ELECTRONICS AND ELECTRICAL ENGINEERING
ISSN 1392 – 1215 2009. No. 6(94)
ELEKTRONIKA IR ELEKTROTECHNIKA

SIGNAL TECHNOLOGY
T121
SIGNALŲ TECHNOLOGIJA

Inertia (slowness) of Zero Order Components Filter

U. Jakšić, N. Marković
Advanced Polytechnic School of skilled studies Zvečan
B. Nušića Street No. 6, Zvečan, Serbia,381-64-3360633, uros_jaksic@yahoo.com,
381-63-1898000, nen.mark@sezampro.yu
S. Bjelić
Faculty of Technical sciences Kosovska Mitrovica
K. Miloša Street No. 7, Kosovska Mitrovica, Serbia, 381-63-8822492, slobodan_bjelic@yahoo.com

Introduction

Performance time of initial element is included in performance time of relay, which means that time depends of used filters inertia of inverse order components. According to definition, inertia time t_y, presents time of establishing of amplitude on frequency signal [1].

Classic symmetric components filters consisted of relative elements in the form of passive four-end geometric figures that have frequency depending transient characteristic and are described by the width of pass-band $\Delta f_{0,7}$, [1]. However, determination of t_y by known relation $t_y = 1/\Delta f_{0,7}$ has sense only if the construction of their frequency characteristics is necessary.

Time inertia influences the most on duration of its own transient filter process. Determination of inertia of different filter type, as is given in [1], is possible according to character of transient process and calculated time constants. In addition are given methods and results of analysis of voltage inverse order group filters. This procedure can be applied to general filters of asymmetric components, as is shown on [1].

Methods of voltage inverse order group filters

Current through resistant R of inverse order voltage filters can, according to theory of four-end geometric figure, be determined by given operational form:

$$I(p) = \frac{U_{o.c.}(p)}{Z_{kF}(p) + R}, \qquad (1)$$

where $U_{o.c.}(p)$ – open circuit voltage (idle time), $Z_{kF}(p)$ – operation impedance of short circuit, determined on the side of outgoing ends of filter in short circuited entering ends-internal impedance.

Open circuit voltage is calculated according to:

$$U_{o.c.}(p) = \sum K(p) U_{mf}(p) = \frac{U(p)}{M(p)N(p)}, \qquad (2)$$

where $K(p)$ – transfer coefficient, $U_{mf}(p)$ – sized to k – branch of filer inter-phase voltage, $M(p)N(p)$ – polynomial value determined by transformation of input value.

Denominator in expression (1) is determined according to:

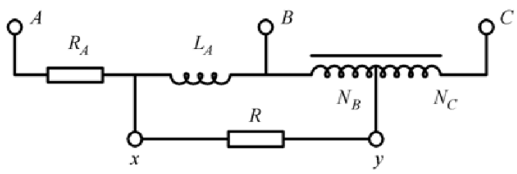
$$Z_{kF}(p) + R = \frac{Q(p)}{N(p)} + R = \frac{Z(p)}{N(p)}. \qquad (3)$$

If (2) and (3) are replaced in (1), the following form is obtained:

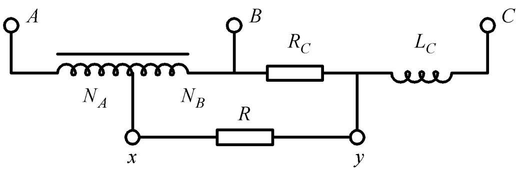
$$I(p) = \frac{U(p)}{M(p)Z(p)}. \qquad (4)$$

Character of its own transient filter process and its time constants are determined according to $Z(p) = 0$.

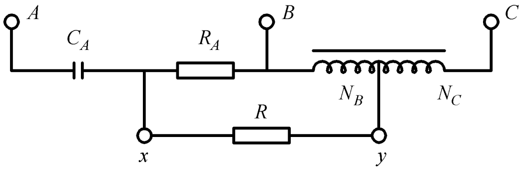
In that way, operational impedance of short circuit must be determined for each analysed filter, and further, according to (3) must be determined characteristic equation. During determination of short circuit impedance was assumed that reactive filter elements are ideal and have no losses. For capacitors this assumption is reasonable. In additional analysis also is included assumption that transformers and autotransformers are without loss, so the schemes and general relations are used in that sense.



