

CDV

COMPACT DIGITAL VFO



CONSTRUCTION MANUAL

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Change History		
Date	Issue	Comments
30-Jan-2017	1	First release
10-Jan-2020	2	Added BFO fixed output feature. Added user programmable steps. Improved frequency accuracy. Minor text changes.

1 INTRODUCTION

The CDV (Compact Digital VFO) is a variable frequency oscillator suitable for homebrew radio transceivers and general signal generator applications. The CDV is built on a very small PCB that holds all parts including the rotary encoder and OLED display.

The CDV can simultaneously generate two separate signal sources. The first output has a fixed frequency while the second is a variable frequency source using a rotary encoder as the control. The outputs are square wave but can be conditioned by an optional add-on attenuator/low-pass filter board.

1.1 CDV FEATURES

- Two simultaneous outputs. One variable frequency and one fixed frequency.
- User programmable frequency steps.
- BFO fixed output feature provides a replacement for a crystal in superhet rigs.
- Simple and flexible configuration through on screen menus.
- Clear and bright low current OLED display.
- Very small overall size.
- Simple control via a rotary encoder and two small pushbuttons.
- Low power consumption.
- Wide frequency range.
- IF offset function.
- Scanning function.
- Receiver incremental Tuning (RIT).
- RX/TX indication.
- USB/LSB indication.
- Power supply voltage display.
- Automatic frequency adjustment when changing sidebands.
- Calibration of frequency and voltage display.
- Low power supply voltage warning.
- Easy mounting using the rotary encoder shaft.
- PCB comes with all SMD parts pre-loaded.

Assembly is quick and easy as most of the components are surface mount (SMD) and come pre-installed on the PCB. There are only a handful of through-hole parts to install.

A kit of parts for the CDV including everything you need is available from www.ozQRP.com.

1.2 CDV SPECIFICATIONS

1. PCB size: 52mm x 32mm.
2. Controls: Rotary encoder and 2 pushbuttons.
3. Display: 0.96 inch monochrome OLED.
4. Signal outputs: 1 x fixed frequency, 1 x variable frequency.
5. Fixed output frequency range: 100KHz to 100MHz.
6. Variable output frequency range: 100KHz to 100MHz.
7. Scan mode ranges: $\pm 5\text{KHz}$, $\pm 50\text{KHz}$ of start frequency.
8. IF offset: $\text{VFO} > \text{IF}$, $\text{VFO} < \text{IF}$, NONE.
9. Receiver incremental Tuning (RIT) range: no limit.
10. Programmable frequency steps: Select from the range 1Hz, 10Hz, 100Hz, 1KHz, 5KHz, 10KHz, 25KHz and 100KHz.
11. Operating supply voltage range: 5 to 15V DC.
12. Average operating current: 35mA.
13. TX/RX and USB/LSB logic inputs. An input larger than 3.3V is logic high.
14. Low power supply alarm: 5 to 15V DC.
15. Output impedance: 50 Ohms.
16. Output drive level: over 3V pk-pk Hi Z. 2V pk-pk 50 ohms.
17. Output coupling: series capacitor (100nF).
18. Reverse polarity protection: series diode.
19. Input Output connectors: JST 2mm pin pitch polarised connectors.

2 THE SI5351A

The heart of the CDV is the Si5351A-B-GT clock generator from Silicon Labs. This amazing device includes two programmable Phase Locked Loops (PLL), a matrix switch, and three programmable fractional dividers. The PLLs obtain a reference frequency from an external 25MHz crystal to generate an intermediate high frequency clock between 600MHz and 900MHz. The PLL outputs are directed by the matrix switch to the respective fractional divider where the PLL frequency is divided down to provide the desired output frequency. The PLL and fractional dividers are controlled by a microcontroller via an I2C interface. Through a combination of programmable PLL frequencies and fractional divider values the clock generator is capable of outputting frequencies from a few KHz up to 200MHz with high accuracy and fine resolution.

The CDV uses two PLL and two fractional dividers to provide a fixed output and a variable output. The third output is unused.

3 CIRCUIT DESCRIPTION

Integrated circuit U2 is a Si5351A clock generator chip. A 25MHz crystal supplies the master clock on pins 2 and 3. The Si5351A is controlled over a shared I2C bus by microcontroller U1. The 3.3V power supply rail is applied to pins 1 and 7. Capacitors C8 and C12 and a ferrite bead help guard against instability and decouple the IC from the power supply. The variable output (VFO) appears on pin 10 and is capacitively coupled by C5 to the VFO output connector. Similarly the fixed frequency output on pin 9 is capacitively coupled by C11 to the FIX output connector.

The output signals from the Si5351A are square wave in shape with a frequency spectrum being almost entirely comprised of odd harmonics. While this is adequate for most situations, an external add-on attenuator filter board is available for more demanding applications. See section 11 for more details.

The microcontroller is an Atmel ATmega328 and runs an internal 8MHz clock which avoids the need for an external crystal. It controls the OLED and Si5351A over a common I2C bus on pins 28 and 27. The I2C standard calls for bus pull-up resistors and this is achieved through two 4.7K resistors R7 and R8.

A rotary encoder produces quadrature signals when rotated and one line (REA) is fed into the microcontroller interrupt input (pin 32) and becomes the reference input. Once an interrupt is detected the state of the other line (REB) is read and the direction determined. The rotary encoder also incorporates a press button switch input on U1 pin 1 and is used for a number of functions as described later. U1 incorporates pull-up resistors for the encoder inputs so they are normally held high and capacitors C9 and C10 help limit encoder switch bounce.

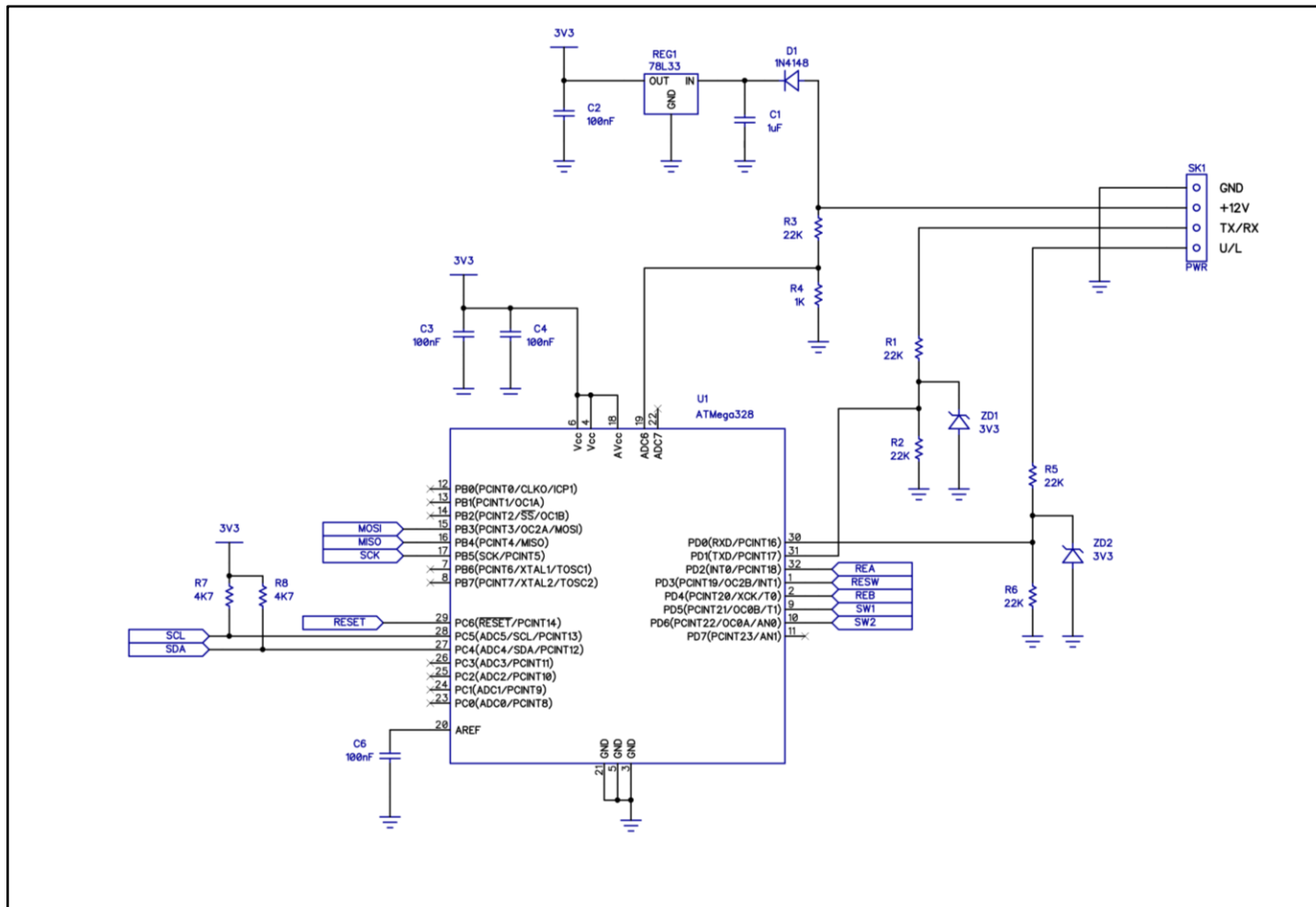
The CDV uses a small 0.96 inch monochrome 128 x 64 pixel matrix OLED for display. If characters were written unmodified to the matrix they would be small and difficult to read, so the firmware combines pixels to write larger characters with 4 rows of 10 characters. The OLED does not require a backlight and has excellent brightness and contrast in high ambient light levels. It is also controlled through the common I2C bus.

