

VOLTAGE TO CURRENT WAVEFORM CONVERSION  
(Example Of The 10/700  $\mu$ s Surge)

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**INTRODUCTION**

CCITT members have generated a great deal of recommendations which have permitted national

administrations to publish local standards. In particular they have defined a 10/700  $\mu$ s surge waveform and its associated generator diagram (see fig.1).

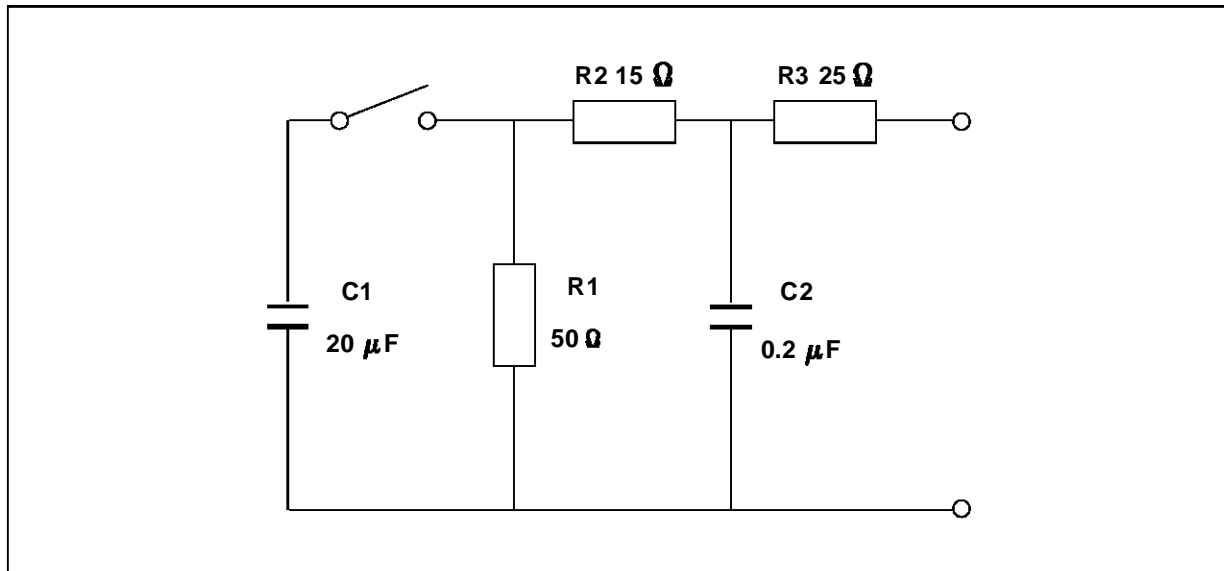
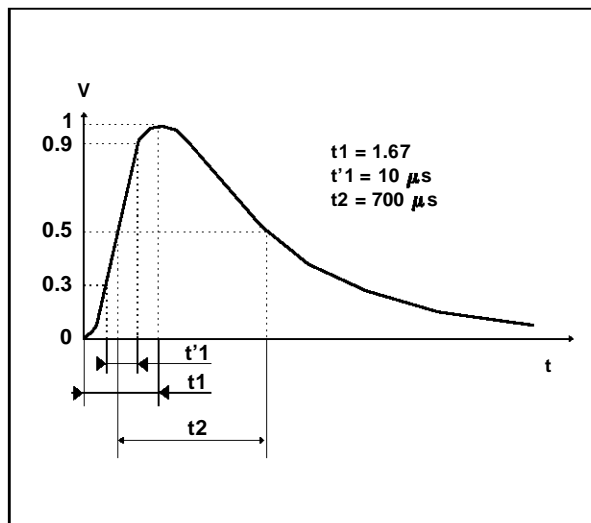


Figure 1 : CCITT 10/700  $\mu$ s Surge Definition



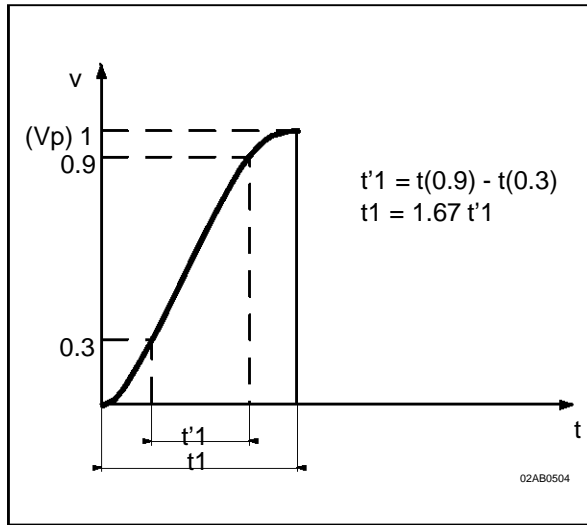
**GENERATOR DIAGRAM  
OPEN OUTPUT SURGE WAVEFORM**

