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JSIM Preliminary Version User's Guide

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1. Introduction

JSIM (Josephson SIMulator) is a circuit simulation program for Josephson circuits. Circuits may contain resistors, capacitors, inductors, mutual inductors, independent voltage and current sources, lossless transmission lines and Josephson junctions. At present time, only transient analysis is allowed.

The input format of JSIM is quite similar to SPICE. If you are not familiar with SPICE, it is recommended that you read the SPICE user guide also.

2. Circuit Description

2.1. Resistors

General form : RXXXX N1 N2 VALUE

Example : RC1 12 9 1KOHM

2.2. Capacitors

General form : CXXXX N1 N2 VALUE <IC=VALUE>

Example : C1 10 11 1PF

Initial value may be specified, but currently it is ignored. This applies to ALL initial values.

2.3. Inductors

General form : LXXXX N1 N2 VALUE <FCHECK> <IC=VALUE>

Example : L2 1 0 2.3PH FCHECK

If FCHECK (flux check) is specified, JSIM will keep track of the change of flux through the inductor. It is recommended particularly for phase mode circuit. In each superconductive loop, at least one inductor should be considered for FCHECK option.

2.4. Mutual Inductors

General form : KXXXX LXXXX LYyyy VALUE

Example : K1 L1 L2 0.9

2.5. Independent Voltage Sources

2.5.1. Sinusoidal Sources

General form : VXXXX N1 N2 SIN(VO VA FREQ TD THETA)

Example : V1 1 0 SIN(0 1MV 100MEGHZ 0US 0)

Note VO must be zero.

2.5.2. Pulse Sources

General form : VXXXX N1 N2 PULSE(V1 V2 TD TR TF PW PER)

Example : V2 2 0 PULSE(0MV 1MV 0PS 2PS 2PS 10PS 50PS)

Note V1 must be zero.

2.5.3. Piece-wise Linear Sources

General form : VXXXX N1 N2 PWL(T0 V0 T1 V1)

Example : V3 3 0 PWL(0PS 0MV 1PS 1MV)

Note T0 and V0 must be zero.

2.6. Independent Current Sources

2.6.1. Sinusoidal Sources

General form : IXXXX N1 N2 SIN(IO IA FREQ TD THETA)

Example : I1 1 0 SIN(0 1MA 100MEGHZ 0US 0)

Note IO must be zero.

2.6.2. Pulse Sources

General form : IXXXX N1 N2 PULSE(I1 I2 TD TR TF PW PER)

Example : I2 2 0 PULSE(0MA 1MA 0PS 2PS 2PS 10PS 50PS)

Note I1 must be zero.

2.6.3. Piece-wise Linear Sources

General form : IXXXX N1 N2 PWL(T0 IO T1 I1)

Example : I3 3 0 PWL(0PS 0MA 1PS 1MA)

Note T0 and IO must be zero.

2.7. Josephson Junctions

General form : BXXXX N1 N2 MODNAME <AREA>
<CONDEV=DEVNAME> <IC=V0,PHI0>

Example : B1 2 3 JJMOD1 AREA=1.5 CONDEV=L2

MODNAME is the model name, CONDEV is used to simulate the modulation of critical current due to magnetic field, DEVNAME can only be inductors, voltage and current sources.

2.8. Transmission Line

General form : TXXXX N1 N2 N3 N4 LOSSLESS <Z0=VALUE>
<TD=VALUE>

Example : T1 1 0 2 0 LOSSLESS Z0=50 TD=100PS

N1 and N2 are nodes for port 1, and N3 and N4 are nodes for port 2.
Default Z0=50ohm, TD=1sec.

