

T35

TRANSFORMER PROTECTION SYSTEM

Cost effective differential protection for transformers with up to 6 sets of CTs

KEY BENEFITS

- Secure high-speed transformer differential protection with advanced features in a cost-effective package
- Improved security for transformer energization and inrush provided through a superior Adaptive 2nd Harmonic Restraint algorithm
- Application flexibility for transformers with up to 6 sets of CTs, with independent magnitude/phase angle compensation and grounding settings
- Robust network security enabling Critical Infrastructure Protection through user command logging, and dual permission access control
- Complete IEC 61850 Process Bus solution providing resource optimization and minimizing total P&C life cycle costs
- Advanced automation capabilities for providing customized protection and control solutions
- Advanced fault and disturbance recording, including internal relay operating signals thus eliminating the need for redundant recording devices
- Reduced relay to relay wiring and associated installation costs through high-speed inter-relay communications
- Ambient temperature monitoring with alarming when outside temperature exceeds upper thresholds

APPLICATIONS

- Combined protection for transformer and small bus zone, including breaker-and-a-half and ring bus diameters
- Stand-alone or component in automated substation control system
- Primary and backup protection of power transformers, autotransformer, reactors, split-phase and angle regulating transformer
- Advanced data logging for asset management and maintenance optimization

FEATURES

Protection and Control

- Percent restrained and unrestrained differential protection
- 2nd harmonic inrush inhibit and overexcitation inhibit
- TOC elements for backup protection
- Transducer I/Os (RTD & dcmA)
- Flex Elements™
- FlexCurves™

Communications

- Networking interfaces – 100Mbit Fiber Optic Ethernet, RS485, RS232, RS422, G.703, C37.94
- Multiple Protocols - IEC61850, DNP 3.0 Level 2, Modbus RTU, Modbus TCP/IP, IEC60870-5-104, Ethernet Global Data (EGD)
- Direct I/O – secure, high-speed exchange of data between URs for Direct Transfer Trip applications
- Embedded Managed Ethernet Switch with 4 - 100 Mbit Fiber optic ports and 2 copper ports

IEC 61850 Process Bus Interface

- Robust communications with up to 8 HardFiber Bricks
- Seamless integration with existing T35 functions
- Redundant architecture for dependability and security

Monitoring and Metering

- Metering - current, voltage, power, energy, frequency, temperature
- Oscillography – analog and digital parameters at 64 samples/cycle
- Event Recorder - 1024 time tagged events with 0.5ms scan of digital inputs
- Data Logger - 16 channels with sampling rate up to 1 sample / cycle
- Setting Security Audit Trail for tracking changes to T35 configuration

EnerVista™ Software

- Graphical Logic Designer and Logic Monitor to simplify designing and testing procedures
- Document and software archiving toolset to ensure reference material and device utilities are up-to-date
- EnerVista™ Integrator providing easy integration of data in the T35 into new or existing monitoring and control systems



Digital Energy
Multilin

Protection and Control

The T35 Transformer Protection System is a three-phase transformer relay designed to protect power transformer with up to six windings/restraints. The T35 provides for automatic or user definable magnitude reference winding selection for CT ratio matching. The T35 performs automatic phase shift compensation for all types of transformer winding connections. The T35 algorithm allows the user to enable removal of the zero-sequence current even for delta connected transformer windings, facilitating transformers with a variety of grounding configurations.

As part of the Universal Relay (UR) Family, the T35 provides cost-effective solutions and superior protection and control.

Multi-CT Configurations

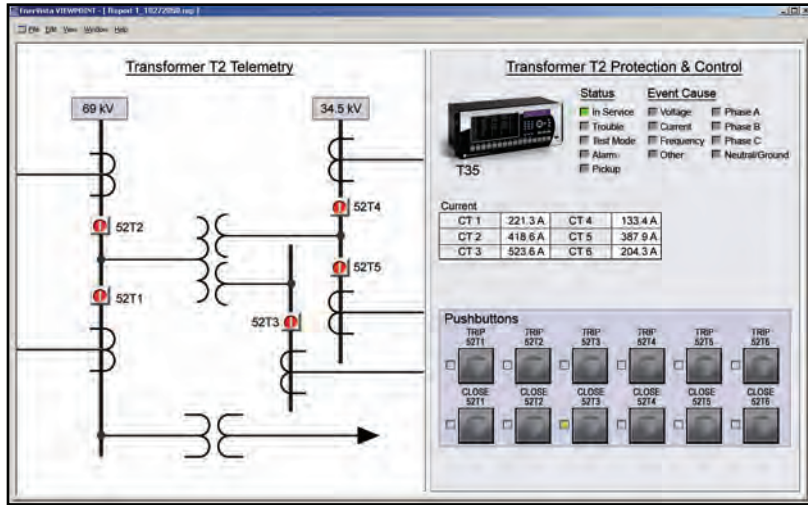
The T35 can be used to protect transformer differential zones with up to 6 three-phase current inputs (six restraints), making it possible to include multiple breakers or small buses in the differential zone.

