California Instruments

Revision A
March 2001

P/N 5004-981

Pre-Compliance Test System
User Manual
PCTS

SAFETY SUMMARY

These power system components contain high voltage and current circuits that are potentially lethal. The following safety guidelines must be followed when operating or servicing this equipment. These guidelines are not a substitute for vigilance and common sense. California Instruments assumes no liability for the customer's failure to comply with these requirements.

APPLYING POWER AND GROUNDING

Verify the correct voltage is applied to the equipment.

Verify that the input power cord to the PACS-X unit is plugged into a properly grounded utility outlet.

Verify that the input power line to the AC power source used is connected to a properly grounded utility outlet.

FUSES

Use only fuses of the specified current, voltage, and protection speed.

Do not short out the fuse holder or use a repaired fuse.

The PACS-X unit uses a North-American ferrule type input fuse rated at 0.5A and 250Volts. (Fast Acting)

The 1251RP unit uses a North-American ferrule type input fuse rated at 15A and 250Volts. (Fast Acting)

DO NOT OPERATE IN A VOLATILE ATMOSPHERE

Do not operate the system in the presence of flammable gases or fumes.

DO NOT TOUCH ENERGIZED CIRCUITS

Disconnect power cables before servicing this equipment. Even with the power cable disconnected, high voltage can still exist on some circuits. Discharge these voltages before servicing. Only qualified service personnel may remove covers, replace components or make adjustments.

DO NOT SERVICE ALONE

Do not remove covers, replace components, or make adjustments unless another person, who can administer first aid, is present.

DO NOT EXCEED INPUT RATINGS

Do not exceed the rated input voltage or frequency. Additional hazards may be introduced because of component failure or improper operation.

DO NOT MODIFY INSTRUMENT OR SUBSTITUTE PARTS

Do not modify these instruments or substitute parts. Additional hazards may be introduced because of component failure or improper operation.

MOVING THE POWER SOURCE

When moving the power source, observe the following:

1. Remove all AC power to system components.
2. Use two people to prevent injury.

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Revision codes in the Help About screen of the PCTS software indicate the current revision. Minor changes to the software such as bug fixes usually do not require a change to the manual. Therefore, the revision number of the software you received with the PCTS system may be higher than the software revision number shown below. In this case, the information in the manual still applies.

Software changes that require a manual change will be accompanied either by a new edition of the manual or an errata sheet documenting the changes.

This manual applies to software revision 1.0

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Table of Contents

1 Introduction 9
1.1 Manual Organization 9
1.2 Pre-Compliance Test System Description 10
2 IEC Testing 13
2.1 About This Chapter 13
2.2 The EMC Directive 13
2.3 IEC 61000-3-2 Harmonics Standards 14
2.4 The IEC 61000-3-2:1998 Standard 15
2.5 The IEC 61000-3-2:2000 Standard 17
2.6 IEC 61000-3-3 Flicker 20
2.7 References 21
3 System Installation 23
3.1 About This Chapter 23
3.2 Hardware Installation 23
3.3 PACS-1 Unit 23
3.4 Functional Test 23
3.5 Front Panel Connections and Controls 27
3.6 Rear Panel Connections and Controls 29
3.7 Data Acquisition Card Installation - PCI Card Version 30
4 PCTS Program Menus 33
4.1 About this Chapter 33
4.2 Main Menus 33
4.3 File Menu 33
4.4 Edit Menu 34
4.5 View Menu 35
4.6 Options Menu 35
4.7 Test Menu 36
5 Harmonics Testing 37
5.1 About This Chapter 37
5.2 Test Standard Selection 37
5.3 Device Classes 37
5.4 Stationary or Transitory Harmonics Test 40
5.5 Running a Harmonics Test 41
5.6 Additional Setup Parameters for Harmonics 43
5.7 Main Harmonics Test Window Operation 44
5.8 Running the Harmonics Test 48
5.9 Printing Results and Report Formats 49
5.10 Harmonics Test Data Files 49
6 Flicker Testing 51
6.1 About This Chapter 51
6.2 Principle of Operation 51
6.3 Running a Flicker Test 52
6.4 Printing Results 55
6.5 Flicker Test Data Files 55
7 Specifications 56
7.1 About This Chapter 56
7.2 Measurement System Specifications 56
7.3 PACS-1 Specification 58
7.4 Environmental 59
7.5 Regulatory 59
8 Configuration Options 60