The microcontroller has an internal analog to digital converter (ADC) which measures the incoming power supply rail via a resistive attenuator formed with R3 and R4. The calculated value is displayed on the OLED during use.

The microcontroller monitors the state of the TX/RX input on pin 31, while the state of the USB/LSB input is monitored on pin 30. The inputs are attenuated by 22K resistors and the microcontroller inputs are further protected by 3.3V Zener diodes. The inputs are considered low when the input is below about 3.3V. An input above 3.3V is considered a high. The inputs can handle up to 20V levels.

The incoming power supply is regulated to 3.3V by a 78L33 100mA regulator which has its tab soldered to the PCB groundplane to act as a heatsink. The 3.3V rail powers the microcontroller, Si5351A and the OLED. Diode D1 provides reverse polarity protection. When the power supply is connected in reverse, the diode will not conduct and the main circuits will be protected.

The PCB also includes space to fit an ISP connector to allow future software upgrades.



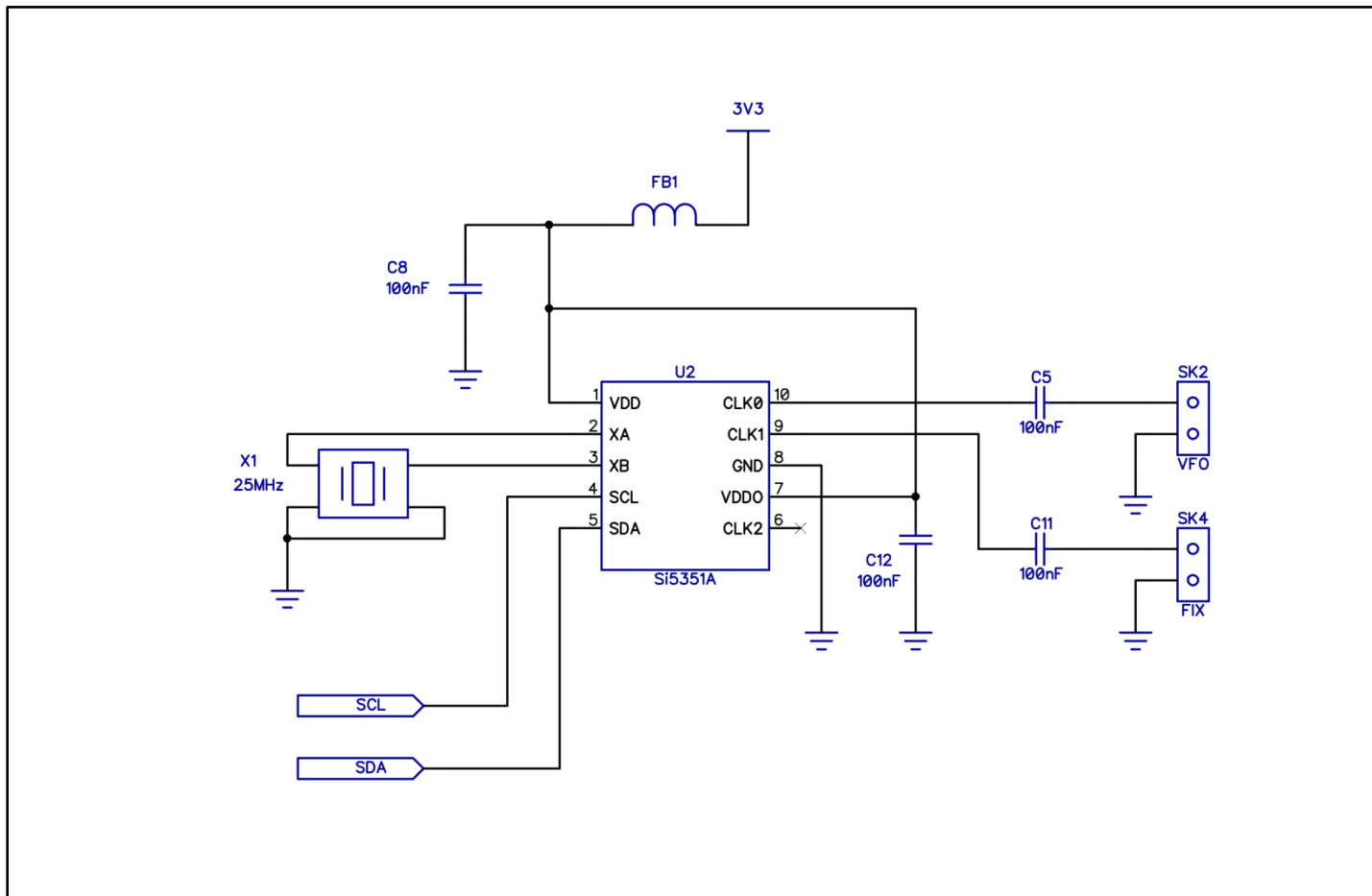


Figure 2 Si5351A Clock generator schematic

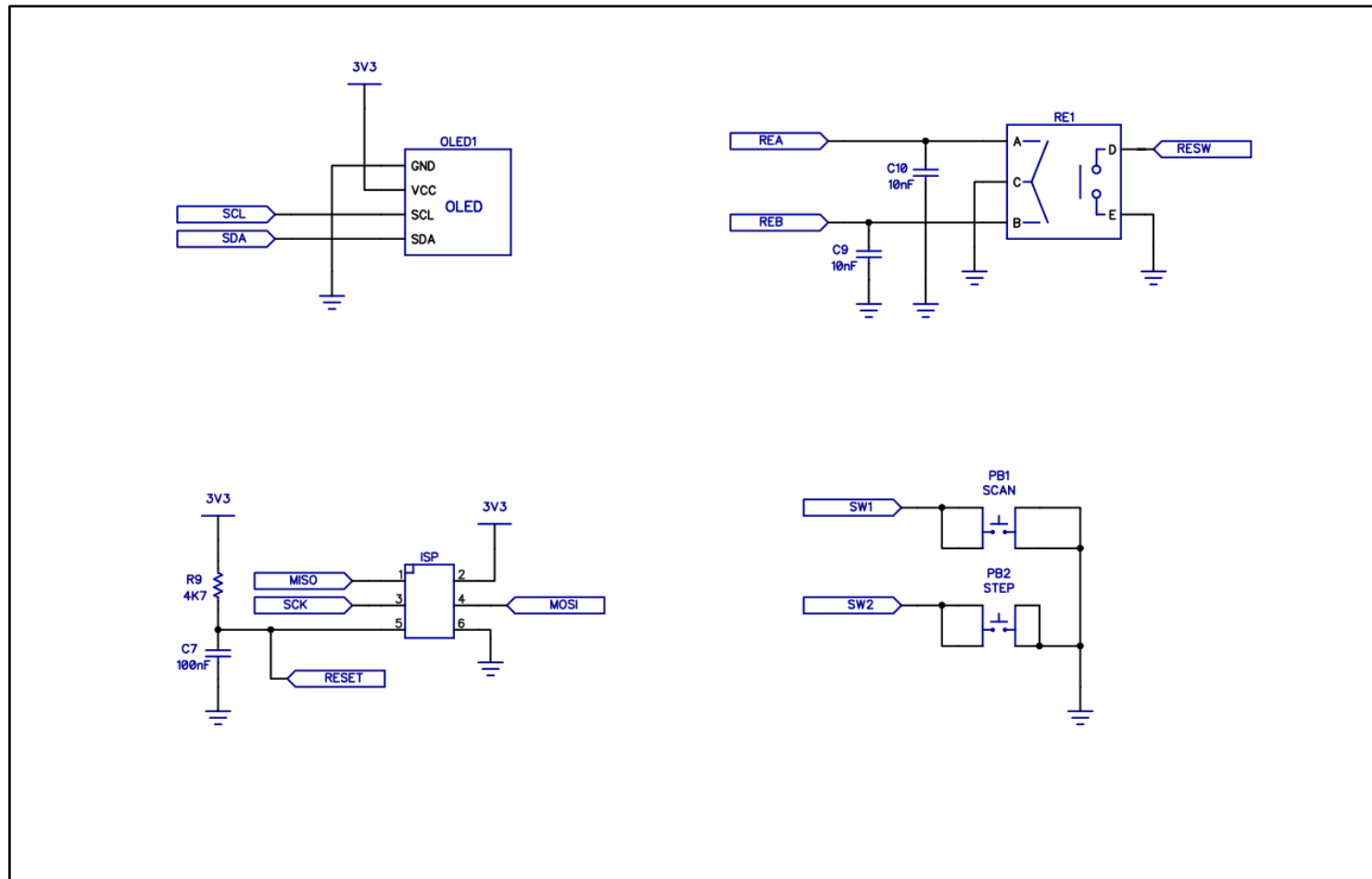


Figure 3 Display and controls schematic

4 KIT SUPPLIED PARTS

QTY	Item	Description
1	CDV PCB	PCB. All SMD parts installed.
1	OLED	0.96 inch OLED display. I2C control
1	Rotary encoder	Rotary encoder. 6mm D style shaft
1	15mm knob	Rotary encoder knob
2	Tactile pushbutton	PCB mount through hole momentary pushbutton
2	Pushbutton caps	Pushbutton actuators
1	4 pin connector	Power and control connector
2	2 pin connector	Signal output connector
1	4 wire cable	Colour coded power/control cable
2	2 wire cable	Colour coded signal output cable

5 PCB INDIVIDUAL PARTS LIST

Desig.	Value	Type
C1	1uF	Capacitor ceramic MLCC SMD 0603
C2	100nF	Capacitor ceramic MLCC SMD 0603
C3	100nF	Capacitor ceramic MLCC SMD 0603
C4	100nF	Capacitor ceramic MLCC SMD 0603
C5	100nF	Capacitor ceramic MLCC SMD 0603
C6	100nF	Capacitor ceramic MLCC SMD 0603
