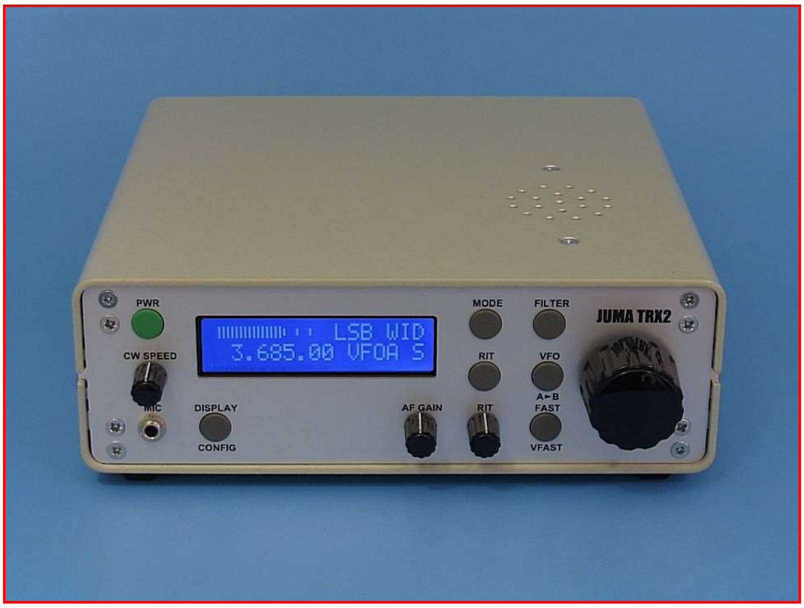
JUMA TRX2

Operation Manual
(Firmware Version 1.07n - 24 October 2011)
Adrian Ryan - 5B4AIY



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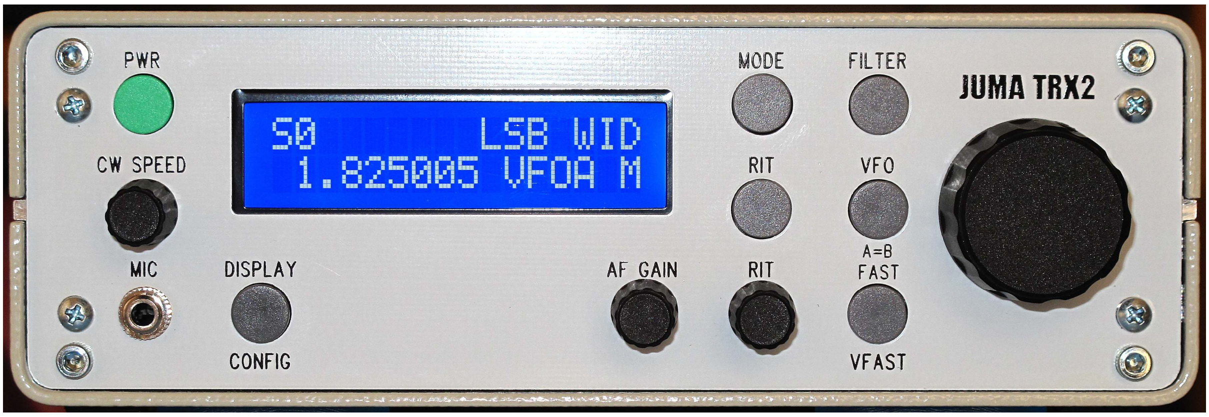
JUMA TRX-2 Operating Manual
5B4AIY Firmware Version 1.07n

The TRX-2 is an all-band QRP transceiver utilising a direct digital synthesiser and employing quadrature phase-shift detection in a direct-conversion arrangement for both transmission and reception, and capable of USB/LSB and CW modes of operation.

This document describes the operation and setup of this equipment using firmware version 1.07n, software modifications and changes made by Adrian Ryan, 5B4AIY.

It assumes that you have already performed the various hardware setup adjustments covering receiver AGC threshold setting, optimisation of sideband suppression, transmitter final amplifier bias current adjustments, amplifier gain compensation and microphone level setting.

Front Panel Controls



Control Description

PWR

This button is used to power-up and power-down the transceiver, as well as several secondary functions. To power up the transceiver, briefly press the button. The display will illuminate and a sign-on message will be displayed:

```
JUMA-TRX2 v1.07n
  OH2NLT OH7SV
```

After a short delay, the current frequency bands in use will be displayed either as:

```
IARU Freq Bands
```

or:

```
USA Freq Bands
```

Then the main display will be shown.

To power down the transceiver, press and hold the power button, and a message will be displayed showing a count-down to zero. At this point the display will clear, the backlighting will be turned off, and the button can be released.

During the count down period the current user settings are being written to the EEPROM. If the button is released during the count-down, it will be aborted, and the previous operation will be resumed.

During normal operation, a brief press of the power button will toggle locking the VFO frequency. Note that this simply disables the VFO tuning knob, the receiver frequency can still be changed by pressing either the VFO button or using the Rapid Band Switch feature.

The power button is also used to acknowledge and cancel any alarms. If an alarm cannot be cancelled, then press and hold the power button for 500 mSec and you will enter the emergency shutdown mode. Release the button and the transceiver will immediately shut off. In this mode it will bypass saving the user settings in favour of a rapid power down. For full details of the alarms, please refer to Annex F.

If the power button is pressed and held whilst powering up, the system setup menu will be selected. The various operations and settings are fully covered in the System Setup section of this document. To exit the setup menu without making any changes, press and hold the power button to power the transceiver down.

CW Speed
This knob controls the speed of the internal keyer, or, can be used as a receiver squelch setting. The operation of this knob is controlled by a setting in the User Configuration menu, which is covered in the User Configuration section of this document.

MIC
The microphone/PTT switch is connected to this socket by means of a 3.5mm stereo jack. The wiring is:

Tip	: Microphone/Line input
Ring	: PTT switch
Screen	: Ground/Shield

The PTT switch requires a dry contact closure to ground, or an open-collector connection capable of sinking 0.5mA from +5V.

The microphone is normally expected to be an electret, and there is a bias voltage of +5V via a source resistance of 5.7K. If a dynamic microphone is used, a DC blocking capacitor should be wired in series with the tip connection. Most dynamic microphones have an impedance of about 400Ω, for optimum speech quality and low frequency response, a capacitor of at least 2μF should be used. If using an electrolytic capacitor, wire the +ve to the tip of the plug.

DISPLAY/CONFIG
This multi-function button is normally used to control the transceiver's display. In the receive mode the normal display has the S-meter, either as a numeric or graphic indication at the top left of the screen, followed by the mode indicator, (LSB/USB/CW/Tune), and the receiver's filter, Wide (Wid), Medium (Mid), or Narrow (Nar).

A brief push of the DISPLAY/CONFIG button will over-write the mode and bandwidth with the PWR display, which is only active during either transmit or tune operations. The next brief push will display the SWR, again only active during transmit or tune. The third push will show the current DC input voltage, the next push the transmitter's final amplifier's drain current, also only active in transmit, and finally back to the normal display.

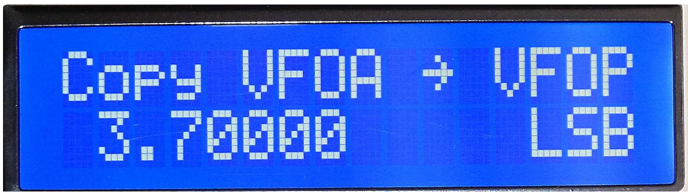
If the button is pressed and held, after a short delay you will be presented with the User Configuration menu. This is more fully covered in the User Configuration section. To exit from this menu, press and hold the button until a long beep is heard, then release.

AF GAIN
This is the normal volume control.

MODE
This multi-function button has four functions:

Mode Selection
The primary function is that of selecting the operating mode. A brief push will select in turn LSB, USB, CW, or the Tune function. If the button is pressed when displaying power, SWR, voltage or current, then the display will blink twice to display the mode change, then return to the previous display page.

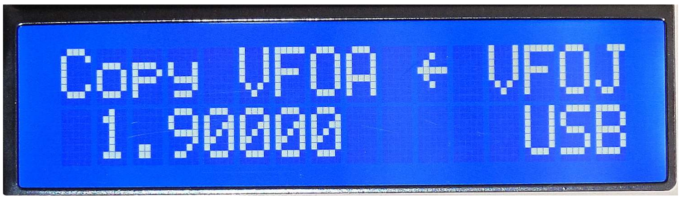
Memory Copy
This function allows you to copy the contents of any active VFO to the User VFO Memory bank.



Copy VFO-A to VFO-P

To access this function, press and hold the MODE button until you hear a long beep. The display will alter as shown above.

To copy from the active VFO to a memory, rotate the VFO knob clockwise, the direction arrow will point right, and the right-hand VFO memory designator will increment. In the example above, the active VFO is A, whose frequency and mode are displayed on the lower line, and is being copied to VFO memory P.



Copy VFO memory J to active VFOA

To copy from a VFO memory to the active VFO, turn the VFO knob anti-clockwise, and the source will decrement until you get to VFOA. The direction arrow will then reverse showing that the direction of the transfer is from the VFO memory to an active VFO. In the example above, VFO memory J, whose frequency and mode are displayed on the lower line, is being copied to the active VFO, A.

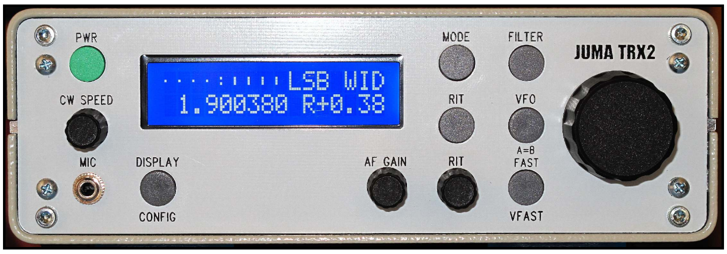
When the MODE button is released, the copy operation will be completed.

Fast User Configuration Page Select
As there are now 23 configuration pages, this feature allows you to rapidly select the desired configuration page. For details, see the User Setting Configuration section.

Reset Defaults
If this button is held and then the transceiver powered up, the system defaults can be restored without the necessity of using the System Setup facility. With the transceiver off, press and hold the MODE button, and briefly press the power button. Wait until the screen displays the message asking whether you wish to restore the factory defaults. Release the MODE button. A momentary push of the MODE button will restore the defaults, a momentary push of the FILTER button will abort the selection, and return you to normal operation.

RIT
A brief push of this button will toggle the Receiver Incremental Tune On/Off. When on, the lower right-hand portion of the screen will display the current offset frequency up to a maximum of ±1kHz, controlled by the RIT knob.

If the Include RIT feature is enabled in the User Setup, then the frequency display will show the actual receiver frequency including the RIT shift.



Frequency Display Including RIT Offset

A long push of this button will invoke the Rapid Band Selection feature.

Rapid Band Select In Use

If this is invoked, the top line of the display will show the band to be selected, from 160 – 10 metres. If the current receiver's frequency is within an amateur band, then the selection will display this band, and the lower frequency display will show the selected frequency. If the frequency is not within a recognised amateur band, then the out-of-band indicator will show on the main display, and the 160m band's frequency will be shown, as illustrated above.

