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$Rg := 4.7\ \Omega$ $RL := 10^{7}\ \Omega$ Impedances of source and load

$Vmeas := 0.41\ V$ Measured voltage between horizontal sections of square wave

$Crad := 220 \cdot 10^{-12}\ F$ Value assigned to radiation capacitor. Adjust to suit

$Rcable := 1\ \Omega$ Resistor which simulates cable losses. Adjust to suit

$Ro1 := 50\ \Omega$ $Ro2 := Ro1$ $Ro3 := 600\ \Omega$ See figure 6.6.1. **Adjust to suit**

$$Loss := \frac{Ro2}{Ro2 + Ro3}$$ Equation (6.6.3)

$$Ro := Ro1 + \frac{Ro2 \cdot Ro3}{Ro2 + Ro3} = 96.154$$ Equation (6.6.1)

$ZT := 2.27\ \Omega$ See equation (7.2.6)

$$K := \frac{50}{96.2}$$ See equation (7.6.1)

$$Vg := \frac{Vmeas}{K}$$ $Vg = 0.789$ See equation (6.6.11)

$T := 83 \cdot 10^{-9}\ s$ Measured transit time. Adjust to suit

$N := 100$ Number of time-steps per transit

$$dt := \frac{T}{N}$$ Time of each step

$T1 := 120 \cdot 10^{-9}\ s$ Time of leading edge of square wave, as displayed on oscilloscope

$T2 := 1.65 \cdot 10^{-6}\ s$ Time of trailing edge of square wave, as displayed on oscilloscope

$T3 := 2 \cdot 10^{-6}\ s$ Sweep time of oscilloscope

$$N1 := \frac{T1}{dt} \quad N2 := \frac{T2}{dt} \quad N3 := \frac{T3}{dt}$$ Number of time steps at which each event occurs.

$n := 1 .. N3$ $t_n := (n - 1) \cdot dt$ Definition of horizontal axis of display

Figure 6.6.2 Definition of input variables.

$$\text{send}(\text{near}, \text{INPUT}, \text{Vgen}) :=$$

$\text{Ini} \leftarrow \text{INPUT}_2$

$\begin{pmatrix} \text{Ina} \\ \text{Int} \\ \text{Ine} \\ \text{Ins} \\ \text{Qns} \end{pmatrix} \leftarrow \text{near}$

$\text{Ina} \leftarrow \dfrac{2 \cdot \text{Ro} \cdot \text{Ini} + \text{Vgen} - \text{Rg} \cdot \text{Ins}}{\text{Ro} + \text{Rg} + \text{Rcable}}$ equation (6.6.8)

$\text{Inr} \leftarrow \text{Ina} - \text{Ini}$

$\text{Ine} \leftarrow \text{Loss} \cdot \text{Ina}$ equation (6.4.7)

$\text{Inf} \leftarrow \text{Inr} - \text{Ine}$ equation (6.6.2)

$\text{Ins} \leftarrow \text{Inf} - \dfrac{\text{Qns}}{\text{Ro} \cdot \text{Crad}}$ equation (6.6.4)

$\text{Qns} \leftarrow \text{Qns} + \text{Ins} \cdot dt$ equation (6.6.5)

$\text{Int} \leftarrow \text{Inf} - \text{Ins}$ equation (6.4.10)

$\begin{pmatrix} \text{Ina} \\ \text{Int} \\ \text{Ine} \\ \text{Ins} \\ \text{Qns} \end{pmatrix}$ equation (6.6.6)

$$\text{recv}(\text{INPUT}) :=$$

$\text{Ifi} \leftarrow \text{INPUT}_1$ Copy of function defined in figure 6.4.4

$\text{Ifa} \leftarrow \dfrac{2 \cdot \text{Ro} \cdot \text{Ifi}}{\text{RL} + \text{Ro}}$

$\text{Ifr} \leftarrow \text{Ifa} - \text{Ifi}$

$\begin{pmatrix} \text{Ifa} \\ \text{Ifr} \end{pmatrix}$

Figure 6.6.3 Subroutines for near-end and far-end calculations.

