Current Transformer

Principle of operation of CT

- A current transformer is defined as "as an instrument transformer in which the secondary current is substantially proportional to the primary current (under normal conditions of operation) and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections."
- Current transformers are usually either "measuring" or "protective" types.

Some Definitions used for CT:

1) **Rated primary current:**

- The value of primary current which appears in the designation of the transformer and on which the performance of the current transformer is based.

2) **Rated secondary current:**

- The value of secondary current which appears in the designation of the transformer and on which the performance of the current transformer is based.
- Typical values of secondary current are 1 A or 5 A. In the case of transformer differential protection, secondary currents of 1/ root 3 A and 5/ root 3 A are also specified.

3) **Rated burden:**

- The apparent power of the secondary circuit in Volt-amperes expressed at the rated secondary current and at a specific power factor (0.8 for almost all standards)

4) **Rated output:**

- The value of the apparent power (in volt-amperes at a specified power (factor) which the current transformer is intended to supply to the secondary circuit at the rated secondary current and with rated burden connected to it.

5) **Accuracy class:**

- In the case of metering CT s, accuracy class is typically, **0.2, 0.5, 1 or 3.**
- This means that the errors have to be within the limits specified in the standards for that particular accuracy class.
- The metering CT has to be accurate from 5% to 120% of the rated primary current, at 25% and 100% of the rated burden at the specified power factor.
- In the case of protection CT s, the CT s should pass both the ratio and phase errors at the specified accuracy class, usually **5P or 10P**, as well as composite error at the accuracy limit factor of the CT.

6) **Current Ratio Error:**

- The error with a transformer introduces into the measurement of a current and which arises from the fact that actual transformation ratio is not equal to the rated transformer ratio. The current error expressed in percentage is given by the formula:
- **Current error in % = (Ka(Is-Ip)) x 100 / Ip**
- Where Ka= rated transformation ratio ,Ip= actual primary current, Is= actual secondary current when Ip is flowing under the conditions of measurement

7) **Accuracy limit factor:**

- The value of primary current up to which the CT complies with composite error requirements. This is typically **5, 10 or 15**, which means that the composite error of the CT has to be within specified limits at 5, 10 or 15 times the rated primary current.

8) Short time rating:

- The value of primary current (in kA) that the CT should be able to withstand both thermally and dynamically without damage to the windings, with the secondary circuit being short-circuited. The time specified is usually 1 or 3 seconds.

9) Instrument security factor (factor of security):

- This typically takes a value of less than 5 or less than 10 though it could be much higher if the ratio is very low. If the factor of security of the CT is 5, it means that the composite error of the metering CT at 5 times the rated primary current is equal to or greater than 10%. This means that heavy currents on the primary are not passed on to the secondary circuit and instruments are therefore protected. In the case of double ratio CT's, FS is applicable for the lowest ratio only.

10) Class PS X CT:

- In balance systems of protection, CT s with a high degree of similarity in their characteristics is required. These requirements are met by Class PS (X) CT s. Their performance is defined in terms of a knee-point voltage (KPV), the magnetizing current (Imag) at the knee point voltage or 1/2 or 1/4 the knee-point voltage, and the resistance of the CT secondary winding corrected to 75C. Accuracy is defined in terms of the turn's ratio.

11) Knee point voltage:

- That point on the magnetizing curve where an increase of 10% in the flux density (voltage) causes an increase of 50% in the magnetizing force (current).
- The 'Knee Point Voltage' (Vkp) is defined as the secondary voltage at which an increase of 10% produces an increase in magnetizing current of 50%. It is the secondary voltage above which the CT is near magnetic saturation.

12) Core balance CT (CBCT):

- The CBCT, also known as a zero sequence CT, is used for earth leakage and earth fault protection. The concept is similar to the RVT. In the CBCT, the three core cable or three single cores of a three phase system pass through the inner diameter of the CT. When the system is fault free, no current flows in the secondary of the CBCT. When there is an earth fault, the residual current (zero phase sequence current) of the system flows through the secondary of the CBCT and this operates the relay. In order to design the CBCT, the inner diameter of the CT, the relay type, the relay setting and the primary operating current need to be furnished.

13) Phase displacement:

- The difference in phase between the primary and secondary current vectors, the direction of the vectors being so chosen that the angle is zero for the perfect transformer. The phase displacement is said to be positive when the secondary current vector leads the primary current vector. It is usually express in minutes

14) Highest system voltage:

- The highest rms line to line voltage which can be sustained under normal operating conditions at any time and at any point on the system. It excludes temporary voltage variations due to fault condition and the sudden disconnection of large loads.

15) Rated insulation level:

- That combination of voltage values (power frequency and lightning impulse, or where applicable, lightning and switching impulse) which characterizes the insulation of a transformer with regard to its capability to withstand by dielectric stresses. For low voltage transformer the test voltage 4kV, at power-frequency, applied during 1 minute.

16) Rated short-time thermal current (Ith):

- The rms value of the primary current which the current transformer will withstand for a rated time, with their secondary winding short circuited without suffering harmful effects.

17) Rated dynamic current (Idyn):

- The peak value of the primary current which a current transformer will withstand, without being damaged electrically for mechanically by the resulting electromagnetic forces, the secondary winding being short-circuited.

18) Rated continuous thermal current (Un)

- The value of current which can be permitted to flow continuously in the primary winding, the secondary windings being connected to the rated burdens, without the temperature rise exceeding the specified values.

19) Instrument security factor (ISF or Fs):

- The ratio of rated instrument limits primary current to the rated primary current. The times that the primary current must be higher than the rated value, for the composite error of a measuring current transformer to be equal to or greater than 10%, the secondary burden being equal to the rated burden. The lower this number is, the more protected the connected instrument are against.

20) Sensitivity

- Sensitivity is defined as the lowest value of primary fault current, within the protected zone, which will cause the relay to operate. To provide fast operation on an in zone fault, the current transformer should have a 'Knee Point Voltage' at least twice the setting voltage of the relay.

21) Field Adjustment of Current Transformer Ratio:

- The ratio of current transformers can be field adjusted to fulfil the needs of the application. Passing

more secondary turns or more primary turns through the window will increase or decrease the turns ratio.

Actual Turns Ratio = (Name Plate Ration- Secondary Turns Added) / Primary Turns.

Types of Current transformers (CT's)

According to Construction of CT:

1) Bar Type:

- Bar types are available with higher insulation levels and are usually bolted to the current caring device.

- Bar type current transformers are insulated for the operating voltage of the system.
- Bar-type CTs operate on the same principle of window CTs but have a permanent bar installed as a primary conductor

2) Wound CT's:

- Capacity: There are designed to measure currents from 1 amp to 100 amps.
- the most common one is the wound type current transformer. The wound type provides excellent performance under a wide operating range. Typically, the wound type is insulated to only 600 volts.

- Since the load current passes through primary windings in the CT, screw terminals are provided for the load and secondary conductors. Wound primary CT’s are available in ratios from 2.5:5 to 100:5.
- 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, to match different CT ratios in summing applications, or to isolate different CT circuits. Wound CTs have very high burdens, and special attention to the source CT burden should be applied when wound CTs are used.

