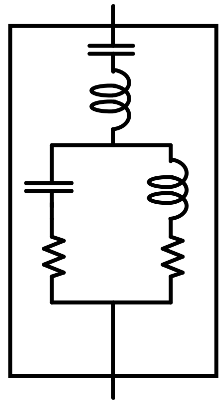
Double tuned filter



Jérôme Cornau, 2/16/2018 9:08 AM

1 Available versions

Available versions are shown in Figure 1-1. This device can be 1-phase, 3-phase Wye, 3-phase Wye grounded or 3-phase Delta.

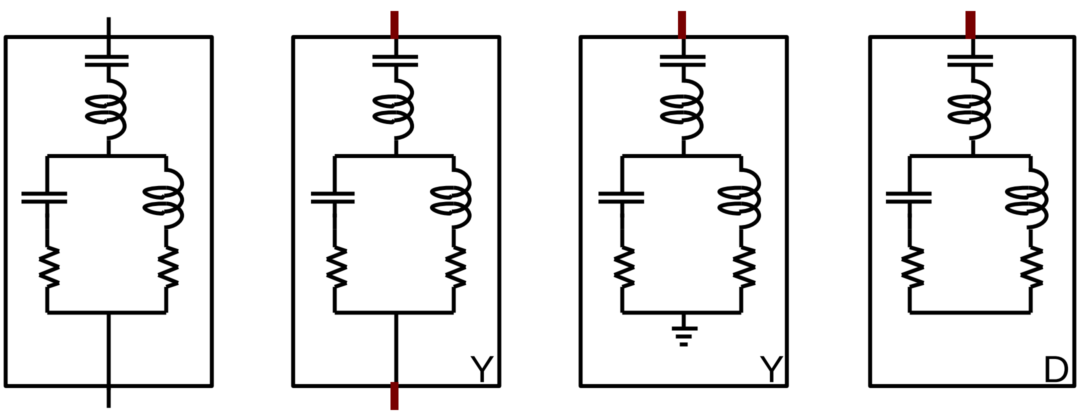


Figure 1-1 Available versions

1.1 When changing phases

It is allowed to change the line type attached to the 1-phase or 3-phase versions of this device. Although it can be ambiguous and should be used with care, EMTP tries to accommodate by applying the following rules.

- When the device is in its 1-phase state and its signal is changed to 3-phase, but the device is not double-clicked (followed by a click on the OK button), balanced conditions are assumed and the 1- phase quantities are automatically propagated to the new phases.
- When the device is in its 3-phase state and its signal is changed to 1-phase, but the device is not double-clicked (followed by a click on the OK button), phase-a quantities are automatically retained in EMTP for the 1-phase version.

1.2 The generic version of "Passive Filter: Double-Tuned"

1.2.1 Parameters

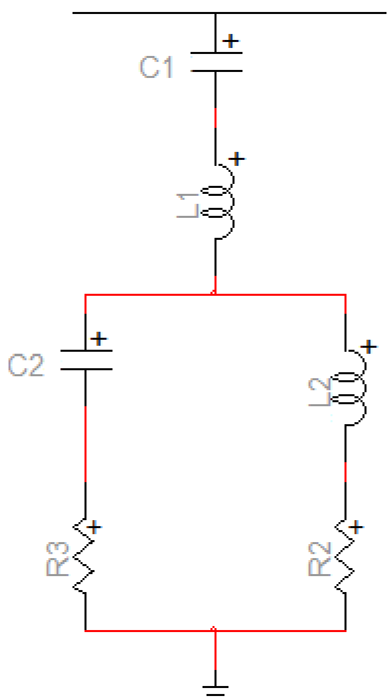


Figure 1-2 Filter model

The generic version of Double-Tuned filter has one pin.
The parameters are:

Data Type	way the filter data are entered (Circuit parameters or filter parameters)
Nominal Voltage	nominal voltage of the bus the filter is connected to
Power frequency	frequency of the bus the filter is connected to
Circuit parameters	
L1	value of filter series inductance
C1	value of filter series capacitance
R2	value of filter second branch resistance

