Background & Objective

Many of us have an iPhone or other smartphone, and there are many options out there to mount the phone in a location visible to the drive so as to allow using the GPS and music functions. I wasn't eager to disrupt the interior of the car and it seemed that most of the necessary components were already present, the stereo, the LCD display, etc., and all I needed to do was connect them together in the way that I wanted.

There are a number of possibilities described in the forums, many with detailed write ups, but none achieved quite what I was looking for. It also happens that I installed Bluetooth at the same time as the AV upgrade, but the two don't have much interaction so I will describe them separately.

I was looking to fully integrate an iPhone into the existing car without doing a substantial upgrade to the stereo head unit and while maintaining the factory look and feel of the interior. In my case I have an iPhone, but there would be little difference in the installation for an Android or other modern smartphone that has an HDMI output. Basically everything could be done the same except for the last bits that have the iPhone specific connector.

The project began with a 2003 XKR coupe that had factory navigation and premium audio. The car had provision for a factory phone, meaning it was wired for the connections and microphone, but never had a phone module or handset installed.

There are a few well documented steps that I won't spend much time describing, in particular the installation of the video input to the Nav display using a PAC VCI-X. WhiteXKR has written a thorough installation guide and in my case, I purchased his pre-fabricated wire harness to tie the VCI-X in to the Nav display so as to save splicing wires or having to build my own harness.

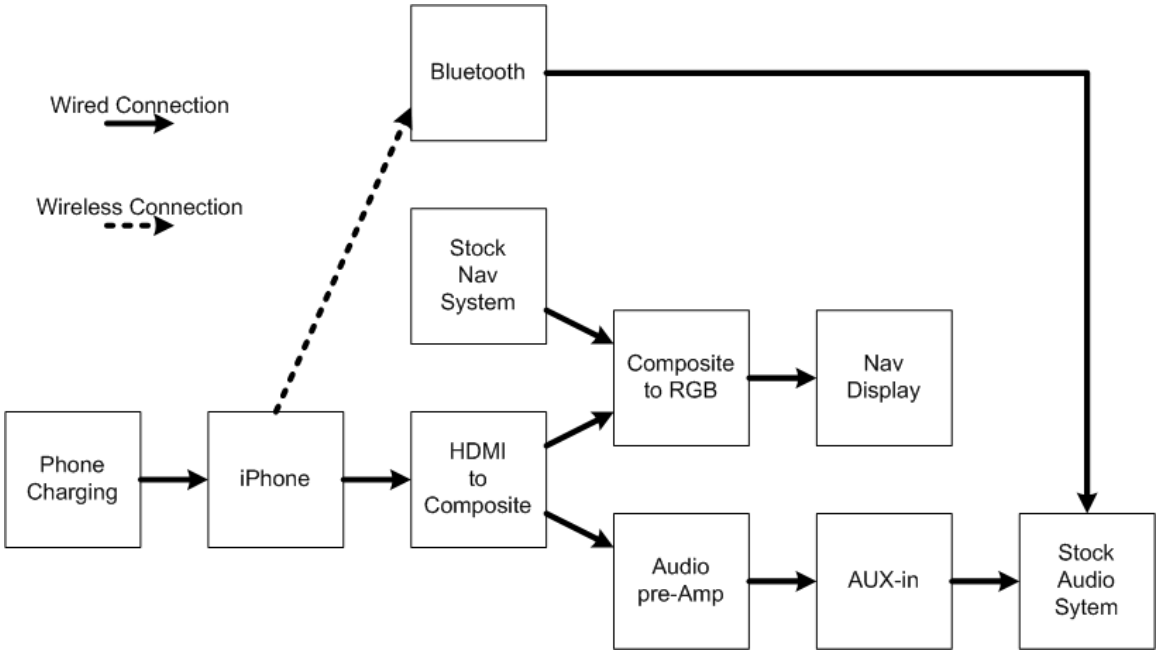
Choosing the AV Output Type

Apple offers a few options for enabling an external display with the iPhone, a VGA output, a composite video output and an HDMI output. Each of these has advantages and disadvantages.

1) **VGA**: outputs is in RGB format, which may allow achieving the video without the use of the VCI-X but there is no audio out, so this one is eliminated right away
2) **Composite video**: has a composite video out an a R-L audio out, which sounds perfect but there is a catch. Only SOME apps support the video out, mostly those aimed at playing video (Netflix, YouTube, etc). most of the iOS interface will not be displayed and nothing shows on the screen when playing music, looking at maps or the web
3) **HDMI**: if you have an iPhone 4S or iPad2, then what they call display mirroring is available. Everything that is shown on the iPhone display can be mirrored to the external display. So when playing music, you see album art, you can see maps, GPS, web pages and everything else.

The HDMI option offers the best overall functionality, but it is also the most complicated to install, needing various format conversions along the way to get the digital HDMI signal converted down to boring, old, low resolution RGB.

