

## P38 Harman / Kardon Audio Systems – How to replace your stock head unit with a standard aftermarket one

### Description

The higher-end stereos fitted to Range Rover P38s are something of a specialty. They come in a few slight variations, but all follow a central theme – using high-quality power amplifiers separate from the head unit to give a much better quality sound. Let's have a look at what there is:

MY up to approx '99 – These systems were fitted with head units and cd changers manufactured by Clarion. There are five separate power amplifiers, one in each door, and a fifth for the boot-mounted subwoofer. These are all fed by 5 discrete (almost) speaker-level channels from the head unit. The door amps also serve as active crossovers, splitting the signal down into separate frequency ranges for each of the door mounted component speakers. These systems are all pretty much the same up to this model year (there were lesser systems fitted to cheaper models, but they are beyond the scope of this tutorial, as replacing the HU is a much more straightforward process). The Clarion head units for these systems look very much like this:

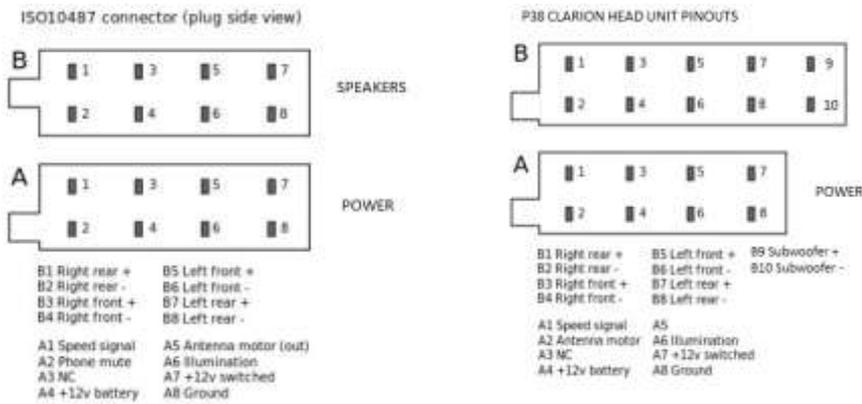


MY '99 onwards – A few changes were introduced. Firstly, the HUs and CD changers were now manufactured by Alpine, and some changes were made to the wiring harnesses. In addition, the system may have a single 'DSP' amp that lives behind the soundproofing behind the subwoofer unit in the boot – OR it may still have the door amps setup. Alpine HUs on the Harman / Kardon systems mostly look like the following picture (although there are some variations about):



## Wiring – Clarion HUs

The pinouts on the Clarion units resemble standard ISO plugs, but with a couple of subtle differences. Firstly, the ‘power’ ISO plug, although a standard 8-pin ISO, is wired a little differently. The ‘Amp / Antenna remote power-on’ lead, which sits on pin 5 in a standard ISO plug, actually sits at pin 2 in this setup. In addition, the ‘speaker’ ISO plug is not a standard 8-pin, it is a 10-pin – the extra set of pins carry the discrete subwoofer output. Here is the complete pinout:

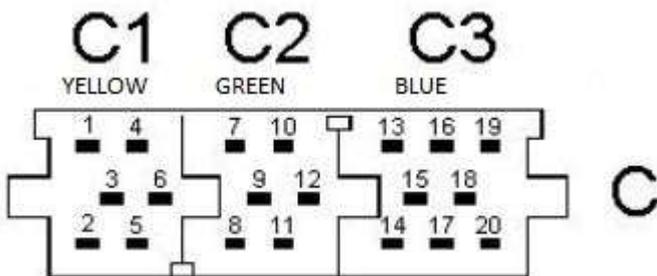


Wire colours on the vehicle harness are as follows:

- |                   |             |                      |            |                    |
|-------------------|-------------|----------------------|------------|--------------------|
| A2 – Grey / black | B1 – Blue   | B2 – Blue / Black    | B3 – Red   | B4 – Red / Black   |
| A4 – Purple       | B5 – Yellow | B6 – Yellow / Black  | B7 – Green | B8 – Green / Black |
| A6 – Red / White  | B9 – Orange | B10 – Orange / Black |            |                    |
| A7 – White / Pink |             |                      |            |                    |
| A8 - Black        |             |                      |            |                    |

## Wiring – Alpine HUs

For the alpine units, the wiring was changed slightly. The ‘power’ connector (A) became ISO-standard, with the amp remote now residing where it belongs, on pin 5. They also now had a totally ISO standard 8-pin ‘speaker’ connector (B) – making direct plug-up to an ISO HU possible without modifying the harness wiring. It also introduced the 20-pin ‘mini-ISO’ connector (which comes in three different coloured sections, labelled as C1-C3) – although, again, wired in a non-standard way. This is now where the subwoofer output channel lives, and where the CD changer connects to:



The ONLY wires from this connector we are interested in, for the purposes of making a HU adaptor harness, are the Orange & Orange / Black wires for the subwoofer output. These reside at pins 1

and 4 on the Yellow (C1) connector. The Green (C2) connector is unpopulated, and the CD changer connects up to the Blue connector (C3) *\*NOTE: At the time of writing, I have been unable to determine the exact pinout of the C3 connector – RAVE is of no help, and even an email directly to Alpine UK's tech dept drew a blank. I am currently looking into this and will update when able, as it may prove promising for making up a direct iPod connection into the CD line in pins!*

Wiring colours on these systems are identical to those on the Clarion systems. Note that the Grey / Black wire that was at pin A2 on the Clarion systems is now at pin A5, where it should be!

