PROTECTA
Electronics Co. Ltd

EuroProt
complex protection

DTD-EP

Three-phase differential protection

Factory configuration

User's manual

Versions:
DTD-2 V3.xx,
DTDZ-2+U (dist.rec.) V3.xx,
DTD-3 V3.xx,
DTD-3 [5*3CT] V3.xx
DTD-2 [Io] V3.xx,
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EUROPROT

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Version history of the „User's manual":

Version	Date	Changes	Editor
.10	16.03.2004.	Application of the unified notation of the EuroProt devices	Póka
.11	01.05.2005.	Minor corrections and new format	Póka
.12	17.05.2005	Earth-fault protection function added	Petri

CONTENTS

1 Field of application

The ***EuroProt*** type complex protection in respect of hardware and software is a modular device. The modules are assembled and configured according to the requirements, then the functions are determined - within the hardware limitations - by the software. This document describes the individual characteristics of a specific application: the factory configuration ***DTD-EP*** complex differential protection. The general description of the members of the ***EuroProt*** type complex protection family can be found in document "***EuroProt*** complex protection, hardware and software description and user's manual" (further "*EuroProt manual*").

The ***DTD-EP*** complex numerical device realises three-phase differential protection function, which can be applied to high speed and selective protection of high voltage transformers, generators and generator-transformer units.

This manual describes several versions. The main information concerning these versions are summarised in the Table below:

Version ID	Date and version	Explanation
DTD - 2	05.12.2003. V3.01	For transformers with two voltage levels
DTDZ – 2 +U(dist.rec.)	16.03.2004. V3.01	For transformers with two voltage levels, additional voltage inputs for disturbance recording
DTD - 3	05.12.2003x. V3.01	For transformers with three voltage levels
DTD - 3 [5*3 CT]	19.09.2003. V3.00	For transformers with three voltage levels, with connections to 5 CT-s
DTD – 2 [+Io]	09.06.2005. V3.11	For transformers with two voltage levels, zero sequence OC extension

Table 1 The most common DTD versions

The device does not require matching intermediate current transformers. The turns ratio and the phase shift due to the connection group of the transformers are matched by the software of the differential protection.

The device includes separate overcurrent protection functions for all voltage levels of the transformer.

As an option the included control (SCADA) functions can extend the device to the complex field unit of the network.

1.1 The main characteristics of the complex differential protection

The ***DTD-EP*** complex differential protection is a member of the ***EuroProt*** device family of PROTECTA Co. Ltd. It is a fully numerical type, microprocessor-based device.

The main characteristics of the ***DTD-EP*** complex differential protection are as follows:

- The protection part of the device includes the following functions:
  - Three-phase differential protection function:
    - Compares the sampled momentary values of the currents,
    - The tripping characteristic is composed of three line sections, which can be set independently,
    - The function operates independently in all three phases,
    - The restraint function is based on the average of the currents at each voltage levels,
    - The function is not sensitive on transformer inrush current,
    - It does not need additional matching auxiliary current transformers, the turns ratio of the transformer and the phase shift due to the connection group of the transformer is matched by the software,
    - The faults are indicated in all three phases selectively,
    - The operation time is about 20...25 ms,
    - If the high current set differential protection stage operates, the reaction time is about 10...15 ms.
  - The three-phase overcurrent function is provided for all voltage levels:
    - In case of two voltage levels:
      - The high voltage side is protected by a single-stage overcurrent function,
      - On the lower voltage side it is a two-stage function,
    - In case of three voltage levels:
      - On all three sides it is a single stage function,
  - Optional earth-fault overcurrent function:
    - The low voltage side is protected by a two-stage zero sequent overcurrent function,
  - The current settings and the time delay can be set individually for all sides,
  - The device is prepared to input the operating status signals of the mechanical protection functions of the transformer,
  - The setting of all functions is independent of each other.

- The main characteristics of the optional SCADA functions in the device can be as follows:
  - The SCADA functions are performed by a dedicated controller of the CPU module, or optionally a separate SCADA module can be involved,
  - The optional high resolution graphic LCD can realise comprehensive local control and supervisory functions,

- The realised SCADA functions can be as follows:
  - Control functions of the field:
    - With local or remote operation,
    - Interlocking functions,
    - Generation of detailed status signals,
    - Event recording function,
    - Remote transmission of protection status signals (tele-protection),
    - Communication with the processor-driven high resolution graphic LCD,
  - Transmission of the messages of the protection function to the SCADA system,
  - Command inputs from the SCADA system and command processing,
  - Command inputs from the local LCD and command processing.

- Continuous and periodic self-supervision functions.
- There are 16 output relays, driven by a software matrix.
- The event log of the device can store up to 50 events, the event sequence recorder is prepared for 300 digital events wit 1 ms time resolution.
- The real-time clock of the device is supported by a battery supplied RAM. The clock can be synchronised either by an external PC or by the SCADA system, and a special device made by the Protecta Co. Ltd for synchronisation (Word Time Synchroniser GPS-OP) is available as well.
- The integrated disturbance recorder of the CPU module can store up to 11 records, the total recording time is about 10 s.
- The device can realise several measuring functions, based on the available analogue signals.

1.2 The main features of the hardware

The ***DTD-EP*** complex digital differential protection device is a fully numerical, micro-controller-based system. The functions are determined by the software within the limitations of the hardware.

The device performs the protection and the SCADA functions of high voltage transformers.

The design and the operation of the EuroProt devices are described in the document „*EuroProt manual*".

The device can be operated by the integrated man-machine interface (2x16 character LCD an 6 push-buttons on the front panel), but the operation is more convenient using a connected external PC, running the „Protect for Windows" operating program, developed by Protecta Co. Ltd. Both possibilities are described in details in the document „*EuroProt manual"*.

The external communication can be performed via the RS 232 serial interface of the front panel (isolated against 2 kV) or via fibre optic interface on the rear side of the device. The application of these communication interfaces is described in the document „*EuroProt manual*" as well.

2 The operation of the protective functions

The ***DTD-EP*** type complex numerical protection contains the following protection functions:

- Three-phase differential protection functions, operating independently in all three phases,
- Three-phase overcurrent functions,
- Optional zero sequence overcurrent function,
- Processing the mechanical protections of the transformer.

The protection functions are fully independent from each other, and the setting is independent too. The outputs are managed by the software matrix, each of them can be enabled or disabled individually. By appropriate parameter setting, they can be programmed for latching.

The following chapters contain the description of the protection functions.

2.1 Differential protection functions

The basic function of the complex device is the three-phase differential protection.

2.1.1 Realisation of the differential protection functions

The precondition of the correct operation of the ***DTD-EP*** type differential protection function is the correct matching of the currents, and the correct handling of the different transformer connection groups.

Current matching

When setting the parameters of the device the primary rated currents of the main transformers on all (two or three) sides of the transformer must be selected (AV1, AV2, and AV3 in primary Amperes). These parameters are needed only to display the measured currents scaled in primary values.

The matching of the currents in ***DTD-EP*** differential protection function is easy. An appropriate *Isetting1* value is to be defined, which must be calculated as transformed to all voltage levels, and are to be expressed as percent of the rated currents of the main current transformers (Iset1%, Iset2%, and Iset3%). This calculation assures the matching of the normal operating currents. The calculation is based on the following formulas:

$$Iset1\% = \frac{Isetting1}{CT1}100\%, \qquad Iset2\% = \frac{Isetting1\dfrac{U_1}{U_2}}{CT2}100\% = \frac{Isetting2}{CT2}100\%,$$

and:

$$Iset3\% = \frac{Isetting\dfrac{U_1}{U_3}}{CT3}100\% = \frac{Isetting3}{CT3}100\%$$

Where U_1, U_2 and U_3 are the rated voltage values of the transformer (in case of regulating coils these are the central values).

The *Isetting*1 defined value is free to choose. It is usual to be selected as the rated current of the transformer on the primary side *Isetting*1 = *Itrn*1. This *Isetting*1 will be the reference value for displaying the *Id* % differential current and for the *Is* % restraint current (when it is considered on the secondary side, it is *Isetting*2, etc.).

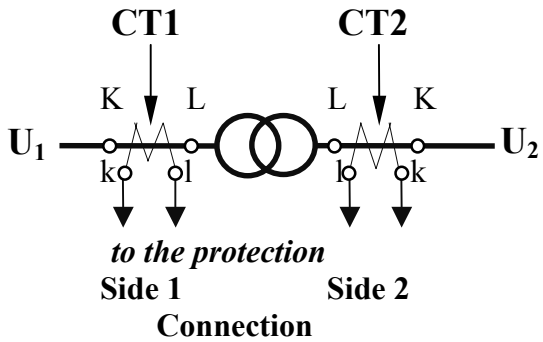
Matching the phase shift of the transformer

The matching of the phase shift of the transformer is solved by a simple parameter setting, which is the code value of the transformer's connection group. (e.g. Yd11). In a differential protection for a transformer with two voltage levels the code values are listed in Table 2 (parameter: Setting code: [0-11]), and that for a transformer with three voltage levels in Table 3 (parameter: Setting code: [0-71]).

Setting code	Connection group	Vectors	Phase shift = α
0	Dd0	U_1 ⇑ U_2	0^0
1	Yy0	U_1 ⇑ U_2	0^0
2	Dy1	U_1 ↑ U_2	30^0
3	Yd1	U_1 ↑ U_2	30^0
4	Dy5	U_1 ↑ U_2 ↓	150^0
5	Yd5	U_1 ↑ U_2 ↓	150^0
6	Dd6	U_1 ↑ ↓ U_2	180^0
7	Yy6	U_1 ↑ ↓ U_2	180^0
8	Dy7	U_2 ↓ U_1 ↑	210^0 (-150^0)
9	Yd7	U_2 ↓ U_1 ↑	210^0 (-150^0)
10	Dy11	U_2 ↑ U_1 ↓	330^0 (-30^0)
11	Yd11	U_2 ↑ U_1 ↓	330^0 (-30^0)

The meaning of phase shift is: $\mathbf{U_2 = U_1.e^{j\alpha}}$.

