Application Note

RESISTOR TESTING: FOR 1000 OHMS OR LESS

Dynalab
TEST SYSTEMS

Resistor Testing: 1K Ohms or less

This document explains how to use PASS 6.0 software to program the Analyzer to detect the presence of a low value 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 1000 ohms or less. For resistors whose values are greater than 1000 ohms, please refer to the Application Note entitled *Resistor Testing: 1K to 50K Ohms*

This document contains the following main sections:

1. a list of assumptions – knowledge required to perform the tasks outlined in this document
2. hardware and software requirements
3. instructions for adding a resistor in PASS - Wires Method
4. instructions for adding a resistor in PASS using the Group Method
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.

Hardware and Software Requirements

The following hardware is required to test for the presence of resistors whose values 1000 ohms or less:

- An XL Series Analyzer with factory-installed enhancements to accommodate low resistance testing. New XL Series Analyzers can be ordered from Dynalab with the necessary enhancements. Existing XL Series Analyzers in the field must be sent to Dynalab for factory upgrade.
- A Low Resistance Test Board, part number 7500039. The Low Resistance Test Board more accurately tests for low resistance values.

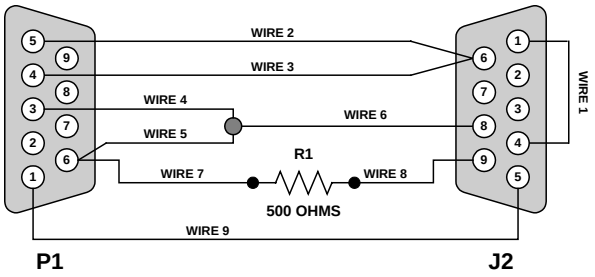
The procedures provided in this Application Note are based on the following software:

- PASS 6.2.500 or later

For low resistance testing with earlier releases of PASS software, please contact Dynalab Test Systems.

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 500 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.

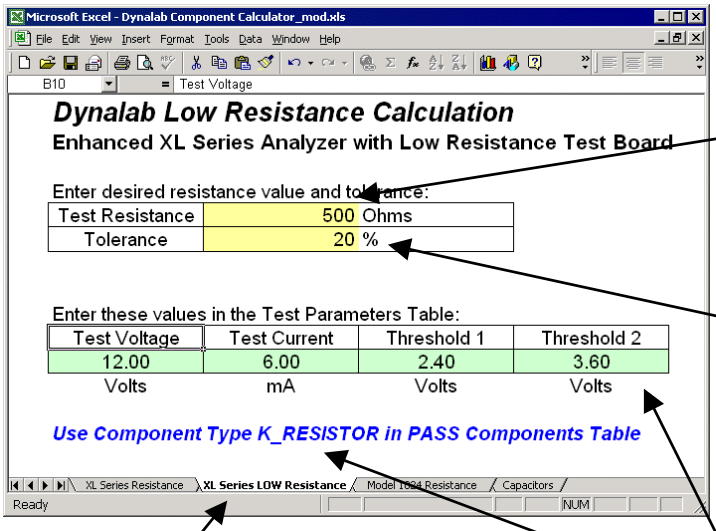
For a given value of resistance and tolerance, the calculator supplies values for:

- 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 whose value is 1000 ohms or less, select the sheet for "XL Series Low Resistance", enter the resistor value in the field labeled "Test Resistance", and enter 20 in the field labeled "Tolerance". It is recommended that 20% be used as the tolerance. The Analyzer is not capable of performing precision resistance measurements, but can verify the presence of a resistor. A 20% 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

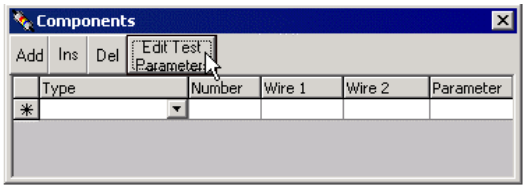
3 - Enter 20% for tolerance

4 – Test Parameters are calculated and component type is indicated

1 - Select XL Series **LOW Resistance** sheet

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.

