URI

USB Radio Interface

Features

- Easy radio connections
- High quality audio
- CM108 audio controller
- Low cost
- PTT, COR, CTCSS
- 2 inputs + 3 GPIO
- +6dB gain op-amp
- Full RF filtering

Description

URI allows a standard land or mobile FM radio to be connected to a host computer via USB interface. Potential radios include amateur, business, public service/safety, GMRS, citizens band, and many others. The host computer requires appropriate software to drive the device such as app_rpt with chan_usbradio. These applications currently run under Asterisk/Linux.

URI may be used for remote radio control or can link two or more radios in repeater mode. Audio can be passed through VOIP/Ethernet.

Many radios provide an interface connector for external access. These signals can be easily connected to the URI's standard DB-25 connector.

The URI contains the C-Media CM108, a high-quality full-duplex USB audio controller. One channel of receive audio is provided along with two channels of transmit audio. Even radios that have separate voice and CTCSS signals may be supported. Optionally, the second audio channel may be used as a line monitor.

URI has dedicated input pins for CTCSS and COR, and an output pin for PTT. There are three general purpose I/O pins that may be controlled by software.

Each audio output channel is fed through a 3-pole low pass filter with a 4KHz cutoff frequency. These filters may be bypassed, if desired, by setting internal jumpers. The filter outputs may be either DC coupled or connected through 10µF non-polarized capacitors. This allows low-frequency CTCSS signals to be passed unattenuated when driving a low impedance input.

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Description Continued…

If the radio requires high input drive levels, an on-board 6dB gain amplifier is provided. An external 12 volt DC power source is needed to power this amplifier, if needed. If this gain is not needed, no external power is required.

If desired, a 1K-bit 93C46 serial EEPROM may be used to store radio-specific configuration data. Internally, the URI circuit board provides space for a surface-mount version of this part, but this is normally not installed. Instead, the EEPROM interface signals are brought out to the DB-25 connector in such a manner that a DIP part may easily be soldered directly to the pins. This way if the URI device is changed, the stored configuration data will remain with the cable attached to the radio.

Table 1. Connector Pin Assignments

Pin No.	Name	Description
1	PTT	Push to talk, open collector output to radio transmitter
2	GPIO1	General purpose input or output
3	GPIO2	General purpose input or output
4	GPIO4	General purpose input or output
5	MUTE_REC	Unused input
6	MUTE_PLAY	Unused input
7	CTCSS_DET	Input, diode isolated, continuous tone-coded squelch system detect
8	COR_DET	Input, diode isolated, receive (carrier operated relay) detect
9	MIC_IN	Direct low-level audio input to CM108, must be AC coupled
10	LEFT_OUT	DC coupled left audio output, 4KHz bandwidth
11	RIGHT_OUT	DC coupled right audio output, 4KHz bandwidth
12	AOUT	AC coupled output from 6dB gain amplifier
13	GND	Ground
14	+5V	5 volts DC power output from USB bus
15	EEP_CS	EEPROM chip select control
16	EEP_CK	EEPROM serial clock
17	EEP_DI	EEPROM data input
18	EEP_DO	EEPROM data output
19	GND	Ground
20	GND	Ground
21	MIC_AC	Audio input, line level, AC coupled
22	LEFT_AC	AC coupled left audio output, 4KHz bandwidth
23	RIGHT_AC	AC coupled right audio output, 4KHz bandwidth
24	AIN	AC coupled input to 6dB gain amplifier
25	AVDD	12 volt DC power input required for 6dB gain amplifier

USB hubs are not recommended. However, if a hub must be used, make sure it is rated at USB 2.0 *High Speed*. Some hubs are USB 2.0 compliant but are rated only at *Full Speed* (12Mbps) not *High Speed* (480Mbps). Do not connect any USB 1.x devices to either the same external hub or to the host computer's internal root hub.

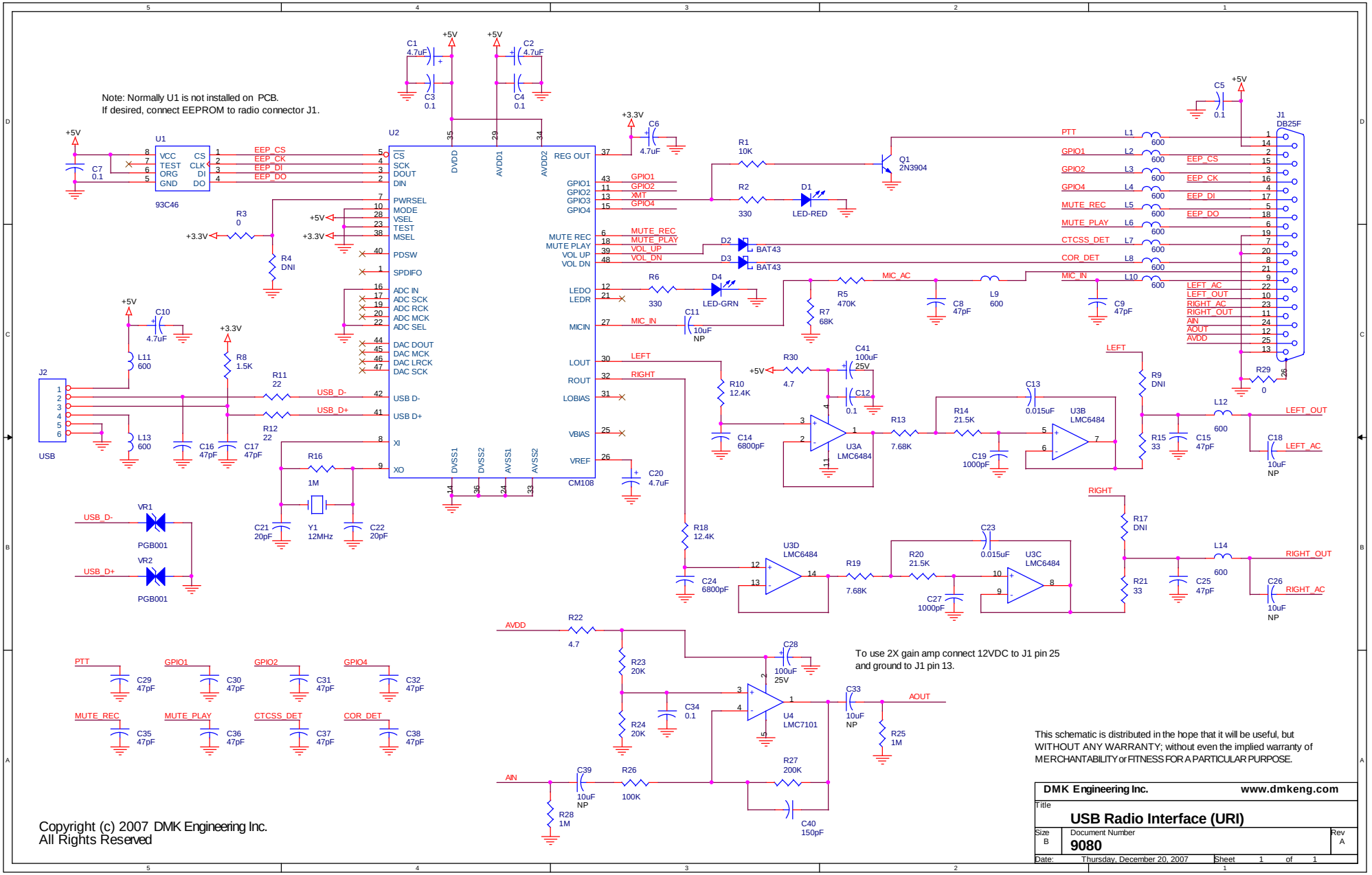
The URI radio interface connector is a standard female 25-pin D-shell. The recommended mating connector is the Amphenol G17S2510110EU or equivalent. This connector is available from both Digi-Key and Mouser Electronics.