C7	100nF	Capacitor ceramic MLCC SMD 0603
C8	100nF	Capacitor ceramic MLCC SMD 0603
C9	10nF	Capacitor ceramic MLCC SMD 0603
C10	10nF	Capacitor ceramic MLCC SMD 0603
C11	100nF	Capacitor ceramic MLCC SMD 0603
C12	100nF	Capacitor ceramic MLCC SMD 0603
R1	22K	Resistor 1% SMD 0603
R2	22K	Resistor 1% SMD 0603
R3	22K	Resistor 1% SMD 0603
R4	1K	Resistor 1% SMD 0603
R5	22K	Resistor 1% SMD 0603
R6	22K	Resistor 1% SMD 0603
R7	4.7K	Resistor 1% SMD 0603
R8	4.7K	Resistor 1% SMD 0603
R9	4.7K	Resistor 1% SMD 0603
D1	1N4148	Diode SMD SOD123
ZD1	3V3	Zener diode 3.3V 500mW SMD SOD123
ZD2	3V3	Zener diode 3.3V 500mW SMD SOD123
REG1	78L33	Voltage regulator 3.3V 100mA SMD SOT89-3
U1	ATmega328P	Atmel 32K 8 bit microcontroller
U2	Si5351A-B-GT	Clock generator
X1	25MHz	Crystal 25MHz SMD
FB1	-	Ferrite Bead SMD
OLED1	-	0.96 inch 128 x 64 monochrome OLED
RE1	-	Through hole rotary encoder with switch
PB1	-	PCB mount through hole tactile momentary action switch
PB2	-	PCB mount through hole tactile momentary action switch
VFO	-	2 pin JST 2mm pitch male shrouded header
FIX	-	2 pin JST 2mm pitch male shrouded header
PWR	-	4 pin JST 2mm pitch male shrouded header
ISP	-	not installed

6 CONSTRUCTION

6.1 GENERAL

The CDV is built on a high quality fibreglass PCB. The PCB is doubled sided with tracks on both sides but with the top side mainly forming a ground plane.

Components are loaded into the PCB from both sides. When the component side is mentioned in the following instructions it refers to the side of the PCB where the SMD parts are installed. The reverse side is referred to as the solder side.

To assist construction the PCB has a screen printed component overlay and a solder mask to help guard against solder bridges.



The components are static sensitive. Use anti-static measures when handling the PCB out of its protective bag.

6.2 STEPS

Step 1: PCB

Remove the PCB from its protective bag. Check for damage during shipping. The PCB comes shipped with all SMD devices pre-installed.

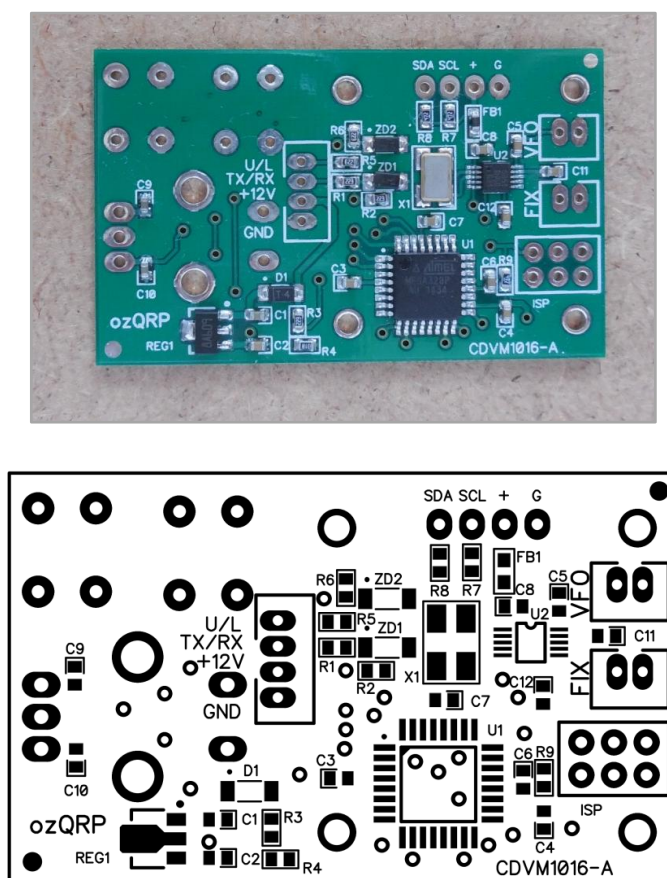
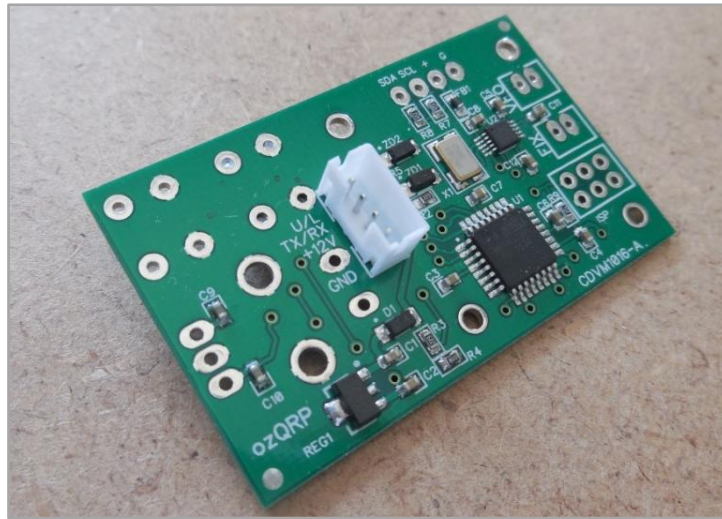