L2	value of filter second branch inductance
R3	value of filter first branch resistance
C2	value of filter first branch capacitance
Filter parameters (One set of parameters for each tuned frequency)	
Reactive power	reactive power produced by one capacitance at nominal frequency and nominal voltage
Tuned harmonic order	harmonic order of tuned frequency
Quality factor	quality factor of the filter

A graphic representation of module and angle of the impedance of the filter is also provided. Some graphic options are allowed concerning the x-axis format:

Harmonic / Frequency

Logarithmic scale /
Linear scale

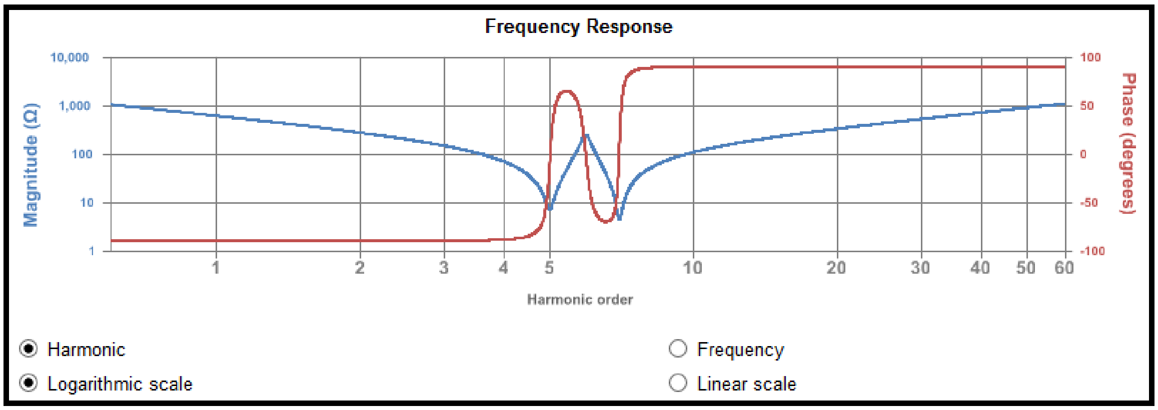


Figure 1-3 Filter impedance

1.2.2 Generic rules

The filter parameters are calculated when the circuit parameters are changed and viceversa.

Netlist format

```
@Passive_Filter_Double_Tuned_3Ph_ba0ad7f0;3phaseYg;3;s9a,s9b,s9c,

L2=0.00549196;
C1=0.00000417861;
C2=0.00003618682;
iL1_A=0;
iL1_B=0;
iL1_C=0;
iL2_A=0;
iL2_B=0;
iL2_C=0;
vC1_A=0;
vC1_B=0;
vC1_C=0;
vC2_A=0;
vC2_B=0;
```

```
vC2_C=0;
va_scope='0,';
vb_scope='0,';
vc_scope='0,';
ia_scope=0,0,0,0,0,,60,,0,0,;
ib_scope=0,0,0,0,0,,60,,0,0,;
ic_scope=0,0,0,0,0,,60,,0,0,;
ParamsA_L1='0,0.04866645,0,0,0,,60,,0,0,';
ParamsB_L1='0,0.04866645,0,0,0,,60,,0,0,';
ParamsC_L1='0,0.04866645,0,0,0,,60,,0,0,';
R2=0.58823166;
R3=0.0419618;
L1=0.04866645;
```

