Lightning Currents Shared by a Buried Grounding Strip Connected to Communication Tower Legs

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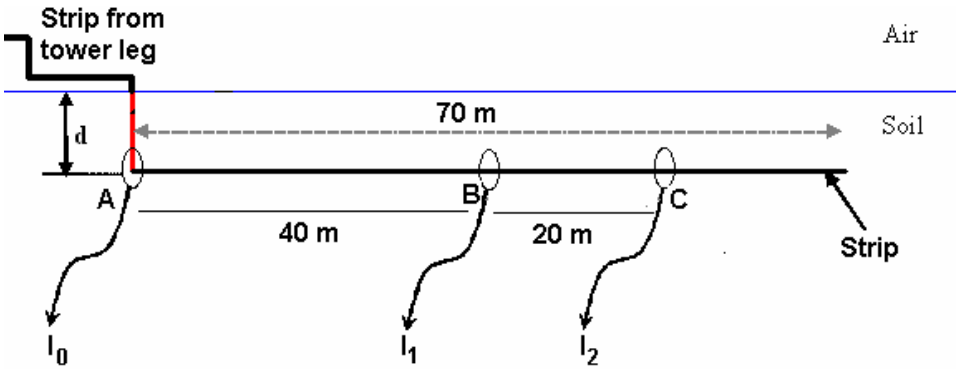
Objective

- **Present the measured current in a grounding strip connected to one of the leg's of Gaisberg communication tower during lightning strike**
- **Compare with the predictions of a frequency dependant lossy transmission line (TL) model.**
- **Show that TL models are appropriate for lightning transient analysis of grounding systems.**

Measurement set up

Ground strip measurement points



grounding strip 70 m long and at a depth of 0.5 m.

rectangular cross section 30 mm $\times$ 3 mm

Measured currents
Flash 513

tower initiated upward negative lightning

the x-axis is a relative time scaling and does not correspond to the real inter stroke interval.

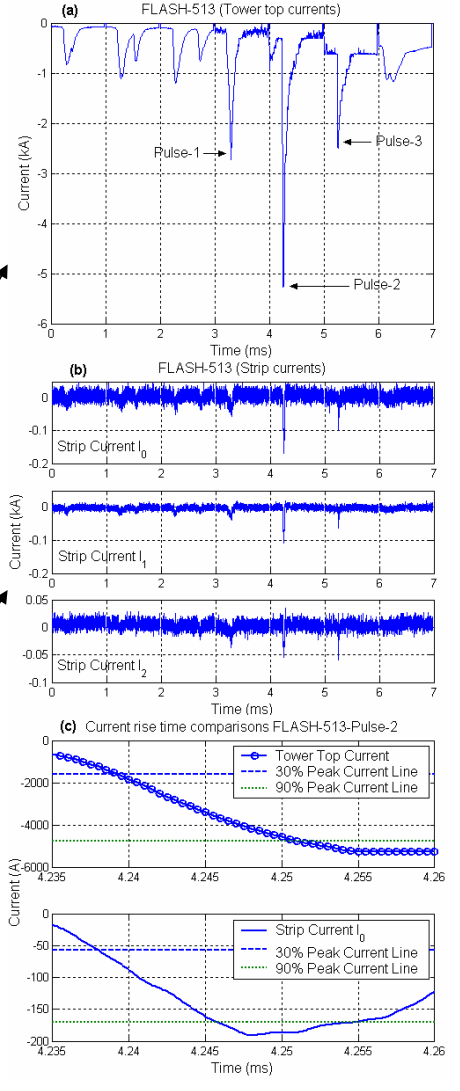
Tower top currents

Pulse-1	2.7 kA	52 μs
Pulse-2	5.3 kA	11.5 μs
Pulse-3	2.5 kA	8 μs

Strip currents

Pulse 2: 150 A (I_0), 100 A, 50 A

the current dissipation rate:
between 0 and 40 m - 1.25 A/m
between 40 m and 60 m - 2.5 A/m.

