Back to the Basics – Current Transformer (CT) Testing

As test equipment becomes more sophisticated with better features and accuracy, we risk turning our field personnel into test set operators instead of skilled field service technicians. A test set operator connects the leads, pushes the buttons, and records the results; hoping the numbers he records are good. A test technician connects the leads, pushes the buttons, and records the results. However, the test technician understands what the test set was doing while all the lights were flashing, and why. The technician can also evaluate the results and determine if a re-test is necessary with different connections or substitute external equipment for tests when the test equipment malfunctions. The purpose of this article is to help a test set operator understand the tests they perform, and hopefully add or re-enforce a test technique to the test technician's repertoire.

The article is organized as per the NETA standards for easy reference:

Description of operation

During normal operation, CT's transforms higher current through its primary into a more manageable CT secondary current. This transformation is made possible by copper coils wrapped around an iron core with the ratio between primary and secondary currents determined by the ratio between the number of primary and secondary turns. Bar and donut type CTs do not have a physical primary winding and are considered to have one primary turn. When current flows through the primary winding, the following actions occur:

- The iron core inside the transformer is magnetized.
- The magnetized iron core induces a voltage in the secondary coils.
- If the secondary circuit is closed, a current will flow through the secondary circuit in proportion to the CT ratio.

The transformation from primary to secondary current requires a small amount of energy to magnetize the iron core and there are some energy losses due to eddy currents and heat caused by current flowing through the windings. Therefore, the secondary current is not a perfect representation of the primary current. All CTs are built to ANSI standards and have an accuracy class to outline what effect the CT losses have on the CT secondary current under normal conditions. The accuracy class is the *minimum* accuracy guaranteed by the manufacturer and the CT may be built to higher standards.

Like every other transformer, CTs can only produce a finite amount of energy. This is usually the volt-amp (VA) rating for normal transformers. The CT energy limitation is also included in the accuracy class but is shown as a maximum burden. The CT burden is the amount of impedance (AC Resistance) connected to the CT secondaries and is usually rated in ohms or volts. The manufacturer only guarantees CT accuracy up to a maximum burden rating and CT performance will degrade if the secondary burden is larger than rated.

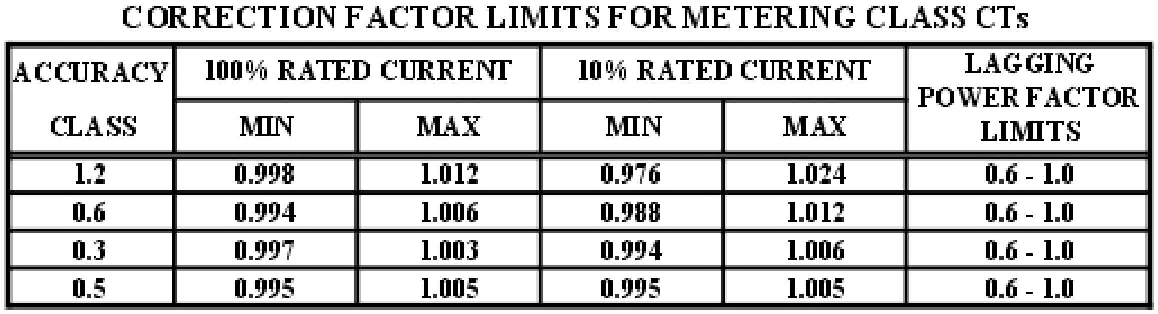
1.0 Visual and Mechanical Inspections

1. 1. Compare equipment nameplate data with drawings and specifications

Every CT test sheet should include the following information:

- **Serial Number** (when possible): The serial number is important to organize test results and allow a reference when comparing test results to manufacturers specifications. The serial number can also be used when ordering replacement or new CTs from manufacturers.
- **Model Number** (when possible): The model number is important when comparing test results to manufacturer's literature and ordering replacement, new, or spare CTs from manufacturers.
- **Ratio**: The CT ratio is the most important piece of information regarding the CT and must be recorded from the nameplate or the design criteria. The ratio determines the CT operating characteristics and is used as reference for CT tests. If the CT has multiple taps (different possible ratio combinations), all taps should be recorded for future reference in case a new CT ratio is required for the application.

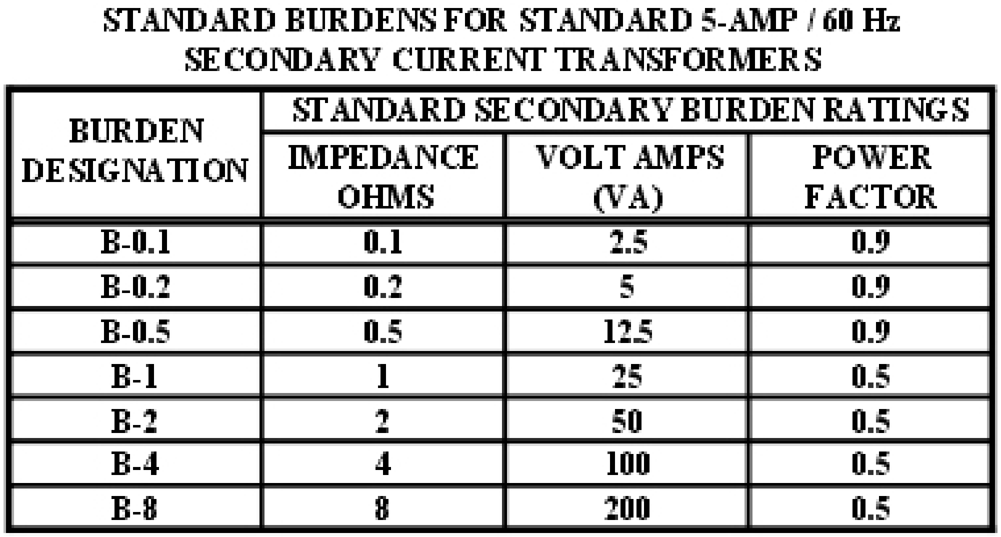
- **Accuracy Class**: The CT accuracy class indicates the CT's ability to perform accurately under different conditions or, in different terms, its performance characteristics and the maximum burden allowable on the CT secondaries. CTs can be separated into 2 distinct groups. However, a CT can have ratings for both groups. See "Figure #1 - CT Accuracy Classes and Correction Factors" for a list of typical accuracy classes.



CORRECTION FACTOR LIMITS FOR METERING CLASS CTs

ACCURACY CLASS	100% RATED CURRENT		10% RATED CURRENT		LAGGING POWER FACTOR LIMITS
	MIN	MAX	MIN	MAX	
1.2	0.998	1.012	0.976	1.024	0.6 - 1.0
0.6	0.994	1.006	0.988	1.012	0.6 - 1.0
0.3	0.997	1.003	0.994	1.006	0.6 - 1.0
0.5	0.995	1.005	0.995	1.005	0.6 - 1.0

Figure #1a CT Accuracy Classes and Correction Factors



STANDARD BURDENS FOR STANDARD 5-AMP / 60 Hz SECONDARY CURRENT TRANSFORMERS

BURDEN DESIGNATION	STANDARD SECONDARY BURDEN RATINGS		
	IMPEDANCE OHMS	VOLT AMPS (VA)	POWER FACTOR
B-0.1	0.1	2.5	0.9
B-0.2	0.2	5	0.9
B-0.5	0.5	12.5	0.9
B-1	1	25	0.5
B-2	2	50	0.5
B-4	4	100	0.5
B-8	8	200	0.5

Figure #1b CT Accuracy Classes and Correction Factors

The CT accuracy class listed on the nameplate can be separated into 3 sections. See “Figure #2 - Understanding CT Ratings” for visual clues of the descriptions below.

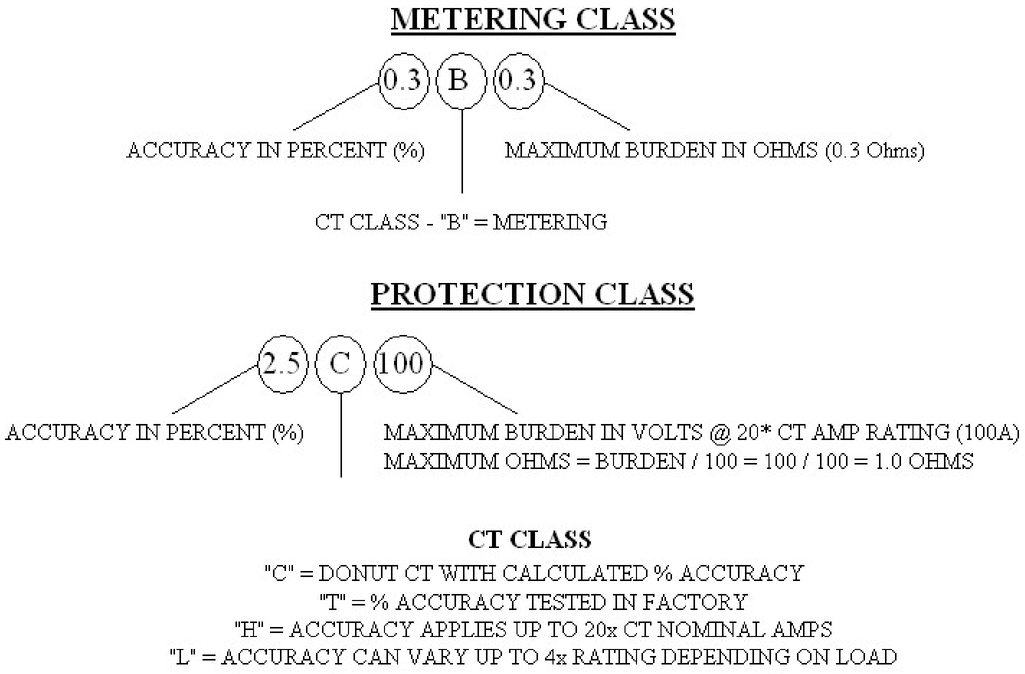


Figure #2 - Understanding CT Ratings

a) **Accuracy –** The first number of the accuracy class for both classes of CTs is the rated ratio accuracy in percent. Therefore a “0.3B0.1” metering class CT’s ratio would be accurate within 0.3% as long as the CT burden rating was not exceeded. The “2.5C100” protection class CT’s ratio would be accurate within 2.5% if the CT burden rating was not exceeded.

