

Mobilinkd TNC2 User Guide

Thank you for purchasing your new Mobilinkd TNC2 Battery-powered Bluetooth TNC.

This TNC is designed to suit all aspects of the Amateur Radio community. It is ready to plug in and go with easy to use and intuitive configuration software, and it is completely open for experimentation. The schematics are published and all software used in the TNC is open source and available online.

Overview

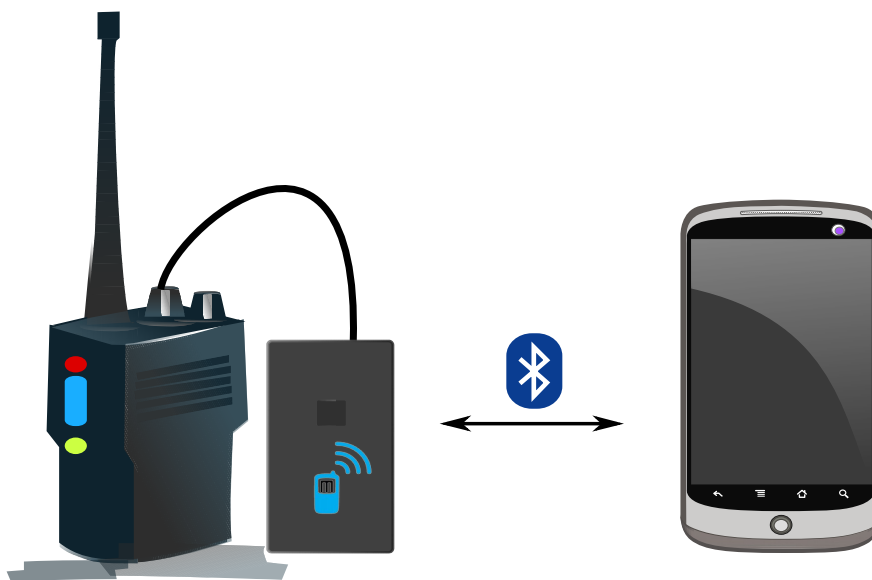
This guide will introduce you to the key features of the TNC, its connectors, switches and indicator LEDs. Most of this manual illustrates the configuration and operation of the TNC using an Android device and Android software. However, the TNC will work with any operating system and software that can talk to a KISS TNC over Bluetooth SPP (Serial Port Profile).

KISS TNC

The TNC2 is a *KISS TNC*, which means that it is purely a modem and not really a *terminal node controller*. A more accurate description of the TNC2 and all KISS devices is a *KISS modem*. The TNC2 does not manipulate the packets it receives in any manner. It cannot, by itself, digipeat (relay) packets or do any store and forward operations associated with an intelligent TNC. This is an important point that can be a source of some confusion. A KISS TNC simply encodes and decodes digital information as audio that can be transmitted over the air by a radio on a voice channel.

