SDR Cube Transceiver

OPERATING MANUAL

Portable, standalone SDR transceiver for SSB and CW using embedded digital signal processing with a Softrock as the RF front end for QRP operation. Live bandscope, high-performance T-R switching, multiple VFOs & memories, and bandswitching control are among the many advanced features. Expansion port support external RF decks and accessories. Optimized interface for NUE-PSK modem provides digital mode support.

(Version 1.08^{+} Software)

Midnight Design Solutions, LLC … “Where the sun never sets”

www.SDR-Cube.com

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Introduction

The SDR Cube is a single-band QRP transceiver consisting of an embedded DSP controller coupled with the Softrock RxTx v6.3 RF front end. Sized at 4" x 4" x 4", the appropriately-named Cube also contains a full, built-in user interface: graphic LCD for spectrum display, typical controls for frequency, mode and signal management, and I/O jacks for connection to the outside world. The Cube's design is optimized to internally accommodate the popular Softrock design for the RF front end electronics. Different from other experimenter "single board" solutions, the Cube was designed from the start to serve as a full transceiver.

The SDR Cube is a totally self-contained, embedded *software defined radio* (transceiver) for CW and SSB operation. It uses a Softrock for the RF front end electronics (RF mixer, amplifiers and filters) and an embedded digital signal processor with software programmed to perform as an HF modem. This programmability is the essence of an SDR's ability to dynamically support virtually any modulation mode. A personal computer (PC) is not needed.

The SDR Cube is housed in a 4" x 4" x 4" black powder-coated aluminum enclosure containing all controls, a blue graphic display showing the transceiver settings and an exciting 8 kHz-wide band scope of spectrum signals, and the popular Softrock RXTX v6.3 board. The SDR Cube may also be used with any of the 11,000 other Softrocks in the field today via the expansion port on the rear panel. Full details are available at the product website (www.sdr-cube.com), and active online user discussion occurs in the SDR-Cube Group in Yahoo Groups.

Feature summary

- Standalone software defined radio (SDR) transceiver ... no PC required, portable, compact, instant-on
- Operating modes ... USB, LSB, CW, CW-R (and PSK, RTTY digital modes with special interface to NUE-PSK modem)
- Self-contained embedded DSP and I/Q-based RF front end ... uses internal Softrock RXTX 6.3
- Single-band capable with internal Softrock … user can easily substitute band modules: 80m, 40m, 30m, 20m or 17m
- Optionally connects to external RF front ends (e.g., Softrock Ensemble, SDR-1000, etc)
- Low power requirements ... 90ma (Cube), plus 300 ma (Softrock)
- QRP transmit levels … 700mW-to-1W, typical per band
- Optimized CW mode … ideally-shaped waveform generation, ultrafast T-R switching
- Receive amp & attenuator module … improves incoming RF, optimizes Softrock front end
- Quadrature sampling clock options ... DDS, Si570, or I^2C to target Softrock
- Built-in keyer ... 1-63 wpm, Iambic A, B, dot priority, or straight key
- Special interface to NUE-PSK Modem ... digital interface provides best quality
- Graphic LCD Display ... Clear indications of transceiver state, status and controls
- Bandscope ... provides +/- 4 kHz spectrum visibility for Rx, signal monitor for Tx, with display sensitivity control
- S-Meter … An accurate indication of incoming RF signal levels, able to be displayed in S-units or as dBm values.
- Audio filtering control ... low corner 200Hz, high corners 700, 1500, 2400 or 3600Hz; with graphic on-screen indicator of filter setting
- Audio output ... Headphones or amplified speaker, quasi-binaural audio output
- Beeper ... User interface clicks, code practice oscillator, and more
- Bandswitching signals … for control of external RF front ends and amplifiers; implemented as digital port or as analog signal on RF path (Yaesu standard)
- Frequency agile ... Tuning rates of 10Hz, 100Hz, 10kHz, 100kHz and 1 MHz; dual VFOs with 40 memories each; RIT/XIT
- Menus ... Two simple menus provide for calibration, set-up and transceiver settings.
- Transmit Lock control … Inhibits out-of-band transmissions
- Field-upgradeable firmware ... Integrated bootloader enable loading of new firmware
- Open Source ... Developers may use the GPL source code to add features, for non-commercial use

Background

"A software-defined radio system, or SDR, is a radio communication system where components that have been typically implemented in hardware (e.g. mixers, filters, amplifiers, modulators/demodulators, detectors, etc.) are instead implemented by means of software on a personal computer or embedded computing devices. While the concept of SDR is not new, the rapidly evolving capabilities of digital electronics render practical many processes which used to be only theoretically possible." [from Wikipedia]

Software Defined Radio (SDR) in the Amateur Radio community has been making great strides in recent years. From the innovative and ground-breaking products of Gerald Youngblood, KSDR, to the most recent state-of-the-art designs in the HPSDR group, SDR technology has really now come of age. This current state-of-the-art has also been greatly enabled by the tireless work of Tony Parks, KB9YIG, the father of the Softrock designs, who has empowered thousands of hams worldwide with his series of inexpensive "RF front ends" that work with a PC sound cards.

Each of these radios in their most basic form consists of electronics that sample the incoming RF after it has been converted down to baseband and send the results to a PC for digital conversion. The PC then performs the complex demodulation computations so we operators can understand the SSB, AM or digital mode communications coming in. And of course the reverse happens for transmit, whereby the PC presents electronic signals to the front end electronics for mixing and ultimate transmission.

However throughout all the excitement of PC-based software defined radio, there has also been a quieter background quest for a form of SDR that is <u>not</u> tethered to a PC. While the PC offers seemingly unlimited processing power, gorgeous user interfaces and lots of memory, the PC is still an expensive and cumbersome accessory to take to the field when the need arises for portable operations. Classic problems are encountered with regard to the ability to see the PC display in bright sunlight, and powering the PC and the power-hungry SDR front-end electronics is tough with limited-capacity batteries. In general, lugging around an expensive and delicate laptop is not something one wants to regularly do. Also, many hams just do not care to operate a ham radio with a mouse controlling knobs shown on a on a PC screen.

However most would still agree that the *performance* of such a PC-based radio is of great value, given the flexibility offered with SDR's innate ability to handle virtually any operating mode – SSB, AM, CW, and digital modes – with just a new software file or program loaded into the radio.

Software defined radio is a relatively new topic in the amateur radio community, and one that is extremely exciting with many barriers regularly being broken. Perhaps the most enticing is the "embedded SDR" barrier, whereby designers are now starting to break free of the artificial limitations imposed by bloated and lethargic PC operating systems that cripple the very technologies which we seek to push forward. By instead approaching an

SDR solution on the “bare metal” of an embedded DSP architecture, we are able to more quickly achieve our design goals, and do it in a more comprehensive manner.

The SDR Cube Transceiver is among the first of its kind, providing performance-oriented SDR in an affordable, modular and extensible fashion. Built initially upon the ubiquitous and wildly popular Softrock “RF front ends”, the open software Cube design is applicable to thousands of hams worldwide … and we eagerly anticipate novel applications of it going forward. Whether it is the addition of a truly high-performance RF deck, or the tight integration of digital mode processing, or someone’s clever packaging to more easily take it to the field, we look to the future with pride and confidence.

