B&W PRODUCTIONS · CREW TRAINING · MODULE 2

Sound Basics for Event Crew

How a PA system works, from the mixer to the speaker. Decibels, amplifiers, ohms, series and parallel wiring, and how to set up a small system that sounds right and doesn't blow up. Written for beginners. Read it, work through the tools, then pass the quiz.

B&W Productions · Proper Planning, Prevents Poor Performance

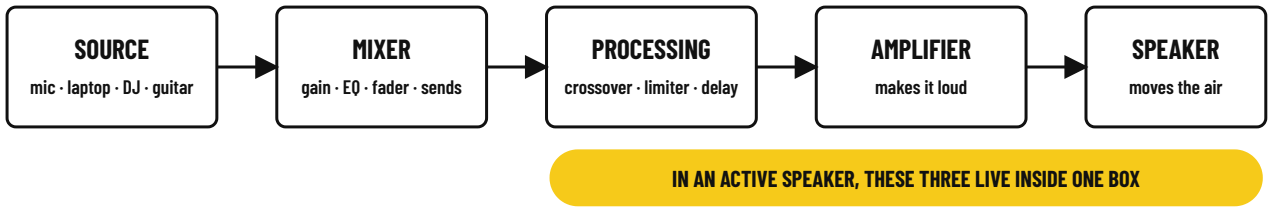


01 The signal chain



One channel strip. Gain at the top sets how hard the signal hits the desk; the fader at the bottom sets how much of it goes to the mix. The peak LED tells you the gain is too high.

Every PA system, from a single speaker on a stick to a stadium rig, is the same five blocks in the same order. If you can draw this chain from memory, you can fault-find any system: start at the source and walk forward until the signal disappears.



Signal flows left to right. Mic level is tiny (millivolts). The mixer lifts it to line level. The amplifier lifts line level to speaker level (tens of volts). Nothing after the mixer can fix what the mixer gets wrong.

Three signal levels you must know

LEVEL	WHERE YOU FIND IT	CABLE	RULE
Mic level	Microphones, DI boxes	XLR (3-pin), balanced	Needs the mixer's gain (preamp) to bring it up. Never plug a mic into a line input.
Line level	Mixer outputs, laptops, DJ decks, keyboards	XLR, TRS jack, RCA	The "normal" level everything talks at. Mixer out to active speaker in is line level.
Speaker level	Power amp output to passive speaker	Speakon, heavy 2-core	High current. Only ever amp-to-passive-speaker. Never into a mixer or active speaker.

> **REMEMBER**
> Mic → Mixer → Amp → Speaker. Walk the chain when it goes quiet. Nine faults out of ten are a cable, a mute, or a gain knob at zero.

02 Decibels: what "loud" means

A decibel (dB) is not a fixed amount of sound. It is a ratio, a way of comparing two levels. Our ears hear in ratios, so dB matches how loud things *feel*. Learn four numbers and you can reason about any system.

+3 dB

Twice the amplifier power. You barely notice it.

+6 dB

Twice the voltage, four times the power. Clearly louder. Also what you lose every time you double your distance from a speaker.

+10 dB

Ten times the power. Sounds about *twice as loud* to a person.

−6 dB per doubling

Stand 2 m from a speaker. Walk to 4 m: 6 dB quieter. To 8 m: 12 dB quieter. This is why one speaker cannot cover a big room.

Try it: power vs loudness

A 500 W speaker turned up 6 dB needs 1 991 W to do the same job. Or move it 2× closer. Power gets expensive fast. Moving the speaker is free.

