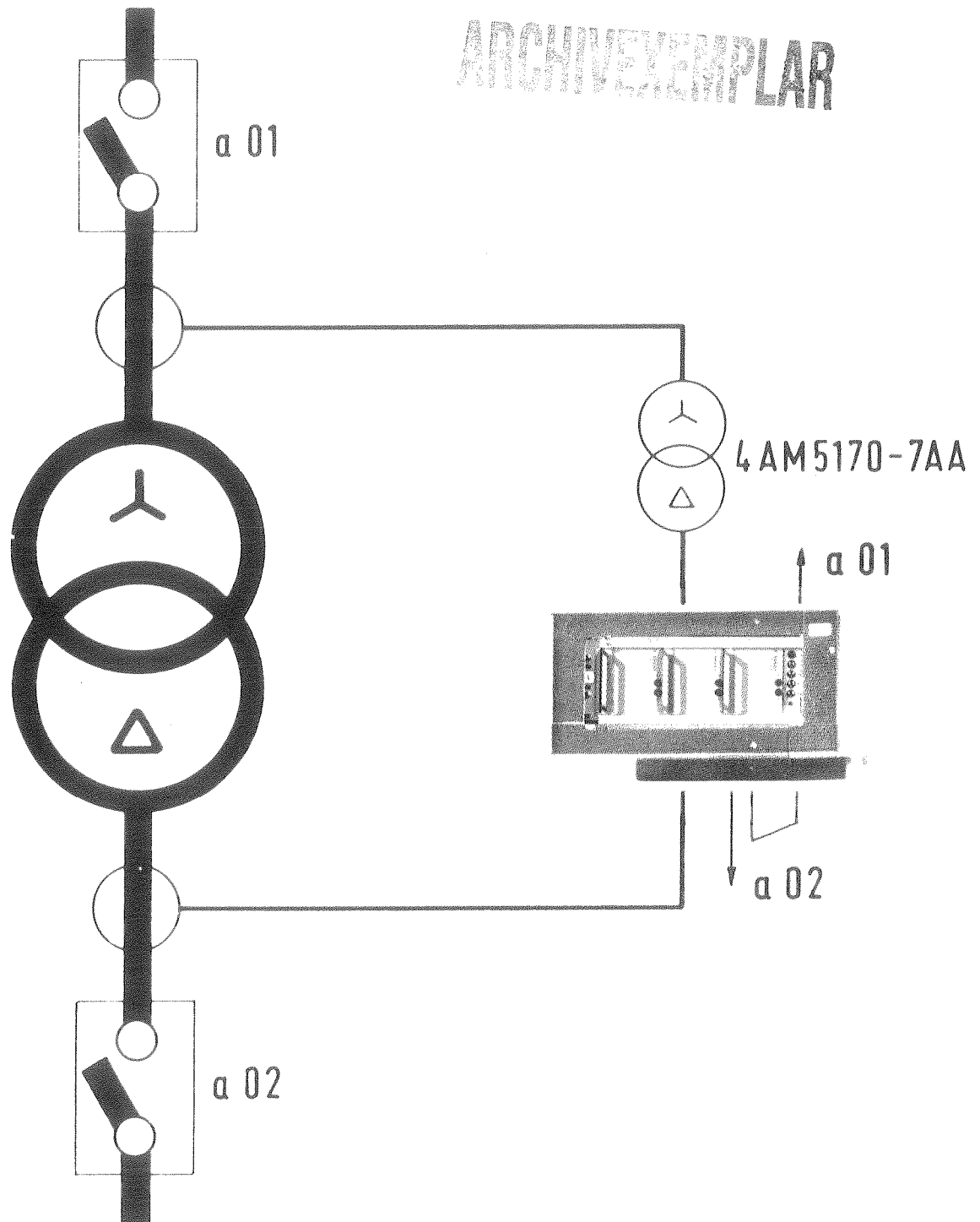


Aktenexemplar
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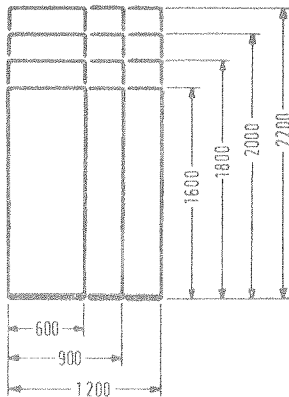
Static Differential Relay System 7UT22/23 for Transformers and Generator-Transformer Units

Description



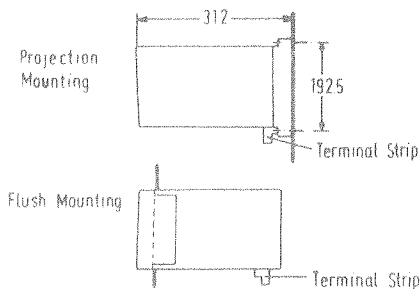
Dimensions

of protection equipment cubicles,
Type BMF



of enclosures, type 6XG1

Clear width of the enclosures:
506 mm



Application

used as a selective protective system for trans-
formers and generator-transformer units.

