Another EMC resource
from EMC Standards

13+14: Suppressing emissions of mains harmonics, voltage fluctuations and flicker

Helping you solve your EMC problems

1 Brassey Road, Old Potts Way, Shrewsbury, SY3 7FA T:+44 (0) 1785 660 247 E:info@emcstandards.co.uk

Modules 13+14: Suppressing emissions of mains harmonics, voltage fluctuations and flicker

(covers the mains harmonics emitted by rectifier-capacitor AC-DC converters)

Keith Armstrong CEng, FIET, Senior MIEEE, ACGI, EurIng(Gp1)
phone/fax: +44 (0)1785 660 247
keith.armstrong@cherryclough.com
www.cherryclough.com www.emcstandards.co.uk

Good Electromagnetic (EM) Engineering…

- is cost-effective SI, PI and EMC engineering: well-proven to save time & money in all lifecycle stages, helping to increase profits & reduce financial risks…
- for PCBs, modules, sub-assemblies, devices, products, equipment, vehicles, sub-systems, systems, installations, etc., etc.; of <u>any</u> size, in <u>all</u> applications
- *see Module 1 especially 1.15 (also in Webinar 1c) and 1.16 (also in Webinar 1d)*

■ <u>This</u> Module contains many EM Engineering guidelines that should *also* be used as an initial design checklist: *any that <u>can't</u> or <u>won't</u> be followed identify a project risk!* *see Module 1, section 1.16 (also in Webinar 1d)*

- to adapt any λ-based design guidelines to different EMC standards, *see Module 1, section 1.18 (also in Webinar 1d)*

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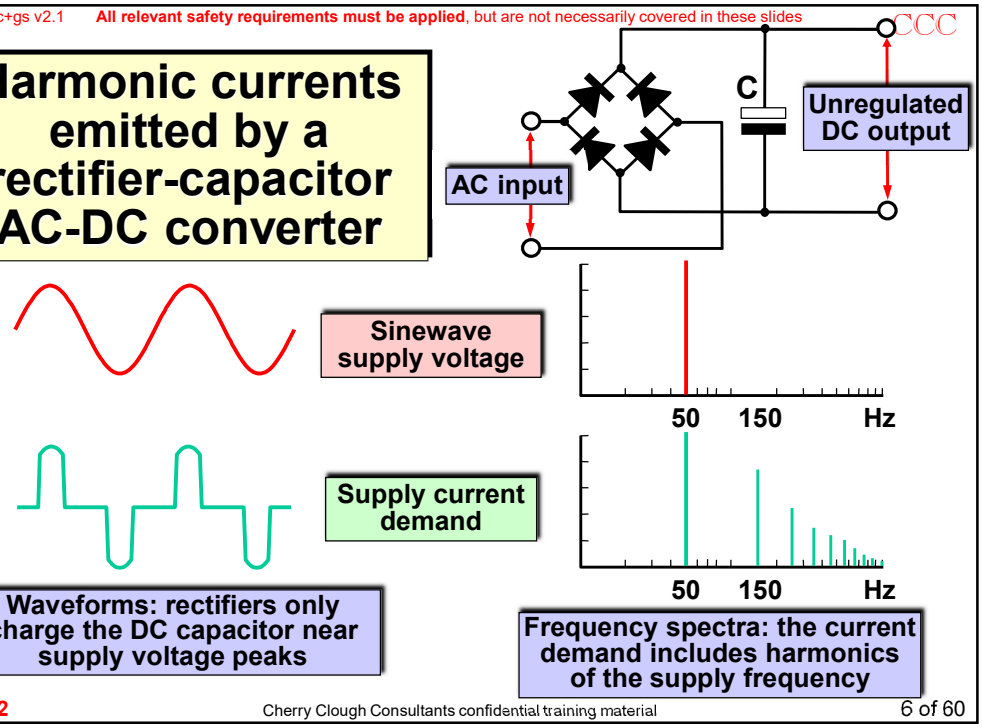
13.1

The mains harmonic currents emitted by rectifier-capacitor AC-DC power converters

Harmonic currents emitted by a rectifier-capacitor AC-DC converter



Power Factor (PF)

