DT3000
Microprocessor-based feeder, transformer backup protective relay

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DT3000 Microprocessor-based feeder, transformer backup protective relay

Description

Eaton’s DT 3000 is a microprocessor-based overcurrent protective relay, with integrated functions of protection, measurement and control. With INCOM interface, DT 3000 can realize data sharing and remote control with remote upstream host computer. Its protection feature generally provides phase components and ground components with: inverse time overcurrent protection, short delay time protection, and instantaneous overcurrent protection, overload alarming, regional interlocking. Complete self-inspection function ensures the device to provide reliable protection for primary equipments. This microprocessor-based protection relay can display intuitively graphic operating characteristic curve types on the panel, with dual-window indication of fault information. Besides, it has a special indicator light for indication in case of remote tripping control. With DIP dial switch configuration on the back panel of the device, an even superior protection solution can be offered as well.

Function overview

Protection function
- Inverse time overcurrent protection
- Short delay time overcurrent protection
- Instantaneous overcurrent protection
- Overload alarming and node output
- Tripping protection for discriminator
- Regional interlocking protection for hierarchy switches

Each protection function is independent from each other. They can meet requirements for all kinds of systems, when used in combination with other functions.

Testing function

This mode can be used in regular inspection of relay’s protective function (can select tripping or no-tripping). But when its single phase or ground current is inspected to be 0.1 times higher than primary rating current of CT, the device will automatically set back to testing mode with indication of “ERR” information.

Other special functions
- Automatic reset function: additional automatic reset function can be provided for protective operating signals (condition is when the current falls below 0.5*In)
- Programmable protection output relay: same output relay can allocate different protection function outputs.
- Withdrawable structure: when relay basic device is withdrawn from its housing frame, the device will automatically be short connected to CT circuit and automatically switch off I/O and power supply circuit, ensuring safety of personnel and equipments.

Remote control function

Based on PowerNet protocol, INCOM interface allows remote monitoring system to control operations for local primary equipments, including:
- Real-time operating information inquiry
- Give remote command for switching circuit breakers
- Reset relay devices after closing
- Download protection set points

Regional interlocking function

Can quickly remove regional protection of inverse time and short delay time as a response, replacing expensive busbar differential protection

Communication function

DT3000 provides function for communication with PowerNet system, monitoring remotely the operation status of primary equipments. Real-time operation parameters can be viewed on the panel and transmitted to PowerNet via INCOM interface:
Dual power supply: when normal power supply voltage for the device falls down to 75% of voltage rating, the device will start CT circuit for power supply. Even in the case of normal power supply faults, the protection function can still work, providing reliable protection constantly for operating equipments.

Introduction of protection function

DT 3000 provides 11 types of protection characteristic curves for primary equipment in medium voltage power distribution system, as shown below.

Characteristic curve diagram of DT 3000 overcurrent protective relay’s phase components and ground components

Explanation:
In the characteristic curves of ANSI and IEC, the unit for horizontal axis is Ipu (CT primary operate value), while in short delay time and instantaneous curves, the horizontal axis unit is In (primary current value when CT secondary current at 5A). In the case of thermal tripping curve, horizontal axis units are In for all the three circumstances, which shall be distinguished in coordination and programming.

Inverse time overcurrent protection
Inverse time overcurrent protection is set up, including curve types, operate values, set up of inverse-time time-factor. Operate value setup item sets up current level when inverse time current tripping function begins timing. If after the pre-setup time, overcurrent conditions still exist, then tripping relay of the device will operate. The picture on the right shows how the inverse time overcurrent operate value passes operate value set-up and make horizontal movement along time-current coordinate system.

Short delay time overcurrent protection
Short delay time overcurrent protection is responding to short circuit condition faults. The set-up items include current operate value setup and delay setup. The former is the current level of the overcurrent when this protection begins timing. The latter is the time size from the beginning of timing till operating tripping.

The above is a typical short delay operate-value setup. The dashed line section is shown when users select different operate-values; the same short delay time setup is the dashed line combination vertical to time axis, as shown below.
Ground fault protection
Ground fault protection has below three protection set-up:
1. Inverse time overcurrent curve, operate-value, time setup;
2. Short delay overcurrent protection operating value and time setup;
3. Instantaneous operating protection operate-value. Ground curve shape is independent from phase component curve shape.
   ■ In addition, below are other differences between them: in thermal curves, when the inverse time overcurrent time factor to ground is 1*In, time factor to phase is 3*In;
   ■ When ground instantaneous protection is set as “NONE”, ground instantaneous protection will be shielded completely, without providing discriminator distinction protection.

