

DOI: <https://doi.org/10.15407/techned2018.03.028>

## IMPROVING THE ELECTROMAGNETIC COMPATIBILITY OF DISCHARGE-PULSE SYSTEMS WITH A POWER NETWORK

|           |                                                                     |
|-----------|---------------------------------------------------------------------|
| Journal   | Tekhnichna elektrodynamika                                          |
| Publisher | Institute of Electrodynamics National Academy of Science of Ukraine |
| ISSN      | 1607-7970 (print), 2218-1903 (online)                               |
| Issue     | No 3, 2018 (May/June)                                               |
| Pages     | 28 – 42                                                             |

### Authors

**N.A. Shydlovska\***, **S.M. Zakharchenko\*\***, **O.P. Cherkaskyi\*\*\***, **Ju.V. Rudenko\*\*\*\***

Institute of Electrodynamics National Academy of Sciences of Ukraine,  
pr. Peremohy, 56, Kyiv, 03057, Ukraine,  
e-mail: shydlovska@ied.org.ua, snzakhar@ukr.net, cherkassky\_a@ukr.net,  
rudenko@ied.org.ua

\* ORCID ID : <http://orcid.org/0000-0002-9907-7416>

\*\* ORCID ID : <http://orcid.org/0000-0002-8597-8045>

\*\*\* ORCID ID : <http://orcid.org/0000-0001-5353-1022>

\*\*\*\* ORCID ID : <http://orcid.org/0000-0003-1852-215X>

### Abstract

*Dependences of the relative amplitude of the voltage pulsations on the capacitor of the buffer filter of the discharge-pulse systems caused by the charge of the working capacitor from it from the ratio of their capacitances, the ratio of initial conditions on them and on the quality factor of the charging circuit are investigated. The analysis of the efficiency of technical means for*

*improving the electromagnetic compatibility of discharge-pulse systems with a power network is given. With the use of application program package Simetrix a models of the active and passive power factor correctors for the discharge-pulse system were created and operation of the active corrector was investigated when the parameters of its main elements and the switching frequency of the power transistor had changed in wide ranges. As a result of analytical calculations and computer simulation, the dependencies of the total harmonic distortion coefficient of the input current of the corrector from the active resistance of its load, the inductance of the charger's inductor, the capacitance of the filter capacitor, and the switching frequency of the power transistor are obtained. Recommendations to increase the stability of the initial conditions on the working capacitor and filter capacitor of discharge-pulse systems and also to improve the electromagnetic compatibility of such systems with the power network are given. References 35, figures 8, tables 2.*

**Key words:** discharge-pulse systems, pulsations, power factor corrector, total harmonious distortions factor.

Received: 07.08.2017

Accepted: 29.01.2018

Published: 13.04.2018

## References

1. Berzan V.P., Gelikman B.Yu., Guraevsky M.N., Ermuratsky V.V., Kuchinsky G.S., Mezenin O.L., Nazarov N.N., Peregudova E.N., Rud V.I., Sadovnikov A.I., Smirnov B.K., Styopina K.I. Electric Capacitors and Capacitors Installations: A Handbook. Moskva: Energoatomizdat, 1987. 656 p. (Rus)
2. Vovchenko A.I., Boguslavsky L.Z., Miroshnichenko L.N. Trends in the Development of High-voltage Pulsed Current Generators in the Institute of Pulses Process and Technologies of the National Academy of Sciences of Ukraine (Review). *Tekhnichna Elektrodynamika*. 2010. No 5. Pp. 69–74. (Rus)