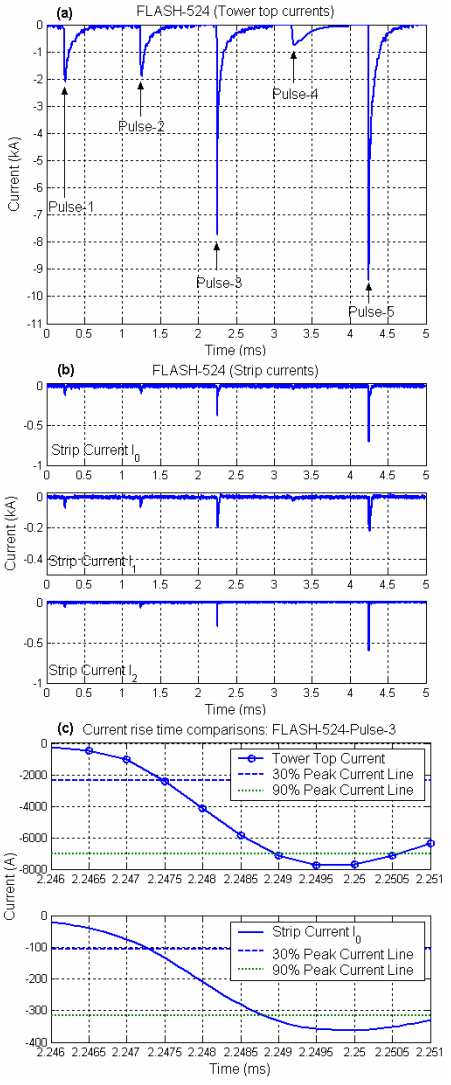


Strip currents faster than tower top currents!

Measured currents

Flash 524

Tower top current peaks	
2 kA (Pulse-1)	2 μs
1.9 kA (Pulse-2)	7 μs
7.8 kA (Pulse-3)	1.5 μs
0.7 kA (Pulse-4)	14 μs
9.4 kA (Pulse-5)	1.2 μs



Pulse 3 – return stroke

Similar rise-time for tower top current and strip current, I_0

Modelling currents in ground strip

$$\frac{dV(x,s)}{dx} = -Z_g \cdot I(x,s)$$

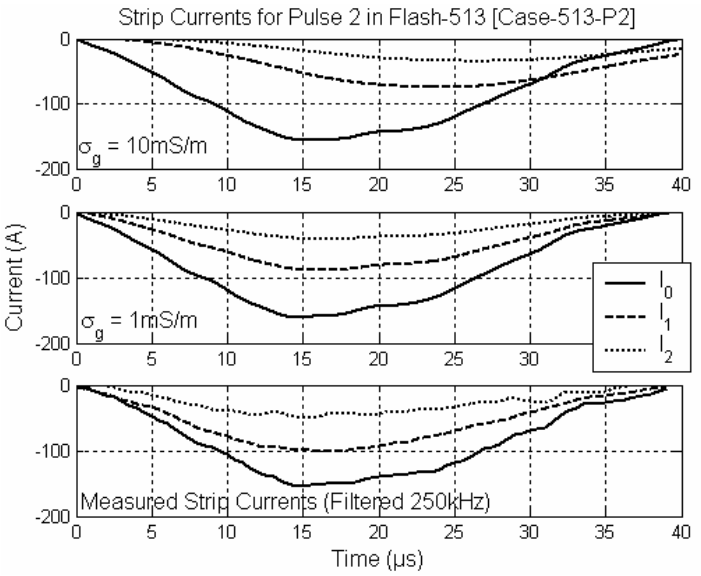
$$\frac{dI(x,s)}{dx} = -Y_g \cdot V(x,s)$$

