Limit Line Scaling

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Limit Line Scaling

- There are only a limited number of category 8 channel measurements available. While more will become available over time, it will always be a limited number.
- Would like to adjust the measured data to the worst case, for PHY development purposes.
- The result of this should be worse than the worst case, but the amount by which it is worse should be minimized.
- Using the channel limit at all frequencies is generally much worse than a realistic worst case.
- Methods to scale insertion loss, return loss, and NEXT are offered, and FEXT is being studied.

Insertion Loss Scaling

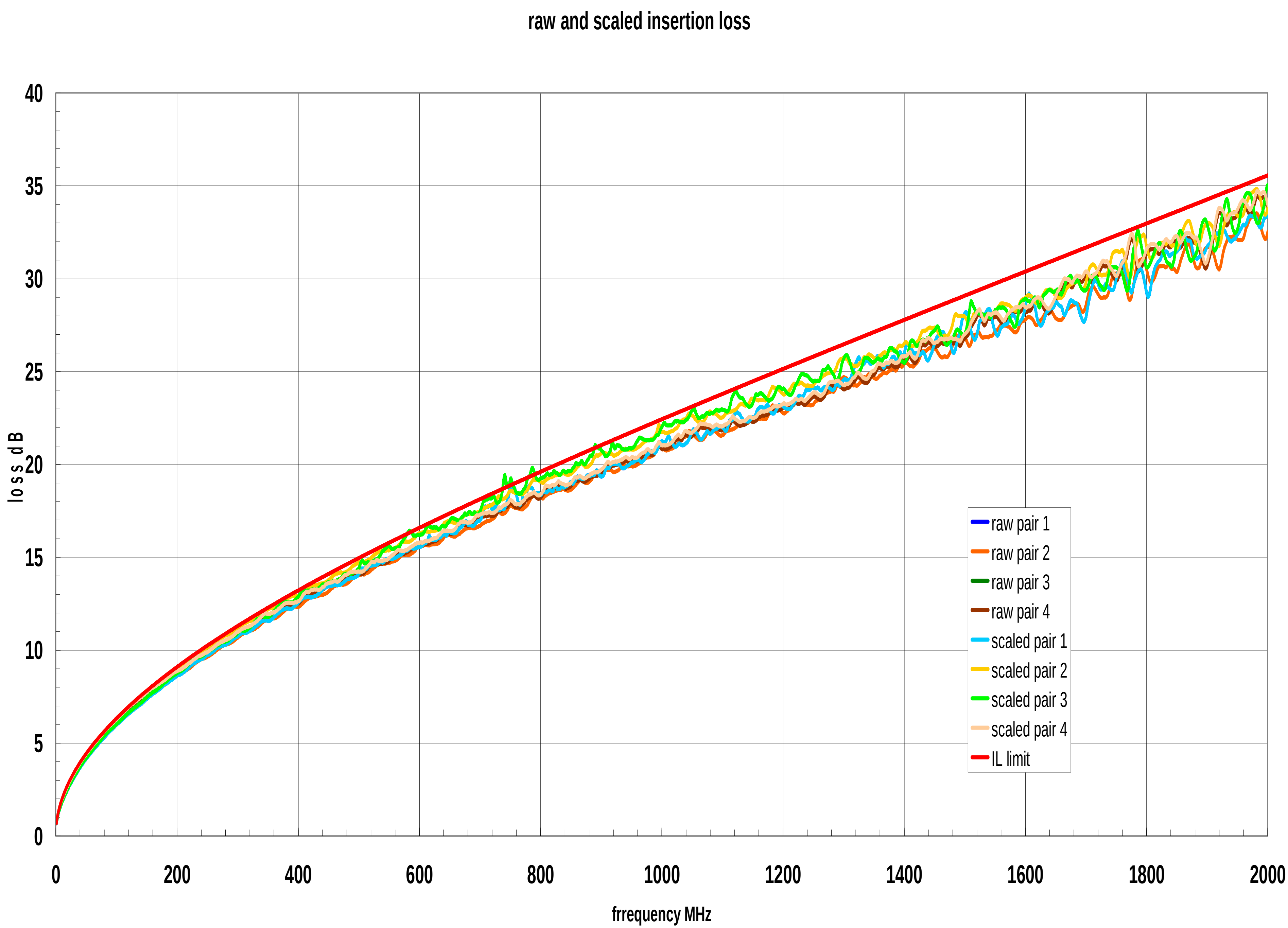
1. Convert the IL data to dB.
2. Ignore data below 10 MHz.
3. Subtract the data from the length scaled limit line.
4. Divide the result by the square root of frequency.
5. Find the minimum value for each pair (the “scaling factor”).
6. Since enhancement of IL is not allowed, replace any values greater then zero with zero.
7. For each of the four pairs separately, multiply the scaling factor by the square root of frequency, and add to the insertion loss.
8. Combine this resulting insertion loss magnitude with the raw measured insertion loss phase to produce the scaled insertion loss.

Return Loss Scaling

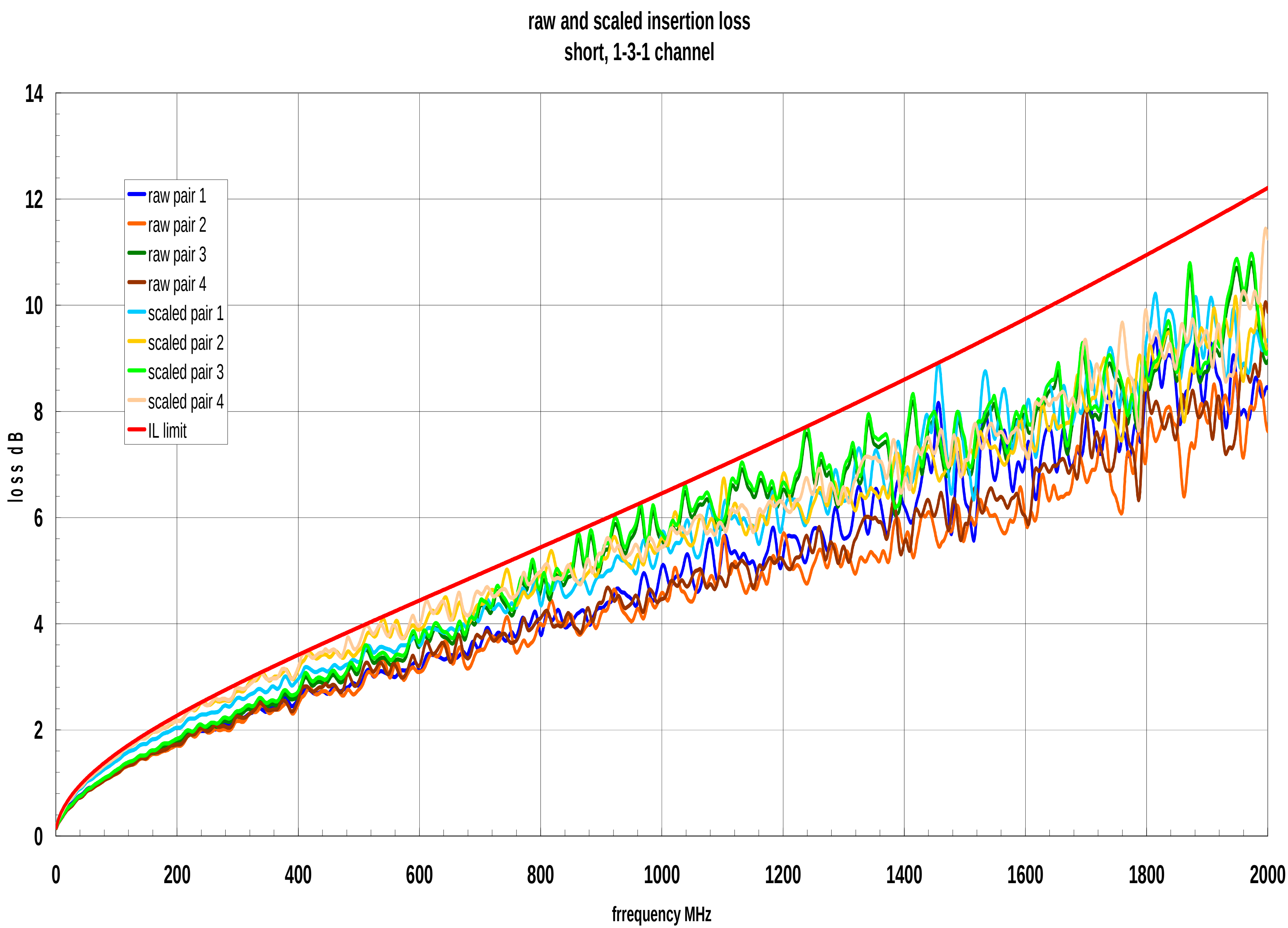
1. Smooth the return loss response:
    1. Convert the RL to linear magnitude
    2. Average the RL over a window 100 MHz wide.
2. Convert the smoothed return loss to dB.
3. Add 3 dB to the return loss limit line, to take into account that the average return loss is greater than the minimum return loss.
4. Subtract the new limit line from the smoothed return loss.
5. Since enhancement is not allowed, replace any values greater than zero with zero.
6. For each pair in each direction, find the minimum margin at any frequency (total of 8 minima).
7. Subtract this margin (a negative number) from the measured dB value of the measured (not smoothed) return loss.
8. Combine this magnitude with the raw measured return loss phase to get the scaled return loss.

