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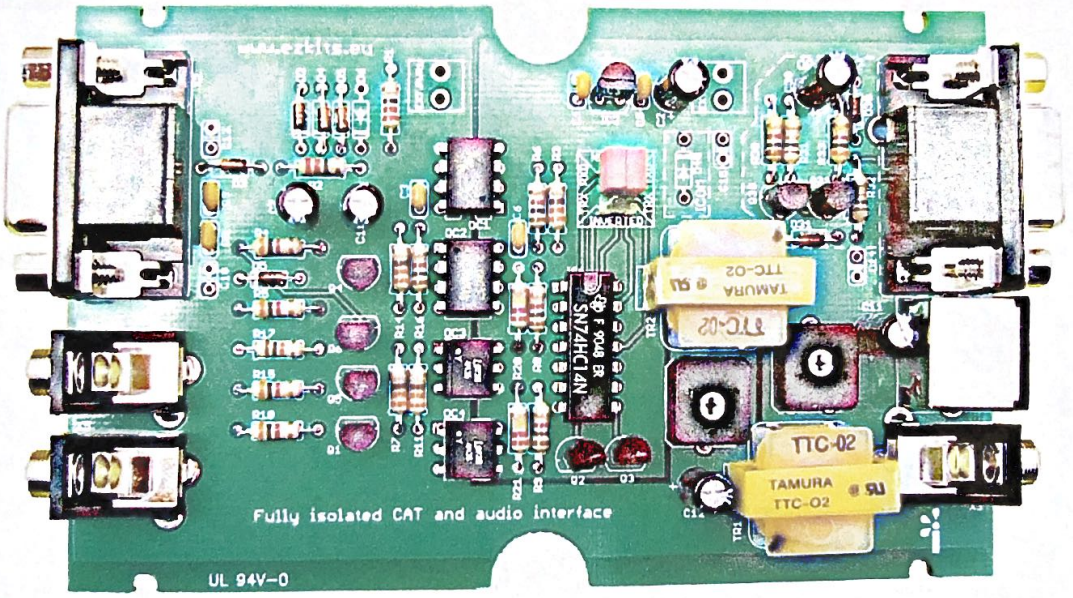
# OptoCAT Mk2

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Please note that this document is preliminary in nature and may be subject to change without notice.

All feedback regarding this document is highly appreciated and can be sent to info@ezkits.eu

## Introduction

Modern transceivers are equipped with a computer interface (CAT). This interface can be used for e.g. automated tuning, and retrieving the tuned frequency for logbook applications. Furthermore digi modes such as PSK31 and WSJT are popular these days. When connecting a transceiver with a PC, ground loops can cause interference or worse, damage you equipment in case of accidental faulty wiring of ground connections. (high current to power the transceiver may go through connected PC which is not dimensioned for such high current rating. The proper solution to prevent these problems is by electrically isolating the transceiver from the PC.

## Design Considerations

To accomplish complete isolation, separate supply voltages need to be available. On the side that is connected to the transceiver, power is drawn from the transceiver. To power the side that is connected to the PC we have 4 possibility to supply power.

1. directly powered from the PC's serial port,
2. powered from PC's USB port,
3. powered from separate power source,
4. derived from transceiver side power through switched inductive coupling.

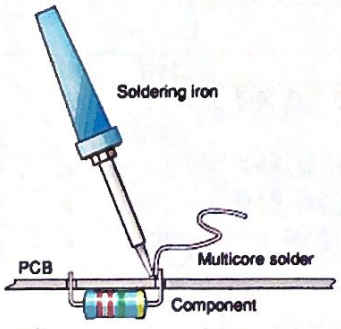
The last option is the most elegant solution, but also the most expensive solution as it requires a switched-mode power supply with transformer. The other 3 options are all possible with the OptoCAT circuit. The circuit board has room for diodes to and connection pads to connect an external power source.

Opto-couplers are generally "slow" components. It should be possible to communicate with the PC at a data rate of at least 38k4 bps. To achieve this special opto-couplers are used which are rated for up to 10 Mb/s. The OptoCAT circuit has been verified with speeds up to 115k2 bps.

