Application Note

RESISTOR TESTING: 1K TO 50K OHMS

Dynalab
TEST SYSTEMS

Resistor Testing: 1K to 50K Ohms

This document explains how to use PASS 6.0 software to program the Analyzer to detect the presence of a resistor in a harness. Although the Analyzer is capable of detecting the presence of a resistor, it is not capable of precise resistance measurements.

This document applies to resistors whose values are between 1K ohms and 50K ohms.

- The Analyzer is not capable of reliably detecting resistors whose values are greater than 50K ohms.
- For resistors whose values are less than 1K ohms, please refer to the Application Note entitled *Resistor Testing: 100 to 1000 Ohms*

This document contains the following main sections:

1. a list of assumptions – knowledge required to perform the tasks outlined in this document
2. instructions for adding a resistor in PASS - Wires Method
3. instructions for adding a resistor in PASS using the Group Method
4. a chart of common resistor values and the PASS Test Parameters values
5. an explanation of the theory of operation

Assumptions

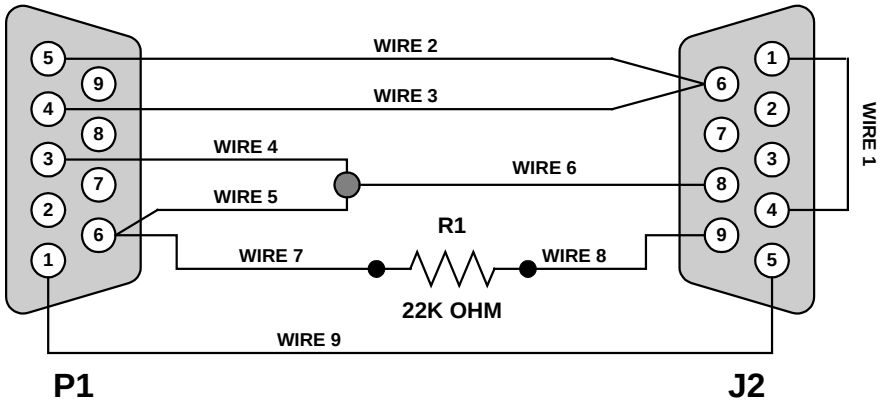
To successfully use this document, the following knowledge is required:

- knowledge of how to build Netlists using PASS 6.0
- knowledge of how to use the Sequence table to create a Sequence

For assistance on how to use features of PASS 6.0, see the PASS 6.0 Help file.

Adding a Resistor: Wires Method

The best way to explain the procedure for adding a resistor to a harness is with an example. This example illustrates how to program a resistor in PASS 6.0 using the Wires Method. This example uses the simple wire harness shown below. Note that there is one resistor connected between Wire 7 and Wire 8. The value of the resistor is 22K ohms.



When building a PASS 6.0 Netlist using the Wires Method, it is necessary to describe the connectors, wires, pins, and splices. It is assumed that the reader is familiar with building a Netlist in PASS 6.0 using the Wires Method, so these details will not be covered in this document.

In addition to describing the connectors, wires, pins, and splices in the PASS 6.0 Netlist, the following steps apply to adding the resistor:

1. Use the Dynalab Component Calculator to compute the test parameters for the resistor.
2. Input the test parameters from Step 1 into the PASS 6.0 Test Parameters table.
3. Add the resistor to the PASS 6.0 Components Table

A detailed explanation of each of these steps is provided on the following pages.

Step 1: Compute the test parameters for the resistor

The Dynalab Component Calculator is used to compute the test parameters for the resistor. It is a Microsoft Excel Spreadsheet and is supplied on the same CDROM as the PASS 6.0 software. It allows the user to derive the proper test parameter values for resistors and capacitors.

