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PREFACE 1

CHAR SYSTEM DEMONSTRATION

OBJECTIVE:

To introduce the class to the complete CHAR System, demonstrating equipment set up and operation to test a basic plant circuit.

DISCUSSION:

Characterizing a circuit can be very useful for locating a fault. The best way to find a fault is to compare the data to a baseline. If a baseline is not available, compare like parts of a circuit. If this is not possible, compare to a similar circuit.

There are five measurements performed in a CHAR System test that define the condition of the circuit:

1. Loop resistance
2. Loop inductance
3. Insulation resistance
4. Capacitance
5. Time domain reflectometer signature

By comparing this data between similar circuits, the condition of the Equipment Under Test (EUT) can quickly be determined. The CHAR System instant report has a built-in warning flag that can be set by the user to detect a given percent tolerance change between the current measurement and baseline measurement on the EUT (trending.) Analysis of the differences between the measurements will immediately determine if a problem exists.

Loop Resistance

Differences in loop resistance (low impedance/short circuit) will define the quality of the connections and also reveal possible shorts in the EUT. Variations outside expected tolerances in the loop resistance of a low impedance/short circuit measurement compared to the loop resistance of another impedance/short circuit measurement can indicate poor connection problems and should be reported to maintenance for corrective action.

Loop Inductance

Differences in loop inductance will aid in locating problems relating to shorted windings in EUTs or to variations in core position. Variations outside allowable limits can be used to identify possible EUT problems.

Loop Resistance versus Inductance

Comparing both the inductive variations and the resistive variations between similar EUTs can identify whether a problem is simply bad connections or is a potential winding problem.

1. Simple resistive variations will define a bad connection. Variation should be an increase on the loop measurements containing the bad connection.
2. Both resistive and reactive variations will define a winding problem. Most likely this will be a decrease in the loop measurements.
3. Simple reactive variations will define a core problem. This would affect all loop measurements and would be dependent on the core position.

Insulation Resistance

Variations in Insulation Resistance will reveal moist or degraded insulation. The presence of moisture will appear as a reduced insulation resistance along with a flat polarization ratio. Often this will be in the EUT windings themselves and can be corrected by drying the EUT out by heating the windings with low voltage. Considerable experience exists in this area.

Aging insulation is much subtler and can appear as either an increase in the insulation resistance or a decrease, depending on the type of dielectric material. Only limited data is available for this area and plant information should be trended carefully before any conclusion can be reached. On the other hand, lack of change will trend a good system.

Capacitance

The capacitance data will readily reveal the presence of moisture through a significant increase in capacitance. The dissipation factor, obtained along with the capacitance measurement, will aid in determining if the moisture has breached the insulation. An increase in capacitance along with an increase in the dissipation factor will reveal moisture intrusion into the insulation. An increase in capacitance without a significant increase in dissipation factor may only reveal that the cable is in a water environment. (The increase in dissipation factor should correspond to a decrease in insulation resistance.)

Time Domain Reflectometer Signature

The time domain reflectometer signature will determine the location of a problem area. Because power cables are poor high frequency conductors, a time domain signature will not be very accurate by itself. However, by comparing the signature between EUTs or between measurements on the same EUT, it will reveal the general area where the cable or EUT is changing. A step change will reveal a resistive connection change. A positive bump will reveal an increase in inductance (not very likely). A negative dip will reveal an increase in capacitance and the presence of moisture (common).

PREFACE 2

WINCHARM SOFTWARE OPERATION

OBJECTIVE:

To illustrate the fundamentals of the WINCHARM Version 6 software. NOTE: This exercise will be performed simultaneously with the instructor, following along with the overhead slides.

DISCUSSION:

The WinCharm Version 6 software provides the capability to maintain control of all CHAR test data for the life of the plant so that it can be used effectively for trending. This software will define the initial test conditions, the sequence for testing, and will become the archive for all of the test data.

Version 6 software assigns test data to a specific CHAR System. You must select the CHAR System prior to starting any testing.

REFERENCES:

Slide presentation: 2 WinCharm V6 Operation.ppt

MATERIALS:

- WinCharm Version 6 Software
- CHAR Acquisition System

LAB PROCEDURE:

1. Start the WINCHARM **Version 6 program**:
 - 1.1. Create Equipment Identifier for **CREATING AN EID** _____
 - 1.2. Enter in your Site information _____
 - 1.3. Enter in the Location information _____
 - 1.4. Enter in the CHARacterization Sequence Information _____
 - 1.5. Enter in the CHARacterization Attachment Information _____
 - 1.6. Enter in the Waveform Sequence Information _____
 - 1.7. Enter in the Waveform Attachment Information _____
 - 1.8. Enter in the IV Curve Sequence Information _____
 - 1.9. Enter in the IV Curve Attachment Information _____
 - 1.10. Enter in the FDR Sequence Information _____
 - 1.11. Enter in the FDR Attachment Information _____
 - 1.12. Finish the new EID Creation _____
 - 1.13. Look at the Cloning Option _____

- 2. Investigate and describe all Tabs and Buttons in TEST QUEUE
 - 2.1. Load: _____
 - 2.2. Edit: _____
 - 2.3. Delete: _____
 - 2.4. Empty _____
 - 2.5. Set Cfg _____
 - 2.6. Reports: _____
 - 2.7. Acquire: _____

- 3. Loading the Test Queue
 - 3.1. Load an EID into Test Queue _____
 - 3.2. Edit Test Queue to change all the records in the Test Queue _____

- 4. Acquiring Test Data on an Attachment (simulated)
 - 4.1. Select Acquire _____
 - 4.2. Enter a comment _____
 - 4.3. Did you get a message? _____ Explain _____

LAB EXERCISE 1

TDR (TIME DOMAIN REFLECTOMETRY) BASICS

OBJECTIVE:

To illustrate TDR fundamentals by viewing the causes of different reflections at the end of a cable.

DISCUSSION:

Any two adjacent conductors, separated only by dielectric, is a transmission line. Every transmission line has characteristic impedance that is made up of the lumped circuit elements, inductance, capacitance, resistance and conductance.

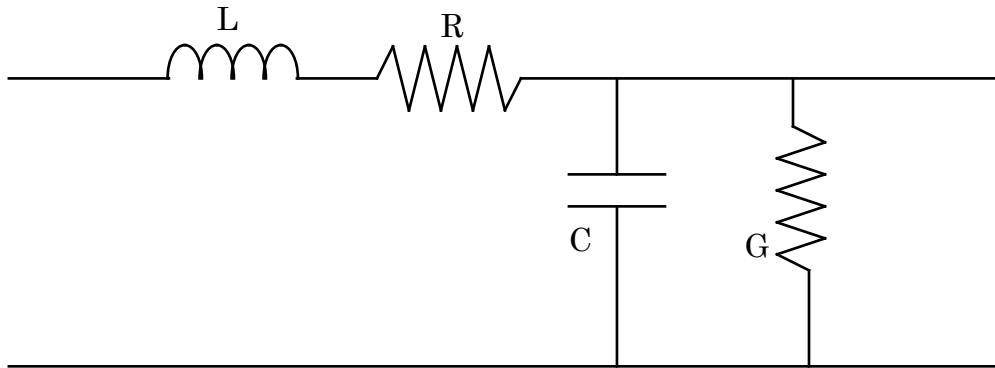
REFERENCES:

CHAR Lab Procedures Sample Data (from instructor)

MATERIALS:

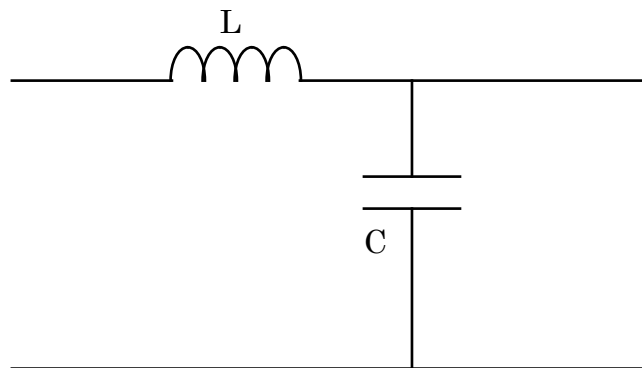
Located in a TDR Lab kit:

- Coax Cable
- Triax Cable
- Twisted Pair Shielded Cable
- Shielded Power Cable
- Power Cable (also used with IR lab)
- 16-Ohm Terminator
- 50-Ohm Terminator
- 75-Ohm Terminator
- Shorted Terminator
- 0.01nF Capacitor Terminator
- Wire Wound Bead
- BNC Barrel Connector

CIRCUIT DIAGRAM:

L = Inductance
 R = Resistance
 C = Capacitance
 G = Conductance

Since most transmission lines are nearly loss less, we will only consider the reactive components L & C.



L = Inductance
 C = Capacitance

$$Z_o = \sqrt{\frac{L}{C}} \Omega$$

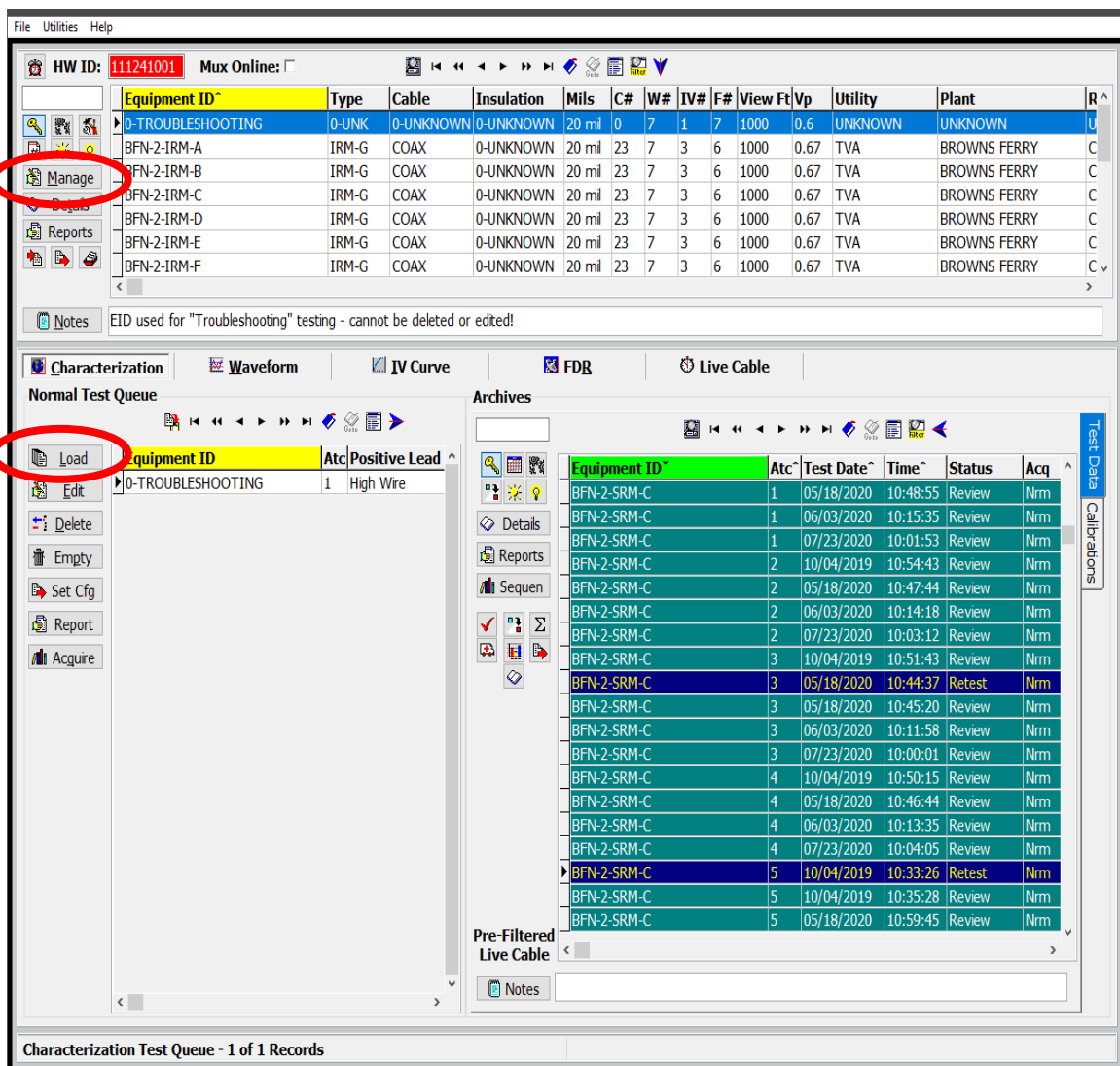
Z_o = Characteristic Impedance of a Transmission Line

The TDR is a measurement concept that provides a method of examining the characteristics of a transmission line and its terminations. In this lab, we will show the characteristics of different terminations and different cables.