Application Information

Audio I/O. In most applications audio inputs and outputs should be AC coupled. Large value non-polarized capacitors are provided on-board to pass low frequency CTCSS signals. The DC coupled signals are provided for use in some applications. The CM108 audio controller chip biases these signals at half-supply, typically 2.5 volts. The MIC_AC input in addition to providing AC coupling also has an 18dB attenuator. This brings line level signals down to the low-level microphone level signals required for the CM108.

LEDs. The URI has two LEDs, one on either side of the USB connector. The green LED on the left is on when the URI is powered from the USB bus. When the app_rpt application is running this LED flashes. The red LED is on when the PTT signal is active.

6dB Gain Amplifier. An on-board 6dB gain amplifier is provided for radios that need more than the 1.7 volt rms maximum signal available from the standard outputs. To use this amplifier, an external 12 volt power source must be connected between pins 25 and 13. The op-amp is the National Semiconductor LMC7101. This amplifier features very low noise and distortion, high speed, rail-to-rail inputs and outputs. Absolute maximum supply voltage is 16 volts. An external jumper must be installed from either pin 10 (left) or pin 11 (right) to the amplifiers input on pin 24. Since the amplifier's input is AC coupled, the AC coupled outputs are not required. The audio output is then taken from pin 12.


Note: Normally U1 is not installed on PCB.
If desired, connect EEPROM to radio connector J1.
U1
93C46
U2
CM108
J1
DB25F
J2
USB
Q1
2N3904
D1
LED-RED
D2
BAT43
D3
BAT43
D4
LED-GRN
U3A
LMC6484
U3B
LMC6484
U3C
LMC6484
U3D
LMC6484
U4
LMC7101
VR1
PGB001
VR2
PGB001
Y1
12MHz
To use 2X gain amp connect 12VDC to J1 pin 25
and ground to J1 pin 13.
This schematic is distributed in the hope that it will be useful, but
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MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
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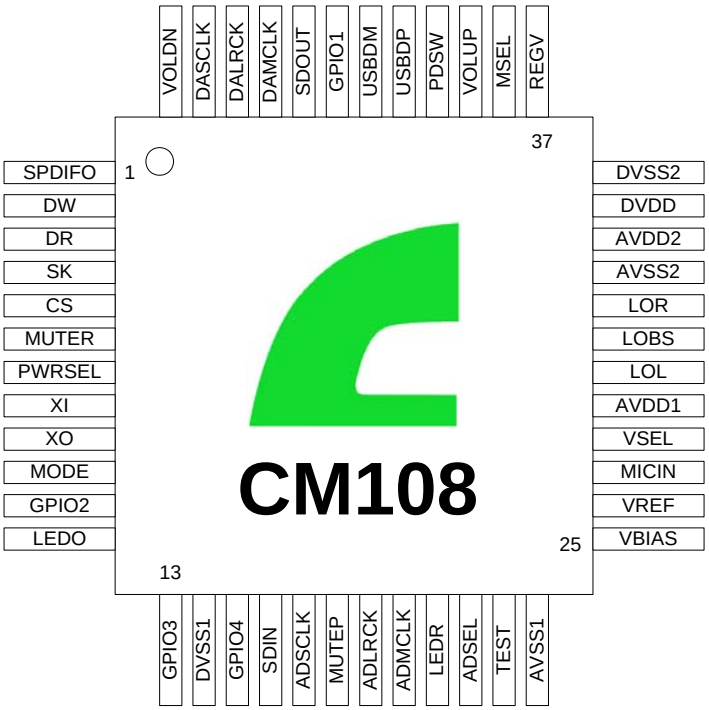
Title
USB Radio Interface (URI)
Size B
Document Number
9080
Rev A
Date: Thursday, December 20, 2007
Sheet 1 of 1

3. PIN DESCRIPTIONS

3.1 PIN ASSIGNMENT BY PIN NUMBER

Pin #	Signal Name	Pin #	Signal Name	Pin #	Signal Name	Pin #	Signal Name
1	SPDIFO	13	GPIO3	25	AO	37	REGV
2	DW	14	DVSS1	26	AI	38	MSEL
3	DR	15	GPIO4	27	AI	39	VOLUP
4	SK	16	SDIN	28	P	40	PDSW
5	CS	17	ADSCLS	29	AO	41	USBDP
6	MUTER	18	MUTEP	30	AO	42	USBDM
7	PWRSEL	19	ADLRCK	31	AO	43	GPIO1
8	XI	20	ADMCLK	32	AO	44	SDOUT
9	XO	21	LEDR	33	AVSS2	45	RAMCLK
10	MODE	22	ADSEL	34	AVDD2	46	DALRCK
11	GPIO2	23	TEST	35	DVDD	47	DASCLS
12	LEDO	24	AO	36	DVSS2	48	VOLDN

3.2 PIN-OUT DIAGRAM



Pin Assignments (Top View)

3.3 PIN SIGNAL DESCRIPTIONS

Pin #	Symbol	Type	Description
1	SPDIFO	DO, 8mA, SR	SPDIF Output
2	DW	DIO, 8mA, PD, 5VT	EEPROM Interface Data read from EEPROM
3	DR	DO, 4mA, SR	EEPROM Interface Data write to EEPROM
4	SK	DO, 4mA, SR	EEPROM Interface Clock
5	CS	DO, 4mA, SR	EEPROM Interface Chip Select
6	MUTER	DI, ST, PU	Mute Recording (Edge Trigger with de-Bouncing)
7	PWRSEL	DI, ST	Chip Power Select Pin, worked with MODE Pin Speaker Mode H：Self Power with 100mA L：Bus Power with 500mA Headset Mode H：Bus Power with 100mA L：Bus Power with 500mA (H: Pull Up to 3.3V; L: Pull Down to Ground)
8	XI	DI	Input Pin for 12MHz Oscillator
9	XO	DO	Output Pin for 12MHz Oscillator
10	MODE	DI, ST	Operating mode select H：Speaker Mode - Playback Only L：Headset Mode - Playback & Recording (H: Pull Up to 3.3V; L: Pull Down to Ground)
11	GPIO2	DIO, 8mA, PD, 5VT	GPIO Pin
12	LEDO	DO, SR, 8mA	LED for Operation; Output H for Power On; Toggling for Data Transmit
13	GPIO3	DIO, 8mA, PD, 5VT	GPIO Pin
14	DVSS1	P	Digital Ground
15	GPIO4	DIO, 8mA, PD, 5VT	GPIO Pin

16	SDIN	DIO, 8mA, PD, 5VT	ADC I2S Data Input
17	ADSCLK	DIO, 4mA, SR	ADC I2S Serial Clock
18	MUTEP	DI, ST, PU	Mute Playback (Edge Trigger with de-Bouncing)
19	ADLRCK	DO, 4mA, SR	ADC I2S Left / Right Clock
20	ADMCLK	DIO, 4mA, SR	11.2896MHz Output for 44.1KHz Sampled Data and 12.288MHz Output for 48KHz Sampled Data
21	LEDR	DO, SR, 8mA	LED for Mute Recording Indicator; Output H when Recording is Muted
22	ADSEL	DI, ST, PD	ADC Input Source Select Pin H: Use external (via I2S) ADC L: Use internal ADC (H: Pull Up to 3.3V; L: Pull Down to Ground)
23	TEST	DI, ST, PD	Test Mode Select Pin; H: Test Mode L: Normal Operation (H: Pull Up to 3.3V; L: Pull Down to Ground)
24	AVSS1	P	Analog Ground
25	VBIAS	AO	Microphone Bias Voltage Supply (4.5V), with a small Driving Capability
26	VREF	AO	Connecting to External Decoupling Capacitor for Embedded Bandgap Circuit; 2.25V Output
27	MICIN	AI	Microphone Input
28	VSEL	AI	Line Out Voltage Swing Select H: Line out Vpp = 3.5 Volts L: Line out Vpp = 2.5 Volts (H: Pull Up to 5V; L: Pull Down to Ground)
29	AVDD1	P	5V Analog Power for Analog Circuit
30	LOL	AO	Line Out Left Channel
31	LOBS	AO	DC 2.25V Output for Line Out Bias

