IMPEDANCE PERMEABILITY TESTER

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ABSTRACT

The paper describes the implementation of an Impedance Permeability Tester for transformer core testing purposes. Testing is an important aspect in any production process, because it defines the performance of the product. Therefore a proper testing method should be adopted. The method should be cost effective and easily implement able. This tester is to improve an existing method of testing process.

This paper deals with the importance of transformer core testing, the problems encounter with the existing method of testing, proposed solution, implementation of new test method and results.

1. INTRODUCTION

The basic building block of a transformer is its core. The performance of a transformer heavily depends on the magnetizing characteristics of the core. The index used for selecting materials for manufacturing of cores, is the impedance permeability curve of the material (Brms Vs Hrms)

The main problem arises in manufacturing a core is that their magnetizing characteristics get changed when they are subjected to very high heat and stresses during the manufacturing process. Improper baking and application of unnecessary stresses while winding of core, are quite undesirable for cores, and causes changes in their magnetizing characteristics. If this happens to be the case it causes humming and very high magnetizing currents, and therefore undesirable to be used.

The objective of this project is to develop an instrument to test the magnetizing characteristics. The instrument is used to plot the impedance permeability curve of a baked core (a toroid) and compare it with the standard critical curve provided by the supplier.

The outcome of the project is a fully automatic, standalone device with a user-friendly interface and fingertip operation.

This tester is intended to be used for quality controlling in manufacturing processes.

2. REQUIREMENT

The basic requirement is to test the magnetisation characteristics of cores and comparing their “Impedance permeability curves”. These curves describe the variation of B and H values according to the primary input voltage variation.

Additionally, the tester should be fit enough for the factory environment. Therefore it should be compact, fast and consist of a graphical user interface. It should also be cost effective. Therefore it should fulfil the following key points.

1. The device should be capable of plotting the impedance permeability curve of a core and compare it with the standard critical curve provided by the supplier.
2. Accuracy of a very high degree should be maintained
3. The device should be a stand-alone device, which should have a user-friendly interface and should be easily operated by a non-technical person.
4. Time taken to perform a single test should be limited to a few seconds.
5. It should have a computer interface to support backup facilities, future changes and maintenance.

3. EXISTING METHOD OF TESTING AND PROBLEMS ENCOUNTERED.

3.1 Existing method of testing

The existing method of testing is based on measuring the B and H values of a point, which lies in normal operating range of the core, and comparing it with corresponding standard values.

3.2 Problems encountered

Consider a core that shows the Impedance Permeability characteristics.

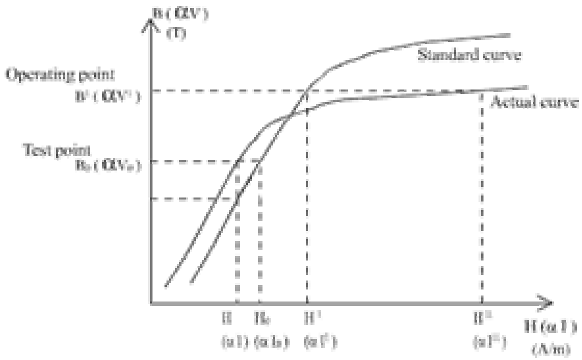

Figure 3.2 Comparison of standard and actual Impedance permeability Curves of the core.

The test point value of magnetic flux density (B_0) has been selected within the operating range.

According to the existing method test the above core is a good one since the measured value H is less than the standard value H_o for flux density B_o. But at the operating point B, the measured value H" is higher than the standard value H'. Therefore in the saturation region the performance of this core is poor. Hence a core that should be rejected is considered to be a good one.

4. PROPOSED SOLUTION AND IMPLEMENTATION

Proposed solution is to get a display of the Impedance permeability curve for the entire range and compare it with the standard one. If the impedance permeability curve of the core lies above the standard cure throughout the entire operating range the core is considered to be good.

4.1 The Implementation

The implementation of this system consists of three main sections. They are the Signal Generating Unit, Control & Signal Processing Unit and the Display Unit as shown in figure 4.1.