Figure 4 Component overlay

Step 2: Power Connector

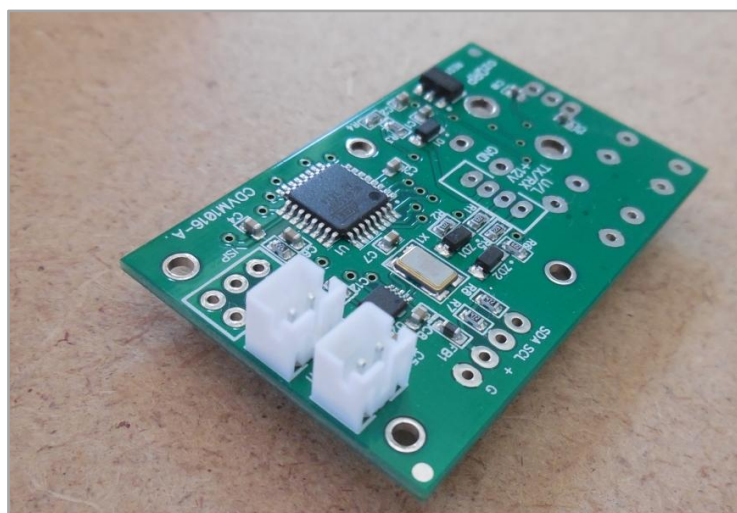
Insert the 4 pin JST connector into the component side of the PCB. The side of the connector with the cutout faces the encoder. Hold firmly against the PCB and solder in place.



Step 3: Output Connectors

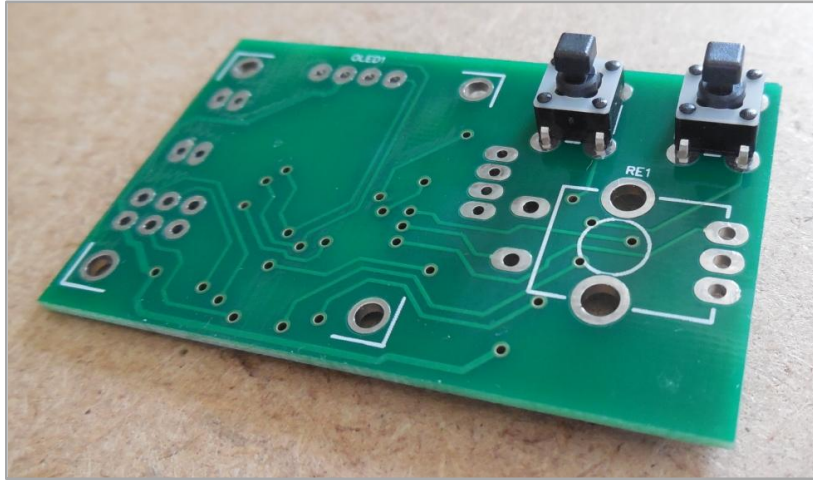
 **If the CDV is to be used with an optional add-on attenuator filter board, decide if it is to be soldered directly to the PCB. If being soldered directly the connector can be omitted.**

Insert the two 2 pin JST connectors into the component side of the PCB. The side of the connector with the cutout faces towards the top of the PCB. Hold firmly against the PCB and solder in place.



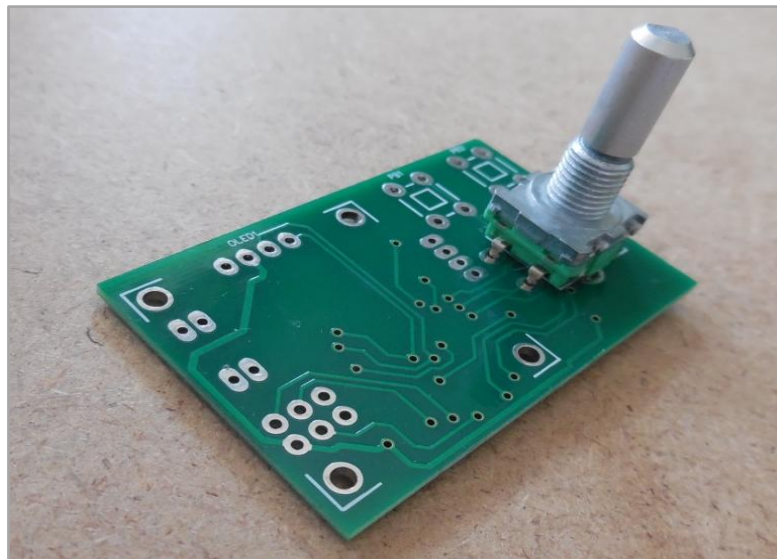
Step 4: Pushbuttons

Insert the pushbuttons into the solder side of the PCB. It may be necessary to straighten the pins slightly so they fit easily. Ensure they sit flat and at right angles to the PCB, then solder in place.



Step 5: Rotary Encoder

Insert the rotary encoder into the solder side of the PCB. Ensure it sits flat and at right angles to the PCB then solder in place.



Step 6: OLED

The OLED is inserted into the solder side of the PCB using the integral 4 pin male header. Position the OLED so that its front face sits just behind the rear of the panel where the CDV is mounted. See Figure 5.

Solder one pin and double check the clearance and ensure that the OLED is parallel to the PCB. If necessary melt the solder and reposition, then solder the remaining pins.

It may also be necessary to trim the top of the header pins if a metal panel is used to avoid the possibility of short circuits.

If the OLED is installed close to the main PCB, it may be necessary to trim the pins on the 2pin JST connectors to avoid them touching the back of the OLED.

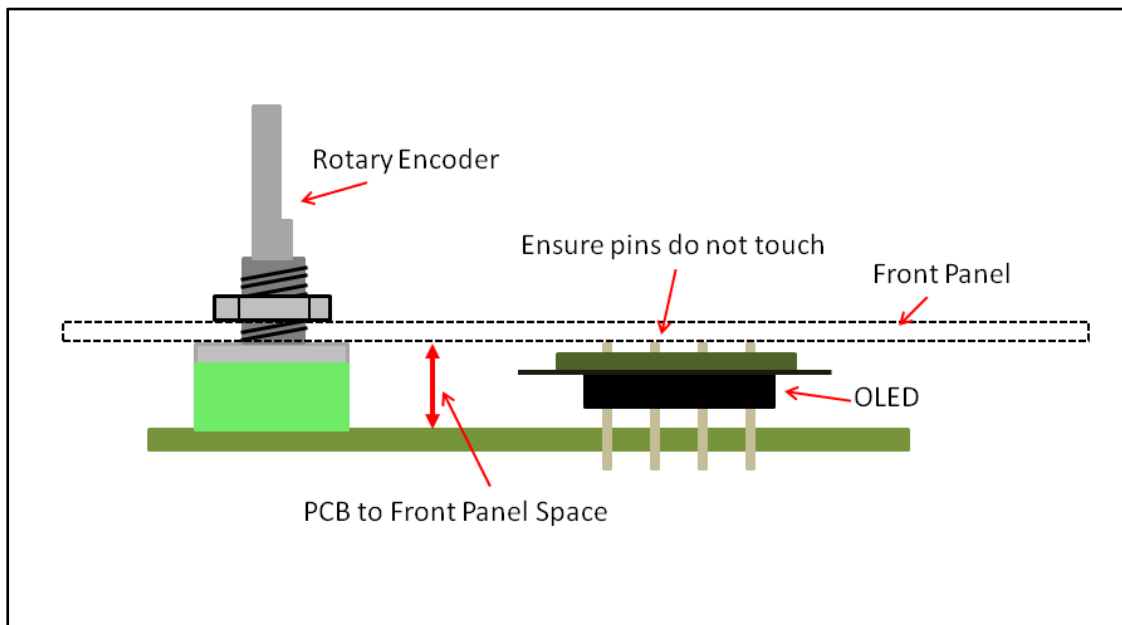


Figure 5 OLED mounting

Step 7: Knobs and caps

Push the small long actuator knobs onto the pushbuttons. Take care to avoid excessive sideways force that could damage the switch.

The encoder knob slides onto the 'D' style encoder shaft. A small amount of lubrication, such as Silicone spray, makes it easier to slide on and off. The knob has a cap that is pressed onto the top of the knob.