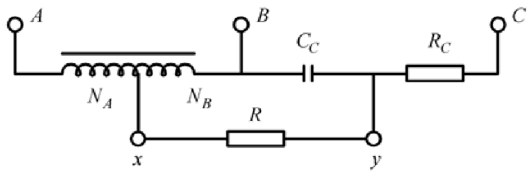
a)



b)



c)

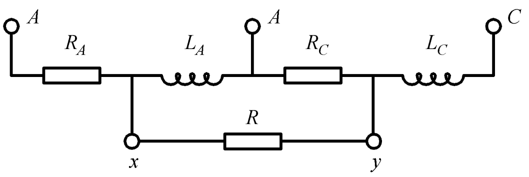


d)

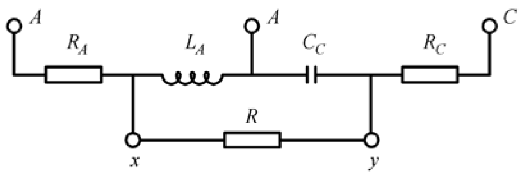
Fig. 1. Filter types

Table 1. Filter parameters

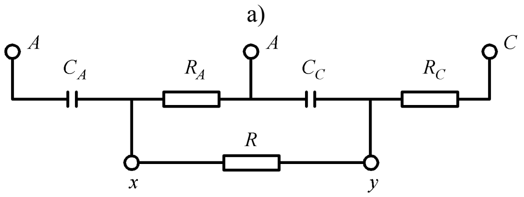
Filter type		Group *a)* Fig. 1., *a*	Group *b)* Fig. 1., *b*	Group *c)* Fig. 1., *c*	Group *d)* Fig. 1., *d*
Filter parameters		$R_A=\frac{\sqrt{3}}{2}$, $L_A=\frac{1}{2}\omega$ $\frac{N_B}{\sum N}=\frac{1}{2}$, $K=\frac{R_A}{R}$ $\beta S_R=0{,}65$, $\gamma_f=0{,}5$ $K_{ks}=2$	$R_C=\frac{1}{2}$, $L_C=\frac{\sqrt{3}}{2}\omega$ $\frac{N_A}{\sum N}=\frac{1}{2}$, $K=\frac{R_C}{R}$ $\beta S_R=0{,}98$, $\gamma_f=0{,}5$ $K_{ks}=2/\sqrt{3}$	$R_A=\frac{1}{2}$, $C_A=\frac{2}{\sqrt{3}}\cdot\frac{1}{\omega}$ $\frac{N_B}{\sum N}=\frac{1}{2}$, $K=\frac{R_A}{R}$ $\beta S_R=0{,}98$, $\gamma_f=0{,}5$ $K_{ks}=2/\sqrt{3}$	$C_C=2\cdot\frac{1}{\omega}$ $\frac{N_A}{\sum N}=\frac{1}{2}$, $K=\frac{R_C}{R}$ $\beta S_R=0{,}65$, $\gamma_f=0{,}5$ $K_{ks}=2$
Characteristic equation		$p+\frac{\omega\sqrt{3}}{1+K}=0$	$p+\frac{\omega}{\sqrt{3}(1+K)}=0$	$p+\omega\sqrt{3}(1+K)=0$	$p+\frac{\omega(1+K)}{\sqrt{3}}=0$
Time constants τ (*ms*) in regime	*ph* $k=0$	1,84	5,52	1,84	5,52
	ks $k=\infty$	Tends to infinity ∞		Tends to zero 0	
	kn K_{ks}	5,52	11,87	0,9	1,84



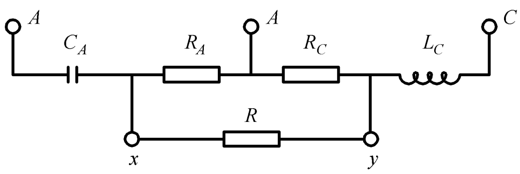
a)



c)



b)



d)

