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Grid Converters: System Architecture

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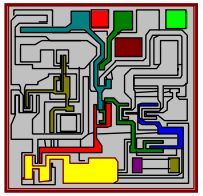
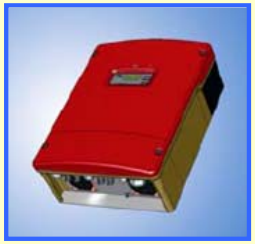


電力電子系統與晶片實驗室
Power Electronic Systems & Chips Lab.
交通大學 • 電機與控制工程研究所

Residential Power Generation System



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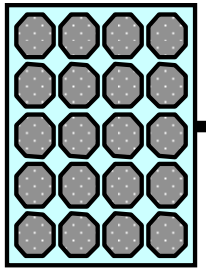
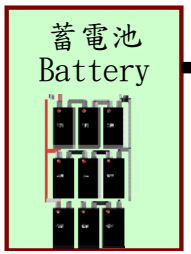
Power Conditioner



太陽能

風能

燃料電池

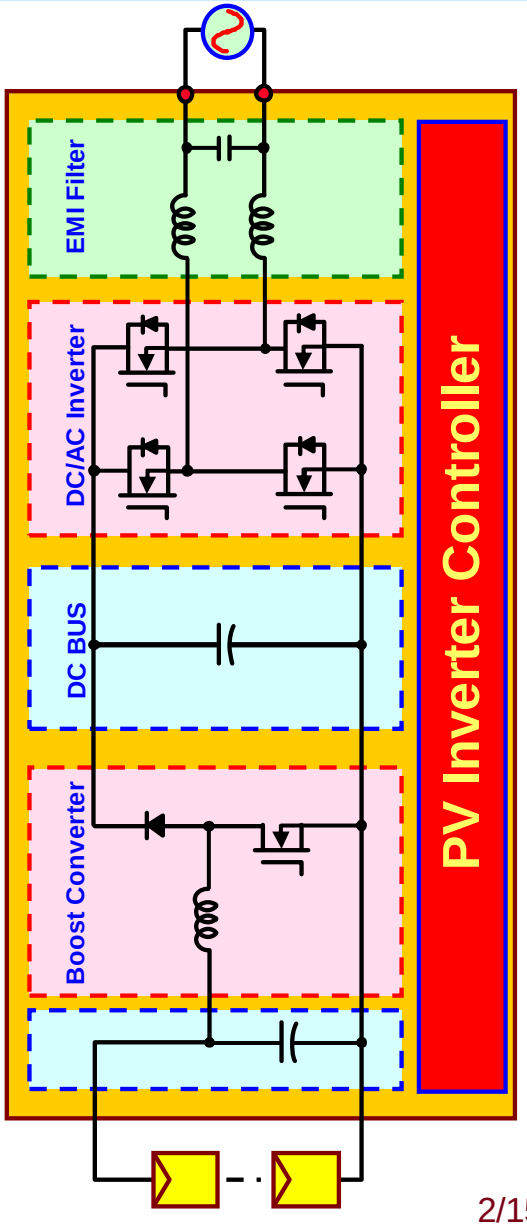


AC DC 併網型變頻器

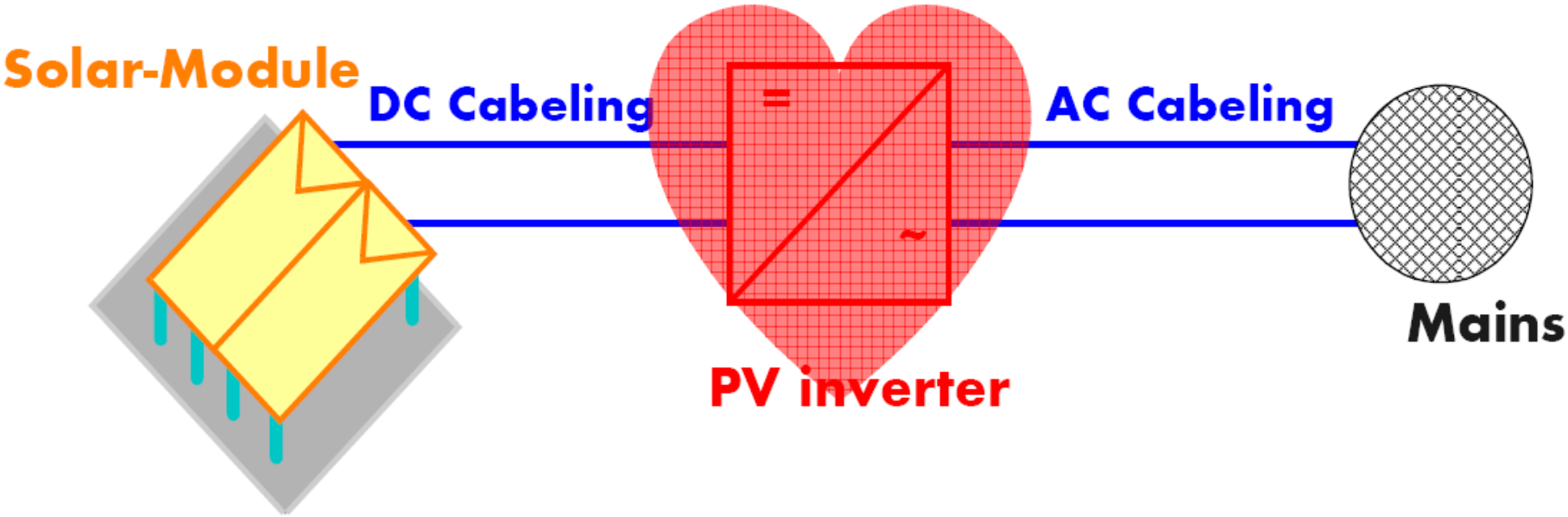