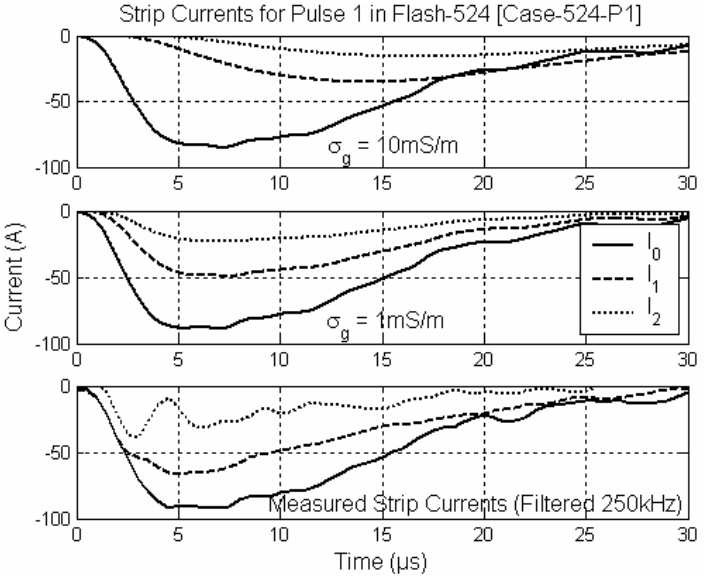
$$Z_g = \frac{s\mu_0}{2\pi}\left\{ln\left(\frac{1+\gamma_g a}{\gamma_g a}\right)+\left[\frac{2e^{-2d|\gamma_g|}}{4+\gamma_g^2 a^2}\right]\right\}$$

$$Y_g = \frac{\gamma_g^2}{Z_g}$$

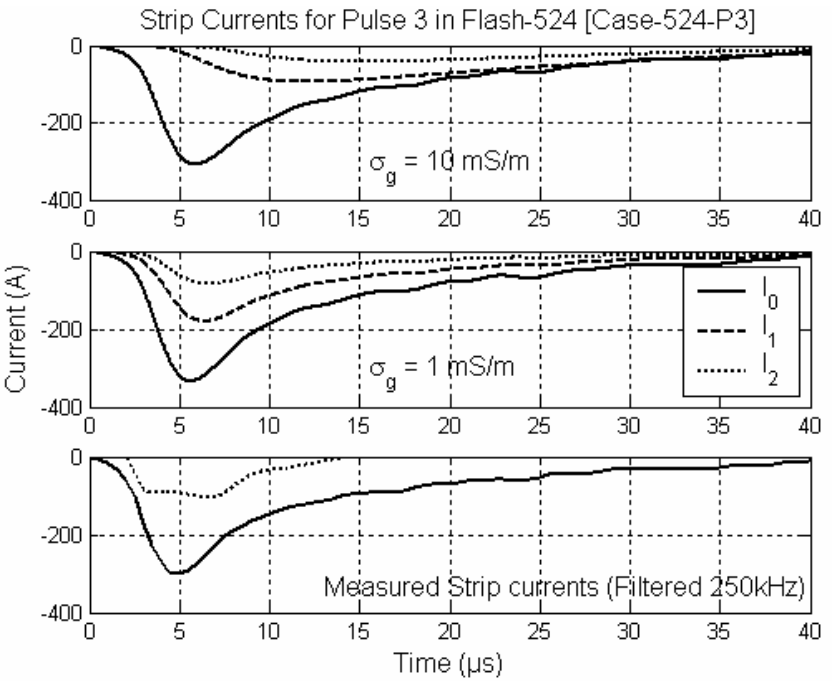
$$\gamma_g = \sqrt{s\mu_0\left(\sigma_g + s\varepsilon_g\right)}$$

Simulation results





Simulation Results



Interesting Observation

- The particular ground strip connected to the tower legs takes about 3% - 5% of the stroke current.
- TL model with ground properties included is suitable for studying lightning pulse propagation in grounding strips
- When the current pulses are not return strokes the rise times of currents entering the strip are faster than the corresponding tower top currents.
- On the contrary the return stroke current pulses entering the strip have similar rise time as that of the pulse at the tower top.

Ref:

Theethayi N, Thottappillil R, Diendorfer G, Mair M & Pichler H, “Currents in Buried Grounding Strips Connected to Communication Tower Legs during Lightning Strikes”, IEEE trans. on Dielectric and Electrical Insulation, 2008 (Accepted and in press for publication).