Logarithmic Damper Tester

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Abstract— The primary task of spacer damper is to maintain the geometry of conductor bundles, within the design limits, under the normal service conditions. It shall withstand the mechanical loads imposed during installation, maintenance and service, including short circuits, without failures and without damaging the conductors. The system is used in industry to test the conductivity and mechanical strength of the spacer dampers so that they can withstand the environmental and electrical conditions where they are used. This paper will present a damping technique for natural damper tester to test and calibrate the neoprene dampers. First, the body of the spacer will be fixed rigidly, a mass will be added to other arm such that the frequency of oscillations will be constant. The arm will be then held at one end and after one minute released. The movement of arm will be recorded for two complete cycles and the peaks of the graph are recorded. In order to make this system, the response of neoprene dampers to natural frequency will be observed and the log of their ratios will be calculated.

Keywords— Logarithmic Damper Tester, Spacer Damper, Neoprene Damper, IS:10162-1982, Mitsubishi PLC, Elipse SCADA, IEC 61854.

INTRODUCTION

Transmission of Electrical Power in bulk for a long distance is done through overhead lines where the power flows through Conductors which are supported by Insulators from Towers. The Conductors are always of stranded type and as the quantum of power goes up, instead of single conductor, bundle conductors are adopted in the same phase viz., twin, triple, quad, hexagonal, octagonal etc[1]. Whenever multi-bundle conductors are used, in order to avoid clashing between sub-conductors and thereby resulting in damage of conductor, Spacer Dampers are deployed to maintain subconductor spacing throughout the run of line as well as to control vibrations on conductors[9]. Conductors are exposed to wind and act as a taut string thereby are subjected to different types of vibration/ oscillatory movements. Mainly following types of vibrations/oscillations may occur depending on surrounding conditions:
1) Aeolian Vibration
2) Sub-span Oscillation
3) Galloping
IS:10162-1982 defines Spacer dampers as mechanical components fitted at specified intervals on transmission lines having more than one sub-conductor per phase to perform all functions of a spacer and in addition control Aeolian vibrations and sub-span oscillations within permissible limits. A spacer damper for transmission line cables comprises of a substantially planar frame and a plurality of clamping arms each resiliently pivotally connected to the planar frame at one end and provided with clamping means for respectively grasping individual conductors at the other end. The frame is of rigid one-piece construction and provided at each region of pivotal connection with a recessed portion into which the end of the arm extends so as to lie substantially in the plane of the frame.Each arm is resiliently pivotally connected to the frame by a pair of spaced resilient energy absorbing elements located on either side of the arm to be traversed by the bolt and lockingly engaged with recesses formed in the arm. Each recessed portion of the frame is provided with at least one end cap, itself provided with a recess for lockingly engaging one of the elements, the end cap being rigidly secured to the frame by the locking bolt so as to straddle the recessed portion, hold the elements in compression and thereby secure the arm for resilient hinged part rotation relative to the frame[2].

DESCRIPTION

The damping characteristic shall be determined as follows. The body of the spacer shall be fixed rigidly, and a mass shall be added to one arm such that the natural frequency of oscillation is between 1 Hz and 2 Hz. The arm shall then be moved to one of the end stops and, after 1 min, suddenly released. The movement of the arm shall be recorded for at least two complete cycles. If the initial swing (from starting position to maximum deflection in the opposite direction) is Y1 and subsequent swings (peak to peak) are Y2, Y3, Y4 the log decrement shall be taken to be equal to

