

VSD – Eficiente energetica



Contact EATON

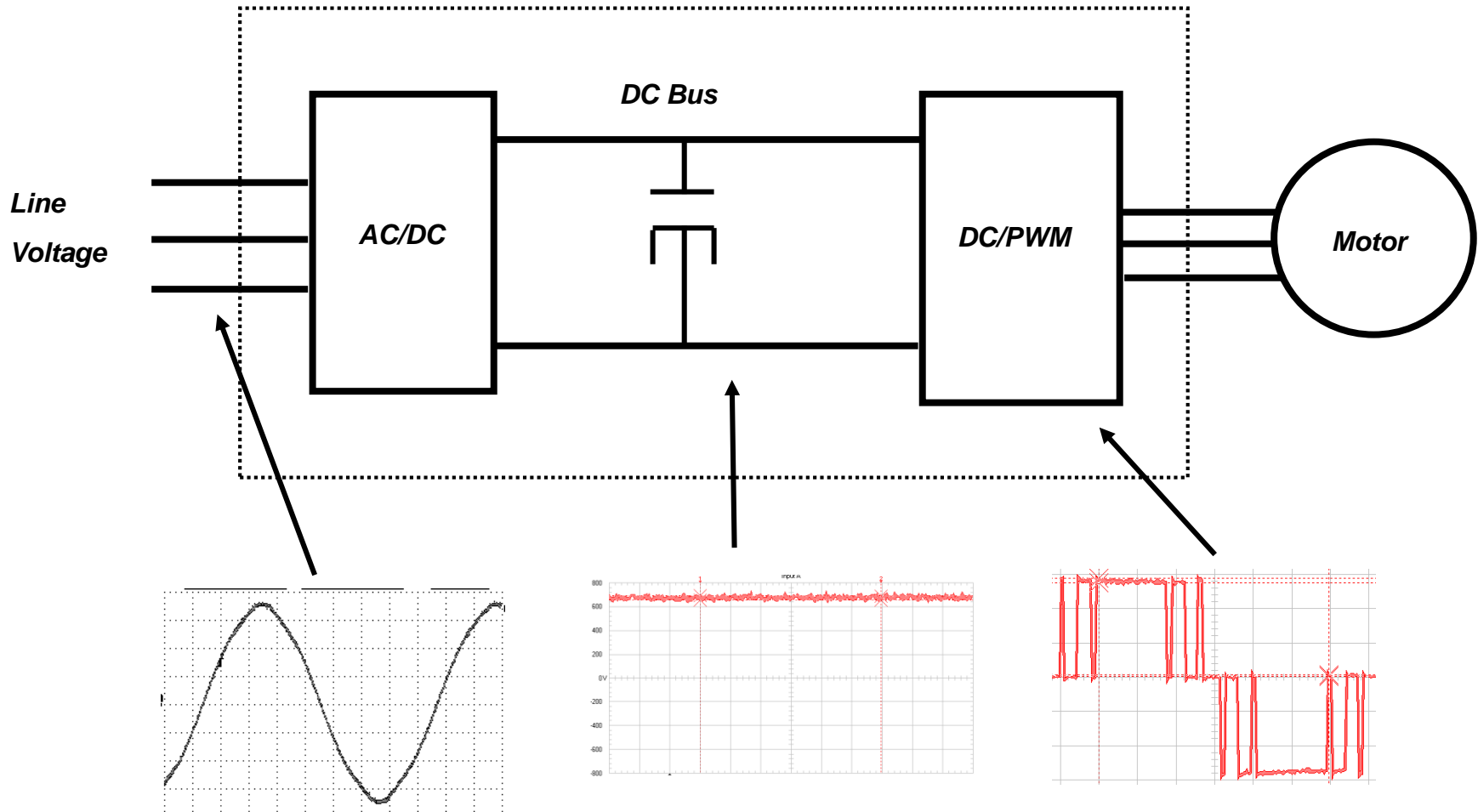
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- Departament OEM
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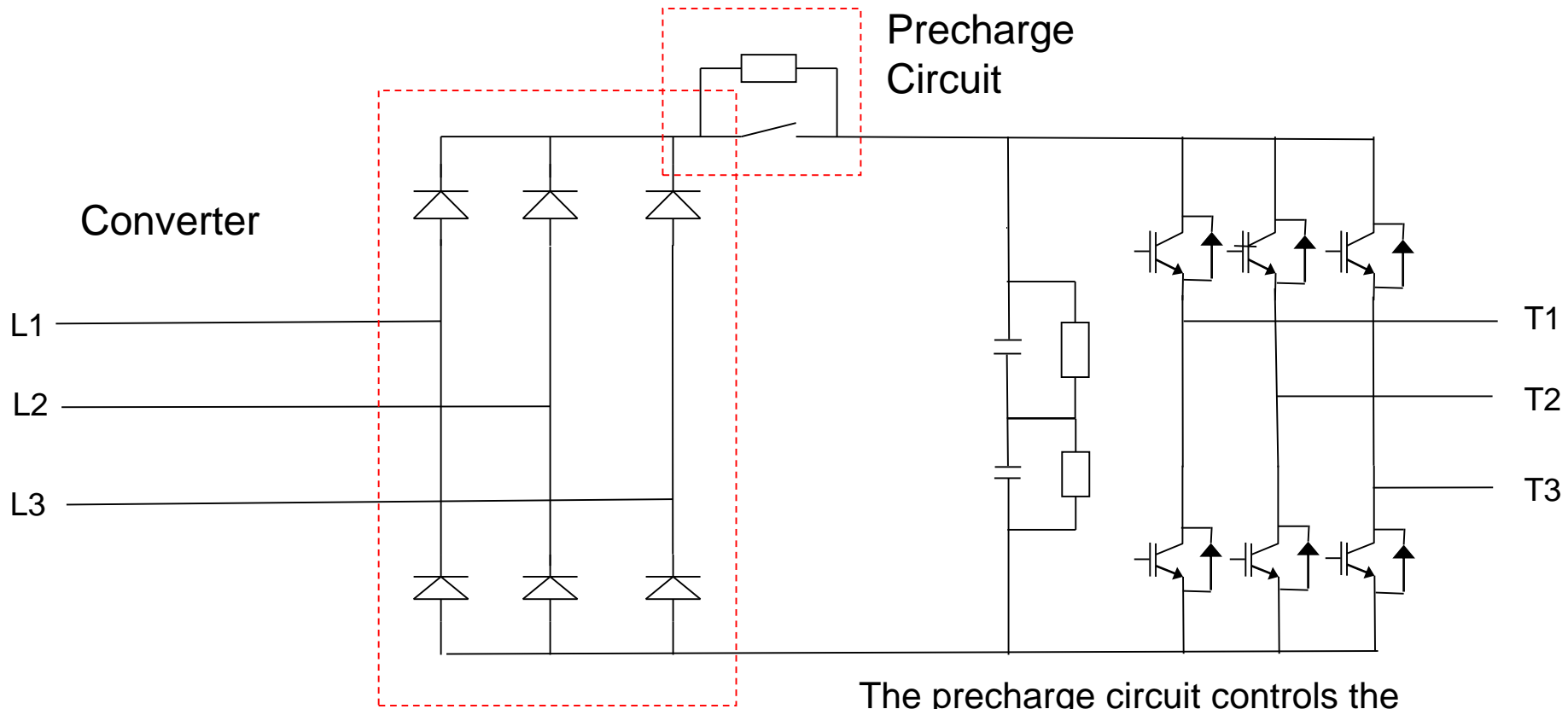
Cuprins

- Descrierea sistemului, principii de functionare, facilitati
- Costurile si pierderile sistemului
- Economii si eficienta in actionarile cu invertor
- Studiu de caz – actionare pompa
- Actionari speciale
- Sesiune de discutii libere / intrebari si raspunsuri

Actionari cu VSD (convertizor frecventa)



