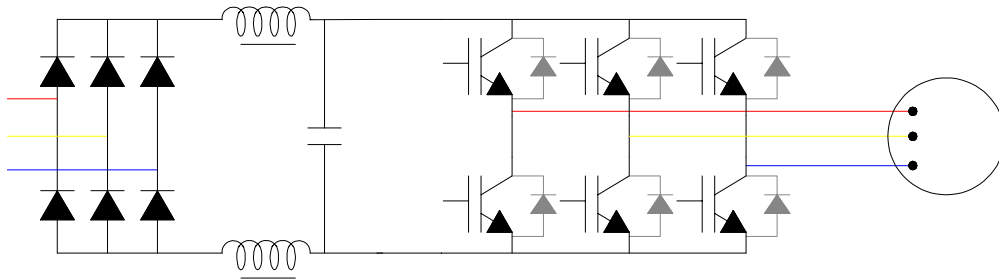


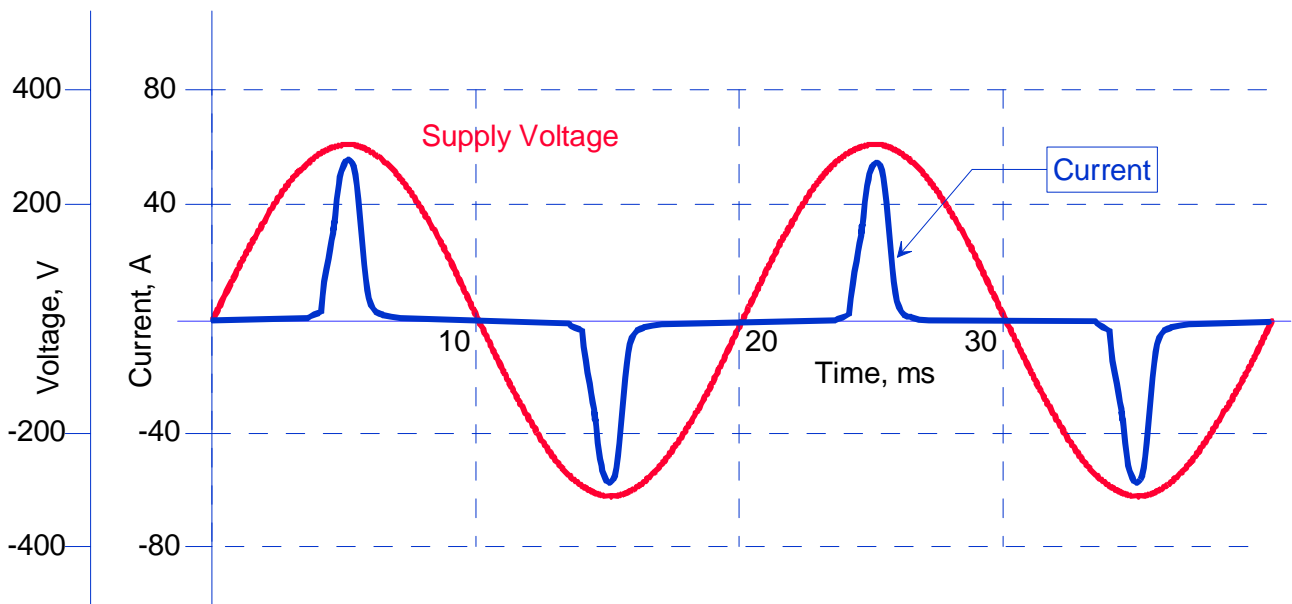
Harmonics

Harmonics are defined as the sinusoidal components of a non-linear periodic waveform with a frequency that is a whole multiple of the fundamental frequency. Putting this simply; any switching operation of the mains supply sine wave will produce lots of other sine waves at higher frequencies. These are not apparent but they are harmful.

Taking a variable speed drive or switch-mode power supply as an example:



The storage capacitor in the centre of the circuit is used to maintain the DC voltage, produced by the input rectifier, at a constant level. However, the DC only requires “topping-up” for part of the mains cycle, so current is drawn in a non-linear manner, at the peaks of the AC supply waveform. Below are the input-voltage and current wave-forms for a single phase, 1.5 kW drive:-



