

The Eastern Specialty Company

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For North Carolina Electric Meter School Advanced XXXXXXXXXXXXXXXXXX





scometering.com





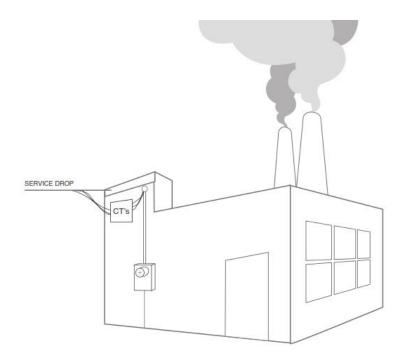
## **TOPICS WE WILL BE COVERING**

- Transformer Rated Meter Forms
- Test Switches and CT's
- Site Inspection and Safety Checks
- Meter Accuracy Testing in the Field
- Checking the Health of your CT's and PT's
- Site Verification and not just meter testing
- Admittance Testing
- Harmonics determination and effects





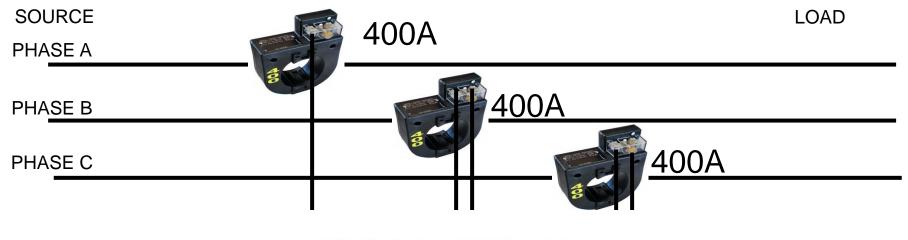
- Meter measures scaled down representation of the load.
- Scaling is accomplished by the use of external current transformers (CTs) and sometimes voltage transformers or PTs).
- The meter is NOT part of the circuit
- When the meter is removed from the socket, power to the customer is not effected.



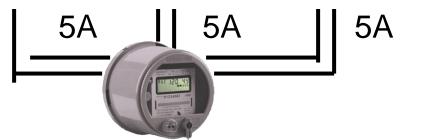


## THE BASIC COMPONENTS

### 9S Meter Installation with 400:5 CT's

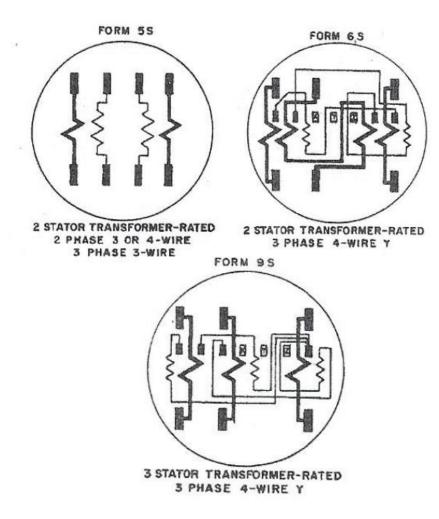








# **TYPICAL METER CONNECTIONS**



Typical Connections for 3 Phase Common Transformer (Instrument) Rated Meter Forms Examples : Form 5s Class 20 Form 6S Class 20 Form 9s Class 20



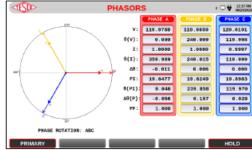
# METER ACCURACY TESTING

### Meter Accuracy Testing Customer Load

- ✓ Customer Load
- ✓ Customer Billing
- ✓ Customer Conditions

### Meter Accuracy Testing Phantom Load

- ✓ Full Load
- ✓ Light Load
- ✓ Power Factor







- One transformer in three wired backwards will give the customer a bill of 1/3<sup>rd</sup> the actual bill.
- One broken wire to a single transformer will give the customer a bill of 2/3<sup>rd</sup> the actual bill
- One dual ratio transformer inappropriately marked in the billing system as 400:5 instead of 800:5 provides a bill that is ½ of the actual bill. And the inverse will give a bill double of what should have been sent. Both are lose-lose situations for the utility.





