ΒΑΣΙΚΕΣ ΑΡΧΕΣ ΗΛΕΚΤΡΟΝΙΚΩΝ ΙΣΧΥΟΣ

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Αναπληρωτής Καθηγητής

Περίγραμμα Μαθήματος

- Οι εφαρμογές των Ηλεκτρονικών Ισχύος.
- Υλοποίηση διακοπτών ισχύος – Τεταρτημόρια Λειτουργίας.
- Ημιαγωγικά στοιχεία ισχύος.
- Επίδραση των διατάξεων ηλεκτρονικών ισχύος στο δίκτυο, αρμονικές συνιστώσες τάσης – ρεύματος, υπολογισμοί ενεργού – άεργου ισχύος, διεθνείς κανονισμοί.
- Ανάλυση των ανορθωτικών διατάξεων με θυρίστορ (1, 2, 3, 6 παλμών).
- Ανάλυση των μετατροπέων AC/AC με αντιπαράλληλα θυρίστορ (soft starters).

Σχέδιο Εργασίας

- Ώρες επικοινωνίας
- Λειτουργία εργαστηρίου
- Παραδόσεις – Φροντιστηριακές Ασκήσεις
- Εθελοντικές Εργασίες Φοιτητών
- Εξέταση - Βαθμολογία

Role of Power Electronics

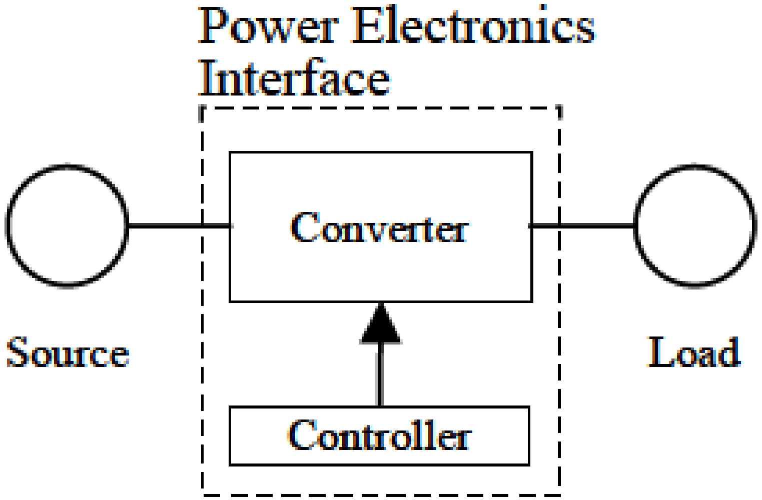


Figure 1-1 Power electronics interface between the source and the load.

The power electronics interface facilitates the transfer of power from the source to the load by converting voltages and currents from one form to another, in which it is possible for the source and load to reverse roles. The controller shown in Fig. 1-1 allows management of the power transfer process in which the conversion of voltages and currents should be achieved with as high energy-efficiency and high power density as possible.

FIGURE 1.14 Power electronics—an interdisciplinary technology.

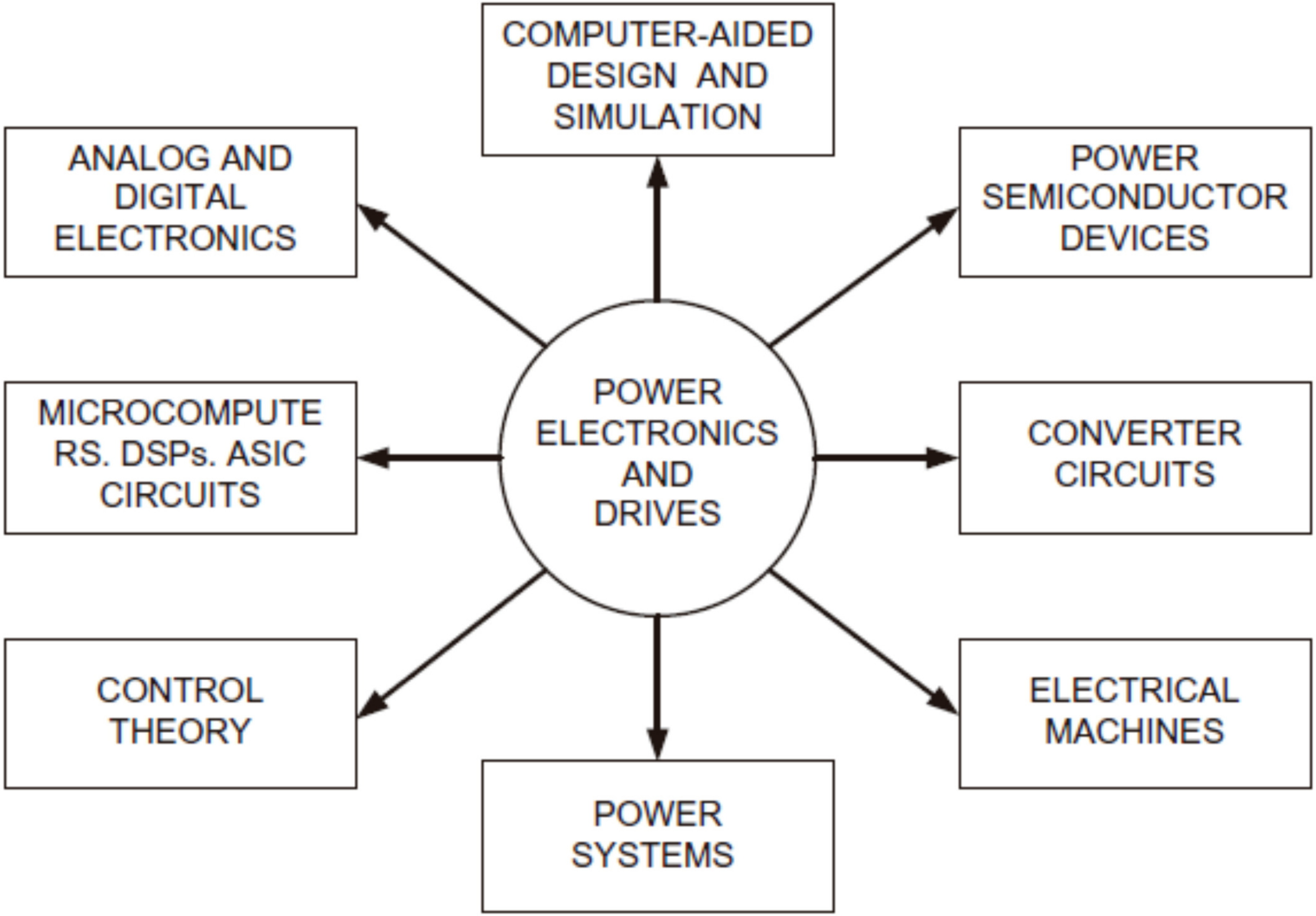


FIGURE 1.16 Four generations of solid-state power electronics.

- *FIRST GENERATION* (1958–1975) (Thyristor Era)
  - Diode
  - Thyristor
  - Triac

- *SECOND GENERATION* (1975–1985)
  - Power BJT
  - Power MOSFET
  - GTO
  - Microprocessor
  - ASIC
  - PIC
  - Advanced control

- *THIRD GENERATION* (1985–1995)
  - IGBT
  - Intelligent power module (IPM)
  - DSPs
  - Advanced control

- *FOURTH GENERATION* (1995–)
  - IGCT
  - Cool MOS
  - PEBB
  - Sensorless control
  - AI techniques: fuzzy logic, neural networks, genetic algorithm

FIGURE 2.1 Evolution of power semiconductor devices.

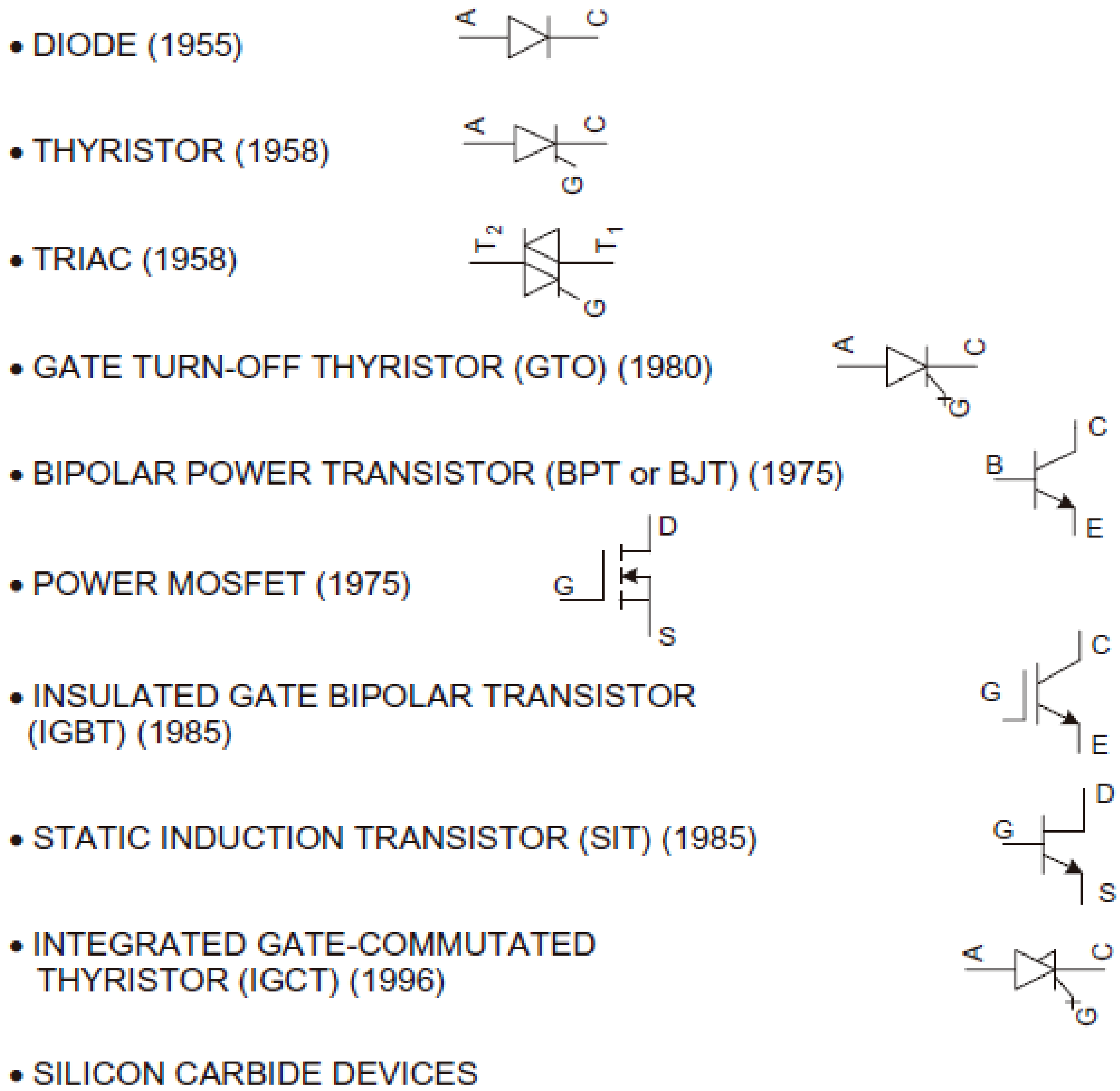
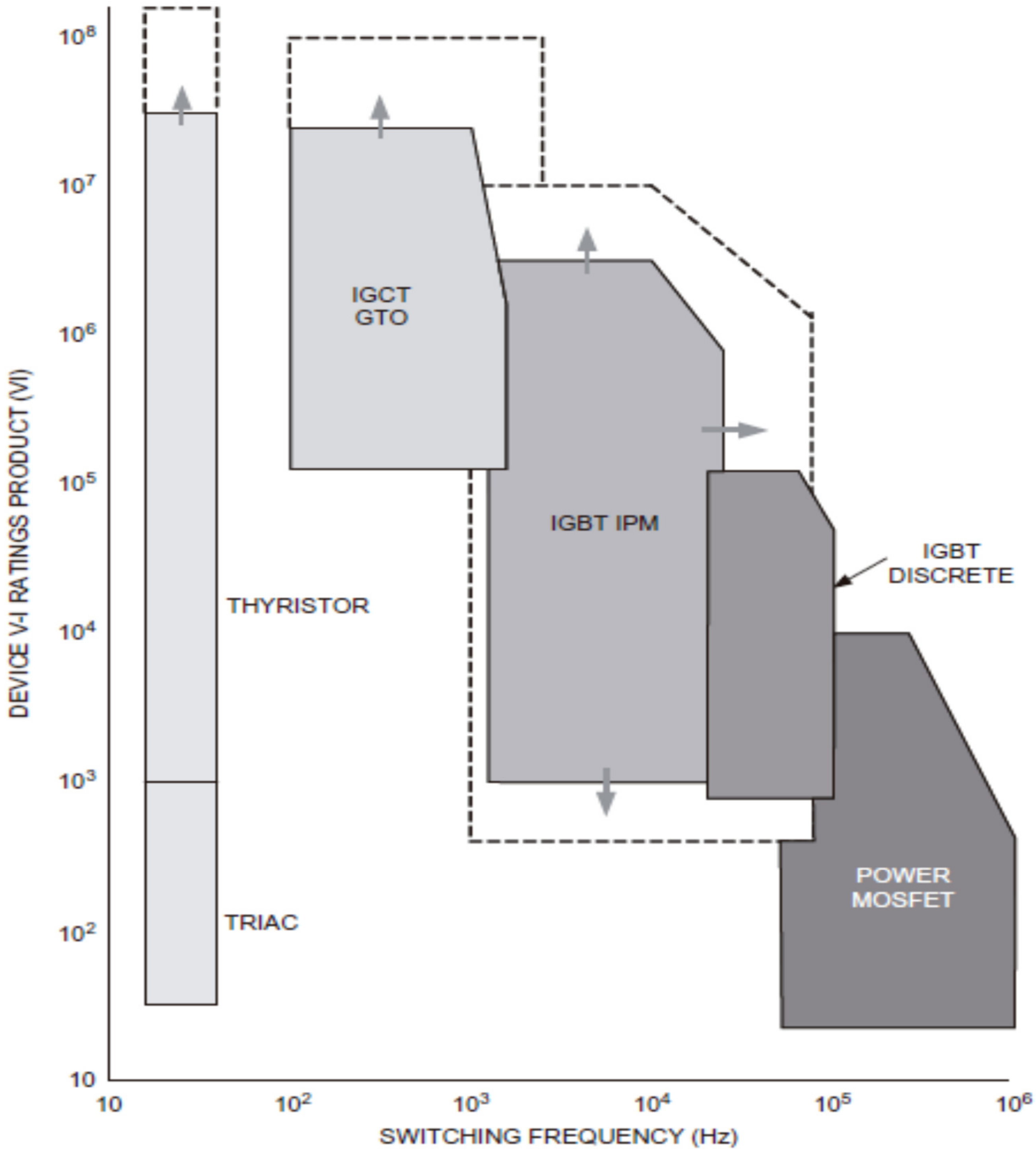


FIGURE 2.2 Power-frequency trends of the devices (from [5]).



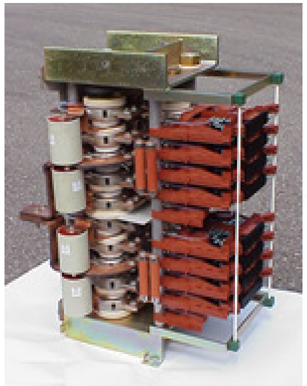
Power Electronic Building Blocks (PEBB)

ABB has developed Power Electronic Building Blocks for the use in all possible voltage source converters. With these building blocks the adaptation to special requirements can easily be done while at the same time the costs can be kept at a reasonable level. With the use of such standardized building blocks, the engineering and development work is limited to a minimum.

Voltage source converter modules are available for various applications, such as:

- Power Quality
- Static Frequency Conversion
- Dynamic VAr Compensation (STATCOM)
- Power Conditioning Systems for Energy Storage

The displayed ratings for the PEBBs are nominal ratings. The final ratings may vary depending on the used system and application.

PEBB	Description
	20 MVA MV voltage source converter module (water cooled)
	6 MVA H-bridge or 2-phase converter block MV Power Electronic Building Block Power Stack (water cooled)

Αναζήτηση →OK
Προϊόντα και υπηρεσίες μόνο
+ Αξιολογήστε αυτή τη σελίδα
+ Μοιραστείτε αυτή τη σελίδα

Οι προτιμήσεις σας:
Ελλάδα →OK
Ελληνικά →OK

PM100CL1A060

FLAT-BASE TYPE
INSULATED PACKAGE

PM100CL1A060

FEATURE

Inverter + Drive & Protection IC

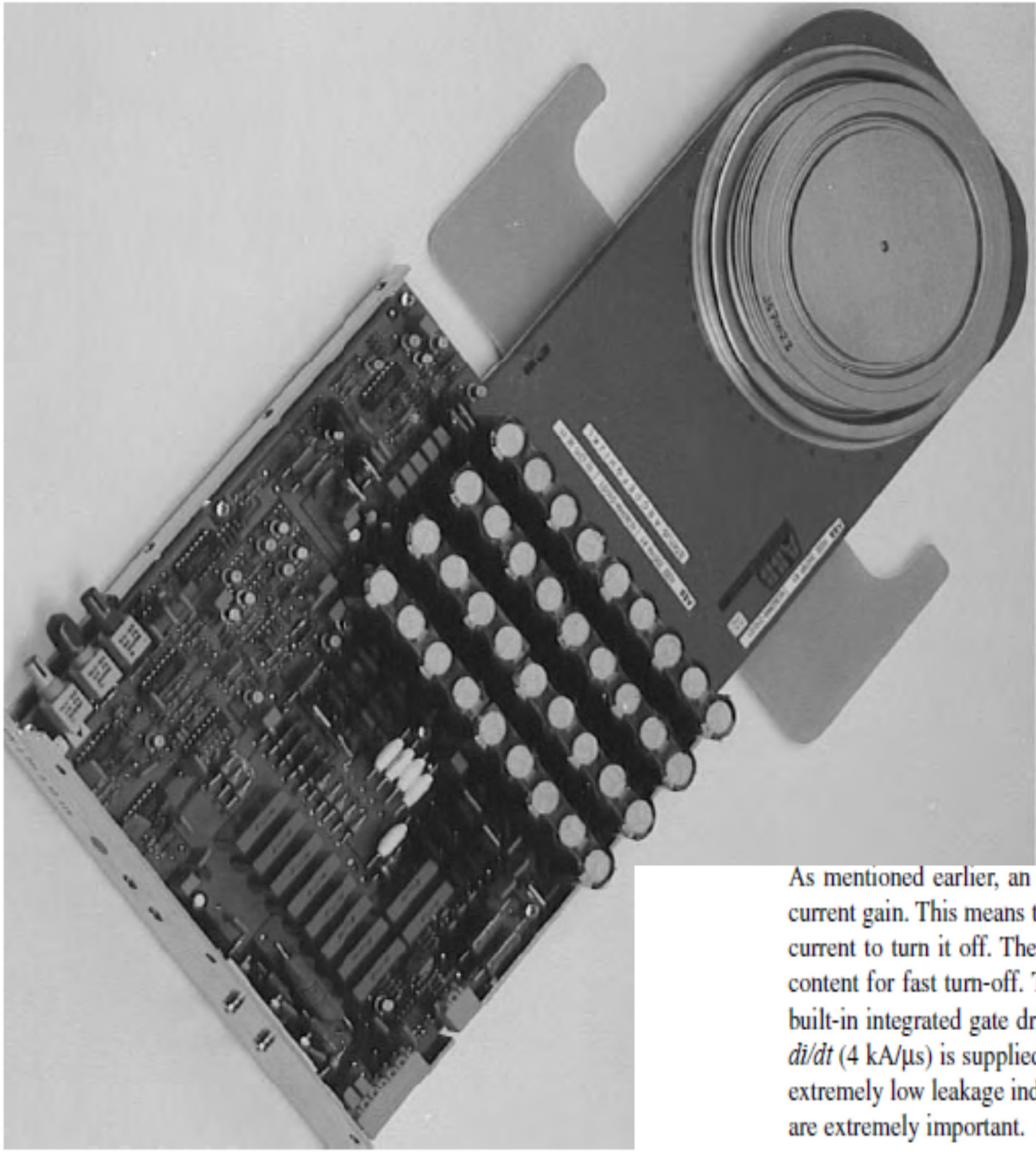
a) Adopting new 5th generation Full-Gate CSTBT™ chip
b) The over-temperature protection which detects the chip surface temperature of CSTBT™ is adopted.
c) Error output signal is possible from all each protection upper and lower arm of IPM.
d) Compatible L-series package.