b) CT Class – The second part of the accuracy class is a letter. The letter distinguishes what application the CT is rated for. A CT can have dual ratings and be used in metering or protection applications if both ratings are listed on the nameplate.

   i. **Metering Class:** Metering class CTs have the letter “B” in the accuracy class rating. They are designed for maximum accuracy from very low currents to the maximum CT rating. These CTs are often used to record power consumption and are the basis for electrical bills, hence the need for accuracy. A typical Metering Class CT would have an accuracy class similar to “0.3B0.1”

ii. **Relay or Protection Class:** Relay or protection class CTs will have the letters "C", "H", "L", or "T" to indicate the protection class rating.
    - A "C" rating indicates that the CT accuracy can be calculated because there is no appreciable leakage flux in the CT design.
    - A "T" rating indicates that the CT can have significant leakage flux and the CT accuracy must be obtained by testing in the factory.
    - An "H" rating indicates that the CT accuracy rating applies within the range of secondary currents from 5 – 20 times the nominal CT rating. These are typically wound CTs.
    - An "L" rating indicates that the CT accuracy applies at the maximum rated secondary burden at 20x rated only. The ratio accuracy can by up to 4x greater than the listed value depending on the connected burden and fault current. These CTs are typically donut, bushing, or bar type CTs.

    Relay class CTs are not as accurate as metering class CTs but are designed to operate over a wider range of current. This wider range is necessary to allow the protective relay to operate at different fault levels. Relay Class CTs are typically rated to accurately operate up to 20x the CT rating. A typical protection Class CT would have an accuracy class similar to "2.5C100"

c) **Burden –** The third part of the accuracy class rating follows the letter and indicates the maximum burden allowed. If the CT secondary burden rating is exceeded, CT accuracy is not guaranteed.
   - **Metering class** CT burdens are displayed as secondary ohms. For Example, a "0.3B0.1" rated CT's ratio is accurate to 0.3% if the connected secondary burden impedance is less than 0.1 Ohms. A "0.6B8" rated metering class CT will operate within 0.6% accuracy if the secondary burden does not exceed 8.0 Ohms.
   - **Protection class** CT burdens are displayed as the maximum secondary volts allowable if 20x (100A) the CT rating was to flow through the secondary circuit. For example, a "2.5C100" protection class CT is accurate within 2.5% if the secondary burden is less than 1.0 Ohms (100V/100A).
   - **CT Type**: There are four typical CT types that are described below.

Donut: Donut CTs are the most common CT installed. These CTs are constructed with no primary winding and are installed around the primary conductor. The electric field created by current flowing through the conductor interacts with the CT core to transform the current to the appropriate secondary output. Donut CTs can be of solid or *split core* construction. The primary conductor must be removed when installing solid donut CTs. However, split core CTs can be installed around the primary conductor without removing the primary conductor. See "Figure #3 – Donut CTs" for pictures of typical donut CTs.

Figure #3 – Donut CTs

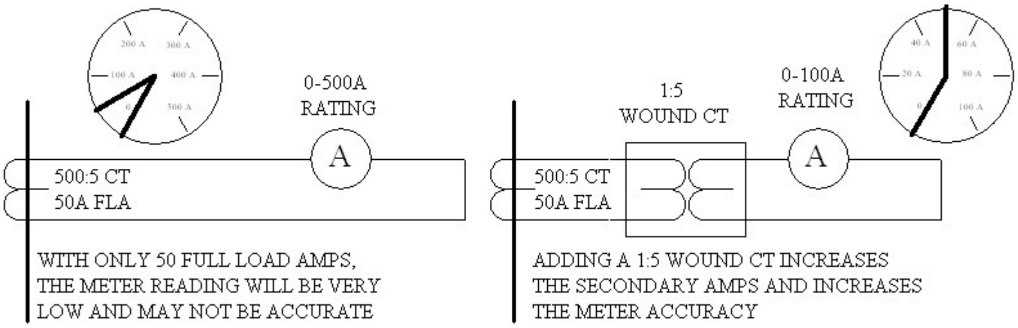
Bushing CT: Bushing CTs are donut CTs specially constructed to fit around a bushing as shown in "Figure #4 – Bushing CT" These CTs usually cannot be accessed and their nameplates are found on the transformer or circuit breaker control cabinets.

Figure #4 Bushing CT

Bar Type CTs: Bar type CTs operate on the same principle of donut CTs but have a permanent bar installed as a primary conductor. An example of a bar type CT is shown in "Figure #5 – Bar Type CT."

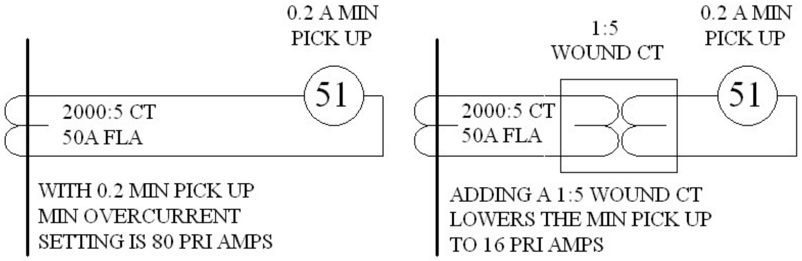
Figure #5 Bar Type CT

Wound CTs: Wound CTs have a primary and secondary winding like a normal transformer. These CTs are rare and are usually used at very low ratios and currents; typically in CT secondary circuits to compensate for low currents, match different CT ratios in summing applications, or to isolate different CT circuits. "Figure #6 – Wound CT Applications" demonstrates some wound CT applications. Wound CTs have very high burdens and special attention to the source CT burden should be applied when wound CTs are use.



