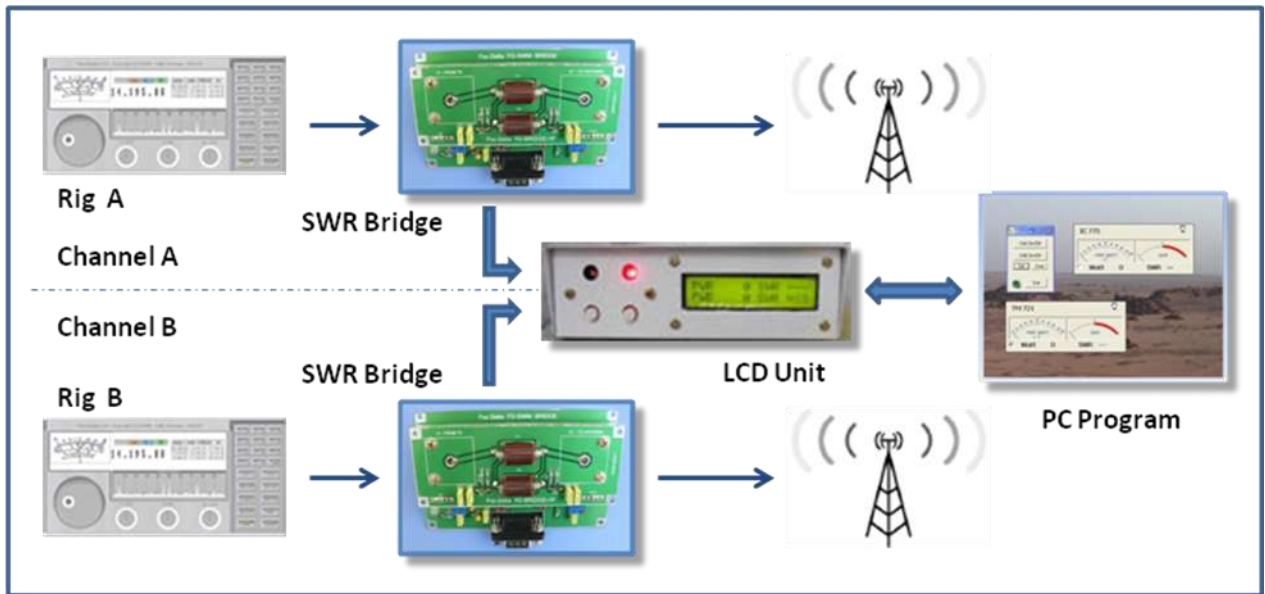


# ***2 Channels Watt & SWR Meter***

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## 1. 2ChWattMeter: The Architecture

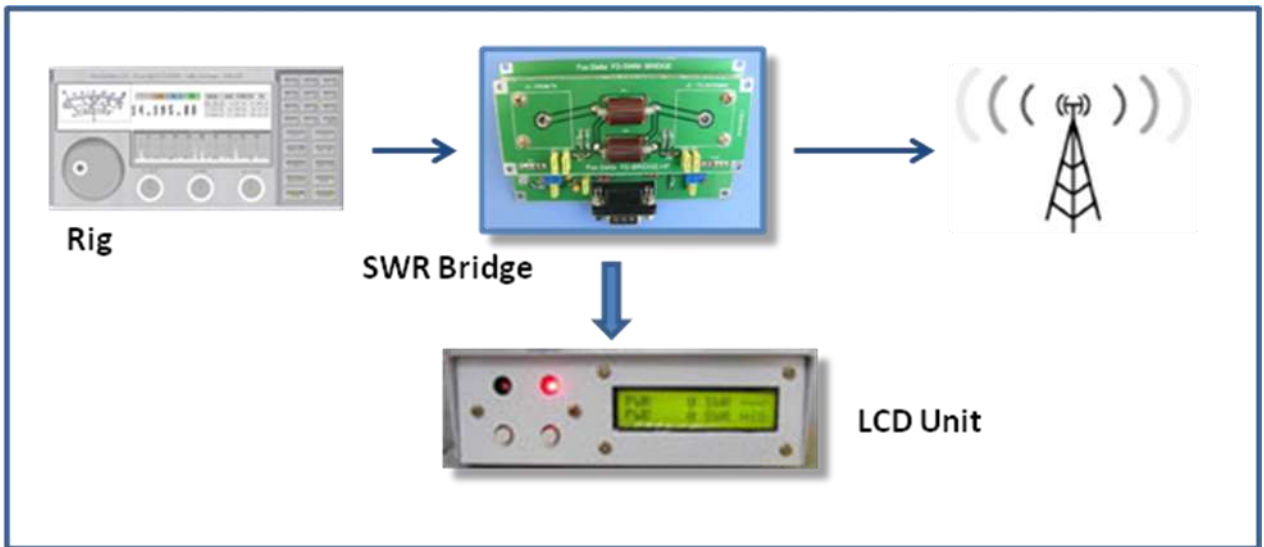
The Two Channels Watt & SWR Meter project has the following architecture:



The components are:

- LCD Unit
- 2 SWR bridges
- PC program (Windows based)

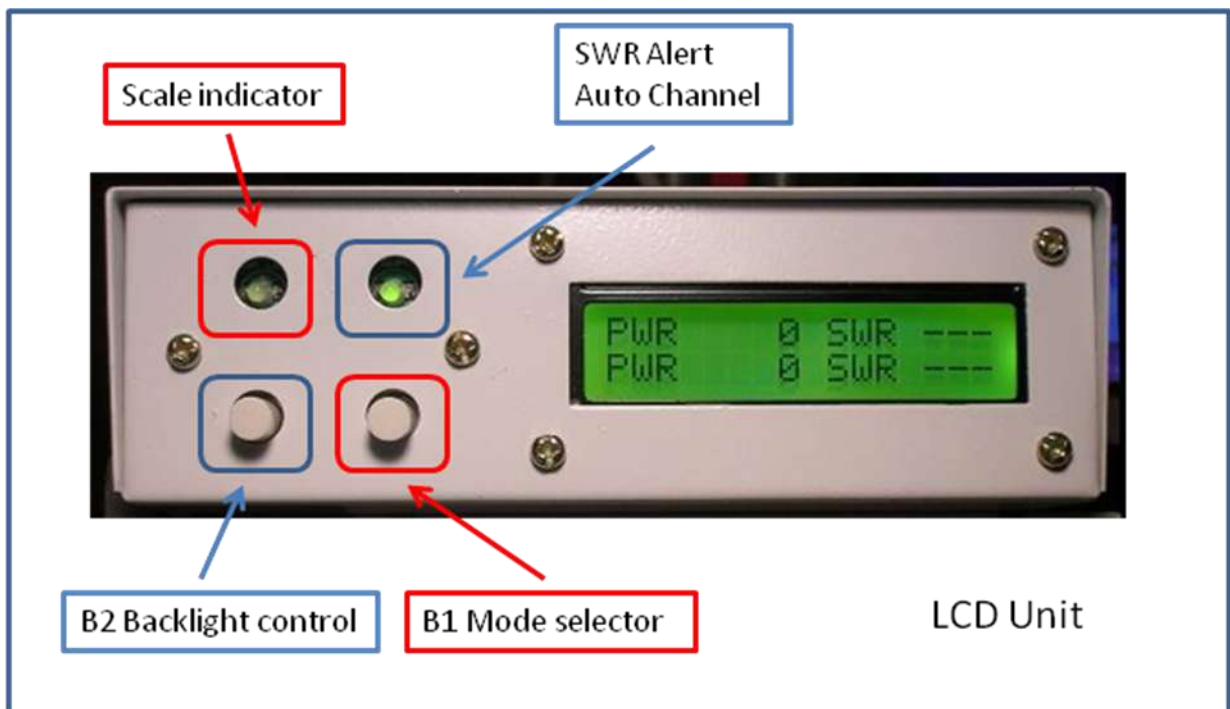
The 2ChWattMeter can be used also as stand-alone unit with a single SWR bridge.

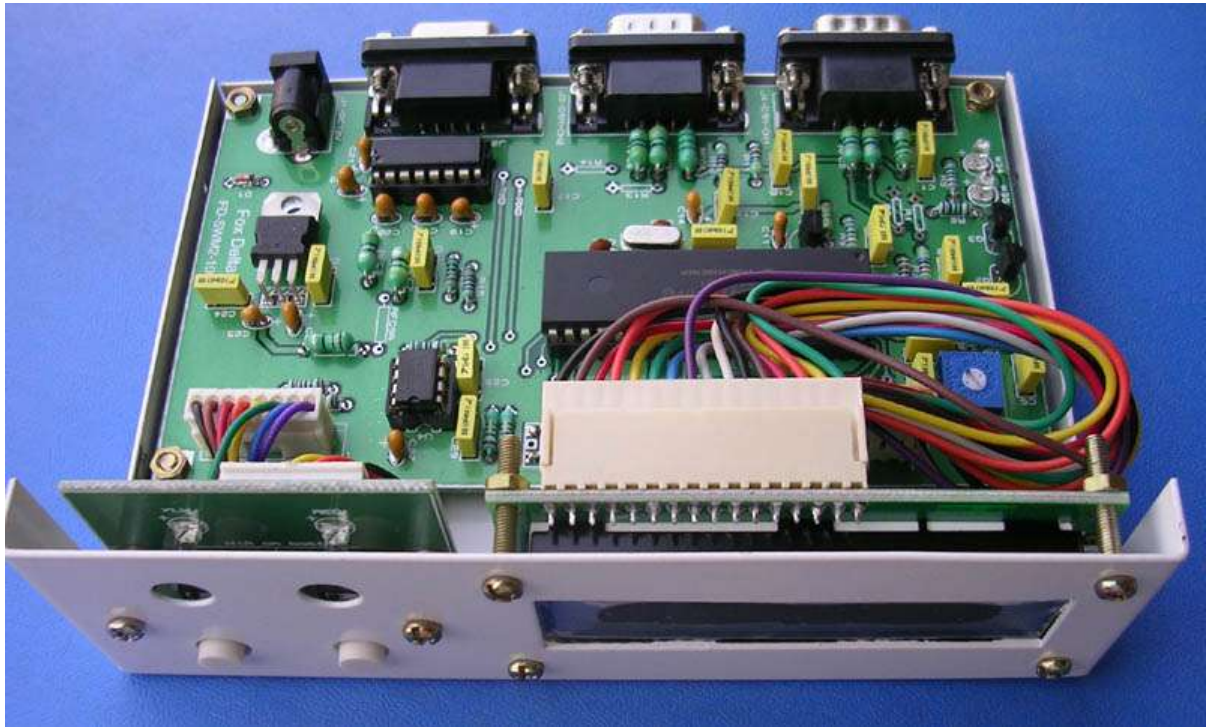


## 2.1 LCD Unit

The main features of the LCD Unit are:

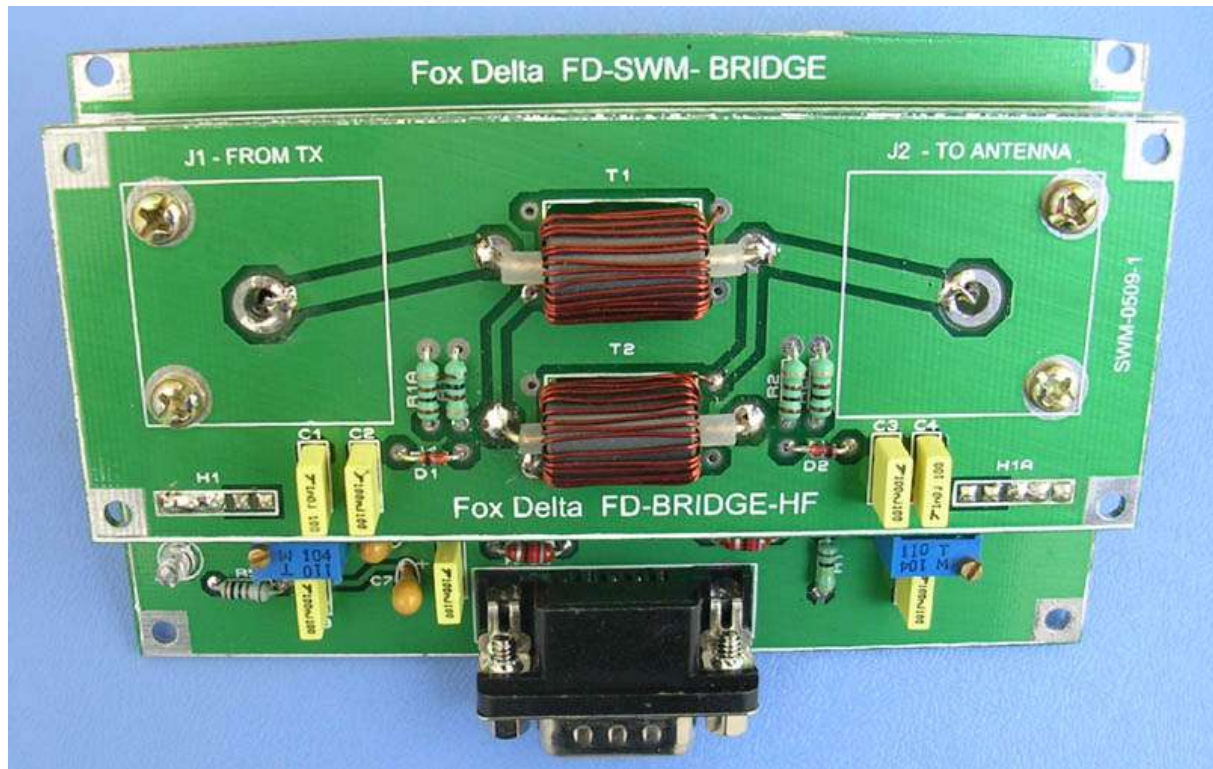
- Simple single Micro Controller with built-in A/D converter.
- 4 A/D 10 bits channels driven by 2 SWR Bridges.
- RS232 port to communicate with the PC at 115200Bauds.
- Back light controlled by steps.
- SWR, FWD and REF Power , Actual Power to antenna calculations/display for 2 Radios .
- Dual Range Bargraph mode for average and PEP Forward Power .
- Compact Design.
- May be powered from DC9V battery or 12V DC.
- Led to alert when high SWR level is detected.
- Led stating the auto channel selection operative mode.
- 2 power scales for each channel, selection based on the SWR Bridge calibration.
- Fully configurable from the PC Program .
- New f/w releases updated from the PC without need of any external PIC programmer.
- Almost real time data exchange via the serial port to replicate on the PC screen the LCD values.
- Data collection for further PC analysis