The polarity of the current transformers is explained in the following Figure:



As the Figure indicates, the connections of the CT marked with same letters are located near to the transformer

Table 2. Phase shift code values for a transformer with two voltage levels

Connection group	Setting code
Dy1y1	**0**
Dy1y5	**1**
Dy1y7	**2**
Dy1y11	**3**
Dy1d0	**4**
Dy1d6	**5**
Dy5y1	**6**
Dy5y5	**7**
Dy5y7	**8**
Dy5y11	**9**
Dy5d0	**10**
Dy5d6	**11**
Dy7y1	**12**
Dy7y5	**13**
Dy7y7	**14**
Dy7y11	**15**
Dy7d0	**16**
Dy7d6	**17**
Dy11y1	**18**
Dy11y5	**19**
Dy11y7	**20**
Dy11y11	**21**
Dy11d0	**22**
Dy11d6	**23**
Dd0y1	**24**
Dd0y5	**25**
Dd0y7	**26**
Dd0y11	**27**
Dd0d0	**28**
Dd0d6	**29**
Dd6y1	**30**
Dd6y5	**31**
Dd6y7	**32**
Dd6y11	**33**
Dd6d0	**34**
Dd6d6	**35**

Connection group	Setting code
Yy0y0	**36**
Yy0y6	**37**
Yy0d1	**38**
Yy0d5	**39**
Yy0d7	**40**
Yy0d11	**41**
Yy6y0	**42**
Yy6y6	**43**
Yy6d1	**44**
Yy6d5	**45**
Yy6d7	**46**
Yy6d11	**47**
Yd1y0	**48**
Yd1y6	**49**
Yd1d1	**50**
Yd1d5	**51**
Yd1d7	**52**
Yd1d11	**53**
Yd5y0	**54**
Yd5y6	**55**
Yd5d1	**56**
Yd5d5	**57**
Yd5d7	**58**
Yd5d11	**59**
Yd7y0	**60**
Yd7y6	**61**
Yd7d1	**62**
Yd7d5	**63**
Yd7d7	**64**
Yd7d11	**65**
Yd11y0	**66**
Yd11y6	**67**
Yd11d1	**68**
Yd11d5	**69**
Yd11d7	**70**
Yd11d11	**71**

The polarity of the current transformers is explained in the following Figure:

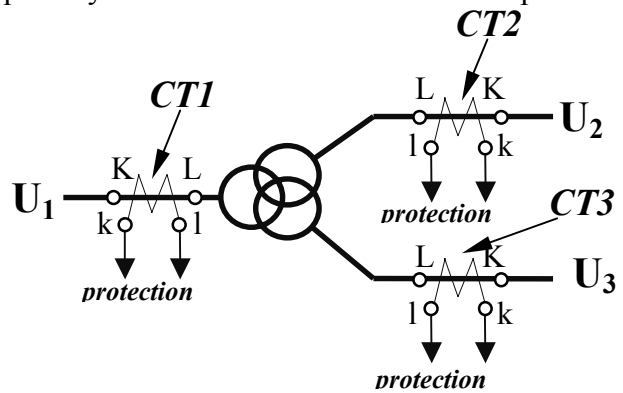


Table 3. Phase shift code values for a transformer with three voltage levels

The differential protection function detects internal fault based on sampled phase current comparison received from all sides of the transformer. "Rectified average" values are calculated for a half period of the network frequency, and then the evaluation is performed in all sampling time steps, in each millisecond. If significant difference is detected in 15 consecutive steps, this means internal fault, and trip command is generated.

In sampled current comparison the regulating range of the transformer and the errors of the current transformers must be considered as well. This is solved by a „percentage" restraint characteristic. If the point in the co-ordinate system defined by the I_d% differential current and the I_S% restraint current is located in the upper part of the figure below, the protection operates, and after 15 consecutive steps with the same decision it generates a trip command.

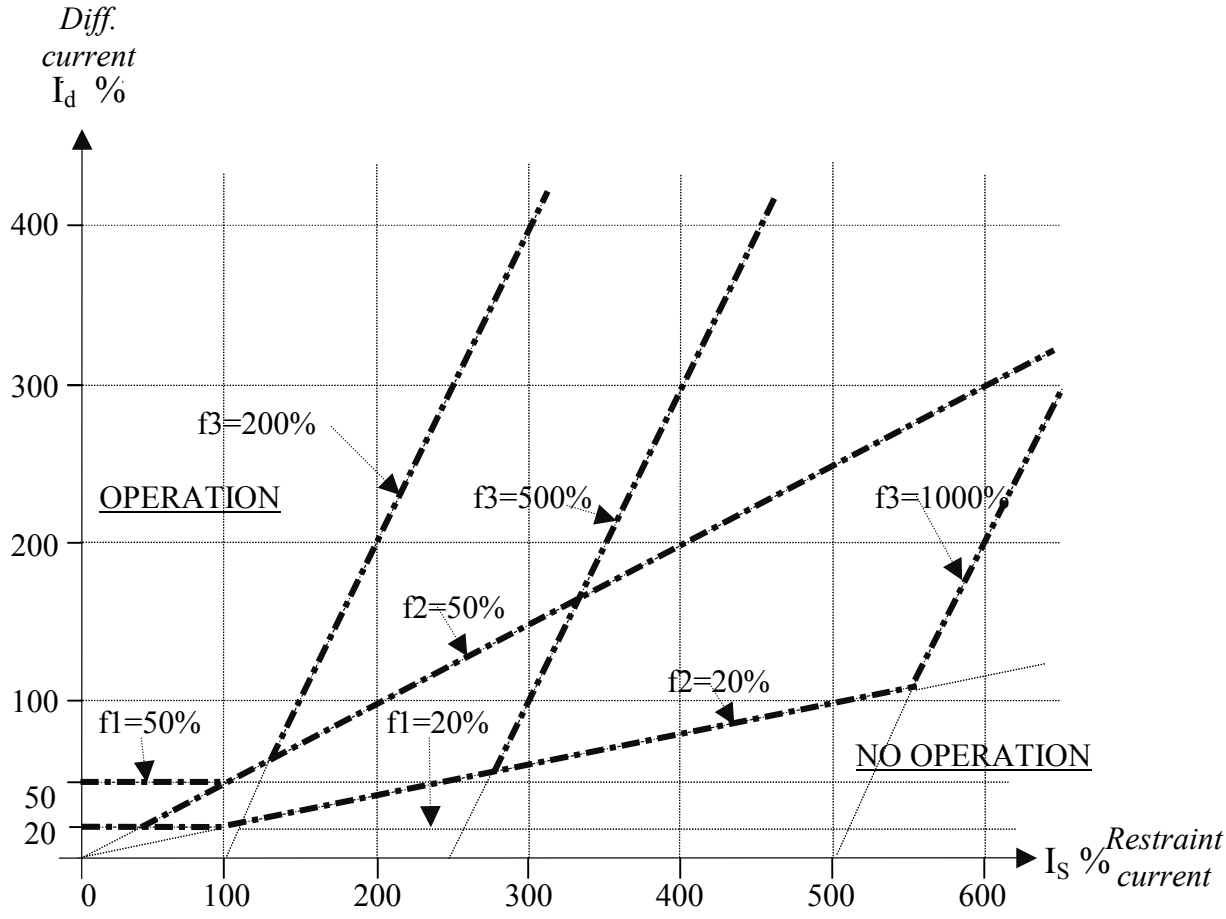


Fig. 1.Differential protection tripping characteristics

The I_S % „Restraint current" and the I_d % difference current is explained with the following formulas.

The I_S % „Restraint current" in transformers with two voltage levels is calculated by:

$$I_S\% = \frac{\left|\frac{I_1}{Isetting1}\right| + \left|\frac{I_2}{Isetting2}\right|}{2} 100\% = \frac{\left|\frac{\frac{I_1}{CT1}100\%}{Iset1}\right| + \left|\frac{\frac{I_2}{CT2}100\%}{Iset2}\right|}{2} 100\%$$

The I_d % differential current is in transformers with two voltage levels:

$$I_d\% = \left(\frac{I_1}{Isetting1} + \frac{I_2}{Isetting2}\right) 100\% = \left(\frac{\frac{I_1}{CT1}100\%}{Iset1} + \frac{\frac{I_2}{CT2}100\%}{Iset2}\right) 100\%$$

The I_S % „Restraint current" in transformers with three voltage levels is calculated by:

$$I_S\% = \frac{\left|\frac{I_1}{Isetting1}\right| + \left|\frac{I_2}{Isetting2}\right| + \left|\frac{I_3}{Isetting3}\right|}{2} 100\% = \frac{\left|\frac{\frac{I_1}{CT1}100\%}{Iset1}\right| + \left|\frac{\frac{I_2}{CT2}100\%}{Iset2}\right| + \left|\frac{\frac{I_3}{CT3}100\%}{Iset3}\right|}{2} 100\%$$

The I_d % differential current is in transformers with three voltage levels:

$$I_d\% = \left(\frac{I_1}{Isetting1} + \frac{I_2}{Isetting2} + \frac{I_3}{Isetting3}\right) 100\% = \left(\frac{\frac{I_1}{CT1}100\%}{Iset1} + \frac{\frac{I_2}{CT2}100\%}{Iset2} + \frac{\frac{I_3}{CT3}100\%}{Iset3}\right) 100\%$$

The individual sections of the tripping characteristics are explained as follows:

f1% This is the setting value of the horizontal section of the tripping characteristic, which defines the basic sensitivity of the differential function. The value is expressed as percent of the *Iset*1 current setting value. The differential protection can operate if: $I_d\% > f1\%$

f2% This is the slope setting of the second section of the differential characteristic. This slope is needed mainly because of the voltage regulation range of the transformer. The differential function is balanced in the medium position of the tap-changer, any other position generates a differential current. The second section of the characteristic starts in the origin, and the section above the first section is valid only. The differential protection operates if the I_d % differential current is above the percent value defined by the I_s % current and the f2 slope setting. The differential protection can operate if: $I_d\% > f2\%/100*I_S\%$.

f3% The third section of the characteristic is needed because the possible saturation of the main current transformers. The slope of this section is constant: $tg\alpha=2$. The starting point of this section on the vertical axis of the co-ordinate system is a negative value defined by f3, it is valid only above the second section of the characteristic. The differential protection can operate if the differential current is above this line too: $I_d\% > (2*I_S\% - f3\%)$.

f2h% To prevent false tripping because of the high inrush current of the transformer, the differential protection is provided wit a second harmonic restraint. The second harmonic restraint prevents the operation of the differential protection, if the second harmonic content of the differential current is above the f2h setting, which is expressed as %. This means: Id2h% >f2h% (Id2h% is the percentage value of the second harmonic content in differential current, related to the basic harmonic).

Id>>% There is a possibility to set a high current value of the differential current, above which the function generates an immediate trip command without restraint calculation. The setting value is referred to the *Isetting*1 value, and it is expressed in %. If this stage operates, the differential protection function generates a trip command within 15...20 ms.

If the differential current is above the characteristic lines, the normal operating time of the differential protection function is about 20 ... 25 ms, (if the high current setting stage operates, the time delay is about 10 … 15 ms.

2.1.2 The parameter setting

The differential protection function – according to the explanation above – needs setting the following parameters, as it is shown in Fig. 2.(Fig.2 is the snapshot of the Parameters Window of the Protect for Windows software):

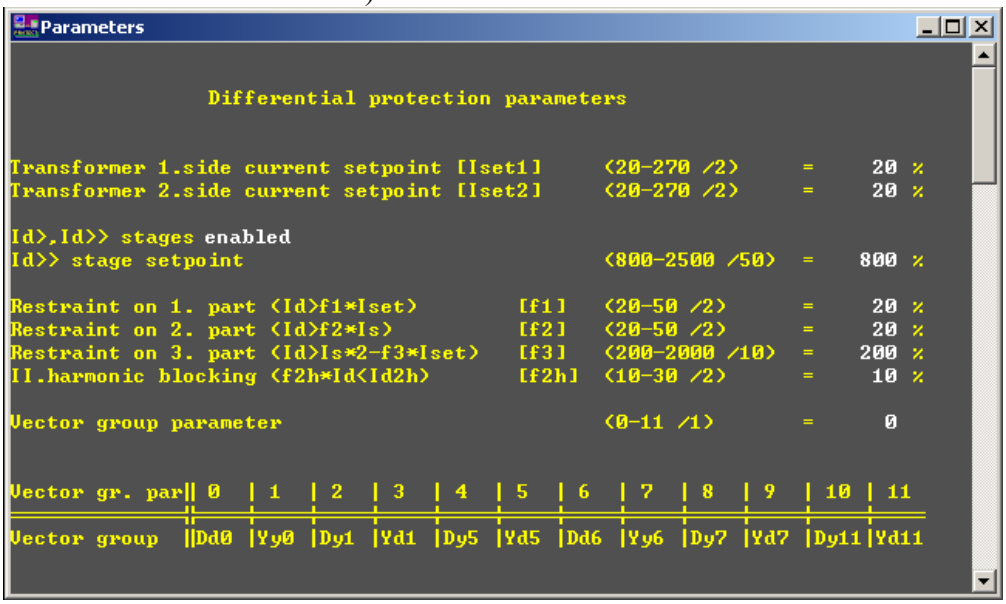


Fig. 2 Parameters of the differential protection for transformers with two voltage levels (Protect for Windows).

