

# TORNADO ... Intelligent 10 Watt AM Modulator with Digital Frequency Synthesizer

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## Introduction

The TORNADO is a 5-15W solid state AM broadcast transmitter.

It uses the latest digital modulation techniques to deliver one of the most efficient AM transmitters.

An un-cluttered front panel offers easy and intuitive control and monitoring of all transmitter functions via the built in Menu.

For maximum ruggedness the transmitter has extensive fault protection, including monitoring SWR, over voltage, current, and temperature conditions.

Automatic tuning and modulation compression simplifies transmitter setup up and operations.

For ease of use the transmitter incorporates VU, Modulation, Voltage, and Power meters..

## Features

- Rugged design
- Easy setup, using the built in Menu and display.
- Accepts audio from Mono or Stereo source.
- Fully digital audio modulation stage
- Inbuilt modulation compressor/limiter
- Full metering of all internal parameters
- Extensive protection features
- User tuneable
- Compact size
- Lightweight
- Manufactured in United Kingdom

## Specifications

- RF output power (0% mod) 4-5W (peak) 9-15W
- RF output connector RCA female
- Frequency range 530kHz to 1730kHz (Medium Wave)
- Frequency range 1800kHz to 2000kHz (160M SW)
- Audio input level 0.24-2.4V RMS
- Audio frequency response 10Hz-13KHz
- Audio distortion <0.5% THD
- Modulation capability 110% positive peak modulation
- Audio input impedance > 600 ohms
- Audio input connectors 3.5mm Stereo jack female
- SWR monitoring
- Over temperature trip 70°C
- Over voltage trip (Antenna voltage) 100 volts
- Over current trip (PA stage current) 1.3 Amps
- Supply voltage 15V IDC
- DC power input connector 2.1mm
- Earth stud M3
- Ambient temperature -5°C to +50°C (Cooling Convection)
- Size 190 x 130 x 30mm
- Weight < 0.6Kg

## Installation

Before using your TORNADO, please read the Installation and Operating instructions.

The TORNADO will be supplied pre-configured with the correct power supply, channel spacing, for the country you are in and a default frequency chosen as a typical operating frequency in that country.

### Antenna

The TORNADO has been designed to operate with a 50 Ohm Antenna that has been set up and tuned for the desired frequency (usually by using an ATU).

If a suitable Antenna is not available, then use a 50 Ohm Dummy Load. Connect the Antenna to the socket marked ANT on the back of the TORNADO.

The antenna load connected to the transmitter must be tuned to minimise reflections. Whilst the transmitter is designed to withstand high levels of reflection for short periods, continually high levels of reflected power will degrade the long term reliability of the transmitter. Operating SWR should be kept to a minimum.

### Earth (Ground)

Adequate earthing of the transmitter is vital to ensure long term reliability and user safety. A separate, independent, earth is required for the transmitter and antenna system..

Connect the TORNADO to a suitable Earth or Ground using the socket marked **GND** on the back of the unit..

**NOTE:** A good, low impedance ground is required for optimum range and performance and to avoid hum (this applies to any AM transmitter).

In addition to the earth connection to the transmitter, the outer conductor of the coax feed to the antenna should be connected to the earth..

### Audio - Input

**Wired** - simply connect the supplied audio cable to your audio sources (i.e. PC sound card, MP3 player headphone or line output and your ready to go).

**Bluetooth BLE (Option)** - with the Bluetooth Streaming option, you can simply pair the Tornado with your Bluetooth Audio source and stream using Bluetooth. (*When using Bluetooth it is recommended to disconnect the wired Audio*)

Note: Bluetooth BLE Audio Streaming is an option.

### Mains Power

Connect the supplied, regulated power supply to the socket marked **PWR** on the back of the **TORNADO**.

## Operation

### Self Test

When the **TORNADO** is powered up it will perform a self-test, which can be viewed on the front panel display. It will then re-call the last used operating frequency and audio gain settings and then wait in **Standby Mode** (not transmitting, PA stage is disabled) until the user selects **On Air Mode** from the front panel.

### Front Panel

Virtually every function of the **TORNADO** can be selected from the **Menu** and the results viewed on the front panel display.

The Menu has been divided into two sections.