The frequency displayed can be either a default band-centre, or a user stored frequency. These user frequencies are in addition to those stored in the 26 VFO memories that are also available, but whereas the VFO memories can store any frequency, the user frequencies can only be valid amateur band frequencies relative to the current frequency band setting corresponding to either IARU Region 1, or the US bands.

To select an amateur band, simply rotate the VFO tuning knob which will cycle you through all the available bands from 160 through 10 metres. When the RIT button is released, the selected frequency will be used along with the mode stored.

Note that this rapid band switching facility is disabled in both the Split mode of operation and if the transmitter is keyed either with the PTT switch or a key. It is also inoperative in the Service and User Configuration modes.

To save a favourite amateur band frequency, please refer to the FILTER button operation.

FAST/VFAST
This button is used to select the various tuning rates that are available. A brief press will cycle through the Slow (S) Medium (M) and Fast (F) tuning rates, corresponding to tuning rates of 1Hz, 10Hz, and 100Hz.

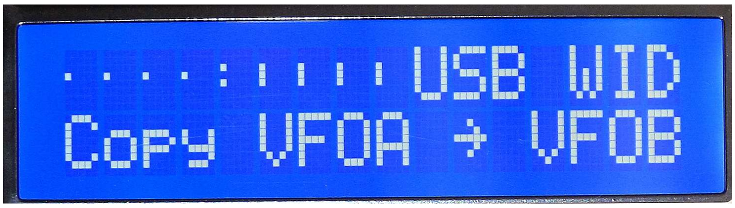
A long push will select the Very Fast (V) tuning rate of 10kHz. To exit the Very Fast mode, briefly press the button, and the default Medium 10Hz tuning rate will be selected.

VFO/A=B
This button selects which VFO will be used, as well as several secondary VFO related functions.

If the operating mode is set to `A/B + Split` in the User Configuration setup, then a brief push of the button will cycle through the VFO-A, VFO-B, and Split modes. In the Split mode the receive frequency and mode is stored in VFO-A, and the transmit frequency and mode in VFO-B.

In the Split mode, the rapid band switch and user frequency select/store operations are inhibited. It is highly inadvisable to change frequencies in this mode for obvious reasons. In order to do so, select either VFO-A or VFO-B.

To copy the VFO-A frequency to VFO-B, select VFO A, and press and hold the VFO button until you hear a long beep, and the display will show:



Split Mode Copy, VFOA to VFOB

To copy the VFO-B frequency to VFO-A, first select VFO-B, and press and hold the button, and a similar display will be shown except that the source will be VFOB, and the destination will be VFOA.

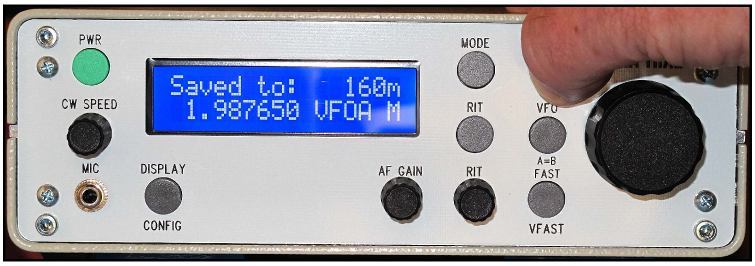
If the button is pressed and held whilst the `Splt` is displayed, this is the same as VFO-A to VFO-B.

If the User Configuration setting is for from 3 to 26 memories, then these can be selected sequentially by a brief press of the button, or if the button is held, they can be selected by rotating the VFO tuning knob. The last frequency/mode used for the selected VFO will be set. Any frequency in the range 0 – 30MHz can be stored in the 26 VFO memories.

FILTER
This button is primarily used to select the receiver bandwidths, but also has a secondary function of storing user frequencies.

A brief press of the button will cycle you through the Wide, Medium, and Narrow filter bandwidths. The actual bandwidths employed are adjustable via the User Configuration Menu. If this button is pressed when displaying power, SWR, voltage or current, the display will blink twice to show which filter has been selected, and then return to the previous display page.

A long press of the button will store the currently displayed frequency and mode into the user band memory. There are 9 such memories, one for each amateur band, and they are selected by the Rapid Band Switch feature assigned as a secondary function of the RIT button.



Saving A Frequency To A User Band

To use this feature, the User Configuration Band Switch setting has to be set to the User mode. In this mode, the current frequency can be stored. Note, only frequencies within a recognised amateur band can be stored. If an attempt is made to store an invalid frequency the top line of the display will show:

```
Out Of Band!
```

Similarly, if the Band Switch setting is in the Default mode, then the display will show:

```
Not In User Mode
```

If the Band Switch setting is in the Locked mode, then the display will show:

```
User Mem Locked!
```

A successful storage operation will display the message:

```
Saved to:    nnn
```

where `nnn` will be replaced by a band from 160 – 10.

In this manner it is possible for the user to preset favourite frequencies for each amateur band, and to retrieve them on demand. By selecting the Locked mode, these frequencies can be protected.

System Calibration & Setup

It is assumed that the initial adjustments and settings have been made. Note that when selecting the Calibration & Setup menu, VFO-A will be selected, the frequency will be set to 3.7MHz, and the Tune mode selected. The Tune Attenuator will be temporarily set to 0dB for power meter calibration, and output power setting. It will be restored to its initial value when leaving the setup mode unless the restore defaults option is selected, when it will be set to -3dB.

To enter the System Calibration & Setup menu, turn the transceiver off, and then press and hold the power button until the message:

```
JUMA-TRX2 v1.07n
  Service Mode
```

is displayed. To cycle through the various setting screens, briefly press the DISPLAY button.

Set Reference Oscillator Frequency
Default: 180000000Hz

The DDS is fed with the output of the precision crystal oscillator, and in the current models is a packaged component with an output frequency of nominally 30MHz. The worst-case tolerance for this oscillator is ±100ppm, which translates to a possible error of ±3kHz at 30MHz, and since this oscillator's frequency is internally multiplied by 6 in the DDS chip, this can be as high as ±18kHz at 180MHz.

To correct this, the reference frequency can be set to the frequency resulting from a x6 multiplication of the crystal oscillator's actual output frequency.

In order to determine the necessary calibration factor, an accurate frequency counter is essential. If you have access to a counter which has an accuracy of better than at least ±1ppm, then measure the output frequency of the oscillator using the 10 second timebase, making at least 10 measurements. Average the results to 2 decimal places and multiply by 6. Round this figure to 1Hz, and this is the frequency to which the reference oscillator should be adjusted.

It is also possible to use a less accurate frequency counter if you can tune to a standard frequency transmission. These are usually maintained to an accuracy of better than 0.1ppm. For an example of how to use this method, please refer to Annex B.

The range of the input setting is checked, and there is an adjustment range of ±20kHz. Anything outside of this figure is cause for extreme suspicion regarding the crystal oscillator.

Even adjustment settings of more than ±10kHz would warrant further investigation as the vast majority of these oscillators have a basic frequency accuracy at room temperature of well within the stated worst-case figure.

Supply Voltage Calibration Factor
Default: 5300
The microprocessor chip uses an internal 12-bit A-D convertor, and this in turn is referenced to the +5V logic supply. Assuming that the regulator chip is exactly at +5V, this gives an incremental digital step size 5mV. This is the basic resolution of the digital meter. Use an accurate digital multimeter and measure the supply voltage at the transceiver's input, and adjust the calibration factor to achieve a display as close as possible to that measured.

The accuracy of the internal measurement system has been enhanced with this version of the firmware, and the incremental quantisation steps are now such that it should be possible to set the voltmeter to exactly match your measured value

The range is checked, and values from 4000 – 6000 are acceptable, although values significantly different (more than ±250) from the default value suggest that the logic voltage should be checked, and investigated.

RF Amplifier Drain Current
Default: 2400
Using an accurate ammeter, measure the current drawn by the amplifier when supplying 10W in the Tune mode to a dummy load. The value is usually in the range of approximately 2.0 to 2.5A Note that the ammeter only measures the amplifier's drain current.

Using an accurate ammeter, measure the current drawn in the transmit mode by selecting CW, and pressing the PTT switch, and subtract this value from the total current drawn in the Tune mode. Adjust the calibration factor to achieve the closest match. The default value is usually satisfactory. The limits are from 1200 – 3600.

Forward Power Calibration Factor
Default: 3550
Using a dummy load, and an accurate power meter, set the transmitter's output in the Tune mode with a Tune Attenuation of 0dB, and using the CARR control on the main board to adjust the forward power to 10W. Adjust the calibration factor to achieve the closest match. The limits are from 1500 – 5000.

S-Meter Calibration Factor
Default: 1920
This adjusts the accuracy of the S-Meter display, and requires careful consideration. Early transceivers had a JFET type SST112 used for the AGC amplifier in position TR4 of the variable gain amplifier A4-B on the main board. Later transceivers had a substitute device type PMBFJ112, and the threshold voltage of this transistor differs from that of the SST112. This leads to a significant difference in the two calibration settings.

In both cases, the adjustment procedure involves terminating the receiver in a 50Ω dummy load, rotating R53 fully anticlockwise to achieve maximum gain, and then carefully rotating clockwise until the audio noise just starts to decrease. This is the AGC threshold.

Using a signal generator inject an S9+40dB signal, 5mV, −33dBm, and adjusting the calibration factor until either the numeric S-Meter just indicates S9+40dB, or the graphical S-Meter just fills the horizontal display. Then lower the signal to S9, 50µV, −73dBm and by a combination of R53 and the calibration factor adjustments try and achieve the best compromise between full-scale and S9 for the two signal levels.

Since the threshold voltage of the two transistors is significantly different, early transceivers are likely to have calibration factors close to the default, whilst later units will be in the range of about 3,500 – 4,000. The limits are from 1,000 – 7,000.

Beep Time
Default: 50mS
This adjustment determines the time of all the audio annunciator signals. Adjust the value to your preference. The range is checked, and values from 0 – 100mS are allowed. If the value is set to 0, no audible annunciation will occur.

High SWR Trip Limit
Default: 3.00
This is a new feature as part of the alarm sub-system. If the SWR exceeds the trip limit, an alarm will be generated and displayed on the main screen. The limit can be set from 1.00 – 5.00. Although a setting of 1.00 may seem odd, it allows you to check that the alarm is working. Set the limit to 1.00, and exit from the System Calibration menu by saving the settings.

Connect the transceiver to a dummy load, select Tune, and press the PTT switch. If the alarm is working, then you should see a blinking message "`HIGH SWR`" on the top line of the display, along with a beep. To cancel the alarm, release the PTT switch, and briefly press the PWR button.

Switch off, and reselect the System Calibration menu again, and reset the SWR Trip to a suitable value.

Overcurrent Trip
Default: ON
This allows you to enable or disable this alarm. If the alarm is disabled, then the following page will be skipped, although its settings will be retained, and can be adjusted if the alarm is re-enabled.

Overcurrent Trip (Adjustment)
Default: 2.5A
This is a new feature. Adjust the limit to a suitable value. The default is usually satisfactory. The value can be set from 1.5A – 3.0A. Temporarily setting the trip to 1.5A allows you to verify that it is working.

