
B&C SPEAKERS
AES NYC 2018 PD07
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TRANSDUCER POWER RATINGS

What do they mean?

THERE'S A (AES) STANDARD FOR THAT

- AES2-1984 (R2003) or AES2-2012?
  - Most still use 1984 test.
- Differences:
  - Minimum Impedance vs. Rated
  - 6dB Crest Factor vs. 12dB Crest Factor noise
  - 12dB/8ve Band Filtering vs. 24dB/8ve
- AES2-2012 Generally results in ≈20% lower power numbers.

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All pro transducers use AES2 power handling standard.

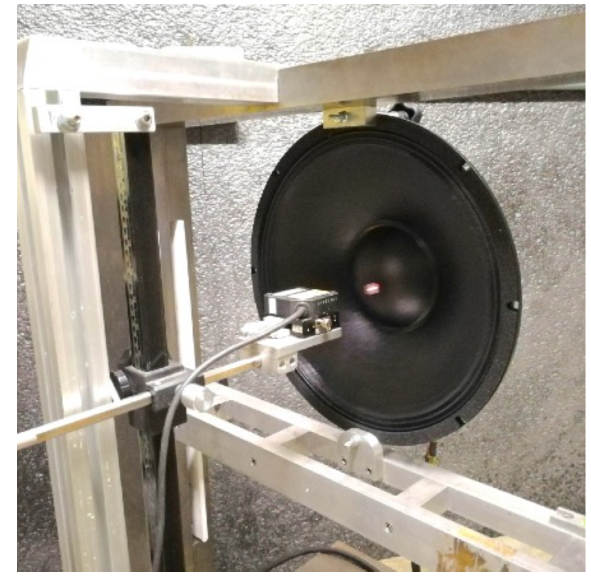
Defined 1984, reaffirmed 2003, then modified 2012.

Compare apples to apples, 2012 and 1984 version are different!

Difference in noise crest factor primarily to avoid amplifier limitations.

WOOFER POWER TESTING

- In Free Air
  - Better cooling, but worse excursion.
- Pink noise, monitored for amp clipping (≈12dB Crest Factor)
- Limits: VC Temp, Motor Temp, Xmech
- Distortion not considered
  - Measured elsewhere in design cycle



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This is how we run the AES test.

TAKEAWAYS ABOUT POWER RATINGS

- AES power test not representative of real world use in general.
- Must determine final power handling in <u>your</u> enclosure.
  - With <u>your</u> processing, amplifier, and test signal!
  - Or send your enclosure to a Reputable Transducer Manufacturer™.
- What is performance when coil and suspension are really hot?
  - Q_{ts}, R_e easily double - so "<u>8Ω</u>" woofer now "<u>16Ω</u>"!
  - Need big amp rails to continue to supply peaks.

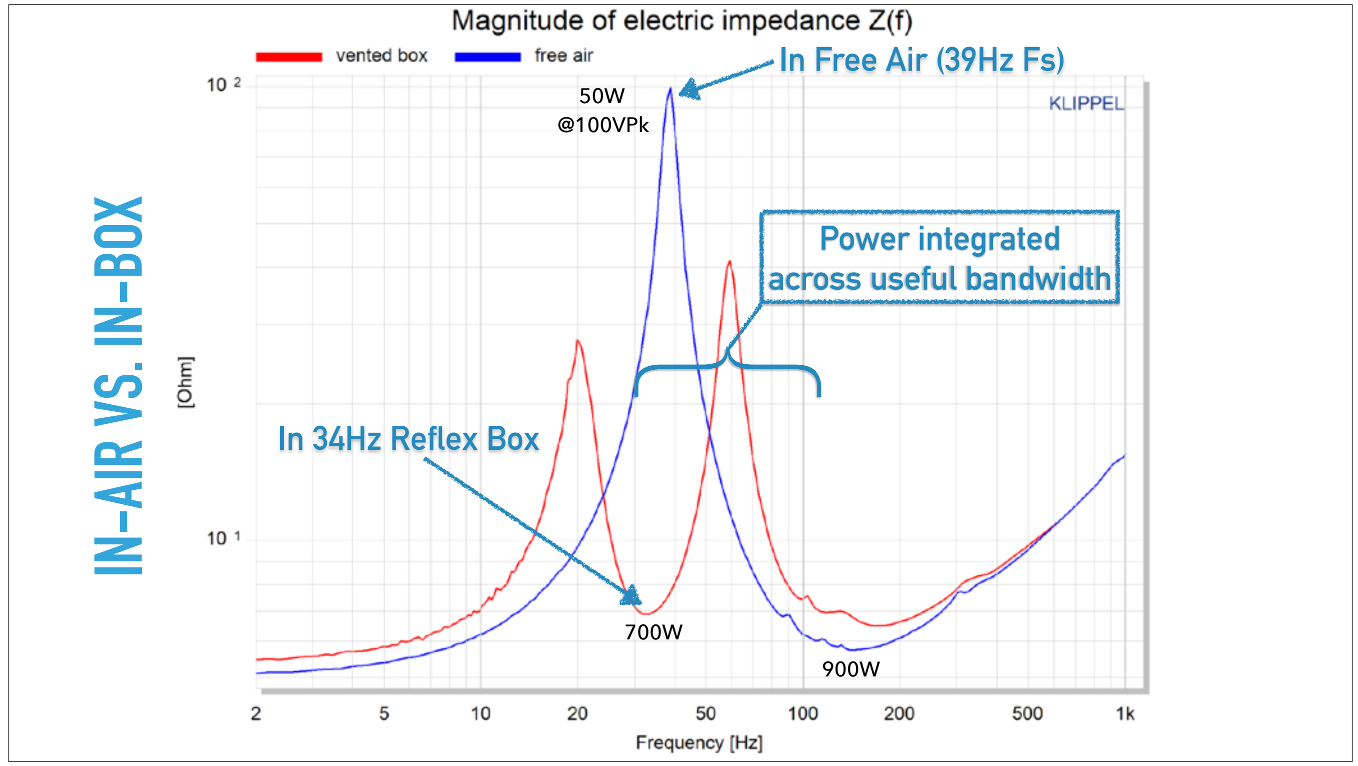
AES test gives defensible and reproducible number, but <u>not actually power</u>.