3) Window:

- Window CTs are the most common. They 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. Window CTs can be of solid or split core construction. The primary conductor must be disconnected when installing solid window CTs. However, split core CTs can be installed around the primary conductor without disconnecting the primary conductor

- **Ring Core CT’s :**
- Capacity: There are available for measuring currents from 50 to 5000 amps

- Size: with windows (power conductor opening size) from 1″ to 8″ diameter.
- **Split Core CT’s:**
- Capacity: There are available for measuring currents from 100 to 5000 amps.
- Size: with windows in varying sizes from 1″ by 2″ to 13″ by 30″.
- Split core CT’s have one end removable so that the load conductor or bus bar does not have to be disconnected to install the CT.

4) Bushing

- Bushing CTs are window CTs specially constructed to fit around a bushing. Usually they cannot be accessed, and their nameplates are found on the transformer or circuit-breaker control cabinets.
- The bushing type is typically used around the bushing on circuit breakers and transformers and may not have a hard protective outside cover.
- Donut type current transformers are typically insulated for 600 volts. To ensure accuracy, the conductor should be positioned in the center of the current transformer opening.

According to Application of CT:

1) Measuring CT:

- The principal requirements of a measuring CT are that, for primary currents up to 120% or 125% of the rated current, its secondary current is proportional to its primary current to a degree of accuracy as defined by its “Class” and, in the case of the more accurate types, that a specified maximum phase angle displacement is not exceeded.

- A desirable characteristic of a measuring CT is that it should **"saturate"** when the primary current exceeds the percentage of rated current specified as the upper limit to which the accuracy provisions apply. This means that at these higher levels of primary current the secondary current is less than proportionate. The effect of this is to reduce the extent to which any measuring device connected to the CT secondary is subjected to current Overload.
- On the other hand the reverse is required of the protective type CT, the principal purpose of which is to provide a secondary current proportional to the primary current when it is several, or many, times the rated primary current. The measure of this characteristic is known as the **"Accuracy Limit Factor"** (A.L.F.).
- A protection type CT with an A.L.F. of 10 will produce a proportional current in the secondary winding (subject to the allowable current error) with primary currents up to a maximum of 10 times the rated current.
- It should be remembered when using a CT that where there are two or more devices to be operated by the secondary winding, they must be connected in series across the winding. This is exactly the opposite of the method used to connect two or more loads to be supplied by a voltage or power transformer where the devices are paralleled across the secondary winding.
- With a CT, an increase in the burden will result in an increase in the CT secondary output voltage. This is automatic and necessary to maintain the current to the correct magnitude. Conversely, a reduction in the burden will result in a reduction in the CT secondary output voltage.
- This rise in secondary voltage output with an increase in burden means that, theoretically, with infinite burden as is the case with the secondary load open circuit, an infinitely high voltage appears across the secondary terminals. For practical reasons this voltage is not infinitely high, but can be high enough to cause a breakdown in the insulation between primary and secondary windings or between either or both windings and the core. For this reason, primary current should never be allowed to flow with no load or with a high resistance load connected across the secondary winding.
- When considering the application of a CT it should be remembered that the total burden imposed on the secondary winding is not only the sum of the burden(s) of the individual device(s) connected to the winding but that it also includes the burden imposed by the connecting cable and the resistance of the connections.
- If, for example, the resistance of the connecting cable and the connections is 0.1 ohm and the secondary rating of the CT is 5A, the burden of the cable and connections (RI2) is 0.1 x 5 x 5 = 2.5VA. This must be added to the burden(s) of the connected device(s) when determining whether the CT has an adequately large burden rating to supply the required device(s) and the burden imposed by the connections.
- Should the burden imposed on the CT secondary winding by the connected device(s) and the connections exceed the rated burden of the CT the CT may partly or fully saturate and therefore not have a secondary current adequately linear with the primary current.
- The burden imposed by a given resistance in ohms [such as the resistance of a connecting cable] is proportional to the square of the rated secondary current. Therefore, where long runs of cable between CT and the connected device(s) are involved, the use of a 1A secondary CT and a 1A device rather than 5A will result in a 25-fold reduction in the burden of the connecting cables and connections. All burden ratings and calculations are at rated secondary current.
- Because of the foregoing, when a relatively long [more than a very few meters] cable run is required to connect a CT to its burden [such as a remote ammeter] a calculation should be made to determine the cable burden. This is proportional to the "round trip" resistance, i.e. twice the resistance of the length of twin cable used. Cable tables provide information on the resistance values of different sizes of conductors at 20o C per unit length.

2) Protective CT:

- The calculated resistance is then multiplied by the square of the CT secondary current rating [25 for 5A, 1 for 1A]. If the VA burden as calculated by this method and added to the rated burden(s) of the device(s) to be driven by the CT exceeds the CT burden rating, the cable size must be increased [to reduce the resistance and thus the burden] or a CT with a higher VA burden rating must be used, or a lower CT secondary current rating [with matching change in the current rating of the device(s) to be driven] should be substituted

Nomenclature of CT:

1. **Ratio:** input / output current ratio
2. **Burden (VA):** total burden including pilot wires. (2.5, 5, 10, 15 and 30VA.)
3. **Class:** Accuracy required for operation (Metering: 0.2, 0.5, 1 or 3, Protection: 5, 10, 15, 20, 30)**.**
4. **Accuracy Limit Factor:**
5. **Dimensions:** maximum & minimum limits
6. Nomenclature of CT: Ratio, VA Burden, Accuracy Class, Accuracy Limit Factor.
7. **Example: 1600/5, 15VA 5P10** (Ratio: 1600/5, Burden: 15VA, Accuracy Class: 5P, ALF: 10)
8. **As per IEEE Metering CT:** 0.3B0.1 rated Metering CT is accurate to 0.3 percent if the connected secondary burden if impedance does not exceed 0.1 ohms.
9. **As per IEEE Relaying (Protection) CT:** 2.5C100 Relaying CT is accurate within 2.5 percent if the secondary burden is less than 1.0 ohm (100 volts/100A).

1) Current Ratio of CT:

- The primary and secondary currents are expressed as a ratio such as 100/5. With a 100/5 ratio CT, 100A flowing in the primary winding will result in 5A flowing in the secondary winding, provided the correct rated burden is connected to the secondary winding. Similarly, for lesser primary currents, the secondary currents are proportionately lower.
- It should be noted that a 100/5 CT would not fulfil the function of a 20/1 or a 10/0.5 CT as the ratio expresses the current rating of the CT, not merely the ratio of the primary to the secondary currents.
- The rated secondary current is commonly 5A or 1A, though lower currents such as 0.5A are not uncommon. It flows in the rated secondary load, usually called the burden, when the rated primary current flows in the primary winding.
- **Increasing or Decreasing Turns Ratio of CT:**
- **Increasing Number of Turn:** Increasing the number of primary turns can only decrease the turn’s ratio. A current transformer with a 50 to 5 turn’s ratio can be changed to a 25 to 5 turn’s ratio by passing the primary twice through the window.
- **Increasing or Decreasing Turns Ratio:**
- The turn’s ratio can be either increased or decreased by wrapping wire from the secondary through the window of the current transformer.
- Increasing the turn’s ratio with the secondary wire, turns on the secondary are essentially increased. A 50 to 5 current transformer will have a 55 to 5 ratio when adding a single secondary turn.

