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PHOTON inverter test

More than 90 inverters from multiple manufacturers have been tested and rated based on their efficiency

Photon
LABORATORY

About us

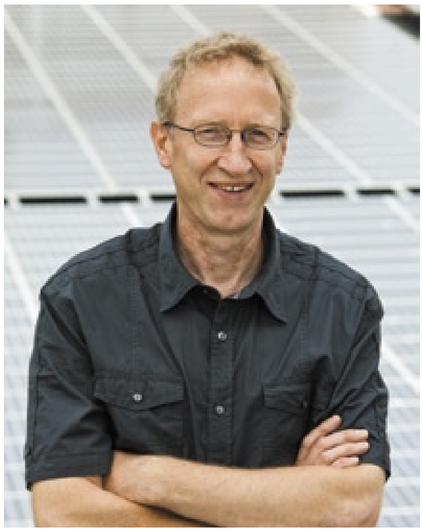
At PHOTON Lab, we have been carrying out inverter tests successfully since 2007, informing PHOTON readers whether or not a device is up to snuff. Grades ranging from A++ to F, which correspond to an overall efficiency defined by PHOTON, are assigned to enable better comparison of the multitude of devices.

Since the beginning of 2007, we at PHOTON Lab have employed our own inverter test methodology. In agreement with our test partners, the test results are regularly published in PHOTON magazines. To make these results easier to comprehend, the editorial staff, drawing its inspiration from school report cards, launched a grading system with its own testing certificates: grades range from A++ to F.

Each month, far over 200,000 planners, decision makers and operators of PV systems trust in the results of our lab tests. Our experts are working continuously on better test methods for even more significant results. Our lab is respected for its independent and reliable tests. Benefit from our expertise and let us test your inverter.

To assign a grade, we first need to determine the efficiency to which the grade refers. Both peak efficiency and European efficiency aren't well-suited for this purpose. That is why we decided to define our own efficiency value, the value of which far exceeds conventional efficiency data (see box, p. 5).

In our lab, we test serial and pre-serial grid-tied inverters as well as microinverters, for both the US and international market. Naturally, releasing test results in PHOTON magazines is an efficient – and editorial-based – measure for manufacturers to build trust among customers.

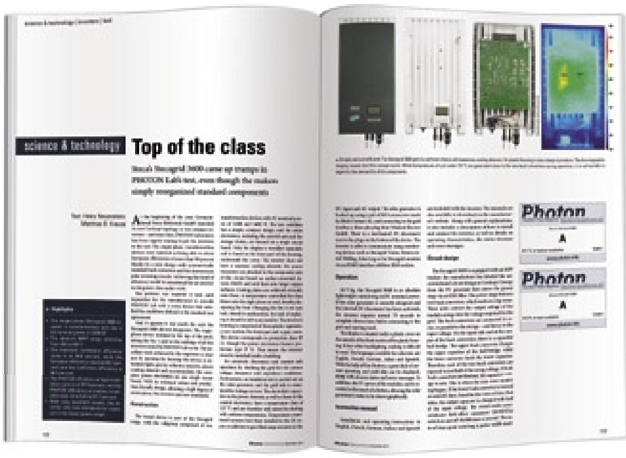


Rolf Schulten / photon-pictures.com

Heinz Neuenstein
Head of laboratory (inverters & system components)

Check the monthly test results in:

- PHOTON – Das Solarstrom-Magazin (German)
- PHOTON Profi – Photovoltaik-Fachwissen für die Praxis (German)
- PHOTON – Le Magazine du Photovoltaïque (French)
- PHOTON – Il Mensile del Fotovoltaico (Italian)
- PHOTON – La Revista de Fotovoltaica (Spanish)
- PHOTON International – The Solar Power Magazine (English)
- PHOTON International – 太阳能产业专业杂志 (Chinese)
- PHOTON – The Photovoltaic Magazine (English)



Every month in PHOTON magazines: Data from inverters tested and rated by PHOTON Lab.

