Operation Manual for TFT VFO/BFO for uBitx with simplified UI and additional facilities with CAT

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A colored display with touch screen based control of a rig gives user an easy to operate system. Some of the homebrewed rigs and semi-assembled rigs provide limited text LCD displays which are simple looking and sometimes not easy to operate. The TFT with touch screens have become quite easily available at affordable price and along with micro-controllers like Arduino provide good combination of looks and control. MCUFriend TFTs are designed specifically to physically match with standard Arduino (Uno, Mega etc) and provide a single unit to be incorporated in the homebrewed transceivers. We have attempted to create such controllers for Bitx and uBitx. The low cost Si5351 programmable generator ICs were introduced a few years back and experimentation by many hams found these to be suitable for use with Bitx/uBitx. Our earlier version of this display system was designed to be quite flexible for experimenters and with number of features incorporated, the display became quite congested, button sizes had to be reduced and one really needed a stylus to operate the TFT by touch. A need was felt to incorporate a few more features and to simplify the display, which gave birth to this new User Interface with larger touch buttons and multiple screens to take care of less frequently used features. (Older version link : https://vu2spf.blogspot.com/2018/08/new-version-3.html)
CAT emulation is also available in the current version. It emulates Yaesu's new cat commands like in FT-2000 and latest rig models.

The new UI was designed to simplify the display and to make it usable with fingers rather than needing a stylus. The main screen has only those buttons required for day to day operation of a rig. All adjustments are shifted to other screens with larger characters and larger easy to operate touch buttons. In addition to existing features, in this new avatar, the essential parameters stored in memory also can be backed up and restored from another portion of memory. A dump of all parameters in memory, on serial terminal, is also introduced, which can be used to copy/ store essential settings on a PC.

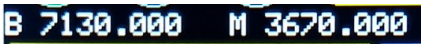
Button Types: All touch buttons are surrounded by a colored border. The white borders indicate buttons which are of touch type (like push to on), the yellow bordered buttons are two sided, whose content changes by touching the left or right half of the button (like volume control on cell phones) and those with Purple border are Labels which are for information only. The Red bordered buttons are for navigating to next or previous screen. (the colours are not captured correctly from TFT , white looks bluish)

Screens: We call the four different screens as Screen 0 (Main), Screen 1 (BFOs and Offsets), Screen 2(PTT, Smeter and Touch Sensitivity) and Screen 3 (Memory related Operations). Each of these are described below.

Main Screen (0)

VFO Buttons: This screen has buttons needed to operate a rig. As seen in the picture the three VFOs are labeled as A, B and M. One of the VFO is selected by touching the circular button once and the selection of VFO is indicated by its Green colour. The second touch on the same VFO button will put the rig in Transmit mode and its corresponding button would become Red. This is equivalent of PTT on microphone which may also be connected. (A, B and M buttons are white bordered). If VFO is changed while in Tx mode, the rig will be first put to Rx mode and then change the VFO. There are 100 memory channels for storing frequently accessed stations. The M VFO button has a channel count displayed on its right which indicates the channel number selected [1 to 100]. The number can be incremented or decremented by touching the elongated channel button on its right or left half. (If the step size [described below] is 1kHz or higher this channel counter changes in steps of 10 and when the step size is less than 1kHz the change is in steps of 1. When the rig is in Tx mode the memory channel can not be changed.

Unselected VFOs: Current frequencies of other unselected VFOs are shown on the line below top VFO indicators for information.



Operating frequency (VFO): The frequency of operation is displayed in larger fonts near the center. The frequency could be changed by touching the button on its left or right half. (Its a yellow bordered button). A rotary encoder connected to proper pins of Arduino also varies the VFO frequency. During Tx frequency cannot be changed.

VFO Band Limits: Legal band limits are set inside the program and can be modified by user. Changing the band limits as per requirements of different regions is explained below. Initially one frequency within each band is programmed as default start frequency. For changing the default start frequency, tune to the desired frequency and save it using SAVE button on one of the following screens.

Side Band: Lower or Upper Side-band is selected by the button to the right of VFO.

Band and Step Size : One of the pre-programmed band can be chosen using the two sided Band button. Selected predefined amateur band is displayed in Green within the band button and the next lower or higher band may be selected by touching the white lettered band names on its both sides. This is a round robin type of display and moves in both the directions.

On the right side of Band button a similar display and button is used for selecting the step size which is used for changing the frequencies. During Tx the band change is not allowed. A special “VFO” band covers full HF (1-30MHz) and is meant for General coverage receive. Tx is not allowed when VFO band is selected / and VFO is not in allowed limits.