8.1 About this Chapter 60
8.2 Accessing the Calibration and Configuration Database 60
9 Calibration 63
9.1 About This Chapter 63
9.2 Calibration 63
9.3 Install A/D Card in PC 64
9.4 PCTS Calibration Setup 64
9.5 Configuration Procedure 65
9.6 Installing New PCTS Calibration Data 67
10 Principle Of Operation 68
10.1 General 68
10.2 AC Power 68
10.3 PACS Measurement Unit 68
10.4 PCTS Software 68
11 Service 70
11.1 Cleaning 70
11.2 General 70
11.3 Basic Troubleshooting 70
11.4 Advanced Troubleshooting 73
12 Index 75

List of Tables

Table 2-1: IEC 61000-3-2 Class Descriptions 15
Table 2-2: IEC 61000-3-2 Class Limits 16
Table 2-3: Harmonics Amendment 14 Test Times 19
Table 5-1 : IEC Harmonics Setup Parameters 42
Table 5-2 : IEC Harmonics Advanced Setup Parameters 44
Table 9-1: Required Calibration Equipment 63

List of Figures

Figure 3:1: Functional Test Setup 25
Figure 3:2: Power Connections for PACS-1. 26
Figure 3:3: Front and Rear Panel Views of the PACS-1 Module. 28
Figure 5:1: Class D Current Wave Shape Template for IEC 61000-3-2:1998 only 38
Figure 5:2: EUT Class Determination Flowchart 39
Figure 5:3: Typical Class D test setup 41
Figure 5:4: Additonal Settings for Harmonics Test 43
Figure 5:5: Harmonics Test Window 44
Figure 6:1: Flicker Test Window 51
Figure 9:1 : PCTS Calibration Program Main Screen 64
Figure 9:2: Calibration Setup 66
Figure 11:1: Location of AC Sensor Assy. 5004-700 in PACS 72

1 Introduction

1.1 Manual Organization

This manual describes the operation of second generation the California Instruments Compliance Test System Software when used in conjunction with the CTS hardware. Its primary function is as a reference manual. If you have a question about a specific screen or how to perform a certain task, turn to the appropriate section of the manual. The manual is organized in accordance with the normal test procedure you would follow when testing for IEC compliance.

Some assumptions were made when producing this documentation. Specifically, it is assumed that you are familiar with the IEC 61000-3-2 and IEC 61000-3-3 standards and their requirements. Some background information on the IEC standards covered by the PCTS system is included in chapter 2. This information is subject to change however as standards do change. We recommend you stay current with evolving test standards and regulations. Furthermore, it is also assumed that you are familiar with operating a personal computer under the Microsoft Windows™ environment.

The manual is organized as follows:

Chapter 1	Introduction. Provides an introduction
Chapter 2	IEC Testing. Overview of IEC 61000-2 Harmonics and Flicker standards
Chapter 3	System Installation. Setup and installation of the PCTS system components
Chapter 4	PCTS Program Menus. Description of the PCTS User Interface
Chapter 5	Harmonics Testing. Operator instructions on performing harmonics tests.
Chapter 6	Flicker Testing. Operator instructions on performing flicker tests
Chapter 7	Specifications. Performance specifications.
Chapter 8	Configuration Options. Available options
Chapter 9	Calibration. Routine calibration
Chapter 10	Principle Of Operation. Describes basic operation of PCTS system.
Chapter 11	Service. Procedures for troubleshooting and repair.

