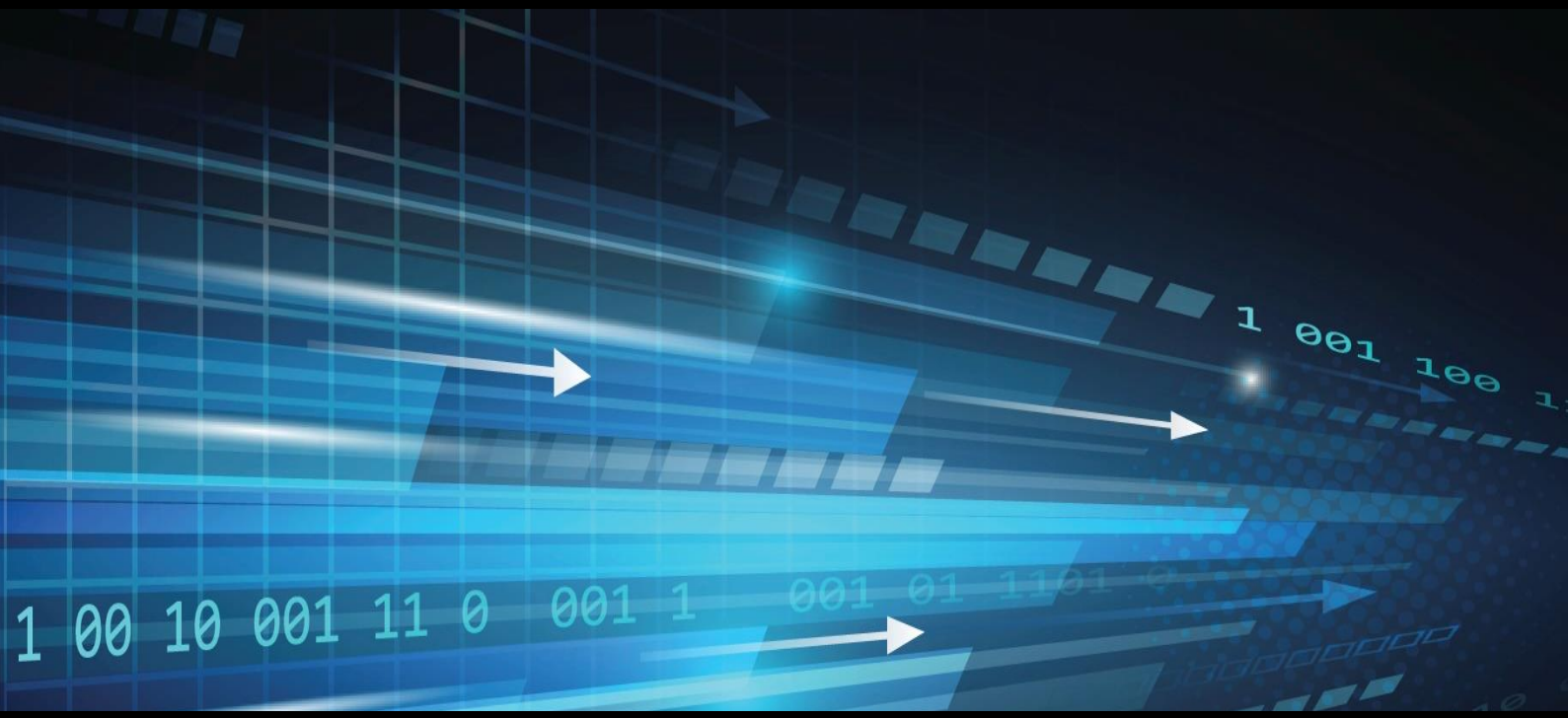
NICOMATIC

CREATIVE INTERCONNECT SOLUTIONS

HF Contacts Characterisation

QTR17015.a



HIGH SPEED

APPLICATIONS

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1 Conclusion

The CMM connectors with HF contacts are characterized in this report in Frequency domain (S parameters). The Frequency range of connectors is depending on requirement, in dB, of Insertion Loss, Return Loss and Crosstalk.
There is no difference between performance on a CMM and a DMM.
The combination of 2 kind of connector (straight vs 90°) will have the performance of the worst of two.

2 Technical Features Proposal

There is 2 ways to use the data of this report:
1 – If a customer wants to know what is the performance of a connector at a specific frequency, we should give him Insertion Loss, Return Loss and Crosstalk performance (in dB).

2 – If a customer wants to know if a connector could be used at a specific frequency, the Insertion Loss, Return Loss and Crosstalk performances have to be required from the customer.

3 Connate Reports

NICOMATIC CMM LF SERIES and DMM HF SERIES MEAUREMENT REPORT.pdf

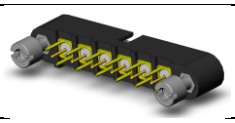
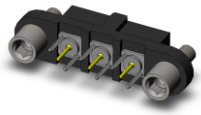
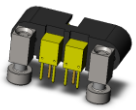
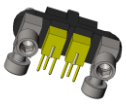
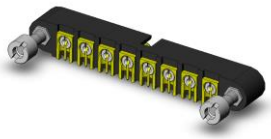
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Test Operator(s)	**A.JAGHMIM**	**Test & Measurement Manager**	**22/11/17**	**AJ**
Checked by	**F.MOREL**	**Smart Co Manager**	**22/11/17**	**FM**
Approved by	**A.ZANCHETTA**	**R&D Director**	**22/11/17**	**AZ**
Requested by	**A.VULLIEZ**	**R&D Manager**	**22/11/17**	**AV**

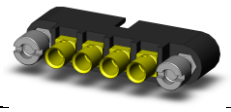
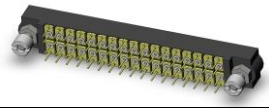
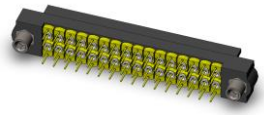
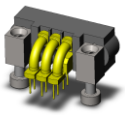
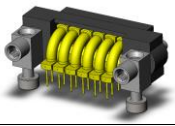
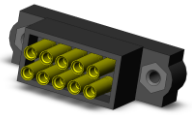
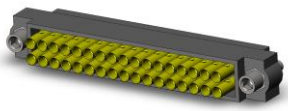
4 Information about the tests

4.1 Object

The object of those tests is to characterise our connector with HF contacts in frequency, in order to analyse the influence of our connectors in a 50 Ohms transmission line.

4.2 Tested Products

Designation	Article Reference	Drawing	Batch / DI	Quantity
Connector CMM220 M straight on PCB 04 cav. F22	221D00F22-0004-1300CMM		DI6664	3
Connector CMM220 F straight on PCB 04 cav. M16	222D00M16-0004-2300CMM		DI6665	3
Connector CMM220 M 90° on PCB 04 cav. F26	221D00F26-0004-1400CMM		DI6671	3
Connector CMM220 F 90° on PCB 04 cav. M21	222D00M21-0004-2400CMM		DI6672	3
Connector CMM220 M straight SMT 04 cav. F24	221D00F24-0004-1600		DI6673	3
Connector CMM220 F straight SMT 04 cavities M16	222D00M16-0004-2600		DI6674	3
Connector CMM220 M 90° SMT 04 cav. F27	221D00F27-0004-1500CMM		DI6675	3
Connector CMM220 M on cables 04 cav. F22 (HFE100D)	221E00F22-0004-1324SS			
Connector CMM220 F on cables 04 cav. M16 (HFE100D)	222E00M16-0004-2324SS			

Connector CMM220 M on cables 04 cav. F22 (UT-047)	221E00F22-0004-1347ZZ			
Connector CMM220 F on cables 04 cav. M16 (UT-047)	222E00M16-0004-2347ZZ			
Connector CMM220 F on cables 04 cav. M16 (HFE100D)	222E00M16-0004-2424ZS			
Connector CMM340 M straight on PCB 08 cavities F42	341D000F42-0008-130012			
Connector CMM340 F straight on PCB 8 alv. H01	342D000H01-0008-230012			
Connector CMM340 M 90° on PCB 08 cav F51	341D000F51-0008-140002			
Connector CMM340 F 90° on PCB 8cav. H08	342D000H08-0008-240002			
Connector CMM340 M crimp 08 cav. F41 (RG-178)	341E000F41-0008-1320ZZ			
Connector CMM340 F crimp 08 cav. H01 (RG-178)	342E000H01-0008-2320ZZ			

4.3 Persons present during the tests

Name	Duty
Su-Wei CHANG	Director TMYtek

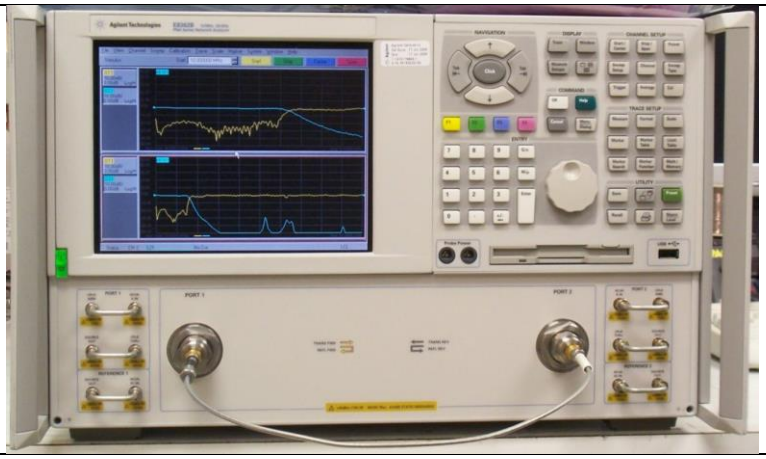
4.4 Date and place of the tests

Tests are done by TMYtek Lab. from 01/01/15 to 27/12/15

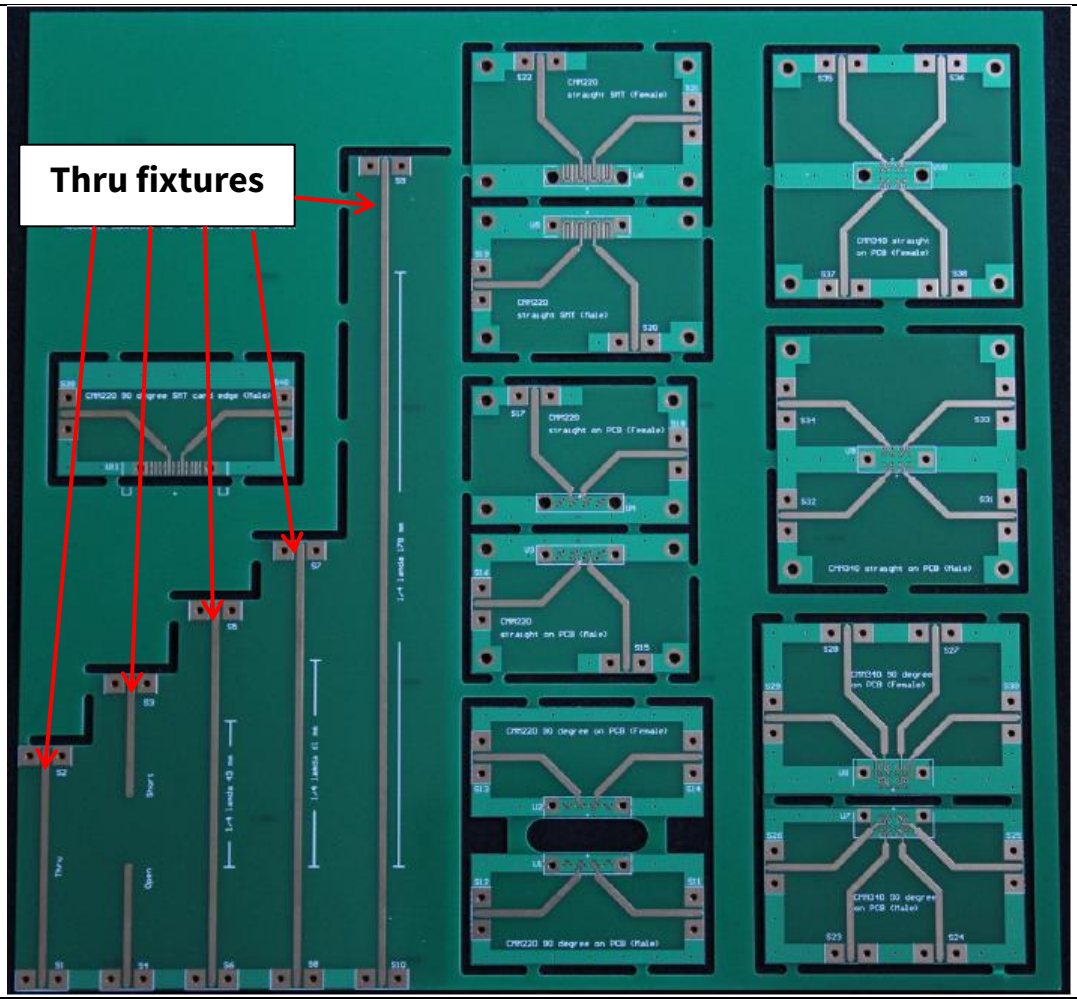
4.5 Environmental conditions

Ambient temperature: ambient
Pressure: ambient
Humidity: ambient

4.6 Test Equipment

Designation
Agilent E8363B PNA Network Analyzer, 10 MHz to 40 GHz

The equipment chosen to perform the entire measurement for the completion of this report is Agilent E8363B PNA Network Analyzer. This network analyzer is capable of performing the s-parameter test for frequency range of 10kHz to 400 GHz, which is sufficient for the needs of the tested HF series.

