Unit Load Based Return Loss

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Objective

Nodes using power coupling inductance that is smaller than ~80uH will violate the existing return loss limit

Higher unit loads should be allowed smaller value power coupling inductance

Specify modifications to Clause 188 return loss lines so that unit load inductance is included

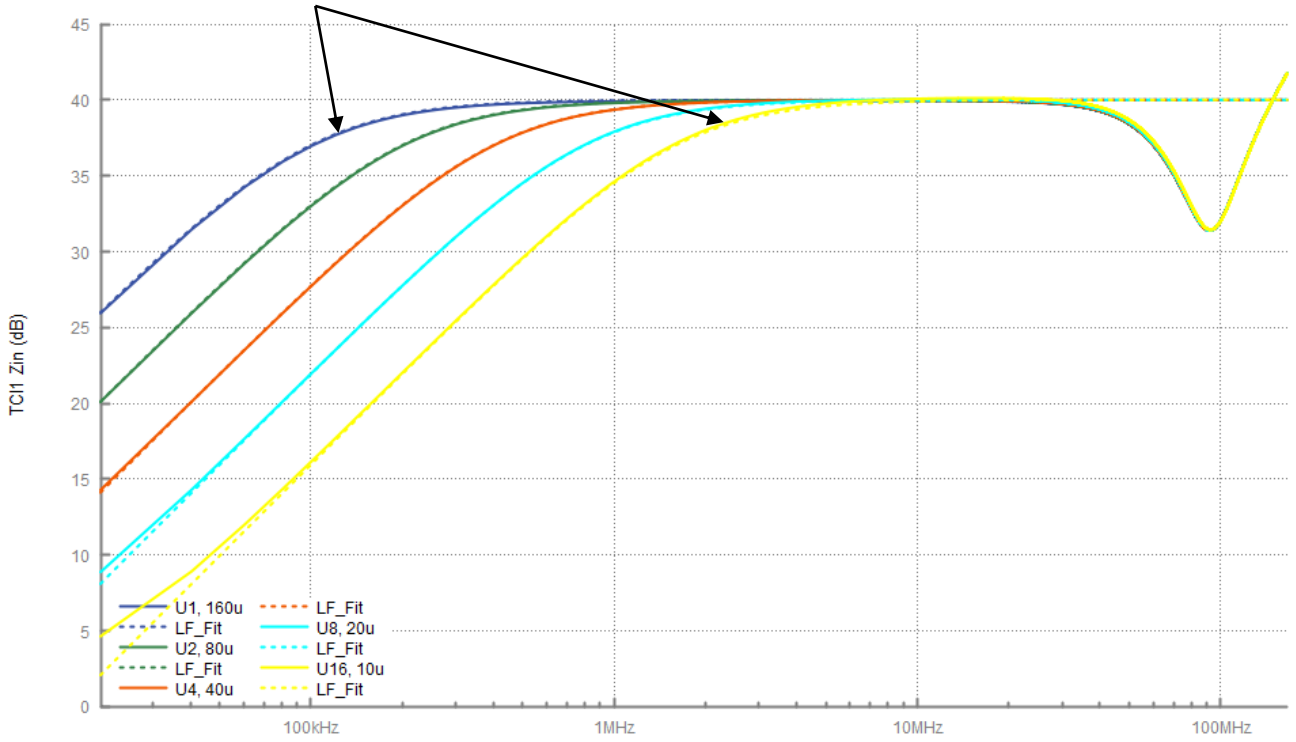
Low Frequency Return Loss of Node

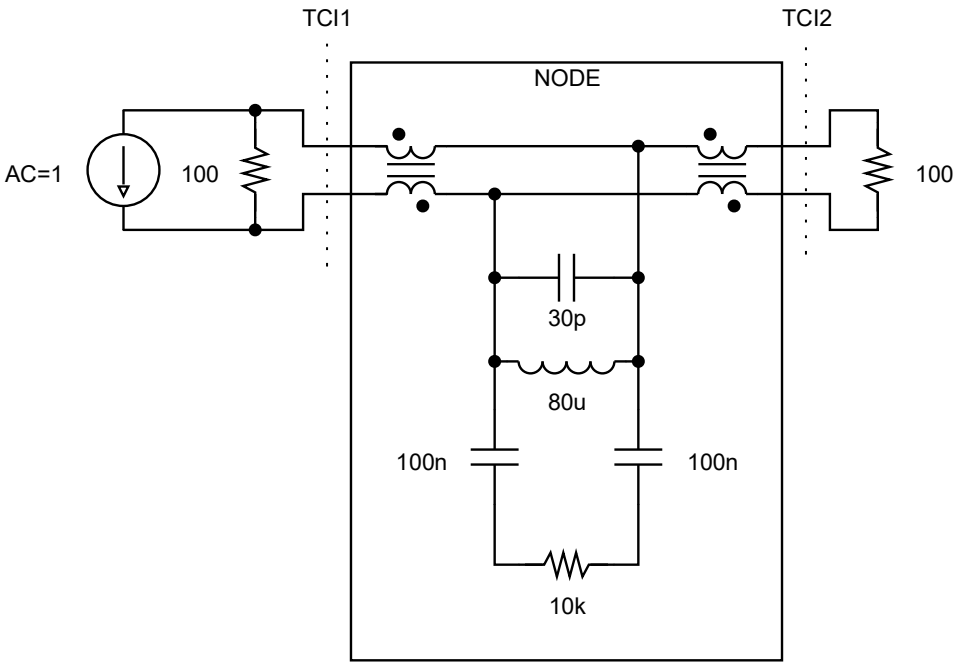
Measure Input Impedance at TC1

Below 10MHz, model input impedance with single pole model

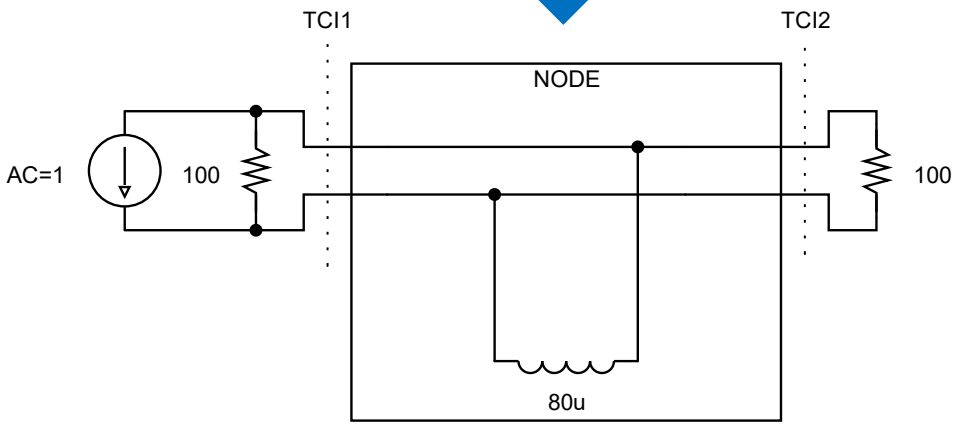
HPF Corner Frequency:

f = 2*pi*(100Ω / Lpodl)





Single Pole Model f < 10MHz