Special features

- Minimum tripping time 20 ms
- Low pick-up value if faults occur in the protected zone (adjustable between 0.15 and 0.4 . rated current I_N)
- Same degree of sensitivity to any type of fault by using separate measuring modules for each phase
- High stability in the event of through fault and inrush-currents
- Power consumption less than 0.3 VA
- Models for multi-winding transformers are also available

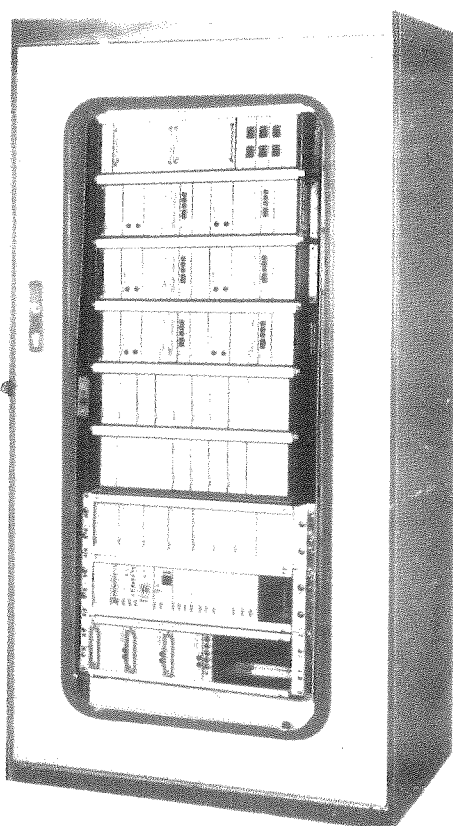
Models

- 7 UT 22 for two-winding transformers
- 7 UT 23 for three-winding transformers

Mounting

In enclosed racks

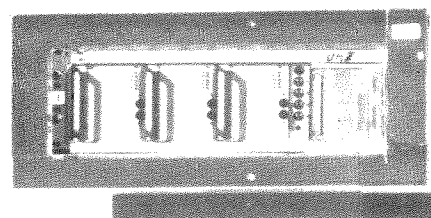
the various modules are installed in racks. The cubicle is delivered completely wired and tested up to the terminal-strips



7UT22 and busbar protection system installed in a common cubicle

On panels

delivery in cases



Transformer differential relay system including back-up protection in a common case

Features

Types of faults which will be detected

- Two-and three-phase shortcircuits
- Inter-winding, inter-layer and inter-turn faults in transformers
- Earth faults if the transformer star-points are earthed
- Doublephase - to - earth faults.

Tripping characteristic

The pick-up value is adjustable in 5 steps from 0.15 to $0.4 \cdot I_N$.

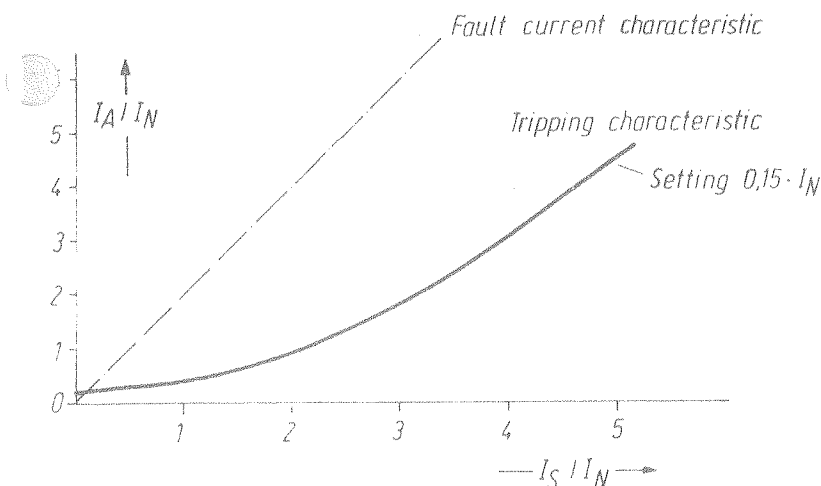
High degree of sensitivity

Since the characteristic line is curved, the protection relay is sensitive in the low-current region, but less in case of large through-fault currents. The protection relay system thus has great stability in the event of external faults without sacrificing its sensitivity in the normal load range.