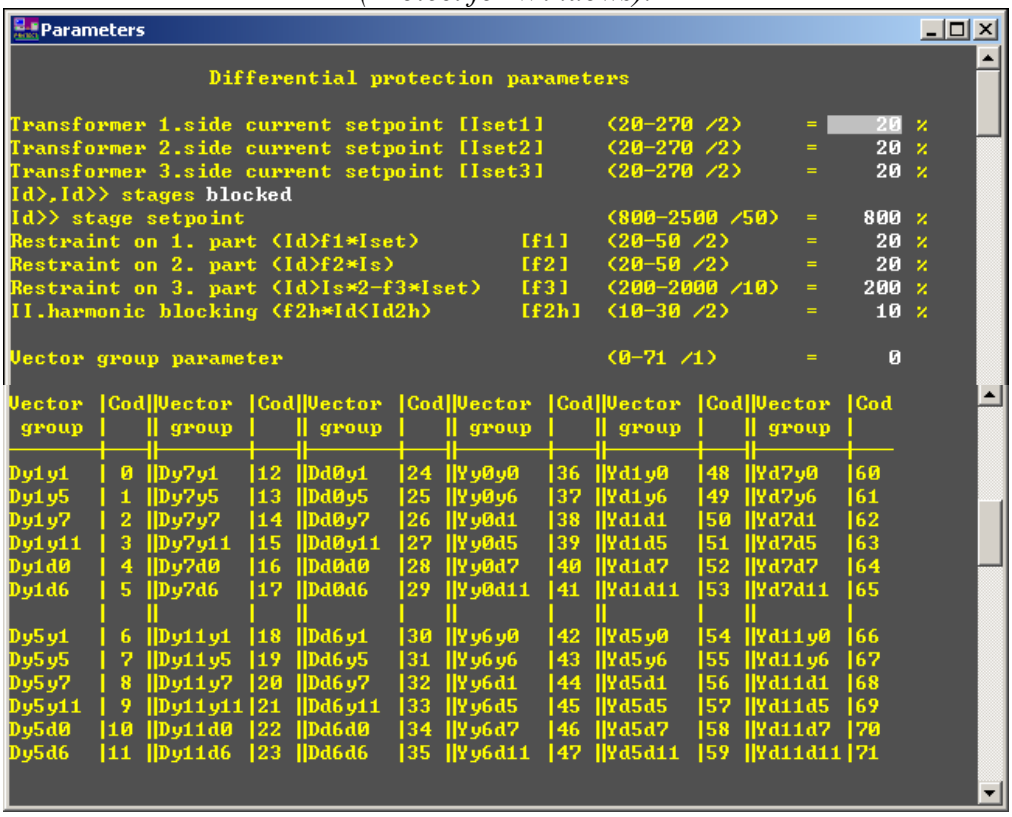


Fig. 3 Parameters of the differential protection for transformers with three voltage levels (Protect for Windows).

LCD parameter name:	Min	Max	Step
Iset1: [%]	20	270	2
Iset2: [%]	20	270	2
Iset3: [%] ◊	20	270	2
Id>>: [%]	800	2500	50
IdEna: +=yes	+	-	
Phase shift code *	0 *	11 *	1
f1: [%]	20	50	2
f2: [%]	20	50	2
f3: [%]	200	2000	10
f2h: [%]	8	30	2

◊ Only for transformers with three voltage levels
* Setting range 0…71 for transformers with three voltage levels

Fig. 4 Parameters of the differential protection for transformers (LCD).

To enable or disable the differential protection function a special parameter is assigned: (On the PC: Id>, Id>> stages, enabled/disabled, on the LCD: IdEna +/-).

2.1.3 Outputs of the differential protection function

The assignment of the 16 (K1…K16) output relays of the device is made using the software matrix (see below, in the Chapter „The digital software matrix"). In the versions DTD-3 V3.xx and DTD-3 [5*3AV] V3.xx additional 8 (K17…K24) output relays can be programmed using the PROTLOG equations (see below in the Chapter „Programming the PROTLOG equations").

The row of the differential protection function as the software matrix input is:

On the PC screen: Id>,
On the LCD: Mx Id>

For the PROTLOG programing the input variable received from the differential protection function is:

Id>, (with latching: *Id>)

The latching of the function can be programmed on the LCD with the following parameter:
„MxSId"
On the PC the latching is set as the following Figure shows:

Fig 5 Programming for latching

2.2 Phase overcurrent function

In the DTD-EP factory configuration the differential protection function is extended with phase overcurrent functions as well.

In the devices designed for transformers with two voltage levels (DTD-2 V3.xx, DTDZ-2+U(dist.rec) V3.xx) the factory configurations realise one stage overcurrent function for the high voltage side, and two-stage definite time overcurrent protection function on the lover voltage side.

In the devices designed for transformers with three voltage levels (DTD-3 V3.xx, DTD-3 [5*3CT] V3.xx) the factory configurations realise one stage overcurrent function for the high voltage side, and for both medium voltage sides as well

2.2.1 Realisation of the phase overcurrent function

The algorithm calculates with numerical Fourier analysis the basic harmonic component of the current, and this is compared with the setting value. If the basic harmonic component is above the setting, the function starts the time counter, the expiry of which generates a trip command.

The measurement and the comparison are performed independently in all three phases, the timer however is common for the three phases, and the trip command is common too.

2.2.2 Parameter setting

The phase overcurrent function needs the following parameter setting, as it is shown on Fig. 6. and 7. The Figures are PC screen snap-shots from the Protect for Windows operating software:

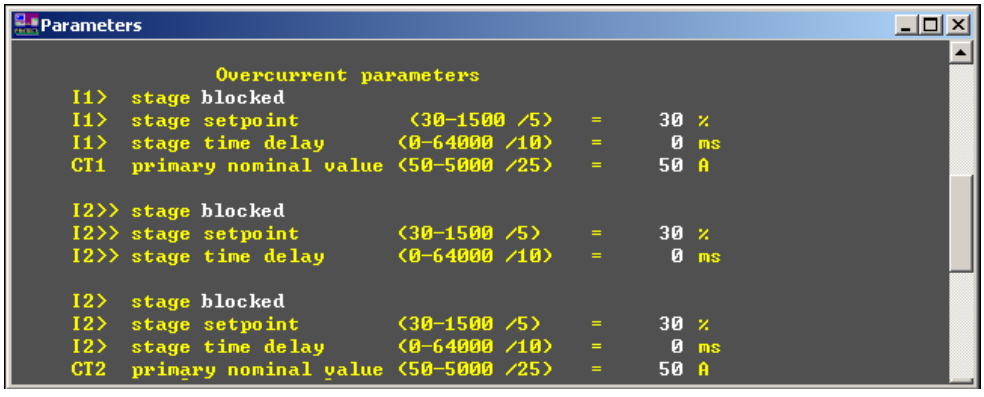


Fig. 6 Parameters of the overcurrent protection function for transformers with two voltage levels (Protect for Windows)

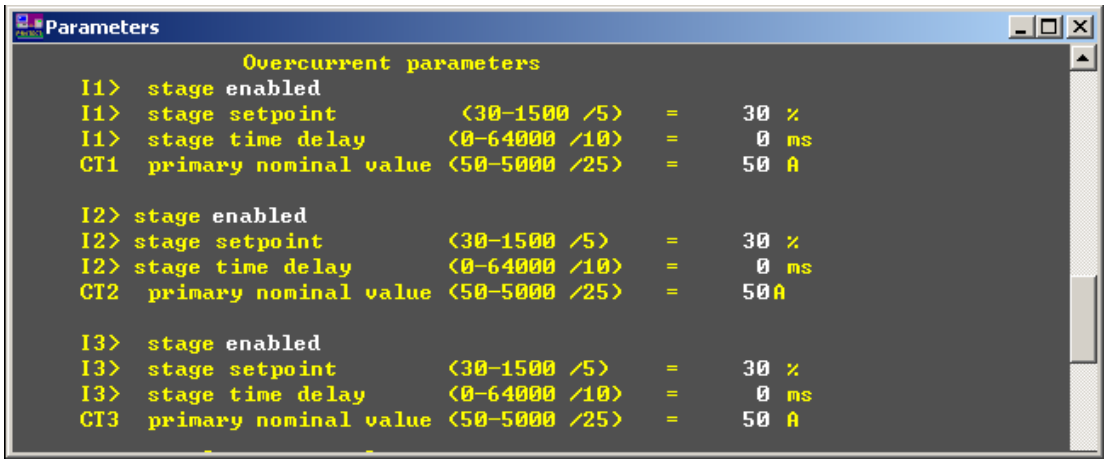


Fig. 7 Parameters of the overcurrent protection function for transformers with three voltage levels (Protect for Windows)

LCD parameter name:	Min	Max	Step
CT1: [A]	50	5000	25
I1>: [%]	30	1500	5
I>1Ena: +=yes	+	-	
t[I>1] [ms]	0	64000	10
CT2: [A]	50	5000	25
I2>: [%]	30	1500	5
I>2Ena: +=yes	+	-	
t[I>2] [ms]	0	64000	10
I2>>: [%]	30	1500	5
I>>2Ena: +=yes	+	-	
t[I>>2] [ms]	0	64000	10

Fig. 8 Parameters of the overcurrent protection function for transformers with two voltage levels (LCD)

LCD parameter name:	Min	Max	Step
CT1: [A]	50	5000	25
I1>: [%]	30	1500	5
I>1Ena: +=yes	+	-	
t[I>1] [ms]	0	64000	10
CT 2: [A]	50	5000	25
I2>: [%]	30	1500	5
I>2Ena: += yes	+	-	
t[I>2] [ms]	0	64000	10
CT 3: [A]	50	5000	25
I3>: [%]	30	1500	5
I>3Ena: += yes	+	-	
t[I>3] [ms]	0	64000	10

Fig. 9 Parameters of the overcurrent protection function for transformers with three voltage levels (LCD)

The enabling of the overcurrent protection functions is programmed with parameter setting: on the LCD of the device the parameters I>1Ena, I>2Ena, I>3Ena and I2>>Ena are to be changed to 1 (yes). On the external PC the Protect for Windows software shows „disabled" or „enabled".

The setting of the parameters does not need any explanations.

2.2.3 Outputs of the overcurrent functions

The programming of the 16 output relays (K1…K16) of the ***DTD-EP*** factory configuration is performed with software matrix (see below in Chapter „The digital software matrix"). The versions DTD3V31 and DTD5 contain additional 8 (K17…K24) output relay, which can be programmed using the PROTLOG equations (see below in chapter „Programming the PROTLOG equations"). In both methods external control functions can be realised as well.

