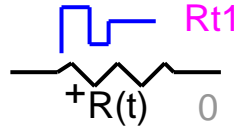


# R(t) staircase device



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## 1 Available versions

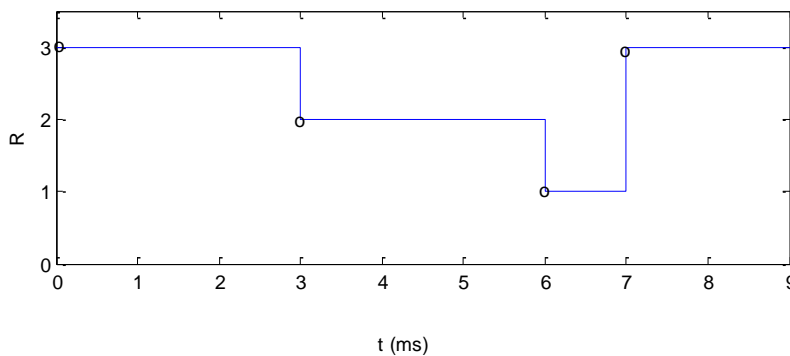
The “R(t) staircase device” accepts both 1-phase and 3-phase signals. The 3-phase version is the equivalent of 3 decoupled branches (one for each phase). The only difference is that in the 3-phase version it is allowed to request scope data for the extra phases.

### 1.1 When changing phases

It is allowed to switch from 1-phase to 3-phase or from 3-phase to 1-phase. The user must only verify the scope requests according to requirements.

## 2 Description

This device can be used to represent a time varying staircase resistance R(t) specified point-by-point. An example is shown in Figure 1.



**Figure 1 Time varying staircase resistance characteristic**

## 2.1 Parameters and Rules

The Data tab allows entering all required parameters:

- ❑ **V<sub>start</sub>** The device becomes connected when the absolute value of its voltage becomes greater or equal to V<sub>start</sub>
- ❑ **Y<sub>ss</sub>** Steady-state admittance. When the admittance Y<sub>ss</sub>=0 this device is disconnected in steady-state. When Y<sub>ss</sub> > 0 the device is represented by the linear admittance Y<sub>ss</sub> in the steady-state solution and V<sub>start</sub> =0 (forced).
- ❑ **t<sub>delay</sub>** When this value is greater than 0, this device will not be connected until the simulation time reaches this delay value. A positive V<sub>start</sub> may provide added delay beyond this point. When t<sub>delay</sub> > 0, Y<sub>ss</sub> must become 0.
- ❑ **Characteristic** Allows entering the staircase characteristic. The following conditions must be verified:
  - The time t values must be strictly positive.
  - Negative and 0 values of R(t) are illegal.
  - If the first time-point is not 0, it will be forced to 0 by EMTP.
  - Entering more than one value of R for a given value of t is illegal.

It is not allowed to delete any pins. Since this device drawing is automatically redrawn by its script, it is not allowed to make changes through the Symbol editor or to perform device attribute or pin attribute changes.

When it is required to observe model data using a control device, then the available observables can be selected in the Observe tab. The device drawing will change automatically to provide the requested visible pin observables through a bundle. Since this device can be 3-phase, the bundle can contain observables for all phases. The phase character is used to identify the selections. The 1-phase character is "a" (phase-a).

## 3 Netlist format

The Netlist format can be explained using the following example:

```
Rs;Rt1;6;6;s14,s16,s17va,s17ia,s17pa,s17Ra,
4,0,0,0,1ms,1,?v,?i,?p,>v,>i,>p,>R,
0 3
3 2
6 1
7 3
```

Field	Description
Rs	Part name
Rt1	Instance name, any name.
6	Total number of pins
6	Number of pins given in this data section
s17va, s17ia, s17pa, s17Ra	Signal names connected to observables
Nobs	Number of observables
V <sub>start</sub>	See Parameters above
Y <sub>ss</sub>	See Parameters above
t <sub>delay</sub>	See Parameters above
units	Units for time in characteristic
units	Units for resistance in characteristic
?v, ?i, ?p	Optional scope requests.
>v, >i, >p, >R	Optional observable requests.

In the 3-phase case, EMTPWorks automatically appends the phase characters and creates 3 separate devices sharing the same data. The extra phase lines are used to carry scope and observable requests in addition to connectivity.

The comma separated data fields are saved into ParamsA, ParamsB and ParamsC attributes of this device. The current-voltage characteristic is saved into the ModelData attribute.

#### **4 Steady-state model and Initial conditions**

The steady-state model is a linear admittance when a non-zero  $Y_{ss}$  value is entered. It becomes disconnected when the time-domain solution is entered. It can be used to force initial conditions into the surrounding network and continuity from steady-state into time-domain when the time-domain initial operation is predictable by the user.

#### **5 Frequency Scan model**

When a non-zero  $Y_{ss}$  value is entered it is used to represent this device for all frequencies of a frequency scan.

#### **6 Time domain representation**

In the time-domain solution this device is a time-varying resistance. Resistance is found at each time-point using a lookup table. No iterations are needed.