- 3φ 100A, 600V Current-sense and temperature sense IGBT type inverter
- Monolithic gate drive & protection logic
- Detection, protection & status indication circuits for, short-circuit, over-temperature & under-voltage (P-Fo available from upper arm devices)
- UL Recognized

APPLICATION

General purpose inverter, servo drives and other motor controls

FIGURE 2.22 IGCT with integrated packaging of gate driver (from [15]; photograph used with permission of ABB).



As mentioned earlier, an IGCT is basically a "hard-driven" GTO with unity turn-off current gain. This means that a 3000-A (anode current) device requires a –3000-A gate current to turn it off. The large current pulse should be very narrow with low energy content for fast turn-off. The photograph shows an ABB presspack-type IGCT with a built-in integrated gate drive circuit on the same module. The current pulse with high *di/dt* (4 kA/μs) is supplied by a large number of MOSFETS operating in parallel in an extremely low leakage inductance path. Skillful design and layout of the control circuit are extremely important.

Powering the Information Technology

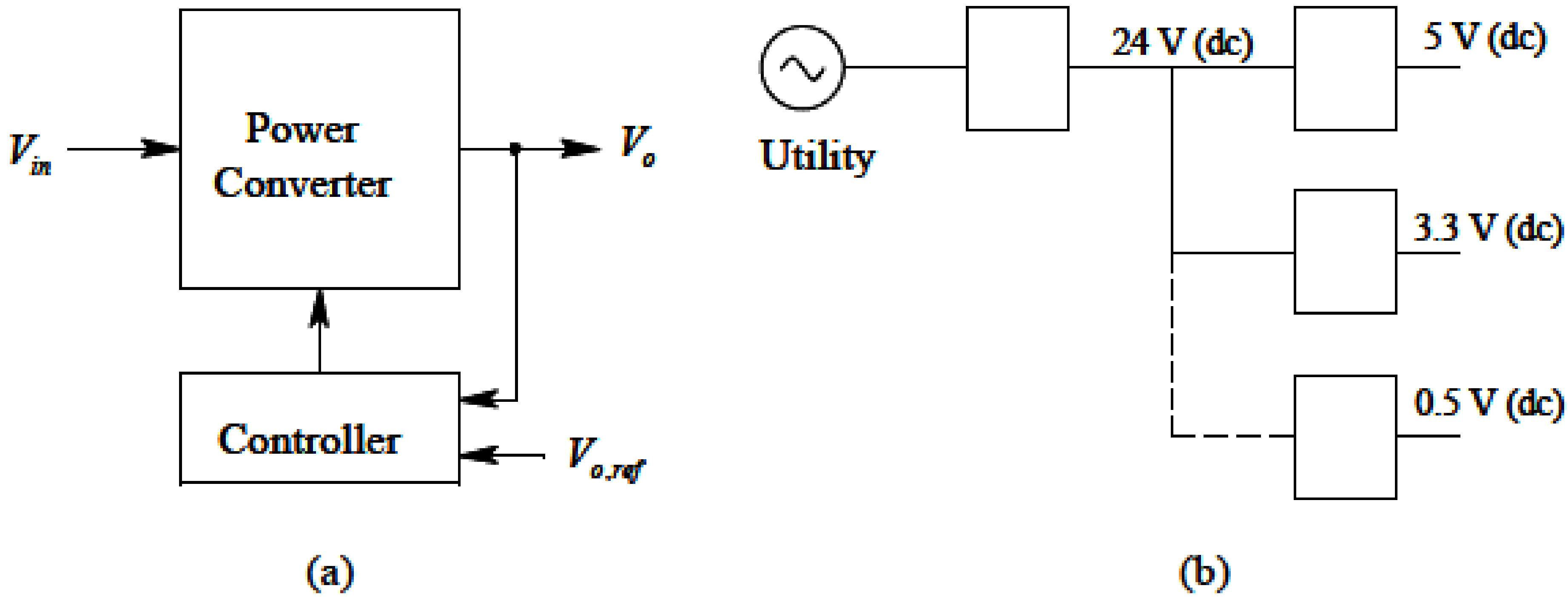


Figure 1-2 Regulated low-voltage dc power supplies.

Boost Converter

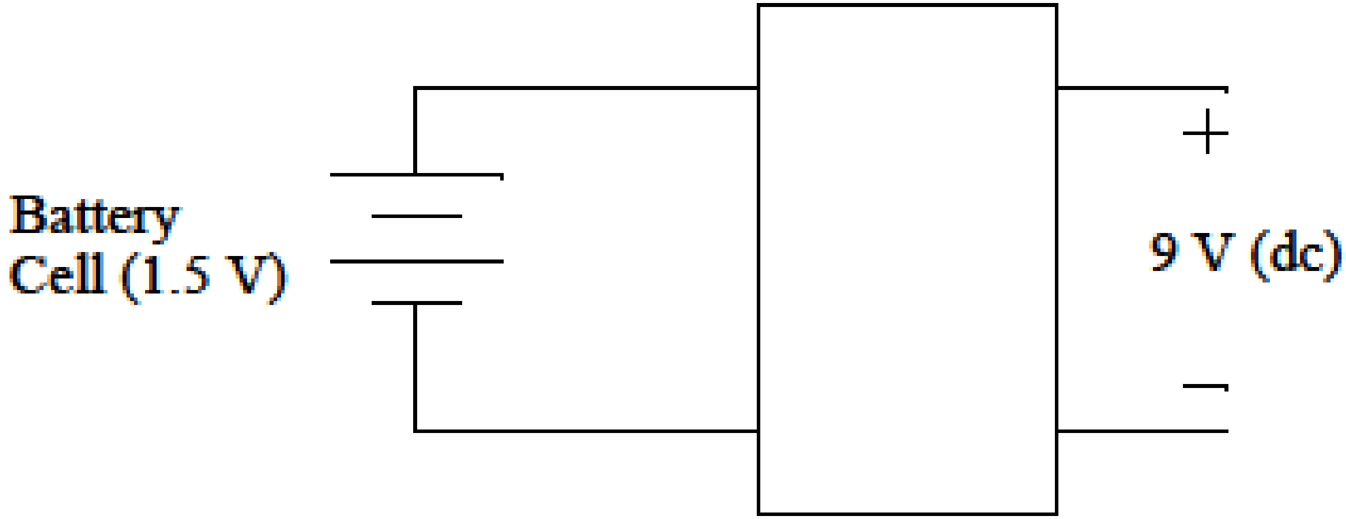


Figure 1-3 Boost dc-dc converter needed in cell operated equipment.

Adjustable Speed Drives

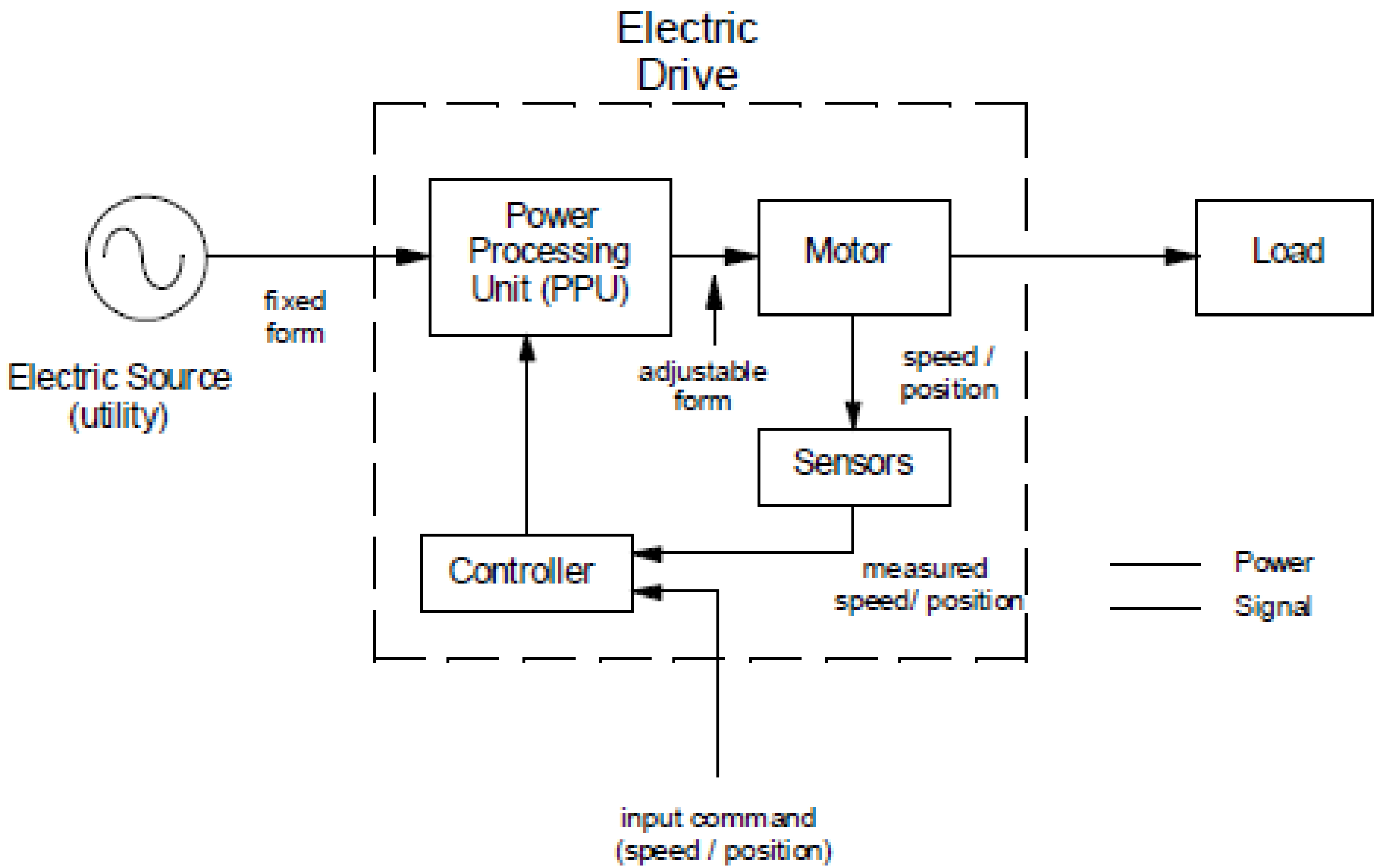
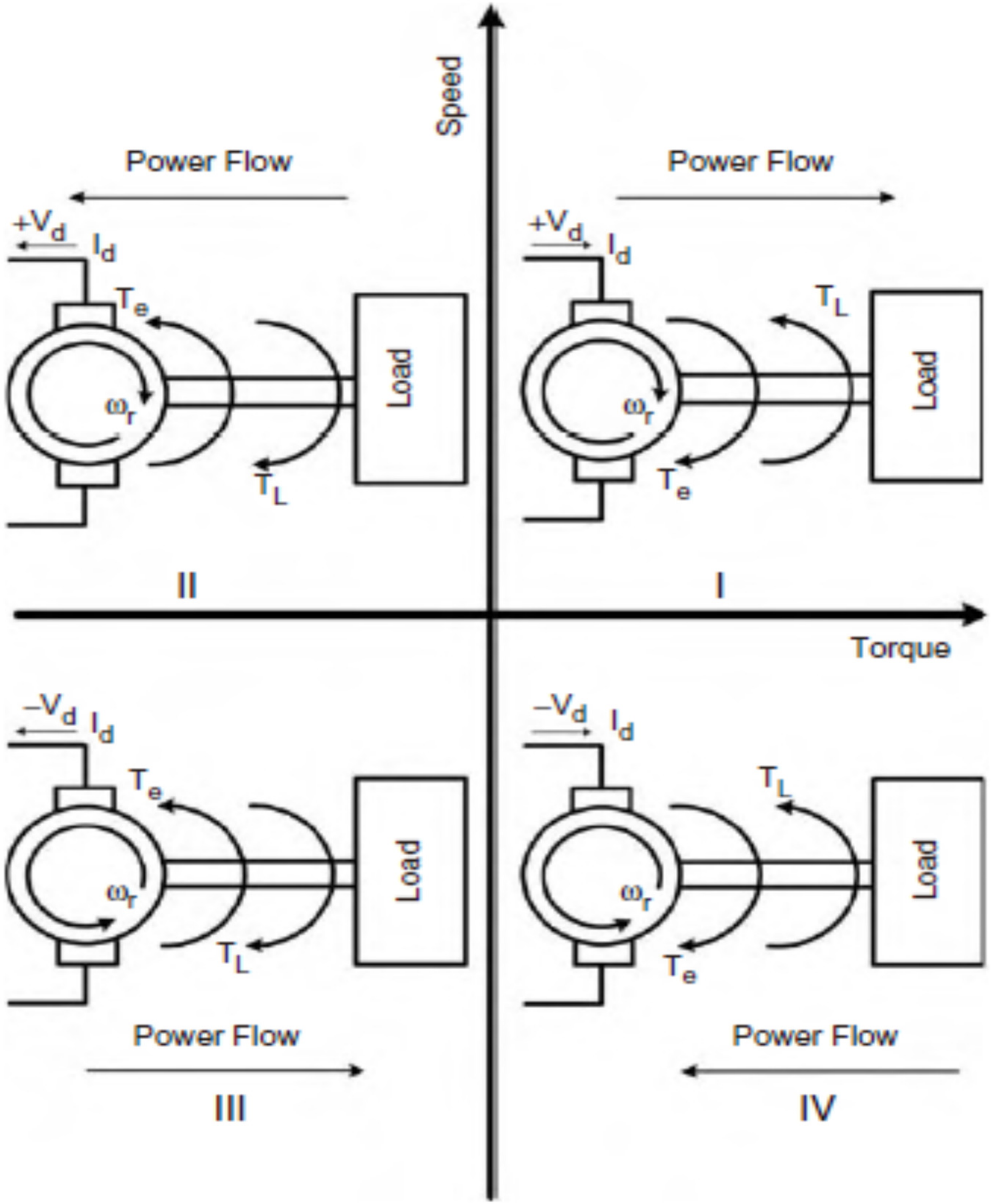
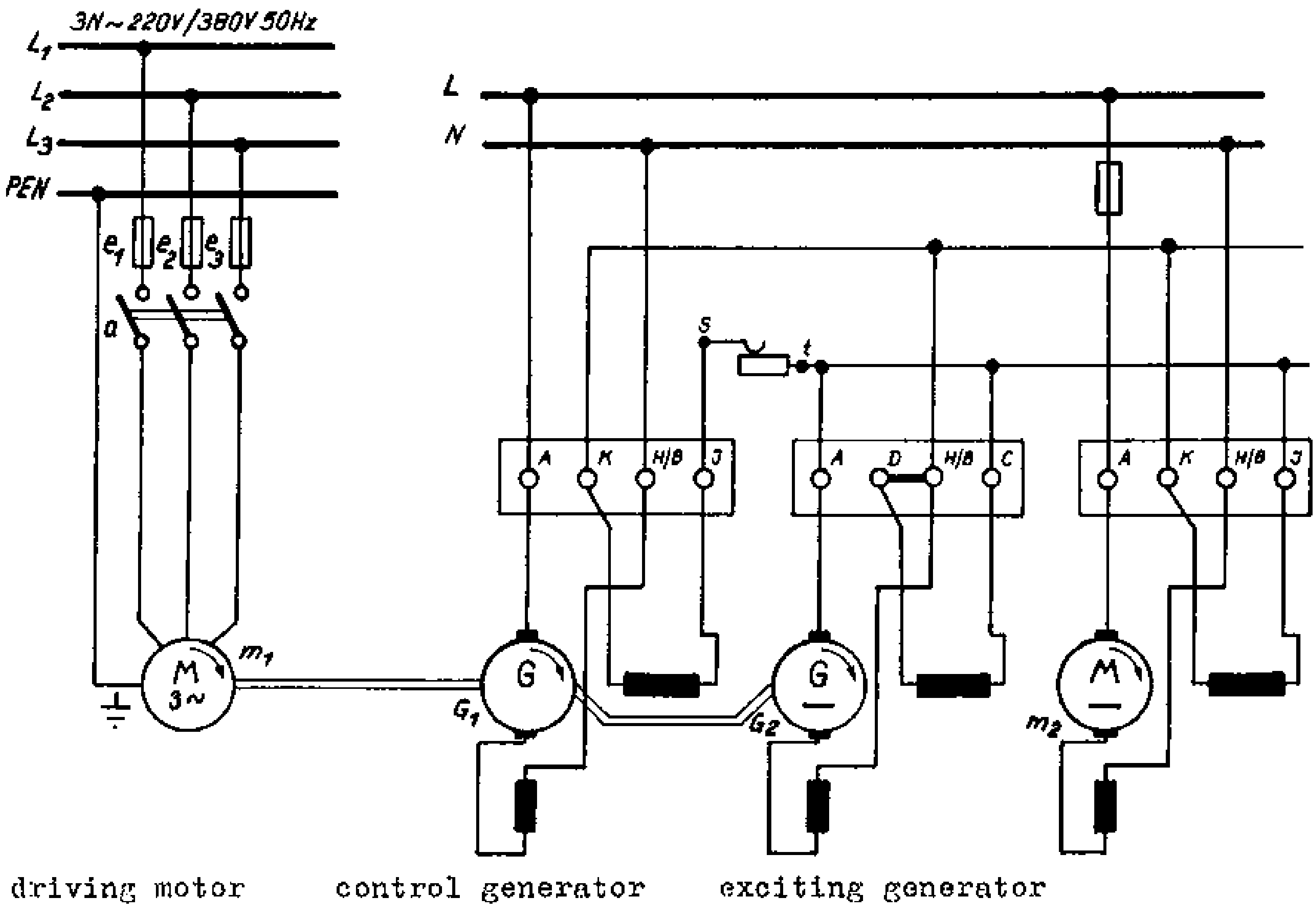


Figure 1-4 Block diagram of adjustable speed drives.

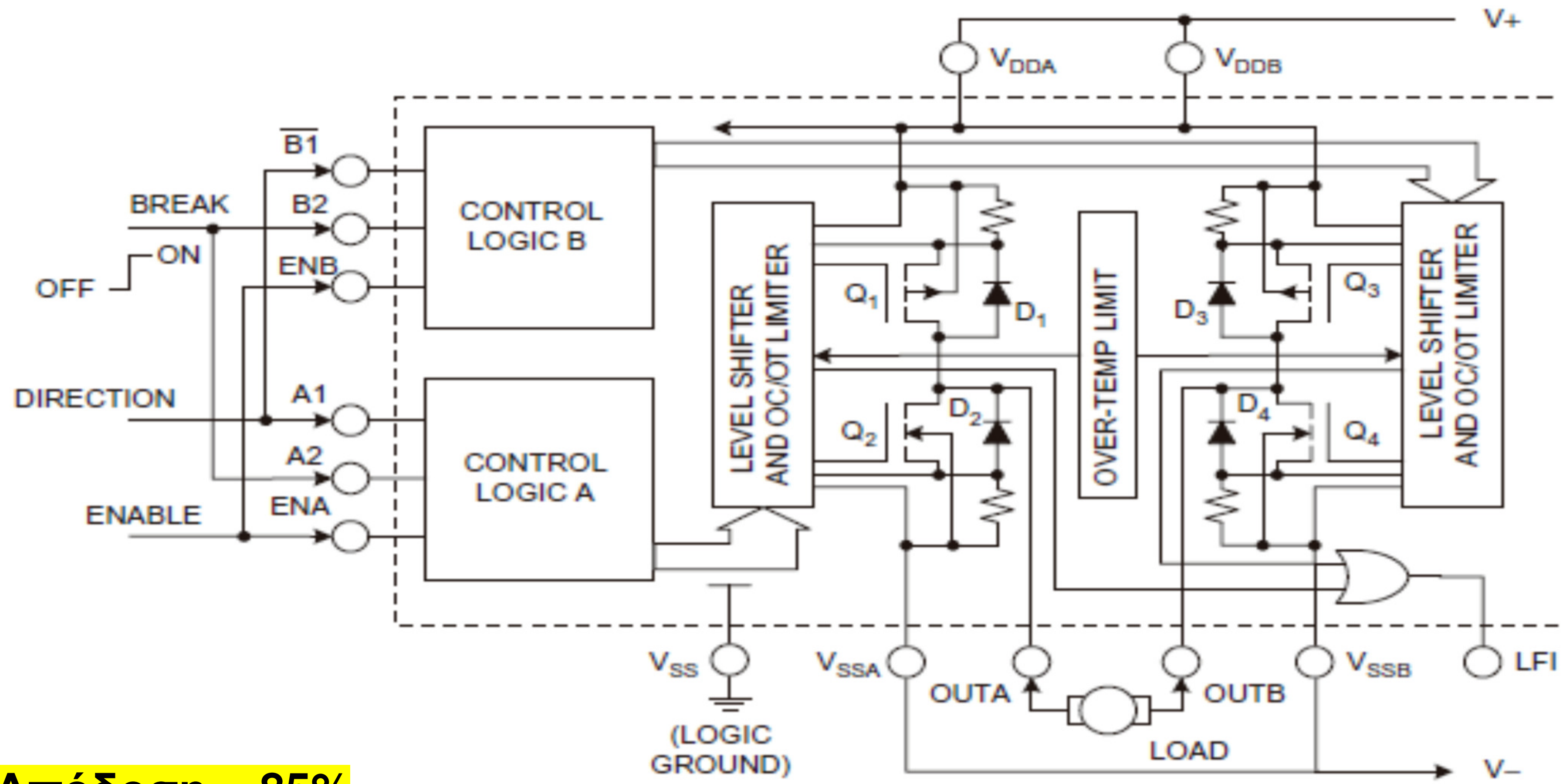
FIGURE 3.21 Four-quadrant operation of dc drive.





