Ultra Isolation Transformer Testing Unit

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Abstract— Many high end electronic equipments, rapidly expanding computer control systems and information networks are sensitive to spikes, surges and line transients. Due to power electronic circuits, welders, variable speed drives and SCR controls used in computers and many other electrical systems, electrical noise is introduced in power distribution system which leads to corruption of clean power. The electronic systems must be protected from high voltage surges and made immune to noise. If they are not suppressed they can cause memory loss in computer, component failure, scrambled data transmission etc. For AC systems, electrical noise is a distortion of the normal sine wave. Some effects noise has on electrical systems are data loss, computer lock-up, equipment malfunction, and occasionally destruction .These impulses are of very short duration of the order of the order of a microsecond to very few milliseconds. But their amplitude can range from hundreds to thousands of volts. They can be caused by lightning, mains line switching air conditioning or switching of any heavy duty machinery. Therefore, noise attenuation devices are a necessity. Although it is impossible to totally eliminate electrical noise, it is possible to drastically reduce it to tolerable levels. Electrical noise attenuation devices, such as, TVSS (Transient Voltage Surge Suppression), noise filters and shielded isolation transformers reduce electrical noise to safe levels. The objective of this project is to design a testing unit for ultra-isolation transformer for measuring its common mode noise attenuation capability. Noise attenuation is expressed as a ratio of the output transient energy (Vto) to the input transient energy (Vti), or by decibels (dB). The Common mode noise rejection should be about -100 dB. If this condition is satisfied, then we can conclude that the ultra-isolation transformer under test is able to eliminate common mode noise providing electrostatic shielding and protection against spikes, surges and transient noise.

Key words: Ultra Isolation, Transformer Testing Unit

I. INTRODUCTION

Present day electronic equipments are far more sophisticated than ever imagined. Any electrical system especially microprocessor based equipments such as industrial computers and data acquisition systems require clean noise free power supply. Noise or interference is any electrical signal which distorts or interfere with the original signal. Noise can be transient (temporary) or constant. Noise can be generated from within the system itself (internal noise) or from an outside source (external noise). [1]

Typical sources of noise are devices, which produce quick changes (spikes) in voltage or current or harmonics, such as:

- Large electrical motors being switched on
- Fluorescent lighting tubes
- Solid-state converters or drive systems
- Lightning strikes
- High-voltage surges due to electrical faults
- Welding equipment.[2]

Electrical systems are prone to such noise due to various reasons. Lightning and switching surges are two of these. These surges produce high but very short duration of distortions of the voltage wave. Another common example is 'notching', which appears in circuits using silicon-controlled rectifiers (power thyristors). The switching of these devices causes sharp inverted spikes during commutation (transfer of conduction from one phase arm to the next). Harmonics in supply system is another form of disturbance. Faults in power systems can also cause voltage disturbances. All these distortions and disturbances can find their way to sensitive electronic equipment through power supply mains connection and cause problem. Apart from these directly communicated disturbances, sparks and arcing generated in power-switching devices and high-frequency harmonic current components can produce electromagnetic interference (EMI) in signal circuits, which will require to be properly shielded or screened to avoid interference. [2]

There are two main types of noise, common mode and normal mode (also known as transverse mode). If a severe common-mode surge, such as a lightning surge, enters into a massive loop and comes into power lines by induction coupling, it propagates through the lines as a travelling wave. The wave runs along a pair of lines in the same direction until it reaches an isolation transformer installed for surge protection. It is not difficult to prevent such a surge from entering into electric devices by electric conduction. Entry can be prevented by carefully insulating the separate coils in the transformer with high-quality insulation material. [3]

It is imperative to protect the sensitive electronic equipment from harsh electrical environments; especially when time and production is at stake. The proper way of accomplishing the necessary protection is by resorting to the fundamentals of power conditioning (isolation and single point grounding).The transformer must be designed for the special needs of the switch-mode power supply in order to obtain the maximum effectiveness.[2][5]

Ultra isolation transformers are specially designed for sensitive critical equipment like industrial, computers & peripherals, medical instrumentation, digital communication telemetry systems, CNC Machines etc. and stopping such disturbances generated by the noisy equipment load from being injected into the power line. Ultra isolation transformer reduces electrical noise to safe levels. Although it is impossible to totally eliminate electrical noise, it is possible to drastically reduce it to tolerable levels. Ultra isolation transformer provides electrical and electrostatic isolation with the most effective screening of spikes, surges and transients. It predominantly eliminates the common mode noise and transverse mode noise and provides noise or interference free power.

