**PLOT.1D**

The **PLOT.1D** statement plots a specific quantity along a line segment through the device, or plots terminal characteristics from data accumulated in a log file or read in from a previous log file.

**PLOT.1D**

**Distance Plot Quantities**

\[
\{ \{ \text{POTENTIA} \mid \text{QFN} \mid \text{QFP} \mid \text{VALENC.B} \mid \text{CONDUC.B} \mid \text{VACUUM} \\
\text{E.FIELD} \mid \text{ARRAY1} \mid \text{ARRAY2} \mid \text{ARRAY3} \mid \text{TRAPS} \mid \text{TRAP.OCC} \\
\text{DOPING} \mid \text{ELECTRON} \mid \text{HOLES} \mid \text{NIE} \mid \text{NET.CHAR} \mid \text{NET.CARR} \\
\text{J.CONDUC} \mid \text{J.ELECTR} \mid \text{J.HOLE} \mid \text{J.DISPLA} \mid \text{J.TOTAL} \\
\text{RECOMBIN} \mid \text{N.RECOMB} \mid \text{P.RECOMB} \mid \text{II.GENER} \mid \text{BB.GENER} \\
( \text{PHOTOGEN} \ [\text{WAVE.NUM}<\text{n}>] ) \mid \text{N.MOIBILI} \mid \text{P.MOIBILI} \mid \text{SIGMA} \\
\text{ELE.TEMP} \mid \text{HOL.TEMP} \mid \text{ELE.VEL} \mid \text{HOL.VEL} \mid \text{J.EFIELD} \\
\text{G.GAMN} \mid \text{G.GAMP} \mid \text{G.GAMT} \mid \text{G.IN} \mid \text{G.IP} \mid \text{G.IT} \\
\text{IMPURITY}<\text{c}> \mid \text{OTHER}<\text{c}> \}
\]

**Lattice Temperature AAM Parameters**

\[
| \text{LAT.TEMP} \\
\]

**Heterojunction Device AAM Parameters**

\[
| \text{X.MOLE} \\
\]

**AC Small-Signal Analysis Quantity Parameters**

\[
[ \{ \text{AC.REAL} \mid \text{AC.IMAG} \mid \text{AC.MAGN} \mid \text{AC.PHAS} \} ]
\]

**Distance Plot Parameters**

\[
[\{ \text{X.COMPON} \mid \text{Y.COMPON} \} \\
\text{X.START}<\text{n}> \mid \text{Y.START}<\text{n}> \mid \text{X.END}<\text{n}> \mid \text{Y.END}<\text{n}> \mid \text{HORZ.STA}<\text{n}> \\
[ \{ \text{FIND.MIN} \mid \text{FIND.MAX} \} \mid \text{SEMICOND} \mid \text{INSULATO} \mid \text{FIND.DIS}<\text{n}> ] \\
]
\]

**Terminal Characteristics Plot Parameters**

\[
[ ( \text{X.AXIS}<\text{c}> \mid \text{Y.AXIS}<\text{c}> \mid \text{ORDER} \mid \text{IN.FILE}<\text{c}> \\
\text{X.MIN}<\text{n}> \mid \text{X.MAX}<\text{n}> \mid \text{CONDITIO}<\text{c}> ] \\
)
\]

( **PLOT.1D**, continued next page)
Plot Controls

[ SPLINE [NSPLINE=<n>] ]
[LEFT=<n>] [RIGHT=<n>] [BOTTOM=<n>] [TOP=<n>] [UNCHANGE]
[ {Y.LOGARI | S.LOGARI | INTEGRAL} ] [ABSOLUTE] [NEGATIVE]
[CLEAR] [AXES] [LABELS] [MARKS] [TITLE=<c>] [T.SIZE=<n>]
[X.OFFSET=<n>] [X.LENGTH=<n>] [X.SIZE=<n>] [X.LOGARI]
[Y.OFFSET=<n>] [Y.LENGTH=<n>] [Y.SIZE=<n>]
[CURVE] [ {SYMBOL=<n> | POINTS} ] [C.SIZE=<n>]
[LINETYPE=<n>] [COLOR=<n>] [DEVICE=<c>] [PAUSE]
[PLOT.OUT=<c>] [PLOT.BIN=<c>] [PRINT] [OUT.FILE=<c>]
[TIMESTAMP] [TIME.SIZ=<n>]

