



THE EASTERN SPECIALTY COMPANY



Georgia Power

# *Verifying Transformer Rated Service Installations*

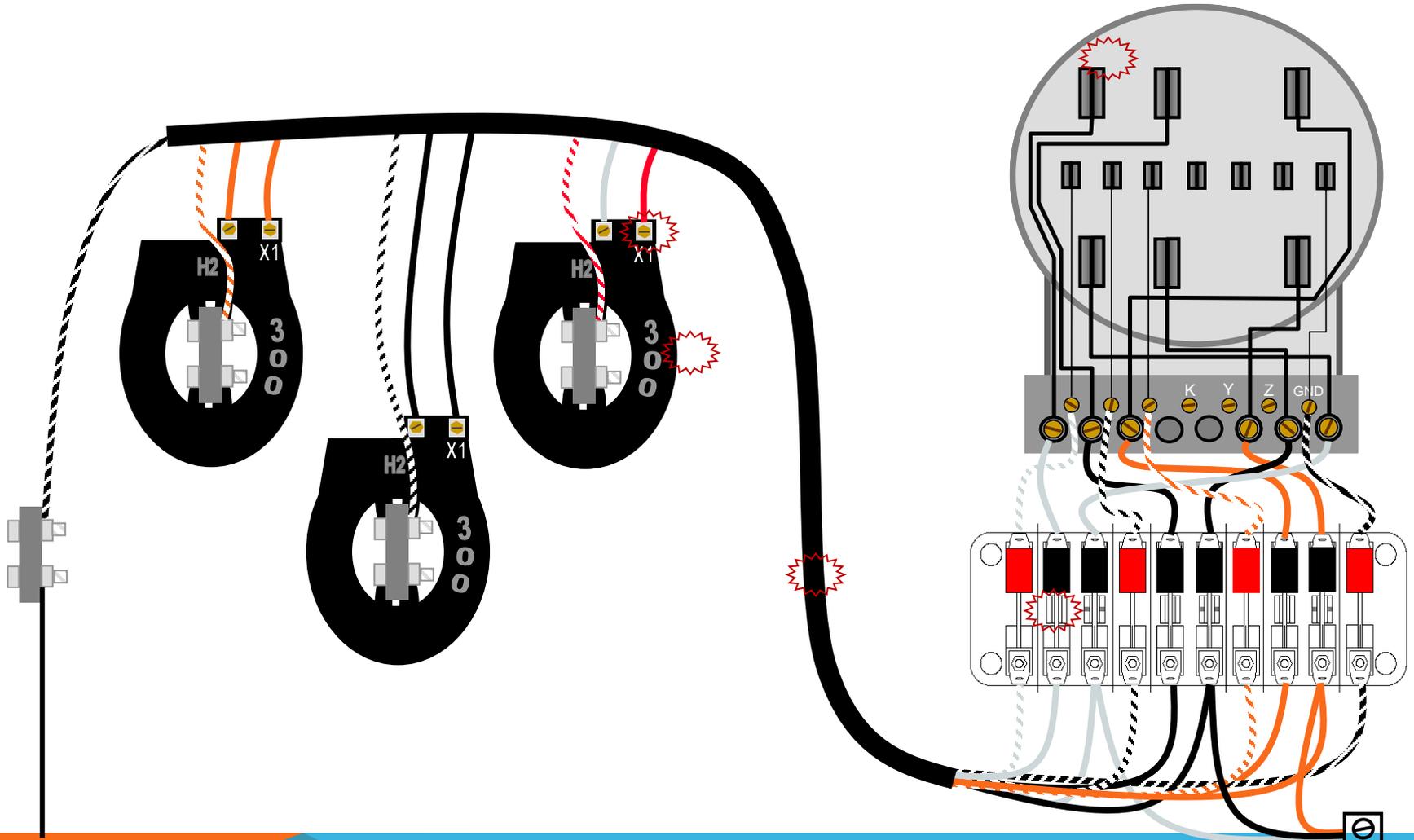
January 2019



# Field Meter Testing Using Phantom Load



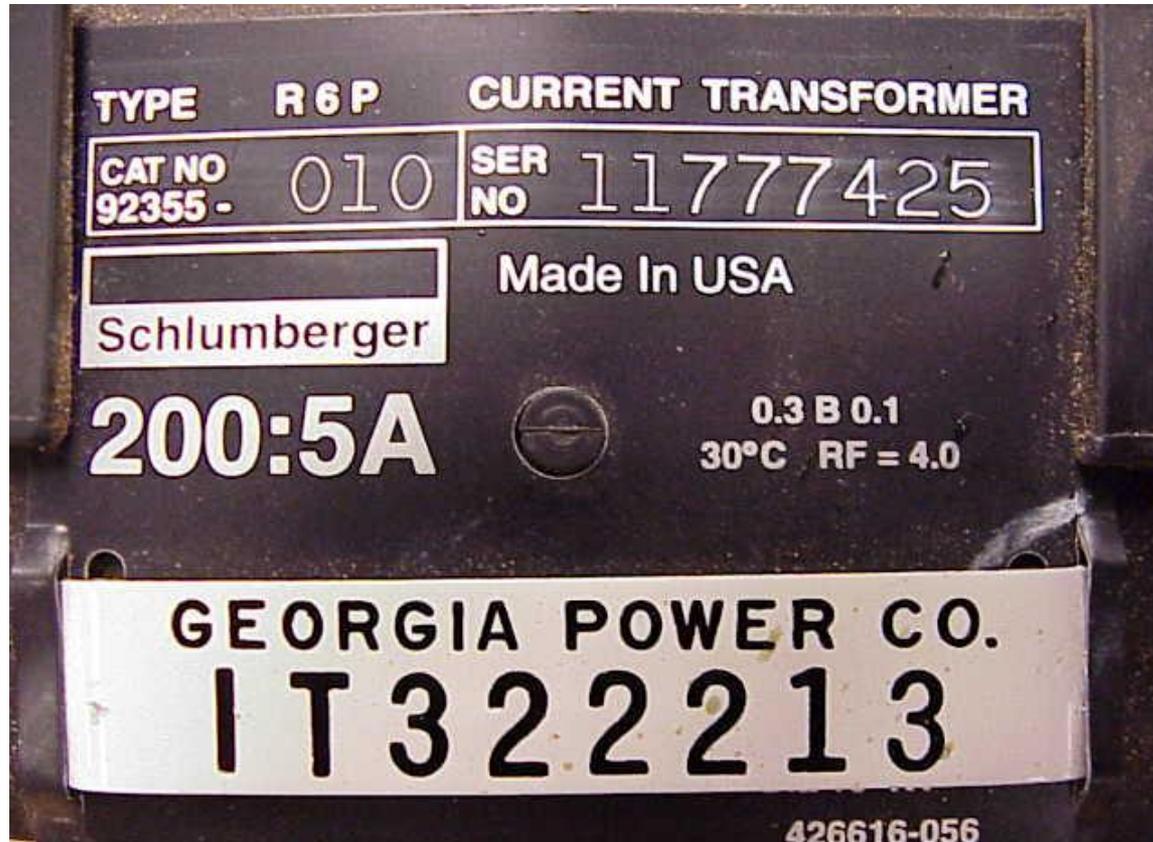
# OPPORTUNITY FOR A PROBLEM BEYOND THE METER?



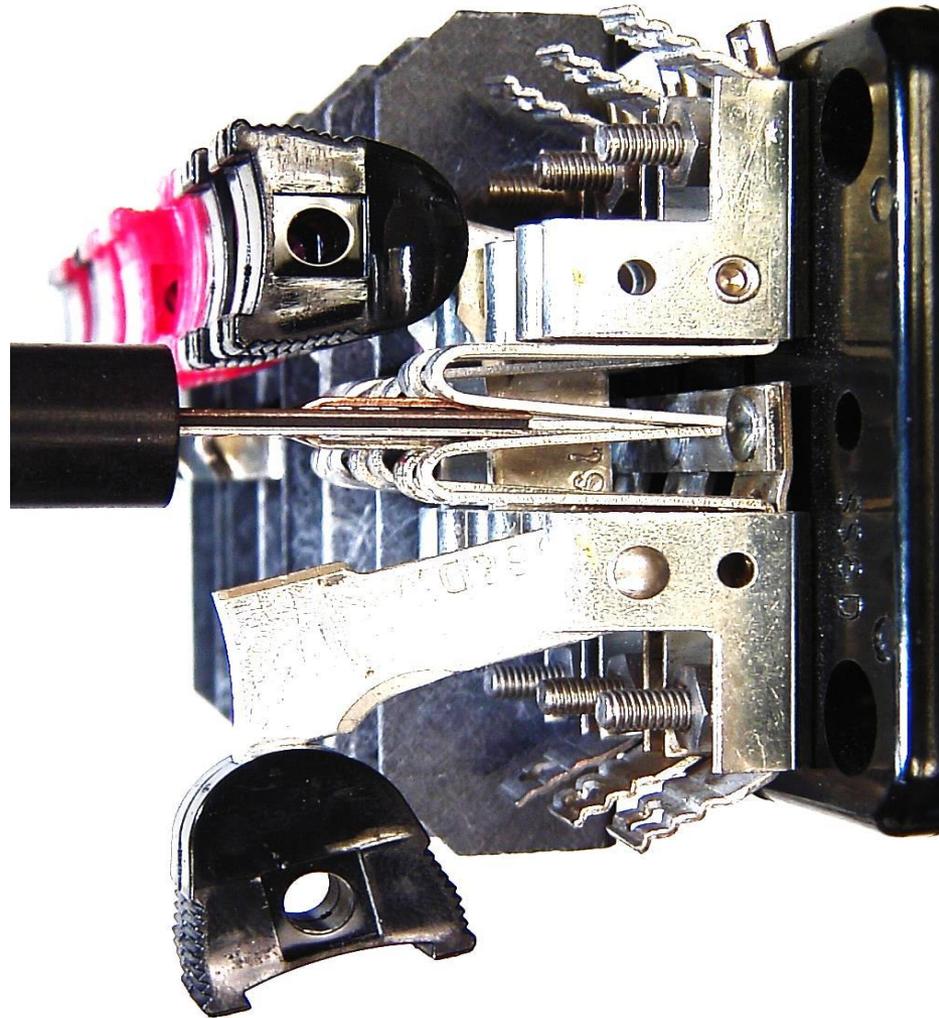
# ***INSTRUMENT TRANSFORMERS***



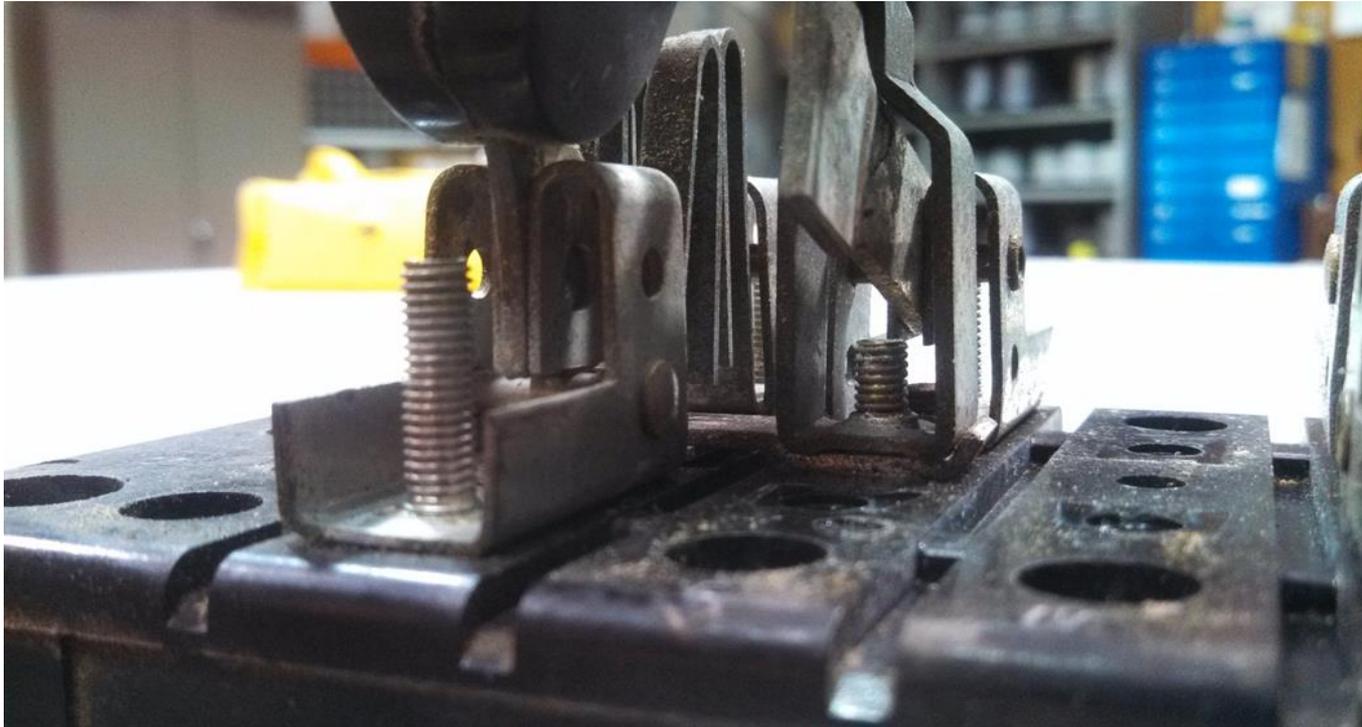
# INSTRUMENT TRANSFORMERS



# ***CURRENT RETURN SWITCHES***



# ***CURRENT RETURN SWITCHES***



***C Phase Current in open position***

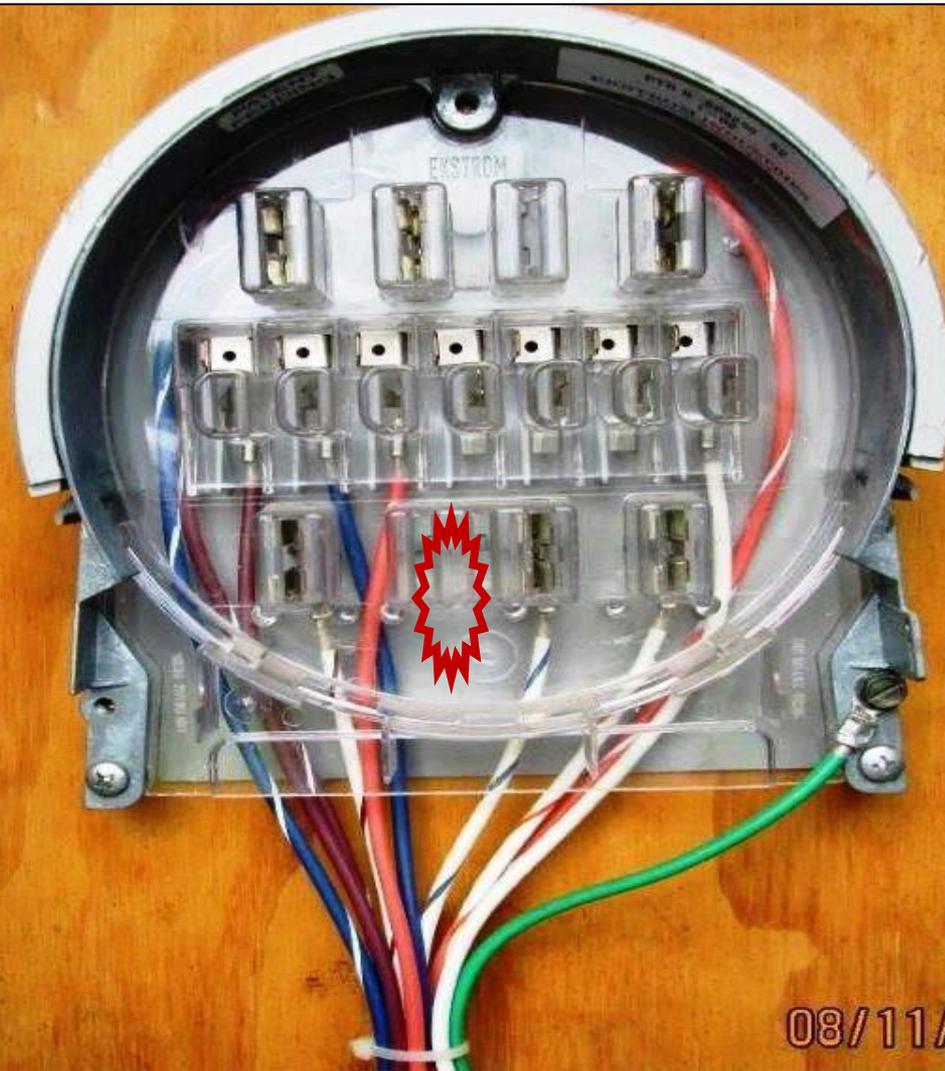
# ***CURRENT RETURN SWITCHES***



***C Phase Current in closed position making contact with attachment screw for shunt buss.***

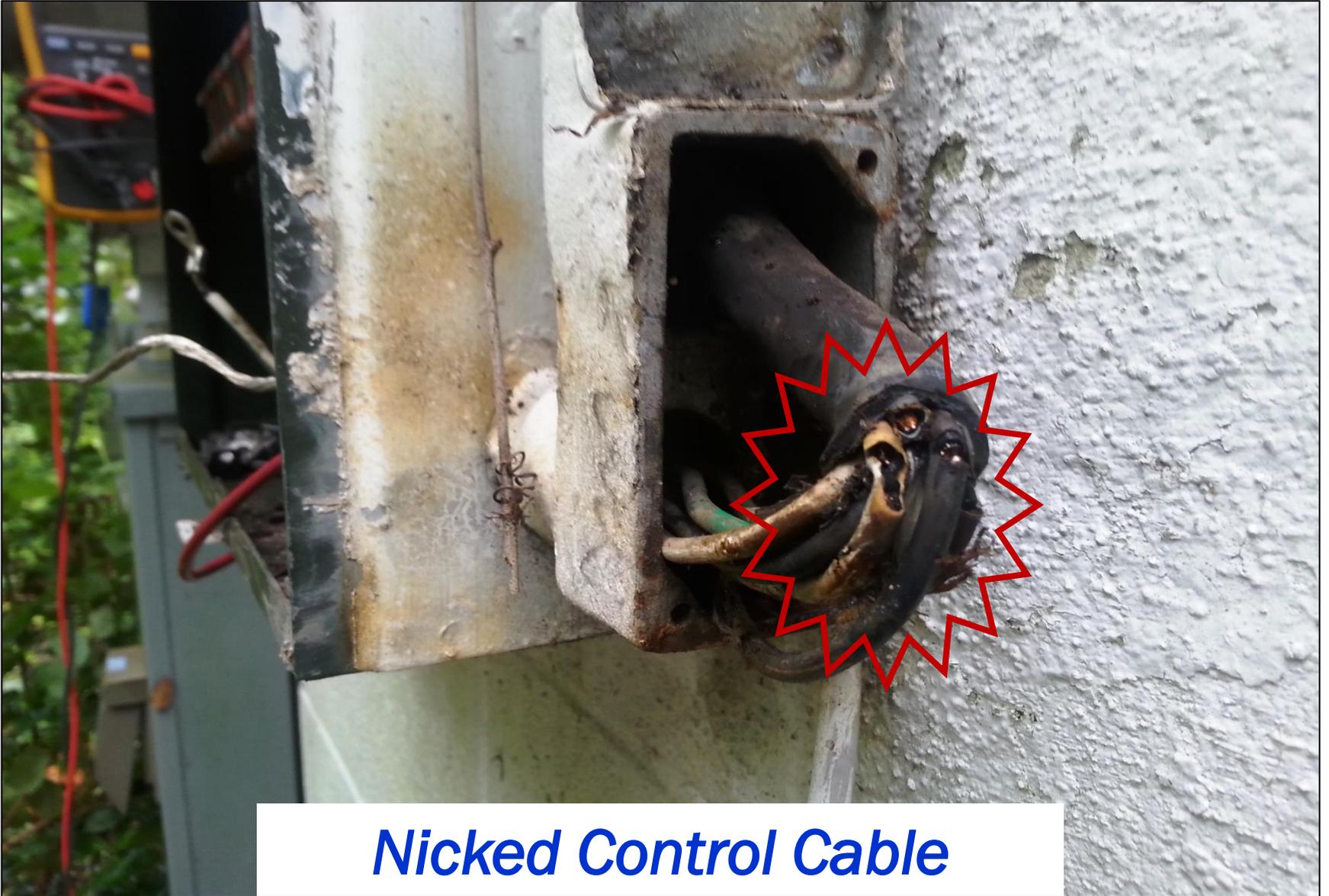
***This re-routes current to by pass the meter.***





08/11/2014 13:38

## *Form 9S Abase Adaptor*



***Nicked Control Cable***

# SYSTEM ANALYZERS

**Radian  
RD31-221**



**Spinlab  
Bird Dog Plus**



**testMET  
Gold Miner**



**PowerMetrix  
PowerMaster**



# ***SYSTEM ANALYZER WE USE***



**PowerMaster  
5 Series Model**

# Testing Options Available On the PowerMaster

 Integrated Site Test Setup

BETA TEST - 462384 - Selected Site: 101

Test Setup **NORMAL TEST** ▼

## Meter Tests

Customer Load

Test Mode **Wh** ▼

Do Demand Test

Test Time **0** Seconds

Test Revs **2**

Phantom Load

Phantom Load Setup **None** ▼

## Transformer Testing

CT Test

Mode **Burden + Ratio** ▼

Max Burden **0.5** ▼

PT Test

Mode

Edit Setup

New Setup

Delete Setup

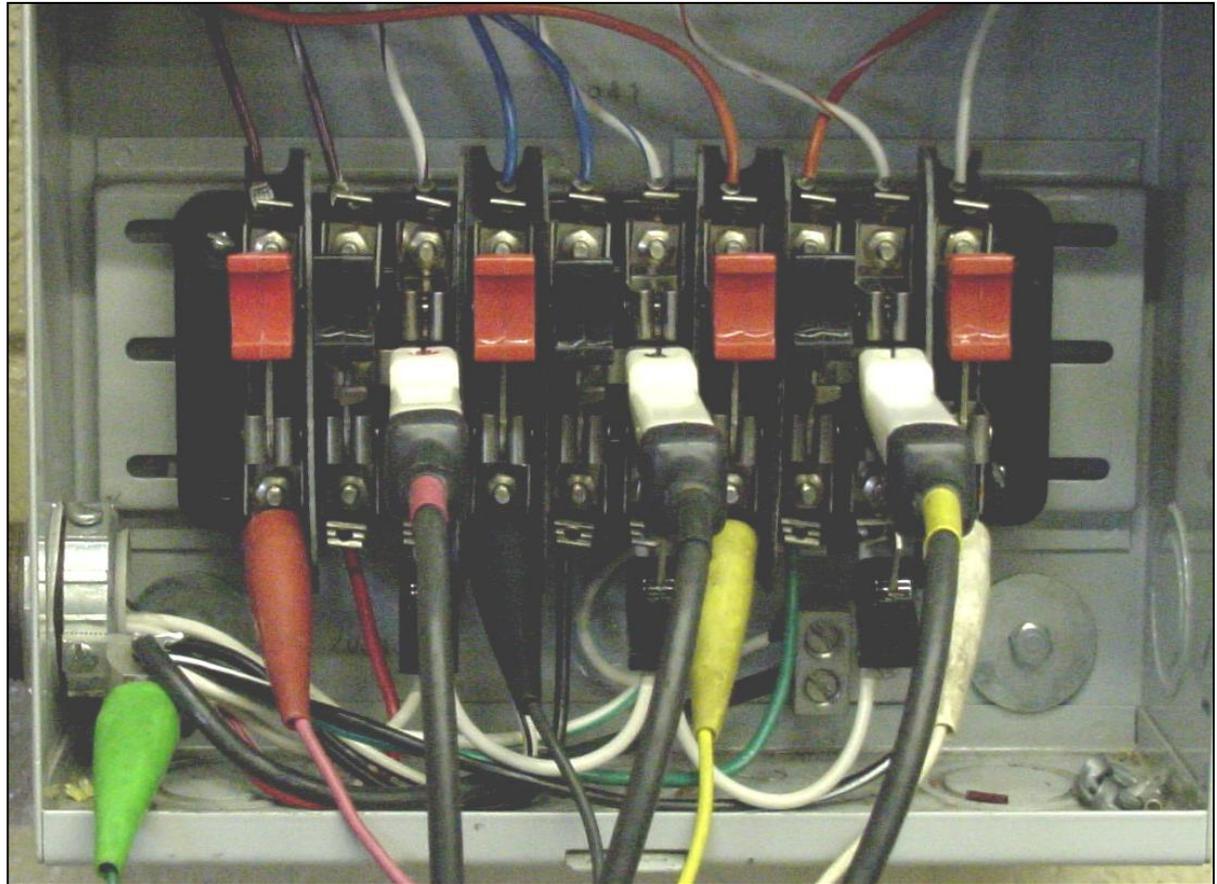
Select

# ***Before Beginning the Integrated Site Scan The Following Steps Must be Performed***

**Proper PPE must be worn and all Safety Guidelines followed.**

**Install the Duckbill Current Leads**

**Connect the Potential Leads making sure they are matched to the proper current.**



# Select the Vector Analysis Option Before Starting



Vector

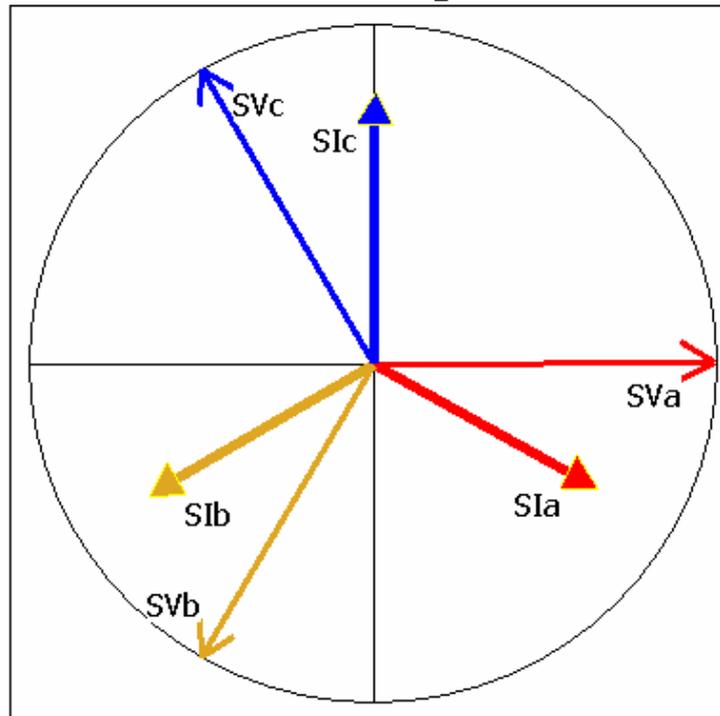
Why ?