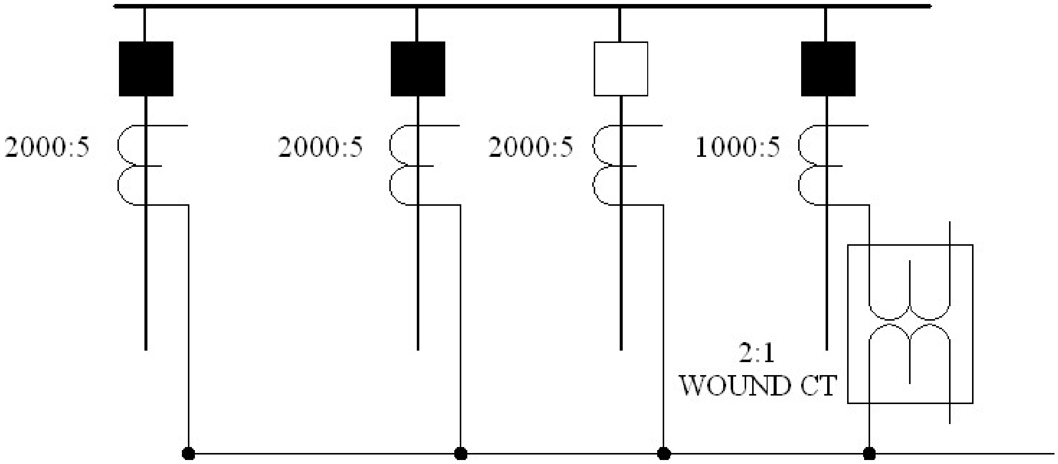
METERING APPLICATION FOR WOUND TYPE CTs

Figure #6a



PROTECTIVE DEVICE APPLICATION FOR WOUND TYPE CTs

Figure #6b



THE CT SECONDARIES COULD NOT BE
CONNECTED IN PARALLEL WITHOUT THE WOUND CT

PARALLELING DIFFERENT CT RATIOS WITH WOUND TYPE CTS

Figure #6c

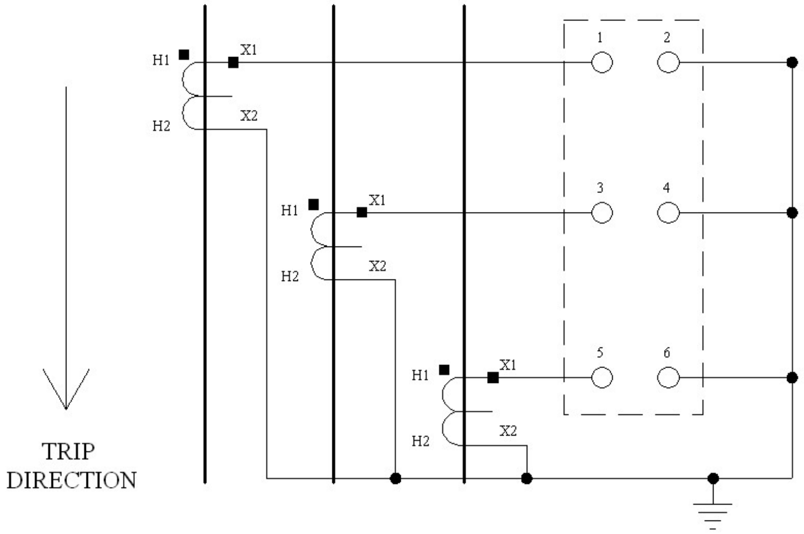
- **Voltage Class:** The CT voltage class determines the maxim voltage that a CT can be in direct contact with. For example, a 600V Donut CT cannot be installed on or around any bare 2400V conductor. However, a 600V donut CT can be installed around a 2400V cable if the CT is installed around the insulated portion of the cable and the insulation is rated correctly.

2. 2. Inspect physical and mechanical condition

When possible, the CT should be inspected for shipping damage, incorrect bracing, cracks, and general overall condition. The CT should be permanently mounted and not supported by the primary conductor.

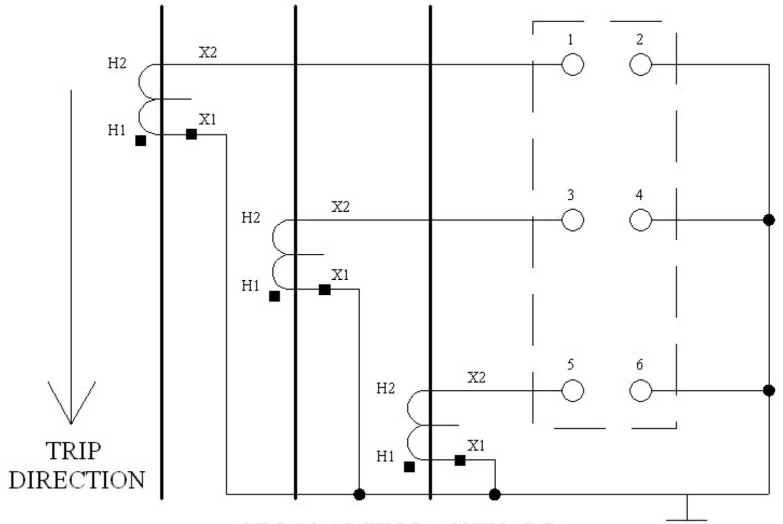
3. 3. Verify correct connection of transformers with system requirements

This step is often the most critical test that is performed. Incorrect CT connections can cause considerable grief on any polarity sensitive metering or protection scheme such as generator protection (IEEE 32, 40, 67); line protection (IEEE 21, 67, 78); or differential elements (IEEE 87). In many instances, the connection is more important than the CT polarity as shown in "Figure 7 – CT Connections" where you can see examples of incorrectly connected CT polarities that still allow the connected devices to operate correctly. Two wrongs OFTEN make a right when working with CT connections.



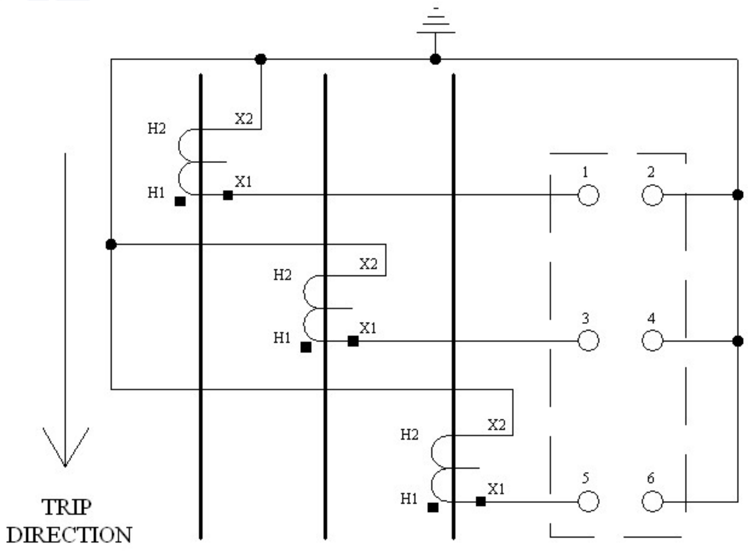
MANUFACTURER SPECIFIED CONNECTION

Figure #7a



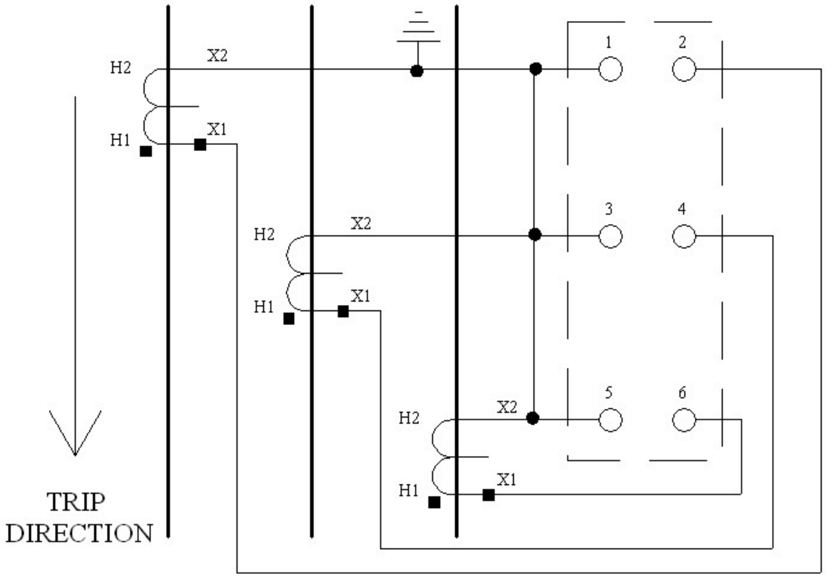
CT POLARITY BACKWARD
EQUIPMENT WILL OPERATE CORRECTLY

Figure #7b



CT POLARITY BACKWARD
POLARITY MARKS CONNECTED AS PER DRAWING
EQUIPMENT WILL NOT OPERATE CORRECTLY

Figure #7c



CT POLARITY BACKWARD
EQUIPMENT WILL OPERATE CORRECTLY

Figure #7d

4. ***4. Verify that adequate clearances exist between primary and secondary circuit wiring.***

   Inspect the space between the CT phases, ground and the secondary conductor to ensure there is adequate clearance. (Quick Rule of thumb = 1” per kV plus 1”) Remember that line-to-line voltages apply between phases. Also check that the secondary wiring is not run parallel and/or close to the primary conductor to prevent any current from being induced into the secondary path. All wiring above the primary conductor should be permanently affixed to the structure to prevent the wiring from falling on the primary conductors in the future. (Sticky backs should NOT be considered permanent)

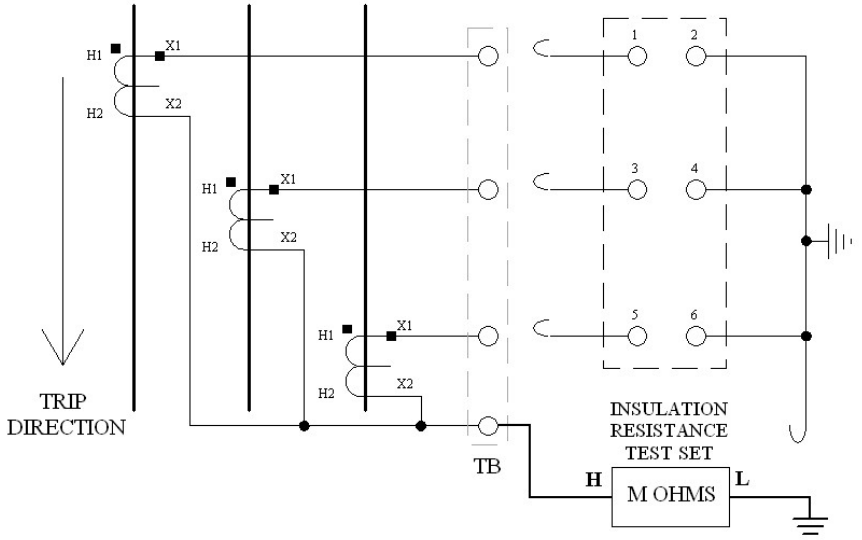
5. ***6. Verify that all required grounding and shorting connections provide contact.***

   CTs should always be shipped with shorting devices installed. Measure the resistance between both sides of the terminal block to ground before removing the shorting device to ensure the device is operating correctly. The measured resistance should be below 1 Ω. The CTs should remain shorted until the secondary wiring is complete and loop tested. Always check to ensure that CT shorting devices are removed on in-service CTs just prior to energization.

