

# PLXTRACKER (v1.02)

MIC-E/BASE-91/PLAIN TEXT POSITION REPORTING  
INTERNAL 512KB POSITION MEMORY  
SIMPLE ALIAS-BASED APRS PACKET DIGIPEATER  
MULTIPATH APRS DECODING ALGORITHM  
WEATHER STATION SUPPORT  
EXTERNAL TELEMETRY MODULE SUPPORT  
INPUT VOLTAGE MEASUREMENT  
SERIAL DEBUG INTERFACE FOR ADMINISTRATION  
EASY USB-HID PROGRAMMING

Instruction manual  
Configuration software manual



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## 1. Technical parameters

Dimensions	94x50x25 mm
Weight	70g
Supply voltage	12VDC typ. (9 - 16VDC)
Power consumption	50mA
Operation temperature	-30 °C / +70 °C
Humidity	95% max.
Power, radio, telemetry connector	DB-9 male
Serial ports connector	Mini DIN 6-pin female

## 2. Device features

### 2.1. Mic-E/Base-91/Plain text position reporting

The main feature for an APRS tracker is position reporting. PLXTracker allows you to select between three most common position reporting formats:

- Mic-E - uses both AX.25 destination address and information field for position report and is the most compact reporting method, giving the shortest packet length,
- Base-91 - second compressed method oriented to short report packet length,
- Plain text - in this method station position report is sent in human-readable plain text format,

You can also select between fixed time interval reporting which means that packets are sent every X number of seconds, and SmartBeaconing. SmartBeaconing is an algorithm which sends position reports with intervals dependant on speed and course, allowing for more accurate reporting especially in urban area. SmartBeaconing algorithm was first developed by Tony Arnerich KD7TA and Steve Bragg KA9MVA and now it is widely used by most APRS tracker devices.

### 2.2. Internal 512KB position memory

Internal device flash memory allow you to store your position history with second by second resolution. You can store more than 20000 history point which include:

- latitude,
- longitude,
- course,
- speed,
- altitude
- time and date,

This feature allows the device to remember 5 hours of position history with second by second resolution or much more with slightly lower resolution like 10 seconds between points. You can simply read stored position history via USB and export them back to NMEA sentences which can be visualized on-line in most internet map services.

### 2.3. Multipath APRS decoding algorithm

In PLXDigi/PLXTracker family of devices we resigned from hardware packet decoding method. MultiPath APRS packet decoding algorithm is a digital signal processing based method utilizing features of modern 32-bit microcontrollers used in our devices.

MultiPath decoding allows to decode received packets simultaneously by two decoding alogorithms, with different digital filters applied to both paths. Packets distorted by low-frequency components or with imbalanced 1200/2200Hz tones are prefiltered which increases the probability of correct packet decoding.

### 2.4. Simple alias-based APRS packet digipeater

With PLXTracker you can do a simple alias-based APRS packet digipeating. Generally APRS tracker units should not be used as a full-featured digipeaters but with alias-based feature you can digipeat WIDE1-1 packets sent by other mobiles increasing their chance of reaching an I-Gate.

## 2.5. Weather station support

PLXTracker allows you to receive weather data from compatible weather stations over RS-232 serial interface. Currently supported stations are:

- 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 RS-232 datalogger),
- Davis Vantage Pro2 (with RS-232 datalogger),
- Davis Vantage Pro Plus (with RS-232 datalogger),
- Davis Vantage Pro2 Plus (with RS-232 datalogger),

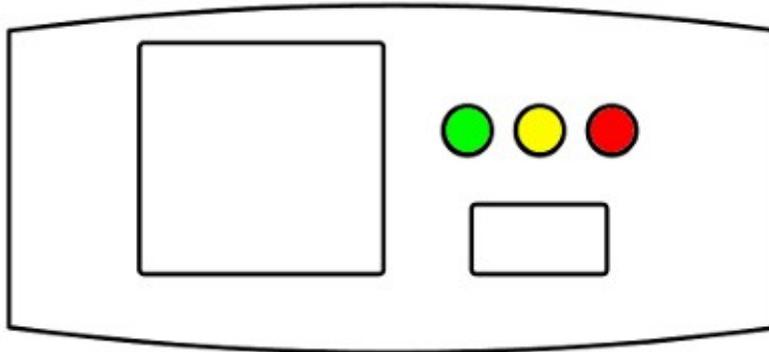
## 2.6. External telemetry module support

You can use an additional telemetry module for reporting of voltages and electric current values of your installation. This is especially useful for monitoring of solar panel powered systems on remote sites. WXTelemetry module allows you to read 2 voltages, 2 currents and one temperature, then sends these values as APRS telemetry reports to RF.

## 3. Connectors and device status leds

### 3.1. Front panel

There are 3 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:

- **Green LED** - illuminates when receiving a signal from the radio (indicates the channel is busy),
- **Yellow LED** - lights during transmission, when the device sends an APRS data packet,
- **Red LED** - blinking is dependent on current device state:
  - one short blink (0.1 second) per 1.6 seconds - no GPS NMEA sentence received within last second, GPS disconnected,
  - two short blinks (0.1 second each) per 1.6 seconds - GPS NMEA sentence received but no position fix,
  - three short blinks (0.1 second each) per 1.6 seconds - GPS NMEA sentence received with position fix,
  - one long blink (1 second) per 1.6 seconds - APRS packet was properly received.