Circuit Analysis AAM Parameters
[STRUCTURE=<c>]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Definition</th>
<th>Default</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>POTENTIA</td>
<td>logical</td>
<td>Specifies that midgap potential in volts is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>QFN</td>
<td>logical</td>
<td>Specifies that the electron quasi-Fermi potential in volts is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>QFP</td>
<td>logical</td>
<td>Specifies that the hole quasi-Fermi potential in volts is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>VALENC.B</td>
<td>logical</td>
<td>Specifies that the valence band potential in volts is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>CONUC.B</td>
<td>logical</td>
<td>Specifies that the conduction band potential in volts is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>VACUUM</td>
<td>logical</td>
<td>Specifies that the vacuum potential in volts is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>E.FIELD</td>
<td>logical</td>
<td>Specifies that the magnitude of electric field in volts per centimeter is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>ARRAY1</td>
<td>logical</td>
<td>Specifies that the user generated array number 1 is to be plotted along the specified line. Refer to the EXTRACT statement for more information.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>ARRAY2</td>
<td>logical</td>
<td>Specifies that the user generated array number 2 is to be plotted along the specified line. Refer to the EXTRACT statement for more information.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>ARRAY3</td>
<td>logical</td>
<td>Specifies that the user generated array number 3 is to be plotted along the specified line. Refer to the EXTRACT statement for more information.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>TRAPS</td>
<td>logical</td>
<td>Specifies that the trap density in number per cubic centimeter is to be plotted along the specified line.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>TRAP.OCC</td>
<td>logical</td>
<td>Specifies that the filled trap density in number per cubic centimeter is to be plotted along the specified line.</td>
<td>false</td>
<td></td>
</tr>
</tbody>
</table>
### Section 3.3 Input/Output Statements

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Definition</th>
<th>Default</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOPING</td>
<td>logical</td>
<td>Specifies that the net impurity concentration in number per cubic centimeter is plotted versus distance along the specified line through the device. The net impurity concentration is the donor impurity concentration minus the acceptor impurity concentration.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>ELECTRON</td>
<td>logical</td>
<td>Specifies that electron concentration in number per cubic centimeter is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>HOLES</td>
<td>logical</td>
<td>Specifies that hole concentration in number per cubic centimeter is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>NIE</td>
<td>logical</td>
<td>Specifies that effective intrinsic carrier concentration in number per cubic centimeter is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>NET.CHAR</td>
<td>logical</td>
<td>Specifies that the net charge concentration in number per cubic centimeter is plotted versus distance along the specified line through the device. The net charge concentration is the sum of the donor impurity concentration and hole concentration minus the sum of the acceptor impurity concentration and electron concentration plus the concentration of any trapped charge.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>NET.CARR</td>
<td>logical</td>
<td>Specifies that the net carrier concentration in number per cubic centimeter is plotted versus distance along the specified line through the device. The net carrier concentration is the hole concentration minus the electron concentration.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>J.CONDUC</td>
<td>logical</td>
<td>Specifies that conduction current in amps per square centimeter is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>J.ELECTR</td>
<td>logical</td>
<td>Specifies that electron current in amps per square centimeter is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>J.HOLE</td>
<td>logical</td>
<td>Specifies that hole current in amps per square centimeter is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>J.DISPLA</td>
<td>logical</td>
<td>Specifies that displacement current in amps per square centimeter is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>J.TOTAL</td>
<td>logical</td>
<td>Specifies that total current in amps per square centimeter is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>RECOMBIN</td>
<td>logical</td>
<td>Specifies that net recombination in number per cubic centimeter per second is plotted versus distance along the specified line through the device. For unequal electron and hole recombination, RECOMBIN is the same as N.RECOMB.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>N.RECOMB</td>
<td>logical</td>
<td>Specifies that net electron recombination in number per cubic centimeter per second is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>P.RECOMB</td>
<td>logical</td>
<td>Specifies that net hole recombination in number per cubic centimeter per second is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>II.GENER</td>
<td>logical</td>
<td>Specifies that the total generation rate due to impact ionization in pairs per cubic centimeter per second is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>BB.GENER</td>
<td>logical</td>
<td>Specifies that the total generation rate due to band-to-band tunneling in pairs per cubic centimeter per second is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>PHOTOGEN</td>
<td>logical</td>
<td>Specifies that total photogeneration in pairs per cubic centimeter per second is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Type</td>
<td>Definition</td>
<td>Default</td>
<td>Units</td>
</tr>
<tr>
<td>-------------</td>
<td>------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
<td>N.MOBILI</td>
<td>logical</td>
<td>Specifies that the electron mobility in cm²/V·s is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>P.MOBILI</td>
<td>logical</td>
<td>Specifies that the hole mobility cm²/V·s is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>SIGMA</td>
<td>logical</td>
<td>Specifies that the conductivity in (Ohm·cm)⁻¹ is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>ELE.TEMP</td>
<td>logical</td>
<td>Specifies that the electron temperature in Kelvins is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>HOL.TEMP</td>
<td>logical</td>
<td>Specifies that the hole temperature in Kelvins is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>ELE.VEL</td>
<td>logical</td>
<td>Specifies that the electron mean velocity in cm/s is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>HOL.VEL</td>
<td>logical</td>
<td>Specifies that the hole mean velocity in cm/s is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>J.EFIELD</td>
<td>logical</td>
<td>Specifies that the component of the electric field in V/cm in the direction of the total current density is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>G.GAMN</td>
<td>logical</td>
<td>Specifies that the probability per unit length that an electron is injected into the oxide is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>G.GAMP</td>
<td>logical</td>
<td>Specifies that the probability per unit length that a hole is injected into the oxide is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>G.GAMT</td>
<td>logical</td>
<td>Specifies that the probability per unit length that an electron or hole (the sum of the electron and hole probabilities) is injected into the oxide is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>G.IN</td>
<td>logical</td>
<td>Specifies that hot electron injection current initiated from each point in amps/micron is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>G.IP</td>
<td>logical</td>
<td>Specifies that hot hole injection current initiated from each point in amps/micron is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>G.IT</td>
<td>logical</td>
<td>Specifies that total hot carrier injection current initiated from each point in amps/micron is plotted versus distance along the specified line through the device.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>IMPURITY</td>
<td>char</td>
<td>The name of an impurity to plot in number per cubic centimeter as a function of distance along the specified line through the device.</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>OTHER</td>
<td>char</td>
<td>The name of an <strong>OTHER</strong> quantity to plot as a function of distance along the specified line through the device.</td>
<td>none</td>
<td></td>
</tr>
</tbody>
</table>