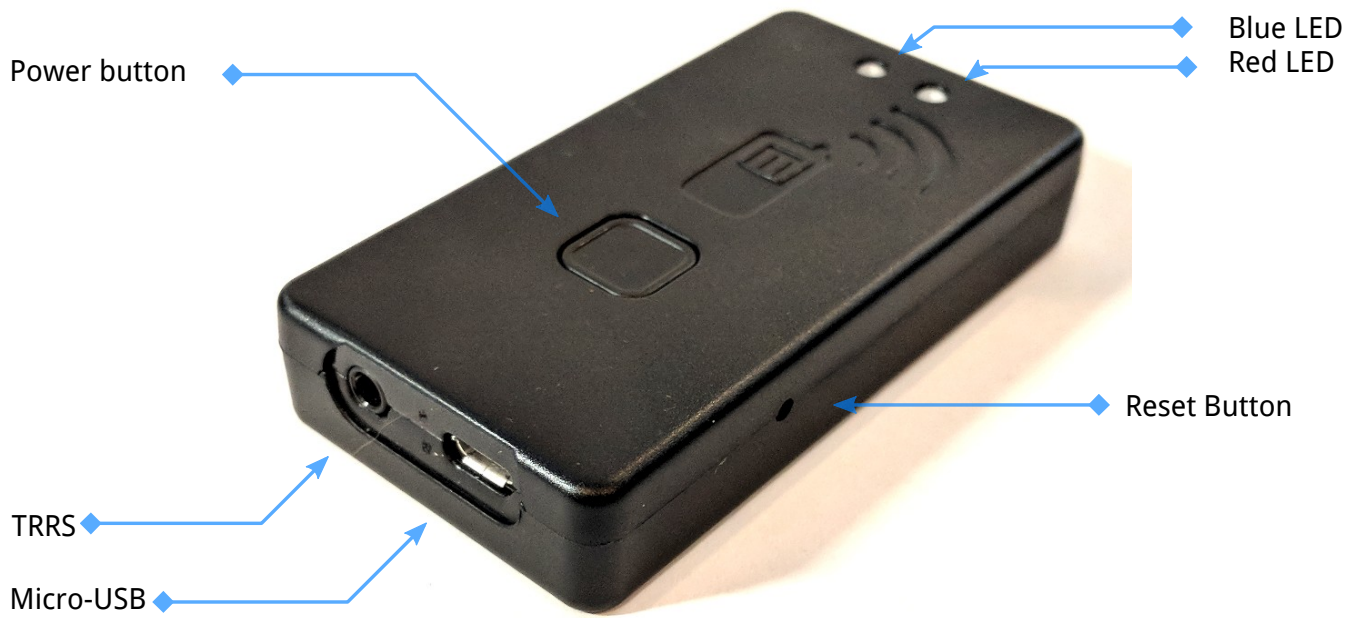
The Mobilinkd TNC System

The Mobilinkd TNC System is comprised of three physical components: A radio, the Mobilinkd TNC, and a computer, tablet or smart phone that supports Bluetooth SPP (serial port profile). *This currently excludes all Apple iOS devices because Apple does not support SPP in iOS.* The TNC connects to the radio with a cable and talks to the smartphone or computer via Bluetooth connection.



TNC Switches, Connectors and Indicators

The Mobilinkd TNC2 has two switches, two connectors and two indicators. Each of these is shown in the image and described below.



S1 – Power button. Press briefly to turn on. Power/BT LED will flash. Press briefly to turn off. The power/Bluetooth LED will turn off.

S2 recessed reset switch. To reset the TNC, gently insert the tip of a pen into the hole and depress the switch.

USB – Micro-USB connector for charging/power. (Cannot be used for data.)

TRRS – 3.5mm TRRS audio connector for Radio.

1. Tip = Speaker (audio input to TNC)
2. Ring 1 = PTT (Simplex PTT mode)
3. Ring 2 = Mic (and PTT in Multiplexed PTT mode)
4. Sleeve = GND/Common

Blue LED – The power/Bluetooth indicator. Flashes fast when pairing and slow when paired.

Red LED – Charge indicator. On when connected to USB and charging, otherwise off.

Before First Use

The battery will not be fully charged when you receive the TNC. It is always best to plug in a micro-USB cable and charge the battery before first use. When the Red LED turns off, the battery is charged. The battery will typically last for 48 hours of continuous use when paired to another device. The

battery drains much faster when powered on but not paired. The TNC consumes about 6x as much power when unpaired than when paired.

TNC Cable

Now is also a good time to put the ferrite bead on the TNC cable. All TNC2s come with a ferrite bead. The ferrite bead must be installed on the cable between the TNC and radio to prevent RF from the radio from interfering with the operation of the TNC.

For thinner HT cables, pass the cable twice through the core of the bead by forming a loop with the cable and pulling it tight before clipping the ferrite bead closed. This may take some force to get the cable to fit, but it is important, especially if you are running a Baofeng radio. These radios can emit a lot of RF energy through the speaker-mic connector, affecting the performance of the TNC.



Radio Settings

Each radio is different, so having a comprehensive list of optimal settings in a document like this is not possible. However, it is important to understand what radio settings impact the performance of the TNC and its ability to decode packets.

One of the more important aspect of how well the TNC will decode packets is how quickly the radio can open its squelch when a signal is present. If the radio cannot open its squelch fast enough, the start of each packet will be truncated and the TNC will be unable to decode any packets.

Troubleshooting Tip: *If you are having trouble decoding packets, set the radio's squelch setting to 0 (open squelch) and turn the on the TNC's DCD setting. If the TNC can decode packets with the squelch open, the radio is opening its squelch too slowly.*

The most important setting to disable on virtually all HTs is the “**Battery Saver**” option. This puts the radio to sleep for short periods of time. You will never notice for voice communication, but for many radios this will prevent most packets from being decoded.

If you have an inexpensive Chinese radio (Baofeng, Wouxun, and many others) with a “**Dual Receive**” feature, this must also be disabled. This essentially operates the receiver as a scanner, switching the receiver between two frequencies.