The knob must be removed from the shaft before mounting the CDV to a panel.

7 TESTING

7.1 GENERAL

The CDV microcontroller has been programmed and the board given a functional check before being dispatched. This means the CDV should work first time, however the following procedure provides a quick check that the CDV is operating correctly once assembled.

If there are problems look for errors with the soldering of the connectors, controls and OLED. If there is no sign of life check that the power supply is connected with the correct polarity. No damage should result as the CDV has reverse polarity protection.

7.2 POWER ON

1. Connect the 4 pin connector red wire to the power supply positive lead. Connect the black wire to the power supply negative lead. The power supply can be between 5 and 15V DC.
2. Turn on the supply and note the current. It should be around 30mA. If it's far from this turn off immediately and look for problems.
3. The OLED should display the opening banner along with the firmware version number, then after a short period display the operating screen.

7.3 CONTROLS

1. Rotate the encoder knob and check that the frequency can be changed up and down.
2. Press the **SCAN** button and check that Scan mode menu appears, and select Exit with the **STEP** button to return to the operating screen.
3. Press the **STEP** button and check that the frequency step can be changed.
4. Press and hold the encoder button for a few seconds and check that the Set-up screen is displayed. Select FULL with the **STEP** button and step through the menus using the **SCAN** button and return to the operating screen.
5. Connect the 4 pin connector white wire to the power supply positive lead. The RX/TX display should change state.
6. Connect the 4 pin connector yellow wire to the power supply positive lead. The USB/LSB display should change state.

7.4 OUTPUT SIGNALS

1. Terminate the outputs with a 50 ohms resistor (two 100 ohm in parallel) and place an oscilloscope across the load. Verify a square wave output signal with an amplitude of around 2V pk-pk at the expected frequency.



The fixed output is disabled by default so it needs to be enabled in Set-up to view its output.



If an optional add-on board is installed, then the output will be conditioned. The amplitude depends on the attenuator fitted and the waveform will be closer to a sine wave.

8 MOUNTING TO A PANEL

The CDV is small and light and can be mounted to a panel simply by using nothing more than the rotary encoder shaft.

Before mounting a rectangular cutout and 4 holes need to be made to the panel as shown in Figure 6.

Once the cutout and the holes are complete insert the CDV from the rear of the panel then place the nut and washer on the shaft. Check that the display lines up with the cutout and the pushbuttons are free to operate in their holes and tighten the nut.

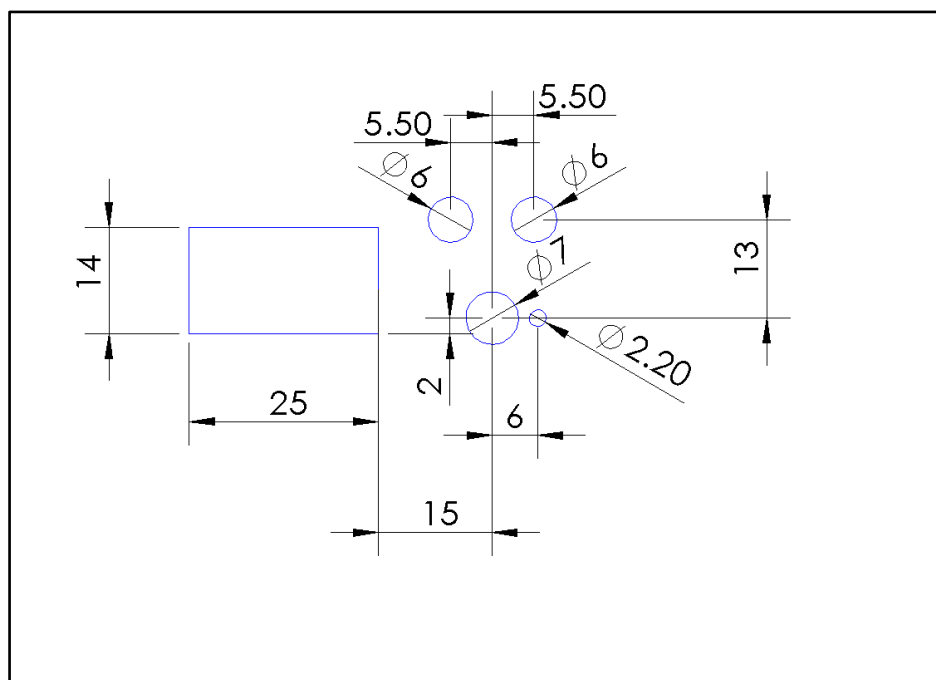


Figure 6 CDV panel cutting

9 SET-UP

9.1 GENERAL

The CDV has a comprehensive range of programmable parameters which allow the CDV to be used in a number of varied operating conditions.

To provide for easy and faster operation the Set-up menus are divided into three levels:

- a. QUICK – this level only includes the common main menus.
- b. MISC – this level is used to set the miscellaneous functions.
- c. FULL – all Set-up menus are available.

9.2 PROCEDURE

1. To enter Set-up mode, press and hold the encoder switch down for 2 seconds until the display shows **CDV SETUP** and then release.
2. Press the **STEP** button to select the Set-up level and then confirm with the **SCAN** button.
3. The menus are sequentially accessed by pressing the **SCAN** button.
 - a. Menu items that have multiple fixed values (e.g. YES/NO, +/-) are selected by pressing the **STEP** button.
 - b. Menu options that have numerical values (e.g. frequency) are incremented and decremented using the rotary encoder.
 - c. Menus displaying frequency use the **STEP** button to step the cursor through the digits.
4. Once the last menu is completed the Set-up procedure is exited and any new values stored in non-volatile memory. These are loaded again at power on.



The menus and their current values can be displayed anytime without alteration by progressing through the menus using only the SCAN button.

9.3 UNDERSTANDING MENU OPTIONS

Fixed O/P

The variable output is always enabled. The Fixed output can be enabled or disabled if not required with this option. The Fixed output has three options:

1. **NO** – the output is disabled.
2. **YES** – the output is enabled and the frequency is manually entered.
3. **BFO** – the output is enabled. The frequency is set to IF low or IF high depending on the state of the USB/LSB input and the VFO mixing scheme.

Fixed Freq

This option allows the setting of the fixed output frequency, and is only available if the **Fixed O/P** is set to **YES**.

IF Offset

This option is set when the CDV is used as a local oscillator in a Superhet rig. The OLED will display the receive/transmit frequency while the actual VFO signal frequency will be offset by an amount equal to the difference between the IF and TX frequencies.

To accommodate a wide range of applications there are two offset options available.

- a) **VFO > IF.** This places the VFO frequency above the IF frequency and is the most commonly used option.

The VFO frequency is calculated in firmware using the following equation:

VFO frequency = IF frequency + TX frequency.

80M example. 13.5MHz = 10MHz + 3.5MHz.

20M example. 24MHz = 10MHz + 14MHz.

- b) **VFO < IF.** This places the VFO frequency below the IF frequency and is most suitable when the TX frequency is below the IF frequency.

The VFO frequency is calculated in firmware using the following equations:

If TX frequency < IF frequency, then VFO frequency = IF frequency - TX frequency.

80M example. 6.5MHz = 10MHz - 3.5MHz.

If TX frequency > IF frequency, then VFO frequency = TX frequency - IF frequency.

20M example. 4MHz = 14MHz - 10MHz.

An **IF Offset** of **NONE** means the VFO output frequency will be the same as the displayed frequency. This is the setting selected when the VFO is to be used as a general purpose signal generator or with a Direct Conversion receiver.



**Depending on the transceiver mixing arrangement there may be a sideband inversion if the offset is VFO > IF.
For example, LSB generated in the balanced modulator would be USB at the transmitter output, and vice versa.
If this is the case, the display can be corrected using the Set-up SIDEBAND option.**

IF Freq High and IF Freq Low

Two separate IF frequencies (IF HI Freq and IF LO Freq) are included to allow the VFO firmware to correct the output frequency when sidebands are changed. To generate the opposite sideband it is necessary to shift the carrier oscillator frequency from one side of the filter passband to the other. Without this adjustment the transmitted frequency would not accurately reflect the displayed frequency.

If it is required that the carrier oscillator does not change frequency when the sideband is changed, then simply make both **IF HI Freq** and **IF LO Freq** the same.