As with the SWR test, save the calibration settings, using a dummy load and the Tune mode, press the PTT switch. The top line of the display will show the blinking message "`OVERCURRENT`", there will be a beep. Release the PTT switch and briefly press the PWR button to cancel the alarm. Switch off and reselect the System Calibration menu and reset the trip to a suitable value.

Note that the current measured is that of the final amplifier. The internal fuse is rated at 3.5A, and since the transceiver's logic and display sections can consume up to 400mA, the normal trip limit of 2.5A represents a conservative safety margin. Under some circumstances, especially if you are attempting to obtain the maximum power out of the transceiver, then it may be necessary to set the limit to the maximum permissible, 3.0A. Be aware however that with the logic and backlighting current as well, this is running very close to the fuse rating.

Overvoltage Trip
Default: ON
This allows you to enable or disable this alarm. If the alarm is disabled, then the following page will be skipped, although its settings will be retained, and can be adjusted if the alarm is re-enabled.

Overvoltage Trip (Adjust)
Default: 14.5V
This is a new feature. Adjust the limit to your preference. The range is from 14.0V – 15.0V.

Undervoltage Trip
Default: ON
This allows you to enable or disable this alarm. If the alarm is disabled, then the following page will be skipped, although its settings will be retained, and can be adjusted if the alarm is re-enabled.

Undervoltage Trip (Adjust)
Default: 11.0V
This is a new feature. Whilst the transceiver will continue to operate down to quite low voltages, when operating portable from a sealed lead-acid battery, most manufacturers recommend terminating the discharge when the terminal voltage falls to 10.5V.

The transceiver can be set to warn you with a blinking "`UNDERVOLTAGE`" display and a beep at any voltage from 10.50V – 11.50V. Note, in addition to this final warning, there is a pre-limit warning which occurs at a voltage 100mV higher than this setting. This will display the blinking alarm message: "`Low Batt Voltage`", and beep.

Acknowledge and cancel the warning by briefly pressing the PWR button. This warning will only be given once – it will NOT repeat! Once you have acknowledged the warning it disappears. The only way to reset it is to power the transceiver off and back on again.

The next screen displays the message:

```
Push FAST long =
factory defaults
```

Only in this screen can you reset the transceiver to these default values. Push and hold the FAST button until you hear a long beep, and the values will have been reset to the default settings.

Otherwise, press the DISPLAY button briefly to return you to the initial screen, and briefly press the FAST button to save the current values.

To abort the whole process, press and hold the PWR button to turn the transceiver off.

User Configuration Settings
To enter the User Configuration settings, press and hold the DISPLAY button until you hear a long beep.

With version 1.07n there are now 22 settings that can be adjusted to your preferences. With this many configurable settings there is now an additional feature allowing you to rapidly access any configuration page.

To use this feature, press and hold the MODE button until you hear a long beep. Rotate the VFO knob to select the desired configuration page. To adjust the setting, release the MODE button, and use the VFO knob to adjust the current setting.

AGC Speed
Default: Slow
Use the tuning knob to select either Fast or Slow AGC action.

Low-Pass Filter Cut-Off Frequencies
Default: Wide – 2,500Hz, Mid – 2,205Hz Narrow – 1,000Hz
Use the FILTER button to select the filter whose cut-off frequency you wish to adjust. Use the tuning knob to select the desired cut-off frequency. Note that the frequency resolution is relatively coarse due to the methods used to clock the SCAF filter, but this is of little consequence, since precise cut-off frequencies are not required.

Noise Blanker Option
Default: OFF
This is set to ON/OFF with the tuning knob. If no accessory board is installed, it should be set to OFF.

Speech Processor
Default: OFF
The transceiver is equipped with a simple speech processor which uses a soft-clipping method to achieve a higher peak to average ratio for speech to increase the average talk-power.

However, this also leads to a certain amount of distortion, and thus this setting has to be carefully related to the transmit SSB gain setting, R26. Too little gain, and no compression will occur, too high a gain, and excessive distortion will occur. Turn the Speech Processor on, and listen on another receiver when operating into a dummy load to determine the optimum gain setting.

Audio Input Source
Default: Mic
Use the tuning knob to select microphone or line. When set to line, the gain is reduced by about 30dB. This allows the connection of the transceiver to the output of a computer’s audio system for digital mode operation.

Note however that to satisfactorily use digital modes the speech processor must be turned off, and the transceiver’s microphone amplifier circuit slightly modified to completely disable the speech processor in the off mode.

Keyer Mode Selection
Default: Iambic B
Select Iambic A, Iambic B, Dot Priority, or Straight key operation.

CW Pitch
Default: 700Hz
Use the tuning knob to select the desired pitch for CW signals. The range is checked and values from 300Hz – 1,100Hz are acceptable. This is also the offset used when transmitting. The actual transmit frequency is lower than the receive carrier by this amount.

CW Pot Mode
Deafult: CW Speed
The CW pot can be used either as a keyer speed setting or a receiver squelch control. Use the tuning knob to select the desired function.

LCD Backlight
Default: 350
The intensity of the LCD display can be adjusted with this setting. Values from 0 – 1,100 are accepted.

LCD Contrast
Default: 2000
This setting adjusts the display contrast. The default of 2,000 is usually acceptable. The range of values accepted is from 0 – 3,500.

LCD Timer
Default: OFF
The display can be automatically turned off after a preset time using this feature. Adjust the timer to a value between OFF and 3,600 seconds.

RS-232
Default: Yaesu CAT
This setting governs a number of peripheral features. It can be set to the following modes:

JUMA TRX2
This mode is used to enable serial communication with the companion JUMA PA100D 100W linear amplifier.

Yaesu CAT
This allows communication with PC logging programs, and emulates a Yaesu transceiver. For a list of commands that are emulated, please see Annex C.

Kenwood CAT
This allows communication with PC logging programs, and emulates a Kenwood TS-480 transceiver. For a list of commands that are emulated, please see Annex D.

Voice Memory
This mode is used with the accessory voice memory board.

Test
This mode is used to verify the integrity of the transceiver's internal circuitry and software, as well as check that the serial communications port is working correctly. In this version of the firmware several serial port bugs were corrected, and a user help feature added which briefly describes the operation of each command.

Connect the transceiver to a PC, use a suitable terminal program, ensure that the speed settings are correct. Send the letter I, ?, H, or h from the PC and the transceiver should respond with a screen of information.

Note that these commands are not in any way destructive – they cannot permanently affect the overall operation of the transceiver. For a brief description please see Annex E.

Baud Rate
Default: 9600
This allows setting the speed of the serial port from 1,200 – 115,200 Baud. The default of 9,600 is usually satisfactory.

VFO Memory Operation
Default: A/B + Split
This setting governs how the various VFO memories are used and organised. The settings range from A/B + Split mode, to 3 – 26 memories.

Split mode operation involves transmitting on one frequency, and receiving on another. The frequencies can be anywhere in the tuning range of the transceiver. VFO A is used for the receive frequency; VFO B for transmit.

When not using Split mode, you can select the number of VFO memories available to you from 3 – 26, which will be indicated on the display by the letters VFOA – VFOZ. The current displayed frequency and mode is automatically stored in the selected VFO.

These VFOs can be selected by a brief press of the VFO button, or the VFO button can be held down and the memories selected by the tuning knob.

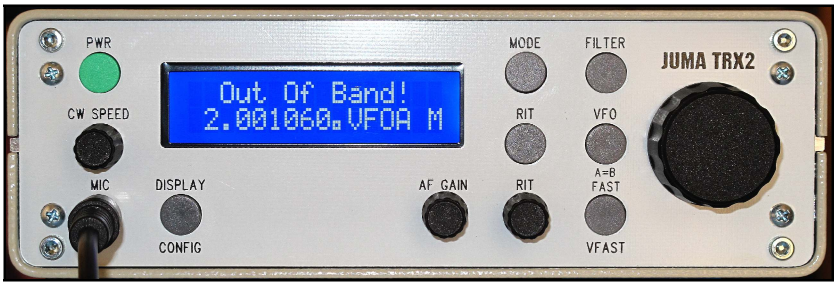
S-Meter
Default: Graphic
This new feature allows you to select either a graphical S-Meter (Original) or a numeric S-Meter. The gain characteristics of a correctly adjusted and calibrated receiver are almost exactly logarithmic over the dynamic range of the receiver, which lends itself to an easy implementation of either display with reasonable accuracy. Use the tuning knob to select either type of display.

TX Disable
Default: ON
This is a new feature. The original firmware allowed transmission on any frequency, including those outside the amateur bands. This meant one had to pay careful attention when operating close to the band edges in order to avoid an infraction of your licence conditions.

By enabling this feature, if you attempt to transmit in any mode on a frequency outside the recognised band, the transmitter is inhibited, and the display will show a message:

```
Out Of Band!
```

In addition, in the receive mode, there is a small annunciator displayed immediately between the frequency display and the VFO selection/mode section of the lower line of the screen if the current receive frequency is outside the amateur bands.



Transmit Inhibit

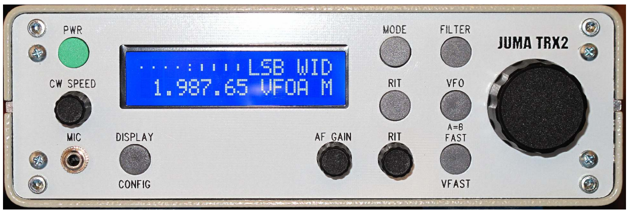
Even if this feature is turned off, the receive annunciator is still displayed, and storage of a frequency in the User Band memory is inhibited.

Note: In split mode if this feature is turned off, then the out-of-band indicator will displayed in the receive mode for VFO-A, but will only display for the transmit VFO when the PTT switch or key is pressed. If its frequency is out-of-band the annunciator will be displayed, but transmission will not be inhibited. It is recommended that this feature is enabled at all times.

Auto Sideband Select
Default: ON
This is a new feature. Conventionally, for frequencies above 10MHz USB is the preferred mode for voice communication, conversely, LSB for frequencies lower than 10MHz. This feature will automatically select the correct sideband when tuning to an amateur band using the Rapid Bandswitch Feature. It does not affect tuning when using the tuning knob. Even with auto sideband selected, you may still choose any operating mode on any band.

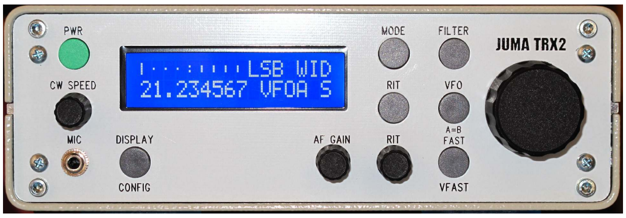
Frequency Display Selection
Default: Fixed B
This is a new feature. The original frequency display was limited to 10Hz resolution, and used two decimal points, between the MHz and 100kHz digits and between the kHz and 100Hz digits. This feature now permits a variety of display options.

