SMA attenuators: protect the input

A fixed pad lowers everything by a known number of dB, turns the rest into heat, and passes DC. Pick it by three numbers: how many dB, how many watts, and whether DC can reach the port.

Level and heat

Power in dBm	$P_{\text{dBm}} = 10 \log_{10} (P/1\ \text{mW})$	0 dBm = 1 mW, +10 dBm = 10 mW, +30 dBm = 1 W, +37 dBm = 5 W.
Level after a pad	$P_{\text{out}} = P_{\text{in}} - A$ (dBm, dB)	Pad needed = source level − instrument limit + margin.
Power left	$P_{\text{out}}/P_{\text{in}} = 10^{-A/10}$	30 dB passes 0.1%.
Heat in the pad	$P_{\text{heat}} = P_{\text{in}} (1 - 10^{-A/10})$	30 dB, 1 W in: 0.999 W of heat. In a stack the first pad takes the largest share: 90% or more if it is 10 dB or more.
DC into the pad	$P = V^2/50\,\Omega$	12 V of bias: 2.9 W, above a 2 W rating. Put a DC block first.

Inside the pad and the match

Pi pad, $K = 10^{A/20}$	$R_{\text{shunt}} = Z_0 \frac{K+1}{K-1}, \quad R_{\text{series}} = Z_0 \frac{K^2-1}{2K}$	50 Ω system, 10 dB: 96.2 Ω shunt, 71.2 Ω series.
Return loss through an ideal pad	$RL = 2A$	The reflection crosses the pad twice: a 10 dB pad adds 20 dB.
Return loss from VSWR	$RL = 20 \log_{10} \frac{\text{VSWR}+1}{\text{VSWR}-1}$	The pad's own VSWR 1.25 sets a ceiling of about 19.1 dB.
Sensitivity	$\Delta(\text{S/N}) = -A$	When the analyzer's own noise dominates, each dB of pad costs a dB.

Level after the pad

Source	Level	After 10 dB	After 20 dB	After 30 dB
Wi-Fi/BLE, 100 mW	+20 dBm	+10 dBm	0 dBm	−10 dBm
Radio, 1 W	+30 dBm	+20 dBm	+10 dBm	0 dBm
Radio, 5 W	+37 dBm	+27 dBm	+17 dBm	+7 dBm

Watch out

- The SMA pads we stock: DC–18 GHz, 2 W maximum input, VSWR 1.25; no derating curve or pulse rating stated. Leave margin in a warm box; a 5 W source needs a high-power pad first.
- Pads pass DC. The DC block we stock: 30 MHz–27 GHz, at most 0.8 dB loss, 2 W RF; no DC voltage stated, so ask before a 12 or 24 V line. It is specified from 30 MHz only: leave it out for HF.
- Accuracy from the datasheet: ±0.4 dB (1–5 dB), ±0.5 dB (6–10 dB), ±0.6 dB (15, 20 dB), ±0.8 dB (30 dB). Tolerances add when you stack.
- Unknown source: start with the biggest pad and remove pads one by one; never add pads to a hot input. Enter the pad value as the analyzer's reference offset.

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