

High speed, 3 phase differential protection for transformer faults.



DESCRIPTION

The DTP-B is a digital relay that provides high-speed differential and backup instantaneous differential three phase protection functions for power transformers. Different models of the DTP are available for protecting and monitoring transformers with two, three or four windings.

The special characteristics of the DTP-B are necessary to provide differential protection for transformer internal faults and avoid tripping for unbalances caused by high magnitude external faults. Harmonic restraint is used to prevent the differential function from operating during transformer energization or overexcitation. For each phase a high-set, unrestrained, differential function provides back-up protection for those high magnitude internal faults that produce sufficient current transformer saturation to cause harmonic restraint of the differential protection.

The DTP has 7 digital inputs, all of them configurable by the user with the GE-INTRO configuration software. The DTP has 13 outputs: 4 are trip contacts, 1 is an alarm contact, and 8 are configurable outputs.

The DTP has metering and monitoring functions. It displays the line current with module and argument for each phase and winding, the differential and through current for each phase and the second and fifth harmonic differential current for each phase. The DTP keeps a record of the last 166 events, which are time tagged to 1/100 of a second. Four oscillography records can be stored in memory with a sampling rate of 16 samples per cycle.

DTP

Digital Transformer Protection

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Application

- Main transformer protection

Protection and Control

- Current differential protection
- 2, 3 or 4 windings
- Dual-slope percentage restraint
- 2nd & 5th harmonic cross-restrained
- Internal phase shift compensation
- 7 configurable digital inputs
- 4 trip contacts
- 8 configurable outputs

Monitoring and Metering

- All currents
- Event recorder
- Oscillography recorder
- Self-Checking functions
- Settings tables

User Interfaces

- 20 key keypad
- Alphanumeric 2-line LCD
- 16 LED indicators
- RS232, plastic or glass fiber optic
- Time synchronization

Features

- GE-LOCAL software
- GE-INTRO configuration software
- IRIG-B input
- DDS system compatible



PROTECTION AND CONTROL

Differential Protection

For high magnitude external faults, the impossibility of obtaining a completely balanced differential circuit due to the differences in the CT outputs makes the special characteristics provided in the DTP necessary. To prevent operation on these unbalances, a current differential with percentage restraint is used.

The differential current is defined as the difference of the currents in both ends of the circuit. Through current is defined as the smallest among the primary and secondary currents (the energy that effectively crosses the power transformer). As the through current increases, the level of differential current must increase to operate the relay. The DTP differential unit has programmable dual-slope percentage restraint with adjustable slope breakpoint.

The fundamental component of the differential current is obtained via a Discrete Fourier Transformation (DFT). This DFT provides excellent frequency filtration, making the differential current measurement immune to noise, DC components and wave distortion. This gives the digital DTP relay a clear advantage over other analog and hybrid (analog measurement and microprocessor support for other functions) models. Through current is computed as an RMS value. This takes into account not only the fundamental value but also all of the harmonics up to fifth. The algorithm used to calculate the RMS value permits a high level of accuracy in the through current measurement.

Phase Shift Compensation

The DTP allows internal compensation to be selected to adjust for the phase shift across the protected transformer. This is accomplished by settings that define the connection group of each power transformer winding as well as the connections of the current transformers (CT). With this approach all of the external CTs can be wye connected. When the internal compensation is selected the DTP makes the proper phase adjustments to the applied currents and eliminates the zero-sequence component of the current.

Conventional external compensation can also be selected. In this case the phase shift adjustment and elimination of the zero-sequence component of the current are brought about by the proper connections of the external CTs. This setting is useful for testing the relay with single phase and three phase test sources that supply in-phase currents.

Harmonic Restraint

For each phase a harmonic restraint current is calculated proportionally to the second and fifth harmonics of the differential current. The harmonics are extracted using DFTs. The total harmonic restraint is an RMS value equal to the square root of the sum of the squares of the second and fifth harmonics.

The magnitude of the harmonic restraint current is used to discriminate between fault conditions and the inrush of exciting current to the transformer when it is energized. This value is used to restrain the differential function from operating during conditions of transformer energization and overexcitation. Harmonic cross restraint is used, where if the harmonic content of one phase is sufficient to restrain that phase, then the other two phases are also restrained from operating.

