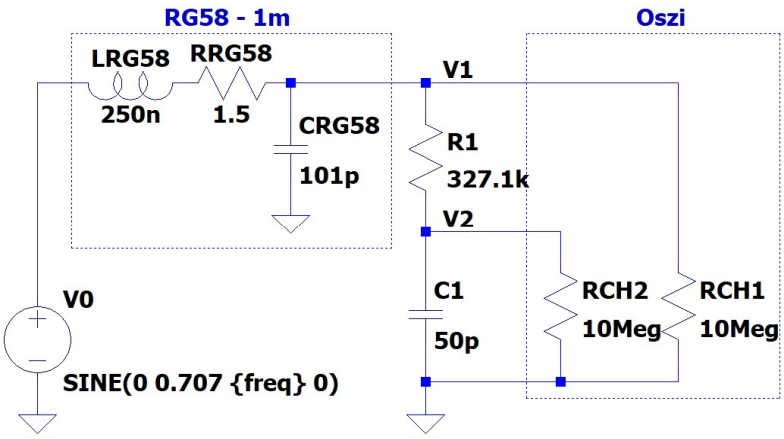
Versuch mit R und C mit Oszi




```
.tran 0 500u 200u 0.1u
.param freq=10000
.meas TRAN vr PP V(V1,V2)
.meas TRAN vc PP V(V2)
.meas TRAN tr FIND time WHEN V(V1,V2)=0 FALL=1
.meas TRAN tc FIND time WHEN V(V2)=0 FALL=1
.meas TRAN tv FIND time WHEN V(V1)=0 FALL=1
.meas TRAN delayr PARAM tr-tv
.meas TRAN delayc PARAM tc-tv
.meas TRAN phaser PARAM delayr*freq*360
.meas TRAN phasec PARAM delayc*freq*360
```

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vr: PP(V(V1,V2)) = 0.997877171263
vc: PP(V(V2))    = 0.970532409745
tr: time = 3.79651318291e-05
tc: time = 6.24605775778e-05
tv: time = 5.00005064151e-05
delayr: tr-tv = -1.2035374586e-05
delayc: tc-tv =  1.24600711627e-05
phaser: delayr*freq*360 = -43.3273485095
phasec: delayc*freq*360 =  44.8562561857
```

$R1 := 327{,}1\ \text{k}\Omega$

$C1 := 50\ \text{pF}$

$F0 := \frac{1}{2 \cdot \pi \cdot R1 \cdot C1} = 9731{,}2714\ \text{Hz}$

$\omega 0 := 2 \cdot \pi \cdot F0 = 61143{,}3812\ \text{Hz}$

$T0 := \frac{1}{F0} = 0{,}1028\ \text{ms}$

$ZC1 := \frac{\text{i}}{\omega 0 \cdot C1} = 327{,}1 \cdot \text{i}\ \text{k}\Omega$

$ZLRG58 := \omega 0 \cdot 250\ \text{nH} \cdot \text{i} = 15{,}2858 \cdot \text{i}\ \text{m}\Omega$

$RRG58 := 1{,}5\ \Omega$

$ZCRG58 := \frac{\text{i}}{\omega 0 \cdot 101\ \text{pF}}$

$RCH1 := 10\ \text{M}\Omega$

$RCH2 := RCH1$