Unrealistic because: not in box, based on voltage @ min. or rated impedance.

Considered pretty abusive by our R&D team.

As coil gets hot need to deliver more volts for same performance.

Transducer performance changes, can start to sound boomy due to higher Qes.



Put woofer in generic reflex box and impedance curve changes almost completely.

Power assumptions from before go out the window - they were wrong anyway!

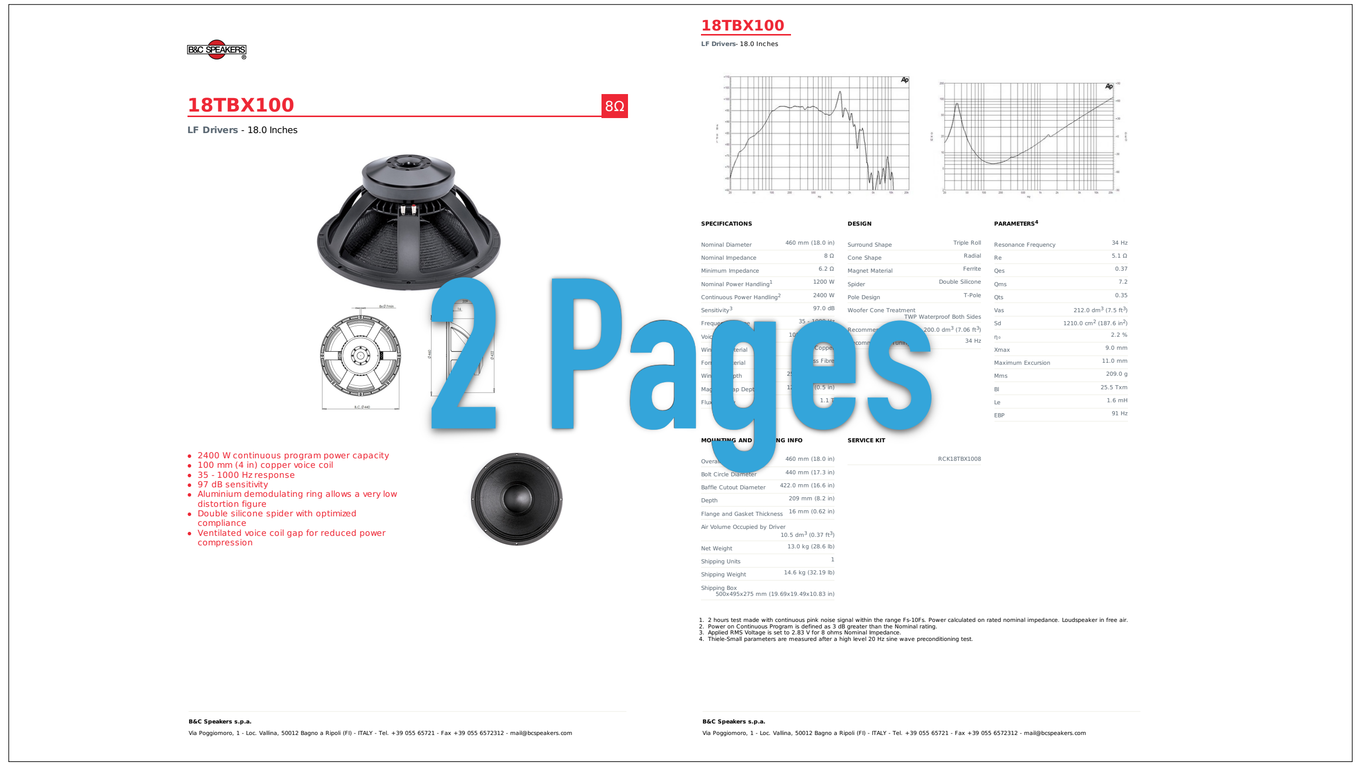
None of these watt numbers are “real”, we don’t (usually) listen to sine waves.

