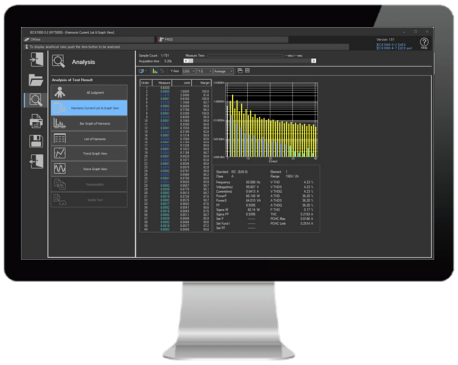
YOKOGAWA

Application Note

Harmonic and Voltage fluctuation/flicker measurement according to IEC61000

IS8000 Integrated Software Platform



1. Introduction

The 50/60Hz commercial power supply waveform is a sine wave, but when a device such as an inverter-driven motor or switching power supply is connected, a frequency component that is an integer multiple of the 50Hz/60H signal is generated from the device, distorting the commercial power supply. If a distortion signal containing this harmonic component is applied to home appliances or OA equipment via the power supply line, various adverse effects such as overheating and malfunction of the equipment occur.
The current flowing through a refrigerator instantaneously increases the instant its compressor operates, which results in a voltage drop in the power supply. This load fluctuation causes the lighting equipment (incandescent light bulb) to flicker, giving discomfort to humans.
To suppress such harmonics and voltage fluctuation/flicker, there are regulations on harmonics and voltage fluctuation/flicker.
Detailed measurement methods, supply voltage settings, and others are specified for the harmonic/flicker standard test. The contents of the standards are reviewed and revised periodically, and engineers must stay current with the specialized knowledge and up-to-date information to carry out the latest compliance test.

2. Challenges

Harmonic current and voltage fluctuation/flicker measurements require a current measurement instrument (power measurement instrument) that is capable of measuring current/voltage with high accuracy according to the IEC standards. The types of the standards are IEC61000-3-2, 3-3, 3-11, and 3-12 and each has different measurement procedures and standard values. Accordingly, the procedure is very complicated and troublesome even for someone familiar with the standard. For example, the limits defined in IEC61000-3-2, which is the harmonic current measurement standard, apply to a variety of devices and are divided into class A, B, C, and D. It is relatively easy to choose a class depending on the EUT and it is possible to determine whether the harmonic current of the EUT is within the limits by calculating harmonic measurement data from measured data. However, it is difficult to calculate the correct value and to judge pass or fail according to the IEC61000-3-2 without a thorough knowledge of the IEC standards.
The power source is on during measurement as a measurement procedure and it should be turned off for safety when changing the measurement target or when the test is completed. Even so, if the procedure is followed incorrectly, the power source may be turned off during the measurement. In that case, the test must be started over again. The timing of on/off of the power source is important. Additionally, if a wrong class is chosen for judgment after measurement, a retest is required, which consumes more time and effort.
As various condition settings and operating procedures should be carried out correctly in the test, human error is likely to occur. There is, therefore, a demand for standard test software that enables a user to easily perform operations from condition setting to final test report creation without any specialized knowledge.

3. IS8000 Solution

- Supported IEC/JIS standards
- Preset test menu*
- PASS/FAIL judgment by high-precision power measurement*
- Easy testing by Power Supply* Control (included as standard)*
- Detailed analysis of pass/fail judgment and measurement result data*
- Trend display of Harmonic current in time series
- Report output function

*The solutions are described using the example of the IEC61000-3-2 standard.

4. IS8010 Solution (Detailed descriptions)

4.1 Supported IEC standards

Harmonic measurement and voltage fluctuation/flicker measurement comply with the following standards*.

