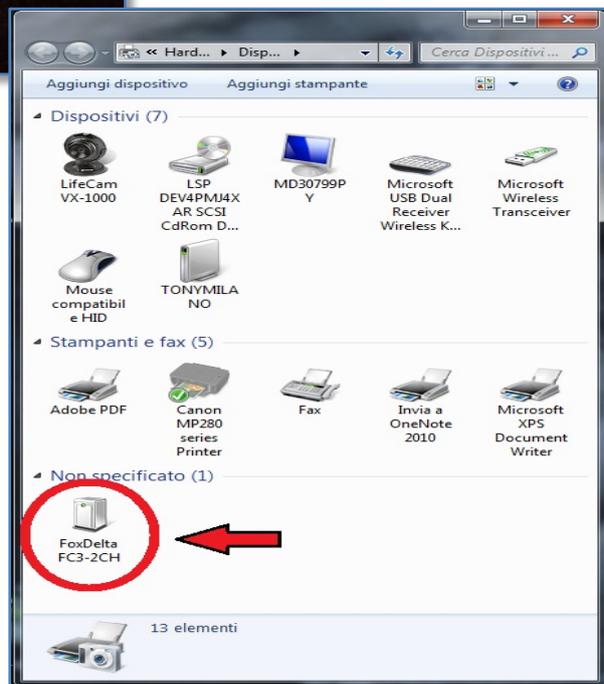
4   Running Stand Alone

Although FC3 can work without a permanent PC link, the USB connection to the PC is needed to customize and fine calibrate the unit.

Stand-alone mode is automatically select powering the FC3 at 12V and NO USB cable.

If the unit is powered from the USB connector, stand-alone can be forced just pushing any button during the USB initialization time.

```
FC3_2CH    i2tzk
USB INIT  v02.03
```

```
FC3_2CH    i2tzk
STD ALONE v02.03
```

5   Launch the PC program

The software application doesn't need any installation procedure, just create a new folder and copy there the file "FC3.exe" you've downloaded from the FoxDelta server.

To launch the program, navigate to this folder and DoubleClick "FC3.exe".

For your convenience you can create a link to the desktop right clicking on "FC3.exe" and selecting "Send to Desktop".
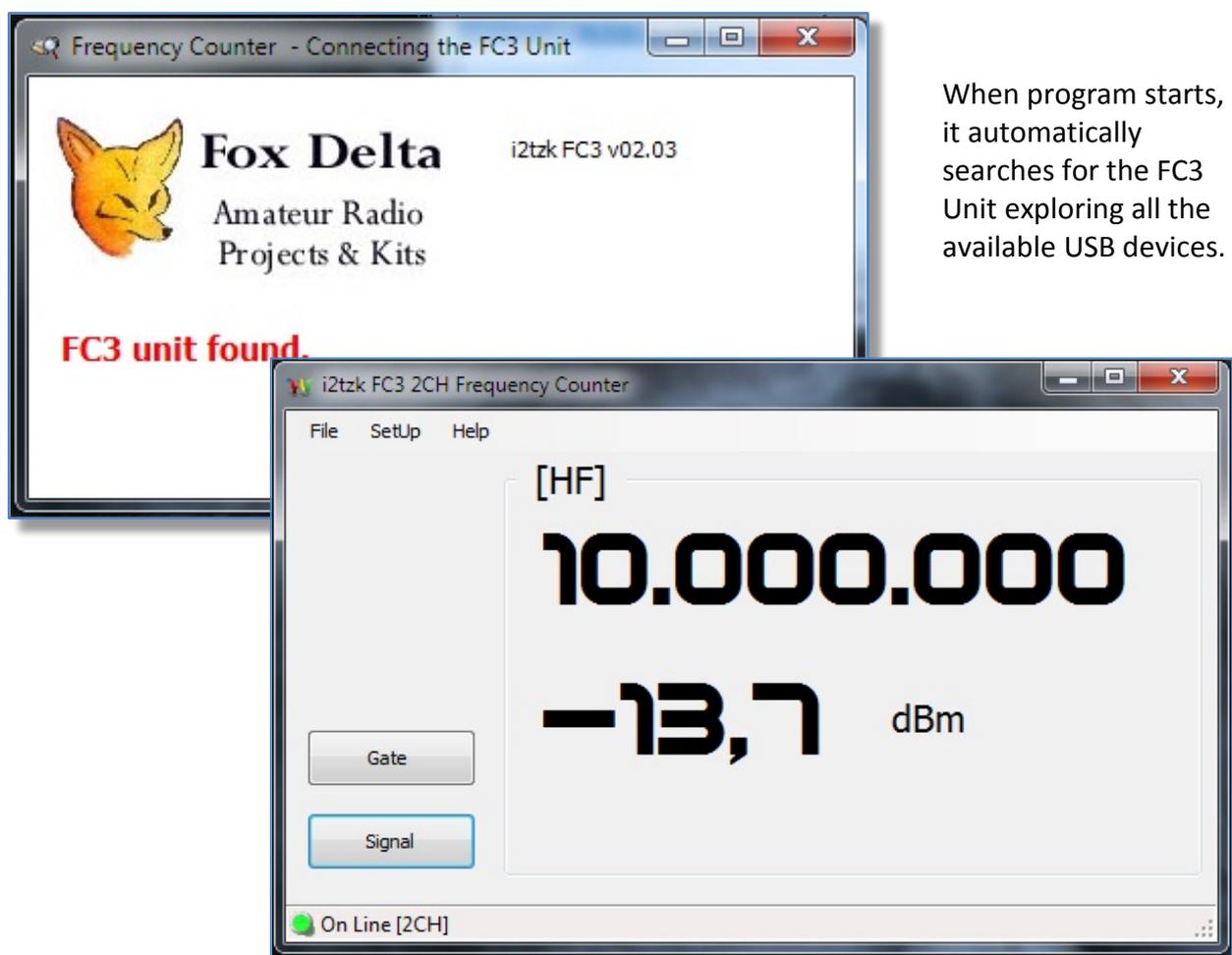
When program starts, it automatically searches for the FC3 Unit exploring all the available USB devices.

