



SOLARWORLD AMERICAS INC.

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January 6, 2016

To whom it may concern,

Mating MC4 connectors to SolarWorld photovoltaic modules manufactured with Amphenol H4 or UTX H4 connectors is not an exclusion to the SolarWorld Module Warranty and performance guarantee so long as the connectors are installed per the manufacturer's instructions in a professional manner.

Amphenol has provided the attached test reports from Intertek validating the connection of MC4 connectors to Amphenol connectors to industry standard UL 6703 (Outline of Investigation for Connectors for use in Photovoltaic Systems).

SolarWorld always reserves the right to deny warranty claims based on the exclusions outlined in our Warranty policy.

Best regards,

Eric Olson

Manager Product Marketing

SolarWorld Americas Inc.

Attachments

Sunmodule[®] Plus

25-YEAR LIMITED WARRANTY

Valid from 03.25.2015



By purchasing the solar modules (hereafter referred to as: products) from SolarWorld Americas Inc. ("SolarWorld"), you have chosen a level of quality, which meets the highest requirements. SolarWorld assumes that use in accordance with regulations will reliably maintain the function of the products to produce electricity (hereinafter referred to as: functional capability) as well as reliably maintaining the performance of the products. As a sign of our confidence in this quality, SolarWorld is happy to grant you as the end-user of the products (i. e., the person who put the products into operation correctly for the first time or the person who has legitimately purchased the products from such an end-customer without any modifications) the rights which are presented below:

A - Limited product warranty:

- SolarWorld provides you with a warranty for the functional capability of the products until ten years has elapsed since the purchase of the product and that the product:
 - will not suffer from any mechanical adverse effects, which limit the stability of the solar module. A condition for this is correct installation and use in accordance with regulations, as described in the installation instructions enclosed with the product.
 - will not be subject to any clouding or discoloration of the glass.
 - with its cable and connector plug will remain safe and operational, if they are installed professionally and are not permanently positioned in water (puddle). However, damage to the cable, which is caused by abrasion on a rough lower surface owing to insufficient fixing or owing to unprotected running of the cable over sharp edges, is excluded. Any damage caused by animals (e. g., rodent bites, birds, insects) is also exempted.
 - with its aluminium frames will not freeze up when it is frosty if it is installed correctly. The appearance of the product as well as any scratches, stains, mechanical wear, rust, mould, optical deterioration, discoloration and other changes, which occurred after delivery by SolarWorld, do not represent defects, insofar as the change in appearance does not lead to a deterioration in the functional capability of the product. A claim in the event of glass breakage arises only to the extent that there was no external influence.
- If the products exhibit one of the above mentioned defects during this period and this has an effect on the functional capability of the product, SolarWorld will repair the defective products, supply replacement products or provide the customer with an appropriate residual value of the products as compensation at its discretion.

B - Limited performance guarantee:

- SolarWorld guarantees that the actual output of the product will amount to at least 97 % of effective output during the first year after purchase of the product and as of the second year after purchase of the product, the effective output will decline annually by no more than 0.7 % for a period of 24 years, so that by the end of the 25th year after purchase an actual output of at least 80.2 % of effective output will be achieved. In the event of a negative deviation of actual product performance from the so-called threshold values, SolarWorld will either supply you with replacement products, which make it possible to maintain actual performance, carry out repairs, which make it possible to achieve actual performance or provide you with financial compensation for the lower performance of the product. During the first 15 years of the guarantee period SolarWorld will exclusively either supply replacement products, which make it possible to maintain the actual performance or carry out repairs, which make such an actual performance possible. After 15 years of the guarantee period SolarWorld is free to also grant financial compensation for the lower performance of the products.
- When replacement products are supplied, there is no entitlement for the use of new products or those which are as good as new. On the contrary, SolarWorld is authorized to also supply used and/or repaired products as replacements.

C - Further conditions of entitlement:

- The period of the performance guarantee under B) is restricted to a period of 25 years from the purchase of the product and will not be extended even in the event of a repair or exchange of a product.
- The effective output and the actual output of the products are to be determined for the verification of any guarantee case using standard test conditions, as described under IEC 60904. The decisive measurement of performance is carried out by a recognized measuring institute or through SolarWorld's own measurements (the assessment of measurement tolerances is undertaken in accordance with EN 50380). The guarantee does not cover transport costs to return the products or for a new delivery of repaired or replacement products. It also does not cover the costs of the installation or reinstallation of products, as well as other expenditure by the end-customer or seller.
- Ownership of all products which have been replaced passes to SolarWorld.
- The term of the rights granted to you in this Certificate in paragraphs A) and B) starts with the original purchase of the products, insofar as they were purchased by the original end-customer after 11.01.2014. SolarWorld retains the right to adjust voluntary special services in accordance with this document at any time. However, any product purchases, which have already been concluded, remain unaffected by this – including the voluntary special services in accordance with this document. You can find out about the current status of this document at any time under www.solarworld-usa.com.

D - Assertion of claims:

The assertion of the services specified under A) and B) requires you (i) to inform the authorized seller/dealer of the product of the alleged defect in writing, or (ii) to send this written notification directly to the address mentioned in G), if the seller/dealer who should be informed no longer exists (e. g., owing to business closure or insolvency). Any notification of defects is to be added to the original sales receipt as evidence of the purchase and the time of the purchase of the SolarWorld products. The assertion should take place within six weeks of the occurrence of the defect. The connecting factor for the recognition of the occurrence of a defect is acknowledgement of material and/or processing errors for claims from the product guarantee (letter A). For claims from the performance guarantee (letter B) the connecting factor is acknowledgement of the lower performance of the products. The return of products is permitted only after the written consent of SolarWorld has been obtained.

E - Use in accordance with this Limited Warranty.

- The services described above can be ensured only if the product is properly assembled, used and operated. Services provided by SolarWorld must therefore be withdrawn if the defects to the product are not exclusively based on the products themselves; e. g., in the following cases:
 - Delays on your part or on the part of the fitter in observing the assembly, operational and maintenance instructions or information, if this leads to defects and/or a loss of the products' performance.
 - Exchange, repair or modification of the products, if this was not undertaken correctly and professionally.
 - Incorrect use of the products.
 - Vandalism, destruction through external influences and/or persons/animals.
 - Incorrect storage or inappropriate transport before installation, if this leads to defects and/or a loss of the products' performance.
 - Damage to the customer system or incompatibility of the customer's system equipment with the products, if this leads to defects and/or a loss of the products' performance.
 - Use of products on mobile units such as vehicles or ships.
 - Influences such as dirt or contamination on the faceplate; contamination or damage by e. g., smoke, extraordinary salt contamination, or other chemicals.
 - Force majeure such as flooding, fire, explosions, falling rocks, direct or indirect lightning strikes, or other extreme weather conditions such as hail, hurricanes, whirlwinds, sandstorms or other circumstances outside the control of SolarWorld.
- The entitlements referred to under A) and B) will not be granted if and as soon as the manufacturer's labels or serial numbers on the PV modules have been changed, deleted, peeled off or made unrecognizable.

F - Exclusive remedy:

The remedies set forth in this Limited Warranty are the exclusive remedies available to you as a product purchaser. SolarWorld shall not be liable for damage, injury or loss arising out of or related to a product except as set forth in this Limited Warranty. In particular, under no circumstances shall SolarWorld be liable for incidental, consequential, special or other indirect damages in any way connected with a product. SolarWorld's aggregate liability, if any, shall be limited to a product's purchase price or any service furnished in connection with a product, as the case may be.

