Customer Measurement Report:
CrossBow Connector Comparison:
FCI Header / ATCS Receptacle
vs.
ATCS Header / ATCS Receptacle

19-Nov-2009
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Andrew Zambell
Signal Integrity Team

Purpose

- To compare the high-speed performance of FCI's Crossbow Connector with that of Amphenol's using high-bandwidth test boards
  - Calibration kit: SOLT
  - Parameters tested will include
    - Differential Impedance
    - Differential Return Loss
    - Differential Insertion Loss
    - Differential Crosstalk
    - Within-pair skew
    - Propagation Delay

Conclusions

- For all parameters measured, the FCI and Amphenol products exhibited similar performance.

Conclusions cont.

- **Differential Impedance**
  - The FCI exhibited about 90-106 ohms on all pairs in both directions at a system risetime ~137ps (10-90%)
  - The Amphenol exhibited about 90-106 ohms on all pairs in both directions at a system risetime ~137ps (10-90%)
  - FCI's and Amphenol's impedance are almost identical

- **Differential Return Loss**
  - All the FCI and Amphenol headers exhibited less than -8dB up to 20GHz, with most pairs having less than -10dB up to 20GHz.

- **Differential Insertion Loss**
  - The FCI sample exhibited less than 5dB of loss up to about 6GHz and less than 20dB of loss up to 18.5GHz
  - The Amphenol sample exhibited less than 5dB of loss up to about 6GHz, less than 20dB of loss up to 18.5GHz

Conclusions cont.

- **Frequency-Domain Differential Crosstalk**
  - Near-End
    - FCI
      - Single active: < -38dB up to 20GHz
      - Multi-active: < -32dB up to 20GHz
    - Amphenol
      - Single active: < -38dB up to 20GHz
      - Multi-active: < -32dB up to 20GHz
  - Far-End
    - FCI
      - Single active: < -40dB up to 20GHz
      - Multi-active: < -38dB up to 20GHz
    - Amphenol
      - Single active: < -40dB up to 20GHz
      - Multi-active: < -38dB up to 20GHz

Conclusions cont.

- **Time-Domain Differential Crosstalk - @ ~157ps (10-90%)**
  - Near-End
    - FCI
      - Single active: .36% max
      - Multi active: 1.82% max
    - Amphenol
      - Single active: 0.33% max
      - Multi active: 1.58% max
  - Far-End
    - FCI
      - Single active: 0.31% max
      - Multi active: 1.4% max
    - Amphenol
      - Single active: 0.37% max
      - Multi active: 1.3% max

Conclusions cont.

- **Within Pair Skew - @ ~157ps (10-90%)**
  - FCI
    - 10% level – 8 ps max
    - 50% level – 6 ps max
  - Amphenol
    - 10% level – 9 ps max
    - 50% level – 7 ps max
- **Propagation Delay-@ ~157ps (10-90%)**
  - Both the FCI and Amphenol's parts are similar

Equipment Used

- Agilent Technologies N5230C PNA-L Network Analyzer
  - Frequency Range: 300KHz – 20GHz
  - SOLT calibration from 10MHz to 20GHz with 2000 data points and having an IF Bandwidth of 1KHz
- Gore™ PHASEFLEX® Microwave test cables, P/N SJ083000-07
  - 3 foot cable length used on the Advantest Pattern Generator and the Agilent PNA

Test Board Details

- Calibration trace measured on Crossbow™ daughter card test board PCB67 RevB
- The two Amphenol Crossbow right-angle receptacles, P/N DM32600011, were mounted on Crossbow™ daughter card test boards PCB67 RevB. An orthogonal midplane was used to connect the two receptacles. Both Amphenol vertical headers, P/N 2827002000, and FCI vertical headers, P/N 10089480-1001, were tested.
- The headers were mounted on PCB201 Rev A midplanes.
- SMA: SV Microwave Inc. P/N 2921-6929.SF.PDD

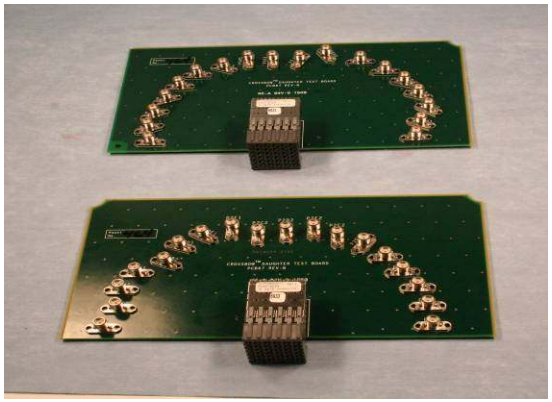


Figure 1: Crossbow™ daughter card test board PCB67 RevB

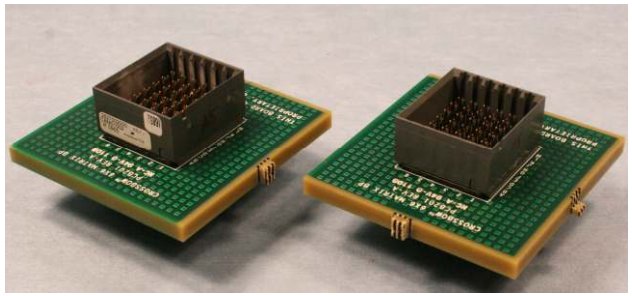


Figure 2: FCI and Amphenol midplane

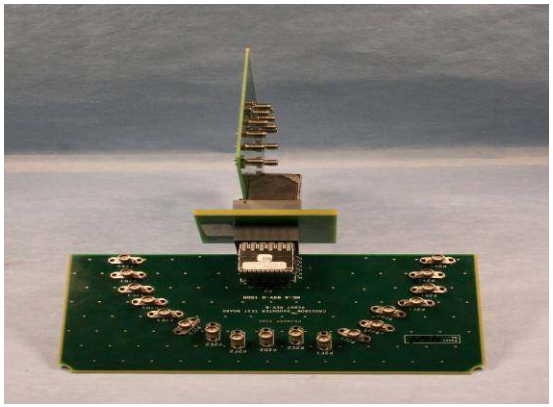


Figure 3: Mated 270° Crossbow

Test Procedures

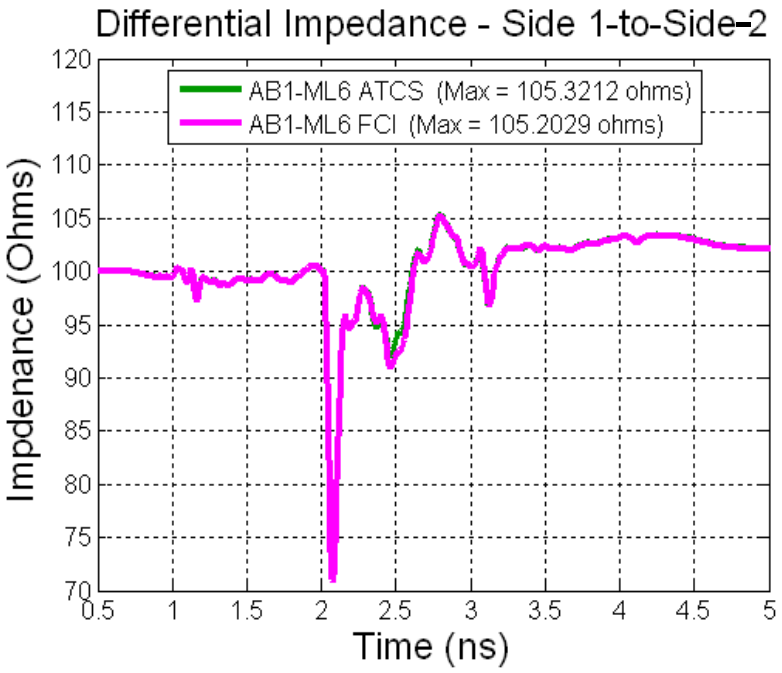
- **Differential Impedance**: Data was taken in the Frequency Domain. It was then transformed into the Time Domain using MATLAB and plotted in both directions. An input risetime of 35ps (10-90%) was used to achieve a system risetime of ~137ps (10-90%).

- **Return Loss**: Data was plotted for the side 1-to-side-2 direction and include PCB effect.

- **Insertion Loss**: Data was plotted for the side 1-to-side-2 direction. The data was plotted with and without the PCB loss.

- **Crosstalk**: Data was plotted for the side 1-to-side-2 direction for both Near-End and Far-End Crosstalk. Frequency-Domain data was plotted and transformed into the Time Domain using MATLAB. Time Domain data was plotted at a system risetime of ~157ps (10-90%).

Differential Impedance – Side 1-to-Side-2



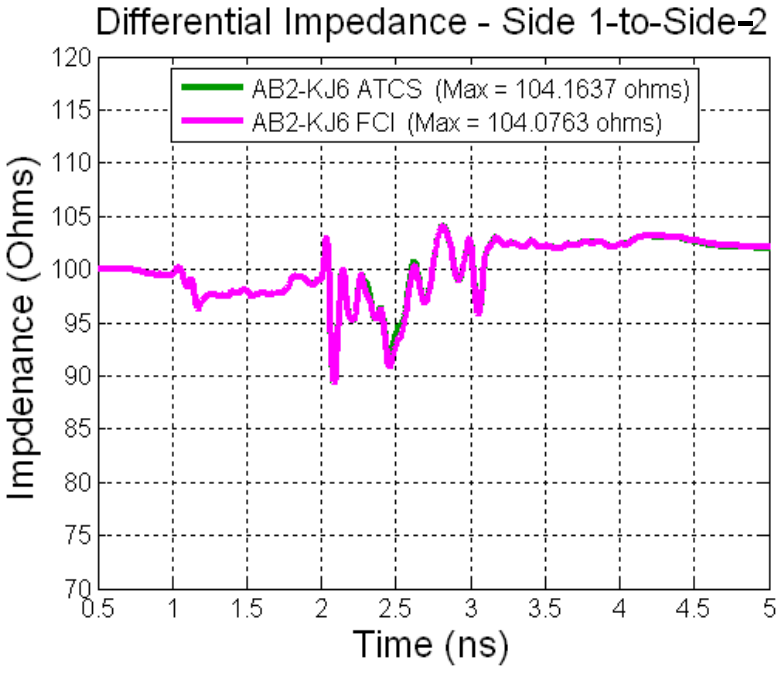
SOLT Calibration

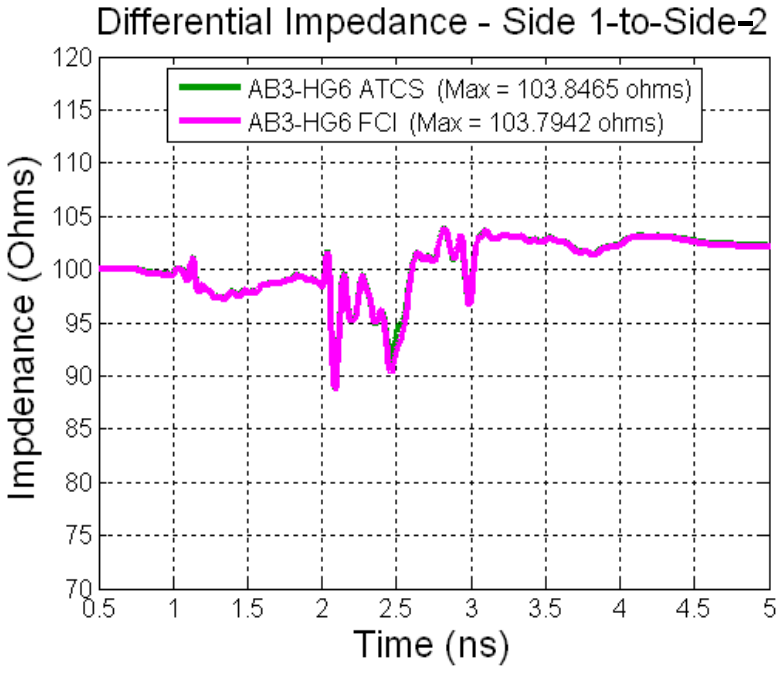
A1B1-M6L6	A2B2-K6J6	A3B3-H6G6
C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
E1F1-M4L4	E2F2-K4J4	E3F3-H4G4

Amphenol

FCI

Data is shown in this slide





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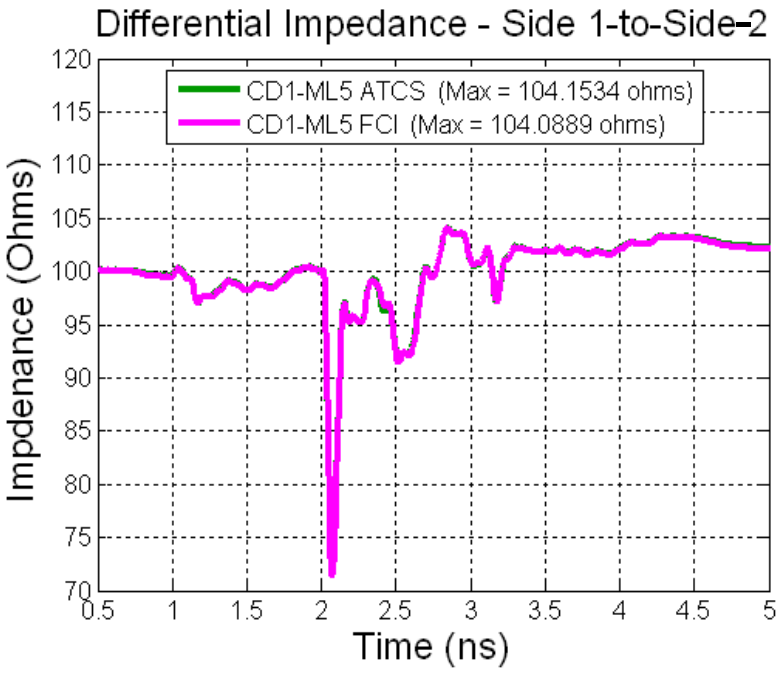

SOLT Calibration

A1B1-M6L6	A2B2-K6J6	A3B3-H6G6
C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
E1F1-M4L4	E2F2-K4J4	E3F3-H4G4

Amphenol

FCI

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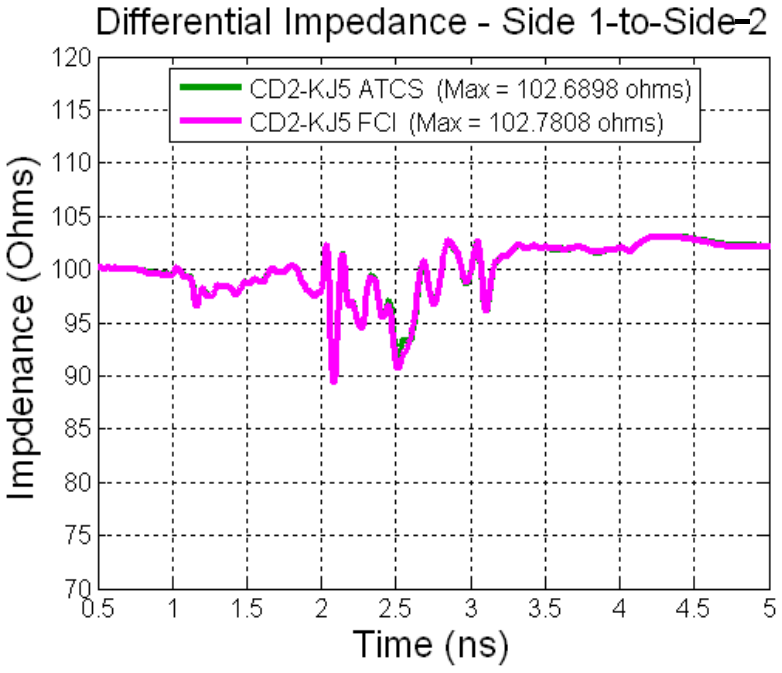
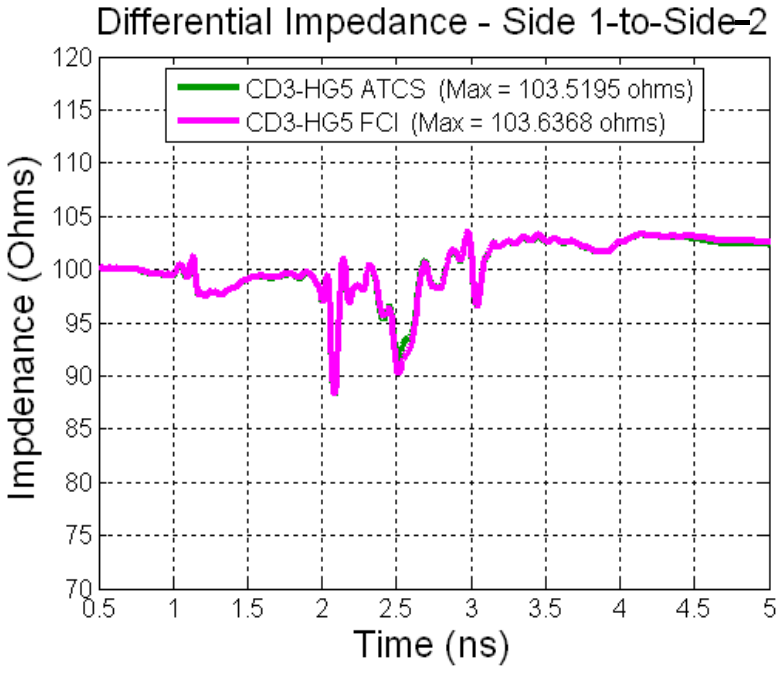
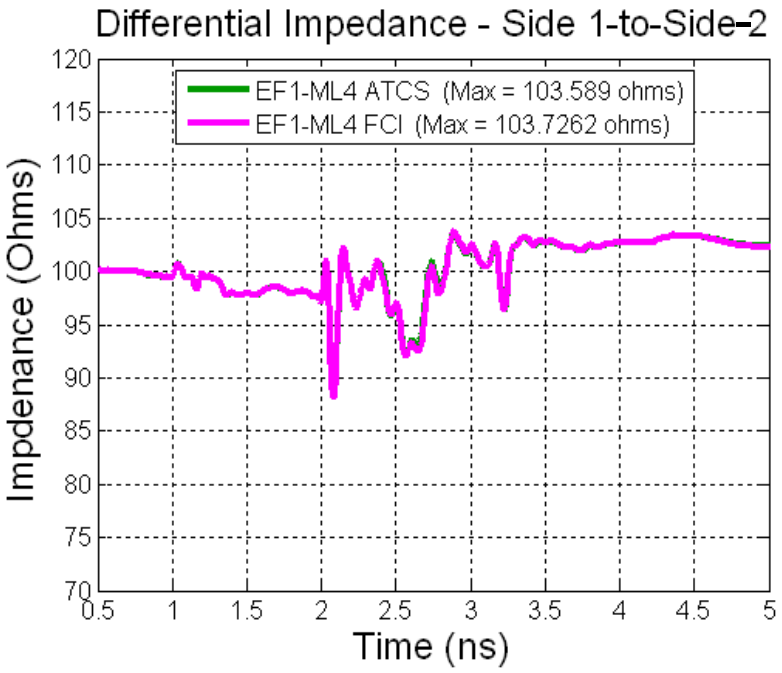




Differential Impedance – Side 1-to-Side-2



SOLT Calibration

A1B1-M6L6	A2B2-K6J6	A3B3-H6G6
C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
E1F1-M4L4	E2F2-K4J4	E3F3-H4G4

Amphenol

FCI

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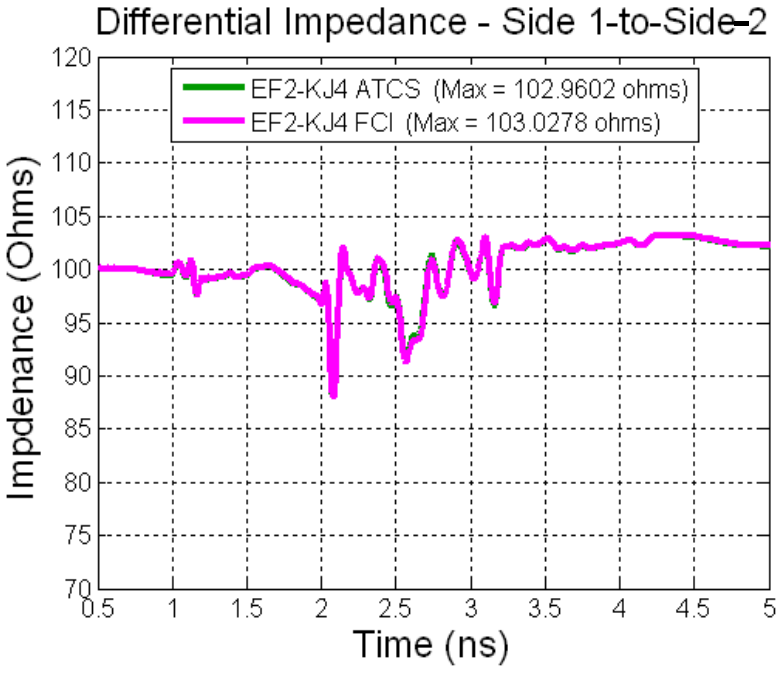
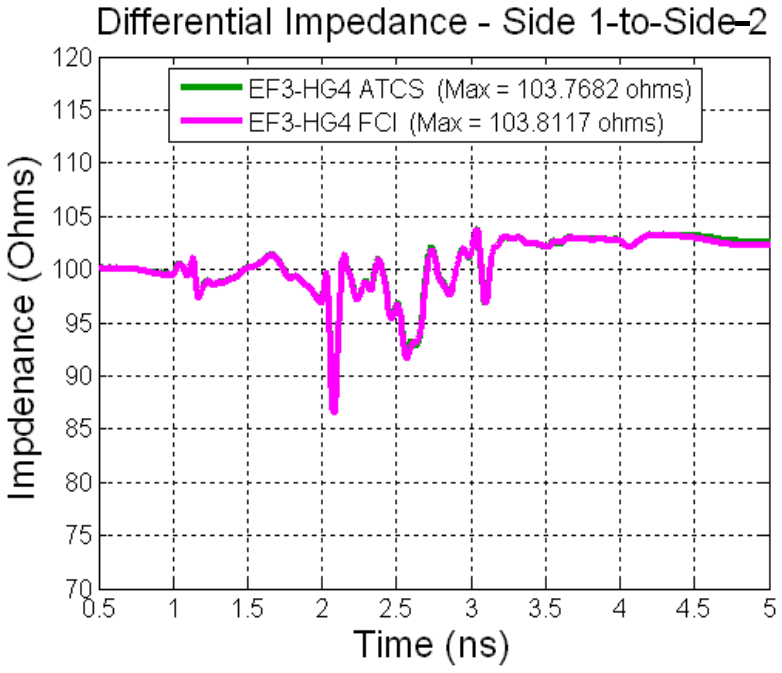
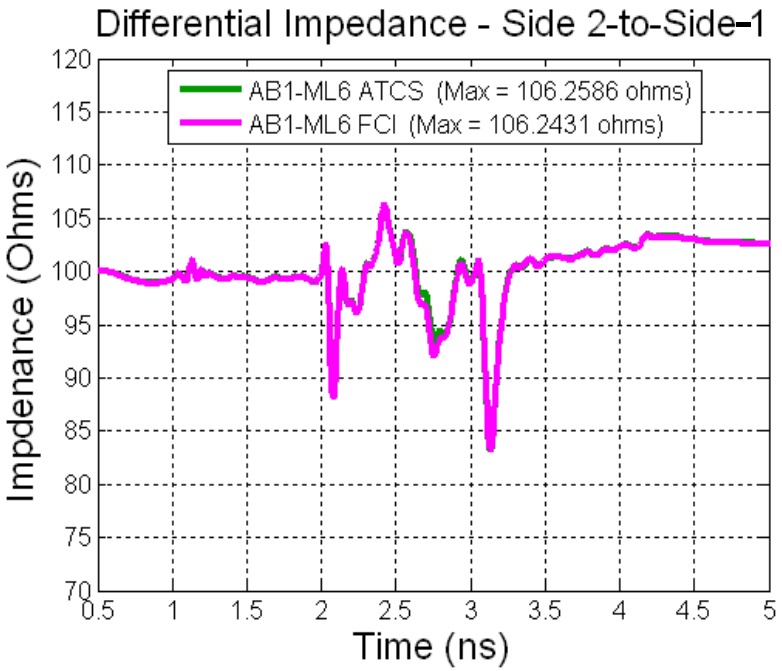




Differential Impedance – Side 2-to-Side-1



SOLT Calibration

A1B1-M6L6	A2B2-K6J6	A3B3-H6G6
C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
E1F1-M4L4	E2F2-K4J4	E3F3-H4G4

Amphenol

FCI

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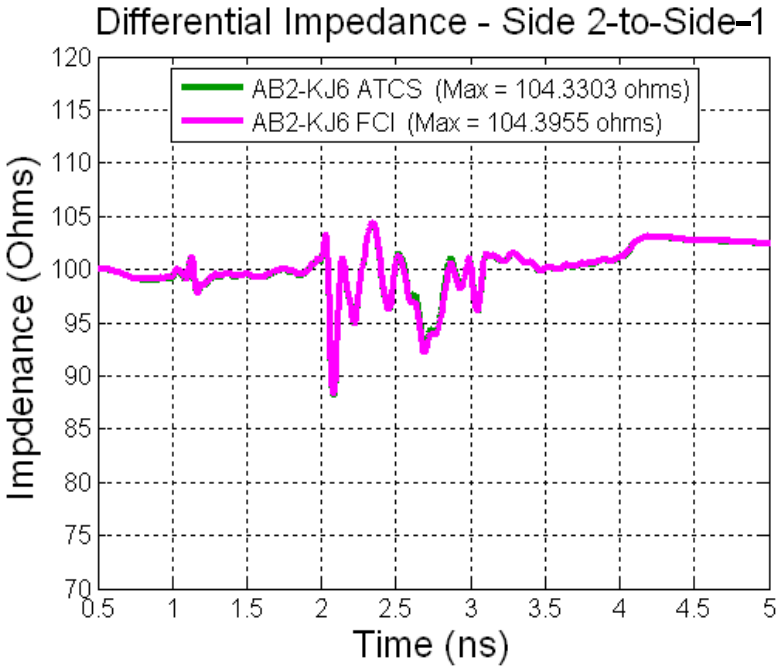