*\*NOTE – DSP systems – On DSP equipped systems, there are only 2 sets of wires populated in the B connector – those at pins B3-6 (basically, the 'front' channels from the HU) – since the DSP amp handles signal distribution to all the speakers. It is unclear from RAVE wiring diagrams whether the DSP amp also handles distribution to the subwoofer amp (which definitely DOES exist as a separate entity to the DSP amp), so there may NOT be a separate discrete subwoofer output in the C1 connector. I haven't yet had the chance to see one 'in the wild' to confirm this, but if the Orange & Orange / Black wires are absent from C1, it means that no separate output to the subwoofer amp is required.*

So how do we fit an aftermarket HU? Sounds easy to get around, right? Well, not quite...

So, what's the big problem? Actually, there are two. First, let's look at how the Harman / Kardon amp setup works – hopefully this will explain why you can't simply plug-up (or adapt the wiring to plug up) a standard aftermarket HU...

## **The Harman / Kardon Amp System**

The Harman / Kardon amps fitted in this system are the absolute shiznit. I have been tinkering with car audio for years, and they are the best OEM-fit pieces of kit I've ever seen, with perhaps the exception of Bose. They, and the speakers they drive, are perfectly matched to the P38's interior acoustics and, when given a decent input from a decent HU, they produce a brilliant, high-quality, distortion-free soundstage. Bottom line – Don't get rid of them unless you absolutely HAVE to!

### **How do amps work?**

Amps take a +ive signal, and compare it to a reference voltage. They then amplify that difference. In an *unbalanced* system, that reference voltage is the common audio ground, usually found at the HU, which is ultimately connected to the vehicle's electrical ground. A vehicle's electrical ground is a VERY noisy environment, hence there will always be subtle changes in that 'ground' reference voltage. An amplifier will amplify this 'noise' as well as the signal it is meant to amplify. For most run-of-the-mill systems, with relatively low amp gain, this isn't too much of a problem, as long as all the components are grounded to the same point, therefore using the same reference voltage. (Where components are grounded to different parts of the chassis, there will be subtle differences in the reference voltage potential between those points. This 'difference' is amplified by different amounts by different parts of the system, and you end up with what is known as a 'ground loop' – this causes all manner of interference problems on ANY system). In order to step things up a notch, though, we use a system that takes variations in the reference voltage out of the equation altogether.

Like many high-end and professional audio amps, the H/K units use *balanced* inputs. This means that BOTH the +ive AND -ive wires on a channel carry a signal, the one on the -ive wire being the inverse of the one on the +ive. This confers a number of advantages; as well as requiring half the amplification power of an unbalanced system (on each individual amp channel), it is virtually immune from induced noise, for two reasons – firstly, the ‘audio’ ground is *completely* isolated from the vehicle’s electrical ground, and secondly, when the signal wires are arranged as twisted pairs (as they almost always are in balanced systems, and certainly are in the P38’s harness) any interference induced in the wiring affects BOTH wires equally. Since the amp ONLY measure the difference between the +ive signal and its reference (-ive or ground), any such interference cancels itself out passively and is ignored by the amplifier. Hence, with a balanced system, an amp can run a much higher gain safely, as it’s amplifying a totally ‘clean’ signal.

Curiously, almost ALL modern HUs have balanced speaker outputs from MOSFET transformer amps in order to combat this very noise problem. So problem solved? No... sorry, it’s not that easy!

The input impedance of the H/K amps is 70 ohms... whereby the output impedance of a speaker-level output from a standard HU is around 4 ohms (they can normally cope with a range of loads from speakers of between 4 and 16 ohms). Any lower than that will blow the amp... any higher will produce far too quiet a signal to be of any real use. The Clarion and Alpine HUs fitted by LR are actually bespoke units, designed specifically to work with the H/K setup, hence they have a much lower level of output on their ‘speaker’ output wires than a standard aftermarket HU.

#### So why not use the RCA line-outs that all aftermarket HUs have?

Two reasons – Firstly, RCA outputs are unbalanced – ALL the outer contacts, and the shielding in the cabling, are connected to the common audio ground, and if plugged up to the H/K system, will almost certainly induce a very loud ‘buzzing’ noise into the system. Secondly, the output impedance of RCA line-outs is very high – something in the order of 1000 ohms +. Therefore the signal level is far too low for our system. In short, you will end up with a very quiet, and buzzy, output – that CANNOT be solved with ground-loop isolators (because it’s NOT a ground loop!) – DESPITE what some commercial adaptor lead manufacturers may tell you!

