

## APPLICATION NOTE - 007

### Measuring low THD with the PSM range

#### Introduction

Amongst the many measurement modes of the PSM range there is a harmonic analyser that can measure a single harmonic or can compute total harmonic distortion (THD) from a series of harmonics.

PSM units measure THD by simultaneous computing a DFT for each of the harmonics in the series up to the maximum number specified. The THD then is given by:

$$i = n$$
$$THD = \left[ \sqrt{\sum_{i=2}^n h(i)^2} \right] \times 1/h(1)$$

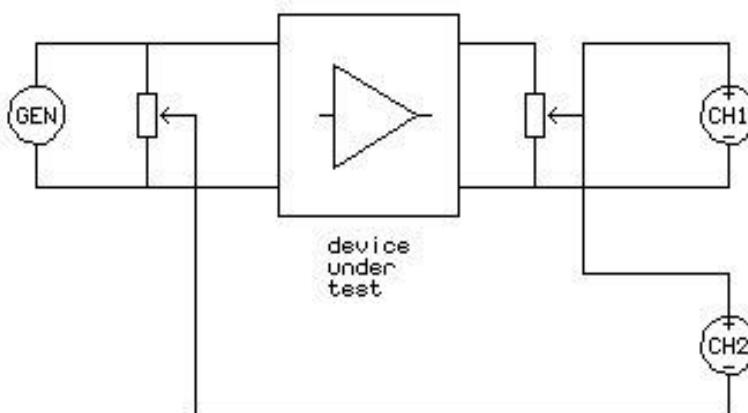
where  $h(i) = i^{\text{th}}$  harmonic  
and  $n = \text{maximum harmonic}$

THD is usually expressed in % or dB.

Because the measurement channels of PSM units are high performance with low distortion the distortion can be measured directly when the thd is above about 0.05%. To accurately measure thd distortion below this level, requires the enhanced harmonic measurement mode.

#### Enhance harmonic measurement

Most low distortion measurements are made on circuitry that also exhibits low phase shift, which allows the fundamental to be reduced and more accurate harmonic measurements to be made. The isolation and high CMRR on PSM inputs allow one channel to measure the fundamental component while the other channel measures the difference between the input signal and the output signal (distortion). The only external circuitry required is a high-quality attenuator to compensate for any gain in the system under test:





NB. only one attenuator is needed in any given test – use on the input if the forward gain of the DUT is 1 or lower, use on the output if the gain is greater than 1. The attenuator should be of low impedance so that the capacitance of the leads and inputs does not filter the signal.

Then the harmonic voltages are measured on channel 2 but divided by the fundamental value that is measured on channel 1 to give the percentage or dB. By cancelling the fundamental, channel 2 can range down to the level of the harmonics.

In order for the fundamental to be cancelled, the phase shift of the DUT needs to be low at the fundamental frequency. With a phase shift of 5 degrees, there is an out of phase component with a magnitude of <10%, which allows a 10 times increase in the accuracy of the measurement of the harmonic components. With a phase shift of 10 degrees, the out of phase component will be 17% of the fundamental, which would only allow a fivefold increase in the accuracy.

APP007 - Measuring low THD	June 2021	Doc ref: D000301_3
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