Calibration of IEC1000-3-2 Harmonic Analysers

P.S.Wright

1. Abstract

A new measurement system for the calibration of Harmonic Analysers to IEC 1000-3-2:1995 [1] is described. Details are given of the measuring system components and their use for the calibration of this type of device. The problems in measuring signals composed of fluctuating harmonics are discussed. A method of calibration for a special case of this type of signal is described.

2. Introduction and Background

In an attempt to regulate the growth of distorting loads on the electricity supply system, an IEC standard, IEC1000-3-2 has been published which prescribes limits on current harmonic pollution generated by a given electrical appliance.

In order to make compliance tests on these electrical appliances, new analysing instruments sometimes known as "Harmonic" or "Power Analysers" are now marketed to assess the various aspects of the load as prescribed in the standard. Unfortunately some of the measurements described in the standard have proved difficult to make in a traceable fashion. Hence the need has arisen to find a method to provide an calibration for these analysers.

This paper describes a new calibration system which is now available for use with these analysers.

3. Description of the Calibration System

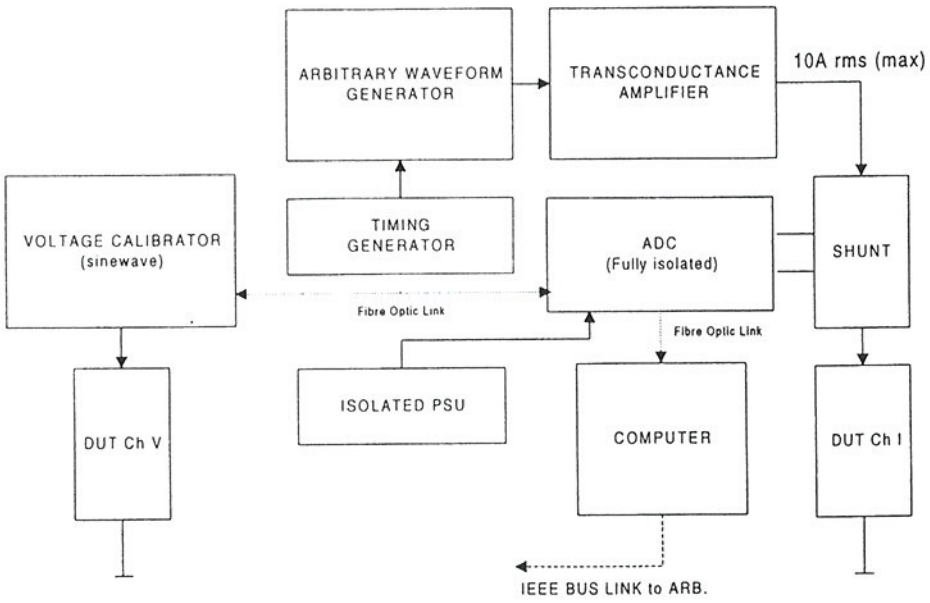

Figure 1, Harmonic Analyser Calibration System

P.S.Wright is with the National Physical Laboratory (NPL), Queens Road, Teddington, UK.

The calibration system is shown in Figure 1. The Device Under Test (DUT) is shown divided in to its separate voltage and current channels (ChV and ChI).

The components and method of operation of the system are described as follows.

3.1 ADC Measuring Head

The calibration system is based on an Analogue to Digital Converter (ADC). Various computer-based cards and units were tried for this purpose, however it was found that in general there were noise problems with these devices. Therefore, it was decided to construct a purpose built ADC measuring head isolated from the data processing computer.

The measuring head has 16-bit resolution and can operate at a maximum 100 kHz sampling frequency. It is powered by a highly isolated power supply unit [2]. Data exchange between the head and the computer is carried out using an optical-fibre [3]. The sampling clock signal is also sent via optical-fibre. Thus the head is fully isolated, the only point of electrical connection being the input terminals.

Signal conditioning consists of a differential input stage and anti-aliasing filter. The filter is based on a linear phase 7-pole Bessel response with -80db attenuation at 25 kHz. The filter is designed to have a stable and near-unity gain up to the maximum harmonic frequency of interest at 2 kHz.

The measuring head is calibrated over the required measurement frequency range using an electronic AC/DC measurement standard. This measurement is carried-out under computer control and corrections obtained which are automatically applied in subsequent measurements.

3.2 Waveform Generation

The IEC standard defines four classes of current wave shape named A, B, C and D. The maximum limits for these waveforms are given in the standard. In this measurement system, each wave class can be produced at either the limits or any proportion of the limits.

Generation is achieved using a commercial arbitrary waveform generator (ARB). Waveforms are sent via the IEEE bus to the ARB. The output voltage from the ARB, drives a transconductance amplifier to produce the current which is typically in the 1 to 5 A range. This current is then applied to a standard shunt resistor and to the device under test (DUT) current channel. With one terminal of the DUT at earth potential, the shunt will be at the voltage developed across the DUT, hence the need for the isolated and differential input ADC that samples the voltage developed across the shunt.

Currently the ARB has a 12-bit digital to analogue converter (DAC). It is hoped that this will be replaced by a higher resolution DAC for improved waveform definition

The sampling frequency for the measuring head is obtained by dividing the ARB sample clock and it is transmitted using an optical-fibre.

The voltage waveform in this phantom power system is assumed to be sinusoidal at 240 V, 50 Hz. This waveform is produced by a commercial calibrator. The calibrator is phase locked to the ARB using a synchronization pulse produced at the start of each current cycle. This pulse is sent using an optical-fibre in order that the voltage and current channels remain isolated.