# View the Vector to Verify your Connections ...

Vector Graph

Selected Site: 3PH 4W WYE (100:5 CT)

## Vector Diagram



### $\Phi$ SVaSIa

SVa	118.747	0.00°
SIa	2.478	29.39°
PF =	0.871	29.39°
Lag		

### $\Phi$ SVbSIb

SVb	119.579	119.92°
SIb	2.504	149.03°
PF =	0.874	29.11°
Lag		

### $\Phi$ SVcSIc

SVc	119.885	240.00°
SIc	2.645	270.54°
PF =	0.861	30.54°
Lag		

### SYS

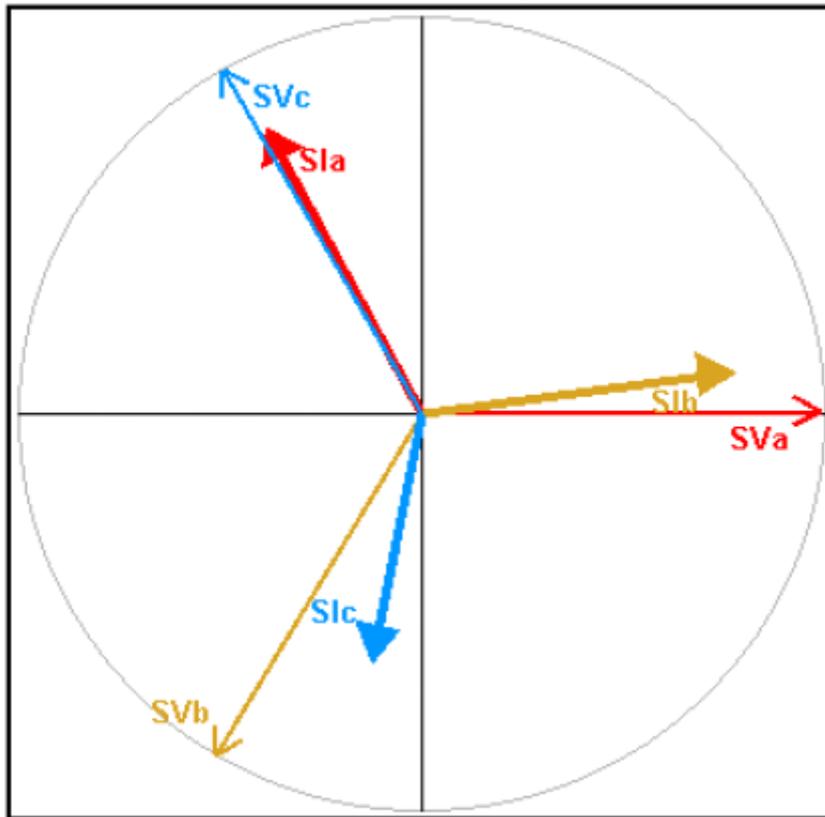
Vsys =	119.404
Isys =	2.542
PF =	0.869
ROT =	ABC

Measurement: Live Test, Sec V/Sec I, Instantaneous

Reference	Connect View	Interval	Sec V/Pri I	Stop
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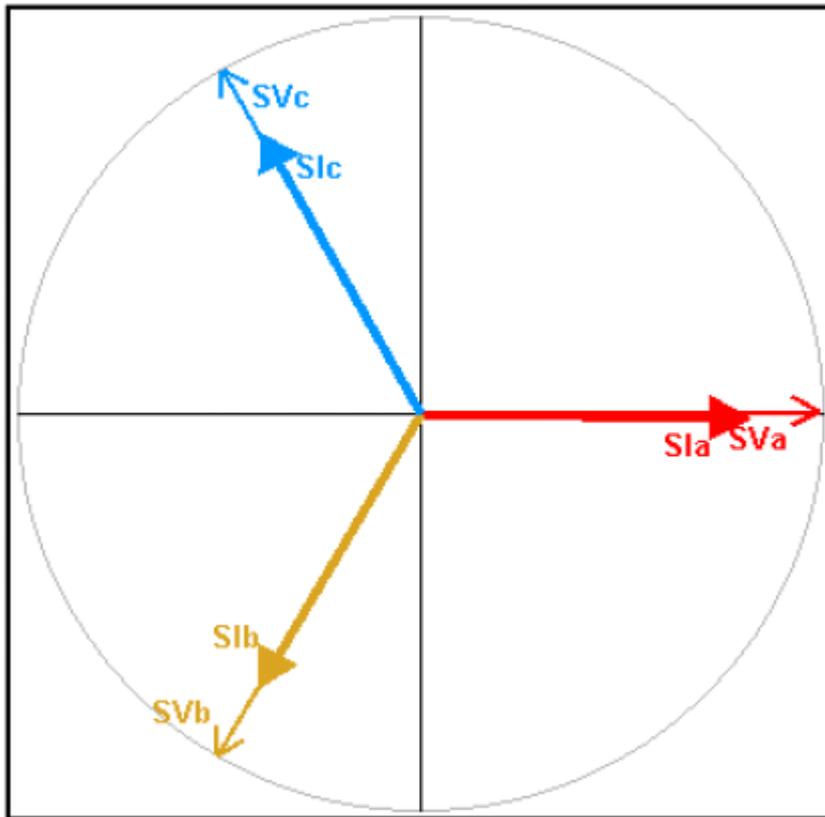
# View the Vector to Verify your Connections ...

Meter Vector Diagram



# 4 Wire Wye Service at Unity Power Factor

Meter Vector Diagram



Waveform Report



Site ID: SCREEN CAPS

Customer:

Test Date: Thursday, January 31, 2013 2:34:17 AM (UTC+05:00)

Service: 3-Phase, 4-Wire, Wye (3V, 3C) TR

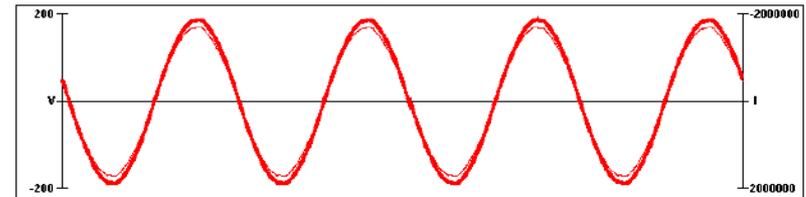
Account No:

Tech 1:

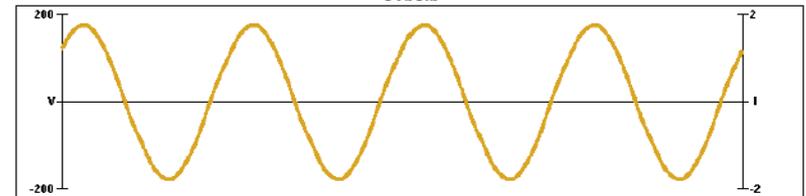
Tech 2:

Sys ID: 7332-130003

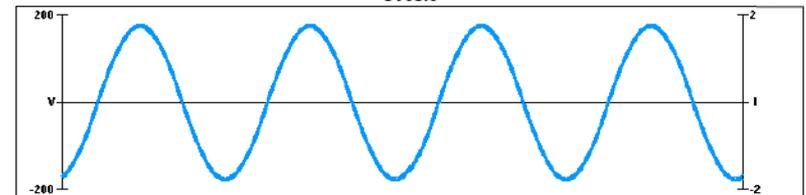
SVaSIa



SVbSIb

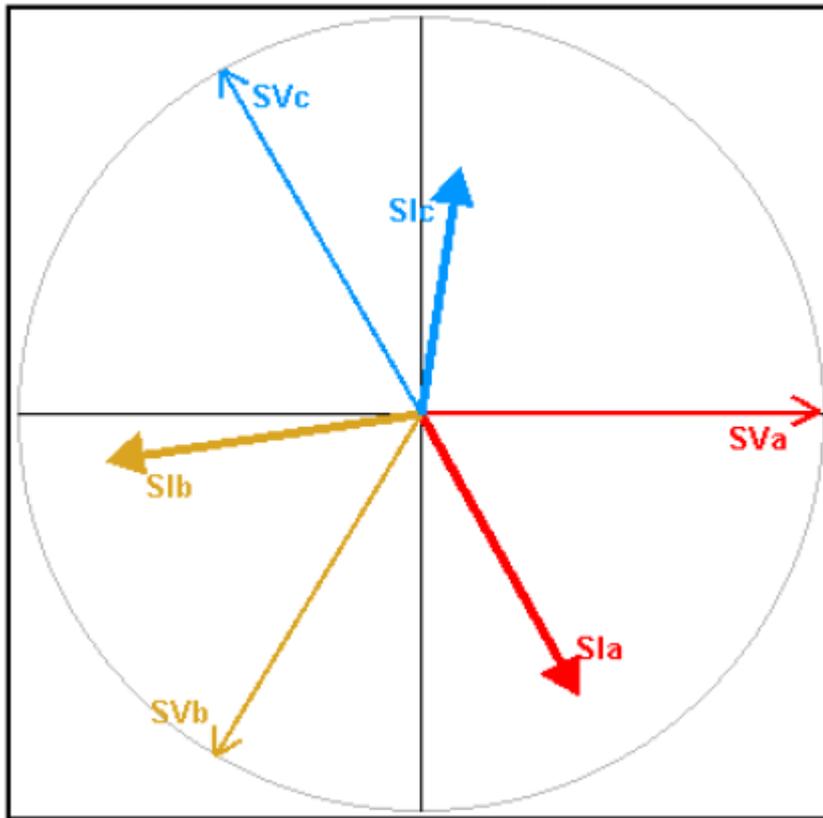


SVcSIc



# 4 Wire Wye Service at 50% Power Factor

Meter Vector Diagram

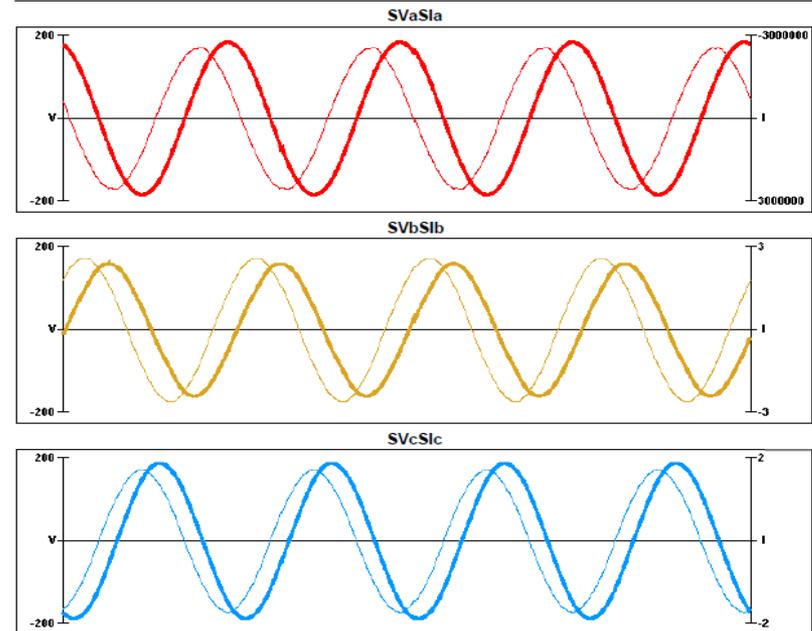


Waveform Report



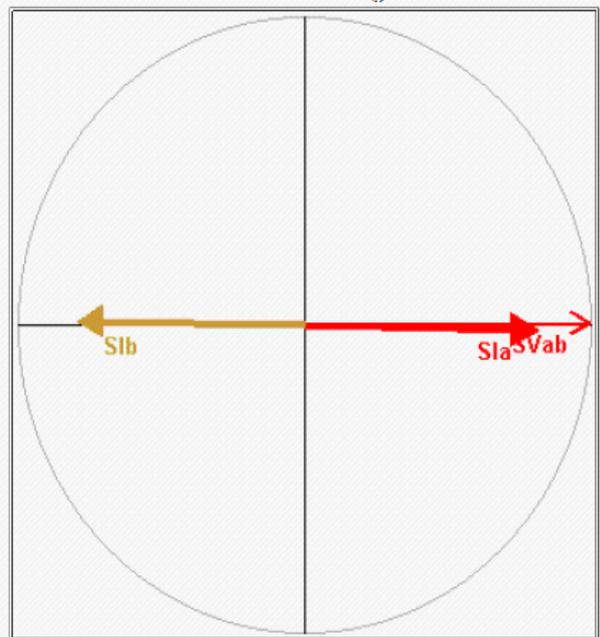
Site ID: SCREEN CAPS  
Customer:  
Test Date: Thursday, January 31, 2013 2:35:30 AM (UTC+05:00)  
Service: 3-Phase, 4-Wire, Wye (3V, 3C) TR

Account No:  
Tech 1:  
Tech 2:  
Sys ID: 7332-130003



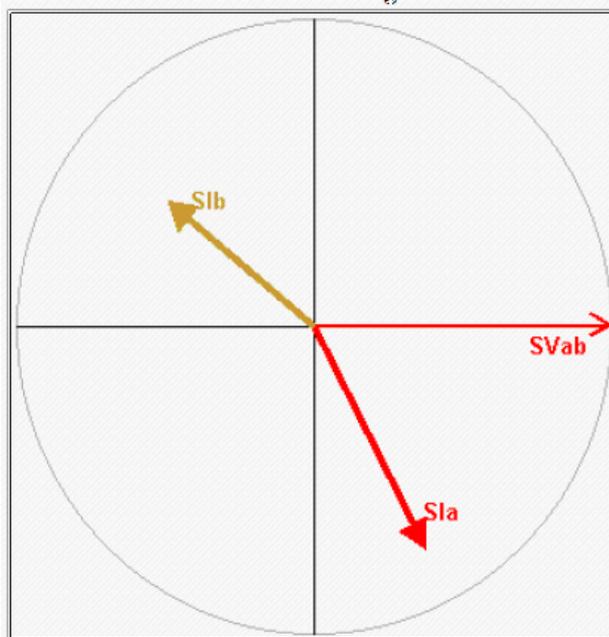
# Single Phase Service

Meter Vector Diagram



Unity

Meter Vector Diagram



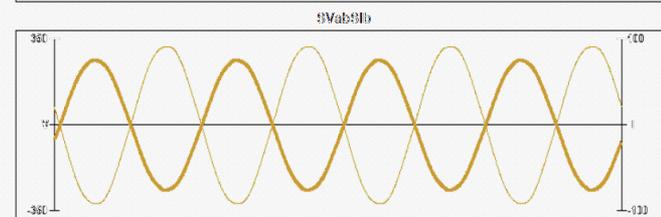
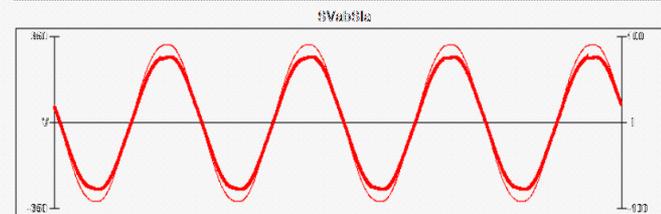
50% PF

Waveform Report



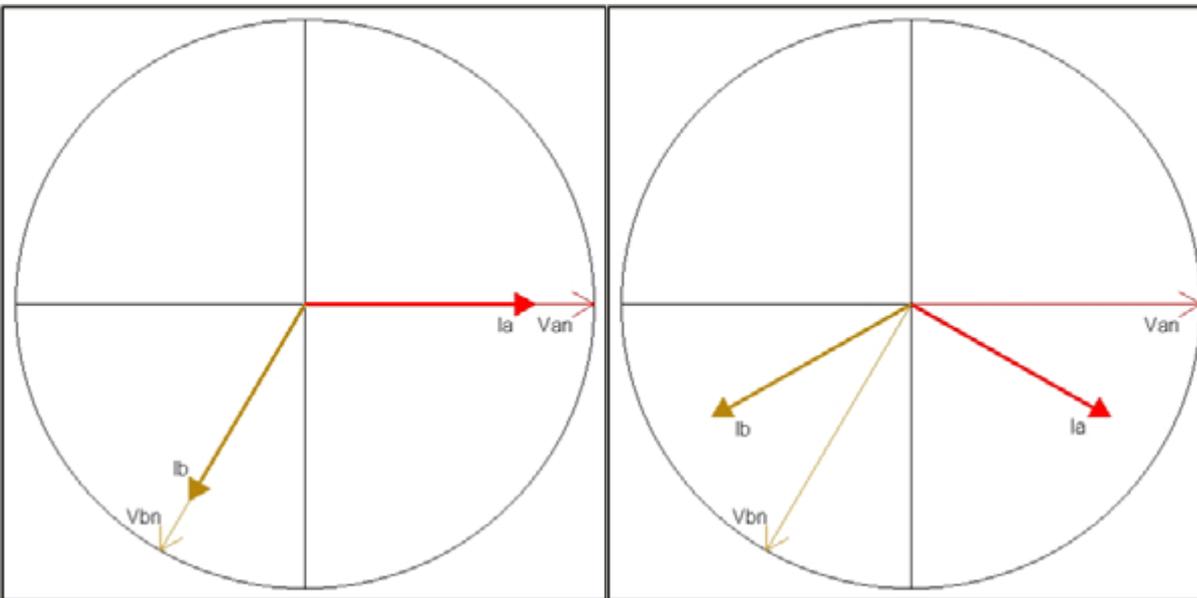
Site ID: 1PHASE  
Customer:  
Test Date: Thursday, January 31, 2013 1:54:22 AM (UTC+05:00)  
Service: 1-Phase, 3-Wire (1V, 2C) IT

Account No:  
Tech 1:  
Tech 2:  
Sys ID: 7332-130003



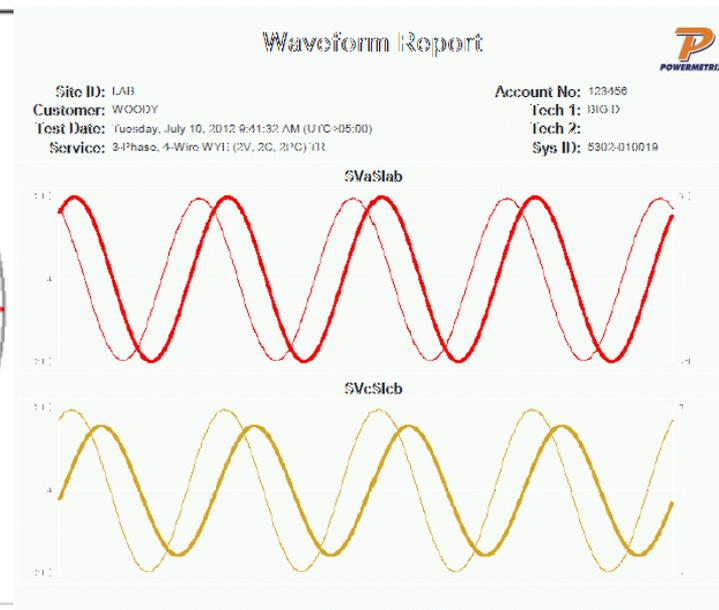
Unity

# Three Wire Three Phase Network Service



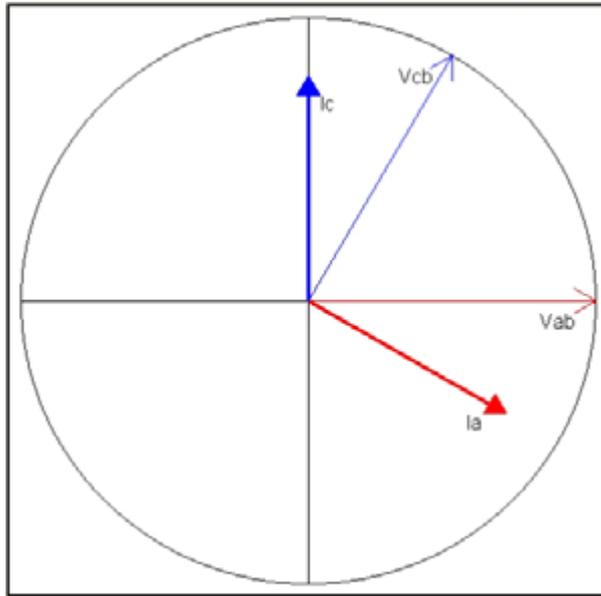
No Lag (1.00 PF)

$30^\circ$  Lag (0.866 PF)

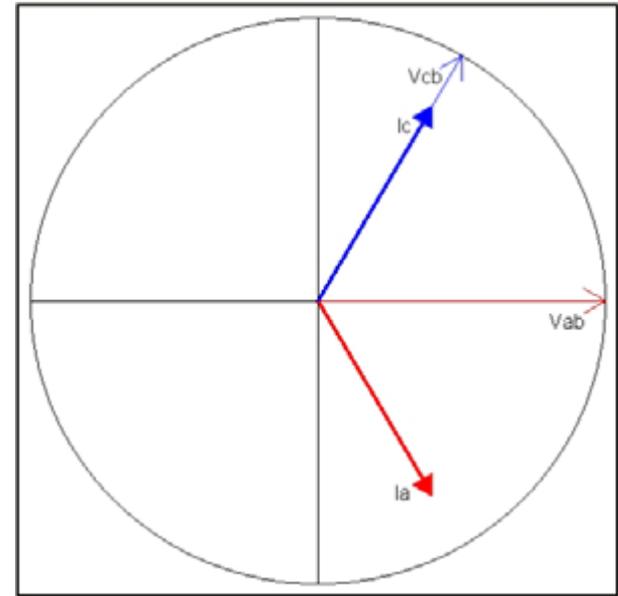


Waveform

# Three Wire Three Phase Delta Service

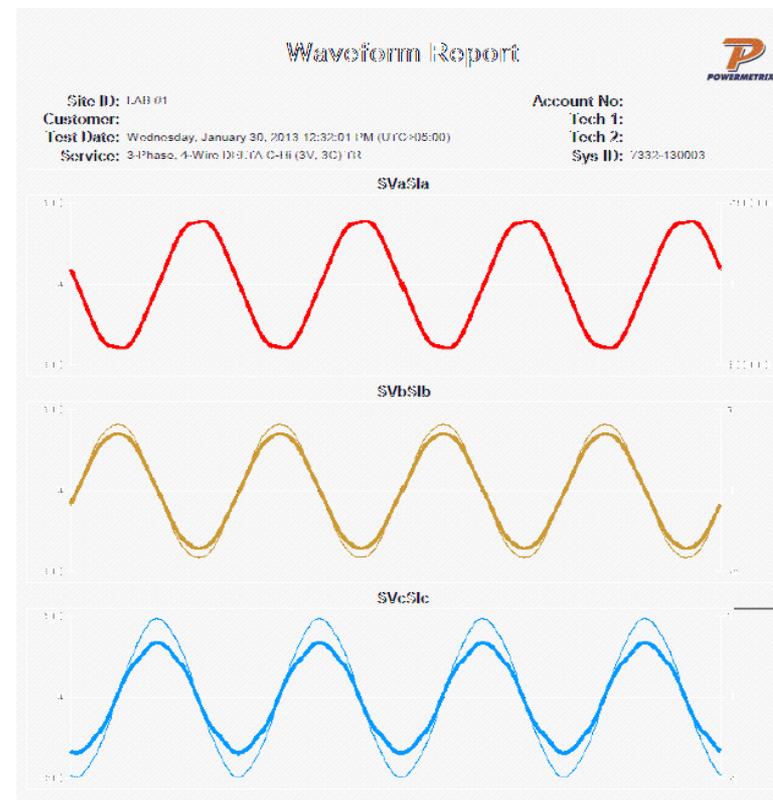
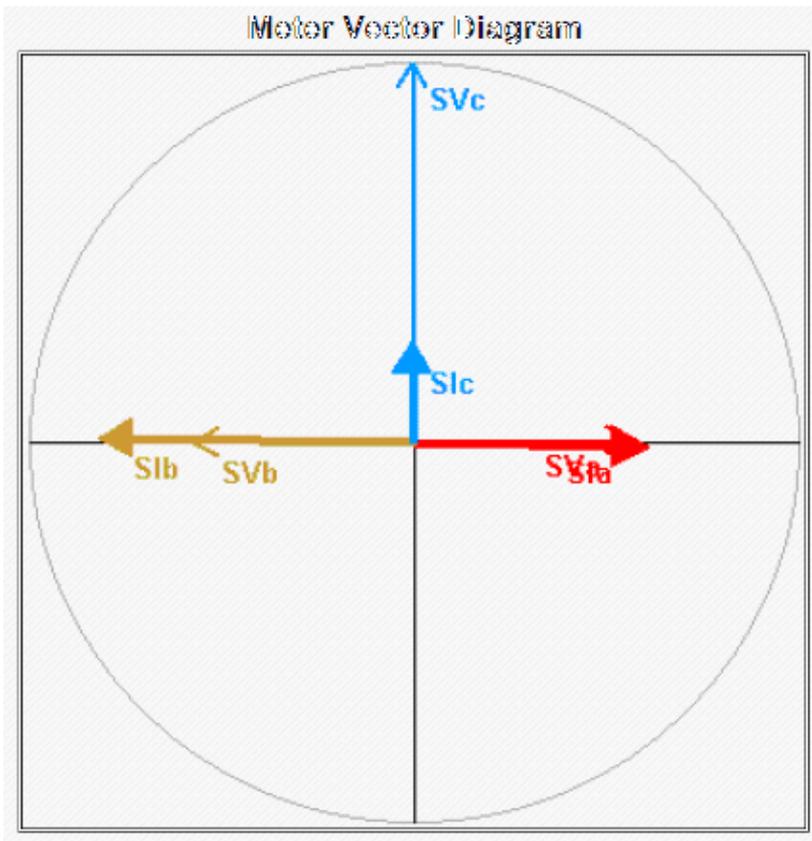


No Lag (1.00 PF)



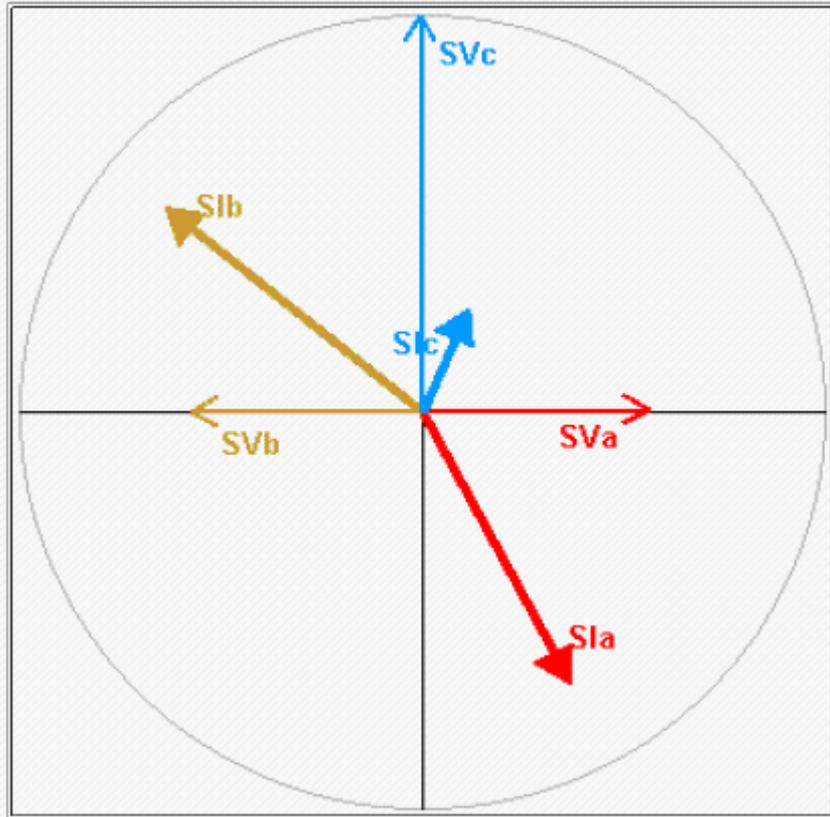
30° Lag (0.866 PF)

