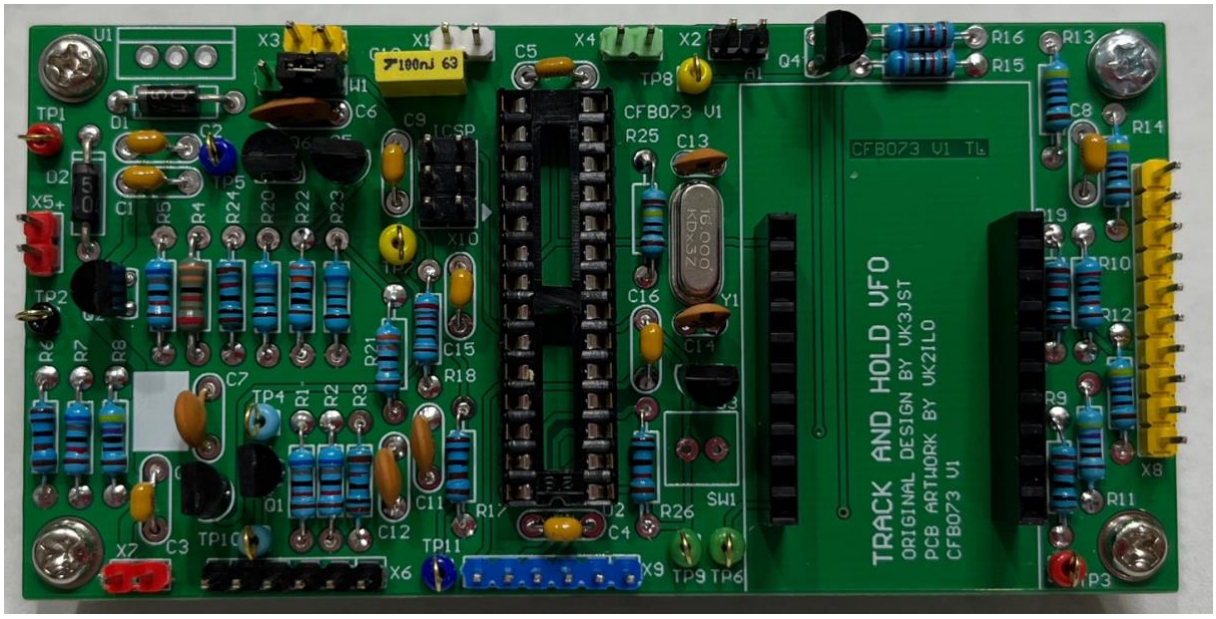
TRACK AND HOLD VFO FOR

HF TRANSCEIVERS

INSTRUCTIONS FOR THE BUILDING OF A TRACK AND HOLD VFO IMPLEMENTED ON PRINTED CIRCUIT BOARDS CFB073 V1 AND CFB073 V2



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1. Preface

Having started my journey into amateur radio and foundation license and been given an old Kenwood HF transceiver type TS-520S with Vernier type frequency scales for tuning I starting to feel some stress about operating near the edges of the HF amateur bands. This type of frequency tuning requires the reading of the transceiver frequency scale and some mental arithmetic to arrive at the actual transmit frequency.

The solution to my stress came in the form of an article in WIA Amateur Radio by Jim Sosnin VK3JST describing an external Track and Hold VFO with a digital readout. The article even solved another problem with older HF transceivers and that was VFO drift. The external Track and Hold VFO is much more stable than the original analogue VFO in the HF transceiver.

I contacted VK3JST about the Track and Hold VFO and if it might be suitable for use with my Kenwood TS-520S transceiver, one thing lead to another and it was decided to produce a printed circuit board for the VFO. Please read the original Amateur Radio articles by Jim Sosnin VK3JST for a technical description, testing and use of the Track and Hold VFO.

2. Introduction

This document is a description of one implementation of the Track and Hold VFO designed by Jim Sosnin VK3JST. His original articles were published in the WIA Amateur Radio magazine Vol. 92 No. 3 and Vol.92 No. 6. Jim's original VFO was constructed using prototype 0.1" perf boards. The implementation described in this document is based on printed circuit boards CFB073 V1 and CFB073 V2 produced by Phil Brown VK2ILO. The design is essentially the same even to the point of preserving the original component designators, R6, C2 etc. After CFB073 V1 was assembled and tested a version 2 of the printed circuit board CFB073 V2 was produced to incorporate some improvements and fix a couple artwork errors.

Some changes have been made to the original design, namely, the addition of a reset chip U3, the addition of an ICSP port X10, the addition of a FTDI compatible Arduino programming port X9 and the substitution of the Arduino Nano with an ATmega328P processor chip. None of these alterations change the original operation of the Track and Hold VFO or the software written by Jim.

3. Applicable Documents

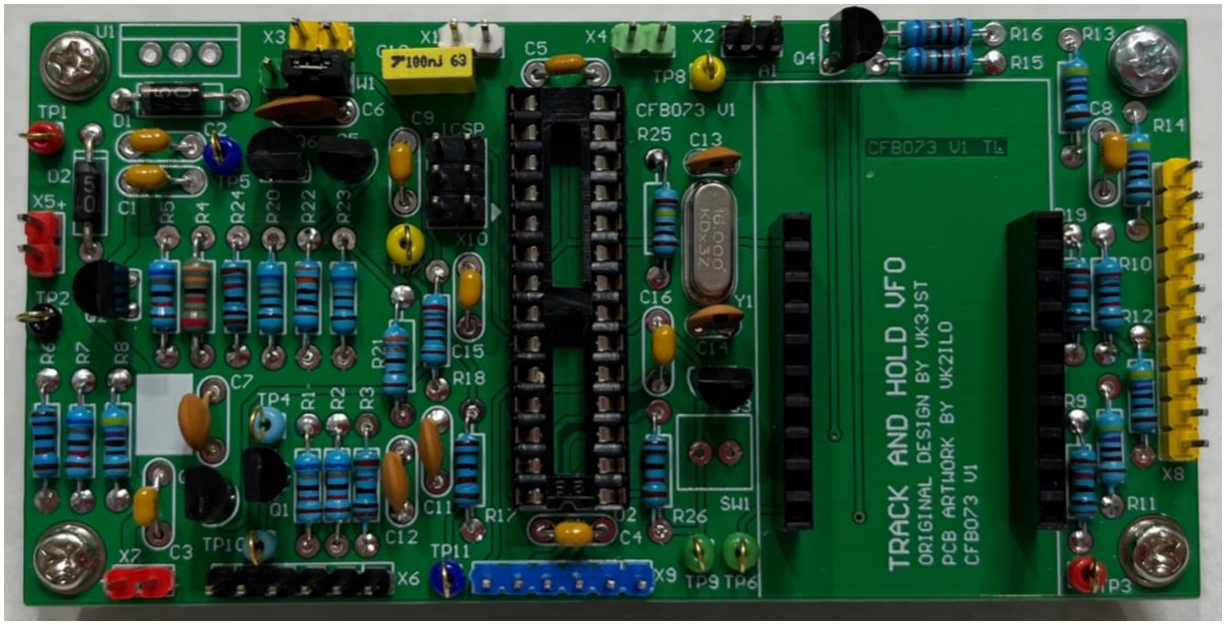
The table below shows the documents applicable to the two different versions of the track and hold VFO printed circuit board.

TRACK AND HOLD VFO APPLICABLE DOCUMENTS		
DOCUMENT	CFB073 V1 GREEN SOLDER RESIST	CFB073 V2 RED SOLDER RESIST
SCHEMATIC	CF115-01-03-0101-02_vfo_schematic.PDF	CF115-01-03-0101-03_vfo_schematic.PDF
ARTWORK	CF115-02-21-0101-01_CFB073V1.PCB	CF115-02-21-0101-02_CFB073V2.PCB
MANUAL	CF115-03-12-xx21-01_vfo_manual.PDF	CF115-03-12-xx21-01_vfo_manual.PDF

Table 1 Track and hold VFO applicable documents

4. The Printed Circuit Board

Photograph 1 below shows the VFO printed circuit board CFB073 V1 with the DDS module removed.



Photograph 1 Track and Hold VFO built on CFB073 V1

4.1. The Printed Circuit Board CFB073 V1

The Track and Hold VFO is built on a double-sided printed circuit board measuring 100mm x 50mm x 1.6mm thick and has four 3.2mm diameter mounting holes to suit M3 screws. The mounting centers are 92mm x 42mm. The board is labelled CFB073 V1. Green solder resist is applied to both sides of the board to help reduce shorts between the pads and adjacent tracks. All solder pads are plated through and have hot air levelled solder top and bottom. The minimum clearance between tracks is 0.2mm.

