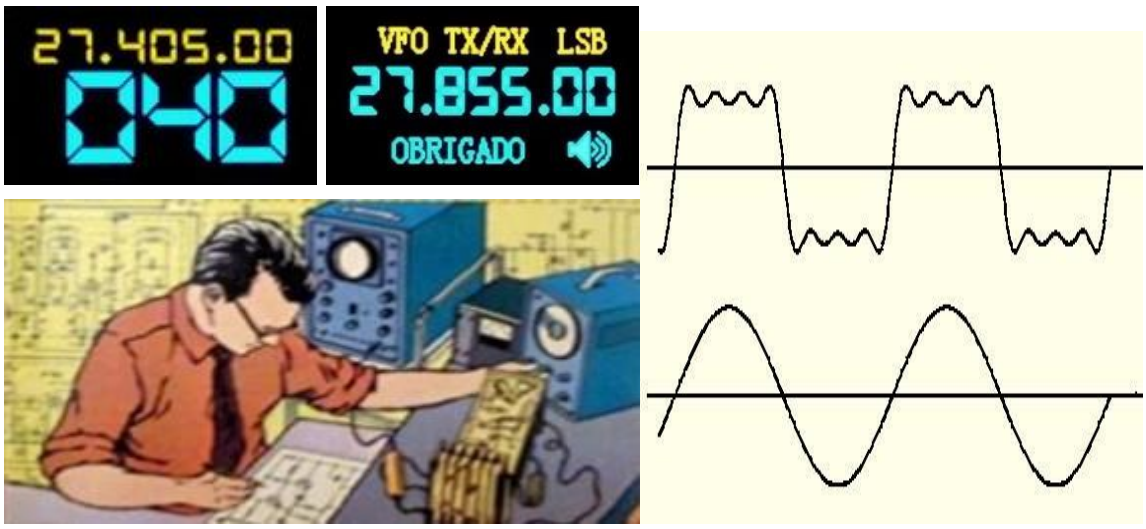
TECHNICAL MANUAL

for

DDS WLG KIT VER 6.27

By PU4WLG

Sold and installed in the USA by www.ddsvfo.com



This manual details the installation on a Cobra 148 GTL Transceiver, but there is nothing to prevent adaptations on other radio models even crystal controlled oldes.

Brief history about this system:

It started as a hobby. In 2015, I, PU4WLG, and a friend, PU4ADD, were talking about Arduino and RF generators, my friend found the SI5351 module on Ebay and bought 2 for us to test.
One day, we went to a junkyard well known to radio amateurs here in Minas Gerais and my friend PU4ADD showed me an old TELEFUNKEN RTH-220 radio transceiver and told me that it would be possible to put the module we bought on Ebay and make a racing band system. I bought the radio and with the help of my friend PU4ADD, who has a lot of knowledge in RF, I took the tests practicing my hobby, because programming Arduino was already the easiest for me. So my friend showed me where to put the generator in TELEFUNKEN, he also told me what frequency should I generate to be in LSB and what frequency should I generate to be in USB, with this information I wrote a software to control the SI5351 and using a 16x4 display I made the modification on the transceiver. Search for telefunken dds on YouTube and see the modification. After testing on another radio, I was asked if it would be possible to make this modification on a Cobra 148 GTL. For this, I purchased a Cobra 148 GTL, made a modification using SI5351 and SSD1306 display and to my amazement, many who saw it, were delighted with the modification. With the intention of receiving 40 meters in this project, I asked for help to another friend, PY2SFY, who showed me how to use a BF982 with the configuration of a mixer, observing the can converter that was exactly like the configuration presented by PY2SFY, so I saw that it would be complete conversion is possible, not just 40 meters. I was suggested to make a KIT for sale. For this reason you are reading this manual. Thanks. I made a modification using SI5351 and SSD1306 display and to my amazement, many who saw it, were delighted with the modification. With the intention of receiving 40 meters in this project, I asked for help to another

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Thanks:

I would also like to express my thanks to those who never stopped testing and helping to publicize this system, thank you very much to everyone who always pointed out the errors in the project and thus contributed to the improvement of the system that is always being improved. Thank you all.

Description:

The DDS KIT now comes with polyphonic beeps, SPECTRUM RF scan and AUTO-SCAN.
A firmware with a free version is available for download at the link www.ddsvfo.com or www.kitdds.blogspot.com
The free version has a Nag screen with a countdown, after going through the Nag screen the system is fully functional, limited only to changing the user name and number of channels. To remove the opening screen, a key is required. I provide the key to remove the splash screen and complete the system release at a small cost.

The KIT DDS WLG VER 6.27 system has the following features:

- User menu for selecting the modes: Channel, Bandwidth, Radio Receiver, Settings Menu.
- Channel mode with frequency display or user name.
- Channel mode can be adjusted with a maximum limit of 500 positive channels and 500 negative channels.
- Displays the AM / USB / LSB modulation switch position.
- Lock or Un-Lock of tuning for channel mode.
- Channels change 1 in 1 or 10 in 10 channels.
- For Channel mode, it has 20 polyphonic beeps and a beep random mode.

- VFO mode with display of the AM/USB/LSB/FM selector, user name and Tx/RX status.
- VFO mode can be adjusted with a minimum limit of 0Hz to 99MHz.
- Operation status displays an indication for receive, transmit, beep and failure of the PTT key.
- Has Step in steps from 10Hz to 1MHz.
- It has signal and RF spectrum scanning mode and also an auto-scan function.
- Channel mode has 20 polyphonic beeps and a beep Random mode.

- Transverter mode with display of the USB/LSB/CW andFM switch position, user name and operation status.
- Transverter mode can be adjusted to display frequency reference for any HF transformer.
- Operation status displays indication for receive, transmit, beep and failure of the PTT key.
- Has Step in steps from 10Hz to 1MHz.

- For the transverter mode, it has 20 polyphonic beeps and a beep random mode.

- User menu with 4 shortcut screens to access the system's operating modes.

- Settings menu allows up to 9 simple adjustments for end users or 29 adjustments for technicians.

- End user can adjust 9 items: (1) User name, (2) Beeps, (3) Adjust the interval between PTT and BIP, (4) Anatel table, (5) Channel mode frequency on / off, (6) Lock / Un-lock claifyer in transmission mode, (7) Control screen brightness, (8) Transmission time limit, (9) Align Transverter.

Installation technician can adjust all items of the end user as well as: (10) Check SI5351 module reference crystal, (11) Check the RF amplitudes of the SI5351 module driver, (12) Define the internal capacitors for the SI5351 reference, (13) Generate any frequency between 400KHz to 99MHz at the CLK1 output of SI5351, (14) Set OFFSET to I.F in RX, (15) Set OFFSET to I.F in TX, (16) Set OFFSET AM, (17) Set OFFSET LSB, (18) Set OFFSET USB, (19) Determine the maximum frequency for Bandwidth mode, (20) Determine the minimum frequency for Bandwidth mode, (21) Determine the maximum of positive channels, (22) Determine the maximum number of negative channels, (23) Set a frequency to activate a filter for lower frequencies, (24) Adjust clarifyer width,(25) Set conversion frequency for Transverter mode, (26) Determine the maximum frequency for transverter mode, (27) Determine the minimum frequency for transverter mode, (28) Choose between 2 encoder models, (29) Reverse the direction of the selector switch.

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System operating modes.

The DDS WLG 6.27 system has 3 operating modes that can be selected through a user menu, it also has a transverter mode that requires a switch to be activated. The 3 modes of the user menu allow to operate the radio as the traditional channel mode or the bandwidth mode or VFO mode, and if you have installed a converter card, you can also have the RECEIVER HF mode.

These photos are from each operating mode.

The channel mode allows you to operate the radio by changing the channels using the encoder switch, displaying the channel frequency and allows you some features, such as the step to change 1 channel at a time or change 10 channels at a time. it also has an automatic return to 1 channel at a time after 5 seconds of inactivity. It is tuned by the clarifyer potentiometer, which can be in locked or unlocked , depending on the setting made in the menu. You can also remove the frequency meter and display your name or call sign instead.(If you did not want to have the channel mode, the technician can leave item 21 in the settings menu to zero.)

How to use the system in channel mode:

The first step is to understand how to use the encoder switch button.
We will understand the button as option 1, 2 and 3 of the encoder switch button.
Option 1 (Short press, less than 1 second pressed.)
Option 2 (Middle touch, more than 1 second and less than 3 seconds pressed.)
Option 3 (Long press, long press.)

To enter Channel mode, use option 2 on the button and the system will enter the user menu. When in the user menu, rotate the encoder to the CH MODE icon. To access this mode, use any of the 3 button options. In channel mode, change channels by moving the encoder to either side or use option 1 on the button to change the step step. (Note: the mode of opperation (Lsb/Usb/CW/FM) will be displayed for 3 seconds with each switch change).

How to use the system in running band mode:

To enter VFO, use option 2 on the button and the system will enter the user menu. When in the user menu, rotate the encoder to the RUNNING BAND icon. Change the frequency by turning the encoder in any direction, use option 1 on the button to change the steps in the step. Note: In VFO mode, a status will show the following: radio is  transmitting,  receiving,  beeping or has occurred  PTT failure. If you can not transmit, for example, time out of the time limit allowed for transmission (item 8 of the settings menu) the status will show an X indicating that the TX has been interrupted or is inactive.

The VFO mode allows you to operate the radio by changing the frequency using the encoder switch, it has step steps from 10Hz to 1MHz. The VFO mode and HF receiver mode are identical in use, with the exception of TX for the HF receive mode, but both are identical and also have a very useful feature that serves as a spectrum analyzer, which can help track and eliminate spurious signals.

To enter the spectrum analyzer, use option 3 of the encoder switch button. The system will scan frequencies exactly in the step of the step that was left before starting the spectrum, the spectrum screen allows an auto-scan option that will search for signals outside the natural pattern of the spectrum, finding a signal outside the pattern, the system for scanning and remains at that frequency as long as the signal is present, but if the signal disappears, the system waits for 3.5 seconds and resumes scanning. To activate auto-scan, turn the encoder switch to the right and horizontal lines will appear on the scan screen. To exit the auto-scan, in case the scan stops at an unwanted signal, turn the encoder to the left and the auto-scan will be deactivated, to activate it, turn the encoder again to the right. To exit the scan or auto-scan and return to the previous mode, use option 1 on the button or click on the PTT button.

The amplitude of the spectrum can be controlled using the RF-GAIN on your radio. The auto-scan function is perfect to perform a good alignment of the DDS system, because through it, you can check if your radio has a spurious over some frequency that corresponds to a certain channel.

Configuring the system for VFO mode .

Depending on the equipment used, the technician will be able to remove the channel mode, as he performed the installation on the transceiver. In this case, the CH MODE icon can be removed from the system simply by resetting item 21 of the settings menu.

Removing the HF RECEIVER mode

The technician may have done a DDS installation where the customer has chosen not to have the HF or RADIO RECEIVER mode, in which case the technician may remove the RADIO RECEIVER mode icon by resetting item 25 in the settings menu.

SETTINGS MENU overview

NOTE: The SETTINGS MENU icon will appear for the installer, but after grounding the Arduino D12 pin, this icon will be removed from the user menu and will only appear when the user turns on the radio with the encoder switch button pressed, even so, the user will only have access to item 9 of the settings menu.

Learning to use the settings menu.

The settings menu, popularly known in the technical field as the service menu, allows a total of 29 adjustments. To access the settings menu, the DDS WLG system must have a D12 pin free from grounding.

The encoder button has 3 options.

Option 1 Short click (Less than 1 second pressed)
Option 2 Medium click (1 to 2 seconds pressed)
Option 3 Long click (Long press)

To access the settings menu, you will enter the user menu using option 2 on the button, entering the user menu you will select the SETTINGS MENU and use option 2 on the button. (The only icon that accesses only with option 2 on the button is the settings menu. The rest of the icons can be accessed with option 1, 2 or 3 on the button).

Entering the service menu, the system will display item 1/29

In this item your technician or end user can add a prefix or any word with up to 8 characters. To change the word THANK YOU, use option 2 on the button and a cursor will appear below the corresponding letter. Also note that the word ADJUST will appear in place of MENU CONF.

Note that on this screen, we only have 1/9 items, the reason is because this photo was taken on a system with the D12 pin grounded and in this case, the system releases only 9 basic items for the end user, but as you are reading the technical manual, you will most likely be seeing ADJUST 1/29.