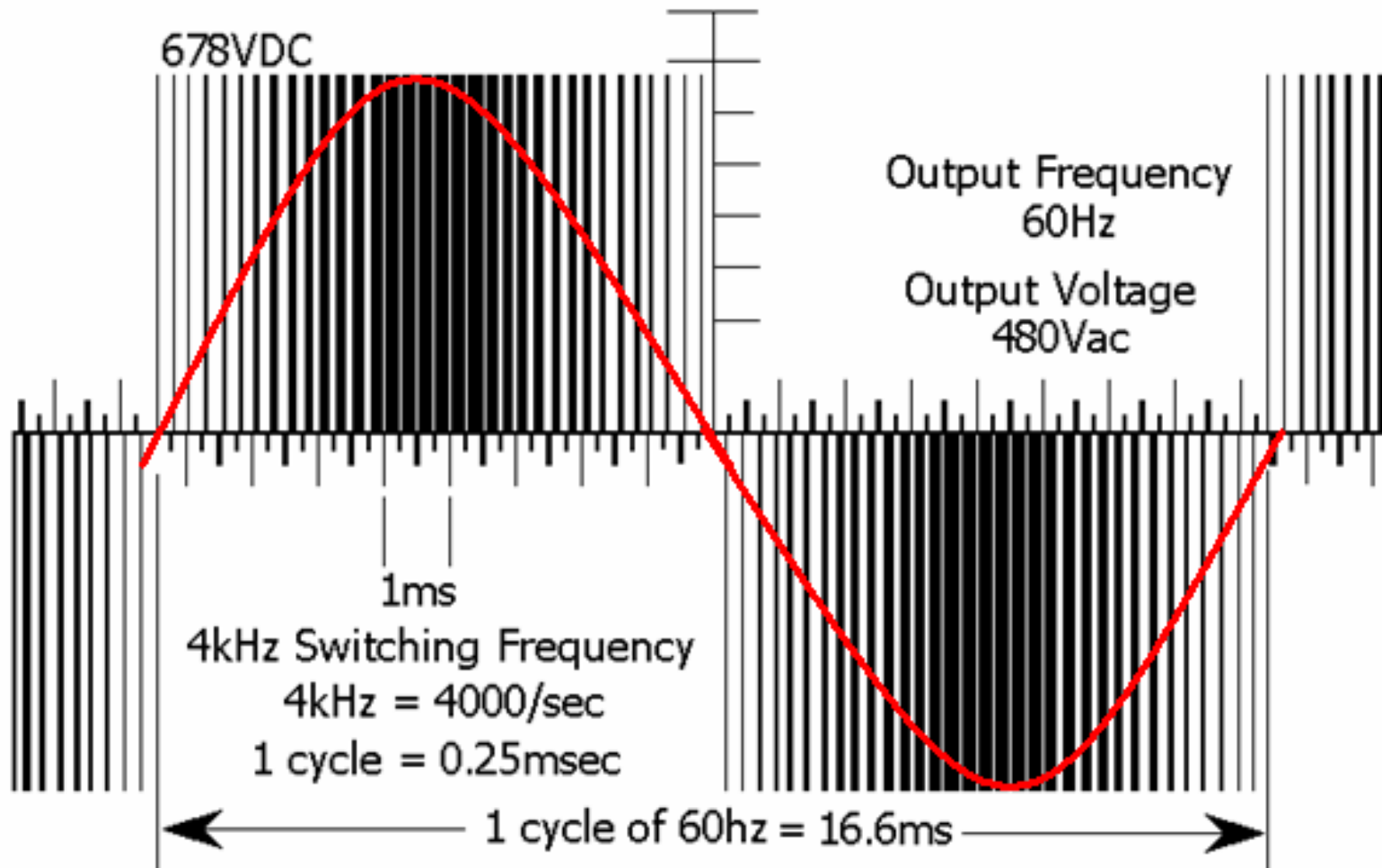
Actionari cu VSD (convertizor frecventa)



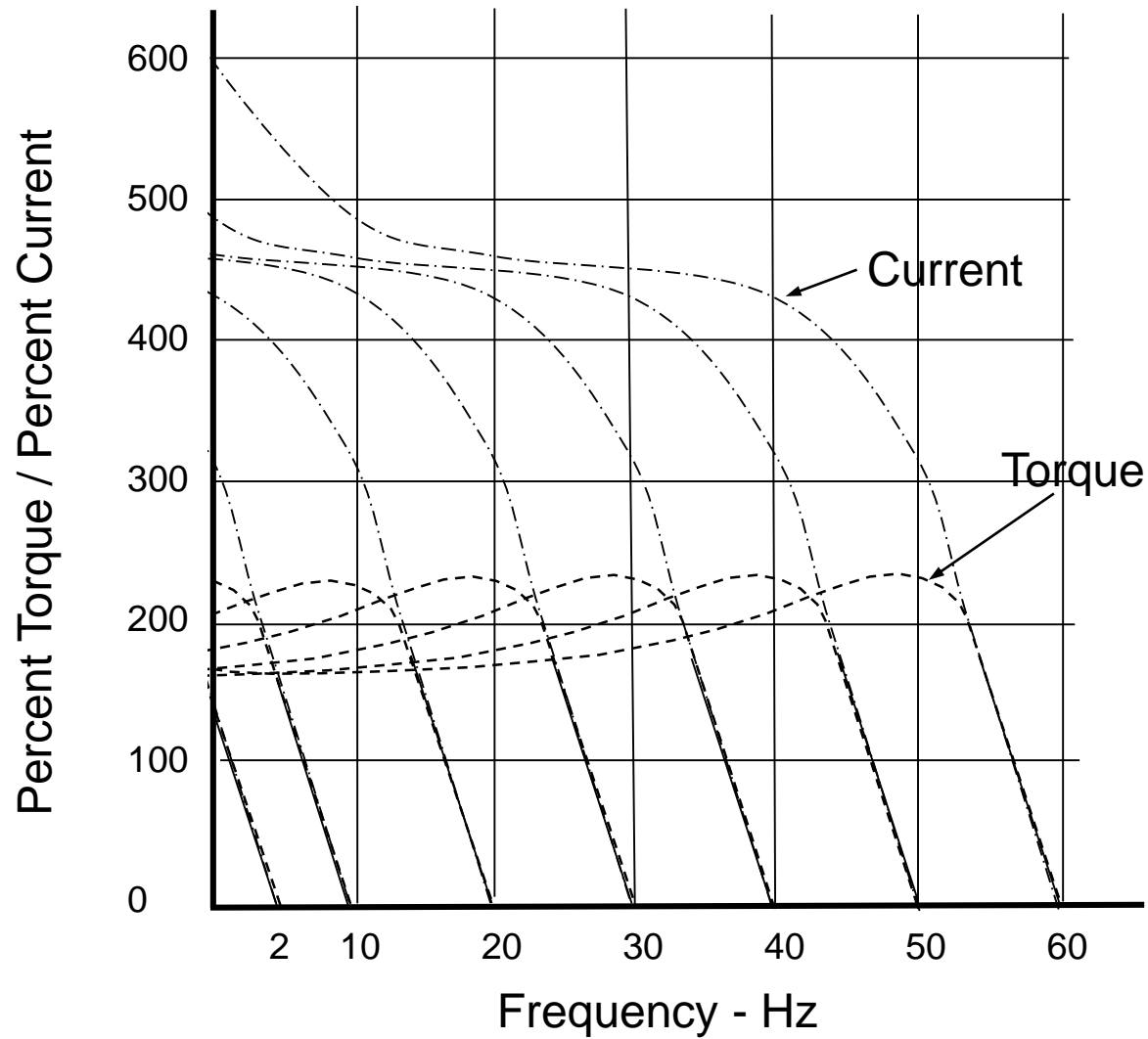
The converter section converts the AC line voltage to a fixed DC voltage.

The precharge circuit controls the current inrush that occurs when the drive is initially energized.