But of all our excitement and feelings of accomplishment, we believe the most notable achievement with the SDR Cube is making SDR look and feel like a real radio, while simultaneously untethering the radio from the grips of the dreaded and unnecessarily complex PC. To paraphrase a line from the movie classic Treasure of the Sierra Madre … *“We don’t need no stinkin’ PC!”*

Specifications

Important Note: Parameters listed below with an asterisk (*) are typical and highly dependent on the characteristics of the specific RF front end used with the SDR Cube. The Softrock RXTX 6.3 provided standard with the CUBE-SR model has RF specs and/or characteristics published by other parties and may be located via the References section in this manual.

General

Frequency Coverage:	Depends on specific RF front end electronics installed. Softrock RXTX 6.3 front end provided in assembled Cubes External rf front ends may be used for 100 kHz to 2.4 GHz.
	Receive: RxAmp Module 1: 2-4 MHz *(general coverage)* RxAmp Module 2: 4-8 MHz *(general coverage)* RxAmp Module 3: 8-15 MHz *(general coverage)* RxAmp Module 4: 15-30 MHz *(general coverage)*
	Transmit: TXPA Module 1: 3.5-7.4 MHz *(ham bands only)* TXPA Module 2: 10-15 MHz *(ham bands only)*
Emission Modes:	CW, USB/LSB
Frequency Steps:	1 MHz, 100 kHz, 1kHz, 10 Hz
Antenna Impedance:	50 Ohms, Unbalanced
Operating Temp. Range:	-10 to 40 degrees C
Frequency Temp Stability:	50 ppm (w/Si570 Grade A) or 100 ppm (w/DDS)
Frequency Accuracy:	Can be calibrated in software
Supply Voltage:	13.8 VDC, Negative Ground
Operating:	9.0-18 VDC, Negative Ground
Current Consumption:	Receive: 200 ma (nominal) Transmit: 440 ma (nominal)
Case Size (W x H x D):	4” x 4” x 4.5”
Weight:	1.5 pounds

Transmitter

Circuit Type:	Quadrature Sampling Exciter (QSE)
RF Power Output*:	700mw-1W, typical
Modulation Types:	SSB, sin(x)/x-shaped high quality CW
Spurious Radiation*:	-50 dB
Opp. Sideband Supp.*:	-47 dB
SSB Freq Response:	400 Hz – 2600 Hz (-6 dB)
Mic Type:	Electret, or dynamic with external amplifier

Receiver

Circuit Type:	Quadrature Sampling Decoder (QSD)
Sensitivity*:	MDS = -130 dBm
Image Rejection*:	-30 dB
AF Output:	30 mW, (32 Ohms), ranging from 6 dB to -73 dB
AF Output Impedance:	32 Ohms or higher, headphones or amplified speakers
S-Meter:	Accurate to 1 dBm from -110 to -15dBm Displayable in S-units or as absolute level (dBm)

Miscellaneous

Keyer:	1-63 wpm; PTT hold time is proportional to the keyer speed

Specifications are subject to change without notice. Frequency ranges vary according to transceiver software version.

Quick Start

Before plugging in for the first time …

Before powering up the SDR Cube for the first time, remove the cover and ensure that all cables and modules are firmly plugged into their respective connectors. Rough handling during shipping or transport might have disturbed the internal connections and you should check to ensure everything is fine.

Prepare the interface cables …

Details are shown in a later section of this manual for making (or obtaining) the four main cables that interface the Cube to the world:

1) **DC Power** – A 2.1mm coaxial power plug is provided for you to bring +12V to the Cube;
2) **Headphones** – A 3.5mm stereo plug is provided for you to cable the Cube audio output to suitable headphones or amplified speakers;
3) **Mic** – A 3.5mm stereo plug is provided for you to connect an appropriate microphone (with PTT switch) to the Cube;
4) **Paddle** – A 3.5mm stereo plug is provided for you to connect a two-contact paddle set or single contact key to the Cube for CW transmission;
5) **Aux** – A 3.5mm stereo plug is provided for you to connect the Cube's RS232 serial port over to the PC serial port, optionally needed for Terminal Menu usage and for bootloading new software into the Cube.
6) **NUE**-PSK – A male-to-male 8-pin miniDIN cable may be fabricated (or separately purchased) to interconnect the NUE-PSK modem with the Cube for digital mode support.

The First Power-Up … "Operating Basics"

This section is a simple introduction to the basics of operation to help guide you through first using your SDR Cube.

1) Attach antenna, headphones or amplified speakers, and 12V power (12V at ~500ma is needed).
2) Turn on the Cube using the toggle switch at the bottom of the rear panel.
3) The "splash screen" will appear for a few seconds in the LCD, showing the software version number of the Cube software and copyright information.
4) The display then changes to the main screen showing the frequency, band, mode, audio and RF gain, filter, memories, supply voltage and a live spectrum display along the top.

5) The default settings have the VFO set to the appropriate band modules contained in the specific Cube that was ordered, and the frequency is set to the lower edge of that ham band. RF gain, AF Gain and Filter controls should each be turned to maximum (fully clockwise). The Mode should be 'CW' – if not, tap the Mode pushbutton until CW is displayed. The frequency tune rate should show the underscore under the kilohertz digit – if not, tap the Rate pushbutton until it is.

6) If the band is open you will hear the activity and see many signals on the bandscope when you start turning the Frequency control for the VFO. You may immediately need to adjust the AF Gain to a comfortable listening level, and reduce the RF Gain so as to not overload the Cube. Ideally, a balance is established between having good audio levels and having maximum signals shown on the bandscope (vertical lines only just touching the top of the display).

7) Turning the Frequency dial with these default settings will move the VFO at 1 kHz steps, allowing you to easily move across the band to find activity. When a signal of interest is found, you can tap the Rate pushbutton several times to position the cursor beneath the 10 Hz digit in order to fine tune the CW signal such that its tone is around 800 Hz (or whatever your ideal listening frequency is), which can also be seen on the bandscope. When in CW or USB, the signal should be positioned to the right side of display center, somewhere between 0 Hz (center of display) and 1 kHz, which is the first tic mark shown along the top of the display. You will find that the signal diminishes below about 300 Hz, so place the signal around 800 Hz for ideal listening. Note that you will only hear signals to the right of the 0 Hz display center when in CW or USB mode. Similarly, you will only hear signals to the left of 0 Hz when in LSB or CW-R modes.

8) You will hear all signals above this target signal, which can be confusing when there is a lot of band activity, such as during a contest. You can filter out those higher signals by using the Filter control, which adjusts the upper side of a BPF (bandpass filter) as shown by the width of the bold line beneath the kHz label in the screen graphic above. Experiment with this control to move that upper edge lower and lower to knock out audio interference. You may need to move the signal lower with the VFO dial in order

to keep it within the decreasing bandwidth of the filter. This is an excellent control for focusing only on the signal of interest.

9) To tune in an SSB station, you can easily move the VFO up to the phone portion of the band by spinning the VFO upward with the step rate cursor under the 1 kHz digit, or you can set the tuning Rate to the 100 kHz digit. (Tap the Rate pushbutton several times until the cursor is where you want it). Then when you are in the general phone area (say 14.2xx), tap the Rate pushbutton to put the cursor again beneath the 1 kHz digit and tune around as desired.