With option 1 of the button, you will change the position of the cursor, to change the letter, turn the encoder switch in any direction. If you want to change the item, you will use option 2 of the button again, using option 3 anywhere in the settings menu, the system will exit the settings menu and return to the user menu.**Another important detail is that any changes in the settings menu will only be saved if you leave the settings menu without turning off the system.**

Note: All items that allow only 0 or 1, means that 0 is off and 1 is on.

Details of all service menu items.

1- Prefix or user name with up to 8 characters.

two-Beeps selection. Allows you to choose between 20 polyphonic beeps, or you can use the LUCKY option.

3- Time interval between speaker and carrier relay.
(Eliminate popping noise from the speaker)

4-If connected, configure the system according to FCC standard, following the table from 1 to 40 channels.

5- If it is off, (0) it will remove the frequency display in Channel mode and display the call sign.

6- If it is on (1), it will Lock the tuning of the clairfyer (VOICE LOCK) with TX and RX.

7- Controls the brightness of the screen.

8- Limits the time in seconds that the PTT can keep the carrier active.

9-Removes or adds the value in the VFO in transversion mode. (Display the exact frequency of the transverter)

10- Tells the system what the frequency of the crystal used in SI5351. (Check DDS on that item).

11- Set output current CLK0, CLK1, CLK2 of module SI5351. (When in doubt, use 4 or 6mA).

12- Adjust internal capacitors for the reference crystal. (When in doubt, use 8pF).

13- It allows generating any frequency between 400KHz up to 99MHz on the CLK1 (only one optional).

14- Intermediate frequency deviation in RX. (OFFSET for when the system is not transmitting).Any changes to that item will be automatically copied to item 15.

15- Intermediate frequency deviation in TX. (OFFSET for when the system is transmitting).

16- Frequency deviation for AM mode. (OFFSET for when the system is in AM).

17- Frequency deviation for LSB mode. (OFFSET for when the system is in LSB).

18- Frequency deviation for USB mode. (OFFSET for when the system is on USB).

19- Maximum frequency that Band mode can reach. (For Scan, always use 5000 at the end).

20- Minimum frequency that Band mode can reach. (For Scan, always use 5000 at the end).

21- Maximum number of Positive Channels. (If you want to remove Channel mode, leave items 21 and 22 reset)

22- Maximum number of Negative Channels. (If you want to remove Channel mode, leave items 21 and 22 reset)

23- Connect Arduino output A0, while the system is below that frequency.

24- Adjust the clarifier tuning value in Channel mode. (Adjusts the width of the clarifier).

25- Frequency at which the radio remains while using a mixer board for RX HF
By resetting this item, the system will no longer display the RADIO RECEIVER mode icon.

26- Maximum frequency that the Radio Receiver mode can reach.

27- Minimum frequency that the Radio Receiver mode can reach.

28- It allows to use 2 different types of encoder. (The most common is type 4).

29- It allows changing the direction of rotation of the encoder without the need to invert wires.

Detailed Arduino pinout (KIT DDS VER 6.27)

.Pin (VIN) - Voltage input 7V to 9V (**Maximum 12V - not recommended**)

.Pin (VDC) - 5V Stabilized output (you can supply 5V here or use the 5V stabilized)

.Pin (5V) - 5V Stabilized output (you can supply 5V here or use the 5V stabilized)

Pin (GND) - Grounding.

.Pin (D2) - Direction of the encoder switch (DT or CLK)

.Pin (D3) - Direction of the encoder switch (CLK or DT)

.Pin (D4) - Encoder switch button (SW)

.Pin (D5) - Switching to GND for AM mode

.For LSB mode, do not switch D5 and D6; and for FM mode, switch to GND D5 and D6 together

.Pin (D6) - Switching to GND for USB mode

Pin (D7) - Switching to GND for CW mode.

.Pin (D8) - Audio output for the beep

.Pin (D9) - Output 5V to arm relay that turns on / off loudspeaker (BIP)

.Pin (D10) - Output 5V to arm carrier

.Pin (D11) - Switch with GND to display frequency reference of the external converter

.Pin (D12) - Ground this pin to prevent critical changes to the service menu (**this is important**)

.Pin (D13) - Status LED (If it is flashing slowly, it is processing normal)

.Pin (A0) - Filter for frequencies below the value defined in item 23 of the service menu

.Pin (A1) - 5V output for activating the switching relay of the converter board

.Pin (A2) - Clarifyer potentiometer (**Never exceed 5V**)

.Pin (A3) - PTT sensor. (Be very careful when installing this pin, see details in the diagram)

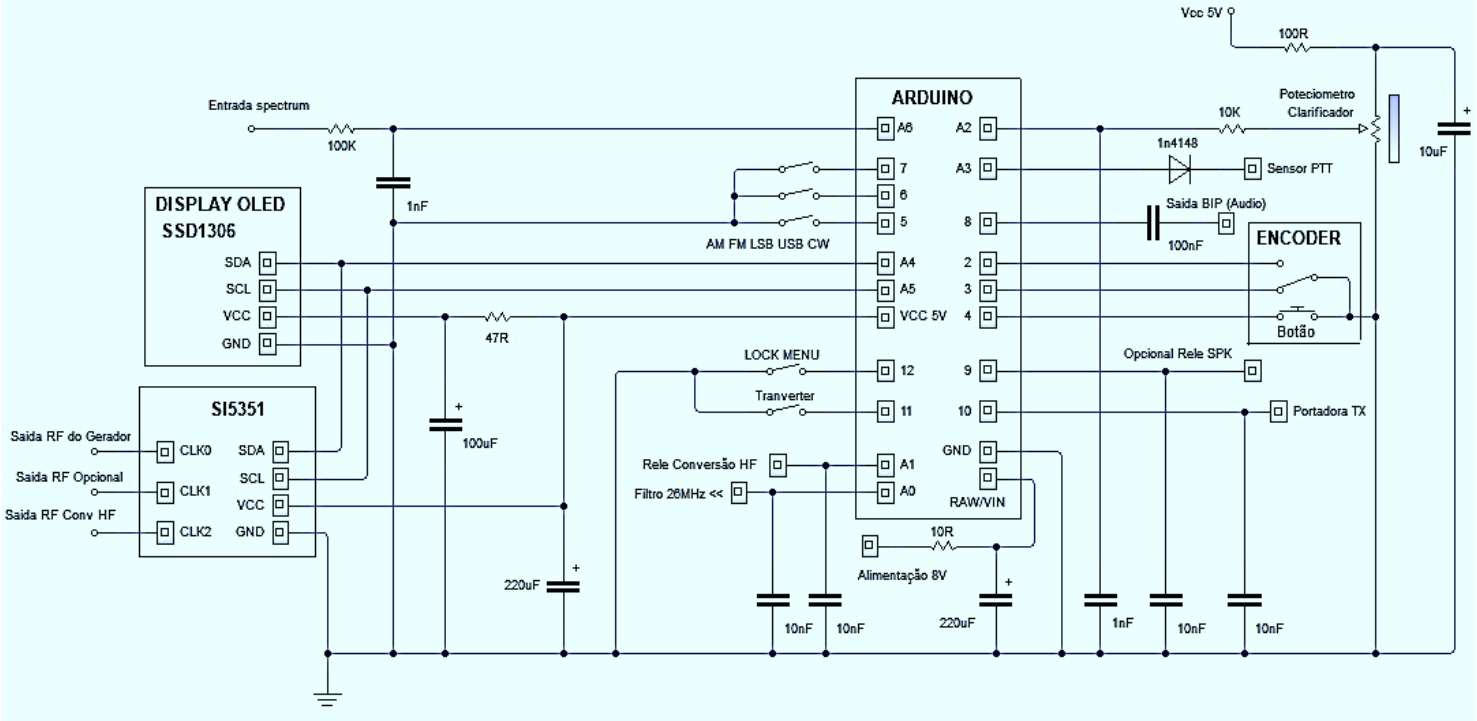
.Pin (A4) - SDA pin used in the i2C communication protocol (Display + SI5351)

.Pin (A5) - SCL pin used in the i2C communication protocol (Display + SI5351)

.Pin (A6) - Sensor for spectrum scanning and auto-scan mode

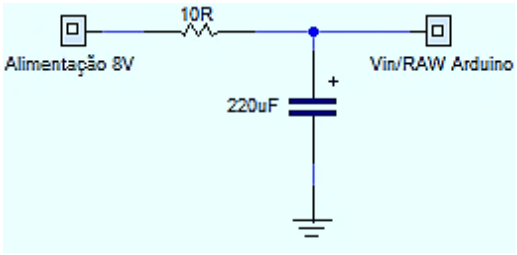
.Pin (A7) - S-Meter Sensor (Depending on the DDS version)

General circuit diagram.



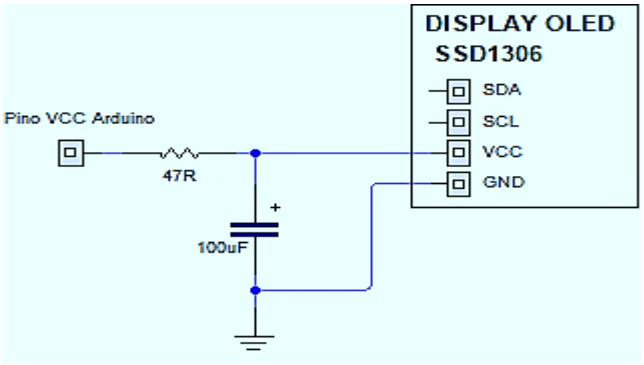
Arduino module power

The Arduino module already has a 5V voltage regulator, but because the Arduino is a very low consumption circuit, the regulator used is for low current, to avoid damage, try to use voltage around 8V. It is interesting to use a 10R resistor and a capacitor from 220uF to 1000uF at the power input, this works as an RC filter, blocking noises that can return and be amplified by the radio's audio amplifier circuit. At the same time, this RC circuit acts as a current limiter that helps to protect the Arduino module in the event of a short circuit in the 5V line. The VCC pin and 5V pin on the Arduino, is already a voltage-stabilized output, however the current is very low, but it is more than enough to power the SI5351 display and module.



Power for SSD1306 Display

To use the display in circuits as a radio transceiver, it is necessary that the power be through an RC filter, because this display has OLED technology that maintains the multiplexing of the LEDs that will form the pixels of the screen and this multiplexing returns to the radio circuit, being amplified by the audio amplifier circuit, resulting in a characteristic noise to a vibration of a loop relay.

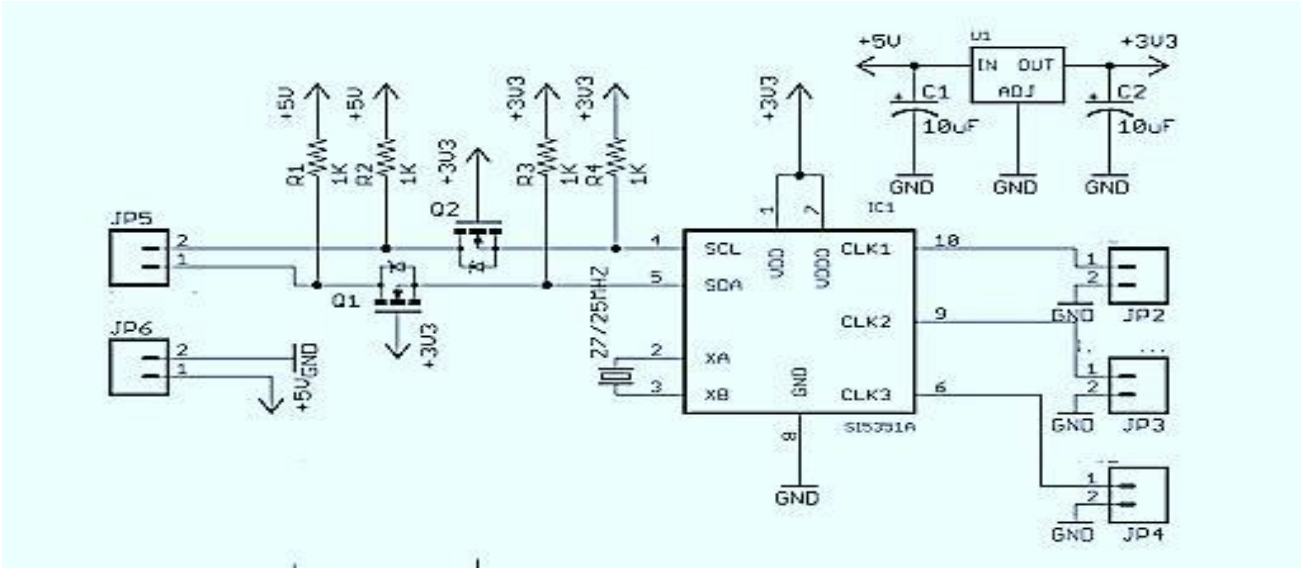


The DDS WLG 6.22 system has a display brightness adjustment, this adjustment can be defined in item 7 of the settings menu. The SDA terminal of the display is connected to pin A4 of the Arduino and the SCL terminal of the display is connected to pin A5 of the Arduino.