Unrestrained Instantaneous Overcurrent

For each phase a high set unrestrained differential function is provided. This acts as a backup protection for those high magnitude internal faults that produce sufficient CT saturation to cause harmonic restraint of the differential protection. The instantaneous trip function uses the fundamental component of the differential current.

Digital Inputs

The DTP has 7 digital inputs configurable by the user with the GE-INTRO configuration software. One of the following values can be assigned to each input:

- Unused input
- External trigger (P)
- Table 0 selection (L)
- Table 1 selection (L)
- Buchholz alarm (L)
- Buchholz trip (L)
- Overtemperature alarm (L)
- Overtemperature trip (L)
- Trip block (L)

(P) means that the function assigned to the input is activated by pulse, and

(L) means that the function is activated by level.

In addition, the configurable inputs can be used for implementing different schemes performing logic ANDs with the inputs, and assigning them to the outputs.

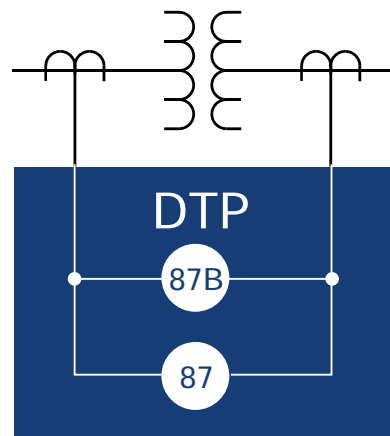
The Buchholz and overtemperature inputs are contacts from sensing devices located on the power transformer. They cause either an alarm or trip contact to close and an event to be stored.

Digital Outputs

The DTP system has 8 user configurable outputs and 5 non-configurable outputs, 4 of them are trip contacts and the other one is an alarm contact. The configurable outputs can be programmed using logic based on the internal protection states. The internal states of the DTP can be used to carry out logical operations NOT, AND, and OR.

The output configuration is done using the different levels. At the first level it is possible to use AND gates of up to 16 signals. The output is incorporated into the states matrix so that it can in turn be used in next AND gates of up to 16 inputs. This process can continue until the 16 ANDs are used. Once the AND gates have been configured, it is possible to create a second level with OR gates of 16 inputs limited to the established groups of bytes, and whose logical outputs are assigned to physical outputs of the unit.

FUNCTIONAL BLOCK DIAGRAM



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MONITORING AND METERING

Measurement

The DTP relay can measure the following magnitudes:

- Line current (module and argument for each phase and winding)
- Differential and through current for each phase
- Second and fifth harmonic current for each phase

These measurements can be accessed either locally, on the LCD display on the front of the relay, or via the GE-LOCAL communication software, in the measurements screen.

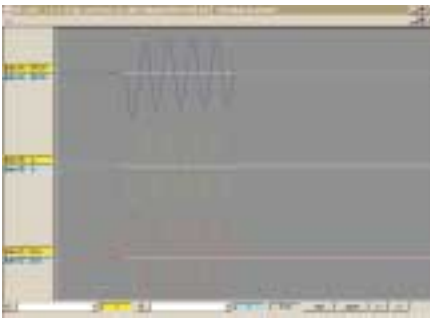
Event Recorder

The DTP equipment keeps a record of the last 166 events and stores the following information:

- Date and time (1 millisecond resolution)
- Type of event
- Value of the differential and through currents
- Internal states matrix of the unit

This event recorder is stored in a non-volatile memory and can be maintained indefinitely, even with no power supply. The generated events are associated to the internal protection and communication states.

DTP oscillography.



Oscillography Recorder

The DTP unit stores up to 4 oscillography records, with a resolution of 16 samples per cycle. Each record has a maximum capacity of 66 cycles. The number of prefault cycles can be selected from 2 to 10 cycles. Each of the records includes the following information:

- Instantaneous values for current inputs
- Digital information
- Date and time
- Causes that generated the oscillography record
- Active settings in the moment of the record

The possible causes to perform the oscillography triggering are the following:

- 87B phase A trip
- 87B phase B trip
- 87B phase C trip
- 87 phase A trip
- 87 phase B trip
- 87 phase C trip
- Buchholz trip
- Overtemperature trip
- Input trigger
- Communications trigger

There is a mask that can be configured and that determines which functions or internal trips start the oscillography. It may also be started by a configurable digital input, by communications or directly from the MMI.

