Transistor Voltage-Divider Bias and Common-Emitter Gain

Quiescent collector current and voltage of an NPN transistor with voltage-divider bias, and the small-signal voltage gain of the common-emitter stage.

Method: Voltage-divider bias and small-signal common-emitter gain

Input parameters

Unit system: SI

Parameter	Value	Unit
Supply voltage	12.000	V
Upper divider resistor	47.000	kΩ
Lower divider resistor	10.000	kΩ
Collector resistor	4.7000	kΩ
Emitter resistor	1.0000	kΩ
Unbypassed part of the emitter resistor	0	kΩ
Load resistor (0 = none)	10.000	kΩ
Current gain	150.00	
Base–emitter voltage	0.65000	V

Calculated results

Parameter	Value	Unit
Thevenin bias voltage	2.1053	V
Collector current	1.3708	mA
Collector–emitter voltage	4.1775	V
Intrinsic emitter resistance V_T/I_E	18.735	Ω
Voltage gain (inverting)	-170.66	

Notes for this case

• Replacing the divider by its Thevenin equivalent, the base current is (V_TH − V_BE)/[R_TH + (β + 1)R_E]; the emitter resistor makes the collector current depend little on β. The small-signal gain is −(R_C ⍰ R_L)/(r_e + R_E,u), where r_e = V_T/I_E ≈ 26 mV/I_E at room temperature and R_E,u is the part of R_E not bypassed by a capacitor. Leaving some emitter resistance unbypassed trades gain for linearity and stability.

Formula and method

$$I_B = \frac{V_{TH} - V_{BE}}{R_{TH} + (\beta + 1)R_E}, \quad V_{CE} = V_{CC} - I_C R_C - I_E R_E, \quad A_v = -\frac{R_C \parallel R_L}{r_e + R_{E,u}}$$

Variables

V_{CC}	Supply voltage	V
R_1	Upper divider resistor	Ω
R_2	Lower divider resistor	Ω
R_C	Collector resistor	Ω
R_E	Emitter resistor	Ω
$R_{E,u}$	Unbypassed part of the emitter resistor	Ω
R_L	Load resistor (0 = none)	Ω
β	Current gain	-

V_{BE}	Base–emitter voltage	V
V_{TH}	Thevenin bias voltage	V
I_C	Collector current	A
V_{CE}	Collector–emitter voltage	V
r_e	Intrinsic emitter resistance V_T/I_E	Ω
A_v	Voltage gain (inverting)	-

Method and standards

Divider bias.

Assumptions and limits

- Active region; V_T at about 27 °C.

References

Voltage-divider bias and small-signal common-emitter gain

Report details

Report reference	FCC-7HDB-B8G2 (the same inputs always give the same reference)
Generated	23 November 2026, 17:34 UTC
Calculator	Transistor Voltage-Divider Bias and Common-Emitter Gain
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/bjt-voltage-divider-bias

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.