The high level architecture looks like this:



Parts List

Monster iCarCharger 1000
iPhone 4S
Apple Digital AV adapter
HDMI Video Converter (unbranded)
VCI-X Composite Video to RGB switch
VCI-X installation harness from WhiteXKR
PAC LD-10 Audio pre-amp
PIE ALP/AI-AUX
Compact USB "car charger" (cheapest you can find)
Sacrificial USB cable (cheapest you can find)
HDMI Cable (the ultra-thin type are easiest to route)
Composite video cable
RCA audio cable
Various lengths & color of wire
Selection of wire splices & unions

Most of these parts can be found on eBay or Amazon for reasonable prices. There are a lot of different choices for the HDMI converter, almost none of them with any sort of brand name on them. They seem to be more or less the same price and I have had good luck with the one I happened to try but your mileage may vary. The other components are all from reputable companies.

Video

I won't spend too much time on the VCI-X parts because WhiteXKR's solution (http://www.thejagwrangler.com/) is a simple plug and play affair.

Believe it or not, the most difficult part was removing the center dash panel to get access to the nav display. There are 4 clips near the corners that hold the panel in by friction and these should just pull out. The problem comes from the fact that the clips have 4 inward facing "teeth" that dig in when you

pull on the panel. There isn't a trick to it, at least none that I could find, so my best advice is just to be patient and don't force it. Keep pressure on them, wiggle the panel and eventually they should let go.

Once removed I took a pair of needle nose pliers and bent the tips of the "teeth" slightly so that they wouldn't dig in so much if I ever had to remove the panel again. With the panel out, the nav display can be removed by loosening the four screws and disconnecting the two connectors on the left side.

Plug in WhiteXKR's harness and feed the VCI cable down behind the radio. I found that it was helpful to remove the lower dash panel under the steering column to get better access. Plug the connectors in to the nav display, tuck the new wiring behind and replace the four screws. Take care to put the display back in the original position as there is a little left-right play in the mounting holes and you may end up with the buttons not being completely centered once you put the dash panel back in.

If you are daring, put the panel back in now, otherwise, it can be left out until we've got everything hooked up and tested.

We need an HDMI to composite video converter and this unbranded model seems to be one of the most widely available, and generally runs about $40.

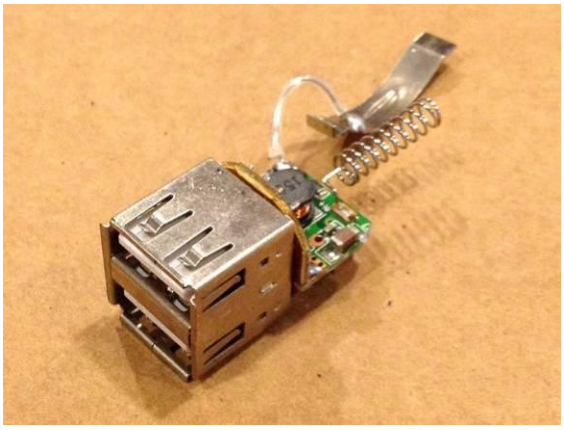
There is an HDMI input port, a power connection for the 5V input to run the converter and an LED to indicate power is being supplied.

On the other side are the output ports, Composite video and the separate L and R audio RCA style connections, a selector switch for PAL/NTSC (we will use NTSC), and a zoom button to scale the size of the output image.

The power to the converter is problem number one, as the adapter that is shipped with the little box is an AC style to be used in an ordinary household outlet, so, not of much use in our automotive application.

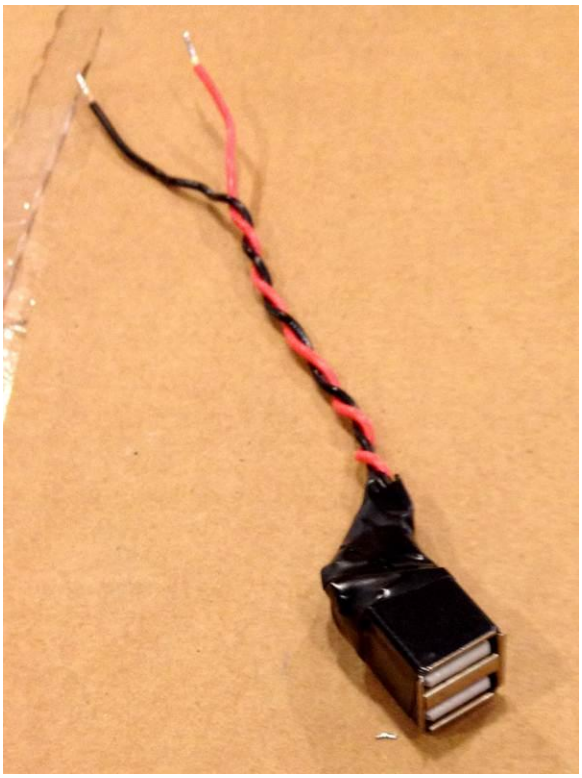
The converter box needs +5V, and while there are several ways you could go about getting it, I opted for cheap and easy. There are power supplies available that are purpose built to do this sort of thing, but in shopping around I found these to be rather expensive and also fairly large, which is a problem for putting it in the already busy console.