SI5351 module feeding and alignment

The SI5351 module does not require a specific filter at the power input, as it has a 3.3V regulator of great quality and very low noise, it is also not necessary to use a converter for the logic voltage level, as it already has 2 mosfets performing this 5V conversion to 3.3V.

The SI5351 SDA terminal is connected to the Arduino pin A4 and the SI5351 SCL terminal is connected to the Arduino pin A5.



The SI5351 module has 3 frequency independent outputs, in the DDS WLG system we will use the CLK0 output as the main RF generator replacing the original VCO system and forming the digital VFO system.

We have the output CLK1 that can be ignored or if you need an extra generator, you can define a fixed frequency in the output CLK1, which can be defined in item 13 of the service menu. This frequency can be any frequency between 400KHz up to 99MHz.

At the CLK2 output, the system generates a summation frequency for the HF “receiving” card mixer. The formula is very simple, so that you understand the operation perfectly, the calculation is as follows:

Suppose you will hear the frequency of 7,153MHz, CLK2 will generate 19,847MHz (CLK2 = 27MHz - 7,153)

27MHz is a fixed frequency that you must define in item 25 of the settings menu.
This frequency is necessary to leave your radio on a fixed PX Channel, thus, every conversion will be delivered on that frequency. In case of spurious conversion, the clarifying potentiometer will act directly at this fixed frequency.

The settings menu has 4 items that will act directly on the SI5351 module. Items 10, 11, 12, 13.

In item 10 you must inform and adjust the frequency of the reference crystal used in the SI5351 module, the most common

is 25MHz. This frequency must be defined in Hz and requires alignment.

In item 11 you must inform the current of the drive 

present in the SI5351 you intend to use, this adjustment can be made when aligning the coil L19 and L20 in the case of a 148 GTL. Values are 4, 6 or 8mA.

Item 12 determines the 2 capacitors for the reference crystal, 

these capacitors are internal to the SI5351 and can be set between 4, 6, 8, 10pF. In case of 25MHz reference crystal, leave the value at 8pF. This adjustment is not critical, but if you change the capacitance value, a new alignment in item 10 will be necessary.

Item 13 is only an option to generate at the CLK1 output of the SI5351, any frequency that can start at 400KHz up to 99MHz.

I like to generate 20MHz to align the reference crystal in item 10. If you are not going to use the CLK1 output, it is important that you never leave values defined in item 13, as this causes unnecessary noise.

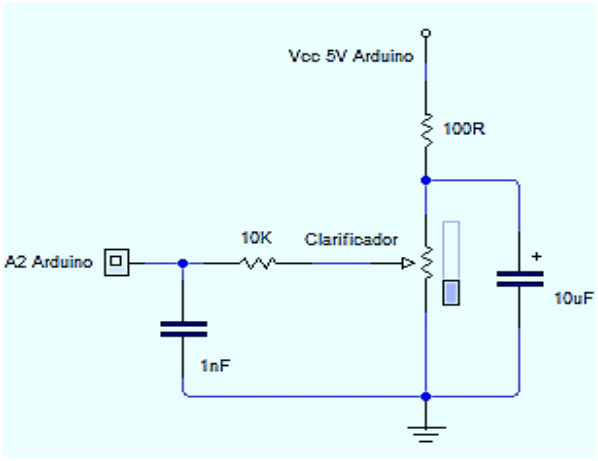
How do I align the SI5351 module?

You will need a reliable frequency meter that has at least 8 digits.

Connect the frequency meter to the CLK1 output of SI5351, enter the system settings menu DDS WLG 6.22, go to item 13 and set a frequency between 10MHz (10 000 000) to 30MHz (30 000 000) observe the reading on your frequency meter, go to item 12 and set the crystal to 8pF (depending on the value of the crystal used in SI5351), if the frequency read on the frequency meter is different from the value defined in item 13, go to item 10 and adjust the final squares and keep watching the value being displayed on your frequency meter, when that value is exactly like the value defined in item 13, go back to item 13 and change the frequency value and observe the reading on the frequency meter, confirming that its alignment is correct, zero the frequency of item 13 and you're done.

Clarifying potentiometer (VOICE LOCK)

It is suggested to use a filter for the clarifying potentiometer, which in addition to stabilizing the voltage and avoiding unwanted jumps in the “frequency meter” in channel mode, protects the potentiometer in case of accidentally grounding the central pin. It is not recommended to use pots with values below 5K, but above 5K you can use any value up to about 470K. The potentiometer must receive 5V voltage at the side terminals and the adjustable voltage at the central terminal will be used to determine which tuning step has been deviated by adding or subtracting the value in the “frequency meter” in channel mode.The central terminal of the pot is connected to pin A2 of the Arduino.



In DDS WLG systems (any version) the clarifying potentiometer has two functions, the first function is the most common and is for the use of tuning in channel mode, which can vary up to 10KHz upwards or 10KHz downwards, depending on how it was defined the Hz value in item 24 of the settings menu.

The second use for the clarifying potentiometer is for the RADIO RECEPTOR mode which when performing a frequency mix, converting the entire input to the fixed frequency that was defined in item 25 of the settings menu, so that mix may contain spurious and these spurious can deflected with the clarifying potentiometer that will act directly on the fixed frequency of item 25 of the settings menu.

Filtering the output pins of the Arduino module.

It is also important to use a capacitor from 10nF to 100nF in all 4 Arduino output pins, as these pins will be delivered to the base of a bipolar transistor and these transistors can amplify noise generated by the set of modules that complete the DDS circuit. .

.**TO 1** the base of a transistor will be delivered to effect the switching relay of the RX HF board

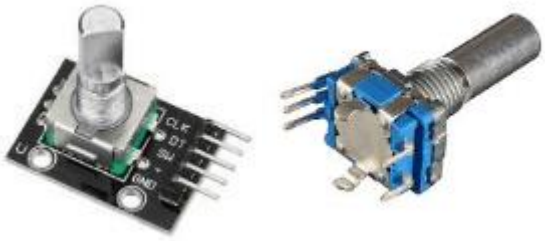
D10 it will switch the carrier (TX) on the radio, through a transistor as well.

A0 it is an option to activate filters on top of some coils, making a larger bandwidth.

D9which can be used as an option for cutting the speaker in TX mode via a relay.

It was suggested by some people to use a 1nF capacitor on the SCL pin to the GND of the display, but I was very insecure with the use of this capacitor with such a high value on the I2C protocol clock. (If using, test values less than 1nF. Try something like 100pF, however, this filter is no longer needed in version 6.22, as it was proposed to eliminate the noise caused by i2c communication, and in version 6.22, this communication is not more constant, because we don't have a display update at a fixed frequency, we have the display update and also the SI5351 constantly only in the spectrum scan, but the frequency will be running, so it makes no sense to filter out noise where there will only be noise.)

Encoders



Installing and configuring the encoder.

The encoder is similar to 3 buttons (including, in the DDS WLG system you can use 3 buttons, instead of the encoder), the encoder is installed by connecting the CLK terminals on the Arduino D2 pin, DT on the Arduino D3 pin and SW on the pin D4 of the Arduino, if you do not want to use power on the encoder, remove the pullup resistors present on the encoder board, as the DDS system already has these internal resistors, but if you are using the encoder with a plate and resistors, it will be necessary to supply 5V on the + terminal of the encoder plate.
The CLK terminal is connected to the Arduino pin D2, the DT terminal is connected to the Arduino pin D3, the SW terminal is connected to the Arduino pin D4.

The DDS WLG system is designed to work with 2 different encoder models, which can be selected in item 28 of the settings menu. 

The most common is type 4, which will be noticed in the system. If you use a model different from the model selected in item 28, it will be observed when you rotate the encoder once and it takes 2 steps, or it may happen that you rotate twice to occur just 1 step; if this is happening, enter item 28 and change from type 4 to type 2 or vice versa. Another thing that can happen is that the direction is reversed. To invert the direction of direction, enter item 29 and adjust by selecting the value 0 or 1. 

Mode switch

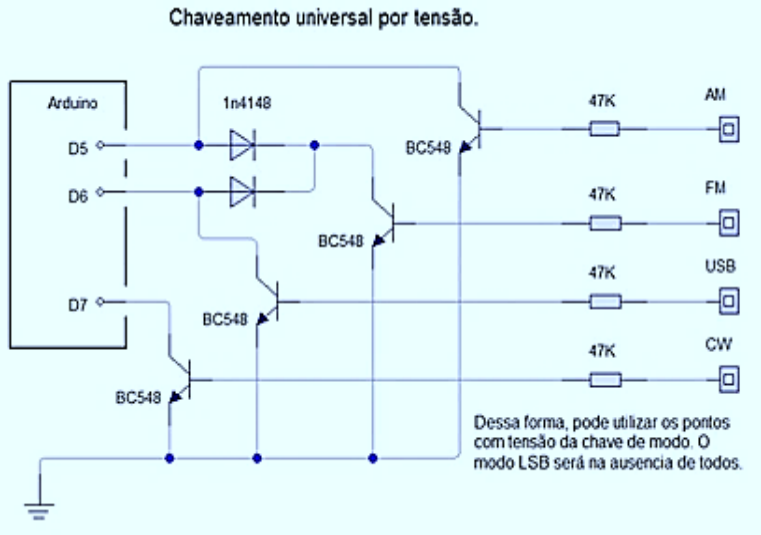
The DDS WLG system always provides a way to adapt to different radio models, for this the system checks the position of the key of the modulation mode of your equipment, this verification is done through a low logical level, that is, taking the corresponding Arduino pins, to the ground. For the arduino to identify this difference, it is necessary that the pin has a voltage of 5V present. We call this a pullup which is a resistor usually 10K connecting the Arduino pin up to 5V, so that the arduino recognizes this change in logic level from 5V to 0V, you should just ground the pin that already has this pullup resistor internally.

The system was designed to read a combination for up to 5 modulation modes, which are AM, FM, CW, USB, LSB
To identify these positions, the system will use Arduino pins D5, D6, D7.

See a table for the combinations:

D5 in GND ..... AM mode
D6 in GND ..... USB mode
D5 and D6 GND ..... FM mode
D7 in GND ..... CW mode
No pins in GND ..... LSB mode

Depending on the radio model, it will be necessary to perform a universal voltage switch. This switching requires 2 bipolar NPN transistors. This in case of being installed in radios that have only AM, USB, LSB. In the diagram of the universal voltage switching, you will easily identify what I am explaining, as the necessary thing is to ground the corresponding pins on the Arduino, so the use of the transistor is exactly to make this ground through the collector that will be connected directly to the corresponding pin of the Arduino, the emitter plays directly to the ground and the base receives the voltage from the radio circuit that made the switching of the modulation mode selected by the switch.



In the settings menu, these pins act on items 16, 17, 18.

Item 16 will measure a deviation that can add or subtract the value entered in the item (OFFSET AM).

Item 17 will measure a deviation that can add or subtract the value entered in the item (OFFSET LSB).

Item 18 will measure a deviation that can add or subtract the value entered in the item (USB OFFSET).

FM and CW offsets are not present in the menu, as in PX radios, these modulation modes use the AM offset.

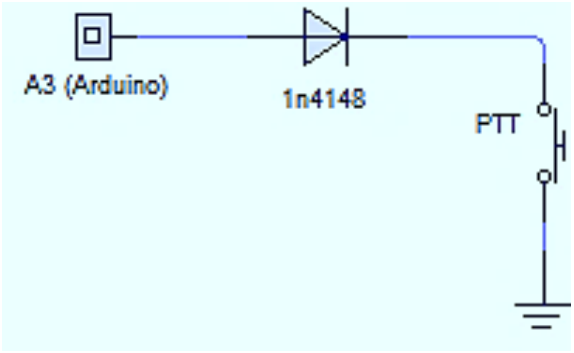
These adjustments are made in Hz and do not replace the radio's main Carrier, here only a calibration should be done for a higher frequency accuracy.

