SDR Cube Transceiver

Software Release Notes

Version 3.01 *(July 31, 2013)* **...**

1) NEW FEATURE: Band Switching Support for Multi-Rx Board

The Band Switching Table in the Cube software was adjusted to provide 2-bit switching to the Multi-Rx Board, thus allowing the four onboard filters to be switched accordingly for the following frequency band segments:

Rx Filter 0: 0-4 MHz
Rx Filter 1: 4-8 MHz
Rx Filter 2: 8-15 MHz
Rx Filter 3: 15-30 MHz

For a detailed view of the Band Switching Map and two output bits used on the DSP Board's P13 "Band Switch" connector, please refer to **Band Switch Map**.

2) NEW FEATURE: Mic Filters

In order to provide a more configurable voice response when transmitting in SSB or AM modes, a selection of four mic filters is now available in the User Menu. Most notable is the filter selection that allows more low-frequency (bass) energy from the mic to be used, resulting in a fuller, deeper and more natural-sounding voice signal to be transmitted. Refer to the **Mic Filters** pages for full details.

3) NEW FEATURE: OH2UG Multi-Platform Flash Loader

A new-and-improved way to update the SDR Cube Transceiver with the latest software has been developed by **Tauno Voipo OH2UG.** Three big new sets of capabilities are available for use with the SDR Cube Transceiver ...

- It programs, compares, checks, prints and erases the SDR Cube flash memory;
- The Embedded Flash Agent has a progress indicator ("railroad moving tracks") on the Cube display to indicate that a bootload is in progress; and
- The PC Client Program works on Windows, Mac and Linux platforms!

The OH2UG Multi-Platform Flash Loader is also backward compatible with the previous flash agent used in the SDR Cube. This means that the existing FlashCube.bat program (which uses the 16-bitFlashProgrammer.exe) will still work, in case people are not yet ready to try the new PC Client Program.

Version 3.00 *(March 26, 2013)* **...**

1) NEW FEATURE: AM Mode

A major feature “AM Mode” has been added to the SDR Cube Transceiver software, enabling the operator to select and use the AM mode for voice communications. Mode selections of either AM▲ (upper) or AM▼ (lower) provide a unique and powerful approach for AM reception, and an efficient method is implemented in software to generate AM transmissions. This latest software release gives the SDR Cube owner a distinctly capable way to communicate in AM mode, and when coupled with some RF power amplification he will be able to participate in AM discussion nets on the air with other hams using this classic mode.

2) NEW FEATURE: CW Spotting Indicator

When in either CW or CW-R mode, a tiny triangular indicator is placed on the bandscope at the “CW Offset” frequency to assist in zero beating an incoming CW signal for ideal reception. By presenting this indicator, an operator who may not have “good pitch” would be able to tune the received CW signal to be positioned at the CW Offset frequency (which is a setting in the User menu, thus ensuring that the Cube’s transmitted signal will be heard on the receiving side as the same tone he is hearing. That is, the transmit and receive stations will be “zero beat” with each other.

Version 2.02 *(Jan 20, 2013)* **...**

1) IMPROVEMENT: Eliminate occasional "EEPROM Checksum" condition

A minor bug was fixed in the I2C EEPROM driver to reliably write all settings. (An occasional “EEPROM Checksum Error” was displayed in the Terminal menu at power on, indicating a reverting back to default settings.)

Version 2.01 *(Dec 31, 2012)* **...**

1) IMPROVEMENT: Retain I-Q balance settings through power cycling

A minor bug was fixed to properly retain the I-Q balance settings when the Cube powered down

Version 2.00 *(Dec 06, 2012)* **...**

1) NEW FEATURE: AGC

Many points of monitoring were added to adjust overall gain in the Rx chain to keep signals within the numerical range of the FIR filters and other processing blocks, thus reducing the occasion of overload and raising the gain for lower-level signals. The net effect is an improvement of 24 dB in dynamic range and a significantly improved listening experience for AM and other stations in the presence of QSB (heavy changes in propagation) and interference from strong adjacent stations.