2. *Electrical Tests - Current Transformers*

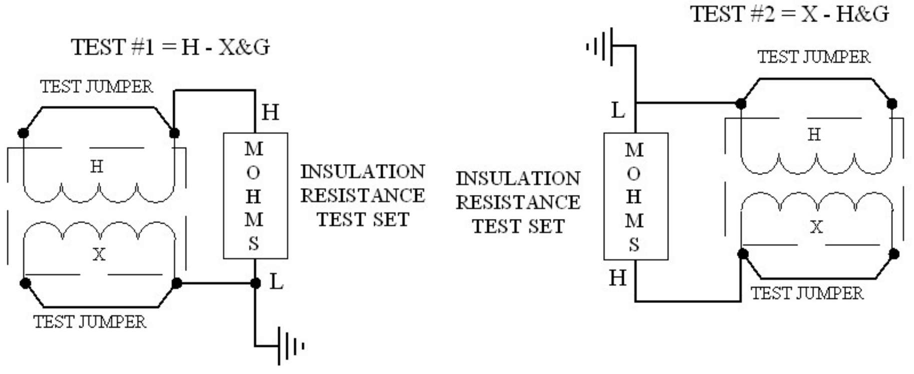
6. ***Perform insulation-resistance tests of the current transformer and wiring-to-ground at 1000 volts dc. For units with solid-state components, follow manufacturer’s recommendations.***

7. **When applicable, perform insulation-resistance and dielectric withstand tests on the primary winding with secondary grounded. Test voltages shall be in accordance with Tables 10.13 and 10.9 respectively.**
   When electromechanical relays were king, insulation resistance tests of CTs and wiring was an acceptable method of testing the entire CT circuit, including the internal relay wiring. In the age of microprocessor relays the risk of damage to the new, more sensitive relays must be weighed against the benefit of the test. I recommend isolating the CTs from the external wiring at the first terminal block or test point and applying the test voltage between the CT circuit and ground. All three CTs can be tested simultaneously as shown in “Figure #8 – CT Insulation Test Connections.” Investigate any measurement below 100MΩ. NEVER perform this test on transformer CTs while the transformer is under vacuum. Although a perfect vacuum is a perfect insulator, the transformer vacuum is not perfect and there is a strong possibility that you could cause a flashover inside the transformer.



DONUT OR BUSHING TYPE CT INSULATION TEST CONNECTION

Figure #8a



WOUND OR BAR TYPE CT INSULTAION TEST CONNECTION

Figure #8b

8. *Perform a polarity test of each current transformer.*

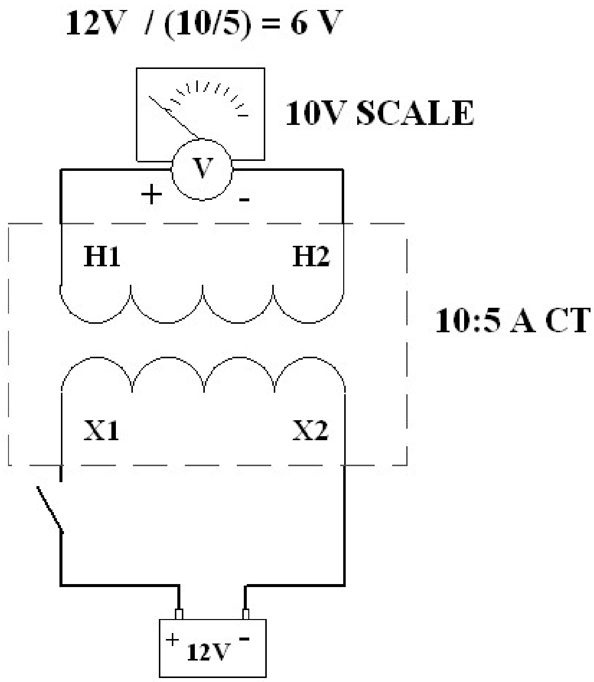
There are 2 generally accepted methods of testing a CT's polarity using simple meters and connections.

- **<u>DC Kick / Flick Test</u>**

  This is the tried and true method for testing CT polarity, used before electricity was discovered by some accounts. For this test you need a 6 or 9V lantern battery, a DC voltmeter or ammeter (preferably analog), and test leads.

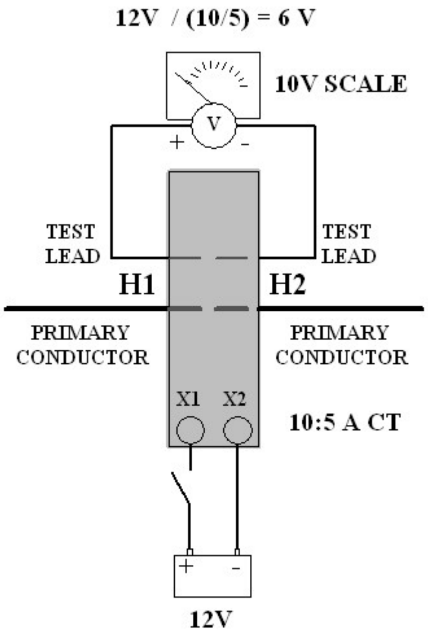
  This method is a quick and easy test for polarity but there is a very small possibility that it may saturate the CT. Always perform an excitation and/or saturation test after performing this test.

i. Connect the positive of the voltmeter to the marked terminal of the high voltage side of the CT and the negative lead to the non-marked as shown in "Figure #9 – CT DC polarity Test Connections"

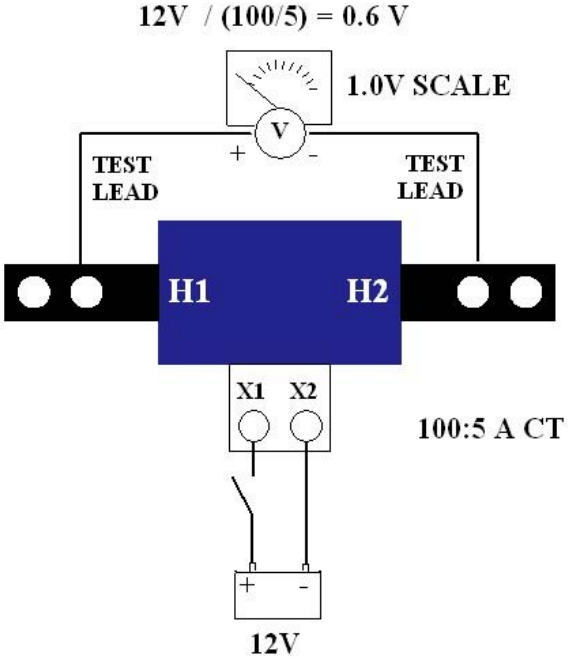


DC POLARITY TEST CIRCUIT
WOUND TYPE CT

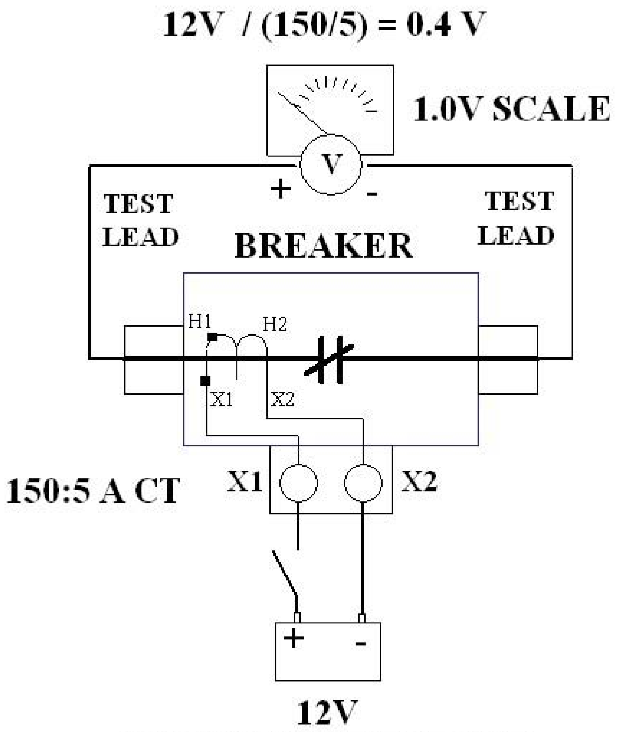
Figure #9a



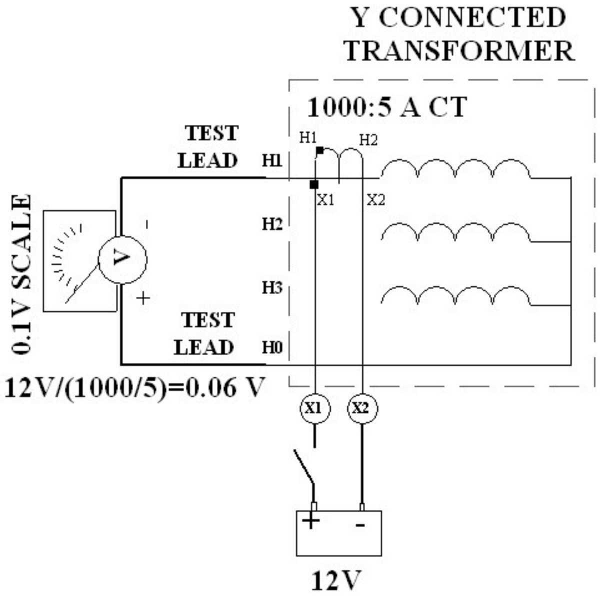
DC POLARITY TEST CIRCUIT
DONUT TYPE CT
Figure #9b