Real power delivered is integrated in <u>time</u> *and* <u>frequency</u>.

PROGRAM POWER IS A GUIDE FOR AMPLIFIER SELECTION, AND RELATIVE PERFORMANCE WITHIN OUR LINE

This Guy Right Here

How can we get a deeper understanding of power handling?



18TBX100 8Ω

LF Drivers - 18.0 Inches

- 2400 W continuous program power capacity
- 100 mm (4 in) copper voice coil
- 35 - 1000 Hz response
- 97 dB sensitivity
- Aluminium demodulating ring allows a very low distortion figure
- Double silicone spider with optimized compliance
- Ventilated voice coil gap for reduced power compression

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18TBX100

LF Drivers- 18.0 Inches

SPECIFICATIONS

Nominal Diameter	460 mm (18.0 in)
Nominal Impedance	8 Ω
Minimum Impedance	6.2 Ω
Nominal Power Handling[1]	1200 W
Continuous Power Handling[2]	2400 W
Sensitivity[3]	97.0 dB
Freque[illegible]	35 - 1000 Hz
Voic[illegible]	10[illegible]
Win[illegible]terial	Coppe[illegible]
For[illegible]terial	[illegible]ss Fibre
Win[illegible]pth	2[illegible]
Mag[illegible]ap Depth	12[illegible] (0.5 in)
Flux[illegible]	1.1 T

DESIGN

Surround Shape	Triple Roll
Cone Shape	Radial
Magnet Material	Ferrite
Spider	Double Silicone
Pole Design	T-Pole
Woofer Cone Treatment	TWP Waterproof Both Sides
Recomme[illegible]	200.0 dm^3 (7.06 ft^3)
[illegible]ecomm[illegible] Tuning	34 Hz

PARAMETERS[4]

Resonance Frequency	34 Hz
Re	5.1 Ω
Qes	0.37
Qms	7.2
Qts	0.35
Vas	212.0 dm^3 (7.5 ft^3)
Sd	1210.0 cm^2 (187.6 in^2)
η_0	2.2 %
Xmax	9.0 mm
Maximum Excursion	11.0 mm
Mms	209.0 g
Bl	25.5 Txm
Le	1.6 mH
EBP	91 Hz

MOUNTING AND [illegible]NG INFO

Overal[illegible]	460 mm (18.0 in)
Bolt Circle Diameter	440 mm (17.3 in)
Baffle Cutout Diameter	422.0 mm (16.6 in)
Depth	209 mm (8.2 in)
Flange and Gasket Thickness	16 mm (0.62 in)
Air Volume Occupied by Driver	10.5 dm^3 (0.37 ft^3)
Net Weight	13.0 kg (28.6 lb)
Shipping Units	1
Shipping Weight	14.6 kg (32.19 lb)
Shipping Box	500x495x275 mm (19.69x19.49x10.83 in)

SERVICE KIT

RCK18TBX1008

1. 2 hours test made with continuous pink noise signal within the range Fs-10Fs. Power calculated on rated nominal impedance. Loudspeaker in free air.
2. Power on Continuous Program is defined as 3 dB greater than the Nominal rating.
3. Applied RMS Voltage is set to 2.83 V for 8 ohms Nominal Impedance.
4. Thiele-Small parameters are measured after a high level 20 Hz sine wave preconditioning test.

