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E-BOOK 10 INTERMEDIATE EDITION

Cable Sizing, LT Panel & Short-Circuit (kA) Guide

Current, Voltage Drop, Derating, K Factor and Main DB Ratings Made Practical



FIG 10.1 — PCC / MCC SWITCHGEAR & SHORT-CIRCUIT FAULT WITHSTAND

SYLLABUS
10 Structured Chapters

CALCULATIONS
Worked SI Examples & Tables

SITE READY
Forms & Hinglish Glossary

Shree Ganesh Enterprises (SGE) — AMC MEP 24x7
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Cable Sizing, LT Panel & Short-Circuit (kA) Guide

Current, Voltage Drop, Derating, K Factor and Main DB Ratings Made Practical

A practical electrical design and site execution guide covering connected/demand load estimation, the 3-step LT cable sizing method (ampacity with derating, mV/A/m voltage drop, and I2t short-circuit withstand), transformer prospective fault current (kA) for breaker selection, clear resolution of 'K factor' vs 'kA rating', LT panel busbars, and pre-energisation testing.

Intended Audience: Electrical site engineers, LT panel builders, MEP project supervisors, commissioning engineers, and engineering students verifying feeder calculations.

Engineering Notice & Standards Policy

This publication is an educational and field-reference guide prepared by **Shree Ganesh Enterprises (SGE)**. It is **not** a substitute for a stamped project design, statutory approval, or the governing text of the National Building Code of India (NBC), Bureau of Indian Standards (BIS) codes, Indian Electricity Rules / CEA Regulations, or your State/Municipal Fire Service Bye-Laws. Standards are cited at document level; always verify the **current applicable edition**, manufacturer datasheets, and local amendments before design, procurement, testing, or certification.

Worked numerical examples across this book are illustrative engineering demonstrations. All design inputs, pipe friction factors, battery deratings, and protective clearances must be re-checked for project conditions by a competent licensed professional. High-voltage electrical testing, pump-room servicing, and gaseous fire suppression operations can be fatal if undertaken without qualified personnel, written Permits-to-Work, and Lockout-Tagout (LOTO) controls.

Roman-script Hindi/Hinglish site terms are included cleanly to assist execution teams; formal English engineering terminology governs contractual and code interpretations.

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What You Will Learn

- Calculate accurate 3-phase and single-phase Full Load Currents (FLA) from motor kW and panel kVA
- Select Cu vs Al and PVC vs XLPE vs FRLS/FS cable insulation cleanly using ambient and grouping derating
- Execute quick mV/A/m voltage drop arithmetic to stop motor under-voltage burnout on long runs
- Calculate prospective short-circuit current (Isc in kA) from transformer %Z to pick safe Main DB breakers
- Separate the two meanings of 'K factor' cleanly (adiabatic cable withstand 'k' vs harmonic K-factor rating)
- Check LT panel busbar density, armour gland earthing, insulation resistance (IR), and Lockout-Tagout safety

Chapter 1: Connected Load, Demand Factor and 3-Phase Current Calculation

Sizing Begins with Accurate Amperes, Not Wild Guesses

Buying a heavier cable than needed drains project budgets; picking one size too thin overheats insulation inside trays, starves fire pump motors during voltage dips, and melts terminations. Every calculation starts cleanly from **Power to Amperes**.

- **Connected Load:** Total sum of nameplate kW / kVA across every appliance wired onto a distribution board.
- **Maximum Demand:** Connected Load multiplied by **Diversity / Demand Factor** (for instance, an office tower does not run every lift, HVAC chiller, microwave, and spare hydrant pump simultaneously at 100% nameplate load—except dedicated individual motor feeders like a single fire pump, which always size at **100% Full Load + starting margin!**).

FORMULA

`Three-Phase Full Load Current (415 V AC nominal): I_3ph (Amps) = (Power_W) / (1.732 x V_ll x pf x efficiency) Single-Phase Full Load Current (230 V AC nominal): I_1ph (Amps) = (Power_W) / (V_ln x pf x efficiency)` *(For kVA equipment like transformers or ups heaters directly: drop pf and efficiency since kVA already represents apparent power: I_3ph = (kVA x 1,000) / (1.732 x 415) !)*

WORKED EXAMPLE 1

45 kW Fire Pump Motor Full-Load Current (Illustrative). A three-phase 415 V fire pump motor has rated shaft mechanical output **45 kW**, assumed power factor **0.85**, and assumed motor efficiency **92% (0.92)**.

Electrical input power drawn = `45,000 W / 0.92 = 48,913 W`. Full Load Current (FLA) = `48,913 / (1.73205 x 415 x 0.85) = 48,913 / 610.98 = 80.06 Amps` ! Note: A Star-Delta or DOL motor draws **5x to 7x** locked-rotor starting current briefly; ensure upstream MCCB/starter and feeder voltage drop handle start cleanly!