Great stability also if used in conjunction with transformers having a wide tap-changing range

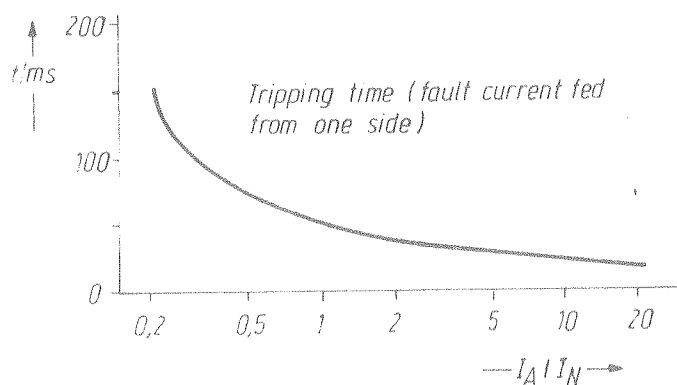
A differential relay system adjusted so as to suit the mid-position of tap-changing transformers "sees", in the event of rated current and an extreme tapping position, a considerable current difference.

With a view to such cases, the restraining current for the low-current range is slightly increased. From this it follows that the characteristic curve has a slight up-gradient in the load range.



Minimum tripping time

The minimum tripping time is 20 ms.



Indications

The tripping signal is indicated by an operation indicator in each phase and stored until the indicators on the module are reset either locally or remotely from the control station.

Signalling contacts are also available for remote indications.

Plug-in modules

The protection relay system is made up of plug-in modules which can be easily interchanged. Each phase has one measuring module. Signalling and tripping relays and operation indicators are grouped on one module.

Easy to connect

The protection relay system and the add-on units are supplied integrally in one enclosure. Additional wiring work on site, for instance between differential relay systems and back-up equipment, is not required.

Add-on units

Back-up protection equipment, for instance, overcurrent time or distance protection relay system.

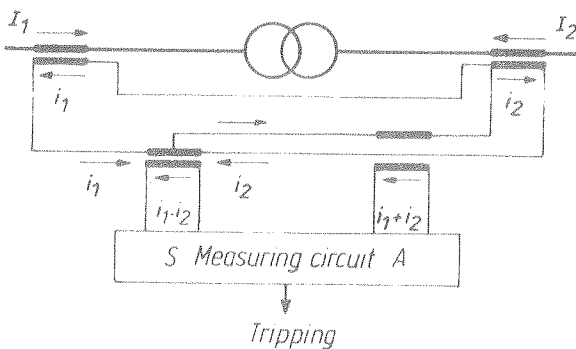
The add-on units are designed on the same engineering principles as the differential relay system. It is therefore advisable to accommodate them together in one case or enclosed rack.

Accessories

To match the currents on the high voltage and the low voltage side matching transformers of type 4AM5170-7AA are well suited.

Method of measurement

Tripping criterion



The differential relay system compares the sum $A = I_1 + I_2$ with the difference $S = I_1 - I_2$.

$A = I_1 + I_2$ develops an operating force while $S = I_1 - I_2$ sets up a restraining force. I_1 and I_2 are assumed to be positive, so becoming effective in the protection zone.

In the event of external faults, the operating force $A = I_1 + (-I_2)$ is theoretically zero while the restraining force $S = I_1 + I_2$. The relay is therefore safely restrained in the event of external faults.

If an internal fault occurs, I_2 becomes positive so that the operating force $A = I_1 + (+I_2) = I_1 + I_2$ while the restraining force $S = I_1 - (+I_2) = I_1 - I_2$.

The protective relay will then trip reliably.

