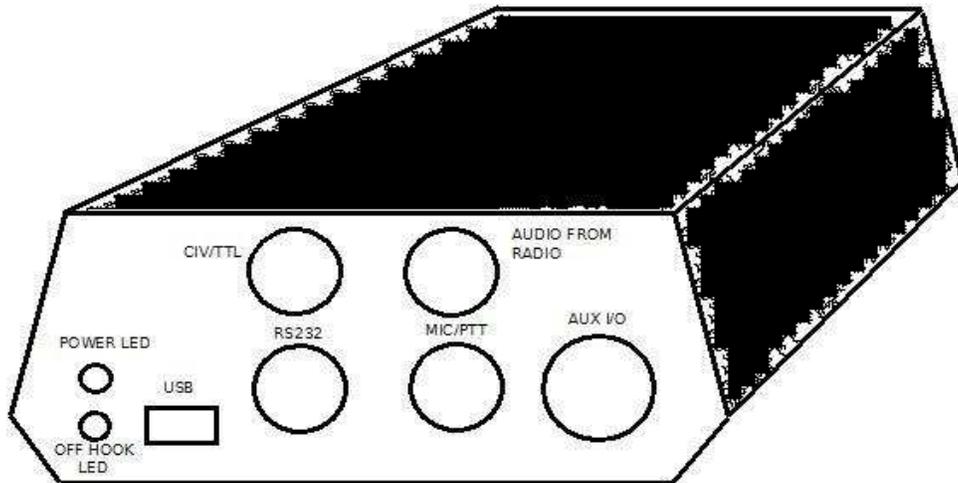# CELLTENNA

User Manual
Draft Version 5
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CONTENTS

1) Overview of Features

CellTenna makes possible a more enjoyable, efficient, and manageable approach to mobile HF operation by providing a means to directly operate your base radio at home via cell phone or any other conventional phone connection. Using DTMF commands on your phone, the following controls are available when used with an HF radio having a compatible CAT (Computer Aided Tuning) link:

- Directly enter desired frequency
- Change operating mode (LSB, USB, AM, FM)
- Step frequency up/down
- Scan frequency up/down
- Set frequency change step size
- Select up to 99 memory channels (must be programmed into the HF radio first)
- Speech synthesized read back of HF radio frequency/mode
- Adjust receive audio level
- Adjust transmit audio level
- Transmit/Receive
- Disconnect link

Also built in are timers to disconnect the link in case the connection is lost. If no DTMF keys are pressed for 5 minutes, CellTenna will indicate that it is about to logoff with a voice prompt. If a DTMF is not entered within 20 seconds, the link will be dropped and CellTenna will hang up the phone line. In transmit mode, a warning tone is emitted after 60 seconds if no DTMF key has been entered. After the warning tone, a DTMF key (other than the "*") must be entered or CellTenna will return the radio back to receive within about 15 seconds.

A variety of pick-up modes are available for activating the CellTenna. The user must select from pick-

up on ring, pick-up on caller ID match, pick-up on distinctive ring, and password.

2) Typical Application

Most HF radios with a CAT port can work with CellTenna. In the figure below, a typical use is shown with a Kenwood TS2000 which uses RS232 for its CAT port. CellTenna connects to the radio's Microphone input, PTT input, audio output, and RS232 port. CellTenna is connected to the telephone network via POTS or a VOIP connection such as Vonage or Skype. The user connects to CellTenna using a cellphone or any other telephone connection.