$$\log \frac{1}{2} \left(\frac{Y1}{Y3} + \frac{Y2}{Y4} \right)^{[3]}$$

Acceptance Criteria
The log decrement shall not differ by more than 20 % from the value declared by the supplier and stated on contract drawings[3].
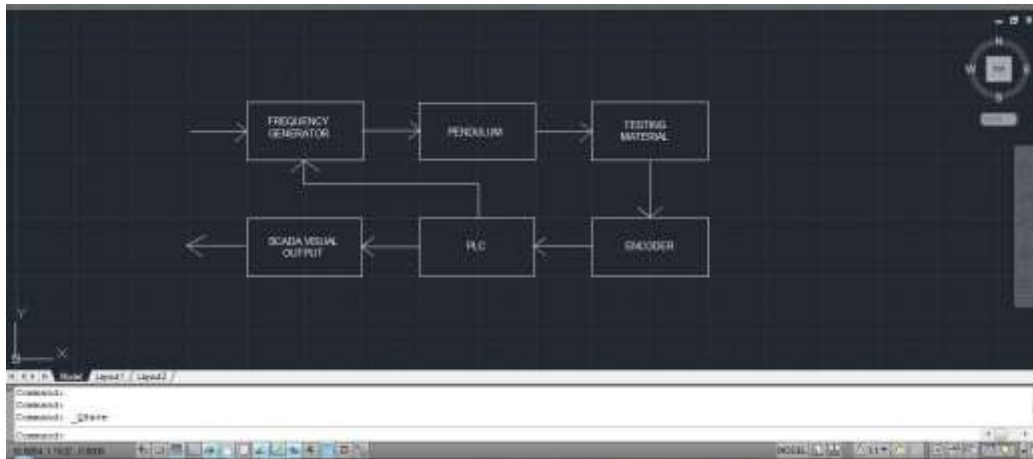
Fig. 1: Block Diagram of the system

HARDWARE DESIGN

Frequency Generator:

Frequency generator is a device which generates a frequency of desired range of 1Hz to 2Hz to test the neoprene damper. Generally a pendulum is used for generation of the frequency. It consists of a valve which turns on the cylinder to hold the pendulum at a position for 60 secs.

Pendulum:

When the pendulum is released from the hold position, it transfers the oscillations to the neoprene damper oscillating at 1Hz to 2Hz and creating critically damped oscillations which in turn gives the peaks and bottoms (p1,p2,b1,b2) which are used for further calculations.

Testing Material:

The material under test is the neoprene damper[10]. The material is tested for its conductivity and mechanical strength. Its one end oscillates with the pendulum and other ends are fixed rigidly to the system body.

Encoder:

The optical type of encoder is used to note the oscillations of the damper material. It checks the maximum positions to both the sides and give the output to the PLC. It is of 4096 ppr[4].

PLC:

PLC used is of Mitsubishi, Fx3Ge-24M model. It has in-built ethernet port which is used for communication with SCADA. PLC takes the output of the encoder which are values of the movement of the damper and checks for the peaks. After checking the peaks it takes the four consecutive peaks from starting, applies the formula and calculates the value[5].

SCADA:

SCADA used is Elipse E3. It is of 75 tags. It uses Ethernet to communicate with PLC. SCADA is basically used to display the graph output of the tester and to give the numeric value of the output. It also manages the whole process. The starting and stopping of the process is done using SCADA[6].

The test bed consists of a mounting plate for the spacer damper, a pendulum which is connected to the clamp of the spacer damper and measuring equipment. The frame of the spacer damper is fixed rigidly on the test bed. The clamp, in its normal position, is connected to the pendulum in its rest position. The fixation of the spacer damper frame to the test machine was done by a bolted strap. The fixation shall be useable for a twin triple and quad bundle spacer damper. The connection between pendulum and clamp is in a way that both parts have the same angle of deflection. On the backside of the test-bed the pendulum and the angle sensor are placed. The pendulum is connected to the front arm of the test bed via an axle. The displacement of the arm can be adjusted via the bolt-strap connection on the front of the test machine. Additionally the mass on the pendulum is adjustable to alter the frequency of the oscillation. The force shall be applied perpendicular to the clamp. When the spacer damper is fixed on the test bed and the clamp is connected to the pendulum, the pendulum is deflected to the maximum angle of the clamp and blocked for 1 min. After 1 min. the pendulum is unlocked and at least the first 4 amplitudes are measured. Due to the damping characteristics of the spacer damper the amplitudes are decreasing. An angle sensor measures the deflection of pendulum (and clamp). This signal gets amplified and further send to an X-Y Plotter to plot the oscillation graph. Alternatively the signals can be recorded by a computer and analysed by a software program. Based on the amplitude of the first 4 half waves the logarithmic decrement can be calculated. Y1. Amplitude of twist on test start Y2. Max. displacement after first zero crossing Y3. Maximum displacement after second zero crossing Y4. Max. displacement after third zero crossing With the values of Y1, Y2, Y3 and Y4 the logarithmic decrement of the spacer damper can be calculated with the formula:

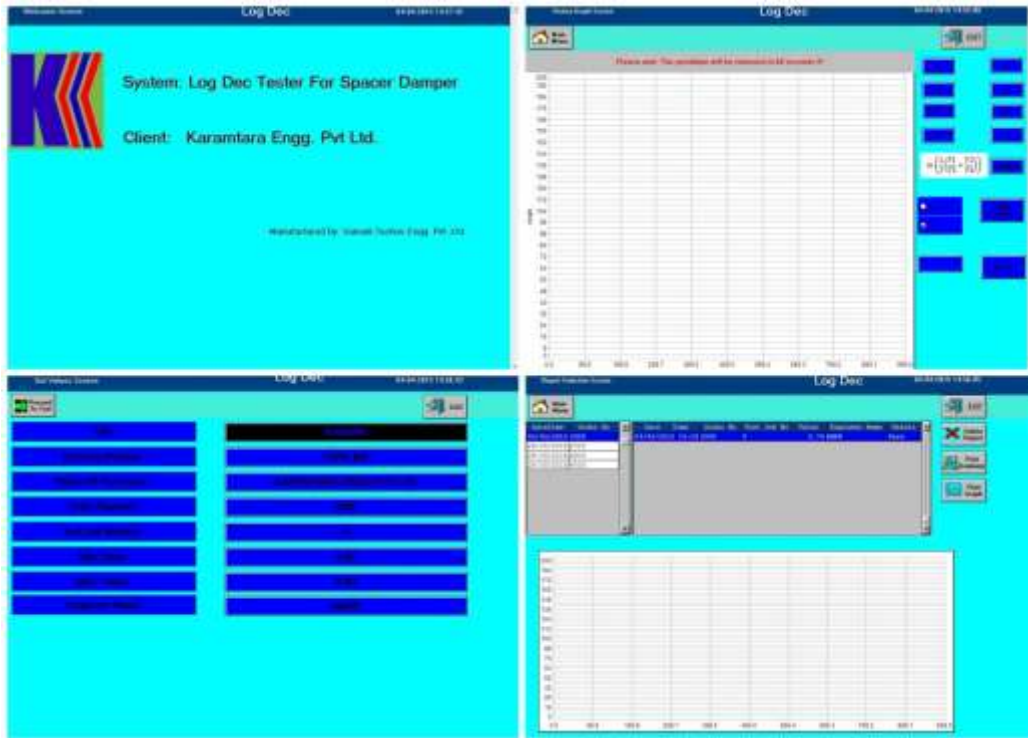$$\log \frac{1}{2}(\frac{Y1}{Y3} + \frac{Y2}{Y4})$$

Fig.2 SCADA screens

SOFTWARE DESIGN

The basic two softwares used in this system are

1) Elipse as SCADA: Elipse SCADA with 75 tags is used in this system. There are four screens for the mentioned system. Screen 1 is the welcome screen which is displayed for 3 secs. It has the clients name, the clients logo, the device name and the manufacturer's name. Screen 2 is set values screen. On this screen we set the title, order no., test job no. and the min and max value is changed according to clients acceptance criteria. Screen 3 is the history graph screen in which we start logging data once pendulum is released and in still position. We display the peak values, final log value, the graph of the job being tested and whether the job is pass or fail. Screen 4 is report selection screen in which we can either print the graph or print the summary or delete the desired report. We can also get the reports from past of particular job. SCADA also calculates the final log value according to the formula mentioned[7,8].