G - Your contacts:

To receive service under this Limited Warranty, please contact the authorized seller/dealer of your product or SolarWorld at the following addresses: Customer Service, SolarWorld Americas Inc., 25300 NW Evergreen Road, Hillsboro, OR, 97124, USA. Email: customerservice@solarworld-usa.com. Phone: (855) 467-6527. Fax: (503) 844-3403.

H - Choice of law:

This Limited Warranty, including without limitation the rights and responsibilities granted hereunder, shall be governed and construed in accordance with the laws of the State of Oregon, without regard to the conflicts of law provisions thereof.

I - Validity:

The following table contains all the current products to which this Limited Warranty is to be applied. Products, which do not appear in this list, are also not subject to this Limited Warranty.

Sunmodule/Sunmodule Plus/black/laminate

SW 245 poly	SW 250 poly	SW 255 poly	SW 260 poly
SW 265 poly	SW 270 poly	SW 260 mono	SW 265 mono
SW 270 mono	SW 275 mono	SW 280 mono	SW 285 mono
SW 290 mono	SW 295 mono	SW 300 mono	SW 310 XL mono
SW 315 XL mono	SW 320 XL mono	SW 325 XL mono	SW 330 XL mono
SW 335 XL mono	SW 340 XL mono	SW 345 XL mono	SW 350 XL mono
SW 355 XL mono			

J - Exclusion of liability:

This Limited Warranty is expressly intended to exclude all other express or implied warranties, including without limitation the warranties of merchantability and fitness for a particular purpose, to the periods set forth herein. This Limited Warranty gives you specific legal rights, and you may also have other rights which vary from state-to-state. Some states do not allow limitations on implied warranties or the exclusion or limitation of damages, so some of the above limitations may not apply to you.

K - Severability:

If any provision of this Limited Warranty is held unenforceable or illegal by a court or other body of competent jurisdiction, such provisions shall be modified to the minimum extent required such that the rest of this Limited Warranty will continue in full force and effect.

Hillsboro, 11.01.2014

Mukesh Dulani
President
SolarWorld Americas Inc.

Ardes Johnson
Vice President, Sales and Marketing
SolarWorld Americas Inc.



INTERMATEABILITY OF THE AIST H4 UTX™ PV CONNECTOR WITH THE MULTI-CONTACT AG MC4 PV CONNECTOR

APPLICATION NOTE

3/12/2015

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INTERMATEABILITY OF THE AIST H4 UTX™ PV CONNECTOR WITH THE MULTI-CONTACT AG MC4 PV CONNECTOR

WHY INTERMATEABILITY?

Intermateability of PV connectors is very important due to the fact that large PV component suppliers differ in their choice of connector for supply chain-driven, economic, and legacy design reasons. Knowing this, Amphenol Industrial Solar Technologies (AIST) began design of the new H4 UTX™ connector by establishing the highly important criterion of excellent intermateability with the Multi-Contact AG MC4 PV connector, AIST's closest competitor in the solar marketplace. To this end, AIST chose to go beyond the claim that these connector systems are intermateable, in order for the term to mean more than just the ability to couple two similar PV connector systems.

In general, this same effort was widely accepted when it was first implemented to show intermateability between AIST's existing generation of PV connector, the H4™ system, and the MC4 (acceptance documentation, data, and independent testing can be provided to show this conclusively). However, it is important to note that variations exist. In general, some jurisdictions are fairly liberal while others restrict the use of intermated connections. Here are some examples:

- 1) Germany generally allows intermated connections, especially when the particular interconnection is verified by an independent testing agency
- 2) France and Australia generally prohibit intermated connections
- 3) In USA, the determination is up to the inspector
- 4) Most other countries generally allow intermated connections

AIST has once again used the same established design criteria, coupled with an independent testing regimen for intermateability, to soundly verify that when the MC4 PV connector is intermated with the H4 UTX™, a highly reliable connection is made that satisfies the majority of regional, national, and local jurisdictions' PV installation regulatory concerns.

INTERMATEABILITY CONDITIONS

Based on years of experience in the PV industry and previous work to show intermateability with MC4, the following important criteria were used in the design of the H4 UTX™ to create a safe, functional, and repeatable interconnection to either of the two connector other systems:

- 1) Interface dimensions and tolerances must be carefully established so that the connectors mate under all circumstances.
- 2) Locking/latching mechanisms must properly interact
 - a. The connectors can be securely mated without excessive force
 - b. The retention force of the locking/latching mechanism must be high enough to ensure proper mating even under mechanical stress
 - c. The retention force must also be low enough to allow the connectors to un-mate without exposing energized parts in the event of a forced separation.
- 3) The contacts must be properly sized and positioned so that they correctly mate
 - a. Contacting elements and surfaces must be designed so that sufficient contact pressure and area exist
 - b. Dimensional and geometrical variations must be allowed for in the design
- 4) The material and plating of the contacts in the two must be compatible

INTERMATEABILITY OF THE AIST H4 UTX™ PV CONNECTOR WITH THE MULTI-CONTACT AG MC4 PV CONNECTOR

- 5) The insulating material of the connectors' bodies and the sealing elements must be compatible
- 6) The sealing elements (i.e. o-ring) and the sealing surfaces and dimensions must have correct tolerances to guarantee a tight environmental seal

In addition to these design criteria, AIST also contracted with Intertek Testing Services to show that when H4 UTX™ is intermated with MC4, the interconnection meets all aspects of UL 6703 and the appropriate tests as defined therein. A test report and verification of conformity are provided at the end of this document.

H4 UTX™ INTERMATEABILITY WITH MC4

When designing the H4 UTX™ connector, we mirrored the H4™ connector carefully in order to again establish intermateability with MC4. However, AIST's new H4 UTX™ connector is far from a copy of the H4™. Our goal was to design a PV connector that is fully intermateable with the MC4, but has better performance, better functionality, is constructed of finer materials, is easier to manufacture, and is more competitively priced than the Multi-Contact AG connector system. This was achieved through optimization of superior plastics and elastomers, a refined locking mechanism that requires a tool to unlock (unlike MC4), and a cable gland seal revision that allows for an increased cable OD acceptance range, among a myriad of other upgrades.

While implementing these improvements, we maintained our goal of being fully intermateable with MC4. Still, it must be understood that the MC4 is a proprietary product of Multi-Contact AG and as such the interface dimensions, tolerances, etc. are not controlled by AIST and can be changed by Multi-Contact AG at-will. For this reason, AIST cannot guarantee intermateability with MC4 under all conditions and in perpetuity. No entity other than Multi-Contact AG can, because no other has control over the MC4 mating interface design.

However, for all practical purposes at this time, the H4 UTX™ connector is fully intermateable with the Multi-Contact AG MC4. Please refer to the Intertek Testing Services report at the end of this document that shows the interconnection meets all aspects of UL 6703 and the appropriate tests as defined therein.

It should also be recognized that AIST has only been shown to intermate with MC4, and not any other PV connector that claims to be "H4™ compatible" or "MC4 compatible." AIST has found that while these adjacent connector systems are certified to the same standards as the H4 UTX™ and the MC4, their overall design and quality can vary greatly, even to the point of a wholly different mating interface in the case of Tyco Electronics' PV connector. This greatly affects the success of the intermate with these connector systems and therefore, this Application Note DOES NOT imply compliance with any "H4™ compatible" or "MC4 compatible" PV connectors.