How PHOTON conducts its test

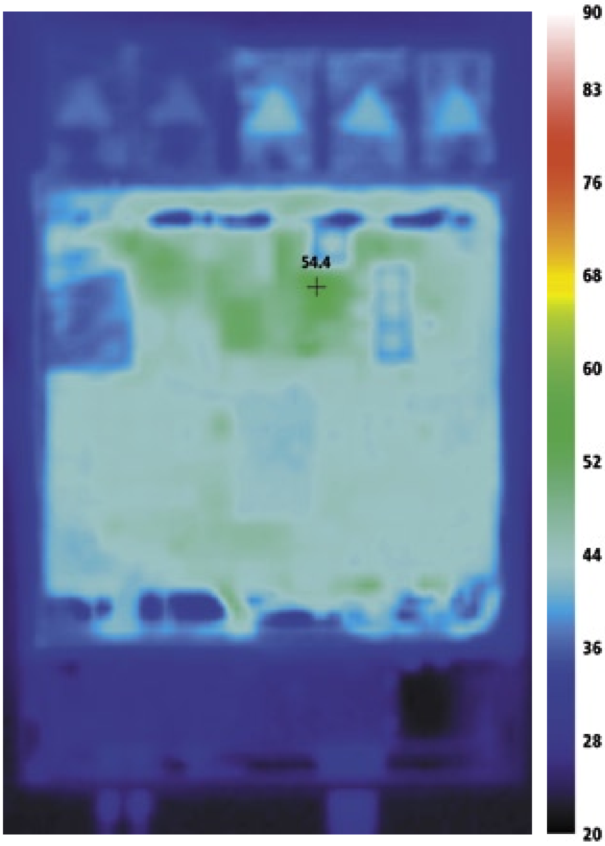
Steca Elektronik GmbH

Inverters in serial production: PHOTON Lab selects test devices randomly from a list of a hundred consecutive serial numbers.

Our goal: Helping system operators select the right inverters.

Since the beginning of 2007, we at PHOTON Lab have employed our own inverter test methodology. In agreement with our test partners, the test results are regularly published in PHOTON magazines. To make these results easier to comprehend, the editorial staff, drawing its inspiration from school report cards, launched a grading system with its own testing certificates: grades range from A to F. The highest grade (»A«) has three different levels: an A grade, an A+ or an A++. An F grade is assigned to an inverter with an efficiency so poor that it's essentially not worth the money paid for it. In this sense, devices like these are too expensive to even give away. To assign a grade, we first need to determine the efficiency to which the grade refers. Both peak efficiency and European efficiency aren't well-suited for this purpose. That is why PHOTON decided to define its own efficiency value, the value of which far exceeds conventional efficiency data (see box p. 5). Furthermore, the goal of this grading system is to enable better comparisons of individual devices.

The grades provided in the survey can essentially be associated with the devices' overall utility, which is often difficult to determine for



A thermographic image shows temperature hotspots within an inverter. Naturally, these hotspots can be critical for the long-term performance of a device.

installers, wholesalers, system operators, insurance companies and banks. To give readers of our inverter test an immediate sense of a device's value, we assign a single grade for both medium and high irradiation to each inverter that takes into account all relevant factors such as an inverter's efficiency dependence on input voltage, the suggested MPP operating point, information on the input current limitation on the operating point, and the relation between temperature and conversion efficiency. No other individual scores have an influence on the grade. The parameters reflected in the grade are reviewed on an annual basis and are discussed with manufacturers in advance.

The total grade is based on two criteria: the assessment of the efficiency determined by PHOTON and the temperature-related reduction of efficiency. The grade for this efficiency is assigned without any differentiation based on the suitability of the inverters' use with a particular solar generator. The best device is the one with the highest efficiency independent of whether or not it has potential separation, is exclusively designed for use indoors or outdoors, or has a broad voltage range. In the meantime, there are now suitable transformerless inverter topologies for all known module types. Only the conversion efficiency's temperature interdependency has a relevant influence on the grade. Furthermore, we provide information on the inverter's efficiency at 25 °C and the maximum temperature before any power reduction is detected. Both values are subtracted from one another. If the resulting efficiency reduction reaches or exceeds the difference from the next, lower grade (for example, there's a 1.5 gap between »B« and »C«), the device receives the lower grade (i.e. »C«).