Conveniently, USB car chargers put out 5V, are readily available, cheap and generally will supply a pretty accurate and clean power signal.

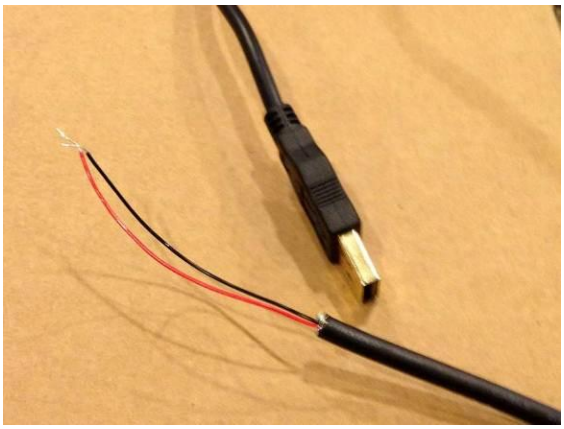


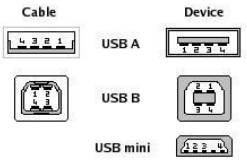
The model chosen is a “compact” style, meaning that it is not much larger than the cigarette lighter socket itself. There was no current requirement marked on the converter box, but the AC adapter said 2A output so I sourced a USB adapter that could do something similar. I expect that you wouldn’t have any problems with the more common 1A version either, but it was only $4 so why not.

After removing all of those unnecessary plastic bits you are left with something that is mostly USB socket with a small attached voltage regulator. Using the soldering iron you can remove the positive (coil spring) and negative (leaf) connections and replace them with wires that can be used to tap a switched 12V circuit in the car. A little electrical tape for protection and we have something that looks like this:



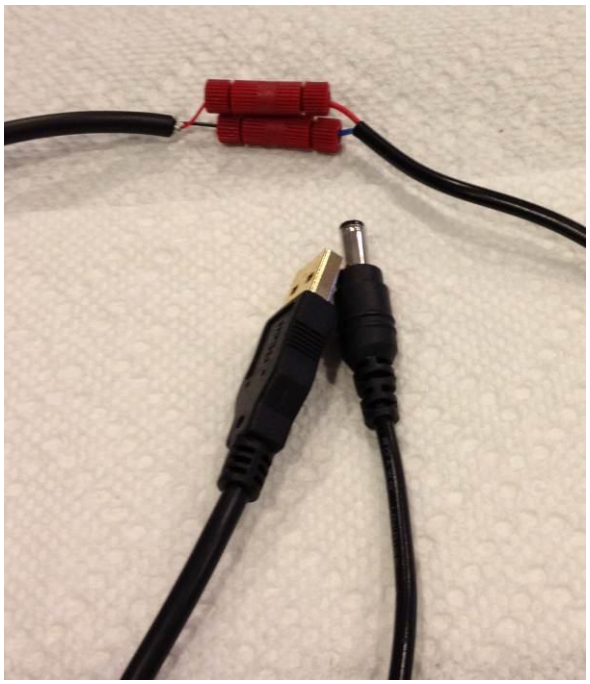
We now need a power cable for our HDMI converter box. I wanted to retain the plug in option so dug up an old USB cable and lopped the end off. Pulling out the red and black wires (pins 1 and 4) we now have one half of a plug in power cable for the 5V power outlet we made earlier.





Pin	Signal	Color	Description
1	VCC		+5V
2	D-		Data -
3	D+		Data +
4	GND		Ground

The power adapter that comes with the HDMI converter isn't much use except for the connector so we can lop the end of that off and splice it together with the half USB cable. The pictures show a Posi-lock union but you could use a crimp style as well. A little electrical tape to act as a strain relief and keep everything together and the power cable is done. A total length of 18-24 inches is plenty to give flexibility in where things are placed under the console carpet but not have too much unnecessary wiring to deal with.



Finally, connect the new power cable to the HDMI converter and wrap some foam weather stripping around the metal to prevent rattles when it is tucked under the carpet. Be careful to avoid covering any of the vents.

Now it's time to start installing the components, and to be able to route the wiring and tuck the components behind the carpet, it is necessary to remove the console from the car.

Reverend Sam has a very good description of how the console comes out:
http://www.youtube.com/watch?v=gU8QeZWoWr0&list=UUAgIVTq-C4gqcsWPF9JyaYg&index=9&feature=plcp

With the console out, the VCI-X can be tucked behind the carpet under the radio and the HDMI converter will fit between the carpet and the transmission tunnel. To prevent rattles, both are wrapped in self-adhesive weather stripping.

By removing the plastic retainer the console carpet can be pulled back and the VCI-X can be tucked up behind the radio support structure.

The video output of the HDMI converter should be connected to input #2 on the VCI-X. Input #2 is active when +12V is applied to the center pole of the 3 position switch and we will use this signal to trigger the audio input.