Change	Power	Sounds
+3 dB	2×	barely louder
+6 dB	4×	clearly louder
+10 dB	10×	twice as loud
+20 dB	100×	four times as loud

Sound pressure level (dB SPL): the real-world scale

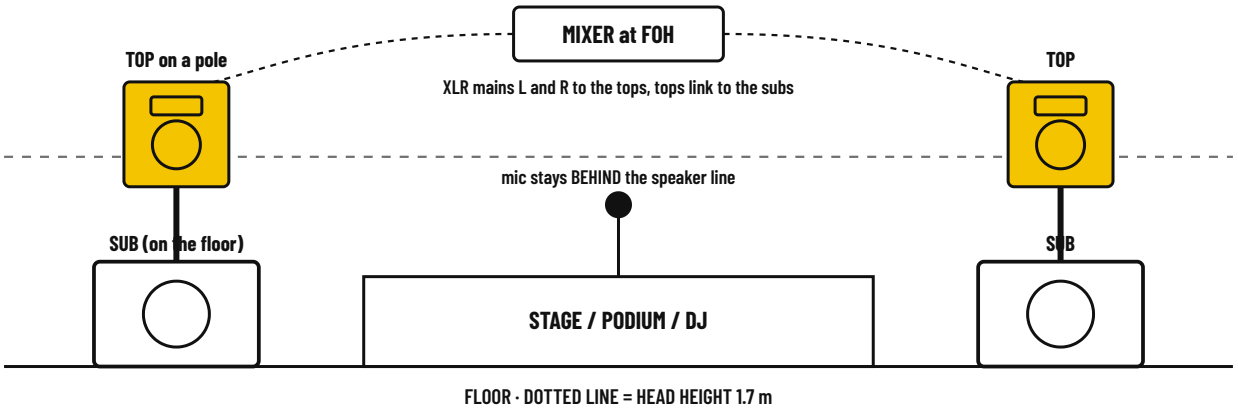
When someone says "it was 100 dB at the bar", they mean dB SPL: sound pressure measured against the quietest thing a human can hear (0 dB). You measure it with an SPL meter or a phone app, set to **A-weighting**, which ignores the deep bass the way ears do.

DB SPL (A)	SOUNDS LIKE	FOR CREW
60	Normal conversation at 1 m	Background music at a cocktail function
75	Busy restaurant	A speech system doing its job
85	Heavy traffic	South African OHS limit for 8 hours a day. Above this, ear protection for crew.
95	Loud bar, dance floor edge	Typical corporate party peak. About 45 minutes of safe exposure.
105	Front of stage at a concert	Minutes, not hours. Earplugs for anyone working there.
120	Jet engine, pain threshold	Never. A limiter should stop the system here.

> **HEARING IS NOT A RENEWABLE RESOURCE**
> Crew spend more hours in front of a PA than any guest. Carry earplugs. The 85 dB limit halves for every 3 dB louder: 88 dB is 4 hours, 91 dB is 2 hours, 94 dB is 1 hour.

03 The small PA

A "small PA" is anything you can set up in under an hour with two people: two tops on stands, one or two subs, a mixer. It covers 90% of corporate work: speeches, awards, a DJ for 150 people, a cocktail function. Know the parts and what each one is for.



Tops go on poles so the high-frequency horn sits just above head height and fires over the crowd. Subs stay on the floor: bass couples with the floor and gains level for free.

The parts

TOPS (MID/HIGH)

A 10", 12" or 15" woofer plus a horn. They carry voice and the "music". Aim them at the back third of the audience.
In the B&W kit: RCF Evox 12 columns and the Evox 8s on the music bus.

SUBS (LOW)

8", 12", 15" or 18" drivers that only do bass, typically below 100 Hz. One sub per side, or both together in the middle (see Module 3).
In the B&W kit: JBL single 8" and double 8" powered subs.

COLUMN ARRAYS

A sub on the floor with a slim vertical column of small drivers on top. Wide and even coverage, tidy on stage, fast to set up. Covered properly in Module 3.
In the B&W kit: the Evox 8 and Evox 12 are column arrays. The DAS 208A is a true double-8" line-array element.

MIXER

Where every source meets. Each channel has gain, EQ, aux sends and a fader. Main L/R goes to the speakers.

DI BOX

Turns a laptop, keyboard or DJ output into a balanced mic-level signal that can run 50 m on XLR without hum. Lift the ground switch if it buzzes.