Connectors:

- **Mini DIN 6-pin** - two RS-232 serial data interfaces,
- **Mini USB** - a mini USB socket, used to connect to a computer for configuration,

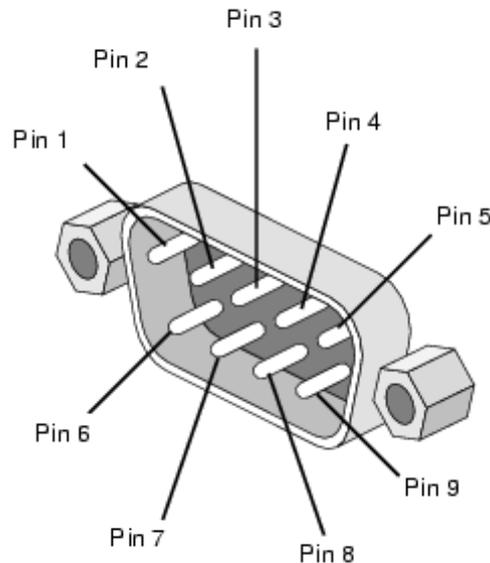
### 3.2. Rear panel

Connectors:

- **DB9 male connector** - used for connecting of supply voltage, radio, and RS-485 telemetry module.

## 4. Power, radio, RS-485 connector

DB-9 male connector is used for supply voltage input, audio in, audio out, ptt, and RS-485 bus for telemetry and other external devices.



DB9 connector pins description:

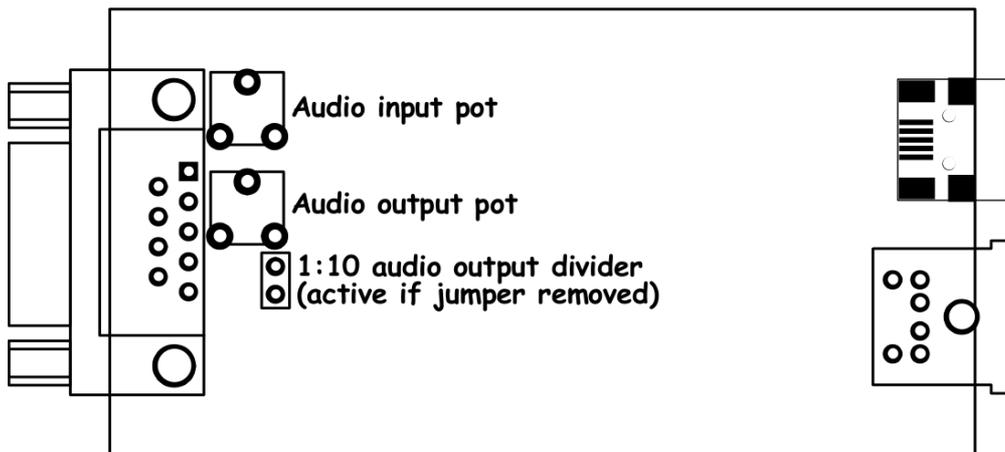
- Pin 1 - PTT output, open collector, if the external PTT output is selected in device configuration, this pin is shorted to ground while broadcasting,
- Pin 2 - GND,
- Pin 3 - GND,
- Pin 4 - APRS audio input from radio to PLXTracker,
- Pin 5 - GND,
- Pin 6 - RS-485 A+ positive differential input/output,
- Pin 7 - RS-485 B- negative differential input/output,
- Pin 8 - 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),
- Pin 9 - supply voltage input.

The level of input and output should be individualized in such a way that packets are decoded correctly. Audio levels can be regulated using potentiometers placed on a PCB inside of the device.

### 4.1. Audio output level regulation

Audio output level is regulated after production to some default value. The most suitable value is dependent on the radio used, because of various input impedance of different radios (for example, most Motorola radios have a strong DC voltage bias on the front audio input connector, so the output driver should be set to drive a stronger signal on the output to overcome this bias voltage). If you need to adjust output level, you can use a potentiometer located inside the device. To do that, you will need to open the

case and gain access to the PCB of the device. Output signal should be set to achieve the desired modulation depth at the output of the radio.



## 4.2. Audio input level

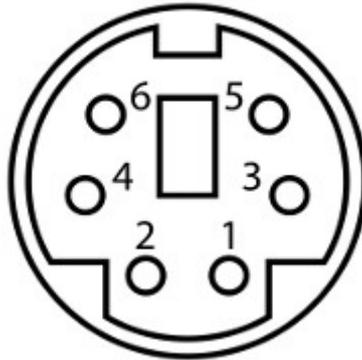
Audio input level should be regulated for proper packet decoding. There is no easy way to tell you how to do in properly because you will not be able to measure your signal level without an oscilloscope or similar equipment.

