THE EASTERN SPECIALTY COMPANY

Georgia Power

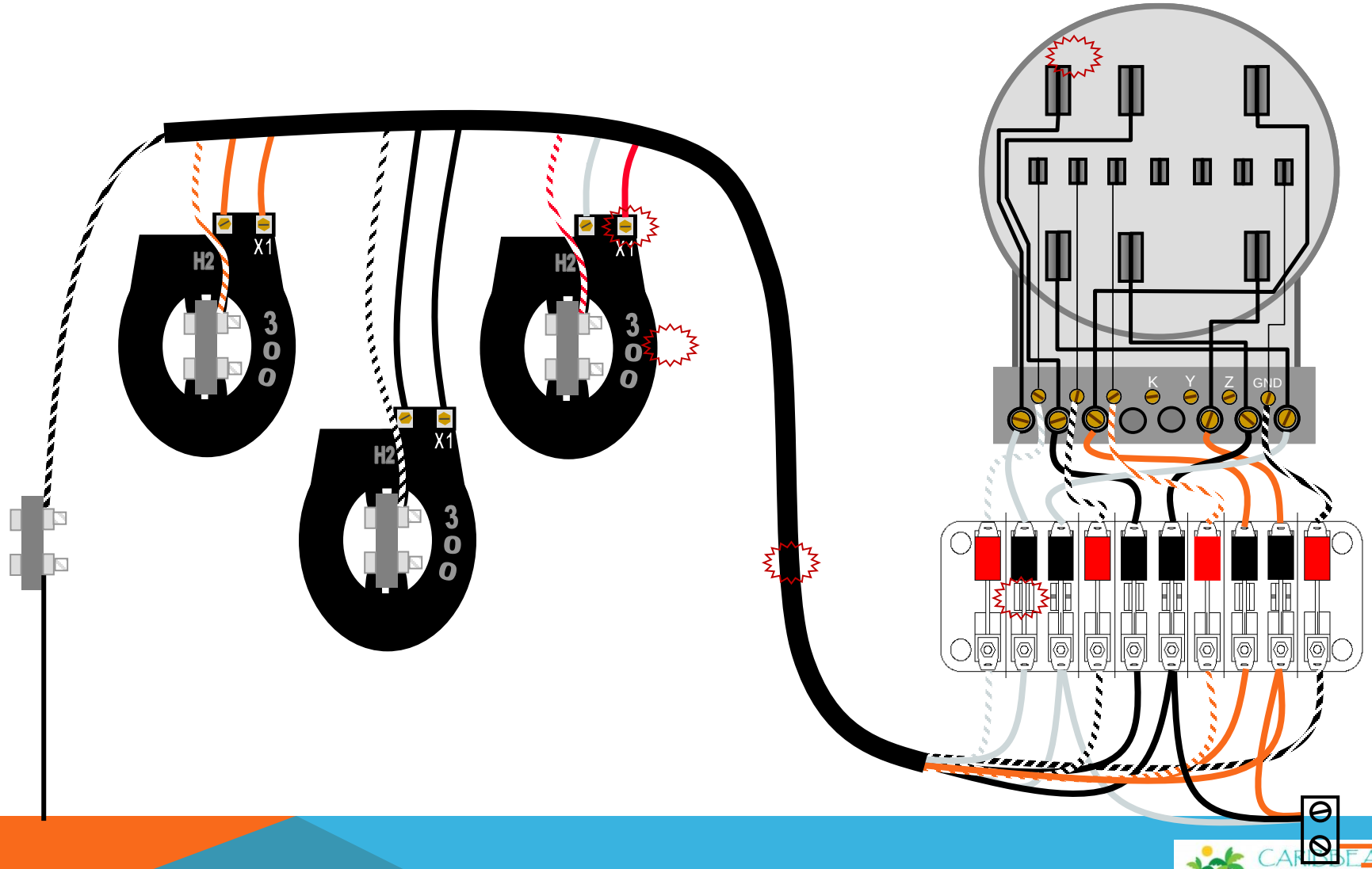
Verifying Transformer Rated Service Installations

January 2019

Field Meter Testing Using Phantom Load

CARIBBEAN & LATIN AMERICAN METER SCHOOL

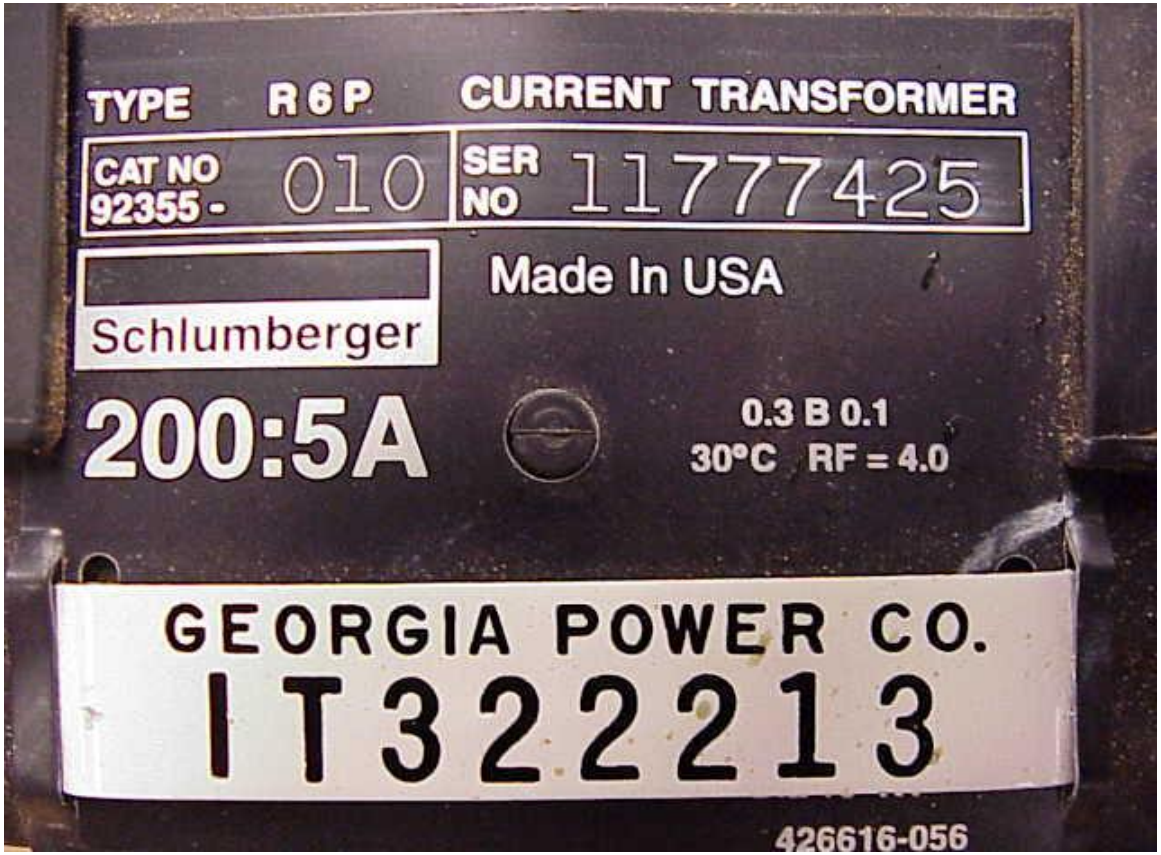
OPPORTUNITY FOR A PROBLEM BEYOND THE METER?



INSTRUMENT TRANSFORMERS

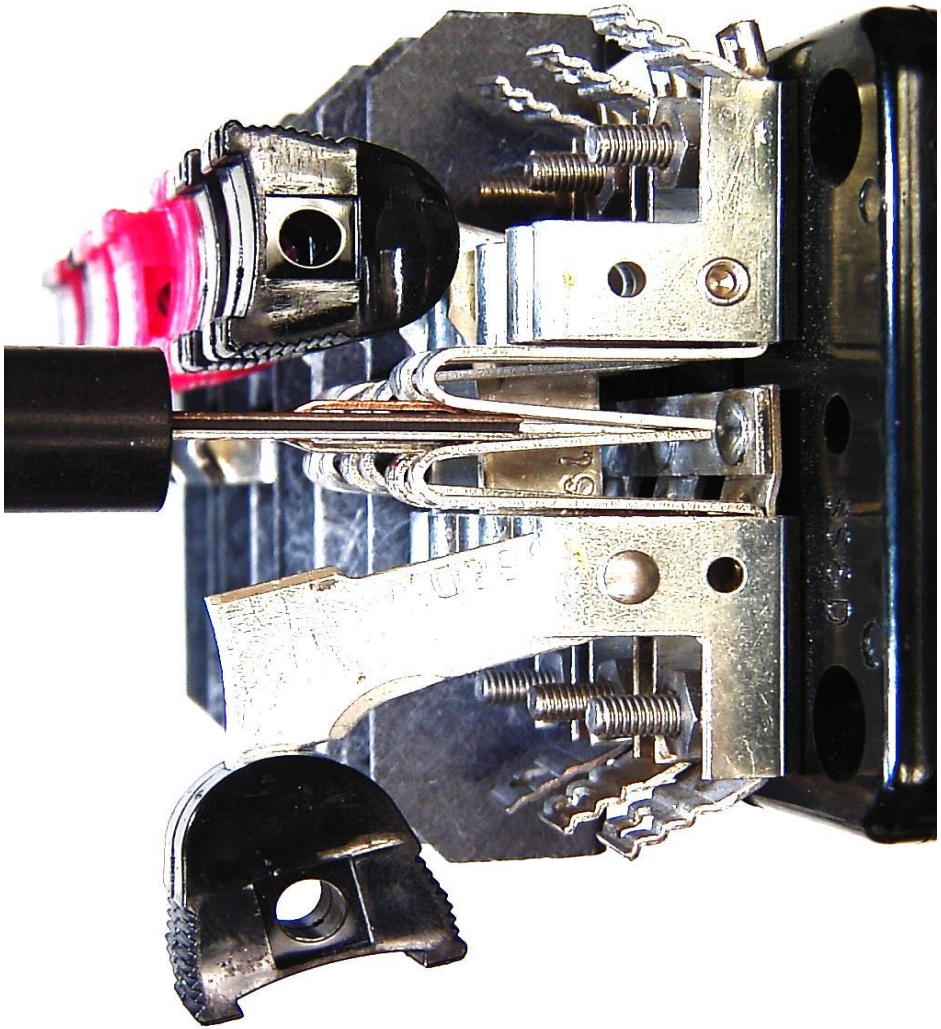
CARIBBEAN & LATIN AMERICAN METER SCHOOL

INSTRUMENT TRANSFORMERS



CARIBBEAN & LATIN AMERICAN METER SCHOOL

CURRENT RETURN SWITCHES



CARIBBEAN & LATIN AMERICAN METER SCHOOL

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.

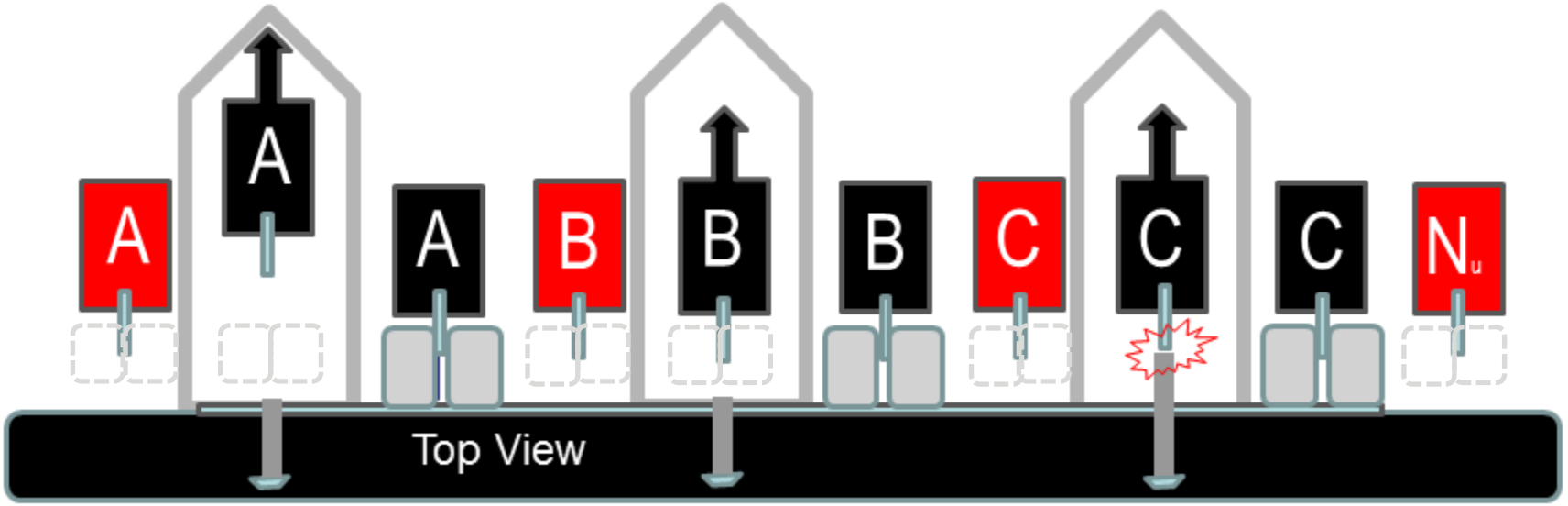
CARIBBEAN & LATIN AMERICAN METER SCHOOL

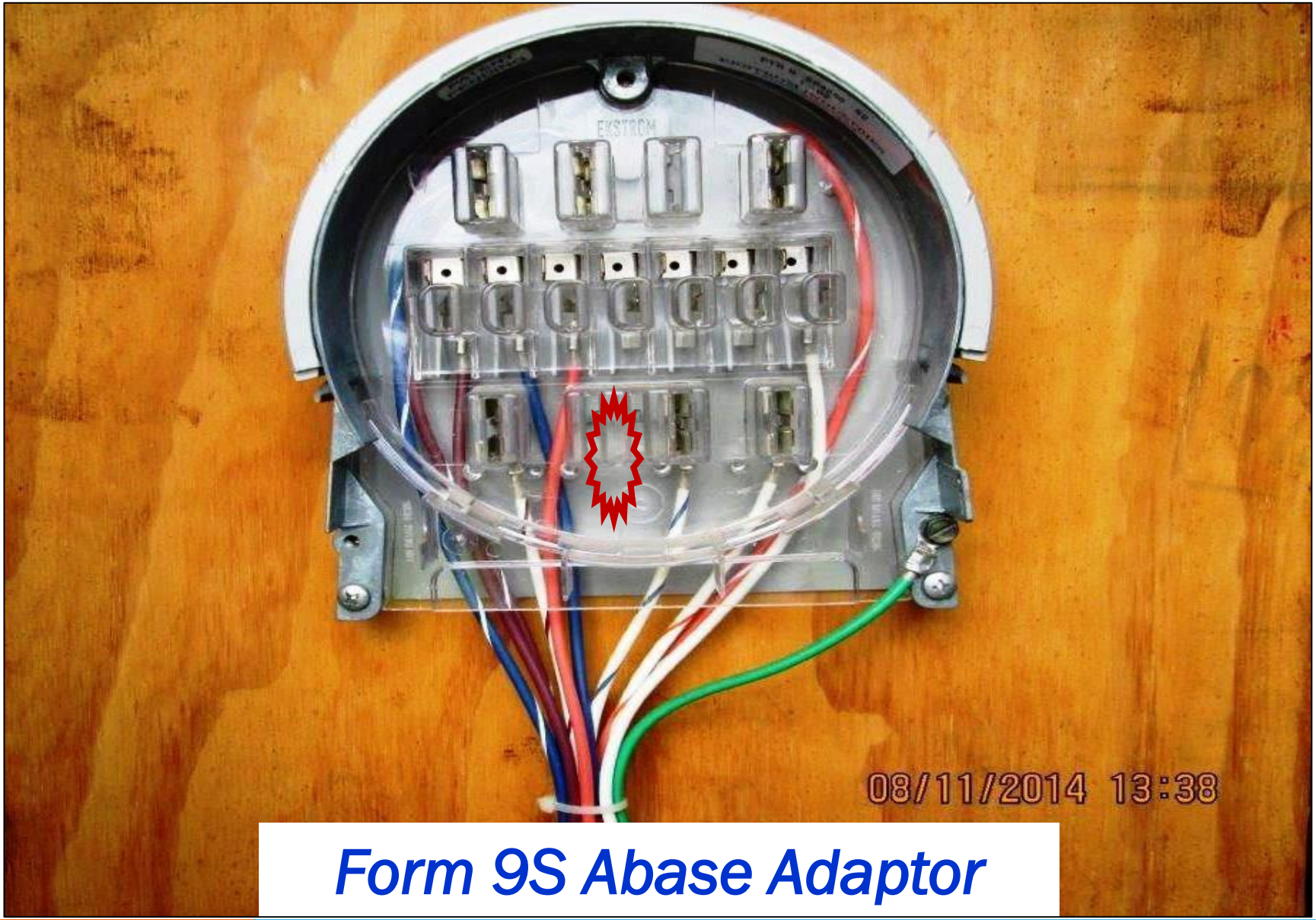
CURRENT RETURN SWITCHES

Test switch A in the open position, current circuit is shorted- meter bypassed

Test switch B in the closed position

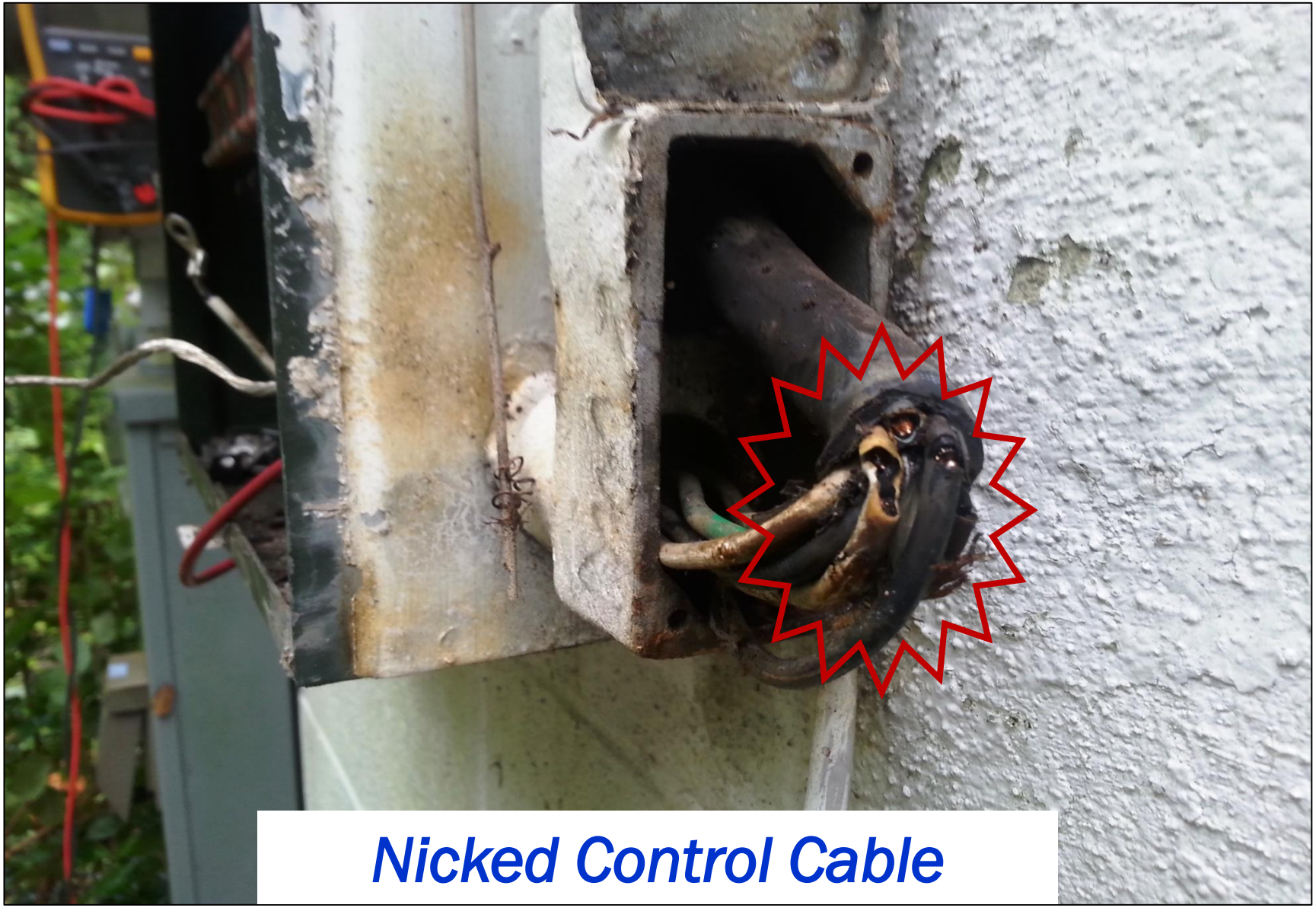
Test switch C in the closed position, long screw makes improper contact, current circuit is shorted- meter bypassed





Form 9S Abase Adaptor

CARIBBEAN & LATIN AMERICAN METER SCHOOL



Nicked Control Cable

SYSTEM ANALYZERS

Radian
RD31-221

Spinlab
Bird Dog Plus

testMET
Gold Miner

PowerMetrix

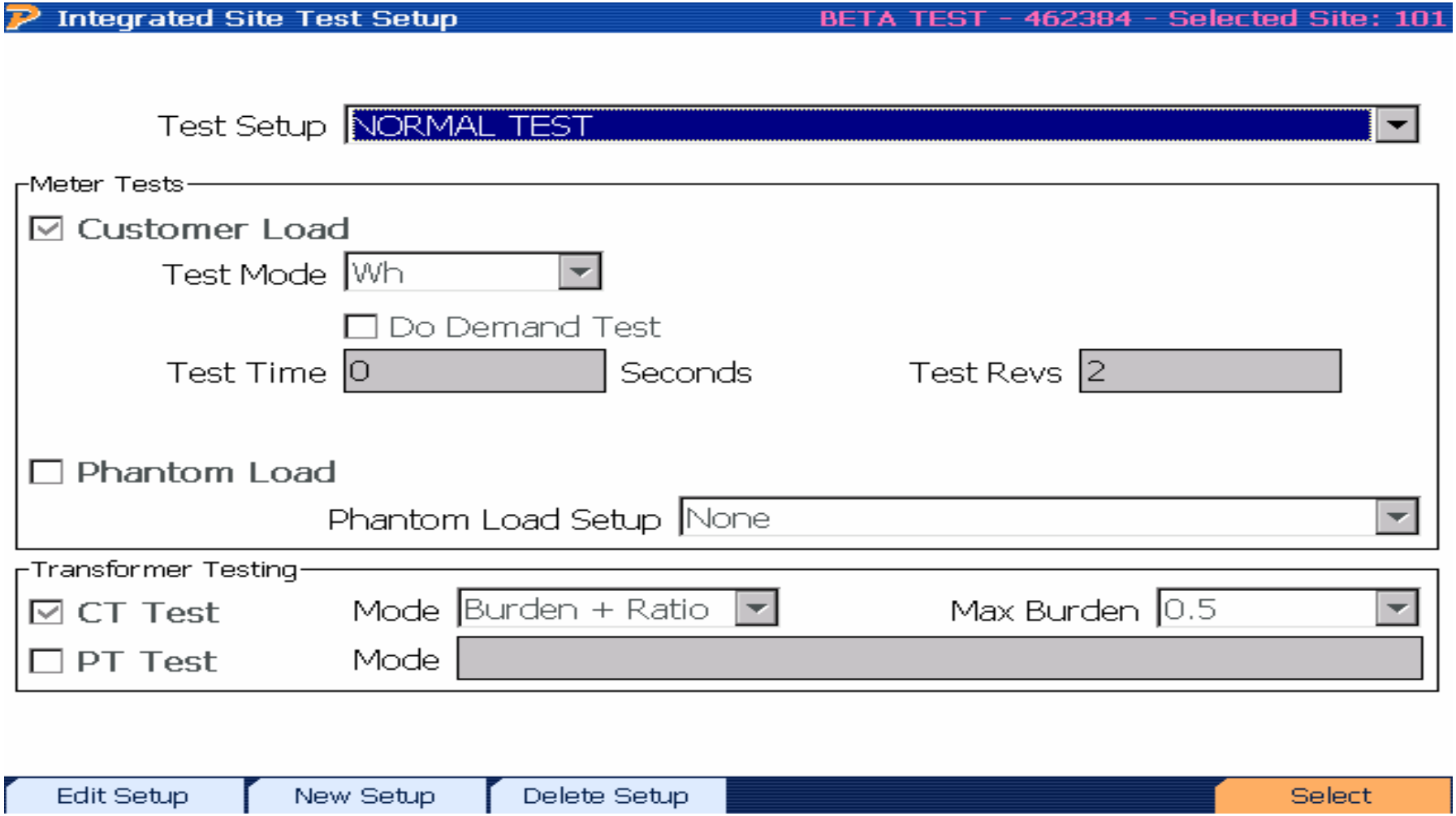
PowerMaster

CARIBBEAN & LATIN AMERICAN METER SCHOOL

SYSTEM ANALYZER WE USE

CARIBBEAN & LATIN AMERICAN METER SCHOOL

Testing Options Available On the PowerMaster



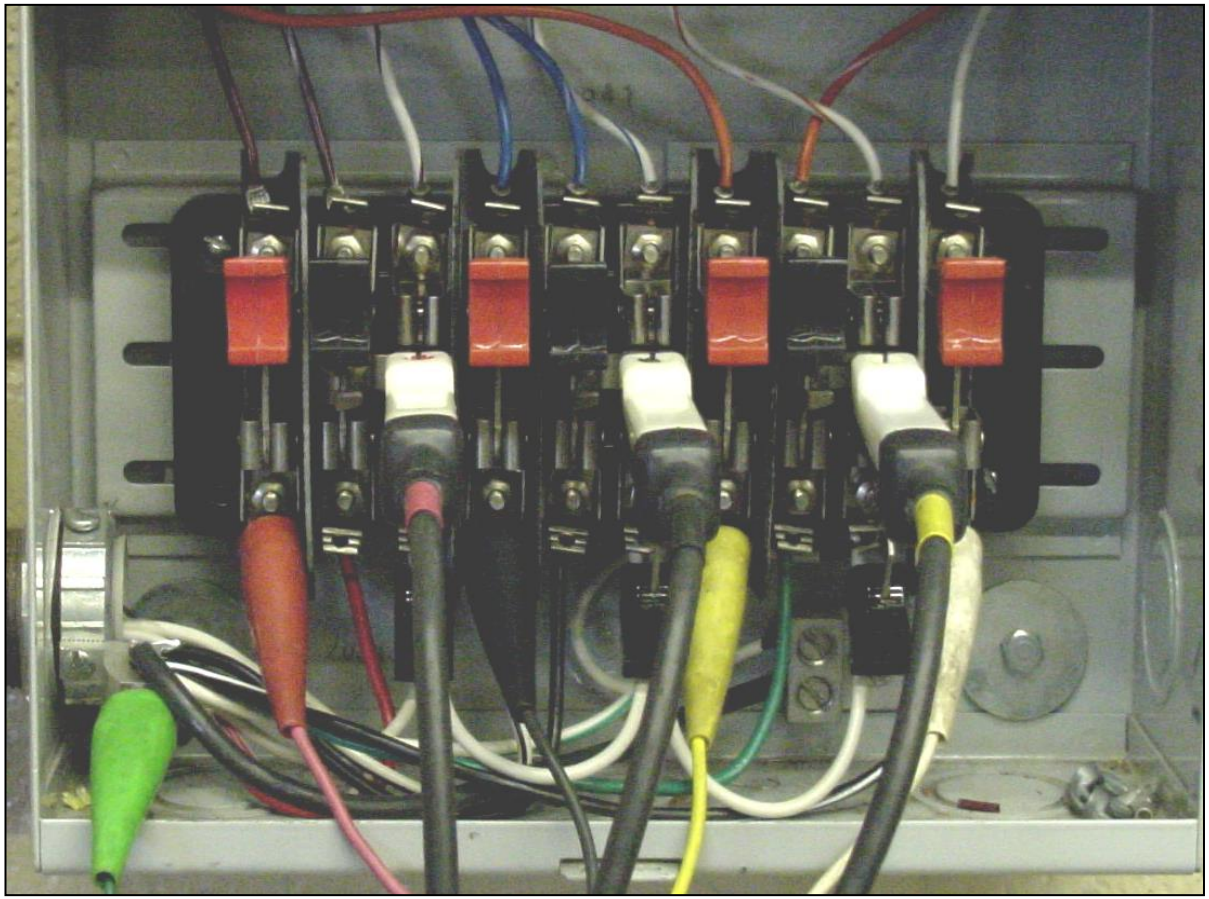
CARIBBEAN & LATIN AMERICAN METER SCHOOL

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.

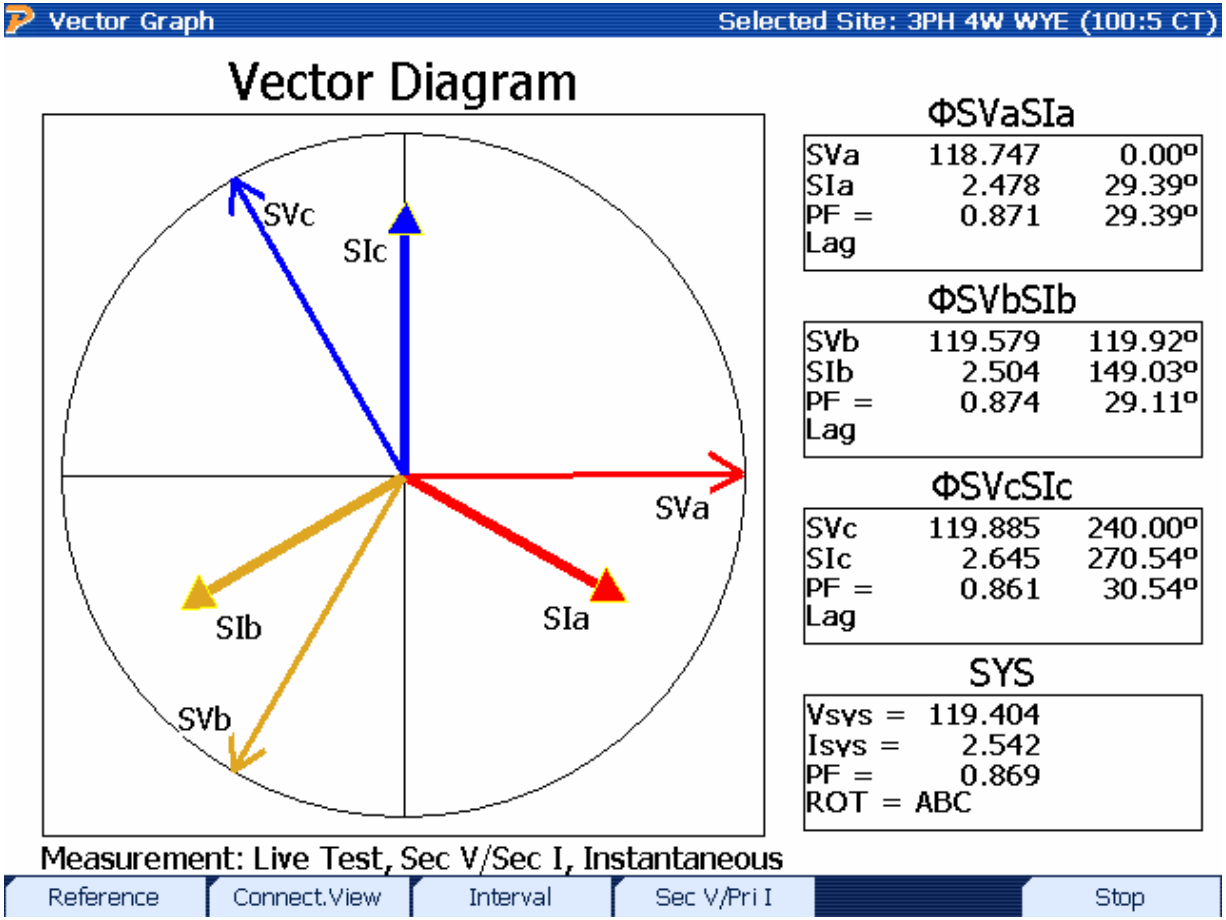


CARIBBEAN & LATIN AMERICAN METER SCHOOL

Select the Vector Analysis Option Before Starting

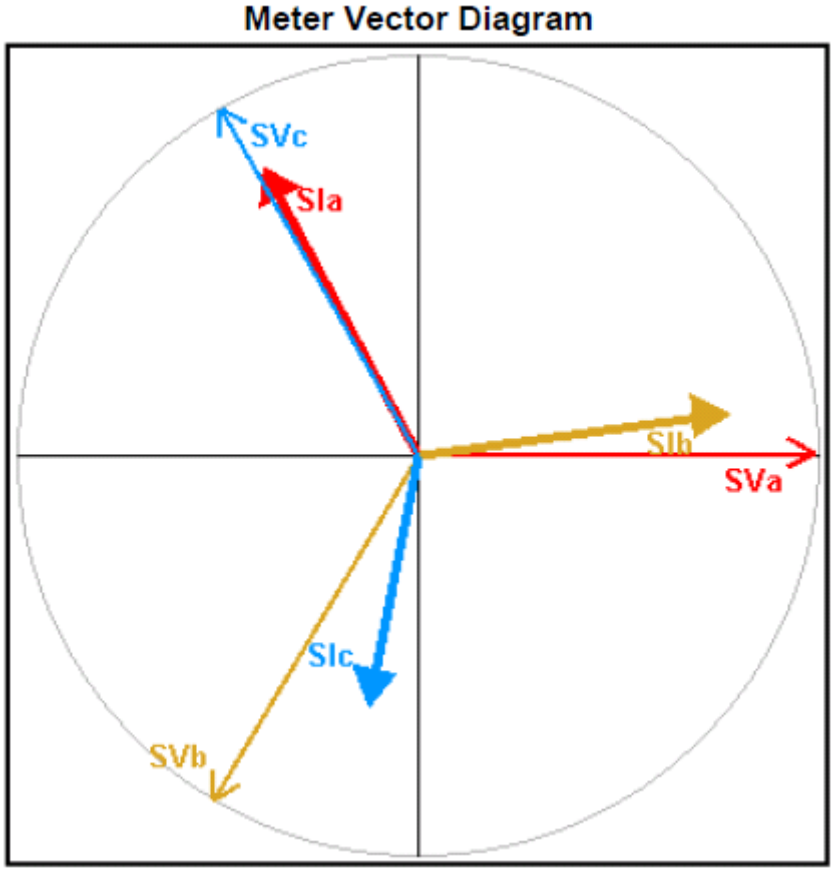
Why ?