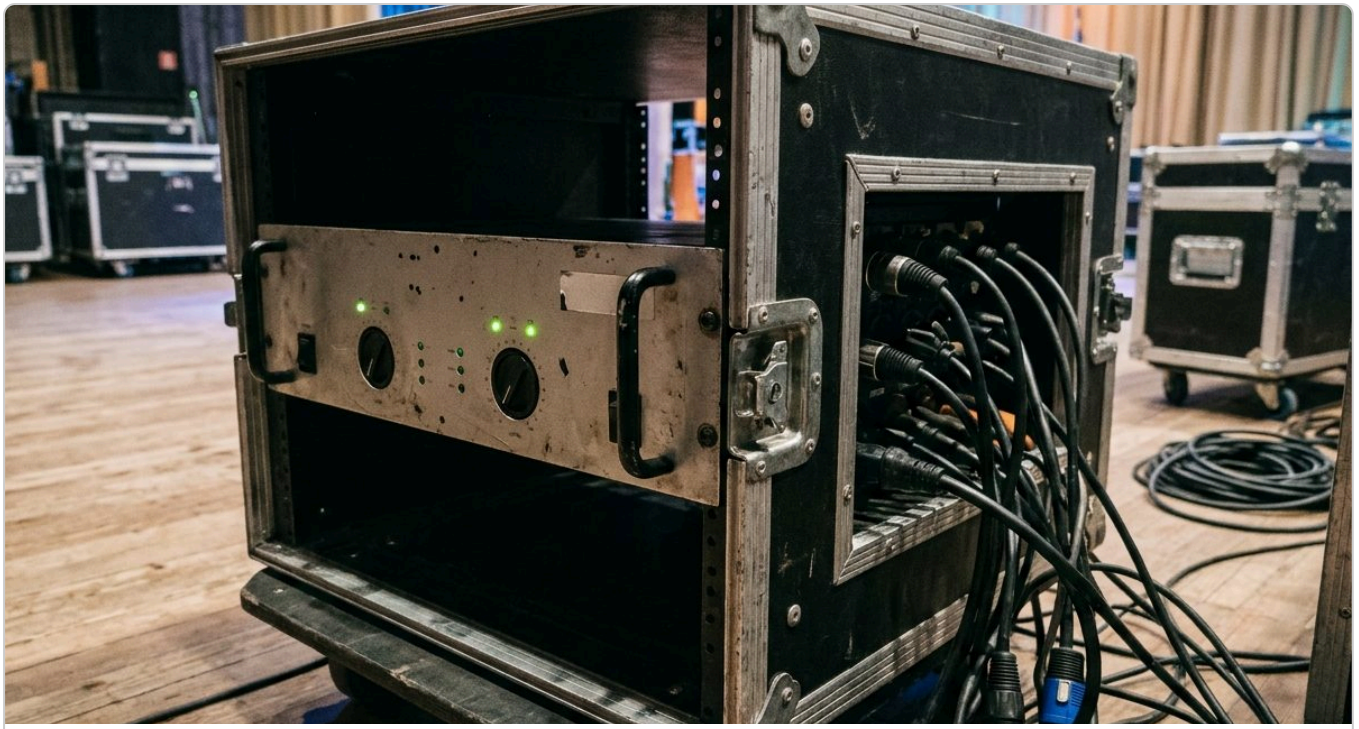
CABLES AND STANDS

XLR for everything signal. Speakon for passive speakers. Two cable types, two stand types, three adaptors. Count them in and out.

Active or passive?

An **active** (powered) speaker has the amplifier and crossover built in. It needs a line-level XLR in and a power cable. Most small PAs today are active, including every column array. A **passive** speaker is just drivers in a box; it needs a separate power amp and a Speakon cable. Passive systems are cheaper per box, lighter, and you only run one cable to the stage, but you must match the amp to the speaker (Lesson 5).