**Lattice Temperature AAM Parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Definition</th>
<th>Default</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAT.TEMP</td>
<td>logical</td>
<td>Specifies that the lattice temperature in Kelvins is plotted versus distance along the specified line through the device. This parameter is only used with the Lattice Temperature AAM.</td>
<td>false</td>
<td></td>
</tr>
</tbody>
</table>
### Heterojunction Device AAM Parameters

- **Parameter**: X.MOLE
- **Type**: logical
- **Definition**: Specifies that the mole fraction for the material is plotted versus distance along the specified line through the device. This parameter is only used with the Heterojunction Device AAM.
- **Default**: false

### AC Small-Signal Analysis Quantity Parameters

- **Parameter**: AC.REAL
- **Type**: logical
- **Definition**: Specifies that the real part of the quantity obtained from AC analysis is plotted.
- **Default**: false

- **Parameter**: AC.IMAG
- **Type**: logical
- **Definition**: Specifies that the imaginary part of the quantity obtained from AC analysis is plotted.
- **Default**: false

- **Parameter**: AC.MAGN
- **Type**: logical
- **Definition**: Specifies that the magnitude of the quantity obtained from AC analysis is plotted.
- **Default**: false

- **Parameter**: AC.PHAS
- **Type**: logical
- **Definition**: Specifies that the phase of the quantity obtained from AC analysis is plotted. Phase is defined as \( \text{atan} (\text{imag}(X) / \text{real}(X)) \), where X represents the quantity to be plotted.
- **Default**: false

### Distance Plot Parameters

- **Parameter**: X.COMPON
- **Type**: logical
- **Definition**: Specifies that the x component of a vector quantity is plotted as opposed to the default magnitude.
- **Default**: false

- **Parameter**: Y.COMPON
- **Type**: logical
- **Definition**: Specifies that the y component of a vector quantity is plotted as opposed to the default magnitude.
- **Default**: false

- **Parameter**: X.START
- **Type**: number
- **Definition**: The x location of the initial point of the line segment along which the specified quantity is plotted.
- **Default**: None

- **Parameter**: Y.START
- **Type**: number
- **Definition**: The y location of the initial point of the line segment along which the specified quantity is plotted.
- **Default**: None

- **Parameter**: X.END
- **Type**: number
- **Definition**: The x location of the final point of the line segment along which the specified quantity is plotted.
- **Default**: None

- **Parameter**: Y.END
- **Type**: number
- **Definition**: The y location of the final point of the line segment along which the specified quantity is plotted.
- **Default**: None

