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Automated Disconnect Transformer Tester

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Presentation Outline

- Background and Introduction
- Requirements and Schedule
- System Hardware/Software Design
- Validation (Hardware, Software, System)
- Costs, Lessons Learned, and Conclusion

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Background

- Schneider Electric manufacture disconnect transformers
 - Currently test done manually by test tech
 - No data logging (loss of valuable data)
- Must be tested for quality control
 - Voltage ratio
 - Verification that HiPot test passed
 - Verification of transformer inside enclosure
 - Different transformers could fit inside an enclosure
 - Verification that pilot-light ON (when required)
 - Data logging

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Introduction

- The ADTT was proposed to Schneider
- How does it work?
- Not as easy as anticipated
- 90 different xfrm models (currently)
 - ADTT must test all models
 - ADTT must test future models
 - New method required

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Database Application

- A database containing testing information
- VB.NET program will search DB for record using catalog number
- To test new transformer model, add new record to DB

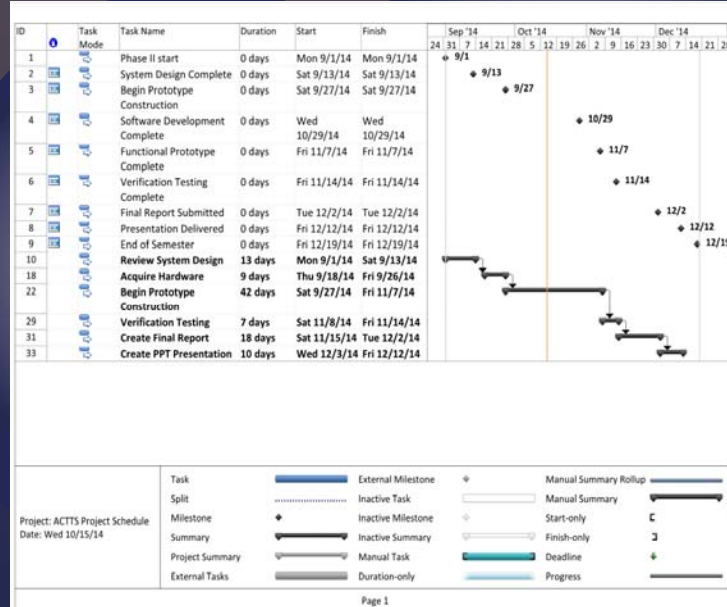
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Main Requirements

- Perform each test in less than half the time as current method, **tested and passed**
- Reduce the chance of human error in the testing process, **verified by inspection**
- Automatically save all testing results, **tested and passed**
- Protect user from shock/injury, **tested and passed**

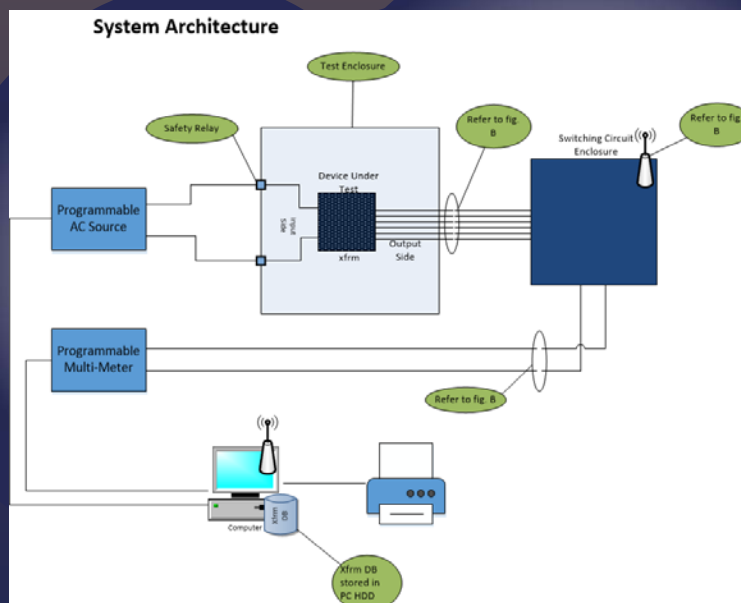
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Project Schedule



