

# Multilin™ 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
- Advanced automation capabilities for providing customized protection and control solutions
- Three independent fiber or copper Ethernet ports for simultaneous/dedicated network connections with advanced 1 microsecond time synchronization via LAN with IEEE® 1588 support
- Reduced relay-to-relay wiring and associated installation costs through high-speed inter-relay communications
- Increase network availability by reducing failover time to zero through IEC® 62439-3 “PRP” support
- CyberSentry™ provides high-end cyber security aligned to industry standards and services (NERC® CIP, AAA, Radius, RBAC, Syslog)
- Advanced fault and disturbance recording, including internal relay operating signals, eliminating the need for redundant recording devices
- Complete IEC 61850 Process Bus solution provides resource optimization and minimizes total P&C life cycle costs

## 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, autotransformers, reactors, split-phase and angle regulating transformers
- 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
- Thermal overload and time overcurrent elements for backup protection
- Transducer I/Os (RTD & dcmA)
- FlexElements
- FlexCurves

### Communications

- Networking interfaces: up to three Ethernet ports 100Mb fiber or copper, RS485, RS232, RS422, G.703, C37.94
- Multiple protocols: IEC 61850, DNP 3.0 and Modbus® serial/TCP, IEEE 1588, IEC 60870-5-104 and 103, PRP, SNTP, HTTP, TFTP, EGD
- Direct I/O: secure, high-speed exchange of data between URs for direct transfer trip (DTT) applications
- Embedded managed Ethernet switch with four 100 Mbit fiber optic ports and 2 copper ports

### IEC 61850 Process Bus Interface

- Robust communications with up to 8 HardFiber Bricks
- Redundant architecture for dependability and security

### Monitoring and Metering

- Metering: current, voltage, power, energy, frequency, temperature
- Advanced recording capabilities deliver a 1024 event recorder, configurable and extended waveform capture and data logger
- Setting for security audit trails for tracking changes to T35 configurations

### EnerVista™ Software

- Graphical Logic Designer and Logic Monitor to simplify designing and testing procedures via EnerVista UR Engineer
- Service and update notification toolset ensures device documents and software are up-to-date via EnerVista Launchpad
- EnerVista Integrator providing easy integration of data in the T35 into new or existing monitoring and control systems



imagination at work

## Protection and Control

The T35 transformer protection system is a three-phase transformer relay designed to protect power transformers 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 the removal of the zero-sequence current even for delta connected transformer windings, accommodating 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

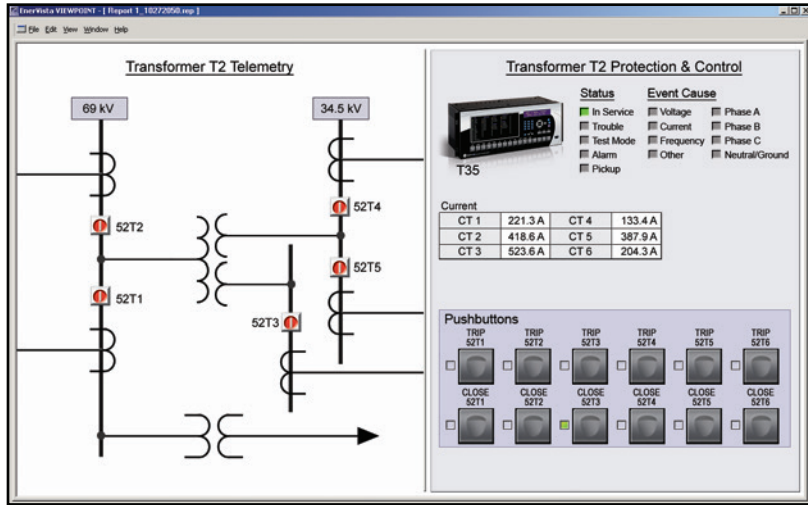
The T35 can be used to protect transformer differential zones with up to 6 three-phase current inputs (six restraints), making it possible to include multiple breakers or small buses in the differential zone.

