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EXPERIMENTAL DETERMINATION AND ANALYSIS OF TRANSMISSION LINE PERFORMANCE

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Abstract

It is necessary to calculate the voltage, current and power at any point on a transmission line provided the values at one point are known. We are aware that in three phase circuit problems it is sufficient to compute results in one phase and subsequently predict results in the other two phases by exploiting the three phase symmetry. Although the lines are not spaced equilaterally and not transposed, the resulting asymmetry is slight and the phases are considered to be balanced. As such the transmission line calculations are also carried out on per phase basis. For that purpose in the transmission line demo panel we will be designed to –To study the performance of the line.1)e.g. Relation between sending end quantity and receiving end quantity, Ferranti effect, efficiency of power line etc.2) To demonstrate fault clearing process using distance relay(Future Scope)

Introduction

Transmission line performance is governed by its four parameters series resistance, inductance, shunt capacitance and conductance .All these parameters are distributed over the length of the line .The insulation of the line is seldom perfect and leakage currents flow over surface of the insulators especially during bad weather. This leakage is simulated by shunt conductance. The shunt conductance is in parallel with the system capacitance .Generally the leakage currents are small and the shunt conductance is ignored in calculation. Transmission lines may be classified as short, medium and long. In general for high voltage transmission generally above 66KV overhead transmission line the performance of transmission line cannot be easily determined in an efficient way and less cost. even though if we do so then it will cause abnormal operation in our system and also current to go high value. In this paper we have approached a way to find performance of transmission line. We have divided the line into four different sections of a π-network each containing R,L and C. The values of R,L and C are taken as according to the standard approximate values for high voltage transmission. Hence ,we have adopted the 220KV line into per phase basis and made a prototype model of it for single phase.

Methodology

A transmission line model has been prepared on per phase basis having length 400kms and voltage 220kv. Parameters will be considered as lumped. Four stages each representing 100kms are cascaded to make 400kms length. The demo panel consist of digital voltmeter, ammeter, indicating lamps, circuit breakers. The panel is protected by MCB's from abnormal conditions.

A. Transmission Line Model

Transmission line of 400kms, 220kv is modelled with four models. Cascaded each representing 100kms having following parameters.R=4.7Ω,C=0.47µf,L=110mH [2]. With current capacity 1 Ampere.

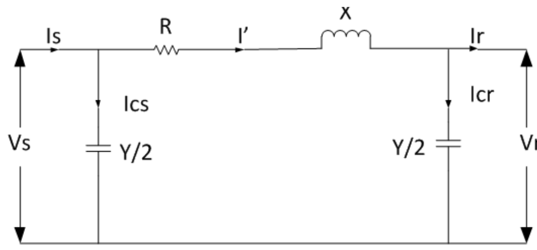

Fig.1:Medium transmission line

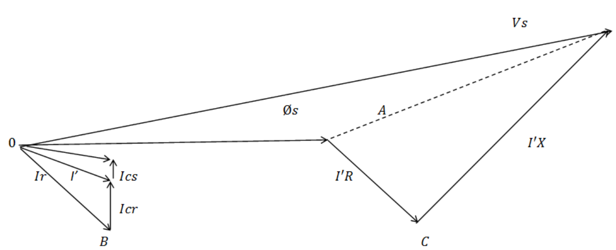

Fig.2:Phasor diagram for nominal π circuit

We have prepared a single phase prototype model to show performance of short, medium and long transmission line. We can select any type of transmission line for analysis just by adding or removing the sections. Each section consists of lumped parameters for 100KM line. The performance of a transmission line such as Ferranti effect and ABCD parameters will be different for different transmission lines.

Fig.3:Actual Photo Of Model

The performance of a transmission line is mainly depend upon its active and reactive parts of power being transmitted through it. This can done by knowing the ABCD parameters. A single phase prototype model can be taken as a two port network. To find the ABCD parameters of a transmission line chosen on our prototype model, we have made an arrangement of microprocessor kit and LCD display to directly indicate the value of short circuit and open circuit parameters which are nothing but ABCD parameters.