NEXT scaling

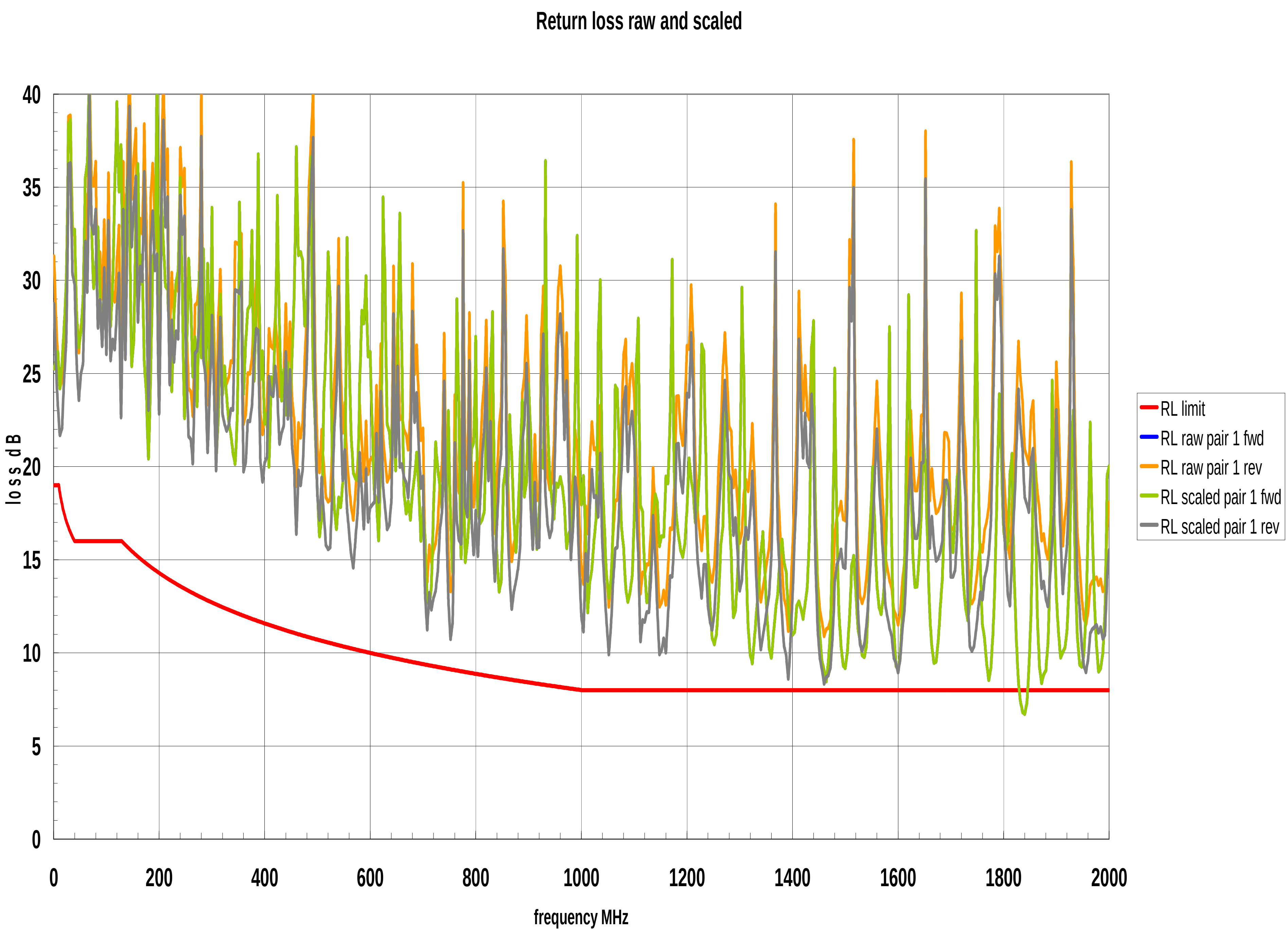
1. Find the power sum NEXT of each pair in each direction.
2. Smooth the PSNEXT:
   1. Convert to a linear amount.
   2. Average over a window 100 MHz wide.
   3. Convert back into dB.
3. Subtract the PSNEXT limit from the smoothed PSNEXT.
4. Since enhancement is not allowed, replace any values greater than zero with zero.
5. Ignoring frequencies below 50 MHz, find the minimum value of step 3 above for any pair at any frequency.
6. Subtract this margin (a negative number) from all the unsmoothed PSNEXT traces, the same adjustment for all traces. This results in scaled PSNEXT magnitudes.
7. Converting the measured NEXT to dB, also subtract this same margin from the raw measured NEXT.
8. Combine this with the raw measured NEXT phase to get the scaled NEXT.