Mátrix rows (inputs of the matrix), related to the overcurrent functions:

For two voltage levels:

External PC	LCD
I>1R =	Mx I>1R =
I>1S =	Mx I>1S =
I>1T =	Mx I>1T =
I>1 [t] =	Mx I>1 t =
I>>2 =	Mx I>>2 =
I>>2 [t] =	Mx I>>2 t =
I>2 =	Mx I>2 =
I>2 [t] =	Mx I>2 t =

For three voltage levels:

External PC	LCD
I>1R =	Mx I>1R =
I>1S =	Mx I>1S =
I>1T =	Mx I>1T =
I>1 [t] =	Mx I>1 t =
I>2 =	Mx I>2 =
I>2 [t] =	Mx I>2 t =
I>3 =	Mx I>3 =
I>3 [t] =	Mx I>3 t =

PROTLOG equation input variables, related to the overcurrent functions:

For two voltage levels:

External PC
I>1R
I>1S
I>1T
I>1 [t]
I>>2
I>>2 [t]
I>2
I>2 [t]

For three voltage levels:

External PC
I>1R
I>S
I>1T
I>1 [t]
I>2
I>2 [t]
I>3
I>3 [t]

The variables are repeated wit *, which mean latching.

The latching of the status signals for can be programmed using an external PC, as it is indicated in Fig.10:

Fig. 10 Latching the status signals of the overcurrent function, two voltage levels (Protect for Windows).

Fig. 11 Latching the status signals of the overcurrent function, three voltage levels (Protect for Windows).

On the LCD the same parameters are indicated with MxS prefix.

2.3 Earth fault protection

One of the main functions of the complex motor protection is the earth fault protection. This function measures the zero sequence current partly as the sum of the three phase current, partly the zero sequence current is measured on an independent input. The earth fault protection is a two-stage definite time zero sequence overcurrent protection. The low current setting stage uses the zero sequence current measured on the dedicated current input, the decision of the high current setting stage is based on the sum of the three phase currents. The operation of the earth-fault protection is similar to that of the phase overcurrent protection, but beside the enabling the operation of the low current setting stage has an additional constraint as well:

- the phase overcurrents protection may not operate at the same time.

2.3.1 Realisation of the earth fault protection

In the ***DTD-EP*** factory configuration the zero sequence overcurrent function operates independently of the phase overcurrent protection. The algorithm determines the basic harmonic of the zero sequence current (both for the current measured on the dedicated input and for the sum of the phase currents) and these values are compared with the settings.

The zero sequence current (3Io) is calculated as the sum of the phase currents, and it is measured on the independent zero sequence current input as well.

Ir+Is+It 3Io

2.3.2 Parameters of the function

The function needs setting for the following parameters:

LCD	Min	Max	Step	Explanation
CTPrN[CTdevN] A	15	15000	5	Primary rated current of the current transformers (needed for displaying the measured current only)
3Io>/In[CtoProt]=%	10	140	1	Current setting of the low current stage related to the zero sequence CT rated current in percent
t[3Io>]= ms	0	64000	10	Delay time of the low current setting stage independent of the current value
3Io> enable: (+=ena.)	-	+		Enabling of the zero sequence overcurrent function low current setting stage (+= enabled)

3Io>>/In[CT2]:%	30	1500	5	Current setting of the high current stage related to the phase CT's rated current in percent
t[3Io>>]= ms	0	64000	10	Delay time of the high current setting stage independent of the current value
3Io>> enable: (+=ena.)	-	+		Enabling of the zero sequence overcurrent function high current setting stage (+= enabled)

The settings related to the earth-fault protection on the connected PC screen (Parameters of other functions are masked):

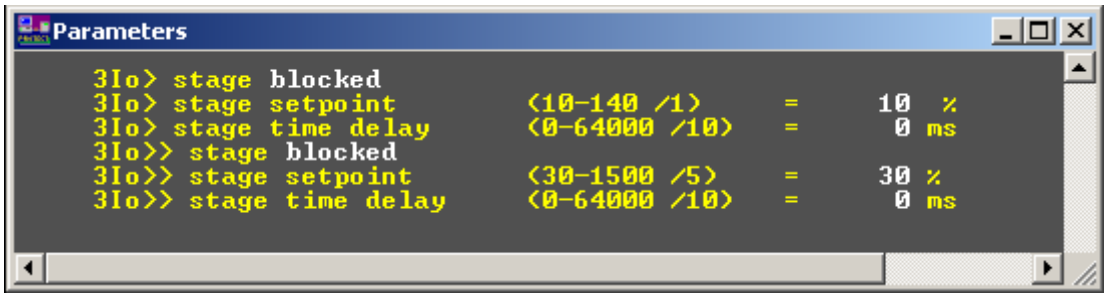


Fig. 2-7 Parameter setting/2

2.3.3 Digital outputs of the function

The zero sequence overcurrent functions provide inputs for the PROTLOG equations. (The outputs of the PROTLOG equations can be directed to relay outputs using the software matrix.) :

PROTLOG input	Explanation
StIo>	Starting of the low current setting stage of the earth fault protection (if it is enabled, latching is possible)
StIo>t	Trip command of the low current setting stage of the earth fault protection (if it is enabled, latching is possible).
StIo>>	Starting of the high current setting stage of the earth fault protection (if it is enabled, latching is possible)
StIo>>t	Trip command of the high current setting stage of the earth fault protection (if it is enabled, latching is possible).

2.4 Additional functions

2.4.1 The digital software matrix

Using the software matrix the status signals of the individual protection functions or internal status signals of the self-check function can be marshalled to output relays. The inputs of the matrix are the status signals; the outputs are the relay contacts.

The most convenient way to program the matrix is the application of the Protect for Windows software, running on an external PC. The logic connection between the OR connection of the inputs and outputs is established by changing the appropriate matrix element from „-„ to „+" by clicking with the mouse on the appropriate element.

The matrix can be programmed with the man-machine interface of the device as well. In this case to the input signals (matrix rows) the binary sum of the code values of the outputs must be assigned (see details in the document *„EuroProt manual"*).

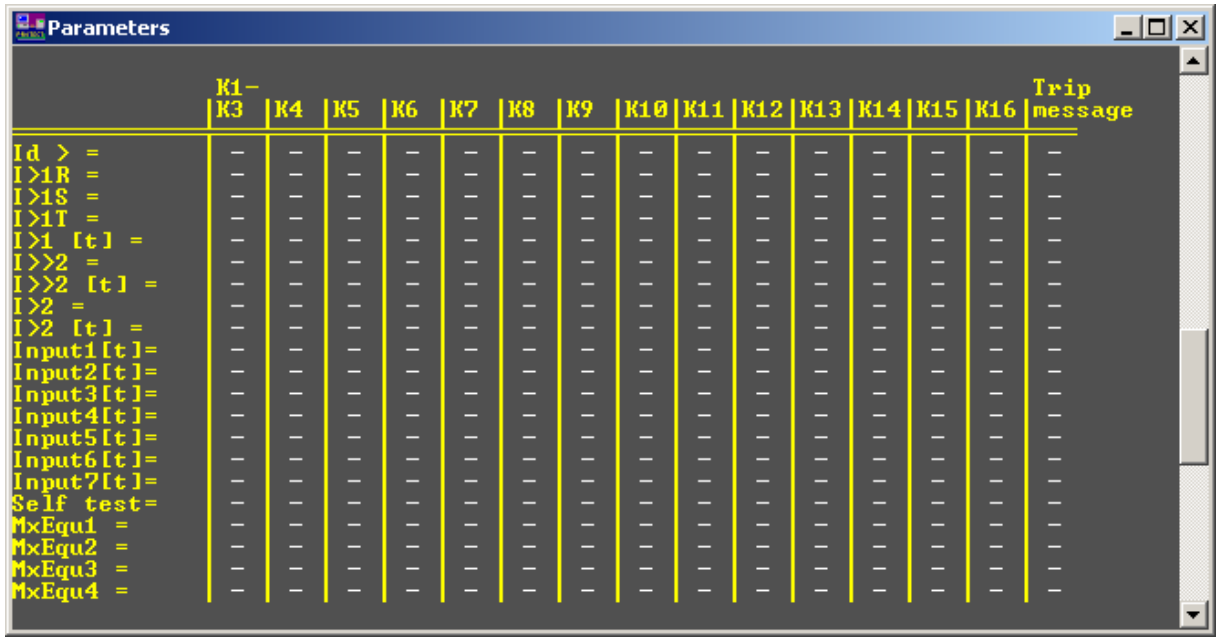


Fig. 12 matrix of a device designed for transformers with two voltage levels (Protect for Windows)

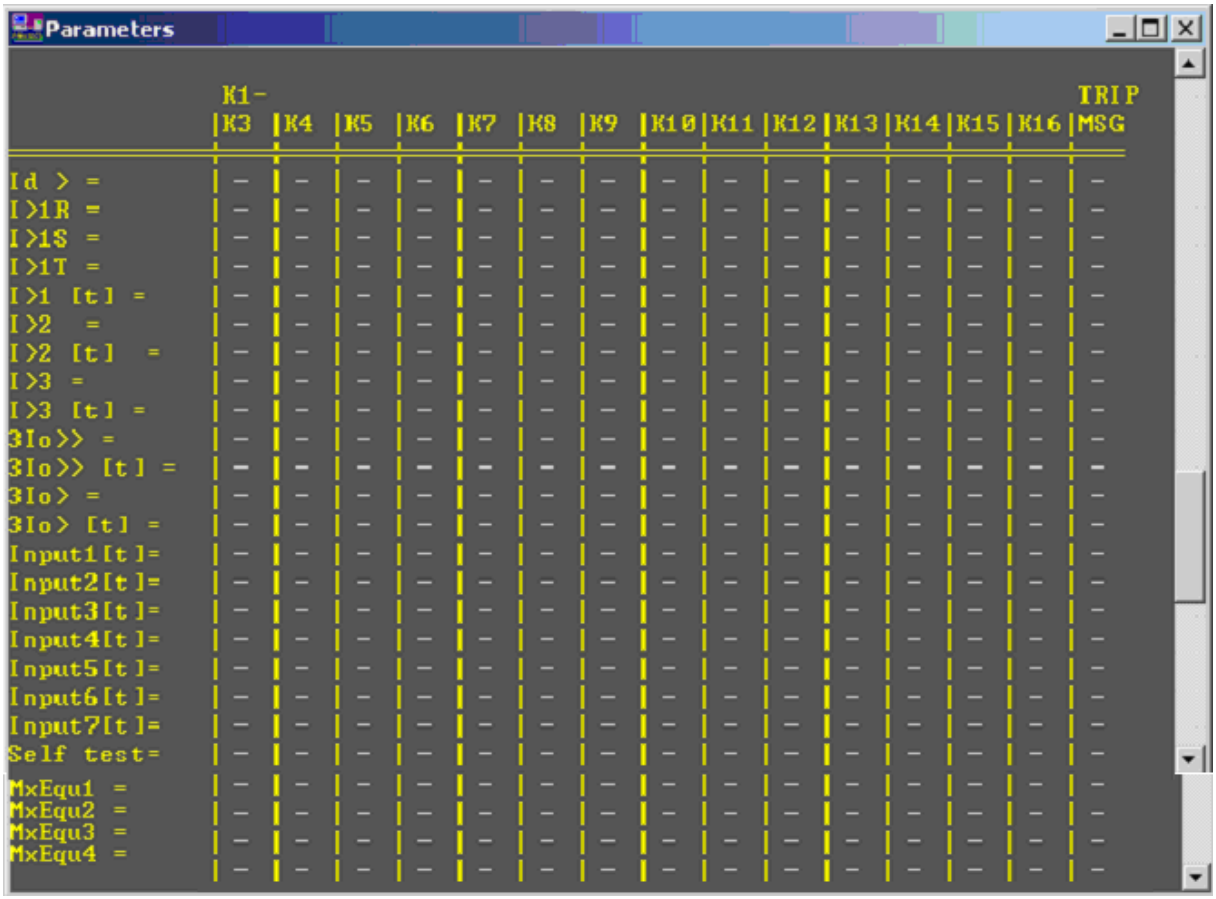


Fig. 13 matrix of a device designed for transformers with three voltage levels (Protect for Windows)

The binary code values of the matrix columns (outputs) are listed in Fig. 14:

Matrix-column element:	Code value:
K1…K3 output relays	2^0 = 1h
K4 output relay	2^1 = 2h
K5 output relay	2^2 = 4h
K6 output relay	2^3 = 8h
K7 output relay	2^4 = 10h
K8 output relay	2^5 = 20h
K9 output relay	2^6 = 40h
K10 output relay	2^7 = 80h
K11 output relay	2^8 = 100h
K12 output relay	2^9 = 200h
K13 output relay	2^{10} = 400h
K14 output relay	2^{11} = 800h
K15 output relay	2^{12} = 1000h
K16 output relay	2^{13} = 2000h
TRIP message	2^{14} = 4000h

Fig.14 The binary code values of the matrix columns (LCD).