The question of whether an inverter is well-suited for use with a particular module type is best answered by the manufacturer, but our tests should provide some guidance. For instance, the connections of some thin-film module types cannot be charged with negative potential against the ground. A few crystalline high-power modules require a high-impedance ground at the DC connection to avoid polarization effects. We request approval from the manufacturers of these module types for the inverter under examination. As a matter of principle, the inverter input's potential in relation to the ground has to be known.

Naturally, our lab also measures the efficiency and the MPPT adjustment efficiency, both based on the specified P_{MPP} power – the product of which is the overall efficiency. This is then applied across all the measured input voltages to establish the average at each power level. This average is then weighted according to European and Californian efficiencies, and included in the evaluation. The overall efficiency is based on Heinrich Häberlin's definition of »total efficiency,« which is described in his book on the efficiency of PV inverters published in 2005.

The PHOTON efficiency for medium and high irradiation levels is an artificial value that represents an image of the voltage and power interdependencies of an inverter's efficiency. The European and Californian weighting system reveals the dependence of the average overall efficiency on the geographic latitude at which the PV system is installed. This dependency is expressed with different weighting factors that result from the inclusion of meteorological data. This data allows the testers to make frequency distributions for certain solar irradiation values, which in turn provide weighting factors for particular power levels. The innovative part of the calculations used to establish the PHOTON efficiency parameters is that it includes all measured input voltages as specified in the manufacturer's description of the device's input voltage range – even if the device cannot perform as required in all parts of this range, in which case the efficiency is then listed as 0 percent. This reflects the conditions of a real PV system: after all, if an inverter had to face these conditions, it would cease operating properly.

The graphical representation shows these areas. For instance, the color diagram included in our inverter tests shows the inverter's efficiency, the MPPT adjustment efficiency and the overall efficiency. The diagram is colored black if the maximum MPP voltage isn't adequately distanced from the inverter's maximum DC voltage, and if it doesn't have an active overload limit according to the manufacturer, which means no measurements can be conducted in this range, since the MPP tracker won't operate properly. The diagram also reflects the DC current limitation range. These black areas, which reflect a value of zero, are used to calculate an average based on the PHOTON grading system and, therefore, have a strong influence on the grade. The resulting effect is desired and a consequence of considerations about the inverter's actual, useable MPP range: an inverter will only get a good grade in the test if it actually can operate without limitations in the voltage range specified by the manufacturer. Finally, manufacturers who change their product data to reflect a more sensible MPP range will receive an improvement in their grade.

The color diagram also includes white hatched areas. These represent areas in the MPP voltage range that are considered critical when designing a PV system. They are located at the upper end of the MPP range. There are two types of hatching marks. The diagonal upward lines represent an MPP range in which the V_{MPPmax} is generally absent for PV systems with crystalline modules.

The hatching marks in the other direction (i.e. sloping diagonally downward) represent the MPP range in which the V_{MPPmax} is generally absent for PV systems with thin-film modules. The exact definition of these limits can be established when designing a system with actual modules. Hatching can also be seen in the lower portion of the MPP range. This highlights the area in which the activation of the DC current limitations prevents the inverter from feeding 100 percent of available DC power into the grid. A PV system's V_{MPP} shouldn't be located in this range either, since that would result in a yield loss.

The result of all of this is an efficiency number that is generally lower than the European efficiency, since this is usually measured at the »best« voltage levels, and does not take mismatching and unreliable operating ranges into account. That means that PHOTON's efficiency can make an inverter look like it will fair worse than its true performance in a real PV system, since it takes the entire input voltage range specified by the manufacturer into consideration – regardless of whether that range will actually be exploited by a particular PV system. Hence, PHOTON's efficiency tells us something about the least you can expect from an inverter – and provides information about all system configurations that operate within the input voltage range specified by the manufacturer.

Heinz Neuenstein, Ines Rutschmann

Efficiency: Explanations of measurements and diagrams

The diagrams for MPPT efficiency, conversion efficiency and overall efficiency demonstrate the dependence of these values on input voltage V_{MPP} and input power P_{DC}. The MPP voltage range is divided into 20 steps and the DC power range into 24 steps. The result is 480 different solar generator curves and every curve has a fill factor of 75 percent.