### 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 restraint 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



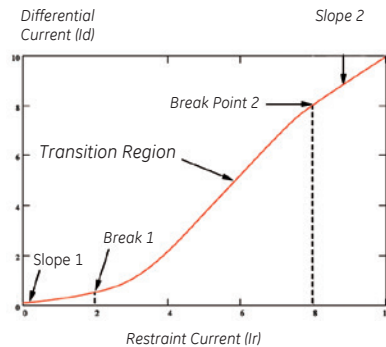
The T35 is the single point for protection, control, metering, and monitoring in one integrated device that can easily be connected directly into DCS or SCADA monitoring and control systems like Viewpoint Monitoring as shown.

### Inrush Inhibit

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

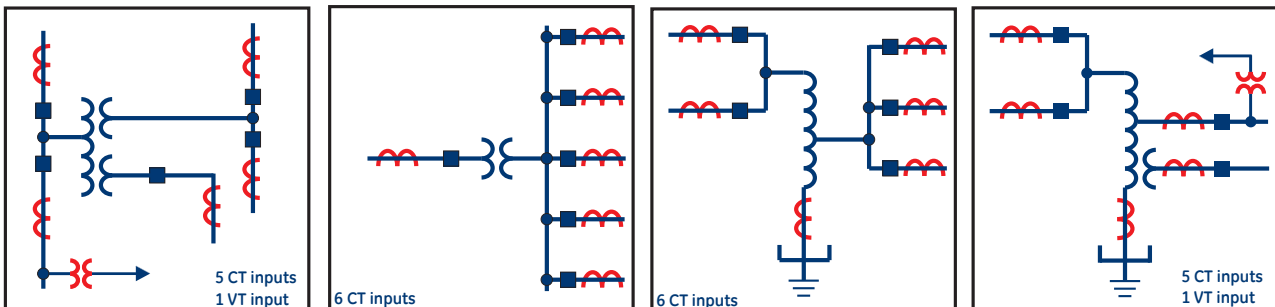
The adaptive mode maximizes dependability on internal faults and ensures security during inrush conditions even with weak second harmonics. It reduces the sensitivity of magnitude comparison, by biasing towards security, based on an angular relationship. Dependability is maintained by applying the restraint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

### Differential vs. Restraint Characteristic (I<sub>d</sub> vs. I<sub>r</sub>)



The settings for the dual-slope, dual-breakpoint characteristic provides higher flexibility for shaping up the characteristic and achieving 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 to 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.

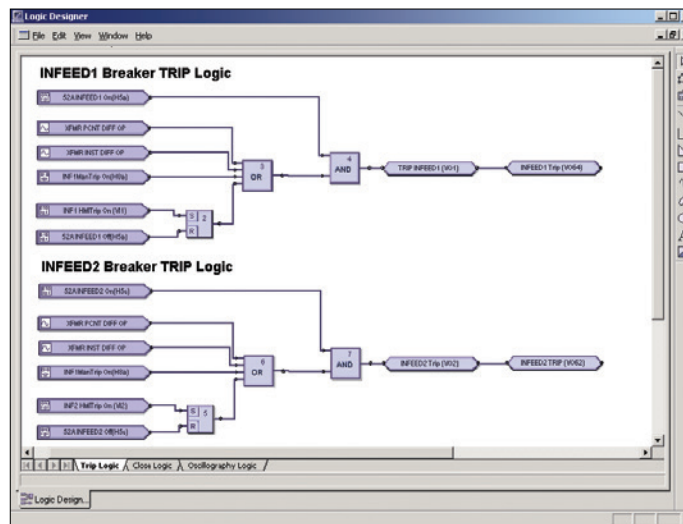
### Overcurrent Functions

T35 provides thermal overload, time overcurrent elements for phase, neutral, and ground, which can run in parallel with primary differential protection or can be programmed to provide primary protection under conditions when other protection 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,

### 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.

frequency, power factor, etc.). Applications could include overvoltage, overpower, low power factor, temperature differential, and more.

