EE-463 STATIC POWER CONVERSION-I

A Few Important Converters

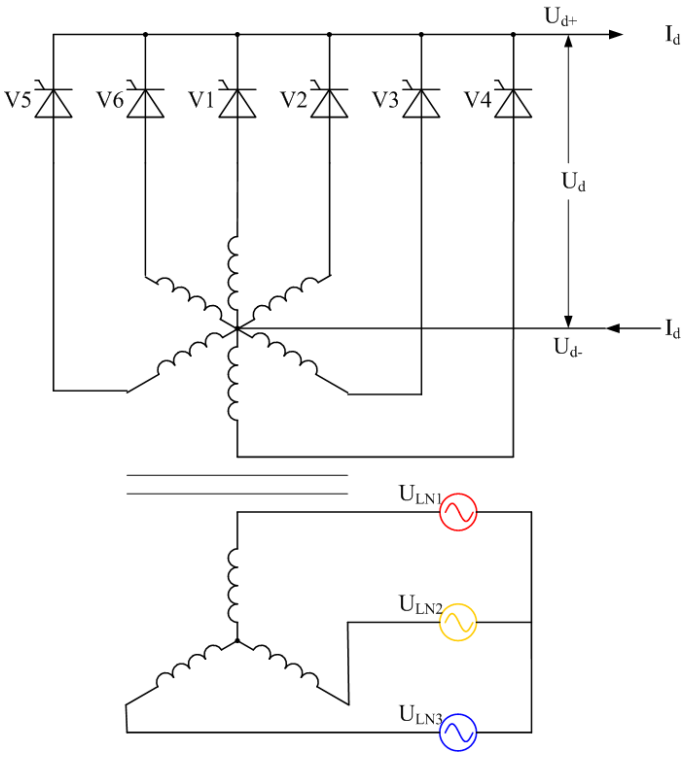
Ozan Keysan

keysan.me

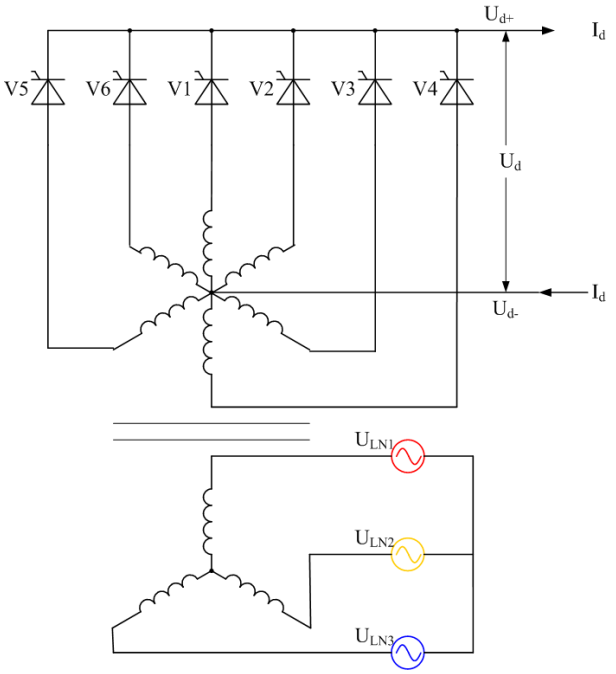
Office: C-113 • Tel: 210 7586

What's the name of this rectifier?

What's the name of this rectifier?