Original
The frequency will be displayed as:

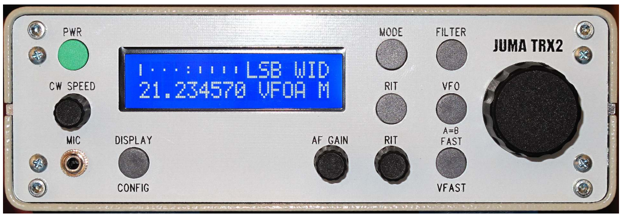


Original Frequency Display

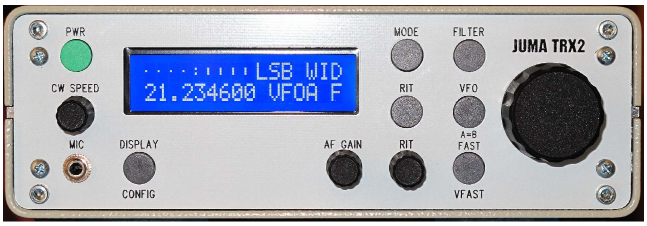
New
The frequency will be displayed depending upon the tuning rate being used, thus:



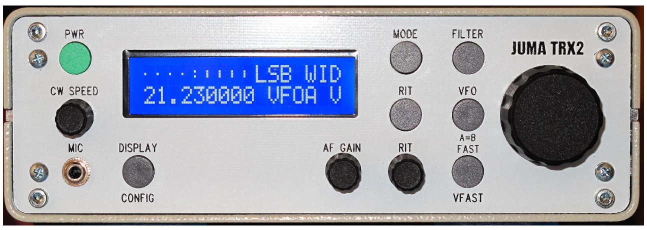
Slow Tuning Rate – 1Hz



Medium Tuning Rate – 10Hz



Fast Tuning Rate – 100Hz

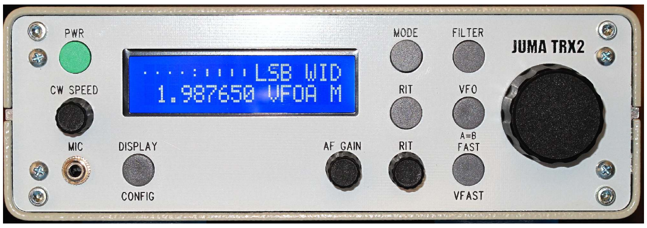


Very Fast Tuning Rate – 10kHz

Note that the precision is not affected, the frequency is rounded to the appropriate tuning rate's resolution if this mode is selected in the User Configuration menu.

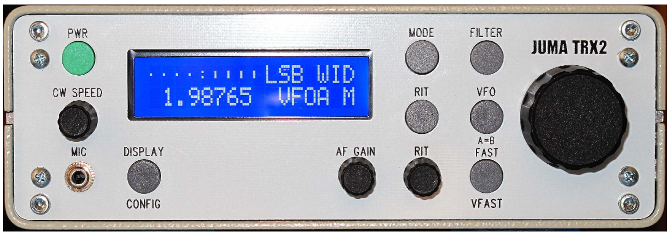
With version 1.07g and later, the accuracy of the synthesiser has been improved. See Annex A for a full explanation.

Fixed A
The display is fixed at 1Hz resolution independent of the tuning rate used. For frequencies below 1MHz the decimal point will move to the kHz position, and no leading zeros are used. (See note 6 at the end of this document.)



Fixed Resolution – 1Hz

Fixed B
The display is fixed at 10Hz resolution, independent of the tuning rate used.



Fixed Resolution – 10Hz

Band S/W
Default: Default
This is a new feature. This setting governs how the Rapid Bandswitch feature operates.

Default
In this mode, when selecting an amateur band, the frequency used will be fixed at the band's centre.

BAND	FREQUENCY MHz
160 metres	1.900
80 metres	3.650
40 metres	7.100
30 metres	10.125

20 metres	14.175
17 metres	18.118
15 metres	21.225
12 metres	24.940
10 metres	28.850

User
In this mode, initially, when the firmware is first loaded, the frequencies are set to match the default settings. However, the user can store new frequencies as desired, provided that they are within the amateur band in question. The upper and lower frequencies to be used as the band edges are determined by the setting of the Band Limits parameter in a following menu.

The out-of-band indication is dependent upon the mode in use. For USB, the carrier frequency has the transmit filter bandwidth of 2.6kHz added to ensure that the entire upper sideband falls within the upper band edge, no correction is applied to the lower band edge.

For LSB, the frequency has the transmit filter bandwidth subtracted to ensure that the entire lower sideband falls within the lower band edge. Similarly for CW, where in this case the CW Pitch is used.

For the Tune mode, no corrections are applied, as the carrier frequency itself is used.

Locked
This mode uses the currently preset User frequencies, but the memory is locked so that no alteration can occur.

Include RIT
Default: NO
This is a new feature. If this is turned on, then the RIT offset frequency will be used to modify the frequency displayed to show the actual receive frequency.

Band Limits
Default: IARU
This is a new feature. The transceiver's band edge frequencies can be set to either the IARU Region 1 limits, or the USA limits. When altering this setting note that it will take effect when the transceiver is next powered up.

Tune Attenuation
Default: −3dB
This is a new feature. A number of users have requested a way to tune the transceiver without using its maximum power. This is a sensible idea, both to avoid interference, as well as providing more protection for the PA from high SWR that may be encountered, and their resulting over-current events.

Using the VFO tuning knob, adjust the attenuation to the desired value, −3dB is recommended.

VFO Adjust
Default: OFF
This is a new feature. With the ability to adjust the VFO frequency in several steps, from 1Hz increments to 10kHz, the need arose to be able to round the frequency to the nearest decade increment. This is particularly important if you use either the default frequency display or frequency Display B, as these only show to 10Hz.

If you select the slow (1Hz) tuning rate then the transmitted frequency's last digit could be anywhere in the 0Hz – 9Hz range when displaying only to 10Hz resolution. With this new feature, you can select whether to round the frequency to the nearest tuning step decade.

The default is OFF, and no rounding will occur when switching tuning rates.

If the 10Hz adjustment is selected, then when switching to this tuning rate the last digit will be rounded up or down to the nearest 10Hz boundary. Similarly, when the 100Hz/10Hz setting is selected, rounding will occur whenever you select either the 10Hz tuning rate or the 100Hz rate. If the ALL setting is chosen, then rounding will occur for all tuning rates, including the very fast 10kHz step rate.

Obviously, when the next tuning rate is selected the VFO will shift slightly in frequency, and for the 10Hz rate this could amount to ±5Hz, for the 100Hz tuning rate, ±50Hz, and for the 10kHz rate, ±5kHz.

For some applications, particularly digital modes, these rounding shifts might not be desirable, and thus you have to ability to select which rounding rates to use, or to completely disable this feature as you wish.

Minor Enhancements

1. The RIT, VFO, and FAST/VFAST buttons are locked out when in the User Setup mode. The MODE button is used to rapidly access the configuration pages. Note that although the MODE button is active in the User Setup mode, no mode changes will occur, that is, the existing mode (LSB/USB/CW/Tune) will not be disturbed.

2. The MODE, FILTER, RIT, VFO, and FAST/VFAST buttons are locked out when in the transmit mode.

3. The power-down sequence timing is no longer critical. In the previous software, one had to time the release of the power button fairly accurately to avoid either aborting the sequence or powering the transceiver back up. In this version, as soon as the display blanks you can release the button, holding it down will no longer cause a power-up to occur.

4. Various audio glitches when changing frequencies or modes have been eliminated or greatly suppressed, although there are still a few stubborn candidates left. Work in progress.

5. The lowest frequency to which the transceiver can be tuned is 0Hz. Whilst the frequencies below about 30kHz have no real importance, the very low frequency output at audio frequencies does allow the user to verify that the DDS chip is operating. By tuning down into the audio range you will hear an audio beat note which can be measured with a frequency counter to provide an approximate indication that the frequency synthesis is correct.

6. Version 1.07h and later slightly modified the way that the Fixed-A display operates. After careful consideration, I decided that displaying frequencies below 1MHz with leading zeros was simply ugly. The display now shows a decimal point at the MHz position for frequencies above 999.999kHz, and simply moves the decimal point to the kHz position and fills the leading spaces with blanks for frequencies from 1kHz to 999.999kHz. For frequencies below 1kHz, no decimal point is displayed.

7. The spurious power-down count when locking or unlocking the VFO has been cleared.

8. The filter change points for the 2MHz and 4MHz filters have been moved up by 1kHz. It was particularly disconcerting that right at the 2.0MHz and 4.0MHz frequencies these filters would be changed. The new frequencies are 2.001MHz, and 4.001MHz.

9. The Serial Test facility has been enhanced with the addition of a dump of the attenuator settings corresponding to the various internal filters, as well as an Auto-Equalise function.

10. If the mode or filter bandwidth is changed when displaying the power, voltage, current or SWR, the display will blink twice and display the setting which has been changed, and then return to the previously selected display page.

11. The filter button is now ignored in the User Configuration menu except for the filter page itself where it is allowed to select the filter whose bandwidth you wish to adjust.

12. Various minor internal code optimisations.

Adrian Ryan – 5B4AIY
25 October 2011

Annex A

JUMA Frequency Step Accuracy

The Juma TRX2 using firmware revision 1.06 has an inherent frequency resolution of 10Hz. This means that the actual frequency to which the transceiver is tuned is within ±5Hz of the displayed frequency, if we neglect the reference oscillator errors. Or is it?

If we carefully examine the frequency display, we can observe some interesting quirks. Try this, tune the transceiver to, say, 10.00000Mhz, and select the fast tuning rate of 100Hz, now rapidly rotate the VFO knob to increase the frequency and carefully observe the least significant (10Hz) digit. After a large number of steps the digit will suddenly change by 1. Select the slow (10Hz) tuning rate and carefully go back and find the exact frequency at which the 10Hz digit changed, and note it. As an example, in my case it was 10.20840MHz.

Now re-select the fast tuning rate and increase the frequency, and in my case at 10.46510 the 10Hz digit changed again and with a single increment from the tuning knob the display changed from 10.46510 to 10.46519, and the next increment was to 10.46529.

The reason for this anomaly is not hard to find. The output frequency of the synthesiser is:

$$f_{\text{local oscillator}} = N * 180000000 / 2\text{^}33 \text{ Hz}$$

Where N is the 32-bit binary word used to load the DDS chip. In fact, the actual output frequency is twice this, but the synthesiser's frequency is divided by two to obtain the phase-quadrature local oscillator signal.

The frequency steps are obtained from an array of steps and for a step increment of 100Hz the value is 4,772. This is the binary increment that is added to the existing frequency word for every step generated by the VFO encoder at the 100Hz tuning rate.

The actual frequency increment is therefore:

$$f_{\text{increment}} = 4772 * 180000000 / 8589934592$$

$$= 99.996104837 \text{ Hz}$$

There is thus an incremental step error of −0.003895164 Hz for each step, and eventually these step errors accumulate until there is sufficient error for the next step to cause the 10Hz digit to change.

In fact, after every 2,567 steps this anomaly will appear, corresponding to a frequency change of about 256Khz.

Now, one could reasonably say, “So what?” and I would entirely agree that for all practical purposes this is of no real significance, the actual frequency of the transceiver is always within ±5Hz of the displayed frequency, which is more than adequate – even on the lowest amateur band this represents a tuning accuracy of ±2.5ppm, and even better at the higher frequencies.

But, I'm a perfectionist, you might even say obsessive, and it occurred to me that the synthesiser could do better. After all, when you increment the DDS word by 1 the local oscillator's frequency changes by 0.020955 Hz, and thus there is the potential for the transceiver's actual resolution accuracy to be improved by a factor of 250.

