Shorting and open-circuiting elements

Let's load in an arbitrary circuit, in this case an op-amp circuit.

```
circuit = Circuit('circuits/rc_op_amp.txt');
circuit.list
```

```
ans =
    'Vs 1 0 AC Vs
     R1 1 2 20000
     R2 3 4 20000
     C1 2 3 C1
     C2 3 4 C2
     O1 0 3 4
     '
```

We may be interested in its transfer function.

```
ELAB.ec2sd(circuit,1,4)
```

```
Symbolic analysis successful (0.380181 sec).
Symbolic transfer function calculated successfully (3.900203e-01 sec).
ans =
```

$$\frac{v_4}{v_1} = -\frac{C_1 R_2 s}{(C_1 R_1 s + 1)\,(C_2 R_2 s + 1)}$$

We see two poles at $s = -1/R_1C_1$ and $s = -1/R_2C_2$

1. Shorting

Suppose, we want to know what happens, if we short C_1. We get a reference to the capacitor in question, just to look at how it's defined. This is not necessary.

```
C1 = circuit.Capacitors(1)
```

```
C1 =
  Capacitor with properties:

      capacitance: C1
        impedance: 1/(C1*s)
            anode: 2
          cathode: 3
         v_across: Vs/(C1*R1*s + 1)
        i_through: Vs/(C1*(C1*R1*s + 1))
    num_terminals: 2
               id: 'C1'
        terminals: [2 3]
```

Shorting is as simple as calling a function.

```
circuit.short(C1)
```

The circuit now looks like this. Note, that the nodes have been appropriately relabelled. This has be taken into account, when finding the new transfer function.

```
circuit.list
```

```
ans =
    'Vs 1 0 AC Vs
     R1 1 2 20000
     R2 2 3 20000
     C2 2 3 C2
     O1 0 2 3
     '
```

```
ELAB.ec2sd(circuit,1,3)
```

```
Symbolic analysis successful (0.304582 sec).
Symbolic transfer function calculated successfully (3.120531e-01 sec).
ans =
```

$$\frac{v_3}{v_1} = -\frac{R_2}{R_1\,(C_2 R_2\,s+1)}$$

We see that shorting C_1 will remove the pole at $s = -1/R_1C_1$ as expected.

2. Open-circuiting

Suppose we want to know what would have happened, if we open-circuited the second capacitor C_2 instead. We can reload the original circuit. We skip getting a reference to the element this time.

```
circuit = Circuit('circuits/rc_op_amp.txt');
circuit.open(circuit.Capacitors(2));
circuit.list
```

```
ans =
    'Vs 1 0 AC Vs
     R1 1 2 20000
     R2 3 4 20000
     C1 2 3 C1
     O1 0 3 4
     '
```

```
ELAB.ec2sd(circuit,1,4)
```

```
Symbolic analysis successful (0.361129 sec).
Symbolic transfer function calculated successfully (3.704922e-01 sec).
ans =
```

$$\frac{v_4}{v_1} = -\frac{C_1 R_2\,s}{C_1 R_1\,s+1}$$

This time, the pole at $s = -1/R_2C_2$ was removed.