



Mobilinkd TNC3 User Guide

Rev A - 2019-01-14

Thank you for purchasing your new Mobilinkd TNC3 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.

Warning

Do not store your TNC where prolonged exposure to extreme temperatures can occur (such as in the trunk or cabin of a car). It can cause permanent damage.

- *Short term storage: -4° – 140°F (-20°C – 60°C)*
- *Long Term Storage: 32° – 77°F (0°C – 25°C)*
- *Operating Temperature: -4°F – 131°F (-20°C – 55°C)*

Regulatory Information

This is the stuff I am legally obligated to put in this document. If I am obligated to put it in here, you are obligated to read it. Enjoy!

United States of America

Contains FCC ID:A8TBM78ABCDEFGH

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.
- *Or, you know – you're a licensed amateur radio operator. Figure it out!*

Canada

Contains transmitter module IC: 12246A-BM78SPPS5M2

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

The TNC does not contain a user-modifiable antenna – unless you have a soldering iron. Then all bets are off. You're an ham radio operator. Go wild.

Europe

The Microchip BM78 radio module inside the TNC3 has been fully tested to comply with EC requirements for CE marking. These tests include Health, Safety, EMC and Radio. Further testing of the final product (the TNC3) was conducted to ensure compliance of the integrated product.

The TNC3 is RoHS compliant. *Still, I would avoid eating the PCB if I were you.*

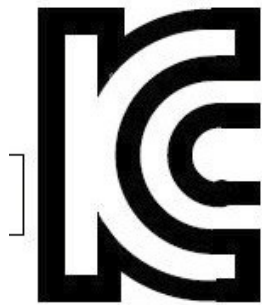
Japan

Integration of this module into a final product does not require additional radio certification provided installation instructions are followed and no modifications of the module are allowed.

So, if you are in Japan, you cannot modify the Bluetooth module. You've been warned.



Korea



MSIP-CRM-mcp-BM78SPPS5MC2

I think Korea requires that I provide a user manual in Korean. I don't (yet) speak, read or write the language. Sorry. Give Google Translate a try:

Taiwan



CCAN15LP0510T4

注意！

依據 低功率電波輻射性電機管理辦法

第十二條 經型式認證合格之低功率射頻電機，非經許可，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

第十四條 低功率射頻電機之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。前項合法通信，指依電信規定作業之無線電信。

低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

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), Bluetooth LE using our custom service, or via USB CDC (serial port emulation).

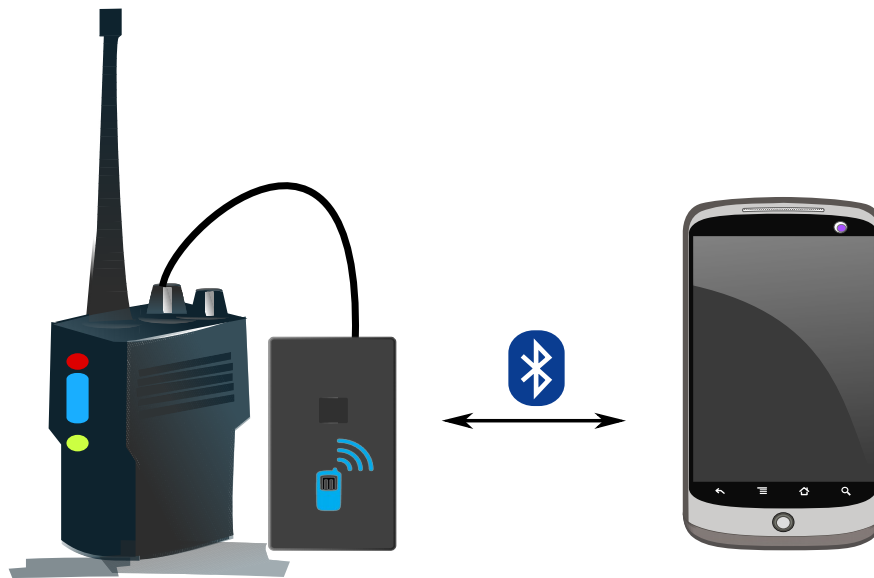
KISS TNC

The TNC3 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 TNC3 and all KISS devices is a *KISS modem*. The TNC3 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 or LE-TNC. The TNC connects to the radio with a cable and talks to the smartphone or computer via Bluetooth connection.