Ward Leonard (1891): Απόδοση < 50%

FIGURE 2.28 Power integrated circuit for dc motor drive (Harris HIP4011) (from [18]).

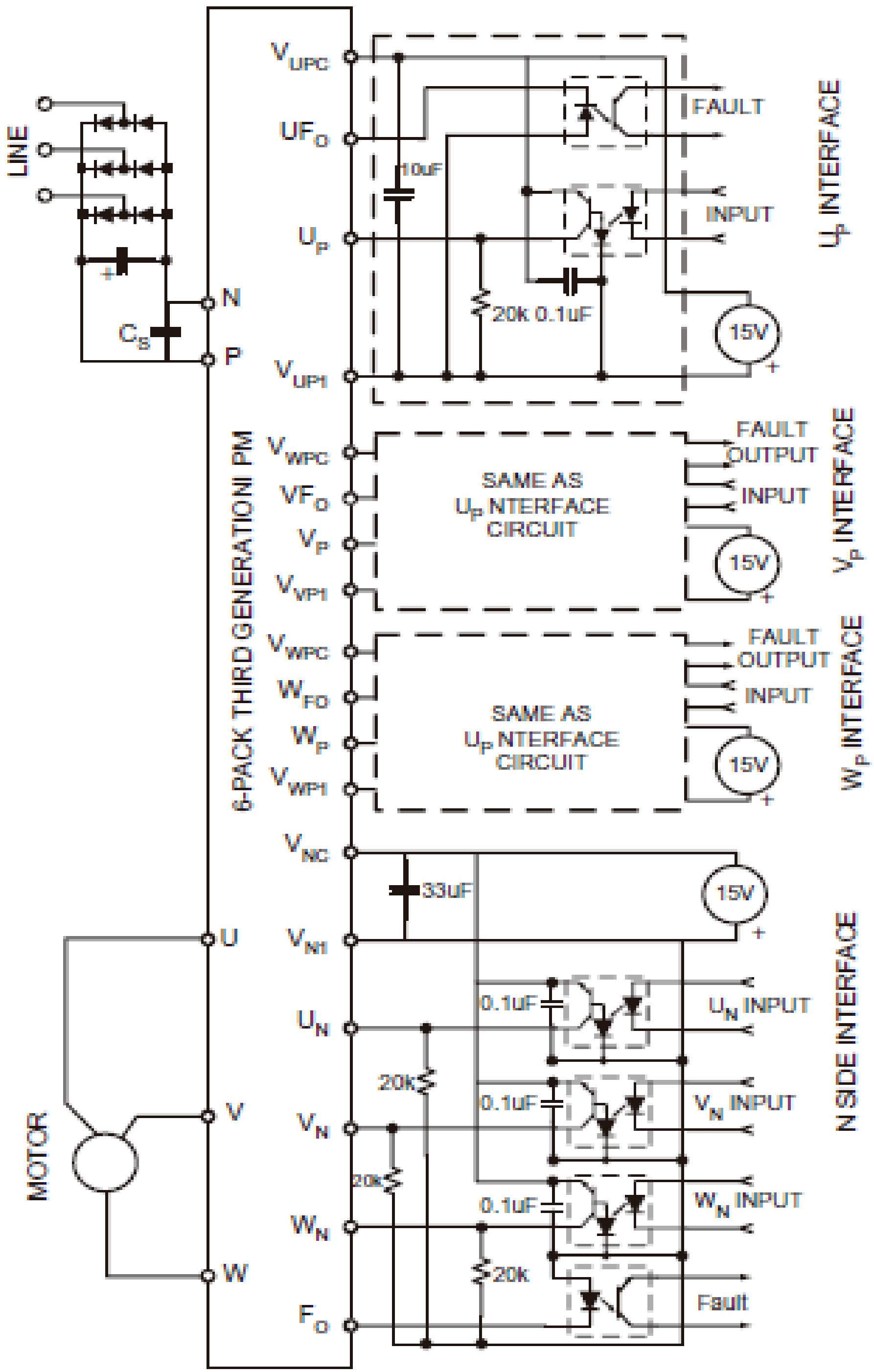


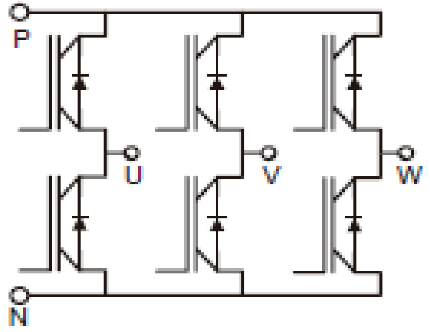
Απόδοση > 85%

TRUTH TABLE

SWITCH DRIVER A				SWITCH DRIVER B			
INPUTS			OUTPUT	INPUTS			OUTPUT
A1	A2	ENA	OUTA	B1	B2	ENB	OUTB
H	L	H	OH	L	L	H	OH
L	L	H	OL	H	L	H	OL
H	H	H	OL	L	H	H	OL
L	H	H	OL	H	H	H	OL
X	X	L	Z	X	X	L	Z

FIGURE 2.21 IGBT six-pack intelligent power module (IPM) with gate drive interface logic (from www.pwrx.com).





Powerex L-series IPM Grid for Six-Pack

Type	Voltage(V)	Current(A)
PM50CLA060	600	50
PM50CLB060	600	50
PM75CLA060	600	75
PM75CLB060	600	75
PM100CLA060	600	100
PM100CLB060	600	100
PM150CLA060	600	150
PM150CLB060	600	150
PM200CLA060	600	200
PM300CLA060	600	300
PM25CLA120	1200	25
PM25CLB120	1200	25
PM50CLA120	1200	50
PM50CLB120	1200	50
PM75CLA120	1200	75
PM75CLB120	1200	75
PM100CLA120	1200	100
PM150CLB120	1200	150
PM300CLA120	1200	300

Induction Heating

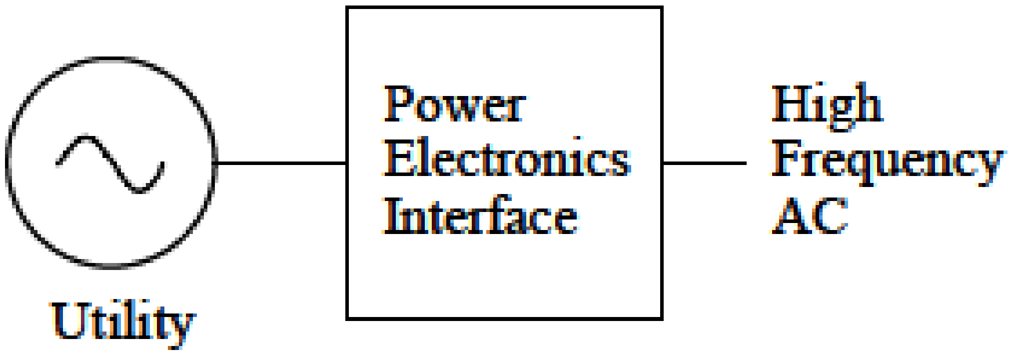


Figure 1-5 Power electronics interface required for induction heating.

Electric Welding

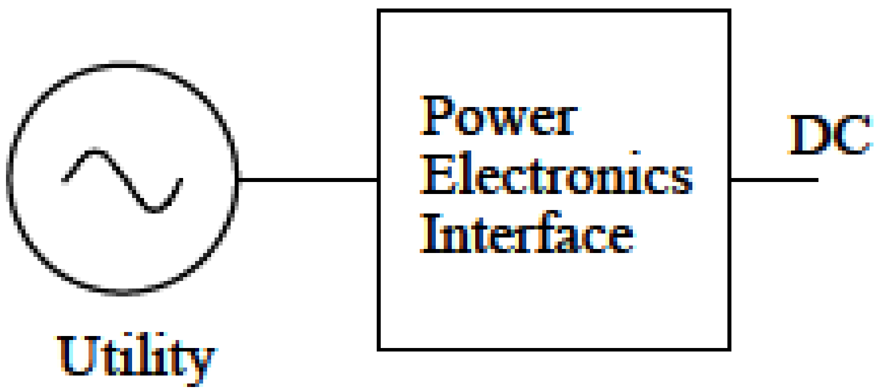


Figure 1-6 Power electronics interface required for electric welding.

Transportation

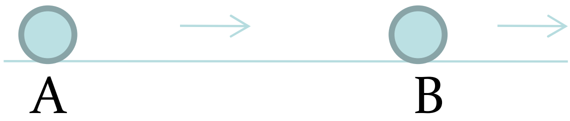
Figure 1-10 Hybrid electric vehicles with much higher gas mileage.

- Hybrid electric vehicles with much higher gas mileage
- light rail, fly-by-wire planes
- all-electric ships
- drive-by-wire automobiles.

How hybrids save fuel

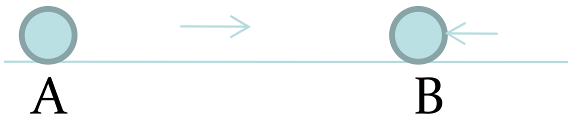
1. Engine is turned off at:
   - Stops
   - Lower speed (say less that 15 km/h), an electric motor drives the car until speed reaches a certain limit, then engine kicks in
   - When vehicle is stopping or going downhill, engine is turned off, Regenerative braking is applied
2. When engine operates in an inefficient mode(e.g. at very high or very low engine speeds), the electric motor kicks in and assists engine. Engine is driven to its optimum operating zone
3. Engine can be made smaller, due to electric motor assistance

Vehicle kinetic energy



$$E = \frac{1}{2} m (V_A^2 - V_B^2)$$

- $V_B > V_A$ accelerating, fuel is consumed, kinetic energy is increased



- $V_A > V_B$ braking, very little fuel is consumed, kinetic energy is reduced

  energy is dissipated in the brakes as heat in conventional cars

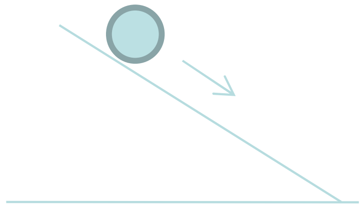
  In hybrids braking energy is recovered by an electric generator and stored in a battery

  it is called regenerative energy, or “Regen Energy”

Vehicle potential energy

$$E = mgh$$

Need engine power, fuel is consumed, potential energy is increased



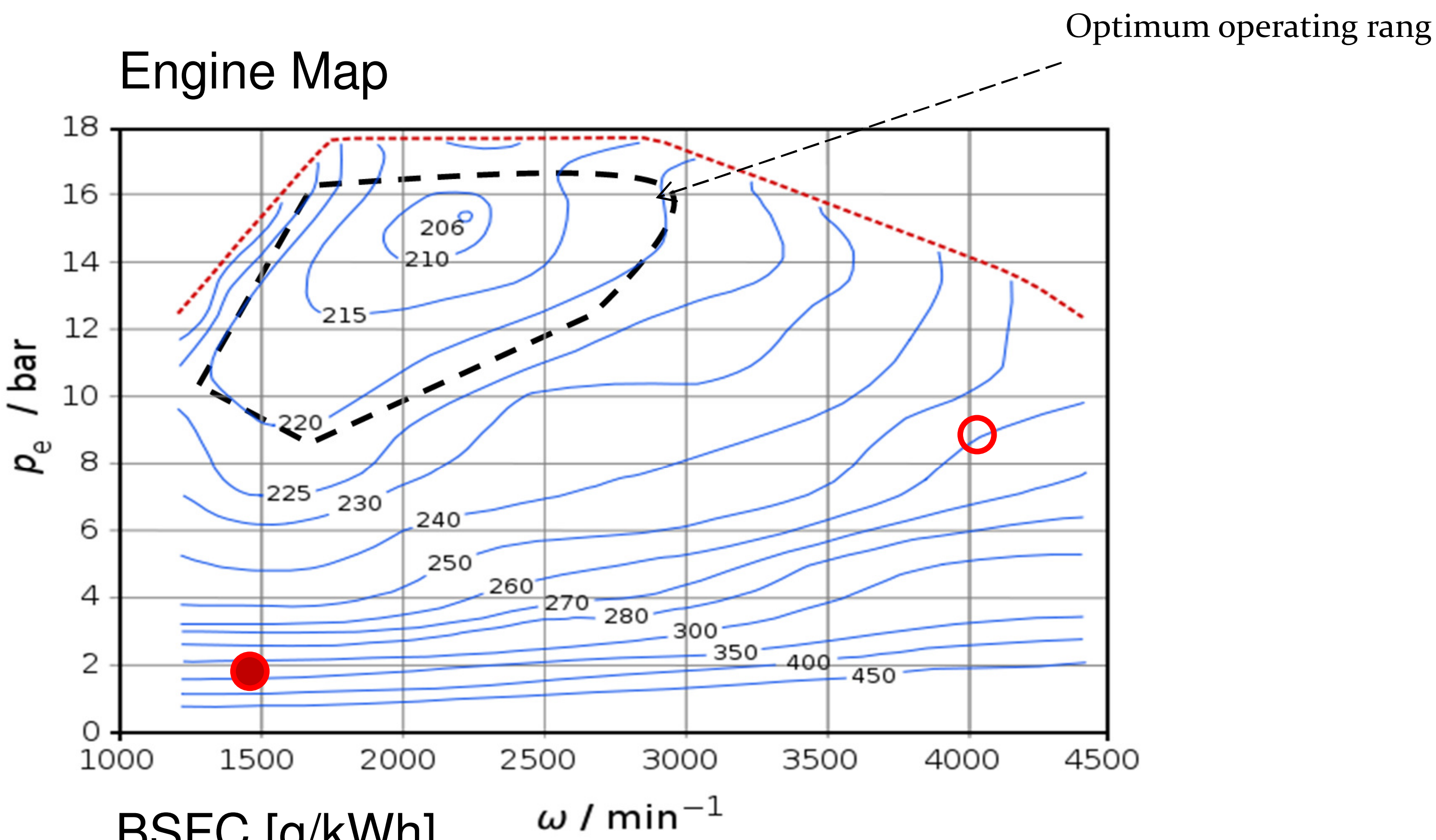
no need for engine power

Braking, very little fuel is consumed, potential energy is reduced energy is dissipated in the brakes as heat in conventional cars

In hybrids braking energy is recovered, Engine can be turned off automatically going downhill

Optimum engine operation condition

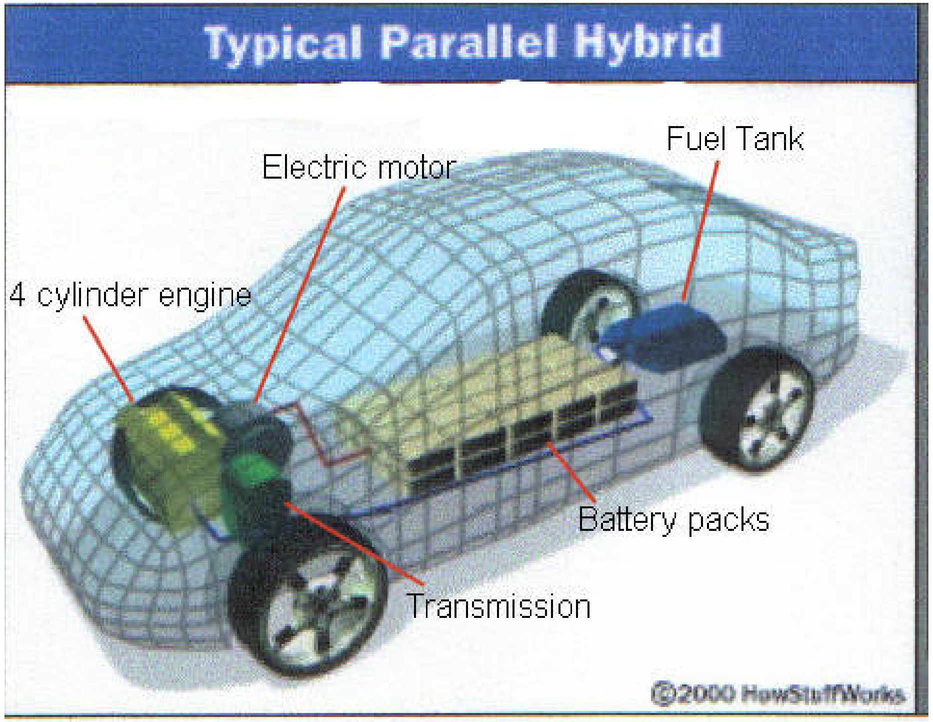
Engine Map



BSFC [g/kWh]

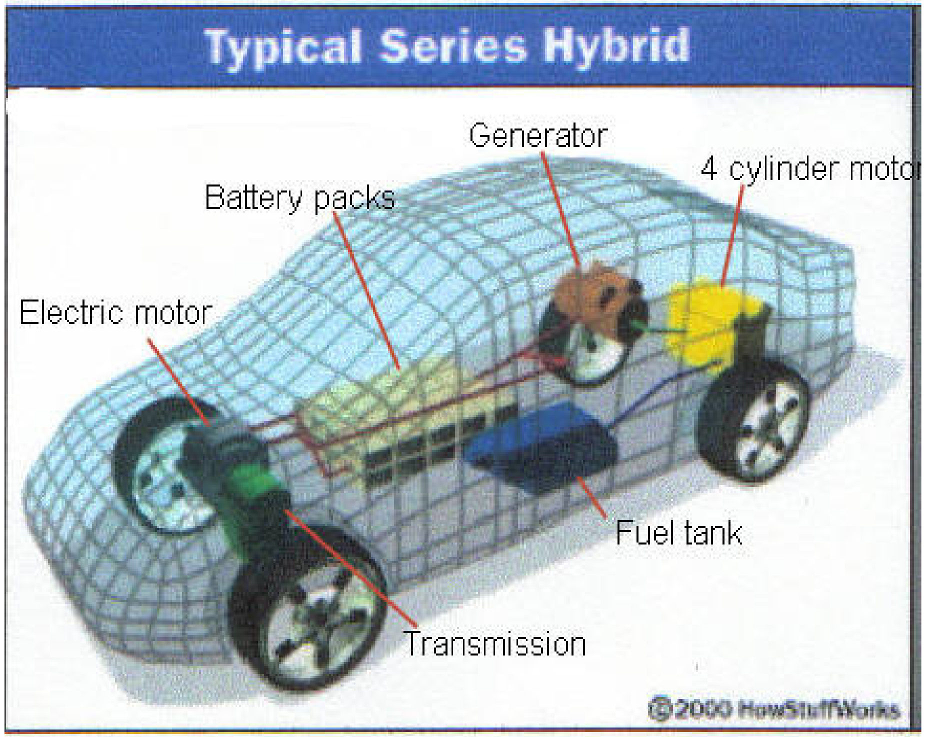
PARALLEL HYBRID

- Gasoline motor
- Batteries which powers an electric motor
- Both can power the transmission at the same time
- Electric motor supplements the gasoline engine



SERIES HYBRID

- Gasoline motor turns a generator
- Generator may either charge the batteries or power an electric motor that drives the transmission
- At low speeds is powered only by the electric motor



PURE EVs

- EV Batteries are DC while charging is from AC [converter]
- Advance in EVs = Advances in technology / Batteries:
  - ✓ Nissan Leaf in 2010 ran at 110 km on one charge
    - ✓ Latest model now have a range of 300 km or more.
  - ✓ PHEVs smaller battery capacity —commonly with an all-electric range of only 40-50km — but supplemented with a petroleum-fuelled engine
  - ✓ 30% more efficient than comparable non-hybrid vehicles
  - ✓ Battery capacity of 24 kWh charging at a rate of 1.7kW would take about 14 hrs
  - ✓ Nowadays there are fast charging at 50kW and ultra rapid at 350kW
  - ✓ e-bikes and e-scooters are charged at as little as 2A from a supply of 230V AC – a fraction of the draw from an electric kettle (for comparison, a normal domestic socket outlet is rated at 10A).