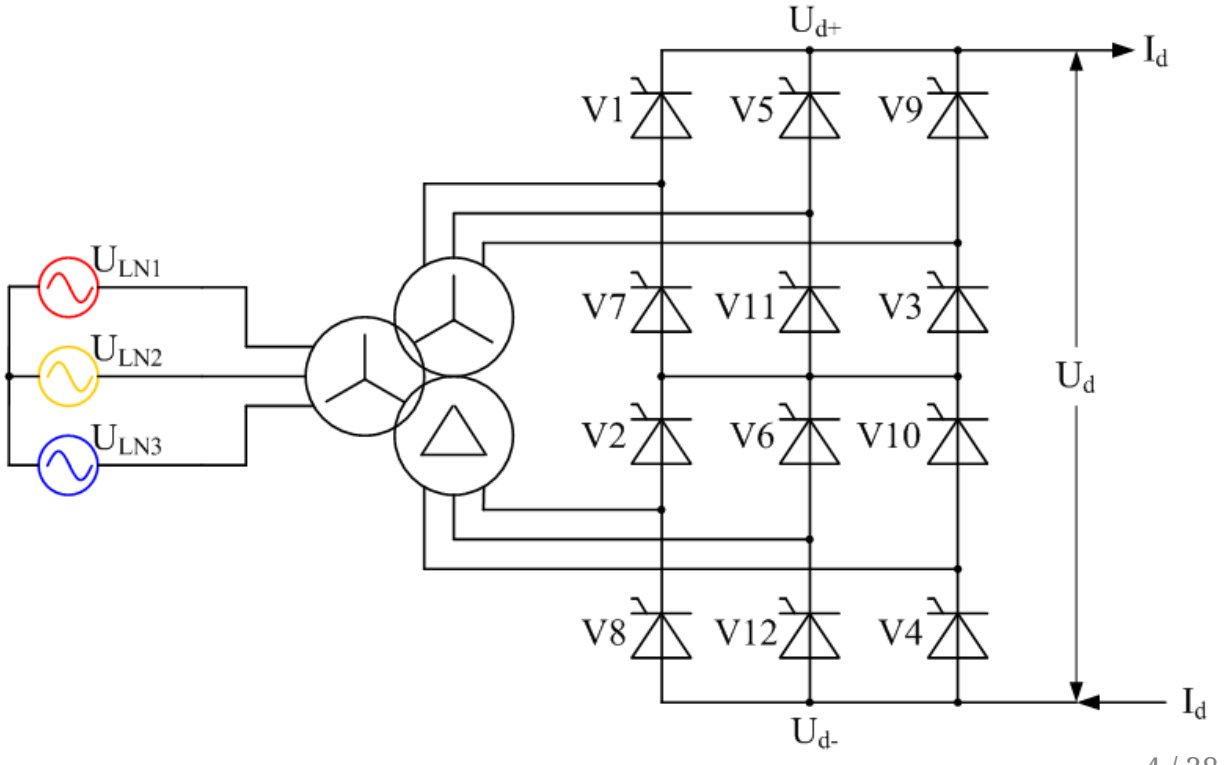
6-pulse (Diode or Thyristor) Rectifier



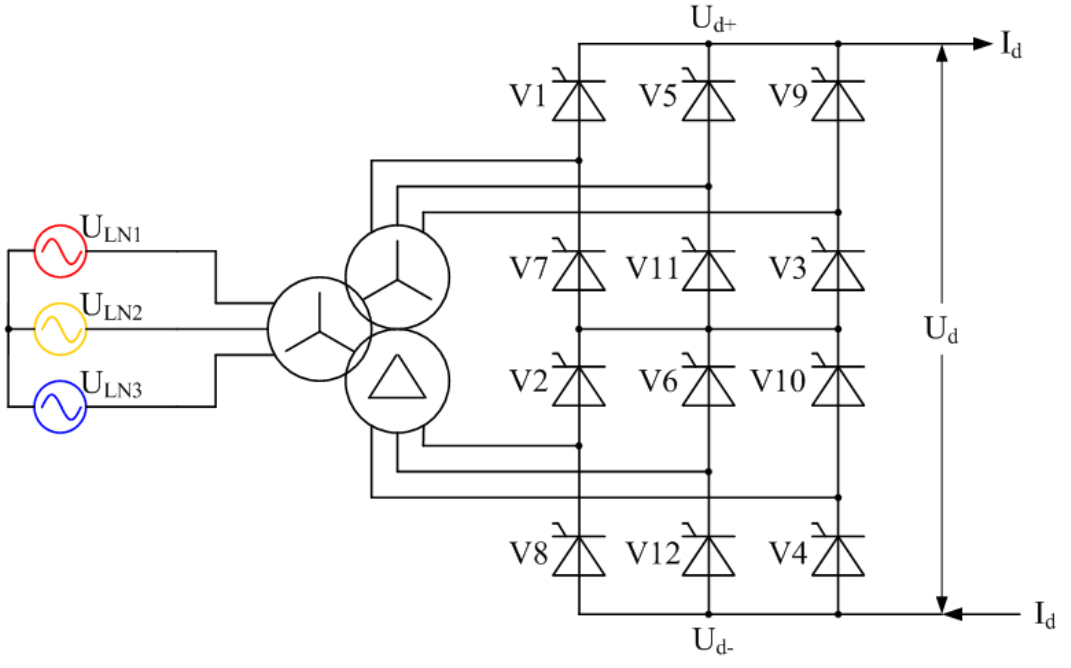
Identical to 3-phase full bridge rectifier

What's the name of this rectifier?

What's the name of this rectifier?