# Delta Service at Unity Power Factor



# Delta Service at 50% Power Factor

Meter Vector Diagram



Waveform Report



Site ID: LAB01

Customer:

Test Date: Wednesday, January 30, 2013 12:30:14 PM (UTC+05:00)

Service: 3-Phase, 4-Wire (D) 3.1A C-B (3V, 3C) 1R

Account No:

Tech 1:

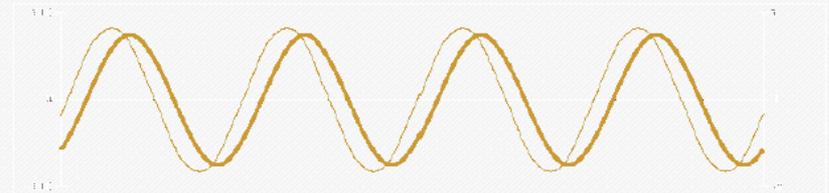
Tech 2:

Sys ID: 7332-130003

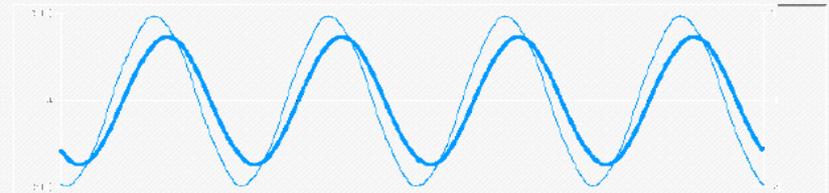
SVaSIa



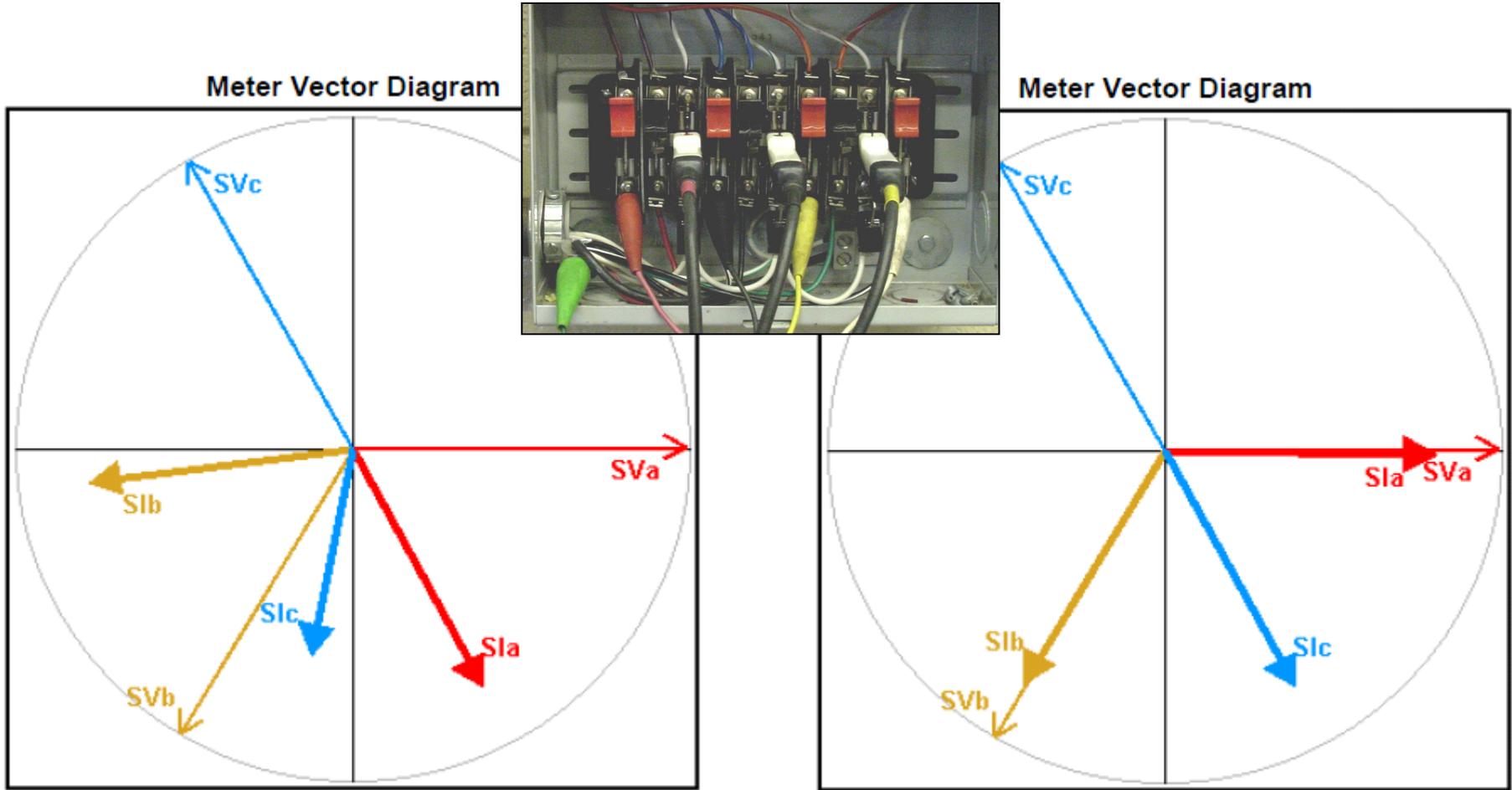
SVbSIb



SVcSIc

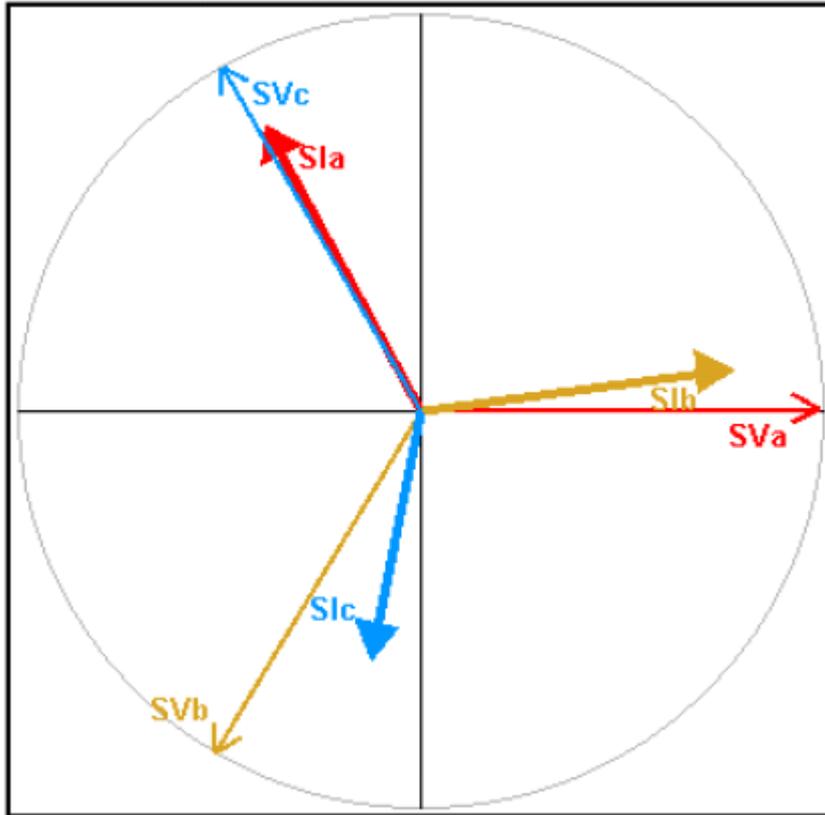


# VIEW THE VECTOR TO VERIFY YOUR CONNECTIONS ...

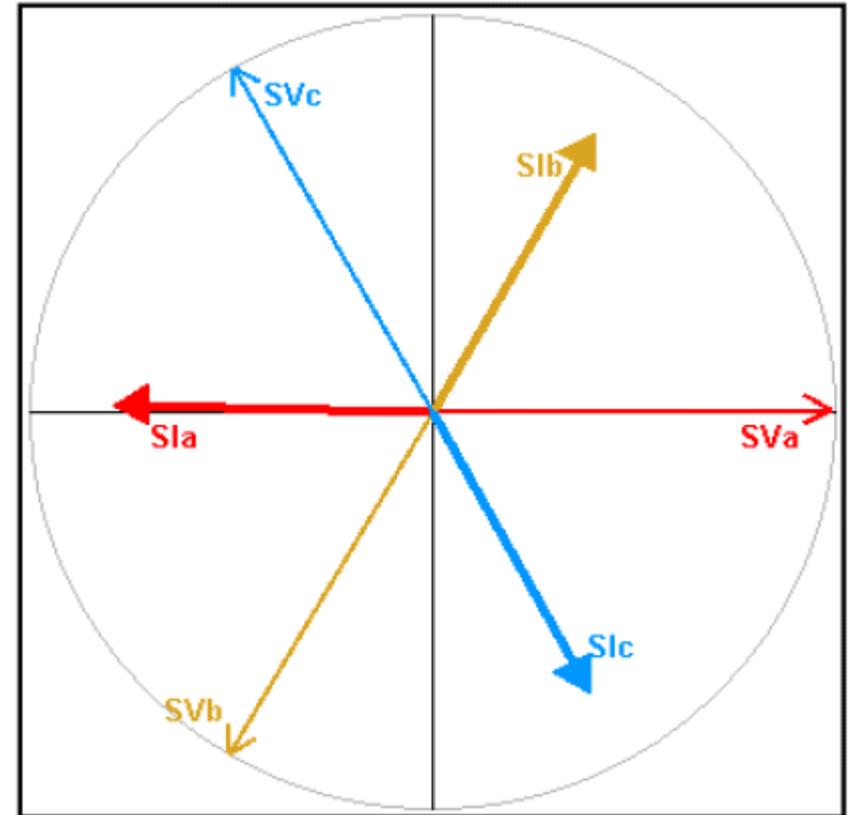


# View the Vector to Verify your Connections ...

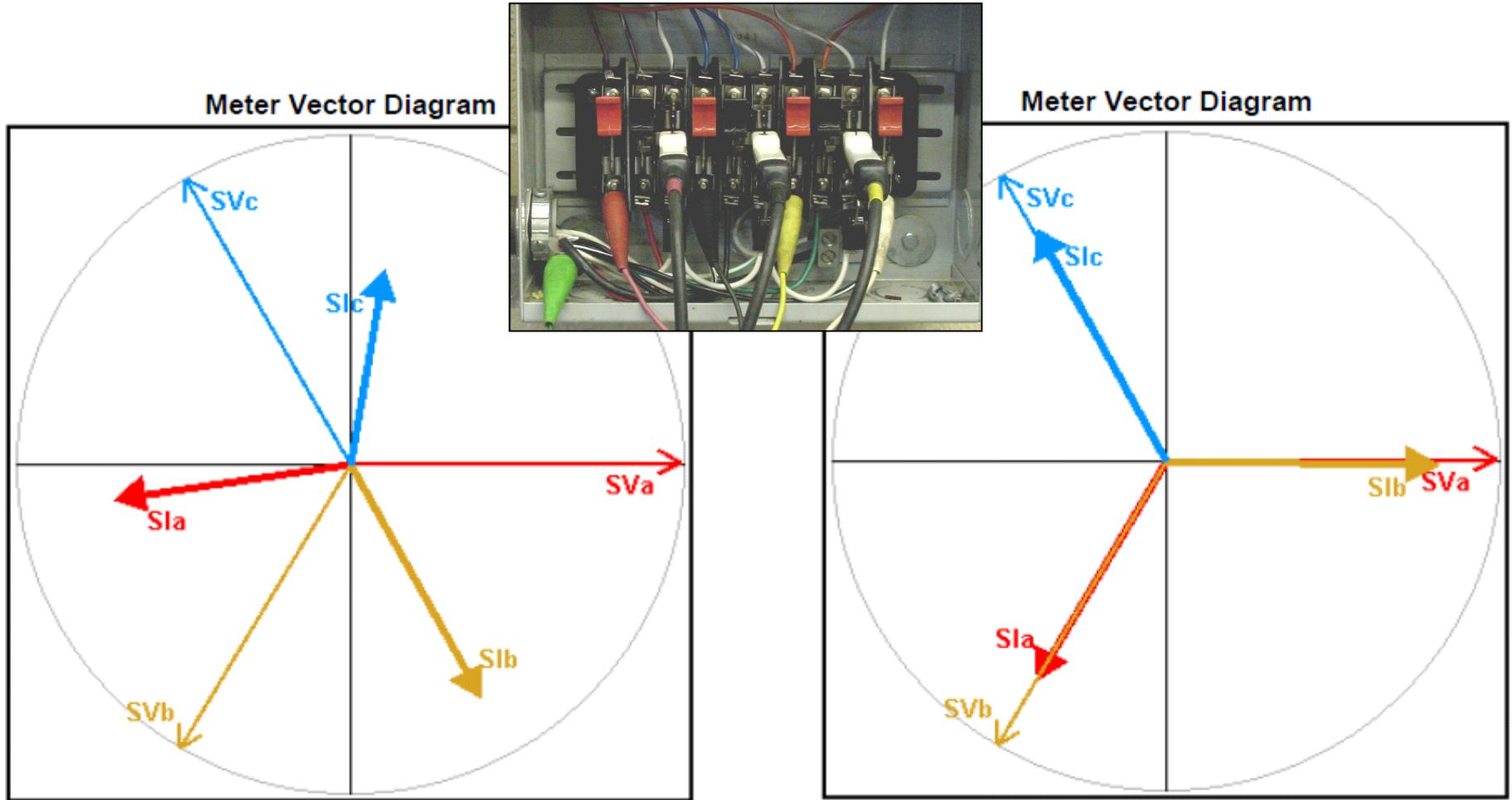
Meter Vector Diagram



Meter Vector Diagram



# View the Vector to Verify your Connections ...

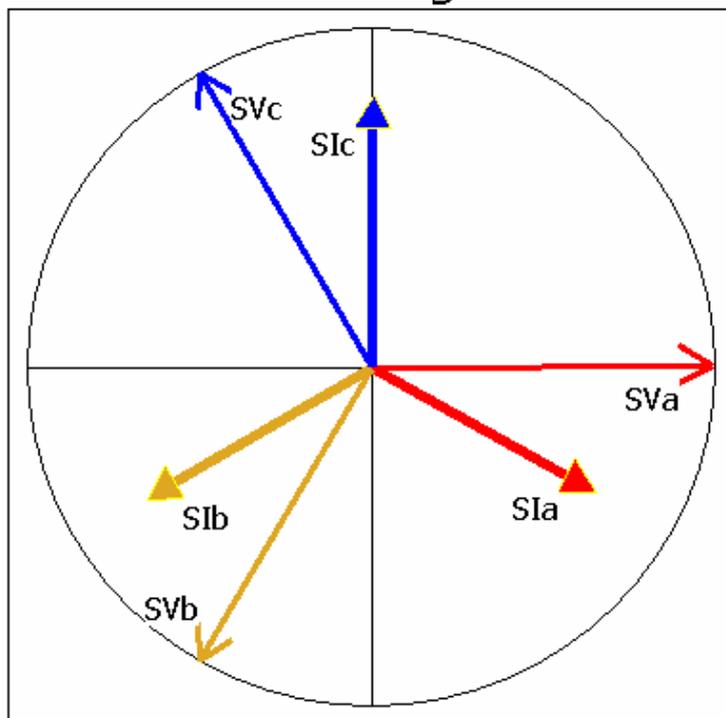


# What your Looking For!

Vector Graph

Selected Site: 3PH 4W WYE (100:5 CT)

## Vector Diagram



### $\Phi$ SVaSIa

SVa	118.747	0.00°
SIa	2.478	29.39°
PF =	0.871	29.39°
Lag		

### $\Phi$ SVbSIb

SVb	119.579	119.92°
SIb	2.504	149.03°
PF =	0.874	29.11°
Lag		

### $\Phi$ SVcSIc

SVc	119.885	240.00°
SIc	2.645	270.54°
PF =	0.861	30.54°
Lag		

### SYS

Vsys =	119.404
Isys =	2.542
PF =	0.869
ROT =	ABC

Measurement: Live Test, Sec V/Sec I, Instantaneous

Reference	Connect.View	Interval	Sec V/Pri I	Stop
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**Correct Vector  
Potentials and Currents Match.  
Start the Scan**

# ***INTEGRATED SITE TEST***

 Main Menu BETA TEST - p19.00M/v16.94M/c#326.13K - Selected Site: 95

**1** Select Site

**2** Integrated Site Test

**3** Meter Testing

**4** Instrument Transformer Testing

**5** Data Trending

**6** Transducer Testing

**7** Deselect Site

**8** Utilities

**9** Recall Data

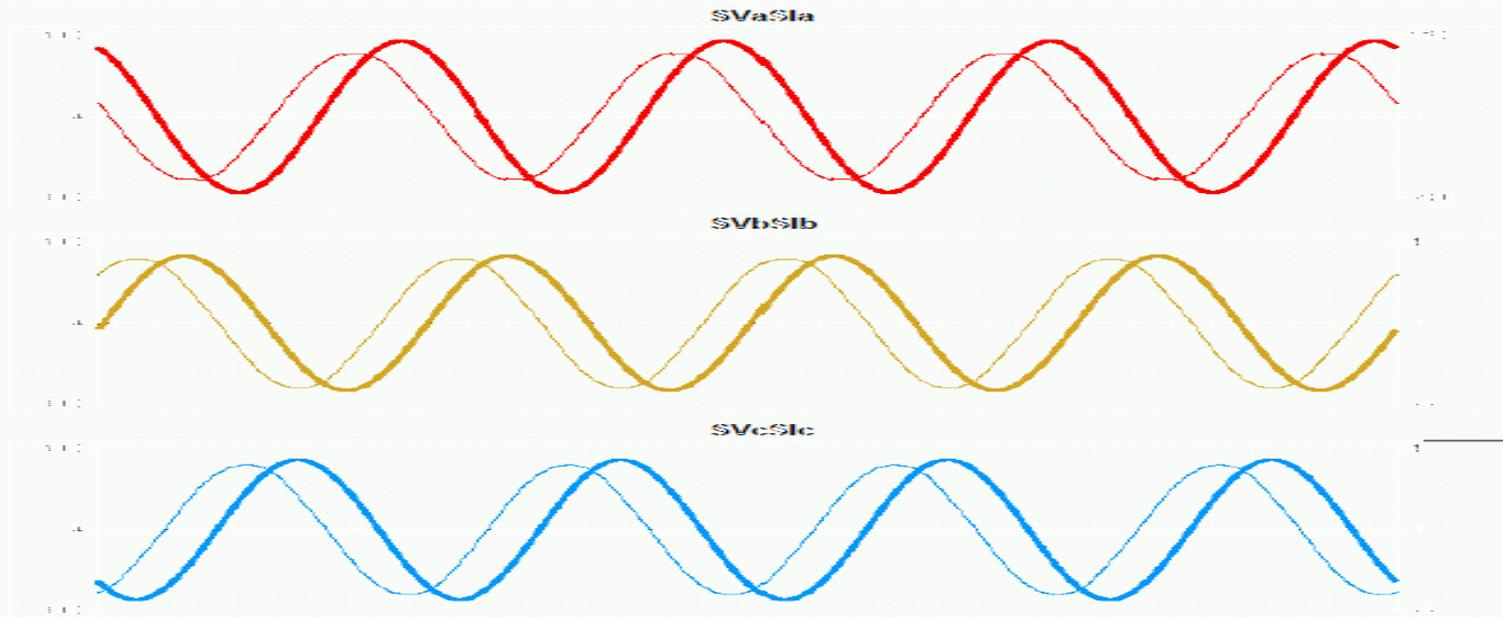
# Capture of Sine Waves of Amps & Volts

## Waveform Report



Site ID: BIG DADDY'S  
Customer: BIG D  
Test Date: Friday, September 07, 2012 9:57:59 AM (UTC+05:00)  
Service: 3-Phase, 4-Wire, Wye (3V, 3C) 112

Account No: 007  
Tech 1: BIG D  
Tech 2: BIG G  
Sys ID: 5302-010019

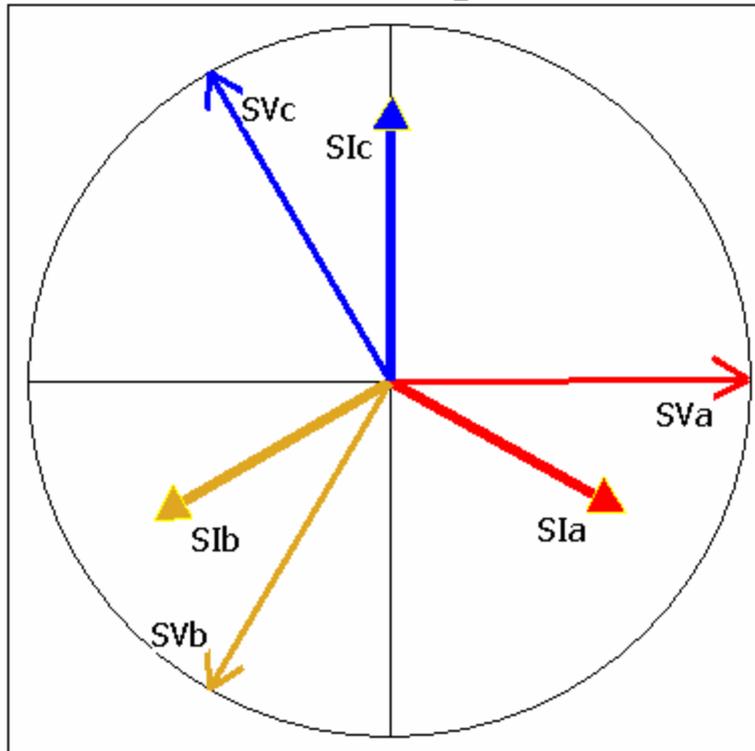


# Capture of Vector

Vector Graph

Selected Site: 3PH 4W WYE (100:5 CT)

## Vector Diagram



### $\Phi$ SVaSIa

SVa	118.747	0.00°
SIa	2.478	29.39°
PF =	0.871	29.39°
Lag		

### $\Phi$ SVbSIb

SVb	119.579	119.92°
SIb	2.504	149.03°
PF =	0.874	29.11°
Lag		

### $\Phi$ SVcSIc

SVc	119.885	240.00°
SIc	2.645	270.54°
PF =	0.861	30.54°
Lag		

### SYS

Vsys =	119.404
Isys =	2.542
PF =	0.869
ROT =	ABC

Measurement: Live Test, Sec V/Sec I, Instantaneous

Reference | Connect.View | Interval | Sec V/Pri I | Stop

# Captures System Overall Summary

## “Breakdown Of Vector”

Power Meter Selected Site: 4W Y 3V 3C S000F09

### SYSTEM OVERALL SUMMARY

	$\Phi$ SVaSIa	$\Phi$ SVbSIb	$\Phi$ SVcSIc	SYSTEM
V(FDRMS)	118.5935	119.4417	119.7183	119.2512
V(Fund)	118.5872	119.4416	119.7181	119.2490
I(FDRMS)	2.506571	2.544676	2.672775	2.574674
A(Fund)	2.506556	2.544665	2.672768	2.574663
$V\theta$	0.0000°	119.8656°	239.9556°	
$I\theta$	359.9395°	119.8011°	241.0687°	
DPF $\theta$	-0.060506°	-0.064425°	1.113085°	
PF(PF1a)	0.999999	0.999999	0.999811	0.999937
<b>W(P1)</b>	<b>297.2454</b>	<b>303.9387</b>	<b>319.9184</b>	<b>921.1025</b>
VA(S1)	297.2456	303.9389	319.9788	921.1633
VAR(Q1)	-0.314487	-0.341550	6.216074	5.560037
THD V	1.030761%	0.125475%	0.173148%	0.443128%
THD I	0.337406%	0.297266%	0.238195%	0.290956%
FREQ	60.00011	60.00008	60.00012	60.00011

Measurement: Live Test, Sec V/Sec I, Instantaneous

Connect.View

Interval

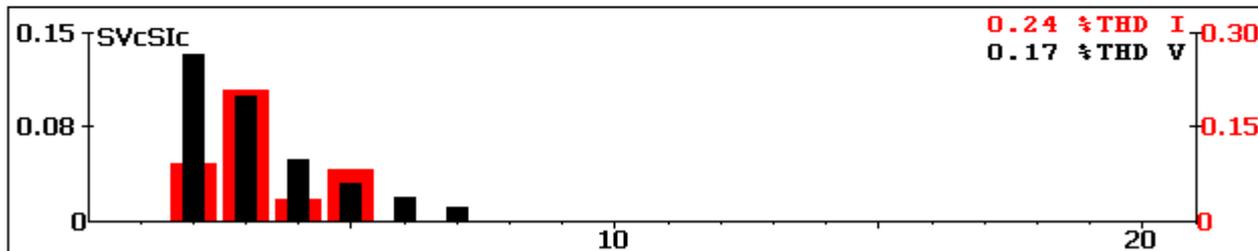
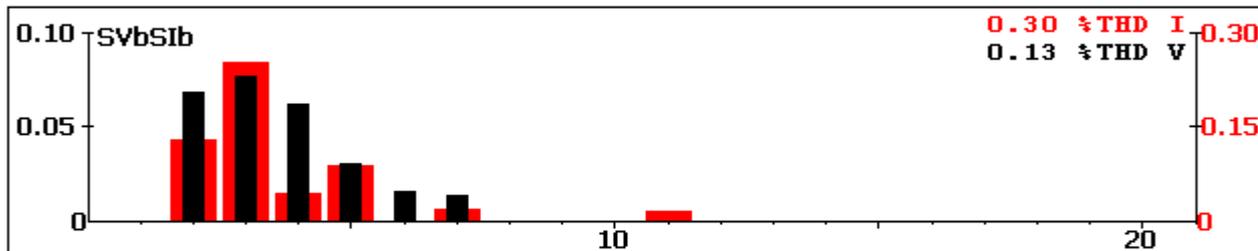
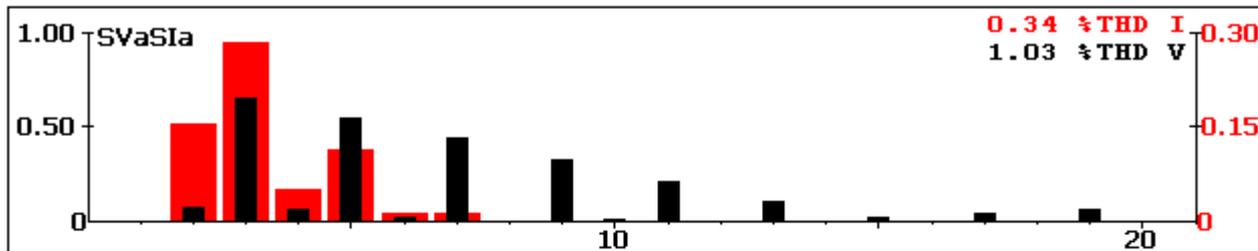
Sec V/Pri I