Connecting the TNC

Connect the TNC to the HT with both the TNC and the radio turned off.

Plug the straight 3.5mm connector into the TNC. If your radio's Speaker/Mic connector also uses a single 3.5mm audio connector, the elbow connector goes to the radio. Plug the radio connector (these styles vary) into the radio's Speaker/Mic connector.

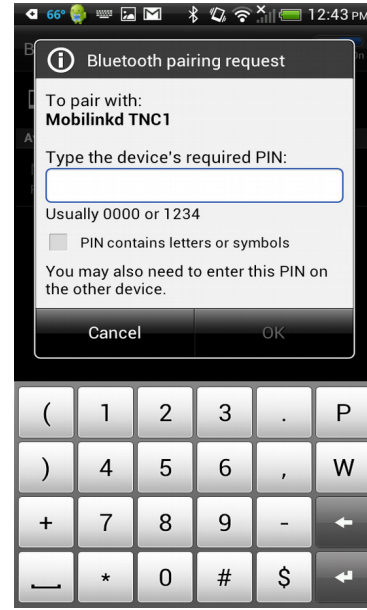
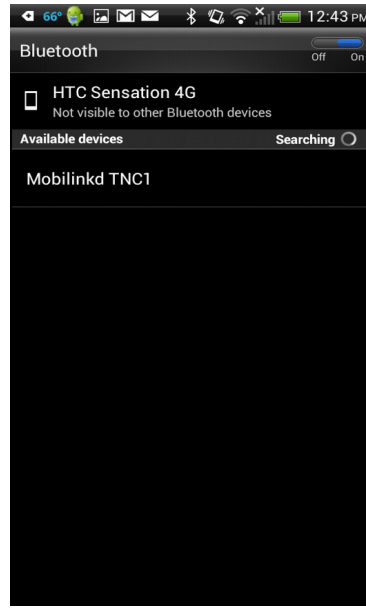
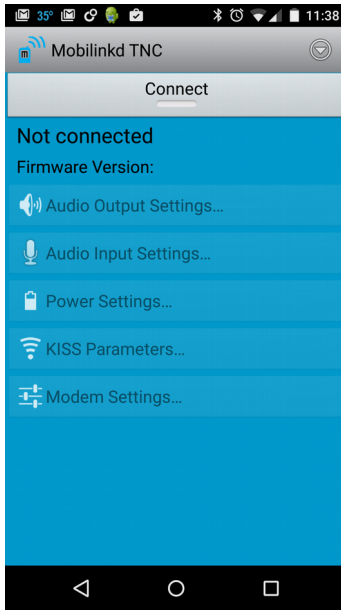
Connecting/Pairing

Detailed instructions for pairing the TNC on Android are below.

1. Press S1 briefly to turn on TNC. The blue LED will flash rapidly.
2. Ensure Bluetooth is enabled on other device.
3. On other device, scan for Bluetooth devices. You should see "Mobilinkd TNC2".
4. Connect to "Mobilinkd TNC2". Use password "1234" when prompted.

Pairing with an Android Device

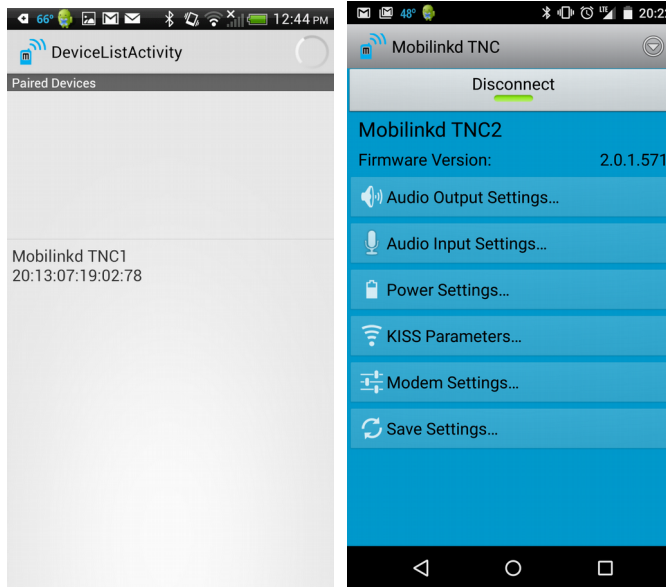
1. Install the [Mobilinkd Configuration App for Android](#) (available on Google Play.)
2. Open the Mobilinkd app.
3. Press S1 briefly to turn on TNC. The blue LED will flash rapidly.
4. Open the app menu and select “Bluetooth settings”
5. In the Bluetooth settings menu, select “Search for devices”
6. When you see “Mobilinkd TNC2”, select it.
7. Use password “1234” when prompted for a password. You should notice that the blue LED on the TNC starts flashing more slowly.
8. Hit the back button to go back the the Mobilinkd app.