From our AGC Overview document … *"AGC is an adaptive system found in high-end commercial and professional radios that adjusts the receive channel gain to an appropriate level for a range of input signal levels. For example, without AGC the sound emitted from a receiver would vary to an extreme extent from a weak to a strong signal; and many times, especially in radios implementing software processing of the signal chain (such as in software defined radios), overloading of the codecs/ADCs can cause distortion. To remedy these situations, the AGC control loop protects intermediate gain stages from becoming overloaded by effectively reducing the volume if the incoming signal is strong and raising it when it is weaker."*

User Interface Changes:

- "A" added next to the CW/USB/LSB/Digital mode status to indicate AGC in on.
- "AGC meter" added to left side of horizontal line beneath VFO Frequency
- User-adjustable AGC controls added to User Menu: State, Attack, Release, Slope, Knee and Samples

See document "AGC Operation" for complete description of AGC usage

Comments from a few of our beta testers …

> *"Overall, I am VERY pleased with the new AGC. It's a keeper as far as I'm concerned. Plus, you have provided enough controls to allow users to tweak AGC action to meet their personal needs. I realize it probably took a while to get this AGC coded and functional, and to me the improvement is very worthwhile. I would vote to keep all those settings user-adjustable, maybe with a few examples on preferred settings for voice, CW, and data modes."*
>
> *"I have played with it on 40M, both CW and phone. The big difference is that now I don't have to play with the RF Attenuator much at all. I've played a little with voice/LSB signals, and I can move up and down 40M without adjusting RF ATTEN at all, including the real strong signals just above the 40M ham band."*
>
> *"This is a great improvement in the Cube. Not having to constantly adjust the RF Atten is a big win in my book. I can tune to signals that I can't even see on the spectrum, to signals that are overloading the spectrum, and not have to adjust the RF atten at all."*

2) IMPROVEMENT: Faster return to main screen from User Menu

"Fast Page Write" now implemented for saving changed parameters in User Menu (instead of saving all EEPROM) before returning to the main operating screen. Results in 10x improvement.

3) IMPROVEMENT: TUNE power level made consistent with max tone to Mic input.

About 74mV RMS in the Mic input now gives same RF output as when the Tune pushbutton is pressed.

4) IMPROVEMENT: TUNE power level made consistent with max tone to Mic input.

Soft DDS phase now synchronized with CW keying to improve Tx signal quality.

Version 1.08 *(Feb 19, 2012)* ...

1) NEW FEATURE: S-METER

Information displayed on the SDR Cube was slightly rearranged in order to add a new and exciting control: an S-Meter! The new S-Meter text field is in the lower right quadrant of the display, where the Filter graphic was previously displayed. Our s-meter may be displayed in S-units, or as dBm, as determined by the S-Meter configuration setting in the User menu. The meter has 1dB accuracy over the range -110 to -15dBm, which is far better than those in average commercial rigs. The exact range depends on which band module is installed, and there is a way for the user to calibrate the s-meter. A low level dBm meter exhibiting 1dB accuracy is a good tool when a better instrument is not available for power measurement. Note that the Cube's s-meter shows the signal power only when the signal is located inside the selected RF Filter width. If you have a broadband signal or one with plenty of harmonics, the Cube's s-meter may not agree with results of a wide band diode or thermal meter.

CALIBRATION -- Calibrating the SDR Cube's s-meter is simple:

- Connect an S9 (-73dBm) signal source to the Cube's antenna socket. A calibrated signal source such as an HP8640B signal generator is ideal for providing a reference RF signal, or even an inexpensive Elecraft XG3 may be used in a pinch.
- Adjust the Tuning dial such that the signal's audio tone is about 1 kHz, and ensure that the Filter control is at the widest setting. It does not matter if LSB or USB is used.
- Set the Cube's RF Atten control to 0dB
- Set the s-meter to display in dBM. (Use the S-Meter Type item in the User menu to do this.)
- Alternating between the User menu and the operating screen, adjust the s-meter calibration setting so that you get -73dBm reading in the operating screen. The calibration factor being adjusted is opposite in direction that you want the displayed value to move. For example, if your Cube's meter displays -75dBm with a -73dBm source, you would need to make the calibration value increase by 2.
- Return to the desired S-Meter Type (dBm or S-units) and exit the User menu one last time in to save the settings.

If a real signal generator is being used as the signal source, other calibration points may be verified. Always keep the Cube's RF Atten setting such that system is not clipping and ensure that the

signal is set to be within the Filter width. We have found the typical calibration factor to be about 65. If the factor needed to calibrate the meter is significantly more or less than 65, you may have sensitivity problems in the RF front end.