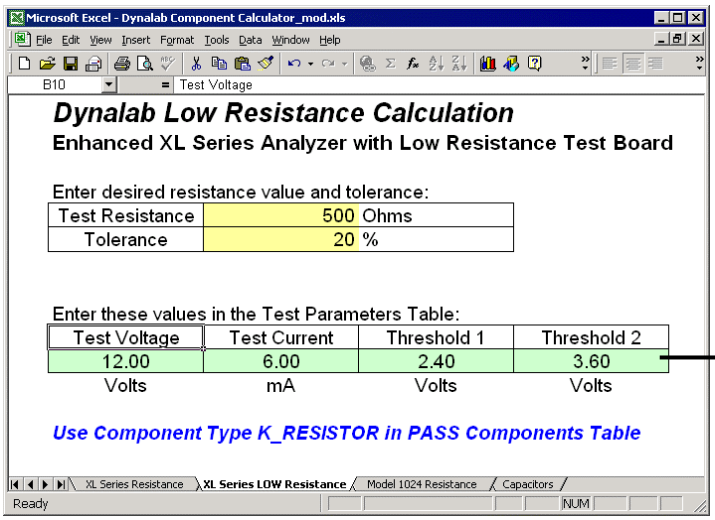


Test Parameters

	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

Test Parameters

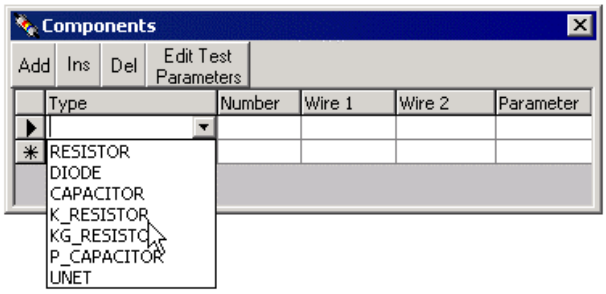
	Test Voltage	Test Current	Threshold 1	Threshold 2
1	12.00	6.00	2.40	3.60
2	5.00	2.00	2.00	2.00

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

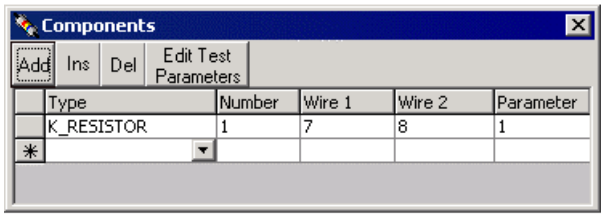
After the test parameters for the resistor have been calculated and entered into the Test Parameters table, it is necessary to add the resistor to the Components Table.

Resistor value is greater than 100 ohms

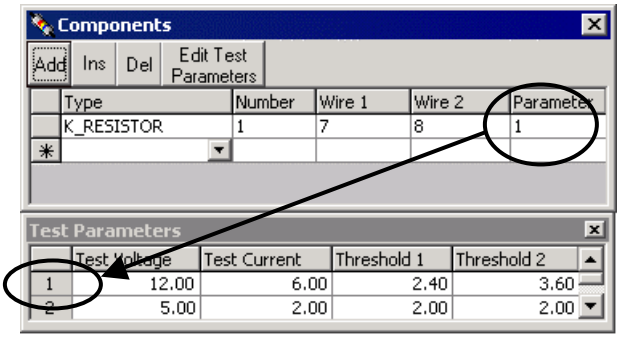
The following instructions apply to the case where the value of the resistor is 1000 ohms or less, but **greater than 100 ohms**. In this example, resistor R1 is added to the Components table as follows:



In the Components table, populate the Type field with the type of component. A pull down menu of possible selections is provided. If the value of the resistor is 1000 ohms or less, but **greater than 100 ohms**, select **K_RESISTOR**.



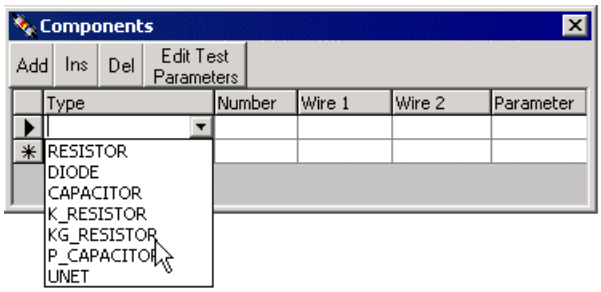
The Number field should contain the Resistor number. In this case, the value is 1. Wire 1 and Wire 2 fields should be populated with the two wires to which the resistor is connected. In this case, these are 7 and 8.