AC DC 併網型變頻器

AC DC 併網型變頻器

AC DC 雙向併網型變頻器



PV Inverter is Heart and Brain of PV Systems



The inverter is the heart (and the brain) of a PV system and therefore has a huge impact on the PV system performance

… But there's more to System Technology…

Ref: Bernd Engel and Mike Meinhardt, State of the Art and Future Trends of PV-System-Technology, SMA Technologie AG, Niestetal, Germany, 2006.

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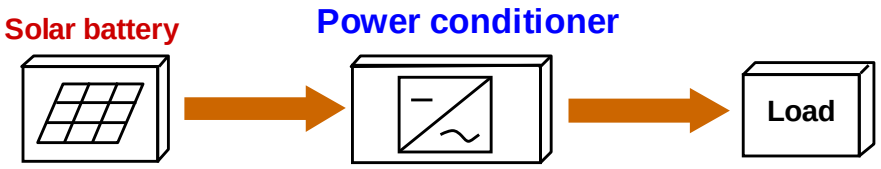
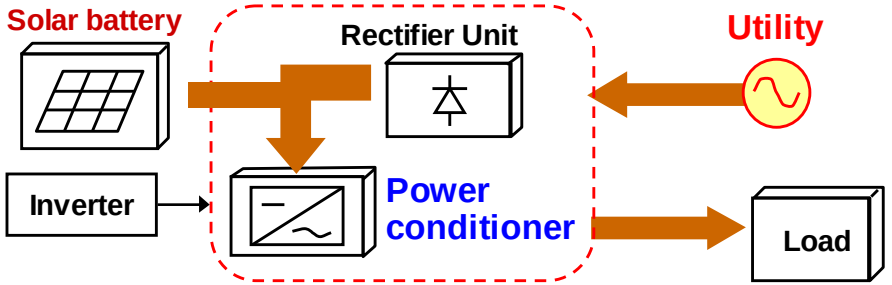
Types of PV Inverter for Power Generation