CellTenna converts DTMF commands into RS232 formated commands compatible with the CAT format of the radio.
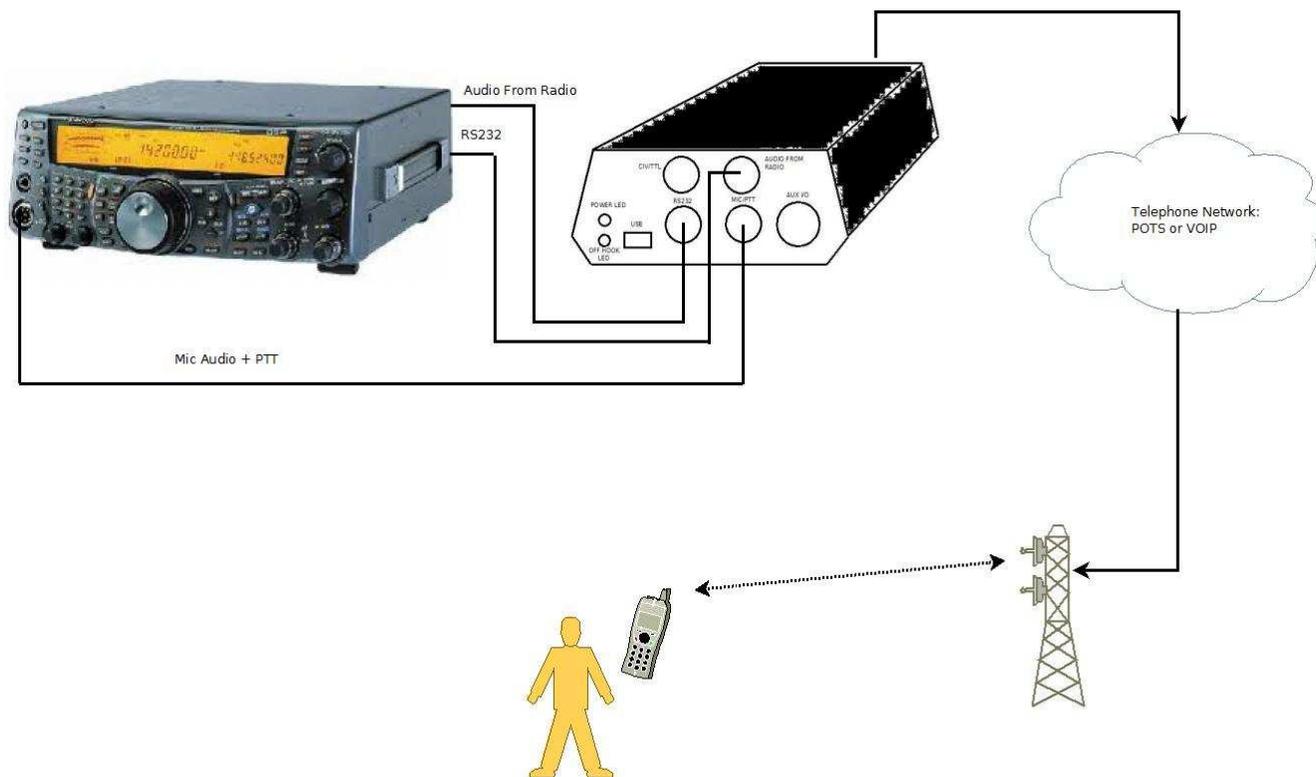
3) Configuration

CellTenna has several options that must be selected from for desired operation. These include telco pick-up mode, the type of radio to be used, the baud rate of the radio control link, login password (if used), and caller id number (if used).

There are two ways to configure options for CellTenna operation – via USB or by using dtmf via telco line. There is also a "auto find" mode that will test for the correct CAT format and baud rate.

3.1) Via USB:

First make sure you have downloaded the driver file TBD.INF from TBD. **<<< Need to define**
Open a terminal program like Tera Term or Hyperterminal.
With CellTenna connected to power and a USB connection between CellTenna and your PC, press and hold CellTenna's program button. After a few seconds, the yellow connection LED will start to blink once every second. Continue holding the program button until the LED blinks at the fast rate of about 8 times a second. Release the program button. CellTenna is now in USB mode. (Note that the yellow LED will stop blinking after releasing the program button.)
Once the PC recognizes CellTenna and the driver (you may have to direct your PC to the proper INF file), the terminal program should see CellTenna as a virtual serial port. Baud rate is unimportant with USB.
Enter the letter "M" for menu. (Not case sensitive.) The configuration options should appear.

As indicated by the menu, you have the following options that you can select from. It also states if the radio type has been confirmed via auto find, the version of the firmware, and the version of the speech file. The menu response will look like this depending on the configuration of your device:

```
CellTenna Settings:
Radio Type Verified
Radio Type=2 - Standard Kenwood,  Pick Up Mode=2
CID Number:5555551212
Password:3210,  Baudrate = 9600
Voice Prompts Version = 1, Firmware Version = 2,
CellTenna Menu:
Enter 1 to Set Radio Type
Enter 2 to Set Pick-up Mode
Enter 3 to Set Caller ID Number
Enter 4 to Set Password
Enter 5 to Set Radio Baudrate
Enter 6 to Exit USB Progamming Mode
```