- Decreasing the turn's ratio with the secondary wire, turns on the secondary are essentially decreased. A 50 to 5 current transformer will have a 45 to 5 ratio when adding a single secondary turn.
- Decreasing the turn's ratio with the primary, accuracy and VA burden ratings are the same as the original configuration.
- Increasing the turn's ratio with the secondary will improve the accuracy and burden rating.
- Decreasing the turn's ratio with the secondary will worsen the accuracy and burden rating.
- When using the secondary of a current transformer to change the turn's ratio, the right hand rule of magnetic fields comes into play. Wrapping the white lead or the X1 lead from the H1 side of the transformer through the window to the H2 side will decrease the turn's ratio. Wrapping this wire from the H2 side to the H1 side will increase the turn's ratio.
- Using the black or X2 lead as the adjustment method will do the opposite of the X1(white) lead. Wrapping from the H1 to the H2 side will increase the turns ratio, and wrapping from the H2 to the H1 side will decrease the turns ratio.

2) Burden of CT:

- **Common burden ratings of CT:** 2.5, 5, 10, 15 and 30VA.
- The external load applied to the secondary of a current transformer is called the "burden".
- The burden of CT is the maximum load (in VA) that can be applied to the CT secondary.
- The burden can be expressed in two ways.
- The burden can be expressed as the total impedance in ohms of the circuit or the total volt-amperes (VA) and power factor at a specified value of current or voltage and frequency.
- Formerly, the practice was to express the burden in terms of volt-amperes (VA) and power factor, **the volt-amperes being what would be consumed in the burden impedance at rated secondary current** (in other words, rated secondary current squared times the burden impedance). Thus, a burden of 0.5Ωimpedance may be expressed also as "12.5 VA at 5 amperes," if we assume the usual 5-ampere secondary rating. The VA terminology is no longer standard, but it needs defining because it will be found in the literature and in old data.

Burden for Measuring CT:

- **Total burden of Measuring CT = Sum of Meters Burden in VA (Ammeter, Wattmeter, Transducer etc.) connected in series to the CT secondary circuit + Connecting Secondary Circuit Cable Burden in VA.**
- Cable burden = I^2 x R x2 L, where I = CT secondary current, R = cable resistance per length, 2L is the tro &fro distance of cable length L from CT to metering circuits. If the proper size and short length of wire is used, cable burden can be ignored.
- The CT secondary circuit load shall not be more than the CT VA rating. If the load is less than the CT burden, all meters connected to the measuring CT should provide correct reading.
- In the case of Measuring Current transformer, the burden depends on the connected meters and quantity of meters on the secondary i.e. no of Ammeters, KWh meters, Kvar meters, Kwh meters, transducers and also the connection cable burden (I^2 x R x2 L) to metering shall be taken into account.
- Note Meters burden can be obtained from manufacturer catalogue.

- Selected CT burden shall be more than the calculated burden

Burden for Protecting CT:

- In the case of Protection CTs the burden is calculated in the same way as above except the burden of individual protective relays burden shall be considered instead of meters. The connecting cable burden is calculated in the same way as metering CT
- **Total burden of Protection CT=Connecting cable Burden in VA + sum of Protective relays Burden in VA.**
- All manufacturers can supply the burden of their individual devices. Although not used very often these days, induction disk over-current devices always gave the burden for the minimum tap setting. To determine the impedance of the actual tap setting being used, First Square the ratio of minimum divide by the actual tap setting used and, second multiply this value by the minimum impedance.
- Suppose an impedance of 1.47 + 5.34j at the 1A tap. To apply the relay at the 4A tap the engineer would multiply the impedance at the 1A taps setting by (1/4)2. The impedance at the 4A tap would be 0.0919 + 0.3338j or 0.3462 Z at 96.4 power factor.
- **The CT burden impedance decreases as the secondary current increases,** because of saturation in the magnetic circuits of relays and other devices. Hence, a given burden may apply only for a particular value of secondary current. The old terminology of volt-amperes at 5 amperes is most confusing in this respect since it is not necessarily the actual volt amperes with 5 amperes flowing, but is what the volt-amperes would be at 5 amperes
- If there were no saturation. Manufacturer’s publications give impedance data for several values of over current for some relays for which such data are sometimes required. Otherwise, data are provided only for one value of CT secondary current.
- If a publication does not clearly state for what value of current the burden applies, this information should be requested. Lacking such saturation data, one can obtain it easily by test. At high saturation, the impedance approaches the DC resistance. Neglecting the reduction in impedance with saturation makes it appear that a CT will have more inaccuracy than it actually will have. Of course, if such apparently greater inaccuracy can be tolerated, further refinements in calculation are unnecessary. However, in some applications neglecting the effect of saturation will provide overly optimistic results; consequently, it is safer always to take this effect into account.
- It is usually sufficiently accurate to add series burden impedances arithmetically. The results will be slightly pessimistic, indicating slightly greater than actual CT ratio inaccuracy. But, if a given application is so borderline that vector addition of impedances is necessary to prove that the CTÕs will be suitable, such an application should be avoided.
- If the impedance at pickup of a tapped over current-relay coil is known for a given pickup tap, it can be estimated for pickup current for any other tap. The reactance of a tapped coil varies as the square of the coil turns, and the resistance varies approximately as the turns. At pickup, there is negligible saturation, and the resistance is small compared with the reactance. Therefore, it is usually sufficiently accurate to assume that the impedance varies as the square of the turns. The number of coil turns is inversely proportional to the pickup current, and therefore the impedance varies inversely approximately as the square of the pickup current.
- Whether CT is connected in wye or in delta, the burden impedances are always connected in wye. With wye-connected CT the neutrals of the CT and of the burdens are connected together, either directly or through a relay coil, except when a so-called zero phase-sequence-current shunt is used.

