Cable Design Equations—Balanced Pair

CAPACITANCE (UNSHIELDED TWISTED PAIR):

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

IMPEDANCE (UNSHIELDED TWISTED PAIR):

$$Z_o = \frac{1016\ \varepsilon^{1/2}}{C},\ \Omega$$

CAPACITANCE (SHIELDED TWISTED PAIR):

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

IMPEDANCE (SHIELDED TWISTED PAIR):

$$Z_o = \frac{276}{\varepsilon^{1/2}}\ \text{LOG}\left[\frac{1.2\ (D)}{(f)\ (d)}\right],\ \Omega$$

CAPACITANCE (OVERALL SHIELDED & CABLED):

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

IMPEDANCE (OVERALL SHIELDED & CABLED):

$$Z_o = \frac{347}{\varepsilon^{1/2}}\ \text{LOG}\left[\frac{1.5\ (D)}{(f)\ (d)}\right],\ \Omega$$

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
- Z_o = 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