When the board has been found, the main screen is presented.

6 Personalization and Calibration

Default FC3 parameters allow to run a quite precise frequency measurement, nevertheless hardware tolerances can be compensate by an accurate fine tune process.

Select the menu "SetUp" to access the calibration and customization routines.
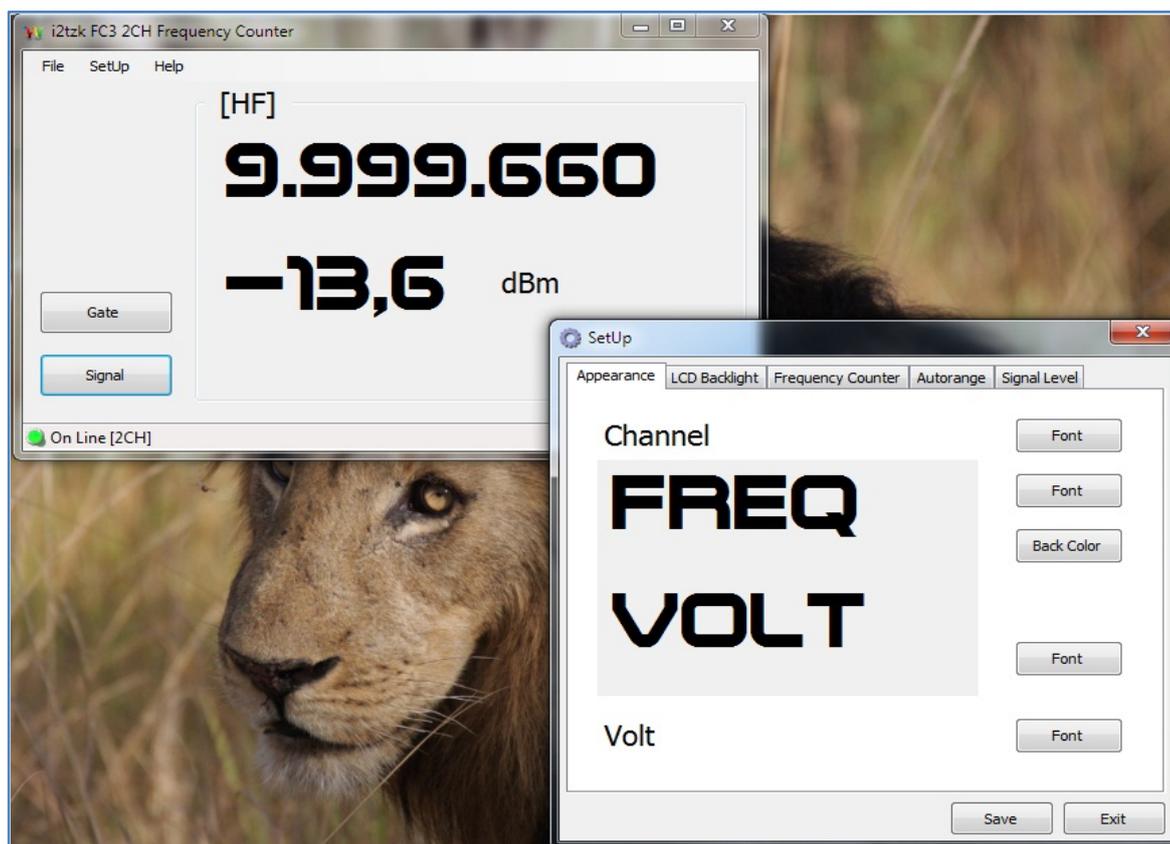
6.1 Appearance
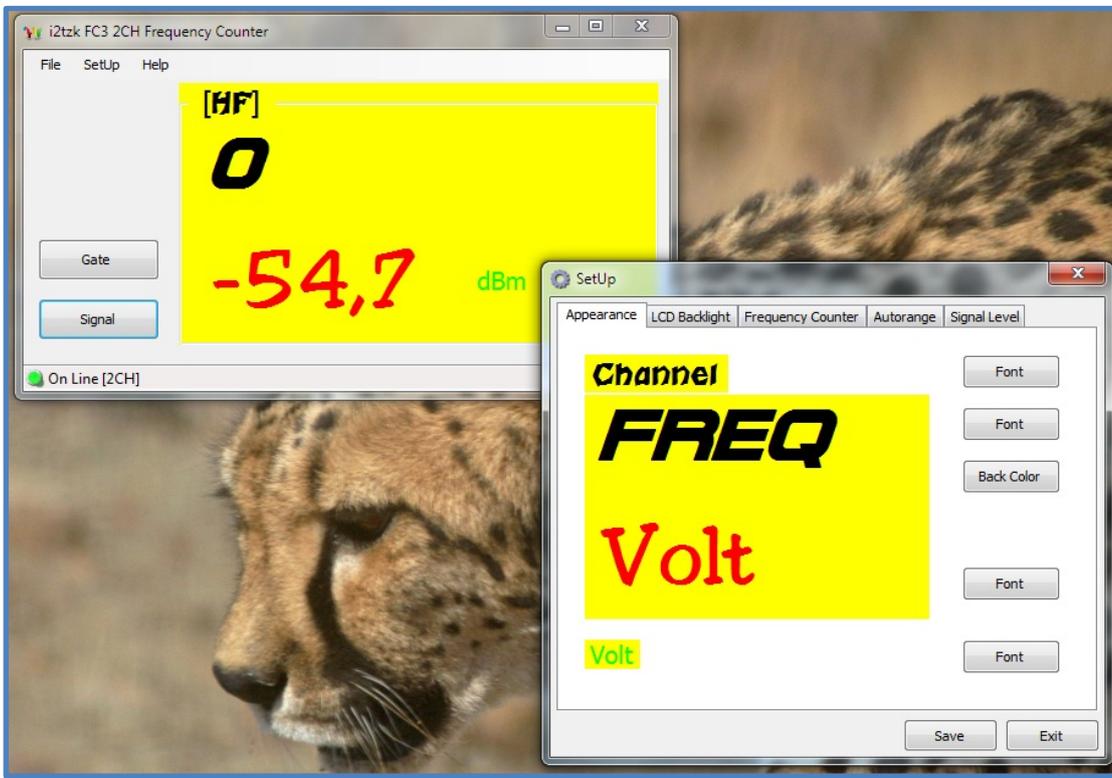
Don't forget to click "Save" to store the new parameters.