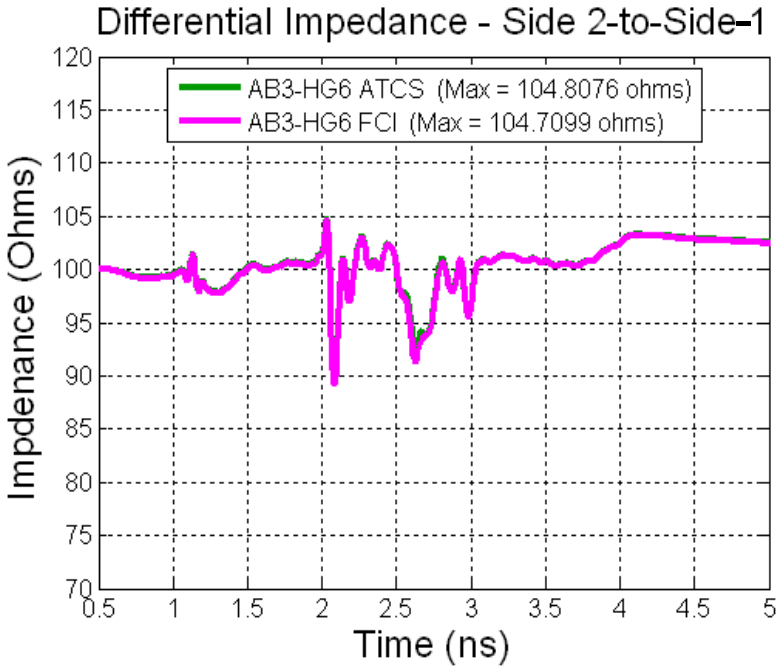

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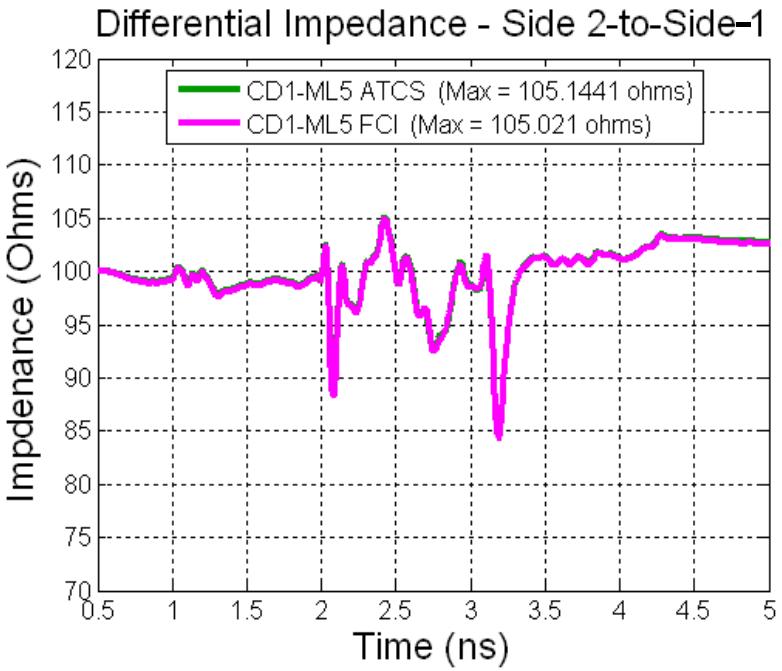

SOLT Calibration

A1B1-M6L6	A2B2-K6J6	A3B3-H6G6
C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
E1F1-M4L4	E2F2-K4J4	E3F3-H4G4

Amphenol

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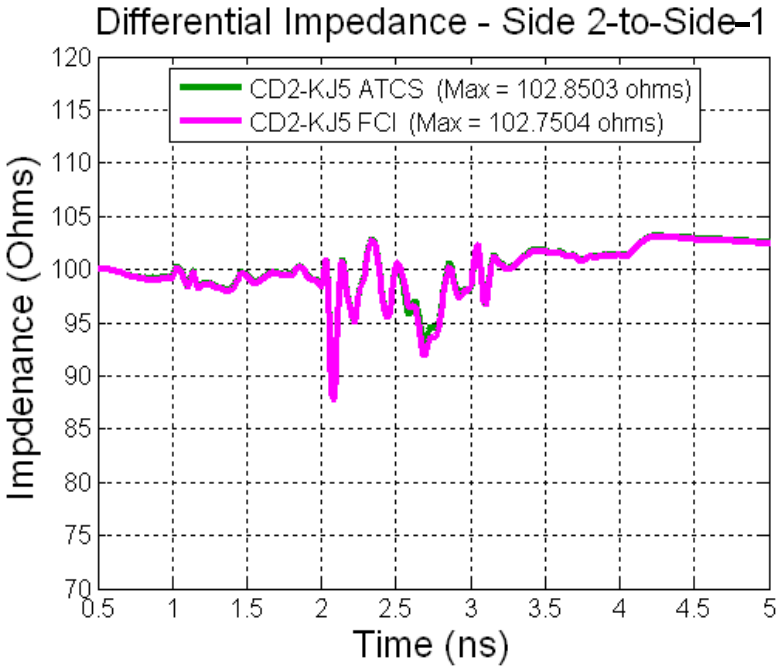
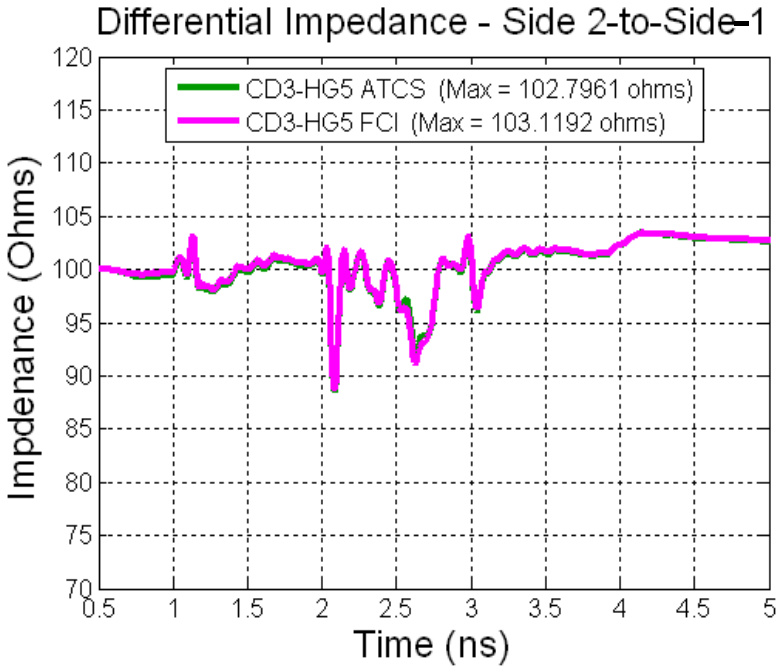
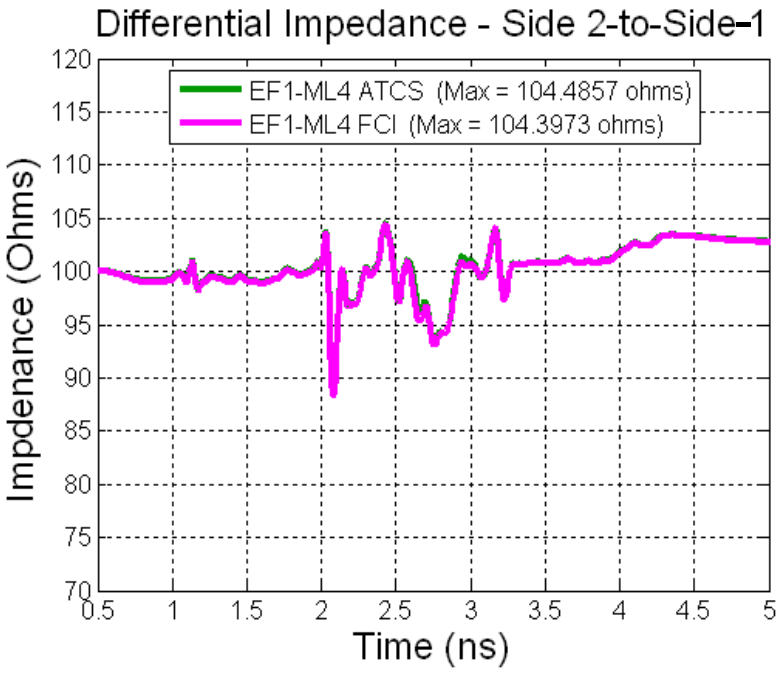




Differential Impedance – Side 2-to-Side-1



SOLT Calibration

A1B1-M6L6	A2B2-K6J6	A3B3-H6G6
C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
E1F1-M4L4	E2F2-K4J4	E3F3-H4G4

Amphenol

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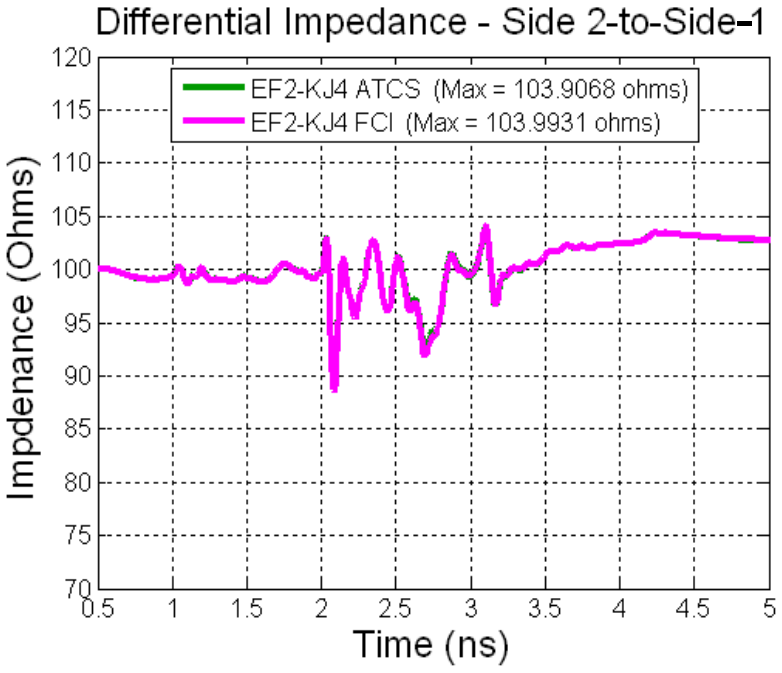
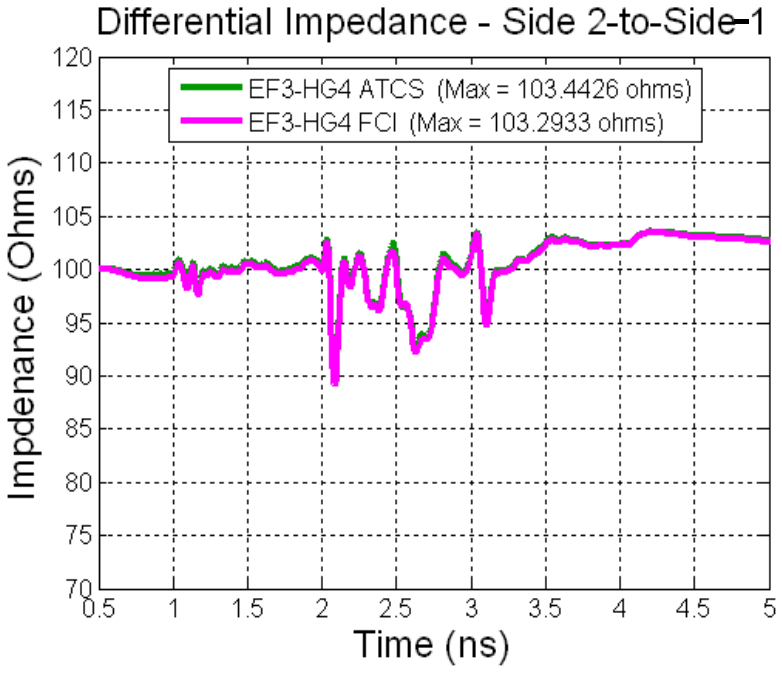
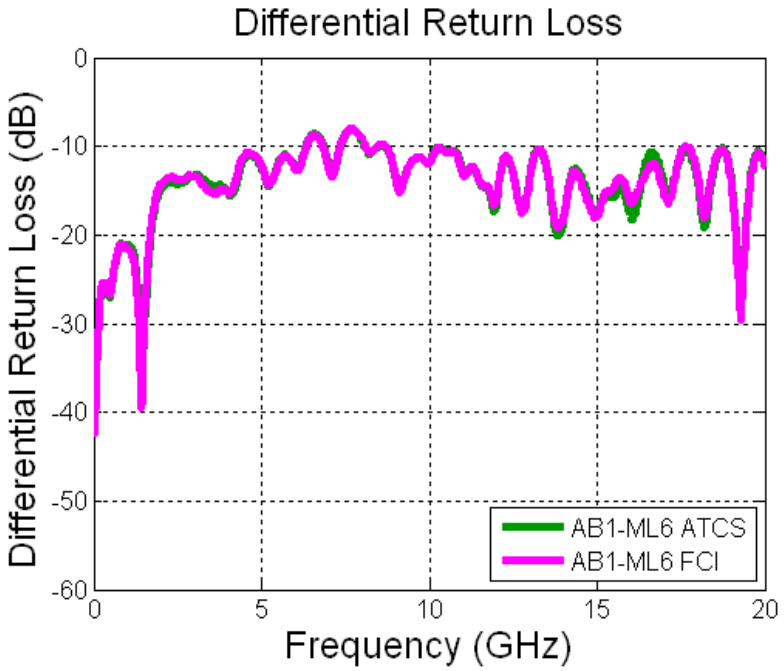




Differential Return Loss



SOLT Calibration

A1B1-M6L6	A2B2-K6J6	A3B3-H6G6
C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
E1F1-M4L4	E2F2-K4J4	E3F3-H4G4

Amphenol

FCI

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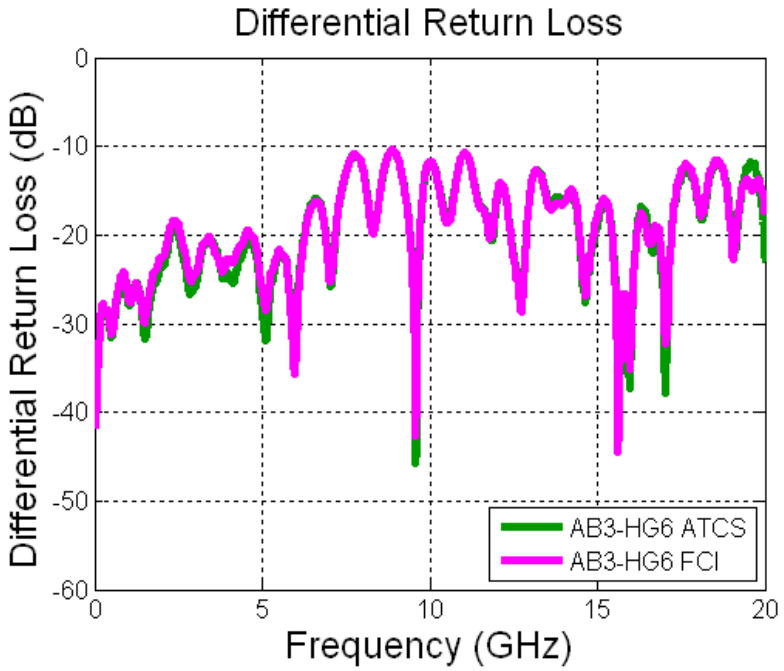

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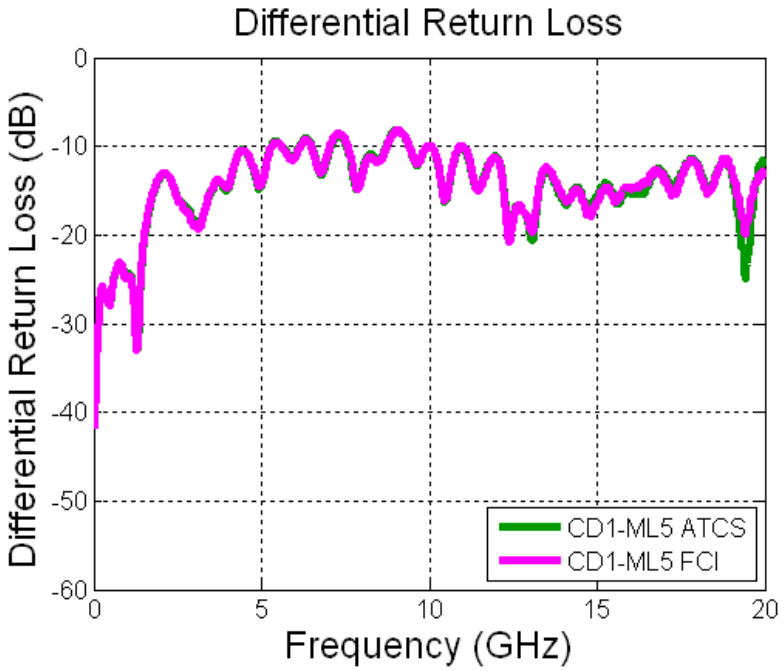

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C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
E1F1-M4L4	E2F2-K4J4	E3F3-H4G4

Amphenol

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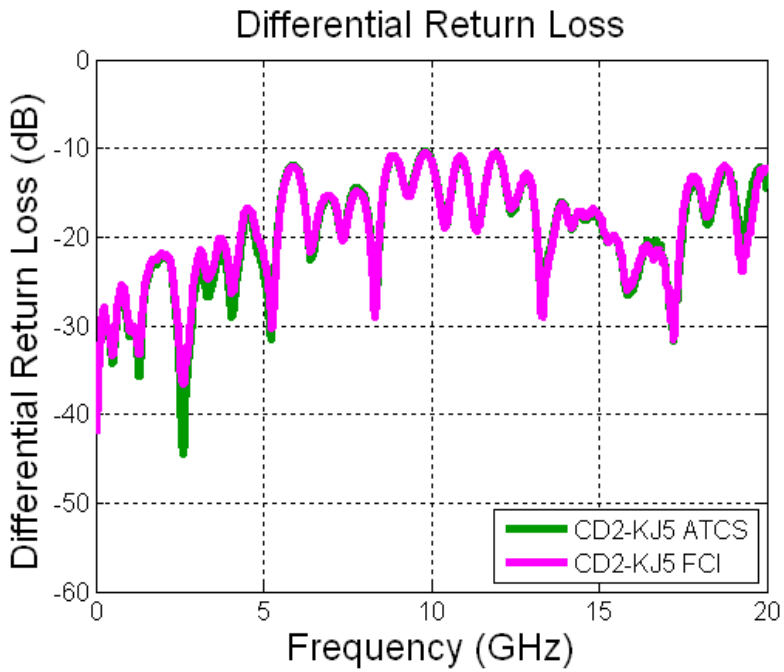
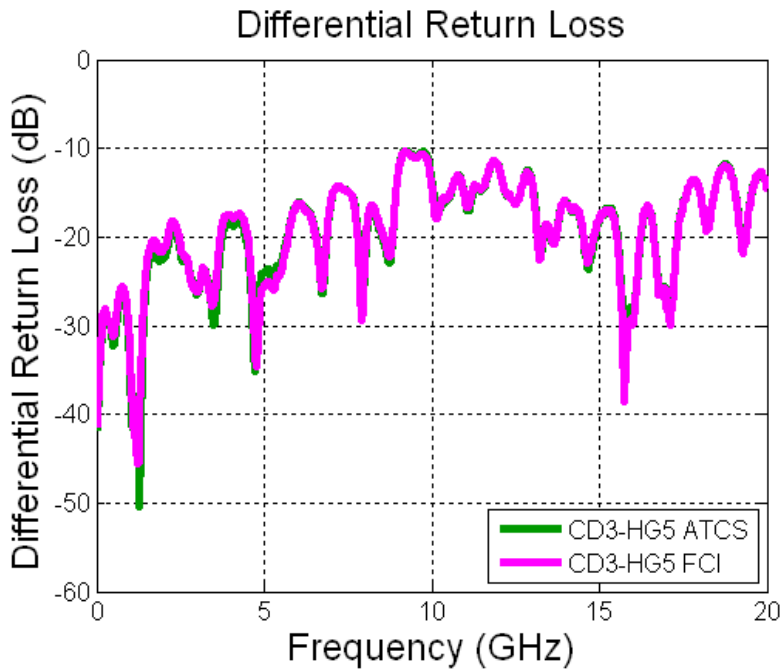
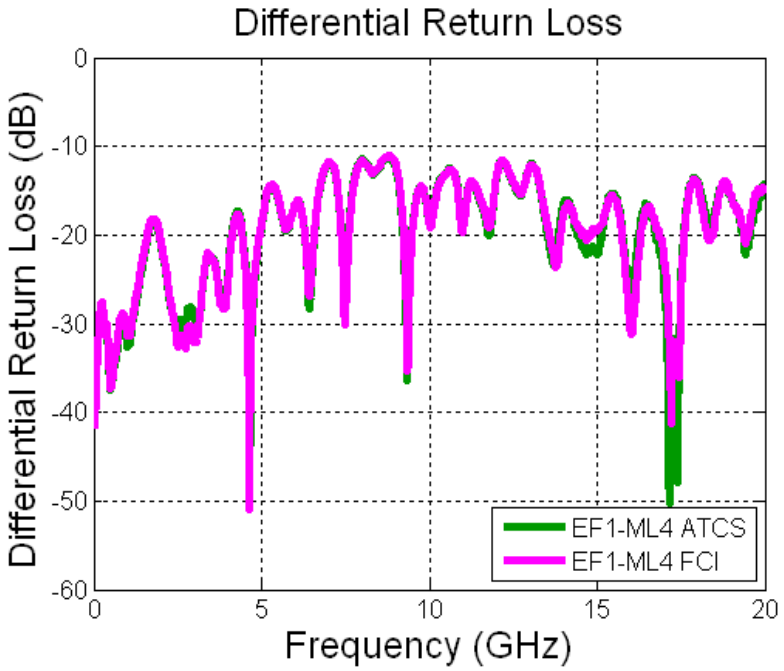




Differential Return Loss



SOLT Calibration

A1B1-M6L6	A2B2-K6J6	A3B3-H6G6
C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
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Amphenol