The 480 individual measurements form the basis of the three-dimensional diagrams. The third dimension in the diagrams is color, which shows all efficiencies achieved at different V_{MPP} and P_{DC} levels. The color spectrum and its correlation to measurements are pictured next to the diagram. While the input voltage V_{MPP} (in the range specified by the manufacturer) is provided in absolute numbers on the y-axis, the specified power P_{MPP} is shown on the x-axis in relative values. This is standardized according to the inverter's nominal input power P_{DCNom} and given in percent of P_{MPP} nominal power. Just how far this range stretches beyond the 100-percent mark depends on manufacturer specifications.

If the maximum MPP voltage specified by the manufacturer is close to the maximum DC voltage, hatched areas show limitations on the inverter when it's used with crystalline modules, and below that another area with hatching in the opposite direction that shows limitations when used with thin-film modules.

MPPT adjustment efficiency is calculated comparing the available DC power (P_{MPP}) with the DC power absorbed by the inverter. It provides insight into the inverter's static MPP tracking – so how well the solar generator absorbs the inverter's predefined P_{MPP} power.

Conversion efficiency is the relationship between the AC power P_{AC} supplied by the inverter and the power absorbed on the inverter's DC side P_{DC}. Both above and to the right of the diagram are cross-sections that are pictured in the three-dimensional color diagram. These show the dependency of efficiency on standardized power, and efficiency on voltage V_{MPP}. At the top right, the inverter's operating range is shown in relation to the MPP voltage range and the MPP power.

The **overall efficiency** is calculated as a product of the conversion efficiency and the MPPT adjustment efficiency for all 480 measurements. The diagram is arranged in a manner similar to that of conversion efficiency.

The diagram showing **weighted conversion efficiency** shows the measured efficiency level for medium irradiation (European efficiency) and for high irradiation (Californian efficiency), based on the California Energy Commission's (CEC) definition, over the entire MPP voltage range.

The graph displaying **efficiencies at different V_{MPP} voltages** shows the course of efficiency at nominal power P_{MPP} for minimum and maximum MPP voltage (V_{MPPmin} and V_{MPPmax}), as well as for the lowest and highest MPP voltage value at which the inverter's maximum efficiency is achieved ($V_{MPP\eta SumMaxMin}$ and $V_{MPP\eta SumMaxMax}$). The maximum values (η_{SumMax}) for each of these levels are noted in the diagram. In the event that the courses of the $V_{MPP\eta SumMaxMin}$ and V_{MPPmin} or $V_{MPP\eta SumMaxMax}$ and V_{MPPmax} are identical, only one plot will be shown in the graph with the corresponding values (V_{MPPmin} and V_{MPPmax}).

The **average overall efficiency gradient** is shown in the same diagram and its highest value is noted, too ($\eta_{AvgSumMax}$). Average overall efficiency is attained by averaging all overall efficiencies at every level of the MPP nominal power range over the entire MPP voltage range outlined by the manufacturer. The average gradient is formed for power levels between 5 and 100 percent of nominal power. If the figures for medium (η_{Pmed}) and high irradiation (η_{Pmax}) are weighted, the **PHOTON efficiency** is determined. This value is also stated in the diagram.

New grades in PHOTON Lab's inverter test as of 2011

The table showing the results achieved by the inverters tested in our lab looks slightly different due to a new grading system as of 2011. All of the inverters tested before 2011 have two grades: one based on the old system and one related to the new method.

The grades are based on the PHOTON efficiency at medium and high irradiation. More detailed information about the inverters can be found in the corresponding test reports (the issue in which each report was published is noted in the last column of the table). The rankings are also based on the PHOTON efficiency.

The changes to the grading system were made to reflect the current status in the sector and the system will be updated again in the future to reflect technical advancements. Now, inverters have to get a higher PHOTON efficiency to secure a better grade: what would have gotten an A in 2010 with 96.4 percent, would now get a B. Should manufacturers further improve their devices, these inverters could even get downgraded to a C as our grading system changes to reflect the current times.