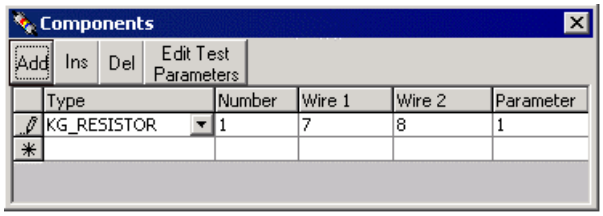
The Parameter field is populated with the number that corresponds to the entry in the Test Parameters table for this resistor. Previously, entry number 1 of the Test Parameters table was populated with the values calculated for this resistor. Therefore, the Parameter field is populated with the value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

Resistor value is 100 ohms or less

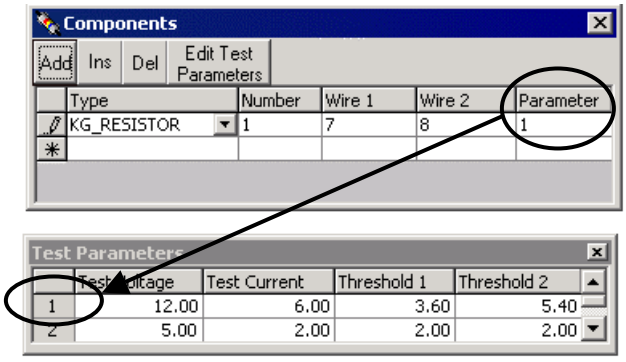
The following instructions apply to the case where the value of the resistor is **100 ohms or less**. In this example, resistor R1 is added to the Components table as follows:



In the Components table, populate the Type field with the type of component. A pull down menu of possible selections is provided. If the value of the resistor is **100 ohms or less**, select **KG_RESISTOR.**

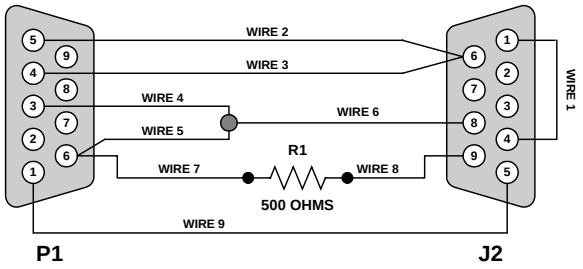


The Number field should contain the Resistor number. In this case, the value is 1. Wire 1 and Wire 2 fields should be populated with the two wires to which the resistor is connected. In this case, these are 7 and 8.