- **Parameter**: HORZ.STA
- **Type**: number
- **Definition**: The value along the horizontal plot axis associated with the starting point of the line. This value establishes the reference for horizontal distance along the line.
- **Default**: 0.0

- **Parameter**: FIND.MIN
- **Type**: logical
- **Definition**: Specifies that the minimum value of the specified quantity is plotted versus distance along the specified line through the device. For each point along the specified line, the program finds the minimum value by searching along a line that passes through the point and is perpendicular to the specified line.
- **Default**: false

- **Parameter**: FIND.MAX
- **Type**: logical
- **Definition**: Specifies that the maximum value of the specified quantity is plotted versus distance along the specified line through the device. For each point along the specified line, the program finds the maximum value by searching along a line that passes through the point and is perpendicular to the specified line.
- **Default**: false

- **Parameter**: SEMICOND
- **Type**: logical
- **Definition**: Specifies that when FIND.MIN or FIND.MAX is used, the search area should include semiconductor materials.
- **Default**: true
### Medici User’s Manual

#### Terminal Characteristics Plot Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Definition</th>
<th>Default</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSULATO</td>
<td>logical</td>
<td>Specifies that when <strong>FIND_MIN</strong> or <strong>FIND_MAX</strong> is used, the search area should include insulator materials.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>FIND.DIS</td>
<td>number</td>
<td>The maximum distance to either side of the specified line over which the search takes place when <strong>FIND_MIN</strong> or <strong>FIND_MAX</strong> is specified.</td>
<td></td>
<td>microns</td>
</tr>
</tbody>
</table>

#### Terminal Characteristics

**X.AXIS** char  
The quantity used for the horizontal axis when plotting data stored in a log file. If a log file is available or read using the **IN.FILE** parameter, the choices include the following:

- **VA(<name>)** applied bias for electrode `<name>`
- **V(<name>)** contact bias for electrode `<name>`
- **I(<name>)** total terminal current for electrode `<name>`
- **IE(<name>)** electron terminal current for electrode `<name>`
- **IH(<name>)** hole terminal current for electrode `<name>`
- **ID(<name>)** displacement terminal current for electrode `<name>`
- **QE(<name>)** total charge on electrode `<name>`
- **HE(<name>)** hot carrier injection current into electrode `<name>`
- **TIME** simulation time (transient simulations)
- **II** impact ionization current (integrated I.I. gener. rate)
- `<name>` a quantity defined with the **EXTRACT** statement

#### AC Analysis Quantities  
**FREQ** AC frequency

#### Programmable Device AAM Quantities

- **FE(<name>)** FN tunneling current into electrode `<name>`

#### Circuit Analysis AAM Quantities

- **VC(<name>)** voltage at circuit node `<name>`
- **IC(<name>)** current in voltage source `<name>`
- **V(<dn>.<tn>)** voltage at electrode `<tn>` of device `<dn>`
- **I(<dn>.<tn>)** total current at electrode `<tn>` of device `<dn>`
- **IE(<dn>.<tn>)** electron current at electrode `<tn>` of device `<dn>`
- **IH(<dn>.<tn>)** hole current at electrode `<tn>` of device `<dn>`
- **ID(<dn>.<tn>)** displacement current at electrode `<tn>` of device `<dn>`
### Circuit Analysis AAM AC Quantities

Note: Quotes are required.

- "VCR(<name>)" AC real voltage component for node `<name>`
- "VCI(<name>)" AC imaginary voltage comp. for node `<name>`
- "ICR(<name>)" AC real current component for source `<name>`
- "ICI(<name>)" AC imaginary current comp. for source `<name>`

### Optical Device AAM Quantities

- **WA**  
  Wavelength (microns)
- **IT**  
  Intensity (W/cm²)
- **LF**  
  Frequency of light modulation (Hz)
- **IP**  
  Internal photo current (Amps/micron)
- **EP**  
  External photo current (Amps/micron)
- **TR**  
  Transmittance at the illumination surface
- **RF**  
  Reflectance at the illumination surface
- **CE(name)**  
  External collection efficiency at electrode `<name>`
- **CI(name)**  
  Internal collection efficiency at electrode `<name>`
- **IS(name)**  
  Light modulation small signal current at elec `<name>`

### Y.AXIS

The quantity used for the vertical axis when plotting data stored in a log file. The choices are the same as given previously for the X.AXIS parameter.

### ORDER

Specifies that the data points in log files are sorted by abscissa value before plotting. If ^ORDER is specified, the data points in the log file are plotted as they occur.