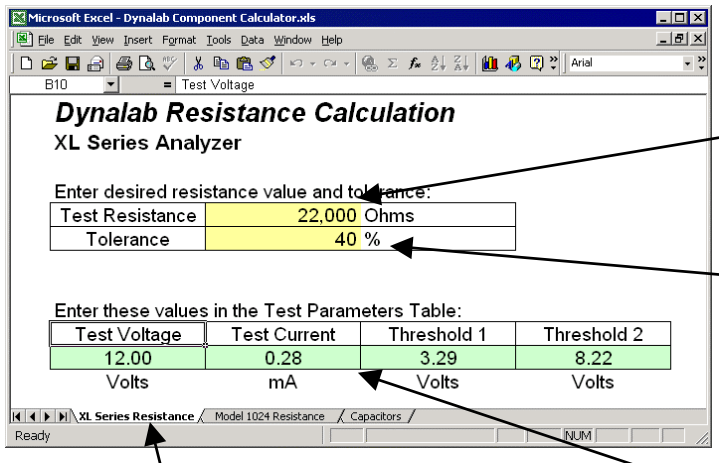
For a given value of resistance and tolerance, the calculator supplies values for:

- Test Voltage
- Test Current
- Threshold 1 voltage
- Threshold 2 voltage

The significance of these parameters is explained in a subsequent section of this document entitled *Theory of Operation.*

To use the Component Calculator to calculate the test parameters for a resistor, select the sheet for "XL Series Resistance" (unless the Analyzer is an old Model 1024), enter the resistor value in the field labeled "Test Resistance", and enter 40 in the field labeled "Tolerance". It is recommended that 40% be used as the tolerance. The Analyzer is not capable of performing precision resistance measurements, and can only verify the presence of a resistor. A 40% tolerance is sufficient to allow the Analyzer to detect the resistor's presence.

After entering the resistance value and tolerance, the Component Calculator will calculate the corresponding test parameters.



2 - Enter resistance

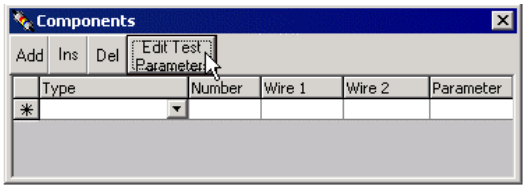
3 - Enter 40% for tolerance

1 - Select sheet that corresponds to Analyzer

4 – Test Parameters are calculated

Step 2: Input the test parameters into the PASS 6.0 Test Parameters table

The test parameters provided by the Component Calculator must be entered into the PASS 6.0 Test Parameters table. To access this table, open the Components table, and select Edit Test Parameters.

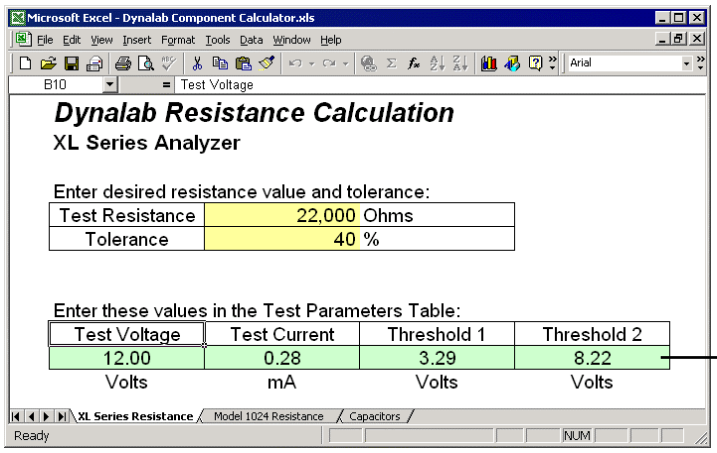


Test Parameters

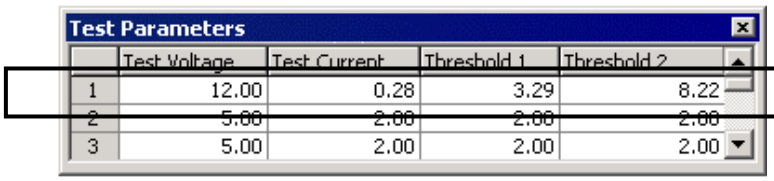
	Test Voltage	Test Current	Threshold 1	Threshold 2
1	12.00	0.28	3.91	7.61
2	5.00	2.00	2.00	2.00
3	5.00	2.00	2.00	2.00
4	5.00	2.00	2.00	2.00
5	5.00	2.00	2.00	2.00
6	5.00	2.00	2.00	2.00
7	5.00	2.00	2.00	2.00
8	5.00	2.00	2.00	2.00
9	5.00	2.00	2.00	2.00
10	5.00	2.00	2.00	2.00
11	5.00	2.00	2.00	2.00
12	5.00	2.00	2.00	2.00
13	5.00	2.00	2.00	2.00
14	5.00	2.00	2.00	2.00
15	5.00	2.00	2.00	2.00

The Test Parameters table will appear. It has fifteen sets of Test Parameters. Each set is available for testing a particular component.

