



PS1 – Poster-17



Definition of the Damaged Feeder and Place of Single Phase to Ground Fault in a Network with the Isolated Neutral

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KEYWORDS

Single phase to ground fault, a damaged feeder, a isolated neutral, a zero sequence.

1 INTRODUCTION

Now phase definition place to phase fault on transmission line in all networks is made with enough accuracy – less than 5 % [1], but the place of single phase to ground fault in networks with the isolated and compensated neutral not always can be calculated by means of universal algorithms and devices [2]. For such networks it is developed and made many devices (for example, КБАХТ, Бреслер-0107.080, ОМЗЛ, СИИУС-ОЗЗ etc.). However by means of the device to define a place damages it is possible or at movement lengthways transmission line – КБАХТ, or it is possible to define only the damaged feeder - Бреслер-0107.080, СИИУС-ОЗЗ, or to reveal place damages by inclusion of the intact phase for a while nearby 150 мс and creations thus "loops" double single phase to ground fault (or phase to phase fault) – ОМЗЛ.

2 THE BASIC PART

2.1 Purpose

For the purpose of simplification of definition of the damaged feeder and search of place damages single phase to ground fault the algorithm of definition of the damaged feeder and search of a place of single phase to ground fault in a network with the isolated neutral [3, 4] is offered.

2.2 Theory

The algorithm essence consists in the following: in a normal mode periodically do artificial ОЗЗ (a **fig. 1**) and remember currents of zero sequence of each line - I_{C1} , I_{C2} , ..., I_{Cn} , which can be calculated also in conformity [5]

$$\begin{aligned} I_{C1} &= j 3 \omega C_{\pi 1} E_{\phi}, \\ I_{C2} &= j 3 \omega C_{\pi 2} E_{\phi}, \\ &\dots\dots\dots, \\ I_{Cn} &= j 3 \omega C_{\pi n} E_{\phi}, \end{aligned} \tag{1}$$

or by means of specific parameters transmission line thus:

$$\begin{aligned}
 I_{Cn} &= 3 \omega C_{y\partial n} l_{\mathcal{L}n} U_{\Phi} = I_{y\partial n} l_{\mathcal{L}n}, \\
 &\dots\dots\dots, \\
 I_{C2} &= 3 \omega C_{y\partial 2} l_{\mathcal{L}2} U_{\Phi} = I_{y\partial 2} l_{\mathcal{L}2}, \\
 I_{C1} &= 3 \omega C_{y\partial 1} l_{\mathcal{L}1} U_{\Phi} = I_{y\partial 1} l_{\mathcal{L}1}.
 \end{aligned}
 \tag{2}$$

where $C_{y\partial n}, \dots, C_{y\partial 2}, C_{y\partial 1}$ - specific capacities of n-th, ... the second, first lines [mF/km]; $I_{y\partial n}, \dots, I_{y\partial 2}, I_{y\partial 1}$ - specific currents of n-th, ... the second, first lines [A/km]; $l_{\mathcal{L}n}, \dots, l_{\mathcal{L}2}, l_{\mathcal{L}1}$ - lengths of n-th, ... the second, first lines [km].

In spite of the fact that we can calculate currents of zero sequence each transmission line, it is necessary to do measurement at artificial single phase to ground fault because parameters and a network configuration can change.

