ELECTRICAL POWER ENGINEERING

Protection Techniques

In electrical power supply systems, currents and voltages are constantly measured and monitored to ensure that they remain within certain limits.
These values are needed in order to provide constant information on the state of the system, to calculate the amount of power supplied to a customer and to switch off rapidly faulty sections of a network in case of a fault.
In general, the current and voltage values are so high that they cannot be measured directly and special transformers have to be used to reduce these values to a level which can be measured safely and economically.
In this laboratory single and three-phase current and voltage transformers are studied.
But, a very important subject must also be considered, the one related to the protection of electrical power systems, in order to avoid that any fault could spread through the network and result in a collapse of the entire power supply system. In cases of short-circuit, for instance, the very high fault currents produced can destroy parts of the system and could often even endanger the lives of humans.
For these reasons, special protection systems, which must react quickly and reliably in the event of faults, have been developed in the area of electrical power distribution.
A fundamental task of a protective system is to recognize the damaged system component and, where possible, to disconnect only this component so that the remaining power distribution can be maintained.
In this laboratory a number of protective relays are analyzed: under/over voltage time relays, definite time over-current relays, inverse time over-current relays, earth-fault relays, etc.).
Then, special attention is paid to the problem of high voltage line protection, with discussions on the criteria about the most suitable protective system to be used. Experiments on over-voltage and under-voltage monitoring, short-circuit protection and earth-fault monitoring complete the analysis of this very important problem.

Protection of HV line - GTU103.3

- demonstration of how an under/over voltage time relay monitors the protection of a load against under- and over-voltage
- demonstration of the protection of a transmission line connected in a solid earthed network, when there is a three-phase, two-phase or single-phase short-circuit
- demonstration of how an earth-fault warning relay monitors the transmission line for an earth fault in a network with isolated neutral connection

Instrument transformers - GTU103.1

- determination of the transformation ratio of a current transformer for various primary currents and investigation on the influence of the load on the transformation ratio
- explanation of the terms: ratio error (current error), accuracy class and rated accuracy limit factor
- test on the performance of the current transformer at over-current
- assembly of the common current transformer circuit for measurement on three-phase network
- measurement of the zero-phase sequence current of a three-phase system
- measurements on a summation current transformer
- demonstration of the principle of differential protection
- determination of the transformation ratio of a voltage transformer for various primary voltages and investigation on the influence of the load on the transformation ratio
- explanation of the terms: ratio error (voltage error) and accuracy class
- assembly of the common voltage transformer circuit for measurements in three-phase network
- measurement of the residual voltage in a three-phase system with a fault to ground
- assembly of a voltage transformer circuit in open delta connection
- measurement of the three conductor voltages on symmetrical and asymmetrical loads

Protective relays - GTU103.2

- connection of an under/over voltage relay in a three-phase net- work and investigation on its behaviour with respect to under and over-voltages
- determination of the resetting ratio of an under/over voltage relay
- measurement of the operating time of an under/over voltage relay
- connection of a definite time over-current relay in a three-phase network and investigation on its behaviour with respect to different settings
- determination of the resetting ratio of a definite time over-current relay
- measurement of the operating time of a definite time over-current relay
- connection of an inverse time over-current relay in a three-phase network and investigation on its behaviour with respect to different settings
- measurement of the operating time of an inverse time over-current relay
- investigation on an earth-fault relay
- check of the operate time set
- demonstration of an earth-fault alarm in a three-phase network
- reaction to so-called transient earth faults
- investigation on a directional earth-fault relay behaviour for effective currents and on the direction of operation
- investigation on a combined over-current and earth-fault relay behaviour connected in a solid earthed three-phase network
- demonstration of how the external blocking input works

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Finally, special attention is given to the issue of protection of the generation (GTU 103A), of the transmission (GTU 103B) and of transformers (GTU 103C).

Generation protection - GTU103A

- Overcurrent protection
- Earth fault protection
- Unbalanced protection
- Over voltage/under voltage protection
- Frequency protection
- Differential protection

Transmission protection - GTU103B

- Overcurrent protection
- Unbalanced load protection
- Directional power protection
- Distance protection
- Differential protection

Transformer protection - GTU103C

- Overcurrent protection
- Unbalanced load protection
- Directional power protection
- Differential protection

		GTU103.1	GTU103.2	GTU103.3	GTU103A	GTU103B	GTU103C	TOTAL
Variable three-phase power supply	DL 1013T1	1	1					1
Variable DC power supply	DL 1013T2				1			1
Line model	DL 7901TT			1		2		2
Three-phase transformer	DL 1080TT		1	1		1	1	1
Resistive load	DL 1017R	1	1	1	1	1	1	1
Inductive load	DL 1017L					1		1
DC motor	DL 1023PS				1			1
Three-phase synchronous machine	DL 1026A				1			1
Base	DL 1013A				1			1
Electronic tachometer	DL 2025DT				1			1
Experiment transformer	DL 1055TT	1						1
Three-phase power supply	DL 2108TAL-SW		1	1	1	1	1	1
Variable DC power supply	DL 2108T01				1			1
Power circuit breaker	DL 2108T02		1	1	1	2	1	2
CT load	DL 2108T10	1						1
VT load	DL 2108T11	1						1
Under/over-voltage time relay	DL 2108T12		1	1				1
Inverse time over-current relay	DL 2108T13		1					1
Definite time over-current relay	DL 2108T14		1	1				1
Combined over-current & earth fault relay	DL 2108T15		1					1
Single-phase directional relay	DL 2108T16		1					1
L/C loads	DL 2108T17		1					1
Three-phase over/under voltage relay	DL 2108T18			1				1
Differential transformer relay	DL 2108T21						1	1
Distance protection relay	DL 2108T22					1		1
Feeder manager relay	DL 2108T23				1	1	1	1
Generator differential relay	DL 2108T24				1	1		1
Moving coil ammeter (100-500-1000mA)	DL 2109T1A	4			2			4
Moving coil ammeter (1.25-2.5A)	DL 2109T2A5		1	1			1	1
Moving iron ammeter (5A)	DL 2109T5A	2						2
Moving iron voltmeter (125-250-500V)	DL 2109T3PV	4	1	1			2	4
Double voltmeter	DL 2109T17/2				1			1
Single-phase current transformer	DL 2109T21	1						1
Three-phase current transformer	DL 2109T22	1			2	2	2	2
Single-phase voltage transformer	DL 2109T23	1						1
Three-phase voltage transformer	DL 2109T24	1	1	1	1			1
Summation current transformer	DL 2109T25	1						1
Acoustic continuity tester	DL BUZ		1	1				1
Electronic stopclock	DL CRON		1					1
Connecting leads	DL 1155GTU	1	1	1	1	1	1	1
Table	DL 1001-1	1	1	1	1	1	1	1
Frame	DL 2100-3M	2	2	2	2	2	2	2
Accessory: Storage cabinet	DL 2100TA	1	1	1	1	1	1	1
For Countries with 3-phase mains different from 380V :								
Three-phase transformer	DL 2100TT	1	1	1	1	1	1	1