04 How amplifiers work



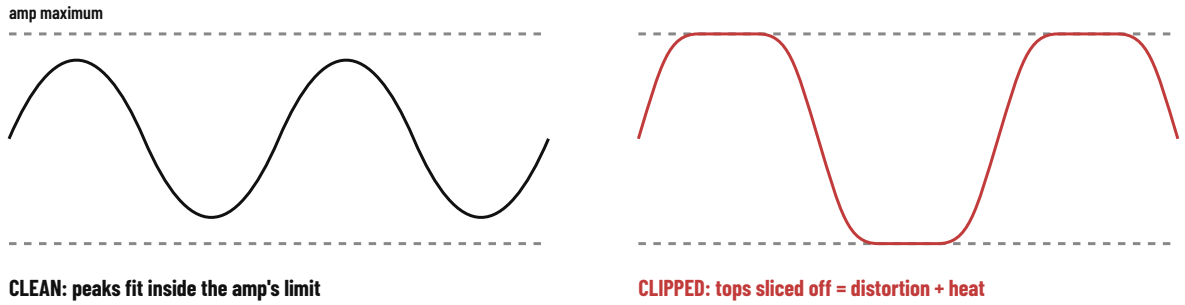
A power amp in its rack. Line level in at the back, speaker level out on Speakon. The only numbers that matter are RMS watts and the minimum load in ohms.

An amplifier takes the small line-level signal from the mixer and makes a big copy of it, with enough voltage and current to push a speaker cone back and forth. It does not add sound. It only scales what it is given, including any noise, hum or distortion from upstream.

Watts, and why the number on the box lies

- **RMS (continuous) watts** is the only number that matters. It is what the amp can deliver all night without overheating.
- **Peak** or **programme** watts are marketing: usually 2× to 4× the RMS figure. A "2 000 W" plastic speaker is often 300 W RMS.
- An amp rated 500 W into 8 Ω will usually give 800 to 1 000 W into 4 Ω. Lower impedance pulls more current, so more power, up to the amp's limit.
- Match amp RMS to speaker RMS, or go up to 1.5× the speaker rating. A slightly bigger amp running clean is safer than a small amp clipping.

Headroom and clipping



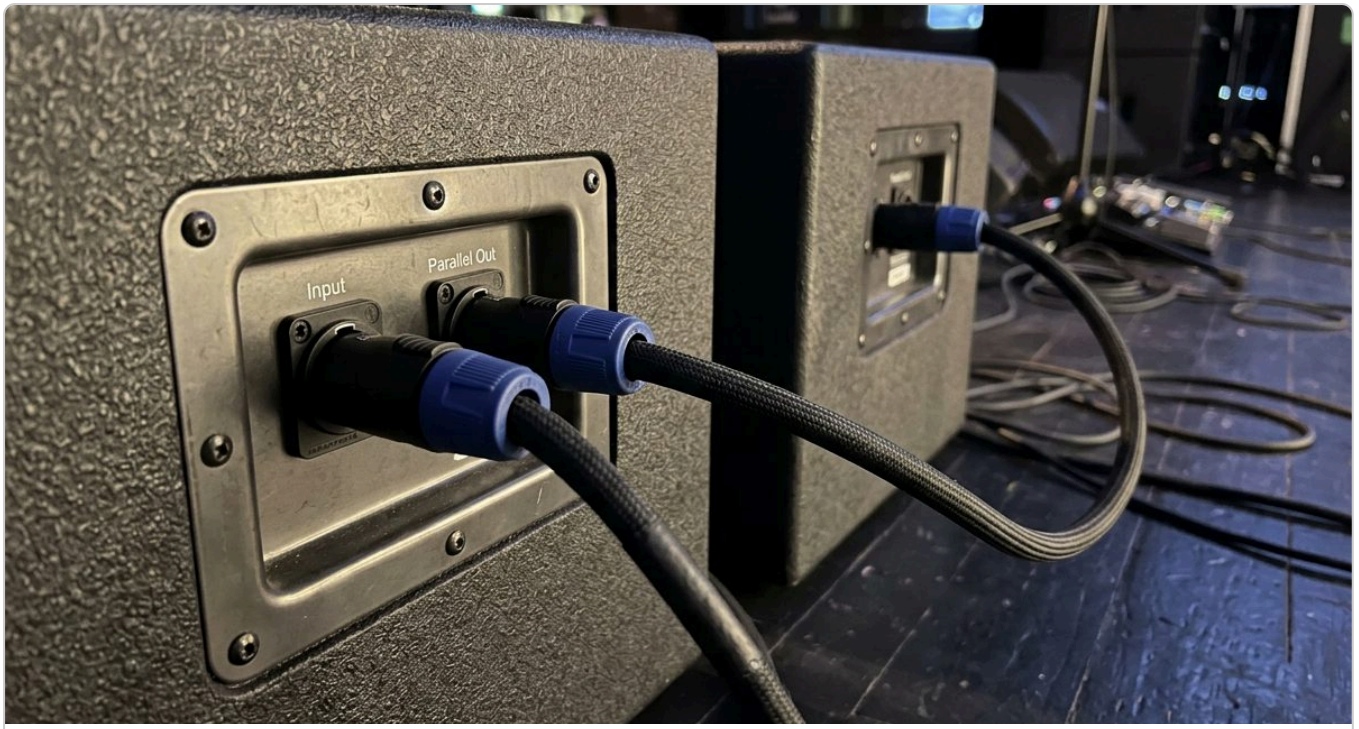
When the signal asks for more than the amp can give, the peaks get flattened. Clipped signal is full of harmonics that cook tweeters. More tweeters die from a small amp clipping than from a big amp running clean.