Enter 1 to select the radio type. At this point, the radio type submenu will appear.
NOTE: You can skip this step by using the auto find mode.
Radio type submenu:
- Select 0 for CIV/TTL format for most Icom radios such as the IC706
- Select 1 for CIV/TTL format for older Icom radios such as the IC735
- Select 2 Kenwood RS232 format

- Select 3 for newer Yaesu radios that use an RS232 format like Kenwood
- Select 4 for older Yaesu radios such as TBD
- Select 5 for portable Yaesu radios such at the FT-817

Enter 2 to select the pick-up mode. At this point, the pick-up mode submenu will appear.
Pick-up mode submenu:
- Select 0 for pick up on ring. (Not recommended except for testing.)
- Select 1 for pick up on ring plus enter password after pickup.
- Select 2 for pick up on CID match. (Probably the most convenient and secure mode.)
- Select 3 for pick up on CID match plus enter password after pickup.
- Select 4 for pick up on short-short distinctive ring plus enter password after pick up
- Select 5 for pick up on short-long-short distinctive ring plus enter password after pick up

Enter 3 to program the caller ID match number. At this point, the CID submenu will appear. As directed, enter the 10-digit caller ID that you would like CellTenna to respond to for incoming calls.

Enter 4 to program the 4-digit password. At this point, the password submenu will appear. As directed, enter the 4-digit password for CellTenna to look for when using one of the password modes. Only numbers between 0 and 9 are allowed for each digit.

Enter 5 to program the baud rate for the radio connection. *(NOTE: You can skip this step if you use the auto find feature.)* At this point, the baud rate submenu will appear. Select the desired baud rate for the radio communication connection.

Enter 6 or "E" or "e" to exit USB mode.

Enter 7 to re-program the voice prompt EFLASH memory.
This menu item is hidden, but should only be selected if a new CellTenna program and voice file is available for field updating. A new voice file would only be needed if new prompts were added to go with a new version of the main CellTenna program.
If 7 is selected, the submenu will tell you to enter the letter "r" to indicate that you are ready to update the voice file. Select r and the submenu will tell you to start sending the file. In the terminal program, select "send file". Select the updated voice file and the process will begin. When completed, you can program other options or exit the USB mode.

3.2) Via Telco
Instead of using USB, you can configure CellTenna using the telco connection and dtmf to select options.
Apply power to CellTenna and attach a phone line to the CellTenna input telco port.
Press and hold the program button on CellTenna. Release the button when the yellow connection LED blinks once every second. Make sure to release it before it reaches the fast blinking USB program mode. CellTenna is now in the Telco program mode. Using your cellphone, call the number for the line connected to CellTenna. CellTenna will pick up as soon as the ring is detected. You will hear voice prompts instructing what number to press to configure which option.

Options are the same as they are for USB mode with a few exceptions.
1 – Radio type
2 – Pick up mode
3 – Caller ID
4 – Password
5 – Baud

There is no way to reprogram the voice file in this mode as USB is required.
To exit, press "#" key and CellTenna will hang up and will be ready to use.

3.3) Auto CAT Detect
An easy way to configure the proper radio type and baud is to enable the Auto CAT Detect.
To do this, press and hold CellTenna's program button until the connection LED begins to blink fast (8 times per second). Release the button. Disconnect power from CellTenna. Make sure there is the proper data connection between CellTenna and your radio. Turn on your radio. Apply power to CellTenna. After powering up, CellTenna will try each format at each potential baud until it gets a valid response. The connection LED will blink as it cycles through the various attempts. When it finds a match, the LED will blink quickly several times then go out. If there is no match, there will be no quick blink and the LED will go out as soon as all configurations have been tried.

If this fails, check your connections. If you cycle power to CellTenna, it will try again and try each time you cycle power until it finds a match.

By going into USB mode after Auto Find, you an verify what connection Auto CAT Detect matched.

4) CellTenna Operation
Once CellTenna is configured and all proper connections are made between your radio and CellTenna and CellTenna and your phone line, call the phone number that CellTenna is connected to.

4.1) Pick Up Modes:
If pick up mode is set to pick up on ring (setting 0) CellTenna will pick up as soon as a ring is detected.

If pick up mode is set to pick up on ring with password, CellTenna will pick up after detecting a ring then wait for a 4-digit DTMF password. If an incorrect sequence is entered CellTenna will hangup. CellTenna will hang up after TBD if password entry is not complete.

