



WoAD

Interfacing to a radio [DRAFT]

<https://woad.sumusltd.com/>

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Bringing the functionality of Winlink to your Android device

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Introduction

The use of WoAD requires a valid amateur radio license. Do not use, install, or download WoAD unless you have a valid amateur radio license, or a license from a participating government service or agency. Ship station, marine or general radiotelephone licenses **do not** qualify.

WoAD supports a number of protocols and interfaces to connect your Android device to a radio. The choices available to you may be restricted by the capabilities of your Android device and/or radio. Other factors to consider might include cost, PTT vs. VOX, ease of configuration and use, level of support, *etc.*

Please note that any equipment referred to in this documentation is for the purpose only of providing information. Any such equipment is not being endorsed in any way and is used at your own risk.



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Session Protocol

A newly created session will, by default, use the **Telnet Winlink** protocol.

This document will consider only sessions using the **Packet** protocol - as this is likely the most common scenario, provides the greatest number of options, and so potentially the greatest difficulty in configuring.

Session Type

A user-created packet session can be one of two types:

- **Outgoing:**
 - when you want to send/receive messages to/from a Winlink RMS server. For advanced users this type can also be used to connect to a Winlink client program capable of P2P connections (a list of Winlink client programs, of which WoAD is one, and their functionality can be found at <https://winlink.org/ClientSoftware>)
- **Listener:**
 - for advanced users this type is to listen for incoming connection requests from a Winlink client program, capable of P2P connections, that wants to send/receive messages to/from you

The default is **Outgoing**. This document will consider only sessions using the **Outgoing** type - as this is likely the most common scenario, and the **Listener** settings are essentially the same as for the **Outgoing** settings: only without the **Destination address**.

Session Settings

- **Destination address**

The **Destination address** is described in the [primary documentation](#) and is used to configure the destination address of the Winlink session. Usually this will be the address of a Winlink RMS server. For advanced users this can be the address of a P2P program. Also for advanced users digipeaters and connection scripts can be optionally configured.



- TNC settings

The TNC settings are also described in the [primary documentation](#) and allow you to configure several characteristics of the AX.25 protocol, which can be useful in making the connection as robust or efficient as possible.

- TNC type

The TNC type can be one of several **Audio** options or **KISS**. If you select one of the Audio options you will almost certainly want the **Audio (AFSK, 1200 bps)** option, as this is by far the most widely used and is supported by almost all Winlink RMS servers. For advanced users other **Audio** options are available.

- TNC configuration

The TNC configuration options are dependent on the TNC type selected and will be dealt with at length in the following section.