- **Main Menu** – used everyday operation
- **Setup Menu** – used for setup or diagnostics

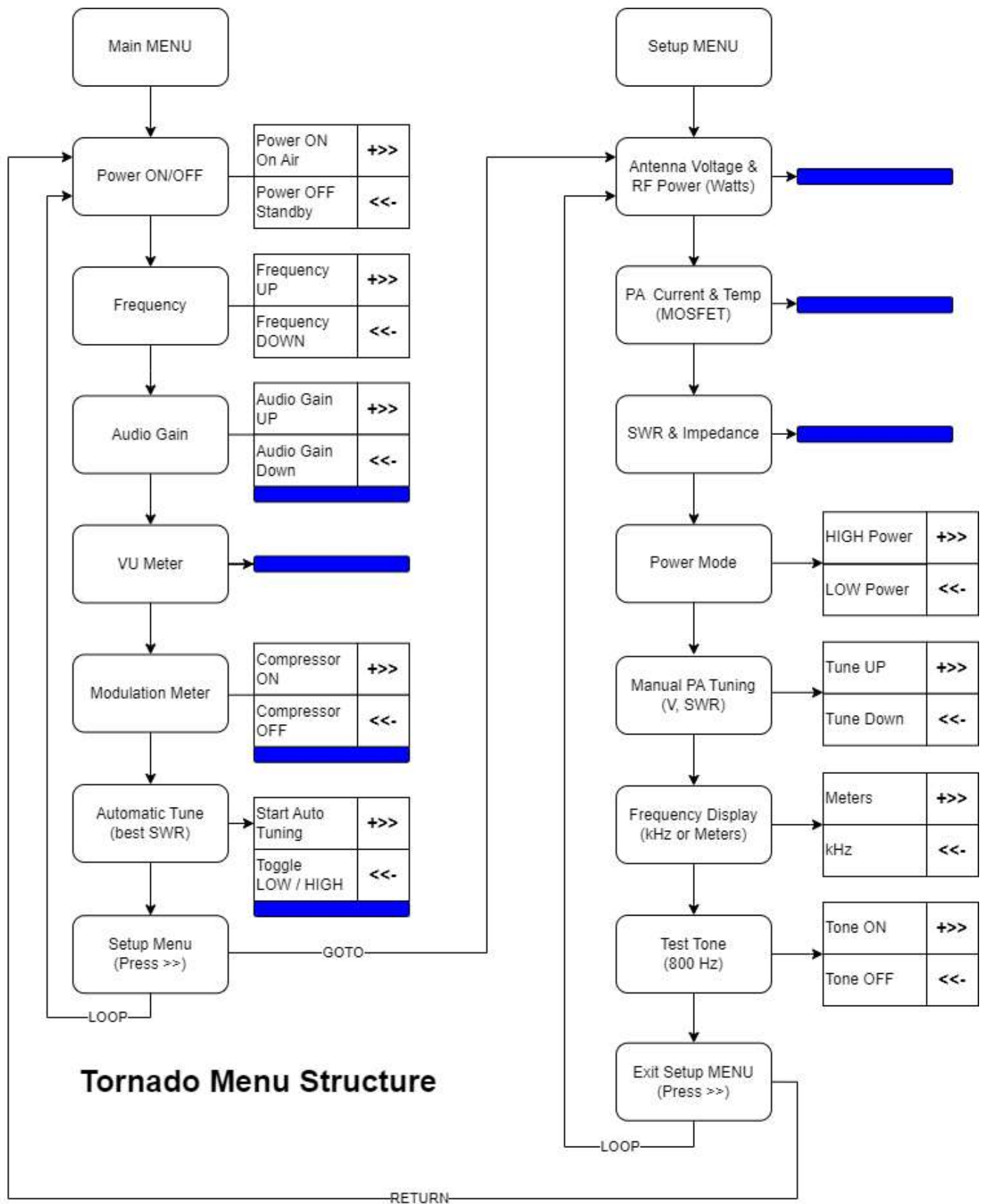
### Main Menu (*structure*)

To select each menu option, press the front panel **Menu** button to advance to the next menu option (in sequence as follows).

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**NOTE: All measurements are based on an ideal pure 50 Ohm PA load (the Antenna), however in the real-world all Antennas**

**and feed lines present a complex load. Therefore the measurements are subject to minor inaccuracies.**



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## Menu (cont)

To select each menu option, press the front panel **Menu** button to advance to the next menu option (in sequence as follows).

### Power ON / OFF

Pressing the +>> button will turn the Tornado ON. (On Air) and will recall all saved settings.

Pressing the <<- button will turn the Tornado OFF. (Standby)

**NOTE: When a over voltage, over current or over operating temperature fault is detected you should wait 30 seconds before resetting the fault condition.**

**Also please NOTE after any fault condition has been detected, the Tornado may revert to PA LOW PWER MODE.**

### Frequency

Use the +>> and <<- keys to select the desired operating frequency.

### Audio Gain

Use the +>> and <<- keys to select the desired Audio Gain.

### VU Meter

Display the VU bar graph.

### Modulation Meter & Compressor

Display the Modulation Index as a percentage and bar graph.