Dasteri
Lighting your needs

Υλοποίηση του καινοτόμου εικονικού φορτίου:

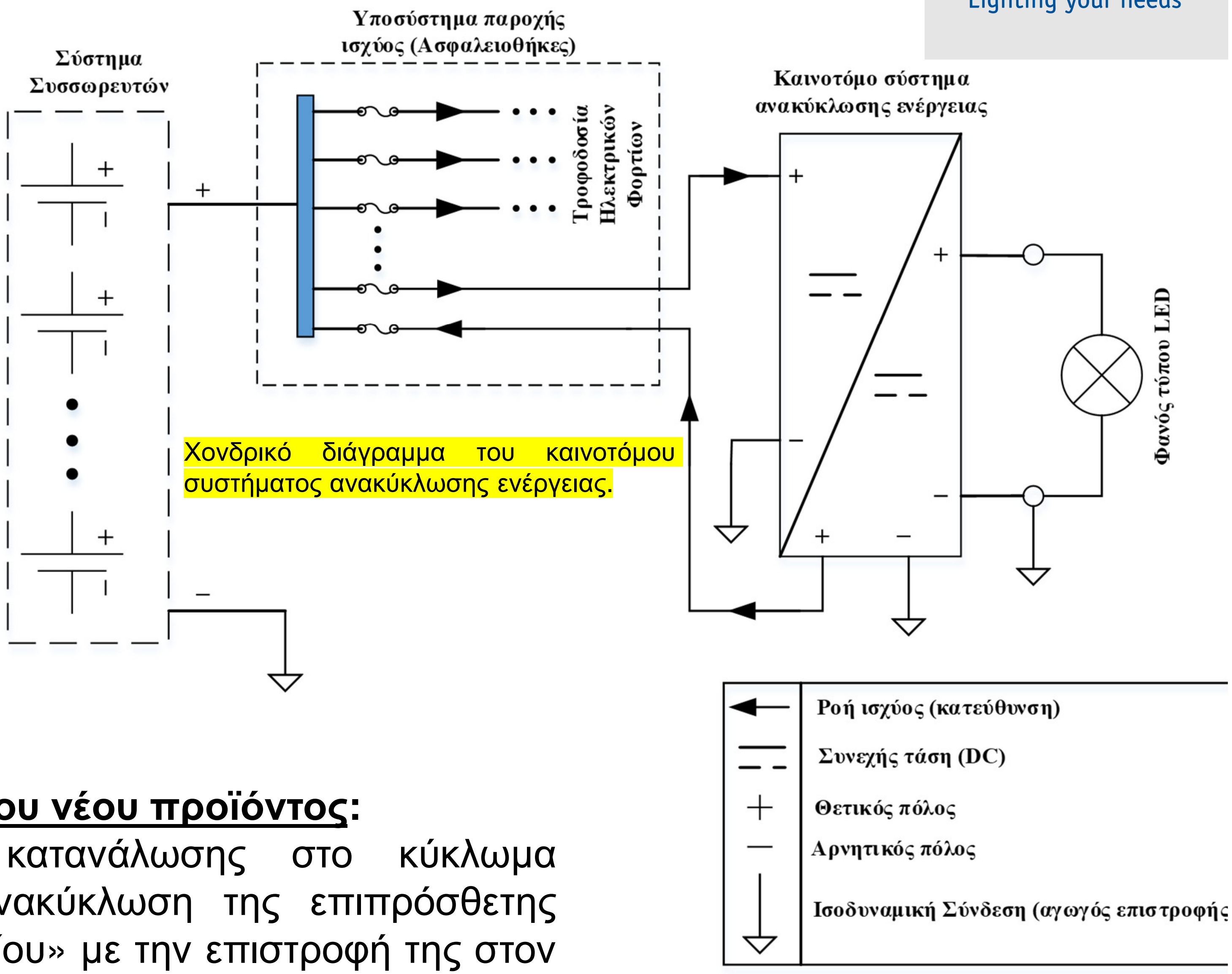
Γενική περιγραφή

Κατάλληλος μετατροπέας συνεχούς τάσης σε συνεχή τάση (Σ.Τ./Σ.Τ.).

Λειτουργίες:

α) Άμεση τροφοδότηση του φανού τύπου LED από τον συσσωρευτή

β) Εικονική αύξηση της ηλεκτρικής κατανάλωσης του φανού τύπου LED, επιστρέφοντας την περίσσεια ενέργειας στον συσσωρευτή.



Χονδρικό διάγραμμα του καινοτόμου συστήματος ανακύκλωσης ενέργειας.

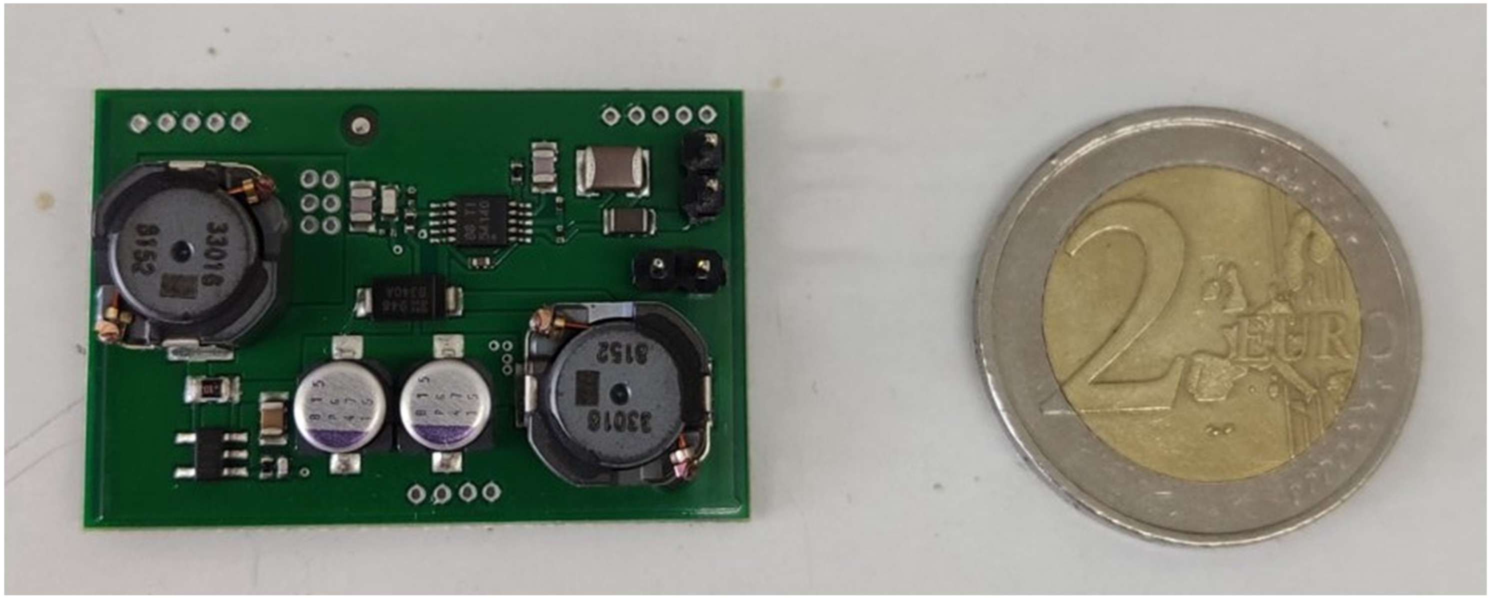
Πλεονέκτημα του νέου προϊόντος:

Δραστική μείωση της κατανάλωσης στο κύκλωμα φωτισμού, χάρις στην ανακύκλωση της επιπρόσθετης ενέργειας «του ψευδοφορτίου» με την επιστροφή της στον συσσωρευτή σε πραγματικό χρόνο.

Προτυποποίηση-δοκιμές υπό πραγματικές συνθήκες

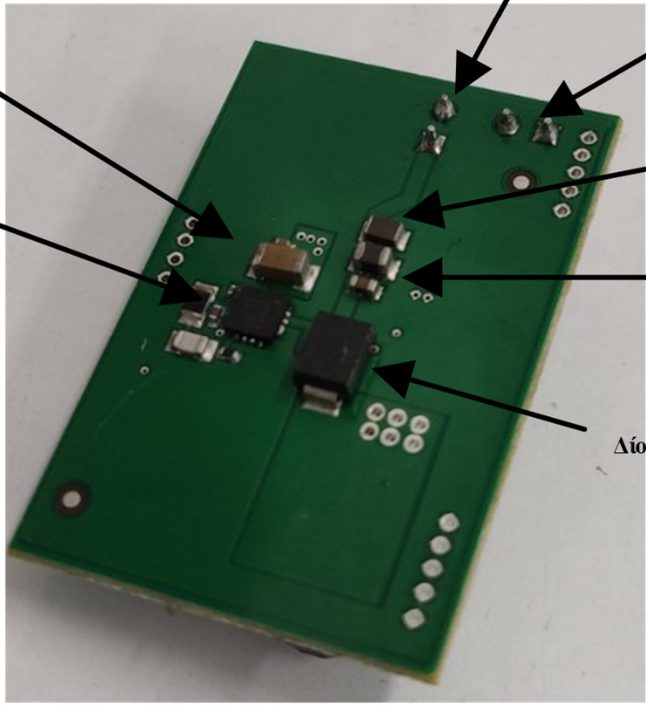
Dasteri
Lighting your needs

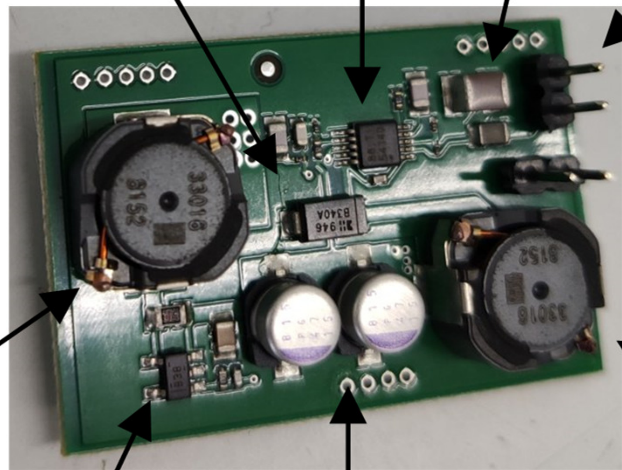
Ελάχιστη Ισχύς	10 W
Ύψος	10 mm
Πλάτος	39 mm
Μήκος	27 mm
Μέγιστη Θερμοκρασία	70 ^{o}C
Βάρος	15 gr
Πυκνότητα Ισχύος	0.67 kg/kW
Ελάχιστο MTBF	100.000 ώρες
Ελάχιστος Βαθμός Απόδοσης	>80%



Προτυποποίηση-δοκιμές υπό πραγματικές συνθήκες

Τυπωμένο κύκλωμα του καινοτόμου εικονικού φορτίου





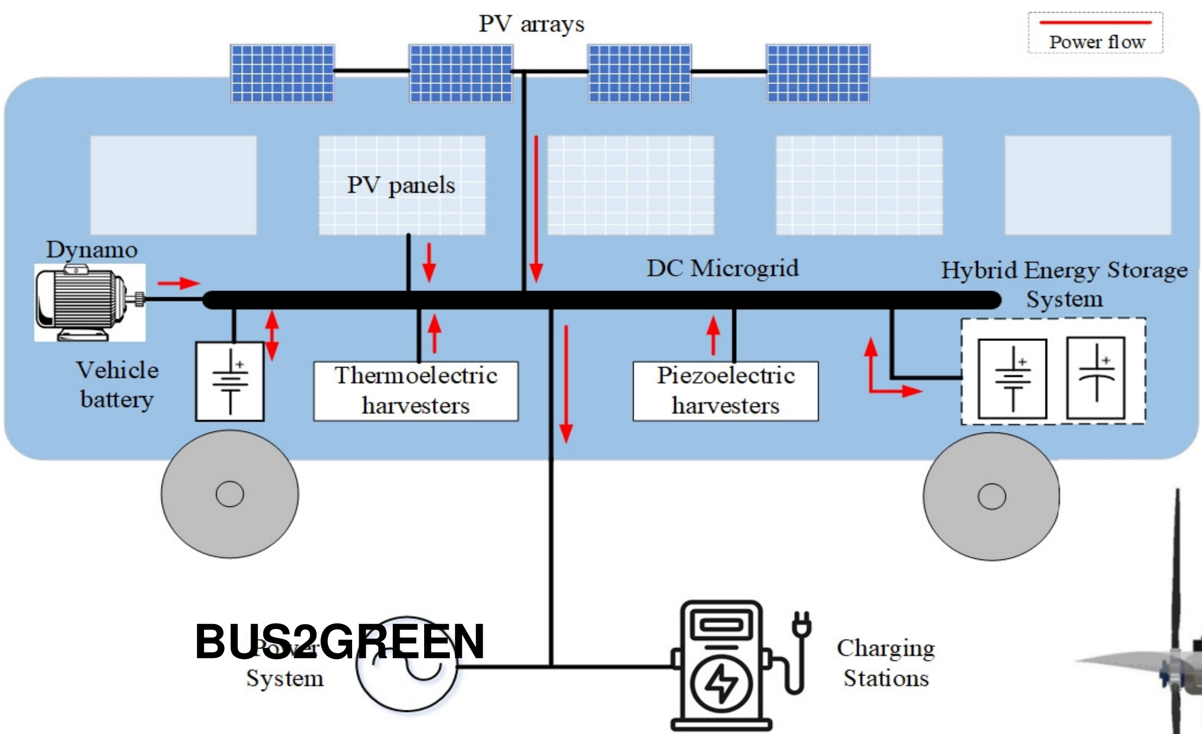
Προτυποποίηση-δοκιμές υπό πραγματικές συνθήκες

Αποτελέσματα εξοικονόμησης ενέργειας

Δοκιμή	% εξοικονόμηση ενέργειας σε σχέση με την κατανάλωση από την πηγή εισόδου.	Επιβάρυνση που έχει το εικονικό φορτίο στην πραγματική κατανάλωση του φανού.
1) συμβατικό ψευδοφορτίο υπό λειτουργία φωτισμού πορείας	0%	• Ωμικό ψευδοφορτίο 12.8 W + Φανός 3.2 W = 16 W • Ισχύς ανακύκλωσης 0 Συνεπώς επιβάρυνση 12.8/3.2 = 400% (ισοδυναμεί με 4 φανούς επιπλέον)
2) Συμβατικό ψευδοφορτίο υπό λειτουργία δυναμικού φλας	0%	• Ωμικό ψευδοφορτίο 6.4 W + Φανός 1.6 W = 8 W • Ισχύς ανακύκλωσης 0 Συνεπώς επιβάρυνση 6.4/1.62 = 400% (ισοδυναμεί με 4 φανούς επιπλέον)
3) Καινοτόμο εικονικό φορτίο, υπό λειτουργία φωτισμού πορείας	**70%**	• Καινοτόμο εικονικό 1.65 W + Φανός 3.2 W = 4.85 W • Ισχύς ανακύκλωσης 11.3 W Συνεπώς: επιβάρυνση 1,65/3.2 = 51,56% (ισοδυναμεί με 0.5 φανό επιπλέον)
4) Καινοτόμο εικονικό φορτίο, υπό λειτουργία δυναμικού φλας	**65%**	• Καινοτόμο εικονικό 1.48 W + Φανός 1.6 W = 3.08 W • Ισχύς ανακύκλωσης 5.72 Συνεπώς επιβάρυνση 1.48/1.6 = 92.5% (ισοδυναμεί με 0.92 φανό επιπλέον)

Ετήσιες ώρες λειτουργίας	Ετήσια κατανάλωση ενέργειας ($kWh_{th,h}$)/λίτρων καυσίμου (lt)		Ετήσια εξοικονόμηση ενέργειας/λίτρων καυσίμου	
	Συμβατικού	Καινοτόμου	$kWh_{th,h}$/lt	%
4000 (11 h/d)	200/16.8	60.63/5.09	139.375/11.71	70
5000 (13 h/d)	250/21	75.78/6.37	174.29/14.63	
6000 (16 h/d)	300/25.21	90.94/7.64	209.063/17.57	
7000 (19 h/d)	350/29.41	106.09/8.92	243.907/20.49	

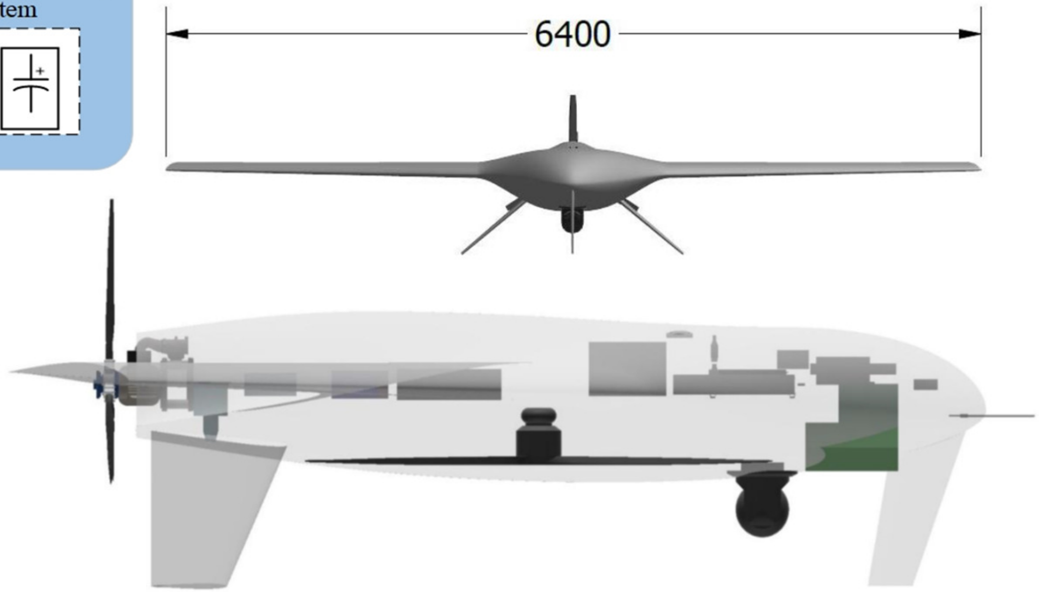
Innovation Norway · Iceland Liechtenstein Norway grants · Ευρωπαϊκή Ένωση Ευρωπαϊκό Ταμείο Περιφερειακής Ανάπτυξης · ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ ΥΠΟΥΡΓΕΙΟ ΟΙΚΟΝΟΜΙΑΣ & ΑΝΑΠΤΥΞΗΣ ΕΙΔΙΚΗ ΓΡΑΜΜΑΤΕΙΑ ΕΠΑ & ΤΣ ΕΙΔΙΚΗ ΥΠΗΡΕΣΙΑ ΔΙΑΧΕΙΡΙΣΗΣ ΕΠΑνΕΚ · ΕΠΑνΕΚ 2014-2020 ΕΠΙΧΕΙΡΗΣΙΑΚΟ ΠΡΟΓΡΑΜΜΑ ΑΝΤΑΓΩΝΙΣΤΙΚΟΤΗΤΑ ΕΠΙΧΕΙΡΗΜΑΤΙΚΟΤΗΤΑ ΚΑΙΝΟΤΟΜΙΑ · ΕΣΠΑ 2014-2020 ανάπτυξη - εργασία - αλληλεγγύη
Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης



BUS2GREEN

ΑΡΧΥΤΑΣ

Ανάπτυξη του πρώτου Ελληνικού UAV



MICROGRAV

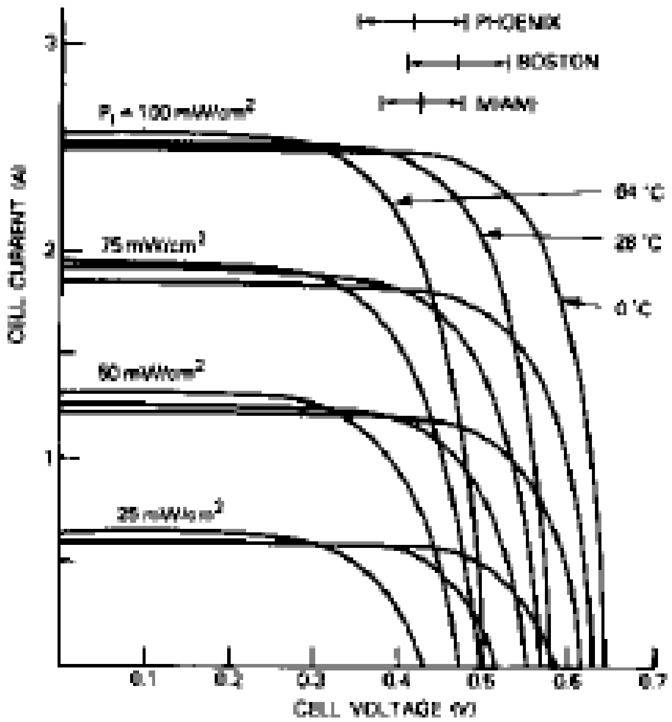
ΗΛΕΚΤΡΟΔΟΤΩ

RECOMAR

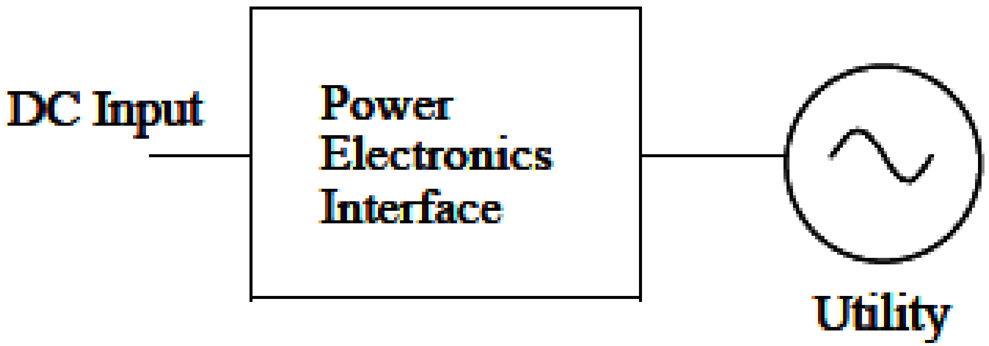
Σχεδιασμός “Πράσινων” Μεταφορών

Renewable Energy

Photovoltaic Systems



(a)

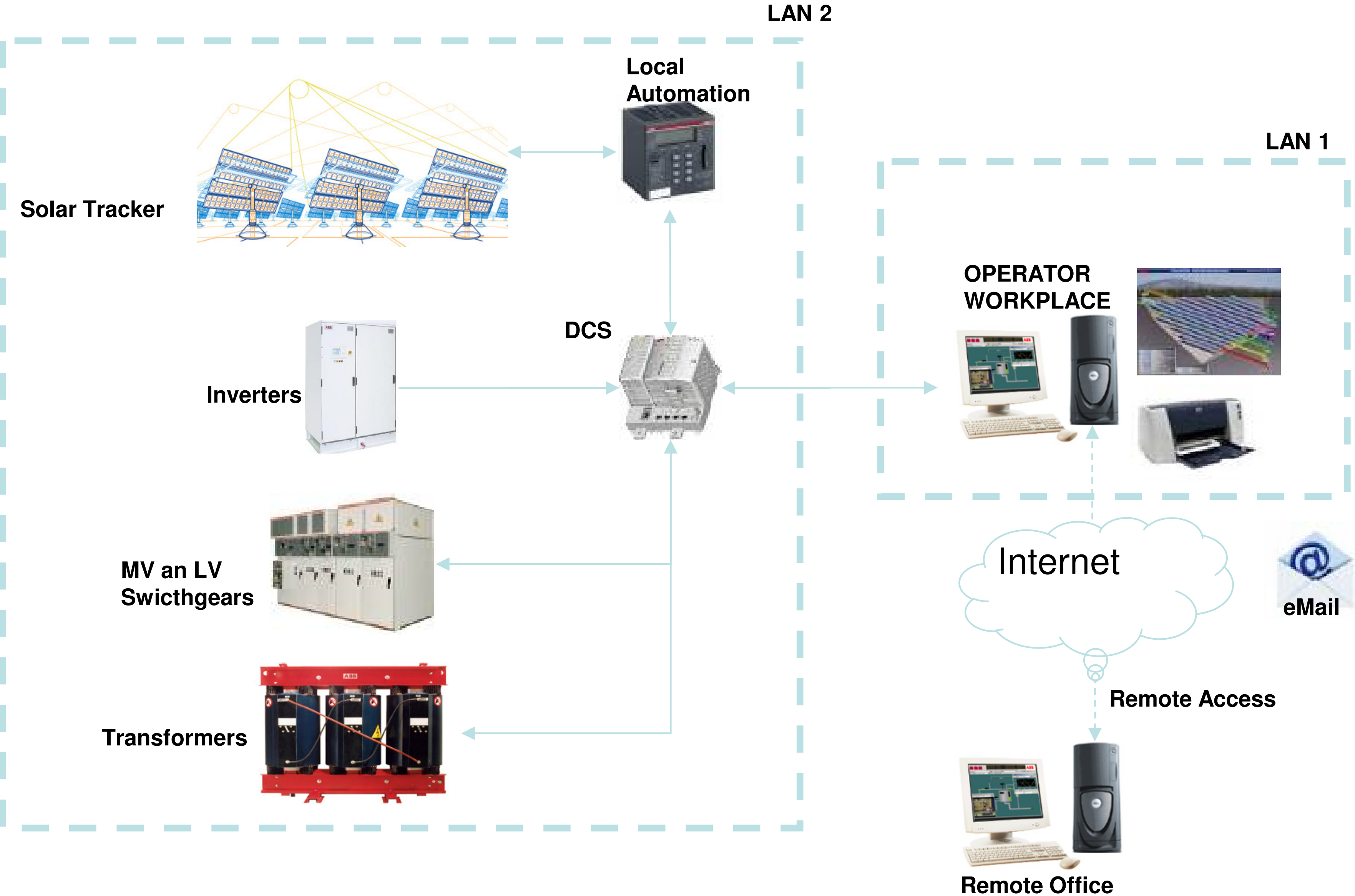


(b)

Figure 1-11 Photovoltaic Systems.

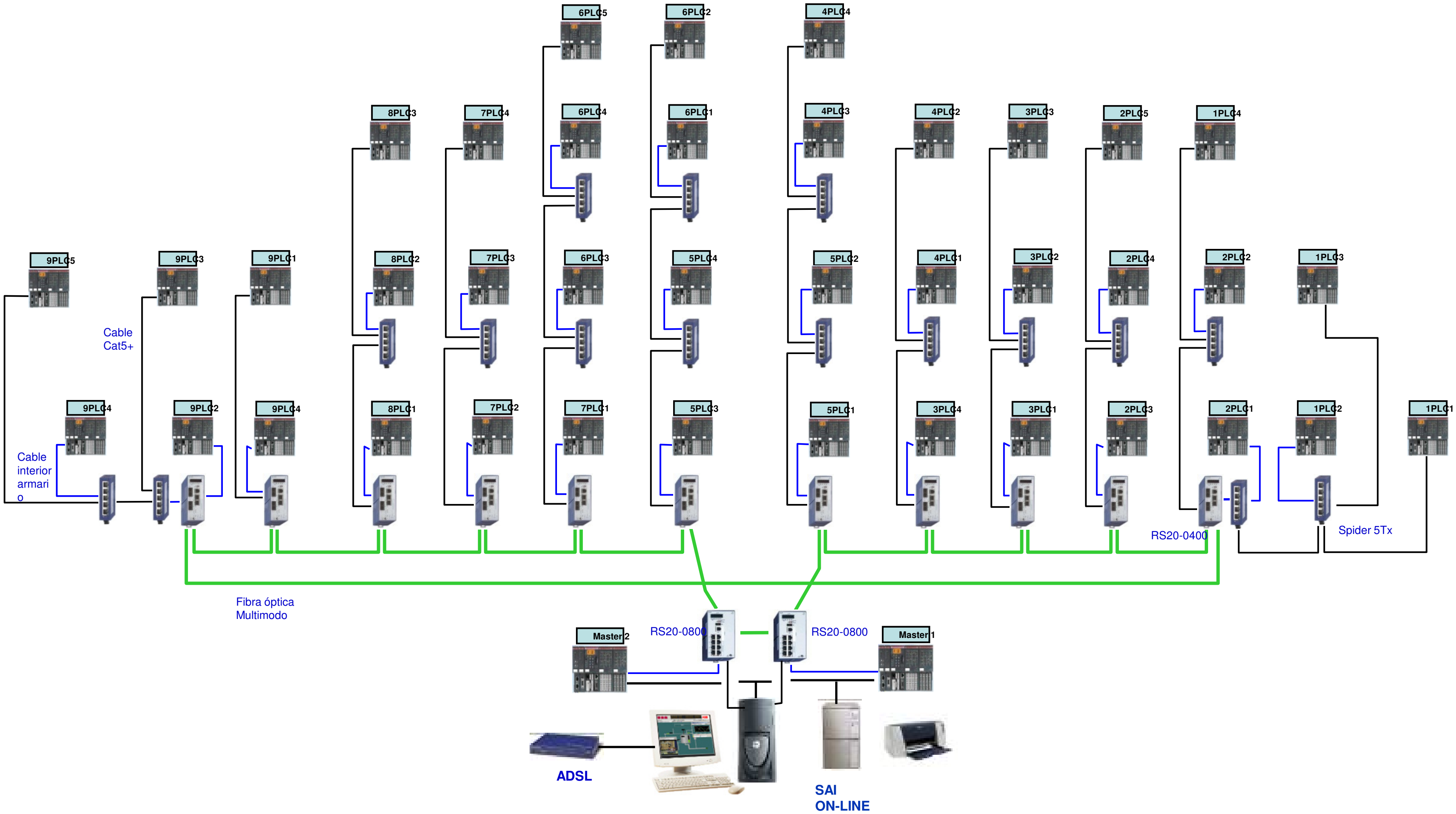
Photovoltaic plant automation

Architecture

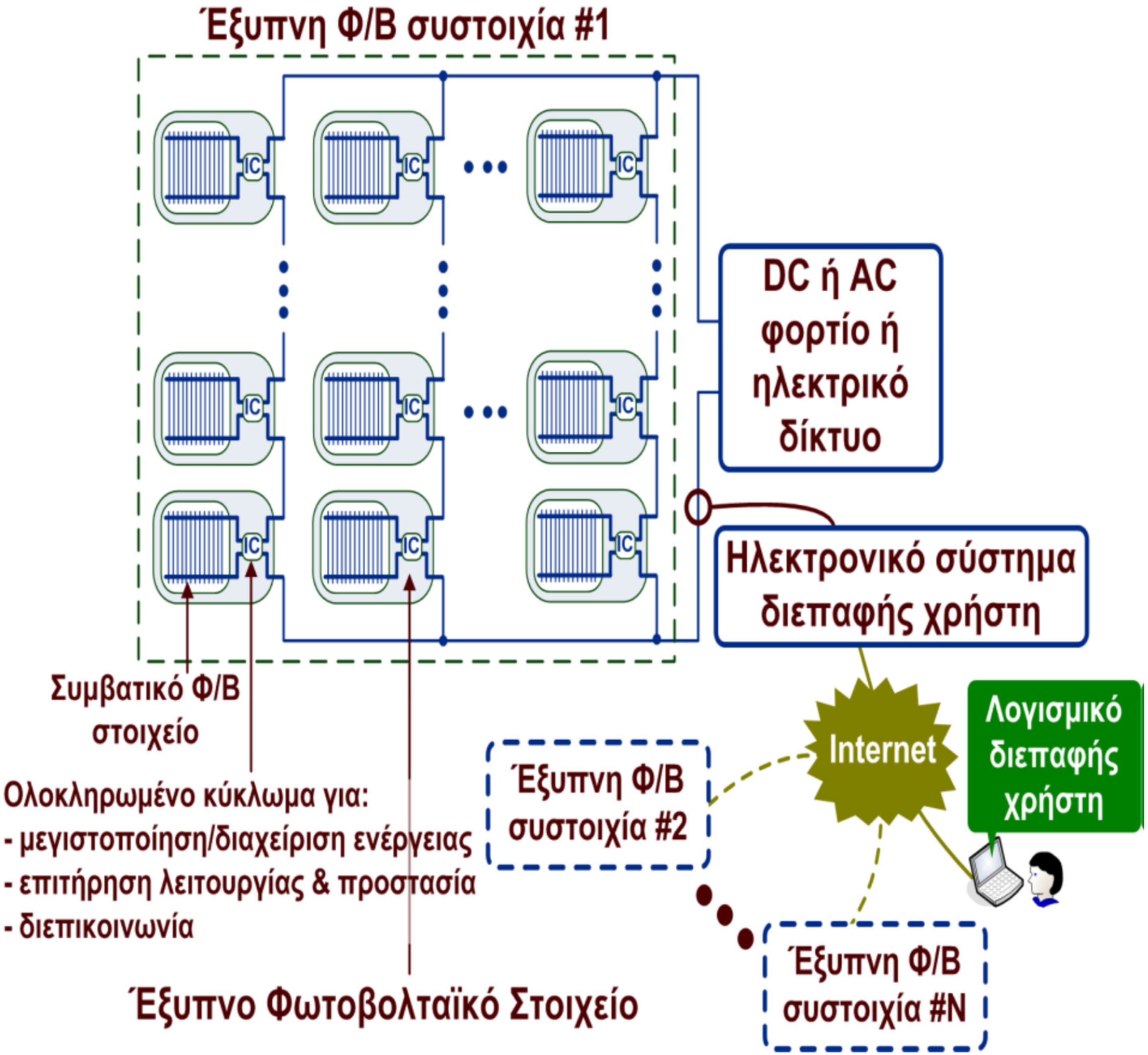


Photovoltaic plant automation
Local automation architecture

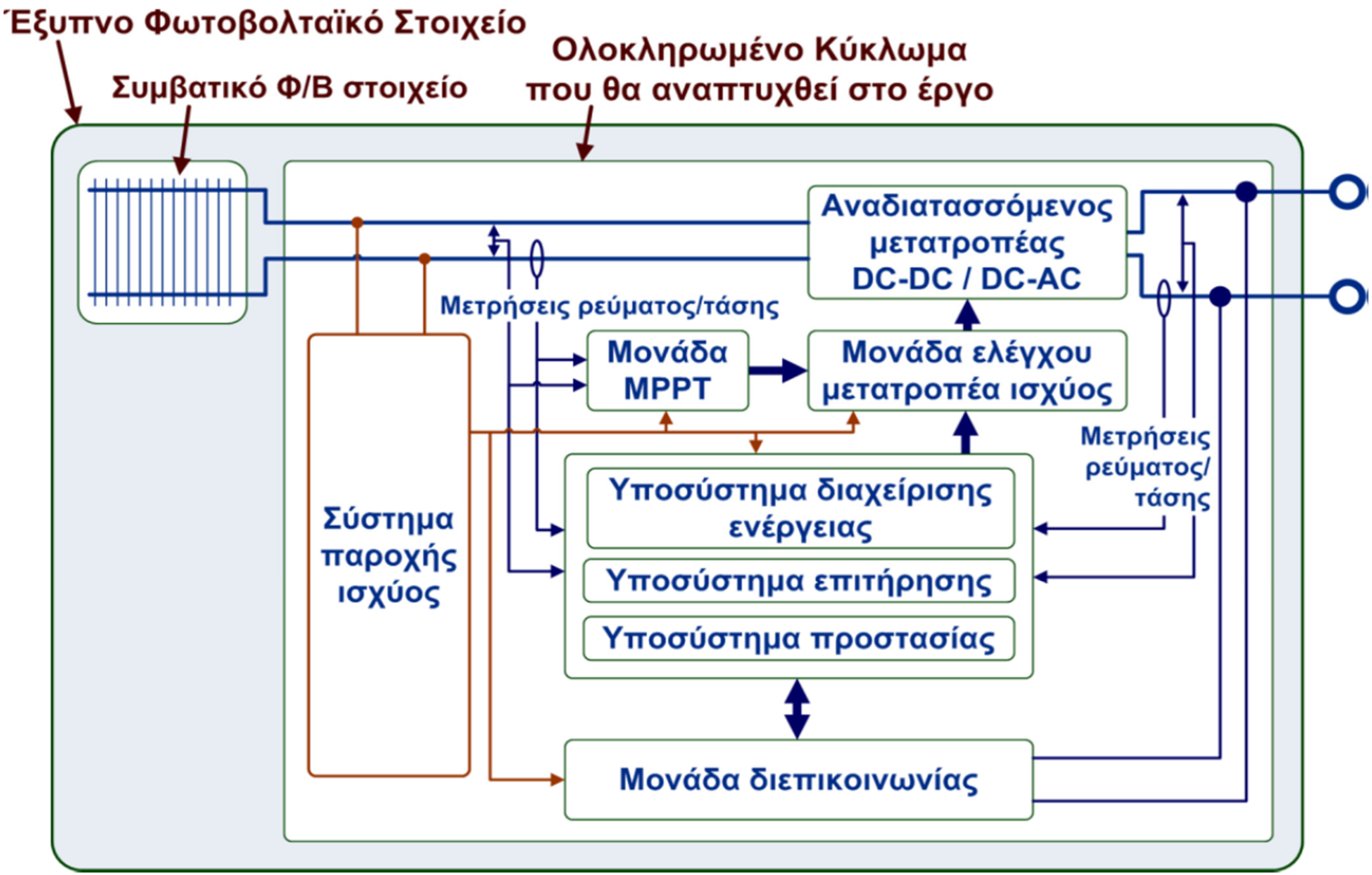
Supervision & control systems



Το σύστημα Έξυπνων Φ/Β Στοιχείων που αναπτύσσεται

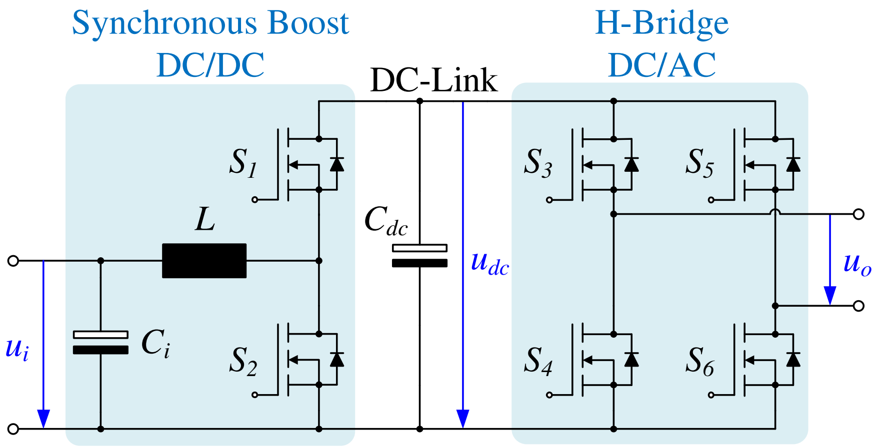


Το σύστημα Έξυπνων Φ/Β Στοιχείων που αναπτύσσεται



overall system

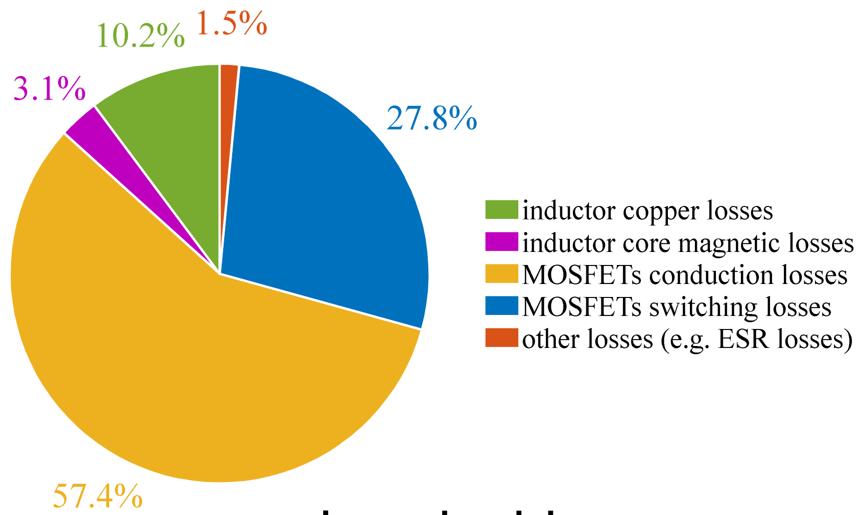
- DC/AC power stage: The **transformerless H-bridge** inverter topology is selected, as it provides **simplicity**, **high efficiency**, **compactness** and **cost-effectiveness**, due to the low components count.
- A **power losses analysis** is performed, so as to calculate the theoretically expected efficiency and have an accurate description of the losses distribution.
- Various tests are carried out on a prototype converter, designed and constructed with miniature-sized SMD components, so as to experimentally validate its functionality and performance (prior to on-chip integration).