Additionally, it should be noted that AIST does not recommend intermating the H4 UTX™ with any other system. This test report contained within this document should be construed as a statement of existing data and information, and NOT an endorsement by AIST to intermate.

Of note is that this situation is not unique to the solar marketplace. Connectors of many designs and purposes from competing entities, but of similar interface, are intermated safely on a regular basis. AIST chooses to go further via testing to UL 6703 to show conclusively that the H4 UTX™ will mate with MC4 under normal operating conditions for any PV system.

TEST REPORT
UL 6703
Outline of Investigation for Connectors
for use in Photovoltaic systems

Report Number..... : 140600367SHA-002

Tested by (name + signature) : Ken Gu 

Approved by (name + signature).. : Michael Huang 

Date of issue : Jan 16, 2015

Total number of pages : 10

Applicant's name : Amphenol Technology (Shenzhen) Co.,Ltd.

Address..... : Block 5, Fuan 2nd Industrial Park, Dayang Road Dayang
Development Zone, Shenzhen, Guangdong, 518103

Testing Laboratory : Intertek Testing Services Shanghai

Address..... : Building No.86, 1198 Qinzhou Road (North), Shanghai 200233, China

Testing location/Procedure : TL [X] SMT [] TMP []

Address..... : 1-2F, No.2 Alley 1218, Wan Rong Road, Shanghai China 200436

Test specification:

Standard : UL 6703:2011

Test procedure : Testing

Non-standard test method : N/A

Test Report Form No. : UL6703_TTRF

Test Report Form(s) Originator : INTERTEK

Master TRF : Dated 2012-02

Test item description..... : Connectors for use in Photovoltaic systems

Manufacturer's name..... : Same as applicant

Manufacturer's address : Same as applicant

Trade Mark..... : Amphenol

Model/Type reference..... : H4 UTX mated H4, H4 UTX mated MC4

Ratings..... : 1000V, 10/12/14AWG

Summary of testing:

Tested samples are listed as follows:

7 assemblies of MC4 male connector mated with H4 UTX female connector.

7 assemblies of MC4 female connector mated with H4 UTX male connector.

7 assemblies of H4 male connector mated with H4 UTX female connector.

7 assemblies of H4 female connector mated with H4 UTX male connector.

Sample No.	Male connector + female connector
#1-#7	MC4 male connector + H4 UTX female connector
#8-#14	MC4 female connector + H4 UTX male connector
#15-#21	H4 male connector + H4 UTX female connector
#22-#28	H4 female connector + H4 UTX male connector

Possible test case verdicts:

- test case does not apply to the test object : N/A
- test object does meet the requirement : P (Pass)
- test object does not meet the requirement : F (Fail)

Testing :

Date of receipt of test item : May 19, 2014

Date(s) of performance of tests : May 20, 2014 to June 2, 2014

General remarks:

The test results presented in this report relate only to the object tested.

This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.

"(see Enclosure #)" refers to additional information appended to the report.

"(see appended table)" refers to a table appended to the report.

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Throughout this report a ☒ comma / ☐ point is used as the decimal separator.

UL 6703			
Clause	Requirement + Test	Result - Remark	Verdict

9.3.1	STATIC-HEATING TEST (#1-#4)		
	Mated specimen		
	Test conductor length	0,9m for each connector	
	Test conductor cross-section	14AWG	
	Test current	30A a.c	
	Ambient temperature	21,6 °C	
	Temperature rise (Enclosure)	17,8 °C (maximum)	P
	Temperature rise (Conductor)	23,4 °C (maximum)	P
	The temperature rise cannot exceed 45 °C above ambient temperature.		P
	No breakage of the conductor or other damage to the connector.		P

9.3.1	STATIC-HEATING TEST (#8-#11)		
	Mated specimen		
	Test conductor length	0,9m for each connector	
	Test conductor cross-section	14AWG	
	Test current	30A a.c	
	Ambient temperature	21,9 °C	
	Temperature rise (Enclosure)	17,4 °C (maximum)	P
	Temperature rise (Conductor)	23,1 °C (maximum)	P
	The temperature rise cannot exceed 50 °C above ambient temperature.		P
	No breakage of the conductor or other damage to the connector.		P

UL 6703			
Clause	Requirement + Test	Result - Remark	Verdict

9.3.1	STATIC-HEATING TEST (#15-#18)		
	Mated specimen		
	Test conductor length	0,9m for each connector	
	Test conductor cross-section	14AWG	
	Test current	30A a.c	
	Ambient temperature	22,1 °C	
	Temperature rise (Enclosure)	16,9 °C (maximum)	P
	Temperature rise (Conductor)	23,0 °C (maximum)	P
	The temperature rise cannot exceed 50 °C above ambient temperature.		P
	No breakage of the conductor or other damage to the connector.		P

9.3.1	STATIC-HEATING TEST (#22-#25)		
	Mated specimen		
	Test conductor length	0,9m for each connector	
	Test conductor cross-section	14AWG	
	Test current	30A a.c	
	Ambient temperature	21,5 °C	
	Temperature rise (Enclosure)	17,4 °C (maximum)	P
	Temperature rise (Conductor)	23,3 °C (maximum)	P
	The temperature rise cannot exceed 50 °C above ambient temperature.		P
	No breakage of the conductor or other damage to the connector.		P

	WATER SPRAY TEST (#5-#7)		
	Mated specimen		
	Maximum and minimum cross-section wiring or cable diameter connected	14AWG	
	Exposure duration	1h	
	After exposure, no water penetration to uninsulated live part	No ingress of water	P
	DIELECTRIC STRENGTH (#5-#7)		

UL 6703			
Clause	Requirement + Test	Result - Remark	Verdict

	Mated specimen		
	DC withstand voltage	3000V	
	No breakdown or flashover between	Live parts and accessible parts	P
	LEAKAGE CURRENT TEST (#5-#7)		
	Mated specimen		
	DC test voltage	1000V	
	Measured leakage current for accessible part (Maximum current 1mA)	2,8x10 ⁻⁶ mA (maximum)	P

	WATER SPRAY TEST (#12-#14)		
	Mated specimen		
	Maximum and minimum cross-section wiring or cable diameter connected.....	14AWG	
	Exposure duration.....	1h	
	After exposure, no water penetration to uninsulated live part	No ingress of water	P
	DIELECTRIC STRENGTH (#12-#14)		
	Mated specimen		
	DC withstand voltage	3000V	
	No breakdown or flashover between	Live parts and accessible parts	P
	LEAKAGE CURRENT TEST (#12-#14)		
	Mated specimen		
	DC test voltage	1000V	
	Measured leakage current for accessible part (Maximum current 1mA)	2,9x10 ⁻⁶ mA (maximum)	P

	WATER SPRAY TEST (#19-#21)		
	Mated specimen		
	Maximum and minimum cross-section wiring or cable diameter connected.....	14AWG	
	Exposure duration.....	1h	
	After exposure, no water penetration to uninsulated live part	No ingress of water	P

UL 6703			
Clause	Requirement + Test	Result - Remark	Verdict

	DIELECTRIC STRENGTH (#19-#21)		
	Mated specimen		
	DC withstand voltage	3000V	
	No breakdown or flashover between	Live parts and accessible parts	P
	LEAKAGE CURRENT TEST(#19-#21)		
	Mated specimen		
	DC test voltage	1000V	
	Measured leakage current for accessible part (Maximum current 1mA)	$3,4 \times 10^{-6}$ mA (maximum)	P

	WATER SPRAY TEST (#26-#28)		
	Mated specimen		
	Maximum and minimum cross-section wiring or cable diameter connected.....	14AWG	
	Exposure duration.....	1h	
	After exposure, no water penetration to uninsulated live part	No ingress of water	P
	DIELECTRIC STRENGTH (#26-#28)		
	Mated specimen		
	DC withstand voltage	3000V	
	No breakdown or flashover between	Live parts and accessible parts	P
	LEAKAGE CURRENT TEST (#26-#28)		
	Mated specimen		
	DC test voltage	1000V	
	Measured leakage current for accessible part (Maximum current 1mA)	$3,8 \times 10^{-6}$ mA (maximum)	P

Photos of sample (H4 UTX female + H4 male):



Photos of sample (H4 UTX male + H4 female):



Photos of sample (H4 UTX female + MC4 male):



Photos of sample (H4 UTX male + MC4 female):



Intermateability of Helios H4 PV Connector with Multi-Contact MC4

1 Intermateability Conditions

The tremendous success of Multi-Contacts's MC4 connector established it as a de facto standard for PV connectors. Many connector manufacturers now have similar products that claim to be intermateable with MC4.

