

VOLTECH NOTES

Testing with Constant AC Current

Voltech
AT3600

CAUTION: HIGH VOLTAGE

VoltechTM

Testing Transformers and Cores with Constant Current

1 Introduction

It is a requirement of standards like IEC60404-2 that measurements of core loss are made under constant current test conditions.

Ideally, current transformers will also be tested with constant current drive.

Unlike most general-purpose transformer test equipment, the AT Tester has a built in, fully programmable constant current drive.

The AT Series transformer testers from Voltech contain a wide variety of programmable signal sources. These are used to test multiple parameters at high speed on parts ranging from surface-mounting ferrite inductors to steel laminate trans-formers of a few kVA.

By following the guidance given in these notes, customers may also configure the AT Tester to test cores, inductors and transformers under constant AC current conditions.

2 Features of constant current AC drive on the AT Tester.

Constant current is fully programmable for amplitude and frequency.

Simultaneous measurement of rms or rectified mean (rms scaled) voltage.

Current carefully ramped up and down under software control.

Can use external AC source to extend the VA range.

Integrates into normal test sequence with all other tests available on an AT (including HiPOT).

3 Constant current testing with up to 2A drive.

2A is the maximum available from the AT's generator. Greater than 2A can be delivered for testing by using an external source (as described in a later section) or simply by using multiple turns of the drive signal through the transformer or core under test.

Programming the current is simple using the Voltech AT Editor and limits may be set as RMS or mean-scaled RMS.

The screenshot shows the 'Open Circuit Voltage' dialog box. It contains the following settings:

- Test Parameters:** Signal: 1.34, Unit: A (selected), Nominal V: 10, Frequency: 400 Hz.
- Measurement:** Mean sense, RMS scaled (selected).
- Integration:** Medium (selected).
- Energised Terminals:** High Terminal: [dropdown], Low Terminal: [dropdown].
- Measured Terminals:** High Terminal: [dropdown], Low Terminal: [dropdown].
- Voltage Limits:** Minimum: 9.9, Maximum: 10.1. Units: mV (selected).
- Polarity:** +ve (selected).
- User Offset:** User Offset Enabled: [checkbox], nV: [field].

Once downloaded to the AT as part of a program, the test will be performed automatically with the constant current ramped up and down smoothly and quickly.

Comprehensive measurement results may be stored and analysed later if required

4 Constant current testing with greater than 2A drive.

The simplest way of testing with an apparent drive of greater than 2 amps is simply to use more than one turn of the drive signal through the core or transformer under test.

For transformers or cores that require greater drive, or when the resulting drive voltage is too small for the AT to stabilize properly, the AC Interface accessory may be used to provide up to 10A of constant current AC drive.