Designation
Keysight E5071C ENA Network Analyzer, 300kHz to 20 GHz



In order to measure the PCB-type connectors, the 50-Ω transmission line has been designed with the suggested layout of each connector. Thru-Reflection-Line (TRL) calibration method has been implemented in order to move the measured reference plan right at the connectors. The TRL calibration kit has been designed to cover the frequency range from 60 MHz to 26 GHz. All the circuits and calibration kit are manufactured by using FR-4 laminate with Au-plating.

Calibration technology: SOLT calibration, TRL calibration
Impedance: 50Ω
PCB laminate: FR-4
RF connector (CMM): 2.9 mm End-launch connector (up to 40 GHz)
Measured parameters: S-parameter
Specification of HF: HF30 series – 6 GHz
HF22 series – 1.5 GHz

5 Test description

5.1 PCB Verification

In order to measure the PCB-type connectors, the 50-Ω transmission line has been designed with the suggested layout of each connector. Thru-Reflection-Line (TRL) calibration method has been implemented in order to move the measured reference plan right at the connectors. The TRL calibration kit has been designed to cover the frequency range from 60 MHz to 26 GHz. All the circuits and calibration kit are manufactured by using FR-4 laminate with Au-plating.

5.2 High frequency coaxial cable specification and measurement

In order to find the highest frequency of the HF series connector, the higher frequency performance of RF coaxial cables have been considered for this measurement. For HF30, HFE100D and UT-047 have been used which are flexible and semi-rigid cable respectively. The two cables are provided by Micro-Coax, PA, USA. For HF22, RG-178 has been used which is suggested by Nicomatic. The performances of HFE100D and UT-047 have been verified by third party organization.

HFE100D

The frequency performance of HFE100D is up to 26.5 GHz. The verification has been performed up to 40 GHz by third party.

Table of specification – HFE100D

Micro-Coax Description		HFE100D
Dimensions	Units	
Cable Diameter	inch	0.100 ± 0.004
	millimeter	2.540 ± 0.102
Outer Shield Diameter	inch	0.082 ± 0.003
	millimeter	2.083 ± 0.076
Dielectric Diameter	inch	0.066 ± 0.002
	millimeter	1.676 ± 0.051
Center Conductor Diameter	inch	0.0201 ± 0.0005
	millimeter	0.5105 ± 0.0127
Length (Minimum)	feet	25
	meter	7.6
Electrical Characteristics		
Characteristic Impedance	ohm	50
Capacitance	pF/ft	29
	pF/m	95
Velocity of Propagation	%	70
Shielding Effectiveness	dB	> 90
Maximum Voltage	VRMS @ 60 Hz	1500
Signal Delay	ns/ft	1.45
	ns/m	4.76
Frequency Range	GHz	DC - 26.5
Attenuation (dB/100 ft, Typical)	0.5 GHz	13.4
	1.0 GHz	19.2
	5.0 GHz	45.2
	10.0 GHz	66.4
	18.0 GHz	92.9
	26.5 GHz	116.7

UT-047

The frequency performance of UT-047 is up to 90 GHz. The verification has been performed up to 40 GHz by third party.

Table of specification –UT-047

Micro-Coax Description		UT-047
MIL-DTL-17 Description		UT-047-M17
MIL-DTL-17 Part Number		M17/151-00001
DIMENSIONS	Units	
Outer Conductor Diameter	inch	0.047 ± 0.001
	millimeter	1.194 ± 0.025
Dielectric Diameter	inch	0.037 ± 0.001
	millimeter	0.940 ± 0.025
Center Conductor Diameter	inch	0.0113 ± 0.0005
	millimeter	0.2870 ± 0.0127
Straight Length (Maximum)	feet	20
	meter	6.10
Coiled Length (Maximum)[1]	feet	50
	meter	15.24
ELECTRICAL CHARACTERISTICS		
Characteristic Impedance	ohm	50.0 ± 1.5
Capacitance	pF/ft	29.0
	pF/m	95.2
Velocity of Propagation	%	70
Corona Extinction Voltage	VRMS @ 60 Hz	1000
Voltage Withstanding	VRMS @ 60 Hz	3000
Higher Order Mode Frequency	GHz	109
Attenuation (dB/100 ft, Typical)	0.5 GHz	24.0
	1.0 GHz	34.2
	5.0 GHz	78.8
	10.0 GHz	113.8
	18.0 GHz	156.5
	26.5 GHz	193.8
	40.0 GHz	244.2
	50.0 GHz	277.5
	65.0 GHz	323.0
	90.0 GHz	391.3

RG-178

The frequency performance of RG-178 is up to 6 GHz



Conductor
Material
Silver-Coated Copper Clad Steel

Construction
30AWG
(7/0.102 mm)

Diameter
0.31 mm

Insulation
Material
FEP

Average Thickness
0.28 mm

Color
Clear

Diameter
0.86 ± 0.03 mm

Shield
Material
Silver-Coated Copper

Construction
16 / 3 / 0.092 mm

Coverage
91.8 %

Jacket
Material
FEP

Average Thickness
0.25 mm

Color
Brown

Diameter
1.80 ± 0.05 mm

Electrical Characteristics

Description	Specification
Impedance	50 ± 5 Ω
Conductor Resistance	828 Ω/km 20°C Max.
Insulation Resistance	3000 MΩ/km Min.
Capacitance	95.8 pF/M
Dielectric Strength	AC 1.0 KV/Minute
Spark Test	2.0 KV
Nom. Vel. of Prop.	69.5 %
VSWR (0 ~6 GHz)	1.3 Max.

Physical Characteristics

Description		Specification	
Item		RG-178 (30AWG)	
Rating Temp Voltage		-55°C ~ +200°C 30V	
Thermal Shock		Max 1 mm at 232°C/1HR	
Minimum Bend Radius		9.0 mm	
Insulation	Unaged	Tensile Strength	2500 PSI Min. (1.76 Kg / mm²)
		Elongation	200% Min.
	Aged	Tensile Strength	Unaged Min.75% (168HRS×232°C)
		Elongation	Unaged Min.75% (168HRS×232°C)
Jacket	Unaged	Tensile Strength	2500 PSI Min. (1.76 Kg / mm²)
		Elongation	200% Min.
	Aged	Tensile Strength	Unaged Min.75% (168HRS×232°C)
		Elongation	Unaged Min.75% (168HRS×232°C)

Attenuation

Attenuation	1 GHz	1.8 GHz	2.4 GHz	5.2 GHz	6 GHz
dB/1m	1.8	2.6	2.9	4.5	4.9
dB/1ft	0.55	0.8	0.89	1.38	1.5

5.3 Definition

S parameters:

Linear two-port (and multi-port) networks are characterized by a number of equivalent circuit parameters, such as their transfer matrix, impedance matrix, admittance matrix, and scattering matrix. Figure 1 shows a typical two-port network.

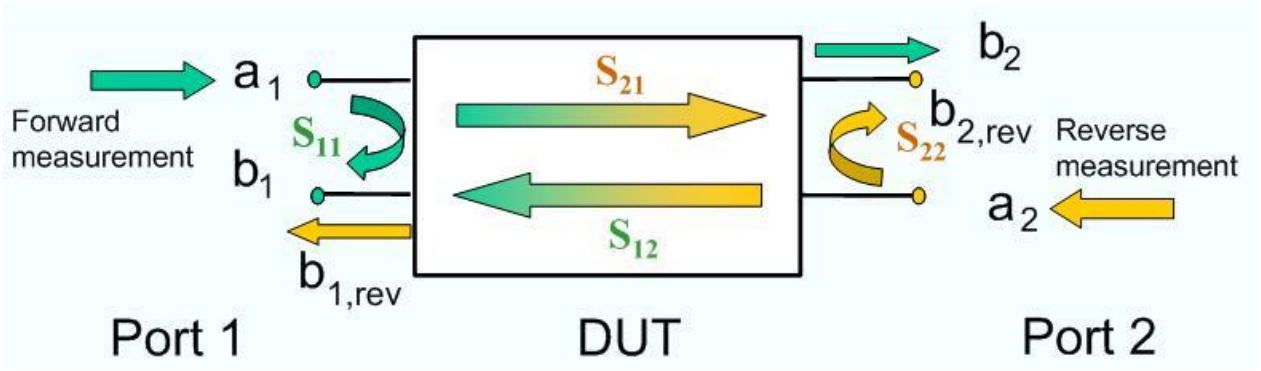


Figure 1 : Two-port network (DUT = Device Under Test)

Insertion loss (S21):

Insertion Loss or Attenuation is the degree of signal amplitude decrease (or loss), measured in Decibels. Electrical signals transmitted by a link lose some of their energy as they travel along the link. Insertion loss measures the amount of energy that is lost as the signal arrives at the receiving end of the cabling link. The insertion loss measurement quantifies the effect of the resistance the cabling link offers to the transmission of the electrical signals.

It is the extra loss produced by the introduction of the device under test (DUT) between the 2 reference planes of the measurement. Notice that the extra loss can be introduced by intrinsic loss in the DUT and/or mismatch.

It is thus given by:

$$IL = -20\log_{10}|S_{21}| \text{ dB.}$$

Return Loss: Return loss is the loss of power in the signal returned/reflected by a discontinuity in a transmission line. Return Loss measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair.

- **Input return loss (S11):**

Input return loss (RLin) can be thought of as a measure of how close the actual input impedance of the network is to the nominal system impedance value. Input return loss expressed in decibels is given by:

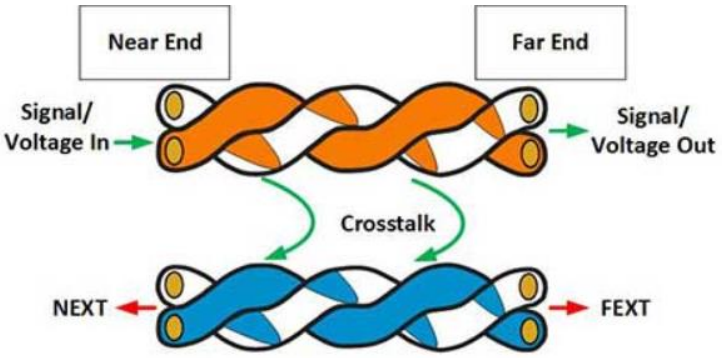
$$RL_{\text{in}} = 10\log_{10}\left|\frac{1}{S_{11}^2}\right| = -20\log_{10}|S_{11}| \text{ dB.}$$

- **Output return loss (S22):**

The output return loss (RLout) has a similar definition to the input return loss but applies to the output port (port 2) instead of the input port. It is given by:

$$RL_{\text{out}} = -20\log_{10}|S_{22}| \text{ dB.}$$

Crosstalk: Crosstalk is defined as the unwanted induction of signal from one circuit to another.



5.4 Measurement of Thru fixtures



Figure 2 – Thru fixture with 2.9 mm end-launch connectormounted

According to the measurement result, the 50-Ω transmission line for this type of configuration could be used up to 20 GHz (Figure 3).

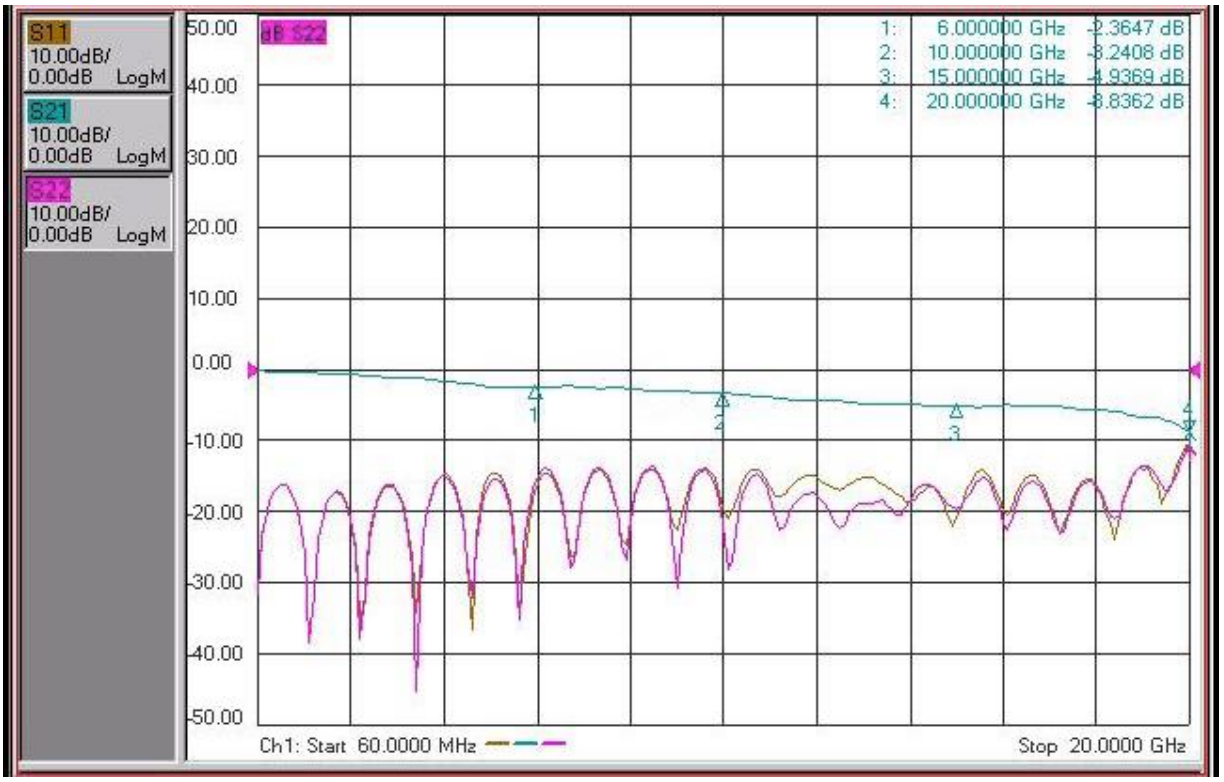


Figure 3 - S-parameter measurement result

5.5 Measurement Result of HFE100D

This cable could be used up to 40 GHz according to the measurement results.

