



GE VERNOVA

Advanced Transformer Monitoring 8 Series Mini Paper



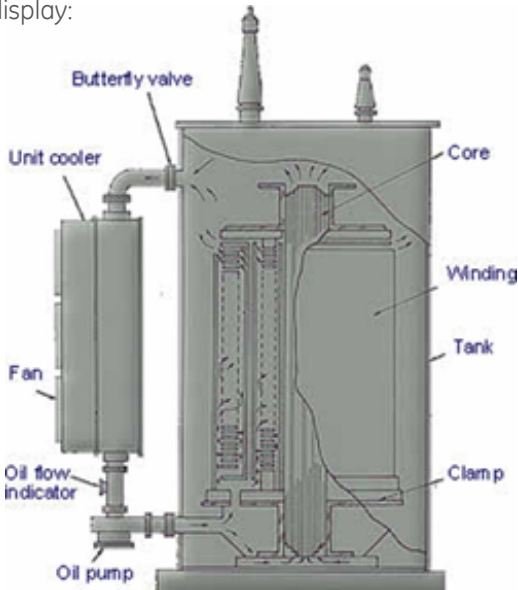
Advanced Transformer Monitoring - A Comprehensive Monitoring Solution for All Transformer Applications

Part of the Multilin 8 Series of modern Protection & Control devices, GE's Multilin 845 Transformer Management Relay offers advanced protection, control, asset health monitoring, with advanced communications for Medium and Large 2- and 3-winding power transformers. As part of this advanced platform the Multilin 845 is built from common hardware, firmware, and utilizes the same simplified device setup software as the other Multilin 8 Series devices reducing training, setup and commissioning time and effort, and maintenance requirements. Other relays in this platform include the Multilin 850 Feeder Protection System and Multilin 869 Motor Management System.

Thermal Elements

The Multilin 845 relay can be set to monitor the hottest-spot winding temperature, the aging acceleration factor, and the transformer insulation life. In order for the relay to perform the correct computations, the user needs to enter transformer data and program the RTD or dcma inputs for measuring ambient and top-oil temperatures. The menu below shows the selections for ambient and top-oil temperatures as found through the relay's advanced color display:

..\System\Transformer\Thermal Inputs		
Setpoints	Value	Unit
Winding Currents	CT Bank 1-J1	
Ambient Temperature	Monthly Average	
January	-20	°C
February	-20	°C
March	-20	°C
April	7	°C
May	15	°C
June	25	°C
July	30	°C
August	30	°C
September	20	°C
October	17	°C
November	14	°C
December	9	°C
Top-Oil Temperature	Computed	
<<	Status	Thermal
Tap Chan		



In cases where the ambient temperature is not measured directly, the relay offers a table of programmable monthly temperatures used for calculation of the hottest-spot winding temperature. The algorithm has a provision for a directly measured or computed top-oil temperature.

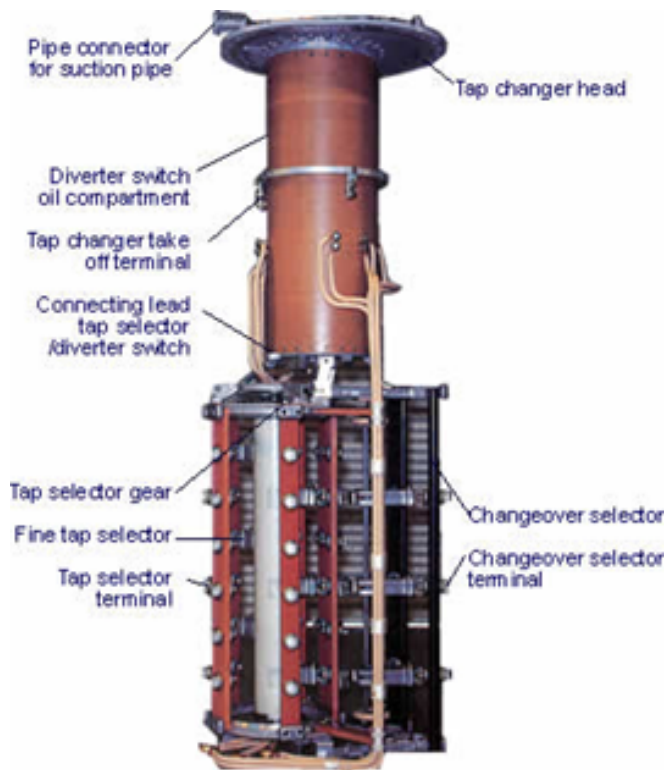
Further, the detection of the hottest-spot winding temperature is used by three monitoring elements to indicate increase of winding temperature, increase of aging factor of the transformer insulation, and loss of transformer life.

