AWARD ~ SESSION

- 2004 Marks Our 25th Anniversary Year -

Gear Talk... the stuff no one tells you

A plain talking guide, written by a qualified electronics technician with over thirty five years experience in the entertainment business, for musicians interested in their equipment. Learn the truth about the basic electronic and electro-mechanical parts which will help you make informed decisions about component up-grades and the equipment you buy in the future. Further, this guide sets out to dispel some of the fables and 'musicians folklore' surrounding many aspects of musical instruments and electronics.

Please feel free to distribute this guide amongst all your musician friends!

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Are valve amps louder than transistor for the same power rating? The short answer is no. Watts are a precise measurement and is exactly the same for valves or transistors. Valves do not have some 'mysterious' ability to alter the laws of physics... sadly for some romantics! But there are factors which can make transistor amps seem quieter. There are three main reasons to explain this:

Session's 15:30 valve amp from 1979 - a 'beautique' ahead of its time?

1. Valve amplifiers are usually fitted with premium grade speakers. As mentioned in 'Speaker Talk', these can make your amp much louder for the same input power to the speaker. Unfortunately, transistor amplifiers are not viewed with much esteem by the general guitar player or magazine writers. They are, by default, expected to be much cheaper than a valve equivalent. So the manufacturers of these amplifiers do not invest a lot of time and expertise at the design stage. Further, most of the expensive components used are cut down to the bone in order to achieve the 'expected' low price. Resultantly, as the speaker is the single most expensive component used in an amplifier, it becomes a cost cutting target! Therefore, and even though it may exhibit a 'famous name', it is not usually to the same high standard as the one fitted to a valve amp.

One way to cut down the cost of a speaker is to reduce the size of the magnet, as it is the most expensive component in the speaker. This also makes the amp lighter, which is great in helping to save freight costs if the amplifier is being shipped from some far away country. Freight is charged by weight.

Session's very successfull Rockette:30 - c1985

However, the down side to this is that the smaller magnet means that the speaker is bound to be less efficient, which results in the amp sounding a lot quieter on stage in a performing situation. But, in a shop or at home, it still seems very loud. This is deceptive and lots of guitarists (and reviewers) get caught out by this.
At the time of writing, some guitar speakers are coming onto the market using 'Neodymium' magnets - Celestion's G12 Century for example. This newish material enables very small magnets to be made which are much stronger than conventionally sized ceramic ones. These new magnets should therefore, not be confused with the traditional 'ceramic' type we are talking about above.

2. Transistor amps are able to deliver more power when you add an extension speaker cabinet. Whereas, valve amps have their speakers 'matched' to the output transformer, which means that the amplifier always delivers the maximum power into the speakers. As you know, when you connect an extension cabinet you usually have to select another impedance setting using a switch at the back of the valve amp.

Session's stereo 250W SG2100 combo - c1985

The often overlooked point here, is that guitarists do not realise that the power quoted by the manufacturer on the front of the transistor amp, is usually the maximum total power the amplifier is able to deliver when an extension cabinet is connected. This means that you should expect to derate the power of a 100 watt transistor amplifier to around 60/65 watts RMS when using just the internal speaker(s). This makes quite a difference and it is perfectly understandable why any guitarist might be surprised to find that a transistor amp which says 100 watts on the front does not seem as loud as a similarly rated valve amp... especially when it is likely to be fitted with one of those less efficient speakers as mentioned earlier!

3. There are, annoyingly, too many occasions where the manufacturer has mis-quoted the output power of an amplifier. It might be a bit strong to accuse them of lying... but they have certainly used some dubious measurement techniques to establish their power ratings. All too frequently, we come across well known British manufacturers who indulge in these tactics. For example, we regularly see examples of a popular mid-1990s 40 watt budget transistor amplifier come through our workshops for servicing, which I must say sounds really good, but the output power falls way short of that quoted at only 28 watts RMS. To my calculations this amp is overstated by over 40%. As it happens, the speaker sounds great, but has a rather small ceramic magnet. So, all-in-all, the amp is bound to be disappointing in the loudness stakes when used in anger in front of a drummer!

Fender have a power measurement statement on some of their schematics which is to be applauded. It says... "Output power 100 watts RMS into an 8 ohm resistive load, allowing for 5% THD at 1kH, at the rated AC input voltage." Because of this well worded statement, there is no chance of misunderstanding what the power actually is. It is the only way to measure the output power of any amplifier - period!

However, many manufacturers use an 8 ohm speaker as the load, which is where the ratings become a joke. A guitar speaker's impedance varies with frequency and is likely to be significantly higher than 8 ohms at 1kH and results in an overstated power specification. This is exactly the case with the 40 watt amp mentioned.

Why do amps seem to sound better when they're played loudly? Well, guitar speakers are designed to add harmonics to the tone when driven hard. This effect is caused by 'cone break-up modes', as it is called in technical terms. It adds harmonic tones to the sound which has the effect of making it seem warmer. This is particularly true of the premium grade speakers. The more budget types do too... but not to the same degree or quality.

Jan Ackermann - Focus, with his Sessionette:75. c1985

Another problem lies with your hearing and how the brain processes the sound coming into it. You 'perceive' the sound to be fuller and fatter at high volume. This is because your hearing widens its bandwidth as sound levels get louder - this is a long established 'psycho-acoustic' effect written about in great detail in acoustics law books. This seemingly defective response dates back to the days when we used to hunt for our food. Our hearing evolved to be extremely sensitive to sounds of rustling leaves and snapping twigs, and the like. It is still the same today. This is exactly the reason that telephone lines are not HiFi sounding. The early telephone engineers worked out that they could reduce their electricity demand and costs by making the lines equal to the most sensitive range of our hearing... and use less transmission power. Clever eh?

However, as the volume of sound increases our hearing becomes more equally sensitive to all frequencies. This is why your favourite CD sounds much better when played loudly. It is all just a trick of our brains and there is no way you can alter this. Guitar amps will always seem less exciting at lower volumes.

Unlike HiFi, guitar amplifiers are not designed to be perfect arbiters of the signal which is plugged into the input socket. Further, guitar amps have unintentional distortions created by the circuitry which enhances the overall sound. These are happy accidents which we designers call 'beneficial defects.'

We would like to point out that Session amplifiers are not designed like the other makes described in this article. We use only premium grade speakers able to maximise the acoustic sound volume. In addition, our powers quoted are true 'electronic engineers' ratings as stipulated by the Fender statement. Therefore, Session amplifiers are equally as loud as any similarly rated valve amplifier.

Sadly, the image of transistor amplifiers is marred by the cost cutting actions of a few of the bigger makers. We do not make valve amplifiers, so Session makes the best quality transistor amps possible. That's why Session amps are not as cheap as other 'apparently' similar products.

Why does the distortion on my amp sound fizzy? - This is a common complaint and is easily explained... but, perhaps, not so easily understood unless you have an appreciation of basic electronics and acoustic principles. Anyway, here goes and I hope I can make it clear!

A guitar's sound is made up of a 'fundamental' tone and superimposed on top of the fundamental are the harmonics. It is the harmonics which enable you to identify what type of guitar is being played... without looking at it (hopefully). It is also the way I could identify you voice from anyone else's.

The SG2100 stereo head and 2x12" diagonal cabs - 1985

So, all sounds have a fundamental and harmonics. It is the fundamental tone, a sine wave if the harmonics were to be removed, which dictates the pitch or note that is being played. For example, an open 'E' on the sixth string has a pitch of 82hz when tuned to concert pitch with an electronic tuner. 'A' played at the fifth fret on the first string has a fundamental frequency of 440hz, although, because of the rich harmonic content, many think the frequency is much higher.

Ok, so we all know that, as a very rough comparison, that Gibson guitars sound much mellower than Fenders when played with a clean tone. We can also probably relate to the fact that Gibsons, in general, produce a smoother distortion sound than Fenders do. It is probably the Les Paul guitar that is mostly associated with great sustaining and smooth overdriven tones... although today there are many other guitars which can do just as good a job. Extending this overview of the guitars even further, you'll perhaps agree that out and out distortion freaks tend to go for guitars like the Ibanez Jem series, which are ideal for that Steve Via/Joe Satriani genre of music.

Now lets think about why all those guitars perform in the ways that they do... and the most obvious thing that stands out to me is the differing intensity, relative to the fundamental frequency, of the harmonic content of all those instruments. The Gibsons tend to have far less high order (treble tones) harmonics in their signals coming out of the output jack. And, I don't know if you've tried playing a Jem with a clean tone, but I find they tend to be rather characterless and uninspiring for clean work. However, this is not meant as a criticism, but to help bring home a point. To my mind, the Jem excels at distortion because of it's extreme lack of harmonics. I liken them to a mother keyboard which produces no tone of its own, but purely serves to generate note information, allowing midi sound modules to add whatever sound you choose to. So, in effect, the Jem tells the amp what notes are being played, for how long and carries any vibrato information too... that's about it. The amp and effects take over from that point on and add all the tonal embellishments. Of, course all the other guitars can do it as well, but not quite with the same finesse.