It is important to note that the given waveform is the generator output voltage without load. For a protection component user the most important parameter to take into account is the current waveform flowing through the surge suppressor. The goal of this paper is to give the current waveform parameters.

2 - WAVEFORM CALCULATION

2.1 : Generator output voltage without load.

Figure 2 : Voltage Rise time



2.1.1 : Rise time

The equation of this curve is :

$$v(t) = V_p (1 - \exp(-t/T))$$

$$\Rightarrow t = -T \log_n (1 - (v(t)/V_p)) \quad (1)$$

In this case the time constant may be estimated as :

$$T = R_2 C_2$$

So  $t(0.3)$  and  $t(0.9)$  will be calculated respectively with  $v(t)/V_p = 0.3$  and  $0.9$

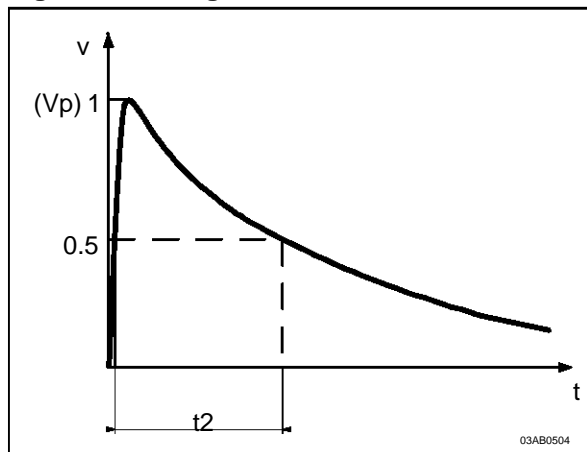
$$t(0.3) = 1 \mu s$$

$$t(0.9) = 6.9 \mu s$$

and then

$$t1 = 1.67 (t(0.9) - t(0.3)) = 9.8 \mu s \approx \underline{\underline{10 \mu s}}$$

Figure 3 : Voltage duration



2.1.2 : Voltage surge duration

The equation of this curve is:

$$v(t) = V_p \exp(-t/T)$$

$$\Rightarrow t = - \log_n (v(t)/V_p) \quad (2)$$

with a time constant due essentially to  $R_1$  and  $C_1$

$$T = R_1 C_1$$

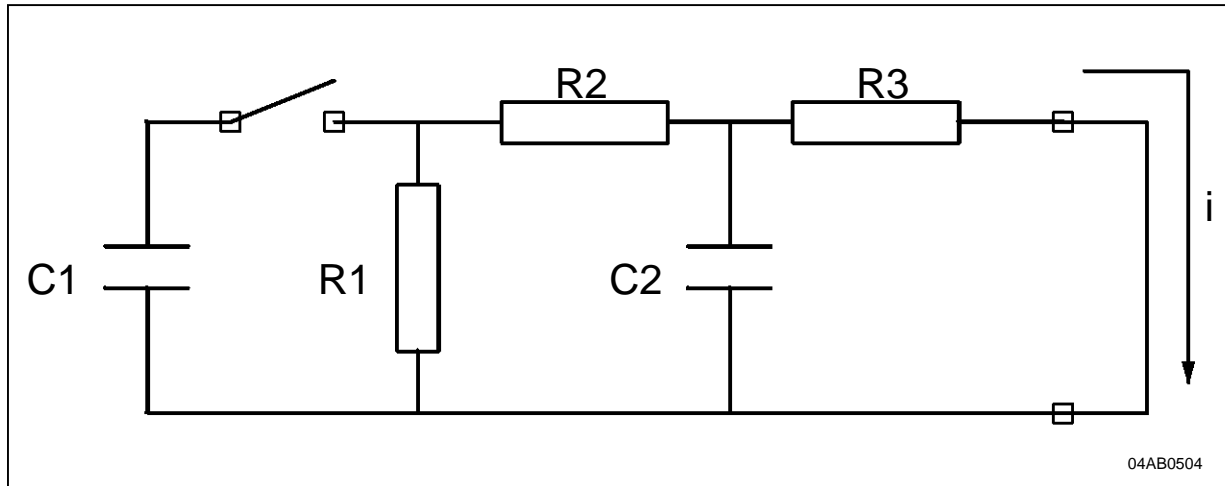
So  $t_2$  may be calculated with  $v(t)/V_p = 0.5$