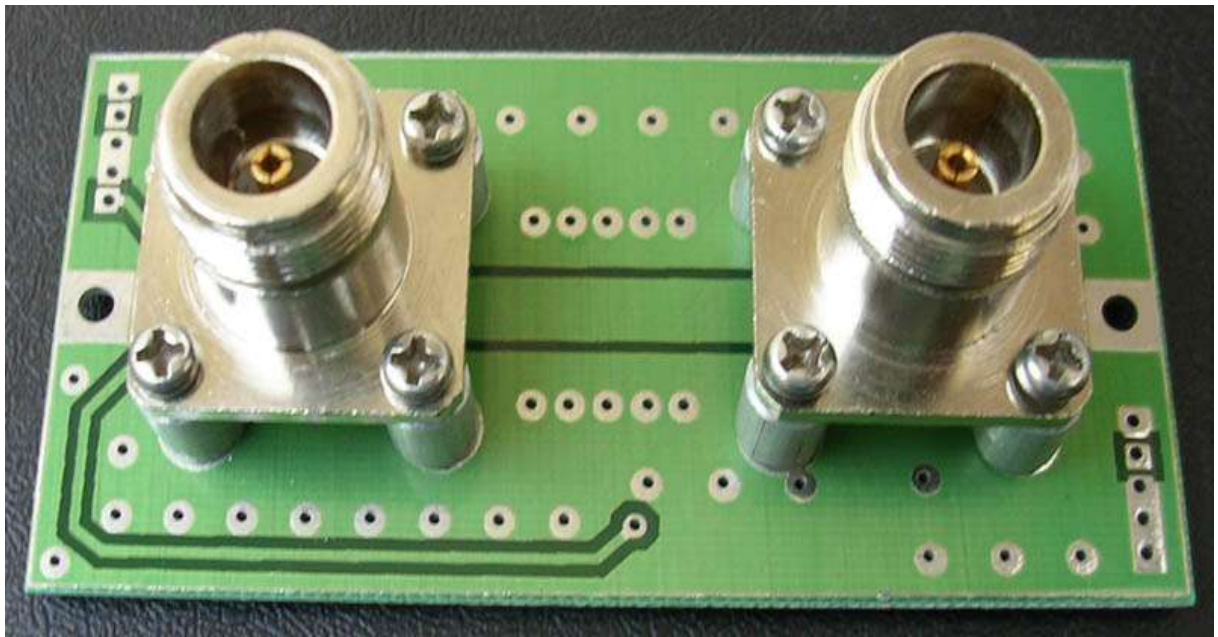
## 2.2 SWR Bridge

HF Bridge



VHF Bridge



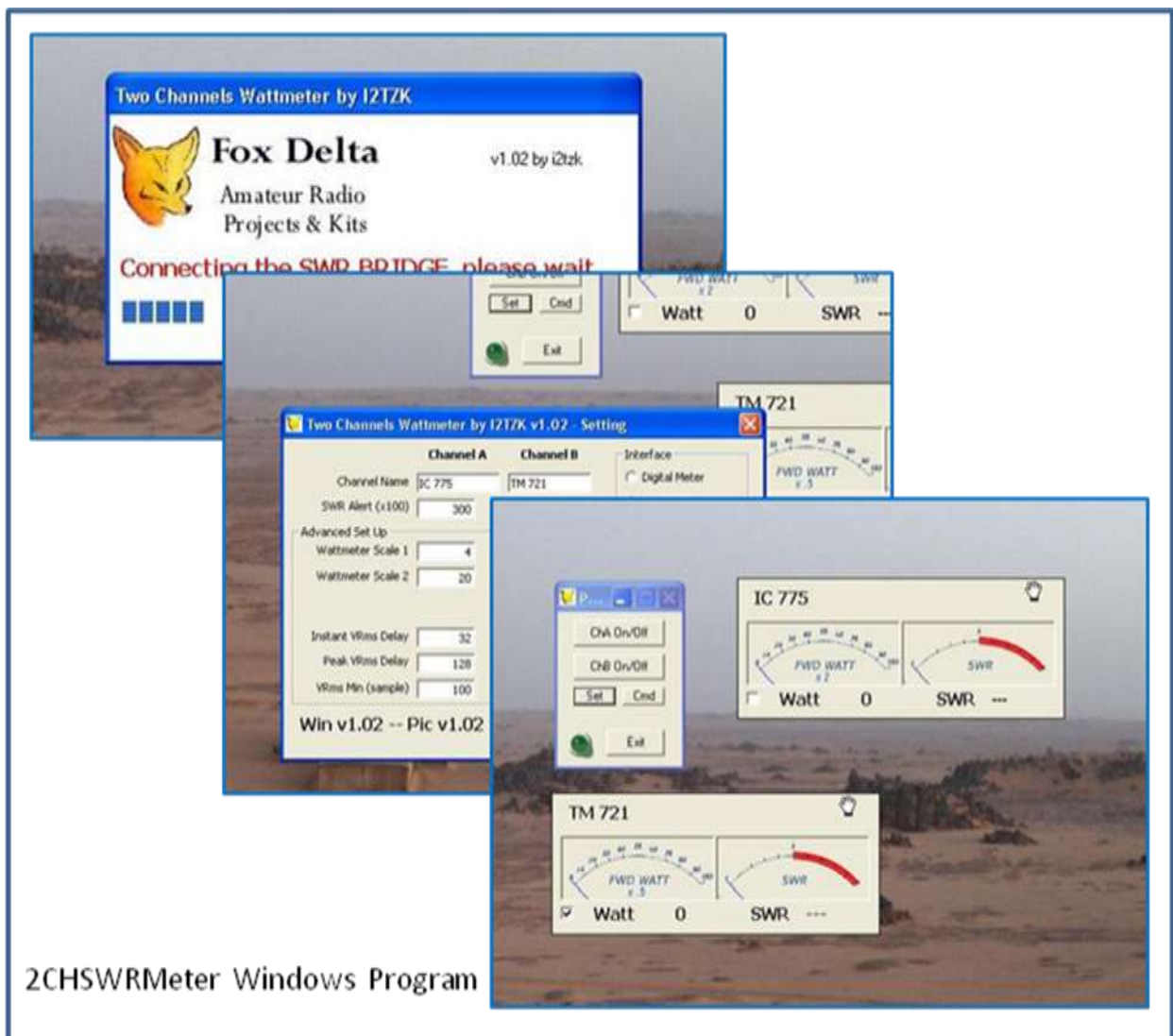


## 2.3 WINDOW BASED PROGRAM

2ChWattMeter.exe is a PC Windows Program written to connect the PC to the LCD Unit, exchange data and send commands.

The program's main features of are:

- Simple detection of the port where the LCD Unit is connected.
- Graphic interface to display data read from the LCD Unit: Digital and Analog Meter, Compact and Test window.
- Emulate the buttons of the LCD Unit and send relevant commands to switch the unit to any operative mode.
- Configure the computational parameters of the LCD Unit.
- Collect data for statistical analysis





The program has been tested on WinXp SP3 environment.

## 2. LCD UNIT

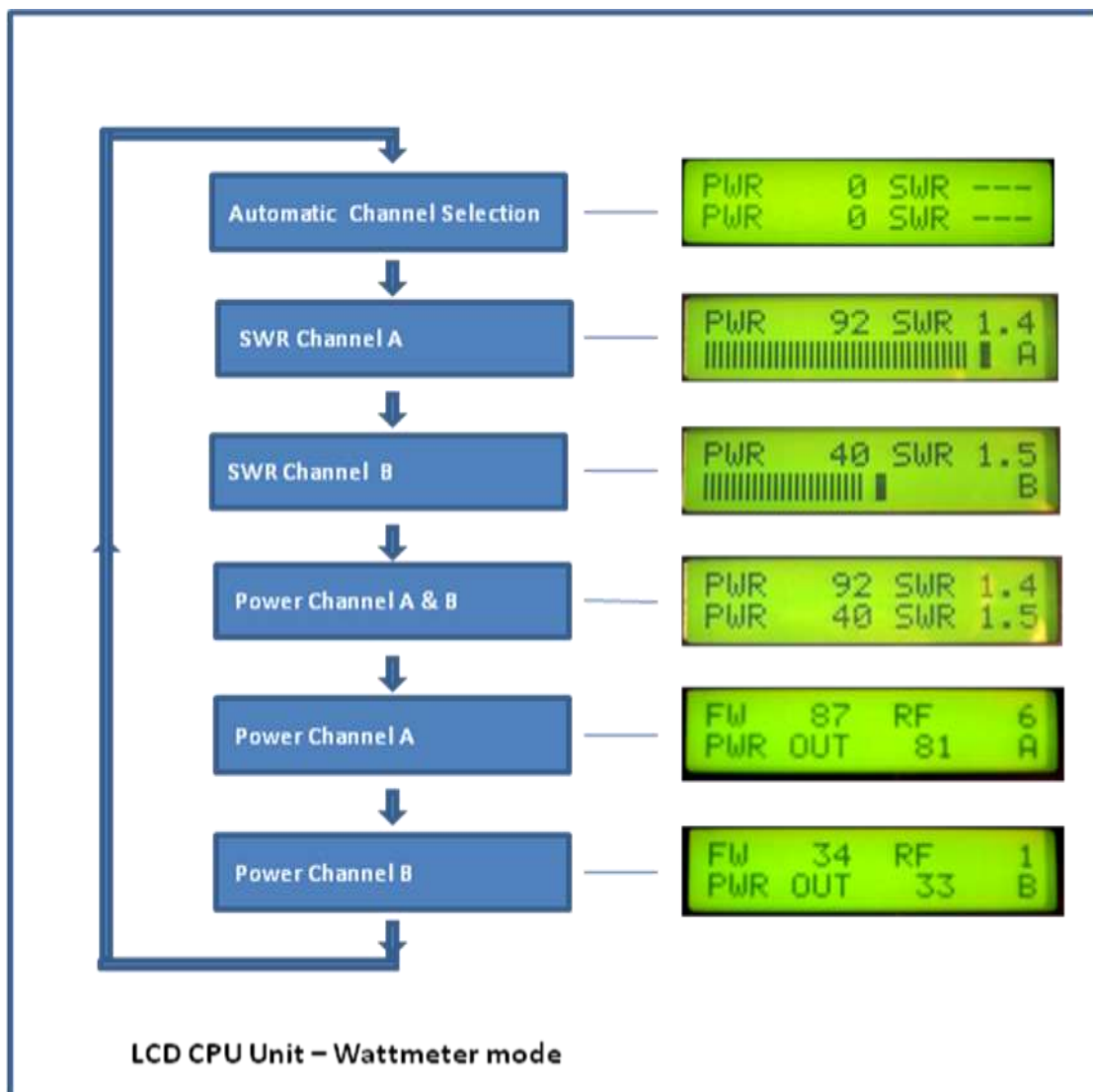
### 3.1 Operative Modes

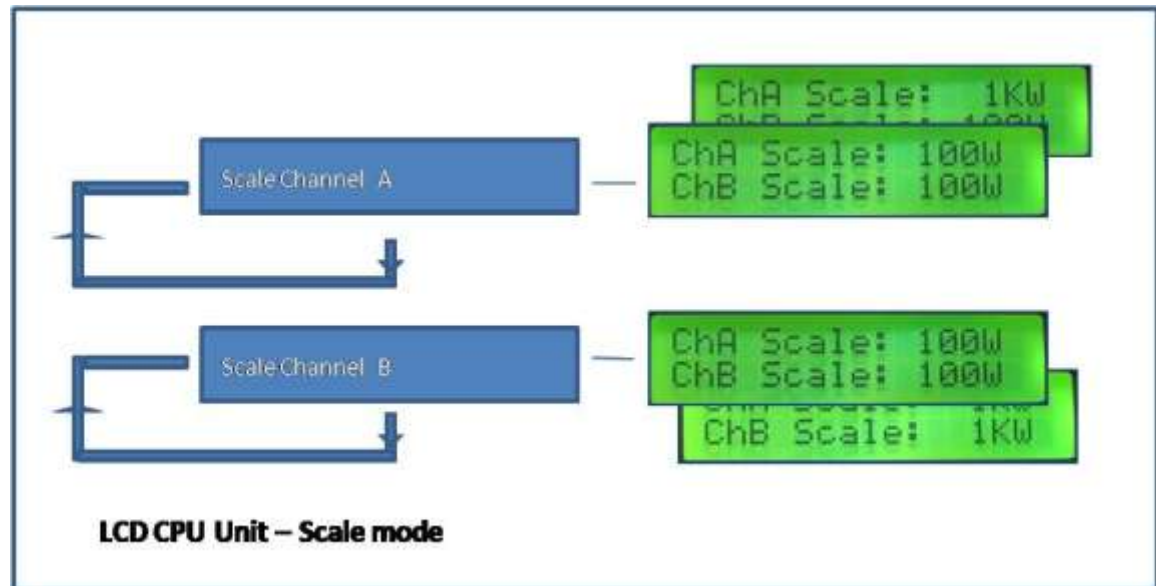
The LCD Unit offers two operative modes :

- Wattmeter mode
- Scale mode

The unit switches between the two modes by pressing button B2 for few seconds, a quick pressure on button B1 moves through the available options of the selected mode.