1.2 Pre-Compliance Test System Description

The California Instruments Compliance Test System is a complete IEC AC power test system that covers many of the IEC regulatory test standards involving AC and/or DC powered equipment.

To ensure maximum flexibility of both the hardware and the software required to create a turn-key system, the PCTS system uses a modular structure consisting of the following components:

- Power Analysis and Conditioning System unit. The PACS unit creates the electrical and mechanical interface between the AC source, the Equipment Under Test (EUT) and the PC based data acquisition system. It provides the necessary signal conditioning and isolation for the acquisition system.
- PC Based data acquisition system. The data acquisition system uses a fast Analog to Digital conversion card that plugs into an available card slot in the user's PC. The PCTS software controls all aspects of the A/D card and processes the data for IEC test purposes.
- PCTS Software. The PCTS software implements the harmonics and flicker IEC tests.

The AC line voltage is connected to the rear of the PACS unit. For single-phase applications the user only needs to connect the EUT to the IEC/77 connector located on the front panel of the PACS unit to set up his test hardware. All user interactions with the PCTS system are accomplished through the PCTS software. There are no front panel controls required to operate the PCTS system.

The PCTS is designed to work with either line power (100-230 VAC 50/60 Hz) or with a power source. When used with line power, the system automatically compensates for line voltage distortion. This feature can be disabled if so required. The user may operate the PCTS with a variety of (programmable) power sources such as the California Instruments iX Series.

1.2.1 AC Source

The EUT AC source for a PCTS system is supplied by the utility or a frequency converter/power source capable of supplying the correct output frequency.

Note: The PACS-1 is rated for a maximum of 40 amps RMS line current. Damage to the PACS systems can occur if higher currents are present. Care must be taken to not exceed this rating when using the system directly with the utility line or with higher power sources.

1.2.2 PACS Unit

The Power Analysis and Conditioning System provides the required electrical and mechanical interface between the AC line or source, the user's equipment under test and the data acquisition PC system. This allows all signal connections to be made easily and conveniently.

The PACS unit has several AC power input and output connections as well as an interface connector to the PC based data acquisition system.

Note: Especially when operating from line current, it is important to run the PACS unit from the same supply that the PC (refer to section 1.2.3) is operated from. Experience has shown that there can be substantial neutral currents (and thus voltage drop) in premise power systems. Voltages as high as $12V_{rms}$ have been observed on the neutral conductor. These neutral voltages can affect the measurement accuracy if the PACS is operated from a power supply having such a neutral voltage while the PC's neutral potential differs.

1.2.3 PC Based Data Acquisition System

All measurements required for IEC testing are performed by the data acquisition system that resides on the user's PC. The measurement card needs to be installed in an available slot and the software needs to be installed. All signal connections between the PC and the PACS unit are made with a single 37 to 60 pin cable supplied with the system.

The following card is supported by the PCTS software:

CI400PCI PCI card

The data acquisition system samples all voltage and current channels at a high sampling rate and provides the data to the PCTS software for further processing. The PACS provides a single voltage input channel and three current input channels to the PC. This allows for current range changing on the fly. There is no need for the user to select a current range as the software automatically uses the most suitable range available for the current signal.

Note: Especially when operating from line current, it is important to run the PACS unit from the same supply that the PC (refer to section 1.2.3) is operated from. Experience has shown that there can be substantial neutral currents (and thus voltage drop) in premise power systems. Voltages as high as $12V_{rms}$ have been observed on the neutral conductor. These neutral voltages can affect the measurement accuracy if the PACS is operated from a power supply having such a neutral voltage while the PC's neutral potential differs.

1.2.4 PCTS Software Functions

The PCTS software application supports IEC 61000-3-2 and IEC 61000-3-3 compliance testing requirements using an intuitive graphical user-interface from which you can:

- Set up and run compliance tests. The setting of many IEC details is facilitated through the use of embedded standards expertise.
- Select desired test standard.
- Collect real-time test data from the PCTS system.
- Display and monitor real-time test results.
- Save test results to disk for analysis using other programs such as MS Excel™.
- Print reports and graphs in MS Word™ formats.