schematic of the designed converter

experimental prototype main parameters

Parameter / Component	Description / Value
Input voltage (u_i)	0.5 V – 1 V
DC-link voltage (u_{dc})	3 V
Boost switching frequency ($f_{s,b}$)	100 kHz
Inverter switching frequency ($f_{s,i}$)	100 kHz
Switches ($S_1 – S_6$)	**FDS6680AS** power MOSFET with integrated Schottky diode *(30 V, 11.5 A,* $R_{DS(on),max} = 10\ m\Omega$ @ $V_{GS} = 10\ V$*)*
Bootstrap driver	**NCP81075** dual MOSFET gate driver with on-chip bootstrap diode
Inductor (L)	**HCM1A1305-1R0-R** *(*$L = 1\ \mu H$*,* $DCR_{typical} = 2.1\ m\Omega$*)*
Input capacitor (C_i)	90 mF *(3 x* **BZ015B303ZSB** *supercapacitor in parallel with 1 x* **C1210C104J5GACTU** *ceramic,* $ESR = 64\ m\Omega$*)*
DC-link capacitor (C_{dc})	30 mF *(1 x* **BZ015B303ZSB** *supercapacitor in parallel with 1 x* **C1210C104J5GACTU** *ceramic,* $ESR = 192\ m\Omega$*)*