Isolation of the audio signals is achieved with 1:1 audio transformers.

To allow modifications and additions to the circuit, part of the board is used as breadboard.

## Soldering Tips





Soldering is not difficult. However, if you are completely unexperienced, or if it has been a long time ago since you've last soldered electronic components, you may wish to practice a bit on some old PCBs and components. If you still don't feel confident, ask an electronics hobbyist for assistance. There are many electronics enthusiasts around and most of them will be delighted to help you out. The PCB in the kit is of professional quality. It contains tracks on both sides and the holes are through plated. The latter is particularly useful as it will help the solder to flow better, resulting in a better connection. Use a good quality soldering iron with a small tip of about 25 to 40 Watt. If the iron is too hot, you are likely to damage the components. If it's too cold, it takes too long for the solder to start flowing, which may also cause damage. Wipe the tip often on a wet sponge or cloth to keep it clean. Then apply solder to the tip to give it a wet look. This will protect the tip, improve transfer of heat and enables you to to make good quality solder joints. Always use appropriate multi-core solder. Don't use solder paste or solvents. You may want to bend the leads of the component a little bit, to ensure that they stay in position when you turn the PCB upside down. Don't bend the leads too much! Some components get easily damaged when the leads are bent too far. Furthermore, it may result in badly soldered connections and may even lead to short circuits. You may also use a sponge to keep the components pressed to the PCB when turning the board. Please note that the PCB has two sides. One side has got the numbers of all components printed on it. This side is called the Component Side. Unless stated otherwise, all components must be fitted at the component side. The leads of each component must be soldered at the other side of the board (at

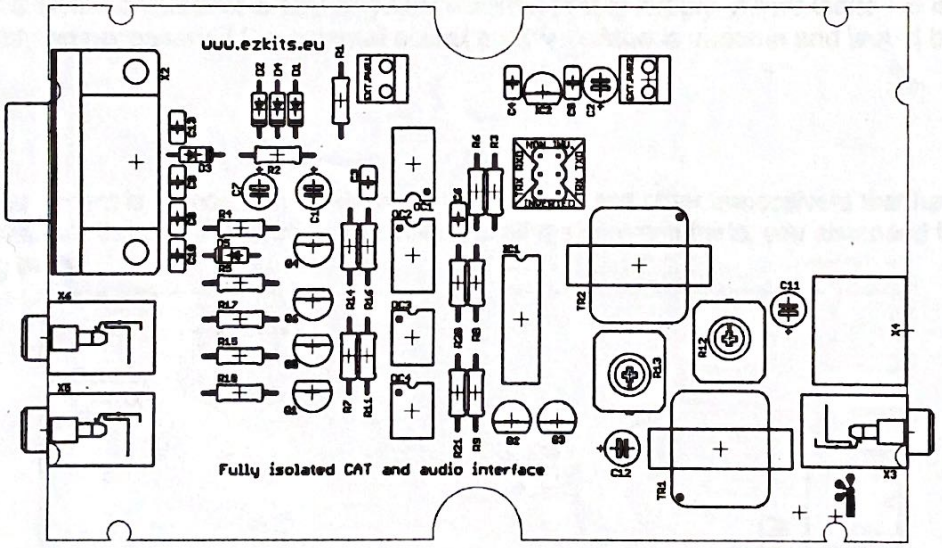
the soldering side). Please note that some components, such as resistors, have no polarity and may be fitted either way around. Other components, such as diodes, transistors and ICs, MUST be fitted exactly in the way it is printed at the component side of the PCB.
Also, take extra care in identifying the resistors. Brown, orange, and sometime red color rings on the resistors may look alike. It is always a good idea to use a multimeter to verify resistance before mounting the resistors.

## Assembly

The OptoCAT Mk2 board can be populated in different varieties. Several types of connectors can be mounted depending on the transceiver to which you are going to hook-up to. Most of these connectors have overlapping space on the board, so you will have to choose which variant to make (building option 1, 2, or 3 as described on following pages).

When assembling the tracker PCB it is recommended to mount the components in order of size. First mount the smaller components, followed by the slightly taller components. For your convenience the parts list in the table below is already sorted according to component size.