6.2 LCD Backlight
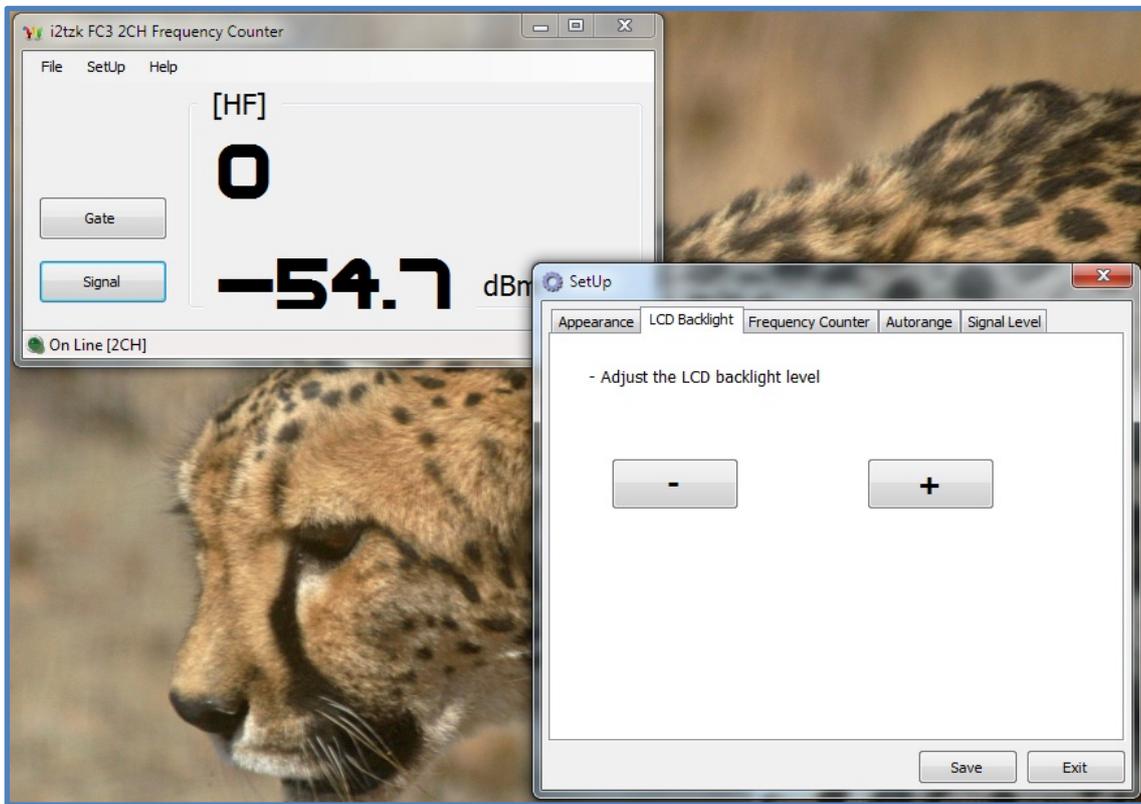
6.3 Frequency Counter and Offsets

The FC3 time base is driven by a crystal oscillator, the frequency generated is stable and precise, generally speaking it is no necessary any adjustment, nevertheless a fine tune is always possible.

To calibrate the FC3 local oscillator a **very stable and precise clock reference** like a Rubidium or a GPS conditioned oscillator is required.

Connected FC3 to PC, launch the FC3.exe program, select the menu "SetUp" and the tab "Frequency Counter".