The matrix inputs (matrix-rows), which can be assigned to the outputs are listed in Fig. 15:

Matrix-row element:	Explanation:
Mx Id>	Trip command of the differential protection function
Mx I>1R	Starting of the overcurrent function in phase R
Mx I>1S	Starting of the overcurrent function in phase S
Mx I>1T	Starting of the overcurrent function in phase T
Mx I>1 t	Trip command of the overcurrent function
Mx I>>2 or I>2 *	Starting of the overcurrent function
Mx I>>2 t or I>2 t *	Trip command of the overcurrent function
Mx I>2 or I>3 *	Starting of the overcurrent function
Mx I>2 t or y I>3 t *	Trip command of the overcurrent function
Mx IN1	Status signal of digital input No. 1 **
Mx IN2	Status signal of digital input No. 2 **
Mx IN3	Status signal of digital input No. 3 **
Mx IN4	Status signal of digital input No. 4 **
Mx IN5	Status signal of digital input No 5 **.
Mx IN6	Status signal of digital input No. 6 **
Mx IN7	Status signal of digital input No. 7 **
Mx CHK	Fault detection of the self check function
Mx Equ1	Output of the Protlog equation No.1
Mx Equ2	Output of the Protlog equation No.2
Mx Equ3	Output of the Protlog equation No.3
Mx Equ4	Output of the Protlog equation No.4

* for transformers with three voltage levels
** See chapter „Application of the digital inputs

Fig. 15 The matrix row elements (LCD).

2.4.2 Programming PROTLOG equations

The available status signals can be used to program logic equations, the result of which can be used freely.

2.4.2.1 Inputs of the PROTLOG equations

The available status signals are listed in Fig.16 and Fig.17.

Input identifier:	Explanation:
Id	Trip command of the differential protection function
I>1R	Starting of the overcurrent function in phase R
I>1S	Starting of the overcurrent function in phase S
I>1T	Starting of the overcurrent function in phase T
I>1 [t]	Trip command of the overcurrent function on the primary side of the transformer
I>>2	Starting of the high current setting overcurrent function on the secondary side of the transformer
I>>2 [t]	Trip command of the high current setting overcurrent function on the secondary side of the transformer
I>2	Starting of the overcurrent function on the secondary side of the transformer
I>2 [t]	Trip command of the overcurrent function on the secondary side of the transformer
Input1 [t]	Status signal of digital input No. 1 with time delay
Input2 [t]	Status signal of digital input No. 2 with time delay
Input3 [t]	Status signal of digital input No. 3 with time delay
Input4 [t]	Status signal of digital input No. 4 with time delay
Input5 [t]	Status signal of digital input No. 5 with time delay
Input6 [t]	Status signal of digital input No. 6 with time delay
Input7 [t]	Status signal of digital input No. 7 with time delay
Input8	Status signal of digital input No. 8
2. harm. block	Second harmonic blocking in the differential protection function
SW1	SW1 push-button (acknowledgement)
SW2	SW2 push-button (All trip commands disabled)
StIo>	Starting of the low current setting stage of the earth fault protection
StIo>t	Trip command of the low current setting stage of the earth fault protection
StIo>>	Starting of the high current setting stage of the earth fault protection
StIo>>t	Trip command of the high current setting stage of the earth fault protection
*	All the status signals are repeated with *. This means latching:

Fig. 16 The PROTLOG inputs for transformers with two voltage levels

Input identifier:	Explanation:
Id>	Trip command of the differential protection function
I>1R	Starting of the overcurrent function in phase R
I>1S	Starting of the overcurrent function in phase S
I>1T	Starting of the overcurrent function in phase T
I>1 [t]	Trip command of the overcurrent function on the primary side of the transformer
I>2	Starting of the overcurrent function on the secondary side of the transformer
I>2 [t]	Trip command of the overcurrent function on the secondary side of the transformer
I>3	Starting of the overcurrent function on the tertiary side of the transformer
I>3 [t]	Trip command of the overcurrent function on the tertiary side of the transformer
Input1 [t]	Status signal of digital input No. 1 with time delay
Input2 [t]	Status signal of digital input No. 2 with time delay
Input3 [t]	Status signal of digital input No. 3 with time delay
Input4 [t]	Status signal of digital input No. 4 with time delay
Input5 [t]	Status signal of digital input No. 5 with time delay
Input6 [t]	Status signal of digital input No. 6 with time delay
Input7 [t]	Status signal of digital input No. 7 with time delay
Input8	Status signal of digital input No. 8
2. harm. block	Second harmonic blocking in the differential protection function
SW1	SW1 push-button (acknowledgement)
SW2	SW2 push-button (All trip commands disabled)
StIo>	Starting of the low current setting stage of the earth fault protection
StIo>t	Trip command of the low current setting stage of the earth fault protection
StIo>>	Starting of the high current setting stage of the earth fault protection
StIo>>t	Trip command of the high current setting stage of the earth fault protection
*	All the status signals are repeated with *. This means latching:

The optically isolated inputs can be used to process the status signals of the mechanical transformer protections.

Fig. 17 The PROTLOG inputs for transformers with three voltage levels

2.4.2.2 Outputs of the PROTLOG equations

Output name	Explanation
Dist.rec.level trig.	Starting the disturbance recorder with signal level
Dist.rec.edge trig.	Starting the disturbance recorder with signal rising edge
Us.Def.Equ 1	Equation defined by the user, directed to the software matrix
Us.Def.Equ 2	Equation defined by the user, directed to the software matrix
Us.Def.Equ 3	Equation defined by the user, directed to the software matrix
Us.Def.Equ 4	Equation defined by the user, directed to the software matrix

Fig. 18 PROTLOG equations for transformers with two voltage levels

Output name	Explanation
Dist.rec.level trig.	Starting the disturbance recorder with signal level
Dist.rec.edge trig.	Starting the disturbance recorder with signal rising edge
K17	K17 output relay contact
K18	K18 output relay contact
K19	K19 output relay contact
K20	K20 output relay contact
K21	K21 output relay contact
K22	K22 output relay contact
K23	K23 output relay contact
K24	K24 output relay contact
Us.Def.Equ 1	Equation defined by the user, directed to the software matrix
Us.Def.Equ 2	Equation defined by the user, directed to the software matrix
Us.Def.Equ 3	Equation defined by the user, directed to the software matrix
Us.Def.Equ 4	Equation defined by the user, directed to the software matrix

Fig. 19 PROTLOG equations for transformers with three voltage levels

2.4.2.3 Programming the PROTLOG equations

The PROTLOG equations can be programmed with external PC only, using the „Protect for Windows" operating program's graphic editor possibility (The LCD of the device does not support this programming).

The method of graphical equation editor is described in details in the document „*EuroProt manual*".

2.4.3 Application of the digital inputs

The factory configuration of the DTD-EP device is extended with 8 digital inputs. The first seven inputs are connected to digital timers, and additionally the first four can be programmed for drop-off delay or for starting delay, all others are pre-programmed for starting delay. The first seven status signals serve as inputs for the software matrix, and all of them can be applied as input variables of the PROTLOG equations. The „Protect for Windows" operating program, running on an external PC supports the programming:

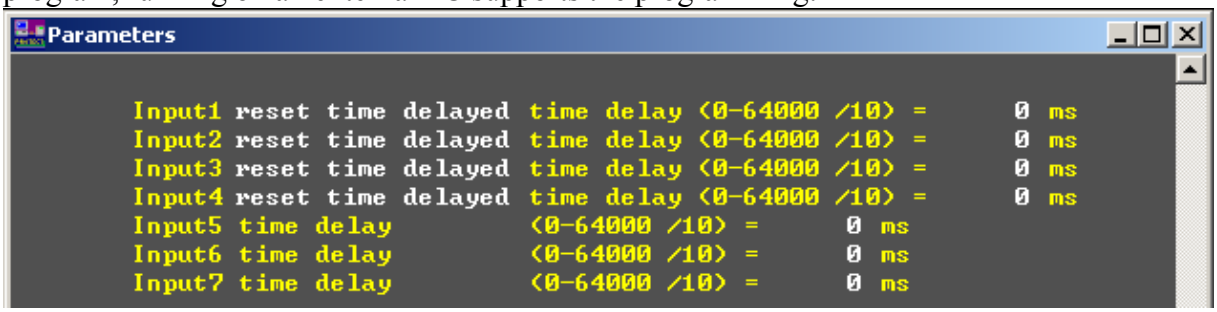


Fig. 20 Parameters of the input timers (Protect for Windows).

The „reset time delayed" means that the timer delays the drop-off of the status signal. This can be changed to „oper. time delayed" which means that the status is set with time delay.

The LCD of the device displays these parameters as follows (they can be found in menu I>):

LCD parameter name	Min	Max	Step
t[IN1]: [ms]	0	64000	10
tIN1 S/D: (+=start.)	1	0	
t[IN2]: [ms]	0	64000	10
tIN2 S/D: (+=start.)	1	0	
t[IN3]: [ms]	0	64000	10
tIN3 S/D: (+=start.)	1	0	
t[IN4]: [ms]	0	64000	10
tIN4 S/D: (+=start.)	1	0	
t[IN5]: [ms]	0	64000	10
t[IN6]: [ms]	0	64000	10
t[IN7]: [ms]	0	64000	10

Fig. 21 Parameters of the input timers (LCD)

The latching programmed in the device can be acknowledged and reset by pressing the SW" push-button on the front panel of the device. Input8 or Input7 optically isolated digital inputs can be used for acknowledgement. The selection is with parameter setting:

On the PC: Acknowledgement: SW2 or Input8 (Toggle: SW2 or Input7)
LCD-n: IN7/Ackn.

The integrated disturbance recorder function records the status of the first four inputs only.

2.4.4 Application of the relay outputs

The program of the ***DTD-2*** hardware configuration supports 16 output relays, the program of the configuration for transformers with three voltage levels uses 24 output relay contacts. Out of them the first 16 output relay contacts can be programmed with the software matrix (see Chapter „The digital software matrix"). In the version for transformers with three voltage levels additional 8 output relay contacts are assigned to the PROTLOG equation outputs (see Chapter „The PROTLOG equations").