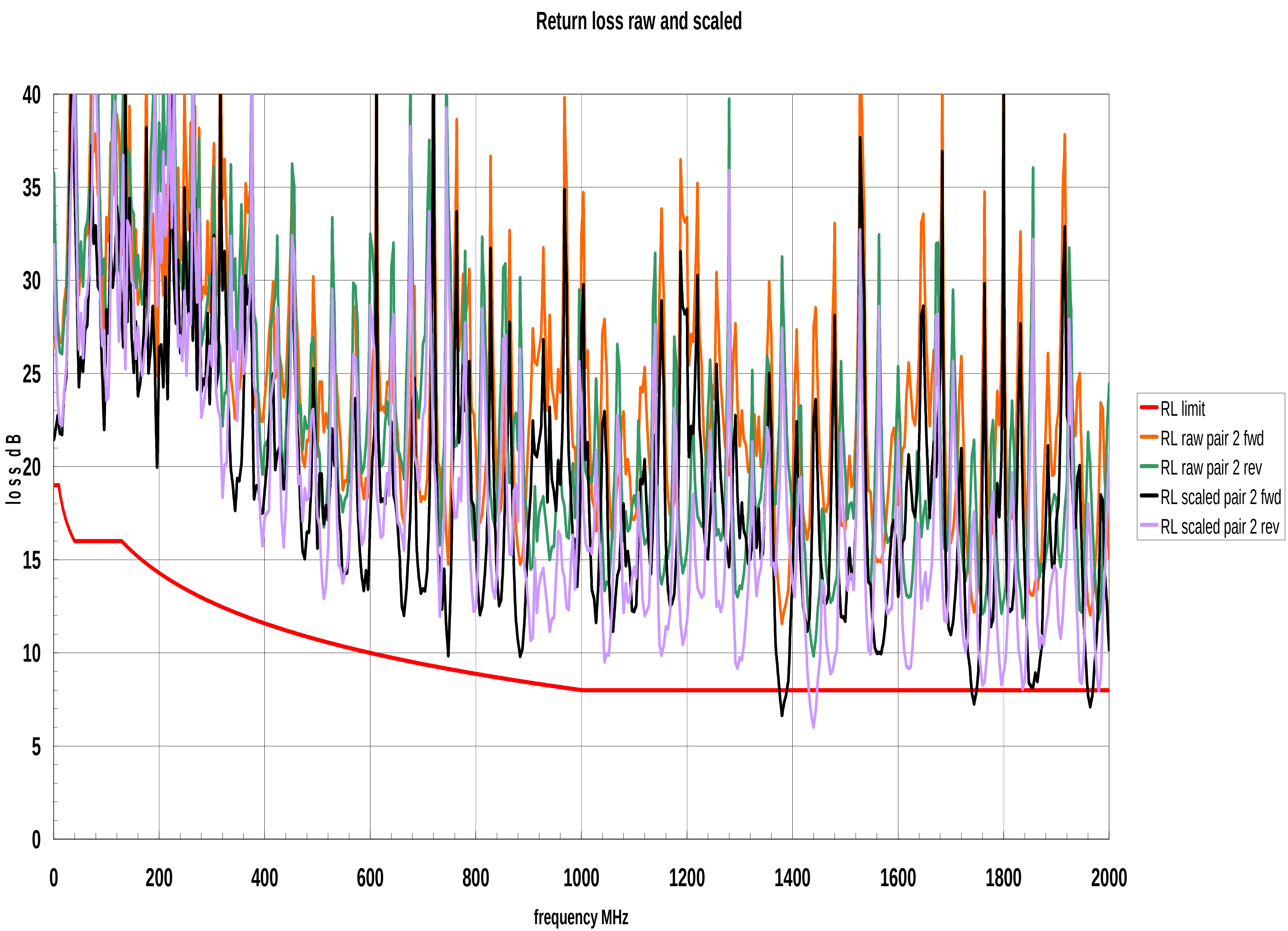


raw and scaled insertion loss
loss dB
frrequency MHz
0
5
10
15
20
25
30
35
40
0
200
400
600
800
1000
1200
1400
1600
1800
2000
raw pair 1
raw pair 2
raw pair 3
raw pair 4
scaled pair 1
scaled pair 2
scaled pair 3
scaled pair 4
IL limit

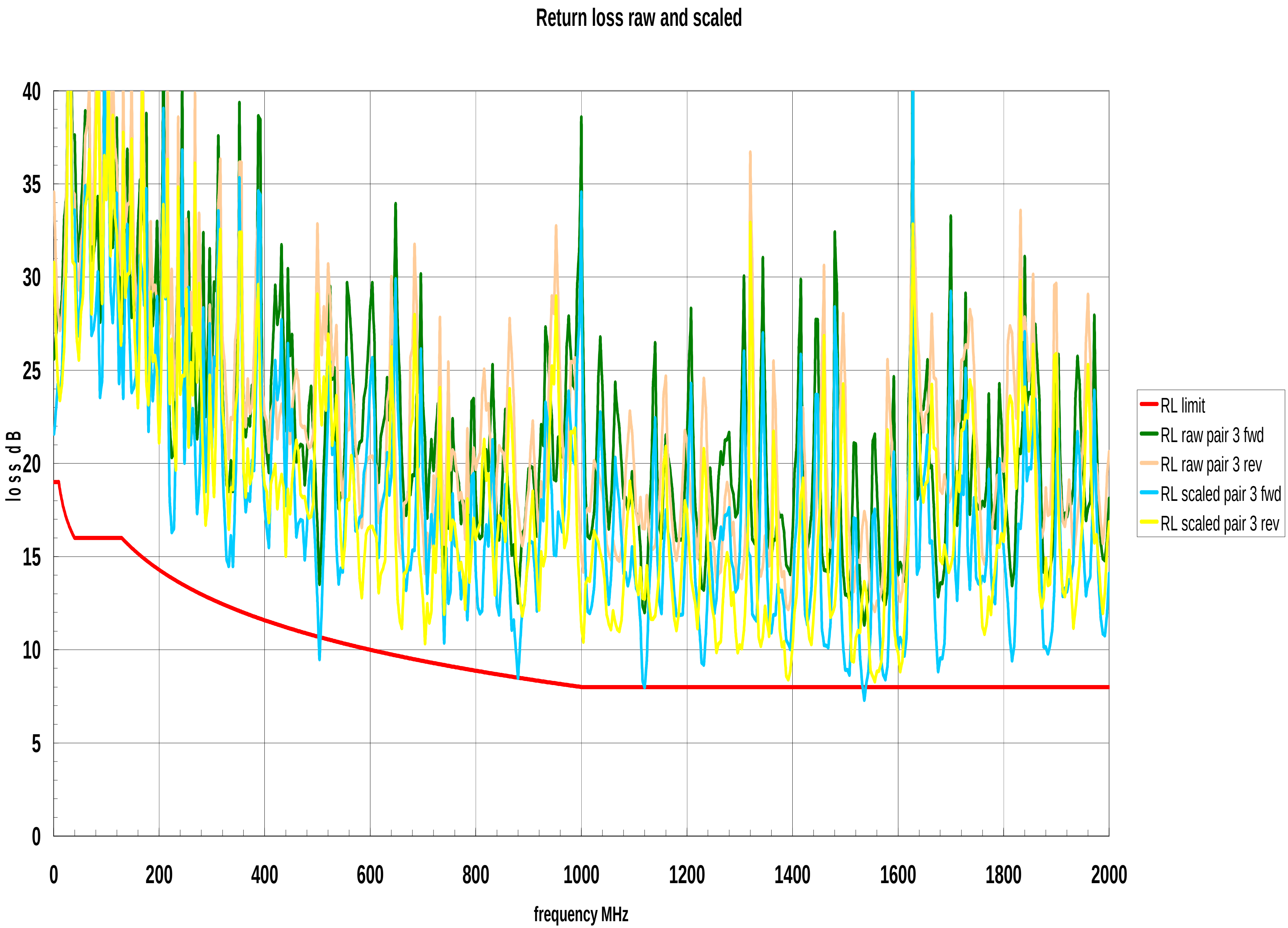


raw and scaled insertion loss
short, 1-3-1 channel
raw pair 1
raw pair 2
raw pair 3
raw pair 4
scaled pair 1
scaled pair 2
scaled pair 3
scaled pair 4
IL limit
loss dB
frrequency MHz
0
2
4
6
8
10
12
14
0
200
400
600
800
1000
1200
1400
1600
1800
2000