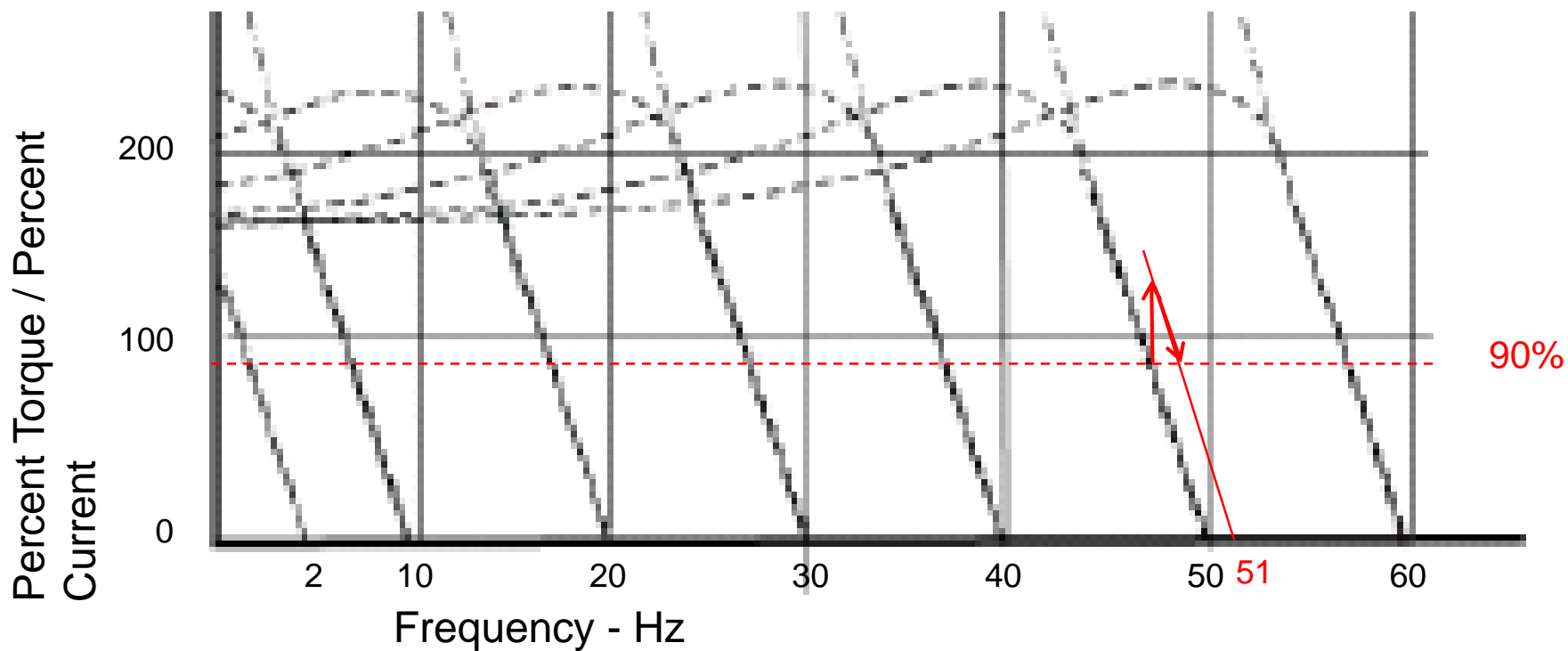
Actionari cu VSD



Actionari cu VSD



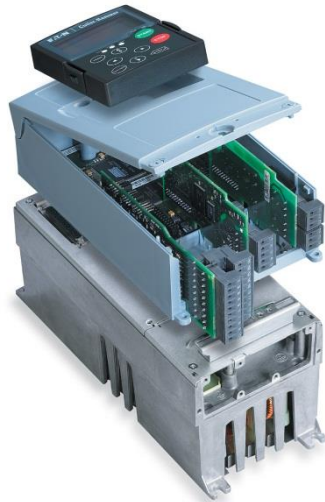
Actionari cu VSD (convertizor frecventa)



Actionari cu inverter – costuri de instalare si eficienta energetica

Costuri principale de instalare:

- *Climatizarea panoului electric
(vezi randament termic)*
- *Costuri de parametrizare/pif*
- *Cabluri/pozare pentru indeplinirea normelor EMC (obligativitate in UE)*
- *Costuri de mentenanta*



Economii la instalare vs alte sisteme:

- *Numar redus componente (cu mtbf 500,000h)*
- *Numar redus conductoare/ economii la cablare*
- *Eficienta in depanare*
- *Solutie moderna si ergonomica ce ofera informatii pentru diagnoza proactiva.*
- *Inlaturarea necesitatii altor echipamente (compensare energie reactiva, contor energetic, PLC etc)*

Actionari cu inverter – costuri de instalare si eficienta energetica

Costuri principale in functionare vs alte sisteme similare:

- *Randamentul inverterului (75% din total eficienta)*
- *Costuri generate de armonici (curenti eddy/turbionari) (10% din total eficienta)*
- *Efecte asupra lagarelor prin curenti de scurgere catre pamant (gripare) (5% din total eficienta)*
- *Posibile efecte generate de rezonanta a cablului sau du/dt (5% din total eficienta)*
- *Ventilare suplimentara a **motorului** in aplicatii cu turatie redusa (5%)*
- *Efecte interfatare radio (nec%.)*



Randamentul inverterului (>96%)

