Mech263 Electrical Technology

Lab. 2

Auto Transformers and Current Transformers

A) Objective

To study the construction and basic properties of a 1-ph auto-transformer and a 1-ph current transformer.

B) Facilities

- ETL 170: Electrotechnology Panel with current transformer
- A digital multimeter

C) Introduction

Voltage dividers may be implemented using resistors to step down voltages. As it is resistive in nature, there is no phase shift and may be used in AC circuits. However, one major drawback is that the resistor present a constant load and cause heating problems.

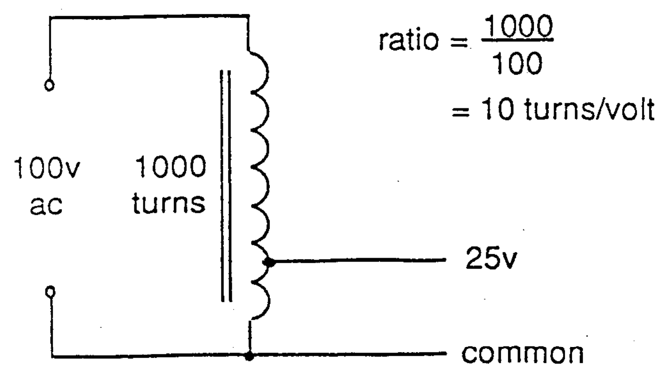
The use of auto-transformers as voltage divider avoid these problems. In addition, the auto-transformer principles is available for measuring the large current without the need of interrupting the circuit. One major caution for operating CT while high turn ratio is that the secondary should never be open-circuited due to the presence of high voltages.

D) Experiments

The Auto Transformer

Consider Fig 1. If 100 volts are applied across the winding ends and the winding has 1000 turns, then a ratio of 10 turns/volts exists. Thus if we were to tap the coil at 250 turns, we could expect a voltage of 25V.

Fig.1



The main thing to remember regarding the design of an auto transformer, is that the primary and secondary windings are the same and therefore the winding carries the sum of both currents. This is shown diagramatically in Fig. 2.

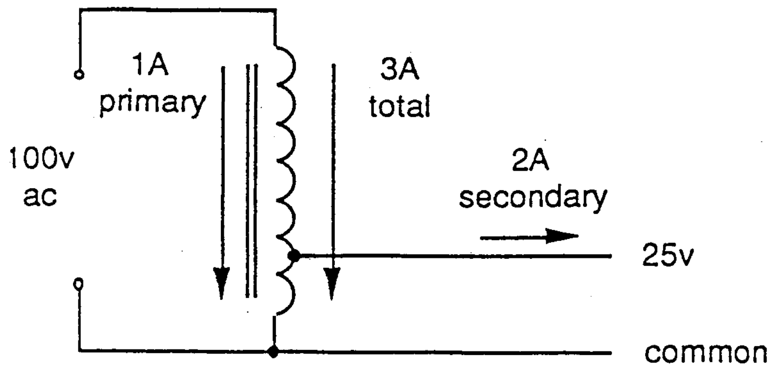


Fig.2

This can be demonstrated on the unit by applying a voltage to the 25:10 transformer.

- Link the two coil ends and connect the 25V ac supply across the ends as shown in fig 3.

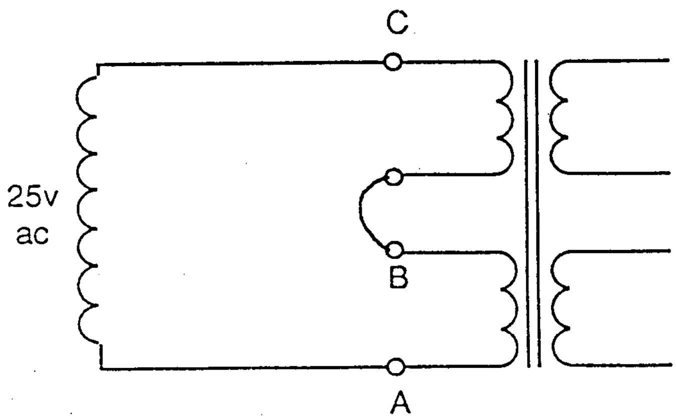
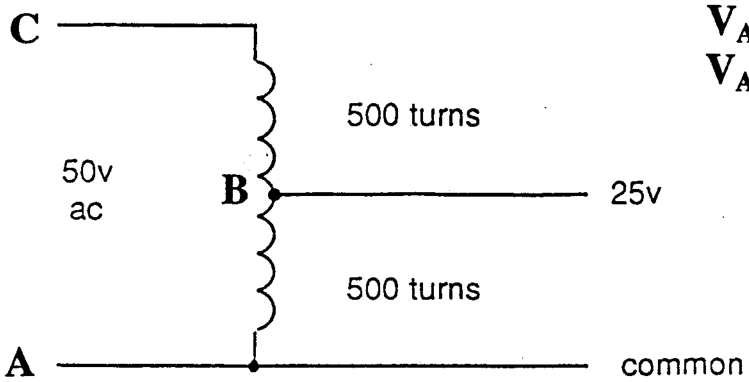