Stand alone • no power supply



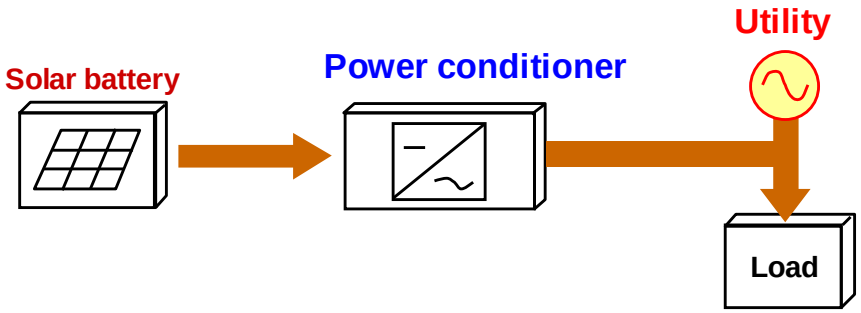
(a) Stand-alone

DC interconnection • inverter control



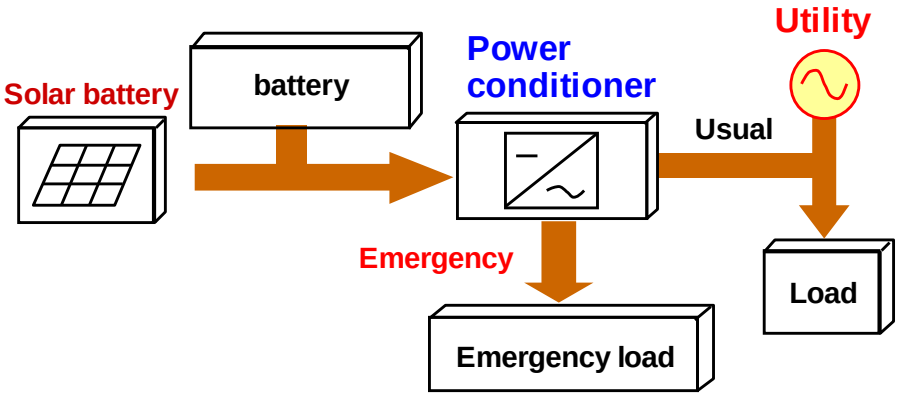
(b) Stand-alone with utility

Interconnection system • Clean energy



(c) Line tie PV inverter

Self type system • emergency power



(d) Line tie PV inverter with AC Backup

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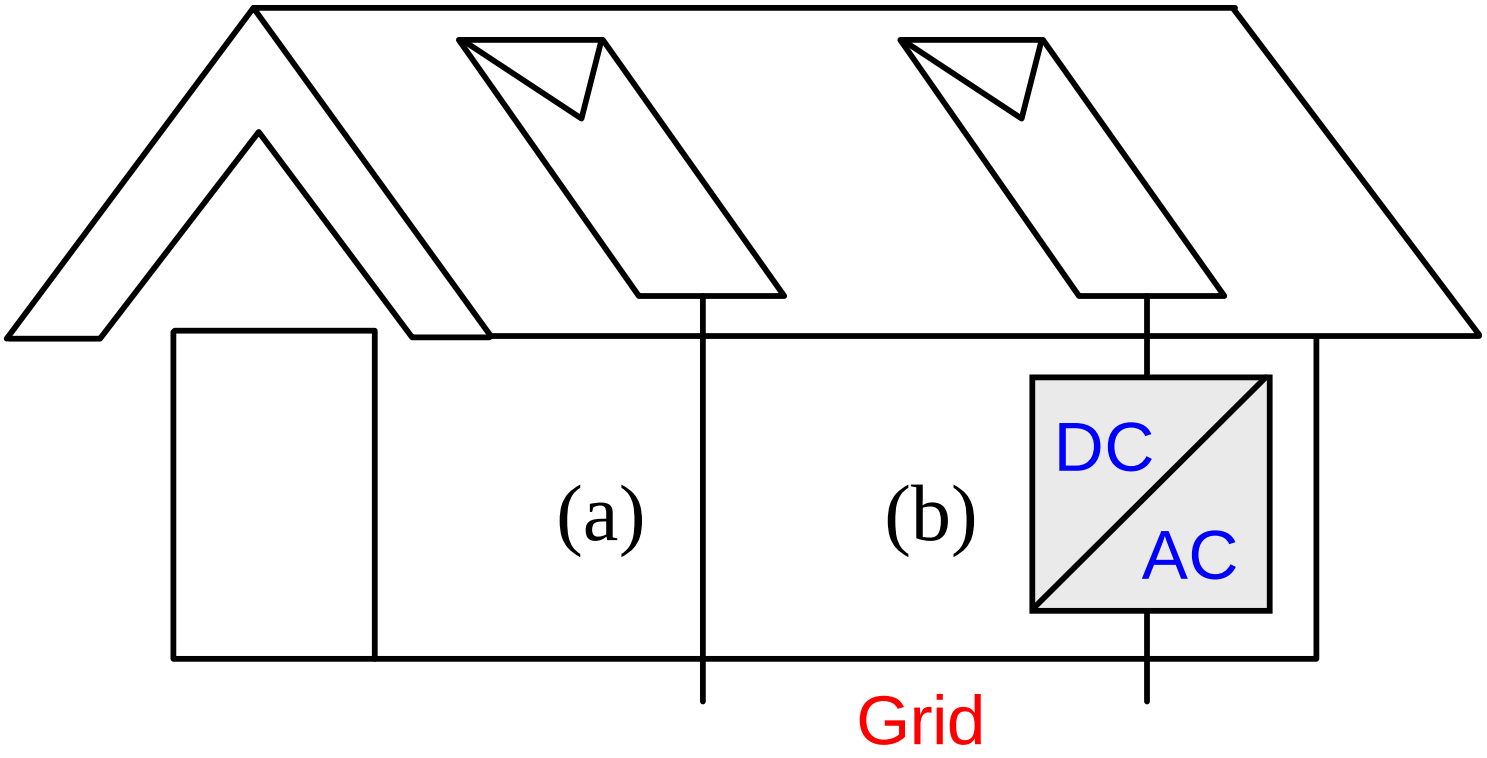
PV Inverter ~ System Layout



The two investigated layouts.

A) The inverter and the PV module is integrated into one device, placed on the roof.

B) The inverter is located inside the residence and the PV module is located on the roof.

