

Universidad Técnica Federico Santa María
Departamento de Electrónica

Assessing Harmonic Current Distortion at PCC 220 kV with RPM

I. Generalities:

In the Chilean industrial sector, with facilities with high-power rectifiers, nowadays the harmonic limits of Std. IEEE 519-92 are taken as reference for energy contracts concerning the harmonic distortion at point of common coupling (PCC). The question is if the RPM instrument (multipoint) is useful for this evaluation.

1. For 220 kV, with $I_{SC}/I_L < 50$ the Current Distortion Limits for individual harmonic orders h are:

ISC/IL <50	h<11	11 ≤h<17	17≤h<23	23≤h<35	35≤h	THD
	2%	1%	0.75%	0.30%	0.15%	2.50%
Even harmonics are limited to 25% of the odd harmonic limits above						

2. Limits of even harmonics $35 \leq h$, should be as small as $25\% \cdot 0.15\% = 0.0375\%$. (Because this group of high-frequency are non-characteristic harmonics, this group may be neglected as first approach).

3. Commonly, the current measurements of a Harmonic Analyser are taken from metering CT's with 0.2% accuracy class, at the secondary side 5 Amps.

II. We made following measurement in a mining facility El Tesoro @220 kV PCC with instrument RPM (Multipoint).

Situation: It was used a (IEC 60044-1) CT 200/5 Amps (ratio=40), 0.2% Accuracy class. Measured $I_L = 67$ Amps. The corresponding limit values IEEE-519-92 are:

ISC/IL <50	h<11	11 ≤h<17	17≤h<23	23≤h<35	35≤h	THD
	2%	1%	0.75%	0.30%	0.15%	2.50%
$I_L = 67$ Amps	1.3 A	0.67 A	0.503 A	0.201 A	0.101 A	1.675 A
Even harmonics are limited to 25% of the odd harmonic limits above						

Concerning odd characteristic harmonics

Situation: In the frequency range $23 \leq h < 35$, we have measured for $h=23$, $I_{23}=0.415$ A ($0.415A/67$ A =0.62%). The IEEE-519-92 limit is 0.201 A (0.3%).

Considering only the instrument error:

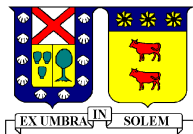
Error1: Discretization error E_c .

Using input range: 20 Amps rms

Input range peak-peak= $2 \cdot 1.4142 \cdot 20 = 56.568$ Amps peak

Resolution: 14 bits

N=Number of discretization levels: $2^{14} = 16384$



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Delta=Dinamic range/N=56.568/16384=0.00345 Amps peak
Statistic error Amp peak= 50%*delta=0.5*0.00345 Amps peak=0.001726 Amps peak
Statistic error, Amp rms=0.001726/1.4142= **0.00122 Amps rms**

@220 kV side, using CT 200/5 A, **Error Ec=(200/5)*0.00122=0.049 Amp rms**

Error 2: Analog error Ep: {metering CT error (+/-5%) + Analog Instrument error (+/-1%)}= +/-6%

The CT 200/5 A was supposed to have flat frequency response (+/- 5%).

I_{meas}=I_{real}*(1+Ep)+Ec

a) Ep=+6%, max. Additive error

$V_{real}=(V_{meas}-E_c)/(1+Ep)$
 $= (0.415-0.049)/(1+0.06)=\mathbf{0.345\ A} > \text{Limit IEEE-519-92 (0.201 A)}$

b) Ep=-6%, máx subtractive error

$V_{real}=(V_{meas}-E_c)/(1-0.06)=\mathbf{0.494\ A} > \text{Limit IEEE-519-92 (0.201 A)}$

We believe the instrument is accurate enough to say IEEE-519-92 is not met.

Question: Do you agree with this conclusion based on the shown measurement?

Your soon comments are welcome. Thanking your attention,

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