Configuring the TNC

This section assumes that you have followed the “Pairing with an Android Device” section above and have the Mobilinkd TNC config application running. The TNC and radio should be connected, the TNC should be on, and the radio should still be off at this point.

1. Push the “Connect” button to connect the Mobilinkd TNC Bluetooth device. You will see the device name and firmware version displayed.



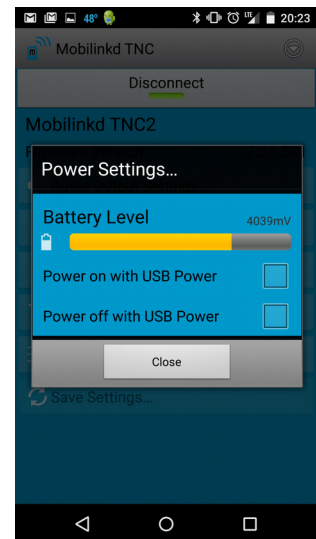
The image on the right shows the main menu for the Mobilinkd Config app. This menu is the starting point to launch the various screens shown in the documentation below. When you are done with a certain activity, press the “Close” button to go back to this screen.

Configuring the Power Settings

You can check the battery level and configure the power settings from the “Power Settings” dialog. The TNC2 is fully charged when it reads approximately 4.2V (4200mV). The nominal battery voltage is 3.7V. Avoid operating the TNC below 3.4V, otherwise erratic behavior may occur.

The TNC may be configured to automatically turn itself on when USB power is present, and automatically turn itself off when USB power is not present. This is often desirable when using the TNC in a vehicle. These settings are controlled independent of one another.

- To power on when USB power is present, select the “Power on with USB Power” option.
- To power off when USB power is removed, select the “Power off with USB Power” option.



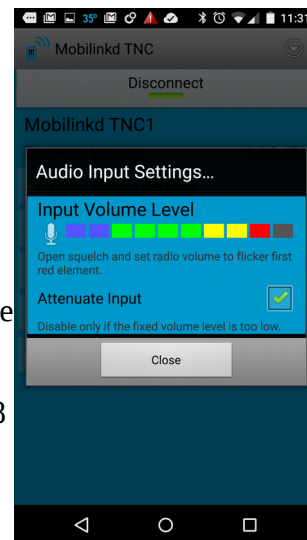
Configuring Receive (RX/Input) Volume

The radio's volume level must be properly adjusted for optimal packet decoding. Press the “Audio Input Settings” button.

1. Turn the radio on.
2. The Attenuate Input options should be selected. If not, turn it on.*
3. Hold open the squelch on the radio either by pressing the radio's monitor button or by setting the squelch level to 0. You should see the volume meter activate.
4. Adjust the volume on the radio until the volume meter lights up 8 of the 10 indicators and the 9th indicator (first red indicator) occasionally flickers.**
5. If you cannot turn up the volume high enough on the radio to light up 8 of the indicators, turn Attenuate Input off.
6. Press the Close button to return to the main menu.

* In general it is best to have input attenuation turned on. This often not possible with fixed volume mobile or base stations.

** If your radio uses the volume knob for on/off, it may be helpful to mark on the radio and knob with the optimal volume setting so it can be set quickly after turning on the radio.



Configuring Transmit and (TX/Output) Volume

Select the “Audio Output Settings” button on the main menu to open the audio output settings.

Modern ham radios use two different signaling methods for the Push-to-Talk (PTT) signal, which causes the radio to transmit.

Most base stations, mobile rigs (anything that uses a MiniDIN-6 data connector) and any radios with a Kenwood-style connector use a separate PTT line to trigger PTT. This form of PTT signaling is called “simplex” since there is one signal on the line.

Many HTs (Yaesu, Icom, Alinco and others) use the Mic+ line for both audio and PTT signaling. This form of PTT signaling is called “multiplex” since there are multiple signals on the same line.