Fig. 2. Filter types

Table 2. Filter parameters

Filter Type	Group *a)* Fig. 2., *a*	Group *b)* Fig. 2., *b*	Group *c)* Fig. 2., *c*	Group *d)* Fig. 2., *d*
Filter parameter	$R_A=\frac{1}{2}$, $L_A=\frac{\sqrt{3}}{2}\omega$ $R_C=\frac{\sqrt{3}}{2}$, $L_C=\frac{1}{2}\omega$ $\beta S_R=0{,}58$, $\gamma_f=0{,}29$ $K_{ks}=0{,}8$	$R_A=\frac{\sqrt{3}}{2}$, $C_A=2\cdot\frac{1}{\omega}$ $R_C=\frac{1}{2}$, $C_C=\frac{2}{\sqrt{3}}\cdot\frac{1}{\omega}$ $\beta S_R=0{,}58$, $\gamma_f=0{,}29$ $K_{ks}=1{,}03$	$R_A=\frac{1}{2}$, $L_A=\frac{\sqrt{3}}{2}\omega$ $R_C=\frac{1}{2}$, $C_C=\frac{2}{\sqrt{3}}\cdot\frac{1}{\omega}$ $\beta S_R=0{,}75$, $\gamma_f=0{,}29$ $K_{ks}=0{,}67$	$R_A=\frac{\sqrt{3}}{2}$, $C_A=2\cdot\frac{1}{\omega}$ $R_C=\frac{\sqrt{3}}{2}$, $L_C=\frac{1}{2}$ $\beta S_R=0{,}75$, $\gamma_f=0{,}29$ $K_{ks}=2$, $K=0{,}87$

Filter Type		Group *a)* Fig. 2., *a*	Group *b)* Fig. 2., *b*	Group *c)* Fig. 2., *c*	Group *d)* Fig. 2., *d*
Time constants τ, τ_1, τ_2 (*ms*) and own circular frequency ω_s in regime	*ph* $k = 0$	$\tau_1 = 1{,}84$		$\tau_2 = 5{,}58$	
	ks $k = \infty$	$\tau = 3{,}18$		$\tau_1 = 1{,}0$ $\tau_2 = 9{,}9$	$\tau = 5{,}52$ $\omega_s = 258$
	nor $K = K_{ks}$	$\tau_1 = 2{,}7$ $\tau_2 = 9{,}9$	$\tau_1 = 1{,}03$ $\tau_2 = 3{,}7$	$\tau_1 = 1{,}36$ $\tau_2 = 7{,}4$	$\tau = 4{,}14$ $\omega_s = 201$
	nor $K =$ K	-	-	-	$\tau_1 = \tau_2 = 3{,}18$

Legend: *ph* – idle time, *ks* – short circuit, *nor* – normal.

Examples of analysis of different filter types

First group. Filters with autotransformers and active-reactive cycle that is plugged on two three-phase voltage. Filer schemes are given on Fig. 1, *a-d*, and filter parameters according to scheme 1,*a* are:

$$R_A = \frac{\sqrt{3}}{2},\ \omega L_A = \frac{1}{2},\ \frac{W_B}{W_B + W_C} = \frac{1}{2},\ \beta = \frac{1}{2},$$

$$S_R = 1{,}33,\ \gamma_f = 0{,}5, \qquad (5)$$

where γ_f – unbalance coefficient caused by frequency drift dependable on filter type; $\beta = \frac{S_{opt}}{p_{akt}}$ – indicator that indicates relation of loading power and active power in the circuit.

Operative impedance of short circuit and characteristic equation is $Z_{kF}(p) = \frac{pL_A + R_A}{pL_A \cdot R_A}$, $Z(p) = pL_A(R_A + R) + R_A \cdot R = 0$ and equation roots are:

$$p = -\frac{R \cdot R_A}{L_A(R + R_A)}. \qquad (6)$$

According to expression (6) proper transient filter process can only be aperiodic. Its time constants (τ) depend only according to (5, 6) from filter load impedance:

$$\tau = \frac{1 + K}{\omega\sqrt{3}},\ K = \frac{R_A}{R} \qquad (7)$$

and have minimal value $\tau_{\min} = \frac{1}{\sqrt{3}\omega}$ where $K = 0$, which corresponds to idle time regime. In the regime of short circuit they tend to (∞) and during coordination of loading $(K_s = 2)$ time constant is:

$$\tau_S = \frac{\sqrt{3}}{\omega}. \qquad (8)$$

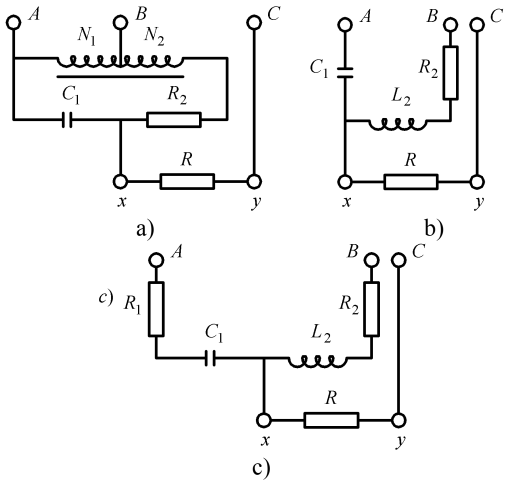


Fig. 3. Filters with autotransformers (1)

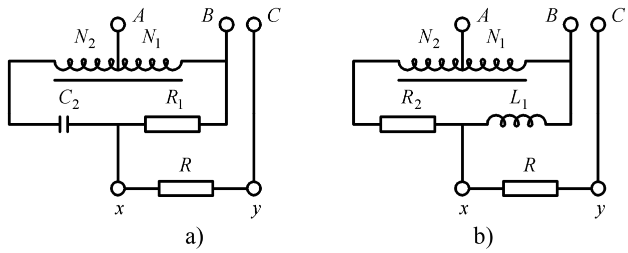


Fig. 4. Filters with autotransformers (2)

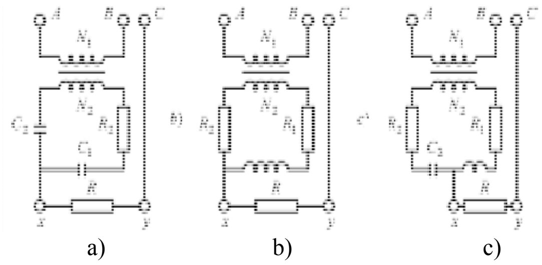


Fig. 5. Filters with autotransformers and active-reactive cycle (1)

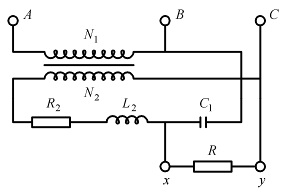
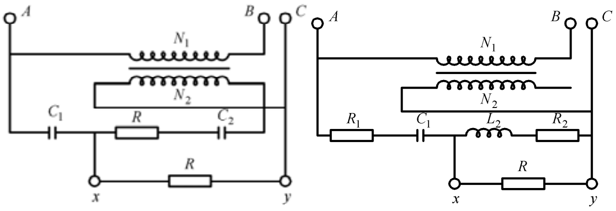


Fig. 6. Filters with autotransformers and active-reactive cycle (2)



a) b)

Fig. 7. Filters with autotransformers (3)

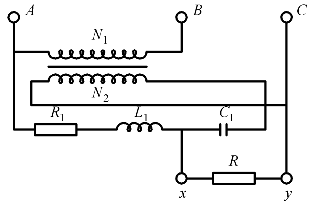


Fig. 8. Filters with autotransformers (4)

Expressions (6) and (7) can be applied on filters of groups $(b-d)$. Parameters of first group filters and obtained results are presented in table 1.

