DDS1 MCU CONTROLLER/DDS VFO

HANDS ELECTRONICS
Tegryn Llanfyrnach Pembs
SA35 0BL Tel 01239 698 427

Thank you for purchasing one of our kits. We hope it will give you many hours of service once built. Our aim is to provide satisfaction and service. If you have any problems with the construction or use of the equipment, please ring, or write to us. We will do all we can to help.If you are new to construction we suggest you read carefully the about part identity and soldering contained in the tools and construction section.

Sheldon Hands

Tools and Construction Practice

We recommend the following tools to make your HANDS kit

15/25w soldering iron

small electrical screwdriver

4inch phillips screwdriver

small side cutters

electricians pliers

snipe nosed pliers

small half round file

multimeter

Below are some notes on construction practice with a heavy emphasis on soldering.

You must use solder with a non-corrosive flux. Acid cored solder MUST NOT be used. A 60/40 type will be ideal. The secret of good soldering is to have the correct temperature at the joint. Make sure the tip of the iron is clean, if necessary clean it on a damp sponge. Do not carry solder on the iron to the joint, by the time you get it there the flux will have burnt or vaporised.

Although it seems to contradict the above, do lightly tin the iron before making a joint. This will aid the heat transfer and lessen the chance of damage to the track or component through prolonged application of the iron.When you are ready to make the joint, apply the iron and the solder at the same time. Do not apply too much solder, a thin gauge helps in this respect. Humps of solder on a joint either means you did not leave the iron on the joint long enough or you used too much solder.

Try to get a medium coating over the track and the component lead. If you use too much heat you may damage the track or the component. We suggest you try some test joint on scrap wire, you will find it inspires confidence! When the board is complete check for solder bridges and dry joints, an Ohmmeter can be used for checks.

Most large parts in the kit are readily identifiable, but value identification systems are varied and may pose a problem. For wire ended resistors (ie not SMD) a colour code chart is included at the back of the manual. Most supplies of resistors are coded with 3 bands for the value , i.e. 1st fig, 2nd fig, 3rd multiplier. But we increasingly receive resistors with a 4 band code this then becomes 1st fig, 2nd fig, 3rd fig, 4th multiplier e.g 1k5 = brown, green, black, brown = 1 5 0 0 .

Capacitor identification for electrolytics is straight forward but ceramic caps may pose a problem. Where n values are used n10 = 100pf and 1n = 1000pf, those with just a 3 digit number use the first 2 numbers as figures and the 3rd indicating the number of zeros, i.e. 102 = 1000pf. For those with a 3 digit number followed by letters treat as a 3 digit number, where only 2 digits and a letter are used this indicates the value is less then 100pf i.e. 82J = 82pf and 4.7C = 4.7pf.

Inductor value systems are as varied as capacitors but generally there are two common types. The first uses coloured bands with the same colour values as resistors, the inductors are the same length as a 0.25w resistor but much thicker with flat ends where the lead exits the body.

HARDWARE EXPLANATIONS

Schematic Page 1:

This page shows most of the 'Plugs' to the outside world. It also includes the pots and their connections.

Schematic Page 2:

This page is the heart of the system, as it contains the microcontroller. The input clock for the MCU is provided by the 40 mHz canned oscillator, and then divided by 10 by U3, the 74HC390. The PTT line feeds into the IRQ line via an isolation diode. IRQ is a maskable interrupt to the MCU. Whenever the PTT line is grounded, it will interrupt whatever the MCU is doing, and go into the transmit mode. There is also a line called MPTT, which feeds the IRQ line directly. These must be separated, as the DASH/DOT inputs from the key also drive the MPTT line. The microphone PTT line is connected (off the board) to the MUTE line on the IF board, to make sure that no audio can flow through when you push the PTT key on the mike. Feedback would occur if you didn't have some provision for muting the audio in SSB modes. In CW, you want to be able to hear your own signal, so we bypass the MUTE line via diode D1. The line VCWT goes to the IF board, and turns on and off the carrier oscillator for CW transmission. The A to D converter (Analog outside -- digital inside) is used for 4 different things: RIT, CW SPEED, AGC input, and RF (REF/FWD) input. The PLMA driver of the MCU drives the S-meter, and the PLMB driver is used for the LCD contrast control. The keyboard's inputs are directly fed into some of the I/O ports of the MCU. To save I/O lines, a 74HC164 shift register (U13) is used to synthesize a "data bus". It is clocked serially from the MCU, and the parallel outputs are used for the LCD and DDS chip. The serial bus of the MCU also drives several 74HC595 shift registers to provide the necessary band driver sources. Finally, the EEPROM device (93C56) is also fed with serial data from the MCU.