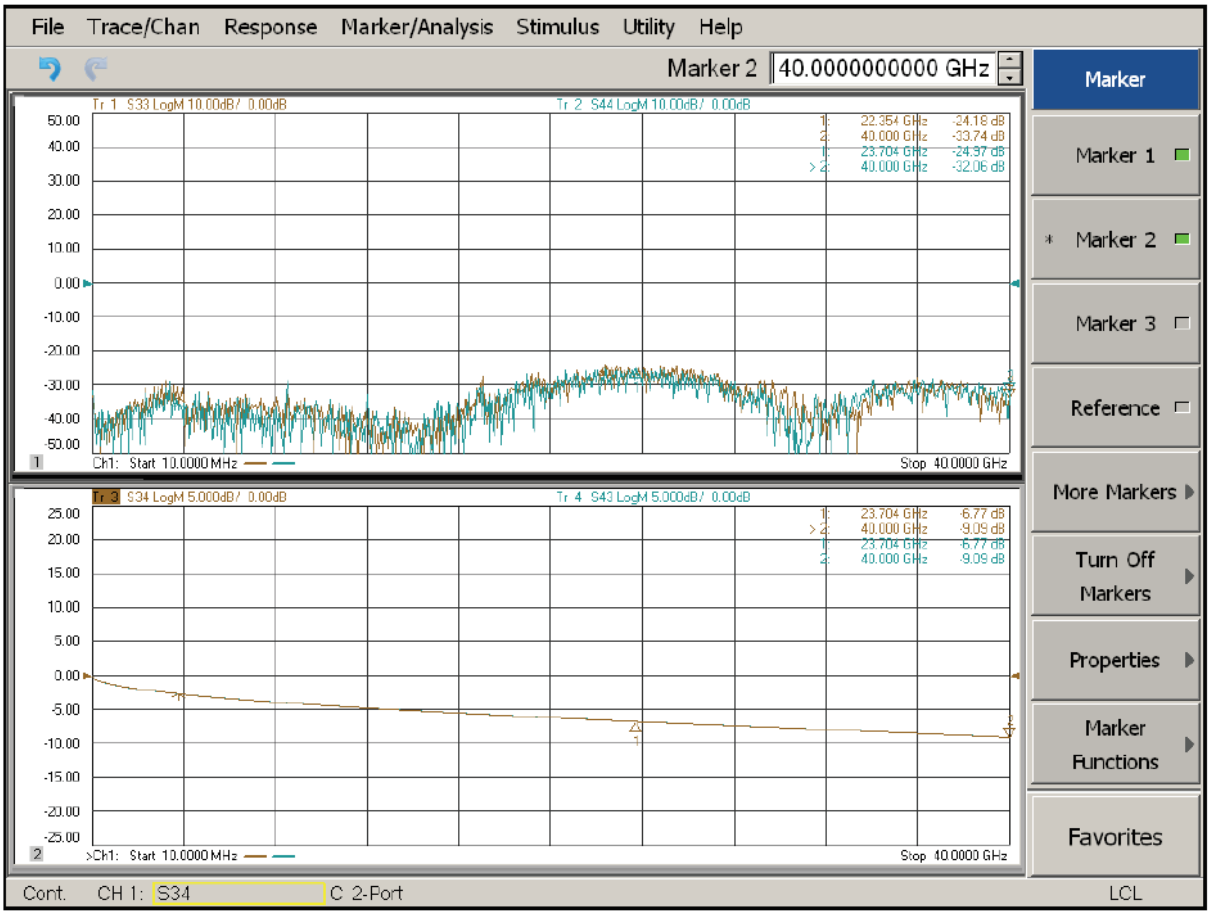


Figure 4 – HFE100D measurement results

5.6 Measurement Result of UT-047

This cable could be used up to 40 GHz with low loss according to the measurement results.

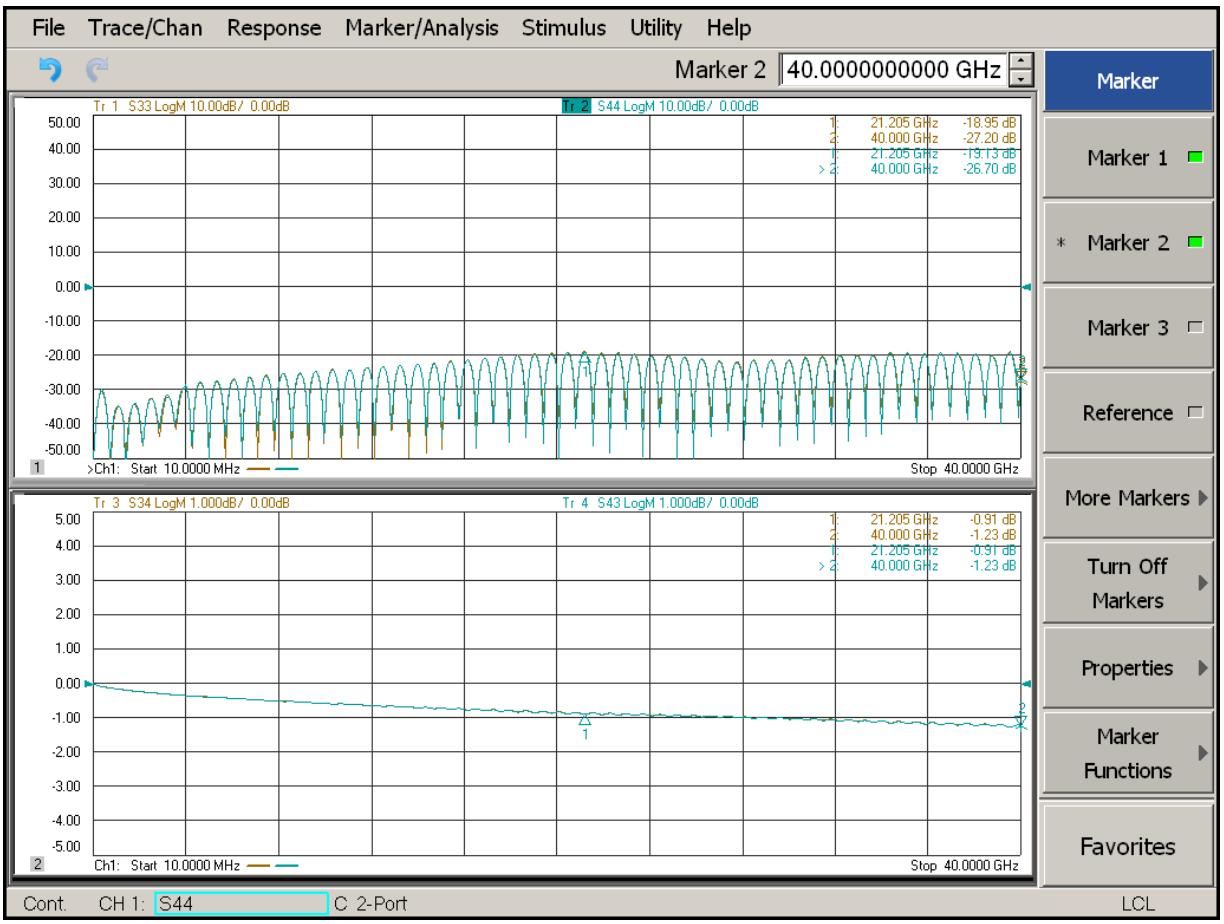


Figure 5 – UT-047 measurement results

6 HF30 Results

6.1 Straight on PCB (thru)

In this section, the straight on PCB (thru) type of HF30 has been measured. The part numbers of male and female connectors are 221D00F22-0004-1300CMM and 222D00M16-0004-2300CMM.

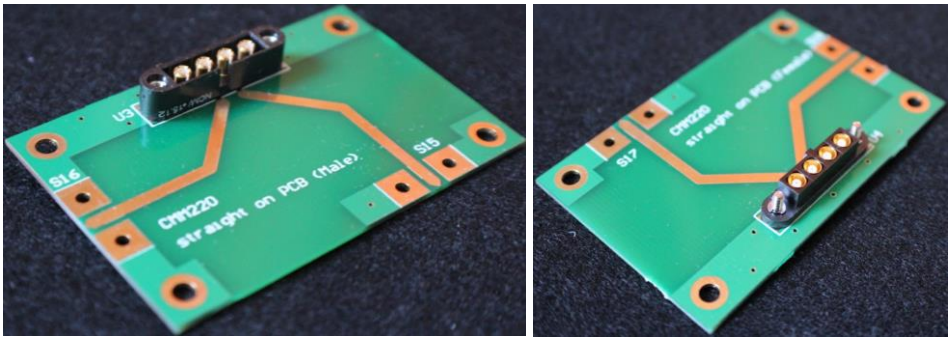


Figure 6 - Male (left) and female (right) straight on PCB (Thru) connectors

According to the measurement result shown in Figure 7, the connectors could work up to 8 GHz with a return loss (orange and magenta lines) < -8 dB and an insertion loss = -2.95 dB (the green line). It could also work up to 6 GHz with a return loss < -15 dB and an insertion loss = -0.66 dB.

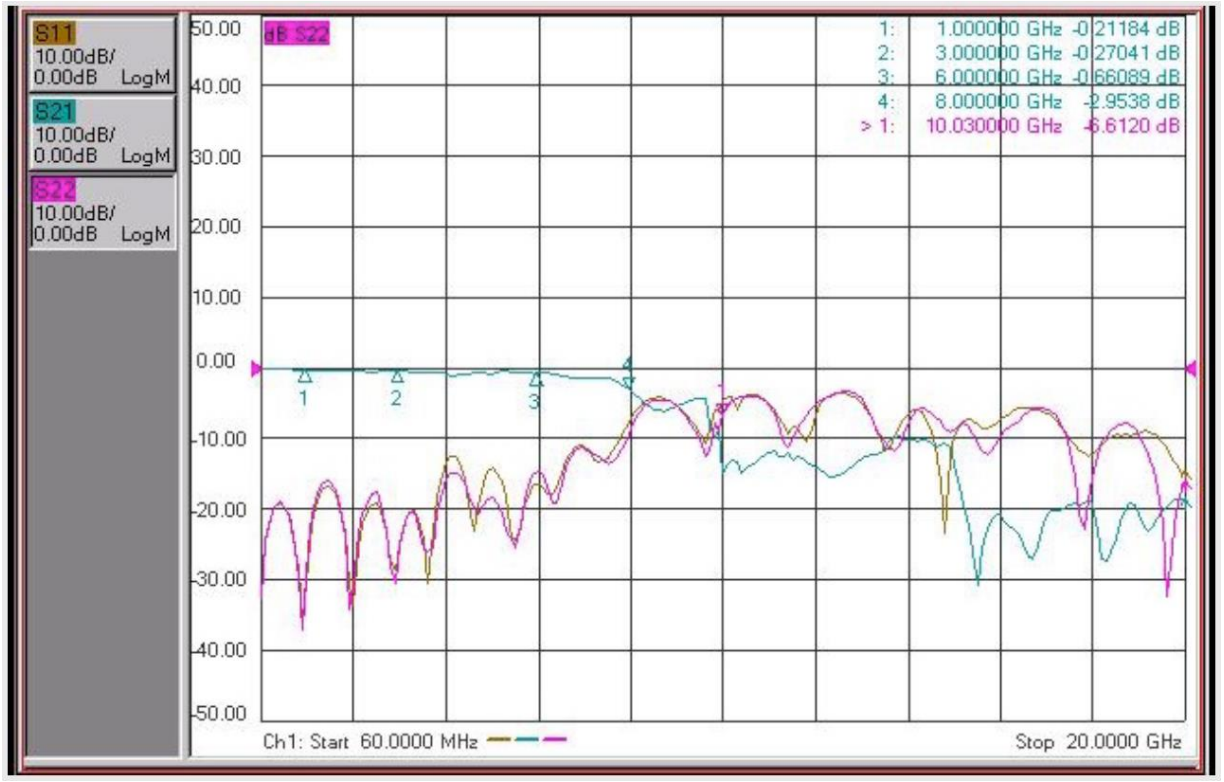


Figure 7 - S-parameter thru performance of the straight n PCB (thru) connector pair

6.2 90° on PCB (thru)

In this section, the 90° on PCB (thru) type of HF30 has been measured. The part numbers of male and female connectors are 221D00F26-0004-1400CMM and 222D00M21-0004-2400CMM.