Stop

# Harmonics for Amp And Volts

Harmonic Analysis

Selected Site: 4W Y 3V 3C S000F09



Measurement: Live Test, Sec V/Sec I, Instantaneous

Details    Connect.View    Interval    Sec V/Pri I    Amplitude    Stop

Amps

Volts

# Harmonics

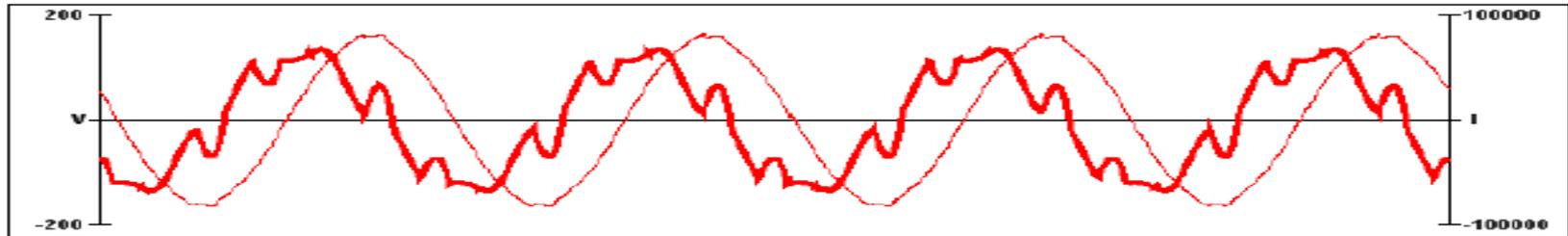
## Waveform Report



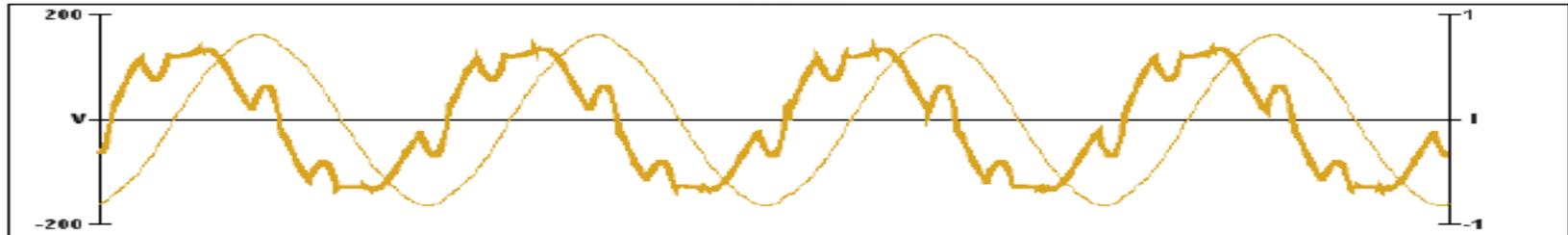
**Site ID:** CIRCUIT4 5 CONCOURSE PKY  
**Customer:** CONCOURSE V ASSOC  
**Test Date:** Thursday, January 24, 2013 1:57:36 PM (UTC+05:00)  
**Service:** 3-Phase, 4-Wire, Wye (3V, 3C) TR

**Account No:** 3386301  
**Tech 1:** BOB HENRY  
**Tech 2:**  
**Sys ID:** 5302-010025

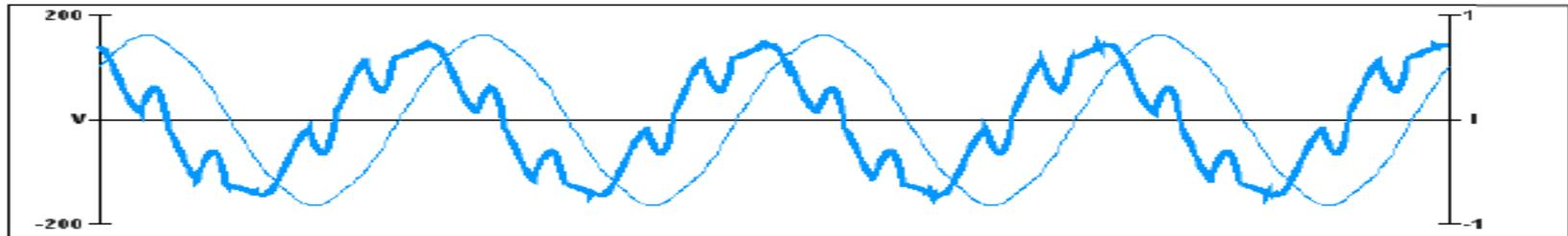
SVaSIa



SVbSIb



SVcSIc



# ***CAUSES OF HARMONICS***

**Harmonics are caused by devices that use an irregular current sinewave when the normal sinewave voltage is applied**

## **LINEAR LOADS (Few Harmonics)**

- Incandescent Lights
- Heating Loads (Resistive)
- Some Motors

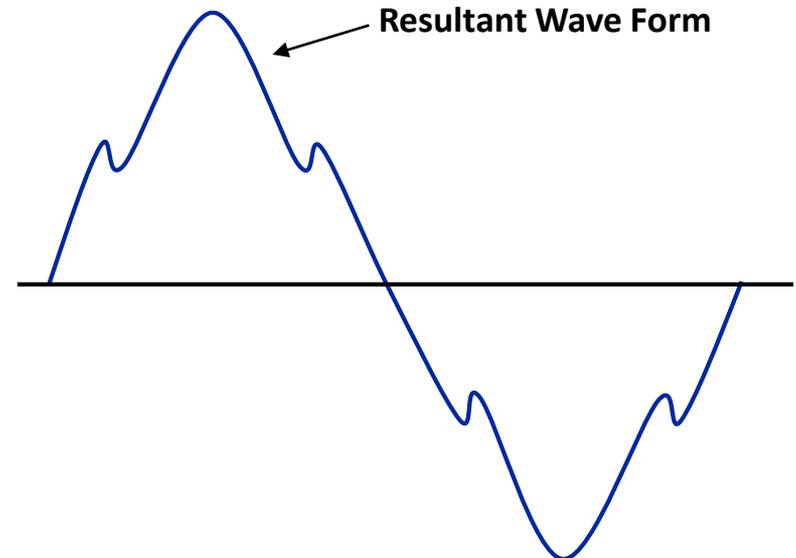
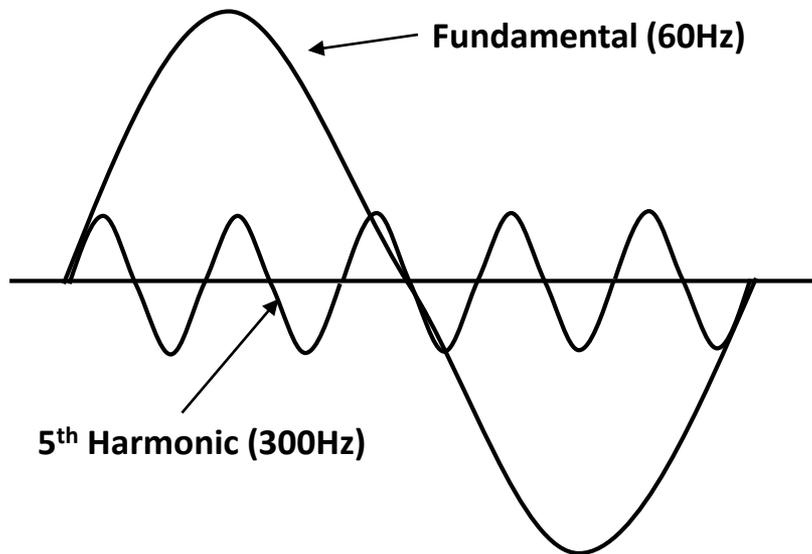
## **NON-LINEAR LOADS (Harmonics)**

- DC Drives
- Power Rectifiers
- Compact Fluorescent Bulbs

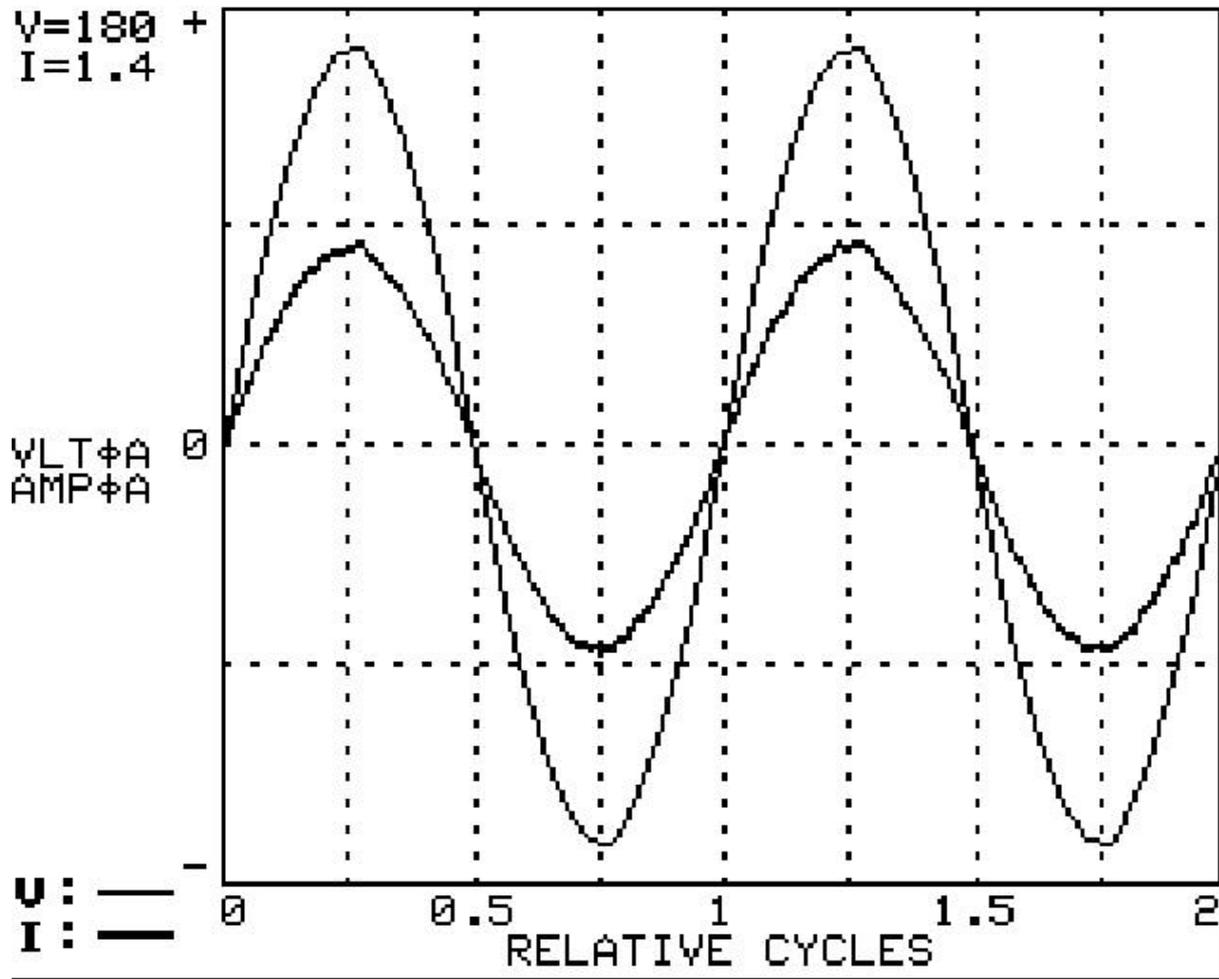
# ***HARMONIC DISTORTION***

Harmonic waveforms are simply multiples of the fundamental waveform.

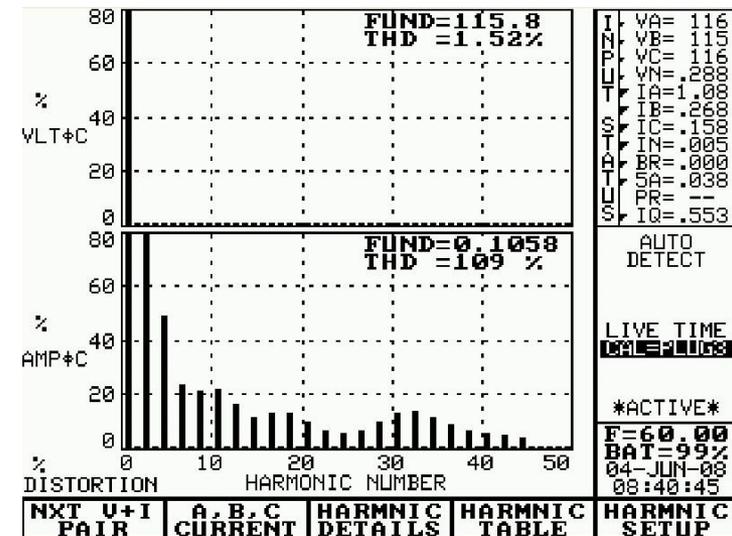
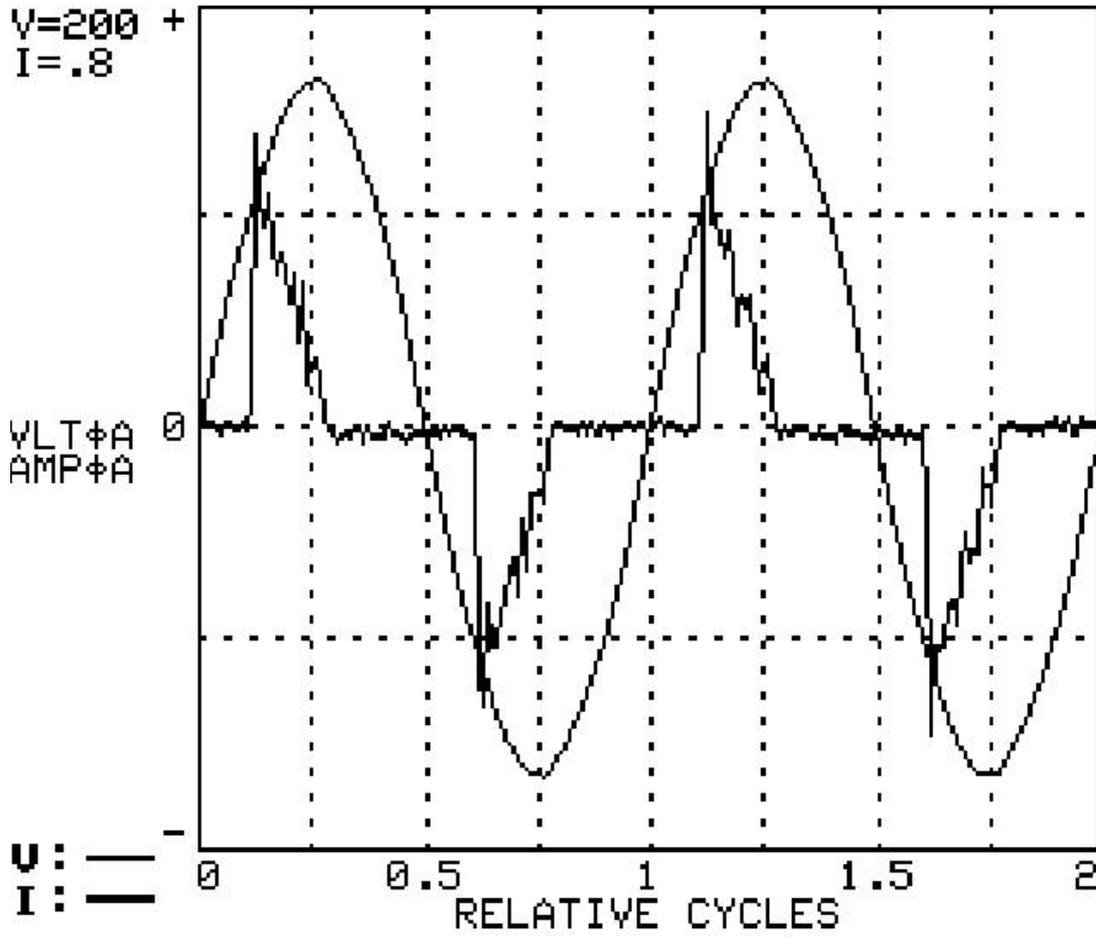
The graphs below show the relationship between a fundamental (60 Hz) current waveform and a 5<sup>th</sup> harmonic (300 Hz) component with about 25% peak deviation.



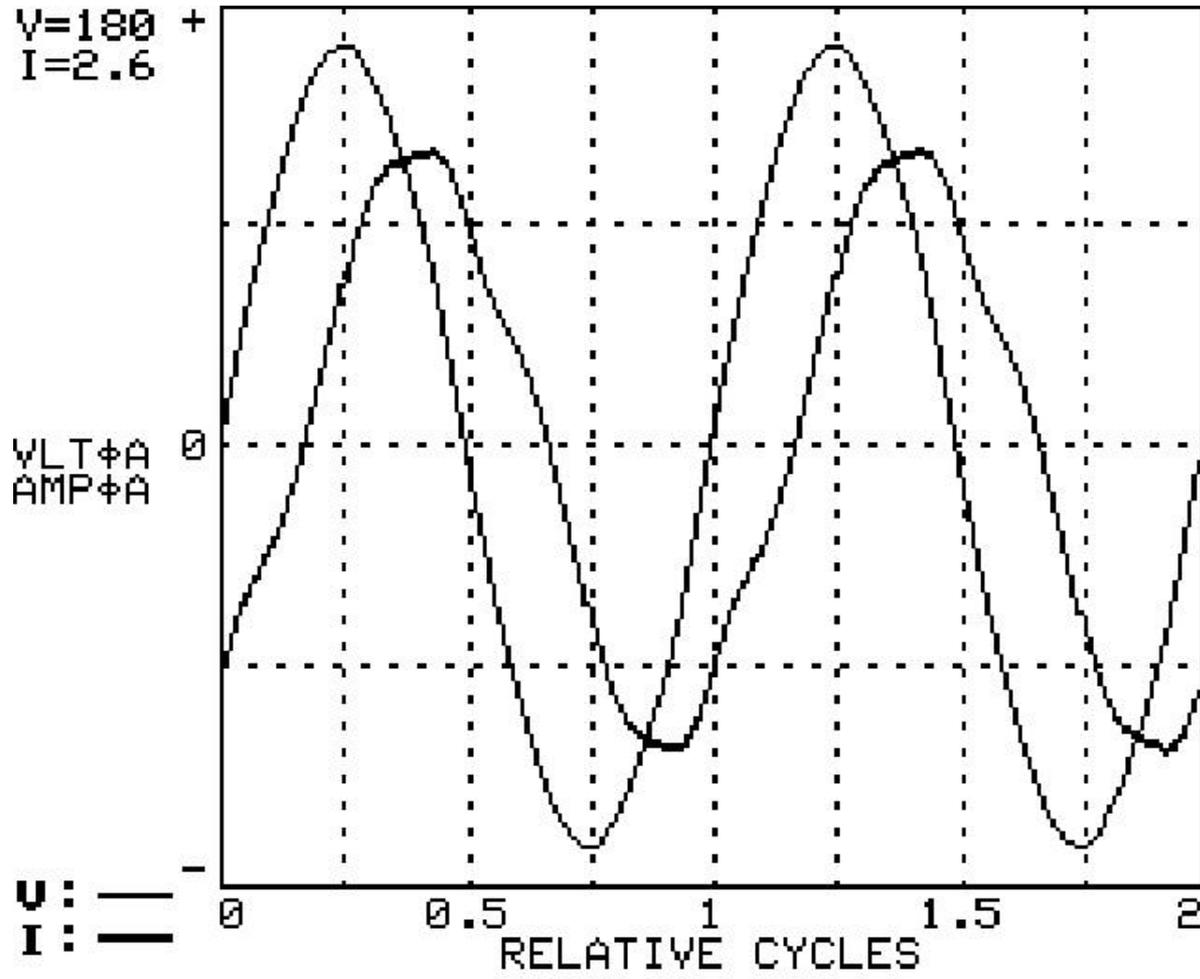
# INCANDESCENT BULB



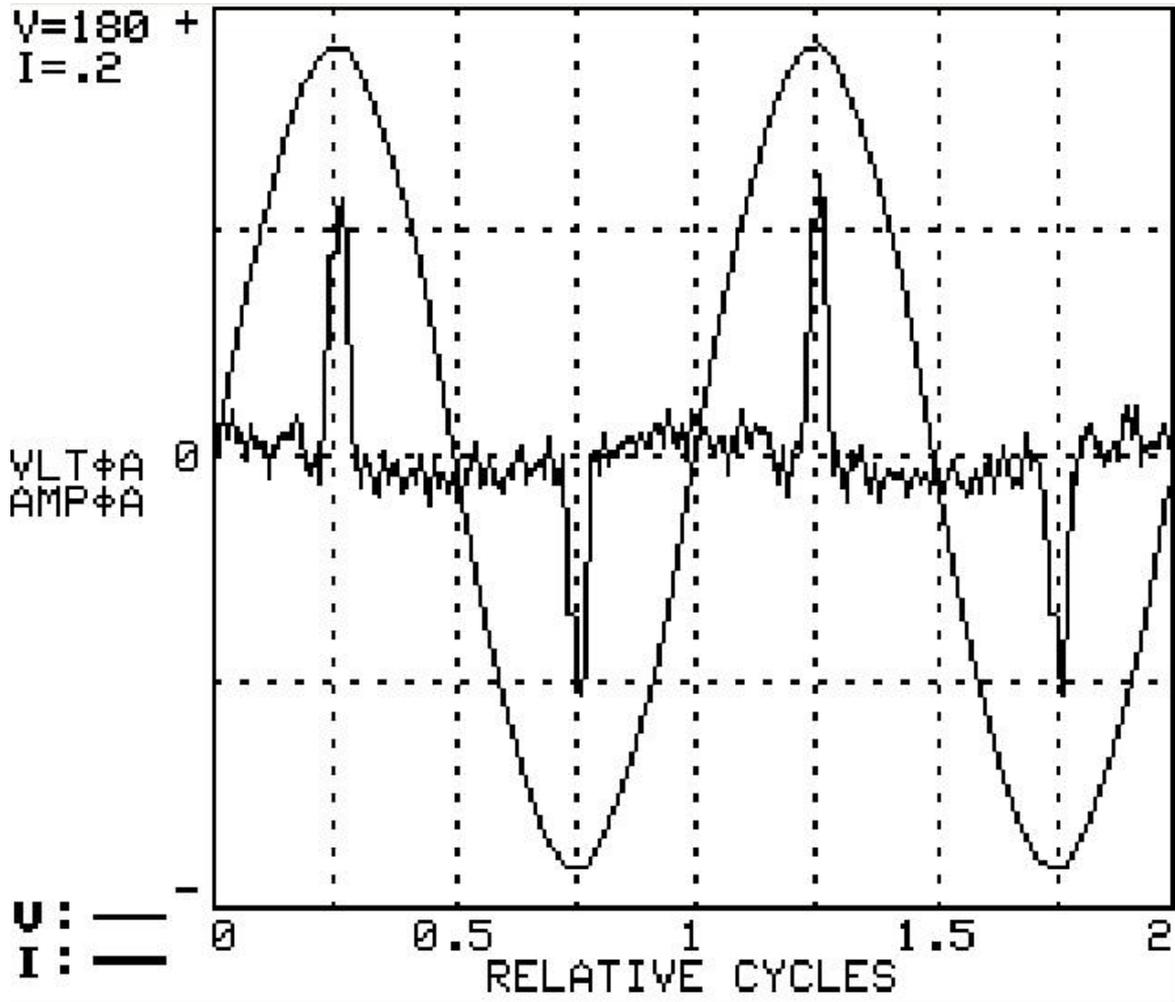
# COMPACT FLUORESCENT BULB



# MOTOR



# POWER SUPPLY FOR LAP TOP COMPUTER



# Meter Accuracy Test

 Main Menu BETA TEST - p19.00M/v16.94M/c#326.13K - Selected Site: 9S

- 1** Select Site
- 2** Integrated Site Test
- 3** Meter Testing
- 4** Instrument Transformer Testing
- 5** Data Trending
- 6** Transducer Testing
- 7** Deselect Site
- 8** Utilities
- 9** Recall Data

# Meter Accuracy Test

Customer Load Test Results

Selected Site: HIGH SCHOOL

Phantom Load Results

Selected Site: None

## Customer Load Meter Test Wh Test

**% Registration 100.055**

### Test Info

### Sys Info

Time(sec)	20.275	Wh	5.3971
Time Left	0.000	VAh	5.3973
Pulses Exp	2.9984	VARh	-0.0435
Pulses Act	3.0000	V	119.473
Meter PF	1.0000	I	2.6770

**FL 99.902**

Phase	Voltage	Current	PF	Time	Pulses
All	120.01	30.009	1.000	36.03	4

**PF 99.866**

Phase	Voltage	Current	PF	Time	Pulses
All	120.01	30.035	0.500	35.98	2

**LL 99.909**

Phase	Voltage	Current	PF	Time	Pulses
All	120.01	3.037	1.000	88.97	1

Test Complete

Page 1 / 2

Restart

View Trend

Done

Retest

Retest All

Next Page

Done

# *Customer or Phantom Load Test*

 Meter Testing

Selected Site: TEST

- 1** Customer Load
- 2** Phantom Load
- 3** Phantom Load with MTA15Z

# Meter Accuracy Test Setup

Customer Load Test Setup

Selected Site: 101

Phantom Load Setup

Selected Site: TEST

Service Type

Setup Name

Test Setup

Kt

Test Mode

Kt

Do Demand Test

Test Time  Seconds

Test Revs

Meter Model

Mfr.SN

Meter No

Test	Phase	Label	Mode	Voltage	Current	PF	Lead/Lag	Flow	Pulses	Time	Rotation	Harm
1	All	FL	Wh	120V	2.5	1	Lag	DLV	10	30	ABC	
2	All	FL PF	Wh	120V	2.5	0.5	Lag	DLV	10	30	ABC	
3	All	LL	Wh	120V	0.25	1	Lag	DLV	10	30	ABC	

Setup changes will apply to this test only

Reset

Next

Edit

Select

# Meter Test Results

## kWH

Customer Load Test Results

Selected Site: HIGH SCHOOL

### Customer Load Meter Test

#### Wh Test

**% Registration 100.055**

#### Test Info

Time(sec)	20.275
Time Left	0.000
Pulses Exp	2.9984
Pulses Act	3.0000
Meter PF	1.0000