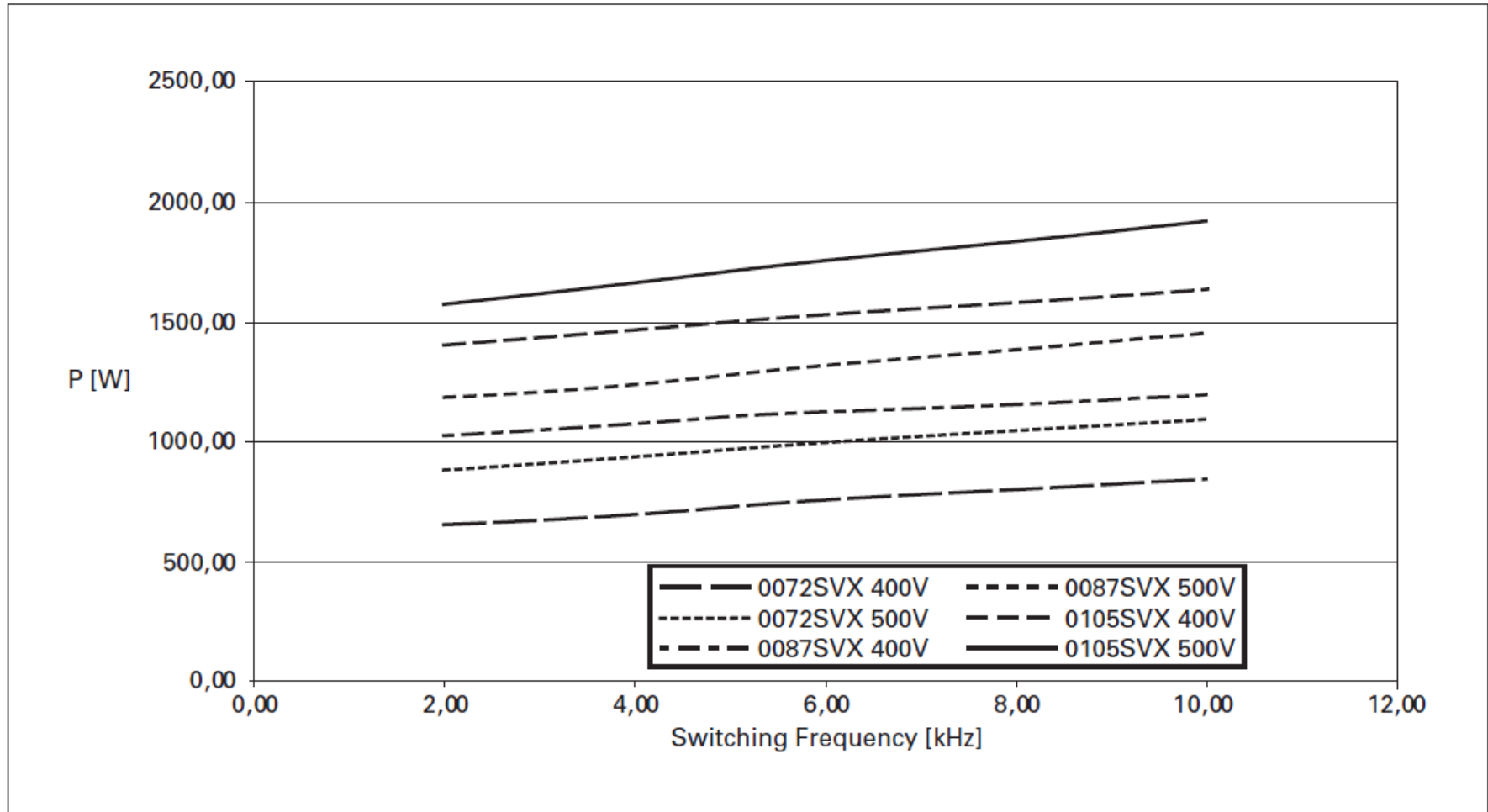
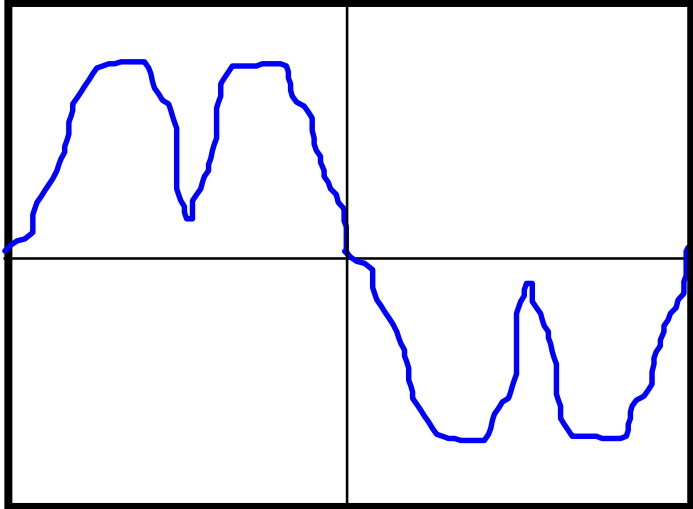
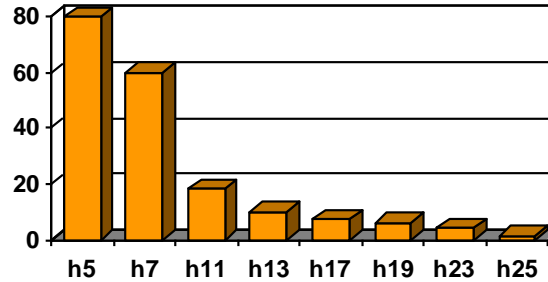


Figure A-5: Power Loss as Function of Switching Frequency —
20 – 30 hp 230V, 40 – 60 hp 480V

Armonici si compensarea lor

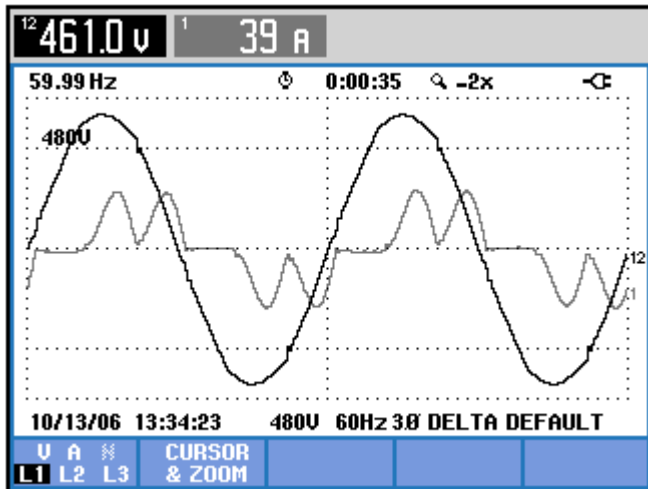


Harmonic Distribution



Harmonic Content

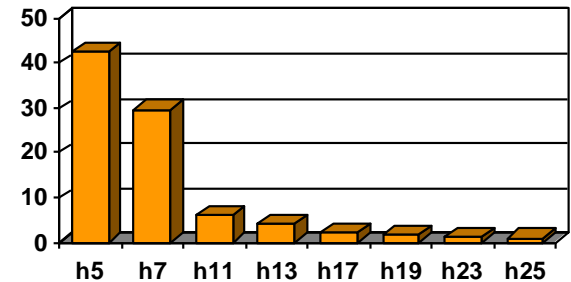
$h_5 = 79.5\%$
 $h_7 = 60.1\%$
 $h_{11} = 18.2\%$
 $h_{13} = 10.0\%$
 $h_{17} = 7.3\%$
 $h_{19} = 6.0\%$
 $h_{23} = 4.1\%$
 $h_{25} = 1.2\%$