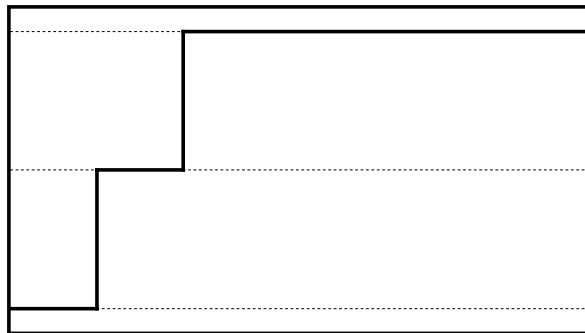
PROCEDURE:

Part 1 – Terminations

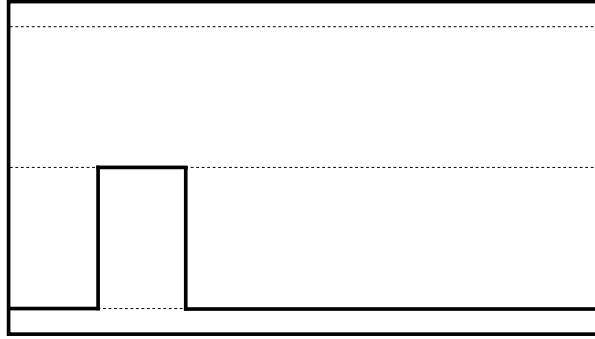
1. Set up the CHARacterization system hardware.
2. Start the **WINCHARM Version 6 program** by selecting the WINCHARM Version 6 icon.
3. Perform a CHARacterization system calibration:
4. Select the **Calibrations** tab in the WinCharm Maintenance Database window.
5. Click **<Calibrate>**.
6. Follow the on-screen instructions to complete the CHAR System calibration.
7. Click **<OK>**, at the Calibration Pass prompt.
8. When asked if the current calibration should be set as the baseline, click **<YES>**
9. Repeat the calibration until the “Calibration Passed” Message is received.
10. Review the Calibration results.
11. Click the **<Close>** button after reviewing the results.



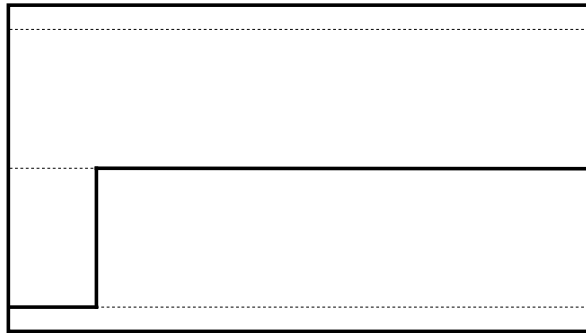
12. Click the <Manage> button in the EID management pane
13. Create a new EID called “TDR Lab”
14. Choose Equipment: “0-UNK Unknown” and Cable Type: “0-UNKNOWN”
15. Select Attachment 1 by clicking on the first line of the listed Test Queue attachments.
16. Click the CUSTOMIZE button to enable editing for the EID parameters.
17. Click the checkbox beside the IR test parameters to remove the Insulation resistance test for the upcoming attachment 1 connections.
18. Close the Test Queue Edit Form.
19. Click the LOAD button in the Normal Test Queue to load the newly created EID.
20. Click OK to load all EID attachments into the test queue grid.
21. Using an un-terminated Test Lead, acquire attachment 1 test data. Select ACQUIRE.
22. Review preview window before data acquisition begins. Verify the IR test button is not checked.
23. Verify the Comments area includes a default blue highlight for the user to enter test specific identifying comments of the current configuration. Type the comment “open test lead”
24. Select OK to start the acquisition cycle for attachment 1.
25. Open the TDR plot window in the Post Queue form using the TDR button.
26. Observe the resulting TDR waveform with no load and confirm that it is similar to the waveform in the space below. Use the zoom slider to adjust the distance axis of the TDR plot.



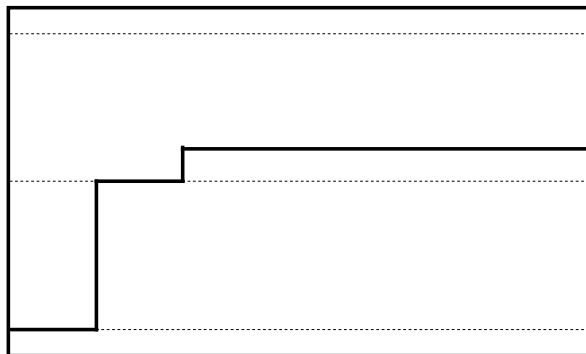
27. Select RETEST to save test data to the Archives and allow the Test Queue attachment 1 to be available for additional termination connections.
28. Place a shorting cap on the end of the test lead and Acquire attachment 1 data including the comment “SHORT terminator”. Next, confirm the TDR is similar to the waveform in the space below.



- 29. Select RETEST to save test data to the Archives and allow the Test Queue attachment 1 to be available for additional termination connections.
- 30. Place a 50Ω terminator on the end of the test lead and Acquire attachment 1 data including the comment “50 ohms”. Next, confirm the TDR is similar to the waveform in the space below.

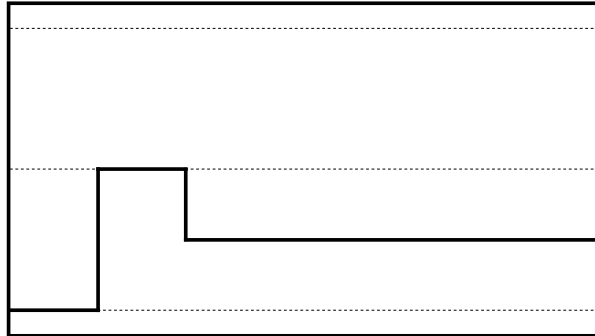


- 31. Select RETEST to save test data to the Archives and allow the Test Queue attachment 1 to be available for additional termination connections.
- 32. Place a 75Ω terminator on the end of the test lead and Acquire attachment 1 data including the comment “75 ohms”. Next, confirm the TDR is similar to the waveform in the space below.

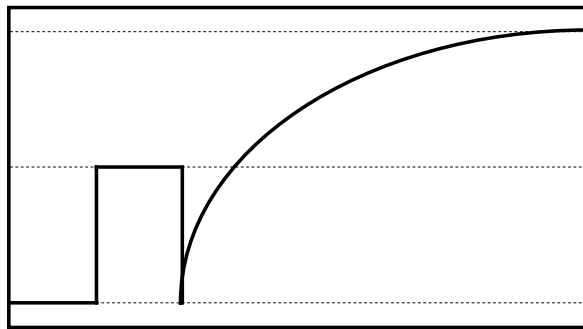


- 33. Select RETEST to save test data to the Archives and allow the Test Queue attachment 1 to be available for additional termination connections.

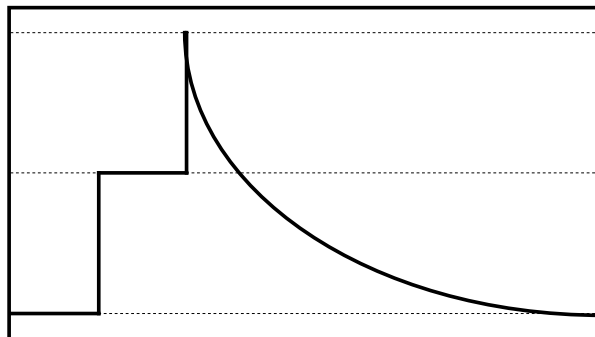
34. Place a 16Ω terminator on the end of the test lead and Acquire attachment 1 data including the comment “16 ohm”. Next, confirm that the TDR is similar to the waveform in the space below.



35. Select RETEST to save test data to the Archives and allow the Test Queue attachment 1 to be available for additional termination connections.
36. Place a $.01\mu\text{f}$ terminator on the end of the test lead and Acquire attachment 1 data including the comment “capacitor termination”. Next, confirm the TDR is similar to the waveform in the space below.



37. Select RETEST to save test data to the Archives and allow the Test Queue attachment 1 to be available for additional termination connections.
38. Place a wire-wound ferrite bead termination and Acquire attachment 1 data including the comment “inductive coil termination”. Next, confirm the TDR is similar to the waveform below.



Part 2 – Cables

Students will create the EID, Test the cable, and Review Data

*Note: Each cable **must** be characterized using **both** open (for capacitance/foot) and short circuit (for resistance and inductance/foot) terminations.*

1. Create an EID for the following cable types:
 - 1.1. Coax cable; Power cable; Triax cable, and Twisted Shielded (TS) cable.
2. From the WinCharm Maintenance screen:
 - 2.1. Select the <Manage> button to start the WinCharm Equipment ID Management. (Be sure to select a record other than the 0->TROUBLESHOOTING record)
 - 2.2. Select <Add>
 - 2.3. Enter in the “Enter New Identifier:” **LAB COAX CABLE**.
 - 2.4. Select <OK>
 - 2.5. Select <...> next to the “Type Equipment” display box
 - 2.6. Find and select the Equipment type “CABLE”
 - 2.7. Select <OK>
 - 2.8. Select <...> next to the “Cable Type” display box
 - 2.9. Select the Cable type “COAX”
 - 2.10. Select <OK>
 - 2.11. Enter in the Utility name.
 - 2.12. Select <...> next to the “Plant” display box
 - 2.13. Select <...> next to the “Plant” display box to enter in the Plant name. A pop up window will appear.
 - 2.14. Select <Add> to enter a new Plant into WinCharm 6. Enter the Plant name and select <OK>. (If Plant is already listed in the Plant Lookup table, skip step 2.14 and proceed on with step 2.15.)
 - 2.15. Select the Plant from the Plant Lookup table and select <OK>.
 - 2.16. Select <...> next to the “Room” display box to enter in the Room name. A pop up window will appear.
 - 2.17. Select <Add> to enter a new Room into WinCharm 6. Enter the Room name and select <OK>. (If Room is already listed in the Room Lookup table, skip step 2.17 and proceed on with step 2.18.)
 - 2.18. Select the Room from the Room Lookup table and select <OK>.
 - 2.19. Enter in the Description text box, “Coax cable”

3. The CHARacterization Attachment Subsection
 - 3.1. Select the CHARacterization tab to view the options for CHARacterization testing.
 - 3.2. Select the <Sequence> in the CHARacterization Attachments subsection. The CHARacterization Sequence Details screen will list the Attachments that will be tested. Select <Close> to close out the Sequence Details.
 - 3.3. Select the <Edit> button to edit the EID
 - 3.4. Select the Attachment number 1. This will highlight the box.
 - 3.5. Select the <Customize> button to enable editing
 - 3.6. For the Attachment 1 type, select **Open Circuit** from the Attachment Type drop down list.
 - 3.7. Positive lead is center conductor, negative lead is shield, select <OK>
 - 3.8. Select the Attachment number 2. This will highlight the box.
 - 3.9. Select the <Customize> button to edit the Attachment
 - 3.10. Customize Attachment 2, select **Short Circuit** from the Attachment Type drop down list.
 - 3.11. Positive lead is **center conductor**, negative lead is **shield**, select <OK>
4. At the Equipment Identification Management main window, verify accuracy of the input information.
 - 4.1. Select <OK> to finish creating the Equipment ID
 - 4.2. Select <Close> to close out the Equipment ID Management window
5. From the WinCharm Maintenance screen:
 - 5.1. Select the <Manage> button to start the WinCharm Equipment ID Management. (Be sure to select a record other than the 0->TROUBLESHOOTING record)
 - 5.2. Select <Add>
 - 5.3. Enter in the “Enter New Identifier:” **LAB POWER CABLE.**
 - 5.4. Select <OK>
 - 5.5. Select <...> next to the “Equipment Type” display box
 - 5.6. Find and select the Equipment type “CABLE”
 - 5.7. Select <OK>
 - 5.8. Select <...> next to the “Cable Type” display box
 - 5.9. Select the Cable type “2C-PWR”
 - 5.10. Select <OK>
 - 5.11. Enter in the Utility name.
 - 5.12. Select <...> next to the “Plant” display box
 - 5.13. Select <...> next to the “Plant” display box to enter in the Plant name. A pop up window will appear.