Field	**Description**
@Passive_Filter_Double_Tuned_55c01596	Name of the type of filter subcircuit. NB: It is different in 1-phase and in 3-phase
DT3	Instance name, any name.
3	Number of signals attached to the pin
s3a	Signal connected to the phase a of the pin
s3b	Signal connected to the phase b of the pin (unused in 1-phase)
s3b	Signal connected to the phase c of the pin (unused in 1-phase)
L2=0.00549196;	Value of the second branch inductance in H
C1=0.00000417861;	Value of filter series capacitance in F
C2=0.00003618682;	Value of filter first branch capacitance in F
iL1_A=0;	Initial current of the phase a of the filter in A
iL1_B=0;	Initial current of the phase b of the filter in A (unused in 1-phase)
iL1_C=0;	Initial current of the phase c of the filter in A (unused in 1-phase)
iL2_A=0;	Initial current of the second branch phase a of the filter in A
iL2_B=0;	Initial current of the second branch phase b of the filter in A (unused in 1-phase)
iL2_C=0;	Initial current of the second branch phase c of the filter in A (unused in 1-phase)
vC1_A=0;	Initial series capacitance voltage of phase a in V
vC1_B=0;	Initial series capacitance voltage of phase b in V (unused in 1-phase)
vC1_C=0;	Initial series capacitance voltage of phase c in V (unused in 1-phase)
vC2_A=0;	Initial first branch capacitance voltage of phase a in V
vC2_B=0;	Initial first branch capacitance voltage of phase b in V (unused in 1-phase)
vC2_C=0;	Initial first branch capacitance voltage of phase c in V (unused in 1-phase)
va_scope='0,';	1 means phase a voltage can be plotted
vb_scope='0,';	1 means phase b voltage can be plotted (unused in 1-phase)
vc_scope='0,';	1 means phase c voltage can be plotted (unused in 1-phase)
ia_scope=0,0,0,0,0,,60,,0,0,;	"ParamsA" attribute of series measurement resistor. (used for delta winding)
ib_scope=0,0,0,0,0,,60,,0,0,;	"ParamsB" attribute of series measurement resistor. (used for delta winding)
ic_scope=0,0,0,0,0,,60,,0,0,;	"ParamsC" attribute of series measurement resistor. (used for delta winding)
ParamsA_L1='0,0.04866645,0,0,0,,60,,0,0,';	"ParamsA" attribute of series inductance.
ParamsB_L1='0,0.04866645,0,0,0,,60,,0,0,';	"ParamsB" attribute of series inductance.

ParamsC_L1='0,0.04866645,0,0,0,,60,,0,0,';	"ParamsC" attribute of series inductance.

Please note that subcircuits must be defined in the Netlist. They are defined by:

3-phase Wye:

```
<Passive_Filter_Double_Tuned_3Ph_b9f7a084;6;s10a,s10b,s10c,SIG1a,SIG1b,SIG1c,
_RLC;C2a;2;2;s10a,s7a,
0,0,#C1#,0,#vC1_A#,,60,,0,0,
_RLC;C2b;2;2;s10b,s7b,
0,0,#C1#,0,#vC1_B#,,60,,0,0,
_RLC;C2c;2;2;s10c,s7c,
0,0,#C1#,0,#vC1_C#,,60,,0,0,
_RLC;C3a;2;2;s3a,s12a,
0,0,#C2#,0,#vC2_A#,,60,,0,0,
_RLC;C3b;2;2;s3b,s12b,
0,0,#C2#,0,#vC2_A#,,60,,0,0,
_RLC;C3c;2;2;s3c,s12c,
0,0,#C2#,0,#vC2_A#,,60,,0,0,
_RLC;L2a;2;2;s3a,s16a,
0,#L2#,0,#iL2_A#,0,,60,,0,0,
_RLC;L2b;2;2;s3b,s16b,
0,#L2#,0,#iL2_A#,0,,60,,0,0,
_RLC;L2c;2;2;s3c,s16c,
0,#L2#,0,#iL2_A#,0,,60,,0,0,
_RLC;R4a;2;2;s12a,SIG1a,
#R3#,0,0,0,0,,60,,0,0,
_RLC;R4b;2;2;s12b,SIG1b,
#R3#,0,0,0,0,,60,,0,0,
_RLC;R4c;2;2;s12c,SIG1c,
#R3#,0,0,0,0,,60,,0,0,
_RLC;R5a;2;2;s16a,SIG1a,
#R2#,0,0,0,0,,60,,0,0,
_RLC;R5b;2;2;s16b,SIG1b,
#R2#,0,0,0,0,,60,,0,0,
_RLC;R5c;2;2;s16c,SIG1c,
#R2#,0,0,0,0,,60,,0,0,
_RLC;ia;2;2;s7a,s3a,
#ParamsA_L1#
_RLC;ib;2;2;s7b,s3b,
#ParamsB_L1#
_RLC;ic;2;2;s7c,s3c,
#ParamsC_L1#
_VM;va;2;2;s10a,SIG1a,
#va_scope#
_VM;vb;2;2;s10b,SIG1b,
#vb_scope#
_VM;vc;2;2;s10c,SIG1c,
#vc_scope#
>
```

