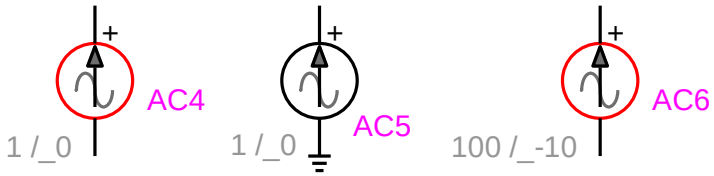
AC current source device



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1 Available versions

The “I 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 “I ac”

1.3.1 Parameters

The generic version of “I ac” has two pins. The generic version of “I ac” allows entering all required parameters for a cosine waveform:

$$i(t) = I_m \cos(\omega t + \theta)$$

$$\omega = 2\pi f$$

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

- I_m amplitude of the cosine waveform, any value, default units are A.
- 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 an open-circuit. If t_{start} < 0, the source is active in the steady-state solution.
- t_{stop} stop time, if t > t_{stop} the source is an open-circuit. The stop time must be greater than the start time.

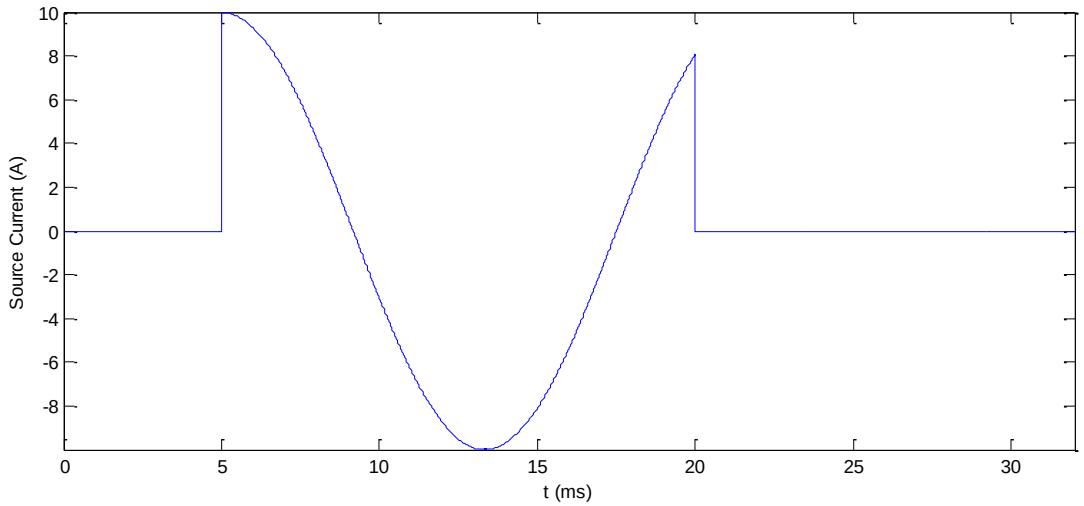

Figure 1 Sample source waveform for $t_{start} = 5ms$ and $t_{stop} = 20ms$

1.3.2 Netlist format

```
_Isine;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
I_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 ib (branch 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.

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.

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

```
_Isine;AC1a;2;2;s12a,s13a,
10,60,0,-1,1E15,
_Isine;AC1b;2;2;s12b,s13b,
10,60,-120,-1,1E15,
_Isine;AC1c;2;2;s12c,s13c,
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.

```
_Isine;AC1a;2;2;s12a,s13a,
10,60,0,-1,1E15,
_Isine;AC1b;2;2;s12b,s13b,
<b>,,,,,
_Isine;AC1c;2;2;s12c,s13c,
<b>,,,,,
```

2 Steady-state model

The “I 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 an open-circuit otherwise. This phasor is *independent* from the source frequency and is evaluated as:

$$i_{ss} = I_m\left(\cos\theta + j\sin\theta\right) \tag{1}$$

3 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 an open-circuit otherwise.

4 Time-domain model

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

$$i(t) = I_m \cos\left(\omega\left(t - t_{start}\right) + \theta\right) \qquad \text{for } t \geq t_{start} \tag{2}$$

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