Overload alarming
When load current reaches 85% of phase component inverse time overcurrent operate-value, overload function starts timing, with “High load” LED flicking in red. If the current is below 85%, the timer will reset. Only when the current reaches 85% again, the timer will restart. When there are 3 times of timer overtime:
1. “High Load”LED on relay’s panel keeps in red.
2. Alarming signal transmitting to the whole communication network
3. If DIP-5 is in “0N” position, closed terminals TB2-4 and TB2-5 conduct overload signal node output. When the current is below 85%, the relay returns.

Regional interlocking function
When subordinate protection device sends out tripping signal, it will generate a 175ms-delay regional interlocking signal to superior protection device. Before the superior protection device responds to the fault, the subordinate protection device clears faults during this period. When the signal ends, if the current does not fall down below the fixed value, then the superior protection device will operate immediately for tripping.
   ■ Phase component regional interlocking terminal: TB1-13,14,
   ■ Ground component regional interlocking terminal: TB1-11,12,
   ■ When this function is not used, they should be short connected separately.

Protection function list and respective ANSI standard codes

<table>
<thead>
<tr>
<th>Function</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 phase overcurrent protection</td>
<td>50</td>
</tr>
<tr>
<td>3 phase quick-break ground overcurrent protection</td>
<td>51G</td>
</tr>
<tr>
<td>Ground overcurrent protection</td>
<td>50G</td>
</tr>
<tr>
<td>Regional interlocking</td>
<td>51G</td>
</tr>
</tbody>
</table>
**Technical data**

**Testing standards**
- **Certification:**
  - CUL / UL, recognized (file# E154882)
  - CAN / CSAC22.2 14.M91
  - EN 61010-1(1993)-limited to DT303*
  - EN 55011(1991)
- **Radiation tests**
  - C37.90.1 (1989) surge capacity 2.5kV
  - OSWC 4kV FT SWC
  - ANSI C37.90.1 (1995)-RF
- **FCC47 CFR – Chapter 1, Part15, Class A**
- **Immunity test**
  - ANSI C37.90.1 (1989) surge capacity 2.5kV
  - OSWC 4kV FT SWC
  - ANSI C37.90.1 (1995)-RF
  - Radiation capacity 35V / M- all modes
  - EN61000-4-2(1995)-ESD immunity 8kV
  - IEC255-22-2(1989)-ESD immunity 8kV
  - EN61000-4-3(1995) fast transient 10V/m
  - EN61000-4-4(1995) frequency radiation immunity 10V/m
  - IEC255-22-6(1995) frequency radiation immunity 10V/m
  - EN61000-4-5(1995) frequency carrying immunity 10V/m
  - EN61000-4-11(1994) voltage dip, fluctuation, intermittent interference
  - ANSI C37.90.1 (1989) surge capacity 2.5kV
  - OSWC 4kV FT SWC
  - ANSI C37.90.1 (1995)-RF
  - Radiation capacity 35V / M- all modes
  - EN61000-4-2(1995)-ESD immunity 8kV
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  - EN61000-4-5(1995) frequency carrying immunity 10V/m
  - EN61000-4-11(1994) voltage dip, fluctuation, intermittent interference

**Insulation strength**
- Current input end: 3000V 1m, phase to phase
- Seismic test
- In accordance with UCB requirements and California law

**Current input**
- **CT secondary rating:** 5A
- **CT load:** <0.04 Ohm
- **Saturation value:** 28 *In
- **Instantaneous value:** 30 *In(Chicago version)
- **Ct thermal parameter:** 100 *In 1 second
  - 10A continuous
  - 500A 1 second

**Output tripping node**
- (Tripping OC / Comm, Trip Inst&CommClose)
- Instantaneous 30A ac / dc 0.25 second
- Breaking 0.25A 250Vdc
- Breaking 5A 120 / 240Vac
- Continuous 5A @ 120 / 240Vac
- Reference ANSI C37.90 Chapter 6.7

**Control power supply**

<table>
<thead>
<tr>
<th>Model</th>
<th>Rating</th>
<th>Operating Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DT3000</td>
<td>48V-250Vdc</td>
<td>28V-280Vdc</td>
</tr>
<tr>
<td>DT3030</td>
<td>24V-48Vdc</td>
<td>19V-56Vdc</td>
</tr>
</tbody>
</table>

