

Industrial wiring & panel build guide

Practical conventions for building control panels that pass inspection, are safe to work on and can be maintained by someone who has never met you. Aligned with IEC 61439, IEC 60204-1 and common Kenyan utility practice.

1 · Layout principles

- Split the backplate by energy level: incoming and power distribution top-left, drives and contactors centre, 24 V DC control and PLC lower or right. Keep a clear vertical spine for wire ducts.
- Leave 20 % free DIN rail and 30 % free duct capacity. Every panel gets modified within two years.
- Mount heat sources (drives, transformers, PSUs) with the manufacturer's clearances and never directly below sensitive electronics.
- Doors carry HMI, pilot devices and E-stop only — no terminals, no components that need a wiring loom crossing the hinge without a door loop.

2 · Conductor sizing and colour

Circuit	Colour (IEC 60204-1)	Typical size	Notes
AC power, live	Black	$\geq 2.5 \text{ mm}^2$	Size to breaker, derate for ambient and grouping
AC neutral	Light blue	= phase	Never switch neutral alone
Protective earth	Green / yellow	$\geq$ phase up to 16 mm^2	Star point on PE bar, no daisy chain
AC control	Red	1.0–1.5 mm^2	Fused separately from power
24 V DC positive	Dark blue	0.75–1.5 mm^2	Fused per load group
24 V DC common	White / blue	0.75–1.5 mm^2	Single 0 V reference point
External / live with main off	Orange	as required	Label the source on the door
Analogue / instrument	Shielded pair	0.5 mm^2	Shield earthed at panel end only

3 · Termination workmanship

- One conductor per terminal point. Two conductors need a jumper bar or a double-level terminal, never a doubled-up screw.
- Ferrules on every stranded conductor, crimped with a four-indent tool. No tinned conductor ends under screw terminals — solder cold-flows and the joint loosens.
- Torque terminals to the manufacturer's figure and mark them. Re-torque power terminals after 48 hours of thermal cycling.
- Strip length matched to the terminal: no copper visible outside, no insulation trapped inside.

- Wire numbers at both ends matching the schematic, readable in the same orientation across the panel.

4 · Segregation and EMC

- Minimum 100 mm separation between motor cables and signal cables; cross at 90° where they must meet.
- Use screened motor cable with 360° EMC glands at both drive and motor. Pigtailed defeat the screen.
- Bond the backplate, door, gland plate and DIN rails with braid — paint is not a conductor.
- Keep a single 0 V star point; multiple ground references are the usual cause of drifting analogue readings.
- Suppress every inductive load: RC across AC coils, flyback diode across DC coils.

5 · Protection and safety

- Coordinate protection: upstream breaker, motor circuit breaker, contactor and overload chosen as a verified combination (type 2 coordination).
- Selectivity between the main incomer and the branch devices so a single fault does not black out the plant.
- Control transformer or 24 V PSU sized for inrush, with the secondary fused and one leg earthed where required.
- Safety circuits wired to the required performance level with dual channel monitoring; no safety functions in standard PLC logic.
- Arc-flash and voltage labelling, lockout points identified, and a laminated schematic pocket inside the door.

6 · Pre-power test sequence

- Continuity of PE to every door, plate and metal enclosure part: $< 0.1 \Omega$.
- Insulation resistance at 500 V DC with electronics disconnected: $> 1 M\Omega$.
- Point-to-point ring-out of control circuits against the schematic.
- Dielectric test where required by IEC 61439 for the assembly class.
- Energise stage by stage: incomer, distribution, PSU, control, drives — verifying voltage at each step before the next.

7 · Documentation pack

- As-built schematics, panel layout, bill of materials with part numbers and suppliers.
- I/O list with tag numbers, signal type, range and destination.
- Parameter files for drives, PLC and HMI backups, and licence keys.
- Test records: continuity, IR, functional tests, torque log and punch list closure.
- Spares list and recommended maintenance intervals.

Standards referenced: IEC 61439-1/-2 (low-voltage assemblies), IEC 60204-1 (electrical equipment of machines), IEC 60364 and KS IEC 60364 (installations), ISO 13849-1 (safety-related control systems).