Schematic Page 3

This page has the AD7008 DDS device, RF low pass filter for the 5 mHz output, Shaft Encoder hookups, power inputs, and Vt and Vr drivers.

Schematic Page 4

This final page contains all of the band drivers for the boards. These are straight forward NPN-PNP drivers.

CONSTRUCTION

- Although the board has been computer checked for shorts and open circuits its still a good idea to check it over. You will also have the opportunity to become familiar with the parts layout.

  DO NOT USE A SOLDERING GUN, OR IRON OF GREATER THAN 50 WATTS TO ASSEMBLE THIS BOARD.

- If you wrongly install a part or subsequently need to remove a part for service you MUST remove on a pin by pin basis. This will mean the loss of the part, but it is the only option otherwise severe board damage will result. Remove the body of the device by cutting all the pins. Heat the pin stubs individually and then remove with pliers.

- If a through plate hole on a ground connection is clogged with solder the only real option is to drill with a 0.6-0.7mm bit. When installing multi pin parts solder one pin only then re-check A its the right part and B the orientation is correct.

> **Do not remove parts in static protection bags until instructed to install them. The DDS and MPU are expensive parts and easily damaged by a static loaded finger!!!! All the socketed ic's will not be fitted until the test and setup stage. All parts are placed on the silk side of the board unless you are instructed otherwise. The silk screen side is the one with package outlines and part numbers.**

- Fit and solder the 0.1uf [104] axial capacitors. Bend the leads at a right angle 2mm from the body and insert tight to the pcb.

- Fit and solder R26 as you did for the axial capacitors.

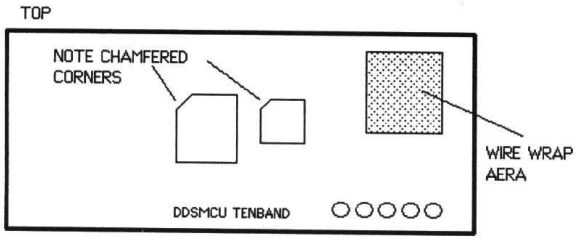
- Fit and solder L2,3 then L1

- Fit and solder the DIP sockets. The cut out in the holder must agree with the package silk screen outline This is also the pin 1 end. Pin 1 is also identified by a square pad. Solder two opposite end pins first and re-check that the socket is square to the pcb. Do not use excess solder as it can wick through to cause a solder splash or bridge on the opposite side of the board.

- Fit and solder resistor network RN1,3. These resistors have a common return pin and can therefore only be installed one way. Pin 1 the common pin is identified by a dot on the package. The board legend Pin 1 is the small square on the end of the oblong outline, this is further identified by a square pad.

- Repeat for RN2,4,6. Check all the networks for solder bridges caused by wicking on the on the silk screen side. A bright light behind the board will assist in this check.

- Fit and solder the PLCC sockets for U2 and U12. The chamfered corner of the socket must agree with the silk screen outline. This is very important as the IC is also chamfered on one corner and will only fit one way. Pin 1 is identified by a square pad.



- Fit and solder the remaining resistors. These are mounted vertically by bending one lead back parallel to the body. Fit the resistor body so that it is within the circle of the outline. Solder the body pad first and adjust the resistor position, then solder the other lead.

- Fit and solder D1,3,4,5. The cathode is indicated by the narrow coloured band on the diode body. This end is identified by the circle within the package outline on the pcb. Install vertically as for the resistors.

- Fit and solder the Berg pin headers for P1,2,3,4,5,6,7,9,10,11,12,13,14,15. Snap off from the long length as required.

- Prepare the 16 pin right angle header for the LCD display. Remove the inner line of pins by nicking along the back of the pins with a sharp craft knife. Use a swipe action, the pins will part from the header when sufficient depth has been cut. Do not attempt to part with wire cutters as the lateral force will break the header.

- Install with the straight pins to the pcb with just 1-2mm protruding on the solder side and the angle pins pointing to and above U13. Solder out of vertical to improve the clearance to U13.

- Fit and install the Tantalum bead capacitors C2,5,7,17,18 then the 1uf unit C3. These are all polarised and must be installed with the + sign on the body in agreement with the + on the pcb legend. The pcb positive connection is further identified by the a square pad. [reverse connected tantalum capacitors can explode !!!!]