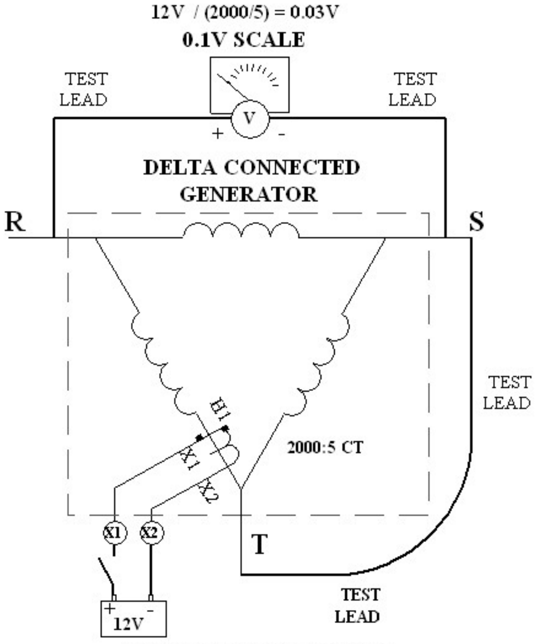
DC POLARITY TEST CIRCUIT
BAR TYPE CT
Figure #9c



DC POLARITY TEST CIRCUIT
CIRCUIT BREAKER BUSHING TYPE CT
Figure #9d



DC POLARITY TEST CIRCUIT
Y CONNECTED TRANSFORMER
BUSHING TYPE CT
Figure #9e



DC POLARITY TEST CIRCUIT
DELTA CONNECTED GENERATOR
Figure #9f

- If you are testing a donut type CT, you can run a wire through the CT and connect your meter across the wire. Make note of the wire and meter polarity.
- If the CT is enclosed within a breaker, close the breaker and connect your voltmeter across the breaker poles. Review the CT drawing carefully, note the CT polarity, and Meter polarity.
- If the CT is enclosed within a generator, connect your voltmeter across the generator windings. Review the CT drawing carefully and note the CT polarity and Meter polarity. If the star point is not accessible, connect the Voltmeter across 2 generator leads and short the remaining generator lead to one of the generator leads under test.
- If the CT is enclosed within a transformer, connect your voltmeter across the transformer bushings associated with the CT and short the remaining bushings to the non-polarity bushing under test. Review the CT drawing carefully and note the CT polarity and Meter polarity

ii. Calculate the expected voltage using the battery voltage and the CT ratio. (Battery voltage / CT ratio.)

iii. Connect the negative terminal of the battery to the non-polarity of the CT winding under test. Momentarily touch or connect the battery positive terminal to the polarity terminal of the CT winding under test.

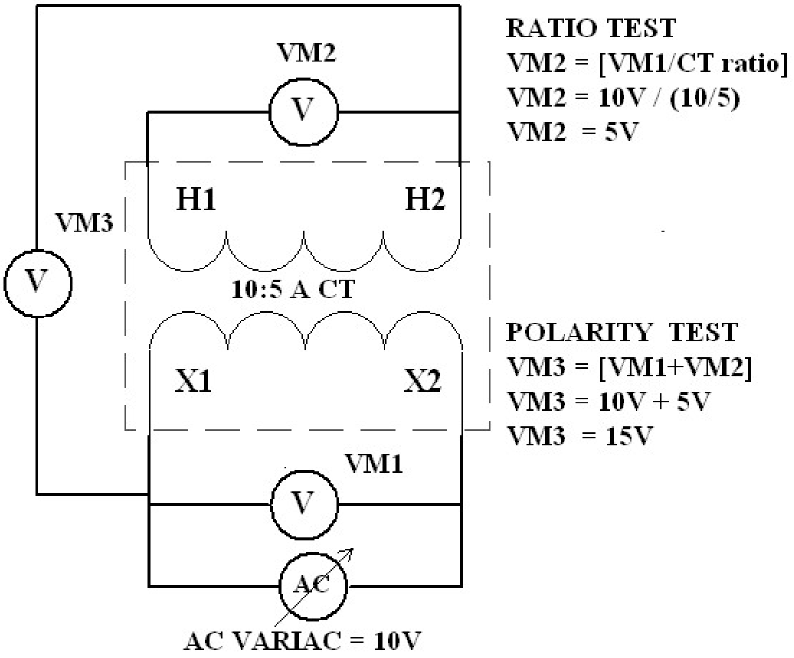
iv. Closely watch the needle or analog scale of the voltmeter. It should jump in the positive direction. This happens in a fraction of a second and the meter must be monitored very closely. If the voltmeter kicks in the positive direction the polarity marks are correct and if it kicks in the negative direction, the polarity marks are incorrect.

- **AC Voltage Method**

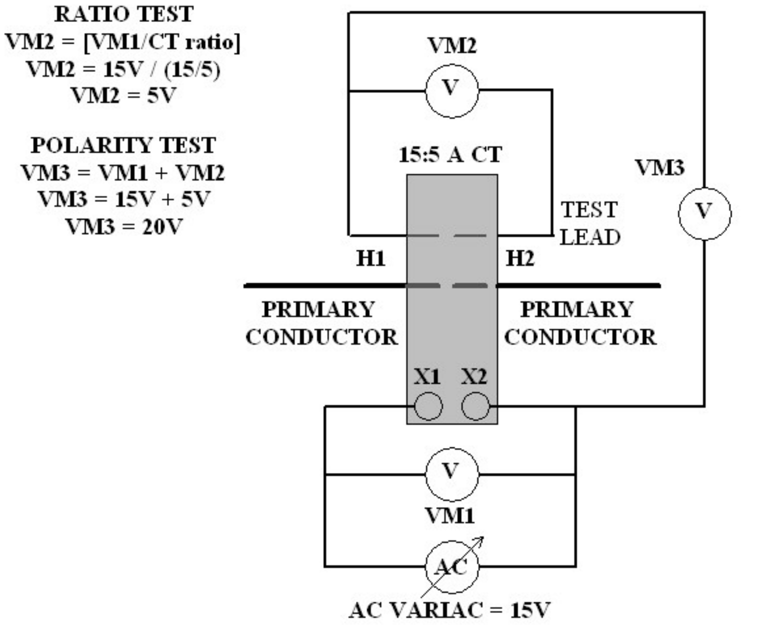
This method digs deep into transformer theory and can be used with any kind of transformer. Most transformer polarities are marked with additive polarity that allows you to create an autotransformer by connecting X1 and H2 or H1 and X2 together.

This method is limited by the accuracy of your meters and may not be reliable with unstable voltage sources and high ratio CTs due to the low H side voltages induced.

To test polarity using ac voltage; a variac and (preferably 2) voltmeter(s) are required. Use the following steps to test for CT polarity using the AC method as shown in "Figure #10 – CT AC polarity Test Connections".