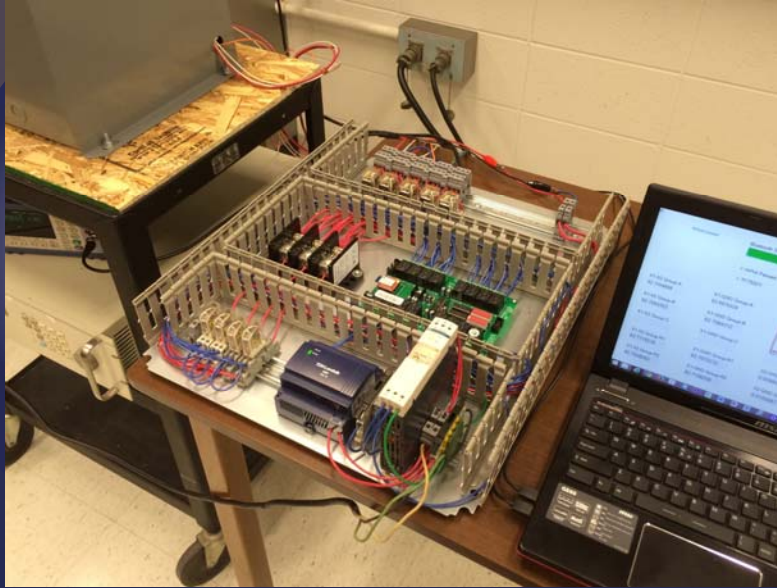
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System Architecture



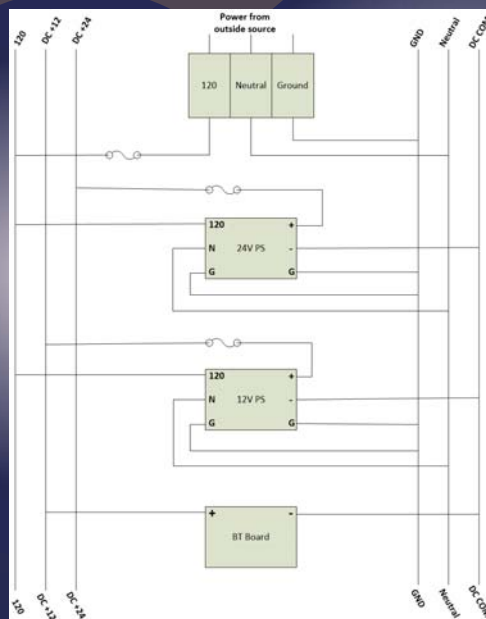
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Relay Switching Circuit



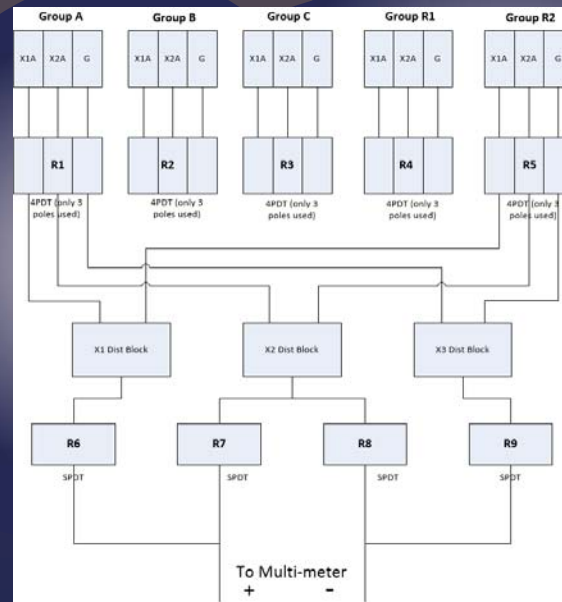
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Power Connections