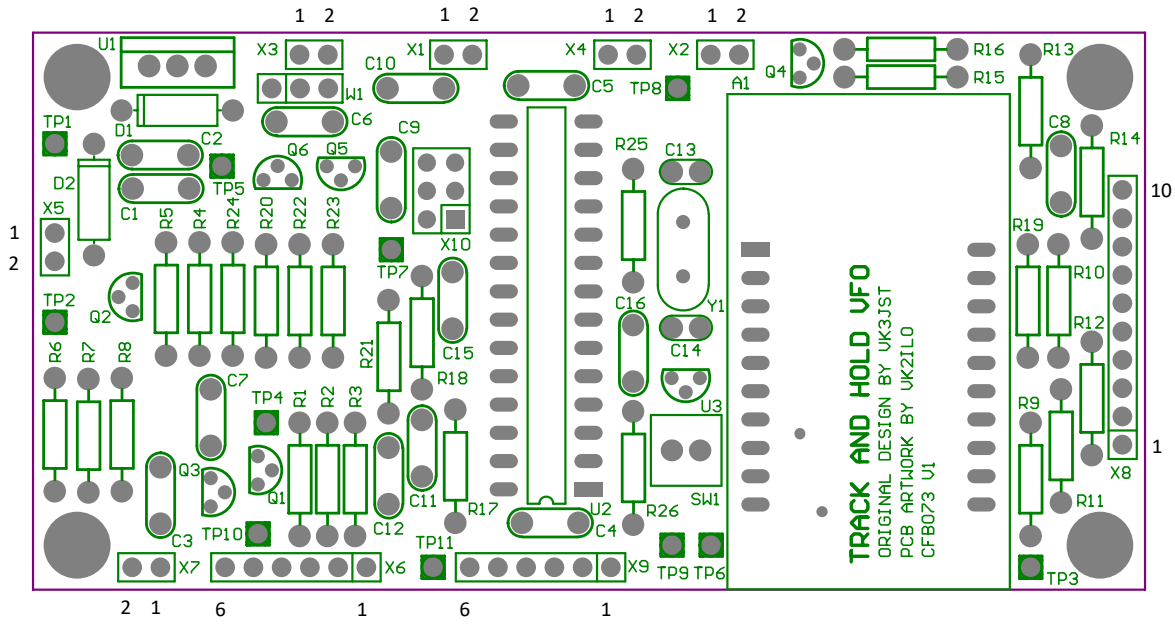


Figure 1 Printed circuit board CFB073 V1 component code (green)

All components have a component designator e.g. R14 adjacent to the component symbol to label the component. The component code is printed in white.

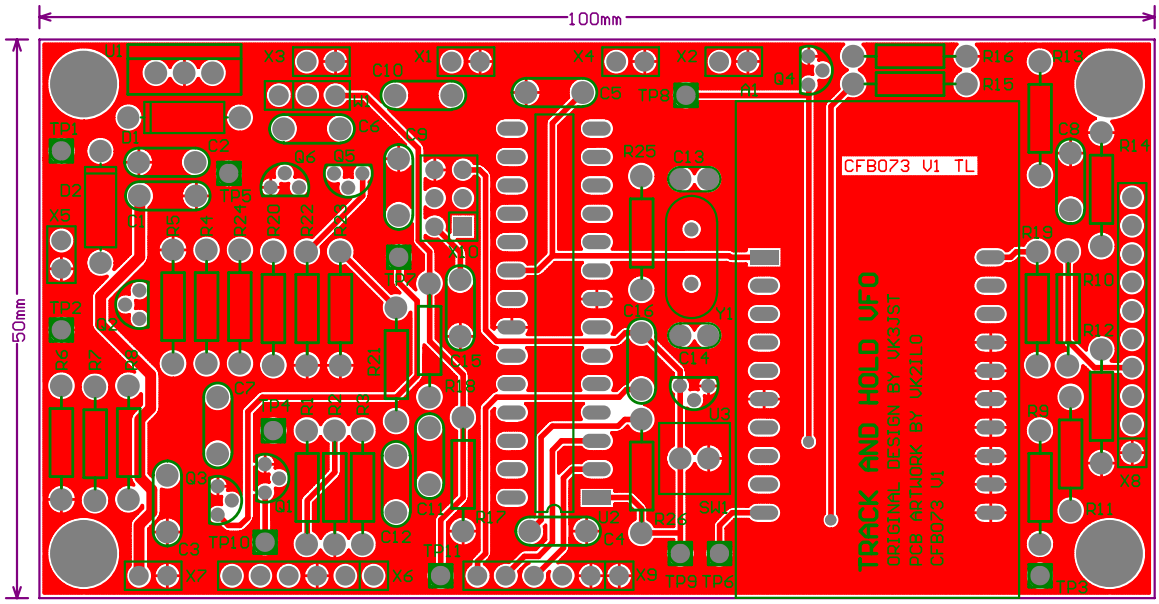


Figure 2 printed circuit board CFB073 V1 top layer (red)

The component or top side of the board (red) has a ground plane connected to 0V or ground to reduce any RF noise that may be induced into the circuit.

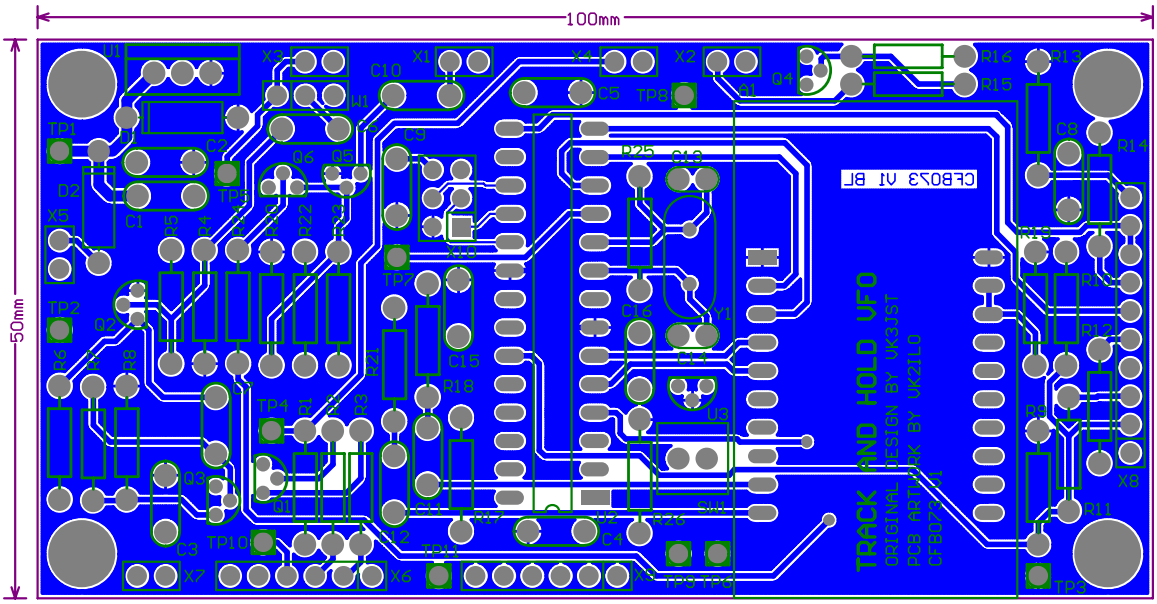


Figure 3 Printed circuit board CFB073 V1 bottom layer (blue) (viewed through board)

The solder or bottom side of the board (blue) has a plane connected to +5V. The board has eleven test points (TP) for testing. These test points can be fitted with wire loop test points or left empty, either way it is easy to make contact with a multimeter or oscilloscope probe.

4.2. The Printed Circuit Board CFB073 V2

Version 2 of the printed circuit board is essentially the same as version 1, except for the following changes:

- The footprint of U3 (MC34064) has been corrected.
- Pin 12 of A1 (DDS) is no longer connected to ground.
- The footprint for SW1 (Reset switch) has been corrected.
- The footprints of X1 – X5 and X7 have been altered to allow polarized connectors. Note that the pin 1 positions have changed from CFB073 V1 due to the polarized connectors.
- The solder resist colour has been changed to red to allow easy identification.

