AN ON-LINE TECHNIQUE FOR TALKHA POWER STATION INTERLOCKING USING A TOPOLOGICAL DESCRIPTION

تطبيق طريقة جديدة على تشابك شبكة طلخا الكهربائية مستخدما الوصف الطوبولوجى لها

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الخلاصة – مع زيادة حجم الشبكات الكهربائية واستخدام الجهد العالى فى نقل وتوزيع الطاقة الكهربائية أصبحت مشكلة تحقيق أمان التشغيل للعاملين والأجهزة مطلب أساسى يتحتم تحقيقه بدراسة شروط التشابك فى هذه الشبكات ، وقد بذلت محاولات عديدة فى هذا المجال يعتمد بعضها على استخدام دوائر منطقية لربط المفاتيح والقواطع بشكل يمكن معه تحقيق شروط التشابك واستخدام الحاسب الآلى لتحقيق هذه الشروط أو تمثيل جميع المفاتيح والقواطع بنماذج رياضية معقدة تختلف باختلاف شكل الشبكة . وهدف هذا البحث هو تطبيق طريقة جديدة لتحقيق شروط التشابك فى الشبكات الكهربائية أيا كان شكل الشبكة وعند حدوث توسعات أو تغيرات فى الشبكة لا يستدعى وضع قواعد جديدة للتشابك . وتعتمد هذه الطريقة على الوصف الطوبولوجى للشبكة . كما أنها تمتاز عن الطرق السابقة بامكانية استخدامها لجميع أنواع الشبكات المختلفة . بالاضافة أنها تحتاج الى وقت قصير للوصول للقرار المناسب – بواسطة الحاسب الآلى – الذى يجب اتخاذه لتلافى حدوث أيه أضرار للعاملين أو الأجهزة . كما أنها تمتاز بسهولة استخدامها لمراقبة التشغيل وقلة تكاليفها .

ABSTRACT

This paper presents the appliction of a new interlocking method for Talkha power station using a digital computer. The new method is found to be more efficient, less expensive and more flexible to fit any topological variations that will be happened in future in the networks than the conventioal methods.

1. INTRODUCTION

In the early days of the electricity-supply industry, there was a tendency to rely on the human operator vigilance for performing switching sequences correctly. Almost, only the simplest form of deterrents, such as padlocks, were provided. However, as the complexity and importance of the high voltage main transmission system increases, the human operator vigilance alone will not be sufficient for performing the switchgear operations. So, it is important to use some form of interlocking.

As regards the interlocking, there is a policy of complete interlocking in which every contingency is covered and the reliance on the human operator vigilance no longer exist. The interlocking arrangements used in this method may be electrical, electronic, mechanichal, or pneumatic. The construction of such arrangements is based on a number of rules which can be easily understood by using interlocks algebra [3]. However, these interlocking arrangements are very expensive and it is too difficult to modify to follow any variations in the network configuration. Moreover, if a scheme fails the operator could, from former attitudes, be unthinking about an operation it was performing and cause a system fault.

This paper presents the application of a new method of interlocking using the digital computer. This method uses the topological state of the power system which is stored in the computer as a hierarchically structured data base to perform the interlocking and fast on-line topology processing is carried out. So, this method can be applied with more flexiability and any changes in the system configuration can be incorporated more easily. The new method is applied to Talkha power station and the results are presented.

2. TOPOLOGICAL DESCRIPTION OF POWER SYSTEM [5]

For a description the following notation of a full object descriptor, consisting of the parts: *LOCAL*, *NUMERAL*, *PARTIAL* and *SPECIES*, is defined:

'''ABCDE ''12345 'ABCDEFGH [ABCDEFGH]

or for short:

'''L ''N 'P [S]

In the chained form all species of one partial reside in one common bracket; for the stock description their sequence is irrelevant. This degree of freedom, together with the assignment of topological properties to species, is used to design a *syntactical* notation of potential *field topologies*. Connections to objects *outside of the field* (partial) are described by *references*. For that aim the species are classified according to Fig. 1. The class (1 or 2) of the species as well as their further topological properties are seen from their names and can also be derived from their numbers. Species designated for bearing a reference have to be assigned a data element of appropriate length in the dictionary.

