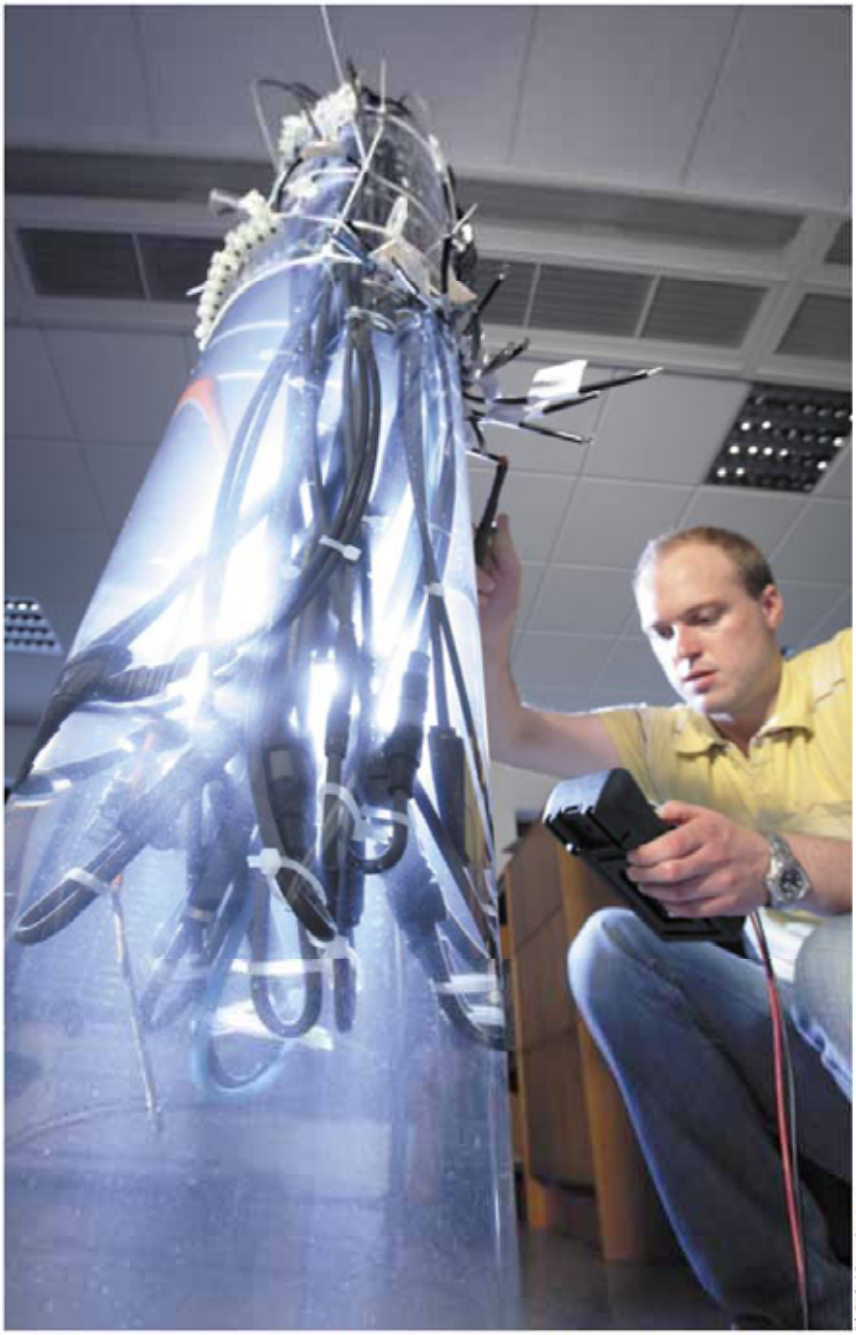
PV connectors – small, but powerful!

Connectors can influence both a PV system's yield and lifespan

First there was one, then three, and now more than 20 – for the time being. The number of PV connectors to choose from has dramatically increased since the first of their kind hit the market in 1996. Competition really began to get heavy in 2003. Today, 18 manufacturers offer connectors, and the selection is growing. For the first time, PHOTON's test laboratory has conducted a comparative examination of 19 of these products. Our top priority was product safety: one vendor completely failed in this regard. However, the largely identical Asian products on the market competing against European manufacturers saw very varied results.



19 PV connectors in a 1 m deep water bath for three weeks: That's one way PHOTON Lab tested each connector's stamina. Pictured here is lab engineer René Düpont.

Often, it's the small things in life that prove to be decisive. That's also true when it comes to planning PV systems: everyone pays attention when selecting modules and inverters, but the devil can be in the details: for instance, the choice of anchoring systems, cables, and connectors. These components are often considered secondary, but a bad choice can negatively impact the system's long-term operation, or even pose potential hazards.