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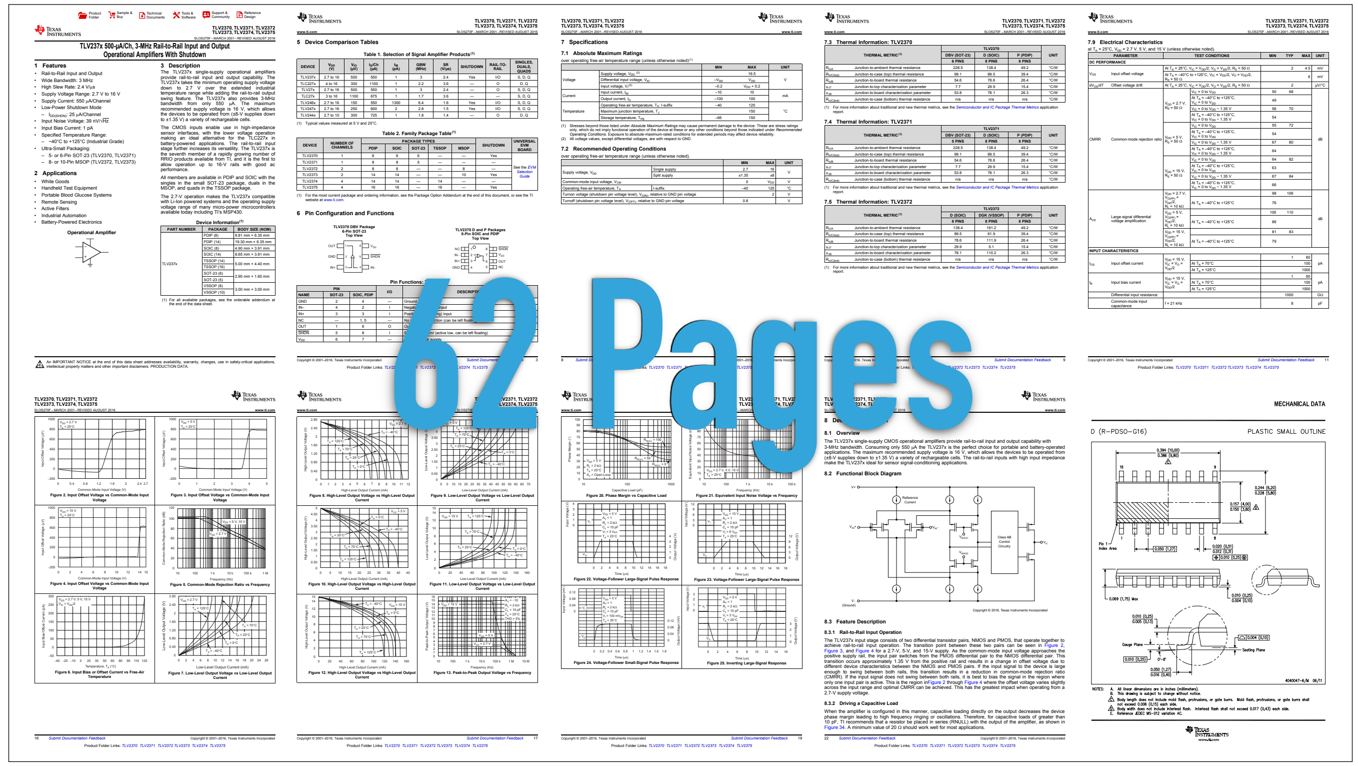
This is what most people consider a transducer data sheet.
Really one page, the first page is just a summary of the second page!

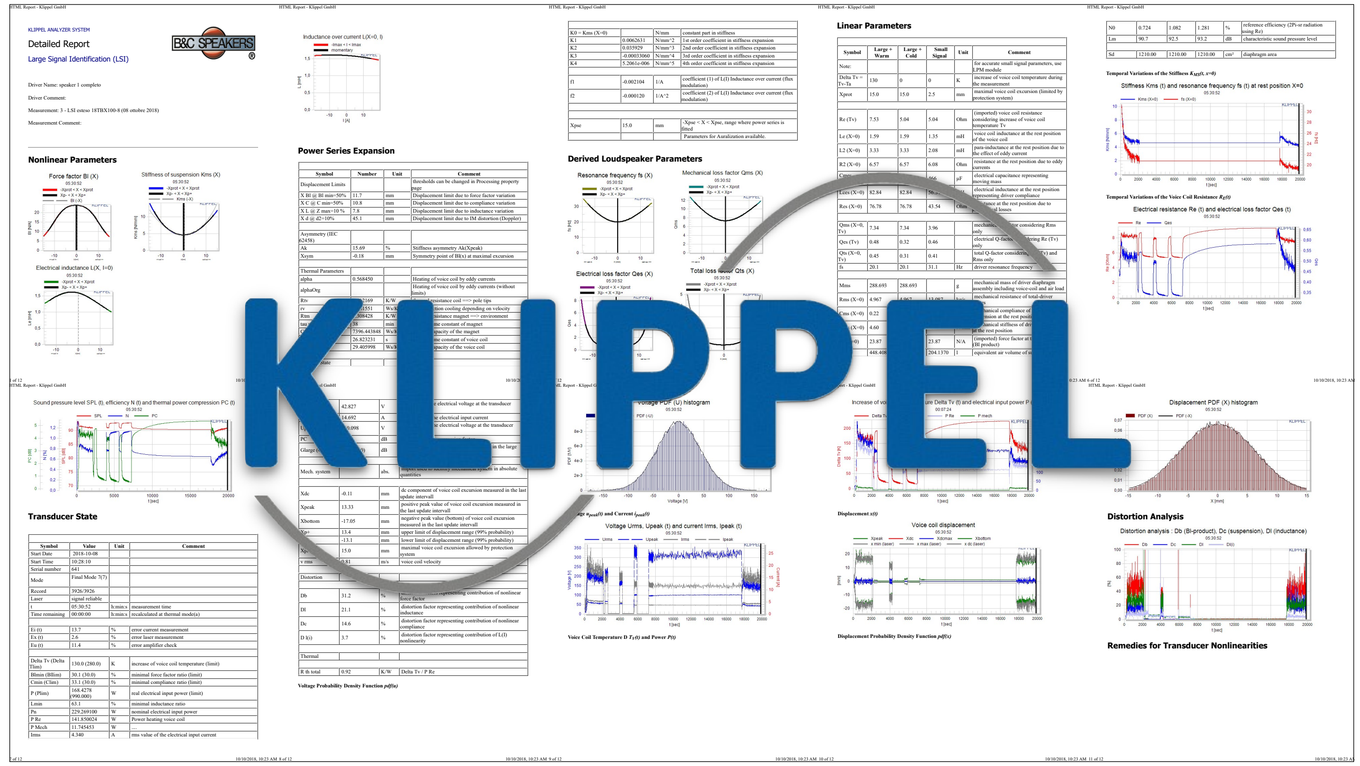
Texas Instruments TL074, very common $0.50 op-amp for line level audio.