2) NEW FEATURE: FILTER GRAPHIC MOVED TO NEW POSITION ON DISPLAY

The Filter graphic has been moved up to the right end of the horizontal separation line beneath the A##/B## VFO fields. The Filter setting is indicated by a bold line with a length proportional to the filter settings: 2.6 kHz (longest), 1.5 kHz and 500 Hz (shortest).

3) IMPROVEMENT: 100 HZ TUNING CAPABILITY ADDED

A new tuning step has been added to the Rate control, now allowing the user to change frequency at 100 Hz steps. This new tuning rate enables the user to quickly and more easily adjust the reception of SSB stations for good clarity. (Previously, the 10 Hz tuning rate was somewhat too fine, and the 1 kHz rate was too course to allow convenient adjustment for SSB reception.) The 100 Hz tuning rate is nestled in the regular rotation of 10 Hz, **100 Hz**, 1 kHz and 100 kHz settings, as achieved by successive taps of the Rate pushbutton. And per usual, the selected rate is indicated by the underline of corresponding digit on the frequency display.

Also, don't forget the "quick tune" method of changing the frequency in 1 MHz steps. This mode is accessed by a double-tap of the Rate pushbutton, which places the cursor beneath the 1 MHz digit for subsequent changes of the frequency dial. After the desired change is made, another tap of the Rate pushbutton gets you back into the normal step size rotation.

4) IMPROVEMENT: KEYER SPEED settable to 63 WPM (max)

The maximum setting of the Keyer control was reduced from 100 wpm to 63 wpm. This changes better accommodates a user's natural keying speed limits, and allows one to more easily set the Keyer speed to a specific value. (That is, the control is less touchy.)

5) NEW FEATURE: RECEIVE OFFSET IN CW MODE

A "receive offset" has been added to the Cube's internal local oscillator in CW mode in order to operate similar to the way most commercial transceivers work, and notably similar to the Yaesu standard. A configurable frequency offset (default is 600 Hz) is subtracted from the LO in CW normal mode during receive to allow the user to "hear" (receive) slightly lower than what the frequency dial reading indicates. This technique allows the Cube to more easily tune and zero-beat with an incoming CW signal, which most often is being transmitted slightly above the displayed frequency shown on the other operator's radio. The opposite sense is present for CW-Reverse mode, whereby the Rx Offset value is added to the LO during receive to allow the user to hear slightly higher than the displayed frequency.

Most simple direct conversion transceivers do not worry about this and operators are able to adequately place the incoming signal within the radio's audio passband, resulting in a comfortable tuning situation without the two stations in QSO chasing each other up or down the band.

A minor point should be kept in mind is that the displayed frequency will change by the Rx Offset value when switching between CW and SSB modes. This is usually not a concern. Also, this technique of

offsetting the receive frequency is not standard among radio vendors. ICOM's technique is different, and Elecraft's is also different.

The bottom line is that the Cube's CW modes now behave very similar those of the Yaesu FT-817 (for example). The most discerning operators will note the more conventional display and tuning technique, and all operators will probably note a greater ease of use while tuning in and working other stations in CW mode.

The Rx Offset value is adjustable in the User menu. The default setting is 600 Hz, which again tends to be the standard offset used in commercial transceivers.

The band scope always shows what comes in from the antenna. Now with an Rx Offset implemented, the operator will see the dial frequency at the peak what you are listening to, which is not at the not at the center of the display. The dial frequency is shown exactly +/- the Rx Offset value from the center. In other words, the band scope always shows the "real" 8kHz piece of the band. But now the center of the band scope differs from display frequency when we use a receive offset between display and local oscillator setting.

Important Note: Because of now using an Rx Offset in CW mode, frequency calibration must only be accomplished in SSB modes. If done in CW mode, the Cube will be off by the Rx Offset amount!

Version 1.06 *(July 13, 2011)* **...**

1) NEW FEATURE: Bandscope Sensitivity Adjustment

Sometimes the band is so quiet that little-to-no spectrum indication can be seen on the bandscope, yet you can still hear the signals. In these conditions, we now have the ability to increase the "bandscope sensitivity" in order to better see those very low signals and thus enable the user to tune to them. The control for this adjustment was added to the User Menu and is called BANDSCOPE ...