> **THE RULE**
> If the clip or limit light is flashing on every beat, turn it down. Don't buy a bigger amp first; check your gain staging (Lesson 8). Most "we need more power" calls are a gain problem.

Inside an active speaker

Every active top is three things in one box: a **crossover** that splits lows to the woofer and highs to the horn, a **limiter** that stops you destroying it, and one or two **amplifier channels**. That is why an active speaker has a gain knob and a few DSP presets on the back: you are setting the amp, not just the speaker.

05 Ohms: 4 Ω vs 8 Ω



Linking a second passive box through the first one's parallel socket. Two 8 Ω boxes on one amp channel = 4 Ω. Check the amp's minimum before you plug the second lead in.

Impedance, measured in ohms (Ω), is how hard a speaker "pushes back" against the amp. It only matters for **passive** speakers, but it matters a lot: get it wrong and the amp shuts down, overheats, or dies.

- A single typical PA speaker is **8 Ω**.
- A **lower** number means the speaker draws **more** current from the amp. 4 Ω is a heavier load than 8 Ω.
- Every amp has a **minimum load**, printed on the back, usually 4 Ω (sometimes 2 Ω). Go below it and the amp works too hard.
- Two 8 Ω speakers on one amp channel, wired the normal way (parallel), make a 4 Ω load. Three make 2.7 Ω. Four make 2 Ω.

> **WHY A BOX WITH TWO 8 Ω DRIVERS IS A 4 Ω BOX**
> Open up a double-8" sub or a dual-driver cabinet. Inside, the two 8 Ω drivers are wired in parallel. The amp sees them together as one 4 Ω load. Hang two of those boxes on one amp channel and you are at 2 Ω, which most amps will not survive.

TRY IT: WHAT LOAD DOES THE AMP SEE?

BOXES IN PARALLEL	8 Ω BOXES	4 Ω BOXES
1	8 Ω	4 Ω
2	4 Ω	2 Ω
3	2.7 Ω	1.3 Ω
4	2 Ω	1 Ω

Most amps stop at 4 Ω. Stay at or above the number printed on the amp.

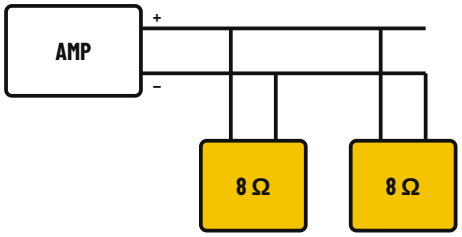
What about active speakers?

You never think about ohms with an active speaker. The amp inside is already matched to the driver. You just need enough mains power on the cable feeding it, which is Module 5.

06 Series vs parallel

There are only two ways to wire more than one speaker to one amp channel. Parallel is what you get when you "link through" from one box to the next. Series is rare in PA but you must recognise it.

PARALLEL (normal "link through")

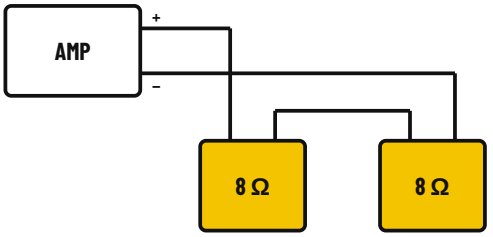


+ to +, – to –. Both see the full voltage.