Standard, publicly available data sheet is 62 pages long.

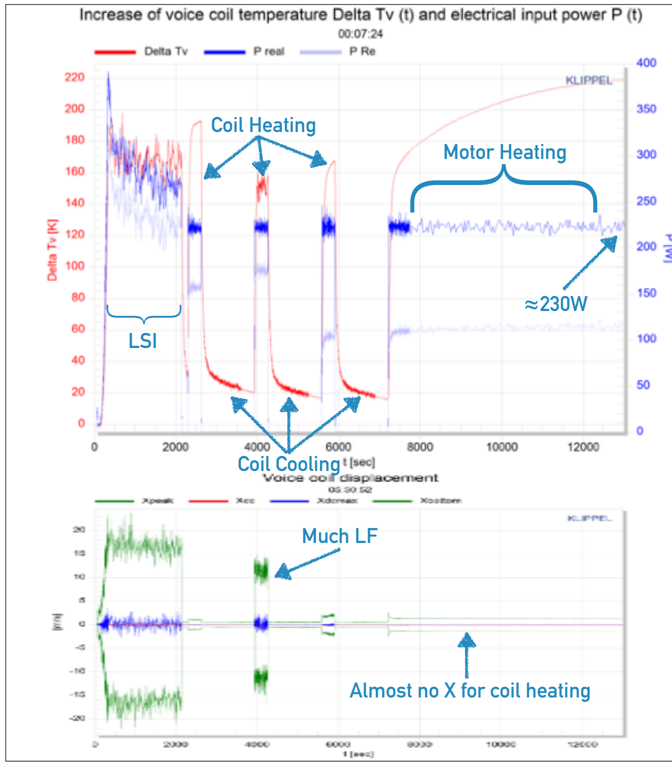
Clearly engineers need more information to characterize woofer performance.

Transducers are way harder to characterize than op amps!



Run a full Klippel woofer report with power testing.

12 pages of specs mostly concerned with large signal behavior.



THERMAL CHARACTERIZATION

- Long (≈6 Hour) test
- Nonlinear LSI before and after
  - To make sure no parameter shift
- Separates Coil & Motor heating
  - Including with and without high X (cooling)
  - Using four separate signals, one with significant LF (see excursion graph)
- Takes a long time for these structures to heat

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Bottom graph is excursion, top graph is power (blue) and heat (red) above ambient.
Point out time constants here, graph scale (x axis) is almost four hours.
Power capacity asymptotically approaches long term conditions and is pretty reliable.

After running these tests we pretty much know the answer in terms of real power.

TAKEAWAYS ABOUT APPLIED POWER

- Coil Heating Time Constant: 27 Seconds
- Motor Heating Time Constant: 38 Minutes
- Real Applied Power: **230 Watts** (*including power factor adjustment*)
  - Into a loudspeaker rated 1200 Watts AES
  - ≈6dB *power compression* by end of test
  - Which is fine, 12dB Crest Factor is ≈16x so 3600W amp appropriate.

