Transformer Protection Relay

T-PRO 2000

Product Overview

The T-PRO 2000 is a numerical, multifunction transformer protection relay, designed to provide dependable and versatile protection solutions that enhance the safety, reliability, and longevity of two winding transformers. Its user-friendly settings software and draw-out construction, streamline both commissioning and ongoing maintenance, thereby reducing time and effort for operators and end users. The T-PRO 2000 is also an ideal solution for ensuring optimal transformer protection, offering robust functionality with seamless integration across diverse industrial applications.

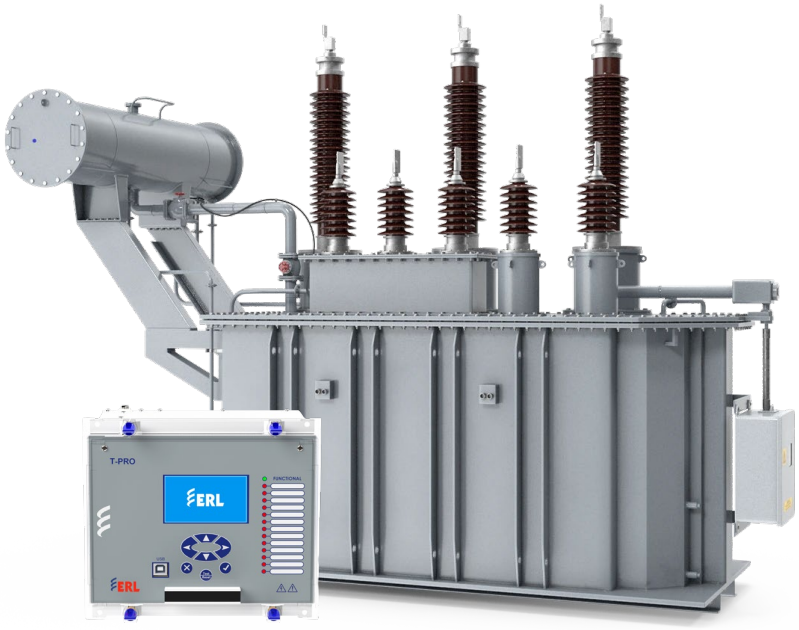
Designed with precision, it provides a comprehensive range of Key features, including:

- **Advanced Monitoring and Metering:** Ensures continuous, real-time monitoring of transformer health and performance.
- **Robust Communication Capabilities:** Seamless integration into your existing infrastructure with support for various communication protocols such as IEC 61850 Ed2.0 and DNP 3.0, along with serial-based protocols like IEC 60870-5-103, DNP 3.0, and Modbus RTU/ASCII for flexible connectivity.
- **Fault Logs and Disturbance Recordings:** Detailed logging for accurate fault diagnosis, aiding in quicker resolution of issues.
- **Sequence-of-Events Tracking:** Features high-resolution timestamping (1ms) for precise fault analysis and diagnostics.
- **Flexible Connectivity Options:** Offers both electrical and fiber-optic ports, ensuring adaptability in diverse network environments.
- **Optional PRP Support:** Configurable feature for IEC 62439-3 (Parallel Redundancy Protocol), providing enhanced system reliability in mission-critical applications.

Application

Applicable on a wide Range of two winding transformers used in Generation, Transmission, Distribution utilities.

Comprehensive primary and backup protection, along with advanced management, for small, medium, and large power transformers and reactors.