The following set of components are common for all mounting variants.




| Qty | Ref. | Description |
|---|---|---|
| 5 | D1, D2, D3, D4, D5 | Diode, 1N4848 (marking 4148) |
| 1 | R2 | Resistor, 22Ω 5% 0.25W (color code red, red, black, gold) |
| 4 | R3, R7, R11, R14 | Resistor, 330Ω 5% 0.25W (color code orange, orange, brown, gold) |
| 4 | R4, R5, R10, R15 | Resistor, 3kΩ 5% 0.25W (color code orange, black, red, gold) |
| 4 | R6, R8, R9, R16 | Resistor, 1kΩ 5% 0.25W (color code brown, black, red, gold) |
| 1 | R17 | Resistor, 10kΩ 5% 0.25W (color code brown, black, orange, gold) |
| 2 | R20, R21 | Resistor, 220kΩ 5% 0.25W (color code red, red, yellow, gold) |
| 4 | C3, C4, C5, C6 | Capacitor, 100nF (marking 100n, of 104) |
| 4 | C8, C9, C10, C13 | Capacitor, 1nF (marking 1n, of 102) |
| 2 | OC1, OC2 | Opto-coupler, DIP8, 6N137 |
| 2 | OC3, OC4 | Opto-coupler, DIP6, 4N35 |
| 1 | IC1 | IC, Hex inverting Schmitt trigger, DIP14, 74HC14 |
| 2 | R12, R13 | Resistor, trimmer, 10kΩ (marking 10k of 103) |
| 3 | Q1, Q4, Q5 | Transistor, NPN TO-92, BC547, BC546 |
| 1 | Q6 | Transistor, PNP TO-92, BC557, BC556 |
| 2 | Q2, Q3 | MOSFET, N-Channel TO-92, 2N7000 |
| 1 | IC2 | IC, Voltage regulator, TO92, 78L05 |
| 3 | X3, X5, X6 | Connector, 3.5mm jack, KLBR-2 |
| 2 | C11, C12 | Capacitor, alu electrolytic, 1 µF (or 22 µF), radial |

| | | |
|---|---|---|
| 3 | C1, C2, C7 | Capacitor, alu electrolytic, 22 µF, radial |
| 1 | X4 | Connector, 6p mini-DIN |
| 1 | X2 | Connector, 9p, sub-D |
| 2 | TR1 | Transformer, audio, 1:1, 600Ω, TTC-02 |
| 1 | | Header, 2 x 3 way straight |
| 1 | R1 | See assembly instruction |

All opto-couplers have a small round dot on the package indicating pin 1. Pin 1 on the PCB is indicated with a square solder pad. Note that OC1 has a different orientation than the other opto-couplers.

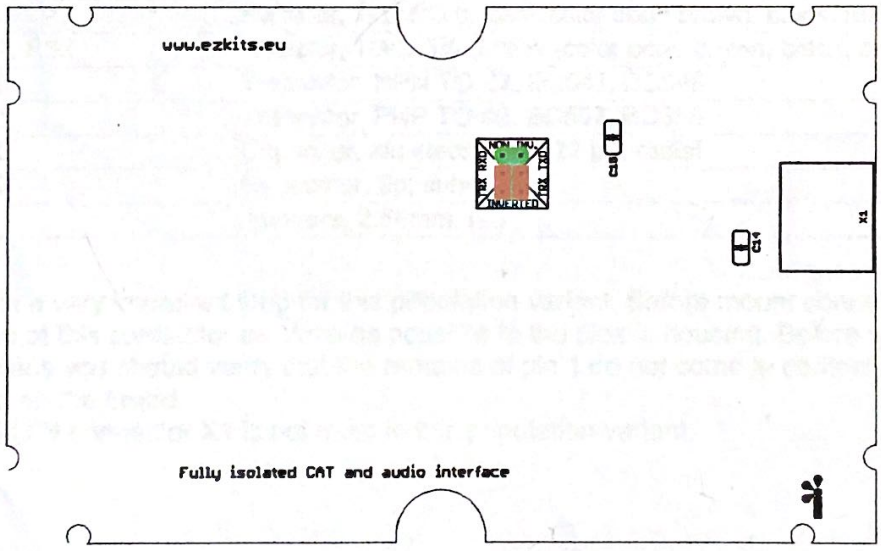
Take care not to solder the 6 pin connector in the place on the board for the 8 pin connector. It is physically possible to fit the 6 pin mini-DIN connector in the place on the board for the 8 pin one, but it is difficult to de-solder the component once you've done that.