**Consumption power**

<table>
<thead>
<tr>
<th>Model</th>
<th>Rating</th>
<th>Operating Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DT3000(DC)</td>
<td>48V</td>
<td>125V</td>
</tr>
<tr>
<td></td>
<td>10VA</td>
<td>10VA</td>
</tr>
<tr>
<td>DT3100(DC)</td>
<td>48V</td>
<td>125V</td>
</tr>
<tr>
<td></td>
<td>10VA</td>
<td>10VA</td>
</tr>
</tbody>
</table>

**Phase components and ground components time current curve**

<table>
<thead>
<tr>
<th>Thermal mode</th>
<th>It</th>
<th>(It/2t)</th>
<th>(It/4t)</th>
<th>FLAT</th>
<th>ANSI C37.112 1996</th>
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</thead>
<tbody>
<tr>
<td>IEC A</td>
<td>IEC B</td>
<td>IEC C</td>
<td>IEC D</td>
<td></td>
<td></td>
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<tr>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Rating**

<table>
<thead>
<tr>
<th>DT3030</th>
<th>10VA Maximum</th>
</tr>
</thead>
</table>

DT3000 Microprocessor-based feeder, transformer backup protective relay Aug-2011
**CT ratio (primary)set range:**

Phase & ground components

<table>
<thead>
<tr>
<th>Value</th>
<th>Set Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/25/50/75/100/150/200/250/300/400/500/600/630/800/1000/1200/1250/1500/1600/2000/2400/2500/3000/3200/4000/5000</td>
<td></td>
</tr>
</tbody>
</table>

Phase & ground components (Chicago version)

<table>
<thead>
<tr>
<th>Value</th>
<th>Set Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/10/25/50/75/100/150/200/250/300/400/500/600/630/800/1000/1200/1250/1500/1600/2000/2400/2500/3000/3200/4000/5000</td>
<td></td>
</tr>
</tbody>
</table>

**Time precision:**

- Counter delay overcurrent time ±10% 1.5Ipu
- Short delay time ±50ms

**Time delay set**

- Counter delay overcurrent time factor:
  - IT 12T 14T Curve: 0.2~40148 alternate values
  - IT 12T 14T Curve: 0.2~40[48 alternative values](Chicago version)
- Fixed time:
  - 0.2-2.0[2 alternative values]
- ANSI(all): 0.1-5.0[50 alternative values]
- IEC(all): 0.025-1.0[40 alternative values]
- IEC(all): 0.05-1.0[20 alternative values](Chicago version)
- Short delay: 0.05-1.5[22 alternative values]

**Auxiliary relay**

- Continuous 5A@120/240Vac
- 5A@30Vdc
- 5A continuous (Chicago version)

**Communication function:**

- Compatible to PowerNet，via INCOM
- Baud rate: 1200bps or 9600bps
- Address: INCOM setting up from the front panel

**Phase component overcurrent operate-value set range**

- Inverse time overcurrent set * Note: 1
  - (0.2-2.0)[29 alternative values]
- Inverse time overcurrent set * Note: 1
  - (0.2-1.0)[16 alternative values](Chicago version)
- Short delay set
  - (1-11)[25 alternative values]
- Instantaneous value set * Note: 2
  - (1-25)[26 alternative values]
- Ground component overcurrent set reference range
  - Inverse time overcurrent set
  - (0.1N2.0)[26 alternative values]
- Short delay set
  - (0.1-11)[45 alternative values]
- Instantaneous value set
  - (1-25)[33 alternative values]

**Environment factor**

- External environment: indoors only
- Pollution index: II
- Altitude: 2500m mounting type: II
- Equipment position: close to main switch ASAP
- Operating temperature: -30°C to 55°C
- Operating humidity: 0-95% relative humidity (no condensing)
- Storage temperature: -40°C to 70°C

**Regional selectivity interlocking:**

- Phase: inverse time overcurrent and short delay
- Ground: inverse time overcurrent and short delay

**Current monitoring:**

- RMS 3 phase and ground
- Display precision: ±1% full scale (0.04In-In)
- ±2% full scale (In-2In) demand current: average sampling rate
  - for 5 seconds
- Overload: 85% inverse time overcurrent fixed value

**Note 1:** When the device sets overcurrent value of phase components, there is no “NONE” option. That is, “NONE” option can be applicable for all protection functions. Charge can at least provide inverse time overcurrent protection;