Percent Differential Protection

The Percent Differential element is based on a configurable dual-breakpoint/dual slope differential restraint characteristic with inrush and overexcitation inhibits. The maximum winding current is used as a restraining signal for better through fault stability under CT saturation conditions.

The percent differential protection characteristic allows the element to account for both DC and AC saturation of the current transformers.

T35 - Protection, Metering, Monitoring and Control



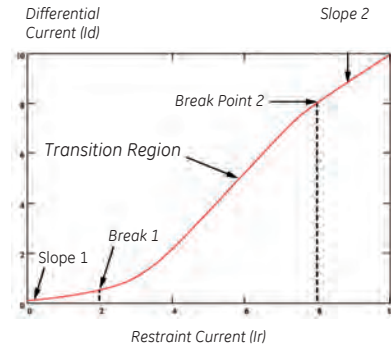
The T35 is the single point for protection, control, metering, and monitoring in one integrated device that can easily be connected directly into DCS or SCADA monitoring and control systems like Viewpoint Monitoring as shown.

Inrush Inhibit

The 2nd harmonic inhibit function is selectable in order to cover energization of different type transformers, and can be set to either traditional or adaptive mode.

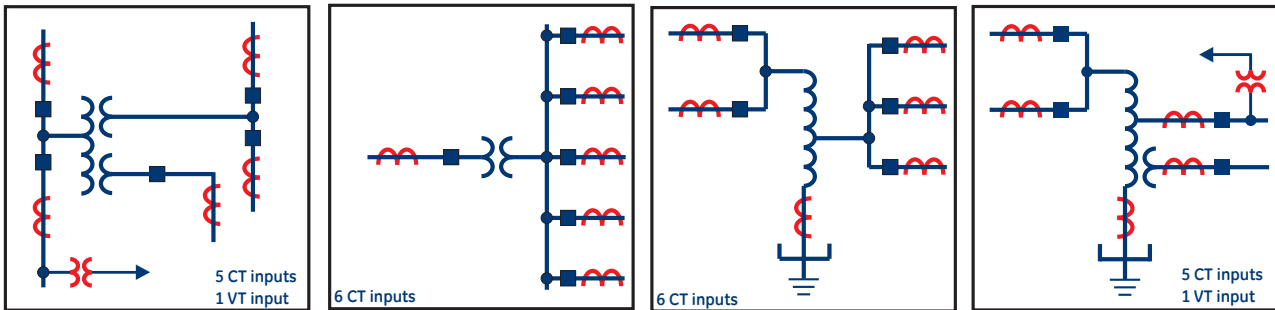
The adaptive mode maximizes dependability on internal faults and ensures security during inrush conditions even with weak second harmonics. It reduces the sensitivity of magnitude comparison by biasing towards security based on angular relationship. Dependability is maintained by applying the restraint signal only for a period of time dependent on the magnitude ratio.

Differential vs. Restraint Characteristic (Id vs. Ir)



The settings for the dual-slope, dual-breakpoint characteristic provides higher flexibility for shaping up the characteristic and achieve better sensitivity and security.

Multi-CT Configurations



Examples of T35 applications for transformers and autotransformers connected to more than two breakers.

Overexcitation Inhibit

An increase in transformer voltage or decrease in system frequency may result in the transformer becoming overexcited. It is often desirable to prevent differential element operation in these cases, therefore, a fifth harmonic inhibit is integrated into the percent differential element to cater for overexcitation conditions resulting from an increased V/Hz ratio.

Unrestrained Differential

An unrestrained differential element is provided for fast tripping on heavy internal faults to limit catastrophic damage to the transformer and minimize risks to the rest of the power system.