Harmonic standards

IEC 61000-3-2: Ed3.0 (2005), Ed3.0 A2 (2009),
IEC 61000-3-2: Ed4.0 (2014), Ed5.0 (2018)
EN61000-3-2: 2006, 2009, 2014
IEC 61000-3-12: Ed1.0 (2004), Ed2.0 (2011)
EN 61000-3-12: 2005, 2011
IEC 61000-4-7: Ed1.0 (1991), Ed2.0 (2002), Ed2.0 A1 (2008)
EN 61000-4-7: 1993, 2002, 2009

Voltage fluctuation/flicker standards

IEC 61000-3-3: Ed2.0 (2008), Ed3.0 (2013)
IEC 61000-3-3: Ed3.0 A1(2017)
EN 61000-3-3: 2008, 2013, 2019
IEC 61000-3-11: Ed 1.0 (2000)
EN 61000-3-11: 2000
IEC 61000-4-15: Ed1.1 (2003), Ed2.0 (2010)
EN 61000-4-15: 2003, 2011
*As of January 2021

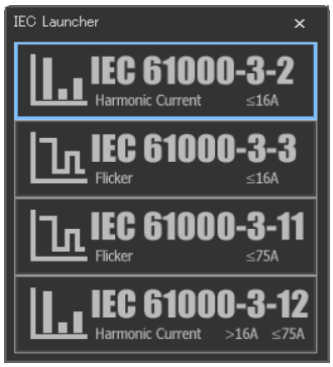


Figure 1. IEC standard evaluation menu

4.2 Preset test menu

Five types of preset test menus are provided. A user can choose from “New Measurement” for performing a test for the first time, “Save Data Analysis” for analyzing/reanalyzing the measured data, “Save Data Print” for reading out the data and outputting it to a report, “Repeat Measurement” for repeating the test to check the repeatability of the test data, or " Simple Test Measurement" for testing the upgraded model of the equipment that has been tested previously. Users can easily complete the process up to the final report output (data saving) by following the procedure. For example, in the case of New Measurement, it starts with making a communication connection between the WT5000 and a PC, goes on to setting, measurement, analysis, and report printing, and ends with data saving.

Since the test data analysis work is the data confirmation work, it is not necessary to perform analysis if the overall judgment is PASS. Furthermore, Simple Test Measurement automatically determines whether or not the conditions for applying the simple test are met just by loading the compliance test data of the EUT's conventional model tested previously. If the conditions are not met, a message is displayed and the simple test cannot be applied, preventing mistakes in testing.

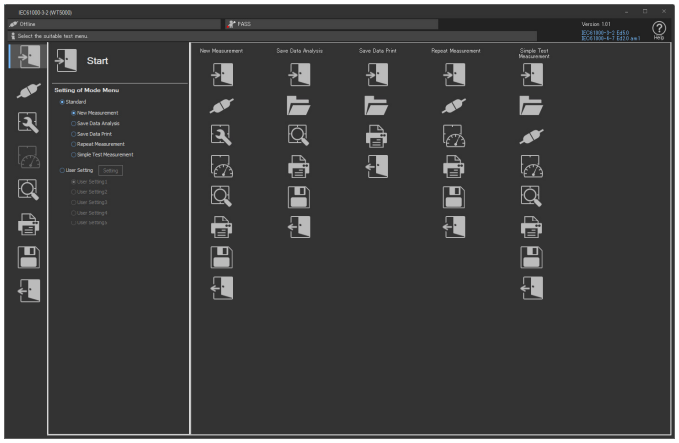


Figure 2. Standard test measurement menu screen

4.3 power measurement

Specify Class A, B, C, or D according to the test target, and then pass or fail is automatically determined based on the judging criteria for the specified class. A judgment graph of measured values is available besides a list of measured values. The limits and judgment results for each harmonic order are displayed color-coded in the graph. Also, the software has a convenient function that allows a user to load the saved data file, change the class, and then make a judgment again. High-precision power measurement (a high-precision power analyzer) is useful particularly in a test to determine whether or not the power consumption of Class C lighting equipment exceeds 25 W, or the power consumption of a class D refrigerator exceeds 600 W.

The WT5000 can measure the active power with the world's best in class accuracy. It is also capable of measuring the power factor, which needs to be checked in Class C. Since the circuit power factor is calculated by dividing the active power by the apparent power, a more accurate power factor can be calculated* by using the WT5000.

*A user may also specify a value and perform a compliance test.