32	LOR	AO	Line Out Right Channel
33	AVSS2	P	Analog Ground
34	AVDD2	P	5V Power Supply for Analog Circuit
35	DVDD	P	5V Power Supply for Internal Regulator
36	DVSS2	P	Digital Ground
37	REGV	AO	3.3V Reference Output for Internal 5V → 3.3V Regulator
38	MSEL	DI, ST	Mixer Enable Select, worked with MODE pin H: With Mixer / AA-Path Enable (With Default Mute) L: Without Mixer / AA-Path Disable (H: Pull Up to 3.3V, L: Pull Down to Ground) USB Descriptors will also be changed accordingly
39	VOLUP	DI, ST, PU	Volume Up (Edge Trigger with de-Bouncing)
40	PDSW	DO, 4mA , OD	Power Down Switch Control Signal (for PMOS Polarity) 0: Normal Operation, 1: Power Down Mode (Suspend Mode)
41	USBDP	AIO	USB Data D+
42	USBDM	AIO	USB Data D-
43	GPIO1	DIO, 8mA, PD, 5VT	GPIO Pin
44	SDOUT	DO, 4mA, SR	DAC I2S Data Output
45	DAMCLK	DO, 4mA, SR	11.2896 MHz Output for 44.1KHz Sampled Data and 12.288 MHz Output for 48KHz Sampled Data
46	DALRCK	DO, 4mA, SR	DAC I2S Left/Right Clock
47	DASCLK	DO, 4mA, SR	DAC I2S Serial Clock
48	VOLDN	DI, ST, PU	Volume Down (Edge Trigger with de-Bouncing)

Note: DI / DO / DIO – Digital Input / Output / Bi-Directional Pad

AI / AO / AIO – Analog Input / Output / Bi-Directional Pad

SR – Slew Rate Control

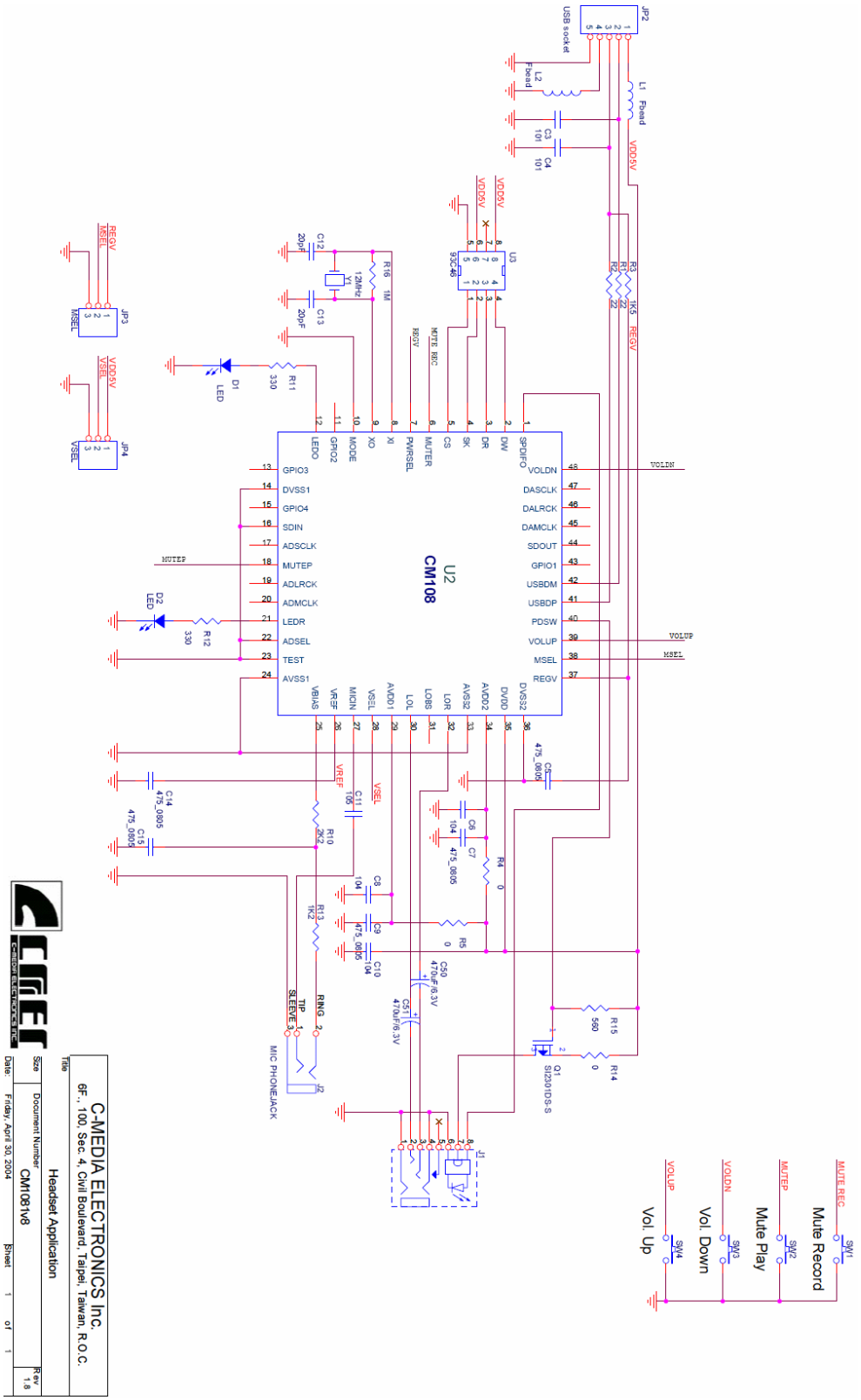
ST – Schmitt Trigger

PD / PU – Pull Down / Pull Up

5VT – 5 Volt Tolerant (3.3V Pad)

OD – Open Drain

10. REFERENCE APPLICATION CIRCUIT



Modifying a USB sound fob to act as a repeater interface for app_rpt

Rev E 9/13/2008

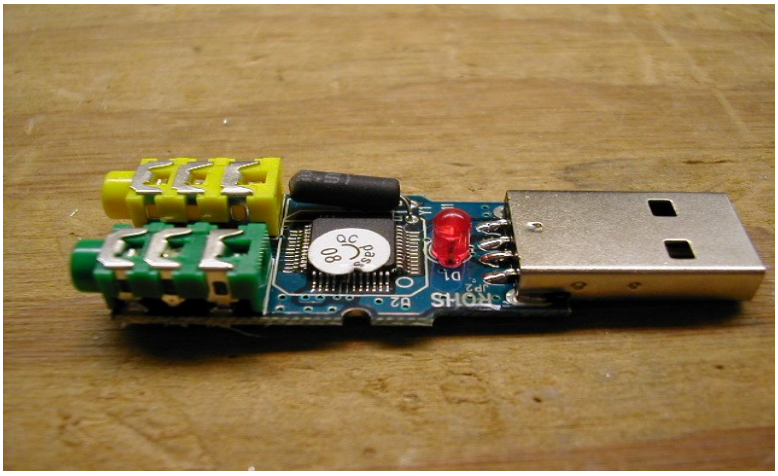
This document explains how to modify a USB sound fob to work as a repeater interface for app_rpt. For a guide on setting up and configuring Asterisk, app_rpt, and chan_usbradio.c please see http://app-rpt.qrvc.com/usbradio.pdf

The following materials and tools are required:

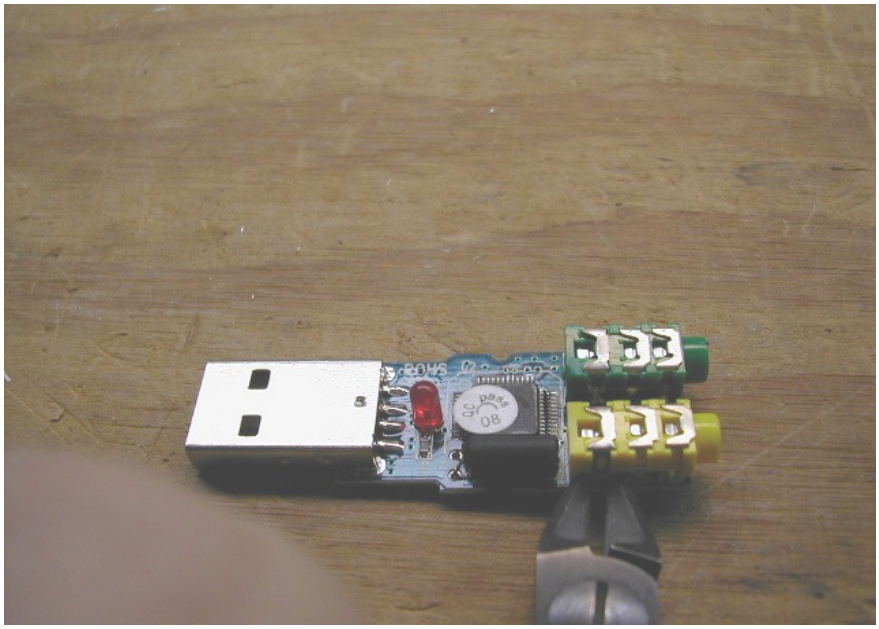
1. USB sound fob based on the CM108 chip
2. 10K ohm 1/8W 5% through hole resistor. Digi Key P/N 10KEBK-ND
3. 68K ohm 1/8W 5% through hole resistor. Digi Key P/N 68KEBK-ND
4. 470K ohm 1/8W 5% through hole resistor. Digi Key P/N 470KEBK-ND
5. Two 10 microfarad 25V non-polarized electrolytic capacitors. Digi Key P1176-ND
6. BAT43 or equivalent schottky diode in DO-35 package. Digi Key 497-2492-1-ND
7. 2N4401 NPN bipolar transistor in a TO-92 package. Digi Key 2N4401-ND
8. Plastic sleeving and heat shrink tubing
9. Hot melt glue and glue gun
10. Male D-sub connector and hood
11. 1ft. of 5 conductor shielded cable with 28awg stranded wires or smaller.
12. Temperature controlled Soldering iron with a fine tip, and 0.020" diameter solder
13. Precision cutters and long nose pliers.

Below is a picture of a typical USB sound fob. This is one which was purchased for $7.95. **When shopping for a suitable sound fob, it is important to purchase one which uses the CM108 chip,** as that is the only version supported.

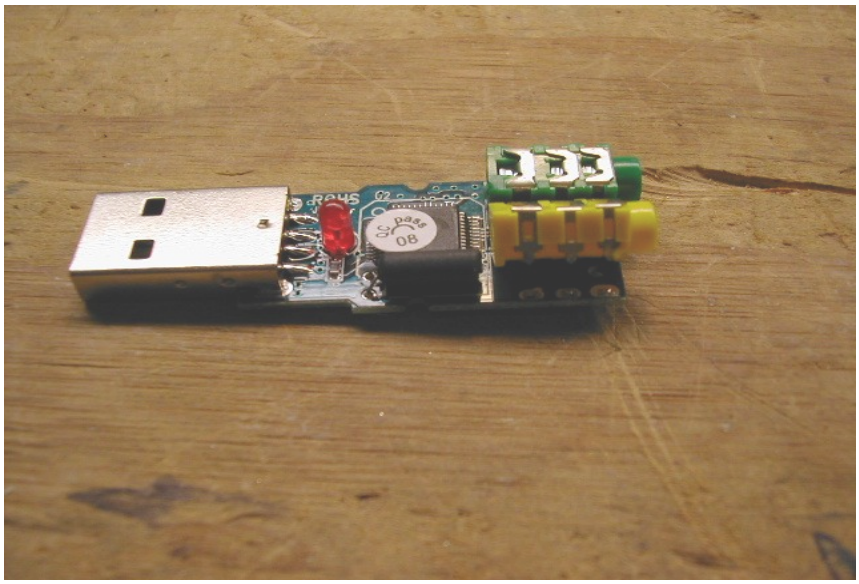
The first thing to do is open up the case. The case is usually press-fit together with four plastic posts on one side and 4 sockets for the posts on the other side. Getting the case to come apart requires a small thin bladed screwdriver. Work the screwdriver along the seams until one side starts to separate, then work on the other side. Be very careful with the use of downward pressure. You don't want the screwdriver going in and damaging the components on the board. Pry the case open near the audio jacks since they will be removed anyway. Once the case is separated, you should have something like this:



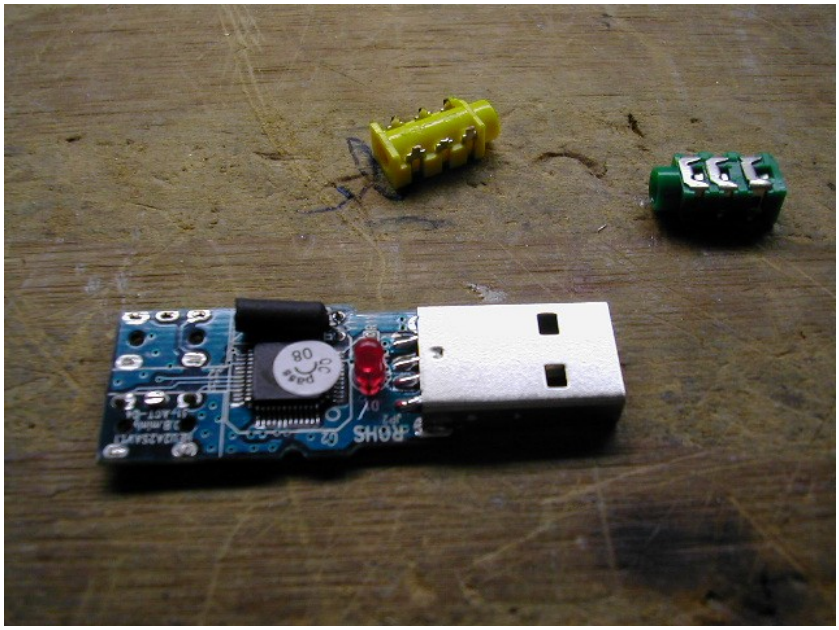
Peel the QC sticker off the chip and verify it is a CM108. If it isn't a CM108, it cannot be used. Then using a pair of precision cutters, remove the 3.5mm jacks by cutting the metal connections on the side of the jack as shown:



Once the connections are free on the outsides of each jack, rock them back and forth to cause the inner connections to break free as shown:

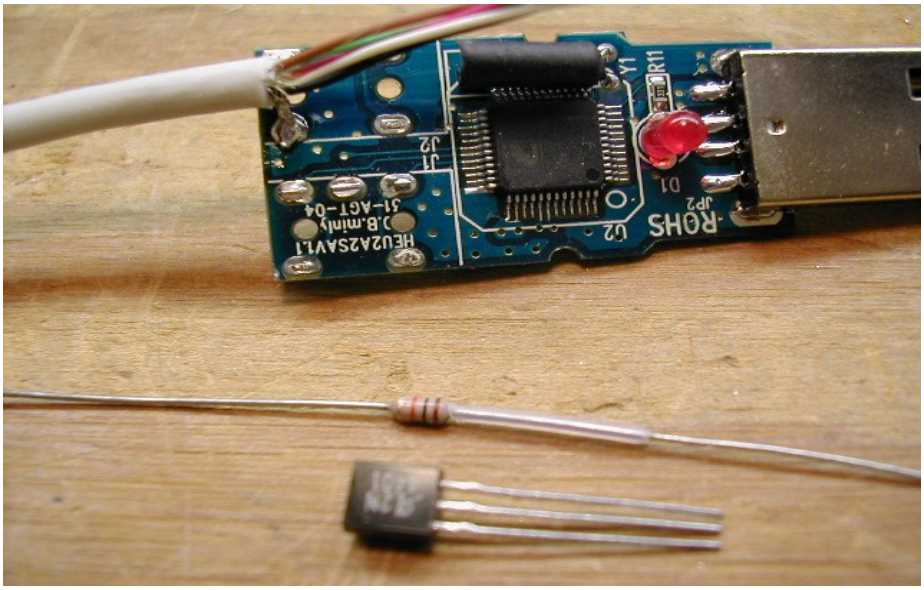


When both jacks are removed, your board should look like this:

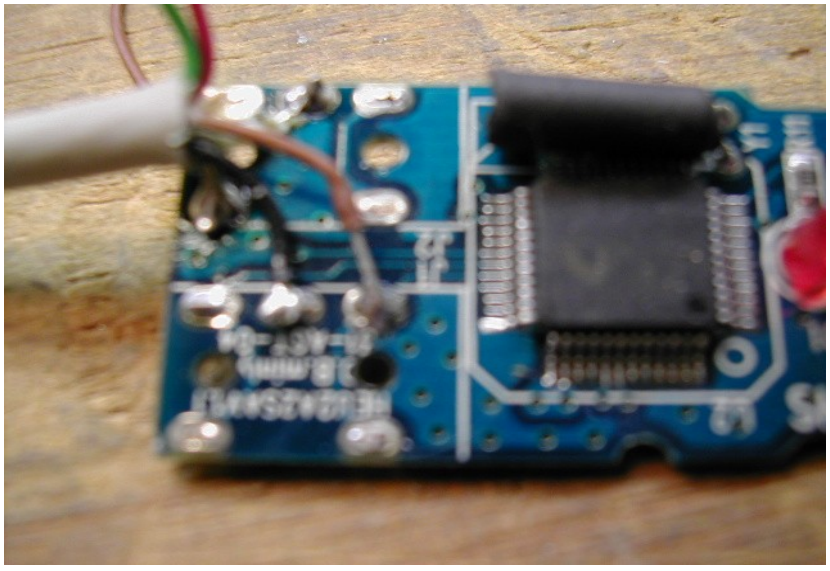


Do not be tempted to clean out the pins from the holes used by the jacks, The traces on the board lift very easily.

Prepare one end of the 5 conductor cable by separating the shield, twisting it tightly, then soldering it to the ground on the board below as shown. The shield is soldered to the point where the sleeve contact of the microphone jack used to connect.

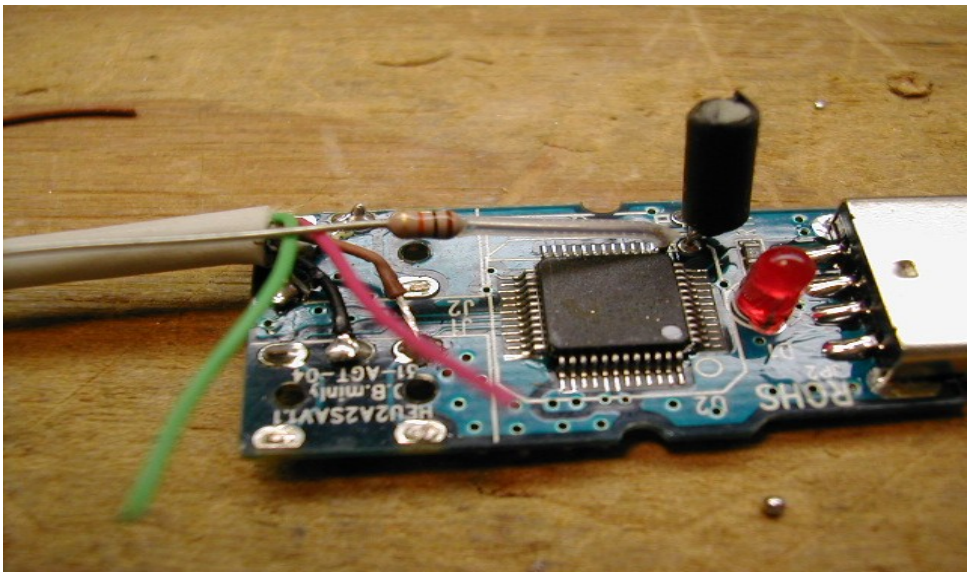


Now we connect some wires to points on the board. For the multiconductor cable I'm using, white is receive audio, black is transmit audio, brown is auxiliary audio, red is PTT, and green is COR. For now we will solder down the receive audio (white), transmit audio (black) , and auxiliary audio (brown) wires as shown:

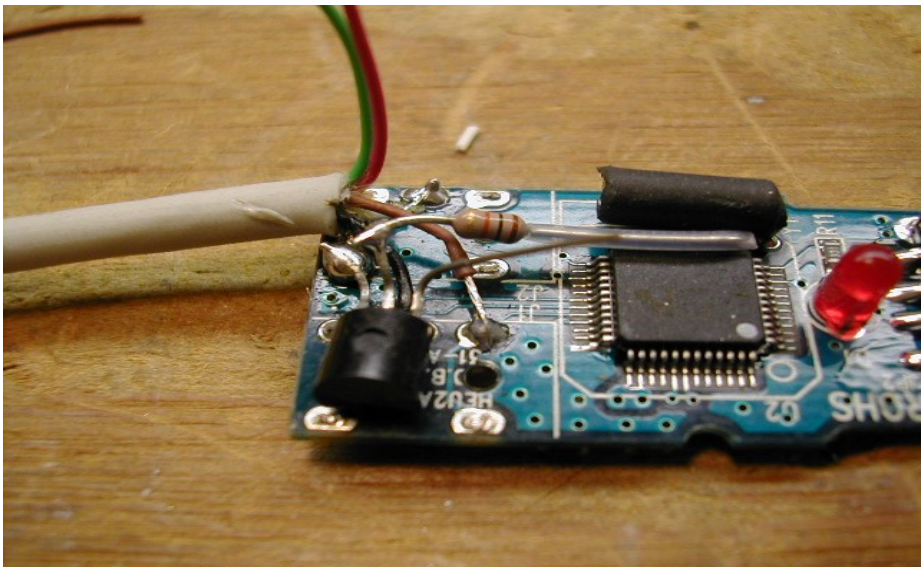


Note that the rxaudio (white) lead is connected to the middle pin of the mic connector at the top.

Next, we add the 10K resistor shown prepped above with some plastic tubing to pin 13 of the CM108. To get access to pin 13 on this particular board, I had to temporarily bend the crystal up and out of the way. Make a 90 degree bend in the resistor lead so that it can be soldered to pin1 3 as shown in the picture below. Be very careful not to place undue force on the resistor lead after it is soldered to the pin, as the pin will break away from the pad if you are not careful.