2 IEC Testing

2.1 About This Chapter

This chapter provides some background information on the various IEC test standards that apply to AC powered products. It also reviews some of the test equipment requirements that are important when testing for IEC compliance. Note that this information is subject to change as IEC standards change over time. This overview is by no means comprehensive and is only provided for reference. If the reader is not familiar with IEC test requirements for AC powered products, we strongly recommend consulting information on this subject that is available through other sources. References are provided at the end of this chapter.

The standards covered in this chapter include those supported by the PCTS system specifically:

- EN / IEC 61000-3-2:1998, Amendment 1 and 2. Quasi Static and Transitory Harmonics
- EN / IEC 61000-3-2:2000-08, Amendment 14 Transitory Harmonics
- EN / IEC 61000-3-3:1994-12. Flicker

2.2 The EMC Directive

As the world population grows and the overall energy consumption increases, industrialized nations have become increasingly concerned with the future availability of energy. Reducing energy consumption by using more energy efficient lighting and motor drive systems is one approach being taken by European, US and Japanese governments. The need of more efficient electrical systems however typically requires the use of sophisticated semi-conductor based electronic circuits that produce current harmonics. This in turn may effect power quality which is an increasing problem on public utility networks. As lighting systems with electronic ballasts and equipment with switching power supplies such as computers, TV's, fax machines and printers proliferate, power quality deteriorates. The same is true for PWM controller motor drives. The International Electrical Committee (IEC) has released standards dealing with the low frequency public supply system. Initial standards were 555.2 (Harmonics) and 555.3 (Flicker) which have since been refined and are now available as IEC 61000-3-2 and IEC 61000-3-3 respectively. Effective January 1, 1996, most electrical devices sold within the member countries of the European Union (EU) must meet these standards as governed by the EMC directive.

2.2.1 Why do you have to test?

In general, these IEC directives do not have the legal force of law. However, the European Union (EU) has issued Euro Norms in the context of these IEC directives that are legally binding and are enforced by the EMC Police. The relevant enforceable standards are EN61000-3-2 and EN61000-3-3, which supersede EN60555.2 and EN60555.3 respectively. These standards are also known under the IEC designator IEC 61000-3-2 and IEC 61000-3-3. Recently, the universal IEC 61000 convention has been adopted for all IEC standards.

Individual member countries have issued identical national norms, either in their native language or in English, which carry the same legal enforceability. Other countries such as Japan and the USA are in the process of adopting similar standards. Penalties for violating these norms range from hefty fines to jail time. In cases where the manufacturer is not located in the EU, his distributor or authorized agent will be held liable. Local customs agencies can stop equipment that does not meet these IEC norms at the border. Compliance testing of equipment is performed by accredited laboratories run by European government agencies assigned with enforcing these norms. Also, competing vendors have been known to submit failing test results on competitors' products to local governments to force prosecution and gain a competitive advantage in the market place.

Conformance to the EMC low voltage directive is indicated by the CE mark. Note however, that the CE mark includes **MORE** than just IEC 61000-3-2 and IEC 61000-3-3.

2.3 IEC 61000-3-2 Harmonics Standards

The purpose of enforcing the IEC 61000-3-2 standard is to limit the amount of current harmonics produced by electronic loads. Since harmonic currents caused by a load in turn produce voltage harmonics across the public utilities impedance, they affect other equipment connected to the same circuit. In fact, most public utilities exhibit voltage distortion caused by non-linear loads. Because harmonics can have serious effects on many electrical devices, efforts to set standards to limit their presence date back to the 1930's. This resulted in the IEC's Technical Committee (TC) setting standards dealing with current harmonics as far back as 1977. These standards became the basis for IEC standards 61000-3-2 and 61000-3-3 adopted in 1993. Because of their long history, many people still refer to these standards as 555.2 and 555.3 although there are some differences between the older and newer versions. Tests performed today should be done according to the new standards, not the old ones.