If the **IF Offset** option is set to **NONE** the IF Freq menus are not displayed.

TX Freq

This option allows the initial operating frequency to be set.

The **TX Freq** value in conjunction with the **IF Offset** and **IF Freq** is used by the firmware to calculate the actual VFO frequency.

When the **IF Offset** option is set to **NONE** the VFO displayed frequency is the same as the transmit frequency.

Steps

The option allows the selection of steps. The step value is the amount the frequency is changed as the rotary encoder moves one position. When this option is reached the current steps will be displayed. If no changes are required simply press the **SCAN** button to go to the next option.

To change the steps do the following:

1. Press the rotary encoder switch down briefly to clear and reset the current steps.
2. Rotate the rotary encoder to display the required step in the top line.
3. Press the **STEP** button to select the step. This is then displayed in the bottom screen.
4. Repeat steps 2 and 3 to add extra steps.
5. When finished press the **SCAN** button to go to the next option.

30S Freq Save

This option enables automatic saving of the current frequency and step in EEPROM so that it is recalled the next time the VFO is powered on. The EEPROM has a maximum specification of 100,000 write/erase cycles, so to protect it from excessive writes, the save is performed only once per frequency change and only after a 30 second idle period has elapsed. If the encoder is operated so that there is less than 30 seconds between changes no saves will be performed.

CAL Freq

The accuracy of the VFO frequency is dependent on a number of factors. These include practical limitations in the clock generator fractional dividers, the necessary rounding of calculations in firmware and the tolerance of the crystal clock frequency. The result is that the actual VFO frequency may not match the displayed frequency. This option allows trimming of the VFO output frequency in firmware so that the operating frequency matches the displayed frequency.

CAL Volts

The microcontroller measures the battery voltage using an analog to digital converter through a resistive divider. Due to the tolerance in the resistors and voltage reference within the microcontroller the displayed voltage may not be exact. This option allows the displayed value to be trimmed to match the correct value.

SIDEBAND

The CDV displays **USB** or **LSB** and calculates output frequencies depending on the state of the U/L input wire. This option allows the state to be reversed.

 **If the IF Offset option is set to NONE, the USB/LSB state will be ignored.**

LO V Alarm

This option flashes a low voltage message on the OLED when the supply voltage goes below the programmed limit. This is helpful when operating on batteries to avoid excessive discharge.

9.4 MENU OPTION RANGES

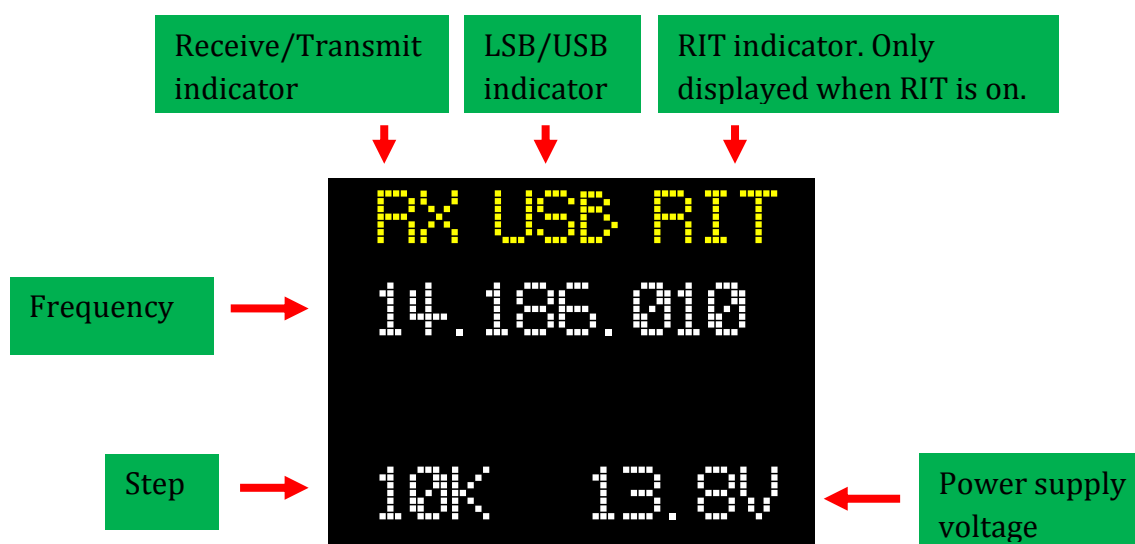
Menu	Option Ranges
Fixed O/P	NO YES BFO
Fixed Freq	100KHz to 100MHz in 1Hz steps
OFFSET	VFO > IF VFO < IF NONE
IF HI Freq	100KHz to 100MHz in 1Hz steps
IF LO Freq	100KHz to 100MHz in 1Hz steps
TX Freq	100KHz to 100MHz in 1Hz steps
STEPS	1Hz, 10Hz, 100Hz, 1K, 5K, 10K, 25K, 100K
30S Save	YES NO
CAL Freq	-990Hz to +990Hz in 10Hz steps
CAL Volts	-0.9V to +0.9V in 0.1V steps
SIDEBAND	Normal Reverse
LO V ALARM	5 to 15V in 1V steps.

10 OPERATION

The following sections describe how to use the CDV.

10.1 OPERATING DISPLAY

The CDV OLED display fields are shown below.



10.2 TUNING

To tune the VFO rotate the encoder knob. Rotating clockwise increments the frequency, while rotating counter-clockwise decrements the frequency.

10.3 STEP SELECTION

Press the **STEP** button to cycle through the tuning frequency steps. The step values must be set in Configuration when the CDV is first powered up.

When the rotary encoder is operated, each indent will increment or decrement the frequency by the step value.

10.4 SCAN MODE

1. Before running a scan, tune to a frequency that is around the centre of the desired scan range.
2. Press the **SCAN** button to open the scan screen. Select the scan range with the **STEP** button. The ranges are:
 - a. **10KHz**. The frequency starts 5kHz below the initial tuned frequency and stops 5kHz above. Once the top is reached it goes in the reverse direction to the bottom again repeating until stopped.
 - b. **100KHz**. The frequency starts 50kHz below the initial tuned frequency and stops 50kHz above. Once the top is reached it goes in the reverse direction to the bottom again repeating until stopped.
 - c. Once the desired range is selected press the **SCAN** button again to start the scan.
3. The scan frequency will be displayed along with a graphical bar at the bottom of the screen.
4. The scan can be stopped in two ways:
 - a. Press the **SCAN** button. The tuning will revert to the initial tuned frequency before scan mode was started.
 - b. Press the **STEP** button. The tuning will be set to the frequency where scan mode was stopped.

If the scan mode is entered by mistake select EXIT and then press the **SCAN** button to return to normal operation.

10.5 RIT

To enable RIT, briefly press the encoder switch. The receive frequency can now be tuned independently of the transmit frequency. When the PTT is operated the VFO will use the transmit frequency. When PTT is released the VFO will return to the receive frequency.

To exit RIT, briefly press the encoder switch again. The receive and transmit frequencies will now be the same.

10.6 VFO FREQUENCY CALIBRATION

1. Measure the actual CDV output frequency and compare this to the frequency displayed on the OLED. Note the difference.
 - a. If the CDV output frequency is less than the displayed frequency, the difference needs to be subtracted in the Frequency Calibrate screen.
 - b. If the CDV output frequency is greater than the displayed frequency, the difference needs to be added in the Frequency Calibration screen.
2. Enter Set-up and select either MISC or FULL. Step to the **CAL Freq** screen.
3. Press the **STEP** button to toggle the sign indicator.
4. Rotating the encoder will increase or decrease the difference value.
5. Once set press the **SCAN** button to skip the remaining screens until Set-up is exited.



The frequency calibration process is only applicable to the variable output. Trimming of the fixed output frequency can only be done through altering the Fixed frequency setting.

10.7 VOLTAGE DISPLAY CALIBRATION

1. Measure the power supply voltage and compare this to the voltage displayed on the OLED. Note the difference.
 - a. If the power supply voltage is less than the displayed voltage, the difference needs to be subtracted in the Volts Calibrate screen.
 - b. If the power supply voltage is greater than the displayed voltage, the difference needs to be added in the Volts Calibration screen.
2. Enter Set-up and select either MISC or FULL. Step to the **CAL Volts** screen.
3. Press the **STEP** button to toggle the sign indicator.
4. Rotating the encoder will increase or decrease the difference value.
5. Once set press the **SCAN** button to skip the remaining screens until Set-up is exited.