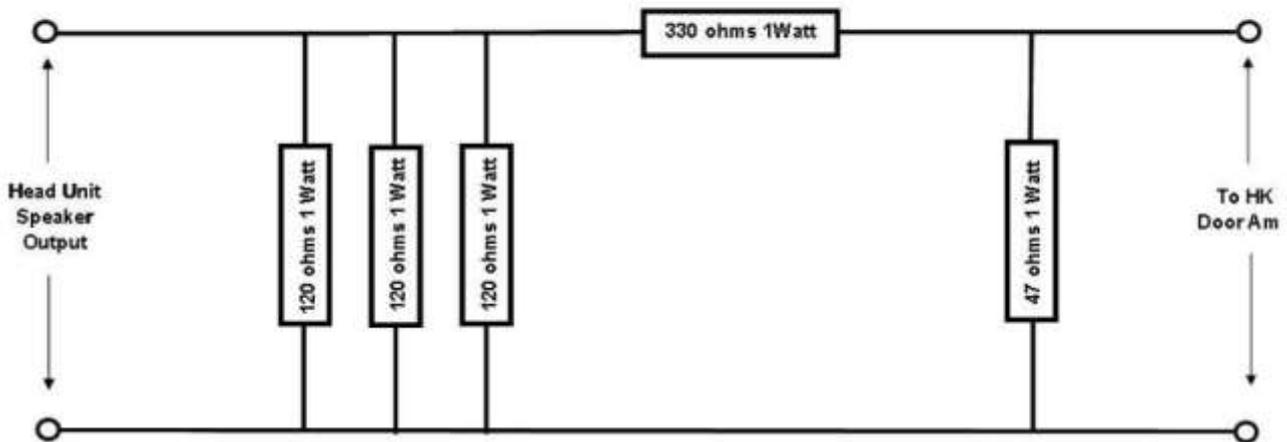
#### So how DO we solve this little conundrum?

Simple – we build ourselves an impedance-matching attenuator, using resistors. It needs to do 3 things:

1. Let the head unit ‘see’ an appropriate load, between 4 and 16 ohms.
2. Attenuate the output from the HU to a level that the H/K amps can cope with.
3. Let the H/K amps ‘see’ an input impedance of 70 ohms.

A very clever man, far cleverer than I, has come up with such a circuit specifically matched to the P38’s H/K system. Ray Ambler, from RangeRovers.net, has published a similar write-up to this, explaining in much greater technical detail how his circuit works. Just google ‘Ray Ambler Attenuator’ if you want to learn more. This is what his circuit looks like:

Designed by Ray Ambler to allow the replacement of the original ALPINE radio in later P38a Range Rovers



We need to build 4 of these, one for each channel, and splice them into a standard ISO extension harness, to go inbetween the aftermarket HU and the vehicle harness. Fortunately, I have spent quite a bit of time messing about with this, and come up with an implementation that is simple, cheap, compact, and easy to make yourself if you are handy with a soldering iron.

*\*Note – yes, you only need 4, since the subwoofer channel seems quite happy being run directly from an RCA output. I am not entirely sure why this is (possibly because any interference generated in the system sits above the frequency response range of the sub, and is therefore automatically filtered out by the amp?) – all I know is, it's worked perfectly in every implementation I've tried so far!*

You need to use 1 watt, metal film or carbon resistors (NOT the cheaper wire-wound ones). The attenuator circuit is built in exactly the same way for both the Clarion and Alpine-headed systems, although the methodology of building a complete adaptor harness is slightly different for each.

## **PARTS REQUIRED**

I used CPC to source the electronics parts, and Nexxia for the appropriate connectors.

### CPC

- PC01298 x 1 - Stripboard (any standard stripboard will do)
- RE05096 x 12 - Resistor, 120 ohm 1 watt
- RE05091 x 4 - Resistor, 47 ohm 1 watt
- RE05101 x 4 - Resistor, 330 ohm 1 watt
- AV14984 x 1 - RCA Phono plug (or just cut up a spare phono lead)

Suitable Heat shrink – I used 30mm ID stuff that has hot-melt coated on the inside – part number escapes me at the moment, but the shortest length they do it in is 1-metre. Alternatively, you could use electrical insulation tape, but I prefer the heatshrink as it gives a much more robust finish.

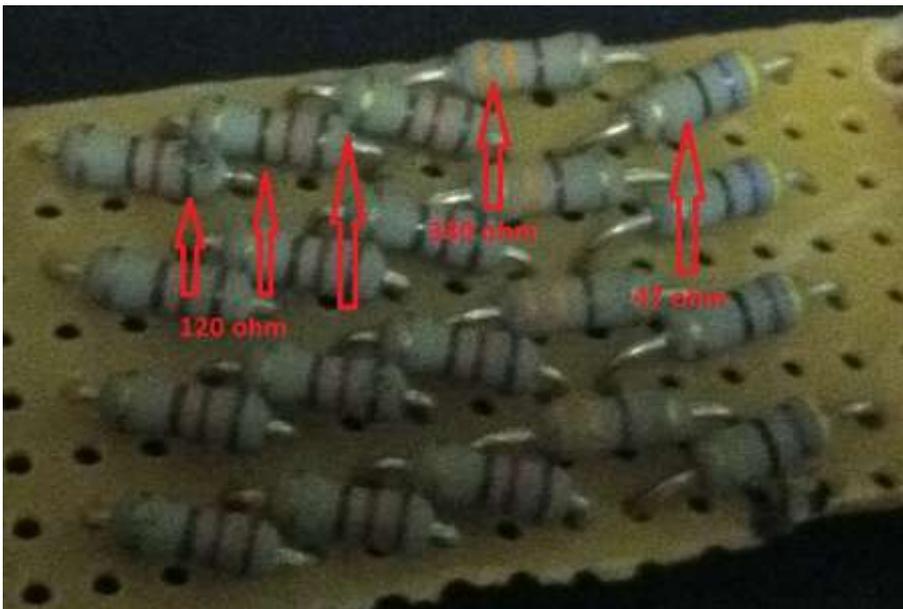
### NEXXIA

- M-51-1 x 1 - 10-pin ISO speaker housing (CLARION only)
- M-50 terminals -only need 2, but the smallest pack is 10 (CLARION only)
- M-46-1 x 1 - 20-way mini-ISO housing female (ALPINE only)
- M-48-1 x 1 - mini-ISO connector pins – only need 2, but come in packs of 10 (ALPINE only)

You will also need an ISO male-to-female ‘extension’ harness – these can be had almost anywhere, but the ones that have completely separate plugs / sockets at both ends are the easiest to work with.