Mode and options currently used are stored into the non-volatile memory of the microprocessor when power is turned off restoring last operative status for the next switch on



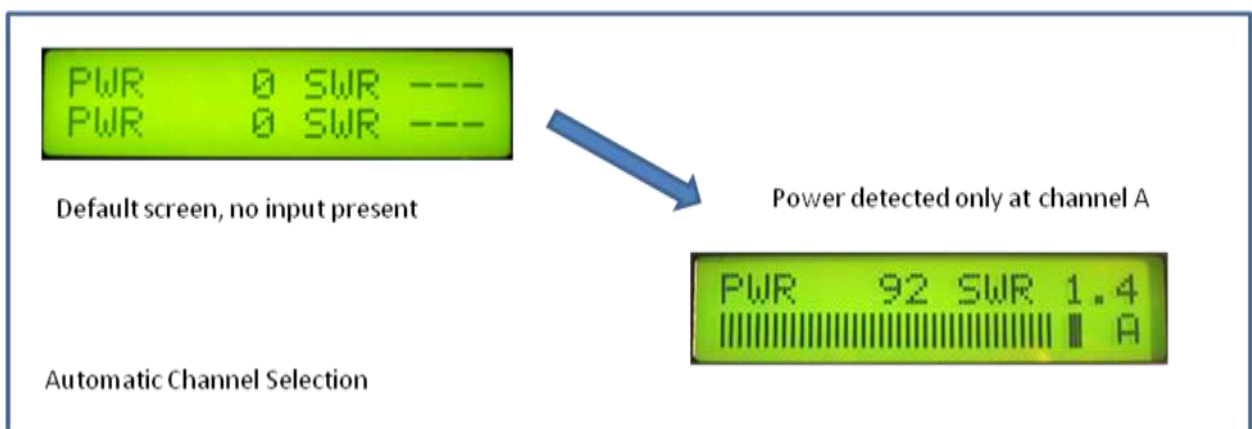


### 3.2 Wattmeter Mode: Automatic Channel Selection

The “Automatic Channel Selection” option is signaled by blinking the YELLOW Led.

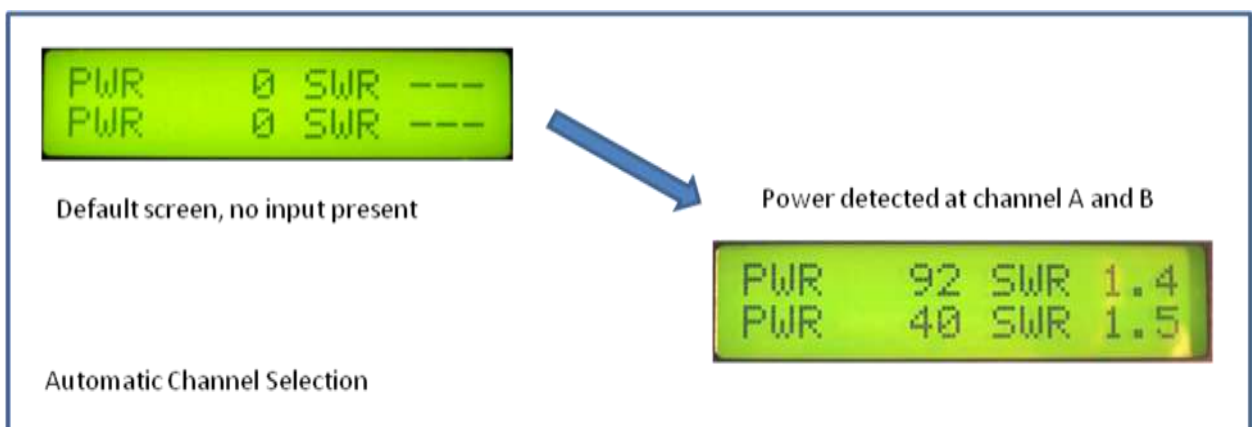
When power signal greater than the minimum level (see Configuration paragraph ) is detected as input of one channel, the unit switches from the default position to the “SWR single channel” showing the values of the active channel.

When the input returns to zero, the default screen is restored.



If power is detected on both channels at the same time, POWER and SWR levels of the two channels are presented.

Power and SWR levels are computed with the same algorithm used by “SWR mode” .



### 3.3 Wattmeter Mode: SWR Single Channel

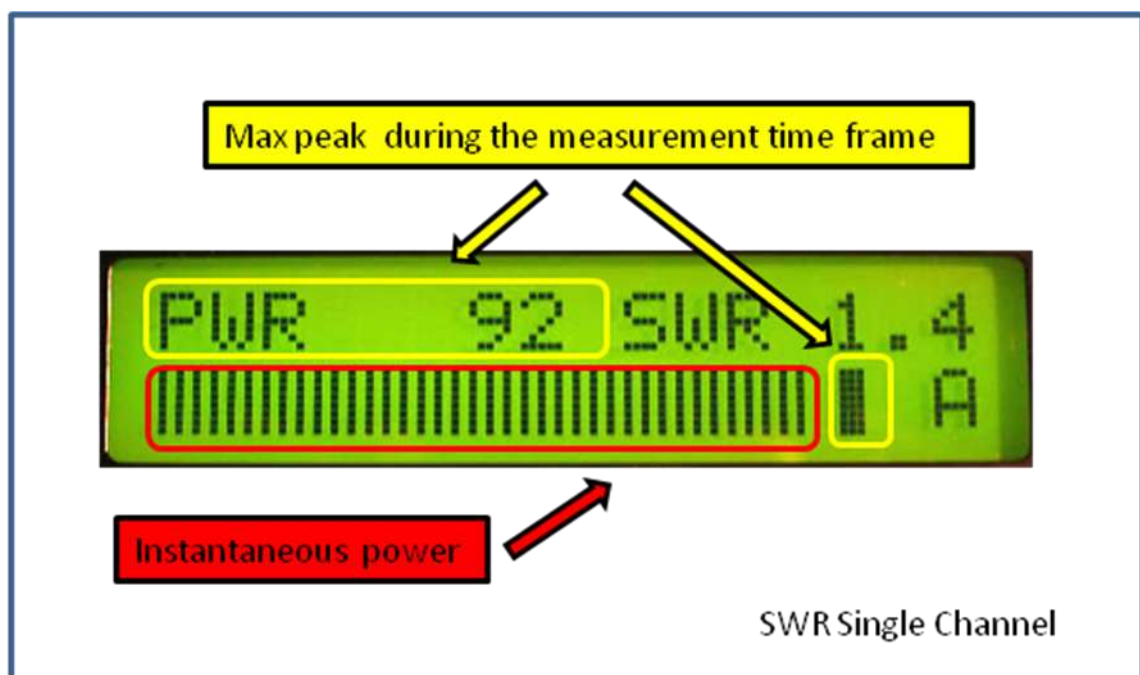
The Channel selected is shown at the bottom right position of the LCD.

The power value (PWR) is the highest value read during the measuring time frame and it is updated every 1 second by default. The second LCD row shows the instantaneous power as a digital bar graph, this reading is updated 8 times/sec.

If needed, the measuring time frame and the instantaneous power updating time can be changed (see Configuration paragraph) to obtain a more stable value also with very low or very high speed cw modulated carrier.

If the input power is less than the 25% of the full scale value, the bargraph, by default, will expand to the full scale. This allows a better measure at low power level.

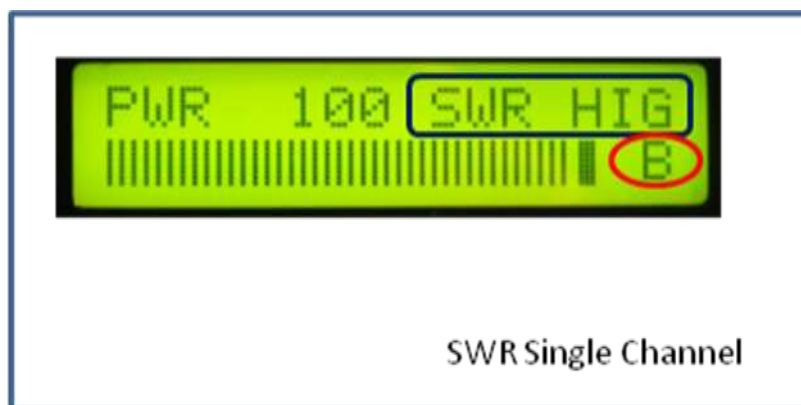
This default can be changed (see Configuration paragraph).



The SWR is computed according to the formula :  $SWR = (V_f + V_r) / (V_f - V_r)$ ,  $V_f$  and  $V_r$  are the Vrms forward and reflected voltages detected by the SWR bridge. The highest values read from the bridge during the measuring time frame are used to calculate the standing wave ratio.

An alert signal is generated by lightening the RED Led, if the SWR measured is greater than 3.0 (default value) and the symbol "HIG" is printed on the display. The alert signal refers only to the displayed channel, i.e. value of the other channel is ignored.

The alert level can be changed (see Configuration paragraph).