### IN.FILE

The identifier for a log file containing either I-V data or AC data to be used when plotting terminal characteristics. If IN.FILE is not specified, data accumulated in the most recent log file during the present run is used.

**SYNONYM:** INFILE

### X.MIN

The minimum abscissa value plotted. Data points in the log file with smaller abscissa values are ignored.

### X.MAX

The maximum abscissa value plotted. Data points in the log file with higher abscissa values are ignored.

### CONDITIO

Specifies a numeric expression that must evaluate to “TRUE” before data will be plotted.

### Plot Controls

- **SPLINE**  
  Specifies that spline smoothing is performed on the data.
  - **Default:** false

- **NSPLINE**  
  The number of interpolated points to use when spline smoothing is specified. The maximum allowed is 1000.
  - **Default:** 100
  - **Units:** none

- **LEFT**  
  The value associated with the left end of the horizontal axis.
  - **Default:** none
  - **Units:** abscissa dependent

---

**Parameter** | **Type** | **Definition** | **Default** | **Units**
---|---|---|---|---
Circuit Analysis AAM AC Quantities | Note: Quotes are required. | | |
VCR(<name>) | AC real voltage component for node `<name>` | | |
VCI(<name>) | AC imaginary voltage comp. for node `<name>` | | |
ICR(<name>) | AC real current component for source `<name>` | | |
ICI(<name>) | AC imaginary current comp. for source `<name>` | | |
Optical Device AAM Quantities | | | |
WA | Wavelength (microns) | | |
IT | Intensity (W/cm²) | | |
LF | Frequency of light modulation (Hz) | | |
IP | Internal photo current (Amps/micron) | | |
EP | External photo current (Amps/micron) | | |
TR | Transmittance at the illumination surface | | |
RF | Reflectance at the illumination surface | | |
CE(name) | External collection efficiency at electrode `<name>` | | |
CI(name) | Internal collection efficiency at electrode `<name>` | | |
IS(name) | Light modulation small signal current at elec `<name>` | | |
Y.AXIS | char | The quantity used for the vertical axis when plotting data stored in a log file. The choices are the same as given previously for the X.AXIS parameter. | none | |
ORDER | logical | Specifies that the data points in log files are sorted by abscissa value before plotting. If ^ORDER is specified, the data points in the log file are plotted as they occur. | true | |
IN.FILE | char | The identifier for a log file containing either I-V data or AC data to be used when plotting terminal characteristics. If IN.FILE is not specified, data accumulated in the most recent log file during the present run is used. | none | |
X.MIN | number | The minimum abscissa value plotted. Data points in the log file with smaller abscissa values are ignored. | The minimum value available. | abscissa dependent |
X.MAX | number | The maximum abscissa value plotted. Data points in the log file with higher abscissa values are ignored. | The maximum value available. | abscissa dependent |
CONDITIO | char | Specifies a numeric expression that must evaluate to “TRUE” before data will be plotted. | none | |
SPLINE | logical | Specifies that spline smoothing is performed on the data. | false | |
NSPLINE | number | The number of interpolated points to use when spline smoothing is specified. The maximum allowed is 1000. | 100 | none |
LEFT | number | The value associated with the left end of the horizontal axis. | The minimum value available. | abscissa dependent |
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Definition</th>
<th>Default</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>RIGHT</td>
<td>number</td>
<td>The value associated with the right end of the horizontal axis.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOTTOM</td>
<td>number</td>
<td>The value associated with the bottom end of the vertical axis.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOP</td>
<td>number</td>
<td>The value associated with the top end of the vertical axis.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNCHANGE</td>
<td>logical</td>
<td>Specifies that the data is added to the previous plot. UNCHANGE has the</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>effect of disabling CLEAR and AXES, and forces the previous axis bounds to</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>be used for scaling. UNCHANGE can be used to plot more than one curve on</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>the same plot.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y.LOGARI</td>
<td>logical</td>
<td>Specifies that a logarithmic vertical axis is used.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>S.LOGARI</td>
<td>logical</td>
<td>Specifies that a signed logarithmic vertical axis is used. To avoid</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>overflow, the actual quantity plotted is given by sign(y) * log(1 +</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTEGRAL</td>
<td>logical</td>
<td>Specifies that the integral of the ordinate is plotted.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>ABSOLUTE</td>
<td>logical</td>
<td>Specifies that the absolute value of the ordinate is plotted.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>NEGATIVE</td>
<td>logical</td>
<td>Specifies that the negative of the ordinate is plotted.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>CLEAR</td>
<td>logical</td>
<td>Specifies that the graphics display area is cleared before beginning the</td>
<td>true</td>
<td></td>
</tr>
<tr>
<td>AXES</td>
<td>logical</td>
<td>Specifies that the horizontal and vertical axes, axis labels, distance</td>
<td>true</td>
<td></td>
</tr>
<tr>
<td>LABELS</td>
<td>logical</td>
<td>Specifies that axis labels are to be plotted.</td>
<td>true</td>
<td></td>
</tr>
<tr>
<td>MARKS</td>
<td>logical</td>
<td>Specifies that distance marks are to be plotted along the plot axes.</td>
<td>true</td>
<td></td>
</tr>
<tr>
<td>TITLE</td>
<td>char</td>
<td>The character string to be used as the title of the plot.</td>
<td>The character string in</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>the most recent TITLE statement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T.SIZE</td>
<td>number</td>
<td>The height of the characters in the character string used as the plot title.</td>
<td>0.4</td>
<td>cm</td>
</tr>
<tr>
<td>X.OFFSET</td>
<td>number</td>
<td>The distance by which the left end of the horizontal axis is offset from</td>
<td>2.0</td>
<td>cm</td>
</tr>
<tr>
<td>X.LENGTH</td>
<td>number</td>
<td>The length of the horizontal axis.</td>
<td></td>
<td>cm</td>
</tr>
<tr>
<td>X.SIZE</td>
<td>number</td>
<td>The height of the characters used to label the horizontal axis.</td>
<td>0.25</td>
<td>cm</td>
</tr>
<tr>
<td>X.LOGARI</td>
<td>logical</td>
<td>Specifies that the horizontal axis is logarithmic.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>Y.OFFSET</td>
<td>number</td>
<td>The distance by which the bottom end of the vertical axis is offset from</td>
<td>2.0</td>
<td>cm</td>
</tr>
<tr>
<td>Y.LENGTH</td>
<td>number</td>
<td>The length of the vertical axis.</td>
<td></td>
<td>cm</td>
</tr>
</tbody>
</table>
### Section 3.3 Input/Output Statements