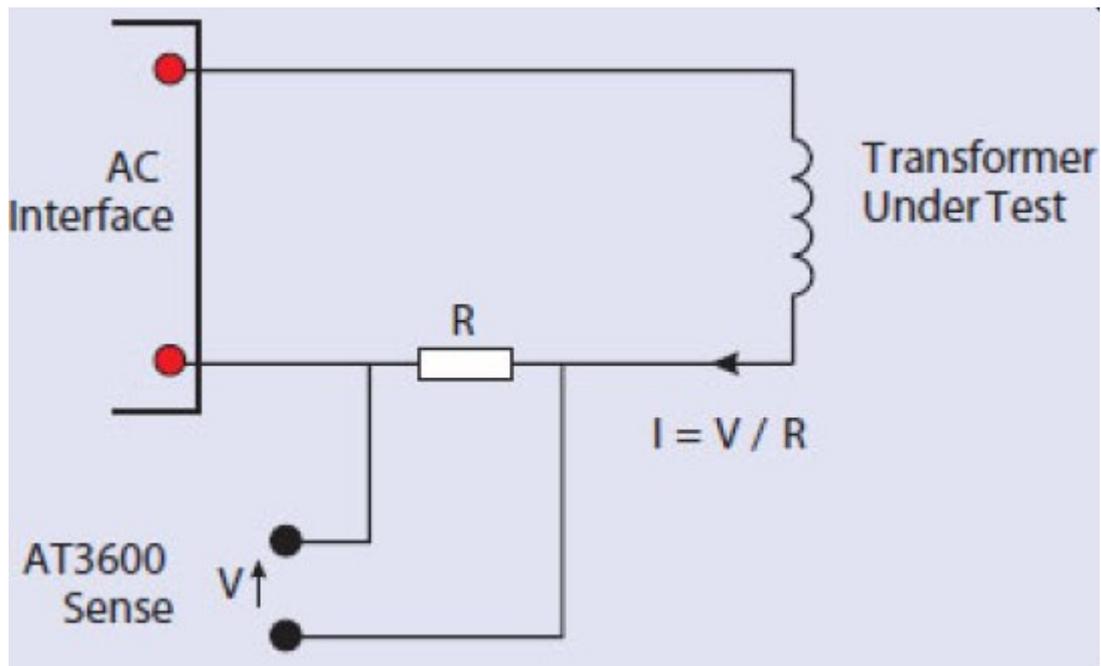
4.1 Equipment Required

- AT Tester.
- AC Interface.
- VOCX test. (MAGX is useful during program development.)
- A current-sensing resistor.
- A step-down power transformer.