Second group. Their characteristic is that they are plugged on two lineal voltages. Filter schemes of group $(a-d)$ are presented on Fig. 2. Single filters in the group differ in values $n = R_C / R_A$. Character of proper filters transient process also depends on these values, because filters contain two independent electric circuits and have characteristic equations of the second degree, which solutions can be two real and two conjugate-complex roots. Solutions of characteristic equation (for $K = R_A / R$) for:

$$p_{1,2} = \frac{-\omega\left[\frac{4}{\sqrt{3}} + K\left(n+\sqrt{3}\right)\right]}{2\left[1+K\left(n\sqrt{3}+1\right)\right]} \pm$$

$$\pm \frac{\omega\sqrt{\left[\frac{4}{\sqrt{3}} + K\left(n+\sqrt{3}\right)\right]^2 - 4\left[1+K\left(n\sqrt{3}+1\right)\right]}}{2\left[1+K\left(n\sqrt{3}+1\right)\right]}. \quad (9)$$

For scheme on Fig. 2., *b* are:

$$p_{1,2} = -\frac{\omega}{2}\left[\frac{4}{\sqrt{3}} + K\left(n+\frac{1}{\sqrt{3}}\right)\right] \pm$$

$$\pm\, \omega\sqrt{\frac{1}{4}\left[\frac{4}{\sqrt{3}} + K\left(n+\sqrt{3}\right)\right]^2 - \left[1+K\left(n\sqrt{3}+1\right)\right]}. \quad (10)$$

For scheme on Fig. 2.*c* are:

$$p_{1,2} = \frac{\omega\left[4+3K(n+1)\right]}{2\sqrt{3}(K+1)} \pm \omega\sqrt{\frac{\left[4+3K(n+1)\right]^2}{12(K+1)^2} - \frac{1+n\cdot K}{K+1}}. \quad (11)$$

Table 3. Filter parameters

Filter type		Group *a*) Fig. 3., *a*	Group *c*) Fig. 4., *a*	Group *c*) Fig. 4., *b*	Group *c*) Fig. 5., *b*
Filter parameters		$C_1 = \frac{1}{\omega}$, $R_2 = \sqrt{3}$ $N_1 = N_2$, $K = \frac{R_2}{R}$ $\beta S_R = 0{,}67$, $\gamma_f = 0{,}5$ $K_s = 0{,}8$	$R_1 = 1$, $C_2 = \frac{1}{\sqrt{3}} \cdot \frac{1}{\omega}$ $N_1 = N_2$, $K = \frac{R_1}{R}$ $\beta S_R = 1{,}26$, $\gamma_f = 0{,}5$ $K_s = 1{,}15$	$L_1 = \frac{1}{\omega}$, $R_2 = \sqrt{3}$ $N_1 = N_2$, $K = \frac{R_2}{R}$ $\beta S_R = 1$, $\gamma_f = 0{,}5$ $K_s = 2$	$R_1 = \frac{1}{2}$, $L_1 = \frac{\sqrt{3}}{2}\omega$ $R_2 = 1$, $N_1 = N_2$ $\beta S_R = 0{,}31$, $\gamma_f = 0{,}5$ $K_s = 1{,}73$, $K = \frac{R_2}{R}$
Characteristic equation		$p + \frac{\omega(1+K)}{\sqrt{3}} = 0$	$p + \omega\sqrt{3}(1+K) = 0$	$p + \frac{\omega\sqrt{3}}{(1+K)} = 0$	$p + \frac{\omega(3+K)}{\sqrt{3}(1+K)} = 0$
Filter regime	*ph* $k = 0$	$\tau = 5{,}52$	$\tau = 1{,}84$		
	ks $k = \infty$	Tends to zero 0		Tends to infinity ∞	$\tau = 5{,}52$
	nor K_{ks}	$\tau = 1{,}84$	$\tau = 0{,}86$	$\tau = 5{,}52$	$\tau = 3{,}18$

For scheme on Fig. 1., d:

$$p_{1,2} = \frac{-\omega\left[4+K(n+1)\right]}{2\sqrt{3}(1+nK)} \pm$$

$$\pm \frac{\omega\sqrt{4-4K(n+1)^2 + K^2\left(n^2-10n+1\right)}}{2\sqrt{3}(1+nK)}. \quad (12)$$

Analysis of expressions (9-12) shows that proper transient process of filter in group $(a-d)$ can include only to aperiodic components with different time constants. Filters in group *d*) can have harmonic and periodical transient process, and also critical with equal time constants of components and minimal establishing time t_y [1].