10) You can even more quickly move to the phone portion of the band by changing VFO memory banks. Tapping the VFO pushbutton changes from VFO A to VFO B, as shown to the right of the displayed frequency. The default settings of the VFOs are the lower edge of the CW band (VFO A) and the lower edge of the phone band segment (VFO B). There are 21 memory banks, and each has an A and a B VFO. Thus A04 and B04 represent the fifth memory bank, holding the CW-start and SSB-start frequencies, respectively. (Memories are numbered 00-to-20.) You can change memory banks by a push-and-turn of the Frequency dial.

11) Once in the phone portion of a band, you can tune a signal in the same manner as before with a CW signal. USB signals will be properly tuned when the signal shown on the bandscope is to the right of the center position (i.e., the upper sideband); while LSB signals are tuned to the left of center. The Mode pushbutton my be tapped several times in order to change to the desired USB or LSB mode, as dictated by band conventions. (LSB us generally used below 10 MHz; USB above this frequency.) SSB signals are easily tuned using the fine tuning rate (10 Hz). You'll note that SSB signals display with wider bandwidth than CW signals, of course because they are! Still, you will be able to "see" multiple SSB signals on the bandscope and use the Filter control to assist in isolating the signal of interest.

12) In either mode, you may command the Cube to transmit a continuous single 800 Hz tone for tuning purposes by pressing-and-holding the "Rate (Tune)" pushbutton. (The second functions for all pushbuttons are accessed by holding the pushbutton in for a few seconds.) While the Cube is in the Tune mode, "tune" will be displayed next to the mode and you can adjust your antenna tuner or power amplifier during this time. The Cube drops back to receive mode when the pushbutton is released.

13) If you are accustomed to using a paddle when using CW mode, you will find that we have a built-in keyer with adjustable speed with the keyer control. The default keyer type is the most popular "Iambic B", but Iambic A and Dot Priority types may be selected in the User Menu (see below). A manual key may also be selected in the menu for straight key use. A useful characteristic of the keyer is the variable T-R hold time, depending on the position of the Keyer control. The faster you are going in words-per-minute (wpm), the shorter the delay occurring when dropping back from Tx to Rx

mode, thus allowing comfortable break-in operation. This delay is also adjustable with the Keyer control when a straight key is used.

14) Two menus are provided for configuring the different settings and operating characteristics in the Cube …

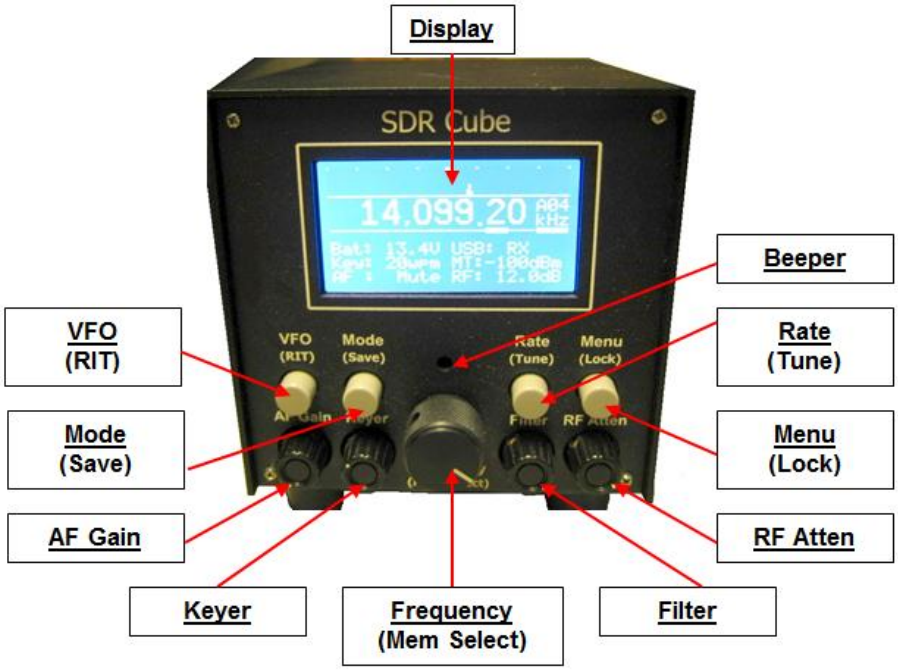
    User Menu – When the Menu pushbutton is tapped, the User Menu is shown on the Cube display, listing numerous parameters that may be custom-set to adjust the Cube's behavior. Tapping the pushbutton again saves the changed settings and returns the Cube back to normal operation.

    Terminal Menu – When the Cube's Aux serial port (on rear panel) is connected to the PC, and a terminal program like TeraTerm or RealTerm is running on the PC, various Cube status messages will be displayed during startup and normal operation. Additionally, a rich diagnostic command list is sent to the terminal to help the user in troubleshooting the Cube's operation when needed. The default serial port rate for the Terminal Menu operation is 9600 baud.

See specific sections in this manual for detailed descriptions of the controls, operational characteristics, and parameters available for customization within the menus.

Front Panel Controls

The user interface of the SDR Cube was carefully designed to provide the maximum amount of control of the transceiver, while using a minimum-yet-convenient number of physical controls. The main focus of the interface is on the graphic display for real-time status and tuning, and the tuning dial for frequency agility.



In order to provide additional functions for the five pushbutton-capable controls, we adopted the technique of accessing the main function with a tap of the control, a secondary function with a long press of the control, and select tertiary functions with a quick double-tap of the control. In this way, for example, the user is able to tap the Rate pushbutton to select a 100kHz/1kHz/100Hz/10Hz tuning rate, a double-tap to *fast tune* the radio by the 1 MHz digit, or a long-press the rate pushbutton to put the SDR Cube into tune mode (continuous carrier transmitted). The main function label is shown first line, and the sub-function(s) are shown in the second line and in parentheses.

Display

The attractive, blue-screen graphic LCD serves to display many status functions. The display has a backlight that may be turned on/off via the Configuration Menu.

Bandscope – The top portion of the display is the band scope area, where an 8 kHz swath of spectrum is displayed, centered at zero in the middle of the display. When the frequency dial is moved, the spectrum energy (i.e., signals, noise, etc.) is moved up or down along the spectrum relative to the center zero frequency point, which is numerically displayed as the kilohertz frequency below the spectrum. In essence, the signal indications in the spectrum display are the audio signals after demodulation. So a CW tone of 800 Hz will appear as a small, narrow "pyramid" to the right of center. Similarly, the voice energy of an SSB signal on lower sideband would appear to the left of the zero point, as shown in the photo above. When USB is the selected mode, the signals appear to the right of the zero point. Marks are located along the top of the band scope, indicating the 1,000 Hz positions for easier signal identification.

Frequency Display – The current operating frequency, in kHz, is shown in large digits on the display.

The Tuning Rate – The tuning Rate is indicated by the underline cursor beneath one of the digital in the displayed frequency.

S-Meter – The S-Meter text field is in the lower right quadrant of the display, and may be displayed in S-units or as dBm, as determined by the S-mtr 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.)