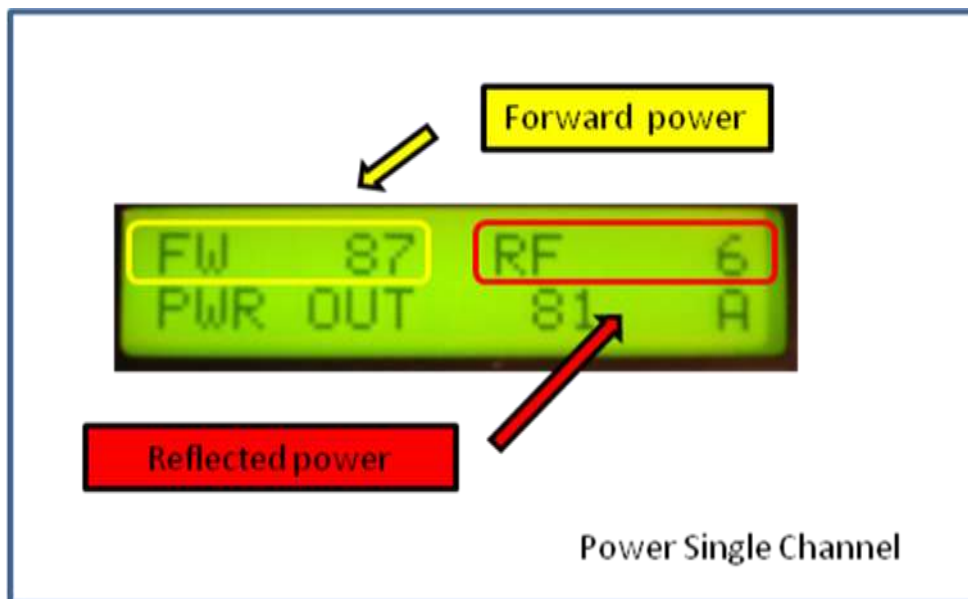




### 3.4 Wattmeter Mode: Power Single Channel

The Channel selected is shown at the right bottom position of the LCD.

The first row of the LCD presents the forward (FW) and the reflected (RF) power levels. The power value is the highest value read during the measuring time frame and it is updated every 1 second by default.



At the second LCD row, the power out (PWR OUT) figure represents the difference (FW-RF).

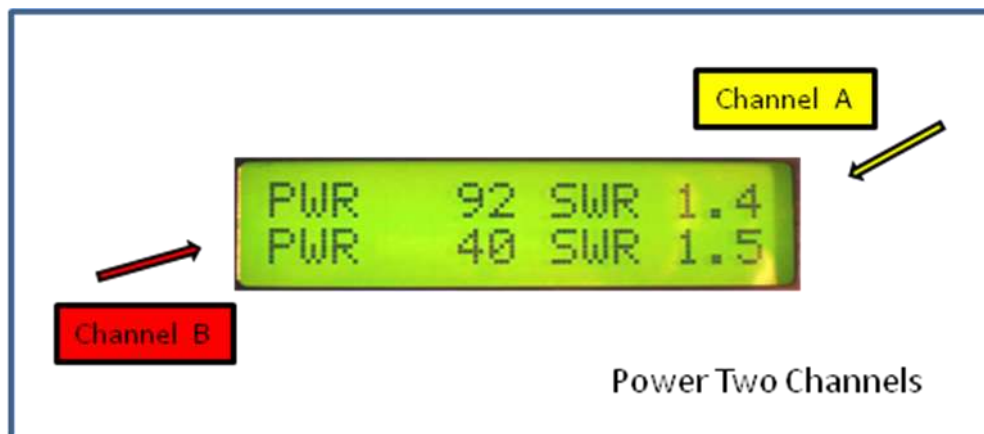
### 3.5 Wattmeter Mode: Power two Channels

The first row of the LCD presents the forward power and the SWR level at Channel A, whilst the second row refers to the Channel B. The power figures are the highest value read during the measuring time frame with a default updating interval of 1 second.

The SWR is computed according to the formula :  $SWR = (V_f + V_r) / (V_f - V_r)$ ,  $V_f$  and  $V_r$  are the  $V_{rms}$  forward and reflected voltages detected by the SWR bridge. The highest values read from the bridge during the measuring time frame are used to calculate the standing wave ratio.

An alert signal will illuminate the RED Led. If the SWR of at least one channel, is greater than 3.0 (default value) and the symbol "HIG" is presented.

The alert level of the single channel can be changed (see Configuration paragraph).



### 3.6 Scale Mode

The LCD Unit uses two full scale levels to measure the power input off each channel.

By default the two scales are initialized to 100W and 1KW, they are configurable to different values (ex. 200W / 2KW ) according with the SWR Bridge calibration . (see Configuration paragraph).

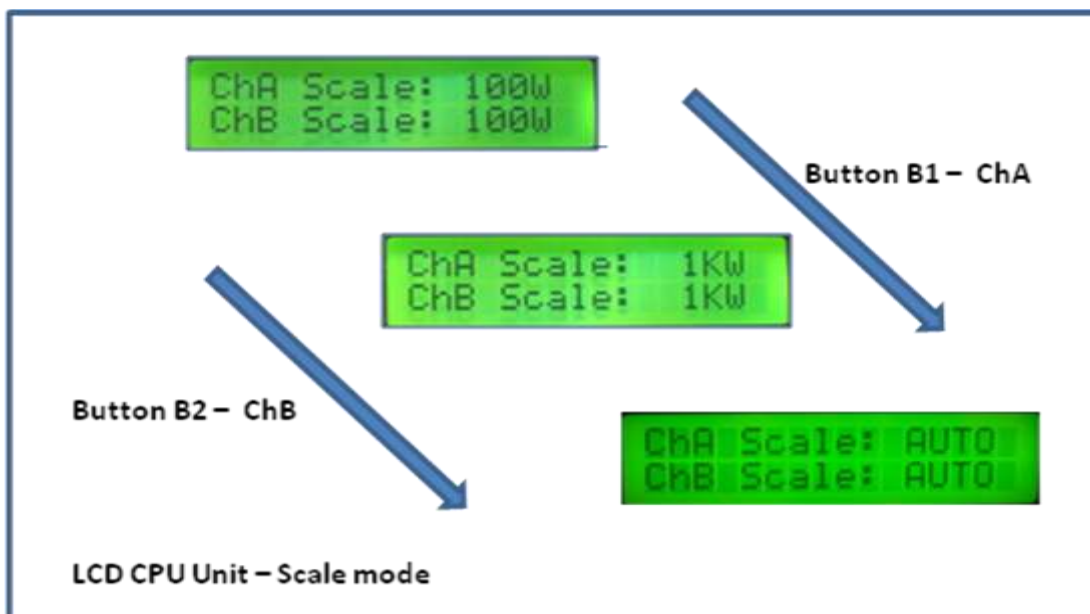
Depending on the bridge functionalities, the most appropriate scale can be selected to display the power of each Channel:

- from the window "Command" of the PC Program
- selecting the "Scale Mode" on the LCD Unit.

By default the LCD Unit forces the usage of the Scale 1 initialized at 100Watt.

The AUTO position let the wattmeter select the most appropriate scale (Scale1 or Scale2) for each channel depending on the power input.

A signal at the SWR Bridge connector indicates the scale selected.



Button B1 toggles the scales of the Channel A, B2 toggles the scales of the Channel B.

### 3.7 Backlight control

The LCD backlight level is controlled by the Button B2, 16 steps are available: at 0 the backlight is OFF , at 15 the backlight is at the max level.

## 3.8 Configuration

Most of the parameters used by the computational algorithms of the LCD Unit can be changed from the PC Program.

The default values are initialized to have a comfortable level of measurement reaching a good compromise between the need of an “almost real time” data acquisition and a stable view of the results. Nevertheless anyone can change those values to get a different level of usage .

The global parameters that can be modified are:

- Instantaneous Vrms time frame (Instant Vrms delay)
- Measuring time frame of the max higher Vrms value (Max Vrms delay)
- Minimum Vrms level to start the data acquisition (Vrms min)

The parameters related to each channel that can be modified are:

- SWR alert level
- Wattmeter Full Scale 1 and 2
- Expand Bargraph

### 3. WINDOW BASED PROGRAM

#### 4.1 2ChWattMeter program setup

The 2ChWattMeter Win program requires a very simple setup process:

- Create a folder (ex. C:\FoxDelta).
- Unzip/copy the \*.exe file in this folder.
- Optional: create a link to the desktop (right click the file 2ChWattMeter.exe, select “Send to” “Desktop”).
- Launch the program by double clicking the file name or the desktop icon.

When program starts, it automatically creates, the 2ChWattMeter.ini file containing all the default values, if the file doesn't already exist it will be created with the default values.

Then program attempts to connect the LCD Unit.

Please be sure :

- The serial cable is properly connected to the LCD Unit and the PC.
- The right serial port has been selected.
- The LCD Unit is powered ON.