The oscillography records are retrieved and converted into a COMTRADE IEEE standard format file using the GE-LOCAL communications program. They can be visualized using the GE-OSC program, or any other program that accepts the COMTRADE IEEE C37.111-1991 International Standard format.

Self Checking Functions

As an advantage of its digital technology, the DTP system incorporates self-checking functions, which guarantee the correct performance of the unit and will block the operation in case of internal errors.

These self-monitoring checks are carried out both when the unit is started up and during normal operation. The checks are carried out on the internal power supply, program memory (ROM), working memory (RAM), oscillographic memory (RAM) and settings and calibration memory (EEPROM).

In addition there is a hardware test for the LED indicators, which light them all up when the button TARGET RESET is pressed.

Setting Tables

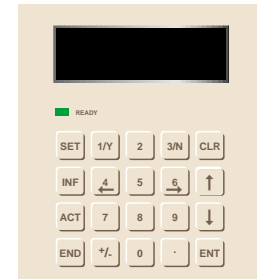
The DTP has three independent setting tables, stored in non-volatile memory. Only one setting table is active each time, and this is the one used by the system for performing the different functions. Of all the existing settings in a DTP unit, there are several generic groups which are common to all the settings tables, while the Differential Function Settings Group is accessed separately for each table.

USER INTERFACES

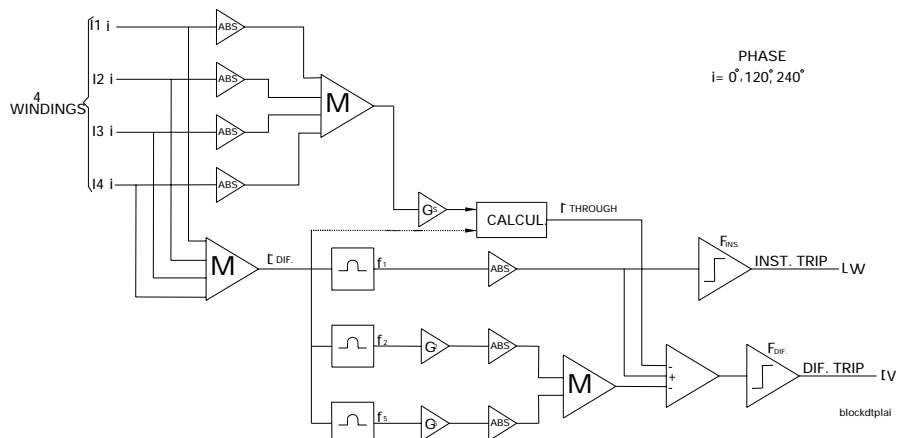
Man-Machine Interface (MMI)

The DTP unit includes a 20 key keyboard and a 2-line LCD display with 16 characters per line. This display has highly reliable LED diode back lighting. By means of this interface, the user can change the settings, visualize measurements, carry out operations and access information stored in the unit.

A keypad and display allow local communication with the DTP-B.



BLOCK DIAGRAM



USER INTERFACES

LED Indicators

The DTP unit has a total of 17 LED indicators, one fixed bicolor assigned to the critical alarm function of the unit and 16 red LED indicators, arranged in one column. They can be configured using the GE-INTRO configuration software to any of the user definable alarms assigned from among the protection and communication states. Each LED can be configured to have memory in the absence of auxiliary power supply. They can also be configured to blink when turned on.

Communication Software

Two Windows® based software packages are included with the DTP:

- GE-LOCAL enables the user to visualize the protection settings, alarms, LEDs, measurements and status, to retrieve oscillography records, to retrieve event record
- GE-INTRO enables the user to configure the inputs, outputs and LEDs

As an option, GE-OSC software enables the user to study the oscillography records.

These software packages are part of the GE-NESIS software (GE Network Substation Integration System) used by the DDS system.

TYPICAL WIRING

Table 1: Default LED configuration.