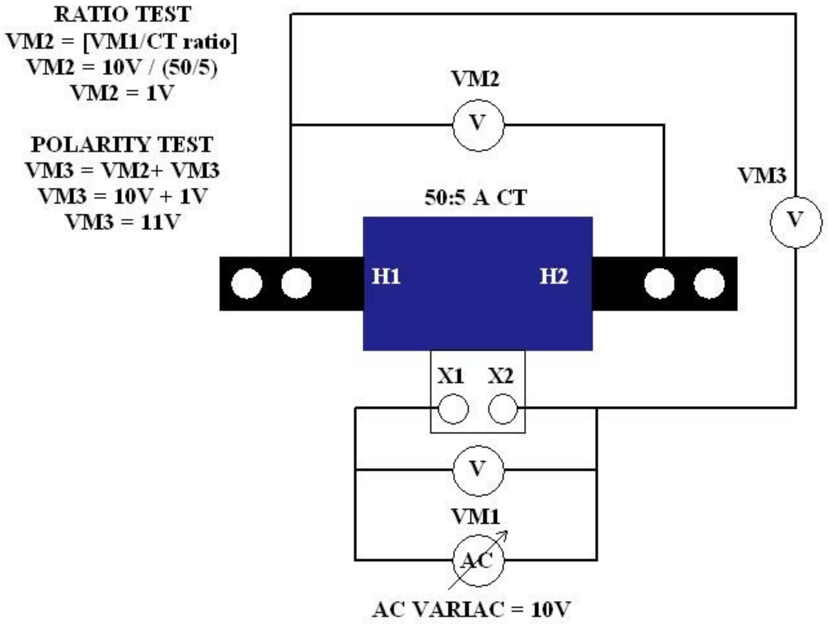


AC VOLTAGE RATIO TEST CIRCUIT
WOUND TYPE CT
Figure #10a



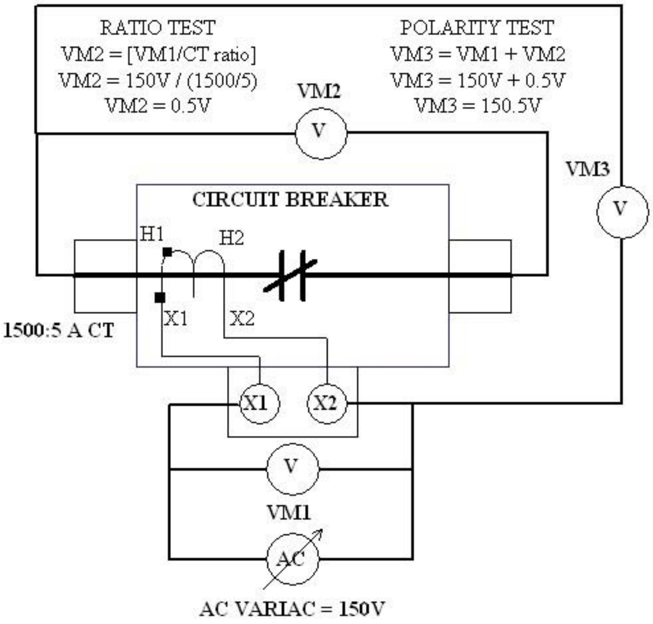
AC VOLTAGE RATIO TEST CIRCUIT
DONUT TYPE CT

Figure #10b



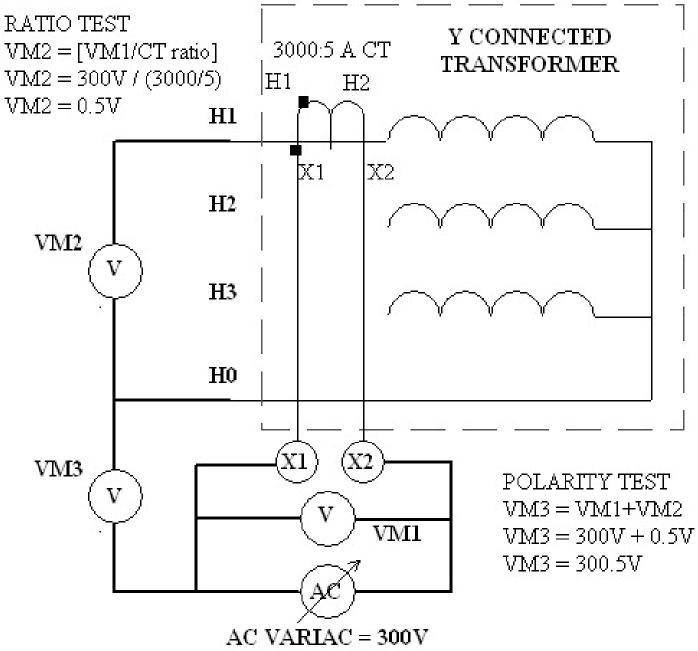
AC VOLTAGE RATIO TEST CIRCUIT
BAR TYPE CT

Figure #10c



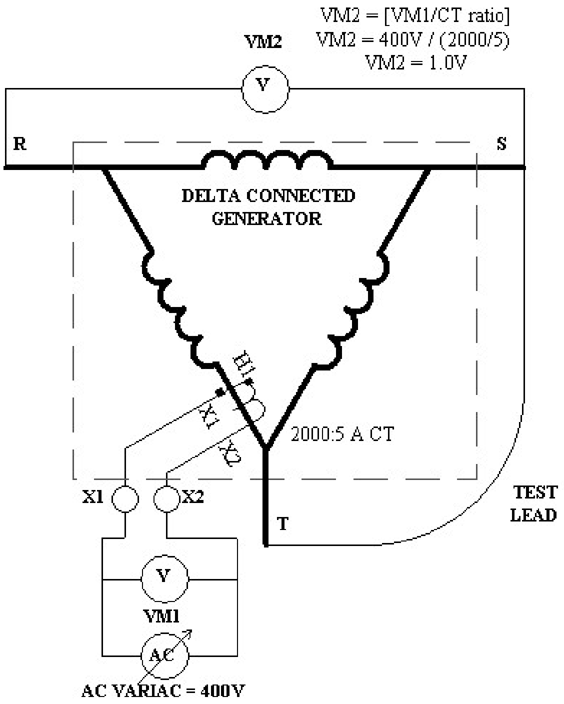
AC VOLTAGE RATIO TEST CIRCUIT
CIRCUIT BREAKER BUSHING TYPE CT

Figure #10d



AC VOLTAGE RATIO TEST CIRCUIT
Y CONNECTED TRANSFORMER
BUSHING TYPE CT

Figure #10e



AC POLARITY TEST CIRCUIT
DELTA CONNECTED GENERATOR
BUSHING TYPE CT

Figure #10f

i. Connect a variac across the secondary winding of the CT.
ii. Connect a voltmeter (VM1) across the secondary CT winding and variac.
iii. Connect a jumper between the non-polarity of the H winding and the polarity of the X winding.
iv. Connect a voltmeter (VM3) from the polarity mark of the H winding to the non-polarity mark of the X winding.
v. Increase the variac test voltage to a known value. Calculate the expected value. ([VM1/CT ratio]+[VM1]). If VM3 displays the expected result, the CT polarity markings are correct. If VM3 is less than VM1, the test connection or the CT polarity markings are incorrect. (Note: VM1 and VM3 can be 1 voltmeter switching between positions if the test voltage remains stable.)

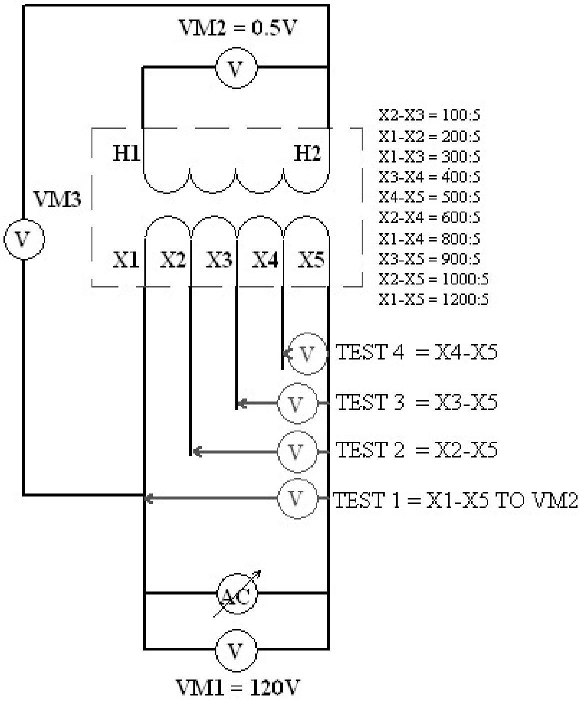
4. ***Perform a ratio-verification test using the voltage or current method in accordance with ANSI C57.13.1 (IEEE Guide for Field Testing of Relaying Current Transformers).***

   The CT ratio test determines the CT accuracy and the results should be compared to the accuracy class. The easiest and most accurate ratio test method for CT ratio is the voltage method for most applications and is the method we will discuss here.

   It may seem strange to use voltage to test a CT ratio, but basic transformer theory applies to all transformers, including CTs. One of the first transformer fundamentals is that the transformer ratio applies inversely to current and voltage. A 400:5 CT will convert 400 primary amps to 5 secondary amps and convert 80 secondary volts to 1 primary volt. We apply this principle to CT testing because it is easier to locate, carry, and apply an 80V voltage source instead of a 400A current supply. The voltage method is also more accurate because you can measure the test and resultant values directly instead of applying CTs and clip on ammeters that add error based on their accuracy.

   i. Connect a voltage source (Variac) and voltmeter (VM1) across the CT secondary as shown in “Figure #10 – CT AC polarity Test Connections”.
   ii. Connect a voltmeter (VM2) across the CT Primary.
   iii. Apply a voltage to the CT secondary and measure the Secondary (VM1) and Primary voltages (VM2) simultaneously. Calculate the ratio between the two voltages. (VM1 / VM2)
   iv. This voltage should match the CT ratio. (Pri / Sec)

   You can repeat the procedure above for each tap of a multi-tap CT, but I prefer to treat the CT taps as I would an autotransformer. I apply a voltage across the maximum ratio tap and measure all remaining taps to a common point as shown in “Figure #11 – Multi Ratio CT AC Ratio CT Test Connections.” You can prove all tap combinations using the information recorded from this test.



