Helios H4, H4CFC4D / PV-100508-M / -F

Amphenol-Tuchel Electronics GmbH offers a preconfigured connector. It cannot be detached by hand, but rather requires a special tool that is included with the product. The connector is similar to Multi-Contact's de facto standard MC4 connector.

The product's insertion force is 131 Newton, so you'll need to press the two connector halves together with a decent amount of force. In fact, no other connector in the test requires a higher insertion force. Separation force is 260 Newton, which is in the medium range, and lower than the extraction force of 452 Newton, which ensures the product is safe.

We measured a transfer resistance of 0.13 Milliohm at a rated current of 45 Amps – the best value for a starting resistance. No other connector had a higher rated current.

Resistance remained stable after five connection cycles. After 100 cycles, it increased slightly to 0.15 Milliohm – still a very good value. Temperature development is rather high, which is primarily due to the connector's very high approved rated current. We saw no red flags in test probe measurements and the permeability test.

Amphenol-Tuchel's new connector: Similar to the MC4, but with a special tool for detaching.

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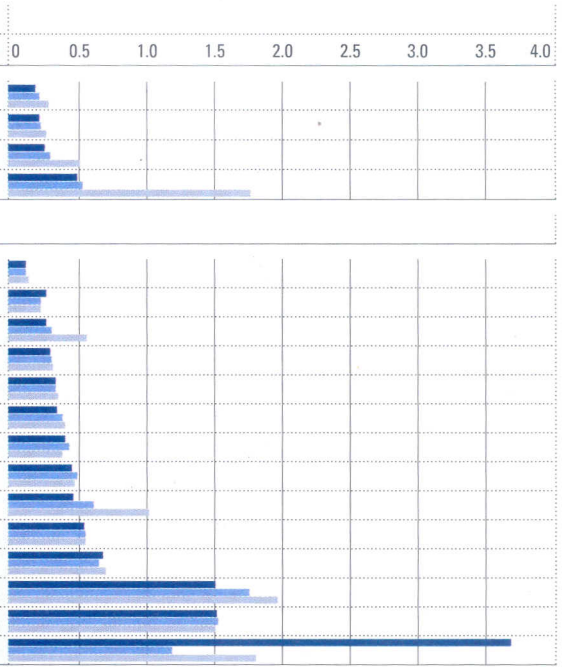
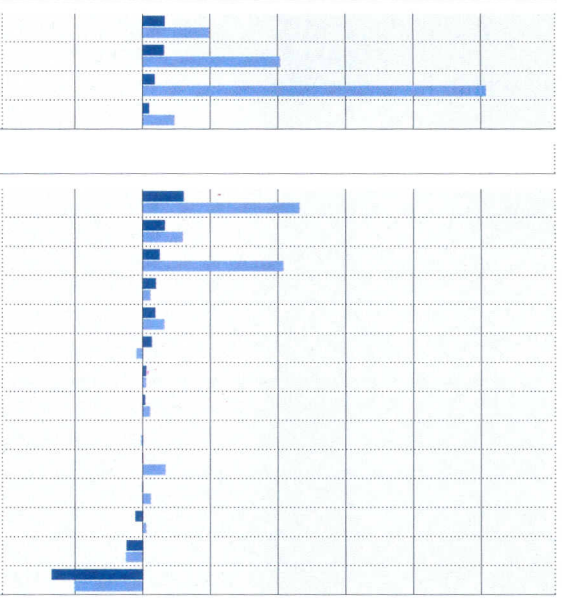
Contact resistance