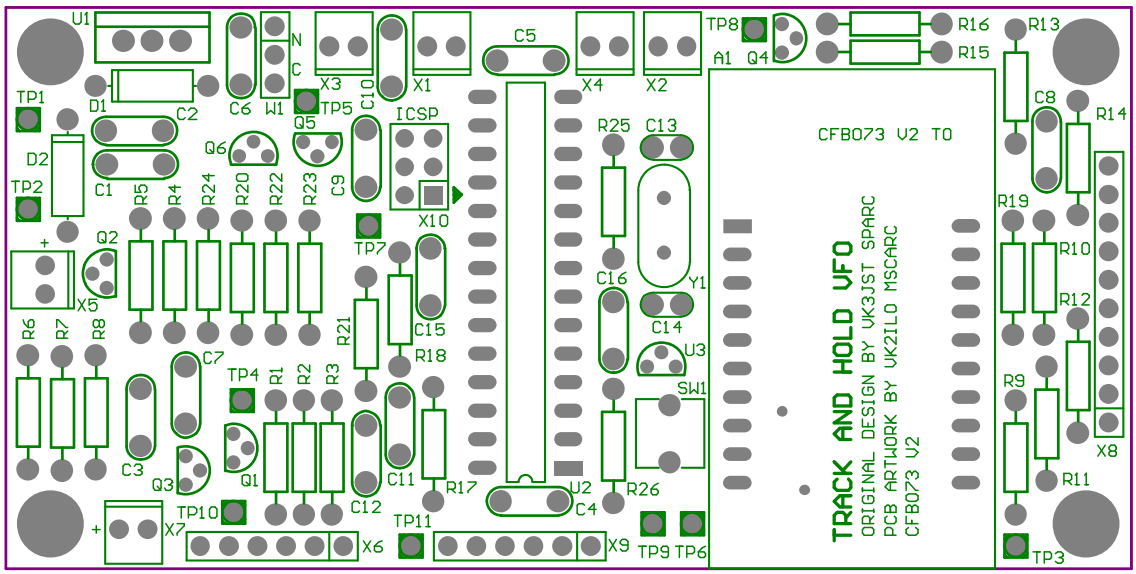


Figure 4 Printed circuit board CFB073 V2 component code (green)

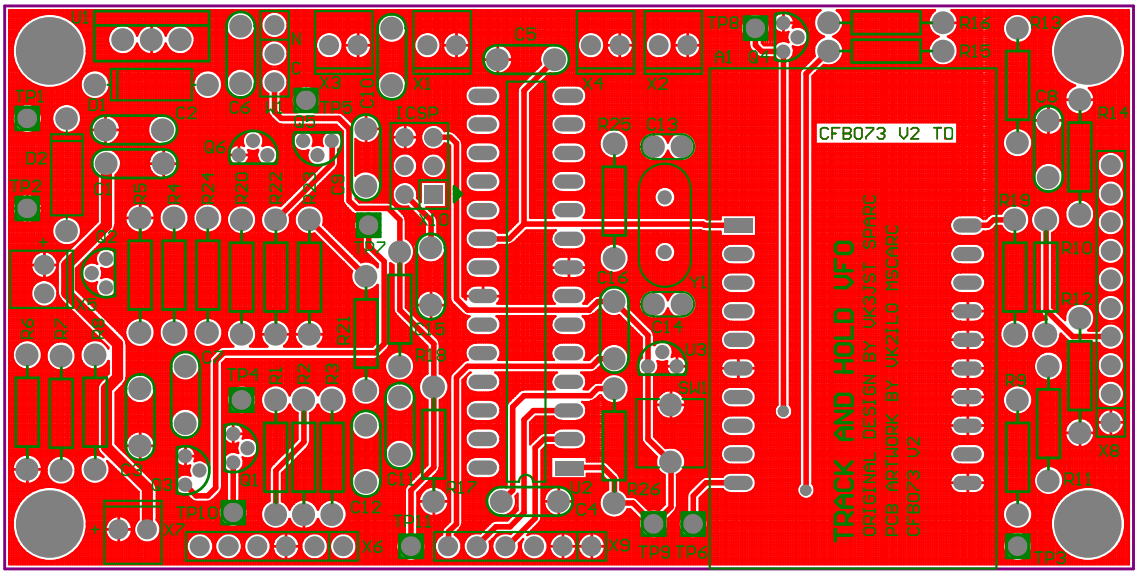


Figure 5 Printed circuit board CFB073 V2 top layer (red)

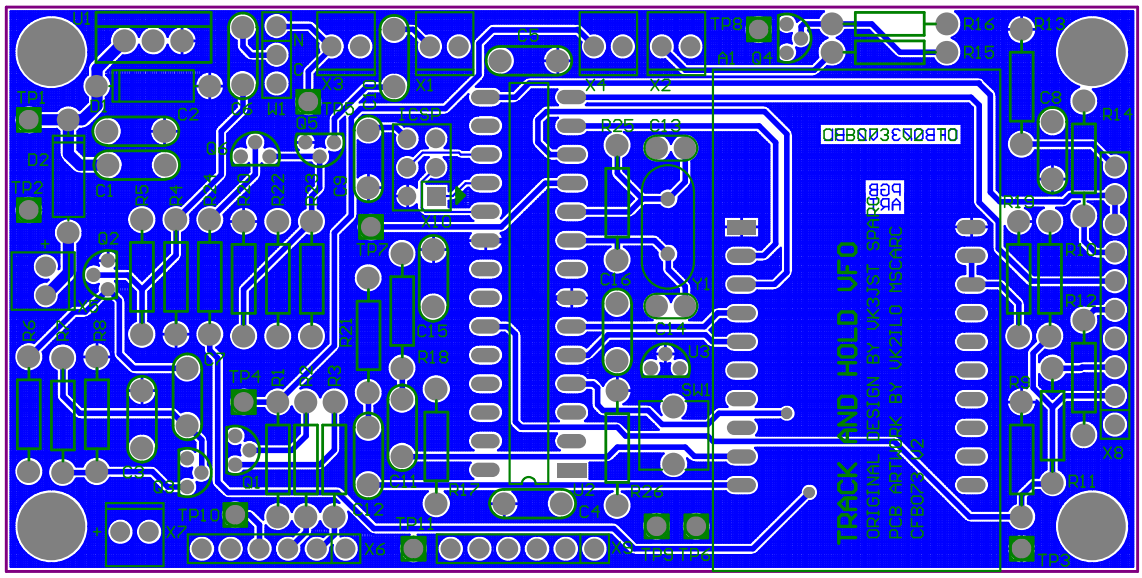


Figure 6 Printed circuit board CFB073 V2 bottom layer (blue) (viewed through board)

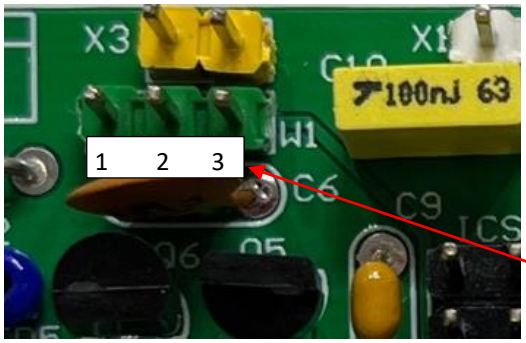
5. Power Supply Connections and Requirements.

The track and hold VFO including the frequency display are supplied power by the host HF transceiver. Most older HF transceivers provide some sort of DC power on the rear chassis panel to power external VFOs or phone patches etc. Most of this DC power is in the range of 8 to 9 volts DC.

Both the track and hold VFO and frequency display have on board voltage regulators. These regulators are capable of accepting an input voltage of 8 to 12 volts DC. Therefore, the typical supply voltage of the HF radio is ideal for powering the VFO and display. Supply voltages above 10V may cause excessive heat dissipation in the on-board regulators of the VFO and frequency display.

The VFO accepts power from the host radio via connector X5 to power the VFO and passes the supply onto the frequency display board via connector X7. This reduces wiring and minimises ground loops.

6. Hardware Programming Links

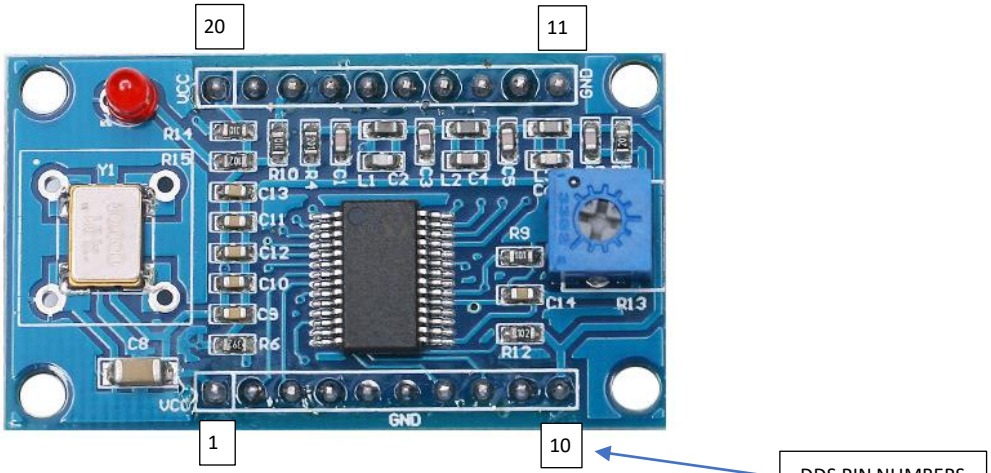


The track and hold VFO is fitted with one three-way hardware programming link W1. This link is used to select normal operation mode or calibration mode. When the shunt is fitted to pins 1 and 2 the VFO is in operational mode. When the shunt is fitted to pins 2 and 3 the VFO is in calibration mode.