The problem arises because all the frequency calculations are done in the DDS domain, and thus the approximation errors accumulate. If the calculations and increments are performed entirely in the decimal domain, then there are no display anomalies, and with the decimal frequency being converted only once to its DDS equivalent word, the worst error that can occur is a ±1 bit quantisation error leading to a worst-case resolution error of 0.04Hz allowing for rounding errors in the calculation.

I have thus changed the complete frequency synthesis numerical base from DDS units to decimal, and modified the `load_dds()`function so that it is passed a decimal frequency and the conversion to the DDS word is performed once.

As a result, and confirmed with an accurate frequency counter, the accumulating step errors are eliminated.

Firmware versions from 1.07h on incorporate this change, as well as a number of other minor internal changes.

By correcting for the production tolerances of the 30MHz oscillator, the transceiver can now achieve a frequency accuracy on a par with almost anything on the market – what a really nice little 'gem' this is!

Adrian Ryan 5B4AIY

Annex B

Reference Oscillator Calibration

The accuracy of the reference oscillator determines the overall frequency accuracy of the transceiver. The master oscillator is the 30MHz package oscillator on the DDS board, and its output is used both to clock the microprocessor, as well as provide the reference for the DDS synthesiser chip.

The IQD IQX-350 series of packaged oscillators have a worst-case frequency tolerance of ±100ppm over a temperature range of 0°C – 70°C. In fact, at room temperature, the actual output frequency is usually well within the worst-case specification. Nevertheless, your oscillator is unlikely to be at exactly 30MHz, and thus since this frequency is multiplied by 6 in the DDS chip, the output frequency will have an offset error. By inserting the appropriate calibration frequency this offset can, to a large extent, be eliminated, thus greatly improving the accuracy of the frequency generating system.

Method 1 – Direct Calibration
The first method of calibrating the system simply involves measuring the output frequency of the 30MHz oscillator directly using a stable, accurate frequency counter. The time-base of the counter has to be a precision reference, preferably locked to a rubidium standard, and certainly within ±1ppm.

This is a fairly stringent specification to meet, and the average frequency counter from, for example, eBay is unlikely to meet this. It really requires access to a laboratory grade counter whose calibration is current.

If you have access to such a counter, then carefully measure the output frequency to an accuracy of 1Hz using the 10 second time-base setting and collect at least 10 measurements. Average these to 2 decimal places. Multiply the result by 6 and round to 1Hz, and this is the reference oscillator calibration frequency to be inserted.

Method 2 – Indirect Calibration
This second method uses a combination of a transmitted standard frequency and a frequency counter of nominal accuracy. In this method the audio beat frequency will be used, and the accuracy of the frequency counter is less important. Even a counter whose time-base is in error by 100ppm will suffice. If the time-base error is 100ppm, then at an audio frequency of 1,000Hz, the actual reading will be between 999.9Hz and 1000.1Hz. Although this will lead to an uncertainty of about ±5Hz at 180MHz, this is still accurate enough.

Tune the receiver to a standard frequency transmission, and set the display to be exactly 1,000Hz higher than the carrier frequency. For example, suppose we use a transmitter on 5MHz. Set the display to 5.001000 (Use the 1Hz tuning rate, and the 1Hz frequency display option, and lock the VFO.) Select LSB, and MID filter.

Connect the frequency counter to the phone output socket, and adjust the audio gain for a suitable level to trigger the counter. In order to avoid excessive jitter the signal must be reasonably clean and reasonably free from noise.

Set the frequency counter to display to 1Hz using the 10 second time-base. Make at least 10 measurements, and average the results to 2 decimal places.

If the reference oscillator were at its exact frequency, then the audio beat note would be exactly 1,000Hz. Any error will cause the frequency to be higher or lower than this. Subtract the 1,000Hz from the averaged result. Since the standard frequency in this example is 5MHz, to find the error at 30MHz multiply the error by 30/5 and this is the frequency offset at 30MHz. Add this to 30MHz and multiply by 6, and this is the reference oscillator calibration frequency. A numerical example should make this clear.

Assume the standard frequency is 5MHz, and the receiver is tuned to 5.001000MHz, LSB.

Measured Beat Frequency
950
949
949
950
950
948
949
949
950
950

Averaging these results gives a beat frequency of: 949.40Hz

Error: 949.40 − 1000 = − 50.60Hz

Crystal Oscillator Frequency = 30,000,000 + ((30,000,000 / 5,000,000) * − 50.60)

= 30,000,000 − 303.60 Hz

= 29,999,696.40Hz

Reference Oscillator Frequency = 29,999,696.40 * 6

= **179,998,178Hz**

In this case, the crystal oscillator was low by about 10ppm.

Now an example where the oscillator is high in frequency.

For this example, assume the standard frequency is 10MHz. Tune the receiver to a display setting of: 10.001000MHz, LSB.

Measured Beat Frequency
1250
1251
1251
1250
1249
1250
1251
1250
1250
1251

Averaging these results gives a beat frequency of: 1250.00Hz

Error: 1250.00 − 1000 = +250.00Hz

Crystal Oscillator Frequency = 30,000,000 + ((30,000,000 / 10,000,000) * +250.00)

= 30,000,000 + 750.00 Hz

= 30,000,750.00Hz

Reference Oscillator Frequency = 30,000,750.00 * 6

= **180,004,500Hz**

In this case, the crystal oscillator was high by about 25ppm.

Annex C

Yaesu CAT Command Emulation

If the RS-232 serial port mode is set to Yaesu CAT, then the transceiver will respond to the following command sequences:

Yaesu Command Description

Yaesu CAT commands are organised as a 5-byte sequence, with the parameters first, and the last byte being the command byte.

The following commands are emulated (values are in hexadecimal):

Read RX frequency & mode	: 03
Read RX status	: E7
Read TX status	: F7
Split Mode ON	: 02
Split Mode OFF	: 82
VFO Select	: 81
Set operating mode	: 07
Set frequency	: 01
PTT ON (TX)	: 08
PTT OFF (RX)	: 88
Lock VFO	: 00
Unlock VFO	: 80

Command Format

The commands take the form of a 5-byte string terminating with the command byte. The leading 4 bytes are the parameter values required. If a command does not require any parameters, then these bytes can contain any value, but nulls are preferred.

Read RX Frequency and Mode

Assume the transceiver's frequency is 145.43210Mhz

Command To Transceiver	: 00 00 00 00 03
Transceiver Response	: 14 54 32 10 xx

xx is the mode byte, with the following meaning: 00 = LSB, 01 = USB, 02 = CW
There are a number of other values, but they are not applicable to the Juma TRX-2

Read RX Status

Command To Transceiver	: 00 00 00 00 E7
Transceiver Response	: xx 00 00 00 00

xx is the data byte, and the bits have the following meanings:

7 Squelch Status 0 = OFF, Signal present, 1 = ON, Receiver squelched
6 CTCSS/DCS code. For Juma = 0
5 Discriminator Centering, for SSB/CW = 0
4 Dummy Data 0
3 S-Meter Bit 3
2 S-Meter Bit 2
1 S-Meter Bit 1
0 S-Meter Bit 0

The S-meter value is coded into 15 levels from S0 to S9+40dB

Read RX Status
Command To Transceiver : 00 00 00 00 F7
Transceiver Response : xx 00 00 00 00

xx is the data byte, and the bits have the following meanings:

7 PTT Status 0 = TX, 1 = RX
6 High SWR 0 = OFF, 1 = ON
5 Split Mode 0 = ON, 1 = OFF
4 Dummy Data 0
3 PWR Meter Bit 3
2 PWR Meter Bit 2
1 PWR Meter Bit 1
0 PWR Meter Bit 0

The PWR-meter value is coded into 15 levels from 0 – 100W

Split Mode ON
Command To Transceiver : 00 00 00 00 02

Split Mode OFF
Command To Transceiver : 00 00 00 00 82

VFO Select (Toggle VFO-A, VFO-B)
Command To Transceiver : 00 00 00 00 81

Set Operating Mode
Command To Transceiver : xx 00 00 00 07
Where xx has the following meanings: 00 = LSB, 01 = USB, 02 = CW

Set Operating Frequency
Command To Transceiver : aa bb cc dd 01
Assume the frequency is: 14.23456MHz, aa = 01, bb = 42, cc = 34, dd = 56

PTT ON (Transmit)
Command To Transceiver : 00 00 00 00 08

PTT OFF (Receive)
Command To Transceiver : 00 00 00 00 88

Lock VFO
Command To Transceiver : 00 00 00 00 00

Unlock VFO
Command To Transceiver : 00 00 00 00 80

Annex D

Kenwood TS-480 CAT Command Emulation

If the RS-232 serial port mode is set to Kenwood CAT, then the transceiver will respond to the following command sequences:

Read/Set VFO-A Frequency	: FA	
Read/Set VFO-B Frequency	: FB	
Select/Read Receiver VFO	: FR	
Select/Read Fine Tune	: FS	
Select/Read Transmitter VFO	: FT	
Read Transceiver Status	: IF	
Set/Read CW Keyer Speed	: KS	(Not implemented)
Read Current Mode	: MD	
Set/Read Noise Blanker	: NB	
Set/Read Speech Processor	: PR	
Clear RIT Offset Frequency	: RC	(Not implemented)
Move RIT Down	: RD	(Not implemented)
Move RIT Up	: RU	(Not implemented)
Set/Read RIT Function	: RT	
Set/Read DSP Low Frequency	: SL	
Set/Read DSP High Frequency	: SH	
Read S-Meter Status	: SM	
Set/Read Squelch Level	: SQ	(Not implemented)
Turn TX ON	: TX	
Turn RX ON	: RX	
Read Transceiver Status	: RS	

The command format is a two-letter ASCII command followed by a variable length parameter string of ASCII characters. The command is always terminated by the semi-colon (;) character. Note that a command can have zero parameters, in which case it is generally a data request.