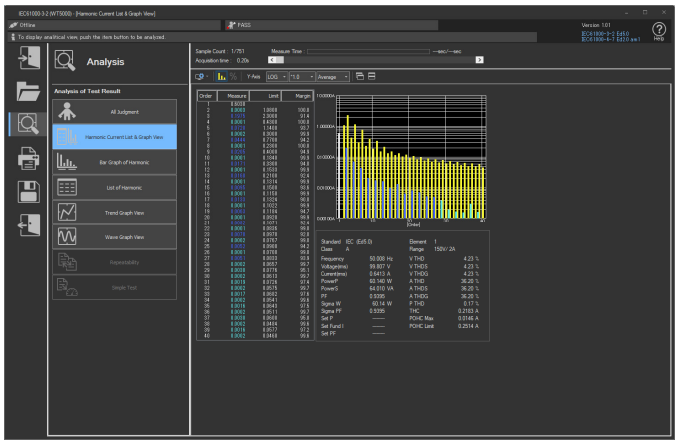


Figure 3. Example of test results using the power values of a high-precision power analyzer

4.4 Easy testing by Power Supply* Control (included as standard)

In the IEC standard test, power is supplied to the EUT for testing, so the linkage between the ON/OFF of the power source and software is important for a safe test procedure. With GP-IB communication*, the IS8010 IEC harmonic/flicker measurement software can perform the test safely while remotely controlling the WT5000 Precision Power Analyzer and NF CORPORATION Power Source ES series or DP series from outside the EMC test room.
Voltage fluctuation/flicker measurement requires a test using the power source and RIN (Reference Impedance Network) ES4152 (single-phase, for ES series or ES4153 (single-phase/three-phase, for ES series). They also can be controlled from the IS8000.

*NF CORPORATION power supply: Programmable AC Power Source ES series, Programmable AC Power Source DP series
*When operating the WT5000 only, Ethernet communication and USB communication are available.

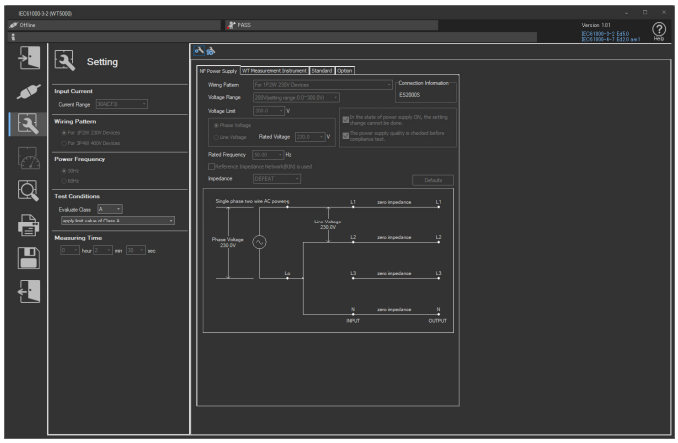


Figure 4. Setup screen of supply source and RIN

4.5 Detailed analysis of pass/fail judgment and measurement result data

Pass/fail judgment is important in the IEC standard test. Not only the pass judgment reports or the test conditions but also the acquired test data can be stored as a file. If a user checks the details of a report and finds a value close to the limit value in harmonic data at a later date, the user can read out the test data on the software and see when and at what timing the harmonic data was generated. There is a concern that a passed EUT whose test data is barely below the standard limit may fail when tested again or tested by an external certification body due to the fluctuations in power consumption or differences in the test environment. For that, the IS8010 IEC harmonic/flicker measurement software allows a user to specify a margin to the limit as a percentage while the standard limits are fixed. For example, when the limit is 1A, judgment* is made using the limit of 0.9 A by setting the margin degree to 10%.
Furthermore, called data can be judged according to the JIS or IEC standards. Users may also specify* the edition of JIS and IEC. All test data can be saved as CSV data, which can be used in EXCEL.

*Some specifications may not be changed if there are differences in measurement methods related to the IEC61000-4-7 standard.
*The compliance test needs to be performed with the margin degree set to 0.00%.

