

Transmission Line Protection Relay

L-PRO 4000

Product Overview

The L-PRO 4000 provides easy-to-use, state-of-the-art comprehensive distance and directional line protection for medium to extra-high-voltage transmission lines using communication-based schemes. It provides control, automation, metering, monitoring, fault oscillography, dynamic swing recording, event logging with advanced communications in a flexible cost effective package.

Apply the L-PRO 4000 system for high speed protection and complete control in multi-breaker applications in ring or breaker-and-a-half arrangements. The L-PRO 4000 is ideal for multi-circuit line applications to monitor mutual coupling.

- Easy-to-use, intuitive setting and analysis software
- IEC 61850 communication via optical ports
- Selectable single and 3 pole trip and reclose
- High-speed five-zone user-defined mho or quad phase and ground distance protection
- Single and multi-breaker applications (i.e. ring bus and breaker-and-a-half capability, including breaker failure and individual breaker monitoring)
- 4 shot recloser with dead line/dead bus control and sync check
- High quality fault and swing recording and event log
- 8 setting groups for many operating conditions
- Ethernet ports with 2 unique MAC addresses accommodate network access security needs

**IEC 61850
Compliant!**



Distributed
Network
Protocol

**10 Year
WARRANTY**

Application

- Primary and backup protection on transmission and sub-transmission lines (using pilot protection schemes)
- Overhead lines and underground cables

Protection & Control

- Protection functions — IEEE devices 21P, 21N, 25/27/59 (25C), 27, 50BF, 50LS, 50/51/67, 50N/51N/67, 46/50/51/67, 59, 60, 68, 79, 81, Dead Line Pickup (SOTF) and Weak Infeed
- High-speed 5 zones of phase and ground distance functions — user-defined Mho shapes or Quadrilateral phase and ground distance protection and communication based schemes
- Operating speed - 1.0 to 1.3 cycle at 80% reach
- Selectable single and 3 pole trip and reclose
- CCVT compensation

Features & Benefits

Ease of Use

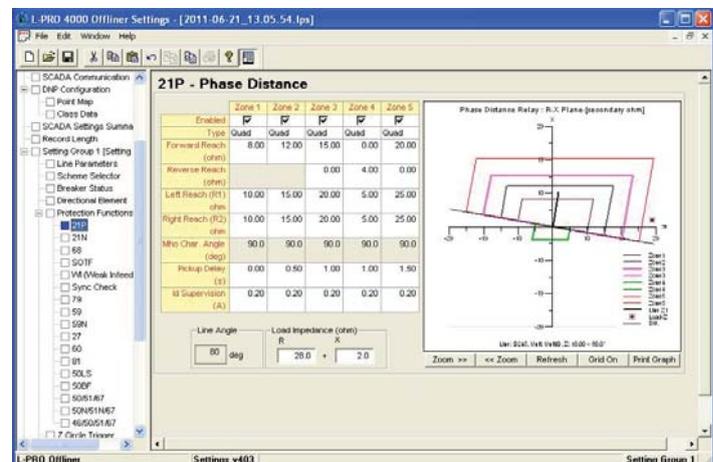
- Easy-to-use, install, and maintain
- Easy to order – no complex product codes
- User-friendly, Windows®-based relay setting and record analysis software
- Setting software tool – relay specific application
- On-Line setting tool – terminal emulator (VT100)
- Flexible programmable logic for building customized schemes with ProLogic™ statements – 24 control logic statements (total of 192 statements)

Reduce Installation and Operation Cost

- Substation automation cost – includes IEC 61850 protocol to display and transfer operational data via local-area network (LAN) for local HMI and wide-area network (WAN) for remote monitoring SCADA
- Engineering, installation and commissioning cost – IEC 61850 GOOSE messages communicate high-speed information between IEDs on the substation LAN such as transfer trips, interlocking, load-shedding and commands
- Product setting time – 240 x 128 LCD graphical user interface provides convenient means to check/change specific settings and parameters

- Backup protection for generators, transformers and reactors
- Ideal for multi-circuit line applications (to monitor mutual coupling via additional VT and CT inputs)

- Breaker failure and individual breaker monitoring 4 shot recloser with dead line/dead bus control and sync check
- Enhanced user-configurable logic – with ProLogic™ which includes 24 control logic statements
- 8 setting groups with unique Group Logic Control Statements – full Boolean graphics to create logic for setting groups switching based on a combination of given conditions



