VOLTAGE TO CURRENT WAVEFORM CONVERSION (Example Of The 10/700 μs 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 μs surge waveform and its associated generator diagram (see fig.1).

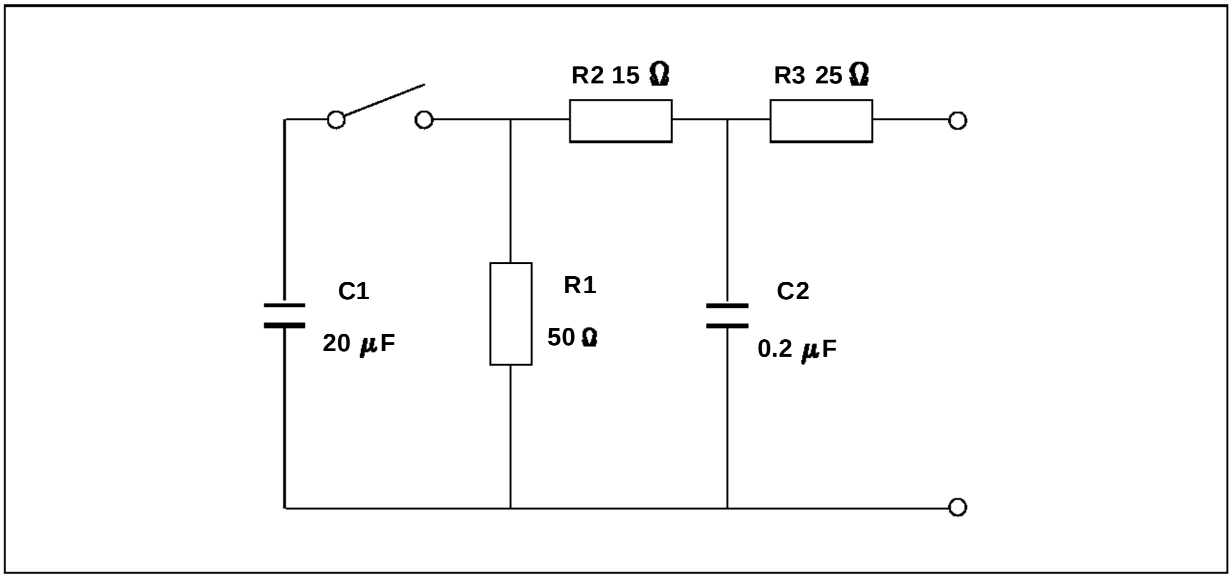
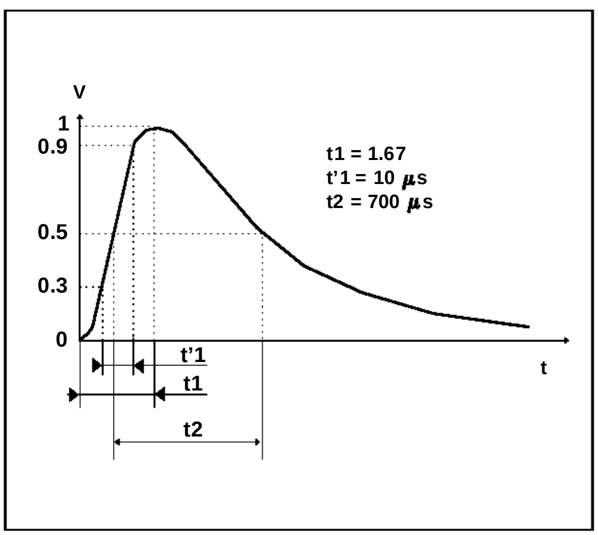


Figure 1 : CCITT 10/700 μs Surge Definition



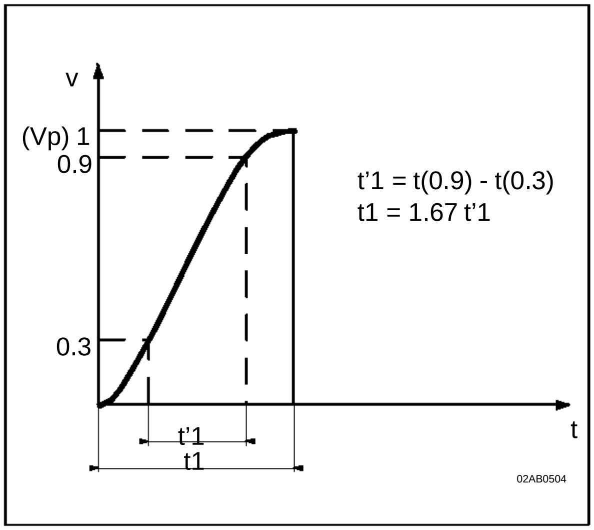
GENERATOR DIAGRAM OPEN OUTPUT SURGE WAVEFORM

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 :

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

$$\Rightarrow t = - T\ \log_n (1 - (v(t)/Vp)) \qquad (1)$$

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)/Vp = 0.3 and 0.9

t(0.3) = 1 µs

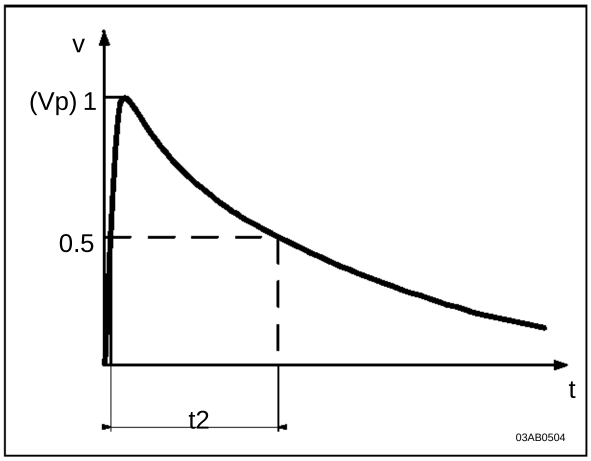
t(0.9) = 6.9 µs

and then

$$t1 = 1.67\ (t_{(0.9)} - t_{(0.1)})$$

$$= 9.8\ \mu s \approx \underline{\underline{10\ \mu s}}$$

Figure 3 : Voltage duration



2.1.2 : Voltage surge duration

The equation of this curve is:

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

$$\Rightarrow t = - \log_n (v(t)/Vp)) \qquad (2)$$

with a time constant due essentially to R_1 and C_1

$$T = R_1\ C_1$$

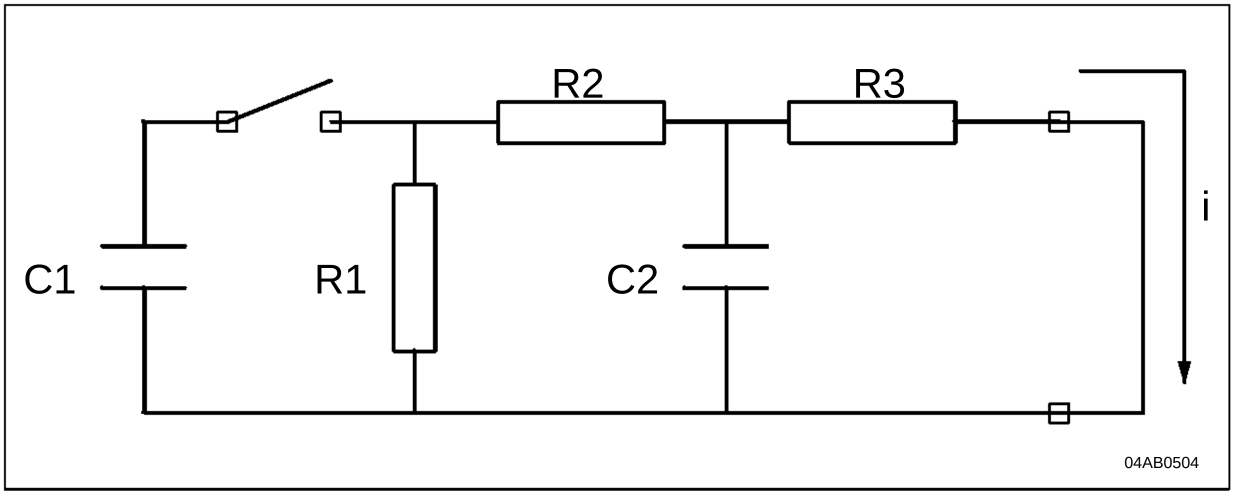
So t_2 may be calculated with v(t)/Vp = 0.5

$$\Rightarrow t2 = 693\ \mu s \approx \underline{\underline{700\ \mu s}}$$

2.2 Generator short circuted output current.

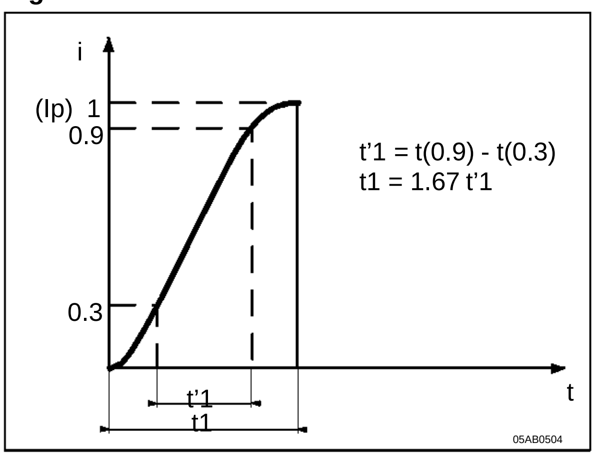
In this chapter we will do the calculations with the generator output in short circuit (see fig.4), this is generally the case during the surge suppressor action (for example the Trisil technogy devices from SGS THOMSON).

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



2.2.1 : Rise time

Figure 5 : Current rise time



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 :

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

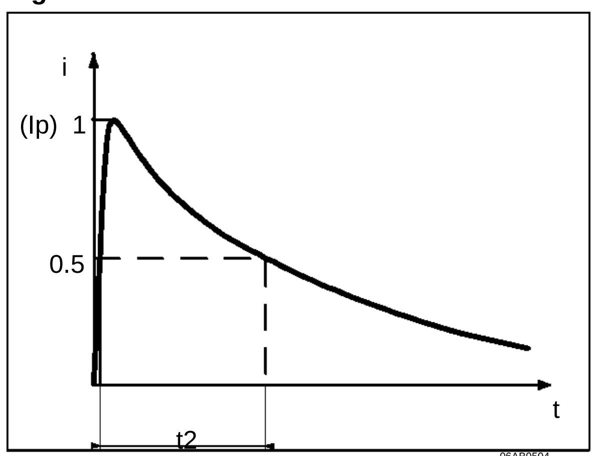
So $t_{(0.3)} = 0.67\ \mu s$

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

$$\Rightarrow t1 = 1.67 (t(0.9) - t(0.1)) = 6\ \mu s \approx \underline{\underline{5\ \mu s}}$$

2.1.2 : Current surge duration.

Figure 6 : Current duration



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 $R_2 + R_3$

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

$$\Rightarrow t2 = 308\ \mu s \approx \underline{\underline{310\ \mu s}}$$

3 - SUMMARY

The 10/700 µs 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 µs CCITT generator gives a 5/310 µs 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 µs.

Please note that in certain documents we find a 8/320 µs current wave which represents the same surge test.