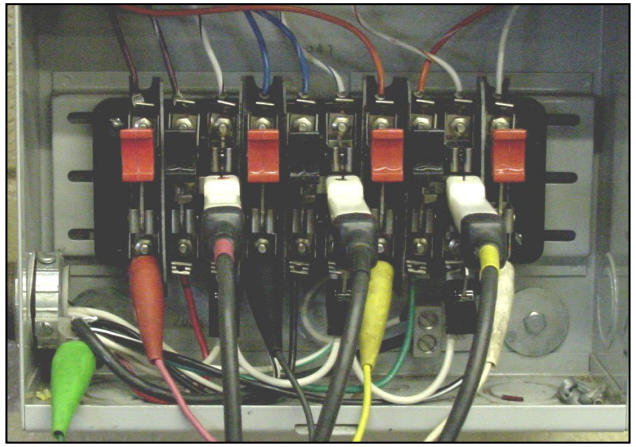
View the Vector to Verify your Connections …



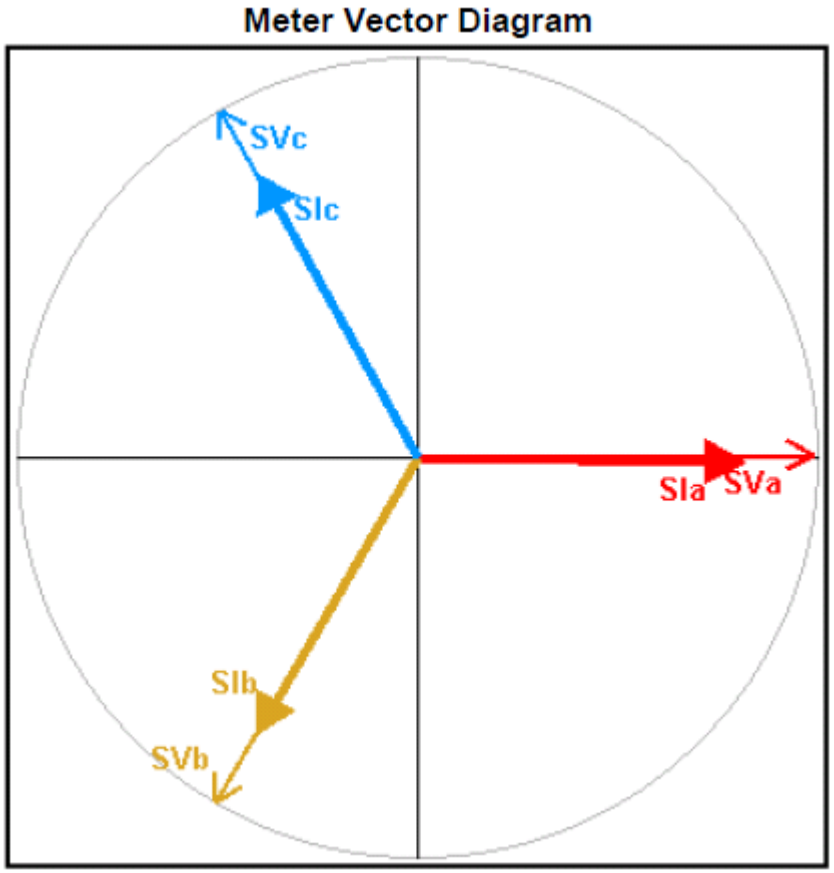
CARIBBEAN & LATIN AMERICAN METER SCHOOL

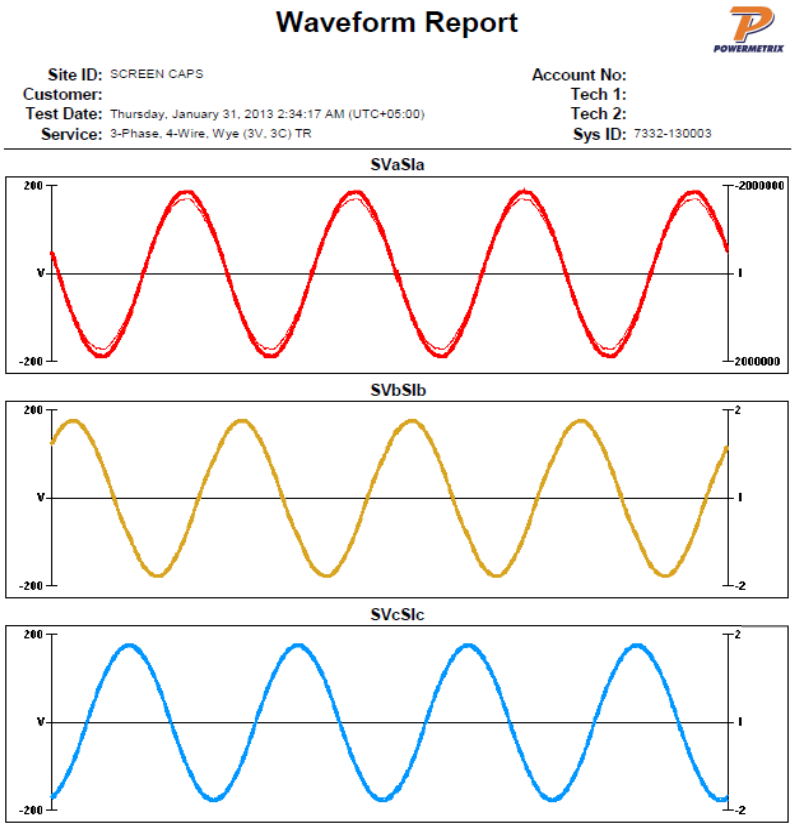
View the Vector to Verify your Connections …





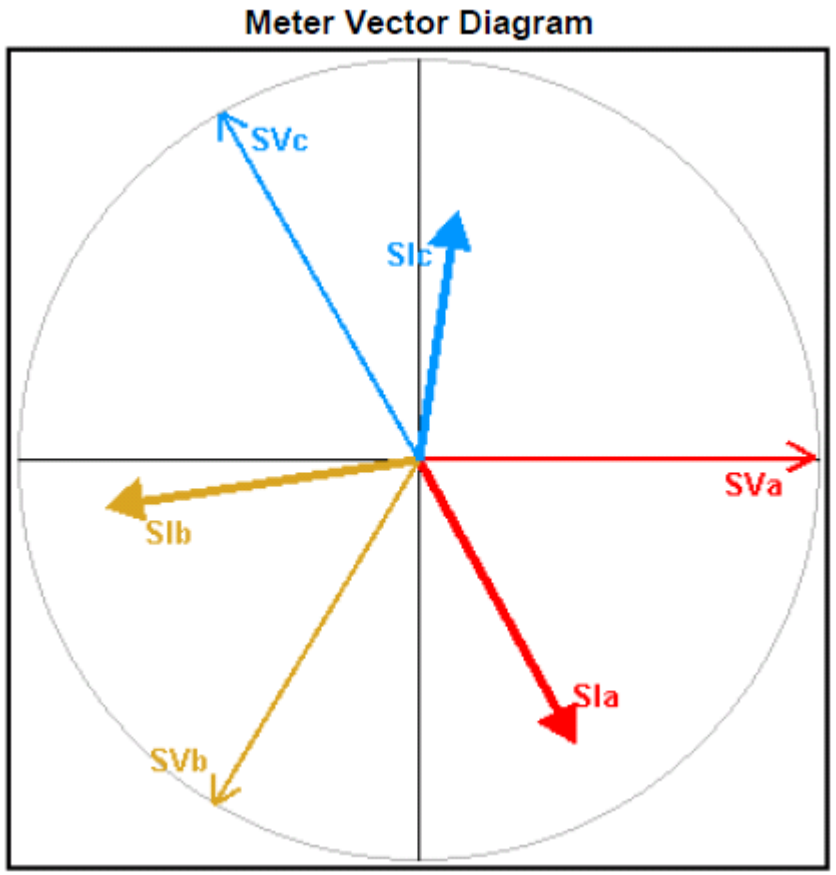
4 Wire Wye Service at Unity Power Factor

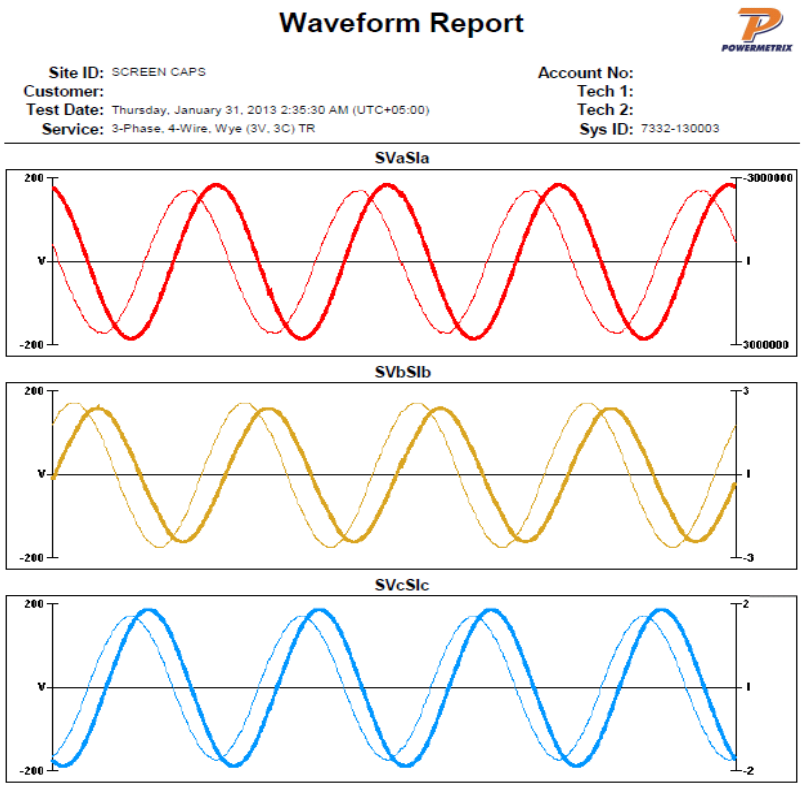




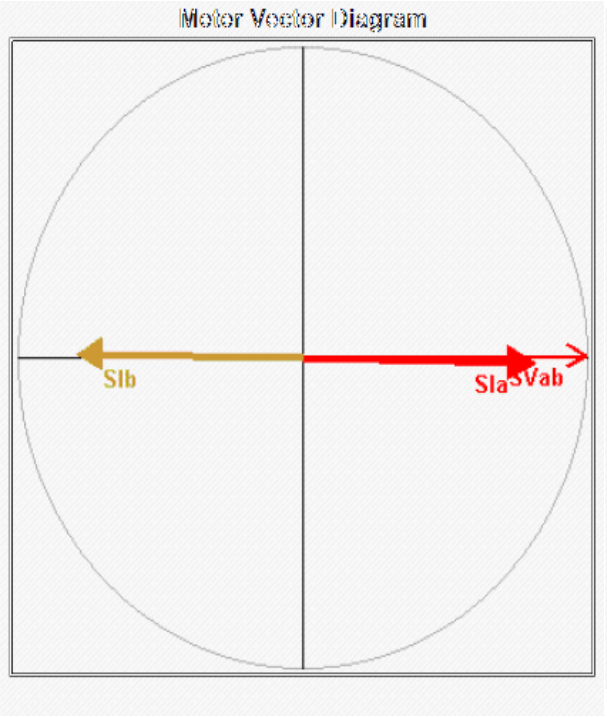
CARIBBEAN & LATIN AMERICAN METER SCHOOL

4 Wire Wye Service at 50% Power Factor

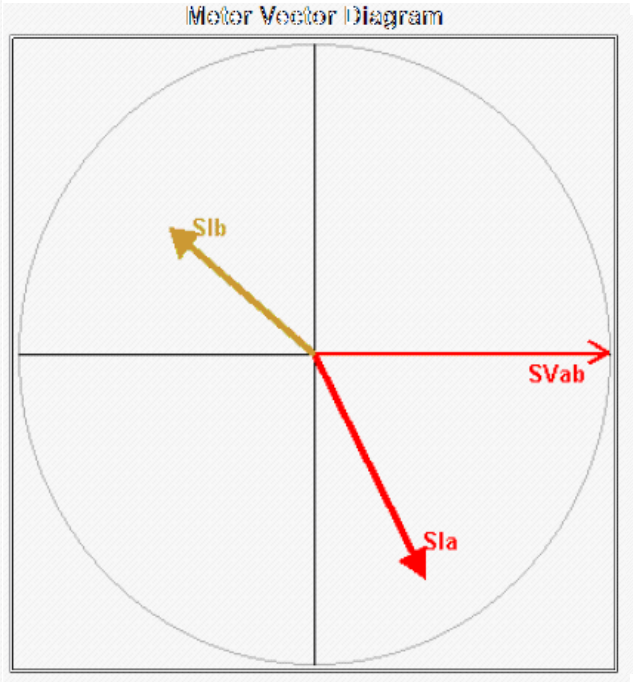




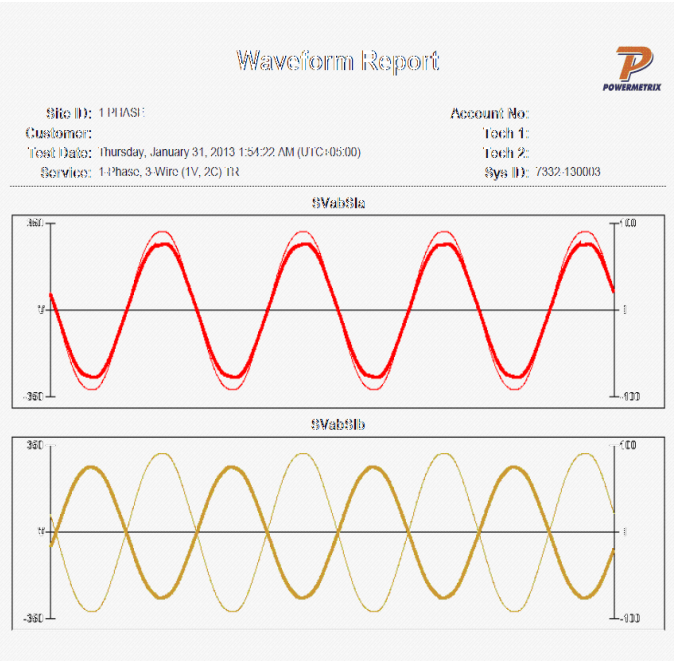
Single Phase Service



Unity

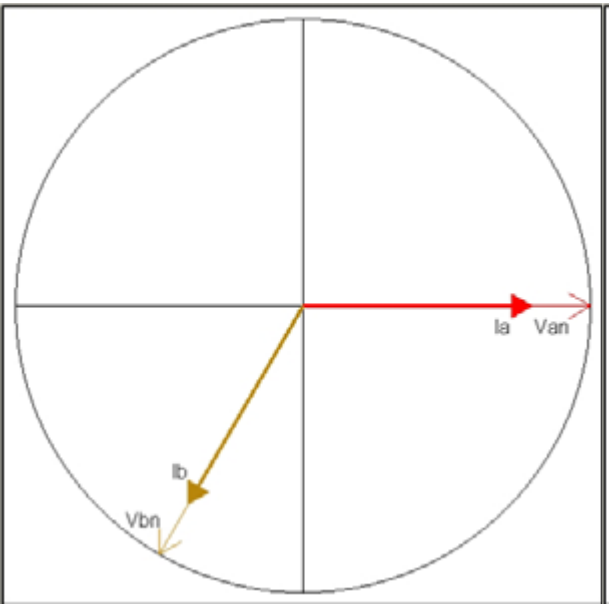


50% PF

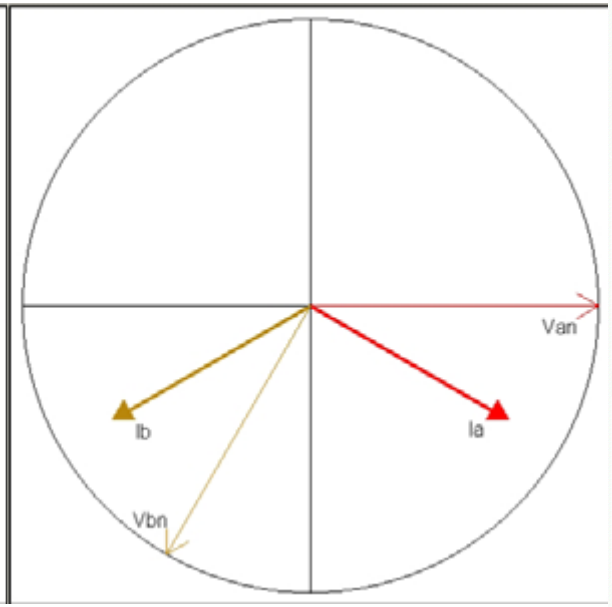


Unity

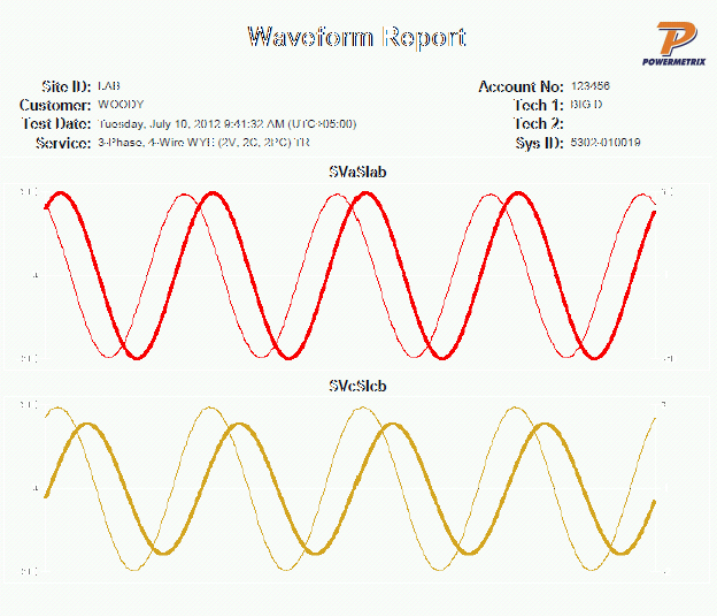
Three Wire Three Phase Network Service



No Lag (1.00 PF)

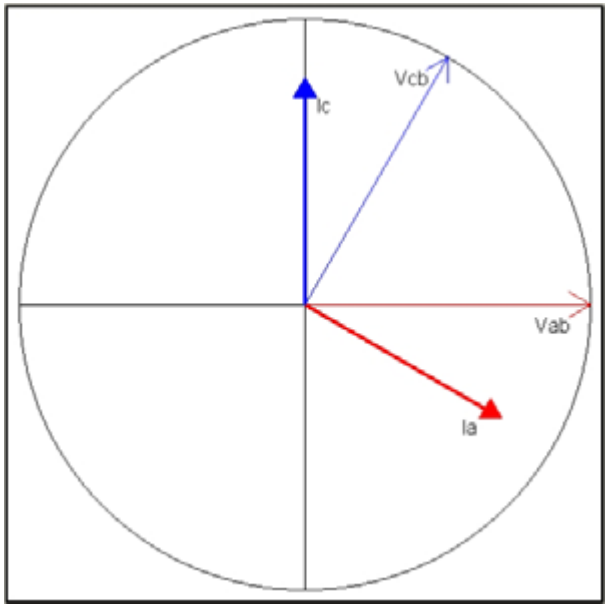


30° Lag (0.866 PF)

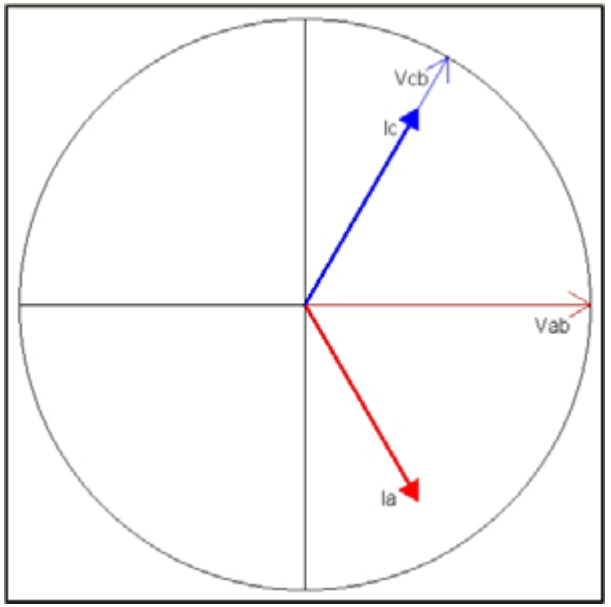


Waveform

Three Wire Three Phase Delta Service

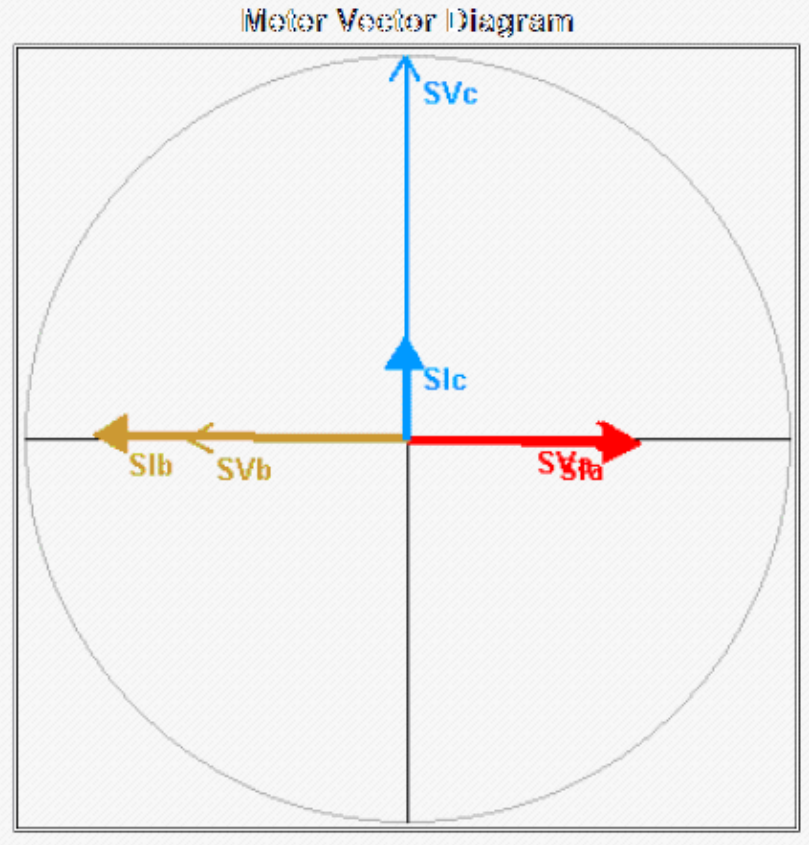


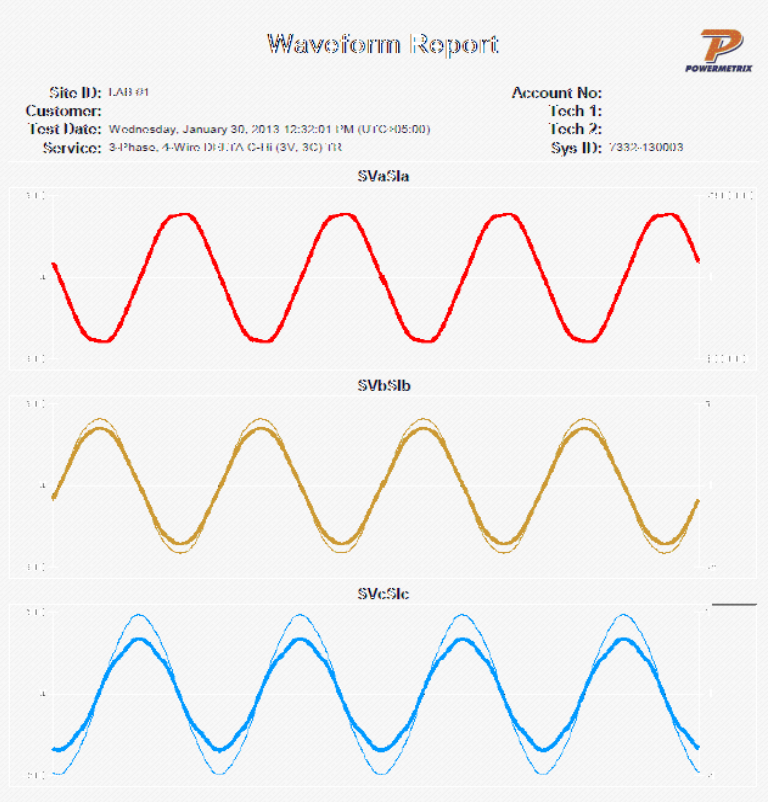
No Lag (1.00 PF)



30° Lag (0.866 PF)

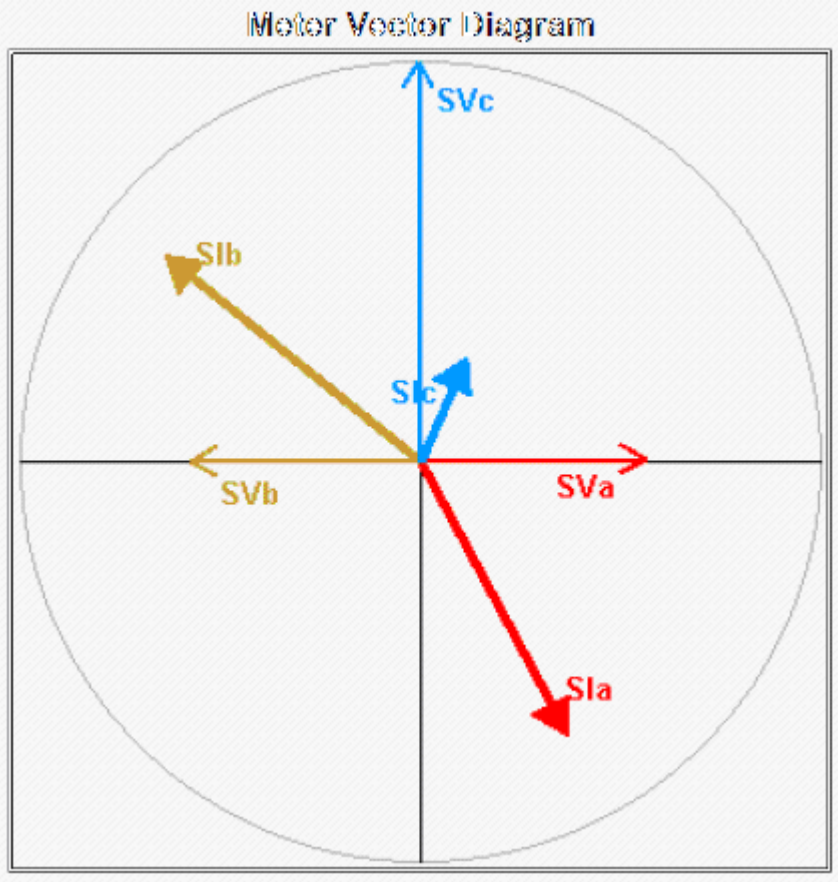
Delta Service at Unity Power Factor

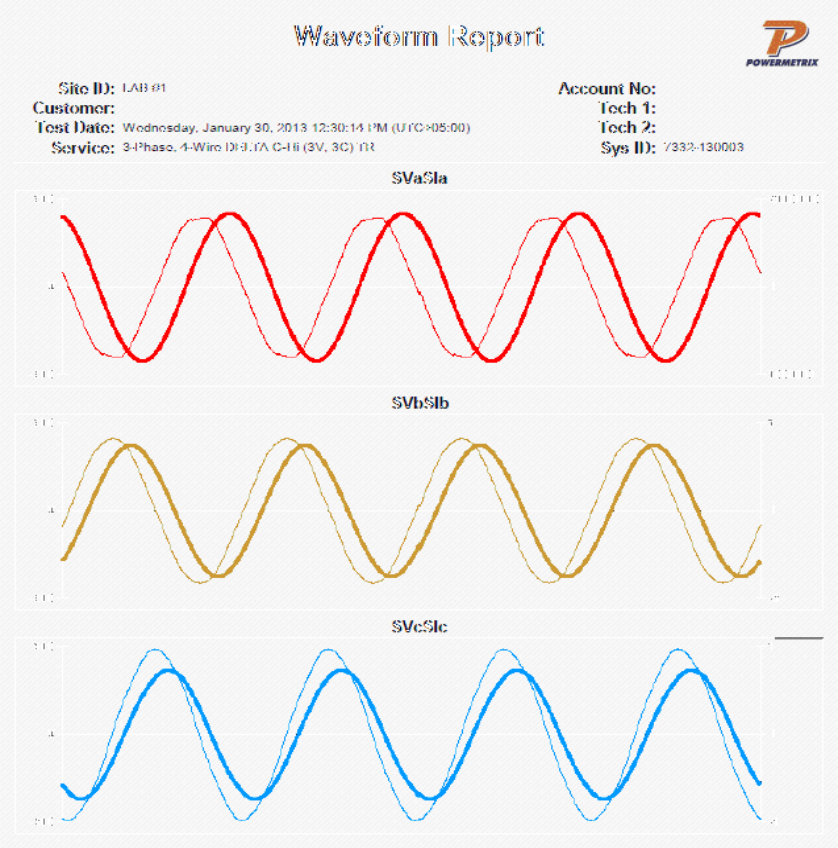




CARIBBEAN & LATIN AMERICAN METER SCHOOL

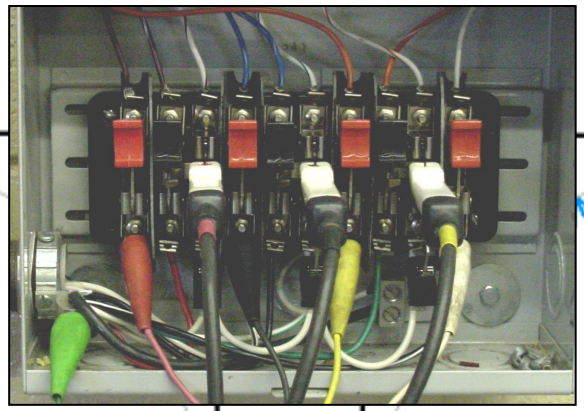
Delta Service at 50% Power Factor

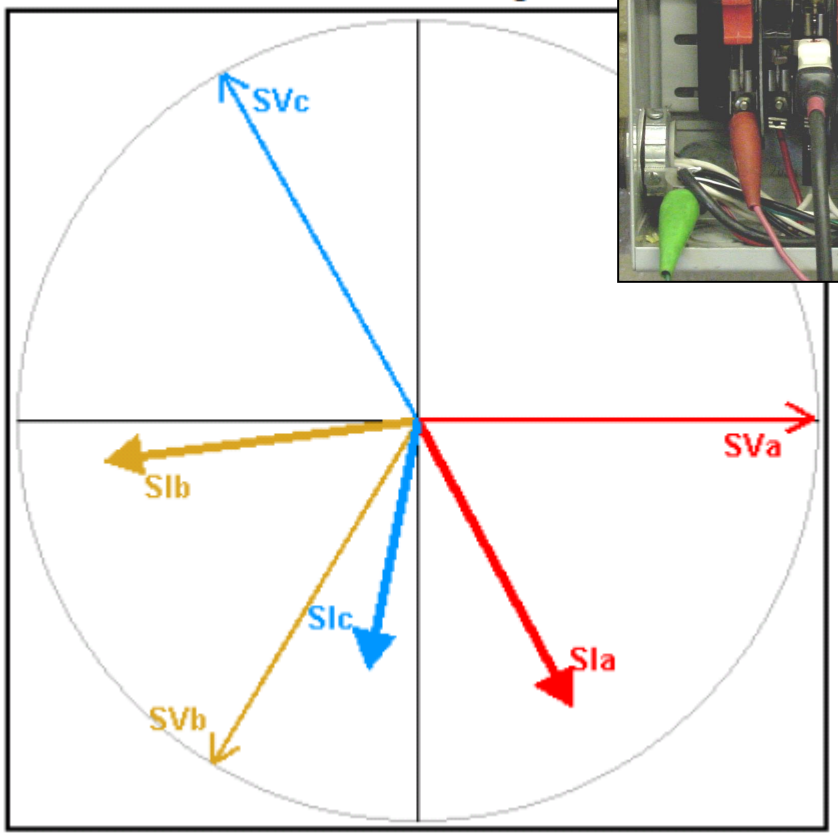


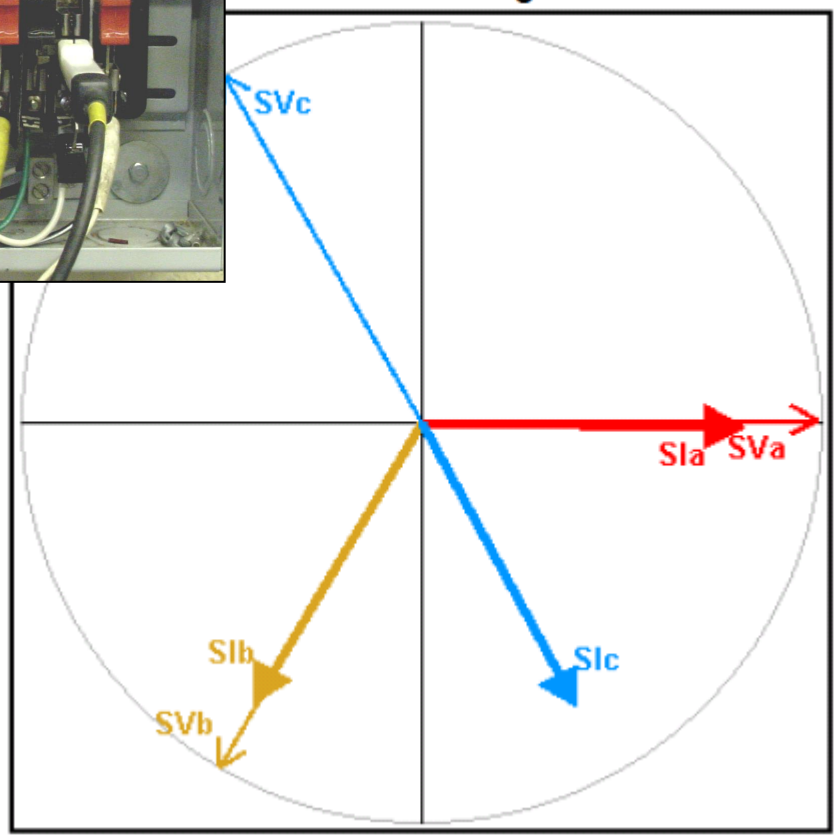


CARIBBEAN & LATIN AMERICAN METER SCHOOL

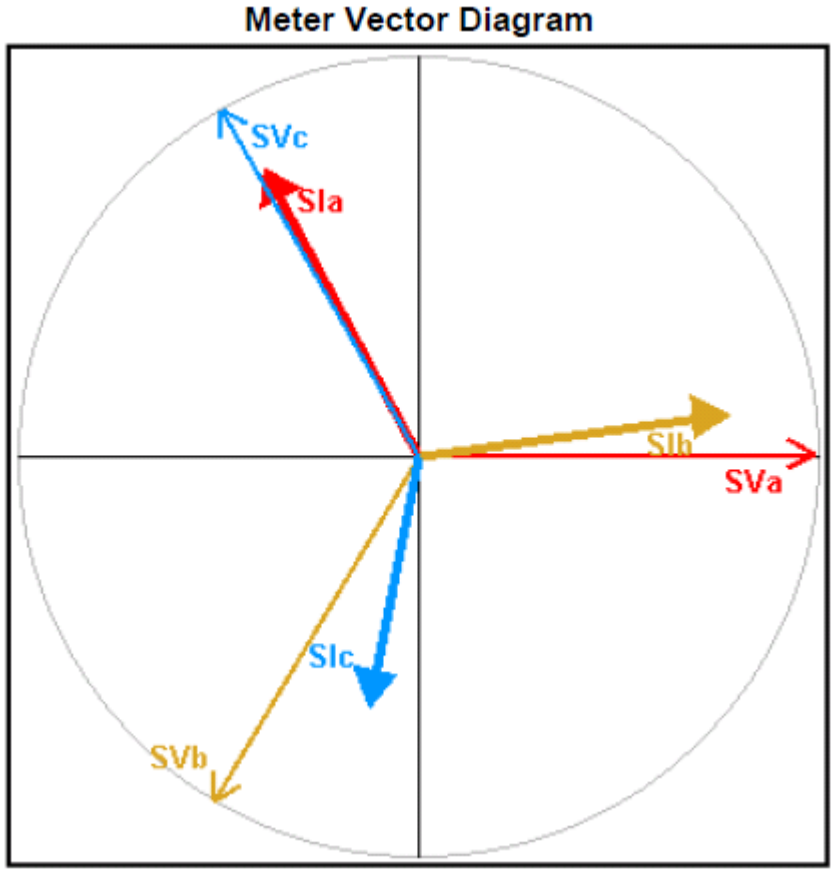
VIEW THE VECTOR TO VERIFY YOUR CONNECTIONS …

