Advanced Power Technologies, LLC

Application Note-AN014

Title: Current Shunt for excess CT input		**Model:** TTC-1000
Written By: T. Tennille	**Date:** 7/27/2009	Rev B

Application Summary

This Application Note covers application of the TTC-1000 where the CT1 current is in excess of what the CT input can handle or below the level at which accuracy is decreased. For serial numbers ending in "A" through "F" CT1 is limited to 10 Amperes of current through the AuxCT metering window. For serial numbers ending in "G"or later CT1 is limited to 15 Amperes of current through the AuxCT metering window. Below 1.5 Amperes, accuracy declines.

For cases where the CT current is in excess of what can be used for the CT1 Input

The CT input on the main board (Terminal TB3) is limited to 10 Amperes through the AuxCT. Depending on the hot spot or bushing CT it is connected to and the load on the transformer this level can be exceeded.

To bring the current into the input to a reasonable level, a shunt resistor can be added to the terminal block (TB3) across the AuxCT leads.

- **Determination of needed shunt resistance.**
  The value of the shunt resistance can be calculated by:

$$R_{Shunt} = 301 * I_{Input} / (I_{CT} - I_{Input})$$

Where:

I_{Input} = *Current into TTC-1000 CT1 input*
I_{CT} = *Current from AuxCT*
R_{Shunt} = *External Shunt Resistance*

For example, if the current through the Aux CT is 15 Amperes, and the effective current is to be limited to 10 Amperes, the resulting calculation would be:

$$R_{Shunt} = 301 * 10 / (15 - 10) = 602$$

So, a 602 ohm resistor would be needed to change the incoming 15 Ampere current to read as a 10 Ampere current. The CT ratio entered in the settings would have to be modified accordingly. For example, if the incoming CT ratio were 100, it would now be set for the equivalent of 150. This would give a correct reading of 150 Amps for an actual current into the CT input of 100 Amps.

- **Finding new Effective Ratio for specific resistance.**

In practice, it would be uncommon for the exact resistance needed to be available. Using the resistance determined above, find a ½ watt, 1% resistor near to, but below, the value needed. It must be below to ensure that the current into the TTC-1000 input is below the limit. Use the resistance value and the value of the current into the CT input to determine the CT current.

To determine the current, use the following formula:

$$I_{CT} = ((R_{Shunt} + 301) / R_{Shunt}) * I_{Input}$$

Using the values in the example above, the result would be:

$$I_{CT} = ((602 + 301) / 602) * 10 = (903 / 602) * 10 = 1.5 * 10 = 15$$

So, to get near the value needed, use the first equation to get close and then the second using the nearest resistance value available. The resulting value is the primary Amperes.

- **Effective Ratio**

You will need to change the CT Ratio setting in the TTC-1000 to accommodate for the shunt resistor. To do this, you must multiply the original CT Ratio by the ratio of the CT1 input current to the CT current. Use the following ratio factor calculation to get the multiplier:

$$Ratio = I_{CT} / I_{Input}$$

For the values used in the above example the computation would be:

$$Ratio = I_{CT} / I_{Input} = 15 / 10 = 1.5$$

If the ratio to be programmed into the CT RATIO line in the settings listing were 100:1, the effective ratio would now be 150:1. So, 150 would be entered in place of the 100 (that would be used without the shunt resistor).

- Resistor Characteristics
  The resistor will be in an environment with a wide temperature variance and any change in resistance with temperature will result in measurement error. It is advisable to use a resistor with an accuracy of 1% and a temperature coefficient of less than 100 ppm.

For cases where the CT current is less than what should be used for the CT1 Input

In some cases, generally with certain hot-spot CT's, the ratio is such that the output current is low. It can be as low as one Ampere or less. For good accuracy, the full load amperes through the window of the AuxCT should be near 5 amperes, but not more than 10.

To gain the necessary current, wind the CT lead multiple times through the window of the AuxCT. Each turn reduces the ratio. For example two turns will halve the effective ratio. Thus if the hot-spot CT ratio is 500:1.5, it is now effectively 500:3. A third pass would bring the ratio to 500:4.5 which is very close to optimum. A fourth pass would bring the resulting ratio to 500:6 which is still well within the usable range and will give more accuracy than the original 500:1.5

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