Now, back to the fizz. If you take a Fender Stratocaster plugged into an amp set up with very high gain distortion and select the middle and neck pickup combination, you will probably find the amp sounds quite fizzy. Now, if you roll the guitar's tone control down to 1 (least treble) you'll here the distortion sound suddenly smoothen up. Eric Clapton calls this his 'Woman Tone' and can be heard with great effect on any of the old Cream albums... 'Spoonful' springs to mind in particular.

So what has happened to the Strat's tone? Well (this is for electronics bods), when you turn the tone control down, the capacitor forms a 'tuned circuit' with the inductance of the guitar pickup. Guitar pickups have huge inductances (around 4 Henrys) but a very low Q factor. This means that any tuned frequency band has quite a wide bandwidth. But narrow enough to have a significant affect on the guitars tone and resultant distortion sound. I'll now get to the point... the tone control has basically removed mostly all the upper harmonics from the guitar's sound - and it is this which removes the fizz from the distortion sound.

The upper harmonics (treble) content in guitars like Strats are very large in relation to the fundamental note, so when distorted they form lots of high frequency distorted waveforms which are triangular in shape. Now, you can take it from me, that high frequency triangular waveforms sound pretty obnoxious, and our hearing interprets them a 'shhhhh' noise (slewing). It is this which you can hear mixed in with the distortion and causes the fizzy edge to the tone. It is also worth noting that power amps with poor 'slew rates' can give rise to a lesser, but similar affect.

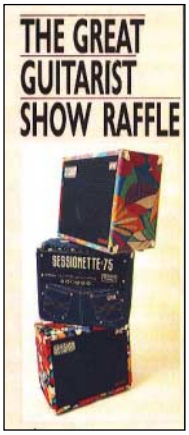
I suppose, because it might not be obvious to others, I should highlight that this is also why cheap copy guitars fitted with very 'tinny' sounding pickups make such a diabolical distortion sound.

So, please refrain from blaming your amp. It's your guitars causing the FIZZ! But, to be fair, some amps are able to cope with this better than others depending on how they've been designed. Some amp designers prefer mellow sounding amps with quite a small range of tone variation... like old 'vintage' amps for example. These amps seem to automatically reduce the treble in the guitar signal and, resultantly, produce a really pleasant distortion sound. At Session, we design our distortion circuitry with automatically variable frequency response. That means at high gains the amp reduces the upper harmonics in the signal before it is distorted, therefore, virtually eliminating this annoying affect. But at low gains the sound restores to it's former brighter tone. This is what valves do naturally when driven hard and it has to be said, that many of the leading makes of tranny amps do not take this into account in the design. Is it any wonder then, that many tranny amps sound so awful? A little more care and understanding could do much to improve their status in the guitar amp world. But then, those same famous makers rely on the power of their 'Names' and know they'll sell loads of amps anyway. Why bother when you can 'plant' a non-beneficial valve in an amp and know that the 'valve' tag will sell product?

SNIP-ETTE

It was around 1985 when we developed a new method of gluing covering cloth to our cabinets. It involved using paint spray guns to cover the back of the cloth and the outside of the cabinet with sprayable contact adhesive. This enabled us to use ANY kind of fabric - the picture shows three amps covered in domestic furnishing fabrics. We named them Miami Vice, Hill Street Blues and xxxxxxxxxx after the then popular TV 'cop' programs.

We auctioning them off at a GUITARIST show in London and the proceeds were donated to CHILDLINE.



Why, when I play two notes at the same time, do I get additional tones? When you play two notes simultaneously, you hear not only the two, individual notes, but also the sum and the difference. That means note pitch 1 plus note pitch 2 and note pitch 1 minus note pitch 2. This, in the audio engineering world, is called 'intermodulation distortion'.

A nice example of this intermodulation effect, is in warbling tone telephones. When the phone rings, two separate notes are generated, but at slightly different frequencies. The warbling is created by the two notes coming into and out of phase causing a tremolo (amplitude modulation) kind of effect. At the same time you can hear the sum and difference of the two notes - warbling (intermodulation distortion).

This effect is greatly heightened when guitar amp distortion is being used and can be capitalised on with wonderful tonal effect. Because, if you play one note whilst bending another upward, you can hear another note diving down in proportion to the bend. This has been used thousands of times by many rock and metal bands.

It is often attributed to valve distortion... but, sadly again I have to state the rule of sound, it is not exclusive to valve amps. It happens with ALL amplifiers whether valve, tranny, water, steam or electrically powered and is a perfectly natural occurring phenomenon. No one can alter this affect whatever they wish to claim. Period. End of topic!

Why do 1x12 combos have less 'spread' than 2 x 12s?

With single speakers the high frequency sound transmission off the cone is projected in a straight line to the back of the hall. Closed back cabs seem to make this even worse. Open back cabs allow a certain amount of the low frequency sound to radiate off the back of the speaker and sometimes is reflected by nearby walls behind the combo. This gives an increased illusion of a wider spread.

When you put two speakers side by side, it forms an acoustic lens and the sound is focused in an up and down direction. So if you are standing at say, typical mic' distance from the combo, you can hear your guitar sound more clearly. This, coupled with the rear reflections effects of open back cabs, leads to the perception of a bigger sound. Funnily, big 4 x 12 stacks sound very loud on stage, but the lens effect limits the distance the sound travels.

To use a simple analogy, you can compare the 1 x 12 to a garden hose

1984 - A 2 x 10" Sessionette:75 on a 2 x 12" cab. Also Stewart's 1963 Tele

Typical 1960s 4x12 PA speaker columns... could they come back into fashion?

set to a fine jet and the 4 x 12 to the same hose set to spray. In both cases the volume of water or sound is the same. It is only the dispersion which alters. This lens effect, is well understood by acoustics engineers and accounts for why many of the old PA systems used vertical 4 x 12 speaker columns - like the old WEM, Marshall and Selmer gear of the sixties and seventies. They spread the sound across the audience horizontally. They work exceptionally well... but are just not fashionable at the moment. Although the fidelity was not so hot because they usually were fitted with guitar speakers, which are totally inappropriate for PA systems.

I guess, one day, some bright spark will re-invent them - using decent PA speakers of course, and all the bands will trade in their trapezoidal systems to keep up with the fashions. Still, it keeps us engineers in work!

Do valve amplifiers really produce a compressed 'spongy' sound?

Yes they can do, but not all valve amplifiers do. So it is incorrect to assume that because an amp has valves in it, that it will automatically exhibit this characteristic.

The reason some amps compress is due to the power supply and the rectifiers which convert the incoming AC mains (line) voltages into the DC which the electronics in the amp needs to function. Some valve amplifiers have valve rectifiers, but most have solid state rectifier diodes. The valve amps that incorporate the latter DO NOT compress the signal. So that rules out about 95% of the popular valve amps on the market. If you particularly like the effect that this kind of compression brings, then you should ask your amp dealer if the amp you are trying has valve rectification.

Amps that compress in this way seem to be very loud when you initially play a clean loud sustained chord and then it soon sinks down into a mushy semi-distorted tone. Under these conditions, the rectifier valve is unable to deliver sufficient current (known as current limiting) to the power amp, so the voltage across the output valves severely drops to a level where the power is reduced and distortion creeps into the tone. When you stop playing, the power supply returns to its former levels, until you play another loud chord and the same effect repeats. The power supply needs just a fraction of a second to 're-charge', so you don't really notice anything happening.

Usually, it's only low powered amps that have valve rectification. Larger 50-100 watt amps have solid state diodes. This has been the case since about 1963, when higher powered amps first started to come onto the market and valve rectifiers were unable to be economically used, in what were then, just cheap guitar amps. Everything was down to the cost. But really it was an improvement, because everyone wanted loud un-distorted power back then. Remember, these amps were designed long before distortion was a desirable guitar sound. Classic amps like the Fender Twin Reverb, known for it's loud 'n' clean performance, owe their reputations largely to the fact that they have solid state rectification and two very efficient speakers with large magnets.

The classic Marshall 50 and 100 watt 'Super Lead' amps also are equipped with solid state rectification. It was really only the low powered amps up to the 30 watt 'Bluesbreaker' types that had valve rectifiers. VOX AC30s employ (and still do) valve rectifiers, as did the Selmer 'Treble 'n' Bass 50', Zodiac 30 Twin and Thunderbird 50 combo amps - using the famous GZ34 on an octal base, but 50 watts is right on the limits of its current capabilities at 250mA.

Some say that this is exclusive to valve amps, but again, that's not strictly true. Tranny amps behave pretty much in the same way as a valve amp with solid state diodes. However, it is possible to build a solid state power supply for an amp which has intentional, and even adjustable, current limiting. So it would be quite possible to surpass the effects caused by a valve rectifier! Just how useful this would be is another question... but it is easily possible. It's worth saying though, that I have never seen a tranny amp made this way. That's probably due to the fact that it would make it much more expensive and... tranny amps are expected to be cheap. If player's prejudices were reversed at some time... then I'm sure a brilliant tranny amp could be designed that would be a top selling product! A classic in time even?

What's the difference between high and low impedance?

High impedance signals, like guitars for example, cannot drive their signals for a long distance and are easily affected by stray interferrances. They are weak. Low impedance signals, on the other hand, are strong and can transmit over a very long cable without too much signal degradation.

