dummy

Student Group

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Table of Contents

Exercise E1 Machine-Vision Strobe: Capacitor Charging and Safe Discharge 2

capacitors, rc circuit, transient response, energy storage, industrial safety, chapter1 1

Exercise E1 Machine-Vision Strobe: Capacitor Charging and Safe Discharge

A [illegible] Result [illegible] voltage? and what is the safe discharged voltage? maintenance.

Solution

Solution

Solution

Data: $\begin{align*} C &= 1~{\rm \mu F} \\ W &= 0.1~{\rm J} \\ I_{\rm max} &= 100~{\rm [illegible]}$

$\begin{align*} [illegible] \end{align*}$

$\begin{align*} [illegible] \end{align*}$

Assume the DC charging source is adjusted to the required final capacitor voltage.

$\begin{align*} [illegible] \end{align*}$

$\begin{align*} [illegible] \approx [illegible] \end{align*}$

.. What [illegible] energy? it stores the required energy?

with

$\begin{align*} [illegible] \end{align*}$ A practical standard value would be about $4.7~{\rm k\Omega}$.

Since capacitor [illegible] fully charged after about 5τ.

Solution

$\begin{align*} U_0 &= 447.2~{\rm V} \\ RC &= 4.47~{\rm ms} \end{align*}$

with

$\begin{align*} W(t) &= \frac{1}{2} C u_C^2(t) \end{align*}$

Initial and final values:

$\begin{align*} t_{\rm charge} &\approx 5\tau \approx 5 \cdot 4.47~{\rm ms} \approx [illegible] \approx 4.47~{\rm ms} \end{align*}$

$\begin{aligned} u_C(0) &= 0 \quad u_C(\infty) &= U_0 \\ u_R(0) &= U_0 \quad u_R(\infty) &= 0 \end{aligned}$

$\begin{aligned} W(0) &= 0 \quad W(\infty) &= \frac{1}{2} C U_0^2 \end{aligned}$

$\begin{aligned} u_C &= U_0 \\ u_R &= U_0 e^{-t/(RC)} \end{aligned}$

$\begin{aligned} W &= \frac{1}{2} C U_0^2 \\ u &= \sqrt{\frac{2W}{C}} = \sqrt{\frac{2 \cdot 0.1~{\rm J}}{1~{\rm \mu F}}} = \sqrt{200000}~{\rm V} \approx 447.2~{\rm V} \end{aligned}$

$\begin{aligned} W(t) &= W_0 e^{-2t/(R_i C)} \end{aligned}$

$\begin{aligned} t &= \frac{R_i C}{2} \ln(2) \end{aligned}$

$\begin{aligned} W_0 &= 0.1~{\rm J} \end{aligned}$

With

After full discharge, the capacitor energy is zero, so the entire initial energy is dissipated in the resistor.

$\begin{aligned} R_i C &= 10~{\rm k\Omega} \cdot 1~{\rm \mu F} = 10~{\rm s} \end{aligned}$

$\begin{aligned} W_R &= W_0 = 0.1~{\rm J} \end{aligned}$

we get

In a real design, the resistor must therefore be checked for pulse-load capability.

$\begin{aligned} t &= \frac{10~{\rm s}}{2} \ln(2) \approx 3.47~{\rm s} \end{aligned}$

The voltage at this instant is

$\begin{aligned} u_C &= U_0 \cdot \frac{1}{\sqrt{2}} = \frac{447.2~{\rm V}}{\sqrt{2}} \approx 316.2~{\rm V} \end{aligned}$

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