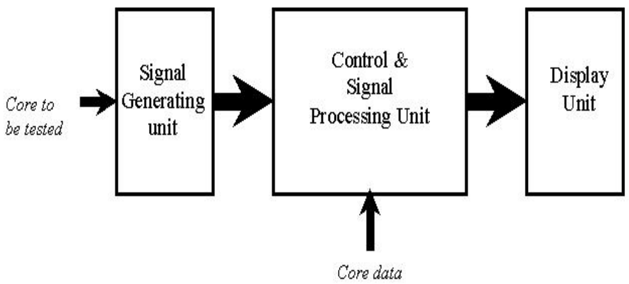

Fig 4.1 Main signal processing and flow diagram

4.1.1 Signal Generating Unit

This part is responsible for generating current and voltage signals required for the testing process. The detailed block diagram is given in figure 4.1.1.

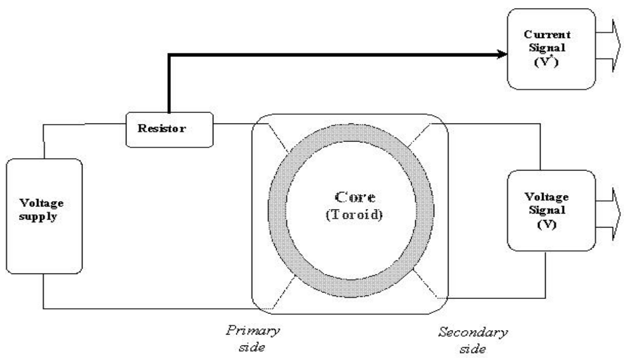

Fig 4.1.1 Capture unit block diagram

The core is tested with primary 13 turns and secondary 6 turns. Voltage is applied to primary coil through a resistor. Since the voltage across the resistor is proportional to the primary current, it is taken as the measure of primary current. The secondary side voltage is directly used for the testing without any modifications.

4.1.2 Control & Signal Processing and Display Unit

This is the main section of the system. The detailed block diagram of this unit is shown in figure 4.1.2.

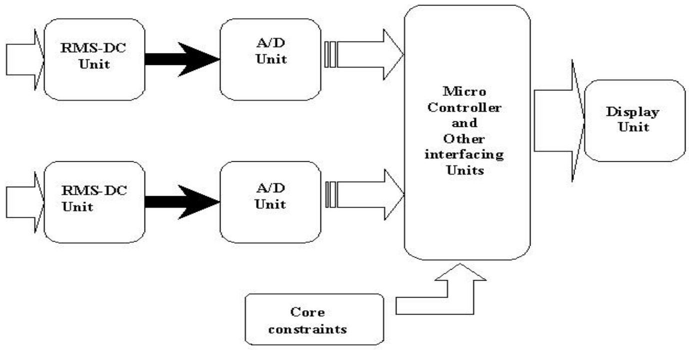

Figure 4.1.2 Control & Signal Processing and Display Unit

5. COMPONENTS AND COST

5.1 Rms to DC Unit

The major component of this unit is the MX536A (Maxim) True RMS-to-DC Converter IC module. This IC has the following characteristics.

- 2MHz Bandwidth for VRMS > 1V
- Single- or Dual-Supply Operation
- Low Power: 1.2mA
- Input signals from 0 to 7VRMS.

5.2 A/D Unit

This unit uses MAX 187 (Maxim) IC module which is serial 12-bit, 8.5μs successive-approximation analogue-to-digital converter (ADC).

- 12-Bit Resolution
- 75kHz Sampling Rate
- Single +5V Operation
- Low Power: 2μA Shutdown Current
  1.5mA Operating Current
- Internal 4.096V Buffered Reference
- 3-Wire Serial Interface

5.3 Micro Controller and Other interfacing Units

This unit does data processing, storing and analysing part. This section mainly consists of the microcontroller and other supporting units. ATMEL AT89S8252 microcontroller was used.

- Industry-standard 80C51 instruction set and pinout compatible
- Low-power; high-performance CMOS 8-bit microcontroller
- 8K bytes of downloadable Flash memory
- 2K bytes of EEPROM
- 256 bytes of RAM
- 32 I/O lines
- Programmable watch-dog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port

There are four input/output interfaces to the microcontroller.