FCI

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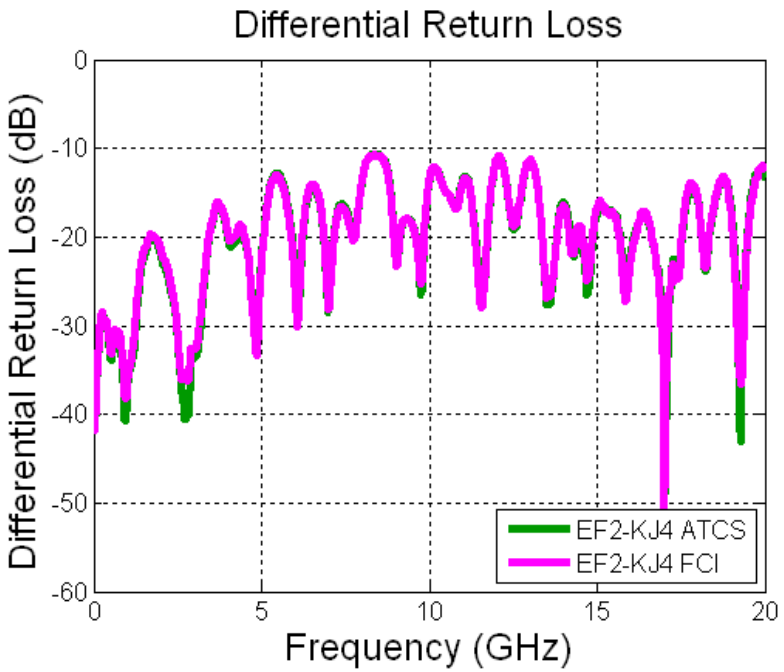
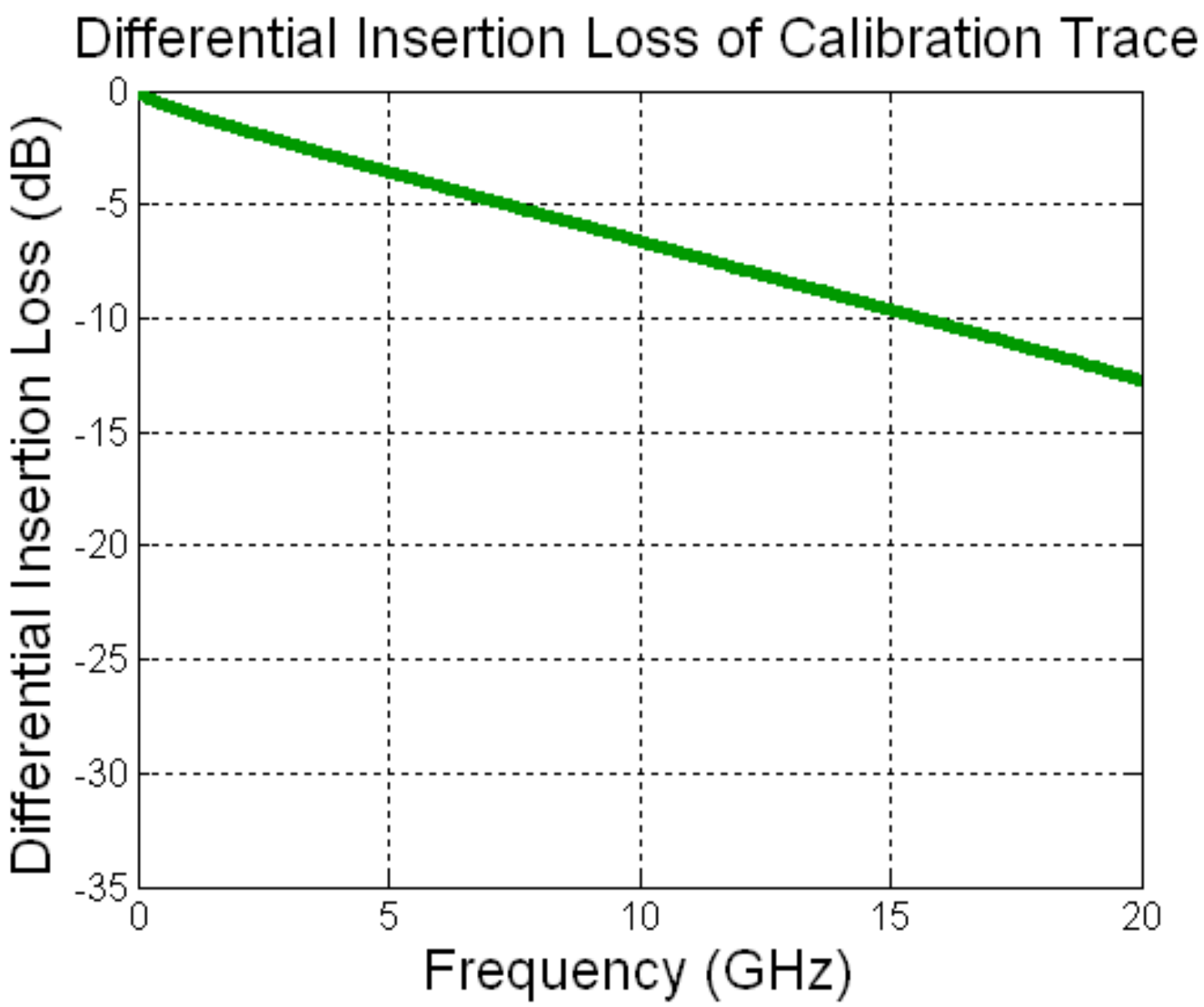
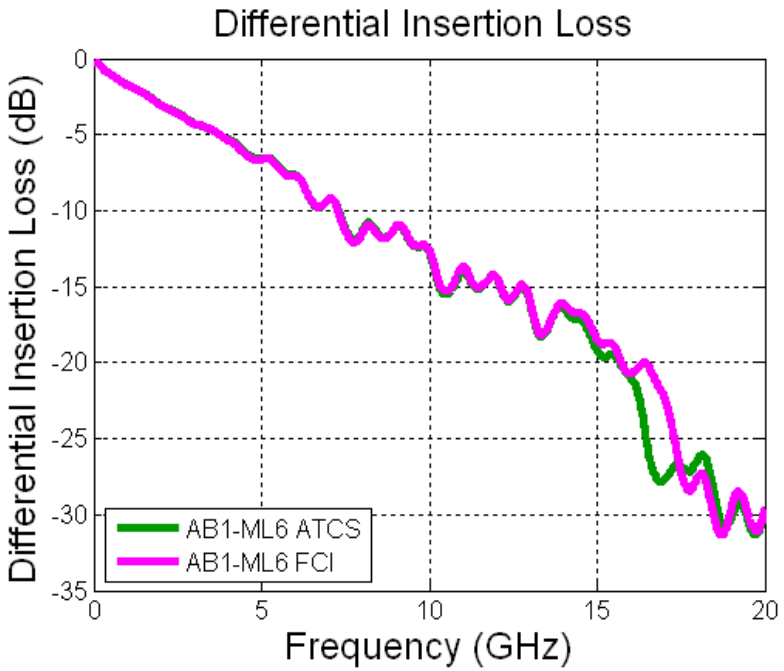


PCB Loss


Differential Insertion Loss of Calibration Trace
Differential Insertion Loss (dB)
0
-5
-10
-15
-20
-25
-30
-35
0
5
10
15
20
Frequency (GHz)

Differential Insertion Loss



SOLT Calibration

A1B1-M6L6	A2B2-K6J6	A3B3-H6G6
C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
E1F1-M4L4	E2F2-K4J4	E3F3-H4G4

Amphenol

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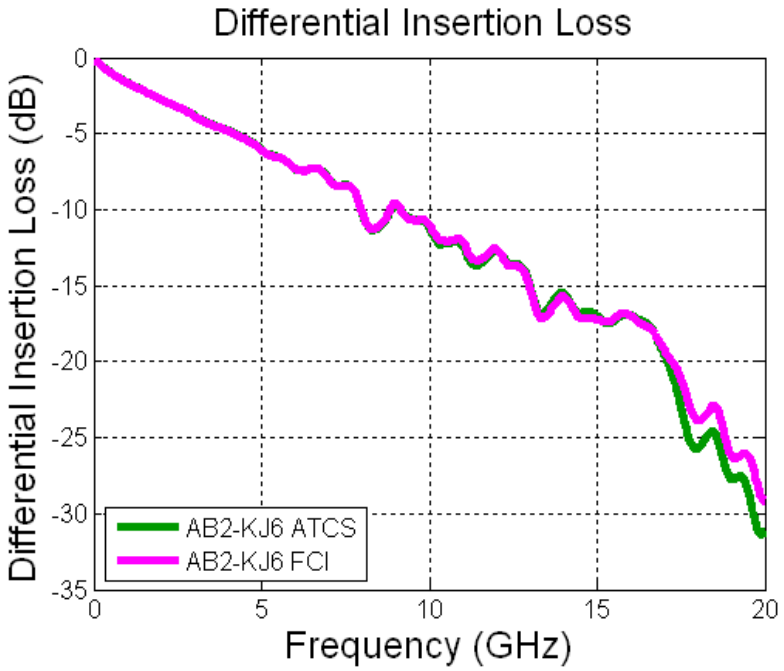
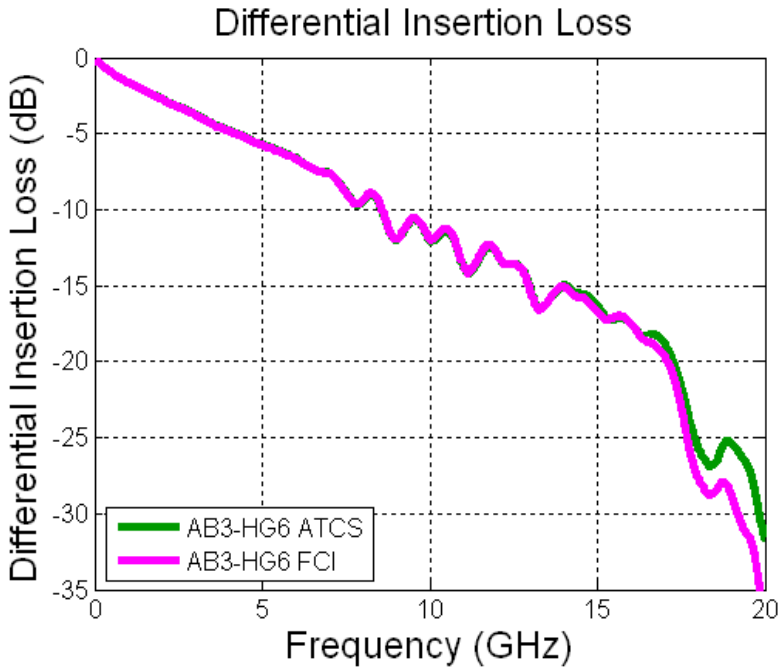
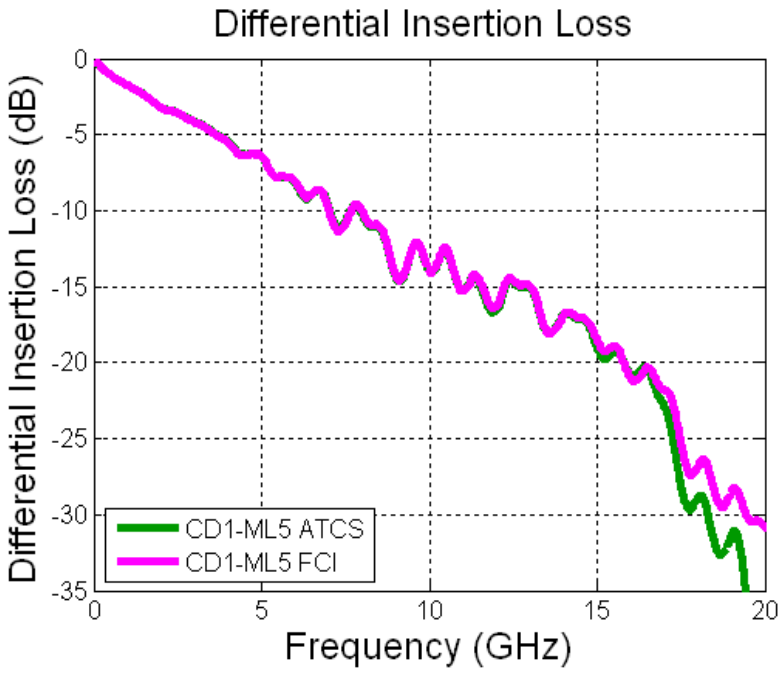




Differential Insertion Loss



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C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
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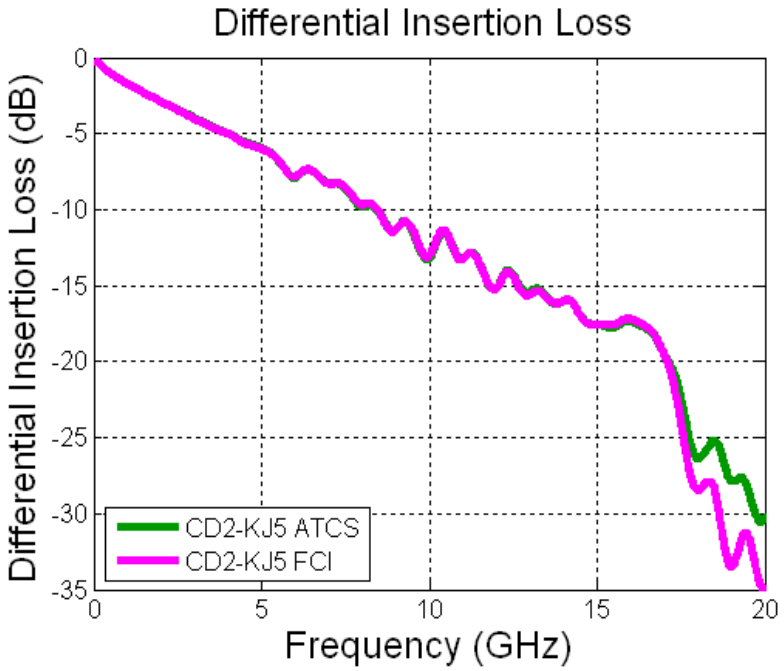
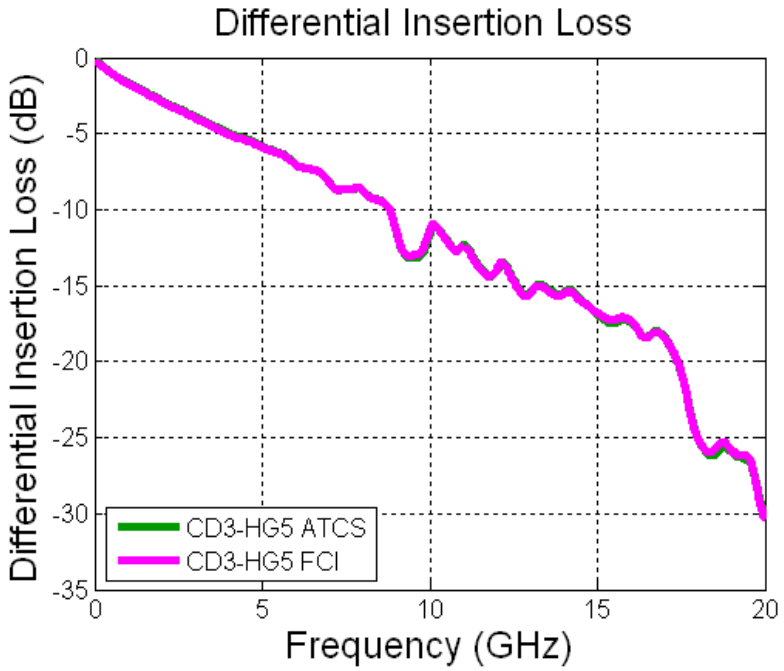
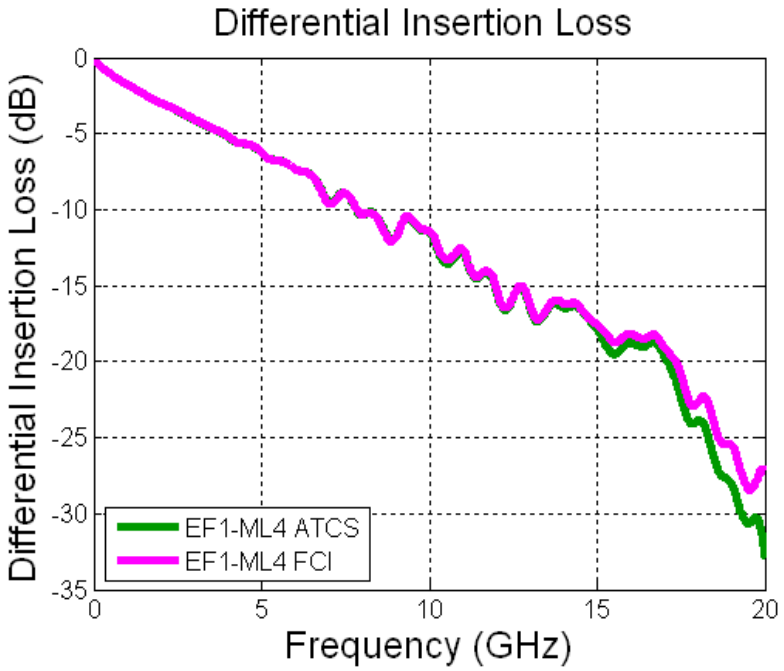




Differential Insertion Loss



SOLT Calibration

A1B1-M6L6	A2B2-K6J6	A3B3-H6G6
C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
E1F1-M4L4	E2F2-K4J4	E3F3-H4G4

Amphenol

FCI

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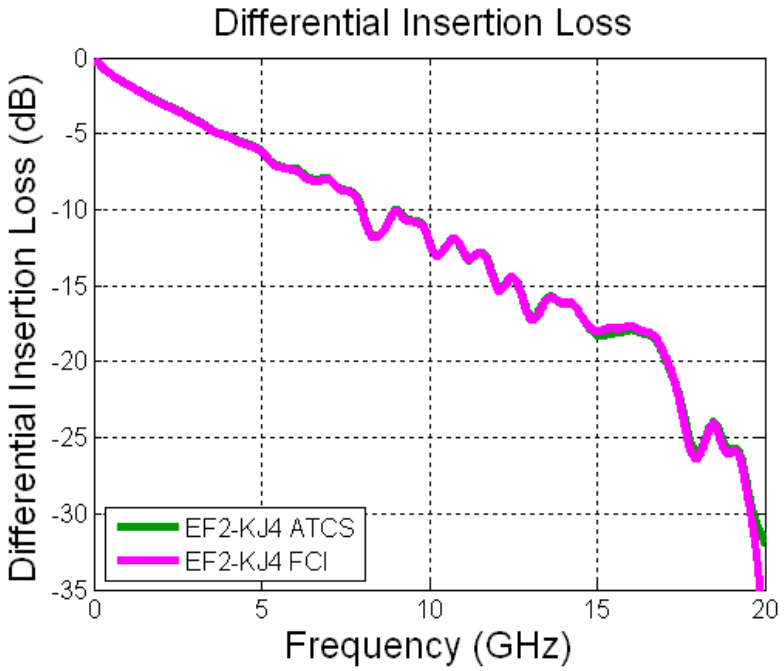
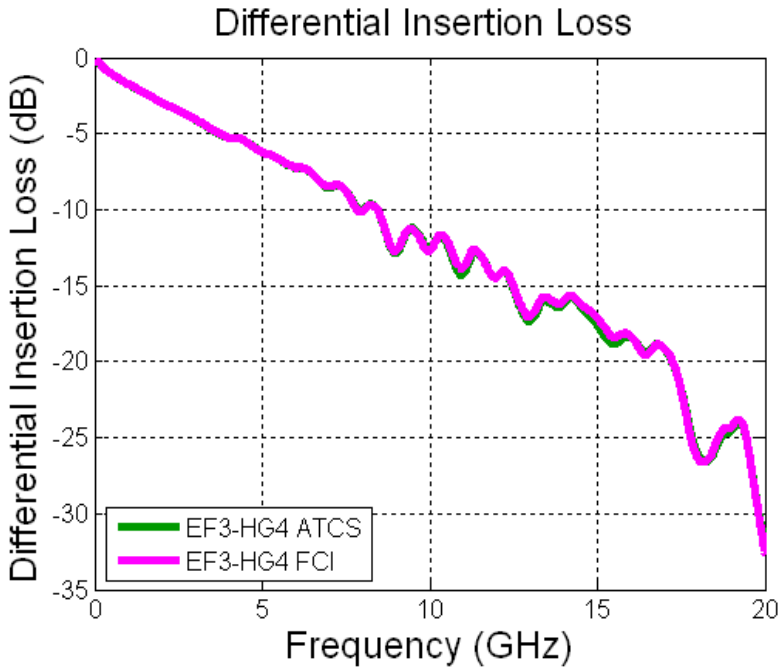
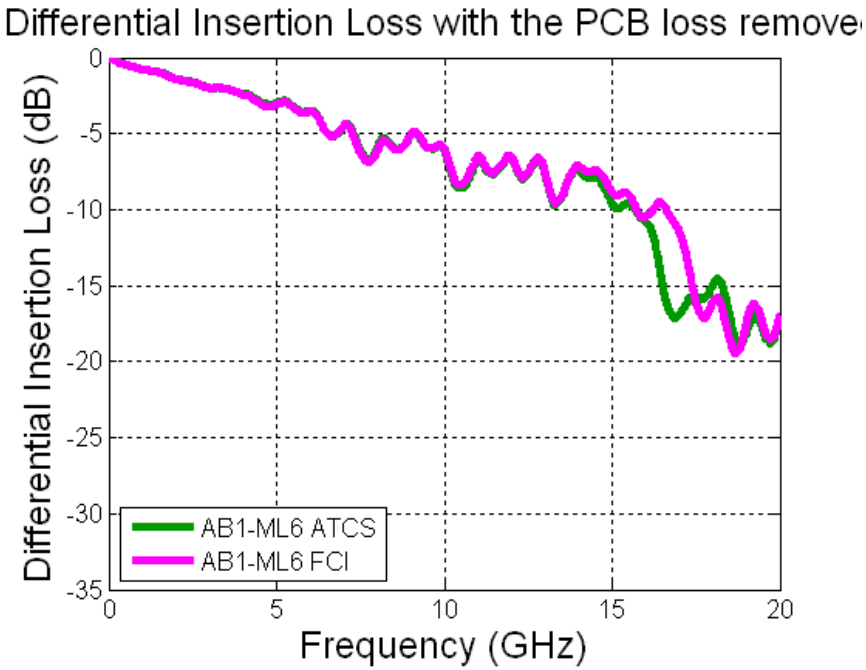




Differential Insertion Loss – PCB Loss Removed



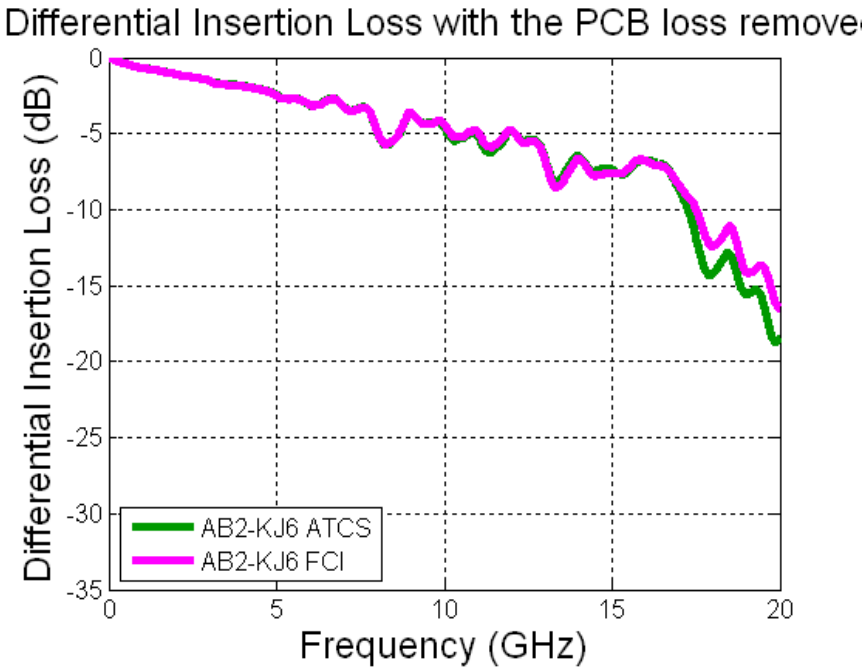
SOLT Calibration

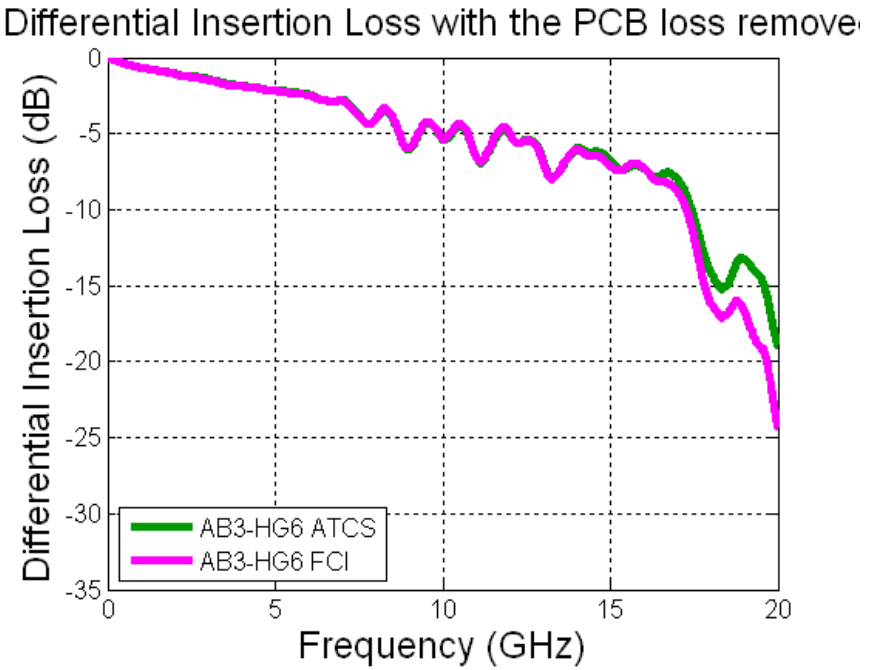
A1B1-M6L6	A2B2-K6J6	A3B3-H6G6
C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
E1F1-M4L4	E2F2-K4J4	E3F3-H4G4