Fig.4:Microcontroller kit for ABCD parameters

Circuit Description

The 1-Ph., 230V AC input supply is given though a 6A, DP MCB. The voltage is stepped down with the help of AC Auto transformer. Contactor C1 and C2 acts like circuit breakers at sending and receiving end respectively. The pushbuttons PB1 & PB2 are used to energize coils of contactors C1 and C2 respectively. Indications are also provided by the indication lamps. A transmission line model having the lumped parameters 4.7 ohms, 110 mH, 0.47 μF per phase per 100 Km line length and four π -networks are cascaded for 400Km length. When the supply is switched on with the help of 6A,DP MCB, MAINS ON indication will be given by indicating lamp. When PB1 is pressed, the coil of the contactor C1 gets energized. The NO contact of C1 is used as a hold on contact. Thus the input supply is given to the transmission line model. KIT ON indication is given through indicating lamp. When push button PB3 is pressed, contactor C2 gets energized. The NO contact of C2 is used as a hold on contact. The load gets connected to transmission line and LOAD ON indication is given.

Procedure

A. Procedure for observing Ferranti effect

1) Patch the cords on the panel to have long transmission line model

2) Ensure Dimmer is at zero position.

3) Switch on the supply to the panel.

4) Make MCB ON.

5) Make the switch C1 ON

6) Apply voltage gradually using dimmer. Adjust receiving end voltage to 230V. Observe sending end voltage and sending end current that is Ferranti effect.

7) Now to show, Ferranti effect is only observed on no load or at low load, switch C2 is ON.

8) Put load (one step of 036 kW). Make the one switch of the load bank is ON.

9) Observe receiving end voltage and receiving end current.

B. Procedure for obtaining Ferranti effect

1) Patch the cords for only two sections of the transmission line model (which represents 200km long line).

2) Ensure Dimmer is at zero position.

3) Switch on the supply to the panel.

4) Make MCB ON.

5) Make the switch C1 ON

6) Apply voltage gradually using dimmer. Adjust receiving end voltage to 230V.Observe sending end voltage and sending end current.

7) Compare readings obtain theoretically and practically observe from the panel.

Observations

By observing the readings on LCD display and calculating it we found the tabulations given as follows. We found that both values matched together approximately.

Line condition	**Vs (volts)**	**Is (amp)**	**Vr (volts)**	**Ir (amp)**
Open circuit	220	0.125	230	0
Short circuit	72	0.999	0	1.015

Type of line	**Vs (volts)**	**Is (amp)**	**Vr (volts)**	**Ir (amp)**
Medium Transmission Line	220	0.125	230	0
Long Transmission Line	200	0.249	230	0
With Connected Load	198	0.802	144	0.854
With load terminal shorted	72	0.999	0	1.015

Results

A. For Ferranti Effect

Results	Vs	Is
Theoretically	225.292	0.13445
Practically	220	0.125

B. For ABCD Parameters

Parameter	Theoretically	Practically
A	0.9796	0.9565
B	69.61	70.93
C	0.000584	0.000568
D	0.9796	0.9565

Future Scope (Fault Simulation)

Rotary switches SW1, SW2, and SW3 are used to simulate the phase to each fault at a distance 220kms, 300kms and 400kms from sending end. Fault will be sensed by distance protection. A timer will be started to count the time of fault persists for specific time. FAULT indication will be made on and trip signal will be initiated.

Conclusion

From our project "Transmission Line Performance" we studied the performance of short, medium and long transmission line. Also we studied the Ferranti effect for medium transmission line during no-load or light load condition. In this case receiving end voltage is greater than sending voltage. In short transmission line the effect of shunt capacitance can be ignored and line is designated as short line. In medium and long transmission line the effect of shunt capacitance becomes more and more pronounced with increased in the length of line. In medium transmission line the shunt capacitance can be considered as lumped. By using “Transmission Line Performance” (nominal π circuit) we can easily find out the ABCD Parameters of medium transmission line. The effect of shunt capacitance in long transmission line is greater than medium transmission line. When the line is loaded Ferranti effect will be vanishes. We get receiving end voltage less than sending end voltage. Hence with help of our “Transmission Line performance” We proved practical values equal to theoretical values.

References

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[2] www.lucas-nuelle.com(accessed-sept11,2014)