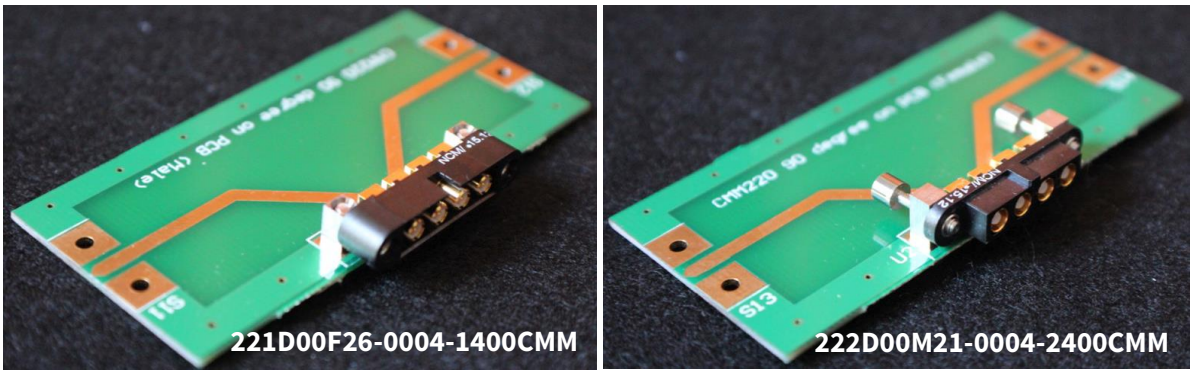


Figure 8 - Male (left) and female (right) 90° on PCB (thru) connectors

According to the measurement result shown in Figure 9, the connectors could work up to 6 GHz with a return loss (orange and magenta lines) < -10 dB and an insertion loss of -3.9dB (the green line). It could also work up to 5.5 GHz with a return loss < -10 dB and an insertion loss of -0.66 dB.

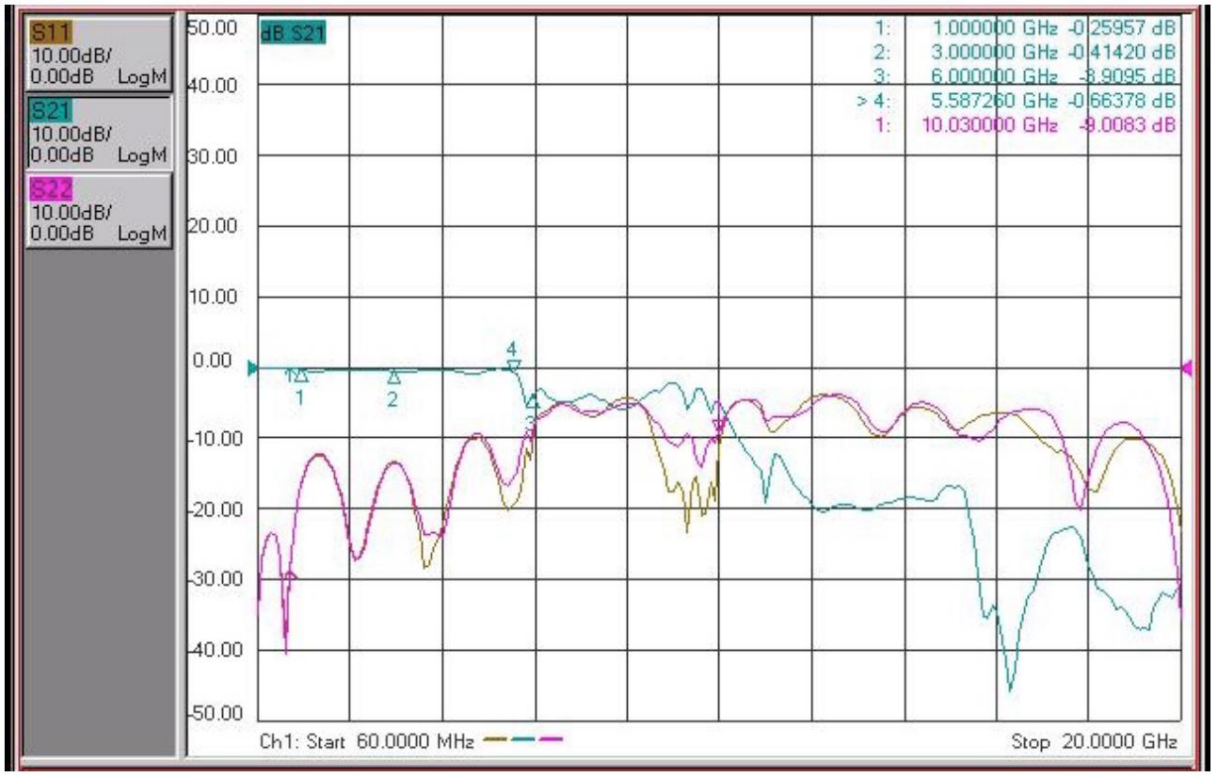


Figure 9 - S-parameter thru performance of the 90° on PCB (thru) connector pair

6.3 Straight on PCB (SMT)

In this section, the straight on PCB (SMT) type of HF30 has been measured. The part numbers of male and female connectors are 221D00F24-0004-1600 and 222D00M16-0004-2600.

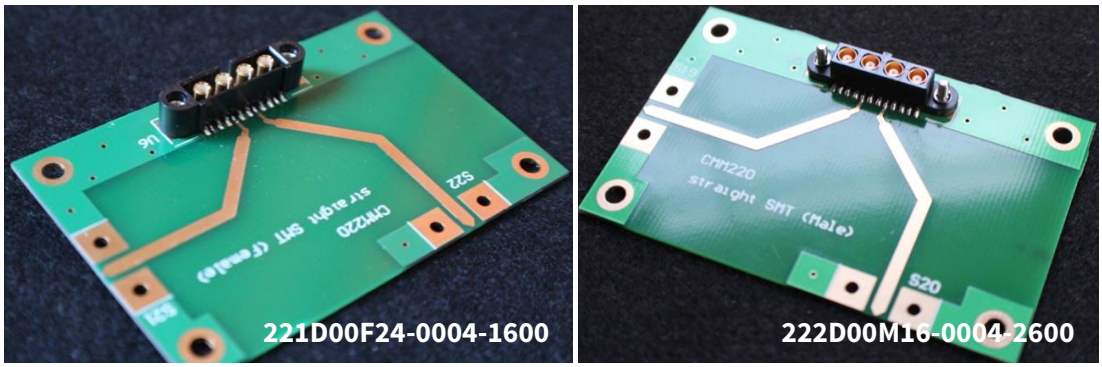


Figure 10 – Male (left) and female (right) straight on PCB (SMT) connectors

According to the measurement result shown in Figure 11, the connectors could work up to 5.2 GHz with a return loss (orange and magenta lines) < -8 dB and an insertion loss = -1.2 dB (the green line). It could also work up to 3 GHz with a return loss < -13 dB and an insertion loss of -0.26 dB.

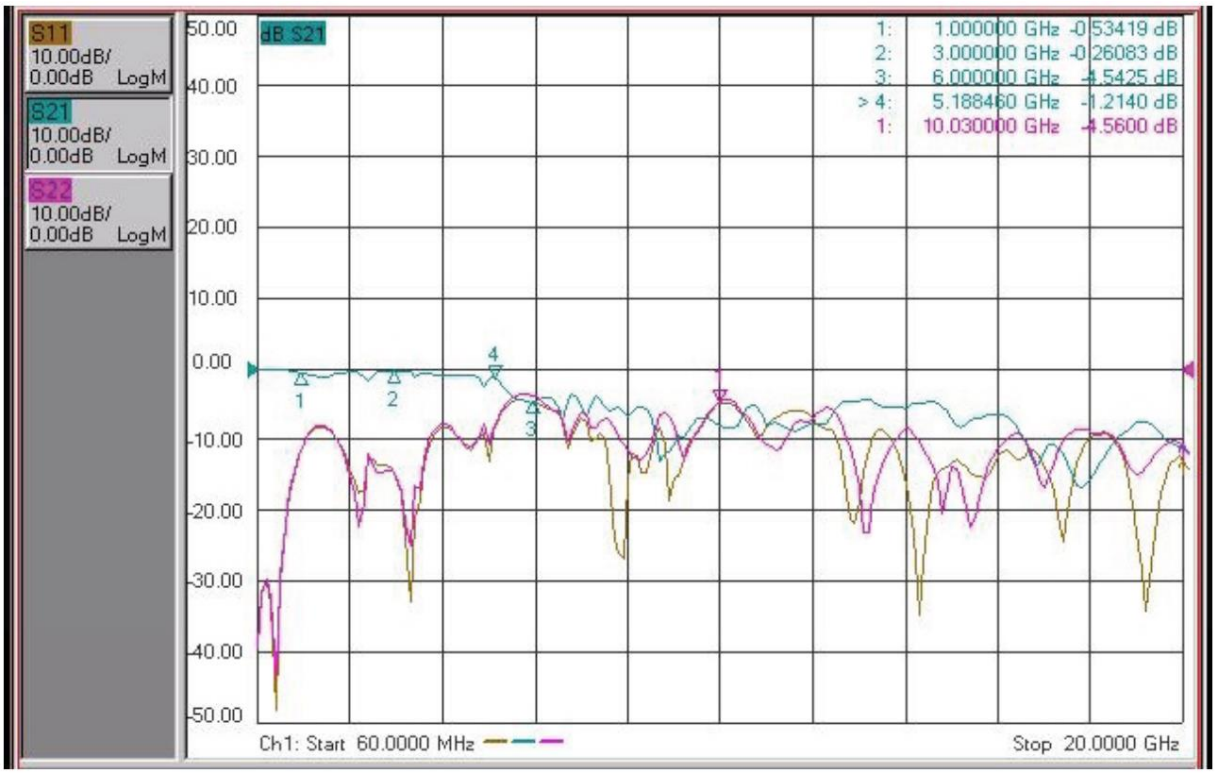


Figure 11 - S-parameter thru performance of the straight on PCB (SMT) connector pair

6.4 90° on PCB (SMT)

In this section, the 90° on PCB (SMT) type of HF30 has been measured. The part numbers of male connector is 221D00F27-0004-1500CMM. Since there is no female connector of this type, the mating connector is 222D00M16-0004-2300CMM.

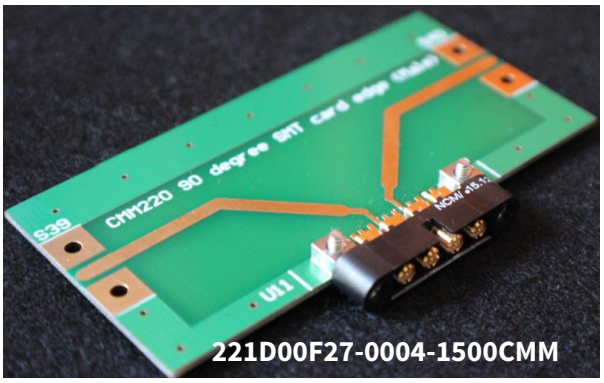


Figure 12 - Male 90° on PCB (SMT) connectors

According to the measurement result shown in Figure 13, the connectors could work up to 7.7 GHz with a return loss (orange and magenta lines) < -5 dB and an insertion loss = -2.64 dB (the green line). It could also work up to 6 GHz with a return loss < -10 dB and an insertion loss of -2.85 dB.

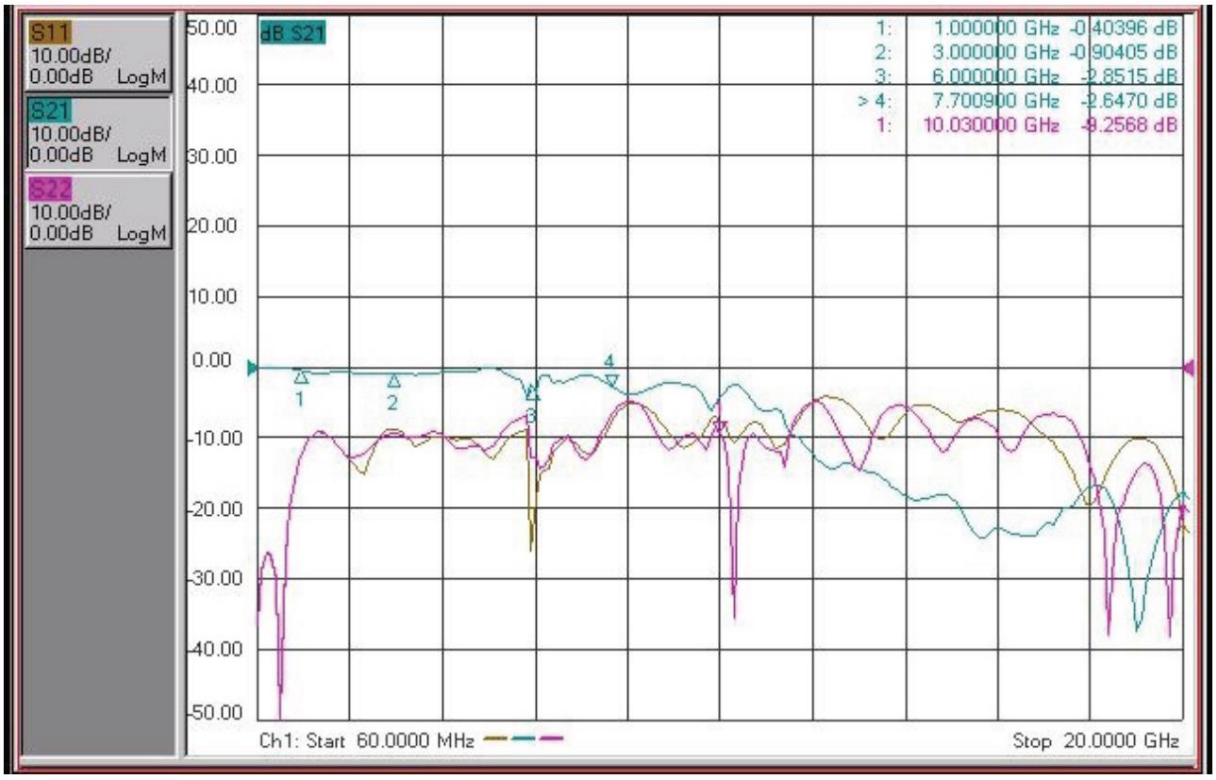


Figure 13 - S-parameter thru performance of the 90° on PCB (SMT) connector pair

6.5 Straight on Coaxial Cables

6.5.1 HFE100D

In this section, the straight on coaxial cable type of HF30 has been measured with HFE100D. This assembly is operated by Nicomatic. The part numbers of male and female connectors are 221E00F22-0004-1324SS and 222E00M16-0004-2324SS. This measurement is up to 26.5 GHz.