#### Sys Info

Wh	5.3971
VAh	5.3973
VARh	-0.0435
V	119.473
I	2.6770

Test Complete

Restart

View Trend

Done

# Phantom Load Tests Results

Phantom Load Results

Selected Site: 4WIRE WYE TEST 5:5ct

**FL 100.42**

Phase	Voltage	Current	PF	Time	Pulses
All	119.67	5.01	1.00	32.28	9

**FL PF 100.03**

Phase	Voltage	Current	PF	Time	Pulses
All	119.74	5.00	0.48	37.23	5

**LL 100.07**

Phase	Voltage	Current	PF	Time	Pulses
All	120.32	0.50	1.00	35.75	1

Page 1 / 1

Retest

Retest All

Done

# VERIFYING CT ACCURACY

 Main Menu

BETA TEST - p19.00M/v16.94M/c#326.13K - Selected Site: 9S

**1** Select Site

**2** Integrated Site Test

**3** Meter Testing

**4** Instrument Transformer Testing

**5** Data Trending

**6** Transducer Testing

**7** Deselect Site

**8** Utilities

**9** Recall Data

# SETUP SCREEN FOR VERIFYING CT ACCURACY

CT Testing

Selected Site: 101

## CT Test Setup

Service Type

CT Mode

Maximum Burden

## Transformer Specs for Phase A

Manufacturer

Model

Accuracy Class

Catalog #

Burden Class

Serial No

Nameplate Ratio  :5

Rating Factor

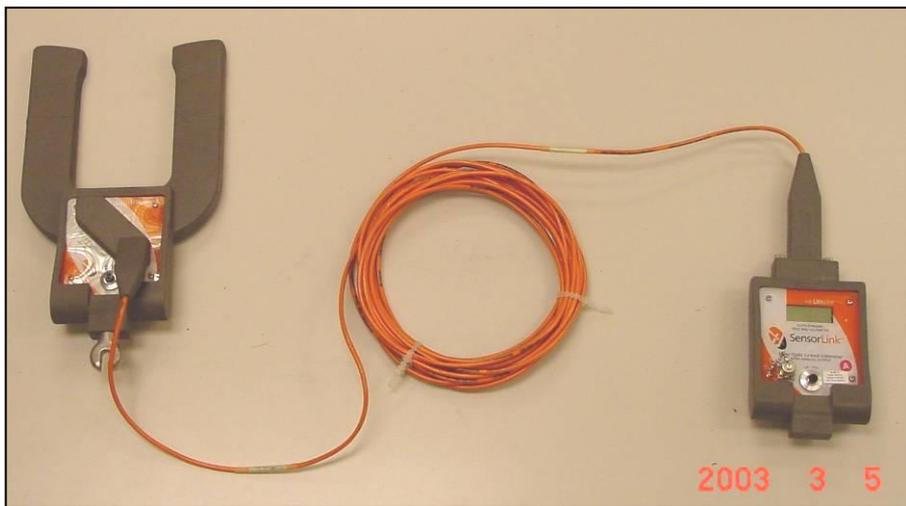
$\Phi$  A

$\Phi$  B

$\Phi$  C

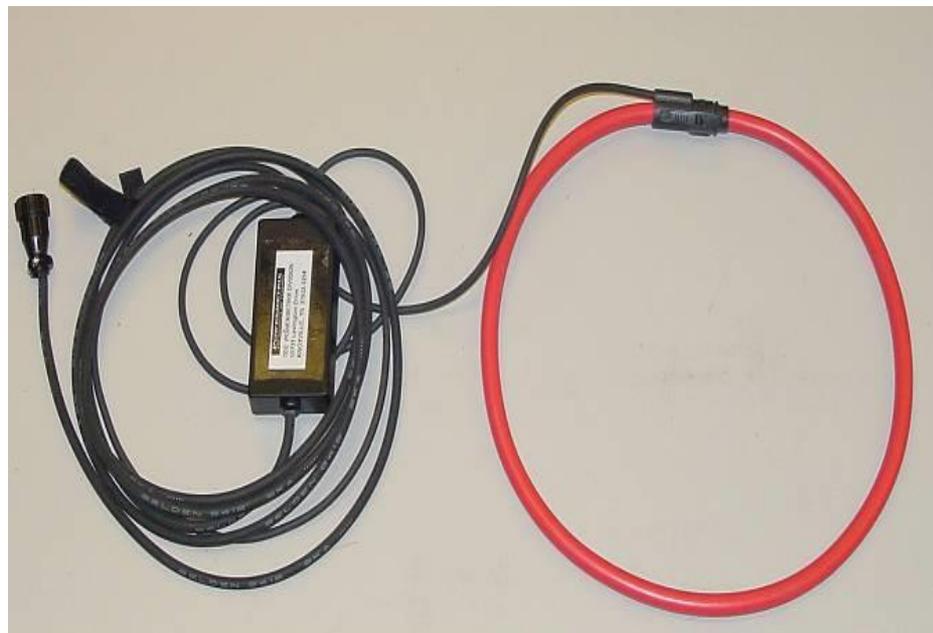
Start Test

# ***DEVICES USED TO MEASURE THE CT'S "PRIMARY" CURRENT (CUSTOMER LOAD)***

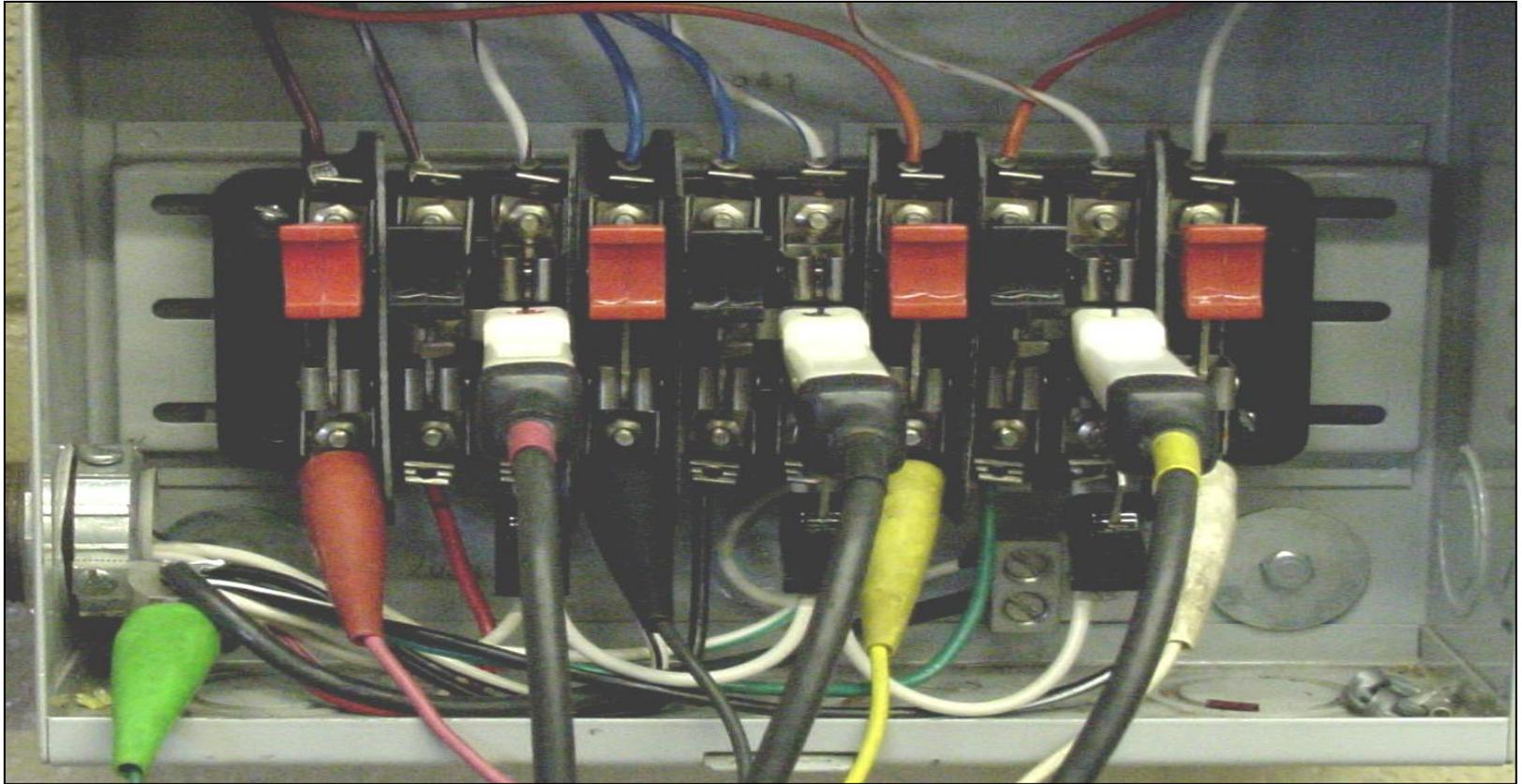


**High Voltage Fiber Optic  
Probe  
Used on Primary and Overhead  
Secondary Services**

**Flex 36 for Services 600 Volts or Less**



# ***MEASURING SECONDARY CURRENT***



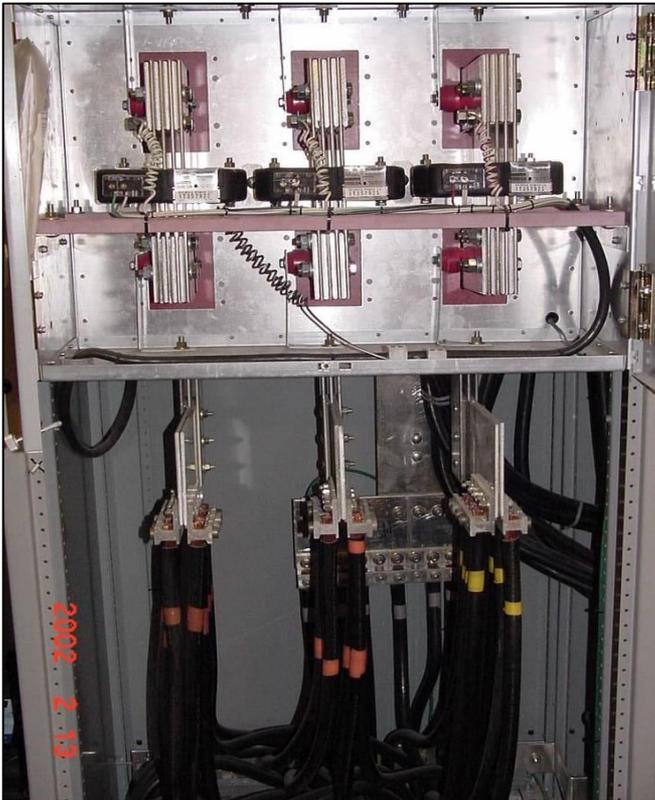
# VERIFYING CT ACCURACY ON 600 VOLTS OR LESS



# ***FLEX PROBE MEASURING CT'S "PRIMARY" CURRENT IN AN U.G. TRANSFORMER***



# FLEX PROBE MEASURING CT'S "PRIMARY" CURRENT IN SWITCHGEAR



**! DANGER**

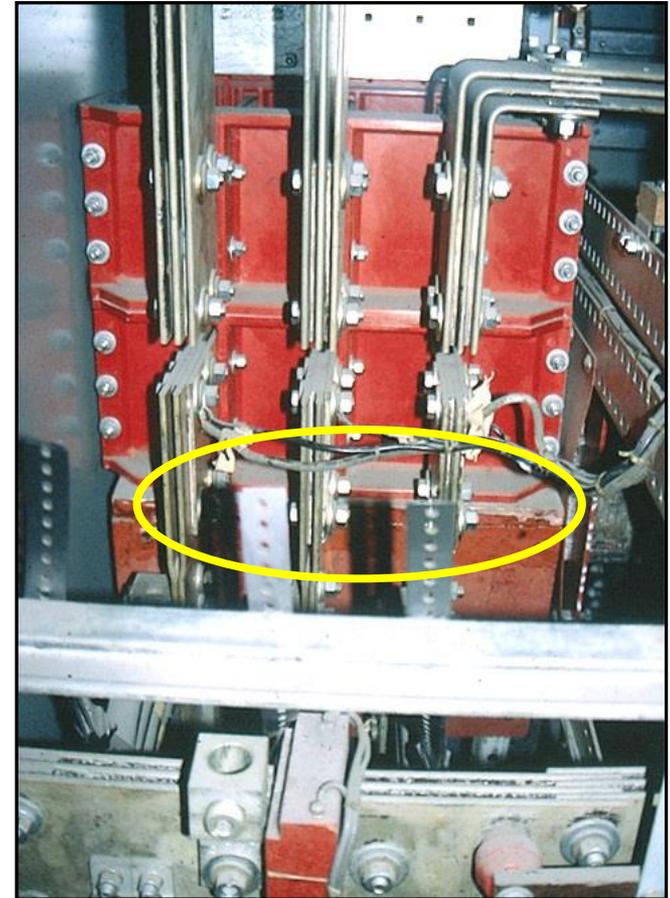
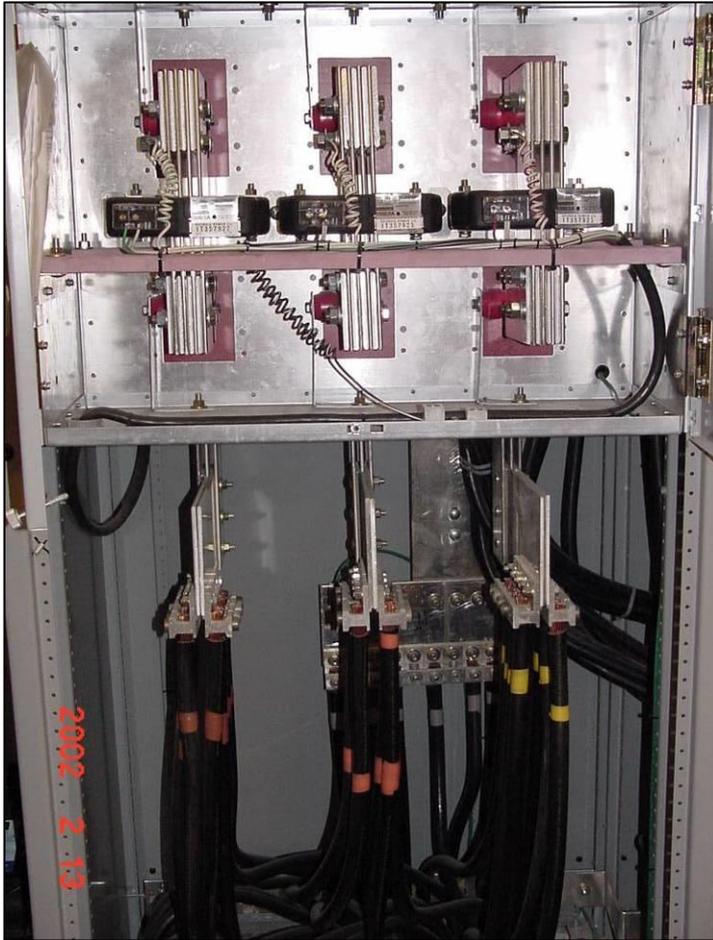
**NO SAFE PPE EXISTS  
ENERGIZED WORK PROHIBITED**

FLASH PROTECTION		SHOCK PROTECTION	
Flash Hazard Category	D	Shock Hazard when cover is removed	480 VAC
Min. Arc Rating:	306 cal/cm <sup>2</sup>	Limited Approach:	42 in
Flash Protection Boundary:	528 in	Restricted Approach:	12 in
PPE	<ul style="list-style-type: none"><li>■ No FR Category Found</li><li>■ Do not work on LIVE!</li></ul>	Prohibited Approach:	1 in

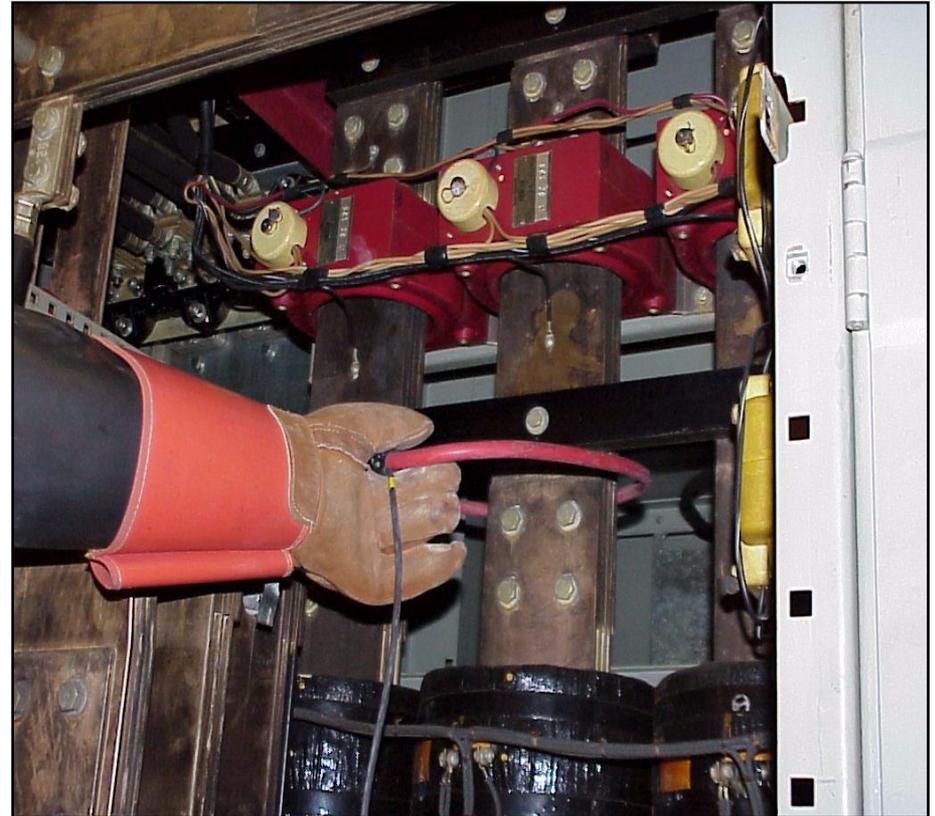
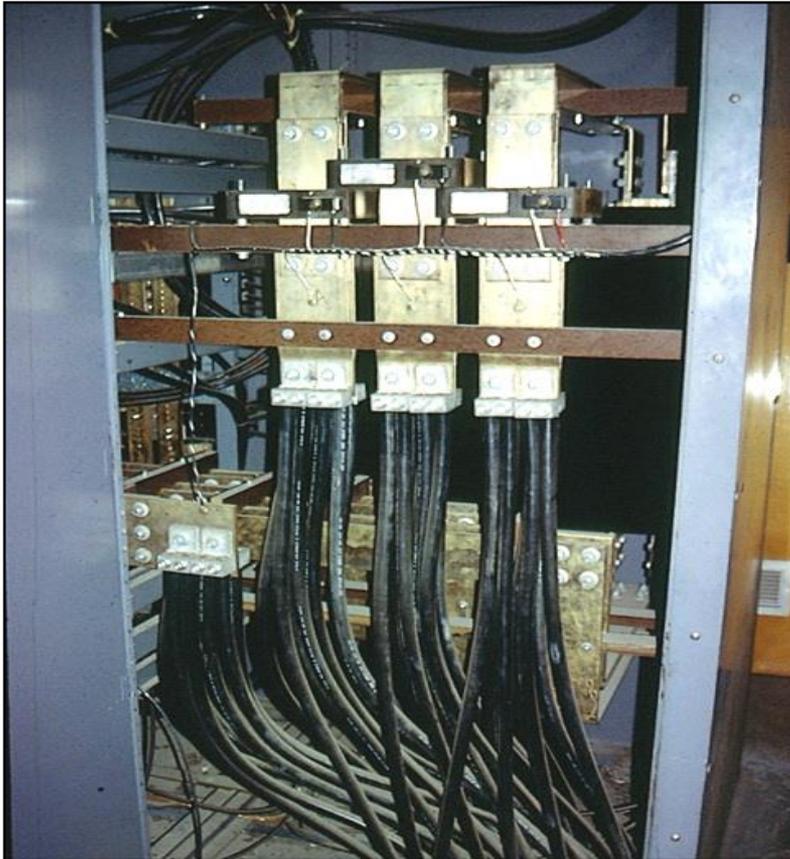
**SWBD MSB-4** **1/6/13** **By: Phillips Consulting Engineers, LLC**

# IMPORTANT NOTE GET AHEAD OF THE CTS...

WHY?



***Do your best to get close to the source as possible...***

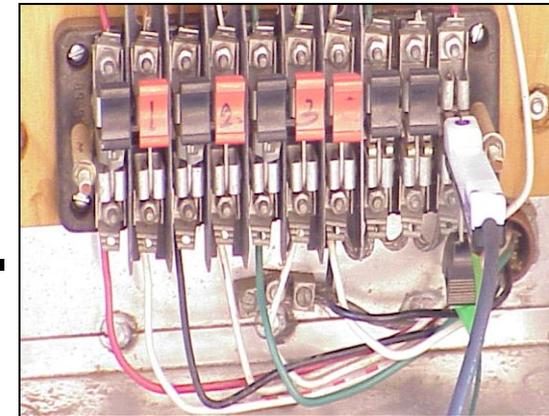


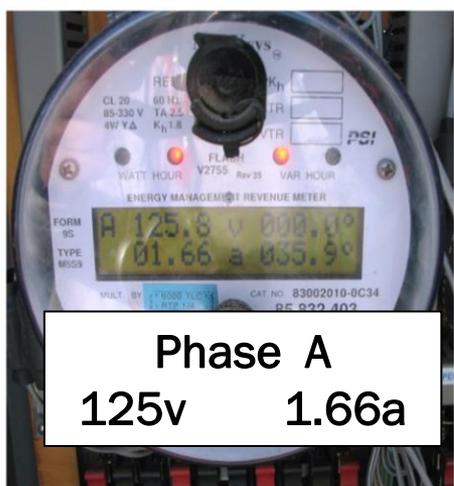
**But do it SAFE!**

# *Fiber Optic Horseshoe Probe used on Primary Services (above 600 volts)*

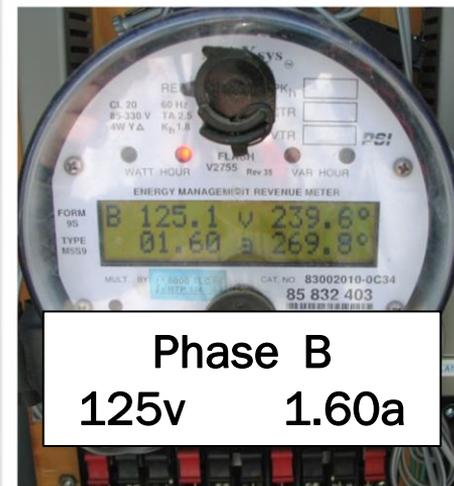


# *Fiber Optic Horseshoe Probe used on Primary Service (above 600 volts)*

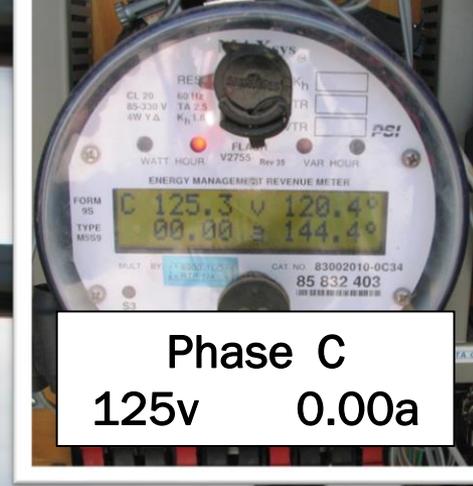




**Phase A**  
125v 1.66a



**Phase B**  
125v 1.60a



**Phase C**  
125v 0.00a

# *Fiber Optic Horseshoe Probe used on Primary Service (above 600 volts)*





# *Fiber Optic Horseshoe Probe can also be used on Over Head Secondary Service*

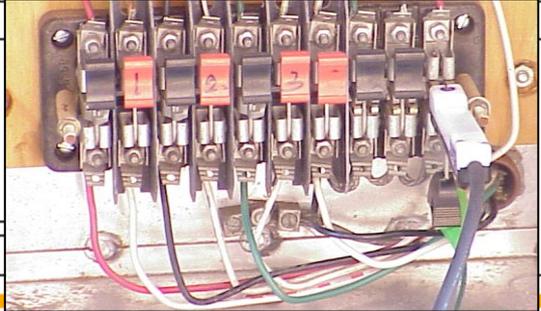


# CT Ratio Test Information Results

CT Testing Results Selected Site: TEST WCM

<b>Measured Ratio: 99.84</b>	<b>FAIL</b>	<b>A</b>
Nameplate Ratio: 100 : 5	Primary Amps: 50.54	
Ratio Error (%): -0.16%	Secondary Amps: 2.531	
Phase Error (degrees): <b>179.844°</b>	Phase Error (minutes): <b>179° 50' 38"</b>	

<b>Measured Ratio: 99.77</b>
Nameplate Ratio: 100 : 5
Ratio Error (%): -0.23%
Phase Error (degrees): -0.149°



<b>Measured Ratio: 99.65</b>	<b>PASS</b>	<b>C</b>
Nameplate Ratio: 100 : 5	Primary Amps: 53.74	
Ratio Error (%): -0.35%	Secondary Amps: 2.696	
Phase Error (degrees): -0.205°	Phase Error (minutes): -12' 17"	

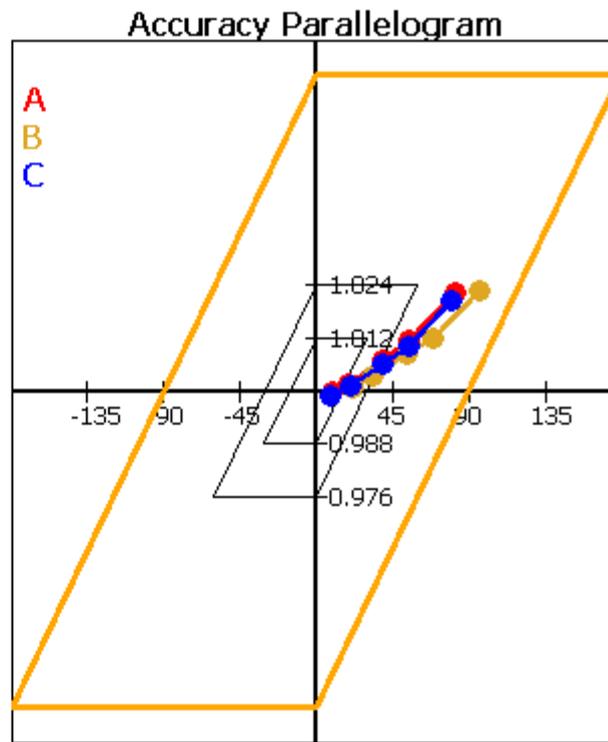
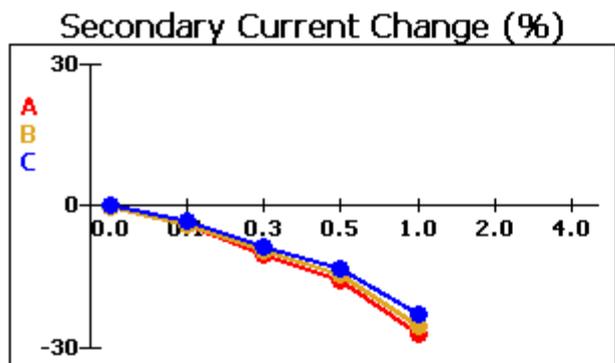
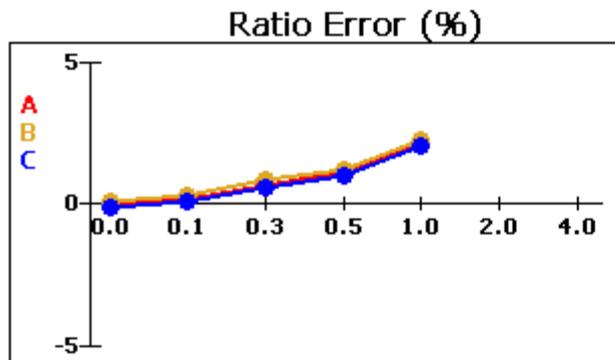
Test Complete

Retest Retest All Demagnetize Graphs Data Done

Possible Errors will be in **RED**, this appears to be a CT running backwards.  
If you didn't check the vector before starting, this is probably your probe installed in reverse. Check the probe and retest the phase in question.