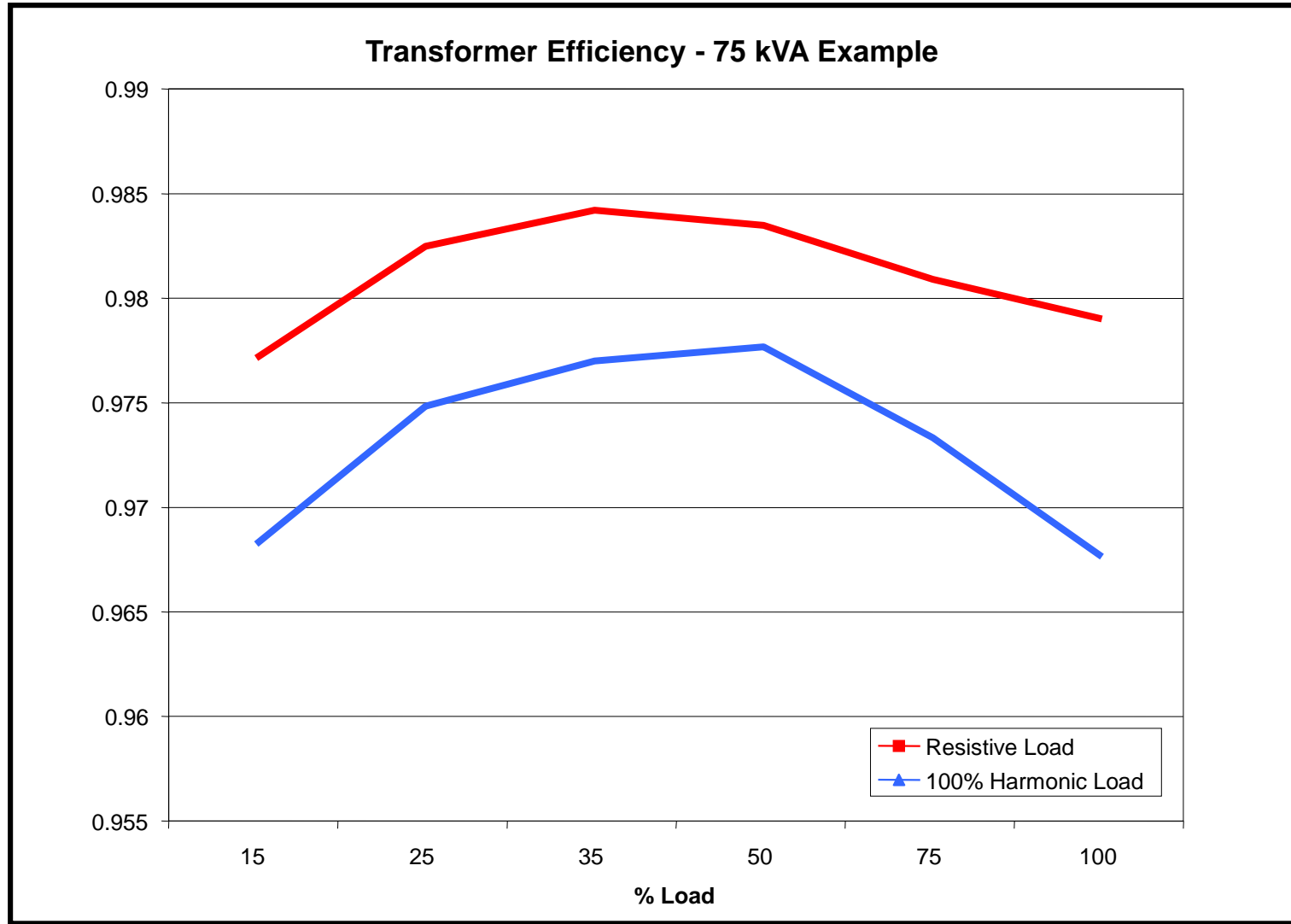
Harmonic Content

$h_5 = 42.5\%$
 $h_7 = 29.38\%$
 $h_{11} = 6.10\%$
 $h_{13} = 4.06\%$
 $h_{17} = 2.26\%$
 $h_{19} = 1.77\%$
 $h_{23} = 1.12\%$
 $h_{25} = 0.86\%$

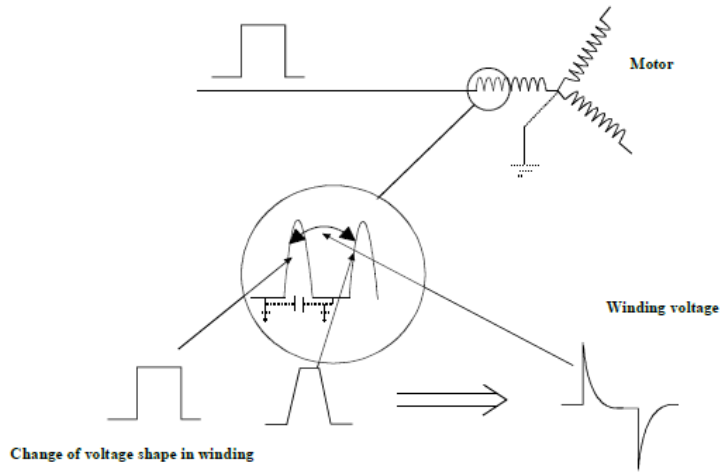
Harmonic Distribution



Armonici si compensarea lor



Incoming pulse



Type designations

DUT-0012-6-0-P

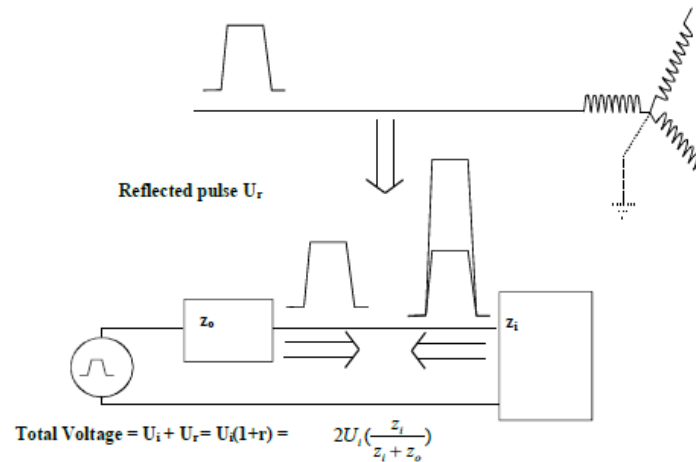
P = Manufacturer
 0 = Enclosure class
 0 = IP00
 2 = IP20
 5 = IP 54

4 = nominal voltage:
 2 = 200 V
 4 = 400 V
 6 = 690 V

0012 = Maximum current [A]

Incoming pulse U_i

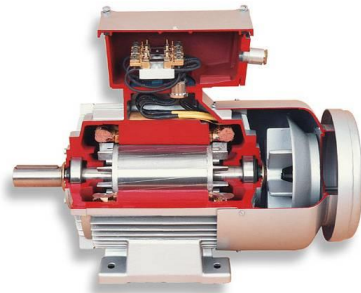
≅ radio frequency filter



$$\text{Total Voltage} = U_i + U_r = U_i(1+r) = 2U_i \left(\frac{z_i}{z_i + z_o} \right)$$

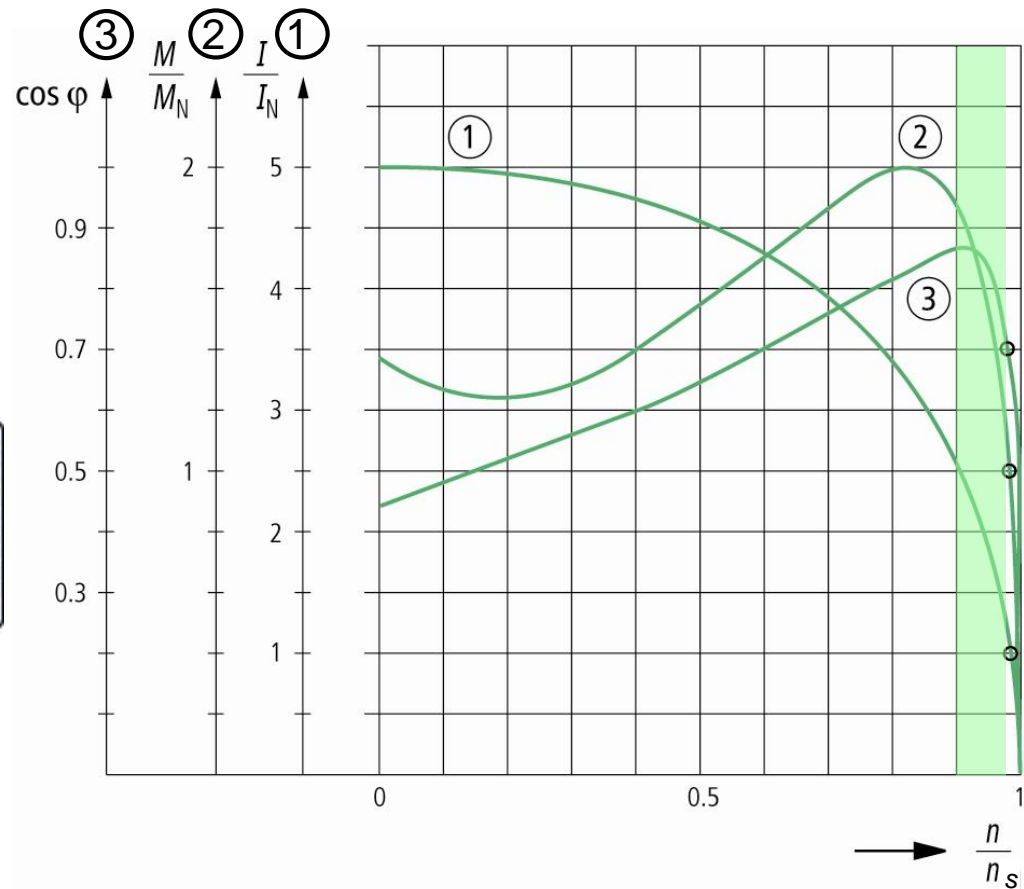
Eficiența energetică a sistemelor cu inverter

