

# MHF<sup>®</sup> 4 / 4L Connector

Part No. MHF 4L Plug:20632-001R-37 MHF 4 Receptacle:20449-001E-\*\*

## Product Specification

Qualification Test Report No. TR-14100

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4	S22218	June 1, 2022	Y. Imaji	K. Yufu	Y. Hashimoto
3	S21513	October 26, 2021	K. Ikeshita		M. Takemoto
2	S18305	May 22, 2018	M. Abe	K. Shinozaki	T. Matsumoto
Rev.	ECN	Date	Prepared by	Checked by	Approved by

**1. Scope**

This specification covers the requirements for product performance and test methods of MHF4 / 4L Connector.  
Test method is complied with "PCI Express M.2 Electromechanical Specification DRAFT Revision 1.0".

**2. Product Name and Parts No.****2.1 Product Name**

MHF 4 / 4L connector

**2.2 Parts No.**

MHF 4L Plug: 20632-001R-37

MHF 4 Receptacle: 20449-001E-\*\*

**3. Rating****3.1 Applicable Cable**

## (1) Description

Inner conductor: AWG#30(7/0.102)

Silver plating annealed copper wire

Dielectric core: Fluoro-plastics, diameter 0.88(+0.04,-0.02)mm , nominal thickness 0.29mm

Outer conductor: 16/5/0.05 , nominal diameter 1.13mm , silver plating annealed copper wire or tin-copper alloy

Jacket: Fluoro-plastics , diameter 1.37(±0.08)mm , nominal thickness 0.12mm

## (2) Requirements

Characteristic impedance :  $50 \pm 2\Omega$  by TDR method

Nominal capacitance (Reference value): 98 pF/m

Conductor resistance of inner conductor at 293K (20°C)(Reference value) : 320Ω/km

Insulation resistance : 1,500MΩ·km MIN.

Dielectric withstanding voltage: no breakdown at AC 1500V for 1 minutes.

**3.2 Operating Conditions**

Rated voltage	AC60Vr.m.s
Nominal characteristic impedance	50 ohm.
Frequency	DC~12GHz
VSWR	Plug: 1.30 MAX. (0.1~3HGz), 1.40 MAX. (3~6GHz) 1.50MAX. (6~9GHz), 1.60MAX. (9~12GHz) Receptacle : 1.30 MAX. (0.1~3HGz), 1.40 MAX. (3~6GHz), 1.55MAX. (6~9GHz)
Service temperature	233K~363K (-40°C~90°C)

**3.3 Storage Conditions**

Storage temperature: 248 to 333K(-25°C to 60°C)

Storage humidity: 85% max. (Non-condensing)

**4. Test and Performance****Test Condition**

Unless otherwise specified, all tests and measurements shall be performed under the following conditions in accordance with MIL-STD-202.

Temperature: 288K to 308K(15°C to 35°C)

Pressure: 866hPa to 1066hPa(650mmHg to 800mmHg)

Relative humidity: 45 to 75% R.H.