Sometime musicians try to plug high impedance instruments into amplifiers with only low impedance inputs. The results are usually, low signal levels and poor tonal qualities. Bass and treble are often seriously reduced. This is particularly the case with piezo transducers. In the early days of piezo pickups for acoustic guitars, musicians used to plug them directly into the PA amps and the resulting tone was diabolical. Hard and very unnatural. Sadly, for the first popular guitars with passive piezo transducers fitted inside during the 1970s, this became referred to as the 'Ovation' sound. Of course, it was not the fault of Ovation, it was due to the fact that musicians did not understand that a matching pre-amp was required to get the best tone. And, be be honest, no one told them that either. Anyway, most come with some sort of pre-amp built in already, so the problem has largely disappeared now.

So why was this? An analogy might be appropriate at this point. A high Z (impedance) signal being plugged into a low Z amp input can be compared to a thin and weak man trying to pedal an exercise bicycle with maximum resistance applied to the driven wheel. Whereas, a low impedance signal being plugged into a low impedance input is matched and the tone is not impaired. It's like a chunky strong man riding the exercise bicycle - he has all the strength needed to turn the wheel with maximum resistance applied.

Ok, if you've understood that, then you might be thinking... "What if I plug a low impedance signal, from say a microphone, into a high impedance amp input?" Well, that would be OK, because the high impedance input needs very little power to 'drive' it. As a rule of thumb, Low Z signals will run into High and Low Z inputs, but High Z signals will not work into Low Z inputs.

Generally speaking, the following are examples of typical impedances that can be expected with different kinds of gear inputs/outputs:

Low Impedance
Pro Mics - 200/600 ohms.
Balanced Line Inputs/Outputs - 600 ohms
Professional Mic Pre-amp Balanced Outputs - 600 ohms

Medium Impedance
High Z Mics - 47,000/100,000 ohms (47-100k)
Effects Send/Returns - about 10,000 ohms (10k)
Mixing Desk Line In - 10,000 ohms (10k)

High Impedance
Guitar Amp Inputs - 1,000,000 ohms (1m)
Bass Guitar Amps - 1,000,000 ohms (1m)

Ultra High Impedance
Acoustic Guitar Piezo Amps - 10,000,000 ohms (10m)

DI Boxes

Whilst DI boxes are generally recommended for matching high and medium Z signals to amps with low Z inputs, most are not good enough to work well with the piezo transducers usually fitted to electro-acoustic guitars. Most DI boxes only cover impedances up to 1,000,000 ohms (1m), which is far too low for piezo transducers. From the chart above, you can see clearly that 10,000,000 ohms (10m) is required. So, if you have a valuable 1937 Martin 0018, you won't want to build in a matching pre-amp. In which case you will need to buy an external pre-amp specially made for such situations - such as our own AP10 for example, which has a 10m input Z and a very low output Z to drive long cables. Both XLR and jack outputs are provided, with equal signal quality and can be used simultaneously. The AP10 is the one

used by Gordon Giltrap (formerly called the GG10).

If my acoustic has a pre-amp fitted, do I need a DI box?

Not really, because the pre-amp already has a low output Z that will match the low input Z of the amp's input. However, there are certain times that you might want to 'isolate' your instrument from the amplifier's circuitry. This can be for all kinds of safety reasons which are too wide for inclusion here. But basically, if the amplifier develops a fault, it can transmit the problem into your instrument and cause your instrument to become 'live' with high DC voltages. A DI box with an isolating transformer built into it will prevent the DC reaching your guitar and possibly killing you if you touch anything that is metal and grounded/earthed.

As most modern amplification systems are solid state and run on low level DC voltages, there is very little chance of this becoming a problem. But be careful, some 'valve loaded' mic and acoustic 'fashion' pre-amps are coming onto the market which could develop this kind of fault. So, always ask the PA man if you are not sure.

How does PAT testing affect me?

PAT stands for 'portable appliance testing'. A 'portable appliance' relates to any mains powered appliance which you use in the course of performing. Guitar amps, PA amps, Bass amps, keyboards, power supplies, lighting, mains extension boards.... you name it, even the drummers fan, it's got to be tested at least once a year if you are using it in a public place - **BY LAW!** And, you must have a log book which shows a list of ALL your equipment, the date it was tested and the test results. It's like an MOT for your gear!

What does it entail? PAT testing is done by a small automatic testing appliance which checks that your equipment is properly earthed (Earth Bond Test), performs an insulation test on the mains transformer and checks that the mains fuse is OK. All of these tests a vital to maintaining a good safe environment on stage or in the studio. We've all heard the stories where musicians have been 'spot welded' to microphone stands or even killed by electric shock. These tests would most likely have picked up any problems and saved their lives!

What happens if I don't have it tested. Firstly, you could arrive at a gig and the organiser might ask to see your log books. If you have not got any, then it is most likely that you will be **SENT HOME** without playing and **NO PAY!** Many local authority owned venues are very strict on this.

Let's say someone is hurt or killed by your equipment which has not been tested. You would face a serious criminal charge. You would almost certainly be sued. It could be that your insurance company, if you have one, will refuse to pay out on any public liability claims made upon you! In which case, the plaintiff will force you to sell your home and any other items of value to pay his claim for compensation if awarded.

If you have not already had your equipment tested, do so right away before it's too late.

Why don't manufacturers not fit longer mains cables?

The don't really have any choice. Eight feet is the accepted safe length by most European safety standards. If you want a longer mains cable, then you must use a mains extension board.

Where's the mains fuse?

Often, customer can't find the amps mains fuse. They always think the only fuse there is is in the mains plug!

Most modern products use an **IEC** cable and connector - musicians call it a 'kettle' lead, although it won't actually fit a kettle! The IEC mains connector mounted on the equipment has a small draw under where the mains lead plugs in. A picture of a fuse is embossed onto it it. You can prize it open with a screwdriver, and the fuse will come out with the draw. It is quite stiff so be firm with it.

Always fit the correct type of fuse. Usually, the fuse is a 20x5mm style. There are two types available. **Quick Blow** which is type **'F'** (for **fast** acting) and a slow blow type **'T'** (for **time lag**). It is **VERY** important to use the correct type. Mostly, mains fuses are type 'T'. If you fit a type 'F', then you could find that the fuse will blow as soon as you turn on the equipment. This is due to current surge when you switch on, which the fuse cannot withstand.

Fuses are labelled: F1A, F2A or T1A, T2A... and so on. Check your manual for correct value.

Fuses can also blow for no reason when they get old or tired, as they take quite a hammering!

Always use an RCD on your mains supply!

An RCD is a cheap way of protecting yourself and the rest of the band from a potentially fatal incident should one of the mains powered items you use on stage develops an electrical fault which causes it to become live with 230VAC main s voltages.

The RCD can detect 'residual' current flowing to earth/ground and disconnects the mains supply almost instantly. So, you might feel an electric shock, but the mains is turned off before it has a chance to hurt of kill you.

You can get a 'plug-in' RCD a few pounds at any branch of Homebase or B&Q, or look in Yellow Pages under 'Electrical Supplies Wholesaler'. **It might be the best investment you ever make.**

Distortion Talk - For Guitar Players

Distortion comes in many forms and all sound different to each other. But in order to understand what you are hearing, you must know what an un-distorted and totally distorted sound looks like displayed on an oscilloscope.

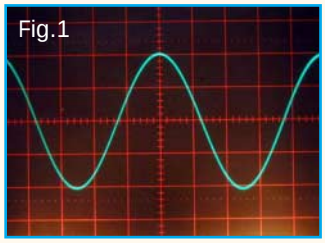
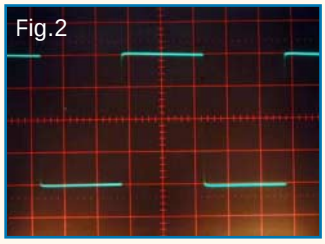


Fig.1 left, shows a pure tone. This is a sine wave, and is the purest sound known to man. A sine wave represents natural movement... like, if you had a pencil attached to a swinging pendulum and moved a piece of paper in it's path, then it would draw a sine wave shape on the paper.

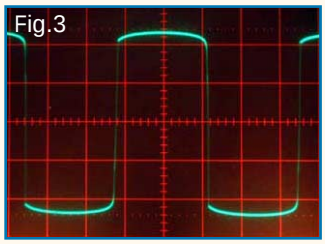


In Fig.2, there is a very nasty sound lurking... the square wave! As you can probably imagine from it's appearance, it sounds sharp and buzzy... a bit like a chain saw tearing through a sheet of corrugated steal. Not at all musical. So distortion has to fit within these two extremes.

The first thing we have to do is identify where, mainly, the different distortions are created. An amplifier is split up into 'stages'. These are the pre-amp, the phase splitter stage of a valve amp, the power output stage and the power supply. Then of course, there's the speaker and cabinet. Although for this topic's simplicity we can ignore these.

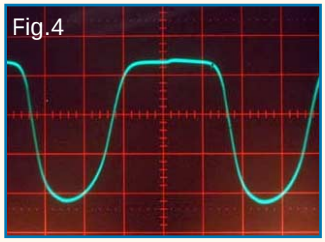
Ok, so distortion comes in two basic types. Symmetrical, where both the upper and lower 'peaks' are flattened at the same level and, asymmetrical where both peaks are flattened at different levels.