Fig. 3

- Switch on the unit and measure the voltage between points A and B in fig 4. If you measure the voltage across points A and C, because both halfs of the winding are the same, you should find that A and B, is exactly half. Switch off the unit.

V_{AB} = ____________ V_{AC} = ____________

- Reconnect the supply to points A-B. Switch on the unit and measure the voltage across A and C. This shows that the auto transformer can also be used to step up the voltage as well as step down. Fig 4 shows how this is achieved. Switch off the unit.



V_{AC} =
V_{AB} =

Fig.4

The main reason for production of this type of transformer, is the ease of manufacture (only one coil is required) and the cost.

The auto transformer is also produced in a form similar to that of the potentiometer. The winding is would flat. i.e. one layer, on a suitable core and a graphite wiper is allowed to run over a bare section of the winding picking up the voltage, one turn at a time.

The Current Transformer

Current transformers are simply transformers designed with an emphasis on the ratio of the currents flowing through the primary and the secondary windings, rather than on the voltage ratio. Thus, for an ideal transformer, the primary and secondary ampere-turns are equal, i.e. $I_pT_p = I_sT_s$

We know that the transformer functions by having a magnetic field induced into the core. In theory, if the current in the primary is strong enough or the requisite number of turns are available on the secondary, then there is no reason why we should not reduce the number of turns in the primary to 1.

This is basically the working of the current transformer or CT. A large current passed through a single conductor, induces a current into the secondary. It should be remembered that a small voltage is required to ' drive ' the current in the secondary, so this must be allowed for.

Supplied with the ETL170, you will find a current transformer. This is a commercially made CT and we shall now use it to study how the ratios change depending on the primary current and turns.

- Place the CT into its locating holes in the bottomleft-handcorner of the panel and connect as shown in fig 5

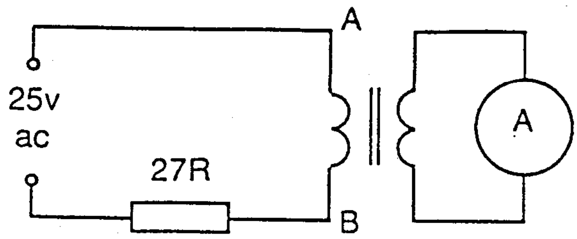


Fig.5

- Connect points A and B with a wire passed through the toroidal core and switch on the unit.

- Record the primary current, secondary current and number of primary turns. Substitute the known values into the above formula and calculate the CT ratio.
  I_p = ____________________
  I_s = ____________________
  N = ____________________

- Switch off the unit and make 2 passes of the wire through the CT. Switch on the unit and using the ratio calculated in the above, calculate the secondary current. Now measure the secondary current and verify your answer.

  Calculated value of I_s = _______________
  Measured value of I_s = _______________

- Switch off the unit and make another pass of the wire in the CT. Switch on the unit. This time calculate the primary current. Have you noticed that for each turn of the wire in the CT, the current in the secondary increases proportionally ?

  I_p = _____________

  The ratio label on a commercial CT, usually gives a clue to its maximum rating. In this case, the maximum primary current is 120A to give a 5A secondary.

CT's of this type, are commonly used in power engineering to monitor the large currents which may flow in some circuits. They are available in many ratios, some of which run at thousands to 1.