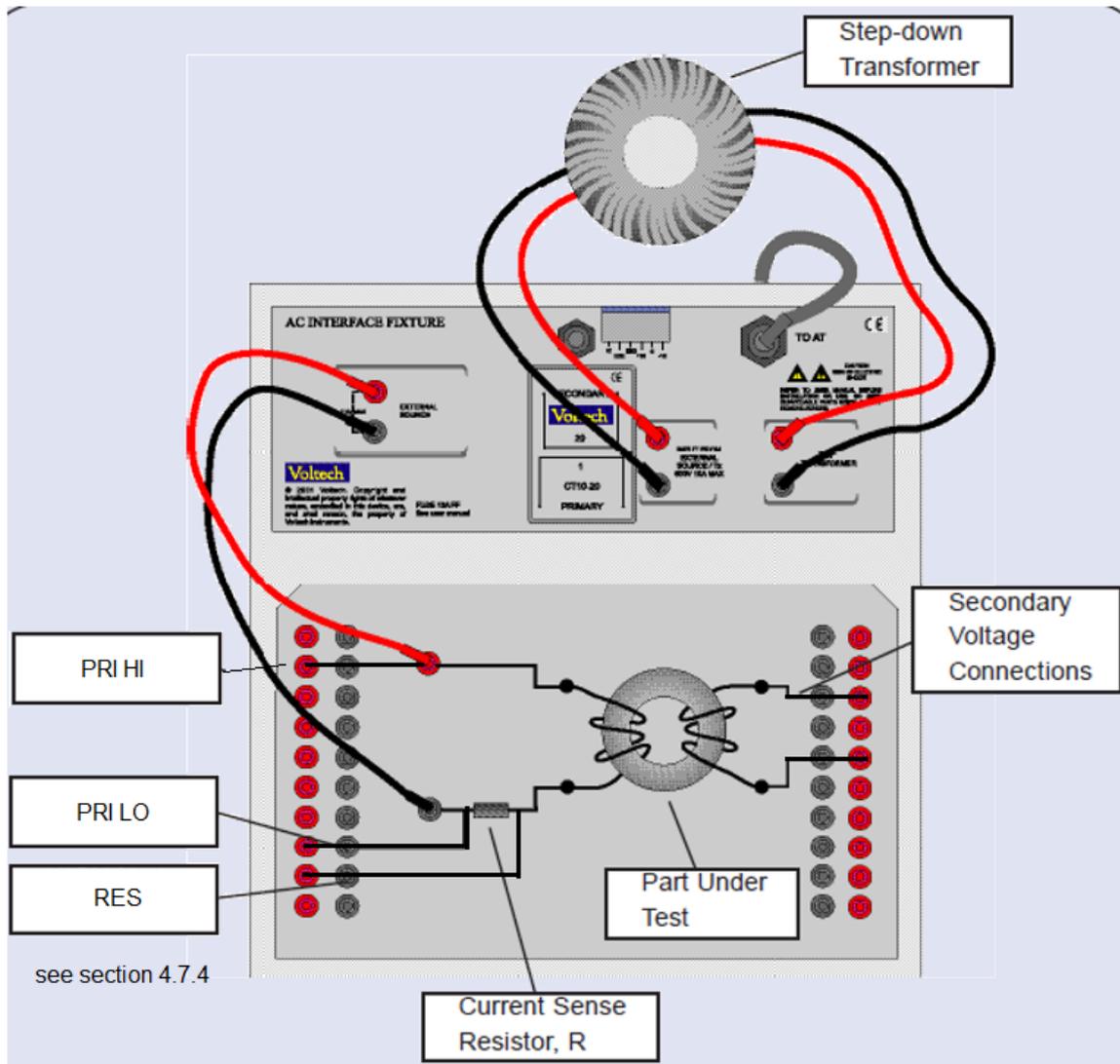
4.2 Basic Principle

Constant-current AC testing uses the normal VOCX test to control the current and make the secondary voltage measurement.

- The current to be controlled, I , is converted to a voltage, V , by means of a current-sensing resistor, R .
- The voltage, V , is connected to the sense terminals of the AT tester, which would normally be used to measure the energizing voltage.
- In the PC Editor, the voltage, V , is used as the energized voltage.
- When VOCX is performed, the AT will trim the source, such that the desired current is provided, $I = V / R$.
- The transformer secondary voltage is measured in the normal way as the result of the VOCX test.
- The AT adjusts the source voltage to maintain a constant AC current, through resistor, R .



4.3 Connection Diagram



4.4 Current-Sense Resistor

The resistor is used to convert the current flowing through the part into a voltage for the AT to measure.

- The voltage produced ($V = I \times R$) should be in the range 10mV to 1V.
- To minimize waveform distortion, the resistor should be less or equal to 1ohm.
- Check the power consumed (I^2R) and choose a suitably rated resistor.

4.5 Step-down Transformer

The step-down transformer is used to increase the current capability of the AT and to better match the voltage across the part to the characteristics of the AT source.

- Ratio should provide required current with good margin.
- VA rating must be greater than VA required to energize the part and the sense resistor.
- An external AC source may be used to increase the VA rating of the ATs generator.

4.6 Worked Example

4.6.1 THEORY

A laminate core is to be tested in accordance with IEC60404-2.

Under a constant AC current of up to 3A, 1V at 50Hz in the primary test winding, the secondary voltage is measured and limits are applied in terms of the rectified mean voltage (rms scaled).

Resistor:

To produce **1.0 V** at **3A**,

$$R = 1 \text{ V} / 3\text{A}$$

$$R = 0.333 \text{ Ohm.}$$

Choose **0.5 Ohm** standard value.

$$V = 3\text{A} \times 0.5 \text{ Ohm}$$

$$V = 1.5 \text{ V}$$

$$W = I \times I \times R$$

$$W = 3 \times 3 \times 0.5$$

$$W = 4.50$$

Choose **5W** standard part.

Resistor is 0.5 Ohm, 5W. Voltage drop over resistor produced will be 1.5V.

4.6.2 STEP DOWN Transformer for use with AC INTERFACE

Look for a stock transformer with, say, a 5A secondary current rating.
A stock transformer will usually have a 110 and/or 230V primary.

VA rating is that of the part plus the current sense resistor.

