

# Shielding Effectiveness of Meshed Panels in Single and Sandwich Structure.

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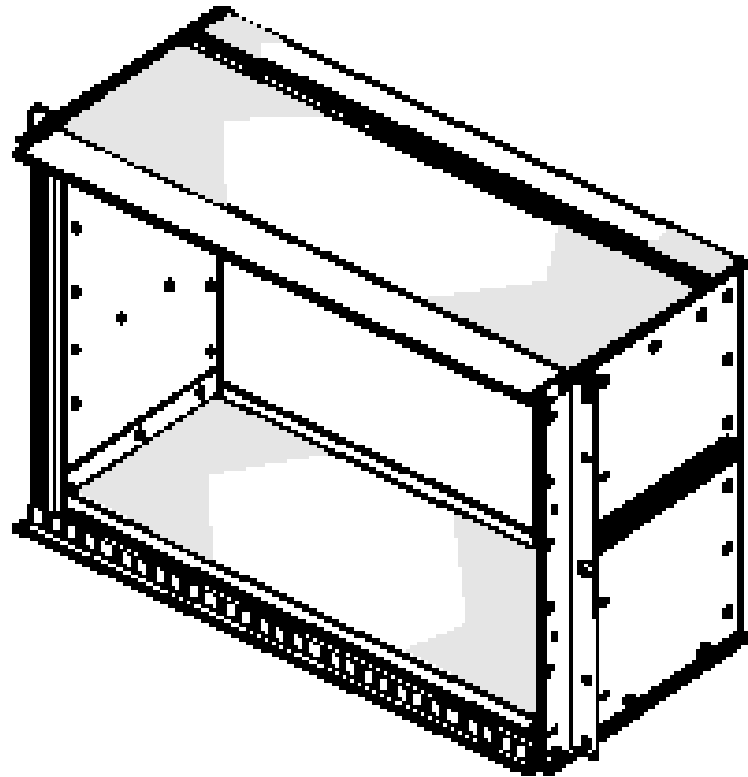
Ericsson AB

Development Unit IP Network (DIPN)

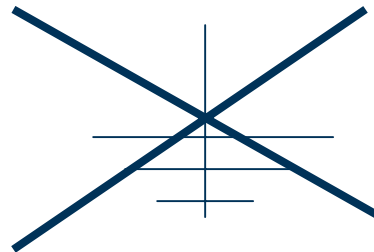
Älvsjö

# Subrack EMC and cooling problem

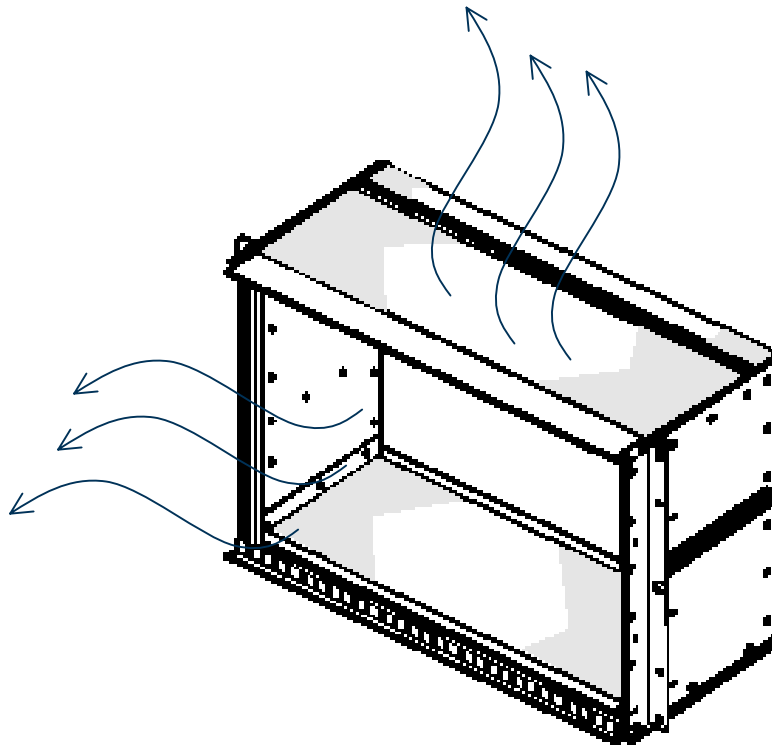
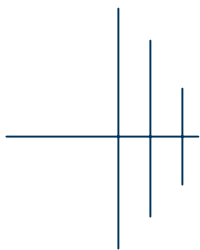
- Subrack needs air ventilation openings in top and bottom covers.
- Small holes to maintain EMC.
- Large holes for air flow.
- Conflict between EMC and cooling.



