Cascaded Noise Figure of a Receiver Chain (Friis)

Overall noise figure, noise temperature and gain of up to three cascaded stages, such as an LNA, cable and mixer, by Friis's formula for noise.

Method: Friis formula for cascaded noise

Input parameters

Unit system: SI

Parameter	Value	Unit
Stage 1 noise figure (dB)	1.0000	
Stage 1 gain (dB; loss negative)	18.000	
Stage 2 noise figure (dB; a passive loss L has NF = L)	3.0000	
Stage 2 gain (dB)	-3.0000	
Stage 3 noise figure (dB)	10.000	
Stage 3 gain (dB)	20.000	

Calculated results

Parameter	Value	Unit
Overall noise factor (linear)	1.5593	
Overall noise figure (dB)	1.9293	
Equivalent noise temperature	162.20	K
Overall gain (dB)	35.000	
Noise figure added after stage 1 (dB)	0.92931	

Notes for this case

• Friis: F = F_1 + (F_2 − 1)/G_1 + (F_3 − 1)/(G_1G_2), with linear factors; T_e = 290(F − 1) K. A high-gain, low-noise first stage makes the later stages almost irrelevant.

Formula and method

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2}, \quad NF = 10 \log_{10} F, \quad T_e = 290(F - 1)$$

Variables

NF_1	Stage 1 noise figure (dB)	-
G_1	Stage 1 gain (dB; loss negative)	-
NF_2	Stage 2 noise figure (dB; a passive loss L has NF = L)	-
G_2	Stage 2 gain (dB)	-
NF_3	Stage 3 noise figure (dB)	-
G_3	Stage 3 gain (dB)	-
F	Overall noise factor (linear)	-
NF	Overall noise figure (dB)	-
T_e	Equivalent noise temperature	K
G	Overall gain (dB)	-
ΔNF_1	Noise figure added after stage 1 (dB)	-

Method and standards

Friis noise cascade.

Assumptions and limits

- Matched stages, linear operation, standard 290 K reference.

References

Friis formula for cascaded noise

Report details

Report reference	FCC-HAYW-07D2 (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/electronics/noise-figure-cascade

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.