Third group. This group of filter is made of active-reactive components and variable values of voltage and here are considered filter groups $(a-e)$ which don't require transformers with three magnetic poles. These are presented on Fig. 3-8. From the aspect of proper transient processes, third group filters are divided into two versions:

1) Filters with one reactive element in a group whose transient process contains only one aperiodic component. Extent of testing of time constant value depending on resistance of filter loading is determined by character of reactive element in the branch. For filters with capacitor in short circuit regime, time constants tends to zero value.

2) Second version filters with two reactive elements. Character of proper transient processes is determined by the type of reactive element, relation of mutual parameters of active resistances. For some of filters, depending on resistance of loading, transient process can be harmonic or aperiodic in a sense that can become critical. Estimation results for third group filters are given in Table 3 for first version filters and in Table 4 for second version filters.

Table 4. Filter parameters

Filter type		Group *a*)		Group *d*)	Group *e*)
		Fig. 3., *b*	Fig. 3., *c*	Fig. 6.	Fig. 8.
Filter parameters		$C_1=\frac{1}{\omega}$, $R_2=\frac{\sqrt{3}}{2}$ $L_2=\frac{1}{2}\omega$, $\beta S_R=0{,}93$ $\gamma_f=0{,}76$, $K=\frac{R_2}{R}$ $K_s=0{,}86$, $K_{nk}=3{,}43$	$R_1=R_2=\frac{1}{2}$, $C_1=\frac{2}{\sqrt{3}}\cdot\frac{1}{\omega}$ $L_2=\frac{\sqrt{3}}{2}\omega$, $\beta S_R=0{,}75$ $\gamma_f=0{,}87$, $K=\frac{R_2}{R}$ $K_s=0{,}5$, $K_{nk}=2{,}73$	$C_1=L_2=\frac{1}{\omega}$, $R_2=\sqrt{3}$ $N_2=2N_1$, $\beta S_R=0{,}65$ $\gamma_f=0{,}5$, $K=\frac{R_2}{R}$ $K_s=1{,}5$, $K_{nk}=6{,}46$	$R_1=\frac{\sqrt{3}}{2}$, $L_1=\frac{1}{2}\omega$ $C_1=\frac{2}{\omega}$, $N_1=2N_2$ $\beta S_R=0{,}65$, $\gamma_f=0{,}5$ $K=\frac{R_1}{R}$, $K_s=1{,}5$ $K_{nk}=6{,}46$
Characteristic equation		$p^2+\frac{p\omega}{\sqrt{3}}(3+2K)+$ $+2\omega^2(1+K)=0$	$p^2+\frac{p\omega^2(1+2K)}{\sqrt{3}(1+K)}+\omega^2+$ $+2\cdot\omega^2(1+K)=0$	$p^2+\frac{p\omega}{\sqrt{3}}(3+K)+\omega^2(1+K)=0$	
Time constants τ, τ_1, τ_2 in regime	*ph* $k=0$	$\tau=3{,}66$ $\omega_{sop}=220$	$\tau=5{,}52$ $\omega_{sops}=246$	$\tau=3{,}64$ $\omega_{sop}=157$	
	ks $k=\infty$	$\tau=1{,}84$	$\tau_1=1{,}84$ $\tau_2=5{,}52$	$\tau=1{,}84$	
	k K_s	$\tau=2{,}32$ $\omega_{sopst}=333$	$\tau=4{,}13$ $\omega_{sops}=201$	$\tau=2{,}45$ $\omega_{sopst}=283$	
	k K_n	$\tau_1=\tau_2=1{,}12$	$\tau_1=\tau_2=2{,}32$	$\tau_1=\tau_2=1{,}11$	
Filter type		Group *c*)		Group *d*)	
		Fig. 5.*a*.	Fig. 5.*b*.	Fig. 7.*b*.	Fig. 7.*a*.
Filter parameters		$R_1=\frac{\sqrt{3}}{2}$, $C_1=2\cdot\frac{1}{\omega}$ $C_2=2{,}76\frac{1}{\omega}$, $\gamma_f=0{,}5$ $N_1=2{,}76N_2$, $\beta S_R=0{,}41$ $K=\frac{R_1}{R}$, $K_{ns}=2{,}88$	$R_1=R_2=\frac{\sqrt{3}}{2}$, $L_1=\frac{2}{\omega}$ $C_2=\frac{2}{\omega}$, $N_1=N_2$ $\beta S_R=0{,}25$, $\gamma_f=0{,}29$ $K=\frac{R_1}{R}$, $K_{ns}=1{,}5$	$R_1=R_2=\frac{\sqrt{3}}{2}$, $C_1=\frac{2}{\omega}$ $L_2=\frac{1}{2\omega}$, $N_1=N_2$ $\beta S_R=0{,}25$, $\gamma_f=0{,}29$ $K=\frac{R_2}{R}$, $K_{ns}=1{,}5$	$C_1=\frac{1}{\omega}$, $R_2=\frac{\sqrt{3}}{2}$ $C_2=\frac{2}{\omega}$, $N_1=N_2$ $\beta S_R=0{,}65$, $\gamma_f=0{,}6$ $K=\frac{R_2}{R}$, $K_{ns}=1{,}5$
Characteristic equation		$p^2+p\omega\left[1+\frac{K(\sqrt{3}+1)}{\sqrt{3}}\right]+$ $+\frac{K(\sqrt{3}-1)}{3}\omega^2=0$	$p^2+\frac{p\omega^2(3+2K)}{\sqrt{3}(1+K)}+\omega^2+$ $+2\cdot\omega^2(1+K)=0$		$p^2+\frac{p\omega}{\sqrt{3}}(3+2K)+$ $+\frac{2K}{3}\omega^2=0$
Time const. τ, τ_1, τ_2 in regime	*ph* $k=0$	$\tau=3{,}18$	$\tau_1=1$ $\tau_2=9{,}9$		$\tau=1{,}84$
	ks $k=\infty$	$\tau=5{,}52$	$\tau_1=1{,}84$ $\tau_2=5{,}52$		$\tau=5{,}52$
	nor $K_{ns}=K$	$\tau_1=2{,}61$ $\tau_2=3{,}18$	$\tau_1=1{,}36$ $\tau_2=7{,}4$		$\tau_1=1$ $\tau_2=9{,}4$