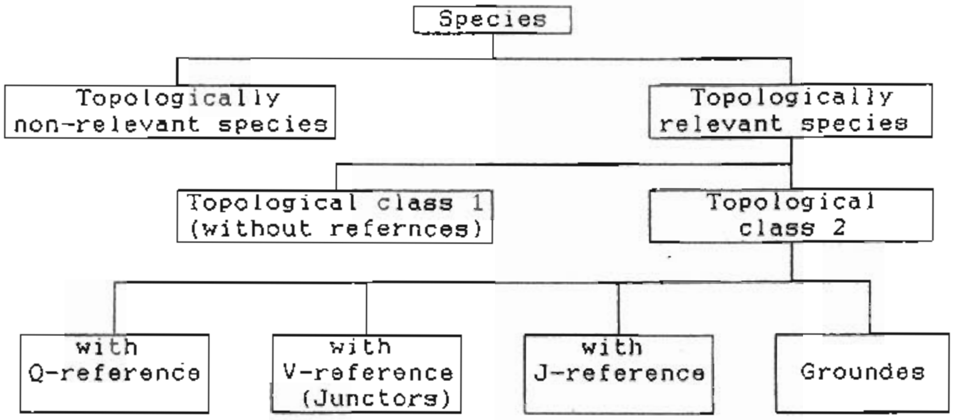

Fig. 1 *Topological classification of species*

2.1 References

Referencing is done from two sides, i.e. from object A to object B and from object B to object A. There are three types of references available:
The *Q-reference* consists of the full descriptor of the next connected (2) which is enclosed by round brackets and attached to the species- (1)- name:

$'''L_1\ ''N_1\ 'P_1\ [S_1\ /Q\ ('''L_2\ ''N_2\ 'P_2\ [S_2]),\ldots.]$

The *V-reference* can refer to a plurality of objects (2,3,4..) in *the same numeral package*. V-references are exclusively assigned to 32 standard species which are called JUN for "Junctor". These are especially useful in describing busbar segments. This reference has the form:

$'''L_1\ ''N_1\ 'P_1\ (JUn13/V\ ('P_2\ [S_2]'P_3\ [S_3]'P_4\ [S_4]\ \ldots..)\ldots.)$

The *J-reference* is referring from an object to a junctor in *the same numeral package*. As the junctors are numbered and the number is not allowed to be duplicated in one numeral package, it is sufficient to mention the junctor number in the topological addition of the species name, e.g.:

ISO 1 /J31, ISO3/J2

2.2 Syntactical Topology Description

The following rules apply to the sequence of species within one partial package [2].

- A sequence of topologically relevant species forms an association, which is limited by topologically non-relevant absolute species or the brackets in the partial package. Intercalated relative species are not concerned.
- Class 1 Species bind to the next class 1 Species preceding and/or following in the association. Intercalated class 2 or relative species are not concerned.
- One or more class 2 Species stated in sequence from a band which is limited by class 1 species or the limits of the association. Class 2 species bind to all species of their band as well as to the next class 1 Species preceding and/or following. Intercalated relative species are not concerned.

By these rules a chain of series connected switches of any length can be described, allowing for a one-step fan-out of any number of switched branches at the beginning, end, and all intermediate points of the chain (see Fig. 2). This structure is sufficient to cover most of the practical field configurations. Seldom appearing, fan-outs of more than one step require the use of 2 standard-species *BOPE*= Bracket-open and *BCLO*= Bracket-close, which mimick the structure of the mathematical bracket-operations, thus extending the syntax to cover any topological tree structure. Very rarely occuring meshes within fields (partials) have to be closed by applying references.

The facilities of the topological description are further enriched by standard species depicting fixed connections (PEC/Q, CON/J), and disconnections with (SEPAR) and without (SEPOT) isolating capability.