# EMC test of an apparatus



Not tested



# What Gives Shielding Effectiveness

- Types of effects to reduce penetration of EM waves in a shield are:
  - Reflection loss
    - Wave impedance dependent.
    - Surface impedance dependent.
  - Absorption loss
    - Caused by ‘Ohmic’ losses in metal.
    - Independent on wave impedance.
    - No absorption of fields passing in an opening of a shield (if neglect of wave guide losses).
  - Multiple reflection loss
    - Reduce the total Shielding Effectiveness of a sheet.
    - Can be neglected if absorption losses are high.

# Simulation Tool

- Model as a cascade of 1D transmission lines (chain parameters).
  - Features
    - + Fast simulation.
    - + Good enough to get a picture of performance.
  
    - Only infinite large panels.
    - Only TEM waves.
    - No point source.
    - Only even distribution of openings.
- Handle solid screens and mash screens.



# SE Definition in the Simulation Tool



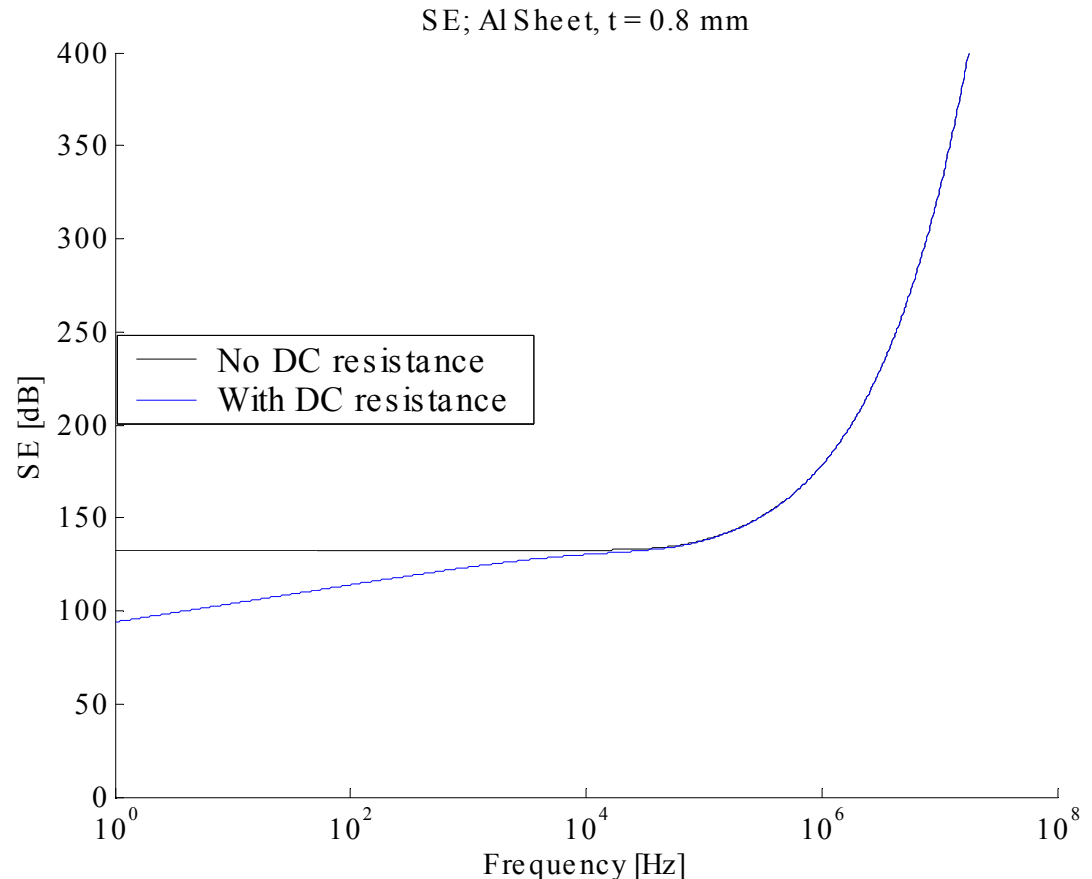
$$SE = 20 * \log \left( \frac{E_0}{E_{SH}} \right)$$

# SE in a Metal Sheet

- Absorption loss at high frequency, when  $t \gg \delta$  (skin depth).
- Reflection loss at low frequency
- $SE$  at low frequencies saturate due to multiple reflections in the sheet and skin effects

$$SE = 20 * \log\left(\frac{377}{2} \sigma t\right) = 45.5 + \log(\sigma t)$$

(no DC resistance)