Fourth group. These are the filters on the basis of mutual inductance. These filters are derived from the third group of filters that consists of intertransformer and inductance which are joined into one element, whereat inductance of transformer secondary winding is used as inductance of configuration. In this sense, filer does not differ from third group filter, and not even in number and character of transient process.

Fifth group. These filters are based on bridge schemes. Electric circuit in general case, is consisted of three branches that presents active-reactive circuits. In the fourth branch if filter loading. Voltages of secondary windings of intertransformer are introduced into diagonal, and their primaries are connected to interphased voltages. We shall not discuss filters whose branches are consisted of reactive elements, since their time inertias are big and since they have high fault levels and bad indicator γ_f .

All shown filters are consisted of two independent configurations with reactive elements. Their transient processes depending on resistance of loading, can be harmonic or aperiodic with two components, and often can be critical.

Conclusion

During selection of symmetric component filter in measuring system, specially in relay protection, important role have not only filter parameters in stationary regime but also parameter βS_R and γ_f and their time inertia, which must be degraded as much as possible. Results of this analysis enable the selection of the best symmetric components filters, with parameters that lessen their inertia. From filters that have the best indicators βS_R and the smallest time inertia during regulation of loading, first group filters, version *c*) (Fig. 1., *c*) and third group filters, version *b*) (Fig. 3., *b*) are distinguished. From filters that have the best indicators γ_f and the smallest time inertia, second group filter, version *b*) (Fig. 2., *b*) are to be distinguished.

For accomplishment of given performance time of measuring element, in the sense of time inertia, we must chose filter of a type that on the account of parameters change limits duration of proper transient processes. These filters are filters that contain only one capacitor (first and third group), whose transient process is aperiodic, and time constants that are determined by relation of filter resistance and loading can be set to be very small. In the widest sense, the most appropriate filters are third group filters, version *b*) .

Analysis, conducted for inverse order voltage filter, can also be accomplished for inverse order current filter, as well as for other symmetric components filters.