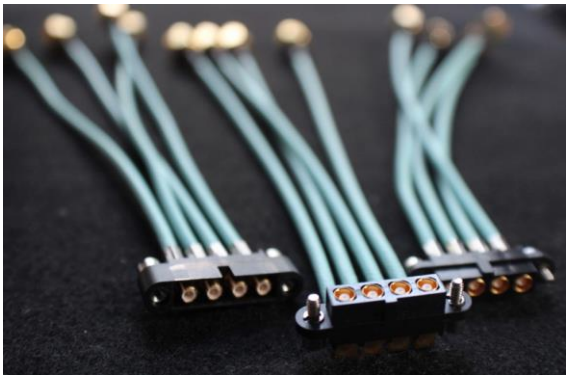


Figure 14 – Male (left) and female (right) straight on coaxial cables (HFE100D) connectors

According to the measurement result shown in Figure 15, the connectors could work up to 20 GHz with a return loss (orange and magenta lines) < -10 dB and an insertion loss = -2.5 dB (the green line). It could also work up to 10 GHz with a return loss < -15 dB and an insertion loss of -1.22 dB.

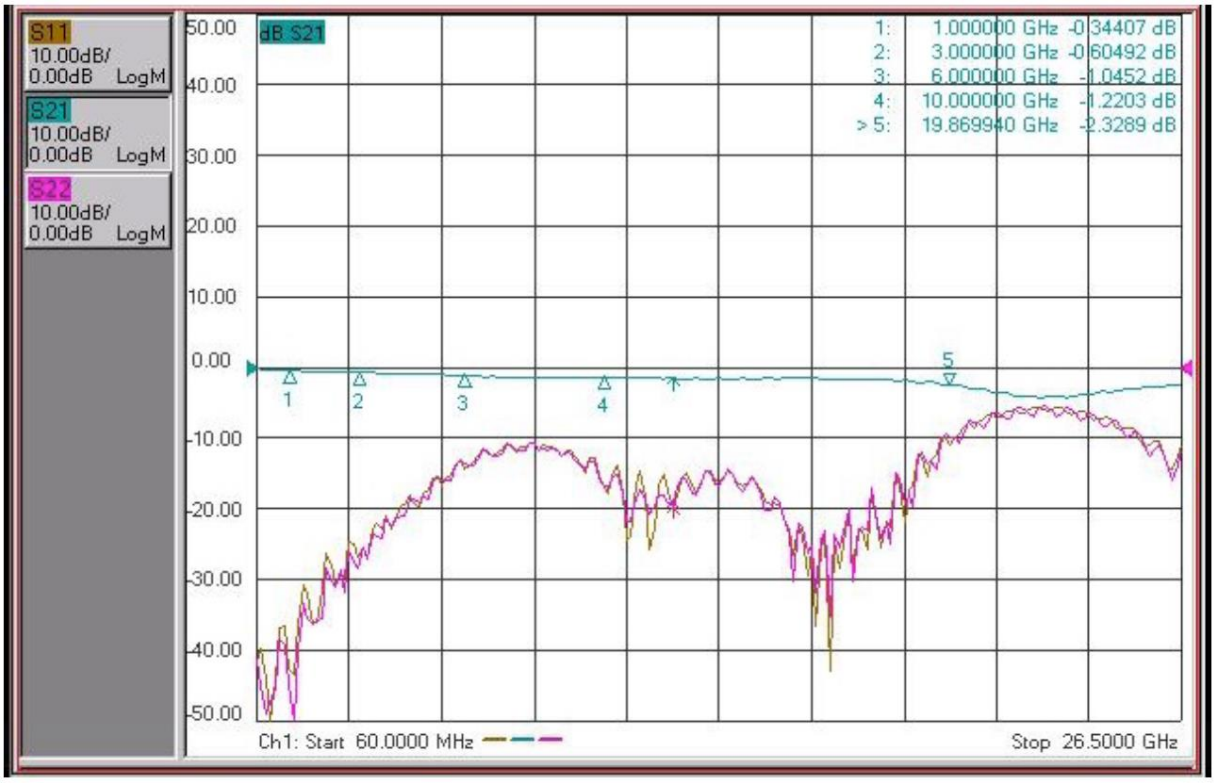


Figure 15 – S-parameter thru performance of the straight on coaxial cables (HFE100D) connector pair

Isolation Characteristic

The cross-talk measurement has been performed to understand how is the isolation characteristic. There are two different ways to do this measurement: port 1 male with port 2 male (on same connector); port 1 male with port 2 female (on different connectors).

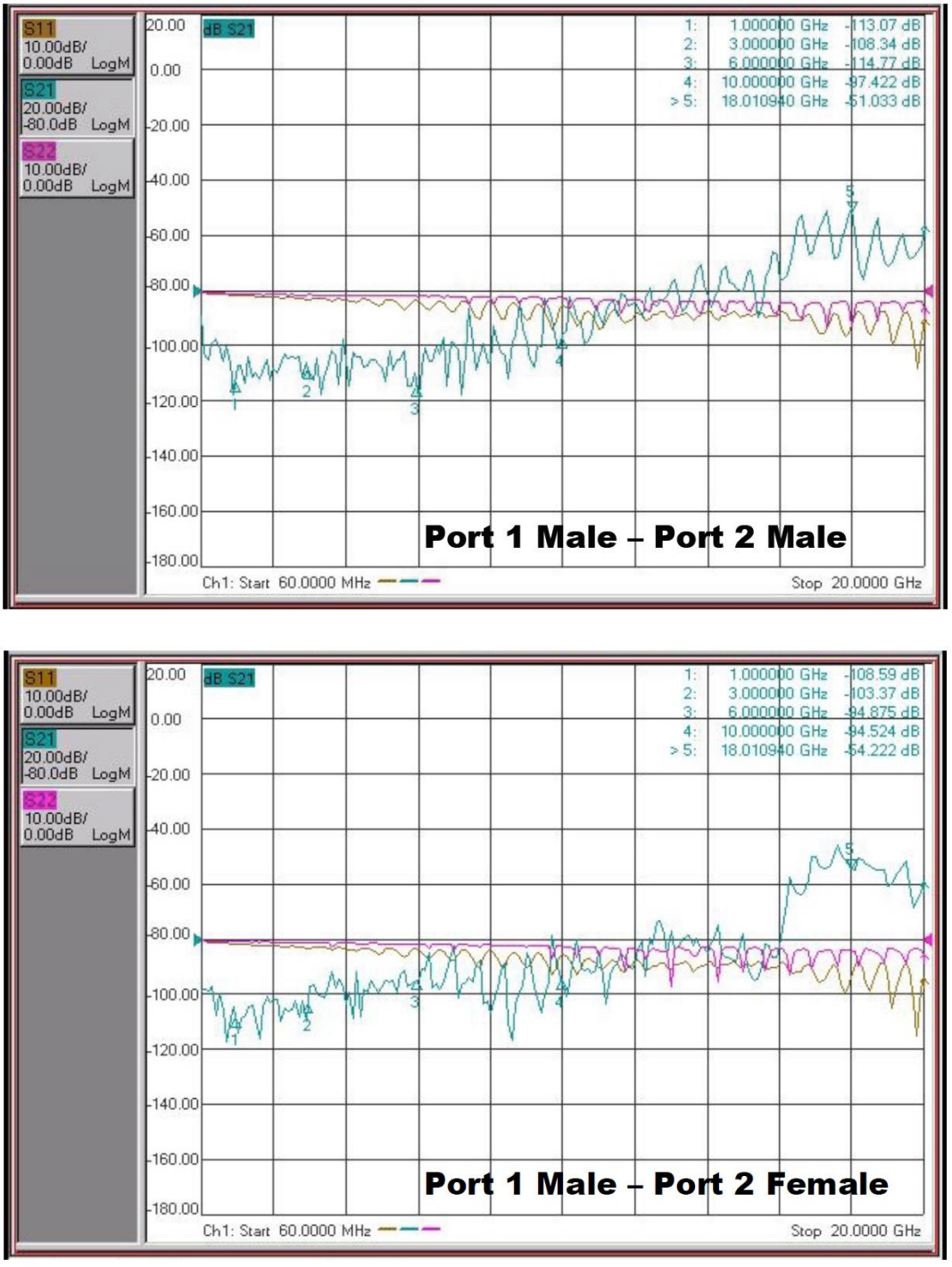


Figure 16 - S-parameter isolation performance of the straight on coaxial cables (HFE100D) connector pair

6.5.2 UT-047

In this section, the straight on coaxial cable type of HF30 has been measured with UT-047. This assembly is operated by Nicomatic. The part numbers of male and female connectors are 221E00F22-0004-1347ZZ and 222E00M16-0004-2347ZZ.

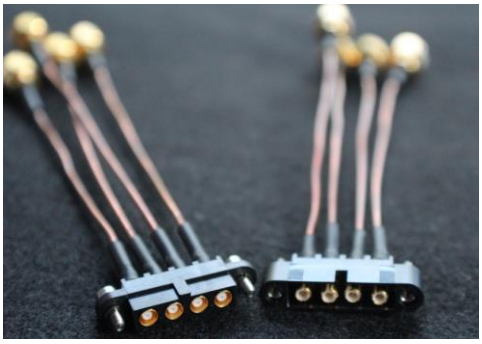


Figure 17 – Male (left) and female (right) straight on coaxial cables (UT-047) connectors

According to the measurement result shown in Figure 18, the connectors could work up to 13.5 GHz with a return loss (orange and magenta lines) < -10 dB and an insertion loss = -1.47 dB (the green line). It could also work up to 6 GHz with a return loss < -15 dB and an insertion loss of -0.86 dB.

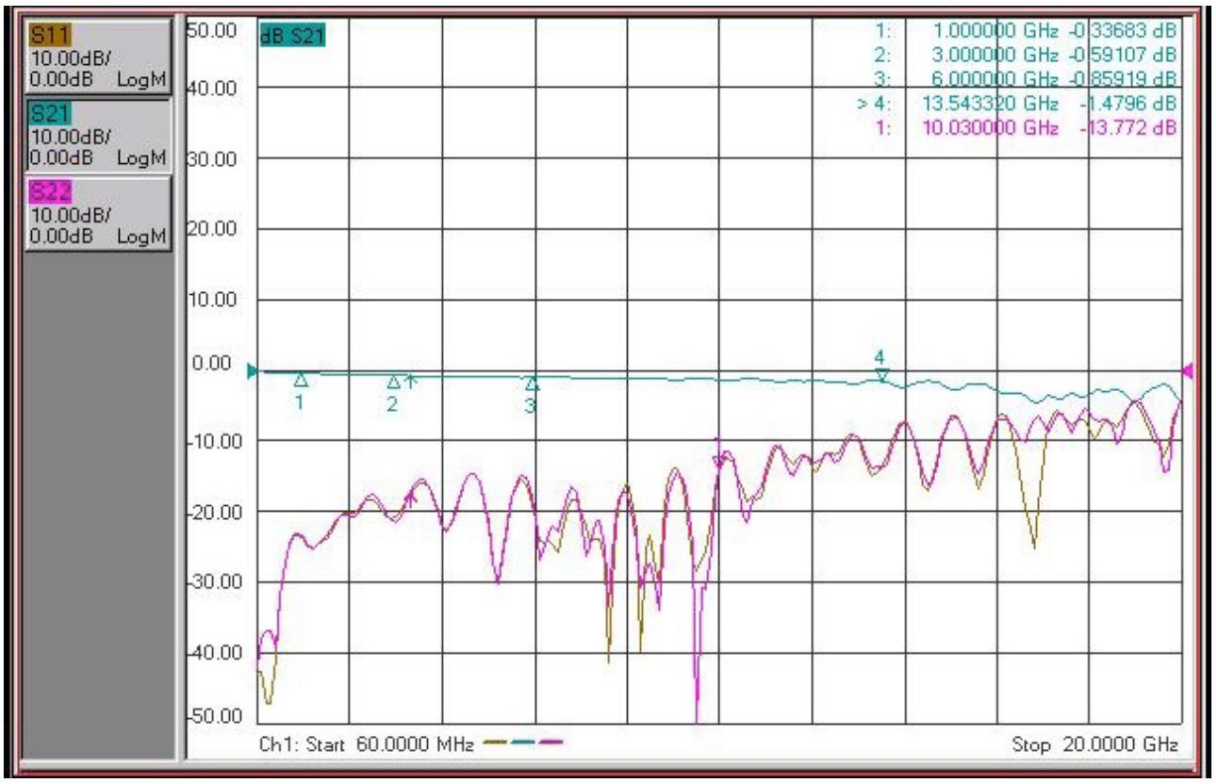


Figure 18 – S-parameter thru performance of the straight on coaxial cables (UT-047) connector pair

6.6 90° on Coaxial Cables

In this section, the 90o on coaxial cable type of HF30 has been measured with HFE100D. This type only has female connector. This assembly is operated by Nicomatic. The part number of female connector is 222E00M16-0004-2424ZS. The mating part is used 222E00M16-0004-2424ZS. This measurement is up to 26.5 GHz.