The offset patterns are:
1.5KHz for Cobra models and 2.5KHz for Voyager models.

PTT sensor

This time the DDS WLG system has a beep and in order for the beep to work, it is necessary to read the PTT key, as this way the system knows when it is being transmitted and waits as long as necessary before emitting the beep.

The installation of the key is very simple, however, you will have to be very careful and careful in this installation, as it is one of the most risky, running the risk of burning the Arduino module. For that not to happen we will use a 1n4148 diode between the Arduino pin A3 and the point on the radio connector where it is grounded when we press the PTT button.



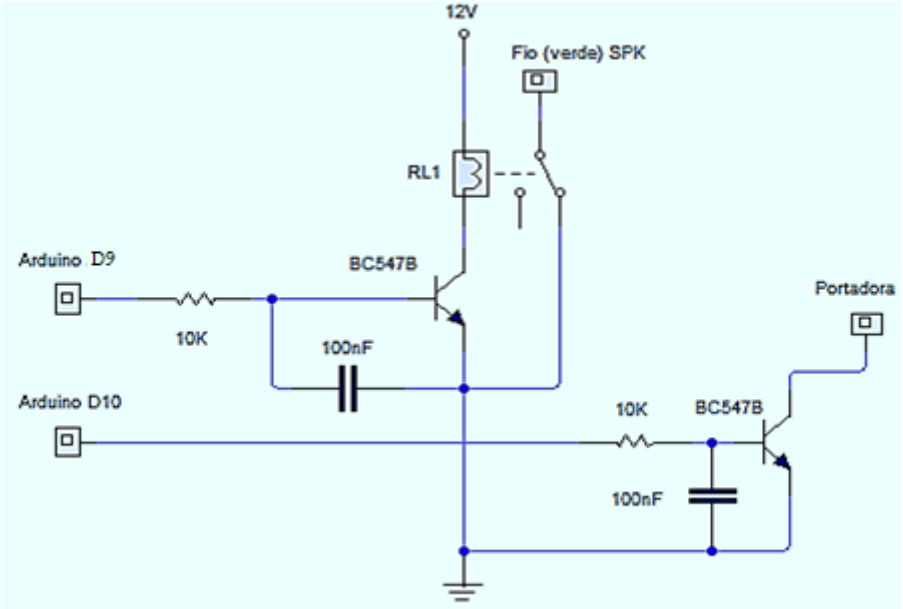
The reason for this diode is in case the installation of this pin is done at a point where the PTT switch will be grounding a voltage of 8V, so this 8V cannot be delivered to pin A3 of the Arduino, because the maximum voltage limit on the pin of the Arduino is 5V. Technically it works like this: pin A3 needs a constant voltage of 5V to inform the system that the radio is not transmitting, this voltage is the Pullup that should use a resistor generally 10K between VCC 5V and the corresponding pin on Arduino, on case here, pin A3. To inform the system that the radio is transmitting, pin A3 must be grounded, reducing the voltage from 5V to less than 2V, so the system will understand that the radio is transmitting. By connecting the anode to a general purpose diode and grounding the cathode, pin A3 will have a reduction of 5V to approximately 700mV which is well below 2V and thus the system will understand it as a low logical level. So the diode is only protecting the Arduino in case of a voltage return above 5V on pin A3, but if you removed the PTT switch from the radio circuit that makes the TX and you are sure that there is no voltage returning, no it is necessary to use the diode.

Cutting Loudspeaker and Arming Carrier through the DDS system (BIP Circuit)

As the new DDS system monitors the use of PTT, the system now controls the right moment to arm a carrier on your radio through the Arduino D10 pin. This pin remains at 0V until the PTT is pressed, but as soon as the PTT sensor detects that it

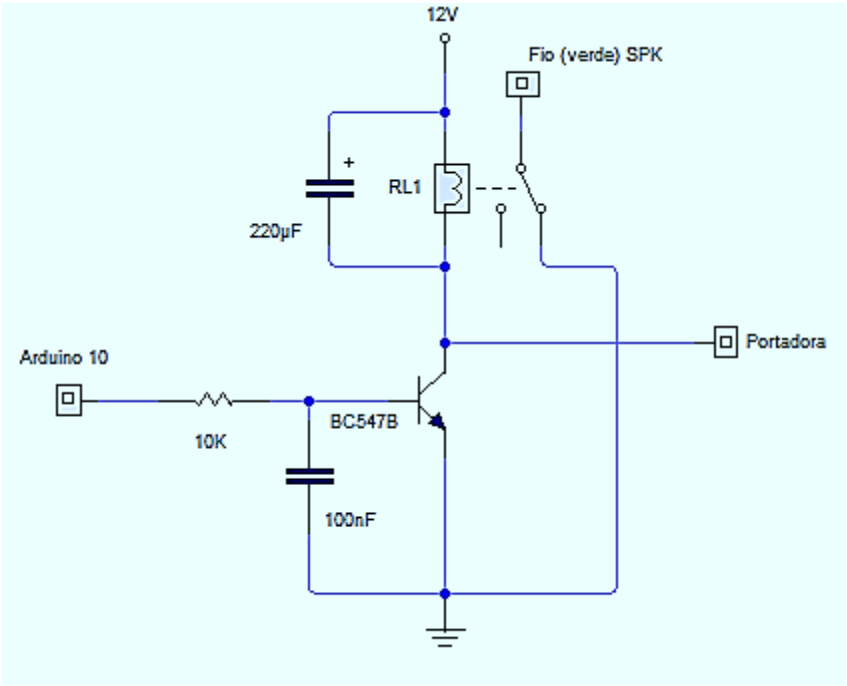
hears the PTT button being pressed, the system checks the interval value in item 3 of the settings menu and makes a time correction between pin D9 and pin D10. The D9 pin of the Arduino is an option to correct an initial noise that can occur in the speaker, when you press the PTT, because if the system turns off the speaker and arm carrier in the same interval, the radio circuit will allow to generate a brief popping sound on the speaker, so that this doesn't happen, the system will first switch off the relay via pin D9,

The proposed circuit using a specific Arduino pin for the loudspeaker cutout relay and a specific pin for arm carrier, must be made using a general purpose NPN bipolar transistor and a 12V relay that has a normally closed contact for the loudspeaker cut and 10K resistor between pin D9 and base of the transistor, to eliminate noise, use a 100nF capacitor between base and ground. To arm carrier use a general purpose bipolar NPN transistor and 10K resistor between pin D10 and base of the transistor, to eliminate noise, use 100nF capacitor between base and ground.



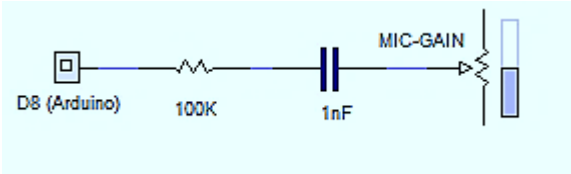
On the radio, it will be necessary to remove a wire from terminal 3 of the PTT connector, in the case of the 148 GTL, this is the green wire that cuts the speaker through the PTT switch. Removing this wire, this same wire will be connected to the SPK (green) wire terminal of the beep circuit. The Carrier Terminal of the beep circuit will be connected to the wire that was removed from terminal 5 of the PTT connector. (You removed a wire from terminal 5 to connect a PTT sensor diode, it is exactly this wire that has 8V, in this case, as you removed this wire from terminal 5, it is not necessary to use the diode, but I recommend using it like this.

But there is a more common form used in almost all beep circuits which is using only one Arduino pin to arm carrier and arm relay that cuts speaker at the same time. But it does not correct the initial noise, it only corrects the final noise. In this circuit the relay carries the weapon and cuts the speaker at the same time, and depending on the radio, it will be possible to hear a brief noise similar to a burst in the speaker, as soon as the PTT is pressed, but when releasing the PTT, the carrier cuts shortly before the relay resets the speaker. This time correction is done through the 220uF capacitor, this capacitor must be adjusted depending on the impedance of the relay used.



Audio output for BIP

With the new feature in the system that allows you to place polyphonic BIPs on your radio without the need for an external beep plate, the system makes use of the Arduino D8 pin to generate the beep sounds. There are several ways to match this audio output to your radio, the most common of which is to input audio into the MIC-GAIN pot next to the microphone. What is necessary is that you use a resistor of about 100K and a capacitor of a maximum of 100nF. On 148 GTL models, you can simply use a 100K resistor followed by a 1nF capacitor and connect directly to the central terminal of the MIC-GAIN potentiometer.

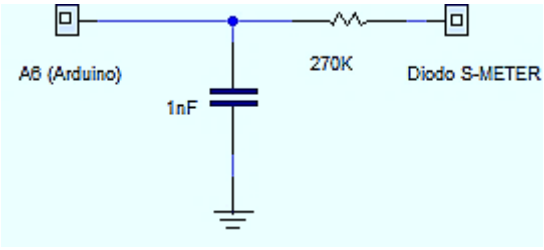


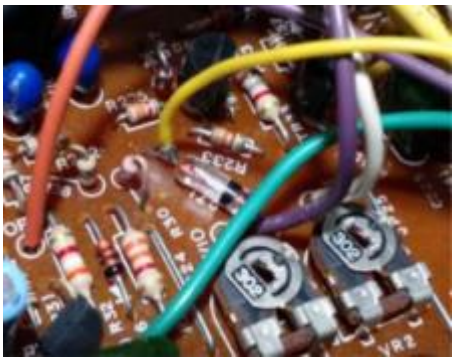
But this match will depend on how it will look on your radio, because in some cases, it may be that someone has made changes to the original audio circuit of the radio and this match is not good, so adjust the capacitor for a better result.

Installing the spectrum sensor and auto-scan

The new DDS 6.27 system has a spectrum scanning function that can be used as a tool for perfect radio alignment. This spectrum allows to scan the entire frequency limit that was defined in items 19 and 20 of the service menu, and can be used in the RADIO RECEPTOR mode by sweeping the entire limit defined in items 26 and 27 of the service menu. The use is very simple and for more details on how to use, see the page about the system's operating modes.

The maximum voltage for the spectrum scanning sensor is 1.1V. I will detail here the installation on a Cobra 148 GTL radio, but it can be done on any other radio model, as we will use the reference of the radio's S-Meter.



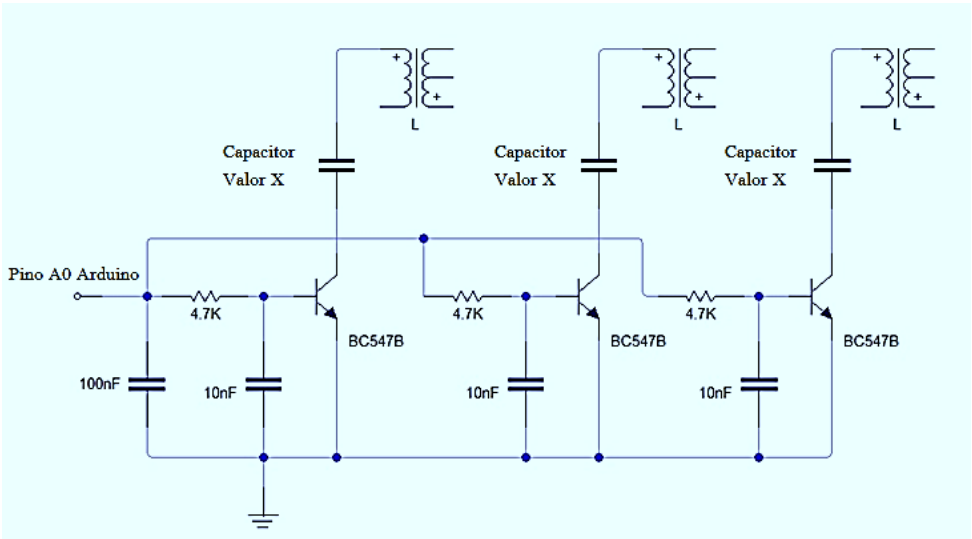


The most indicated point in the 148 GTL is at the anode of the D71 diode which is delivering the signal to the S-METER adjustment trimpots. Use a 270K resistor between the diode anode and the Arduino pin A6, also use a 1nF capacitor between the Arduino pin A6 and GND. (Higher values for the 1nF capacitor can be tested. This capacitor will act by filtering the spectrum graph on the screen).

Using item 23 of the settings menu (Filter for negative channels).