- Cross Phasing (wiring errors)
- Loose or Corroded Connections
- CT Mounted Backwards
- CT's with Shorted Turns
- Wrong Selection of Dual Ratio CT
- Detect Magnetized CT's
- Burden Failure in Secondary Circuit
- Open or Shorted Secondary
- Mislabeled CT's
- Ensures all Shorting Blocks have been Removed



- ✓ Safety walk around site
- ✓ Check PPE
- Check test switch
- Tighten any loose connections
- ✓ Check primary cabinet
- Check connections
- ✓ Thermal scan
- ✓ Connect field tester





## **TESTING AT TRANSFORMER RATED SITES**

- ✓ Meter Accuracy
- ✓ Customer Load
- ✓ Full Load
- ✓ Light Load
- ✓ Power Factor
- ✓ CT Health
- ✓ Burden Testing
- ✓ Ratio Testing
- ✓ Demagnetization
- ✓ Admittance Testing
- ✓Harmonics Assessment
- ✓ Site Verification





# METER ACCURACY TESTING



- Meter Accuracy Test using IR Pulse Detection
- ✓ Make connections from Field Tester to Meter Form
- ✓ Connect IR Pulse Detector to meter output
- ✓ Check pulse indictor
- ✓ Pulse Align if necessary





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# METER ACCURACY TESTING

ACCURACY TEST		
≪S₽>	MANUAL METER TEST	1 🖵 😾 7:39 PM 03/13/2020
UTILITY METER TO TEST		
FORM: 95 Kh:	1.80 SERVICE: 4-Wire, Wye	
TA: 2.5 PULSES PER REV:	1 SERIAL NO:	
SELECT TEST LOADS	TEST TYPE	
(SHORTCUT: PRESS THE EQUIVALENT NUMBER)	🔘 ACCURACY 🔿 TIMED RUN 🔿 TIN	IED REG 🔿 DEMAND 🔿 ENERGY
1-CL (CUSTOMER LOAD)	PULSES WEIGHT ITR	TOLERANCE:
🗍 2-FL (TA)		0.50%
🗍 3-LL (10%TA)	FL: 0 0 0	PASS OR FAIL CRITERIA
🗍 4-PF (TA @ 0.5PF LAG)	LL: 0 0 0	WARM-UP TIME:
5-ADV (ADVANCE SETUP)	PF: 0 0 0	00:00:00
•	ADV: 0 0 0	(htcmmcss) NOTE: ONLY RUNS BEFORE THE FIRST TEST.
NEW ADV SETUP	PL	JLSE ALIGN START

- Meter Accuracy Test using IR Pulse Detection
- ✓ Make connections from Field Tester to Meter Form
- Connect IR Pulse
  Detector to meter
  output
- ✓ Check pulse indictor
- ✓ Pulse Align if necessary





TAG:		ITERATION: TEST STATUS: TEST FINISHED								
PULSES:	PRESET:	ACTUAL:		REMAINING:		И	/Hrs:			
TEST RESUL	TS									
TEST	ITR	TAG	WHrs	%ERROR	REG	P/F	W	Va		
0	1	CL ACC	1.798	0.12	100.11	PASS		285.40		
0	AVE		1.798	0.12	100.12	PASS	1.00	285.40		
ALL	WAVG			0.12	100.12	PASS				

- Meter Accuracy Test using IR Pulse Detection Make
- connections from Field Tester to Meter Form
- Connect IR Pulse Detector to meter output
- ✓ Check pulse indictor

 $\checkmark$ 

 $\checkmark$ 

Pulse Align if necessary



## CUSTOMER CT RATIO TEST WITH BURDEN

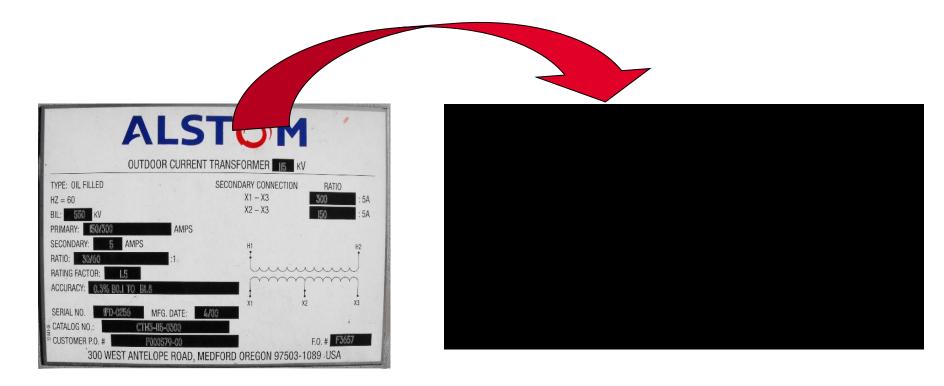


- Make Connections from Field Tester to Primary current phases
- Make connections from Field Tester to Secondary test switch
- ✓ Connect IR Pulse
  Detector to meter output



