

WX3IN1 Plus 2.0 (v1.00)

(manual revision 22 October 2014)

APRS STANDALONE DIGIPEATER
APRS/RF TO APRS-IS IGATE
APRS-IS TO APRS/RF FORWARDING
WEATHER STATION SUPPORT
WEATHERUNDERGROUND SERVICE REPORTING
EXTERNAL TELEMETRY MODULE SUPPORT
INPUT VOLTAGE MEASUREMENT
DIGITAL THERMOMETER INPUT

WWW INTERFACE FOR ADMINISTRATION
TELNET INTERFACE FOR MONITORING
NTP SUPPORT FOR TIME SYNCHRONIZATION
REMOTE FIRMWARE UPDATE VIA TFTP

Instruction manual
Configuration software manual



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1. Technical parameters

Dimensions	126x99x43 mm
Weight	270g
Supply voltage	12VDC typ. (9 - 16VDC)
Power consumption	150mA
Operation temperature	-20 °C / +70 °C
Humidity	95% max.
Ethernet	10/100 Base-T
Power connector	5.5/2.1mm connector
Telemetry module connector	Terminal block, RS-485 2-wire standard
Thermometer connector	Terminal block, DS18B20/DS18S20 standard
Serial ports connector	Mini DIN 6-pin, 2 ports, RS-232 standard
Radio connector	Mini DIN 6-pin
PC connector	USB-B (printer cable type)

2. Device features

2.1. APRS client

WX3in1 Plus 2.0 allows you to generate APRS data packets with information field defined by user and send them in a specified interval. In this way, it is possible to send beacons, objects, weather and telemetry data.

2.2. APRS digipeater

The main purpose of the device is receiving and sending APRS data packets via amateur radio transceiver. WX3in1 Plus 2.0 is capable of receiving an APRS packet, decoding the sender, recipient, path and information field. Then actions are performed in accordance with the options configured by user:

- Packet is digipeated via the APRS network,
- Packet is sent to the APRS-IS server,
- Packet is ignored if it was corrupted.

Device firmware implements the following mechanisms:

- Checksum Verification - packets with errors are ignored,
- Anti-flood - packets repeated in a short time interval are not forwarded,
- Path checking - a decision whether to digipeat a packet or not is made using a filter stored in configuration data of the device. User defines whether to forward WIDE1-1, WIDEn-N, SPn-N, or local path packets and the maximum value of N (so called New-N paradigm),
- Callsign filter - a simple callsign filter allows you to add stations to black list (these stations will be ignored) or white list (only these stations will be digipeated).

2.3. RF -> APRS-IS forwarding (I-Gate)

WX3in1 Plus 2.0 allows you to connect to APRS-IS server network. After logging to selected server, it is possible to gate data received from the APRS radio network. All packets with correct format and checksum are forwarded to APRS-IS.

2.4. APRS-IS -> RF forwarding

The device allows you to receive packets from APRS-IS server. Then a decision is made whether to gate a packet to RF or not. It is possible to forward different types of packets based on a filter defined in device configuration. APRS message packets can be forwarded to stations which were heard on RF within limited number of digi-hops (local RF), and they are repeated up to 3 times in case of no ACK packet received from message recipient.

2.5. Weather station support

WX3in1 Plus 2.0 allows you to receive weather information from weather stations via the RS-232 cable. Data is then encoded into the APRS packet and may be sent to APRS network at specified intervals. Additionally WX3in1 Plus 2.0 allows you to send weather data to APRS-IS server.

Supported weather stations:

- LaCrosse/Technoline WS-2300,
- LaCrosse/Technoline WS-2350,
- Peet Bros Ultimeter 100,
- Peet Bros Ultimeter 800,
- Peet Bros Ultimeter 2000,
- Peet Bros Ultimeter 2100,
- Davis Vantage Pro (with RS232 datalogger),
- Davis Vantage Pro2 (with RS232 datalogger),
- Davis Vantage Pro Plus (with RS232 datalogger),
- Davis Vantage Pro2 Plus (with RS232 datalogger),

2.6. Weather Underground service support

Weather Underground is one of the biggest weather services available on the web. It allows you to create an account for your weather station and send weather reports which are stored in their database. Data is then available for view in form of graphs, tables or a simple web page applet showing current conditions in your location. Everyone can send his weather data using a simple internet protocol.

In WX3in1 Plus 2.0 you can configure your Weather Underground account name, password and send weather data in preconfigured time intervals. You can also send your weather data in “rapid fire” mode every 5 seconds and see your weather changes realtime using their web page applet.

2.7. Telemetry reports

Device allows you to send telemetry reports to APRS/APRS-IS network. Possible telemetry channels are:

- input voltage,
- received APRS packets in 1 hour or 10 minutes window,
- digipeated APRS packets in 1 hour or 10 minutes window,
- packet decoding efficiency in 1 hour window or in the whole range from device power-up,

2.8. WXTelemetry module support (analog channels)

You can get more telemetry report options when using external WXTelemetry module. With WXTelemetry module you can measure and send following values:

- two current measurement inputs,
- two voltage measurement inputs,
- DS18B20 digital thermometer input.

2.9. WXBits telemetry module support (digital inputs/outputs)

You can use an additional WXBits module for reporting of digital input channels and administration of output channels. WXBits is a module which includes:

- 4 optocoupler digital inputs,
- 4 mosfet transistor open-collector outputs.

States of both inputs and outputs can be reported in APRS telemetry reports and outputs

can also be controlled with WX3in1 telnet interface.

2.10. RTC clock and NTP time synchronization support

With WX3in1 Plus 2.0 you always have the current date and time thanks to NTP support. Device connects to a defined NTP server every few minutes and checks for the current time. Local passage of time is handled by on-board RTC clock with a battery.

2.11. Firmware and configuration updates

In WX3in1 Plus 2.0 you can do all firmware and configuration updates over an USB cable connection from your PC using a simple Configurator application. If your device is located in a remote location, you can update firmware and configuration over TFTP protocol.

2.12. Remote WWW access

With WX3in1 Plus 2.0 device it is possible to configure and view device statistics remotely via web browser.

2.13. Remote telnet access

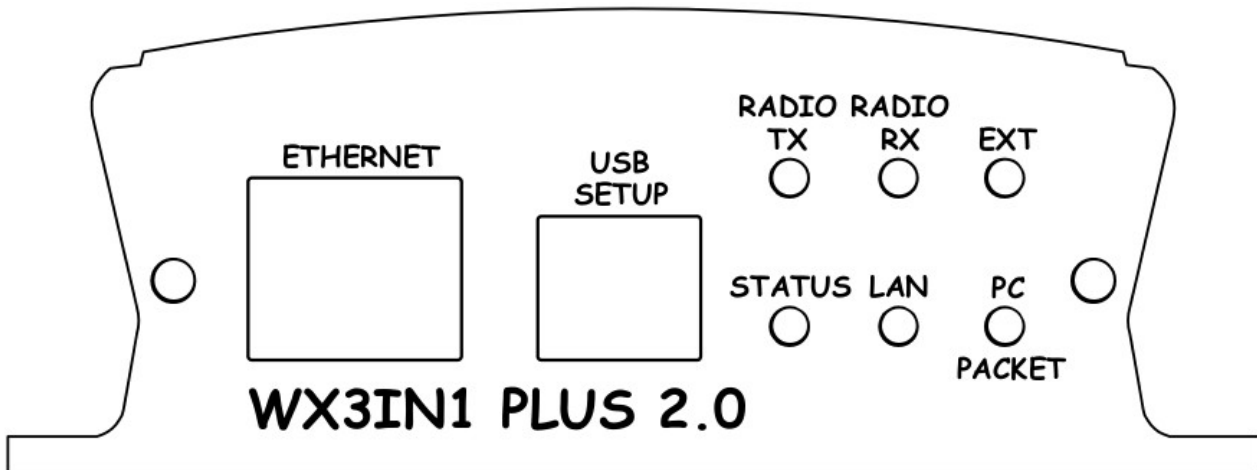
You can connect to your WX3in1 Plus 2.0 device with a telnet client. Telnet connection allows you to check all device operation messages, read device statistics, send some test packets useful during installation, control digital outputs of WXBits module, and much more.



3. Connectors and device status leds

3.1. Front panel

There are 6 leds on the front panel that show the status of device operation. The following image shows the location of front panel LEDs and connectors.



Leds:

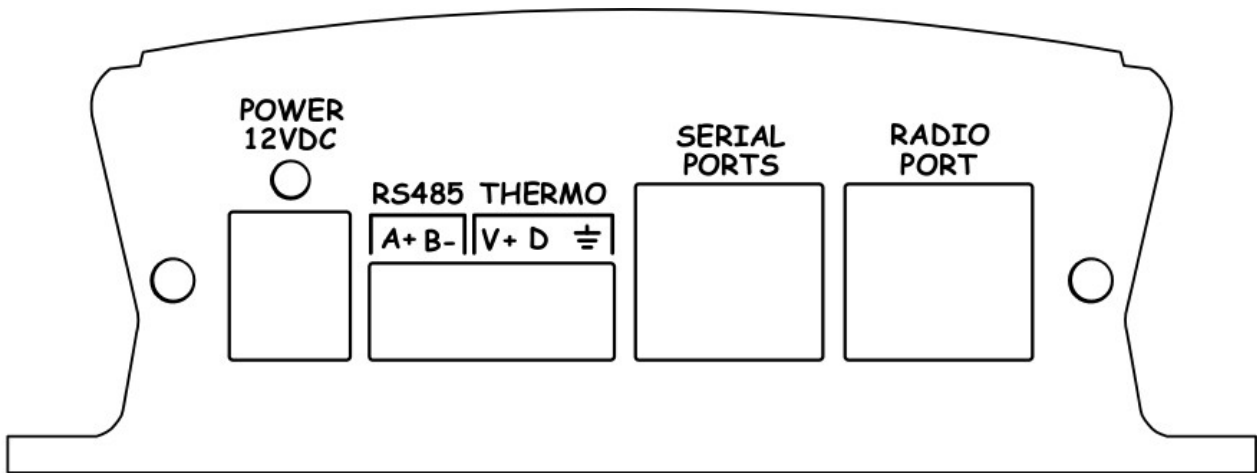
- **Radio TX** - The red led lights during transmission - the device sends an APRS data packet,
- **Radio RX** - Yellow led illuminates when receiving a signal from the radio (indicates the channel is busy),
- **Ext** - Green led indicates proper communication with external device, it blinks after reception of:
 - correct weather data from Weather Station,
 - GPS NMEA sentence with fixed position,
 - temperature from external sensor,
 - telemetry data from WXTelemetry/WXBits.
- **Status** - Green led indicates the status of the device (led lights up regularly every 3 seconds, indicating correct operation),
- **Lan TX** - Blue led illuminates when sending TCP/IP packet to the Ethernet,
- **PC/Packet** - This red led has two purposes. In PC configuration mode it blinks regularly and in device working mode it blinks when there is a proper packet received from the radio.

Connectors:

- **Ethernet** - RJ45 (ethernet network connection),
- **USB** - a USB socket-B (printer type), used to connect to a computer,

3.2. Rear panel

The following image shows the location of rear panel LEDs and connectors.



Leds:

- **Power led** - The red led above the power connector indicates that the power is applied.

Connectors:

- **Power** - 5.5/2.1 type power connector (center pin is a power supply plus),
- **RS485** - terminal block connector for serial port for WXTelemetry/WXBits,
- **Thermo** - terminal block connector for DS18B20/DS18S20 connector,
- **Serial ports** - Mini DIN 6-pin connector for dual serial ports and 5V voltage output (the same pinout as PLXDigi/PLXTracker),
- **Radio connector** - Mini DIN 6-pin connector for radio audio in, audio out, GND, and PTT.

Warning: PTT switch is operated using MOSFET transistor. Please make sure that there are no short-circuits in radio cable. Shorting PTT output do positive voltage can result is transistor damage.

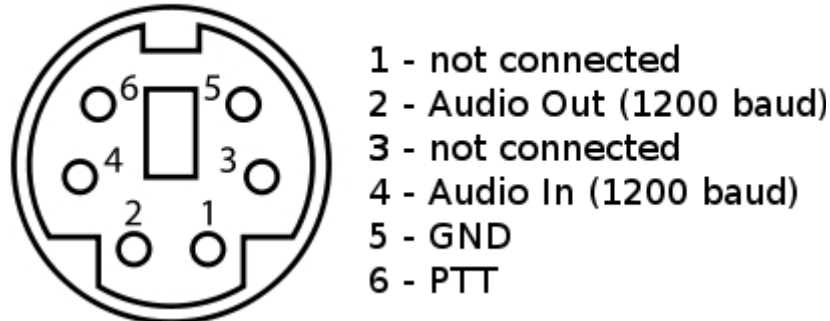
Serial port 5V voltage output is protected with diode and polymer fuse. Maximum output current should not be above 100mA.