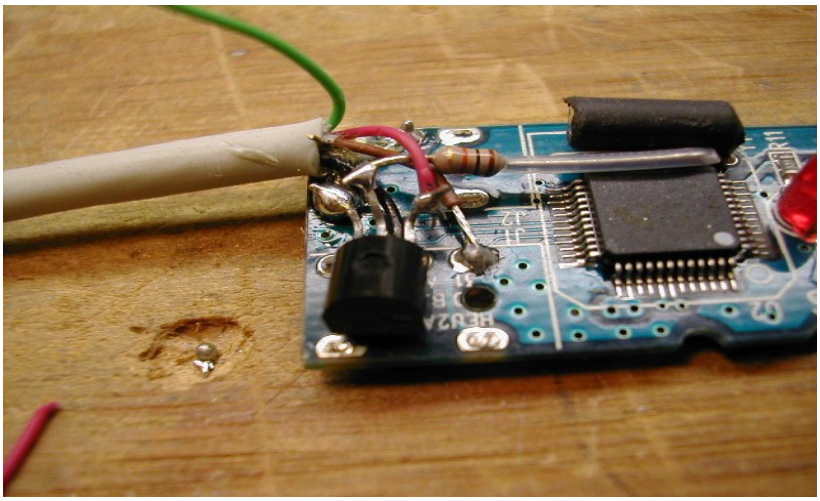


Next, we attach the 2N4401 transistor as shown:

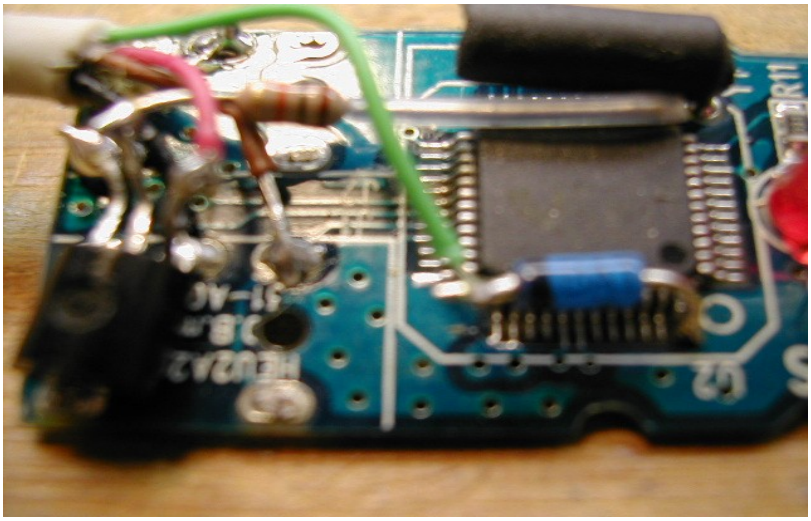


The free end of the 10K resistor attached to the middle pin (base) of the 2N4401. The transistor is mounted flat side down and the leftmost lead (emitter) is soldered to ground at the same point used by the cable shield. Note that the crystal was bent back down to its original orientation.

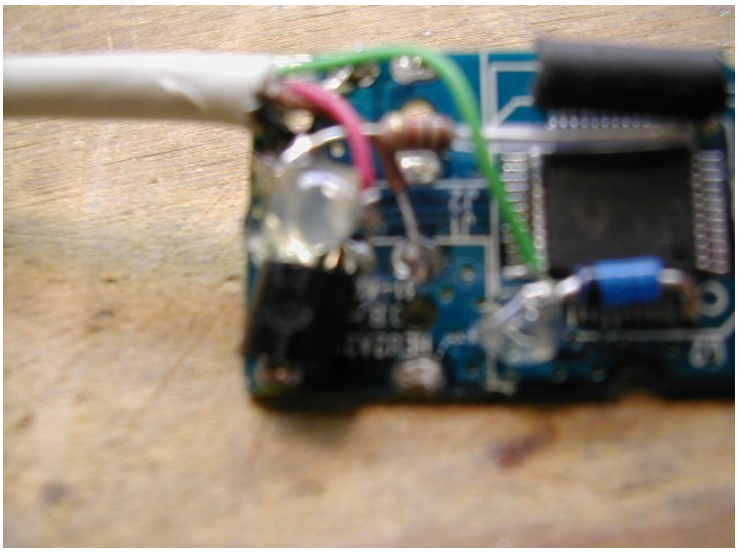
The PTT (red) lead is then attached to the rightmost pin of the 2N4401 (collector) as shown:



Now we prep the BAT43 diode similar to how we prepped the 10K resistor and solder the prepped end to pin 48 of the CM108, and the other end to the COR (green) wire. Note that the banded end (cathode) of the diode connects to the green wire:

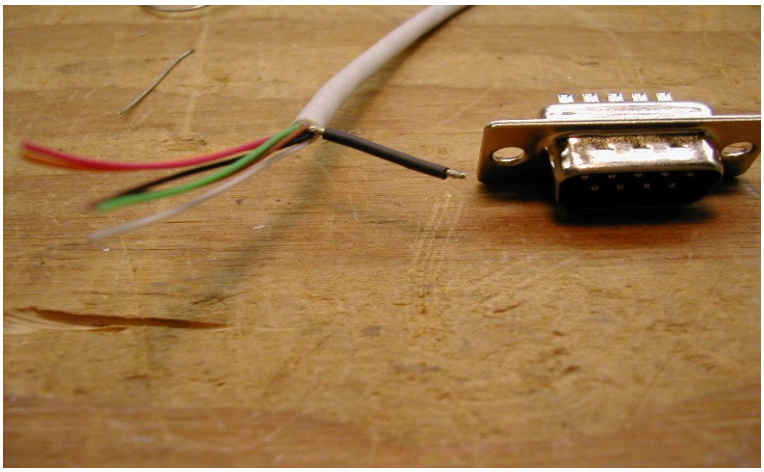


Because of the way the parts are mounted, it would be a good idea to secure the diode and transistor with some glue. I used hot melt glue as it is removable. Silicone RTV should be avoided due to its acid content.

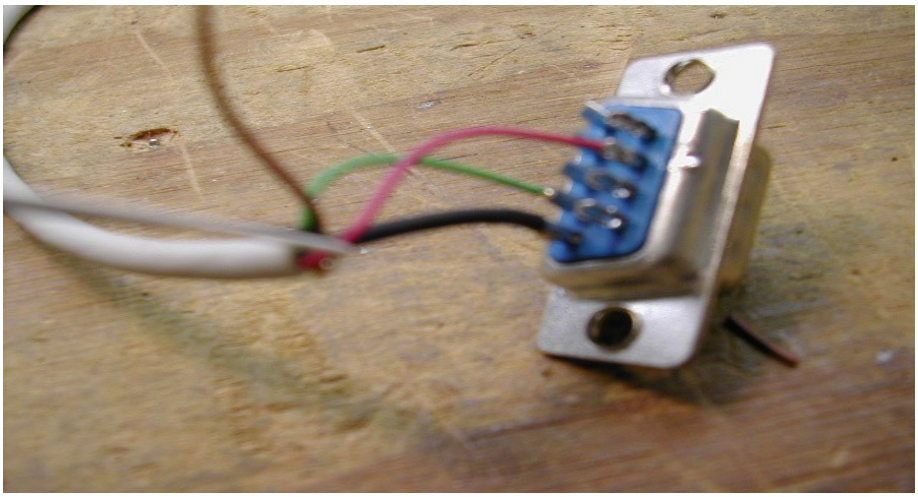


This completes the internal modifications. The rest of the parts are installed inside of the D-sub connector hood. The case halves can now be snapped back over the board.

