Transistor Switch Base Resistor (BJT Saturation)

Base resistor to drive an NPN transistor into saturation as a switch from the drive voltage, load current and a forced current gain, with the base current and power.

Method: Saturated bipolar switch design

Input parameters

Unit system: SI

Parameter	Value	Unit
Drive voltage (logic high)	3.3000	V
Collector (load) current	150.00	mA
Forced current gain for hard saturation (about 10–20)	10.000	
Base-emitter voltage in saturation	0.80000	V
Load supply voltage	12.000	V
Collector-emitter saturation voltage	0.20000	V

Calculated results

Parameter	Value	Unit
Base resistor (largest value)	0.16667	kΩ
Base current	15.000	mA
Transistor dissipation I_C V_CE(sat) + I_B V_BE	42.000	mW
Equivalent load resistance (V_CC − V_CE)/I_C	78.667	Ω

Notes for this case

• R_B = (V_drive − V_BE)/(I_C/β_forced). A forced gain of about 10 guarantees saturation over temperature and transistor spread; check that the driving pin can source I_B. For inductive loads add a flyback diode.

Formula and method

$$I_B = \frac{I_C}{\beta_{forced}}, \quad R_B = \frac{V_{drive} - V_{BE(sat)}}{I_B}, \quad P_T = I_C V_{CE(sat)} + I_B V_{BE}$$

Variables

V_{drive}	Drive voltage (logic high)	V
I_C	Collector (load) current	A
β_{forced}	Forced current gain for hard saturation (about 10–20)	-
$V_{BE(sat)}$	Base-emitter voltage in saturation	V
V_{CC}	Load supply voltage	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V
R_B	Base resistor (largest value)	Ω
I_B	Base current	A
P_T	Transistor dissipation I_C V_CE(sat) + I_B V_BE	W
R_{load}	Equivalent load resistance (V_CC − V_CE)/I_C	Ω

Method and standards

Bipolar transistor switch design.

Assumptions and limits

- Saturated operation, room-temperature datasheet values.

References

Saturated bipolar switch design

Report details

Report reference	FCC-ZGSA-BRZY (the same inputs always give the same reference)
Generated	23 November 2026, 17:34 UTC
Calculator	Transistor Switch Base Resistor (BJT Saturation)
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
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/transistor-base-resistor

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.