LED No.	Description
1	87 A trip
2	87 B trip
3	87 C trip
4	87B A trip
5	87B B trip
6	87B C trip
7	Buchholz alarm
8	Buchholz trip
9	Temperature alarm
10	Temperature trip
11	Out of service
12	Trip not permitted
13	EEPROM alarm
14	Date and time alarm
15	Internal communication error
16	Remote mode

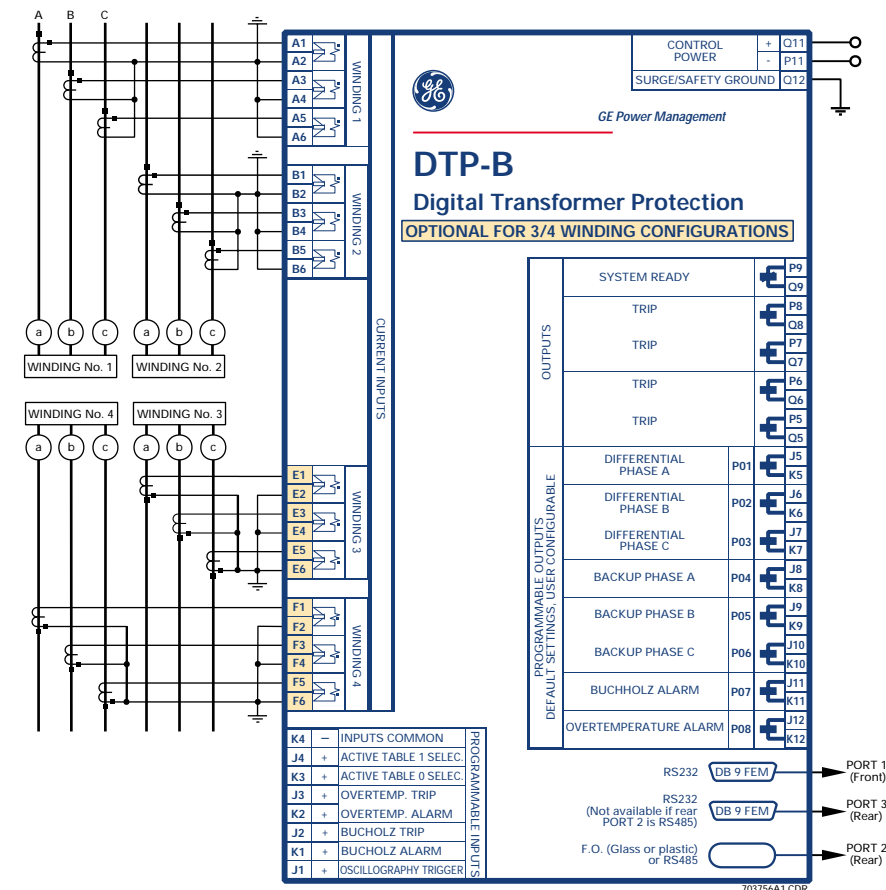
Communication Ports

The DTP has 2 serial gates and 3 connectors. Gate 1 can be reached from the front of the relay in connector 1 (PORT 1) or from the back (PORT 3). The second gate can be reached from connector 2 (PORT 2) which is located on the rear.

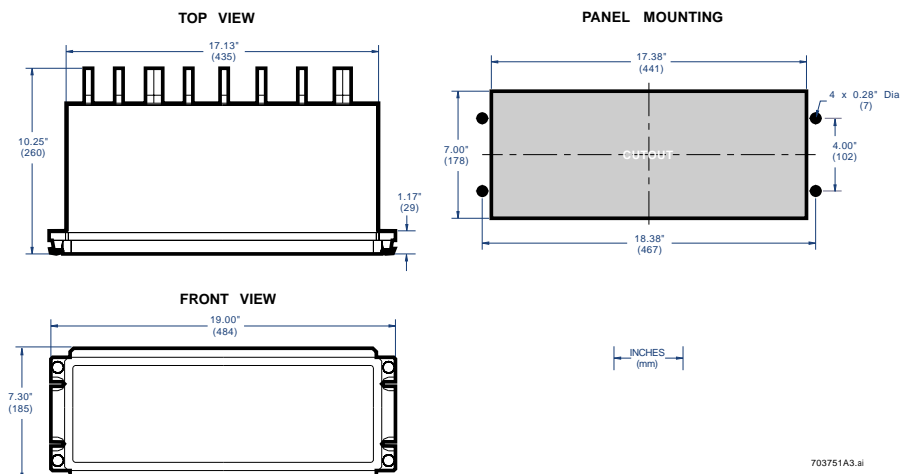
PORT 1 connector has priority over PORT 3 connector and is selected when the DCD (Data Carrier Detect) signal is activated. Gate 1 (PORT 1 and PORT 3 connectors) and 2 (PORT 2 connector) are independent and the unit can serve them simultaneously.