2) GX WORKS2 For PLC programming: This software is specifically used for programming MITSUBISHI PLC. On pressing the proceed to test button in SCADA, the start push button in PLC gets activated and on pressing that button the cylinder gets actuated. The piston of cylinder holds the pendulum for 1 min. After 1 min, the pendulum is released and the PLC starts recording the data from encoder to the PLC registers[11,12].

OBSERVATION

The results are calculated with the help of values drawn from the graph. The values of Y1,Y2,Y3 and Y4 are calculated referring to the graph below as

Y1= peak 1
Y2= peak1-bottom1
Y3= peak2-bottom1
Y4= peak2-bottom2
From the graph we can see
Y1= 139
Y2= 88
Y3= 63
Y4= 44
Putting the values in equation,

$$\log \frac{1}{2}(\frac{Y1}{Y3} + \frac{Y2}{Y4})$$

Test/Analysis	Test 1	Test 2
Output value	0.743448	0.678008
Result	Pass	Fail
Graph	fig 3	fig 4
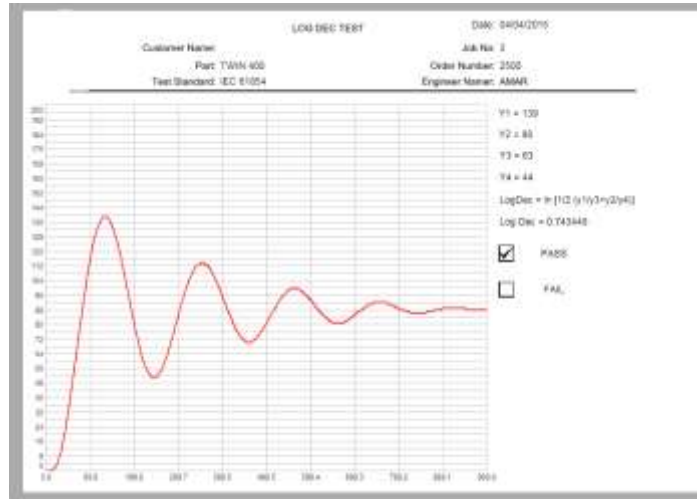
Fig. 3: Resulting graph of a tested job(pass)
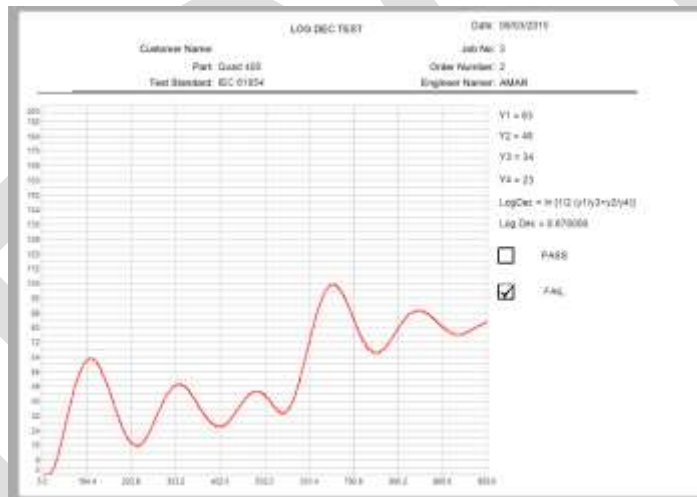
Fig. 4: Resulting graph of a tested job(fail)

ACKNOWLEDGMENT

CONCLUSION

The above mentioned system works according to the discussed standard i.e. IEC 61854 as follows:

The log decrement shall not differ by more than 20% from the value declared by the supplier and stated on contract drawings. The purpose of designing suitable system to test the neoprene dampers has been accomplished successfully. The use of PLC and SCADA has helped in implementation of the system. Parameters of damping can be changed according to the user requirement. The experimental results shows that the system is generating correct results for pass/fail jobs depends on the calculated output value. The system gives accurate damping factor for neoprene dampers, so that they can be used in various environmental and electrical conditions.

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