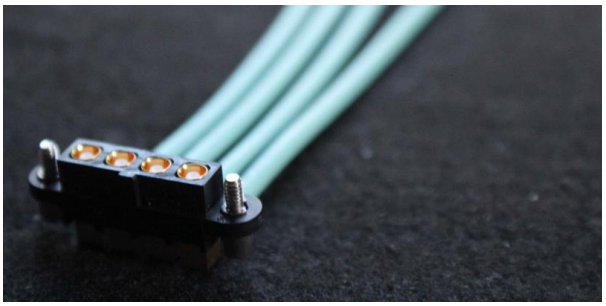


Figure 19 – Male 90° on coaxial cables (HFE100D) connectors

According to the measurement result shown in Figure 20, the connectors could work up to 20 GHz with a return loss (orange and magenta lines) < -20 dB and an insertion loss = -1.58 dB (the green line). It could also work up to 6 GHz with a return loss < -15 dB and an insertion loss of -1.12 dB.

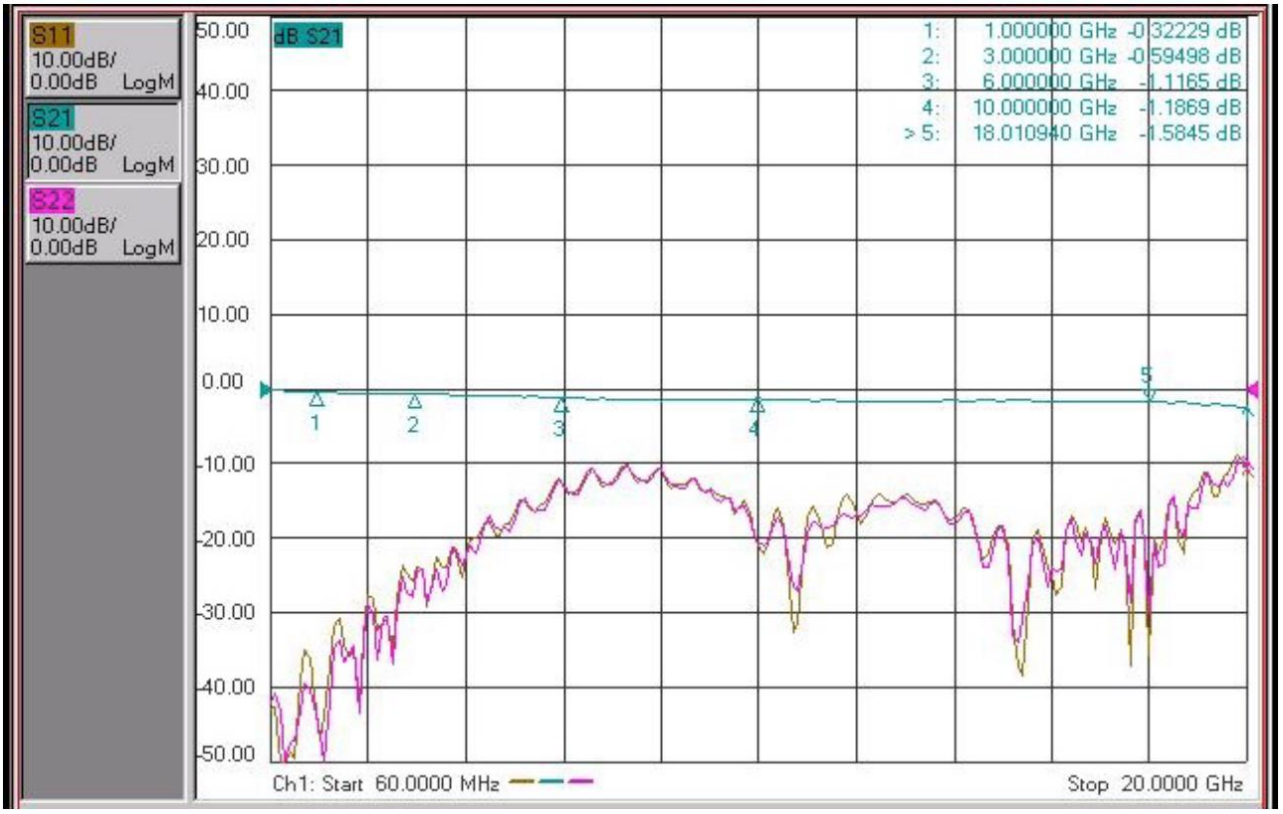


Figure 20 – S-parameter thru performance of the 90° on coaxial cables (HFE100D) connector pair

Isolation Characteristic

The cross-talk measurement has been performed to understand how is the isolation characteristic. There are two different ways to do this measurement: port 1 male with port 2 male (on same connector); port 1 male with port 2 female (on different connectors).

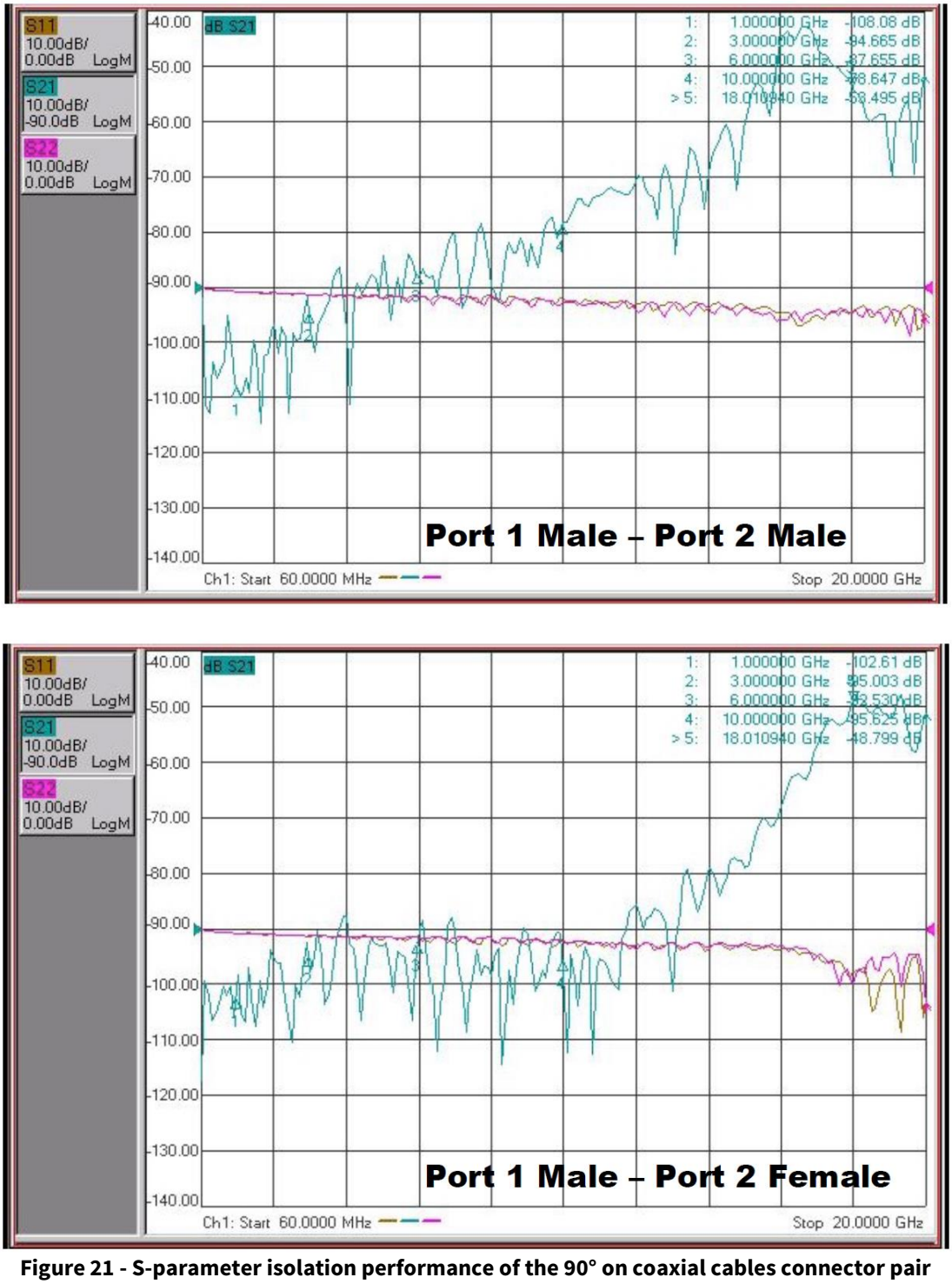


Figure 21 - S-parameter isolation performance of the 90° on coaxial cables connector pair

7 HF22 Results

7.1 Straight on PCB (thru)

In this section, the straight on PCB (thru) type of HF22 has been measured. The part numbers of male and female connectors are 341D000F42-00080130012 and 342D000H01-0008-230012.

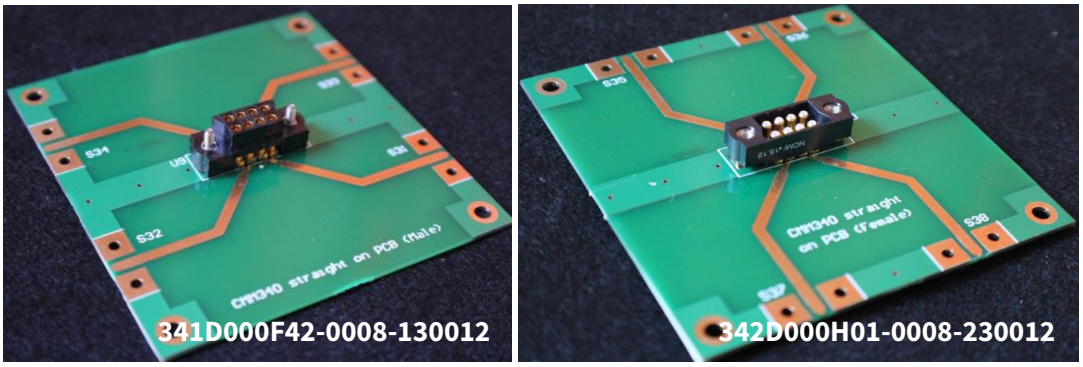


Figure 22 - Male (left) and female (right) straight on PCB (Thru) connectors

According to the measurement result shown in Figure 23, the connectors could work up to 4 GHz with a return loss (orange and magenta lines) < -8 dB and an insertion loss = -2.49 dB (the green line). It could also work up to 3 GHz with a return loss < -18 dB and an insertion loss of -0.25 dB.

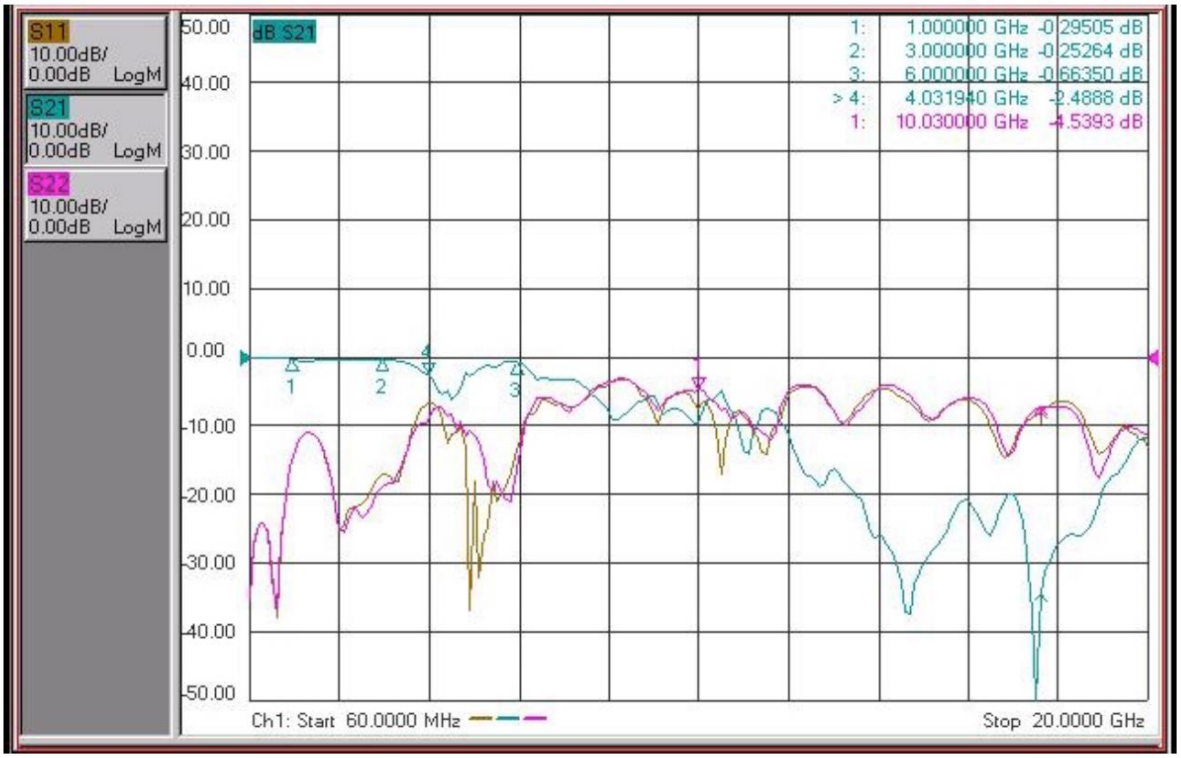


Figure 23 - S-parameter thru performance of the straight on PCB (thru) connector pair

7.2 90° on PCB (thru)

In this section, the 90o on PCB (thru) type of HF22 has been measured. The part numbers of male and female connectors are 341D000F51-0008-140002 and 342D000H08-0008-240002.