Protejarea lanțului cinematic de socuri mecanice



230 / 400 V Δ / Υ	4.0 / 2.3 A
0,75 kW	cos Φ 0.67
1410 min ⁻¹	50 Hz

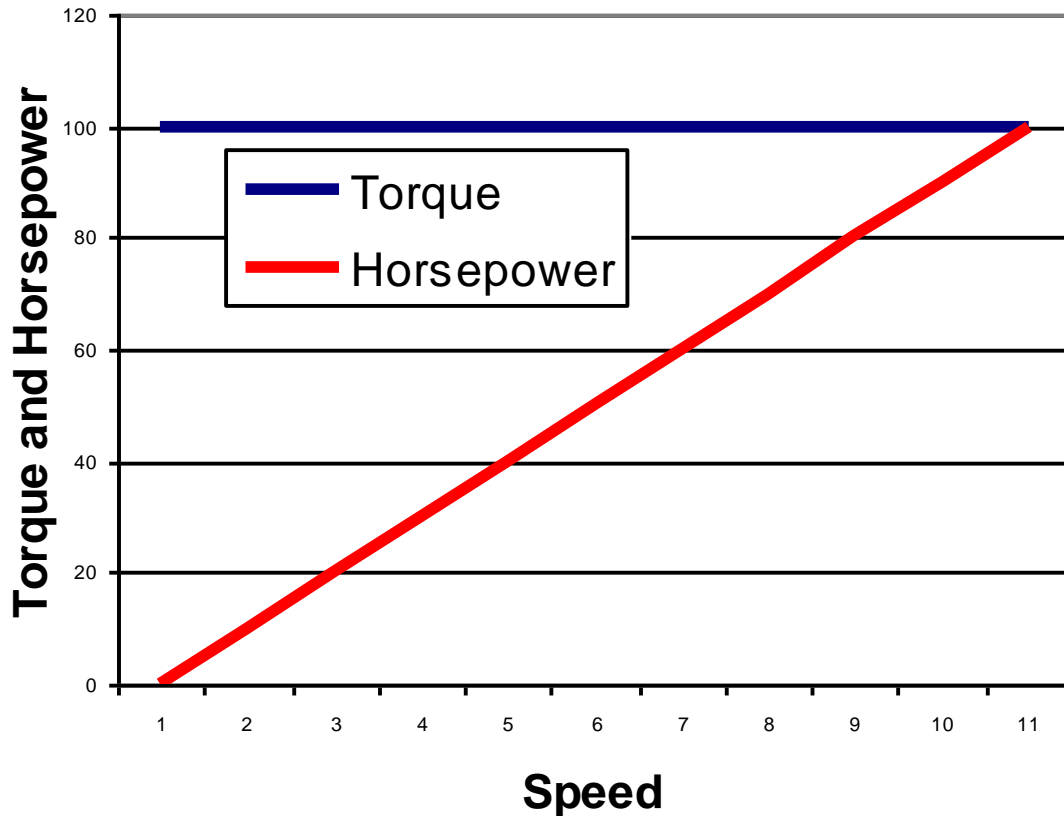
$$\eta = \frac{P_2}{P_1}$$



Eficiența energetică a sistemelor cu invertor

Sarcini cu necesar de cuplu constant

Constant Torque Loads



Cuplul necesar sarcinii este constant pe toată plajă de turații

Puterea necesară pentru a opera cu sarcina crește direct proporțional cu turația

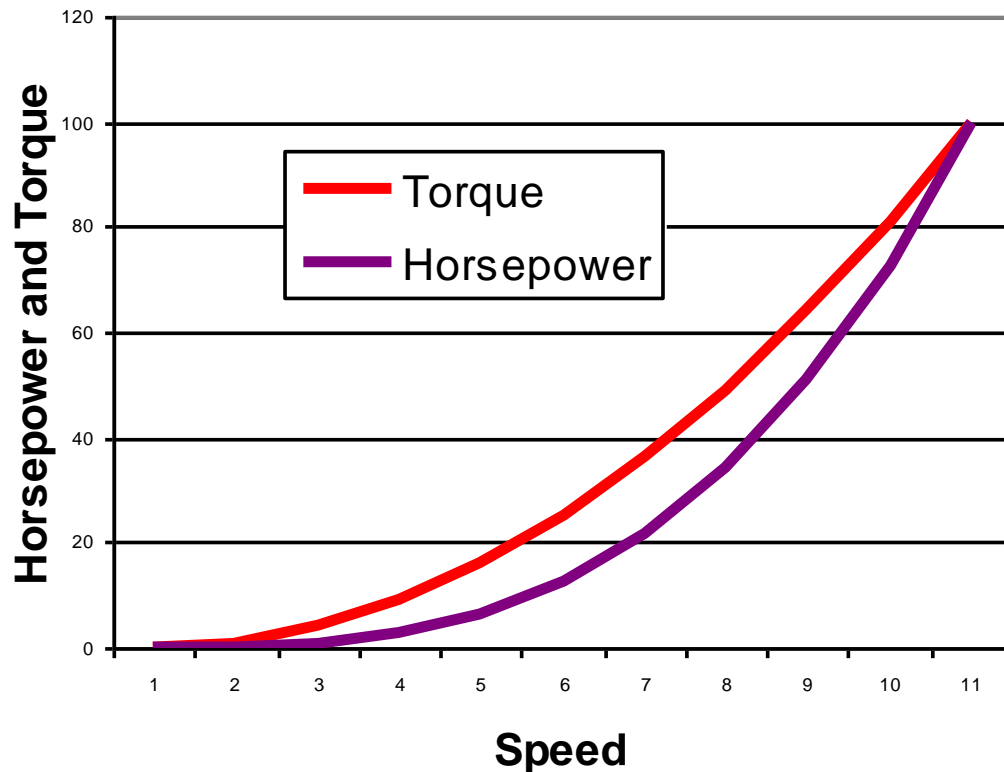
90% din toate aplicațiile, altele decât pompe sau ventilatoare, sunt de tipul CT

Aplicații comune: instalații de ridicat, de transportat materiale, macarale, prese, unele extrudere, mixere

Eficiența energetică a sistemelor cu inverter

Sarcini cu necesar de cuplu variabil

Variable Torque Load



**Cuplul necesar sarcinii
variază cu turatia.**

**Puterea necesară pentru a
opera cu sarcina variază cu
puterea a 3-a a turatie**

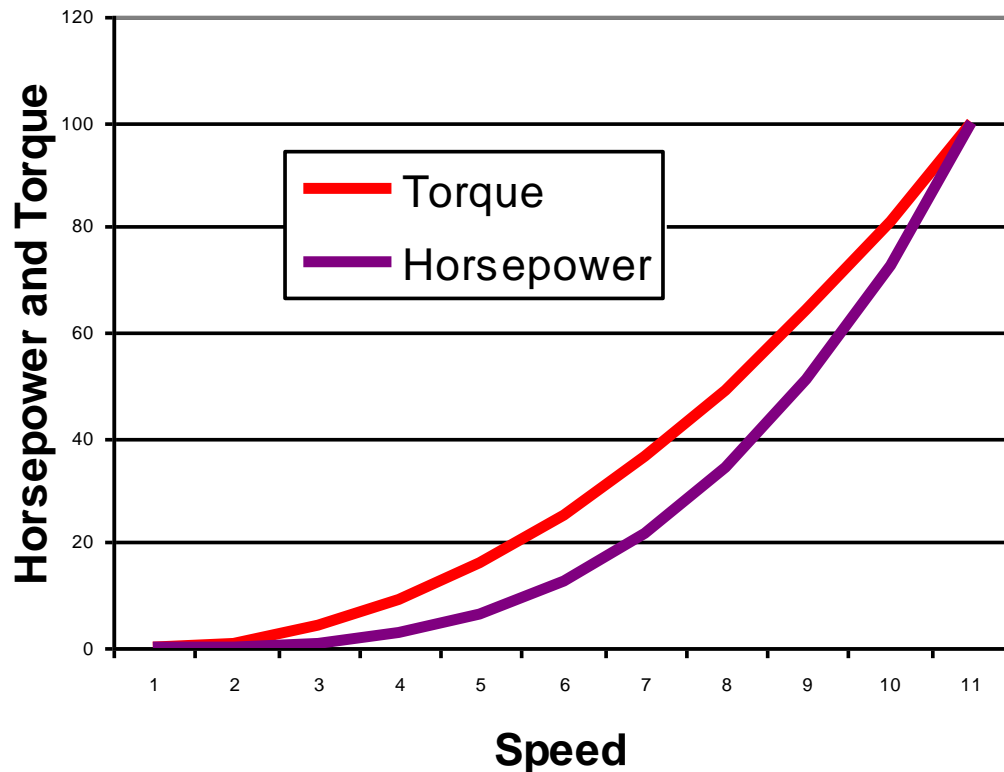
Aplicatii comune:

**Pompe centrifugale,
ventilatoare, masini cu
volanta etc**

Eficienta energetica a sistemelor cu inverter

Sarcini cu necesar de cuplu variabil

Variable Torque Load



Cuplul necesar sarcinii variaza cu turatia.