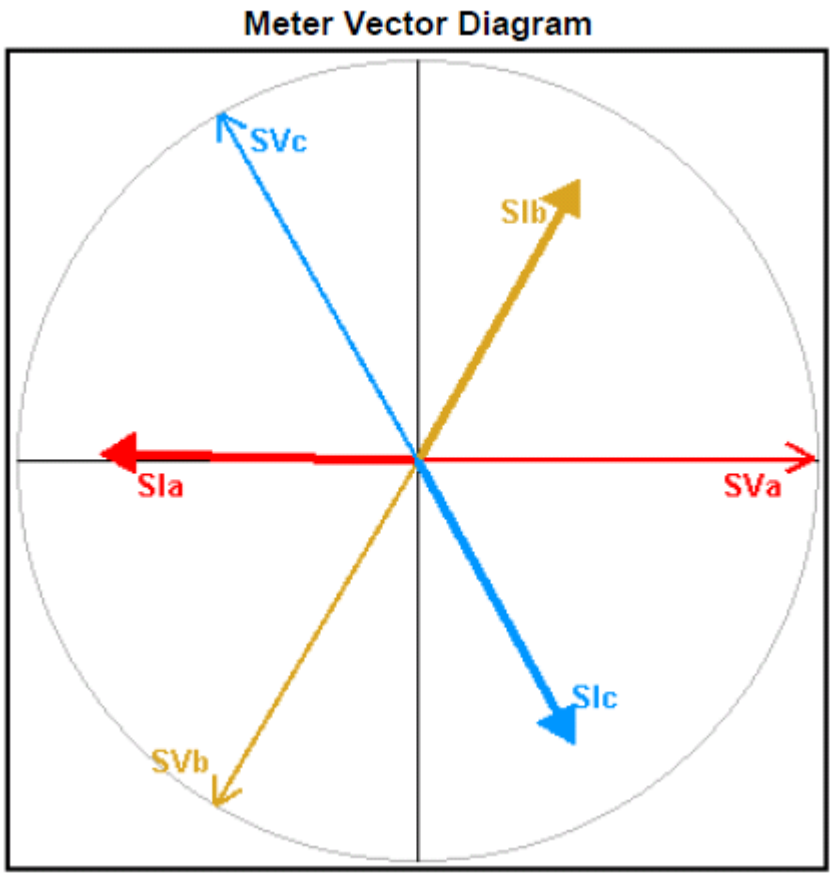




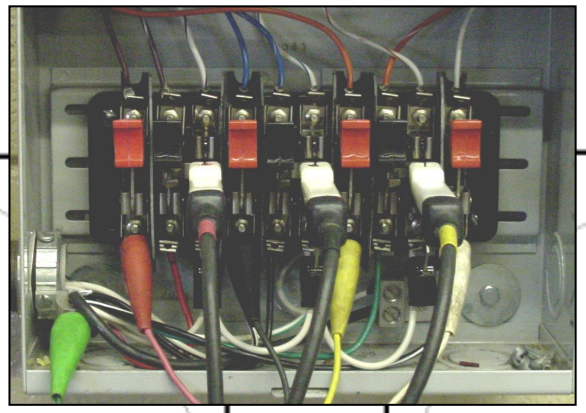


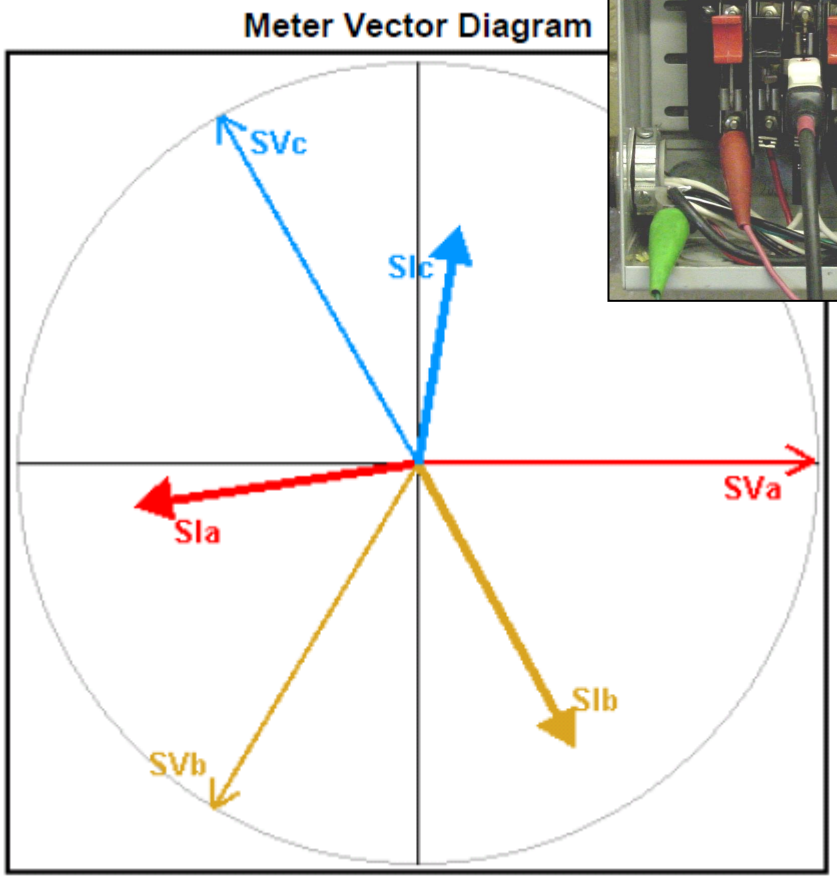
View the Vector to Verify your Connections …

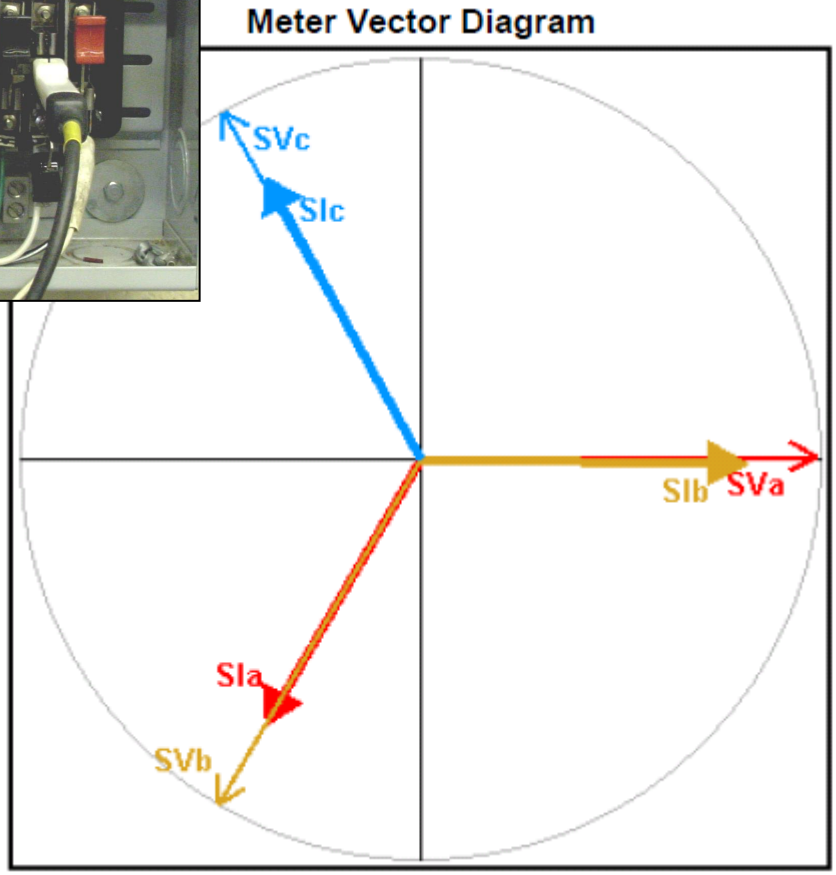




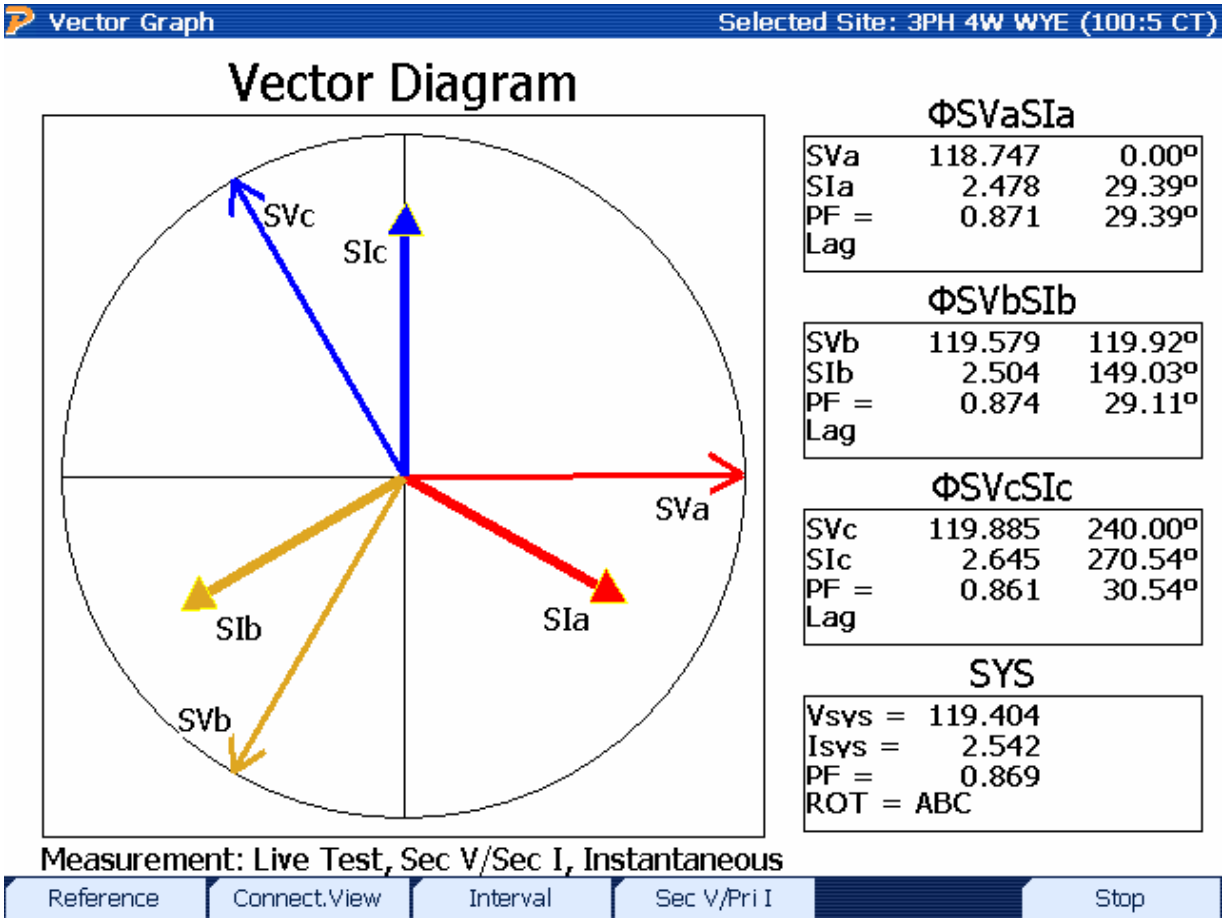
View the Vector to Verify your Connections …







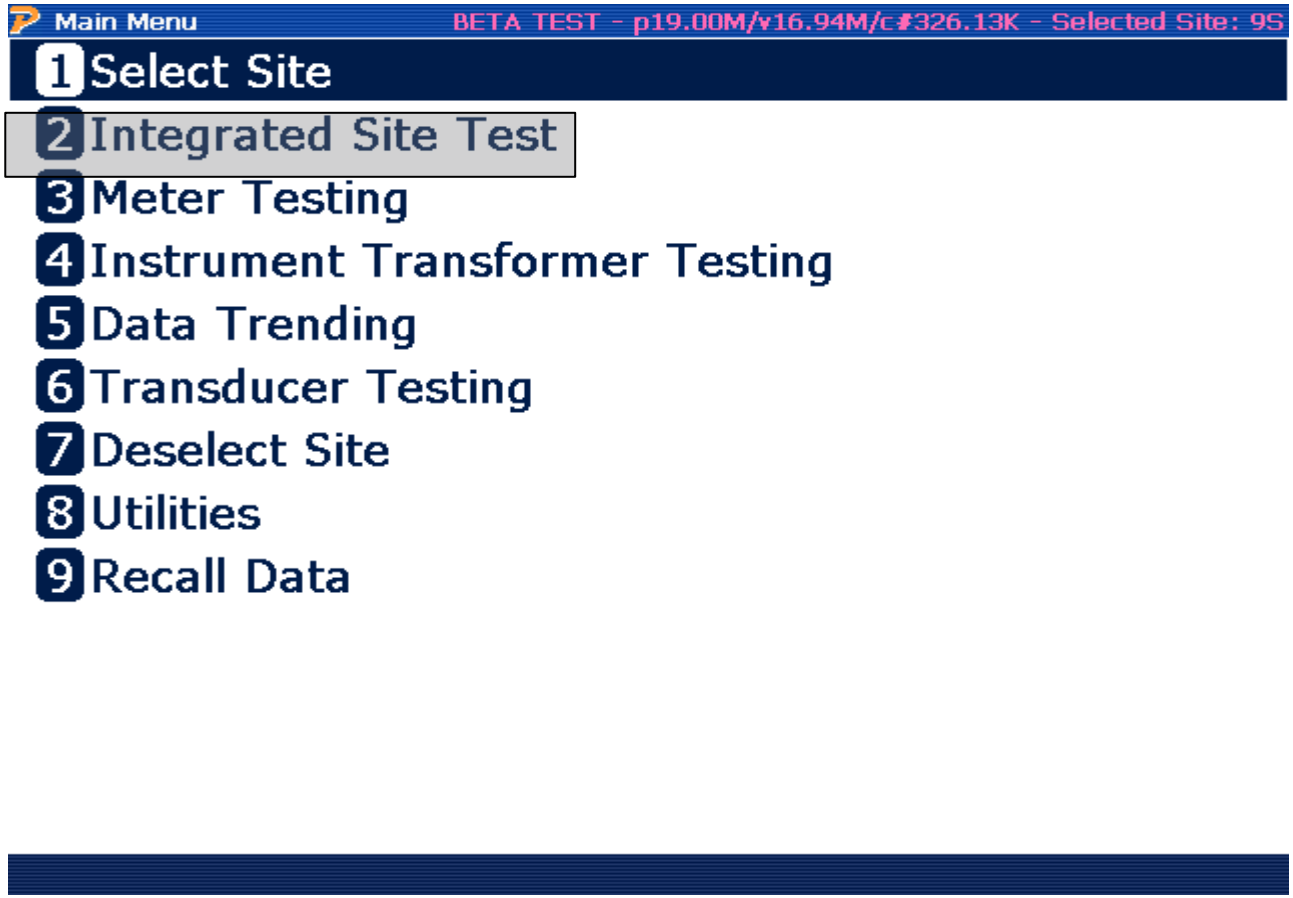
What your Looking For!



Correct Vector
Potentials and Currents Match.
Start the Scan

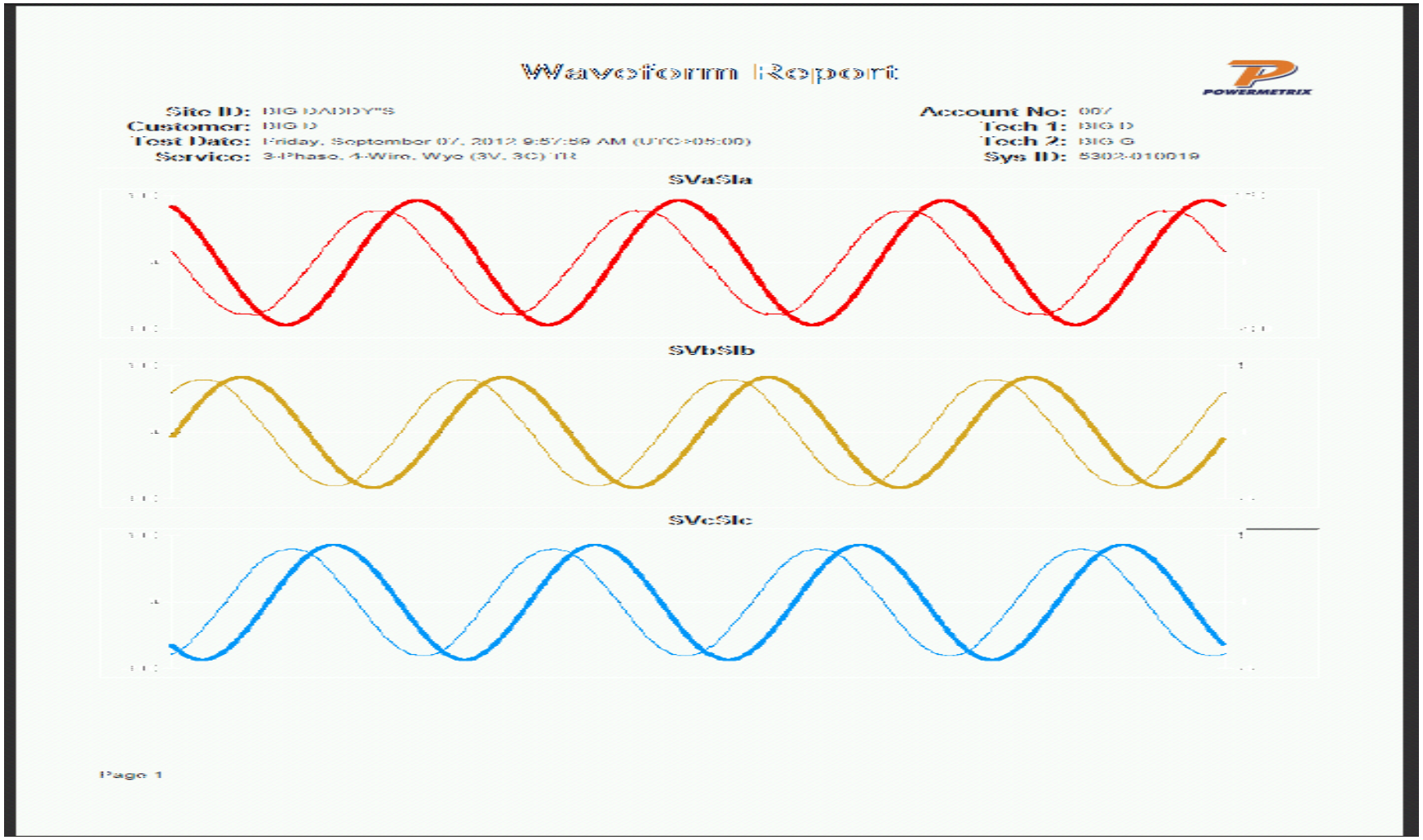
CARIBBEAN & LATIN AMERICAN METER SCHOOL

INTEGRATED SITE TEST



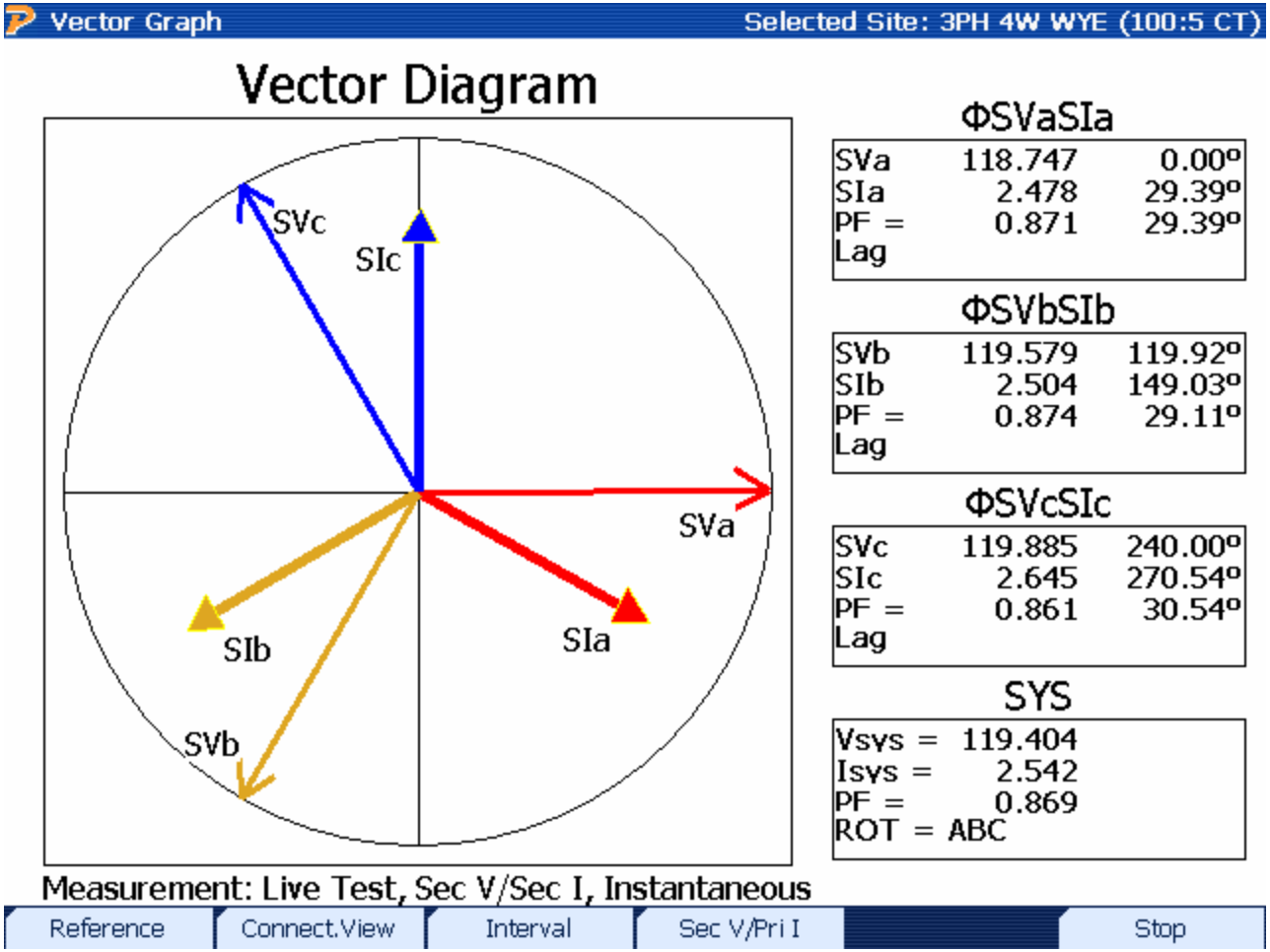
CARIBBEAN & LATIN AMERICAN METER SCHOOL

Capture of Sine Waves of Amps & Volts



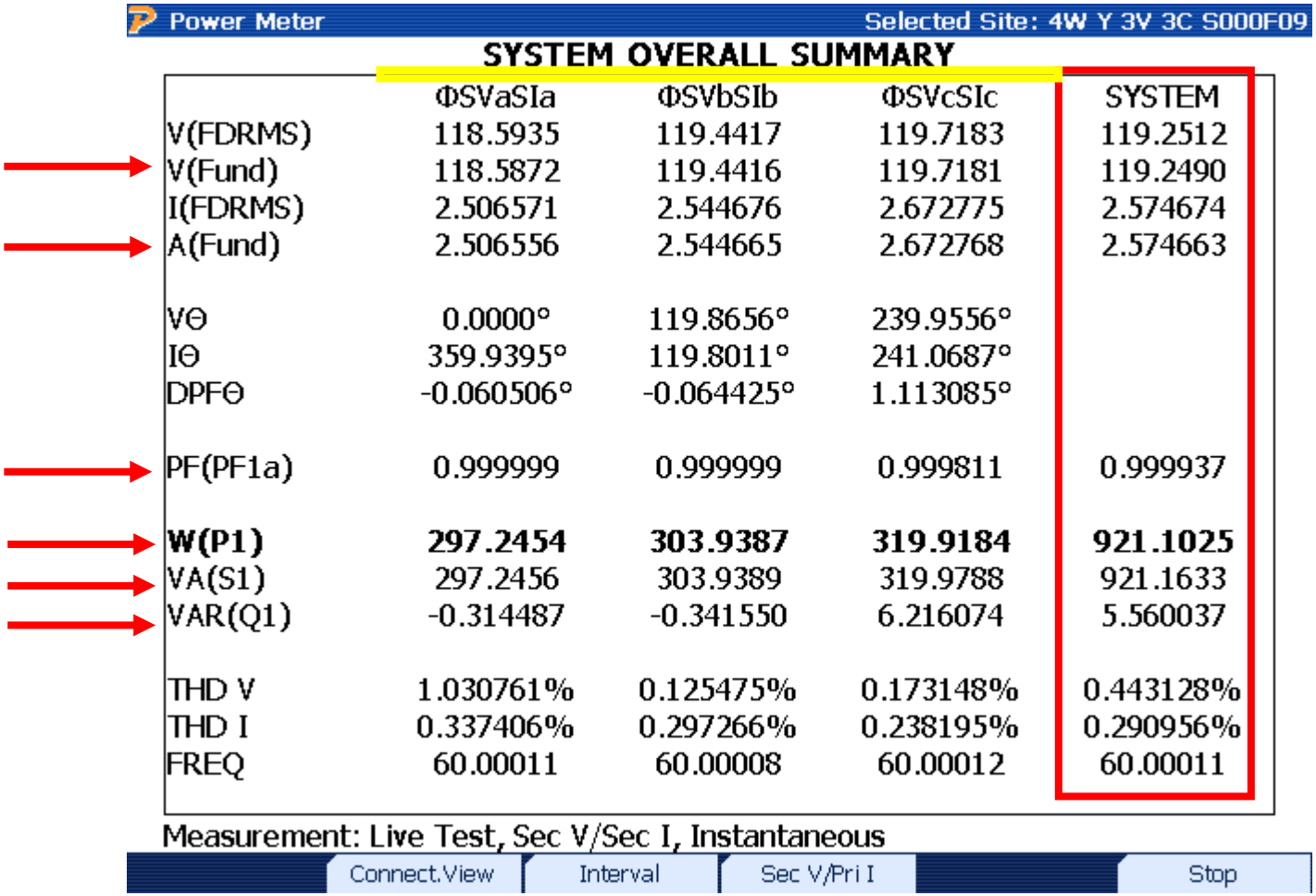
CARIBBEAN & LATIN AMERICAN METER SCHOOL

Capture of Vector



CARIBBEAN & LATIN AMERICAN METER SCHOOL

Captures System Overall Summary "Breakdown Of Vector"



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

SYSTEM OVERALL SUMMARY

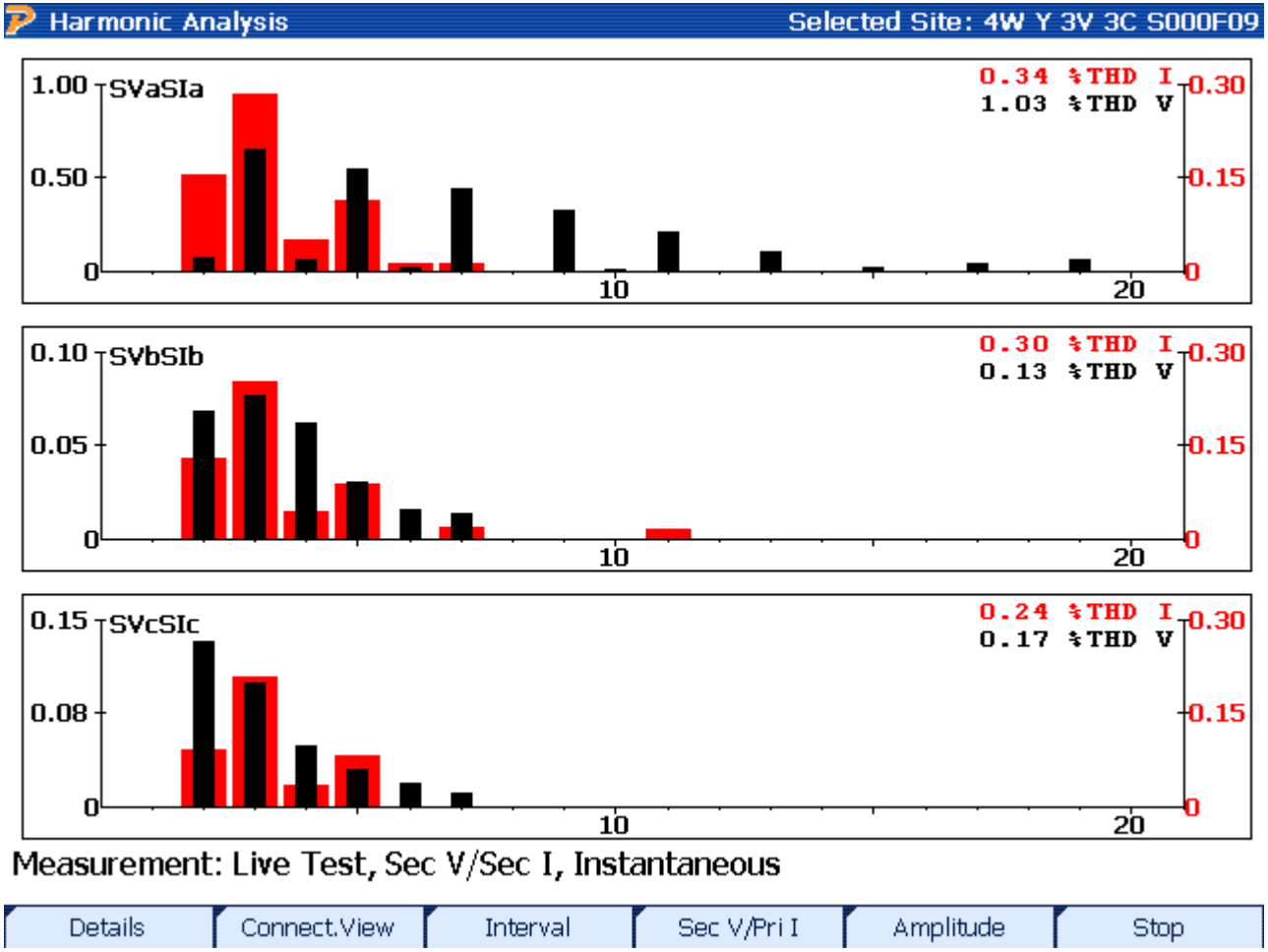
	ΦSVaSIa	ΦSVbSIb	ΦSVcSIc	SYSTEM
V(FDRMS)	118.5935	119.4417	119.7183	119.2512
V(Fund)	118.5872	119.4416	119.7181	119.2490
I(FDRMS)	2.506571	2.544676	2.672775	2.574674
A(Fund)	2.506556	2.544665	2.672768	2.574663
VΘ	0.0000°	119.8656°	239.9556°	
IΘ	359.9395°	119.8011°	241.0687°	
DPFΘ	-0.060506°	-0.064425°	1.113085°	
PF(PF1a)	0.999999	0.999999	0.999811	0.999937
W(P1)	**297.2454**	**303.9387**	**319.9184**	**921.1025**
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