$$\Rightarrow t_2 = 693 \mu s \approx \underline{\underline{700 \mu s}}$$

2.2 Generator short circuited output current.

In this chapter we will do the calculations with the generator output in short circuit (see fig.4), this is generally the case during the surge suppressor action (for example the Trisil technology devices from SGS THOMSON).

Figure 4 : CCITT 10/700 ms generator with output in short circuit



2.2.1 : Rise time

2.1.2 : Current surge duration.

Figure 5 : Current rise time

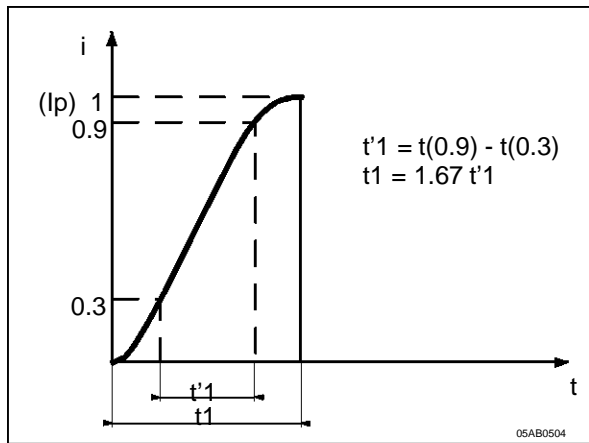
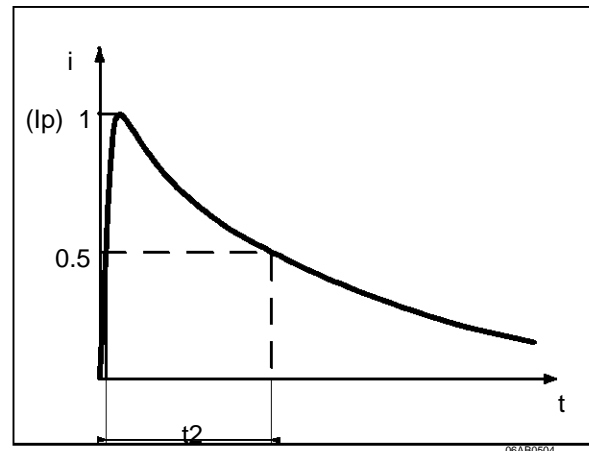


Figure 6 : Current duration



The formula (1) given in the chapter 2.1.1. remains true, but the time constant must take into account  $R_3$  and may be estimated as :

$$T = (R_2 R_3 / (R_2 + R_3)) C_2$$

So  $t_{(0.3)} = 0.67 \mu s$   
 $t_{(0.9)} = 4.3 \mu s$

$$\Rightarrow t_1 = 1.67 (t_{(0.9)} - t_{(0.1)})$$

$$= 6 \mu s \approx \underline{\underline{5 \mu s}}$$

The formula (2) given in the chapter 2.1.2. remains true but the time constant is now due to the capacitor  $C_1$  with the resistor  $R_1$  in parallel with  $R_2 + R_3$

$$T = (R_1 (R_2 + R_3) / (R_1 + R_2 + R_3)) C_1$$

$$\Rightarrow t_2 = 308 \mu s \approx \underline{\underline{310 \mu s}}$$

## APPLICATION NOTE

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### 3 - SUMMARY

The 10/700  $\mu\text{s}$  surge waveform given by the CCITT recommendation is a voltage wave produced by the generator in open circuit. This curve is very important as a test reference for telecommunication equipment.

The protection function designers or users have to know the actual current waveform flowing through the protector in order to optimize it.

The 10/700  $\mu\text{s}$  CCITT generator gives a 5/310  $\mu\text{s}$  current wave when its outputs are in short circuit. (In the case of a crowbar device, for example Trisil).

For certain cases the resistor R3 is equal to zero and then the duration time becomes 160  $\mu\text{s}$ .

Please note that in certain documents we find a 8/320  $\mu\text{s}$  current wave which represents the same surge test.

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