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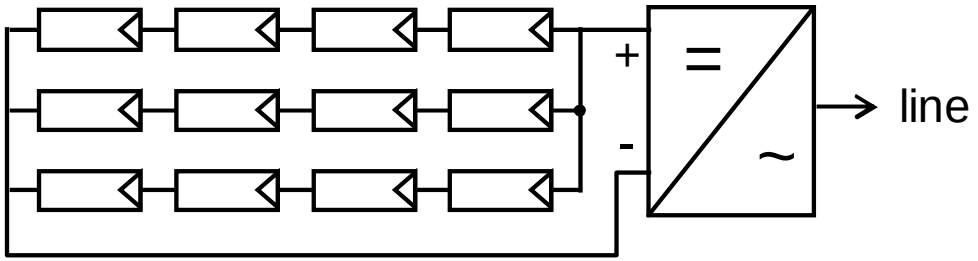
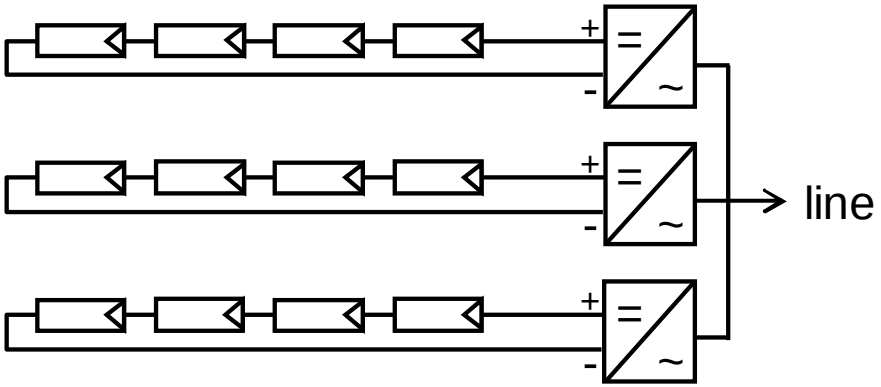
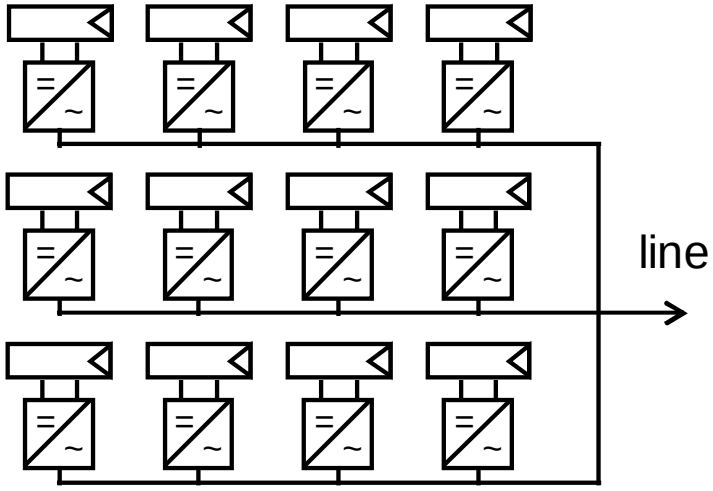
併網型太陽光發電系統三種主要的系統電路架構



(a) Centralized Inverters (5kW-500kW)



(b) String Inverters (1kW-5kW)



(c) Modularized Inverters (<300W)

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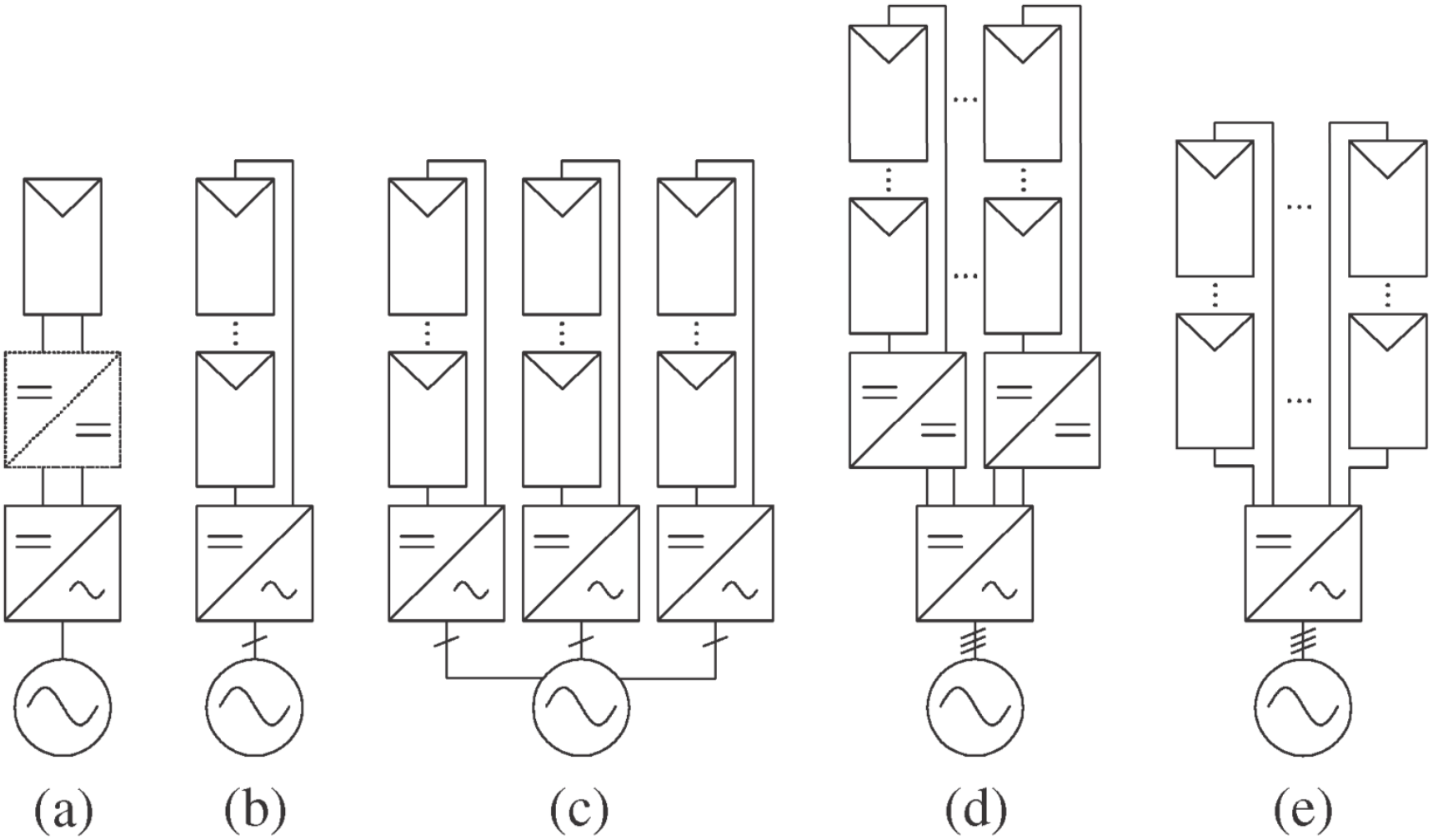
Overview of Grid-Connected PV Systems