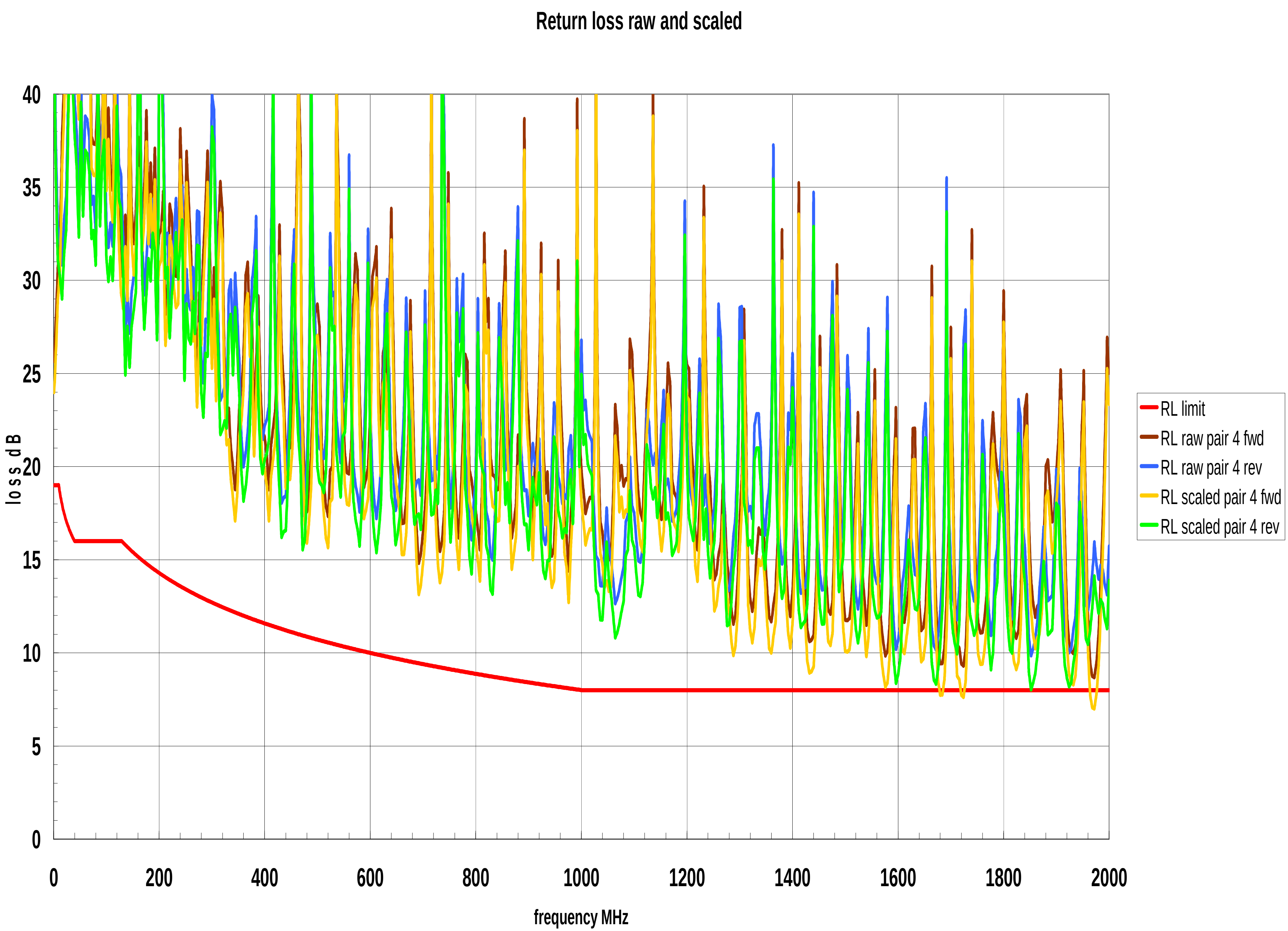

Return loss raw and scaled
40
35
30
25
20
15
10
5
0
lo s s d B
0
200
400
600
800
1000
1200
1400
1600
1800
2000
frequency MHz
RL limit
RL raw pair 1 fwd
RL raw pair 1 rev
RL scaled pair 1 fwd
RL scaled pair 1 rev



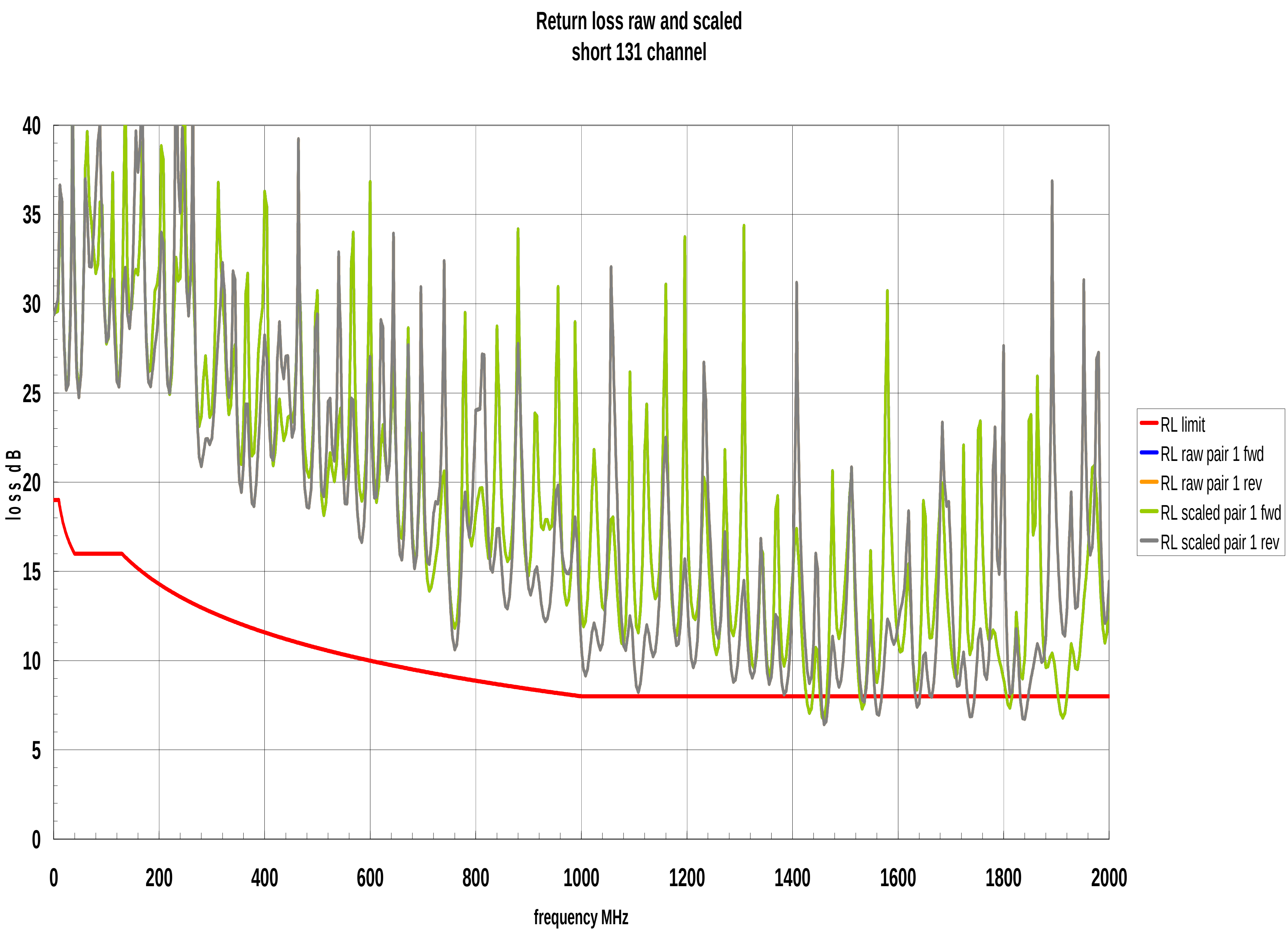
Return loss raw and scaled
40
35
30
25
20
15
10
5
0
lo s s d B
0
200
400
600
800
1000
1200
1400
1600
1800
2000
frequency MHz
RL limit
RL raw pair 2 fwd
RL raw pair 2 rev
RL scaled pair 2 fwd
RL scaled pair 2 rev