- It is seldom correct simply to add the impedances of series burdens to get the total, whenever two or more CT are connected in such a way that their currents may add or subtract in some common portion of the secondary circuit. Instead, one must calculate the sum of the voltage drops and rises in the external circuit from one CT secondary terminal to the other for assumed values of secondary currents flowing in the various branches of the external circuit. The effective CT burden impedance for each combination of assumed currents is the calculated CT terminal voltage divided by the assumed CT secondary current. This effective impedance is the one to use, and it may be larger or smaller than the actual impedance which would apply if no other CTÕs were supplying current to the circuit.
- If the primary of an auxiliary CT is to be connected into the secondary of a CT whose accuracy is being studied, one must know the impedance of the auxiliary CT viewed from its primary with its secondary short-circuited. To this value of impedance must be added the impedance of the auxiliary CT burden as viewed from the primary side of the auxiliary CT; to obtain this impedance, multiply the actual burden impedance by the square of the ratio of primary to secondary turns of the auxiliary CT. It will become evident that, with an auxiliary CT that steps up the magnitude of its current from primary to secondary, very high burden impedances, when viewed from the primary, may result.
- **Burden is depending on pilot lead length**
- **For Metering Class CTs burden is expressed as ohms impedance. For Protection-class CTs burden is express as volt-amperes (VA).**
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VA	**Applications**
1 To 2 VA	Moving iron ammeter
1 To 2.5VA	Moving coil rectifier ammeter
2.5 To 5VA	Electrodynamics instrument
3 To 5VA	Maximum demand ammeter
1 To 2.5VA	Recording ammeter or transducer

- **Burden (VA) of copper wires between instrument & current transformer for 1A and 5A secondary's**

Cross Section (mm2)	**CT 1 Amp Secondary Burden in VA (Twin Wire)**					
	Distance					
	10 meter	20 meter	40 meter	60 meter	80 meter	100 meter
1.0	0.35	0.71	1.43	2.14	2.85	3.57

1.5	0.23	0.46	0.92	1.39	1.85	2.31
2.5	0.14	0.29	0.57	0.86	1.14	1.43
4.0	0.09	0.18	0.36	0.54	0.71	0.89
6.0	0.06	0.12	0.24	0.36	0.48	0.6

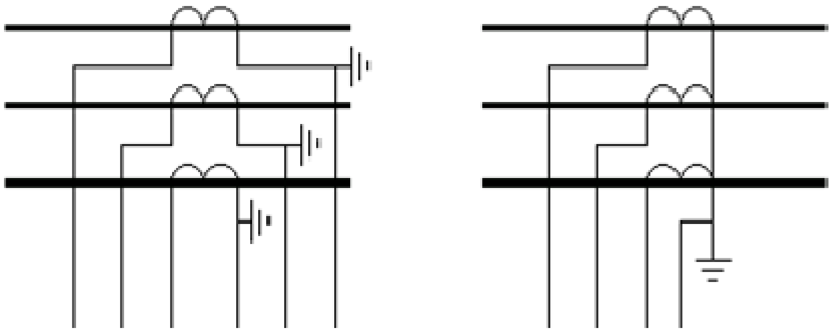
Cross Section (mm2)	**CT 5 Amp Secondary Burden in VA (Twin Wire)**					
	Distance					
	1 meter	2 meter	4 meter	6 meter	8 meter	10 meter
1.5	0.58	1.15	2.31	3.46	4.62	5.77
2.5	0.36	0.71	1.43	2.14	2.86	3.57
4.0	0.22	0.45	0.89	1.34	1.79	2.24
6.0	0.15	0.30	0.60	0.89	1.19	1.49
10.0	0.09	0.18	0.36	0.54	0.71	0.89

CT Burden Calculation:

- The Actual burden is formed by the resistance of the pilot conductors and the protection relay(s). The resistance of a conductor (with a constant cross-sectional area) can be calculated from the equation:
- **R =ρxL / A**
- where ρ = resistivity of the conductor material (given typically at +20°C) ,L= length of the conductor , A = cross sectional area
- If the resistivity is given in μΩm, the length in meters and the area in mm2, the equation 1 will give the resistance directly in ohms.
- Resistivity: Copper **0.0178 μΩm** at 20 °C and **0.0216 μΩm** at 75 °C

Burden of CT for 4 or 6 wire connection:

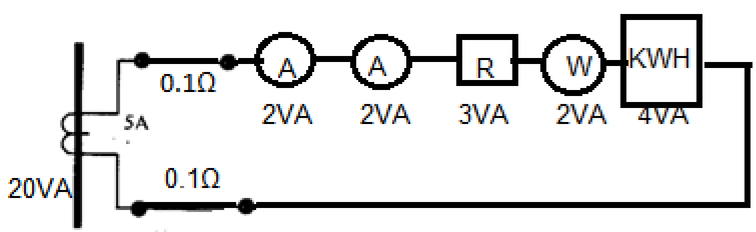
- If 6-wire connection is used, the total length of the wire, naturally, will be two times the distance between the CT and the relay. However, in many cases a common return conductor is used as shown in figure then, instead of multiplying the distance by two, a factor of 1.2 is typically used. This rule only applies to the 3-phase connection only. The factor 1.2 allows for a situation, where up to 20% of the electrical conductor length, including terminal resistances, uses 6-wire connection and at least 80% 4-wire connection.



- Example: the distance between the CT and the relay is 5 meters the total length is 2 x 5 m = 10 meter for 6-wire connection, but only 1.2 x 5 m = 6.0 meter when 4-wire connection is used.

Burden of the relay:

- **Example:** The Distance between the CTs and the protection relay is 15 meters, 4 mm2 Cu conductors in 4-wire connection are used. The burden of the relay input is less than 20 mΩ (5 A inputs). Calculate the actual burden of the CT at 75°C , the input impedance is less than 0.020 Ω for a 5 A input (i.e. burden less than 0.5 VA) and less than 0.100 Ω for a 1 A input (i.e. less than 0.1 VA):
- **Solution**:
- p = 0.0216 µΩm (75°C) for copper conductor.
- R =pxL / A ,R = 0.0216 µΩm x (1.2 x 15 m) / 4 mm2 = 0.097 Ω
- Burden of CT = 0.097 Ω + 0.020 Ω = **0.117 Ω.**
- Using CTs of burden values higher than required, is unscientific since it leads to inaccurate reading (meter) or inaccurate sensing of fault / reporting conditions.
- Basically, such high value of design burden extends saturation characteristics of CT core leading to likely damage to the meter connected across it under overload condition. e.g. When we expect security factor (ISF) to be 5, the secondary current should be restricted to less than 5 times in case primary current shoots to more than 5 times its rated value.
- In such an overload condition, the core of CT is desired to go into saturation, restricting the secondary current thus the meter is not damaged. However, when we ask for higher VA, core doesn't go into saturation due to less load (ISF is much higher than desired) which may damage the meter.
- To understand the effect on Accuracy aspect, let's take an example of a CT with specified burden of 15 VA, and the actual burden is 2.5 VA:15 VA CT with less than 5 ISF will have saturation voltage of 15 Volts (15/5×5), and actual burden of 2.5 VA the saturation voltage required shall be (2.5/5 x 5) 2.5 Volts against 15 Volts resulting ISF = 30 against required of 5.
- **Example:** Decide Whether 5A,20VA CT is sufficient for following circuit



- Total instrument burden = 2 + 2 + 3 + 2 + 4 = 13V A.
- Total pilot load resistance = 2 x 0.1 = 0.2 ohm.

- With 5A secondary current, volt-drop in leads is 5 x 0.2 = 1 V.
- Burden imposed by both leads = 5A x 1 V = 5V A.
- Total burden on CT = 13 + 5 = 18V A.
- As the CT is rated 20V A, it has sufficient margin.