Set VFO-A Frequency
Transmitted From PC (Assume the frequency is: 14.195MHz)
FA00014195000;

Read VFO-A Frequency
Transmitted from PC
FA;
Response from TS-480 (Assume the frequency is: 14.195MHz)
FA00014195000;

Set VFO-B Frequency
Transmitted From PC (Assume the frequency is: 14.195MHz)
FB00014195000;

Read VFO-B Frequency
Transmitted from PC
FB;
Response from TS-480 (Assume the frequency is: 14.195MHz)
FB00014195000;

Select Receiver VFO
Transmitted from PC
FR0; Select VFO-A
FR1; Select VFO-B

Read Receiver VFO
Transmitted from PC
FR;
Response from TS-480
FR0; VFO-A selected
FR1; VFO-B selected

Select Fine Tune (1Hz)
Transmitted from PC
FS0; Fine Tune function OFF (Select 10Hz tuning rate)
FS1; Fine Tune function ON (Select 1Hz tuning rate)

Read Fine Tune
Transmitted from PC
FS;
Response from TS-480
FS0; Fine Tune function OFF (10Hz tuning rate)
FS1; Fine Tune function ON (1Hz tuning rate)

Select Transmitter VFO (See Split Mode Note)
Transmitted from PC
FT0; Select VFO-A
FT1; Select VFO-B

Read Transmitter VFO
Transmitted from PC
FT;

Response from TS-480
FT0; VFO-A selected
FT1; VFO-B selected

Read transceiver ID number
Transmitted from PC
ID;
Response from TS-480
ID020;

Read Transceiver Status
Transmitted from PC
IF;
Response from TS-480

IFp1p1p1p1p1p1p1p1p1p1p1p2p2p2p2p2p3p3p3p3p3p4p5p6p7p7p8p9p10p11p12p13p14p14p15;

p1 : 11 digits of receiver frequency to 1Hz, example: 14.234567MHz = 00014234567
p2 : 5 spaces
p3 : RIT frequency ±nnnn Hz
p4 : 0 = RIT Off, 1 = RIT On
p5 : 0 = XIT Off, 1 XIT On (Not Applicable)
p6 : 0 (Always 0)
p7 : Memory Channel number 00 – 99 (Not Applicable)
p8 : 0 = RX, 1 = TX
p9 : 1 = LSB, 2 = USB, 3 = CW
p10 : 0 = VFO A, 1 = VFO B
p11 : 0 = Scan Off
p12 : 0 = Simplex, 1 = Split
p13 : 0 (Not Applicable)
p14 : 00 (Not Applicable)
p15 : space character
; : End-Of-Command character

Example 1: `IF00014003920     00000000000020000080;`
RX Freq: 14.003920MHz RIT Freq: 0000, RIT Off, USB, VFO A, Scan Off, Simplex

Example 2: `IF00014003920     01230100000020000080;`
RX Freq: 14.003920MHz RIT Freq: +123, RIT On, USB, VFO A, Scan Off, Simplex

Example 3: `IF00014003920     -01230100000020000080;`
RX Freq: 14.003920MHz RIT Freq: -123, RIT On, USB, VFO A, Scan Off, Simplex

Example 4: `IF00014003920     00000000000020010080;`
RX Freq: 14.003920MHz RIT Freq: 0000, RIT Off, USB, VFO A, Scan Off, Split

Set Mode
Transmitted from PC
MD1; LSB
MD2; USB
MD3; CW

Read Current Mode
Transmitted from PC
MD;

Response from TS-480 (Other modes are possible, but not applicable to a TRX-2)
MD1; LSB
MD2; USB
MD3; CW

Set Noise Blanker
Transmitted from PC
NB0; Noise Blanker OFF
NB1; Noise Blanker ON

Read Noise Blanker
Transmitted from PC
NB;
Response from TS-480
NB0; Noise Blanker OFF
NB1; Noise Blanker ON

Set Speech Processor
Transmitted from PC
PR0; Speech Processor OFF
PR1; Speech processor ON

Read Speech Processor
Transmitted from PC
PR;
Response from TS-480
PR0; Speech Processor OFF
PR1; Speech processor ON

Set RIT Function
Transmitted from PC
RT0; RIT OFF
RT1; RIT ON

Read RIT status
Transmitted from PC
RT;
Response from TS-480
RT0; RIT OFF
RT1; RIT ON

Set Low Frequency Filter DSP Settings
Transmitted from PC
SLnn;

where nn can have the following meanings:

00: 10, 01: 50, 02: 100, 03: 200, 04: 300, 05: 400, 06: 500, 07: 600, 08: 700, 09: 800, 10: 900, 11: 1000, all frequencies in Hz. The Juma emulation ignores this command.

Read Low Frequency DSP Settings
Transmitted from PC
SL;
Response from transceiver
SL04; Essentially, ignore, but satisfy the CAT program.

Set High Frequency Filter DSP Settings
Transmitted from PC
SHnn;

where nn can have the following meanings:

00: 1400, 01: 1600, 02: 1800, 03: 2000, 04: 2200, 05: 2400, 06: 2600, 07: 2800, 08: 3000, 09: 3400, 10: 4000, 11: 5000, all frequencies in Hz.

At present, the emulation examines the transmitted request and selects the wide, mid, or narrow filter that matches as close as possible, taking into account the current bandwidth settings.

Read High Frequency DSP Settings
Transmitted from PC
SH;
Response from transceiver
SHnn;

where nn has the following meanings:
00: 1400, 01: 1600, 02: 1800, 03: 2000, 04: 2200, 05: 2400, 06: 2600, 07: 2800, 08: 3000, 09: 3400, 10: 4000, 11: 5000, all frequencies in Hz.

The Juma emulation calculates the wide, mid, and narrow cut-off frequencies currently in use, and responds with the code that is closest to the filter/bandwidth currently selected.

Read S-Meter Status
Transmitted from PC
SM0; Main transceiver S-Meter
SM1; Sub-receiver
SM2; Main transceiver S-Meter level
SM3; Sub-receiver S-Meter level

Response from TS-480
SM0nnnn;
SM1nnnn;
SM2nnnn;
SM3nnnn; Where nnnn is 0000 – 0030 (main receiver) 0000 – 0015 (Sub receiver)

Turn TX ON
Transmitted from PC
TX0; Transmit from MIC (TS-480)
TX; Transmit (TS-2000) If TS-2000 is already in transmit mode, response is ?; otherwise no response.
Response from TS-480
TX0;

Turn RX ON
RX;
Response from TS-480
RX0;
No response from TS-2000. If TS-2000 is already in RX mode, response is: ?;

Read Transceiver Status
Transmitted from PC
RS;
Response from TS-480
RS0; Normal
RS1; Busy

Split Mode
To enable Split Mode first set the frequency of VFO-B. This will be accomplished by the FB command, then the FT1; command will be sent to use VFO-B as the transmit VFO, this is the signal to turn split mode on in the TRX2.

The emulation has been tested using CI-V Commander version 5.8.7, and it operates with this program.

Annex E

Serial Port Test Mode

When the serial port mode is set to the Test Mode, the user can investigate the current settings of the transceiver via a terminal program. Set the terminal program to the same settings as the TRX-2, typically, 9600 Baud, 8 data bits, 1 stop bit, no parity.

If the terminal is connected and the transceiver powered up, the following data will be printed:

```
JUMA-TRX2 Copyright OH7SV & OH2NLT

Software version v1.07n, Copyright Juha Niinikoski OH2NLT
(Additional features and modifications - Adrian Ryan - 5B4AIY)
~~~~~~~~~~~~~~~~~~~~~[COMMAND TABLE]~~~~~~~~~~~~~~~~~~~~~
I      Help - (This Screen)
A      Display A-D Convertor Samples
a      Alarm Function Test
b      LCD Bar Graph Test
C      Clear Factory Default reset counter
c      Continuous SPI write
E      Dump EEPROM contents
f      Display SPI bus control bits
m      Display mSec counter
o      Reference Oscillator calibration value
p      Display scaled S-Meter & CW Speed Pot A-D value
Q      Auto Equalise RF Output Power
R      RF Attenuator Settings
S      Start SCAF (Audio On)
s      Stop SCAF (Audio Off)
t      Single SPI write
U      Dump User Frequency Memory
u      Dump Transceiver Configuration Settings
W      Write ASCII to LCD
+      Increment RF Attenuator
-      Decrement RF Attenuator
Z      Divide-By-Zero Trap
```

Entering the letter I, ?, H, or h will display the help facility, above.

Enter the letter A, and you will obtain a dump of the A-D convertor’s current measurements thus:

```
A-D Convertor Samples
 Channel   Sample   Scaled(V)   Displayed
------------------------------------------
    9         0      0.000         0.000A
   10      2578      3.147        13.663V
   11         0      0.000        S0
   12         0      0.000  Rev:  0.00W
   13         0      0.000  Fwd:  0.00W
   14      1901      2.321  CW Speed Pot
   15      2063      2.518  RIT:    0Hz
------------------------------------------
```

Each line of the display now identifies the channel number, its raw value from 0 – 4095, the scaled voltage to which this value corresponds, and the displayed measurement.

The above display show the A-D convertor output when using the factory default values for the measurement system. The next dump shows a more representative set of values obtained when keying the transceiver in the Tune mode operating into a dummy load:

```
A-D Convertor Samples
 Channel   Sample   Scaled(V)   Displayed
------------------------------------------
    9       1862      2.273        2.247A
   10       2531      3.090       13.591V
   11          0      0.000       S0
   12         16      0.020  Rev:  0.00W
   13       1785      2.179  Fwd: 11.31W
   14       1901      2.321  CW Speed Pot
   15       2063      2.518  RIT:    0Hz
------------------------------------------
```

By entering the letter u, the transceiver’s calibration and configuration settings can be dumped thus:

```
System Settings
Reference Oscillator: 180000000 Hz
DC Voltmeter        : 5300
Ammeter             : 2400
Power Meter         : 3550
S-Meter             : 1920
SWR Trip Setting    :  300
Over-Voltage Trip   : 2736 = 14.50V
Under-Voltage Trip  : 2076 = 11.00V
Over-Current Trip   : 2084 =  2.50A
Beep Time           :  50 mS

User Settings
AGC Speed        : Slow
Filter Roll-Off Frequencies
Wide             : 1000 Hz
Mid              : 2205 Hz
Narrow           : 2500 Hz
Transmit         : 2586 Hz
Noise Blanker    : OFF
Speech Processor : OFF
Audio Source     : Mic
Keyer Mode       : Dot Priority
CW Pitch         : 700 Hz
CW Pot Mode      : CW Speed
LCD Backlight    : 350
LCD Contrast     : 2000
LCD Timer        : 0
RS-232 Mode      : Test
Speed            :   9600 Baud
VFO Memory       : A/B + Split
S-Meter          : Graphic
TX Disable       : ON
Auto-Sideband    : ON
Frequency Display: Fixed B: 12.34568
Band Switch      : Default
Include RIT      : No
```

```
Band Limits      : IARU Region 1
Tune Attenuator  : -3dB
VFO Adjust       : Off
```

This shows the system calibration and configuration using the standard factory defaults. A representative display after calibration is:

```
System Settings
Reference Oscillator: 179998910 Hz
DC Voltmeter        : 5370
Ammeter             : 2414
Power Meter         : 3550
S-Meter             : 3900
SWR Trip Setting    :  300
Over-Voltage Trip   : 2756 = 14.80V
Under-Voltage Trip  : 2049 = 11.00V
Over-Current Trip   : 2485 =  3.00A
Beep Time           :  50 mS

User Settings
AGC Speed        : Slow
Filter Roll-Off Frequencies
Wide             : 1000 Hz
Mid              : 2205 Hz
Narrow           : 2500 Hz
Transmit         : 2586 Hz
Noise Blanker    : OFF
Speech Processor : OFF
Audio Source     : Mic
Keyer Mode       : Dot Priority
CW Pitch         : 700 Hz
CW Pot Mode      : CW Speed
LCD Backlight    : 350
LCD Contrast     : 2000
LCD Timer        : 0
RS-232 Mode      : Test
Speed            :   9600 Baud
VFO Memory       : A/B + Split
S-Meter          : Graphic
TX Disable       : ON
Auto-Sideband    : ON
Frequency Display: Fixed B: 12.34568
Band Switch      : Default
Include RIT      : No
Band Limits      : IARU Region 1
Tune Attenuator  : -3dB
VFO Adjust       : 10Hz decade only
```

Enter the letter a, and you can exercise the alarm sub-system thus:

```
Set Alarm Flag
Enter 0, 1, 2, 4, 8, or 9 ...
1 - Over-Current Alarm
Set Alarm Flag
Enter 0, 1, 2, 4, 8, or 9 ...
2 - High SWR Alarm
Set Alarm Flag
Enter 0, 1, 2, 4, 8, or 9 ...
4 - Over-Voltage Alarm
Set Alarm Flag
Enter 0, 1, 2, 4, 8, or 9 ...
```

```
8 - Under-Voltage Alarm
Set Alarm Flag
Enter 0, 1, 2, 4, 8, or 9 ...
9 - All Alarms ON
Set Alarm Flag
Enter 0, 1, 2, 4, 8, or 9 ...
0 - All Alarms OFF
```

You will receive a prompt requesting you to enter a digit of 0, 1, 2, 4, 8, or 9. The software will ignore other responses. The alarms are saved as flags in a single word, entering an appropriate digit will set that alarm flag, and the display will blink with the alarm message, and beep. Briefly press the PWR button to acknowledge the alarm and cancel it.

Note that the alarm system can handle multiple alarms. Entering the digit 9 will set all the alarm bits on. The first press of the PWR button will cancel the highest priority alarm, and reveal the next lowest alarm. Pressing the PWR button again will cancel this alarm, and reveal the next, and so on until all the alarms have been acknowledged and cancelled.

If an alarm is permanent, then the only option is to power off the transceiver. Press and hold the PWR button, and the transceiver will enter the emergency power-down mode, as soon as you see the prompt, release the PWR button. Note that no user settings are saved, the transceiver will simply drop the power latch line and shut down.

Note that switching off only removes power from the DDS, Main and Filter boards, the power amplifier is still connected to the power supply. If the fault is with this assembly then the power supply must be shut off as well. Only the main fuse will protect the power amplifier.

Entering the letter U will dump the contents of the User Band Memory thus:

```
VFO-A:  3.70007 MHz  LSB
VFO-B:  7.06000 MHz  LSB
VFO-C:  3.70500 MHz  LSB
VFO-D: 10.12500 MHz  LSB
VFO-E: 14.17500 MHz  LSB
VFO-F: 18.11800 MHz  LSB
VFO-G: 21.22500 MHz  USB
VFO-H: 24.94000 MHz  USB
VFO-I: 28.85000 MHz  USB
VFO-J:  1.90000 MHz  USB
VFO-K:  3.65000 MHz  USB
VFO-L:  7.10000 MHz  USB
VFO-M: 10.12500 MHz  LSB
VFO-N: 14.17500 MHz  LSB
VFO-O: 18.11800 MHz  LSB
VFO-P: 21.22500 MHz  USB
VFO-Q: 24.94000 MHz  USB
VFO-R: 28.85000 MHz  USB
VFO-S:  1.90000 MHz  USB
VFO-T:  3.65000 MHz  USB
VFO-U:  7.10000 MHz  USB
VFO-V: 10.12500 MHz  LSB
VFO-W: 14.17500 MHz  LSB
VFO-X: 18.11800 MHz  LSB
VFO-Y: 21.22500 MHz  USB
VFO-Z: 24.94000 MHz  USB
```

Entering the letter R will display the RF filters and their corresponding attenuator settings:

```
RF Attenuator Settings
 Filter  Attenuator
--------------------
 250kHz     -3dB
 500kHz     -3dB
   1MHz     -1dB
   2MHz     -1dB
   4MHz     -1dB
   8MHz     -1dB
  12MHz     -1dB
  15MHz     -1dB
  19MHz     -1dB
  23MHz     -1dB
  26MHz     -1dB
  28MHz     -1dB
--------------------
```

These attenuator settings are the factory defaults; to equalise the RF output power across the amateur bands, the attenuation factors can be changed. Please refer to Annex H for further details of the manual method, or use the Auto-Equalise command.

Entering the letter E will dump the EEPROM contents, thus:

```
Dump EEPROM contents
 0000 B342 0037 BA20 006B 88A8 0038 7EC8 009A
 0010 4B18 00D8 7570 0114 DE28 0143 8DE0 017C
 0020 3750 01B8 FDE0 001C B1D0 0037 5660 006C
 0030 7EC8 009A 4B18 00D8 7570 0114 DE28 0143
 0040 8DE0 017C 3750 01B8 FDE0 001C B1D0 0037
 0050 5660 006C 7EC8 009A 4B18 00D8 7570 0114
 0060 DE28 0143 8DE0 017C 3750 01B8 FDE0 001C
 0070 B1D0 0037 5660 006C FDE0 001C B1D0 0037
 0080 5660 006C 7EC8 009A 4B18 00D8 7570 0114
 0090 DE28 0143 8DE0 017C 3750 01B8 003A 0021
 00A0 02BC 0000 14ED 0001 0000 0002 0000 0000
 00B0 0000 0000 0000 0000 0001 0001 0001 0001
 00C0 0001 0001 0000 0000 0000 0001 0001 0001
 00D0 0001 0001 0001 0000 0000 0000 0001 0001
 00E0 0001 0001 0001 0001 0000 0000 0000 0001
 00F0 0001 0001 0001 0001 0001 0001 0000 0001
 0100 0000 0000 0002 07D0 015E 0000 004B 0022
 0110 001E 001D 0002 0004 0001 0000 0003 0000
 0120 0001 0001 0003 0000 0000 0000 0003 2541
 0130 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
 0140 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
 0150 9500 0ABA 096E 0000 14FA 0000 0E32 0000
 0160 0DDE 0000 0DDE 0000 0032 0303 0001 0101
 0170 0100 0100 0001 0101 0101 012C 0007 0AC4
 0180 0910 0800 F2AF FFFF FFFF FFFF FFFF FFFF
 0190 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
 01A0 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
 01B0 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
 01C0 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
 01D0 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
 01E0 FFFF FFFF FFFF FFFF FFFF FFFF FFFF FFFF
 01F0 FFFF FFFF FFFF FFFF FFFF FFFF FFFF 0000
Last success code = 7F
```

It is beyond the scope of this document to give a detailed explanation of the contents and the layout. You will need to refer to the source code and particularly the file: `trx2_eeprom.h` for the layout of the EEPROM contents. The above dump represents the values written to the EEPROM when restoring the factory defaults.

Auto-Equalise
This is a new function, which automates the process of equalising the output power of the transceiver. To invoke, enter the letter Q, you will receive the following prompts:

```
Auto Equalise RF Output Power
Ensure transceiver is connected to a 50 Ohm dummy load.
This may alter your current attenuator settings.
Do you wish to continue (Y/N)?: Y
Press and hold the PTT switch to start...
Equalising...
Band:  10m  Averaged Power:  8.9 Watts
Band:  12m  Averaged Power: 11.0 Watts
Band:  15m  Averaged Power: 10.5 Watts
Band:  17m  Averaged Power:  8.9 Watts
Band:  20m  Averaged Power: 11.8 Watts
Band:  30m  Averaged Power:  9.3 Watts
Band:  40m  Averaged Power: 11.6 Watts
Band:  80m  Averaged Power: 11.2 Watts
Band: 160m  Averaged Power: 10.0 Watts

Band: 160m Rel Power:  0.51dB Attenuator: 0dB
Band:  80m Rel Power:  1.00dB Attenuator:-1dB
Band:  40m Rel Power:  1.18dB Attenuator:-1dB
Band:  30m Rel Power:  0.21dB Attenuator: 0dB
Band:  20m Rel Power:  1.24dB Attenuator:-1dB
Band:  17m Rel Power:  0.04dB Attenuator: 0dB
Band:  15m Rel Power:  0.76dB Attenuator: 0dB
Band:  12m Rel Power:  0.92dB Attenuator:-1dB
Band:  10m Rel Power:  0.00dB Attenuator: 0dB
Release the PTT switch to complete.