Intermateability means more than just the ability to couple two connectors of different manufacturers. The following criteria are important for the safe, functional and repeatable interconnection of two connector systems:

- 1) Interface dimensions and tolerances need to be carefully established so that the connectors mate under all circumstances.
- 2) Locking/latching mechanisms need to properly interact so that the connectors can be securely mated without undue force. The retention force of the locking/latching mechanism needs to be high enough to ensure proper mating even under mechanical stress, but low enough to allow the connectors to un-mate without exposing live parts in the event of a forced separation.
- 3) The contacts must be properly sized and positioned so that they correctly mate. The contacting elements and surfaces must be designed so that sufficient contact pressure and area can be maintained while allowing for dimensional and geometrical variations.
- 4) The material and plating of the contacts must be compatible.
- 5) The material of the body/insulation and the sealing elements must be compatible
- 6) The sealing elements (i.e. o-ring) and the sealing surfaces and dimensions must be within close tolerances to guarantee a tight environmental seal.

The Multi-contact MC4 connector is a proprietary design. There are no published dimensions, tolerances, surface specifications etc. available. Multi-contact can (and did!) change any of the specifications without notice. This has to be taken into consideration when establishing intermateability with MC4.

2 Helios H4 intermateability with MC4

When designing the H4 connector, we analyzed and measured the MC4 connector carefully. However, our H4 connector is far from a copy of the MC4. Our goal was to design a PV connector that is fully intermateable with MC4, but has better performance, has better handling, is NEC 2008 compatible and is easier to manufacture to be competitive. We achieved this with improved contact design, improved locking mechanism, improved cable gland etc. While implementing these improvements, we maintained our goal to be fully intermateable with MC4.

We had several independent testing agencies verify the intermateability of our H4 with the MC4 connector, most notably TUV Rheinland (Cologne).

Given the fact that the MC4 is a proprietary product without established interface dimensions, tolerances etc. and can be changed by Multi-Contact at will, we cannot guarantee intermateability with MC4 under all conditions. Nobody other than Multi-Contact can, because nobody other than Multi-Contact has control over the MC4 interface.

However, for all practical purposes, our H4 connector is fully intermateable with Multi-Contact's MC4.

This situation is not unique to the PV connector market; there are many other connectors on the market that are private designs but are being intermated with competing products as a matter of course. Most specialized connector designs start out as private developments; some designs become standardized in due time.

The performance of an intermated connection is always determined by the weakest link. The intermated H4-MC4 connections are limited by the current capacity of the MC4 contacts.

3 Intermated connections in practical use

When properly designed, intermated connectors rarely cause actual trouble in the field. However, the authorities overseeing PV installations have sometimes reservations using intermated connections. Some countries are fairly liberal while others restrict the use of intermated connections. Here some examples:

- 1) Germany generally allows intermated connections, especially when the particular interconnection is verified by an independent testing agency.
- 2) France generally prohibits intermated connections
- 3) In USA, the determination is up to the inspector. Generally, inspectors allow intermated connections as long as both connectors bear similar approval marks (UR)
- 4) Most other countries generally allow intermated connections.

D. Lenel
May 6th, 2011

Prüfbericht - Nr.: 21148974 002f			Seite 1 von 23 Page 1 of 23		
Test Report No.:					
Auftraggeber: Client:		Amphenol Industrial Operations Europe, Via Barbaiana 5, 20020 Lainate Italien			
Gegenstand der Prüfung: Test item:		Connector for photovoltaic systems			
Bezeichnung: Identification:		Helios H4		Serien-Nr.: Serial No.: N/A	
Wareneingangs-Nr.: Receipt No.:		86269 96273		Eingangsdatum: 22.03.2010 Date of receipt: 08.12.2010	
Prüfört: Testing location:		TÜV Rheinland LGA Products GmbH, Am Grauen Stein, 51105 Köln			
Prüfgrundlage: Test specification:		EN 50521:11-2008 see other aspects below			
Prüfergebnis: Test Result:		Der Prüfgegenstand entspricht nicht oben genannter Prüfgrundlage(n). The test item failed the test specification(s).			
Prüflaboratorium: Testing Laboratory:		TÜV Rheinland LGA Products GmbH, Am Grauen Stein, 51105 Köln			
geprüft/ tested by:			kontrolliert/ reviewed by:		
03.01.2011	Heinz Müller/SV		03.01.2011	Michael Degen/SV	
Datum Date	Name/Stellung Name/Position	Unterschrift Signature	Datum Date	Name/Stellung Name/Position	Unterschrift Signature
Sonstiges/ Other Aspects:					
This test is performed to evaluate the inter-mate-ability of Amphenol plug and socket to Multicontact MC4 (KST4 / KBT4) plug and socket. The connectors (plug and corresponding socket) of both manufacturers are already tested and certified: (Amphenol: R 50157783; Report: 17011847; Multicontact: R 60017180; Report: 21120907). The following test groups of above mentioned standard were tested: A1, A7, A8, A9, A10, B1, B2, B3, C1, C2, C3, C4, C5, D1, D2, D3, D4, D6, E2 and E3 Because of some fail results at initial tests the following clauses were retested: A1, C3, heating and E2-E3, IP65/-67 protection. See also "General testing remarks" on next page. Recommendation: Trademark or manufacturers name should be on both parts of H4 connector. In case of mixing up with other connectors, the female part of Helios H4 can not be identified. Failure: Heating test could not be passed by the combination with 4mm² cable and 30 A load. This test report consists of 23 pages + 3 pages photo documentation.					
Abkürzungen:		Abbreviations:			
P(ass) = entspricht Prüfgrundlage		P(ass) = passed			
F(ail) = entspricht nicht Prüfgrundlage		F(ail) = failed			
N/A = nicht anwendbar		N/A = not applicable			
N/T = nicht getestet		N/T = not tested			
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. This test report relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any safety mark on this or similar products.					

Verwendete Messgeräte/Prüfmittel / Measuring equipment list

Measurement	Inventory No.	Calibrate until
Timer	30101735	2012-04
Flow rate meter (propane)	30102375	2012-07
Flow rate meter (air)	30102374	2012-07
Glow wire test	30102462	2012-11
Heating cabinet / Thermometer	30102433	2011-09
Test finger	14100486	2012-12
Slide gauge	14100372	2011-12
Impact tester	14400133	2011-10
Test pin	30101951	2011-02
Dust chamber IP6X	30101730	2012-06
Flow meter IPX5	30102136	2011-03
High voltage tester	14100478	2011-03
Insulation tester	14100563	2012-04
Climate chamber	785 TIE ²⁾	2011-01
Temperature recorder	30101639	2011-06
Ampere meter	30102279	2012-04
Direct voltage meter	30101847	2012-05
Köhler Kammer	5516 ³⁾	2011-01

Remarks:

¹⁾ Tests were performed in laboratory of TÜV Rheinland Italia.