- Interface to LCD Module
- Interface to Keypad
- Serial interface (Computer Interface) and
- Parallel interface (Programming Interface)

5.4 LCD

The LCD module (DMF-50840NB-FW-AKE-AS) is directly connected to the Microcontroller Port 2 through the LCD in built driver. This is produced by Optrex America and has the following specifications

- **Module Type**: Monochrome-Graphic
- **Size**: 5.7"
- **Type**: Transmissive
- **LCD Mode**: Black/White
- **Dot Format**: 320*240
- **Luminance**: 50
- **Data Transfer:** 4- bit parallel data transfer

5.5 Keypad

The Keypad is also directly connected to the Microcontroller through Port 1 and Port 0. This is 4 * 4 Array keypad produced by MULTICOMP

5.6 Power supply

- RMS-DC - Dual supply of +/- 15V.
- AD unit - Single supply of +5V
- Microcontroller and series interfacing unit - +5V
- LCD module - supply of +25 V and +5V.

5.7 Software Used

Microcontroller has been programmed using C language.

At the initial testing and development stages MS Visual Basic and Delphi were used to develop testing programmes and interfaces.

5.8 Cost

- Mx536 ICs = Rs. 2800 (1400 * 2)
- Max 187 ICs = Rs.5350 (2675 * 2)
- AT89S8252 = Rs. 1300
- DMF-50840NB-FW-AKE-AS = Rs. 8970
- Inverter = Rs. 2000
- Transformer = Rs. 500
- PCB = Rs. 3661
- Other components = Rs. 1650
- Overhead (30%) = Rs. 7870
- Total cost =Rs. 34101

6. RESULTS

At the initial stages a computer was used for processing and for the display unit. This is to ensure that the other components like Rms to DC unit and A/D unit are working correctly. Some of the results shown in figure 6.1 & 6.2.

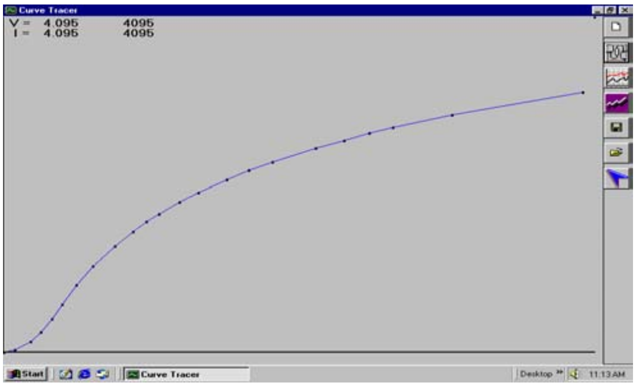

Fig 6.1 Screen plot of a V_{rms} Vs I_{rms} obtained for a typical core using Visual Basic

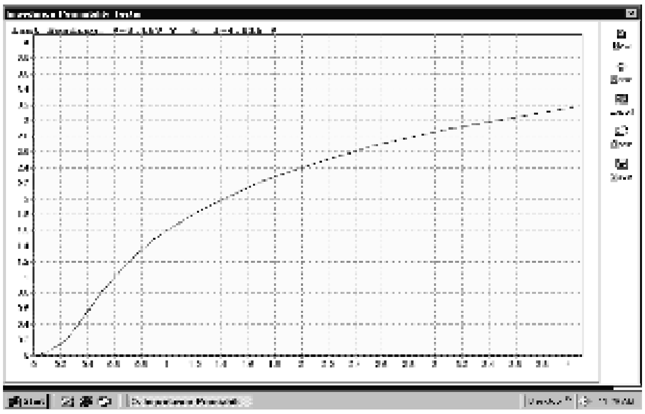

Fig 6.2 Screen plot of a V_{rms} Vs I_{rms} obtained for a typical core Using Delphi

Results obtained from the microcontroller by using the computer as a display unit is show in figure 6.3. The is shown in the numerical format since the implementation of LCD is in process. The first two columns are the values of the tested core and the next two columns are the values of the standard curve