- Fit and solder the disc ceramic capacitors C13,15,16. Pre- form the leads to suit the hole pitch, do not force the capacitors down.

- Fit and solder Q3,U15,U16. The package outline must agree with the silk screen ledged.

- Fit and solder Q1,2. The double line side of the outline indicates the face with the metal insert on the transistor.

- Install BZ1 Piezo element on the solder side of the pcb. Solder in place from the silk screen side.

- Fit the pcb stand offs to the board.

- Fit the LCD display on the solder side of the pcb. DO NOT ATTACH THE CABLE CONNECTOR. Bolt in place using the plastic washer to isolate the bolt head at the hole adjacent to U5 on the silk screen side.

- Prepare S1 by filling if necessary the solder pins to fit the pcb pad holes. Install S1 from the solder side of the pcb and adjust its spacing from the board so that the

shaft thread is through the front panel. Solder the three pins from the silk screen side.

- Install VR1-5 on the board from the solder side. DO NOT SOLDER YET. Fit the 3/8 washers over the shaft bushes being careful that washers do not overlap between pots. Fit the pcb to the panel and locate the potentiometer shaft bushes in the panel holes. Mount the pots to the panel and recheck all alignment. Solder the potentiometer pins to the pcb.

- Remove the pcb from the panel and re-flow the VR1-5 pot pins from the solder side paying particular attention to the ground plane connections.

- Attach the 8 pin socket header to the keypad and insert the socket through to panel and locate the pins on the pcb. Locate the keypad plastic pins on the panel until the keypad is down tight. Solder the socket pins to the pcb at the pre-determined distance. Solder from the silk screen side.

- Prepare the shaft encoder for installation. Cut 3 x 40mm lengths of the 20swg tinned copper wire. Cut off the solder tags on the shaft encoder and insert one wire length through the rivet from the rear of the encoder. Solder to form a tail to the rear of the encoder. Repeat for the other two connections and pre-form the tails to fit the 0.1 pitch of the pcb at the SE1 pcb pads.

- Insert the encoder tails in the pcb from the solder side and offer the pcb assembly to the panel. Fix the pcb in place and screw up the encoder panel bush. Solder the encoder tails to the pcb from the silk screen side.

- Fit and solder U1. The continuous double line side of the outline indicates the metal tab on the transistor [this is the outer edge of the board]. The centre leg is a ground connection, as the pad is through plated to the ground plane it will take a lot of heat to flow the solder correctly. On completion check this leg from the IC to a stand off for dc continuity.

Test

- Visually check the pcb for dry joints, solder splashes and bridged tracks or pins due to solder wicking.

- Make up a cable shell with 2 leads for +13.8v and ground to suit P1.Check for a +5 to Ground and a +12 to Ground short. This is easily done by using an ohmmeter in an R x 1 mode.

- Connect the pcb to a 13.8v dc supply through a multimeter on at ampere range. Switch on and check that the current is around 10ma.

- Re-connect normally to the supply and measure the output of the 78T05 regulator, make sure that it is +5v. This easily checked at the 5v pads in the wire wrap area. This will indicate correct operation of U1.

Remove as indicated below the static sensitive parts from their package and install. Do not wear nylon clothing during thisoperation, do not wave the ic about and do not touch the pins directly. Discharge any body static on your person by touching a suitable ground point such as a copper central heating pipe.

- Fit the Canned oscillator U4. The dot on the package indicates pin 1.
- Install U3. If a frequency counter is available power up the board and check for operation of the oscillator and the U3 divider chain.
- Disconnect from the supply and fit the remaining ic's BUT NOT the MPU or DDS chip.
- Reconnect the supply and check for any power rail problems. Disconnect the supply and install the MPU and DDS. Also plug in the LCD onto the 16 pin Berg strip.
- Re-connect the supply. Hold down the 4 button on the keypad and turn on the power switch. Release the 4 button and adjust the RIT control for correct contrast. Press the 1 button to load the setting into in memory.
- Check the SIG pin for frequency output Turn the shaft encoder and check that the frequency steps.
- This completes the tests and further checks on other functions are best carried after interfacing with the RF deck.

STARTUP

The recommended steps following RF board assembly are listed below:

1. Reset the memories. 2. Adjust LCD viewing angle 3. Checkout proper operation on all bands 4. Go through calibration routines 5. Operate and have fun!