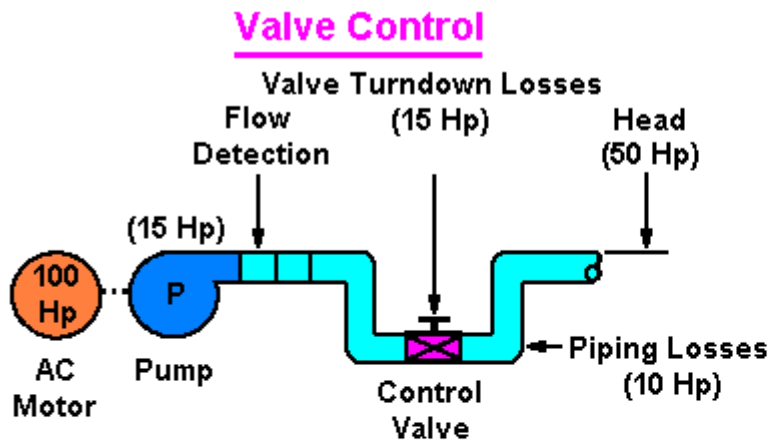
Puterea necesara pentru a opera cu sarcina variaza cu puterea a 3-a a turatie

Aplicatii comune:

Pompe centrifugale, ventilatoare, masini cu volanta etc

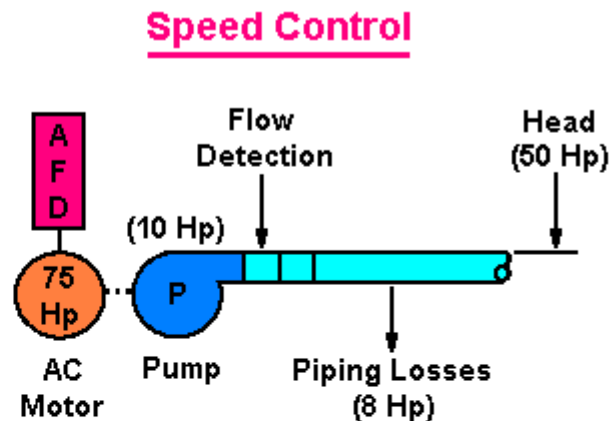
Studiu de caz – Actionare pompa

**Calculul economiei de energie
vs. reglaj cu electro/vana sau
vs fara reglaj de presiune**



Losses: 15 Hp Valve Turndown
10 Hp Piping
15 Hp Pump
50 Hp Head (Load)

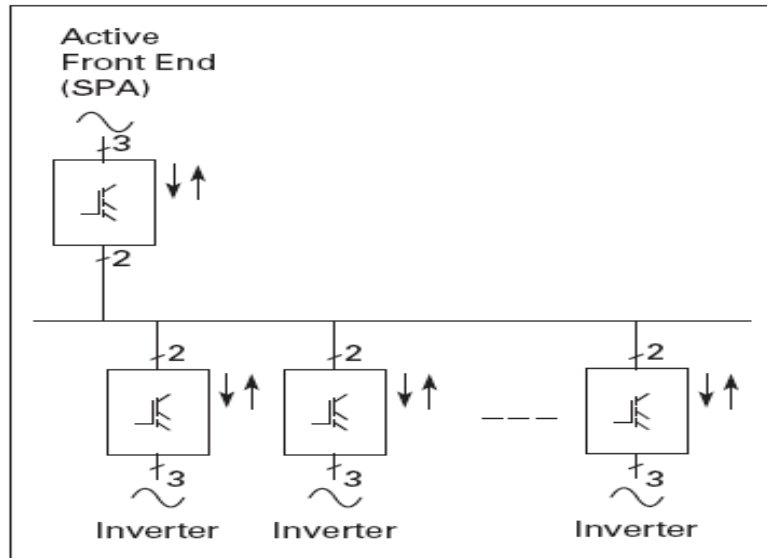
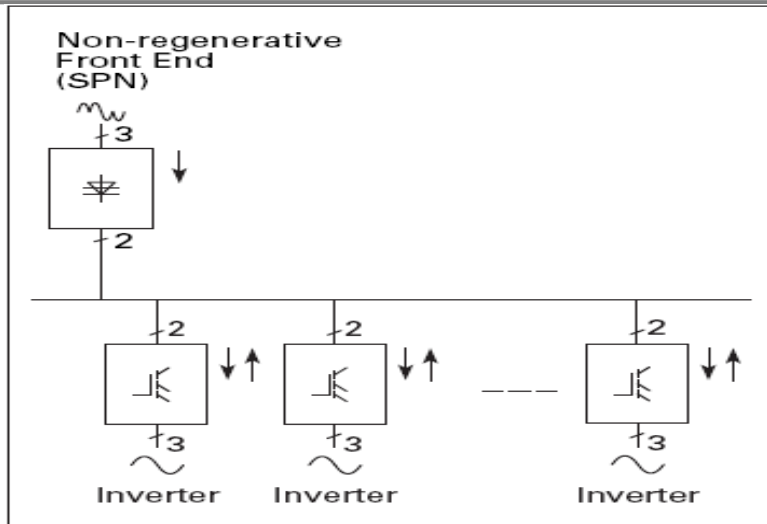
Requires: 90 Hp



Losses: 0 Hp Valve Turndown
8 Hp Piping
10 Hp Pump
50 Hp Head (Load)