# CT Ratio Test Information Results

CT Testing Results Graphs BETA TEST - p10.37M/v10.19M/c#353.97K - Selected Site: TEST



Φ A
Φ B
Φ C
All
Data

# RESULTS FOR RATIO ONLY

CT Testing Results BETA TEST - p19.43M/v18.50M/c#288.20K - Selected Site: DELETE ME

<b>Measured Ratio: 99.67</b>	<b>PASS</b>	<b>A</b>
Nameplate Ratio: 100 : 5	Primary Amps: 19.97	
Ratio Error (%): -0.33%	Secondary Amps: 1.002	
Phase Error (degrees): -0.045°	Phase Error (minutes): -2' 42"	

<b>Measured Ratio: 99.66</b>	<b>PASS</b>	<b>B</b>
Nameplate Ratio: 100 : 5	Primary Amps: 19.95	
Ratio Error (%): -0.34%	Secondary Amps: 1.001	
Phase Error (degrees): -0.044°	Phase Error (minutes): -2' 38"	

<b>Measured Ratio: 99.68</b>	<b>PASS</b>	<b>C</b>
Nameplate Ratio: 100 : 5	Primary Amps: 19.97	
Ratio Error (%): -0.32%	Secondary Amps: 1.002	
Phase Error (degrees): -0.053°	Phase Error (minutes): -3' 9"	

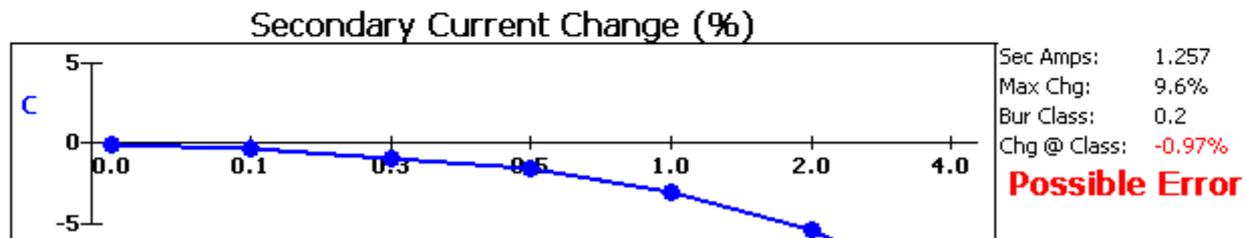
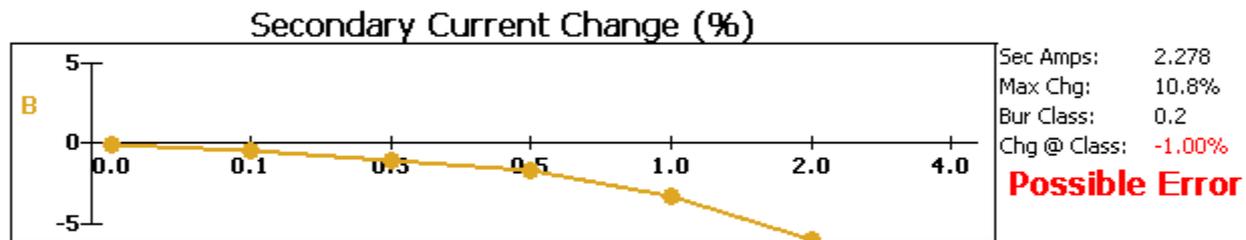
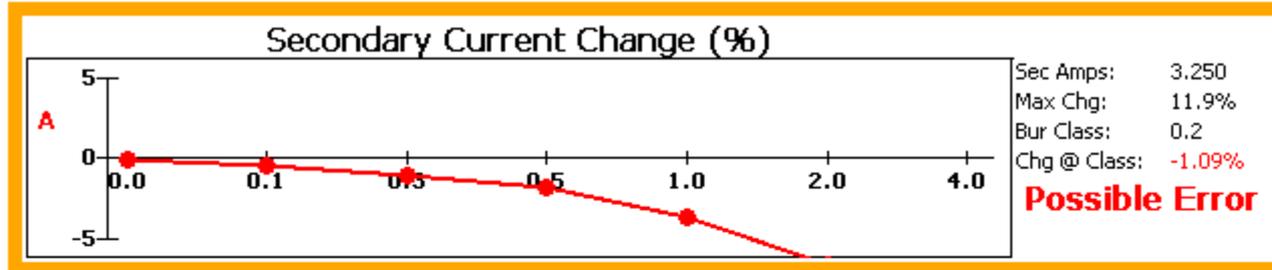
Test Complete

Retest	Retest All	Demagnetize	Graphs	Data	Done
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# Results for Burden Only

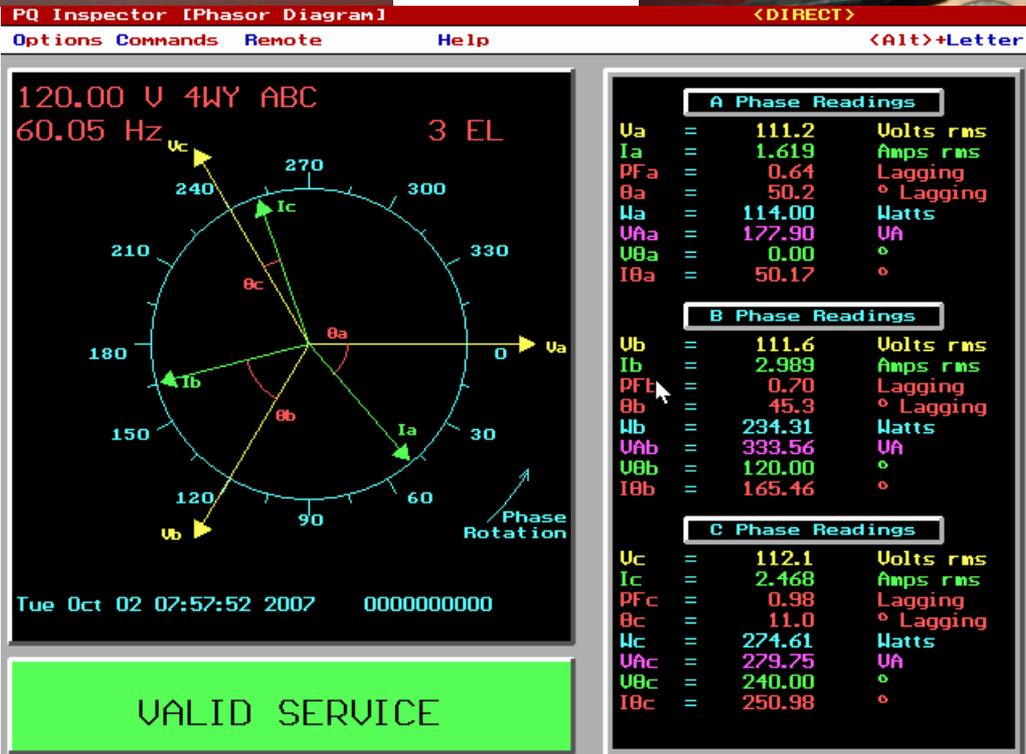
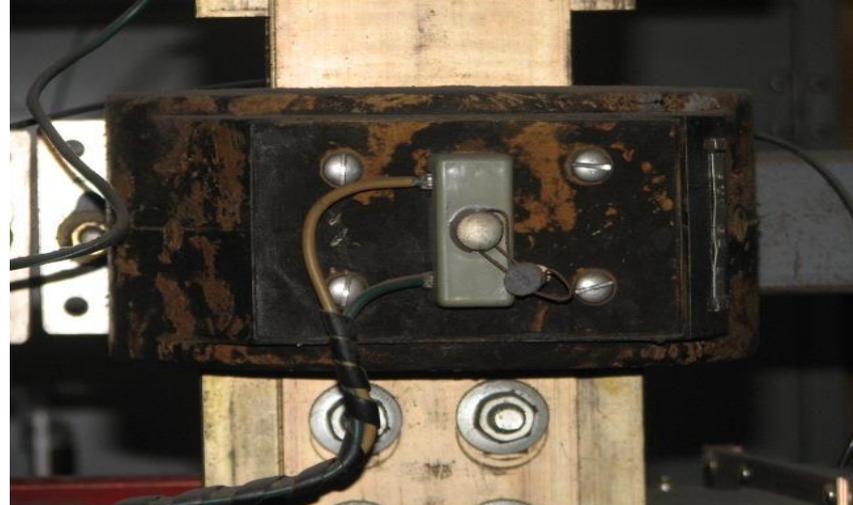
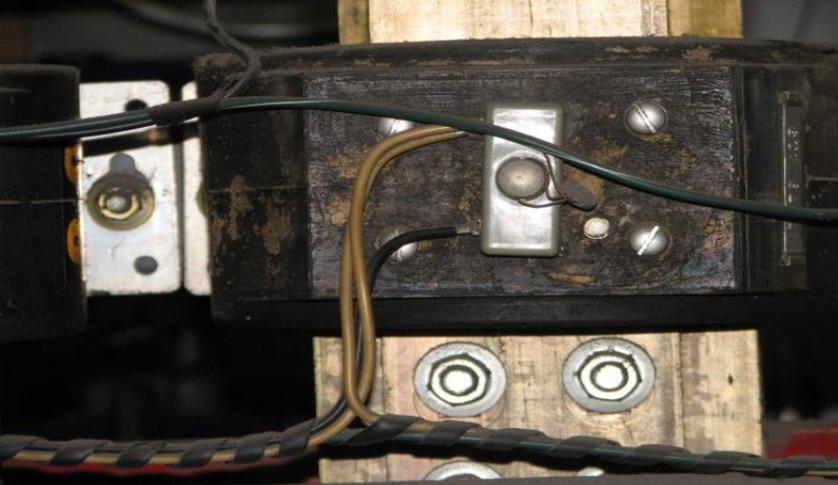
CT Testing Results

Selected Site: TEST



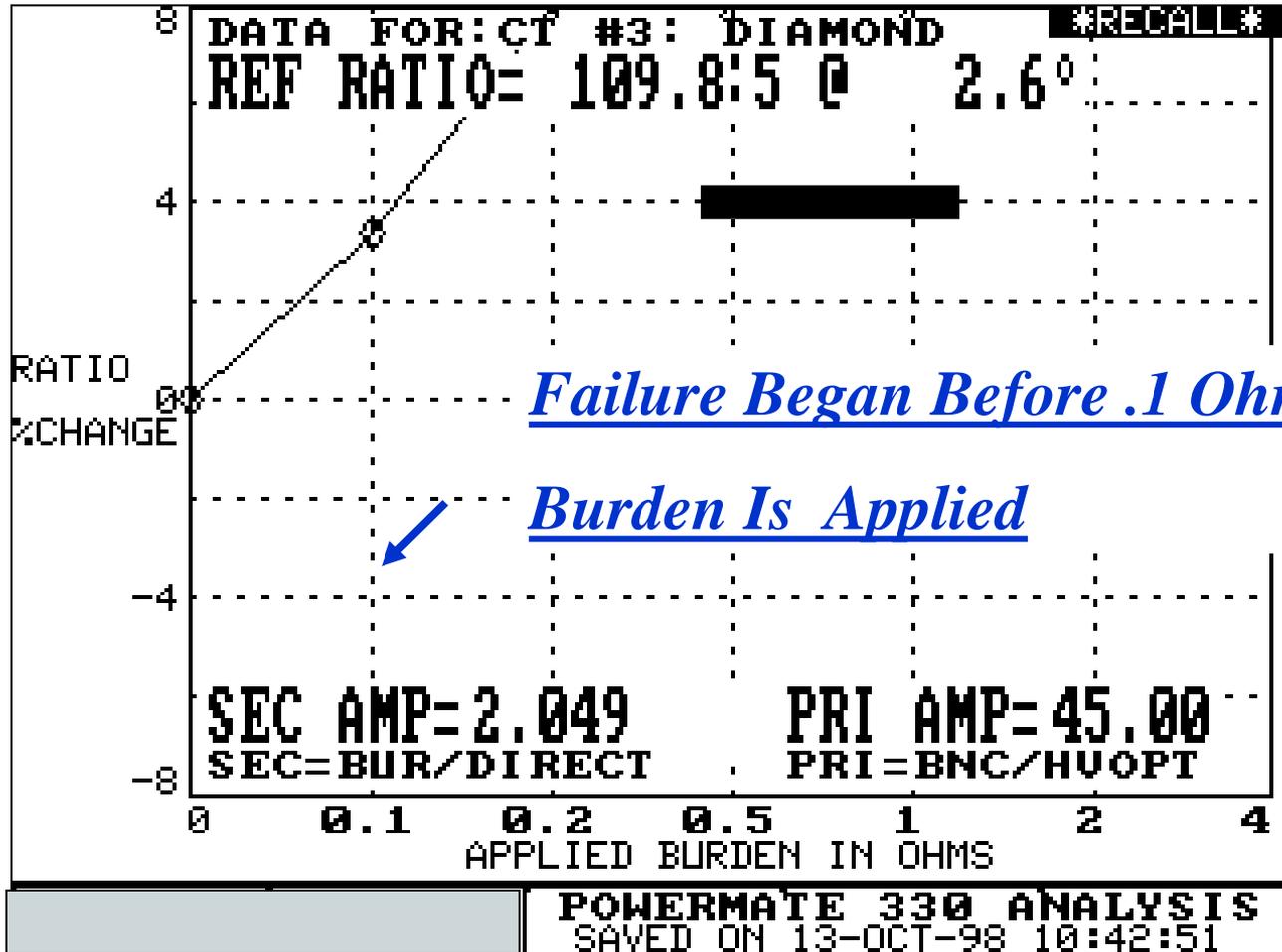
Test Complete

Retest Retest All Data Done



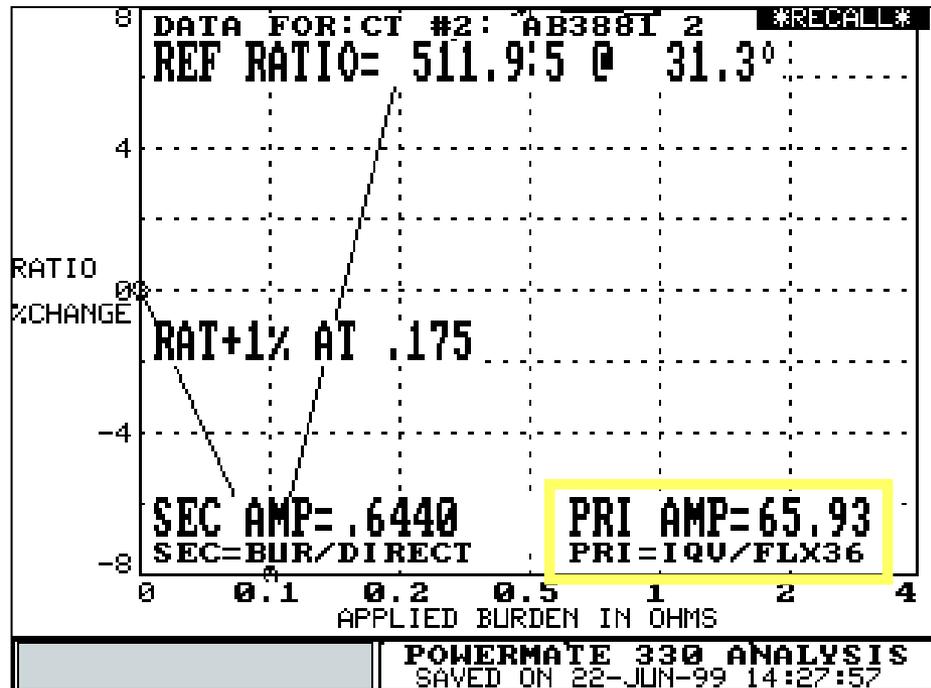
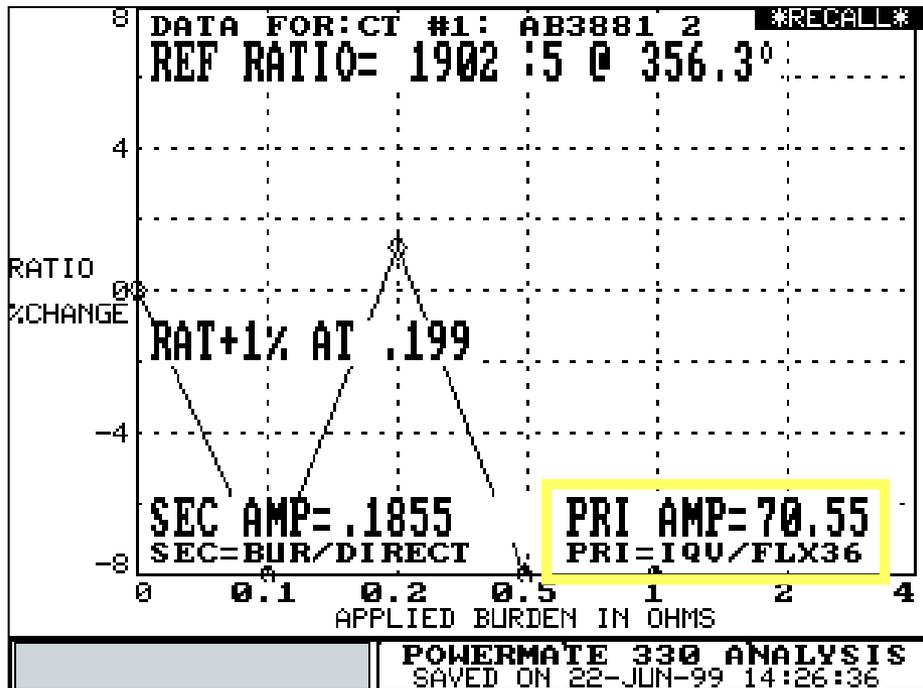


# Bad CT



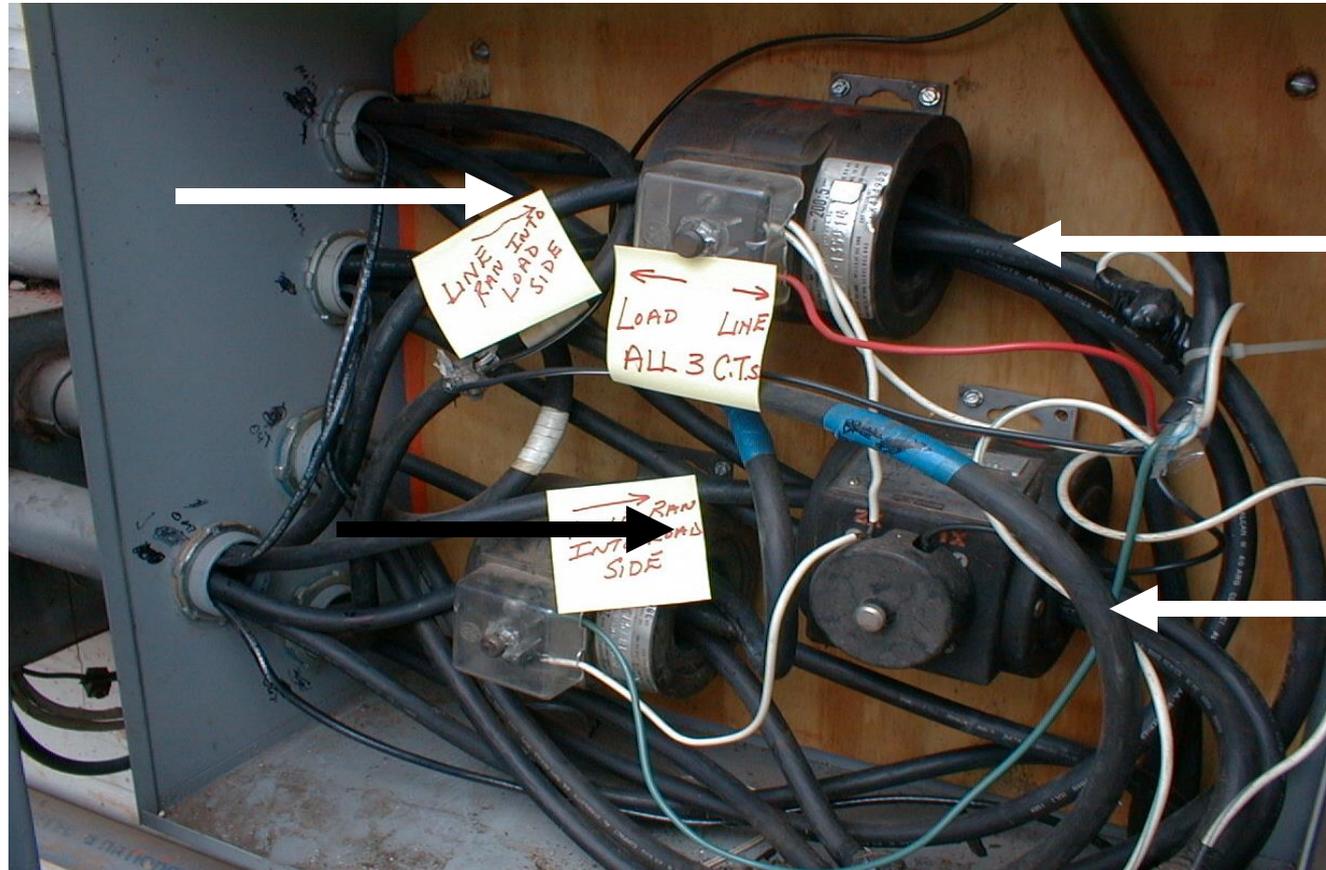
# Bad CT ?

Ratio Should Be 200 : 5



# No, Just A Bad Electrician

Additional run of wire installed and pulled through Two CTs backwards

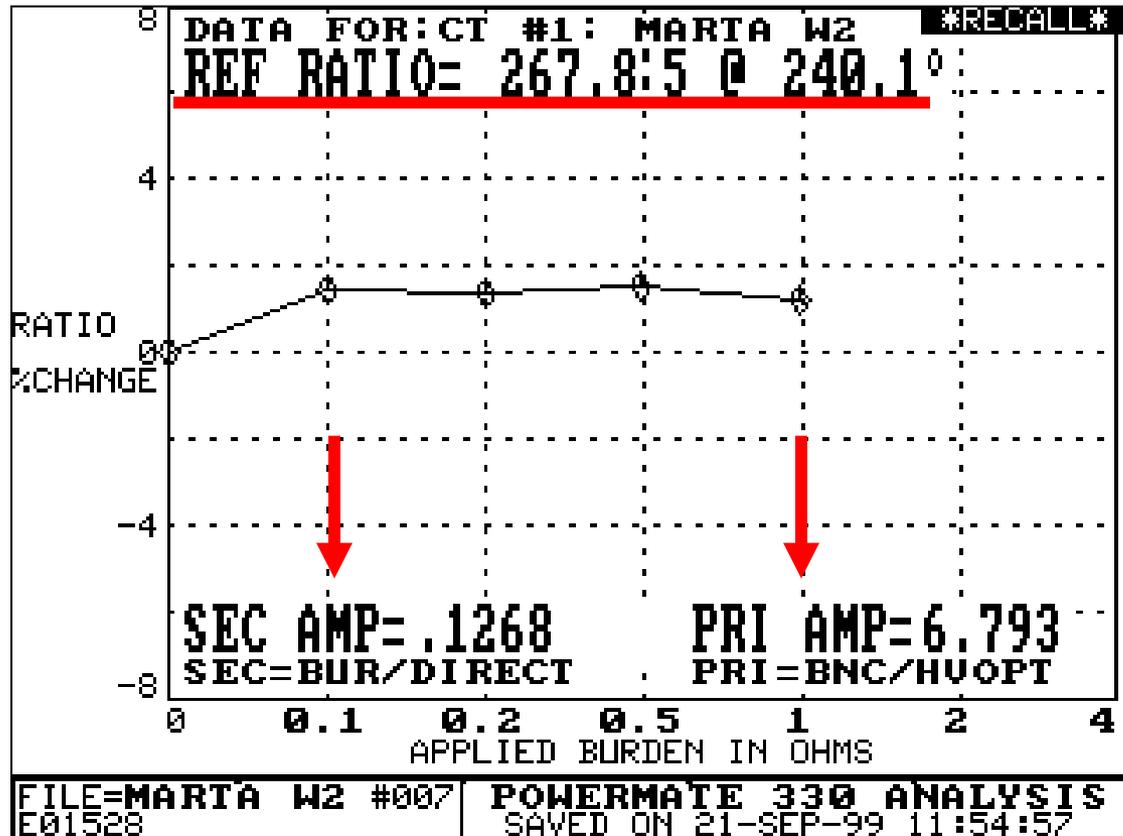


Current Flow

Current Flow

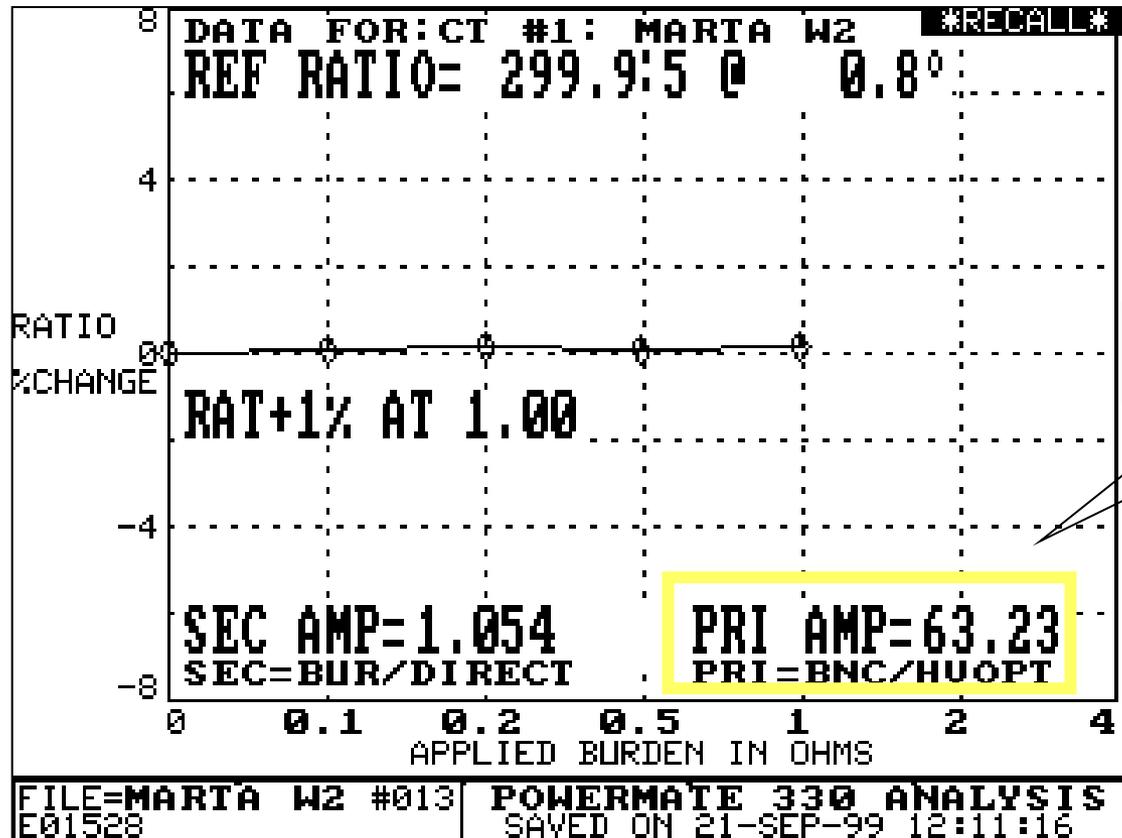
# Bad CT ?

