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APPLICATION NOTE - 001
Testing communication transformers with the PSM Range

Introduction

PSM units are well suited to testing transformers either manually or automatically (using a PC). PSM units have the measurement capability (DFT and true rms, from 10mHz to 2.4MHz) to perform most commonly required transformer tests including:

> turns ratio
> primary inductance and resistance
> leakage inductance
> interwinding capacitance
> magnetising current
> insertion loss
> return loss
> harmonics
> thd
> longitudinal balance

Most of these tests require some simple circuitry such as resistors to be fitted on the test fixture. Switching the circuit arrangement can be achieved manually for development work, or with manual switches for small quantities, but the best way is to use an automatic Transformer Analyser Fixtures (TAF) that allows selection of tests and windings.

Using the PSM generator the test conditions can be set up to any frequency within the range of 10mHz to 3MHz (dependent on the PSM model being used), and an amplitude of ±10mV peak to ±10V peak. Attenuators, dc blocking filters or amplifiers may be used with the PSM and if the amplitude setting is adjusted accordingly – the PSM always makes measurements on the two input channels and does not rely on the accuracy of the generator. For larger transformers, external excitation can be used, and the test frequency can be measured from the circuit under test to make measurements under real load conditions.
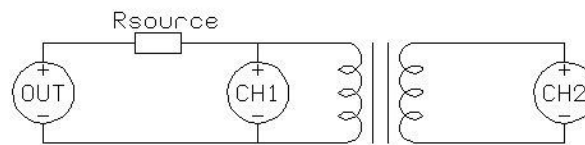
For communication transformers, the most interesting tests are turns ratio, primary inductance, return loss, insertion loss, thd, and longitudinal balance. These tests are illustrated with a simple 1:1 transformer designed for 600Ω (refer to connection diagrams).

The following descriptions apply to the transformer analyser mode of the PSM – remember to enter the value of the source resistance and load resistance used.

As well as measuring the transformer at a single frequency, all the measurements can be performed automatically over a range of frequencies.

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Turns ratio

Turns ratio is computed from the measured amplitude and phase of the secondary voltage with respect to the primary voltage. The turns ratio is given by the ratio of the in-phase components (CH1/CH2). Note that as this result is from a true vector measurement, it gives good results even on transformers with high leakage inductance.
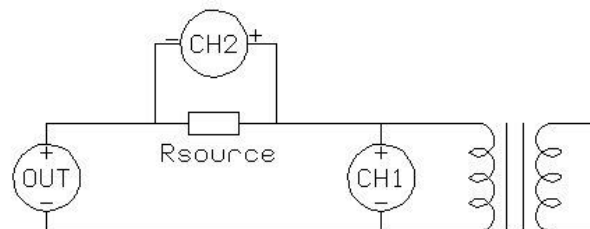Use the TAF fixture or connect the transformer as shown below.

Set the test conditions using the OUT menu.
Select turns ratio test using the SETUP menu on the PSM2200 or MODE menu on the PSM1700/35. To compute a number of turns as well as turns ratio, enter the number of primary turns in the 'nominal turns' window and then the computed secondary turns figure is given, rounded to ±0.5 turn.

Primary inductance

Primary inductance is computed from the vector measurements of the voltage across the primary and the current flowing through it, with the secondary open circuit.
Use the PSM LCR fixture, TAF fixture, or connect the transformer as shown below.
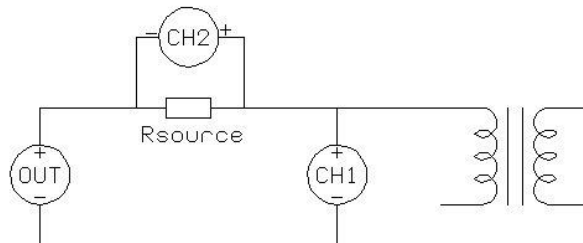
Set the test conditions using the OUT menu.
Select inductance test using the SETUP menu on the PSM2200 or MODE menu on the PSM1700/35 and enter the value of the source resistance. Dc and ac resistance are also available.