There is a 1000 Ohm potentiometer on the input. The best method for first try is to set in on a neutral center position. Audio input after the potentiometer should not exceed about 400mV and should not be below 25mV. So on device input you should provide audio level of around 50-800mV (for potentiometer in neutral position).

Our tests revealed that decoding works fine for wide range of audio input levels. Packets were decoded properly even with audio input overdriven with a high audio signal from speaker outputs.

## 5. Serial ports connector

In PLXTracker 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,
- Pin 4 - RS-232 Port 2 TXD,
- Pin 2 - GND,
- Pin 1 - 5V output, do not short-circuit, max. current 100mA,
- Pin 3 - RS-232 Port 1 TXD,
- Pin 5 - RS-232 Port 2 RXD.

RS-232 Port 1 and Port 2 functions are selectable in software.

## 6. Connecting the weather station

### 6.1. LaCrosse/Technoline WS-2300, WS-2350 stations

These stations are somehow problematic when you try to use them with RS-232 interfaces other than personal computer serial ports.

WS-23XX stations need an additional polarization positive and negative voltage on pin 4 and pin 7 of DB9 connector. For that purpose we can use our 5V voltage output, but we will also need to use the second RS-232 port's TXD line for negative voltage polarization. If you want to use WS-23XX weather stations, you will not be able to use your second RS-232 port for any other purpose (so both ports are used by WS-23XX weather stations).

### 6.2. Peet Bros Ultimeter stations

For Peet Bros Ultimeter weather stations, you need to use RXD, TXD, and GND lines of PLXTracker serial interface. 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".

### 6.3. Davis Vantage stations

To connect PLXTracker to Davis weather stations you need to use an additional RS-232 "datalogger" interface available from the manufacturer. Device part number is 06510SER. You need to use RXD, TXD and GND lines of PLXTracker serial interface.

## 7. Connecting to PC

Configuration of PLXTracker can be done via USB interface with PLXTracker Configurator software.

PLXTracker enters into configuration mode only when USB cable is detected while powering up and it is indicated by Red LED blinking.

To connect to your computer, follow these steps:

- Disconnect PLXTracker DB-9 cable, device should be unpowered,
- Connect the USB cable from your computer to PLXTracker, Red LED should start to blink (device is now powered from USB),
- Now you can use PLXTracker Configurator for device configuration read/write or firmware update.

PLXTracker device appears as USB-HID device in Windows operating system, and should be detected automatically. Therefore you don't need to install any device drivers for PLXTracker.

## 8. Description of configuration software

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

### 8.1. 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 PLXTracker internal memory.

### 8.2. Writing configuration to the device

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

### 8.3. Firmware update

If there is a new software update, you should upload the new firmware attached to PLXTracker Configurator software package. For this purpose, click on the **“Upload firmware”** button, this operation will open a file selection window. From PLXTracker Configurator folder please select the firmware file `plxtracker_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.