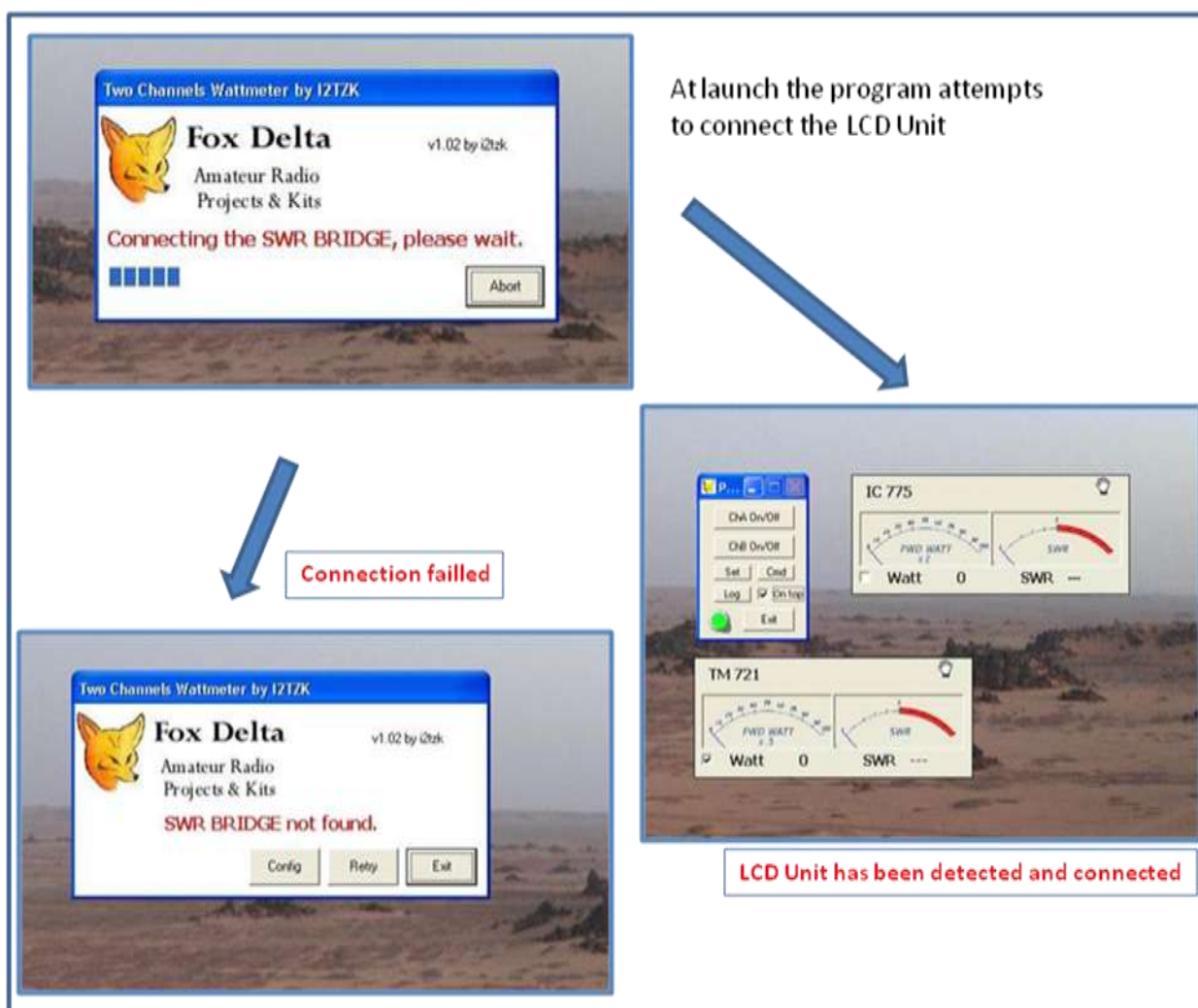
## 4.2 Running the program

Before launching the 2ChWattMeter program, please verify that:

- The serial cable is properly connected to the LCD Unit and the PC.
- The right serial port has been selected (by default COM1 is selected).
- The LCD Unit is powered ON.

When program starts it attempts to connect the LCD Unit on the last used serial port.

If the LCD Unit is detected, the program reads from the Unit the configuration parameters used by the computational Power/SWR algorithms, then the last used graphical interface is selected.



If the LCD Unit detection fails, three options are available :

- Exit: terminate the program.
- Retry: before retrying double check that the cable LCD Unit <-> PC is working properly , the right PC Serial port has been selected and the unit is powered on.
- Config: verify / change the current port selection.

To change/verify the port selection, click the button “Config” then the button “START”, the list of the available active ports is generated.

Click the icon related to the port you want to select or enter the port number next to the label “Current selected port”.

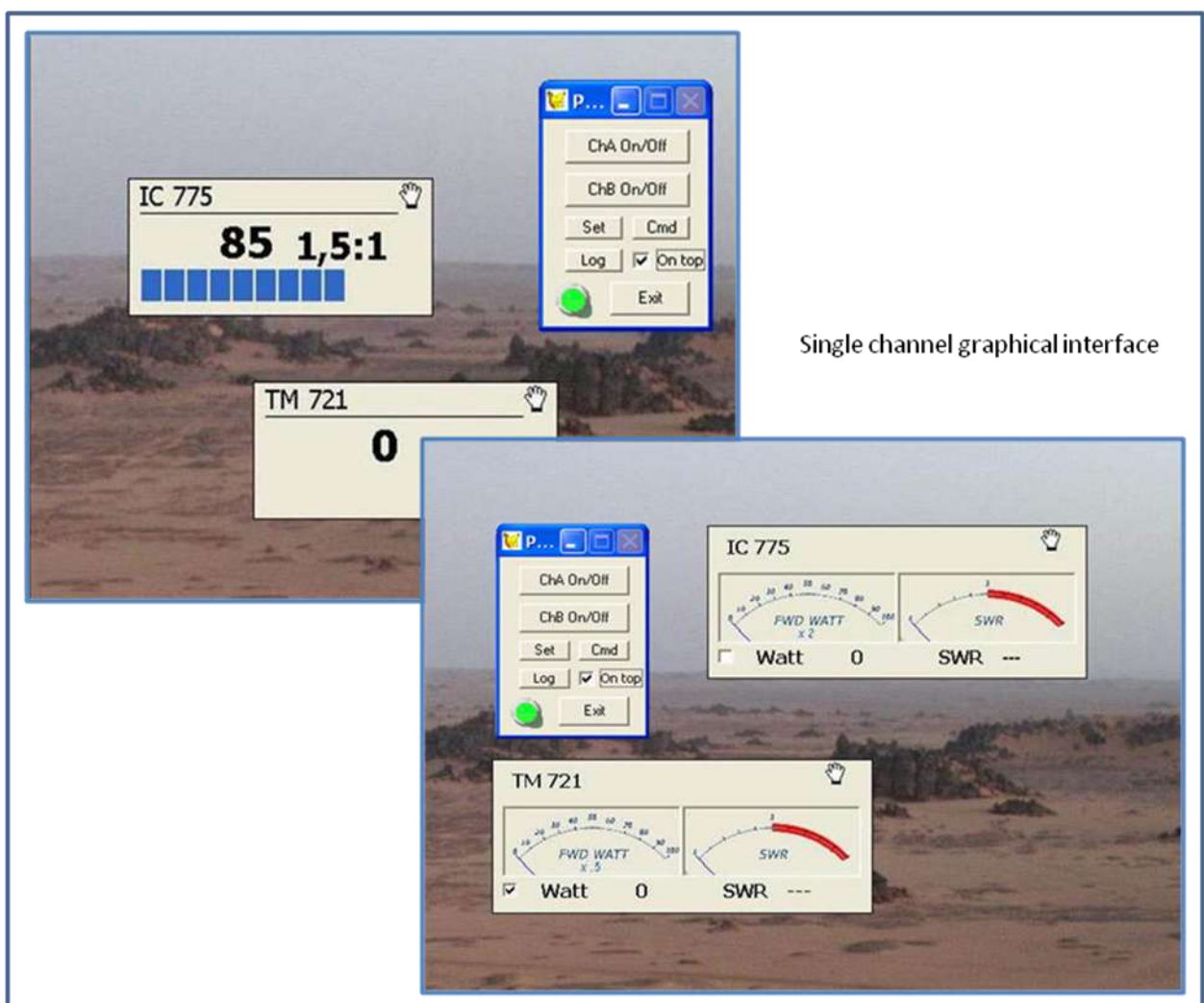
“OK” returns back to the previous window from where you can try again to connect the LCD Unit.



### 4.3 Graphical windows

Single and multi-channel graphical interfaces are available, choose the one you prefer from the configuration window clicking the button “Set”.

The blinking GREEN led points out that the LCD Unit link is active, led is YELLOW blinking when the data collection function is also active.



Button “Cmd” activates the “Command” window , “Set” the LCD Unit configuration window.

## Two channels interface


**WattMeter**

**IC 775**

	Peak	Max
Power FWD	54	69
Power REF	2	2
SWR		1,4

**TM 721**

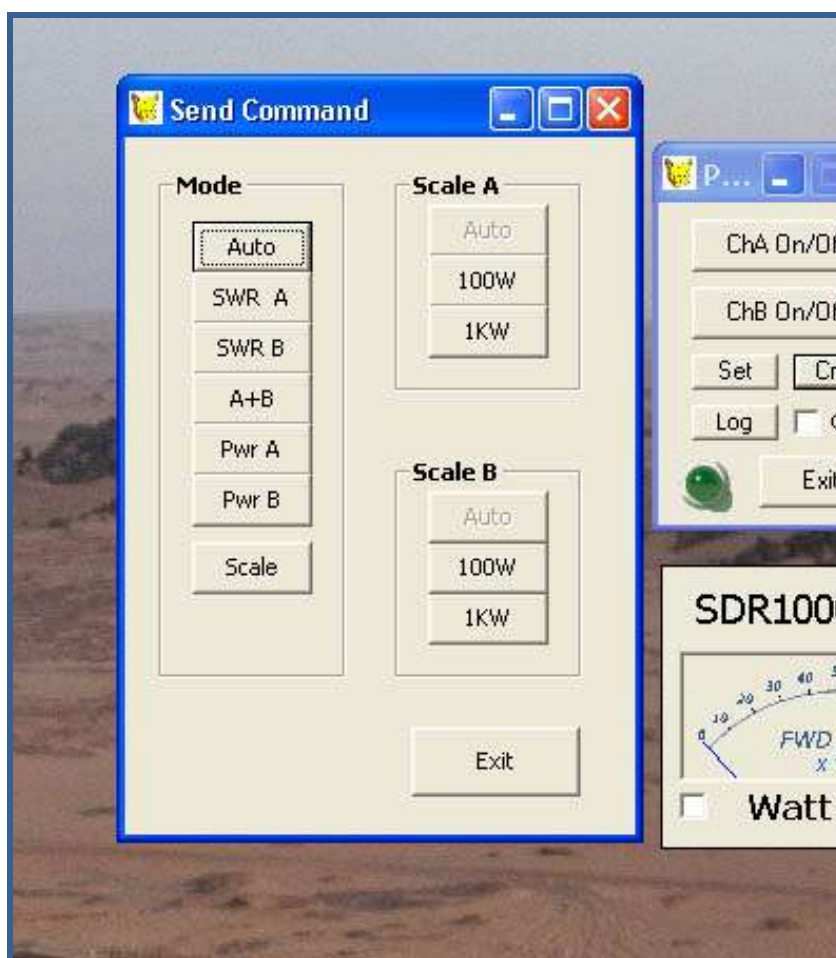
	Peak	Max
Power FWD	0	0
Power REF	0	0
SWR		---

Cmd Set  Exit

## 4.4 Command window

The “Send Command” window emulates the Buttons B1 and B2 of the LCD Unit sending the commands to switch operative modes and selections.