- FIRST RESET THE MEMORIES

The first time you power up the radio, go ahead and make sure that the EEPROM is properly initialized. You can do this by holding the number 3, and turn the power on. Wait 5 seconds, release the button, then turn off the power. This will set all the memory channels to 7.0000 mHz, LSB. If in any of the later calibration routines you find yourself lost, or the radio is doing things that don't seem logical, go ahead and perform this master reset.

- LCD VIEWING ANGLE ADJUSTMENT

Hold down the number 4, and turn the power on. Rotate the RIT potentiometer until you are seeing some text on the LCD, and it appears clear and legible. This is setting the viewing angle of the LCD. When you are satisfied with the display, press the number 1. This will save the contrast value into EEPROM. You need not do this procedure again, unless you want to change the way the display looks.

OPERATION

Operation of this board in a transceiver is probably not unlike those that you have used before. The major difference is that YOU built it, and basically understand how it works (at least from a hardware point of view). When you turn on the radio, it uses default values for the oscillator and S-meter operation, and has all ten memory channels set to 7.00000 mHz LSB.

° Keyboard Operation

The keyboard has sixteen buttons, but many more functions than available keys. We have chosen to use one of the keys as a shift key, like on a typewriter keyboard. Through this key, we can access all of the functions. The functions are broken up into three separate categories. They are:

Primary Functions	2nd Functions	3rd Functions
0 - 9	MODES	KEY
	PREAMP	LIGHT
ENTER	AGC	BEEP
RIT	MEMORY IN	LOCK
UP BAND	MEMORY RECALL	SLOW
DOWN BAND	A/B VFO	FAST
2nd	AB BA	SPLIT
3RD	TUNE	FILTER

For example, to change to the LSB mode, you would press '2nd', followed by the number 1 key. When you press the '2nd' key, the LCD will show that you are in the second function by displaying a '2nd'. To toggle the backlight function, notice that the 'LIGHT' key is a 3rd function. Press '2nd', '3rd', 'LIGHT'.

ENTERING FREQUENCIES First, use the 'UP' or 'DWN' key to select the band that you wish to operate on. Next, enter the frequency by pressing the appropriate number of keys. For example, to get to 7.125 mHz, use the UP/DWN key to get to 40 meters. Press '1','2','5','ENT' to change the digits on the right hand side of the decimal point. If 7.100 is desired, only press '1','ENT". The software routines will assume all 00's to the right. This version of software does not allow you to enter the mHz, or use the decimal point key.

RIT - RECEIVER INCREMENTAL TUNING ON/OFF This is a primary function, meaning that you need only press one key to turn it on and off. If off, obviously, no offset is added to the displayed frequency. If you turn on RIT, then the RIT pot will shift the received frequency either plus or minus. The offset is roughly +/- 2.5 kHz. RIT is not active in the SPLIT mode. The display increments in 20 Hz steps, so you will only see even numbers.

A/B Select VFO A or B

There are two VFOs accessible within the system. To shift between them, press the A/B key. The display will show an 'A' or 'B' on the right hand-most position to distinguish which VFO you are operating on. Whenever you are entering/changing frequencies, the TOP frequency is the receive frequency, and the one that the shaft encoder and keyboard will modify.

AB Load VFO B with VFO A Frequency

BA Load VFO A with VFO B Frequency

SPLIT Split Mode Toggle This function allows you to transmit and receive on two separate frequencies (in the same band). The TOP VFO is used for receive, and the Bottom VFO is used for transmit. The A/B button will switch the frequencies between top and bottom positions on the LCD. Note that during split mode CW operation, we do not recommend split frequencies of 100 kHz, due to SYNTH lock-up time constraints. SSB should be better, due to the inherent delay of PTT to voice application.

MODES In this version of the software/hardware, the only modes that are available for the user are: LSB, USB, and CW.

MIN - MEMORY ENTER This is the memory input mode. To place a specific frequency in memory, press the '2nd', 'MIN', '0-9', where 0-9 is the specific memory channel that you wish to store the current VFO and mode.

MRCL - MEMORY RECALL This is the memory recall mode. To recall a specific memory channel to the current VFO, press '2nd', 'MRCL', '0-9', where 0-9 is the specific memory channel to get the data.

KEY - KEYER TYPE SELECT This is a toggle function that selects between the internal keyer, and an external straight key. The straight key should be connected to the 'dot' connection on the plug. There is no LCD indication of its state.

