EVALUATION YOKOGAWA WT210 FOR STANDBY POWER

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Abstract

We have evaluated the Yokogawa WT210 Power meter performance using the IEC 62301 Ed. 2.0 standard. Using challenging signals the Yokogawa WT210 was checked if it would fulfill the requirements of the standard.

Introduction

The requirements of the IEC 62301 Ed. 2.0 states for the power values greater or equal to 1,0 W then the uncertainty should be less than 2% of the measured value. For measured power values less than 1,0 W the uncertainty should be better than 0,02 W while the Maximum Current Ratio (MCR) ≤ 10. If the MCR $>$ 10 an equation is used to calculate the required uncertainty. The Yokogawa WT210 is compared to a high speed sampling Wattmeter calibration system.

High Speed Sampling Wattmeter

A high speed sampling wattmeter was developed to calibrate from DC to 1 MHz power. This system is excellent in calibrating high frequency power, distorted waveforms and harmonics.

Generator

The generator for the signals is a Yokogawa FG 320. This is a two channel arbitrary waveform generator. The output of the generator drives wide band amplifiers (DC – 1 MHz). The amplifiers generate the reference Voltage and Current. The total harmonic distortion of the Voltage signal is smaller than 0,1% at 230 Volt. The current amplifier is able to drive from 0 to 5 A.

Front end

The front end is the part that converts the voltage and current to a 1 Volt signal that the sampling system uses for the A/D input. The 230 Volt is converted to a 1 Volt signal by using a capacitor compensated resistance divider. To convert the current into a 1 Volt signal a special wide band shunt was developed. The 1 Volt signals is fed to a differential amplifier to avoid common mode effects.

Sampling System

The core of the sampling system is the NI-5922 A/D converter. This is a high speed high resolution converter. Running on 500 kS/s the resolution is 24 bits. At a maximum of 15 MS/s the resolution is still 16 bits. There are two input channels using the same clock source. Using software we are able to calculate the voltage, current, power, etc. The accuracy of the total system is many times higher than needed for the IEC 62301 Ed. 2.0 standard. Therefore we are able to check the Yokogawa WT210 against the sampling system.

Measurements

We used the standby power software from Yokogawa to read out the values measured by the Yokogawa WT210 power meter. A minimum of five minutes was set and the averaged value was taken. During the five minutes the applied signals where stable. The voltage was sine wave of 230 Volt. The current range was set to auto. The WT230 measures the peak current and select the proper current range.

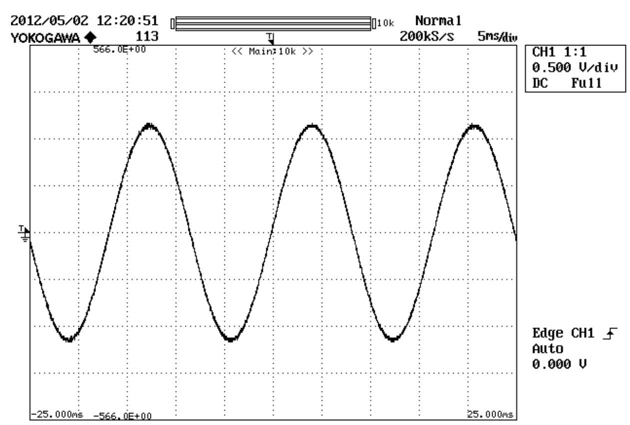

Figure 1 Applied Voltage Signal

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For the first measurement a sine waveform was used for the current range and a power factor of 1.

First measurement:

Current waveform	: sine
Voltage	: 230 Volt
Power factor	: 1
Phase	: 0 °
Crest factor	: 1,41
Apparent power	: 2,3003 VA
Reference Power	: 2,3003 W
WT210 Power	: 2,3014 W
Difference	: 0,0011 W
Relative difference	: 0,049 %

Conclusion:
The power is > 1,0 W the 2% requirement is met.

Second measurement:

Current waveform	: sine
Voltage	: 230 Volt
Power factor	: 0,1043
Phase	: 84,002 °
Crest factor	: 1,41
Apparent power	: 4,8302 VA
Reference Power	: 0,5053 W
WT210 Power	: 0,5050 W
Difference	: -0,0003 W
Relative difference	: -0,057 %

Conclusion:
The power is < 1,0 W so the 0,02 W requirement is met.

Next the current wave form is changed into a pulse shaped wave form with a very high crest factor.