CARIBBEAN & LATIN AMERICAN METER SCHOOL

Harmonics for Amp And Volts



Amps

Volts

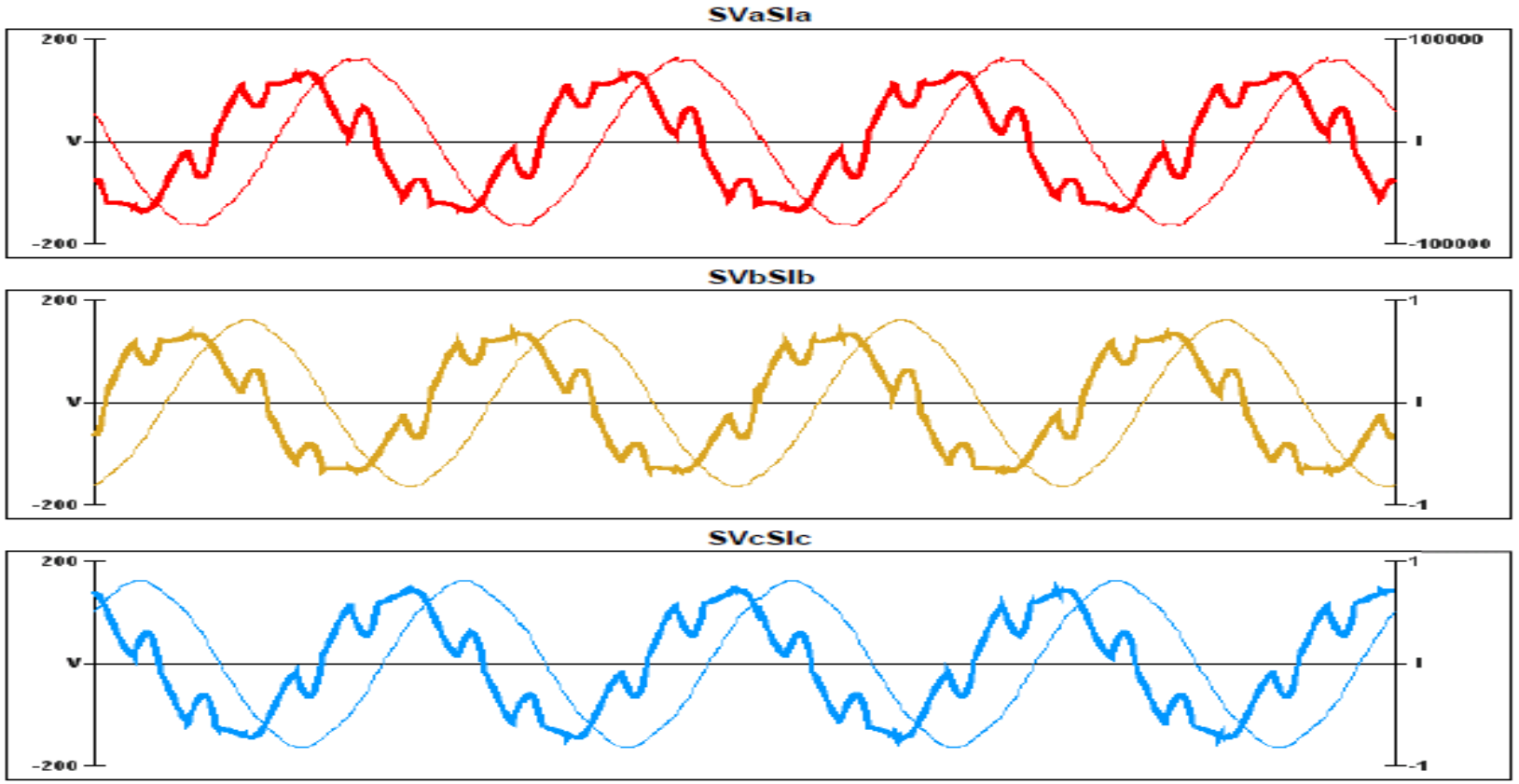
CARIBBEAN & LATIN AMERICAN METER SCHOOL

Harmonics

Waveform Report

POWERMETRIX

Site ID:	CIRCUIT4 5 CONCOURSE PKY	**Account No:**	3386301
Customer:	CONCOURSE V ASSOC	**Tech 1:**	BOB HENRY
Test Date:	Thursday, January 24, 2013 1:57:36 PM (UTC+05:00)	**Tech 2:**	
Service:	3-Phase, 4-Wire, Wye (3V, 3C) TR	**Sys ID:**	5302-010025



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**

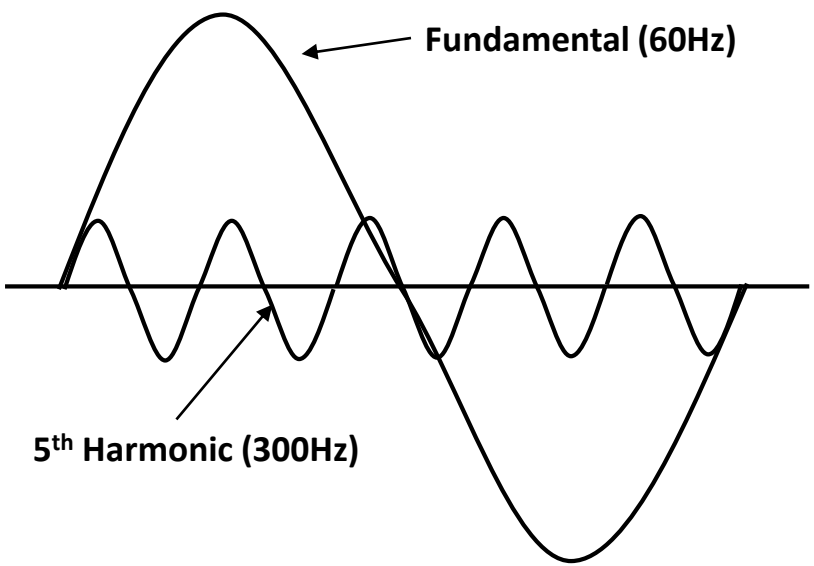
NON-LINEAR LOADS (Harmonics)

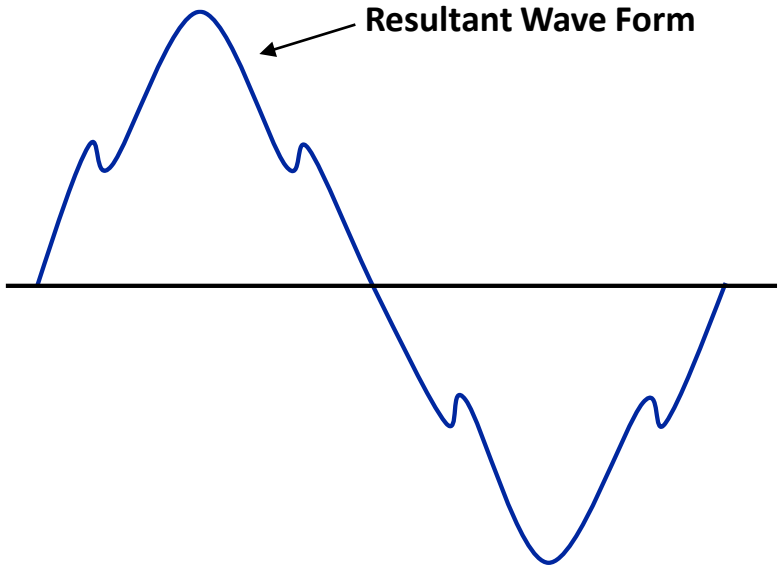
- **DC Drives**
- **Power Rectifiers**
- **Compact Fluorescent Bulbs**

HARMONIC DISTORTION

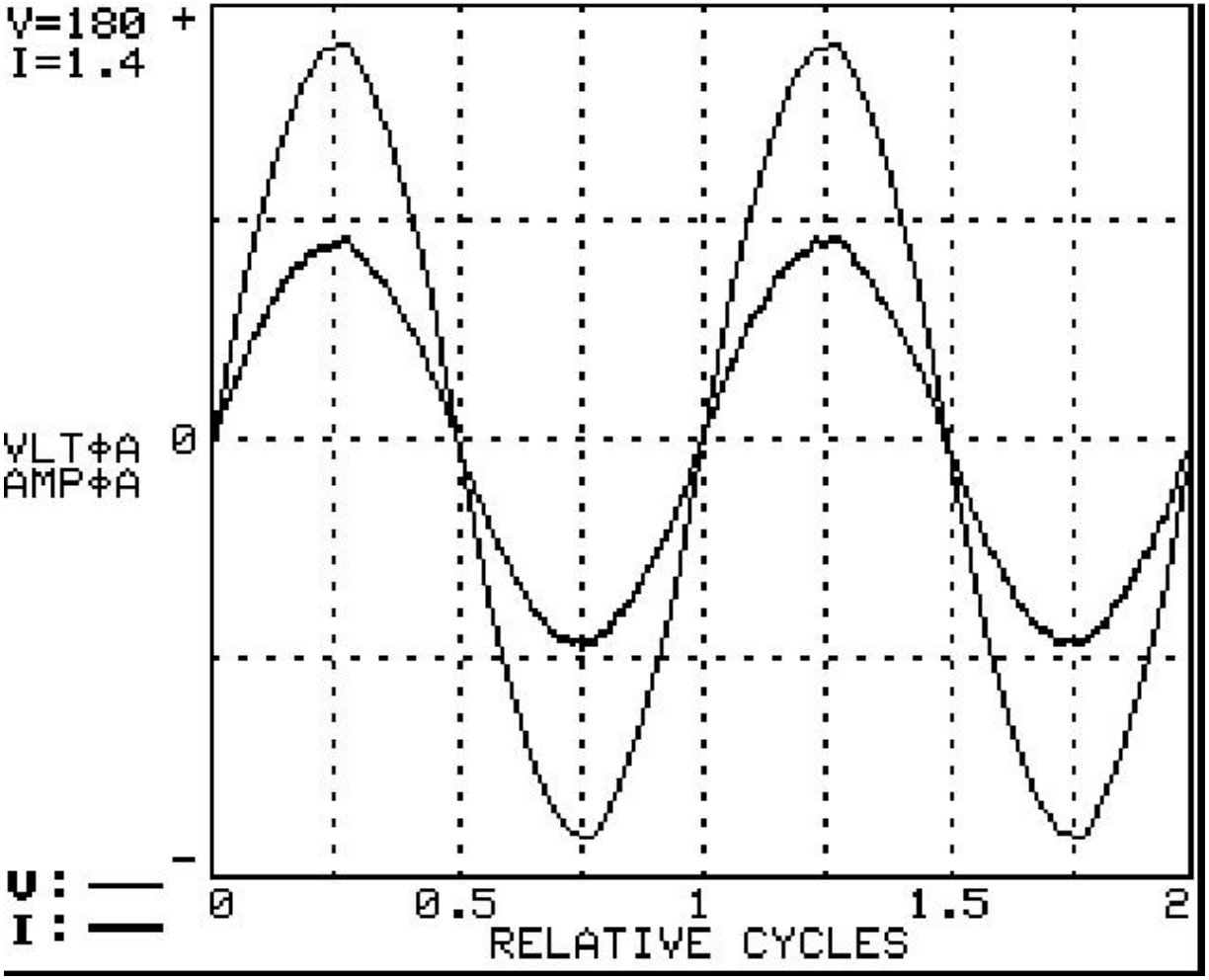
Harmonic waveforms are simply multiples of the fundamental waveform.