$$VA = 3.0 \text{ A} \times (1.0 + 1.5) \text{ V} = 7.5 \text{ VA}$$

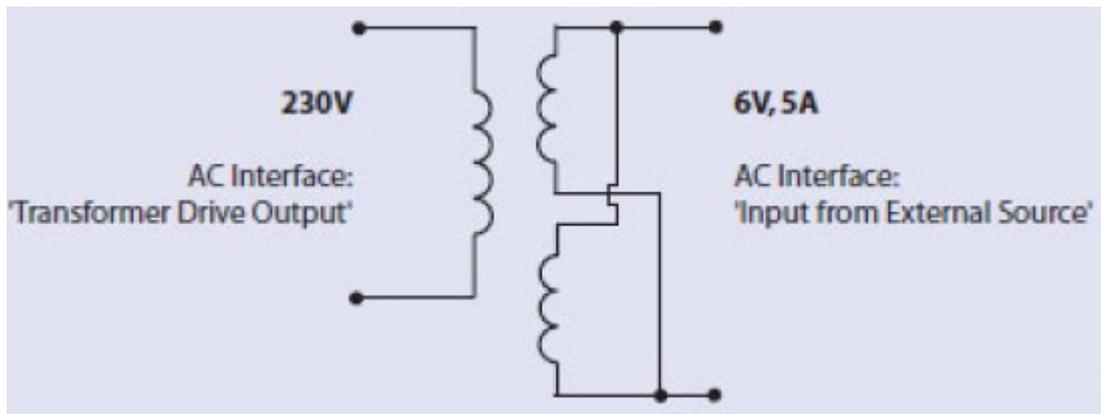
Choose a 7.5VA (or greater) transformer with a 5A low-voltage secondary.

Toroidal transformers are ideal, since they will have low losses.

For example:

Primary: 230V Secondary: 2 x 6V @ 2.5A.

The secondaries are connected in parallel to provide a 6V, 5A output.



The step-down transformer will supply the part under test and the current-sense resistor in series. The step-down transformer's secondary voltage, V_s , being:

$$V_s = 1.5\text{V} + 1\text{V} = 2.5\text{V}$$

The AT must supply $2.5 \times 230:6$ to the primary of the transformer.

$$2.5 \times 230 / 6 = 95.8\text{V}$$

The AT can supply 270V, so 95.8V is well within its capability.