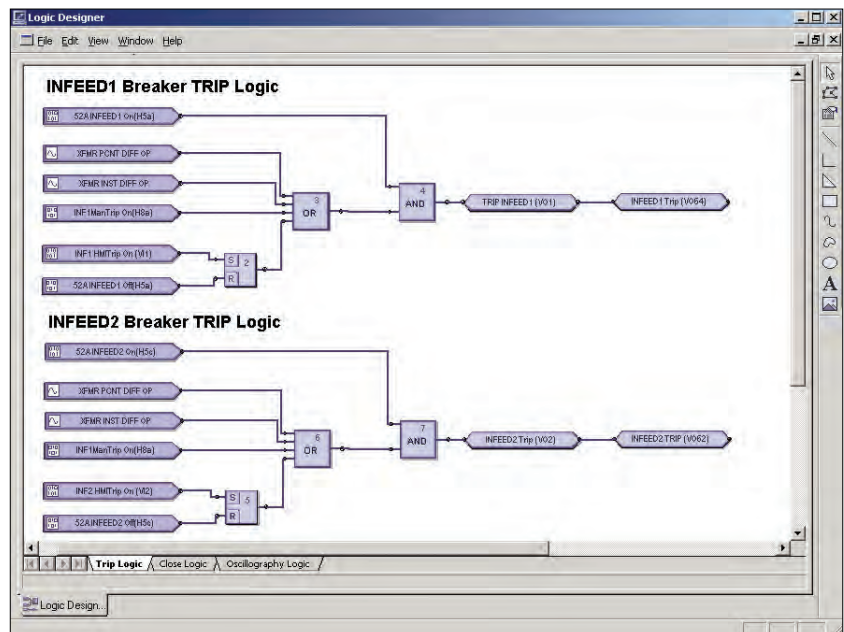
Overcurrent Functions

T35 provides overcurrent functions for phase, neutral and ground which can run parallel with differential protection or can be programmed to provide primary protection under conditions when differential elements are unavailable.

User-Definable Protection Functions

Sixteen user-definable protection functions (FlexElements™) can be programmed to respond to any quantity measured or computed by the relay (phase, ground and sequence currents and voltages, power, frequency, power factor, etc.) Applications could include overvoltage, overpower, low power factor, temperature differential, and more.

FlexLogic™ Designer



Flexlogic™ allows for customizing the T35 to operate and control the breakers and other auxiliary devices needed to fit most transformer protection schemes and applications.

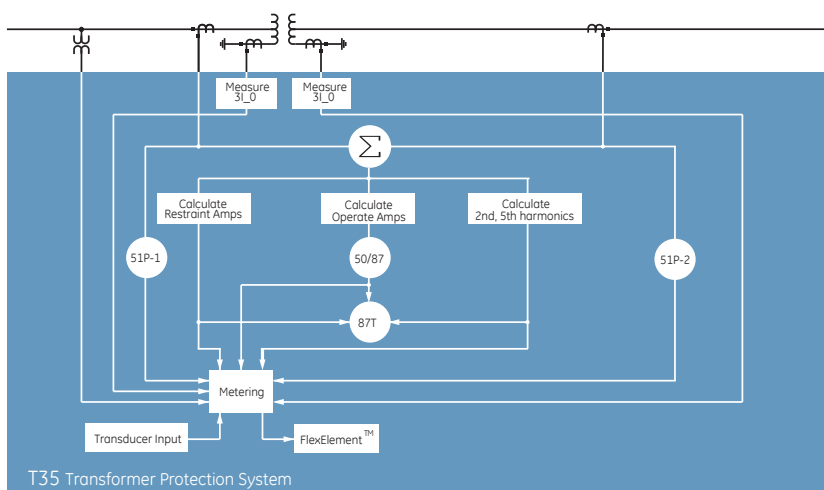
IEC 61850 Process Bus

The IEC 61850 Process Bus module is designed to interface with the GE Multilin HardFiber System, allowing bi-directional IEC 61850 fiber optic communications. The HardFiber System is designed to integrate seamlessly with the existing Universal Relay applications, including protection functions, FlexLogic, metering and communications.

The GE Multilin HardFiber System offers the following benefits:

- Communicates using open standard IEC 61850 messaging
- Drastically reduces P&C design, installation and testing labor by eliminating individual copper terminations
- Integrates with existing T35's by replacing traditional CT/VT inputs with IEC 61850 Process Bus module

Functional Block Diagram



ANSI Device Numbers & Functions

Device Number	Function
50/87	Instantaneous Differential Overcurrent
51G	Ground Time Overcurrent
51P	Phase Time Overcurrent
87T	Transformer Differential

- Does not introduce new Cyber Security concerns

Visit the HardFiber System product page on the GE Multilin web site for more details.