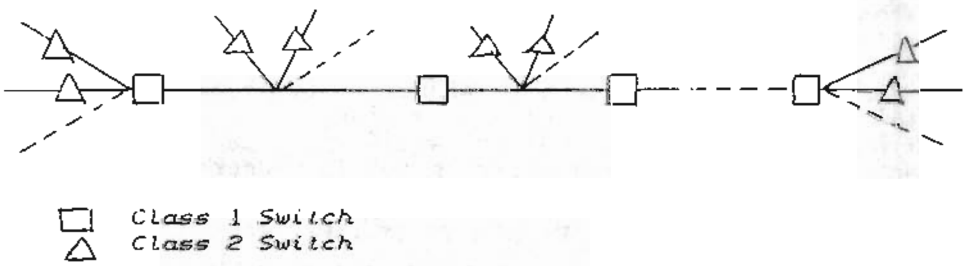

Fig. 2 *Maximal structure depictable by syntax without "BOPE" and "BCLO"*

3. DESCRIPTION OF THE NEW TECHNIQUE

A full description of the method is given by Abd-Raboh [8] and can be summarized in the following. The topology description of the system can be derived as defined and commented by Rumpel [5]. This description has the facilities of declaring operational objects and describing their topological connections, their states, properties as well as the operational processes. The structure of the new topology is deduced from the operational terminology of utilities, nations and abberviated names. This toplogy can also be derived from the special operational terminology of one utility. It is so formalized that it can be translated into data sets on machine-level applying general rules.

The derived topology allows the effective search for "through connections" which only contains the outside connections of the power station part under consideration to further parts of the Unified Egyptian Power System. The basic rules for the interlocking system (8) have been transformed into two decisions. One is "Old through-connection" (before using the switch unit) and the other one is "New through-connection" (after using it). In advance; of sending a switch command, for example:

LSWI = ON

where LSWI = Line-Switch, through the computer by means of the power station description and according to the state of the circuits, tests, whether the basic rules have been observed or not. According to the result of the interlocking test the operator receives the message: *"Clear Switch Command"* or *"Block Switch Command"* with additional identification of the blocking reasons. For example: *it is not allowed for LSWI = ON due to the connection of the earth.*

4. PRACTICAL APPLICATION

The new method is applied to Talkha power station for which the single line diagram is shown in Fig. 3. The topological description of Talkha power station is shown in table 1. A FORTRAN Seventy-Seven program has been written to perform both the Field interlocking (Tanta) and the station interlocking (Talkha). The running time of the program on the computer ATARI 1040 ST^{F} is found to be 0.14 second for Field-interlocking (Tanta) while for the Station-interlocking it is found to be 0.6 second (Talkha).

5. CONCLUSIONS

This paper presents a method for Talkha power station interlocking using a digital computer. By using this method, there is no constraints imposed upon the new topological technique as in the case of using conventional techniques.

It is possible to modify the computer interlocking and topology description to fit any variation in the networks configuration. In addition, all the conventional techniques were hardware based and requires very expensive apparatus and instrumentation, while the new topological technique presented in this paper is software based. This fact makes the new technique, in addition to be more efficient, less expensive.

6. REFERENCES

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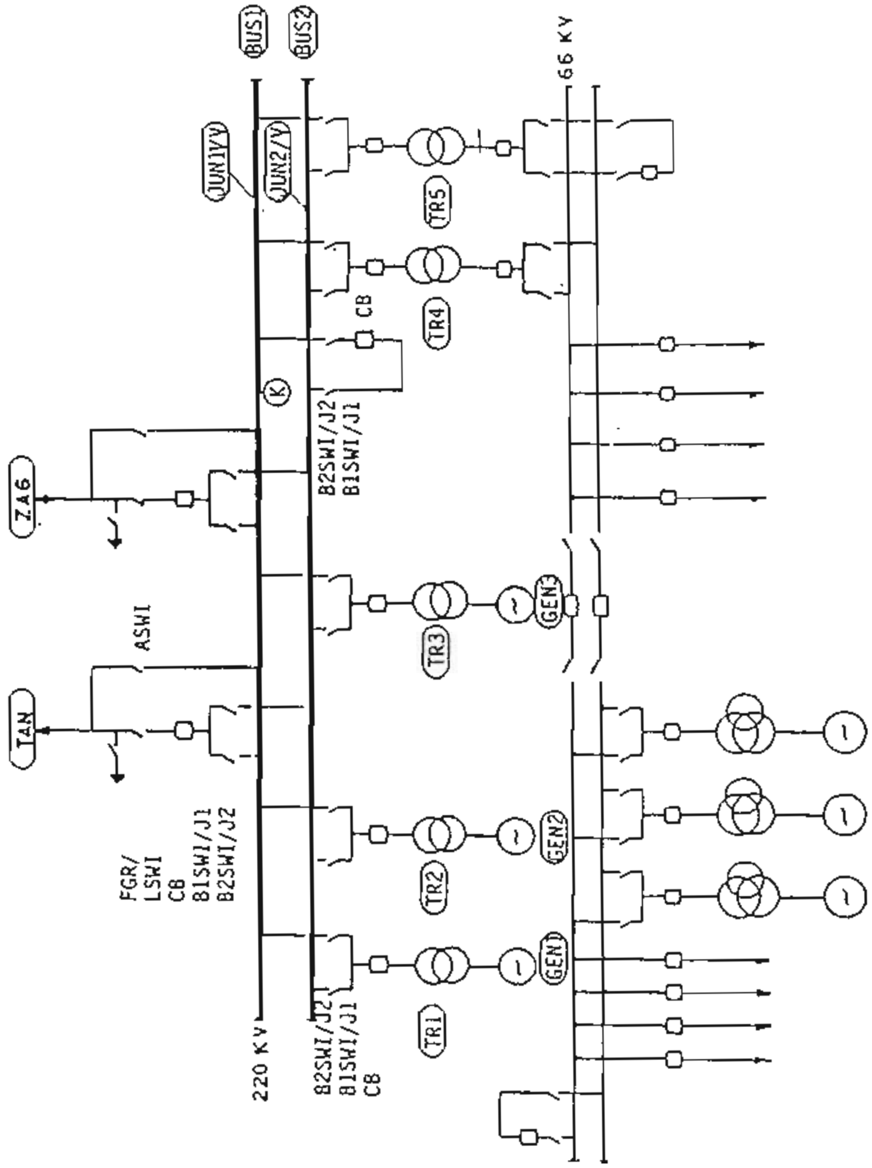