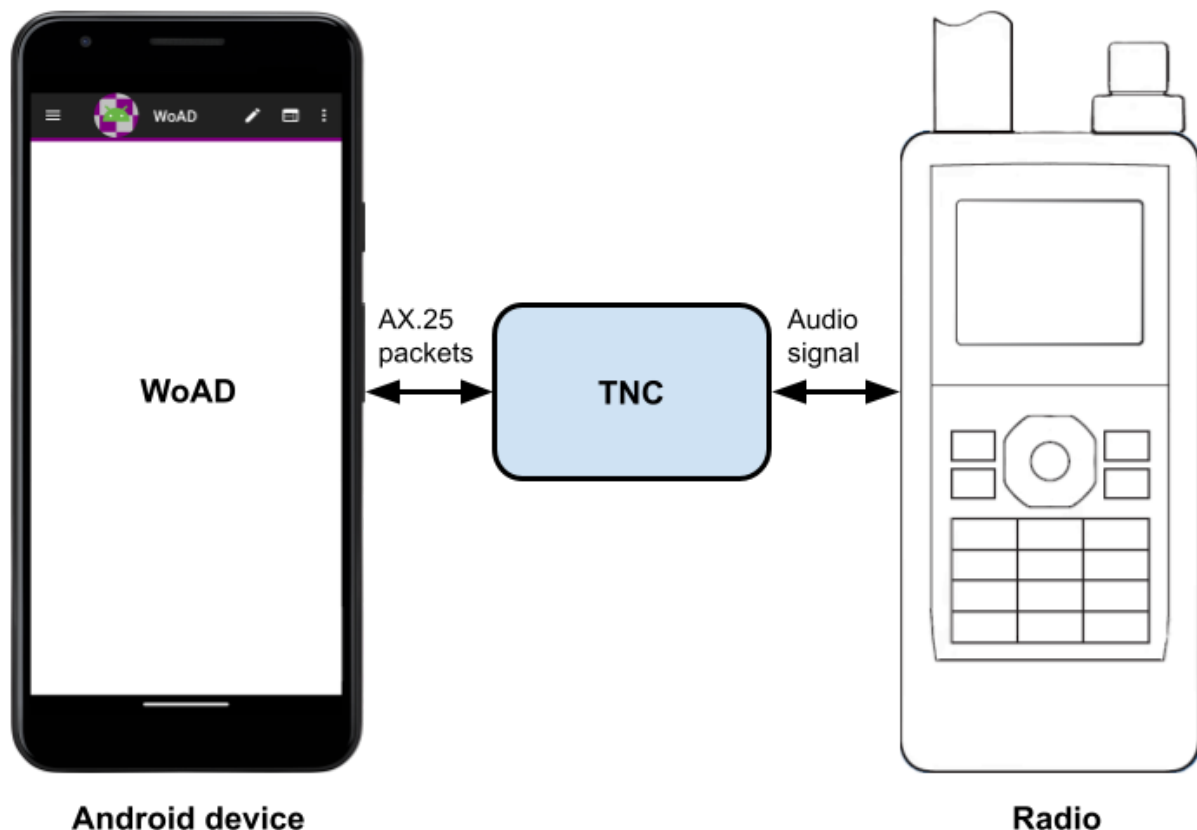
Interfaces

There are an almost overwhelming number of ways to interface between your Android device and your radio. It is beyond the scope of this document to consider every possibility, so instead we will attempt to give you sufficient understanding to allow you to configure any suitable interface quickly and simply, with some specific examples to better convey the necessary information.

The first concept that it is important to understand is that of the terminal node controller (TNC). A TNC is used to:

- engage in the necessary AX.25 conversation: AX.25 is the protocol used between the two sides of a Winlink connection
- convert the outgoing AX.25 data packets to the audio signal transmitted by the radio
- convert the incoming audio signal received by the radio into AX.25 data packets

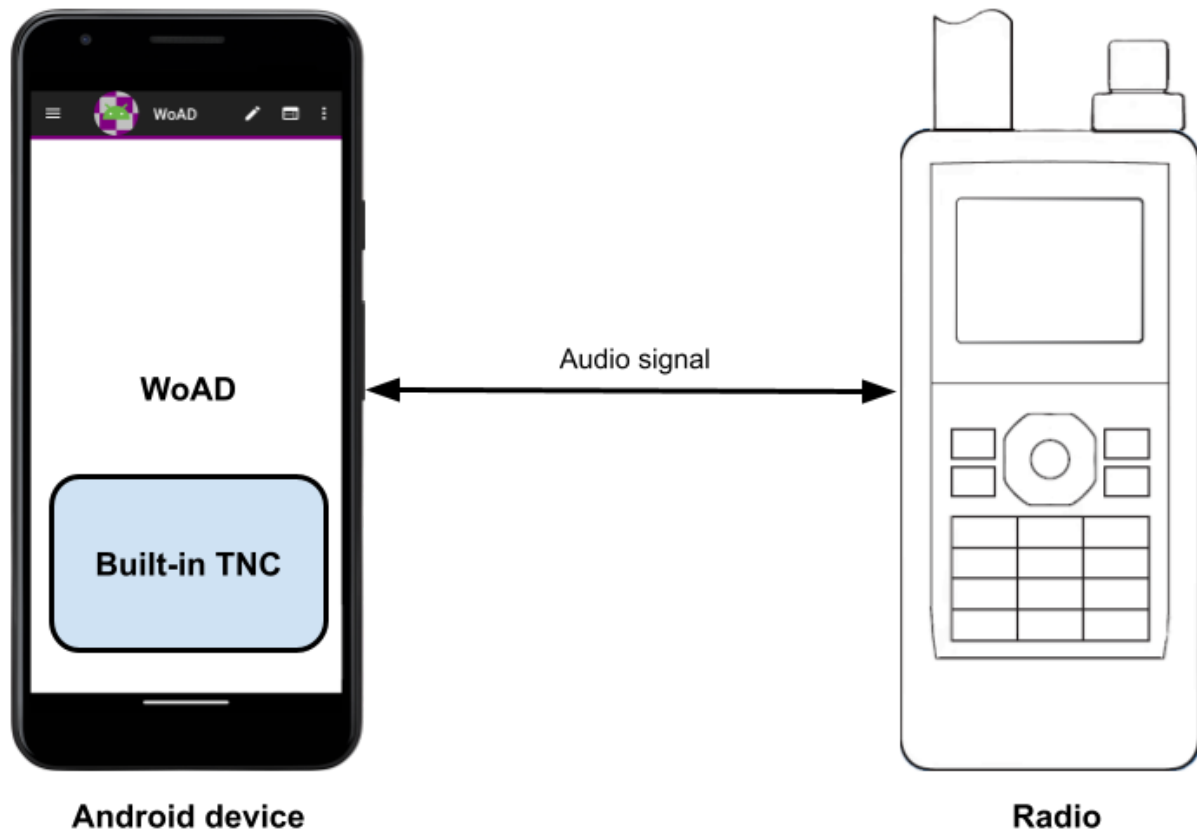
Conceptually this looks like:



However, the TNC does not have to be a physical device external to both the Android device and radio, as WoAD has a built-in TNC, which is used whenever the **TNC type** is set to one of the **Audio** options.



Using WoAD's built-in TNC



When using WoAD's built-in TNC it is important to keep in mind that you should:

- Silence any other sounds that might be created by the Android device, as these will also be sent to the radio
- Set the optimal volume level for both the Android device and radio. This will involve some trial and error and the level will depend on at least the type of connection used and your make and model of radio.

For all the interfaces using WoAD's built-in TNC we will assume that the **TNC type** is set to **Audio (AFSK, 1200 bps)**, as this is the most likely scenario.

Audio only connection

In theory it should be possible to run a packet session with no physical connection between the Android device and radio - relying on the audio transmitted from the Android device's speaker being picked up by the radio's microphone, and vice versa. This would require the radio's VOX functionality to be enabled.



In practice this method is undesirable for the following reasons:

- Background noise making the packet audio indecipherable in either direction
- Background noise alone triggering the radio's VOX
- Distortion introduced by the speaker and microphone of both devices
- Having to correctly set the optimal VOX level for the radio

The **TNC configuration** options on WoAD would be as follows:

- Mode: **Simplex**
- Channel: **Both**
- Set packet volume: **<determined by user>**
- PTT tone: On unused channel: **Unchecked**
- PTT USB RTS: Enable: **Unchecked**
- PTT BLE: Enable: **Unchecked**
- FX.25 FEC: Transmission check bytes: **None**

Audio cable connection

A direct audio cable connection between the Android device and radio ensures that the signals are not impacted by background noise. Instead you would have to consider the possibility of RF interference and ground loops. The former can be mitigated by the use of suitable chokes and the latter by isolation transformers. Make sure you understand the risks and the mitigation efforts taken with any cable you are thinking of using.

Obviously the choice of cable would also depend on the make (and possibly model) of the radio you are going to connect to.

As the mic connection to the radio is mono but the audio output from the Android device is stereo, most cables simply ignore one audio output channel. Thus, within WoAD you can choose the **Channel** setting to be either **Left** or **Right**, depending on the cable used. WoAD also lets you choose a **Channel** setting of **Both**.

You will still need to set the optimal VOX level for the radio.

Some examples of such a cable include:

- <https://baofengtech.com/product/aprs-k1/> (for the Baofeng UV-5R and similar)

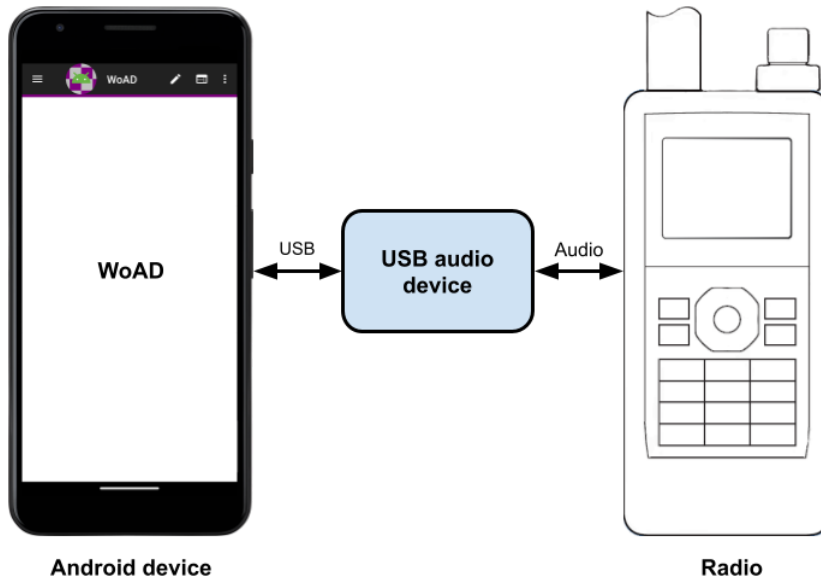
The **TNC configuration** options on WoAD would be as follows:

- Mode: **Simplex**
- Channel: **<cable dependent>**
- Set packet volume: **<determined by user>**
- PTT tone: On unused channel: **Unchecked**
- PTT USB RTS: Enable: **Unchecked**



- PTT BLE: Enable: **Unchecked**
- FX.25 FEC: Transmission check bytes: **None**

USB audio connection



“Android 4.1 (API level 16) added limited support for audio playback to the host. While in accessory mode, Android automatically routes its audio output to USB... Android 5.0 (API level 21) and above supports a subset of USB audio class 1 (UAC1) features:” (quoting from <https://source.android.com/docs/core/audio/usb>). However, this support is also dependent on the manufacturer of each particular make and model of Android device.