Advanced Automation

The T35 incorporates advanced automation features including powerful FlexLogic™ programmable logic, communication, and SCADA capabilities that far surpass what is found in the average transformer relay. The T35 integrates seamlessly with other UR relays for complete system protection.

FlexLogic™

FlexLogic™ is the powerful UR-platform programming logic engine that provides the ability of creating customized protection and control schemes thereby minimizing the need, and the associated costs, of auxiliary components and wiring. Using FlexLogic™, the T35 can be programmed to provide required tripping logic along with custom scheme logic for transformer breaker control (including interlocking with external synchronizers), transfer tripping schemes for remote breakers and dynamic setting group changes.

Scalable Hardware

The T35 is available with a multitude of I/O configurations to suit the most demanding application needs. The expandable modular design allows for easy configuration and future upgrades.

- Multiple CT/VT configurations allow for implementation of many different schemes, including multi-winding transformer differential protection
- Flexible, modular I/O covering a broad range of input signals and tripping schemes
- Types of digital outputs include tripped Form-A and Solid State Relay (SSR) mechanically latching, and Form-C outputs
- Form-A and SSR outputs available with optional circuit continuity monitoring and current detection to verify continuity and health of the associated circuitry
- Mechanically latching outputs can be used to develop secure interlocking applications and replace electromechanical lockout relays

- RTDs and DCmA inputs are available to monitor equipment parameters such as temperature & pressure

Monitoring and Metering

The T35 includes high accuracy metering and recording for all AC signals. Voltage, current, and power metering are built into the relay as a standard feature. Current and voltage parameters are available as total RMS magnitude, and as fundamental frequency magnitude and angle.

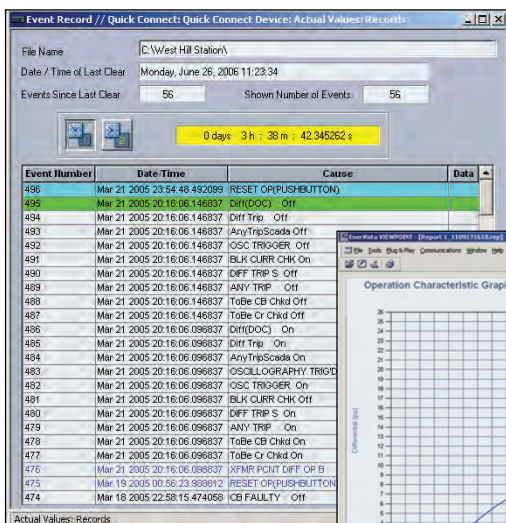
Fault and Disturbance Recording

The advanced disturbance and event recording features within the T35 can significantly reduce the time needed for postmortem analysis of power system events and creation of regulatory reports. Recording functions include:

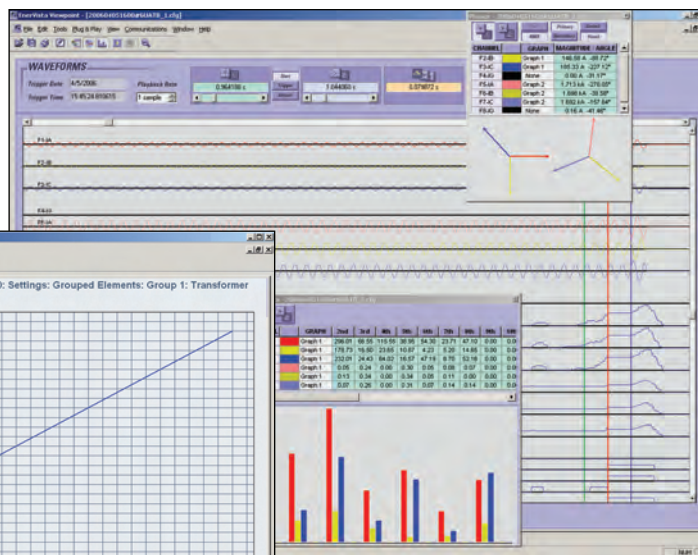
- Sequence of Event (SOE)
 - 1024 time stamped events
- Oscillography,
 - 64 digital & up to 40 Analog channels
- Data Logger, disturbance recording - 16 channels up to 1 sample / cycle / channel

Power System Troubleshooting

The T35 contains many tools and reports that simplify and reduce the amount of time required for troubleshooting power system events.