Audio

The HDMI converter has an RCA style line audio output which needs to be connected to the PIE ALP/AI-AUX in the boot area neat the CD changer & nav system. The easiest way to route the RCA cable is to remove the rear seat. The bottom cushion is held in place by two nuts under the front lip at the far left and right sides. When the nuts are removed the seat can be lifted up, exposing a single philips screw on each side that holds the seat back in place. The rear seat back has a hook near the top behind the headrest part. When the screw is removed the seat back and be pushed upward to unhook and release it.

With the seat back out and the bottom loose the RCA cable can be routed out the back of the console, under the carpet and through the wire tray that runs between the rear seats. Once the wire is fished under the padding then it can be run it up the rear bulkhead to one of the holes that allow access to the boot area.

In a coupe, there is a cutout in the rear bulkhead at the right side that is covered in black duct tape (circled in red). I peeled back the corner of the tape and passed the RCS cable though. Even though it is a reasonably heave cable I wrapped a few layers of electrical tape trough the hole to ensure there were not any sharp edges.

The picture also shows a gray cable, which is used to trigger the audio in the final configuration. I had a multi wire cable laying around and used it here, but this could be replaced with a single small wire. Size is not especially important as there will be very little current, we are simply going to apply +12V as a switching signal for the audio.

Since duct tape was good enough for Jaguar when they built the car, I continued the tradition and lengths of duct tape to secure the wire routing and keep it against the rear bulkhead.

Also visible in the picture is a blue box. This is the Parrot CK3000 Bluetooth system that is discussed in another write up.

Next came the installation of the PIE APL/AI-AUX audio input which connects to the Alpine audio network between the navigation system and the amplifier and it was at this point that I went through several rounds of installation and modification to get the audio portion to work correctly. I will give some explanation of the problems and describe what the final solution ended up looking like.

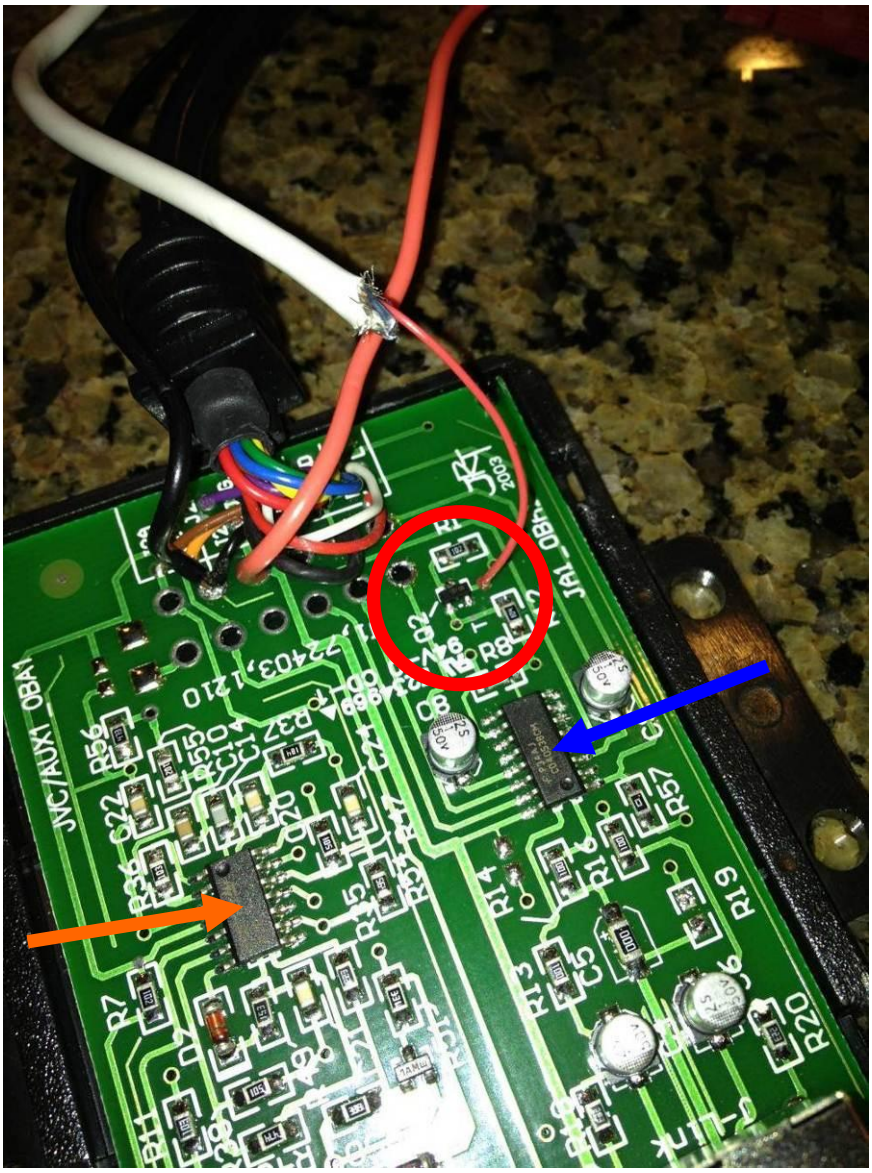
The AUX in is supposed to be a plug and play solution and in simple application it can work very well, but this configuration was somewhat problematic. The idea is logical enough: normally the AUX in routes the audio signal from its AI-Net input to the output. When it detects a signal on the RCA line it then switches in the RCA audio and overrides the other input. This is supposed to happen automatically, and it does, but only if the RCA signal is loud enough and constantly on.