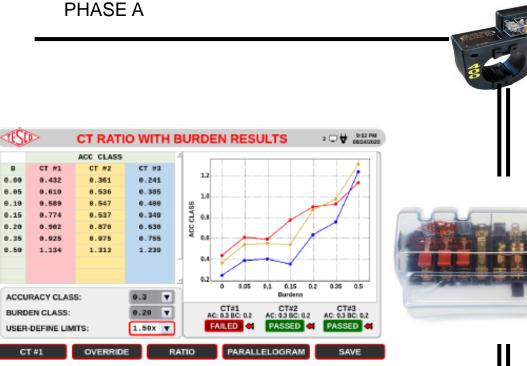
### FUNDAMENTALS OF POLYPHASE FIELD METER TESTING AND SITE VERIFICATION

### Functionality with Burden Present on the Secondary Loop





### Functionality with Burden Present on the Secondary Loop



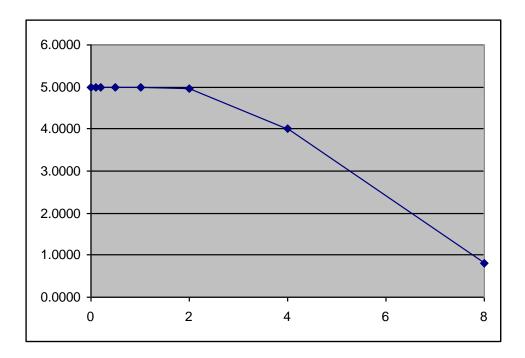
- Some burden will always be present – junctions, meter coils, test switches, cables, etc.
- CT's must be able to maintain an accurate ratio with burden on the secondary.





### FUNDAMENTALS OF POLYPHASE FIELD METER TESTING AND SITE VERIFICATION

Functionality with Burden Present on the Secondary Loop



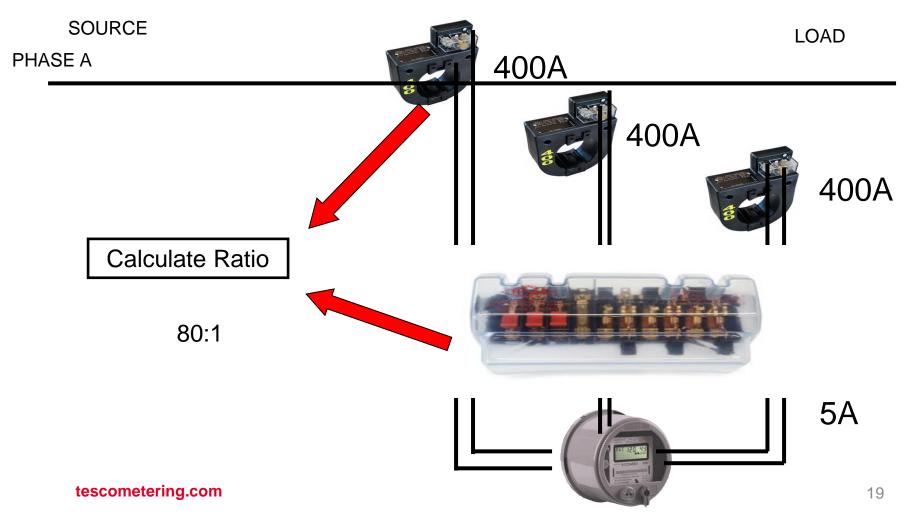
0.3% @ B0.1, B0.2, B0.5

Initial Reading = 5Amps  $0.3\% \times 5A = 0.015A$ 5A - 0.015 = 4.985A

Burden	Reading
0	5.0000
0.1	4.9999
0.2	4.9950
0.5	4.9900
1	4.9800
2	4.9500
4	4.0000
8	0.8000