Convert Low Frequency Corner To Return Loss

Single – pole model works well below ~10MHz

Convert TC1 impedance to Return Loss…

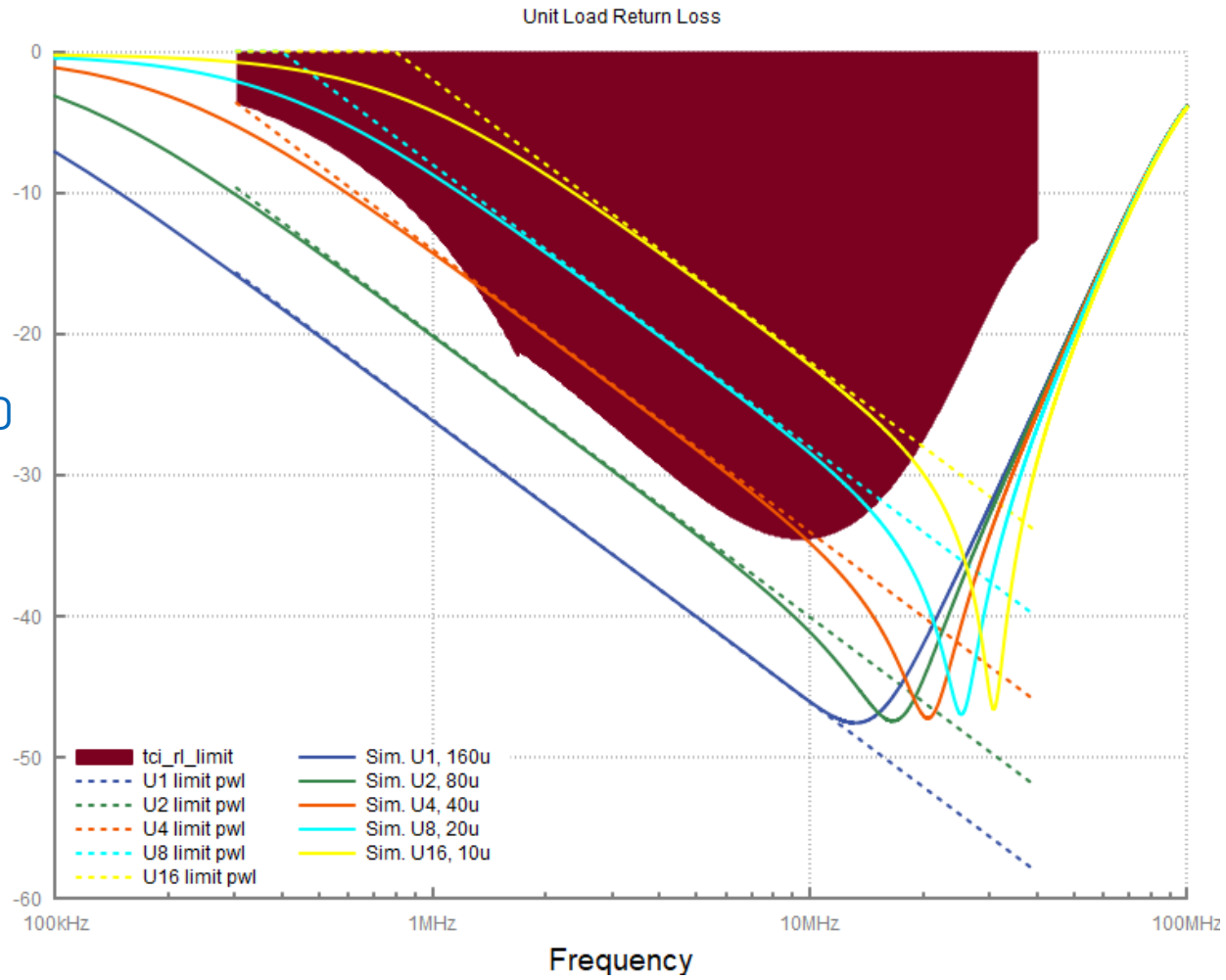
Low frequency return loss based on unit load:

RL(f) <= min(0, -26.06-20*log10(f/NUNIT)) dB 0.3 <= f < TBD

Where

f is the frequency in MHz

NUNIT is the unit load value of the node; 1<= NUNIT <=16



Blending Low Frequency Return Loss

Low frequency RL is easy to calculate because it is based on power coupling inductance and termination resistance

At higher frequencies, RL is dependent on

- Parasitic Capacitance - Cnode
- Compensation Inductance – Lcomp

Higher frequency portion of the curve needs to be fit instead of calculated….