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<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Definition</th>
<th>Default</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y.SIZE</td>
<td>number</td>
<td>The height of the characters used to label the vertical axis at the left edge of the plot.</td>
<td>0.25</td>
<td>cm</td>
</tr>
<tr>
<td>CURVE</td>
<td>logical</td>
<td>Specifies that solid or dashed line curves are to be plotted connecting the data points in the plot.</td>
<td>true</td>
<td></td>
</tr>
<tr>
<td>SYMBOL</td>
<td>number</td>
<td>The type of centered symbol plotted at the data points in the plot. The value of this parameter may lie in the range 1 to 15. If this parameter is not specified, the plot will not contain centered symbols. Values of this parameter are associated with the following symbol:</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1    Square</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2    Circle</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3    Triangle</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4    Plus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5    Upper case X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6    Diamond</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7    Up-arrow</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8    Roofed upper case X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9    Upper case Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10   Upper case Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>11   Curved square</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>12   Asterisk</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>13   Hourglass</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>14   Bar</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15   Star</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POINTS</td>
<td>logical</td>
<td>Specifies that centered squares are plotted at the data points in the plot. This parameter has the same effect as specifying SYMBOL=1.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>C.SIZE</td>
<td>number</td>
<td>The size of the centered symbol used for the plot.</td>
<td>0.25</td>
<td>cm</td>
</tr>
<tr>
<td>LINE.TYP</td>
<td>number</td>
<td>The type of line used for the plot. A line type value of 1 generates a solid line plot. Line type values greater than 1 generate dashed line plots, with the dash size increasing with the value of line type.</td>
<td>1</td>
<td>none</td>
</tr>
<tr>
<td>COLOR</td>
<td>number</td>
<td>The index of the color used for the plot. The color associated with each color index is dependent upon the color graphics device that is used. This parameter has no effect if a color graphics device is not used.</td>
<td>1</td>
<td>none</td>
</tr>
<tr>
<td>DEVICE</td>
<td>char</td>
<td>The name of the graphics output device. Valid names are defined by the file mdpdev (see Chapter 1, “Plot Device Definition File—mdpdev” on page 1-14 and Appendix B). If the value of this parameter is “DEFAULT”, the first entry in mdpdev preceded by “*” is chosen.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAUSE</td>
<td>logical</td>
<td>Specifies that program execution pauses after the completion of all graphical output associated with this statement. The user must enter a space followed by a carriage return to continue execution.</td>
<td>false</td>
<td></td>
</tr>
<tr>
<td>PLOT.OUT</td>
<td>char</td>
<td>The identifier for the file in which the character sequences controlling the graphics device are saved. This file may be output to the graphics device to reproduce the graphical output. This output is only available for the direct device drivers such as those used when the DEVICE parameter is HP2648, HP2623, HP7550, TEK4010, TEK4100, REGIS, or POSTSCRIPT.</td>
<td>&lt;base&gt;.dplt</td>
<td></td>
</tr>
</tbody>
</table>