The integrated disturbance recorder function records the status of the first four output relay contacts only.

2.4.5 Circuit breaker control function

A dedicated window of the „Protect for Windows" operating program supports generating manual close or open commands to the circuit breaker, but the ***DTD*** factory configurations do not support circuit breaker control function.

2.4.6 The integrated disturbance recorder function

The CPU module includes an integrated disturbance recorder function, which records sampled analogue values and digital status signals. This function does not have own man-machine interface, it can communicate with and external PC via fibre optic connection. The records can be analysed on the screen of the external PC, they can be printed or sent to the central engineering workstation for further evaluation.

The sampled analogue signals transmitted for recording are:

Recorded signal:	Explanation:
I1r	R phase current, primary side
I2r	R phase current, secondary side
I1s	S phase current, primary side
I2s	S phase current, secondary side
I1t	T phase current, primary side
I2t	T phase current, secondary side
Ur * or 3Io meas.	R phase voltage *
Us *or -	S phase voltage *
Ut * or -	T phase voltage *

* *only in* **DTDZ-2+U (dist.rec.)** *version*

Fig. 22. Recorded analogue signals (DTD-2 V3.xx and DTDZ-2+Udist.rec) V3.xx version).

Recorded signal:	Explanation:
I1r	R phase current 1. side
I2r	R phase current 2. side
I3r	R phase current 3. side
I1s	S phase current 1. side
I2s	S phase current 2. side
I3s	S phase current 3. side
I1t	T phase current 1. side
I2t	T phase current 2. side
I3t	T phase current 3. side

*Fig. 23 Recorded analogue signals (DTD-3V3.xx and DTD3 [5*3CT] V3.xx version).*

The digital status signals, recorded in the disturbance recorder:

Recorded signal	Explanation
Id>R	Trip command of the differential protection function in phase R
Id>S	Trip command of the differential protection function in phase S
Id>T	Trip command of the differential protection function in phase T
Id>>R	Trip command of the high set differential protection function in phase R
Id>>S	Trip command of the high set differential protection function in phase S
Id>>T	Trip command of the high set differential protection function in phase T
I>1R	Phase overcurrent protection function start, side 1, phase R
I>1S	Phase overcurrent protection function start, side 1, phase S
I>1T	Phase overcurrent protection function start, side 1, phase T
I>>2R	High set phase overcurrent protection function start, side 2, phase R
I>>2S	High set phase overcurrent protection function start, side 2, phase S
I>>2T	High set phase overcurrent protection function start, side 2, phase T
I>2R	Phase overcurrent protection function start, side 2, phase R
I>2S	Phase overcurrent protection function start, side 2, phase S
I>2T	Phase overcurrent protection function start, side 2, phase T
3Io>>	Zero sequence high set overcurrent protection function start
3Io>	Zero sequence low set overcurrent protection function start

Fig. 24 Recorded status signals (DTD-2 V3.xx and DTDZ-2+U(dist.rec) V3.xx version)

Recorded signal	Explanation
Id>R	Trip command of the differential protection function in phase R
Id>S	Trip command of the differential protection function in phase S
Id>T	Trip command of the differential protection function in phase T
Id>>R	Trip command of the high set differential protection function in phase R
Id>>S	Trip command of the high set differential protection function in phase S
Id>>T	Trip command of the high set differential protection function in phase T
I>1R	Phase overcurrent protection function start, side 1, phase R
I>1S	Phase overcurrent protection function start, side 1, phase S
I>1T	Phase overcurrent protection function start, side 1, phase T
I>2R	Phase overcurrent protection function start, side 2, phase R
I>2S	Phase overcurrent protection function start, side 2, phase S
I>2T	Phase overcurrent protection function start, side 2, phase T
I>3R	Phase overcurrent protection function start, side 3, phase R
I>3S	Phase overcurrent protection function start, side 3, phase S
I>3T	Phase overcurrent protection function start, side 3, phase T
3Io>>	Zero sequence high set overcurrent protection function start
3Io>	Zero sequence low set overcurrent protection function start

*Fig. 25 Recorded digital status signals (DTD-3 V3.xx and DTD3 [5*3CT] V3.xx version)*

The integrated disturbance recorder function has factory setting. There is only one possibility for the user to influence the operation of the recorder: using the Protect for Windows program logic equations can be edited to trigger the recording (see Chapter „PROTLOG equations" and the document „*EeuroProt manual"*).

As an option an additional disturbance recorder module can be ordered in the device. For this module the triggering can be configured using the external PC, the timer settings can be changed, (pre-fault time, etc.), the name of the individual channels can be edited, etc. The record of this disturbance recorder module can be accessed, analysed or printed using the external PC.

2.4.7 The free programmable timers

There are no free programmable timers in the DTD-EP factory configurations. If it is needed, the timers dedicated to external input signals can be used (see Chapter „Application of the digital inputs").

2.4.8 The LED indication

If any of the protection functions generate a trip command, the seven LED signals on the front panel enable quick information about the events. The assigned meaning of the seven LED-s is as follows:

LED text:	Explanation:
LCD	Warning LED: if the LCD contains a new message, or operator intervention is needed (e.g. acknowledgement of parameter changes)
Id>R	Trip command of the differential protection function in phase R
Id>S	Trip command of the differential protection function in phase S
Id>T	Trip command of the differential protection function in phase T
I>1	Phase overcurrent protection function start, side 1
I>>2	High set phase overcurrent protection function start, side 2
I>2	Phase overcurrent protection function start, side 2

Fig. 26 LED signals on the front side (DTD-2 V3.xx and DTDZ-2+Udist.rec) V3.xx version)

LED text:	Explanation:
LCD	Warning LED: if the LCD contains a new message, or operator intervention is needed (e.g. acknowledgement of parameter changes)
Id>R	Trip command of the differential protection function in phase R
Id>S	Trip command of the differential protection function in phase S
Id>T	Trip command of the differential protection function in phase T
I>1	Phase overcurrent protection function start, side 1
I>2	Phase overcurrent protection function start, side 2
I>3	Phase overcurrent protection function start, side 3

*Fig. 27 LED signals on the front side (DTD-3 V3.xx and DTD3 [5*3CT] V3.xx version)*

The LED-s can be programmed for latching (see subsequent chapter). In this cane they keep the signal until acknowledgement. Acknowledgement can be generated with the SW1 push-

button or using Input7 or Input8 digital inputs, according to the enabling with parameter setting (see Chapter „Application of the digital input").

2.4.9 Latching

All matrix rows and the LED-s can be programmed for latching (for latching the „-„ character must be changed for „+" by clicking with he mouse)

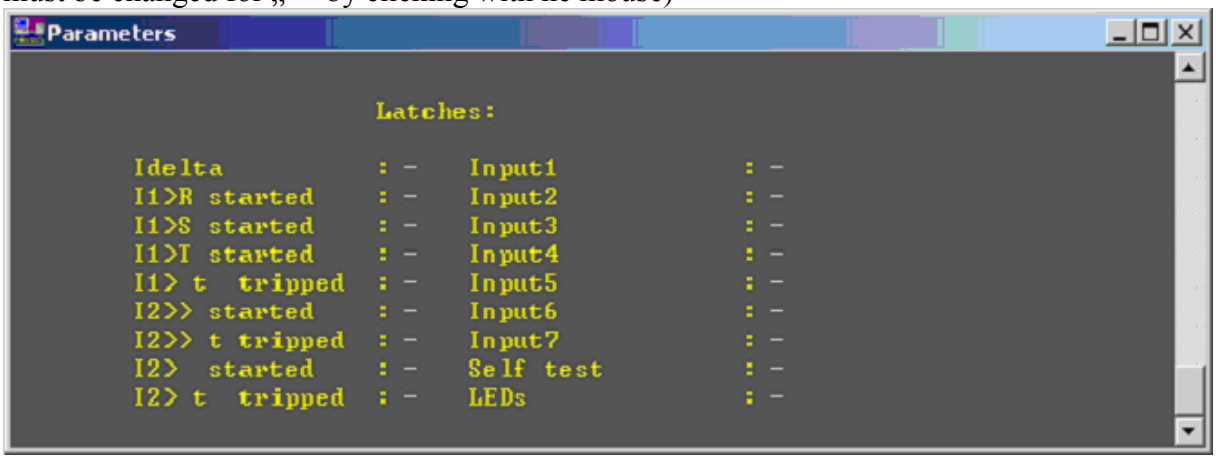


Fig. 28 Latching in devices designed for transformers with two voltage levels (PC).

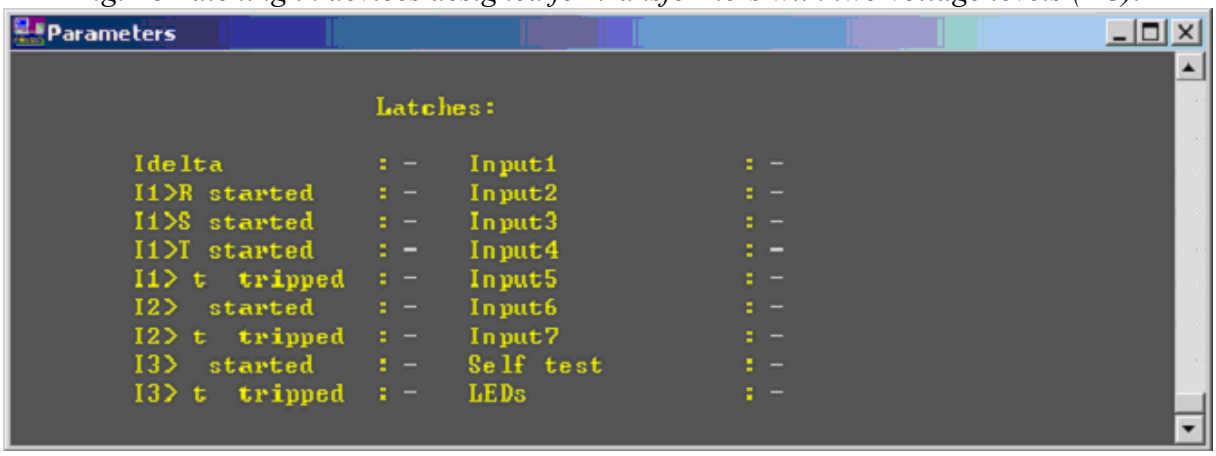


Fig. 29 Latching in devices designed for transformers with three voltage levels (PC).

LCD text:	Explanation:
Mx Id> latch: /+=yes/	Trip command of the differential protection
Mx I>1R latch: /+=yes/	Overcurrent protection function start
Mx I>1S latch: /+=yes/	Overcurrent protection function start
Mx I>1T latch: /+=yes/	Overcurrent protection function start
Mx I>1[t] latch: /+=yes/	Trip command of the overcurrent protection
MxI>>2 or I>2 * latch: /+=yes/	Overcurrent protection function start
MxI>>2 t or I>2 t * latch: /+=yes/	Overcurrent protection function start
MxI>2 or I>3 * latch: /+=yes/	Overcurrent protection function start
MxI>2 t or I>3 t * latch: /+=yes/	Trip command of the overcurrent protection
Mx IN1 latch: /+=yes/	1. input + timer timeout
Mx IN2 latch: /+=yes/	2. input + timer timeout
Mx IN3 latch: /+=yes/	3. input + timer timeout
Mx IN4 latch: /+=yes/	4. input + timer timeout
Mx IN5 latch: /+=yes/	5. input + timer timeout
Mx IN6 latch: /+=yes/	6. input + timer timeout
Mx IN7 latch: /+=yes/	7. input + timer timeout
Mx CHK latch: /+=yes//	Self-check error detection
LED latch: /+=yes/	LED signals

** for transformers with three voltage levels*

Fig. 30 Latching parameter setting (LCD).