For the following simulations:

- Set nominal parasitic capacitance to 10pF, 20pF, 30pF
- Calculate compensation inductance for Cnode
- Vary parasitic capacitance +/-10%
- Vary Lcomp +/-20%

Simulate the corner cases for Cnode, Lcomp

Compare to proposed RL

Equation

$$RL(f) = -10 * log10\left(\frac{10e3 + \frac{(40.192f)^2}{N_{UNIT}}}{10e3 + \left(\frac{2010f}{N_{UNIT}}\right)^2} + \frac{f^{2.5}}{480e3}\right) \text{ dB; } 0.3 \leq \text{f} \leq 40$$

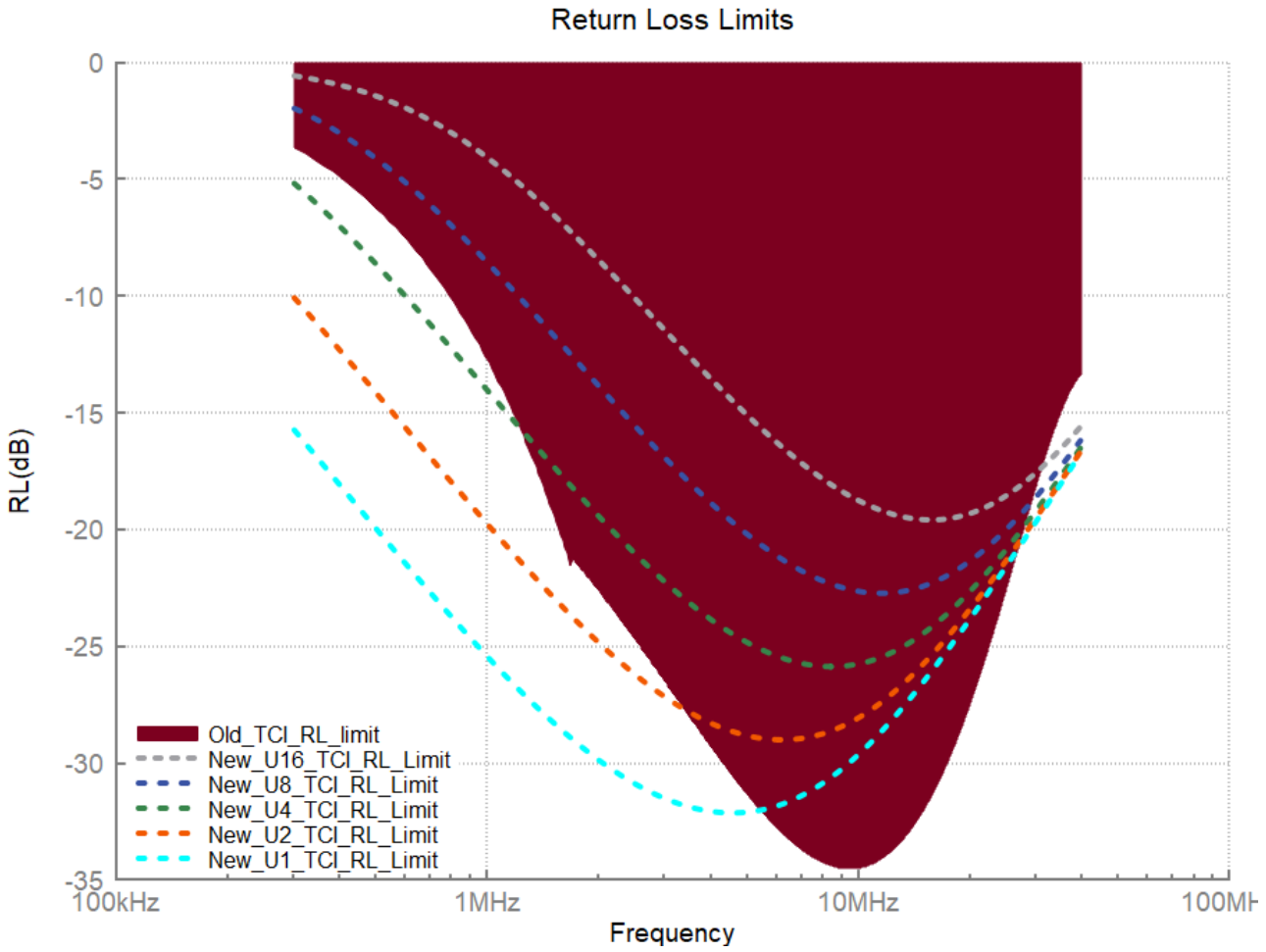
Where:

f is the frequency in MHz

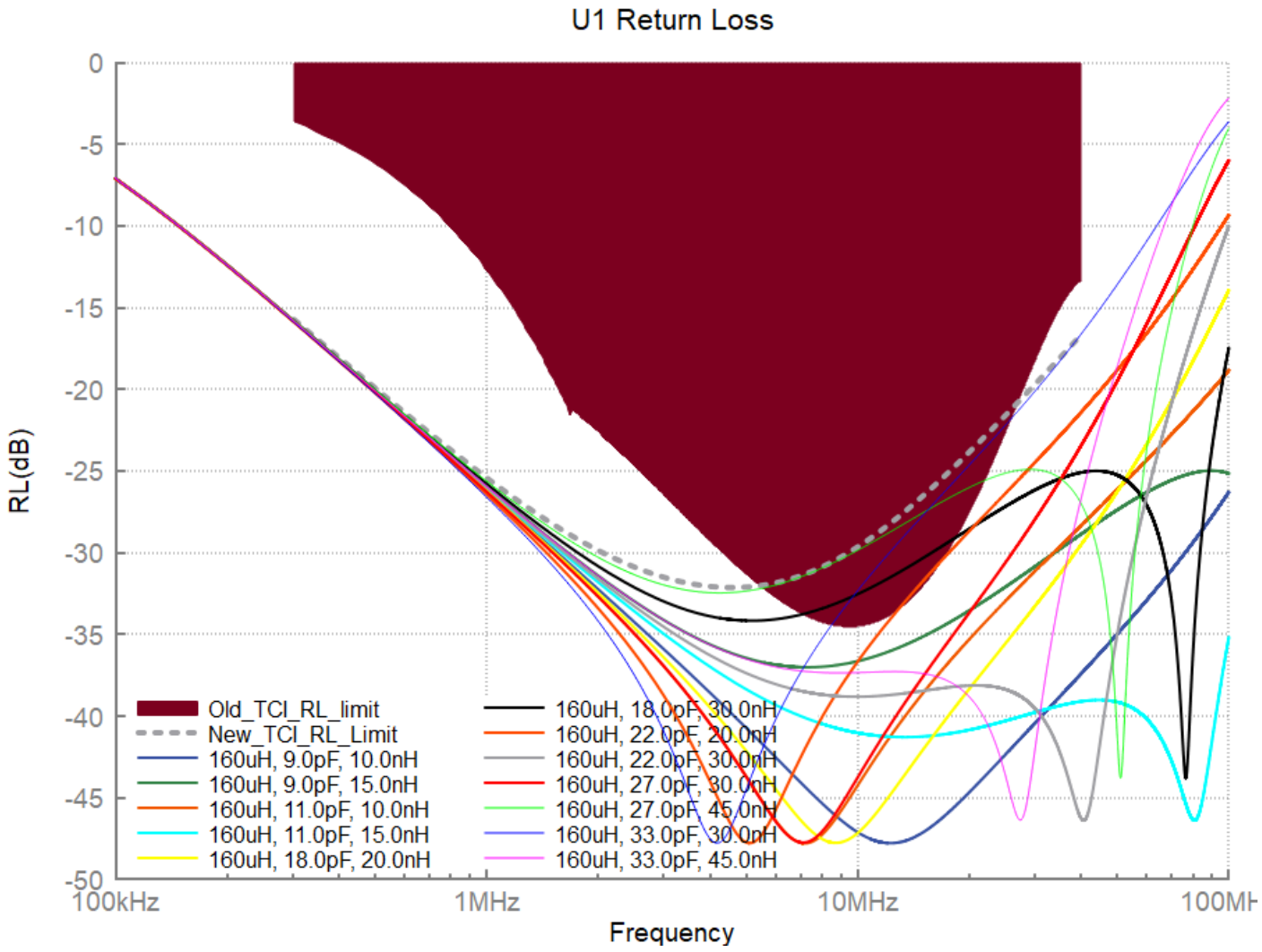
N_{UNIT} is the MPD unit load value

For MPSEs N_{UNIT} = 16

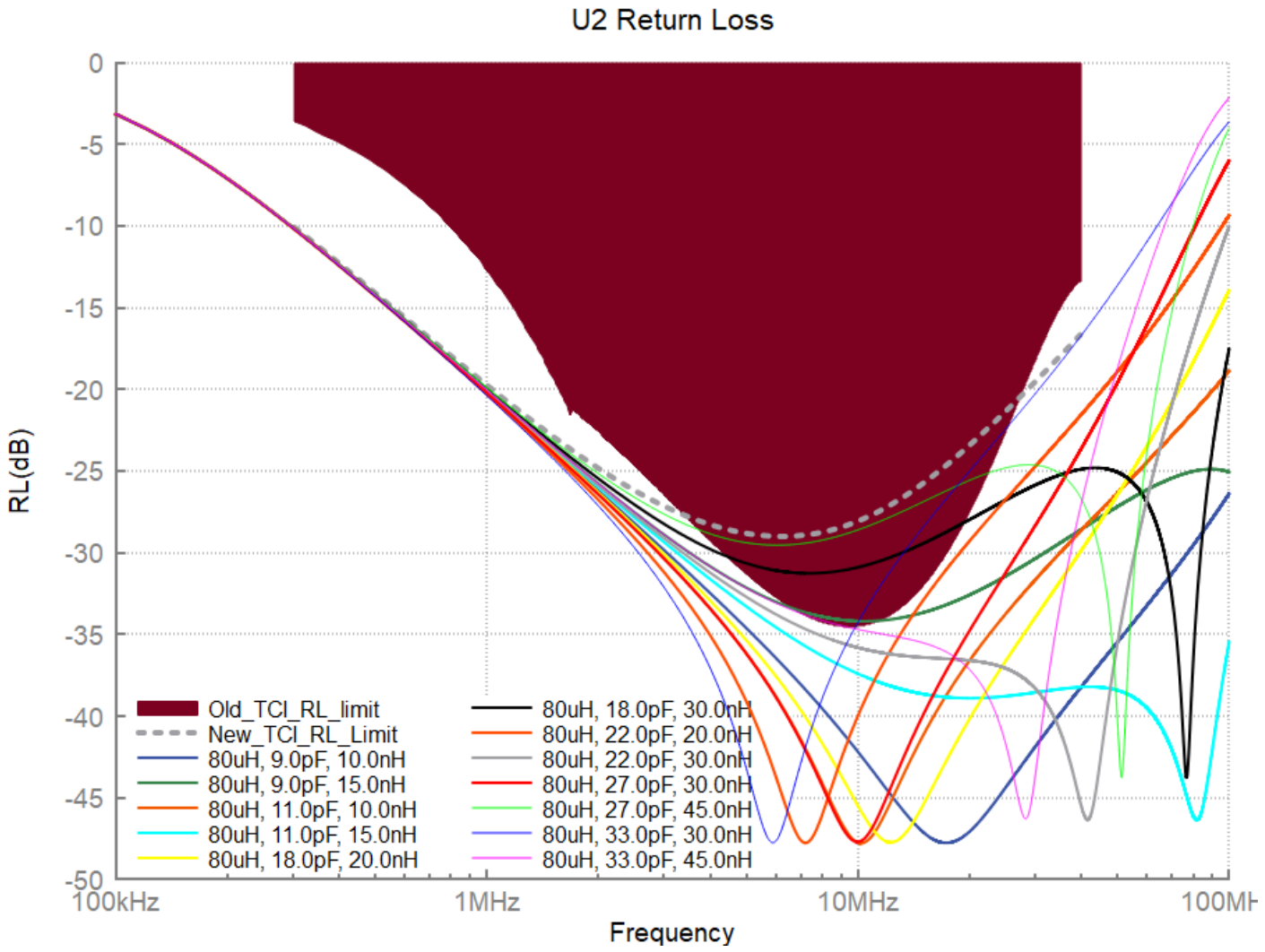
*The equation will produce an inverted version of the graph