This is an additional feature that requires a lot of technique and patience too, as it is basically a realignment of coils for use with negative channels. This feature will always be activating the Arduino pin A0 at 5V output, when the frequency value in the DDS system is in VFO mode or Channel mode is below the value of item 23 of the settings menu. The technician will be able to use capacitors on the corresponding coils and these capacitors will be switched through an NPN BC547 transistor.

In summary, the Arduino pin A0 will have a 5V output whenever the system frequency is below the filter frequency in item 23.



The diagram only shows how this switching can be done. In this example, only 3 coils are being used.

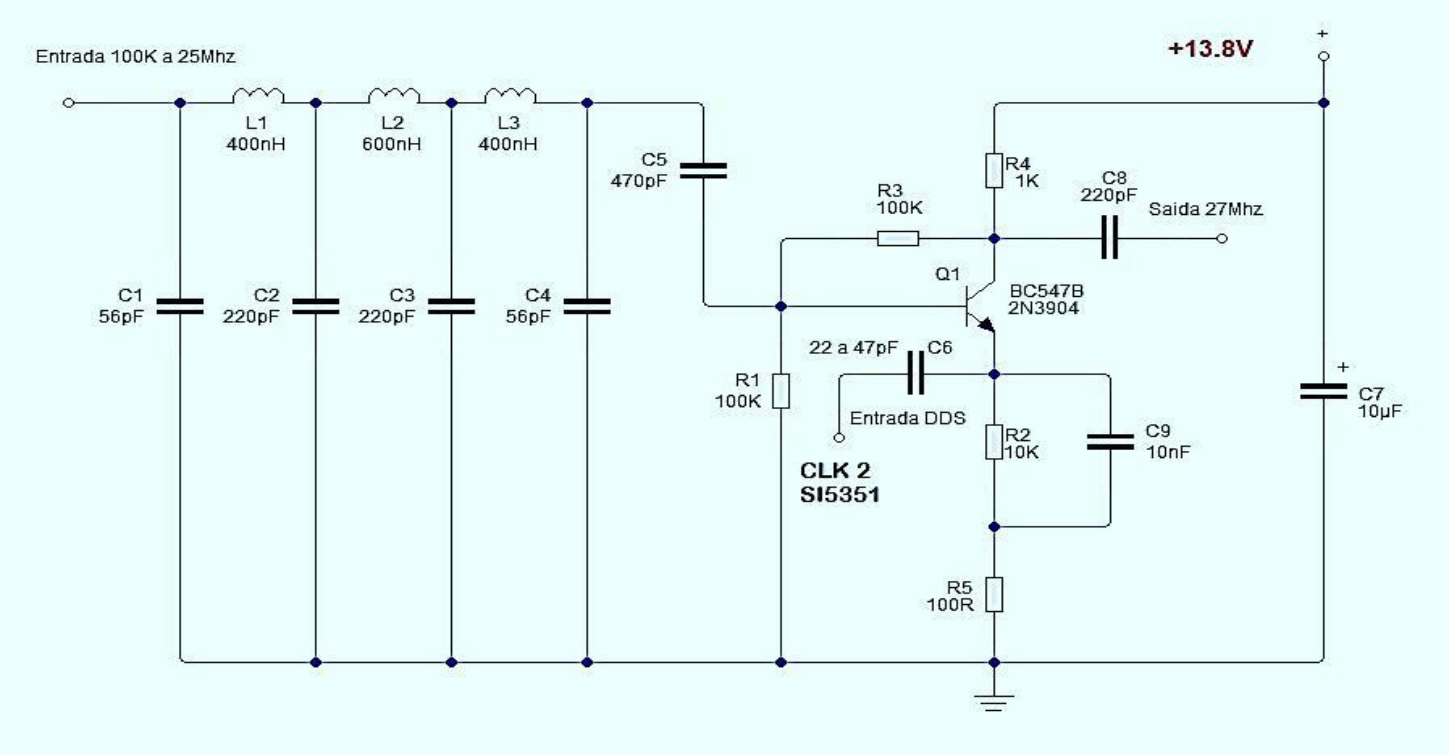
About converting to RADIO RECEPTOR mode

The RADIO RECEPTOR or HF Receiver mode is an option in the DDS system that allows you to hear frequencies below the 11 m range of the PX. In this mode, the system will perform a frequency calculation generating at the CLK2 output of the

SI5351 a frequency equivalent to the frequency of item 25 of the settings menu minus the frequency being displayed in the VFO of the RADIO RECEPTOR mode. To make use of the RADIO RECEPTOR function, it will be necessary to use a MIXER plate that can be easily made using general purpose components.

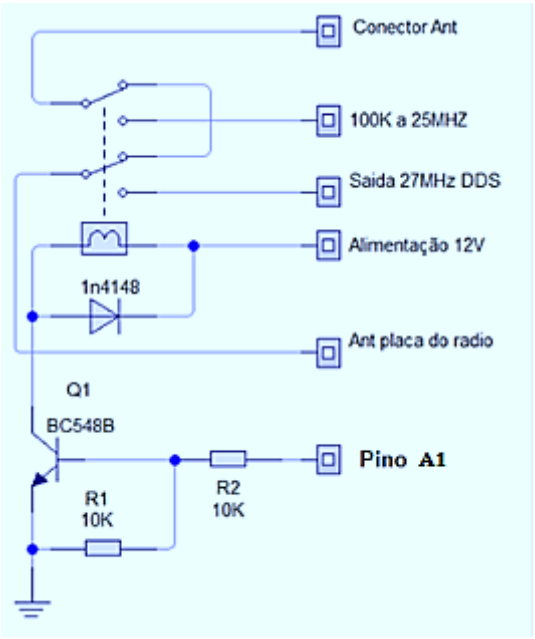
List of required components:

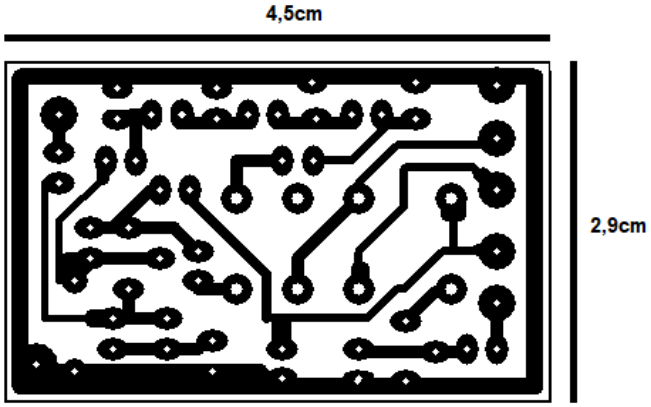
2 - BC547 Bipolar NPN Transistors
1 - Relay model ML2RC2 (12V)
2 - 100K resistors
3 - 10K resistors
1 - 1K resistor
1 - 100R resistor
1 - 10nF ceramic capacitor
3 - 470pF ceramic capacitors
2 - 220pF ceramic capacitors
2 - 56pF ceramic capacitors
1 - 22pF ceramic capacitor
1 - 22pF ceramic capacitor
2 - 400nH Inductors (Can be made by wrapping 16 turns 32 Awg wire over 1M resistor)
1 - 600nH Inductor (Can be made by winding 22 turns 32 Awg wire over 1M resistor)



The transistor used was a BC547, because it is easy to be found, but for a better result you can check possible substitutes indicated for RF, also try placing a FET, for example, a 2n7000

The PCB board is also very simple to make.

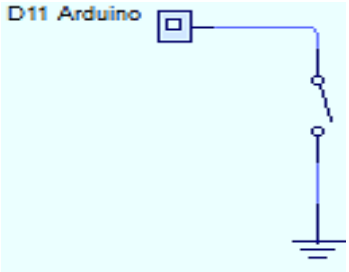




This mixer card, will provide a great reception between 500KHz to 14MHz, you can try to go up to 21MHz, but above 14MHz the reception will drop a lot, because the filter starts to cut. The conversion has no selective filter, requiring a specific antenna for the band you want to receive. To use the conversion card, enter the user menu using option 2 of the encoder switch button, select the RADIO RECEPTOR icon and use any of the 3 button options to access this mode. Note: for better reception, adjust item 25 of the settings menu by placing the radio on a fixed frequency in the 11M band. Choose a frequency that isn't exactly a Channel and preferably where you don't usually have many rounds and if you happen to hear beats,

Using the Transvert function

This function will only display the correct frequency in case of using an external transverter. Here the user can adjust item 9 of the settings menu to add or subtract a value in the VFO frequency display. For example, if you place the radio in a conventional 40M transformer, generally the conversion frequency will be removing 20MHz to deliver to the PX, so if the radio is on channel 30 (27,305.00) and is using a 40M transformer, it will be actually receiving (7.305.00) but without using the correction function in the DDS system, 27.305.00 will be displayed. Passing the key to the transverter mode, which is grounding the D11 pin of the Arduino, the system makes a calculation by adding or subtracting the value in item 9 of the settings menu, as it will probably be in -20000000 in item 9, the system will make 27.305.000 - 20000000 = 7.



Installing DDS on a Cobra 148 GTL radio

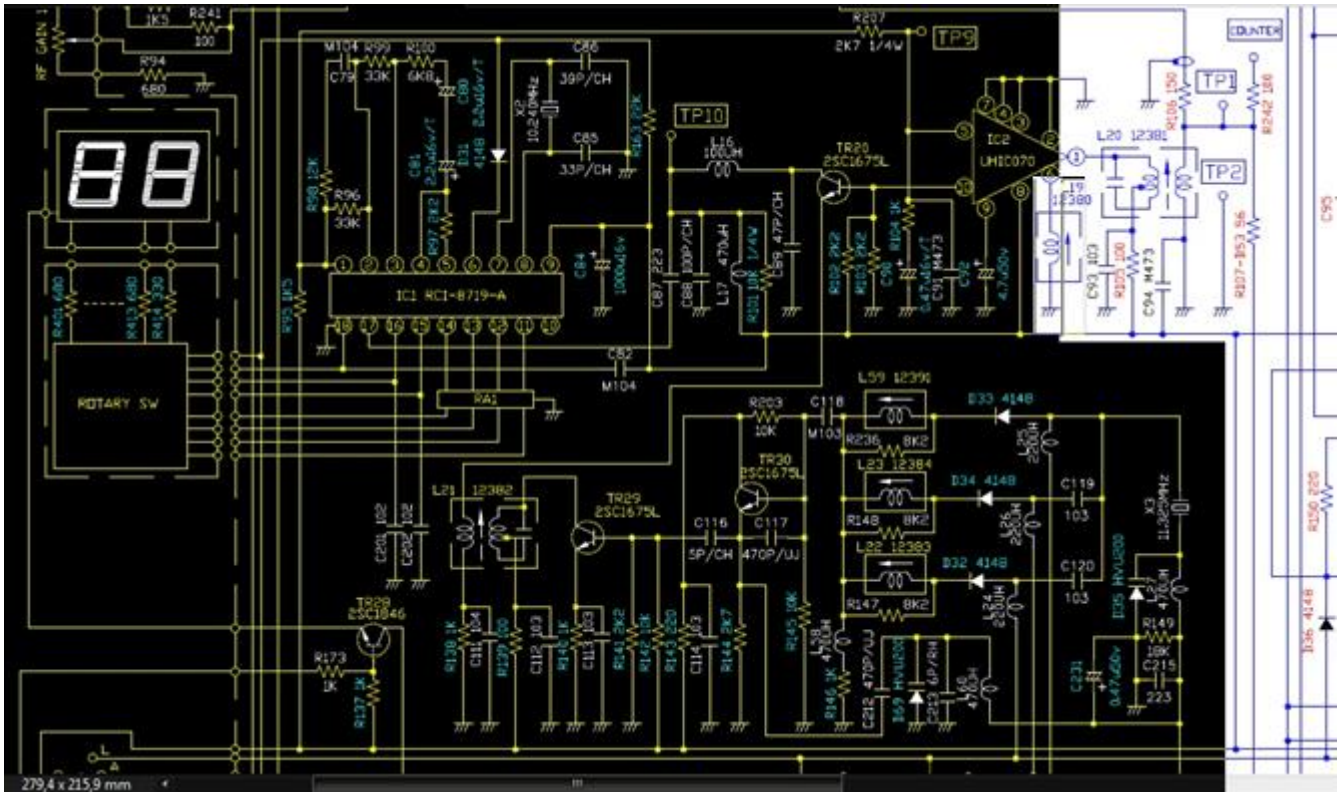
This part of the manual is entirely focused on installing the DDS KIT on a Cobra 148 GTL transceiver, but as you have already noticed, the DDS WLG 6.27 system is quite versatile and can adapt to any other radio model, including the old HF transceivers .