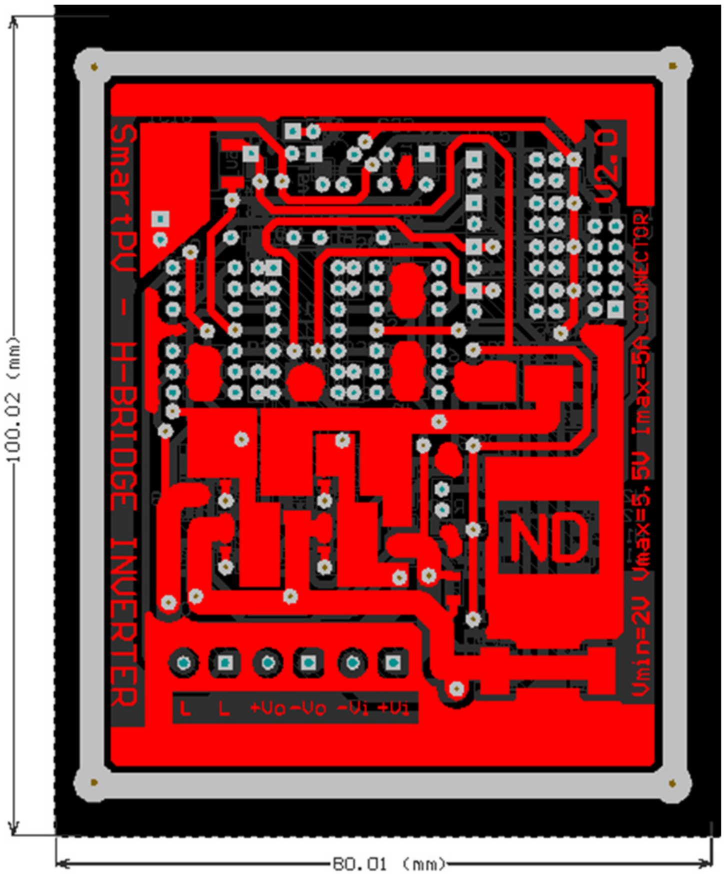


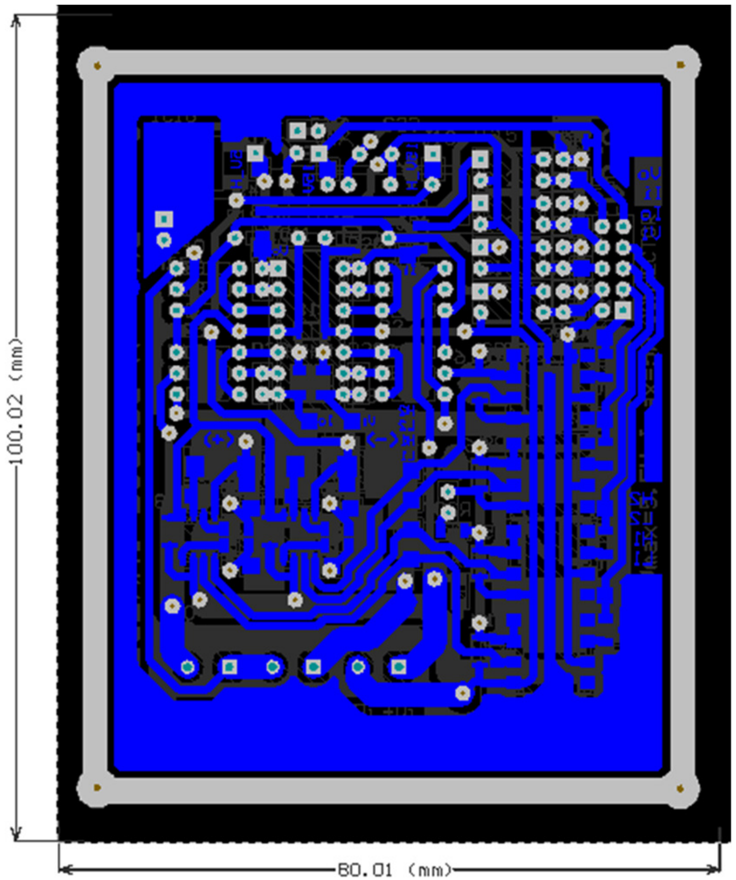
power losses breakdown

MOCAST 2021 Conferece

Printed Circuit Board

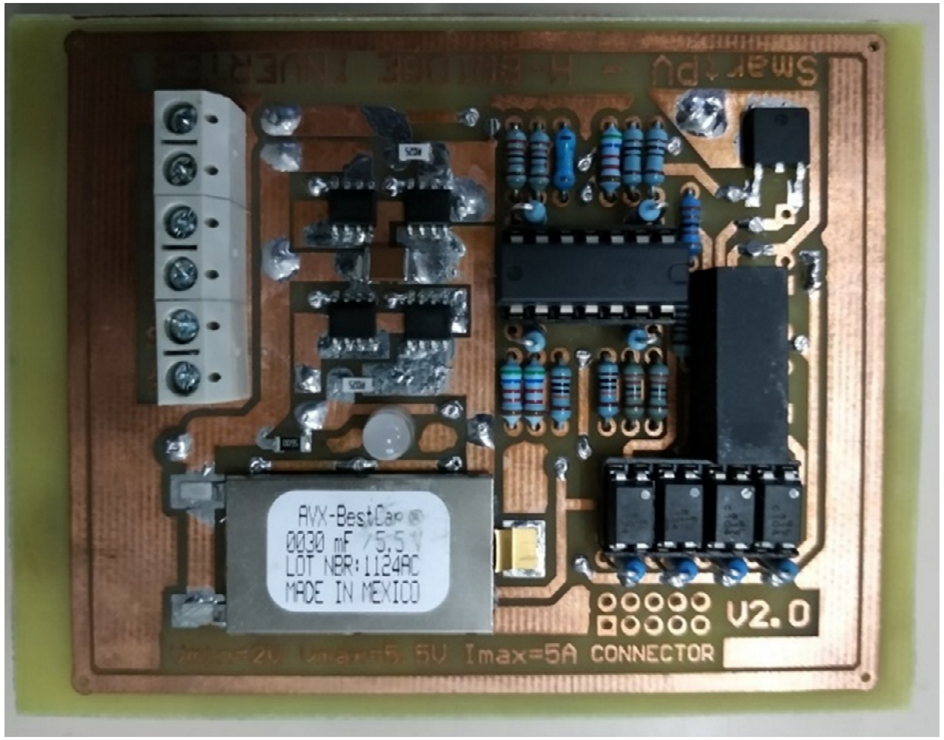
PCB 3ης Έκδοσης

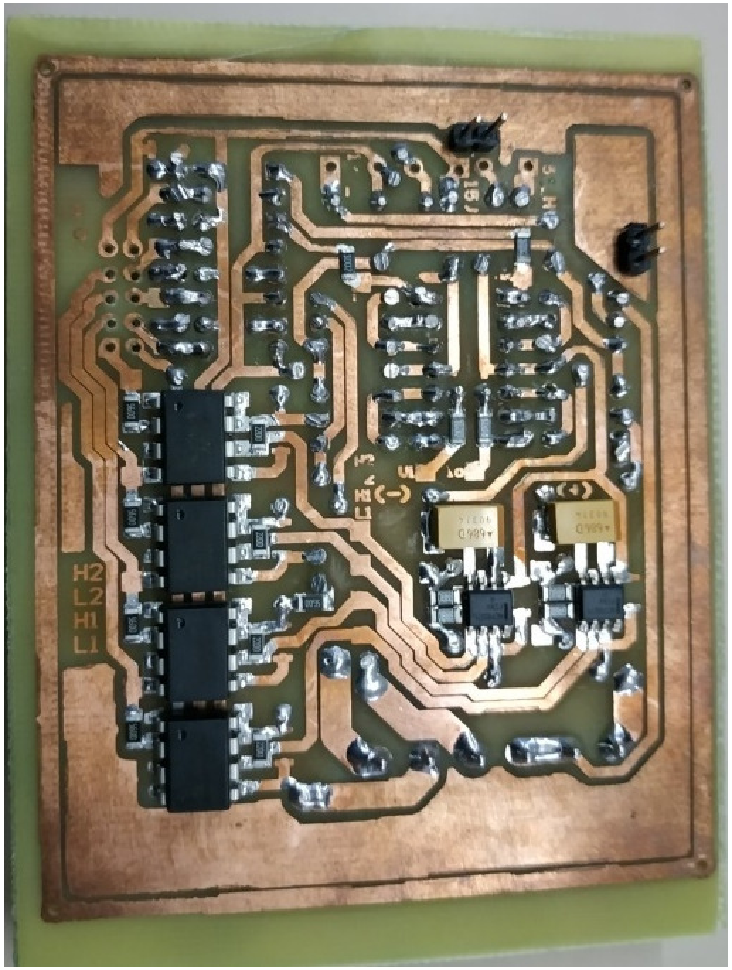




Υλοποίηση Πλακετών

3η Έκδοση Πλακέτας





Πειραματική Διάταξη

Τέσσερις Αντιστροφείς Συνδεδεμένοι στο Δίκτυο

Τροφοδοσία

Τροφοδοτικό εργαστηρίου με λειτουργία Constant Current

Δίοδοι

Προστασία τροφοδοτικών από ανάστροφο ρεύμα

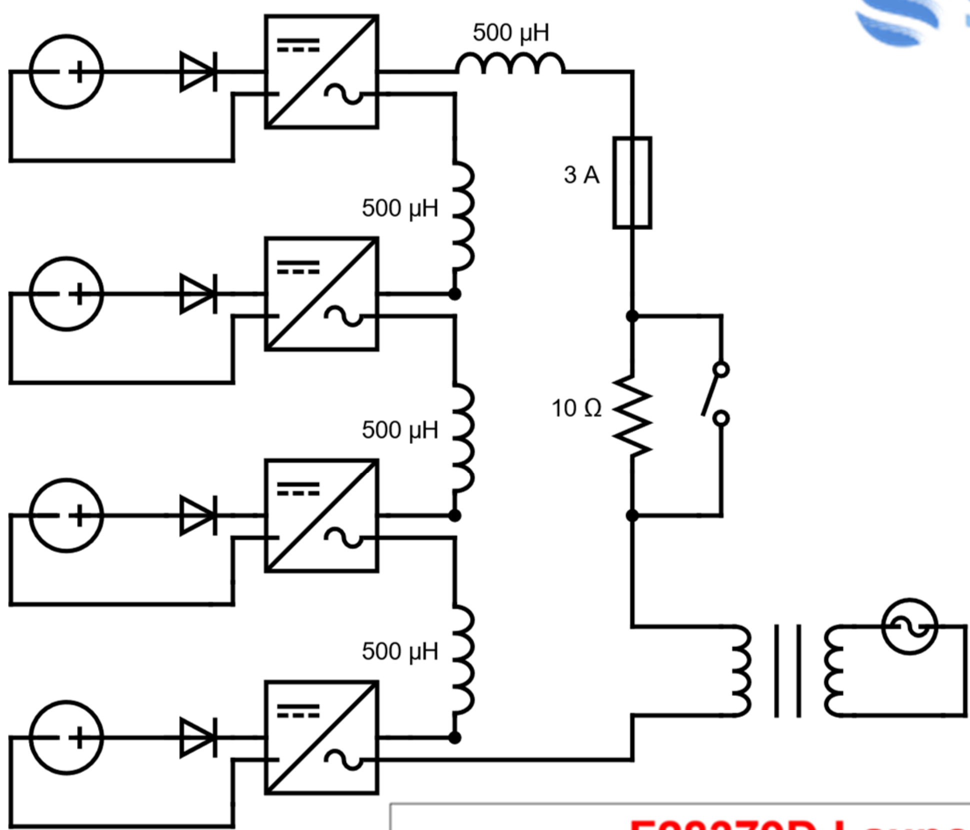
Ασφάλεια 3 A

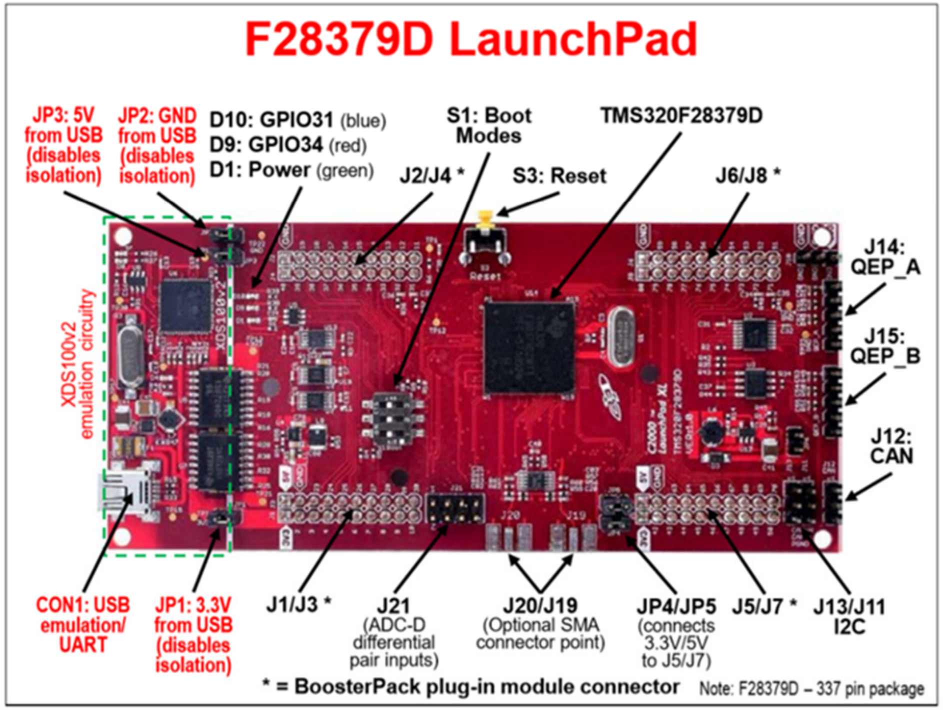
Αντίσταση περιορισμού ρεύματος

Μετασχηματιστής

Σύνδεση με το δίκτυο

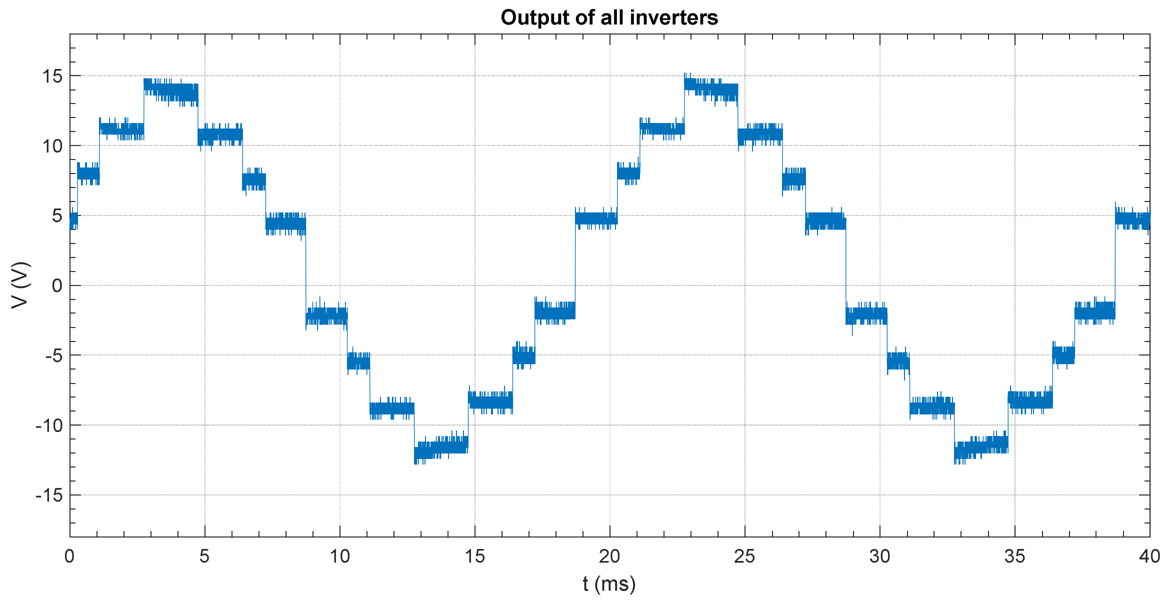
Λόγος σπειρών 1:29,3



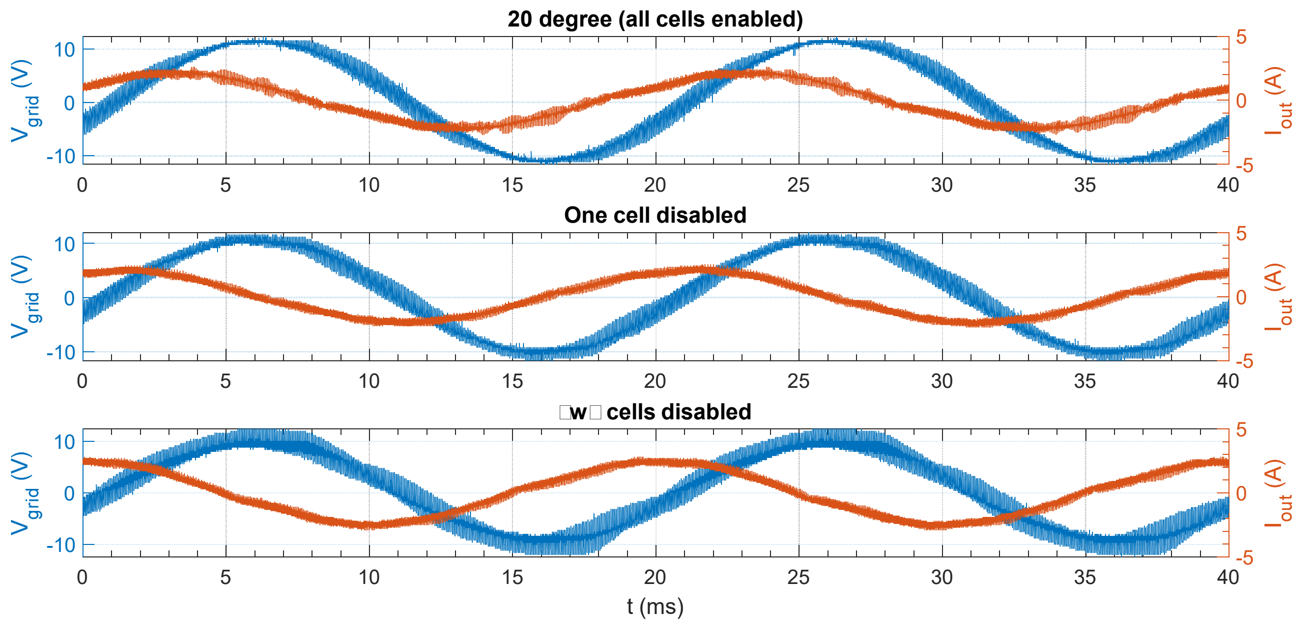


Έξοδος Αντιστροφέα Τεσσάρων Επιπέδων

Αποτελέσματα Multi-Level Τεχνικής



Αποτελέσματα SPWM Τεχνικής



Wind-Electric Systems

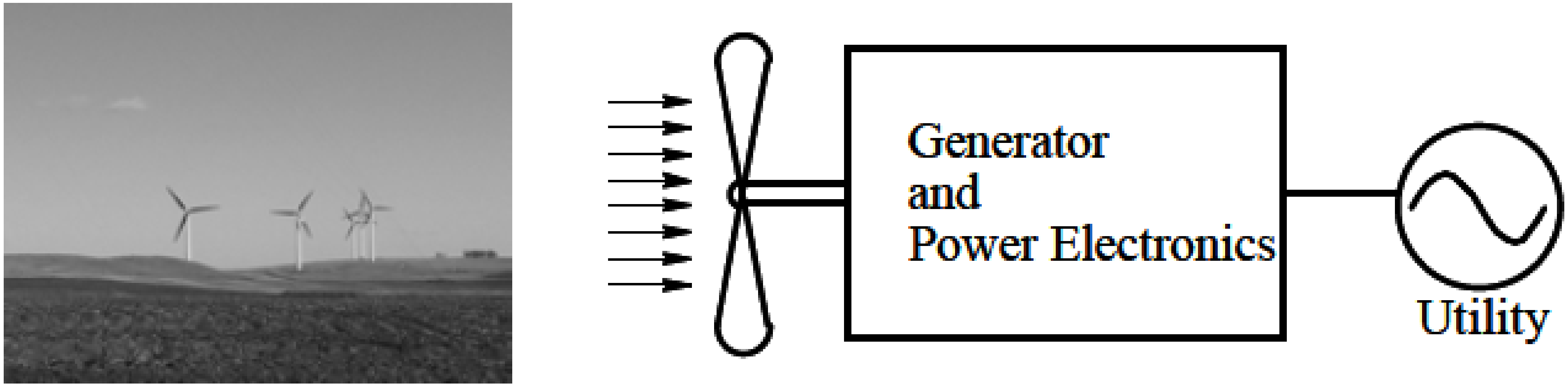
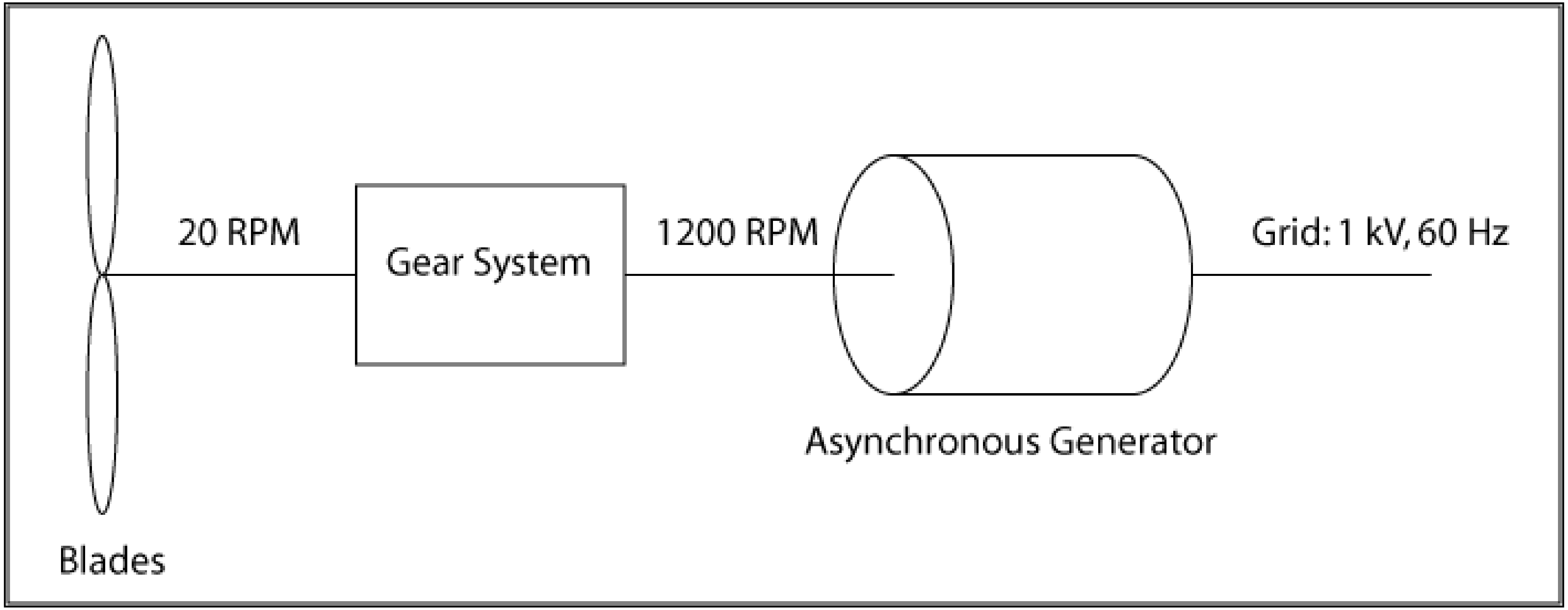


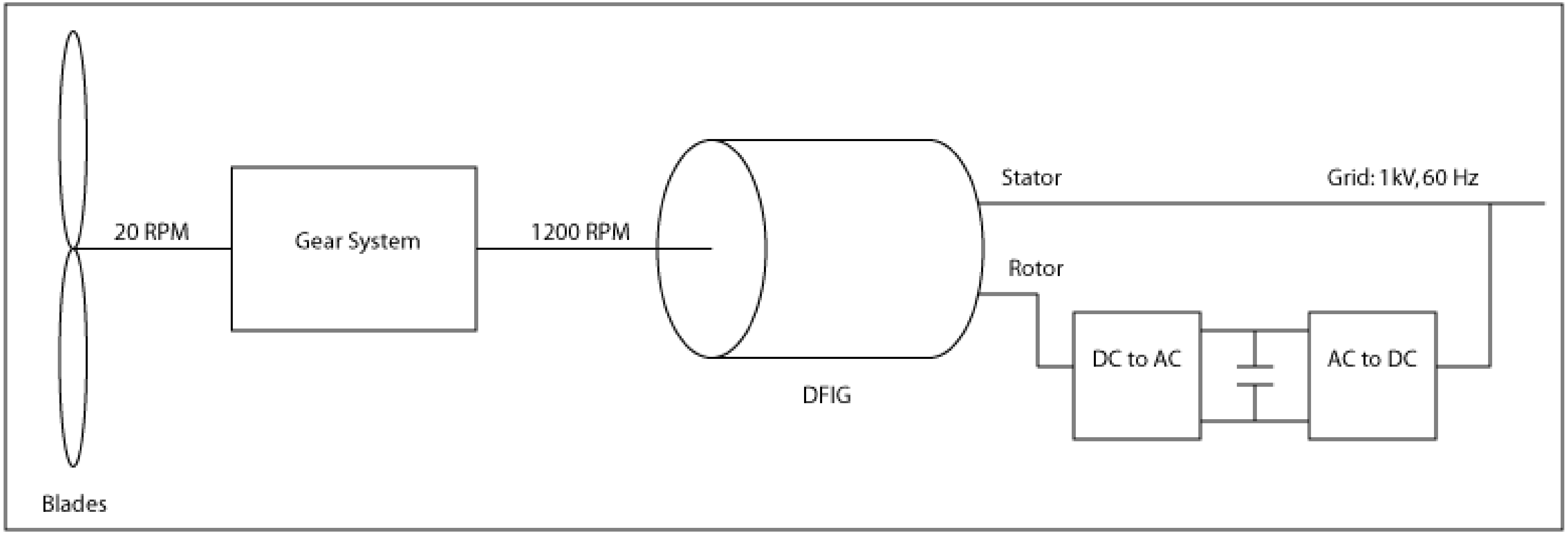
Figure 1-12 Wind-electric systems.

Wind Generator Topologies



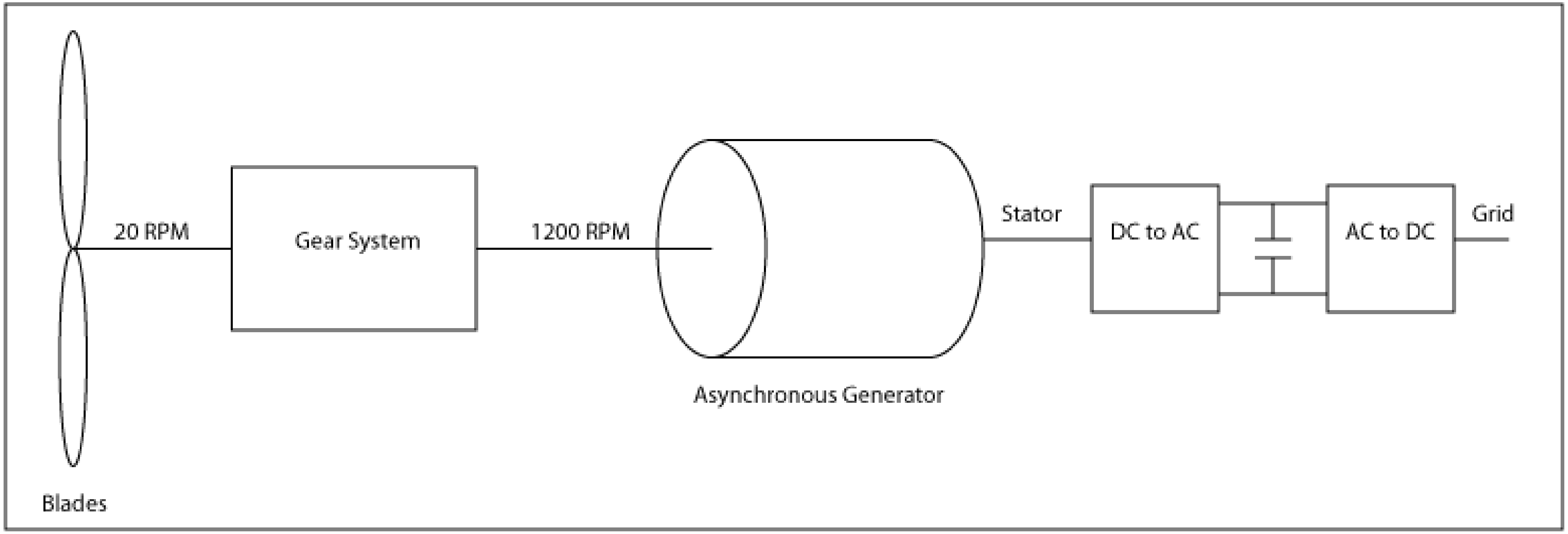
- Direct connected.
- Simplest.
- Requires switch to prevent motoring.
- Draws reactive power with no reactive control.

Wind Generator Topologies



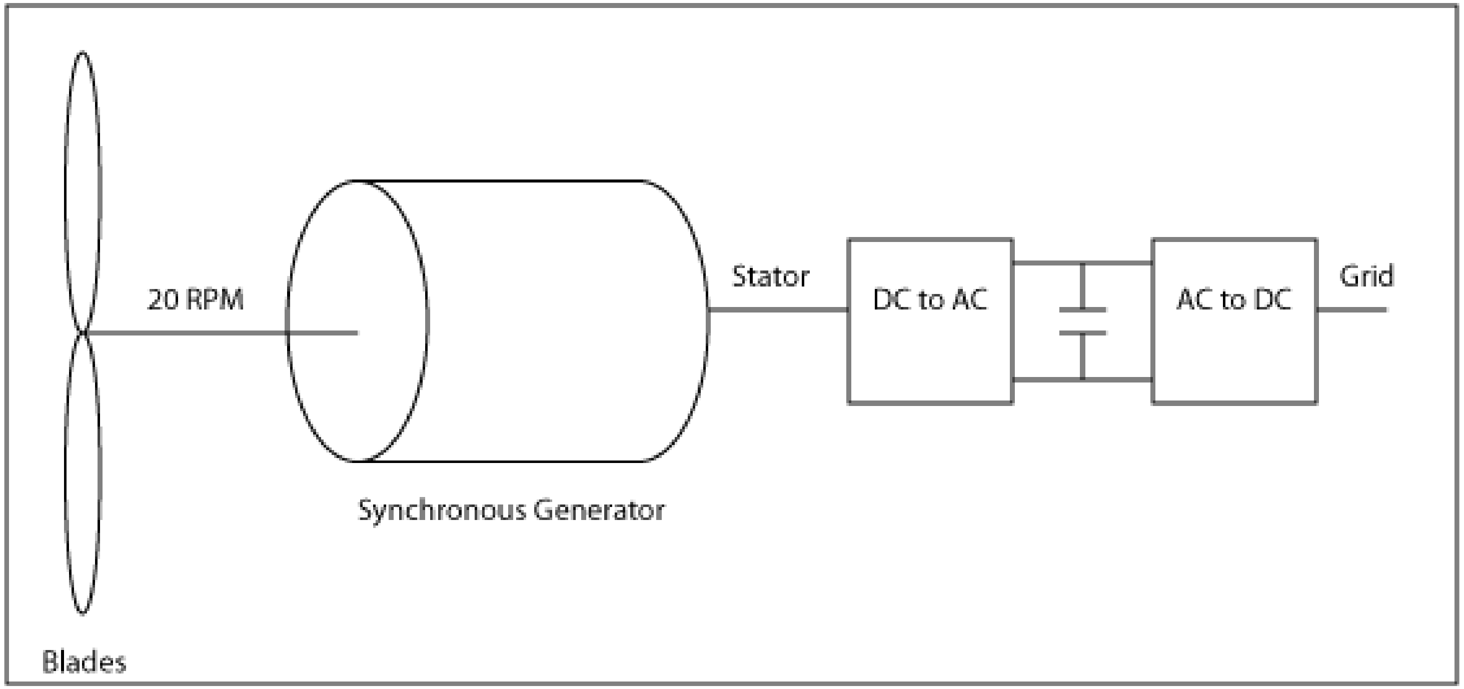
- Doubly-fed.
- The doubly-fed topology is the most common for high power.
- Rotor control allows for speed control of around 25% of synchronous.
- Rotor converter rating is only around 25% of total generator rating.
- Reactive power control.

Wind Generator Topologies



- Full-rated converter connected.
- Lower cost generator than DFIG. Lower maintenance.
- Converter must be fully-rated.
- Full-rated converter allows for complete speed and reactive power control.
- Could also be used with a synchronous generator.

Wind Generator Topologies



- Direct-drive.
- Eliminate the gearbox by using a very-high pole synchronous generator.
- Resulting generator design is relatively wide and flat.
- No gearbox issues.
- Full-rated converter is required.
- Full speed and reactive power control.

Uninterruptible Power Supplies

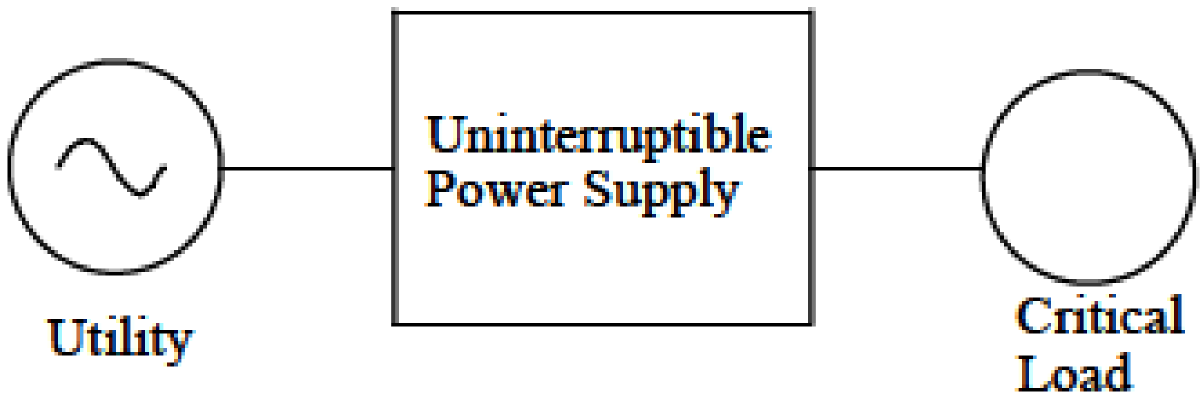
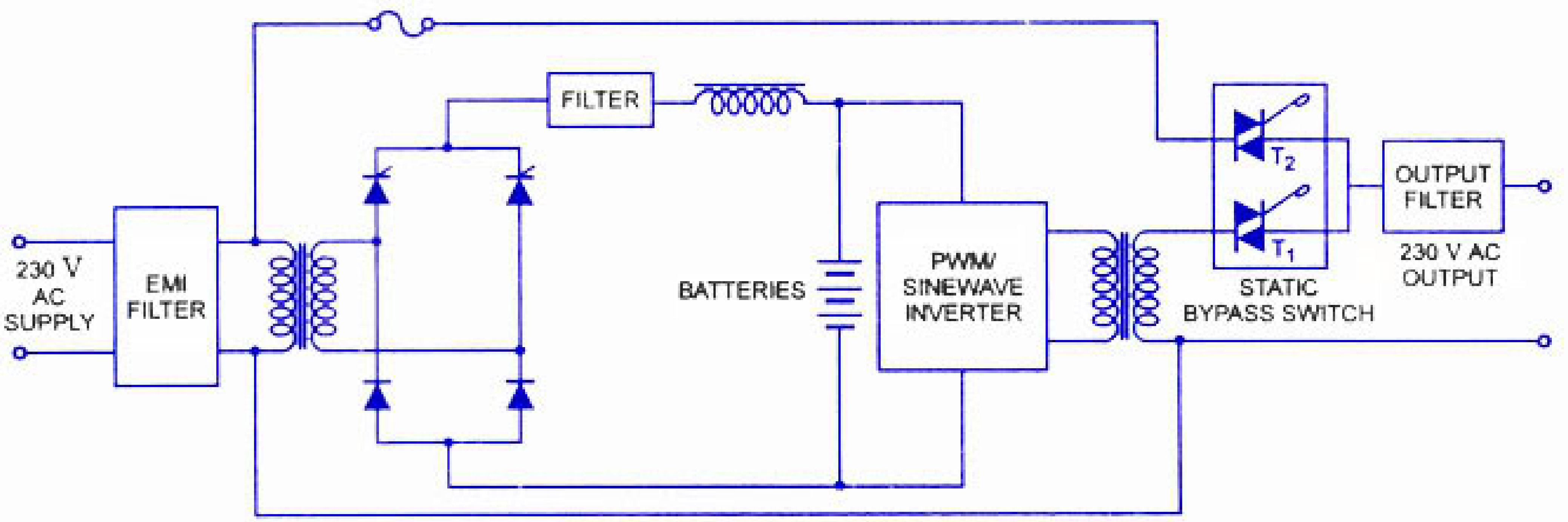
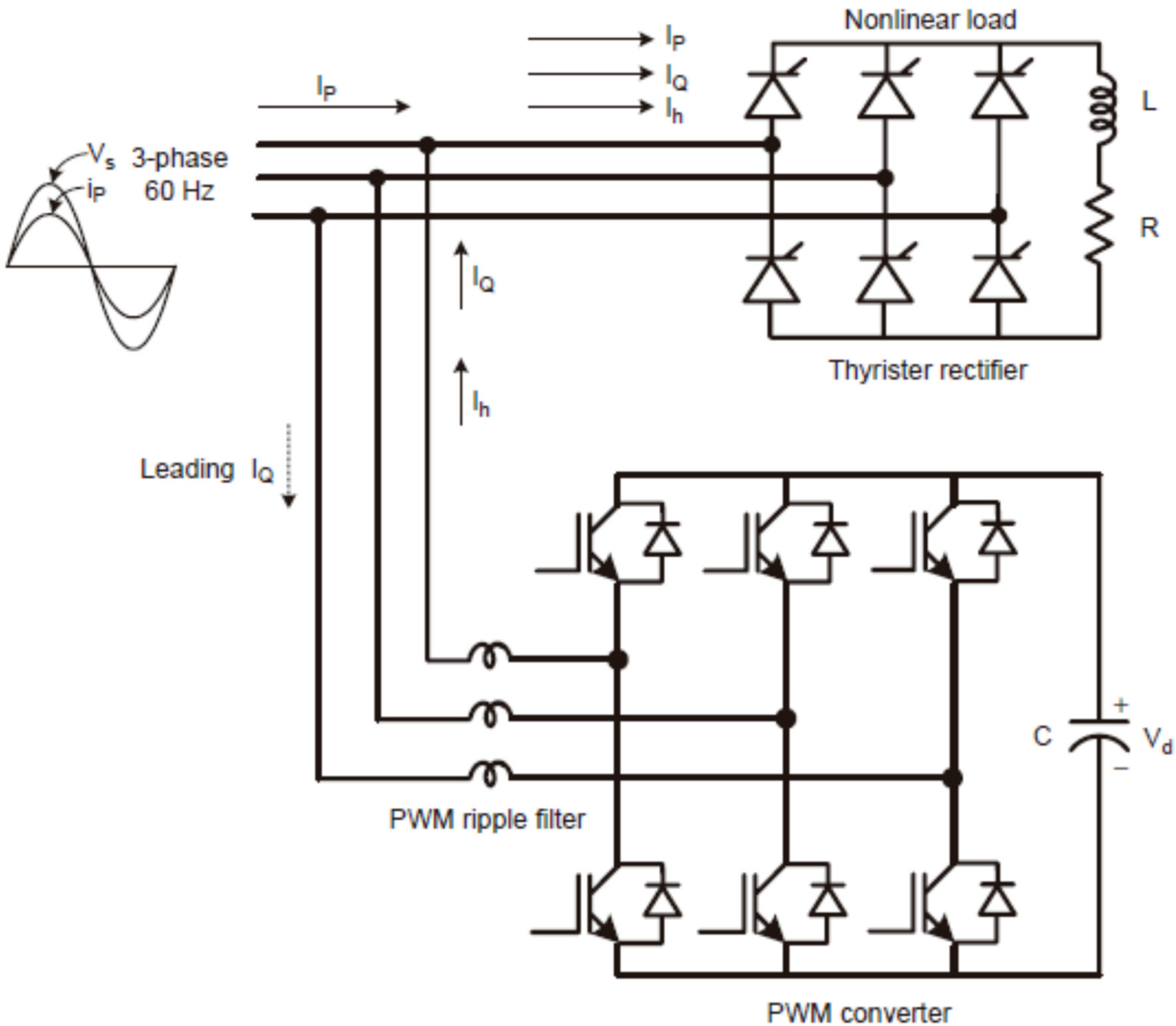