### Step 1 – build the attenuator

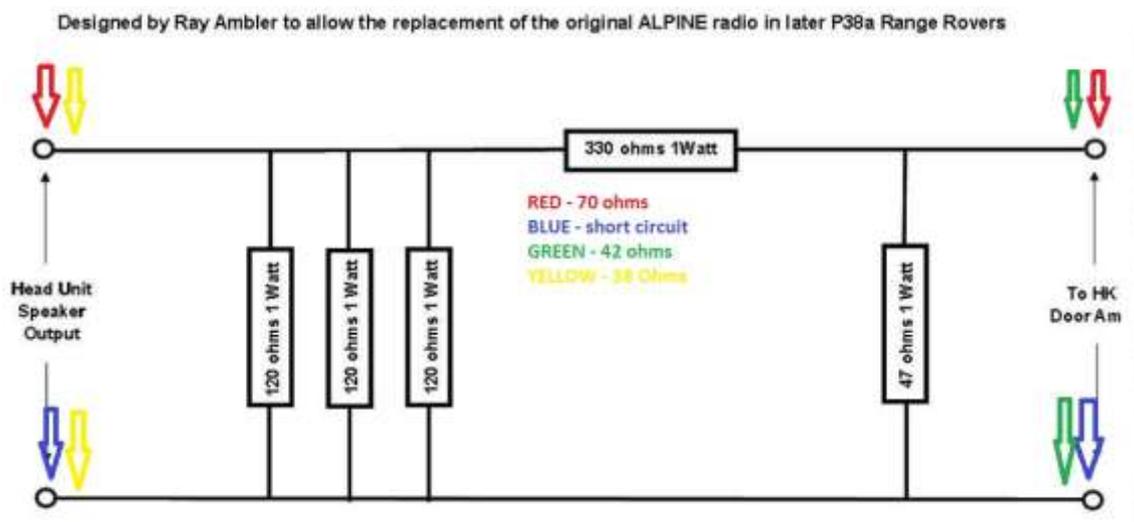
This step is common to both systems. Cut an appropriate sized piece out of your stripboard, and fit the resistors to make the circuit shown above. I found the most compact arrangement to be like this:



This gets all 4 channels on one piece of stripboard and keeps everything nice and compact.

Once that's all in place, solder them on. Once done, **don't forget to spot-cut the track underneath the 330 ohm resistors** – else there would be little point in them being there!

Now probe the board with your multimeter, to make sure all is as it should be. Measuring between the points shown by the coloured arrows should give approximately the values shown (bear in mind 5% resistor tolerance):



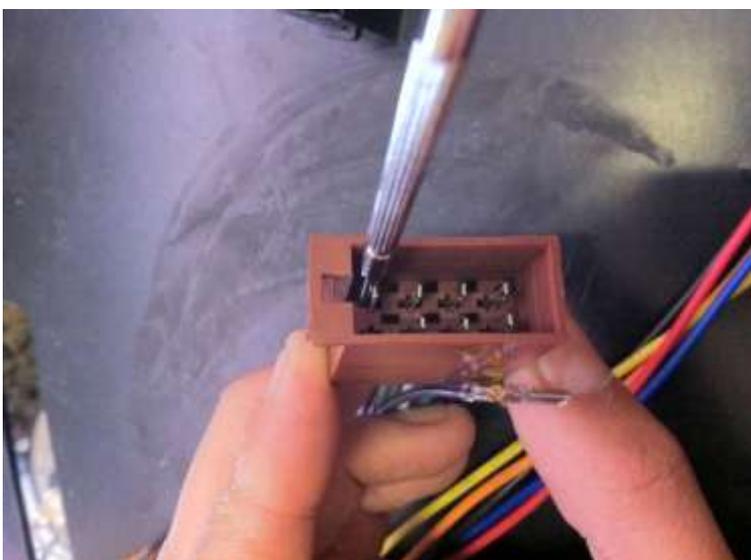
If the values seen are different, or if any one channel is wildly different to the others, check your soldering. It's also worth checking across adjacent tracks between channels to make sure you haven't 'cross-soldered' inadvertently.