There are different models each with a different physical connection for the PORT 2 connector. In the "RS232" models the two connectors are RS232 (PORT 3 does not exist). In the "RS232 and RS485" models, PORT 1 is RS232, while PORT 2 is RS485 (PORT 3 does not exist). In the "RS232 and fiber-optic" models the PORT 1 and PORT 3 connectors are RS232 while a fiber-optic connector replaces the PORT 2 connector (see ordering guide for clarification).

The communications protocol is the same as that used for the rest of the DDS system GE Digital Protections, and requires the use of the GE-LOCAL software. The protocol is reliable and allows communication with different protection systems. It guarantees very efficient data transfer (especially for the oscillography and other large files) along with error detection and automatic communication recovery.



DIMENSIONS



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TECHNICAL SPECIFICATIONS

PROTECTION	
General Settings:	
Frequency:	50 or 60 Hz
Winding CT ratio:	1-4000 in 1 steps
Protection Settings:	
Winding tap:	0.5-20 x I_n
Winding configuration:	Y, D, ZZ
Winding time group:	0 - 11
Winding CT configuration:	Y0, Y6, D1, D5, D7, D11
Differential Function Settings:	
Sensitivity:	0.2 - 0.4 x I_{lap}
K1 percentage restraint:	15 - 100%
K2 percentage restraint:	15 - 100%
K1-K2 inflexion:	0 - 10 x I_{lap}
2nd harmonic restraint:	12 - 100%
5th harmonic restraint:	12 - 100%
87B tap:	4 - 12 x I_{lap}

POWER SUPPLY	
Auxiliary Voltage:	48/125 VDC
	110/250 VDC

OUTPUTS	
TRIPPING CONTACTS	
Rated Voltage:	250 VAC
Maximum Opening Voltage:	440 VAC
Rated Current:	16 A
Closing Current:	25 A
Operating Power:	4000 VA
Mechanical Life:	30 x 10 ⁶ ops.

INPUTS	
Digital Input Voltage:	As auxiliary voltage
Thermal Capacity:	
Current circuits:	
Continuous:	4 x I_n
During 3 sec:	50 x I_n
During 1 sec:	100 x I_n
DC Burden:	12W
Burden Per Active Input:	8mA per input

TYPE TESTS	
The DTP equipment complies with the following standards, which include the GE insulation and electromagnetic compatibility standard and the standards required by Community Directive 89/336 for the EC market, in line with European standards. It also complies with the European directive requirements for low voltage, and the environmental and operating requirements established in ANSI standards C37.90, IEC 255-5, IEC 255-6 and IEC 68.	
Insulation Test Voltage:	IEC 255-5, 600V, 2kV 50/60 Hz, 1 min
Impulse Voltage Withstand:	
	IEC 255-5, 5 kV, 0.5 J
1 MHz Interference:	IEC 255-22-1, Class III
Electrostatic Discharge:	IEC 255-22-2, Class IV
Immunity to Radio Interference:	
	IEC 255-22-3, Class III
Electromagnetic Fields Radiated with Amplitude Modulation:	
	ENV 50140, 10 V/m
Electromagnetic Fields Radiated with Amplitude Modulation:	
Common mode:	ENV 50141, 10 V/m
Electromagnetic Fields Radiated with Frequency Modulation:	
	ENV 50204, 10 V/m
Fast Transients:	IEC 255-22-4, IEC 61000-4-4, Class IV
Magnetic Fields at Industrial Frequency:	
	EN 61000-4-8, 30 A/m
RF Emission:	EN 55011, Class B