Symmetrical distortion is found in both Class AB and B power stages. Because of the way these power amps work, the distortion is nearly always symmetrical unless, in the case of a valve amp, one of the power valves is seriously run down with respect to the others. Class AB and B applies equally to both valve and transistor amplifiers... as does Class A. So these terms are not applied exclusively to valve amplifiers. Symmetrical distortion is usually found in tranny amplifier preamps and also some valve amps which use solid state diodes to create the distortion... many Marshall valve amps employ this technique. Fig. 3 shows the wavform taken from a Fender Duluxe 85. This kind of harsh distortion is fine for really heavy saturated sounds. But, for blues and the like, it is not very subtle and displays a tendency to suddenly change from clean to distorted. For bluesy tones, asymmetrical distortion is a must.



Because the two peaks of an asymmetrical waveform do not clip at the same levels, the sound appears to have a far wider transition from clean to overdrive. Of course, how flat or how rounded these 'clipped' peaks are affects the sound too. The flatter the clipped signal, the more buzzy it sounds. Whereas, the more rounded clipped peaks sound very much softer. However, there is a point where the peaks can be too rounded, which results in the signal not sounding very distorted at all. So, you have to find a balance and that may be different for every guitarist depending on the kind of music he plays.

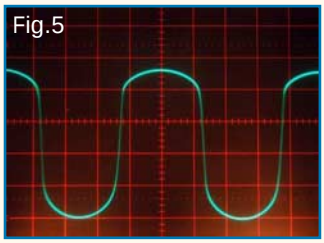
Another benefit of asymmetrical distortion is, it's distortion is richer in second harmonics - it adds a tone one octave higher in pitch than the note you are playing. It is said that valve amps always do this, but that's not strictly correct. It only happens in certain types of valve amps where the distortion is made to be asymmetric as described.



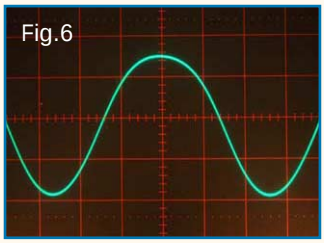
Solid state amplifiers can create symmetrical and asymmetrical distortion too - including the second harmonics. However, most tranny amps over the years have been designed for cheapness and, generally, no real special effort has been made to make them sound better.

Fig. 4 shows typical asymmetrical distortion made by the valve distortion circuitry of a, mainly tranny, MusicMan RD50-110, similar to the one used by Eric Clapton on occasions. This produces a 'grumbly' kind of sound which is great for blues and on-the-edge slide playing.

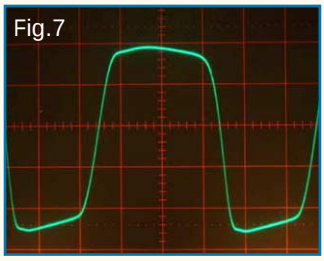
This kind of distortion is never created by power output stages **unless** it is a true single ended (one power valve) Class A amp. Class AB, B or any other configuration **can't** do it - only Class A. That means hardly any Marshalls, Fenders, Voxes - unless they are low powered (around 6watts) Class A as shown in Fig. 6 & 7.



In Fig. 5, the asymmetrical distortion is made by a Session Sessionette HiFlex 140 in the pre-amp. Session amps are renowned for their valvey sounds and loudness. You will probably notice that the peaks are more rounded than those of the valve distortion shown in Fig. 4. Contrary to popular belief, this all tranny amp has a very much softer distortion sound than its valve counterpart.



The Fender Champ is a popular recording amp, so we have included, in Fig. 6 & 7, photos of what the output stage distortion looks like. Fig. 6 is the amp just breaking into audible distortion and Fig. 7 is when the Class A biased single 6L6GC output valve is driven hard into heavy distortion. The rather square peaks are not what you'd really expect, when you take into account what is said about valve distortion... but there it is - in glorious colour. A quite brittle sound in my opinion. However, the speaker is not particularly bright, so a certain amount of brightness is taken off the tone by it.



There are other aspects which can affect the final choice of the amplifier you buy. You should remember that some amps have their EQ controls before (pre) the distortion circuitry and other more modern ones have the EQ after (post) the distortion. The latter produces a much more aggressive character to the distorted sound and may not suite certain kinds of players. These will be great for heavy rock... but not so kind for the bluesy players. Many of the older amps are pre distortion types. Most Marshalls up to the JCM800 series were and account for their 'vintage' tone status. Also many of the Boogies are too, although some have post distortion EQ in the form of a simple passive graphic EQ as well.

An especially nice feature of pre overdrive EQ is it's ability to enable you to add treble or bass before the signal is distorted. This means you can make the high notes sing and keep the low notes fairly clean... a la Roy Buchanan. All of the old style 'tweed' amps that create the distortion in the power stage obviously have pre distortion EQ. The much favoured, and soon to return, updated 1980s Sessionette:75 was designed with pre distortion EQ, but had a post distortion tone control too. So you had the best of both worlds.

However, there are two serious drawbacks of pre distortion EQ. Firstly, with ultra high gain applied, the EQ controls appear to have little or no effect on the tone. This is because their limited range is over powered by the phenomenal gain of the distortion circuitry. Sadly, there is nothing that can be done to remedy this. You just have to live with it. Secondly, if you have a bass-heavy tone from the pre distortion EQ, then it makes the guitar tone seem as if there are very few upper harmonics in the sound. This is because the higher order harmonic information (treble) which 'sits' on top of the low frequency waveform is cut off and lost by the distortion circuitry. Again this is not able to be fixed, but you could turn down the bass pre-distortion and use a graphic equaliser inserted into the amps FX loop to pump up the bass post distortion, if you want a fatter distorted tone. Modern Session amps have this circuitry already built into them and operate full-time.

AWARD-SESSION Cable Talk - For Guitar Players

Instrument leads look similar and it's easy to become confused as which to buy, so here's some guidelines from an electronics engineers point of view, based on accepted technical facts.

What does 'low loss' mean? - It is important to understand that all screened cables reduce the high frequencies that pass along them. The longer the cable, the more the loss. This is true of ANY make or type of screened cable. Always select 'low loss' cables for best performance when using guitars or other similar instruments.

A good guitar cable will have an inter-conductor capacitance of 130pf (pico farads) or less per metre. 6 metres is about the maximum length for a lead used with passive guitar pickups. With passive electro-acoustic guitar transducers you will need to keep guitar leads to an absolute minimum length, otherwise treble will become heavily lost! Always fit a pre-amp to your electro-acoustic if you can. If your guitar already has a pre-amp, then you can use leads as long as you like without any problems or loss of tone.

Can cables make my sound more 'juicy'? - No, cables cannot do this! The signal passing along a cable cannot be improved, no matter what it's made from. Any such suggestion should be viewed as a dishonest claim.

What does 'noiseless' mean? - Some low cost cables, when used with guitars, can cause a crackling sound when you move about. Noiseless cables have a special conductive plastic layer inserted between the signal conductor and the screening braid which removes this source of unwanted noise.

Should I buy leads with gold plated plugs? - Don't waste your money on 'hyped' imported cables with gold plated connectors. The thin soft gold (5-10 microns) 'flash' plating looks cool, but scrapes off easily and the brass material underneath stops you from seeing that the gold has worn off! The brass eventually tarnishes and causes crackling when the plug moves or twists in the socket contacts.

The input socket inside your guitar amplifier is not usually gold either. Gold is a very good conductor of electricity, but only when mated with a gold plated socket.

Are 'moulded' jack plugs better? - In some respects, but cables usually break just outside the plug where the cable gets bent a lot. So, if this happens, you cant open the plug to repair it and you'll have to throw it away.

Do I need special speaker cables? - Yes, using instrument cables for connecting speakers is not recommended. Very high currents pass along speaker cables, so you need much thicker wire to handle it. Guitar lead conductors are very thin and such use could result in damage to your cables. Power reaching the speakers may be reduced as well. Don't be tight... buy what's right!

As with anything, common sense rules... so try not to be fooled by marketing hype, glossy adverts or music business mythology.

Tip.... "A good cable does **nothing** to your tone"

We only use the robust Neutrik range of connectors favoured by the worlds top studios and touring bands... but, watch out for inferior copies!

Just a few of the different cables and conversion leads available from Award-Session

Tranny Amps – Do They Deserve The Slaggings?

As an Aquarian, I like change. Having an analytical mind means I'm suspicious of unproven generally accepted beliefs. Whilst I am a musician and engineer who grew up using valves, valve amp folklore has no place in my world. I'm a realist who listens with his ears... not his eyes! Solid state fits nicely with my expectations from equipment... great tone, features that work well, reliability and low running costs. So why does the music biz in general hold trannies in such low esteem?

There are many reasons, some true others not. So, we need to go back to the beginning of transistors to find the main reason. Back in the late 1950s transistors became commercially viable and later thought of as the way forward to provide musicians with greater performance and, mainly, lower cost products. Sadly, they were not yet ready for use in guitar amps, primarily because it was very difficult to design circuitry with a high input impedance, which electric guitars need – valves provide this naturally. Their low impedance at the input for example, made electric guitars sound hard and the volume died away quickly when you turned the guitar's volume down – plugging into a PA amp produces the same effect. There were other drawbacks, far too complicated to explain here, which made it a cumbersome technology with serious limitations at that time.