Non-locking connectors	Contact Resistance (in Milliohm) after 1st connection	5th connection	100th connection
MC3 (preconfigured)	0.20	0.23	0.30
MC3 (configurable)	0.23	0.24	0.28
Yamaichi 3 (preconfigured)	0.27	0.31	0.53
Coyo CN30-19 (configurable)	0.51	0.55	1.79
Locking connectors			
Amphenol (preconfigured)	0.13	0.13	0.15
Ningbo Newray (preconfigured)	0.28	0.24	0.24
Coyo CN30-51 (configurable)	0.28	0.32	0.58
MC4 (preconfigured)	0.31	0.32	0.33
MC4 (configurable)	0.35	0.35	0.37
QC Solar (preconfigured)	0.36	0.40	0.42
Huber+Suhner (configurable)	0.42	0.45	0.40
Yamaichi 4 (preconfigured)	0.47	0.51	0.49
Coyo CN40-19 (configurable)	0.48	0.63	1.04
Tyco (configurable)	0.56	0.57	0.57
Tyco (preconfigured)	0.70	0.67	0.72
Coyo CN24-1 (configurable)	1.53	1.78	1.99
Lumberg LC4 (preconfigured)	1.54	1.55	1.53
Coyo CN24-3 (configurable)	3.71	1.21	1.83



Contact resistance

Non-locking connectors	Difference (in %) 5th to 1st connection	100th to 1st connection
MC3 (preconfigured)	16.37	49.37
Yamaichi 3 (preconfigured)	15.85	101.70
Coyo CN30-19 (configurable)	8.99	253.75
MC3 (configurable)	4.78	23.48
Locking connectors		
Coyo CN40-19 (configurable)	30.40	115.82
Coyo CN24-1 (configurable)	16.38	29.66
Coyo CN30-51 (configurable)	12.52	103.88
Yamaichi 4 (preconfigured)	9.78	5.70
QC Solar (preconfigured)	9.27	15.98
Huber+Suhner (configurable)	6.69	-4.64
Tyco (configurable)	2.59	2.41
MC4 (preconfigured)	1.76	5.29
Lumberg LC4 (preconfigured)	0.13	-1.17
Amphenol (preconfigured)	-0.39	16.76
MC4 (configurable)	-0.43	5.89
Tyco (preconfigured)	-5.54	2.56
Ningbo Newray (preconfigured)	-12.00	-12.55
Coyo CN24-3 (configurable)	-67.42	-50.55



To test increases in resistance due to normal use, the lab separated and re-attached each connector five times. The number represents the maximum number of times a connector is likely to be attached and detached when installing a system. Then they re-measured contact resistance.

In addition to these measurements, PHOTON Lab also measured contact resistance after 100 connection cycles. In reality, a connector is probably never disconnected and connected this many times during a PV system's lifetime. Rather the experiment served to give some indication of the products' durability.

The results of the contact resistance tests showed great differences between products. Most of the products scored well, and they all fell under the norm of maximum 5 Milliohm – but there were