If caller ID mode is selected, CellTenna will pick up as soon as it sees a CID match.

If caller ID + password mode is selected, CellTenna will pick up after CID match then look for a 4-digit password.

There are also two distinctive ring modes available. Distinctive ring allows the use of one phone line with two unique phone numbers. The main number will have a normal ring (which will be ignored by CellTenna) while the distinctive ring number has a different ring for incoming calls. One has a short-short ring while the other is short-long-short. Both require password entry after CellTenna picks up.

4.2) Radio Control:
After logging in, the following commands are available:

DTMF 1: Direct frequency mode. CellTenna's prompt will say "frequency". Enter the frequency using DTMF keys in hz followed by the # key. For example, to go to 14.250Mhz, enter the following sequence: 1 <CellTenna will announce "frequency"> 14250000#. CellTenna will read back each digit as you enter it to confirm that it has been detected properly. (Cell connections and VOIP can cause dropouts that lead to missed DTMF detection.) It's always a good idea to confirm the frequency entered by requesting status with the 8 key.

DTMF 2: Change operating mode. This key will signal the CellTenna to change the operating mode. Below 28Mhz, the CellTenna will cycle through LSB, USB, and AM. Above 28Mhz LSB, USB, AM, and FM are cycled through. Each time 2 is entered, the CellTenna will go to the next mode and announce what mode it has changed to.

DTMF 3: Step up frequency. Each press of 3 will increase the operating frequency by one step.

DTMF 4: Set step size. When 4 is pressed, the CellTenna will announce "Stepsize". Enter the stepsize desired in hz followed by the # key. For example, to set a 1khz stepsize, enter the following sequence: 4 <CellTenna will announce "step size"> 1000#. Each digit will be announced as it is entered to confirm proper detection. Step size directly controls the frequency increment for step up, the decrement for step down, plus the step size for the scan up and scan down commands.

DTMF 5: Logoff. The first time 5 is entered, the CellTenna announces "logoff". To disconnect the link, you must enter 5 a second time to confirm. If any other key is entered, the logoff command is cancelled.

DTMF 6: Step down frequency. Each press of the 6 key will decrease the frequency by one step size. (See DTMF 3 – Step up)

DTMF 7: Enter memory. When 7 is pressed, the CellTenna will announce "Memory". Enter the desired memory followed by the # key. The memory number can be 1 or 2 digits long. For example, to go to memory 5, enter the following sequence: 7 <CellTenna announces "Memory"> 5#. The memory locations must be programmed into the HF radio ahead of time. After CellTenna directs the HF radio to go to the selected memory, CellTenna will read back the frequency and mode into its own memory so that frequency increments/decrements can be made from that point. *Pressing 7 while transmitting will toggle the state of the open collector auxiliary output on pin 5.*

Note: Some Yaesu mobile radios don't allow access to stored memory via the control link. These radios are the types used by selection "5" of the radio type menu. In this case, CellTenna has 9 built-in memories that you can access. See section 9 for details.

DTMF 8: Radio status. When 8 is pressed during receive, CellTenna will announce the frequency and the mode. Use this feature to verify direct entry of frequency, memory channel, or after scanning. *During transmit, pressing 8 will cause CellTenna to emit a 2 second long tone into the radio mike input. Intention is to create a signal for an autotuner when in SSB mode.*

DTMF 9+3: Scan up. Entering 9 followed by the 3 key will instruct the CellTenna to begin scanning upward in frequency steps set by the step size. Stop by pressing 3, 6, or #.

DTMF 9+6: Scan down. Entering 9 followed by the 6 key will instruct the CellTenna to begin scanning downward in frequency steps set by the step size. Stop by pressing 3, 6, or #.

DTMF 9 during transmit will check the voltage level on pin 6 of the auxiliary input connector. CellTenna will announce it's value as a number between 0 and 9; 0 being 0 volts and 9 being 3.3 volts. Can be used for SWR level or other fault detection.

DTMF *: Transmit/receive toggle. When in receive mode, pressing the * key will cause CellTenna to emit a short tone. Press * a second time to begin transmitting. Press * once when transmitting to return to receive.

DTMF 0 + 2: Toggle filter between wide and narrow on radios for which this feature is available.