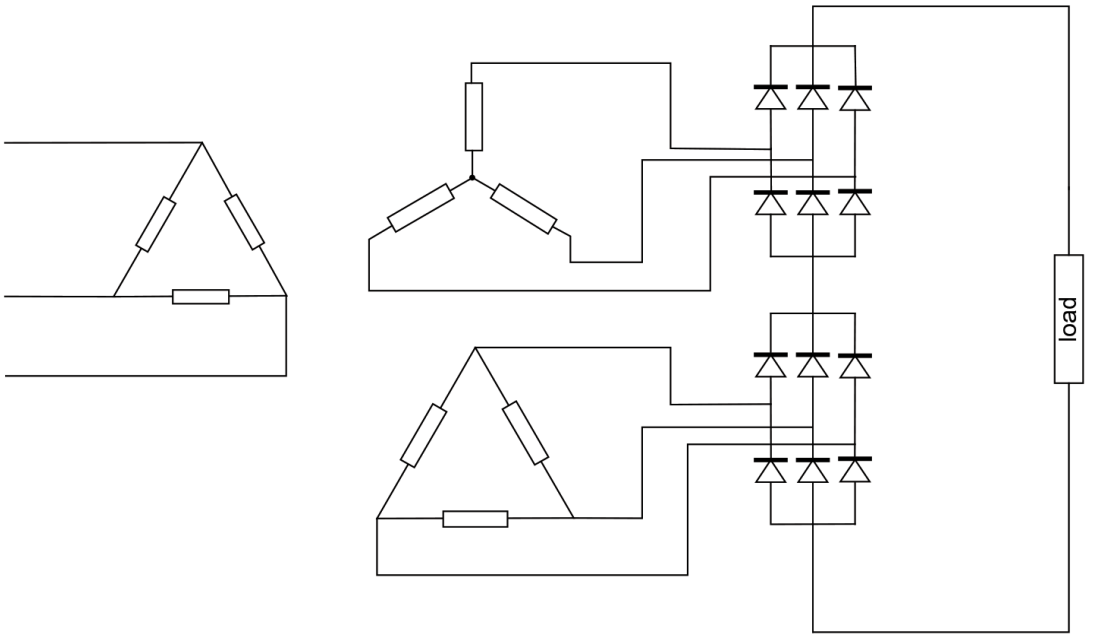


12-pulse Rectifier



Reading: Power Electronics, Lander, Section 2-9

12-pulse Rectifier: Source Side



Two secondary windings: Delta and Wye connected

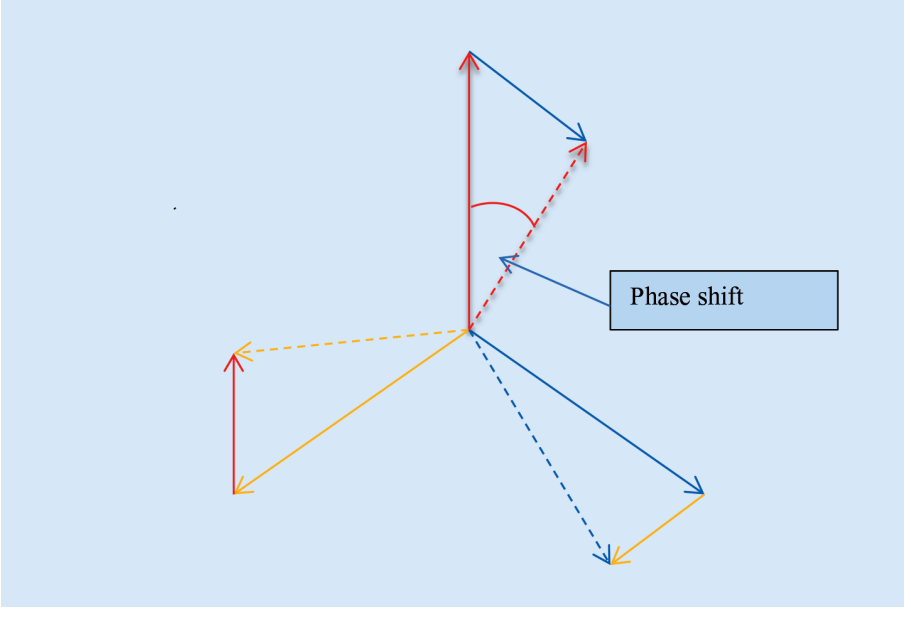
How can you obtain 24 pulse, or 48 pulse?

How can you obtain 24 pulse, or 48 pulse?

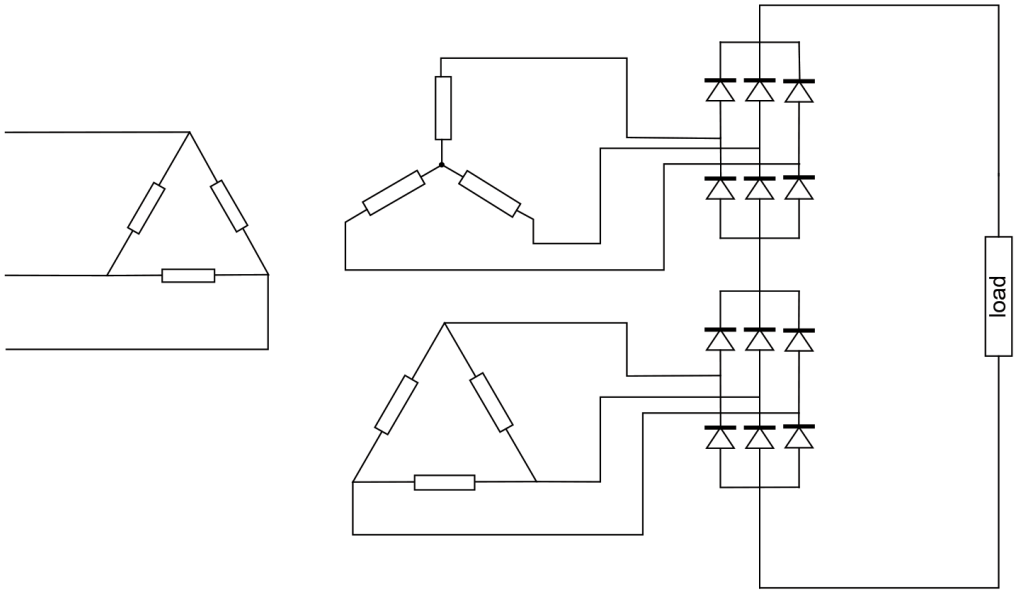
Phase Shifting Transformer

How can you obtain 24 pulse, or 48 pulse?

