

Cable Design Equations – Balanced Pair

CAPACITANCE (UNSHIELDED TWISTED PAIR):

$$C = \frac{2.2 \epsilon}{\text{LOG} \left(\frac{1.3 (D)}{(f) (d)} \right)}, \text{ pF/ft}$$

IMPEDANCE (UNSHIELDED TWISTED PAIR):

$$Z_0 = \frac{1016 \epsilon^{1/2}}{C}, \Omega$$

CAPACITANCE (SHIELDED TWISTED PAIR):

$$C = \frac{3.7 \epsilon}{\text{LOG} \left(\frac{1.2 (D)}{(f) (d)} \right)}, \text{ pF/ft}$$

IMPEDANCE (SHIELDED TWISTED PAIR):

$$Z_0 = \frac{276}{\epsilon^{1/2}} \text{LOG} \left(\frac{1.2 (D)}{(f) (d)} \right), \Omega$$

CAPACITANCE (OVERALL SHIELDED & CABLED):

$$C = \frac{2.9 \epsilon}{\text{LOG} \left(\frac{1.5 (D)}{(f) (d)} \right)}, \text{ pF/ft}$$

IMPEDANCE (OVERALL SHIELDED & CABLED):

$$Z_0 = \frac{347}{\epsilon^{1/2}} \text{LOG} \left(\frac{1.5 (D)}{(f) (d)} \right), \Omega$$

where:

- C = mutual capacitance, pF/ft
- ε = insulation dielectric constant (see Table I)
- f = stranding factor (see Table II)
- d = diameter of the conductor, inches
- D = diameter over the insulation, inches
- Z₀ = characteristic impedance Ω

TABLE I

DIELECTRIC CONSTANTS & V _p OF INSULATIONS		
MATERIAL	ε	V _p , %
ECTFE (Halar™)	2.60	63
FEP	2.15	68
PFA Teflon®	2.15	68
PVC	5.00	45
PVC (Semi-rigid)	3.60	53
PVDF (Kynar™, SOLEF™)	7.70	36
Polyethylene	2.29	66
Polypropylene	2.25	67
Polyurethane	6.50	39
Rubber, butyl	4.0	50
Rubber, natural	5.0	45
Rubber, SBR	4.0	50
Rubber, silicone	3.1	57
TFE Teflon®	2.1	69
TPE	5.0	45
Teflon®	2.10	69
Tefzel®	2.6	62

TABLE II

NO. OF STRANDS	f
1	1.000
7	0.939
19	0.970
37	0.980
61	0.985
91	0.988