GRADING SYSTEM FOR INVERTER TESTS AS OF 2011

	A++	A+	A	B	C	D	F*[1]
PHOTON efficiency	≥ 99	≥ 98 - < 99	≥ 96.5 - < 98	≥ 95 - < 96.5	≥ 93.5 - < 95	≥ 92 - < 93.5	< 92
Deviation from next grade	1	1	1.5	1.5	1.5	1.5	–

*[1] to align grades with our US sister publication, we have changed the letter »E« to »F«

INVERTER TEST RESULTS

Inverter	Observed voltage range*3	Medium irradiation				High irradiation				PI issue
		eta_{Pmed}	Grade as of 2011	Grade before 2011	Position	eta_{Phigh}	Grade as of 2011	Grade before 2011	Position	
SMA's STP 20000TLHE-10	580 - 800 V	98.5%	A+	–	1	98.6%	A+	–	1	12/2011
Steca's StecaGrid 3600	350 - 600 V	97.7%	A	–	2	97.8%	A	–	2	12/2011
Siemens' Sinvert PVM20	480 - 850 V	97.5%	A	–	3	97.7%	A	–	3	4/2011
Siemens' Sinvert PVM17	460 - 850 V	97.4%	A	–	4	97.7%	A	–	3	4/2011
Refusol's 17 K	460 - 850 V	97.4%	A	A+	4	97.6%	A	A+	5	12/2010
Refusol's 13 K	420 - 850 V	97.3%	A	A+	6	97.6%	A	A+	5	12/2010
Siemens' Sinvert PVM13	420 - 850 V	97.3%	A	–	6	97.6%	A	–	5	4/2011
SMA's STP 17000TL	400 - 800 V	97.3%	A	A+	6	97.5%	A	A+	8	12/2010
SMA's STP 10000TL-10	320 - 800 V	97.1%	A	–	9	97.5%	A	–	8	10/2011
Chint Power's CPS SC20KTL-O	500 - 800 V	97.1%	A	–	9	97.4%	A	–	10	11/2011
Siemens' Sinvert PVM10	380 - 850 V	97.0%	A	–	11	97.4%	A	–	10	1/2011
Mastervolt's Sunmaster CS20TL	350 - 800 V	96.9%	A	–	12	97.2%	A	–	12	5/2011
Refusol's 11 K*1	380 - 800 V	96.9%	A	A+	12	97.2%	A	A+	12	9/2008
SMA's SMC 8000 TL	335 - 487 V	96.9%	A	A+	12	97.0%	A	A+	15	10/2007
SMA's SMC 11000TL	333 - 500 V	96.9%	A	A+	12	96.8%	A	A+	22	7/2010
Sputnik's Solarmax 13MT	250 - 750 V	96.8%	A	–	16	97.1%	A	–	14	9/2011
Diehl AKO's Platinum 6300 TL	350 - 710 V	96.8%	A	A+	16	96.9%	A	A+	20	2/2009
Danfoss' TLX 15 k	430 - 800 V	96.7%	A	A+	18	97.0%	A	A+	15	6/2010
Eversolar New Energy's Eversol-TL 4600	290 - 500 V	96.7%	A	–	18	97.0%	A	–	15	9/2011
Sunways' NT 4200	340 - 750 V	96.7%	A	A+	18	96.8%	A	A+	22	3/2010
Conergy's IPG 15T	450 - 800 V	96.6%	A	A+	21	97.0%	A	A+	15	8/2010
SMA's SMC 700TL	333 - 500 V	96.6%	A	A+	21	96.8%	A	A+	22	5/2010
Danfoss' TLX 10 k	430 - 800 V	96.5%	A	A+	23	97.0%	A	A+	15	8/2010
Samil Power's Solarriver SR4K4TLA1	200 - 500 V	96.5%	A	–	23	96.8%	A	–	22	8/2011
Eltek Valere's Theia 4.4HE-t	230 - 480 V	96.5%	A	–	23	96.7%	A	–	27	11/2011
Power-One's Aurora PVI-12.5-OUTD-FS	360 - 750 V	96.4%	B	A	26	96.9%	A	A+	20	4/2010