2.9. Subcircuit Calls

General form : XYYYY SUBDEFNAME N1 N2

Example : X1 SGA 1 3 4 5

3. Subcircuit Definition

General form : .SUBCKT SUBDEFNAME N1 N2

General form : <circuit elements>

General form : .ENDS

Example : .SUBCKT TEST 1 2 3

Example : R1 1 2 3K

Example : C1 2 3 3PF

Example : .ENDS

4. Model Specification

4.1. Josephson Models

General form : .MODEL MNAME JJ(<PARAM=VALUE>,....)

Example : .MODEL JJMOD1 JJ(VG=2.5MV, CAP=0.6PF, ICRIT=100UA)

RTYPE : quasiparticle model, can be zero or one. Zero is for zero conductance, and one is for piece-wise linear conductance curve, default is 0.

CCT : control current type, can be zero or one. Zero is for no control current, and one is for sine x over x, default is 0.

VG : gap voltage, default is 2.8mV.

DELV : gap transition voltage, default is 0.1mV.

ICON : control current scale, default is 1mA.

R0 : subgap resistance, default is 30ohm.

RN : normal resistance, default is 5ohm.

CAP : junction capacitance, default is 2.5pf

ICRIT : critical current, default is 1mA.

5. Transient Analysis Specification

General form : .TRAN PRSTEP TSTOP <TSTART> <MAXTSTEP>

Example : .TRAN 1PS 100PS 20PS 0.5PS

PRSTEP is the printing step.

TSTOP is the stop time.

TSTART is the starting time for printing, default is 0.

MAXTSTEP is the maximum internal time step, default is 1ps.

6. Print and File Specifications

General form : .FILE FILENAME

General form : .PRINT PRTYPE PRNAME <PART>

Example : .FILE OUT1

Example : .PRINT NODEV 2 0

Example : .PRINT DEVV X1_X2_B1

Example : .FILE OUT2

Example : .PRINT DEVI B2 JJTOTAL

Example : .PRINT PHASE B3

Example : .PRINT DEVV T1 PORT1

Example : .PRINT DEVI T1

To print out device voltage or current of a subcircuit element, just expand the element name by the subcircuit call name. In the above examples, X1_X2_B1, means B1 belong to subcircuit call X2 which is in turn called by X1. This eliminates the need for a long node list in the subcircuit definition in order to print out values associated with subcircuit elements as in SPICE.

JJTOTAL : total current.

JJJOSEPH : Josephson current.

JJCAP : current due to capacitive effect.

JJRESIS : quasi-partical current.

JJALL : print all currents in the order specified.

PORT1 : print port1 of transmission line.

PORT2 : print port2 of transmission line, no port specification prints both ports.

7. Option Specifications

General form : .OPTIONS <PARAM,>

Example : .OPTIONS RELTOL=0.01 MAXPHISTEP=1.5

RELTOL=VALUE : relative tolerance, default is 0.001.

PHITOL=VALUE : absolute tolerance for phase, default is 0.0001, (too small, set it to 0.01).

VNTOL=VALUE : absolute voltage tolerance, default is 0.1 uV, only in effect when LTE option is used.

INTOL=VALUE : absolute current tolerance, default is 0.1 uA, only in effect when LTE option is used.

MAXPHISTEP=VALUE : maximum phase change allowed in one time step, default is 1.5.

MAXFLUXSTEP=VALUE : maximum flux change in inductor allowed in one time step. Only applies to those inductors with FCHECK flag specified. Default is 0.5e-15.

LTE : check for local truncation error in choosing step size, default no LTE.

IGWARN : ignore warning and proceed with simulation.

NUMDGT=VALUE : number of digits to be printed, default is 3.

8. Special Files

JSIM will generate some special files. All the special files start with .jsim. They are devlist, devname, model, nodemap and subdef.

9. CAUTION

This is a preliminary version of the program. Many parameters have no defaults, and have to be specified.

10. BUGS

If you find any problems, please send e-mail to esfang@argon.berkeley.edu, include the input deck that causes the problem and a description of the problem. Also you may call (415) 642-0502 and contact Emerson Fang, or write to Prof. Ted Van Duzer at the above address.