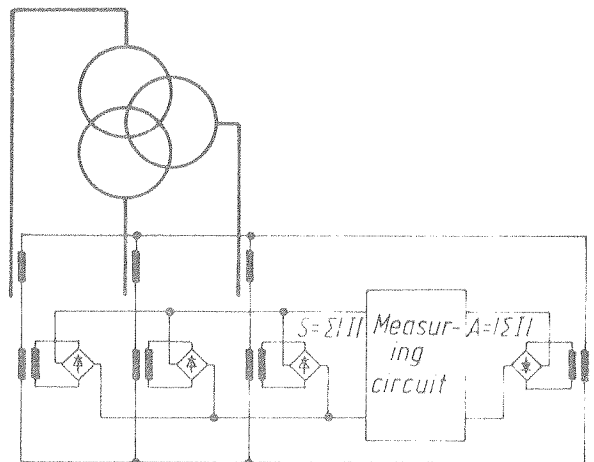
Tripping criterion in the case of three-winding transformers

In the case of three-winding transformers, it is not the vectorial difference of the currents which is utilized as the restraining force, but the arithmetical sum of the currents $S = K \cdot (|I_1| + |I_2| + |I_3|)$ since no clear vectorial difference can be formed from more than two currents.

If faults occur externally, the vectorial sum $A = I_1 + I_2 + I_3$ is theoretically zero (operating force) while $S = K (|I_1| + |I_2| + |I_3|)$ remains unchanged.

With internal faults, the operating force $A = I_1 + I_2 + I_3$ exceeds the restraining force $S = K (|I_1| + |I_2| + |I_3|)$ because $K < 1$.

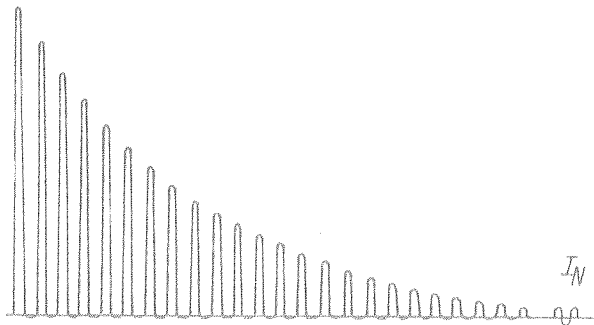
The value K varies as a function of S and A and is determined by the tripping characteristic.



The protection scheme for four-winding transformers can also be based on this principle.

Inrush current restraint

When transformers are energised, high currents result.



Typical inrush current

These currents flow only on one side of the transformer so that there is a large current difference flowing in the differential relay system.

To prevent tripping, the second harmonic of the inrush current is utilized as an additional restraining current.

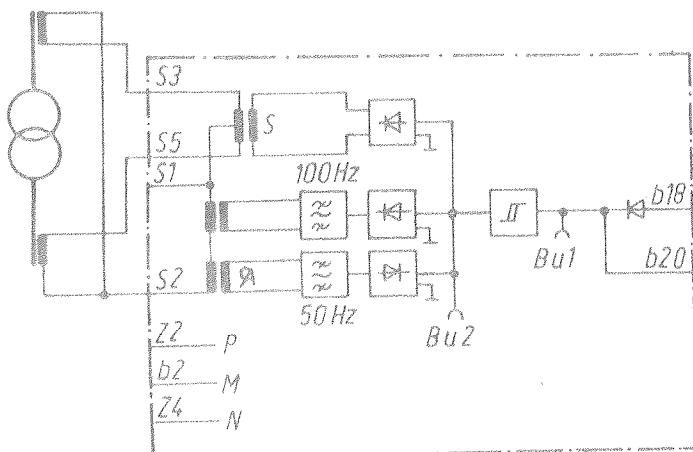
The relay then has a great enough restraining force to resist even very large transformer inrush currents.

Measuring circuit arrangements

The differential relay system has one measuring module per phase. Sensitivity is therefore constant, irrespective of the type of the fault.

The mode of operation is described in the following for one of the measuring modules.

Measuring circuit arrangement for two-winding transformers



The sum S and the difference A of the currents is formed in the input current transformers.

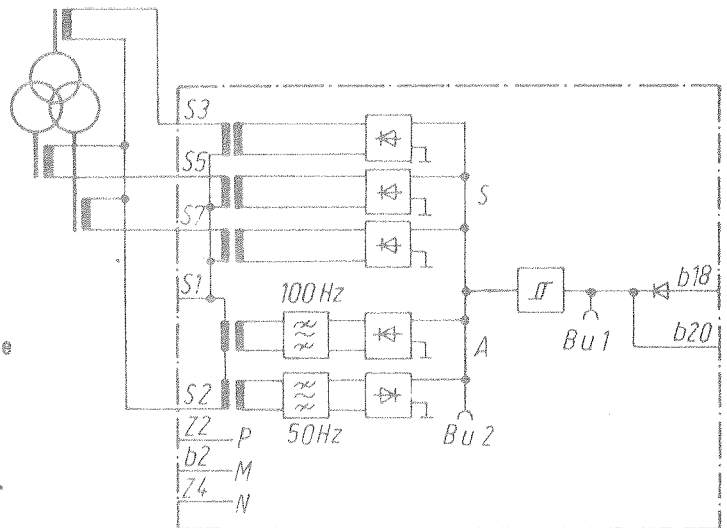
These two values are rectified and converted into proportional voltages.