### IEC 61850 Process Bus

The IEC 61850 Process Bus module is designed to interface with the Multilin HardFiber System, allowing bi-directional IEC 61850 fiber optic communications. The

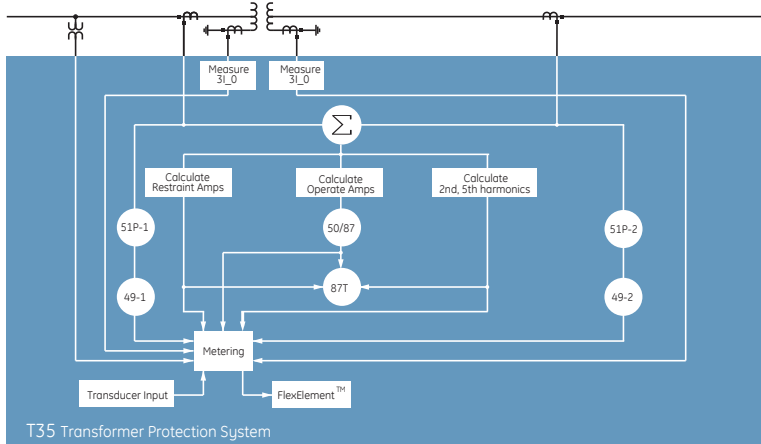
HardFiber System is designed to integrate seamlessly with existing UR applications, including protection functions, FlexLogic, metering and communications.

The 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 the IEC 61850 Process Bus module
- Does not introduce new cyber security concerns

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

### Functional Block Diagram



#### ANSI Device Numbers & Functions

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

### 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 to create customized protection and control schemes, minimizing the need and associated costs of, auxiliary components and wiring. Using FlexLogic, the T35 can be programmed to provide the 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 the 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 trip-rated 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 and pressure

- Sequence of Event (SOE)
  - 1024 time stamped events
- Oscillography
  - 64 digital & up to 40 analog channels
  - Events with up to 45s length
- Data Logger and Disturbance Recording
  - 16 channels up to 1 sample/cycle/channel
- 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 stand-alone recording equipment.

### 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

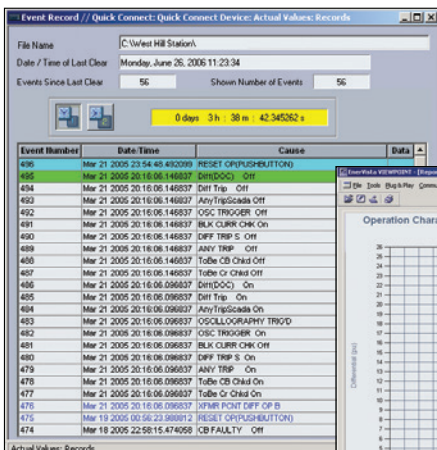
The advanced disturbance and event recording features within the T35 can significantly reduce the time needed for postmortem analysis of power system events and the creation of regulatory reports. Recording functions include:

### Advanced Device Health Diagnostics

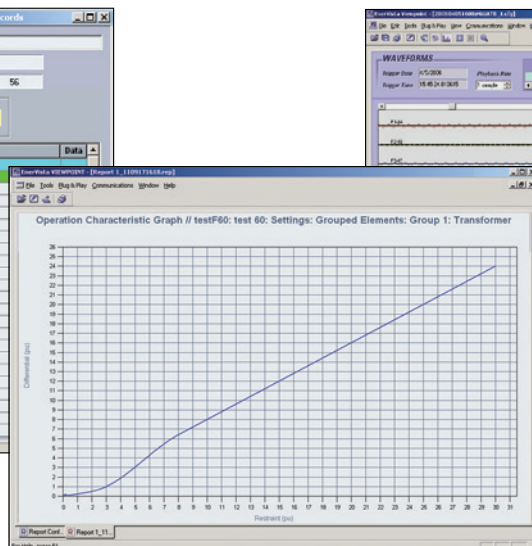
The T35 performs comprehensive device health diagnostic tests at startup and continuously during run-time to test its own major functions and critical hardware. These diagnostic tests monitor for conditions that could impact security and availability of protection, and present device status via SCADA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

## 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 for setting verification and operation troubleshooting.



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.

