VOLTAGE OPTIMISATION

Technical Guide | Industrial Electrical Installations

Practical engineering guidance on assessing, specifying, installing and verifying voltage optimisation (VO) systems for factories, warehouses and manufacturing facilities. System suitability and savings must be demonstrated for the actual site.

01 | Principle of operation

A voltage optimisation system controls the voltage delivered to selected electrical loads, typically through transformer-based regulation or other manufacturer-specific arrangements. The purpose is to avoid unnecessarily high supply voltage where equipment can operate efficiently and safely at a lower level. VO does not automatically reduce the energy consumption of every connected load.

02 | Site voltage and demand survey

Record incoming and downstream voltages over a representative operating period, including peak production, low-load conditions and starting events. Measure real power (kW), energy (kWh), current, power factor and where appropriate harmonics and voltage imbalance. Confirm minimum and maximum voltage, supply arrangements and any existing on-site generation.

03 | Load-by-load suitability assessment

Identify voltage-dependent loads such as some resistive and lighting equipment, and distinguish them from constant-power or electronically regulated loads. Variable-speed drives, switch-mode power supplies and some modern LED drivers may offer little direct energy saving. For motors, reducing voltage may alter torque, current, temperature and starting performance; verify equipment requirements rather than assuming a benefit.

04 | Voltage limits and performance

Check the statutory supply characteristics and each connected item’s permitted operating range, including transient and low-voltage conditions. The chosen regulated output must leave adequate margin for voltage drop, motor starts and normal supply variation. Avoid settings that could cause undervoltage trips, contactor dropout or reduced process reliability.

05 | Baseline energy and financial appraisal

Estimate potential savings using measured load composition and voltage response, not a fixed percentage of total site consumption. Compare equivalent operating conditions before and after installation, allowing for production output, weather, operating hours and equipment changes. Include system losses, maintenance, shutdown costs and any bypass operation in payback calculations.

DESIGN & INSTALLATION

06 | Electrical integration

Assess the proposed point of connection relative to the incoming LV supply, main switchboard, distribution sections and critical loads. Confirm maximum demand, continuous current, prospective short-circuit current, thermal rating and system compatibility. A site may benefit from optimising selected distribution sections rather than the whole installation.

07 | Protection, isolation and bypass

Design suitable upstream/downstream protection, isolation and safe maintenance arrangements. Where operational continuity is important, consider a correctly rated bypass arrangement and interlocking to prevent unsafe switching. Review discrimination, protective conductor continuity, fault levels and the manufacturer’s fault and overload behaviour.

08 | Submains, earthing and neutral

Check cable sizing, voltage drop, short-circuit withstand, terminations and ventilation around the unit. Confirm earthing and neutral arrangements, including any implications for RCDs, earth fault protection, surge protection and transformer construction. Never assume the VO unit changes the earthing system without a verified design.

09 | Industrial machinery and process loads

Assess DOL and soft-start motors, VSD-fed drives, compressors, conveyors, pumps, production lines, contactors, PLCs and safety controls. Review start-up sequences and maximum inrush currents. Exclude or separately feed sensitive, safety-critical or manufacturer-restricted loads where necessary. A site trial may be appropriate before committing to a full installation.

10 | Power quality and monitoring

Consider harmonic distortion, phase imbalance, flicker, transients and interaction with power factor correction equipment, UPS systems, solar PV and standby generators. Select monitoring points that permit meaningful upstream/downstream comparison. Any claim that VO improves power quality should be supported by the chosen equipment’s tested capabilities.

11 | Physical installation and shutdown planning

Confirm footprint, access, floor loading, lifting arrangements, clearances, cooling, environmental rating and maintenance access. For live production sites, coordinate an approved isolation and switching plan, lock-off arrangements, temporary supply needs and commissioning windows. Install and test to the applicable requirements of BS 7671 and the manufacturer.

COMMISSIONING & VERIFICATION

12 | Pre-energisation checks

Verify equipment identification, ratings, cable terminations, earthing, insulation and continuity as appropriate, protective settings, bypass logic, ventilation and safe access. Confirm that all intended loads are suitable for the proposed output voltage and that any excluded circuits remain correctly supplied.

13 | Functional commissioning

Record incoming and outgoing voltages on each phase under representative loading. Test normal operation, regulation response, alarms, protection and bypass operation in accordance with the manufacturer's instructions. Verify machinery starts, controls and safety-related functions remain reliable. Record settings and test outcomes.

14 | Measurement and verification

Compare pre- and post-installation energy performance over sufficiently representative periods. Use agreed metering boundaries and normalisation factors such as production throughput, shift patterns and operating hours. Separate demonstrable kWh savings from reduced kVA, current or voltage readings, which alone do not establish energy savings.

15 | Handover and ongoing maintenance

Provide updated schematics, operating instructions, isolation/bypass procedures, test records, equipment settings, monitoring arrangements and manufacturer documentation. Agree maintenance intervals and periodic review of performance, especially after major machinery changes or electrical distribution alterations.

ENGINEERING CHECKLIST

Survey	Voltage profile, kW/kWh demand, power quality and load inventory
Compatibility	Equipment operating ranges, motor starting and sensitive loads
Electrical design	Fault level, current rating, protection, earthing and cable design
Operations	Bypass, shutdown strategy, access and maintenance provisions
Verification	Commissioning readings and normalised energy comparison

QUEST Electrical: Industrial LV distribution, metering, power monitoring and electrical infrastructure assessments to support informed voltage optimisation decisions.

Note: This guide is general technical information, not a project-specific design, guaranteed savings estimate or product specification. Confirm current applicable standards, manufacturer requirements and site conditions before installation.