- 5.14. Select <**Add**> to enter a new Plant into WinCharm 6. Enter the Plant name and select <**OK**>. (If Plant is already listed in the Plant Lookup table, skip step 5.14 and proceed on with step 5.15.)
 - 5.15. Select the Plant from the Plant Lookup table and select <**OK**>.
 - 5.16. Select <...> next to the “Room” display box to enter in the Room name. A pop up window will appear.
 - 5.17. Select <**Add**> to enter a new Room into WinCharm 6. Enter the Room name and select <**OK**>. (If Room is already listed in the Room Lookup table, skip step 5.17 and proceed on with step 5.18.)
 - 5.18. Select the Room from the Room Lookup table and select <**OK**>.
 - 5.19. Enter in the Description text box, “Power cable”
6. The CHARacterization Attachment Subsection
 - 6.1. Select the CHARacterization tab to view the options for CHARacterization testing.
 - 6.2. Select the <**Sequence**> in the CHARacterization Attachments subsection. The CHARacterization Sequence Details screen will list the Attachments that will be tested. Select <**Close**> to close out the Sequence Details.
 - 6.3. Select the <**Edit**> button to edit the EID
 - 6.4. Select the Attachment number 1. This will highlight the box.
 - 6.5. Select the <**Customize**> button to edit the Attachment
 - 6.6. For the Attachment 1 type, select **Open Circuit**.
 - 6.7. Change the Positive Lead to “**Hot Wire**.” Change the Negative Lead to “**Neutral Wire**.” Select <**OK**>
 - 6.8. Select the Attachment number 2. This will highlight the box.
 - 6.9. Select the <**Customize**> button to edit the Attachment
 - 6.10. Customize Attachment 2, select **Short Circuit**.
 - 6.11. Change the Positive Lead to “**Hot Wire**.” Change the Negative Lead to “**Neutral Wire**.” Select <**OK**>
7. At the Equipment Identification Management main window, Verify accuracy of the input information.
 - 7.1. Select <**OK**> to finish creating the Equipment ID
 - 7.2. Select <**Close**> to close out the Equipment ID Management window
8. From the WinCharm Maintenance screen:
 - 8.1. Select the <**Manage**> button to start the WinCharm Equipment ID Management. (Be sure to select a record other than the 0->TROUBLESHOOTING record)
 - 8.2. Select <**Add**>
 - 8.3. Enter in the “Enter New IDentifier:” **LAB TRIAX CABLE**.

- 8.4. Select <**OK**>
 - 8.5. Select <...> next to the “Equipment Type” display box
 - 8.6. Find and select the Equipment type “CABLE”
 - 8.7. Select <**OK**>
 - 8.8. Select <...> next to the “Cable Type” display box
 - 8.9. Select the Cable type “TRIAX”
 - 8.10. Select <**OK**>
 - 8.11. Enter in the Utility name.
 - 8.12. Select <...> next to the “Plant” display box
 - 8.13. Select <...> next to the “Plant” display box to enter in the Plant name. A pop up window will appear.
 - 8.14. Select <**Add**> to enter a new Plant into WinCharm 6. Enter the Plant name and select <**OK**>. (If Plant is already listed in the Plant Lookup table, skip step 8.14 and proceed on with step 8.15.)
 - 8.15. Select the Plant from the Plant Lookup table and select <**OK**>.
 - 8.16. Select <...> next to the “Room” display box to enter in the Room name. A pop up window will appear.
 - 8.17. Select <**Add**> to enter a new Room into WinCharm 6. Enter the Room name and select <**OK**>. (If Room is already listed in the Room Lookup table, skip step 8.17 and proceed on with step 8.18.)
 - 8.18. Select the Room from the Room Lookup table and select <**OK**>.
 - 8.19. Enter in the Description text box, “Triax cable”
9. The CHARacterization Attachment Subsection
- 9.1. Select the CHARacterization tab to view the options for CHARacterization testing.
 - 9.2. Select the <**Sequence**> in the CHARacterization Attachments subsection. The CHARacterization Sequence Details screen will list the Attachments that will be tested. Select <**Close**> to close out the Sequence Details.
 - 9.3. Select the <**Edit**> button to edit the EID
 - 9.4. Select the Attachment number 1. This will highlight the box.
 - 9.5. Select the <**Customize**> button to edit the Attachment
 - 9.6. For the Attachment 1 type, select **Open Circuit**.
 - 9.7. Select <**OK**>
 - 9.8. Select the Attachment number 2. This will highlight the box.
 - 9.9. Select the <**Customize**> button to edit the Attachment
 - 9.10. Customize Attachment 2, select **Short Circuit**.
 - 9.11. Select <**OK**>
 - 9.12. Select the Attachment number 3. This will highlight the box.
 - 9.13. Select the <**Customize**> button to edit the Attachment

- 9.14. Change the Positive Lead from “**Outer Shield**” to “**Not Used.**” Change the Negative Lead from “**Ground**” to “**Not Used.**” Select <**OK**>
10. At the Equipment Identification Management main window, verify accuracy of the input information.
 - 10.1. Select <**OK**> to finish creating the Equipment ID
 - 10.2. Select <**Close**> to close out the Equipment ID
11. From the WinCharm Maintenance screen:
 - 11.1. Select the <**Manage...**> button to start the WinCharm Equipment ID Management. (Be sure to select a record other than the 0->TROUBLESHOOTING record)
 - 11.2. Select <**Add**>
 - 11.3. Enter in the “Enter New Identifier:” **LAB TWISTED SHIELDED CABLE.**
 - 11.4. Select <**OK**>
 - 11.5. Select <...> next to the “Equipment Type” display box
 - 11.6. Find and select the Equipment type “CABLE”
 - 11.7. Select <**OK**>
 - 11.8. Select <...> next to the “Cable Type” display box
 - 11.9. Select the Cable type “2CTS-SIG”
 - 11.10. Select <**OK**>
 - 11.11. Enter in the Utility name.
 - 11.12. Select <...> next to the “Plant” display box
 - 11.13. Select <...> next to the “Plant” display box to enter in the Plant name. A pop up window will appear.
 - 11.14. Select <**Add**> to enter a new Plant into WinCharm 6. Enter the Plant name and select <**OK**>. (If Plant is already listed in the Plant Lookup table, skip step 11.14 and proceed on with step 11.15.)
 - 11.15. Select the Plant from the Plant Lookup table and select <**OK**>.
 - 11.16. Select <...> next to the “Room” display box to enter in the Room name. A pop up window will appear.
 - 11.17. Select <**Add**> to enter a new Room into WinCharm 6. Enter the Room name and select <**OK**>. (If Room is already listed in the Room Lookup table, skip step 11.17 and proceed on with step 11.18.)
 - 11.18. Select the Room from the Room Lookup table and select <**OK**>.
 - 11.19. Enter in the Description text box, “Twisted Shielded cable”

12. The CHARacterization Attachment Subsection
 - 12.1. Select the CHARacterization tab to view the options for CHARacterization testing.
 - 12.2. Select the <Sequence> in the CHARacterization Attachments subsection. The CHARacterization Sequence Details screen will list the Attachments that will be tested. Select <Close> to close out the Sequence Details.
 - 12.3. Select the <Edit> button to edit the EID
 - 12.4. Select the Attachment number 1. This will highlight the box.
 - 12.5. Select the <Customize> button to edit the Attachment
 - 12.6. For the Attachment 1 type, select **Open Circuit**.
 - 12.7. Change the Positive Lead from “**Wire 1**” to “**White Wire.**” Change the Negative Lead from “**Wire 2**” to “**Black Wire.**” Select <OK>
 - 12.8. Select the Attachment number 2. This will highlight the box.
 - 12.9. Select the <Customize> button to edit the Attachment
 - 12.10. Customize Attachment 2, select **Short Circuit**.
 - 12.11. Change the Positive Lead from “**Wire 1**” to “**White Wire.**” Change the Negative Lead from “**Shield**” to “**Black Wire.**” Select <OK>
 - 12.12. Select the Attachment number 3. This will highlight the box.
 - 12.13. Select the <Customize> button to edit the Attachment
 - 12.14. Change the Positive Lead from “**Wire 2**” to “**Not Used.**” Change the Negative Lead from “**Shield**” to “**Not Used.**” Select <OK>
 - 12.15. Select the Attachment number 4. This will highlight the box.
 - 12.16. Select the <Customize> button to edit the Attachment
 - 12.17. Change the Positive Lead from “**Shield**” to “**Not Used.**” Change the Negative Lead from “**Reference Ground**” to “**Not Used.**” Select <OK>
13. At the Equipment Identification Management main window, verify accuracy of the input information.
 - 13.1. Select <OK> to finish creating the Equipment ID
 - 13.2. Select <Close> to close out the Equipment ID Management window. Now we are ready to load the Test Queue.
14. Select the **CHARacterization** tab from the WinCharm Maintenance screen and then the **Normal Test** tab. The CHARacterization Test Queue Screen will be displayed.
 - 14.1. Select the <Empty> button if there are any Attachments in the Test Queue
 - 14.2. Select the <Load> Button to bring in the four newly created EIDs, LAB COAX CABLE, LAB POWER CABLE, LAB TRIAX CABLE, and LAB TWISTED SHIELDED CABLE to the Test Queue. For each Equipment ID, Click <Load>, select the Equipment ID, and click <OK> to load the test in the Test Queue.

- 14.3. Delete any attachments marked as **NOT USED** in the positive and negative lead fields.
- 14.4. Use <**Set Config**> button to select a 1-minute IR.
- 14.5. Use <**Set Config**> button to select Fast IR.
- 15. Perform a CHARacterization test:
 - 15.1. Select the 1st Test Queue record for this lab exercise.
EID: LAB COAX CABLE
Attachment: 1 –Place cable connections
 - 15.2. Click <**Acquire**> to begin the data acquisition cycle.
 - 15.3. Connect the positive (Red) and negative (Black) leads of the Test Clips as described in the Attachment fields. Use a BNC barrel to connect to coaxial cables. Enter comments.
 - 15.4. Open or Short the opposite ends of the cable as indicated in the Attachment Type.
 - 15.5. Click <**OK**> to acquire the data.
 - 15.6. Review the acquisition results for completeness.
 Click <**Post**> to accept the results.
(Removes Attachment from Test Queue)
 - OR**
 - Click <**Retest**> to retest the attachment.
(Leaves Attachment in Test Queue for retesting)
 - OR**
 - Click <**Delete**> to remove any invalid results.
(Leaves Attachment in Test Queue for retesting)
- 16. Characterize the power cables listed below under varying conditions:
 - 16.1. Acquire data for each EID/Attachment record in the Test Queue.
 - 16.2. Use <**Post**> after each CHARacterization test to store the data in the Archives and removes the Attachment from the Test Queue.
 - 16.3. Continue to the next Attachment in the Test Queue until all acquisitions are completed. All Attachments should be posted as “Pass.”

Cable	Equipment ID
Coaxial cable	LAB COAX CABLE
Power cable	LAB POWER CABLE
Triaxial cable	LAB TRIAX CABLE
Twisted Shielded pair	LAB TS CABLE

Fill in the following table using equations listed below. Repeat steps 15 and 16 for all cables listed. You can get all the data from an Instant report after each EID test or a Summary report from all the EIDs that were tested.

	Length	Rho	Z _o	V _p ft./nS	C/ft	L/ft	Rdc/ft
Coaxial Cable				0.67 ft/nS			
Power Cable				0.5 ft/nS			
Triaxial Cable				0.67 ft/nS			
Twisted Shielded Pair				0.6 ft/nS			

Length: Determine length from the TDR plot. The beginning of the open is the end of the cable.

Rho: Rho is the Y-axis of the TDR plot. Find the average Rho value for the length of cable. This will be used to calculate cable impedance, or Z_o.