- Comprehensive device health diagnostic performed at startup
- Monitors the CT/VT input circuitry to validate the integrity of all signals

## Cyber Security – CyberSentry UR

CyberSentry UR enabled UR devices deliver full cyber security features that help customers to comply with NERC CIP and NIST® IR 7628 cyber security requirements. This software option delivers the following core features:

### AAA Server Support (Radius/LDAP)

Enables integration with centrally managed authentication and accounting of all user activities and uses modern industry best practices and standards that meet and exceed NERC CIP requirements for authentication and password management.

### Role Based Access Control (RBAC)

Efficiently administrate users and roles within UR devices. The new and advanced access functions allow users to configure up to five roles for up to eight configurable users with independent passwords. The standard “Remote Authentication Dial In User Service” (Radius) is used for authentication.

### Event Recorder (Syslog for SEM)

Capture all cyber security related events within a SOE element (login, logout, invalid password attempts, remote/local access, user

in session, settings change, FW update, etc), and then serve and classify data by security level using standard Syslog data format. This will enable integration with established SEM (Security Event Management) systems.

## 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 three independent Ethernet ports, redundant Ethernet option and the embedded managed Ethernet switch provide the means to create 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.

- IEC 61850 with 61850-90-5 support
- DNP 3.0
- Ethernet Global Data (EGD)
- IEC 60870-5-103 and IEC 60870-5-104
- IEEE 1588 for time synchronization
- Modbus RTU, Modbus TCP/IP
- PRP as per IEC 62439-3

## Interoperability with Embedded IEC 61850

Use the T35 with integrated IEC 61850 to lower costs associated with transformer protection, control and automation. GE Digital Energy’s leadership in IEC 61850 comes from thousands of installed devices and follows on extensive development experience with UCA 2.0.

- Replace expensive copper wiring between devices with direct transfer of data using GOOSE messaging
- Configure GE systems based on IEC 61850 and also monitor and troubleshoot them in real-time with EnerVista Viewpoint Engineer

## Direct I/O Messaging

Direct I/O allows for the 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.

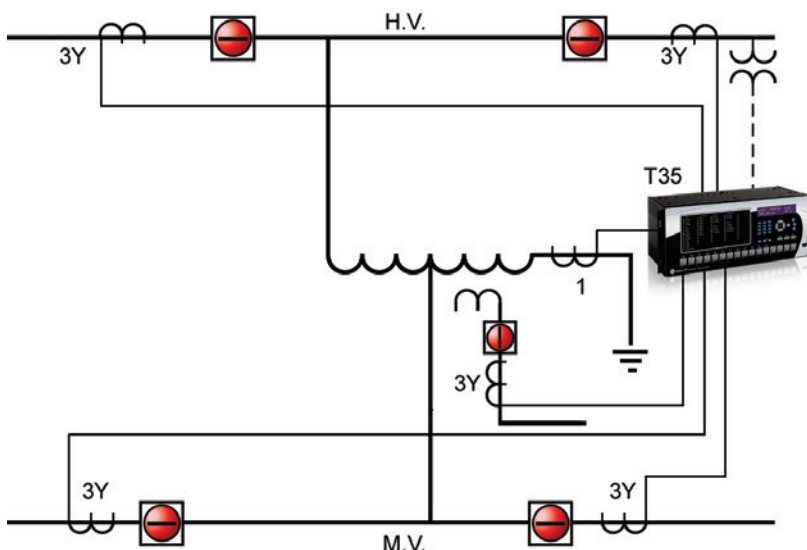
Direct I/O provides superior relay-to-relay communications that can be used in advanced interlocking, generation rejection and other special protection schemes.