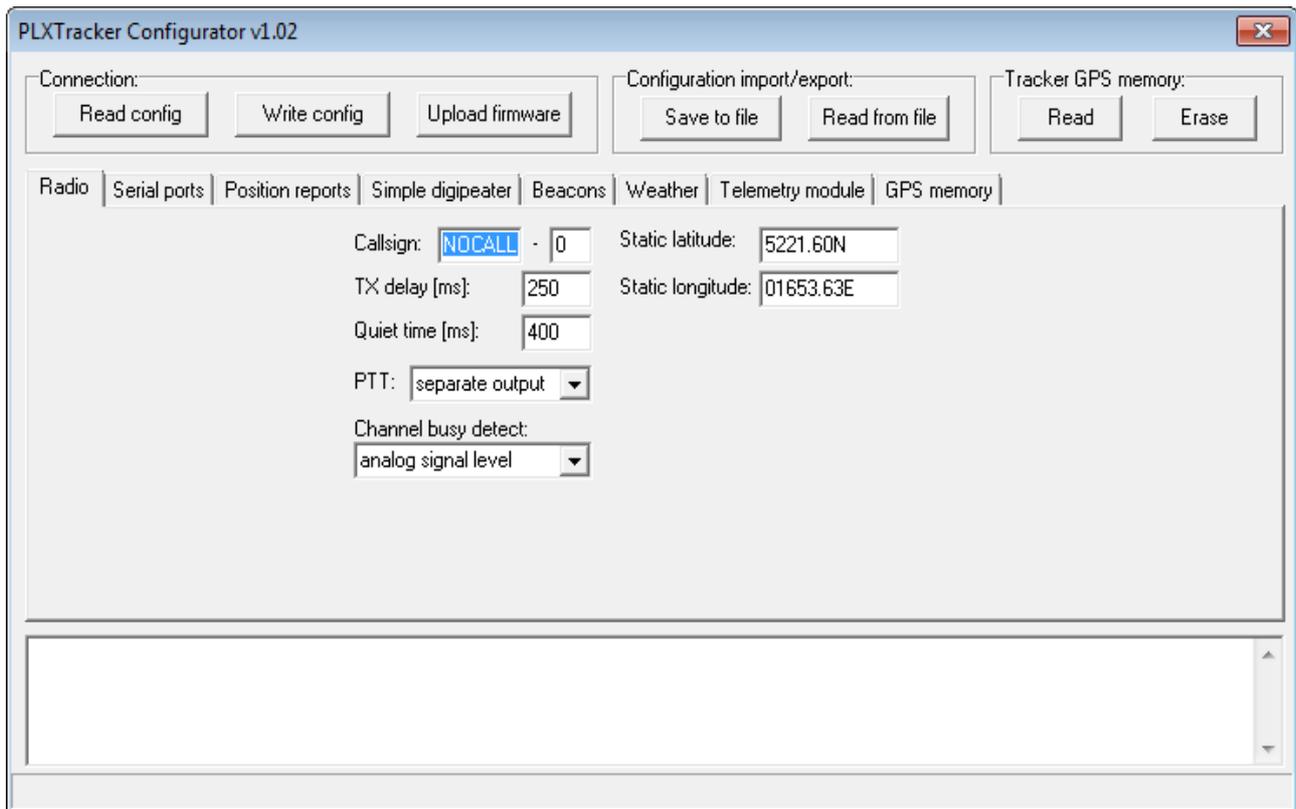
### 8.4. Configuration import/export

With **“Save to file”** button you can export your current configuration from PLXTracker 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 PLXTracker 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.

### 8.5. Tracker GPS memory

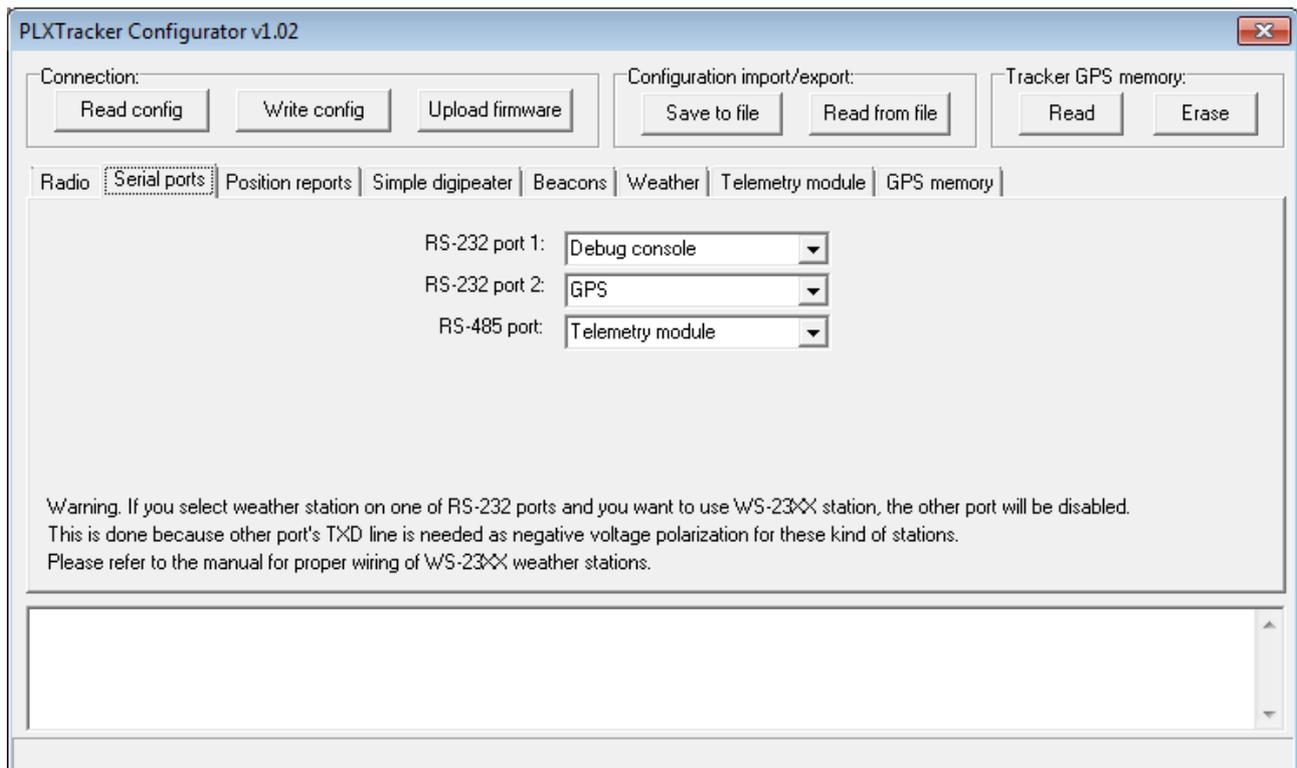
**“Read”** button is used to read position points from internal flash memory, and **“Erase”** button is used to remove all points from internal flash memory.