Features & Benefits

Protection Functions

- Transformer differential (87)
- Neutral Current Differential (87N)
- Phase Definite Time Under/Over Voltage (27/59 DT)
- Phase Inverse Time Under/Over Voltage (27/59 IT)
- Definite Time Over flux (24 DT)
- Inverse Time Over flux (24 IT)
- Measured Residual Definite Time Overvoltage (59G DT)
- Measured Residual Inverse Time Overvoltage (59G IT)
- DMT Phase Overcurrent (50 -HV/LV)
- IDMTL Phase Overcurrent (51-HV/LV)
- Derived DMT Neutral Overcurrent (50N-HV/LV)
- Derived IDMTL Neutral Overcurrent (51N-HV/LV)
- Measured Instantaneous Neutral Overcurrent (50G)
- Measured IDMTL Neutral Overcurrent (51G)
- DMT Negative Sequence Overcurrent (46/50-HV/LV)
- IDMTL Negative Sequence Overcurrent (46/51-HV/LV)
- Thermal Overload (49)
- Breaker failure (50BF)
- Under Frequency / Over Frequency (81-U/O)
- Rate of Change of Frequency (81R)
- Trip Circuit Supervision (74TCS)
- CB Condition (I^2t-CB)
- Total Harmonic Distortion (THD)
- Through Fault Monitor

Measurements

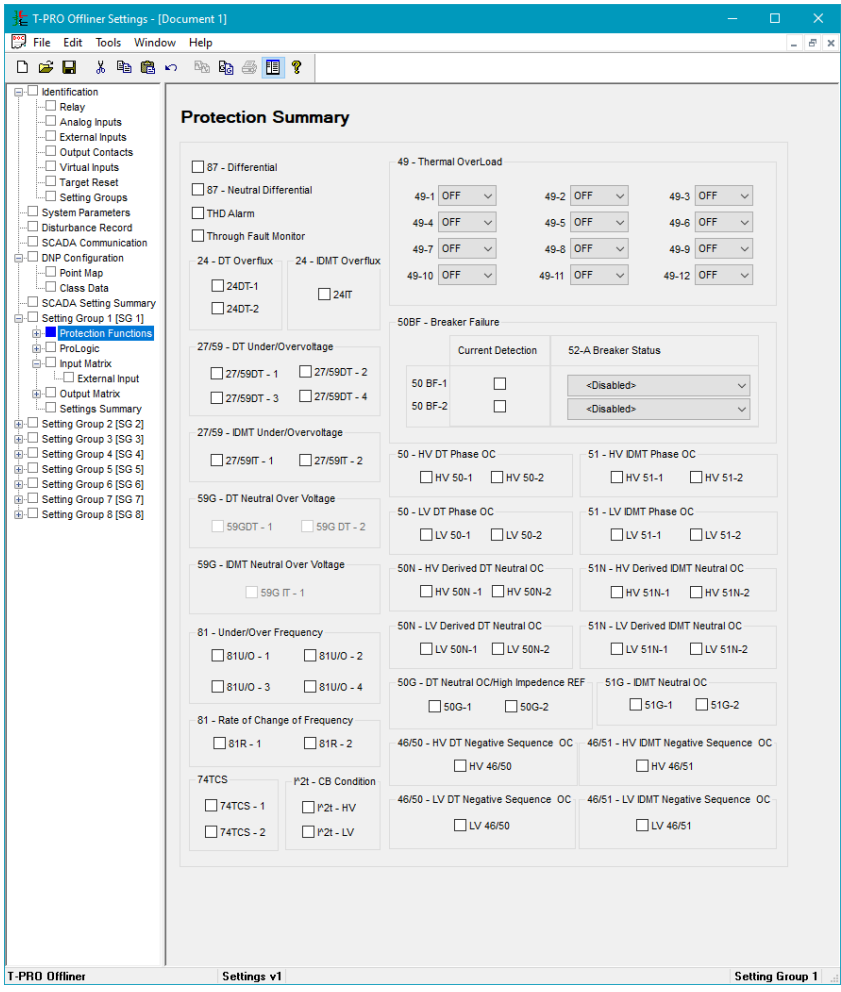
- Phase Voltage – Magnitude & Angle
- Phase-wise Current – Magnitude & Angle
- Phase-wise winding currents for HV, LV
- Residual winding currents for HV, LV
- 87 and 87N operating and restrain currents
- Thermal state current – Magnitude for HV, LV
- Sequential current for all inputs
- Phase-wise Through Fault Monitoring
- THD Percentage
- Over flux
- Frequency
- I^2t accumulated for both HV, LV
- I^2t for last operation for both HV, LV
- 2nd and 5th harmonic magnitudes for all inputs and windings
- All Protection function status
- All Virtual Inputs, External Inputs, Pro-Logic and Output Contact status