Frequency / (Mem Select)

The center large Frequency dial is the way that operating frequency is changed, as well as option selection for various sub-menus. It is a smooth rotary encoder.

When a long press is made on this control, a bank of twenty **Memories** may be accessed. Two memories, or VFO settings (A and B) are actually associated with each memory setting. When the control is turned while being pushed in (i.e., push-hold-turn) any of the memories in the Cube may be selected as the main operating memory, as shown at the VFO position in the center-right of the display. It may be convenient, for example, to designate certain groups of memories as being set with frequencies for a certain band, thus enabling quick change to different bands or band segments. Once the desired memory number is seen in the display, releasing the control sets the main operating frequency to that memory setting in either the VFO A or VFO B location associated with that memory.

Rate / (Tune)

The **Rate** control is used to adjust the tuning rate of the VFO when the Frequency dial is changed. A step rate cursor (underline) is always present beneath one digit of the displayed frequency, and this digit is incremented/decremented whenever the Frequency dial is changed.

The step rate cursor may be moved to other digits through sequential taps of the Rate pushbutton. Upon each tap, the cursor is moved to the next digit in the wraparound sequence of 10 Hz, 100 Hz, 1 kHz, and 100 kHz. Using this Rate control, an operator may quickly and easily navigate the frequency spectrum with increasing degrees of tuning granularity, as desired.

A “fast tune” capability is also present to allow the 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 “double-tapping” (two quick taps) 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, 100 Hz, 1 kHz and 100 kHz positions, per normal.

The **Tune** control is accessed by a long press of the control button. When activated, the transceiver begins transmitting a continuous tone. This is useful for tuning other equipment connected to the SDR Cube, such as an ATU or an amplifier. Taping the control or the CW paddle will terminate the Tune mode and drop the Cube back into receive mode.

Menu / (Lock)

The **Menu** function is accessed with a tap, and the Configuration Menu is brought up on the display for subsequent selection. See the **User Menu** section for details.

When one long presses this control, the **Lock** function is activated. In this state, most user interface controls are locked in order to prevent unwanted state changes. Useful when engaged in a QSO and you don’t wish to inadvertently change frequency by bumping the Frequency dial. The lock mode is terminated by another long press of the control.

Mode / (Save)

The **Mode** of the SDR Cube is selected by tapping the Mode control. Currently supported modes are CW, USB and LSB.

When a long press is made on this control, all user settings (memories, VFOs, and current operating frequency) are **Saved** to nonvolatile EEPROM memory. When the Cube is again powered up, these settings are pulled from EEPROM and put in place on the transceiver.

VFO / (RIT)

When the **VFO** control is tapped, the VFO setting is toggled between A and B. Each VFO is able to hold a different frequency, and this control can provide convenient “split” operation. To set up the A and B VFOs, select the A VFO and move the Frequency dial to the desired point. Then tap the VFO control to select the B VFO and again move the Frequency dial to another desired point. Press-hold the Mode/(Save) control to save the specific momory’s A and B VFOs for use in the future.

In order to lock in one of the VFOs, either A or B, press-hold the control to designate the VFO as the stationary memory. Then “**RIT ON**” is displayed and that VFO is held stationary while the other is able to move. This capability is convenient in the case of being in QSO with a station that is drifting. You want to keep your transmitted frequency unchanging, yet be able to follow the frequency of your drifting mate.

AF Gain

This conventional potentiometer control provides audio output level control from a maximum of 6 dB down to a minimum of -73 dB, as shown in the display at the “AF” location. When turned completely counter-clockwise, the audio is fully muted, and “Mute” is displayed.

Keyer

This conventional potentiometer control provides for varying the speed of the built-in electronic keyer. The range of the control is from 1 to 63 wpm. The PTT hold time is proportional to the keyer speed, thus allowing convenient auto-setting for QSK operation according to the keying speed of the operator. (“PTT hold time” is how long the Cube stays in transmit mode after the dit or dah is complete. Longer times prevent potentially distracting receive audio from being heard when the operator is sending; shorter times enable the operator to hear band activity while he is sending.)

Filter

Adjustment of this conventional potentiometer control presents a variable audio filter to the audio output stream of the transceiver, thus aiding in the reception of SSB and CW in crowded band conditions. Common filter widths provided are: 2.6 kHz, 1.5 kHz and 500 Hz. The corresponding filter graphic is located on the display beneath the kHz frequency label, and is presented as a bold line with a length proportional to the filter settings.

RF Gain

The RF Gain is adjusted by means of a conventional potentiometer control. Two functions are wrapped into this control: changing the state of the two cascaded attenuator pads on the RxAmp board of the Softrock, and changing the Codec gain settings for the receive path. Thus a wide range of attenuation may be achieved with a single control.

The range of codec line control is 36.5 dB, and we couple it with the binary settings of physical attenuator pads (none, 6 dB, 10 dB, and 16 dB) to create four mini-ranges for controlling attenuation The level perceived by the user (and displayed on the LCD), can be seen as a downward zig-zag pattern of attenuation in decibels as the control is progressively turned counterclockwise through the mini-ranges ...

- **12 db to -34.5 dB** ... At full clockwise position (12 dB), the pads are both switched out and for a portion of the CCW pot turn just the codec line gain is reduced, down to –34.5 dB
- **6 dB to -40.5 dB** ... This 2nd mini-range starts by flipping in the first attenuator pad (6 dB) and then continued CCW turning of the control reduces codec line gain down to –40.5 dB

- **2 dB to -44.5 dB** ... This 3rd mini-range starts by flipping out the first pad and flipping in the second one (10 dB), and then continued CCW turning of the control reduces line gain down to –44.5 dB
- **-4 dB to -50.5 dB** ... This 4th mini-range starts by flipping the first pad back in (both are in now), and continued CCW turning to the remainder of travel reduces the codec line gain ultimately down to –50.5 dB.

Beeper

This miniature piezo speaker, located behind a hole in the front panel serves multiple purposes: "key click" for changes to menu settings, side tone for use as a code practice oscillator, and as a beeper to indicate possible error conditions occurring in the SDR Cube.

Frequency Behavior

This section overviews several characteristics of the SDR Cube operation that are important for the operator to understand

Receive Offset in CW Mode

A "receive offset" is present when the Cube's internal local oscillator is in CW mode. This technique is 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 applies 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 to note 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.

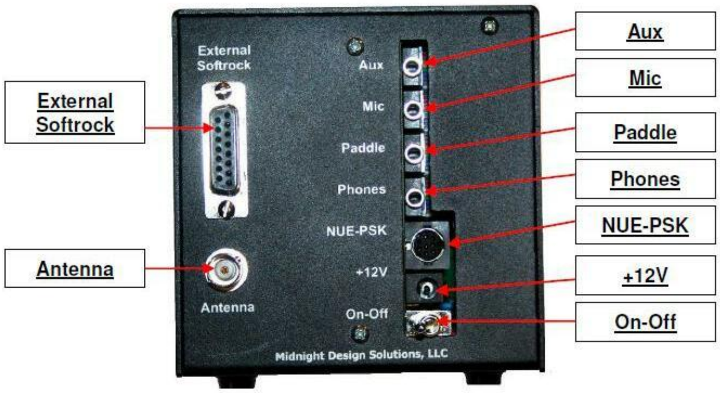
The bottom line is that the Cube's CW modes now behave very similar those of the Yaesu FT-817 (and others). The most discerning operators will note the more conventional display and tuning technique, and all operators will probably note a greater ease of use while tuning in and working other stations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

The Rx Offset value is adjustable in the User menu with the CW RF Pitch menu item. 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!