Phase Shifting Transformer



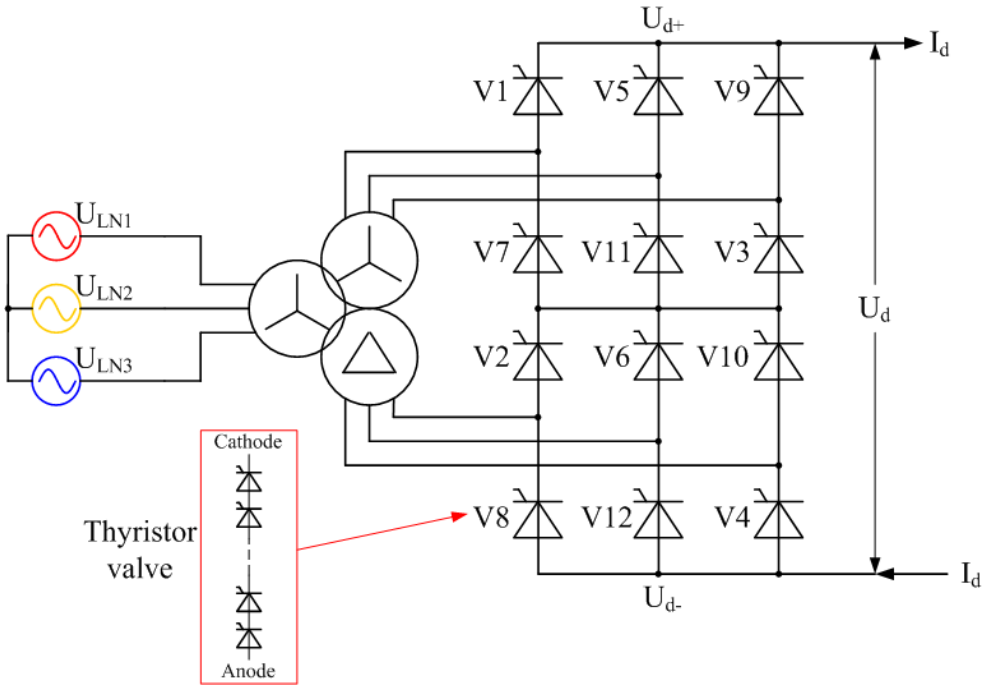
12-pulse Rectifier: Devices



What is the rated device voltages compared to output voltage?

12-pulse Rectifier

Used in HVDC systems with series devices

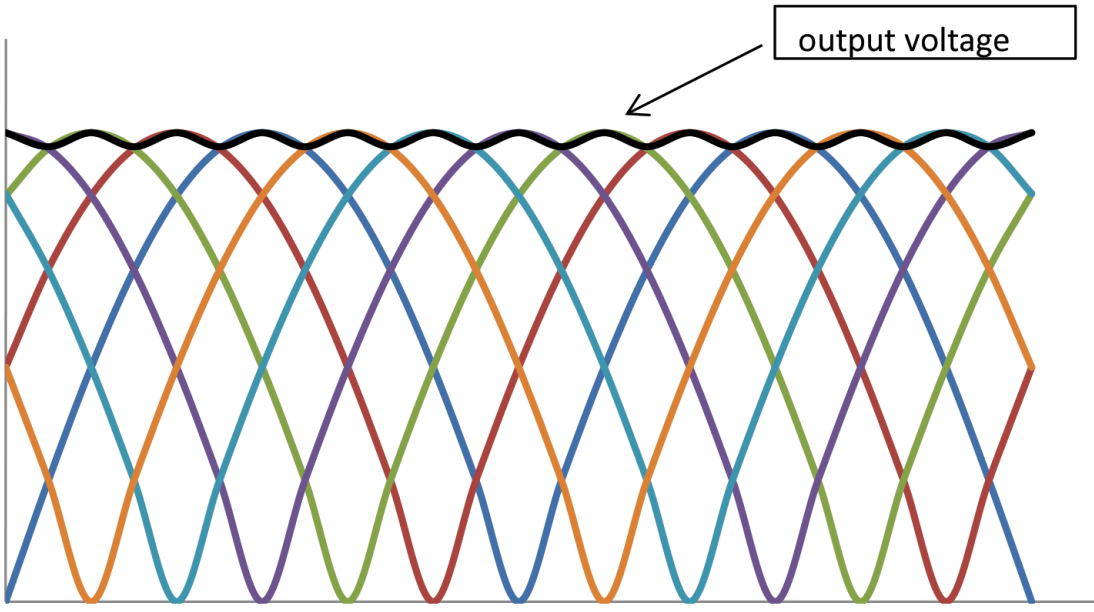


12-pulse Rectifier: Output

Can you plot the voltage waveform?

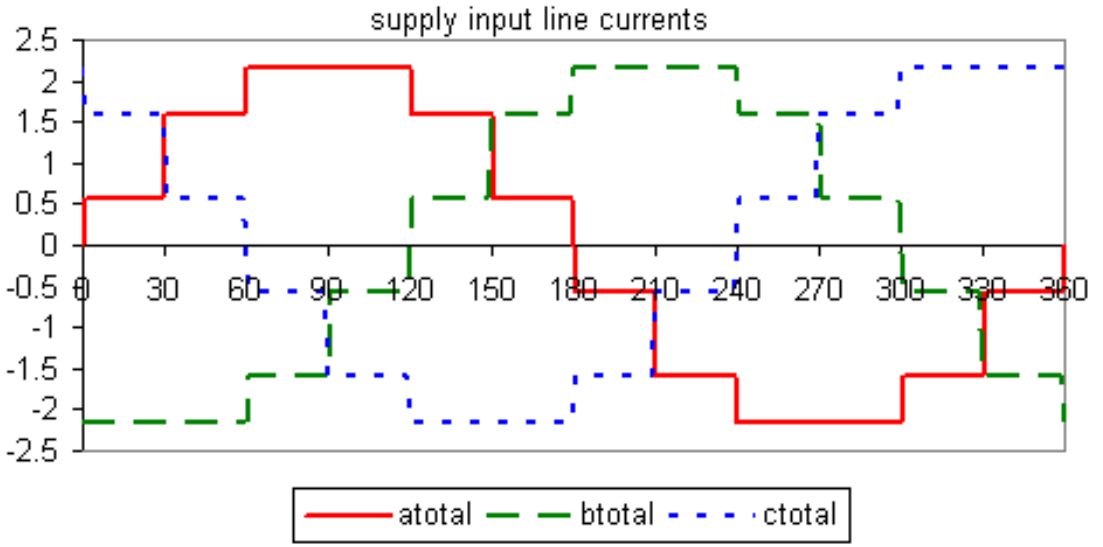
12-pulse Rectifier: Output

Can you plot the voltage waveform?



12-pulse Rectifier: Input

12-pulse Rectifier: Input



What about harmonics?

What about harmonics?

- 6 pulse:

What about harmonics?