What this means in practice is that when you connect a USB audio device to your Android device, audio should be automatically routed to the USB audio device. This is handled at the operating system level and is not controlled by WoAD.

Some examples of such a device include:

- Almost any USB audio device compatible with Android

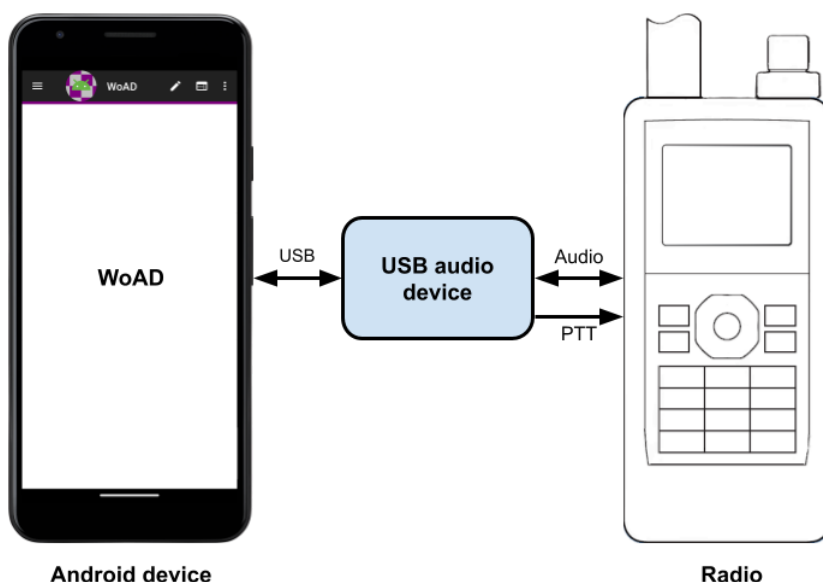
The **TNC configuration** options on WoAD would be as follows:

- Mode: **Simplex**
- Channel: **<cable dependent>**
- Set packet volume: **<determined by user>**
- PTT tone: On unused channel: **Unchecked**
- PTT USB RTS: Enable: **Unchecked**
- PTT BLE: Enable: **Unchecked**



- FX.25 FEC: Transmission check bytes: **None**

USB audio connection with PTT



USB audio devices aimed at the ham radio market may also include PTT control, which is triggered when the device detects an audio signal from the Android device. This requires no additional configuration within WoAD, but allows you to disable VOX on your radio.

Some examples of such a device include:

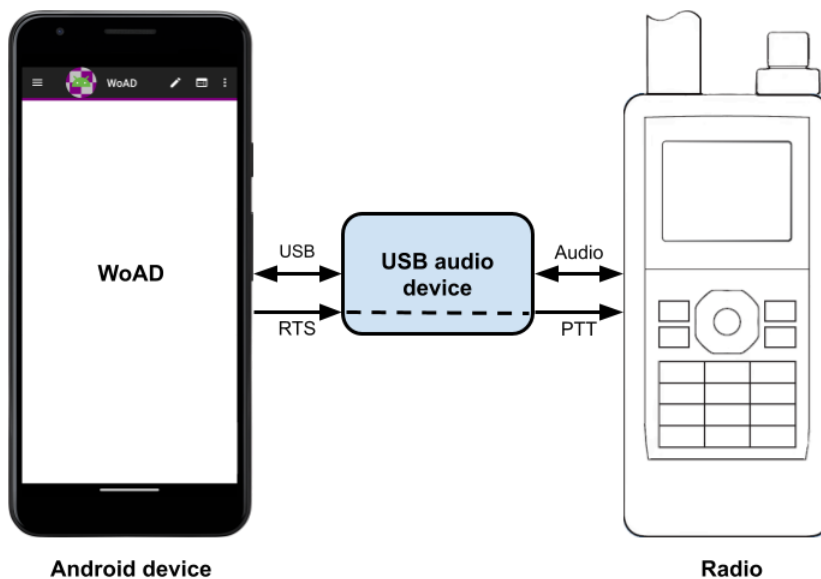
- <https://tigertronics.com/slusbmain.htm> (SignalLink™ USB)