For music it worked great, but for a podcast or a movie with dialog or other soft parts the audio would cut in and out. The level problem can mostly be managed by using the PAC LD-10 pre-amp to boost the signal but there is also a timing circuit that will switch back to the AI-Net audio if the RCA signal is "off" for too long.

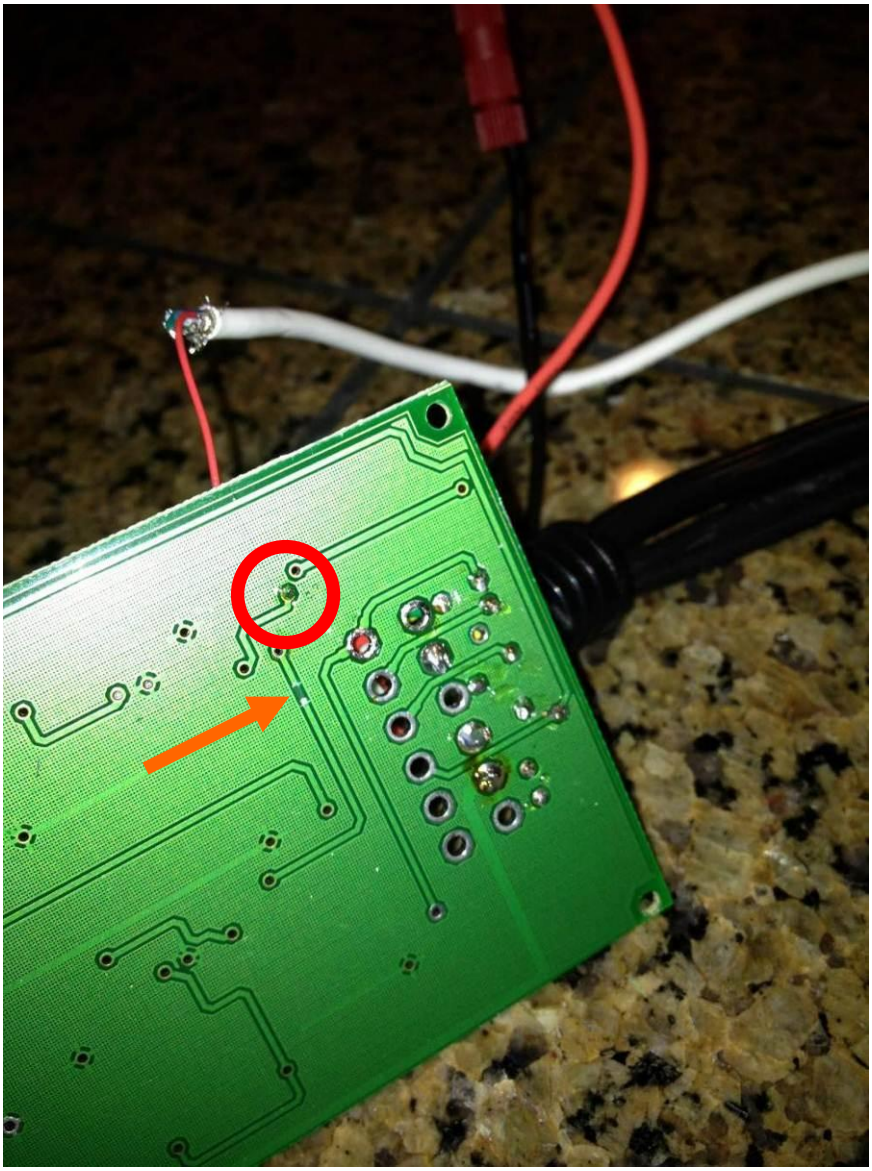
I tried several different methods to make the automatic switching work but ultimately gave up and just went with a manual switch to toggle the RCA or radio sound. For the manual switch method, you could use a relay instead of the AI-AUX box, but I already had purchased one and it does give a convenient connection to the AI-Net inputs. It's always fun to take things apart and see how they work, and after trying four or five increasingly aggressive modifications to the box, I finally ended up with something that is reliable and gives me the functionality I was looking for.

Inside the AI-AUX box the RCA signal is split and used for two different purposes. The section on the right (blue arrow) is the audio switch, that changes between the radio and RCS signals. The section on the left (orange arrow) is the timing circuit. The output of the timer is sent to the input of a transistor (Q2, red circle) and the +12V output of Q2 is sent to the audio switch to toggle between radio and RCA sound.