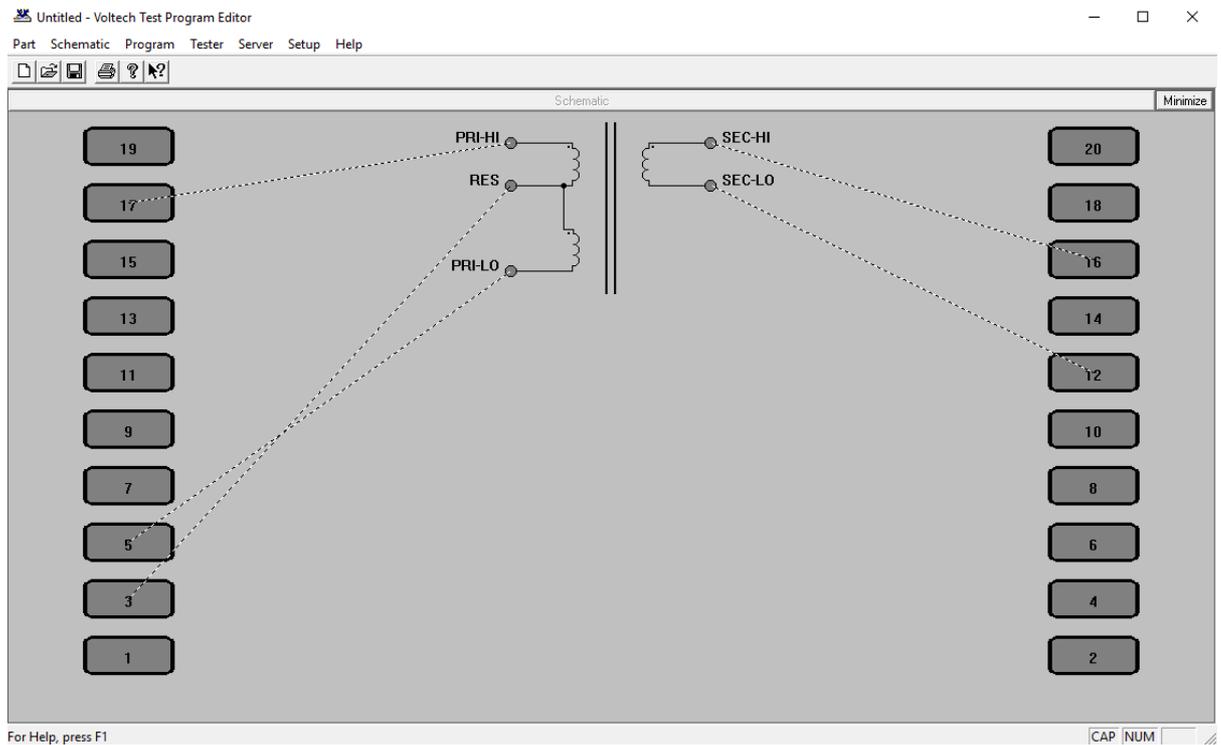
4.6.3 PROGRAMMING

It is convenient to use the MAGX test at first, since this will confirm that the desired current is being generated.

4.6.4 SCHEMATIC

In the previous connection diagram, the return or 'low' end of the sense resistor has been connected to node 5, and the higher voltage end of the resistor connected to node 3.

For optimum accuracy, it is important that the physical 'low' connection is also designated as the 'low' terminal in the program.



4.6.5 AC INTERFACE SET UP

Next, you must set up the External Source in the Editor.

The source type is 'AT Output Transformer', and you are required to enter the nominal turns ratio of the transformer.

Remember that the AT will trim the output voltage by comparing the desired voltage (from the program) with that measured across the programmed sense terminals.

The ratio is used to establish a target for voltage ramp-up, when the tester starts the test.

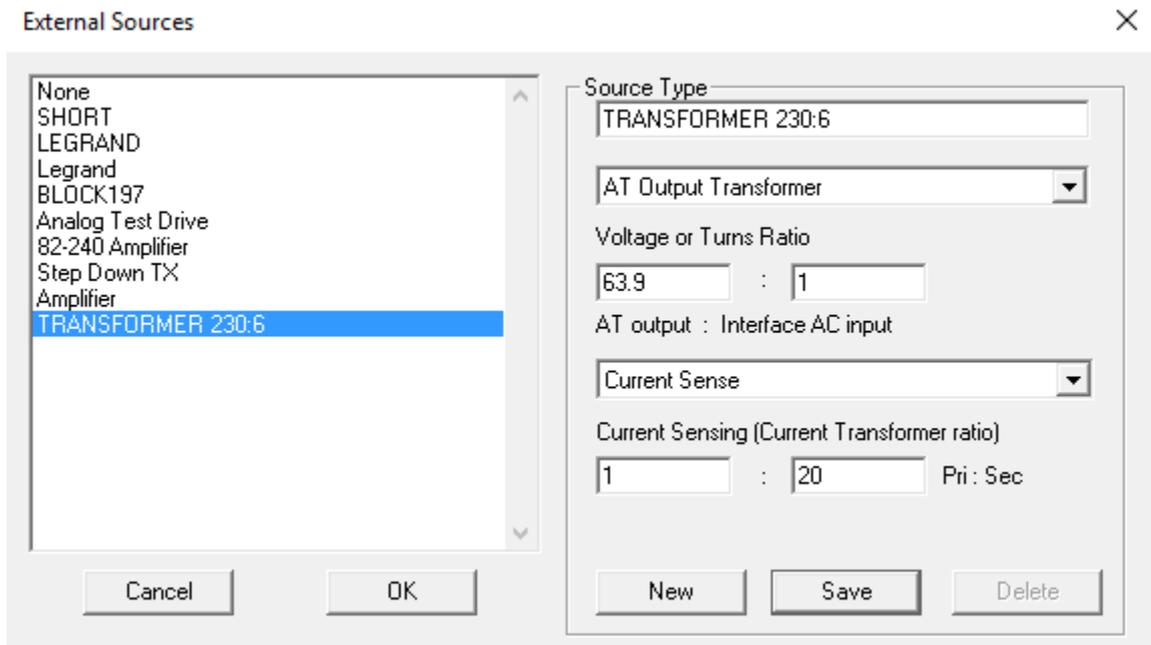
Using the correct ratio will optimize test speed.

In this case, the ratio is modified because, when the desired 1.5V is achieved across the resistor, the step-down transformer must also supply the 1V across the part under test.