The Rear Panel



+12V

12V DC power input. 2.1mm jack. Power requirements: SDR Cube (80ma), Softrock RXTX 6.3 receiver-only (+120 ma), RXTX transmit (+100ma).

On-Off

Toggle switch turns the power on and off.

NUE-PSK

Optimized digital connection for the NUE-PSK Digital Modem. 8-pin miniDIN jack.

Phones

Jack for standard 1/8" stereo plug headphones or external amplified speakers.

Paddle

Jack for standard 1/8" stereo plug on paddle or key.

Mic

Jack for standard 1/8" stereo plug for microphone (with PTT)

Aux

Jack for standard 1/8" stereo plug cable providing RS-232 signals to PC serial port for Bootloading feature

Antenna

BNC jack for antenna feedline

External Softrock

15-pin D-style connector for connecting the Cube signals to an external Softrock.

User Menu

Many infrequently-used or one-time configured transceiver parameters are accessed by taping the Menu pushbutton on the front panel. When tapped, the following list of items is displayed in a circular list manner, showing the individual settings currently in place for each. In order to change a given setting, the main dial is turned until that setting is displayed with the cursor (>) next to it, and then may be changed by pressing the dial. At that point the parameters allowable settings are displayed in a list that is again controlled by the dial. Once the desired setting is displayed for the parameter, it may be selected by pressing the dial pushbutton. Once the desired settings have been changed to one's satisfaction, the user presses the Menu pushbutton to exit and the settings are saved to nonvolatile EEPROM memory.

CW Sounder

Tone adjustment for the piezo speaker in the front panel.

CW RF Pitch

Changes the offset of the CW frequency generated during transmit. This is the offset from zero beat that the receiving operator would hear for the SDR Cube's transmitted signal.

CW Sidetone

Changes audio pitch of the CW sidetone, as heard in the headphones during transmit.

Binaural RX

Changes the delay imposed between the left and right audio output channels, thus simulating binaural receive function. This feature enhances many operators' listening experience and enables improved selectivity in the brain while listening to a crowded band of CW signals, and provides a more rich and enjoyable listening experience for SSB signals.

Trm UART br

Baud rate settings for use with Terminal Menu.

PSK UART br

Baud settings for the high speed digital link to the external NUE-PSK Digital Modem.

Keyer Type

Allow selection of Iambic Mode A/B, Dot Priority, or Manual (straight key) key types.

Paddle Pins

Provides for normal or reverse connection of DIT and DAH paddle contacts

Disp BL tmr

Allows setting of a timer for turning off the display backlight. When the timer count expires, backlight automatically turned off, but any “touch” of a front panel control retriggers the timer and turns the backlight on again for that period of time.

Beep length

Adjusts the length of the beep, or click, from the piezo speaker in the front panel.

RX Gain I

Calibration setting control for opposite sideband rejection.

RX Gain Q

Calibration setting control for opposite sideband rejection.

RX Gain X

Calibration setting control for opposite sideband rejection.

Codec MAG

Provides variable gain levels in the Codec receive path.

Tx Lock

When set to ‘on’, transmission is inhibited when the VFO dial is outside the ham bands.

Tx-Rx Delay

Adjustment of time delay imposed when transitioning from Tx to Rx in SSB mode.

TX Gain I

Calibration setting control for opposite sideband suppression.

TX Gain Q

Calibration setting control for opposite sideband suppression.

TX Gain X

Calibration setting control for opposite sideband suppression.

Bandscope Sensitivity

Provides variable sensitivity for the spectrum displayed in the bandscope. Lower numbers provide increasing sensitivity.

FFT Window

Select FFT processing algorithms for bandscope spectrum display

Si570 XTAL

Calibration setting control for Si570 frequency.

DDSrefosc

Calibration setting control for DDS frequency.

LO Type

Selects onboard clock options (DDS or Si570) or control of an off-board Si570 clock via the I2C control bus.

LO Multiplier

Provides for 1x, 2x or 4x clock generation, depending on the needs of the specific Softrock being used.

S-mtr type

Selects the S-meter display to be in S-units or dBm units.

S-meter cal

Adjustable factor to allow S-meter to be calibrated against a known incoming RF signal level.

Terminal Menu

When the Aux serial port is connected to the PC, and a terminal program like TeraTerm or RealTerm is running on the PC, various Cube status messages will be displayed during startup and normal operation, as well as a rich menu of diagnostic commands to help in troubleshooting the SDR Cube. The default serial port rate for the Terminal Menu operation is 9600 baud, as set in the Cube's User menu (on the LCD, accessed by pressing the Menu pushbutton). The PC's serial port must also be set to the same speed by adjusting the Serial Port setting within TeraTerm/RealTerm program running on the PC.

Many one-time configured transceiver parameters are available via a menu presented over the serial port connection from the Aux jack on the rear panel. Typically connected to a PC running a terminal emulator application, the Terminal menu has numerous interactive commands for set-up, calibration and testing the SDR Cube.

Power-On Status Information

When first turning on the SDR Cube, the following status information is sent to the Aux serial port. This information indicates the state of the Cube as it is initializing and coming to a ready state.

```
SDR Cube Start
CPU speed, FCY = 38707200 Hz
ADC system started
LCD init
24LC256 EEPROM I/O init
User data restored successfully
Timer system started
DSP filters initialized
Codec started
Si570 I2C init
DDS started
Si570 LO selected
Change Terminal UART to user baud rate 9600
Change PSK Modem UART to user baud rate 9600
SDR Cube UART user baud rate = 9600
SDR Cube SW started
George Heron N2APB / Juha Niinikoski OH2NLT

Version: v1.02
Date: 27-FEB-2011
Starting Main
```

Terminal Menu Commands

If/when a spacebar is entered on the keyboard of the computer terminal, the following list of Test and Diagnostic commands is displayed on the terminal. These commands are useful only in advanced problem diagnosis scenarios.

```
----  SDR Cube Test Commands, Tstamp = 4(s)  ----
```

```
Battery voltage = 12.0V
i print user parameters
a print ADC data
p print I/O port data
e read Encoder & switch
t test tones
d test PWM DACs
o test RF attenuator relay outputs
x print Si570 factory XTAL freq
r Read EEPROM
f Reset EEPROM data to factory defaults

---- SDR Cube Debug Commands, see source code for details ----

q op mode flags
s print Si570 registers
c set Codec DCI mode
v Codec volume controls
m Mic On / Off switch
0 Init & test LCD
1 Show LCD characters (chgen test)
2 Write LCD
3 Write Large LCD
w Write EEPROM, Caution: Causes factory default reset at next start
>
```

Bootloading New Software into the Cube

The SDR Cube has a field programming ("bootloading") feature that allows a user to send the hex file of a new/updated software application to the Cube over its Aux serial port.. When bootloading is complete, the new software is permanently burned into the controller's memory.