Another confusing issue that is rooted in history is the nature of the products that fall under these IEC norms. While the original 555 specifications focused primarily on consumer products and excluded many professional and industrial products, the new IEC 61000-3 norms expanded coverage to include all electrical products with a rated input current up to 16 A rms per phase. Presently, only products with a line input voltage of 220 V and above are included. Japan and the US are working towards similar requirements that would cover products that require 100 Volts and up. Due to the original scope of the IEC 555 norms, many manufacturers are still under the impression that their products are exempt since they are not considered consumer products. Especially manufacturers of switching power supplies - some of the worst "offenders" when it comes to generating harmonics currents - have been caught off guard.

As of January 1, 2001 the EN / IEC 61000-32 and 61000-3-3 standards along with their respective amendments are in force. Hence all products with < 16 Amp per phase have to comply, although no harmonics limits are defined for product < 75 watts and professional equipment > 1000 watt.

Amendment 14

A new revision of the IEC 61000-3-2 Harmonics standard was published at the end of 2000, referred to as Amendment 14. Per this amendment, harmonics tests per EN61000-3-2 can either be done per

the existing standard, or the user may test per the amendment. The amendment changes the classification of many products, i.e. allows the manufacturer to test them per the more relaxed Class-A limits, instead of using the potentially more strict Class-D limits. Also, the amendment changes the way limits are computed for Class-D and Class-C products, and requires that the overall measurement is performed in accordance with IEC61000-4-7. In fact, the complete Annex-B to IEC61000-3-2 (second edition), which describes the measurement methodology, is to be replaced by IEC61000-4-7. These changes impact the implementation of the harmonics standard on harmonics and flicker test systems such as the PCTS.

The PCTS allows the operator to select either standard implementation and fully supports both the old and the new test standard.

2.4 The IEC 61000-3-2:1998 Standard

This section covers the 1998 standard including amendments 1 and 2. This standard may be used to test products until January 2004. After this date, only the 2000 revision of the standard including Amendment 14 should be used.

2.4.1 Test Classes

The 1998 standard divides products to be tested into four classes, A, B, C and D. Each class has its own harmonic current limits. Class A is the default class, meaning if a product does not fall into the categories for class B, C or D, it is by default class A. The product classes are defined as follows:

Table 2-1: IEC 61000-3-2 Class Descriptions

Class	Description
A	All motor driven equipment, most “domestic” appliances and virtually all 3 phase equipment (<16 A rms per phase)
B	All portable electric tools
C	All lighting products, including dimmers, with an active input power above 25 Watts.
D	Products having a power range from 75 to 600 Watts AND a current waveform that has a special wave shape.

Test limits are most stringent for Class-C and Class-D equipment. These classes were established to cover the wide range of products that uses “cheap” switching power supplies with a rectifier capacitor input. These units typically exhibit relatively high odd harmonics. Since this type of supply is so commonly used, the effect of a large quantity of products like this can add up to significant problems. To limit this effect, the current harmonic limits for class-D equipment are specified in mA/W instead of an absolute current value as is done for class A and B. Many consumer and professional devices such as TV’s*, VCR’s, stereos, PC’s, fax machines*, printers*’ etc. may fall into the more stringent class D category. (* Changed per Amendment 14)

Class-C limits are not specified in absolute values either but rather as a percentage of the fundamental current. The third harmonic limit is also a function of the power factor so it is harder to meet as the power factor decreases. Neither class C nor D devices have to meet even current harmonics limits except for the second harmonic on class C devices.

This dynamic nature of the class C and D limits has resulted in some confusion and a possible problem of inconsistent test results when using IEC test systems for different vendors. The Standards

body working group for harmonics has resolved these issues in Amendment 14. The PCTS software maintains a database of test limit values that can be updated over time if needed without changing the core program.