2.4.10 Displayed messages

If any of the protection function operates, or if the self-check function detected any error of the operation, then the LCD of the front panel displays a message. The table below lists the possible messages:

LCD messageC	Explanation
EEPROM error !	
RAM battery error !	The RAM memory battery discharged
A/D error !	Self-check function detected an error
Internal DC supply error !	
No event stored!	No new event since last readout
ALL TRIPS ARE BLOCKED !	No output is enabled, no trip command or signal is possible!
DSP processor error !	
Relay tripped!	Any of the protection functions generated a trip command
Id> tripped !	The differential protection function generated a trip command
I>1[t] tripped!	Overcurrent protection side 1 generated trip command
I>>2[t] tripped! / I>2[t] tripped! **	High set overcurrent protection /Overcurrent protection side 2 generated trip command
I>2[t] tripped! / I>3[t] tripped! **	Overcurrent protection side 2 generated trip command Overcurrent protection side 3 generated trip command
3Io>>[t] tripped!	High set zero sequence overcurrent protection generated trip command
3Io>[t] tripped!	Low set zero sequence overcurrent protection generated trip command

*** the first message is valid for transformers with two voltage levels, the second one for three voltage levels.*

Fig. 31 The possible messages (LCD).

The messages are not displayed in the real event sequence, but they are arranged according to the list of the table above.

The messages and the error signals of the self-check function are logged in the event log as well, which can store up to 50 events. In the digital event sequence the events are logged with 1 ms time resolution; here 300 events can be stored. The events are not deleted by the acknowledgement. The event log can be displayed with the LCD of the front panel, and the contents of the event log and the content of the event sequence log can be evaluated using the connected PC or by the SCADA system too. (See detailed description in the document „*EuroProt manual*").

2.4.11 The displayed information (On-line window, summary)

The algorithms applied for protective functions – as a by-product – generate measure or calculate several values. These values and information can be displayed on the screen of the PC, connected via serial line, or on the small LCD or on the optional high-resolution graphic display of the device. Additionally they are available on the optionally connected SCADA system as well.

2.4.11.1 Information displayed on an external PC

The measured values (phase currents) and calculated values (difference of the currents, restraint currents), the status information of the protective functions (starting, trip signals), status of the digital inputs and output relays, accumulated counter values and additional service information can be displayed in the On-line window of the connected PC (see the following figure and details in the document *„EuroProt manual"*).

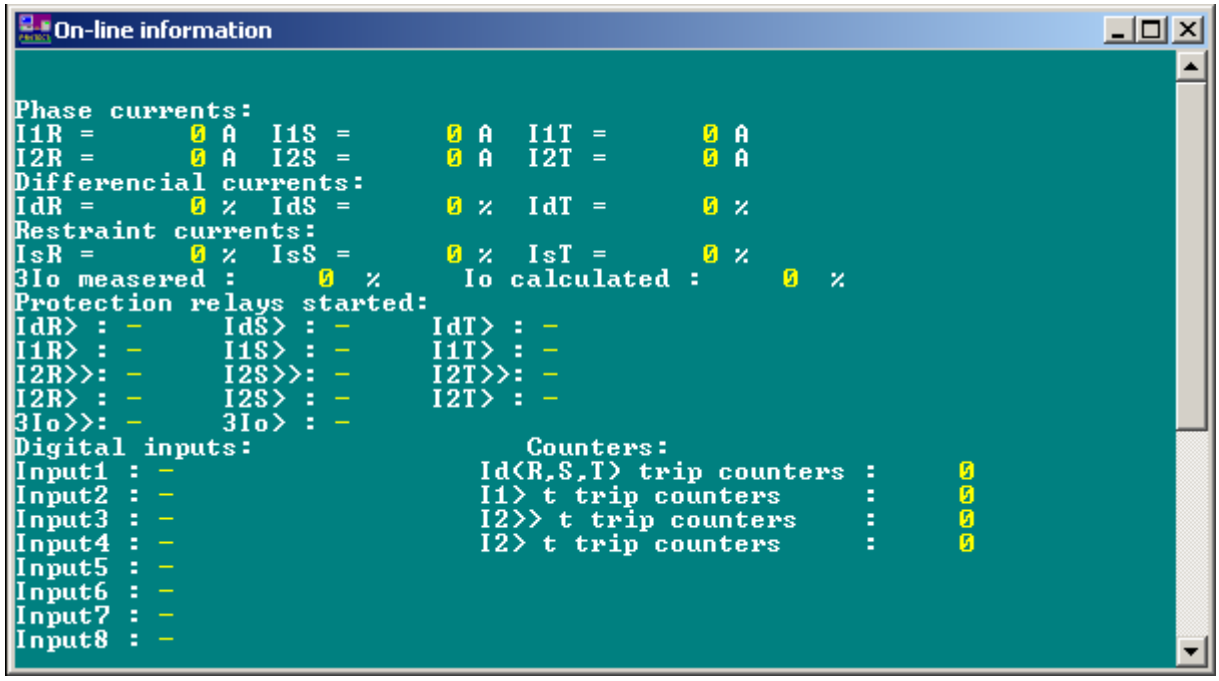


Fig. 32 The full On-line window for transformers with two voltage levels

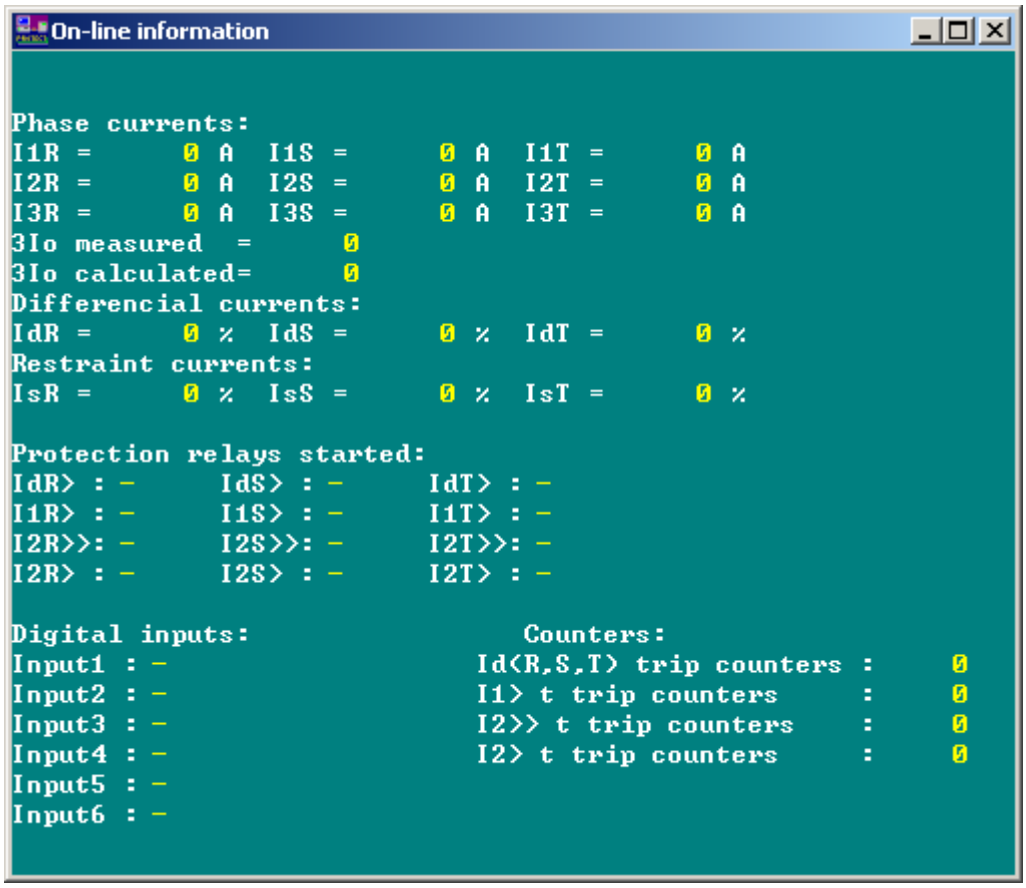


Fig. 33 The full On-line window for transformers with three voltage levels

2.4.11.2 Information displayed on the LCD

In the „Test" menu of the LCD sequencially the following information can be displayed:

Value	Explanation
Idr	Differentrial current in phase R
Ids	Differentrial current in phase S
Idt	Differentrial current in phase T
Isr	Restraint current in phase R
Iss	Restraint current in phase S
Ist	Restraint current in phase T
I1r	Primary current RMS value, side 1, phase R
I1s	Primary current RMS value, side 1, phase S
I1t	Primary current RMS value, side 1, phase T
I2r	Primary current RMS value, side 2, phase R
I2s	Primary current RMS value, side 2, phase S
I2t	Primary current RMS value, side 2 phase T
3IoMeas.	3Io measured primary current RMS value
3IoCalc.	3Io calculated primary current RMS value
DTD 1.Status :	Status information No. 1 (see details below)
DTD 2.Status :	Status information No. 2 (see details below)

Fig. 34 On-line information of the LCD of the device for transformers with two voltage levels

The explanation of the status information (see last two items in Figure above) can be found in the document *„EPU-2002*". The displayed items are listed below.

The LCD of the ***EuroProt*** device displays the status information at the end of the „Test" menu. As an example the first status word:

DTD-EP 1.status:
11011101

In this window the figures show that the binary values are refreshing. Character 1 means activ state of the status signal, 0 means inactive state.

The numbering of the individual codes is right to left:

8.7.6.5.4.3.2.1.
1 1 0 1 1 1 0 1

The meaning of the status values is configured in the program of the device. They are listed in the table below:

	DTD-EP 1.status:	Meaning:
1	-	No meaning for the user
2	RStdn	Trip command of the differential protection function, phase R
3	SStdn	Trip command of the differential protection function, phase S
4	TStdn	Trip command of the differential protection function, phase T
5	-	No meaning for the user
6	-	No meaning for the user
7	-	No meaning for the user
8	-	No meaning for the user

	DTDA-EP 2.status:	Meaning:
1	-	No meaning for the user
2	-	No meaning for the user
3	-	No meaning for the user
4	-	No meaning for the user
5	-	No meaning for the user
6	DistRec_Trig	Disturbance recorder triggering
7	SF_EEPROM_ERROR	SYSTEM error (EEPROM)
8	H_BATT_LOW	SYSTEM error (BATTERY)

Further in the „Test" menu there are counter values. The four counters are listed in the tables below:

For transformers with two voltage levels	
Id trip counter:	0
I>1[t] counter:	0
I>>2[t] counter:	0
I>2[t] counter:	0

For transformers with three voltage levels	
Id trip counter:	0
I>1[t] counter:	0
I>2[t] counter:	0
I>3[t] counter:	0

2.4.12 The self-check functions

The correct operation of the program system is supervised by the „Watch-dog" circuit. Additionally there are continuous and cyclic self-check functions programmed in the factory configuration. The self-check function detects internal errors of the hardware system.