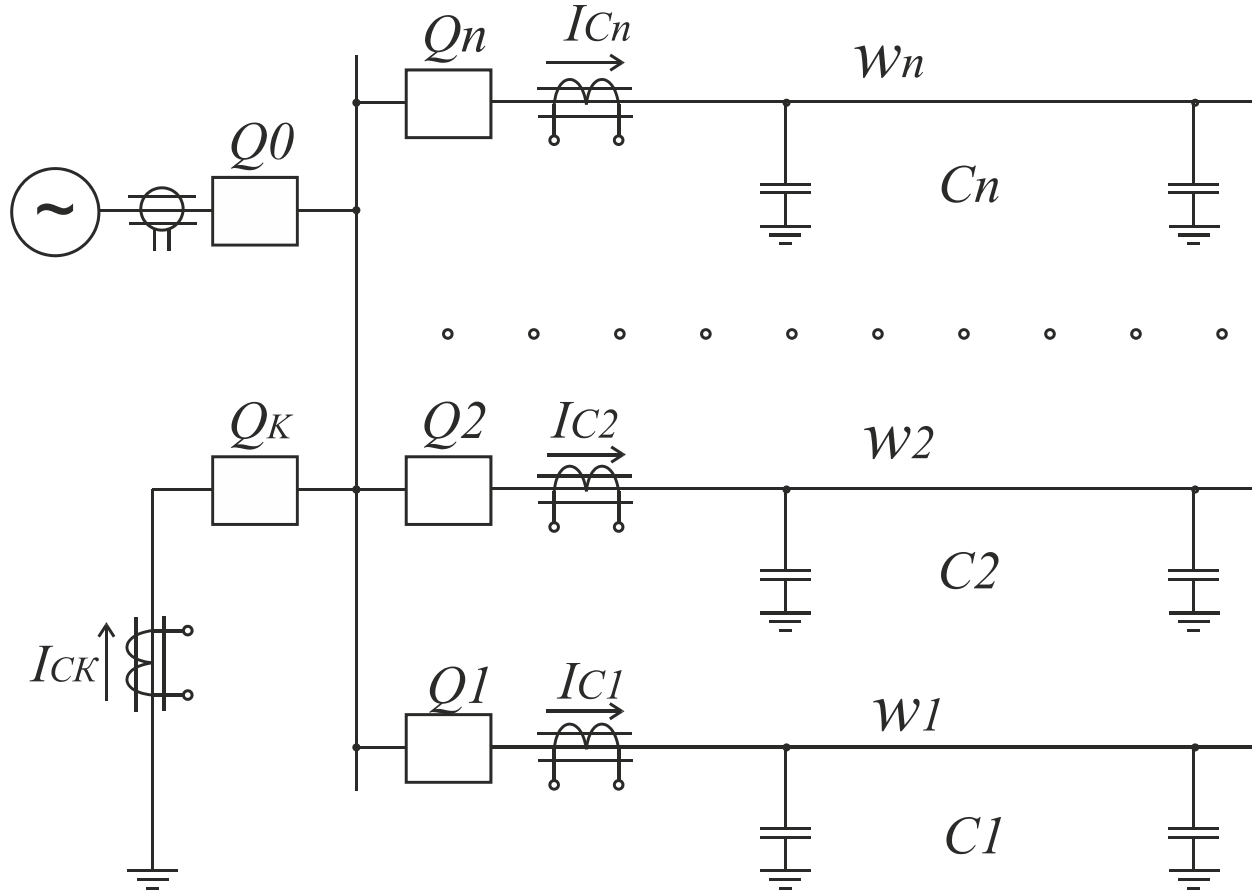


Fig. 1: Network with a key for artificial single phase to ground fault

At occurrence single phase to ground fault (a fig. 2), w_1 the current is equal in the damaged line:

$$I_{3I} = I_{Cn} + \dots + I_{C2} + I_{C1} - I_{C1.2} = I_{Cn} + \dots + I_{C2} + I_{C1.1}. \tag{3}$$