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

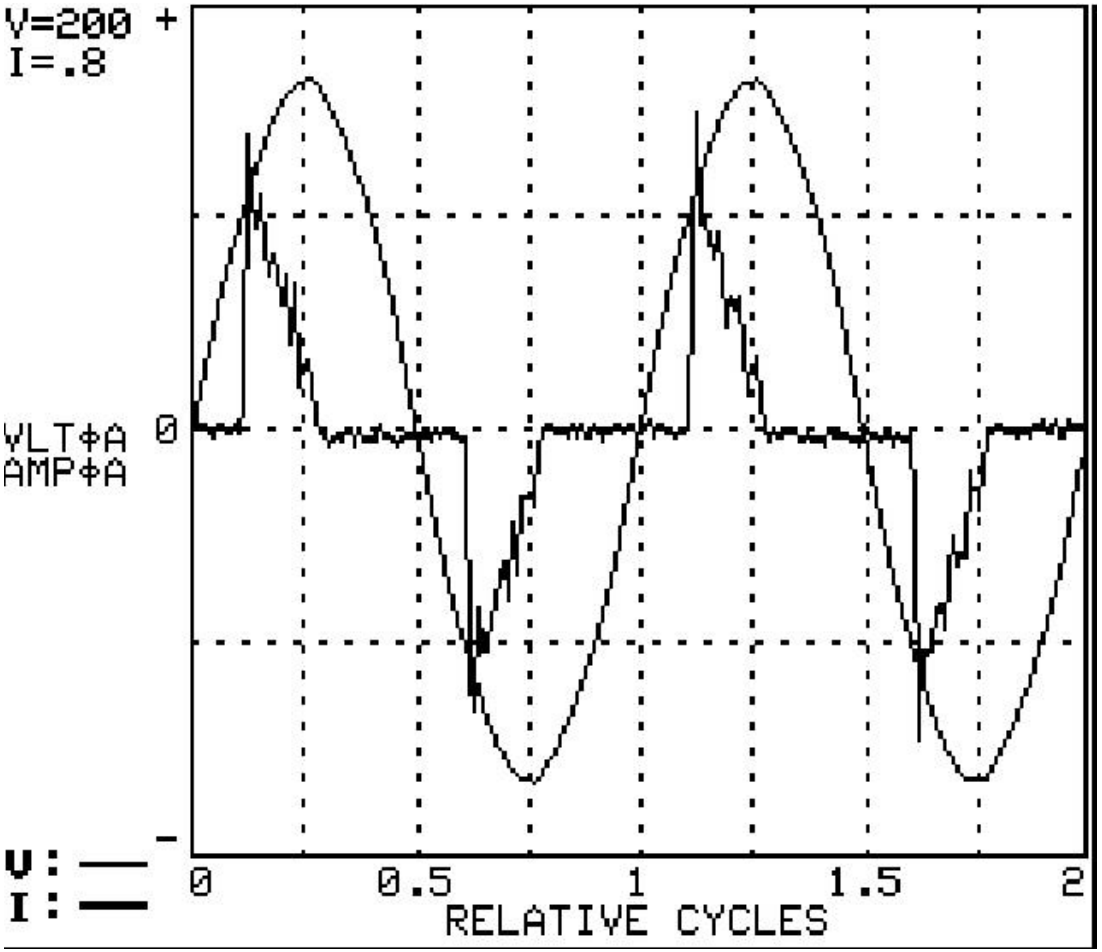


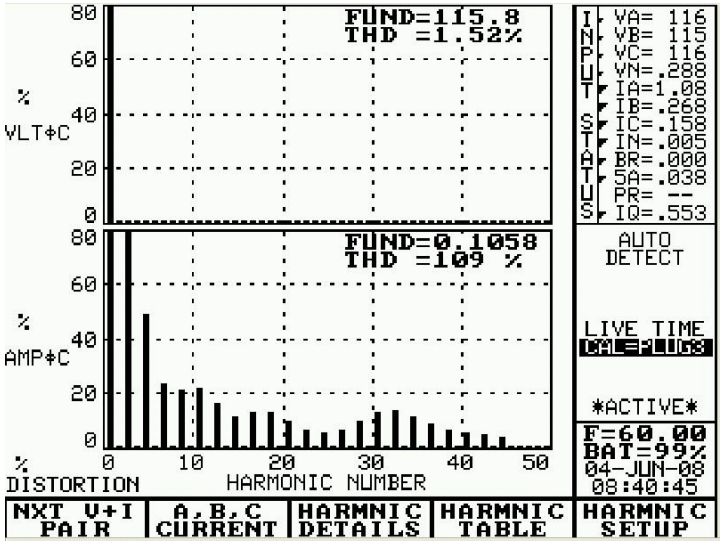


INCANDESCENT BULB



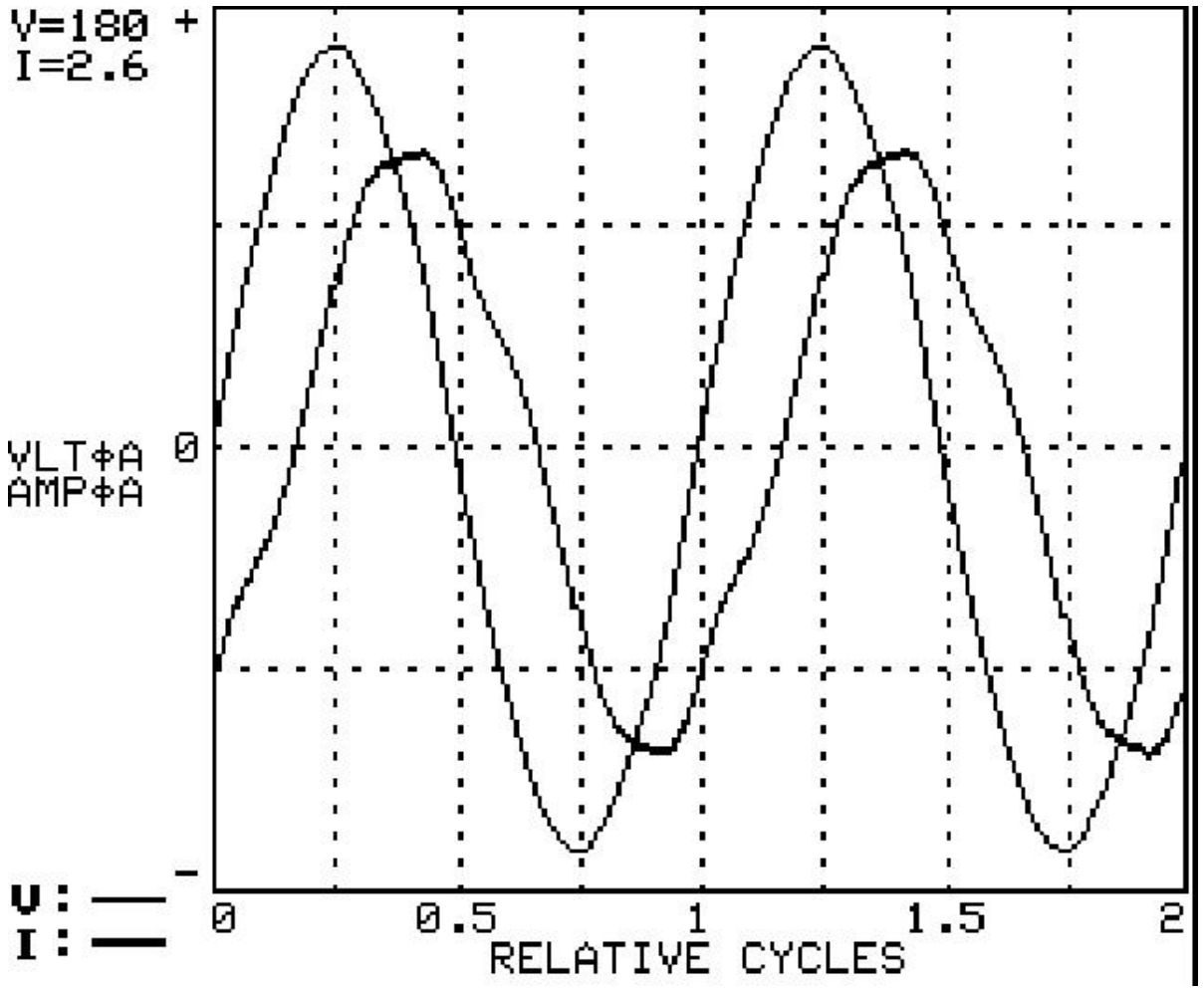
COMPACT FLUORESCENT BULB





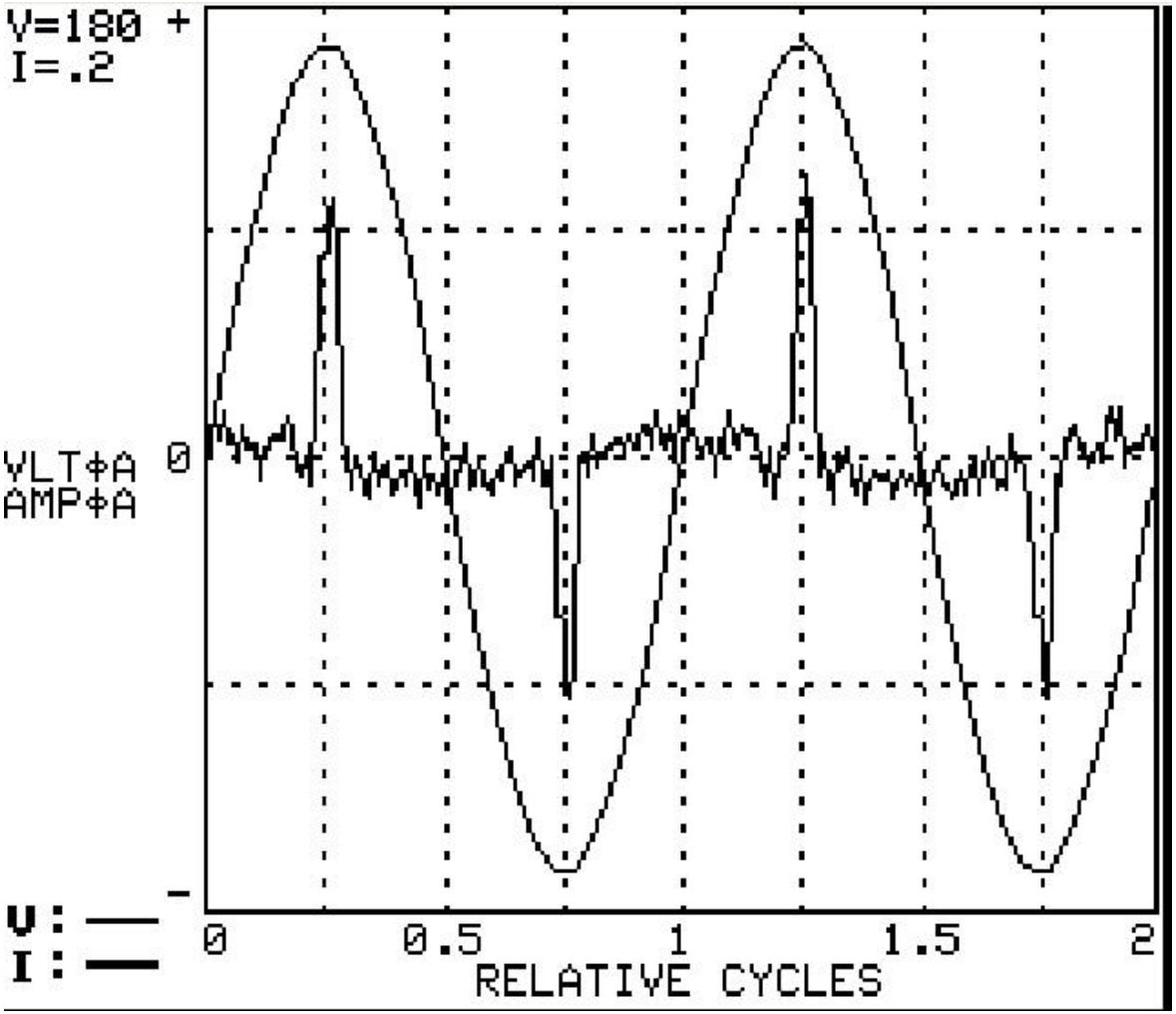
CARIBBEAN & LATIN AMERICAN METER SCHOOL

MOTOR


V=180
I=2.6
+
VLT∅A
AMP∅A
0
-
V:
I:
0
0.5
1
1.5
2
RELATIVE CYCLES


Belt Drive Fan And Blower Motor
MOD NO. 5K901C

POWER SUPPLY FOR LAP TOP COMPUTER

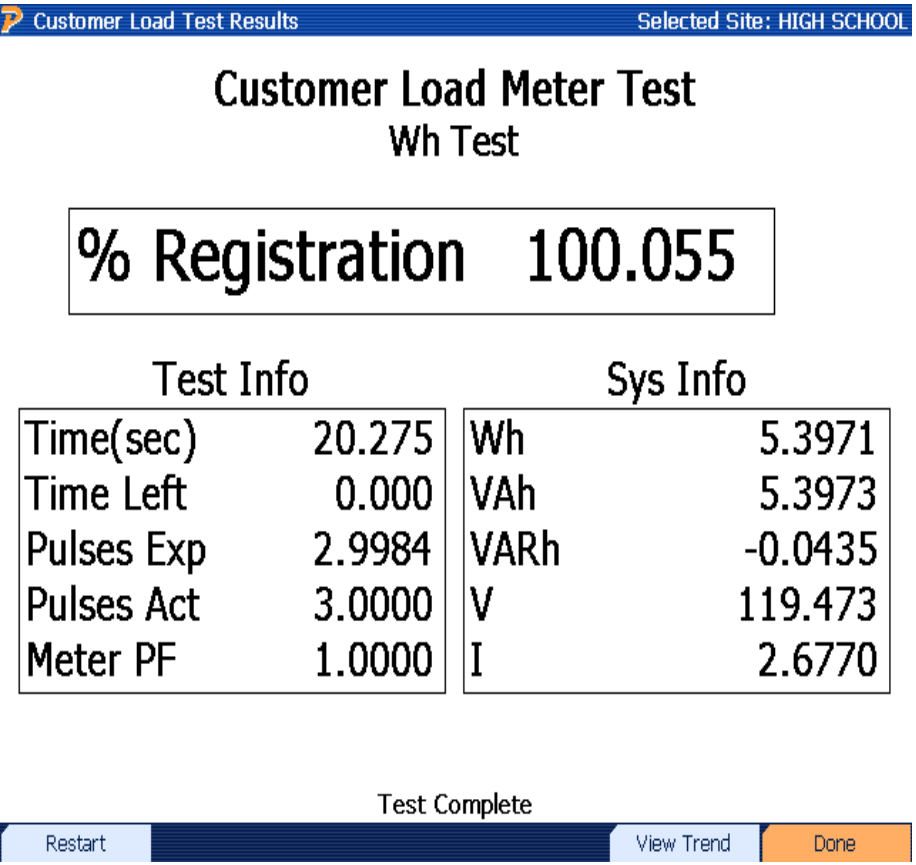


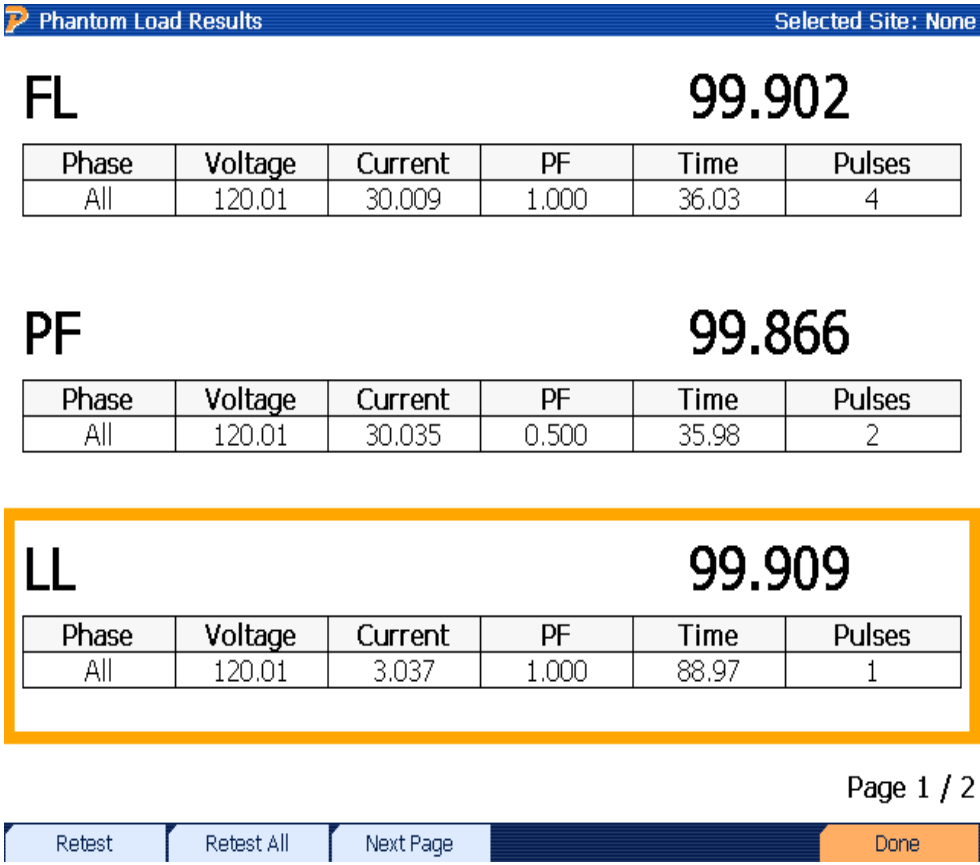
CARIBBEAN & LATIN AMERICAN METER SCHOOL

Meter Accuracy Test

CARIBBEAN & LATIN AMERICAN METER SCHOOL

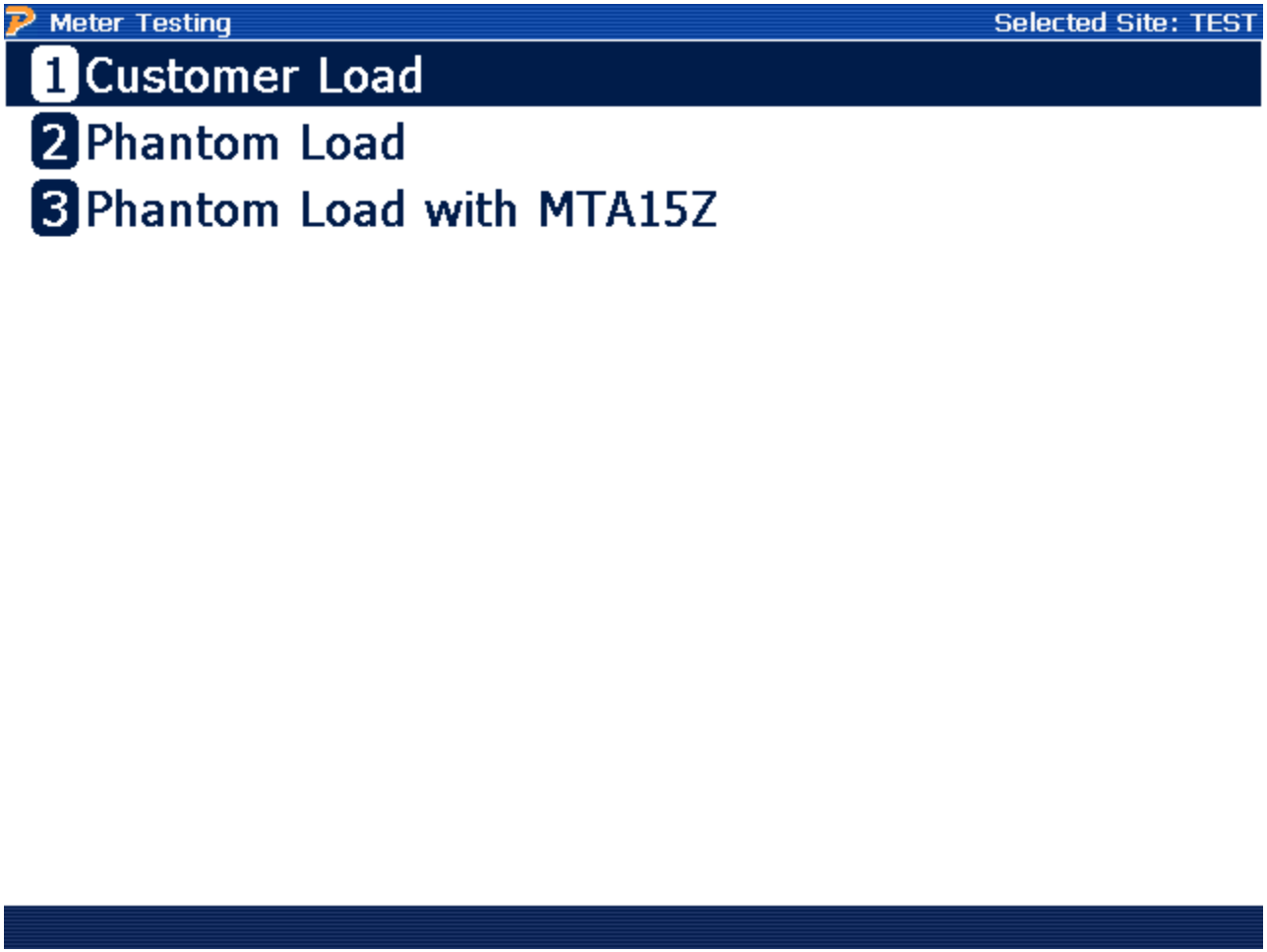
Meter Accuracy Test





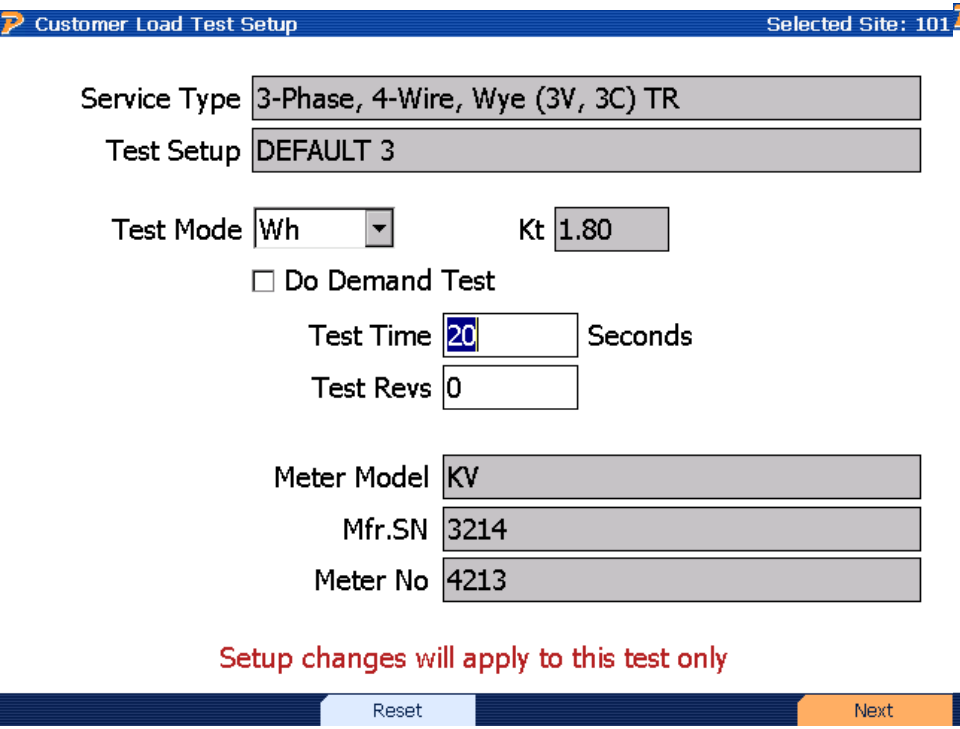
CARIBBEAN & LATIN AMERICAN METER SCHOOL

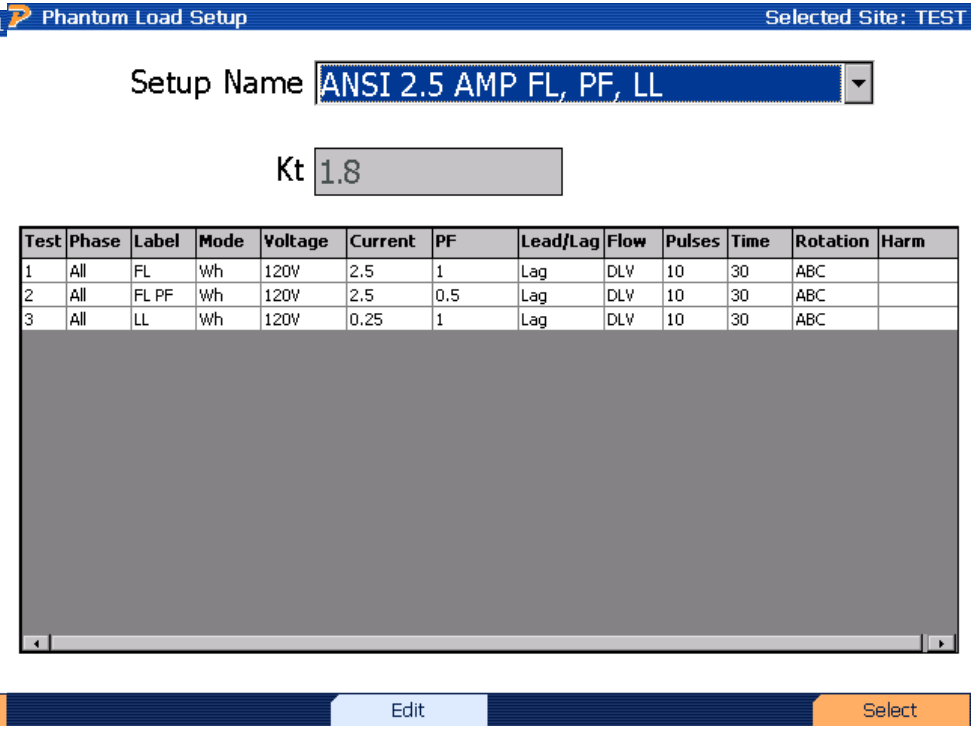
Customer or Phantom Load Test



CARIBBEAN & LATIN AMERICAN METER SCHOOL

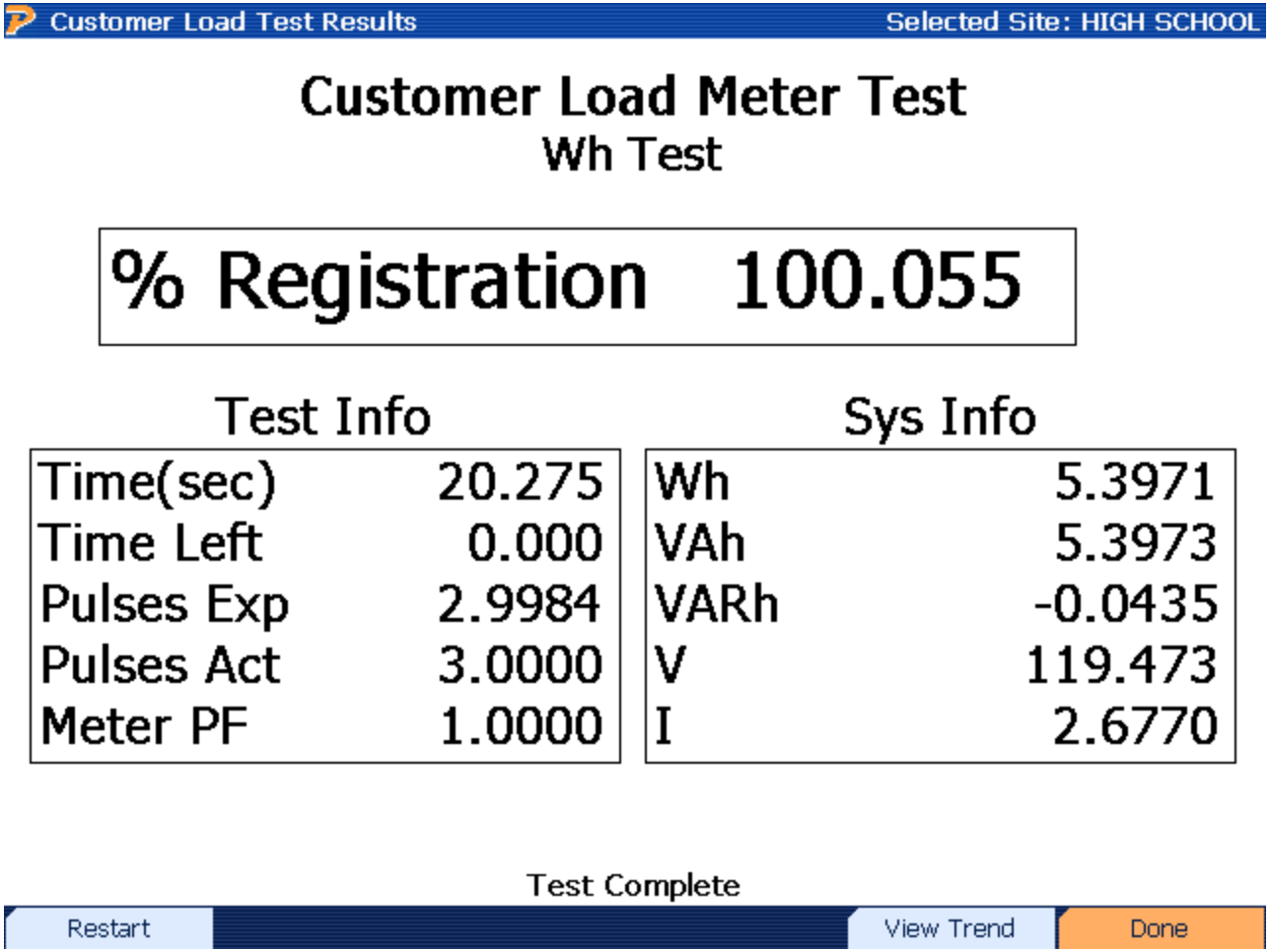
Meter Accuracy Test Setup



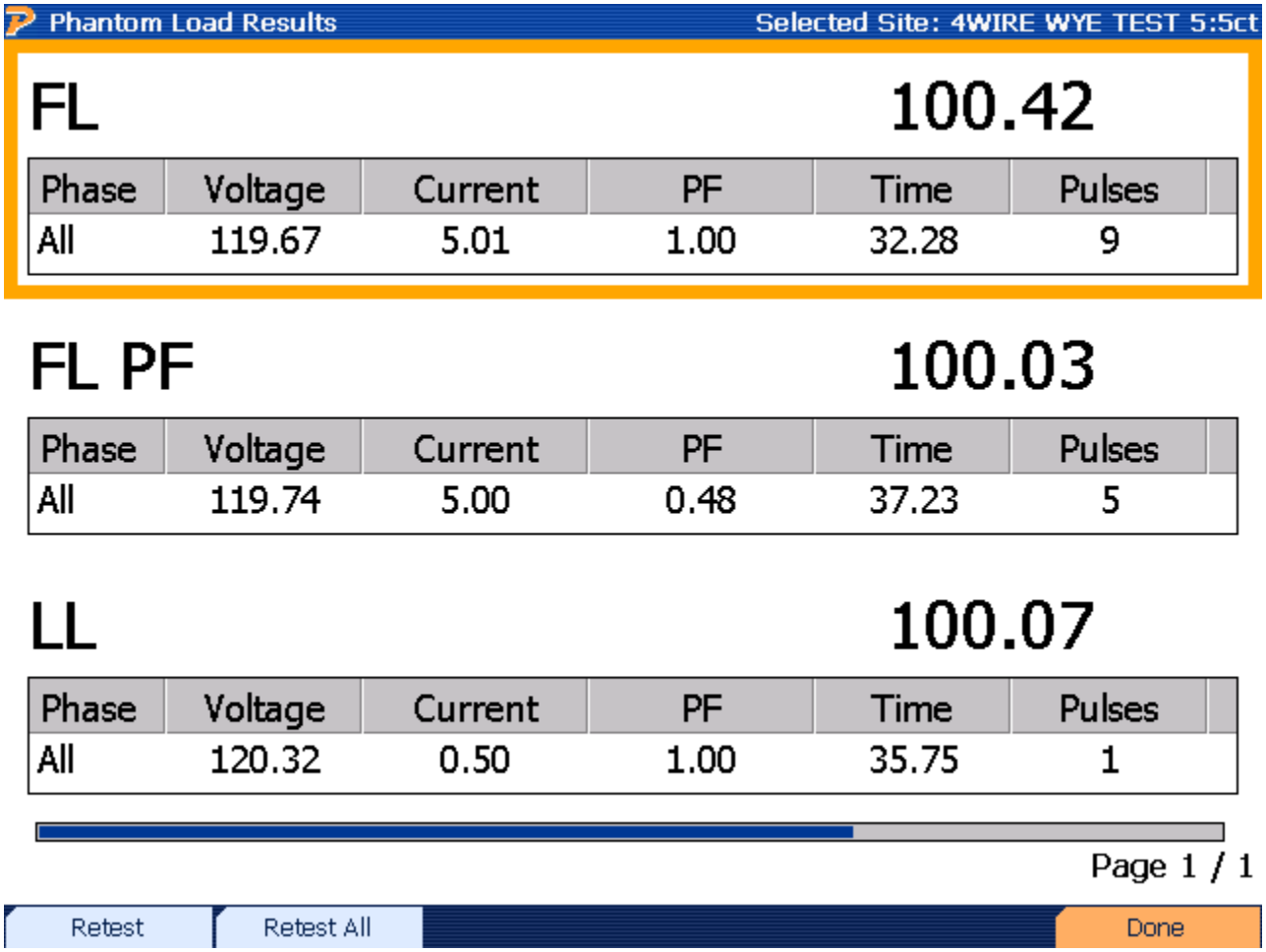


CARIBBEAN & LATIN AMERICAN METER SCHOOL

Meter Test Results
kWH

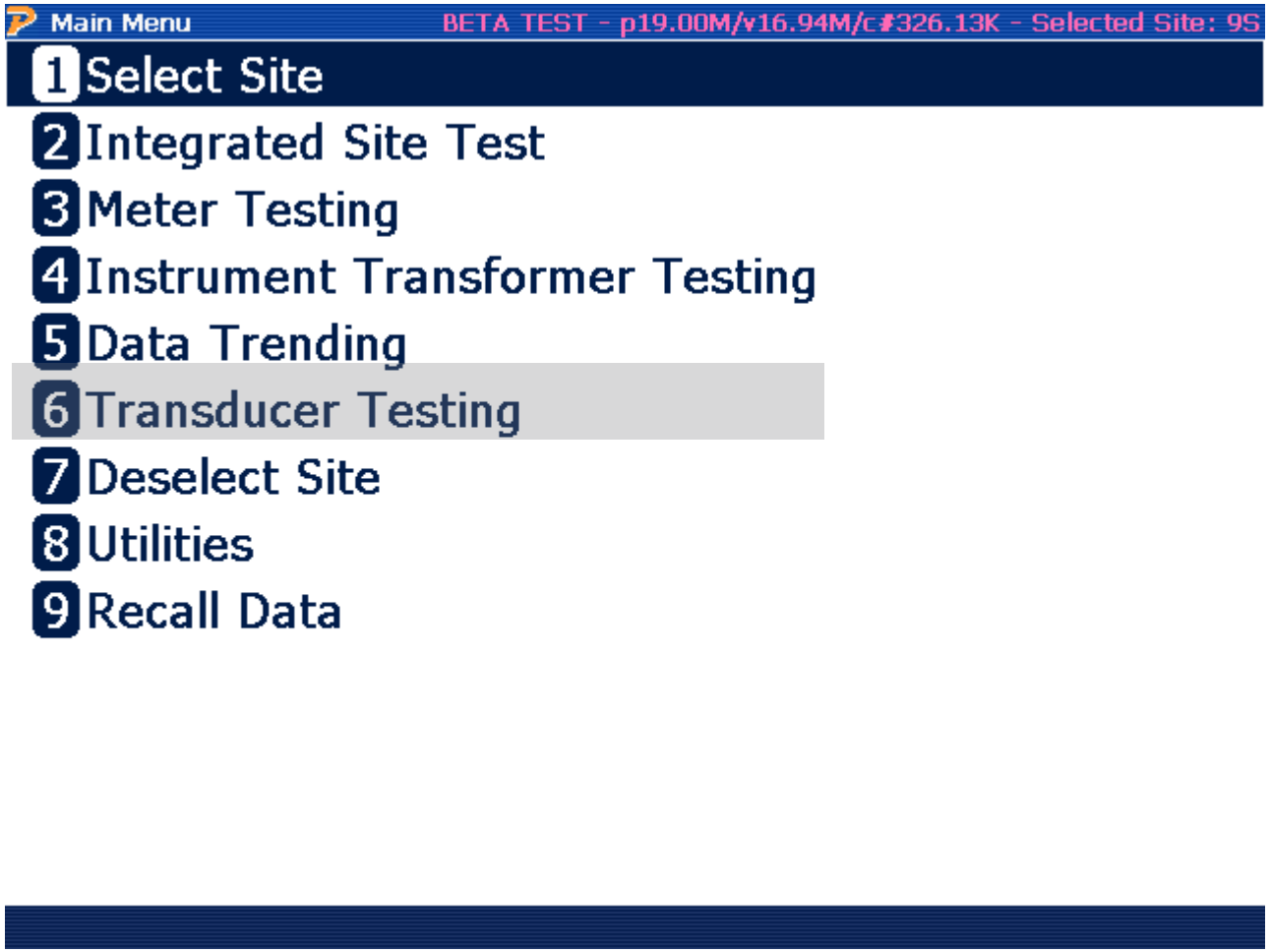


Phantom Load Tests Results



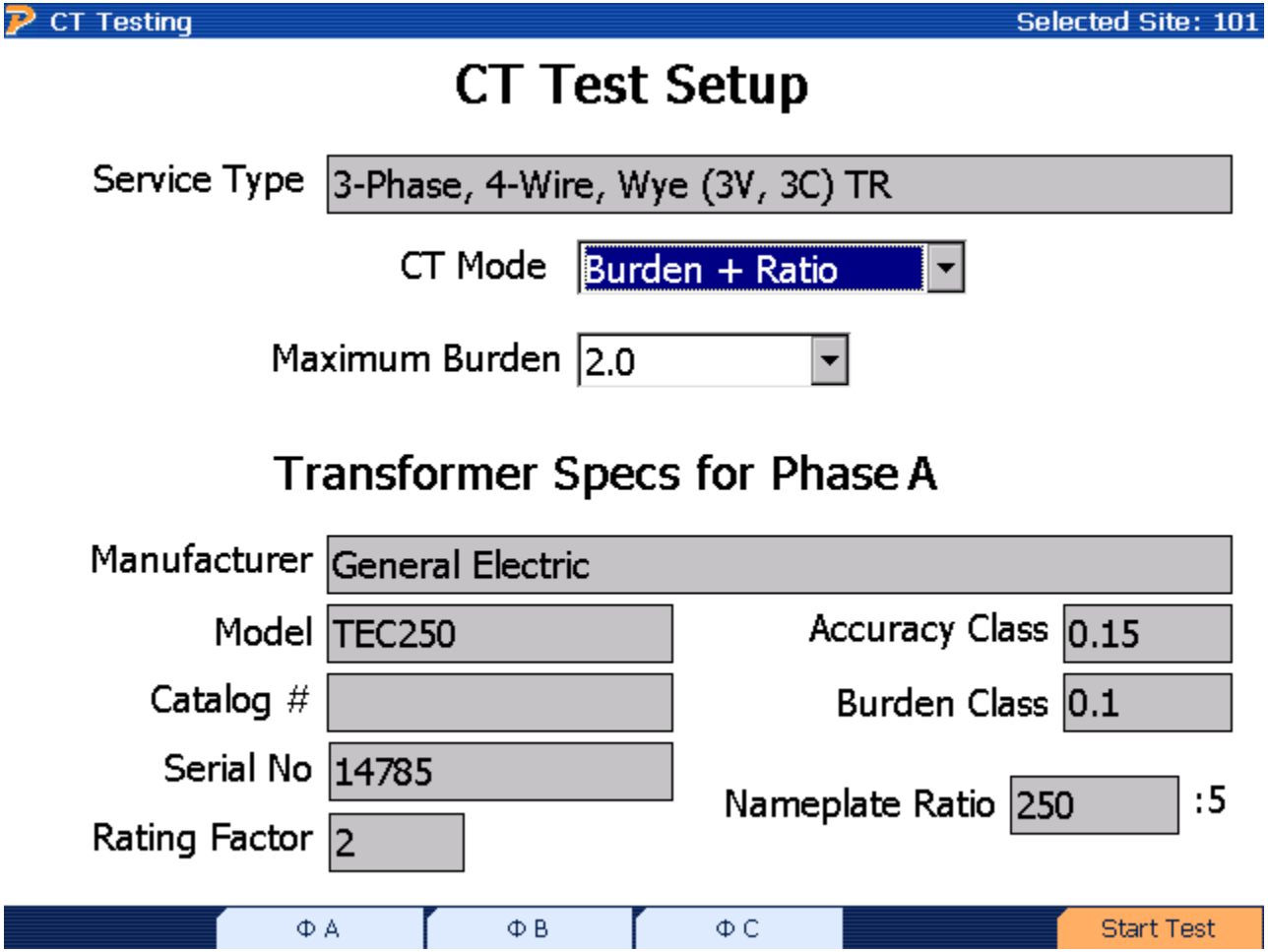
CARIBBEAN & LATIN AMERICAN METER SCHOOL

VERIFYING CT ACCURACY

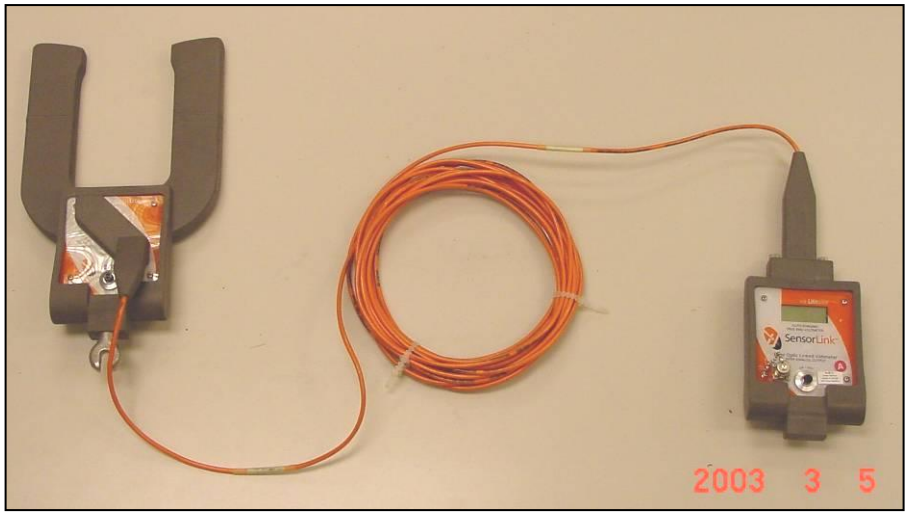


CARIBBEAN & LATIN AMERICAN METER SCHOOL

SETUP SCREEN FOR VERIFYING CT ACCURACY

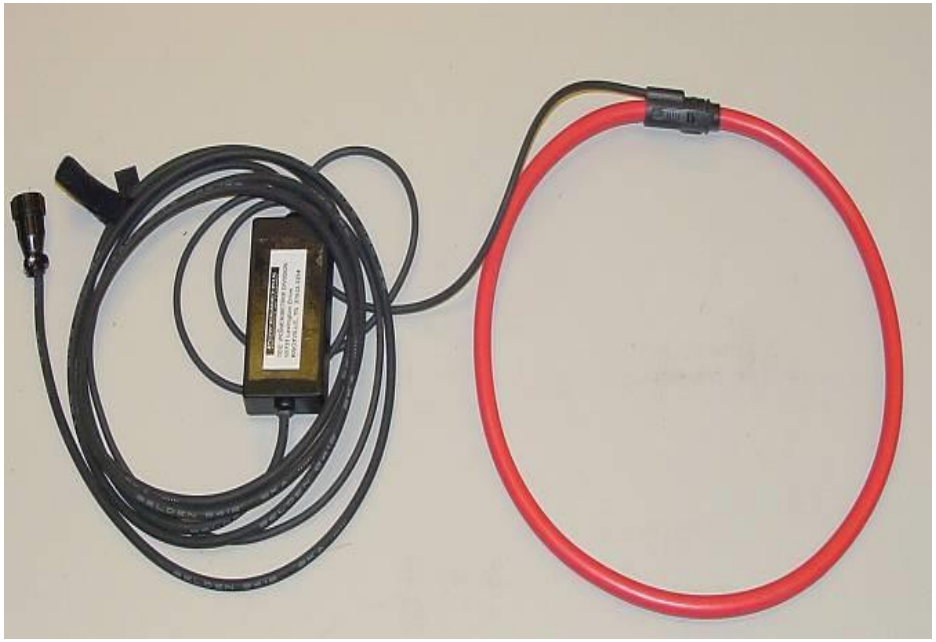


DEVICES USED TO MEASURE THE CT'S "PRIMARY" CURRENT (CUSTOMER LOAD)



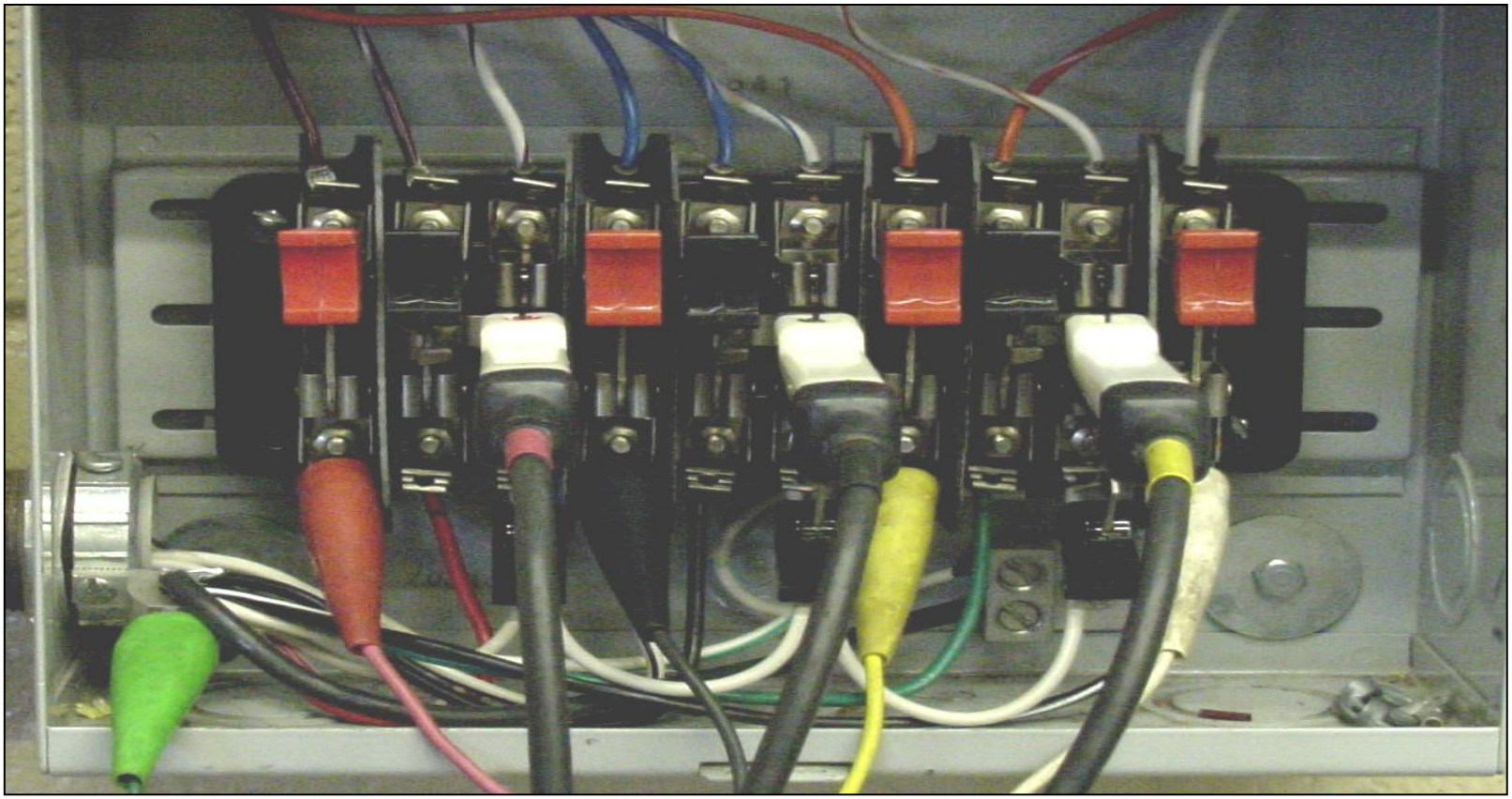
High Voltage Fiber Optic Probe
Used on Primary and Overhead Secondary Services

Flex 36 for Services 600 Volts or Less



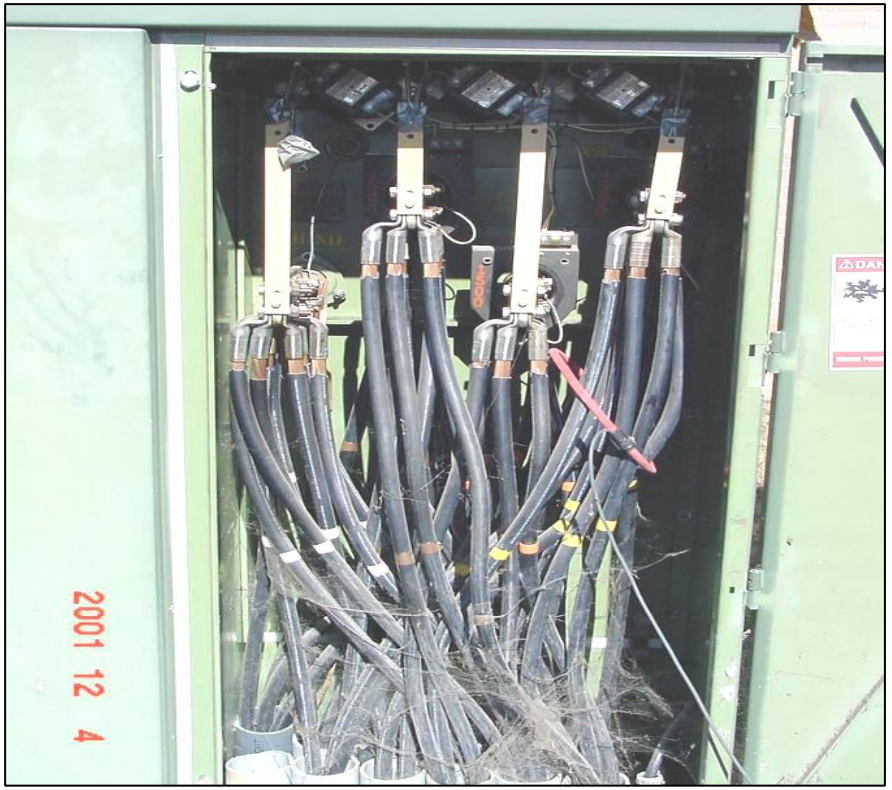
CARIBBEAN & LATIN AMERICAN METER SCHOOL

MEASURING SECONDARY CURRENT



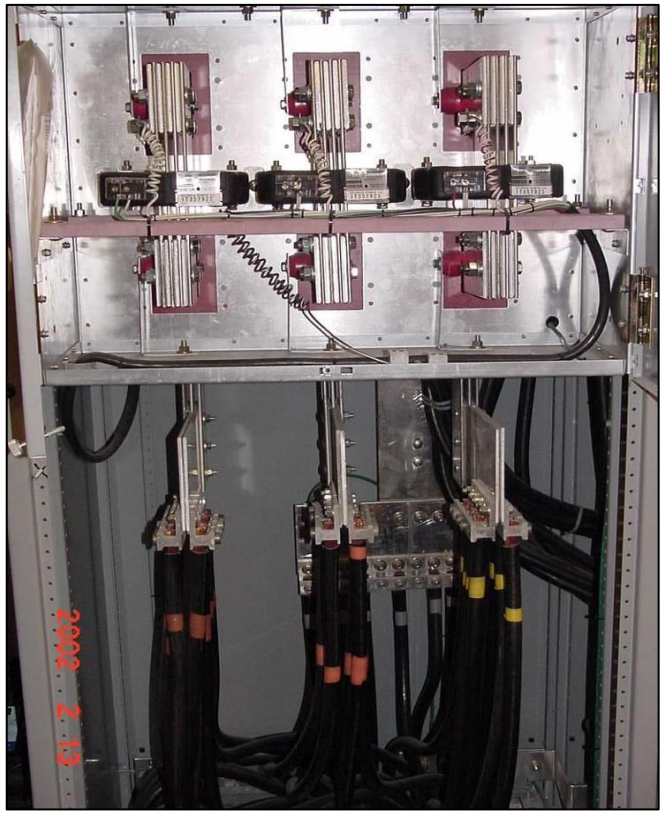
VERIFYING CT ACCURACY ON 600 VOLTS OR LESS