Buttons on the frames “Scale” allow to select the Scale 1 or Scale 2.



## 4.5 Data collection

This feature collects data from the LCD Unit and generates a file that can be imported in any spreadsheet (like Microsoft Excel or OpenOffice Calc) able to read the CSV file format.

The “Data collection” is activated clicking the button “LOG” in the graphical interface, the blinking GREEN led that point out the LCD/PC link activity, switches to the YELLOW color during the data acquisition time.

A record will be appended to the log file each time data are collected from the LCD unit, the reading period is the figure “Instant Vrms Delay” (see Setting window).

Enter the path and the file name in the set-up frame of the setting window.

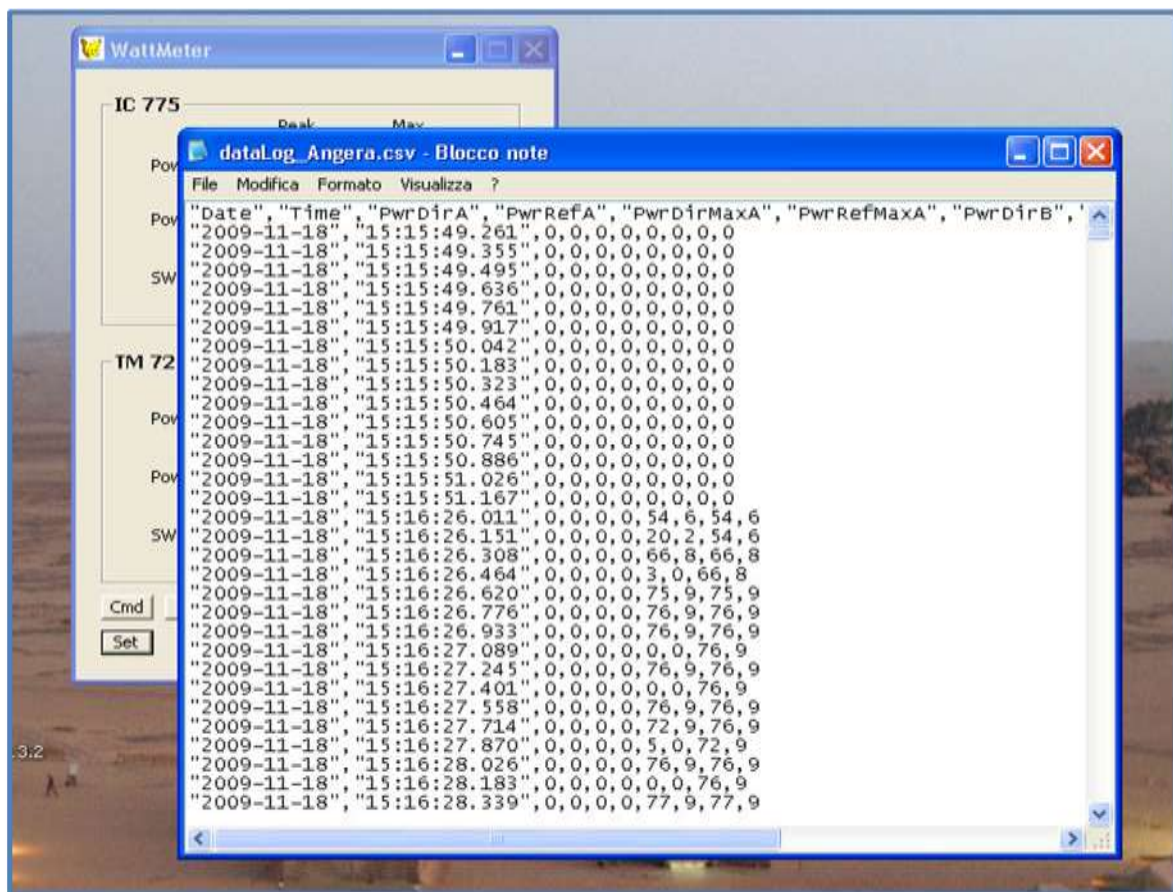
If option “Clear data file” is enabled, the contents of the file will be cleared before starting a new data collection session. On the contrary, if option “Clear data file” is disabled new data are appended at the end of the existing ones.

“No zero pwr” allow to collect data only if a power level greater than the minimum (VRms min sample) is detected.

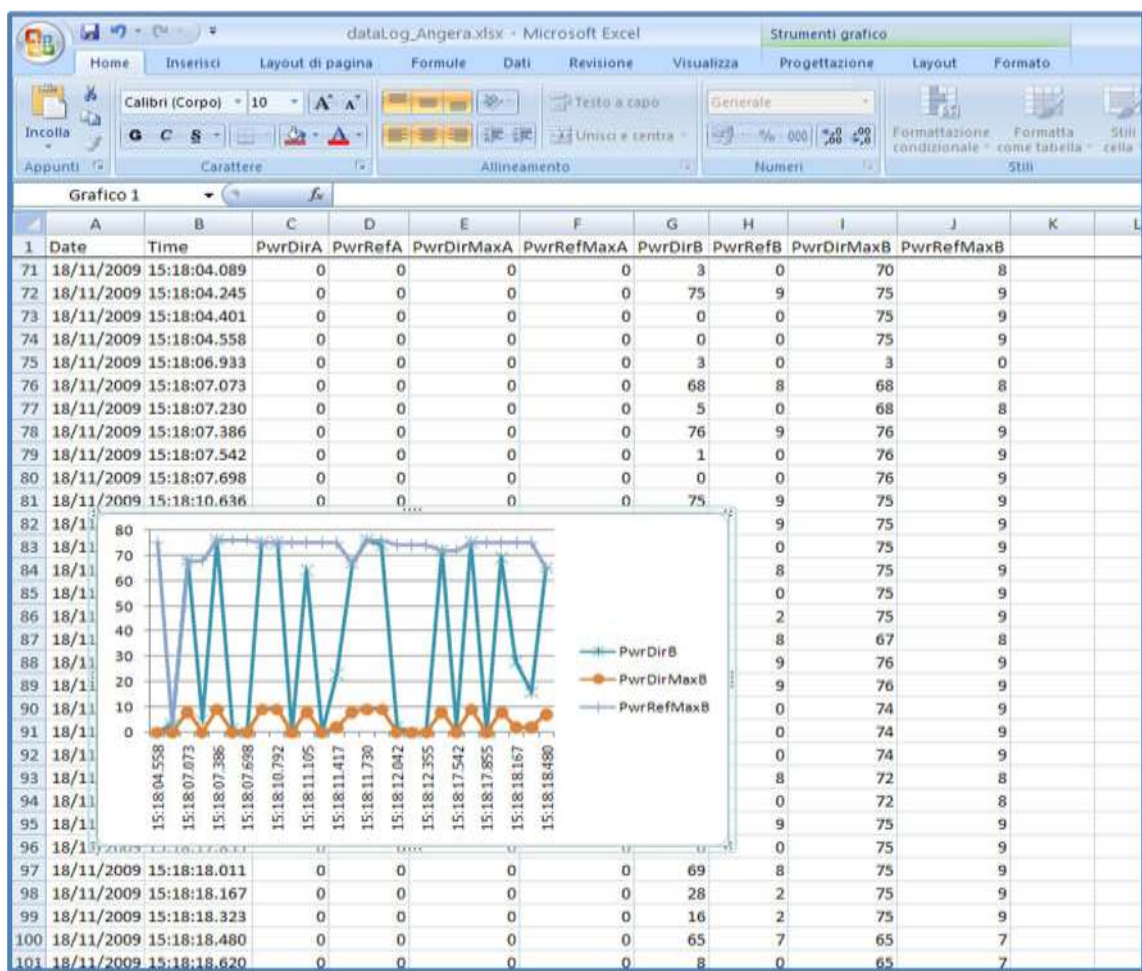
The record layout is :

“Date”, “Time”, “PwrDirA”, “PwrRefA”, “PwrDirMaxA”, “PwrRefMaxA”, “PwrDirB”, “PwrRefB”, “PwrDirMaxB”, “PwrRefMaxB”.