Connect the generator and enter in fields "fine" and "large" the values needed to adjust the FC3 reading to the reference frequency.
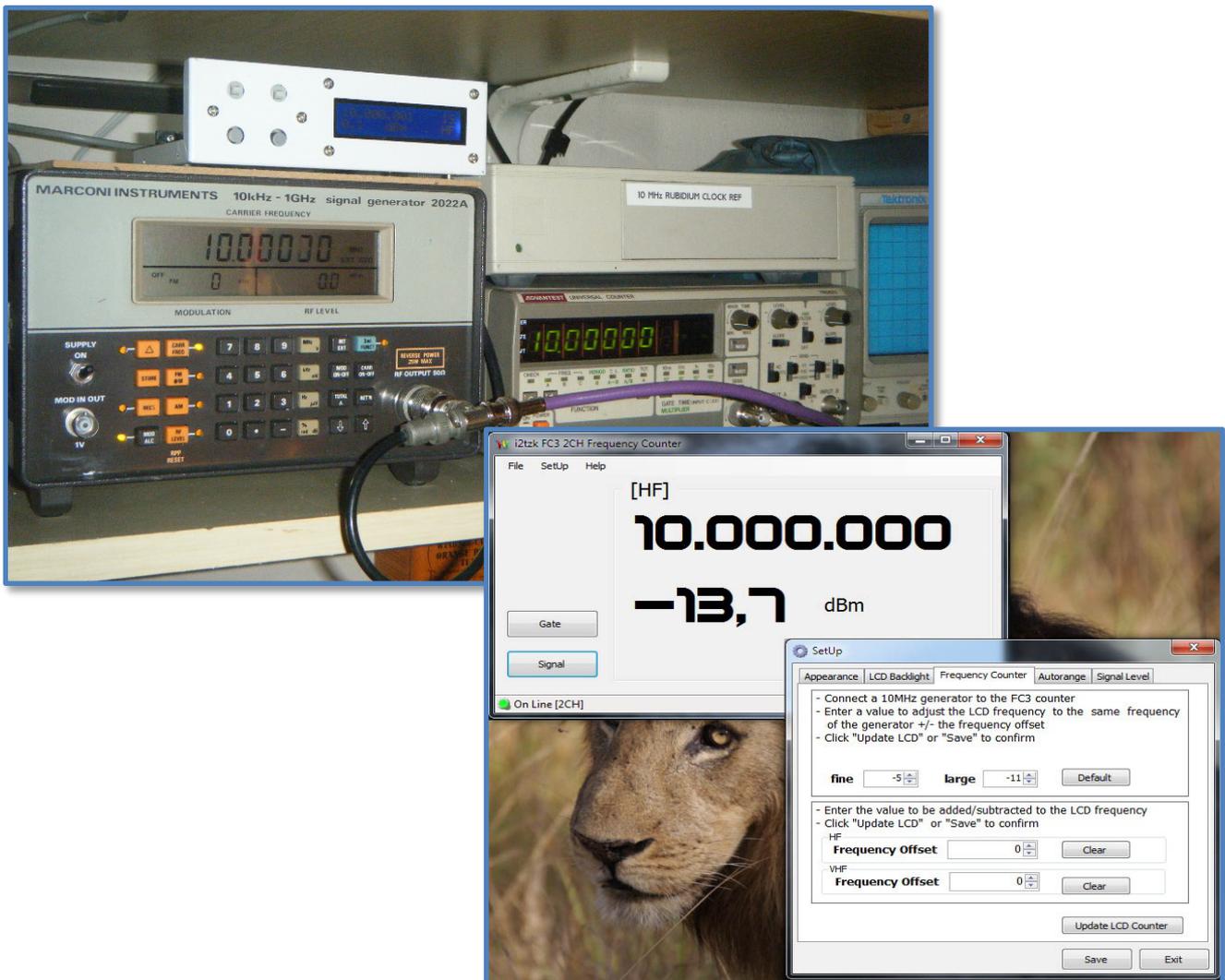
Two offsets are available for HF and VHF channels.

Enter in fields "HF Frequency Offset" and "VHF Frequency Offset" the values (positive or negative) you want to add to the readout frequency when the HF or the VHF channel is selected.

Don't forget to click "Update LCD" to store into the FC3 memory the new parameters.