---

Y.SIZE The height of the characters used to label the vertical axis at the left edge of the plot.
CURVE Specifies that solid or dashed line curves are to be plotted connecting the data points in the plot.
SYMBOL The type of centered symbol plotted at the data points in the plot. The value of this parameter may lie in the range 1 to 15. If this parameter is not specified, the plot will not contain centered symbols. Values of this parameter are associated with the following symbol:
- **1**: Square
- **2**: Circle
- **3**: Triangle
- **4**: Plus
- **5**: Upper case X
- **6**: Diamond
- **7**: Up-arrow
- **8**: Roofed upper case X
- **9**: Upper case Z
- **10**: Upper case Y
- **11**: Curved square
- **12**: Asterisk
- **13**: Hourglass
- **14**: Bar
- **15**: Star

POINTS Specifies that centered squares are plotted at the data points in the plot. This parameter has the same effect as specifying SYMBOL=1.
C.SIZE The size of the centered symbol used for the plot.
LINE.TYP The type of line used for the plot. A line type value of 1 generates a solid line plot. Line type values greater than 1 generate dashed line plots, with the dash size increasing with the value of line type.
COLOR The index of the color used for the plot. The color associated with each color index is dependent upon the color graphics device that is used. This parameter has no effect if a color graphics device is not used.
DEVICE The name of the graphics output device. Valid names are defined by the file mdpdev (see Chapter 1, “Plot Device Definition File—mdpdev” on page 1-14 and Appendix B). If the value of this parameter is “DEFAULT”, the first entry in mdpdev preceded by “*” is chosen.
PAUSE Specifies that program execution pauses after the completion of all graphical output associated with this statement. The user must enter a space followed by a carriage return to continue execution.
PLOT.OUT The identifier for the file in which the character sequences controlling the graphics device are saved. This file may be output to the graphics device to reproduce the graphical output. This output is only available for the direct device drivers such as those used when the DEVICE parameter is HP2648, HP2623, HP7550, TEK4010, TEK4100, REGIS, or POSTSCRIPT.
Description

The **PLOT.1D** statement plots the following:

- A specific quantity along a line segments through the device (distance plots)
  or
- Terminal characteristics from data accumulated in a log file or read in from a previous log file, I-V, AC, or user-defined (arbitrary) data

**See Also...** To further illustrate the **PLOT.1D** statement, refer to:

- Input file *mdex1* in N-Channel MOSFET Examples, Chapter 4, “Impurity Distribution Plots” on page 4-9
- Input file *mdex1g* in N-Channel MOSFET Examples, Chapter 4, “Simulation of Gate Characteristics” on page 4-11
- Input file *mdex1d* in N-Channel MOSFET Examples, Chapter 4, “Simulation of Drain Characteristics” on page 4-12
- Most other examples that have graphical output
Distance Plots

Plots of quantities along a specified line segment through the device require that a device structure be previously defined. This may be accomplished with a structure definition initiated by a \texttt{MESH} statement or by using the \texttt{INFILE} parameter on the \texttt{MESH} statement to input a structure file generated previously.

Plots of all quantities except impurity concentration (\texttt{DOPING}), require that a solution be present. This may be accomplished with a solution initiated by a \texttt{SOLVE} statement or by using a \texttt{LOAD} statement to input a data file generated previously by a \texttt{SOLVE} statement.

A distance plot requires specifying the endpoints of the line segment through the device along which the specified quantity is plotted. As an example, the following statement plots the potential horizontally through a device:

\begin{verbatim}
  PLOT.1D  POTENTIAL  X.START=0  X.END=3  Y.START=0  Y.END=0
\end{verbatim}

Minimum or Maximum Quantity and Location

The parameters \texttt{FIND.MIN} and \texttt{FIND.MAX} can be used to find and plot the minimum or maximum of the specified quantity as a function of distance along the specified line segment through the device.

For each point along the line segment, the program searches for the minimum or maximum value along a line that passes through the point and is perpendicular to the line segment.