- 6 pulse: 5th, 7th harmonics (no triple harmonics)

What about harmonics?

- 6 pulse: 5th, 7th harmonics (no triple harmonics)
- 12 pulse:

What about harmonics?

- 6 pulse: 5th, 7th harmonics (no triple harmonics)
- 12 pulse: 11th, 13 th harmonics

$$h = n * 12 \pm 1$$

What about harmonics?

- 6 pulse: 5th, 7th harmonics (no triple harmonics)
- 12 pulse: 11th, 13 th harmonics

$$h = n * 12 \pm 1$$

- 18 pulse:

What about harmonics?

- 6 pulse: 5th, 7th harmonics (no triple harmonics)
- 12 pulse: 11th, 13 th harmonics

$$h = n * 12 \pm 1$$

- 18 pulse: 17th, 19th

What about harmonics?

- 6 pulse: 5th, 7th harmonics (no triple harmonics)
- 12 pulse: 11th, 13 th harmonics

$$h = n * 12 \pm 1$$

- 18 pulse: 17th, 19th
- 24 pulse:

What about harmonics?

- 6 pulse: 5th, 7th harmonics (no triple harmonics)
- 12 pulse: 11th, 13 th harmonics

$$h = n * 12 \pm 1$$

- 18 pulse: 17th, 19th
- 24 pulse: 23rd, 25th

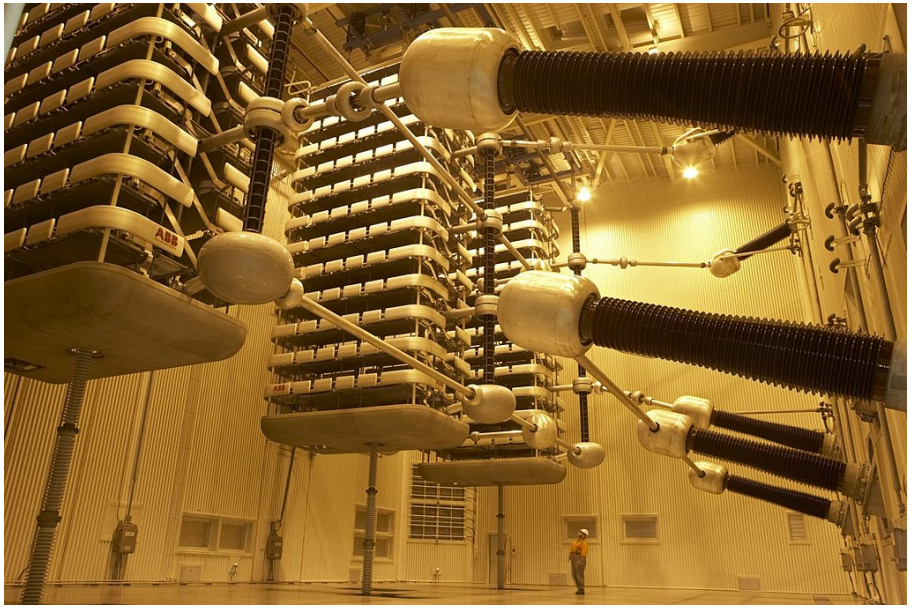
What about harmonics?

	Harmonic order (h)	5	7	11	13	17	19	23	25	THD_i
Typical values of harmonic current (% of fundamental current) of different types of front end configurations (% I_h / I_1)	6-pulse without line reactor (Stiff source)	80.0%	58.0%	18.0%	10.0%	7.0%	6.0%	5.0%	2.5%	**101.5%**
	6-pulse with 2-3% line reactor	40.0%	15.0%	5.0%	4.0%	4.0%	3.0%	2.0%	2.0%	**43.6%**
	6-pulse with 5% line reactor	32.0%	9.0%	4.0%	3.0%	3.0%	2.0%	1.5%	1.0%	**33.9%**
	6-pulse with line harmonic filter (LHF)	2.5%	2.5%	2.0%	2.0%	1.5%	1.0%	0.5%	0.5%	**4.9%**
	12-pulse	3.7%	1.2%	6.9%	3.2%	0.3%	0.2%	1.4%	1.3%	**8.8%**
	18-pulse	0.6%	0.8%	0.5%	0.4%	3.0%	2.2%	0.5%	0.3%	**3.9%**

NOTE: Relative short circuit ratio of the power system is assumed to be between 20 to 50. For a relative short circuit ratio higher than 50 (strong supply system), the values in table above will be higher.

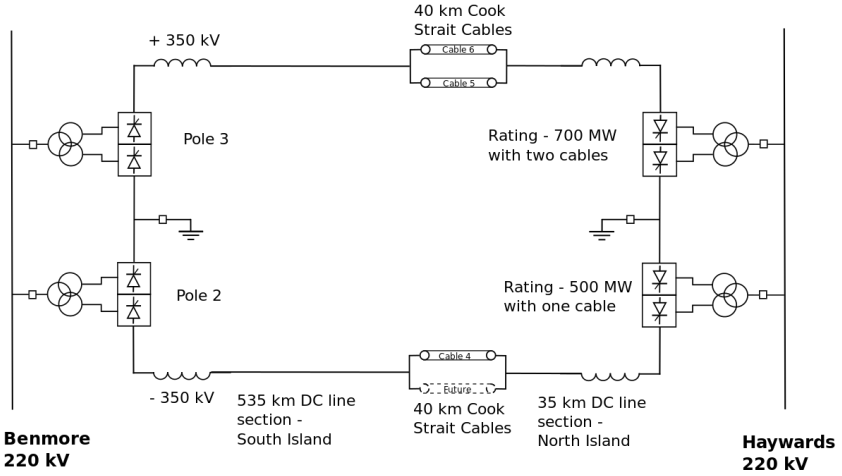
HVDC Rectifiers

How does it look like?



