

Executive Brief: High-Voltage Design & Standards Summary

Executive Summary

This brief summarizes the technical parameters, compliance testing, and regulatory voltage classifications relevant to the ATE-32 Potential Transformer (PT) interface hardware used in hydro governor control systems. The layout and physical insulation design ensure full galvanic isolation, high dielectric withstand capacity, and compliance with international standards for power-generation environments.

Key Compliance & Dielectric Test Results

Official testing (CRIQ EMC Test Report No. 29739) confirms that the PT interface module meets rigorous international industrial standards:

- **Dielectric Rigidity (IEC 60255-5):** Successfully withstood **2.0 kV AC** relative to ground with a minimal leakage current of **0.031 mA**.
- **Impulse Voltage Withstand (IEC 60255-5):** Withstood **5.0 kV** transient surges (0.5 Joules energy) without arc-over or dielectric breakdown.

Physical PCB Architecture & Isolation Strategy

The physical board design achieves galvanic separation between primary sensing inputs and secondary control processing through three key features:

Parameter	Design Implementation	Engineering Purpose
Clearance Boundary	1/2 inch (12.7 mm) blue air-gap zone devoid of copper traces on top (red) or bottom (green) layers.	Prevents air breakdown under 2.0 kV continuous or 5.0 kV surge conditions.
Isolation Barrier Bridge	AD210AN Isolation Amplifier rated at 2,500 V rms (Continuous) / +/- 3,500 V Peak (Continuous).	Allows signal transmission while preventing direct electrical coupling.
EMI Prevention	Milled physical slots cut into the FR-4 dielectric to mount the magnetic flux suppression shroud.	Captures stray flux leaking from toroidal transformers inside the AD2310AN.

Technical Clarification: 2,500 V vs. 3,500 V Ratings

The AD210AN isolation amplifier is commonly referred to by two voltage figures depending on whether AC RMS or AC Peak notation is used:

- **2,500 V rms Continuous:** The effective continuous AC RMS isolation capacity.

- **+/- 3,500 V Peak Continuous:** The absolute peak continuous AC sine-wave voltage isolation (2,500 V rms multiplied by the square root of 2 yields approximately 3,535 V peak).

Voltage Classification & Standard Definitions

While equipment dealing with 115 VAC to 600 V requires strict handling due to human safety thresholds, official engineering frameworks classify voltages into distinct tiers:

- **Lethality Hazard Threshold (≥ 50 V AC / 120 V DC):** Voltages above 50 V present electrocution hazards to human tissue, dictating circuit insulation and touch-safety requirements.
- **Low Voltage ($\leq 1,000$ V AC):** Under IEC and modern NEC guidelines, voltages up to 1,000 V (including 115 VAC, 200 V, 480 V, and 600 V) are formally classified as **Low Voltage**.
- **Medium Voltage (1,000 V to 69,000 V):** Standard classification for regional distribution and generator output lines.
- **High Voltage ($> 69,000$ V or > 69 kV):** Utility transmission lines; IEC defines general high voltage as anything exceeding 1,000 V AC or 1,500 V DC.

Operational Role: ATE-32 Bus Frequency Sensing

- **Primary Function:** Converts incoming 115 VAC Bus VT signals into a 24 VDC pulse stream routed to a High-Speed Counter for grid synchronization.
- **Isolation Amplifier provides High Insulation Resistance.**
- **Three-Pole Butterworth filter** to block main breaker contact bounce noise.