V_p: Velocity of Propagation

Formulas:

$$Z_o = 50 \frac{(1 + \rho)}{(1 - \rho)}$$

ρ = (Rho) Reflection coefficient

(Read off of the Rho axis on the TDR plot, and is a magnitude indication)

$$V_p = L/T \text{ nS}$$

L = Length of cable in feet

T = 1/2 round trip time in nanoseconds

(Read off of the X Axis on the TDR plot)

$$C_{/ft} = C_{cable}/\text{Length} \quad (\text{Use open circuit attachment data})$$

$$L_{/ft} = L_{cable}/\text{Length} \quad (\text{Use short circuit attachment data})$$

$$R_{/ft} = R_{cable}/\text{Length} \quad (\text{Use short circuit attachment data})$$

CLASS DISCUSSION AT THE END OF THE LAB

LAB EXERCISE 2

INSULATION RESISTANCE (IR)

OBJECTIVE:

To illustrate the fundamentals of testing insulation resistance.

DISCUSSION:

Insulation resistance (IR) can be affected by moisture. Moisture around the insulation can cause a reduction in IR and the polarization ratio (PR). If the moisture actually penetrates the insulation, the IR can be reduced significantly and the PR decreases to one. The IR measurement can be used to determine moisture intrusion of a circuit.

REFERENCES:

CHAR Lab Procedures Sample Data (from instructor)

MATERIALS:

- 4 Conductor Power Cable
- Container of Water

PROCEDURE:

1. Set up the CHARacterization system hardware.
2. Start the **WINCHARM Version 6 program** by selecting the WINCHARM Version 6 icon.
 - 2.1. Select the **CHARacterization** tab from the WinCharm Maintenance screen and then the **Normal Test** tab. The CHARacterization Test Queue Screen will be displayed. The Test Queue should be empty.
3. From the WinCharm Maintenance screen
 - 3.1. Select the **<Manage>** button to start the WinCharm Equipment ID Management. (Be sure to select a record other than the 0->TROUBLESHOOTING record)
 - 3.2. Select **<Add>**
 - 3.3. Enter in the “Enter New Identifier:” **LAB IR.**
 - 3.4. Select **<OK>**
 - 3.5. Select **<...>** next to the “Equipment Type” display box
 - 3.6. Find and select the Equipment type “CABLE”
 - 3.7. Select **<OK>**
 - 3.8. Select **<...>** next to the “Cable Type” display box

- 3.9. Select the Cable type “4C-PWR”
 - 3.10. Select <OK>
 - 3.11. Enter in the Utility name.
 - 3.12. Select <...> next to the “Plant” display box
 - 3.13. Select <...> next to the “Plant” display box to enter in the Plant name. A pop up window will appear.
 - 3.14. Select <Add> to enter a new Plant into WinCharm 6. Enter the Plant name and select <OK>. (If Plant is already listed in the Plant Lookup table, skip step 3.14 and proceed on with step 3.15.)
 - 3.15. Select the Plant from the Plant Lookup table and select <OK>.
 - 3.16. Select <...> next to the “Room” display box to enter in the Room name. A pop up window will appear.
 - 3.17. Select <Add> to enter a new Room into WinCharm 6. Enter the Room name and select <OK>. (If Room is already listed in the Room Lookup table, skip step 3.17 and proceed on with step 3.18)
 - 3.18. Select the Room from the Room Lookup table and select <OK>.
 - 3.19. Enter in the Description text box, “IR Lab”
4. The CHARacterization Attachment Customization Screen
 - 4.1. Select the CHARacterization tab to view the options for CHARacterization testing.
 - 4.2. Select the <Sequence> in the CHARacterization Attachments subsection. The CHARacterization Sequence Details screen will list the Attachments that will be tested. Select <Close> to close out the Sequence Details.
 - 4.3. Select the <Edit> button to edit the EID
 - 4.4. Select <Customize> to open the Attachment editing panel.
 - 4.5. For each Attachment number select the <Customize> button to edit the Attachment
 - 4.6. For the Attachment 1 type, select **Open Circuit**.
 - 4.7. Change the Positive Lead to “**Black Wire.**” Change the Negative Lead to “**White Wire.**” Select <OK>
 - 4.8. For Attachment 10, change the Positive Lead to “**Not Used.**” Change the Negative Lead to “**Not Used.**” Select <OK>
5. At the Equipment Identification Management main window, verify accuracy of the input information.
 - 5.1. Select <OK> to finish creating the Equipment ID
 - 5.2. Select <Close> to close out the Equipment ID Management window. Now we are ready to load the Test Queue.

6. Select the **CHARacterization** tab from the WinCharm Maintenance screen and then the **Normal Test** tab. The CHARacterization Test Queue Screen will be displayed.
 - 6.1. Select the **<Empty>** button if there are any Attachments in the Test Queue
7. Select the **<Load>** Button and click on the EID, LAB IR. Use the Search window, if needed. Click **<OK>** to load the test in the Test Queue.
 - 7.1. The test can be edited now by scrolling down to Attachment 10. Select the **<Delete>** button to remove this Attachment.
 - 7.2. Edit all attachments as described in the table below: Select **<OK>** after each Edit Attachment.

Attachment	Positive Lead	Negative Lead	IR Voltage	Comment
1	Wire 1	Wire 2	15	Dry cable
2	Wire 1	Wire 2	100	Dry cable
3	Wire 1	Wire 2	1000	Dry cable
4	Wire 1	Wire 2	15	Wet cable
5	Wire 1	Wire 2	100	Wet cable
6	Wire 1	Wire 2	1000	Wet cable
7	Wire 1	Wire 2	15	Wet conductors
8	Wire 1	Wire 2	100	Wet conductors
9	Wire 1	Wire 2	1000	Wet conductors

8. Verify the Attachments are set up correctly. Attachments 1,4, and 7 are 15 volts IR test, 2, 5, and 8 Attachments are set up for 100 volts IR test, and 3, 6, and 9 are set up for 1000 volts IR test.
9. At this point, select the **<Set Config>** button to adjust all the Attachments for a **Fast IR** test. In the Change column, check “IR Fast” and the line will activate. Check “Yes”. Select **<OK>**, and now all Attachments are set to the fast IR time duration. When “Fast IR” is selected, all IR measurements are 15 seconds.
10. Perform a CHARacterization system calibration:
 - 10.1. Select the **Calibrations** tab in the WinCharm Maintenance Database window.
 - 10.2. Click **<Calibrate>**.
 - 10.3. Follow the on-screen instructions to complete the CHAR System calibration.
 - 10.4. Click **<OK>**, at the Calibration Pass prompt.
 - 10.5. When asked if the current calibration should be set as the baseline, click **<YES>**
 - 10.6. Repeat the calibration until the “Calibration Passed” Message is received.
 - 10.7. Review the Calibration results.
 - 10.8. Click the **<Close>** button after reviewing the results.

11. Perform a CHARacterization test:
 - 11.1. Select the 1st Test Queue record in the grid for this lab exercise.
 - 11.1.1. *EID: LAB IR*
 - 11.1.2. *Attachment: 1*
 - 11.2. Click <Acquire> to begin the data acquisition cycle.
 - 11.3. Connect the positive (Red) and negative (Black) leads of the Test Clips as described in the Attachment fields.
 - 11.4. Click <OK> to acquire the data.
 - 11.5. Review the acquisition results for completeness and process.
Click <Post> to accept the results.
(Removes Attachment from Test Queue)

OR

 - Click <Retest> to retest the attachment.
(Leaves Attachment in Test Queue for retesting)

OR

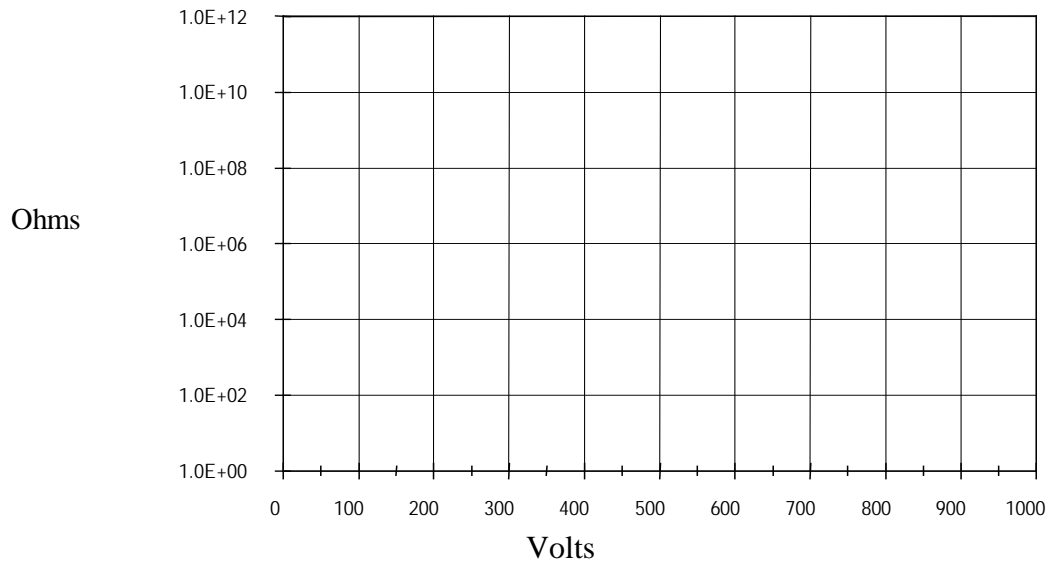
 - Click <Delete> to remove any invalid results.
(Leaves Attachment in Test Queue for retesting)
12. Characterize the power cable under varying conditions:
(NOTE: For wet insulation, place the separated insulated cables in a container of water. For wet conductors, place the cable end in a container of water.)
13. Acquire data for each EID/Attachment record in the Test Queue.
 - 13.1. *(Cabinet and Terminal Board fields indicate test conditions)*
 - 13.2. Use <Post> after each CHARacterization test to store the data in the Results Queue and remove the Attachment from the Test Queue.
 - 13.3. Continue to the next Attachment in the Test Queue until all acquisitions are completed.
14. Record the Capacitance and final IR measurement for each Attachment in the table below: A summary report will provide this information.

(Fill in by going across using the indicated voltages)

Capacitance	15V	100V	1000V
Dry Cable (att. 1, 2, 3)			
Wet Insulation (att. 4, 5, 6)			
Wet Conductor (att. 7, 8, 9)			

Insulation Resistance	15V	100V	1000V
Dry Cable (att. 1, 2, 3)			
Wet Insulation (att. 4, 5, 6)			
Wet Conductor (att. 7, 8, 9)			

15. Plot Resistance vs. Voltage from the table.



16. Compare TDR signatures by overlaying Attachments 1, 4, & 7.
- 16.1. Select the **CHARacterization** tab from the WinCharm Maintenance screen and the **Test Data** tab on the lower right hand of the WinCharm Maintenance screen window. The CHARacterization Archives Screen will be displayed.
 - 16.2. Locate LAB IR. Select Attachment 1. Click **<Details>**.
 - 16.3. Click **<TDR>** to display a new TDR plot window with the TDR signature.
 - 16.4. Minimize the TDR plot window to return to the application program.
 - 16.5. Navigate to the LAB IR, Attachment 4 results record in the grid to display the details.
 - 16.6. Click **<Add>** button in the TDR thumbnail plot to display the current TDR signature in the open TDR plot window.
 - 16.7. Navigate to the LAB IR, Attachment 7 results record in the grid to display the details.
 - 16.8. Click **<Add>** button in the TDR thumbnail plot to display the current TDR signature in the open TDR plot window.
 - 16.9. Note any differences between the overlaid signatures.
 - 16.10. Maximize the TDR plot window from the taskbar at the bottom of the screen.
 - 16.11. Click on the **<X>** button on the upper right hand of the Windows task bar to return to the application program.

LAB EXERCISE 3

WINCHARM ANALYSIS SOFTWARE

OBJECTIVE:

To illustrate the fundamentals of the WINCHARM Version 6 Analysis software. NOTE: This exercise will be performed simultaneously with the instructor, following along with the overhead slides.

DISCUSSION:

Characterizing a circuit can be very useful for locating a fault. The best way to find a fault is to compare the data to baseline. If baseline is not available, compare like parts of a circuit or compare to a similar circuit.