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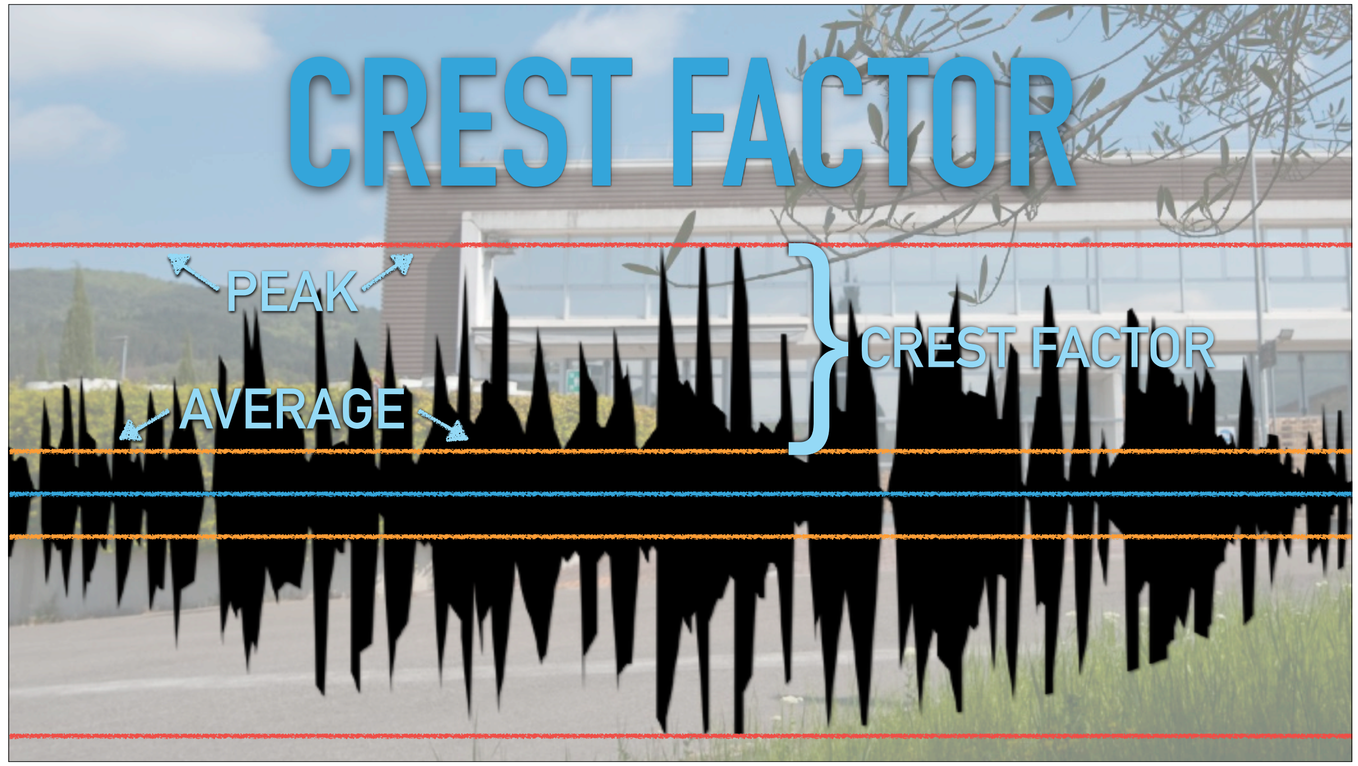
Almost any pro amp can overheat any transducer within minutes given right signal.
Max practical power compression ≈8dB, transducer almost dead at that point.
Coil at 300-400°C, motor at 100-110°C
Coming back to 12dB crest factor in next slides.



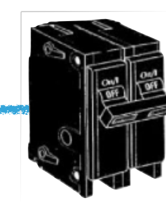
What is Crest Factor?
Amplifiers have to be sized for signal peaks, They care a lot about volts.
Transducers care about long term (average) power, which is much lower.

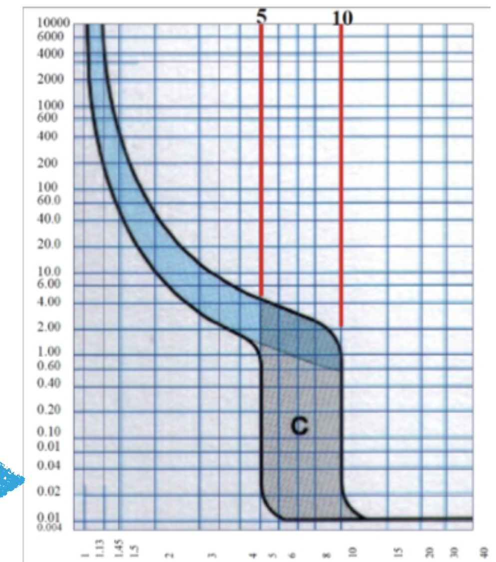
Notice how close to zero that average line is.

IS 12DB CREST FACTOR REALISTIC?

- Pretty similar to other system component capabilities:
  - Circuit Breakers
  - Amplifiers
  - Ears

Time	No trip current	Headroom for more power
>60 min	1.0	0 dB
2 min	1.1	0.3 dB
30 s	1.5	1.8 dB
6 s	2	3.0 dB
2 s	**3**	**4.8 dB**
600 ms	**5**	**7.0 dB**
<10 ms	>16	>12 dB