The **TNC configuration** options on WoAD would be as follows:

- Mode: **Simplex**
- Channel: **<device dependent>**
- Set packet volume: **<determined by user>**
- PTT tone: On unused channel: **Unchecked**
- PTT USB RTS: Enable: **Unchecked**
- PTT BLE: Enable: **Unchecked**
- FX.25 FEC: Transmission check bytes: **None**



USB audio connection with WoAD-controlled PTT (RTS)



A USB audio device can also support a USB-to-UART device, which allows WoAD to directly trigger the PTT of the radio via the RTS signal. The advantage to this over the USB audio connection only (with or without PTT) is that you will not inadvertently transmit if your Android device makes a sound outside of WoAD - although it will not prevent interference if the Android device makes a sound while WoAD is transmitting.

You will need to select the PTT USB RTS port within the **TNC configuration** to enable the PTT functionality.

Some examples of such a device include:

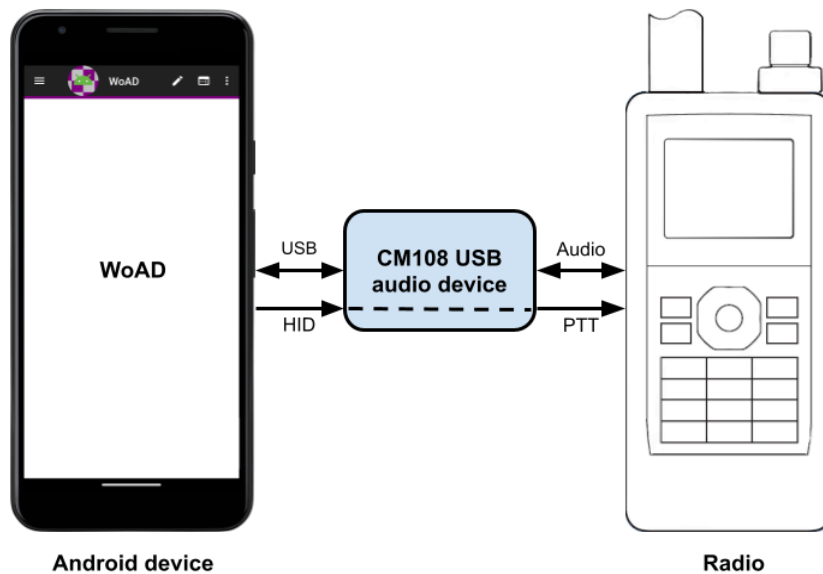
- <https://digirig.net/> (Digirig Mobile)

The **TNC configuration** options on WoAD would be as follows:

- Mode: **Simplex**
- Channel:
 - **Left** for Digirig Mobile
 - **<device dependent>** otherwise
- Set packet volume: **<determined by user>**
- PTT tone: On unused channel: **Unchecked**
- PTT USB RTS:
 - Enable: **Checked**
 - USB port: **<selected by user>**
- PTT BLE: Enable: **Unchecked**
- FX.25 FEC: Transmission check bytes: **None**



USB audio connection with WoAD-controlled PTT (GPIO)



USB audio devices based on the CM108 include one or more GPIO pins, which can be controlled via a USB Human Interface Device (HID) interface to drive the GPIO high or low. This, together with some simple circuitry, allows WoAD to trigger the PTT during packet transmission.

