Power dividers: Wilkinson

A power divider splits one signal into equal parts while keeping every port matched to 50 Ω and the outputs isolated; run backwards it is a combiner. The split itself is sharing; the part's own loss comes on top.

What a split costs

Ideal N-way split	$10 \log_{10} N$ dB per output	2-way 3.01 dB, 4-way 6.02 dB, 8-way 9.03 dB. Sharing, not heat.
Loss per path	3.01 dB + IL	Divider we stock, IL ≤ 1.0 dB: at most about 4.0 dB per path.
Resistive splitter	$R = Z_0/3 \approx 16.7\ \Omega$ (three in a star)	Works to DC, but 6.02 dB per output and only 6 dB between outputs.

The Wilkinson divider (50 Ω)

Quarter-wave lines	$Z_{line} = \sqrt{2}\, Z_0 \approx 70.7\ \Omega$, length $\lambda/4$	One section works near one frequency; wideband parts typically use several.
Isolation resistor	$R = 2Z_0 = 100\ \Omega$	Across the outputs. No current while both outputs carry the same signal.
Input match	$Z_{in} = Z_{line}^2/Z_{load}$	70.7^2 / 50 = 100 Ω per branch; two in parallel: 50 Ω.
Signal into one output	half to the resistor, half out of the input	The two paths to the other output cancel: that is the isolation.

Combining and open ports

Two equal inputs P	$P_{out} = P(1+\cos\varphi)$, $P_R = P(1-\cos\varphi)$	1 W + 1 W in phase: 2 W out. Opposite: 2 W in the resistor. Different frequencies: half each on average.
Open output	$\lvert\Gamma\rvert^2 = 1/4 \Rightarrow \text{VSWR} = 3$	A quarter of the input comes back out, another quarter heats the resistor.

Datasheet of the 2-way SMA divider we stock

Line	Limit	What it means
Frequency range	0.5–6 GHz	where all limits below apply
Insertion loss	≤ 1.0 dB	on top of the 3.01 dB split
Amplitude / phase balance	± 0.2 dB / ± 2°	how equal the two outputs are
Isolation	≥ 18 dB	output-to-output leakage
VSWR	≤ 1.4	return loss ≥ 15.6 dB
Power	30 W CW	as a divider; no combiner rating

Watch out

- As a combiner, power that does not add in phase ends up in the internal resistor. The 30 W CW is a divider rating; ask for the combiner rating before combining anything strong.
- Terminate unused outputs with a 50 Ω load. An open output sends about a quarter of the input power back out of the input (VSWR about 3).
- Isolation is finite: with 18 dB, a signal at one output appears 18 dB down at the other. Fine for two receivers on one antenna, not for a transmitter and a receiver.
- Stay inside 0.5–6 GHz: below 0.5 GHz the quarter-wave sections are electrically too short, and match and isolation fall off.

Full article, derivations and figures: kymopsis.com/rf-power-divider-splitter-wilkinson/

Formulas and values from the chapter; conditions as stated there. Free to print and share.