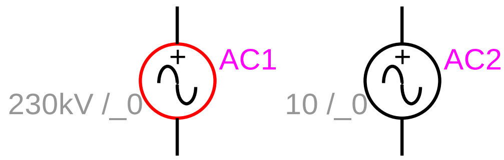
AC voltage source



Jean Mahseredjian, 12/28/2019 11:34:00 PM

1 Available versions

The "V ac" device accepts both 1-phase (general) and 3-phase signals. The 3-phase version provides 3 sources with phase shift. The default phase shift constitutes a positive sequence source.

1.1 When changing phases

- When the device is in its 1-phase state and any of its signals are changed to 3-phase, but the device is not double-clicked, balanced positive sequence conditions are assumed using the amplitude and the phase angle of phase-A. The user can double-click and modify the sources as required. The Netlist is generated for the 3-phase version.
- When the device is in its 3-phase state and its signal is changed to 1-phase, but the device is not double-clicked, phase-A quantities are automatically retained for the 1-phase version. The Netlist is generated for the 1-phase version.

1.2 Default color coding

The default color coding changes the device line color to red to indicate that the source is active in steady-state. The source is active in steady-state when its start time is smaller than 0.

1.3 The generic version of "V ac"

1.3.1 Parameters

The generic version of "V ac" has two pins. The generic version of "V ac" allows entering all required parameters for a cosine waveform:

$$v(t) = V_m \cos(\omega t + \theta)$$

$$\omega = 2\pi f$$

A typical example for $V_m = 10V$, $t_{start} = 5ms$ and $t_{stop} = 20ms$ is shown in Figure 1. The waveform precision is related to the simulation time-step Δt.

- ❑ V_m — amplitude of the cosine waveform, any value, default units are V.
- ❑ f — frequency in Hertz, must be greater than 0.
- ❑ θ — phase angle, default units are degrees.
- ❑ t_{start} — start time, if t < t_{start} the source is shorted. If t_{start} < 0, the source is active in the steady-state solution.
- ❑ t_{stop} — stop time, if t > t_{stop} the source is shorted. The stop time must be greater than the start time.

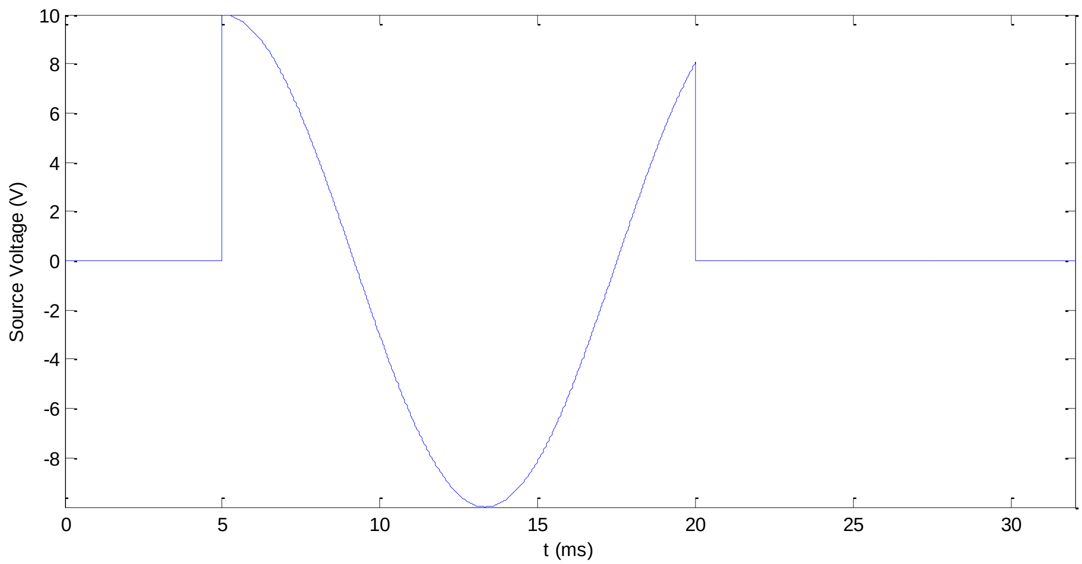


Figure 1 Sample source waveform for $t_{start} = 5ms$ **and** $t_{stop} = 20ms$

1.3.2 Netlist format

This device allows method-based scripting. The object data and methods are described in the script file referenced by the device Script.Open.Dev attribute.