6.4   Autorange
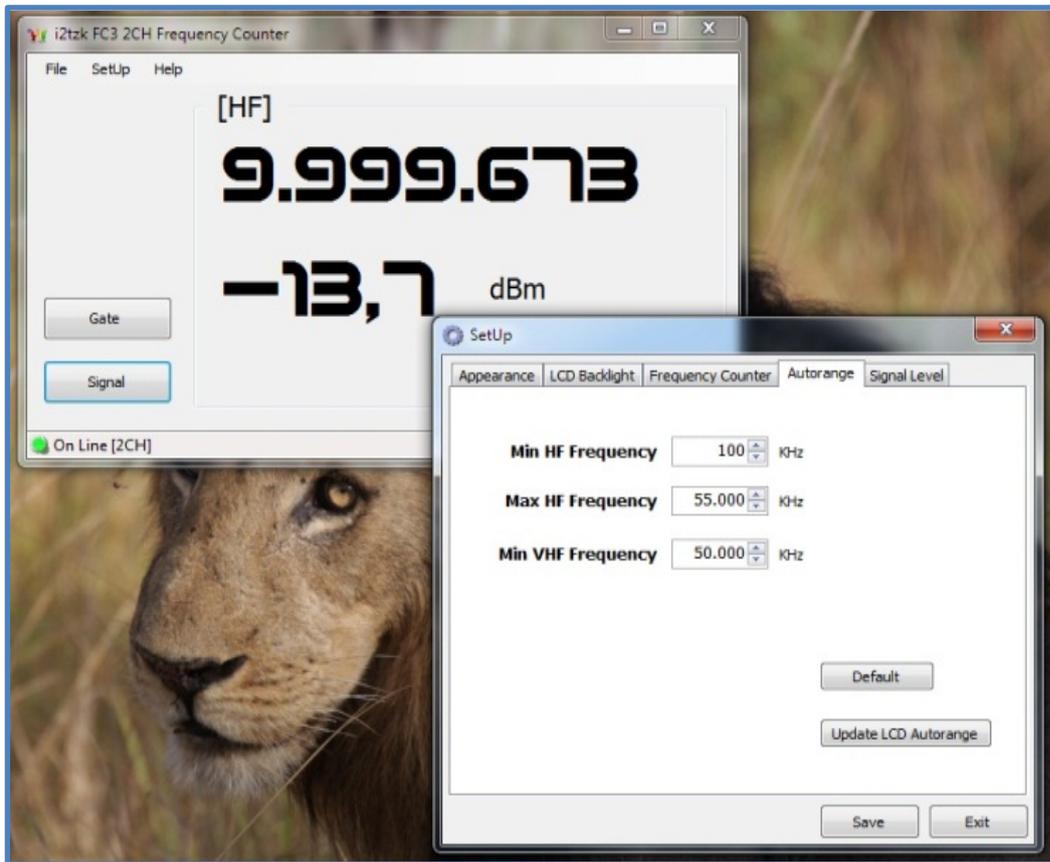
Don't forget to click "Update LCD" to store into the FC3 memory the new Autorange limits

6.5   Signal level

The input frequency amplitude is measured by the Analog AD8307 device configured as detector/differential comparator, this provide a very precise conversion of input signal level to decibel form.

The measure is automatically adjusted to take in count tolerances and errors due to the front end stage.

The methodology used is the simple linear regression analysis, the offset to by applied to signal level, is computed by interpolating the values stored by the table "Frequency / 0dB".