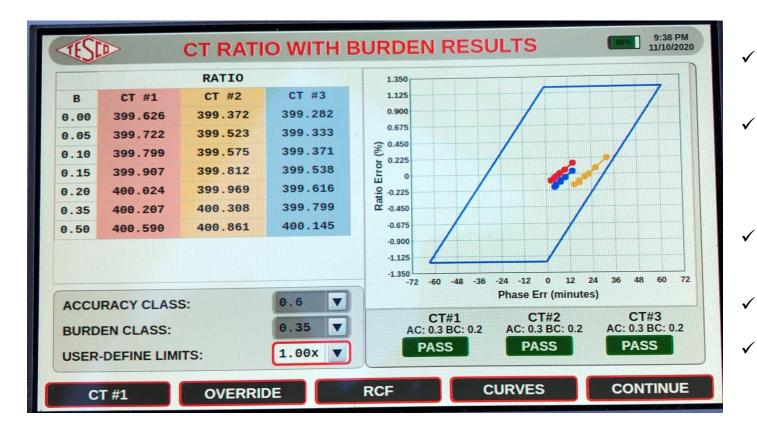


#### Ratio of Primary Current to Secondary Current





### **CT RATIO TESTING WITH BURDEN ADDED**



- Meter Accuracy Test using IR Pulse Detection
  - Make connections from Field Tester to Meter Form
- Connect IR Pulse Detector to meter output
- ✓ Check pulse indictor
- ✓ Pulse Align if necessary

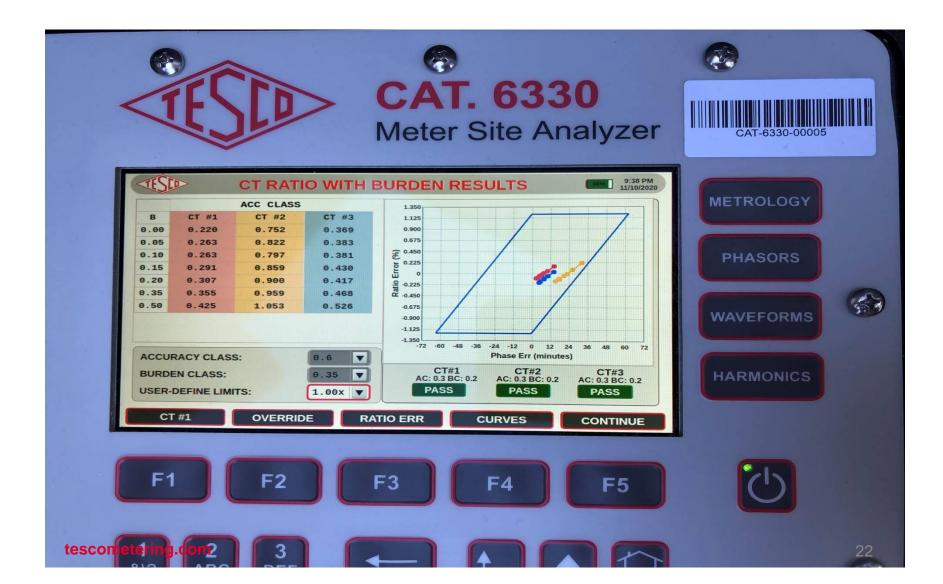


### CT RATIO TESTING WITH BURDEN ADDED

		RATIO		1.350
В	CT #1	CT #2	CT #3	1.125
0.00	399.626	399.372	399.282	0.900
0.05	399.722	399.523	399.333	0.675
0.10	399.799	399.575	399.371	
0.15	399.907	399.812	399.538	D.225
0.20	400.024	399.969	399.616	
0.35	400.207	400.308	399.799	₫ -0.450
0.50	400.590	400.861	400.145	-0.675
ACCU	RACY CLAS	ç.	0.6	-0.900 -1.125 -1.350 -72 -60 -48 -36 -24 -12 0 12 24 36 48 60 72 Phase Err (minutes)
	EN CLASS:	-	0.35 🔻	CT#1 CT#2 CT#3 AC: 0.3 BC: 0.2 AC: 0.3 BC: 0.2 AC: 0.3 BC: 0.2
	DEFINE LIM	ITS:	1.00x V	PASS PASS PASS