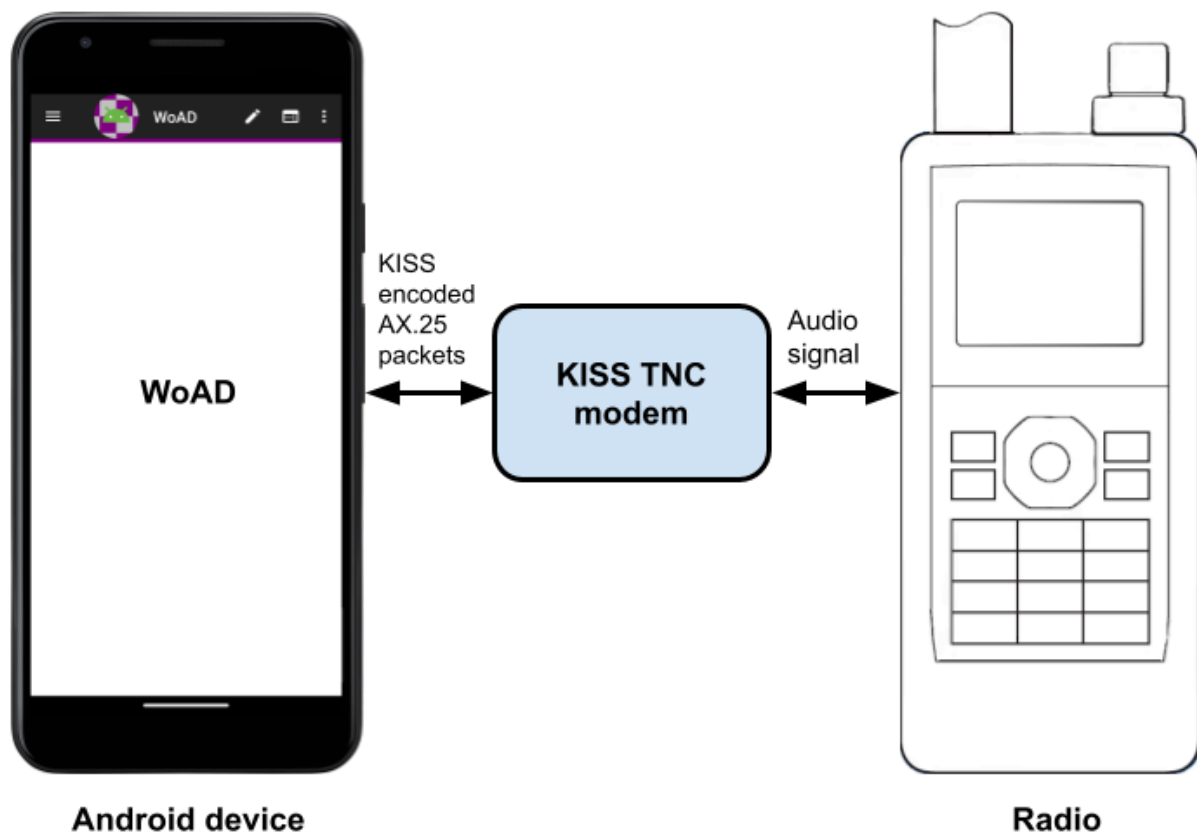
The audio controllers supported include:

- C-Media Electronics:
 - CM108
 - CM108AH
 - CM108B
 - CM109
 - CM119
 - CM119A
 - CM119B
- Solid State System:
 - SSS1620
 - SSS1621
 - SSS1623

There are numerous descriptions on where to purchase or how to modify a USB sound card to provide PTT control - the following terms "ptt usb soundcard gpio" or similar entered into your favored search engine should provide a representative selection.



Using an external KISS TNC modem



An external KISS TNC modem provides the same functionality as WoAD's built-in TNC, but the AX.25 packets are KISS-encoded when being sent between WoAD and the modem. The KISS protocol also allows WoAD to configure some basic parameters of the KISS TNC modem.

Many KISS TNC modems will have additional settings which can be configured using jumpers, their own app, or other methods. In particular many TNCs support multiple over-the-air data transmission speeds, but this must be configured from the TNC rather than in WoAD.

The advantage of using an external KISS TNC modem is that any sound generated by the Android device will not interfere with the audio signal that is transmitted to the radio, so you no longer need to be concerned about silencing your Android device when using WoAD.

Most KISS TNC modems support PTT control.

When using an external KISS TNC modem the **TNC type** must be set to **KISS**.

The associated **TNC configuration** options include the following:



- **KISS connection:** this allows configuration of the **Connection type** to the external KISS TNC modem and its associated **Connection configuration**, which we will address in further detail in the sections below.
- **Device initialization:** for some number of devices additional configuration specific to that device can be performed. In general the **Device manufacturer** should be set to **Generic**. We will discuss the devices supported in later sections.
- **KISS:** The **Port number** should be set to **0**, for all but advanced users.

We will consider each supported **Connection type** in turn.

Bluetooth KISS connection

Some examples of such a device include:

- <http://www.mobilinkd.com/> (Mobilinkd TNC1 - TNC4)

The **Connection configuration** options on WoAD would be as follows:

- Device: **<select paired device>**
- Settings...: used to display Android's Bluetooth settings page

BLE KISS connection

Some examples of such a device include:

- <http://www.mobilinkd.com/> (Mobilinkd TNC4)

The **Connection configuration** options on WoAD would be as follows:

- Device: **<select device>**
- Scan for KISS BLE devices:
- Settings...: used to display Android's Bluetooth settings page

TCP/IP KISS connection

Some examples of such a device include:

- <https://github.com/wb2osz/direwolf> (Dire Wolf, a virtual device running under Windows)

The **Connection configuration** options on WoAD would be as follows:

- IP address: **<IP address of device>**
- IP port: **<IP port of device>**

USB KISS connection

For KISS TNC modems using a DB9 serial port a USB serial adapter can be used between the Android device and the TNC.