3) Accuracy Class of CT:

- The CT accuracy is determined by its certified accuracy class which is stamped on nameplate. For example, CT accuracy class of 0.3 means that the CT is certified by the manufacturer to be accurate to within 0.3 percent of its rated ratio value for a primary current of 100 percent of rated ratio.
- CT with a rated ratio of 200/ 5 with accuracy class of 0.3 would operate within 0.45 percent of its rated ratio value for a primary current of 100 amps. To be more explicit, for a primary current of 100A it is certified to produce a secondary current between 2.489 amps and 2.511 amps.
- Accuracy is specified as a percentage of the range, and is given for the maximum burden as expressed in VA. The total burden includes the input resistance of the meter and the loop resistance of the wire and connections between the current transformer and meter.
- Example: Burden = 2.0 VA. Maximum Voltage drop = 2.0 VA / 5 Amps = 0.400 Volts.
- Maximum Resistance = Voltage / Current = 04.00 Volts / 5 Amps =0.080 Ohms.
- If the input resistance of the meter is 0.010Ω, then 0.070Ω is allowed for loop resistance of the wire, and connections between the current transformer and the meter. The length and gauge of the wire must be considered in order to avoid exceeding the maximum burden.
- **If resistance in the 5 amp loop causes the burden to be exceeded, the current will drop. This will result in the meter reading low at higher current levels.**
- As in all transformers, errors arise due to a proportion of the primary input current being used to magnetize the core and not transferred to the secondary winding. The proportion of the primary current used for this purpose determines the amount of error.
- The essence of good design of measuring current transformers is to ensure that the magnetizing current is low enough to ensure that the error specified for the accuracy class is not exceeded.
- This is achieved by selecting suitable core materials and the appropriate cross-sectional area of core. Frequently in measuring currents of 50A and upwards, it is convenient and technically sound for the primary winding of a CT to have one turn only.
- In these most common cases the CT is supplied with a secondary winding only, the primary being the cable or bus bar of the main conductor which is passed through the CT aperture in the case of ring CTs (i .e. single primary turn) it should be noted that the lower the rated primary current the more difficult it is (and the more expensive it is) to achieve a given accuracy.
- Considering a core of certain fixed dimensions and magnetic materials with a secondary winding of say 200 turns (current ratio 200/1 turns ratio 1/200) and say it takes 2 amperes of the 200A primary current to magnetize the core, the error is therefore only 1% approximately. However considering a 50/1 CT with 50 secondary turns on the same core it still takes 2 amperes to magnetize to core. The error is then 4% approximately. To obtain a 1% accuracy on the 50/1 ring CT a much larger core and/or expensive core material is required
- **Accuracy Class of Metering CT:**

Metering Class CT	
Class	**Applications**
0.1 To 0.2	Precision measurements
0.5	High grade kilowatt hour meters for commercial grade kilowatt hour meters
3	General industrial measurements
3 OR 5	Approximate measurements

Protective System	CT Secondary	VA	Class
Per current for phase & earth fault	1A	2.5	10P20 Or 5P20
	5A	7.5	10P20 Or 5P20
Unrestricted earth fault	1A	2.5	10P20 Or 5P20
	5A	7.5	10P20 Or 5P20
Sensitive earth fault	1A or 5A		Class PX use relay manufacturers formula
Distance protection	1A or 5A		Class PX use relay manufacturers formula
Differential protection	1A or 5A		Class PX use relay manufacturers formula
High impedance differential impedance	1A or 5A		Class PX use relay manufacturers formula
High speed feeder protection	1A or 5A		Class PX use relay manufacturers formula
Motor protection	1A or 5A	5	5P10

- **Accuracy Class of Letter of CT:**
-

Metering Class CT	
Accuracy Class	**Applications**
B	Metering Purpose
Protection Class CT	
C	CT has low leakage flux.
T	CT can have significant leakage flux.
H	CT accuracy is applicable within the entire range of secondary currents from 5 to 20 times the nominal CT rating. (Typically wound CTs.)
L	CT accuracy applies at the maximum rated secondary burden at 20 time rated only. The ratio accuracy can be up to four times greater than the listed value, depending on connected burden and fault current. (Typically window, busing, or bar-type CTs.)

- **Accuracy Class of Protection CT:**
-

Class	Applications
10P5	Instantaneous over current relays & trip coils: 2.5VA
10P10	Thermal inverse time relays: 7.5VA
10P10	Low consumption Relay: 2.5VA
10P10/5	Inverse definite min. time relays (IDMT) over current
10P10	IDMT Earth fault relays with approximate time grading:15VA
5P10	IDMT Earth fault relays with phase fault stability or accurate time grading: 15VA

- **Accuracy Class: Metering Accuracy as per IEEE C37.20.2b-1994**

Ratio	**B0.1**	**B0.2**	**B0.5**	**B0.9**	**B1.8**	**Relaying Accuracy**
50:5	1.2	2.4	-	-	-	C or T10
75:5	1.2	2.4	-	-	-	C or T10
100:5	1.2	2.4	-	-	-	C or T10
150:5	0.6	1.2	2.4	-	-	C or T20
200:5	0.6	1.2	2.4	-	-	C or T20
300:5	0.6	1.2	2.4	2.4	-	C or T20
400:5	0.3	0.6	1.2	1.2	2.4	C or T50
600:5	0.3	0.3	0.3	1.2	2.4	C or T50
800:5	0.3	0.3	0.3	0.3	1.2	C or T50
1200:5	0.3	0.3	0.3	0.3	0.3	C100
1500:5	0.3	0.3	0.3	0.3	0.3	C100
2000:5	0.3	0.3	0.3	0.3	0.3	C100
3000:5	0.3	0.3	0.3	0.3	0.3	C100
4000:5	0.3	0.3	0.3	0.3	0.3	C100

Important of accuracy & phase angle

- Current error is an error that arises when the current value of the actual transformation ratio is not equal to rated transformation ratio.
- **Current error (%) = {(Kn x Is – Ip) x 100}/Ip**
- Kn = rated transformation ratio, Ip = actual primary current, Is = actual secondary current
- Example: In case of a 2000/5A class 1 5VA current transformer
- Kn = 2000/5 = 400 turn, Ip = 2000A, Is = 4.9A
- Current error = ((400 x 4.9 – 2000) x100)/2000 = -2%
- For protection class current transformer, the accuracy class is designed by the highest permissible percentage composite error at the accuracy limit primary current prescribed for the accuracy class concerned.
- Accuracy class includes: 5P, 10P

By phase angle

- Phase error is the difference in phase between primary & secondary current vectors, the direction of the vectors to be zero for a perfect transformer.
- You will experience a positive phase displacement when secondary current vector lead primary current vector.
- Unit of scale expressed in minutes / cent radians.
- Circular measure = (unit in radian) is the ratio of the distance measured along the arc to the radius.
- Angular measure = (unit in degree) is obtained by dividing the angle subtended at the center of a circle into 360 deg equal division known as “degrees”.
- Limits of current error and phase displacement for measuring current transformer (Classes 0.1 To 1)