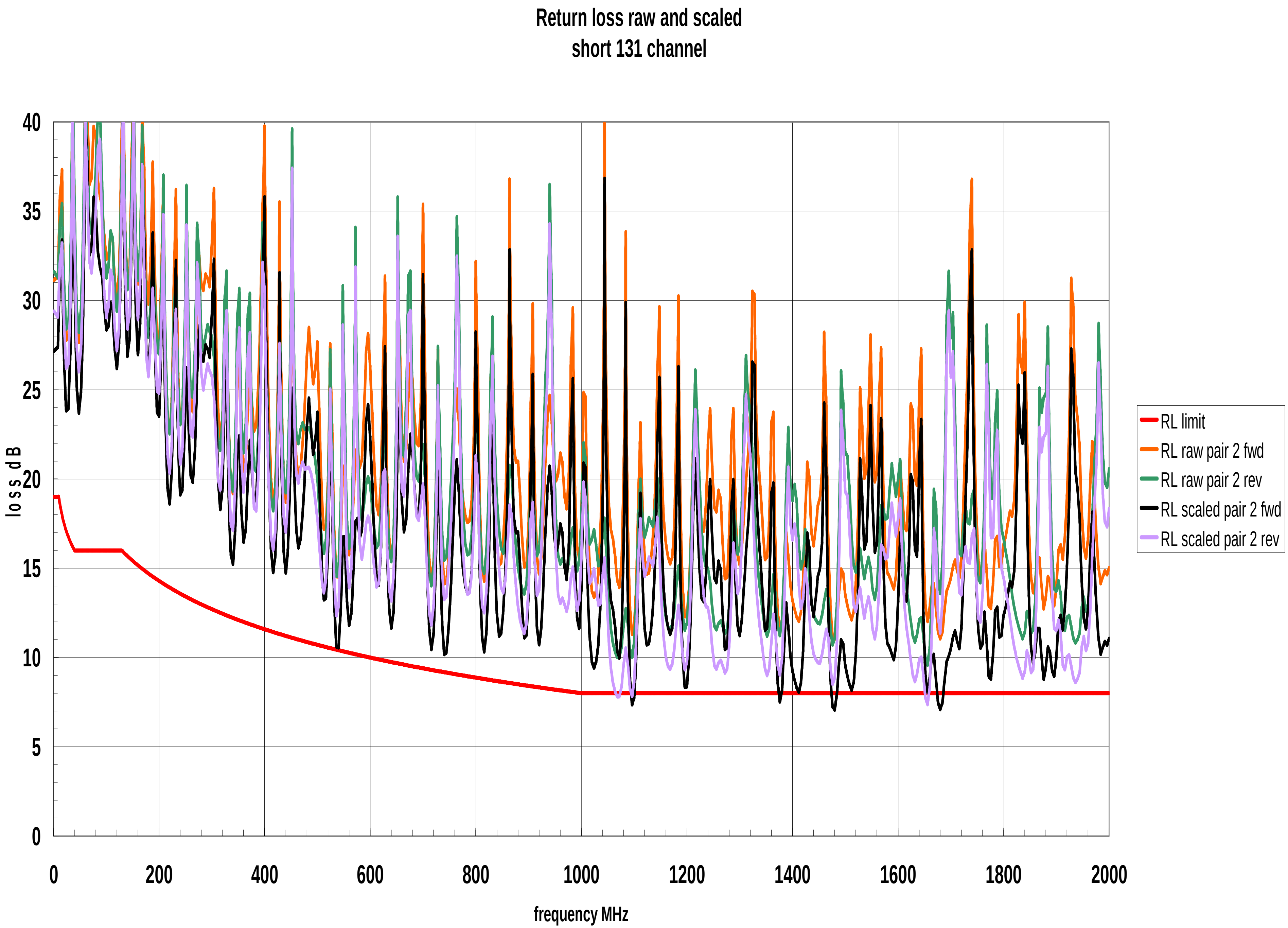
Return loss raw and scaled
40
35
30
25
20
15
10
5
0
loss dB
0
200
400
600
800
1000
1200
1400
1600
1800
2000
frequency MHz
RL limit
RL raw pair 3 fwd
RL raw pair 3 rev
RL scaled pair 3 fwd
RL scaled pair 3 rev

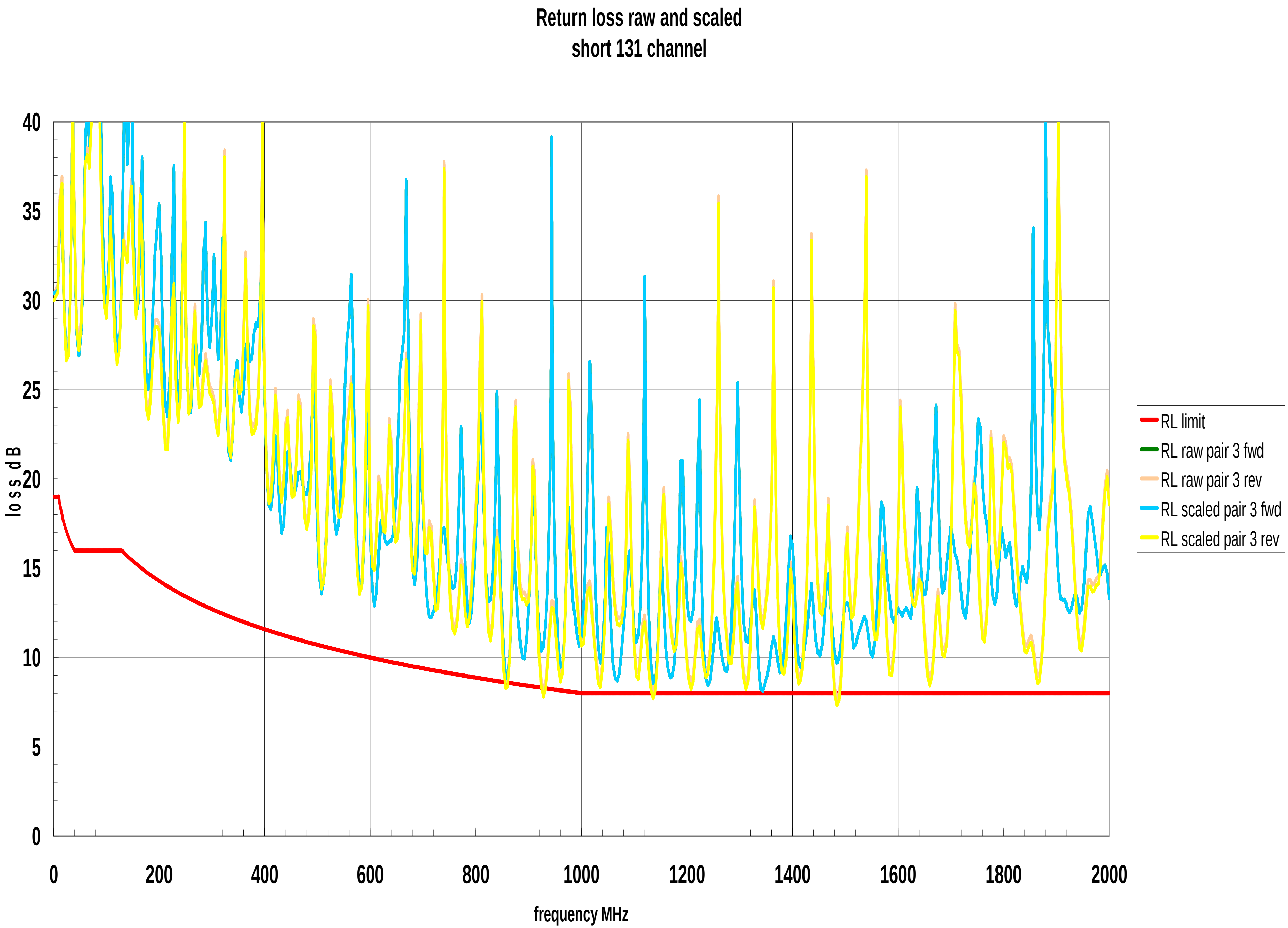


Return loss raw and scaled
40
35
30
25
20
15
10
5
0
loss dB
0
200
400
600
800
1000
1200
1400
1600
1800
2000
frequency MHz
RL limit
RL raw pair 4 fwd
RL raw pair 4 rev
RL scaled pair 4 fwd
RL scaled pair 4 rev