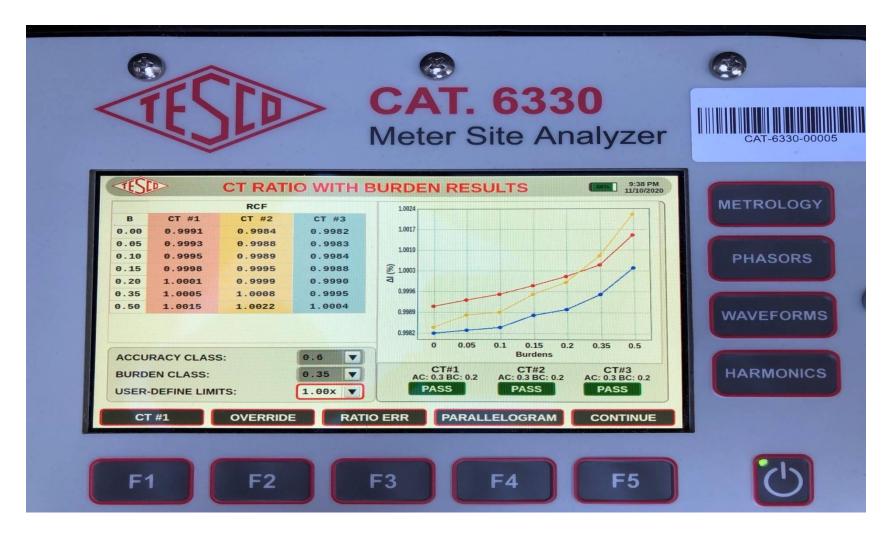


### **CT RATIO TESTING WITH BURDEN ADDED**





### CT RATIO TESTING WITH BURDEN ADDED & RATIO CORRECTION FACTOR



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# PHANTOM LOAD TESTING



- ✓ Determine the TA (Test Amps) from Meter Faceplate
- Ensure Safety shorting switch and test jack have been disengaged
- Make connections from Field Tester to Meter Form using jumper EZ Clips.
- ✓ Connect IR Pulse Detector to meter output
- ✓ Check pulse indictor
- ✓ Pulse Align if necessary



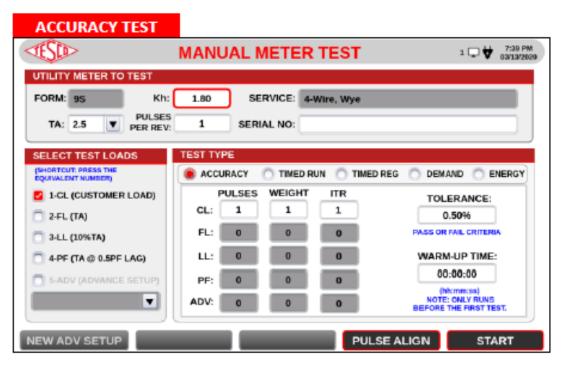
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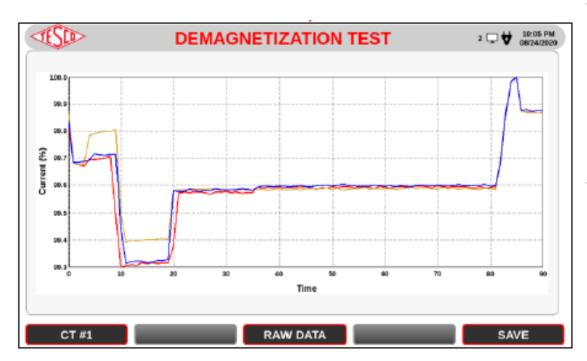
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## **PHANTOM LOAD TESTING**