Accuracy Class	+/- Percentage Current (Ratio) Error at % Rated Current				+/- Phase Displacement at % Rated Current							
					Minutes				Centi radians			
	5	**20**	**100**	**120**	**5**	**20**	**100**	**120**	**5**	**20**	**100**	**120**
0.1	0.4	0.2	0.1	0.1	15	8	5	5	0.45	0.24	0.15	0.15
0.2	0.75	0.35	0.2	0.2	30	15	10	10	0.9	0.45	0.3	0.3

0.5	1.5	0.75	0.5	0.5	90	45	30	30	2.7	1.35	0.9	0.9
1.0	3	1.5	1	1	180	90	60	60	5.4	2.7	1.8	1.8

- limits of current error and phase displacement for measuring current transformer For special application

Accuracy Class	+/- Percentage Current (Ratio) Error at % Rated Current					+/- Phase Displacement at % Rated Current									
						Minutes					Centi radians				
	1	5	20	100	120	1	5	20	100	120	1	5	20	100	120
0.2S	0.75	0.35	0.2	0.2	0.2	30	15	10	10	10	0.9	0.4	0.3	0.3	0.3
0.5S	1.50	0.75	0.5	0.5	0.5	90	45	30	30	30	2.7	1.3	0.9	0.9	0.9

- limits of current error for measuring current transformers (classes 3 and 5)

Accuracy Class	+/- Percentage Current (Ratio) Error at % Rated Current		
	50	**120**	
3	3	3	
5	5	5	

Class X Current Transformer:

- Class X current transformer is use in conjunction with high impedance circulating current differential protection relay, eg restricted earth fault relay. As illustrated in IEC60044-1, the class X current transformer is needed.
- The following illustrates the method to size a class X current transformer.
- Step 1: calculating knee point voltage Vkp
- **Vkp = {2 x Ift (Rct+Rw)}/ k**
- Vkp = required CT knee point voltage, Ift = max transformer through fault in ampere
- Rct = CT secondary winding resistance in ohms, Rw = loop impedance of pilot wire between CT and the
- K = CT transformation ratio
- Step 2: calculate Transformer through fault Ift

- **Ift = (KVA x 1000)/ (1.732 x V x Impedance)**
- KVA = transformer rating in kVA , V = transformer secondary voltage, Impedance = transformer impedance
- Step 3: How to obtain Rct
- To measure when CT is produce
- Step 4: How to obtain Rw
- This is the resistance of the pilot wire used to connect the 5th class X CT at the transformer star point to the relay
- In the LV switchboard. Please obtain this data from the Electrical contractor or consultant. We provide a table toServe as a general guide on cable resistance.
- Example:
- Transformer Capacity: 2500kVA
  Transformer impedance: 6%
  Voltage system : 22kV / 415V 3phase 4 wire
  Current transformer ratio: 4000/5A
  Current transformer type: Class X PR10
  Current transformer Vkp : 185V
  Current transformer Rct : 1.02½ (measured)
  Pilot wire resistance Rw : 25 meters using 6.0mm sq cable
  = 2 x 25 x 0.0032 = 0.16½
  Ift = (kVA x 1000) / (1.732 x V x impedance) = (2500 x 1000) / (1.732 x 415 x 0.06)= 57,968 (Say 58,000A)
  Vkp = {2 x Ift (Rct+Rw)} / k= {2 x 58000 (1.02+0.16)} / 800= 171.1½.

4) Accuracy Limit Factor:

- **Standard Accuracy Limit Factors:** 5, 10, 15, 20 and 30.
- Accuracy of a CT is another parameter which is also specified with CT class. For example, if a measuring CT class is 0.5M (or 0.5B10), the accuracy is 99.5% for the CT, and the maximum permissible CT error is only 0.5%.
- Accuracy limit Factor is defined as the multiple of rated primary current up to which the transformer will comply with the requirements of 'Composite Error'. Composite Error is the deviation from an ideal CT (as in Current Error), but takes account of harmonics in the secondary current caused by non-linear magnetic conditions through the cycle at higher flux densities.
- The electrical requirements of a protection current transformer can therefore be defined as :
- **Selection of Accuracy Class & Limit Factor.**
- Class 5P and 10P protective current transformers are generally used in over current and unrestricted earth leakage protection. With the exception of simple trip relays, the protective device usually has an intentional time delay, thereby ensuring that the severe effect of transients has passed before the relay is called to operate. Protection Current Transformers used for such applications are normally working under steady state conditions Three examples of such protection is shown. In some systems, it may be sufficient to simply detect a fault and isolate that circuit. However, in more discriminating schemes, it is necessary to ensure that a phase to phase fault does not operate the earth fault relay.
- **Calculation of the Accuracy limit factor**
- **Fa=Fn X ((Sin+Sn) / (Sin+Sa))**
- Fn = Rated Accuracy Limit Factor, Sin = Internal Burden of CT secondary Coil

- Sn= Rated Burden of CT (in VA), Sa= Actual Burden of CT (in VA)
- **Example:** The internal secondary coil resistance of the CT(5P20) is 0.07 Ω, the secondary burden (including wires and relay) is 0.117 Ω and the CT is rated 300/5, 5P20, 10 VA. Calculate the actual accuracy limit factor.
- Fn = 20 (CT data 5P20), Sin = (5A)2 × 0.07 Ω =1.75 VA, Sn = 10 VA (from CT data),
- Sa = (5A)2 × 0.117 Ω = 2.925 VA
- **Accuracy limit factor ALF (Fa)** = 20 X ((1.75+10) / (1.75+2.925)) =**50.3**

Selection of CT:

1) **Indoors or Out Door:**

- Determine where CT needs to be used. Indoor transformers are usually less costly than outdoor transformers. Obviously, if the current transformer is going to be enclosed in an outdoor enclosure, it need not be rated for outdoor use. This is a common costly error in judgment when selecting current transformers.

2) **What do We need:**

- The first thing we need to know that what degree of accuracy is required. Example, if you simply want to know if a motor is lightly or overloaded, a panel meter with 2 to 3% accuracy will likely suit for needs. In that case the current transformer needs to be only 0.6 to 1.2% accurate. On the other hand, if we are going to drive a switchboard type instrument with 1% accuracy, we will want a current transformer with 0.3 to 0.6 accuracy. We must keep in mind that the accuracy ratings are based on rated primary current flowing and per ANSI standards may be doubled (0.3 becomes 0.6%) when 10% primary current flows. As mentioned earlier, the rated accuracies are at stated burdens. We must take into consideration not only the burden of the load (instrument) but you must consider the total burden. The total burden includes the burden of the current transformers secondary winding, the burden of the leads connecting the secondary to the load, and the burden of the load itself. The current transformer must be able to support the total burden and to provide the accuracy required at that burden. If we are going to drive a relay you must know what relay accuracy the relay will require.

3) **Voltage Class:**

- You must know what the voltage is in the circuit to be monitored. This will determine what the voltage class of the current transformer must be as explained earlier.

4) **Primary Conductor:**

- If you have selected a current transformer with a window you must know the number, type and size of the primary conductor(s) in order to select a window size which will accommodate the primary conductors.