The credit for the success or failure of any amplifier's ability to please guitarists can only go to the designers, not the technology.

As if that wasn't bad enough, many designers of the day understood little about electric guitars, a situation which has been true until fairly recently. But under pressure from marketing personnel and accountants for cheaper and more easily made products, 'big company' designers would have been powerless to compensate for those limitations within the budgets afforded. This resulted in a proliferation of horrible sounding amps that, unfortunately, earned solid state a bad reputation from the outset. Even now, some fifty years later, musicians still hold the same prejudices. I can understand that to a certain extent... so many of those bad tranny amps were sold by household names that, one would expect, ought to have known better. This remained the case until the early 1980s. Yet today, much has changed. Solid state now offers so much flexibility and the chance to design circuitry with levels of performance, which valves can only dream of. These changes came with the introduction of 'linear' integrated circuits (ICs). The most well known being the TL071 family and is still the backbone of many modern guitar amps. I realised then that they were a serious threat to valves, so I immediately switched to designing solid state amps. The first was called the Sessionette:75 guitar amp, which went on sale in April 1981 and achieved sales of 55,000 plus amps over its lifetime. Session was first company to make trannies respectable and more top players used them than you could shake a stick at. The solid state amps around today owe a lot to that amp's design.

The tranny madman aged 16 with his Burns Artiste - 1963

Solid state is a good reliable technology which can easily out-perform valves. Maybe, in some amp designs this is part of the problem, leaving a cold sterile tone. However, with a little more design care the tone can be warmed. It may not be a big surprise to learn that many valve amp designers are not so hot when it comes to solid state design, so naturally they do tend to put solid state down. Valve amplifiers exhibit all kinds of 'beneficial defects', which are largely overlooked when designing a solid state amp. Only a complete understanding of both valve and solid state design enables them to be incorporated into solid state amps. Never-the-less, a myriad of 'mediocre' tranny amps still find their way onto the market whose performance does more to perpetuate the poor image of solid state than raise it. Laughable as it may seem, these 'iffy' tranny amps sell well for no other reasons than cheapness, the power of their badge and that they are easily available in the shops. All the wrong reasons.

It isn't unusual for a player to dislike the sound of any particular amp. But if it's solid state the reason given by default is... "Because it's a 'tranny' amp!" That's crazy. I've plugged into hundreds of valve or tranny amps that I didn't like, but I would never blame the technology! Often it's simply because the designer designed them to sound that way - someone else will love them. We must accept that and try others until finally, we find one we like – whether valve or tranny.

How do you know what's the truth about amps? I mean, if valves make a unique kind of distortion, why has one amp maker used solid state distortion in their 'supposedly' valve amps for the last fifteen years? What about the 'Class A' AC30 valve amps that are really AB1 push-pull? What's the reasoning behind 'point-to-point' wiring and military spec components when they cannot improve the tone? And the poor quality of today's valves? Why pay for all that and then plug in a tranny distortion pedal? Does it all really matter... isn't it the sound that's important? Is all this 'mojo' not really an insult to you and the reviewers who love their '(solid state) hot-bottled' tone?
We constantly hear all sorts of weird ideas why valves are best... but never with any supporting evidence to back the claims. Because they 'believe' it and speak with a low slung John Wayne voice, it must be true? Nothing is done to move amplifier design forward. Technology alone is not the reason for the sounds you hear. It needs the intervention of a creative person with the specialist knowledge to make good use of the benefits it brings. It's where science meets art. Without the human input, technology is like a computer with no software... useless. For example, my 1981 Sessionette, 1997 Sessionette, RetroTone, AceTone and Stockton amplifier designs all use the same technology. So explain why they all sound different? The answer is easy... I designed them to sound different to each other. The technology is merely the bricks and mortar - the paints and canvas, nothing more. When you buy an amp, you invest in the designer's knowledge and quality of sound that his knowledge brings. The credit for the success or failure of any amplifier's ability to please guitarists can only go to the designers, not the technology.

I say transistors are not the ugly beasts that destroy the sound of guitar. You just haven't tried the right amps yet. So, when you next visit your music store, ignore the badges and technology and audition each amp with an open mind. Choose on the basis of sound quality. And if that turns out to be a valve amp... I won't get upset. Neither any other manufacturer nor I will ever please every guitarist. But, there'll be plenty that we will please. Just remember though, that the sound you hear from a tranny amp today, will be the same as the sound it makes in thirty years time! Solid state does not ware out or run down. And if designed to run cool, will last forever!

Keep music fun... whatever!

This was an article written for Guitarist magazine which appeared in 2001.

The 2004 Re-issue Sessionette:75

Convert a Strat into a Jazzmaster sound-a-like!

Here's a nifty little project which was instigated by someone on the uk.music.guitar newsgroup wishing he could find a nice cheap Fender Jazzmaster.

I imagine the Jazzmaster would be a nice guitar to own, but not if it means a serious investment to own one. So, I said to the guy... "Why not buy a cheap Squier and convert it?" Well anyone would think I'd suggested he should sell his mother. Everyone on the group unanimously said "You can't do that. It'll never work. What about the special pickups and bridge? Neah, it just can't be done!"

"OK", I said. "Look at it this way. Most of the Fender guitars are made of roughly the same materials, including the Jazzmaster. The pickups do look quite different, but they're not really that much different. I accept the bridge is very not the same and will reduce the sustain, but isn't it worth a try even if you get just 85% of the tone?"

You may not realise this, but it is where the pickups are under the strings which is responsible for most of the tonal differences between the various Fender models. If this were not the case... why are many guitars fitted with more than one pickup and at different locations? In order to experiment yourself with the pickup measurements, and to get a standard result, you have to measure this to the exact centre line of the PU magnets, using the 12the fret as a datum point.

For example, the neck PU on a Telecaster is 165mm from the 12th fret. On a Strat, the neck PU is located at 168mm. That 3mm is enough to make a significant tonal difference. Most players can tell the the difference between those two guitars. Sadly, the simple act of putting a Strat pickup on a Telecaster, or vice versa, makes no significant difference to the sound.

Looking now at the bridge pickup, the Tele has a much more accute angle than the Strat... so that would largely account for the sound being a lot more 'twangy' on a Telecaster, although the treble strings are a lot more piercing than a Strat. Of course, the bridge pickup on a Jazzmaster is straight across the strings at a 90° angle.

So, gave it a lot of though and got to the point that I really fancied having a go to see what the outcome would be like. I managed to picked up a used but good condition Olympic white Chinese Strat for around £50. It had a white scratch plate which I thought looked a bit naff. Anyway, Olympic white Jazzmasters traditionally have tortoise shell pick guards. So I bought a blank sheet from WD Products and used the old scratch plate as a template for the outline of the new one. Then, I borrowed a 1964 Jazzmaster from a friend and measured the distance of the pickup poles from the 12th fret. With the new scratch plate attached to the Strat's body with masking tape, I marked the plate with the positions of the Jazzmaster pickups, but using the original Strat ones instead. As for the middle PU, I just put that in it's original location. So, the idea was a Jazzmaster sound with an extra middle PU.

The worst part of the job was cutting out the PU holes. But I had used a PU cover to mark the outline. I had to carfully cut the hole using my electric jigsaw and then finish them off with a round file. It worked out fin, as you can probably see from the photo. I was dead chuffed. After installing some decent vintage Strat PUs, I put the guitar back together and put on a nice set of 10-46thou DR strings... my fav's.

AWARD-SESSION Speaker Talk - For Guitar Players

Can changing my amp's speaker make it louder? - Yes. The speakers in your amp probably 'look' adequate and most amps usually seem loud enough... until you meet the drummer on stage! This is because many amp makers cut costs by fitting inefficient speakers.

Fig.1

A speaker's loudness is measure in decibels (dB) and is quoted as Sound Pressure Level (SPL). The higher the SPL figure, the louder the acoustic output will be for the same power input to the speaker. To buy an amplifier on the basis of watts alone is not a very good indicator of volume.

Fig.2

This important measurement is related to the magnet strength. Budget speakers often have an SPL of 93 to 95dB (Seventy-80 - Fig. 3), many are 97dB and really good ones are 100/103 dB. The difference between the numbers is only small, but each 3dB step up is like doubling your amplifiers power. That means a 50 watt amplifier fitted with a 100dB speaker (Vintage 30 - Fig.2) will produce the same acoustic sound output as putting 100 watts of power into a 97dB speaker. Taking this further, if you fit a 103dB speaker (Celestion G12-Century - Fig. 4) into the same amp, it will be like quadrupling the amps power... the equivalent of 400 watts into the 97 dB speaker.

Fig.3

Fig.4

So, if you have an amplifier which you really like, but it's just not loud enough, it would make good economic sense to replace the speaker with one which is more efficient. It's far less expensive than buying a whole new amplifier. As a very rough guide, select a speaker with the biggest diameter and thickness magnet you can find or afford.