Record the operation of the internal T35 elements and external connected devices with 1ms time-stamped accuracy to identify the Sequence of Operation of station devices during transformer faults and disturbances.



Visualization of differential characteristics allows to verify settings and trouble shoot operations.

Analyze transformer faults using both analog and digital power system quantities that are measured and recorded up to a rate of 64 samples per cycle.

- Fault Reports
 - Powerful summary report of pre-fault and fault values

The very high sampling rate and large amount of storage space available for data recording in the T35 can eliminate the need for installing costly standalone recording equipment.

Advanced Device Health Diagnostics

The T35 performs comprehensive device health diagnostic tests during startup and continuously at runtime to test its own major functions and critical hardware. These diagnostic tests monitor for conditions that could impact security and availability of protection, and present device status via SCADA communications and front panel display. Providing continuous monitoring and early detection of possible issues helps improve system uptime.

- Comprehensive device health diagnostic performed during startup
- Monitors the CT/VT input circuitry to validate the integrity of all signals
- IEC61850
- DNP3.0
- Ethernet Global Data (EGD)
- IEC60870-5-104
- Modbus RTU, Modbus TCP/IP

Communications

The T35 provides advanced communications technologies for remote data and engineering access, making it easy and flexible to use and integrate into new and existing infrastructures. Direct support for fiber optic Ethernet provides high-bandwidth communications allowing for low-latency controls and high-speed file transfers of relay fault and event record information. The available redundant Ethernet option and the embedded managed Ethernet switch provide the means of creating fault tolerant communication architectures in an easy, cost-effective manner without the need for intermediary communication hardware.

The T35 supports the most popular industry standard protocols enabling easy, direct integration into DCS and SCADA systems.

Interoperability with Embedded IEC61850

Use the T35 with integrated IEC61850 to lower costs associated with transformer protection, control and automation. GE Multilin's leadership in IEC61850 comes from thousands of installed devices and follows on seven years of development experience with UCA 2.0.

- Replace expensive copper wiring between devices with direct transfer of data using GOOSE messaging
- Configure systems based on IEC61850 and also monitor and troubleshoot them in real-time with EnerVista™ Viewpoint Engineer
- Integrate GE Multilin IEDs and generic IEC61850-compliant devices seamlessly in EnerVista™ Viewpoint Monitoring

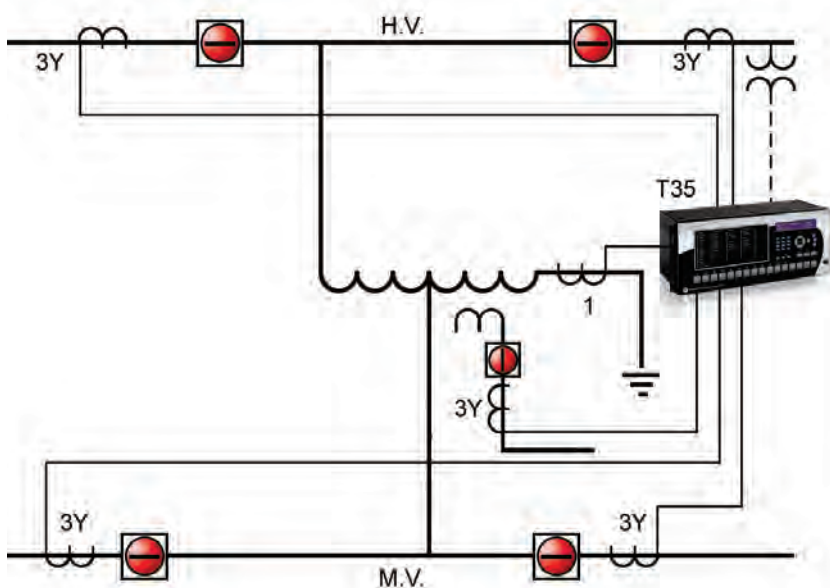
Direct I/O Messaging

Direct I/O allows for sharing of high-speed digital information between multiple UR relays via direct back-to-back connections or multiplexed through a standard DS0 multiplexer channel bank. Regardless of the connection method, Direct I/O provides continuous real-time channel monitoring that supplies diagnostics information on channel health.