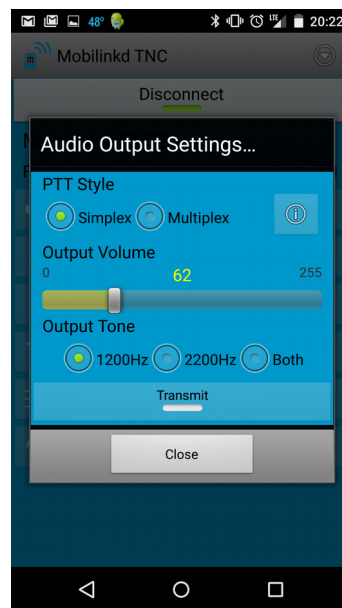
If you don't know which one yours uses, trial and error works to figure it out.

Transmit (TX/Output) Volume

Configuring the transmit volume requires a second radio and, without expensive monitoring equipment, will be a bit subjective. The default volume level (128) is a very good starting point. It may not be necessary to adjust the volume level at all.

This exercise is best done with the TNC/radio connected to a dummy load or at low power. Both radios should be set for simplex on an open frequency so as not to interfere with others. **Do not adjust the radio's output volume while tuned to the primary APRS frequency.**

To adjust the radio volume, select 2200Hz tone button, then press the Transmit button.



While monitoring the tone on the second radio, adjust the Output Volume slider until you do not hear the volume increasing any more. Then back off the volume by 10%.

You cannot adjust the output volume unless the Transmit button is selected. This is by design, to prevent accidentally changing the output volume.

Troubleshooting: *If you do not hear the any audio or the TX indicator on your radio does not light up, verify that the PTT Style selected above is correct. Disable TX, then change the PTT Style selection and try again.*

Configuring the KISS Parameters

These parameters are best left at their default values:

TX Delay – 33

Persistence – 64

Slot Time – 10

TX Tail – 2

TX Delay represents the amount of time in 10s of milliseconds that the TNC will key the radio and transmit the preamble before sending the packet.

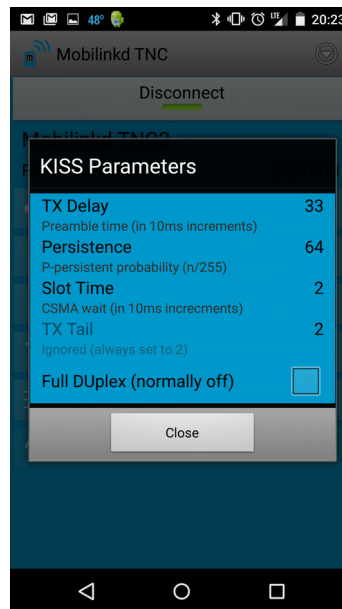
Persistence is part of the CSMA backoff represents the odds (out of 256) that the TNC will transmit within its slot time when no carrier is detected.

Slot Time is also part the the CSMA protocol; it is the delay in 10s of milliseconds that the TNC waits before checking whether it can transmit.

TX Tail is the amount of time in 10s of milliseconds the TNC keys the transmitter after the packet is sent. It must always be 2.

Full Duplex – ignore carrier detect and the CSMA parameters and trasmit without waiting for a clear channel. The assumption is that while running duplex, the TX channel is always clear.

Please see <http://www.ka9q.net/papers/kiss.html> for a more in-depth discussion of these KISS parameters.



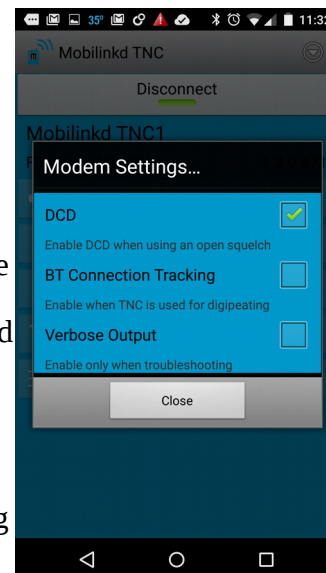
Modem Settings

The other TNC options that can be set are:

DCD – whether to use the Data Carrier Detect feature of the TNC rather than just audio energy detected. **DCD is required when running with an open squelch.** Please enable this setting. It should be on by default.

BT Connection Tracking – When enabled, the TNC tracks the state of the Bluetooth connection and discards any packets received while the Bluetooth connection is down. Otherwise packets are queued and downloaded when the the connection is re-established. This must be enabled when operating a digipeater or iGate in order to prevent old, stale packets from being digipeated (relayed) or entering APRS-IS.