Some examples of such a device include:

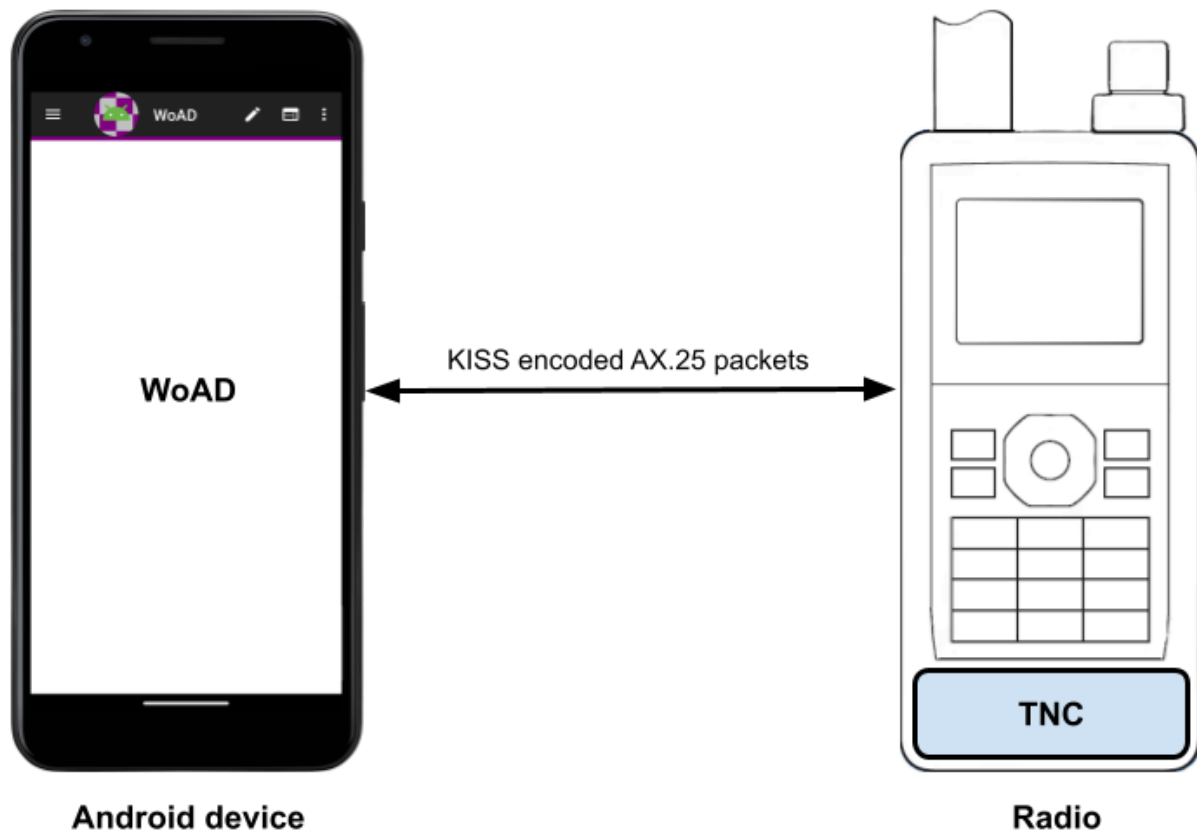
- <https://kantronics.com/> (several models)
- <http://www.mobilinkd.com/> (Mobilinkd TNC4)
- <https://tarpn.net/t/nino-tnc/nino-tnc.html> (NinoTNC)

The **Connection configuration** options on WoAD would be as follows:

- USB port: **<select device>**
- Use device settings: **Checked** for all but advanced users. If left unchecked the additional options are available:
 - Baud rate:
 - Data bits:
 - Stop bits:
 - Parity:
 - DTR:
 - RTS:



Using a radio with a built-in TNC



Some radios have a TNC modem built-in. It is important to note that not all radios with a built-in TNC make the TNC accessible from outside the radio - instead using it only, for example, to transmit APRS packets generated within the radio.

From the perspective of WoAD a radio that exposes its built-in TNC KISS modem is the same as a radio with an external KISS TNC modem. However, in a few cases WoAD also supports additional configuration for a radio with an accessible built-in TNC, by sending the required CAT commands at the start of a session.