3. Volkov I.V., Zozulev V.I., Sholokh D.A. Magnetic-semiconductor Pulse Devices of Converter Technology. Kyiv: Naukova Dumka, 2016. 230 p. (Rus)
4. Honorovsky I.S. Radio engineering circuits and signals. Moskva: Radio i sviaz, 1986. 512 p. (Rus)
5. State Standard of Ukraine 13109-97. Interstate Standard. Electric Energy. Electromagnetic Compatibility of Technical Means. Norms of Quality of Electric Energy in General-purpose Power Supply Systems. Kyiv, IPK Standards Publishing, 1999, 33 p. (Rus)
6. State Standard of Ukraine EN 50160:2014. Characteristics of Power Supply Voltage in Electrical Networks for General Purpose (EN 50160:2010, IDT). Kyiv, Ministry of Economic Development of Ukraine, 2014, 27 p. (Ukr)
7. State Standard of Ukraine IEC 61000-4-30:2010. Electromagnetic Compatibility. Part 4-30. Methods of Test and Measurements. Measurement of Electricity Quality Indices (IEC 61000-4-30:2008, UT). Kyiv, Ministry of Economic Development of Ukraine, 2010, 56 p. (Ukr)
8. Zharkin A.F., Pazeev A.G. Single-phase Active Power Factor Correctors for Multi-modules Power Supply Systems. Kyiv: Institut Elektrodynamiky Natsionalnoi Akademii Nauk Ukrainy, 2014. 212 p. (Ukr)
9. Zakharchenko S.N. Features of Electromagnetic Processes in Spark Erosion Coagulation Installations for Water Treatment Systems, Heating Systems and Units. *Novyny Enerhetyky*. 2012. No 6. Pp. 41–48. (Rus)
10. Zakharchenko S.M. Statistical Research of Equivalent Electric Resistance of the Heterogeneous Current-carrying Medium at its Electric-erosive Processing on an Example of Granules of Aluminum in Water. *Naukovyi Visnyk Natsionalnoho hirnichoho universytetu*. 2013. No 1 (133). Pp. 62–67. (Ukr)
11. Zakharchenko S.N., Rudenko Ju.V. Comparative Analysis of Capacitors Pulse Charge Algorithms at the Systems of Plasma-erosive Treatment for Heterogenic Conductive Media. *Pra tsi Instytutu Elektrodynamiky Natsionalnoi Akademii Nauk Ukrainy* . 2014. No 37. Pp. 100–108. (Rus)
12. Zakharchenko S.N., Rudenko Ju.V., Cherkassky A.P. Improving the Accuracy of the Voltage Regulation in the Capacitive Energy Storage Devices for Pulse Plasma-erosion Treatment Systems of Heterogeneous Conductive Media. *Tekhnichna Elektrodynamika*. 2016. No 6. Pp. 30–37. (Rus)
13. Kalachev A. With a Low Starting Current: Power Factor Correctors From STM. *Novosti Elektroniki* . 2011. No 9 (101). Pp. 17–23. (Rus)
14. Mesyats G.A. Pulse Power and Electronics. Moskva: Nauka, 2004. 704 p. (Rus)
15. Mykhalskyi V.M. Means for improving the quality of electricity at the input and output of frequency and voltage converters with pulse-width modulation. Kyiv: Institute of Electrodynamics of the National Academy of Sciences of Ukraine, 2013. 340 p. (Ukr)
16. Rashchepkin A.P., Kondratenko I.P., Zakharchenko S.M., Rudenko Ju.V. Development of equipment for electroerosive coagulation purification in water treatment systems of heat aggregates. *Problemy resursu i bezpeky ekspluatatsiikonstruktsii, sporud ta mashin*. Kyiv: Instytut Elektrozvariuvannia im. Ye.O.Patona Natsionalnoi Akademii Nauk Ukrainy, 2015. Pp. 451–454. (Ukr)
17. Rohal V.V., Demchenko Yu.S. Investigation of the Input Current Spectrum of High-Frequency Power Factor Correctors. *Tekhnichna Elektrodynamika*. 2014. No 5. Pp. 80–82. (Ukr)