### Step 2 – Cut the ISO speaker harness

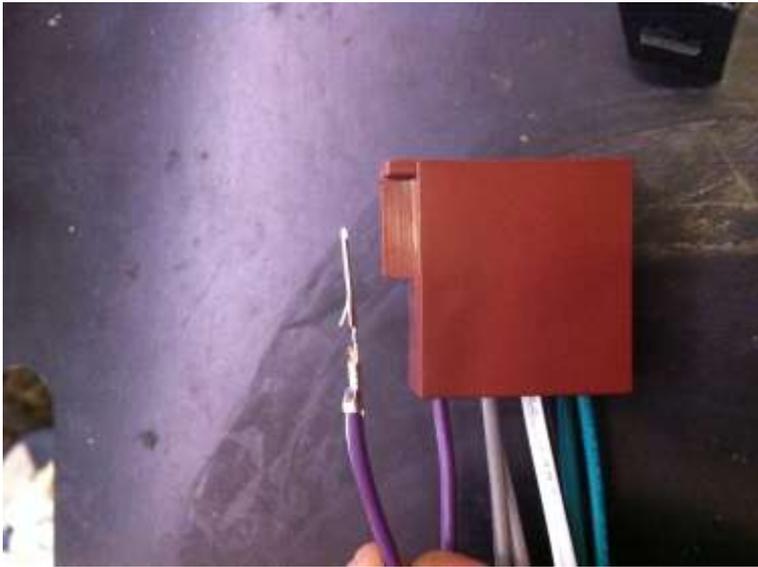
The speaker harness is the one with the (usually) brown plugs and 4 pairs of wires – Purple, Green, Grey, and White. Be careful to end up with bare wires all the same length, otherwise soldering them to the board later will become a bit of a nightmare.

### Step 3 – CLARION SYTEMS ONLY – Modify your harnesses

First, we need to get the pins out of the standard 8-pin socket and transfer them to the new 10-pin one that fits the vehicle harness. Using a small precision screwdriver, or similar, insert it into the front of the socket just above the pin you are trying to remove, and depress the locking tab. It should stay depressed:

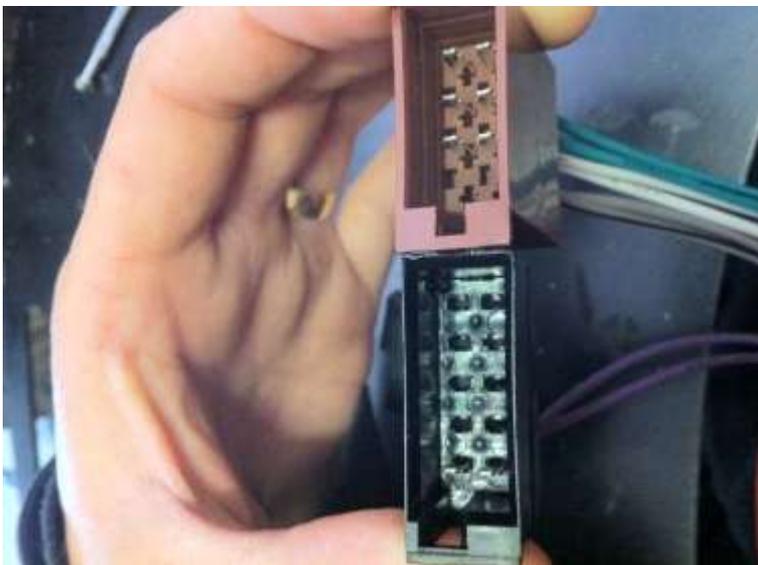


For reference, the locking tabs on the M-50 pins are on one side only, the same side as the crimping in the back of them:



Once the tab is depressed, you should be able to pull the wire out from the back with very little force. Don't yank it, or you may break the tab.

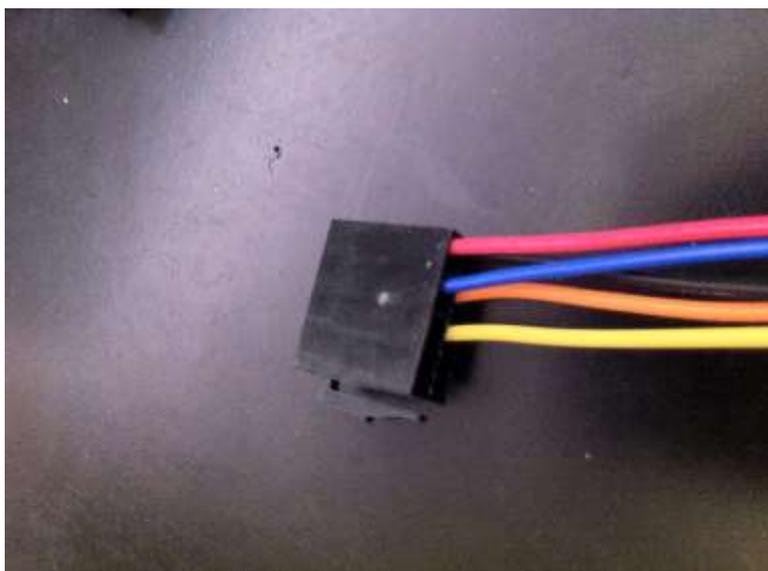
I found it easiest to do one pair at a time, and transfer them as I went along to the 10-pin housing. Start at the end with the cut-out, with the purple wires. Remember to keep the polarity the same. All the -ive (black striped) wires are in the same row, as are all the +ives:



When done, you should have 2 slots left over in the housing (9 and 10). They are for the subwoofer output wires, which we will deal with later.

