Automation in LTspice using `.param`, `.step`, and `.meas`

Prepared for LTspice Users
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1 Introduction

LTspice provides powerful automation commands that allow you to:

- Define variables (`.param`) for component values.
- Sweep parameters over a range of values (`.step`).
- Automatically measure results (`.meas`) such as maximum voltage, rise time, and RMS.

These commands help reduce manual simulation effort and make experiments reproducible.

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2 1. The `.param` Command

The `.param` command defines a variable to be used in component values.

Syntax:

```
.param <name>=<value>
```

Example:

```
.param Rval=1k
R1 N001 N002 {Rval}
```

Explanation:

- ‘Rval‘ is the resistor parameter.
- ‘Rval‘ is used in the component, so changing the parameter automatically updates the circuit.

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3 2. The `.step` Command

The `.step` command is used to sweep a parameter over a range of values.

Syntax:

`.step param <param_name> <start> <stop> <increment>`

Example:

```
.step param Rval 1k 5k 1k
```

This will run 5 simulations with Rval = 1k, 2k, 3k, 4k, 5k.

List Sweep Example:

```
.step param Rval list 1k 2k 4k 8k
```

This simulates for Rval = 1k, 2k, 4k, 8k.

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4 3. The `.meas` Command

The `.meas` command allows automatic extraction of values from simulations.

Syntax:

`.meas <tran/freq> <name> <what_to_measure> <expression>`

Common Examples:

- Maximum voltage:

```
    .meas tran Vmax MAX V(N002)
```

- Time when voltage reaches a value:

```
    .meas tran Tcross WHEN V(N002)=2
```

- RMS voltage:

```
    .meas tran Vrms RMS V(N002)
```

Integration with Parameter Sweep:

```
.meas tran Vpeak PARAM Rval MAX V(N002)
```

- Measures max voltage for each value of Rval during a sweep.

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5 4. Simple Example: Sweep Resistor and Measure Max Voltage

```
* Simple Example
V1 N001 0 DC 5
R1 N001 N002 {Rval}
C1 N002 0 1u

.param Rval=1k
.step param Rval 1k 5k 1k
.tran 0 1ms
.meas tran Vmax PARAM Rval MAX V(N002)
.end
```

Explanation:

- Defines ‘Rval‘ as a parameter.
- Sweeps resistor from 1k to 5k.
- Measures the maximum voltage at node N002 for each resistor value.
- Results are shown in the SPICE error log.

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6 5. Advanced Example: Sweep Resistor and Capacitor, Measure Multiple Metrics

```
* Advanced Automation Example
V1 N001 0 DC 5
R1 N001 N002 {Rval}
C1 N002 0 {Cval}

.param Rval=1k
.param Cval=1u

.step param Rval 1k 5k 1k
.step param Cval 1u 5u 2u
.tran 0 5ms

.meas tran Vpeak PARAM Rval PARAM Cval MAX V(N002)
.meas tran Trise PARAM Rval PARAM Cval TRIG V(N002) VAL
   =0.5 TARG V(N002) VAL=4.5
.meas tran Vrms PARAM Rval PARAM Cval RMS V(N002)
.end
```

Explanation:

- Sweeps `Rval` from 1k to 5k in steps of 1k.
- Sweeps `Cval` from 1u to 5u in steps of 2u.
- Measures:

1. `Vpeak` → Maximum voltage
2. `Trise` → Rise time from 0.5V to 4.5V
3. `Vrms` → RMS voltage

- All results are automatically stored in the SPICE error log.

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7 6. Tips for Automation

- Use curly braces {} when referencing parameters in components.
- ‘.step‘ can sweep multiple parameters; LTspice does a nested sweep automatically.
- ‘.meas‘ is extremely flexible; it can calculate max, min, RMS, rise/fall time, and even formula-based expressions.
- Always check the **SPICE error log** to see results after a sweep.

8 References

- LTspice User Guide: `https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html`