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H = 574,  B = 910,  H' = 625,  B' = 910,
H = 685,  B = 1090, H' = 750,  B' = 1090,
H = 748,  B = 1220, H' = 1000, B' = 1220,
H = 810,  B = 1271, H' = 1250, B' = 1250,
H = 875,  B = 1330, H' = 1500, B' = 1330,
H = 962,  B = 1361, H' = 1750, B' = 1360,
H = 1054, B = 1393, H' = 1875, B' = 1370,
H = 1127, B = 1413, H' = 2000, B' = 1380,
H = 1250, B = 1432, H' = 2125, B' = 1390,
H = 1375, B = 1469, H' = 2250, B' = 1400,
H = 1620, B = 1511, H' = 2500, B' = 1410,
H = 1810, B = 1529, H' = 2625, B' = 1420,
H = 2250, B = 1599, H' = 2750, B' = 1430,
H = 2420, B = 1640, H' = 2875, B' = 1440,
H = 2710, B = 1657, H' = 3000, B' = 1450,
H = 3080, B = 1682, H' = 3125, B' = 1460,
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Fig 6.3 Results obtained from Microcontroller

The graph of this result is shown in figure 6.4

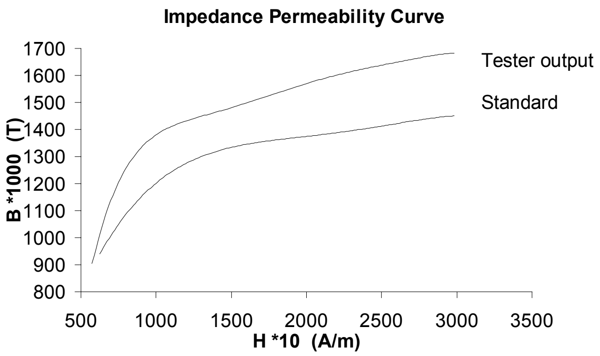
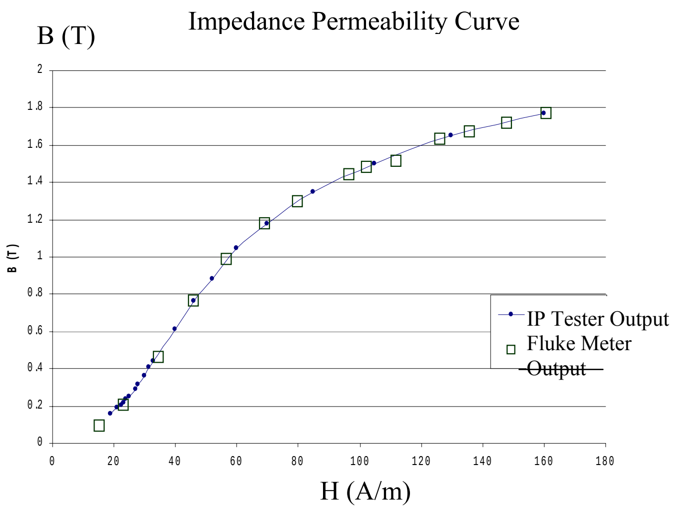


Figure 6.4 Graph of result obtained from microcontroller.

The whole unit was tested by comparing few characteristics curves drawn using the instrument with characteristics curves drawn using "Fluke True RMS meters". The graph in figure 6.5 shows the accuracy of the output.
Figure 6.5 Impedance Permeability Curve



7. BARRIERS ENCOUNTERED

There were many technical and other barriers, which hinder the project. Although we had sufficient financial and technical assistance, we found that certain components are too costly and certain technical solutions are difficult to implement.

These problems sometimes cause the degrading of the overall product. Although we had the ability to improve the performance of certain units by using more complex techniques and expensive components, we realized that doing so is not appropriate as the overall products performance is limited by certain units, which are not feasible to improve within our financial, and time frame.

One of the biggest barriers to this project was unavailability of components. Except for few common components, all the main components had to be imported. Since certain manufacturers, do not publish data sheets until we buy the product, we had to order only one product at a time and once we get the data sheet then go for the other components. This process slowed down the whole project. Even finding necessary compilers was challenging and took a long time.

9. CONCLUSION

The final product performs well enough to fulfil the industrial requirement. Since the product has been design in such a way that it can be modified and improved in the future, we can expect better versions of this product in operation in near future.

The overall project is a success and we are happy to announce that TOROIDS Company is quite happy with the product and has decided to use it in their quality control process. Finally we would like to say that these types of projects are really important for the developments of the industry and also the development of students. They help us lot to gain practical experience as well to develop a good relationship with the industry.

8. ACKNOWLEDGEMENT

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