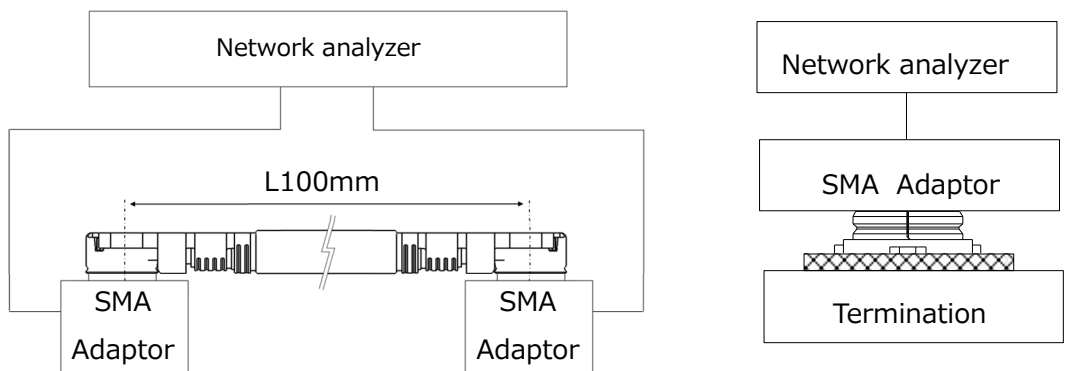
4.1. Electrical Performance

1. Contact resistance	
Reference standard:	MIL-STD-202-307
Test conditions:	Solder the receptacle connector to the test board and mate the plug connector together, then measure the contact resistance as shown in Fig.1 by the four terminal methods. Apply the low level condition of 20mV MAX. DC for the open circuit voltage and 10mA MAX. DC for the closed circuit current.
<p>Fig. 1 Contact resistance</p>	
Pass criteria:	<p>Contact Initial: 20 mΩ MAX. After testing: <math>\triangleleft</math>R20 mΩ MAX.</p> <p>Ground contact Initial: 20 mΩ MAX. After testing: <math>\triangleleft</math>R20 mΩ MAX.</p>

2. Insulation resistance	
Reference standard:	MIL-STD-202-302
Test conditions:	Mate the plug and receptacle connector together, and then apply DC 100 V between the inner contact and the ground contact.
Pass criteria:	Initial: 500 MΩ MIN. After testing: 100 MΩ MIN.

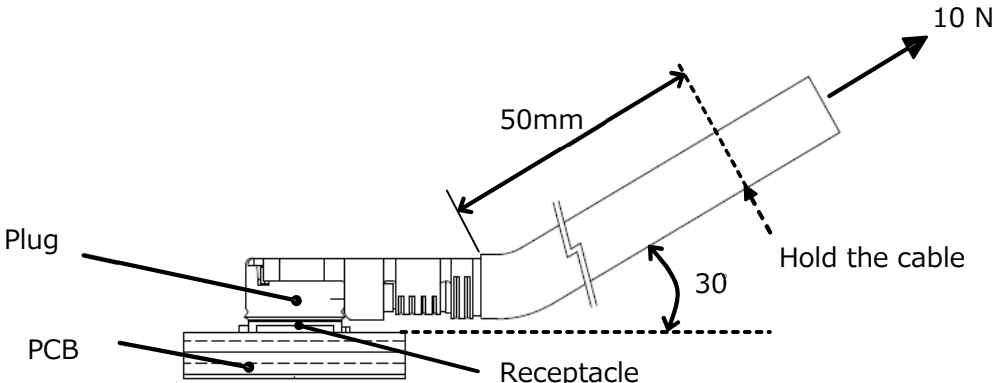
3. Dielectric withstanding voltage	
Reference standard:	MIL-STD-202-301
Test conditions:	Mate the receptacle and plug connector together, then apply AC 200V(rms) between the neighboring contacts for a minute.
Pass criteria:	No creeping discharge, flashover, no insulator breakdown shall occur.

4.1. Electrical Performance

4.VSWR	
Reference standard:	-
Test conditions:	Measure the VSWR as shown in Fig. 2 by the network analyzer. Frequency : 0.1GHz ~ 12GHz
	
<b>Fig. 2 VSWR</b>	
Pass criteria:	PLUG: 1.30 MAX. at 0.1~3GHz, 1.40 MAX. at 3~6GHz 1.50 MAX. at 6~9GHz, 1.60 MAX. at 9~12GHz RECEPTACLE: 1.30 MAX. at 0.1~3GHz, 1.40 MAX. at 3~6GHz, 1.55 MAX. at 6~9GHz

4.2. Mechanical Performance

1. Mating force and Un-mating force	
Reference standard:	-
Test conditions:	Solder the receptacle connector to the test board, then place the board and plug on push-on/pull-off machine, measure of initial and mating/unmating 30 cycles at a speed 25±3mm/min. along the mating axis.
Pass criteria:	Mating force Initial: 30 N MAX. 30cycles: 30 N MAX. Unmating force Initial: 20 N MAX., 5 N MIN. 30cycles: 20 N MAX., 3 N MIN..