The WINCHARM Version 6 software provides the capability to maintain control of all Charm test data for the life of the plant so that it can be used effectively for trending. This software will define the initial test conditions, the sequence for testing, and will become the archive for all of the test data.

REFERENCES:

CHAR Lab Procedures Sample Data (from instructor)

PROCEDURE:

Start the WINCHARM Version 6 by selecting the Version 6 icon. The program will open to the CHARacterization Equipment Identifiers screen.

1. To retrieve Results data from the zip file on the memory card:
This will be done by the instructor at this time
2. Insert the USB Adaptor into the computer USB Port
 - 2.1. Click <**File** -> Database Import...> to start the WinCharm V6 Database Import Tool.
 - 2.2. Click <**Browse**>.
 - 2.2.1. Locate the CHAR Lab Procedures Sample Data
 - 2.3. Select the appropriate “.wc6” file for Nuclear Instrumentation data
 - 2.4. Click <**Open**> to exit the selection dialog.
 - 2.5. Check the “Use All Records” box to select all the Equipment ID in the imported file.
 - 2.6. Verify all checkboxes under “Import” are checked.
 - 2.7. Select <**Import**> to import the Equipment IDs to the WinCharm software.
 - 2.8. Click <**Close**> to close the Import Tool.

3. Generate an Instant Report
 - 3.1. Select <**Instant Reports**> button, to start the CHARacterization Instant Report form.
 - 3.2. In the search window, enter appropriate EID title
 - 3.3. Highlight Attachment 1 by clicking on the attachment number.
 - 3.4. Select <**Select Record**>
 - 3.5. Check all boxes under the “Report Options”
 - 3.6. Select <**Report**>
 - 3.7. Complete Instant report, examining inductance and resistance data and the TDR display.

4. Generate a Comparison Report
 - 4.1. Select <**Comparison**> button to start the CHARacterization Comparison Report form.
 - 4.2. Select Attachment 1 in the “Compare” Section
 - 4.3. Select Attachment 4 in the “Reference To” Section
 - 4.4. Check all boxes under the “Report Options”
 - 4.5. Select <**Report**>
 - 4.6. Complete Comparison report, examining differences between Attachment 1 and Attachment 4.

5. Generate a Summary Report
 - 5.1. Select <**Summary**> button to start the CHARacterization Summary Report form.
 - 5.2. Check the “Use All Records” to select all 6 attachments.
 - 5.3. Check all boxes under the “Report Options” Set the Frequency to 1KHz
 - 5.4. Select <**Report**>
 - 5.5. Complete Summary report, examining capacitance, inductance and resistance data and the TDR displays.

6. If there is no motor data in the CHAR Lab Procedures Sample Data (from instructor), then the following steps will be performed after the **3-PHASE MOTOR CHARACTERIZATION LAB**.

7. Generate an Analysis report of the results as follows:
 - 7.1. Select <**Analysis**> button to start the CHARacterization Analysis Report.
 - 7.2. Select <...> next to the Analysis Report Type display box to open the Analysis Report Lookup table.
 - 7.3. Select the <**Motor Analysis**> then select <**OK**>
 - 7.4. Select the Equipment ID from the Equipment ID Lookup selection box.

- 7.5. Click <**Select Record**> for each six attachments. Each attachment will appear in the “Selected” section.
- 7.6. Adjust the tolerance values if desired.
- 7.7. Check all boxes under the “Report Options”
- 7.8. Select <**Report**> to generate the Analysis report.
- 7.9. Click <**Close**> when finished viewing the report.
- 7.10. Observe the display of the custom Analysis TDR plots.
- 7.11. Click on the upper right hand <**X**> in the Windows Toolbar to close out the TDR plots window.

LAB EXERCISE 4

REVERSE TDR

OBJECTIVE:

To illustrate high frequency noise coupling into a coaxial cable system and to demonstrate techniques to eliminate the noise from the cable system.

DISCUSSION:

Frequencies greater than 1 Megahertz have relatively short wavelengths and cause system problems in the far field region. Any cable within a far field region can look like a conductor of an RF transmission line and become susceptible to electromagnetic wave coupling. The electromagnetic wave will travel between the shield of a triaxial cable and any other conductor running parallel with the shield, such as a cable tray, conduit, or another cable. When a triaxial connector or a termination is not symmetrical about the center conductor, noise may inductively couple into the circuit because of the current flowing in the shield.

Using a high frequency noise source generator, the RTDR test capacitive couples noise between the shield of triaxial cable system and the triaxial cable's cable tray. With the "bad" connector, noise will be inductively coupled to the interior of the coaxial cable and the noise will be observed on the oscilloscope. Ferrite beads and grounding techniques will be used to "hide" the coupling path.

REFERENCES:

CHAR Lab Procedures Sample Data (from instructor)

MATERIALS:

- 1 roll aluminum foil
- 3 Ferrite Beads "½"
- 3 Female BNC Couplers
- 1 Non-symmetrical Coupler
- 2 50-Ohm Terminators
- 2 Coaxial Cables

PROCEDURE:

1. Set up the CHARacterization system hardware.
(See Application Note AN_RTDR for details.)
2. Start the **WINCHARM Version 6 program** by selecting the Version 6 icon on the Windows Desktop. The program will open to the CHARacterization Equipment Identifiers screen.
3. Create a simulated ground plane cable tray out of aluminum foil.
 - 3.1. Lay a 50 ohm coax cable on the cable tray.
 - 3.2. Insulate the connections from the tray.
 - 3.3. Connect a 2nd 50 ohm coax to the first with a non-symmetrical connection.
 - 3.4. Terminate the 2nd cable with a 50 ohm terminator.
(Additional cables may be added to improve visual effect.)
 - 3.5. Connect to the RTDR Test Lead “RTDR RETURN”
 - 3.6. Connect RTDR Test Lead “SHIELD CONNECT” to coax shield (pos) and ground (neg).
4. From the WinCharm Maintenance screen
 - 4.1. Select the <**Manage**> button to start the WinCharm Equipment ID Management.
(Be sure to select a record other than the 0->TROUBLESHOOTING record)
 - 4.2. Select <**Add**>
 - 4.3. Enter in the “Enter New IDentifier:” **LAB RTDR**.
 - 4.4. Select <**OK**>
 - 4.5. Select <...> next to the “Equipment Type” display box
 - 4.6. Find and select the Equipment type “0-UNKNOWN”
 - 4.7. Select <**OK**>
 - 4.8. Select <...> next to the “Cable Type” display box
 - 4.9. Select the Cable type “COAX”
 - 4.10. Select <**OK**>
 - 4.11. Enter in the Utility name.
 - 4.12. Select <...> next to the “Plant” display box
 - 4.13. Select <...> next to the “Plant” display box to enter in the Plant name. A pop up window will appear.
 - 4.14. Select <**Add**> to enter a new Plant into WinCharm 6. Enter the Plant name and select <**OK**>. (If Plant is already listed in the Plant Lookup table, skip step 4.14 and proceed on with step 4.15.)
 - 4.15. Select the Plant from the Plant Lookup table and select <**OK**>.
 - 4.16. Select <...> next to the “Room” display box to enter in the Room name. A pop up window will appear.

- 4.17. Select <**Add**> to enter a new Room into WinCharm 6. Enter the Room name and select <**OK**>. (If Room is already listed in the Room Lookup table, skip step 4.17 and proceed on with step 4.18.)
 - 4.18. Select the Room from the Room Lookup table and select <**OK**>.
 - 4.19. Enter in the Description text box, “RTDR Lab”
 - 4.20. At the Equipment Identification Management main window, verify accuracy of the input information.
 - 4.21. Select <**OK**> to finish creating the Equipment ID
 - 4.22. Select <**Close**> to close out the Equipment ID Management window. Now we are ready to load the Test Queue.
5. Select the **Waveform** tab from the WinCharm Maintenance screen. The Waveform Test Queue Screen will be displayed.
- 5.1. Select the <**Empty**> button if there are any Attachments in the Test Queue
 - 5.2. Select the <**Load**> Button and click on the EID, LAB RTDR. Use the Search window, if needed. Click <**OK**> to load the test in the Test Queue.
 - 5.3. Edit both attachments by clicking on the <**Edit**> button. Do this for both Attachments.
 - 5.4. Select the Acquisition Type drop down menu and set to RTDR. Select <**OK**>.
 - 5.5. Select the “Set Config Button”, check the box for time base and set to 62.5 ns. This will set up all the Attachments at one time. The Acquisition Type can also be set for all Attachments this way.
6. Perform a Waveform acquisition:
- 6.1. Select the 1st Test Queue record in the grid for this lab exercise.
EID: LAB RTDR Attachment: 1
 - 6.2. Click <**Acquire**> to begin the data acquisition cycle.
 - 6.3. Click <**OK**> to acquire the data.
 - 6.4. Click <**OK**> when the plot is set up as desired and you are ready to capture the plot.
 - 6.5. Review the acquisition results for completeness and process.
Click <**Post**> to accept the results.
(Removes Attachment from Test Queue)
- OR**
- Click <**Retest**> to retest the attachment.
(Leaves Attachment in Test Queue for retesting)
- OR**
- Click <**Delete**> to remove any invalid results.
(Leaves Attachment in Test Queue for retesting)

7. Modify the circuit conditions:
 - 7.1. Restart the test using the next Attachment and follow steps 7.1 through 7.5.
 - 7.2. Note the distance from the connection.
 - 7.3. With the bad connection attempt to reflect the traveling wave by shorting the two conductors of the noise path together - the shield of the coax cable to the cable tray.
 - 7.4. Try different length shorts at different points between the noise source and the bad connection. What happens?
 - 7.5. Try shorting these conductors past the bad connection. What happens? Explain the difference.
 - 7.6. Instead of using a short, try making a section of the shield/cable tray transmission line look like high impedance. Do this by changing the inductance by installing a high permeability material (ferrite beads) around the signal conductor (shield).
 - 7.7. Move the ferrite beads to the far side of the bad connection. What happens to the noise? (Note that the peak amplitude remains the same as without any beads, but the ringing changes frequency and magnitude.) What happened to the traveling wave after it passed the bad connection?
 - 7.8. Take a large ferrite bead (1/2" diameter hole) and install it on the shield between the noise source and bad connection. Note the noise amplitude:_____.
 - 7.9. Increase the turns to three and note the amplitude:_____.
 - 7.10. (Note that if you can wind the conductor around the bead, the effect increases faster than if you were just adding additional beads.)
 - 7.11. Ground the shield of the cable to a spatial capacitor just before the bad connector. What happened to the noise level? Why?
 - 7.12. Acquire data for each EID/Attachment record in the Test Queue.
(*Cabinet and Terminal Board fields indicate test conditions*)
 - 7.13. Use <Retest> after each CHARacterization test to store the data in the Archives.
 - 7.14. Continue to retest the Attachment in the Test Queue until all acquisitions are completed.
8. From the WinCharm Maintenance Database Screen, confirm that the **Waveform** tab is displayed. The lower right hand Archives section will be the Waveform Archives.
 - 8.1. Locate the EID **LAB RTDR**.
 - 8.2. Select an Attachment and select the <Details> button to view the results.
 - 8.3. Click on the <Plot> button to view the plots.
 - 8.4. When finished viewing the plots, click the <X> button in the upper right hand corner of the TDR Plot Window.
 - 8.5. Click the <Close> button in the Waveform Archives screen to return to the WinCharm Maintenance Database screen.
9. Exit the **WINCHARM Version 6 program**:
 - 9.1. Click the <X> button in the upper right hand corner of the form.
 - 9.2. Click <OK> at the confirmation prompt to Exit the application.

LAB EXERCISE 5

IV CURVE ACQUISITION

OBJECTIVE:

To illustrate the fundamentals of IV Curve Acquisition for radiation detector health monitoring.

DISCUSSION:

IV Curve Acquisition can be very useful for obtaining the high voltage plateau curves, or troubleshooting of installed detectors. Comparing IV curves from similar detector assemblies may indicate a leaking (gas) or failed detector. Version 6 software includes a sequence with two attachments for testing B&W, Westinghouse, and CE detectors. This allows testing the signal A (Upper) and signal B (Lower) using the same EID instead of cloning with a Sig A or Sig B designation.