- Front panel indicators – 11 user-configurable LEDs, Relay Functional, IRIG-B Functional, Service Required, Test Mode, Alarm



Flexible Communications

- 2 rear ports, 100BASE-TX RJ-45 or 100BASE-FX 1300 nm multimode optical with ST style connector
- Ethernet ports with 2 unique MAC addresses that easily accommodate network access security needs
- Front panel USB and 100BASE-TX RJ-45 Ethernet port interfaces



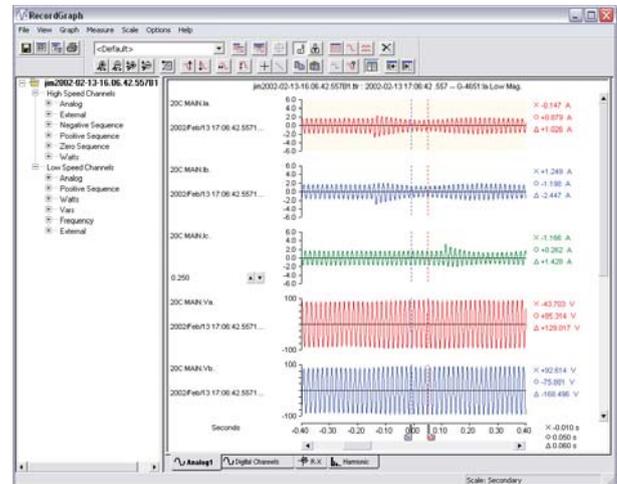
Substation Automation – Ethernet Ready

- IEC 61850 Station Bus on a dedicated optical/copper Ethernet Port
- Enhanced DNP3 SCADA communication protocol including user-selectable point lists, class support and multiple master station support
- Modbus SCADA communication protocol

- IRIG-B port (through BNC connector) for precise time stamping and sample synchronization
- Serial communication port
- 30 virtual inputs for local and remote control
- Optional internal modem

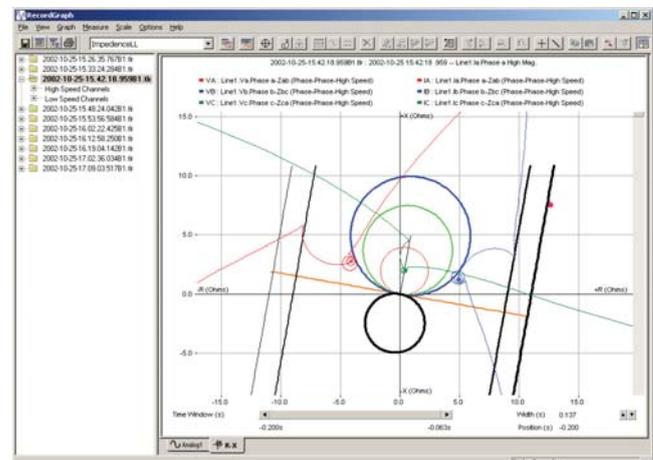
Multi-Functional Recording and Event Logging

- Exceptional fault recording capabilities (with 96 samples/cycle or 5760 Hz) and dynamic swing recording (at nominal frequency)
- Fault location — information provided by event log access or analog input point for SCADA
- Up to 150 x 2 second transient records, or up to 150 x 120 seconds swing records, or combination of transient, swing and optionally event records
- Breaker monitoring
- Metering functions for each input connection
- Sequence of Event Recorder – 250 events with 1 ms resolution
- Compressed event record capabilities – a compressed sequence of event file is created approximately every 230 events



RecordGraph™ and RecordBase View™

- Display multiple channels simultaneously and combine records
- Display multiple component voltage, current or summed channels
- Display THD, harmonic magnitude
- Zoom, alignment, scaling, unit functions
- Record summaries including event lists
- COMTRADE, PTI and MS Excel export



Best in Class Human-Machine Interface

Large LCD display, allows for better metering display

Navigation controls allow for an easy experience through settings, maintenance, service and view menus

Programmable target LEDs provide tripping information to expedite response to systems events