We now focus on assembly of the D-sub connector and the components installed inside the connector hood. The first thing to do is prep the other end of the multiconductor cable by stripping off 1.5 inches of the jacket. Separate the braid from the conductors, twist it tightly together, slip a small piece of heat shrink tubing over the braid as shown:

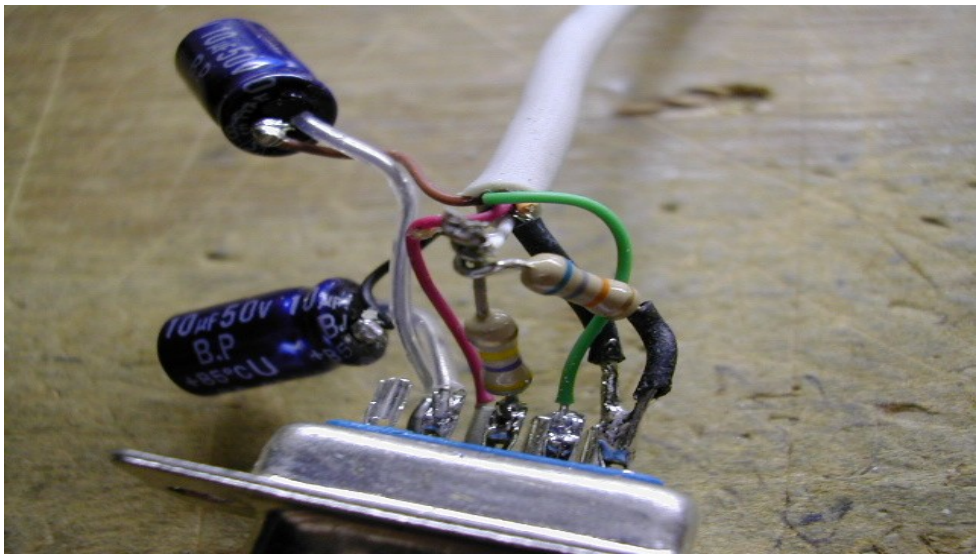


We can now attach the wires which connect directly to the connector pins. These would be ground, COR and PTT. The cable shield (ground) gets soldered to pin 5. The PTT (red) lead gets soldered to pin 7, and the COR lead (green) gets soldered to pin 4:

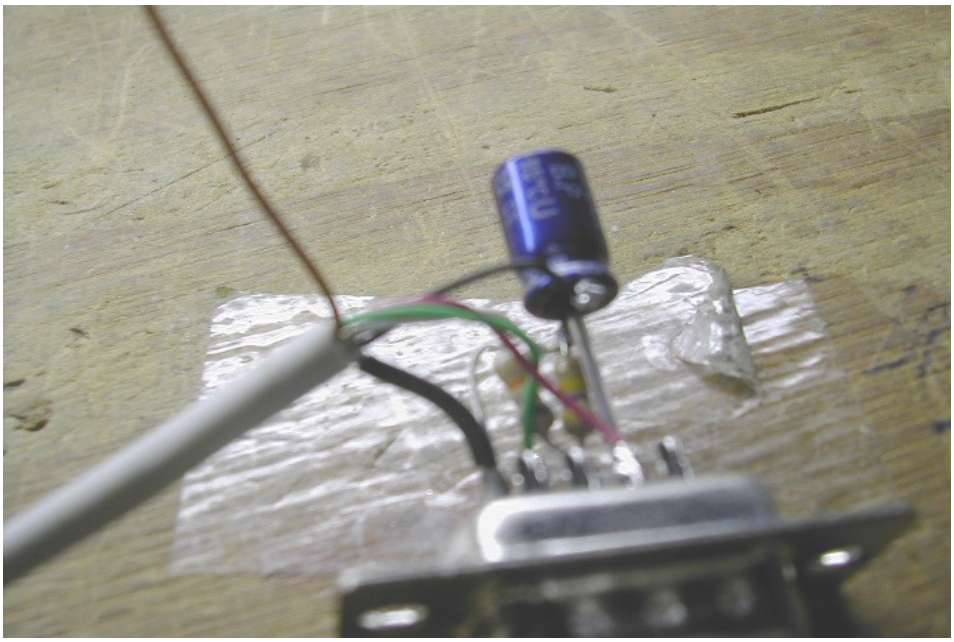


We then make up the receive audio voltage divider out of a 68K ohm and a 470K ohm resistor as shown:

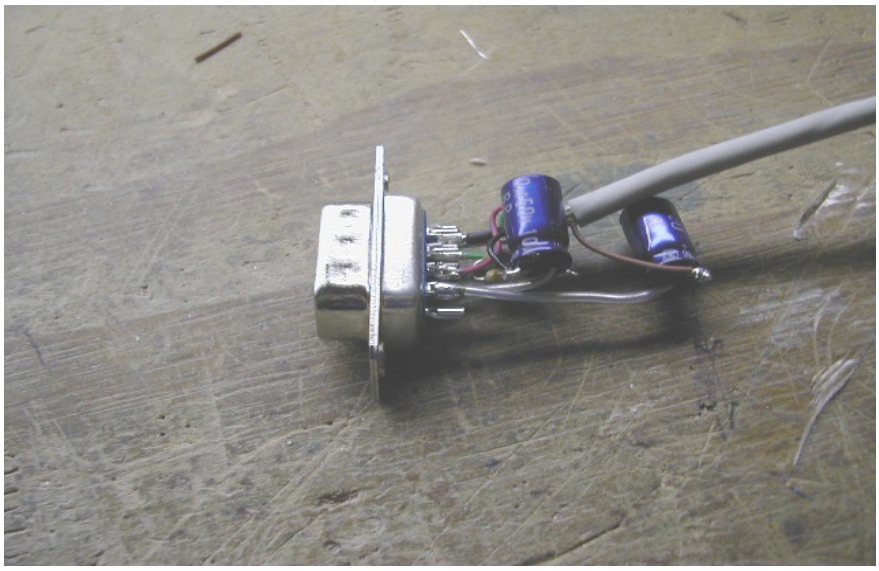
The loose end of the 68K resistor gets soldered to pin 5 (some plastic sleeving slipped over the bare wire would be helpful) . The junction of the 68K and the 470K is soldered the white wire, and the loose end of the 470K resistor goes pin 3 of the D-sub connector:



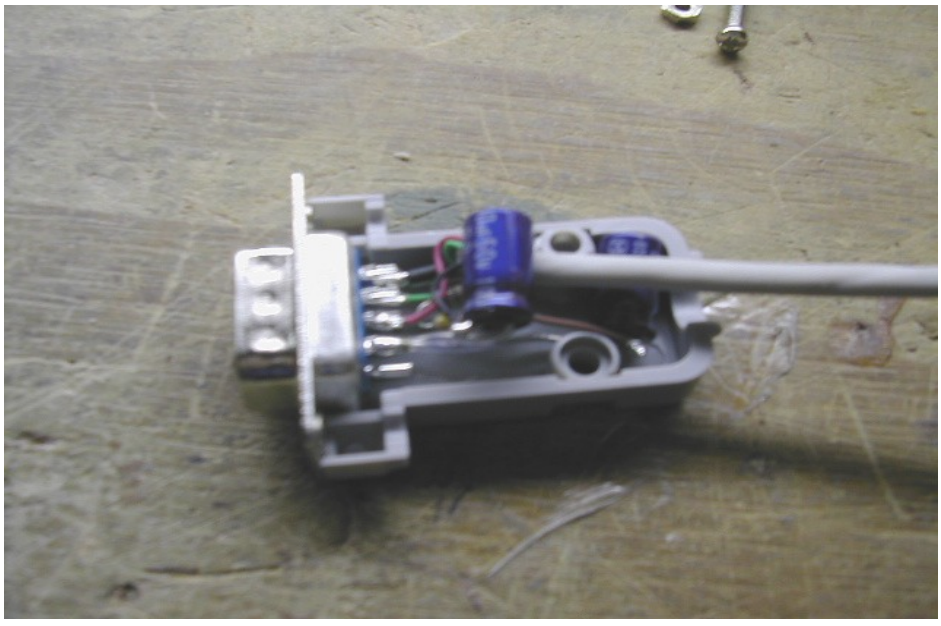
Next we connect the transmit audio (black) wire (through a 10 microfarad non polarized electrolytic capacitor as shown below to pin 2 of the D-sub connector. Be sure to use plastic sleeving over the bare lead of the capacitor to avoid a short circuit.