The two analogue voltages are connected in series so that the difference can be fed to a Schmitt trigger which responds when $A-K.S$ reaches a specified limit value.

The inrush filter circuit is connected to the restraining side.

Measuring circuit arrangement for three-winding transformers

Its method of operation is basically the same as that described above. However, the arithmetical sum of the currents is utilized as the restraining force.



Connections

Current-transformer circuits

Since the relay system cannot compare currents unless they agree in magnitude and phase relation, the c.t. currents at both ends of the transformer to be protected have to be matched in magnitude and phase relation by a matching transformer.

The vector group of the matching transformers is governed by that of the transformer to be protected, the position of the starpoints of the current transformers being taken account of.

The magnitudes of the currents are adapted to each other by varying the transformation ratios of the matching transformers.

The type 4AM5170-7AA is well suited for this purpose. It has light separate windings which enable the transformation ratios to be varied over a wide range with adequate accuracy.

Ratio of Windings	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q
Ratio Current I_N	1	5	2	5	7	5	16	1	5	1	5	2	5	7	16	1

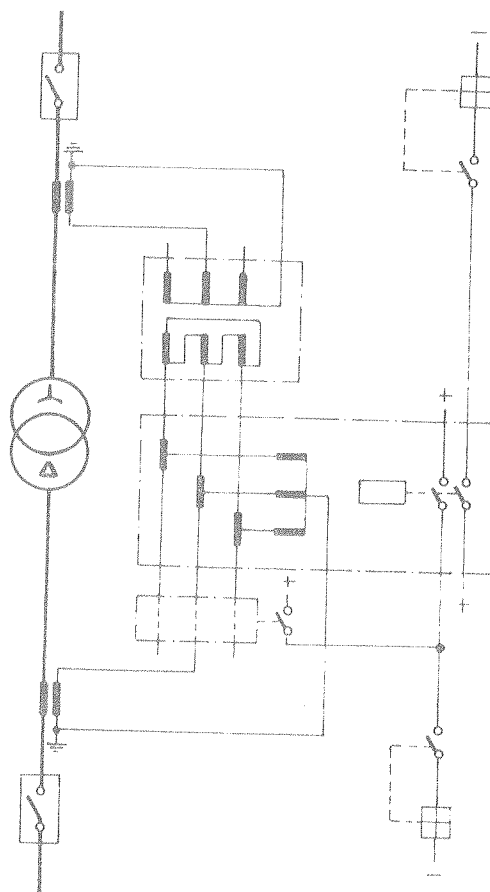
Three matching transformers are required if star-delta transformers are concerned.

For star-star transformers, six matching transformers have to be provided if both the starpoints are earthed.

Tripping circuits

The differential relay system disconnects the transformer completely from the system when internal faults occur; the associated relay then acts upon both the circuit breakers.

The back-up unit protects the transformer in the event of external short-circuits. Hence it operates only one circuit breaker after the pre-set tripping time has elapsed.



Differential- and back-up protection for two-winding transformer

Technical data

Rated current

5 A, 1 A

Frequency

50 Hz or 60 Hz

Overload capacity

0.5 s, 100 . rated current I_N ,
10 s, 20 . rated current I_N ;
continuously 2 . rated current I_N

Power consumption

0.15 VA per phase with rated current
 $I_N = 1$ A
0.30 VA per phase with rated current
 $I_N = 5$ A

Auxiliary d.c. voltage

24 to 250 V D.C. (converter is exchangeable)
Permissible working range 80 to 115 %
of the rated voltage U_N

D.C. power consumption

max. 15 W
normally approx. 10 W

Settings

0.15; 0.2; 0.25; 0.3; 0.4 . rated current I_N

Minimum tripping time

20 ms

Installation

In subracks which are to be installed in type
6XG1 cases or enclosed racks

Conductor connected

up to 6 mm² (terminal strips)

Test voltage

2000 V, 50 Hz, impulse voltage 5 kV 1.2 per
50 μ s between metallically isolated external
circuits

Specifications

VDE 0435