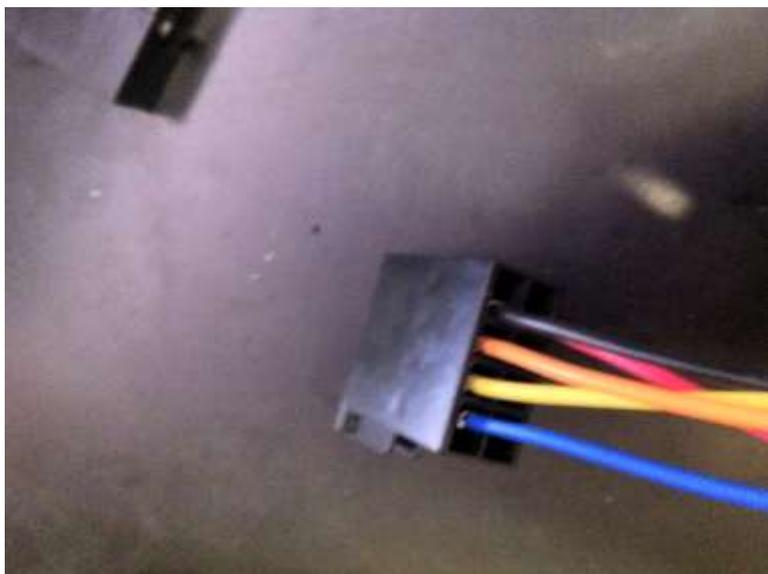
Next, we need to modify the ISO power lead to move the amp remote, which is on pin 5, to pin 2 at the SOCKET end.

This is the standard ISO location:



Pin 5, at the PLUG end – it needs to STAY here at this end.

And this is where you should have it at the SOCKET end, pin 2:



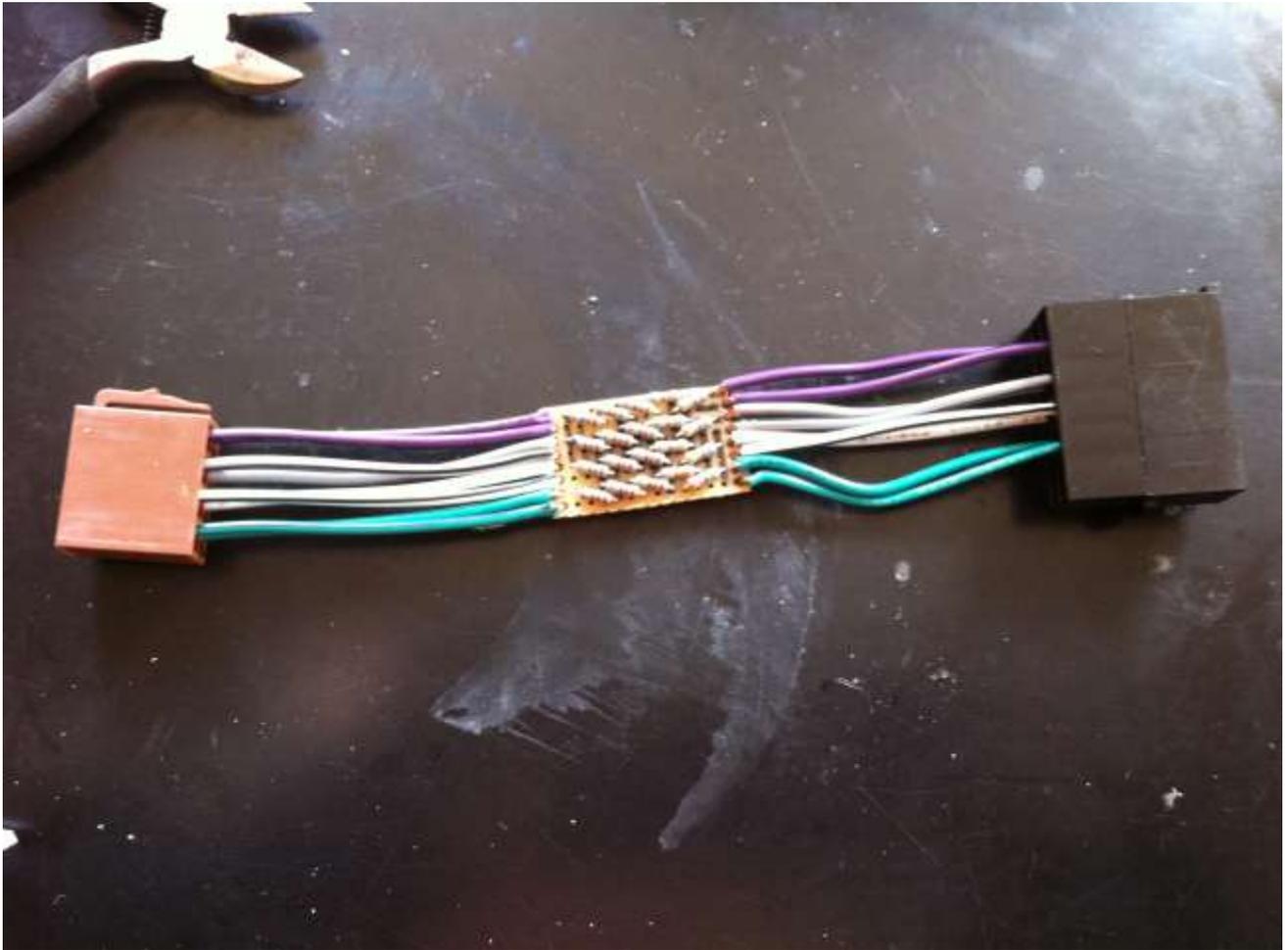
The blue wire should now match up to the Grey / Black wire on pin 2 at the vehicle harness.