²⁾ Tests were performed in laboratory of TÜV Rheinland Immissionschutz und Energiesysteme GmbH.

³⁾ Tests were performed in laboratory of TÜV Rheinland LGA Nürnberg.

General testing remarks:

The rated values of Amphenol connector Helios H4 are at a higher level than rated values of Multicontact connector KST4 / KBT4. The use of Amphenol Helios H4, as replacement for Multicontact KST4 / KBT4, covers the lower limited characteristics of Multicontact connectors, but not the other way around. Test conditions and limits for all tests were used of Multicontact connector ratings. See tables at the end of this report.

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Clause	Requirement – Test	Result - Remark	Verdict
A	MECHANICAL TEST GROUP A (TABLE 6)		—
A1	VISUAL EXAMINATION: IEC 60512 / Test [1a], [1b]		—
5.2.1	Identification		—
	All other markings of 5.2.1 shall be given in the technical documentation or catalogue of the manufacturer.		P
	a) trademark.....:	On the male part of H4 on both parts of MC4	P
	b) type identification.....:	In the documentation	P
	c) Rated current	According to Helios 4 Approval : 32A/ta=90C, for 2,5mm ² 40A/ta=90C, for 4,0mm ² 44A/ta=90C, for 6,0mm ² According to MC 4 Approval : 22,5A/ta=90C, for 2,5mm ² 30A/ta=90C, for 4,0mm ² 30A/ta=90C, for 6,0mm ²	P
	d) Rated voltage	1000V DC	P
	e) Over voltage category	III	P
	f) Pollution degree	3	P
	g) Protection degree	IPX7 was considered for the tests because of MC4 Approval.	P
	h) Range of temperature (limit temp. & ta).....	ta _{range} : -40 ...+90°C t _{limit} : +105°C (MC4)	P
	i) Type of terminals	Crimp, clip for into the connector	P
	j) Connectable conductors		N/A
	k) Reference to this standard	EN 50521: 11-2008	P
	l) hint “do not connect or disconnect under load” (this hint can also be in national language)	symbol and hint used on connector	P
	m) polarity of connectors	“+” or “-“ symbol on respective connector used	P

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Clause	Requirement – Test	Result - Remark	Verdict
5.2.2	Marking indelible and easily legible: - The minimum marking on the connector shall be a) ; l) ; m) - Marking a) trademark and b) type identification shall be found on the smallest unit of packaging	Only on the male part of H4 connector on both parts of MC4 connector	P
5.7.1	Fixing means shall not be used to fix live parts		N/A
5.7.2	Connectors shall be so designed that connection of conductors of the type and cross- sectional areas as specified by the manufacturer shall be possible.		P
	No damage of the insulation is possible, e.g. by avoiding of sharp edges.		P
5.7.3	Non-rewirable connectors shall be so designed that:		P
	-the flexible cable can not be separated from the connector without marking it permanently useless		P
	-the conductor be verified with rated values of the connectors and for the use in photovoltaic systems		P
	-the connector cannot be opened by hand or by using a general purpose tool, for example a screwdriver, as intended		P
	- means are provided to prevent live parts, e.g. free strands of a conductor, from reducing the minimum insulation distance between such live parts and all accessible external surface of the connector, with the exception of the engagement face of the male connector.		P
	If this cannot be granted by the design or manufacturing process itself, the in-process test schedule according to 6.4 or another test of the same safety level shall be carried out.		P
5.8	Design of a free connector		—
	In a free connector the wires shall be protected against shear and tensile stress at the termination and be secured to prevent twisting		P
	This requirement does not apply to:		—

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Clause	Requirement – Test	Result - Remark	Verdict
	a) free connectors for termination to cables in fixed mountings		P
	b) free connectors in which the termination is protected against pull and twisting mounting provisions in the end-use product.		P
	DIMENSIONAL EXAMINATION: IEC 60512		—
5.18	Clearances and creepage distances according to IEC 60664-1 / DIN VDE 0110	The connectors are all approved.	N/T
	Connector dimensions shall comply with the DS or manufacturers specification		N/T
A2	DURABILITY OF MARKING		—
6.3.2	The test liquid shall be water Test piston size 1; force or 5N; 10 cycles:	Moulded marking	P
	VISUAL EXAMINATION: IEC 60512 / Test [1a]		—
	Visible with the naked eye		P
A3	POLARISATION: IEC 60512 / Test [13e]		—
	Test force: 20N or 1,5 times the insertion force, whichever is higher		N/T
5.3	Multipole connectors shall be so polarised that improper connection of mating parts is prevented:		N/T
	VISUAL EXAMINATION: IEC 60512 / Test [1a]		—
	No damage likely to impair function:		N/T
A4	TERMINATIONS		—
5.5	Terminations and connection methods		—
	Connection method		—
	a) Crimped connections according to IEC 60352-2:		—
	- visual tests on the crimp barrel as specified in IEC 60352-2		N/T
	- tensile strength test of the crimp connection as specified in IEC 60352-2.		N/T
	- If deviations to IEC 60352-2 exist, the tensile strength according to IEC 60352-2		N/T

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Clause	Requirement – Test	Result - Remark	Verdict
	- and the dimensions according to the manufactures specification are tested to fulfil IEC 61984.		N/T
	b) Insulation displacement connections according to IEC 60352-3 (accessible IDC) or IEC 60998-2-3:		—
	- Visual examination is carried out on new parts for insulation displacement terminals according to IEC 60352-3 clause 12.1		N/A
	- and for solderless non-accessible displacement terminals according to IEC 60352-4, clause 12.2.4		N/A
	- Electrical tests are carried out according to IEC 61984.		N/A
	- Thermal tests are carried out according to IEC 61984.		N/A
	c) Insulation displacement connections according to IEC 60352-4 (non-accessible IDC) or IEC 60998-2-3:		—
	- Visual examination is carried out on new parts for insulation displacement terminals according to IEC 60352-3 clause 12.1		N/A
	- and for solderless non-accessible displacement terminals according to IEC 60352-4, clause 12.2.4		N/A
	- Electrical tests are carried out according to IEC 61984.		N/A
	- Thermal tests are carried out according to IEC 61984.		N/A
	d) Press-in connections according to IEC 60352-5:		—
	- visual test as specified in IEC 60352-5		N/A
	- dimensional tests on the press-in post as specified in IEC60352-5		N/A
	- test of the push-out force as specified in IEC 60352-5		N/A
	e) Insulation piercing connections according to IEC 60352-6 or IEC 60998-2-3:		—
	- Tests according to IEC 60352-6 or IEC 60998-2-3		N/A