12-pulse thyristor converter for Pole 2 of the HVDC Inter-Island between the North and South Islands of New Zealand (± 350kV).

How does it look like?



12-pulse thyristor converter for Pole 2 of the HVDC Inter-Island between the North and South Islands of New Zealand.

- ABB HVDC
- Siemens HVDC
- Thyristors – The heart of HVDC

Even more pulses?

Even more pulses?

24 Pulse

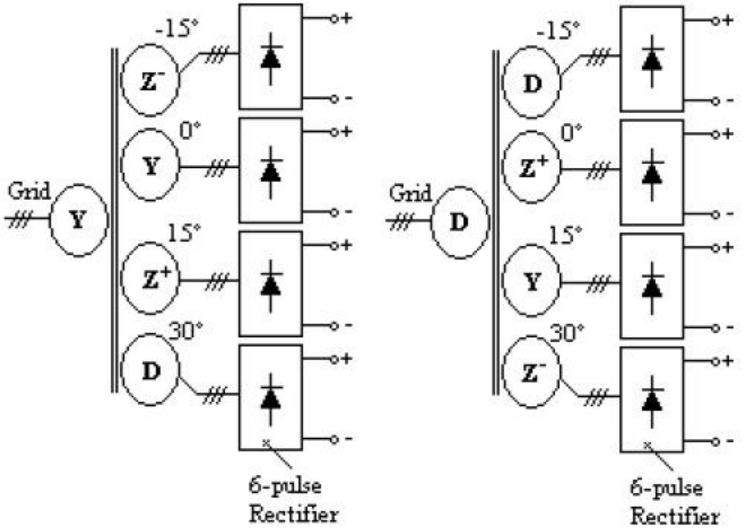
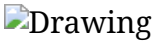


Figure 6. Using zig-zag transformer for reducing systems' harmonic content

Even more pulses?

48 Pulse



Frequency Conversion:

Frequency Conversion:

Cycloconverters

Frequency Conversion:

Cycloconverters

Converts AC to (lower frequency) AC

Frequency Conversion:

Cycloconverters

Converts AC to (lower frequency) AC

No need to have DC-link

Frequency Conversion:

Cycloconverters

Converts AC to (lower frequency) AC

No need to have DC-link

Used in MW-sized motor drives (ships, mines, traction)