VFO ↔ Memory exchanges: The V> M button saves the currently selected VFO to currently selected memory channel and the M>V button will copy the frequency in current memory channel to the selected VFO. If you want to store your daily net frequency just tune in to the net frequency in VFO A or B, select memory channel where it is to be stored (say ch#10), using the channel counter next to M button and then touch V>M button. Briefly its colour will change to Red to indicate memory write operation. Next whenever you wish to tune in to that frequency just select channel 10 and VFO M. Alternately it may be copied to currently selected VFO A or B by M>V button. M>V button does not operate during Tx.

A simple **S-meter** shows audio derived signal strength by a moving pointer. This is a relative meter and its upper and lower limits are set from Screen 2.
The red bordered button with → arrow opens next Screen (1).

BFO / Offset Screen (1)

BFO and Offset adjustment: There are two BFOs in uBitx. Both need to be tuned for getting correct reception and transmission. The changes on this screen are affected by the step size selected in the Main screen. As it is easy to step back to main screen using arrow buttons (described below) fine tuning of BFOs with 1 Hz step is possible. This screen has three main adjustments.

VFO Frequency: On top line it displays current frequency of operation. This frequency can also be adjusted by touch or rotary encoder as in the main screen.

BFO1 and BFO2 controls: The two BFOs are next. Both BFOs are adjustable with the step size defined in Screen 0. When a station is tuned, the two BFOs are adjusted to get the best audio. BFO1 needs to be **around** 33MHz for LSB and **about** 57MHz for USB while BFO2 is tuned to fixed frequency of 12MHz (actual frequency of BFO2 may be 11.993 MHz). These values are varied to get the best audio for a known frequency station (initially it may be somewhere near the known frequency).

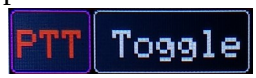
Offset adjustment: If the station does not tune on desired frequency but somewhere nearby, the offset adjustment will bring it to the correct frequency. Each band has separate offset. Offsets can have both negative or positive values.

Previous & Next screen navigation : The Red bordered left and right buttons are for moving to previous and next screens, (similarly shown in all the following screens).

Modes and Timeouts Screen (2)

Several parameters are adjusted from this screen. These help in operation of the rig. All of these buttons have two parts : the label and its value.

PTT Modes: There are two possible modes for PTT viz Normal and Toggle PTT. In Normal mode every press of PTT will activate Tx which will remain in Tx as long as the PTT is kept pressed and on releasing the PTT the rig goes back to Rx. Alternatively in the Toggle mode one short press of the PTT switch will start Tx while the second short press will bring it back to Rx mode. The two modes are selected by touching the button next to PTT label (purple bordered).



PTT Timeout: Touching the PTO button (white border touch type) activates the automatic time out for Tx. The time out feature helps to reduce unnecessary heating of the finals. It is specially useful in digital modes. Time out period is adjustable from the button next to PTO. Green fonts of Time out period indicates inactive PTO while its font color changes to Red when active.

S Meter settings: The S-meter display on Screen 0 is audio derived. We need to set its lower and upper limit to match with the approximate S values. The lower

limit is set by tuning to a quite spot on band and touching the SML button. It will read the current S-meter input and displays that value in the box next. Fine adjustments to this value are possible by touching left or right side of this button. Similarly the Upper limit for the S-meter is adjusted by tuning to a strong station and touching SMU button. Absolute minimum and maximum value for these two S-meter limits are 0 and 1023.

Touch Sensitivity Control: Different touch screens may have different sensitivities to touch. More sensitive ones respond fast and may need to be slowed down, otherwise they may record multiple touch for each real touch. The TS parameter adjusts this Touch Sensitivity and has to be done by experimenting. Most touch screens tested work well with touch sensitivity values between 80 and 100 .

Save Parameters: The SAVE button saves all adjustable parameters to memory for use later. The button will change colour while the save operation is in progress.

Split Mode operation: The SPLT button invokes split mode where VFO A works as Rx frequency and VFO B as Tx frequency. Second touch on SPLT button will deactivate this mode. During the SPLIT mode the colour of this button changes to Yellow and similarly the secondary frequency display on Screen 0 also changes colours (Green Rx and Red Tx). During Split mode if VFO M is selected the split mode is turned off.

Memory and Essential Constants Screen (3)

When this program is run for the very first time or when the magic number (line 18 magic_no) is changed the initial values of the various parameters is stored in EEPROM. Also whenever Save button is activated the parameters are refreshed in EEPROM.

Backup Mem : This button creates a back up of all saved parameters, in a different location within the EEPROM. Usually this should be done once after setting up the radio for the first time or whenever adjustments are made for better signal.

Restore Mem button: will restore back memory from Backup copy onto original location. Thus while playing with various parameters if any change is made and saved it can be recovered.

Dump Param button: sends these parameters in memory to a serial terminal, from where these could be printed or stored. Very good to keep a record of the essentials.