Type “C” Circuit Breaker Trip Curve

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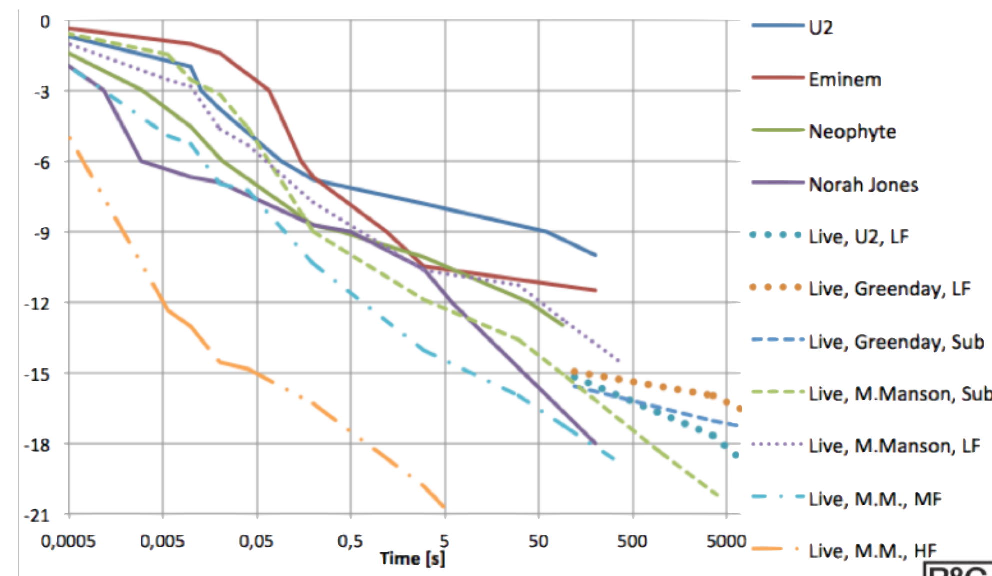
Why did I pick 12dB crest factor?

Loudspeakers are made out of wire, so power limitations similar to a circuit breaker.

Short term (<10s) 10x over-current maybe fine!

IS 12DB CREST FACTOR REALISTIC?



Crest factor over time for a wide variety of live and recorded music.

Live and recorded music trends towards 12dB crest factor quickly, somewhere between 5 seconds and 5 minutes.

Much higher for Mid and High bandpasses, 18dB or more crest factor there.

Well within transducer heating time constants of 30 seconds - 30 minutes.

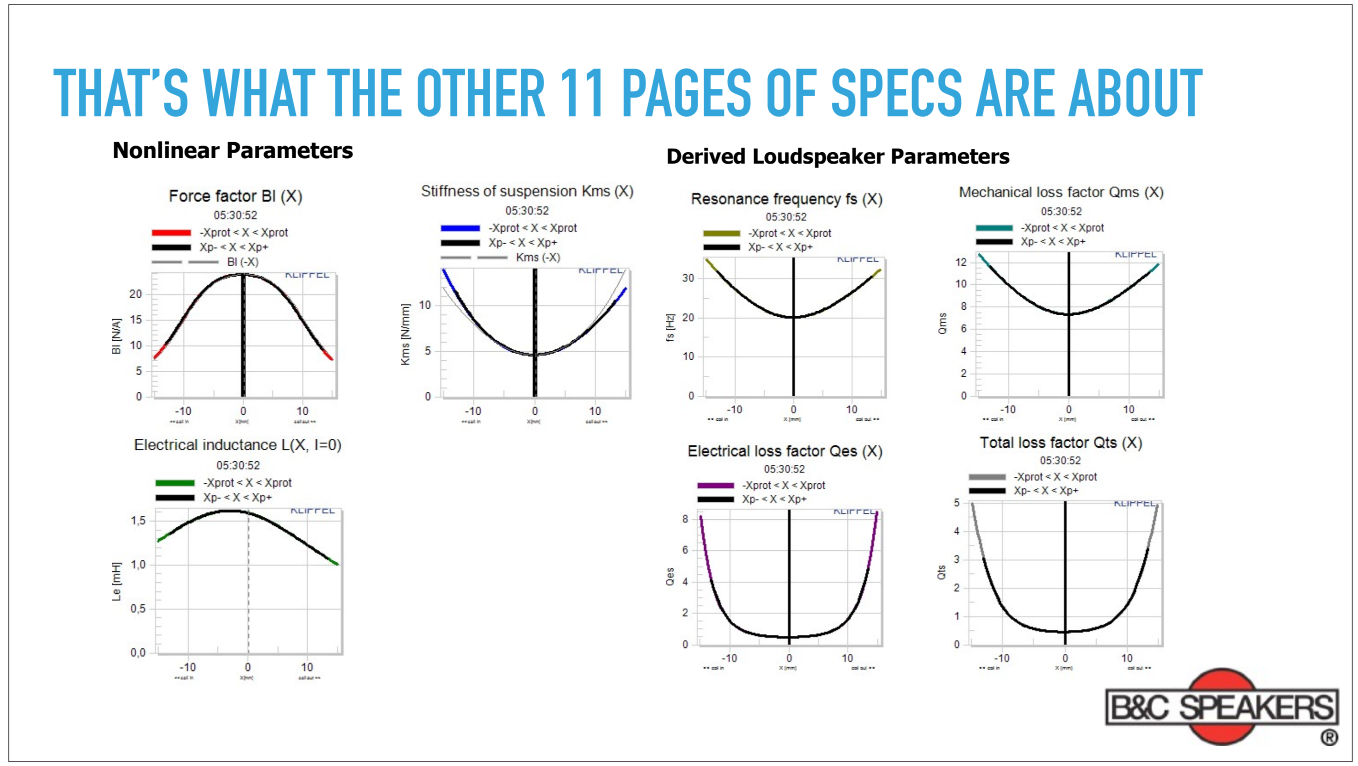
TRANSDUCER OVERPOWERING SHOULD BE A SOLVED PROBLEM.