The TNC3 is also able to talk to the phone, tablet or computer via USB serial port emulation.



TNC Switches, Connectors and Indicators

The Mobilinkd TNC3 has three 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, carefully insert the tip of a pen into the hole and gently depress the switch.

S3 recessed DFU button. This is used when updating the device firmware. To enter firmware update mode, carefully insert the tip of a pen into the hole and gently 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

RGB LED – This is a multi-function indicator. The blue LED flashes slowly when disconnected, flashes a double-blip when connected via Bluetooth, or flashes a triple-blip when connected via USB. The LED shows red when transmitting and green when receiving data.



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.

TNC Cable

The TNC must be connected to the radio via a cable. Mobilinkd sells cables for a wide range of hand-held radios, as well as data cables for mobile and base radios with TNC ports.

The cable connects four signals:

1. Audio in (this is the speaker or data out on the radio)
2. Audio out (this is mic or data in on the radio)
3. PTT signal
4. Common (GND)

On some hand-held radios, the PTT signal is multiplexed onto the audio output. In this case, the dedicated PTT signal is not used.

Unlike with the TNC1 or TNC2, the TNC3 incorporates ferrite beads on the PCB so attaching a ferrite bead to the cable is not the necessity that it once was. The TNC is expected to operate properly without a ferrite bead on the cable. However, if the cable is being run right next to the antenna, it does not hurt to add one.

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.

The squelch should be left open on the radio when connected to the TNC. The TNC3 will detect the presence of data on the audio signal (it uses DCD or Data Carrier Detection). With a closed squelch, part of a packet preamble will be missed before the squelch on the radio opens. This will prevent decoding of packets.

The “**Battery Saver**” option should be disabled. This should have no impact on the life of the battery when the radio is run with an open squelch.

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. *In general, with these radios, every setting that can be turned off should be turned off. That is especially true for any squelch tail elimination settings.*

Please allow me to editorialize for a moment. The quality of the radio will directly impact the ability of the TNC to decode packets. Do not connect the TNC3 to a cheap radio and expect miracles. The system is only as strong as its weakest link.

Connecting the TNC

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

Plug the 3.5mm connector into the TNC. Plug the radio connector (these styles vary) into the radio's Speaker/Mic connector.



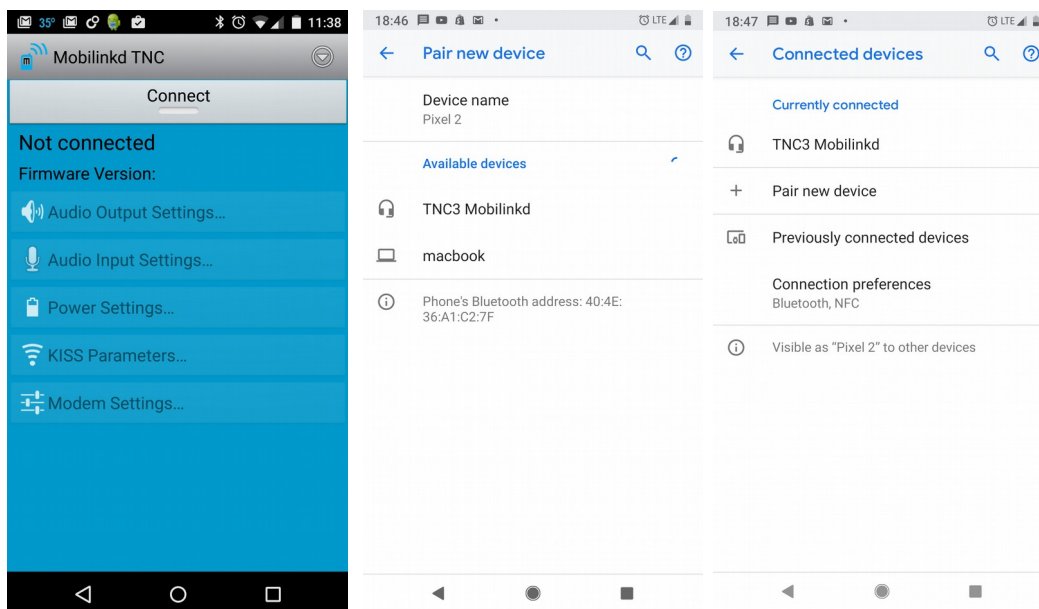
Connecting/Pairing

Detailed instructions for pairing the TNC on Android are below. Instructions for iOS are omitted because this happens more seamlessly with BLE.