Amphenol

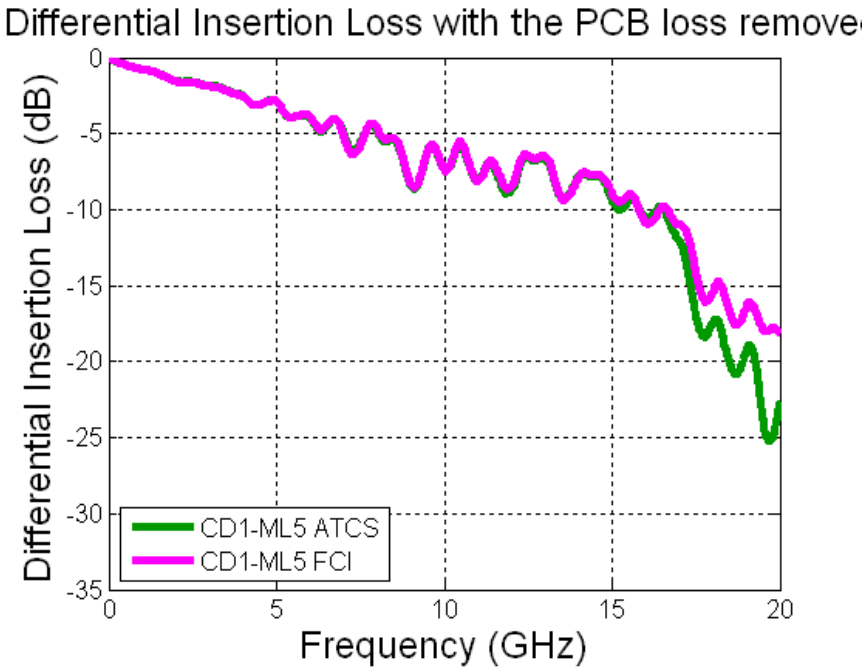
FCI

Data is shown in this slide





Differential Insertion Loss – PCB Loss Removed



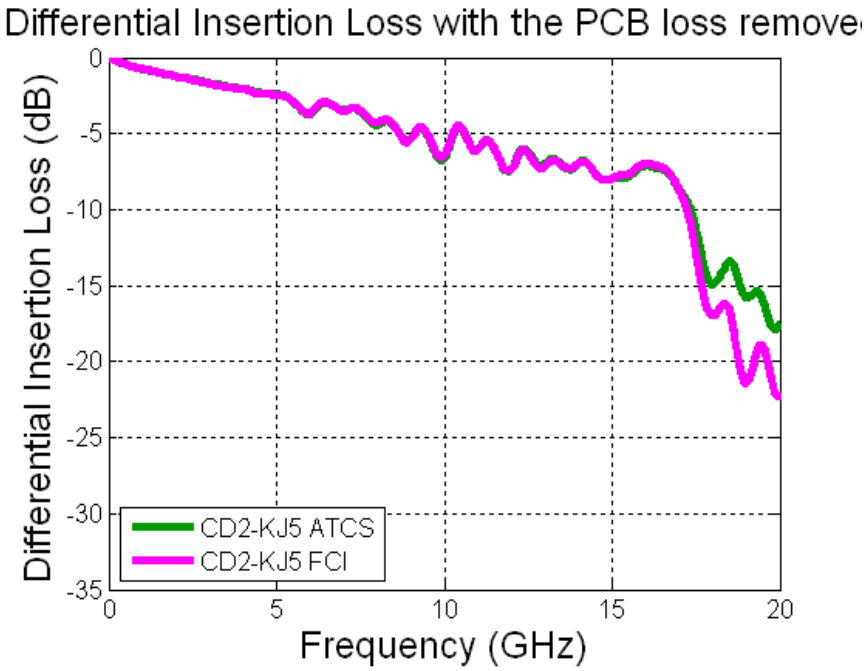
SOLT Calibration

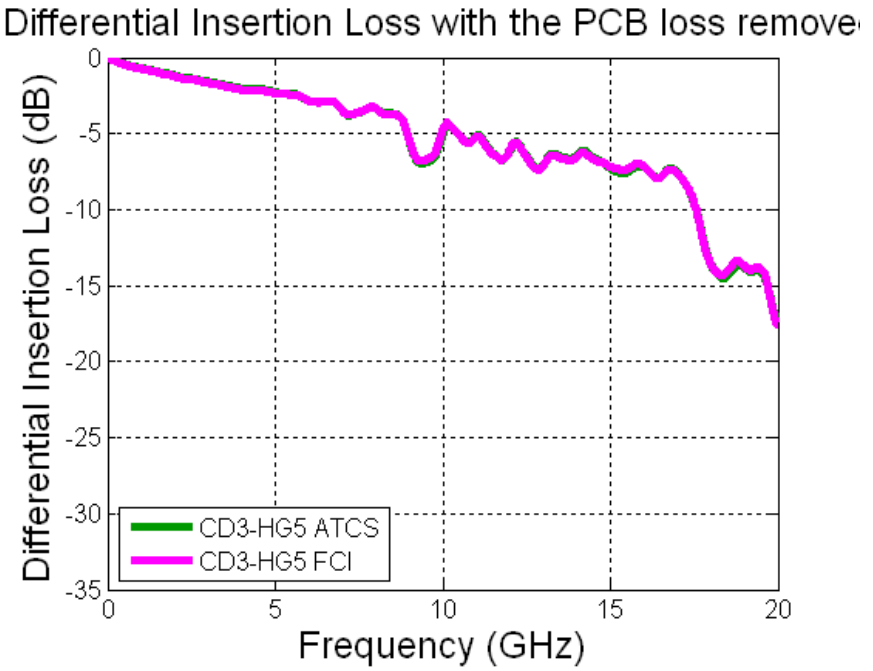
A1B1-M6L6	A2B2-K6J6	A3B3-H6G6
C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
E1F1-M4L4	E2F2-K4J4	E3F3-H4G4

Amphenol

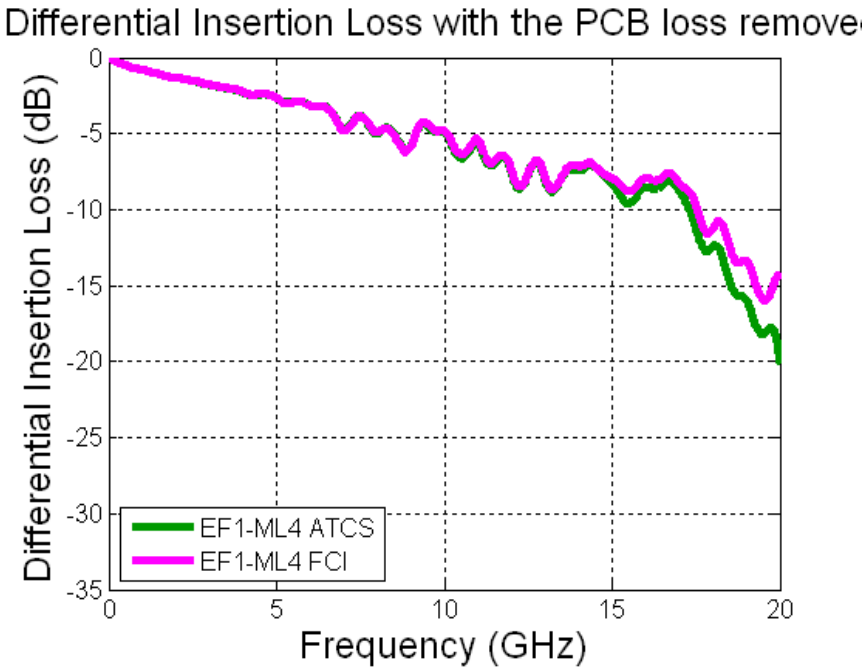
FCI

Data is shown in this slide





Differential Insertion Loss – PCB Loss Removed



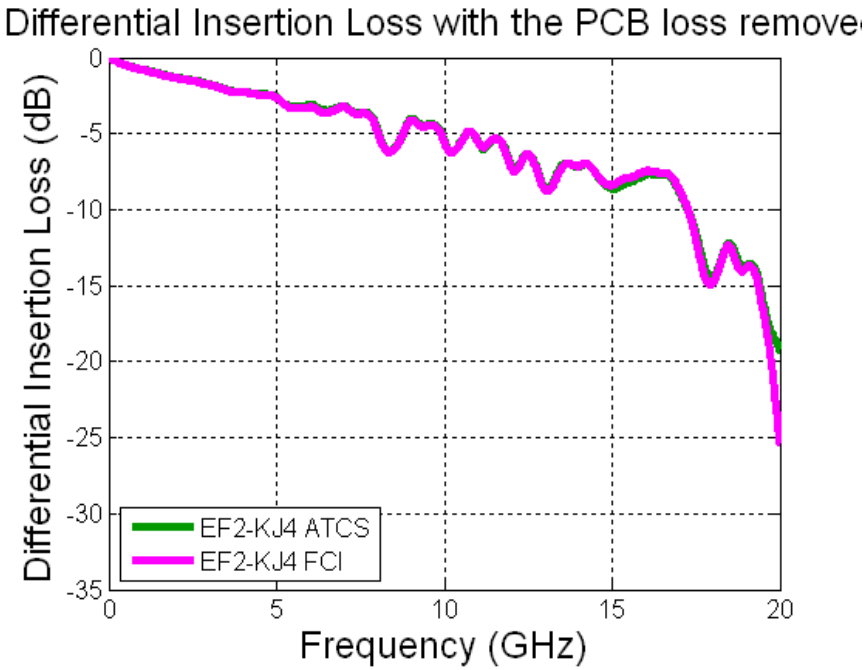
SOLT Calibration

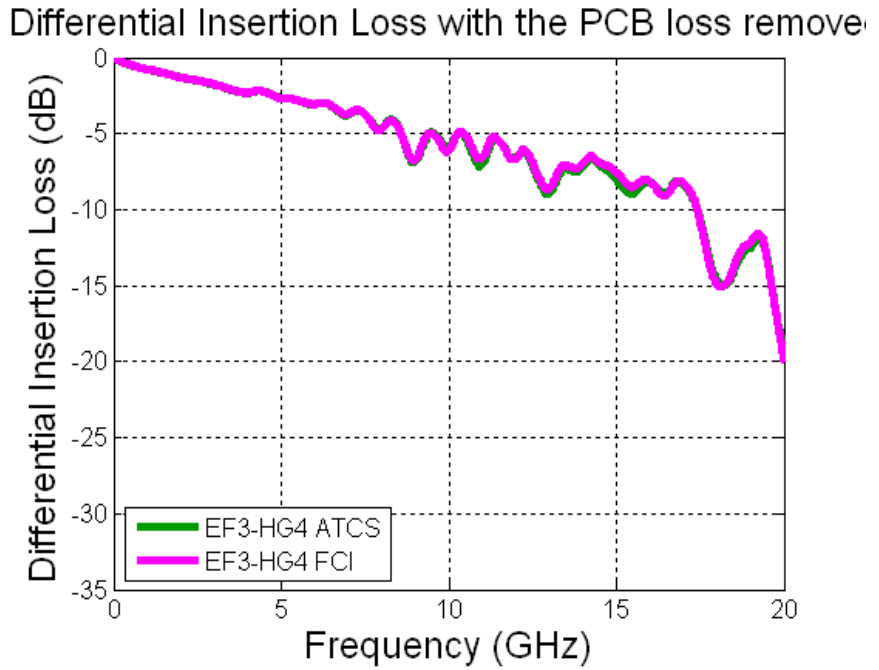
A1B1-M6L6	A2B2-K6J6	A3B3-H6G6
C1D1-M5L5	C2D2-K5J5	C3D3-H5G5
E1F1-M4L4	E2F2-K4J4	E3F3-H4G4

Amphenol

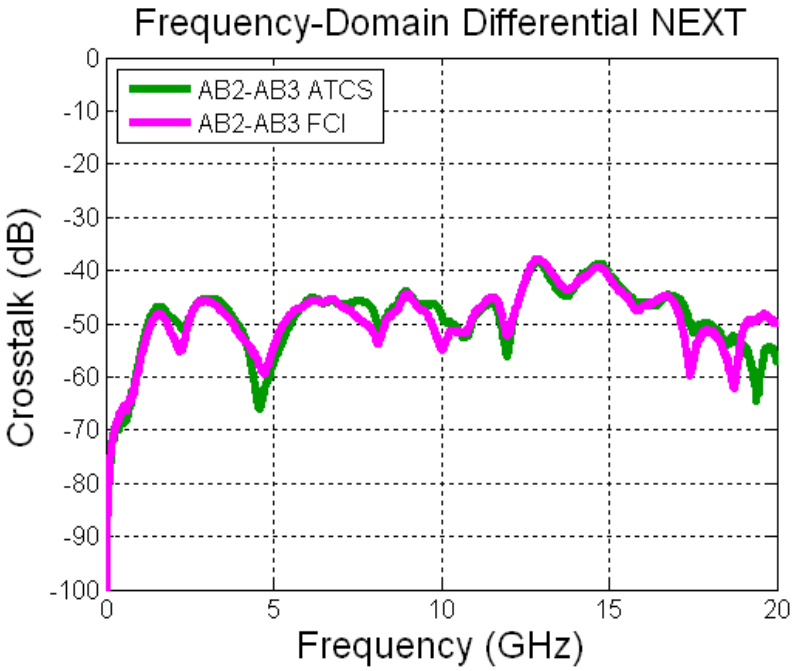
FCI

Data is shown in this slide





Frequency Domain Near-End Crosstalk



Single active

A2B2	A3B3
C2D2	C3D3

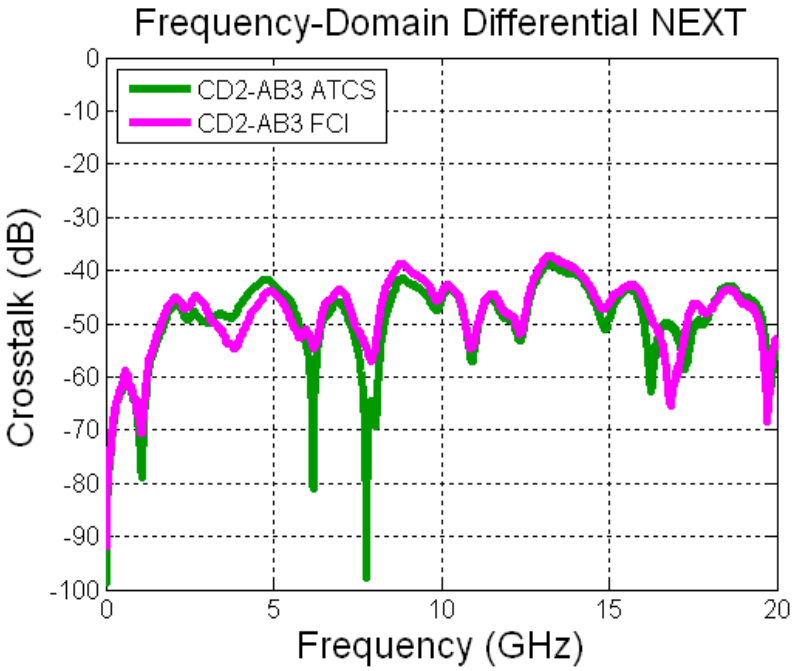
Victim pair

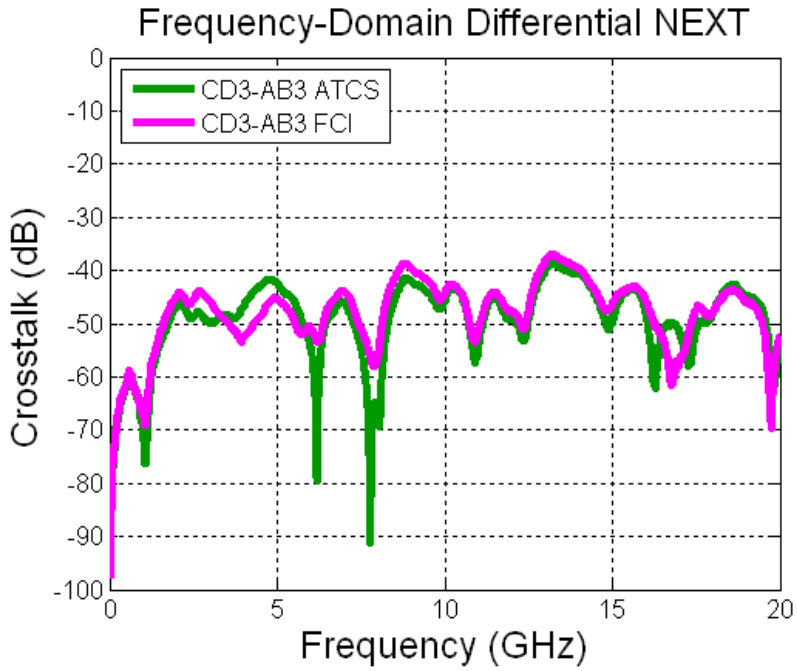
Active pair

Amphenol

FCI

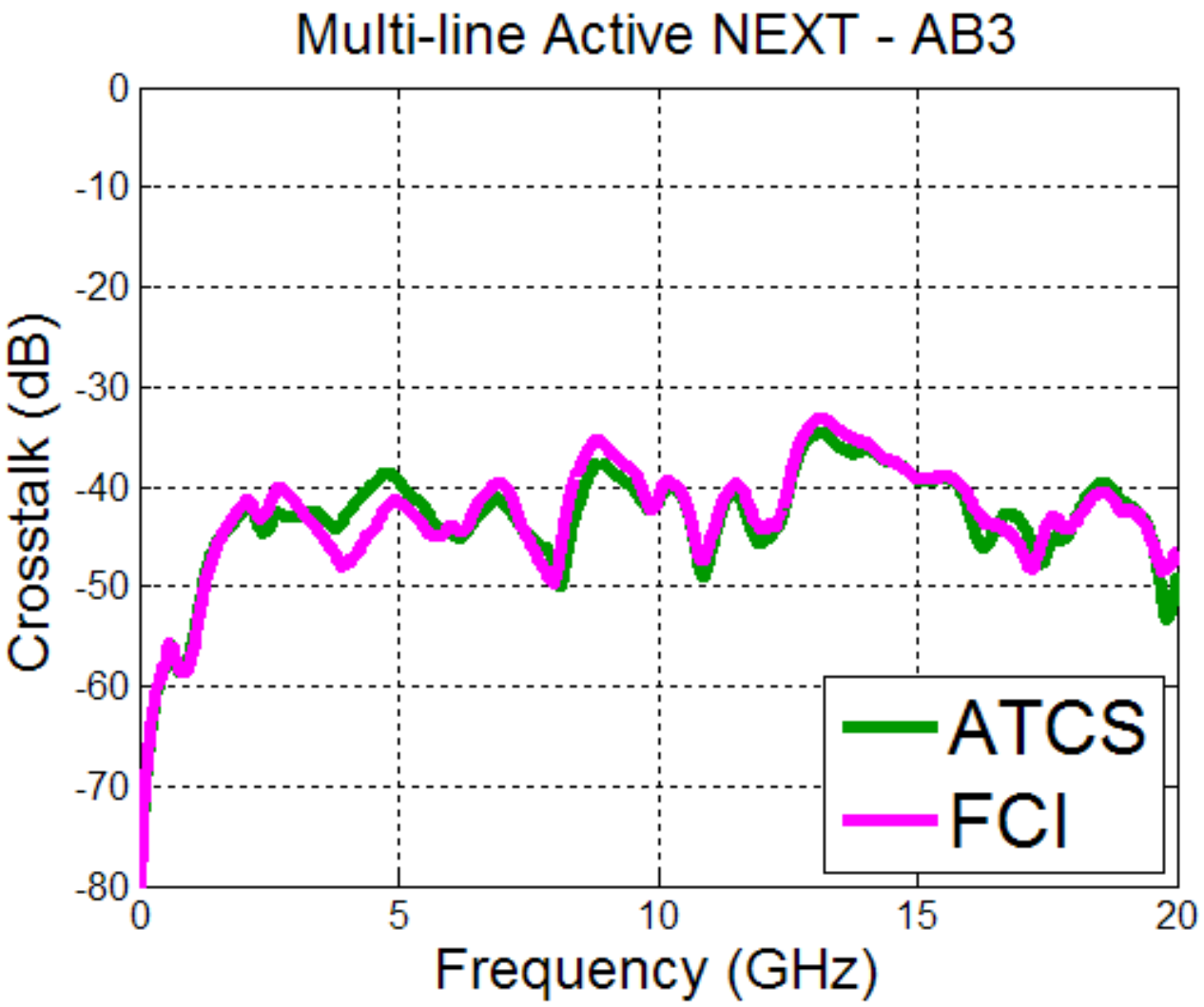
SOLT Calibration





Frequency Domain Near-End Crosstalk

Multi-Active (3:1)



A2B2	A3B3
C2D2	C3D3

Victim pair

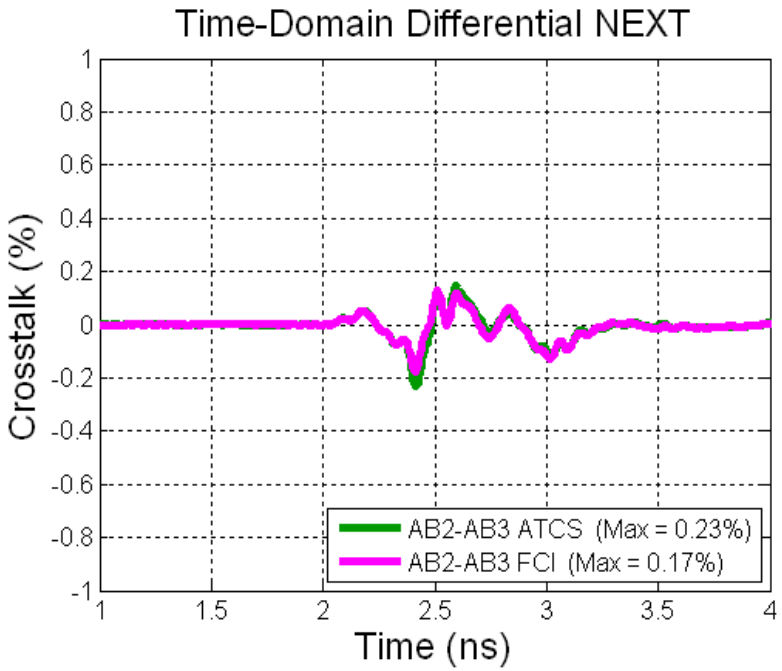
Active pair

SOLT Calibration

Amphenol

FCI

Time Domain Near-End Crosstalk



Single active

A2B2	A3B3
C2D2	C3D3

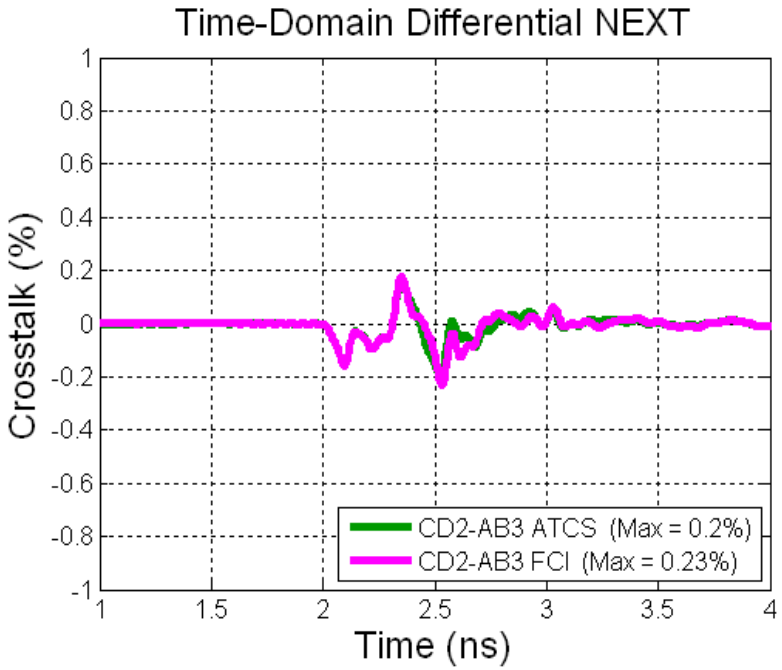
Victim pair

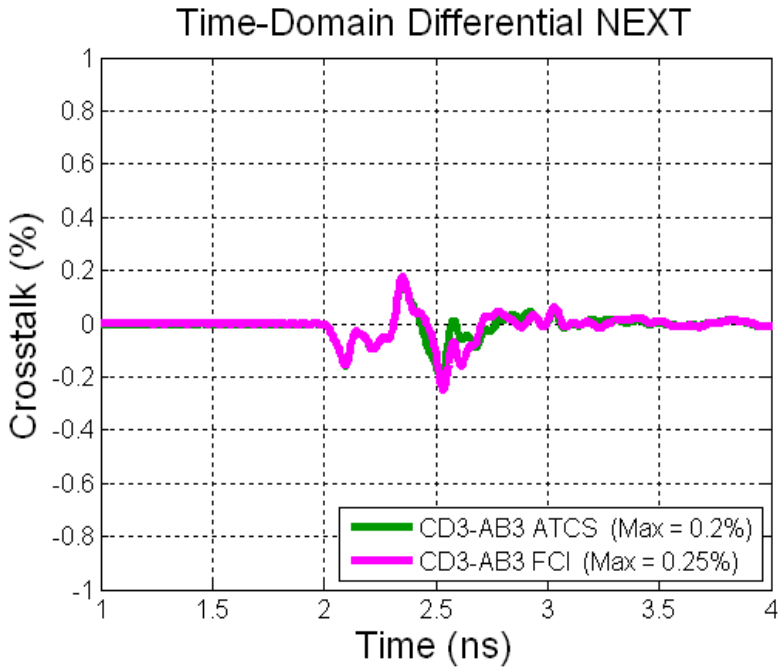
Active pair

Amphenol

FCI

SOLT Calibration





Time Domain Near-End Crosstalk

Multi-Active (3:1)

