ASSEMBLY PROCEDURES FOR DIGITAL INTERFACE UNIT

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Introduction - The following describes the basic procedures for assembling the Digital Interface Unit (DIU). This DIU is designed to allow digital data not exceeding +/- 5 kHz deviation for VHF/UHF FM radios as well as for H.F./M.F. radios using a BW of 300 to 2700Hz.

Intent of Project - The intent of this project is to design and build a simple yet cheap DIU to allow hams to communicate with each other over radio both for pleasure or for emmergency purposes. The board is made large enough to provide ease in assembly for advanced hams as well as beginners. It is not the intent of this author to design this interface to work with all radios and therefore it is up to the individual user to ensure they follow their manufactures requirements for proper interface connections to make this interface work correctly.

Applications - This interface design can be wired to work with various ham handheld or base radios. To date, this DIU has been tested with an Alinco DJS11, Radio Shack HTX202 and Icom IC-W31A and a Wouxun KG-UV6D. The basic differences between these radios and others like the Wouxum and Kenwood DH-D7 (as example) they use a different pinout location for microphone and (PTT) push-to-talk. These particular radios and others like them, use the common shell connection for their PTT and the ring (middle connection) for microphone with the ground return being the shell of the earphone/speaker of that radio. Some radios may use the tip (plug end) for mike/PTT and the shell for ground return. Therefore, any attempt to join the shells of these radios together will cause the radio's PTT to be activated. **NOTE:** It is important to make sure the VOX of the radios so equiped with VOX are turned on. A typical setting as in the case of the KG-UV6D would be position 2 or 3.

Optional USB - The kit includes a Mini USB 2.0 3D 7.1 channel soundcard, however, this is an optional item, if not used, all the necessary pin-outs required for interfacing to both the I/P and O/P of computer's soundcard as well as the radio's PTT/mike and earphone connections are available through the J1 8 pin DIN connector. If the USB soundcard is used, the only connections required from the pc board to the DIN connector J1 are the following; radio speaker O/P pin 4 and its return pin 5, radio's mike pin 8 and its return pin 7. The USB soundcard helps to eliminate ground path returns by virtue of the isolation from the A.C. ground path it provides.

Speaker O/P attenuator - A built in attenuator is provided on the pc board when not using the soundcard. This attenuator is provided to help protect the internal soundcard from excessive overdrive.

LEDs Function and Options - The front panel has a green LED to indicate when the interface USB soundcard is functioning correctly, failure to see a blinking green light might indicate the soundcard may not have been selected correctly in the program being used for decoding. If selecting the correct external soundcard does not fix the problem, close the program and re-start the program again, then repeat the selection of external soundcard in the program's configuration set up.

PTT Requirements - Nearly every radio has a minimum resistive value to make the PTT become activated when a signal tone is applied to the DIU. This particular design uses a common value found that works for at least three radios tried so far. This resistor is named R4 on the schematic

provided. If your radio's PTT fails to operate, this value may have to be changed as defined in the notes provided in the schematic. If unsure, contact the author to assist in determining the correct value for R4. The process for determing the optimum value is done by applying a pot resistor with a value of ~100k connected from the PTT line of the radio and ground or shell in some radios. If not using a dummy load, first select the radio's operating frequency of 145.550MHz, if the channel is clear, proceed by placing the 100k pot leads across the applicable PTT line and its return, ensure the pot is fully turned for max value of 100k. Slowly turn pot down until the PTT becomes activated. Remove the pot and measure the resistance value. That value determins the minimum resistance required to activate the PTT. Any value less than that value may be used for R4.

Application Used - To date, this design has been successfully used to communicate using 2-way transmissions using both text and still pictures using programs such as DigiPan, MMSTV (slow scan) and MultiPSK. Text files may be sent using DigiPan but not Word or PDF files. DigiPan allows users to select BPSK31 (most commonly used), BPSK63 (double the speed of BPSK31) and FSK31, (not tried as yet). Fldigi software program has one of the largest modes available next to MultiPSK. MultiPSK not only has most all modes available but conveniently includes SSTV. MultiPSK is not as flexable for adding text to pictures as MMSTV is, but is adequate for most applications. In MMSTV, Pictures can be either sent in jpeg or bmp or wmf extensions.

Requirements and Preparation - To save time, all parts have been pre-cleaned and bent to accomodate the hole spacing provided in the board. Part leads other than the more rigid component leads such as T1, T2, VR1 and LED are best left straight unbent. For ease of assembling resistors and diodes, leads can be bent ~30 degrees from vertical to stop the component from falling out prior to soldering. Leads should be cut short so as to not exceed ~3mm or 0.125" in height from board. Diodes and transistor should be heat sinked if possible, otherwise keep dwell time in soldering to less than ~4 seconds on each lead.