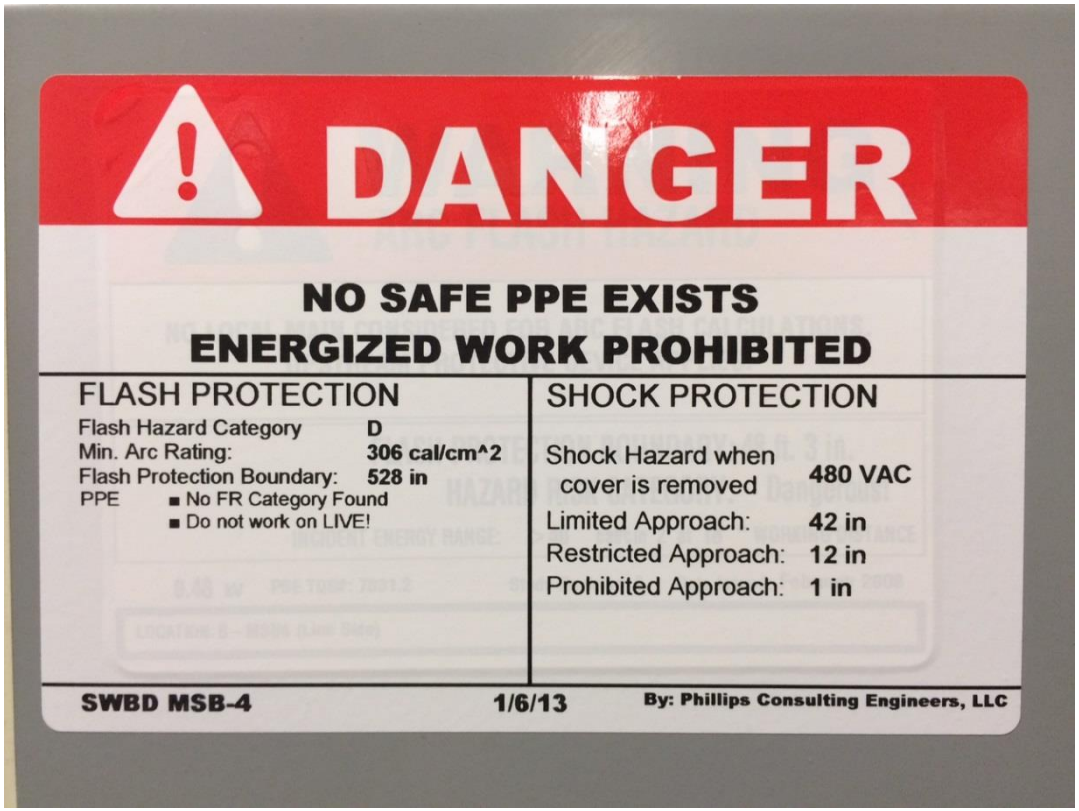
FLEX PROBE MEASURING CT'S "PRIMARY" CURRENT IN AN U.G. TRANSFORMER



CARIBBEAN & LATIN AMERICAN METER SCHOOL

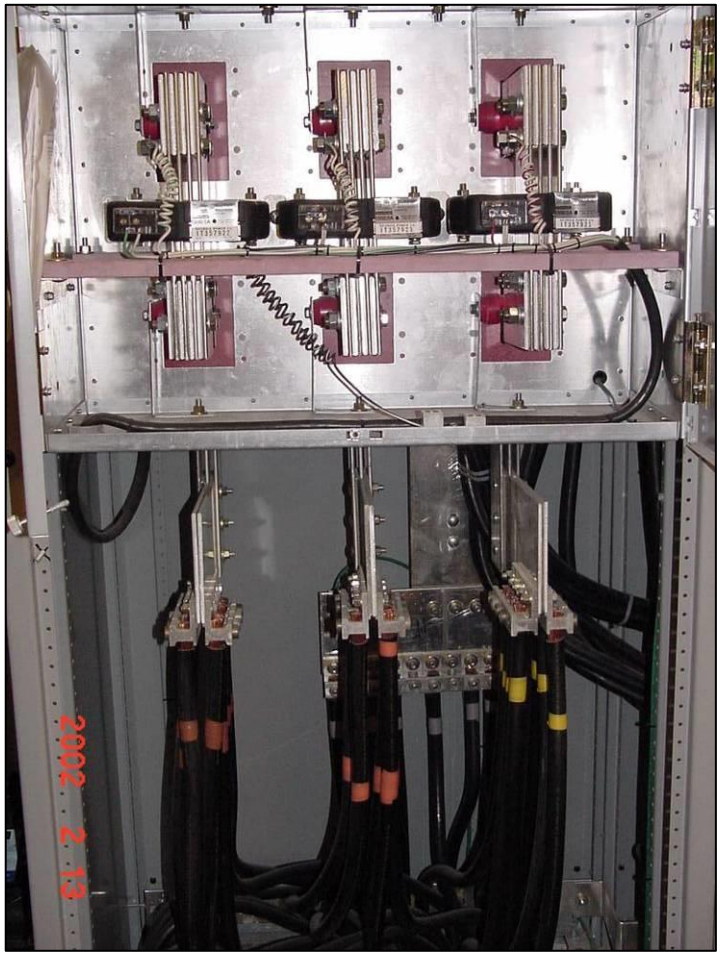
FLEX PROBE MEASURING CT'S "PRIMARY" CURRENT IN SWITCHGEAR

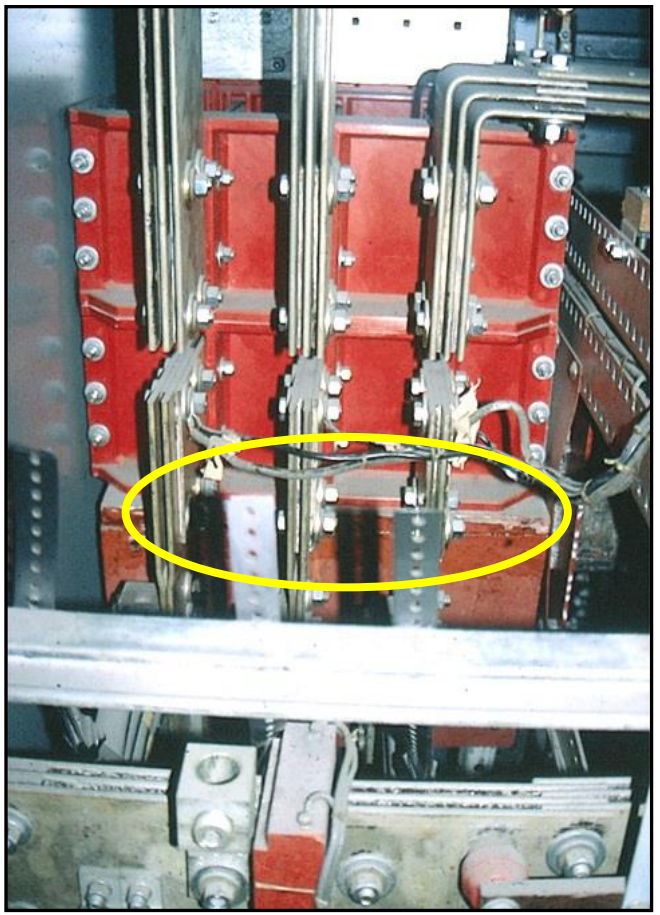




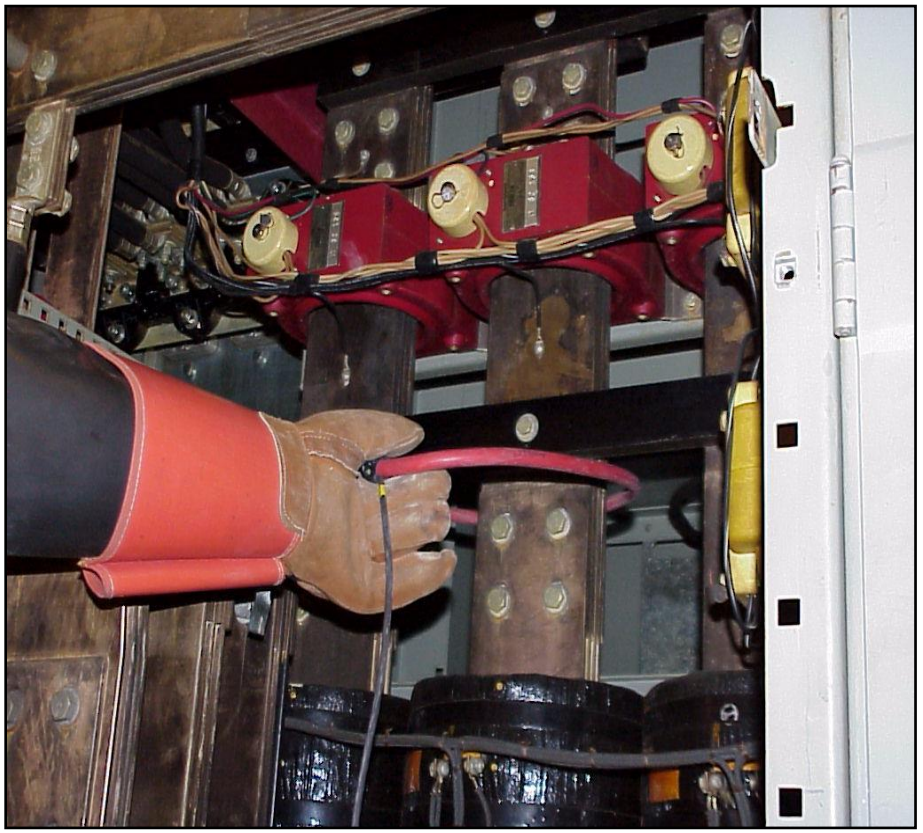
IMPORTANT NOTE
GET AHEAD OF THE CTS…

WHY?





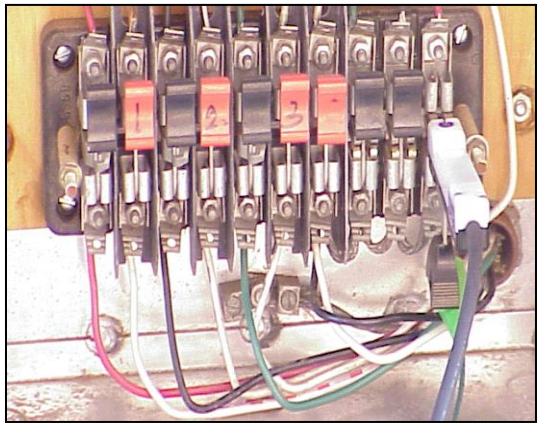
Do your best to get close to the source as possible…



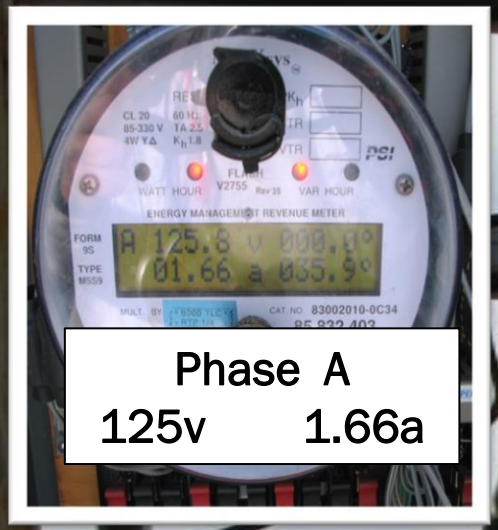
But do it SAFE!

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

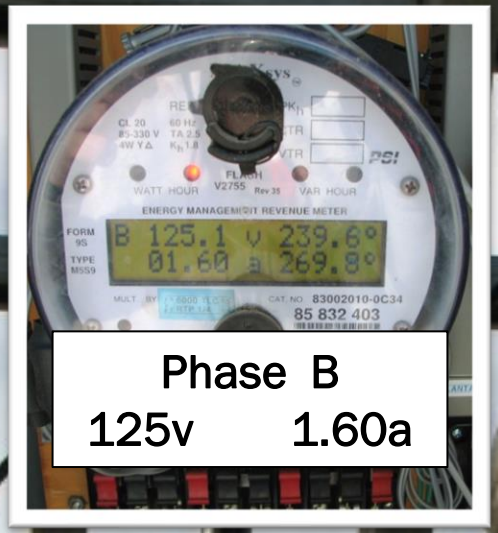
Fiber Optic Horseshoe Probe used on Primary Service (above 600 volts)



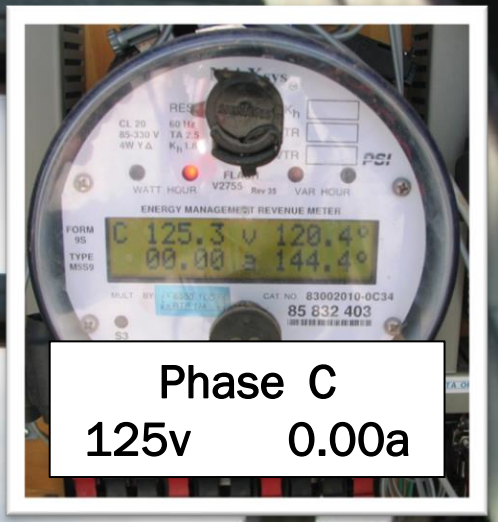
CARIBBEAN & LATIN AMERICAN METER SCHOOL



Phase A
125v 1.66a



Phase B
125v 1.60a



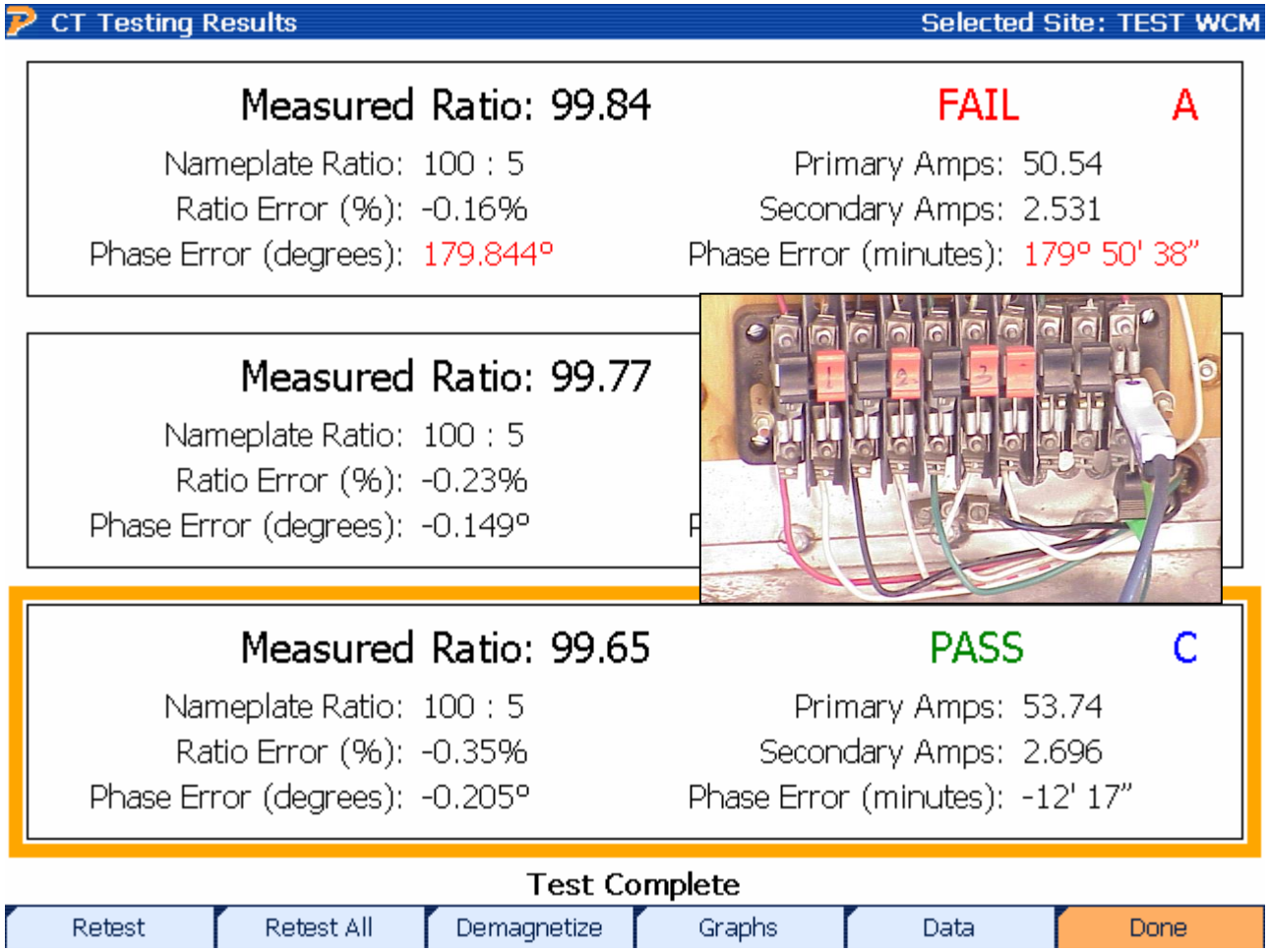
Phase C
125v 0.00a

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

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

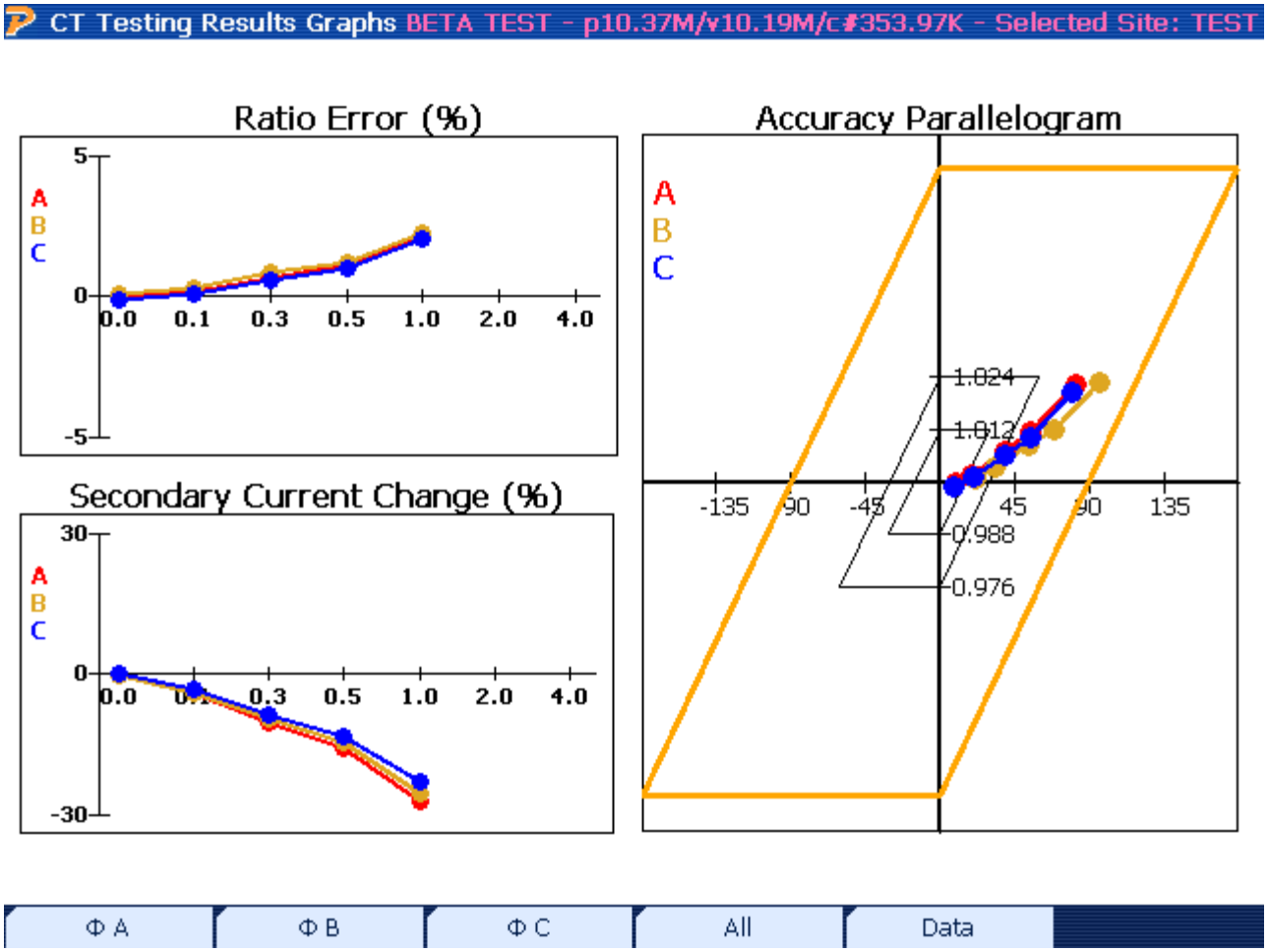
CT Ratio Test Information Results

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.

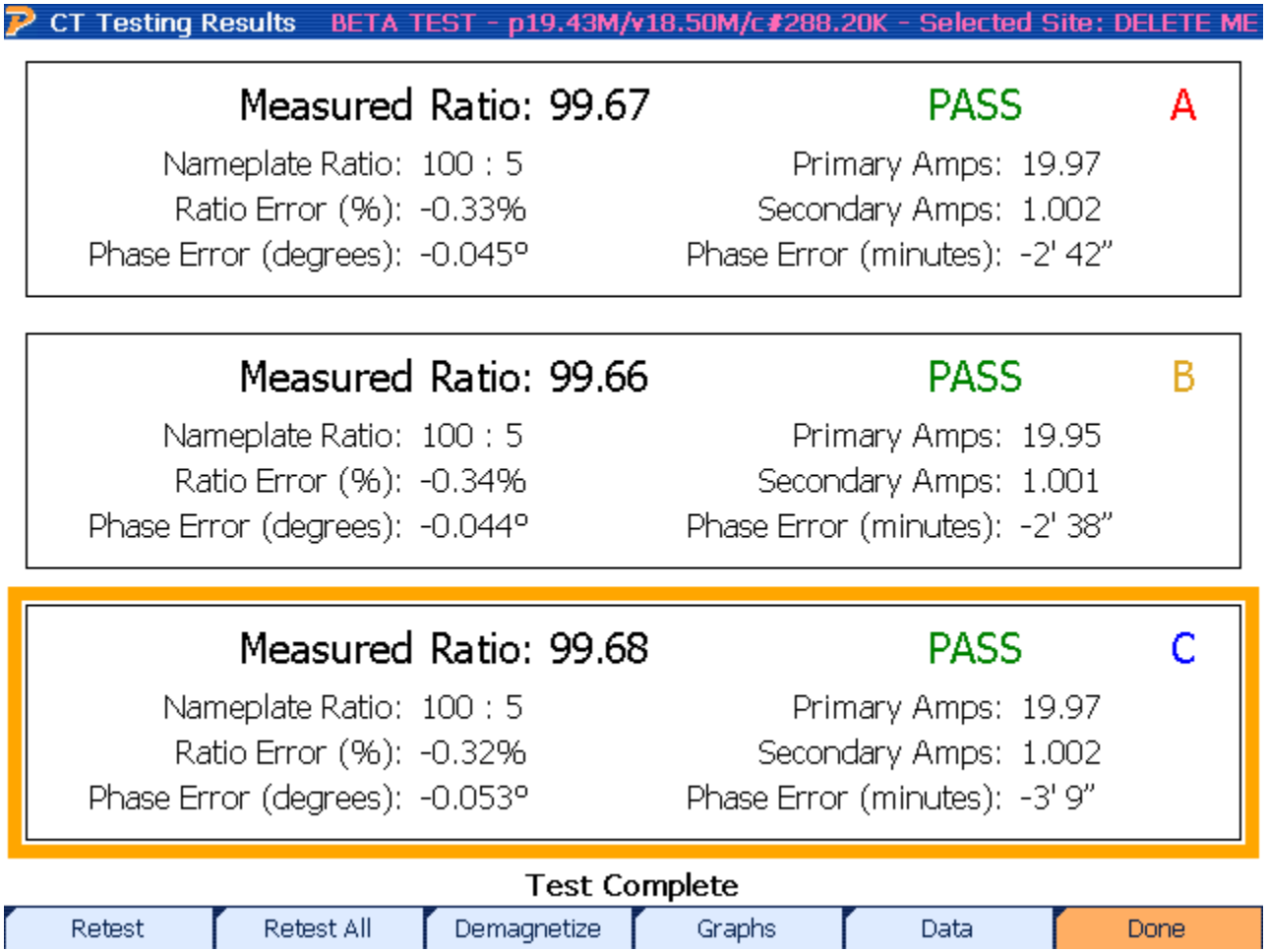


CARIBBEAN & LATIN AMERICAN METER SCHOOL

CT Ratio Test Information Results

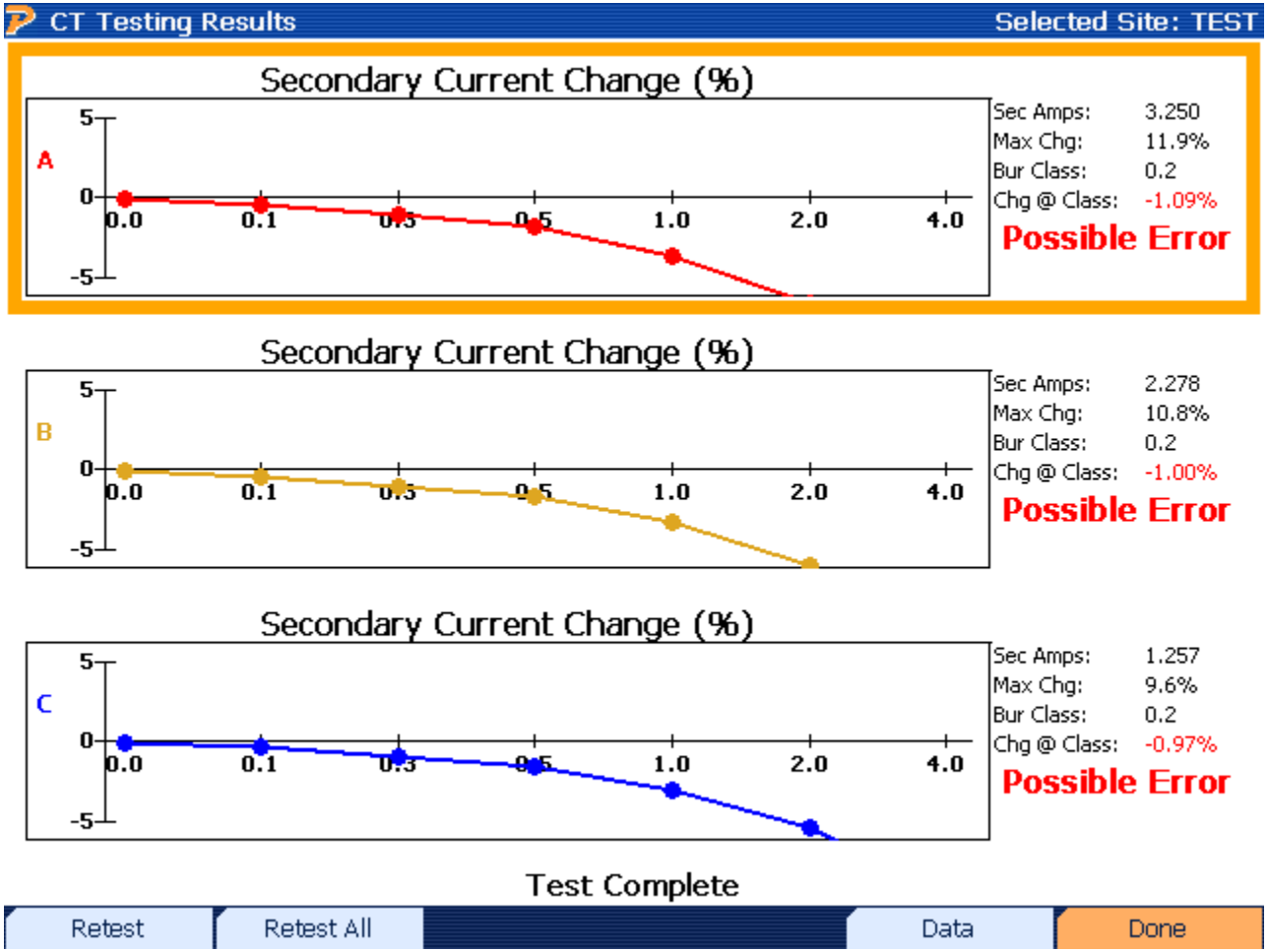


RESULTS FOR RATIO ONLY

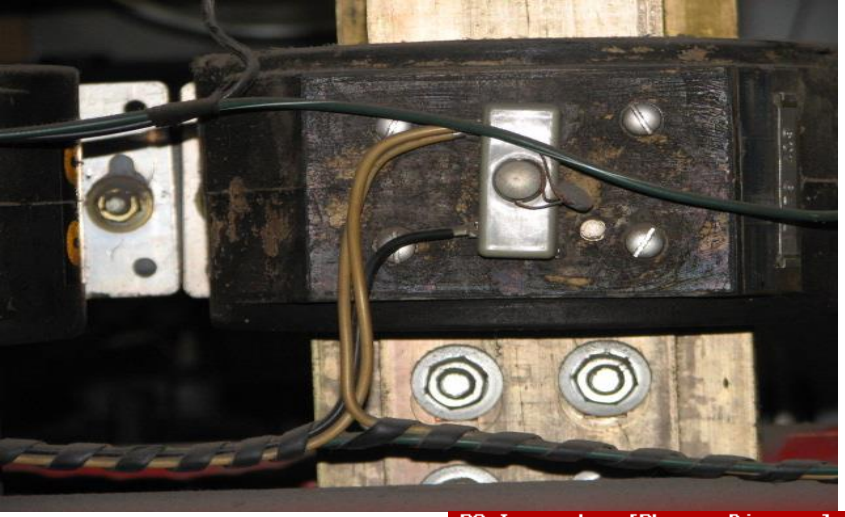


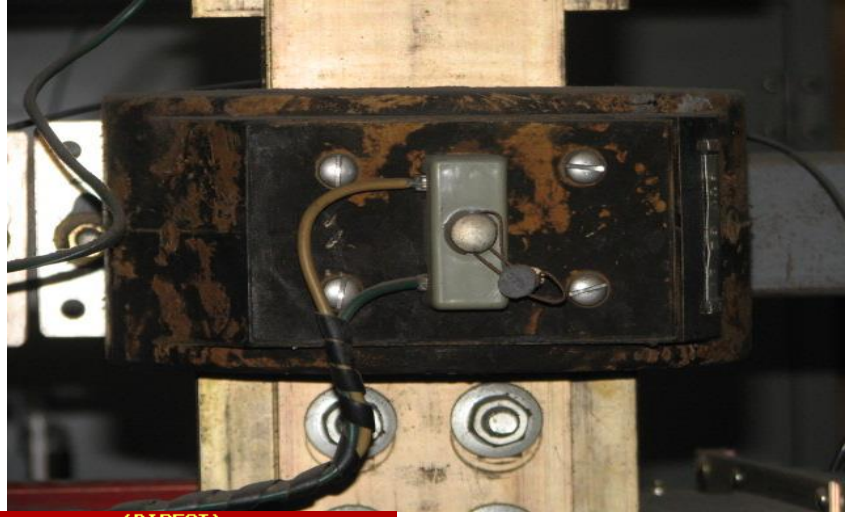
CARIBBEAN & LATIN AMERICAN METER SCHOOL

Results for Burden Only



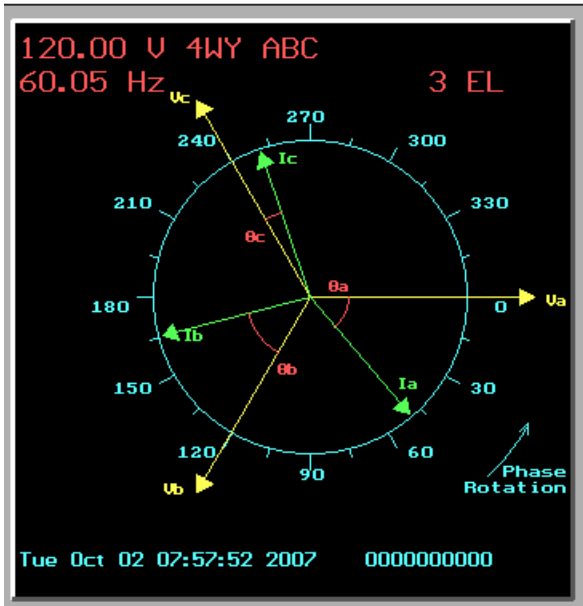
CARIBBEAN & LATIN AMERICAN METER SCHOOL





PQ Inspector [Phasor Diagram] <DIRECT>

Options Commands Remote Help <Alt>+Letter



VALID SERVICE

A Phase Readings

Va	=	111.2	Volts rms
Ia	=	1.619	Amps rms
PFa	=	0.64	Lagging
θa	=	50.2	° Lagging
Wa	=	114.00	Watts
VAa	=	177.90	VA
Vθa	=	0.00	°
Iθa	=	50.17	°

B Phase Readings

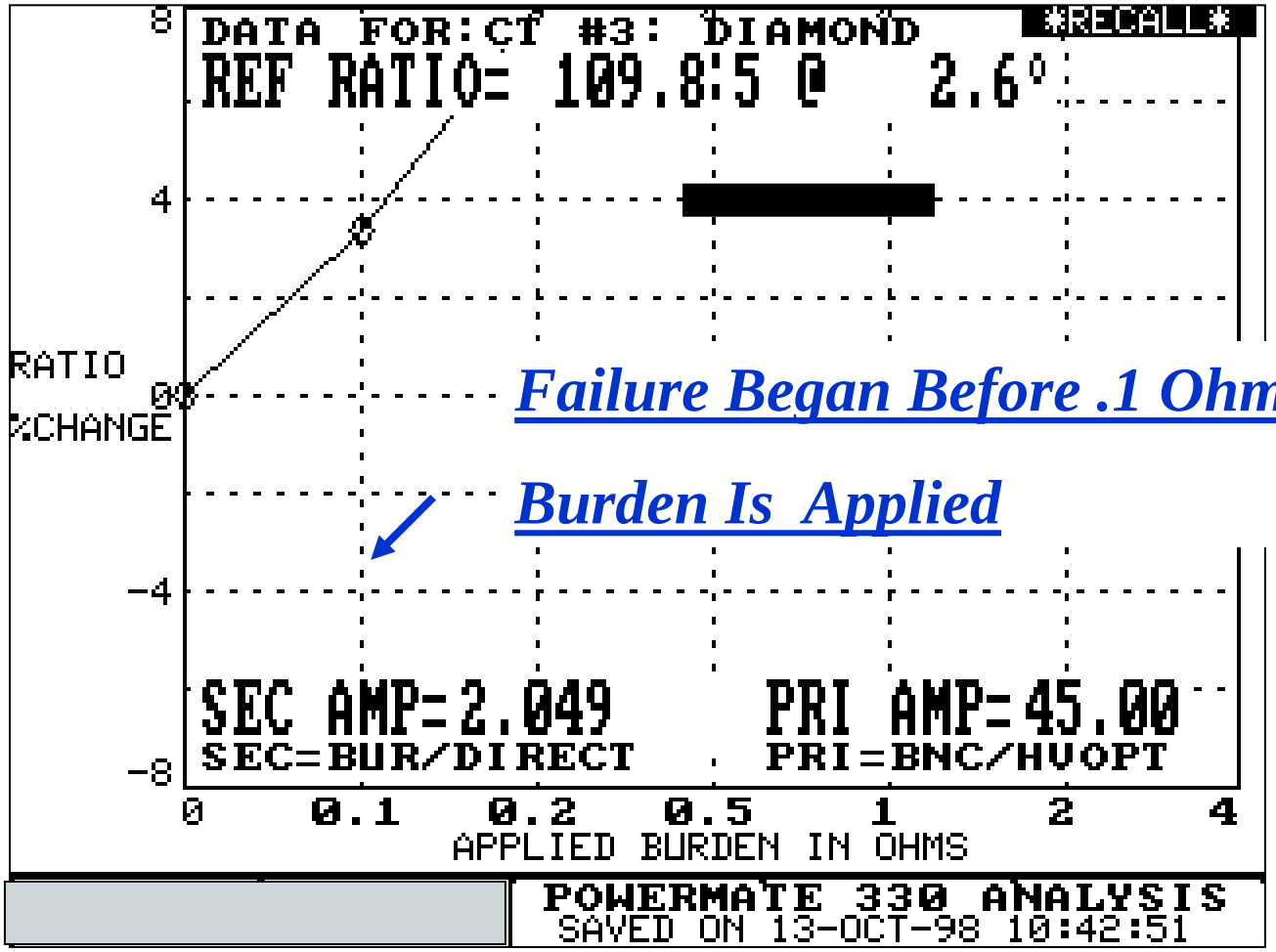
Vb	=	111.6	Volts rms
Ib	=	2.989	Amps rms
PFb	=	0.70	Lagging
θb	=	45.3	° Lagging
Wb	=	234.31	Watts
VAb	=	333.56	VA
Vθb	=	120.00	°
Iθb	=	165.46	°