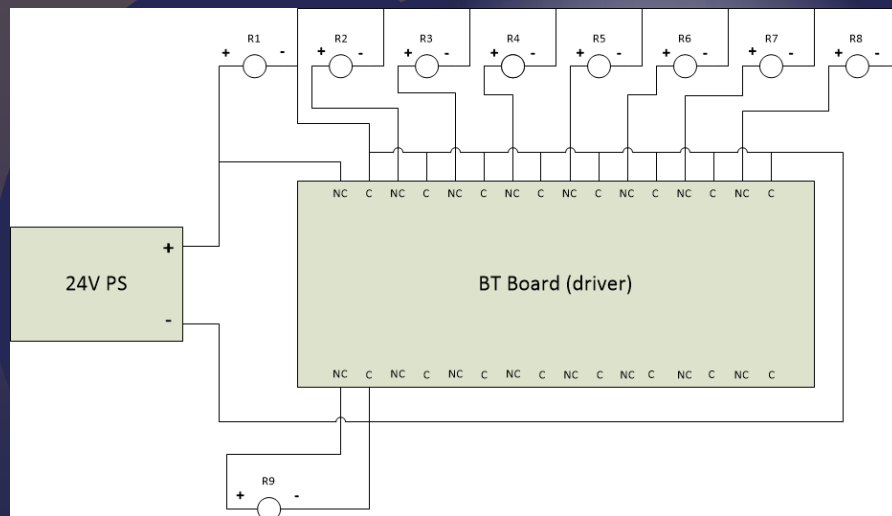
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Switching Circuit Design



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Relay Coil Connections



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Splash Form



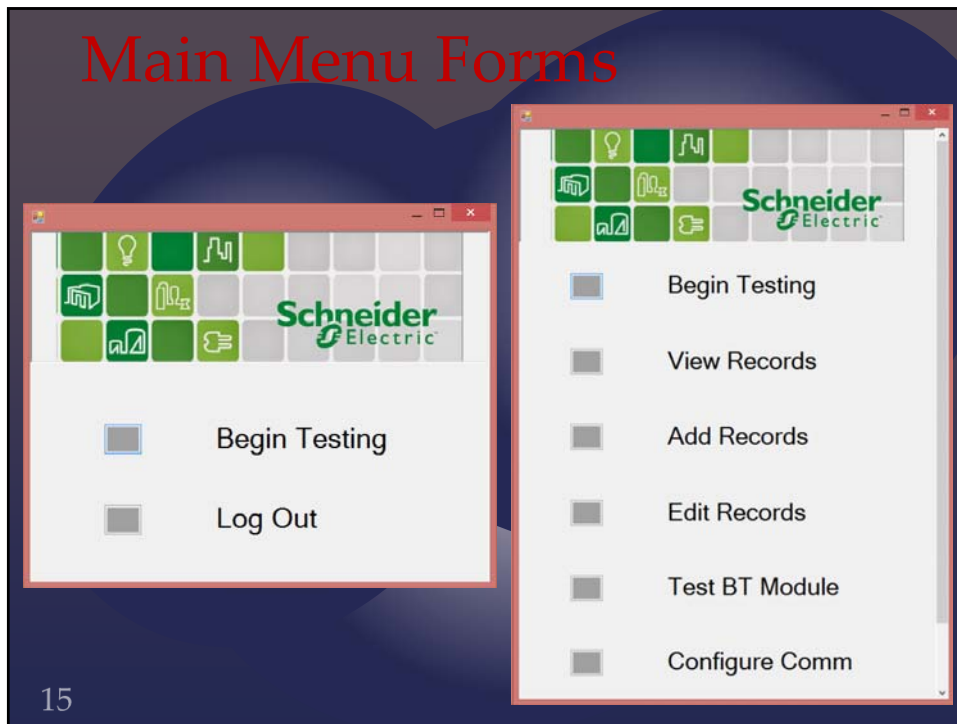
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Log-in Form

The screenshot shows a Windows application window titled "Log-in Form". The window has a light gray background. It contains two text input fields. The first field is labeled "Login Name:" and the second field is labeled "Password:". Below the input fields, there are two buttons: "OK" and "Cancel".

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Main Menu Forms



View Records (Selection)