#### Step 4 – Solder the attenuator into the speaker harness

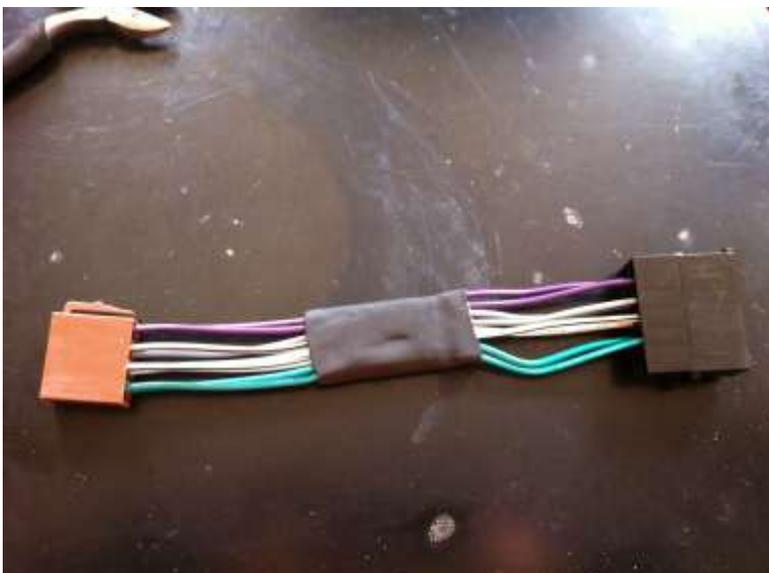
I found that the wires from the harness were a little too big to fit through the holes in the stripboard, so I used a small drill bit, twisting it BY HAND ONLY, to widen them. Start on the copper track side of the stripboard, to avoid lifting the strip off the board as you push the drill bit through.

Then, solder the wires in turn, making sure that the POSITIVE wires go to the tracks containing the 330 ohm resistors. Alternate +ive, -ive, down the board. ALSO – ensure that the PLUG end of the

harness goes to the end of the attenuator that has the 3 120 ohm resistors, as that's the end for the head unit. You should end up with something that looks like this:



Once complete, re-check your circuit impedances – only this time, probe the terminals in the plug and socket, just to ensure nothing has gone awry. It is very easy to end up cross-soldering the bare ends of the wires, as space on this board is tight. Once you're happy, apply your heatshrink and shrink away! Be careful not to burn it or melt any of the wire insulation:



That's the attenuator done!

#### Step 5 – Subwoofer hookup

Next, take your RCA phono plug (or butchered lead), add a couple of short lengths of suitable gauge wire to it, and seal it up. I prefer to solder the wires together, then seal with heatshrink. Remember to make one of your short lengths of wire a little longer than the other, so that your joins are separated lengthwise along the lead – less chance of them inadvertently shorting. Ensure that you can identify which of your 'exit' wires is +ive (connected to RCA centre pin / wire) and which is -ive (connected to RCA outer ring / wire outer shield):



Note where the RCA outputs are on your new head unit, relative to the ISO sockets, and ensure your RCA lead is long enough to reach them. They're often on the other side of the back of the unit to the ISO sockets. Give yourself plenty of length to play with (so to speak...!).

FOR CLARION UNITS – Crimp a pair of M-50 terminal pins to the bare ends of this new lead.

FOR ALPINE UNITS – Same, but use the small M-48 terminals

#### Step 6 – (ALPINE ONLY) Insert pins into the red M-46 20-pin mini-ISO housing

They go into positions 1 (+ive) and 4 (-ive). Refer to the pinout diagrams shown earlier. They should match up to the Orange and Orange / Black wires in the Yellow portion of the mini-ISO connector on the vehicle harness, which looks like this:



(Sorry, no pic of the red mini-ISO housing that that connector plugs into!) The pins should 'click' home when the locking tabs engage.

For CLARION systems, do not connect the RCA hookup to ANYTHING just yet, at either end. We will deal with that at the fitting stage.

CONGRATULATIONS! Your adaptor is now complete, and we are ready to proceed to FITTING.

FULL acknowledgement here to Ray Ambler and RangeRovers.net - all info and images used are open-source and publicly available.

## **Fitting Instructions - CLARION**

### You should now have:

1 x Speaker Output adaptor lead with in-line attenuator circuit (BROWN 8-pin ISO plug with black 10-pin ISO socket)

1 x ISO Power lead extension lead (BLACK 8-pin ISO plug / socket) – this has been adapted to have the amp / antenna remote lead from the ISO wiring (blue wire) pin 5, to pin 2 at the vehicle end (grey / black wire) – for some reason this is where Clarion and LR decided to put this wire!

1 x RCA pre-out to Subwoofer Input lead (bare-ended M50 terminals)

1 x DIN to ISO Antenna adaptor (if your new HU requires it – most will)

### Fitting:

1. Remove original CLARION head unit from dash.
2. Remove the 2 ISO plugs (Grey and Pink) and the (usually 2) antenna connections from the rear of the original head unit. Ensure that they do not fall back into the dash! Also remove the CD changer input (round DIN-style 13-pin connector) and shove that away somewhere into the depths of the dash – you won't be needing it again.
3. Connect the Speaker Output Adaptor (BLACK 10-pin socket) to the vehicle speaker ISO harness (PINK plug). You will notice the black 10-pin socket has two pins missing – we will deal with them shortly.
4. Connect the ISO Power Lead Extension (BLACK plugs) to the vehicle ISO power harness (GREY plug).
5. Connect the antenna adaptor (if your new head unit requires it) to ONE of the vehicle's antenna leads (note that on UK / Euro models, only ONE of these leads will carry an antenna signal, although there may be TWO identical leads. If no radio reception is possible once powered up, try connecting the other one).