Read this whole assembly procedure before starting anything.

Tool Requirements – The following is a guideline for the correct tools needed for the assembling of this DIU.

- Soldering iron with grounded tip (3-wire type) with temperature controller (preferred). Grounded tip soldering irons are required due to the high A.C. voltages that can develop on ungrounded iron tips. The voltages can exceed the maximum capability of the delicate sensitve chips inside USBs. Use an iron with a small tip with either a chisel, flat or round conical end. A wet sponge is needed to keep the soldering iron clean during the soldering process.
- Solder, 60/40 or 63/37 (utectic solder), 0.8mm diameter preferred
- Small needle nose plyers
- Small wire cutters, (small toe nail cutters also work well)
- Exacto or similar small knife
- Small crescent wrench or nut drivers
- Small Philip screw driver (req'd for 4-40 screws)
- Silicone RTV adhesive, white or clear, (used for securing USB soundcard)

Kit Contents - The DIU kit contains the following items. Check box can be used for checking off after each step of assembly. Note, voltage rating of capacitors may vary.

VR1- Trim pot, 500 ohms, carbon, 25%. ☐

R1, R3 – 4.7k, 1/4w 5%, carbon film. ☐

R2 – 1k, 1/4w, 5% carbon film. ☐

R4 – 3.3k, 1/4w, 5% carbon film. ☐

R5 - 680 ohm, 1/4w 5% carbon film. ☐

R6 - 10k, 1/4w 5% carbon film. ☐

Q1 - 2N3904 transistor, (NPN) (with flat facing you EBC). ☐

C1 – 4.7uF electrolytic capacitor, 35V. ☐

C2 – 1uF electrolytic capacitor, 50V. ☐

C3 – 10uF electrolytic capacitor, 50V. ☐

C4 – 10uF electrolytic capacitor, 25V. ☐

C5 – 10uF electrolytic capacitor, 50V. ☐ (Used for Wouxun and similarly configured radios)

D1, D2, D3 – diode 1N4148 ☐

T1, T2 – Isolation Transformer, 600/600 ohms. ☐

LED – Green, model TI-3/4, right angle PCB style, DigiKey P/N L20315-ND ☐

JP1 Jumper wire, length A/R, bare tinned copper wire #24 AWG. ☐

J1 – Chassis connector, jack, 8-pin DIN ☐

P1 – Plug, 8-pin DIN ☐

USB Mini USB 2.0 3D 7.1 channel soundcard ☐

Aluminum Box - 112mm (4.33") x 60mm (2.36") c/w front and back cover plates and screws. ☐

Pair of 4-40 x 1/4" counter sunk or std round head screws, required for mounting of J1. ☐

FR4 – Printed circuit board, FR4, 1.52mm (0.06") thick {alternate 0.76mm (0.03") thick} ☐

Various colored solid copper wires supplied with kit, 0.51mm (0.020"dia.). ☐

USB Soundcard Preparation – If the USB soundcard is used, follow the instructions provided.

The USB soundcard's green LED is to be removed and is no longer used in this unit. It will be replaced by the LED that will be later installed on the board facing the front panel. First remove the USB from its black casing. Locate the LED leads on the underside, using a solder sucker or drywick, remove the green LED from the board. Install two ~1.5" (38mm) long prepared wires into the location for the original LED, note the color of the wires, the brown wire (-) goes to the side closest to the outside edge of the board, the red (+) wire into remaining hole. These wire will later go to the locations provided on the board marked K (cathode) and A (anode). Install USB back into its black bottom case, leave the top cover off and put the USB aside for now.