In this example, there is only one component. Therefore, it is recommended that Test Parameter set 1 be used. Simply enter the values from the Component Calculator in the PASS 6.0 Test Parameters table for set 1 as shown below:

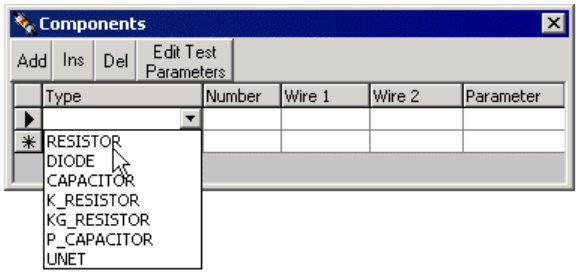


Enter the calculated values in the PASS 6.0 Test Parameters table

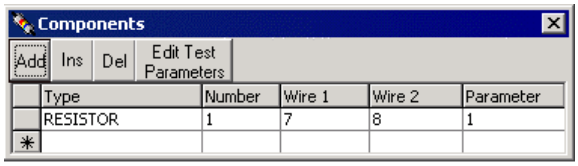


Step 3: Add the resistor to the PASS 6.0 Components Table

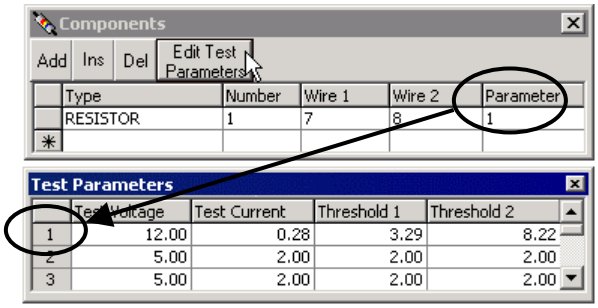
After the test parameters for the resistor have been calculated and entered into the Test Parameters table, it is necessary to add the resistor to the Components Table. In this example, resistor R1 is added to the Components table as follows:



In the Components table, populate the Type field with the type of component. A pull down menu of possible selections is provided. In this case, select RESISTOR.

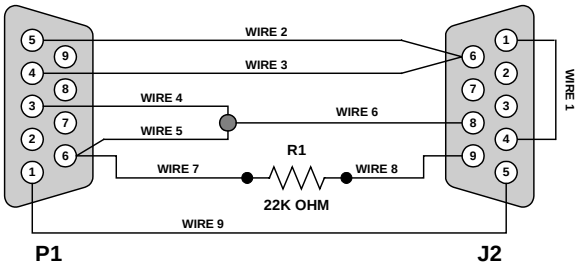


The Number field should contain the Resistor number. In this case, the value is 1. Wire 1 and Wire 2 fields should be populated with the two wires to which the resistor is connected. In this case, these are 7 and 8.



The Parameter field is populated with the number that corresponds to the entry in the Test Parameters table for this resistor. Previously, entry number 1 of the Test Parameters table was populated with the values calculated for this resistor. Therefore, the Parameter field is populated with the value 1. This links the resistor with its associated test parameters.

Example Netlist tables for harness with resistor using Wires Method



In summary, the PASS 6.0 Netlist tables for the example harness including the resistor, are shown below:

Dynalab PASS 6.0 - Resistor_Wires_Method.dpf

File Edit Netlist Tables Sequence Tools Window Help

Sequence | New | Open | Save | Print | Paste | Labels | File Settings | Compile | Download

Paste

Connectors

Add | Ins | Del | Next F5 | Find

	Connector	Pins Qty
▶	P1	9
	J2	9
✳		

Wires

Add | Ins | Del | Next F5 | Edit Colors | Find

	Wire	Base Color	Stripe Color
▶	1	BLK	(none)
	2	BLU	(none)
	3	BRN	(none)
	4	GRN	(none)
	5	GRY	(none)
	6	ORG	(none)
	7	RED	(none)
	8	VIO	(none)
	9	WHT	(none)
✳			