EST RESULTS      TEST    ITR    TAG    V/F    V    Va      TEST    ITR    TAG    NP/F    V    Va      0    AVE    8.987    0.15    100.15      1    ILLACC    -0.984    2052.60    2152.60      ITEST PARAMETERS    ITEST PARAMETERS      ITEST PARAMETERS      ITEST PARAMETERS      ITEST PARAMETERS      ITEST PARAMETERS      ITEST PARAMETERS      ITEST PARAMETERS      ITEST PARAMETERS      ITEST PARAMETERS      ITEST FINISHED      VHrs    VEF      VHrs    VEF      ITEST STATUS:    TEST FINISHED      ULLSES:    PRESET:    ACTUAL:    REGG P/F    V      ITEST TIT    TAG	TAG:		ITERATION:		TEST ST	ATUS: T	EST FINISH	ED							
TEST    ITR    TAG    WHYS    XERROR    REG    P/F    W    Va      0    1    FLACC    8.987    0.15    100.14    PASS    283.60      0    AVE    8.987    0.15    100.15    PASS    1.00    283.60      1    1    LLACC    -0.084    2052.60    2152.59    METER TEST RESULTS    Image: Constraint of the state of	PULSES:	PRESET:	ACTUAL:	F	EMAINING:		WH	rs:							
0    1    FL ACC    8.987    0.15    100.15    PASS    283.69      0    AVE    8.987    0.15    100.15    PASS    1.00    283.60      1    1    LL ACC    -0.084    2052.60    2152.50    2152.60    2162.60	TEST RESUL	TS													
0    AVE    8.987    0.15    100.15    PASS    1.00    283.60      1    1    LL ACC    -0.084    2052.60    2152.59    METER TEST RESULTS    Image: Constraint of the state of the	TEST	ITR	TAG	WHrs	%ERROR	REG	P/F	W	Va						
1    1    LL ACC    -0.084    2052.60    2152.60    2152.60    2152.60    2152.60    2152.60    2050.00    2010    11:2    08/30      2    1    PF ACC    3.759    -4.23    95.77    3.759    -4.23    95.77    ALL    WAVG    682.84    782.84    TAG:    ITERATION:    TEST STATUS:    TEST FINISHED    UHrs:    UHrs	θ	1	FL ACC	8.987	0.15	100.14	PASS		283.60						
1    AVE    -0.084    2052.60    2152.61    21	θ	AVE		8.987	0.15	100.15	PASS	1.00	283.60						
1    AVE    -0.084    2052.60    2152.60    2152.60    2    1    PF ACC    3.759    -4.23    95.77      2    AVE    3.759    -4.23    95.77    ALL    WAVG    682.84    782.84      MALL    WAVG    682.84    782.84    782.84    PULSES:    PRESET:    ACTUAL:    REMAINING:    WHrs:      TEST RESULTS    TEST RESULTS    TEST RESULTS    TEST RESULTS    TEST RESULTS      1    0    CL    1.800    0.02    100.02    PASS    277.0      1    0    FL    1.800    -0.00    100.00    PASS    277.0      1    0    FL    1.800    -0.00    100.00    PASS    277.0	1	1	LL ACC	-0.084	2052.60	2152.59	STFSTD	>	MET					2 😾 🚺	11:24
Z    AVE    3.759    -4.23    95.77      ALL    WAVG    682.84    782.84      DULSES:    PRESET:    ACTUAL:    REMAINING:    WHrs:      TEST RESULTS    TEST RESULTS    TEST 9.00    PASS    277.00      0    AVE    1.800    0.02    100.02    PASS    277.00      1    0    FL    1.800    -0.00    100.00    PASS    277.00      1    AVE    1.800    -0.00    100.00    PASS    1.00    277.00	1	AVE		-0.084	2052.60	2152.60								- V -	08/30/
ALL    WAVG    682.84    782.84      PULSES:    PRESET:    ACTUAL:    REMAINING:    WHrs:      TEST RESULTS    TEST RESULTS    TEST RESULTS    277.0      0    AVE    1.800    0.02    100.02    PASS    277.0      1    0    FL    1.800    -0.00    100.00    PASS    277.0      1    AVE    1.800    -0.00    100.00    PASS    277.0	2	1	PF ACC	3.759	-4.23	95.77	TEST PAR	AMETERS		G					
PULSES:    PRESET:    ACTUAL:    REMAINING:    WHrs:      TEST RESULTS    TEST RESULTS    TEST RESULTS    Serror REG    P/F    W    Va      0    0    CL    1.800    0.02    100.02    PASS    277.0      0    AVE    1.800    0.02    100.02    PASS    277.0      1    0    FL    1.800    -0.00    100.00    PASS    277.0      1    AVE    1.800    -0.00    100.00    PASS    1.00    277.0      1    AVE    1.800    -0.00    100.00    PASS    1.00    277.0	2	AVE		3.759	-4.23	95.77	TAG:		ITERATION:		TEST ST	TATUS:	EST FINIS	HED	
TEST RESULTS        0      0      CL      1.800      0.02      100.02      PASS      277.0        0      AVE      1.800      0.02      100.02      PASS      277.0        1      0      FL      1.800      -0.00      100.00      PASS      277.0        1      AVE      1.800      -0.00      100.00      PASS      277.0	ALL	WAVG			682.84	782.84		DDCCCT.						// Inc.	
TEST      ITR      TAG      WHrs      %ERROR      REG      P/F      W      Value        0      0      CL      1.800      0.02      100.02      PASS      277.0        0      AVE      1.800      0.02      100.02      PASS      1.00      277.0        1      0      FL      1.800      -0.00      100.00      PASS      277.0        1      AVE      1.800      -0.00      100.00      PASS      277.0        1      AVE      1.800      -0.00      100.00      PASS      277.0							POESES.	PRESET.	ACTOAL	· []	REMAINING.		vi Vi		
0      0      CL      1.800      0.02      100.02      PASS      277.0        0      AVE      1.800      0.02      100.02      PASS      1.00      277.0        1      0      FL      1.800      -0.00      100.02      PASS      277.0        1      AVE      1.800      -0.00      100.00      PASS      1.00      277.0	J						TEST RES	ULTS							
00    AVE    1.800    0.02    100.02    PASS    1.00    277.0      1    0    FL    1.800    -0.00    100.00    PASS    277.0      1    AVE    1.800    -0.00    100.00    PASS    1.00    277.0							TEST	ITR	TAG	WHrs	%ERROR	REG	P/F	W	Va
1    0    FL    1.800    -0.00    100.00    PASS    277.0      1    AVE    1.800    -0.00    100.00    PASS    1.00    277.0							Θ	Θ	CL	1.800	0.02	100.02	PASS		277.0
1 AVE 1.800 -0.00 100.00 PASS 1.00 277.0							Θ	AVE		1.800	0.02	100.02	PASS	1.00	277.0
							1	0	FL	1.800	-0.00	100.00	PASS		277.0
ALL WAVG 0.01 100.01 PASS										1.800				1.00	277.0
							ALL	WAVG			0.01	100.01	PASS		