## 8.6. Radio Tab



- **“Callsign”** - The sign of our 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,
- **“TX delay (ms)”** - The 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,
- **“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 broadcasting,
- **“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,
- **“Latitude”** - north-south position of your radio station (this a static position which can be used if GPS is not connected),
- **“Longitude”** - east-west position of your radio station (this a static position which can be used if GPS is not connected).

## 8.7. Serial ports Tab



- “**RS-232 port 1**” - selects the feature of PLXTracker serial port 1,
  - “**None**” - nothing will be output on port 1,
  - “**Weather station**” - port 1 will be used as weather station interface,
  - “**Debug console**” - port 1 will be used as debug console,
  - “**Negative voltage output**” - port 1 TXD will be set to RS-232 logic high which means a negative voltage of around -6V (necessary when WS-23XX station is connected to the other port),
  - “**GPS**” - port 1 will be used as an input for GPS NMEA sentences,
- “**RS-232 port 2**” - selects the feature of PLXTracker serial port 2,
  - “**None**” - nothing will be output on port 2,
  - “**Weather station**” - port 2 will be used as weather station interface,
  - “**Debug console**” - port 2 will be used as debug console,
  - “**Negative voltage output**” - port 2 TXD will be set to RS-232 logic high which means a negative voltage of around -6V (necessary when WS-23XX station is connected to the other port),
  - “**GPS**” - port 2 will be used as an input for GPS NMEA sentences,
- “**RS-485 port**” - currently only telemetry module is available on RS-485 port.

If you select weather station on one of RS-232 ports and you want to use WS-23XX station, the other port will be disabled. This is done because other port's TXD line is needed as negative voltage polarization for these kind of stations.

## 8.8. Position reports Tab

The screenshot shows the 'Position reports' tab in the PLXTracker Configurator. The 'Position report mode' is set to 'SmartBeaconing'. The 'Position encoding protocol' is 'Mic-E'. Under 'SmartBeaconing', the 'Min Turn Angle [deg]' is 27, 'Turn Slope' is 410, 'Min Turn Time [s]' is 5, 'Slow Speed [km/h]' is 8, 'Slow Period [s]' is 1800, 'Fast Speed [km/h]' is 95, and 'Fast Period [s]' is 90. The 'Fixed time interval' section shows 'Position report interval [s]' set to 60. The 'Report encoding settings' section includes 'Symbol code' (a right-pointing triangle), 'Symbol table' (a slash), 'Mic-E message' (Off Duty), 'Path' (WIDE1 - 1, WIDE2 - 1), 'Status text' (empty), 'Time' (Day, hour, min), 'Course/Speed' (Yes), 'Send last position if fix lost' (Yes), 'Altitude' (Yes), and 'Send interval on fix lost [s]' (600).

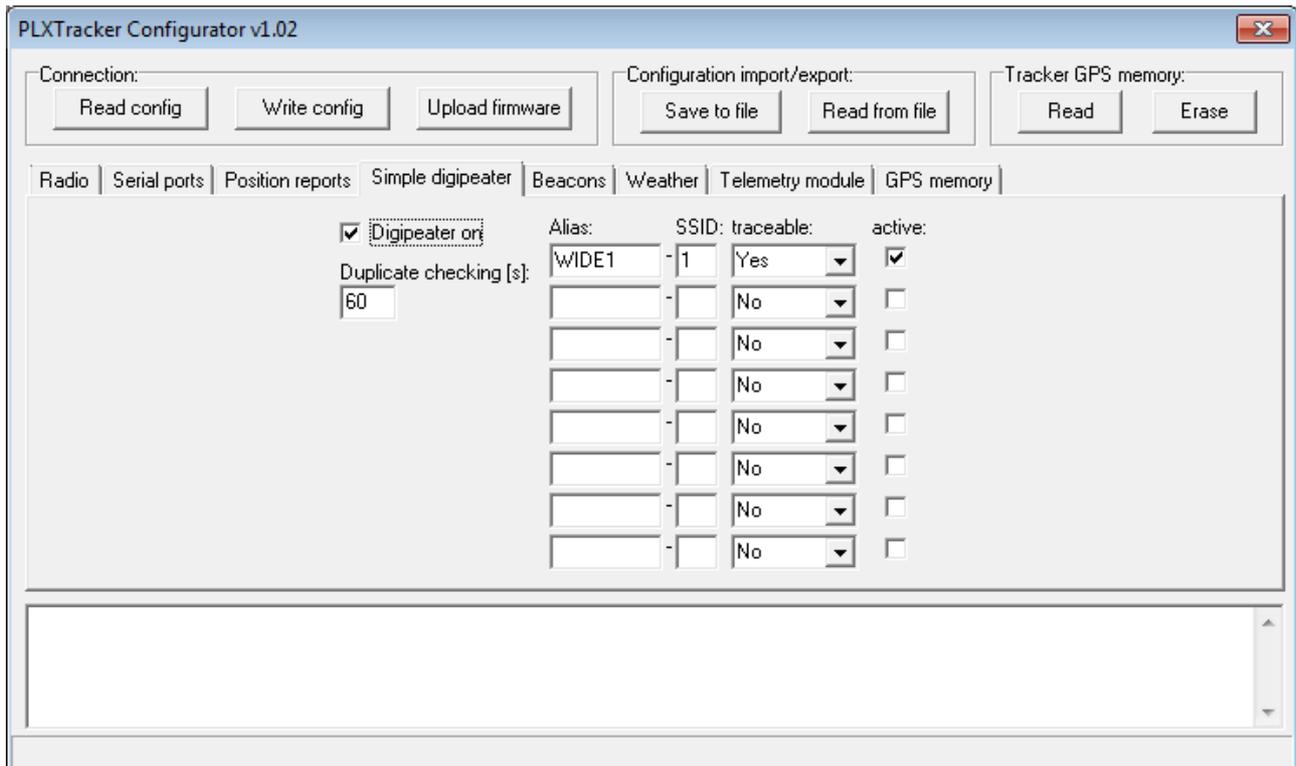
- “Position report mode” - selects position report mode,
  - “SmartBeaconing” - algorithm which sends position reports with intervals dependant on speed and course, allowing for more accurate reporting especially in urban area,
  - “Fixed time interval” - packets are sent every with a fixed time interval,
- “SmartBeaconing” is an algorithm invented by Tony Arnerich KD7TA and Steve Bragg KA9MVA,
  - “Min Turn Angle [deg]” - this is a minimum heading change which causes an immediate position report packet send,
  - “Turn Slope” - this value is a coefficient used to modify heading change necessary for immediate position report packet send.