Overview of the grid-connected PV system concepts showing from the left to the right: (a) module integrated, (b) string, (c) mini-central, (d) multistring, and (e) central inverter concepts.

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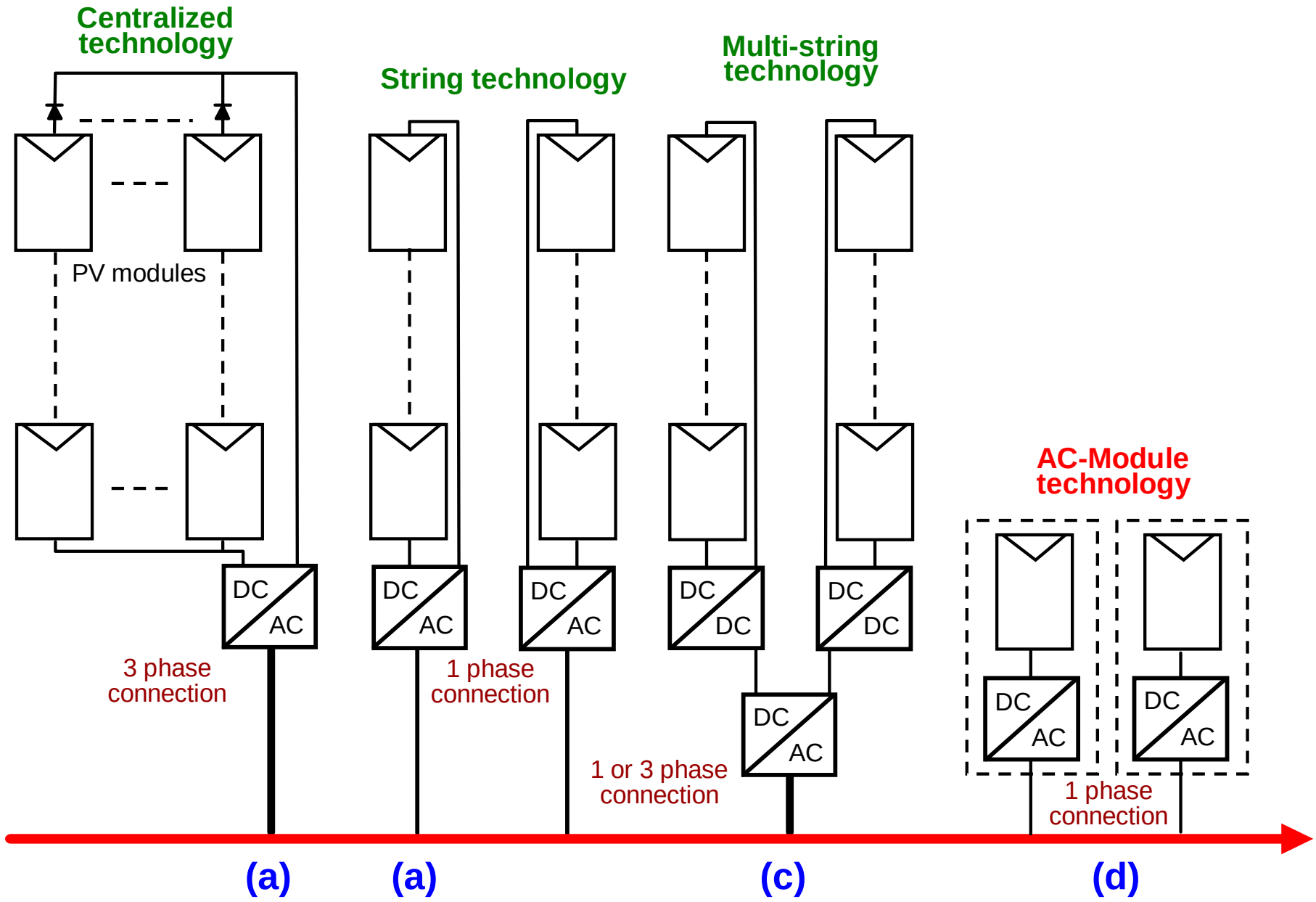
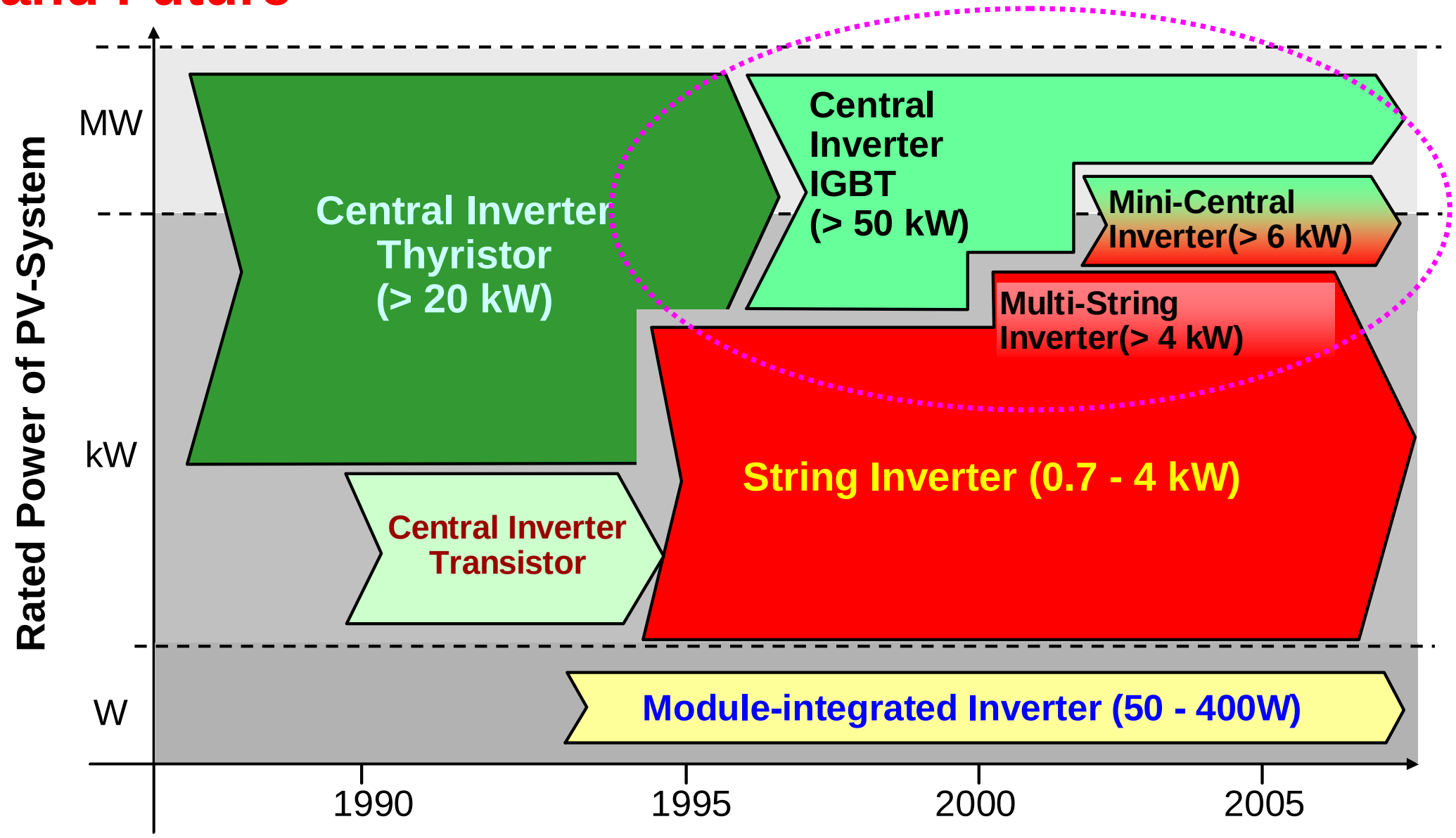
Development of PV Inverter Architecture