Example of data:

```
_Vsine;AC1;2;2;s1,s2,
10,60,0,-1,1E15,?v,?i,?p,
```

Field	Description
_Vsine	Part name
AC1	Instance name, any name.
2	Total number of pins
2	Number of pins given in this data section
s1	Signal name connected to k-pin (positive), any name
s2	Signal name connected to m-pin, any name
V_m	Amplitude
f	frequency, default is 60
θ	Phase angle

t_{start}	Start time
t_{stop}	Stop time
?v	Request for voltage scope, sent to scope group vb (branch voltages), optional
?i	Request for current scope, sent to scope group ivs (voltage source currents), optional
?p	Request for power scope, sent to scope group p (branch power), optional

Source data fields are saved in ParamsA, ParamsB and ParamsC device attributes. If "Participate in Load-Flow solution is checked", then an extra data line is saved in the ModelData attribute:
LF=1

The m-pin of this device can be deleted to create an automatic ground connection.

If there is only one pin, the second signal name field is not present:

```
_Vsine;AC2;1;1;s3,
735kVRMSLL,60,0,-1,1E15,
```

A 3-phase version example of a source that is active in steady-state and never stops:

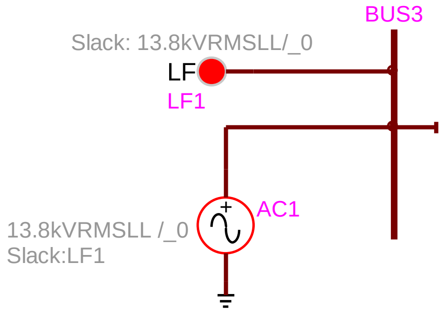
```
_Vsine;AC1a;2;2;s1a,s2a,
10,60,0,-1,1E15,?v,?i,?p,
_Vsine;AC1b;2;2;s1b,s2b,
10,60,-120,-1,1E15,
_Vsine;AC1c;2;2;s1c,s2c,
10,60,120,-1,1E15,
```

EMTPWorks automatically generates 3 separate sources, one per phase. The phase identification character (a, b or c) is automatically appended to the device instance name and signals.
When a source phase is changed, but the source is not double-clicked, the Netlist generator places a code b>> to indicate to EMTP that the source is balanced and the phase angle for phases B and C must be automatically calculated from phase-A for a positive sequence source.

```
_Vsine;AC3a;1;1;s5a,
735kVRMSLL,60,-10,-1,1E15,
_Vsine;AC3b;1;1;s5b,
b>>,,,,,
_Vsine;AC3c;1;1;s5c,
b>>,,,,,
```

2 Load-Flow model

When this device does not participate (open-circuit) into the Load-Flow solution, it can reference a Load-Flow solution device (see "Load-Flow solution device" on the first data tab) for automatically retrieving its steady-state voltage phasors from the Load-Flow solution file.
The "Load-Flow solution device" can be an LF device or "BUS:". It establishes a link (a reference) for retrieving data from a load-flow solution. In this example (below) the source AC1 is disconnected in the load-flow solution and is referring to LF1 for its load-flow solution data automatically retrieved by EMTP from the "Load-Flow solution data file" during the subsequent Steady-state and/or Time-domain solutions, when "Start from Load-Flow solution" is turned on in the EMTP>Simulation Options. Note also that AC1 is retrieving voltage phasors after the internal impedance of LF1.



If the selection is "BUS:" the connected stator signal name (bus) will be used to retrieve data. *You must enforce the signal name by making it visible*. This method is optional; it is suggested to use the LF device naming approach shown above.

A load function ("Load now" button) is also available on the first data tab to manually load the steady-state voltage phasors and optionally eliminate the reference to the Load-Flow solution device.

When this device participates directly in the Load-Flow solution, it maintains its voltage phasor at the given frequency when contributing to the steady-state solution (t_{start} < 0). The steady-state model conditions given below are also applicable in the Load-Flow solution.

3 Steady-state model

The "V ac" device is represented in steady-state for automatic harmonic initialization. The harmonic initialization process must solve the network for all available source frequencies. The steady-state phasor value of a given source is only evaluated if the source frequency is equal to the solved frequency and $t_{start} < 0 < t_{stop}$. The source is a short-circuit otherwise. This phasor is *independent* from the source frequency and is evaluated as:

$$v_{ss} = V_m \left(\cos\theta + j\sin\theta \right) \quad (1)$$

4 Frequency Scan model

The source automatically participates at each scan frequency according to equation (1). The source frequency is set to the scanned frequency. The source participates only if $t_{start} < 0 < t_{stop}$, it is a short-circuit otherwise.

5 Time-domain model

The device is evaluated at each simulation time-point according to the equation:

$$v(t) = V_m \cos\left(\omega \left(t - t_{start} \right) + \theta \right) \qquad \text{for } t \geq t_{start} \quad (2)$$

The source is active (not a short-circuit) for $t_{start} \leq t \leq t_{stop}$.