MATERIALS:

- 1 BNC Female Coupler
- 1 BNC to F-Banana Adapter
- 1 Neutron Detector

PROCEDURE FOR IV TEST:

PROCEDURE:

1. Set up the CHARacterization system hardware.
2. Start the **WINCHARM Version 6 program** by selecting the Version 6 icon on the Windows Desktop. The program will open to the CHARacterization Equipment Identifiers screen
3. From the WinCharm Maintenance screen
 - 3.1. Select the <**Manage**> button to start the WinCharm Equipment ID Management. (Be sure to select a record other than the 0->TROUBLESHOOTING record)
 - 3.2. Select <**Add**>
 - 3.3. Enter in the “Enter New Identifier:” **LAB IV**.
 - 3.4. Select <**OK**>
 - 3.5. Select <...> next to the “Equipment Type” display box
 - 3.6. Find and select the Equipment type “0-UNKNOWN”
 - 3.7. Select <**OK**>
 - 3.8. Select <...> next to the “Cable Type” display box
 - 3.9. Select the Cable type “COAX”
 - 3.10. Select <**OK**>
 - 3.11. Enter in the Utility name.

- 3.12. Select <...> next to the “Plant” display box
 - 3.13. Select <...> next to the “Plant” display box to enter in the Plant name. A pop up window will appear.
 - 3.14. Select <Add> to enter a new Plant into WinCharm 6. Enter the Plant name and select <OK>. (If Plant is already listed in the Plant Lookup table, skip step 3.14 and proceed on with step 3.15.)
 - 3.15. Select the Plant from the Plant Lookup table and select <OK>.
 - 3.16. Select <...> next to the “Room” display box to enter in the Room name. A pop up window will appear.
 - 3.17. Select <Add> to enter a new Room into WinCharm 6. Enter the Room name and select <OK>. (If Room is already listed in the Room Lookup table, skip step 3.17 and proceed on with step 3.18.)
 - 3.18. Select the Room from the Room Lookup table and select <OK>.
 - 3.19. Enter in the Description text box, “radiation detector.”
 - 3.20. In WinCharm Equipment ID Management pane under the IV Curve tab, click <Edit> and then click <Customize>.
 - 3.21. Click <Specify Range> and choose a maximum range that is typically the detector operating voltage plus 10%. Leave the start voltage set to 5 Volts. For this lab, the maximum range will be set to 500 Volts.
 - 3.22. Change the number of **Steps** to 25 and the **Dwell Time** to 2 seconds. (A dwell time of 5 seconds is typically used for in plant IV Curve testing.)
 - 3.23. Click <Insert Step> and insert several steps in the low-voltage region of the IV Test. Inserting steps will provide more voltage resolution of the transition to the plateau region of the detector.
 - 3.24. At the Equipment Identification Management main window, verify accuracy of the input information.
 - 3.25. Select <OK> to finish creating the Equipment ID
 - 3.26. Select <Close> to close out the Equipment ID Management window. Now we are ready to load the Test Queue.
4. Select the **IV Curve** tab from the WinCharm Maintenance screen. The IV Curve Test Queue Screen will be displayed.
 - 4.1. Select the <Empty> button if there are any Attachments in the Test Queue
 - 4.2. Select the <Load> Button and click on the EID, LAB IV. Use the Search window, if needed. Click <OK> to load the test in the Test Queue.
5. Perform an IV Curve test:
 - 5.1. Select the 1st Test Queue record in the grid for this lab exercise.
EID: LAB IV Attachment: 1
 - 5.2. Connect the Detector to the IV Test terminal using the red and black banana leads.
 - 5.3. Click <Acquire> to begin the data acquisition cycle.
 - 5.4. Click <OK> to acquire the data.

- 5.5. Click <**OK**> at the High Voltage Warning prompt.
- 5.6. Observe the IV Curve data acquisition cycle.
- 5.7. Review the acquisition results.
Click <**Post**> to accept the results.
(Removes Attachment from Test Queue)
OR
Click <**Retest**> to retest the attachment.
(Leaves Attachment in Test Queue for retesting)
OR
Click <**Delete**> to remove any invalid results.
(Leaves Attachment in Test Queue for retesting)
6. Generate an Instant report of the results as follows:
 - 6.1. Click on the <**Reports. . .**> button and select <**Instant**> then <**OK**>.
 - 6.2. Select the Attachments needed for the report by selecting the attachment number and selecting <**Select Record**>. The attachments will display in the “Selected” table.
 - 6.3. Adjust the tolerance values if desired.
 - 6.4. Check all boxes under the “Report Options”
 - 6.5. Select <**Report**>
 - 6.6. Review Summary Data report details
 - 6.7. Click <**Close**> when finished viewing the Summary Data.
 - 6.8. Observe the display of the custom IV Curve plots.
 - 6.9. Click on the <**X**> button on the Windows task bar to return to the application program close the IV Curve plot window.
7. Exit the **WINCHARM Version 6 program**:
 - 7.1. Click the <**X**> button in the upper right hand corner of the form.
 - 7.2. Click <**OK**> at the confirmation prompt to Exit the application.

NUCLEAR INSTRUMENTATION SYSTEM CHARACTERIZATION

OBJECTIVE:

To illustrate the fundamentals of characterizing a nuclear instrumentation system circuit.

DISCUSSION:

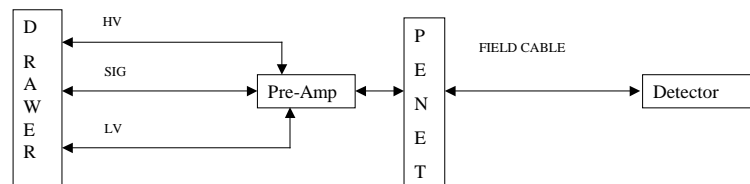
Characterizing a circuit can be very useful for locating a fault. The best way to find a fault is to compare the data to baseline. If baseline is not available, compare like parts of a circuit or compare to a similar circuit.

The purpose of this lab is to find a fault using baseline data and comparing this data to identify the fault and where the fault is located.

MATERIALS:

- Detector cable (Coax)
- HV Cable (Coax)
- Signal Cable (Coax)
- Pseudo Pre-Amp
- Pseudo Detector
- Fault

Typical Source Range Diagram



PROCEDURE:

1. Set up the CHARacterization system hardware.
2. Start the **WINCHARM Version 6 program** by selecting the Version 6 icon on the Windows Desktop. The program will open to the CHARacterization Equipment Identifiers screen
3. From the WinCharm Maintenance screen
 - 3.1. Select the **<Manage...>** button to start the WinCharm Equipment ID Management. (Be sure to select a record other than the 0->TROUBLESHOOTING record)

- 3.2. Select <**Add**>
- 3.3. Enter in the “Enter New Identifier:” **LAB NI**.
- 3.4. Select <**OK**>
- 3.5. Select <...> next to the “Equipment Type” display box
- 3.6. Find and select the Equipment type “PRM-W” for PWR, or “SRM-G” for BWR.
- 3.7. Select <**OK**>
- 3.8. Select <...> next to the “Cable Type” display box
- 3.9. Select the available Cable type “Triax” or “Coax”
- 3.10. Select <**OK**>
- 3.11. Enter in the Utility name.
- 3.12. Select <...> next to the “Plant” display box
- 3.13. Select <...> next to the “Plant” display box to enter in the Plant name. A pop up window will appear.
- 3.14. Select <**Add**> to enter a new Plant into WinCharm 6. Enter the Plant name and select <**OK**>. (If Plant is already listed in the Plant Lookup table, skip step 3.14 and proceed on with step 3.15.)
- 3.15. Select the Plant from the Plant Lookup table and select <**OK**>.
- 3.16. Select <...> next to the “Room” display box to enter in the Room name. A pop up window will appear.
- 3.17. Select <**Add**> to enter a new Room into WinCharm 6. Enter the Room name and select <**OK**>. (If Room is already listed in the Room Lookup table, skip step 3.17 and proceed on with step 3.18.)
- 3.18. Select the Room from the Room Lookup table and select <**OK**>.
- 3.19. Enter in the Description text box, “NI Source Range Lab”
- 3.20. Select the CHARacterization tab to view the options for CHARacterization testing.
- 3.21. At the Equipment Identification Management main window, verify accuracy of the CHARacterization input information and that the CHARacterization Sequence Number is #18 for PWR or #64 for BWR.
- 3.22. Select the <**Sequence**> in the CHARacterization Attachments subsection. The CHARacterization Sequence Details screen will list the Attachments that will be tested. The PWR attachment descriptions are:
 - Att 1 – HV Center Conductor to Inner Shield
 - Att 2 – Will not be used (delete in test queue)
 - Att 3 – HV Outer Shield to Ground
 - Att 4 – UD Center Conductor to Inner Shield
 - Att 5 – Will not be used (delete in test queue)
 - Att 6 – UD Outer Shield to Ground
 - Att 7 – LD Center Conductor to Inner Shield
 - Att 8 – Will not be used (delete in test queue)
 - Att 9 – LD Outer Shield to Ground
 - Att 10 – Will not be used (delete in test queue)
 - Att 11 – Will not be used (delete in test queue)

The BWR attachment descriptions are:

- Att 1 – HV Cable Center Conductor to HV Cable Shield
- Att 2 – HV Cable Shield to Ground
- Att 3 – Signal Cable Center Conductor to Signal Cable Shield
- Att 4 – Signal Cable Shield to Ground
- Att 5 – Bypass preamp, Signal Center to Signal Shield
- Att 6 – Bypass preamp, Signal Shield to Ground
- Att 7 – LV Center Conductor to LV Shield
- Att 8 – LV Shield to Ground

3.23. Select <**Close**> to close out the Sequence Details.

4. The IV Curve Attachment Subsection:

- 4.1. Select the IV Curve tab to view the options for IV Curve testing.
- 4.2. In the “IV Curve Attachments” Subsection of the Equipment ID Management, select the <...> button next to the Sequence display box.
- 4.3. Select Sequence ID #23 which is “Westinghouse HV Source Range NI” then select <**OK**> or Sequence ID #2 for “GE SRM IV Curve Data.”
- 4.4. At the Equipment Identification Management main window, verify accuracy of the input information under the IV Curve Subsection.
- 4.5. Select <**OK**> to finish creating the Equipment ID
- 4.6. Select <**Close**> to close out the Equipment ID Management window.

5. Perform a CHARacterization system calibration:

- 5.1. Select the <**CHARacterization**> tab
- 5.2. Select the <**Calibrations**> tab (located in the lower right hand of the window).
- 5.3. Click <**Calibrate**>.
- 5.4. Click <**Yes**> at the confirmation prompt for connecting to the CHARacterization hardware.
- 5.5. Observe the shorted clip calibration.
- 5.6. At the Open Calibration prompt:
- 5.7. Open the Test Clip ends.
- 5.8. Click <**OK**> to continue with the Open Test Clip calibration.
- 5.9. Click <**OK**>, at the Calibration Pass prompt.
- 5.10. Review the Calibration results. Click <**Close**> after reviewing the results.
(If Calibration fails, repeat step 5.3.)

6. Setup NI circuit model:

- 6.1. Refer to the Typical Source Range Detector Diagram. If possible, set up model on a ground plane, isolating the Pre-Amp

NOTE: Testing of a Source Range Channel is performed when there is a problem. Waveform testing is performed *FIRST, before any cables are disturbed*. In a noisy

channel, the next operation would be the RTDR test. If you are using a ground plane, consider performing an RTDR, and do all testing to locate the fault.