- 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

## LAN Redundancy

Substation LAN redundancy has been traditionally accomplished by reconfiguring the active network topology in case of failure. Regardless of the type of LAN architecture (tree, mesh, etc), reconfiguring the active LAN requires time to switchover, during which the LAN is unavailable. UR

## Cost Effective Solution



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

devices deliver redundancy as specified by PRP-IEC 62439-3, which eliminates the dependency on LAN reconfiguration and the associated switchover time. The UR becomes a dual attached node that transmits data packets over both main and redundant networks simultaneously, so in case of failure, one of the data packets will reach the receiving device with no time delay.

### Multi-Language

UR devices support multiple languages: English, French, Russian, Chinese, Turkish and German. These language options are available on the front panel, in the EnerVista setup software, and in the product manuals. 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 SOE viewers are an integral part of the UR setup software included with every UR relay, to carry out postmortem event analysis and 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 Multilin products. The setup software within Launchpad allows for the configuration of 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 UR Engineer

Viewpoint UR 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 UR 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

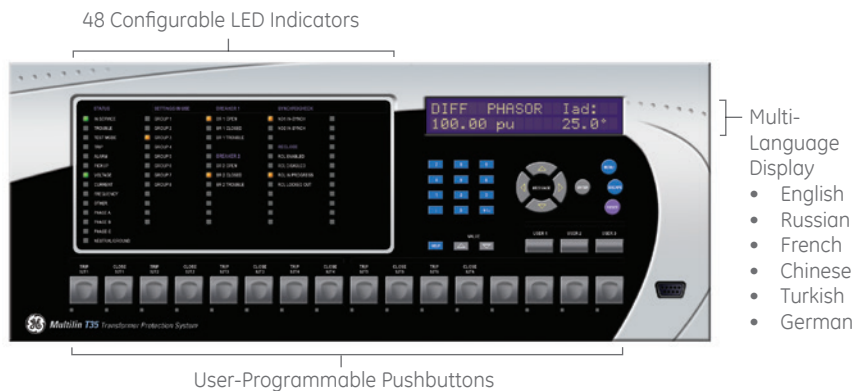
### EnerVista Integrator

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

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

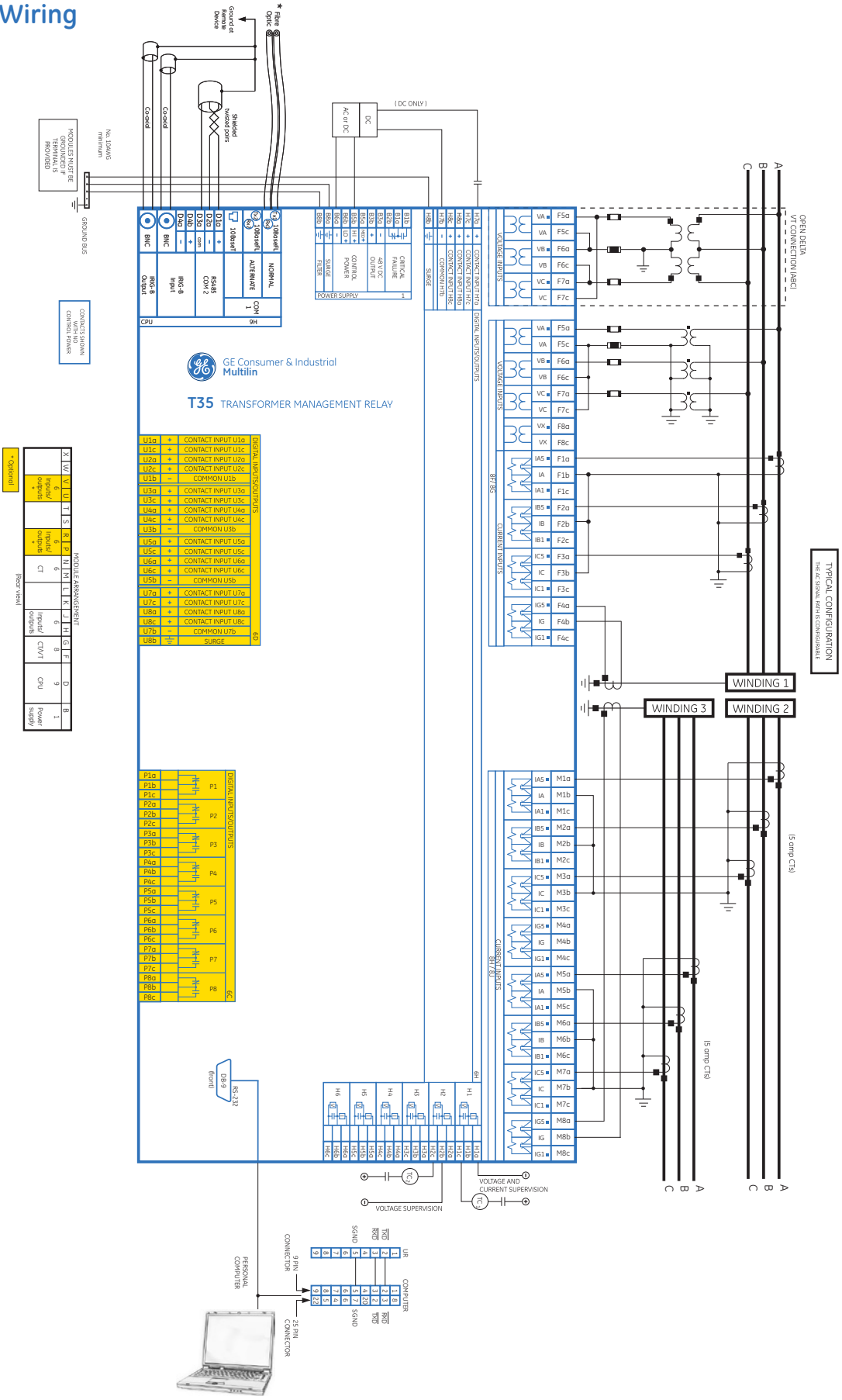
### User Interface

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.



- English
- Russian
- French
- Chinese
- Turkish
- German

Typical Wiring



Terminal	Function	Notes
U10	CONTACT INPUT U10	
U11	CONTACT INPUT U11	
U12	CONTACT INPUT U12	
U13	CONTACT INPUT U13	
U14	CONTACT INPUT U14	
U15	CONTACT INPUT U15	
U16	COMMON U16	
U17	CONTACT INPUT U17	
U18	CONTACT INPUT U18	
U19	CONTACT INPUT U19	
U20	CONTACT INPUT U20	
U21	CONTACT INPUT U21	
U22	CONTACT INPUT U22	
U23	CONTACT INPUT U23	
U24	CONTACT INPUT U24	
U25	CONTACT INPUT U25	
U26	CONTACT INPUT U26	
U27	CONTACT INPUT U27	
U28	CONTACT INPUT U28	
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U31	CONTACT INPUT U31	
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U35	CONTACT INPUT U35	
U36	CONTACT INPUT U36	
U37	CONTACT INPUT U37	
U38	CONTACT INPUT U38	
U39	CONTACT INPUT U39	
U40	CONTACT INPUT U40	
U41	CONTACT INPUT U41	
U42	CONTACT INPUT U42	
U43	CONTACT INPUT U43	
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U87	CONTACT INPUT U87	
U88	CONTACT INPUT U88	
U89	CONTACT INPUT U89	
U90	CONTACT INPUT U90	