C Phase Readings

Vc	=	112.1	Volts rms
Ic	=	2.468	Amps rms
PFc	=	0.98	Lagging
θc	=	11.0	° Lagging
Wc	=	274.61	Watts
VAc	=	279.75	VA
Vθc	=	240.00	°
Iθc	=	250.98	°

CARIBBEAN & LATIN AMERICAN METER SCHOOL

Bad CT

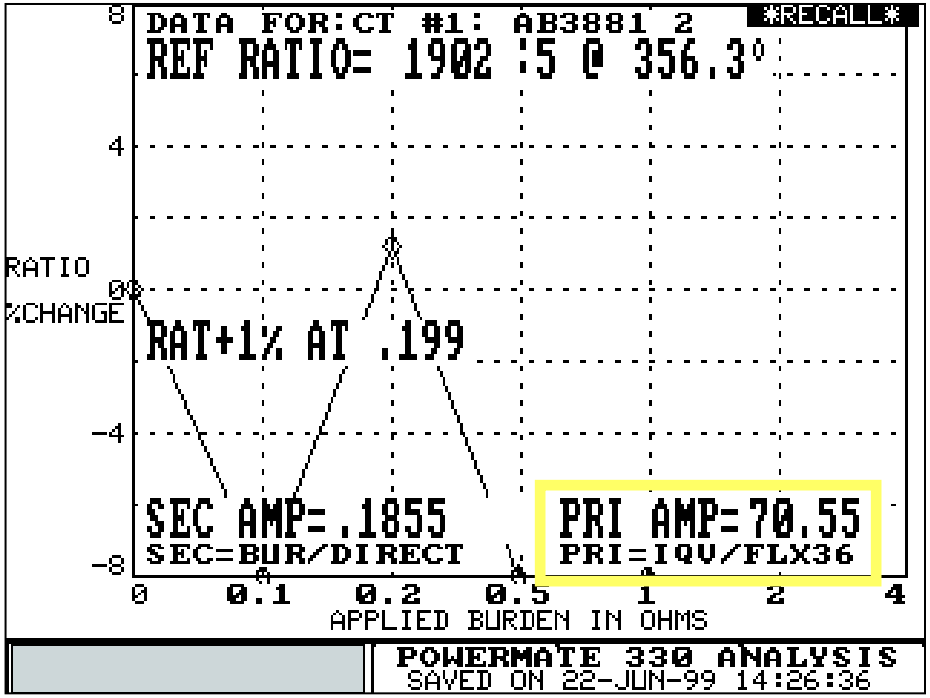


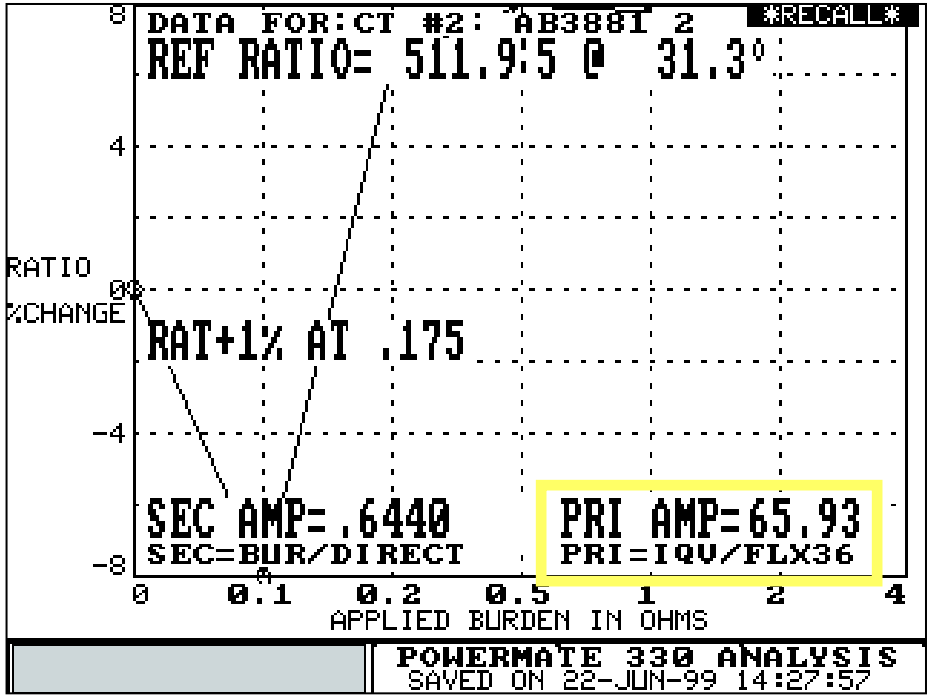
Failure Began Before .1 Ohms Of Burden Is Applied

CARIBBEAN & LATIN AMERICAN METER SCHOOL

Bad CT ?

Ratio Should Be 200 : 5

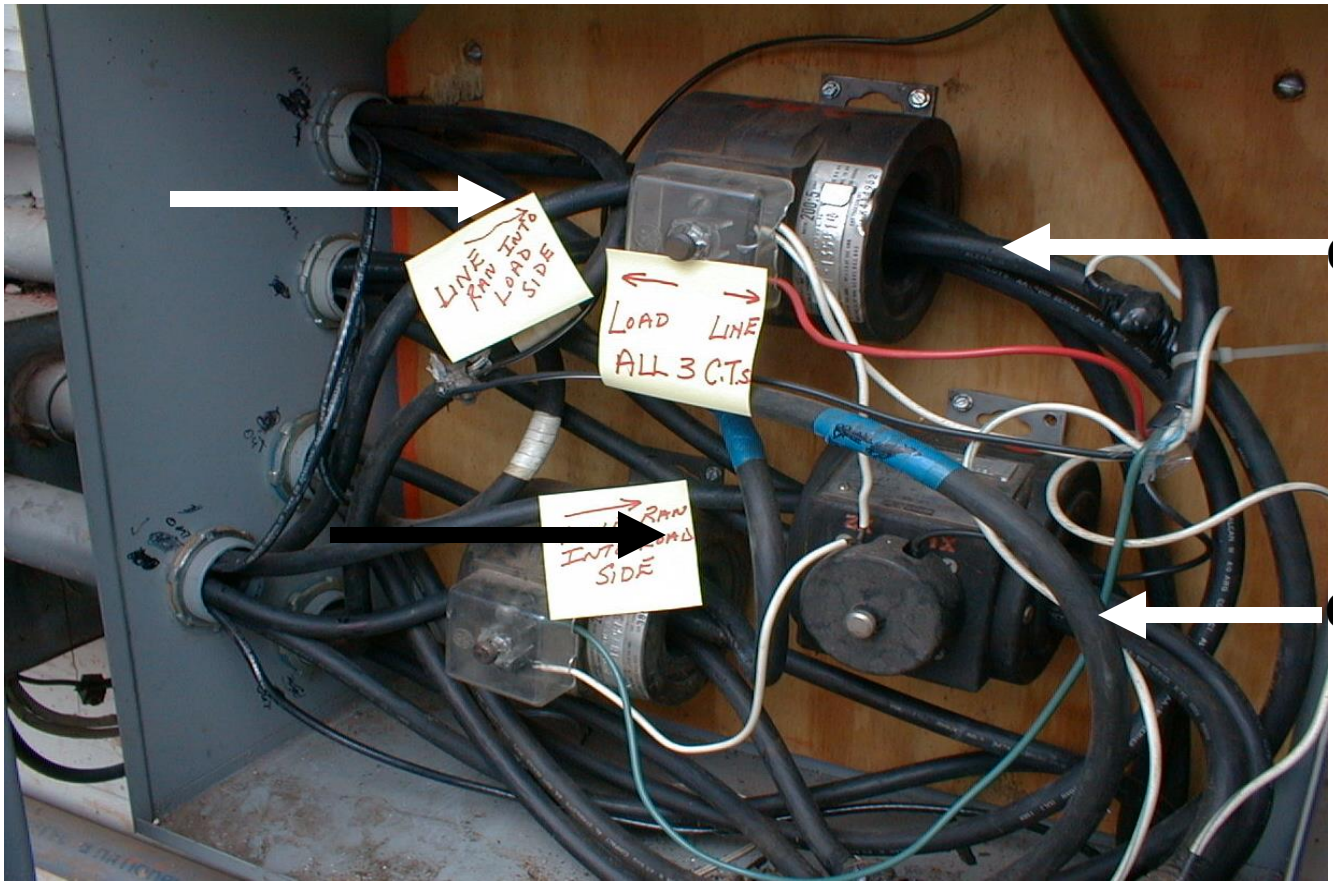




CARIBBEAN & LATIN AMERICAN METER SCHOOL

No, Just A Bad Electrician

Additional run of wire installed and pulled through Two CTs backwards

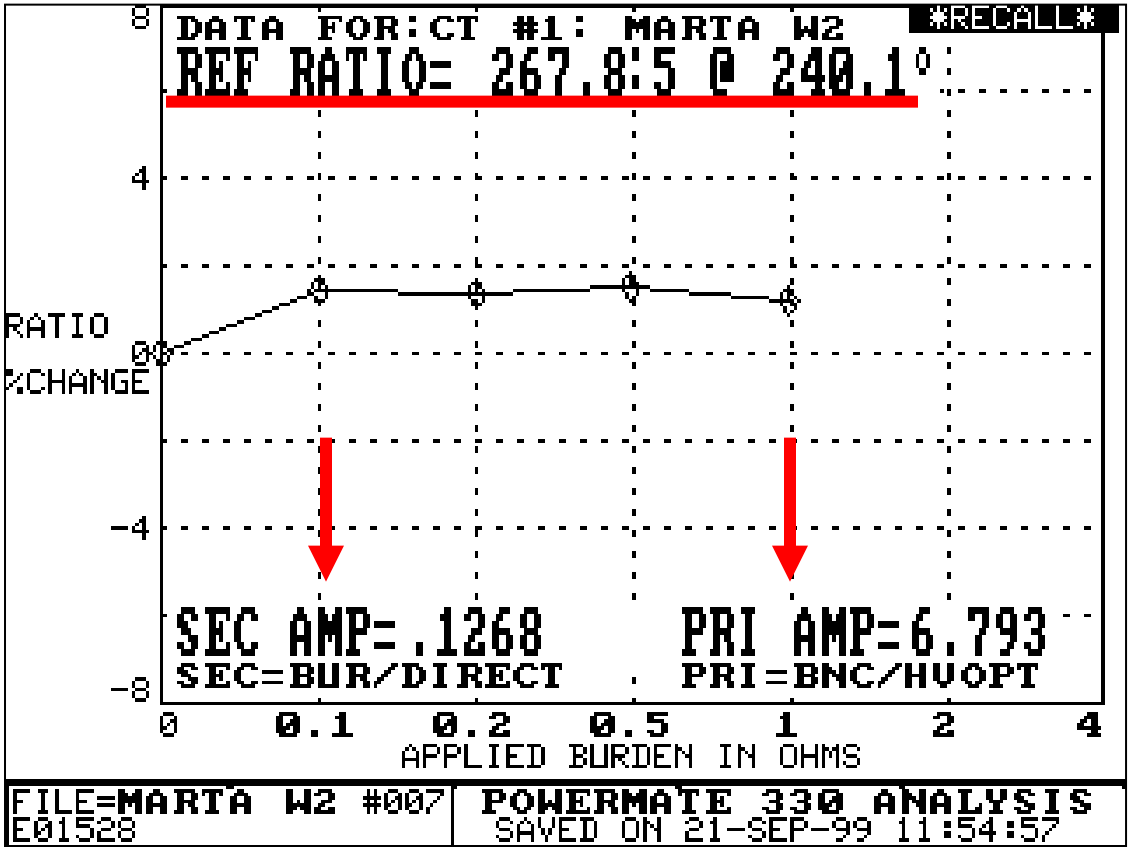


Current Flow

Current Flow

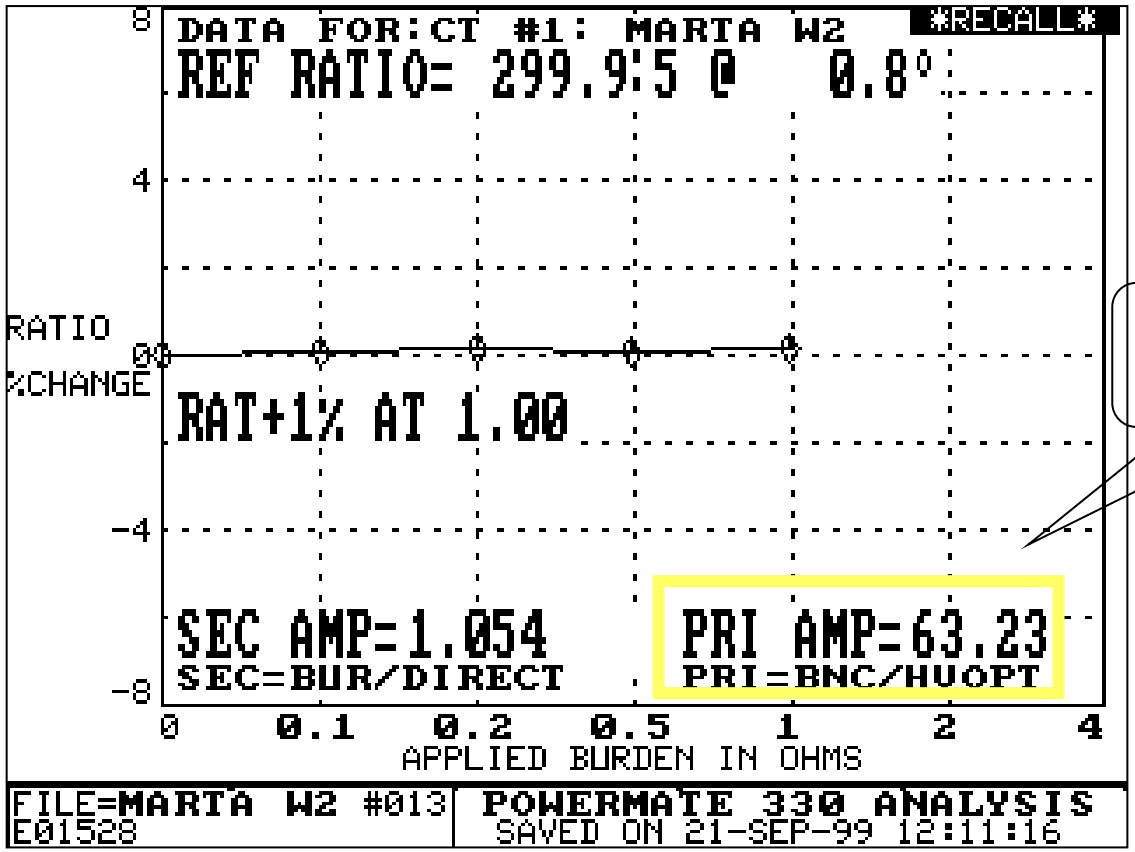
Bad CT ?

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

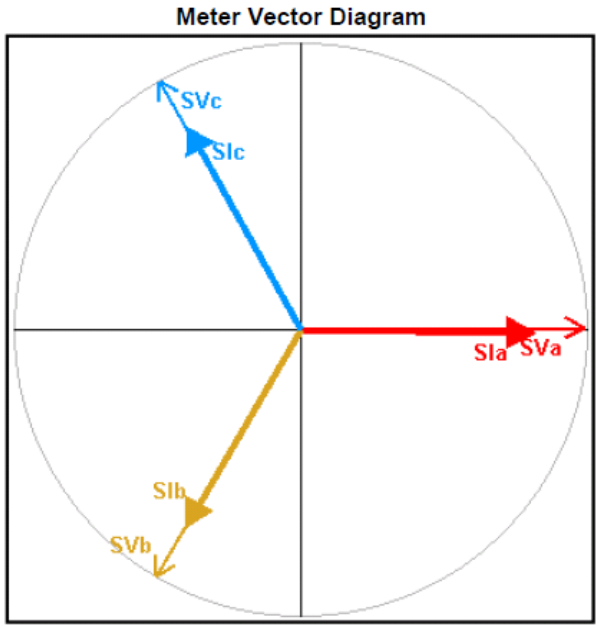
CARIBBEAN & LATIN AMERICAN METER SCHOOL

Vectors

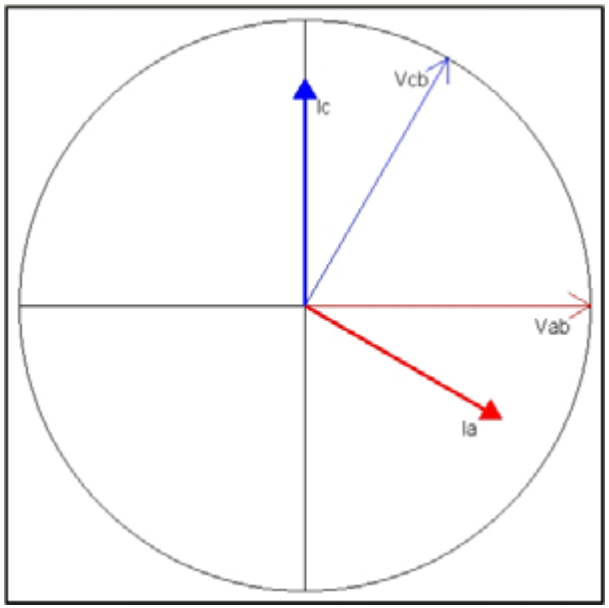
What Do We Look For ?

Services At Unity Power Factor

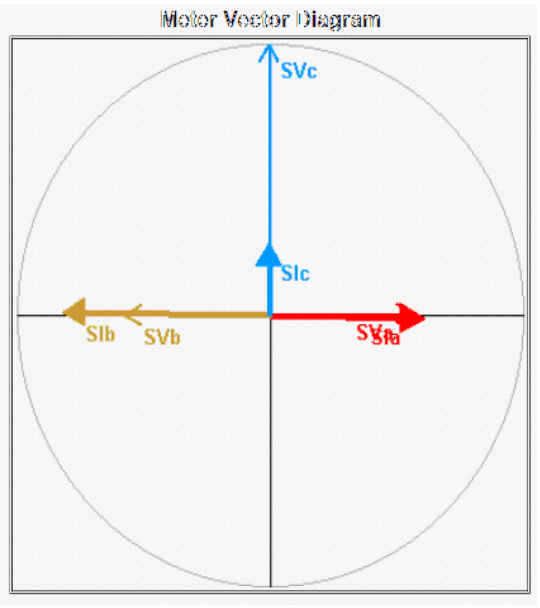
4 wire WYE



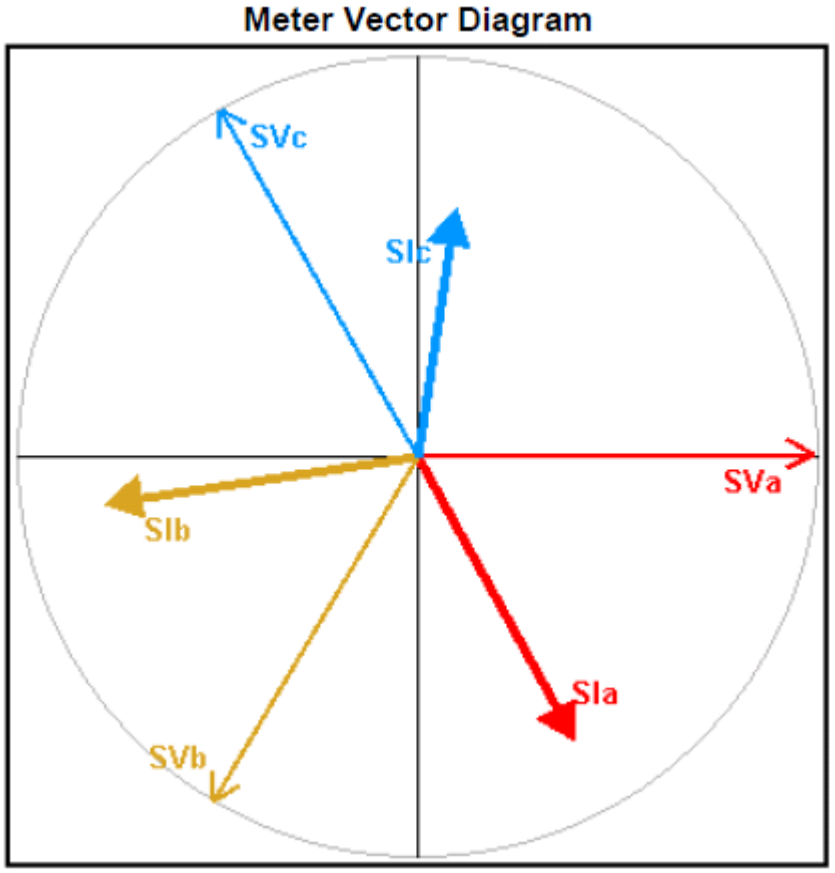
3 wire Delta



4 wire Delta

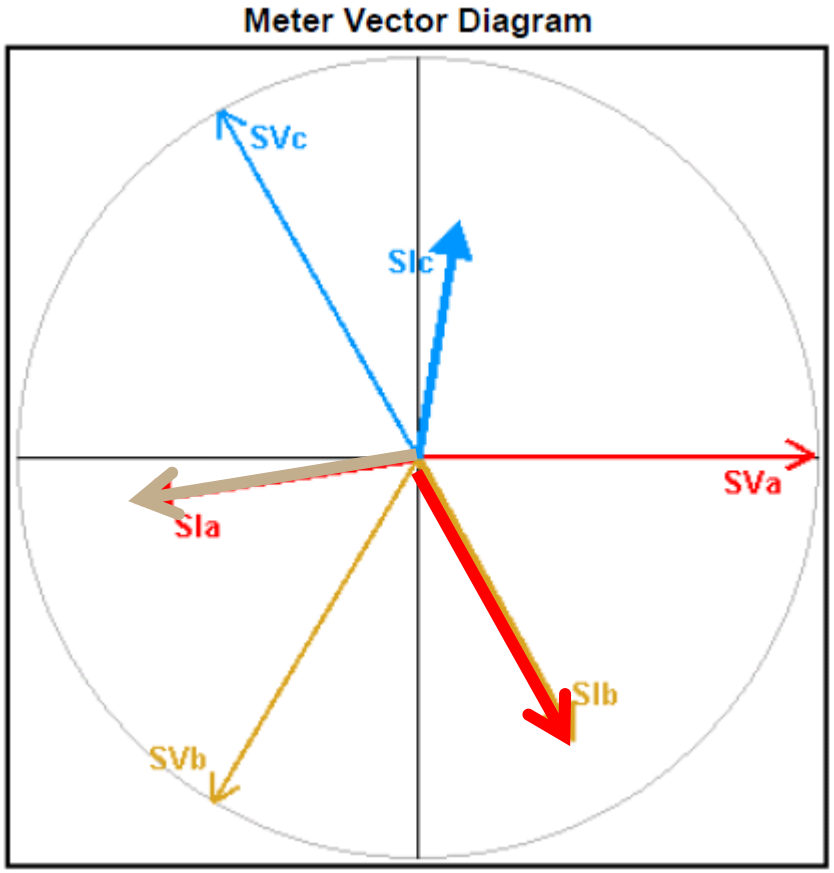


Typical WYE Service



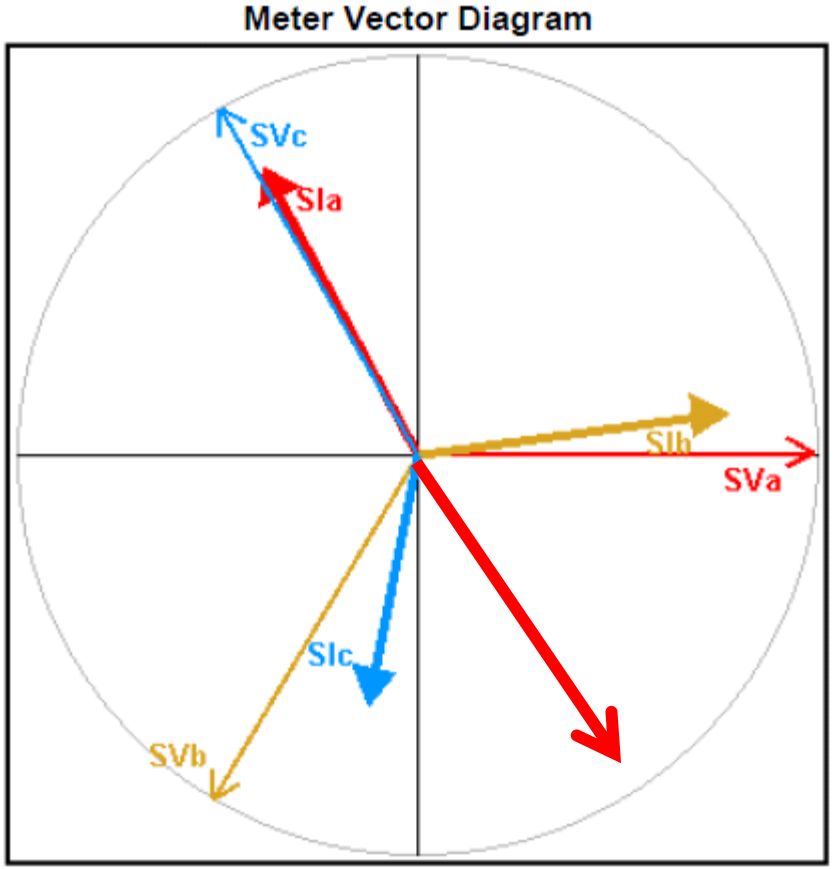
Problem ?

A Phase and B Phase Current Crossed

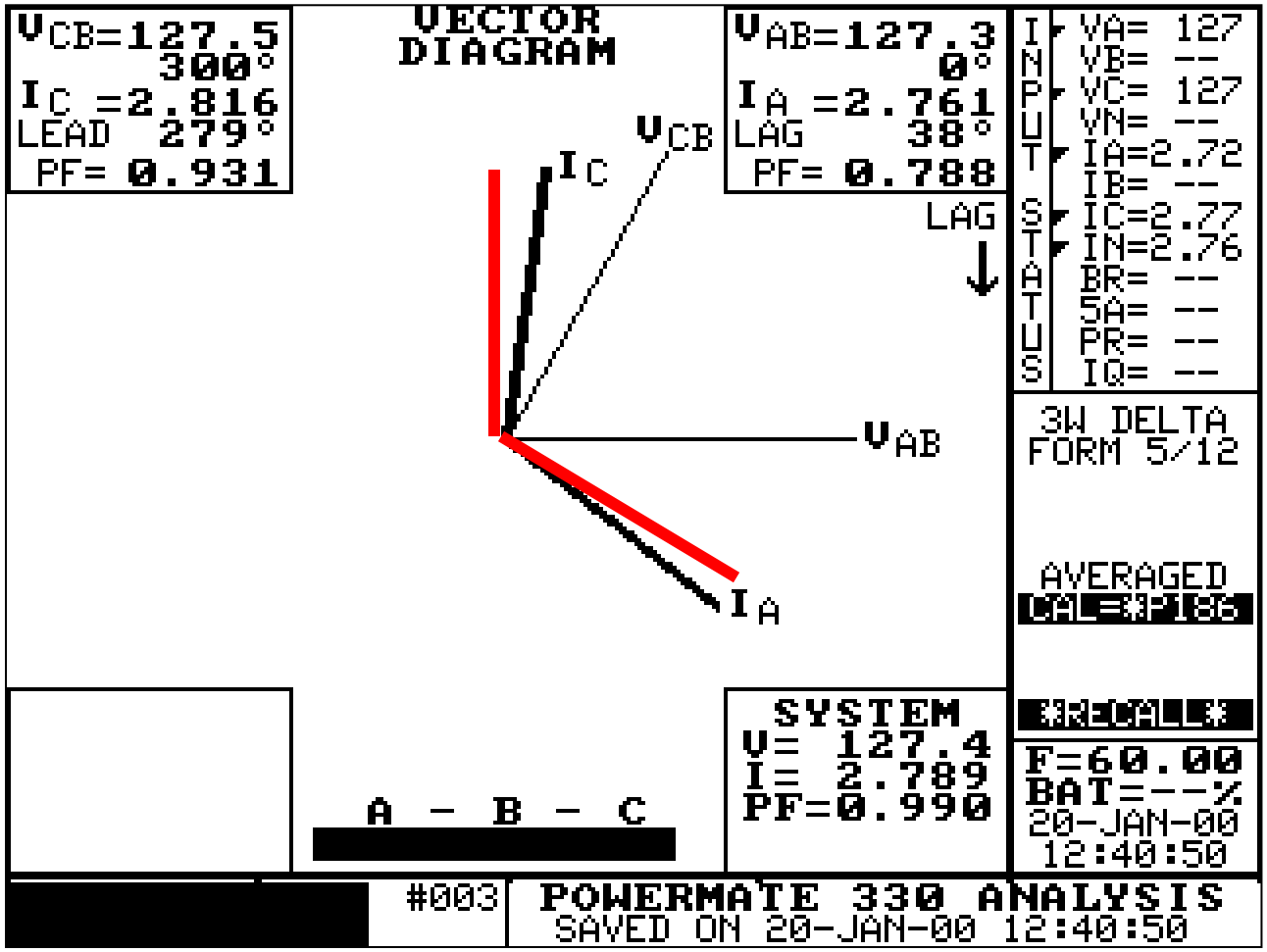


Problem ?