Reset Mem button: will reset all parameters in memory to factory settings except the memory channels which a user might have populated.

CAT Emulation: This version is now capable of handling CAT commands for general dital communiction. For using this the rig should be selected as Yaesu FT-2000 and speed set to 38400 baud. WSJTX, FLDIGI, JS8CALL have been tested to work with this program.

Note: If PTT is kept pressed at power up, a banner with Version information is displayed, for as long as PTT remains pressed.

User modifications: There are many tabs (or files) in the whole program in which functions are grouped by their utility. Many parameters are user controllable. These are listed in userdefs.h tab of the program.

Tweaking Band Limits: Current band limits are set in the program as per prevailing regulations in VU land. It is easy to change the band limits in the program. The userdefs.h tab of the program contains the following lines :

```
// Band Limits and frequencies and their corresponding display on band button
volatile uint32_t F_MIN_T[9] = {100000UL,  3500000UL, 7000000UL, 10100000UL, 14000000UL, 18068000UL, 21000000UL, 24890000UL, 28000000UL};

volatile uint32_t  F_MAX_T[9] = {30000000UL,  3800000UL, 7200000UL, 10150000UL, 14350000UL, 18168000UL, 21450000UL, 24990000UL, 29700000UL};

String  B_NAME_T[] = { "VFO", "80m", "40m", "30m", "20m", "17m", "15m", "12m", "10m" };
```

For example to modify the upper limit on 40 m band to say 7300 kHz , change the 7200000UL to 7300000UL in F_MAX_T[9] array. F_MIN_T[9] array has lower band limits.

Tweaking Step Sizes: The default step sizes are also modifiable from the userdefs.h file.

Hardware:

Details published earlier at : https://vu2spf.blogspot.com/2018/05/digital-inerface-card-for-ubitx.html

Arduino Mega 2560 with a Mcufriend type TFT display is needed to control the Si5351 generator. The TFT shield sits on top of Arduino, thus making it one unit to handle. Mounting on front panel of the rig is also therefore easy. A small PCB is designed to connect the uBitx to Arduino. (Si5351 breakout boards can also be connected to Arduino and to uBitx.) On this PCB two additional circuits for Tx POP reduction and audio derived S-meter are also included for the users of earlier versions of uBitx. This small PCB plugs into the uBitx board at one end and the connector on the other end is connected to Arduino with parallel wires. Currently this replaces the Raduino on uBitx.

Display: Various TFT screens of MCUfriend type are useful for this application. The button and text sizes are automatically scaled to match the 2.4” to 3.5” displays. In case a TFT is not displaying the screens properly or the touch buttons are not working as per design the following procedure is to be followed.

1. From MCUFriend_kbv library (https://github.com/prenticedavid/MCUFRIEND_kbv) load and run the various utilities in examples folder to test and check the TFT display and touch.
2. Load the Touch_shield_new sketch in Arduino and carry out the calibration of touch panel. Please open the Serial Monitor when running this program. It will display (i) Display size ,
e.g. LANDSCAPE CALIBRATION 480 x 320

(ii) touch screen pin connections :

Output of Touch_shield_new sketch	To be written in our program as (around line 330)
Touch Pin Wiring XP=8 XM=A2	XM = A2, XP = 8 ;

YP=A3 YM=9	YP = A3, YM = 9;

(sometimes A1 is reported as 54, A2 as 55, A3 as 56 etc)

(iii) touch coordinate conversion expressions :

Output of Touch_shield_new sketch	To be written in our program as (around line 580)
x = map(p.y, LEFT=956, RT=97, 0, 480)	xpos = map(tp.y, TS_LEFT = 956, TS_RT = 97, 0, 480);
y = map(p.x, TOP=921, BOT=126, 0, 320)	ypos =map(tp.x, TS_TOP = 921, TS_BOT = 126, 0, 320);

These details must be put in the program at around line numbers 330 and 580.
Most of the time the display and touch work well with these data. In case the touch is not at proper location, one has to try playing with these coordinates of left, right, top and bottom. If touch is inverted in x (touching right affects button on left) exchange xpos and ypos names. If the y is inverted (touch in upper half affects button in lower half) exchange tp.x and tp.y in these expressions.
identifier == 0x9320 is the type of controller reported by one of the example programs. If your display identifier does not exist in the program one of the existing identifiers may be substituted along with other details.

Acknowledgement: Many Hams and other enthusiasts have opened up their creations for the whole community and society’s benefit. We thank them for their gracious efforts and sharing their creations. We are highly motivated by their generousness. Many Hams have provided great feedback on the previous versions of this program. Thanks are due to all of them too. Please keep sending yur suggestions and comments for improving these small efforts.

73’s