Since the timer wasn't working well in my application I attached wire to the output side of Q2 (toggle input to the audio switch) so that I could directly apply +12V and select the audio type manually. A single wire is all that is necessary to make this work, the larger multi-wire cable in the picture is left over from an earlier experiment that didn't work.

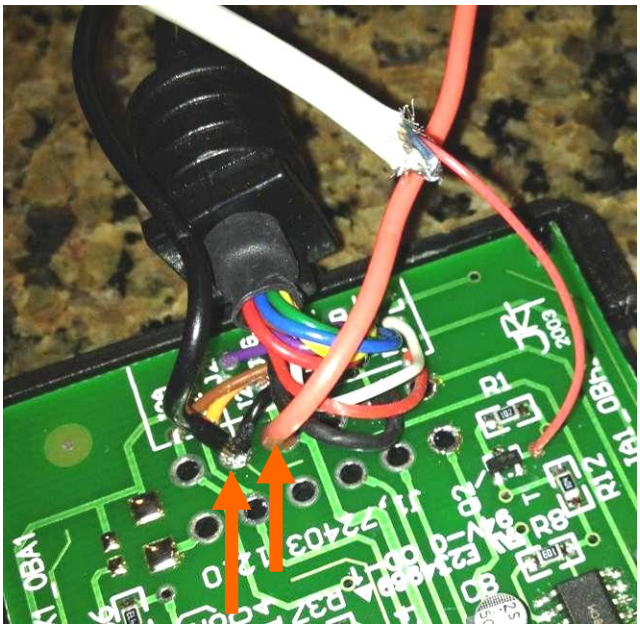


There is a conveniently located trough hole connecting the Q2 transistor to a trace on the back side of the board. I used this as the solder point for the switching wire (red circle). I also severed the trace connecting the timing circuit to the input side of the transistor (orange arrow). This probably isn't necessary but it ensures that the audio signal is completely isolated from our 12V switching signal.



The PAC LD-10 pre-amp requires a +12V and GND be connected. It doesn't draw much current and since the AI-AUX box was already apart, I thought I would tie in to the power connections. Both the +12V and GND are available in the AI-Net cable so once the LD-10 is tied in to the AI-AUX, it will be a self-contained, plug in unit and won't need any splicing at all.

Attach two wires to the locations indicated by the orange arrows. There are large through holes that can be used as solder points. The ground (black) already has a wire attached but the hole is large enough to accommodate a second. The +12V (red) is completely empty and can be soldered from the back side of the board. I cut some extra space in the plastic housing of the AI-AUX to make room for the additional wires. The plastic is soft and the extra space can be made with a sharp knife.



The audio switching is the reason for using Input #2 on the VCI-X, because when input #2 is active there is +12V applied to the center pole of the video selector switch. If you tie into the center pole of the switch and connect that to the audio toggle signal, then whenever video #2 is turned on, then the audio switches as well.

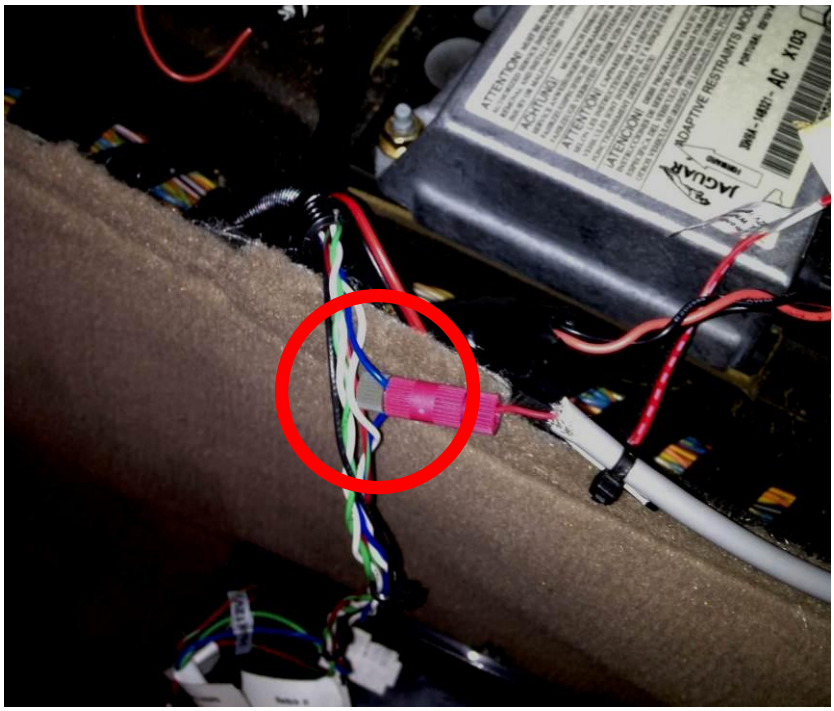
Once reassembled everything is in a tidy package that can be mounted on top of the frame that supports the audio amp using double sided automotive molding tape.