If you are going to use both WXTelemetry and WXBits external telemetry modules, you should connect them in a chained style: A+ and B- pair go from WX3in1 to first telemetry module, and then from first telemetry module to the second one. From a schematic point of view, both modules must be connected in parallel (A+ from WX3in1 goes to A+ of the first module, and then to A+ of the second, similarly with B-). Never connect A+ to B-.

4. Radio connector

Radio MINI DIN 6pin connector is placed on the rear panel of WX3in1 Plus 2.0. Pinout of this connector is described in the following figure.

MINIDIN 6pin female connector



Connector pinout description:

1. not connected,
2. APRS audio output from the device to the microphone input of the radio. This output also acts as a PTT by shorting pin to ground through a 2k2 resistor - an option for portable radios that do not have a separate PTT input (selectable in configuration software, 2k2 resistor is built-in),
3. not connected,
4. APRS audio input from radio to WX3in1,
5. Ground pin,
6. PTT output - if the external PTT output is selected in device configuration, this pin is shorted to ground while broadcasting.

Warning: PTT switch is operated using MOSFET transistor. Please make sure that there are no short-circuits in radio cable. Shorting PTT output do positive voltage can result is transistor damage.

For handheld radios which use 2k2 resistor on microphone input line you don't need to use any external resistor or external PTT (pin 6) output. Connect pins: 2 (audio output), 4 (audio input), 5 (ground) and set "PTT:" to "2k2 resistor" in device configuration. 2k2 resistor is located inside of the device.

4.1. Audio output level regulation

In WX3in1 Plus 2.0, audio output is configured in software. Possible output level range from 40mV to 900mV with output impedance of around 500 Ohm.

4.2. Audio input level

In WX3in1 Plus 2.0 audio input level amplifier is configured in software. Default amplifier setting is configured to +0db and with this amplifier setting device should be able to decode packets with input levels as low as 25mV p-p and as high as 1V p-p. In case of low-level signals it is recommended to increase input amplifier settings for best decoding efficiency.

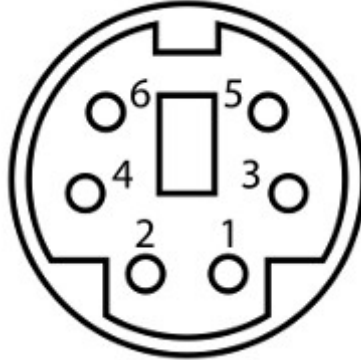
4.3. High-pass filter jumper

There is only one jumper on a PCB inside of the device (located behind radio port connector). It should be open for proper operation of 1200 baudrate APRS decoding (it was added for future functionality of 9600 baudrate decoding which needs flat frequency response down to DC). Closing this jumper may lead to poor 1200 baudrate decoding for some radios.

5. External devices connector

5.1. RS-232 serial ports connector

In WX3in1 Plus 2.0 the MINI DIN 6pin female connector is used for RS-232 serial ports and 5V voltage output.



MINI DIN 6pin connector pins description:

- Pin 6 - RS-232 Port 1 RXD (weather station),
- Pin 4 - RS-232 Port 2 TXD (GPS module),
- Pin 2 - GND,
- Pin 1 - 5V output, do not short-circuit, max. current 100mA,
- Pin 3 - RS-232 Port 1 TXD (weather station),
- Pin 5 - RS-232 Port 2 RXD (GPS module).

In firmware v1.00, serial ports are hard-coded for weather station (port 1) and GPS module (port 2).

Serial port 5V voltage output is protected with diode and polymer fuse. Maximum output current should not be above 100mA.

5.2. RS-485 connector

RS-485 connector is intended to be used with WXTelemetry and WXBits external modules.

If you are going to use both WXTelemetry and WXBits external telemetry modules, you should connect them in a chained style: A+ and B- pair go from WX3in1 to first telemetry module, and then from first telemetry module to the second one. From a schematic point of view, both modules must be connected in parallel (A+ from WX3in1 goes to A+ of the first module, and then to A+ of the second, similarly with B-). Never connect A+ to B-.

5.3. Thermometer connector

Thermometer connector is intended to be used with DS18B20 or DS18S20 digital thermometer. It consists of:

- 5V voltage output (limited with diode and 100R resistor),
- DATA line,

- GND.

Terminals should be connected to appropriate pins of the thermometer.

6. Connecting GPS receiver

WX3in1 Plus 2.0 serial port connector is compatible with our “[GPS-RS232 Receiver/Microsat \(minidin 6-pin\)](#)”. It can be connected directly without any additional adapters.

You can use any GPS receiver with compatible pinout and current consumption below 100mA (below 60mA is recommended, as higher currents may cause a voltage drop below 5V on protection diode and polymer fuse which can prevent proper operation of GPS receiver).

If you are going to use a GPS receiver from other manufacturer, it must provide GPRMC and GPGGA NMEA sentences for proper operation. Most modern GPS receivers and modules support these sentences. Serial port baudrate is selectable in WX3in1 Plus 2.0 configuration.

Following lines of WX3in1 Plus 2.0 serial port are used for GPS data reception:

- Pin 5 - RS-232 Port 2 RXD (GPS module).
- Pin 2 - ground.

Communication with GPS receiver is uni-directional (only data reception), so RS-232 Port 2 TXD is not used (although it is connected in some types of our pre-made cables).

If you want to connect both GPS receiver and weather station to WX3in1 Plus 2.0, please check more details in “Connecting the weather station” chapter.

7. Connecting the weather station

7.1. LaCrosse/Technoline WS-2300, WS-2350 stations

The only difference between WS-2300 and WS-2350 weather stations is that manufacturer has made an external USB to RS232 adapter, which is not used in case of WX3in1 Plus 2.0.

WS-23XX weather stations require a bit exotic connection method. There is no GND connection and both positive and negative 5V voltages are necessary for interfacing (-5V on DTR pin, and +5V on RTS pin). To connect WS-23XX weather station, we need to use WX3in1 Port 2 TXD as negative polarization voltage source on DTR pin.

To connect WS-2300 or WS-2350 station to WX3in1 Plus 2.0 you will need to use:

- "[CAB02 - WX3in1 Plus 2.0/PLXDigi/PLXTracker serial interface cable \(for WS-23XX\)](#)" - in case you don't want to connect also GPS receiver,
- "[CAB28 - WX3in1 Plus 2.0 serial interface cable \(for WS-23XX + GPS\)](#)" - if you want to connect both weather station and GPS receiver.

Schematics for both cables are available on our webpage.

7.2. Peet Bros Ultimeter stations

Peet Bros Ultimeter weather stations use a standard RS-232 serial port interface with TXD, RXD and GND. Other serial lines are not used. Stations must then be manually switched to "data logger" mode. According to the manufacturer's instructions, you should press CLEAR + WIND SPEED buttons for 3 seconds to activate the "data logger".

To connect Peet Bros Ultimeter station to WX3in1 Plus 2.0 you will need to use:

- "[CAB29 - WX3in1 Plus 2.0 serial interface cable \(for Davis, PeetBros\)](#)" - in case you don't want to connect also GPS receiver,
- "[CAB27 - WX3in1 Plus 2.0 serial interface cable \(for Davis, PeetBros + GPS\)](#)" - if you want to connect both weather station and GPS receiver.

Schematics for both cables are available on our webpage.

7.3. Davis Vantage stations

Davis Vantage weather stations use a standard RS-232 serial port interface with TXD, RXD and GND. Fourth wire is connected to DCD, DTR, and DSR inside original DB-9 connector but it shouldn't be used on WX3in1 Plus 2.0 side.

To connect WX3in1 Plus 2.0 to Davis weather stations you need to use an additional RS-232 "datalogger" interface available from the manufacturer. Device part number is 06510SER.

Davis stations datalogger interface comes in two kinds: "standard" datalogger or "APRS" datalogger. According to my current knowledge, both types work fine with WX3in1 Plus 2.0 (it doesn't use an "APRS" feature of datalogger but "APRS" datalogger has also the same communication options like "standard" one).

To connect Davis Vantage station to WX3in1 Plus 2.0 you will need to use:

- "[CAB29 - WX3in1 Plus 2.0 serial interface cable \(for Davis, PeetBros\)](#)" - in case you don't want to connect also GPS receiver,
- "[CAB27 - WX3in1 Plus 2.0 serial interface cable \(for Davis, PeetBros + GPS\)](#)" - if you want to connect both weather station and GPS receiver.

Schematics for both cables are available on our webpage.

8. Connecting to PC

Initial configuration of WX3in1 Plus 2.0 should be done via USB interface with WX3in1 Plus 2.0 Configurator software.

WX3in1 Plus 2.0 enters into configuration mode only when USB cable is detected while powering up and it is indicated by “PC/PACKET” led blinking.

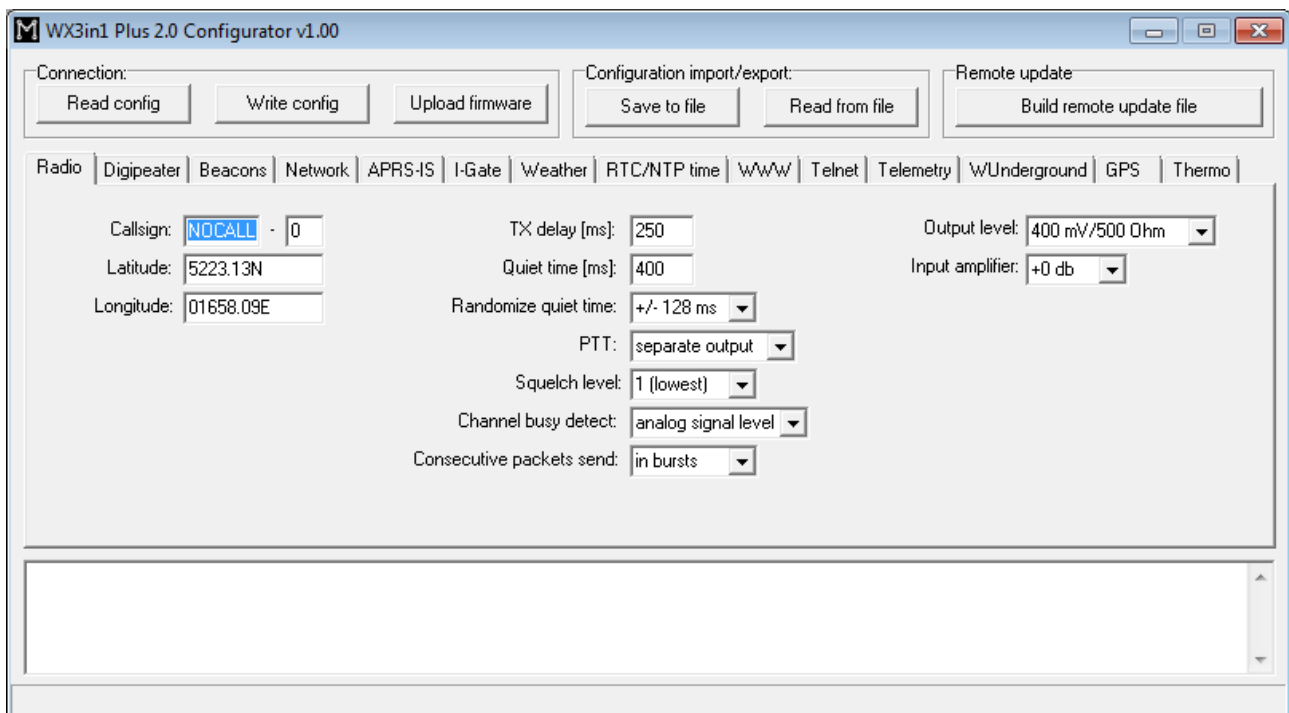
To connect to your computer, follow these steps:

- Power off the WX3in1 Plus 2.0 device,
- Connect the USB cable to your computer,
- Power on the WX3in1 Plus 2.0 device,
- Turn on the Configurator application.

After connecting and powering, WX3in1 Plus 2.0 is detected in Windows as a new USB-HID device.

No device drivers are necessary because standard HID support is present in all Windows operating systems.

Now you can simply use WX3in1 Plus 2.0 Configurator application to read, modify, write configuration to the device. The following image shows the application window.



9. Description of configuration software

In this chapter we will discuss all the Configurator application settings and describe its influence on the device operation.

9.1. Reading configuration from the device

To read the configuration from the device you must use the **“Read config”** button. After this action, the program will download current configuration values from WX3in1 Plus 2.0 internal memory.

9.2. Writing configuration to the device

After entering configuration values in Configurator application, choose **“Write config”** to upload current configuration to WX3in1 Plus 2.0 internal memory.