The black dot on the transformers match with the dots on the PCB. It doesn't really make any difference in performance if they are mounted the other way around.

R1 should really be dimensioned depending on the voltage of the external power supply (if used). 22 Ohms is a suitable value for a 12V or 13.8V external power supply. Zener diode D6 is not used. D6 would only be necessary if the external power supply voltage is variable and would be higher than 15V.

## *Option 1*

This mounting variant is for use with most Yaesu transceivers and other transceivers that have a 8 pin mini-DIN socket for the CAT connection. In addition to all the common parts, you also need to mount the following parts.

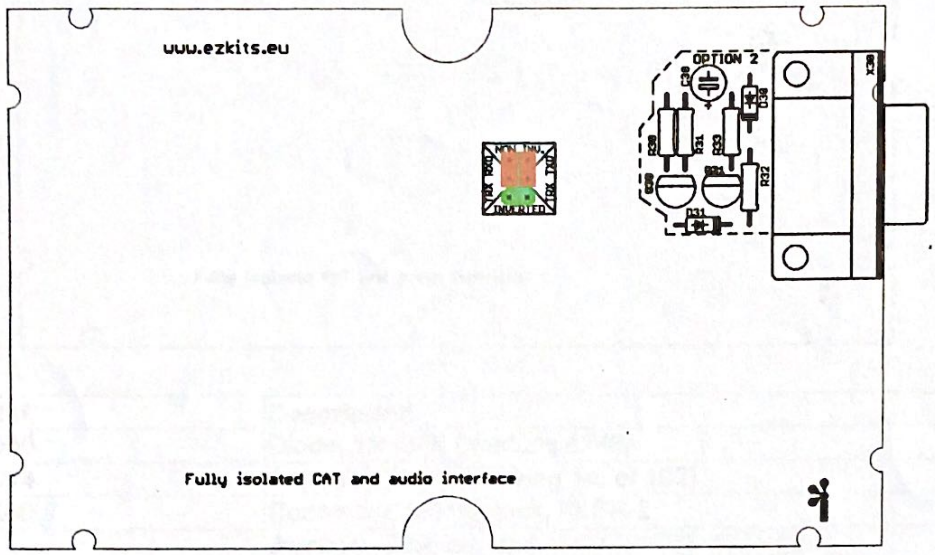



| Qty | Ref. | Description |
|---|---|---|
| 2 | C14, C15 | Capacitor, 1nF (marking 1n, of 102) (see note below) |
| 1 | X1 | Connector, 8p mini-DIN |
| 2 | | Jumpers, 2.54mm, red |

Bypass capacitors C14, and C15 are optional. In case where you experience RFI you could add these capacitors. The value of 1nF will work fine with most transceivers, but it could be the case that some transceivers will not be able to drive the data lines fast enough with the added capacitance. In that case you need to experiment with smaller values. First test your system without C14 and C15 in place. If it works, but you experience RFI problems (I.e. it works fine at QRP, but you experience problems at QRO) then place C14 and C15.

## Option 2

All components with designators in the 30-series, e.g. R30, Q31, X30, belong to a variant called "Option 2". This variant is intended for transceivers that are equipped with a real RS-232 port. Added value of OptoCAT for these transceivers is that OptoCAT provides electrical insulation for this interface. In addition to all the common parts, you also need to mount the following parts.