6. Connect the adaptor plugs to your new head unit. The subwoofer input RCA can use either the left or right output from your head unit – it does not matter which. For now, keep the bare ends of the RCA sub input adaptor lead from touching anything – especially each other!
7. Power up your new head unit, and play something through it, preferably something bassy. (you may, even at this stage, notice much deeper bass than you had previously – stand by to find out why...)
8. Now for the slightly fiddly bit – the Sub input. On my Clarion-headed system, it turns out the sub was wired with inverted polarity – even though all the correct coloured wires seemed to go to the correct terminals! I have no idea if this was just an isolated mistake, or if ALL or SOME of the Clarion-headed systems were wired this way. Hence we must find out which way round your sub needs connecting! Ensuring that your new HU is outputting a subwoofer signal on your chosen RCA socket, take the bare M-50 terminals one at a time and GENTLY push them into the two remaining empty pin holes (9 and 10) in the black 10-pin ISO speaker socket, until you just feel them make contact with the plug. Ensure, at this stage, that they do not ‘click’ fully home – you may wish to temporarily flatten the small locking tab on them to make sure this doesn’t happen. Do this until you can hear the output from the Sub... it will do one of two things – either dramatically enhance the bass, or kill it almost totally (hence the need for a bassy track to be playing at the time). When you find which way round it should be wired (it will be obvious), you can push the M-50 terminals fully home until they ‘click’. Don’t forget to gently bend the lock tabs back out a little if you bent them in earlier!
9. You will almost certainly notice a dramatic improvement of sound quality compared to the original setup. Take care when fitting your new head unit into the dash that you do not foul any of the leads – there is plenty of room in that dash to tuck the leads out of the way!

### Notes

The subwoofer output adaptor uses only ONE RCA plug as the input to the Harmon / Kardon sub is single-channel (downmixing 2 the stereo RCA outputs to Mono without loss of signal level or quality requires some much more complicated and expensive circuitry). All applications tried thus far have given more than satisfactory performance with this setup. Do NOT be tempted to use a ‘Y’-splitter to try and merge the two outputs directly, as this will cause the L and R sides of the head unit amp to ‘fight’ each other and can result in damage!

## Fitting Instructions - ALPINE

### You should now have:

- 1 x Speaker Output adaptor lead with in-line attenuator circuit (BROWN 8-pin ISO plug)
- 1 x ISO Power lead extension lead (BLACK 8-pin ISO plug)
- 1 x RCA pre-out to Subwoofer Input lead (RED 20-pin mini-ISO plug)
- 1 x DIN to ISO Antenna adaptor (if your new HU requires it – most will)

### Fitting:

1. Remove original ALPINE head unit from dash - \*IMPORTANT NOTE – if your system has DSP (single amp in the boot) it is VITAL that you switch it on and turn the volume up to around  $\frac{3}{4}$  of max *before* switching it off and unplugging it. This is to ensure that the amp gain is set to 'high'. Failure to follow this step will result in low overall system volume. It is also worth setting up the DSP to your liking, as you will *not* be able to alter those settings again once the original head unit is removed.
2. Remove the 2 ISO plugs (Grey and Yellow) and the larger mini-ISO plug (multi-coloured), and the (usually 2) antenna connections from the rear of the original head unit. Ensure that they do not fall back into the dash!
3. Connect the Speaker Output Adaptor (BROWN plugs) to the vehicle speaker ISO harness (YELLOW plug).
4. Connect the ISO Power Lead Extension (BLACK plugs) to the vehicle ISO power harness (GREY plug).
5. Connect the Subwoofer Output adaptor (RED mini-ISO plug with RCA plug) to the vehicle mini-ISO harness (multi-coloured plug).
6. Connect the antenna adaptor (if your new head unit requires it) to ONE of the vehicle's antenna leads (note that on UK / Euro models, only ONE of these leads will carry an antenna signal, although there may be TWO identical leads. If no radio reception is possible once powered up, try connecting the other one).
7. Connect the adaptor plugs to your new head unit. The subwoofer input RCA can use either the left or right output from your head unit – it does not matter which.
8. Power up your new head unit, set up as desired – and enjoy! You will almost certainly notice a dramatic improvement of sound quality compared to the original setup. Take care when fitting your new head unit into the dash that you do not foul any of the leads – there is plenty of room in that dash to tuck the leads out of the way!

### Notes

The subwoofer output adaptor uses only ONE RCA plug as the input to the Harmon / Kardon sub is single-channel (downmixing 2 the stereo RCA outputs to Mono without loss of signal level or

quality requires some much more complicated and expensive circuitry). All applications tried thus far have given satisfactory performance with this setup. Do NOT be tempted to use a 'Y'-splitter to try and merge the two outputs directly, as this will cause the L and R sides of the head unit amp to 'fight' each other and can result in damage!

If the volume seems to be very quiet, even with your new head unit turned up very loud, and you have the DSP system, disconnect the power and speaker leads and reconnect your original head unit directly to the vehicle harness (do not connect it through the speaker adaptor lead!). Turn the volume on the original head unit up a little further, then power off and repeat the fitting procedure.

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