Can I change the tone of my amp? Of course. You can experiment with different types. There are many classic and modern models to choose from, providing opportunities for you to develop your own unique sound; important in todays competitive music world.

It's baffling why gutarists spend fortunes on changing their guitar pickups and don't think to change their amp's speaker. Guitar speakers are designed to add rich harmonics to the tone. Pickups cannot do this, so a simple £40-50, ten minute speaker change can bring dramatic and really rewarding results! Celestion's quality is demanded by top amp makers the world over. Their premium grade Classic speakers are certainly more efficient than many 'stock' speakers fitted in budget amps! They can double the volume of the average practice combo and improve tone as well.

If you've ever wondered why old Vox AC15s and AC30s are so loud, it's because of their Celestion Blue speakers, which have an SPL of 100 dB. Surely, Celestion should be credited... not the fabled 'valve power' as claimed?

Is there any advantage to using multiples of speakers? - Yes. Multiple of speakers means a large cabinet - means more bass. This is interpreted by the human ear/brain as more volume. Although not really the case. We are always surprised at the number of guitarists who do not relate the cab size to the tone they hear! A big cab makes a BIG difference... so don't expect a 1x12" combo to sound like a 4x12".

But, more importantly, speakers are **not** linear in their reproduction. As you put more power into the speaker, it's suspension which holds the cone in place, tries to pull the cone back the opposite way to which it's being driven. The further the cone moves back or forth, it feels an increasing amount of opposite resistance from the suspension.

So 100 watts into a single 100 watt speaker mounted in a typical 1x12" cab will not be as loud as the same 100 watts into a bigger 4x12" cab fitted with four of the same spec' speakers. This is because the power is shared between the speakers, and the suspension does not affect the cone movement as much. Therefore, the acoustic output is likely to be much greater. This greatly improves the dynamics of the sound too, as the speaker still has plenty of free movement left unused... not so the 1x12" cab, the speaker is rattling between the end stops almost!

By the sheer size of valve amps, their cabinets are much bigger than tranny amps. Popular vintage style valve amps have multiples of speakers, generally. So, perhaps, now you can begin to see why valve amps sound louder and have greater dynamics. It's actually **nothing** to do with the valves at all. Apply this to a tranny amp and the end results are the same. Mick Ralphs (Bad Company) used one of our Sessionette:75s into two Marshall 4x12" (GreenBacks) cabs on stage, and boy, you wanna hear that tone... nothing like the amp on its own.

This is all common sense really. And just goes to show how many of the 'glib' claims are so misleading. To judge the loudness of a range of 100 watt amps, you must plug them into the **same** cab to compare them, otherwise it's meaningless and a waste of time. You can't just say that a 50 watt 4X12" Marshall is louder than a Session 50 Watt 1x12" just because the Marshall is valve! That's rubbish in extreme! There are just too many variables to take into account.

This 'loudness' thing would be understood better if players started to take more interest in the speakers fitted and attempt to understand that they are **not** all the same. It is vitally important to read between the lines on performance claims.

As an example, take the Marshall MG50DFX "Now you have a choice" advert recently in most mags. It says it is 50 watts... but what kind, peak music power or RMS into a resistive load? That statement is unqualified and meaningless! It says it has a Celestion speaker... so what. What is the efficiency in 'dB SPL'. Does it have a tiny magnet or a whopping great one to turn that power into LOUD guitar tones?

Fig.5

Being totally obsurd here, any maker could ship a 100 watt RMS amplifier **without** any speakers fitted at all... but the amp is still a 100 watt amp. OK, so it will not be very loud, but the statement is still true. It **is** a 100 watt amp. Cheap amps cut serious costs by fitting speakers that sound loud at home or at the shop... but, **not** that loud on stage though.

Fitting a Celestion G12-Century (103dB SPL) to the MG50DFX makes good economic sense. But factory fitted, the amp's price would rocket from £249 RRP to around £380... that's a huge difference. The speaker to buy and retrofit is £89 (£79 discounted). Fitting a better speaker at the manufacturing stage bumps up the amp's cost by much more than the RRP of the speaker at a shop.

DIY Guitar Extension Cabinet Designs

Build yourself a very respectable 1x12", 2x10" OR 2x12"speaker cab'

Award-Session has designed the following cabinet variants as if they were for a product which we were offering for sale ourselves. Using the plans provided and some basic woodworking skills, there is no reason why you can't make them to the same standards as Marshall or anyone else. After all... the speakers you will buy are just the same, so will sound just as good too.

We can supply a kit of speakers, metal corners, feet, handles and the jack plate complete with wiring to connect up your chosen speaker(s). All you have to do is make the woodwork and cover it.

You can get B&Q or Homebase to cut the panels to size from a sheet of chipboard, ply or MDF - whichever you choose as long as it is 18mm material thickness.

Choose from the designs on the following pages.

We hope you find this guide useful and hope to hear from you one day.

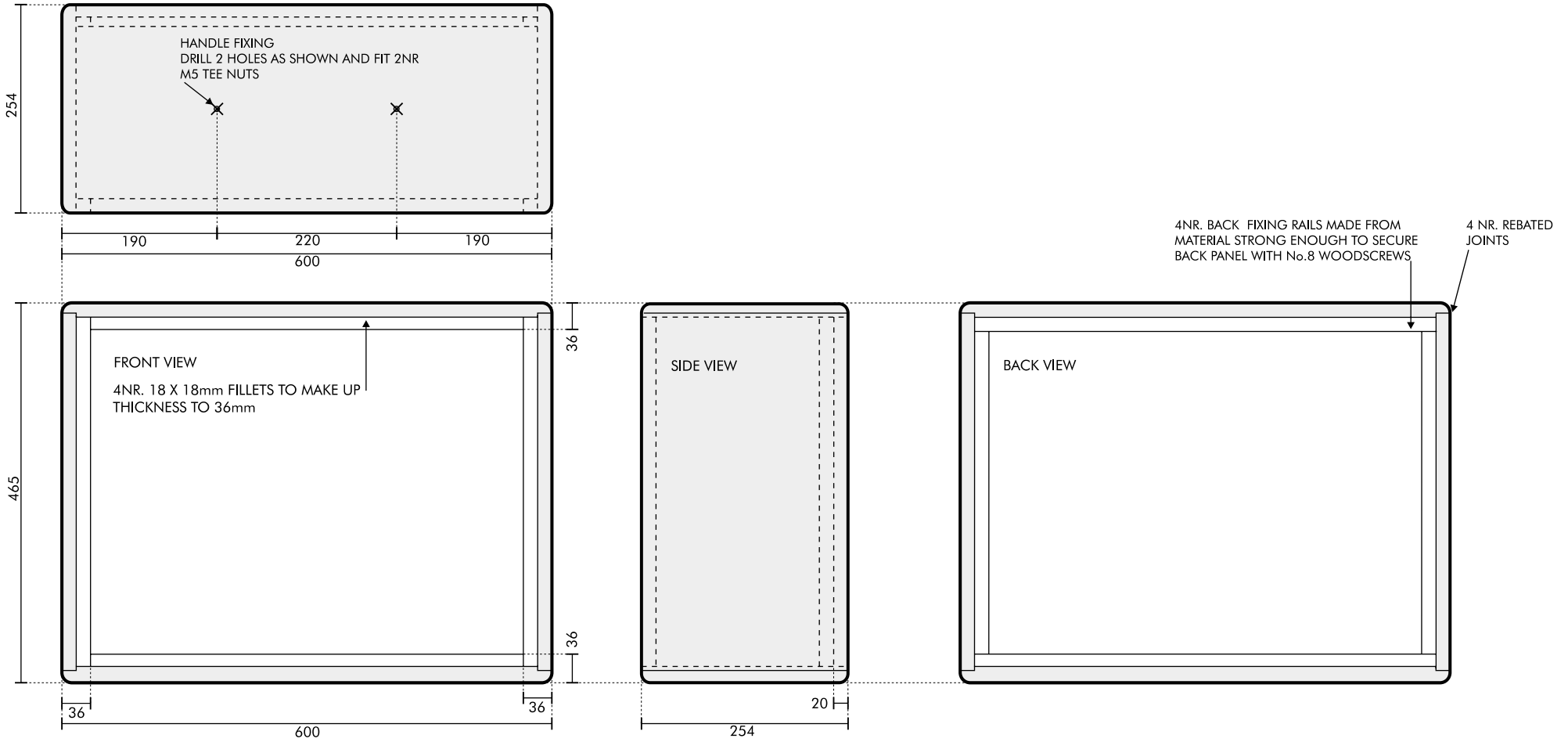
Warning

Award-Session will not accept any responsibility for the accuracy of the information supplied. It is the responsibility of the person using these drawing to ensure that they are suitable for the application intended. The use of these cabinets for 'disco' use is not recommended.

Health & Safety: Seek the advice of a professional if you are not a trained wood machinist. Observe all Health & Safety issues and ware adequate protective clothing. Do not use certain types of glues in confined places. Always read the instructions and follow the manufacturers advice. Make sure proper guards are fitted to circular saws or any other woodcutting machinery. Always use common sense and respect the ethic contained in this message.