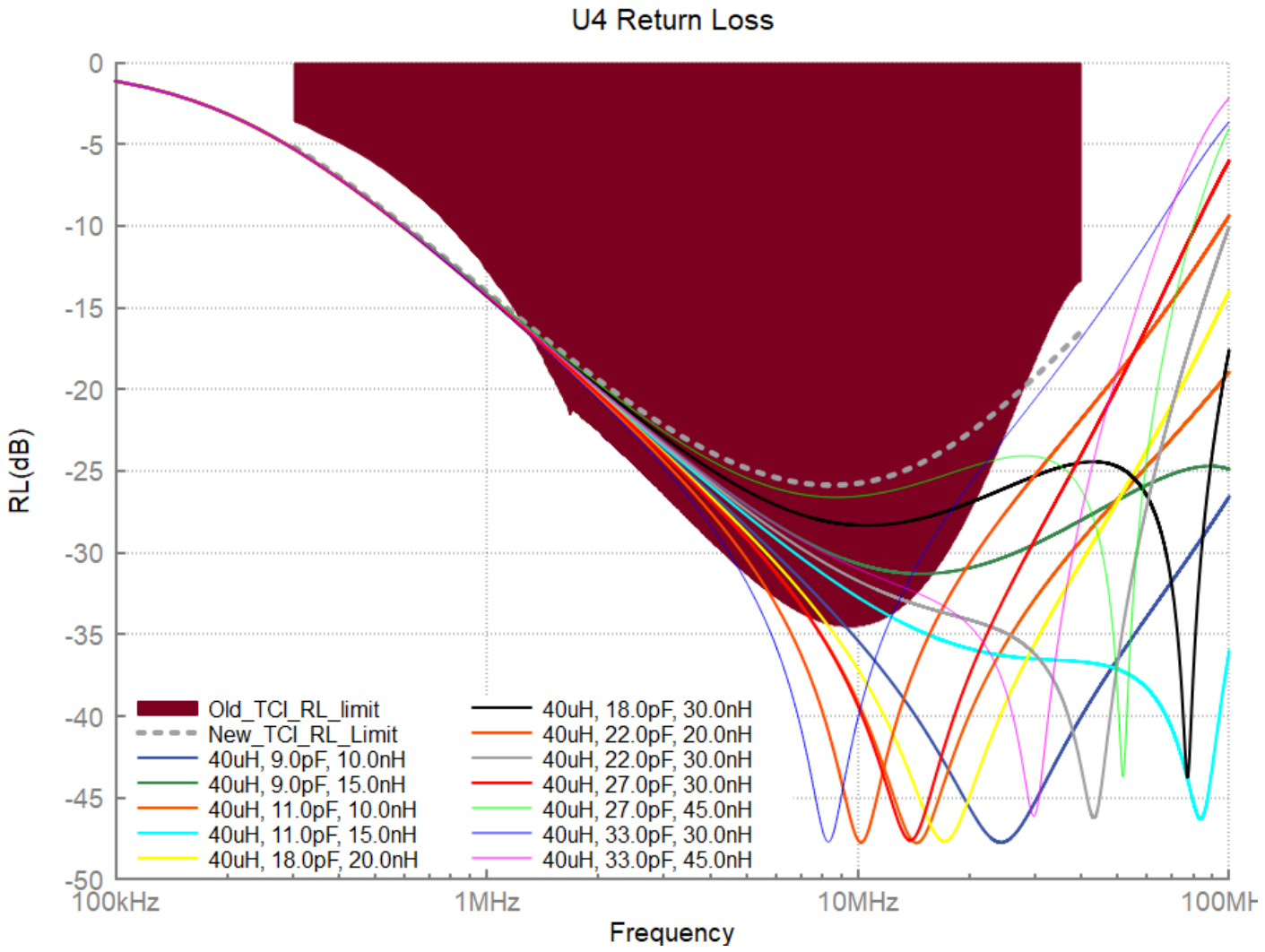
U1


U1 Return Loss
RL(dB)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
100kHz
1MHz
10MHz
100MH
Frequency
Old_TCI_RL_limit
New_TCI_RL_Limit
160uH, 9.0pF, 10.0nH
160uH, 9.0pF, 15.0nH
160uH, 11.0pF, 10.0nH
160uH, 11.0pF, 15.0nH
160uH, 18.0pF, 20.0nH
160uH, 18.0pF, 30.0nH
160uH, 22.0pF, 20.0nH
160uH, 22.0pF, 30.0nH
160uH, 27.0pF, 30.0nH
160uH, 27.0pF, 45.0nH
160uH, 33.0pF, 30.0nH
160uH, 33.0pF, 45.0nH