- **True PF = Total Watts / Total VA**
  - harmonic currents are not in phase with the supply voltage, so they increase the VA but not the Watts
    - design to reduce harmonic emissions is often known as Power Factor Correction (PFC)
  - don't get confused with 'Power Factor' as traditionally used by electrical supply engineers
    - which simply means the cosine of the phase angle between the sine-wave supply voltage and a sine-wave load current – only relevant for *linear* loads

13. Suppressing mains harmonics

13.2

Smaller values of storage capacitor, and the "Valley Fill" method

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Using smaller values of unregulated DC storage capacitor

- Smaller values cause the capacitor to discharge more during each mains cycle…
  - increasing the firing angle (on-time) of the rectifiers and so reduces the harmonic emissions…
    - but not by a large amount (the capacitor would have to be reduced to zero to achieve power factors approaching 1)…
  - AND the following circuit must operate correctly despite the increased ripple on the DC rail
- This technique has been used in powerful variable-speed (i.e. inverter) AC motor drives

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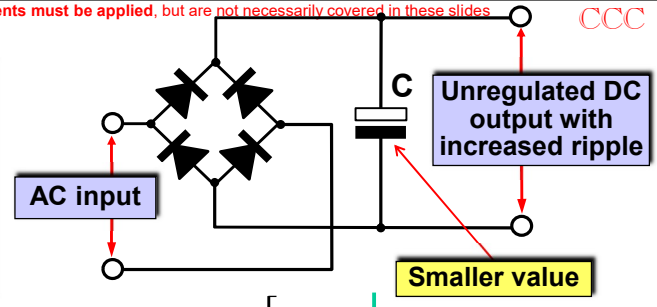
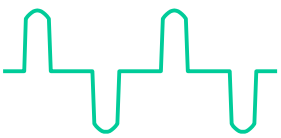
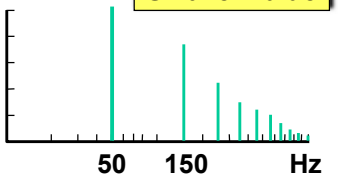
emc14c+gs v2.1 **All relevant safety requirements must be applied**, but are not necessarily covered in these slides

