MLH Services The Art of Automation

HARMONICS

INTRODUCTION

Modern A.C. drives do not usually create voltage 'spikes', but (as with any equipment containing diode bridge rectifiers) still add harmonic currents to the mains supply.
These harmonic currents do not aid in the transmission of power to a load, but still contribute to the volt-ampere (VA) loading in generating losses in the distribution system.

Line harmonic currents should not be confused with harmonic currents generated in the power to an AC motor. These two conditions are isolated by virtue of the DC link in an AC drive.
There are a few ways of addressing problems with harmonic currents caused by inverters.

On a standard AC drive with a 6 pulse input bridge the 5^{th} and 7th harmonics are where the highest currents are generated so when looking at taking measures to reduce these currents we concentrate on this area

Supply Authorities lay down specific levels of harmonic (G5/3) which should not be exceeded. These levels are measured at the point of common coupling (PCC), i.e. the source where a consumer's supply is connected in parallel with other consumers' supplies. Depending on the installation this may be at 415V, 11KV or even 33KV.

As the levels are monitored at the PCC the actual harmonics generated by an individual inverter can become insignificant against the total load on the site. However on sites with large proportions of inverter load (e.g. Pumping Stations) steps need to be taken to limit the levels of Harmonic.

SYMPTOMS

In extreme cases harmonics can cause problems with your installation:

- Burning of Neutral Conductors
- Interference with electronic equipment.
- Overheating of supply transformers.

Harmonic currents add to the normal line currents, this can have the effect of making the power factor of the drive appear much lower than it actually is (in fact it will be near Unity in most circumstances).

SOLUTIONS

6 PULSE DRIVE SYSTEMS

AC & DC CHOKES

Connecting a 3 Phase reactor in series with the supply to the drive, or a DC reactor in series with the drives DC link will reduce the harmonic currents produced by the inverter and at the same time provide some protection to the drive against mains born "Spikes"

THE PASSIVE FILTER

The Passive Filter is a combination of Inductance and capacitance, which is connected in the 3-phase supply to the drive.

THE BROADBAND FILTER

The broadband filter, like the passive filter is connected into the supply to the drive.

The Inductance & Capacitance elements are tuned to filter out a wider band of frequencies than the passive filter making this a more effective solution.

12 PULSE DRIVE SYSTEMS

The 12 pulse solution is more expensive and involves a different input bridge technology on the drive means that the inverter is generally 60% more expensive and is almost twice the physical size.

It also requires a double wound transformer with 2 secondary windings with a phase shift between them, which is normally mounted outside the panel or switch room and is a further addition to the cost of the drive system.

ACTIVE FILTERS

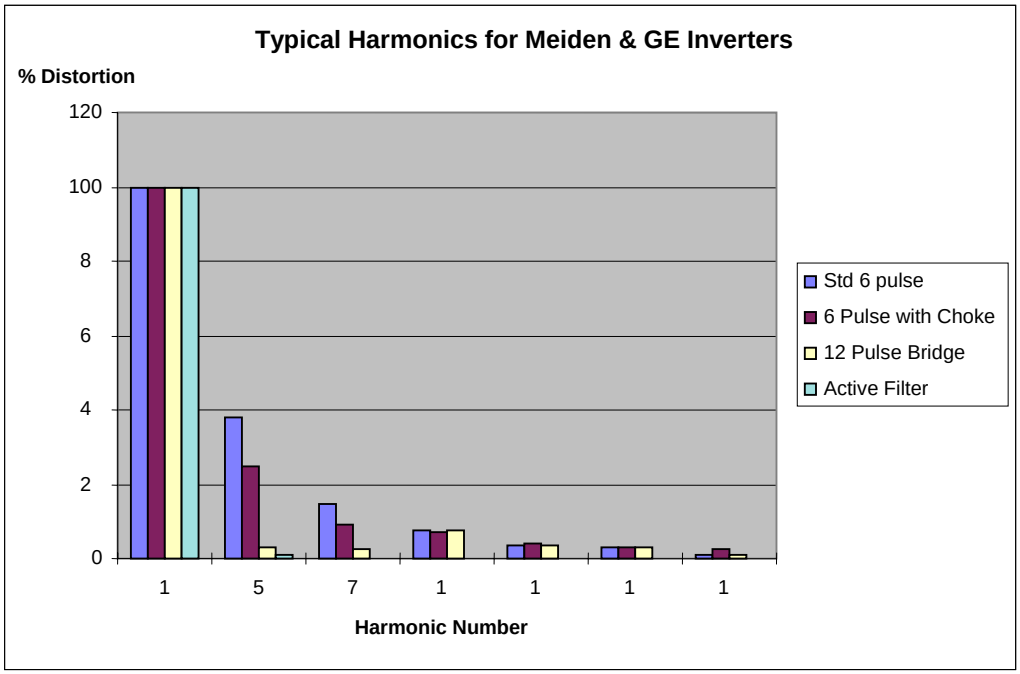
Active filters form part of the drive and replace the normal input bridge rectifier with an IGBT front end (Similar to the output stage of the inverter).

This is the ideal solution as it almost eliminates all the harmonics present. However the down side is the price as this is by far the most expensive and also as it is a part of the drive the physical size of the unit will almost treble.

These units have the added advantage of allowing regeneration into the supply during braking.

TYPICAL HARMONIC LEVELS

The actual level of harmonics generated depends on the impedance of the power supply but the following graph gives some idea of the currents which can be expected.



The '1st Harmonic' shown is sometimes called the "Fundamental" and is always 100 % because it's the current drawn at 50 Hz.

HARMONIC LEVELS PERMITTED BY G5/3

	Harmonic Number																	
PCC	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
415V	48	34	22	56	11	40	9	8	7	19	6	16	5	5	5	6	4	6
6,600-11,000V	13	8	6	10	4	8	3	3	3	7	2	6	2	2	2	2	1	1
33,000	11	7	5	9	4	5	3	2	2	6	2	5	2	1	1	2	1	1
132,000	5	4	3	4	2	3	1	1	1	1	1	3	1	1	1	1	1	1

- The above value shows the maximum level in AMPS at the point of common coupling for the site.
- In order to relate a drive with a 415V input to a high supply voltage at the point of common coupling, use simple algebra so that a 5^{th} Harmonic Current of 56 A at 415 V equates to an 11 kV value of 2A.
- A tolerance of +/- 10 % (whichever is greater) is permissible , provided it applies to not more than 2 harmonics
- The cumulative harmonic effect of multiple drives is calculated by adding all the values for each harmonic number together and multiplying by 0.9