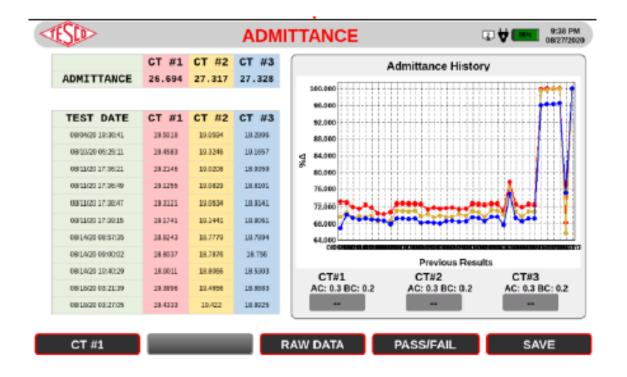




- Current transformers (CTs) show large errors when they are magnetized by dc current. This error can be reduced after proper demagnetization.
- One of the methods to demagnetize the CT is to increase the core flux by increasing its burden. This method enables to restore the nominal precision of the heavily magnetized CT from 2.5% back to 0.2% without interruption of the CT operation.



# **ADMITTANCE TESTING**

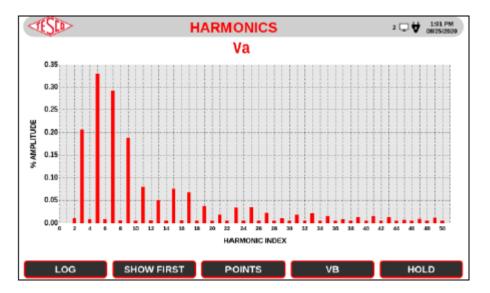


 admittance is a measure of how easily a circuit or device will allow a current to flow. It is defined as the reciprocal of impedance.

 ✓ The SI Unit of admittance is the (symbol S)

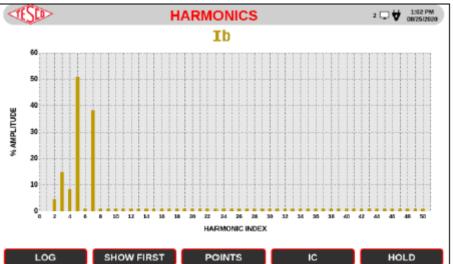


## HARMONICS TESTING



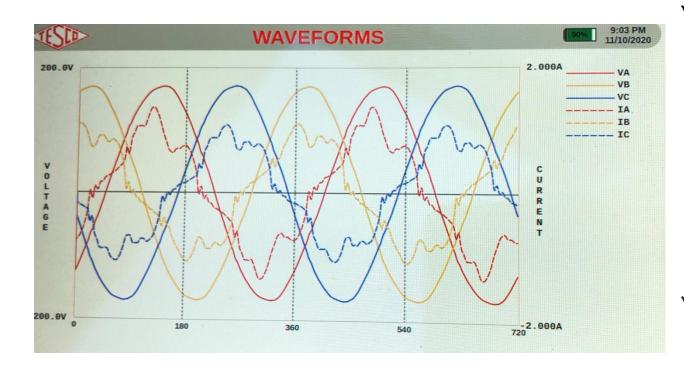
 ✓ Harmonics are integer frequencies often found with non linear loads.