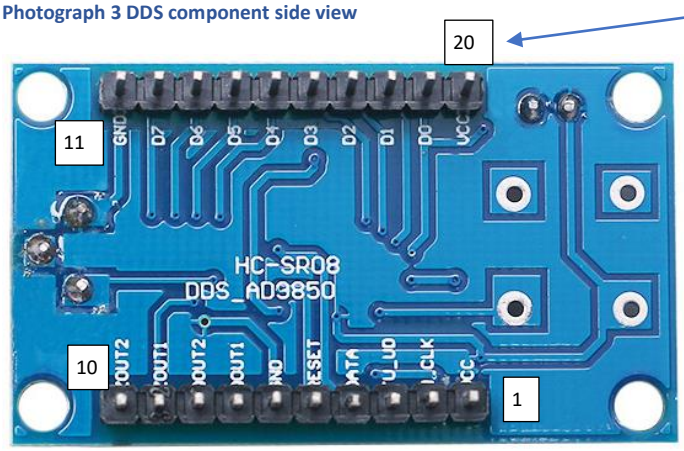
Photograph 2 W1 hardware configuration link

7. DDS Module HC-SR08

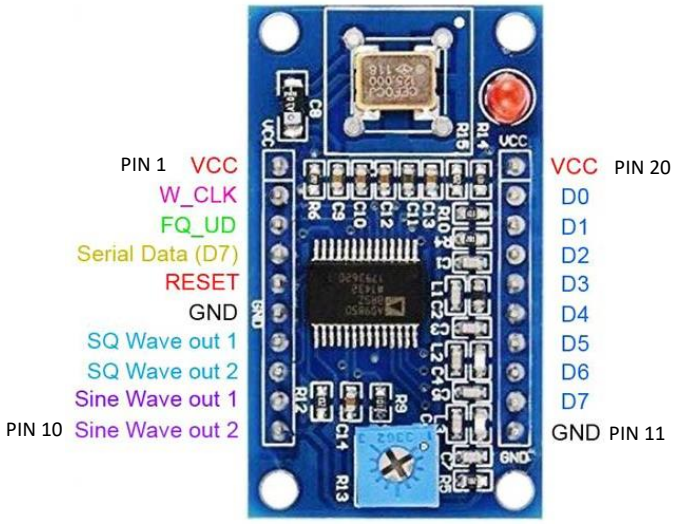
The DDS module is a small printed circuit board module (A1) that is fitted to the VFO to provide a stable clock source for the external VFO. The DDS module is shown in photographs 7, 8 and 9.



Photograph 3 DDS component side view



Photograph 4 DDS solder side view



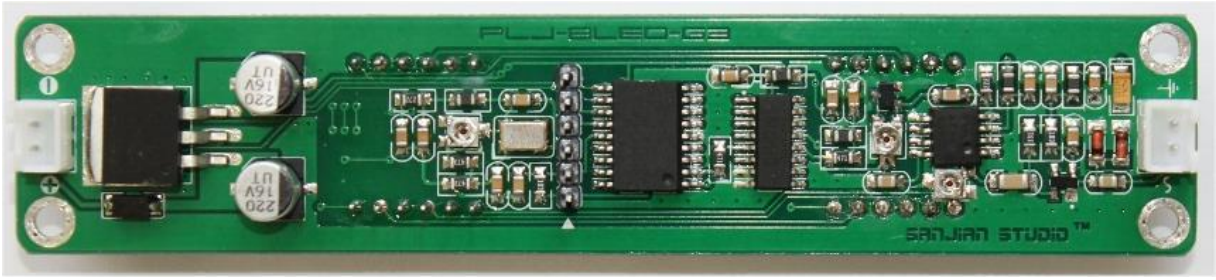
Photograph 5 DDS pin functions

Note: Data line D7 is brought out to two different pins on the DDS module. Pin 4 labelled Serial Data and Pin 12 labelled D7. Version 1 of CFB073 had D7 grounded which grounded Serial Data and prevented the VFO from working. Pin 12 must be removed from the DDS module when used with CFB073V1. If CFB073V2 is used then pin 12 does not need to be removed.

8. Frequency Display Module PLJ-8LED-R or PLJ-8LED-H

Refer to the **8-digit LED Frequency Counter Module Model PLJ-8LED-C user manual V1.0** for detailed information and user instructions for the frequency display module.

Photograph 6 Frequency counter module type PLJ-8LED front view



Photograph 7 Frequency counter module type PLJ-8LED rear view

Figure 7 LED display push button locations

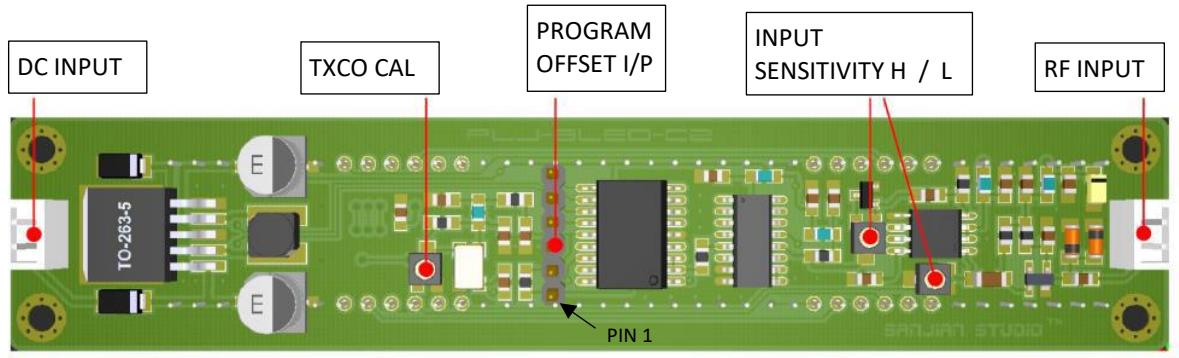
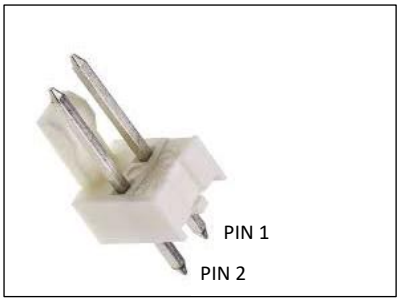


Figure 8 LED display rear adjustments and connections

9. I/O Connector Assignments



Photograph 8 Molex KK 254 connector

The track and hold VFO is provided with ten input – output connectors for the connection to the host HF radio, front panel controls, frequency display, power and programming facilities. All connectors, except X10, are single inline 0.1" headers positioned around the edge of the printed circuit board. The connectors are identified in the PCB component code by their component designator. The component designator is **always adjacent to pin 1** of the connector. Photograph 7 shows the pin orientation of the Molex polarised KK 254 two pin connector, that may be optionally fitted to connectors X1, X2, X3, X4, X5 and X7.

9.1. X1 – External VFO signal to HF transceiver

X1 PIN ASSIGNMENT	
PIN	FUNCTION
1	EXTERNAL VFO SIGNAL TO HOST
2	GROUND

Table 2 X1 External VFO output pin assignment

Connector X1 provides the external VFO signal output to the host HF transceiver. This signal is generated by the HC-SR08 DDS module A1 on the track and hold VFO board. This signal is a sine wave with an amplitude of 300mV peak to peak. This signal is not output when the internal VFO of the host transceiver is in use. This signal should be shielded.

9.2. X2 – Internal VFO power

X2 PIN ASSIGNMENT	
PIN	FUNCTION
1	HOST INTERNAL VFO POWER
2	GROUND

Table 3 X2 Internal VFO power input pin assignment

Connector X2 accepts the host transceiver internal VFO power on signal. This signal indicates if the host internal VFO is being used or not. A low (0V) indicates that the host internal VFO is not in use while a high (+5V to +9V) indicates that the host internal VFO is in use.

9.3. X3 – Internal VFO signal from HF transceiver

X3 PIN ASSIGNMENT	
PIN	FUNCTION
1	INTERNAL VFO SIGNAL FROM HOST
2	GROUND

Table 4 X3 Internal VFO input pin assignment

Connector X3 accepts the VFO output signal from the host radio. This signal is used by the track and hold VFO to measure the frequency of the host internal VFO. This signal is a sine wave with an amplitude of 300mV peak to peak. This signal should be shielded.

9.4. X4 – LSB / USB signal

X4 PIN ASSIGNMENT	
PIN	FUNCTION
1	SIDEBAND IN USE FROM HOST
2	GROUND

Table 5 X4 Sideband input pin assignment

Connector X4 accepts a DC level that indicates whether the upper or lower sideband is selected by the host radio. A low (0V) indicates that the host is operating on the lower side band while a high (+5V to +9V) indicates that the host is operating on the upper sideband.