1) **Determine what COM port number your USB or RS-232 serial port is --** Click START and then right-click My Computer. Select Properties and then the Hardware tab. Click Device Manager and find the Ports line item in the list. Expand that line item to see the COM number.

2) **Download the new software package from our home page --** Save the file to a known location, such as at the root of your hard drive (C:\) and unzip the file.

3) **Edit the two batch files to use your computer's COM port number. --** Right-click the file and select Edit to change COM1 in the command line to be the active COM number of your system. Then close the batch files.

4) **Connect the PC's RS-232 Serial Port to the SDR Cube "Aux" port on the rear panel**

A one-time preliminary step is to read a small memory segment from the SDR Cube. This will show that a successful connection has been made before you attempt to flash a new program into the Cube ...

5) **Power up the Cube in a special way --** Hold down the "Menu" button on the Cube, while turning on the power switch. This commands the Cube to look to the serial port before it continues powering up normally. (If you have the cover open, notice that the red LED LD3 indicates that the running condition of the bootloader program.)

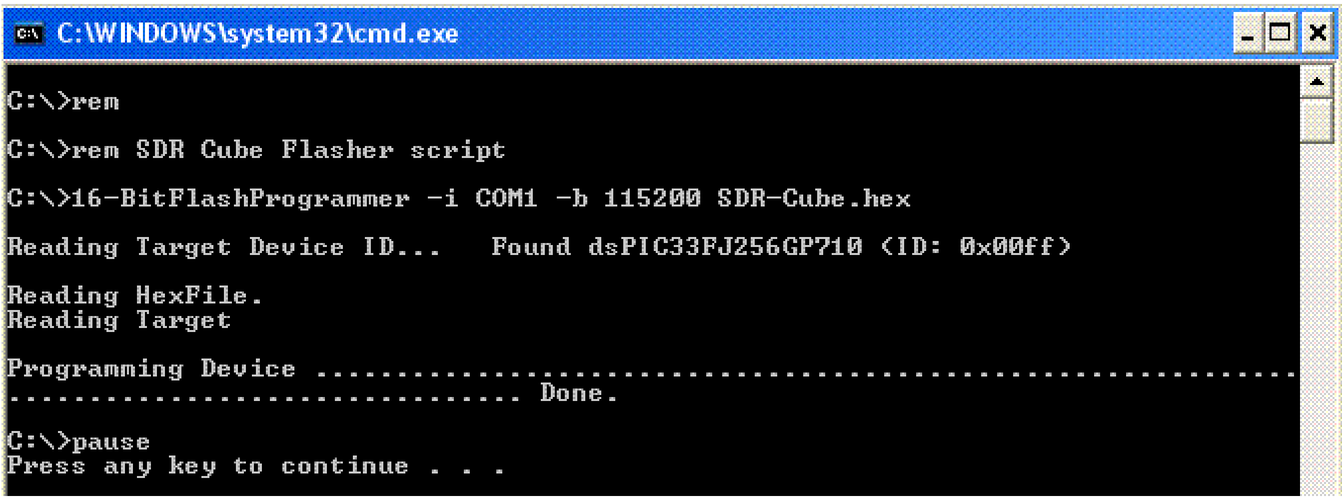
6) **Run the ReadCube.bat file** – The PC screen starts displaying the Cube memory contents in a black "Command Prompt" window, starting at location 0x400**.** Wait for the display on the PC to stop displaying data, and if the message: "Hit any key to continue" shows then you indeed have a fully functioning serial interface!

Knowing that you now have a good serial connection to the Cube, you will next flash the new program into the Cube's controller ...

7) **Once again, power up the Cube in a special way** -- Hold down the "Menu" button on the Cube, while turning on the power switch. This commands the Cube to look to the serial port before it continues powering on normally.

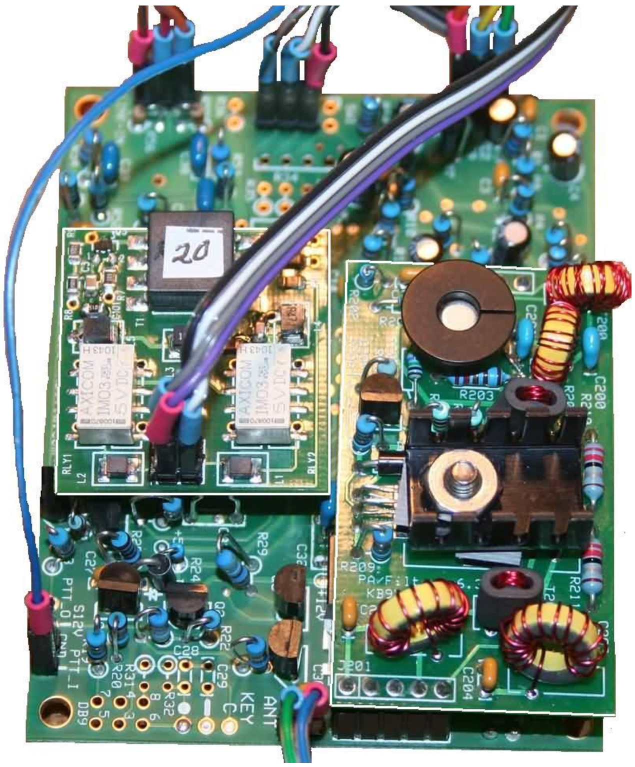
8) **Run the FlashCube.bat file –** The PC starts sending the new program file to the Cube for flashing on a line-by-line basis. Again, if the enclosure cover is off, you will see the green LED on the DSP board change state each time a packet is received. Further,

every time a line of data has been flashed, a dot (‘.’) is displayed. When about 100 dots have been displayed, the PC displays “Hit any key to continue”, and the Cube reboots and runs the new program. The FlashCube process is done! A successful FlashCube screen will look like the following …



Changing Bands

The Cube incorporates an internal, mono-band RF deck called the Softrock RXTX 6.3. This Softrock is comprised of a base board plus a custom-designed RXAMP plug-in module for receive (smaller daughtercard on left), and a TXPA transmit module (shown on right) that together determine which band the Cube is able to operate on.



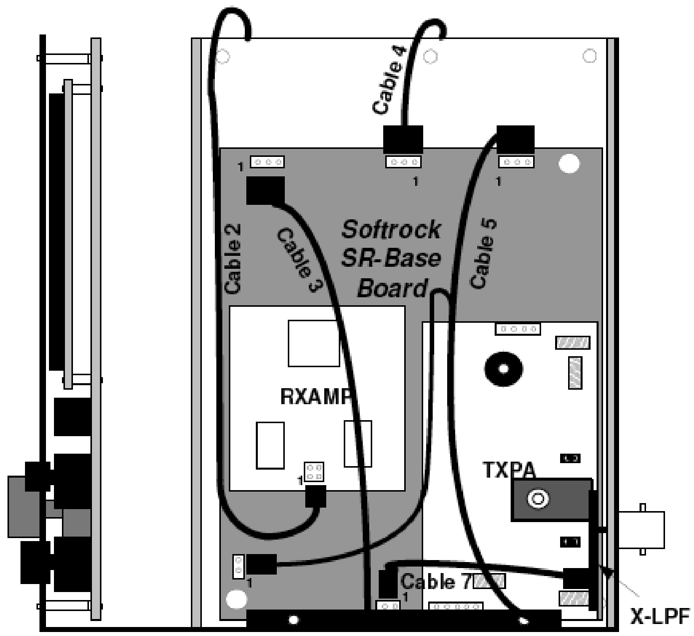
The SDR Cube is able to <u>*transceive*</u> on five ham bands with the appropriate modules in place, as illustrated below. Additionally, the Cube is able to *receive* across the 2-30 MHz HF spectrum, again with the right modules in place, enabling it to perform as a general coverage receiver.