Bandscope = 4: Least sensitive setting, view strong spectrum levels and prevent display from clipping
Bandscope = 3: Normal (DEFAULT)
Bandscope = 2: More sensitive
Bandscope = 1: Even more sensitive
Bandscope = 0: Most sensitive, for viewing the lowest possible spectrum levels

(Note that this control does not affect RF gain – the audio signal will be just as strong (or weak) in the headphones when you change the BANDSCOPE setting; but with it you will be able to adjust the height of the signals seen in the spectrum display, thus allowing you to better see weak signals and then tune to them more easily during times of weak band reception.)

2) NEW FEATURE: Addition of TX Lock/Unlock Control

The Cube currently allows the user to transmitting within the normal ham band limits. However some users have expressed the desire to transmit outside the ham bands , either for experimental purposes or because their country's upper/lower band edges are different than the Cube's settings. So we have added a user-adjustable control to allow this ... Located in the User Menu, the new control is called TX Lock, and it can be selected to permit transmitting only inside the ham bands (TX Lock "ON") or everywhere (TX Lock 'OFF').

3) IMPROVEMENT: Listing of TX->RX delay value
The Terminal command: Print User Parameters ('i') now includes the listing of the TX-to-Rx Delay. As with the other user-settable parameters, this one is useful when re-entering configuration settings in new software releases.

4) IMPROVEMENT: CW Tone Quality
CW pitch generation scheme was changed to produce a cleaner CW tone. This improvement results in a more pure sine wave being used in Tune and CW modes, thus producing even less sideband energy during transmission.

5) BUG FIX: PSK TX audio level
An inadvertent connection between the Codec Mag setting and the PSK Tx audio path was corrected.

6) BUG FIX: PSK TX opposite sideband suppression
The receive FIR needed to be set to unity gain, thus allowing better sideband suppression to be achieved.

Version 1.03 *(Mar 14, 2011)* ...

1) NEW FEATURE: Tx->Rx Delay added -- An adjustable parameter called "Tx->Rx Delay" has been added to the User Menu to provide a user-settable delay when transitioning from Tx-to-Rx in SSB mode. This is being provided to mute an annoying buzz that occurs when mic PTT is released, as caused by a defect in the Texas Instrument codec IC being used. We will be continuing to try resolving this hardware glitch going forward. The guidance for setting this parameter is to first see if the buzz pulse occurs on in your Cube when you release the mic PTT. If so, it can be minimized by increasing the setting from its default of 900. When in the User Menu and having selected this parameter, repeatedly activate and release the mic PTT button while listening in the headphones. (Be sure to have an antenna or dummy load attached to the BNC connector.) Adjust the setting of Tx->Rx Delay while clicking the PTT and save the setting most pleasing to you. [NOTE: This buzz pulse is not present in CW mode and the setting does not affect CW T-R timing or operation. CW T-R transitions remain lightning fast!]'

Version 1.02 *(Feb 27, 2011)* ...

1) NEW FEATURE: Band Switching
- Provided in two ways: Digital bits and Analog level. In general, the switch codes and voltage levels are in effect when tuning a VFO from the lower edge of a ham band to the lower edge of the next ham band. (Actually we define the lower edge as 10 kHz below the start of each ham band to account for possible uncalibrated VFOs.)
- Digital Bits: Four hardware bits are provided on DSP board "Band_Sel" P13 connector, corresponding to the band that the VFO frequency dial currently is in.

P13 pin 1 = Bit 3
P13 pin 2 = Bit 0
P13 pin 3 = Bit 2
P13 pin 4 = Bit 1
P13 pin 5 = Gnd
P13 pin 6 = 5V

- Analog Voltage: The "Yaesu standard" is implemented to provide an analog voltage on DSP board "DAC" connector (P11 pin 4) corresponding to the band that the VFO frequency dial is currently in.
- Band Switching Table:

P13 Bits	DAC Voltage	Lo Freq	Hi Freq	Band	Tx Limit
0000	0V	0 to	1,790	LF	inhibit all
0001	0.33V	1,790 to	3,490	160m	inhibit above 2,010
0010	0.67V	3,490 to	6,990	80/75m	inhibit above 4,010
0011	1.00V	6,990 to	9,990	40m	inhibit above 7,310
0100	1.33V	9,990 to	13,990	30m	inhibit above 10,160
0101	1.67V	13,990 to	18,058	20m	inhibit above 14,360
0110	2.00V	18,058 to	20,990	17m	inhibit above 18,178
0111	2.33V	20,990 to	24,880	15m	inhibit above 21,460
1000	2.67V	24,880 to	27,990	12m	inhibit above 25,000
1001	3.00V	27,990 to	49,990	10m	inhibit above 29,800
1010	3.30V	49,990 to	99,999	6m	inhibit above 54,010
1011	3.30V	139,990 to	221,990	2m	inhibit above 148,010
1100	3.30V	221,990 to	419,990	"222"	inhibit above 225,010
1101	3.30V	419,990 to	901,990	"440"	inhibit above 450,010
1110	3.30V	901,990 to	999,999	"990"	inhibit above 928,010

2) NEW FEATURE: Fast Tune

- Allows operator to tune the VFO frequency at 1 MHz steps, enabling fast and easy dialing of full HF-VHF-UHF spectrum
- The frequency step cursor is placed to the 1 MHz digit by means of "double-tap": two quick taps of the Rate pushbutton.
- After dialing to the desired megahertz position, subsequent taps of the Rate pushbutton once again cycle the cursor among the 10 Hz, 1 kHz and 100 kHz positions, per normal.

3) NEW FEATURE: Default population of all 40 VFO memories

- VFOs default-populated with start of CW and SSB portions of each HF/VHF band segment;
- VFO A = band start (CW).
- VFO B = SSB start within that band.
- User can change preferences at any time.

4) NEW FEATURE: 100 MHz digit added to frequency display

- Allows the Cube to be used to VHF and UHF bands (with appropriate clock and RF front end)

5) NEW FEATURE: Full Listing of User Parameters

- Terminal Menu item 'i' added to allow user to print/save all the Cube's customized settings (including calibration) for easier re-entry later if needed
- Provides a convenient way to identify and record user-specified changes
- Allows for easy user update of parameters after new release (that affected EEPROM)

6) NEW FEATURE: Front panel controls locked while in Tx

- Most user controls are disabled while in Tx mode, preventing accidental changes while transmitting;
- When TX is on most of the front panel functions are disabled. This helps to keep the TX signal clean and where it should be.

- Disabling controls during TX also keeps Cube's T-R logic operating properly.

7) NEW FEATURE: Si570 speed grade selection

- Menu item added to select the specific speed grade for Si570 being used, enabling VHF and UHF operation
- Si570 speed grades options available via User Menu include: 180, 280, 810 and 945 MHz

8) NEW FEATURE: Frequency limits for clock generator chip

- The VFO is limited to the top end of clock chip capabilities, preventing Si570 lock-up if exceeded and false frequencies from being generated if the DDS chip is being used for the clock.
- See the Speed Grade item above for the upper limits of the Si-570 clock chip, as determined by the user-specified speed grade of the device in place.
- The upper limit for the DDS chip is 66 MHz, as determined by the the 30 MHz reference oscillator (internal 6x multiplier used to achieve maximum clock speed for the DDS chip).

9) NEW FEATURE: Disabling Tx outside of ham bands

- While the Cube can tune anywhere as general coverage receiver, Tx mode is only allowed in ham bands to protect user;
- TX disable occurs at the top of the each ham band, allowing RX-only (SWL) in between ham bands

10) NEW FEATURE: Return to Factory Defaults

- Command added to Terminal Menu to allow return to factory default settings. (Same as holding Mode PB during power-up);
- Convenient way to bring the Cube settings back to default factory point
- Equivalent to holding the Mode PB during power-up

11) NEW FEATURE: Better error handling of I2C hardware timeout conditions

- Allows more graceful recovery when I2C bus and/or chips are not working properly
- The Cube no longer hangs up if pull-ups are missing or if Si570 or EEPROM chips are missing/improperly soldered

12) NEW FEATURE: Universal date display

- Date now shown unambiguously in splash screen as DD-MMM-YYYY (e.g, 27-FEB-2011)

13) NEW FEATURE: Low end clock generation with Si570 clock chip

- Si570 software driver updated to allow frequency generation down to 3.5 MHz, allowing the LO to work as follows:
    - 0.875 MHz displayed, with 4x multiplier set ... for divide-by-4 hardware for QSD/QSE operation;
    - 1.750 MHz displayed, with 2x multiplier set ... for divide-by-2 hardware for QSD/QSE operation;
    - 3.500 MHz displayed, with 1x multiplier set ... for direct hardware mixer use at the displayed frequency.