18. Rudenko V.S., Senko V.I., Chizhenko I.M. Conversion technics. Kyiv: Vyshcha shkola, 1983. 431 p. (Rus)
19. Segeda M.S. Electric Networks and Systems. Lviv: Vydavnytstvo Lvivskoi Politekhniky, 2015. 540 p. (Ukr)
20. Tverdov I. Passive Power Factor Correctors for Single-phase and Three-phase Power Modules. *Komponenty i tekhnologii*. 2009. No 4. Pp. 94–97. (Rus)
21. Shydlovskaya N.A., Zakharchenko S.N., Cherkassky A.P. Non-linear-parametrical Model of Electrical Resistance of Conductive Granulated Media for a Wide Range of Applied Voltage. *Tekhnichna Elektrodynamika*. 2014. No 6. Pp. 3–17. (Rus)
22. Shidlovskiy A.K., Zharkin A.F. Higher Harmonics in Low-voltage Electrical Networks. Kyiv: Naukova dumka, 2005. 210 p. (Rus)
23. Shydlovskiy A.K., Shcherba A.A., Suprunovska N.I. Power Processes in Electrical Pulse Devices with Capacitive Energy Storages. Kyiv: Interkontinental-Ukraine, 2009. 208 p. (Rus)
24. Shydlovska N.A., Zakharchenko S.M., Cherkaskyi O.P. Parametric Model of Resistance of Plasma-erosive Load, Adequate in the Wide Range of Change of Applied Voltage. *Tekhnichna Elektrodynamika*. 2017. No 3. Pp. 3–12. (Ukr)
25. Shydlovska N.A., Zakharchenko S.M., Cherkaskyi O.P. Physical Prerequisites of Construction of Mathematical Models of Electric Resistance of Plasma-erosive Loads. *Tekhnichna Elektrodynamika*. 2017. No 2. Pp. 5–12. (Ukr)
26. Shydlovskiy A.K., Novskiy V.O., Zharkin A.F. Stabilization of Electrical Energy Parameters in Three-phase Systems by Semiconductor Correction Devices. Kyiv: Instytut Elektrodynamiky Natsionalnoi Akademii Nauk Ukrainy, 2013. 378 p. (Ukr)
27. Shcherba A.A. Systems of electric-pulse dispersion of conductive materials: abstract of Dr. tech. Sci. diss.: 05.09.03 / Institute of Electrodynamics AN of Ukraine. Kiev. 1993. 38 p. (Rus)
28. Shcherba A.A., Zakharchenko S.N. Semiconductor Adaptive Systems for Volumetric Electric-spark Processing of Materials and Media. *Pratsi Instytutu elektrodynamiky Natsionalnoyi Akademiyi Nauk Ukrayiny: Elektroenerhetyka. Zbirnyk naukovykh prats*. Kyiv: Institut Elektrodynamiky Natsionalnoi Akademii Nauk Ukrainy, 1999. Pp. 66–73. (Rus)
29. Shcherba A.A., Zakharchenko S.N. Stabilization and Regulation of Discharge Pulses Parameters at the Systems of Volume Electric Spark Processing of Heterogeneous Conductive Media. *Pratsi Instytutu elektrodynamiky Natsionalnoi Akademii Nauk Ukrainy. Elektrodynamika*. 2001. Pp. 30–35. (Rus)
30. Shcherba A.A., Zakharchenko S.N., Suprunovska N.I., Shevchenko N.I., Monastirskiy G.E., Peretyatko Yu.V., Petruchenko O.V. Stabilization of Modes of Electrotechnological Systems of Obtaining Spark-eroded Micro and Nano-powders. *Tekhnichna Elektrodynamika. Tematychnyi vypusk Sylova elektronika ta enerhoefektyvnist*. 2006. Vol. 1. Pp. 120–123. (Rus)
31. Aluminum electrolytic capacitors. Large-size capacitors. Series/Type B43508. URL: <https://en.tdk.eu/inf/20/30/db/aec/B43508.pdf> (Accessed 07.06.2017).
32. Danilenko N.B., Savelev G.G., Yavorovskii N.A., Yurmazova T.A. Chemical Reactions in Electric Pulse Dispersion of Iron in Aqueous Solutions. *Russian Journal of Applied Chemistry*.

2008. Vol. 81. No 5. Pp. 803–809.

33. International Rectifier IR1155S Programmable Frequency. One Cycle Control PFC IC. URL: <http://pdf1.alldatasheet.com/datasheet-pdf/view/427261/IRF/IR1155S.html> (Accessed 07.06.2017).

34. Perekos A.E., Chernenko V.A., Bunayev S.A., Zalutskiy V.P., Ruzhitskaya T.V., Boitsov O.F., Kakazei G.N. Structure and Magnetic Properties of Highly Dispersed Ni-Mn-Ga Powders Prepared by Spark-erosion. *J. Appl. Phys.* 2012. Vol. 112. Pp. 093909-1 – 093909-7. DOI: <http://doi.org/10.1063/1.4764017>

35. Stepins D. An Improved Control Technique of Switching-Frequency-Modulated Power Factor Correctors for Low THD and High Power Factor. *IEEE Transactions on Power Electronics* . 2016. Vol. 31. No 7. Pp. 5201–5214.

DOI: <http://doi.org/10.1109/TPEL.2015.2478848>

[PDF](#)