## 300 : 5 Primary CTs Ratio Results at 112%



# Same CT 15 Minutes Later

## What Happened ?



21% of CT  
Rated Load

Best Resolution Achieved If Secondary Amps  
Are At Least 10% of CT Value

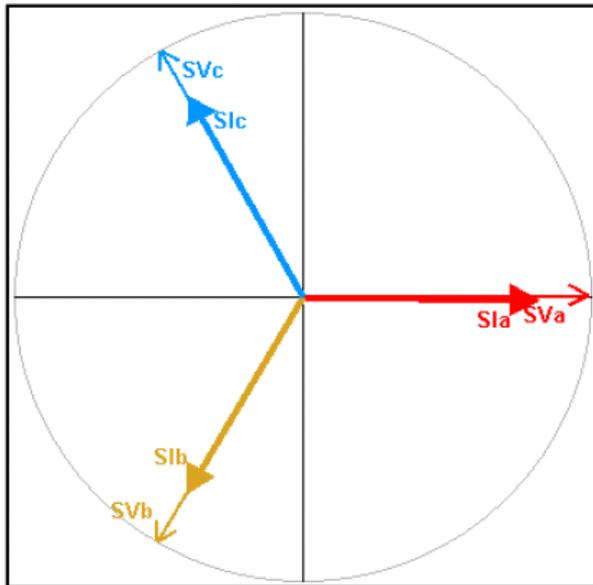
# ***Vectors***

***What Do We Look For ?***

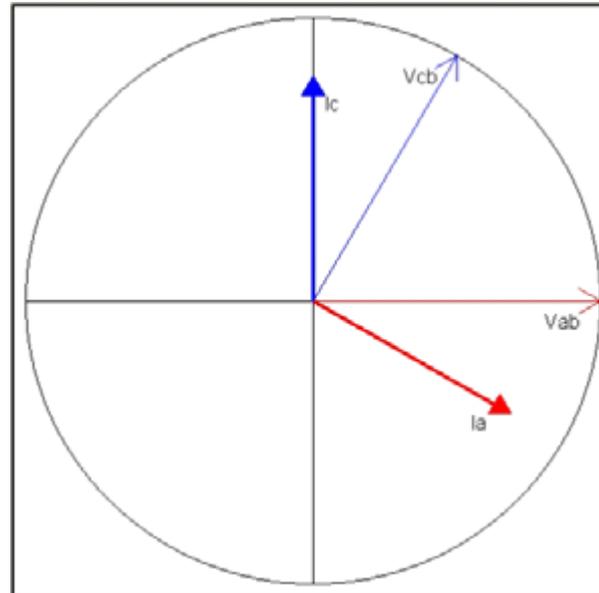
# Services At Unity Power Factor

## 4 wire WYE

Meter Vector Diagram

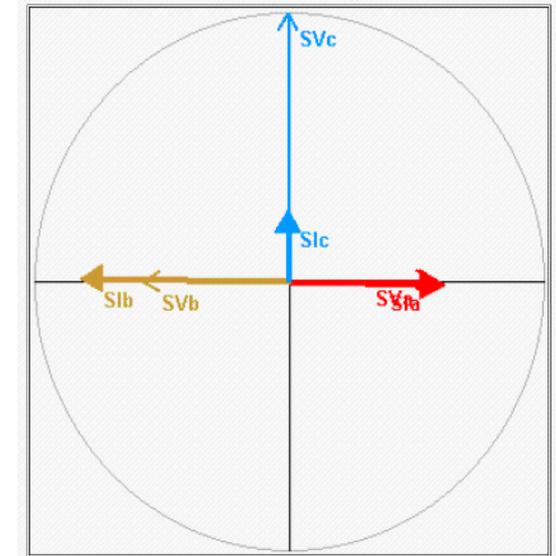


## 3 wire Delta



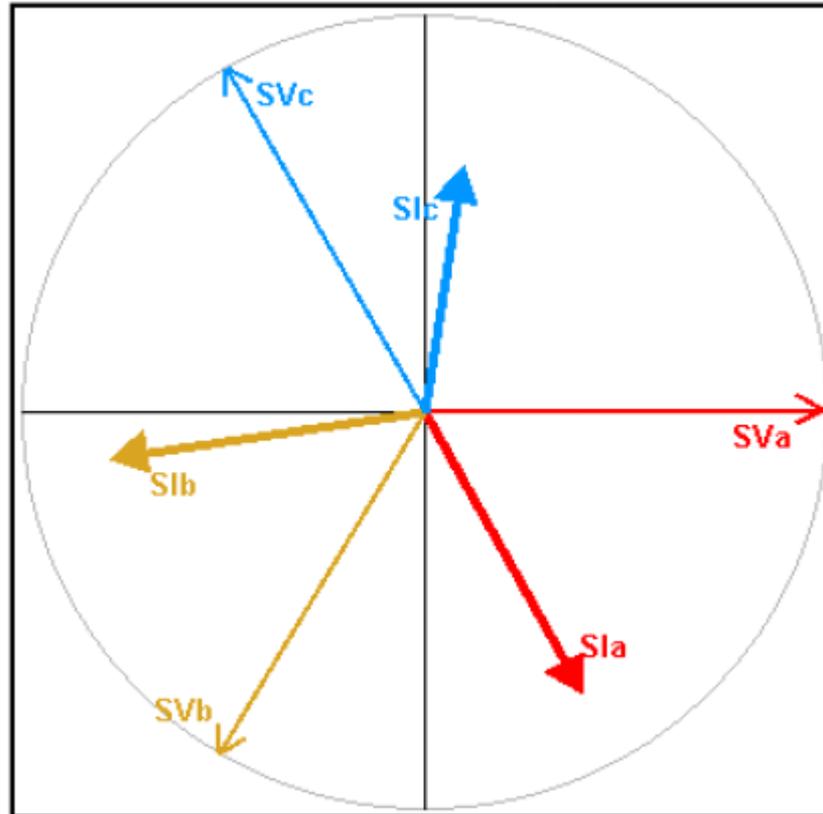
## 4 wire Delta

Meter Vector Diagram



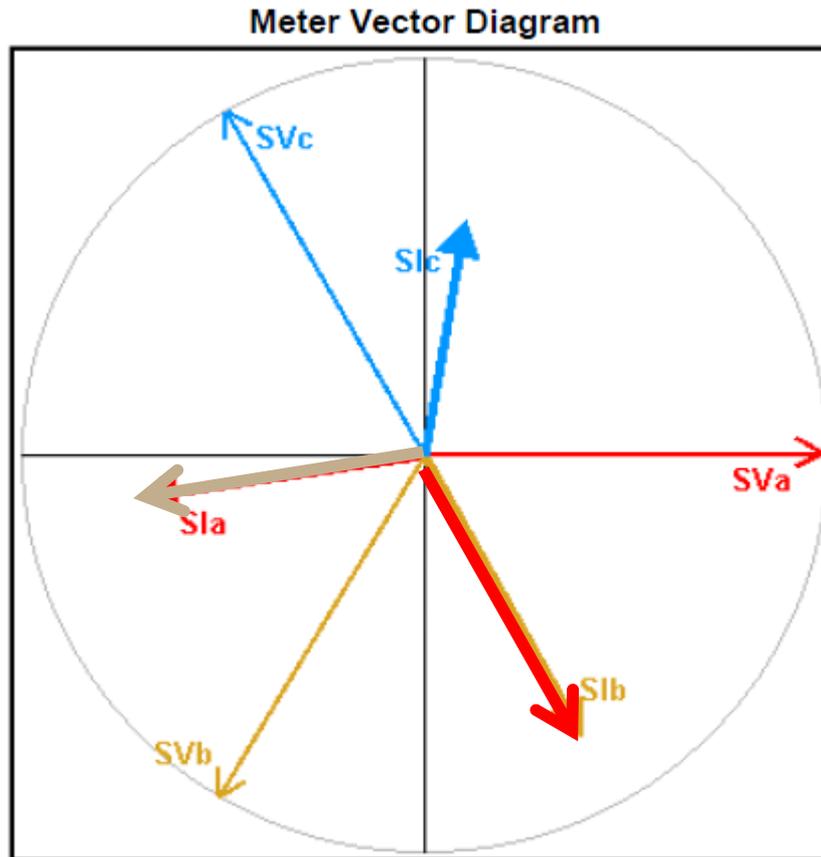
# Typical WYE Service

Meter Vector Diagram



# Problem ?

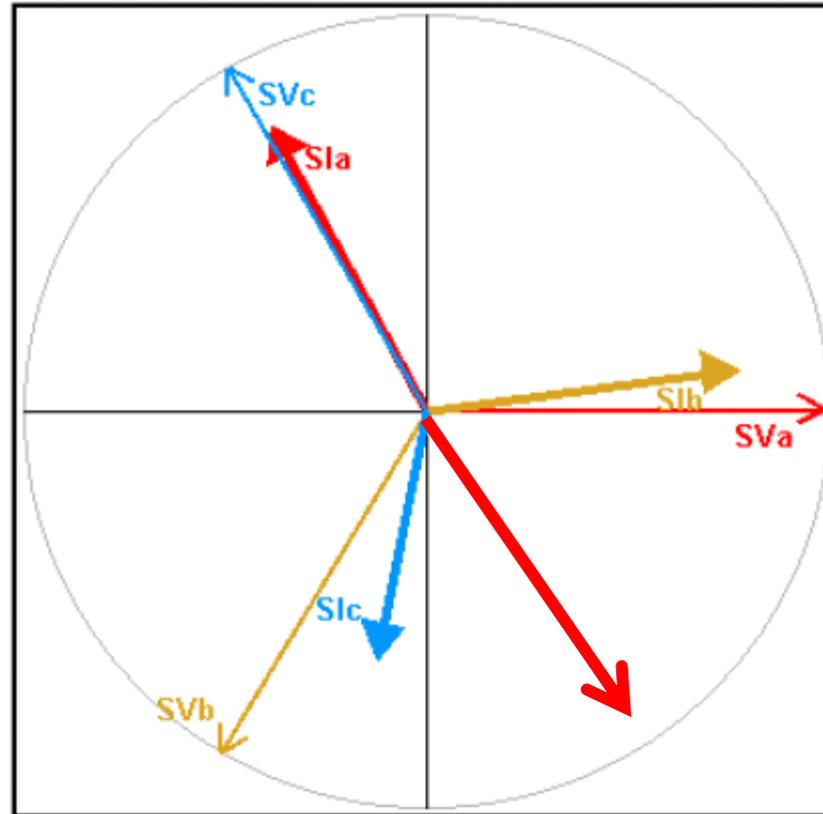
## A Phase and B Phase Current Crossed



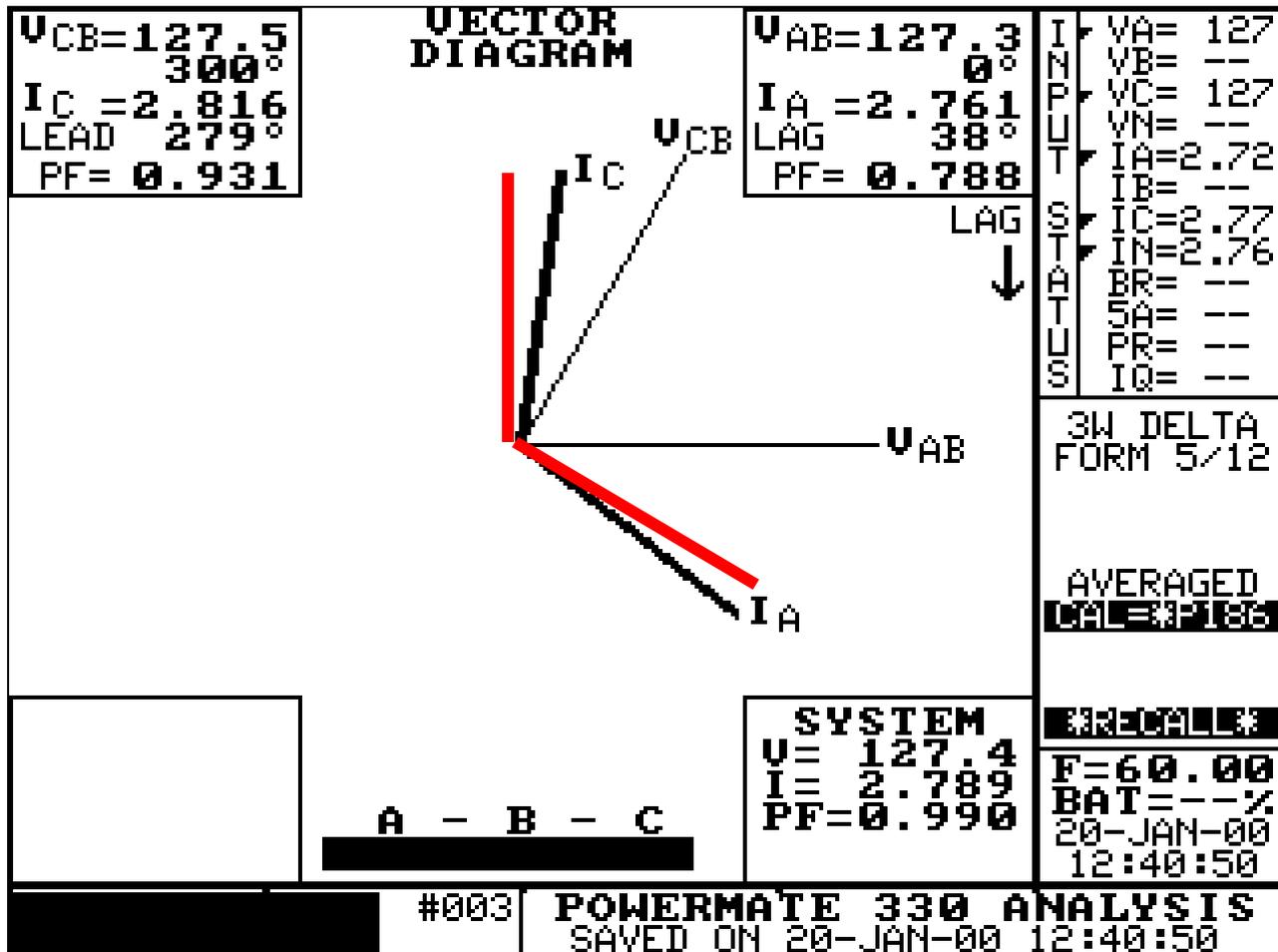
# Problem ?

## CTs Wired Backwards

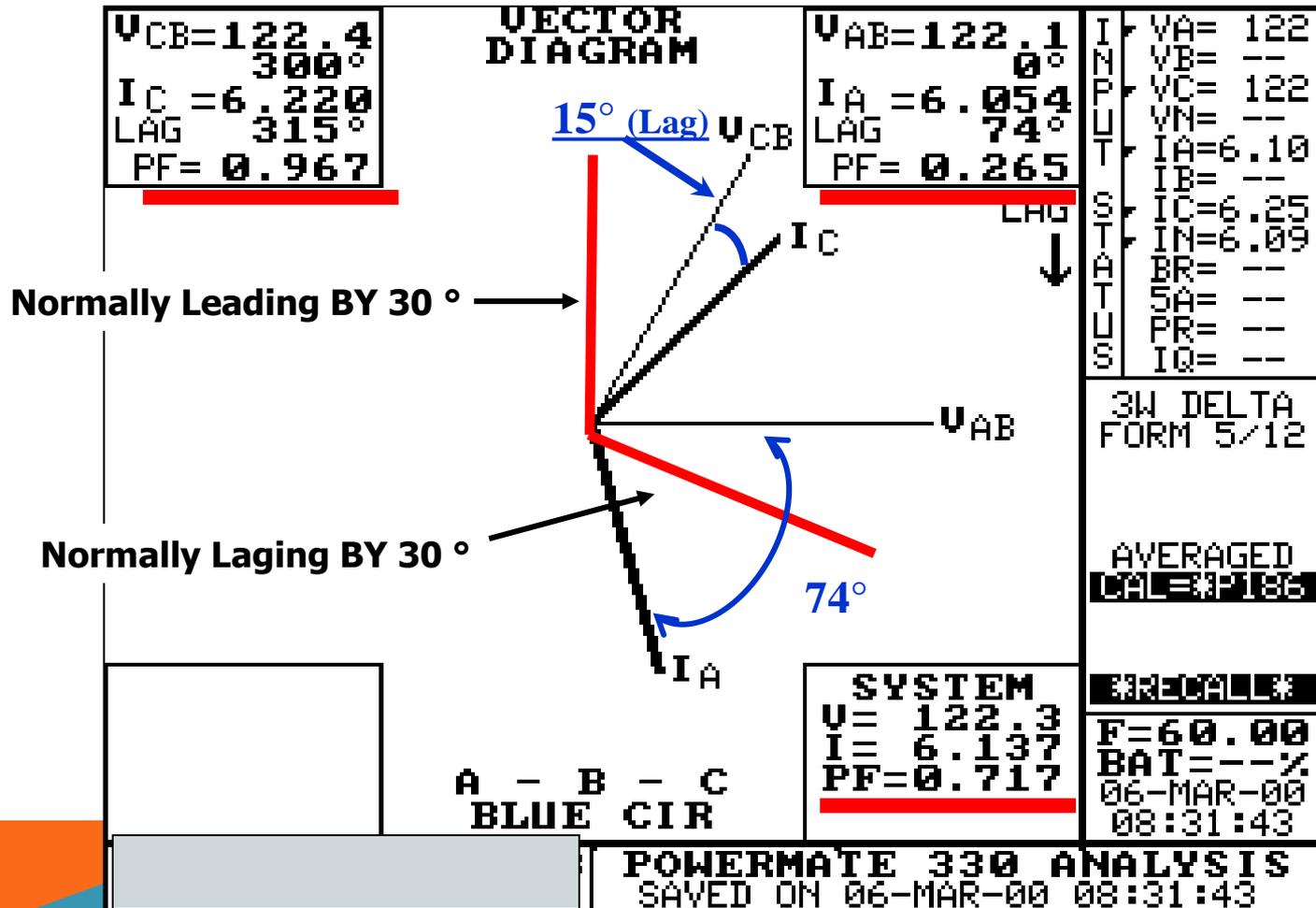
Meter Vector Diagram



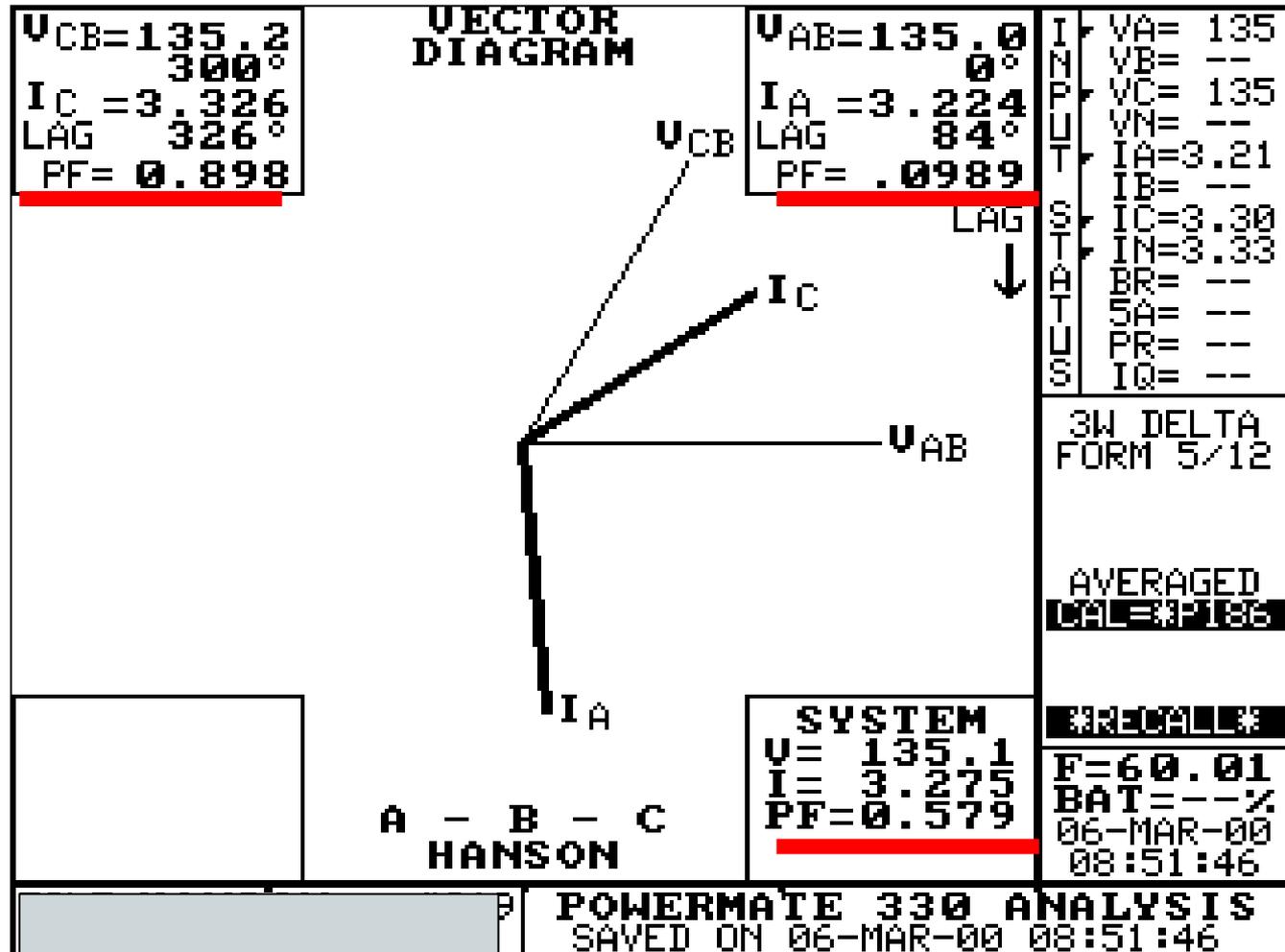
# Three Wire Three Phase Delta Service



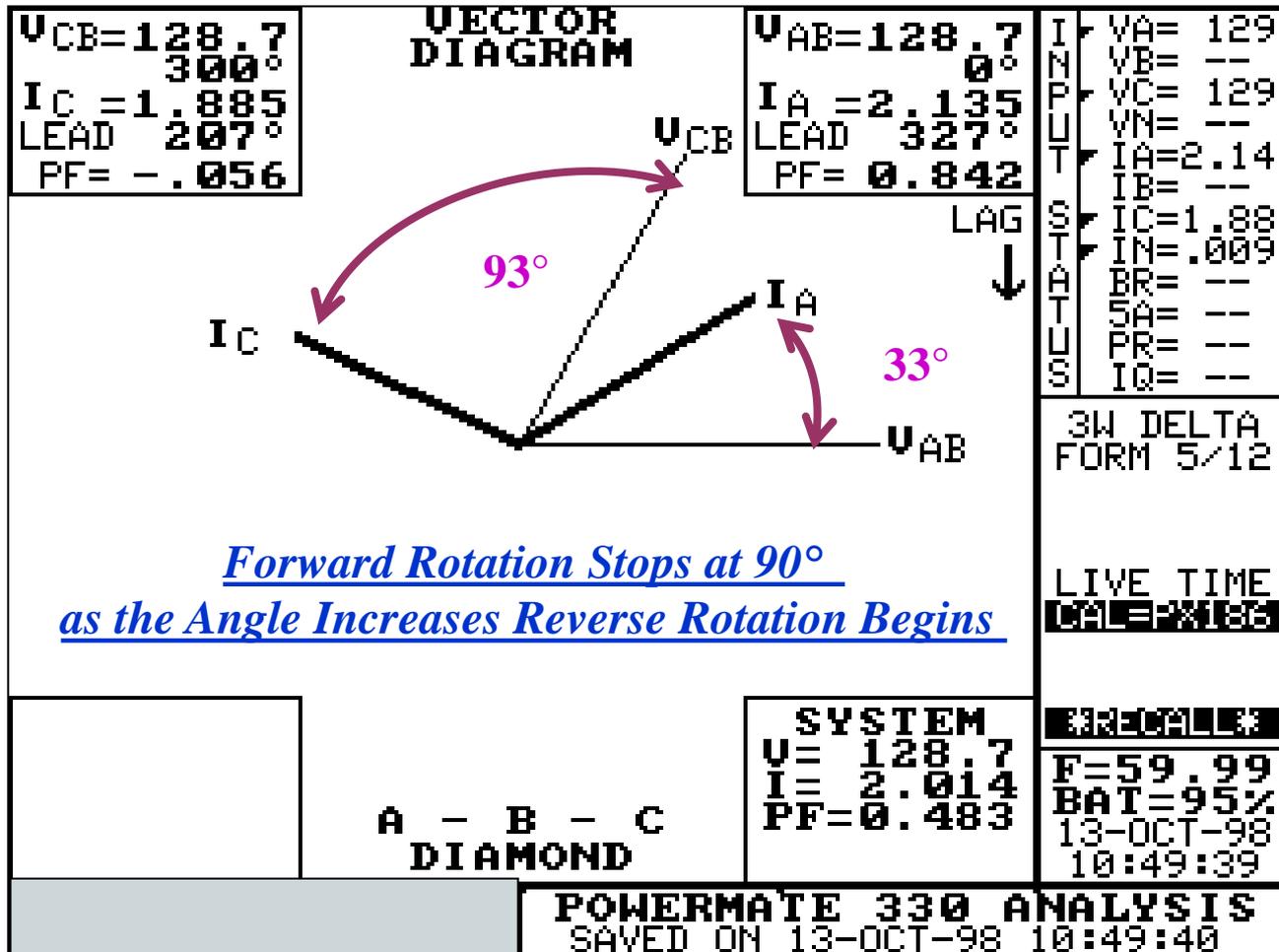
# Three Wire Three Phase Delta Bad Power Factor



# Three Wire Three Phase Delta with Worse Power Factor

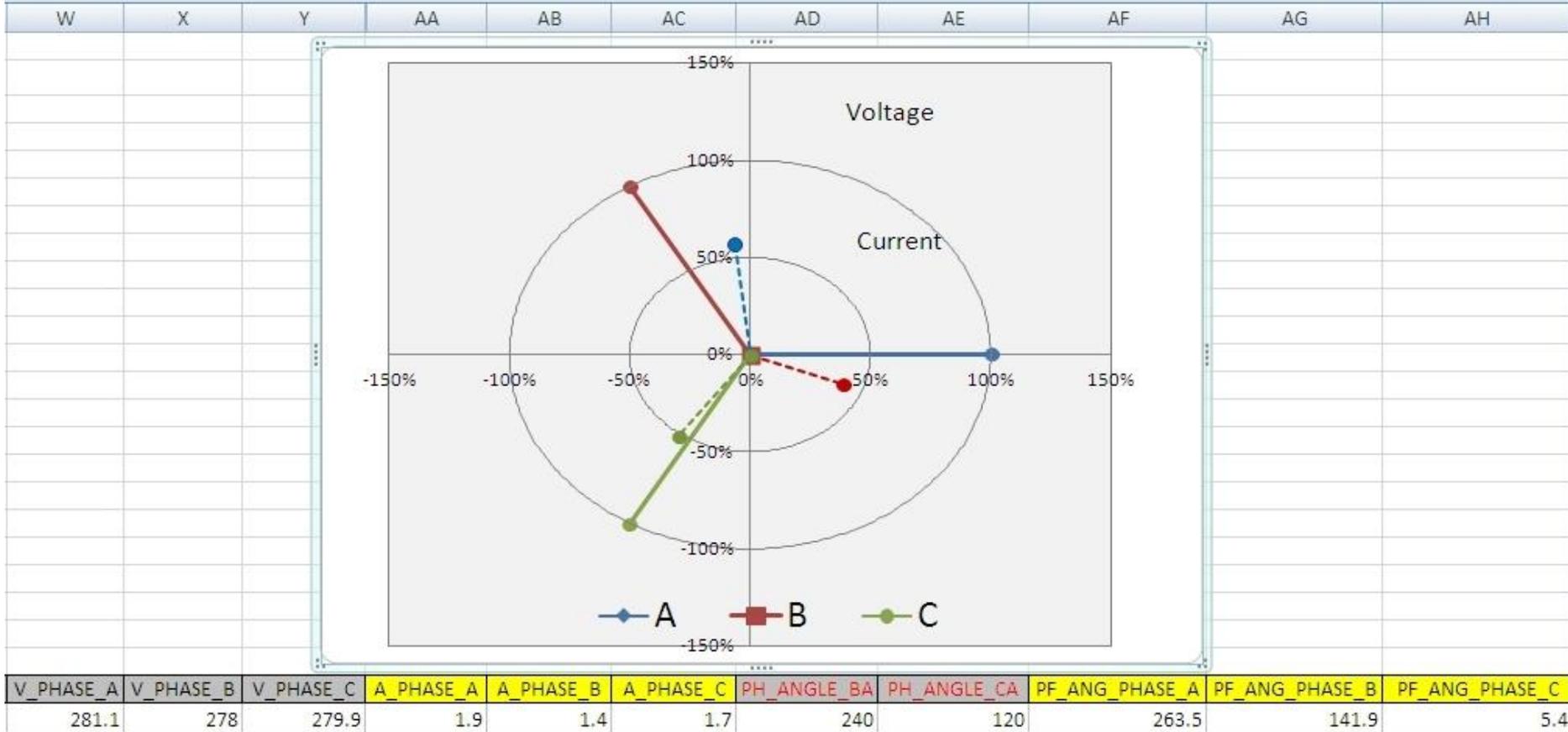


# Three Wire Three Phase Delta with Even Worse Power Factor



# Problem- Crossed Potentials?

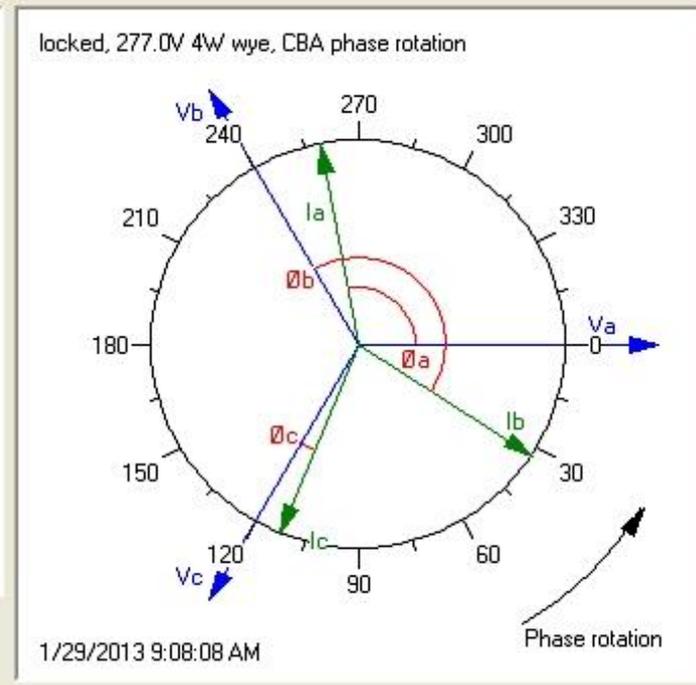
It looks like A-phase current is matched with B-phase potential, and B-phase current with A-phase potential.