RATIO TEST 1 = X1-X5 TO VM2

VM2 = VM1 / CT RATIO
VM2 = 120 / 240
VM2 = 0.5V

POLARITY TEST 1

VM3 = VM1 + VM2
VM3 = 120 + 0.5
VM3 = 120.5V

RATIO TESTS 2-4

TEST 2 = VM1 * (TEST RATIO) / (FULL RATIO)
TEST 2 = 120 * 1000 / 1200
TEST 2 = 100 V

TEST 3 = VM1 * (TEST RATIO) / (FULL RATIO)
TEST 3 = 120 * 900 / 1200
TEST 3 = 90 V

TEST 4 = VM1 * (TEST RATIO) / (FULL RATIO)
TEST 4 = 120 * 500 / 1200
TEST 4 = 50 V

Multi Ratio CT AC Ratio CT Test Connections
Figure #11

5. ***Perform an excitation test on transformers used for relaying applications in accordance with ANSI C57.13.1. (IEEE Guide for Field Testing of Relaying Current Transformers).***

During normal operation, the CT operates as a nearly perfect machine with very small energy losses necessary for CT operation. The magnetic theory involved in transformer operation is too complex to address in this article but the magnetic circuit can be compared to a normal electrical circuit (The primary winding “Generator”, iron core “transmission line”, and secondary winding “load”.) During normal CT operation the Hi side winding (generator) supplies energy through the iron core (transmission line) to the low side winding (load) with small losses in the transmission line.

When a CT is “saturated”, the magnetic path inside the CT operates like a short circuit on the transmission line. Almost all of the energy supplied by the primary winding is shunted away from the secondary winding and is used create a magnetic field inside the CT. Saturated CTs can be very dangerous when used to supply protective relays as the CTs may operate normally at low current levels and not operate at all during fault currents.

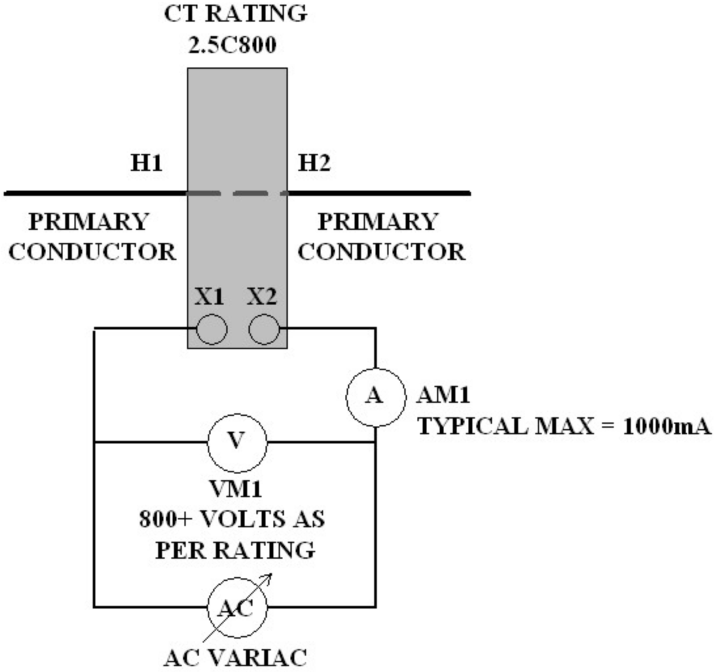
Some of the following conditions can cause CT saturation:

- CT secondary burden higher than rated
- Extremely high current flowing through the CT (Fault current)
- Current flowing through CT primaries with open-circuit secondaries
- DC current flowing through either winding

The excitation test is used to prove that the CT is not saturated and that the CT will operate correctly at the rated burden. It is important to remember when comparing test results to the burden rating that the burden rating is a *minimum* value and the CT could actually have a higher rating. This happens often in transformer bushing applications.

A saturation test is performed by applying an AC voltage to the CT secondary and increasing the voltage in steps until the CT is in saturation. The test voltage is slowly decreased to zero to de-magnetize the CT. The test results are plotted on a logarithmic (log-log) graph and evaluated based on the transition period between normal operation and saturation. This transition is called the “knee” of the curve and is directly related to the voltage burden rating of the CT. Use the following steps to perform an excitation test:

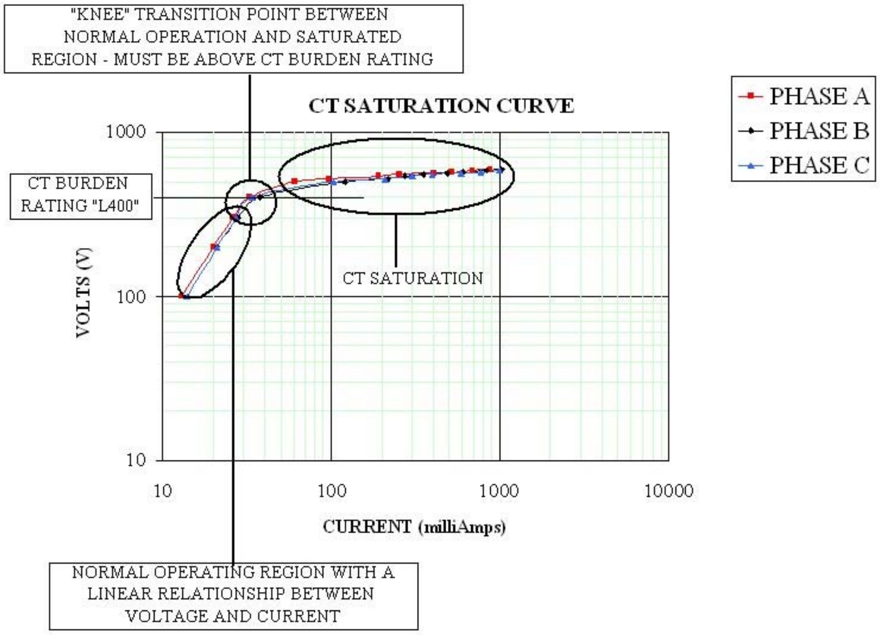
- Obtain the CT accuracy class
- Convert the accuracy class to a voltage burden rating. See “Figure #1 – CT Accuracy Classes” for details
- Connect the test equipment as per “Figure #12 – Excitation Test connection” to the first CT scheduled for test.



Excitation Test connection

Figure #12

- Slowly increase the voltage until saturation (We will use 1000 mA for this article but saturation could be higher or lower depending on CT construction). Watch the current and note the voltage where the current increase ***begins*** to increase dramatically. Note the voltage where the current reaches 1000 mA.
- Slowly decrease the voltage to zero.
- Determine your test voltages using 4 equal steps to the 1st noted voltage and 6 equal steps between the 1st noted voltage and the 2nd noted voltage at 1.0 A.
- Repeat the test using the voltage steps determined above and record the mA at each step. NEVER decrease the voltage until the maximum test voltage is reached. You must either skip the voltage step or re-start the test from 0V if the voltage must be decreased to record a result.
- Slowly decrease the voltage to zero volts. If the voltage is turned off for any reason before the test is complete, the CT may remain saturated. To de-saturate the CT, increase the voltage to 1000 mA and slowly decrease the voltage to zero.
- Graph the results on a log-log graph and compare to manufacturers supplied results. See "Figure #13 – Example Excitation Test Results" to help evaluate the results.



Example Excitation Test Results
Figure #13

  - Manufacturer's results are often typical for a class of CT and each CT may not have been tested. Because every CT has different operating characteristics, the results may not be exactly the same. Look for similarities and glaringly obvious differences when evaluating the results.
  - If manufacturer's results are not available, the "knee" of the curve must be higher than the rated burden voltage.
- Repeat the test using the same test voltages for all CTs of the same rating. Start from the beginning for CTs with another rating.

6. *Measure current circuit burdens at transformer terminals and determine the total burden.*

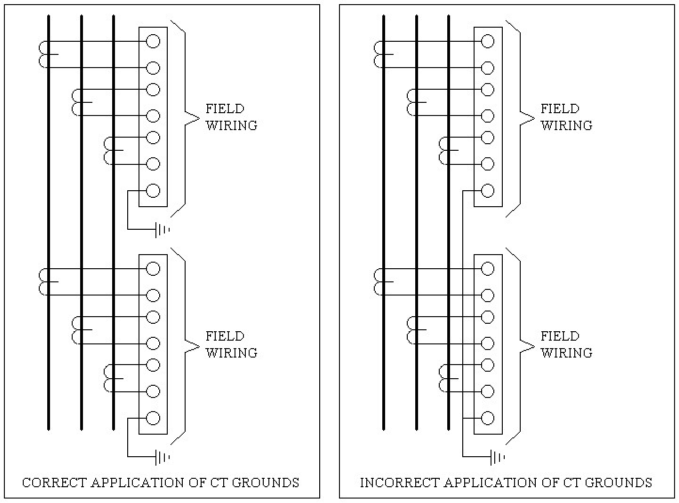
This test is very important and often missed in today's world of "fast track" projects where the testing is broken into stages or multiple testing companies are used in different parts of the project. This test is the final proof test used to ensure that the CTs are:

- Not energized with shorting devices installed if used for metering or protection
- Not left open circuit if not used
- Connected with a single ground point
- CT burden ratings are not exceeded
- All connections are tight.

There are many ways of performing this test, each with its own merits and pitfalls, but this article is focused on the basics and will only cover the voltage drop method. This method is time consuming, but only requires a voltage source, a resistance, and a voltmeter. The test consists of applying 5 amperes through the secondary circuit with a known ground reference at the source and measuring the voltage at every point of the circuit to ground. Measuring the voltage drop at the source combined with ohms law will give us the burden impedance. Analyzing the voltage drop patterns throughout the circuit confirms the wiring is correct.