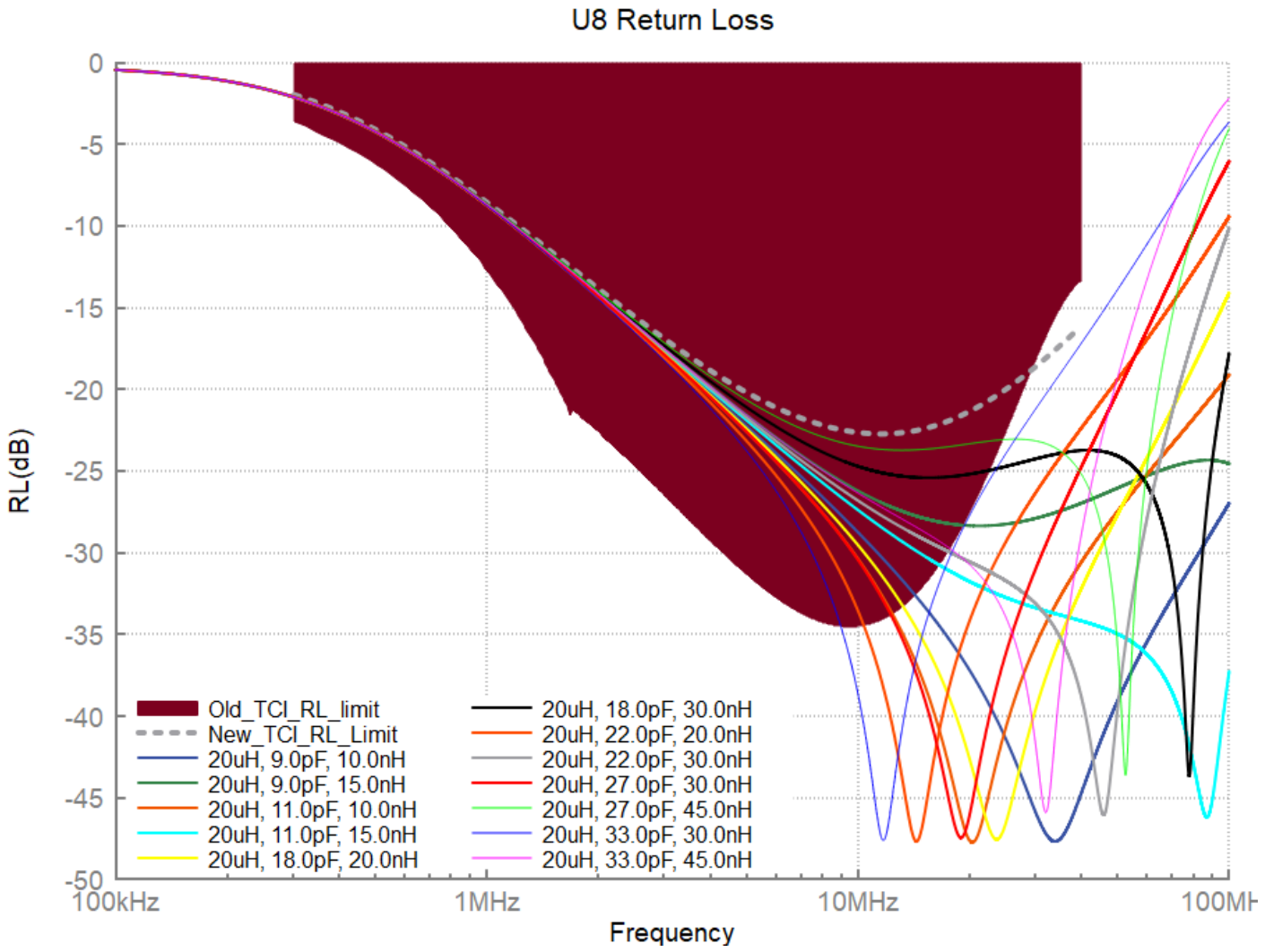
U2


U2 Return Loss
RL(dB)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
100kHz
1MHz
10MHz
100MH
Frequency
Old_TCI_RL_limit
New_TCI_RL_Limit
80uH, 9.0pF, 10.0nH
80uH, 9.0pF, 15.0nH
80uH, 11.0pF, 10.0nH
80uH, 11.0pF, 15.0nH
80uH, 18.0pF, 20.0nH
80uH, 18.0pF, 30.0nH
80uH, 22.0pF, 20.0nH
80uH, 22.0pF, 30.0nH
80uH, 27.0pF, 30.0nH
80uH, 27.0pF, 45.0nH
80uH, 33.0pF, 30.0nH
80uH, 33.0pF, 45.0nH