Requires: 68 Hp

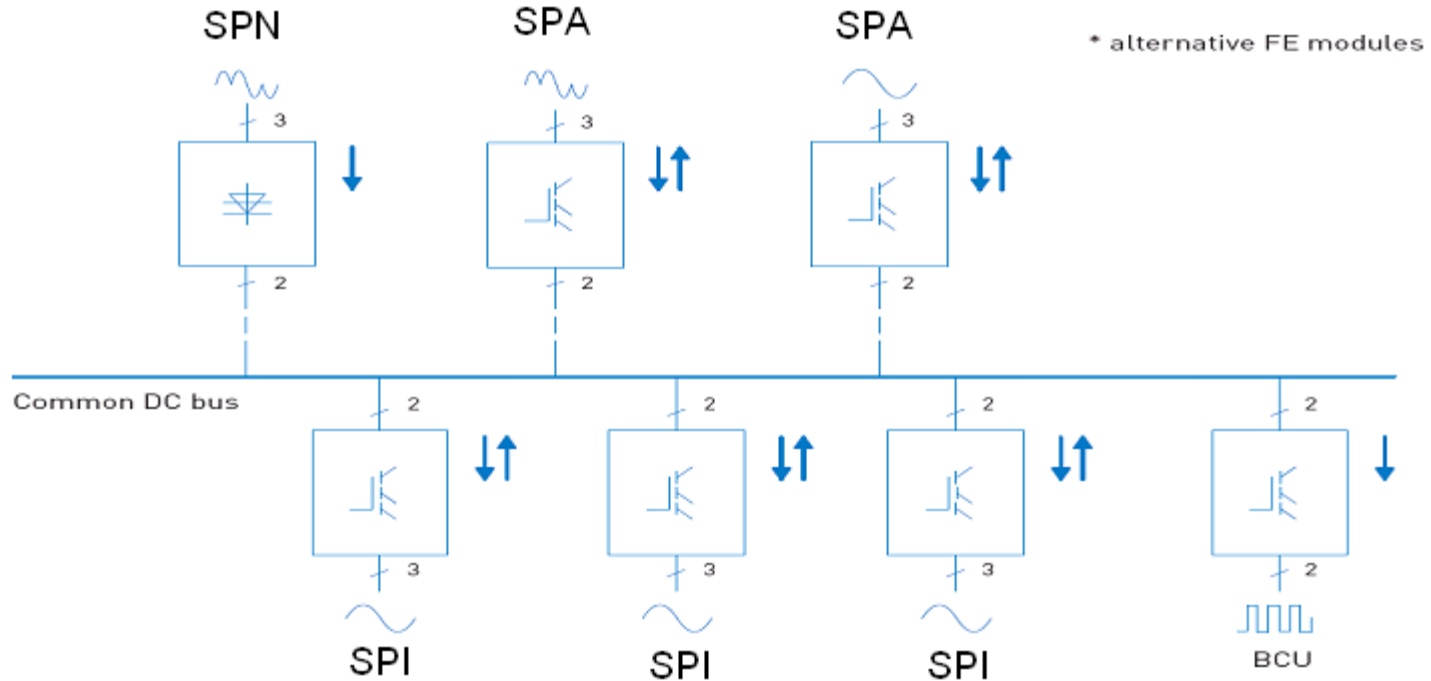
Descrierea sistemului – Aplicatii speciale



- Sistemul are la baza separarea redresorului (*front end*) de inverter
- Modulele se pot cupla in paralel pe o linie de curent continuu
- Puterea magistralei de curent continuu se poate modifica prin introducere / eliminarea de unitati redresoare
- Numarul de invertoare este variabil.
- Functie de tipul dispozitivelor front end se pot genera diferite configuratii.

Descrierea sistemului – aplicatii speciale

HIGH CONFIGURABILITY

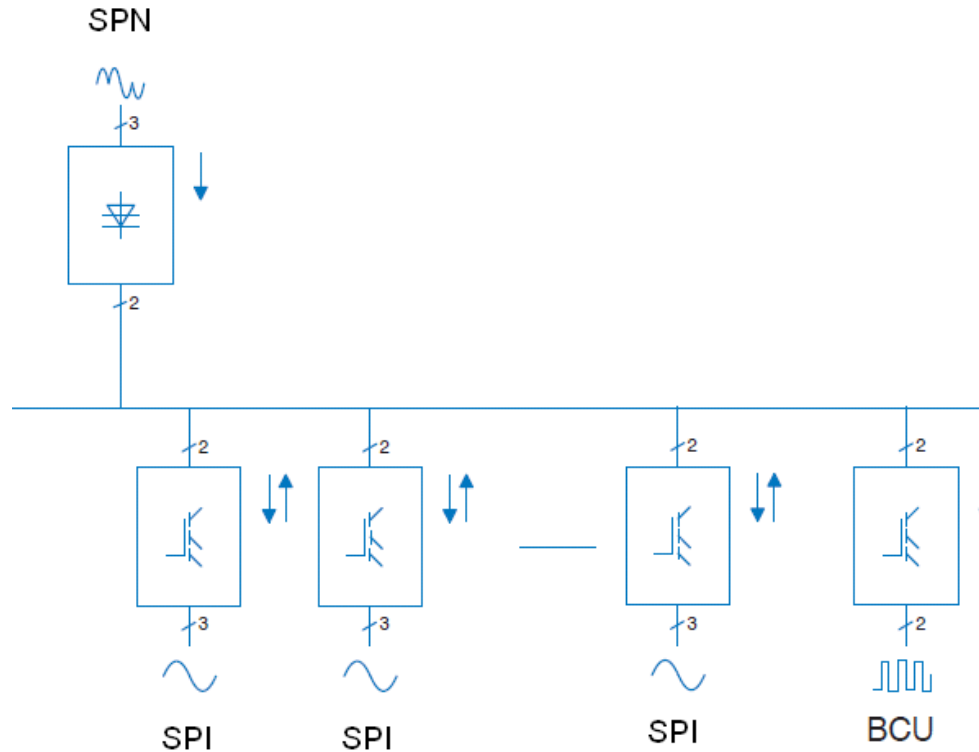


Tipuri de unitati front-end

Caracteristici

	Non-Regenerative Front End	Active Front End
Input device	Choke (L)	Filter (LCL)
Bridge type	Diode/thyristor bridge	IGBT bridge, two-level type
Type of operation	Controlled half-bridge	High frequency modulation (1.5 to 3.6 kHz)
Direction of power	Motoring	Motoring and regenerating
Charging	Constant current	External required
DC voltage	Nominal (approx. 1.35 alternative U_N)	Stable at +10% of nominal (approx. 110% of 1.35 alternative U_N)
THD	Similar to six-pulse bridge normal <40%	Very low

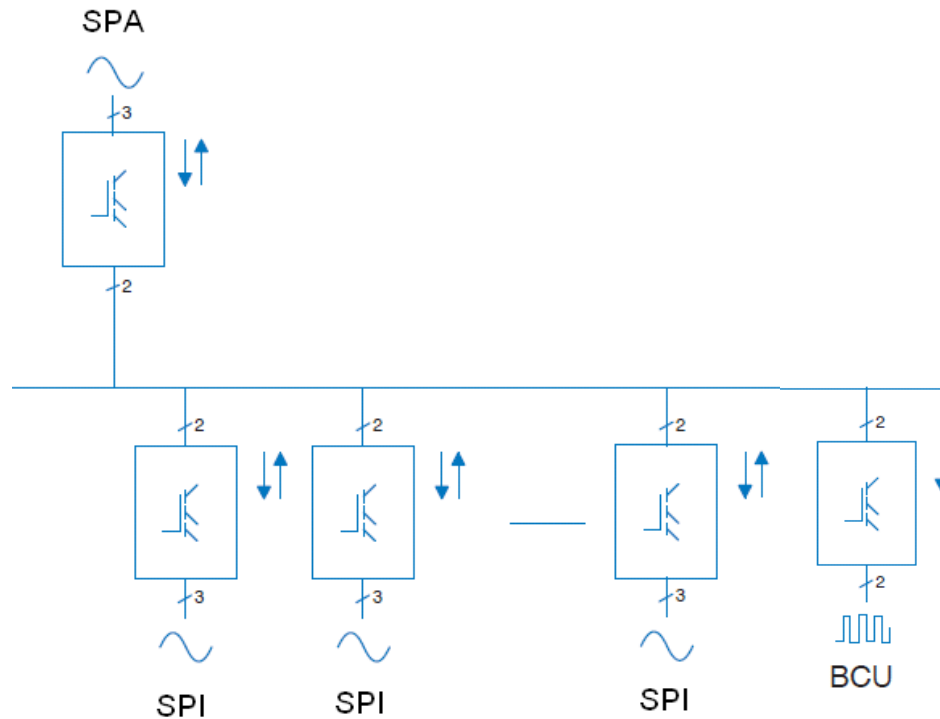
Configuratii posibile (II)



SPN + SPI:

- Putere absorbita redusa $P_{\text{mains}} \leq \sum P_{\text{INU}}$ putere de franare crescuta pentru scurta durata
- Aplicatii posibile : linii de procesare mari ;

Configuratii posibile (III)



SPA + SPI:

- Putere absorbita redusă : $P_{\text{mains}} \leq \sum P_{\text{INU}}$
- Recuperare de energie (injectie in retea) : $-P_{\text{mains}} \approx +P_{\text{mains}}$
- Continut redus de armonici ;
- Aplicatii posibile : aproape orice tip de aplicatie; ex. Benzi care coboara material ;