The advantage of a radio with an accessible built-in TNC is that the cabling requirements are minimal: often using either a single USB cable or, for Bluetooth, no cable at all. Also, there is no concern with the volume levels, as this is all handled within the radio itself.

Kenwood TH-D72 (discontinued)

The Kenwood TH-D72 supports a USB connection to its TNC KISS modem. Under **Device initialization** set:



- **Device manufacturer:** Kenwood
- **Device model:** TH-D72
- **Device configuration:** The following parameters can be set as desired. If a value is set to **Default** then it will be left unchanged.
 - Band
 - Packet transfer rate (bps)
 - Power level
 - A/B band configuration
 - MR/VFO
 - Memory channel
 - Frequency
 - Offset direction
 - Offset frequency (Hz)
 - Step frequency (kHz)
 - Tone mode
 - FM mode

Kenwood TH-D74 (discontinued)

The Kenwood TH-D72 supports both a USB and Bluetooth connection to its TNC KISS modem. Under **Device initialization** set:

- **Device manufacturer:** Kenwood
- **Device model:** TH-D74
- **Device configuration:** The following parameters can be set as desired. If a value is set to **Default** then it will be left unchanged.
 - Band
 - Packet transfer rate (bps)
 - Power level
 - A/B band configuration
 - MR/VFO
 - Memory channel
 - Frequency
 - Offset direction
 - Offset frequency (Hz)
 - Step frequency (kHz)
 - Tone mode
 - FM mode



Kenwood DM-710 (discontinued)

The Kenwood DM-710 supports a serial connection to its TNC KISS modem, requiring a PG-5H programming cable kit. Under **Device initialization** set:

- **Device manufacturer:** Kenwood
- **Device model:** DM-710
- **Device configuration:** The following parameters can be set as desired.
 - Band
 - Packet transfer rate (bps)



Device initialization

In a few cases additional configuration options are available under **Device configuration** for some specific external KISS TNC modems. These are listed below:

SCS RPR-TNC

- **Device manufacturer:** SCS
- **Device model:** RPR-TNC
- **Device configuration:**
 - Operating mode
 - Transmit level for the operating mode

SCS Tracker

- **Device manufacturer:** SCS
- **Device model:** Tracker
- **Device configuration:**
 - Operating mode
 - Transmit level for the operating mode

SCS WinRPR

- **Device manufacturer:** SCS
- **Device model:** WinRPR
- **Device configuration:**
 - Operating mode
 - Transmit level for the operating mode



Glossary

AFSK	Audio Frequency-Shift Keying
APRS	Automatic Packet Reporting System (was Automatic Position Reporting System)
ARDOP	Amateur Radio Digital Open Protocol
AX.25	Data link layer protocol derived from layer 2 of the X.25 protocol suite and designed for use by amateur radio
BER	Bit Error Rate
BLE	Bluetooth Low Energy . A specification for KISS over BLE can be found at https://github.com/hessu/aprs-specs/blob/master/BLE-KISS-API.md
Bluetooth	A short-range wireless technology standard
BPS	Bits Per Second
BPSK	Binary Phase-Shift Keying
B2F	An extension of the original FBB amateur packet radio protocol
CAT	Computer Aided Transceiver
CMS	Common/Central Message Server
Digipeater	Digital repeater
Duplex	Two frequencies are used, one to transmit and one to receive. Full duplex allows reception and transmission to occur simultaneously. See also Simplex.
FBB	Bulletin board software and protocol for amateur packet radio
FEC	Forward Error Correction
FSK	Frequency-Shift Keying
FX.25	Extension to the AX.25 Link Layer Protocol providing FEC capability
GPIO	General-purpose input/output



HF	High Frequency
HID	Human Interface Device
KISS	A protocol for communicating with a TNC device
OTG	USB On-The-Go allows USB devices to act as a host, allowing other USB devices to be attached to them
P2P	Peer-to-peer connection
PDF	Portable Document Format
PSK	Phase-Shift Keying
PTT	Push-To-Talk
RMS	Radio Mail Server
RTS	Request to Send . Used for flow control in serial devices.
Simplex	Bi-directional communication on a single frequency with stations taking turns to receive and transmit. See also Duplex.
SSL	Secure Sockets Layer
TNC	Terminal Node Controller . A device used to interface between the digital signal of a computer and the audio signal of a radio being used for AX.25 packet communication
UART	Universal Asynchronous Receiver-Transmitter
UHF	Ultra High Frequency
USB	Universal Serial Bus
VHF	Very High Frequency
VOX	Voice-operated switch
WoAD	Winlink on Android Devices