Splices

Add | Ins | Del | Next F5 | Same F6 | Find

	Number	Wire
▶	1	4
	1	5
	1	6
✳		

Pins

Add | Ins | Del | Next Pin F5 | Same Pin F6 | New Pin F7 | Find

	Connector	Pin	Wire
	P1	1	9
	P1	3	4
	P1	4	3
	P1	5	2
	P1	6	5
	P1	6	7
	J2	1	1
	J2	4	1
	J2	5	9
	J2	6	2
	J2	6	3
	J2	8	6
▶	J2	9	8
✳			

Components

Add | Ins | Del | Edit Test Parameters

	Type	Number	Wire 1	Wire 2	Parameter
	RESISTOR	1	7	8	1
✳					

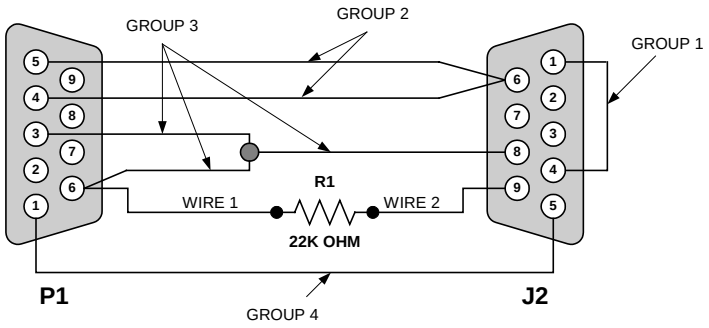
Test Parameters

	Test Voltage	Test Current	Threshold 1	Threshold 2
1	12.00	0.28	3.29	8.22
2	5.00	2.00	2.00	2.00