2. Cable retention force at 30 degree	
Reference standard:	-
Test conditions:	Mate plug with receptacle and tilt cable by 30 degree and pull the cable by 10N force with 10 cycles toward arrowhead direction. (Fig. 3)
	
<b>Fig. 3 Cable retention force at 30 degree</b>	
Pass criteria:	Appearance : No abnormality adversely affecting the performance shall occur Electrical discontinuity: No electrical discontinuity greater than 1µs.

4.2. Mechanical Performance

3. Cable retention force at 0 degree	
Reference standard:	-
Test conditions:	Mate Plug with Receptacle and pull the $\phi 1.37$ cable by 20N force toward horizontal direction.
Fig. 4 Cable retention force at 0 degree	
Pass criteria:	Appearance : No abnormality adversely affecting the performance shall occur Electrical discontinuity: No electrical discontinuity greater than 1 $\mu$ s.

4. Durability	
Reference standard:	-
Test conditions:	Solder the receptacle connector to the test board, then place the board and plug on the push-on/pull-off machine, and repeat mating and un-mating 30 cycles at a speed 25 $\pm$ 3mm/min. along the mating axis.
Pass criteria:	Appearance : No abnormality adversely affecting the performance shall occur Contact Resistance: Shall meet 4.1.1.

5. Receptacle shearing strength	
Reference standard:	-
Test conditions:	Solder the receptacle connector to the test board, push the receptacle connector from each directions as Shown in Fig. 5. Measure the strength when the connector is broken.
Fig. 5 Receptacle shearing strength	
Pass criteria:	Shearing strength: 20 N MIN.

**4.2. Mechanical Performance**

6. Vibration	
Reference standard:	MIL-STD-202-201.
Test conditions:	Apply the following vibration to the mating connector. During the testing, run 100mA DC to check electrical discontinuity. Frequency: 10Hz → 100Hz → 10Hz / approx 15minutes. Half amplitude, Peak value of acceleration: 1.5mm or 59m/s <sup>2</sup> (6G) Directions , cycle: 3 mutually perpendicular direction, 5 cycles (approx 75minutes.) for each direction.
Pass criteria:	Contact resistance: Shall meet 4.1.1. Electrical discontinuity: No electrical discontinuity greater than 1μs shall occur. Appearance : No abnormality adversely affecting the performance shall occur

7. Shock	
Reference standard:	MIL-STD-202-213.
Test conditions:	Apply the following shock to the mating connector. During the testing, run 100mA DC to check electrical discontinuity. MAX.G: 735m/s <sup>2</sup> (75G) Directions: 6 mutually perpendicular direction Duration: 11msec Cycle: 3 cycles about each direction Wave Form: Half Sinusoidal
Pass criteria:	Contact resistance: Shall meet 4.1.1. Electrical discontinuity: No electrical discontinuity greater than 1μs shall occur. Appearance : No abnormality adversely affecting the performance shall occur

**4.3. Environmental Performance**

1. Thermal shock	
Reference standard:	MIL-STD-202, Method 107, Condition A.
Test conditions:	Solder the receptacle connector to the test board, then mate plug connector, and expose them to the following environment. Temperature: 218K(-55°C),30min. → 358K(85°C),30min. Transition time: 5min. MAX. No. of cycles: 5 cycles
Pass criteria:	Contact resistance: Shall meet 4.1.1. Insulation resistance: Shall meet 4.1.2. Dielectric withstanding voltage: Shall meet 4.1.3. Appearance : No abnormality adversely affecting the performance shall occur

2. High temperature life	
Reference standard:	MIL-STD-202-108
Test conditions:	Solder the receptacle connector to the test board, then mate plug connector, and expose them to the following environment. Temperature: 363±2K (90±2°C) Duration: 96 hours
Pass criteria:	Contact resistance: Shall meet 4.1.1. Appearance : No abnormality adversely affecting the performance shall occur

**4.3. Environmental Performance****3. Humidity(Steady state)**

Reference standard: MIL-STD-202-103, Condition A.