DTMF 0 + 3: Increase receive audio. Keep in mind that there are three different receive volume settings. One for USB/LSB, another for AM, and a third for FM. When operating in a given mode, adjusting the receive volume using the 0 + 3 command will only adjust the receive volume for that mode. If you then switch modes, CellTenna will save the setting to EEPROM and load in the previous setting for the mode being switched to. You will want to set this level to give a normal phone listening level. Be careful, as setting it too high can make it difficult for the DTMF detector to tell the difference between tones heard on your received radio signal and the DTMF keys you press on your cellphone. *Note: CellTenna now has an AGC feature for SSB and AM modes. Average audio levels are calculated over .5 second windows. 8 windows (not necessarily in a row) that are below the low threshold will cause the audio level to increase where 4 windows above the high threshold will cause a decrease. Therefore it should only be necessary to adjust the radio's audio to workable level.*

DTMF 0 + 4: Decrease receive audio. See 0 + 3 command.

DTMF 0 + 1: Increase transmit audio. Works just like the 0 + 3 command but affects the microphone audio level going to the HF radio. This adjustment can only be made while in the receive mode.

DTMF 0 + 4: Decrease transmit audio. See DTMF 0 + 1.

DTMF 0 + 7: Toggle the state of the open collector auxiliary output on pin 5. (Same as DTMF 7 in transmit mode)

DTMF 0 + 9: Check the voltage level on pin 6 of the auxiliary input connector. CellTenna will announce it's value as a number between 0 and 9; 0 being 0 volts and 9 being 3.3 volts. Intended for things like SWR level or other fault detection. *(Note: This operates the same as using DTMF 9 during transmit.)*

DTMF 0 + #: Submenu reminder. No action will be taken, but CellTenna will give a voice reminder of the list of sub options available with the 0 key.

DTMF #: Emit tone. With some cell phone vocoders, poor signal to noise ratios coming from the HF radio may cause the vocoder to stop carrying audio. Pressing the # key will cause the CellTenna to emit a tone burst that will cause the vocoder to open up briefly so that you can verify the condition of the frequency. Also, with SSB signals not tuned, the cell phone vocoder may stop carrying audio that it does not recognize as a voice. Using the # key can aid in tuning into such signals by providing a means of opening up the vocoder.


4.3) Shared Line Options:
Quite often, the home phone line is shared with other household members raising the risk of creating an inadvertent radio party line with the unlicensed - should they pick up a home extension while you are connected to CellTenna. To prevent this, CellTenna has an input telco plug and an output plug. The output telco plug is normally connected straight to the input plug. When CellTenna is off-hook, a relay interrupts this connection. Therefore, by having all extensions connected via the output plug, the party line situation will be avoided.

Another problem would be when CellTenna is configured to pick up on caller ID match and you wish to call home and not have CellTenna pick up. One option is to block caller ID when you make the call. Another option is to configure CellTenna in caller ID match plus password mode. In that case, you can first call CellTenna, when it picks up enter "9999" for the password. CellTenna will then hang up and ignore any calls for the next 5 minutes, allowing you to call home and have the phones ring as normal.

5) CellTenna Connectors and Indicators

The front of CellTenna has the following:
1 – Power LED
2 - Off hook and program mode indicator
3 – 1/8" stereo RS232 control connector (tip = data from radio, ring = data to radio)
4 – 1/8" stereo CIV/TTL control connector (tip = data from radio, ring = data to radio)
5 – Audio from radio (tip only)
6 – Microphone connection to radio (tip = Audio, PTT = ring)
7 – Auxiliary connector (See break-out diagram)

