4–20 mA Loop Load Resistance and Cable Length

Largest loop resistance a 4–20 mA transmitter can drive from the supply and its lift-off voltage, the loop's actual resistance and the longest cable allowed.

Method: Two-wire 4–20 mA loop (IEC 60381-1 signal, transmitter load line)

Input parameters

Unit system: SI

Parameter	Value	Unit
Loop supply voltage	24.000	V
Lowest voltage the transmitter needs at its terminals From the transmitter data sheet (lift-off voltage).	12.000	V
Highest loop current to allow for (alarm or saturation)	22.000	mA
Input resistance of the receiving card	250.00	Ω
Other loads in the loop (barrier, indicator)	0	Ω
Resistance of one cable core per length	18.500	Ω/km
Cable length, one way	500.00	m

Calculated results

Parameter	Value	Unit
Largest total loop resistance allowed	545.45	Ω
Actual loop resistance (loads plus both cores)	268.50	Ω
Spare resistance	276.95	Ω
Voltage at the transmitter at the highest current	18.093	V
Longest cable for these loads	7,985.3	m

Formula and method

$$R_{max} = \frac{V_s - V_{min}}{I_{max}}, \quad R_{loop} = R_{in} + R_x + 2r_cL$$

$$V_t = V_s - I_{max}R_{loop}, \quad L_{max} = \frac{R_{max} - R_{in} - R_x}{2r_c}$$

Variables

V_s	Loop supply voltage	V
V_{min}	Lowest voltage the transmitter needs at its terminals	V
I_{max}	Highest loop current to allow for (alarm or saturation)	A
R_{in}	Input resistance of the receiving card	Ω
R_x	Other loads in the loop (barrier, indicator)	Ω
r_c	Resistance of one cable core per length	Ω/m
L	Cable length, one way	m
R_{max}	Largest total loop resistance allowed	Ω
R_{loop}	Actual loop resistance (loads plus both cores)	Ω
$R_{max} - R_{loop}$	Spare resistance	Ω
V_t	Voltage at the transmitter at the highest current	V
L_{max}	Longest cable for these loads	m

Method and standards

A two-wire transmitter needs its minimum terminal voltage at the highest loop current; whatever the supply has left over can be dropped across the receiving card, barriers and both cable cores.

Assumptions and limits

- Steady current; supply at its lowest tolerance value if you enter it.
- Cable resistance at the value entered: correct it for the hottest conductor temperature (about +0.4 % per K for copper), which reduces the margin.
- With zero cable resistance no length limit is shown.

References

- Two-wire 4–20 mA loop (IEC 60381-1 signal, transmitter load line)

Report details

Report reference	FCC-W8PE-0G8S (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/instrumentation/control-loops/loop-load-resistance-4-20ma

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.