To get access to this area remove the right rear light trim cover by loosening the two thumb screws. The right side boot carpet panel can then be pulled out to get access to the amp. You will need to disconnect the AI-Net cable from the audio amp. It isn't visible in this picture but is on the front side of the amp toward the right (outside) of the car.

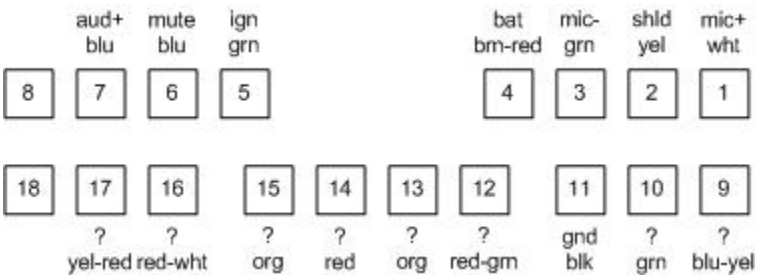
These connectors just pull strait out but sometimes take a little wiggling to get them to let go. There is a simple latching mechanism to the AI-Net cables where the outside of the round connector slides back toward the cable part, squeezing two metal fingers inward to release it.

Connect the AI-Net cable from the amp to the AI-AUX input and the AI-AUX output back to the amp. Connect the RCA cable to the LD-10 and now the rear of the car is finished. You may need to adjust the gain on the LD-10 for L-R balance and to get the overall volume to match the radio.

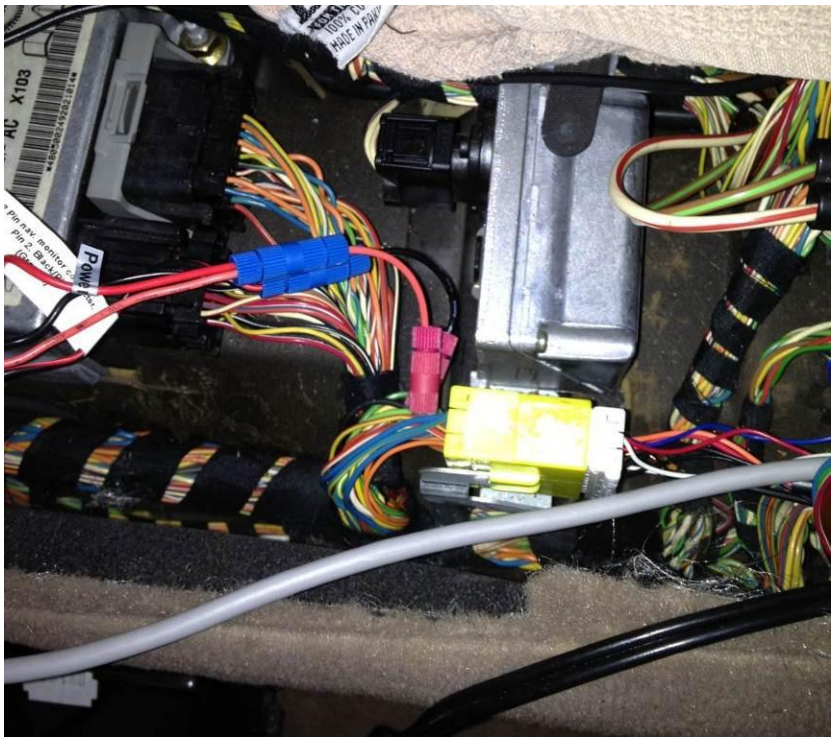
Back at the console, splice into the blue wire just downstream of the video selection switch and connect the audio signal wire that we added to the AI-AUX. The splice in the picture is made by Posi-lock (http://www.posi-lock.com/).



For a power source we need something that is switched with the ignition and we can find it close by in the phone connector. These connectors differ slightly by year but in 2003 the connection is an 18pin connector with the following wires:



The space is a little tight and there are two things to connect but we want to tie in to the green ignition wire and the black ground wire. I opted to use the smallest splice (red) with a short length of wire and the next size up union (blue) to more easily accommodate the two wires needed to power the VCI-X and the HDMI converter.



While the console was out of the car, I took the opportunity to clean all of the spilled coffee and soda from the previous owner. I also removed the ash tray lid entirely, as I plan to use this location for controls and would not have been able to close the lid anyway. This also has the advantage of giving a little more space for routing wires from those controls without the need to cut more holes or otherwise disrupt the interior.

The ash tray lid can only be removed with the console out and upside down. There are four screws holding it in along with the pivot mounts on the side and a spring to retract it.

I chose to mount the video selection switch in the center console. Inside the console the smaller raised area is a separate changeable piece that is different depending on whether the car is fitted with a phone. In my case it is just the felt covered plastic filler piece, since the car never had a phone installed. With the console cubby upside down, there are two slots visible on the sides with a plastic clip that hold the insert in place. Pressing them in and up will release the insert.