Using smaller values of unregulated DC storage capacitor continued…

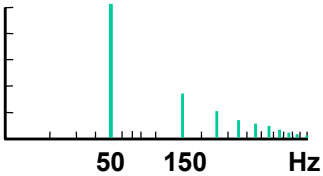




Supply current demand with large capacitor



Supply current demand with smaller capacitor – lower harmonic emissions



Current waveform

Spectrum of the current

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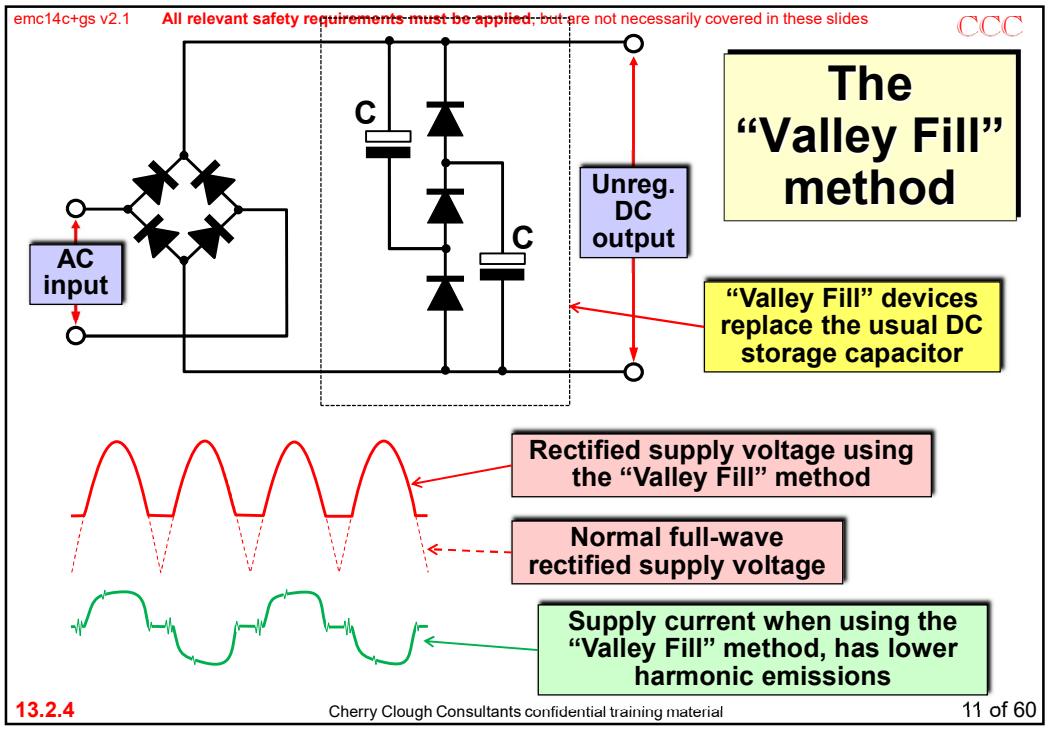
emc14c+gs v2.1
All relevant safety requirements must be applied, but are not necessarily covered in these slides
CCC
The "Valley Fill" method
C
C
AC input
Unreg. DC output
"Valley Fill" devices replace the usual DC storage capacitor
Rectified supply voltage using the "Valley Fill" method
Normal full-wave rectified supply voltage
Supply current when using the "Valley Fill" method, has lower harmonic emissions
13.2.4
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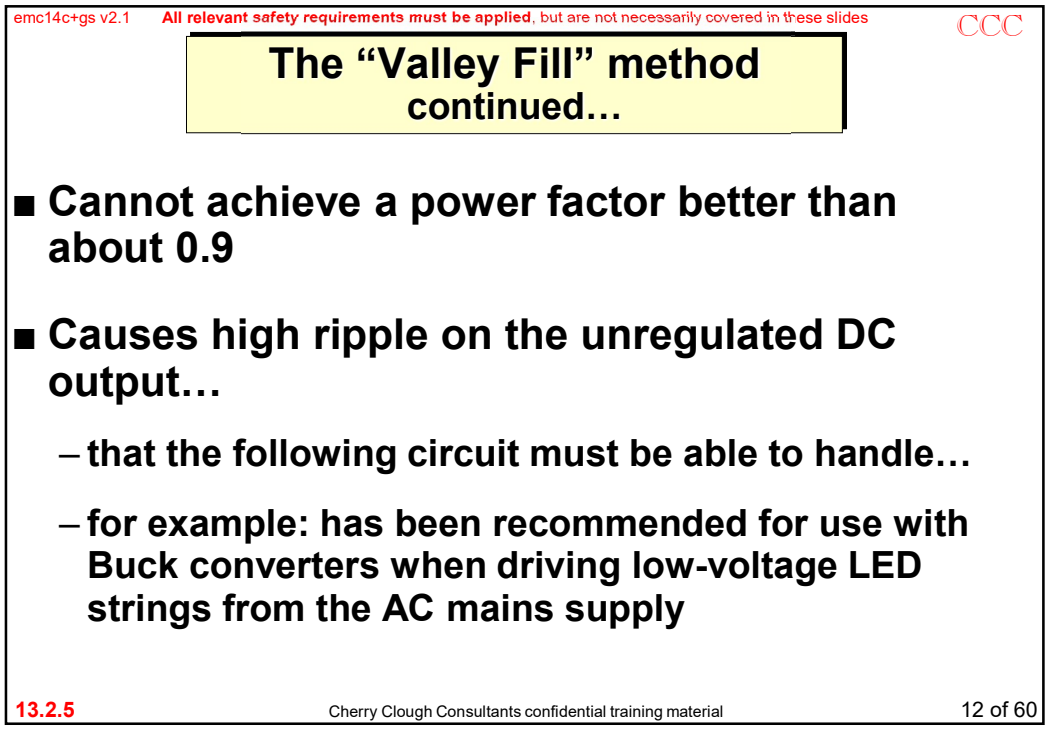
emc14c+gs v2.1
All relevant safety requirements must be applied, but are not necessarily covered in these slides
CCC
The "Valley Fill" method continued…
■ Cannot achieve a power factor better than about 0.9
■ Causes high ripple on the unregulated DC output…
– that the following circuit must be able to handle…
– for example: has been recommended for use with Buck converters when driving low-voltage LED strings from the AC mains supply
13.2.5
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