9.5. X5 – Power Supply

X5 PIN ASSIGNMENT	
PIN	FUNCTION
1	+V POWER SUPPLY FROM HOST
2	GROUND

Table 6 X5 VFO power input pin assignment

Connector X5 accepts power from the host HF radio to power both the track and hold VFO and the frequency display. The supply voltage should be somewhere in the range of +7.5V to +10V, depending on the type and model of the host transceiver.

9.6. X6 – Frequency Display signals

X6 PIN ASSIGNMENT	
PIN	FUNCTION
1	Vpp (Not used)
2	+5V FROM DISPLAY
3	GROUND
4	OFFSET SELECT, 0 = USB, +5V = LSB
5	PGC (Not used)
6	AUX (Not used)

Table 7 X6 Display signal out pin assignment

Connector X6 provides connection to the PLJ-8LED-C frequency display offset select pin. This signal is the inversion of the signal on the input connector X4. A low (0V) indicates that the host is operating on the upper side band while a high (+5V) indicates that the host is operating on the lower sideband.

9.7. X7 – Power Supply to PLJ-8LED-C Frequency Display

X7 PIN ASSIGNMENT	
PIN	FUNCTION
1	+V SUPPLY TO DISPLAY
2	GROUND

Table 8 X7 Display power out pin assignment

Connector X7 provides power for the PLJ-8LED-C frequency display. The output voltage is one diode drop lower than the input voltage on connector X5.

9.8. X8 – External LEDs and Push Buttons

X8 PIN ASSIGNMENT	
PIN	FUNCTION
1	GROUND FOR PUSH BUTTONS
2	LOCK/UNLOCK BUTTON SW4
3	FREQUENCY DOWN BUTTON SW3
4	FREQUENCY UP BUTTON SW2
5	LOCK LD1 CATHODE
6	LOCK LD1 ANODE
7	TUNE (HOST VFO) LD3 CATHODE
8	TUNE (HOST VFO) LD3 ANODE
9	HOLD (DDS) LD2 CATHODE
10	HOLD (DDS) LD2 ANODE

Table 9 X8 Front panel controls pin assignment

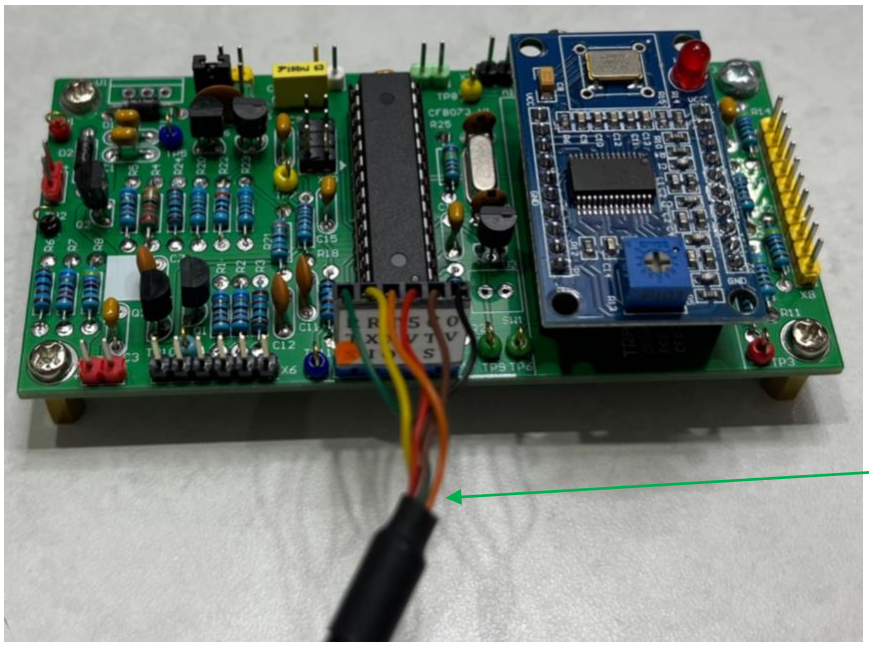
Connector X8 provides connection for the three LED indicators and the three control push buttons of the track and hold VFO.

9.9. X9 – Console Port

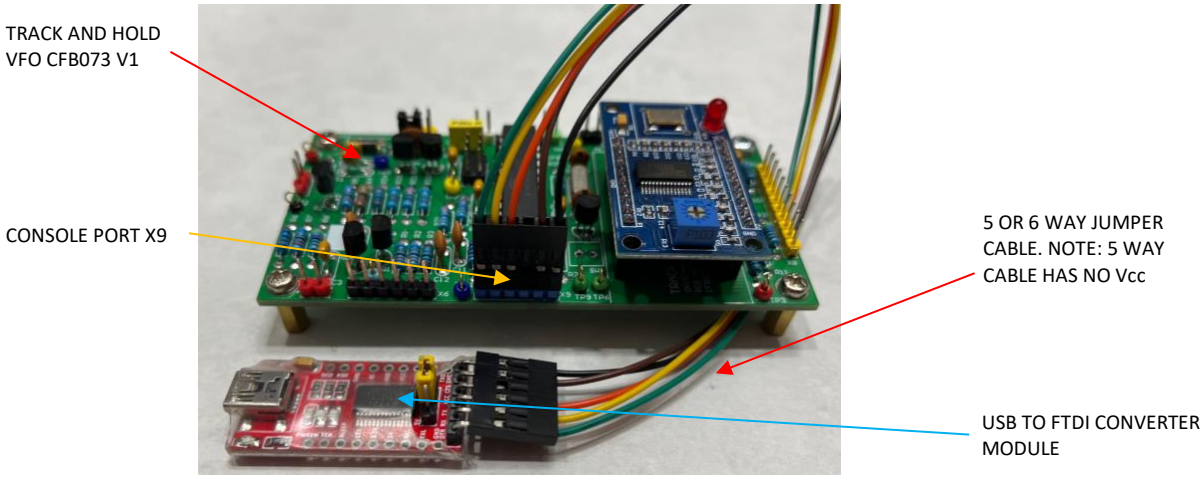
X9 CONSOLE PORT		
PIN	COLOUR	FUNCTION
1	BLACK	GND
2	BROWN	CTS Input to computer
3	RED	Vcc (+5V) output from computer
4	ORANGE	TXO Tx output from computer
5	YELLOW	RXI Rx input to computer
6	GREEN	RTS Output from computer

Table 10 X9 Console port pin assignments

The console port or Arduino Serial port is brought out to a six pin SIL 0.1" pitch header X9. This connector is compatible with the FTDI USB virtual serial port cable standard. The FTDI 232R cable must be a 5.0-volt version to work with the Track and Hold VFO board. The console port is used to download Arduino programs from the Arduino IDE into the VFO. This port will be needed to download the Arduino code into the Track and Hold VFO. See photograph 9 below.

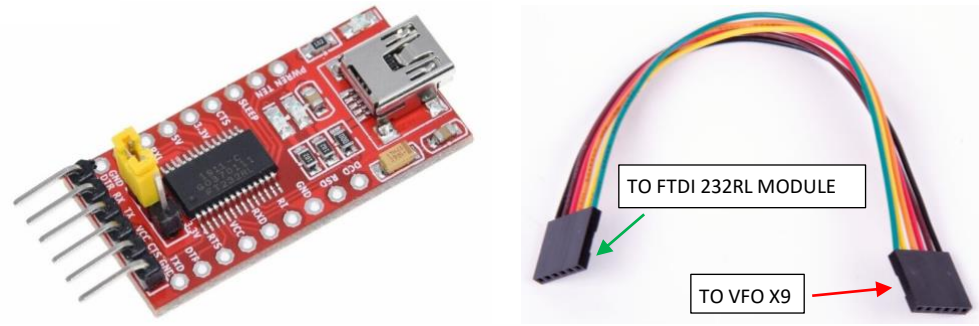


Photograph 9 VFO with FTDI 232RL cable fitted (Arduino IDE – VFO)



Photograph 10 Programming

The FTDI +5V serial cable may be replaced with a FTDI 232RL compatible module and a short six pin cable as shown in photograph 11 below. The module has a link to select the interface voltage of either +5V or +3V3. Ensure that +5V is selected when connecting to X9 on the Track and Hold VFO.



Photograph 11 FTDI 232RL module and 6-pin cable

Note that pin 3 of X9 (Vcc from computer) is not connected to the +5V rail of the VFO. The VFO must be powered via X5 when uploading sketches to the track and hold VFO.

9.10. X10 – ICSP port

The In Circuit Serial Programming (ICSP) port (X10) is a standard 6-pin mini AVR programming port that is compatible with the Atmel AVR In System Programmer type AVRISP mkII. This port is mainly used for programming the Arduino Bootloader but can be used to upload Arduino programs.