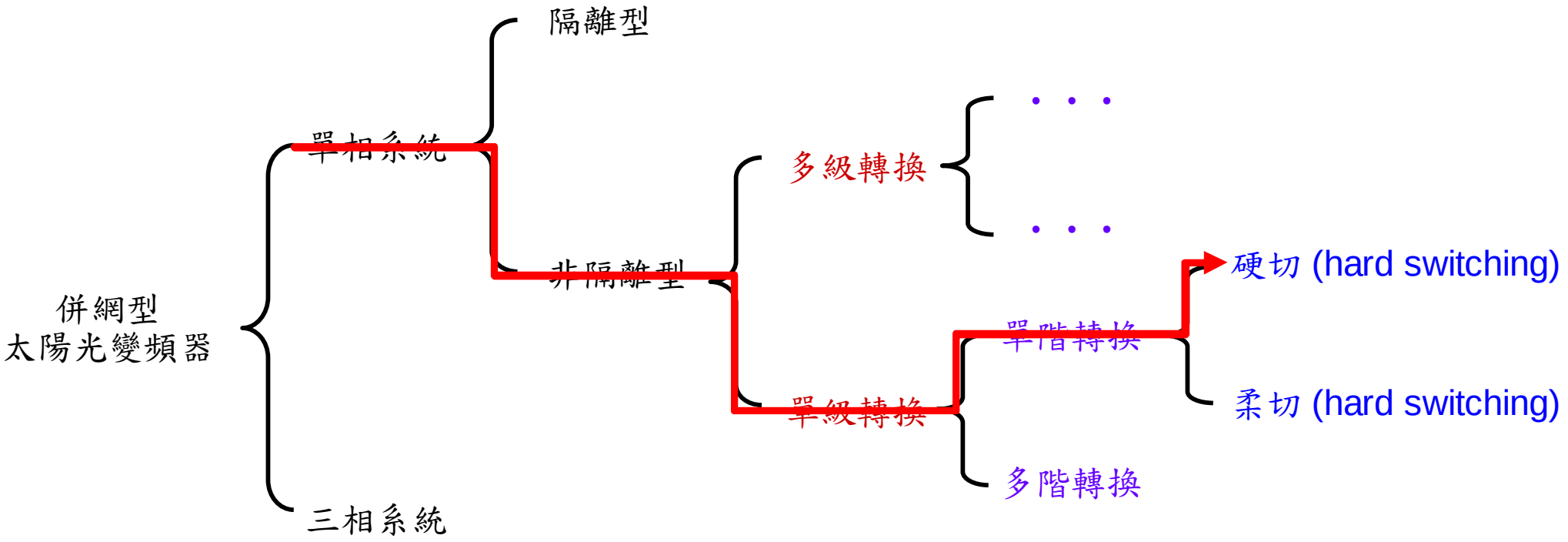
Historical overview of PV inverters. (a) Past centralized technology. (b) Present string technology. (c) Present and future multi-string technology. (d) Present and future ac-module and ac cell technologies.

PV-System Concepts and PV-Inverters: Past, Present and Future



REF: State of the art and future trends of PV-system-technology, Bernd Engel, and Mike Meinhardt, SMT Technology, ECPE Seminar, Feb. 2006.

併網型變頻器電路架構的分類



- **< 4kW Single-Phase Inverter (if possible, single-stage transformerless power conversion)**
- **> 4 kW Three-Phase Inverter**

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Definition of the AC-Module

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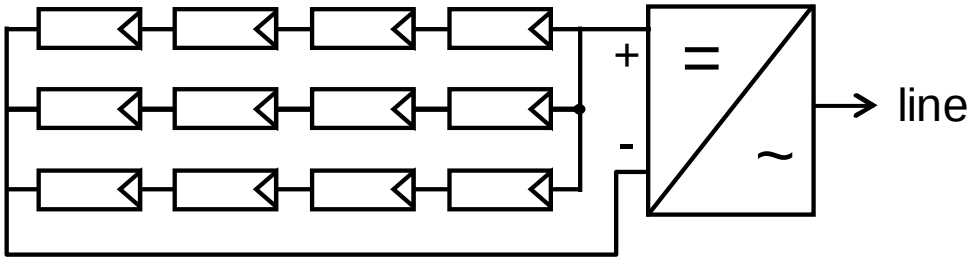
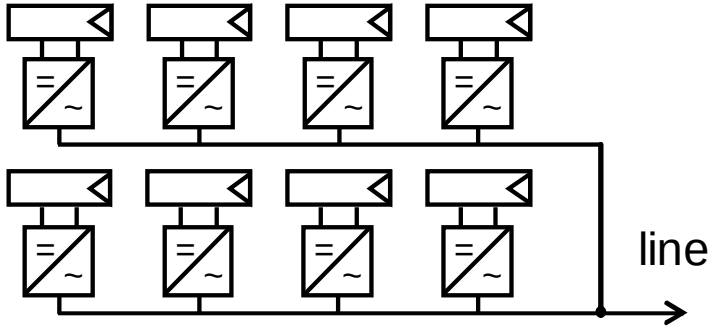
An AC-module is an electrical product and is the combination of a single module and a single power electronic inverter that converts light into electrical alternating (AC) power when it is connected in parallel to the network. The inverter is mounted on the rear side of the module or is mounted on the support structure and connected to the module with a single point to point DC-cable. Protection functions for the AC side (e.g. voltage and frequency) are integrated in the electronic control of the inverter.

REF: Utility aspects of grid connected photovoltaic power systems, International energy agency – photovoltaic power systems programme, IEA PVPS T5-01: 1998, 1998, www.iea-pvps.org .