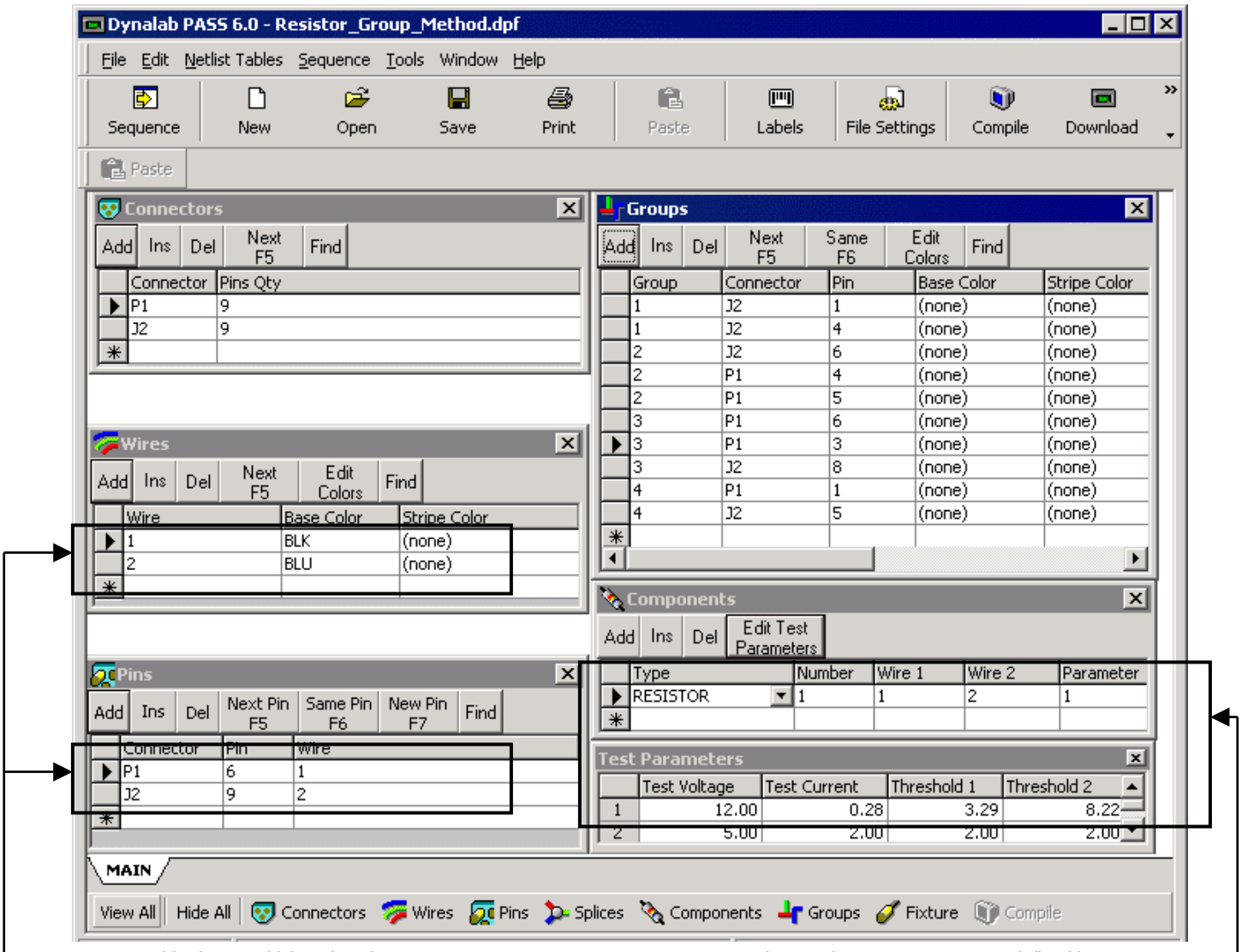
MAIN

View All | Hide All | Connectors | Wires | Pins | Splices | Components | Groups | Fixture | Compile

Adding a Resistor: Group Method



The following example explains how to define a resistor in a Netlist where the Group Method has been used. This example uses the simple wire harness shown at left. Note that four groups are defined in the harness. ***The resistor is not part of any group, but is added to the Netlist using the Wires Method***. So, in addition to defining the four groups in the Netlist, it is also necessary to define Wire 1 and Wire 2 as well as the Pins to which these wires connect. The resistor is defined in the same way as was described in the previous section. The resulting PASS 6.0 Netlist is shown below:



Add Wires to which resistor is connected, and Pins to which wires are connected

Resistor and Test Parameters are defined in the same way as in the Wires Method as described in the previous section

Common Values Chart

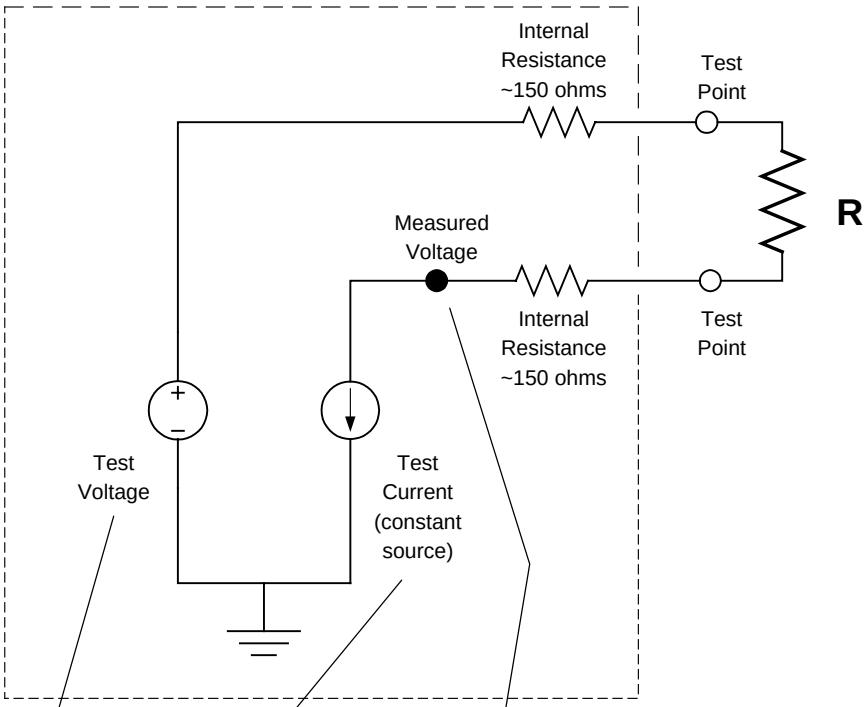
As an alternative to using the Dynalab Component Calculator, the following chart provides the test parameters for several common resistance values at 40% tolerance.