7. Perform a CHARacterization test:
 - 7.1. Select the <**CHARacterization**> tab from the WinCharm Maintenance screen. The CHARacterization Test Queue Screen will be displayed.
 - 7.2. Select the <**Empty**> button if there are any Attachments in the Test Queue
 - 7.3. Select the <**Load**> Button and click on the EID, LAB NI. Use the Search window, if needed. Click <**OK**> to load the test in the Test Queue.
 - 7.4. Select the 1st Test Queue record in the grid for this lab exercise. *EID: LAB NI Attachment: 1*
 - 7.5. Click <**Acquire**> to begin the data acquisition cycle.
 - 7.6. Connect the positive (Red) and negative (Black) leads of the Test Clips as described in the Attachment fields.
 - 7.7. Click <**OK**> to acquire the data.
 - 7.8. Review the acquisition results for completeness and process.
Click <**Post**> to accept the results.
(Removes Attachment from Test Queue)
OR
Click <**Retest**> to retest the attachment.
(Leaves Attachment in Test Queue for retesting)
OR
Click <**Delete**> to remove any invalid results.
(Leaves Attachment in Test Queue for retesting)
8. Characterize the nuclear instrumentation system (NIS) model circuit:
 - 8.1. Acquire data for each Attachment record in the Test Queue.
 - 8.2. Use <**Post**> after each CHARacterization test to store the data in the Archives and remove the Attachment from the Test Queue.
 - 8.3. Continue to the next Attachment in the Test Queue until all acquisitions are completed.
9. Generate a Summary report of the results as follows:
 - 9.1. Click on the <**Reports**> button and select <**Summary**> then <**OK**>.
 - 9.2. Select the Attachments needed for the report by selecting the attachment number and selecting <**Select Record**>. The attachments will display in the “Selected” table.
 - 9.3. Check all boxes under the “Report Options”
 - 9.4. Select <**Report**>
 - 9.5. Review Summary Data report details
 - 9.6. Click <**Close**> when finished viewing the Summary Data.
 - 9.7. Observe the display of the custom TDR plot window.

- 9.8. Click on the <X> button on the Windows task bar to return to the application program close the TDR plot window.
10. Insert a fault into circuit and retest the NI model. (You can insert the non-symmetrical fault from the RTDR lab and perform RTDR as an extra “bonus” lab.
 - 10.1. Obtain a fault from the instructor.
 - 10.2. Insert the fault at one of the connections.
 - 10.3. Perform a complete retest.
 - 10.4. Post each result into the Archives
11. Data analysis:
 - 11.1. From the archives, generate a summary report using the two tests data.
 - 11.2. Identify what the fault is, from comparing the summary data. Use the TDR plots to locate where the problem is.
 - 11.3. If you used a RTDR lab non-symmetrical fault, draw a line diagram. Use actual cable lengths for distances. From the TDR plots, verify the distances. Now overlay the RTDR fault on the TDR plots. (This is as close to real life as it gets.)
12. Exit the **WINCHARM Version 6 program**:
 - 12.1. Click the <X> button in the upper right hand corner of the form.
 - 12.2. Click the <OK> at the confirmation prompt to Exit the application.

3-PHASE MOTOR CHARACTERIZATION

OBJECTIVE:

To illustrate the fundamentals of characterizing a 3-phase motor circuit.

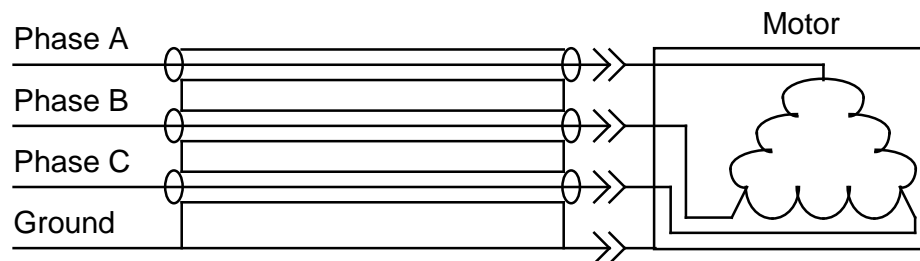
DISCUSSION:

Characterizing a circuit can be very useful for locating a fault. The best way to find a fault is to compare the data to baseline. If baseline is not available, compare like parts of a circuit or compare to a similar circuit.

MATERIALS:

- 3-Phase Motor circuit model
- 3 Conductor Motor cable

CIRCUIT DIAGRAM:



PROCEDURE:

1. Set up the CHARacterization system hardware.
2. Start the **WINCHARM Version 6 program** by selecting the Version 6 icon on the Windows Desktop. The program will open to the CHARacterization Equipment Identifiers screen
3. From the WinCharm Maintenance screen
 - 3.1. Select the <Manage> button to start the WinCharm Equipment ID Management. (Be sure to select a record other than the 0->TROUBLESHOOTING record)
 - 3.2. Select <Add>
 - 3.3. Enter in the “Enter New Identifier:” **LAB MOTOR**
 - 3.4. Select <OK>
 - 3.5. Select <...> next to the “Equipment Type” display box
 - 3.6. Find and select the Equipment type “MOT3”
 - 3.7. Select <OK>

- 3.8. Select <...> next to the “Cable Type” display box
 - 3.9. Select the Cable type “4C-PWR”
 - 3.10. Select <OK>
 - 3.11. Enter in the Utility name.
 - 3.12. Select <...> next to the “Plant” display box
 - 3.13. Select <...> next to the “Plant” display box to enter in the Plant name. A pop up window will appear.
 - 3.14. Select <Add> to enter a new Plant into WinCharm 6. Enter the Plant name and select <OK>. (If Plant is already listed in the Plant Lookup table, skip step 3.14 and proceed on with step 3.15.)
 - 3.15. Select the Plant from the Plant Lookup table and select <OK>.
 - 3.16. Select <...> next to the “Room” display box to enter in the Room name. A pop up window will appear.
 - 3.17. Select <Add> to enter a new Room into WinCharm 6. Enter the Room name and select <OK>. (If Room is already listed in the Room Lookup table, skip step 3.17 and proceed on with step 3.18.)
 - 3.18. Select the Room from the Room Lookup table and select <OK>.
 - 3.19. Enter in the Description text box, “Motor Lab.”
 - 3.20. At the Equipment Identification Management main window, verify accuracy of the input information
 - 3.20.1. Select the CHARacterization tab to view the options for CHARacterization testing.
 - 3.20.2. Verify that the CHARacterization Sequence is #24
 - 3.21. Select <OK> to finish creating the Equipment ID
 - 3.22. Select <Close> to close out the Equipment ID Management window. Now we are ready to calibrate the CHAR System and load the Test Queue.
4. Perform a CHARacterization system calibration:
- 4.1. Select the <CHARacterization> tab
 - 4.2. Select the <Calibrations> tab (located in the lower right hand of the window).
 - 4.3. Click <Calibrate>.
 - 4.4. Click <Yes> at the confirmation prompt for connecting to the CHARacterization hardware.
 - 4.5. Observe the shorted clip calibration.
 - 4.6. At the Open Calibration prompt:
 - 4.7. Open the Test Clip ends.
 - 4.8. Click <OK> to continue with the Open Test Clip calibration.
 - 4.9. Click <OK>, at the Calibration Pass prompt.
 - 4.10. Review the Calibration results. Click <Close> after reviewing the results.
(If Calibration fails, repeat step 4.3.)

5. Perform a CHARacterization test:
 - 5.1. Select the <**CHARacterization**> tab from the WinCharm Maintenance screen. The CHARacterization Test Queue Screen will be displayed.
 - 5.2. Select the <**Empty**> button if there are any Attachments in the Test Queue
 - 5.3. Select the <**Load**> Button and click on the EID, CHAR-MOTOR-1. Use the Search window, if needed. Click <**OK**> to load the test in the Test Queue.
 - 5.4. Select the 1st Test Queue record in the grid for this lab exercise. *EID: **LAB MOTOR Attachment: 1***
 - 5.5. Click <**Acquire**> to begin the data acquisition cycle.
 - 5.6. Connect the positive (Red) and negative (Black) leads of the Test Clips as described in the Attachment fields.
 - 5.7. Click <**OK**> to acquire the data.
 - 5.8. Review the acquisition results for completeness and process.
Click <**Post**> to accept the results.
(Removes Attachment from Test Queue)
OR
Click <**Retest**> to retest the attachment.
(Leaves Attachment in Test Queue for retesting)
OR
Click <**Delete**> to remove any invalid results.
(Leaves Attachment in Test Queue for retesting)
6. Characterize the 3-phase motor model circuit
 - 6.1. Acquire data for each EID/Attachment record in the Test Queue.
 - 6.2. Use <**Post**> after each CHARacterization test to store the data in the Archives and remove the Attachment from the Test Queue.
 - 6.3. Continue to the next Attachment in the Test Queue until all acquisitions are completed.
7. Generate an Analysis report of the results as follows:
 - 7.1. Select <**Analysis**> button to start the CHARacterization Analysis Report.
 - 7.2. Select <...> next to the Analysis Report Type display box to open the Analysis Report Lookup table.
 - 7.3. Select the <**Motor Analysis**> then select <**OK**>
 - 7.4. Select the ***LAB MOTOR*** Equipment ID from the Equipment ID Lookup selection box.
 - 7.5. Click <**Select Record**> for each six attachments. Each attachment will appear in the “Selected” section.
 - 7.6. Adjust the tolerance values if desired.
 - 7.7. Check all boxes under the “Report Options”
 - 7.8. Select <**Report**> to generate the Analysis report.

- 7.9. Click <**Close**> when finished viewing the report.
 - 7.10. Observe the display of the custom Analysis TDR plots.
 - 7.11. Click on the upper right hand <**X**> in the Windows Toolbar to close out the TDR plots window.
8. Insert a fault into circuit and re-characterize the motor model
 - 8.1. Obtain a 1-Ohm resistance fault from the instructor.
 - 8.2. Insert the 1-Ohm resistance fault at one of the connections.
 - 8.3. Retest as performed. Review results, overlay TDR's by attachment
9. Exit the **WINCHARM Version 6 program**:
 - 9.1. Click the <**X**> button in the upper right hand corner of the form.
 - 9.2. Click <**OK**> at the confirmation prompt to Exit the application.

3-WIRE RTD CHARACTERIZATION

OBJECTIVE:

To illustrate the fundamentals of characterizing a 3-Wire Resistance Temperature Detector

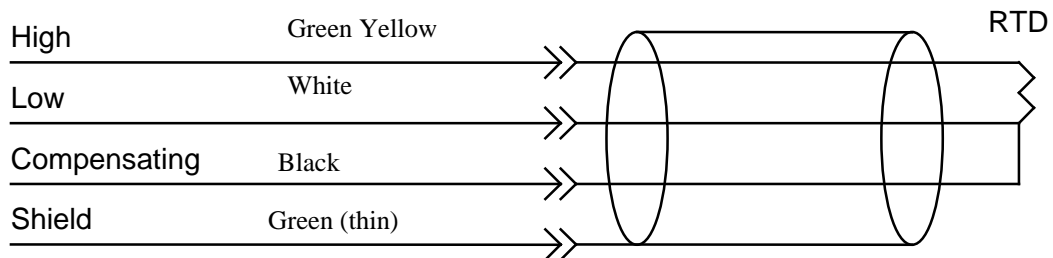
DISCUSSION:

Characterizing a circuit can be very useful for locating a fault. The best way to find a fault is to compare the data to baseline. If baseline is not available, compare like parts of a circuit. If this is not possible, compare to a similar circuit.

