Diode DC forward characteristic SPICE parameter extraction.

The DC forward characteristic Vd=f(Vd) of a diode is typically described by the following equation:

$$Vd = Id \times Rs + N \times \frac{k \times T}{q} \ln\left(\frac{Id}{Is} + 1\right) \tag{1}$$

$\frac{k \times T}{q}$ is the electron temperature Ve

The following parameters must be found:

Rs	Diode series resistance
N	Emission coefficient.
Is	Saturation current.

To calculate the there parameters we need two measurements with very low diode currents to eliminate the effect of the diode series resistance.
The diode series resistance can be calculated if we have found the N and Is parameter using one measurement with a very high diode current. This is because now the series resistance has a significant effect on the diode forward voltage.

First for N and Is we need the two very low values for Id and Vd so we can simplify the basic diode equation solve the two for N and put the two together to solve Is.

$$Vd1 = N \times \frac{k \times T}{q} \ln\left(\frac{Id1}{Is}\right) \qquad Vd2 = N \times \frac{k \times T}{q} \ln\left(\frac{Id2}{Is}\right)$$

$$\frac{Vd1}{\frac{k \times T}{q} \ln\left(\frac{Id1}{Is}\right)} = \frac{Vd2}{\frac{k \times T}{q} \ln\left(\frac{Id2}{Is}\right)}$$

$$Is = Id2\left(\frac{Id2}{Id1}\right)^{\frac{Vd2}{Vd1 - Vd2}} \tag{2}$$

The N parameter can now be calculated using equation (1) without the Rs:

$$N = \frac{Vd1}{\frac{k \times T}{q} \ln\left(\frac{Id1}{Is} + 1\right)} \tag{3}$$

The parameter Rs must be calculated using one Vd value with measured with a very high diode forward current using equation (1)

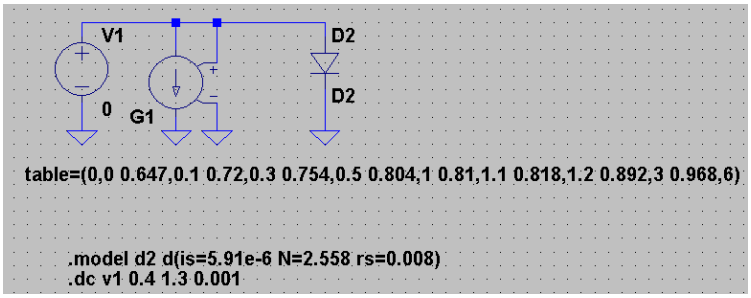
$$Vd = Id \times Rs + N \times \frac{k \times T}{q} \ln\left(\frac{Id}{Is} + 1\right) \qquad Rs = \frac{Vd3 - N \times \frac{k \times T}{q} \ln\left(\frac{Id}{Is} + 1\right)}{Id3} \qquad (4)$$

Example using the BYV29

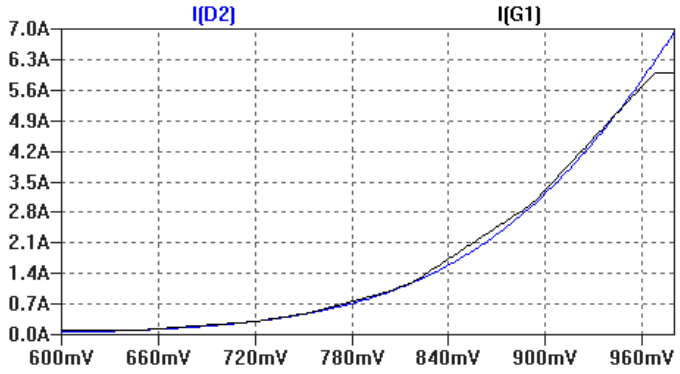
From the dc diode characteristics only high values for Id and Vd could be read from the data sheet so practical measurements with a current source and voltmeter were used to measure the required low Id and Vd values. The values are:

	Dc characteristics		
	Vd	**Id**	
1	0.647	0.100	A
2	0.72	0.300	A
3	0.97	6.000	A

More values were measured and put in a spice test circuit:



Simulation results showing the measured and simulated ID vs Vd:



By: Hendrik Jan Zwerver