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$$\text{point}(n) := \left| \begin{array}{l} m \leftarrow \text{mod}(n, N) \\ m \leftarrow N \quad \text{if} \quad m = 0 \end{array} \right.$$

$$\text{Vch1} := \left| \begin{array}{l} \text{data}_{2,N} \leftarrow 0 \\ \text{near}_5 \leftarrow 0 \\ \text{for} \quad i \in 1 .. N3 \\ \quad \left| \begin{array}{l} \text{Vgen} \leftarrow \text{Vg} \quad \text{if} \quad i > N1 \\ \text{Vgen} \leftarrow 0 \quad \text{if} \quad i > N2 \\ p \leftarrow \text{point}(i) \\ \text{INPUT} \leftarrow \text{data}^{\langle p \rangle} \\ \text{near} \leftarrow \text{send}(\text{near}, \text{INPUT}, \text{Vgen}) \\ \begin{pmatrix} \text{Ina} \\ \text{Int} \\ \text{Ine} \\ \text{Ins} \\ \text{Qns} \end{pmatrix} \leftarrow \text{near} \\ \begin{pmatrix} \text{Ifa} \\ \text{Ifr} \end{pmatrix} \leftarrow \text{recv}(\text{INPUT}) \\ \text{OUTPUT} \leftarrow \begin{pmatrix} \text{Int} \\ \text{Ifr} \end{pmatrix} \\ \text{data}^{\langle p \rangle} \leftarrow \text{OUTPUT} \\ \text{Idiff} \leftarrow \text{Ina} - \text{Ine} \\ \text{Vin} \leftarrow \text{Vgen} - \text{Rg} \cdot (\text{Ina} + \text{Ins}) \\ \text{Vch1} \leftarrow K \cdot \text{Vin} \\ \text{Vdiff} \leftarrow \text{ZT} \cdot \text{Idiff} \\ \text{Vrad} \leftarrow \text{ZT} \cdot \text{Ine} \\ V_i \leftarrow \text{Vrad} \end{array} \right. \\ V \end{array} \right.$$

equation (6.6.9)

equation (6.6.10)

equation (6.6.11)

equation (6.6.12)

equation (6.6.12)

channel 1 selected as output variable

Figure 6.6.4 Main routine used to analyse transient response.(page 3 of worksheet)

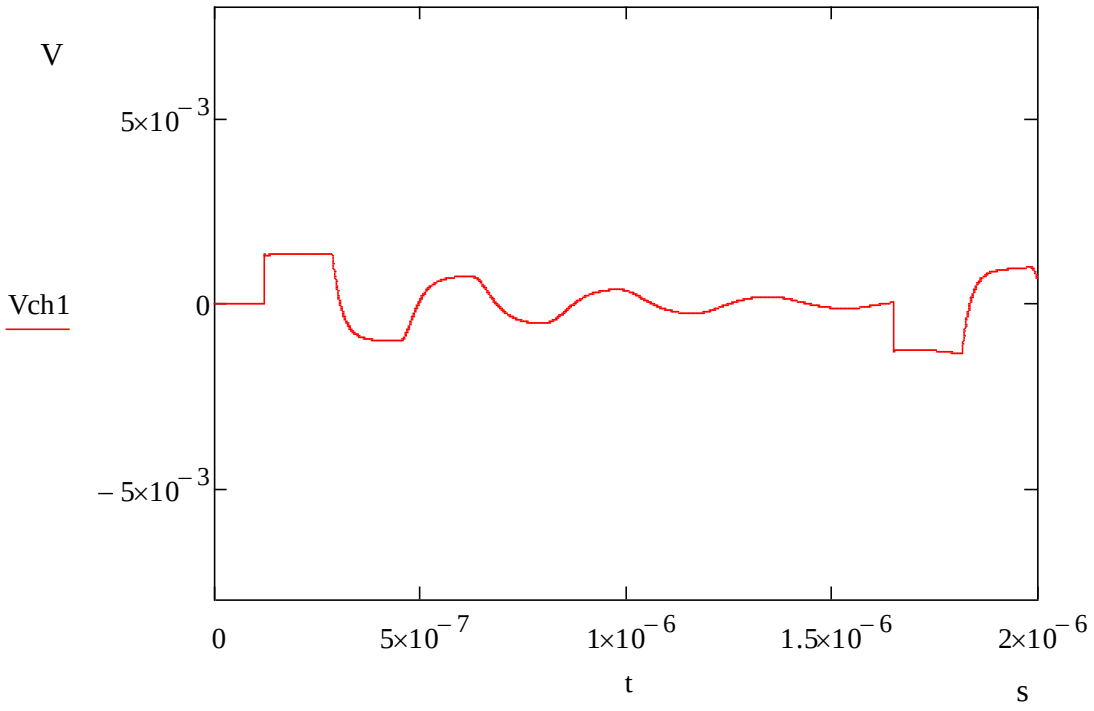

Figure 7.6.8 Simulated voltage at channel 2 input. Antenna current monitored

$T1 = 1.2 \times 10^{-7}$ $T2 = 1.65 \times 10^{-6}$ $T3 = 2 \times 10^{-6}$ $Crad = 2.2 \times 10^{-10}$

Ro1 = 50 Ro3 = 600 Loss = 0.077 Ro = 96.154 Rcable = 1

Vmeas = 0.41

Vertical scale: top = 8 mV, bottom = -8 mV
Horizontal scale : 2 micro-seconds