These two values are used in the following formula:  $\text{turn\_threshold} = \text{min\_turn\_angle} + \text{turn\_slope}/\text{speed}$ . Default value for min\_turn\_angle is 27 degrees, turn slope is 410. So if your speed is 10 km/h, packet will be sent immediately if  $\text{turn\_threshold} = 27 + 410/10 = 68$  degrees. If your speed is 80 km/h, packet will be sent immediately if  $\text{turn\_threshold} = 27 + 410/80 = 32$  degrees. Now we see that packets will be sent with lower heading changes for fast speed and with higher heading changes for low speeds. This is called “corner pegging”.

- “Min Turn time [s]” - this value limits a minimal time between two position packets sent even if above turn\_threshold formula is met,
- “Slow Speed [km/h]” - if speed is below that value, packets are sent with interval of “Slow Period [s]”, corner pegging algorithm is turned off,
- “Slow Period [s]” - time between position packets when speed is below “Slow Speed [km/h]”,
- “Fast Speed [km/h]” - if speed is above that value, packets are sent with

- interval of “Fast Period [s]”, but corner pegging algorithm is tuned on too,
  - “Fast Period [s]” - time between position packets when speed is below “Fast Speed [km/h],
- “Fixed time interval”,
  - “Position report interval [s]” - time between packets in “Fixed time interval” report mode,
- “Position encoding protocol” - this option defines a format of APRS position report packets,
  - “Mic-E” - uses both AX.25 destination address and information field for position report and is the most compact reporting method, giving the shortest packet length,
  - “Base-91” - second method oriented to shortest report packet length,
  - “Plain text” - in this method station position report is sent in human-readable plain text format,
- “Report encoding settings”,
  - “Symbol code” - APRS packet symbol code,
  - “Symbol table” - APRS packet symbol table,
  - “Mic-E message” - you can select one of predefined Mic-E messages,
  - “Path” - there you can define up to 3 APRS position packet path components,
  - “Status text” - this is a status text attached at the end of position packet,
  - “Time” - selects position report time format,
  - “Send last position if fix lost” - if enabled, device will send last known position in fixed intervals on GPS fix lost,
  - “Send interval on fix lost (s)” - fixed interval for packets sent on GPS fix lost if enabled,
  - “Course/Speed” - enables or disables course/speed reports,
  - “Altitude” - enables or disables altitude reports.

## 8.9. Simple digipeater Tab



- **“Digipeater on”** - Enables or disables a function of RF 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,
- **“Alias”, “SSID”** - if packet path will contain this string and SSID, it will be digipeated,
- **“traceable”** - if Yes, PLXTracker 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.