References

1. **Jakšić U.** Development of procedure for measurement of electrical components of currents and voltages in electric networks, PhD dissertation–operating version, Faculty Technical Science, Kosovska Mitrovica, University of Pristina, 2008.
2. **Marković N., Bjelić S., Jakšić U., Bogićević Z.** Graphical zero–sequence cut–offs method of determining of fault to earth in electrical lines, IEEE Catalog Number: CFP08481–PRT, ISBN: 978–1–4244–2903–5, 9th Symposium on Neural Network Applications in Electrical Engineering, Neurel–2008, Faculty of Electrical Engineering, University of Belgrade, Serbia, September 25–27, 2008. – P.73–76.
3. **Bjelić S., Mladenović V.** Measuring of nonsymmetrical components in power energy networks, The IASTED International Conference on Power, Energy, and Applications PEA(2006), September 11–13, 2006, Gaborone, Botswana, ID#506–047.
4. **Bjelić S., Mladenović V.** Algorithm of measurment–information system to make diagnosis faults in electrical networks, 14th Telecomm. forum, TELFOR 2006., IEEE COM SOC Chapter Serbia&Montenegro, Belgrade, Serbia 21–23. November 2006, PEL#7.6.
5. **Bjelić S., Mladenović V.** Methodological aproach developement of data acquisition and processing systems in electrical network, UDC: 621.315.078.001.42: 659.28=861, Elektrotehnika 57(2008)2, Belgrade. – P. 9–16.
6. **Bjelić S., Jakšić U.** The capacitance coupling like alternative to inductance for measurement symmetrical currents components in electrical networks, PES 2007, 3–5 September, Nis EMS PROBLEM, Proceedings of extended abstract. – P. 41–43.
7. **Bjelić S., Mladenović V.** Algorithms and Possible Methods of Emergency Control Electrical Network, RS2.3. Session 2: Applications of NNs 2: Power Control, NEUREL 2008, Belgrade.
8. **Bjelić S., Marković N., Jakšić U.** Multi–sliced–level type phase–comparison carrier relaying system for multiterminal lines, TELFOR Internationale Conference, November 2008, Belgrade.

Received 2009 02 26

U. Jakšić, N. Marković, S. Bjelić. Inertia (slowness) of Zero Order Components Filter // Electronics and Electrical Engineering. – Kaunas: Technologija, 2009. – No. 6(94). – P. 99–105.

For realization of fast measuring relays with frequency-selecting elements that should have given zero initial conditions in transitive process, the initial element for relay switching after occurrence of short circuit is needed. Initial element is realized according to known principles, where one is usage of event or change in asymmetry of voltage and currents in electrical network. In this case initial element is consisted of inverse order voltage or current filter (filters). Group of inverse order voltage filters that are used in measurement of symmetric components in electrical network was analysed. Ill. 8, bibl. 8 (in English; abstracts in English, Russian and Lithuanian).

У. Якшищ, Н. Маркович, С. Бьелич. Исследование инертности компонентного фильтра нулевого ряда // Электроника и электротехника. – Каунас: Технология, 2009. – № 6(94). – С. 99–105.

Указано, что в быстродействующих релейных системах основным критерием является восстановление работы в исходное состояние. Эти условие достаточно хорошо обеспечивается преобразованием симметрии токовых сигналов. Описывается новый фильтр тока и напряжения. Приведены теоретические и экспериментальные исследования фильтров, когда в

электрических сетях применяются симметрические компоненты. Ил. 8, библ. 8 (на английском языке; рефераты на английском, русском и литовском яз.).

U. Jakšić, N. Marković, S. Bjelić. Nulinės eilės komponentinio filtro inertiškumo tyrimas // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2009. – Nr. 6(94). – P. 99–105.

Greito matavimo sistemose naudojamos relės turi užtikrinti pradines savybes po pereinamųjų procesų (po komutacijos). Elementai realizuojami pagal žinomus principus keičiant įtampos ar srovės signalo asimetriją elektros tinkluose. Šiuo atveju pradinis elementas yra sudarytas iš inversinio įtampos ar srovės filtro. Išanalizuoti inversiniai įtampos filtrai, kurie taikomi simetriniams komponentams matuoti elektros tinkluose. Il. 8, bibl. 8 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).