$ZC1RCH2 := \frac{ZC1 \cdot RCH2}{ZC1 + RCH2} = (0{,}0107 + 0{,}3268 \cdot \text{i})\ \text{M}\Omega$

$ZCH := \frac{(ZC1RCH2 + R1) \cdot RCH1}{ZC1RCH2 + R1 + RCH1} = (0{,}3364 + 0{,}3054 \cdot \text{i})\ \text{M}\Omega$

$Zg2 := \frac{ZCRG58 \cdot ZCH}{ZCRG58 + ZCH} = (0{,}0266 + 0{,}125 \cdot \text{i})\ \text{M}\Omega$

$Zg := ZLRG58 + RRG58 + Zg2 = (0{,}0266 + 0{,}125 \cdot \text{i})\ \text{M}\Omega$

$phase := \arg(Zg) = 77{,}983\ °$

$V0pp := \sqrt{2}\ \text{V} = 1{,}4142\ \text{V}$

$\varphi v := 90\ °$

$V0(t) := \frac{V0pp}{2} \cdot \text{e}^{\text{i} \cdot (\omega 0 \cdot t + \varphi v)}$

$Ig(t) := \frac{V0(t)}{Zg}$

$VRG58(t) := Ig(t) \cdot (ZLRG58 + RRG58)$

$V1(t) := V0(t) - VRG58(t)$

$ICRG58(t) := \frac{V1(t)}{ZCRG58}$

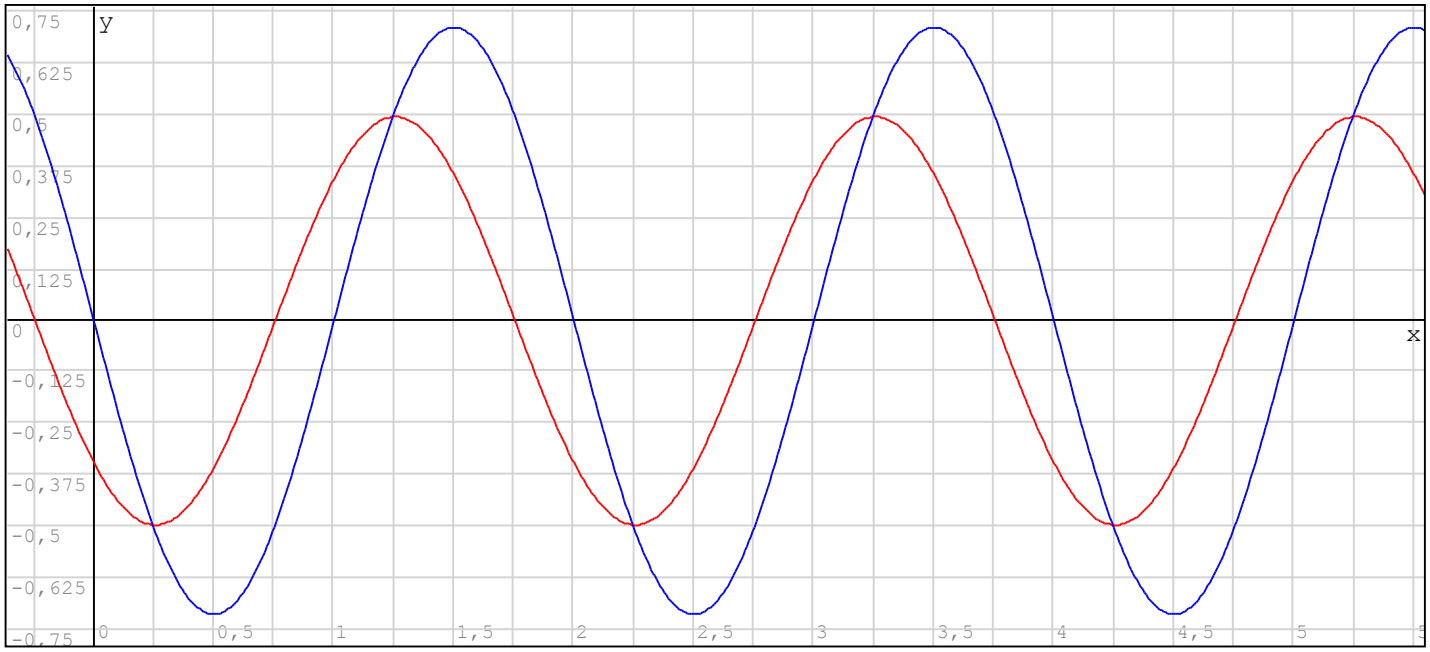
$IRCH1(t) := \frac{V1(t)}{RCH1}$

$VR1(t) := (IR1(t) \cdot R1)$

$IR1(t) := Ig(t) - ICRG58(t) - IRCH1(t)$

$V2(t) := V1(t) - VR1(t)$

$IC1(t) := IR1(t) - \frac{V2(t)}{ZC1RCH2}$



$$\begin{cases} \mathrm{Re}\left(V1\left(x\cdot\frac{T0}{2}\right)\right) \\ \mathrm{Re}\left(V2\left(x\cdot\frac{T0}{2}\right)\right) \end{cases}$$

$V1(0) = (-8{,}1016\cdot10^{-6} + 0{,}7071\cdot i)\ \mathrm{V}$

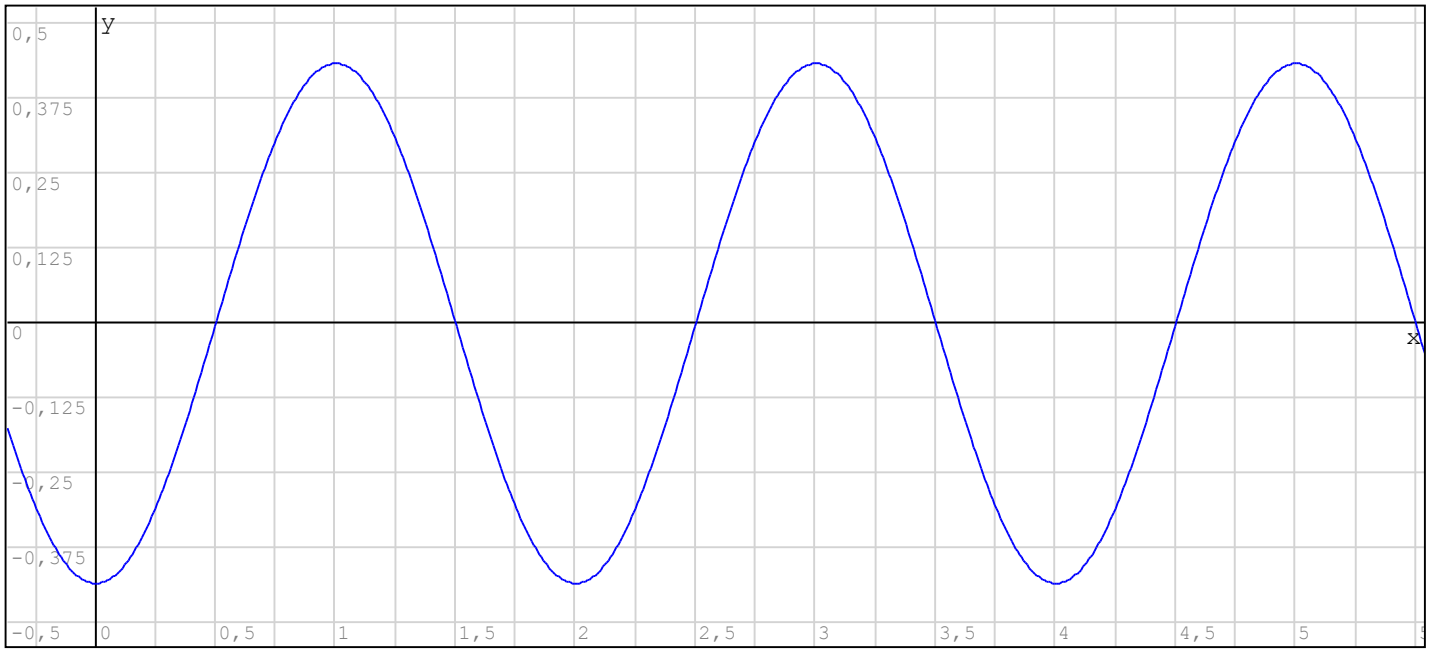
$V2(0) = (-0{,}3422 + 0{,}3534\cdot i)\ \mathrm{V}$

$dV1dt(t) := \frac{d}{d\,t} V1(t)$

$dV2dt(t) := \frac{d}{d\,t} V2(t)$