Test conditions: Solder the receptacle connector to the test board, then mate plug connector, and expose them to the following environment.  
 Temperature:  $313\pm 2\text{K}$  ( $40\pm 2^\circ\text{C}$ )  
 Humidity: 90~95%RH  
 Duration: 96 hours

Pass criteria: Contact resistance: Shall meet 4.1.1.  
 Insulation resistance: Shall meet 4.1.2.  
 Dielectric withstanding voltage: Shall meet 4.1.3.  
 Appearance : No abnormality adversely affecting the performance shall occur

**4. Salt water spray**

Reference standard: MIL-STD-202-101, Condition B

Test conditions: Solder the receptacle connector to the test board, then mate plug connector, and expose them to the following environment.  
 Temperature:  $308\pm 2\text{K}$  ( $35\pm 2^\circ\text{C}$ )  
 Salt water density:  $5\pm 1\%$  [by weight]  
 Duration: 48 hours

Pass criteria: Contact resistance: Shall meet 4.1.1.  
 Appearance : No abnormality adversely affecting the performance shall occur adversely affecting the performance shall occur.

**5. H<sub>2</sub>S gas**

Reference standard: -

Test conditions: Solder the receptacle connector to the test board, then mate plug connector, and expose them to the following environment.  
 Temperature:  $313\pm 2\text{K}$  ( $40\pm 2^\circ\text{C}$ )  
 Relative humidity:  $80\pm 5\%$ RH  
 Gas: H<sub>2</sub>S  $3\pm 1$ ppm  
 Duration: 48 hours

Pass criteria: Contact resistance: Shall meet 4.1.1.  
 Appearance : No abnormality adversely affecting the performance shall occur adversely affecting the performance shall occur.

4.4.Others

1. Solder ability	
Reference standard:	MIL-STD-202-208
Test conditions:	Dip the solder tine of the contact in the solder bath at $518 \pm 5K$ ( $245 \pm 5^{\circ}C$ ) for $5 \pm 0.5$ seconds after immersing the tine in the flux of RMA or R type for 5 to 10 seconds.
Pass criteria:	The surface of the dipped contact must become 95% wet and the non-wetted pinholes must not accumulate in one area but be distributed and must be less than 5% of the contact area to be soldered.

2. Soldering heat resistance	
Reference standard:	-
Test conditions:	Reflow temperature profile as shown in Fig. 6. The number of times of reflow is within 2.
<p>The graph shows a reflow temperature profile. The y-axis represents temperature in Kelvin (K) and the x-axis represents time in seconds (sec). The profile consists of several stages: a ramp up to a plateau at <math>423 \sim 473 K</math> (<math>150 \sim 200^{\circ}C</math>) for a duration of <math>60 \sim 120</math> seconds; a second ramp up to a peak at <math>533 K</math>; a dwell at the peak for <math>30</math> seconds; a ramp down; a secondary peak at <math>528 K</math>; and a final ramp down. Dashed horizontal lines indicate the temperature levels for each stage.</p>	
<p><u>Fig. 6 Reflow Temperature Profile</u></p>	
Pass criteria:	No abnormality adversely affecting the performance shall not occur.



4.5 Test Sequence and Specimen Quantity

Table 1 Test Sequence and Sample Quantity

Test Item	Group																
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	
Contact resistance						1,3		1,3	1,3	1,5	1,3	1,3	1,3	1,3			
Insulation resistance										2,6		2,6					
Dielectric withstanding voltage	1									3,7		3,7					
VSWR		1															
Mating force / Unmating force			1														
Cable retention force at 30 degree				1													
Cable retention force at 0 degree					1												
Durability						2											
Receptacle shearing strength							1										
Vibration								2									
Shock									2								
Thermal shock										4							
High temperature life											2						
Humidity (Steady state)												4					
Salt water spray													2				
H <sub>2</sub> S gas														2			
Solder ability																1	
Soldering heat resistance																	1
Specimen quantity. (pcs.)	Plug	10	10	10	10	10	10	-	10	10	10	10	10	10	10	-	-
	Receptacle		5					12								10	10

※Numbers indicate sequence in which tests are performed.

5. Recommended Metal Mask

Refer to drawing for the recommended metal mask thickness and opening dimension.