DRG: E112A - PAGE 1 OF 2

NOTES
1. CONSTRUCT CARCASE FROM 18mm MDF.
2. MOUNTING RAILS CONSTRUCTED FROM 18 X 18mm MATERIAL.
3. CARCASE JOINTS TO BE MADE WITH 3mm REBATES
4. ALL CORNERS FINISHED TO 12mm RADIUS.



DO NOT SCALE

AWARD-SESSION, BASINGSTOKE, ENGLAND
TEL: 01256 477 222 - FAX: 01256 817 687

EXTENSION 1 X12" SPEAKER CABINET
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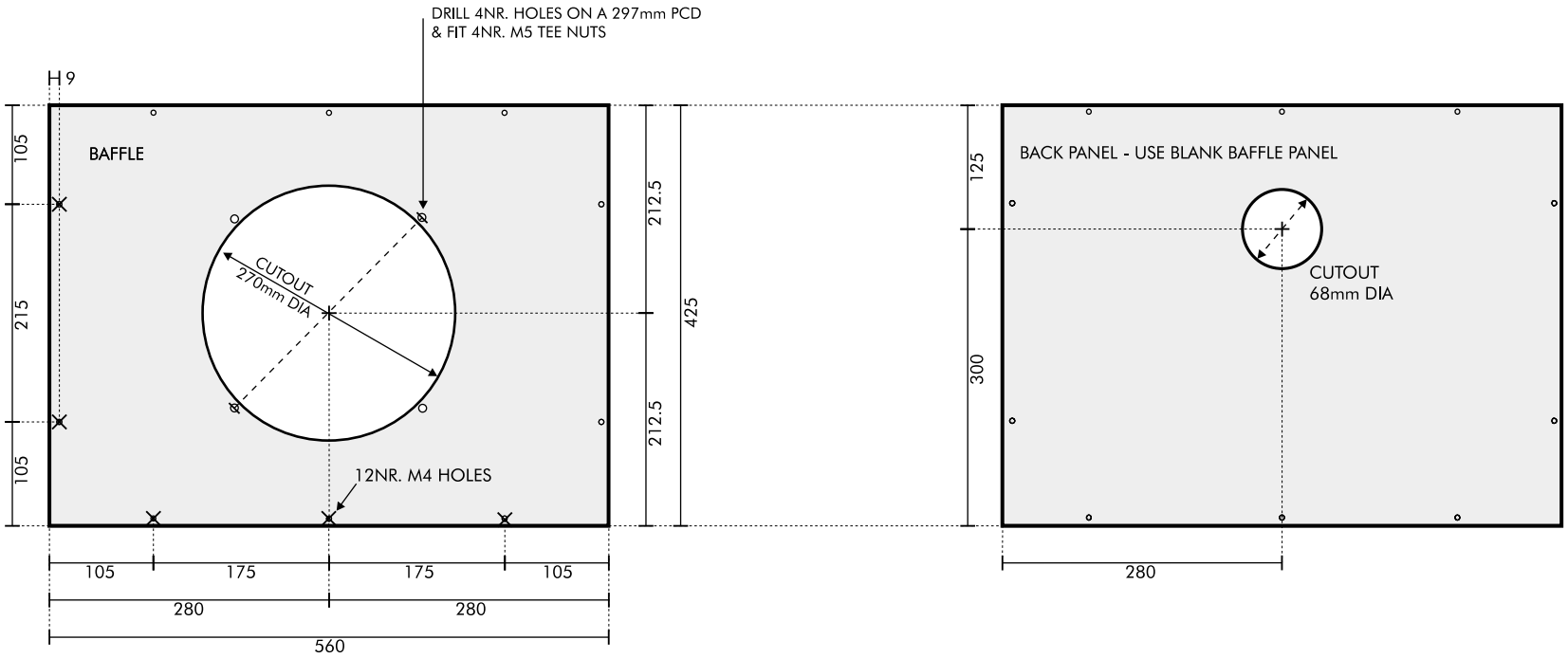

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EXTENSION 1 X12" SPEAKER CABINET
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NOTES
1. CONSTRUCT CARCASE FROM 18mm MDF.
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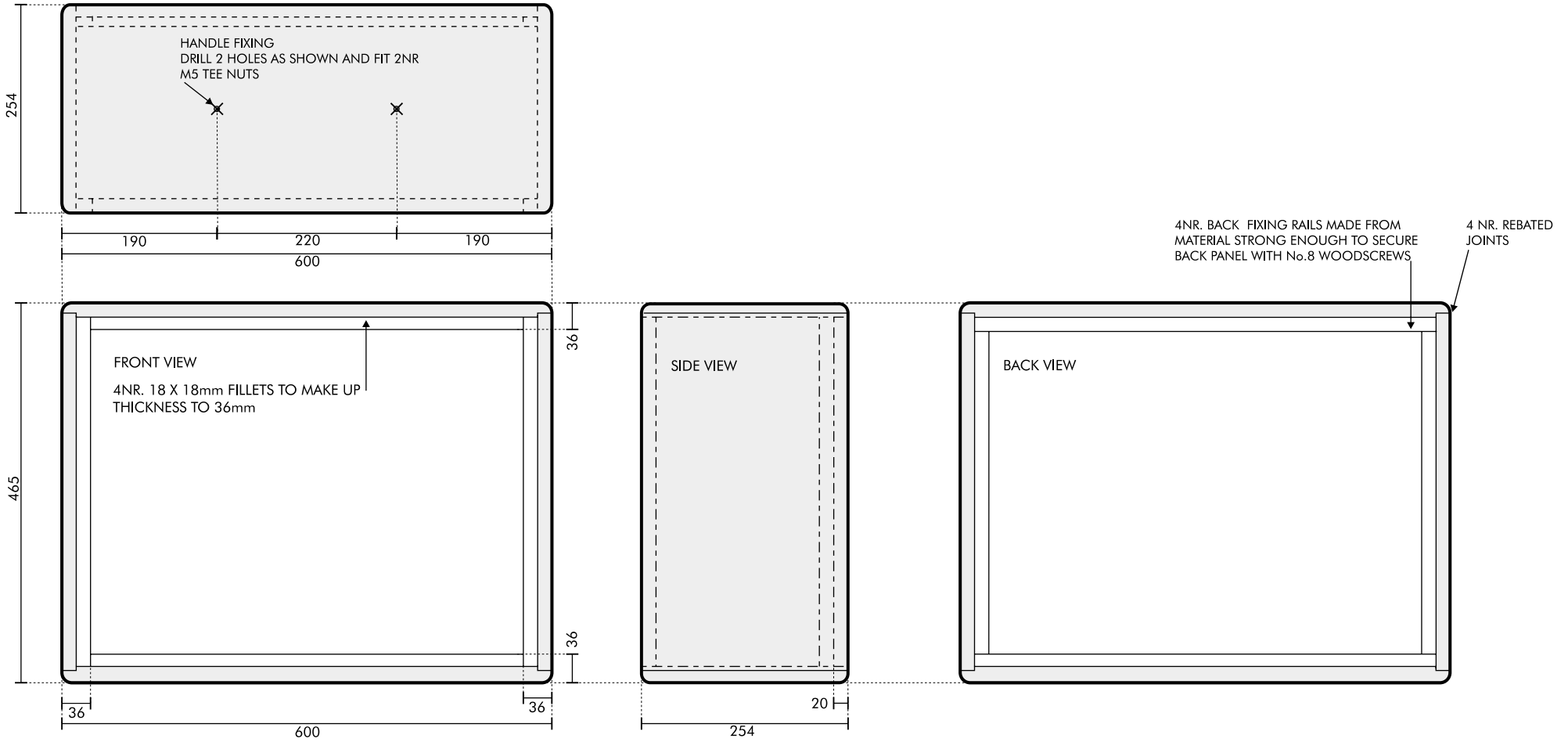