5) **Application:**

- The variety of applications of current transformers seems to be limited only by ones imagination. As new electronic equipment evolves and plays a greater role in the generation, control and application of electrical energy, new demands will be placed upon current transformer manufacturers and designers to provide new products to meet these needs

6) **Safety:**

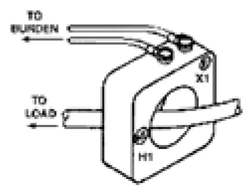
- For personnel and equipment safety and measurement accuracy, current measurements on conductors at high voltage should be made only with a conducting shield cylinder placed inside the CT aperture. There should be a low electrical impedance connection from one end only to a reliable local ground. An inner insulating cylinder of adequate voltage isolation should be between the shield cylinder and the conductor at high voltage. Any leakage, induced or breakdown current between the high voltage conductor and the ground shield will substantially pass to local ground rather than through the signal cable to signal ground. Do not create a “current loop” by connecting the shield cylinder to ground from both ends. Current flowing in this loop will also be measured by the CT.

7) **CT output signal termination:**

- The CT output coaxial cable should preferably be terminated in 50 ohms. CT characteristics are guaranteed only when CT is terminated in 50 ohms. The termination should present sufficient power dissipation capability. When CT output is terminated in 50 ohms, its sensitivity is half that when terminated in a high-impedance load.

Installing of CT:

- Measurements must have the same polarity to keep the power factor and direction of power flow measurements accurate and consistent.
- Most CTs are labelled that shows which side of the CT should face either the source or the load.



- **Primary Side :** The Primary of CT is marked with H1 and H2 (or only marking dot on one side)
- The label “H1” or dot defines the direction as flowing current into the CT (H1 or the dot should face the Power source side). H2 side to load facing direction
- **Secondary Side:** The Secondary (The output wires) of CT is marked with X1 and X2.
- X1 corresponds to H1, or the input side.The X1 secondary terminal is the polarity terminal. The polarity marks of a current transformer indicate that when a primary current enters at the polarity mark (H1) of the primary, a current in phase with the primary current and proportional to it in magnitude will leave the polarity terminal of the secondary (X1).
- Normally **CT’s** should not be installed on live services. The power should be disconnected when the **CT’s** are installed. Many times this is not possible because of critical loads such as computers, laboratories, etc. that cannot be shut down. Split core **CT’s** should not be installed on live un insulated bus bars under any conditions.

Modification of Primary & Secondary Turns Ratio:

- The nameplate current ratio of the current transformer is based on the condition that the primary conductor will be passed once through the transformer opening. If necessary, this rating can be reduced in even multiples by looping this conductor two or more times through the opening.
- A transformer having a rating of 300 amperes will be changed to 75 amperes if four loops or turns are made with the primary cable.
- The ratio of the current transformer can be also modified by altering the number of secondary turns by forward or back-winding the secondary lead through the window of the current transformer.
- By adding secondary turns, the same primary amperage will result in a decrease in secondary output.

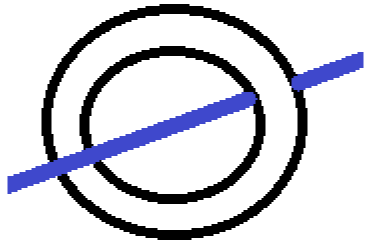
- By subtracting secondary turns, the same primary amperage will result in greater secondary output. Again using the 300:5 example, adding two secondary turns will require 310 amps on the primary to maintain the 5 amp secondary output or 62/1p = 310p/5s.
- Subtracting two secondary turns will only require 290 amps on the primary to maintain the 5 amp secondary output or 58s/5p = 290p/5s. The ratio modifications are achieved in the following manner:
- To add secondary turns, the white lead should be wound through the CT from the side opposite the polarity mark.
- To subtract turns, the white lead should be wound through the CT from the same side as the polarity mark.

1) **Modifications in Primary Turns Ratio of CT:**

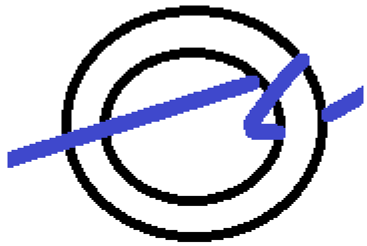
- The ratio of the current transformer can be modified by adding more primary turns to the transformer. By adding primary turns, the current required to maintain five amps on the secondary is reduced.
- **Ka = Kn X (Nn/Na)**
- Ka= Actual Turns Ration.
- Kn=Name Plate T/C Ratio.
- Nn=Name Plate Number of Primary Turns.
- Na=Actual Number of Primary Turns.
- Example: 100:5 Current Transformers.

(1) Primary Turns=1Nos:

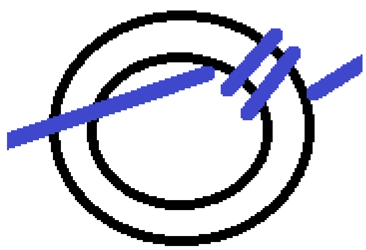
Ka= (100/5) X (1/1) = 100:5



(2) Primary Turns=2Nos:
Ka= (100/5) X (1/2) = 50:5

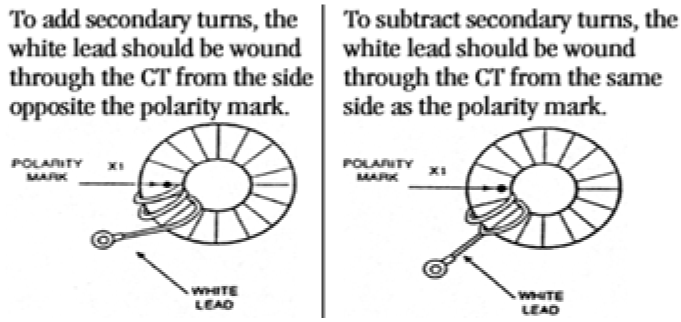


Primary Turns= 4Nos:
Ka= (100/5) X (1/4) = 25:5



2) Modifications in Secondary Turns Ratio of CT:

- Formula : **Ip/Is = Ns/Np**
- Ip = Primary Current , Is = Secondary Current , Np = No of Primary Turns, Ns = No of Secondary Turns
- **Example:** A 300:5 Current Transformer.
- The ratio of the current transformer can be modified by altering the number of secondary turns by forward or back winding the secondary lead through the window of the current transformer.
- By adding secondary turns, the same primary current will result in a decrease in secondary output. By subtracting secondary turns, the same primary current will result in greater secondary output.
- Again using the 300:5 example adding five secondary turns will require 325 amps on the primary to maintain the 5 amp secondary output or: 325 p / 5s = 65s / 1p
- Deducting 5 secondary turns will only require 275 amps on the primary to maintain the 5 amp secondary output or: 275p / 5s = 55s / 1p
- The above ratio modifications are achieved in the following manner:



- **Current Transformer Ratio Modification:**

CT Ratio	Number of Primary Turns	Modified Ratio
100:5A	2	50:5A
200:5A	2	100:5A
300:5A	2	150:5A
100:5A	3	33.3:5A
200:5A	3	66.6:5A
300:5A	3	100:5A
100:5A	4	25:5A
200:5A	4	50:5A
300:5A	4	75:5A

- A primary turn is the number of times the primary conductor passes through the CT's window. The main advantage of this ratio modification is you maintain the accuracy and burden capabilities of the higher ratio. The higher the primary rating the better the accuracy and burden rating.
- You can make smaller ratio modification adjustments by using additive or subtractive secondary turns.
- For example, if you have a CT with a ratio of 100:5A. By adding one additive secondary turn the ratio modification is 105:5A, by adding on subtractive secondary turn the ratio modification is 95:5A.
- Subtractive secondary turns are achieved by placing the "X1″ lead through the window from the H1 side and out the H2 side. Additive secondary turns are achieved by placing the "X1″ lead through the window from the H2 and out the H1 side.
- So, when there is only one primary turn each secondary turn modifies the primary rating by 5 amperes. If there is more than one primary turn each secondary turn value is changed (i.e. 5A divided by 2 primary turns = 2.5A).
- The following table illustrates the effects of different combination of primary and secondary turns:

CT RATIO 100:5A		
PRIMARY TURNS	**SECONDARY TURNS**	**RATIO ADJUSTMENT**
1	-0-	100:5A

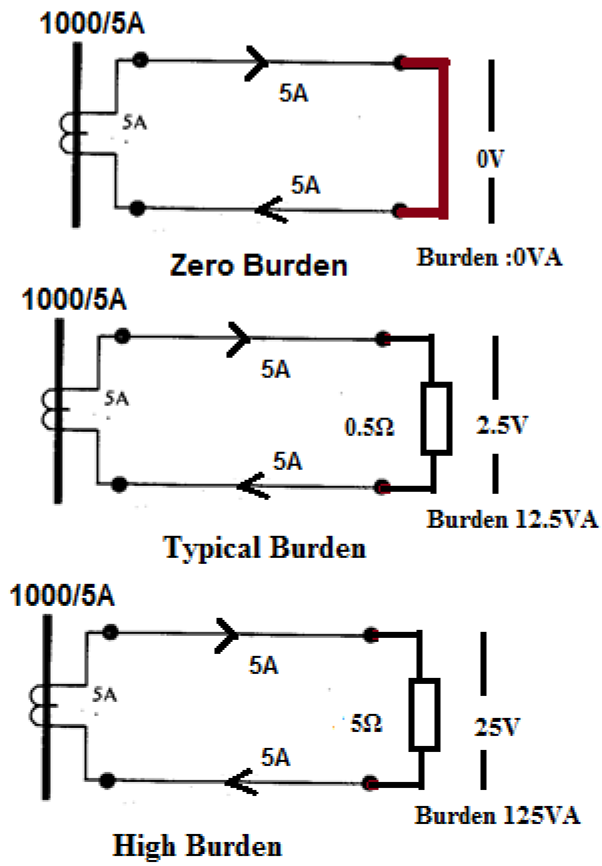
1	1+	105:5A
1	1-	95:5A
2	-0-	50:5A
2	1+	52.5:5A
2	2-	45.0:5A
3	-0-	33.3:5A
3	1+	34.97:5A
3	1-	31.63:5A

Advantages of using a CT having 1A Secondary:

- The standard CT secondary current ratings are 1A & 5A,The selection is based on the lead burden used for connecting the CT to meters/Relays.5A CT can be used where Current Transformer & protective's device are located within same Switchgear Panel.
- 1A CT is preferred if CT leads goes out of the Switchgear.
- For Example if CT is located in Switch Yard & CT leads have to be taken to relay panels located in control room which can be away.1A CT is preferred to reduce the load burden. For CT with very High lead length, CT with Secondary current rating of 0.5 Amp can be used.
- In large Generator Circuits, where primary rated current is of the order of few kilo-amperes only,5A CTs are used, 1A CTs are not preferred since the turns rations becomes very high & CT becomes unwieldy.

Danger with Current Transformer:

- When a CT secondary circuit is closed, current flows through it, which is an exact proportion of the primary current, regardless of the resistance of the burden. In the CT have a ratio of 1OOO/5A and to have 1OOOA flowing in the primary is carrying exactly 5A.



- If the secondary terminals S1 and S2 are short- circuited, there is no voltage between them.
- If now the short-circuit be replaced by a resistance of, say, 0.5 ohm the same 5A will flow through, causing a volt-drop of 2.5V and a burden of 5 x 2.5 = 12.5V A. If the resistance were increased to 5 ohms the terminal voltage with 5A flowing would rise to 25V and the burden to 125V A.
- The greater the resistance, the greater would be the voltage and burden until, as it approached infinity (the open-circuit condition), so also in theory would the voltage (and burden) become infinite. This cannot of course happen in practice because the CT would saturate or the terminals flash over due to the very high secondary voltage between them. But it does show the danger of open-circuiting the secondary of running CT. lethal voltages can be produced at the point of opening. This is why CT secondaries are never fused.
- The danger from an open-circuited CT is twofold. It can produce lethal voltages and so is a very real danger to personnel. The high voltage across the secondary winding could also cause insulation failure in that winding, leading at best to inaccuracy and at worst to burn- out or fire.
- Before ever an instrument or relay is removed from the secondary loop of a running CT (if such a thing had to be done), the wires feeding that instrument must first be securely short- circuited at a suitable terminal box or, better, at the CT itself. Similarly, if a running CT is ever to be taken out of circuit, it must first be firmly shorted. CTs with 1 A secondary's are more dangerous than those with 5A, as the induced voltages are higher.
- Ammeter resistance is very low ,the current transformer normally works short circuited.
- If for any reason the ammeter is taken out of secondary winding then the secondary winding must be short circuited with the help of short circuit switch .
- If this is not done, then due to high m.m.f. will set up high flux in the core and it will produces excessive core loss which produce heat and high voltage across the secondary terminals

- **Hence the secondary of current transformer is never left open**

Sizing of CT for Building:

- **New construction**: size the CT to handle about 80% of the circuit breaker capacity. If the building is served by a 2000 amp breaker, use 1600 amp (2000 x 0.8) CT's.
- **Older buildings:** the peak demand can generally be determined from the power company or from past billings. In this case add 20 to 30% to the peak demand and size the CT's for this load. If the peak demand was 500 kW, the peak current on a 480/3/60 system would be **500,000 / (480 x 1.73 x 0.9 pf) = 669 amps.** This assumes a 0.9 power factor. (Peak current would be higher with a lower power Factor.) Use CT's about 20% larger. 800:5 CT's would be a good selection.
- For older buildings with no demand history, size the **CT's** the same as for new construction. Where possible, use multi-tap **CT's** so that the ratio can be reduced if the maximum load is much less than 80% of the breaker size.
- **CT's** that are used to monitor motor loads can be sized from the nameplate full load motor amps.

Source: http://electricalnotes.wordpress.com/2011/04/16/current-transformer/