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Development of a Short Term Power Interruption Compensator using Lithium-ion Capacitors

Asano Mitsutoshi, Shimada Ikuhiko, Sugimoto Shigeyuki
Chubu Electric Power Co., Inc., Nagoya, Japan
Nakajima Yuusuke, Yamamoto Takayuki, Osamu Sakata
Meidensha Corporation, Numazu, Japan

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Abstract

The high power quality has become all the more important in the high-tech industry having highly value added production lines such as semiconductors and IT (Information Technology) related products which are growing rapidly over the recent years. Especially the voltage sag or short term power interruption has a significant effect on such production lines and there is a strong need to deal with such issues. As a result, the (UPS) uninterruptible power supply systems or short term power interruption compensators are finding more applications. In most of such systems, the lead-acid batteries are commonly used as a storage unit. In view of environmental and maintenance concerns, the lead-acid batteries are being replaced by more advanced storage unit like (ELDC) electric double layer capacitors, lithium-ion batteries, and more recently by (LIC) lithium-ion capacitors.

This paper reports a development of short term power interruption compensator using LIC as a storage unit. The proposed compensator is having very efficient charge and discharge cycles (good enough for 100,000 such cycles), environment friendly and requires no maintenance for about 15 years. These features are quite similar to ELDC, however in terms of the energy density LIC is capable of storing about 3 times more energy than that of EDLC. Consequently, LIC based short term power interruption compensator can provide solutions for short power interruption compensation for the duration up to 20 seconds for the 6.6kV voltage systems. This duration is quite enough to start and pick up the important loads by emergency generators in the event of supply failure for even the longer duration. The compensator can detect the power interruption quickly and can start supplying power all within 2 milliseconds.

This type of compensator is developed for the first time, therefore its prototype (6.6kV, 1MVA, 11 seconds) was manufactured and field tested in a factory for its performance. During field testing over a period of 2 years, in all 16 actual compensation cases were observed, out of which 7 cases were due to system faults and 9 cases were due to large load variations. In all the cases, the compensation operation was carried out perfectly without any problem. Moreover, some capacitors from the storage unit of LIC were also tested for their reliability and deterioration by checking the changes in their capacitance and internal resistance. The test results were found to exhibit much slower degradation of the capacitance and internal resistance than the design values. With the field tests, the right performance and high reliability were verified and the developed compensator is now ready for practical use.