Installion of Parts

- Install D1, D2, D3, ensure to install with correct polarity as shown on the silkscreen. Bend leads ~30 degrees if needed to prevent components from falling out. Keep dwell time of soldering to a minimum, not to exceed ~4 seconds on each lead. Use small heat sink if available, a small alligator clip will suffice.
- Install R1 through R6, again bend leads from ~30 degrees to flush if needed to prevent component from falling out. Note; R4 eventually may change in value due to differences with some radios.
- Install VR1 flush to the board.
- Install Q1, bending the outside leads slightly from ~30 degrees to flush to prevent Q1 from falling out.
- Install C1 through C4, ensure polarity is followed correctly. **Note:** The negative lead usually is indicated by a black, grey or white negaitive symbol running down one side that may look like this (▬). The positive lead of the capacitor must go into the square black marking on the silkscreen which also has a + sign close beside it. Install C5 for Wouxun only.
- Install JP1 jumper. NOTE: If the radio used for testing later has the PTT coming from the shell of its connector and the microphone to the middle sleeve, then this jumper may not be installed. If the microphone is on the tip end and the PTT on the shell, leave this jumper in place. If unsure, check with the author of this procedure.
- Install T1 and T2 position both the same way on board, ensure transformers are flush to board prior to soldering. Pre-tinning of the pads for leads will help in this soldering process. Do not attempt to bend these leads, cut to ~1/8" heigth before soldering. Carefull with heat being appied to these terminals as they are easily over-heated and damaged internally.
- Mount the J1 connector onto the outside of back panel using screws, washers and nuts provided in kit.
- If **not** using the USB soundcard, install and solder the wires provided for pins 1, 2 and 3 of J1 to board, do not solder these leads to J1 connector at this point.
- Install and solder a twisted pair of wires for radio speaker pins 4 and 5 regardless if USB soundcard is used or not.
- Install a single wire to board at the junction of JP1 for pin 6 (PTT).
- Install and solder a twisted pair to pc board for radio mike and PTT/mic return pins 7 and 8.
- If **not** using the USB soundcard, pre-bend ends of leads to form a hook (~270 degrees) from pc board to pins 1, 2 and 3 of J1 connector. Solder these hooked leads to J1 pins 1, 2 and 3 per schematic provided.
- Prepare remaining leads 4 to 8 from pc board by again pre-bending the ends as described above. First install wire for pin 8, gently crimp wire on J1's terminal to hold in place, solder this lead. Repeat for remaining leads from pin 7 down to pin 4.
- If the USB soundcard is used, temporarily removed the board from the black case and put aside. Now apply a small square piece of double sided masking tape measuring ~1/2" (~13mm) to the underside of the bottom of the USB soundcard case nearest the I/P and O/P jack end. Place the case close to holes marked K and A used for LED. Ensure corner of case is pressed against R6 resistor, this will allow sufficient room for board to slide into case later. Press firmly on case to bond case to board. This is a temorary bond until final end plate is attached later, at which point RTV silicone is used for permanent bonding.

- Using prepared wires provided, install the 4 USB related wires to board, the hole location is near end of USB case.
- Solder the ends of the wires installed in the previous step to the yellow jacks, starting with the USB mic tip which is the terminal farthest from the outside of the jack. Pre-bending the end lead to make for a better bond on the jack's terminal will improve the contact. Ensure to solder to the side of the jack termination, as close to the board as possible to avoid damaging the spring used for the electrical contact on the top side.
- Next solder one of the USB Mic and phone shell wires to the outside termination of that same yellow jack, that's the terminal closest to the outside.
- Repeat the soldering of the remaining wires first with the USB phone tip to the green jack terminal farthest from the outside of that jack, again ensure to solder the wire as close to the board as possible. Solder the remaining lead coming from the USB Mic and phone shell pad to the side of the termination of the green jack, that's the terminal closest to the outside.
- Apply a small bead of silicone RTV adhesive to the underside of the USB card over the black round chip. Install the USB board into its case. Bend the leads of the previously installed wires to assist in keeping the board down.
- Install and solder the wire coming from the LED pad on the USB board closest to the outside, this is the cathode (-) lead and and will be installed into the hole marked K on the board. Install and solder the remaining LED lead (pad closest to red LED) into the hole marked A on the board.

Final Assembly

The USB 3D soundcard can now be permanently secured in place. First remove the doublesided masking tape previously installed. The end aluminum cover plate has to be positioned back slightly and the USB connector placed into the rectangular hole provided. Apply a drop of RTV silicone (clear or white) under the black plastic housing. Attach the 4 screws supplied with the box to the end plate to allow better alignment. Allow the RTV to dry overnight before closing of box.

Transmission Test of DIU

Download a program such as DigiPan to use in conjunction with this interface. The link to this program can be found at http://www.digipan.net/ . If you find that your computer is too slow using DigiPan 2.0, DigiPan 1.7 is still available at that link.
The DIU can be tested at this point using a temporary plug and harness for P1. Insert a USB male to female cable beteen the USB soundcard and the computers' USB port. Start the DigiPan program. Select Mode PBSK31. Next, ensure the level is correctly set for the input and output in the soundcard, these settings found under Configuration. Adjust the computer's soundcard level to ~3/4 way up, this can be lowered later for best IMD (Intermod Distortion) levels. The LED on the front of the board might start to blink, if it doesn't blink, go back into the configuration setup, clicking on the choice of USB soundcard will usually start DigiPan runing correctly and the LED will start to blink. If it doesn't, repeat configuration/soundcard step and press ok. The green light should start to blink on the DIU, if it still doesn't there may be a problem with connections elsewhere. Ensure the 3D USB soundcard on your unit is turned up fully by pressing the small button (2nd one from the red LED). A indication bar symbolizing the audio level should come up on the computer screen, it should show 100%, if it doesn't press this button until it does show 100%. If