Covered Bands	SR-Base Board	+	TXPA	+	RXAMP
80m/75m	√		80/40		2-4 MHz
40m	√		80/40		4-8 MHz
30m	√		30/20/17		8-15 MHz
20m	√		30/20/17		8-15 MHz
17m	√		30/20/17		15-30 MHz

Changing the Band Modules

Two TxPA modules are currently available to allow the Cube to transmit on either the 30m/20m/17m band group or on the 80m/40m band group. Four RxAmp modules are currently available to allow the Cube to receive within different frequency ranges: 2-4 MHz, 4-8 MHz, 8-15 MHz and 15-30 MHz. To configure a Cube, one would install the appropriate TxAmp and RxAmp modules for the desired band of operation. For example, a Cube set up for operation on 20 meters (14 MHz) would have the "TxPA 30/20/17" module and the "RxAmp 8-15" module installed.

To change the band modules, the top cover of the Cube is removed (thumb screws conveniently allow for this) and the module(s) are installed for the new band you are interested in using. It takes less than one minute to do this band changing operation.

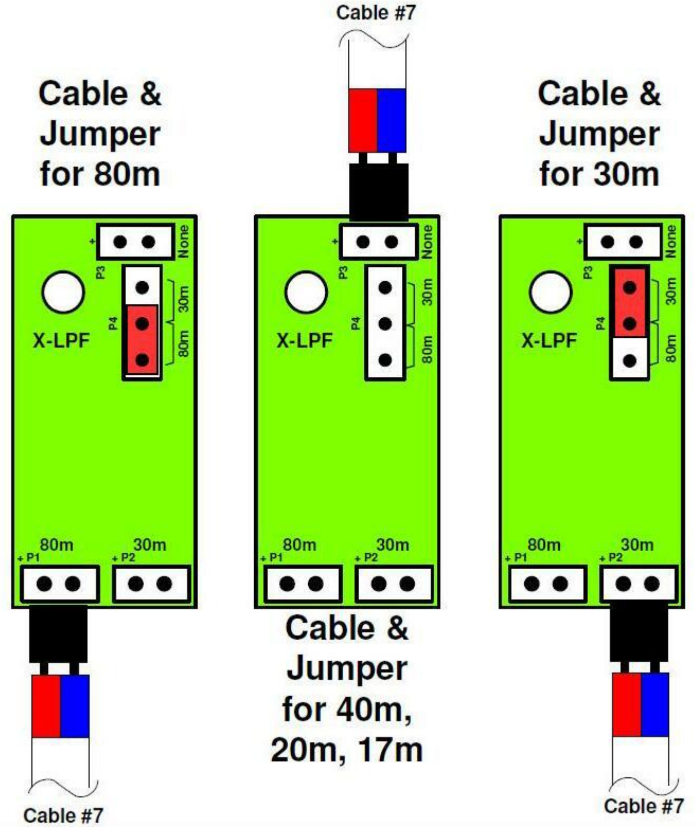


1) Remove cables 2, 3, 4, and 7, noting the orientation of the cable connectors on the baseboard pinheaders.
2) Unplug the RXAMP form the base board and insert the new one, ensuring that the 3-pin and 2-pin headers are properly aligned with the mating sockets on the base board.
3) Unplug the TXPA module using needlenose pliers to grasp one side of the heatsink. Pull up enough to disengage the pinheaders at either end of the TXPA module and carefully pull it away from the baseboard. (Note: The X-LPF board will seem too close to allow this to be done, but it can indeed be done.
4) Using the same technique, grasp the new TXPA module by the heatsink and orient it such that the two pinheaders are aligned over the mating sockets. Then press them down into place.
5) Reconnect the cables and replace the Cube's cover.

X-LPF Board Configuration

It is necessary to provide additional low pass filtering when using the Softrock on the 80m and 30m bands. This will ensure that harmonics generated during transmit on those bands do not exceed FCC limits.

We provided this small "X-LPF" board mounted on the inside of the cabinet on the BNC connector, and in the RF path leading from the SR-Base board as connected by Cable #7. Because the need for the extra LPF differs from band to band, we provide different connectors and jumpers to be used for the designed bands …



Electrical Band Switching Control

Band switching signals are provided to control the external circuitry that may be present to enable multi-band operation when an external RF deck is used.

The Cube's band switch control is provided by digital codes and by an 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.

Digital Codes: DSP board "Band_Sel" P13 connector presents four bits corresponding to the band in which the VFO is currently dialed. Pin 1 = bit 3, Pin 2 = bit 0, Pin 3 = bit 2, Pin 4 = bit 1. Power is also available on P13: Pin 5 = ground and Pin 6 = 5 volts.

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

Band Switching Table:

P13 Bits	DAC Volts	Low Freq		High Freq	Band	Tx Limit
0000	0.00V	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

Set-up & Calibration

New "assembled and tested" SDR Cube Transceivers received from the factory are ready to use and do not need to have the steps described in this section. However, existing Cubes in the field and those built from kits should have these easy procedures performed when certain hardware or software changes are made to the Cube. Examples of such changes include:

- a change or replacement of the RF front end (e.g., the Softrock); and
- a software upgrade that affects the internal nonvolatile storage of user parameters.

VFO Frequency Calibration

There is a small variability in the default XTAL setting for the Si570. This calibration step corrects for that variability and allows the Cube's VFO to accurately report the exact frequency on the display.

- Connect a known-accurate single tone reference signal (about 1-2 mV) to the antenna connector. For example: 14.200.000 Hz.
- Tune the Cube to 14.200.00, LSB or USB (does not matter). A spectrum spike should be seen near the zero Hertz zero center position of the display.
- Go to the User Menu and select **Si570 XTAL**. Adjust the setting to move the spectrum spike closer and closer toward the center of the display, until it completely disappears at 0 Hz.. (The 0 Hz bin is not shown, and thus is a good indicator of when the frequency is exactly calibrated).
- Write down the calibration figure. Exit the menu to save the values and return to normal operation.

Instead of using a signal generator you can also use the known frequency of an AM station in the Shortwave band. Put the VFO dial reading to that frequency and adjust the **Si570 XTAL** setting to move the AM station's carrier to the 0 Hz position on the display. Then exit the User menu to return to calibrated normal operation.

Receive I-Q Balance

Adjusting the receive-side **I** and **Q** audio paths for gain and phase is important to ensure maximum sideband rejection. In this step, you will adjust either the **RX Gain I** or **RX Gain Q** settings, and the **RX Gain X** setting to set the received audio of the opposite sideband to a minimum level.

- Input about 1-2 mV rf signal to Cube's BNC connector. The level must be high enough to get meaningful voltage readings from the audio we are going to measure.
- Select USB and turn the Filter control on the front panel to the widest filter position.
- Tune the VFO so that you have audio between 500 and 1000Hz.