Communication Interface

- Front: USB 2.0 port Type-B
- Rear: RS485, Ethernet - copper / fiber optic (refer to ordering sheet)

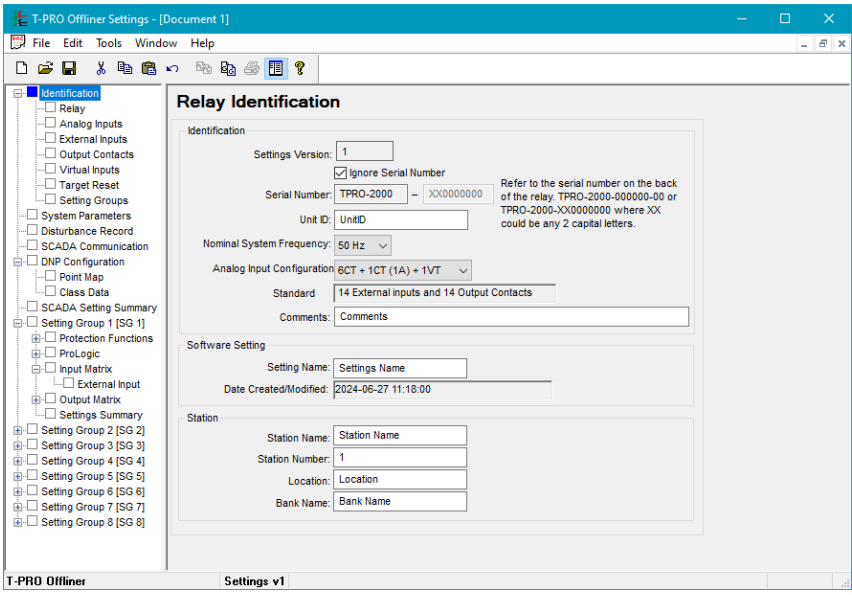
Communication Protocol

- Modbus RTU/ASCII
- IEC60870–5–103
- IEC 61850 Ed2.0
- DNP 3.0

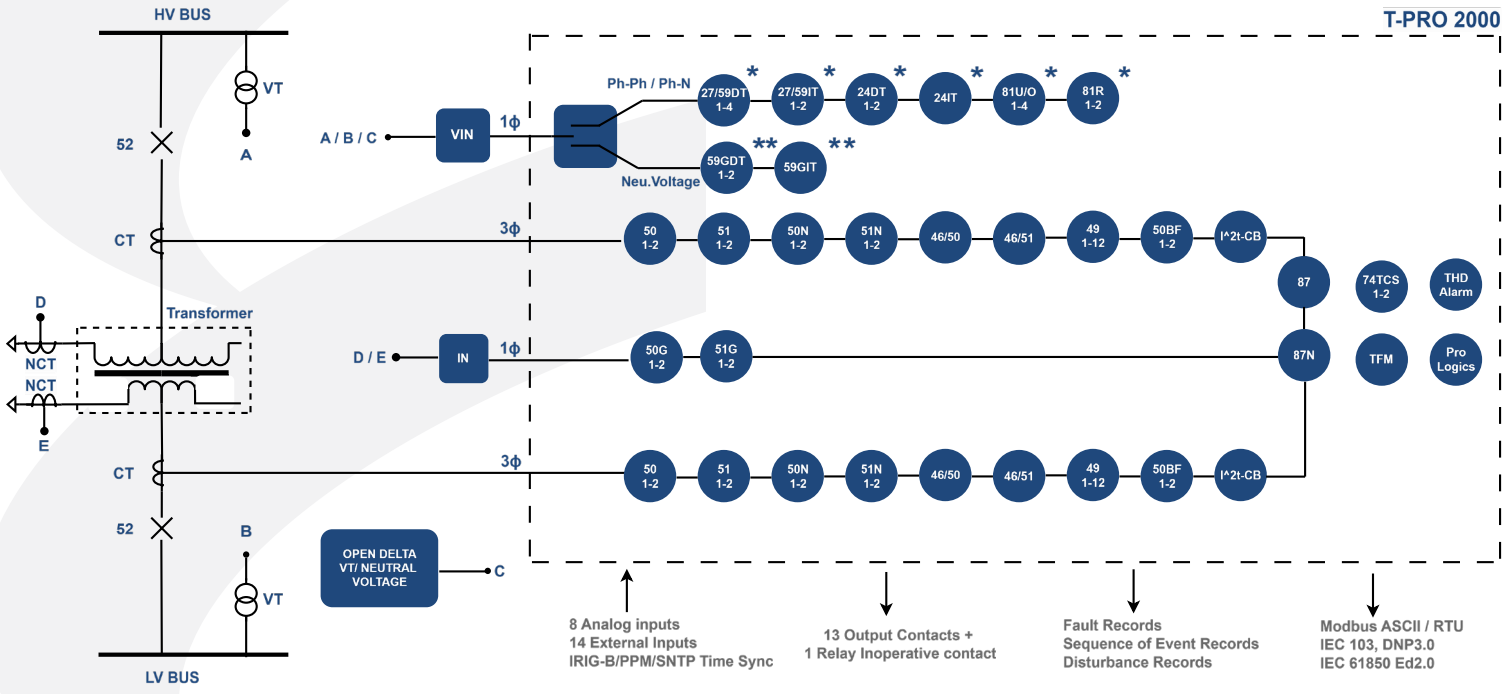


Functional Overview

- Site selectable 1A and 5A CT secondary ratings
- Programmable VT secondary ratings
- 13 prog. LEDs and 1 fixed LED to indicate IED health
- 14 programmable external inputs
- 1000 event records with 1ms time resolution
- 13 programmable output contacts and 1 fixed output
- contact for the watchdog function
- 20 fault logs for detailed fault history tracking
- 20 disturbance records for comprehensive analysis
- 8 distinct setting groups for easy configuration changes
- Multiple levels of password protection to restrict access and ensure secure operation.
- Supports Time Synchronization using PPM, SNTP & IRIG-B (both Modulated & Un-Modulated).
- 24 Prologic's with customizable pickup and drop-off timers for advanced timing control in protection schemes.
- Programmable IEC/ANSI inverse, DT, and user-defined protection curves, offering versatile fault & time Graded protection.
- Through Fault Monitoring function to measure the duration, current peak RMS and accumulated I^2t aids in Preventive maintenance.
- ROCOD feature available with 87 Function aids in rapid fault detection.
- 2nd and 5th harmonic restraint algorithm that improves security for energization, inrush and over fluxing.



Protection & Control Function Diagram



Note 1 : VIN (1ϕ Voltage Input) - can be Connected From Either HV (Marked as A) / LV (Marked as B) / Open Delta (Marked as C)

Note 2 : IN (1ϕ Neutral Current Input) - can be Connected From Either HV (Marked as D) / LV (Marked as E)