# Problem- Crossed Potentials?

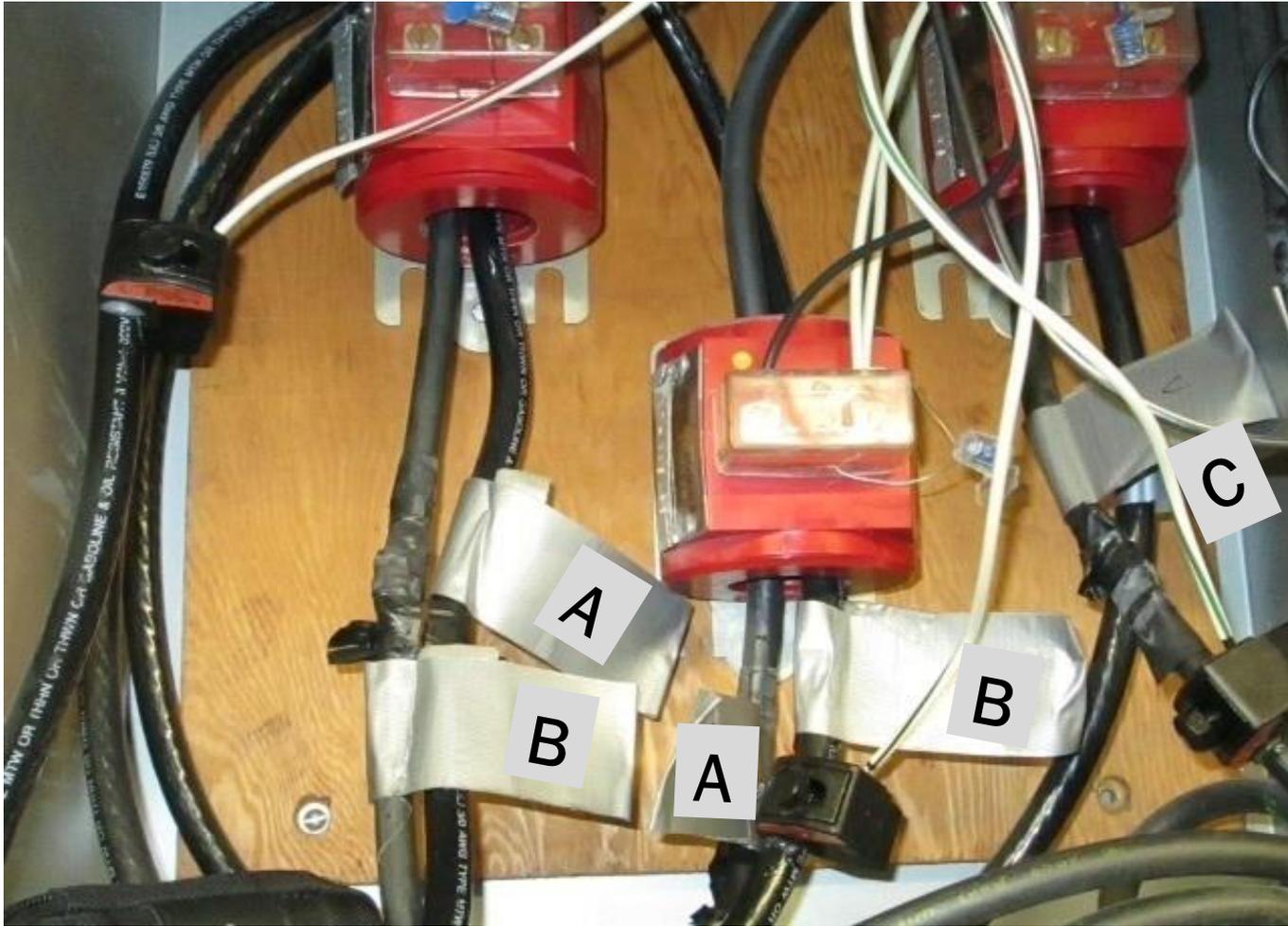
Instrumentation data from the Metercat Diagnostic Read agreed with data reported from the AMI meter.

	Phase A	Phase B	Phase C	System
Voltage	283.84	281.12	283.29	
Voltage Phase Angle	0.00	240.00	120.00	
Current	2.14	1.34	1.48	
Current Phase Angle	259.27	33.19	112.48	
Power Factor (1)	-0.19	0.89	-0.99	-0.07
Power Factor Angle	259.27	153.19	352.48	265.99
kW	-0.11	-0.34	0.41	-0.03
kVAR	-0.60	0.17	-0.05	-0.48
kVA	0.61	0.38	0.42	0.48
Line Frequency				59.99



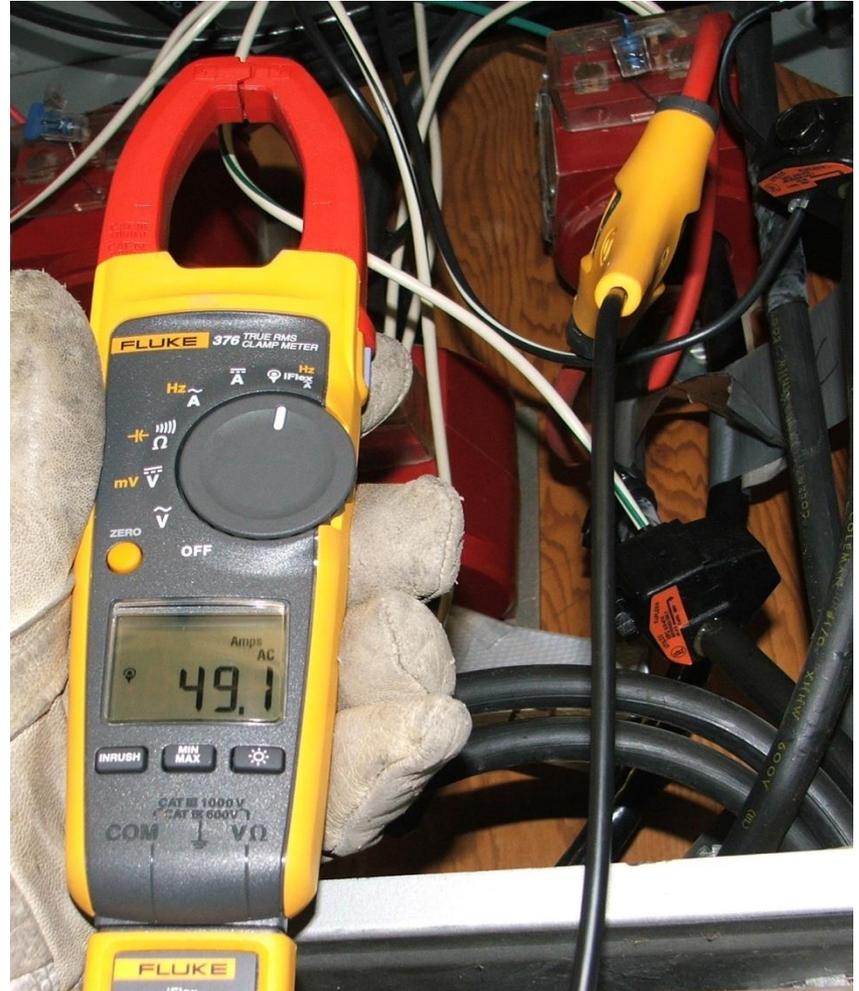
*As the load changed, the meter would alternate between forward energy flow and reverse energy flow.*

*The actual problem was found to be non-brothered service conductors through two of the current transformers. Phase-C current transformer on the far right was correct.*



# C-phase CT

Measured 9.5 amps and 49.1 amps



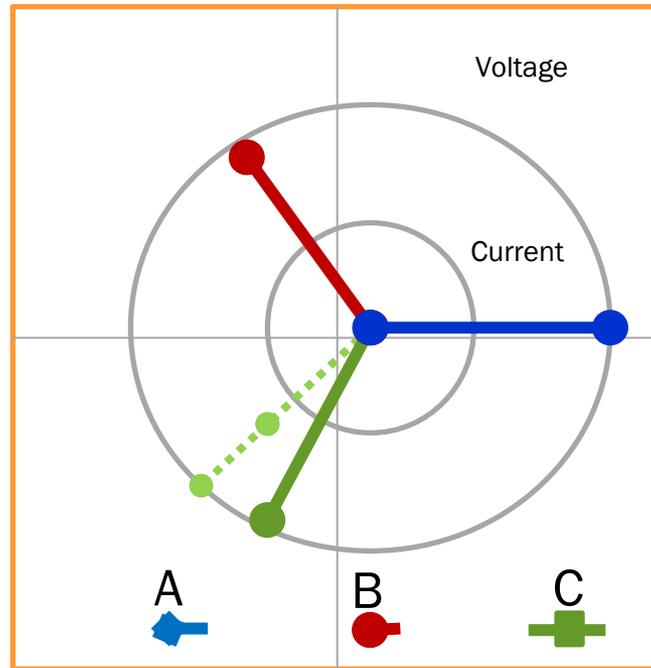
# C-phase CT

Total current measured by C-phase CT was 58.6 amps

Vectors with the same angle simply add together



# Total current measured



# A-phase CT

Measured 92.3 amps on B-phase and 15.4 amps on A-phase



# A-phase CT

Total current measured by A-phase CT was 85.3 amps

**How does 92.3 and 15.4 add up to be 85.3 ?**



# B-phase CT

Measured 12.5 amps on B-phase and 56.9 amps on A-phase



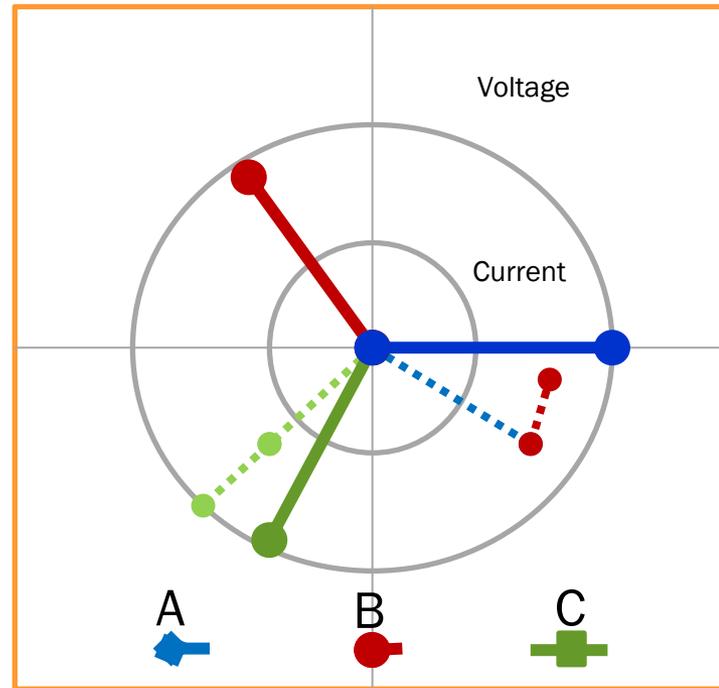
# B-phase CT

Total current measured by A-phase CT was 47.2 amps

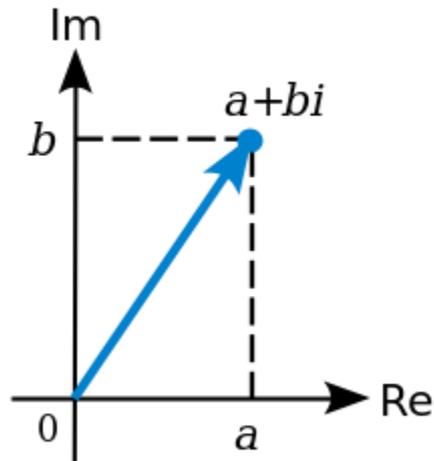
**How does 12.5 and 56.9 add up to be 47.2 ?**



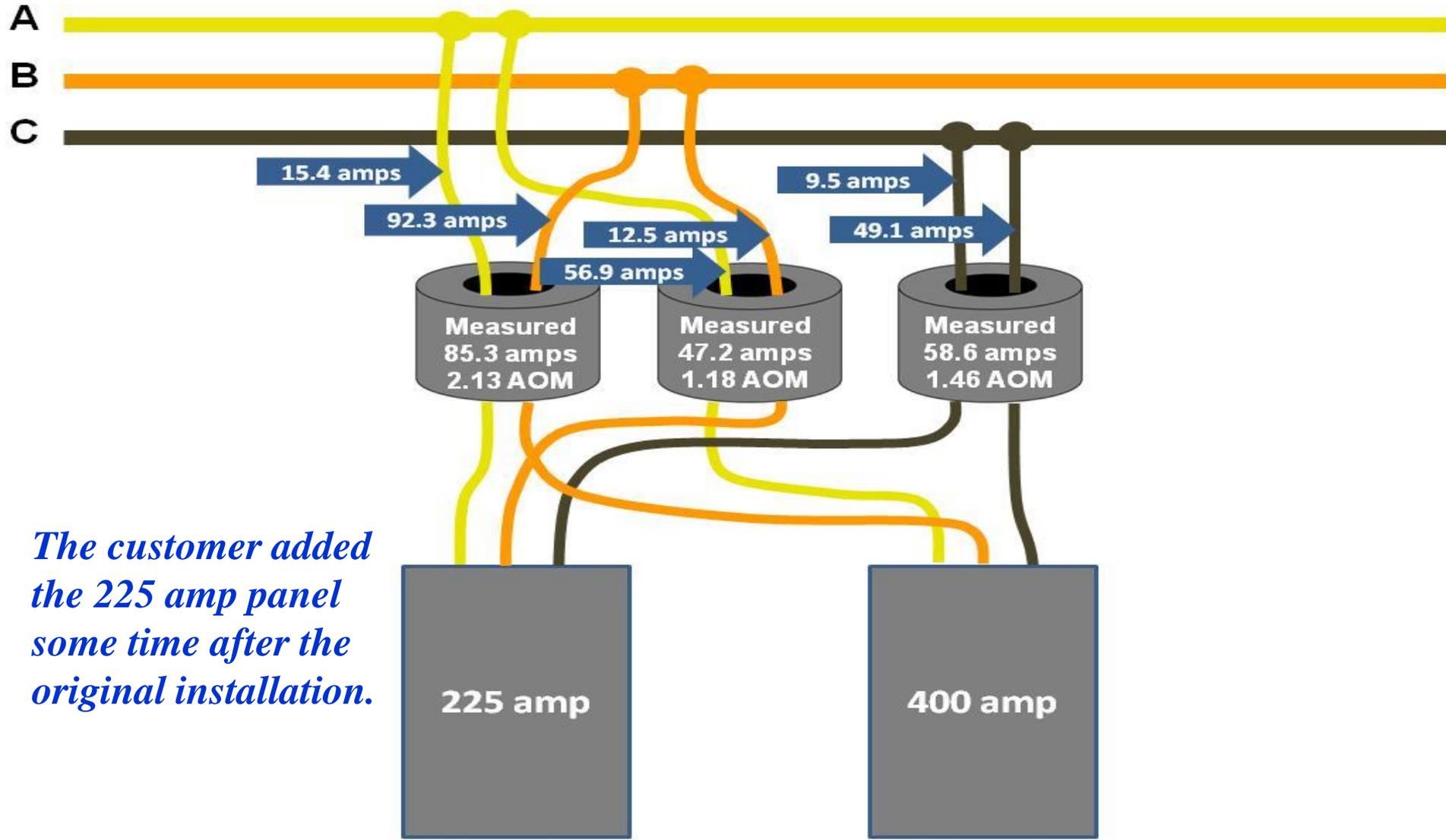
# Total current measured



A complex number can be visually represented as a pair of numbers  $(a, b)$  forming a vector on a diagram, representing the complex plane. "Re" is the real axis, "Im" is the imaginary axis, and  $i$  is the imaginary unit



# Illustration of on-site measurements

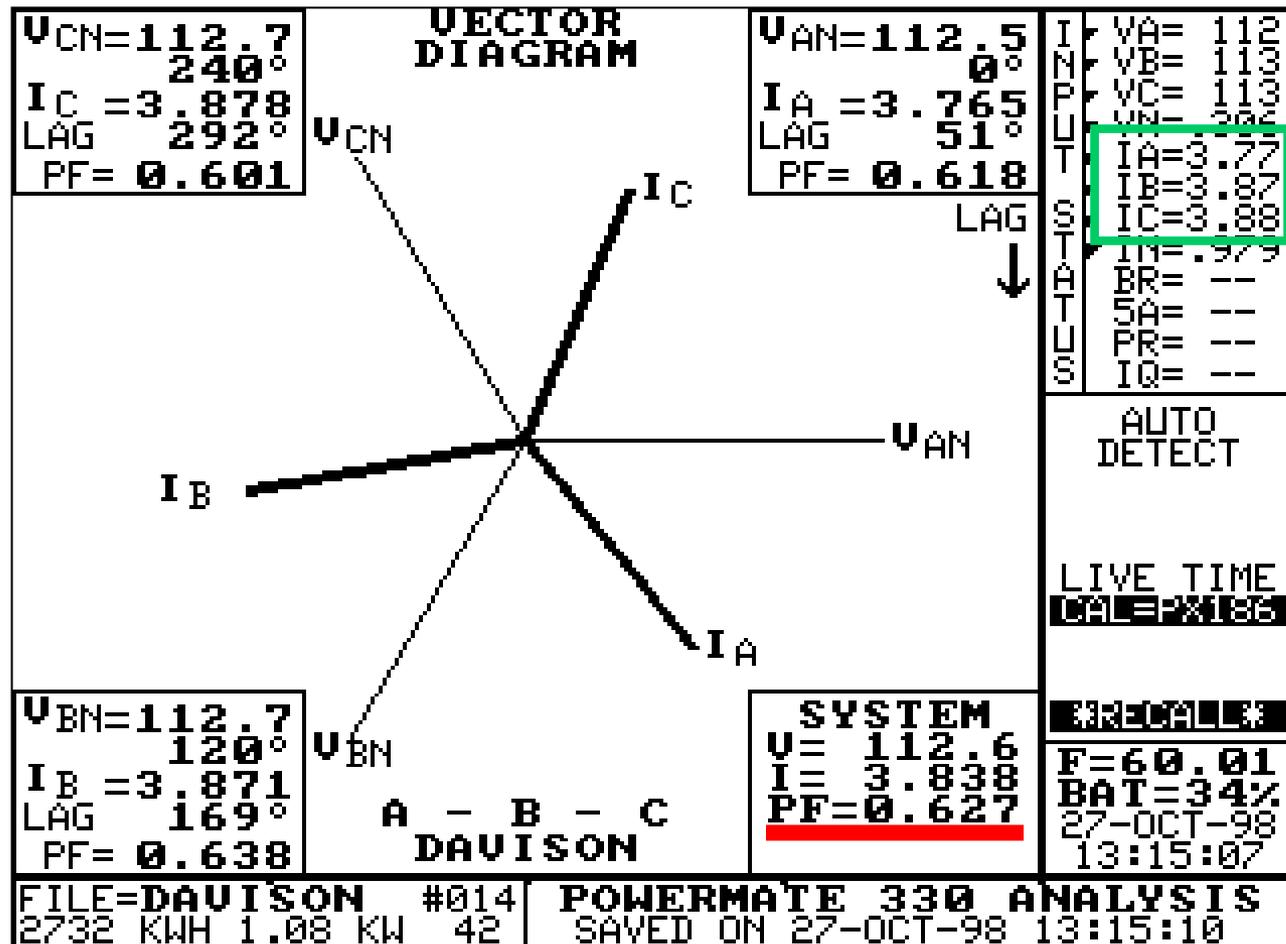


*The customer added the 225 amp panel some time after the original installation.*

# Metering Problem ?

Opportunity to Bill for Excessive Reactive Load

## Bad Power Factor

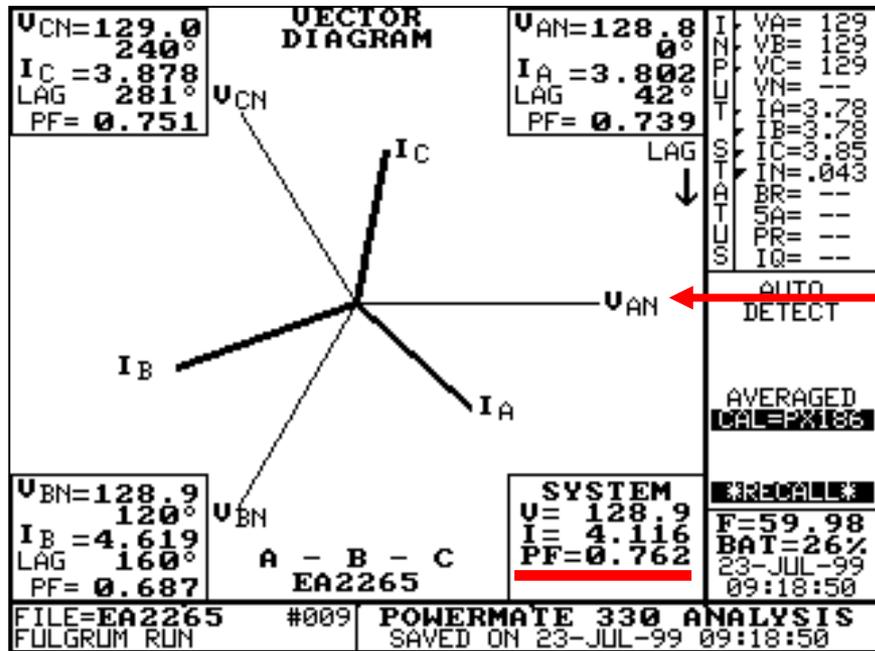


***WHAT CAN A CUSTOMER OR  
UTILITY DO ABOUT BAD FACTOR?***

# *VARs Compensator*

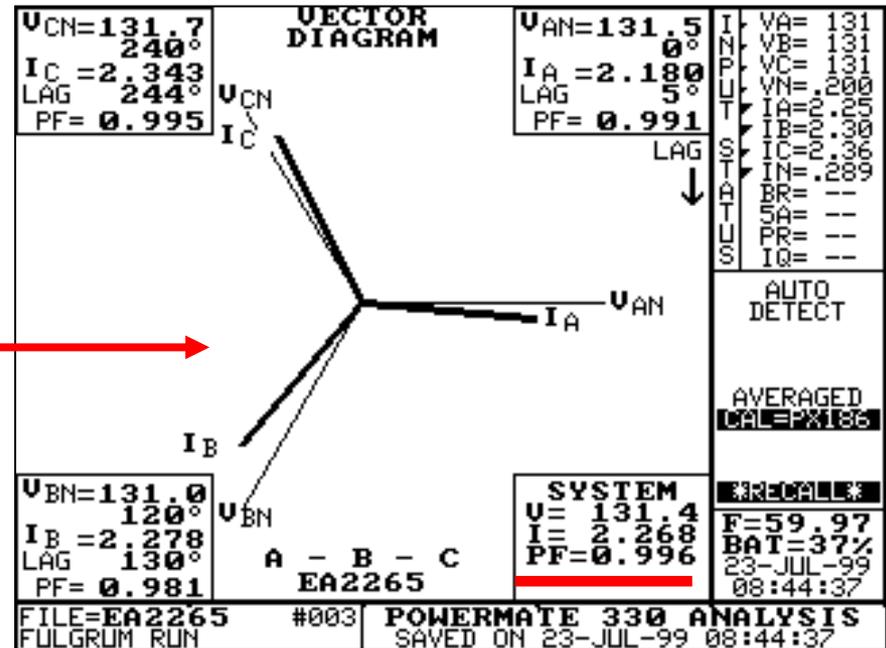


# Site With VARs Compensator Installed



Vars Compensator Off

Vars Compensator On



# SAFETY +

**IS THE ABSOLUTE NUMBER ONE PRIORITY**

- **Hardhat**
- **Eye Protection**
- **FR Clothing**
- **Rubber gloves with “Grabbit” gloves or Leather outer protectors**