## 8.10. Beacons Tab

PLXTracker Configurator v1.02

Connection: Read config Write config Upload firmware

Configuration import/export: Save to file Read from file

Tracker GPS memory: Read Erase

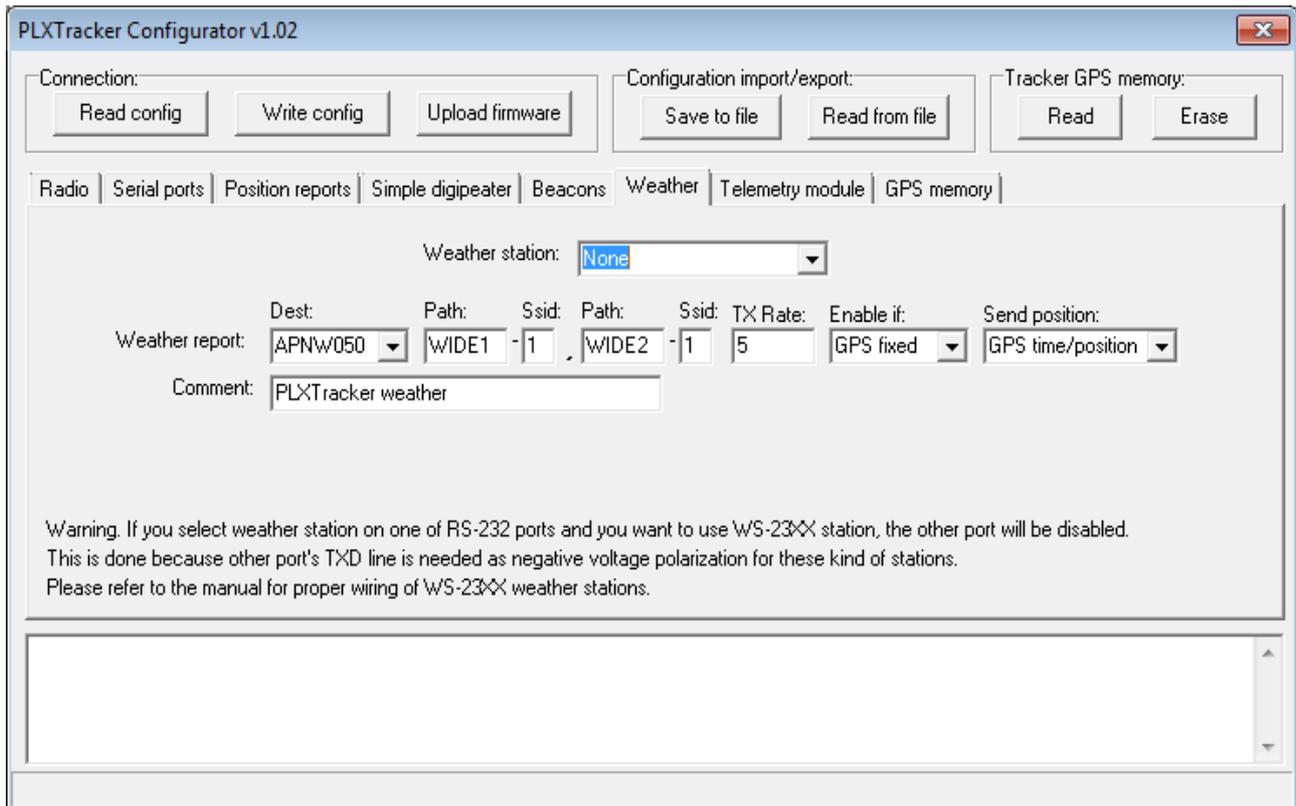
Radio | Serial ports | Position reports | Simple digipeater | **Beacons** | Weather | Telemetry module | GPS memory

Dest:	Path:	Ssid:	Path:	Ssid:	TX Rate:	Enable if:	Message (empty fields are ignored):	Special strings
APNW050	WIDE1	-1	WIDE2	-1	30	GPS fixed	/<gpsdate>z<gpslat>/<gpslong>>PLXTracker U=<volt>V.	
BEACON0	WIDE1	-1	WIDE2	-1	5	Never	!<statlat>/<statlong>>PLXTracker U=<volt>V.	
BEACON0	WIDE1	-1	WIDE2	-1	5	Never		
BEACON0	WIDE1	-1	WIDE2	-1	5	Never		

- **“Dest”** - destination address for a beacon packet. You can choose a destination address of APNW050 or BEACON0.
- **“Path”, “SSID”** - up to 2 components of APRS path and SSID,
- **“TX Rate”** - beacon transmit rate,
- **“Enable if”** - beacon enable condition:
  - **“Never”** - beacon disabled,
  - **“Always”** - beacon enabled,
  - **“GPS fixed”** - beacon enabled if GPS fixed,
  - **“GPS not fixed”** - beacon enabled if GPS not fixed,
- **“Message”** - APRS packet information field content, empty fields are ignored.

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

## 8.11. Weather Tab



PLXTracker Configurator v1.02

Connection:

Configuration import/export:

Tracker GPS memory:

Radio | Serial ports | Position reports | Simple digipeater | Beacons | **Weather** | Telemetry module | GPS memory

Weather station:

Weather report:  Dest:  Path:  Ssid:  Path:  Ssid:  TX Rate:  Enable if:  Send position:

Comment:

Warning. If you select weather station on one of RS-232 ports and you want to use WS-23XX station, the other port will be disabled. This is done because other port's TXD line is needed as negative voltage polarization for these kind of stations. Please refer to the manual for proper wiring of WS-23XX weather stations.

- **“Weather station”** - weather station type selection box,
- **“Dest”** - destination address for a weather packet. You can choose a destination address of APNW040 or BEACON0.
- **“Path”, “SSID”** - up to 2 components of APRS path and SSID,
- **“TX Rate”** - beacon transmit rate,
- **“Enable if”** - beacon enable condition:
  - **“Never”** - beacon disabled,
  - **“Always”** - beacon enabled,
  - **“GPS fixed”** - beacon enabled if GPS fixed,
- **“Send position”** - selects between dynamic position from GPS and static position from “Latitude”, “Longitude” fields in “Radio” Tab,
- **“Comment”** - weather report comment.