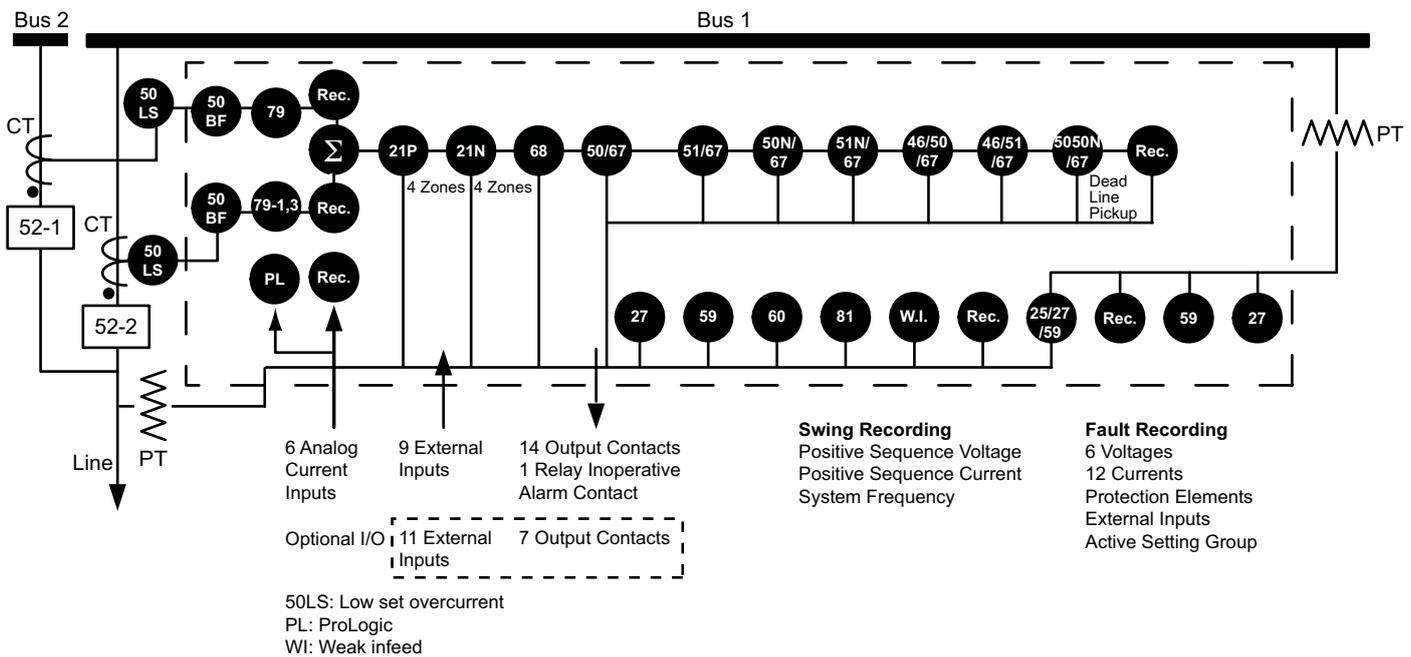


New faster processor and hardware platform

Rear optical ports ready for IEC 61850 Goose

Unique front panel USB and Ethernet ports provide easy and fast access to settings and set up