Direct I/O provides superior relay-to-relay communications that can be used in advanced interlocking, generation rejection and other special protection schemes.

- Communication with up to 16 UR relays in single or redundant rings rather than strictly limited to simplistic point-to-point configurations between two devices
- Connect to standard DS0 channel banks through standard RS422, G.703 or IEEE C37.94 interfaces or via direct fiber optic connections
- No external or handheld tester required to provide channel diagnostic information

Cost Effective Solution



Auto transformer with breaker-and-a-half on both sides and loaded tertiary

Multi-Language

The T35 supports English, French, Russian, and Chinese languages on the front panel, EnerVista™ setup software, and product manual. Easily switch between English and an additional language on the local displays without uploading new firmware.

EnerVista™ Software

The EnerVista™ Suite is an industry-leading set of software programs that simplifies every aspect of using the T35 relay. The EnerVista™ suite provides all the tools to monitor the status of the protected asset, maintain the relay, and integrate information measured by the T35 into DCS or SCADA monitoring systems. Convenient COMTRADE and Sequence of Events viewers are an integral part of the UR Setup software included with every UR relay, to carry out postmortem event analysis to ensure proper protection system operation.

EnerVista™ Launchpad

EnerVista™ Launchpad is a powerful software package that provides users with all of the setup and support tools needed for configuring and maintaining GE Multilin products. The setup software within Launchpad allows configuring devices in real-time by communicating using serial, Ethernet, or modem connections, or offline by creating setting files to be sent to devices at a later time.

Included in Launchpad is a document archiving and management system that ensures critical documentation is up-to-date and available when needed. Documents made available include:

- Manuals
- Application Notes
- Guideform Specifications
- Brochures & Presentations
- Wiring Diagrams
- FAQ's
- Service Bulletins

Viewpoint Monitoring

Viewpoint Monitoring is a simple-to-use and full-featured monitoring and data recording software package for small systems. Viewpoint Monitoring provides a complete HMI package with the following functionality:

- Plug-&-Play Device Monitoring
- System Single-Line Monitoring & Control
- Annunciator Alarm Screens
- Trending Reports
- Automatic Event Retrieval
- Automatic Waveform Retrieval

Viewpoint Engineer

Viewpoint Engineer is a set of powerful tools that will allow the configuration and testing of UR relays at a system level in an easy-to-use graphical drag-and-

drop environment. Viewpoint Engineer provides the following configuration and commissioning utilities:

- Graphical Logic Designer
- Graphical System Designer
- Graphical Logic Monitor
- Graphical System Monitor
- IEC 61850 Configurator

Viewpoint Maintenance

Viewpoint Maintenance provides tools that will create reports on the operating status of the relay, simplify the steps to download fault and event data, and reduce the work required for cyber-security compliance audits. Tools available in Viewpoint Maintenance include:

- Settings Security Audit Report
- Device Health Report
- Single Click Fault Data Retrieval

EnerVista™ Integrator

EnerVista™ Integrator is a toolkit that allows seamless integration of GE Multilin devices into new or existing automation systems. Included in EnerVista™ Integrator is:

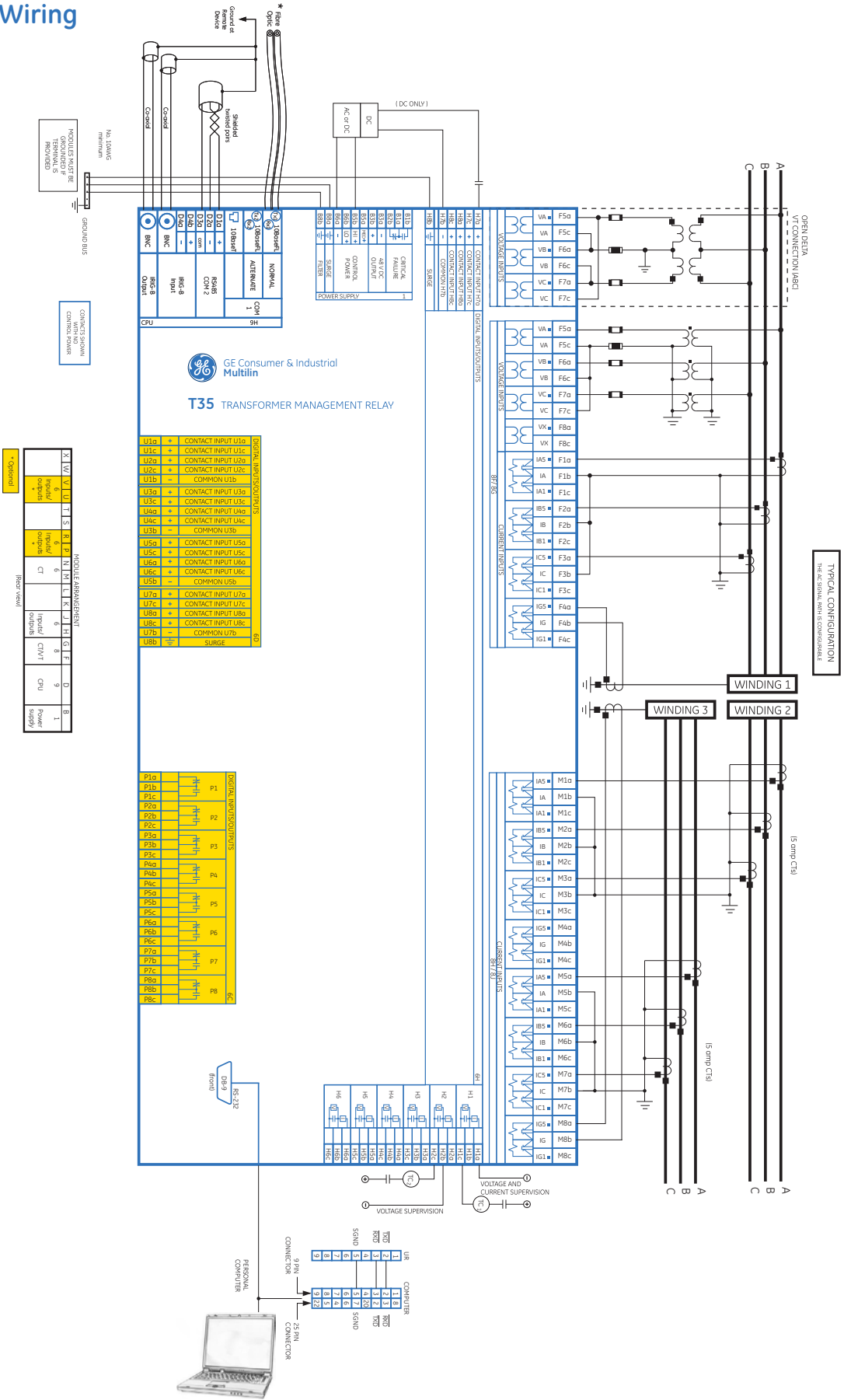
- OPC/DDE Server
- GE Multilin Drivers
- Automatic Event Retrieval
- Automatic Waveform Retrieval

User Interface

The T35 front panel provides extensive local HMI capabilities. The local display is used for monitoring, status messaging, fault diagnosis, and device configuration. User configurable messages that combine text with live data, can be displayed when user-defined conditions are met.