11 USING THE CDV WITH A SUPERHET RIG

The CDV has two outputs, a fixed frequency and a variable frequency output. This makes it suitable for use in a number of scenarios, but especially in a superhet rig. The variable output can be used as the variable frequency oscillator (VFO) while the fixed output can be used as the BFO or carrier crystal.

A great feature of the CDV fixed output is that when set to BFO mode it can automatically switch frequency when changing sidebands. Figure 7 shows the CDV used in a single conversion superhet transmitter for 40M.

Note how the Fixed outputs match the IF low and IF high skirt frequencies, and that they change frequency automatically when the sideband is swapped.

Also note how the firmware automatically adjusts the VFO frequency when the sideband is swapped so that the transmit frequency does not shift.

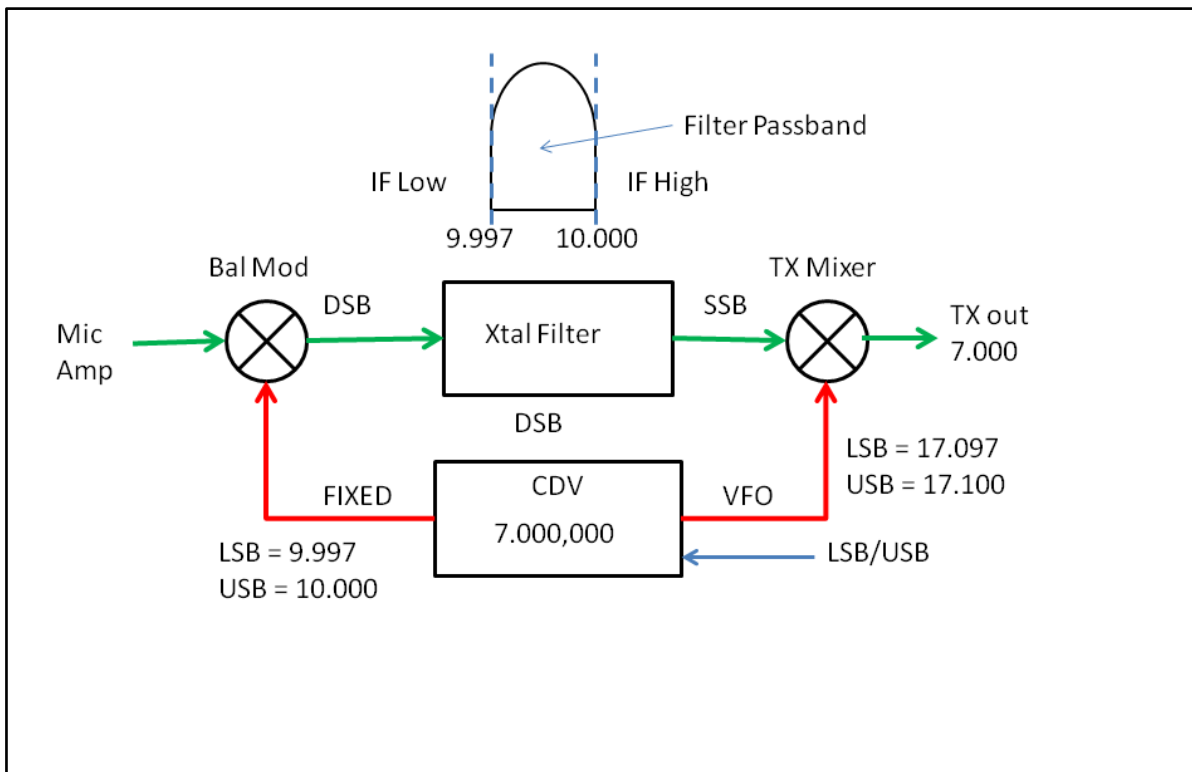
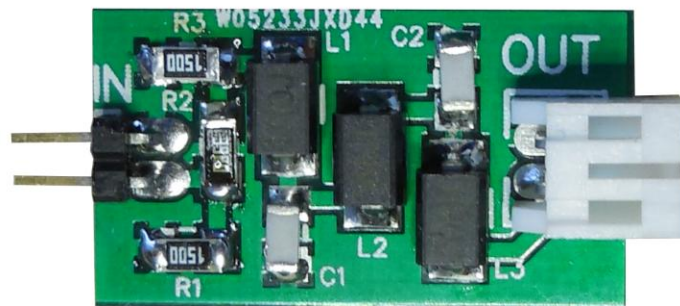


Figure 7 CDV used in a superhet rig



When the CDV is used in a superhet rig and the fixed output is used as a BFO, it is important to keep the BFO signal clear of any IF circuits. If not the BFO may get injected into the IF and appearing as a constant audio tone. A shielded cable may be necessary in difficult situations.

12 OPTIONAL ATTENUATOR LOW PASS FILTER BOARD



The clock generator outputs square wave signals with an amplitude of around 2V pk-pk into 50 ohms. Some situations, however, may require a signal with either lower amplitude or reduced harmonics, or both.

The optional add-on board contains a simple resistive attenuator and a 5 pole low pass filter and can be applied to one or both outputs. It can be soldered directly to the rear of the CDV to make a compact assembly or mounted externally and wired in-line.

The attenuator and low-pass filter values available in the kits are shown in Figure 8. They can be ordered in any attenuator/filter combination.

Attenuator dB (50 ohms)	Low pass filter MHz
6dB	10MHz
12dB	20MHz
	30MHz
	40MHz

Figure 8 Add-on board options

The low pass filter frequency shown in Figure 8 is the filter cut-off frequency, and it is important to understand how this relates to the VFO frequency, and the output signal wave shape.

If the VFO frequency is near the cut-off frequency the waveform will approach a sine wave of the desired level. If the VFO frequency is well below the cut-off frequency the wave shape will be more like a rounded square wave as the upper harmonics are less attenuated.

Moving the VFO frequency well above the cut-off frequency will result in a sine wave but with a greatly attenuated output level.



The attenuator and filter must be terminated in 50 ohms to achieve the expected performance.