Protection & Control Function Diagram



Detailed Specifications

L-PRO 4000 Transmission Line Protection Relay

Item	Quantity/Specs	Notes
General		
Nominal Frequency	50 or 60 Hz	
Operating Time	16 – 25 ms typical	Including relay output operation
Sampling Rate	96 samples/cycle	Records up to 25th harmonic
Power Supply	Range: 43 – 275 Vdc, 90 – 265 Vac	Power Consumption: 25 – 35 VA (ac) 25 – 35 W (dc)
Protection Functions		
IEEE Dev. 21P-1, 2, 3, 4, 5, 21N-1, 2, 3, 4, 5, 25/27/59, 27, 50BF, 50LS, 50/51/67, 50N/51N/67, 46/50/51/67, 59, 60, 68,79, 81, Dead Line Pickup and Weak Infeed	2 x 3-phase voltage inputs (6 voltage channels) for synchronizing during reclosing 4 x 3-phase current inputs	Ring bus configuration and integrated HV breaker auto-recloser
ProLogic™	24 statements per setting group	5 inputs per ProLogic™ statement
Setting Groups	8 (16 group logic statements per setting group)	5 inputs per group logic statement
Recording		
Record Capacity	Up to 150 x 2 second transient records or up to 150 x 120 seconds swing records or combination of transient, swing and optionally event records with a total number of records limited to 150	Transient record length is user configurable (range from 0.2 to 2 seconds); transient record pre-fault time is user configurable (range from 0.10 to 0.5 seconds) Swing record length is user configurable (range from 60 – 120 seconds); swing record pre-trigger time is fixed at 30 seconds Viewing software provides waveform, symmetrical components and harmonic analysis
Transient	96 s/c oscillography of all analog and external input digital channels	
Sequence of Events Recorder	250 events	1 ms resolution. When “event auto save” is enabled, a compressed event record is created is created approximately every 230 events.
A/D Resolution	16 bits, 65536 counts full scale peak – peak	
Input & Output		
Analog Voltage Inputs 2 sets of 3-phase voltage inputs (6 voltage channels)	Nominal voltage Continuous rating over voltage Maximum over-scale thermal rating Thermal Rating Burden	Vn = 69 Vrms 2x Vn = 138 Vrms 3x Vn = 207 Vrms for 10 seconds 400 Arms for 1 second <0.15 VA @ 69 Vrms
Analog Current Inputs 4 sets of 3-phase current inputs (12 current channels)	Nominal current Full scale/continuous Maximum full-scale rating Burden	In = 5 or 1 Arms 3x In = 15 or 3 Arms 40x In = 200 Arms or 40 Arms symmetrical <0.25 VA @ 5 Arms
External Inputs (digital)	9 inputs (3U model) 20 inputs (optional 4U model)	Optional 48/125/250 Vdc nominal, externally wetted
Virtual Inputs	30 Virtual Inputs	

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Item	Quantity/Specs	Notes
Output (contacts)	14 programmable outputs (3U model) and 1 relay inoperative output 21 programmable outputs and 1 relay inoperative output (optional 4U model)	Externally wetted Make: 30 A as per IEEE C37.90 Carry: 8 A Break: 0.9 A at 125 Vdc 0.35 A at 250 Vdc
Interface & Communication		
Front Display	240 x 128 pixels graphics LCD	
Front Panel Indicators	16 LEDs: 11 programmable and 5 fixed	Target (11), Relay Functional, IRIG-B Functional, Service Required, Test Mode, Alarm
Front User Interfaces	USB port and 100BASE-TX Ethernet port	USB 2.0, RJ-45
Rear User Interfaces	LAN Port 1: 100BASE – copper or optical 1300 nm LAN Port 2: 100BASE – copper or optical 1300 nm	Copper: RJ45, 100BASE-TX Optical: 100BASE-FX, Multimode ST style connector
Internal Modem	Two Serial RS-232 ports to 115 kbd 33.6 Kbps, V.32 bis	Com port can support an external modem Optional internal modem
SCADA Interface	DNP3 or Modbus	DNP3: Ethernet or RS-232, Modbus: RS-232
Time Sync	IRIG-B, BNC connector	Modulated or unmodulated, auto-detect
Self Checking/Relay Inoperative	1 contact	Closed when relay inoperative
Physical		
Weight	9.55 kg	21 lbs
Dimensions	13.2 cm height x 48.26 cm width x 32.8 cm depth	5.2" height x 19" width x 12.9" depth
Time Synchronization and Accuracy		
External Time Source	Synchronized using IRIG-B input (modulated or unmodulated) auto detect	
Environmental		
Ambient Temperature Range	-40°C to 85°C for 16 hours -40°C to 70°C continuous	IEC 60068-2-1, 2 LCD contrast impaired for temperatures below -20°C and above 70° C
Humidity	Up to 95% without condensation	IEC 60068-2-30
Insulation Test (Hi-Pot)	Power supply, analog inputs, external inputs, output contacts at 2.0 kV rms, 50/60 Hz, 1 minute	IEC 60255-5, ANSI/IEEE C37.90
Electrical Fast Transient	Tested to level 4 – 4.0 kV 2.5/5 kHz on power and I/O lines	IEEE C37.90.1: 4kV / IEC 60255-22-4 Class 3 / IEC 61000-4-4: Level 3
Oscillatory Transient	Test level = 2.5 kV	IEEE C37.90.1: 2.5 kV / IEC 60255-22-1: Level 3 / IEC 61000-4-12): Level 3
RFI Susceptibility	10 V/m modulated, 35 V/unmodulated	IEEE C37.90.2:35 V/m / (IEC 60255-22-3/ IEC61000-4-3): Level 3
Vibration, Shock and Bump	5 g and 15 g	(IEC 60255-21-1,2 / IEC60068 2-6, 27): Class 1
Conducted RF Immunity		(IEC 60255-22-6 / IEC 61000-4-6): Level 3
Voltage Interruptions	200 ms interrupt	IEC 60255-11 / IEC 61000-4-11