The proposed system will be helpful in determining the common mode noise rejection capability of an ultra isolation transformer. It is designed to test the ability of

transformer to generate clean noise free output voltage. Noise attenuation is expressed as a ratio of the output transient energy (Vto) to the input transient energy (Vti), or by decibels (dB).

II. PROBLEM STATEMENT

Electrical noises can interfere in the operation of digital electronic equipment, microprocessors, sensitive devices, remote control equipments, and telecommunication equipments. Ultra isolation transformer eliminates all types of electrical noises predominantly common mode noises and transverse mode noise providing noise or interference free power. It provides electrical and electrostatic isolation with most effective screening of spikes, surges and transients.

The aim is to design a testing unit for ultra isolation transformer for measuring its common mode noise attenuation capability. This common mode noise attenuation capability is measured by: CMNR = 20log (Vo=Vi). The Common mode noise rejection should be about -100 dB. If this condition is satisfied, then we can conclude that the ultra isolation transformer under test is able to eliminate common mode noise and provide electrostatic shielding and protection against spikes, surges and transient noise.

III. METHODOLOGY

The proposed system is designed to test the noise rejection capability of ultra isolation transformer. If it rejects all electrical noises successfully then only it can generate clean noise and interference free power.

The system is designed by using the PIC16F877 micro-controller. The microcontroller calculates the common mode noise rejection ratio of the ultra isolation transformer by taking voltage values from transformer input sensing device and transformer output sensing device.

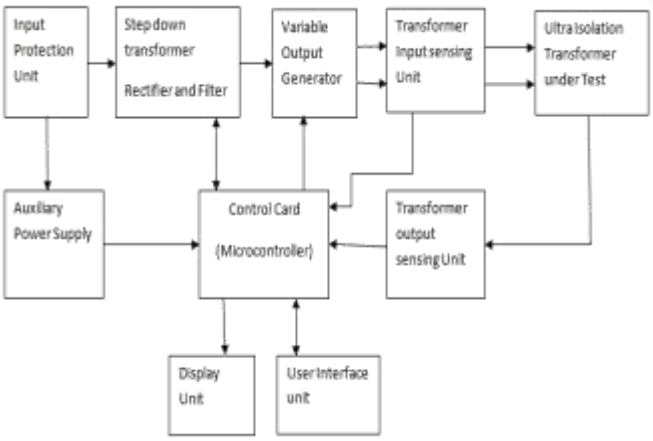

Fig 1: Block diagram of proposed system

A. Input Protection Unit

Input Protection Circuit consists of Fuse, MCB and on-off switch. A fuse interrupts excessive current ("blows") so that further damage by overheating or fire is prevented.

A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Its basic function is to detect a fault condition and interrupt current flow. It automatically switches off the electrical circuit during abnormal condition of the network means in over load condition as well as faulty condition. MCB is much more sensitive to over current than fuse.

B. Step Down Transformer, Rectifier and Filter

A transformer is a device that changes (transforms) and alternating potential difference (voltage) from one value to another value be it smaller or greater using the principle of electromagnetic induction. A step down transformer has less turns on the secondary coil than the primary coil. The induced voltage across the secondary coil is less than the applied voltage across the primary coil or in other words the voltage is steped down.

A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. Output of the rectifier is smoothed by an electronic filter usually a capacitor to produce a steady current. It converts the pulsating nature of the output waveform to steady form. It removes the ripple in the output waveform. If the circuit has just the right timing constant, it can act to smooth the output voltage, and once the voltage leaves the filter stage, most of the variations or "ripple" should be removed.