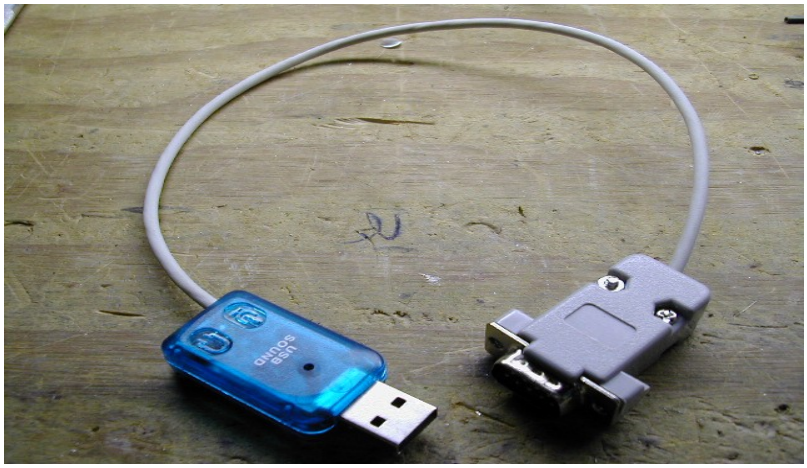
The auxiliary audio (brown) wire is the last connection to be made. It is connected through a 10 microfarad nonpolarized capacitor to pin 6 of the D-sub connector. Be sure to use plastic sleeving over the bare capacitor lead to avoid a short circuit:



Once all of the parts are soldered in place, install the hood and position the parts and the wires so that they are not crimped by the connector hood:



The completed assembly looks like this:



Interfacing the FOB to your radio or repeater (easy method: 3 signals + ground)

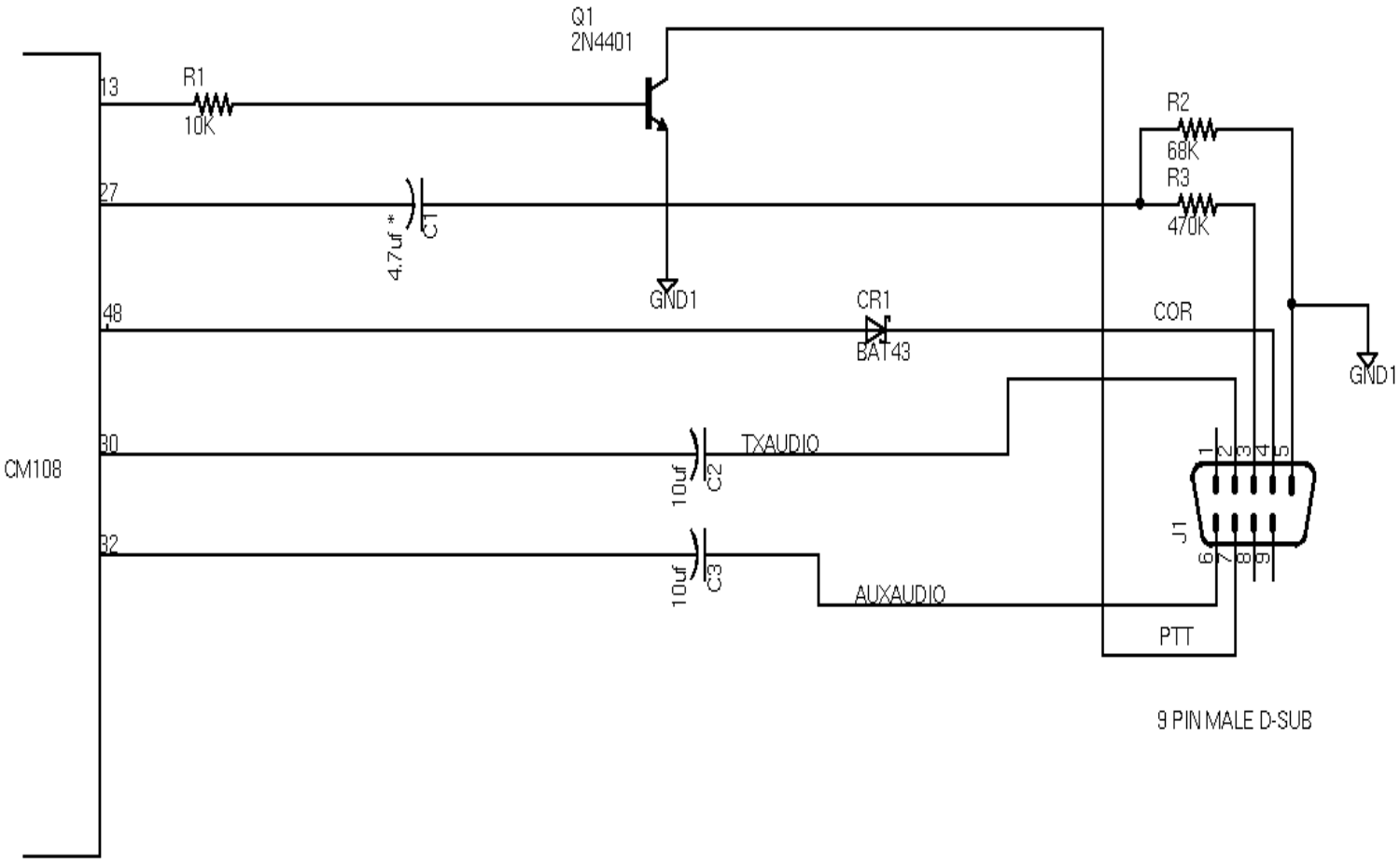
1. Connect pin 3 of the DB-9 connector to your receiver's discriminator output
2. Connect pin 2 of the DB-9 connector to your transmitter's microphone input
3. Connect pin 7 of the DB-9 connector to your transmitter's PTT input (gnd = KEY)
4. Connect pin 5 of the DB-9 connector to the receiver and transmitter DC ground.

In the usbradio.conf config file, make sure the following options are set:

hwtype=0
rxboost=0
carrierfrom=dsp
ctcssfrom=dsp
txctcssdefault=88.5 (or CTCSS tone of your choosing)
rxctcssfreq=88.5 (or CTCSS tone of your choosing)
txctcssfreq=88.5 (or CTCSS tone of your choosing)
txtoctype=notone
rxctcssrelax=1
rxdemod=flat
txprelim=no
txmixb=no
invertptt=0

Follow the radio tuning procedure in usbradio.pdf to set the levels.

The schematic diagram below can be used to check all of the connections if need be:



* PART OF ORIGINAL CIRCUIT

DMK URI (DB-25)	qrvc.com USB FOB (DB-9)	Name	Description	CM108 Chipset Pin
1	7 - PTT	PTT	Push to talk open collector output to radio transmitter	GPIO3 - Pin 13
2		GPIO1	General purpose input or output	GPIO1 - Pin 43
3		GPIO2	General purpose input or output	GPIO2 - Pin 11
4		GPIO4	General purpose input or output	GPIO4 - Pin 15
5		MUTE_REC	Unused input	
6		MUTE_PLAY	Unused input	
7		CTCSS_DET	Input, diode isolated, continuous tone-coded squelch system detect	VOLUP - Pin 39
8	4 - COR	COR_DET	Input, diode isolated, receive (carrier operated relay) detect	VOLDN - Pin 48
9	2 - TXA	MIC_IN	Direct low-level audio input to CM108, must be AC coupled	MICIN - Pin 27
10	3 - RXA	LEFT_OUT	DC coupled left audio output, 4 KHz bandwith	LOUT - Pin 30
11		RIGHT_OUT	DC coupled right audio output, 4 KHz bandwith	ROUT- Pin 32
12		AOUT	AC coupled output from 6dB gain amplifier	
13	5 - GND	GND	Ground	
14		+5V	5 volts DC power output from USB bus	
15		EEP_CS	EEPROM chip select control	
16		EEP_CK	EEPROM serial clock	
17		EEP_DI	EEPROM data input	
18		EEP_DO	EEPROM data output	
19		GND	Ground	
20		GND	Ground	
21		MIC_AC	Audio input, line level, AC coupled	
22		LEFT_AC	AC coupled left audio output, 4 KHz bandwith	
23		RIGHT_AC	AC coupled right audio output, 4 KHz badnwith	
24		AIN	AC coupled input to 6dB gain amplifier	
25		AVDD	12 volt DC power input required for 6DB gain amplifier	

Channel driver for CM108 USB Cards with Radio Interface. Definition in file chan_usbradio.c.

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