NOTE: Reading only this part of the manual, you will not understand how to install BIP, Spectrum, PTT and etc. Do not skip steps. Read the entire manual from the beginning.

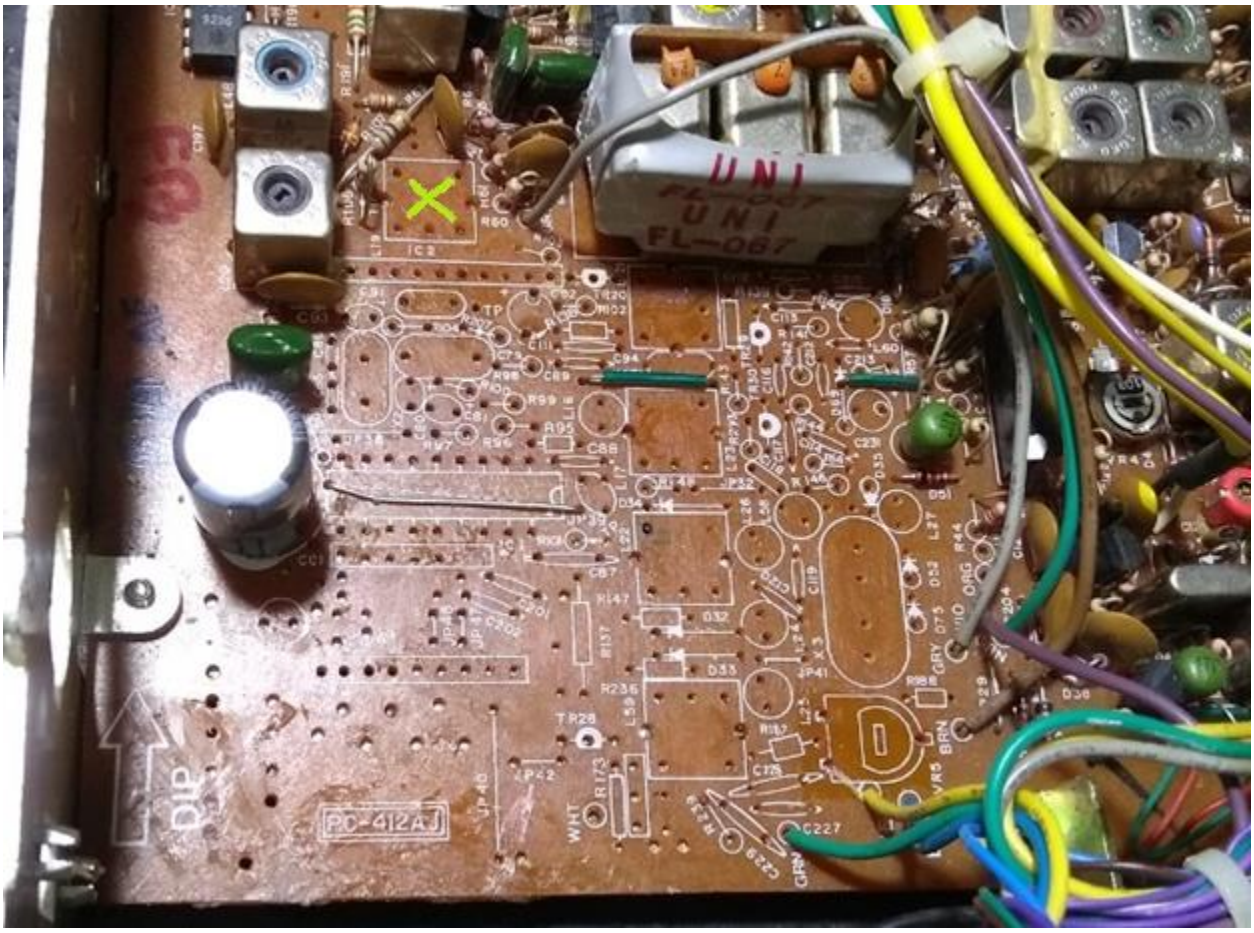
Preparing the radio for DDS installation

First step is to remove the original VCO system. **(But don't do it yet, read and understand, as you can also maintain and use the UHIC070 module)**

To give you an idea, see in this diagram what can be eliminated in a 148 GTL. (Any dark part can be eliminated without a problem).

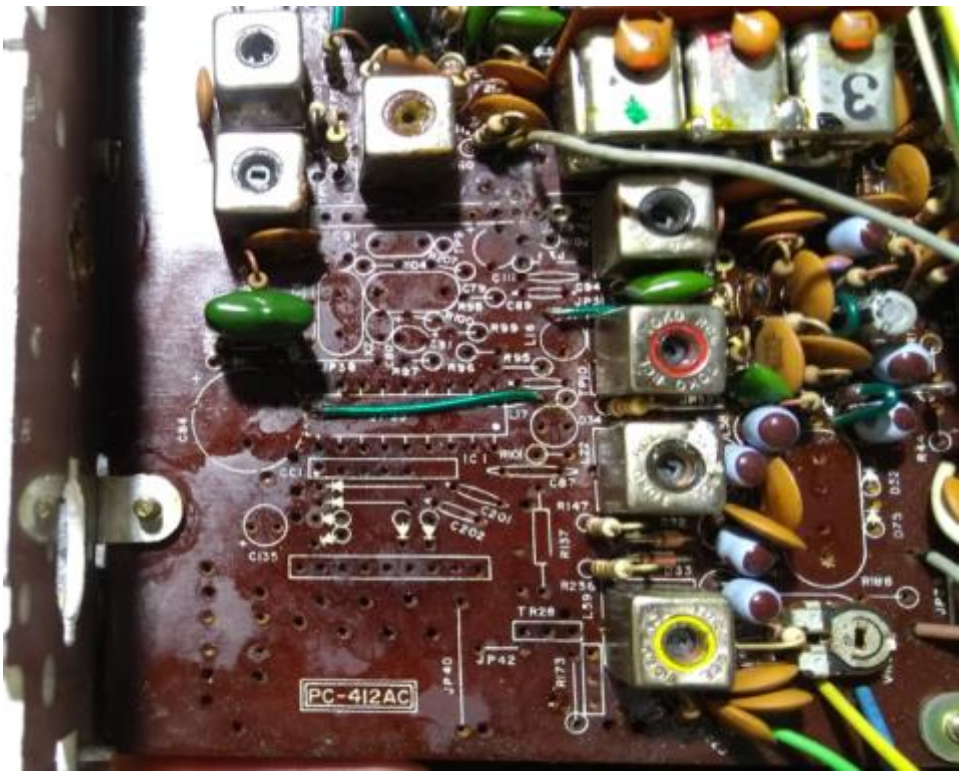


On the board you will get an even better idea. (Do not remove L19).



With the exception of the L19 coil, which will now be used in this new installation.

The following photo shows what we are actually going to remove to effect the DDS modification. Note: the C84 capacitor was removed just to facilitate the assembly, but after adding the SI5351 module, place the 1000uF C84 capacitor again.

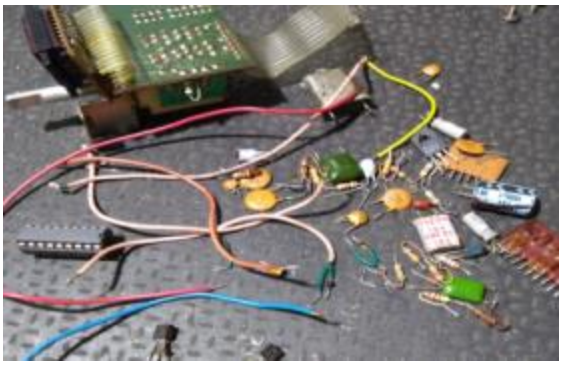


After removing these components, you will need:

1 - Transistor 2SC1675 (You can use what was removed)
1 - Resistor 100R (Has one near the TR29, can be removed and used)

1 - Resistor 470R (You can use two 1K in parallel if not found)
1 - Resistor 1K (You can use what was removed)
1 - 4K7 resistor (You can use two of 2K2 or one of 2K2 and the other of 2k7 in series if not found)
1 - Capacitor 18pF (You can use what was removed)
1 - Capacitor 47pF (You can use what was removed)
1 - 10nF Capacitor (You can use what has been removed)
1 - 100nF Capacitor (You can use what has been removed)

Separate parts.



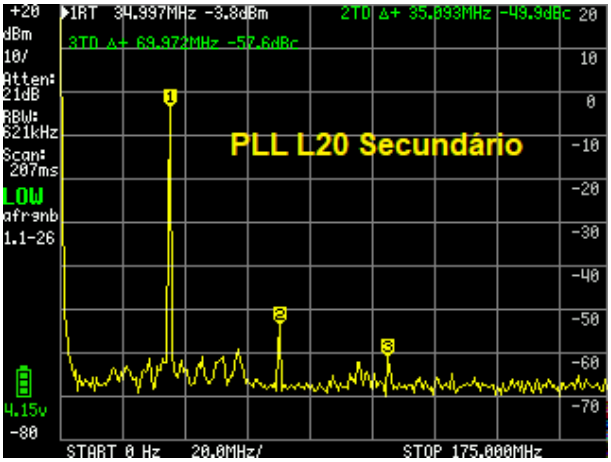
Parts removed.

Only the 470R and 4K7 resistors you will not find in the middle of those that were removed, but you can use 2 to form the value of 1 as suggested in the material list.

With this separate material, you will analyze the diagram of the buffer and on the radio plate, using the positions of the removed components, you will assemble the new buffer, repositioning the components in the material list.
(This requires technique).

Buffer for the main output of the DDS system.

Originally, its radio uses the VCO UHIC070 which was designed for a 40-channel radio, using a spectrum analyzer at the TP1 point of the L20 coil, the fundamental amplitude of this signal is on average -3.8dBm with the second harmonic around -49.9dBm below the fundamental. Of course, the ideal is to maintain these standards, but generally, what the enthusiast likes most is to have as many channels as possible, and this will not be possible if he wants to keep the original .standards



If you go outside of this standard and increase this amplitude, you will have a better performance in the additional channels, however, you will also have a noisier reception and, in the end, this was not beneficial, because the rest of the radio was not designed to accompany these channels. additional, but there is a

technique that can be done and will allow to have a better performance in the additional channels, which is using pin A0 and item 23 of the service menu. (I won't go into detail, because if you've read the manual so far and already know about it.)

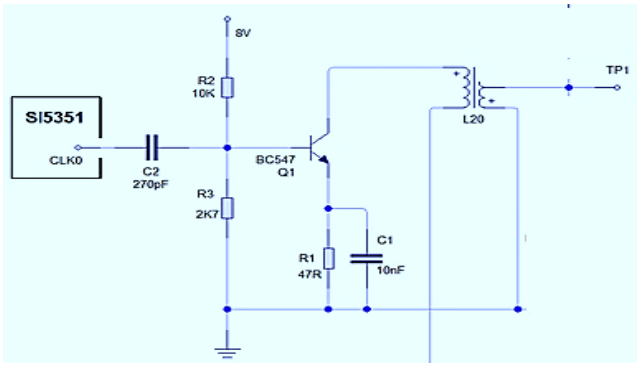
In summary: After a modification by DDS, the whole system was limited to generating a frequency respecting the .standards of the offsets and the final product will be at point TP1 of the L20 coil in case the radio is a Cobra 148 GTL

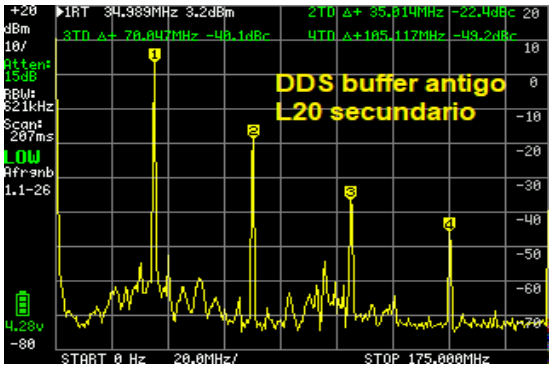
Installing the main buffer.

At this stage of the installation, you probably already understood how the Arduino module should be powered, how to turn on the display, how to turn on the SI5351, how to turn on and filter the clarifying potentiometer (VOICE LOCK) and also already learned about the mode switch. modulation. If you have not read and do not know the reason for these steps, I suggest you start first by reading this manual.