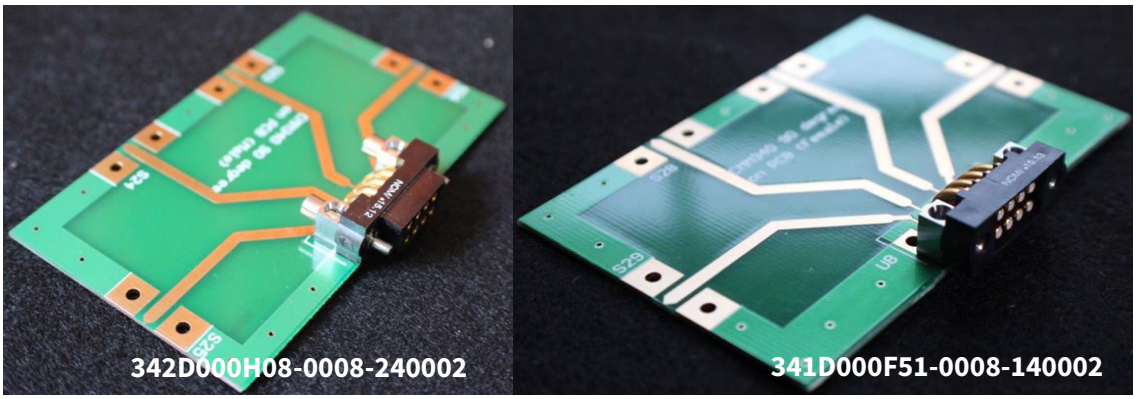


Figure 24 - Male (left) and female (right) 90° on PCB (thru) connectors

According to the measurement result shown in Figure 25, the connectors could work up to 3 GHz with a return loss (orange and magenta lines) < -5 dB and an insertion loss = -1.8 dB (the green line). It could also work up to 1 GHz with a return loss < -10 dB and an insertion loss of -0.78 dB.

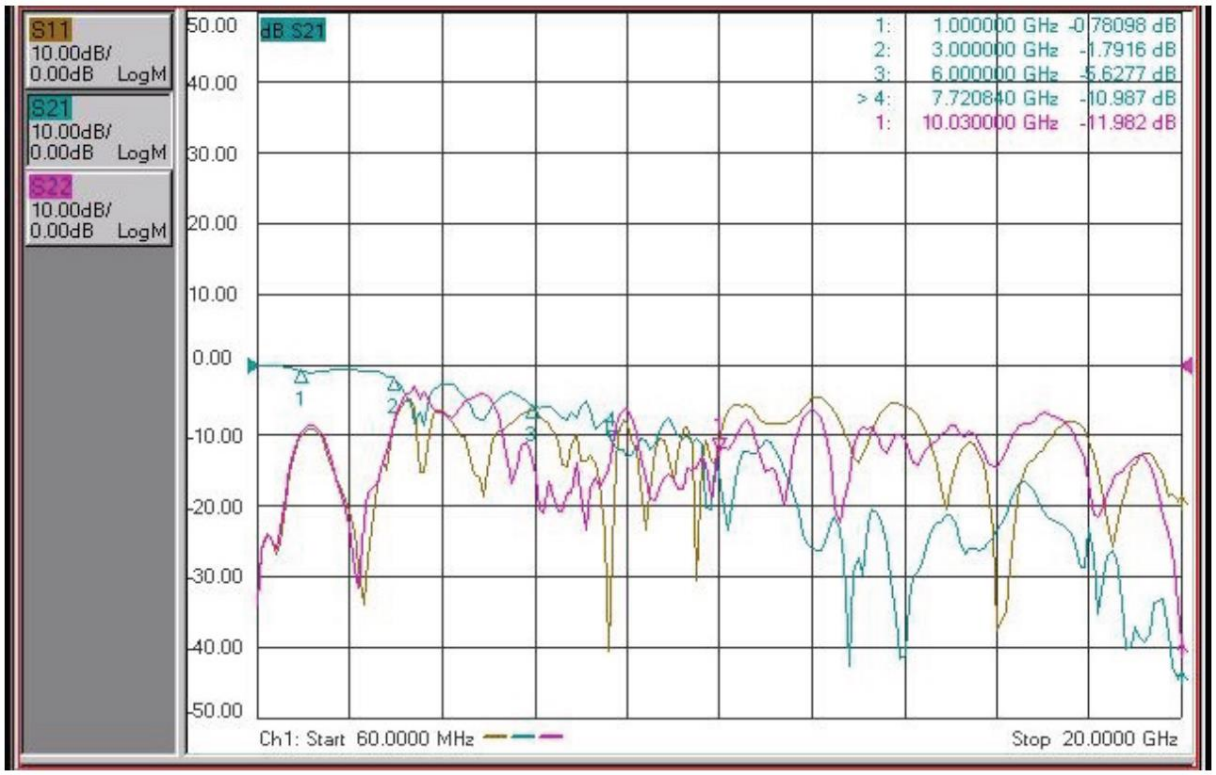


Figure 25 - S-parameter thru performance of the 90° on PCB (thru) connector pair

7.3 Straight on Coaxial Cables

In this section, the straight on coaxial cable type of HF22 has been measured with RG-178. This assembly is operated by Nicomatic. The part numbers of male and female connectors are 341E000F41-0008-1320ZZ and 342E000H01-0008-2320ZZ.

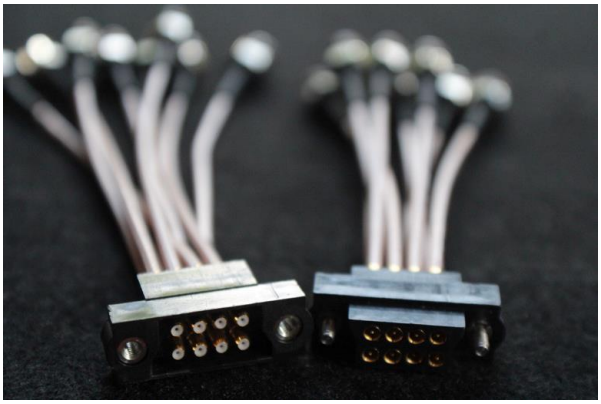


Figure 26 – Male (left) and female (right) straight on coaxial cables (RG-178) connectors

According to the measurement result shown in Figure 27, the connectors could work up to 11.6 GHz with a return loss (orange and magenta lines) < -10 dB and an insertion loss = -1.7 dB (the green line). It could also work up to 6 GHz with a return loss < -10 dB and an insertion loss of -1.51 dB.

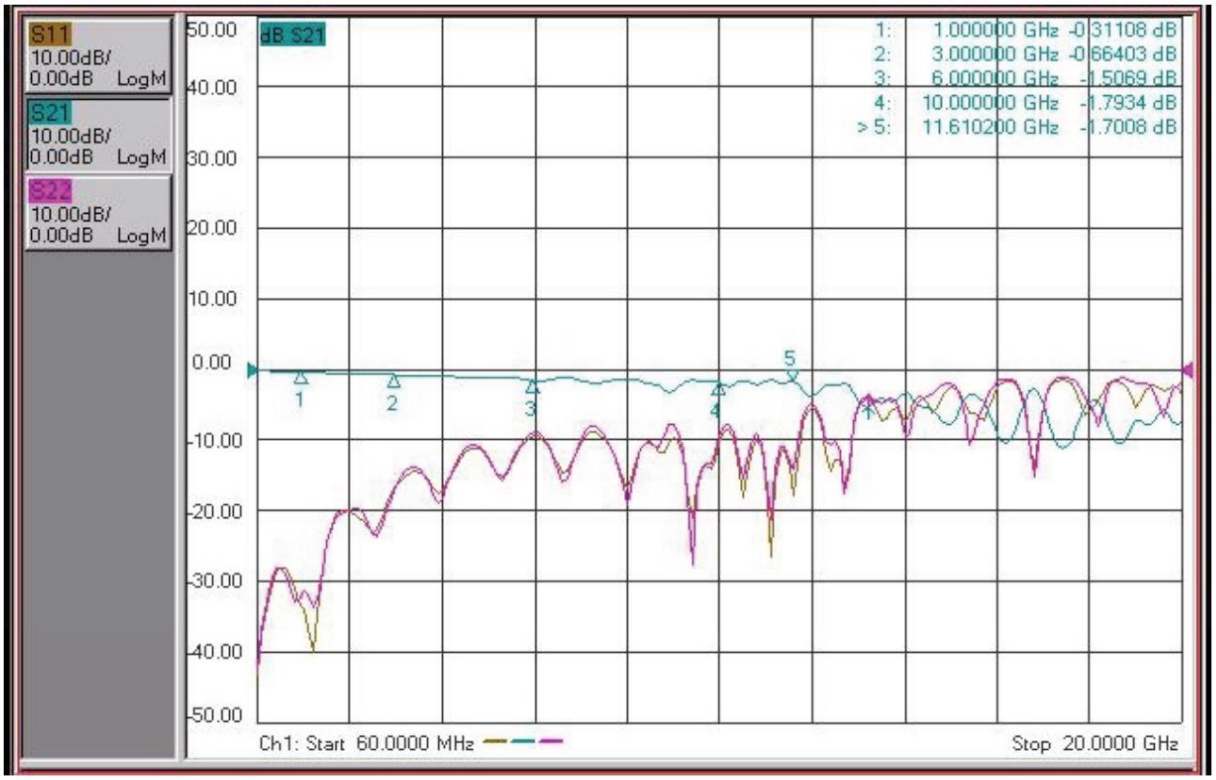
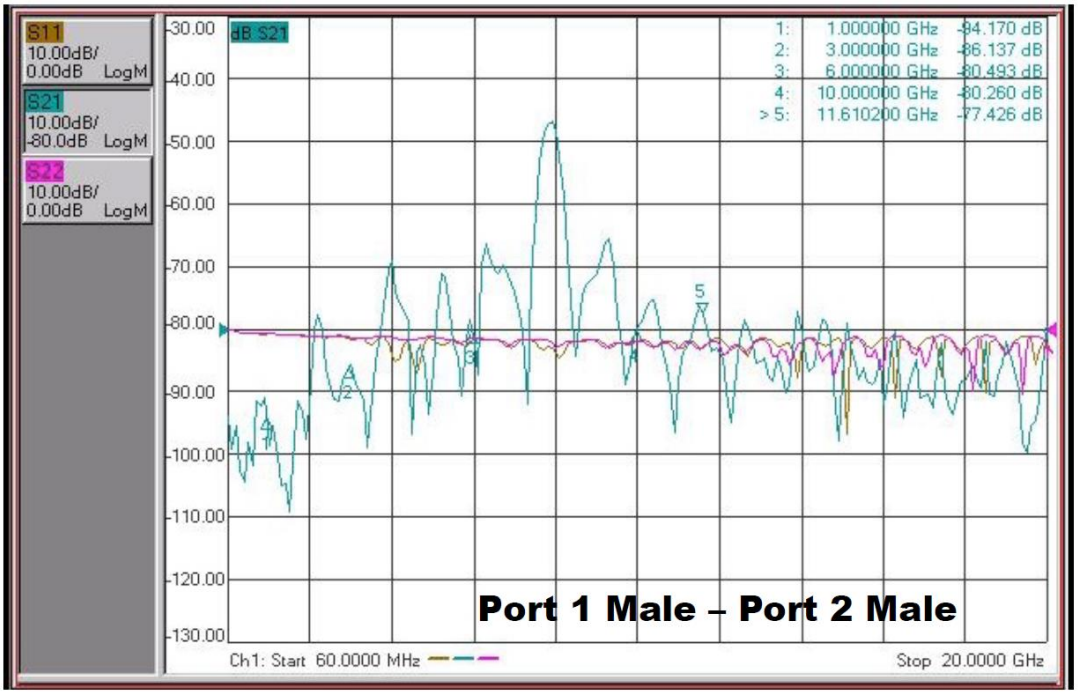


Figure 27 – S-parameter thru performance of the straight on coaxial cables (RG-178) connector pair

Isolation Characteristic

The cross-talk measurement has been performed to understand how is the isolation characteristic. There are two different ways to do this measurement: port 1 male with port 2 male (on same connector); port 1 male with port 2 female (on different connectors).