MATERIALS:

- 3-Wire RTD device
- 1 Twisted Shield Pair cable

CIRCUIT DIAGRAM:



PROCEDURE:

1. Set up the CHARacterization system hardware.
2. Start the **WINCHARM Version 6 program** by selecting the Version 6 icon on the Windows Desktop. The program will open to the CHARacterization Equipment Identifiers screen.
3. From the WinCharm Maintenance screen
 - 3.1. Select the <Manage> button to start the WinCharm Equipment ID Management. (Be sure to select a record other than the 0->TROUBLESHOOTING record)
 - 3.2. Select <Add>
 - 3.3. Enter in the “Enter New IDentifier:” **LAB RTD3**.
 - 3.4. Select <OK>
 - 3.5. Select <...> next to the “Equipment Type” display box
 - 3.6. Find and select the Equipment type “RTD3”
 - 3.7. Select <OK>

- 3.8. Select <...> next to the “Cable Type” display box
 - 3.9. Select the Cable type “3CTS-SIG”
 - 3.10. Select <OK>
 - 3.11. Enter in the Utility name.
 - 3.12. Select <...> next to the “Plant” display box
 - 3.13. Select <...> next to the “Plant” display box to enter in the Plant name. A pop up window will appear.
 - 3.14. Select <Add> to enter a new Plant into WinCharm 6. Enter the Plant name and select <OK>. (If Plant is already listed in the Plant Lookup table, skip step 3.14 and proceed on with step 3.15.)
 - 3.15. Select the Plant from the Plant Lookup table and select <OK>.
 - 3.16. Select <...> next to the “Room” display box to enter in the Room name. A pop up window will appear.
 - 3.17. Select <Add> to enter a new Room into WinCharm 6. Enter the Room name and select <OK>. (If Room is already listed in the Room Lookup table, skip step 3.17 and proceed on with step 3.18.)
 - 3.18. Select the Room from the Room Lookup table and select <OK>.
 - 3.19. Enter in the Description text box, “CHAR Training, RTD3 Lab.”
 - 3.20. At the Equipment Identification Management main window, verify accuracy of the input information
 - 3.20.1. Select the CHARacterization tab to view the options for CHARacterization testing.
 - 3.20.2. Verify that the CHARacterization Sequence is #25
 - 3.21. Select <OK> to finish creating the Equipment ID
 - 3.22. Select <Close> to close out the Equipment ID Management window. Now we are ready to calibrate the CHAR System and load the Test Queue.
4. Perform a CHARacterization system calibration:
- 4.1. Select the <CHARacterization> tab
 - 4.2. Select the <Calibrations> tab (located in the lower right hand of the window).
 - 4.3. Click <Calibrate>.
 - 4.4. Click <Yes> at the confirmation prompt for connecting to the CHARacterization hardware.
 - 4.5. Observe the shorted clip calibration.
 - 4.6. At the Open Calibration prompt:
 - 4.7. Open the Test Clip ends.
 - 4.8. Click <OK> to continue with the Open Test Clip calibration.
 - 4.9. Click <OK>, at the Calibration Pass prompt.
 - 4.10. Review the Calibration results. Click <Close> after reviewing the results. (*If Calibration fails, repeat step 4.3.*)

5. Perform a CHARacterization test:
 - 5.1. Select the <**CHARacterization**> tab from the WinCharm Maintenance screen. The CHARacterization Test Queue Screen will be displayed.
 - 5.2. Select the <**Empty**> button if there are any Attachments in the Test Queue
 - 5.3. Select the <**Load**> Button and click on the EID, LAB RTD3. Use the Search window, if needed. Click <**OK**> to load the test in the Test Queue.
 - 5.4. Delete Attachments 5 and 7 from the test queue, because there is no Station Ground available for this lab exercise.
 - 5.5. Select the 1st Test Queue record in the grid for this lab exercise. *EID: LAB RTD3 Attachment: 1*
 - 5.6. Click <**Acquire**> to begin the data acquisition cycle.
 - 5.7. Connect the positive (Red) and negative (Black) leads of the Test Clips as described in the Attachment fields.
 - 5.8. Click <**OK**> to acquire the data.
 - 5.9. Review the acquisition results for completeness and process.
Click <**Post**> to accept the results.
(Removes Attachment from Test Queue)
OR
Click <**Retest**> to retest the attachment.
(Leaves Attachment in Test Queue for retesting)
OR
Click <**Delete**> to remove any invalid results.
(Leaves Attachment in Test Queue for retesting)
6. Characterize the 3-Wire RTD model circuit:
 - 6.1. Acquire data for each EID/Attachment record in the Test Queue.
 - 6.2. Use <**Post**> after each CHARacterization test to store the data in the Results Queue and remove the Attachment from the Test Queue.
 - 6.3. Continue to the next Attachment in the Test Queue until all acquisitions are completed.
7. Generate a Summary Report of the results as follows:
 - 7.1. Select <**Summary**> button to start the CHARacterization Summary Report form.
 - 7.2. Select the Attachments needed for the report by selecting the attachment number and selecting <**Select Record**>. The attachments will display in the “Selected” table. Need attachments 1 – 6.
 - 7.3. Check all boxes under the “Report Options” Set the Frequency to 1KHz
 - 7.4. Select <**Report**>
 - 7.5. Complete Summary report, examining capacitance, inductance and resistance data and the TDR displays.

8. Evaluate test result data:
 - 8.1. Compare Attachments 1 & 2 for differences.
 - 8.2. Compare Attachments 4 & 6 for differences.
 - 8.3. Check Attachment 3 resistance is less than Attachment 1 resistance.
 - 8.4. Click <Close> when finished viewing the text report.
 - 8.5. Observe the display of the custom Summary TDR plots.
 - 8.6. Click on the upper right hand <X> in the Windows Toolbar to close out the TDR plots window.

9. Insert a fault into circuit and re-characterize the RTD model
 - 9.1. Obtain a 1-Ohm or 5.7-Ohm resistance fault from the instructor.
 - 9.2. Insert the 1-Ohm or 5.7-Ohm resistance fault at one of the connections.
 - 9.3. Retest steps.

10. Exit the **WINCHARM Version 6 program**:
 - 10.1. Click the <X> button in the upper right hand corner of the form.
 - 10.2. Click <OK> at the confirmation prompt to Exit the application.

CHAR MULTIPLEXER

OBJECTIVE:

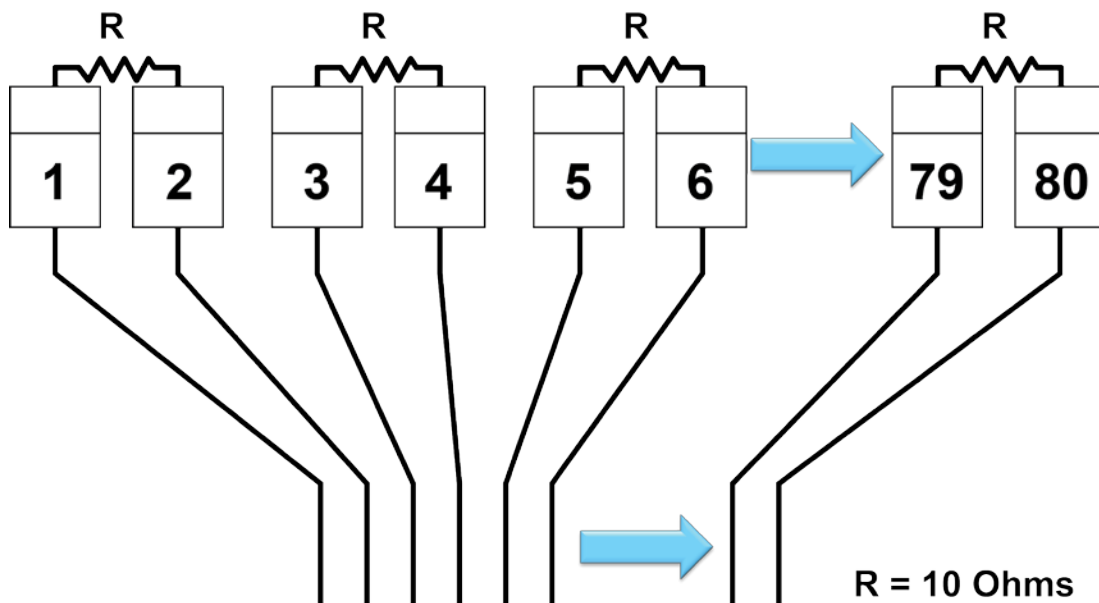
To illustrate the use of the CHAR Multiplexer accessory

DISCUSSION:

The CHAR Multiplexer test accessory allows 80 separate wires to be connected to the CHAR system. It is an 80 x 2 differential matrix. This gives access to each pin of the connector to either the high or low connector of the CHAR system test connection. The 80 channels are distributed across five 16-conductor cables that are terminated in banana plugs. The CHAR Multiplexer can be very useful for testing multiple pieces of equipment or multiple wire systems with a single hook-up. This lab will demonstrate the Multiplexer operation using a 10-Ohm resistor test fixture.

MATERIALS:

- CHAR Multiplexer test accessory
- 10-Ohm Resistor Test Fixture



CIRCUIT DIAGRAM:

PROCEDURE:

1. Set up the CHARacterization system hardware with the Multiplexer connected.
2. Attach 10-Ohm resistor fixture to Multiplexer Switch 80 pin connector.
3. Start the **WINCHARM Version 6 program** by selecting the Version 6 icon on the Windows Desktop. The program will open to the CHARacterization Equipment Identifiers screen.
4. Change the software focus from **Normal Test Queue** to **Mux Test Queue**
 - 4.1. Check the “**Mux Online**” checkbox
 - 4.2. On the Windows Taskbar select the **Utilities > Environment Options**.
 - 4.3. Under the Characterization tab, verify that “**Mux Test Queue**” is shown
5. Perform a Multiplexer system calibration:
 - 5.1. Select the <**CHARacterization**> tab
 - 5.2. Select the <**Calibrations**> tab (located in the lower right hand of the window).
 - 5.3. Click <**Calibrate**>.
 - 5.4. Click <**Yes**> at the confirmation prompt for connecting to the CHARacterization hardware.
 - 5.5. Short circuit mux pins 1 and 2. Observe the Shorted Test Clip calibration. The measurements for pins 1 and 2 will be compensated from all mux measurements that reference this calibration test.
 - 5.6. At the Open Calibration prompt:
 - 5.7. Open the Test Clip ends.
 - 5.8. Click <**OK**> to continue with the Open Test Clip calibration.
 - 5.9. Click <**OK**>, at the Calibration Pass prompt.
 - 5.10. Review the Calibration results. Click <**Close**> after reviewing the results. (*If Calibration fails, repeat step 4.3.*)
6. From the WinCharm Maintenance screen:
 - 6.1. Select the <**Manage**> button to start the WinCharm Equipment ID Management. (Be sure to select a record other than the 0->TROUBLESHOOTING record)
 - 6.2. Select <**Add**>
 - 6.3. Enter in the Enter New IDentifier: “**MUX CHECKOUT**”.
 - 6.4. Select <**OK**>
 - 6.5. Select <**...**> next to the “CHARacterization Sequence” display box
 - 6.6. Find and select the Sequence ID# 412 (Type is QADXP, Cable is PXI MUX)

- 6.7. Enter in the Utility name.
 - 6.8. Select <...> next to the “Plant” display box
 - 6.9. Select <...> next to the “Plant” display box to enter in the Plant name. A pop up window will appear. \
 - 6.10. Select the Plant from the Plant Lookup table and select <OK>.
 - 6.11. Select <...> next to the “Room” display box to enter in the Room name. A pop up window will appear.
 - 6.12. Select the Room from the Room Lookup table and select <OK>.
 - 6.13. Select <OK>
7. Load Test Set & Perform a CHARacterization test:
- 7.1. Select the <CHARacterization> tab from the WinCharm Maintenance screen. The CHARacterization Test Queue Screen will be displayed.
 - 7.2. Select the <Empty> button if there are any Attachments in the Test Queue
 - 7.3. Click <Load>.
 - 7.4. Select “MUX CHECKOUT” EID.
 - 7.5. Click <Acquire>
 - 7.6. Click <Yes> at the calibration prompt.
 - 7.7. Follow the on screen prompts for calibration.
 - 7.8. Following the calibration, the CHAR system will proceed into the test sequence until all attachments have been completed.
 - 7.9. Select “Post” to save all records in database archives.
8. Generate a Statistical report of the results as follows:
- 8.1. Click on the Reports button, select <Statistical>, and <OK>.
 - 8.2. Select the Attachments for the report by clicking on the Attachment and selecting <Select Record> to choose the Equipment ID. They will appear in the Selected Table.
 - 8.3. Under the Select Data Types Options, select the DC Resistance checkbox for the report, make sure all other selections are unchecked.
 - 8.4. In the Report & Graph Title, type “Mux Resistance Test – 10 Ohm resistors”
 - 8.5. Under the Report Options, check the checkboxes “Bar Plots” and “Numerical Data”.
 - 8.6. Under the Tolerance Options, select the <3 Sigma> button.
 - 8.7. Click <Report>.
 - 8.8. Evaluate test result data:
 - 8.8.1. Compare the resistance on each attachment for a 10 Ohm difference
 - 8.8.2. Look for uniform steps on bar graph.
 - 8.9. Click <Close> when finished viewing the reports.

9. Insert various fault into circuit and re-characterize the model
 - 9.1. Obtain a 1 Ohm or 5.7 Ohm resistance fault from the instructor.
 - 9.2. Insert the 1 Ohm or 5.7 Ohm resistance fault at one of the connections.
 - 9.3. Retest steps
 - 9.4. Disconnect one wire of the connections.
 - 9.5. Retest steps

10. Exit the **WINCHARM Version 6 program**:
 - 10.1. Click the <**X**> button in the upper right hand corner of the form.
 - 10.2. Click <**OK**> at the confirmation prompt to Exit the application.