Leakage inductance

Leakage inductance is measured in the same way as primary inductance but with the secondary shorted. Selecting the leakage inductance test shorts the secondaries automatically when using the TAF01.

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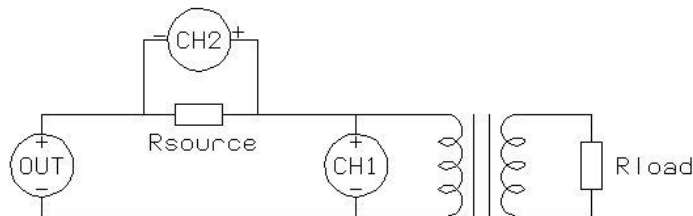www.newtons4th.com

Interwinding capacitance

Interwinding capacitance is computed from the vector measurements of the voltage across primary and secondary and the current flowing through the windings.
Use the PSM LCR fixture, TAF fixture, or connect the transformer as shown below.

Set the test conditions using the OUT menu.
Select capacitance test using the SETUP menu on the PSM2200 or MODE menu on the PSM1700/35 and enter the value of the source resistance.
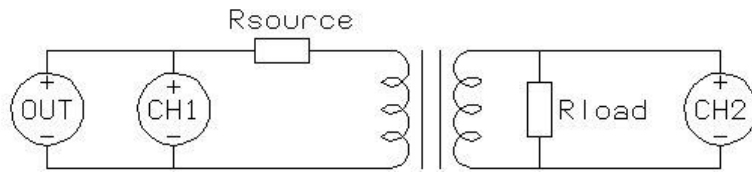
Return loss

Return loss is computed from the measurement of the reflected impedance when the secondary is loaded with the appropriate resistance.
Use the TAF fixture or connect the transformer as shown below.

Set the test conditions using the OUT menu.
Select return loss test using the SETUP menu on the PSM2200 or MODE menu on the PSM1700/35 and enter the value of the source resistance.

Insertion loss

Insertion loss is computed from the vector measurement of the primary and secondary voltages with the secondary loaded with the appropriate resistance.

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Use the TAF fixture or connect the transformer as shown below.
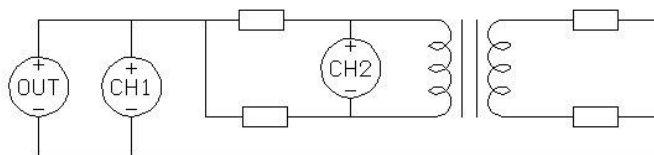
Set the test conditions using the OUT menu.
Select insertion loss test using the SETUP menu on the PSM2200 or MODE menu on the PSM1700/35 and enter the value of the source and load resistances.

THD

Use the same set up as insertion loss to measure thd under load.
Set thd test and the number of harmonics needed to make up thd.

Longitudinal balance

Longitudinal balance is a measurement of the CMRR of a transformer. For reliable measurements, it is essential that loading is minimised. The longitudinal balance fixture available for TAF01 has buffer amplifiers connected adjacent to the device under test.
The equivalent circuit arrangement for the test (buffers not shown) is shown below:

Set the test conditions.
Select longitudinal balance test.

Hints and tips

To repeat the tests with the same conditions, store the settings in the program locations 1-100. Each location can be given a name to make it easy to find the required test.

When making LCR measurements without using either the LCR fixture or TAF fixture, ensure that the connections to channel 2 have the correct polarity. PSM inputs used for current measurement with external shunts have the opposite polarity to voltage inputs so that the common mode capacitance of the input channel is driven from the lowest impedance. Remember to enter the value of the shunt (CH2 menu).

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To preserve accuracy, use 0.1% resistors on the test fixture. If making measurements at high frequency ensure that the resistors are low inductance types, suitable for high frequency use.

When setting the amplitude remember the PSM generator has a 50Ω output impedance. If greater output drive is required there is a dc coupled external buffer amplifier available, LPA01, that is capable of driving 1A from dc to 1MHz.