A little about the old buffer.

In my first modification on the 148 GTL, doing tests and practicing my hobby as an amateur radio, following the diagram I saw that the main point where the DDS should work would be on the L20 coil, since the VCO + PLL and Cristal X3 set of 11.325MHz, worked together and they were delivered to the L20 coil that had fixed frequencies on its output depending on the selected channel and had a 1.5KHz deviation above the AM or below the AM, depending on the position of the USB mode switch, LSB, so the main point was the L20 coil. After writing down some reference frequencies for some channels, I removed the entire VCO + PLL analog circuit and oscillator 11.325 and went to work on the L20, with a lack of knowledge and a desire to do something simple,



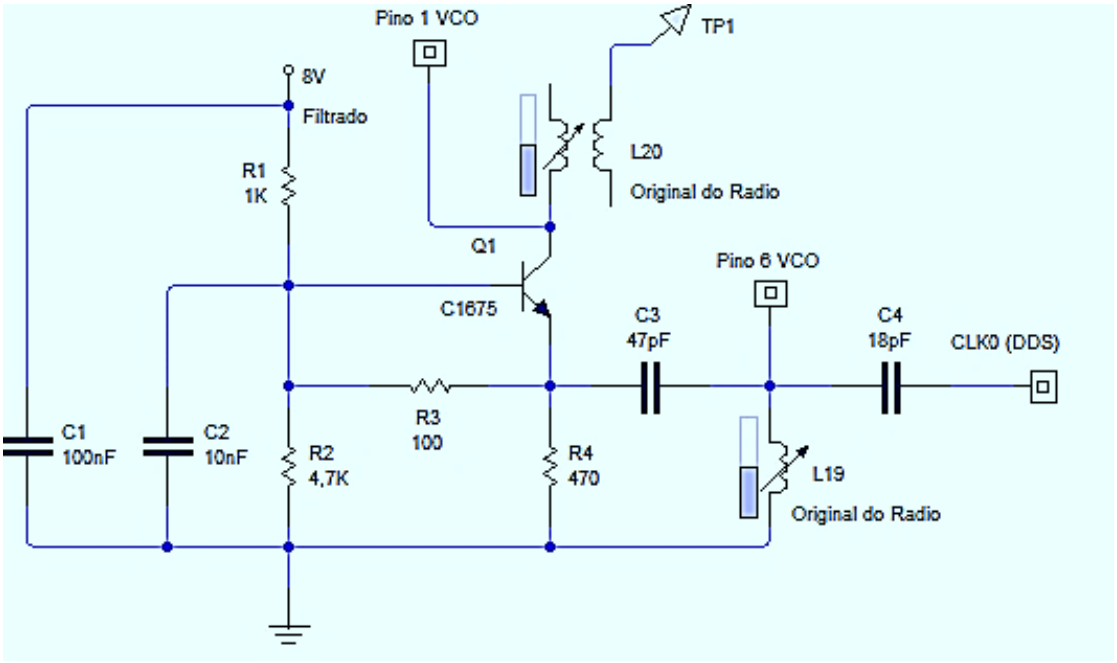


As can be seen in the spectrum above, the levels are absurdly higher than the original levels, and this will provide you with a better performance in the additional channels, but the reception becomes noisier.

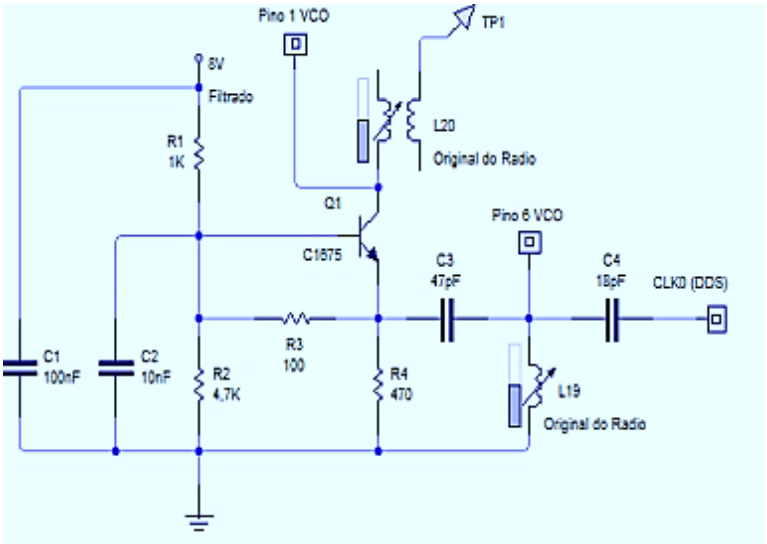
Today I no longer recommend this old buffer, although it works very well and allows a very wide band of channels on the radio, it is not a recommended circuit, it amplifies many spurious. We are using the SI5351 module as the main RF generator that works with digital output forming a square wave, although the L20 coil filters this wave, transforming it into a sine wave, the buffer is not well calculated to maintain a standard amplitude at the output TP1 and for this we have a very large bandwidth, being able to define up to 1000 channels in a radio, but as the radio was designed for 40 channels, this is an illusion, because we do not have filters being switched to allow so many channels, however, this is not a lie in the system, in fact you can define 1000 channels using this buffer, so much that I did a test with the friend PY4AAZ and I modulated in a lateral band from 21MHz to 29.5MHz, only that it was only in one direction, I only did this transmission, but if I had to receive it, I would never be able to, because as explained , the radio is not designed for that bandwidth. In summary, the old buffer was updated to maintain an amplitude equivalent to the original system and now the L19 coil is being used, which will narrow the band, allowing a maximum of 40 negative channels and 120 positive channels, but with the guarantee of maintaining the quality of the analog VCO + PLL system.

New buffer.

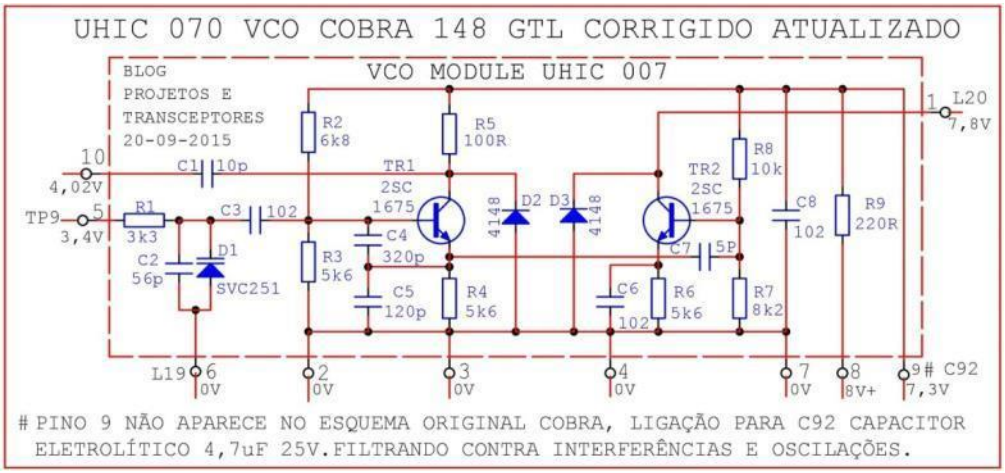
The new buffer can be made using components that will be unusable on the radio itself, because after modification by DDS on your Radio Cobra 148 GTL, an original part of the radio will be inoperable.



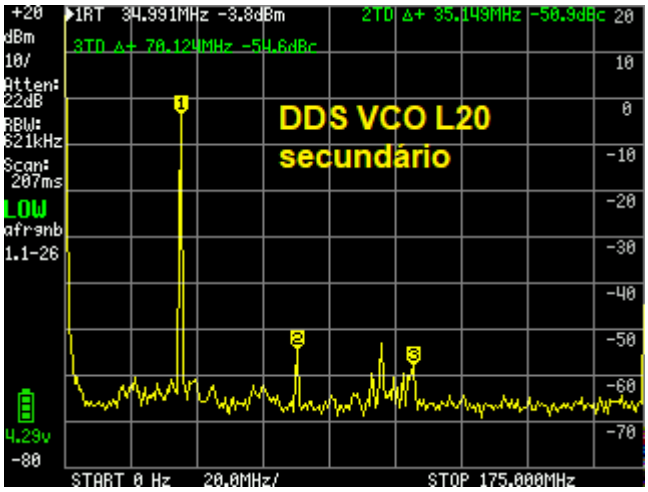
You can assemble by positioning the components in the vacant position after removing the unnecessary components.



Keeping the original 148GTL UCO VHIC070



Installation can also be done, keeping the original VCO, the performance in the additional channels will be lower, but the .standard will be equivalent to the original and will have a quieter reception

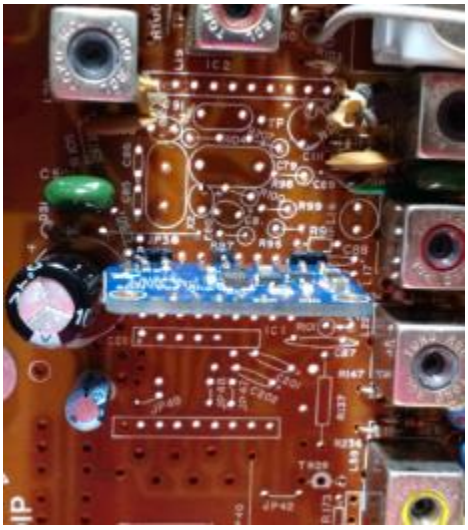


The CLK0 output of the SI5351 module will be delivered to pin 6 of the VCO, along with coil L19. (use a 100pF capacitor between CLK0 and pin 6) To keep the VCO module in place, it will be necessary to keep the following components.

IC2 - UHIC070	C93 - 10nF	R102 - 2K2
L19 - 12380	C92 - 4.7uF	R103 - 2k2
	C91 - 47nF	R104 - 1K
	C90 - 0.47uF	R105 - 100R

Installing the SI5351 module

Now that you have the buffer made in place, you can install the SI5351 module. The most indicated place on the radio plate is exactly where the PLL was. Good grounding on the SI5351 module is important.



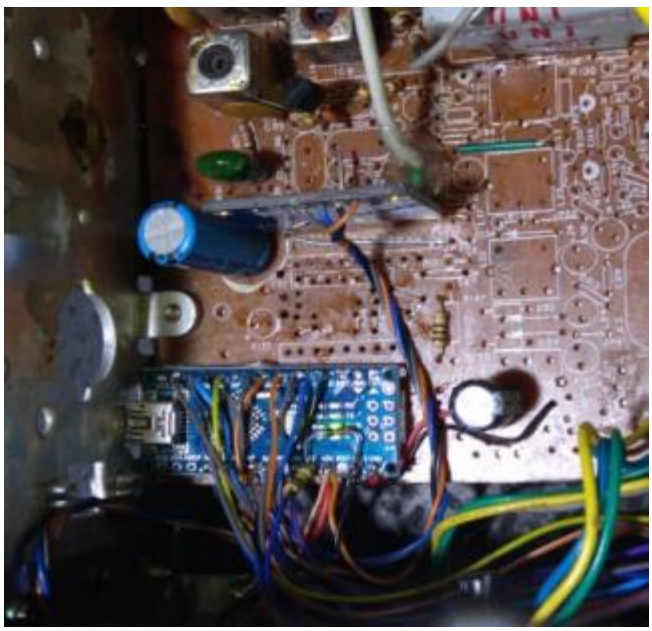
Up to this point in the installation, your radio is already prepared to receive the Arduino module.

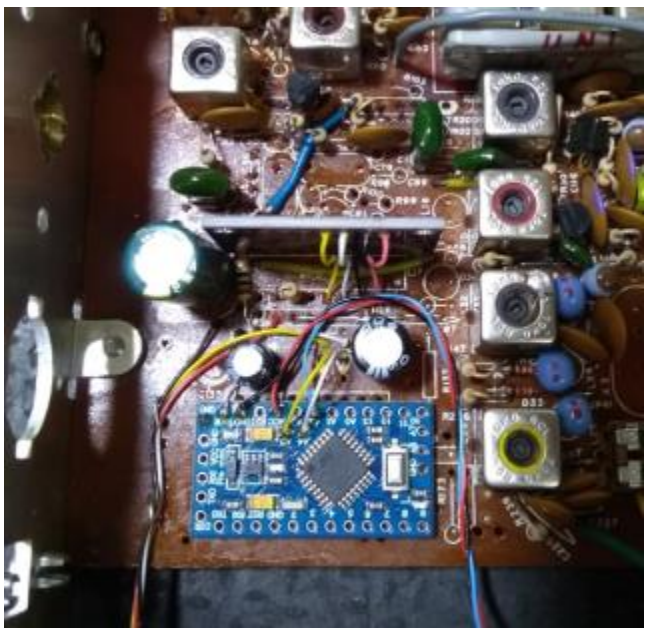
Installing the Arduino module.