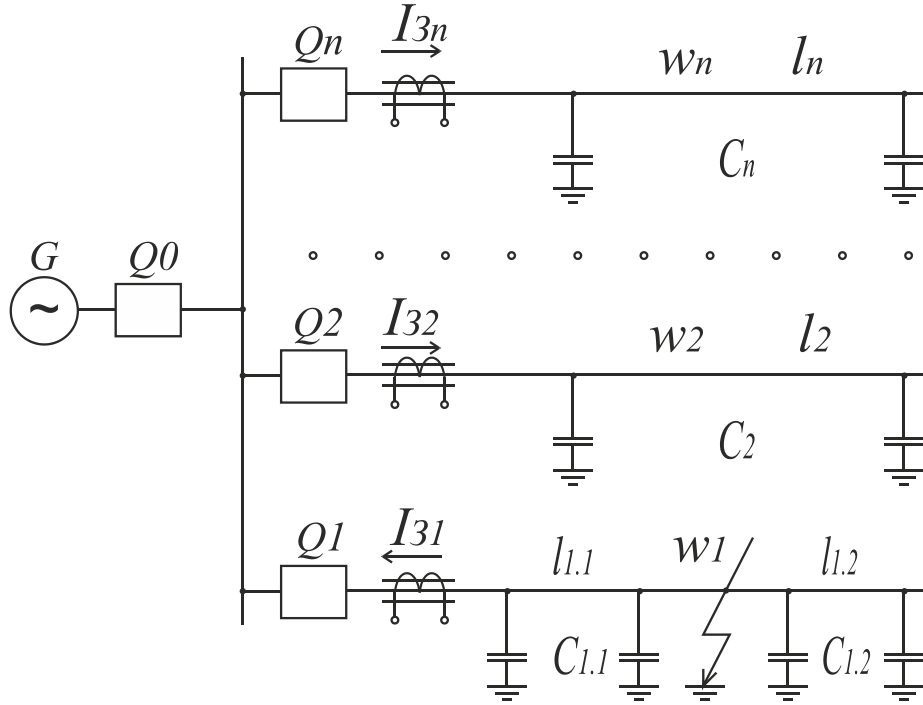


Fig. 2: Network with single phase to ground fault on a line w_1

Knowing own capacitor current of a line w_1 and a total capacitor current of a network

$$I_{C\Sigma} = I_{Cn} + \dots + I_{C2} + I_{C1}, \quad (4)$$

let's find a difference between a total capacitor current of a network and a current of the damaged line

$$I_{C\Sigma} - I_{31} = (I_{Cn} + \dots + I_{C2} + I_{C1}) - (I_{Cn} + \dots + I_{C2} + I_{C1.1}) = I_{C1} - I_{C1.1} \quad (5)$$

As single phase to ground fault divides a line w_1 on two parts $l_{1.1}$ and $l_{1.2}$, and their capacities are proportional to distances, considering it

$$I_{C1} = I_{C1.1} + I_{C1.2} \quad (6)$$

rewrite (5):

$$I_{C\Sigma} - I_{31} = I_{C1} - I_{C1.1} = I_{C1.2} \quad (7)$$

Having divided the received result on $3 \omega C_{y\partial 1} \cdot U_\phi$, we will receive:

$$\frac{I_{C\Sigma} - I_{31}}{3 \omega \cdot C_{y\partial 1} \cdot U_\phi} = \frac{I_{C1.2}}{3 \omega \cdot C_{y\partial 1} \cdot U_\phi} = \frac{3 \omega \cdot C_{y\partial 1} \cdot l_{C1.2} \cdot U_\phi}{3 \omega \cdot C_{y\partial 1} \cdot U_\phi} = l_{1.2} \quad (8)$$

or it is possible to divide on $I_{y\partial 1}$, but as required that the line is homogeneous, i.e. has identical cable transmission line or aerial line with identical sections along all line:

$$\frac{I_{C\Sigma} - I_{31}}{I_{y\partial 1}} = \frac{I_{C1.2}}{I_{y\partial 1}} = \frac{I_{y\partial 1} \cdot l_{C1.2}}{I_{y\partial 1}} = l_{1.2} \quad (9)$$

Thus on the offered algorithm [3, 4] it is possible to define a place damage or distance from the line end w_1 to place single phase to ground fault or from the beginning. However, it is necessary to notice that periodic artificial single phase to ground fault is a lack of such way.

2.3 Algorithm realization

On fig. 3 device the block diagram of the is presented for networks of the isolated neutral at performance on the rigid logic for definition of the damaged feeder and a place of single phase to ground fault.