Kaco's Powador 4000 supreme DCS (9 kHz)	350 - 510 V	96.2%	B	A	27	96.7%	A	A+	27	1/2010
Growatt's 5000 TL	280 - 500 V	96.0%	B	–	28	96.8%	A	–	22	2/2011
Fronius' IG TL 5 0	350 - 700 V	95.9%	B	A	29	96.2%	B	A	30	9/2010
Kaco's Powador 4000 supreme DCS (18 kHz)	350 - 510 V	95.7%	B	A	30	96.1%	B	A	31	1/2010
SMA's SB 5000TL-20	175 - 440 V	95.7%	B	A	30	96.0%	B	A	32	5/2009
Sungrow's SG4KTL	210 - 420 V	95.6%	B	–	32	96.3%	B	–	29	1/2011
Power-One's Aurora PVI-6000-OUTD-S	180 - 530 V	95.4%	B	A	33	95.9%	B	A	33	3/2009
Omnik New Energy's Omniksol-2k-TL	120 - 450 V	95.2%	B	–	34	95.9%	B	–	33	1/2012
Aros' Sirio 4000	250 - 450 V	95.1%	B	A	35	95.7%	B	A	36	12/2008
Dasstech's DSP-123K2	200 - 450 V	95.1%	B	–	35	95.7%	B	–	36	3/2011
Conergy's IPG 5 S	275 - 750 V	95.0%	B	A	37	95.8%	B	A	35	9/2009
Fronius' IG Plus 100	230 - 500 V	94.8%	C	B	38	95.0%	B	A	42	11/2010
Sunways' AT 4500	250 - 600 V	94.6%	C	B	39	94.8%	C	B	46	7/2008
Sungrow's SG3KTL (version 2)	180 - 420 V	94.5%	C	–	40	95.7%	B	–	36	8/2011
Fronius' IG Plus 50	230 - 500 V	94.5%	C	B	40	94.8%	C	B	46	8/2008
Phoenixtec's PVG 2800 (updated model)	250 - 450 V	94.4%	C	B	42	95.1%	B	A	40	5/2008
Kaco's Powador 8000xi (new software; since Jan. 2010)*1	350 - 600 V	94.4%	C	B	42	94.7%	C	B	49	3/2010
Kaco's Powador 2500xi DCS	350 - 600 V	94.3%	C	B	44	95.0%	B	A	42	1/2010
Sunways' AT 2700	181 - 600 V	94.3%	C	B	44	94.8%	C	B	46	8/2009
Sputnik's SolarMax 6000S	220 - 550 V	94.3%	C	B	44	94.7%	C	B	49	11/2009
Carlo Gavazzi's ISMG150DE	200 - 450 V	94.1%	C	B	47	95.0%	B	A	42	5/2010
Xantrex's GT5.0SP	240 - 550 V	94.1%	C	B	47	94.7%	C	B	49	1/2009
Conergy's IPG 5000 vision*1	301 - 706 V	94.0%	C	B	49	94.7%	C	B	49	7/2007
Kaco's Powador 8000xi (old firmware; till Jan. 2010)*1	350 - 600 V	94.0%	C	B	49	94.7%	C	B	49	3/2010
Kostal's Piko 10.1	400 - 850 V	94.0%	C	B	49	94.4%	C	B	61	7/2009
Delta Energy Systems' SI 3300*1	150 - 435 V	93.9%	C	B	52	94.7%	C	B	49	5/2008
Mitsubishi's PV-PNS06ATL-GER	260 - 650 V	93.9%	C	B	52	94.6%	C	B	55	6/2008
SMA's SMC 7000HV	335 - 560V	93.9%	C	B	52	94.2%	C	B	63	9/2009
Sunways' NT 2600 (lower range)*1	350 - 623 V	93.8%	C	B	55	95.1%	B	A	40	11/2007
Steca's Stecagrid 9000 3ph*1	350 - 680 V	93.8%	C	B	55	95.0%	B	A	42	7/2010
Sputnik's SolarMax 2000C*1	165 - 515 V	93.8%	C	B	55	93.1%	D	C	76	4/2007