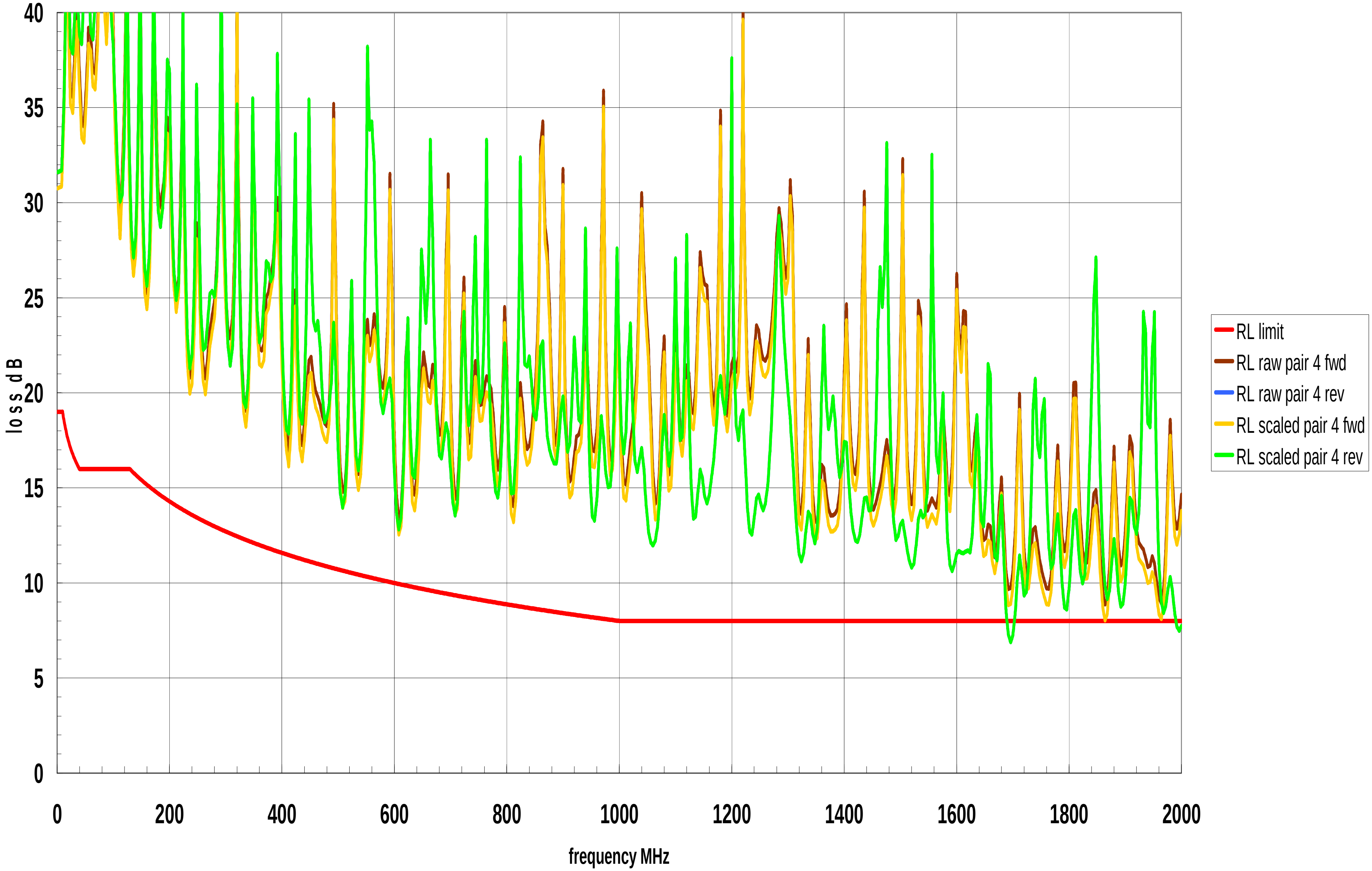


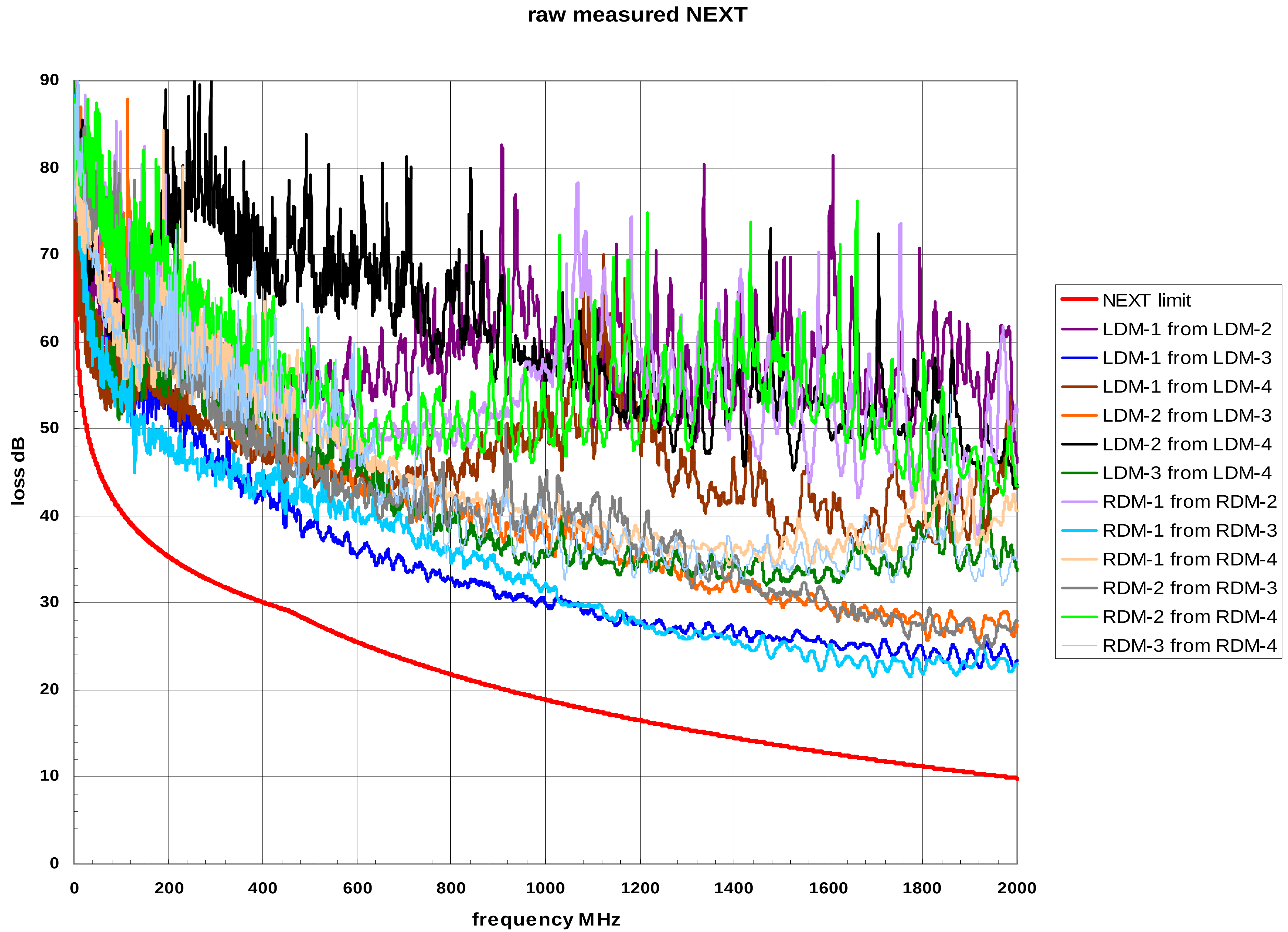
Return loss raw and scaled
short 131 channel
40
35
30
25
20
15
10
5
0
loss dB
0
200
400
600
800
1000
1200
1400
1600
1800
2000
frequency MHz
RL limit
RL raw pair 1 fwd
RL raw pair 1 rev
RL scaled pair 1 fwd
RL scaled pair 1 rev