Typical Wiring



Ordering

	T35	*	**	-	H	*	*	-	F**	-	H**	-	M**	-	P**	-	U**	-	W**		
Base Unit	T35																				For full sized horizontal mount
CPU	E H J K N S																				Base Unit RS485 & RS485 (IEC61850 option not available) RS485 + 10BaseF RS485 + Redundant 10BaseF RS485 + Multi-mode ST 100BaseFX RS485 + Multi-mode ST Redundant 100BaseFX RS485 + 10/100 100BaseT RS485 + 6 port, 100 Mbps, Managed Ethernet Switch
Software Options	00 01 03 04																				No Software Options Ethernet Global Data (EGD) IEC61850
Mount					H A V B																Ethernet Global Data (EGD) + IEC61850 Horizontal (19" rack) - Standard Horizontal (19" rack) - Harsh Chemical Environment Option Vertical (3/4 size) - Standard Vertical (3/4 size) - Harsh Chemical Environment Option
User Interface						K L M N O T U V F															Enhanced English Front Panel Enhanced English Front Panel with User-Programmable Pushbuttons Enhanced French Front Panel Enhanced French Front Panel with User-Programmable Pushbuttons Enhanced Russian Front Panel Enhanced Russian Front Panel with User-Programmable Pushbuttons Enhanced Chinese Front Panel Enhanced Chinese Front Panel with User-Programmable Pushbuttons Vertical Front Panel with English display
Power Supply							H L												RH		125 / 250 V AC/DC 125/250 V AC/DC with redundant 125/250 V AC/DC power supply 24 - 48 V (DC only)
CT/VT DSP									8L 8M 8N 8R				8L 8M 8N 8R								Standard 4CT/4VT w/ enhanced diagnostics Sensitive Ground 4CT/4VT w/ enhanced diagnostics Standard 8CT w/ enhanced diagnostics Sensitive Ground 2CT/6VT w/ enhanced diagnostics
IEC 61850 Process Bus									81												8 Port IEC 61850 Process Bus Module
Digital I/O									XX 4A 4C 4L 67 6C 6D 6E 6F 6K 6L 6M 6N 6P 6R 6S 6T 6U 6V			XX 4A 4C 4L 67 6C 6D 6E 6F 6K 6L 6M 6N 6P 6R 6S 6T 6U 6V		XX 4A 4C 4L 67 6C 6D 6E 6F 6K 6L 6M 6N 6P 6R 6S 6T 6U 6V		XX 4A 4C 4L 67 6C 6D 6E 6F 6K 6L 6M 6N 6P 6R 6S 6T 6U 6V		XX 4A 4C 4L 67 6C 6D 6E 6F 6K 6L 6M 6N 6P 6R 6S 6T 6U 6V		No module 4 Solid State (No Monitoring) MOSFET Outputs 4 Solid State (Current w/opt Voltage) MOSFET Outputs 14 Form-A (No Monitoring) Latchable Outputs 8 Form-A (No Monitoring) Outputs 8 Form-C Outputs 16 Digital Inputs 4 Form-C Outputs, 8 Digital Inputs 8 Fast Form-C Outputs 4 Form-C & 4 Fast Form-C Outputs 2 Form-A (Current w/ opt Voltage) & 2 Form-C Outputs, 8 Digital Inputs 2 Form-A (Current w/ opt Voltage) & 4 Form-C Outputs, 4 Digital Inputs 4 Form-A (Current w/ opt Voltage) Outputs, 8 Digital Inputs 6 Form-A (Current w/ opt Voltage) Outputs, 4 Digital Inputs 2 Form-A (No Monitoring) & 2 Form-C Outputs, 8 Digital Inputs 2 Form-A (No Monitoring) & 4 Form-C Outputs, 4 Digital Inputs 4 Form-A (No Monitoring) Outputs, 8 Digital Inputs 6 Form-A (No Monitoring) Outputs, 4 Digital Inputs 2 Form-A (Cur w/ opt Volt) 1 Form-C Output, 2 Latching Outputs, 8 Digital Inputs	
Transducer I/O									5A 5C 5E 5F			5A 5C 5E 5F		5A 5C 5E 5F		5A 5C 5E 5F		5A 5C 5E 5F		5A 5C 5E 5F	4 dcmA inputs, 4 dcmA outputs 8 RTD Inputs 4 dcmA inputs, 4 RTD Inputs 8 dcmA Inputs
Inter-Relay Communications																					7A 820 nm, multi-mode, LED, 1 Channel 7B 1300 nm, multi-mode, LED, 1 Channel 7C 1300 nm, single-mode, ELED, 1 Channel 7H 820 nm, multi-mode, LED, 2 Channels 7I 1300 nm, multi-mode, LED, 2 Channels 7J 1300 nm, single-mode, ELED, 2 Channels 7S G.703, 2 Channels 7W RS422, 2 Channels 77 IEEE C37.94, 820 nm, multimode, LED, 2 Channel 2S 6 port, 100 Mbps, Managed Ethernet Switch, HI (125/250V AC/DC) 2T 6 port, 100 Mbps, Managed Ethernet Switch, LO (24-48 Vdc)

Notes: 1 - For vertical mounting order codes, please visit www.gemultilin.com/T35
2 - To view the latest options available for the T35, or to order the UR Classic Front Panel, please visit our online store for more details.

Accessories for the T35

- UR Applications I Learning CD TRCD-URA1-C-S-1
- Multilink Ethernet Switch ML2400-F-HI-HI-A2-A2-A6-G1
- Viewpoint Engineer VPE-1
- Viewpoint Maintenance VPM-1
- Viewpoint Monitoring IEC61850 VP-1-61850

Visit www.GEMultilin.com/T35 to:



- View Guideform specifications
- Download the instruction manual
- Review applications notes and support documents
- Buy a T35 online
- View the UR Family brochure