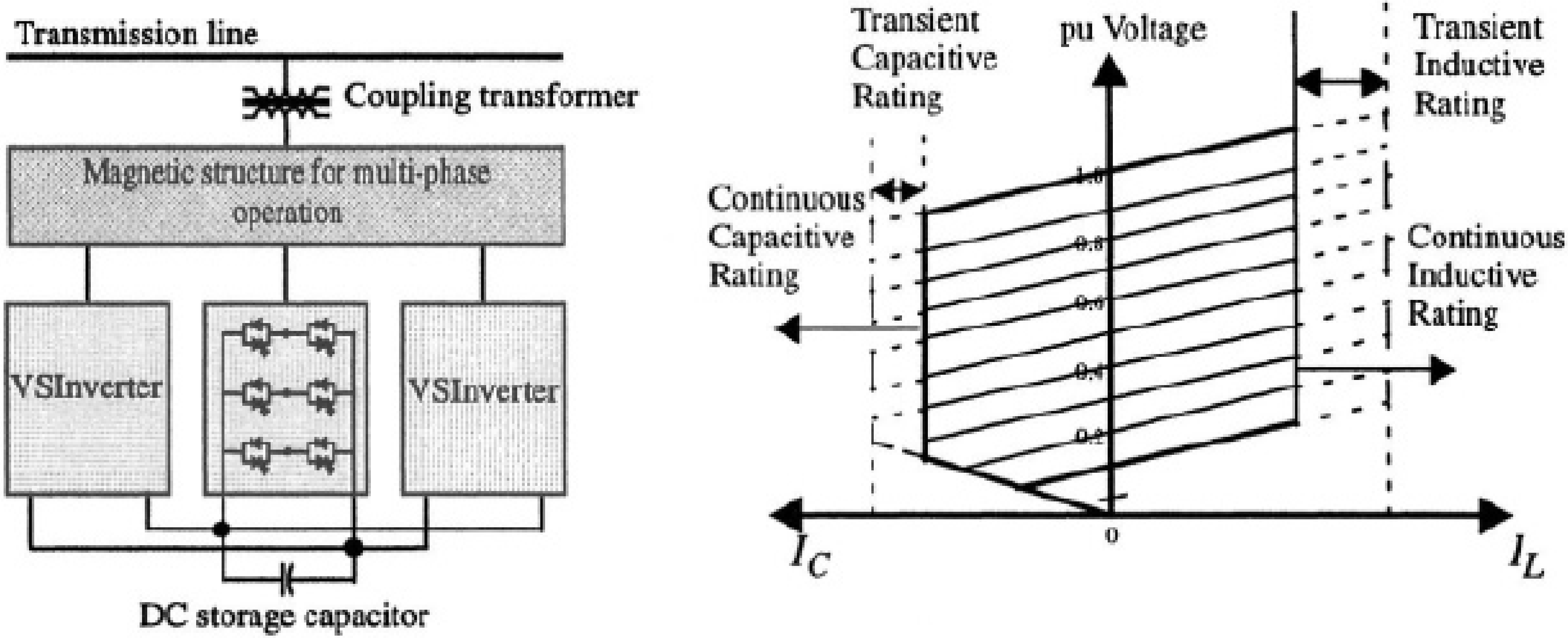
Figure 1-13 Uninterruptible power supply (UPS) system.



Block Diagram of On–Line UPS

FIGURE 4.57 Static VAR compensator (SVC) and active harmonic filter (AHF).



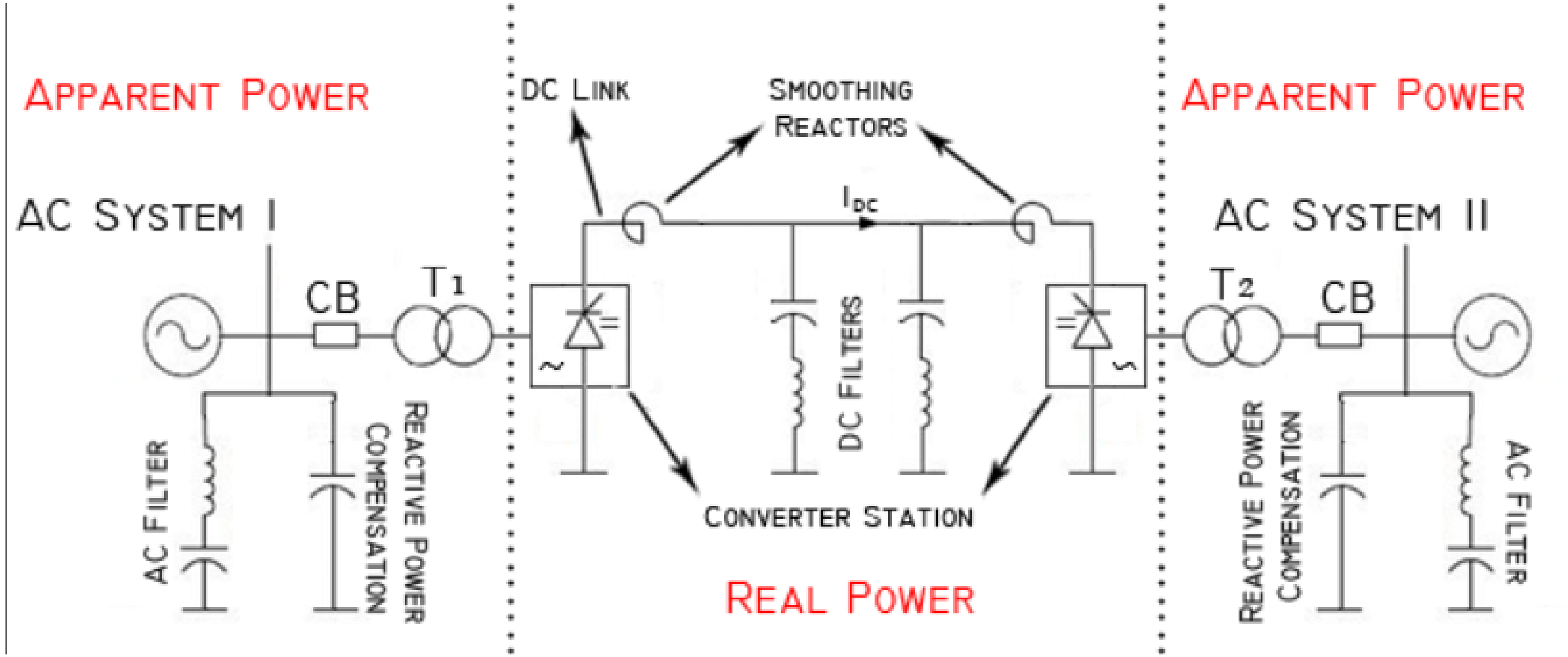


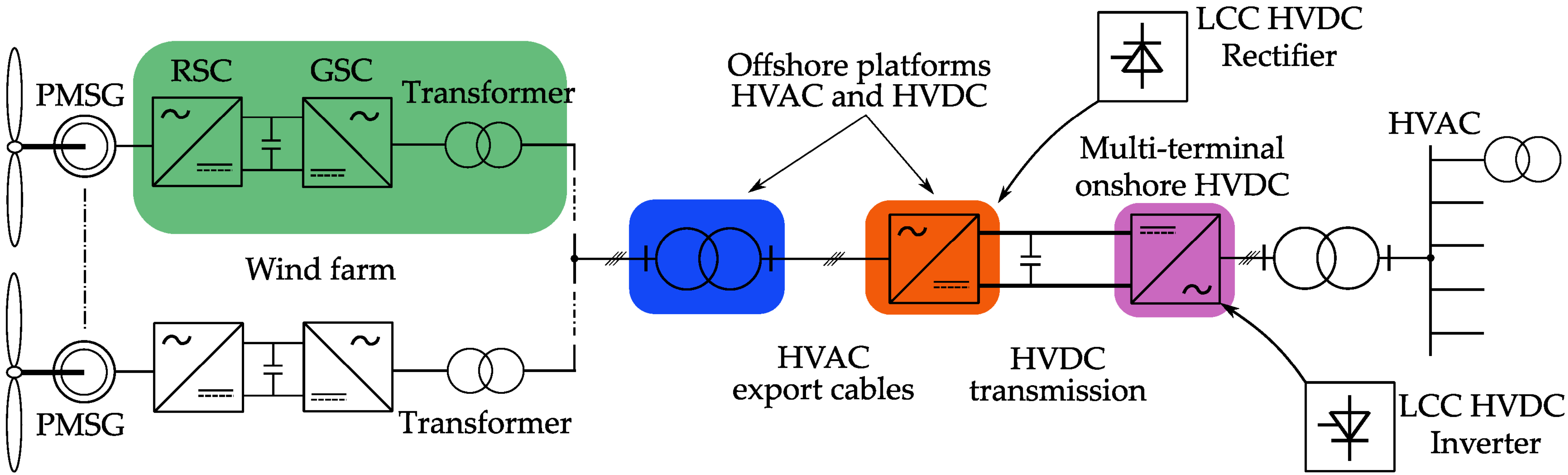
(a)

Figure 7-2: STATCOM

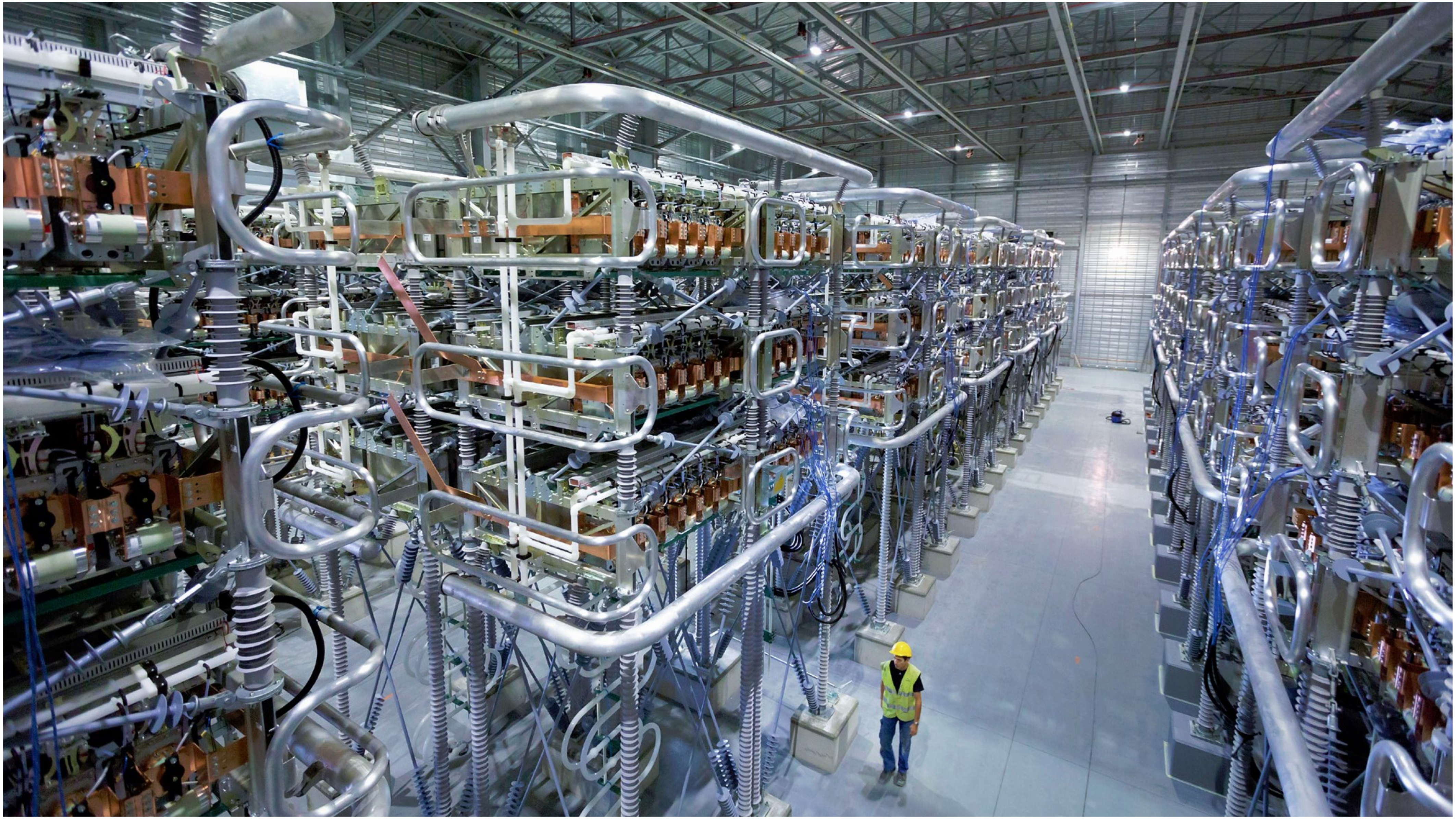
One difference between the STATCOM and the SVC is the performance at the limits of equipment capability. The SVC characteristic is a function of the voltage while the STATCOM can continue to produce capacitive current independent of voltage. In addition, the output current can temporarily exceed the steady-state rating. The amount and duration of the overload capability is dependent upon the thermal capacity of the GTO heat sinks and the minimum turn-off current of the GTO. With converter designs, the transient rating of the STATCOM is likely to vary from 120% to 180% of the steady state rating. Studies on the comparison of performances of SVC and STATCOM (Table 7-1) are the subject of an EPRI Project RP 3023-4.

HVDC SYSTEMS





HVDC STATIONS



HVDC Plus IGBT converter modules, Siemens AG

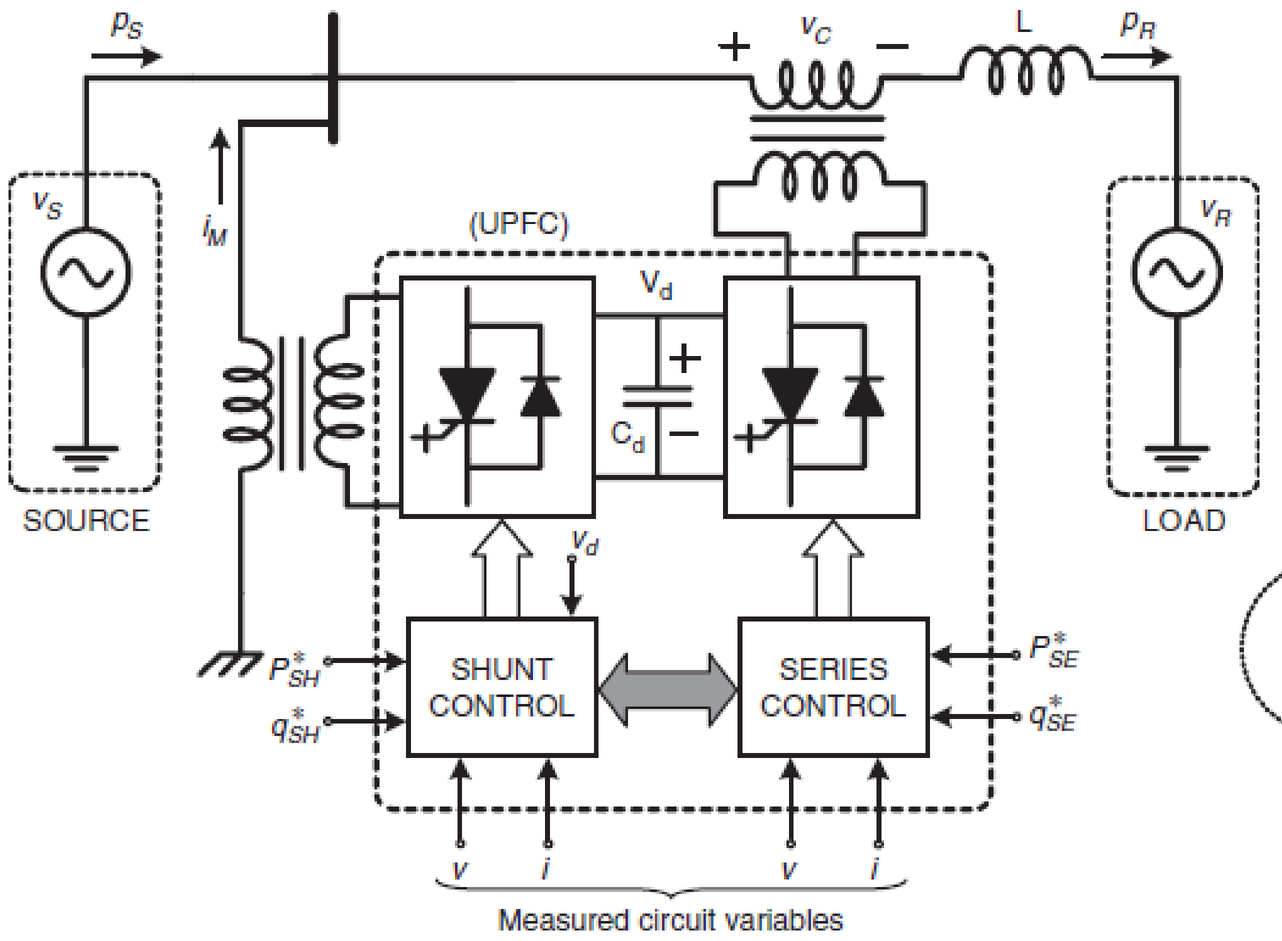


FIGURE 31.39 UPFC block diagram.

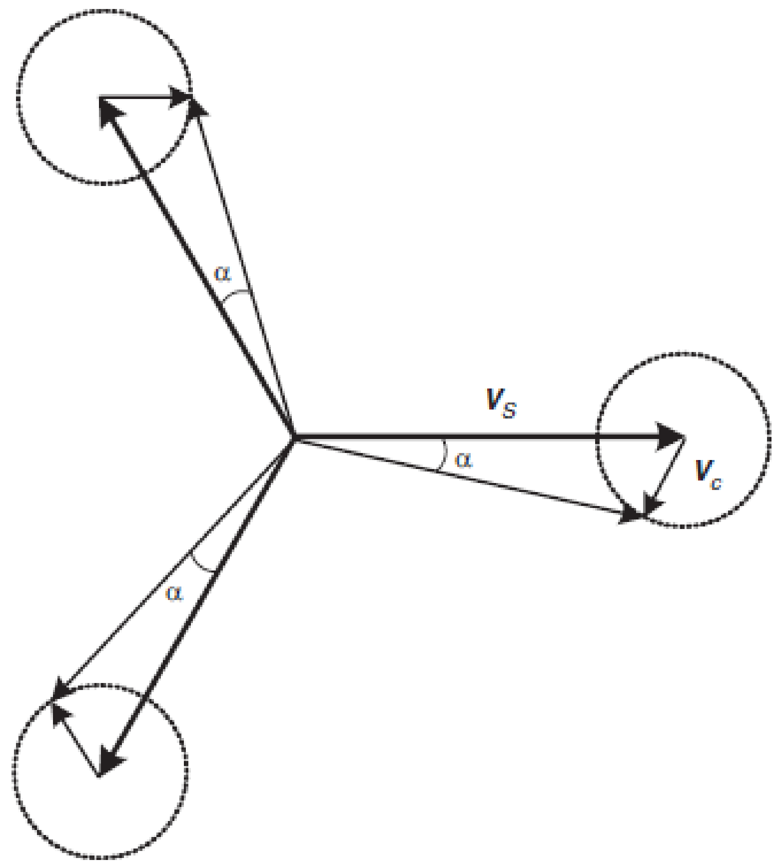


FIGURE 31.40 Phasor diagram for a system with a UPFC.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