4.6 Trend display of Harmonic current in time series

The harmonic component limits are specified for each harmonic order. Harmonic components may increase or decrease within the measurement period. Even the harmonic components of a passed EUT may become very close to the limit at a certain operation timing or may become unstable at some orders and stable at others. Time-series trend display is a very useful function that displays these order data in time series, allowing users to confirm the correlation between the device operation and the harmonic data. As the software can display the trend of harmonic components of voltage, power, and power factor as well as current, the correlation between current and voltage or the correlation between power and power factor can be confirmed in detail.

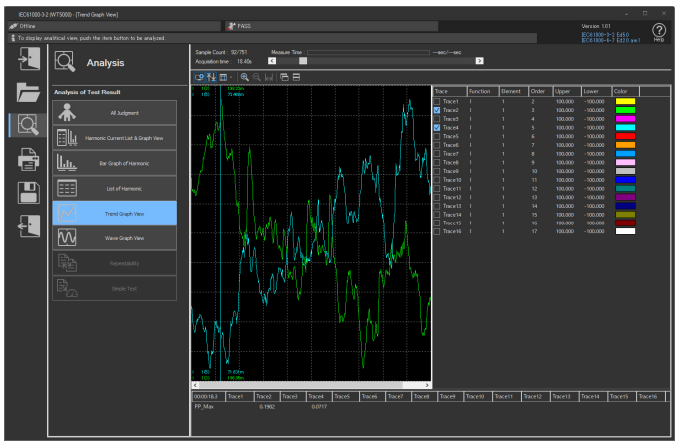


Figure 5. Trend graph analysis (fluctuations in 3rd harmonic)

Version	Version 6.61											
Measurement Date	: Tue May 12 08:44:34 2020											
Data Cour	751											
Element1	[U]											
	TOTal	DC	1	2	3	4	5	6	7	8	9	10
0	99.59906	0	99.51035	0.009675	1.1672	0.007804	3.591631	0.00741	1.273218	0.006199	0.350502	0.005692
1	99.60186	0	99.5131	0.009953	1.171341	0.00828	3.591967	0.007572	1.271142	0.006363	0.352395	0.005885
2	99.61397	0	99.52525	0.009694	1.172596	0.008007	3.590626	0.007797	1.271559	0.00645	0.352043	0.00588
3	99.61223	0	99.52361	0.009391	1.17224	0.007891	3.588588	0.007624	1.27108	0.006475	0.351534	0.005854
4	99.61347	0	99.52487	0.009589	1.172135	0.008021	3.587986	0.007499	1.270988	0.00662	0.350915	0.005978
5	99.61597	0	99.52744	0.009463	1.171793	0.008008	3.58683	0.007388	1.270658	0.006508	0.350669	0.006036
6	99.6212	0	99.5327	0.009514	1.171368	0.00808	3.586196	0.007181	1.270478	0.006376	0.35067	0.006065
7	99.62525	0	99.53678	0.009189	1.171376	0.007965	3.585645	0.007297	1.270684	0.006223	0.350489	0.00628
8	99.63039	0	99.54195	0.009181	1.171339	0.008081	3.584859	0.007388	1.270906	0.006049	0.350265	0.00632
9	99.6338	0	99.54542	0.009378	1.170378	0.008266	3.584239	0.007165	1.271054	0.00571	0.349385	0.006645
10	99.64039	0	99.55201	0.009475	1.169354	0.008333	3.583985	0.007333	1.272281	0.005896	0.349141	0.006667
11	99.64842	0	99.56007	0.009827	1.169038	0.008216	3.583324	0.007275	1.273105	0.005768	0.348939	0.00658
12	99.66072	0	99.57234	0.009846	1.170241	0.008137	3.583079	0.007329	1.273931	0.005854	0.348929	0.006512
13	99.67764	0	99.58922	0.009993	1.172116	0.008061	3.583101	0.007417	1.274337	0.005796	0.348608	0.006487
14	99.69186	0	99.6034	0.010272	1.174439	0.0082	3.582268	0.007622	1.274924	0.005817	0.347779	0.00645
15	99.70792	0	99.61939	0.011072	1.175913	0.00852	3.581991	0.007458	1.275495	0.00568	0.347918	0.00666