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Clause	Requirement – Test	Result - Remark	Verdict
	f) Screwless-type clamping units according to IEC 60999-1 or IEC 60999-2 or IEC 60352-7		—
	- mechanical tests on the conductor connection as specified in IEC 60999-1 or IEC 60999-2 or IEC 60352-7.		N/A
	g) Screw-type clamping units according to IEC 60999-1 or IEC 60999-2:		—
	- mechanical tests on the conductor connection as specified in IEC 60999-1 or IEC 60999-2.		N/A
	NOTE: For prepared conductors the manufacturers instructions for the preparation applies.		N/A
	h) Flat, quick-connect terminations according to IEC 60760 and IEC 61210		—
	- dimensional tests and safety tests as specified in IEC 61210 as far as applicable.		N/A
	- The dimensional test is carried out according to IEC 61210.		N/A
	- The compliance check of dimensions is the verification of the safety of the connection according to IEC 61984.		N/A
	- If the dimensions don't comply with the specification the test is not met.		N/A
	- Flat, quick-connect terminations, which are definitely not designed according to IEC 61210 can be used if the test program according to IEC 61984 is met.		N/A
	Electrical and thermal tests on terminations shall be carried out in conjunction with the test on the connector.		N/T
	Other terminations and connection method has to be tested in accordance with the relevant standards.		N/T
	Electrical connections shall be so designed that the contact pressure is not transmitted through insulating material other than ceramic, pure mica or other material with characteristics not less suitable.		N/T

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Clause	Requirement – Test	Result - Remark	Verdict
	Unless there is sufficient resiliency in the metallic parts to compensate for any shrinkage or yielding of the insulating material (see 25.3 of IEC 60309-1 or clause 7 of IEC 60999-1 or IEC 60999- 2).		N/T
	Range of connectable conductor(s)		N/T
A5	CONTACT RETENTION IN INSERT: IEC 60512 / Test [15a]		—
	Test load shall be three times the specified insertion force (mating) of one contact or the specified insertion force of one contact plus 50N, whichever is less.	Test load 50N	N/T
	VISUAL EXAMINATION: IEC 60512 / Test [1a]		—
5.15.2	Contacts safety retained		N/T
	No axial displacement likely to impair normal operation:		N/T
A6.1	CABLE CLAMP (PULL): IEC 60512 / Test [17c]		—
5.14	The cord anchorage shall be suitable for the cable to be connected. The range of acceptable cable diameters shall be specified in the manufacturer's specification.		N/T
	Loose parts inserted to obtain clamping of the cable are permissible if they are fixed in the connector in the assembled state.		N/T
	The cord anchorage can be made of insulating material or metal. If it consists of metal, it shall meet one of the following requirements:		N/T
	a) be provided with a covering of insulating material to prevent any accessible metal part becoming live in case of a fault		N/T
	b) no contact shall be possible with the test finger according to IEC 60529		N/T
	Compliance is checked with the values of table 1	see table A6.1-1 + A6.2-1	N/T
	VISUAL EXAMINATION: IEC 60512/ Test [1a]		—
	Covers mounted / contacts not connected	See TABLE A6.2-1	N/T
A6.2	CABLE CLAMP (TORSION): IEC 60512 / Test [17d]		—
	VISUAL EXAMINATION: IEC 60512 / Test [1a]		—

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Clause	Requirement – Test	Result - Remark	Verdict
5.14	Cover mounted	See TABLE A6.2-1	N/T
A7	MECANICAL STRENGTH IMPACT (ONLY FREE CONNECTORS)		—
	Dropping cycles: 8 positions in 45° steps		P
	Dropping height 750 mm		P
	VISUAL EXAMINATION: IEC 60512 / Test [1a]		—
	No damage likely to impair safety	No damage of connector	P
	Internal insulations not damaged		P
	Parts against electric shock not damaged		P
	Clearances and creepage distances not Reduced		P
A8	COLD		—
6.3.10	Mated specimen		P
	Test duration 5h		—
	Lower temperature limit -40°C		—
	VISUAL EXAMINATION [1a]: IEC 60512		—
5.15	MECANICAL STRENGTH		P
5.15.1	No visual damage, no cracks on insulations parts likely to impair safety		P
5.15.2	Contacts safety retained		P
5.15.3	Internal insulation shall not show damage likely to impair safety		P
	No damage shall occur which could impair normal use		P
A9	WITHSTAND A WITHDRAWAL FORCE: IEC 60512 [13 b]		—
5.16	Connectors without locking device or without snap-in device shall withstand a withdrawal force of at least 50 N (in accordance with 6.3.13)		N/A
A10	CONNECTOR WITH LOCKING DEVICE: IEC 60512 [15f]		—
5.17	Connectors with locking device or with snap-in device shall withstand a load of at least 80N. Compliance shall be tested according to clause 6.3.14		P

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Clause	Requirement – Test	Result - Remark	Verdict
	VISUAL EXAMINATION IEC 60512/ Test [1a]		—
	No damage shall occur which could impair normal use		P
B	SERVICE LIFE TEST GROUP B (TABLE 7) Test sample:		—
B1	INITIAL MEASUREMENTS (CONTACT RESISTANCE): IEC 60512 / Test [2b]		—
	Reference value for subsequent measurement	See table B1	—
	Test current	1 A	—
B2	MECHANICAL OPERATIONS: IEC 60512 / Test [9a]		—
6.3.5	Operating cycles	50	—
	Insertion speed	0,01 m/s	—
	Rest	30 s	—
	VISUAL EXAMINATION: IEC 60512 / Test [1a]		—
5.11.1	No damage shall occur which could impair normal use		P
B3	FINAL MEASUREMENTS (CONTACT RESISTANCE): IEC 60512 / Test [2b]		—
	Test current	1 A	P
	$R_2 \leq 1,5 R_1$ or $R_2 \leq 5 \text{ m}\Omega + R_1$	See table B3	P
6.3.8b	DIELECTRIC STRENGTH: IEC 60512 / Test [4a]		—
	Mated specimen		—
	r.m.s. withstand voltage	6 kV	—
5.10	No breakdown or flashover between	Contact / Housing	P
B4	BENDING TEST: IEC 60309-1, 24.4 modified		—
6.3.6	Only non-rewireable connectors		—
	Rated current		—
	Rated voltage		—
	Wire cross section		—
	Mass: $> 0,75\text{mm}^2 / 20\text{N}$; $\leq 0,75\text{mm}^2 / 10\text{N}$		—
	Numbers of Bendings		—
	DURING THE TEST		—

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Clause	Requirement – Test	Result - Remark	Verdict
	No interruption of the test current		N/A
	AFTER THE TEST		—
	The cable support sleeve shall not be loosened from the body		N/A
	The insulation shall show no signs of abrasion or of wear and tear		N/A
	Broken strands shall not pierce the insulation		N/A
	VISUAL EXAMINATION: IEC 60512 / Test [1a]		—
5.11.2	No damage shall occur which could impair normal use		N/A
C	THERMAL TEST GROUP C (TABLE 8) Test sample:		—
C1	INITIAL MEASUREMENTS (CONTACT RESISTANCE): IEC 60512 / Test [2b]		—
	Reference value for subsequent measurement	See table C1	—
	Test current	1 A	—
C2	TEMPERATURE RISE TEST: IEC 60512 / Test [5A]		—
	Test conductor length	500mm $\pm$ 50mm	—
	Test conductor	See table C2	—
6.3.4	Mated specimen		—
	Test current	See table C2	—
	Ambient temperature – components	+90 °C according to H4 approval	—
	Upper limit temperature – components	+105 °C according to MC approval	—
5.13	The upper limiting temperature specified for the specimen shall not be exceeded	See table C2	F
C3	DRY HEAT: IEC 60512 / Test [11i]		—
	Mated specimen		P
	Test duration	1000 h	P
	Upper temperature limit	+120 °C	P
C4	VISUAL EXAMINATION: IEC 60512 / Test [1a]		—
	Sufficient contact pressure through insulation		P

