Appendix A
Simulator Options

A.1 Introduction

This appendix describes simulator options that affect accuracy or convergence.

A.2 SPICE Options

A.2.1 Global Options

SPICE expects the global options to be given on the `.options` statement.

A.2.1.1 Abstol

The absolute tolerance for currents. Defines the smallest interesting current anywhere in the circuit. Currents smaller than `abstol` are ignored when checking for convergence, and when choosing the time step. `abstol` is a supplement to `reltol` that plays a role when the simulator is checking the accuracies of very small currents. `abstol` prevents the simulator from attempting to converge femtoampere signals to attoampere levels.

As a rule, an absolute tolerance such as `abstol` should be set 10^6–10^8 times smaller than the largest signal of the same type present

in the circuit. This ratio could be even greater on sensitive circuits. Typically, the largest current present in analog integrated circuits is in the 1μA–100μA range, which is why `abstol` defaults to 1 pA. It should be set higher for power electronic circuits. Setting `abstol` too loose results in degraded accuracy. Setting `abstol` too tight prevents the simulator from converging.

A.2.1.2 Gmin

A very small conductance added across nonlinear devices to prevent nodes from floating if a device is turned completely off. By default, `gmin`=10^{-12}℧. It must be positive, though Spectre allows it to be zero. The manner in which SPICE and Spectre add the `gmin` conductors to the various nonlinear devices is different and is shown in Figures 2.13 and 2.14 on page 41.

If `gmin` is too large it adversely affects accuracy. If it is too small it may adversely affect convergence. Be advised that if `gmin` is large enough to positively affect convergence, it is also large enough to negatively affect accuracy.

A.2.1.3 Limpts

Maximum number of plot points that can be plotted or printed during an AC, DC, or transient analysis. The default value is 201. This nuisance parameter was helpful when hoards of undergraduates were all competing for the same line printer in the basement of Evan's Hall back in the 70's, but it has little value now. Feel free to set it to a value that is as large as you need. In SPICE2, setting this value too high wastes a precious piece of the fixed amount of memory available.

A.2.1.4 Pivrel

The relative threshold used for selecting pivots when factoring the Jacobian matrix. Big pivots are good because they reduce the likelyhood of error building up while factoring. However, insisting on having the largest possible pivots can result in the sparse Jacobian

matrix filling-in during the factorization, which would result in the simulation running much more slowly and requiring more memory. `pivrel` specifies how large an entry in the Jacobian has to be in order to be a pivot candidate. It is defined as the minimum acceptable ratio between the absolute value of a pivot and the largest remaining element in the same column.

In rare cases, increasing the value of `pivrel` solves a convergence problem, but more often it just causes the simulator to run more slowly and gives no benefit. Pinning your hopes on `pivrel` is clearly a desperation move. `pivrel` must be specified between 0 and 1, with the default value being 10^{-3}. Reasonable values range between 10^{-12} to 0.5.

A.2.1.5 Pivtol

The minimum absolute value allowed for a Jacobian entry to be considered as a pivot. Default value is 10^{-13}.

Most likely this parameter is settable simply because the original developers were not sure what value to use and wanted to be able to adjust it if necessary. Fortunately, they chose wisely. It should never need adjusting.

A.2.1.6 Reltol

The universal accuracy control. Give value between 0 and 1, values closer to zero imply greater accuracy. `reltol` directly affects the Newton convergence criteria and the time-step control algorithm. It specifies the upper limit on errors relative to the size of the signals present. The default value is 0.1% and typical values range from 10^{-6} to 10^{-2}.

Reducing `reltol` decreases the error in the results computed by the simulator, however no level of accuracy is guaranteed. Nor is any particular level of accuracy implied from a given value for `reltol`. In particular, setting `reltol` to 0.1% in no way implies that the accuracy attained by the simulator is 0.1%.

A.2.1.7 Vntol

The absolute tolerance for voltage. Defines the smallest interesting voltage anywhere in the circuit. Voltages smaller than `vntol` are ignored when checking for convergence, and when choosing the time step. `vntol` is a supplement to `reltol` that plays a role when the simulator is checking the accuracies of very small voltages. `vntol` prevents the simulator from attempting to converge nanovolt signals to picovolt levels.

Absolute tolerances, such as `vntol`, should be set 10^6–10^8 times smaller than the largest signal of the same type present in the circuit. This ratio could be even greater on sensitive circuits. Typically, the largest voltage present in analog integrated circuits is in the order of 10 V, which is why `vntol` defaults to 1 μV. It should be set higher for high voltage circuits. Setting `vntol` too loose results in degraded accuracy. Setting `vntol` too tight can prevent the simulator from converging, though this problem is not as severe as it is with `abstol`.

A.2.2 DC Analysis Options

SPICE expects the DC analysis options to be given on the `.options` statement.

A.2.2.1 Itl1

Maximum number of iterations for a DC operating point analysis. The default value is 100. Occasionally you can get SPICE to converge by increasing this value. The likelyhood of convergence stops increasing above 1000, with larger values simply resulting in SPICE taking longer to fail.

A.2.2.2 Itl2

Maximum number of iterations per step in a DC sweep. The default value is 50. Set this to a larger value if SPICE has convergence difficulties in the middle of a DC sweep. Alternatively, you can try