Resistor Value (OHMS)	**Test Voltage** (VOLTS)	**Test Current** (mA)	**Threshold 1** (VOLTS)	**Threshold 2** (VOLTS)
1000	12.00	6.00	1.80	6.60
2000	12.00	3.00	2.70	7.50
2700	12.00	2.24	2.86	7.70
3000	12.00	2.00	3.00	7.80
3300	12.00	1.80	3.14	7.90
4000	12.00	1.52	3.03	7.90
5000	12.00	1.20	3.24	8.04
5600	12.00	1.08	3.21	8.05
6000	12.00	1.00	3.30	8.10
8000	12.00	0.76	3.26	8.12
9000	12.00	0.68	3.23	8.12
10K	12.00	0.60	3.42	8.22
12K	12.00	0.52	3.11	8.10
15K	12.00	0.40	3.48	8.28
18K	12.00	0.32	3.84	8.45
22K	12.00	0.28	3.29	8.22
27K	12.00	0.24	2.86	8.04
33K	12.00	0.20	2.70	7.98
39K	12.00	0.16	3.22	8.21
47K	12.00	0.12	4.07	8.58
50K	12.00	0.12	3.56	8.36

Theory of Operation

This section describes the theory of operation of the Dynalab Analyzer, and how it applies to sensing the presence of a resistor.

The figure below depicts the internal circuit used for testing the external connection between two test points. In this case, a resistor (R) is connected between the two test points. The internal circuit consists of a voltage source, a constant current source, and internal series resistances of approximately 150 ohms each. The internal resistance values are approximate and can vary between different test points within the same Analyzer. It is because of this variation that precise resistance measurements cannot be made.



Test Parameters

	Test Voltage	Test Current	Threshold 1	Threshold 2
1	12.00	0.28	3.29	8.22
2	5.00	2.00	2.00	2.00
3	5.00	2.00	2.00	2.00

The voltage source provides the test voltage as specified in the Test Parameters table. The current source generates the test current as specified in the Test Parameters table. The measured voltage is compared to the Threshold 1 and Threshold 2 voltages specified in the Test Parameters table. If the measured voltage falls between Threshold 1 and Threshold 2, the resistor R is considered to be present. Again, note that the Analyzer cannot make precise resistance measurements – it can only sense the presence of a resistance within a broad tolerance range.

In previous sections of this document, the Dynalab Component Calculator was used to calculate the values for the Test Parameters table. The following is an explanation of these calculations.

The equations used in this explanation refer to the following variables:

$\mathbf{I_{TEST}}$	test current
$\mathbf{R_{MAX}}$	maximum resistance value
$\mathbf{R_{MIN}}$	minimum resistance value
$\mathbf{R_{NOM}}$	nominal resistance value
$\mathbf{V_{TEST}}$	test voltage
$\mathbf{V_{TH1}}$	Threshold 1 voltage
$\mathbf{V_{TH2}}$	Threshold 2 voltage

As previously noted, the Analyzer cannot make precise resistance measurements, but instead detects the presence of a resistor given a wide tolerance. The suggested tolerance is +/- 40%. $\mathbf{R_{MAX}}$ is the resistance value at the high tolerance level ($\mathbf{R_{NOM}}$ + 40%). $\mathbf{R_{MIN}}$ is the resistance value at the low tolerance level ($\mathbf{R_{NOM}}$ - 40%).

Threshold 1 and Threshold 2 voltages are calculated according to the following formulas:

$$\mathbf{V_{TH1} = V_{TEST} - [\ I_{TEST}\ x\ (\ 300 + R_{MAX}\ )\ ]}$$

$$\mathbf{V_{TH2} = V_{TEST} - [\ I_{TEST}\ x\ (\ 300 + R_{MIN}\ )\ ]}$$

A reasonable test current is calculated according to the following formula:

$$\mathbf{I_{TEST} = (\ V_{TEST} \div 2\ ) \div R_{NOM}}$$

As an example, assume a test is to be performed using a 12v test voltage for a 22000 Ohms resistor with a tolerance of 40%. In this case, a reasonable load current is [12 ÷ 2] ÷ 22000 = 0.28ma (The Analyzer generates test currents in 40μa steps, and 0.28 is the closest number divisible by the 40μa step size.) Using the 0.28ma load current, the lower and upper limit can be calculated as follows:

$$\mathbf{V_{TH1} = 12 - [\ 0.00028\ x\ (\ 300 + 22000 + 0.40\ x\ 22000\ )\ ]}$$

$$\mathbf{V_{TH2} = 12 - [\ 0.00028\ x\ (\ 300 + 22000 - 0.40\ x\ 22000\ )\ ]}$$

The results are a Threshold 1 value of 3.29 volts and a Threshold 2 value of 8.22 volts. These are the same values provided by the Component Calculator.