Verbose Output – send out of band detailed packet diagnostics. These are displayed in the APRSdroid log. This may be helpful when diagnosing receive or packet decode issues. It should normally be turned off because it reduces the TNCs ability to decode certain packets. (The time spent reporting diagnostics is time the TNC cannot spend decoding packets.)



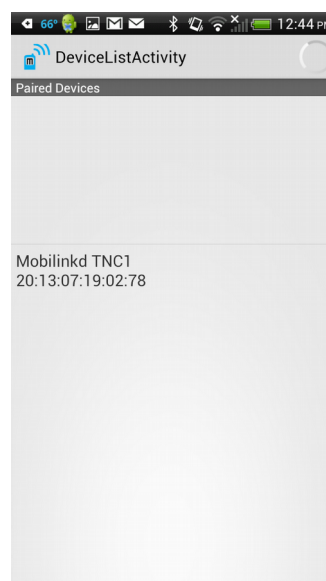
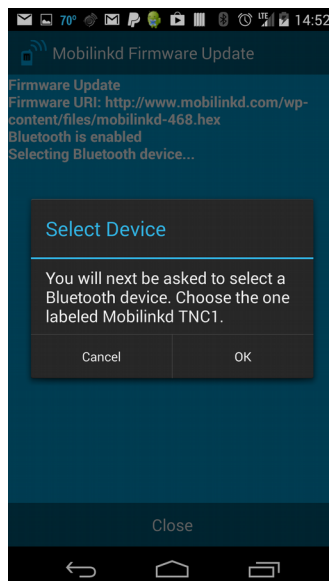
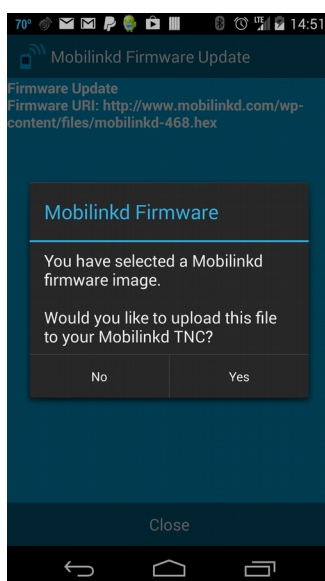
Firmware Update

Mobilinkd releases firmware updates for the TNC from time to time. This allows us to provide enhancements and bug fixes for the TNC, increasing the performance and value of the TNC over time. Firmware updates are typically announced via our web page, Yahoo message board and via Twitter.

To upload a new firmware image to the TNC, make sure than no app is currently connected to the TNC. Exit the Mobilinkd Configuration app and make sure your APRS software not in “Tracking” mode.

Disconnect the TNC from the radio. Then just follow the link to the new firmware image. The configuration app will automatically start and ask if you would like to install the new firmware image.

Only install firmware for the correct model of TNC. Installing firmware for a different model almost certainly will render the TNC inoperable.





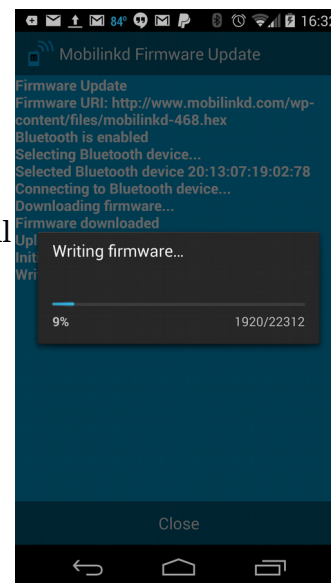
Firmware Update (cont)

Once connected, you will be asked to confirm that you want to upload the image. It is important that you do allow the firmware update to complete before navigating away from the Mobilinkd Config app.

You will see the firmware first being written and then being verified.

Once the firmware is verified, the TNC will reboot and the new firmware will be loaded.

You may need to reset the configuration of the TNC once this is complete. The TNC2 retains the previous settings by default.



Recommendations For Use with APRSdroid

This assumes that you know have followed the “Connecting/Pairing” and “Configuring the TNC” steps above. This is a good first-time setup and should be customized to your needs once you are familiar with APRS and APRSdroid.

You are encouraged to download the [APRSdroid software from Google Play](https://play.google.com/store/apps/details?id=com.ge0rg.aprsdroid). You can also find the software at <http://aprsdroid.org/>. Detailed APRSdroid configuration documentation can be found on the APRSdroid GitHub site: <https://github.com/ge0rg/aprsdroid/wiki/Settings>.

Before starting, turn the radio off to avoid accidentally transmitting bad APRS data.