Typical input current waveform for a 1.5 kW PWM drive

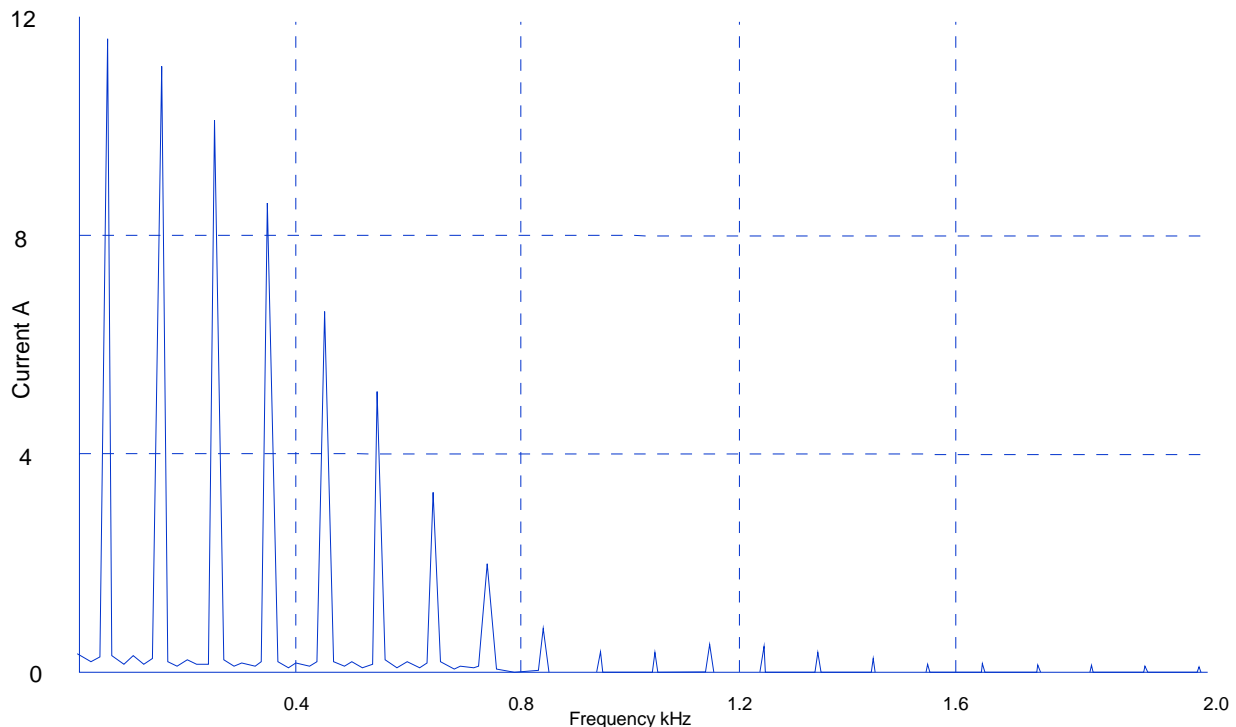
You will see that the current peaks at approximately 60 A. But this is a 1.5 kW drive on a 230V supply and $1500/230 = 6.52$ A..... What is happening?



This fact sheet is one of a series. If you would like to receive other fact sheets or mini guides on a regular basis please contact us on:-
T 01588 673411 **F** 01588 672718 **E** news@reo.co.uk

www.reo.co.uk

If the current waveform is broken down into its component harmonics (using a technique called Fourier analysis), then the harmonic spectrum looks something like this:



Spectrum showing harmonic content of current waveform for 1.5kW PWM drive

There are lots of harmonic currents at higher frequencies and if you add all of these together their sum is approximately 60 A.

This demonstrates one of the main effects of harmonics – exceptionally high currents – and switch-mode power supplies are used everywhere! In computers, televisions, energy-saving bulbs, drives, air-conditioning equipment and phase-angle controllers. Therefore, the limits on harmonics are gradually being tightened; otherwise the supply network cables and transformers would simply not be able to carry sufficient current to satisfy the demand.

Not only this but the harmonic currents cause distortion of the supply voltage waveform, heating of transformers and capacitors, and reduced carrying capacity of cables due to the “skin effect” (the phenomenon of higher frequency currents flowing only in the outer layer of a cable).

From the equipment manufacturers point-of-view it is important to be aware of harmonics because they can cause protective devices and cabling to be seriously under-rated for their required duty. In olden days the loads were usually simple inductive types and capacitors were added to provide power factor correction. Now the loads are much more complex and made up of many different resistive, capacitive reactive and inductive reactive elements. More sophisticated solutions are required to correct for these influences but the term used is curiously still the same – PFC (Power Factor Correction).



This fact sheet is one of a series. If you would like to receive other fact sheets or mini guides on a regular basis please contact us on:-
T 01588 673411 F 01588 672718 E news@reo.co.uk

www.reo.co.uk