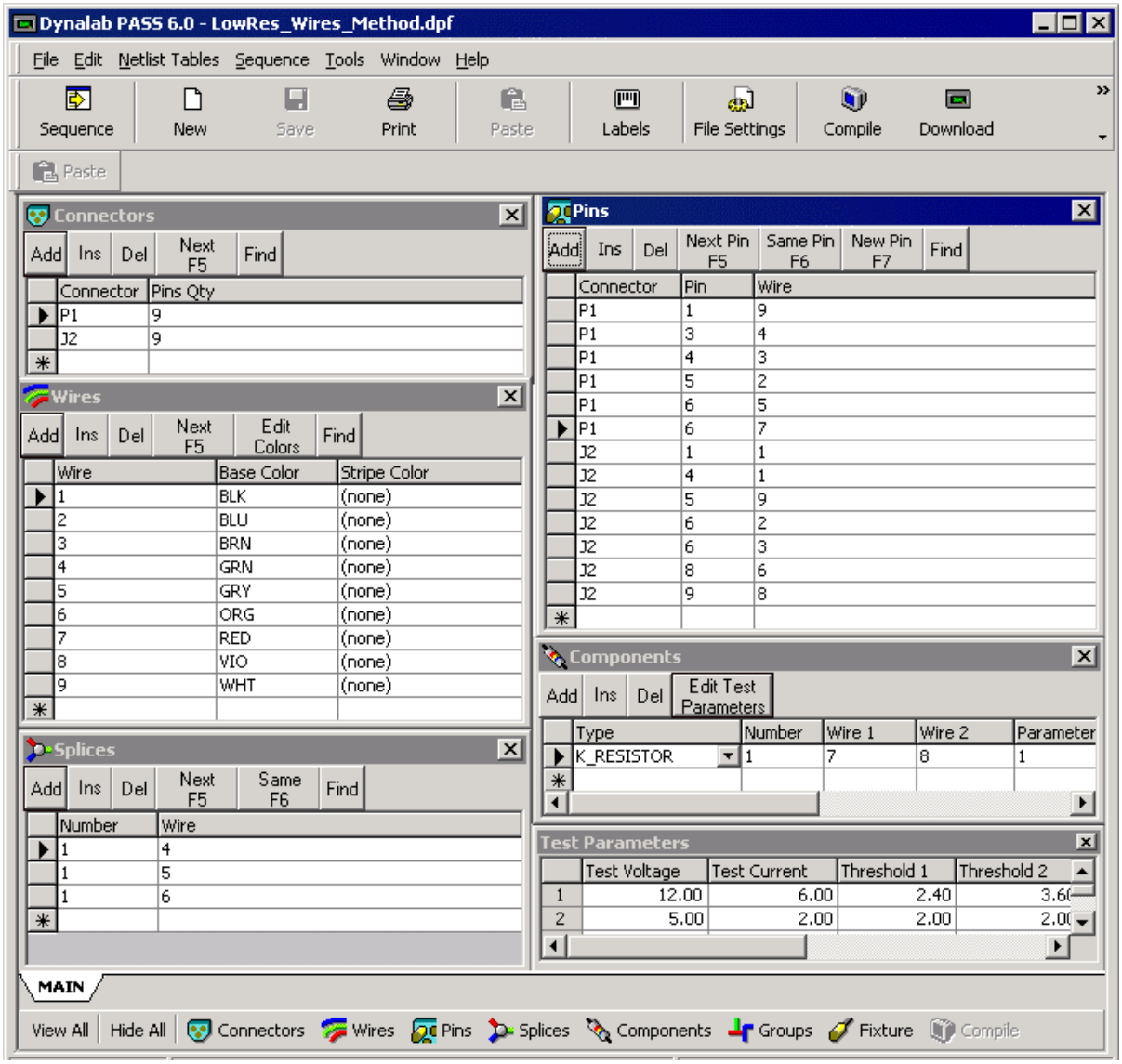


The Parameter field is populated with the number that corresponds to the entry in the Test Parameters table for this resistor. Previously, entry number 1 of the Test Parameters table was populated with the values calculated for this resistor. Therefore, the Parameter field is populated with the value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

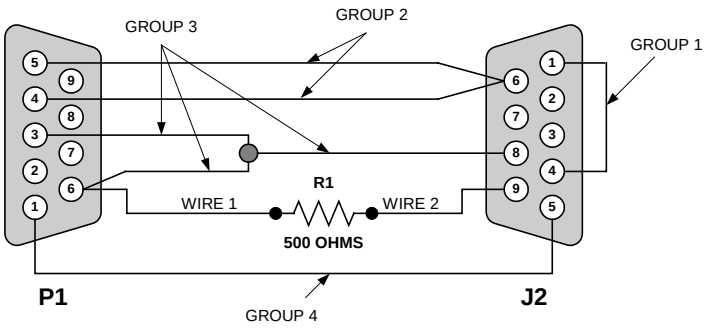
Example Netlist tables for harness with resistor using Wires Method