Use the +>> and <<- keys to turn the Compressor ON and OFF.

### Automatic Tune

Use the <<- button to select HIGH or LOW power mode.

Use the +>> to start the Automatic Tune process this will search to find the optimum settings based on the characteristics of the Antenna and select for the best SWR. (Standing Wave Ratio).

**NOTE: This is not a panacea for very badly matched or very short Antenna's!**

### Setup Menu

Use the +>> button to go to the **SETUP MENU**.

## Setup Menu

### Antenna Voltage & RF Power (Watts)

Display the average Antenna voltage and the average RF Power in Watts.

### PA Current & Temperature

Display the average PA current (MOSFET) and the PA Heat sink Temperature in Centigrade.

### SWR and Antenna Impedance

Display the SWR (Standing Wave Ratio) and the calculated Antenna Impedance.

### Low Power Mode

The tornado has a **PA Low Power** mode which can be used when.

- When testing new Antenna and/or ATU settings
- When using a badly matched or short Antenna.

**Note:** Audio will be turned off in **LOW** Power Mode (Carrier Only)

Press the +>> button to select **PA High Power** mode.

Press the <<- button to return to **PA Low Power** mode.

### Manual PA Tuning (for experienced users only)

Use the +>> and <<- buttons to adjust the Class E PA stage tuning. Best used in conjunction with a dummy load and oscilloscope to monitor peak voltage and waveform.

### Frequency Display (kHz or Meters)

Use the +>> and <<- buttons to select how the Frequency is displayed as either **xxxx kHz** or **xxx Meters**

### Exit Setup MENU

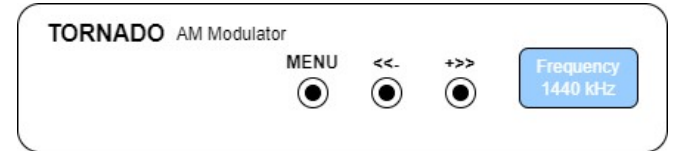
Use the +>> button to exit from the SETUP MENU and return to the MAIN MENU.

## Setup Instructions

### Earth / Ground

**Attach your Earth / Ground wire to the EARTH terminal.**

#### Front View



#### Rear View



## TORNADO Quick Start Guide

We strongly urge our customers to read this manual before attempting to use the transmitter.

The TORNADO range of MF transmitters incorporate features not normally found in equipment of this type, and a thorough understanding of these will lead to easier commissioning and use.

However, we understand that our customers are busy people with a high level of technical competence. So with this in mind the following is a quick procedure to get your transmitter up and running:

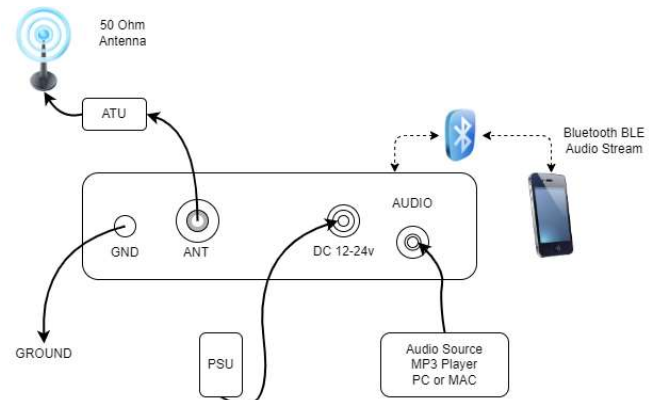
- Connect all the cables (see Installation section)
- Plug in the power supply
- The Tornado will **SELF TEST** and then go into **STANDBY**
- Using the Menu, go to **Frequency** and set as needed
- Using the Menu, go to **Audio Gain** and set to maximum
- Using the Menu, go to **Auto Tune**, then..
  - press <<- to select either **HIGH** (or **LOW** power mode)
  - press +>> to start the **AUTO TUNE** process
- The Tornado will now go and select the best settings
- The Tornado is now **ON AIR**
- If **SWR** is too high then you may need to adjust your Antenna and/or ATU or stay in Low Power Mode.

*Note: If **LOW** power mode was selected, then the Audio will be turned off to facilitate testing.*

*You should go into the **SETUP MENU** and*

- Select the **Low Power Mode** option
- Press the +>> button to select **PA High Power** mode
- The Audio is now enabled.

## Example Installation



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## Alarms and Safety Trips

The TORNADO transmitter incorporates various alarms and safety trips to protect the transmitters output from excess voltage or high currents caused by badly matched Antenna (high SWR).

Upon detection of a high SWR the transmitter will immediately turn off the transmitters output and display a warning message.

### Hidden Menu's

There are three hidden Menus which are invoked if there is an over load condition.