9.3. Firmware update

If there is a new software update, you should upload the new firmware attached to WX3in1 Plus 2.0 Configurator software package. For this purpose, click on the **“Upload firmware”** button, this operation will open a file selection window. From WX3in1 Plus 2.0 Configurator folder please select the firmware file wx3in1plus20_firmware_vXXX.hash (where XXX is the next version of the firmware). Then wait for the update to complete.

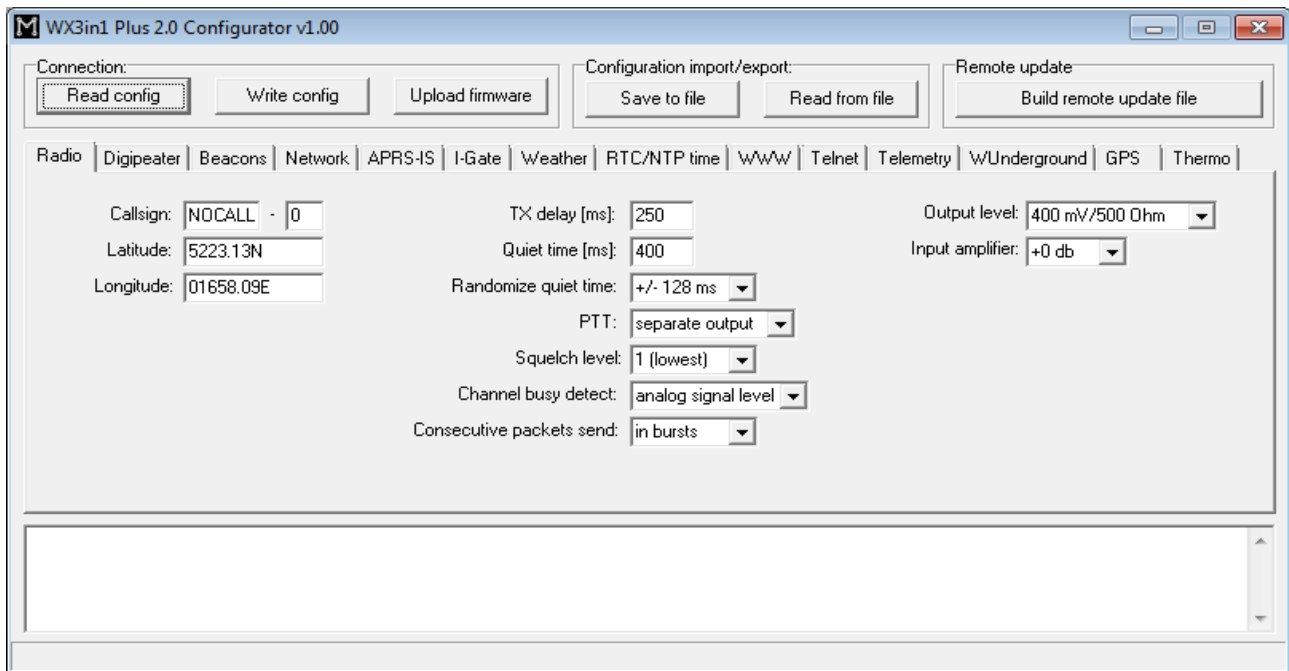
Don't worry, it is not possible to **“brick”** or damage the device with this operation. If anything goes bad, you will simply need to try again with firmware update function.

Please remember that you should update your device with the same Configurator and firmware version numbers. It is also always necessary to upload new configuration after flashing the device with new firmware versions. The device will not start if configuration and firmware versions do not match. If your device simply blinks all the leds when powered up, it means that your configuration version does not match firmware version.

9.4. Configuration import/export

With **“Save to file”** button you can export your current configuration from WX3in1 Plus 2.0 Configurator window to a file on your PC's disk drive. Similarly with **“Read from file”** button you can import configuration from a file to your WX3in1 Plus 2.0 Configurator application. These functions can be used to save your device's configuration and to transfer your device's configuration to recent Configurator and firmware versions.

9.5. Radio Tab



- **“Callsign”** - The callsign of your station with SSID extension. This field can be up to 6 characters long. The default SSID is 0 and allowed SSID's are between 0 and 15,
- **“Latitude”** - north-south position of your radio station,
- **“Longitude”** - east-west position of your radio station.

For APRS beacons latitude is encoded as “XXYY.ZZD” where XX are degrees, YY are seconds (1/60 of a degree), ZZ are hundredths of seconds (1/100), D can be N for north or S for south.

Longitude is encoded as “XXXYY.ZZD” where XXX are degrees, YY are seconds (1/60 of a degree), ZZ are hundredths of seconds (1/100), D can be E for east or W for west.

You can easily find your coordinates in APRS format on aprs.fi map, they are displayed in upper-left corner of the screen.

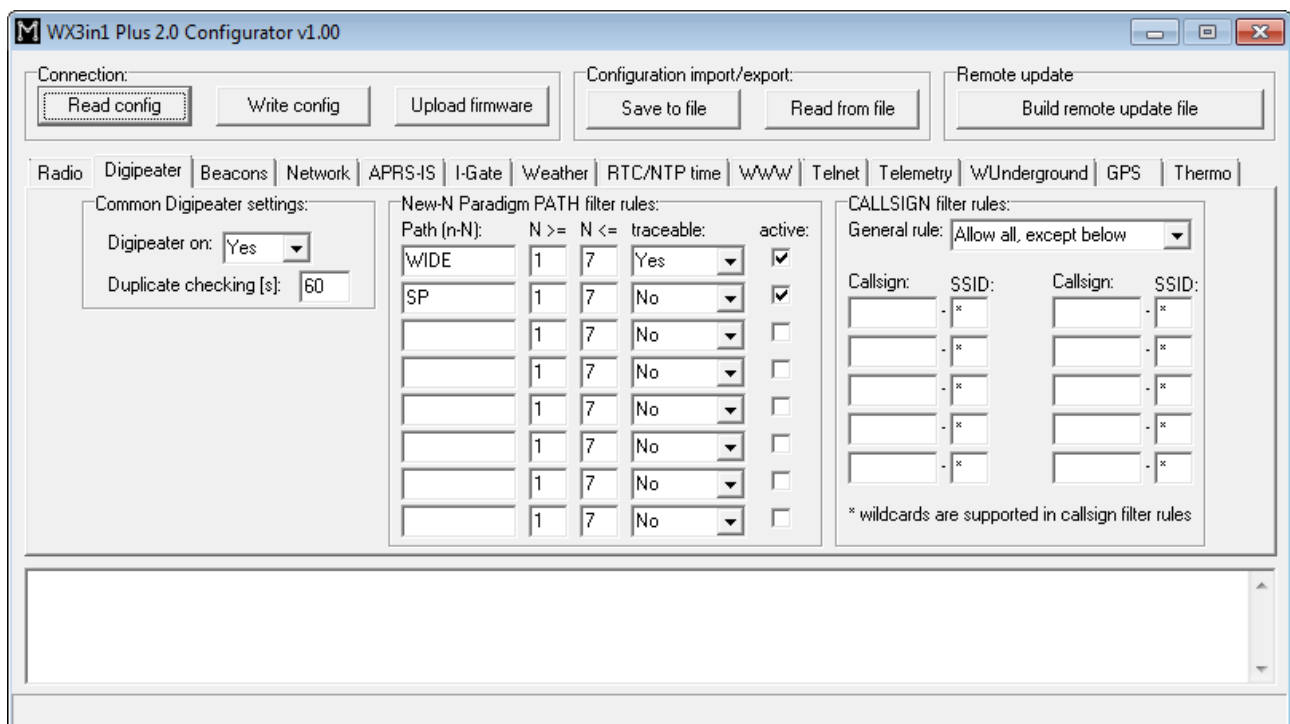
- **“TX delay (ms)”** - Delay time in milliseconds for sending an APRS packet. It is the length of preamble sent before packet and necessary for radio receivers to synchronize with our packet. The recommended value is not less than 250ms,
- **“Quiet time (ms)”** - Minimum time off after the radio channel is busy. After this time next packet can be sent from the transmit buffer,
- **“Randomize quiet time”** - this option adds some randomization to Quiet time value which changes every packet sent with a range selected in this box,
- **“PTT”** - push-to-talk output selection, we can choose between two options:
 - **“separate output”** - PTT output pin is shorted to ground while broadcasting,
 - **“2k2 resistor”** - audio output is shorted to ground via 2k2 Ohm resistor, function used in some handheld radios for transmission enable,
- **“Squelch level”** - this a squelch level selection, with lower values usable signal will be detected with lower signal amplitude. Default value of 1 should be the

best option,

- **“Channel busy detect”** - This option selects if channel busy is detected by input signal amplitude (**“analog signal level”**) or with proper packet start detection (**“digital detect”**). The second option allows to work with open-squelch on the radio, but it can lead to some packet collisions. The first option is default and should be used in most cases,
- **“Consecutive packet send”** - this option will make your device send all the packets from TX queue one after another without any delays (**“in bursts”**), or with TX delay, Quiet time, and channel busy detection between every packet (**“separately”**). The first one is default and used by most APRS devices,
- **“Output level”** - This option selects level of audio output signal from WX3in1 Plus 2.0 to radio,
- **“Input amplifier”** - This option selects amplification of input signal from radio to WX3in1 Plus 2.0.

If you are new to APRS or if you are running the device for the first time, you should change Callsign, Latitude and Longitude field to proper values for your station. These fields are important. You should also change PTT option to be compatible with your radio connection. Other options can be left unchanged as default values should work fine.

9.6. Digipeater Tab



- **“Digipeater on”** - Enables or disables a function of RF APRS packets digipeating,
- **“Duplicate checking (s)”** - Time in seconds after which the next packet will be forwarded, if it has the same content as the previous one. This function allows you to ignore stations, which are flooding the network and also to ignore packets which were heard a while before and are heard again after being digipeated by other stations,

- **“New-N Paradigm PATH filter rules”** - here you can insert New-N Paradigm paths to be handled by WX3in1 Plus 2.0 digipeater function:
 - **“Path (n-N)”** - path name, WIDE, SP, etc.
 - **“N>=”** and **“N<=”** - minimum and maximum N for path to be forwarded, for example WIDEn-N with N>=1 and N<=3 will forward paths: WIDE3-3, WIDE3-2, WIDE3-1, WIDE2-2, WIDE2-1, WIDE1-1,
 - **“traceable”** - if Yes, WX3in1 will add its own callsign to the path, if No, it will not do that,
 - **“active”** - if not checked, current row will not be active.
- **“CALLSIGN filter rules”** - here you can define “black list” (“General rule:” set to **“Allow all, except below”** - all callsigns will be digipeated except listed below), or “white list” (“General rule:” set to **“Deny all, except below”** - only callsigns listed below will be digipeated).

If you are new to APRS or if you are running the device for the first time, you can leave all the options as default. By default, the device will digipeat all packets with WIDEn-N string in path and also local Polish SPn-N string (if you are not from Poland you can remove SP from the second row, it is placed here as an example of a local New-N path).

9.7. Beacons Tab

Dest:	Path:	RF[min]:	IS[min]:	Enable if:	Message (empty fields are ignored):	Special strings
APMI06	- 0 WIDE2 - 2	5	5	Always	@<date>z<lat>/<long>-WX3in1Plus2.0 U=<volt>V,T=<temp>C	
APMI06	- 0 WIDE2 - 2	0	0	Never		
APMI06	- 0 WIDE2 - 2	0	0	Never		
APMI06	- 0 WIDE2 - 2	0	0	Never		
APMI06	- 0 WIDE2 - 2	0	0	Never		
APMI06	- 0 WIDE2 - 2	0	0	Never		
APMI06	- 0 WIDE2 - 2	0	0	Never		
APMI06	- 0 WIDE2 - 2	0	0	Never		

- **“Dest”** - destination field of a beacon packet. It would be best to leave it default which will allow your device to be recognized as WX3in1 Plus 2.0 (and added to working stations callsign list on my webpage),
- **“Path”** - APRS path (default value of WIDE2-2 will allow your device to be digipeated by most nearby digipeaters), if you leave this field empty, beacon will be sent without path,
- **“RF[min]“** - beacon transmit rate to RF (expressed in minutes), beacon will not

- be sent if this field is set to 0,
- **“IS[*min*]“** - beacon transmit rate to APRS-IS (expressed in minutes), beacon will not be sent if this field is set to 0,
- **“Message“** - APRS packet information field content. Beacon will not be sent if this field is left empty.

To properly generate a message field structure, please read the information on the APRS packet format. I recommend the website of the Polish APRS Group's founder Andrew Bartosz SP3LYR, where all is nicely described (in Polish): <http://www.aprs.pl>.

Example beacon packet:

```
@<date>z<lat>/<long>-WX3in1Plus2.0 U=<volt>V,T=<temp>C
```

- @ - APRS data ID,
- <date>z - time and date in the format DDHHMM (day/hour/minute),
- <lat>/<long> - station latitude and longitude,
- „-“ - together with “/” sign between <lat> and <long> defines a station symbol (House in this example), please refer to the table of symbols at <http://aprs.pl/ikony.htm>,
- WX3in1Plus2.0 U=<volt>V,T=<temp>C - beacon information field, <volt> will be replaced with input voltage reading, <temp> will be replaced with temperature from external temperature sensor.