On scheme: Q1, Q2, ..., Qn, K – switchers 1, 2, ..., n - ro and k-th feeders accordingly; ПТ1, ПТ2, ..., ПТn, ПТk – converters of a current 1, 2, ..., n - ro feeders accordingly; B1.1, B1.2, ..., B1.n and B2.1, B2.2, ..., B2.n the first and second subtractors 1, 2, ..., n-th feeders accordingly; П1.1,

$\Pi 1.2, \dots, \Pi 1.n, \Pi 1.k$ and $\Pi 2.1, \Pi 2.2, \dots, \Pi 2.n$ – the first and second memories 1, 2, ..., n-th feeders accordingly; $K1, K2, \dots, Kn$ – comparators 1, 2, ..., n-th feeders accordingly, $O1, O2, \dots, On$ – determinants of distance 1, 2, ..., n-th feeders accordingly; $I1, I2, \dots, In$ – indicators 1, 2, ..., n-th feeders accordingly; $\Gamma\Pi\Pi$ – the generator of periodic impulses; OR – a logic element "OR".

The device works as follows. With the certain period of $\Gamma\Pi\Pi$ gives a command for switch single phase to ground fault, to which does artificial short circuit of one phase (on the scheme "A"). Periodicity depends on frequency of change of parameters of the scheme.

If the scheme is stable and changes seasonally also switch single phase to ground fault, to occurs once a month or a season. Short circuit occurs practically on tires, in a short circuit point the total current of network I_{C2} proceeds, and in the transformer of a current of zero sequence each joining corresponding currents $I_{C1}, I_{C2}, \dots, I_{Cn}$.

At single phase to ground fault the command on memories $\Pi 1.1, \Pi 1.2, \dots, \Pi 1.n$ and $\Pi 1.k$ to remember corresponding currents $I_{C1}, I_{C2}, \dots, I_{Cn}$ и I_{C2} .

In a normal work (in the absence of single phase to ground fault) currents from converters of current $\Pi T1, \Pi T2, \dots, \Pi Tn, \Pi Tk$ doesn't arrive, therefore on subtractors $B1.1, B1.2, \dots, B1.n$ is present the negative size and any of comparators $K1, K2, \dots, Kn$ doesn't work.

In a mode of occurrence single phase to ground fault on 1-st feeder. On the intact lines own capacitor current $I_{C2}, \dots, I_{Cn}$, thus on corresponding exits of comparators there will be "zero". On the damaged feeder on an exit subtracter $B1.1$ there will be a size

$$I_{B1.1} = I_{31} - I_{C1} = I_{Cn} + \dots + I_{C2} + I_{C1.1} - I_{C1} >> 0, \quad (10)$$