...\\Transformer\\Wndg Hottest-Spot ° C		
Item Name	Value	Unit
Function	Disabled	
Pickup	140	° C
Pickup Delay	1	min
Block	Off	
Output Relay X	Do Not Operate	
Events	Enabled	
Targets	Self-Reset	
Hot Spot		

Transformer\Aging Factor		
Item Name	Value	Unit
Function	Disabled	
Pickup	2.0	x CT
Pickup Delay	10	min
Block	Off	
Output Relay X	Do Not Operate	
Events	Enabled	
Targets	Self-Reset	
Ag. Factr		

..Transformer\Loss of Xfmr Life		
Item Name	Value	Unit
Function	Disabled	
Initial Xfmr LOL	0	hrs
Pickup	200000	hrs
Block	Off	
Output Relay X	Do Not Operate	
Events	Enabled	
Targets	Self-Reset	
Loss Life		

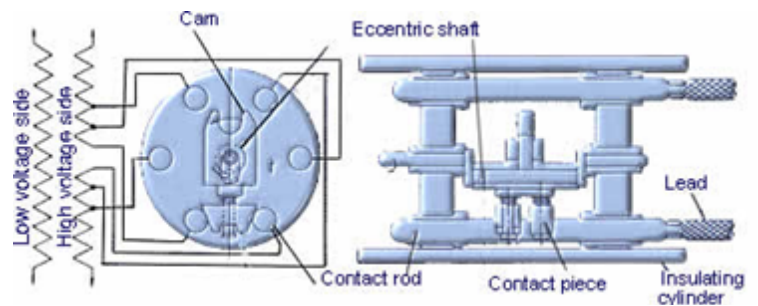
Tap Changer Monitoring and Failure Detection



The transformer tap changer is a vital part of the transformer and needs to be monitored to ensure correct operation.

The Multilin 845 relay offers tap position detection by monitoring either a resistive input from the tap changer control circuitry, a dcmA analog input or by Binary Code Decimals (BCD) inputs. Based on the detected tap, the Multilin 845 relay dynamically corrects the CT and voltage mismatch used for the calculation of differential current by inserting the new voltage transformation ratio into calculations. This provides the user with ability to better define the settings of the percent differential protection characteristic for sensitivity, dependability and security. Thus, the percent differential function of the device can be set with greater sensitivity.

The advancement of the tap position monitoring algorithm makes it suitable for tap detection position of OLTCs installed on either winding of the transformer. Reversing of the tap position with respect to the winding voltage is also implemented.



Harmonics Measurement and Harmonic Derating Factor

Home\..\Harmonic Detection\Harmonic Detection 1		
Item Name	Value	Unit
Function	Disabled	
Signal Input	CT Bank 1 -J1	
Harmonic	2nd	
Pickup	20.0	%
Pickup Delay	0.000	s
Phases for Operation	Any One	
Minimum Oper Current	0.10	x CT
Block	Off	
Output Relays 1 (X)	Do Not Operate	
Events	Enabled	
Targets	Self-Reset	
HarmDet 1		

The presence of harmonic currents in transformers increases the I²R losses, stray losses in the core, clamps and structural parts, and eddy current losses in the windings. Of these losses, the eddy current losses are of most concern since they tend to be proportional to the square of the load current and approximately proportional to the square of frequency, which in turn can cause excessive winding loss and abnormal winding temperature rise in transformers when harmonics are present.

The Multilin 845 relay is capable of measuring up to the 25th harmonic plus THD, which gives the operator a powerful measurement tool for harmonics measurement. Measurements are available remotely via communications protocols, in oscillography, and through the data logger.

When the operator needs to take an action, if excessive harmonics level is present, the Multilin 845 provides six Harmonic Detection elements where harmonics from the 2nd to 5th level plus THD can be individually detected and desired actions can be taken. As an example, this gives the operator the ability to set an alarm if any of these harmonics are present for an extended time.

As per IEEE C57.110-2008, the Harmonic Derating Factor (HDF) is calculated and used to evaluate the load capability of the installed transformer under the non-sinusoidal load currents. Once harmonics were present, the derating factor would decrease from the ideal value of one p.u., which means the load capability is reduced due to harmonics.

The Multilin 845 relay computes HDF using the harmonic content of the current signals and the transformer data. Once the derating factor falls below a set value, the relay will operate accordingly. The derating factor is used to evaluate the load capability of the installed transformer under the non-sinusoidal load currents. Once harmonics are present, the derating factor would decrease from the ideal value of one pu, which would mean decreased transformer loading capability due to harmonics. The relay generates an operand, and turns on the LED "Load-Limit Reduced" when the HDF of any of the windings is less than 0.96, regardless of the element disabled or enabled status.

Home\..\Harmonic Derating\W1 Harmonic Derating		
Item Name	Value	Unit
Function	Disabled	
Minimum Oper Current	0.10	x CT
Pickup	0.90	
Pickup Delay	10	sec
Block	Off	
Output Relay X	Do Not Operate	
Events	Enabled	
Targets	Self-Reset	
W1 HrmFcr		



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