THD=Total Harmonic Distortion Vthd <5%



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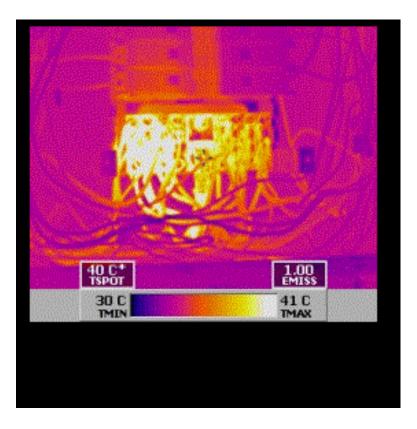


- Harmonics are generated as a voltage or current at an integer frequency of the system, produced by the action of non-linear loads such as rectifiers, discharge lighting, or switch mode power supplies.
- Harmonic frequencies in the power grid are a frequent cause of power quality problems.



## HARMONICS TESTING-WAVEFORMS

### What is the problem with Harmonics?



#### HEAT.

- ✓ Can cause significant damage
- ✓ Safety Hazard
- ✓ Poor Power Factor
- ✓ AMI Mesh Interference
- ✓ Transformer Overheating
- ✓ Loss of service

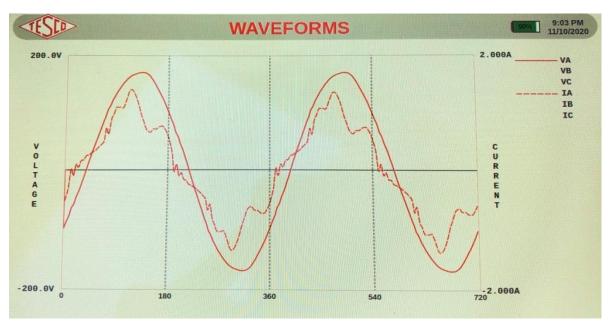
Image courtesy of irinfo.org

#### tescometering.com



Can we reduce or eliminate Harmonics?

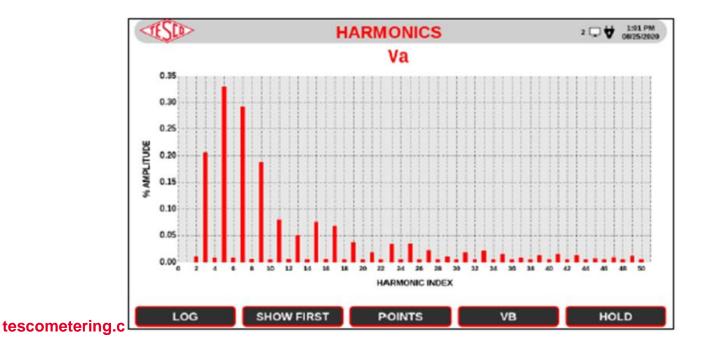
- $\checkmark$  Perhaps not eliminate. But we can reduce their impact.
- $\checkmark$  We live in non linear world of power where harmonics are generated.
- ✓ PWM conversion and AC Frequency Drive Motors and Pumps.
- $\checkmark\,$  Many thousands of todays electrical products have SWPS devices.





How can we reduce the impact of harmonics ?

- ✓ Measure and determine major harmonic condition under customer load.
- ✓ Assess most significant even & odd harmonics.
- ✓ Active Harmonic Filtering can reduce most significant index.
- ✓ Power Factor Correction Capacitor.





## PERIODIC SITE INSPECTIONS.....

#### ....Can Discover or Prevent:

- Billing Errors
- Bad Metering set-up
- Detect Current Diversion
- Identify Potential Safety Issues
- Metering Issues (issues not related to meter accuracy)
- AMR/AMI Communications Issues
- The need for Unscheduled Truck Rolls due to Undetected Field Related Issues
- Discrepancies between what is believed to be at a given site versus the actual setup and equipment at the site





# **QUESTIONS AND DISCUSSION**

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President

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### **TESCO – The Eastern Specialty Company**

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