For information on how to write the firmware on the Arduino module, visit the blogwww.kitdds.blogspot.com

This is without a doubt the most complex and tiring step of the modification. You will position the Arduino in place, easier for you to connect the wires, here there is no rule to be followed, just connect everything correctly. A detail of the entire pinout is on page 4 of this manual.

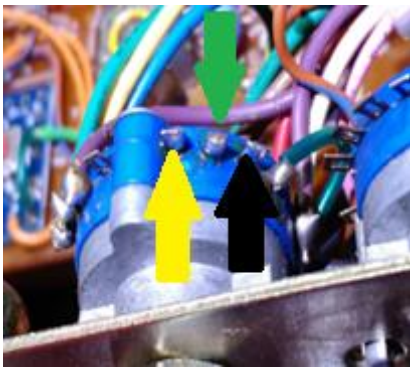
The following images are just a suggestion of how and where you can place your Arduino.

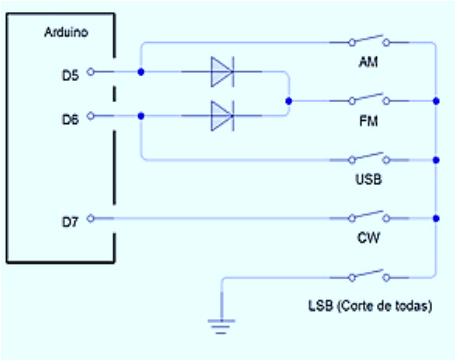




Installing and configuring the modulation mode switch.

Using DDS on a Cobra 148 GTL radio, we already have terminals left on the modulation switch, which can be perfectly used to inform the Arduino, where the switch is located.

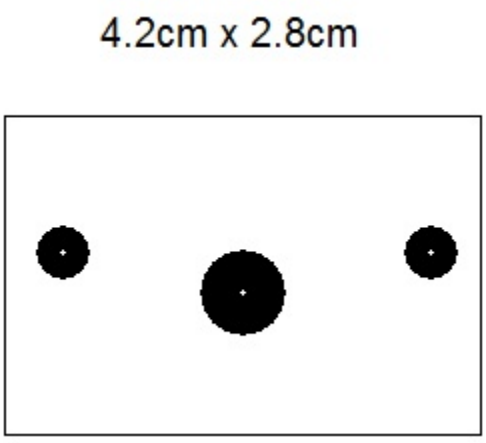


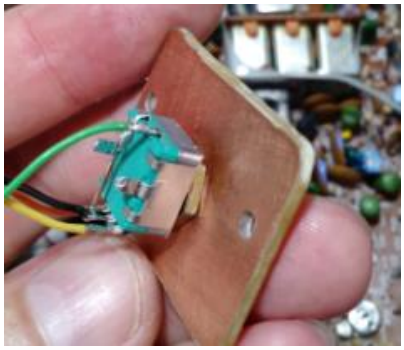


Note that there are 3 free terminals, depending on the radio version, the switch may be placed in another direction and the free terminals are on the other side of the radio chassis. At the point indicated with yellow arrow, you will connect to the D5 terminal of the Arduino, making the identification of the AM position, the point indicated with the green arrow, you will connect to the D6 terminal of the Arduino, making the identification of the USB position and the indicated terminal with black arrow, you will connect to the circuit ground. The LSB position will be identified by the system, when there is no grounding at pin D5 and D6. In short: D5 left terminal (AM), D6 middle terminal (USB) and fully right terminal, GND. This way the key will be requesting AM mode and USB mode, LSB mode is in the absence of these two requests.

Install the encoder switch now

As support for the encoder, it will be necessary to cut a 4.2cm x 2.8cm plate.

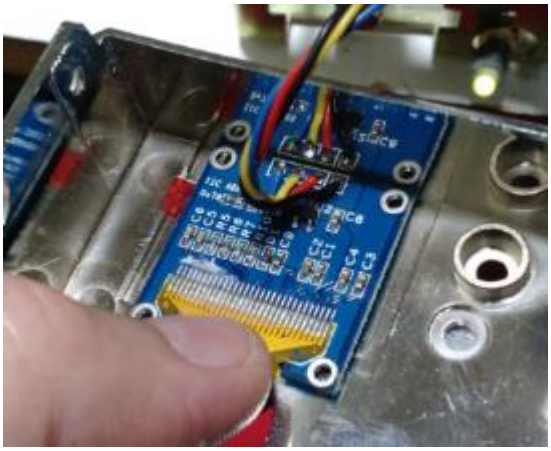




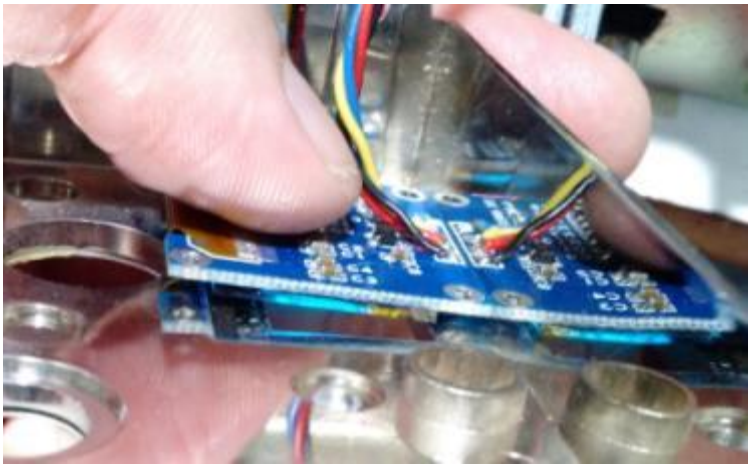
With a screw with nut to secure the 4.2 x 2.8cm plate, the original selector switch holder can be used. The encoder can be installed with the original plate on the models for Arduino, or without this plate as shown in these photos above, however, if the encoder is used with the plate, note that it has 2 or 3 pullup resistors. These resistors must be removed if the encoder is not supplied with 5V on the + VDC pin. If you don't want to power, just remove the resistors, as the DDS system already uses Arduino's internal pullup.

Installing Display

Here at this stage of the installation, you have to be very careful, as the display is very fragile and any error, however small, will damage the display.

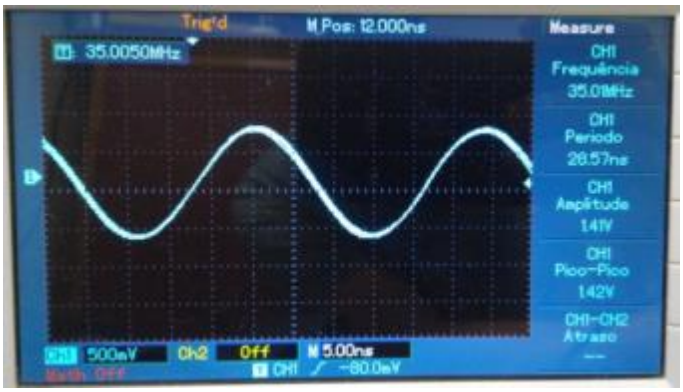


When accommodating the display, observe if it was not touching any corner of the display in any relief of the panel, if this occurs, surely your display will be broken as soon as you fix the panel screws.



In some cases, it will be necessary to use a mini grinder to make the display fit correctly, if you are not achieving a visual alignment of the display, use a thermal blower (hair dryer will do) and blow the display plate well, release the glass and position a little higher or lower, aligning perfectly. The best way to fix the display is to use hot glue.

Aligning L19 coil and L20 coil

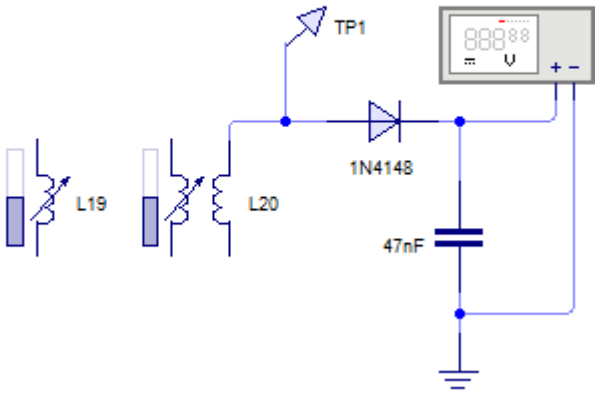


After everything assembled and working. The time has come to leave everything well adjusted.

It will not be necessary to use an oscilloscope, what should be done is just use a diode 1n4148 and a capacitor of 47nF connecting to point TP1 (L20 output) a multimeter.

This diode plus the capacitor were removed from the radio itself.

Canal 20 (27.205) TP1 = 35.005.000
Tensão 600mV a 700mV



Solder the diode anode at point TP1 of the L20 coil and at the diode cathode weld a 47nF capacitor to the ground. Between cathode and ground, connect a multimeter in continuous voltage reading, put the radio in bandwidth mode at the frequency of 27.205.00 enter the settings menu and go to item 11, lower the drive to 2mA and observe the voltage reading on the multimeter. Adjust L20 to the maximum voltage point, after L20 is at the peak voltage, adjust L19 until the maximum

voltage peak is obtained. If the reading is within 600mV to 700mV everything is fine, but if the voltage is too low, you can go up the driver in item 11 from 2mA to 4, 6, 8 and redo the alignment on L20 and L19

After all, leave the settings menu, go back to the running band mode, remove the external radio antenna, leave the RF GAIN n maximum and check how the alignment was using the spectrum scanning function of the DDS system itself 6.27 giving too much spurious, adjust the coil L19 or L20, as it may have been a little out.

Problems and solutions

No information is appearing on the display

The DDS WLG 6.27 system has an operating priority which is to initialize the display (the system needs the display to proceed with initialization), if the display is not showing any information, check whether the LED on pin D13 is lit directly or flashing. If it is blinking, the problem is a defective display, but if the LED on pin D13 is direct access, the problem could be a display defect or simply a short on the line of the i2c pin A4 and pin A5 of the Arduino.

Solution: Remove the SI5351 and check if the display will work; if it doesn't work, replace the display.

System constantly locking

This can also be a problem related to the display or simply some noise on the i2c line. Check that the display does not have any of its terminals touching the radio chassis, any noise caused on the i2c line, can lock the system. If using capacitors between Clock (SCL) or DATA (DAS) to GND, lower the value of this capacitor, as this capacitor helps to clear noise on the i2c line, but if the capacitance value is too high, data loss will occur in the line i2c and the system will lock up.

Solution: Check the Arduino i2c line, pin A4 and A5.

Encoder does not work

You are probably using the encoder with a plate, in which case it is necessary to remove the pullup resistors or simply supply the encoder with 5V on the (+ terminal). do not have one, do a pullup for pin D2 with a resistor value below 10K between VDC 5v and another pullup for pin D3.

Solution: Pullup on pins D2 and D3 of the Arduino, or replacement of the encoder.

Encoder skipping 2 in 2 values or having to turn twice to a single value

Solution: Change the value of item 28 of the settings menu.

Inverted encoder

Solution: invert pins D2 and D3 of the arduino or invert encoder in item 28 of the settings menu.

Clarifying potentiometer is not acting

Solution: Check if it has value in item 24 of the settings menu. Check if there is voltage variation on pin A2 as you move the potentiometer to the right or left.

Not broadcasting

Solution: Check if it has value in item 8 of the settings menu. Check if the PTT makes voltage below 2V on pin A3. Check that when pressing PTT, there is 5V on pins D9 and D10 of the Arduino.

Loud humming speaker with closed volume

Solution: Make RC filter with 47R resistor and 100uF capacitor to supply the display. Use separate voltage regulator for the Arduino module.

Speaker giving pop sound when pressing or releasing PTT

Solution: Check the value in item 3 of the settings menu. Make BIP circuit using pin D9 and D10 from Arduino.

Settings menu is not appearing in the user menu

Solution: Remove ground from pin D12 on the Arduino.

It's generating a lot of spurious

Solution: Reset the value of item 13 in the settings menu. Decrease driver value in item 11 of the settings menu. Align L19 and L20.

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