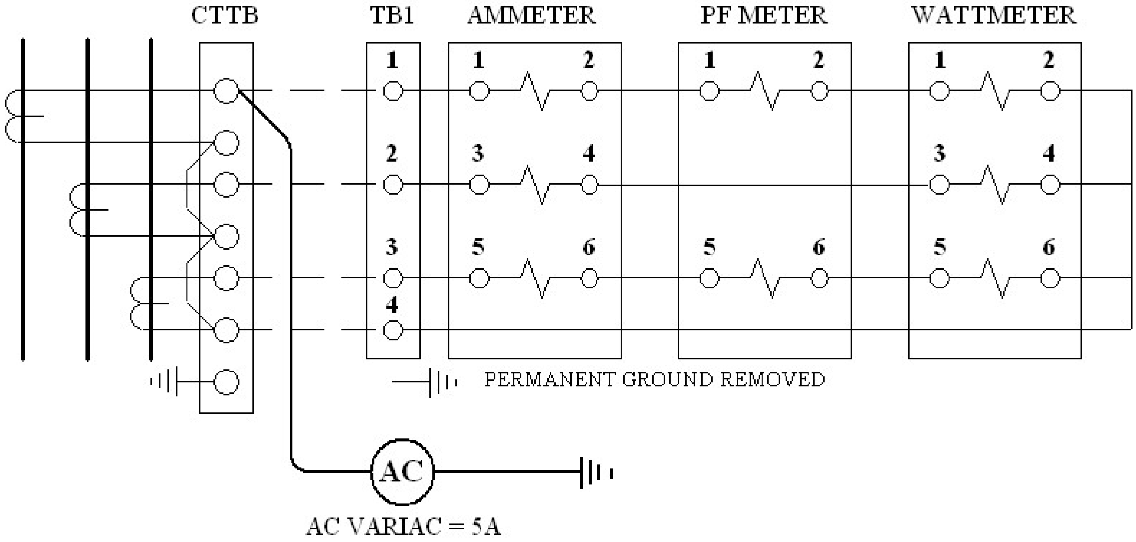
After all CT testing and secondary circuit wiring is complete, follow the following steps to perform a secondary loop test via the voltage drop method.

1. Remove the CT secondary shorting devices and remove the ground from the circuit. Every CT circuit should be grounded at ONE point only and have its own path to ground as per IEEE standard C57.13.2. Many manufacturers incorrectly daisy chain all CT grounds together contrary to this standard. See "Figure #14 – Grounding" for more details.



CT GROUNDING
Figure #14

2. Connect an AC source (A 120V source and light bulbs in parallel or series can be substituted for the AC source) between the CT secondary feeder (as close to the CT as possible) and ground as shown in “Figure #15 – Circuit Burden Test Step #2” and slowly increase the voltage or current dial. No current should flow. If current flows, there is a second ground somewhere in the circuit that must be permanently removed.

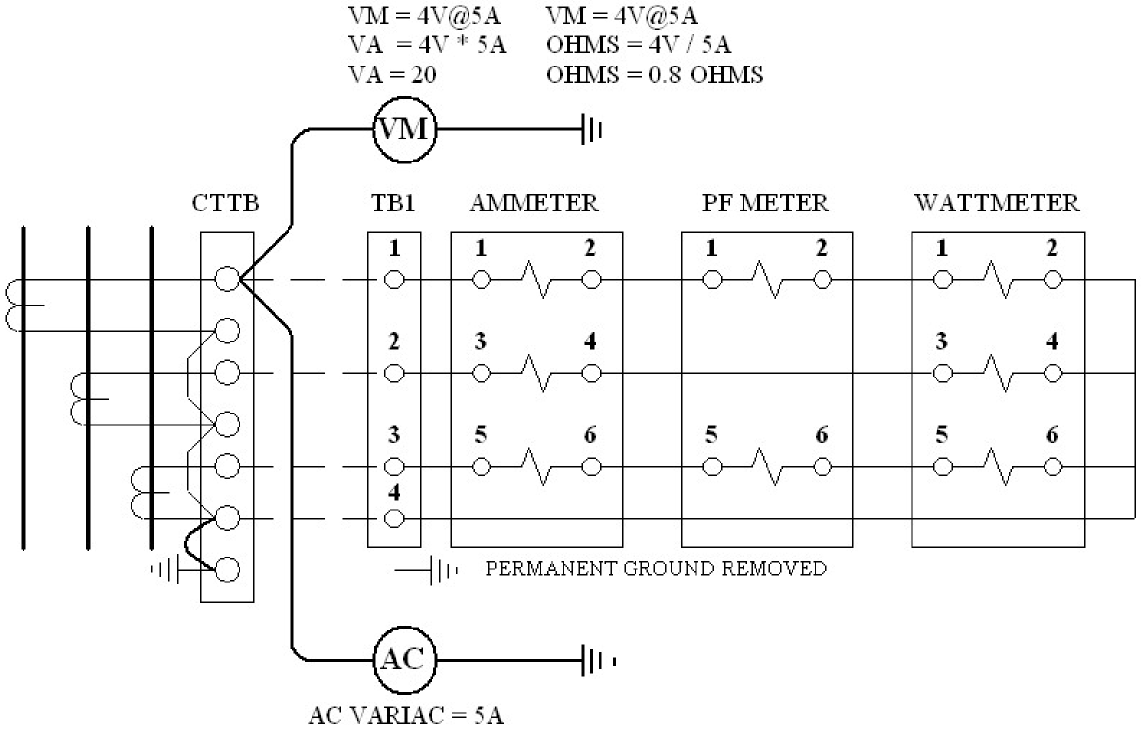


CIRCUIT BURDEN TEST STEP #2

Figure #15

3. Connect a temporary ground between the neutral of the test source and the CT star point. Increase the source voltage until 5 amperes flows in the circuit. If no current flows, the ground is incorrectly applied or the circuit is incomplete. Investigate possible sources of open circuit.

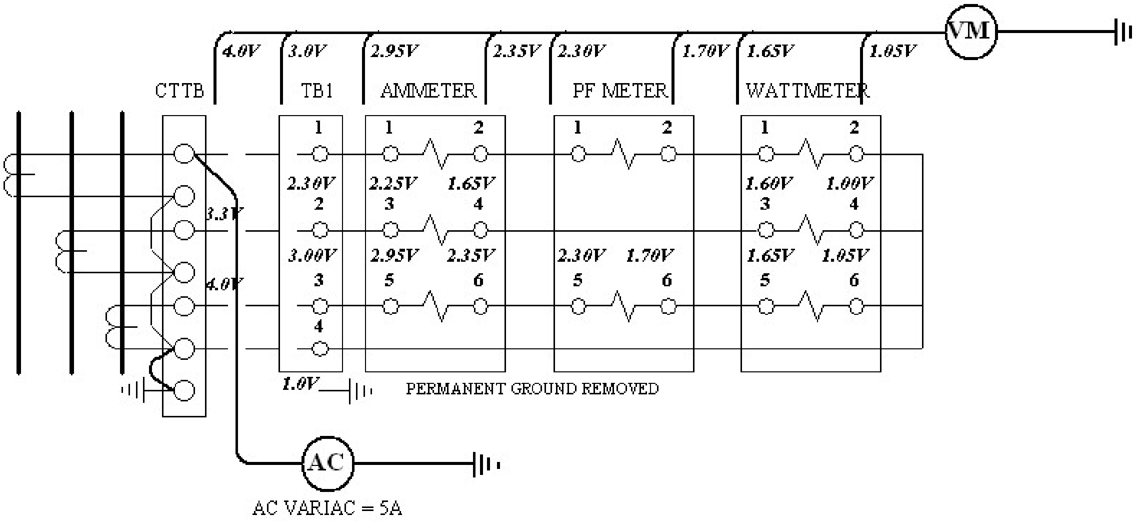
4. Measure the voltage between the first CT circuit terminal and ground. Multiply this number with the measured current to obtain the VA burden. Divide the voltage by the current to determine the burden in Ohms. Check the CT rating to ensure the burden is less than the nameplate value.



CIRCUIT BURDEN TEST STEP #4

Figure #16

5. Measure the voltage between ground and every CT wiring connection. The voltage should drop incrementally as you work through the circuit. Any rise in voltage should be immediately investigated. The most common problems found are:
    - Reverse polarity connections
    - Assuming what the terminal point should be instead of using drawing references.
    - Assuming where the terminal point is instead of reading the designation.



CIRCUIT BURDEN TEST STEPS #5&6 - PERFECT CIRCUIT

Figure #17

6. Repeat steps 2-5 for the other 2 CT phases. The measured voltage patterns should be similar to the other two phases in the circuits if they are identical. Drastic deviations from the voltage pattern should be investigated for tight connections or shorts (single copper strand accidentally connected between terminals). Additional devices in one phase will cause higher voltages, but the difference between devices should be consistent between phases.
7. After all the testing has been completed, the voltages consistently drop throughout the circuit, and the measurements between phases are consistent; turn the AC source off and remove all test leads. Reconnect the CT ground and check with an ohmmeter after it is installed. Record the circuit burdens on your test sheet.