3-phase Wye Grounded:

```
<Passive_Filter_Double_Tuned_3Ph_ba0ad7f0;3;s10a,s10b,s10c,
_RLC;C2a;2;2;s10a,s7a,
0,0,#C1#,0,#vC1_A#,,60,,0,0,
```

```
_RLC;C2b;2;2;s10b,s7b,
0,0,#C1#,0,#vC1_B#,,60,,0,0,
_RLC;C2c;2;2;s10c,s7c,
0,0,#C1#,0,#vC1_C#,,60,,0,0,
_RLC;C3a;2;2;s3a,s12a,
0,0,#C2#,0,#vC2_A#,,60,,0,0,
_RLC;C3b;2;2;s3b,s12b,
0,0,#C2#,0,#vC2_A#,,60,,0,0,
_RLC;C3c;2;2;s3c,s12c,
0,0,#C2#,0,#vC2_A#,,60,,0,0,
_RLC;L2a;2;2;s3a,s16a,
0,#L2#,0,#iL2_A#,0,,60,,0,0,
_RLC;L2b;2;2;s3b,s16b,
0,#L2#,0,#iL2_A#,0,,60,,0,0,
_RLC;L2c;2;2;s3c,s16c,
0,#L2#,0,#iL2_A#,0,,60,,0,0,
_RLC;R4a;2;2;s12a,,
#R3#,0,0,0,0,,60,,0,0,
_RLC;R4b;2;2;s12b,,
#R3#,0,0,0,0,,60,,0,0,
_RLC;R4c;2;2;s12c,,
#R3#,0,0,0,0,,60,,0,0,
_RLC;R5a;2;2;s16a,,
#R2#,0,0,0,0,,60,,0,0,
_RLC;R5b;2;2;s16b,,
#R2#,0,0,0,0,,60,,0,0,
_RLC;R5c;2;2;s16c,,
#R2#,0,0,0,0,,60,,0,0,
_RLC;ia;2;2;s7a,s3a,
#ParamsA_L1#
_RLC;ib;2;2;s7b,s3b,
#ParamsB_L1#
_RLC;ic;2;2;s7c,s3c,
#ParamsC_L1#
_VM;va;2;2;s10a,,
#va_scope#
_VM;vb;2;2;s10b,,
#vb_scope#
_VM;vc;2;2;s10c,,
#vc_scope#
>
```