- ABB Brochure, discontinued
- Siemens Sinamics

Reading: Power Electronics, Lander, Chapter 5

Cycloconverters

Cycloconverters

Simplest Case

Single Phase to Single Phase

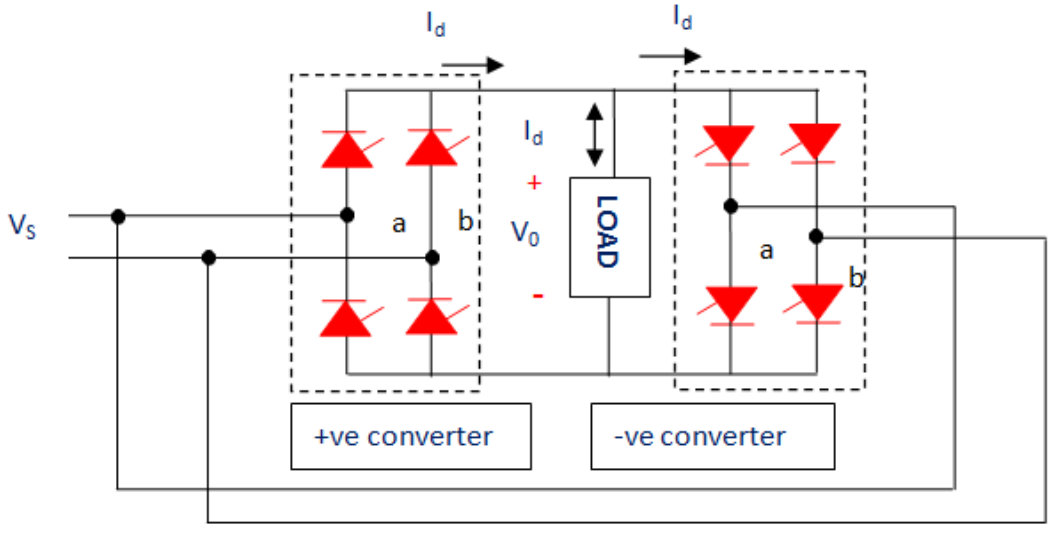


Figure 2

Cycloconverters

Simplest Case

Single Phase to Single Phase

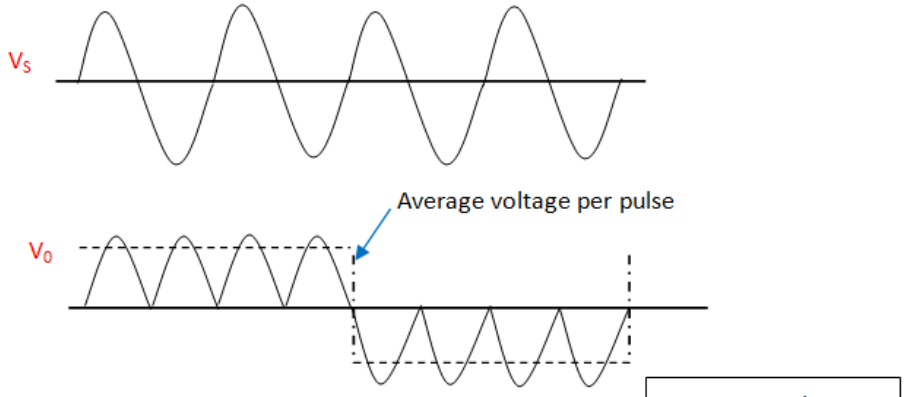


Figure 3

V_S – Input Voltage

V_0 – Output Voltage

Cycloconverters

Three Phase to Single Phase

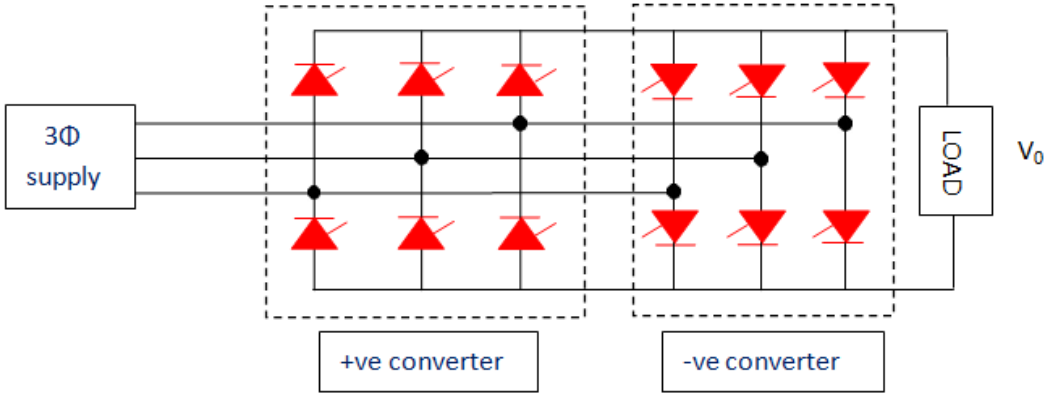
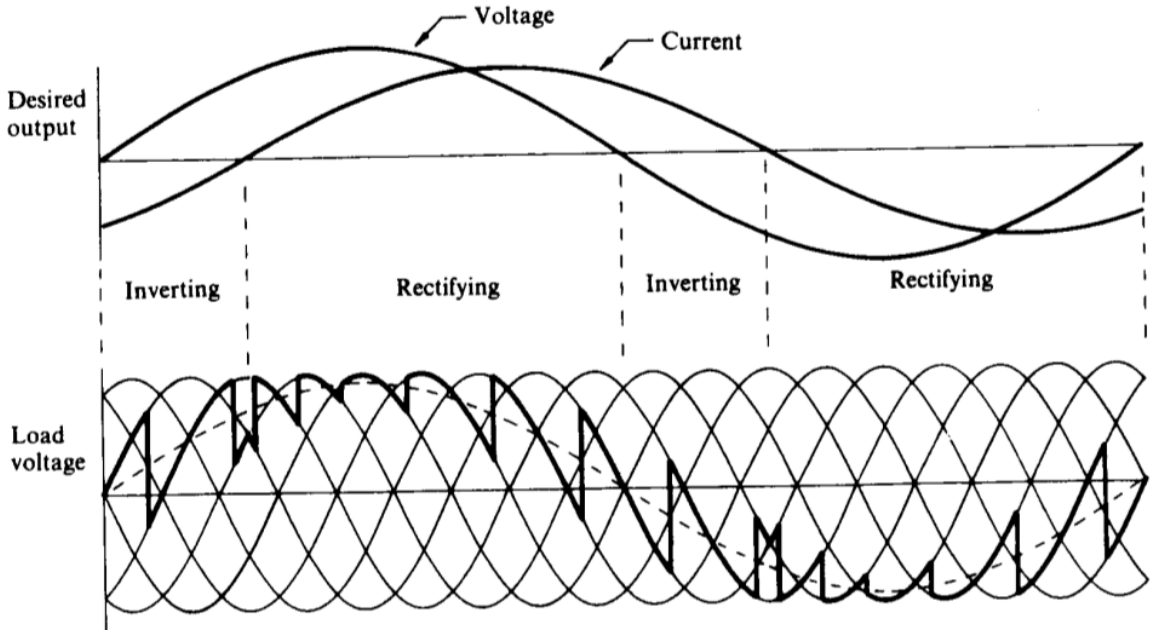