As you can see in the above example, WX3in1 Plus 2.0 allows to use some special strings, which are automatically replaced with corresponding values:

- <date> - inserts current date in DDHHMM (day/hour/minute) format,
- <lat> - inserts your stations latitude defined in “Radio” Tab,
- <long> - inserts your stations longitude defined in “Radio” Tab,
- <gpslat> - inserts latitude received from GPS,
- <gpslong> - inserts longitude received from GPS,
- <gpsdate> - inserts time received from GPS in format: DDHHMM,
- <volt> - inserts measured input voltage,
- <temp> - inserts temperature from rear panel thermometer input.

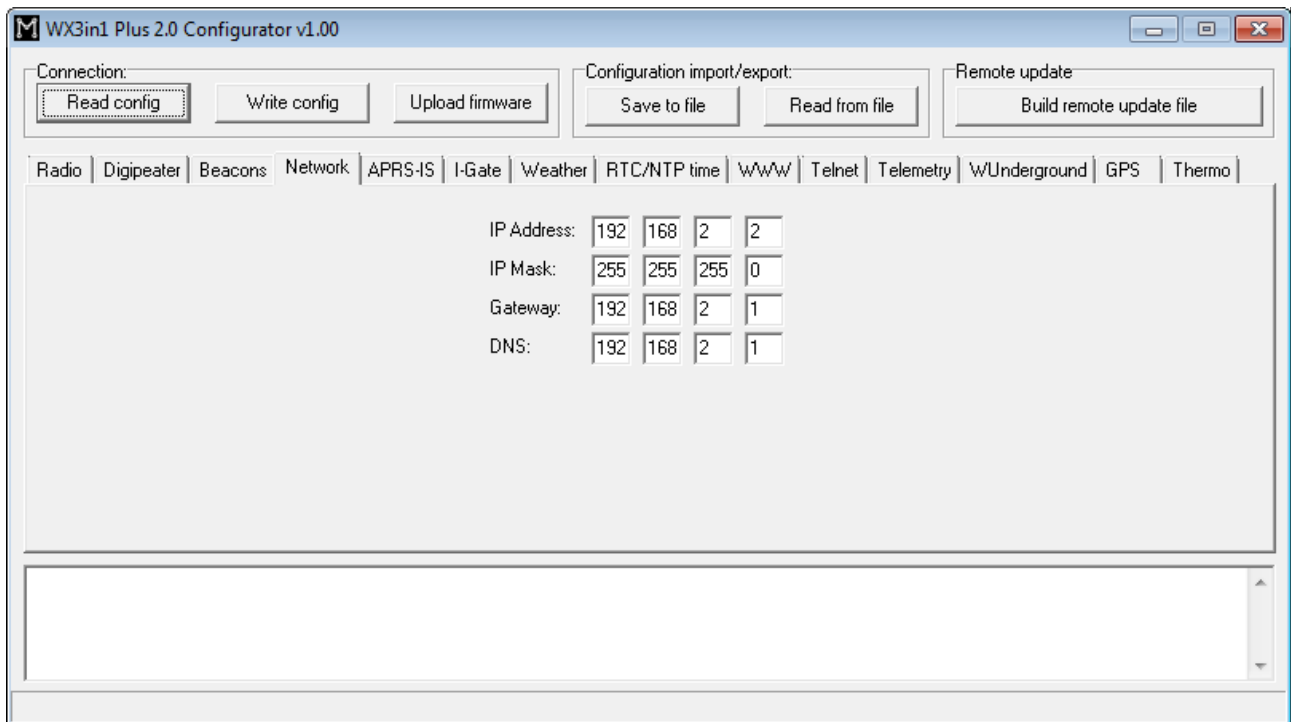
After inserting corresponding values example beacon packet will look for example like that:

```
@100214z5221.60N/01653.63E-WX3in1Plus2.0 U=12.1V,T=21.0C
```

Important note: I sometimes see that users try to replace special <date>, <lat>, <long>, <volt> strings with direct values. You don't need to do that. If you set for example “<date>” string in your beacon, current date will be placed instead of this string. The same for “<lat>”, “<long>”, and “<volt>”.

If you are new to APRS or if you are running the device for the first time, you can leave all the options as default. By default, the device will send standard beacon packet with time, latitude, longitude and current voltage reading both to RF and APRS-IS every 5 minutes. It should make your station appear on the map on aprs.fi.

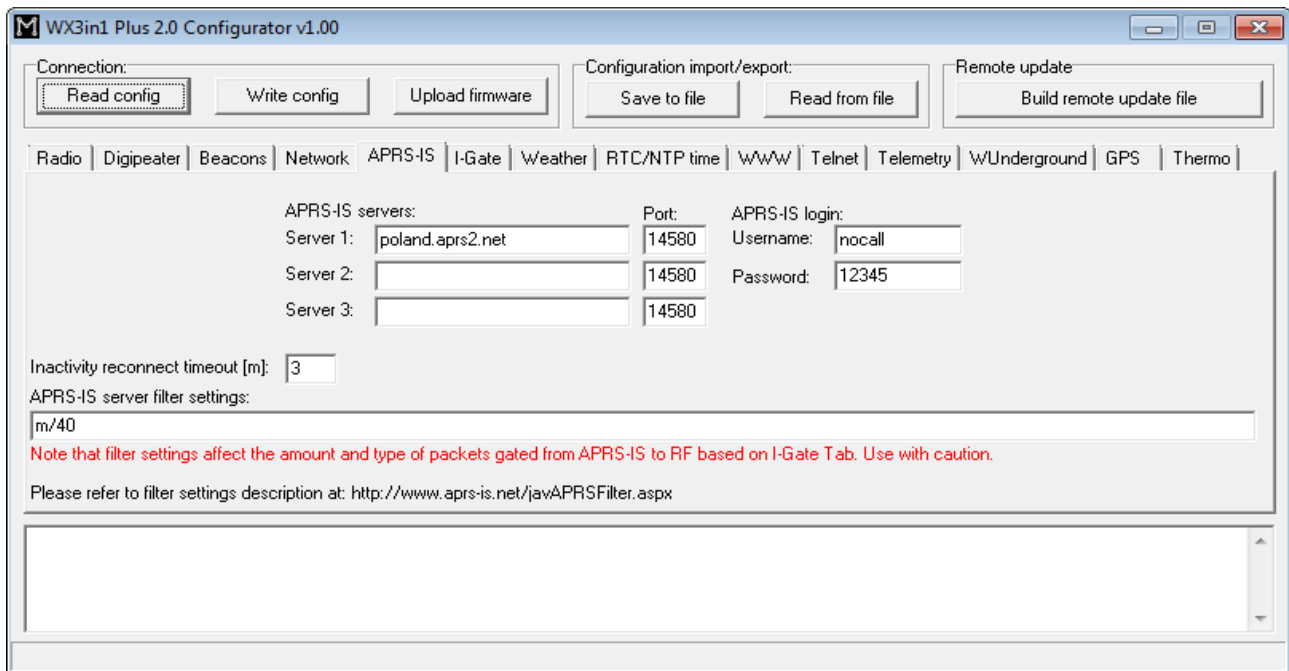
9.8. Network Tab



- **“IP Address”** - IP address of your WX3in1 Plus 2.0 device, you should select a free IP address from your local network,
- **“IP Mask”** - subnet mask of your local network,
- **“Gateway”** - IP address of your network router or other device which provides internet access on your local network,
- **“DNS”** - this should be your internet provider's domain name server address, in most situations you can also use your routers IP address, as most routers do DNS query relaying.

Above network settings must be changed to match you local network and internet configuration.

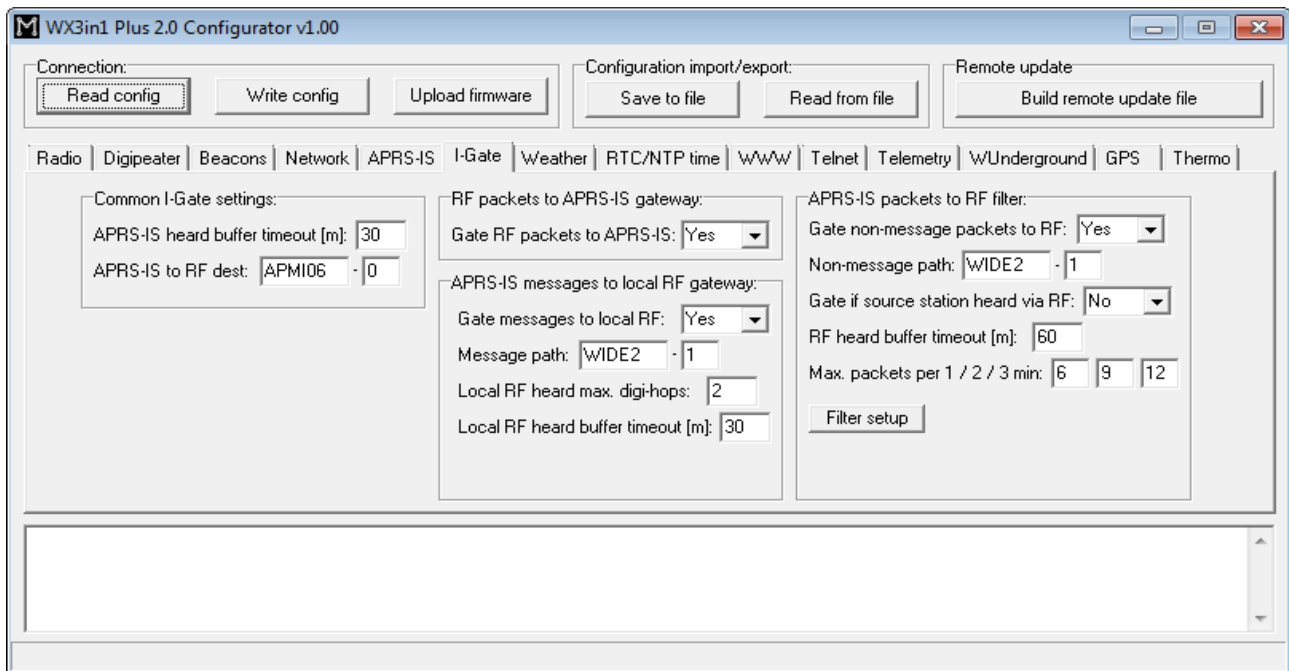
9.9. APRS-IS Tab



- **“APRS-IS servers”** - domain names or IP addresses of APRS-IS server which should be connected by WX3in1 Plus 2.0, APRS Tier 2 Network servers can be found on this page: <http://www.aprs2.net/serverstats.php>.
- **“APRS-IS port”** - IP ports of APRS-IS servers, in most cases default port 14580 should work fine.
- **“APRS-IS login username”** - this should be your callsign with ssid, the same as on Radio Tab,
- **“APRS-IS login password”** - this should be a password for your callsign, passwords should be generated by your APRS-IS server sysop,
- **“Inactivity reconnect timeout [m]”** - this field defines the amount of time after which WX3in1 Plus 2.0 will try to reconnect to APRS-IS server. Most APRS-IS servers send “keepalive” string every few tens of seconds so in case of no data received for a longer time we can assume that something gone wrong with the connection. Default value of 1 minute should work fine but it can be increased in case of frequent reconnects.
- **“APRS-IS server filter settings”** - this is a filter setting string which is sent to APRS-IS server after logging and it tells the server which packets you want to receive from it. Default value of “m/40” tells the server to send all posits, objects from stations within 40 km radius. Messages addressed to these stations will also be received from the server.

APRS-IS server filter setting may be potentially dangerous if you are not sure what you are doing. Please avoid changing filter to a very wide setting to avoid being flooded with packets from APRS-IS server. All packets received from APRS-IS are then processed according to “I-Gate” Tab settings and they can be forwarded to RF as “third-party packets”.

9.10. I-Gate Tab



Please note that below we will call packets of “message” type as “message packets” or “messages” and all other packets as “non-message” packets.

- “Common I-Gate settings”,
 - “APRS-IS heard buffer timeout [m]” - determines the time (in minutes) after which callsigns of stations heard from APRS-IS server are removed from the “APRS-IS heard” buffer.