1. Press S1 briefly to turn on TNC. The blue LED will flash slowly.
2. Ensure Bluetooth is enabled on other device.
3. On other device, scan for Bluetooth devices. You should see “TNC3 Mobilinkd”.
4. Connect to “TNC3 Mobilinkd”. The pairing should happen automatically.

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 pulse slowly.
4. Open the app menu and select “Bluetooth settings”
5. In the Bluetooth settings menu, select “Pair new device”
6. When you see “TNC3 Mobilinkd” under “Available devices”, select it.
7. After a few seconds, you should see the TNC appear under “Currently connected”.
8. Hit the back button to go back to the Mobilinkd app.

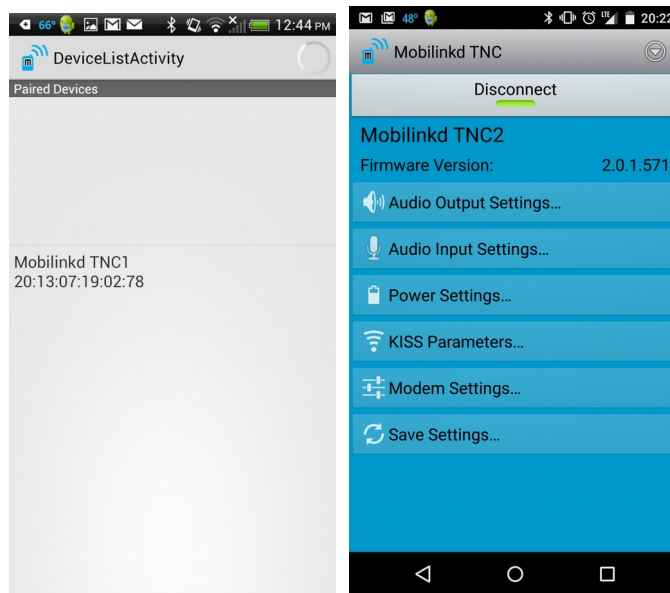


Configuring the TNC

This section describes the configuration process using the Mobilinkd Config App for Android. The Mobilinkd Config App for iOS will be very similar, except the connection and pairing is slightly different (a little less intrusive).

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

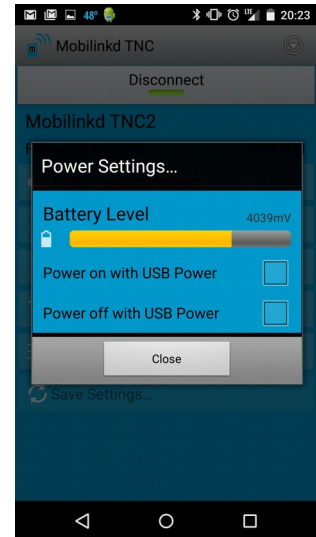
You can check the battery level and configure the power settings from the “Power Settings” dialog. The TNC3 is fully charged when it reads approximately 4.2V (4200mV). The nominal battery voltage is 3.7V. Avoid operating the TNC below 3.4V, otherwise erratic behavior may occur.

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.

The TNC3 will still power on via the Power button when USB power is not present and “Power off with USB Power” is enabled.

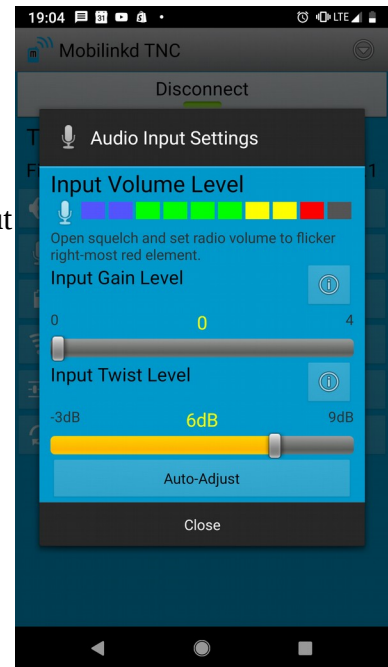
Please be aware: It is a frequent source of confusion for users when they have removed a TNC normally used in a vehicle and have forgotten that these setting are enabled. The TNC will turn itself on and off when connected/disconnected from USB power.