Fig. 3 Single line diagram of Talkha power station.

Table 1 : Topological description of Talkha power station

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'''TALKA
''220
 'BUS1[JUN11/V('TAN[B1SWI/J11]'TAN[ASWI/J11]'ZAG[B1SWI/J11]
              'ZAG[ASWI/J11]'TR1[B1SWI/J11]'TR2[B1SWI/J11]
              'TR3[B1SWI/J11]'TR4[B1SWI/J11]'TR5[B1SWI/J11]
              'K[B1SWI/J11]))]
 'BUS2[JUN2/V('TAN[B2SWI/J2]'ZAG[B2SWI/J2]'TR1[B2SWI/J2]
              'TR2[B2SWI/J2]'TR3[B2SWI/J2]'TR4[B2SWI/J2]
              'TR5[B2SWI/J2]'K[B2SWI/J2]))]
 'TAN[X220/Q('''TANTA''220'TAL[PEC/Q]),ASWI/J11]
 'ZAG[X220/Q('''ZAGZI''220'TAL[PEC/Q]),ASWI/J11]
 'TR1[B1SWI/J11,B2SWI/J2,CB*R,PEC/Q('''TALKA''1'TR1[PEC1/Q]))]
 'TR2[B1SWI/J11,B2SWI/J2,CB*R,PEC/Q('''TALKA''1'TR2[PEC1/Q]))]
 'TR3[B1SWI/J11,B2SWI/J2,CB*R,PEC/Q('''TALKA''1'TR3[PEC1/Q]))]
 'TR4[B1SWI/J11,B2SWI/J2,CB*R,PEC/Q('''TALKA''1'TR4[PEC1/Q]))]
 'TR5[B1SWI/J11,B2SWI/J2,CB*R,PEC/Q('''TALKA''1'TR5[PEC1/Q]))]
 'K[B1SWI/J11,CB*R,B2SWI/J2]
''1
 'TR1[PEC1/Q('''TALKA''220'TR1[PEC/Q]),TRDAT,
      PEC2/Q('''TALKA''11'GEN1[PEC/Q]))]
 'TR2[PEC1/Q('''TALKA''220'TR2[PEC/Q]),TRDAT,
      PEC2/Q('''TALKA''11'GEN2[PEC/Q]))]
 'TR3[PEC1/Q('''TALKA''220'TR3[PEC/Q]),TRDAT,
      PEC2/Q('''TALKA''11'GEN3[PEC/Q]))]
 'TR4[PEC1/Q('''TALKA''220'TR4[PEC/Q]),TRDAT,
      PEC2/Q(<------66KV------>))]
 'TR5[PEC1/Q('''TALKA''220'TR5[PEC/Q]),TRDAT,
      PEC2/Q(<------66KV------>))]
''11
 'GEN1[PEC/Q('''TALKA''1'TR1[PEC2/Q]),GENDAT]
 'GEN2[PEC/Q('''TALKA''1'TR2[PEC2/Q]),GENDAT]
.....'GEN3[PEC/Q('''TALKA''1'TR3[PEC2/Q]),GENDAT]
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