Total = 4 Ω

Rule: 1 / (1/8 + 1/8) = 4. Same boxes: divide by the count.

SERIES (daisy-chain through)



+ of one to – of the next. Voltage is shared.

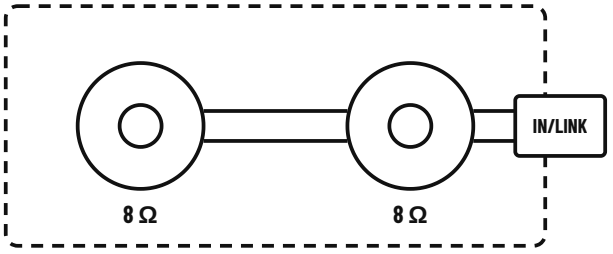
Total = 16 Ω

Rule: 8 + 8 = 16. Add them up. Easy on the amp, but quieter.

Parallel halves the impedance and roughly doubles the power the amp gives. Series doubles the impedance, the amp gives less, and if one speaker fails both go silent.

Inside a double-driver cabinet

Two drivers,
wired parallel



= 4 Ω box

a double-8" sub, for example

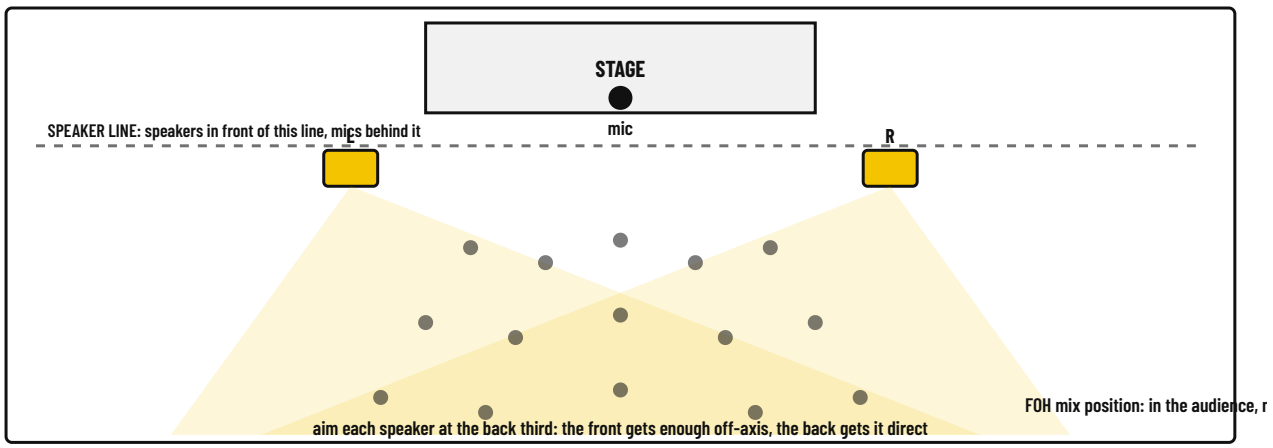
The label on the back tells you the box's total. Trust the label, not the driver count.

FIELD RULE

Linking passive boxes: two 8 Ω boxes per amp channel, maximum. One 4 Ω box per channel. Never link a 4 Ω box to another 4 Ω box on the same channel.

07 Placement and feedback

Where you put the speakers decides most of what the audience hears. The mixer can only polish it. Three rules cover almost every small job.



Feedback is a loop: mic hears speaker, speaker plays mic, louder each time round. Break the loop with geometry first (speakers in front of mics), then with EQ.