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Clause	Requirement – Test	Result - Remark	Verdict
	No visual damage, no cracks on insulations parts likely to impair safety		P
	Internal insulation shall not show damage likely to impair safety		P
	FINAL MEASUREMENTS (CONTACT RESISTANCE): IEC 60512 / Test [2b]		—
	Test current	1 A	P
	$R_2 \leq 1,5 R_1$ or $R_2 \leq 5 \text{ m}\Omega + R_1$	See table C4	P
D	CLIMATIC TEST GROUP D (TABLE 9) Test sample:		—
D1	INITIAL MEASUREMENTS (CONTACT RESISTANCE): IEC 60512 / Test [2b]		—
	Reference value for subsequent measurement	See table D1	—
	Test current	1 A	—
D2	THERMAL CYCLE: IEC 60068-2-14, Test Nb		—
6.3.11	Mated specimen	See table D4	P
	Lower temperature limit	- 40 °C	—
	Upper temperature limit	+ 105 °C	—
	Number of cycles	200	—
	No damage shall occur which could impair normal use		P
D3	DAMP HEAT: IEC 61215 / Test 10.13		—
6.3.12	Test duration	1000 h	—
	Temperature	+85 °C	—
	Relative humidity	+85 %	—
	VISUAL EXAMINATION: IEC 60512 / Test [1a]		—
	No damage shall occur which could impair normal use		P
D4	DIELECTRIC STRENGTH: IEC 60512 / Test [4a]		—
	Mated specimen	See table D4	—
6.3.8 a)	Impulse withstand voltage	8 kV	—
6.3.8 b)	r.m.s. withstand voltage	6kV	—
5.10	No breakdown or flashover between	Contact / Housing	P

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Clause	Requirement – Test	Result - Remark	Verdict
D5	PROTECTION AGAINST CORROSION: IEC 60512 / Test [11g]		—
6.3.9 Test 1	Flowing mixed gas corrosion according to IEC 60512-11-7, test 11g Method 1 or alternatively Method 4 (Table 1 of IEC 60512-11-7)). Test duration shall be 4 days.		N/T
5.21.1	Metal parts shall be so designed that corrosion shall not impair safety with regard to electrical and mechanical characteristics.		N/T
	All current carrying parts shall be consisting of metal, so that during the normal function under the occurring conditions a sufficient mechanical strength, electrical conductivity and corrosion resistance is given.		N/T
5.21.2	Under wet ambient conditions all metal parts may not be in contact with each other which have a difference of their electrochemical potentials from > 350mV according to IEC 60943		N/T
6.3.9 Test 2 alternative	Sulfur dioxide test with general condensation of moisture according to ISO 6988 . Test duration shall be 24h (1 test cycle)		N/T
	VISUAL EXAMINATION: IEC 60512 / Test [1a]		—
	No damage shall occur which could impair normal use		P
D6	FINAL MEASUREMENT (CONTACT RESISTANCE): IEC 60512 / Test [2b]		—
	Test current	1 A	—
	$R_2 \leq 1,5 R_1$ or $R_2 \leq 5 \text{ m}\Omega + R_1$	See table D6	P
E	DEGREE OF PROTECTION TEST GROUP E (TABLE 10)		—
E1	PROTECTION AGAINST ELECTRIC SHOCK		—
6.3.3.1	Connectors are tested by the test finger by IEC 60529 with a test force of 10N. All lids and cover which are removed without a tool are disconnected.		N/T
5.4.1	Connectors shall be so designed, that after mounting, its live parts are not accessible by the IEC test finger in accordance with cl. 5 of IEC 60529 using a test force of 10N.		N/T

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Clause	Requirement – Test	Result - Remark	Verdict
5.4.2	Protection against electric shock shall be ensured also during insertion and withdrawal. This shall be proved by the IEC test finger in accordance with cl. 5 of IEC 60529 with a test force of 10N with consideration of clearances and creepage distances .		N/T
E2	DEGREE OF PROTECTION IP CODE: IEC 60529		—
6.3.3.2	IP-Degree of protection	IPX5 / IPX7 (1m ; 30 min) IPX7 was tested according to MC4 approval	—
	Mated samples		—
5.9	Maximum and minimum cross- section connected	2,5mm ² as worst case	—
	No ingress of dust :		N/T
	No ingress of water :	IPX5: Pass IPX7: Pass	P
E3	DIELECTRIC STRENGTH: IEC 60512 / Test [4a]		—
6.3.8b	Mated specimen		—
	r.m.s. withstand voltage	6kV	—
5.10	No breakdown or flashover between	IPX5: Pass IPX7: Pass	P
F	INSULATION MATERIAL GROUP F (TABLE 11)		—
F1	WEATHER RESISTANCE: ISO 4892-2 Method A		—
	Radiation		—
	Waveband		—
	Black standard temperature		—
	Relative humidity		—
	Cycle		—
	Test duration		—
	VISUAL EXAMINATION: IEC 60512 / Test [1a]		—
	No damage shall occur which could impair normal use		N/T

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Clause	Requirement – Test	Result - Remark	Verdict
F2	ELECTRICAL STRENGTH: IEC 60512 / Test [4a]		—
6.3.8b	r.m.s. withstand voltage		—
5.10	No breakdown or flashover between		N/T
F3	FLAMMABILITY RATING FOR POLYMERIC MATERIALS SERVING AS AN ENCLOSURE FOR LIVE PARTS		—
5.20.2a	Insulation materials serving as an enclosure have flammability rating of HB, V-2, V-1, V-0 acc. to IEC 6195-11-10		N/T
5.20.2c	Glow wire temperature during test acc. to IEC 61695-2-11		—
	No ignition of the material		N/T
F4	FLAMMABILITY RATING FOR PLOYMERIC MATERIALS SERVING TO SUPPORT LIVE PARTS		—
5.20.3a	Insulation materials serving as an enclosure have flammability rating of HB, V-2, V-1, V-0 acc. to IEC 6195-11-10		N/T
5.20.3c	Glow wire temperature during test acc. to IEC 61695-2-11		—
	No ignition of the material		N/T

A6.1-1	TABLE TENSILE FORCE: Covers mounted / contacts not connected						N/T
Identification	cable diameter Ø [mm]	Test mandrel Ø [mm]	Tensile force [N]	Permissible displacement [mm]	Measured displacement [mm]		—
Sample See below	Min.						
	Max.						
	Max.						
	Max.						

A6.2-1	TABLE CABLE ANCHORAGE TWIST TEST: Covers mounted / contacts not connected						N/T
Identification	cable diameter Ø [mm]	Test mandrel Ø [mm]	Torque [Nm]	Permissible angle [°]	Measured angle [°]		—
Sample See below	Min.						
	Max.						
	Max.						