This Guy Right Here

Plenty of amps available with real power limiters in DSP.

- Can keep coil from burning in almost any situation.
- Could check VC temp with sensor and avoid burning ever, likely not necessary.

Real devil in the room, most R&D time is spent studying mechanical limits.
We are not at limits of power handling capability, but in many cases are at the limits of (manufacturable) suspension technology.
No practical method to limit excursion with DSP - cannot detect actual coil position without unacceptable delay.



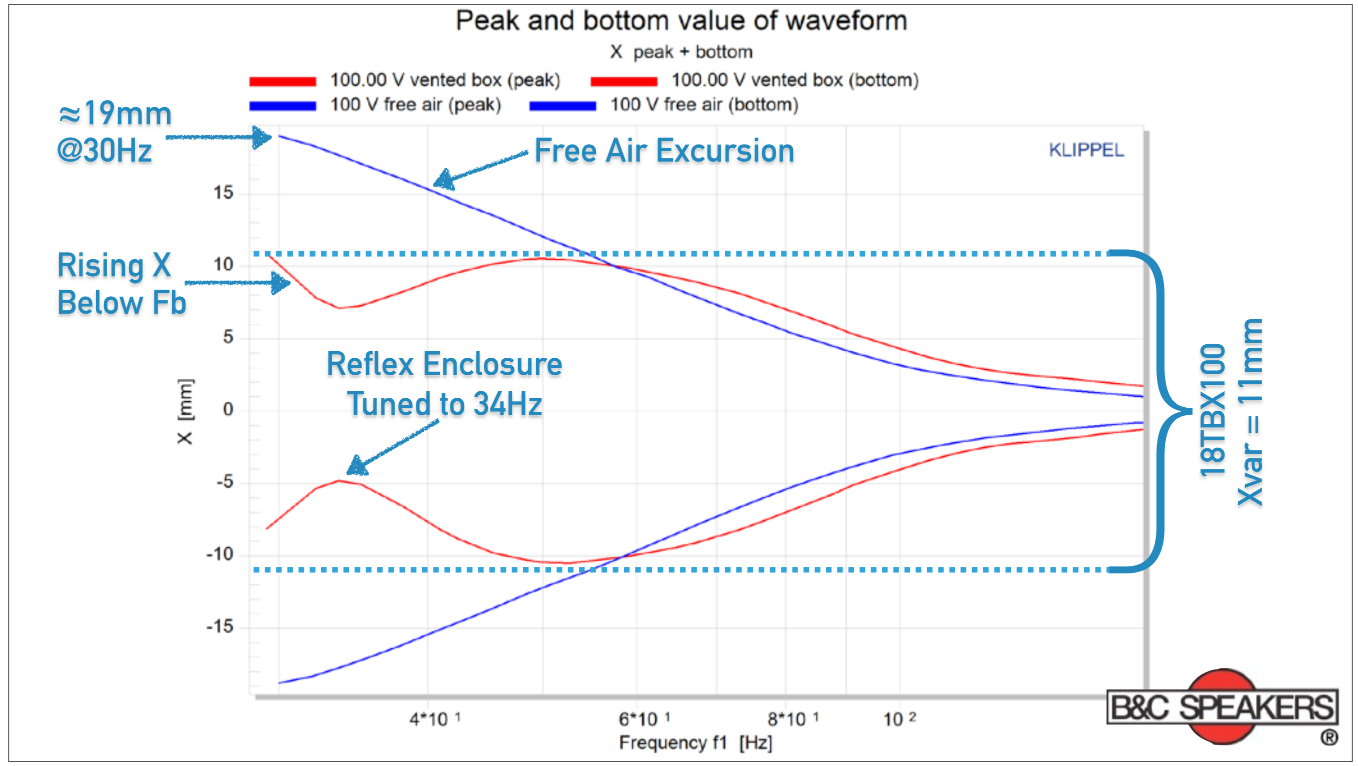
All parameters change with cone position, we study performance at limits.

Small signal (i.e. T-S) good starting point, like AES power, for comparison.

Easy to make look nice, even if transducer badly behaved at limit.

Coil overheating binary, either it still works and doesn't rub - or not.

Suspension aging is an unknown quantity.



Excursion dependent on enclosure *and* signal LF content.

Increases 4x (12dB) per 1/2 frequency (octave).

Crest factor unimportant, peaks don't cause X. Limiters can't save you.

Only 100VPk shown here, woofer capable of much more, but not in free air at 30Hz!

High pass filter and box are best defense against over-excursion.
Big amp rails are important for clean peaks.
    Delivered power actually pretty small - and controllable.
Must do lifetime testing in your own system and use case.