COMMUNICATIONS	
Mode:	Half Duplex
Speed:	1200 to 19200 bps
Physical Media:	
RS232 (ports 1,2)	
Plastic fiber optic (port 2 optional)	
Type of connector:	HFBF-4516
Power supplied:	-8 dBm
Receiver's sensitivity:	-39 dBm
Wave length:	660 nm
Glass fiber optic (port 2 optional)	
Type of connector:	STA
Power supplied:	-17.5 dBm
Receiver's sensitivity:	-24.5 dBm
Wave length:	820 nm

*Specifications subject to change without notice.

PACKAGING	
Weight:	
Net:	26.4 lbs (12kg)
Shipping:	28.6 lbs (13kg)
Dimensions:	NEED INCH EQUIVALENTS
	437 x 200 x 176 mm (19" rack 4 units high)

ENVIRONMENTAL	
Ambient Temperature Range:	
Operation:	-20°C to +55°C
Storage:	-40°C to +85°C
Humidity:	Up to 95% noncondensing

CASE	
Metal Casing	
IP52 grade protection (as per IEC 529)	

GUIDEFORM SPECIFICATIONS

The main transformer protection shall be supplied as an integrated digital system. Standard current transformers shall be used to supply the AC inputs. Models shall be available with 2, 3, or four restraint windings.

The following protection functions shall be included:

- Three phase percentage restraint current differential function
- Harmonic restraint which uses the 2nd and 5th harmonic of the differential current to prevent trips during transformer energization or overexcitation
- High-set, unrestrained, instantaneous differential function which acts as backup protection
- Internal or external settings for phase shift compensation and zero-current elimination

As well as the analog inputs for currents, the relay shall have seven digital inputs. A trip mask shall determine which of trip signals will activate the four trip contacts. Eight signalling outputs are provided.

Metering functions shall include:

- Line current for each phase and winding
- Differential current for each phase
- Through current for each phase
- Second and fifth harmonic current for each phase

Monitoring functions shall include:

- Sequence of events recording with the last 166 events stored
- Oscillography with a sampling rate of 16 samples per cycle, 4 records stored
- Self-test diagnostics

The man machine interface shall include a 20 button keypad and a 2 line backlit LCD. Sixteen red LEDs each can be separately programmed to indicate any of the user definable alarms assigned from among the protection and communication states. Two serial gates and 3 connectors shall be included for remote or local access by a personal computer. Fiber optic connections and RS485 shall be available. The relay shall be packaged in a single 7 inch high (4 rack unit) 19 inch rack mount case.

ORDERING

To order select the basic model and the desired features from the Selection Guide below.

DTP	*	*	*	*	*	0	1	0	*	*	*	B	
DTP													Basic unit
1													Restraint windings: 2 windings
2													Restraint windings: 3 windings
3													Restraint windings: 4 windings
0													P1, P2, P3: M-Link protocol
2													P1, P3: M-Link protocol; P2: ModBus® RTU protocol
													Nominal current rating I_n = 1 A all windings
													Nominal current rating I_n = 5 A all windings
													Nominal current rating I_n = 5 A for 1st winding, 1 A for all others
													Nominal current rating I_n = 1 A for 1st winding, 5 A for all others
													Nominal current rating I_n = 1 A for 1st & 2nd windings, 5 A for windings 3 & 4
													2 RS232 communication ports
													2 RS232 + plastic fiber optic communication ports
													2 RS232 + glass fiber optic communication ports
													RS232 + RS485 communication ports
													Spanish language
													English language
													48/125 VDC supply voltage
													110/250 VDC supply voltage
													Code for special model definition

- ① 0 P1: RS232 P2: RS232 P3: Not available
- 1 P1: RS232 P2: Plastic Fiber Optic P3: RS232
- 2 P1: RS232 P2: Glass Fiber Optic P3: RS232
- 3 P1: RS232 P2: RS485 P3: Not available
- NOTE:** P1 (front) is switched with P3 (rear)
P2 (rear) is independent

DTP revision level A

For ordering information and features on the earlier DTP (Revision A) please visit us at www.GEindustrial.com/pm