there is no indication and a X appears instead, press the small button closest to the outside edge of the USB. If the red LED comes on at any time, press the other small button located across from the last button, that button controls the on/off function of the USB soundcard audio setting.
Temporarily connect a test cable with a male stereo plug on the end to pin 4 and 5 of P1. This male stereo plug can be inserted into the radio's speaker jack, ensure the radio is turned down and squelch open for these intial tests. The optimum audio level will be best when the waterfall is a evening sky blue color. If the radio used for these tests has the PTT coming from the shell of its connector and the microphone on the tip end use pin 8 for the microphone I/P and pin 7 for the return. Ensure pot on the front of the DIU is tuned up clockwise ~3/4 way up, this is the gain control fine adjustment for microphone drive, this will be adjusted later for minimum IMD.
Ensure the user Configuration Personal Data is set up in DigiPan prior to doing any further tests. Select 1000Hz for the transmit frequency by clicking on the 1000Hz, flag will jump to that position. You are now ready to receive or transmit any signals in the normal audio bandwidth of that program. For those who want to ensure you are locked onto that frequency or ***work split*** , then checkout the menu item named ***Lock.*** Click on ***LOCK*** and you can either switch into Split mode or switch out Split mode. ***Lock TX Frequency.*** When this is selected, the ***TX frequency is fixed*** at the position of the active cursor, and the flag above the cursor ***changes to red***. When you select an Rx frequency the little flag will stay at Tx and your curser will follow you to Rx. This allows you to transmit on one frequency and receive on another. ***Unlock TX Frequency.*** When this is selected, transmission will occur on the same frequency as receive, as indicated by the diamond or triangle cursor, and the flag above the cursor will be green. Note when you are in the lock position (red flag) a symbol of a lock appears at the bottom besides the TX tab. Now you are ready to transmit.
For receiving, make sure in Options, the AFC, Snap and Squelch are checked

Pot Adjustment

The pot on the front of the DIU must now be set for the correct level if it isn't already. (Most kits are already pre-adjusted). The best way is to use an oscilloscope with a X1 probe connected to junction of R4 and D3. The level can now be reduced to ~0.020 to 0.030V P/P while transmitting some data. To confirm the correct IMD for this setting, use another receiver/handheld tuned to your transmit frequency, ensure the levels coming from your radio audio O/P level is turned down low to start with. Run Digipan watching the waterfall, it should be a light blue colour. Start a transmission on the other computer by either sending a "brag"or a Call 3. If everything is running correctly, your received signal will appear in the waterfall. Select IMD setting found under Mode. Double click on the word IMD near the bottom of the waterfall display found on the right hand side. Numbers in the range of -25 to -27db are not uncommon, a typical goal is -25dB, some levels can be as high as -35dB which is even better. If the IMD is not better than -25dB, try turning VR1 pot down slightly and repeat the measurement test.

Transmitting PSK

Click on Call 3 button, CQ 3 times followed by your call sign should show in the transmit screen. Note; there is a split screen available, one for transmit the other for receive. The PTT should be activated when in the T/R button is pressed. This sets up the system to transmit data when any key is pressed. After a transmission and there is no <RXANDCLEAR> macro to receive, press the T/R button to go back to receive, otherwise most all macro supplied like CQ, Call 3, Call, BTU, Signoff and Brag, all have the auto shut off at the end of the transmission.
NOTE: The easiest way to stop a transmission at any time is to hit the **Esc** button on the keyboard. Another way to stop transmissions is to select Edit in the menu and click on Insert R.

Receiving Transmissions of DIU

To test for receive, tune to 14.070MHz and select a station that appears to be strong enough to decode. Ensure the soundcard audio level is high enough, light blue colour background is better than a overloaded yellow background colour. An overly bright yellow waterfall could also mean the Configuration/Soundcard is not been recognized yet, going into that menu will solve that problem once you click ok, that should correct the level setting. If using the multiscreen, the stations being received in the passband will show up on the bottom display as a letter. If you move the flag on the waterfall to a station being received, the text will also appear on the left side of the screen, all other stations will be displayed on the right beside the coresponding letter - assuming it is set up for multiscreen.