14) NEW FEATURE: Fix for RF Atten control affecting audio drive levels

- Fixed recent "first bug" that incorrectly coupled the RF Atten control to audio drive levels

15) NEW FEATURE: Improved compiler compatibility

- Since the latest Microchip C30 compiler broke backward compatibility with long double global compile switch, we needed to change double variable to long double, and 64-bit double removed from options.

Version 1.01 *(Jan 27, 2011)* **...**

1) NEW FEATURE: TX I/Q signal balance adjustments added -- Magnitude and phase correction multipliers were added for transmit-side I and Q signals being delivered to the RF front end. These magnitude correction multipliers can also be used to adjust transmit power levels. The adjustment procedure for these new "TX Gain I", "TX Gain Q" and "TX Gain X" controls in the User Menu are below…

a) Place a 50-ohm dummy load on the Cube
b) Lightly couple another receiver (in CW mode with the narrowest filter) and search for the Cube's signal while pressing "Tune" in LSB mode on the Cube.
c) Switch the Cube to CW mode and go into the User Menu to select TX Gain I, TX Gain Q, or TX Gain X.
d) Adjust each of these three settings for the lowest signal heard on the other receiver.
e) To adjust transmit power up or down, move both the TX Gain I and Q settings a fixed amount, and redo step (d) to optimize after the power change.

Note: A good practice would be to place a wattmeter in series with dummy load to view the RF power level. When using a Softrock as the RF front end, conventional wisdom advises placing the power level between 0.7 and 1.0 watts for optimal signal linearity.

2) NEW FEATURE: CW-Reverse added to available Modes -- "CWR" provides CW operation on the lower sideband, instead of on the upper sideband with "CW" mode. CWR is accessed by tapping the Mode pushbutton control to cycle through available modes. Background: Many prefer using CW on the upper sideband only, regardless of band, as it keeps a consistent audio characteristic (decreasing pitch as one tunes up the band) when tuning a received signal.

3) NEW FEATURE: Ability to change paddle polarity -- A User Menu option has been added to provide to change the polarity of the Dit and Dah paddle signals. "Normal" setting now matches the de facto standard of having the dit contact closure on the tip of the Paddle plug and dah on the ring. "Rev" puts dah on the tip and dit on the ring. Default Padlle and Straight settings are changed from v1.00 notation in order to match the de facto standard.

4) NEW FEATURE: Full range of the AF Gain setting now used for audio level control -- The AF Gain scaling was changed so that the full potentiometer range is used, from Mute to 6dB.

5) NEW FEATURE: Codec pass-thru test added -- A display of the bandscope was added to this test in the Terminal Menu.

6) NEW FEATURE: Power-on diagnostic sequencing improved for DSP board LEDs -- Changes were made to the blink and illumination sequences for the red and green LEDs on the DSP board. This provides one to more easily visually/audibly determine the current state of the SDR Cube.
- Both LEDs are turned on when the software starts after power-up.
- LD3 (Red) is turned off after the external EEPROM (IC1) communications is determined to be okay.
- The splash screen next shows on the Cube display and a start-up beep tone is delivered.
- LD4 (Green) is turned off after the Si570 or DDS initialization. If LD4 stays on, an Si570 I2C bus problem probably exists.
- LD4 (Green) is SW heart beat indication during normal Cube operation, slowly flashing on/off at 1

second intervals.
- LD3 (Red) is ADC over load indicator for both channels, and it is illuminated when the signal levels are too high in the ADC.

7) NEW FEATURE: Code practice while in Straight Key mode -- The front panel buzzer is now sounded in Straight key mode, as done in other keyer modes. Thus when the mode is not in CW, the Cube may be used as a "code practice oscillator".

8) NEW FEATURE: Terminal Menu -- Various commands cleaned up as displayed on the terminal screen over the rear panel's Aux serial port connection.

9) NEW FEATURE: User Menu -- Text updated on some menu selections shown on the Cube display when the Menu pushbutton is tapped.