Auxiliary Connector I/O:
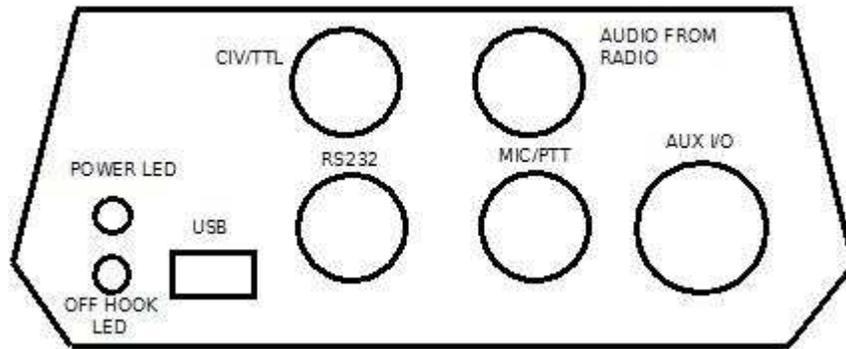
Auxiliary Connector I/O
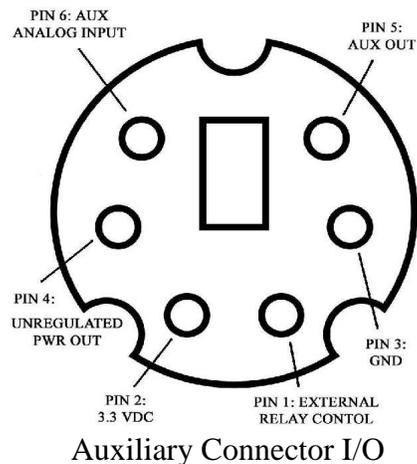
Pin 1: Open collector port for external relay. This signal will be pulled down when CellTenna has reached the login state. Use this to control power for your radio and associated devices such as an autotuner. Current sink limit is about 100ma and there is no pullup resister.
CellTenna has an onboard protection diode to handle the voltage surge when the relay is turned off. Do not use a relay voltage above 4V, or else the protection diode will turn on. If a higher relay voltage is

desired (up to 24 volts), you will need to remove the protection diode D3 on the CellTenna board and include one externally.

Pin 2: Regulated 3.3 volts, 100ma maximum, depending on the current limit of the power source. Avoid surges on this voltage as this is also connected directly to CellTenna's power.

Pin 3: Ground

Pin 4: Unregulated power. Voltage depends on the voltage of CellTenna's wall power supply. Limit current to about 100ma, also depending on the power supply ability.

Pin 5: Auxiliary control output – open collector, limited to about 10ma, 24VDC max.
The state of this pin can be toggled using DTMF 0+7 during receive or DTMF 7 during transmit. There is a 100 ohm series resistor between this pin and the transistor collector. If greater sink current (up to 100ma) is desired, replace resistor R69 with 0 ohm.

Pin 6: Auxiliary analog input. The analog value of this pin can be read during the receive state by entering DTMF 0+9 or during transmit state by entering DTMF 9. CellTenna will announce the value as a number between 0 and 9; 0 being 0 volts and 9 being 3.3 volts. Do not exceed 3.3 volts or go below 0 volts with respect to CellTenna. Protection diodes are present. Also, there is a 100 ohm resistor in series between the pin and the protection diodes and an additional 1k ohm resister between that point and the ADC input pin of the processor.

The rear of CellTenna has the following:

1 – Telco input
2 – Telco output (internal relay interupts the connection from Telco input when CellTenna is off hook)
3 – CellTenna Program button
4 – Power input: 5VDC minimum to 7.5VDC maximum . 100Ma minimum *(CellTenna uses about 30ma on hook, 80ma off hook. If external devices are powered via the aux connector, factor that in as well.)*
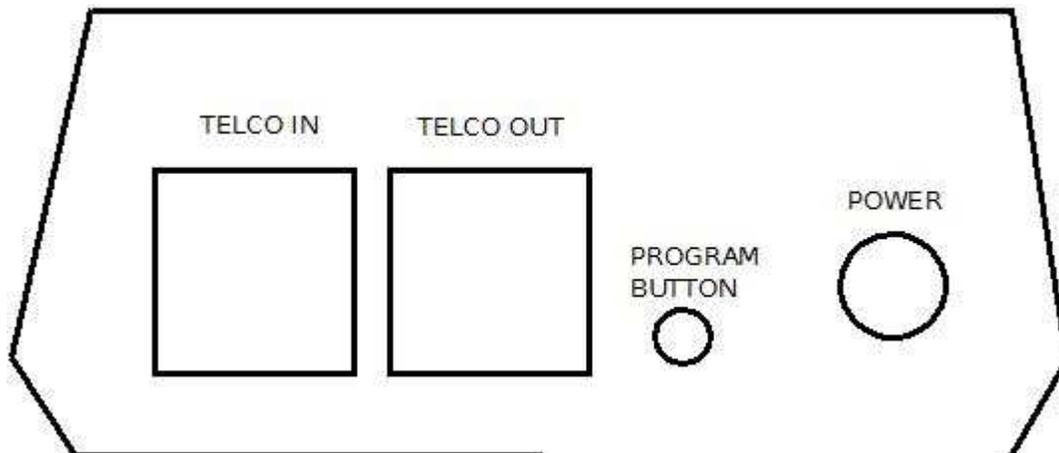
6) Firmware Upgrades

When new versions of CellTenna's firmware become available, the user can easily reprogram CellTenna using a PC and the USB port.