Terminal	Function	Notes
P10	DIGITAL INPUT/OUTPUT P10	
P11	DIGITAL INPUT/OUTPUT P11	
P12	DIGITAL INPUT/OUTPUT P12	
P13	DIGITAL INPUT/OUTPUT P13	
P14	DIGITAL INPUT/OUTPUT P14	
P15	DIGITAL INPUT/OUTPUT P15	
P16	DIGITAL INPUT/OUTPUT P16	
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P81	DIGITAL INPUT/OUTPUT P81	
P82	DIGITAL INPUT/OUTPUT P82	
P83	DIGITAL INPUT/OUTPUT P83	
P84	DIGITAL INPUT/OUTPUT P84	
P85	DIGITAL INPUT/OUTPUT P85	
P86	DIGITAL INPUT/OUTPUT P86	
P87	DIGITAL INPUT/OUTPUT P87	
P88	DIGITAL INPUT/OUTPUT P88	
P89	DIGITAL INPUT/OUTPUT P89	
P90	DIGITAL INPUT/OUTPUT P90	

## Ordering

	T35	-	*	**	-	H	*	*	-	F**	-	H**	-	M**	-	P**	-	U**	-	W**			
Base Unit CPU	T35	E	J	K	N	T	U	V														For full sized horizontal mount Base Unit RS485 & RS485 (IEC 61850 option not available) RS485 + multimode ST 100BaseFX RS485 + multimode ST Redundant 100BaseFX RS485 + 10/100 100BaseT RS485 + three multimode SFP LC 100BaseFX. Req FW v7xx or higher RS485 + two multimode SFP LC 100BaseFX + one SFP RJ45 100BaseT. Req FW v7xx or higher RS485 + three SFP RJ45 100BaseT. Req FW v7xx or higher	
Software Options (See note 1 below)		00	01	03	04	A0	B0	C0	D0													No Software Options Ethernet Global Data (EGD) IEC 61850 Ethernet Global Data (EGD) + IEC 61850 CyberSentry UR Lvl 1. Req UR FW 7.xx or higher IEEE 1588. Req UR FW 7.xx or higher PRP IEEE 1588 + CyberSentry. Req UR FW 7.xx or higher	
Mount						H	A	V	B													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							F	I	J	K	L	M	N	O	T	U	V	W	Y				Vertical Front Panel with English Display Enhanced German Front Panel Enhanced German Front Panel with User-Programmable Pushbuttons 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 Enhanced Turkish Front Panel Enhanced Turkish Front Panel with User-Programmable Pushbuttons
Power Supply (see note 2 below)							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		8L		8L								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 Digital I/O										81												8 Port IEC 61850 Process Bus Module 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	5A	5A	5A	5A	5A	5C	5C	5C	5E	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, multimode, LED, 1 Channel 7B 1300 nm, multimode, LED, 1 Channel 7C 1300 nm, singlemode, ELED, 1 Channel 7H 820 nm, multimode, LED, 2 Channels 7I 1300 nm, multimode, LED, 2 Channels 7J 1300 nm, singlemode, ELED, 2 Channels 7S G.703, 2 Channels 7W RS422, 2 Channels 77 IEEE C37.94, 820 nm, multimode, LED, 2 Channel	

Notes: 1. To view all the options available for T35, please visit GE's On-Line Store <http://store.gedigitalenergy.com/viewprod.asp?model=T35>  
2. Redundant power supply only available in horizontal unit. If redundant is chosen, must be some type. Maximum 2 per chassis.

### Visit GEMultilin.com/T35 to:



- View guideform specifications
- Download the instruction manual
- Review application notes and support documents
- Buy a T35 online
- View the UR family brochure

### Accessories for the T35

- |                                  |                            |
|----------------------------------|----------------------------|
| • UR Applications I Learning CD  | TRCD-URA1-C-S-1            |
| • Multilink Ethernet Switch      | ML2400-F-HI-HI-A2-A2-A6-F1 |
| • Viewpoint Engineer             | VPE-1                      |
| • Viewpoint Maintenance          | VPM-1                      |
| • Viewpoint Monitoring IEC 61850 | VP-1-61850                 |

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