1. Ensure the TNC is on and paired with the Android device. **Make sure the Mobilinkd Config app is disconnected** and that you have exited the app. Leaving the Mobilinkd Config app connected will prevent APRSdroid from connecting to the TNC.
2. Start APRSdroid.
3. Go into Menu|More|Preferences
 1. Set your SSID. SSID 7 is common for hand-held radios.
 2. Set your APRS symbol. If you don't know which one to use, choose /[for now. That will put a “jogger” symbol on the map for your position. See also <http://www.aprs.net/vm/DOS/SYMBOLS.HTM>
 3. Personalize the comment field.
 4. Under “Location Source”, select “Periodic GPS/Network Position”.
 5. Under “Location Settings|GPS Precision”, select “Low”. If this device connects to a mobile phone network, select “Use network position”.
 6. Under “Connection Protocol”, select “TNC (KISS)”.
 7. Under “Connection Type”, select “Bluetooth SPP”.
 8. Under “Connection Preferences|TNC Bluetooth Device”, select “Mobilinkd TNC2”
 9. Under “Connection Preferences|APRS digi path”, enter “WIDE1-1,WIDE2-1”
 10. Enable “Connection Logging”
4. Return to the main screen.
5. There are three views: Hub, Map, and Log. Ensure you are in Log view.
6. Select “Start Tracking”.
7. The blue LED should start blinking more slowly (two brief blinks every 2 seconds).
8. You should see a green line in the APRSdroid log where it sent a position report to the TNC.

If you receive an error “java.io.IOException” in the log when trying to connect, verify that the TNC is on and that it is flashing fast (no established connection). If the TNC is flashing slowly with a double-

pulse, it is connected to another app.

Sending your First Packet

1. Turn on the Radio and ensure its volume level is set properly.
2. Tune the radio to your [primary APRS frequency](#).
3. Press S1 briefly to turn on the TNC. The blue LED will flash rapidly.
4. Start APRSdroid and select “Start Tracking”. The LED will flash slowly when connected. This will immediately beacon your position.

When testing the TNC, it is best to ensure that a digipeater is nearby or that you have another APRS/packet radio to test with. A hand-held radio will typically need line of sight to a digipeater within 3-5km (2-3 miles) in order to have the signal digipeated.

Listen to the audio on the local APRS frequency. If at least some of the signals are clear and free from static or audio distortion, the TNC should be able to decode those APRS packets.

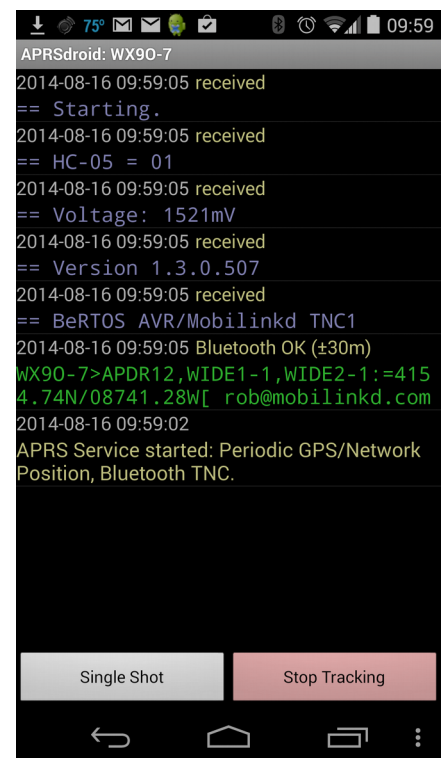
Some adjustment of the audio level may be required to get optimum packet decoding. Every radio model is different and the volume levels necessary may vary considerably. Even after following RX audio configuration steps above, the volume level may need to be adjusted to get the optimal performance out of the system.

The APRSdroid Log

When the Mobilinkd TNC powers on, it writes out diagnostic information that will be captured by APRSdroid in its log. This includes things like the firmware version and the battery voltage.

When troubleshooting problems it is often very helpful to verify the current firmware version and the battery level. To get this information, follow these steps.

1. Press “Stop Tracking” in APRSdroid.
2. Turn the TNC off, then turn the TNC on.
3. Press “Start Tracking” in APRSdroid.