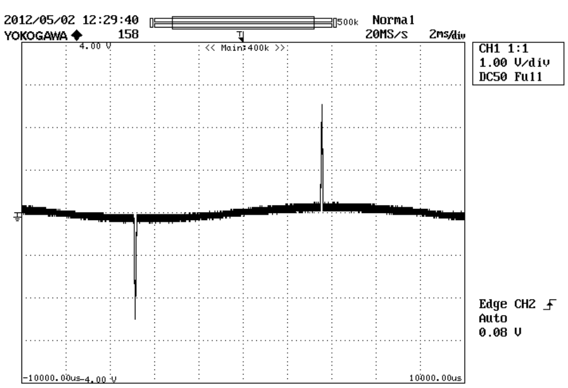

Figure 2 Applied Current Signal

Third measurement:

Current waveform	: pulse shape
Voltage	: 230 Volt
Power factor	: 0,1043
Phase	: 84,002 °
Crest factor	: 11
Apparent power	: 4,8302 VA
Reference Power	: 0,7571 W
WT210 Power	: 0,7580 W
Difference	: 0,0009 W
Relative difference	: 0,113 %

In this situation the MCR is bigger than 10.

$$MCR = \frac{Crest\ Factor\ (CF)}{Power\ Factor\ (PF)} = \frac{11}{0{,}1043} = 105$$

The permitted uncertainty is determined using the following equation:

$$U_{pc} = 0{,}02 \times [1 + (0{,}08 \times \{MCR - 10\})]$$

$$U_{pc} = 0{,}02 \times [1 + (0{,}08 \times \{105 - 10\})] = 0{,}172$$

$$U_{pc} \times measured\ value = 0{,}172\ \times 0{,}758 = 0{,}130\ W$$

Here the difference between the reference value and WT120 reading is only 0,0009 W it met the required uncertainty of 0,130 W by far.

Fourth measurement:

Current waveform	: pulse shape
Voltage	: 230 Volt
Power factor	: 0,0521
Phase	: 87,012 °
Crest factor	: 11
Apparent power	: 0,9955 VA
Reference Power	: 0,0520 W
WT210 Power	: 0,0520 W
Difference	: 0,0000 W
Relative difference	: 0,00 %

In this situation the MCR is bigger than 10.

$$MCR = \frac{Crest\ Factor\ (CF)}{Power\ Factor\ (PF)} = \frac{11}{0{,}0521} = 211$$

The permitted uncertainty is determined using the following equation:

$$U_{pc} = 0{,}02 \times [1 + (0{,}08 \times \{MCR - 10\})]$$

$$U_{pc} = 0{,}02 \times [1 + (0{,}08 \times \{211 - 10\})] = 0{,}342$$

$$U_{pc} \times measured\ value = 0{,}0520 \ \times 0{,}342 = 0{,}0178\ W$$

Because the U_{pc} < 0,02 W the uncertainty requirement will be 0,02 W

Here the difference between the reference value and WT120 reading is 0,0000 W it met the required uncertainty of 0,02 W.

Fifth measurement:

Current waveform	: pulse shape
Voltage	: 230 Volt
Power factor	: 0,296
Phase	: 72,773 °
Crest factor	: 11
Apparent power	: 0,2230 VA
Reference Power	: 0,06805 W
WT210 Power	: 0,06810 W
Difference	: 0,00005 W
Relative difference	: 0,068 %

In this situation the MCR is bigger than 10.

$$MCR = \frac{Crest\ Factor\ (CF)}{Power\ Factor\ (PF)} = \frac{11}{0{,}296} = 73$$

The permitted uncertainty is determined using the following equation:

$$U_{pc} = 0{,}02 \times [1 + (0{,}08 \times \{MCR - 10\})]$$

$$U_{pc} = 0{,}02 \times [1 + (0{,}08 \times \{73 - 10\})] = 0{,}0635$$

$$U_{pc} \times measured\ value = 0{,}0635 \ \times 0{,}0681 = 0{,}0043\ W$$

The U_{pc} < 0,02W the uncertainty requirement will be 0,02 W

Because the difference between the reference value and WT120 reading is 0,00005 W it met the required uncertainty of 0,02 W.

Table 1. Summary

Measurement	Required Uncertainty	Measured Deviation
1	±2 %	0,049 %
2	±0,02 W	-0,0003 W
3	±0,130 W	0,0009 W
4	±0,02 W	0,0000 W
5	±0,02 W	0,00005 W

Conclusion

Using the challenging and extreme signals the Yokogawa WT210 fulfills the requirements of the IEC 62301 Ed. 2.0 standard.
It is recommended to calibrate the Yokogawa WT210 at regular intervals.