Connector test results and ratings in brief

Connector manufacturer and type	Connector Model	Receiver Model	Rated current	Rating contact resistance and thermographic imaging	PHOTON force measurements	Test probe rating	Permeability rating	Cumulative rating
Non-locking connectors								
Coyo Link Co. Ltd.	CN30-D019	CN30-D020	25	1.9	4.8	1	4.6	3.6
Multi-Contact AG	PV - KST 3 (configurable)	PV - KBT 3 (configurable)	20	1.7	4.6	1	2.5	3.2
	PV - KST 3 (preconfigured)	PV - KBT 3 (preconfigured)	20	1.6	4.7	1	1.0	3.0
Yamaichi Electronics Deutschland GmbH	Y-Sol3AOV-M	Y-Sol3AOV-F	30	1.8	3.2	1	1.0	2.3
Locking connectors								
Amphenol-Tuchel Electronics GmbH	Helios H4, H4CFC4D / PV-100508-M	Helios H4, H4CMC4D / PV-100508-F	45	1.7	3.3	1	1.0	2.3
Coyo Link Co. Ltd.	CN24-A001	CN24-A002	30	2.9	5.1	1	2.7	6.0
	CN24-A003	CN24-A004	30	4.2	5.1	1	6.0	6.0
	CN30-A003	CN30-A004	25	1.7	4.7	1	2.6	3.2
	CN40-A003	CN40-A004	25	1.9	5.2	1	2.5	6.0
Huber+Suhner GmbH	Twist-Lock 4/6 mm²	Twist-Lock 4/6 mm²	38	1.9	3.5	1	2.7	2.7
Lumberg Connect GmbH	LC4-AM 00	LC4-AM 01	30	2.6	1.9	1	1.0	1.9
Multi-Contact AG	PV - KST 4 (configurable)	PV - KBT 4 (configurable)	30	1.8	2.9	1	2.6	2.4
	PV - KST 4 (preconfigured)	PV - KBT 4 (preconfigured)	30	1.8	2.9	1	1.0	2.1
Ningbo Newray Solartech Co. Ltd.	03 C (M) (preconfigured)	03 C (F) (preconfigured)	20	1.7	1.9	6	1.0	6.0
QC Solar Corp.	QC4-male	QC4-female	20	1.8	3.7	1	1.0	2.6
Tyco Electronics Ltd.	1394461 (configurable)	1394462 (configurable)	25	1.9	3.2	1	2.9	2.5
	1394461 (preconfigured)	1394462 (preconfigured)	25	2.0	3.4	1	1.0	2.5
Yamaichi Electronics Deutschland GmbH	Y-Sol4AOV-M	Y-Sol4AOV-F	30	1.9	3.4	1	1.0	2.4

The table summarizes the results of a larger story published on connectors in our sister magazine PHOTON Profi. The rating is the result of various partial tests, whose grades run from 1 (excellent) to 6 (very poor). For the partial rating on »force measurement,« the absence or the presence of blockage in the connector is important. The tests show especially if an involuntary disconnection is possible and if the cable connector can be started with a low charge. When this happened with a small charge, we described the connector as »very poor« for security reasons. The major electrical properties fall under »resistance and thermography«. They naturally influence the flow the measure has taken (which has not been rated): what resistance does the connector offer? What is the magnitude of the loss of power produced? Thermography also allows us to know how much the connector heats up. The category »isolation« shows whether the connector provides sufficient insulation resistance, also under water, such as in a puddle. In addition, the PHOTON laboratory studied whether direct contact with a finger test under a force of ten newton is possible. The connectors that failed this test were evaluated with a »very poor« criterion that went directly toward the overall mark, leaving it KO.

resistance close to zero – that is not watertight. The rest of the connectors were at about 50 to 60 Gigaohm, which makes them mostly watertight, and can therefore endure extensive exposure to water. Generally, installers try to place connectors in such a way to prevent them from being fully submerged in water.

Probing for answers

It would be nice if all solar connectors could be child-proof – fully covered so no contact from the outside, and nothing shoved in the inside, could lead to a shock – but at some point the contact has to be accessible in order for the device to do its job. If it's too easy to touch the contacts, though, there's a safety hazard. We tested how child-proof the products were by inserting a test probe into the closed connector, and at each end of the connector.

According to connector regulations, all parts of the product that can be taken off without tools should be removed for this test. This includes components that prevent dirt from entering the connector. Screw-on caps that protect against shock should not be removable by hand. If the cap could be removed by hand, then the connector was tested without it. A 12 mm wide, 80 mm long test probe was pressed at 10 Newton against each part of the connector at every angle. The probe then tried to measure the 40 V running through the connector.

All of the connectors for the US market passed this test with flying colors. The models designed for the European market are another story. Although we aren't covering those products in detail here, suffice it to say that a few of them failed the test probe examination. That could be an indication that UL und Co.'s relatively strict safety regulations are working. On the other hand, these regulations are so difficult to fulfill that many manufacturers hesitate to send their products for UL certification at all – one reason why there are so few models in this connector test suited for the US market. Still, that could change going forward.

René Düpont, Christoph Podewils, Melissa Bosworth