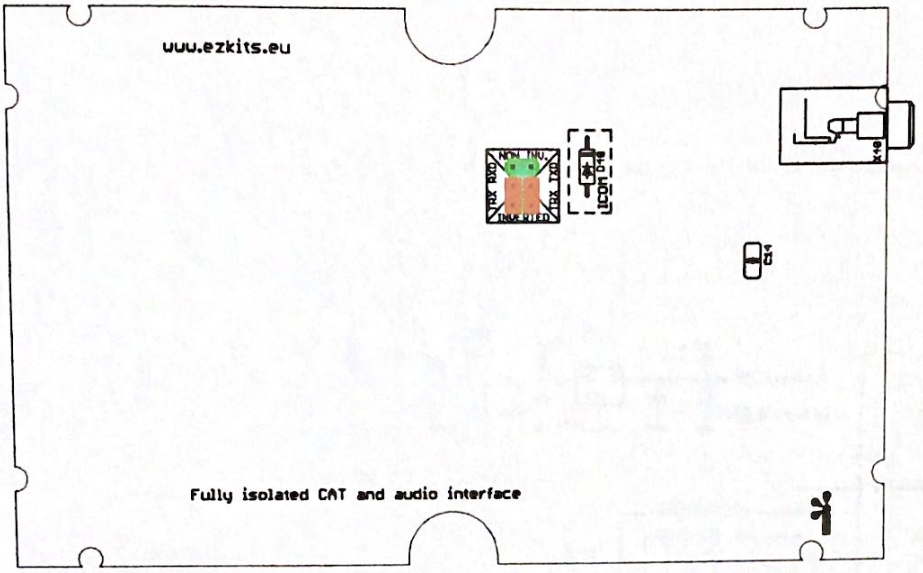



| Qty | Ref. | Description |
|---|---|---|
| 2 | D30, D31 | Diode, 1N4848 (marking 4148) |
| 1 | R33 | Resistor, 3kΩ 5% 0.25W (color code orange, black, red, gold) |
| 1 | R30 | Resistor, 1kΩ 5% 0.25W (color code brown, black, red, gold) |
| 2 | R31, R32 | Resistor, 10kΩ 5% 0.25W (color code brown, black, orange, gold) |
| 1 | Q30 | Transistor, NPN TO-92, BC547, BC546 |
| 1 | Q31 | Transistor, PNP TO-92, BC557, BC556 |
| 1 | C30 | Capacitor, alu electrolytic, 22 µF, radial |
| 1 | X30 | Connector, 9p, sub-D |
| 2 | | Jumpers, 2.54mm, red |

The following is a very important step for this population variant. Before mount connector X30, you must cut off pin of this connector as close as possible to the plastic housing. Before soldering this connector in place you should verify that the remains of pin 1 do not come in contact with the underlying pad on the board.
The 8 pin mini-DIN connector X1 is not used in this population variant.

## Option 3

All components with designators in the 40-series, e.g. D40, X40 are for use with Icom transceivers. In addition to all the common parts, you also need to mount the following parts.

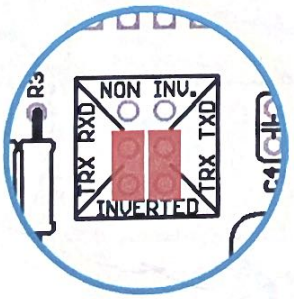



| Qty | Ref. | Description |
|---|---|---|
| 1 | D40 | Diode, 1N4848 (marking 4148) |
| 1 | C14 | Capacitor, 1nF (marking 1n, of 102) |
| 1 | X40 | Connector, 3.5mm jack, KLBR-2 |
| 2 | | Jumpers, 2.54mm, red |

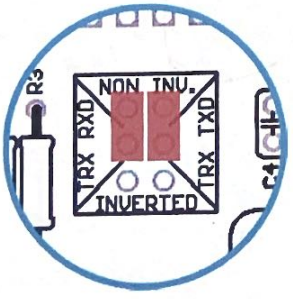
Bypass capacitor C14 is optional. In case where you experience RFI you could add these capacitors. The value of 1nF will work fine when you connect one transceiver to the CI-V bus, but it may not work when you connect multiple devices to the CI-V bus. In that case you need to experiment with smaller values. First test your system without C14 in place. If it works, but you experience RFI problems (I.e. it works fine at QRP, but you experience problems at QRO) then place C14.