Amphenol

A2B2 0.23	A3B3
C2D2 0.2	C3D3 0.2
Total	.63

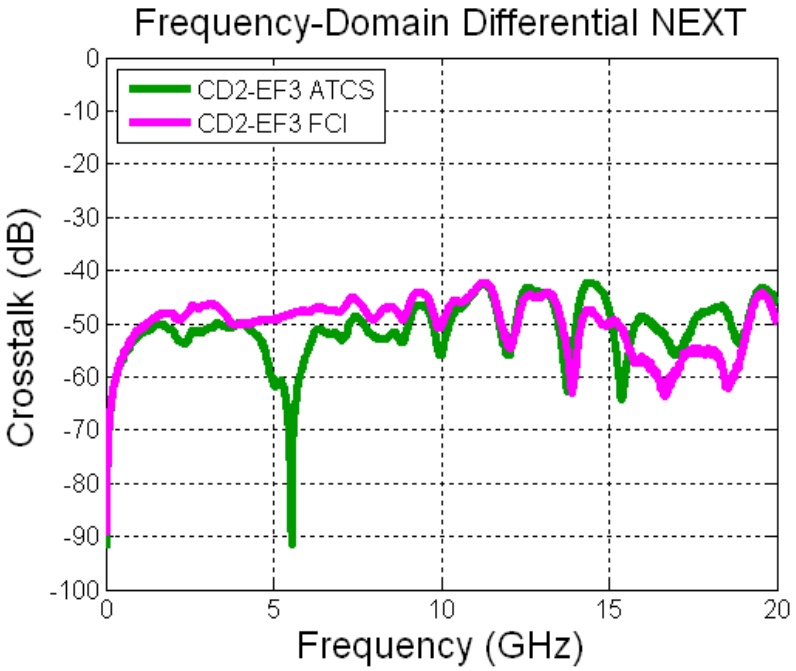
FCI1

A2B2 0.17	A3B3
C2D2 0.23	C3D3 0.25
Total	.65

Victim pair

Active pair

Frequency Domain Near-End Crosstalk



C2D2	C3D3	C4D4
E2F2	E3F3	E4F4
	G3H3	G4H4

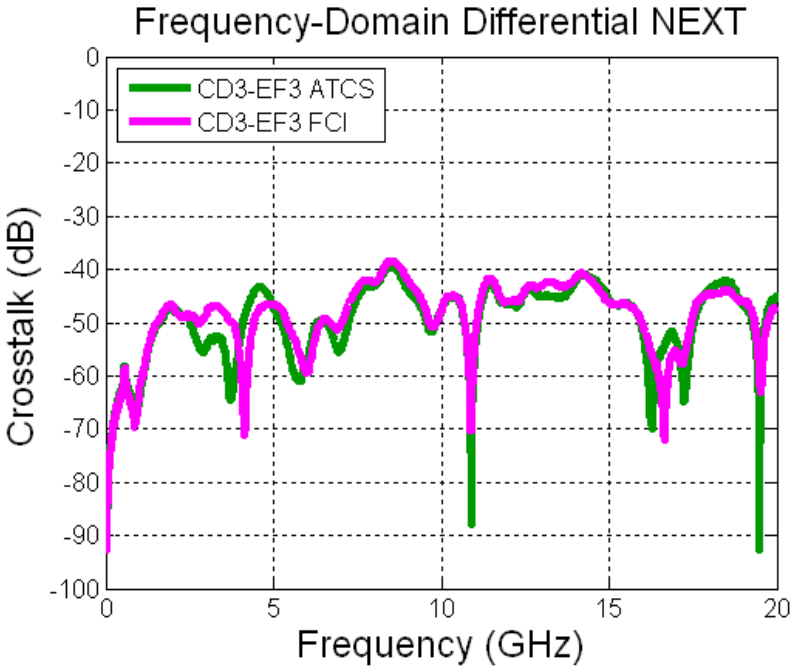
Victim pair

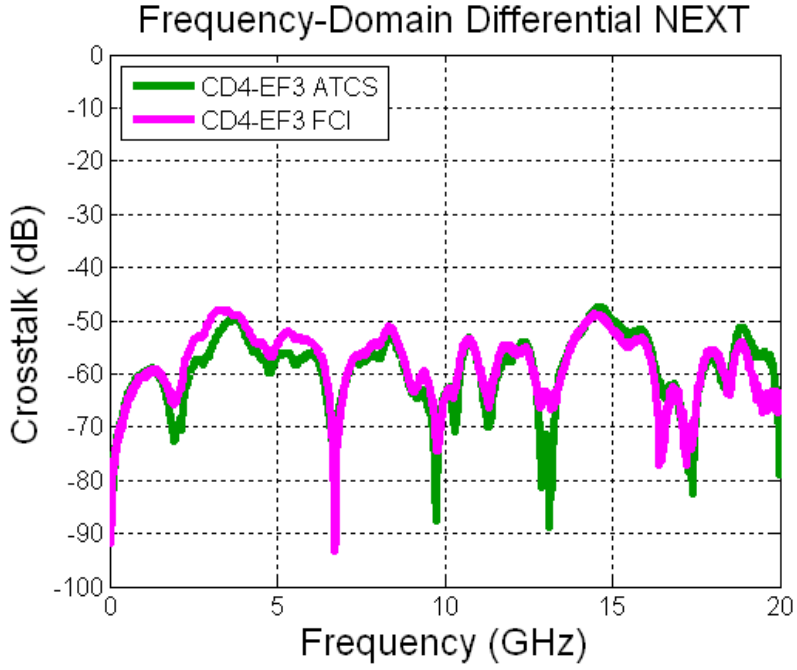
Active pair

SOLT Calibration

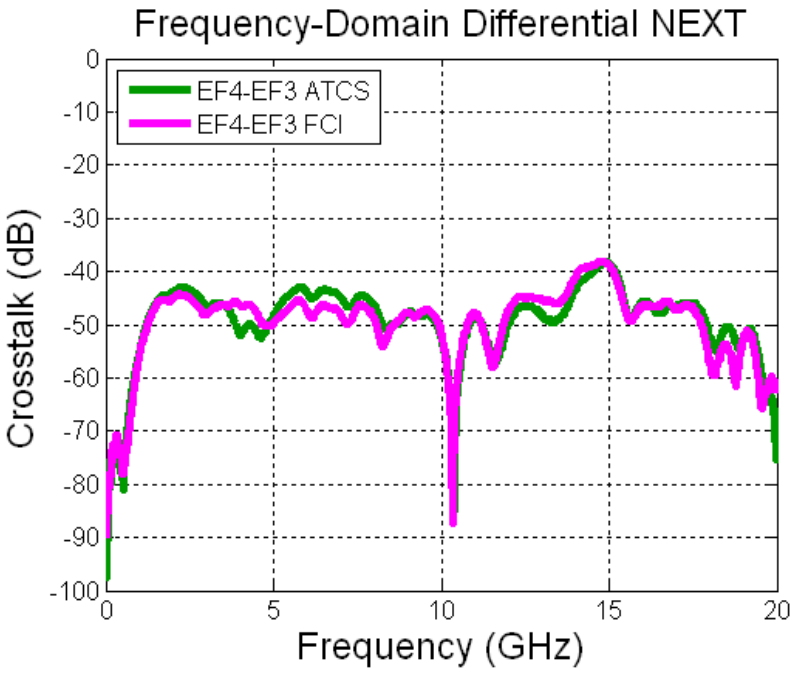
Amphenol

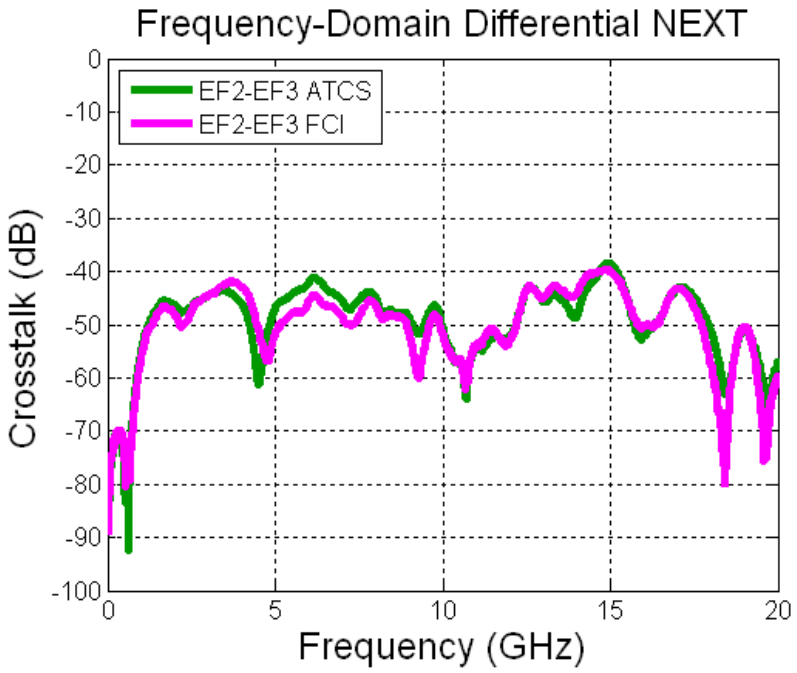
FCI

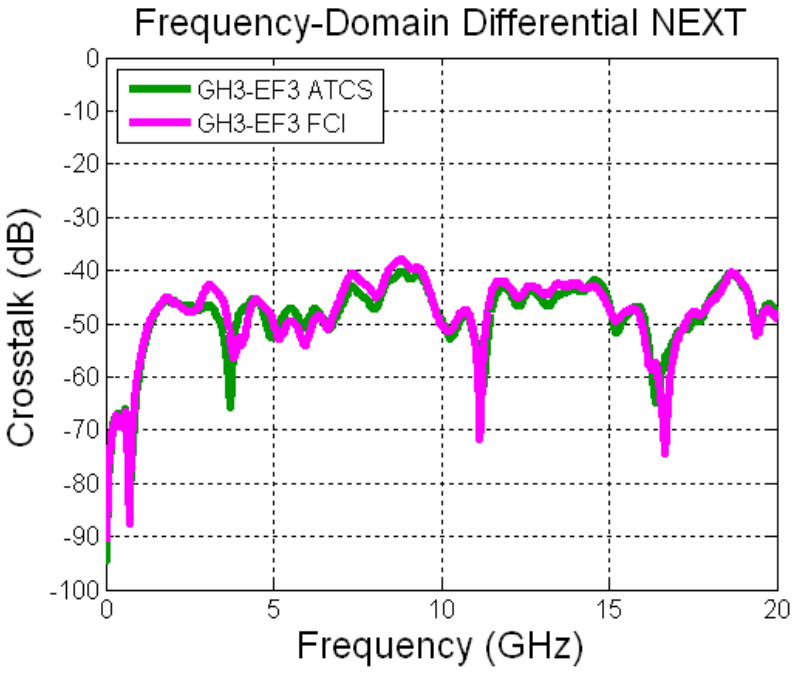


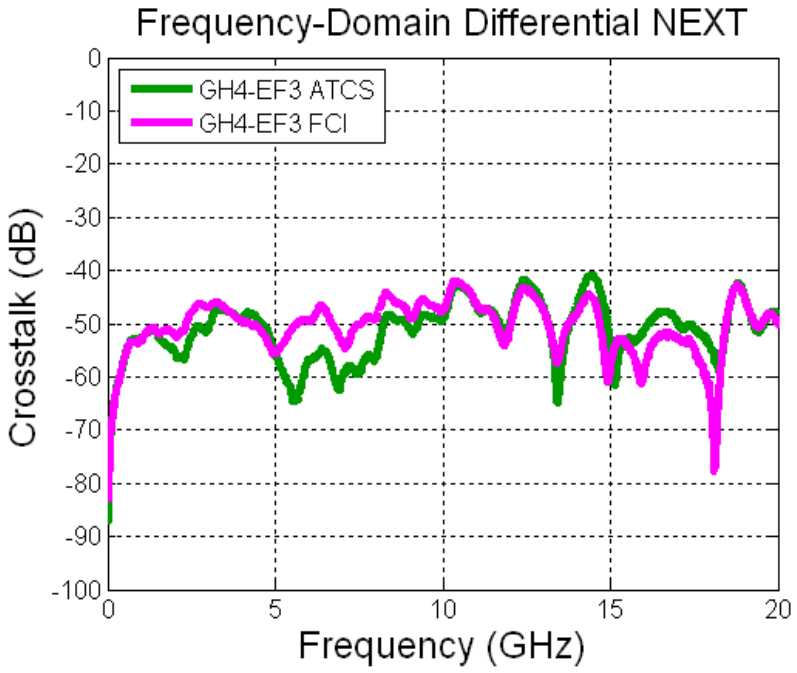


Frequency Domain Near-End Crosstalk



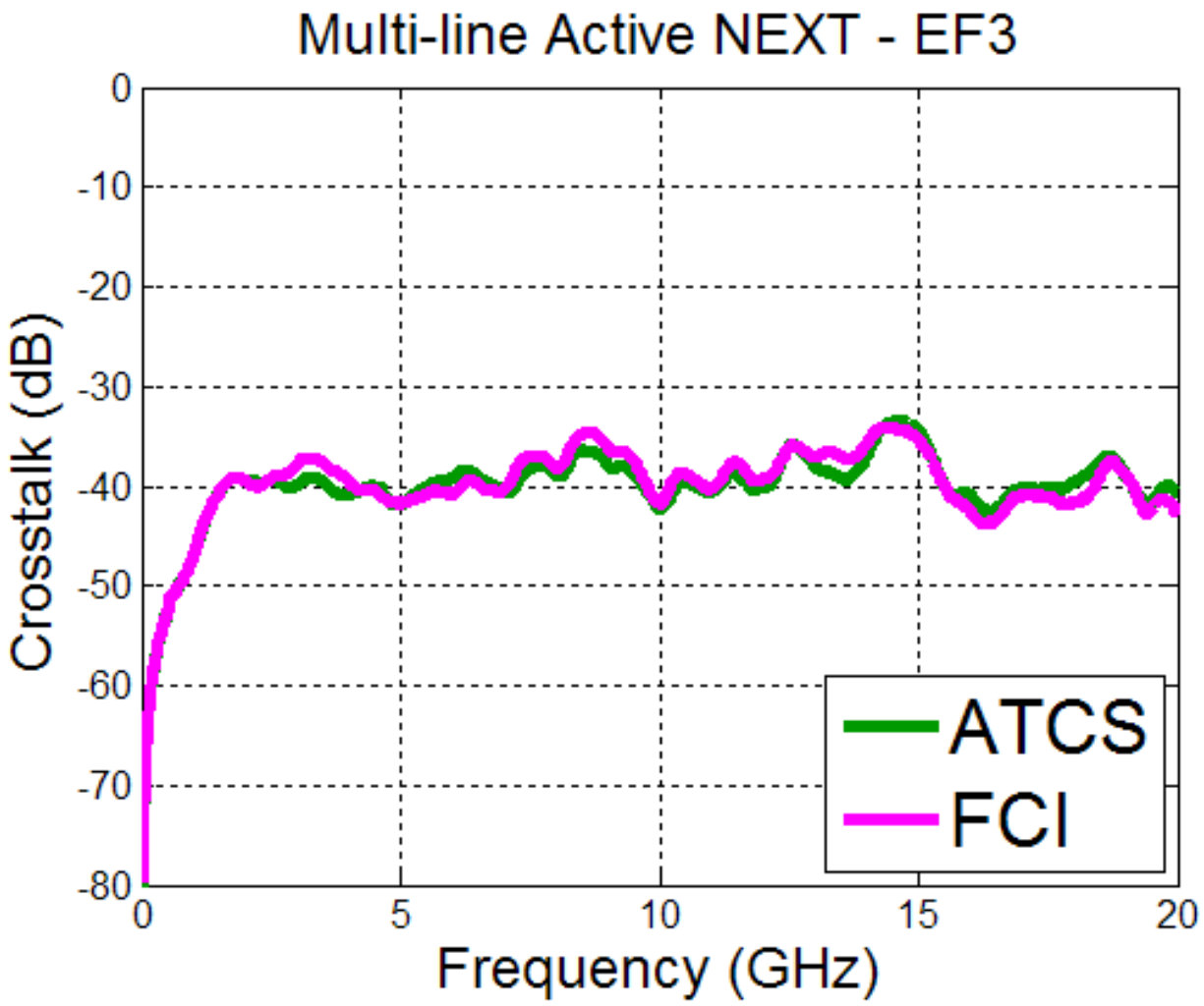






Frequency Domain Near-End Crosstalk

Multi-Active (7:1)



C2D2	C3D3	C4D4
E2F2	E3F3	E4F4
	G3H3	G4H4

Victim pair

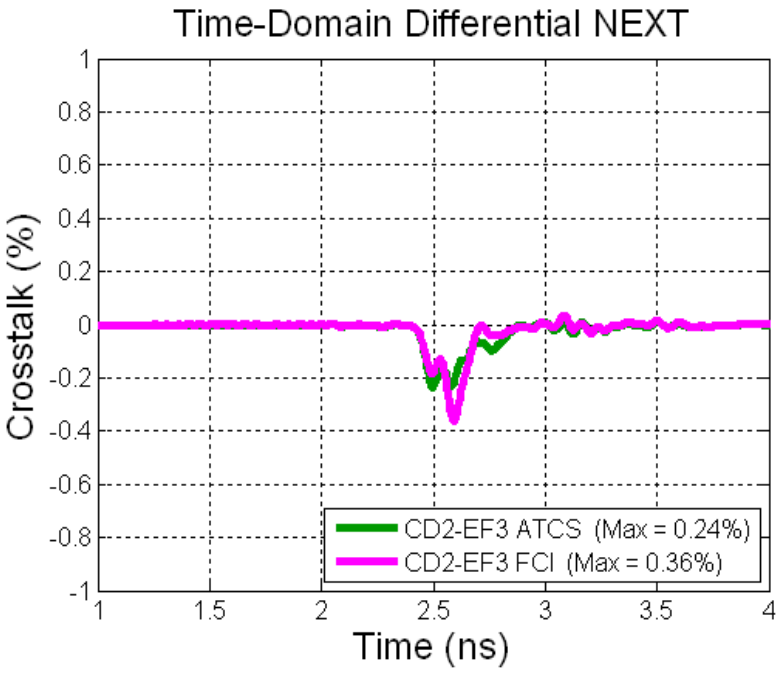
Active pair

SOLT Calibration

Amphenol

FCI

Time Domain Near-End Crosstalk



C2D2	C3D3	C4D4
E2F2	E3F3	E4F4
	G3H3	G4H4

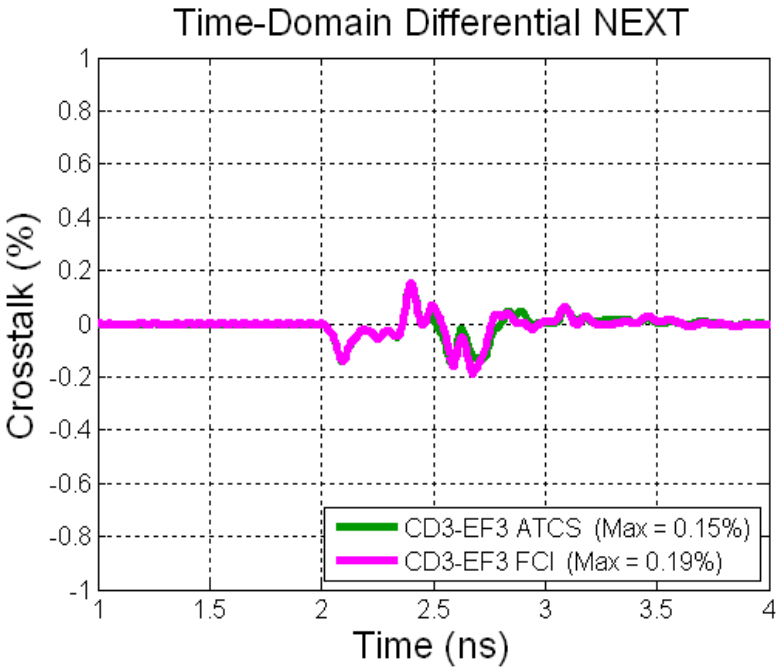
Victim pair

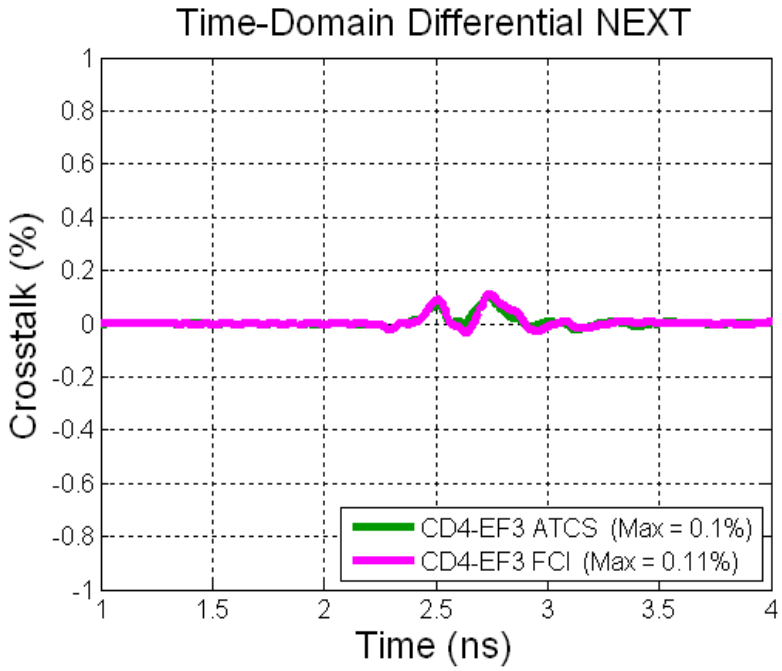
Active pair

SOLT Calibration

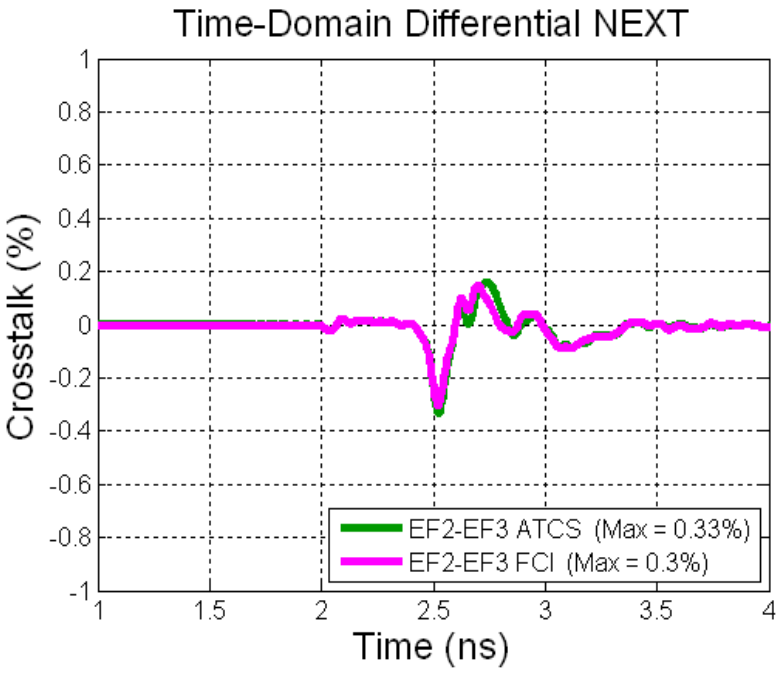
Amphenol

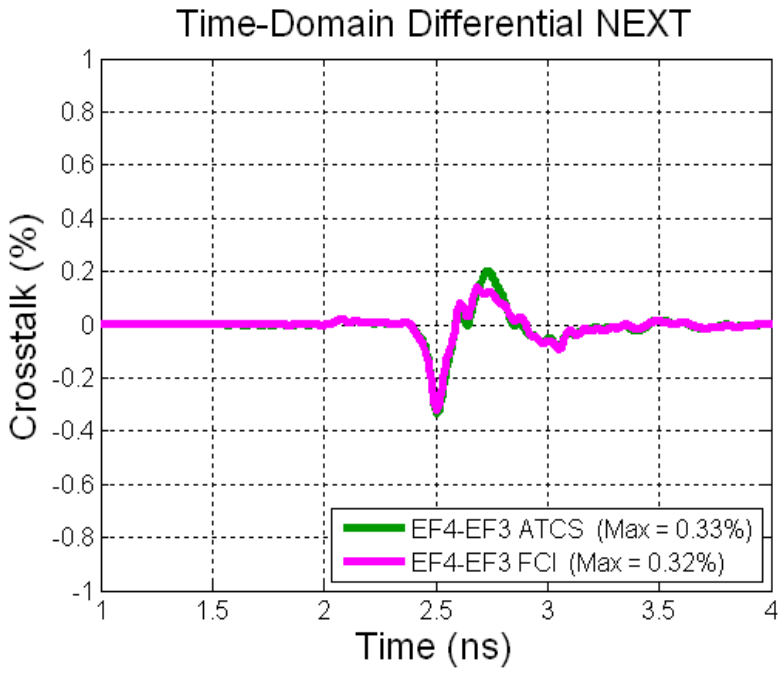
FCI

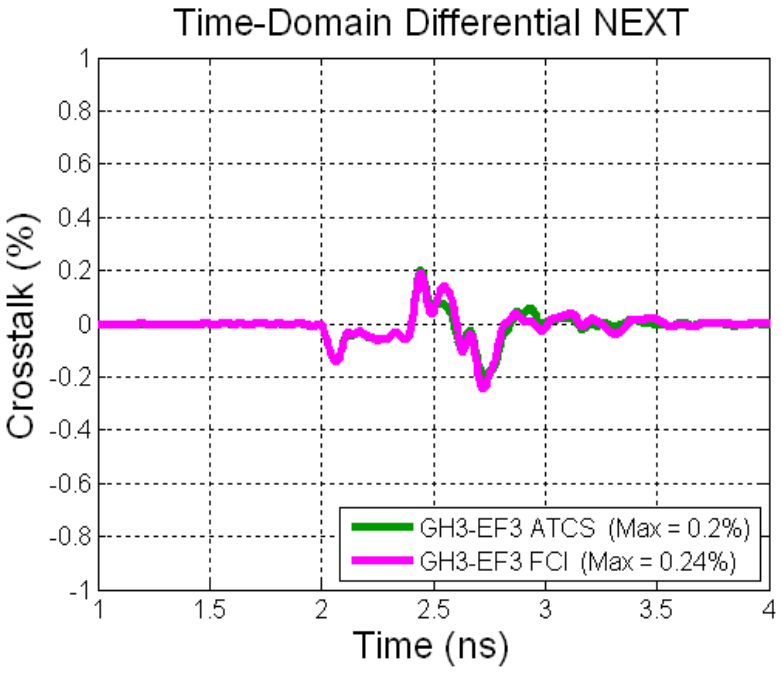


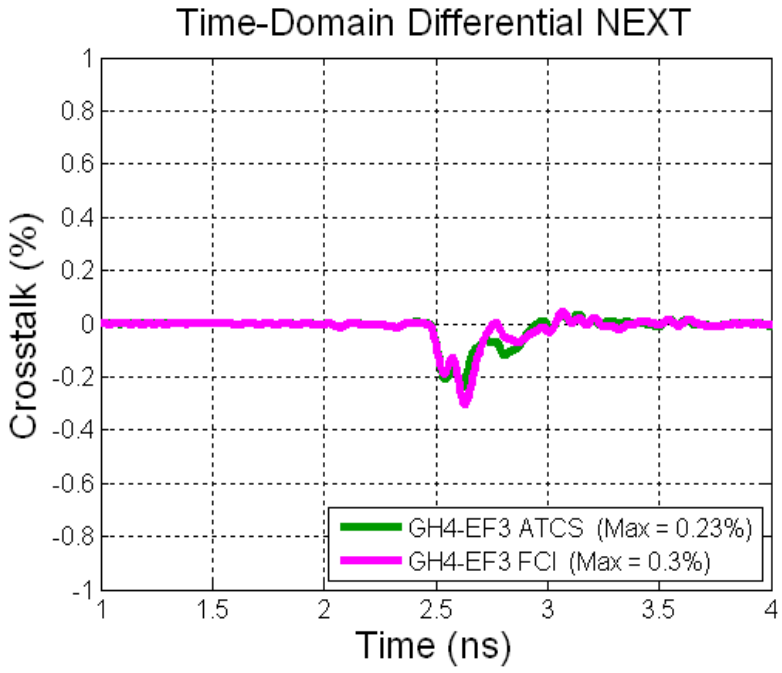


Time Domain Near-End Crosstalk









Time Domain Near-End Crosstalk

Multi-Active (7:1)