However, uploading of Arduino programs is best done using the Console port (X9) and the installed Arduino boot loader.

TRACK AND HOLD VFO IN CIRCUIT SERIAL PROGRAMMING (ICSP) CONNECTOR PIN ASSIGNMENTS		
PIN	FUNCTION	DESCRIPTION
1	MISO	Master in slave out
2	Vcc	VFO +5V power rail (Indicates that track and hold VFO is powered)
3	SCK	Serial clock
4	MOSI	Master out slave in
5	RES	Reset (active low)
6	GND	Ground

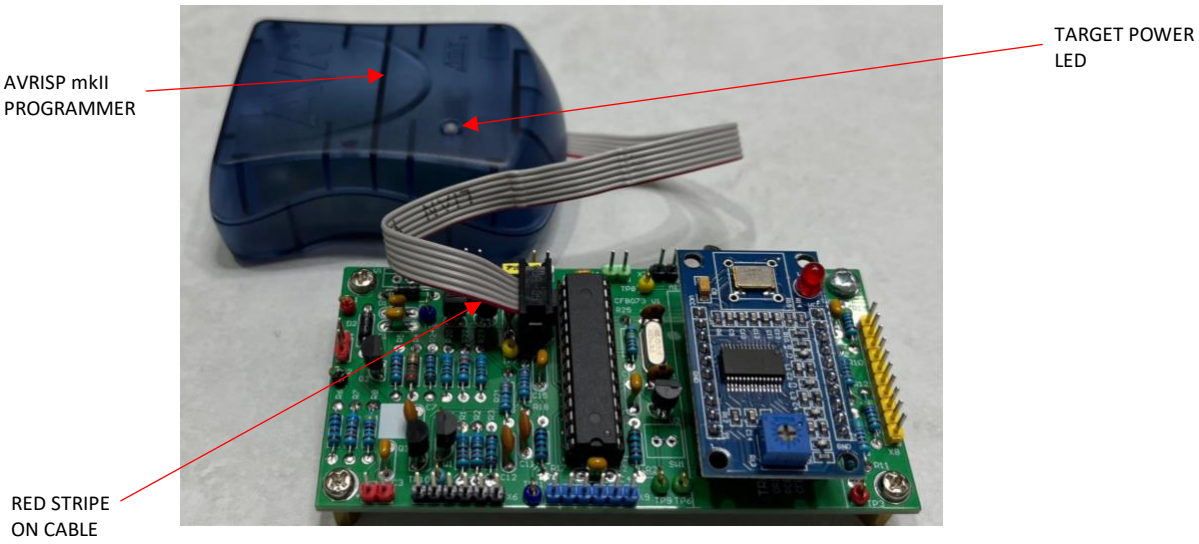
Table 11 X10 ICSP port pin assignment

Pin 1 of the ICSP connector X10 and the AVRISP mkII programmer are marked with a small triangle. Ensure the triangles line up when connecting the programmer to the Track and Hold VFO.

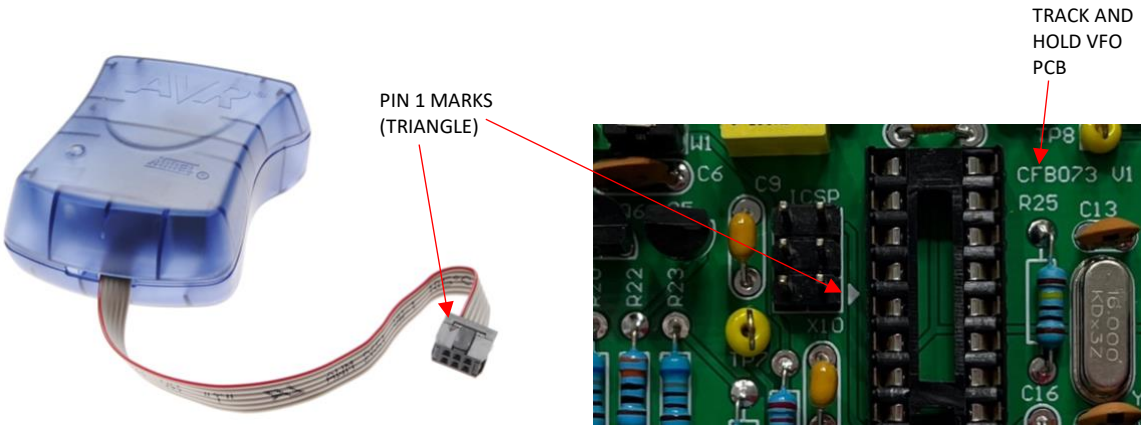
Note that the AVRISP mkII programmer does not provide power to the VFO when programming the Arduino Bootloader into U2. The VFO must be powered via X5 when uploading sketches to the track and hold VFO.

When purchasing the ATmega328P processor for this project you will have the choice of a blank ATmega328P or one with the Arduino bootloader already installed. If you proceed with a processor chip without a Bootloader then you will need to install the bootloader once. Generally, there is no requirement to reinstall

the Bootloader, but should the Bootloader become corrupted it can be reinstalled using the ICSP port (X10) and the AVRISP mkII programmer or similar described on the Arduino website.



Photograph 12 AVRISP Connected to VFO ICSP port X10



Photograph 13 AVRISP mkII programmer and 6-pin cable

See section 10 of this manual for instructions on programming the Arduino Bootloader into the Track and Hold VFO ATmega328P processor.

10. Bootloader and Device programming

For the Track and Hold VFO to function correctly it must have a bootloader installed if it is to be used with the Arduino IDE. This bootloader must be uploaded using the AVRISP mkII programmer and the Arduino IDE. The bootloader is uploaded via the 6-pin ICSP connector X10 on the Track and Hold VFO.

Pin 1 of the ICSP connector X10 is marked by the triangle adjacent to the connector. The connector on the AVRISP mkII programmer cable has a small triangle marking pin 1, this should mate with pin 1 of X10 on the track and hold VFO board.

The bootloader also includes configuration bits for the ATmega328P processor. One of these configuration bits configures the oscillator of the 328 processor. If the bootloader has not been uploaded the ATmega328P 16MHz crystal clock will not oscillate. The 328P processor defaults to an internal RC clock that is not visible on ***any*** of the pins of the processor chip, leading any reasonable technician to the conclusion that the chip is dead!

To upload the bootloader:

1. The Track and Hold VFO board CFB073 V1 or V2 must be powered via X5.
2. Connect the AVRISP mkII to the Track and Hold VFO ICSP header X10 ensuring the correct orientation.
3. The AVRISP mkII power indication LED should change from red to green indicating that the VFO is powered.
4. Start Arduino IDE.
5. Under the Tools menu ensure that programmer is set to “AVRISP mkII”.
6. Connect the AVRISP mkII programmer to the PC running the Arduino IDE.
7. Under the Tools menu select the serial port for the AVRISP mkII programmer.
8. Under the Tools menu click on Burn Bootloader to upload the bootloader to the VFO board.
9. The Track and Hold VFO is now ready to use with the Arduino IDE.

For further details refer to the Atmel AVRISP mkII user manual.

The AVRISP mkII programmer is one of many boot loader programmers that can be used in conjunction with the Arduino IDE. Check the Arduino documentation for details on using these alternate programmers.

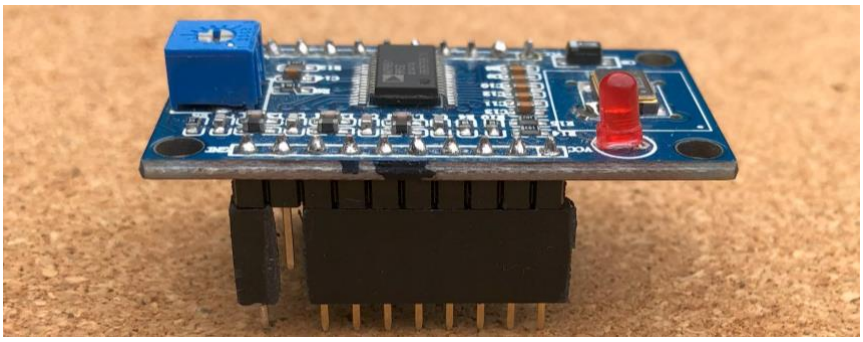
11. Test Points

The track and hold VFO printed circuit boards CFB073 V1 and CFB073 V2 have 11 test points for checking the operation of the VFO and frequency display.