Note 3 : ** Marked Fn get enabled - when VIN Input is Neutral Voltage

* Marked Fn get enabled - when VIN Input is Ph-Ph /Ph -N

Detailed Specifications

Item	Quantity/Specs	Notes
General		
Ingress Protection	IP 5X (Front), IP 1X (Rear), IP 2X (Rear) - optional with Protective cover	
Operate time	1.0 – 1.5 Cycles	Including relay output operation
Memory	Settings and Records are stored in Non-Volatile memory	Records are stored in a circular buffer
Pro-Logic™	24 Statements per setting group	5 inputs per Pro-Logic™ statement
Power Supply	Nominal Voltage: High Range Supply Option: 80 - 250 Vac, 80 - 300 Vdc Low Range Supply Option: 20 - 60 Vdc Power Consumption	Voltage Tolerance: High Range Supply Option: ±20% for Vdc, -10%/+5% for Vac Low Range Supply Option: -15%/+20% <8VA (AC), <8W (DC)
Recording		
Transient (Fault)	32 s/c oscillography of all analog and external input channels	User-configurable 1 to 10 seconds Record length and 0.1 to 2.0 seconds pre-fault length
Events	1000 events circular log with 1ms resolution	A compressed event record can be created with Manual Trigger /Auto save of 1000 events approx. as Event record by Configurable Event Auto save Option
Record Capacity	20 records of a combination of transient and event records	200 sec of transient data can be stored
Inputs and Outputs		
Analog Voltage Inputs **1-Single Phase voltage input**	Nominal Voltage - across input channel: Full Scale/Continuous: Thermal Rating: Burden:	Vn = 69V_{rms} (Ph-N) or 120V_{rms} (Ph-Ph) 2xVn = 138V_{rms} 3xVn = 207V_{rms} for 10sec <0.15VA @ 69V
Analog Current Inputs 2 set of 3-Phase current inputs, **1-Single Phase current input**	Nominal Current: Continuous rating: Maximum full-scale rating: Thermal Rating: Burden:	In = 1A_{rms} or 5A_{rms} 4xIn = 4A_{rms} or 20A_{rms} 40xIn = 40A_{rms} or 200A_{rms} 100xIn for 1second symmetrical 100A_{rms} or 500A_{rms} <0.1VA @ 1A_{rms}, <0.5VA @ 5A_{rms}

Item	Quantity/Specs	Notes
External Inputs	14 isolated inputs	Optional 24, 48, 110 or 220 Vdc nominal, externally wetted. All inputs can be on continuously. Specified voltages are over full ambient temperature range
	Isolation:	2kV optical isolation
	Burden:	<0.2W@110Vdc
	Turn-on Voltage:	24Vdc nominal = 19 Vdc 48 Vdc nominal = 38 Vdc 110 Vdc nominal = 88 Vdc 220 Vdc nominal = 176 Vdc
Output Relays (contacts)	13 programmable outputs (13 NO)	Externally wetted Make: 30A as per IEEE C37.90 Carry (all outputs active): 8A Break: 0.9A at 125Vdc resistive 0.35 A at 250 Vdc resistive
Virtual Inputs	30 Virtual Inputs	
Physical		
Weight	6kg appx.,	
Dimensions	E8 Case: Size in mm: 177mm (H) x 207mm (W) x 225mm (D) Size in Inch: 6.96 Inch (H) x 8.16 Inch (W) x 8.85 Inch (D)	
Accuracy		
Current	±2.5% of inputs from 0.1 to 1.0 x nominal current (In)	
	±1.0% of inputs from 1.0 to 4.0 x nominal current (In)	
Voltage	±1.0% of inputs of nominal voltage (Vn)	
Timers	±2.5% of set value plus 1.00 to 1.50 Cycles of inherent delay	
Inverse Overcurrent Timers	±2.5% or ±1 Cycle of Selected Curve	
Definite Overcurrent Timers	±2.5% or ±1 Cycle non-directional	
Differential Element	±5.0% of set value IO min from 0.10 to 1.0 per unit (pu)	
Frequency Element	±0.003 Hz (fixed level) / ±0.05 Hz (df/dt)	