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Detailed Environmental Tests

Test	Description Type Test	Test Points	Test Level
FCC Part 15	RF emissions Conducted emissions	Enclosure ports ac/dc power ports	Class A: 30 – 1000 MHz Class A: 0.15 – 30 MHz
IEC/EN 60255-25	RF emissions Conducted emissions	Enclosure ports ac/dc power ports	Class A: 30 – 1000 MHz Class A: 0.15 – 30 MHz
IEC/EN 61000-3-2	Power line harmonics	ac power port	Class D: max.1.08, 2.3, 0.43, 1.14, 0.3, 0.77, 0.23 A.... for 2nd to nth harmonic
IEC/EN 61000-3-3	Power line fluctuations	dc power port ac power port dc power port	N/A THD/ 3%; $P_{st} < 1$, $P_{it} < 0.65$ N/A
IEC/EN 61000-4-2 IEC/EN 60255-22-2	ESD	Enclosure contact Enclosure air	+/- 6 kV +/- 8 kV
IEEE C37.90.3	ESD	Enclosure contact Enclosure air	+/- 8 kV +/- 15 kV
IEC/EN 61000-4-3 IEC/EN 60255-22-3	Radiated RFI	Enclosure ports	10 V/m: 80 – 1000 MHz
IEEE C37.90.2	Radiated RFI	Enclosure ports	35 V/m: 25 – 1000 MHz
IEC/EN 61000-4-4 IEC/EN 60255-22-4 IEEE C37.90.1	Burst (fast transient)	Signal ports ac power port dc power Port Earth ground ports	+/- 4 kV @2.5 kHz +/- 4 kV +/- 4 kV +/- 4 kV
IEC/EN 61000-4-5 IEC/EN 60255-22-5	Surge	Communication ports Signal ports	+/- 1 kV L-PE +/- 4 kV L-PE, +/-2 kV L-L
IEC/EN 61000-4-6 IEC/EN 60255-22-6	Induced (conducted) RFI	ac power port dc power port Signal ports ac power port dc power port Earth ground ports	+/- 4 kV L-PE, +/-2 kV L-L +/- 2 kV L-PE, +/-1 kV L-L 10 Vrms: 0.150 – 80 MHz 10 Vrms: 0.150 – 80 MHz 10 Vrms: 0.150 – 80 MHz 10 Vrms: 0.150 – 80 MHz
IEC/EN 60255-22-7	Power frequency	Earth ground ports Binary input ports: Class A	Differential = 150 Vrms Common = 300 Vrms
IEC/EN 61000-4-8	Magnetic field	Enclosure ports	40 A/m continuous, 1000 A/m for 1 s
IEC/EN 61000-4-11 IEC/EN 61000-4-29	Voltage dips & interrupts	ac power port	30% for 1 period, 60% for 50 periods 100% for 5 periods, 100% for 50 periods
IEC 60255-11	Voltage dips & interrupts	dc power port dc power port	30% for 0.1 s, 60% for 0.1 s, 100% for 0.05 s 100% reduction for up to 200 ms

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Detailed Environmental Tests

Test	Description Type Test	Test Points	Test Level
IEC/EN 61000-4-12 IEC/EN 60255-22-1	Damped oscillatory	Communication ports Signal ports ac power port dc power port	1.0kV Common, 0 kV Diff 2.5kV Common, 1 kV Diff 2.5kV Common, 1 kV Diff 2.5kV Common, 1 kV Diff
IEEE C37.90.1	Oscillatory	Signal ports ac power port dc power port	2.5kV Common, 0 kV Diff 2.5kV Common, 0 kV Diff 2.5kV Common, 0 kV Diff
IEC/EN 61000-4-16	Mains frequency voltage	Signal ports ac power port	30V continuous, 300V for 1s 30V continuous, 300V for 1s
IEC/EN 61000-4-17	Ripple on dc power supply	dc power port	10%

NOTE:

The L-PRO 4000 is available with 5 or 1 amp current input. All current specifications change accordingly.

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The specifications and product information contained in this document are subject to change without notice.
In case of inconsistencies between documents, the version at www.erlphase.com will be considered correct. (D02518R18)