We need to store callsigns of stations heard from APRS-IS because:

1) Message packets addressed to these stations should not be forwarded from APRS-IS to RF (it is assumed that if a stations was heard from APRS-IS, then it has an internet connection so it has already received this message packet directly from APRS-IS and it is not necessary to forward it to RF),

- “APRS-IS to RF dest” - default destination field applied to all packets forwarded from APRS-IS to RF,
- “RF packets to APRS-IS gateway”,
 - “Gate RF packets to APRS-IS” - if enabled, device will forward all packets received from RF to APRS-IS,
- “APRS-IS messages to local RF gateway”,
 - “Gate messages to local RF” - in enabled, device will forward message packets to stations heard in local RF,
 - “Message path” - default path applied to message packets forwarded from APRS-IS to RF,
 - “Local RF heard max. digi-hops” - stations which packets were received after being digipeated by numer of digipeaters not higher than defined in this field, will be considered as stations in local RF,

- **“Local RF heard buffer timeout [m]”** - determines the time (in minutes) after which stations heard from local RF are removed from the “local RF heard” buffer.

Difference between local RF heard buffer and RF heard buffer is that:

- 1) Local RF heard buffer stores station callsigns heard within limited number of digi-hops,
- 2) RF buffer stores all other station callsigns heard from RF.

Local RF heard stations can be recipients of messages because they are located nearby, and RF heard stations can't be recipients of messages because, although heard from RF, they are located too far.

We need to store callsigns of stations heard from local RF because:

- 1) Only these stations can be recipients of message packets.
- 2) When a message packet sender is heard by our station from local RF, then its message shouldn't be forwarded from APRS-IS to RF (because we heard this station before from local RF so it is somewhere nearby and probably has already sent the same message packet directly to RF).

- **“APRS-IS packets to RF filter”**,
 - **“Gate non-message packets to RF”** - if enabled, non-message packets will be forwarded from APRS-IS to RF based on a filter rules discussed below,
 - **“Non-message path”** - default path applied to non-message packets forwarded from APRS-IS to RF,
 - **“Gate if source station heard via RF”** - if enabled, the device will forward packets from APRS-IS to RF even if source station was heard on RF. Should be disabled,
 - **“RF heard buffer timeout [m]”** - determines the time (in minutes) after which stations heard from RF are removed from the “RF heard” buffer.

We need to store callsigns of stations heard from RF because:

- 1) If a station is heard from RF and “Gate if source station heard via RF” is disabled, then non-message packets from such station will not be forwarded from APRS-IS to RF.
- 2) When a message packet sender is heard by our station from RF, then its message shouldn't be forwarded from APRS-IS to RF (because we heard this station before from RF so it is somewhere nearby and probably has already sent the same message packet directly to RF).

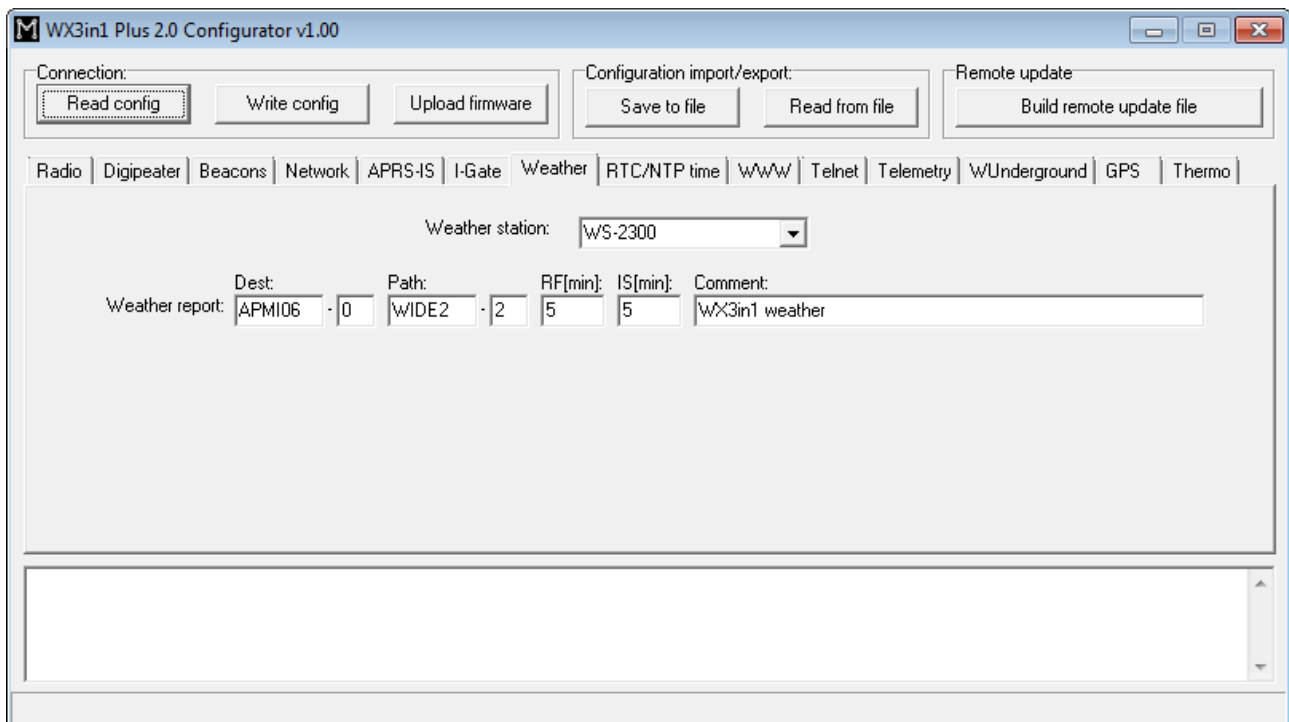
- **“Max. packets per 1 / 2 / 3 min”** - maximum number of packets forwarded from APRS-IS to RF in 1 / 2 / 3 min time periods. This option limits number of packets forwarded from APRS-IS to RF to prevent channel abuse.
- **“Filter setup”** - this is a filter for non-message packets sent from APRS-IS to RF. By default all packets are denied. Then filter entries are processed from first to last field checking for allowed packet type and station. Possible entry types are:
 - Not used - this field will be skipped,
 - Allow all - all packets will be allowed from station defined in callsign/ssid fields,
 - Deny all - all packets will be denied from stations defined in callsign/ssid fields,

- Beacons - beacon type packets starting with '!', '/', '=', '@' symbols from stations defined in callsign/ssid fields,
- Destination - all packets with destination field defined in callsign/ssid fields,
- Telemetry - all telemetry parameters message packets (PARM, UNIT, EQNS, BITS) from station defined in callsign/ssid fields.

Please remember that packets processed through above filter must first be received from APRS-IS server. Therefore you should also use “APRS-IS server filter settings” string (in APRS-IS Tab, default “m/40” should be good for initial tests) to tell APRS-IS server that you want to receive anything.

APRS-IS to RF forwarding is a complicated topic. All above settings were introduced to allow balanced and limited forwarding because RF capacity is much narrower than internet and shouldn't be overflowed with unnecessary traffic. Default setting of this Tab will allow you to forward everything from RF to APRS-IS (not dangerous) and forward messages from APRS-IS to local RF stations (shouldn't generate a lot of traffic). Other packets will not be forwarded from APRS-IS to RF.

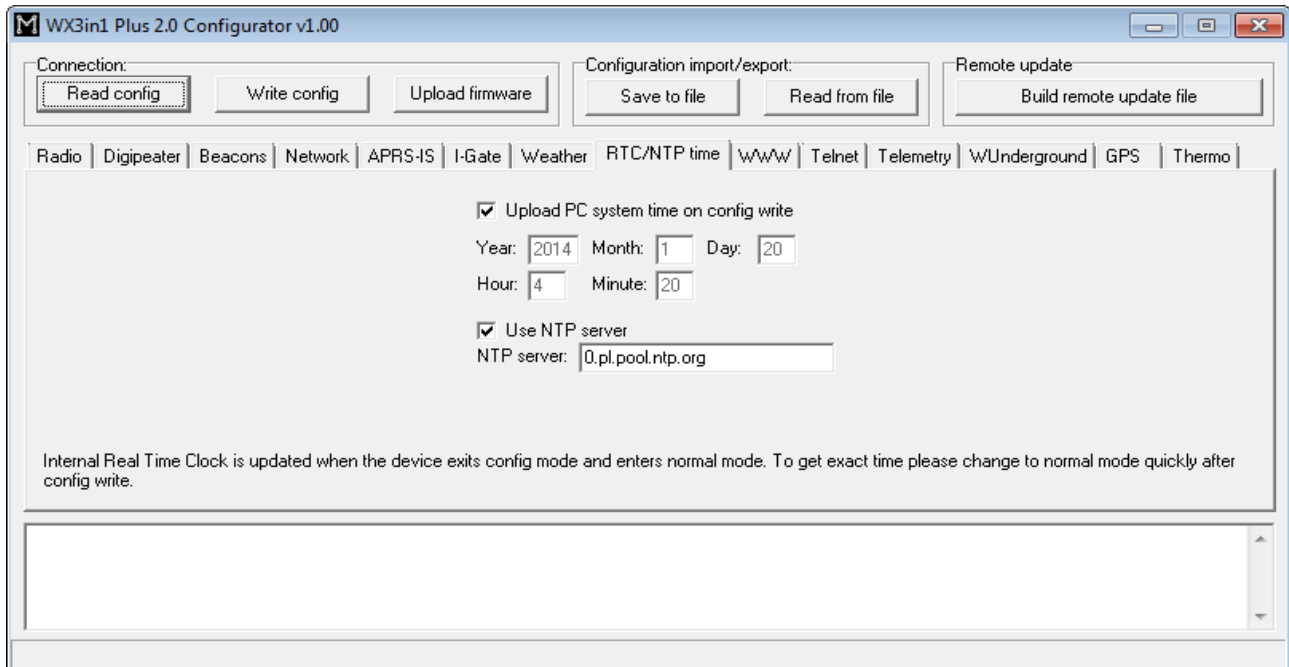
9.11. Weather Tab



- **“Weather station”** - weather station type selection box,
- **“Dest”** - destination field of a weather report.
- **“Path”** - APRS path (default value of WIDE2-2 will allow your device to be digipeated by most nearby digipeaters), if you leave this field empty, weather report will be sent without path,
- **“RF[min]”** - weather report transmit rate to RF (expressed in minutes), report will not be sent if this field is set to 0,

- “IS[**min**]“ - weather report transmit rate to APRS-IS (expressed in minutes), report will not be sent if this field is set to 0,
- “**Comment**“ - This is a short comment which will be appended at the end of weather report.

9.12. RTC/NTP Tab

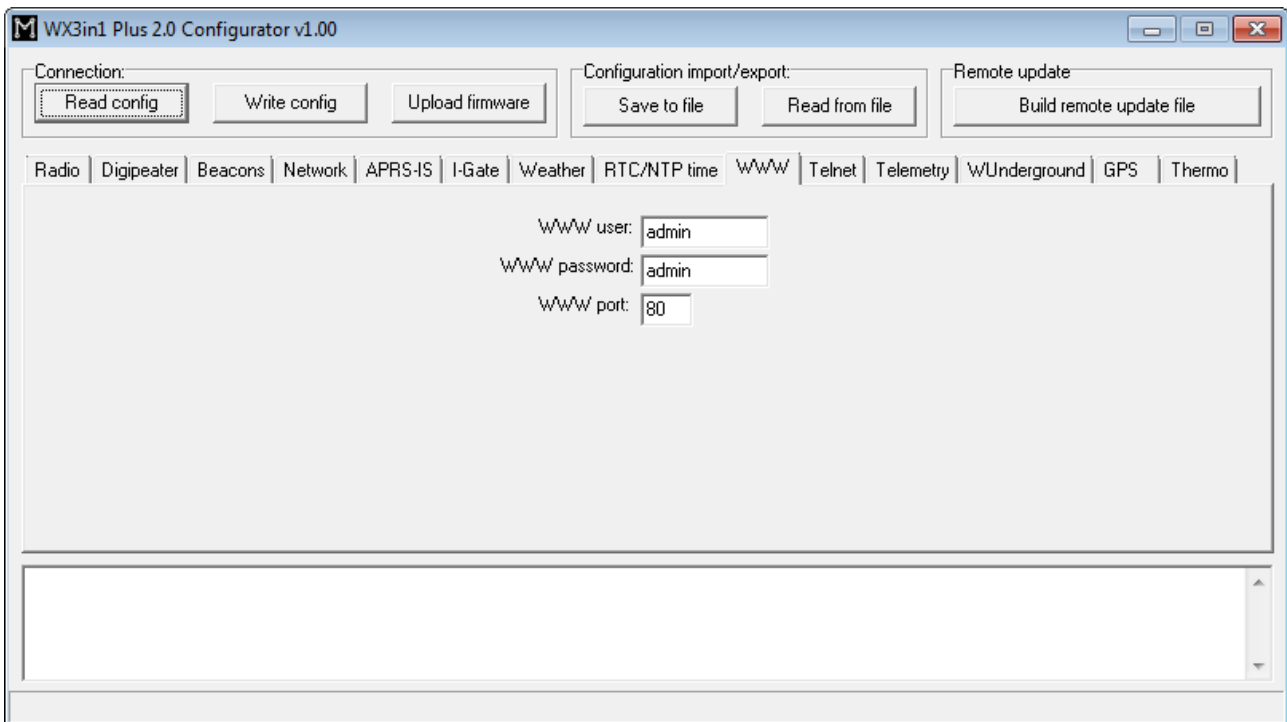


- “**Upload PC system time on config write**” - if this option is selected, application will ignore date and time fields visible below and will upload your PC system time on configuration write,
- “**Year**”, “**Month**”, “**Day**”, “**Hour**”, “**Minute**” - user-defined date and time for WX3in1 Plus 2.0,
- “**Use NTP server**” - if this option is selected, WX3in1 Plus 2.0 will periodically connect to defined network time server and will synchronize its clock,
- “**NTP server**” - domain name or IP of network time server, in some cases this can also be your router’s IP, if NTP option is active on your local network router.