Equalisation Complete
```

If you reply to the prompt with anything other than the letter y or Y, the process will abort without making any changes.

To continue, press and hold the PTT switch. The process takes approximately 10 seconds, with the routine making a 10-sample averaged power measurement on each amateur band from 10 metres down to 160 metres. Since the frequency is being changed, this particular mode was chosen so that when the filter is changed the frequency is always below its natural cut-off frequency, thus avoiding any transient power absorption events.

If you release the PTT switch during the process, then it will abort gracefully without making any changes, as it will if it encounters any alarm conditions. Release the PTT switch at the conclusion to exit from the routine.

The new values will be saved to the EEPROM when you next power the transceiver off, as usual.

Annex F

Improved Accuracy Measurement Sub-System

The original measurement sub-system, whilst sufficient for general purpose indications of the voltage, current and power output of the transceiver, did not completely capitalise on the inherent accuracy available from a 12-bit A-D convertor.

The designers chose to optimise the speed of the main processing loop in the software, and used calibration constants and factors that lent themselves to easy integer manipulation, avoiding the use of floating point mathematics. With further analysis, it would seem that there was sufficient processing capability available that using a more comprehensive set of algorithms could significantly enhance the accuracy of the measurement sub-system with little impact on speed.

Voltage Measurement
The voltage measurement system uses a precision potential divider comprising resistors R27 (33k / 1%) and R28 (10k / 1%) placed across the system bus. At a nominal input voltage of 13.8V, the output from this potential divider will therefore be:

13.8 * 10 / (33 + 10)

= 3.2093V

The A-D convertor is a 12-bit device, and uses the main 5V logic supply as the reference.

Assuming for the moment that this reference voltage is exactly 5.000V, this gives a quantisation step of:

5000 / 2^12

= 1.2207mV

The scale factor for the voltage measurement is therefore:

10 / 43

= 0.23256

which gives a quantisation step for the voltage measurement system of:

1.2207 / 0.23256

= 5.249mV

Thus, in principle, it should be possible to adjust the calibration of the voltage measurement system to have an overall accuracy of about ±5.25mV

In the original firmware the actual calculation was:

$V_{display}$ = (ADC * Calibration Factor) / 256

If we insert some typical values, then the ADC value for 13.8V will be around 2629, and the default calibration value is 135, and thus:

$V_{display}$ = (2629 * 135) / 256

= 354915 / 256

= 1386.386

which, when divided by 100 displays as:

13.86V

If the calibration factor were increased to 136, then the raw value would then be:

1396.656

which would display as:

13.96V

In other words, the quantisation step related to the calibration factor is 103mV, despite the inherent accuracy of the measurement system being 5.25mV.

If the measurement system's calibration factor and calculation is changed, the overall accuracy and resolution can be significantly improved.

The new calculation algorithm is:

$V_{display}$ = (ADC * Calibration Factor) / 10,000,000

If we perform a worst-case analysis, then the lowest output voltage from the potential divider will be when R27 is at its highest tolerance limit, and R28 at its lowest. In this case, the nominal 13.8V input voltage will be scaled down to:

13.8 * 9900 / (9900 + 33330)

= 13.8 * 9900 / 43230

= 3.16031V

Equally, the highest output voltage will occur when R28 is at its highest tolerance limit and R27 at its lowest. In this case, the nominal 13.8V input voltage will be scaled down to:

13.8 * 10100 / (10100 + 32670)

= 13.8 * 10100 / 42770

= 3.25883V

The tolerance of the voltage regulator's output is ±0.25V, and thus the lowest count from the A-D convertor will occur for the lowest input voltage and the highest reference voltage, and would be a count of: 2465. The highest count would be for the highest input voltage and the lowest reference voltage, and this would be: 2810.

From this the calibration factor limits can be calculated. The nominal count would of course still be 2629.

The calibration factor required therefore is:

13,800,000 / 2629

= 5249

and thus the calculation would be:

$V_{display}$ = (ADC * 5249) / 10,000,000

Inserting typical values:

Raw O/P = 2629 * 5249

= 13,799,621

Now, however, if the calibration factor is changed by 1 increment, the display would be:

Raw O/P = 2629 * 5250

= 13,802,250

This gives an increment of 2.6mV/ step, and thus allows the voltage to be more accurately approximated, as it is using the optimum step size of ±1/2LSB.

Whilst in practice temperature variations are likely to cause errors which exceed this, nevertheless a worthwhile improvement in accuracy has been achieved at no extra cost other than an alternative algorithm.

Current Measurement

The ammeter in the TRX2 only measures the drain current of the output amplifier, not the total current consumed by the transceiver. Nevertheless, in order to accurately set the bias currents for both the driver and power amplifier stages, it is essential that the current measurements are performed to as high an accuracy as possible.

The output current measurement is made by sampling the voltage developed across two low value resistors connected in parallel, R23 and R24, each of 0.22Ω. This gives a shunt resistance of 0.11Ω giving a scaling factor of approximately 110mV/A. The DC voltage is amplified by A1-A which has a gain of x10, giving an overall scaling factor of approximately 1.1V/A.

Assuming an amplifier current of 2.5A, this gives a voltage into the A-D convertor of 2.75V, and the raw output from the convertor will be:

2.75 / 5 * 4096

= 2253

The maximum full-scale value of this ammeter is thus 2.5 * 4096 / 2253 or 4.545A, and has a quantisation step size of 4.545 / 4096 or 1.1mA. This is the intrinsic resolution limit of the ammeter.

In order to take advantage of this resolution, at a nominal input current of 2.5A, the required calibration adjustment factor would be 2220. Thus the actual current calculation would be:

$I_{display}$ = ADC * Calibration Factor / 2,000,000

As an example, assuming nominal settings:

$I_{display}$ = 2253 * 2220 / 2,000,000

= 5,001,660 / 2,000,000

= 2.5008 Amps

Power Measurement
This is the least accurate of the measurements. Since power is proportional to the square of the voltage, the output from the A-D convertor has to be squared. Any differences in construction, or differences in components will therefore lead to a squaring of the error terms, leading to a greater uncertainty in the measurement compared to the voltmeter and ammeter. In addition, the diodes used to rectify the RF voltage developed in the dual directional coupler are also non-linear, thus the accuracy of the measurement will degrade significantly at low power levels.

The forward power scaling factor is approximately 2.05V/10W, which would result in a convertor output of:

2.05 / 5 * 4096

= 1679

This has to be squared:

2,819,041

the calibration factor to read 10W is therefore:

3547

The incremental quantisation step is thus 2.8mW, which is a greater precision than actually required, nevertheless, the accuracy of the measurement is now largely determined by the sensor, and not the A-D convertor or its calibration factor.

Annex G

The TRX2 Alarm System

Version 1.07k of the firmware introduces an additional feature to the transceiver, an alarm system to provide the user with a critical warning of potentially damaging factors.

The system can provide a warning for high SWR, power amplifier over-current, and over and under input voltages.

The thresholds for these alarms are set in the revised System Setup & Calibration mode, as earlier described.

High SWR

The original firmware was already provided with a simple SWR alarm, triggered if it exceeded 3.0:1, but it simply displayed this value. Now, the user can adjust the threshold at which the alarm is given from 1.00:1 to 5.00:1 in 0.01 increments. If the SWR exceeds the threshold then a message is displayed and a repetitive beep sounds.

The only active button when an alarm is present is the PWR button. Briefly press this to acknowledge and cancel the alarm. Obviously, if the event is still present, then the alarm will return. If the alarm cannot be cleared, for example, a permanent under-voltage, then press and hold the PWR button to invoke the emergency shutdown. This will occur faster than the regular shutdown, and no user settings will be saved to the EEPROM.

Over-Current

This alarm is triggered if the measured final amplifier’s drain current exceeds the preset threshold. Note that as already mentioned, the current sense only applies to the power amplifier’s output transistors. Excessive current elsewhere in the transceiver is not sensed. Only the input fuse can protect the unit.

The usual reason for an excessive current is a high SWR, in which case this alarm is also likely to exist. If the alarm is present, release the PTT switch or the key and acknowledge the alarm, and investigate its cause.

I considered carefully whether to force the transmitter off in the event of either a high SWR or high PA current, but decided that in doing this it would make matching an antenna to the transceiver a frustrating business if the transceiver kept tripping off whilst attempting to achieve a match when the high SWR might only persist for a short time. It is left to your judgement as to what level to set the alarm, but 2.5A is suggested.

Over-Voltage

This alarm is only really likely to occur when operating mobile using a vehicle electrical system. Be aware that automobile electrical systems can have supply voltages as high as 14.8V or sometimes higher, especially if the battery is old, or has a high internal resistance, or the electrical connections are unsatisfactory, or the alternator is faulty. Although the transceiver can tolerate for short periods of time input voltages up to about +15V, it is unwise to continue to use it if you experience a significant number of over-voltage alarms.

Under-Voltage
Low input voltages are not damaging to the transceiver, but are worth investigating. If the equipment is being operated under portable conditions, then it is likely that the power supply will be a small sealed lead-acid battery. These deep-cycle batteries are a very suitable power source, but to ensure optimum life they do need to be used in a careful and considerate way.

Most manufacturer's recommend that the discharge be terminated when the voltage has fallen to 10.5V. It is certainly very bad for the battery to be discharged beyond this point, and will greatly shorten its service life.

To maximise the life, the cut-off voltage should be somewhat higher than this, and 11.0V is a reasonable compromise between maximum operating time and service life of the battery. If it is discharged down to these voltages it must be placed on charge immediately afterwards or within as short a period of time as possible. Do not leave a sealed lead-acid battery in a discharged state, at low voltages a secondary electrochemical reaction occurs which leads to sulphation, which is not recoverable.

To prevent this, the undervoltage alarm is provided. To give you warning of the approach of the cut-off threshold, a pre-limit warning is given at a voltage 100mV higher than the preset threshold. This will display the warning message: `Low Batt Voltage`.

To cancel the warning, briefly press the PWR button. Note however that this warning will only be given once, and when cancelled will not re-appear. The only way to reset the warning is to turn the transceiver off and the back on again. If operation is continued down to the threshold setting, then the alarm will persist, no buttons other than the PWR button, or other functions will be operative, the only recourse is to turn the transceiver off.

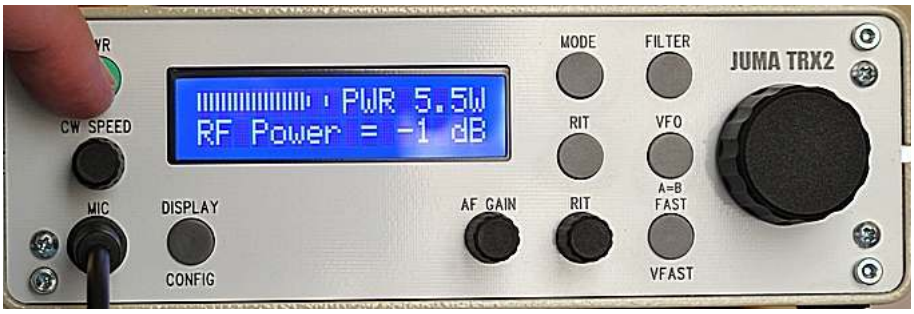
Any or all of the alarms, with the exception of the high SWR, can be disabled, if you wish. Note that if the undervoltage alarm is disabled, then the pre-limit alarm is also disabled.

Annex H

Equalising the TRX-2 Output Power

The Juma TRX-2 has a somewhat ‘hidden’ feature whereby you can set the output power of the transmitter on all bands to be essentially the same despite minor variations in insertion loss of filters, and the varying gain of the output amplifier with frequency.

This attenuator selection feature is enabled by setting the mode to TUNE, pressing and holding the PTT switch, and then holding the PWR button down. The display will then change and will appear as below.



TX Attenuator Adjustment

To select an attenuator, rotate the VFO knob, and you can select one of four attenuation levels from 0dB to −3dB in 1dB steps.

To equalise the output power you will need to measure the output on all bands and at all attenuator settings, and tabulate the results:

Band, Metres	**0dB**	**−1dB**	**−2dB**	**−3dB**
160	7.2W	5.6W	4.2W	3W
80	7.4W	5.8W	4.5W	3.3W
40	7.5W	6.1W	4.9W	3.7W
30	5.6W	4.9W	3.6W	2.8W
20	7.0W	5.6W	4.5W	3.4W
17	5.2W	4.2W	3.3W	2.6W
15	5.9W	4.8W	3.8W	2.9W
12	6.2W	5.0W	3.9W	3.0W
10	4.9W	4.0W	3.2W	2.5W

In this case you can see that using the 0dB attenuator the highest output power was 7.5W, and the lowest 4.9W.

Examine the results, and set the attenuators such that on the band with the lowest output power the attenuator is set to 0dB, and the other band's attenuator setting give a matching output power. In my case this would be:

Band:	**160**	**80**	**40**	**30**	**20**	**17**	**15**	**12**	**10**
Atten:	−1	−2	−2	−1	−2	0	−1	−1	0
Atten:	−2	−2	−3	−2	−2	−1	−2	−2	−1

Note that the second row shows an alternative setting using slightly lower overall gain, but achieving the same result. As you select the various bands, the attenuator setting will be preserved and saved to the EEPROM when the transceiver is powered down, thus you only really need to "calibrate" the transmit chain once. If you wish to obtain a record of the attenuation settings, then use the serial test facility to dump the current values.

Note that if you restore the factory default settings, as well as inserting the measurement system's calibration values, you will have to re-select the various attenuation settings for each band.

It was whilst making these adjustments that I discovered that initially my 40m output was about 3dB lower than the rest. A careful check with my sampling oscilloscope showed that the culprit was the 4Mhz – 8MHz input filter formed with C25, L15, C26, L16, C27, C28, L17, and C29. A close examination showed that one side of C26 had not been soldered. When this was corrected, the measured filter insertion loss was:

Band (Metres)	**Filter (MHz)**	**Input (mV P-P)**	**Output (mV P-P)**	**Attenuation dB**
160	1 – 2	808	648	−1.92
80	2 – 4	808	688	−1.40
40	4 – 8	752	744	−0.09
30	8 – 15	920	680	−2.63
20	8 – 15	744	752	+0.09
17	15 – 30	904	656	−2.79
15	15 – 30	792	688	−1.22
12	15 – 30	752	680	−0.87
10	15 – 30	784	670	−1.36

The output power was set to about 1.8W on 160m just to keep the signal levels well within the derating range of both the oscilloscope input and the x10 probe used.

Whilst this manual method can still be used, please examine the Serial Test suite for the Auto-Equalise function that effectively replaces this somewhat tedious manual method.