INVERTER TEST RESULTS

Inverter	Observed voltage range*[3]	Medium irradiation				High irradiation				PI issue
		eta_{Pmed}	Grade as of 2011	Grade before 2011	Position	eta_{Phigh}	Grade as of 2011	Grade before 2011	Position	
Sungrow's SG3KTL (version 1)	180 - 420 V	93.7%	C	–	58	95.2%	B	–	39	8/2011
Kaco's Powador 4202	200 - 510 V	93.7%	C	B	58	94.6%	C	B	55	10/2010
SMA's SB 2100TL	200 - 480 V	93.7%	C	B	58	94.6%	C	B	55	6/2009
Oelmaier's PAC 4	330 - 600 V	93.6%	C	B	61	94.6%	C	B	55	12/2009
Mastervolt's Sunmaster XS6500	180 - 480 V	93.6%	C	B	61	94.1%	C	B	64	2/2010
Ingeteam's Ingecon Sun 3.3 TL	159 - 414 V	93.4%	D	C	63	94.3%	C	B	62	8/2007
SMA's SB 3800	208 - 395 V	93.2%	D	C	64	93.6%	C	B	68	2/2007
Dasstech's DSP-123KH	350 - 600 V	93.0%	D	C	65	94.6%	C	B	55	10/2010
Diehl AKO's Platinum 4600S	320 - 628 V	92.9%	D	C	66	93.3%	D	C	73	4/2008
Power-One's Aurora PVI-2000-OUTD-DE	210 - 530 V	92.8%	D	C	67	94.0%	C	B	65	2/2010
Diehl AKO's Platinum 2100S	206 - 390 V	92.8%	D	C	67	93.3%	D	C	73	10/2009
Kaco's Powador 3501xi*[1]	125 - 391 V	92.6%	D	C	69	92.9%	D	C	77	6/2007
Kaco's Powador 2500xi*[1]	350 - 597 V	92.5%	D	C	70	93.4%	D	C	70	12/2007
Sunways' NT 2600 (upper range)*[1]	476 - 749 V	92.3%	D	C	71	93.9%	C	B	66	11/2007
Solon's Satis 40/750 IT*[1], *[2]	375 - 575 V	92.3%	D	C	71	93.5%	C	B	69	11/2008
Mastervolt's QS 2000*[1]	212 - 366 V	92.3%	D	C	71	92.7%	D	C	78	1/2008
Opti-Solar's GT 4000 (new software, V2.07)	250 - 400 V	92.1%	D	–	74	94.6%	C	–	55	6/2011
Powercom's SLK-4000	205 - 408 V	92.0%	D	C	75	93.4%	D	C	70	11/2010
Phoenixtec's PVG 10000	320 - 720 V	91.8%	F	D	76	93.3%	D	C	73	6/2010
Riello's HP 4065REL-D*[4]	255 - 435 V	91.7%	F	D	77	93.9%	C	B	66	9/2007
Fronius' IG 30	150 - 397 V	91.4%	F	D	78	92.2%	D	C	79	1/2007
Powercom's SLK-4000 (new software, V2.07)	250 - 450 V	91.1%	F	–	79	93.4%	D	–	70	6/2011
Siemens' Sitop solar 1100 Master*[1]	200 - 552 V	90.2%	F	D	80	91.7%	F	D	81	5/2007
Danfoss' ULX 1800 HV IN	260 - 500 V	89.2%	F	F	81	91.3%	F	D	83	4/2010
SMA's SB1100	139 - 320 V	89.1%	F	F	82	90.5%	F	D	85	10/2009
Opti-Solar's GT 4000 (old software, V1.09)	200 - 450 V	87.8%	F	–	83	92.1%	D	–	80	6/2011
Ehe New Energy's EHE-N2K5	200 - 400 V	87.4%	F	–	84	91.4%	F	–	82	7/2011
SunnySwiss' SSP-6000	250 - 480 V	86.8%	F	–	85	91.2%	F	–	84	2/2011
Ehe New Energy's EHE-N5K	300 - 650 V	80.3%	F	–	86	86.3%	F	–	86	7/2011
Phoenixtec's PVG 2800 (original model)*[1]	255 - 435 V	78.4%	F	F	87	85.8%	F	F	87	2/2008

*[1] device no longer being produced, *[2] prototype, *[3] range at which the model was tested and to which the grade applies, *[4] the identical solar inverter brands Helios Power (Riello UPS) and Sirio (AROS) are now marketed under a single brand, AROS Solar Technology GmbH, and distributed by AROS Neufahrn

Udo Geisler / photon-pictures.com

Simply download our test agreement and order form online at: **www.photon.info → laboratory → inverter test → Download: test agreement**

For a personal assessment, please contact us. Our consultants, Wiebke Gottschalk and Min Ge, are looking forward to assisting you.

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