Amphenol

C2D2 0.24	C3D3 0.15	C4D4 0.1
E2F2 0.33	E3F3	E4F4 0.33
	G3H3 0.2	G4H4 0.23
Total		1.58

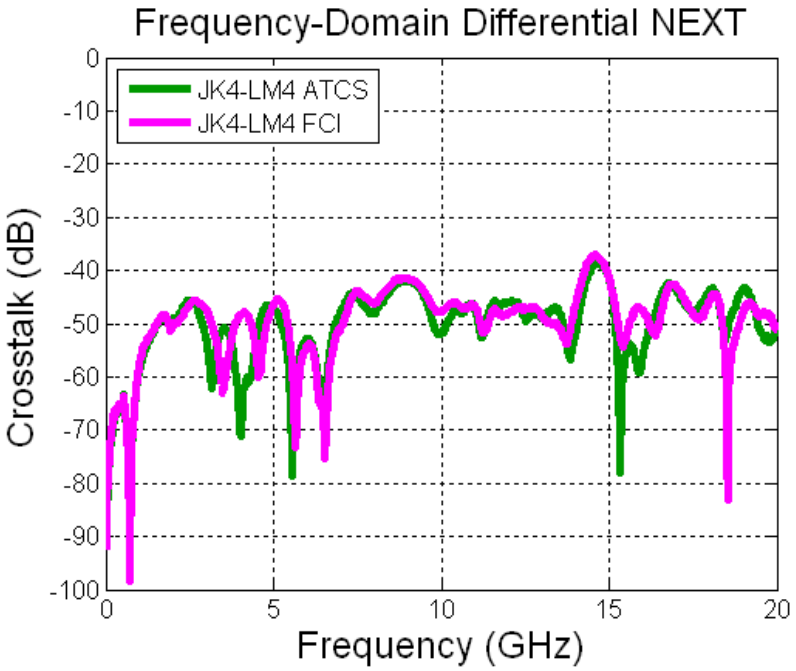
FCI1

C2D2 0.36	C3D3 0.19	C4D4 0.11
E2F2 0.3	E3F3	E4F4 0.32
	G3H3 0.24	G4H4 0.3
Total		1.82

Victim pair

Active pair

Frequency Domain Near-End Crosstalk



Single active

J4K4	J5K5
L4M4	L5M5

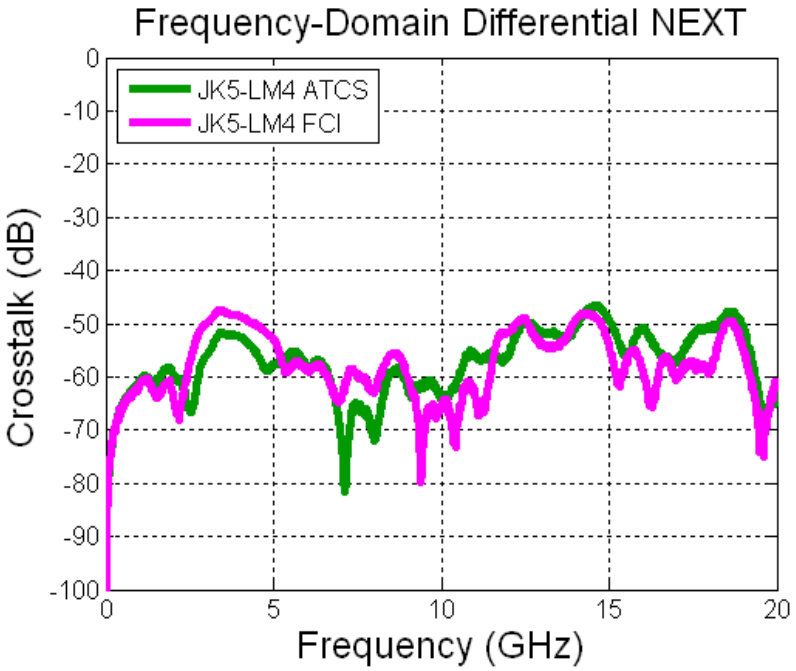
Victim pair

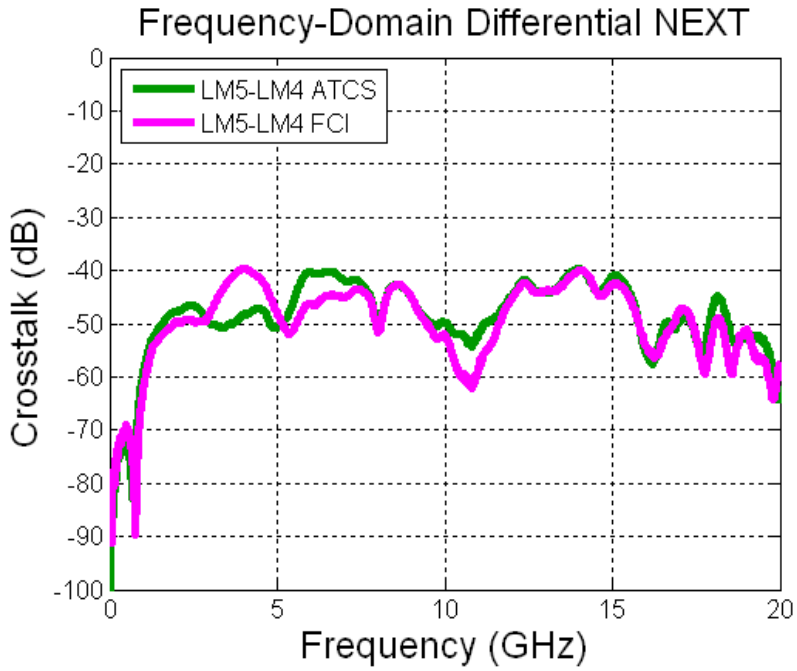
Active pair

Amphenol

FCI

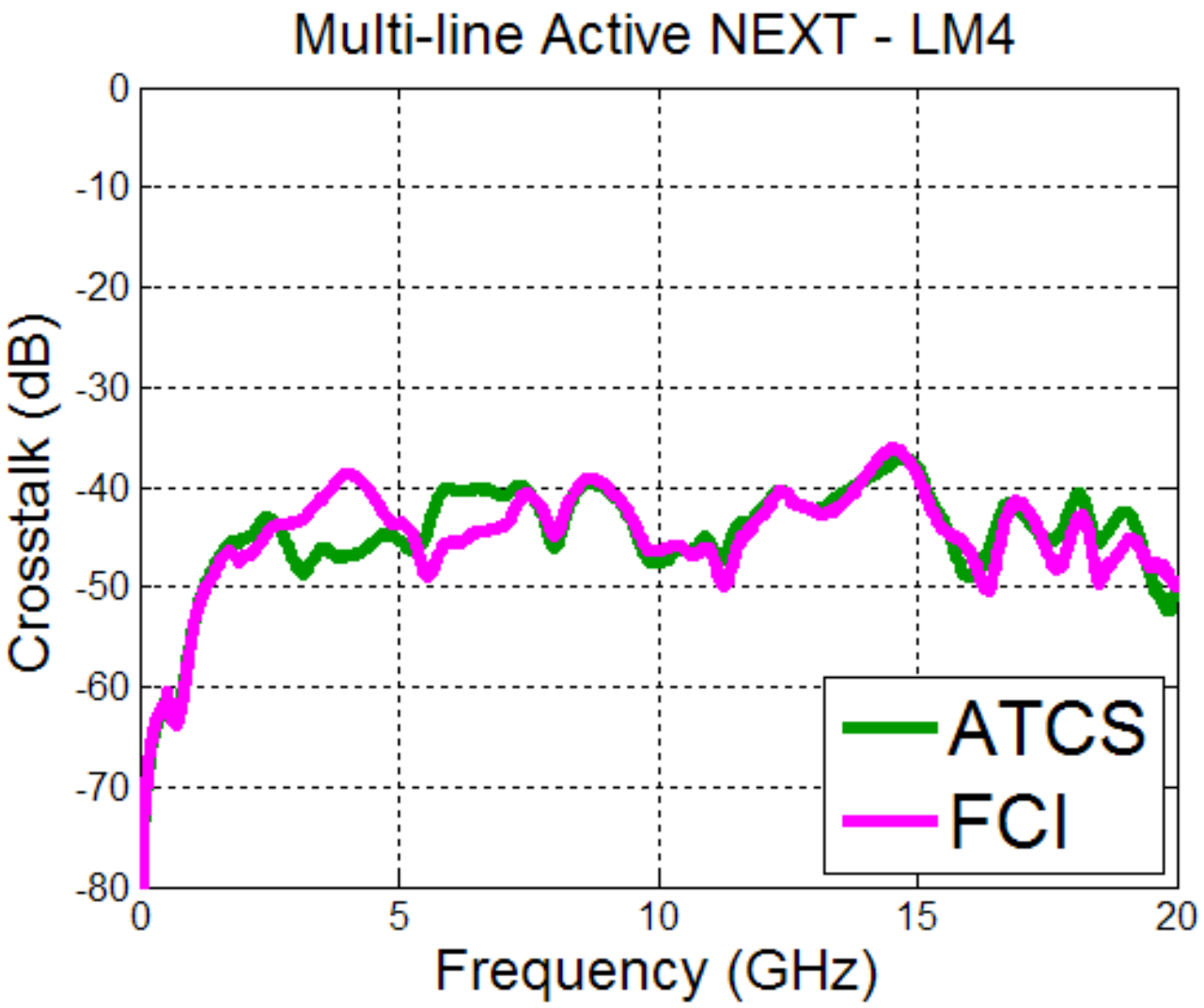
SOLT Calibration





Frequency Domain Near-End Crosstalk

Multi-Active (3:1)



J4F2	J5K5
L4M4	L5M5

Victim pair

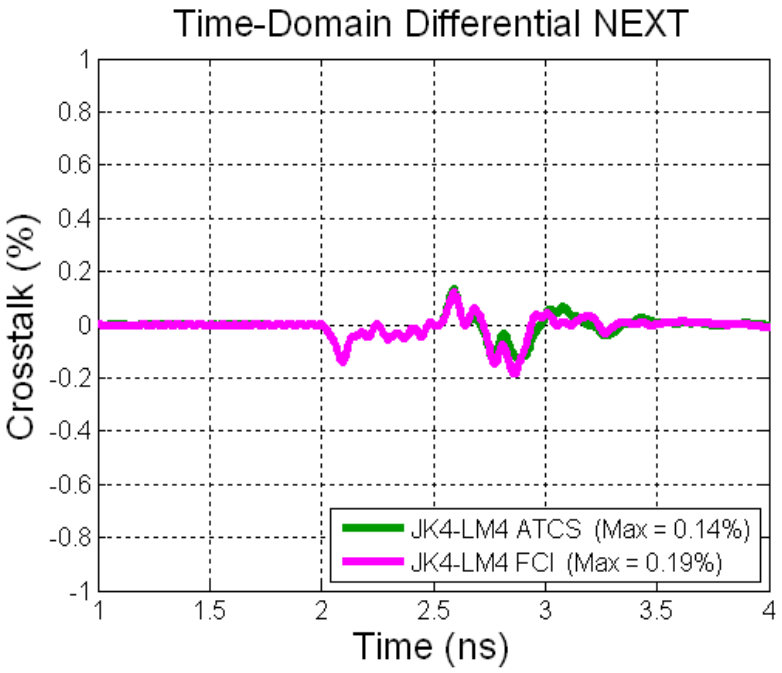
Active pair

SOLT Calibration

Amphenol

FCI

Time Domain Near-End Crosstalk



Single active

J4K4	J5K5
L4M4	L5M5

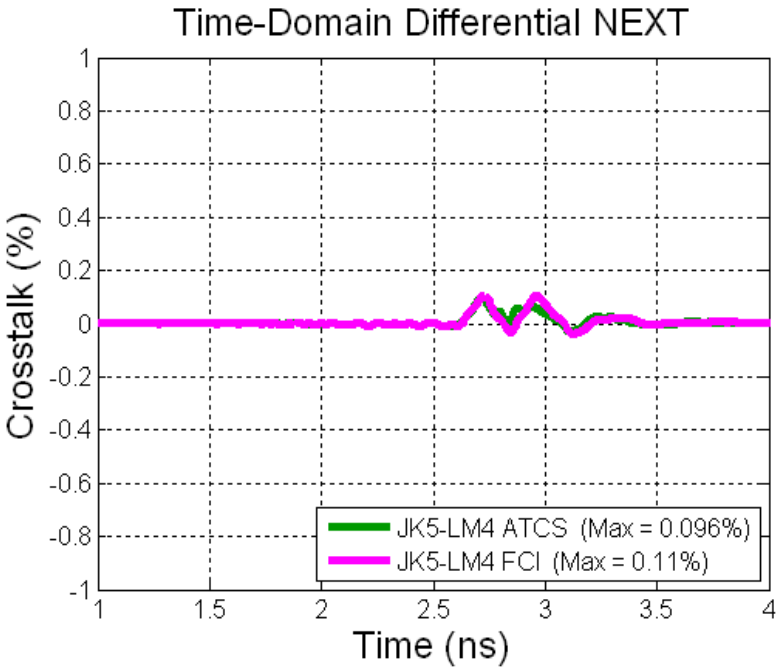
Victim pair

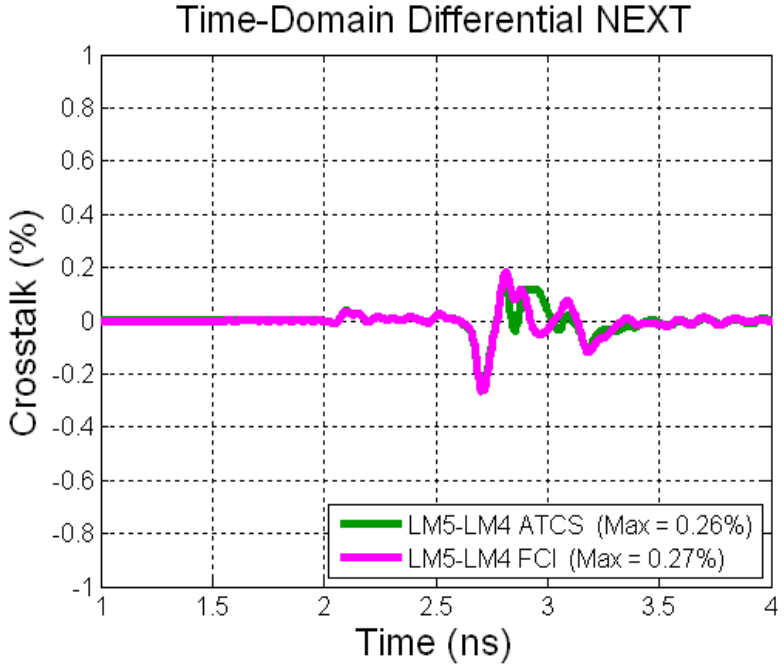
Active pair

Amphenol

FCI

SOLT Calibration





Time Domain Near-End Crosstalk

Multi-Active (3:1)

Amphenol

J4F2 0.14	J5K5 0.096
L4M4	L5M5 0.26
Total	.50

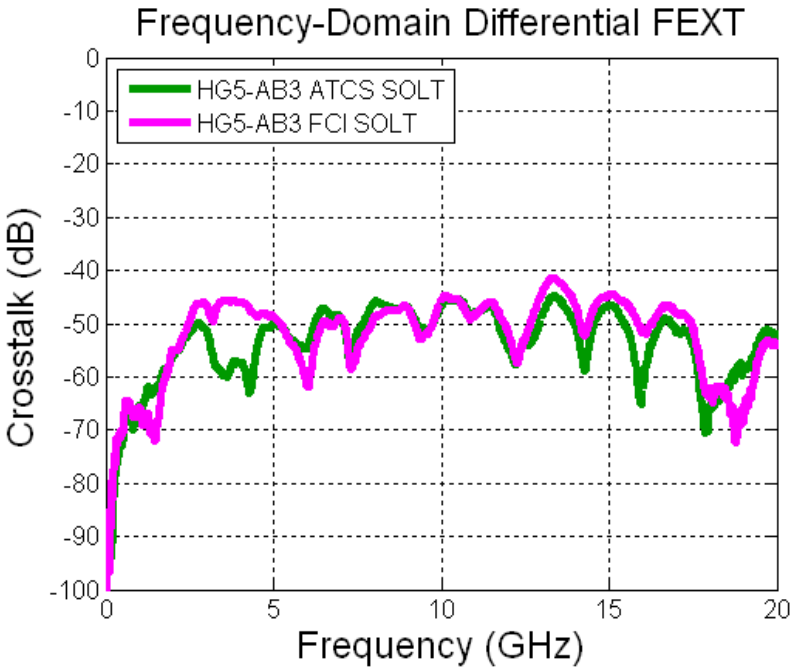
FCI

J4F2 0.19	J5K5 0.11
L4M4	L5M5 0.27
Total	.57

Victim pair

Active pair

Frequency Domain Far-End Crosstalk



Single active

K6J6	A3B3
K5J5	H5G5

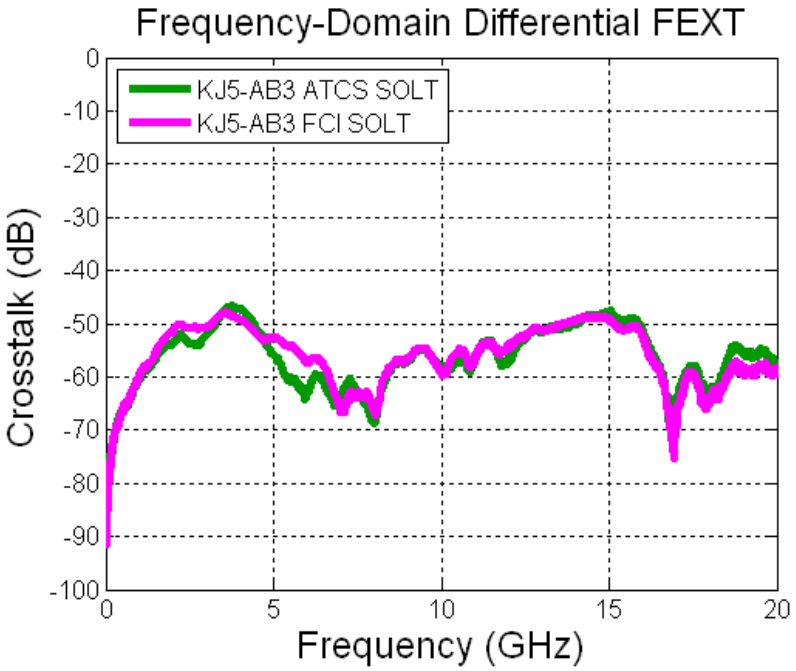
Victim pair

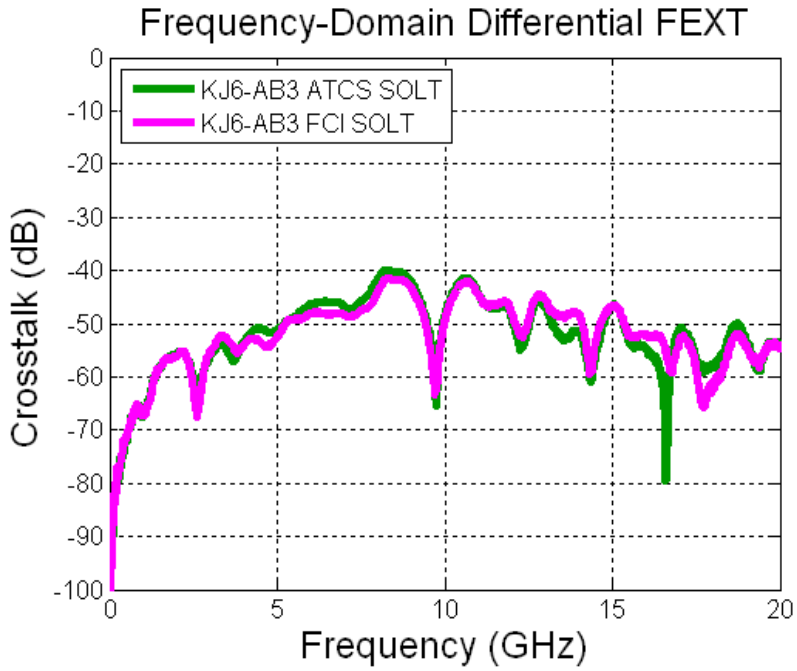
Active pair

Amphenol

FCI

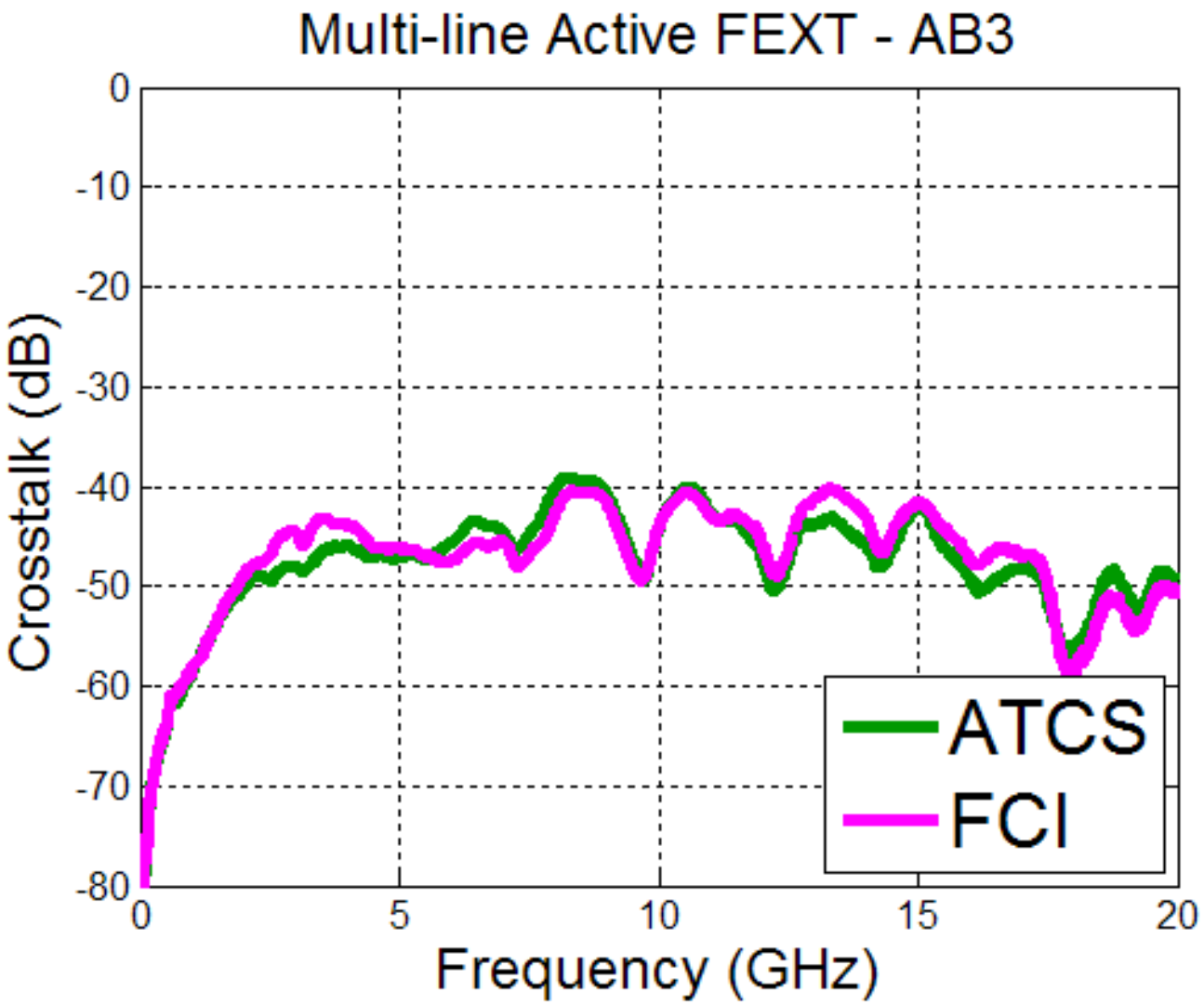
SOLT Calibration





Frequency Domain Far-End Crosstalk

Multi-Active (3:1)