HINGLISH

Connected load = poore board ke sabhi equipment ka kul kW jor. Full Load Current (FLA) = poora wajan dalne par motor dwara khincha jaane wala asli ampere.

Chapter 2: Cable Construction — Cu vs Al, PVC vs XLPE, Armoured vs FRLS

Decoding Cable Alphabet Soup on Site

Parameter Choice	Common Options	Engineering Reasoning & Best Placement
Conductor Metal	Copper (Cu) vs Aluminium (Al)	Copper handles higher current density per mm2 (~1.6x smaller area), bends cleanly inside tiny motor boxes, resists creep; Aluminium cuts heavy feeder cost cleanly above 25–35 mm2!
Insulation Polymer	PVC (70 C max) vs **XLPE (90 C max)**	XLPE carries ~20–25% higher continuous ampacity & better short-circuit thermal withstand (`250 C` peak vs `160 C` PVC!)—preferred for virtually all power mains
Mechanical Armour	Flat GI Wire / Strip Armoured (`AYFY` / `A2XFY`) vs Unarmoured	Underground trenches & exposed trays demand steel armour protection against impact/rodents
Fire Behaviour	Standard PVC vs **FRLS** vs **Fire Survival (FS)**	FRLS delays flame spread & cuts black smoke in shafts; **Fire Survival (mica-tape wrapped)** keeps power running *through* active fire for Fire Pumps, Smoke Fans & Fire Lifts!

FIELD TIP

Never bend a stiff multi-core XLPE armoured feeder tighter than manufacturer minimum bending radius (often **12x to 15x** overall cable outer diameter)—sharp 90-degree hammer bends inside panel cable boxes crack insulation internally!

Chapter 3: The 3-Step Cable Selection Method and Derating Factors

Why Datasheet Ampacity Numbers Shrink on Real Sites

Catalog manufacturer ampacity tables assume clean laboratory environments (e.g., single isolated cable resting in 30 C free air or 25 C cool soil). On crowded Indian MEP shaft trays packed tightly at 45 C summer ambient, heat cannot escape! Always execute **THREE independent checks** and pick the largest size required across all three:

1. **Check 1 — Derated Continuous Ampacity (`I_catalog x K_total >= I_design`)**
2. **Check 2 — Percentage Voltage Drop (`%dV <= code/project limit`)**
3. **Check 3 — Short-Circuit Thermal Withstand (`I^2 t <= k^2 S^2`)**

Derating Parameter	Why It Reduces Rating	Illustrative Typical Range *(Verify Vendor Sheet!)*
Ambient Air Temperature	Hot ceiling slabs / DG rooms cool slower	At 40 C air (~0.91 for 90 C XLPE; ~0.87 for 70 C PVC); at 45 C (~0.87 XLPE)
Grouping / Bunching Factor	Touching parallel cables trap mutual heat	2 touching circuits (~0.88), **3 touching (~0.79)**, 6 touching (~0.68) on perforated tray
Ground Depth & Soil Thermal Resistivity	Dry sandy soil blocks heat dissipation vs damp loam	Adjust strictly per cable OEM burial depth & spacing chart

WORKED EXAMPLE 1 (CONTINUED — DERATED FEEDER SELECTION)

Our 45 kW pump requires **80.1 A** FLA. Suppose feeder runs bundled inside a 40 C basement tray alongside 2 other loaded touching feeders (`3 circuits total -> K_group = 0.79` illustrative; `K_temp = 0.91` illustrative).

Combined Derating Factor `K_total = 0.79 x 0.91 = 0.719` . Required Minimum Base Catalog Rating = `80.1 A / 0.719 = 111.4 Amps` ! Check standard 3.5C/4C XLPE Armoured Aluminium cable in air datasheet (confirm OEM table!): typically `35 mm2 Al XLPE` sits around ~105–110 A in air (TOO CLOSE / borderline fail!), while **50 mm2 Al XLPE** sits cleanly around ~130–140 A -> Pick **50 mm2 Al XLPE** (or **25–35 mm2 Cu XLPE**)!

HINGLISH

Derating factor = garmi ya saath-saath bichi cables ki wajah se taar ki asli bijli jhelne ki kshamta ghatne wala hisaab.

Chapter 4: Voltage-Drop Calculation (mV/A/m Method) and Motor Starting Check

Amps Fit, Yet Pump Trips on Low Volts!

Passing current ampacity means cable won't melt—it does *not* prove voltage reaches the motor across a 180-metre basement run! Every manufacturer catalog prints a **mV/A/m** voltage-drop constant (millivolts dropped per Ampere per metre of 3-phase run—already accounting for both resistance and reactance cleanly!).

FORMULA

```
Delta_V (Volts) = (mV/A/m x I_load x Length_m) / 1,000  % Voltage Drop = (Delta_V / Nominal_Voltage_V) x 100  (Verify allowable drop against IS 732 / IEC 60364 / consultant spec—commonly ~3%–5% steady run across power feeders, checking motor starting surge doesn't pull terminal volts below starter contactor coil hold-in!).
```