Figure 4

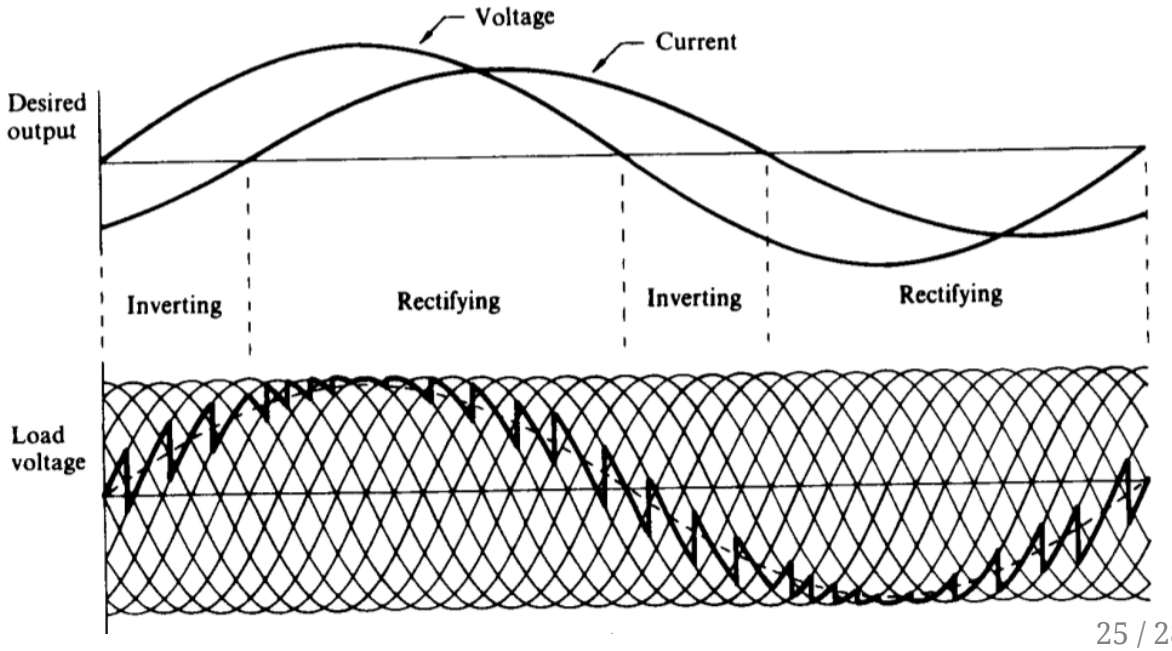
Cycloconverters

Three Phase to Single Phase (with 6 pulse)



Cycloconverters

Three Phase to Single Phase (with 12 pulse)



Cycloconverters

Three Phase to Three Phase (6 pulse)

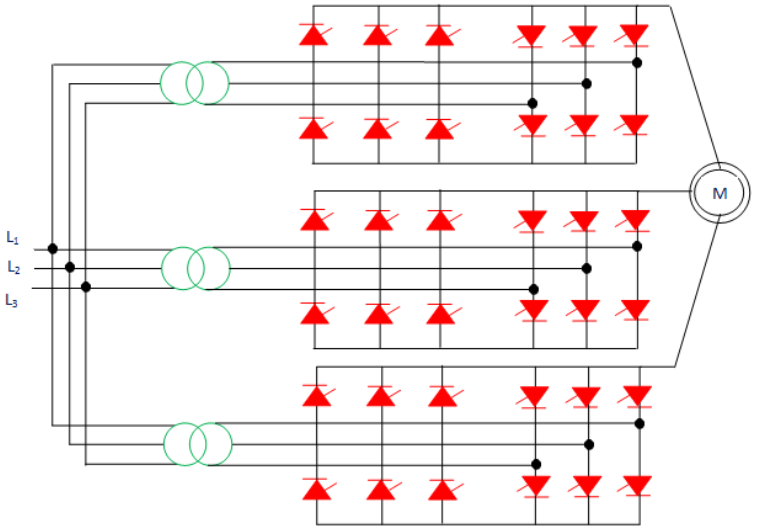
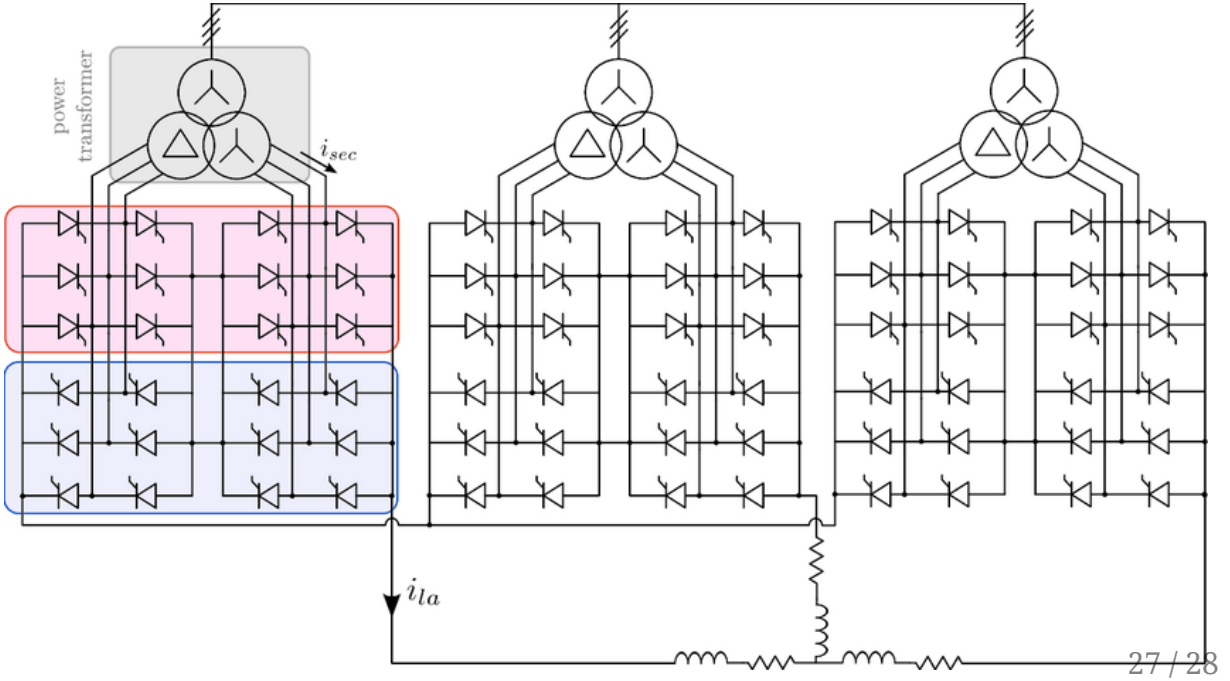


Figure 5

Cycloconverters

Three Phase to Three Phase (12 Pulse!)



You can download this presentation from:
keysan.me/ee463