SURGE AND CARRIER PROPAGATION IN MULTICONDUCTOR CROSSBONDED CABLE SYSTEMS

by

S. THIRUVENGADAM

Thesis submitted to

the Indian Institute of Technology, Delhi

for the award of the Degree of

DOCTOR OF PHILOSOPHY

Department of Electrical Engineering

Indian Institute of Technology, Delhi

November 1974

C E R T I F I C A T E

Certified that the thesis entitled,"Surge and Carrier Propagation in Multiconductor Crossbonded Cable Systems", which is being submitted by Shree S.Thiruvengadam in partial fulfilment for the award of the Degree of Doctor of Philosophy in Electrical Engineering of the Indian Institute of Technology, Delhi is a record of the student's own work carried out by him under my supervision and guidance. The matter embodied in this thesis has not been submitted for the award of any other Degree or Diploma.

(C.S.Indulkar)

Dated 4th Nov 1974

ACKNOWLEDGMENT

The author wishes to express his profound gratitude to Dr.C.S.Indulkar for his invaluable guidance and inspiration in carrying out the work and for his immense help in the preparation of this thesis.

Thanks are due to the authorities of I.I.T.Delhi for providing research facilities and to the staff of the Computer Centre, I.I.T Delhi for their whole-hearted cooperation.

Appreciation is extended to the Calicut Regional Engineering College,Calicut,Kerala and the Ministry of Education Government of India for the award of the scholarship under the Quality Improvement Programme.

(S.Thiruvengadam)

SUMMARY

In this thesis, carrier and surge propagation phenomena in multiconductor crossbonded cable systems are discussed. A new method of analysing non-homogeneous multiconductor systems is presented. The method is applicable to a system in which many identical non-homogeneous multiconductor units are cascaded on an iterative basis. The approach is based on the calculation of matrix iterative admittances and matrix iterative propagation functions of a non-homogeneous unit from the admittance parameters of the unit. Making use of this approach, the two-port admittance matrix of the whole cascade can be obtained in terms of the matrix iterative admittances and matrix propagation functions of a single non-homogeneous unit.

The modified Fourier Transform method which is capable of taking into account the frequency dependence of system parameters and cable losses in a straight-forward manner, is used to compute the transient response of the system. This requires the determination of the Fourier Transform of the excitation function and the frequency characteristics of the system. The latter is determined as discrete function of angular frequency.

In order to gain a clear insight into the phenomenon of transients in a crossbonded cable system, investigations on the effects of a number of parameters on the switching voltage waveforms of the system are conducted. In particular, effects of varying the earth resitivity, the number of major sections, and the upper limit of integration in Fourier integration are considered.

Since crossbonded cable systems are likely to form significant portions of future power transmission systems in congested urban areas as well as in certain special locations, their use as power line carrier links will become necessary. In order to determine suitable coupling arrangements for carrier signals to the crossbonded cable system, the attenuation and velocity characteristics of the system for different coupling arrangements must be known. Such investigations in the carrier frequency range of long and short crossbonded systems have been carried out and the results are reported in this thesis. The means of choosing optimum coupling arrangements at both ends of the system are discussed. It has been found from this study that core-core type of coupling is more advantageous than core-earth coupling. In general, discontinuities at the crossbonding joints cause higher attenuation of carrier signals in crossbonded systems than in non-crossbonded systems.

Some interesting problems like effects of faults, of energisation from the far end of the system, and of earth resistivity on the attenuation characteristics of the system at carrier frequencies are studied and the relevant results are presented.

The effect of using bridging capacitors at the crossbonding joints of the system on the carrier characteristics is also studied. This study has revealed that capacitors at the crossbonding joints have pronounced effect in reducing the overall attenuation in the system, and suitable values of capacitors can reduce the attenuation to a value almost equal to that of a non-crossbonded system. The effect of capacitors on the surge characteristics of the crossbonded cable system is also studied. However, the insertion of capacitors produces only a marginal effect on the transient voltage waveforms of the crossbonded system.

C O N T E N T S