AC Module vs. Centralized PV Inverter



> 20 kW



~ 100 W

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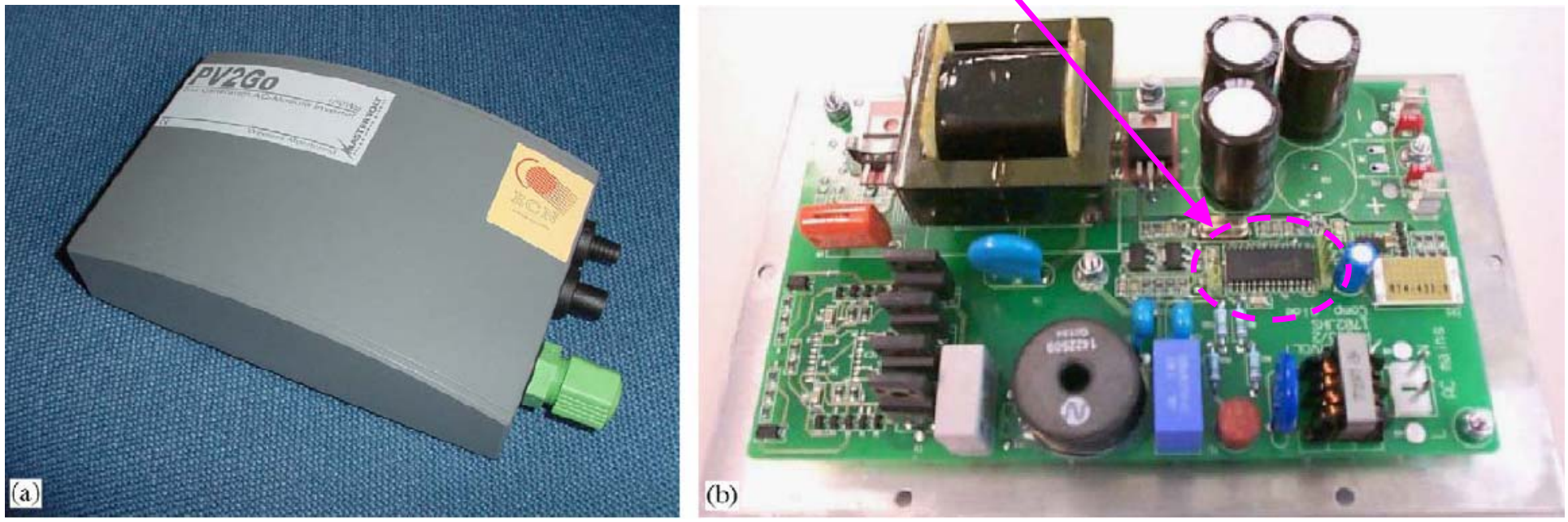
PV2GO 130W AC Module: PV Inverter Controller

For photovoltaic systems from 100 to 800 Wp, AC-modules are currently regarded as one of the ***most optimal system solutions for end-user applications***.

PV2GO: 130W AC Module Inverter



(a) The second prototype of the PV2GO inverter. (b) The second prototype of the PV2GO inverter without enclosure.

Cost effective second generation AC-modules: Development and testing aspects
Saiful Islama, Achim Woyteb, Ronnie Belmansa, Peter Heskesc, P.M. Rooijc, Ron Hogedoorn, Energy, 2005.

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Performance Comparison for Commercial AC-Module Inverters

Vendor	DORF-MÜLLER	EXENDIS	MASTER-VOLT	NKF	PHILIPS	MASTER-VOLT	ASCEN-SION-TECH
Type	DMI 150/35	GRIDFIT 250	SOLADIN 120	OK4E	PSI300	SUN-MASTER 130S	SUNSINE 300
Country and year	D1995	NL2002	NL2001	NL1997	NL2004	NL1998	US2000
Nominal PV-power [W]	100	250	90	100	375	110	300
MPP voltage [V]	28-50	27-50	24-40	24-50	45-135	24-40	36-75
Power decoupling	@ PV	@ PV	@ PV	@ PV	?	?	@ PV
Number of stages	HF	HF+LF	HF+LF	2*HF	?	2*HF+?	HF+LF
Transformer	LF	HF	HF	HF	NON	HF	LF
Mass [kg]	2.80	1.50	0.28	0.63	1.50	0.55	~ 50!
Power density [W/cm^3]	0.06	0.17	0.15	0.30	0.12	0.09	0.10
Start-up power [W]	2.5	0.5	0.4	0.15	2.0	0.95	-
Stand-by power [W]	0	0.008	0.05	0.003	0.1	0.08	0.3
EU (E) or max (M) efficiency [%]	89M	90E	91E	91E	93M	92M	90E
Power factor [ ]	>0.99	>0.99	0.99	>0.99	>0.95	0.99	>0.95

REF: Soren Bakhoj Kjaer, **Design and Control of an Inverter for Photovoltaic Applications**, Ph. D. Thesis, Aalborg University, Denmark Institute of Energy Technology, January 2005.

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References: Grid Converters: System Architecture

[1] Soren Bakhoj Kjaer, **Design and Control of an Inverter for Photovoltaic Applications**, Ph. D. Thesis, Aalborg University, Denmark Institute of Energy Technology, January 2005.

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[5] M. Meinhardt, D. Wimmer, Multi-string-converter. The next step in evolution of string-converter technology, EPE proc. of the 9th European power electronics and applications conference (EPE’01), CDROM, 2001.

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[7] H. Oldenkamp, I.J. de Jong, AC modules: past, present and future, Workshop installing the solar solution, 1998.

[8] M. Wuest, P. Toggweiler, J. Riatsch, Single cell converter system (SCCS), IEEE proc. of the 1st world conference on photovoltaic energy conversion, vol. 1, pp. 813-815, 1994.

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