TEST POINTS		
#	NAME	FUNCTION
TP1	Vin	Power supply rail from host radio
TP2	GND	Power supply rail and signal ground reference
TP3	+5V	Track and Hold VFO internal +5 V rail
TP4	-LSB/USB	LSB / USB select signal. Low = LSB, High = USB
TP5	IVO	HF radio internal VFO output signal
TP6	EXT-VFO	External Track and Hold VFO output signal to HF radio
TP7	INT-VFO-OUT	Buffered HF radio internal VFO output signal
TP8	INT-VFO-PWR	Buffered HF radio internal VFO power
TP9	-RES	ATmega328P processor reset signal, active low
TP10	OFFSET SEL	Buffered LSB/USB select signal to frequency display
TP11	CAL	Calibration output from DDS

Table 12 VFO Test points

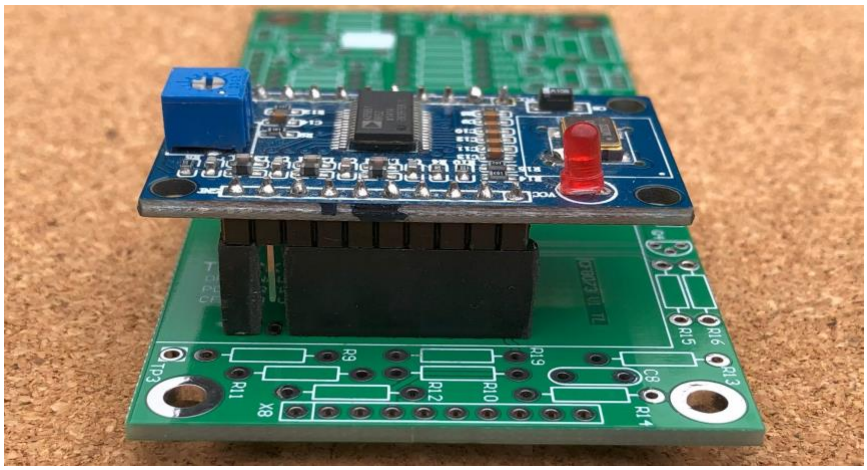
12. Alternate Method of Isolating DDS Data Pin D7 from 0V (CFB073V1 Only)



Photograph 14 Alternative method of isolating DDS D7 pin 12 step 1 (CFB073V1 only)

This section **only** applies when using version 1 of the printed circuit board i.e. CFB073V1.

This section provides an alternate method of isolating data pin D7 (pin 12) than described in sections 7 and 14.3 of this document.



Photograph 15 Alternative method of isolating DDS D7 pin 12 step 2 (CFB073V1 only)

If you do not wish to modify your DDS module by removing pin 12 for use with version 1 of the printed circuit board, the DDS module can be mounted on a modified set of 0.1” header sockets as shown in photographs 14 and 15.

13. Bill of Materials

The table below lists the parts required to build the Track and Hold VFO on printed circuit board CFB073 V1 or CFB073 V2.

TRACK AND HOLD VFO CFB073 V1 OR CFB073 V2 BILL OF MATERIALS		
DESIGNATOR	DESCRIPTION	QTY
A1	Direct digital synthesis module HC-SR08 (AD9850 based)	1
C1, C2, C3, C4, C5, C8, C9, C15, C16	Capacitor mono ceramic 0u1 50V 5mm spacing	9
C6	Capacitor disc ceramic 100pF 50V 5mm spacing	1
C7, C11, C12	Capacitor disc ceramic 820pF 50V 5mm spacing	3
C13, C14	Capacitor disc ceramic 22pF 50V 2.5mm spacing	2
C10	Capacitor polyester 0u1 63V 5mm spacing	1
D1, D2	Diode general rectifier 1N4001	2
Q1 – Q6	Transistor NPN 2N2222 TO-92	6
R1, R2, R5, R7, R15, R16	Resistor 68k ¼ watt 5%	6
R3, R9, R19, R24, R26	Resistor 10k ¼ watt 5%	5
R4	Resistor 33k ¼ watt 5%	1
R6, R17	Resistor 1k ¼ watt 5%	2
R10	Resistor 20k ¼ watt 5%	1
R11	Resistor 4k7 ¼ watt 5%	1
R12, R13, R14	Resistor 470R ¼ watt 5%	3
R18	Resistor 2k2 ¼ watt 5%	1
R20, R23	Resistor 6k8 ¼ watt 5%	2
R21	Resistor 3k3 ¼ watt 5%	1
R22	Resistor 330R ¼ watt 5%	1
R25	Resistor 1M ¼ watt 5%	1
SW1	Switch momentary push button 2 pin 6mm x 6mm, 5mm spacing	1
TP1 – TP11	Test point wire loop. Various colours. Optional	11
U1	Voltage regulator LM7805 or LF7805 TO-220	1
U2	Microprocessor ATmega328P DIP-28 0.3” row spacing	1
U3	Under voltage monitor MC34064 TO-92	1
W1	Header 3 way SIL 0.1” spacing	1
X1, X2, X3, X4, X5, X7	Header 2 way SIL 0.1” spacing or KK 254 AE6064-2 (polarised)	6
X6, X9	Header 6 way SIL 0.1” spacing	2
X8	Header 10 way SIL 0.1” spacing	1
X10	Header 3 + 3 way DIL 0.1 spacing	1
Y1	Crystal 16MHz parallel cut HC49 or HC18	1

Table 13 CFB073 V1 and CFB073 V2 Bill of materials

The CFB073 V1 artwork suited un-polarised 0.1” SIP headers for X1-X5 and X7 which allow connectors to be fitted with the wrong polarity and possibly cause damage to the transceiver or the track and hold VFO.

Polarised 0.1” Molex KK 254 AE6064-2 headers can be fitted to version 1 of the board but the connector body protrudes beyond the edge of the PCB. Version 2 of the PCB will accept polarised or un-polarised headers without this overhang. The Molex KK 254 AE6064-2 headers can be obtained from Jaycar or Altronics.

TRACK AND HOLD VFO COMPONENTS EXTERNAL TO CFB073 V1 BILL OF MATERIAL		
DESIGNATOR	DESCRIPTION	QTY
A2	Frequency counter display SANIJAN PLJ-8LED-R or PLJ-8LED-H	1
LD1	LED Green panel mount TUNE	1
LD2	LED Yellow panel mount HOLD	1
LD3	LED Red panel mount LOCK	1
SW2 -SW4	Switch momentary push button panel mount	3
X1, X2, X3, X4, X5, X7	Header socket 2 way SIL 0.1" spacing with pins DuPont (Optional)	6
X6	Header socket 6 way SIL 0.1" spacing with pins DuPont (Optional)	1
X8	Header socket 10 way SIL 0.1" spacing with pins DuPont (Optional)	1

Table 14 CFB073 V1 external components bill of materials

TRACK AND HOLD VFO CFB073 V1 RUNNING LIST			
#	DESCRIPTION	FITTED & SOLDERED	CHECKED
A1	Direct digital synthesis module HC-SR08 (AD9850 based)		
C1	Capacitor mono ceramic 0u1 50V		
C2	Capacitor mono ceramic 0u1 50V		
C3	Capacitor mono ceramic 0u1 50V		
C4	Capacitor mono ceramic 0u1 50V		
C5	Capacitor mono ceramic 0u1 50V		
C6	Capacitor disk ceramic 100pF 50V		
C7	Capacitor disk ceramic 820pF 50V		
C8	Capacitor mono ceramic 0u1 50V		
C9	Capacitor mono ceramic 0u1 50V		
C10	Capacitor polyester 0u1 63V		
C11	Capacitor disk ceramic 820pF 50V		
C12	Capacitor disk ceramic 820pF 50V		
C13	Capacitor disk ceramic 22pF 50V		
C14	Capacitor disk ceramic 22pF 50V		
C15	Capacitor mono ceramic 0u1 50V		
C16	Capacitor mono ceramic 0u1 50V		
D1	Diode 1N4001 1 amp 100V		
D2	Diode 1N4001 1 amp 100V		
Q1	Transistor 2N2222 NPN TO-92		
Q2	Transistor 2N2222 NPN TO-92		
Q3	Transistor 2N2222 NPN TO-92		
Q4	Transistor 2N2222 NPN TO-92		
Q5	Transistor 2N2222 NPN TO-92		
Q6	Transistor 2N2222 NPN TO-92		
R1	Resistor 0.6 watt MRS25 68k		
R2	Resistor 0.6 watt MRS25 68k		
R3	Resistor 0.6 watt MRS25 10k		
R4	Resistor 0.6 watt MRS25 33k		
R5	Resistor 0.6 watt MRS25 68k		
R6	Resistor 0.6 watt MRS25 1k		
R7	Resistor 0.6 watt MRS25 68k		
R8	Resistor 0.6 watt MRS25 470R		
R9	Resistor 0.6 watt MRS25 10k		
R10	Resistor 0.6 watt MRS25 20k		
R11	Resistor 0.6 watt MRS25 4k7		
R12	Resistor 0.6 watt MRS25 470R		
R13	Resistor 0.6 watt MRS25 470R		
R14	Resistor 0.6 watt MRS25 470R		
R15	Resistor 0.6 watt MRS25 68k		