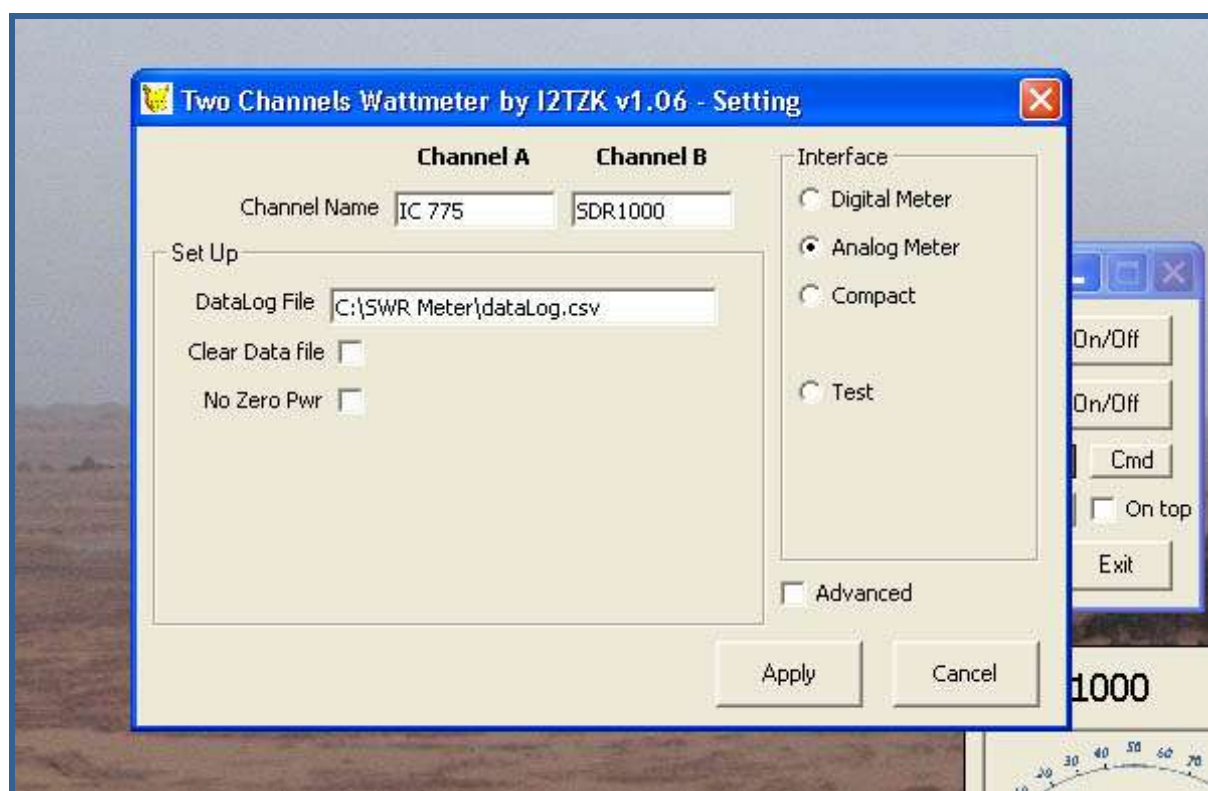
Following figure is an example of the analysis that can be done importing data into Microsoft Excel.



## 4.6 Configuration window

The configuration windows is activated by the “Set” button.

The options of the frame “Interface” are selecting the user interface.

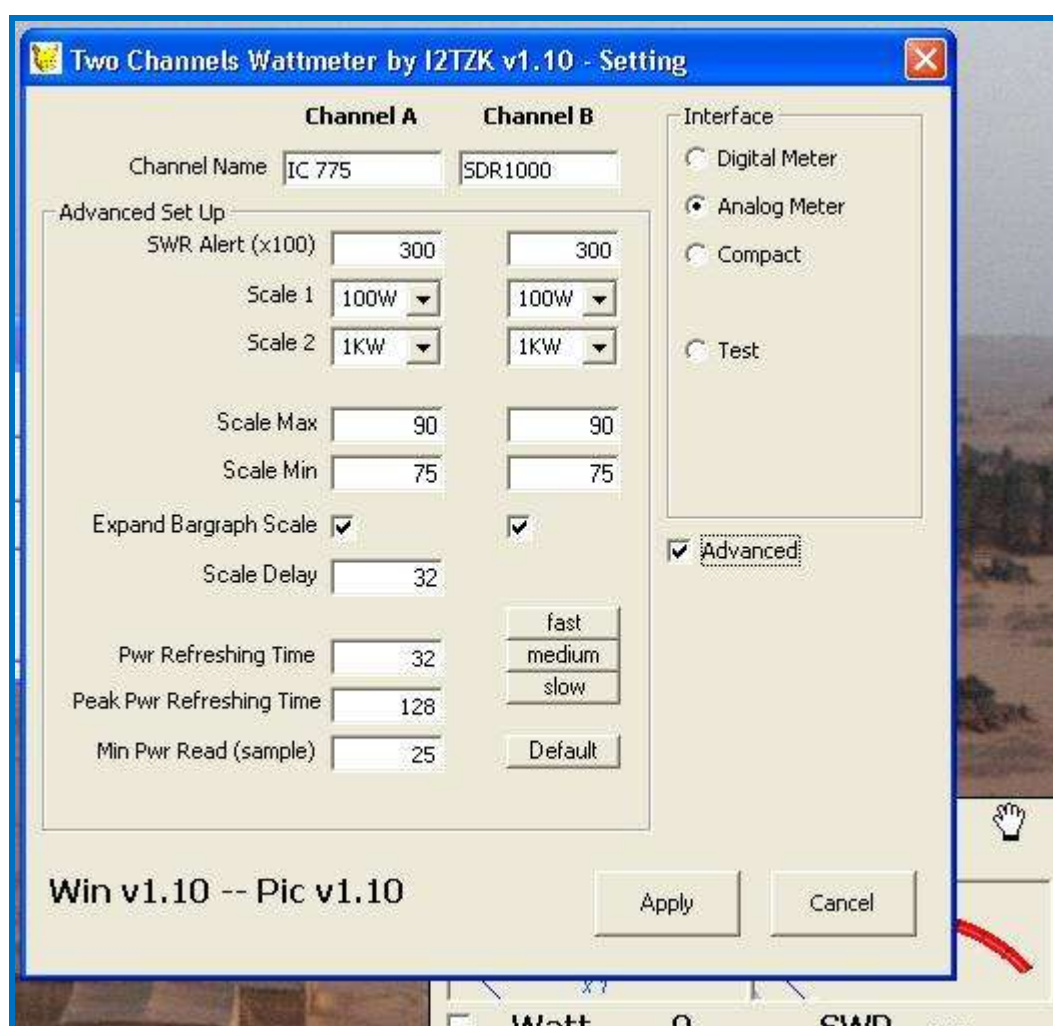


Set Up frame:

- “Channel Name” is the description shown by the graphical interfaces to identify each channel.
- “DataLog file” is the path and file name of file CVS file generated by the data collection feature.
- “Clear data file”, if selected, will clear the file before starting the data collection, unchecked will append data to the already existing records.
- “No zero pwr” allow to collect data only if a power level greater than the minimum (VRms min sample) is detected.
- “Advanced” brings visible the advanced setup panel.

All the parameters shown by the panel “Advanced Set Up” are read at the program startup from the LCD Unit.

The button “Apply” sends back to the LCD Unit the modified fields, synchronizing the computational parameters of the 2ChWattMeter Win program and the LCD Unit.



Advanced Set Up frame:

- SWR Alert level  
This adjustment allows the user to set the maximum SWR value that will be indicated before “SWR Hig” is displayed on the LCD Display. I.e; 300 = a SWR of 3:1 and 200 = 2:1 (Channel “B” can be configured differently from Channel “A”.)

- **Wattmeter Scale1:**  
When using the dual range sensor board, this is the low power scale, and should probably be set to a lower scale than Wattmeter Scale2. Use the drop-down arrow to select the desired scale. Ie: 100W
- **Wattmeter Scale2:**  
When using the dual range sensor board, this is the “High Power” scale that will be switched to when the power on Wattmeter Scale1 is exceeded. Ie: 1000W.
- **Scale Max**  
When using the dual range sensor board and the AUTO scale function, if the input power is greater than this value the wattmeter scale switches from Scale1 to Scale2. (Ie Scale 1 = 100W, Scale2 = 1KW, till power is < 90W Scale1 is selected, if > 90W Scale2 is automatically selected). AUTO scale mode can be selected from the “Command” window
- **Scale Min**  
When using the dual range sensor board and the AUTO scale function, if the input power is less than this value the wattmeter scale switches from Scale 2 to Scale1. (Ie Scale 1 = 100W, Scale2 = 1KW, being the wattmeter measuring in Scale2, untill power is > 75W Scale2 remains selected, if < 75 Scale1 is automatically selected). AUTO scale mode can be selected from the “Command” window
- **Expand bar graph scale:**  
If enabled, when the input power is less that the 25% of the full scale value, the bar graph, will expand to the full scale. This allows a better measure at low power level.
- **Instant Vrms Delay:**  
This value determines the amount of delay on the instantaneous reading of the LCD display. Three preset values can be selected by the “Fast”, “Medium” and “Slow” buttons to the right. The range of values are between xxx and xxx, and can be directly entered.
- **Max Vrms Delay:**  
This value determines the maximum “Hold” time for the display reading. Preset values are available by the “Fast” “Medium” and “Slow” preset buttons. The allowable values are between xxx and xxx, and can also be directly entered.
- **Min Vrms Sample:**  
This value determines the minimum number of samples necessary for the PIC to compute the SWR. This value will affect the minimum amount of power required to make this calculation. The three presets will provide default values, however, the lower values will provide better results. The allowable range of values are between xxx and xxx.