Internal Real Time Clock is updated when the device exits config mode and enters normal mode. To get exact time please reboot your unit to normal mode quickly after config write.

If you enable “Use NTP server” option, time will be updated from Network Time Protocol server on the internet.

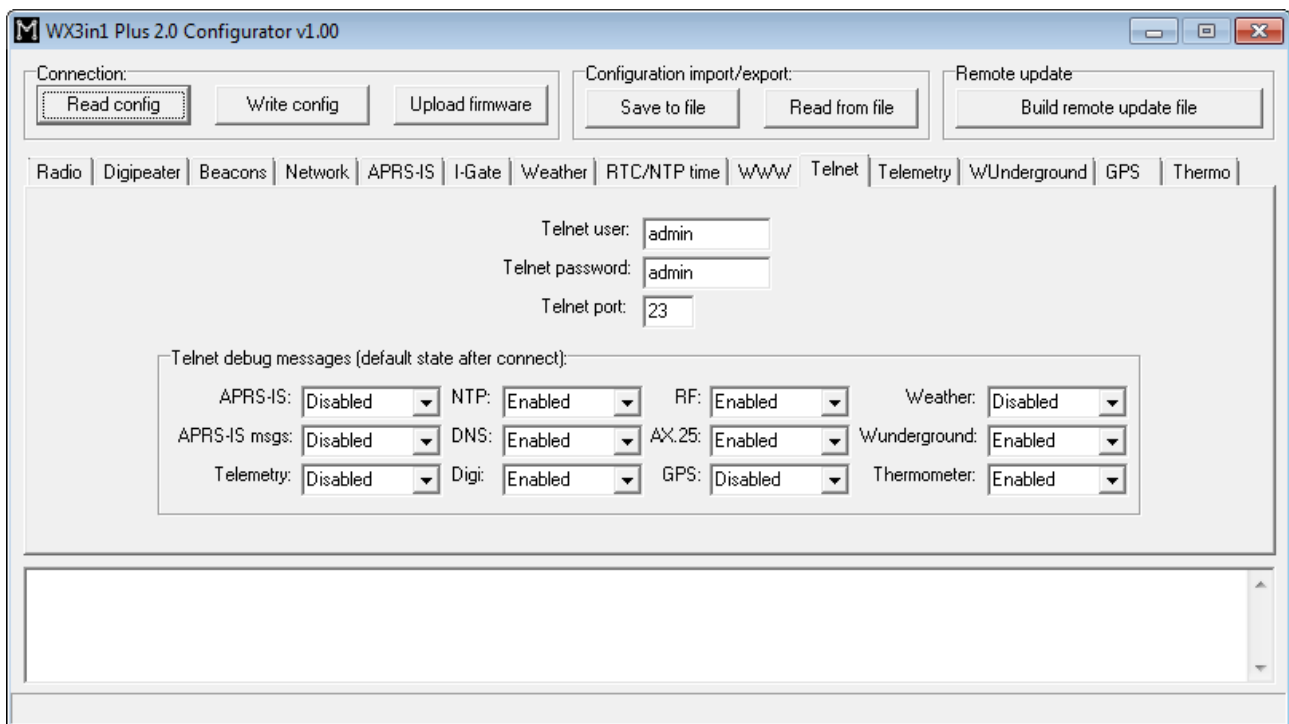
9.13. WWW Tab



- “**WWW user**” - username to access your WX3in1 Plus 2.0 web service,
- “**WWW password**” - password to access your WX3in1 Plus 2.0 web service,
- “**WWW port**” - web service IP port number.

To access your WX3in1 Plus 2.0 web service you should use a web browser and connect to WX3in1 Plus 2.0 IP address defined in Network Tab. For example, to connect to a device with IP address of 192.168.2.2 you should write <http://192.168.2.2/> in your web browser address field.

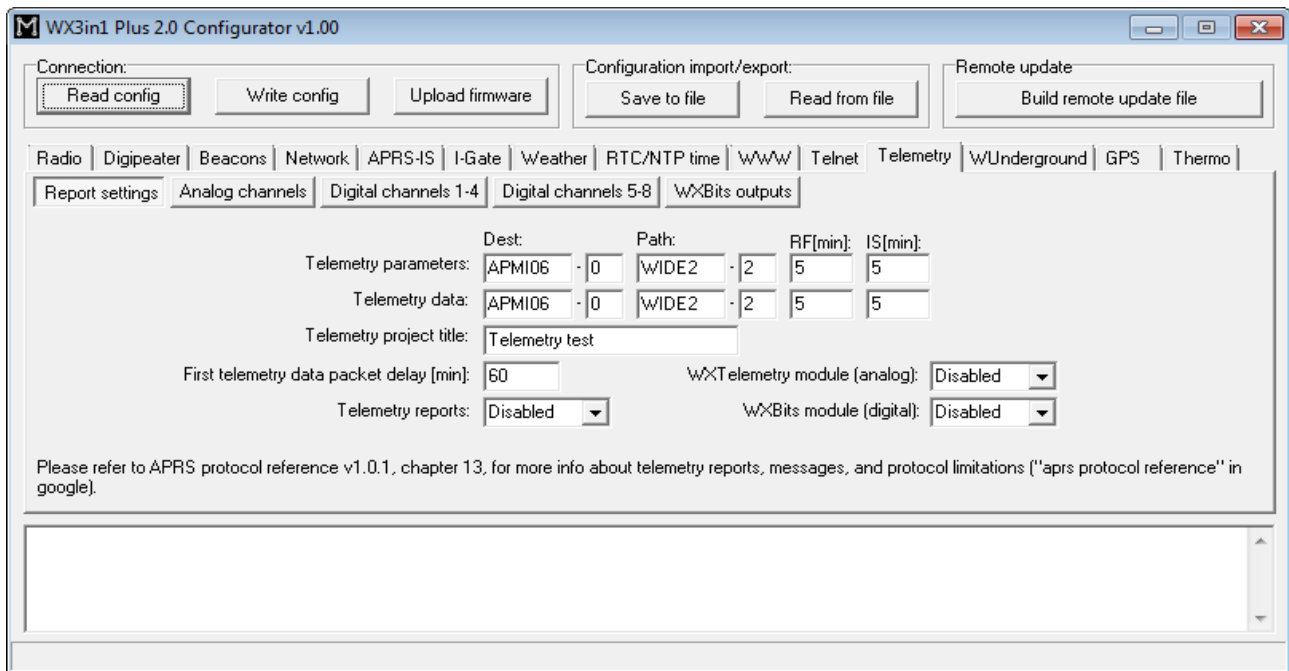
9.14. Telnet Tab



- **“Telnet user”** - username to access your WX3in1 Plus 2.0 telnet service,
- **“Telnet password”** - password to access your WX3in1 Plus 2.0 telnet service,
- **“Telnet port”** - telnet IP port number,
- **“Telnet debug messages”** - options in this group allow to select which telnet debug messages are on by default every time you connect to you WX3in1 Plus 2.0 with telnet terminal.

Telnet access can be very useful for debugging of your WX3in1 Plus 2.0 configuration and the whole installation. Skilled user can resolve most problems by analyzing debug messages sent by WX3in1 Plus 2.0 in a fashion similar to Linux system log. Recommended telnet client is Putty, a free implementation of terminal for Windows and Linux platforms: <http://www.chiark.greenend.org.uk/~sgtatham/putty/>.

9.15. Telemetry reports Tab



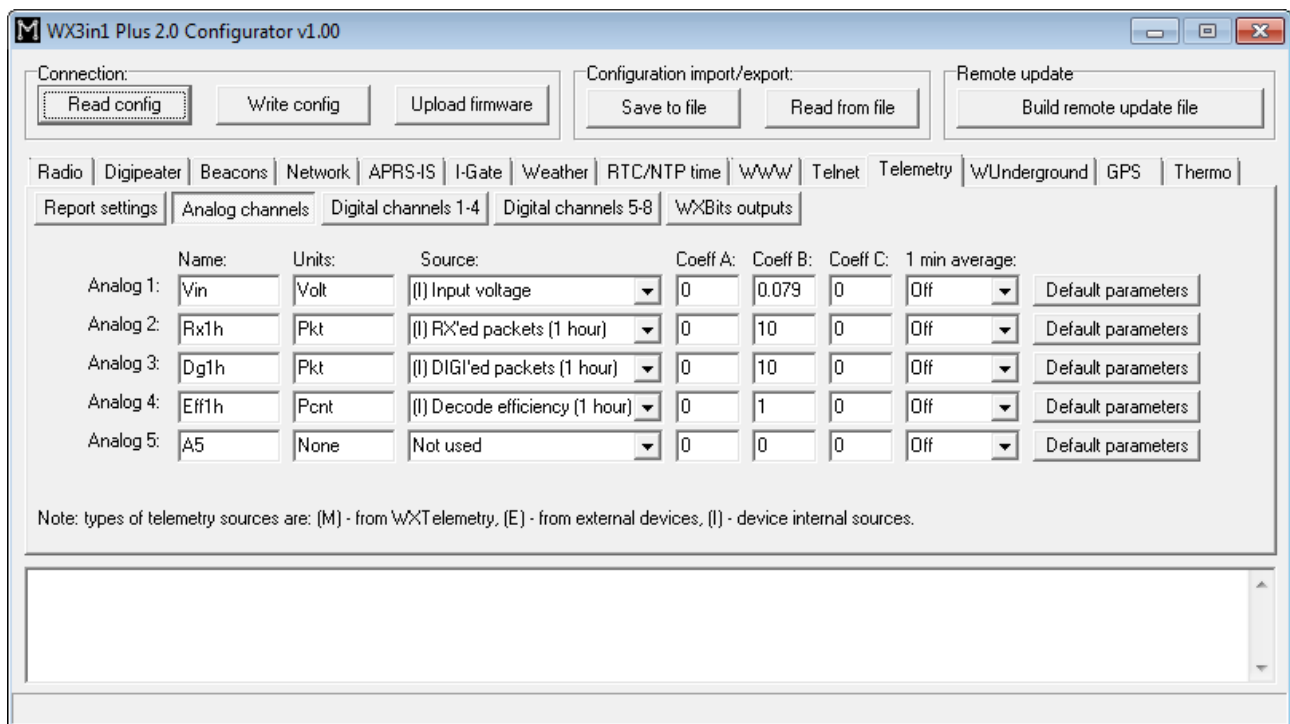
“Report settings” Tab:

- **“Telemetry parameters”** - this group of fields defines settings of PARM, UNIT, EQNS, and BITS parameter packets which describe the telemetry data sent by the device,
 - **“Dest”** - destination field of a telemetry parameters packet.
 - **“Path”** - APRS path (default value of WIDE2-2 will allow your device to be digipeated by most nearby digipeaters), if you leave this field empty, packet will be sent without path,
 - **“RF[min]“** - telemetry parameters packet transmit rate to RF (expressed in minutes), packet will not be sent if this field is set to 0,
 - **“IS[min]“** - telemetry parameters packet transmit rate to APRS-IS (expressed in minutes), packet will not be sent if this field is set to 0,
- **“Telemetry data”** - this group of fields defines settings telemetry data reports,
 - **“Dest”** - destination field of a telemetry data packet.
 - **“Path”** - APRS path (default value of WIDE2-2 will allow your device to be digipeated by most nearby digipeaters), if you leave this field empty, packet will be sent without path,
 - **“RF[min]“** - telemetry data packet transmit rate to RF (expressed in minutes), packet will not be sent if this field is set to 0,
 - **“IS[min]“** - telemetry data packet transmit rate to APRS-IS (expressed in minutes), packet will not be sent if this field is set to 0,
- **“Telemetry project title”** - this is a project name associated with the telemetry station, sent in BITS message,
- **“First telemetry data packet delay [min]”** - delay for the first telemetry data packet, it allows to gather data (especially for 10-min and 60-min report) after device power-up.
- **“Telemetry reports”** - if disabled, no telemetry description messages or

- telemetry data will be sent,
- **“WXTelemetry module (analog)”** - this box enables or disables WXTelemetry module support,
- **“WXBits module (digital)”** - this box enables or disables WXBits module support.

