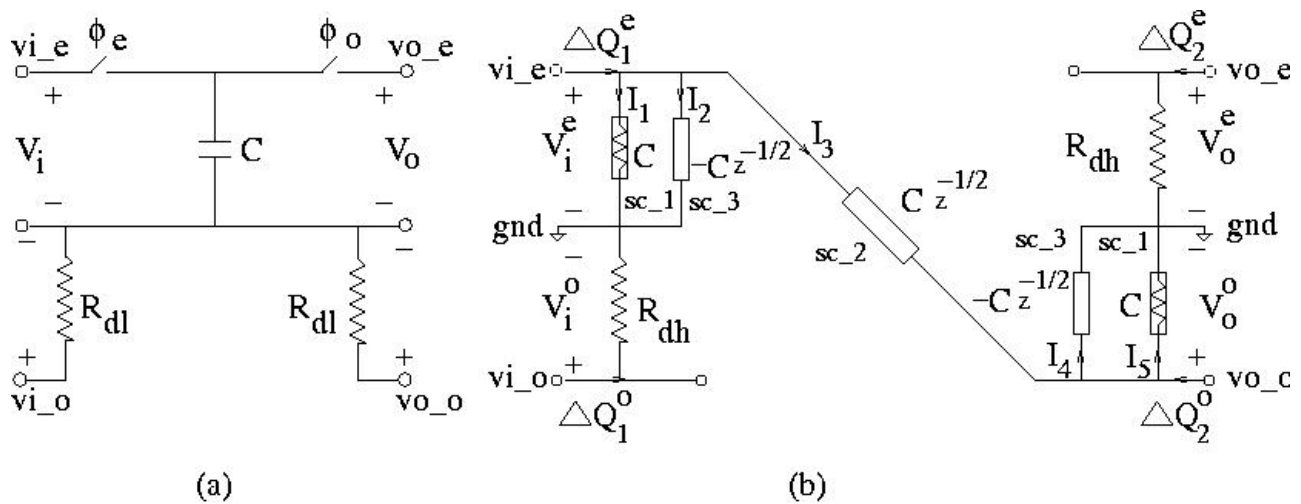


sc_tsc_1.ece (prepared by Rajesh Thakker)

```
mainnodes: vi_e vi_o vo_e vo_o g
auxnodes: aux1
digital_nodes: phi_e phi_o
rparms: ron=1e-3 roff=100M c=10p tc=10n rd=1e18
```

General Description:

Toggle Switched capacitor is one of the common elements found in Switched-capacitor circuits. Its time-domain (a) and frequency-domain (b) circuits are shown below. Ron and Roff are switch "on" and "off" resistances respectively. tc is the clock period. rd is a high value resistance, which is connected to isolated nodes in frequency-domain circuits; this is required to prevent the system matrix from becoming singular.



Toggle Switched Capacitor (TSC)

Large-signal:

Time-domain description requires basic elements such as capacitor, resistor and switch. In reality, it is two-port circuit but as the same file contains time-domain and frequency-domain description, number of ports in both should be equal. It is the reason that unused ports/nodes are connected with low-value resistance.

```
ebe name=s_e type=switch5 p=vi_e n=aux1 d_in=phi_e
+ ron=ron roff=roff
ebe name=s_o type=switch5 p=vo_e n=aux1 d_in=phi_o
+ ron=ron roff=roff
ebe name=c1 type=c p=aux1 n=g c=c v0sv=v0_c1
ebe type=res5 p=vi_o n=g
ebe type=res5 p=vo_o n=g
```

Small-signal:

It is completely different from time-domain description. It requires calling small signal elements, which are specially written for Switched-capacitor circuits, such as sc_1 , sc_2 , sc_3 etc. There also unused nodes are connected

with high-value resistance. It also needs some basic small-signal elements such as vsrcac (ac source), resistor etc.

```
ebe_ac type=sc_1 p=vi_e n=g      c=c
ebe_ac type=sc_3 p=vi_e n=g      c=c tc=tc
ebe_ac type=sc_1 p=vo_o n=g      c=c
ebe_ac type=sc_3 p=vo_o n=g      c=c tc=tc
ebe_ac type=sc_2 p=vi_e n=vo_o c=c tc=tc
ebe_ac type=r p=vi_o n=g r=rd
ebe_ac type=r p=vo_e n=g r=rd
ebe_ac type=r p=aux1 n=g r=rd
```