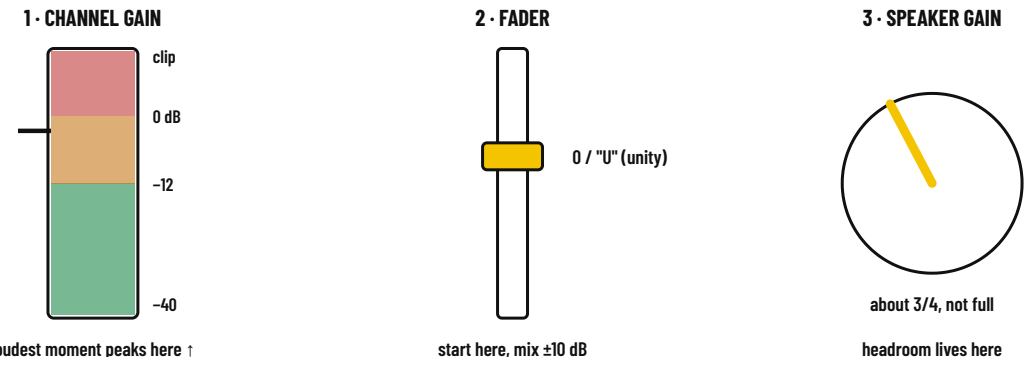
1. **Speakers in front of the mics.** The speaker line is the limit. A podium mic 1 m in front of a top is a guaranteed howl.
2. **Tops above head height, tilted at the back third.** Horn at about 1.8 to 2.0 m. If the people at the back can see the horn, they can hear it.
3. **Subs on the floor.** Against a wall or corner gives you free bass (it also makes it boomy; back off if it muddies the voice). Both subs together in the middle is usually tighter than one per side. Module 3 explains why.

Mic distance: the 3-to-1 rule

If one mic is 10 cm from a mouth, any other open mic must be at least 30 cm away from that mouth. Closer than that and the two mics fight each other, which sounds hollow and feeds back sooner. Fewer open mics is always better: mute what isn't being used.

08 Gain staging

Gain staging is setting each stage of the chain so the signal is strong but never clipping. Done right, the system is quiet when it should be and loud without distortion. Done wrong, you get hiss (too low early on) or distortion (too high early on), and no amount of turning the speakers up or down fixes it.



Set in this order: gain, then fader at unity, then speaker level. If the main mix peaks near 0 dB and the room is still too quiet, turn the speakers up. If the speakers are at full and it's still quiet, you need more speakers, not more gain.

Step by step, every channel

1. Fader down. Gain at zero. Ask for the *loudest* thing that channel will do all night (the speaker's loudest line, the DJ's biggest drop).
2. Press PFL/Solo. Turn the gain up until the loudest peaks sit just under 0 dB on the meter. On a digital desk, peaks around −12 to −6 dBFS are fine; you want no red.
3. Fader to unity (0 / "U"). Now the fader has 10 dB up and lots down, which is what you need to mix.
4. Set the main fader to unity. Set the speaker gain knobs so the room is at the level you want with the mix at unity.
5. High-pass filter (HPF) on every vocal channel at 80 to 120 Hz. Cut, don't boost, when you EQ.

> **WHY CUT, NOT BOOST**
>
> Boosting EQ adds level and eats headroom. Cutting the frequency that rings removes the problem. A feedback howl at 2 kHz is fixed with a narrow cut at 2 kHz, not by turning the whole channel down.

09 Setup order and checklist

Do it in the same order every time. The order protects the gear: speakers come on last and go off first, so no thump ever reaches the drivers.

BEFORE YOU LEAVE

- Count: tops, subs, stands, poles, mixer, DI, XLR (long and short), power, extension leads, gaffer, earplugs
- Test one of everything in the warehouse
- Spare: one XLR, one power lead, one mic, batteries

ON SITE, IN ORDER

- Power first: find the supply, run it, test it
- Stands and subs where they'll stay
- Tops on poles, aimed
- Mixer at FOH, signal cables run and taped
- Mics and sources last

POWER-UP

- All faders and speaker gains down
- Mixer on → processing on → speakers on
- Bring up one channel, confirm sound, then the rest
- Walk the room with music playing

POWER-DOWN

- Speakers off first
- Then processing, then mixer
- Coil cables over-under, count everything back in
- Note any faults on the job sheet

Fast fault-finding

SYMPTOM	CHECK FIRST	THEN
No sound at all	Speaker power and gain, mute buttons, main fader	Swap the XLR from mixer to speaker
One side silent	That speaker's cable and gain	Swap L and R cables at the mixer: if the silence moves, it's the mixer side
Hum or buzz	Ground lift on the DI, laptop charger	Different power socket for mixer and speakers
Feedback	Mic in front of the speaker line, too many open mics	HPF on, narrow EQ cut, turn the monitor down
Distorted, "crunchy"	Red clip light anywhere in the chain	Lower the gain where it clips, raise it after
Thin, no bass	Subs on and linked, polarity switch	Move subs together or to a wall

10 Check what you learnt

Ten questions. Circle one answer for each. The answer key is on the last page. Pass mark: 8 out of 10.