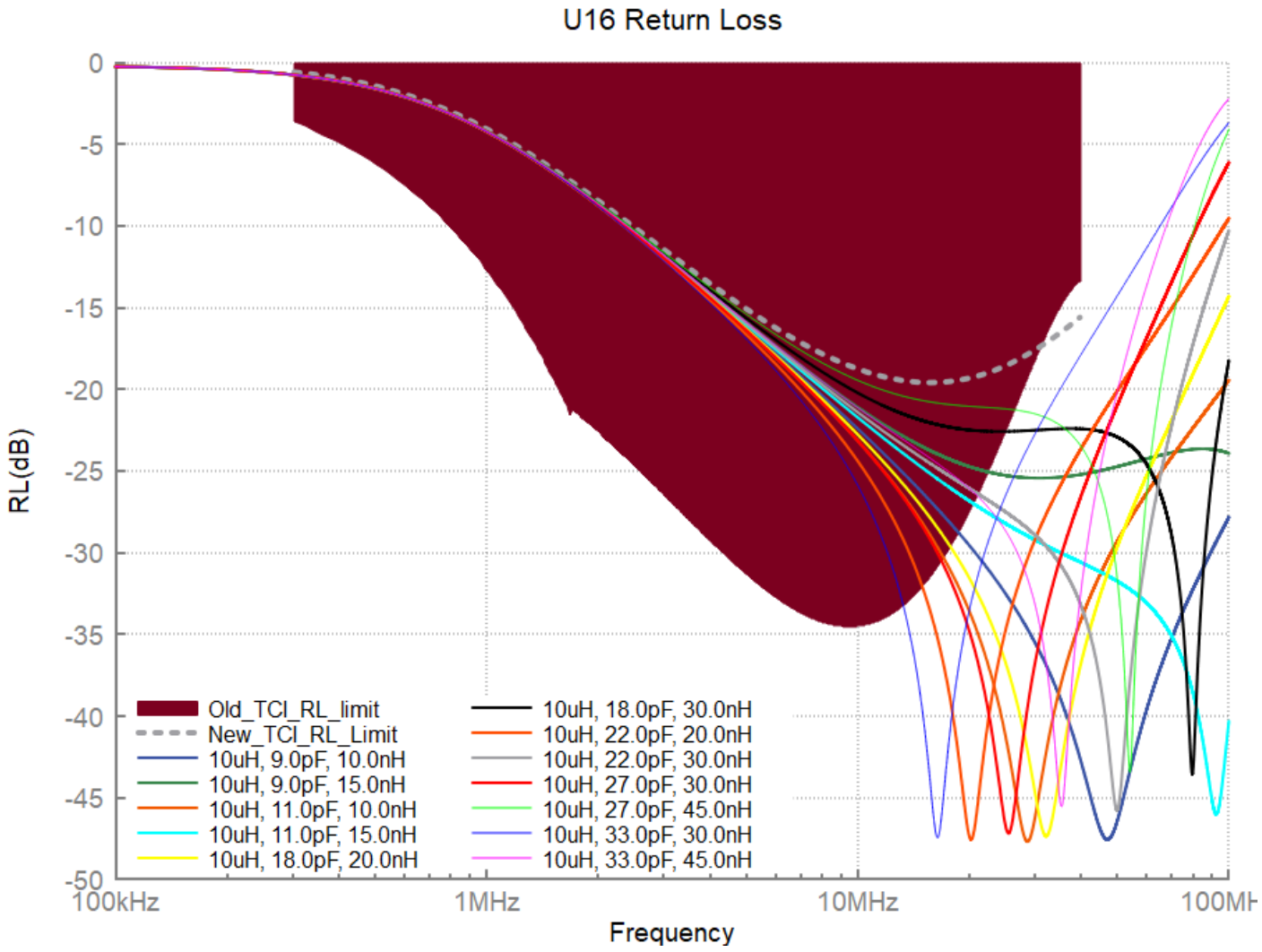
U4


U4 Return Loss
RL(dB)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
100kHz
1MHz
10MHz
100MH
Frequency
Old_TCI_RL_limit
New_TCI_RL_Limit
40uH, 9.0pF, 10.0nH
40uH, 9.0pF, 15.0nH
40uH, 11.0pF, 10.0nH
40uH, 11.0pF, 15.0nH
40uH, 18.0pF, 20.0nH
40uH, 18.0pF, 30.0nH
40uH, 22.0pF, 20.0nH
40uH, 22.0pF, 30.0nH
40uH, 27.0pF, 30.0nH
40uH, 27.0pF, 45.0nH
40uH, 33.0pF, 30.0nH
40uH, 33.0pF, 45.0nH