For 1.5 V programmed, the step-down transformer delivers 2.5V.

$$\text{Ratio} = 230 : 6 \times 2.5 : 1.5 = 63.9 : 1$$

That is, for every 1V programmed, the AT must supply 63.9V to the primary of the step-down transformer.



4.6.6 MAGX TEST

In the MAGX test, simply enter the required voltage, V, across the resistor to program the constant current, I.

In this case, enter 1.5V.

Magnetising Current (External Source)

Test Parameters

Voltage mV V

Frequency Hz kHz

Integration

Short Medium

Long

Terminals

High Terminal Low Terminal

Magnetising Current Limits

>> Minimum uA mA A kA

< Maximum uA mA A kA

User Offset

User Offset Enabled mA

OK Measure Cancel

With an AT connected to the PC Editor and the circuit assembled as shown previously, you may now press the 'Measure' button to run a MAGX measurement.

If the current measured is as desired, then all is well. I

if not, simply adjust the program voltage to suit.

If the tester should fail to return a result, check the wiring and settings carefully.

4.6.7 VOCX TEST

Now secondary connections may be made for VOCX tests.

Open Circuit Voltage (External Source) ✕

Test Parameters		Integration	
Voltage	<input type="text" value="1.5"/> <input type="radio"/> mV <input checked="" type="radio"/> V	<input type="radio"/> Short	<input checked="" type="radio"/> Medium
Frequency	<input type="text" value="50"/> <input type="radio"/> Hz <input checked="" type="radio"/> kHz	<input type="radio"/> Long	
Energised Terminals		Measured Terminals	
High Terminal	Low Terminal	High Terminal	Low Terminal
<input type="text" value="RES"/> ▾	<input type="text" value="PRI-LO"/> ▾	<input type="text" value="SEC-HI"/> ▾	<input type="text" value="SEC-LO"/> ▾
Voltage Limits		Measurement	
<input type="radio"/> % <input checked="" type="radio"/> ><	Minimum <input type="text" value="7.5"/>	<input type="radio"/> mV <input checked="" type="radio"/> V	<input checked="" type="radio"/> AC Voltage
<input type="radio"/> > <input type="radio"/> <	Maximum <input type="text" value="7.6"/>	<input type="radio"/> mV <input checked="" type="radio"/> V	<input type="radio"/> DC Voltage
Polarity		<input type="radio"/> Mean sense <input type="radio"/> RMS Scaled	
<input type="radio"/> +ve <input type="radio"/> -ve <input checked="" type="radio"/> No Test	Note: Polarity is not available if Manual / Line Supply is selected as the external source		
User Offset			
<input type="checkbox"/> User Offset Enabled		<input type="text"/>	mV

OK Measure Cancel 

Note that VOCX has the option to measure rms voltage or "mean sense rms scaled" voltage. For the mean sense option, the tester measures the rectified mean voltage and multiplies that by 1.11.

This option is offered as a means of comparing the measurements with those made by mean sensing analog meters and calculated parameters that require rectified mean.

5 Conclusions

The versatile AT transformer tester already provides an unrivalled range of tests for checking the construction and performance of a wide range of coils and transformers.

By following the above guidelines, users can also seamlessly integrate the testing of cores and transformers under constant AC current conditions into the AT environment, providing high-speed PASS / FAIL testing and accurate, detailed test results for analysis.

6 Appendices

Adding Other Tests

To include other tests such as R, simply use extra nodes to connect directly across the windings in the normal way.

Adding extra tests in this way does not interfere with the operation of the constant current drive explained here.

Extending the Constant Current Range

To test very high VA transformers, the drive may be extended by using an external ac source. 500VA is available from the ATs internal generator.

7 Cautions

- Always observe the health and safety precautions stated in the latest issue of the Voltech AT user manual.
- Do NOT connect the power and sense nodes of the energized voltage together for the constant current circuit. With prolonged use, you may damage protection devices inside the AT.
- Use properly rated and sound connections. Under normal conditions, the AT will safely ramp current up and down. If connections are undone during the middle of a test, dangerous voltages may be generated by the part under test.

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