1. Put the signal chain in the right order.

- ○ **A** Speaker → Amp → Mixer → Mic
- ○ **B** Mic → Mixer → Amp → Speaker
- ○ **C** Mixer → Mic → Speaker → Amp
- ○ **D** Mic → Amp → Mixer → Speaker

2. You turn a system up by 10 dB. Roughly how much more amplifier power does that take?

- ○ **A** Twice as much
- ○ **B** Four times as much
- ○ **C** Ten times as much
- ○ **D** A hundred times as much

3. You double your distance from a speaker. What happens to the level?

- ○ **A** It drops about 3 dB
- ○ **B** It drops about 6 dB
- ○ **C** It drops about 10 dB
- ○ **D** It stays the same

4. What is the South African 8-hour occupational noise limit?

- ○ **A** 75 dB
- ○ **B** 85 dB
- ○ **C** 95 dB
- ○ **D** 105 dB

5. **Two 8 Ω speakers linked through on one amp channel (parallel). What load does the amp see?**

- ○ **A** 16 Ω
- ○ **B** 8 Ω
- ○ **C** 4 Ω
- ○ **D** 2 Ω

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6. **A sub has two 8 Ω drivers inside, wired in parallel. The box is...**

- ○ **A** A 16 Ω box
- ○ **B** An 8 Ω box
- ○ **C** A 4 Ω box
- ○ **D** A 2 Ω box

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7. **Which amplifier spec actually matters when you match an amp to a speaker?**

- ○ **A** Peak watts
- ○ **B** Programme watts
- ○ **C** RMS (continuous) watts
- ○ **D** The size of the box

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8. **The clip light on the active speaker flashes on every beat. First thing to do?**

- ○ **A** Buy a bigger speaker
- ○ **B** Turn the mixer gain or speaker level down
- ○ **C** Boost the bass EQ
- ○ **D** Move the speaker closer to the wall

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9. **Where should the podium mic be, relative to the speakers?**

- ○ **A** Directly in front of a speaker
- ○ **B** Behind the speaker line
- ○ **C** Level with the speakers
- ○ **D** Anywhere, as long as the EQ is set

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10. **Correct power-up order for a small PA?**

- ○ **A** Speakers → mixer → processing
- ○ **B** Mixer → processing → speakers
- ○ **C** Processing → speakers → mixer
- ○ **D** All at once from one switch

Answer key

1. **B**. Source first, speaker last. Mic → Mixer → (processing) → Amp → Speaker. Walk it in that order when fault-finding.
2. **C**. +3 dB is 2× power, +10 dB is 10× power. +10 dB sounds about twice as loud to a person.
3. **B**. Inverse square law: every doubling of distance loses 6 dB. That is why one speaker cannot cover a deep room.
4. **B**. 85 dB(A) for 8 hours. Every 3 dB louder halves the safe time. Crew carry earplugs.
5. **C**. Parallel: 1 / (1/8 + 1/8) = 4 Ω. Same boxes in parallel: divide by the count.
6. **C**. Two 8 Ω drivers in parallel = 4 Ω. Link two of those boxes on one channel and you are at 2 Ω, which most amps will not take.
7. **C**. Only RMS is a real number. Peak and programme are 2× to 4× inflated.
8. **B**. Clipping is distortion and heat. Find where the chain is clipping and bring the level down there. Most "we need more power" is a gain-staging problem.
9. **B**. Speakers in front of the speaker line, mics behind it. Geometry beats EQ for feedback every time.
10. **B**. Speakers on last and off first. That way no switch-on thump reaches the drivers.

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