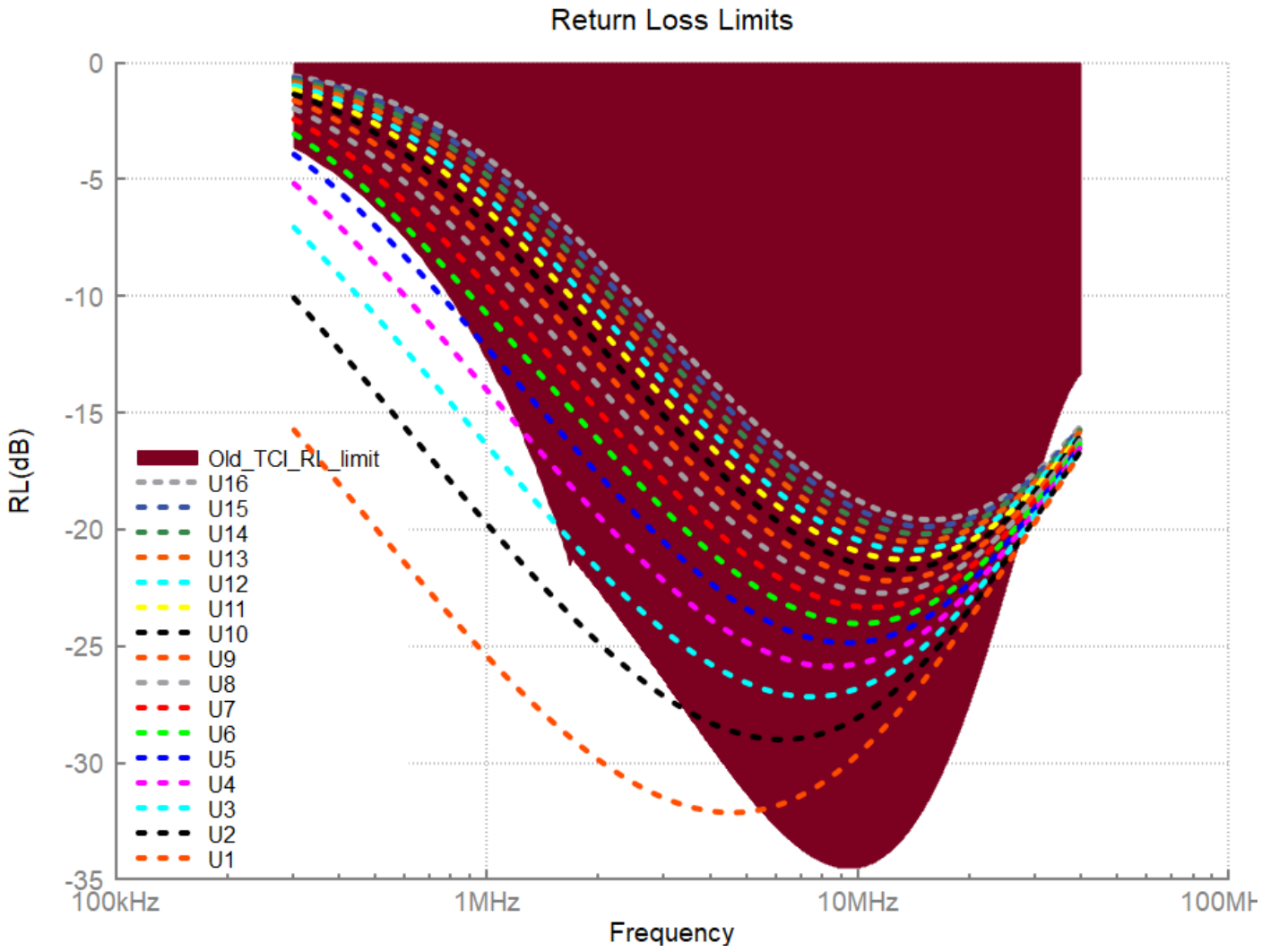
U8


U8 Return Loss
RL(dB)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
100kHz
1MHz
10MHz
100MH
Frequency
Old_TCI_RL_limit
New_TCI_RL_Limit
20uH, 9.0pF, 10.0nH
20uH, 9.0pF, 15.0nH
20uH, 11.0pF, 10.0nH
20uH, 11.0pF, 15.0nH
20uH, 18.0pF, 20.0nH
20uH, 18.0pF, 30.0nH
20uH, 22.0pF, 20.0nH
20uH, 22.0pF, 30.0nH
20uH, 27.0pF, 30.0nH
20uH, 27.0pF, 45.0nH
20uH, 33.0pF, 30.0nH
20uH, 33.0pF, 45.0nH

U16


U16 Return Loss
RL(dB)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
100kHz
1MHz
10MHz
100MH
Frequency
Old_TCI_RL_limit
New_TCI_RL_Limit
10uH, 9.0pF, 10.0nH
10uH, 9.0pF, 15.0nH
10uH, 11.0pF, 10.0nH
10uH, 11.0pF, 15.0nH
10uH, 18.0pF, 20.0nH
10uH, 18.0pF, 30.0nH
10uH, 22.0pF, 20.0nH
10uH, 22.0pF, 30.0nH
10uH, 27.0pF, 30.0nH
10uH, 27.0pF, 45.0nH
10uH, 33.0pF, 30.0nH
10uH, 33.0pF, 45.0nH

All U1 – U16


Return Loss Limits
RL(dB)
0
-5
-10
-15
-20
-25
-30
-35
100kHz
1MHz
10MHz
100MH
Frequency
Old_TCI_RL_limit
U16
U15
U14
U13
U12
U11
U10
U9
U8
U7
U6
U5
U4
U3
U2
U1

Conclusion

$$RL(f) = -10 * log10\left(\frac{10e3 + \frac{(40.192f)^2}{N_{UNIT}}}{10e3 + \left(\frac{2010f}{N_{UNIT}}\right)^2} + \frac{f^{2.5}}{480e3}\right) \text{ dB; } 0.3 \leq \text{f} \leq 40$$

Where:

f is the frequency in MHz

N_{UNIT} is the MPD unit load value

For MPSEs N_{UNIT} = 16

How do we integrate this into clause 188 and 189?

*The equation will produce an inverted version of the graph