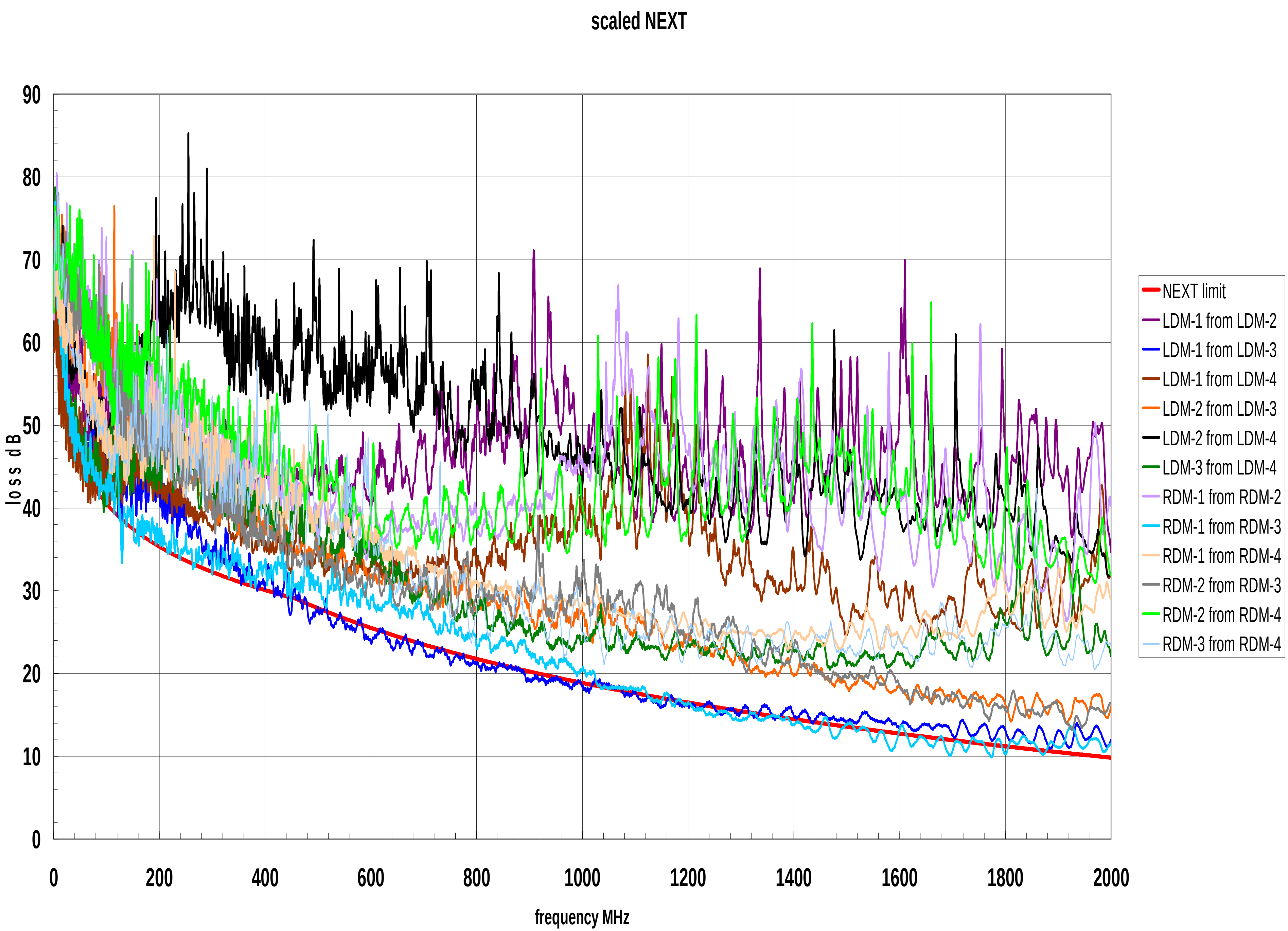

Return loss raw and scaled
short 131 channel
loss dB
frequency MHz
0
5
10
15
20
25
30
35
40
0
200
400
600
800
1000
1200
1400
1600
1800
2000
RL limit
RL raw pair 2 fwd
RL raw pair 2 rev
RL scaled pair 2 fwd
RL scaled pair 2 rev