12.1 SCHEMATIC

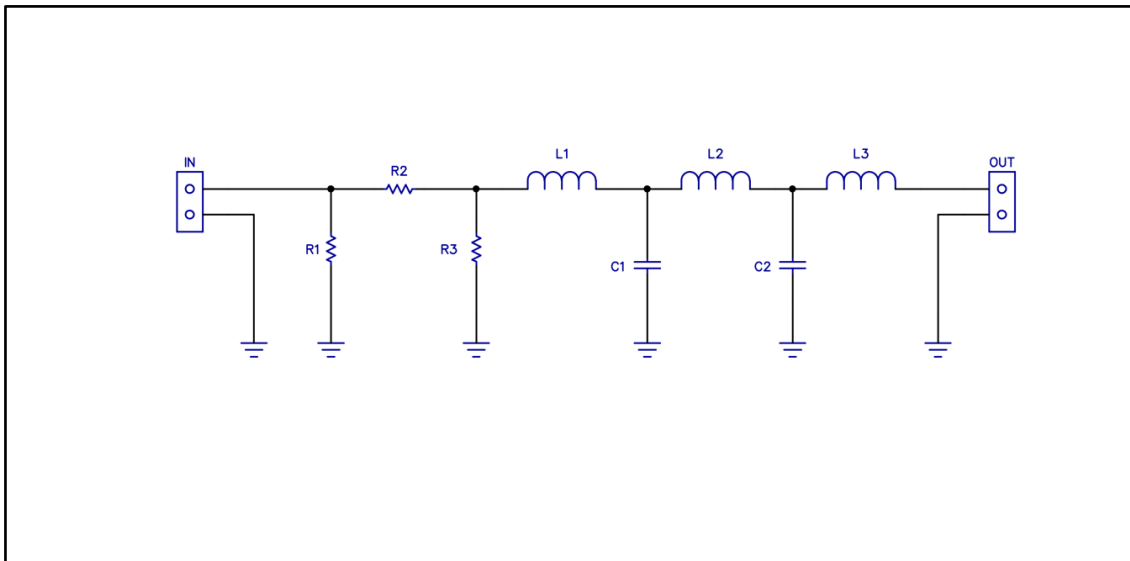


Figure 9 Add-on board schematic

12.2 PCB OVERLAY

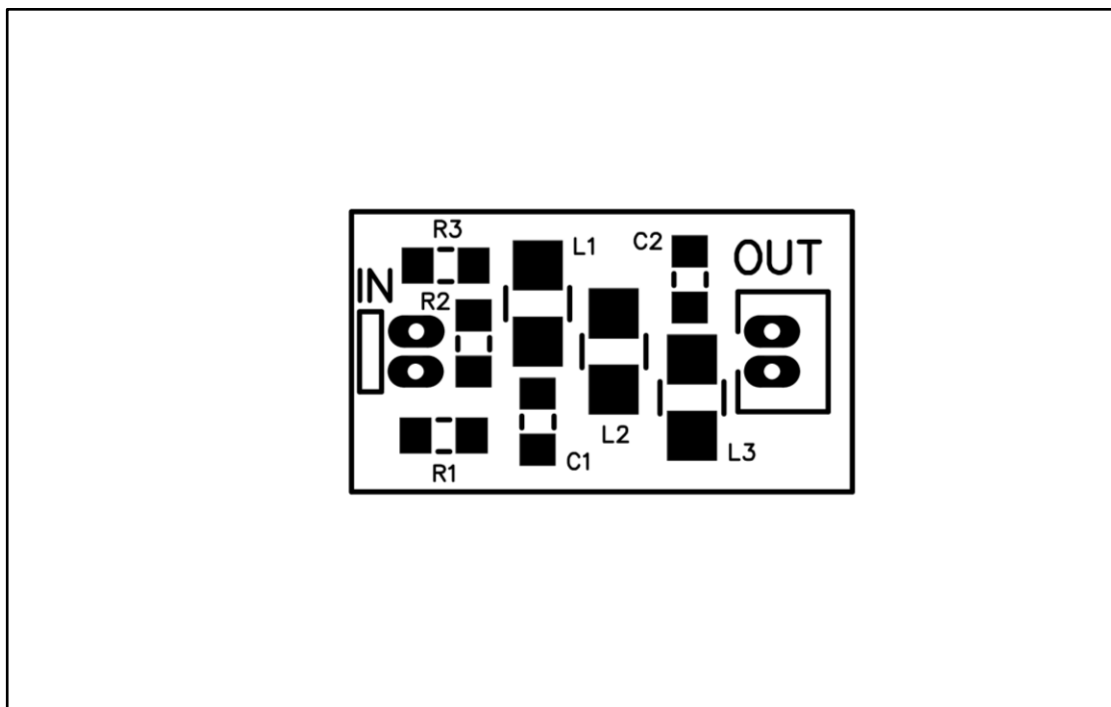


Figure 10 Add-on board PCB overlay

12.3 CONSTRUCTION

12.3.1 SOLDERING SMD DEVICES

The resistors, capacitors and inductors are surface mount (SMD) components. Normally they are difficult to work with, but in this kit larger package types have been specified to make it easier to build. Below is a suggested list of tools to satisfactorily complete construction:

- a. thin solder
- b. small tipped soldering iron
- c. illuminated magnifier
- d. fine tweezers

Melt a small spot of solder onto one of the component PCB pads. Pick up the SMD component by the sides with tweezers and place onto the pads. While holding the component steady place the tip of the soldering iron on the pad with the spot of solder to melt it again. Remove the iron and let things cool and settle. Check the positioning of the component and if not in the correct spot, melt the solder and move gently with tweezers. Once the component is located solder the other end using as little solder as possible. Then go back to the first pad and apply a little more solder to ensure the joint is secure. Inspect the job under a magnifier looking for solder bridges and dry joints.

Step 1: Resistors

Locate and install the three SMD resistors. R1 and R3 have the same value, while R2 has a different value. Use the table below to identify the correct values.

Attenuation	Resistor	Resistor label	Value
6dB	R1, R3	1500	150 ohms
	R2	39R0	39 ohms
12dB	R1, R3	82R0	82 ohms
	R2	91R0	91 ohms



If only the low pass filter is required and no attenuation, then omit the resistors and install a solder bridge across R2.

Step 2: Capacitors

Locate and install the two SMD capacitors. The capacitors have the same value so they can go in either position. In general SMD ceramic capacitors do not have markings, so the values can only be read with a capacitance meter and miniature probes.

Filter	Value
10MHz	470pF
20MHz	220pF
30MHz	150pF
40MHz	120pF

Step 3: Inductors

Locate and install the three SMD inductors. L1 and L3 have the same value, while L2 has a different value. Use the table below to identify the correct values.

Filter	Inductor	Inductor label	Inductor Value
10MHz	L1, L3	1R0	1uH
	L2	1R8	1.8uH
20MHz	L1, L3	R47	0.47uH
	L2	R82	0.82uH
30MHz	L1, L3	R33	0.33uH
	L2	R56	0.56uH
40MHz	L1, L3	R27	0.27uH
	L2	R47	0.47uH

Step 4: Connectors

The IN connector is a 2 pin right angled male header. The end with shorter pins is soldered into the PCB. The longer pins are soldered directly into the CDV PCB.

The OUT connector is a right angle JST 2 pin shrouded male header. It is inserted into the component side.



If the board is to be mounted externally and wired inline, then the connectors can be omitted if desired.

12.4 ATTACHING TO THE CDV

There are two methods for attaching the board to the CDV.

12.4.1 DIRECT

In this method the board becomes a part of the CDV assembly. Insert the 2 pins of the right angled header into the output holes on the CDV PCB. Hold in place and solder into position.

A directly mounted attenuator filter board is shown in Figure 11.

12.4.2 WIRED

Here the board is located remotely from the CDV PCB and connected via wires. The supplied connectors and cable may be used or omitted and discrete wiring used instead.

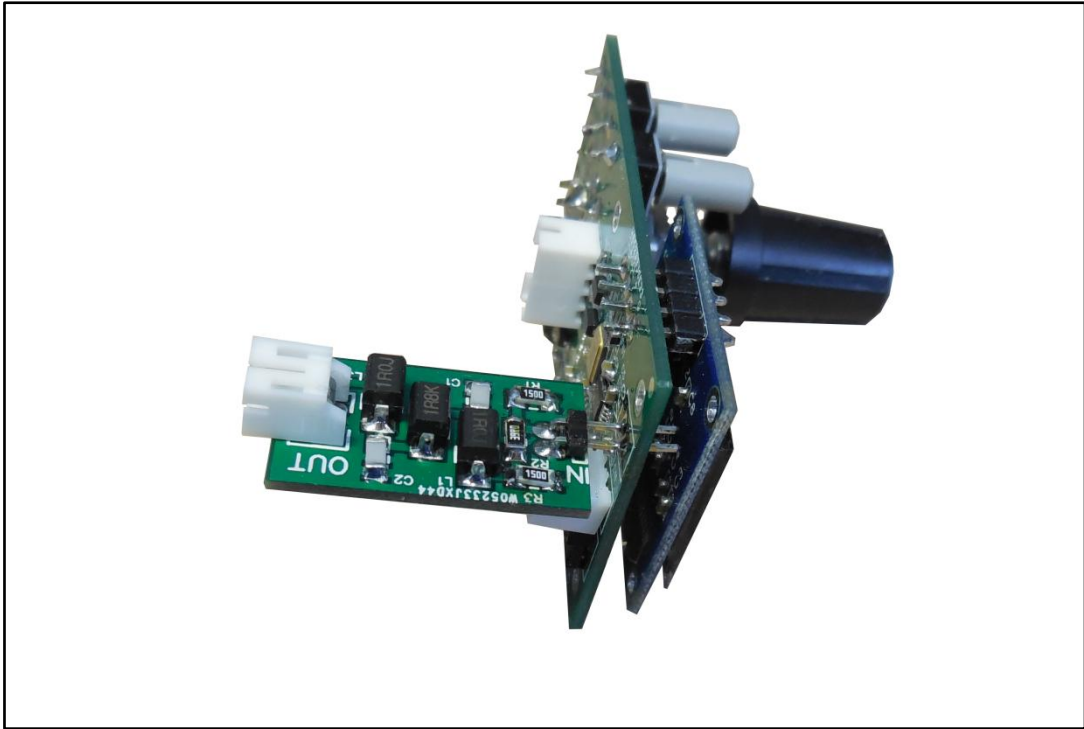


Figure 11 Attenuator filter board fitted to the CDV