3-phase Delta:

```
<Passive_Filter_Double_Tuned_3Ph_c4bad2c9;3;SIG1a,SIG1b,SIG1c,
_RLC;C1;2;2;SIG2b,SIG3,
0,0,#C1#,0,#vC1_A#,,60,,0,0,
_RLC;C2;2;2;SIG2a,s7,
0,0,#C1#,0,#vC1_A#,,60,,0,0,
_RLC;C3;2;2;s3,s12,
0,0,#C2#,0,#vC2_A#,,60,,0,0,
_RLC;C4;2;2;SIG4,SIG5,
0,0,#C2#,0,#vC2_A#,,60,,0,0,
_RLC;C5;2;2;SIG2c,SIG10,
0,0,#C1#,0,#vC1_A#,,60,,0,0,
_RLC;C6;2;2;SIG9,SIG11,
0,0,#C2#,0,#vC2_A#,,60,,0,0,
```

```
_RLC;C7a;2;2;SIG2a,,
0,0,0.01nF,0,0,,60,,0,0,
_RLC;C7b;2;2;SIG2b,,
0,0,0.01nF,0,0,,60,,0,0,
_RLC;C7c;2;2;SIG2c,,
0,0,0.01nF,0,0,,60,,0,0,
_RLC;L1;2;2;SIG4,SIG6,
0,#L2#,0,#iL2_A#,0,,60,,0,0,
_RLC;L2;2;2;s3,s16,
0,#L2#,0,#iL2_A#,0,,60,,0,0,
_RLC;L4;2;2;SIG9,SIG12,
0,#L2#,0,#iL2_A#,0,,60,,0,0,
_RLC;R1;2;2;SIG5,SIG2c,
#R3#,0,0,0,0,,60,,0,0,
_RLC;R2;2;2;SIG6,SIG2c,
#R2#,0,0,0,0,,60,,0,0,
_RLC;R3;2;2;SIG11,SIG2a,
#R3#,0,0,0,0,,60,,0,0,
_RLC;R4;2;2;s12,SIG2b,
#R3#,0,0,0,0,,60,,0,0,
_RLC;R5;2;2;s16,SIG2b,
#R2#,0,0,0,0,,60,,0,0,
_RLC;R6;2;2;SIG12,SIG2a,
#R2#,0,0,0,0,,60,,0,0,
_RLC;ia;2;2;SIG1a,SIG2a,
#ia_scope#
_RLC;ib;2;2;SIG1b,SIG2b,
#ib_scope#
_RLC;ic;2;2;SIG1c,SIG2c,
#ic_scope#
_RLC;ia;2;2;s7,s3,
#ParamsA_L1#
_RLC;ib;2;2;SIG3,SIG4,
#ParamsB_L1#
_RLC;ic;2;2;SIG10,SIG9,
#ParamsC_L1#
_VM;va;2;2;SIG1a,,
#va_scope#
_VM;vb;2;2;SIG1b,,
#vb_scope#
_VM;vc;2;2;SIG1c,,
#vc_scope#
>
```

1-phase

```
<Passive_Filter_Double_Tuned_55c0767a;1;s10,
_RLC;C2;2;2;s10,s7,
0,0,#C1#,0,#vC1_A#,,60,,0,0,
_RLC;C3;2;2;s3,s12,
0,0,#C2#,0,#vC2_A#,,60,,0,0,
_RLC;L1;2;2;s7,s3,
#ParamsA_L1#
_RLC;L2;2;2;s3,s16,
0,#L2#,0,#iL2_A#,0,,60,,0,0,
_RLC;R4;2;2;s12,,
#R3#,0,0,0,0,,60,,0,0,
```

```
_RLC;R5;2;2;s16,,
#R2#,0,0,0,0,,60,,0,0,
_VM;v;2;2;s10,,
#va_scope#
>
```

2 Steady-state model

The Double-Tuned filter device is represented in steady-state for automatic harmonic initialization and frequency scan solutions.
The steady-state model consists of one resistance, one inductance and one capacitance connected in series.
The impedance is given by:

$$Z(j\omega) = \frac{1}{jC_1\omega} + jL_1\omega + \left(\frac{1}{R_3 + \frac{1}{jC_2\omega}} + \frac{1}{R_2 + jL_2\omega}\right)^{-1}$$

3 Initial conditions

Automatic initial conditions are found from the steady-state solution. Manual initial conditions can be provided for the inductance currents and for the voltages of the capacitor.

4 Frequency Scan model

Similar to the steady-state. The branch impedance is found at each frequency.

5 Time Domain model

The device is discretized according to the integration time-step and solved at each simulation time-point.

6 Credits

The Power Quality Toolbox is based on the initial work done by Powersys for Electricité de France (EDF).