CTs Wired Backwards

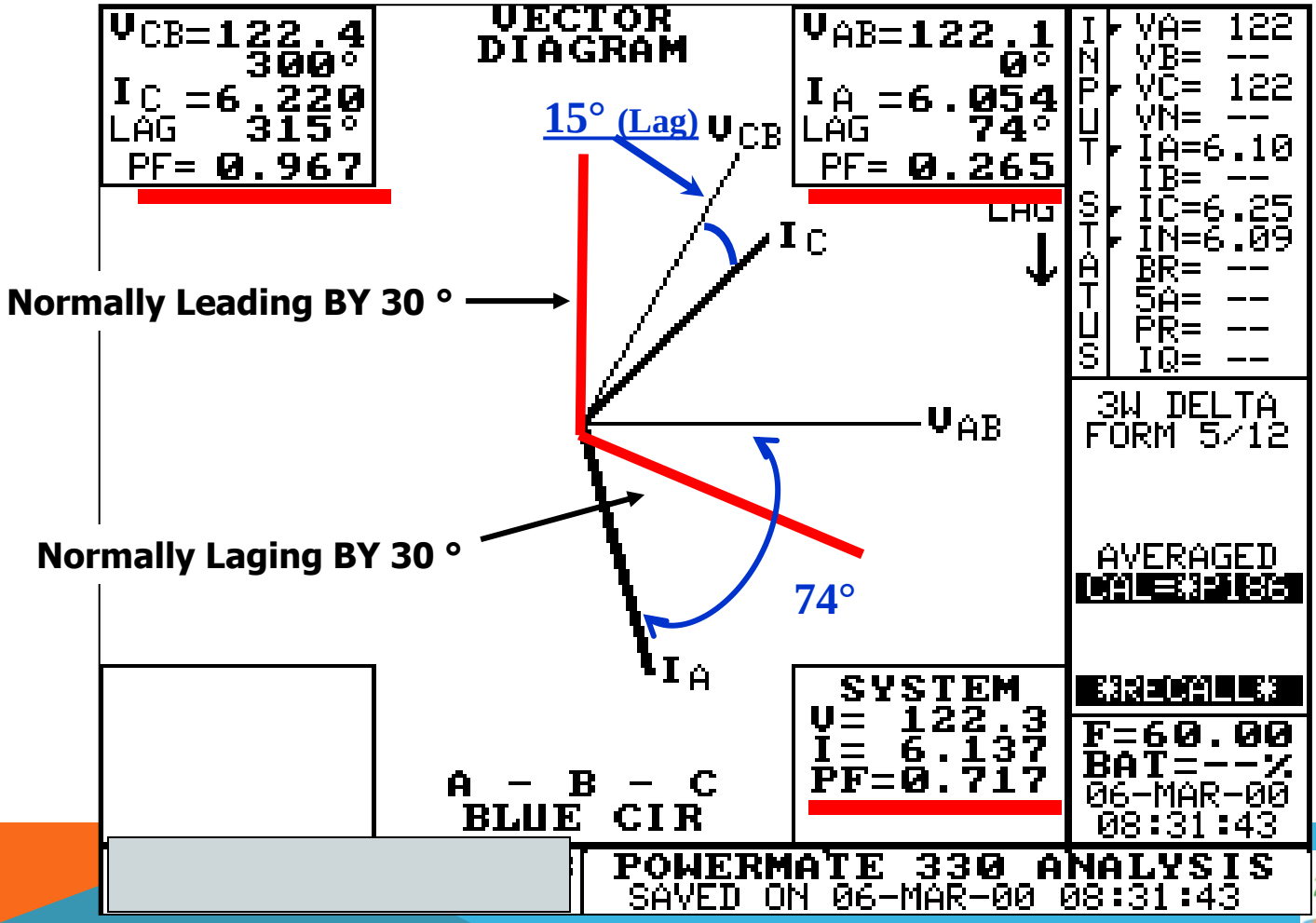


Three Wire Three Phase Delta Service



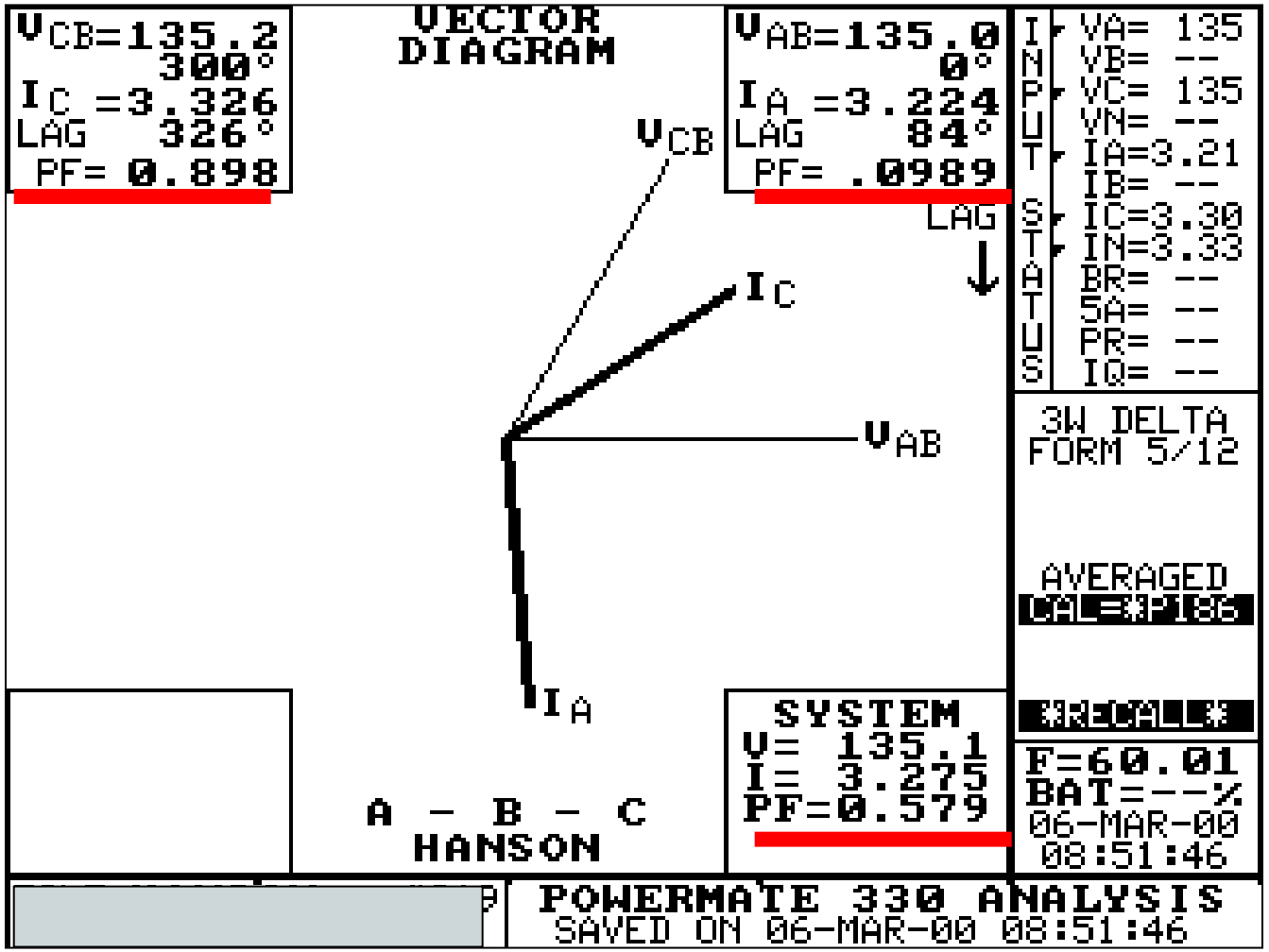
CARIBBEAN & LATIN AMERICAN METER SCHOOL

Three Wire Three Phase Delta
Bad Power Factor



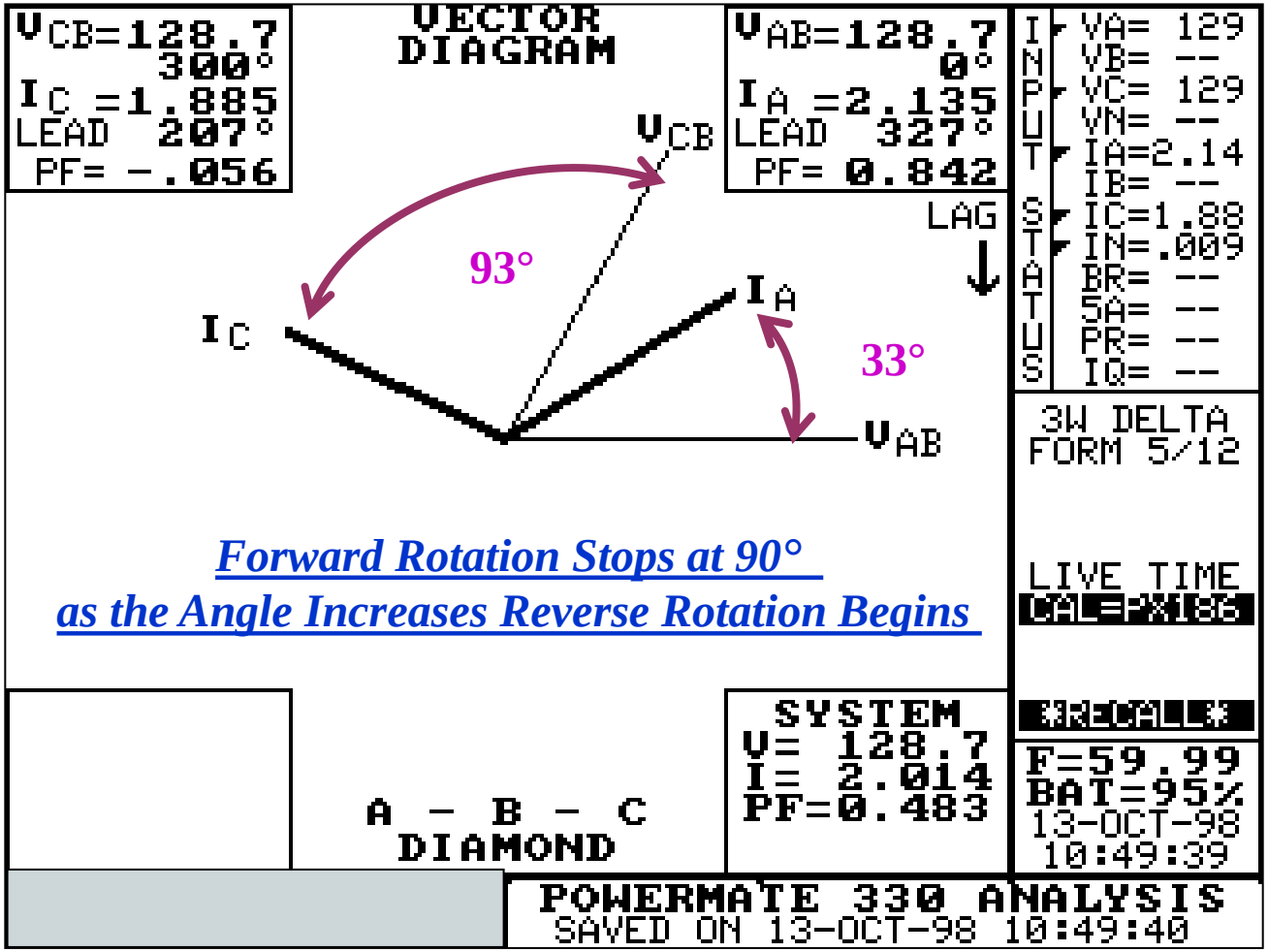
CARIBBEAN & LATIN AMERICAN METER SCHOOL

Three Wire Three Phase Delta with Worse Power Factor



CARIBBEAN & LATIN AMERICAN METER SCHOOL

Three Wire Three Phase Delta with Even Worse Power Factor

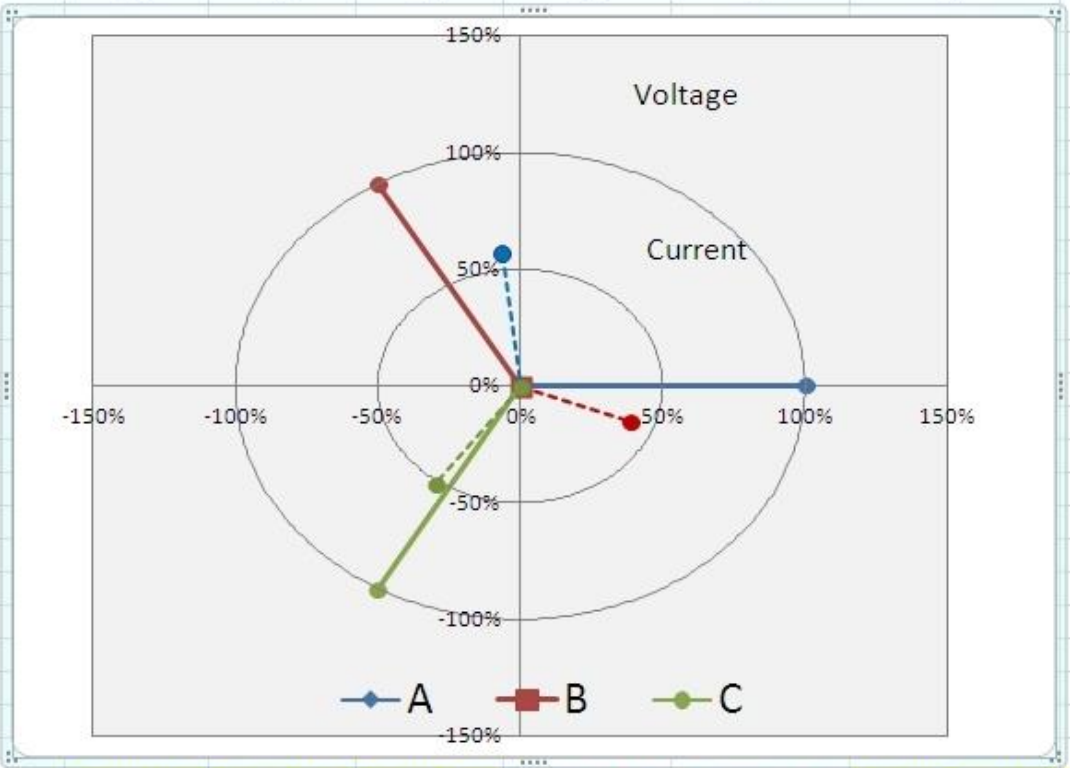


Forward Rotation Stops at 90°
as the Angle Increases Reverse Rotation Begins

CARIBBEAN & LATIN AMERICAN METER SCHOOL

Problem- Crossed Potentials?

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



W	X	Y	AA	AB	AC	AD	AE	AF	AG	AH

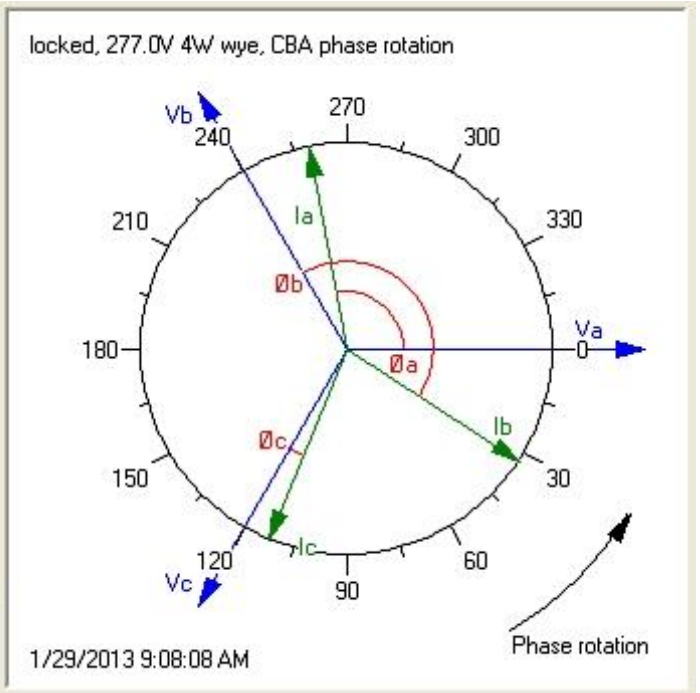
V_PHASE_A	V_PHASE_B	V_PHASE_C	A_PHASE_A	A_PHASE_B	A_PHASE_C	PH_ANGLE_BA	PH_ANGLE_CA	PF_ANG_PHASE_A	PF_ANG_PHASE_B	PF_ANG_PHASE_C
281.1	278	279.9	1.9	1.4	1.7	240	120	263.5	141.9	5.4

CARIBBEAN & LATIN AMERICAN METER SCHOOL

Problem- Crossed Potentials?

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

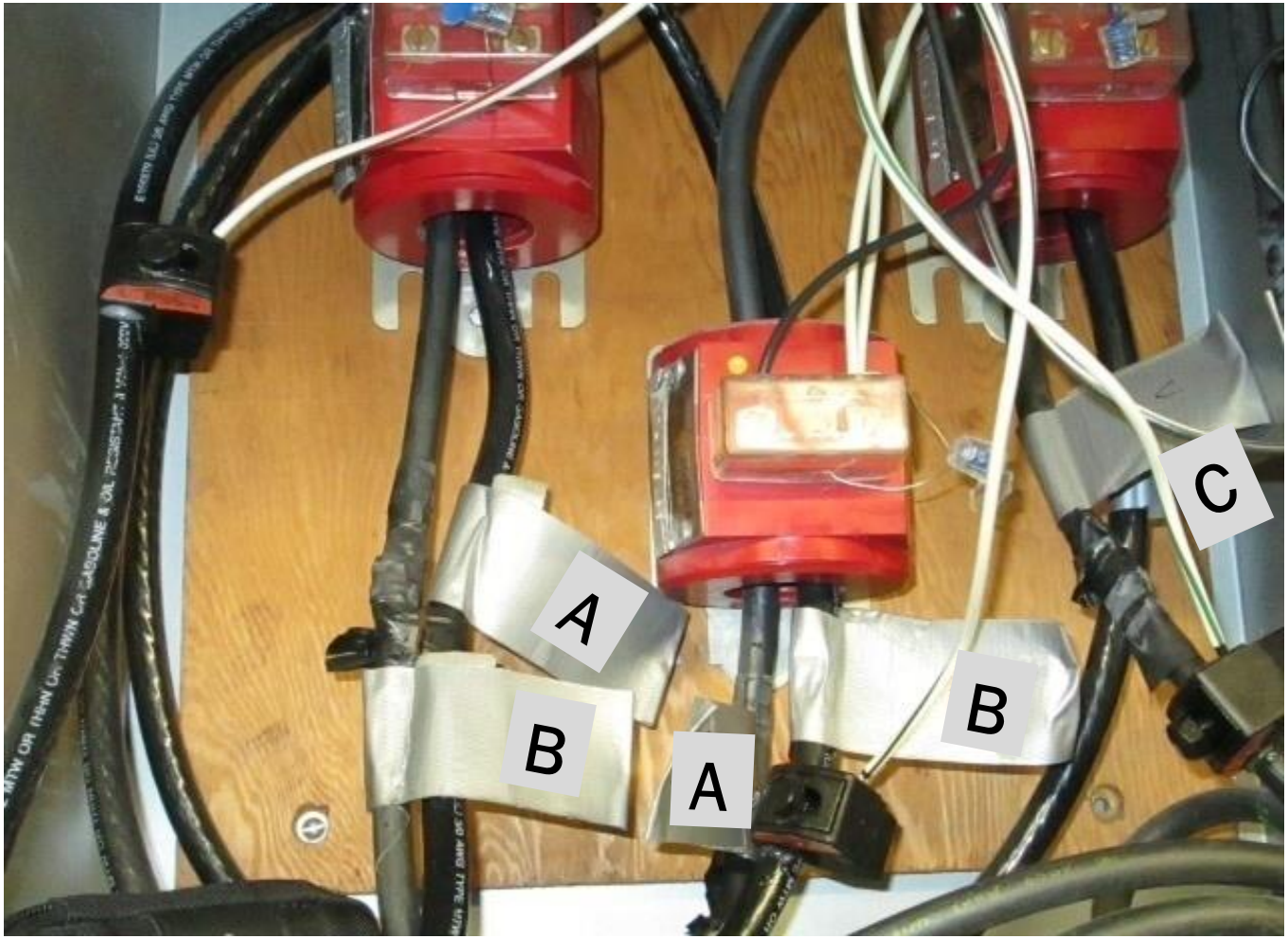
	Phase A	Phase B	Phase C	System
Voltage	283.84	281.12	283.29	
Voltage Phase Angle	0.00	240.00	120.00	
Current	2.14	1.34	1.48	
Current Phase Angle	259.27	33.19	112.48	
Power Factor (1)	-0.19	0.89	-0.99	-0.07
Power Factor Angle	259.27	153.19	352.48	265.99
kW	-0.11	-0.34	0.41	-0.03
kVAR	-0.60	0.17	-0.05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

CARIBBEAN & LATIN AMERICAN METER SCHOOL

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

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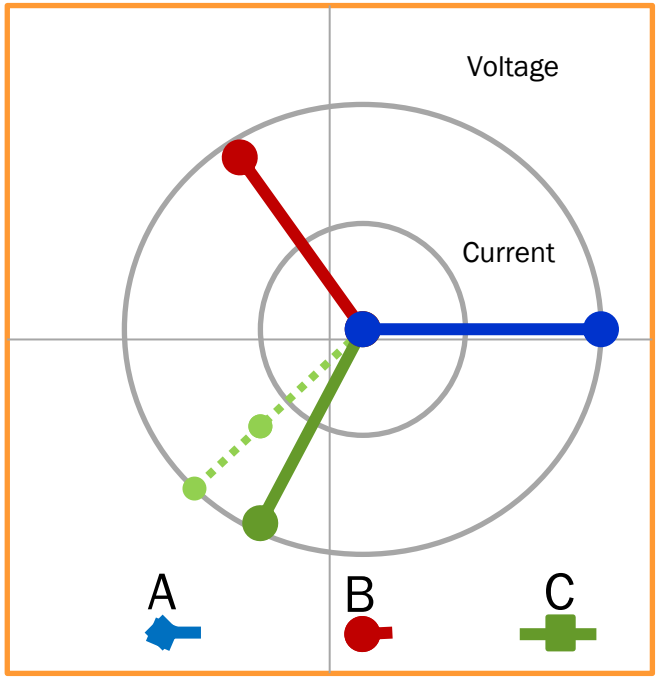
C-phase CT

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 ?

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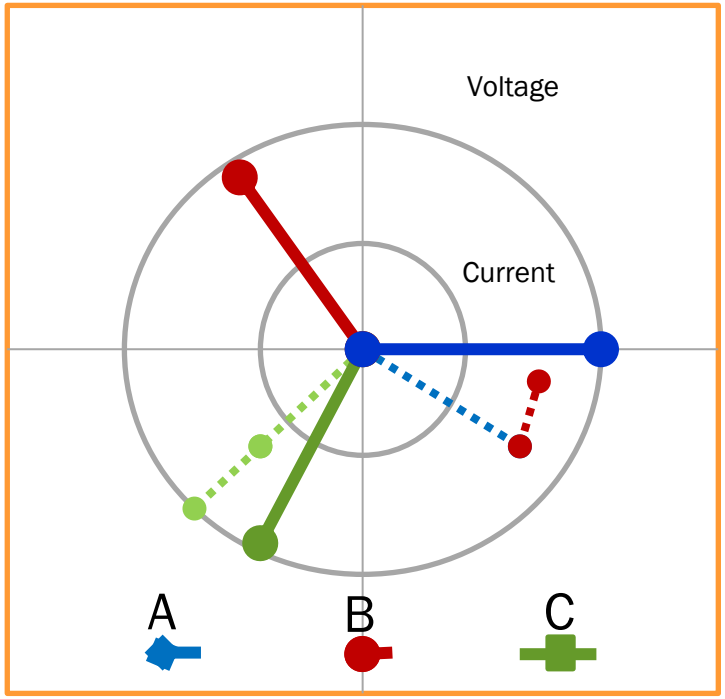
Total current measured



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

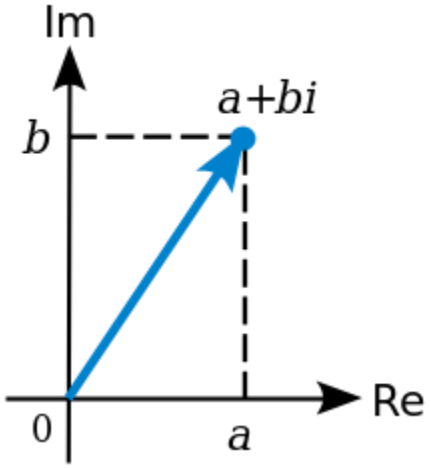
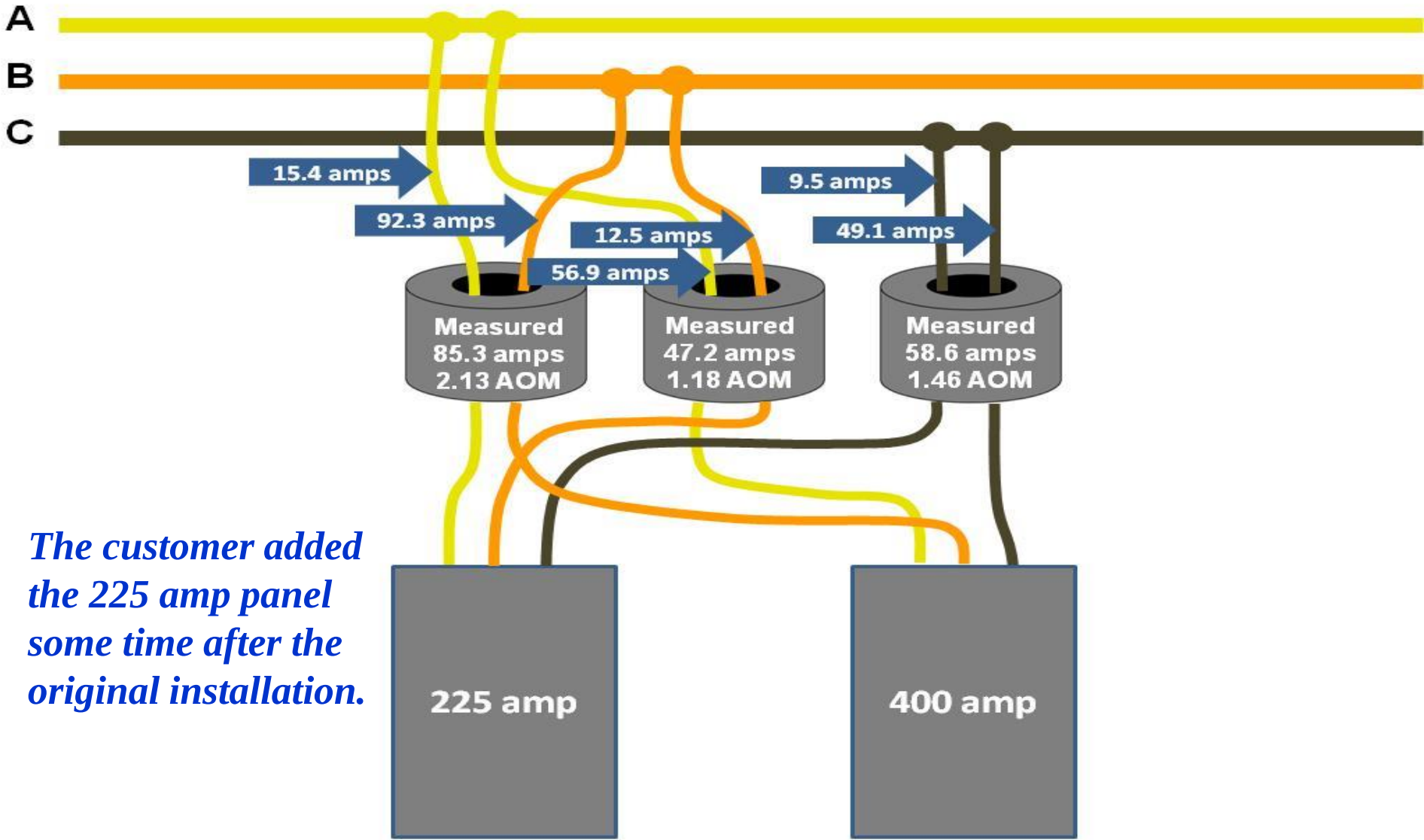


Illustration of on-site measurements

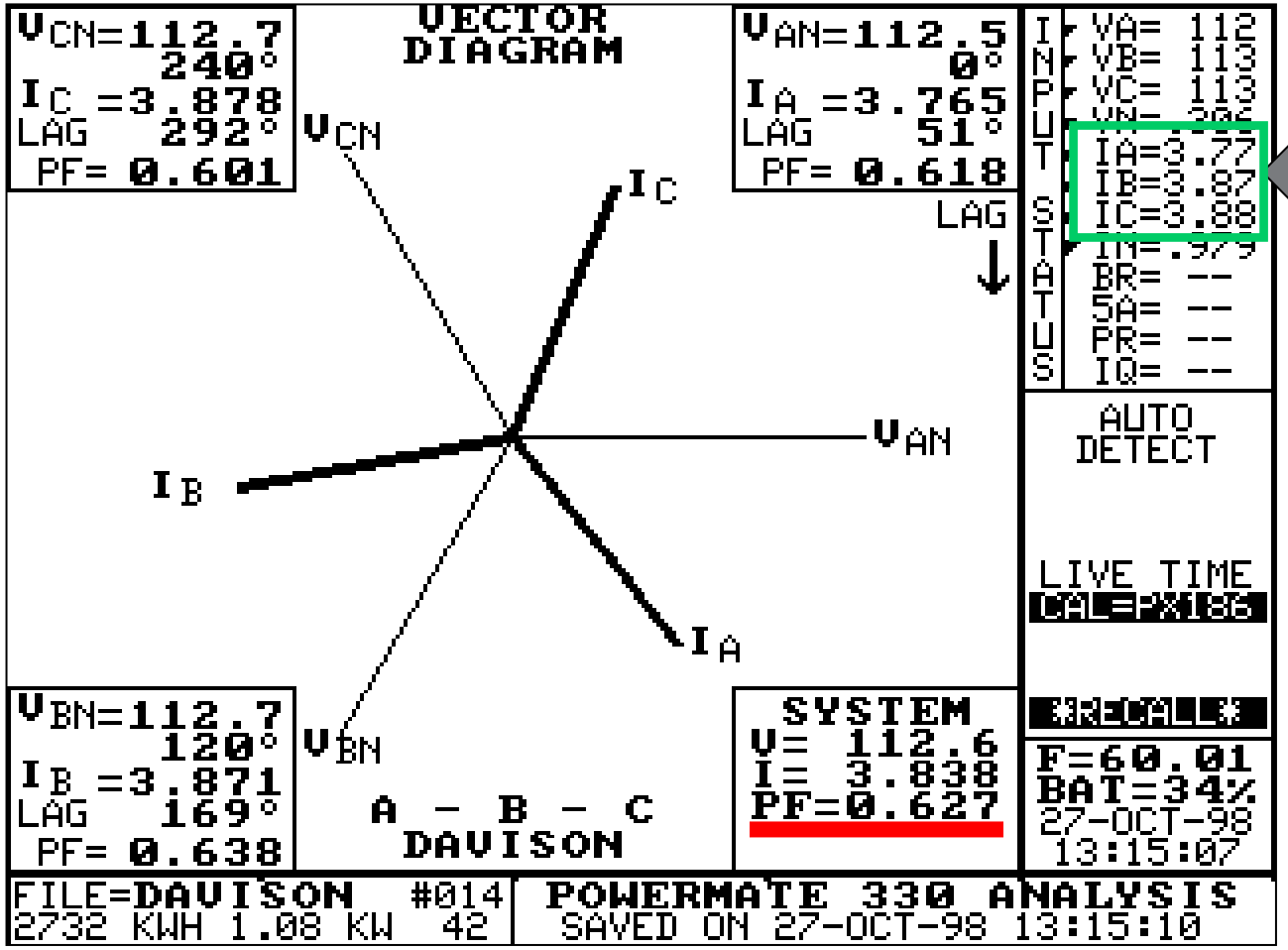


The customer added the 225 amp panel some time after the original installation.

Metering Problem ?

Opportunity to Bill for Excessive Reactive Load

Bad Power Factor

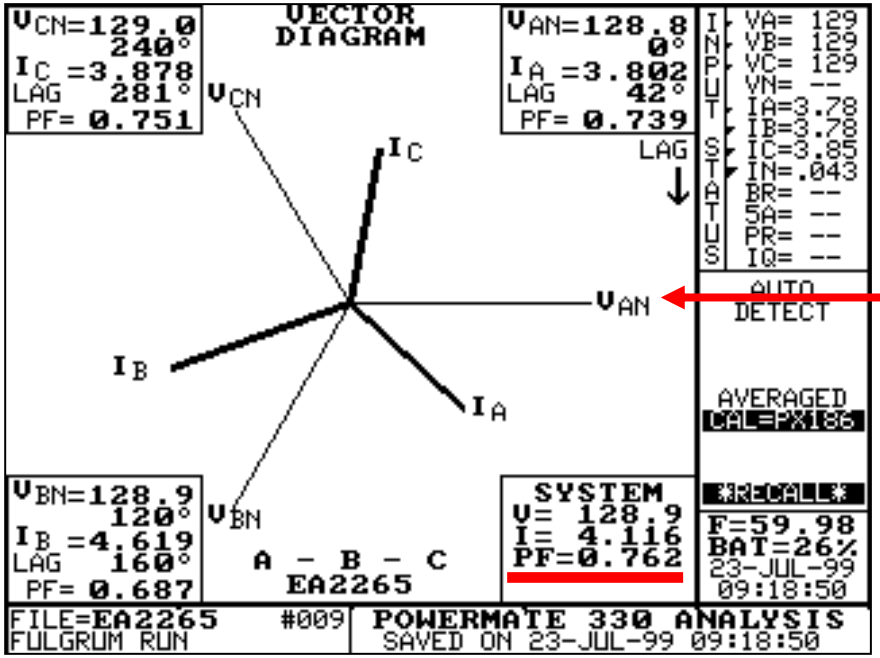


Balanced Load

WHAT CAN A CUSTOMER OR UTILITY DO ABOUT BAD FACTOR?

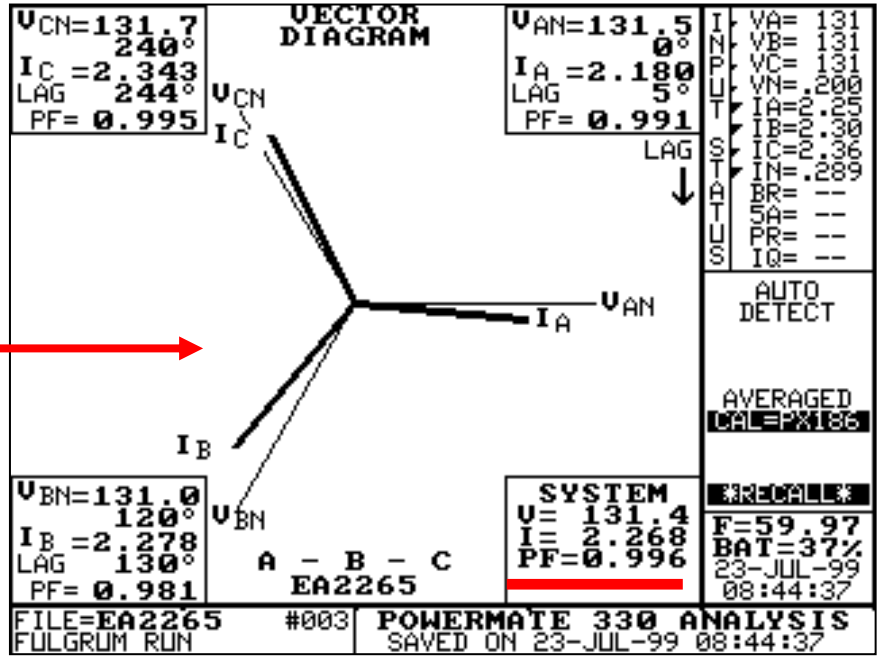
VARs Compensator

Site With VARs Compensator Installed



Vars Compensator Off

Vars Compensator On



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SAFETY +

IS THE ABSOLUTE NUMBER ONE PRIORITY

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

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