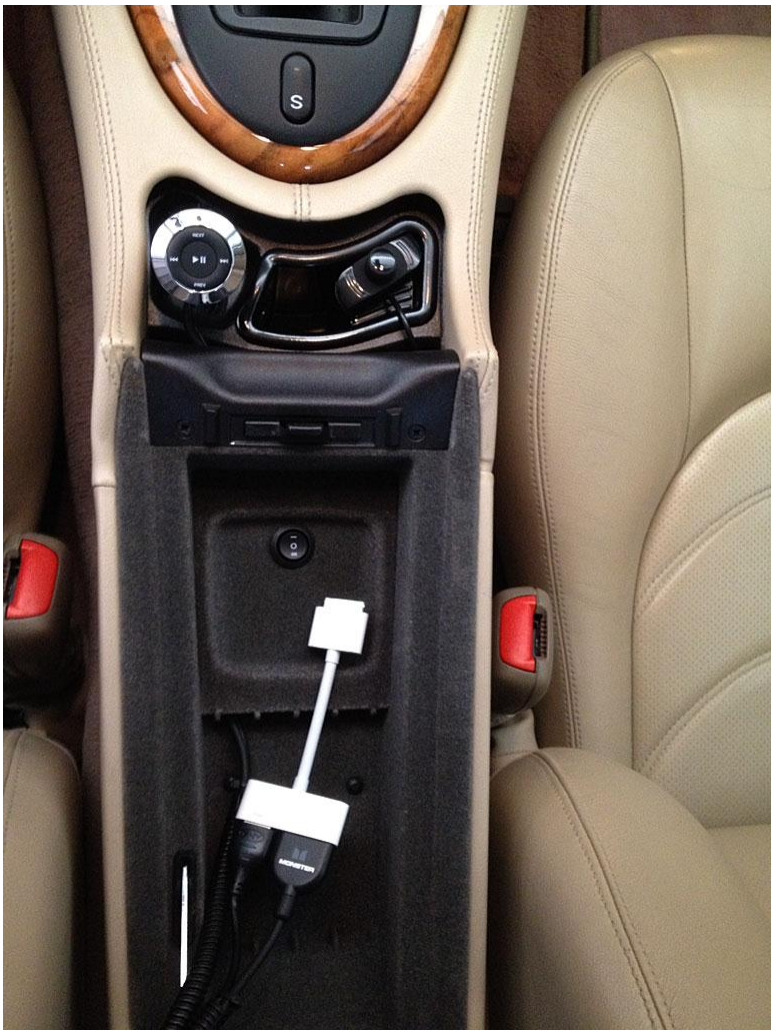
Turning the insert over (felt side down) I drilled a ¾" hole for mounting the switch. This is best done with a drill press but can be done by hand if you are careful. It is also advisable to clamp the insert down to keep it from moving.

The switch has some orientation features that will need to be accommodated on one side of the hole, but this can be done with a sharp knife.

We also need to create access for the HDMI and the charging cable for the phone. To do this, I notched cubby insert. There are 5 ribs at the back of the insert for strength. The flats in between the ribs are reasonably thin and can be cut with a sharp knife.

I used a small cable tie to keep the wires tightly together and set it just on the other side of the insert notch. The cable tie is too large to come through the hole that was cut so acts as a stop to prevent too much cable from being pulled out from inside the console and also acts as a strain relief so that I don't unknowingly pull on the devices hidden underneath.

The video switch normally has the wires coming straight down but this will interfere with the Jaguar control box underneath. I bent the #1 and center tabs at about a 45 degree angle toward the front of the car, and the #2 tab toward the rear of the car to make more clearance.



With everything in place you should be able to switch the ignition on and test everything. When the switch is in the center position, the stock nav system should be visible and when in position #2 the HDMI input should be in use. Position #1 is still available for another input if you should decide to add one in the future.

Now it is simply a matter of putting everything back together.

Idiosyncrasies

It took a number of attempts to get the audio to work consistently and to do it, I effectively had to bypass all of the automated functionality in the AI-AUX. That works well for my purposes, but if I were doing this again, I am not sure I would bother with the AI-AUX vs. a more purpose built manual audio switch. That said, it is convenient that it has all of the AI-Net connections and we were able to source the power for the LD-10 from it so as to avoid any splicing of wires.

The Bluetooth has an interesting interaction with the audio system. Because of where the AI-AUX is tied in to the audio system, the switch has to be set to center or position #1 for the phone audio to be heard. The phone connects to the head unit directly to mute the radio and switch in the phone audio. The AI-AUX is connected downstream of this between the head unit output and the audio amp, meaning that if the phone rings, you don't hear it until the switch is moves away from position #2. Because I'm also using the phone as the audio source also, then phone will stop playing music when a call comes in, so it's easy to tell. I don't really use the phone in the car that often and when I do most often it's for outgoing calls, so it isn't that much of an inconvenience, but is something to be aware of.

Lastly, the Apple Digital AV adapter allows charging but doesn't seem to route the dock controls (play, pause, track skip, etc.) to the phone. That fancy control looks neat, but doesn't do much besides charge the phone. A new version of the adapter that might fix this, or it may be possible to work around the limitation by adjusting the internal wiring a bit, I haven't tried yet.