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. If the squelch is set to be open (as you did when following the instructions above), you should see the input volume level on the audio meter.
2. The TNC has the ability to amplify low-level audio inputs typical of mobile radio data ports. For almost all hand-held radios, the input gain level should be set to 0.
3. Adjust the volume on the radio until the volume meter lights up the right-most level indicator.*
4. If you cannot turn up the volume high enough on the radio to light up the right-most indicator, increase the input gain level.
5. The input twist should typically be set to 6dB when using an audio signal (hand-held speaker output, 1200 baud data output) and 0dB when using correlator output (9600 baud data output).**
6. You can press the “Auto-adjust button” if you are daring. This is best used when connecting to a mobile radio when the input gain and input twist need to be adjusted.
7. Press the Close button to return to the main menu.



* 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.

** The input twist level controls various filter parameters in demodulator. Adjusting the input twist may change the ability (for better or worse) of the demodulator to decode packets.

Configuring Transmit and (TX/Output) Volume

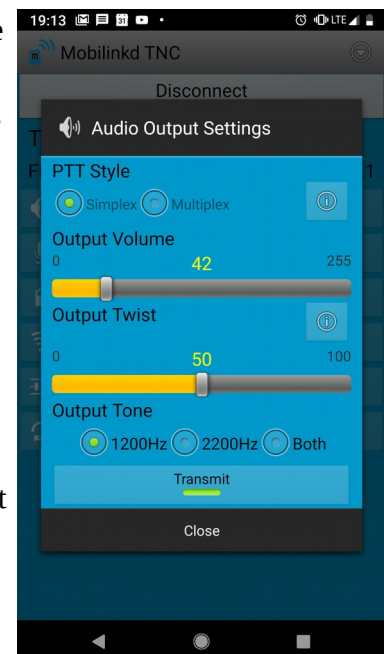
Select the “Audio Output Settings” button on the main menu to open the audio output settings.

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. Press the Transmit button on the bottom to transmit a test signal. You should see the TX indicator on the radio light up.





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 (64) is a reasonable starting point. It may not be necessary to adjust the volume level at all. I recommend lowering the level.

This exercise is best done with the TNC/radio connected to a dummy load or at very 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.*

Output Twist

Output twist controls the level of the Mark and Space (1200Hz and 2200Hz) tones relative to one another. Levels below 50 reduce the level of the 2200Hz tone, while levels above 50 reduce the 1200Hz tone. The output twist should typically left at 50 unless you are using a transmitter that does not do proper pre-emphasis of the audio signal.

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.

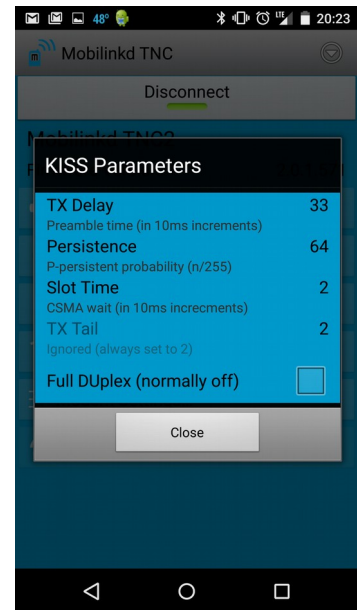
Persistence is part of the CSMA backoff represents the odds (out of 256) that the TNC will transmit within its slot time when no carrier is detected.

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.





Firmware Update

The firmware of the TNC can be updated, but this can only be done via USB.

The TNC firmware is updated using STM32CubeProgrammer from STMicroelectronics. This is a cross-platform programmer for Linux, OS X and Windows.

You can find this tool from the Mobilinkd Download site at <http://www.mobilinkd.com/downloads/> or from STMicroelectronics at <https://www.st.com/en/development-tools/stm32cubeprog.html>

Firmware update instructions will be posted with the firmware file.

The TNC enters firmware update mode by pressing the DFU button on the side when the TNC is plugged into a USB connection. Be warned: the only indication that the TNC is in DFU mode is that there is no blue LED indicator when in this mode, and the power switch does not work. If you do not use the firmware update tool to program the TNC, you must press the reset button to recover.