C. Variable Output Generator

It consists of H-bridge circuit and ferrite core transformer. H-bridge is a circuit, containing four switching element, with the load at the centre, in an H-like configuration. The switching elements (Q1..Q4) are usually bipolar or FET transistors, in some high voltage applications IGBTs. The top-end of the bridge is connected to a power supply and the bottom-end is grounded. Ferrite cores are used in transformers where the supply voltage has a high frequency. The combination of high permeability and high resistivity makes ferrite ideal for high frequency transformer core design. The ferrites have low leakage inductance. The property of high resistivity of the ferrites keeps the eddy current losses very small, at high frequencies.

D. Input and Output Sensing Unit

The input sensing unit sense the input voltage to be provided to the transformer under test and provides it to the controller. Similarly output sensing unit sense the output voltage of the transformer and provide it to the controller for CMNR calculation. Average CMNR is then calculated and displayed by the controller.

E. Ultra Isolation Transformer

In ultra isolation transformer the primary and secondary of the transformer are wound on separate cores ,multiple shielded and fully isolated from each other and ground to ensure extremely low inter winding capacitance. It acts as an effective, low pass filter and suppresses line transients, spikes and galvanic leakage to protect the system. Due to the total isolation from mains line the ultra isolation transformer output is extremely safe to handle and suitable for medical application as well.

With very special construction all types of electrical noise predominantly common mode noise is eliminated by this UIT. Since it isolates primary and secondary and separated neutral to ground bond on the secondary side it can be used to create separately derived source to combat current loops. High insulating materials

with special shielding techniques attenuate common mode noise as well minimize transverse mode noise.[6][7]

Fig 2: Ultra Isolation Transformer

F. Microcontroller PIC16F877

The PIC16 family is the most common used family from the PIC families. The great advantage of this PIC is a Flash memory, allowing to burn to the memory unlimited number of times. You can write the program and burn it to the memory inside the microcontroller. The PIC16F887 is one of the latest products from Microchip. It features all the components which modern microcontrollers normally have. For its low price, wide range of application, high quality and easy availability, it is an ideal solution in applications such as: the control of different processes in industry, machine control devices, measurement of different values etc. Some of its main features are listed below:

- RISC architecture
- Operating frequency 0-20 MHz
- Precision internal oscillator
- Power-Saving Sleep Mode
- Brown-out Reset (BOR) with software control option
- 8K ROM memory in FLASH technology
- In-Circuit Serial Programming Option
- 256 bytes EEPROM memory
- 368 bytes RAM memory
- 3 independent timers/counters
- Master Synchronous Serial Port (MSSP)

G. User Interface and Display Unit

User interface is the space where interactions between humans and machines occur. The goal of this interaction is to allow effective operation and control of the machine from the human end, whilst the machine simultaneously feeds back information that aids the operator's decision making process. User interface allows the frequency and input voltage to change manually. The display is provided to show the resulting CMNR value.

IV. RESULT

Sr. No.	Input Voltage	V1 (p-p)	V1 rms	V2= (V -V1)	CMNR
1.	950v	10.2	3.606 mv	946.394	-108.38 dB
2.	750v	7.7	2.722 mv	747.278	-108.77 dB
3.	500v	5	1.76 mv	498.24	-109.03 dB

Table 1: Results

V. CONCLUSION

Today's equipments require clean noise free power supply to perform optimally. There are various sources of noise. These noises tend to serious malfunctioning problems, data loss, component failure etc. The ultra isolation transformer is designed to eliminate these noises especially common mode noise. Conventional transformers are of almost no use in the protection of very low-immunity and large-scale computer controlled systems and networks from noise of high voltages. To protect such equipments from getting damaged from noise ultra isolation transformer can be used. But it is necessary to test the noise rejection capability of this ultra isolation transformer in order to get the noise free supply. The noise rejection capability of ultra isolation transformer can be verified by measuring the common mode noise rejection ratio (CMNR). This parameter decides how effectively the ultra isolation transformer rejects the common mode noise.

The proposed system can be utilized to test the noise rejection capability of an ultra isolation transformer effectively. We can test the CMNR for various voltage and frequencies. We can study the noise rejection capability also we can store the results for further reference.

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