K6J6	A3B3
K5J5	H5G5

Victim pair

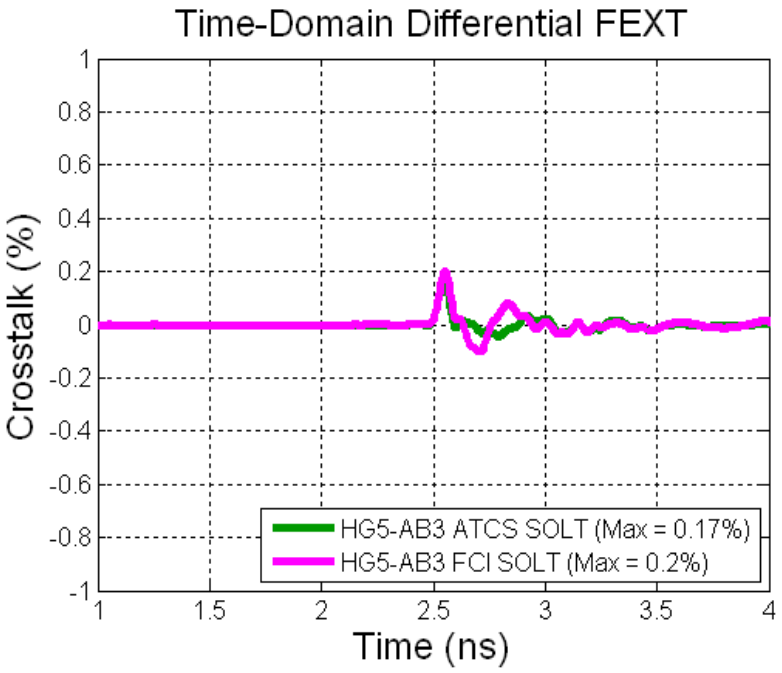
Active pair

SOLT Calibration

Amphenol

FCI

Time Domain Far-End Crosstalk



Single active

K6J6	A3B3
K5J5	H5G5

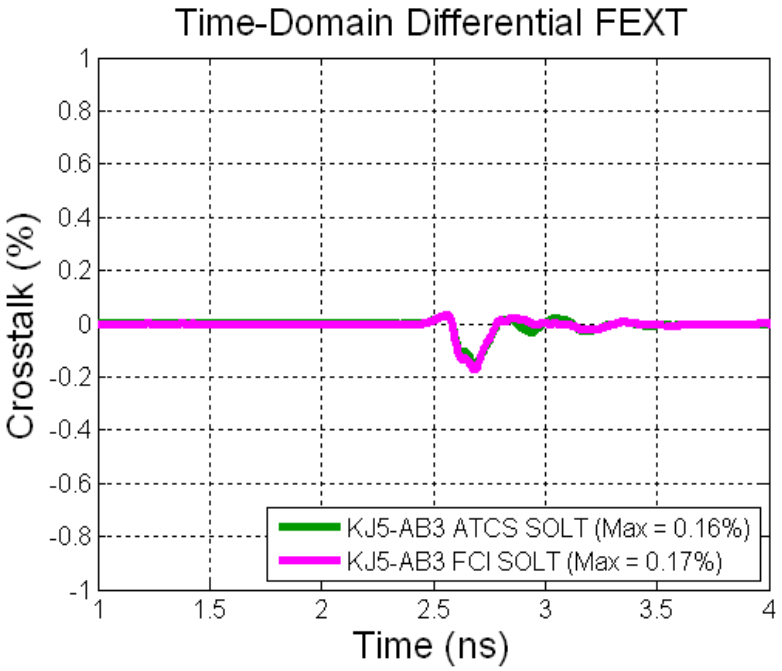
Victim pair

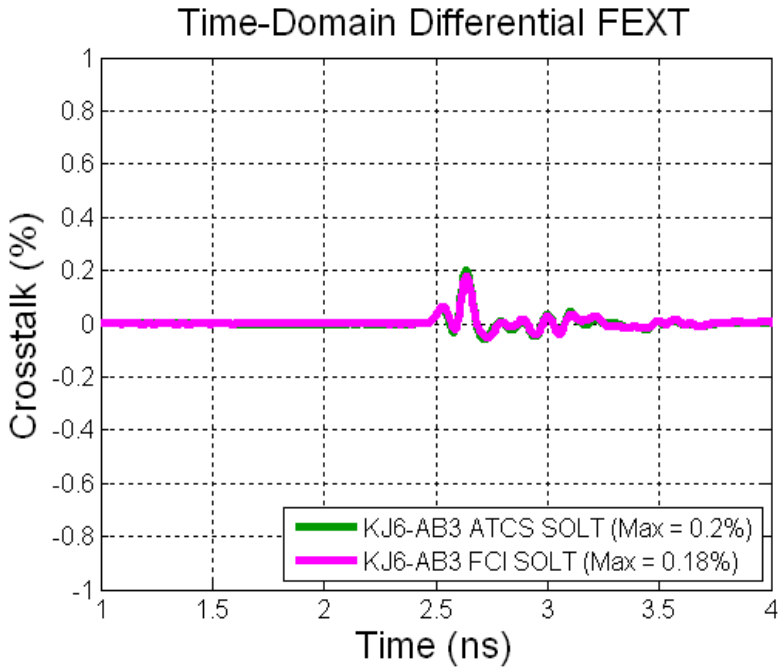
Active pair

Amphenol

FCI

SOLT Calibration





Time Domain Far-End Crosstalk

Multi-Active (3:1)

Amphenol

K6J6 0.2	A3B3
K5J5 0.16	H5G5 0.17
Total	.53

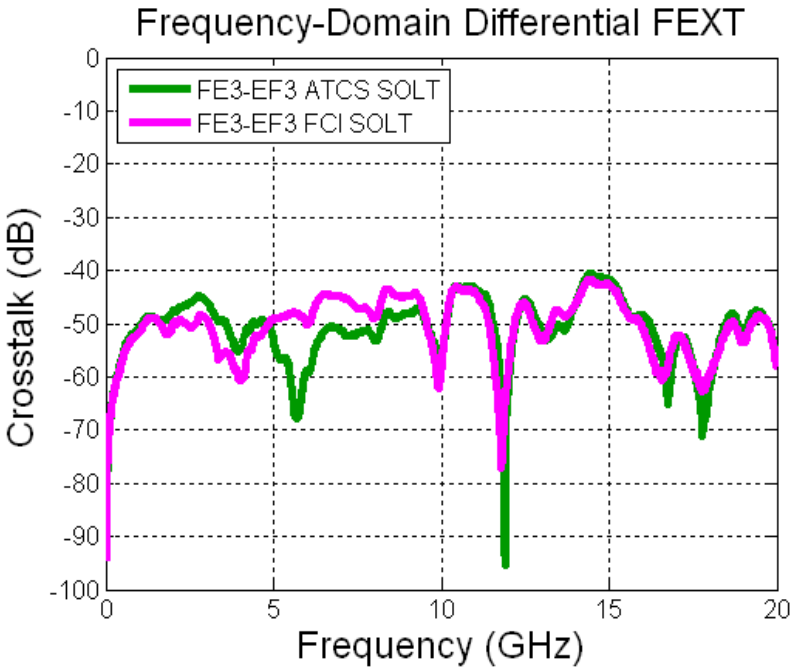
FCI

K6J6 0.18	A3B3
K5J5 0.17	H5G5 0.2
Total	.55

Victim pair

Active pair

Frequency Domain Far-End Crosstalk



K5J5	H5G5	F5E5
K4J4	E3F3	F4E4
	H3G3	F3E3

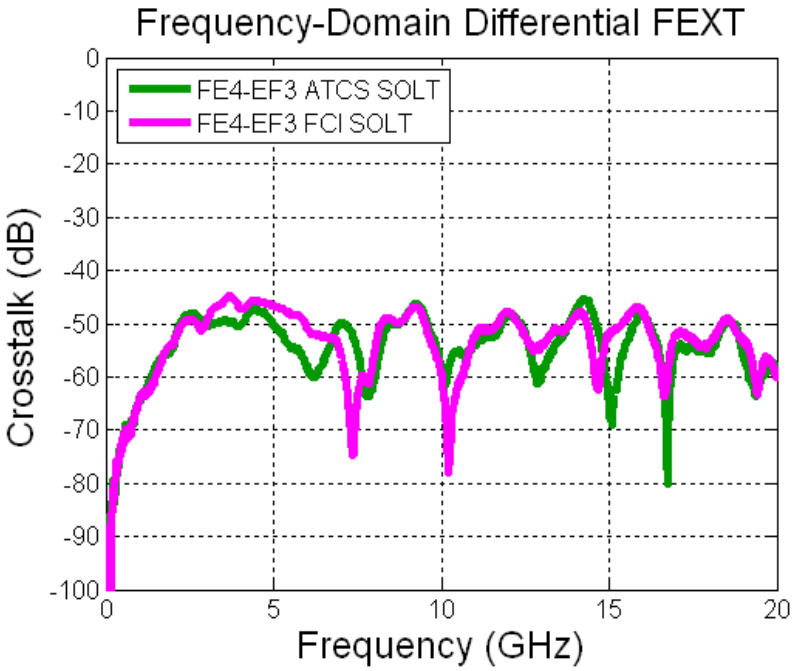
Victim pair

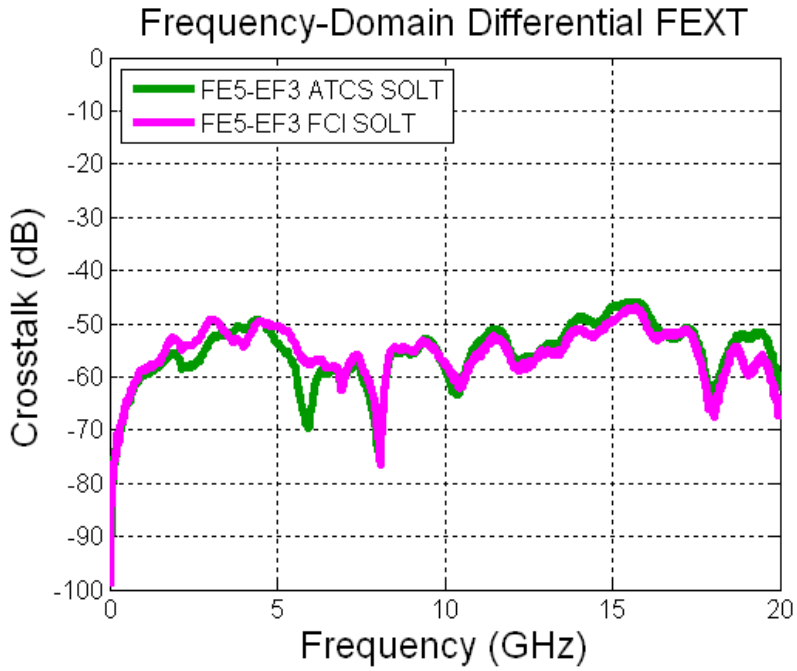
Active pair

SOLT Calibration

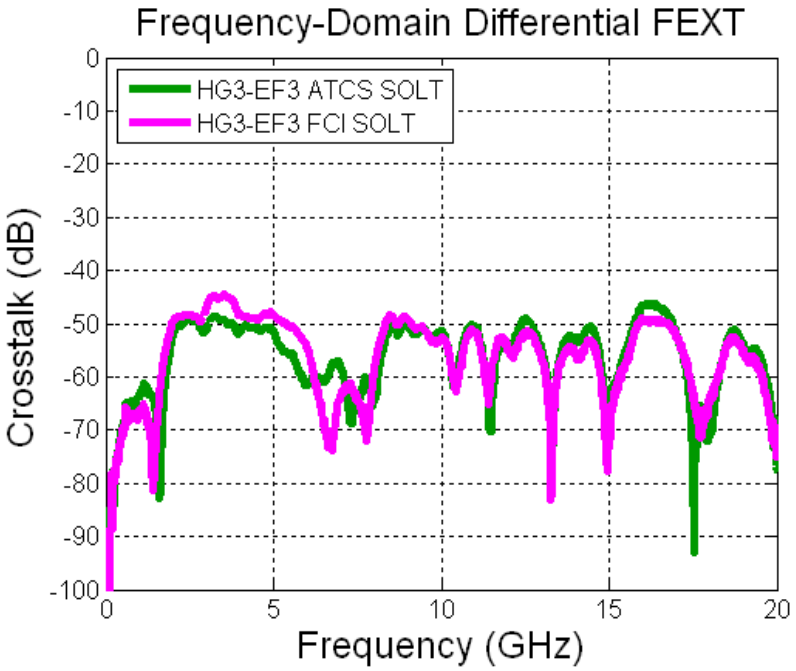
Amphenol

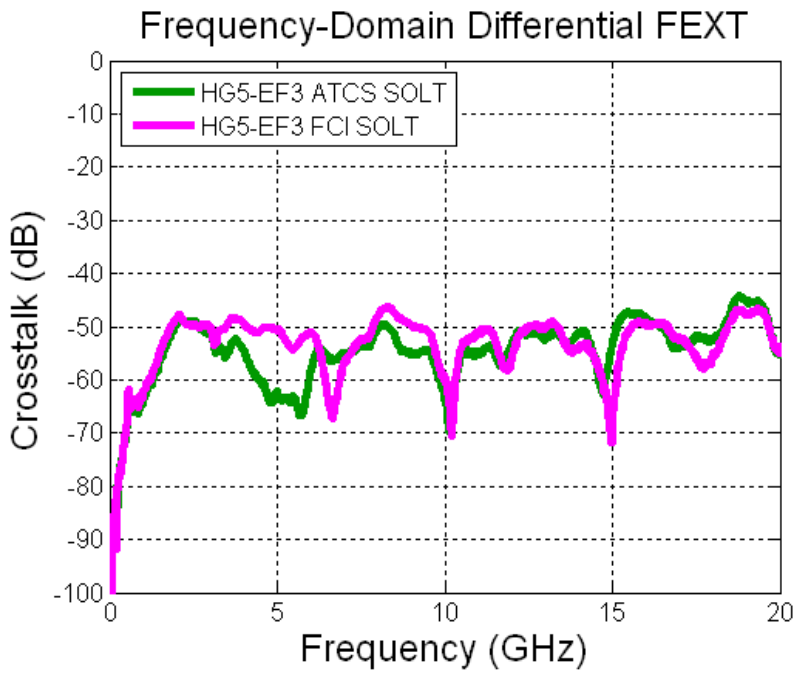
FCI

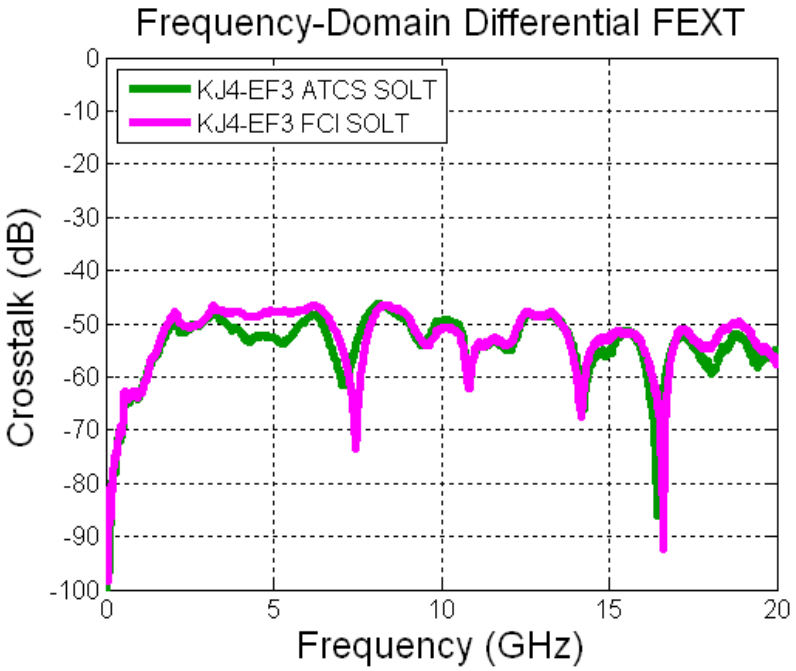


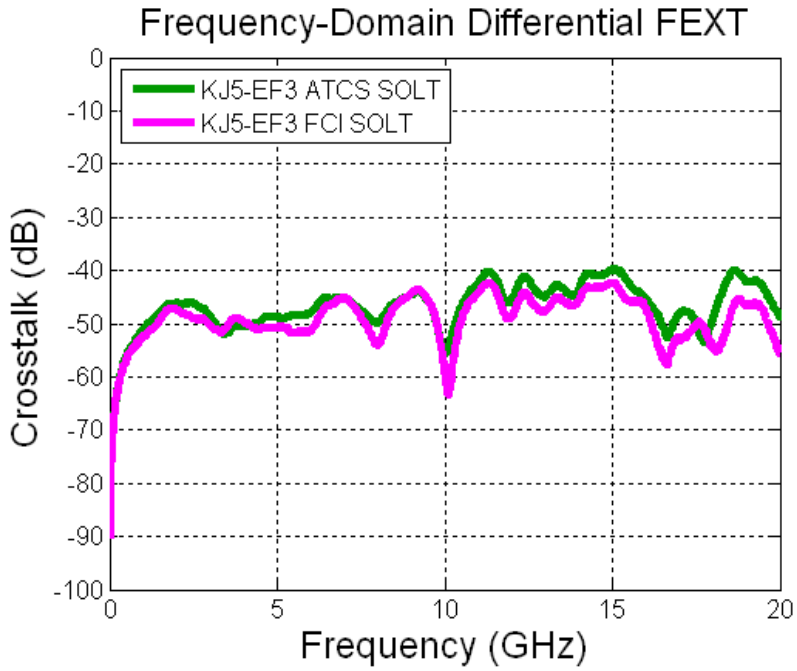


Frequency Domain Far-End Crosstalk



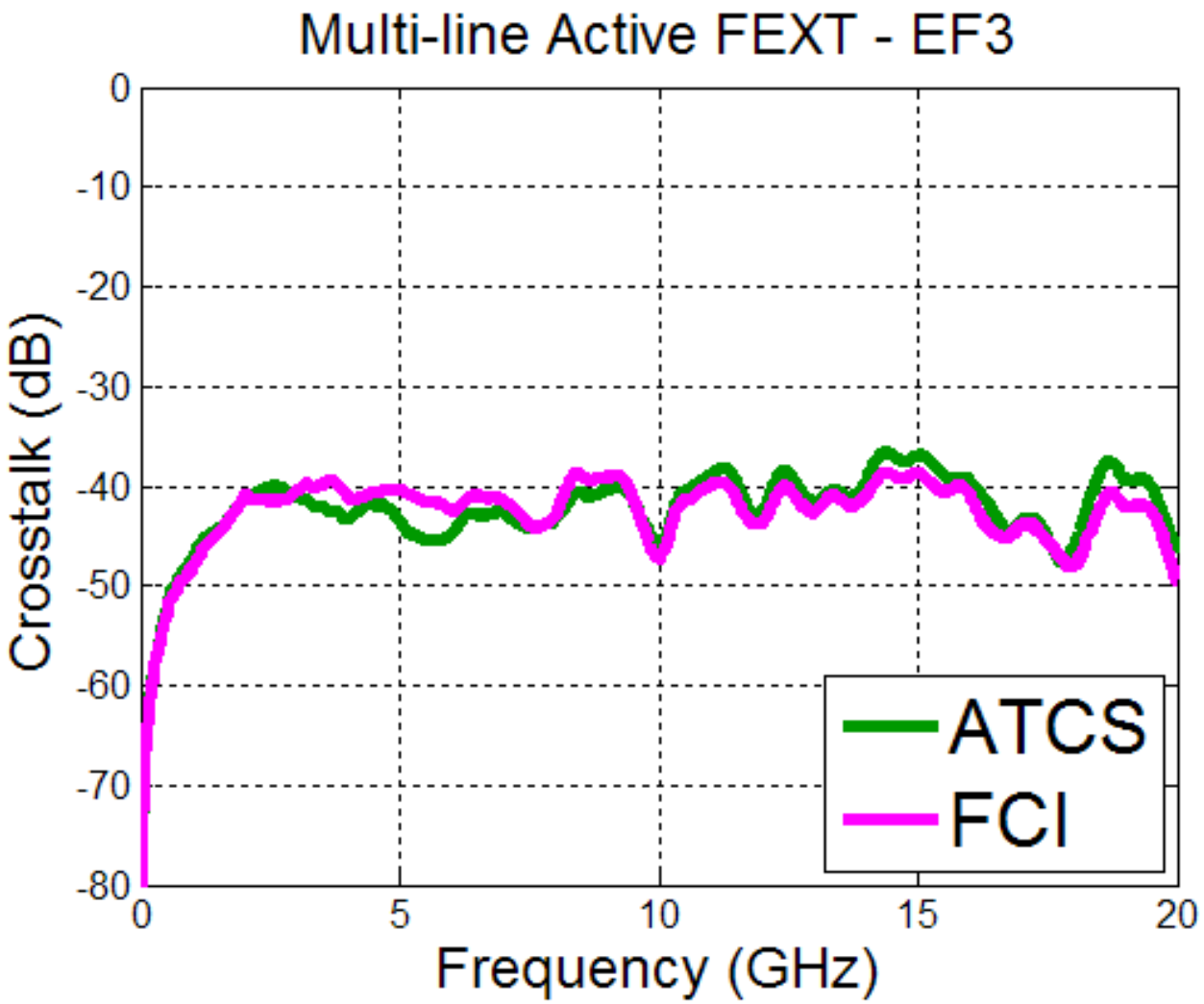






Frequency Domain Far-End Crosstalk

Multi-Active (7:1)