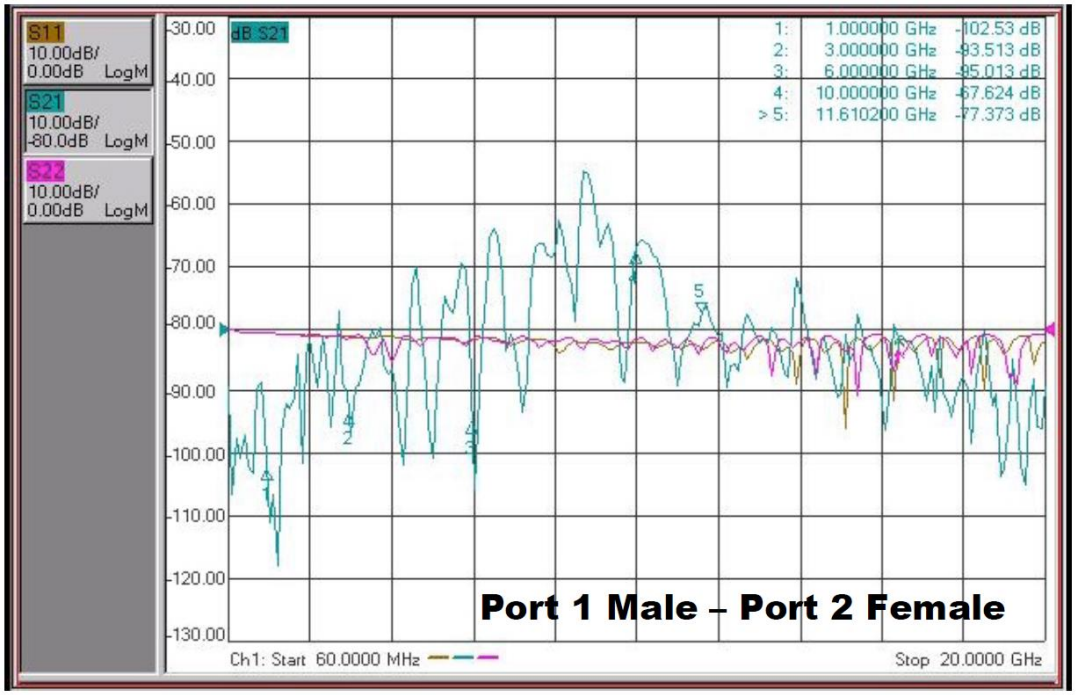


Figure 28 – S-parameter thru performance of the straight on coaxial cables (RG-178) connector pair

8 Performances comparison between CMM and DMM

This section presents the results of the RF characteristic performances of the DMM HF series connectors compare to a CMM series connector with same contact. The goal is to check the impact of the shell on the signal. The results are shown in S-parameter graphs in which the return losses and the insertion losses will be discussed.

8.1 DMM measurements configuration

In this sub-section, both the straight and the 90° on PCB (thru) types of the DMM HF series connectors have been measured using single-ended signals. The part numbers of the 90° male and the straight female connectors are D221D00D52-0004-1400DMM and D222D00D53-0004-2300DMM, respectively (shown in Figure 29). The male connector has been measured on port 1 and the female connector has been measured on port 2.

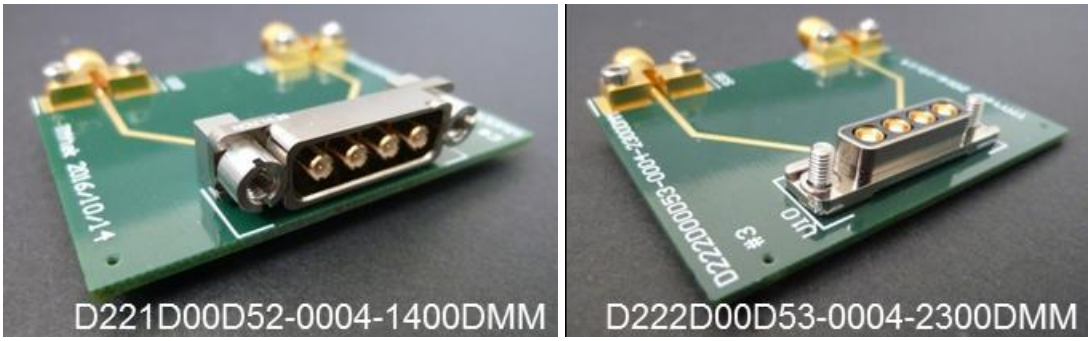


Figure 29 - Male 90° (left) and female straight (right) on PCB (thru) connectors

Measurement Result of Straight and the 90° on PCB (thru) Connectors

According to the measurement result shown in Figure 30 and Figure 31, there is no influence of the shell on the signal performance of the connector. The Return Loss is the same. The Insertion Loss decrease a little bit but not due to the shell. It can be due to combination of a straight version and a 90° version.

Another conclusion that can be made is, when a mixed version is made (straight vs 90° version), the worst signal of the two version is measured in S21, S11 and S22 (see Figure 31, Figure 32 and Figure 33).

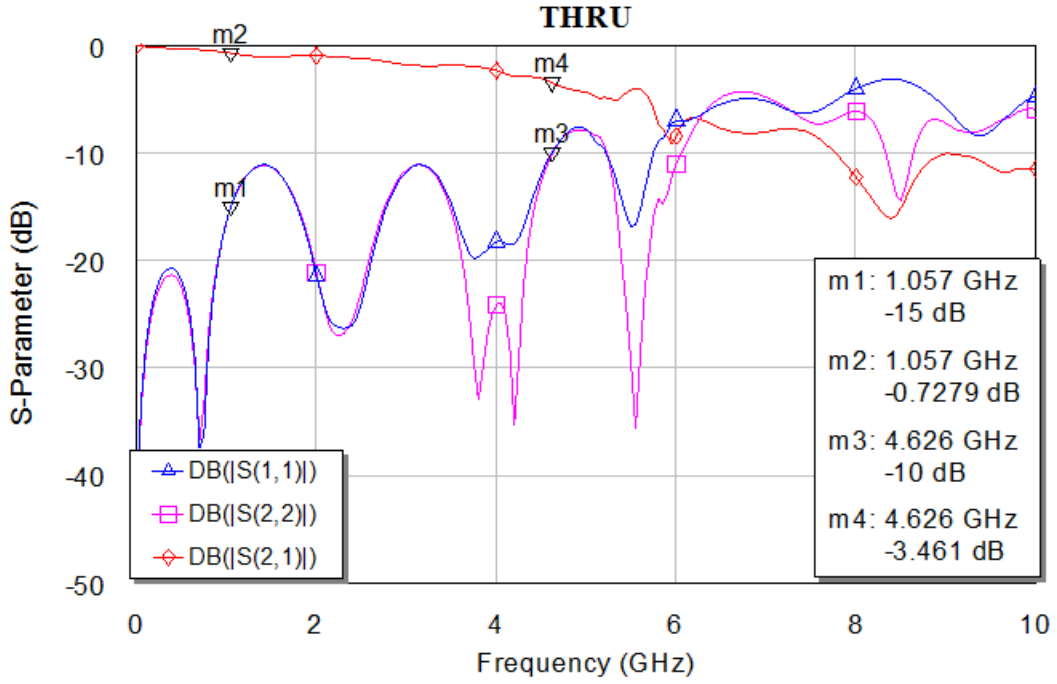


Figure 30 - S-parameter thru performance of the straight n PCB (thru) DMM connector pair

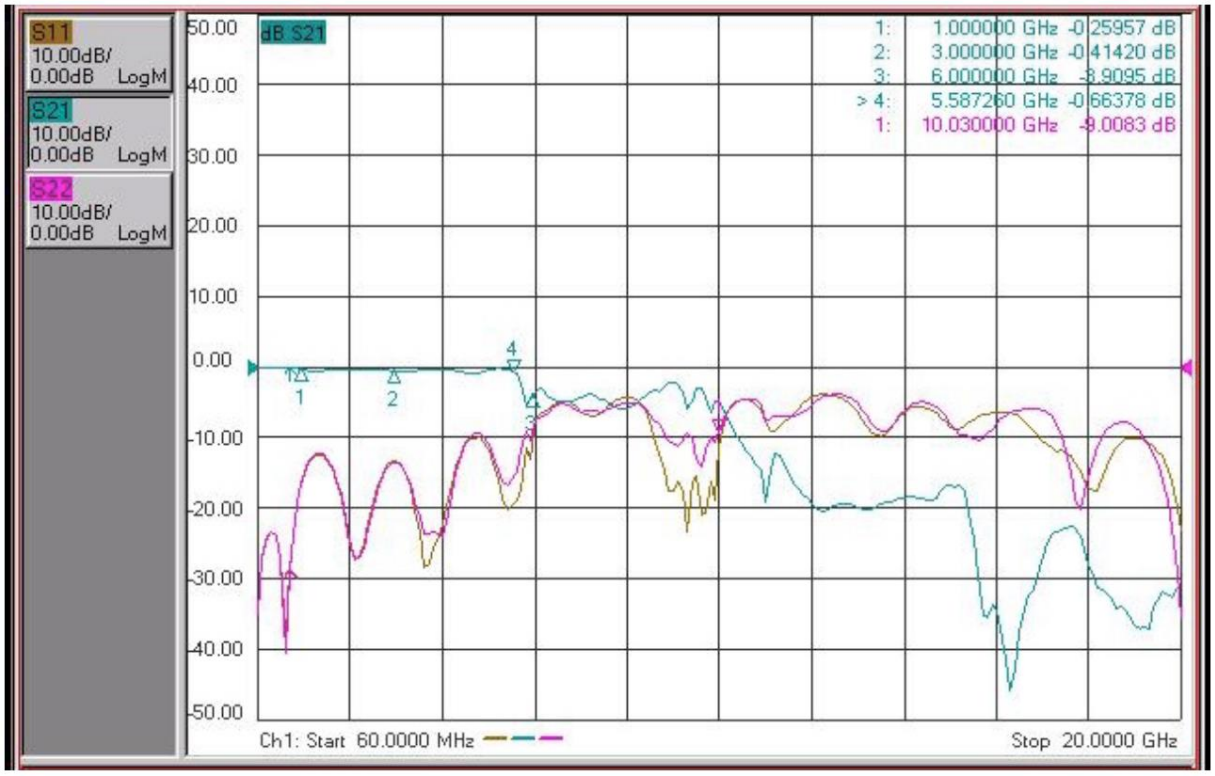


Figure 31 - S-parameter thru performance of the straight n PCB (thru) connector pair

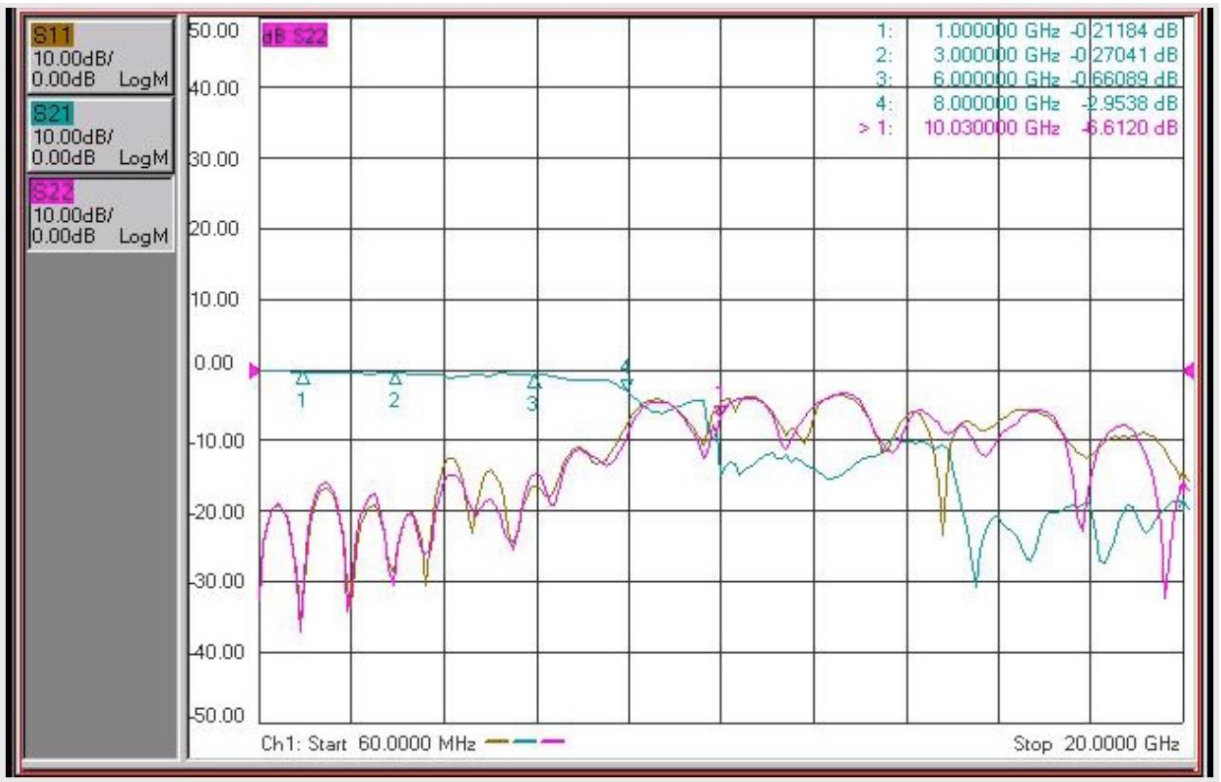


Figure 32 - S-parameter thru performance of the straight n PCB (thru) CMM connector pair