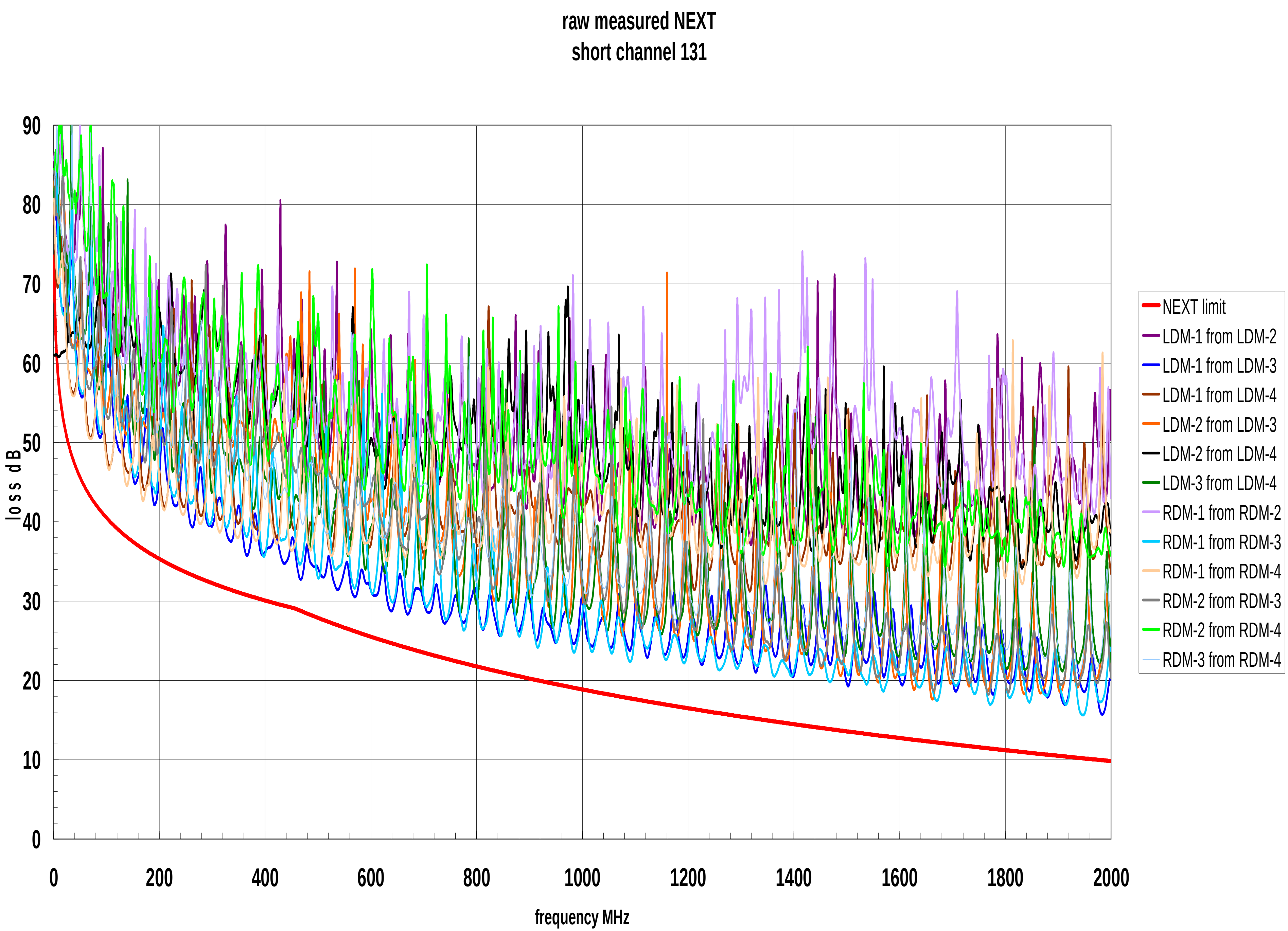

Return loss raw and scaled
short 131 channel
40
35
30
25
20
15
10
5
0
lo s s _d B
0
200
400
600
800
1000
1200
1400
1600
1800
2000
frequency MHz
RL limit
RL raw pair 3 fwd
RL raw pair 3 rev
RL scaled pair 3 fwd
RL scaled pair 3 rev

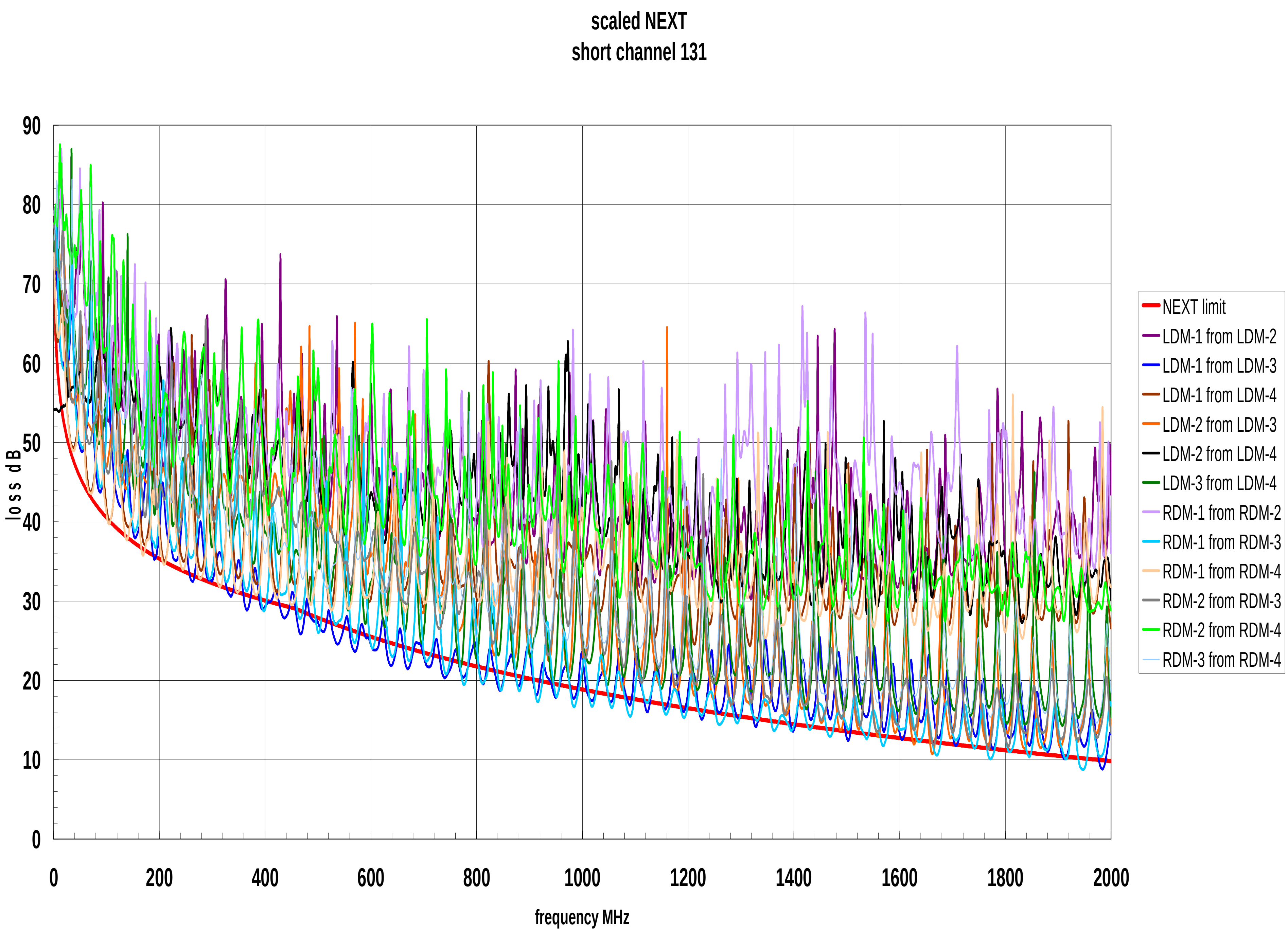
Return loss raw and scaled
short 131 channel




raw measured NEXT
loss dB
frequency MHz
0
10
20
30
40
50
60
70
80
90
0
200
400
600
800
1000
1200
1400
1600
1800
2000
NEXT limit
LDM-1 from LDM-2
LDM-1 from LDM-3
LDM-1 from LDM-4
LDM-2 from LDM-3
LDM-2 from LDM-4
LDM-3 from LDM-4
RDM-1 from RDM-2
RDM-1 from RDM-3
RDM-1 from RDM-4
RDM-2 from RDM-3
RDM-2 from RDM-4
RDM-3 from RDM-4


scaled NEXT
loss dB
frequency MHz
0
10
20
30
40
50
60
70
80
90
0
200
400
600
800
1000
1200
1400
1600
1800
2000
NEXT limit
LDM-1 from LDM-2
LDM-1 from LDM-3
LDM-1 from LDM-4
LDM-2 from LDM-3
LDM-2 from LDM-4
LDM-3 from LDM-4
RDM-1 from RDM-2
RDM-1 from RDM-3
RDM-1 from RDM-4
RDM-2 from RDM-3
RDM-2 from RDM-4
RDM-3 from RDM-4


raw measured NEXT
short channel 131
90
80
70
60
50
40
30
20
10
0
loss dB
0
200
400
600
800
1000
1200
1400
1600
1800
2000
frequency MHz
NEXT limit
LDM-1 from LDM-2
LDM-1 from LDM-3
LDM-1 from LDM-4
LDM-2 from LDM-3
LDM-2 from LDM-4
LDM-3 from LDM-4
RDM-1 from RDM-2
RDM-1 from RDM-3
RDM-1 from RDM-4
RDM-2 from RDM-3
RDM-2 from RDM-4
RDM-3 from RDM-4


scaled NEXT
short channel 131
loss dB
frequency MHz
0
10
20
30
40
50
60
70
80
90
0
200
400
600
800
1000
1200
1400
1600
1800
2000
NEXT limit
LDM-1 from LDM-2
LDM-1 from LDM-3
LDM-1 from LDM-4
LDM-2 from LDM-3
LDM-2 from LDM-4
LDM-3 from LDM-4
RDM-1 from RDM-2
RDM-1 from RDM-3
RDM-1 from RDM-4
RDM-2 from RDM-3
RDM-2 from RDM-4
RDM-3 from RDM-4