This is certainly the case with PV connectors: they're barely 10 cm long, and usually no more than 2 cm thick, so they're easy to ignore. In fact, they didn't even exist 10 years ago. Back then, modules were usually connected with solar cables and screw terminals. But now, connectors are an integral part of any PV system. Prepared cables with connectors simplify and expedite the work at the installation site, especially since they are delivered properly dimensioned straight from the factory. That means installers seldom need to take their cable tools with them onto the roof, where they have to maintain their balance while they cut the cable length to the proper size and then crimp on connectors.

Connectors are required to withstand harsh conditions: like solar modules, they have to operate for at least 20 years, withstanding all weather conditions. Connectors have to successfully pass the same tests to which modules are subjected to obtain certification. Moreover, currents of more than 30 A and voltages of up to 1,000 V flow through

PV connectors: Test results

	Amphenol Quickmate			
Manufacturer	Amphenol-Tuchel Electronics GmbH	U.I. Lap		ion
Model name	71	EPIC SO EPIC SO		58 grey 8 grey
Lockable		yes		
Configurable		yes		
Insertion force of plug*1	30	30 N		
PHOTON measured insertion force	111.48 N	42.33 N		
Release force of plug*1	50 – 100 N	30 N, 10		
PHOTON measured release force (German DIN prenorm ≥ 50 N)	116.06 N	118.98		
Withdrawal force (cable from plug) with cable type*1	9 – 12 mm 100 N > 12 mm 120 N	> 150 N		m² > N
PHOTON measured with drawal force (German DIN prenorm ≥ 80 N)	cable broke	477.05		
PHOTON evaluation for force measurements	1	1	2	2
Rated current*1	27.5 A for 2.5 mm², 32 A for 6 mm²	30 A	25 A	30 A at 70 °C, 23 A at 85 °C
PHOTON measured thermographic examination at 16 A and 22 °C	30 °C	27.5 °C	26 °C	27.5 °C
PHOTON measured thermography at rated current, difference between initial temperature and heated valu as well as power loss at rated current	36 °C at 25 A (23.1 °C) 12.9 °C difference 0.369 W	41 °C at 30 A (23.1 °C) 17.1 °C difference 0.738 W	32 °C at 25 A (23.1 °C) 8.9 °C difference 0.475 W	40 °C at 30 A (23.1 °C) 16.9 °C difference 0.72 W
Transition resistance*1	≤ 2 mΩ	< 2 mΩ	< 1 mΩ	< 5 mΩ
PHOTON measured transition resistance (value / value after 100 plugging cycles)	0.59 mΩ / 0.63 mΩ	0.82 mΩ / 0.84 mΩ	0.76 mΩ / 0.88 mΩ	0.80 mΩ / 0.94 mΩ
PHOTON evaluation for thermography and transition resistance	2	3	2	3
Protection type*1	IP 67	IP 68	IP 67	IP 68
PHOTON measured insulation resistance (value / value after 3 weeks)	> 3 GΩ / > 3 GΩ	> 3 GΩ / > 3 GΩ	> 3 GΩ / > 3 GΩ	> 3 GΩ / > 3 GΩ
PHOTON evaluation for insulation resistance	2	1	2	1
PHOTON evaluation for assembly	cannot be tested	3	2	1
PHOTON overall rating	very good (1.4)	good (1.8)	good (2.0)	good (2.0)

*1 according to manufacturer

Amphenol

No.1

Winners and losers

Generally, our tests show that there are significant differences in connector quality (see table, p. 196). According to the different tests, we graded the different contestants with grades ranging from 1 (very good) to 6 (insufficient). The best test performer was the Amphenol Quickmate. Since this is the only 2-in-1 connector we tested, it's only fair to mention another contestant: Epic Solar

How we graded the connectors

In order to give the individual PV connectors a comparative rating, different aspects of the connectors were compared with one another. The overall evaluation as well as the results for the individual areas tested resulted in grades between 1 and 6: 1 (very good); 2 (good); 3 (satisfactory); 4 (sufficient); 5 (poor); 6 (insufficient). As this test is comparative, the results for individual connectors depended on the performance of their competitors. Therefore, the best connector of the group gets the grade »very good,« and this is seen as the standard against which the other connectors are measured.

In our grading system, we prioritized safety aspects and especially the question of whether the plug would detach when the connector is pulled, or whether the cable would be ripped from the connector first. An »insufficient« grade in this category meant that the connector completely failed the test and that the rest of the grades for the product are given just for statistical value. Otherwise, the grades in this category had a weighting of four.

The second most important aspect was the