## 8.12. Telemetry module Tab

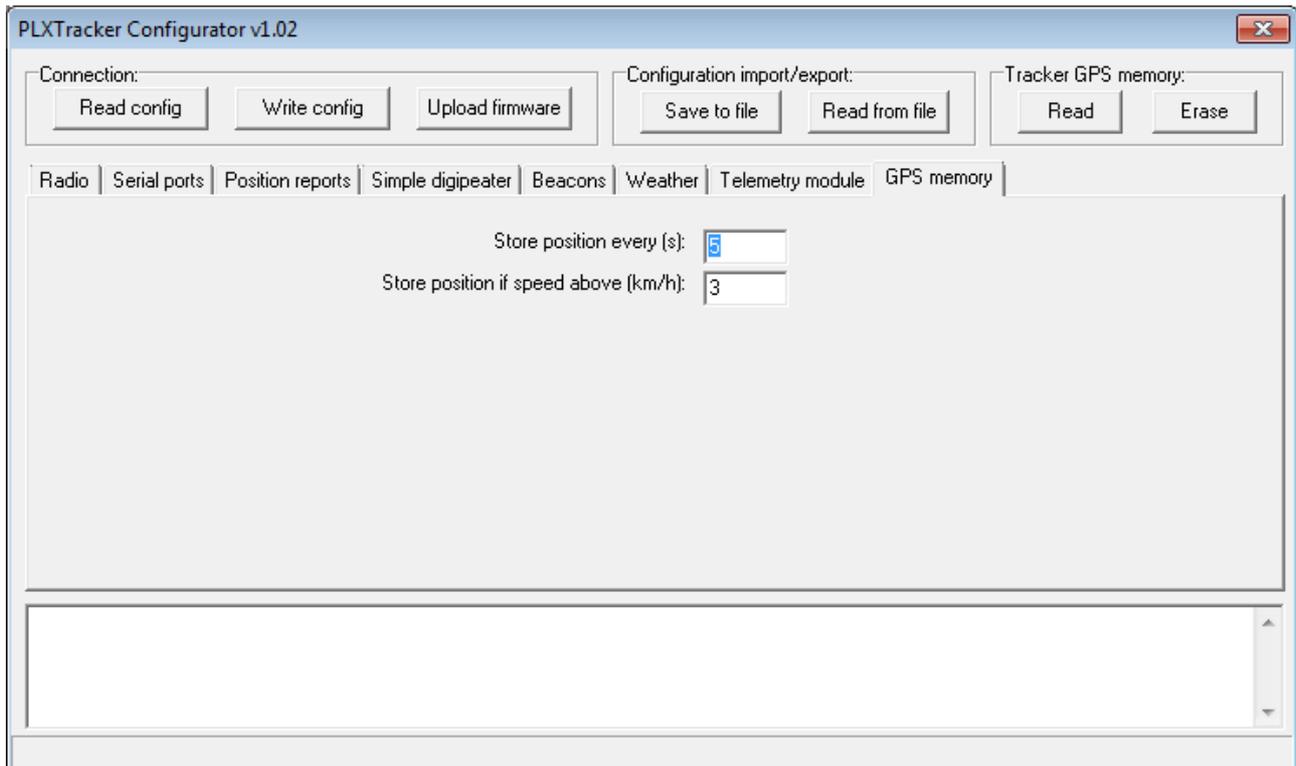
Name:	Units:	Source:	Coeff A:	Coeff B:	Coeff C:	1 min average:		
Analog 1:	I1	mA	Current1 (5A fullscale)	0	19.5	0	Off	Default parameters
Analog 2:	I2	mA	Current2 (5A fullscale)	0	19.5	0	Off	Default parameters
Analog 3:	U1	Volt	Voltage1	0	0.1	0	Off	Default parameters
Analog 4:	U2	Volt	Voltage2	0	0.1	0	Off	Default parameters
Analog 5:	Temp	C	Temperature (DS18B20)	0	0.5	-64	Off	Default parameters

Telemetry parameters:	Dest:	Path:	Ssid:	Path:	Ssid:	TX Rate:	Enabled:	Telemetry module:
Telemetry parameters:	APNW050	WIDE1	-1	WIDE2	-1	5	<input checked="" type="checkbox"/>	Disabled
Telemetry data:	APNW050	WIDE1	-1	WIDE2	-1	5	<input checked="" type="checkbox"/>	

This Tab is intended to be used if you have a WXTelemetry module connected to your WX3in1 Plus. You can find more useful information about telemetry reports format in APRS specification: <http://aprs.org/doc/APRS101.PDF>, page 68.

## 8.13. GPS memory Tab



- “Store position every (s)” - time interval between position points stored in internal flash memory,
- “Store position if speed above (km/h) - minimum speed for position storage.

Both above conditions must be met for position storage in internal flash memory.