CellTenna uses an Atmel ATMEGA32U4 processor, which has the feature of a built-in USB bootloader function for ease of reprogramming. To re-program, you will need the FLexible In system Programmer (FLIP) software from Atmel, which can be downloaded for free from www.atmel.com/tools/FLIP.aspx. Download FLIP version 3.4.5 or newer. You will also need the USB driver which will come with the install.

After downloading FLIP and the latest CellTenna file (format will be CellTenna_FW_xx.hex, where "xx" indicates version number), remove power to CellTenna. With the USB cable connected to your PC and CellTenna, reconnect power to CellTenna while holding down CellTenna's program button until the yellow power LED illuminates.

When you do this for the first time, your PC will start looking for driver file for the bootloader. Direct it to the one that came with the FLIP software.

Open FLIP. Under settings, select USB. Under devices, select atmega32u4. Under file, select "load hex file" and navigate to the new CellTenna hex file.

Click "Run". FLIP should begin re-programming CellTenna's firmware. This should only take a few seconds to complete. When it is done, press "Start Application". CellTenna is now running with the new version.

If the voice prompts are updated, the process is different as the voice file is burned into a separate flash memory external to CellTenna's processor. Review the section on "Programming Via USB" for directions.

7) RFI Tips

It may be required to put a ferrite choke on the phone line and power input depending on rf levels. Also, beware of ground loops. You may need to have only one connection to your radio contain a ground return path. If you are having problems with RFI, try clipping the ground shield at one end of each connection going to CellTenna from your radio except for one.

8) Usage Tips:

It can sometimes be hard enough to understand someone over a cellphone under the best of conditions. Add to the the noises associated with HF radio and the challenge is even greater.
I have found that very decent audio can be achieved by connecting the audio output to some external high fidelity device.
Good quality headphones with integrated microphone are readily available for cellphones, but this is an unsafe (and usually illegal) approach if you are driving.
Another approach is to break out the audio in/out to the cellphone so that a cellphone microphone can

be used and have the receive audio feeding into the car's audio system.
For monitoring, you can simply connect a stereo plug to most cellphones' headset jack.

9) Built-in Yaesu Memories
For some Yaesu radios - such as FT-817, 857, 897 – programmed memories cannot be accessed via the CAT interface. For these radios, CellTenna as 10 fixed memories pre-programmed in order to minimize this inconvenience. The frequencies are: 1.9Mhz, 3.9Mhz, 5.3665Mhz, 7.25Mhz, 14.3Mhz, 18.15Mhz, 21.4Mhz, 24.95Mhz, 28.38Mhz 50.125Mhz
For example, to go to 3.9Mhz, enter the DTMF sequence "7 2 #".
Note: At this time, these memories cannot be modified.

10) Safety
It should go without saying that the user should use good sense when employing CellTenna as a means to drive and operate HF.
- Spend a good bit of time using the CellTenna system while off the road.
- Get connected, set your frequency, mode, etc before you start driving so that all you need to do is hit the * to transmit/receive.
- Conventional phones are safer as they have tactile points that help you locate the keys by feel. If you are using a touch screen phone, deactivate the screen saver shut-off and add a small piece of tape (or other means) to help you locate the * key by feel.
- By far the best way to use CellTenna while mobile is to have someone else drive.

Standards
CellTenna has been designed to and will meet all telco regulatory requirements such as TIA/EIA/IS-968 (formerly FCC part 68), FCC part 15B, TBR-21, EN60950, UL1950, EN55022B, IEC950/IEC60950, CISPR22B, EN55024, and many other standards.   Since wired telco service is in great decline, it was decided not to pursue certification since connection to VOIP adapters such as Vonage do not require certification.

With small changes in passive component values, CellTenna can be made to meet many international telco requirements for certification. This will be pursued if there is sufficient demand.

CellTenna has been designed to meet the requirements for FCC Class B. Certification is in progress.