0.1	TABLE: Characteristic features		
	Example	X	Please mark relevant line with "X"
	Kind of equipment	x	Connector
	Existence of an enclosure		Unenclosed connector
		x	Enclosed connector
	Design of the connector		Fixed connector
		x	Free connector
	Additional characteristics		Connector with protective earthing contact
		x	Connector without protective earthing contact
		x	Connector with cable clamb
			Connector without cable clamp
			Connectors (without breaking capacity) with protection against electric for hand back safety, when mated
			Connectors (without breaking capacity) with protection against electric for finger safety, when mated
			CBC with protection against electric shock for finger safety, both in mated and unmated condition
			Degree of protection of a connector
		x	Connector for class II equipment
		x	Connector with interlock
			Connector without interlock
		x	Non-rewireable connector
			Rewireable connector
	Pollution degree		1
			2
		x	3
			4
	Over voltage category		I
			II
		x	III
			IV
	Operating cycles		10
		x	50

0.1	TABLE: Characteristic features		
			100
			500
			1000
			2000
			5000
			According manufacturer's
	Bendings		10
			50
			100
			500
			1000
			2000
			5000
			20000
			According manufacturer's
	Upper temperature limit		70 °C
			85 °C
			100 °C
			125 °C
		x	105 °C According to MC4 Approval
	Lower temperature limit		-10 °C
			-25 °C
		x	-40 °C
			-55 °C
			0 °C
			According manufacturer's
	Type of conductor		Solid
		x	Flexible
	Termination and connection	x	Crimped connection according to IEC 60352-2
			Insulation displacement connection (accessible) according to IEC 60352-2
			Insulation displacement connection (non-accessible) according to IEC 60352-4

0.1	TABLE: Characteristic features		
			Press in connection according to 60352-5
			Insulation piercing connection according to IEC 60352-6 or IEC 60998-2-3
			Screwless-type clamping units according to IEC 60999-1 or IEC 60999-2
			Screw-type clamping units according to IEC 60999-1 or IEC 60999-2
			Flat, quick-connect terminations according to IEC 60760 and IEC 61210
			According manufacturer's
	Values for cable clamp	Cable diameter	Diameter range according to manufacturer
		≤ 4mm]	
		x [4–9 mm]	4,5mm to 7,8mm
		[9-12mm]	
		[12-20 mm]	
		[20-32 mm]	
		[33-42 mm]	
		≥ 42 mm]	
	Rated voltage(s)	1000V	
	Rated current	According to Helios 4 Approval : 32A/ta=90C, for 2,5mm² 40A/ta=90C, for 4,0mm² 44A/ta=90C, for 6,0mm² According to MC 4 Approval : 22,5A/ta=90C, for 2,5mm² 30A/ta=90C, for 4,0mm² 30A/ta=90C, for 6,0mm²	
	Rated impulse voltage(s)	8kV	
	Rated insulation voltage(s)	6000V	
	Number of poles	1	
	Protection degree (IP-Code)	IPX7 (1m ; 30 min) for MC4 IP68 (1m ; 60 min) for Helios H4	
	Mounting	Free connector	

0.1	TABLE: Characteristic features	
	Wire cross section area or cross section range	2,5mm ² ; 4,0mm ² and 6,0mm

0.2	TABLE: Clearance and Creepage distance			
Type / Shell-size / etc.:				
Rated voltage [V]				
Pollution degree				
Isolation material group				
Impulse withstand voltage [kV] ..:				
Test voltage [kV]				
Clearances required				
Clearances measured				
Creepage distances required				
Creepage distances measured ..:				

0.3.1	TABLE: IEC 60112 / Tracking test						
Specimen				Erosion depth [mm]			
Part	Material	Material-thickness [mm]	Colour	PTI Testsolution [A]	CTI	PTI Testsolution [B]	Result

0.3.2	TABLE: IEC 60695-2-10 / Glow-wire-test [30 s]								
Specimen				Flame					
Part	Material	Material-thickness [mm]	Colour	[°C]	Start [s]	End [s]	Height [mm]	Ignition of tissue paper	Result

Test Group B1: INITIAL MEASUREMENTS (CONTACT RESISTANCE):		
Sample no.:	Cross section [mm ²]	Contact resistance [mΩ]
1 AP(m) – MC(f)	2,5	0,851
2 AP(m) – MC(f)		0,872
3 AP(f) – MC(m)		0,892
4 AP(f) – MC(m)		0,908
5 AP(m) – MC(f)	4,0	0,583
6 AP(m) – MC(f)		0,578
7 AP(f) – MC(m)		0,645
8 AP(f) – MC(m)		0,641
9 AP(m) – MC(f)	6,0	0,428
10 AP(m) – MC(f)		0,438
11 AP(f) – MC(m)		0,488
12 AP(f) – MC(m)		0,492

Test Group B3: FINAL MEASUREMENTS (CONTACT RESISTANCE):		
Sample no.:	Cross section [mm ²]	Contact resistance [mΩ]
1 AP(m) – MC(f)	2,5	0,883
2 AP(m) – MC(f)		0,889
3 AP(f) – MC(m)		0,948
4 AP(f) – MC(m)		0,935
5 AP(m) – MC(f)	4,0	0,596
6 AP(m) – MC(f)		0,607
7 AP(f) – MC(m)		0,657
8 AP(f) – MC(m)		0,674
9 AP(m) – MC(f)	6,0	0,425
10 AP(m) – MC(f)		0,438
11 AP(f) – MC(m)		0,489
12 AP(f) – MC(m)		0,487

Test Group C1: INITIAL MEASUREMENTS (CONTACT RESISTANCE):		
Sample no.:	Cross section [mm ²]	Contact resistance [mΩ]
13 AP(m) – MC(f)	2,5	0,890
14 AP(m) – MC(f)		0,819
15 AP(f) – MC(m)		0,892
16 AP(f) – MC(m)		0,861
17 AP(m) – MC(f)	4,0	0,558
18 AP(m) – MC(f)		0,581
19 AP(f) – MC(m)		0,640
20 AP(f) – MC(m)		0,630

Test Group C4: FINAL MEASUREMENTS (CONTACT RESISTANCE):		
Sample no.:	Cross section [mm ²]	Contact resistance [mΩ]
13 AP(m) – MC(f)	2,5	1,05
14 AP(m) – MC(f)		0,86
15 AP(f) – MC(m)		1,10
16 AP(f) – MC(m)		1,04
17 AP(m) – MC(f)	4,0	0,68
18 AP(m) – MC(f)		0,70
19 AP(f) – MC(m)		0,83
20 AP(f) – MC(m)		0,71

Heating measurement C3 was repeated without retesting contact resistance and dry heat.

Test Group C2: TEMPERATURE RISE TEST				
Sample no.:	Cross section [mm ²]	Test current [A]	Upper temperature limit [°C]	Temperature at contact [°C]
1a AP(f) – MC(m)	2,5	22,0	105° for MC 4	96,0
1b AP(m) – MC(f)	2,5	22,0	105° for MC 4	95,6
2a AP(f) – MC(m)	4,0	30,0	105° for MC 4	110,3
2b AP(m) – MC(f)	4,0	30,0	105° for MC 4	108,0

Test Group D1: INITIAL MEASUREMENTS (CONTACT RESISTANCE):		
Sample no.:	Cross section [mm ²]	Contact resistance [mΩ]
25 AP(m) – MC(f)	2,5	0,862
26 AP(m) – MC(f)		0,897
27 AP(f) – MC(m)		0,877
28 AP(f) – MC(m)		0,918
29 AP(m) – MC(f)	4,0	0,592
30 AP(m) – MC(f)		0,582
31 AP(f) – MC(m)		0,656
32 AP(f) – MC(m)		0,617

Test Group D6: FINAL MEASUREMENTS (CONTACT RESISTANCE):		
Sample no.:	Cross section [mm ²]	Contact resistance [mΩ]
25 AP(m) – MC(f)	2,5	1,70
26 AP(m) – MC(f)		1,45
27 AP(f) – MC(m)		1,09
28 AP(f) – MC(m)		1,60
29 AP(m) – MC(f)	4,0	1,22
30 AP(m) – MC(f)		0,73
31 AP(f) – MC(m)		0,79
32 AP(f) – MC(m)		1,20