#### Antenna (PA) Over voltage alarm (trip)

The over voltage trip becomes active if the Antenna (PA) voltage of the transmitter exceeds 100 volts. Operation of this alarm indicates a problem with the Antenna tuning.

#### PA Over current alarm (trip)

The over current trip becomes active if the MOSFET (PA) current of the transmitter exceeds 1.3 Amp. Operation of this alarm indicates a problem with the Antenna tuning.

#### Temperature alarm (trip)

The temperature trip becomes active if the temperature of the transmitter heat sink exceeds 70°C. Operation of this alarm indicates inadequate ventilation or a problem with the Antenna tuning.

## Reseting any alarm (trip's)

Once an alarm (trip) is active the output of the transmitter (PA stage) is turned off, and must be reset manually by pressing the MENU button.

**NOTE: The transmitter will go into LOW POWER MODE after an alarm reset.**

Once the problem has been resolved (usually an Antenna tuning problem), you can go back to HIGH POWER MODE.

## Trouble Shooting

Audio distorted:	Audio source volume to high.
Hum on audio:	Bad audio cables, check for broken shield wire. Defective Earth connection. Possible Earth Loop (see Earth Loops).
No Audio:	Bad audio cables, Audio volume set to low.

### NOTE:

**The TORNADO has been designed to operate with a 50 Ohm Antenna. If a suitable Antenna is not available, then use a 50 Ohm Dummy Load.**

**Do not run the Tornado without a suitable 50 Ohm Antenna or Dummy Load.**

### NOTE:

**When a over voltage, over current or over operating temperature fault is detected you should wait 30 seconds before resetting the fault condition (this is to allow internal circuitry to discharge and/or cool down below the trip point).**

### NOTE:

**After any fault condition has been detected, the Tornado will always revert to PA LOW POWER MODE.**

## FAQ

**This is the really important.** A good, low impedance ground is required for optimum range and performance and to avoid hum (this applies to any AM transmitter). If you experience noise on the transmitted signal then the EARTH / GROUND is inadequate.

## Earth Loops

An Earth Loop occurs when there is more than one path to Earth (Ground) in the installation. When you connect the TORNADO to an AC powered audio source (such as a PC with an Earth), there may

be an Earth path through the audio cable outer shields and then through the mains wiring to GROUND.

If you suspect Earth Loop might be a problem the solution's are:

1. Fit a Earth Loop adapter to the Audio Jack lead
2. Remove the Earth wire from the TORNADO **GND** terminal and rely on the Earth provided by the Audio lead.
3. Use The Bluetooth Audio with the Audio Jack disconnected.

*Note: These "built in" ground paths may provide good performance in some cases, but variations in house wiring and installation may require you to ground the TORNADO directly GROUND.*

## Convert Meters to Frequency

The dials of the majority of European radios will be marked in wavelengths (metres) rather than frequencies.

To convert from one to the other, divide 300,000 by the known figure the result should be rounded up or down to the closest whole number.

Thus 300,000 divided by 1000 KHz gives 300 Metres. Conversely, 300,000 divided by 300 Metres gives 1000 KHz.

## Bluetooth Audio (Option)

If your TORNADO has the Bluetooth BLE Audio option, then you can simply pair the TORNADO with any Bluetooth BLE enabled Audio device. For example, iphone, Android Smart Phone etc

Both the Audio and Remote Bluetooth option uses the latest BLE mode (that is Bluetooth Low Energy)

Pairing name for Audio look for device ending with **M18 or MX18**

Pairing name for Remote look for device ending with **BT05 or AT09**

## A Little Background....

Almost all functions are done in software for example the VU meter, Modulation meter, Antenna voltage, RF Power meter, Over Load trips etc.

These all assume the following

- The Antenna is 50 Ohm {therefore the readings are only accurate if the Antenna presents an true 50 Ohm impedance}
- Everything is calculated in real time and then averaged

Modulation is done with a Class D 100W Audio chip, this provides **Series Modulation** to the Class E PA stage using an 600v MOSFET, which means that under zero modulation {no audio conditions} the PA stage runs at half the fully modulated PA stage voltage and half the RF Power (Watts), and hence much cooler, and only require a modest Heat sink.

## Glossary of Mnemonics

PA – Power Amplifier

PWM – Pulse Width Modulation

SWR – Standing Wave Ratio

## Warranty

We guarantee the product to be free from defects in materials and workmanship for one year. We will repair or replace such product, if found to be defective in materials or workmanship.

The customer will be responsible for all costs of transportation and insurance, in both directions.

This warranty shall be void and of no force of effect in the event a covered product has been modified in design or function, or subjected to abuse, misuse, mishandling or unauthorized repair.