- Change to LSB using the Mode pushbutton on the front panel. You should now be hearing a much lower volume tone corresponding to the test signal being received on the USB.
- Go into the User Menu and select **RX Gain I**. (Both **I** and **Q** gains should be at the default setting of 30000 when you start.)
- Start adjusting the **RX Gain I** setting downward. If the level of the tone being heard on the LSB also decreases you are adjusting the correct setting. If the audio level increases rises, return the **RX Gain I** setting to 30000 and adjust the **RX Gain Q** setting. Now, decreasing this setting should decrease the audio amplitude of the LSB.
- Adjust the setting to hear the minimum audio volume.
- Now select **RX Gain X** gain. Adjust it to produce a minimum audio level.
- Exit the User menu to save settings and return to normal operation.
- Now switching between LSB and USB should yield a clear difference in the audio levels, with the opposite sideband being nearly inaudible. Typical Rx Gain settings are **I:** 30000, **Q**: 26300, **X:** -3700

Transmit I-Q Balance

Adjusting the transmit-side **I** and **Q** audio paths for gain and phase is important to ensure maximum sideband suppression when transmitting. In this step, you will adjust either the **TX Gain I** or **TX Gain Q,** and **TX Gain X** controls to set the transmit audio levels of I & Q for minimum energy being transmitted on the opposite sideband.

Set TX Power Level

The Tx Gain settings in the user Menu will first be adjusted to set the desired transmit power level. Place a wattmeter in series with a dummy load to view the RF power being generated during this procedure. 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.

- Select CW and go into the User Menu and select Keyer Type = Manual. Press the key and adjust TX Gain I and Q down to level where you have 700mW to 1W RF output. At this point you should dial same number for both I and Q gain settings. Leave TX Gain X to zero.
- The CW signal gives you full power level.

Opposite Sideband Suppression Adjustment

For this step the Cube will transmit into a dummy load, which is lightly-coupled to another receiver set to listen on the opposite sideband from what is being transmitted. Then the Tx Gain I, TX Gain Q and TX Gain X settings will be adjusted to produce the lowest-heard signal on the receiver.

- Place a 50-ohm dummy load on the Cube and lightly couple the signal to another receiver set in CW mode with the narrowest filter
- With the Cube in CW mode, press "Tune" and search for the CW/USB signal on the external receiver until a clear 1 kHz tone is heard.
- Switch the Cube to CW-R mode (LSB) and go into the User Menu to select TX Gain I, TX Gain Q, or TX Gain X.
- While keying the Cube with the paddle, adjust each of these three settings for the lowest signal heard on the other receiver.

NOTE: The adjustment above is accomplished using an internally-generated "soft DDS" tone. This tone is a little rough; better opposite sideband suppression can be achieved if instead a clean audio signal is used. If you have an audio frequency signal generator do following procedure ...

- Connect a toggle switch to the PTT pin on the rear panel Mic jack
- Connect a 4.7uF cap from the Mic audio pin, a 100-ohm resistor to ground from the other end, and a 10k resistor from this point to AF generator. (This is just a DC block and attenuator for the Mic input, as it is easier to set the generator output level.)
- Set the generator frequency between 600 Hz and 1 kHz
- Select USB or LSB mode for the Cube and initiate transmit by switching the toggle switch.
- With external wattmeter or scope adjust the AF generator level so that you have about 0.5W RF output into a 50-ohm dummy load. Something around half output power (~400 mW) is better than full power for this adjustment.
- Continue following the sub-steps above.

T-R Delay

An adjustable parameter called "T-R Delay" is present in the User Menu to provide a user-settable delay when transitioning from transmit-to-receive in SSB mode. This is provided to mute an annoying buzz that occasionally occurs when mic PTT is released, as caused by a defect in the Texas Instrument codec IC being used.

The guidance for setting this parameter is to first see if the buzz occurs on in your Cube when you release the microphone PTT button. If so, it can be minimized by increasing the setting from its default value of 900. When in the User Menu and having selected this parameter, repeatedly press 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 is not present in CW mode and the setting does not affect T-R timing or operation. CW T-R transitions remain lightning fast!]

S-Meter Calibration

Calibrating the SDR Cube's s-mater 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.

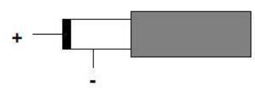
- Return to the desired S-Meter Type (dBm or S-units) and exit the User menu one last time in to save the settings.

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.

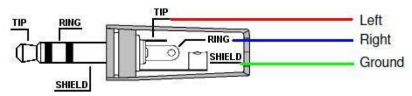
We have found the typical calibration factor to be about 65. If the factor needed to calibrate the meter is significantly more or less than 65, you may have sensitivity problems in the RF front end.

Interface Cables

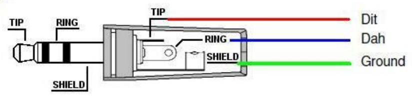
DC Power (+12V)



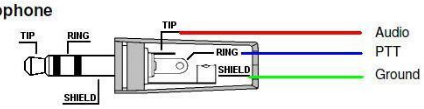
Headphones

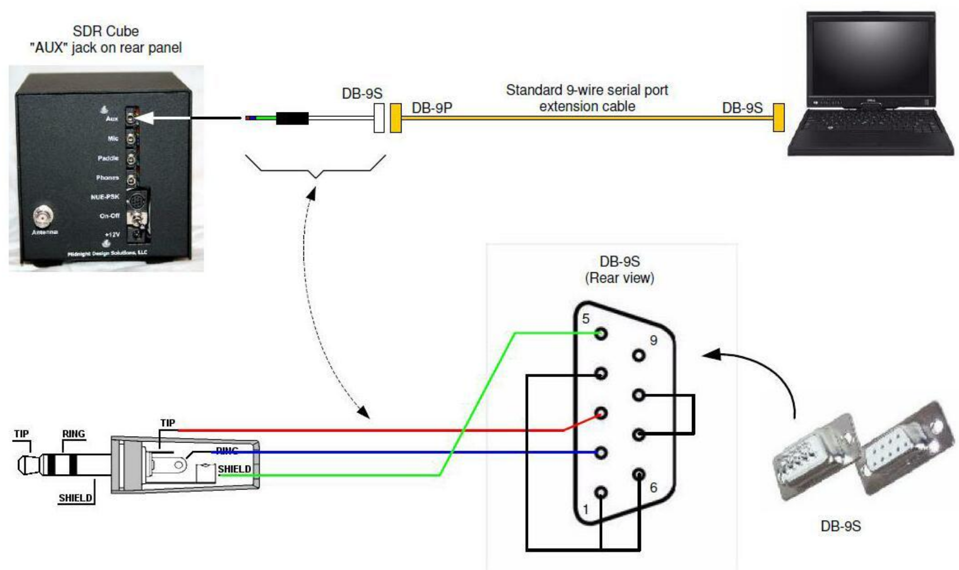


Paddle



Microphone





References

1. SDR Cube website, http://www.sdr-cube.com … contains schematics, photos, parts lists, kits and all other technical information

2. SDR Cube on Yahoo Groups, http://groups.yahoo.com/group/sdr-cube/ … active email list

3. Technical Support … support@sdr-cube.com