Troubleshooting

Cannot Connect to TNC

- Make sure no other applications are currently connected to the TNC. Only one application can connect to the TNC at a time. The TNC should be flashing quickly (about 2Hz). You may need to reboot your device to get it to release the Bluetooth connection. When using APRSDroid, make sure that you press “Stop Tracking” before attempting to use the Mobilinkd Config app. Conversely, when using the Mobilinkd Config app, make sure you “Disconnect” before you attempt to use APRSDroid.
- Turn off WiFi on the device. Some Android devices do not operate well when both Bluetooth and WiFi are enabled. Both use the same 2.4GHz ISM band for communication and, if not managed properly, can interfere with one another.
- Power cycle the TNC.
- Re-pair with the TNC.
- Plug the TNC into USB power.

Cannot Communicate with TNC

- If the squelch on the radio is open and DCD is not selected, the TNC can appear to stop responding. It is, in fact, waiting to send a packet. Disconnect the TNC from the radio. This will allow the TNC to clear its buffer. After the TNC has been disconnected from the radio, start the Mobilinkd Config app and enable DCD. The TNC will function normally.

TNC Will Not Decode Packets

- Verify that the TNC's battery is fully charged. Plug the TNC into USB power and see if the problem persists.
- Verify that strong TNC packets can heard on the channel.
- [Enable the DCD setting](#) and open the squelch on the radio.
- [Verify that the TNC can detect the audio](#) and the RX volume is adjusted properly.

TNC Will Only Decode Packets with Squelch Open

- Adjust the radio's settings to open squelch faster.
- Try a different make/model radio.



No RX Audio Detected

- Ensure that the cable is firmly plugged into the radio and into the TNC.
- Verify connectivity on the cable.
- Verify that the TNC boots properly by checking the APRSdroid log.

TNC Will Not Transmit

- Verify that it is not an improper APRS software configuration by using the Mobilinkd Configuration App to send tones. (See *Configuring Transmit Volume* above.)
- Ensure that the cable is firmly plugged into the radio and into the TNC.
- [Verify that PTT Style is set properly](#) for the radio.
- Verify cable continuity.
- Verify that the TNC boots properly by checking the APRSdroid log.

Packets Not Digipeated

- Make sure packets are being transmitted.
- Make sure packets can be decoded.
- Make sure digipeater is in range.
- Get closer to the digipeater.

Transmitted Packets Not Decoded

- [Lower the transmit volume](#). (See *Configuring Transmit Volume* above.)
- Verify the radio is on the correct frequency.
- Try a different receiver and TNC.
- Increase the TX Delay KISS Parameter. (Values above 50 are not recommended and may reduce APRS network bandwidth in congested areas.)

Not Showing Up in APRS-IS (or on aprs.fi)

- Make sure an iGate is in range of your radio.
- Move closer to the iGate.



TNC Reboots When Transmitting

Do not operate the TNC if it is rebooting when the radio transmits. This is typically indicates that strong RF fields are affecting the TNC's circuitry. This may damage the TNC.

- Verify that the TNC cable has a ferrite bead attached.
- Check the TNC cable, the radio, and radio antenna for damage.
- Re-position the TNC and cable away from the radio's antenna.
- Try another radio.

No Start-up Diagnostics in APRSdroid Logs

- Plug the TNC into USB power.
- [Verify that either the radio's squelch is normally closed or DCD is enabled.](#)
- Re-flash the firmware. (See *Firmware Update* above.)

Software Customization

The TNC has a AVR109-compatible bootloader. Firmware can be updated over the Bluetooth connection using the Mobilinkd Config app for Android or the open source program “avrdude”.

```
avrdude -P <COM PORT> -c avr109 -p m328p -b 115200 -U <FIRMWARE>
```

For the more adventurous types, the TNC has a 6-pin ISP connector. The ISP is programmed using a 6-pin pogo-pin adapter (such as [Digi-Key ED8179-06-ND](#)) that is pressed onto the 6 pin connector. Or a standard 2.54mm 6-pin header can be soldered in place for programming.

The code running on the TNC is based on KISS TNC code contributed to BeRTOS by Robin Gilks G8ECJ. The code has been modified for the hardware. The code is available from GitHub. See <http://www.mobilinkd.com/> and follow the links to GitHub. The firmware for the TNC2 is on the “tnc2” branch.

This firmware is released under the GPL. Hacking (AKA “voiding your warranty”) is highly encouraged.

<https://github.com/g8ecj/bertos/tree/g8ecj/hdlc> – original version

<https://github.com/mobilinkd/tnc1> – latest firmware (the TNC2 code is on the “tnc2” branch)

Acknowledgments

APRSdroid is written and maintained by Georg Lukas, DO1GL.

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