LIGHT - BACKLIGHT ON/OFF This is a toggle function that turns the LCD backlight on and off. It also controls the lamps within the S-meter. There is no LCD indication of its state (other than the light itself).

BEEP - BEEP ON/OFF This is a toggle that turns the beeper on and off. With each press of the keypad, a short beep is generated to let you know that you really pressed the button. If it becomes annoying, press this key to silence the beeper. There is no LCD indication of its state. The default state is on.

LOCK - ENCODER LOCK This is a toggle function that turns the shaft encoder on and off. There is no LCD indication of its state.

FILTR - FILTER SELECT This key provides a signal which will select an alternate filter for receiving purposes. There is no LCD indication of its state. You could attach an LED with appropriate dropping resistor to the FIL line, should you desire some type of indicator. Refer to Sheldon's documentation for proper implementation of this signal.

TUNE - TUNE This key will turn on the transmitter, allowing adjustments to be made without having a key attached. Press any key to cease transmitting. It is a toggle function, and there is no LCD indication of its state.

AGC - AGC ON/OFF This is a toggle function that turns the AGC on and off. An 'A' is displayed on the LCD when the AGC is active.

PRE - PREAMP ON/OFF This is a toggle function that turns the internal receiver preamp on and off. A 'P' is displayed on the LCD when the preamp is on.

CALIBRATION

FREQUENCY. This routine is accessed via Function 8. The routine allows the vfo output to be altered in relation to the display. The default output is 5.5mhz at the lower band edge with the vfo frequency decreasing to 5.00 at the top band edge. This suits a 9mhz IF with high side LO injection. The output frequency may be changed to a full 1mhz bandwidth for any band supported by the display. e.g. on the Hands PLL6/10 synth the DDS output may be changed to give 10mtr as 28-29mhz and 29-30mhz. This is limited by the spectrum purity of the DDS [typ 15mhz max] and the correct LPF [deafault 7mhz].

The routine allows a further 'add in ' due to any frequency error due to mix osillators on pre-mix or pll systems.

- Turn off the DDS power switch. Hold down key 8 and turn power back on. The new screen on the LCD is ready for the band entry number. These are-:

0] 1.8mhz	6] 21.0mhz
1] 3.5mhz	7] 24.0mhz
2]7.0mhz	8] 28.0mhz
3]10.0mhz	9] 29.0mhz
4]14.0mhz	
5]18.0mhz	

- Key in the required band number and press ENT. Display will now show 00.00 on top line

- Calculate the required correction number

  Example -: to change vfo to suit Hands PLL10 on 10mtrs for 28-29mhz and correct offset in PLL mixer xtal.

LCD display for lower band edge	28.000
VFO frequency for lower band edge	6.000

	34.000

- Enter the number by pressing keys 3,4, the . decimal point key then ENT. [the display will not update until the decimal key is pressed]. The MPU will now store the offset in the EEprom and offer a new screen for the next entry. To exit and check the result press R.

- Attach a frequency counter to the DDS output and check that for 28.000 the frequency is 6.000 mhz. and for 28.500 the frequency is 5.5mhz

- Attach the counter to the LO output on your pre-mix or syth board [SYN OUT on PLL6/10 and read the frequency for a display of 28.000. Any offset will be due to the pre-mix or pll xtals.

Example Display 28.000 with Hands pll. SYNTH OUT should be 37.000mhz but counter reads 37.0027

offset number from privious calculation	34.000
high error on xtal osc in pre-mix	.0027

Subtract high[add low]	33.9973

- Now re-program using FUN8 as before but use new number 33.9973

S-METER CALIBRATION

To calibrate the s-meter, press the number 5, while applying power. Disconnect the antenna, (make sure no signals are present, because this operation sets the AGC Floor). Whenever things are quiet, press . This completes the calibration.

SET SLOW/FAST STEP RATES

This mode allows you to customize what the 'slow' and 'fast' rates are for the shaft encoder. To enter this mode, press 9 as you turn on the power. The first value that you set is for the slow mode. Enter a two digit number which equates to the number of 10 hz steps you require. For example, a 10 hz step size will be 01. A 100 Hz step size will be 10. Press ENT. Now, enter the two digit for the fast mode. Press ENT again and you will return to the normal mode of operation. If you enter 99, you will be zipping along at 9.9 kHz per step. zooooooooooom!