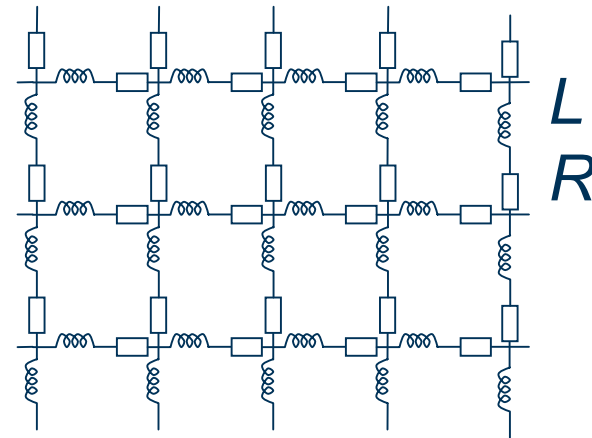
# SE in Metal Net

$$L_y = \frac{\mu_0 s}{2\pi} \ln \left( \frac{1}{1 - e^{-\frac{\pi d}{s}}} \right)$$

$$R_{DC} = \frac{4s}{\pi d^2 \sigma}$$

$R_{AC}$  = Skin effect

$$R = \sqrt{R_{DC}^2 + R_{AC}^2}$$



$s$  = distance between wires  
 $d$  = wire diameter

- Inductance formula from EMMA handbok.