You can find more useful information about telemetry reports format in APRS specification: <http://aprs.org/doc/APRS101.PDF>, page 68.

Analog channels:



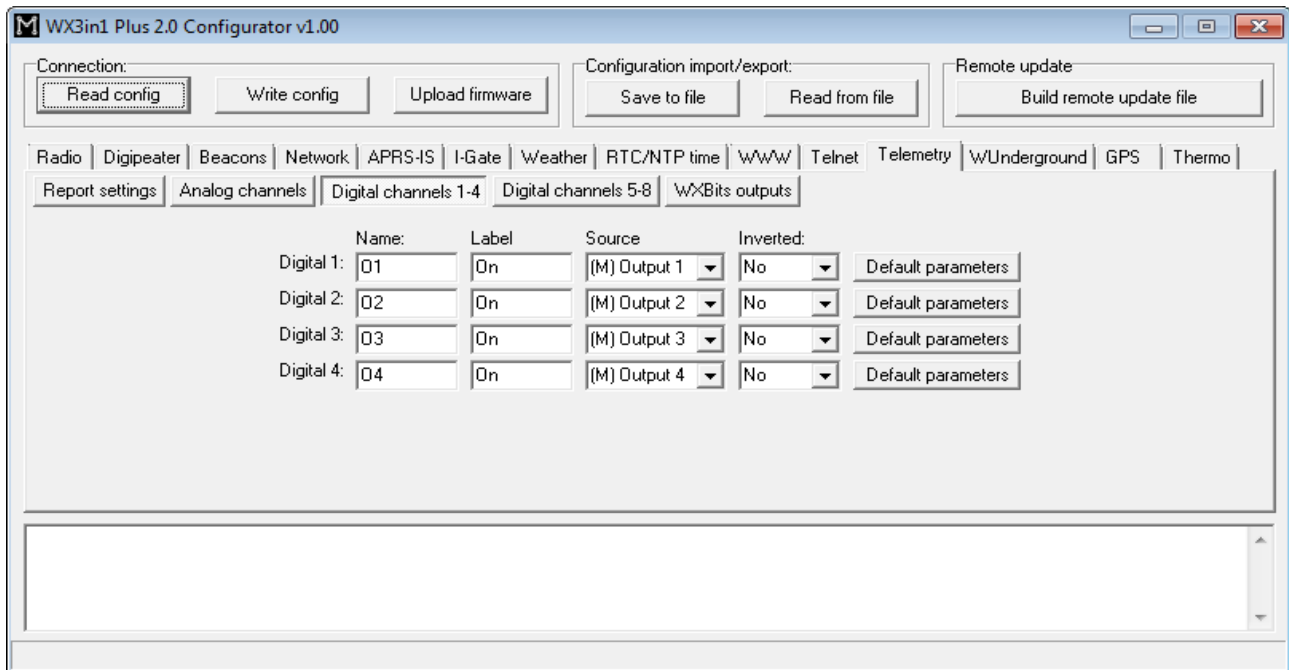
“Analog channels” Tab - defines 5 analog channels available in APRS telemetry reports. You can select many different sources for channels data, including external telemetry module data (M) and internal data (I),

- **“Name”** - short name for the channel, length is limited by APRS standard and is different for different channel numbers,
- **“Units”** - short name for units of data for the channel, length is limited by APRS standard and is different for different channel numbers,
- **“Source”** - most important field, specifies what data will be send for particular channel, (M) sources are associated with WXTelemetry module and (I) sources are associated with device’s internal statistics and measurements,
- **“Coeff A”, “Coeff B”, “Coeff C”** - these coefficients tell recipients of the telemetry reports how to decode analog value in following form:
 $value = A * data * data + B * data + C$,
- **“1 min average”** - only functional for external telemetry module data (M), defines if reported values are averaged or not,
- **“Default parameters”** - you should click this button after you change data source for the channel. It loads default coefficient values and name/units for a channel.

Important note: If you change “Source” field for a channel, you also need to change

“Name”, “Units”, and “Coeffs” fields. Otherwise everyone else who receive your data (including web services like aprs.fi) will not be able do decode your reports properly. Every source has its own coefficients, names and units. With USB Configurator you can get default settings by clicking on “Default parameters” button. When changing configuration via WWW you need to set these fields manually (you can always write them down from USB Configurator application).

Digital channels:

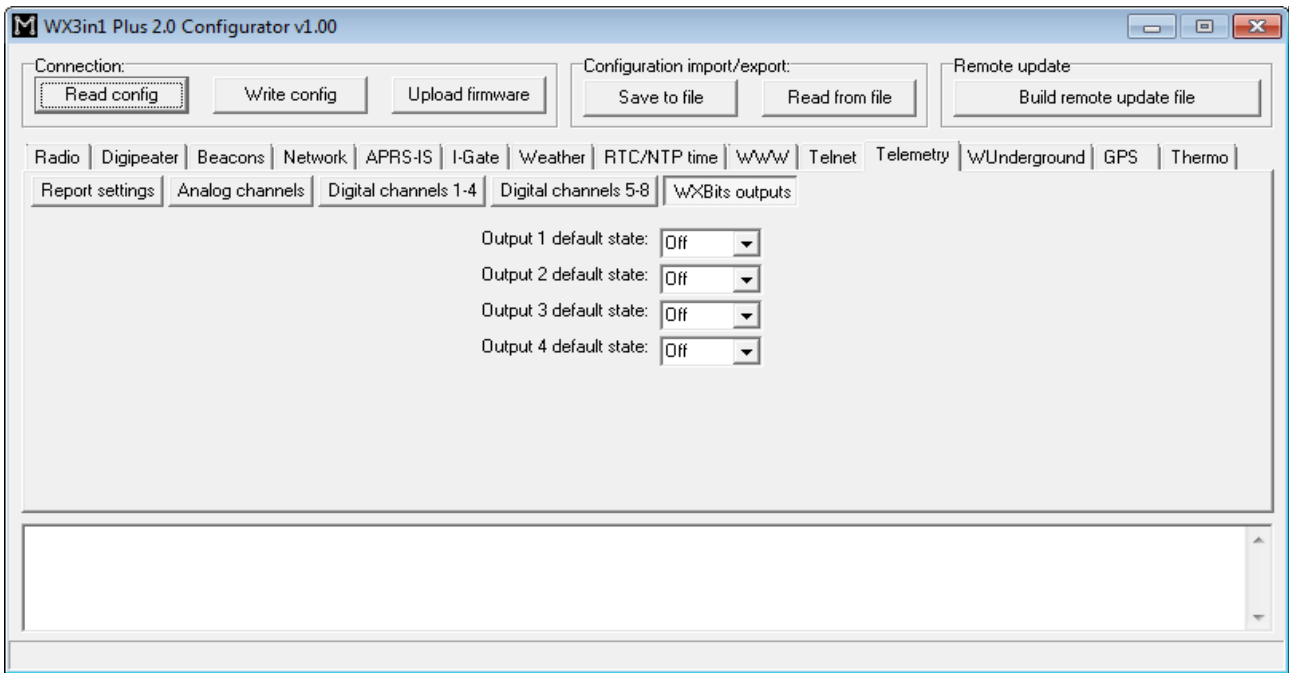


“Digital channels 1-4” and “Digital channels 5-8” Tabs - define 8 digital channels available in APRS telemetry reports. These tabs should be used when WXBits module is connected,

- “Name” - short name for the channel, length is limited by APRS standard and is different for different channel numbers,
- “Label” - short label for the channel, length is limited by APRS standard and is different for different channel numbers,
- “Source” - most important field, specifies what data will be send for particular channel, (M) sources are associated with WXBits module,
- “Inverted” - defines if channels should be reported as inverted in BITS telemetry message,
- “Default parameters” - you should click this button after you change data source for the channel. It loads default coefficient values and name/units for a channel.

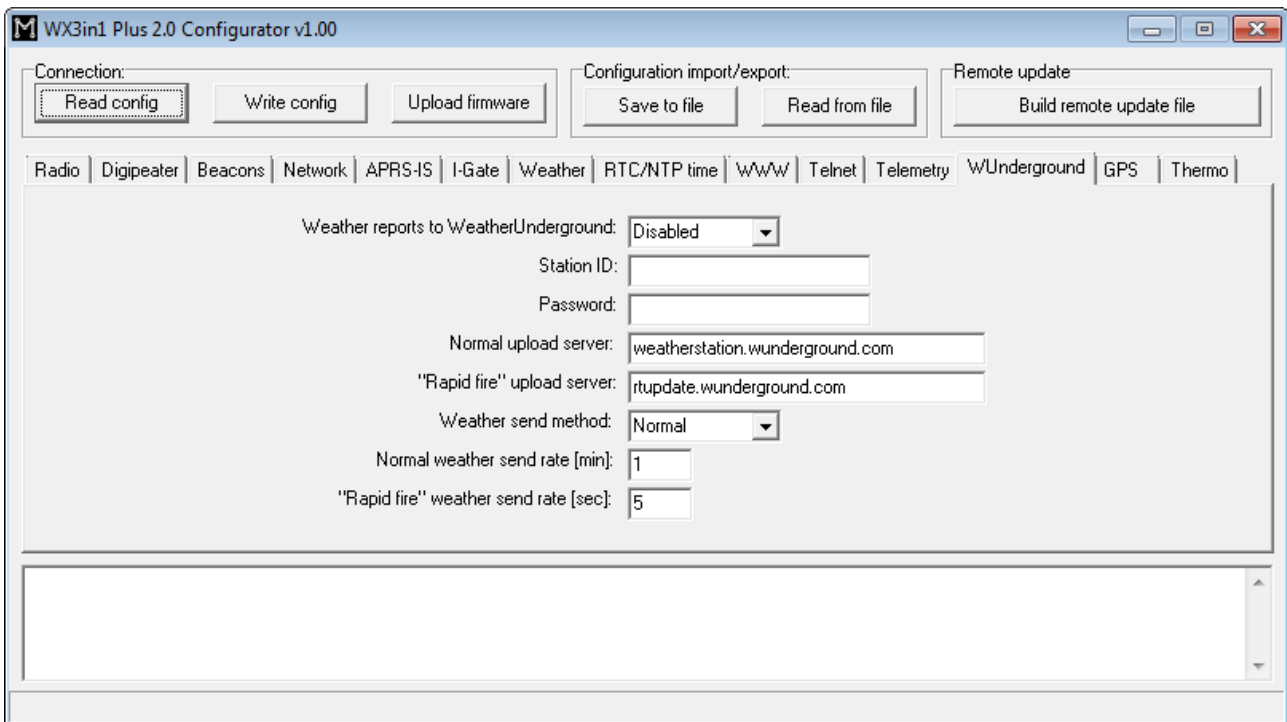
Important note: If you change “Source” field for a channel, you also need to change “Name”, “Label”, and “Inverted” fields. Otherwise everyone else who receive your data (including web services like aprs.fi) will not be able do decode your reports properly.

Wxbits outputs (default state after power-up):



“WXBits outputs” - this Tab defines what should be the default states for WXBits output channels. After power-up WX3in1 will constantly try to set outputs to the defined states, unless changed by the user.

9.16. WeatherUnderground Tab



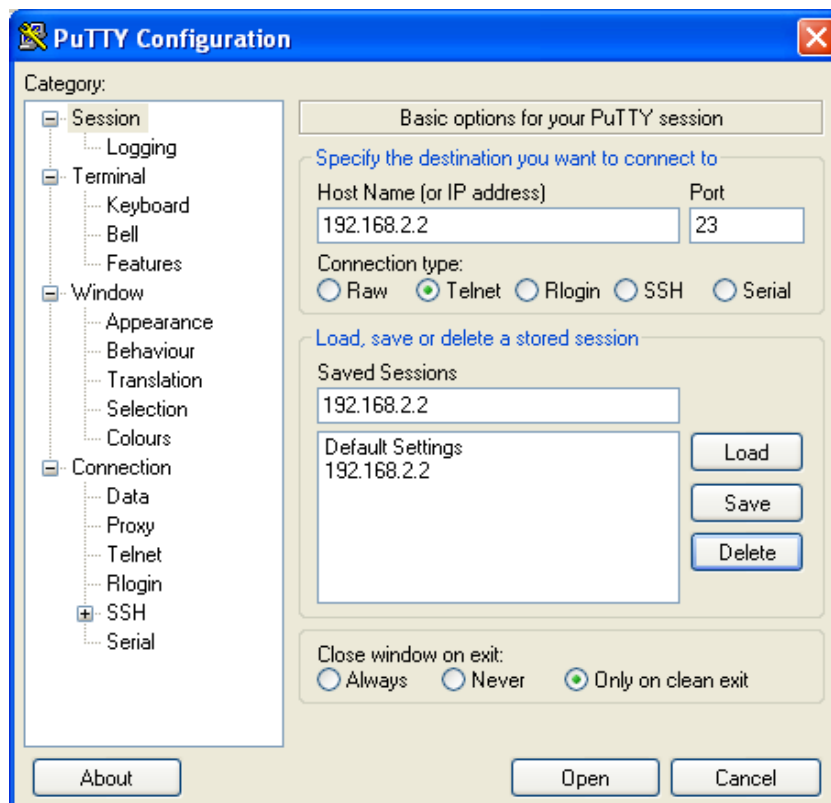
- **“Weather reports to WeatherUnderground”** - enables WeatherUnderground reporting in your WX3in1 Plus 2.0 device,
- **“Station ID”** - ID of the station assigned when you were adding a station in WeatherUnderground account settings on their web page,
- **“Password”** - password of your WeatherUnderground account (as far as I know, it is the same for all stations on your account if you have more than one),
- **“Normal upload server”** - this is WeatherUnderground server name for report reception, you should leave it as is,
- **“Rapid fire upload server”** - this is WeatherUnderground server name for “rapid fire” report reception, you should leave it as is,
- **“Weather send method”** - this option allows you to select between “rapid fire” realtime frequent report update or normal report update every few minutes,
- **“Normal weather send rate [min]”** - Frequency of normal report update (in minutes),
- **“Rapid fire weather send rate [sec]”** - Frequency of “rapid fire” realtime report update (in seconds).

