APPLICATION NOTE #117

iX Series / i Series AC Source for IEC 1000-3-2 Applications

Introduction

Product testing for compliance with the IEC 1000-3-2 current harmonics standard requires the use of an AC source. Any AC source used must meet the AC source requirements set forth in the standard. This relates in particular to the maximum amount of total harmonic distortion of the AC source output voltage under worst case load conditions. When the AC source is used to drive a load that falls just within the IEC 1000-3-2 current harmonic limits, the voltage distortion must be below the limits set by the standard during the entire test run. If not, the test data is invalid as it is no longer possible to determine whether the current harmonics were introduced by the load or the AC source. Use of the public utility as a source for IEC 1000-3-2 testing is not recommended, as the voltage distortion in most public networks often exceeds the IEC limits.

The suitability of a particular AC source relates directly to the dynamic output impedance. Generally, the lower the impedance, the better. Do not confuse dynamic output impedance with static output impedance, which can be corrected with load sensing voltage control.

Voltage distortion limits

Even Harm	Limit (% of V_{RMS})	Odd Harm	Limit (% of Vrms)
2	0.2 %	3	0.9 %
4	0.2 %	5	0.4 %
6	0.2 %	7	0.3 %
8	0.2 %	9	0.2 %
10	0.2 %	11 - 39	0.1 %
12 - 40	0.1 %		

Table 1: IEC 1000-3-2 Voltage harmonics limits

Maximum voltage distortion limits for AC source qualification are expressed in a percentage of the fundamental voltage amplitude for the first 40 voltage harmonics. If this maximum distortion level is exceeded at any time during the test, the test data becomes invalid. The specific harmonic voltage limits set forth by the IEC 1000-3-2 standard are listed in Table 1. The total harmonic distortion (THD) of this waveform equals only 1.2 %.
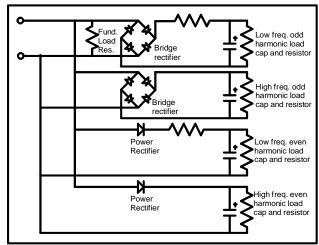

Figure 1: Harmonic AC Source qualification test load schematic.

Checking AC Source Distortion

Testing an AC source for voltage distortion under the IEC 1000-3-2 worst case conditions requires the use of a complex load that produces current harmonics close to or equal to the maximum harmonic current limits allowed under the standard. Since the maximum load specified under the standard draws 16 Amps RMS of fundamental current, the load must be rated for this current. A sample load that generates a current harmonic pattern close to the IEC 1000-3-2 standard is shown in Figure 1. This type of load simulates conditions of a load that would still pass the

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requirement.

With the load connected, harmonic distortion measurements must be made. Since it is unlikely that each individual current harmonic of the load is exactly at the standard's limit, some interpolation may be required, i.e. ratio the voltage distortion up or down, assuming simple ohms law applied to the current, and a fixed output impedance over the small range considered.

Test Data for iX Series and i Series AC Sources

The California Instruments' iX Series and i Series of programmable AC sources is a family of high power, low distortion units offering very low dynamic output impedance. This makes them ideally suited for IEC 1000-3-2 testing. The test data shown in Table 2 shows the actual voltage harmonics with the load depicted in Figure 1 connected. As some of the current harmonics exceed the IEC 1000-3-2 standard limits, some interpolation is used. The load current values for each harmonic are shown in column 2. Column 3 shows the IEC 1000-3-2 specification current limits. While this load would fail the test on several harmonics, it provides a good load for harmonic voltage distortion testing of the source as it is close to or over the limit on most harmonics. The actual voltage distortion of the AC source is shown in column four. The allowable limits are shown in column 5. If we interpolate these values for the difference between actual current harmonics and specification limits (column 6), the AC source meets the source requirements easily.

Conclusion

From this data it is clear that the iX Series and i Series both exceed the source requirements for the IEC 1000-3-2 standard. For IEC 1000-3-3 (Flicker) testing, the iX Series source can be used as it offers a programmable output impedance. The i Series requires use of the optional OMNI-3-18i reference impedance for flicker testing.

The California Instruments Compliance Test System (CTS) uses an iX Series AC source and offers both IEC 1000-3-2 and IEC 1000-3-3 source and measurements for either single or three phase applications.

n	Load Current		Voltage Distortion		Interpolated Distortion
1	2	3	4	5	6
Harm.	Actual (I_A)	Spec Lim (I_L)	Actual $(A_\%)$	Spec Limit	D%= $A_\% * (I_L/I_A)$
2	1.853	1.62	0.078	0.200	0.068
3	3.837	3.45	0.380	0.900	0.342
4	1.139	0.65	0.072	0.200	0.041
5	2.226	1.71	0.130	0.400	0.100
6	0.463	0.45	0.057	0.200	0.055
7	1.073	1.16	0.112	0.300	0.121
8	0.126	0.35	0.019	0.200	0.053
9	0.700	0.60	0.065	0.200	0.056
10	0.190	0.28	0.096	0.200	0.141
11	0.718	0.50	0.089	0.100	0.062
12	0.254	0.23	0.050	0.100	0.045
13	0.605	0.31	0.083	0.100	0.043
14	0.252	0.20	0.037	0.100	0.029
15	0.418	0.23	0.083	0.100	0.046
16	0.173	0.18	0.020	0.100	0.021
17	0.371	0.20	0.093	0.100	0.050
18	0.104	0.16	0.040	0.100	0.062
19	0.357	0.18	0.082	0.100	0.041
20	0.104	0.14	0.026	0.100	0.035
21	0.279	0.16	0.074	0.100	0.042
22	0.119	0.13	0.041	0.100	0.045
23	0.228	0.15	0.066	0.100	0.043
24	0.119	0.12	0.034	0.100	0.034
25	0.209	0.14	0.069	0.100	0.046
26	0.098	0.10	0.032	0.100	0.033
27	0.165	0.13	0.072	0.100	0.057
28	0.063	0.10	0.035	0.100	0.056
29	0.105	0.12	0.055	0.100	0.063
30	0.058	0.09	0.027	0.100	0.042
31	0.069	0.11	0.024	0.100	0.038
32	0.057	0.09	0.025	0.100	0.039
33	0.054	0.11	0.023	0.100	0.047
34	0.043	0.08	0.027	0.100	0.050
35	0.041	0.10	0.009	0.100	0.022
36	0.030	0.08	0.017	0.100	0.045
37	0.040	0.09	0.028	0.100	0.063
38	0.013	0.07	0.008	0.100	0.043
39	0.052	0.09	0.021	0.100	0.036
40	0.014	0.07	0.016	0.100	0.080

Table 2 : iX Series and i Series AC source voltage harmonics under 'worst' case IEC 1000-3-2 load

Before selecting an AC source or IEC test system for IEC testing, be sure to verify compliance of the AC source to the source requirement portion of the IEC 1000-3-2 standard.

Note: Data shown in this application note supersedes data shown in application note # 109.

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