$dV1dt(0) = (-43234{,}7888 - 0{,}4954\cdot i)\ \frac{\mathrm{V}}{\mathrm{s}}$

$dV2dt(0) =$ ∎



$$\begin{cases} 10^{-5}\cdot\mathrm{Re}\left(dV1dt\left(x\cdot\frac{T0}{2}\right)\right) \\ 10^{-5}\cdot\mathrm{Re}\left(dV2dt\left(x\cdot\frac{T0}{2}\right)\right) \end{cases}$$

Aus den Messwerten (mit Toleranzen) C berechnen:

$F4 := 10000\ \text{Hz} \pm 2\ \text{Hz} = \begin{cases} 10002 \\ 9998 \end{cases} \text{Hz}$

$V4pp := 1,3792\ \text{V} \pm 0,003\ \text{V} = \begin{cases} 1,3822 \\ 1,3762 \end{cases} \text{V}$

$VR4pp := 0,51049\ \text{V} \pm 0,0002\ \text{V} = \begin{cases} 0,5107 \\ 0,5103 \end{cases} \text{V}$

$phase4 := 38,529\ ° \pm 2\ ° = \begin{cases} 40,529 \\ 36,529 \end{cases} °$

$R4 := 327,1\ \text{k}\Omega \pm 0,1\ \text{k}\Omega = \begin{cases} 327,2 \\ 327 \end{cases} \text{k}\Omega$

$$C4 := \frac{1}{2 \cdot \pi \cdot F4 \cdot R4 \cdot \tan(phase4)} = \begin{cases} 0,0569 \\ 0,0569 \\ 0,0569 \\ 0,0569 \\ 0,0657 \\ 0,0657 \\ 0,0657 \\ 0,0657 \end{cases} \text{nF}$$

$C4max := \text{Max}(C4) = 0,0657\ \text{nF}$

$C4min := \text{Min}(C4) = 0,0569\ \text{nF}$

$C4mean := \frac{C4max + C4min}{2} = 0,0613\ \text{nF}$

Folienkondensator gemessen 93,6 nF (nominell 100 nF)
Keramikkondensator gemessen 99,3 nF (nominell 100 nF)

$RxC := \frac{1}{2 \cdot \pi \cdot 10\ \text{kHz}} = 1,5915 \cdot 10^{-5}\ \text{s}$

$\frac{RxC}{50\ \text{pF}} = 0,3183\ \text{M}\Omega$