10. Telnet interface

Telnet interface is a very good method to see what happens inside of your WX3in1 Plus 2.0 device. It provides you with a lot of debugging messages and statistics, which allows you to locate any potential problems and solve them.

10.1. Telnet client software

To connect to WX3in1 Plus 2.0 telnet interface you will need to download one of telnet client applications available over the internet. I recommend you to use an open source “putty” application for this task. You can find it here: <http://www.putty.org/>.



To configure “putty” as a telnet terminal for WX3in1 Plus 2.0 you need to set the following fields (visible above):

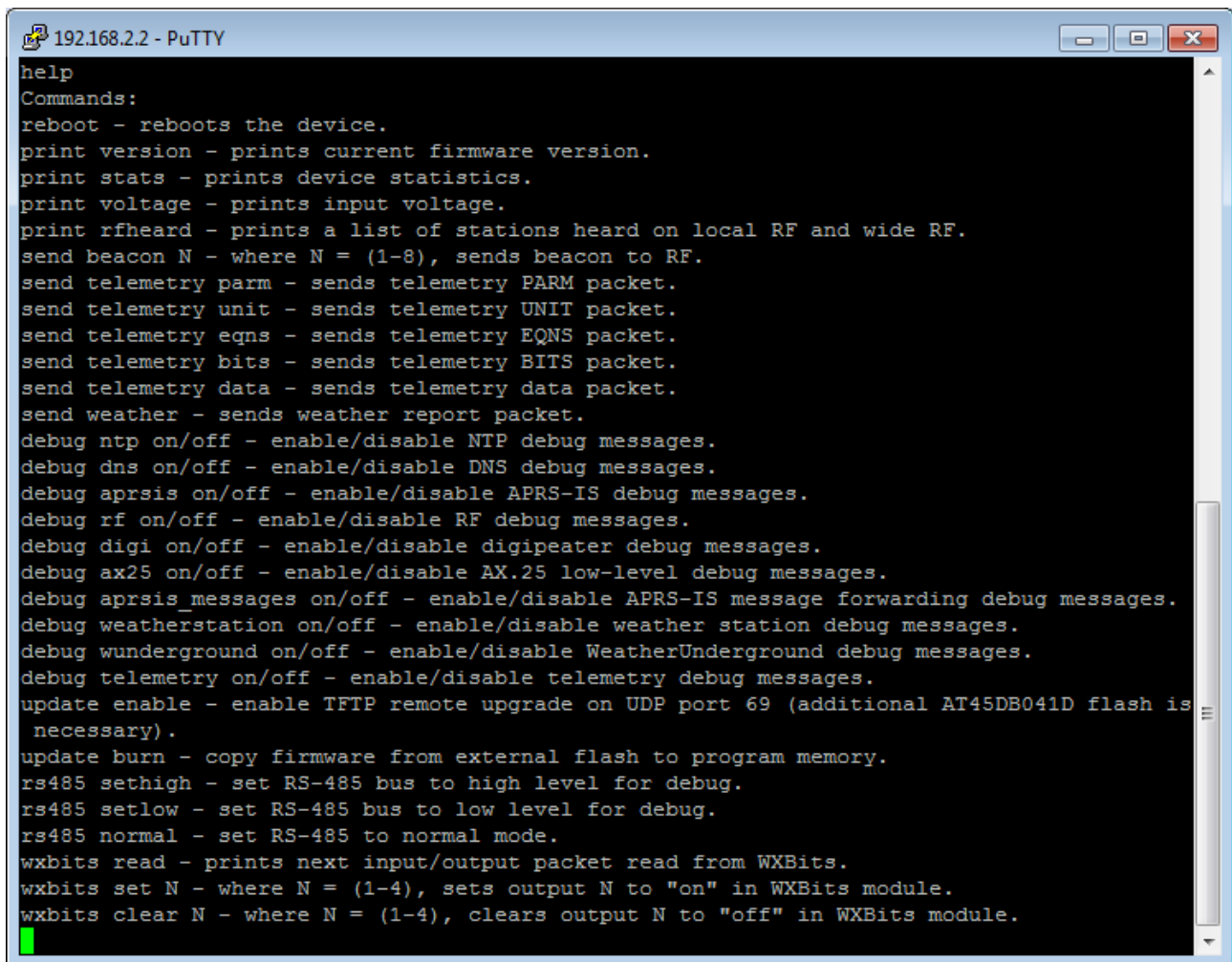
- Host Name (or IP address) - this is your WX3in1 Plus 2.0 network IP address,
- Connection type: Telnet (this is important, as we want to use a simple telnet interface),
- Port - this should be set the same as “Telnet port” in your device's configuration.

After setting proper values you can save them with a “Save” button.

Connect to your device with “Open” button. Then you should see a black window of your telnet terminal with a prompt for your “Username” and “Password”. Use the values from your device's configuration.

10.2. Telnet commands

For a list of available WX3in1 Plus 2.0 telnet commands please issue “help” command, you should see a full list as below:



```
192.168.2.2 - PuTTY
help
Commands:
reboot - reboots the device.
print version - prints current firmware version.
print stats - prints device statistics.
print voltage - prints input voltage.
print rfheard - prints a list of stations heard on local RF and wide RF.
send beacon N - where N = (1-8), sends beacon to RF.
send telemetry parm - sends telemetry PARM packet.
send telemetry unit - sends telemetry UNIT packet.
send telemetry eqns - sends telemetry EQNS packet.
send telemetry bits - sends telemetry BITS packet.
send telemetry data - sends telemetry data packet.
send weather - sends weather report packet.
debug ntp on/off - enable/disable NTP debug messages.
debug dns on/off - enable/disable DNS debug messages.
debug aprsis on/off - enable/disable APRS-IS debug messages.
debug rf on/off - enable/disable RF debug messages.
debug digi on/off - enable/disable digipeater debug messages.
debug ax25 on/off - enable/disable AX.25 low-level debug messages.
debug aprsis_messages on/off - enable/disable APRS-IS message forwarding debug messages.
debug weatherstation on/off - enable/disable weather station debug messages.
debug wunderground on/off - enable/disable WeatherUnderground debug messages.
debug telemetry on/off - enable/disable telemetry debug messages.
update enable - enable TFTP remote upgrade on UDP port 69 (additional AT45DB041D flash is
necessary).
update burn - copy firmware from external flash to program memory.
rs485 sethigh - set RS-485 bus to high level for debug.
rs485 setlow - set RS-485 bus to low level for debug.
rs485 normal - set RS-485 to normal mode.
wxbits read - prints next input/output packet read from WXBits.
wxbits set N - where N = (1-4), sets output N to "on" in WXBits module.
wxbits clear N - where N = (1-4), clears output N to "off" in WXBits module.
```

Telnet command list can be different for new firmware versions. We will not discuss all possible commands in this section. Just a short description of command types:

- print - used to print some data in your telnet terminal window,
- send - used to send test packets to RF,
- debug - used to turn on or off some debug messages in your telnet terminal window,
- update - used for remote firmware update function,
- rs485 - used to set levels on RS-485 bus for cable connection test,
- wxbits - used to read WXBits inputs and change WXBits output levels.

11. Troubleshooting

In this section we will describe some possible problem encountered by users of WX3in1 Plus 2.0 device and try to help you to solve them.

Question: What should I set in APRS-IS Username and Password field?

Answer: In Username field you should set the same string as your WX3in1 Plus 2.0 callsign and SSID, separated by a hyphen. It should be written in uppercase. Example: SQ3PLX-5.

For your APRS-IS password you should ask your APRS-IS server operator. Some password generators are also available on the internet.

Question: I think that my device doesn't connect to APRS-IS or NTP (network time protocol server) or WeatherUnderground, etc. Why?

Answer #1: Check your WX3in1 Plus 2.0 device physical connection to you local network. After connecting RJ-45 network cable, you should check a led on your router or switch, is should be lit, indicating proper physical connection. If it is OK, go to answer #2.

Answer #2: Check your device's IP settings including IP address, IP mask, Gateway and DNS settings in "Network" Tab.

Try to ping your device with "ping <wx3in1 ip address>" command from your operating system's command prompt. It should answer to your pings. Make sure that your gateway IP is set to your network router's IP. If it is not, you will still be able to ping the device, but it will not be able to get out of your local network. If it is OK, go to answer #3.

Answer #3: There can be many other different reasons. But if you feel that your settings are correct and it doesn't connect to any of these services, then it can be problem of your DNS settings. Below you can see how to check this over telnet:

```
00:25:47 (DNS) Server name not found, need to nslookup: time.nist.gov.
```

```
00:26:03 (DNS) Server name nslookup timed out: time.nist.gov.
```

The first line means that server "time.nist.gov" is not known to your WX3in1 Plus 2.0 device. That is OK, it just needs to ask DNS for this server's IP.

The second line means a problem: DNS server didn't answer to your query. You have probably misconfigured your DNS server IP.

You should check your internet service provider's proper DNS IP address. In some cases you can also use your network router's IP address as a DNS, because most network routers are able to do DNS relaying.

If your DNS settings are wrong, you will not be able to connect to any service with it's domain name.

Question: I'm not sure if my device receives APRS packets properly from my radio. How to check this?

Answer: The first and most obvious indicator of proper packet reception is a red "PC/PACKET" led of your WX3in1 Plus 2.0 device. It should work like that:

- When there is something received and radio squelch is open, yellow "RADIO RX" led lights up,
- Shortly after packet reception red "PC/PACKET" led lights up indicating proper

packet reception and decoding.

You can also use telnet to check if anything was received properly. You should see a message indicating that an APRS packet was received.

Next method is to check telnet “print stats” command or check WWW Statistics page to see if there is a non-zero value in “APRS packet received (CRC OK)” field.

Question: I'm not sure if my device sends APRS packets to RF properly. How to check this?

Answer: Well, the simplest method is to check with the second APRS radio if it receives any APRS packets from you.

You can also check on aprs.fi if your packets appear on APRS-IS, i-gated by some other devices near you. But to use this method you should:

- make sure that there is an APRS i-gate near you that is able to hear your APRS packets,
- disconnect RJ-45 cable from your WX3in1 Plus 2.0 device or turn APRS-IS off in your beacon settings, because otherwise all your packets will be visible on aprs.fi gated by your own device (even with radio disconnected).

You can also check telnet messages for any received packets which were sent by your device and then digipeated by other stations nearby.

Question: How to check if my device receives data from weather station / telemetry module / GPS / thermometer?

Answer: Green “EXT” led is an answer. It should blink in short time intervals indicating that your external device is fine and that your WX3in1 Plus 2.0 device receives correct data. “EXT” led is shared between all external devices connected to your WX3in1 Plus 2.0. So if you want to use it as an indicator for one of them, you will need to disconnect others.

You should also see some external device debug messages over telnet which will give you an exact answer if they are connected properly.

Question: After some configuration changes and/or firmware update, my device constantly blinks all the leds and doesn't start up. Why?

Answer: It is necessary to use matching Configurator application, device configuration and device firmware versions. If you download new Configurator application version, you should always update device's firmware and rewrite device's configuration to make sure that all versions match.

Remember that you can't just update a firmware of the device. You always need to rewrite configuration. You also can't read your current configuration if you use different Configurator application and device firmware/configuration version.

Use “Configuration import/export” function to store configuration on your PC hard disk drive each time you change your device configuration settings. Then you will be able to import your configuration in new Configurator application.

Unfortunately these operations are unavoidable as device configuration often changes between firmware versions and new firmware does not understand older configuration.