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](#). 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|Preferences
 1. Set your callsign
 2. Set your SSID. SSID 7 is common for hand-held radios.
 3. Under APRS digi path”, enter “WIDE1-1,WIDE2-1”
 4. Set your APRS symbol. If you don't know which one to use, choose /I for now. That will put a “jogger” symbol on the map for your position.
 5. Personalize the comment field.
6. Go into “Location Settings”
 1. Under “Location Source”, select “Periodic GPS/Network Position”. (You may wish to change this later.)
 2. Under “GPS Precision”, select “Low”. If this device connects to a mobile phone network, select “Use network position”.
 3. You may wish to update the “Minimum update time” and “Minimum update distance.”



7. Go into “Connection Preferences”
 1. Under “Connection Protocol”, select “TNC (KISS)”.
 2. Under “Connection Type”, select “Bluetooth SPP”.
 3. Under “TNC Bluetooth Device”, select “TNC3 Mobilinkd”
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 slowly (no established connection). If the TNC is flashing slowly with a double-pulse, it is connected to another app.

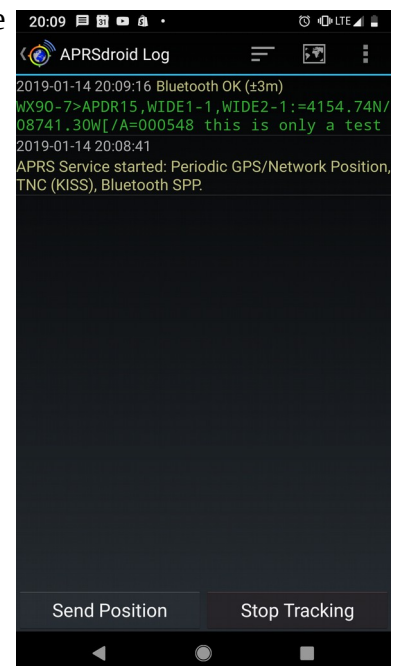
Sending your First Packet

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 pulse slowly.
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.





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 pulsing slowly. 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. (BLE connections do not have the same limitations, but this has other consequences.)
- Turn off WiFi on the device. Some older 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

- Verify that the connection is established by watching the blue LED. If it is pulsing slowly, the TNC is on and disconnected. If it is blinking with a double-blink, the TNC is connected via Bluetooth (either SPP or LE). If it is blinking with a triple-blink, it is connected via USB.
- Try to connect using different connection protocols (USB and Bluetooth)
- Press the reset button. Please send email to support@mobilinkd.com if you find this necessary.

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.
- [Verify that the TNC can detect the audio](#) and the RX volume is adjusted properly.
- Press the “Auto-adjust” button on the Audio Input screen of the config app.

TNC Will Only Decode Packets with Squelch Open

- That is expected. The radio’s squelch setting should be open (set to 0).



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 radio's squelch is open.

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.
- If the TNC will transmit in the config app but not in the packet radio software, verify your software settings, your location settings, your minimum update settings, etc. Contact your packet radio software provider for support.

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 Resets When Transmitting

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

- Check the radio antenna, the radio itself, and the TNC cable for damage.
- Re-position the TNC and cable away from the radio's antenna.
- Try another radio.
- Install a ferrite bead on the cable between TNC and radio.

Software Customization

The TNC has a USB DFU bootloader. Firmware can be updated over the USB connection using the STM32CubeProgrammer.

```
STM32_Programmer_CLI -c port=USB1 -d firmware.elf -v -g 0x80000000
```

For the more adventurous types, the TNC has a 6-pin ST/LINK connector. The ST/LINK is programmed using a 6-pin pogo-pin adapter (such as <https://www.tindie.com/products/FemtoCow/pogo-pin-adapter-row-of-2-to-30-pins/>) that is pressed onto the 6 pin connector.

For most of the development cycle of the TNC, I used an STM32 Nucleo-64 board with it's on-board ST/LINK programmer and a pogo pin adapter.

The code running on the TNC is available on GitHub. See <http://www.mobilinkd.com/> and follow the links to GitHub. The firmware for the TNC3 is in the tnc3-firmware repository.

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

<https://github.com/mobilinkd/tnc3-firmware> – latest firmware

Acknowledgments

APRSdroid is written and maintained by Georg Lukas, DO1GL.

APRS is a registered trademark of Bob Bruninga, WB4APR.

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