## Jumper Settings

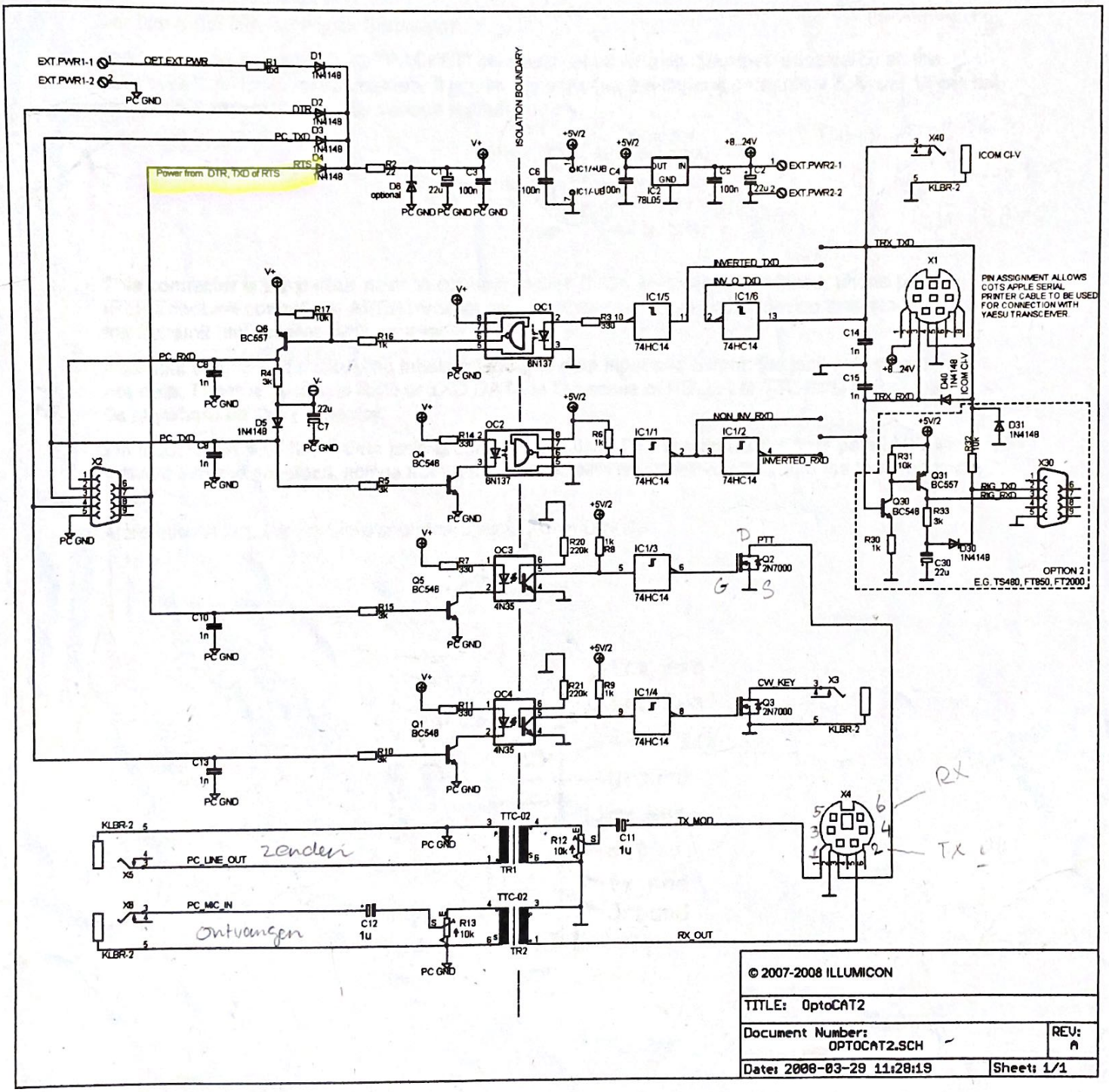
Yaesu and Icom transceivers need the jumpers to be set for inverted input/output.




Kenwood transceivers need the non-inverting setting.