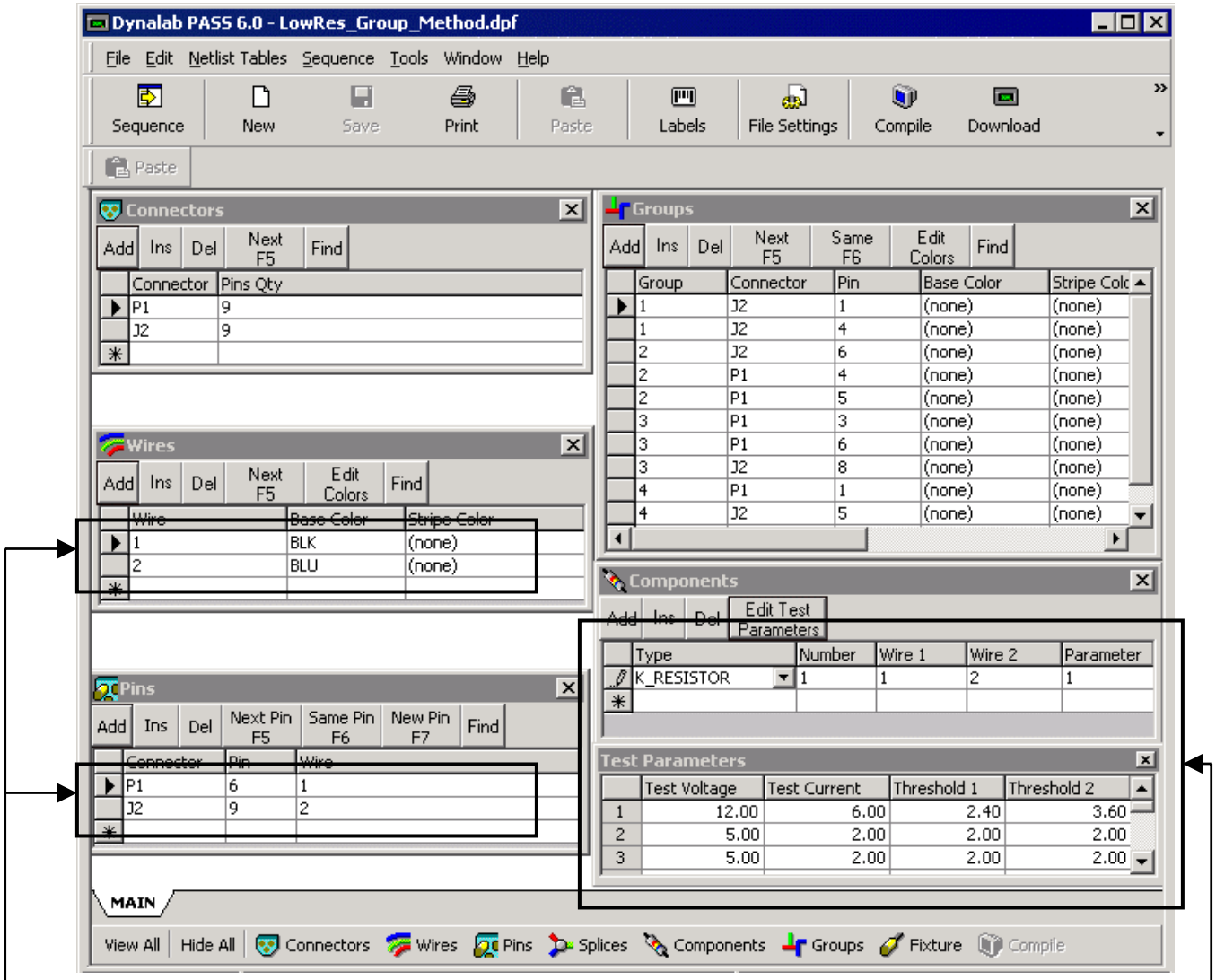
In summary, the PASS 6.0 Netlist tables for the example harness including the resistor, are shown below:



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:



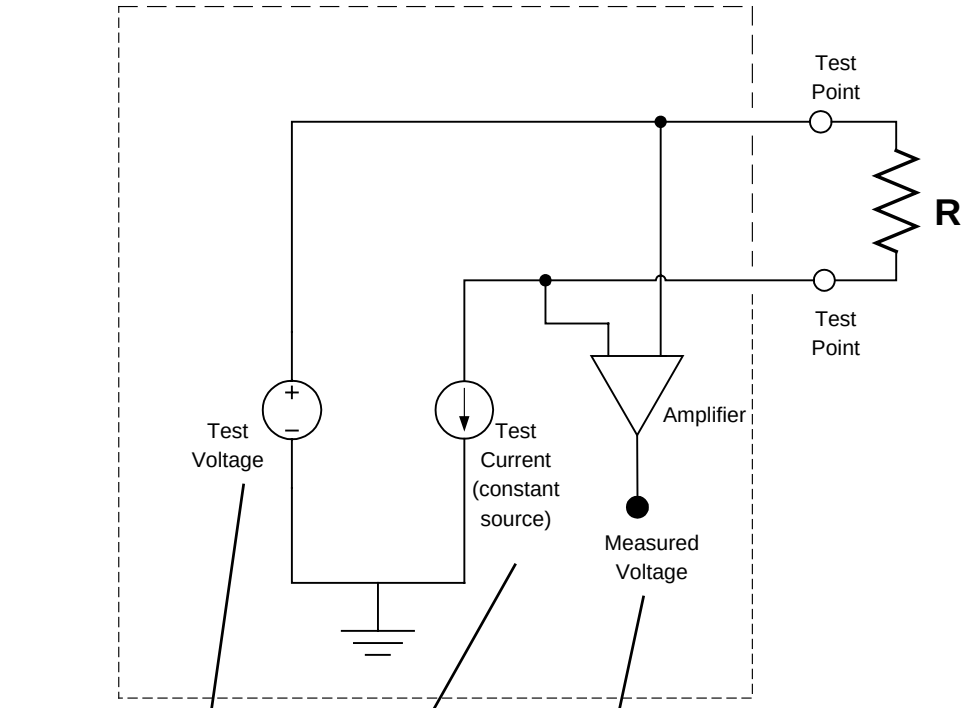
Add Wires to which resistor is connected, and Pins to which wires are connected