Generally speaking it is no necessary any table adjustment, nevertheless a fine tune is always possible.
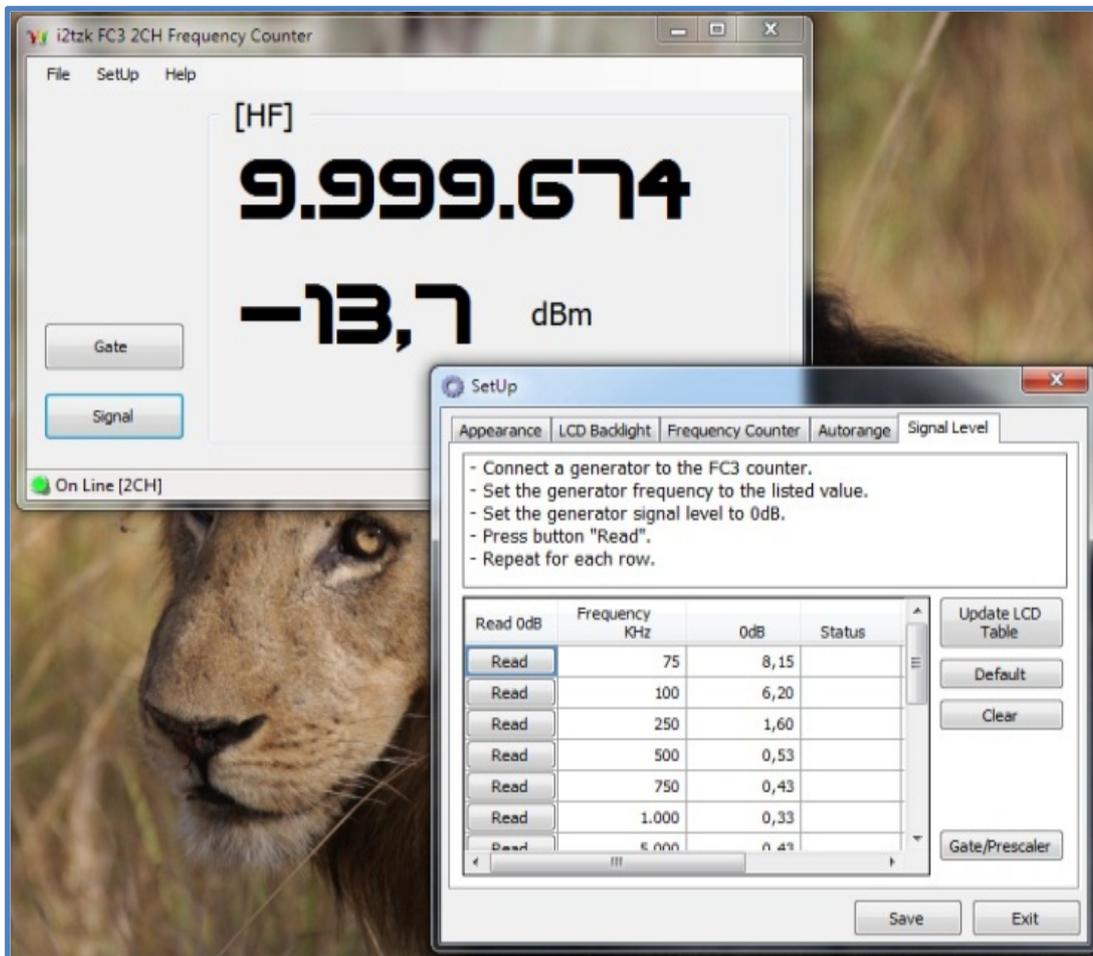
Revising the table values require **to accurately measure the level of signal applied to FC3 input**.

Connected FC3 to PC, launch the FC3.exe program, select the menu "SetUp" and tab "Frequency Counter".

Connect the generator to the FC3 input, set the frequency to the value you want to fine tune (example 1 MHz in the picture) and, *very important, adjust the level to 0dB.*
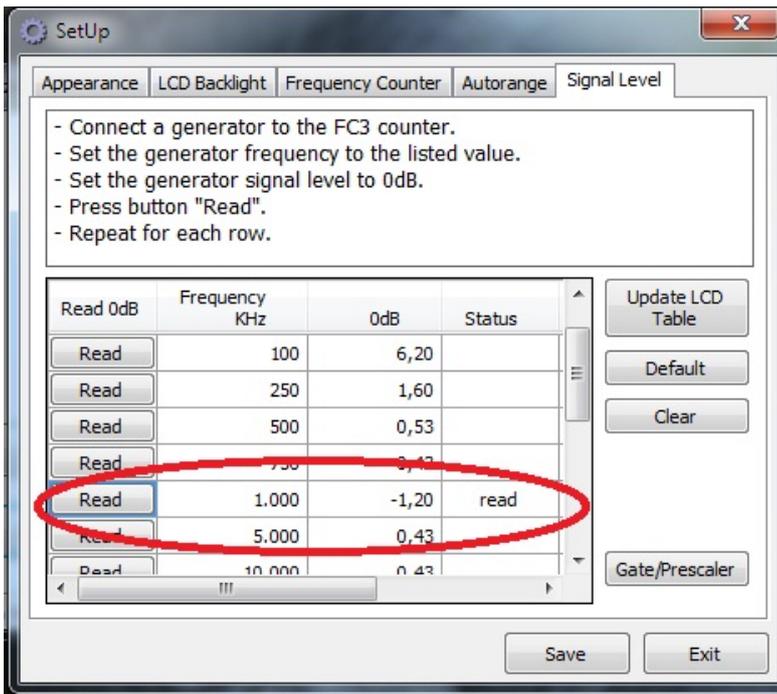
Push the button "Read" next to frequency, FC3 will read the level of the input signal and will use this value as offset.

In column "Status" the label "read" indicates that the 0dB level has been properly read.

Don't forget to click "Update LCD" to store into the FC3 pic memory the new calibration table.