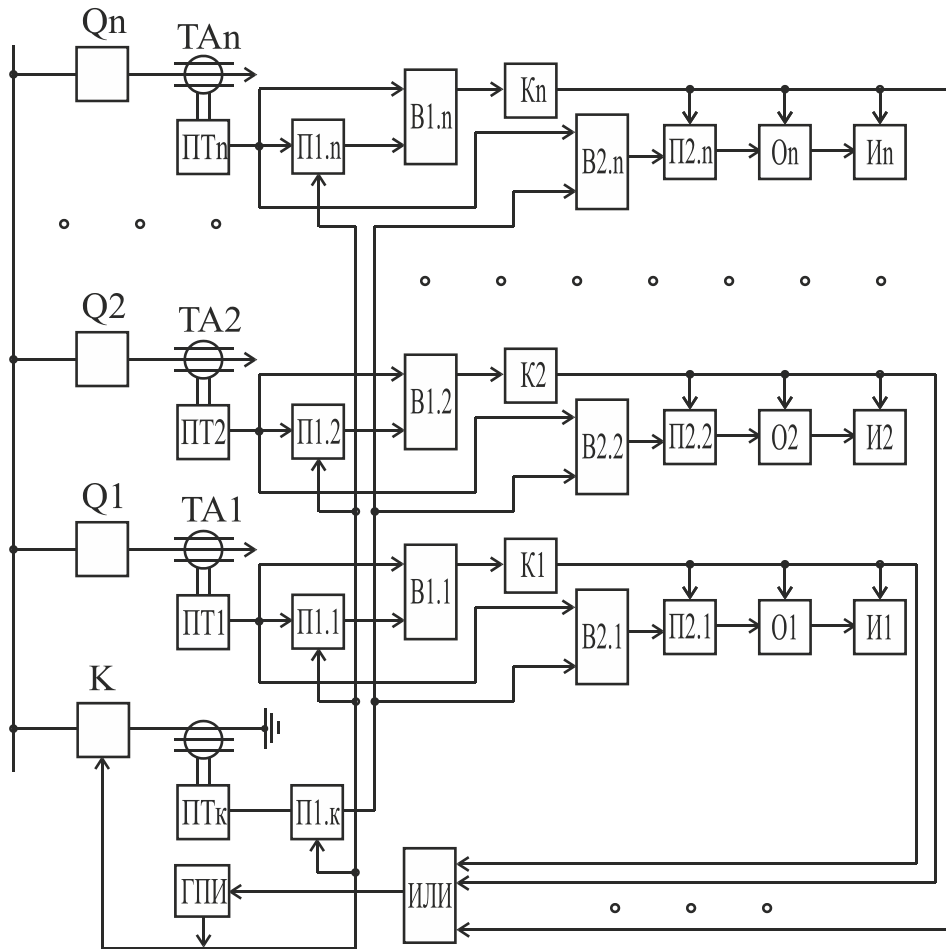


Fig. 3: Block diagram of the device for definition of the damaged feeder and place single phase to ground fault

That there is more size отстройки comparator K1, therefore it works, gives a command to memory П2.1, a determinant of distance O1 and indicator И1. In memory П2.1 the size according to (7) remains:

$$I_{III.1} = I_{BI.1} = I_{C\Sigma} - I_{3I} = I_{CI} - I_{CI.1} = I_{CI.2} \quad (11)$$

The determinant of distance O1 scales current $I_{CI.2}$ in соответствии with specific I_{yDI} a current of the given line:

$$L_{OI} = I_{CI.2} / I_{yDI} = L_{LI.2} \quad (12)$$

And on indicator И1 of the damaged line the distance from the end of a line to a damage place will be displayed.

3 CONCLUSION

1. The device on the offered algorithm defines the damaged feeder.
2. For networks with the isolated neutral the device calculates place single phase to ground fault .
3. A lack of such way it is necessary to note periodic artificial single phase to ground fault.

REFERENCES

- [1] Шалыт Г.М., Айзенфельд А.И., Малый А.С. Определение мест повреждения линий электропередачи по параметрам аварийного режима – М.: Энергоатомиздат, 1983.-208 с
- [2] Арцишевский Я.Л. Определение мест повреждений линий электропередачи в сетях с изолированной нейтралью. –М.: Высш. Шк.,1989.-87 с
- [3] Пат. № 2174690 РФ, МПК G01R 31/08, 3/38, Способ определения поврежденного присоединения и места однофазного замыкания в сети с изолированной нейтралью / Авданин В.В., Никитин К.И., Тупуреин В.Ю. Заявлено 28.09.99; Опубл. 10.10.2001, Бюл. № 28. – 4 с.: ил
- [4] Положительное решение на выдачу патента по заявке №2009111640/28(015902), МПК G01R 31/08, Адаптивный способ определения поврежденного присоединения и места однофазного замыкания в сети с изолированной нейтралью / Никитин К.И. Заявлено 30.03.2009
- [5] Шуин В.А., Гусенков А.В. Защиты от замыканий на землю в электрических сетях 6-10 кВ. – М.НТФ «Энергопрогресс», 2001. – 104 с.; ил. [Библиотечка электротехника, приложение к журналу «Энергетик»; Вып. 11(35)]