2.4.12.1 Internal supervision

The internal supervision covers the following items:

- Error-free state of the memory for parameter storage,
- Power supply of the battery supported RAM for event recording,
- Correct operation of the A/D converter.

In case of any detected errors the status is changing in the CHK input of the software matrix. Optionally this variable integrates the error signals of the circuit breaker supervision system as well. This status signal can be marshalled to the available output contacts by programming the software matrix.

2.4.12.2 The circuit breaker supervision system (option)

If the device is extended by a CB circuit supervision module, it can continuously monitor the healthy state of the CB ON and OFF circuits. The method of supervision and its usage is described in the document „*EuroProt manual*".

The CB circuit supervision module includes three optically isolated inputs. One of them connects the TRIP1 circuit, the second the TRIP2, the third the ON circuit.

3 Communication with the device

3.1 The menu system

The menu system of the LCD on the front panel of the device and the method of operation is described in details in the document *„EuroProt manual"* this section describes the structure of the menu only. When energised, the LCD displays the device type and the current date and time. (month.day hour:minute:second):

DTD-2 PROTECTA 04.19 13:25:32

DTD-3 PROTECTA 04.19 13:25:32

When pressing ENTER, the root menu is displayed:

Events	Test/Chk
Version	Param.

3.1.1 The „Events" menu

When selecting the *Events* menu, the last evaluated event is displayed on the LCD. The push-button ↓ steps to the previous event (the push-button ↑ steps back). The following table lists the possible events:

Message	Explanation
Id>> tripped	Trip command of the high-set differential protection
Id>R tripped	Trip command of the differential protection in phase R
Id>S tripped	Trip command of the differential protection in phase S
Id>T tripped	Trip command of the differential protection in phase T
I>R1 started	Overcurrent protection start, side 1, phase R
I>S1 started	Overcurrent protection start, side 1, phase S
I>T1 started	Overcurrent protection start, side 1, phase T
I>1[t] tripped	Overcurrent protection trip, side 1
I>R2 started	Overcurrent protection start, side 2, phase R
I>S2 started	Overcurrent protection start, side 2, phase S
I>T2 started	Overcurrent protection start, side 2, phase T
I>2[t] tripped	Overcurrent protection trip, side 2
I>R3 started	Overcurrent protection start, side 3, phase R
I>S3 started	Overcurrent protection start, side 3, phase S
I>T3 started	Overcurrent protection start, side 3, phase T
I>3[t] tripped	Overcurrent protection trip, side 3
3Io>> started	Zero sequence high set overcurrent protection start
3Io>>[t] tripped	Zero sequence high set overcurrent protection trip
3Io> started	Zero sequence overcurrent protection start
3Io> [t] tripped	Zero sequence overcurrent protection trip

The short messages in the table are displayed with the exact time of the event. The following table lists the possible events:

Event	Explanation
ID>R	Trip command of the differential protection in phase R
ID>S	Trip command of the differential protection in phase S
ID>T	Trip command of the differential protection in phase T
I>1R	Overcurrent protection start, side 1, phase R
I>1S	Overcurrent protection start, side 1, phase S
I>1T	Overcurrent protection start, side 1, phase T
I>1[t]	Overcurrent protection trip, side 1
I>>2R	High set overcurrent protection start, side 2, phase R
I>>2S	High set overcurrent protection start, side 2, phase S
I>>2T	High set overcurrent protection start, side 2, phase T
I>>2[t]	High set overcurrent protection trip, side 1
I>2R	Overcurrent protection start, side 2, phase R
I>2S	Overcurrent protection start, side 2, phase S
I>2T	Overcurrent protection start, side 2, phase T
I>2[t]	Overcurrent protection trip, side 2
INPUT1	INPUT1 status signal set
INPUT2	INPUT2 status signal set
INPUT3	INPUT3 status signal set
INPUT4	INPUT4 status signal set
INPUT5	INPUT5 status signal set
INPUT6	INPUT6 status signal set
INPUT7	INPUT7 status signal set
OUTPUTS DISABLED	All outputs are disabled
K1	K1 output contact operated
K2	K2 output contact operated
K3	K3 output contact operated
K4	K4 output contact operated
K5	K5 output contact operated
K6	K6 output contact operated
K7	K7 output contact operated
K8	K8 output contact operated
AD error	A/D error detected
2hBlock	Second harmonic restraint operated
EEPROM ERROR	EEPROM error detected
INPUT8/ACKN	INPUT8 is set to external acknowledgement
Id>>R	High set differential protection trip command, phase R
Id>>S	High set differential protection trip command, phase S
Id>>T	High set differential protection trip command, phase T
K9	K9 output contact operated
K10	K10 output contact operated
K11	K11 output contact operated
K12	K12 output contact operated
K13	K13 output contact operated
K14	K14 output contact operated
K15	K15 output contact operated
K16	K16 output contact operated
3Io>>	Zero sequence high set vercurrent protection start
3Io>>[t]	Zero sequence high set overcurrent protection trip
3Io>	Zero sequence vercurrent protection start
3Io>[t]	Zero sequence overcurrent protection trip

Fig. 35 Possible events as displayed in the „Events" menu of the LCD, for transformers with two voltage levels

Event	Explanation
ID>R	Trip command of the differential protection in phase R
ID>S	Trip command of the differential protection in phase S
ID>T	Trip command of the differential protection in phase T
I>1R	Overcurrent protection start, side 1, phase R
I>1S	Overcurrent protection start, side 1, phase S
I>1T	Overcurrent protection start, side 1, phase T
I>1[t]	Overcurrent protection trip, side 1
I>2R	Overcurrent protection start, side 2, phase R
I>2S	Overcurrent protection start, side 2, phase S
I>2T	Overcurrent protection start, side 2, phase T
I>2[t]	Overcurrent protection trip, side 2
I>3R	Overcurrent protection start, side 3, phase R
I>3S	Overcurrent protection start, side 3, phase S
I>3T	Overcurrent protection start, side 3, phase T
I>3[t]	Overcurrent protection trip, side 3
INPUT1	INPUT1 status signal set
INPUT2	INPUT2 status signal set
INPUT3	INPUT3 status signal set
INPUT4	INPUT4 status signal set
INPUT5	INPUT5 status signal set
INPUT6	INPUT6 status signal set
INPUT7	INPUT7 status signal set
OUTPUTS DISABLED	All outputs are disabled
K1	K1 output contact operated
K2	K2 output contact operated
K3	K3 output contact operated
K4	K4 output contact operated
K5	K5 output contact operated
K6	K6 output contact operated
K7	K7 output contact operated
K8	K8 output contact operated
AD error	A/D error detected
2hBlock	Second harmonic restraint operated
EEPROM ERROR	EEPROM error detected
INPUT8/ACKN	INPUT8 is set to external acknowledgement
Id>>R	High set differential protection trip command, phase R
Id>>S	High set differential protection trip command, phase S
Id>>T	High set differential protection trip command, phase T
K9	K9 output contact operated
K10	K10 output contact operated
K11	K11 output contact operated
K12	K12 output contact operated
K13	K13 output contact operated
K14	K14 output contact operated
K15	K15 output contact operated
K16	K16 output contact operated
3Io>>	Zero sequence high set vercurrent protection start
3Io>>[t]	Zero sequence high set overcurrent protection trip
3Io>	Zero sequence vercurrent protection start
3Io>[t]	Zero sequence overcurrent protection trip

Fig. 36 Possible events as displayed in the „Events" menu of the LCD, for transformers with three voltage levels

3.1.2 The „Test" menu

In this menu first the measured values are displayed in primary Amperes. The navigation is supported by the arrows push-buttons (↓ and ↑).

The displayed measured and calculated values, the counters and status signals in the „Test" menu is described in details in the Chapter „Information displayed on the LCD".

3.1.3 The „Chk" menu

In this menu the parameter setting can be checked without need of password input. New setting in this menu is not possible, for setting enter „Param." parameter setting menu.

3.1.4 The „Version" menu

In this menu the device type, the version of the configuration and the time of programming can be seen:

DTD - 2 2003.12.05.V3.01	DTD - 2 +U(dist.rec) 2004.03.16.V3.01
DTD - 3 2003.12.05.V3.01	DTD - 3 [5*3 CT] 2003.09.19.V3.00

The upper row shows the type of the factory configuration, the lower one displays the date of the version and the version identifier.

3.1.5 The „Param." menu

The *Param.* (parameter setting) menu supports the parameter setting for the protection and automatics functions, the communication and the software matrix. The user can enter this menu with password only. The detailed description can be found in the document *„EuroProt manual"*.

The list of the parameters, the setting ranges and the setting steps are in the function descriptions above.

3.1.6 Parameters related to the communication

The parameter setting of the communication function is unified for all EuroProt devices. This is described in the document „ *EuroProt manual*".

3.1.7 Password

The password protection is unified for all EuroProt devices. This is described in the document „ *EuroProt manual*".

3.2 Connecting the device to an external PC

The handling of the device is more convenient and quicker than the operation with the local man-machine interface, if the device is connected to an external PC.

The operating software is the „Protect for Windows" program. This program and the files related to the factory configuration (.bla, .gra or .blk, .grf, and additionally the .dok file) is delivered with the device, and it is stored in the program memory of the CPU as well. Details of the operation of this program pleas find in the document „ *EuroProt manual*".

4 The optional local SCADA functions

In the CPU module of the device a dedicated micro-controller is assigned to perform local SCADA functions. This is supported by the large, high resolution graphic LCD, which is an option of the device. The usage of the SCAD function is unified for all EuroProt devices. This is described in the document „ *EuroProt manual*".

5 Arrangement of the DTD-EP factory configuration

The layout of the device is described in the document „ *EuroProt manual*".

The arrangement of the front panel, the module configuration, the „Protect for Windows" files (.bla, .gra or .blk, .grf, and additionally .dok), and the connection arrangement depend on the configuration. These files and additional documents are attached to the device.

6 Size

The sizes of the different configurations are given in the document „ *EuroProt manual*". The related information is attached to the device.

7 Ordering information

Ordering of the device is helped by filling the ordering sheet, which is the attachment of the ordering. This includes the following information:

- Type of the device configuration: „DTD-EP *EuroProt* multifunctional device, version: DTD2V31, DTD2V31U, DTD3V31 or DTD5, factory configuration"
- Rated power supply voltage
- Rated input voltage [100 V, 200 V]
- Rated current [1 A, 5 A]
- Special requirement for contact rated current (2 A, 4 A)
- Design of the device (19" cabinet mounted, relay panel mounted or flush-mounted)
- Options (SCADA functions, etc.)

8 Information

Data of the described versions:

DTD2V31	NOD-file: DTD2V31.NOD	2004.03.18.
	Version: DTD – 2	2003.12.05.V3.01
DTD2V31U	NOD-file: TD2V31U.NOD	2004.03.18.
	Version: DTD - 2 +U(dist.rec.)	2004.03.16.V3.01
DTD3V31	NOD-file: DTD3V31.NOD	2004.03.18.
	Version: DTD – 3	2003.12.05.V3.01
DTD5	NOD-file: DTD5.NOD	2004.03.18.
	Version: DTD - 3 [5*3 AV]	2003.09.19.V3.00
DTD2(+Io)	NOD-file: DTD2V32A.NOD	2005.06.16.
	Version: DTD - 2 (+Io)	2005.06.13.V3.00