I²C Bus Pull-Up Resistor Range

Minimum and maximum pull-up resistor for an I²C bus from the supply voltage, low-level current, bus capacitance and the rise-time limit of the bus mode.

Method: Pull-up limits from the I²C bus specification

Input parameters

Unit system: SI

Parameter	Value	Unit
Bus mode	Fast-mode 400 kHz (t_r ≤ 300 ns)	
Pull-up supply voltage	3.3000	V
Total bus capacitance	150.00	pF
Maximum low-level output voltage	0.40000	V

Calculated results

Parameter	Value	Unit
Minimum pull-up (V_DD − V_OL)/I_OL	0.96667	kΩ
Maximum pull-up t_r/(0.8473 C_b)	2.3604	kΩ
Rise-time limit of the mode	300.00	ns
Sink current of the mode	3.0000	mA
Suggested value (geometric mean)	1.5106	kΩ

Notes for this case

• Rise time measured 30 % to 70 % of V_DD: t_r = 0.8473 R_p C_b. Pick a standard value between the limits; lower values give faster edges and more noise margin at higher current.

Formula and method

$$R_{p,min} = \frac{V_{DD} - V_{OL,max}}{I_{OL}}, \quad R_{p,max} = \frac{t_r}{0.8473\, C_b}$$

Variables

mode	Bus mode	-
V_{DD}	Pull-up supply voltage	V
C_b	Total bus capacitance	F
V_{OL}	Maximum low-level output voltage	V
$R_{p,min}$	Minimum pull-up (V_DD − V_OL)/I_OL	Ω
$R_{p,max}$	Maximum pull-up t_r/(0.8473 C_b)	Ω
t_r	Rise-time limit of the mode	s
I_{OL}	Sink current of the mode	A
R_p	Suggested value (geometric mean)	Ω

Method and standards

Open-drain bus pull-up sizing.

Assumptions and limits

- Resistive pull-ups; specification limits for each mode.

References

Pull-up limits from the I²C bus specification

Report details

Report reference	FCC-8H2E-ZG2J (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/i2c-pull-up-resistor

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.