Type Tests

Test	Description		Test Level
	Type Test	Test Points	
Electromagnetic Compatibility			
IEC 60255-26 **IEC 61000-4-2**	Electrostatic discharge	Enclosure air	±8kV
		Enclosure contact	±6kV
IEC 60255-26 **IEC 61000-4-3**	Radiated Interference (Electromagnetic field immunity)	Enclosure ports	10 V/m: 80-1000 MHz & 1.4 GHz - 2.7GHz
IEC 60255-26 **IEC 61000-4-4**	Electrical Fast Transient	AC/DC power ports	±4 kV
		AC voltage & current ports	
		External I/P & O/P ports	
IEC 60255-26 **IEC 61000-4-18**	Slow Damped Oscillatory / High Frequency Disturbance / 1MHz Burst Disturbance	AC/DC power ports	±2.5kV (Common Mode) ±1kV (Differential Mode)
		AC voltage & current ports	
		External I/P & O/P ports	
IEC 60255-26 **IEC 61000-4-8**	Power Frequency Magnetic Field	Enclosure	30A/m Continuous (60sec) 300A/m Pulse (3sec)
IEC 60255-26 **CISPR 11 & 32 FCC 15 - ICES 003**	Conducted Emissions	Power ports	Criteria-A
	Radiated Emissions	Enclosure	Criteria-A
IEC 60255-26 **IEC 61000-4-6**	Conducted Disturbances induced by RF (Conducted Susceptibility)	AC/DC power ports	10Vrms: 150kHz – 80MHz
		AC voltage & current ports	
		External I/P & O/P ports	
IEC 60255-26 **IEC 61000-4-11**	AC Voltage Dips	AC Power port	100% reduction for 10ms
IEC 60255-26 **IEC 61000-4-11**	AC Voltage Interrupts	AC Power port	100% reduction for 5000ms
IEC 60255-26 **IEC 61000-4-29**	DC Voltage Dips	DC Power port	100% reduction for 50ms
IEC 60255-26 **IEC 61000-4-29**	DC Voltage Interrupts	DC Power port	100% reduction for 5000ms
IEC 60255-26 **IEC 61000-4-29**	AC Ripple on DC Input Power	DC Power port	10% of Rated DC Value with 100Hz

Test	Description		Test Level
	Type Test	Test Points	
Safety			
IEC 60255-27:2013 Cl.No.10.6.4.3	Dielectric / HiPot	AC/DC power ports	2kV AC/min
		AC voltage & current ports	
		External I/P & O/P ports	
IEC 60255-27:2013 Cl.No.10.6.4.4	Insulation Resistance	AC/DC power ports	>100MΩ @ 500Vdc/min
		AC voltage & current ports	
		External I/P & O/P ports	
IEC 60255-27:2013 Cl.No.10.6.4.5.1	Protective Bonding Resistance	Enclosure	
IEC 60255-27:2013 Cl.No.10.6.4.2	HV Impulse Voltage	AC/DC power ports	±5kV
		AC voltage & current ports	
		External I/P & O/P ports	
Mechanical			
IEC 60068-2-6 IEC 60255-21-1	Vibration Response	Enclosure	Class 1: Frequency 10-150Hz Displacement: 0.035mm (peak) Acceleration: 0.5g Sweep rate: 1octave/min No. of Axis: 3 (X, Y & Z) No. of Sweep Cycles: 1/axis
IEC 60068-2-27 IEC 60255-21-2	Shock Response	Enclosure	Class 1: Acceleration: 5g Pulse Width: 11ms Pulse Sweep: 1/2 sine wave No. of Shocks: 3/direction No. of Directions: 2/axis No. of Axis: 3 (X, Y & Z) Total No. of Shocks: 18 + 18
IEC 60068-2-27 IEC 60255-21-2	Bump	Enclosure	Class 1: 10g, 1000 pulses per direction per axis
IEC 60255-21-3	Seismic	Enclosure	Class 1: For X-axis: Displacement: 3.5mm (peak) Acceleration: 1.0g Sweep rate: 1octave/min For Y-axis: Displacement: 1.5mm (peak) Acceleration: 0.5g Sweep rate: 1 octave/min

Test	Description		Test Level
	Type Test	Test Points	
Environmental			
IEC 60068-2-1	Cold (operating and storage)	Enclosure	Operational: -10˚C, 16Hrs Storage: -25˚C, 16Hrs
IEC 60068-2-2	Hot (operating and storage)	Enclosure	Operational: +55˚C, 16Hrs Storage: +70˚C, 16Hrs
IEC 60068-2-78	Damp Heat Steady State	Enclosure	+40˚C, 240Hrs
IEC 60068-2-30	Damp Heat Steady Cyclic	Enclosure	+25˚C and +55 ˚C, 6 Cycles

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