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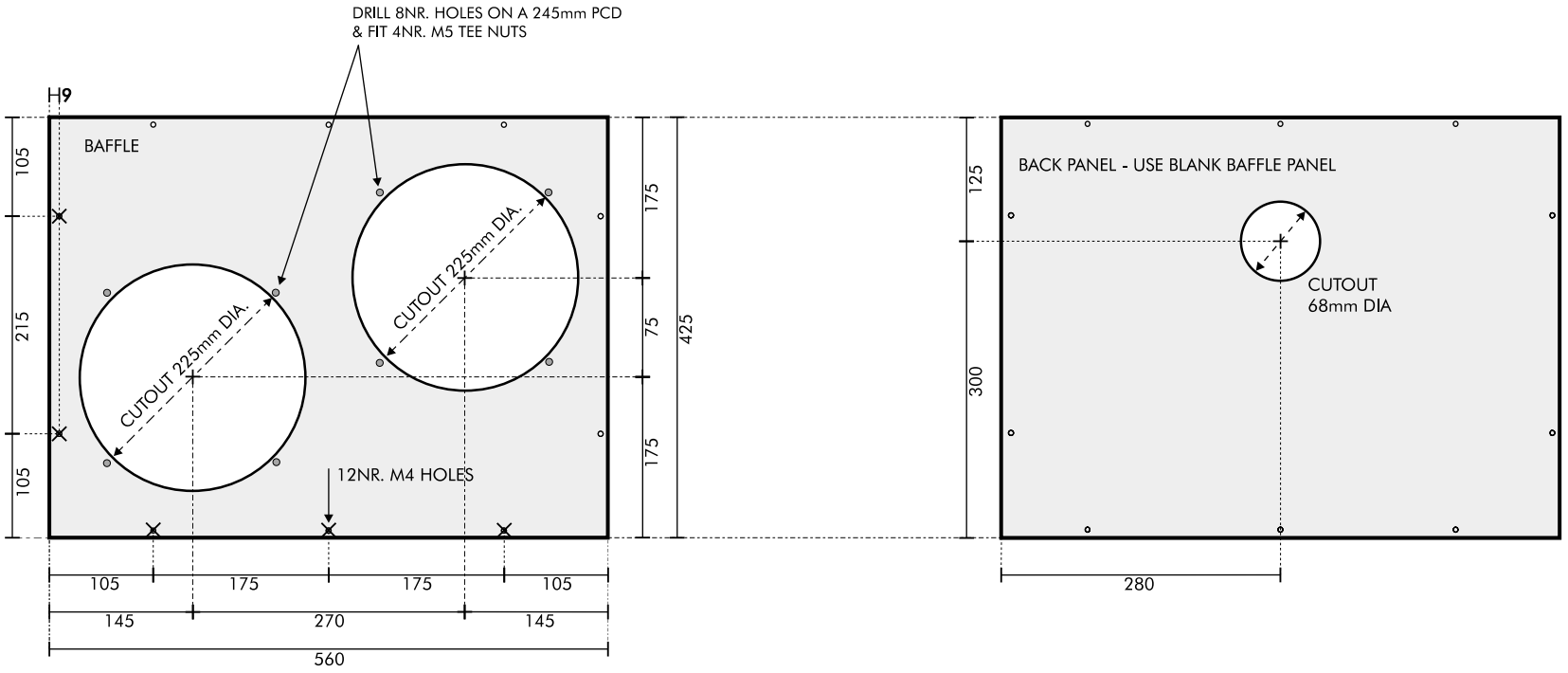

DO NOT SCALE

AWARD-SESSION, BASINGSTOKE, ENGLAND
TEL: 01256 477 222 - FAX: 01256 817 687

EXTENSION 2 X 10" SPEAKER CABINET
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DRG: M212A - PAGE 1 OF 2

NOTES
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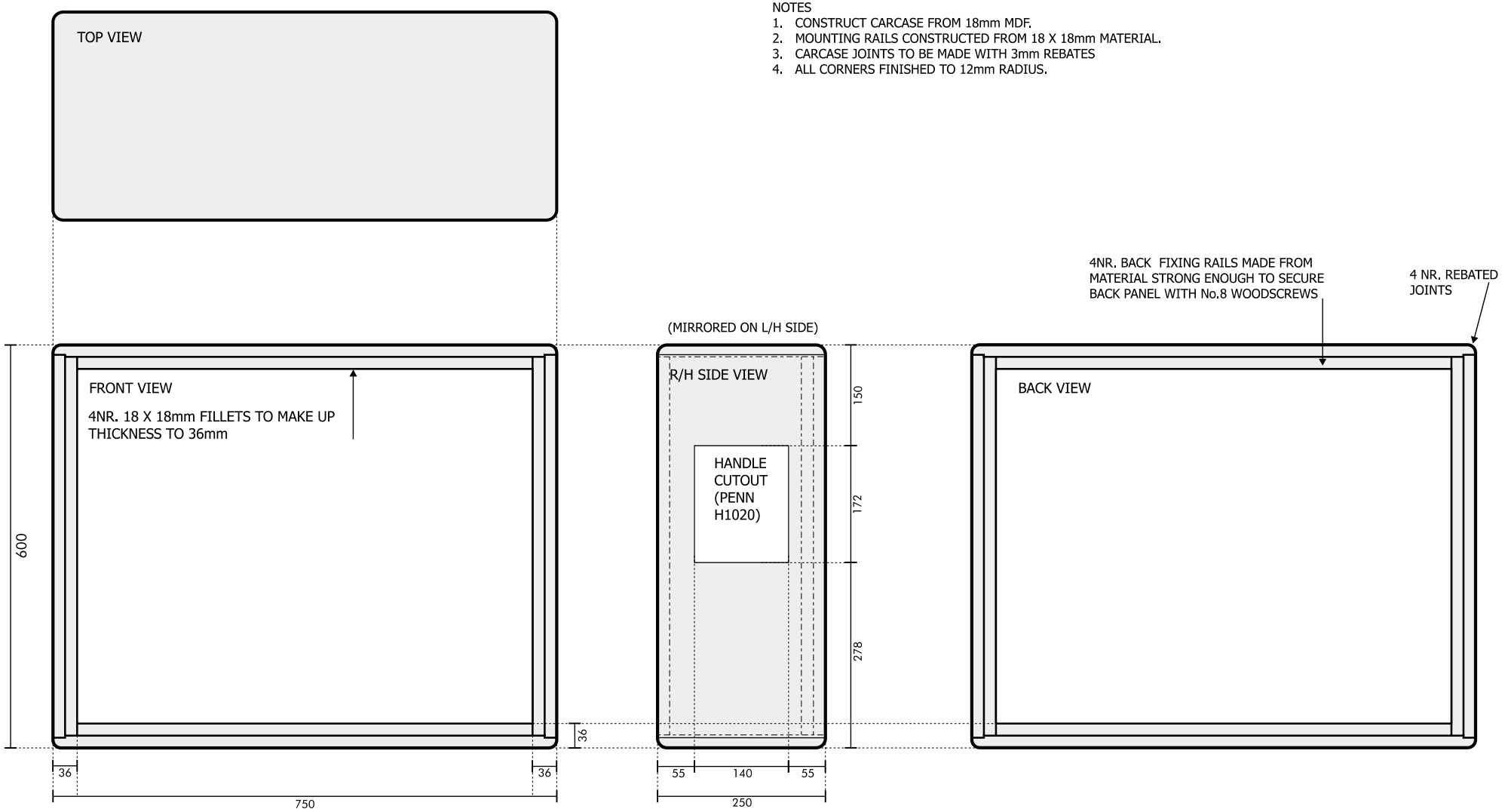
3. CARCASE JOINTS TO BE MADE WITH 3mm REBATES
4. ALL CORNERS FINISHED TO 12mm RADIUS.



DO NOT SCALE

AWARD-SESSION
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EXTENSION 2 X12" STEREO/MONO SPEAKER CABINET

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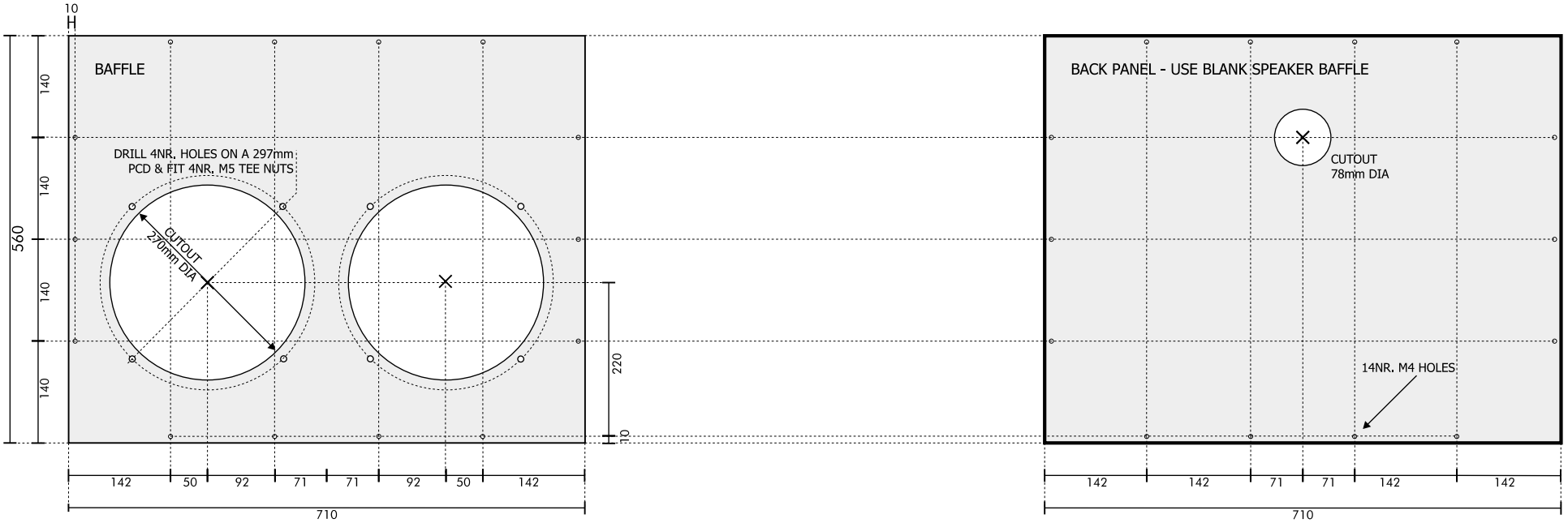

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