**Note 2:** when setting the instantaneous value of phase component as “NONE”, the device provides below functions: if and only if the circuit breaker is at the first 10 cycles in closing position from opening position, if the device detects the current over 11*In, it will trip immediately. Otherwise, only when the circuit breaker switches from opening to closing position next time, this function will work.
Mounting and wiring

DT 3000 device front panel introduction

1. Two display windows provided on device front panel: one is “RMS demand”. This window is used for displaying detected analogue quantity and operating current value for protection operation. The other window is “Setting/Test Time/Trip cause” for displaying current menu items in Setting/Test Time mode, or fault information during operation.

2. 11 buttons on the device front panel for selective paring due to different function requirements. Different colors and characters show each function.

3. The device provides 14 indication LEDs in total, including the communication indicator light on the rear panel of the device for respective function indication, or status indication. And the LED in the curve graph is designed as two-color tube, red or green, indicating current fault type or contents of setting items.

Terminals on DT 3000’s rear panel

TB1
- J1: retain
- J2: retain
- J3: retain J4: GND
- J5: supply input1
- J6: supply input2
- J7: retain
- J8: retain
- J9: circuit breaker status input
- J10: circuit breaker status input
- J11: ground-regional interlocking output
- J12: ground-regional interlocking input
- J13: phase-regional interlocking output
- J14: phase-regional interlocking input
- J15: regional interlocking terminal

TB2
- J1: communication terminal1
- J2: communication terminal2
- J3: communication ground
- J4: closing export, overload alarming
- J5: closing export
- J6: trip alarming ring common terminal
- J7: trip alarming ring normally open terminal
- J8: trip alarming ring normally close terminal
- J9: device fault common terminal
- J10: device fault normally open terminal
- J11: device fault normally close terminal
- J12: phase/ground instantaneous fault trip export
- J13: or ground fault trip export
- J14: inverse time of phase ground/ short delay/ remote tripping export
- J15: or protection exports for any types of phase components

Current input terminal (5A rated)
- A1: A phase current incoming
- B1: B phase current incoming
- C1: C phase current incoming
- G1: Zero sequence current incoming
- A2: A phase current outgoing
- B2: B phase current outgoing
- C2: C phase current outgoing
- G2: Zero sequence current outgoing

Note:

1. TB1-15 regional interlocking signal common terminal shall not be connected to ground;
2. TB1-9, 10 terminals will generate voltage after the device is energized. The voltage is used to detect circuit breaker’s status input;
3. TB2-12, 13, 14, 15 are all export relay nodes.
Typical wiring diagram

When zero sequence CT is not mounted, please see the left diagram.

CT residual current wiring diagram

Communication interface
- Remote closing
- Tripping alarm ring
- Protection function off
- Instantaneous export
- Overcurrent / inverse time
- Remote trip export

Note:
1. Communication shield shall not be connected to ground or any electrical circuits;
2. Protection export nodes can refer to DIP switch setup;
3. When regional interlocking function is used, please remove short connection to regional interlocking terminal.
DT3000 Microprocessor-based feeder, transformer backup protective relay

Dimension and mounting Size

Ordering information

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>CE mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>DT-3000</td>
<td>Fixed, 5A, 48–250Vdc; 120–240 Vac</td>
<td></td>
</tr>
<tr>
<td>DT-3001</td>
<td>Withdrawable, 5A, 48–250Vdc; 120–240 Vac</td>
<td></td>
</tr>
<tr>
<td>DT-3010</td>
<td>Fixed, dual-power supply PS 120 Vac, 5A</td>
<td></td>
</tr>
<tr>
<td>DT-3020</td>
<td>Fixed, dual-power supply PS 240 Vac, 5A</td>
<td></td>
</tr>
<tr>
<td>DT-3030</td>
<td>Fixed, 24–48 Vdc, 5A, CE mark</td>
<td></td>
</tr>
<tr>
<td>DT-3031</td>
<td>Withdrawable, 24–48 Vdc, 5A</td>
<td></td>
</tr>
<tr>
<td>DT-3100</td>
<td>Fixed, 5A, 48-250Vdc; 120–240 Vac (Chicago code version)</td>
<td></td>
</tr>
<tr>
<td>DT-3200</td>
<td>Basic unit with sensitive ground protection</td>
<td></td>
</tr>
</tbody>
</table>
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