XP Power

XPerts in Power - Module 4
Harmonics

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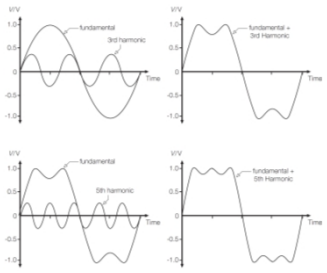
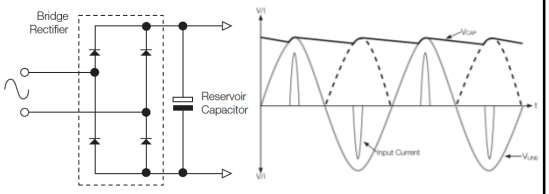
Module Content

- What is a harmonic?
- Power supply harmonic distortion
- Why is power supply harmonic distortion a problem?
- Legislation
- Solutions in power supplies
  - Passive power factor correction
  - Active power factor correction
- Advantages and disadvantages
- Real and apparent power & efficiency
- A practical look at harmonic distortion & power factor

What is a Harmonic



Power supply harmonic distortion



Better power factor = Lower harmonics because waveforms are cleaner

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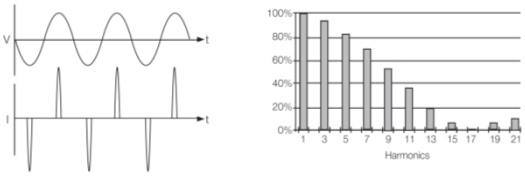
Power Supply Harmonic Distortion



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Why is Harmonic Distortion a Problem ?

- Need to supply apparent power
- Ability to charge for apparent power
- Mains voltage distortion
- Over-sizing of power conductors
- Overheating Neutral conductors

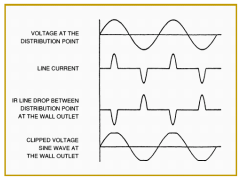

FIGURE 16.
Waveforms illustrating the peak flattening effect that the narrow current pulses impose on the mains voltage

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Legislation

- EN61000-3-2
  - Only applies in Europe
  - Measured at 230Vac
  - Harmonic current distortion by harmonic up to 40
  - AC supplies up to 16A per phase
  - Class A - All equipment not in B,C or D
  - Class B - Portable tools
  - Class C - Lighting
  - Class D - PC's, PC monitors & colour TV

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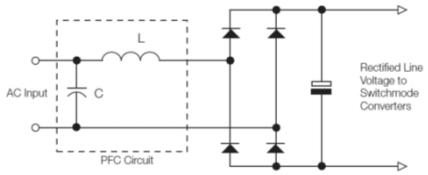
Power Factor Correction in PSUs - Passive



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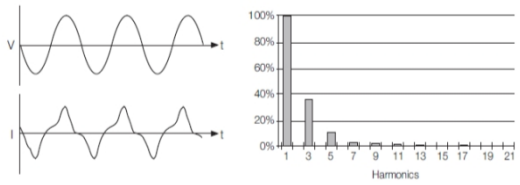
Power Factor Correction in PSUs - Passive



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Passive PFC Advantages & Disadvantages

Advantages	Disadvantages
Simple	Heavy & bulky components (50Hz)
Cost effective	AC range switching required
Reliable & rugged	Low Power Factor (high input current)
No noise (EMI)	Cannot use multiple power supplies
Assists filtering	

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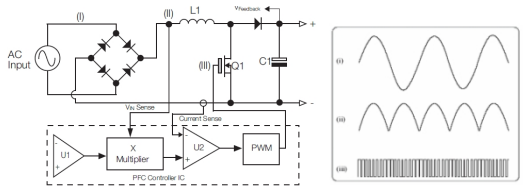
Power Factor Correction in PSUs - Active



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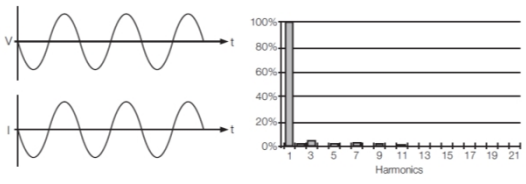
Power Factor Correction in PSUs - Active



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Active PFC Advantages & Disadvantages

Advantages
current
Universal
High Power factor >0.9
Low input current
Regulated high voltage bus
Hold-up time
EN61000-4-11
Multiple power stages

Disadvantages

High cost
High complexity
High component count
Lower MTBF (calculated)

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Real & Apparent Power and Efficiency

Power (W) = Voltage (V) x Current (I)

- Real power is the useful power into the converter & must be used for efficiency calculations
- Apparent power is the power the mains must supply to the converter
- Power factor is a measure of the amount of ***useful*** power that is being drawn from the mains supply

Power (W) = Apparent Power (VA) x Power Factor (PF)

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Real & Apparent Power and Efficiency

Eff (%) = (output power (W) / input power (W)) x 100

Input power = Input voltage x Input current x PF

Output power = Output voltage x Output current

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Practical for Harmonic Distortion & Power Factor

Non Power Factor Corrected Power Supply

Passive Power Factor Corrected Power Supply

Active Power Factor Corrected Power Supply

Input voltage and current waveforms
Input current measured values
Measurement of harmonic currents & Power Factor

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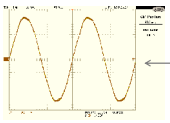
AC Mains Distortion in Pangbourne

As provided from wall socket



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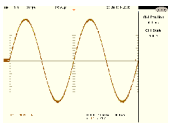
As provided from AC source



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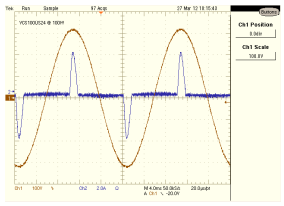
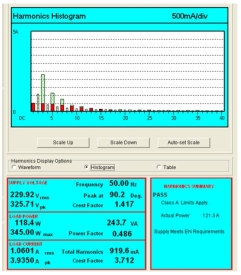
VCS100US24 - non PFC Power Supply @ 100W





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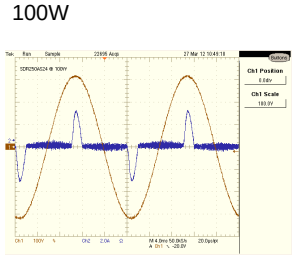
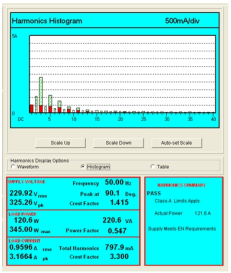
SDR250AS24 - Passive PFC Power Supply @ 100W





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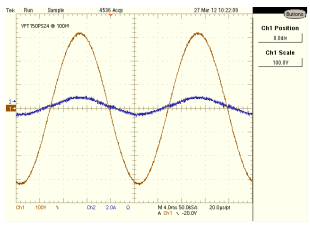
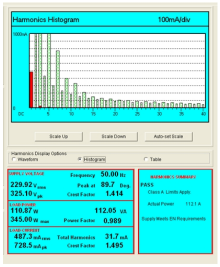
VFT150PS24 - Active PFC Power Supply @ 100W





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