View Records Example

ID	Date Time	Catalog Number	Serial Number	Transformer	Pilot Light	Test Operator	Test Result
102	4/17/2015 3:59:25 PM	9070SK750G2D1F11G16P1	example123	Yes	Yes	Darin Redding	The test failed at the points The points of failure are: x1 x1_gndCktA, x1_x2CktB, x1 x1_x2CktR1, x1_gndCktR1, x1_gndCktR2,
103	4/17/2015 4:03:39 PM	9070SK750G2D1F11G16P1	example123	Yes	Yes	Darin Redding	All tests passed!
104	4/17/2015 4:09:18 PM	9070SK750G2D1F11G16P1	example123	Yes	Yes	Darin Redding	All tests passed!
105	4/17/2015 5:16:59 PM	9070SK750G2D1F11G16P1	example123	Yes	Yes	Darin Redding	The test failed at the points The points of failure are: x1 x1_gndCktA, x1_x2CktB, x1 x1_x2CktR1, x1_gndCktR1, x1_gndCktR2,
106	4/17/2015 5:22:01 PM	9070SK750G2D1F11G16P1	example123	Yes	Yes	Darin Redding	All tests passed!
107	4/17/2015 5:28:12 PM	9070SK750G2D1F11G16P1	example123	Yes	Yes	Darin Redding	All tests passed!
108	4/17/2015 5:48:53 PM	9070SK750G2D1F11G16P1	example123	Yes	Yes	Darin Redding	All tests passed!
109	4/17/2015 5:51:00 PM	9070SK750G2D1F11G16P1	example123	Yes	Yes	Darin Redding	The test failed at the points The points of failure are: x1 x1_gndCktR2,
110	4/17/2015 5:54:28 PM	9070SK750G2D1F11G16P1	example123	Yes	Yes	Darin Redding	The test failed at the points The points of failure are: x1 x1_gndCktR2,

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Configure Comm Form

Com Port: COM10 Connect Main

Baud Rate: 19200 Disconnect Save

☐ Bluetooth Module ☐ Quadtech ☒ BK Precision

Transmit Data

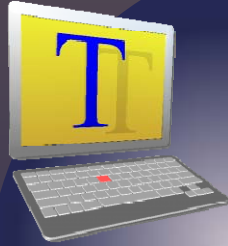
*IDN? Send

Received Data

*IDN?
5491B Multimeter, Ver1.0.10.03.17, 124G11103

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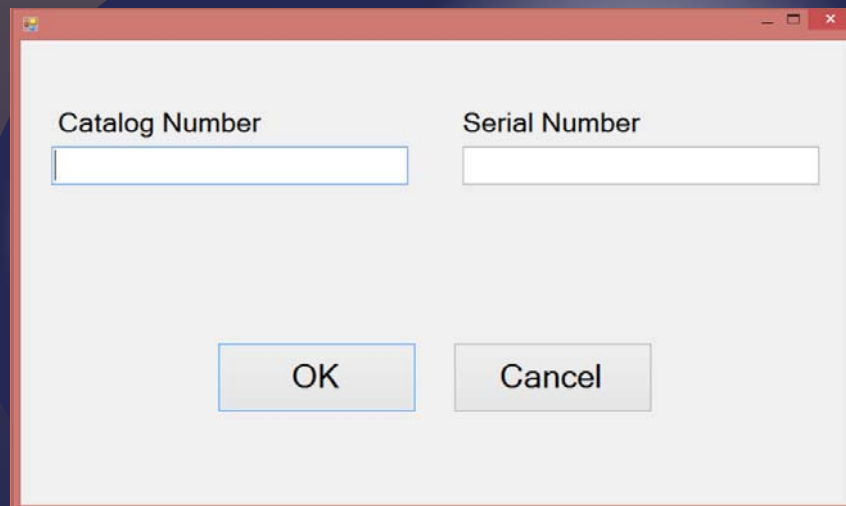
Configure Bluetooth Module



- Tera Term – open source terminal emulator
 - Supports ssh, telnet, serial port connections
- Used to configure BT module
 - Baud Rate, hand shake, etc.
- Commands found inside manufacturer's documentation

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Catalog/Serial Form



Catalog Number

Serial Number

OK Cancel

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Testing Form

The screenshot shows a software interface for testing. It features a 'Meter Display' area at the top left. To its right is the 'Bluetooth Status' section, which includes a green progress bar and two unchecked checkboxes: 'HiPot Passed' and 'TF750D1'. Further right are two buttons: 'Start Test' and 'Main Menu'. The bottom half of the window is organized into three columns of input fields. The first column is labeled 'X1-X2 Group-A' through 'X1-X2 Group-R2'. The second column is labeled 'X1-GND Group-A' through 'X1-GND Group-R2'. The third column is labeled 'X2-GND Group-A' through 'X2-GND Group-R2'.