The actual locations of the minimum or maximum can be found by specifying the \texttt{PRINT} parameter and examining the standard output listing. The search area can be configured to the following:

- Confined to semiconductor materials only (the default)
- Confined to insulator materials only
- Include all materials by using the parameters \texttt{SEMICOND} and \texttt{INSULATO}
- Confined to occur within a specified distance of the line segment by using the parameter \texttt{FIND.DIS}

Internal Plots of AC Quantities

Distance plots of quantities obtained from the results of an AC small-signal analysis can be obtained by specifying one of the parameters \texttt{AC.REAL}, \texttt{AC.IMAG}, \texttt{AC.MAGN}, or \texttt{AC.PHAS} in addition to the desired quantity (\texttt{POTENTIAL}, \texttt{ELECTRON}, \texttt{HOLE}, \texttt{ELE.TEMP}, \texttt{HOL.TEMP}, \texttt{LAT.TEMP}, \texttt{J.CONDUCT}, \texttt{J.ELECT}, \texttt{J.HOLE}, \texttt{J.DISPLA}, or \texttt{J.TOTAL}). For the current vectors, the quantity may be further qualified by specifying \texttt{X.COMPON} or \texttt{Y.COMPON}.

Plots of Log File Data

Plots of data contained in log files include:

- I-V and transient data
• Results of AC analysis
• Optical quantities
• User-defined or arbitrary quantities.

The **IN.FILE** parameter is used to specify the name of a log file containing the data of interest. If **IN.FILE** is not specified, the program attempts to use data from the most recently opened log file.

Log files are opened, named, and initiated using the **LOG** statement or, if no **LOG** statement is specified, a default log file with the name `<base>.ivl` is created.

**Axis Quantities**

A plot of log file data requires specifying the quantity to plot along each axis. As an example, the following statements plot the drain current of a MOSFET as a function of the drain voltage and the drain current as a function of the gate voltage:

```
PLOT.1D IN.FILE=IV.DAT Y.AXIS=I(DRAIN) X.AXIS=V(DRAIN)
PLOT.1D IN.FILE=MOS.IVL Y.AXIS=I(DRAIN) X.AXIS=V(GATE)
```

In the above examples, the I-V data was read from log files named *IV.DAT* and *MOS.IVL*.

**Circuit Analysis AAM**

With the Circuit Analysis AAM, node voltages and the currents flowing in voltage sources are also available as plot options for the x- or y-axis.

- Circuit node voltages are selected using **VC(<name>)**, where `<name>` is the name of the node of interest.
- Currents in voltage sources or inductors can be selected using **IC(<name>)**, where `<name>` is the name of the voltage source of interest.
- To plot the voltage or current at the terminal of a numerical device, use **V(<dname>,<tname>)** or **I(<dname>,<tname>)**, where `<dname>` is the name of the Medici device and `<tname>` is the electrode name.

The following examples plot the voltage at circuit node 1, the current in source `VDD`, and the current at the drain terminal of device `P4` respectively.

```
PLOT.1D X.AXIS=TIME Y.AXIS=VC(1)
PLOT.1D X.AXIS=TIME Y.AXIS=IC(VDD)
PLOT.1D X.AXIS=TIME Y.AXIS=I(P4.drain)
```

**Other Information**

This section contains additional information important to using **PLOT.1D**. It includes the following:

- Disabling the clear operation
- Plotting more than one curve
- Integrating the abscissa
• Labeling
• Electric field lines

Specify \texttt{^CLEAR} to disable the clear operation, and leave the previous plot intact. This allows two or more independent plots to be displayed simultaneously by overriding clearing the display device when a plot is initialized.

The \texttt{UNCHANGE} parameter can be used to plot more than one curve on the same plot. \texttt{UNCHANGE} has the same effect as specifying \texttt{^CLEAR} and \texttt{^AXES}, and additionally forces the previous axis bounds to be used for scaling.

\texttt{INTEGRAL} can be used to integrate the specified function over the abscissa coordinate. If \texttt{INTEGRAL} is specified, the parameters \texttt{X.LOGARI}, \texttt{Y.LOGARI}, and \texttt{S.LOGARI} should not be specified. If \texttt{INTEGRAL} is specified, and either of the parameters \texttt{ABSOLUTE} or \texttt{NEGATIVE} are also specified, then the absolute value or negative, respectively, of the specified function is taken before the integration is performed.

The \texttt{PLOT.1D} statement may be followed by any number of \texttt{LABEL} statements to facilitate placing labels in the graphical output.

\texttt{E.LINE} statements for plotting quantities along electric field lines may also follow \texttt{PLOT.1D} statements.