K5J5	H5G5	F5E5
K4J4	E3F3	F4E4
	H3G3	F3E3

Victim pair

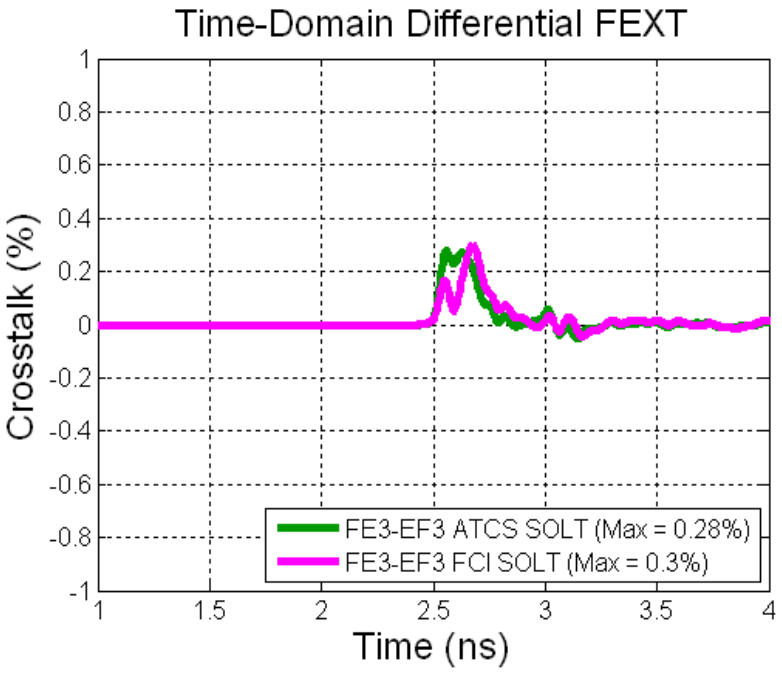
Active pair

SOLT Calibration

Amphenol

FCI

Time Domain Far-End Crosstalk



K5J5	H5G5	F5E5
K4J4	E3F3	F4E4
	H3G3	F3E3

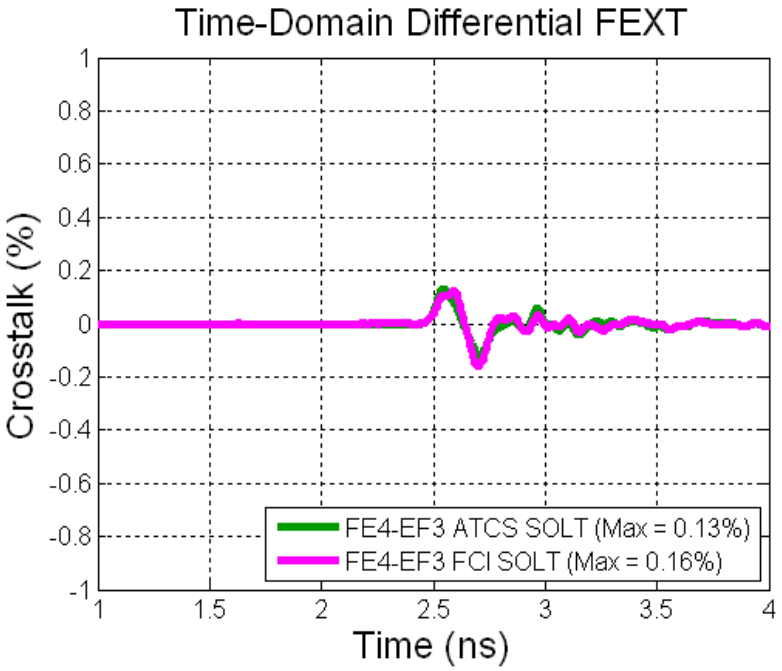
Victim pair

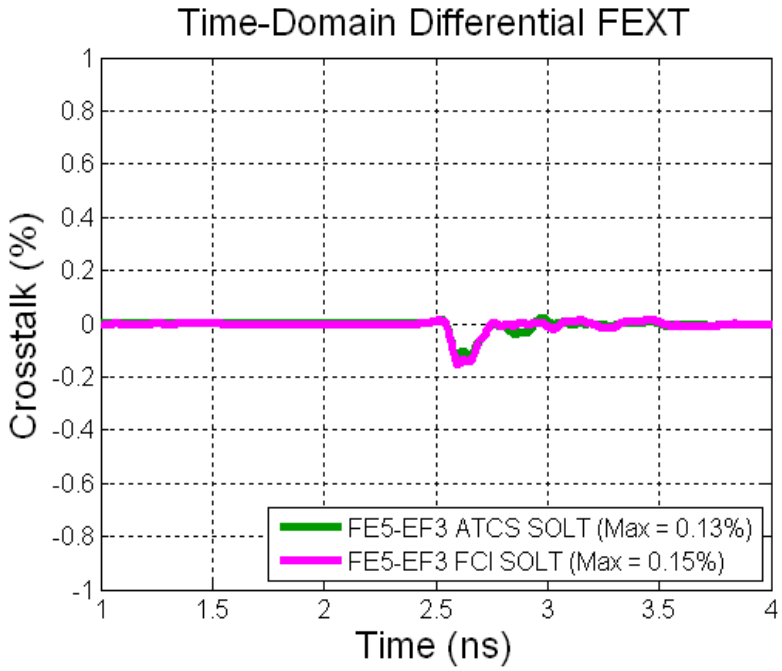
Active pair

SOLT Calibration

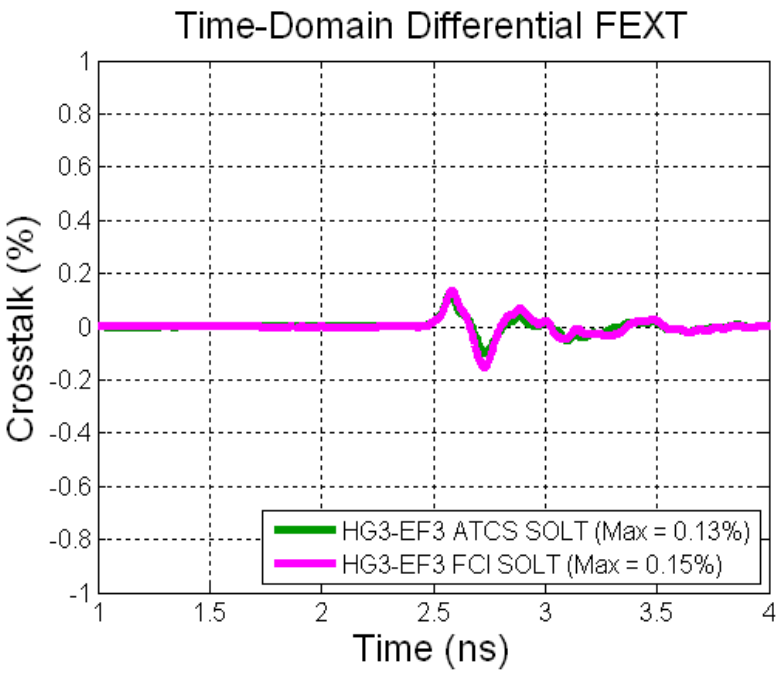
Amphenol

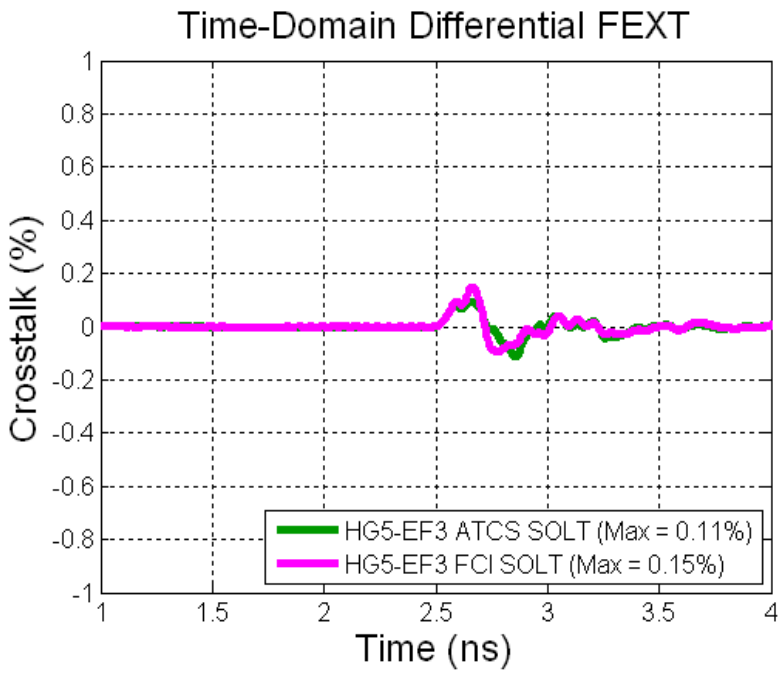
FCI

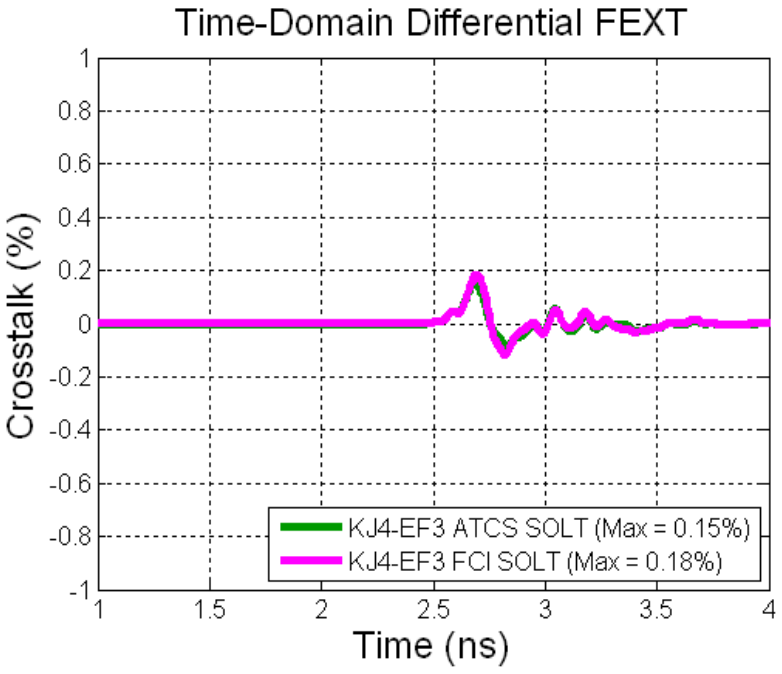


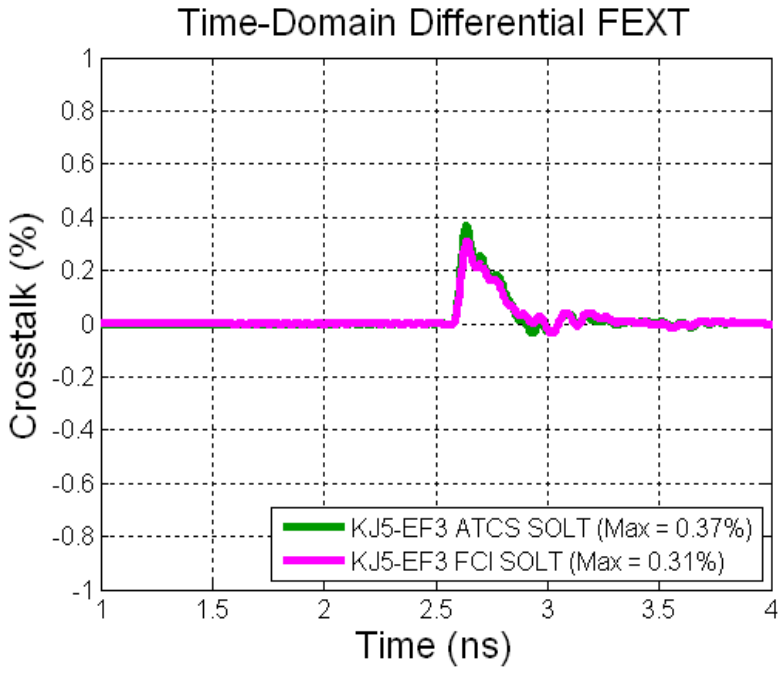


Time Domain Far-End Crosstalk









Time Domain Far-End Crosstalk

Multi-Active (7:1)

Amphenol

K5J5 0.37	H5G5 0.11	F5E5 0.13
K4J4 0.15	E3F3	F4E4 0.13
	H3G3 0.13	F3E3 0.28
Total		1.3

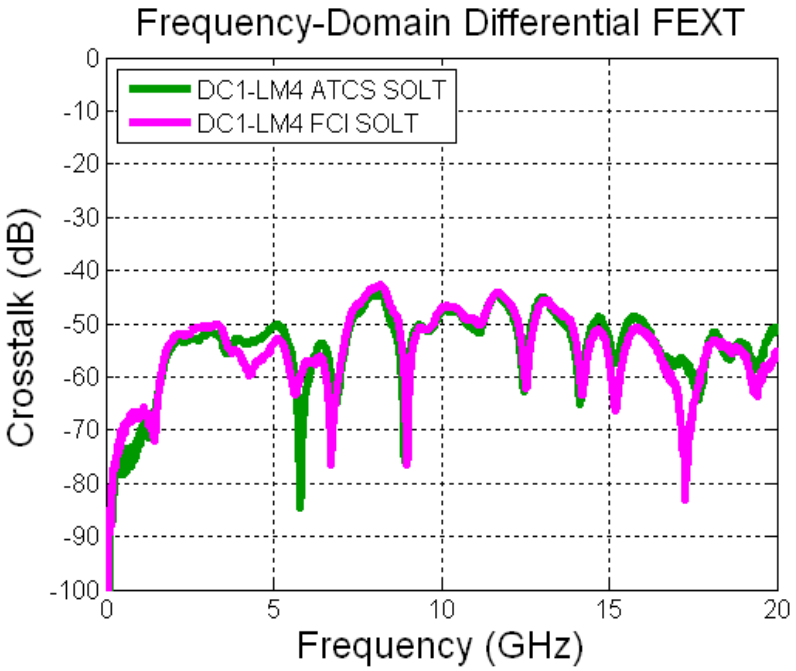
FCI

K5J5 0.31	H5G5 0.15	F5E5 0.15
K4J4 0.18	E3F3	F4E4 0.16
	H3G3 0.15	F3E3 0.3
Total		1.4

Victim pair

Active pair

Frequency Domain Far-End Crosstalk



Single active

F2E2	D2C2
L4M4	D1C1

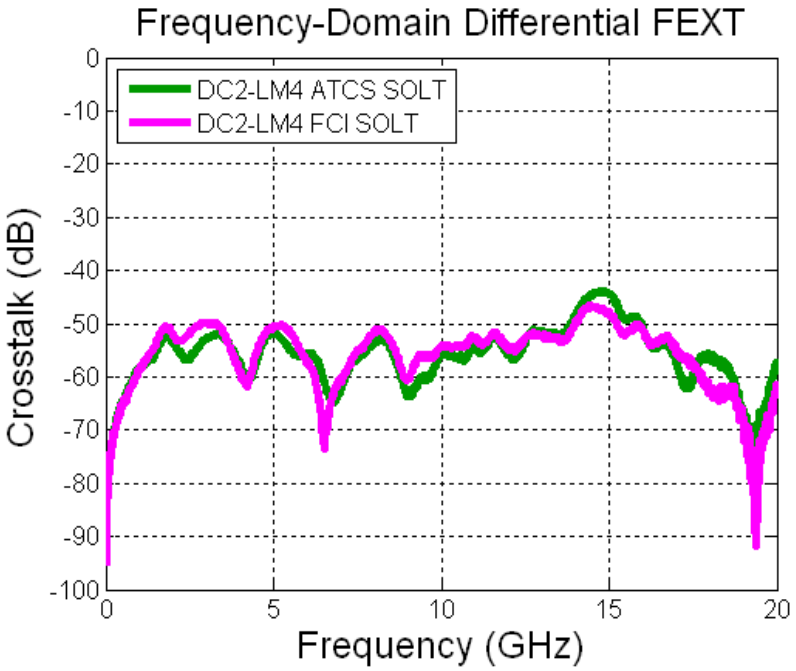
Victim pair

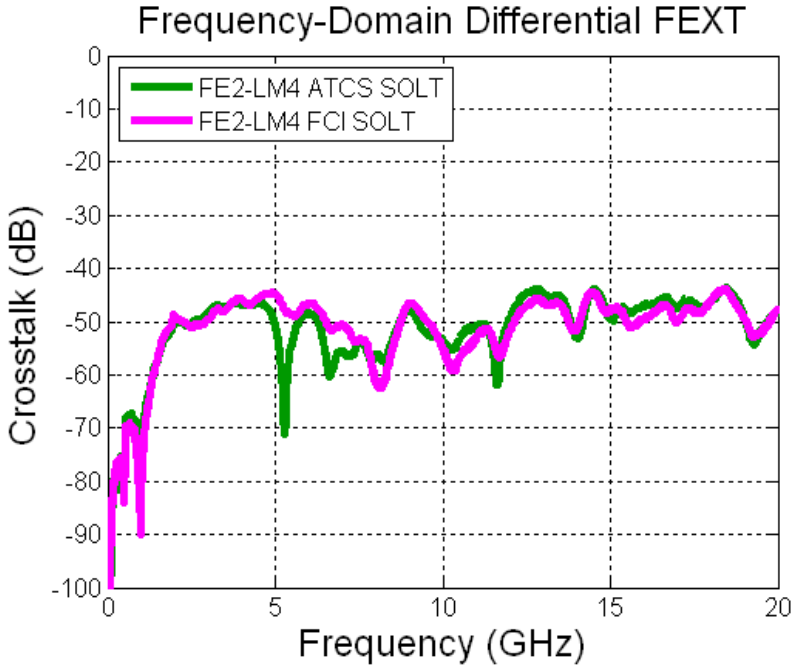
Active pair

Amphenol

FCI

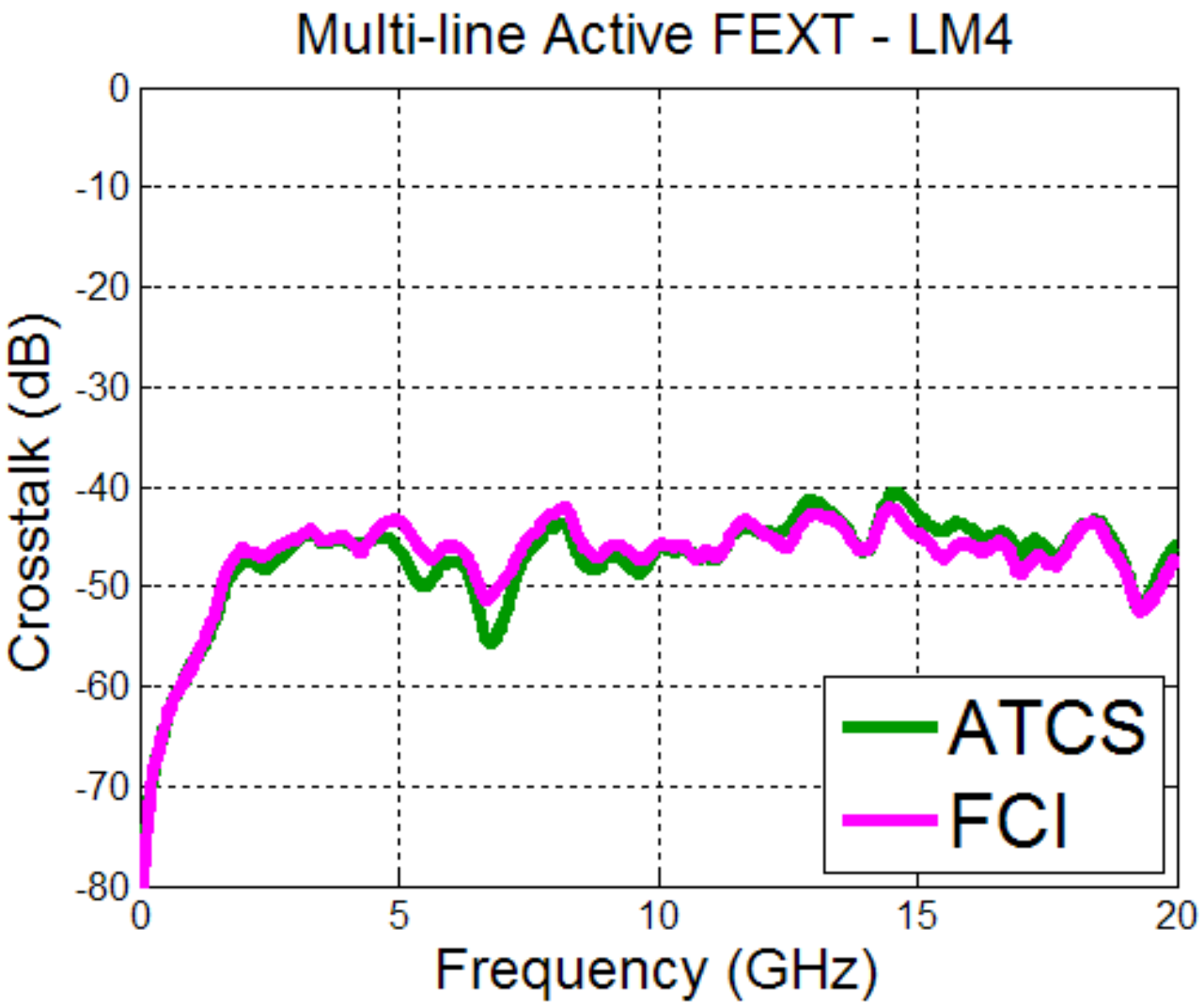
SOLT Calibration





Frequency Domain Far-End Crosstalk

Multi-Active (3:1)



F2E2	D2C2
L4M4	D1C1

Victim pair

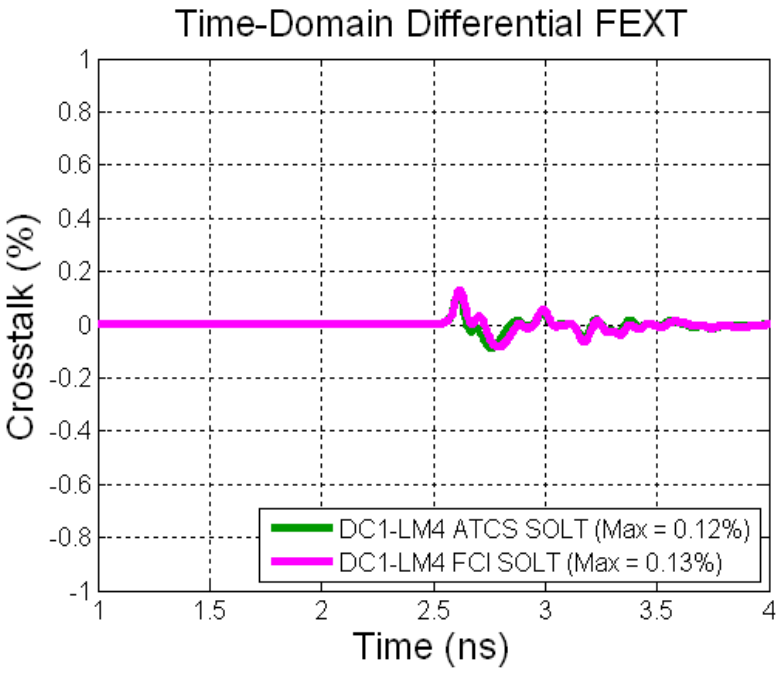
Active pair

SOLT Calibration

Amphenol

FCI

Time Domain Far-End Crosstalk



Single active

F2E2	D2C2
L4M4	D1C1

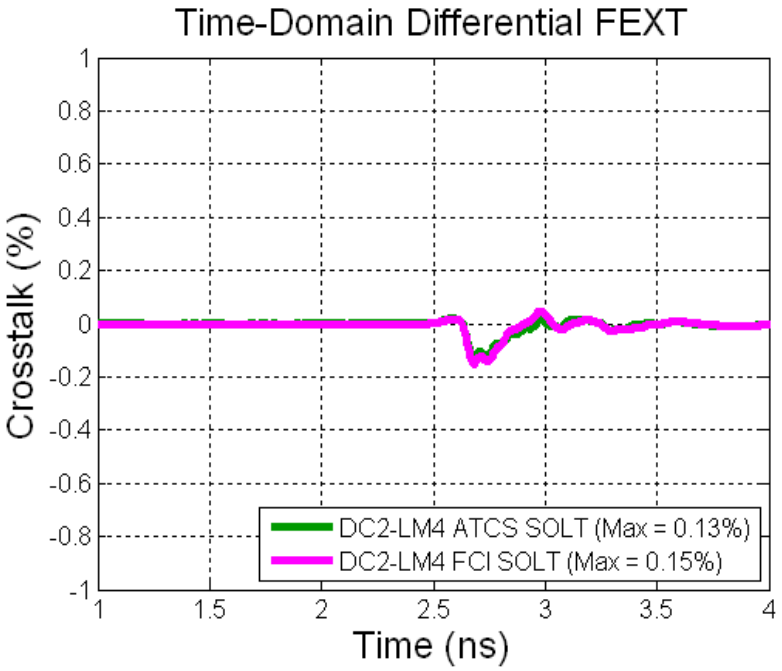
Victim pair

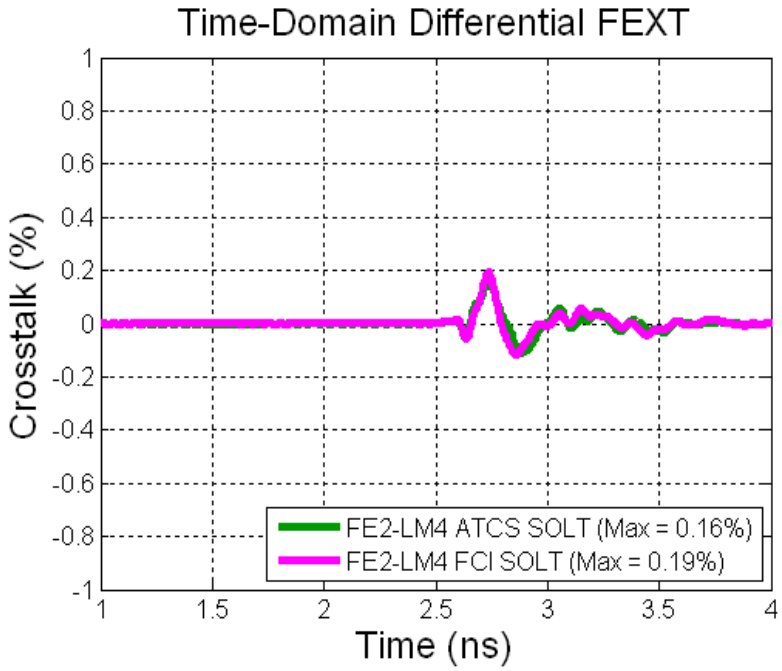
Active pair

Amphenol

FCI

SOLT Calibration





Time Domain Far-End Crosstalk

Multi-Active (3:1)

Amphenol

F2E2 0.16	D2C2 0.13
L4M4	D1C1 0.12
Total	.41

FCI

F2E2 0.19	D2C2 0.15
L4M4	D1C1 0.13
Total	.47

Victim pair

Active pair

Within-Pair Skew

Side 1 - Side2	No.	10% (ps)	50% (ps)
AB1-ML6	ATCS	9	7
	FCI	8	6
AB2-KJ6	ATCS	5	5
	FCI	5	5
AB3-HG6	ATCS	5	3
	FCI	4	3
CD1-ML5	ATCS	9	7
	FCI	8	6
CD2-KJ5	ATCS	5	6
	FCI	5	5
CD3-HG5	ATCS	2	1
	FCI	2	1
EF1-ML4	ATCS	5	5
	FCI	4	5
EF2-KJ4	ATCS	2	4
	FCI	2	4
EF3-HG4	ATCS	4	4
	FCI	4	3

Propagation Delay

Side 1 - Side2	No.	10% (ps)	50% (ps)
AB1-ML6	ATCS	1568	1594
	FCI	1568	1594
AB2-KJ6	ATCS	1532	1554
	FCI	1532	1554
AB3-HG6	ATCS	1501	1523
	FCI	1502	1523
CD1-ML5	ATCS	1593	1619
	FCI	1594	1620
CD2-KJ5	ATCS	1558	1580
	FCI	1557	1580
CD3-HG5	ATCS	1527	1549
	FCI	1528	1550
EF1-ML4	ATCS	1619	1642
	FCI	1619	1642
EF2-KJ4	ATCS	1587	1611
	FCI	1588	1611
EF3-HG4	ATCS	1556	1580
	FCI	1557	1580