Table 1. Harmonic measurement data every 200 ms (CSV data)

	Element1		
Order	Data[A]	Limit[A]	Margin[%]
1	0.6048		
2	0.0004	---------	---------
3	0.1982	0.3072	35.5
4	0.0003	---------	---------
5	0.0725	0.1717	57.8
6	0.0003	---------	---------
7	0.0448	0.0904	50.4
8	0.0002	---------	---------
9	0.0209	0.0452	53.8
10	0.0002	---------	---------
11	0.0174	0.0316	45
12	0.0002	---------	---------
13	0.0164	0.0268	38.6
14	0.0002	---------	---------
15	0.0099	0.0232	57.4

Table 2. Limits and measurement results of each order (CSV data)

4.7 Report output function*

The results of the IEC harmonic or flicker measurement test can be output as a report. The limits and measured values of the current components up to the 40th order can be displayed together in a numerical list and bar graph. Users can add a title and comments to a report and set the language to Japanese or English. The report output may be saved in PDF format to be organized and stored in a PC.

*The report output function is included as standard with the IS8010 subscription license and perpetual license.

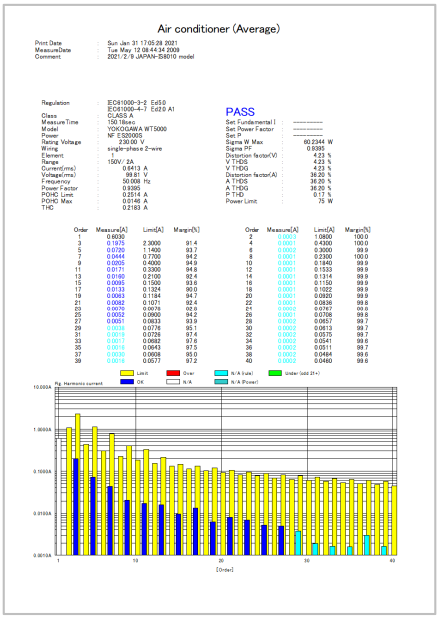


Figure 6. IEC61000-3-2 standard test report

YOKOGAWA

https://tmi.yokogawa.com/ YMI-KS-MI-SE08

YOKOGAWA TEST & MEASUREMENT CORPORATION
Global Sales Dept. /Phone: +81-42-690-8810 E-mail: tm@cs.jp.yokogawa.com
Facsimile: +81-42-690-8826

YOKOGAWA CORPORATION OF AMERICA	Phone: +1-800-888-6400	E-mail: tmi@us.yokogawa.com	
YOKOGAWA EUROPE B.V.	Phone: +31-88-4641429	E-mail: tmi@nl.yokogawa.com	
YOKOGAWA TEST & MEASUREMENT (SHANGHAI) CO., LTD.	Phone: +86-21-6239-6363	E-mail: tmi@cs.cn.yokogawa.com	Facsimile: +86-21-6880-4987
YOKOGAWA ELECTRIC KOREA CO., LTD.	Phone: +82-2-2628-3810	E-mail: TMI@kr.yokogawa.com	Facsimile: +82-2-2628-3899
YOKOGAWA ENGINEERING ASIA PTE. LTD.	Phone: +65-6241-9933	E-mail: TMI@sg.yokogawa.com	Facsimile: +65-6241-9919
YOKOGAWA INDIA LTD.	Phone: +91-80-4158-6396	E-mail: tmi@in.yokogawa.com	Facsimile: +91-80-2852-1442
YOKOGAWA ELECTRIC CIS LTD.	Phone: +7-495-737-7868	E-mail: info@ru.yokogawa.com	Facsimile: +7-495-737-7869
YOKOGAWA AMERICA DO SUL LTDA.	Phone: +55-11-3513-1300	E-mail: eproc@br.yokogawa.com	
YOKOGAWA MIDDLE EAST & AFRICA B.S.C(c)	Phone: +973-17-358100	E-mail: help.ymatmi@bh.yokogawa.com	Facsimile: +973-17-336100