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Algorithm (in a nutshell)

- If HiPot checkbox isn't checked
 - Error message will be displayed
- MessageBox asking user to verify transformer
- Programmable instrumentation configured
- Programmable AC source output ON
- Messagebox asking if pilot light ON

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- Measurements made in sequential order
 - Skipping measurement locations marked NULL
 - Measured value saved in respective textboxes
- Comparison is made between
 - Measured values and values inside record
- Within $\pm 10\%$ tolerance is a pass
- Results displayed inside meter display
- If test failed, user will be asked to print
- Test Results auto saved to DB

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Catalog #	Serial #	Primary	Secondary	X1_X2_A	X1_GND_A	X2_GND_A	X1_X2_B	X1_GND_B	X2_GND_B	X1_X2_C	X1_GND_C
123456789	model123	480	120	120	120	0					

Example Data Record

If measured values within $\pm 10\%$ of data record values, test is a pass.

X1_X2CKTA

120

X1_GNDCKTA

120

X2_GNDCKTA

0

Example Measured Values

NULL locations not tested

X1_X2CKTB

120

X1_GNDCKTB

120

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Test Failure Example

The test failed at the points listed below.

The points of failure are:
x1_x2CktR2, x1_gndCktR2,

Bluetooth Status
☒ HiPot Passed
☒ TF750D1

Start Test

Main Menu

X1-X2 Group-A
62.8277854

X1-X2 Group-B
62.7570037

X1-X2 Group-C

X1-X2 Group-R1
62.7556686

X1-GND Group-C

X1-GND Group-R1
62.7653427

X2-GND Group-A
0.0102537

X2-GND Group-B
0.0164851

X2-GND Group-C

X2-GND Group-R1
0.0138228

Print Dialog
Do you want to print the test results?

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Table of Cost

Material/Tool Cost				
Item	Qty	Cost Each	Total Cost	Comments
BK Precision 5491 B	1	\$ 409.00	\$ 409.00	Salvage from SE storage
AC Power Source (Quadtech 31005)	1	\$ -	\$ -	Salvage from SE storage
Bluetooth relay module	1	\$ 500.00	\$ 500.00	Purchased from RelayPros
TDK Lambda DSP 100-12	1	\$ 62.00	\$ 62.00	Salvage from SE storage
4PDT Relays (RSD14V53)	5	\$ 10.00	\$ 50.00	Made by Schneider Electric
4PDT Relay Socket (8501NR45)	5	\$ 35.00	\$ 175.00	Made by Schneider Electric
SPDT Relays (8501RSD41V53)	4	\$ 37.00	\$ 148.00	Made by Schneider Electric
SPDT Relay Socket (8501NR41)	4	\$ 36.00	\$ 144.00	Made by Schneider Electric
Telemecanique ABL-7-RE2403	1	\$ 141.00	\$ 141.00	Made by Schneider Electric
Power Dist. Block	1	\$ 124.00	\$ 124.00	Made by Schneider Electric
Terminal Block	25	\$ 2.00	\$ 50.00	Made by Schneider Electric
Glass Fuses	3	\$ -	\$ -	Chosen by SE eng
Bluetooth Configuration Kit	1	\$ 50.00	\$ 50.00	Purchased from RelayPros
Wall Mount Enclosure	1	\$ 133.00	\$ 133.00	Made by Schneider Electric
Misc. (wires, screws, spacers, etc)	1	\$ 200.00	\$ 200.00	
		Material Total	\$ 2,186.00	

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Hardware Validation

- Quadtech AC source : Passed
- BK Precision meter : Passed
- Bluetooth Relay Board : Passed
- Relay Switching Circuit : Passed

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Software Validation

- Login system: Passed
- Add/Edit records : Passed
- View records in report format : Passed
- Configure communication settings : Passed
- Catalog # form error checking: Passed

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System Validation

- System communications : Passed
- HiPot/Transformer verification : Passed
- Transformer output ON test start : Passed
- Pilot-light ON/OFF pop-up: Passed
- relay states for each test location : Passed

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System Validation Cont..

- voltage reading at each test location: Passed
- Transformer output OFF test end : Passed
- Pass/Fail Logic : Passed
- Prompts user to print when test fails : Passed
- Testing results auto saved : Passed

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Lessons Learned

- Formal communication is key
 - Avoid misunderstandings
 - Saved dialogue for future references
- It's not uncommon for technical projects
 - Over schedule
 - Over budget
- Prepare for the set-backs
 - Shipping delays
 - Parts not readily available
 - Knowledge gap
 - Anticipate all risks

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Conclusion

- prototype met all the requirements
- Prototype passed verification testing
- Project success (very little cost to SE)
 - Most parts were salvaged and/or made by SE
- Applying finishing touches

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