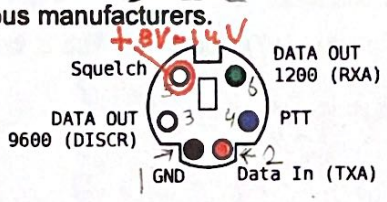
## Schematic



## Connections

X4: The 6-pin Mini-DIN Data Connector

The 6-Pin Mini-DIN "DATA" or "PACKET" connector is an industry standard adopted by all the Japanese ham radio manufacturers. It is now superseding the various proprietary 7, 8 and 13-pin full-sized DIN connectors used by various manufacturers.

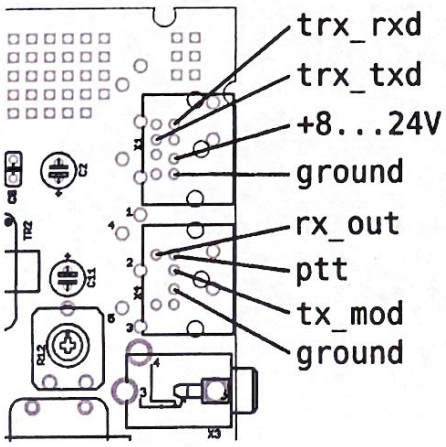



This connector is the perfect point to connect packet TNCs, soundcard interfaces, phone patches, IRLP/EchoLink controllers, APRS trackers, paging encoders, or any other device that needs access to the transmit and receive audio of a radio.

Note that despite the misleading labels referring to data input and output, the jack only carries audio, not data. There is no actual RXD or TXD DATA in the sense of RS-232 or TTL-level streams of 1s and 0s anywhere on this connector.

On most radios with this a data jack, grounding the DIN-6 PTT line mutes the front panel MIC input to prevent extraneous shack noises from getting mixed with whatever you feed into the transmit audio input.

More info on http://kc2rlm.info/soundcardpacket/1miniDIN.htm

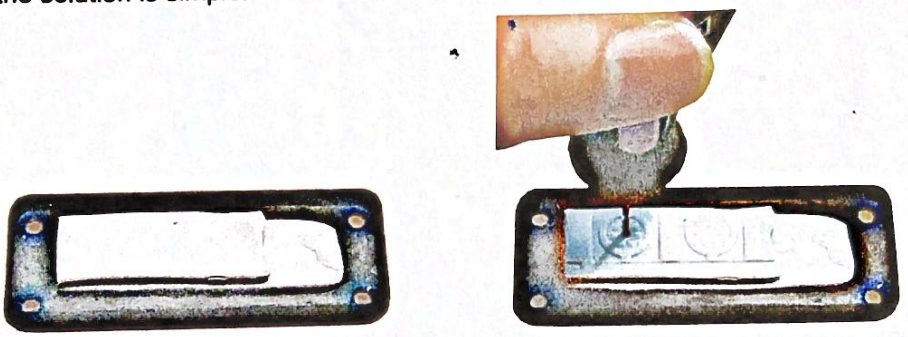


## Boxing the Completed Project

The Hammond box used for this project consists of an anodized aluminum extrusion in a U section with a separate sliding top (bottom) also of aluminum. The sides of the U section include rails to take slide-in circuit boards. The box is closed with thick plastic end plates which are easy to work.

Using this enclosure enables the circuit board to be constructed outside the box and slid into place once completed. Consequently, there are no tricky solder connections to be made within the box itself.

The only obvious problem is the need to drill very precise holes in the end plate to fit the sockets. Fortunately, the solution is simple.



Fill the end plate with a slab of Blu-Tack leaving about 2mm gap all-round to ease the fit. Push the end cap into place; it need not go fully home as long as it is square to the body of the box. Insert the assembled circuit board in its slot and slowly force the sockets into the Blu-Tack. A couple of mm should be sufficient. Very carefully withdraw the circuit board and make sure it does not drag the Blu-Tack with it – repeat the process for the other end. You should end up with an impression similar to that in the accompanying photograph. Take a fine bit, say1.5mm, and drill a hole at the center of each of the impressions right through the Blu-Tack and the end plate. Remove the Blu-Tack, enlarge the holes with progressively larger bits, and finish to size with a reamer. Offer up the circuit board once again and you should have a perfect slide-in fit.