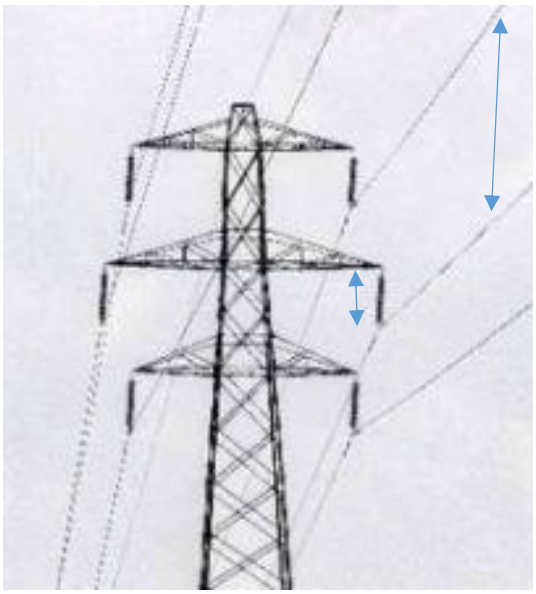
Triple Frequency Injection - Benefits and Technology

This is a technique whereby the power rating of a three-phase grid circuit or a distribution line or cable can be increased by up to 33% by adding a triple frequency component to the voltage waveform.

Electricity is sent through the grid or distribution system as three sinusoidal voltage waveforms. This pylon has a three-phase set of wires on each side of the pylon. The sets of wires work in parallel.

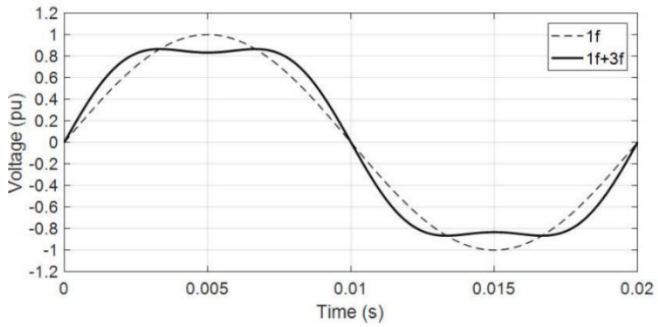


The line-to-line voltage (long arrow) determines how much power the power line can convey.

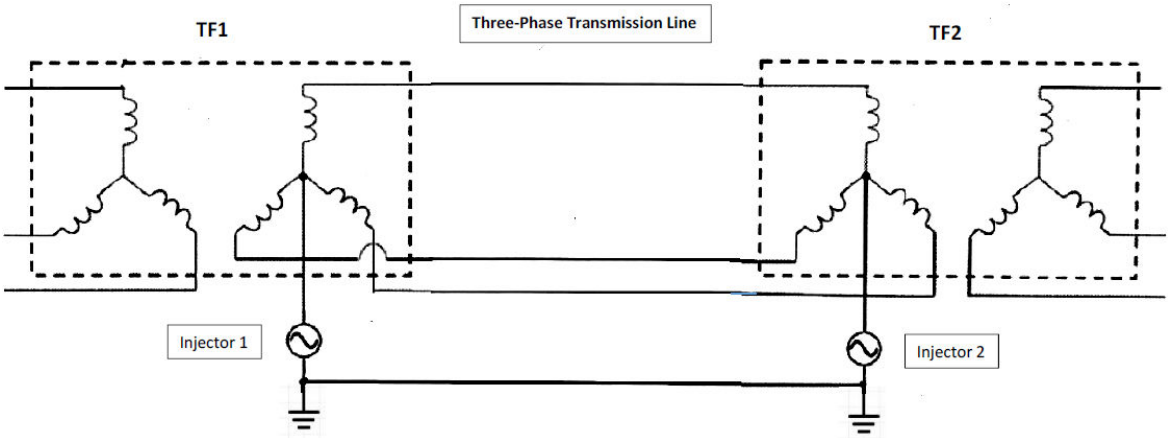
The line-to-ground voltage (short arrow) sets the limit for the line-to line voltage. The power the power line can carry is proportional to the square of the line-to-line voltage.

Triple-harmonic injection allows the line-to-ground voltage to be increased by 15.6%. This permits a theoretical 33% increase in the power that the power line can convey.

This is what the line-to-ground voltage waveform looks like with a third-harmonic component added.



And this is how we add the third harmonic to the line-to-ground voltage waveforms.



The third harmonic is added at the “star point” or junction point of the three phase windings at the sending-end and receiving-end transformers. Normally these star points are connected straight to the ground to fix the line voltages with respect to ground. We insert “injectors” at both star points. This is by far the most economically favourable place to locate the injectors since the main power carrying currents in the line sum to zero at these points and the injectors are relieved of the need to carry these very large currents.

Grid and distribution operators are very used to having the star points of the transformers earthed (connected to ground) and find it hard to envisage a system in which that is not the case. This has been the main objection we encounter to the third harmonic injection arrangement for increasing the power capability of new and already-built power systems. So we have looked at the arguments and devised an injector design which is invisible to the system at the fundamental frequency (50Hz or 60Hz) while providing a source of voltage at three times the fundamental frequency. This concept provides the basic building block of a plug-and-play system which addresses the concerns of the power system operator. We have had an encouraging examiner’s report on our application for a patent for this injector design.

There is more work to be done on the design to address other lesser concerns of operators but we believe we have the main issues solved with the present design. As we refine the design we would like to obtain further patent protection for these improvements and additions. We foresee that the plug-and-play system will be sold by a major equipment manufacturer to grid and distribution system operators. In the meantime we seek a partner to support the on-going work.

3 July 20202.