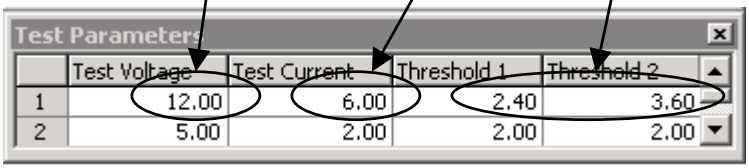
Resistor and Test Parameters are defined in the same way as in the Wires Method as described in the previous section

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 when equipped with the Low Resistance Test Board.

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 an amplifier.





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 voltage drop across the resistance is input to the amplifier. A gain of 1 is used if the PASS component type is K_RESISTOR. A gain of 10 is used if the PASS component type is KG_RESISTOR. 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 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 +/- 20%. $\mathbf{R_{MAX}}$ is the resistance value at the high tolerance level ($\mathbf{R_{NOM}}$ + 20%). $\mathbf{R_{MIN}}$ is the resistance value at the low tolerance level ($\mathbf{R_{NOM}}$ - 20%).

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

If the PASS Component Type is K_RESISTOR (resistance is 100 ohms or more):

$$\mathbf{V_{TH1} = I_{TEST} \ x \ R_{MIN}}$$

$$\mathbf{V_{TH2} = I_{TEST} \ x \ R_{MAX}}$$

If the PASS Component Type is KG_RESISTOR (resistance is less than 100 ohms):

$$\mathbf{V_{TH1} = 10 \ x \ [\ I_{TEST} \ x \ R_{MIN} \ ]}$$

$$\mathbf{V_{TH2} = 10 \ x \ [\ I_{TEST} \ x \ R_{MAX} \ ]}$$

Example Calculations: Resistor value is greater than 100 ohms

As an example, assume a test is to be performed using a 12v test voltage and 6mA test current for a 500 Ohms resistor with a tolerance of 20%. The lower and upper limit can be calculated as follows:

$$\mathbf{V_{TH1} = [\ 0.006\ x\ (500 - 0.20 \times 500\ )\ ] = 2.4}$$

$$\mathbf{V_{TH2} = [\ 0.006\ x\ (500 + 0.20 \times 500\ )\ ] = 3.6}$$

The results are a Threshold 1 value of 2.4 volts and a Threshold 2 value of 3.6 volts. These are the same values provided by the Component Calculator.

In PASS 6.0, this resistor would be entered as Component Type K_RESISTOR. This ensures that the amplifier gain will be 1.

Example Calculations: Resistor value is 100 ohms or less

As an example, assume a test is to be performed using a 12v test voltage and 6mA test current for a 75 Ohms resistor with a tolerance of 20%. The lower and upper limit can be calculated as follows:

$$\mathbf{V_{TH1} = 10 \times [\ 0.006\ x\ (75 - 0.20 \times 75\ )\ ] = 3.6}$$

$$\mathbf{V_{TH2} = 10 \times [\ 0.006\ x\ (75 + 0.20 \times 75\ )\ ] = 5.4}$$

The results are a Threshold 1 value of 3.6 volts and a Threshold 2 value of 5.4 volts. These are the same values provided by the Component Calculator

In PASS 6.0, this resistor would be entered as Component Type KG_RESISTOR. This ensures that the amplifier gain will be 10.