R16	Resistor 0.6 watt MRS25 68k		
R17	Resistor 0.6 watt MRS25 1k		
R18	Resistor 0.6 watt MRS25 2k2		
R19	Resistor 0.6 watt MRS25 10k		
R20	Resistor 0.6 watt MRS25 6k8		
R21	Resistor 0.6 watt MRS25 3k3		
R22	Resistor 0.6 watt MRS25 330R		
R23	Resistor 0.6 watt MRS25 6k8		
R24	Resistor 0.6 watt MRS25 10k		
R25	Resistor 0.6 watt MRS25 1M		
R26	Resistor 0.6 watt MRS25 10k		
SW1	Switch push button momentary 2 pin 6mm x 6mm		
TP1	Test point loop RED Vin		
TP2	Test point loop BLK GND		
TP3	Test point loop RED +5V		
TP4	Test point loop TUR -LSB/USB		
TP5	Test point loop BLU INT-VFO-OUT		
TP6	Test point loop GRN EXT-VFO		
TP7	Test point loop YEL INT-VFO-OUT		
TP8	Test point loop YEL INT-VFO-PWR		
TP9	Test point loop GRN RESET		
TP10	Test point loop TUR OFFSET SEL		
TP11	Test point loop BLU CALIBRATION		
U1	Voltage regulator 5V LM7805 or LF7805 TO-220		
U2	Microprocessor ATmega328P DIP28 0.3”		
U3	Under voltage monitor MC34064 TO-92		
W1	Link SIL 0.1” 3 way NORMAL / CALIBRATE		
X1	Header SIL 0.1” 2 way EXT VFO INPUT		
X2	Header SIL 0.1” 2 way INT VFO POWER		
X3	Header SIL 0.1” 2 way INT VFO OUTPUT		
X4	Header SIL 0.1” 2 way -LSB/USB SELECT INPUT		
X5	Header SIL 0.1” 2 way POWER INPUT Vin		
X6	Header SIL 0.1” 6 way FREQUENCY DISPLAY		
X7	Header SIL 0.1” 2 way FREQUENCY DISPLAY POWER		
X8	Header SIL 0.1” 10 way EXT LEDS AND BUTTONS		
X9	Header SIL 0.1” 6 way CONSOLE PORT		
X10	Header DIL 0.1” 3 + 3 way ICSP BOOTLOADER		
Y1	Crystal 16MHz parallel cut HC49 or HC18		

Table 15 CFB073 V1 and V2 Component Running list

Table 3 assumes that all wiring to the board will be via SIL headers and header sockets, to save cost, all wiring may be soldered directly to the printed circuit board, if so, then delete all headers except X9 and X10.

Table 4 lists those components external to CFB073 V1 that are required to build the Track and Hold VFO.

If SIL headers and header sockets are to be used then the optional header sockets and pins shown in table 4 will be required. Wires, coaxial cables, screws and an enclosure are also required to construct the Track and Hold VFO but are not listed as these will change depending on the final look of the VFO i.e. internal or external to the host HF transceiver.

The LED display PLJ-8LED seems to come with a suffix of -R or -H while the only manual seems to be for the -C suffix. Some suppliers on eBay don’t list a suffix. The PLJ-8LED-H and PLJ-8LED-R work equally well in the VFO.

14. Printed Circuit Board CFB073 V1 Issues and Fixes

Printed circuit board CFB073 V1 has three main issues that need to be addressed in order to make the complete assembly function correctly:

- The footprint for SW1 (reset switch) pin spacing is 2.54mm (0.1”) instead of 5.08mm (0.2”).
- The footprint for U3 (under-voltage detector) has pins 1 and 3 swapped.
- Pin 12 of A1 (DDS) is inadvertently connected to 0V.

14.1. SW1 Pin Spacing Workaround

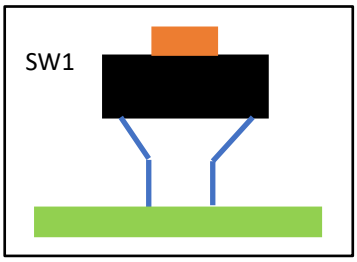


Figure 9 SW1 pin bending

The reset switch SW1 is not required for normal operation of the track and hold VFO. It is only used when debugging code that the user may wish to add to the original code. U3 will provide a clean reset after the +5V rail has established and settled. In most cases SW1 can simply be omitted. Most two pin 6mm square push buttons have a pin pitch of 5mm or 5.08mm. The pins can be bent inwards using a small pair of needle nose pliers, then the inner ends of the pins can be bent again to form two straight pins 2.54mm apart. The switch can then be soldered into position.

14.2. U3 Swapped Pins Workaround

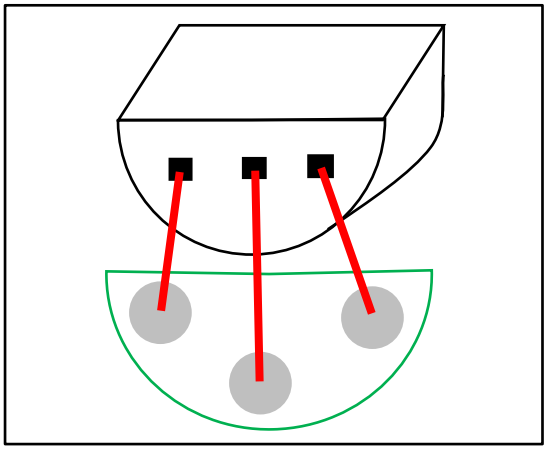
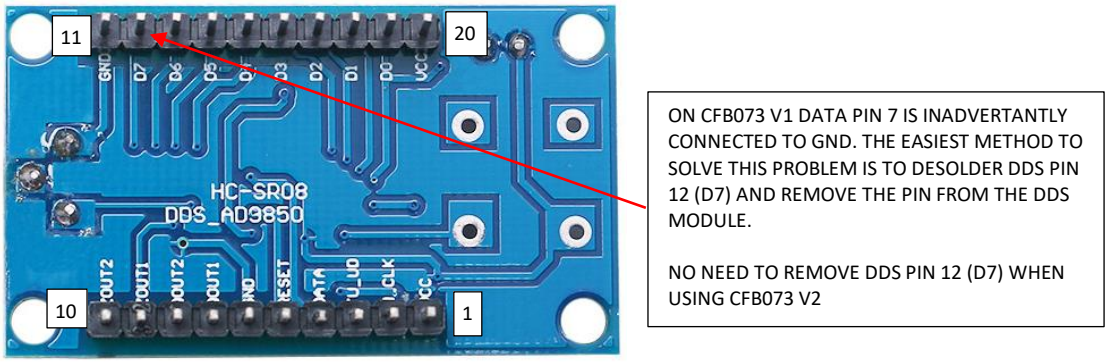


Figure 10 Fitting U3 to CFB073 V1 (only)

To fit U3 to CFB073 V1 spread the legs of U3 out so the tips are roughly 2.54mm apart. Bend the centre pin towards the flat face of the to-92 package so that the tip of the centre pin is displaced by 2.54mm. With the pins facing the PCB rotate the package through 180° in relation to the component code symbol for U3. Fit the pins into the printed circuit board holes as shown in figure 10.

14.3. DDS Module A1 Pin 12 Workaround



ON CFB073 V1 DATA PIN 7 IS INADVERTANTLY CONNECTED TO GND. THE EASIEST METHOD TO SOLVE THIS PROBLEM IS TO DESOLDER DDS PIN 12 (D7) AND REMOVE THE PIN FROM THE DDS MODULE.

NO NEED TO REMOVE DDS PIN 12 (D7) WHEN USING CFB073 V2

Photograph 16 Underside view of DDS module showing pin 12 (D7)

15. Non Display Version of the Track and Hold VFO

As mentioned in the original Amateur Radio article the VFO can be used without the SANJIAN PLJ-8LED-R or PLJ-8LED-H display. If the host HF transceiver already has a digital frequency display, typical of later model Yaesu and Kenwood models, then a second frequency display as part of the VFO is not absolutely required.

If the frequency display is not required then the following components may be omitted from the printed circuit board: X4, X6, X7, R1, R2, R3 TP10 and Q1.

16. Specifications

Name ..... Track and Hold VFO

Type CF115

PCB ..... CFB073 V1 and CFB073 V2

Processor ..... ATMEL ATmega328P DIP28

Clock speed ..... 16MHz @ +5V DC

Processor supply rail voltage ..... +5V DC

Under voltage detector type MC34064 TO-92

Under voltage level 4.6V

Power supply voltage (+Vin) ..... 7 – 12V DC

Power supply current ..... Many TBD???

Power supply filtering ..... Normal mode

Serial port 0 ..... Arduino IDE or console port

PCB Size ..... 100mm (L) x 50mm (W) x 15mm (H)

Mounting hole size ..... 3.2mm dia

Mounting centres ..... 92mm x 42mm