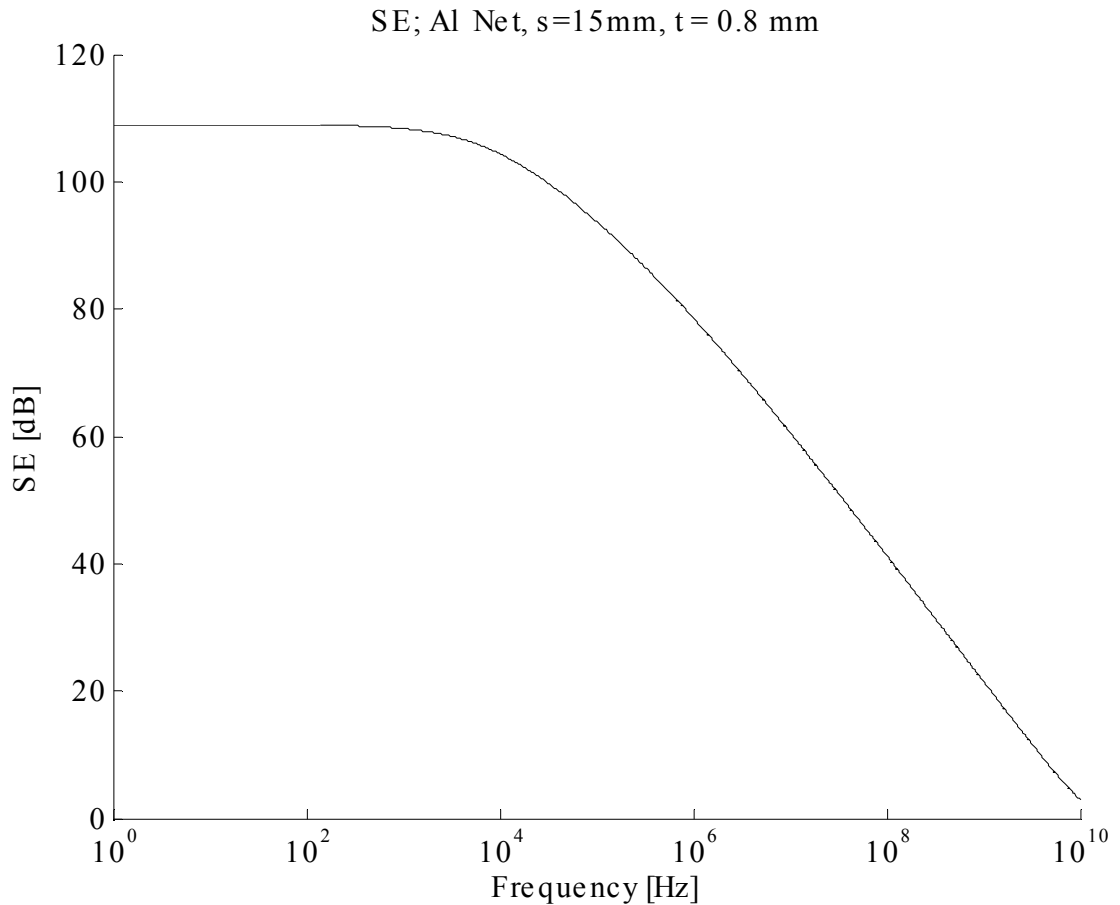
# SE in Metal Net, cont

- SE saturate at low frequencies to

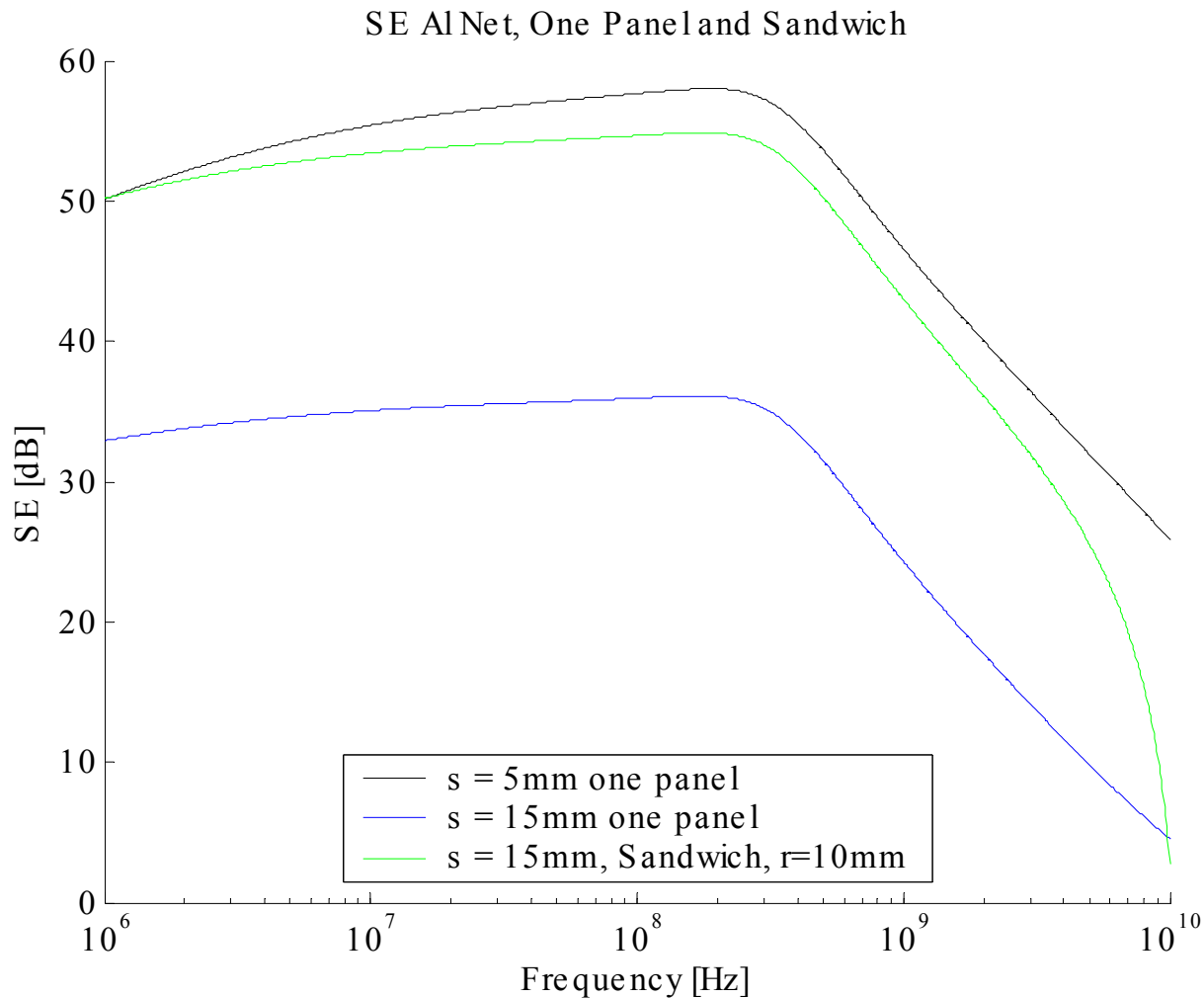
$$SE = 20 * \log\left(\frac{377}{2R_{DC}}\right)$$

- The linear slope of SE pass 0dB at frequency

$$f_{0dB} = \frac{377}{4\pi L_y}$$



# SE of One Mesh Screens and Sandwich Structure



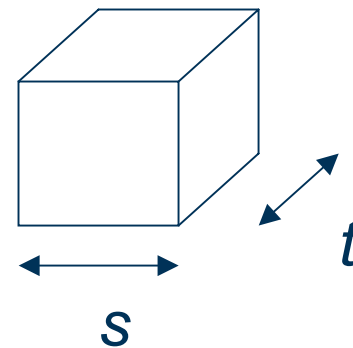
# Wave Guide Damping

- At frequencies below waveguide cut off frequency the propagation constant got real, causing a lossy propagation through the waveguide.
- Cut off frequency for a square hole is

$$f_c = \frac{c}{2s} = \frac{1.5 * 10^8}{s} [Hz]$$

- $SE$  for a square hole at  $f \ll f_c$  is

$$SE = 27.2 \frac{t}{s}$$



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