When selecting the IEC 61000-3-2:1998 mode, the PCTS software uses dynamic classification for Classes A and D. The classification follows the following principle. If during either a Class A or D test the EUT becomes a Class A device, the EUT will be considered a Class A device. If the EUT is a Class D device through out the test, then the device is a Class D device. In other words, Class A is a latching classification. Please note that even though the classification may change during a test, a Class A (or D) test will still be performed according to Class A (or D) specification.

2.4.2 IEC 61000-3-2:1998 Test Limits

The following table summarizes the current harmonic limits for each device class that are presently in effect. The limits are generally built into IEC test software programs such as California Instruments' PCTS Test System software. If the power level of a class D device drops below 50 W or 75 W (configurable), no harmonic current limits are applied.

Table 2-2: IEC 61000-3-2 Class Limits

Harmonic no. (n)	Class A	Class B	Class C	Class D	IEC 555-2
	A RMS	A RMS	% of fundamental RMS current	mA/Watt of input power (75 - 600 W)	A RMS TV Receivers > 165 W
2	1.080	1.620	2	-	0.300
3	2.300	3.450	30 x PF	3.400	0.800
4	0.430	0.645	-	-	0.150
5	1.440	2.160	10	1.900	0.600
6	0.300	0.450	-	-	-
7	0.770	1.155	7	1.000	0.450
8	0.230	0.345	-	-	-
9	0.400	0.600	5	0.500	0.300
10	0.184	0.276	-	-	-
11	0.330	0.495	3	0.350	0.170
12	0.153	0.230	-	-	-
13	0.210	0.315	3	0.296	0.120
Even 14-40	1.84 / n	2.760 / n	-	-	-
Odd 15-39	2.25 / n	3.338 / n	3	3.850 / n	1.500 / n

2.4.3 Steady State versus Transitory Harmonics

Two types of harmonics testing are called for in the IEC 61000-3-2:1998 standard, a quasi steady state and a transitory one. The transitory harmonics tests allow for equipment that has power demands that vary over time to temporarily exceed the harmonic current limits by as much as 50 %, as long as such elevated levels do not occur for more than 10 % of the test period. Since the minimum test time required is 2.5 minutes or 150 seconds, this means the current harmonics can be as high as 150% of the standard limits for no more than 15 seconds in any 150 second period. This requirement imposes more demands on the power analyzer being used than it does on the AC power source.

Steady state harmonics are those exhibited by equipment that has a constant current draw such as a fluorescent lighting fixture. Many pieces of equipment, such as Laser printers that have a heating element that kicks in any time a page is printed, have fluctuating power demands and may require transitory harmonics testing.

2.5 The IEC 61000-3-2:2000 Standard and Amendment 14

The latest version of IEC 61000-3-2 was released in August, 2000. It includes a number of minor changes, and expands the scope of test class C to lighting products with a power level <25 watt. Amendment 14 which is in effect per January 1, 2001, was primarily intended to resolve some ambiguities concerning class D products, but also affects class C evaluation methods.

2.5.1 Test Classes

CENELEC-Amendment 14 changes the definition of Class-D products. Per the amendment, only TV's, PC's and PC monitors are to be tested per Class-D limits. This means that many products migrate to Class-A. Note that there is no change in classification for Class-A, B, and C products, but the harmonic analysis method for products with fluctuating power is affected by Amendment 14 for these products as well.

The limits for Class-C & D are proportional as earlier explained. Whereas this doesn't cause any difficulties for products with a constant current/power level, the situation was less clear for products with fluctuating load levels. Most test systems implemented so-called dynamic limits, with the limits constantly being adjusted per the measured power (or the fundamental current for Class-C) while others used some average power level to set the limits. The latter systems determine this average power/current using some arbitrary method and pre-test period. Thus different test systems implement different limits for the same (fluctuating power) products, which can result in one system PASSING a product while the other REJECTS it.

A second issue for fluctuating loads is the way the old standard (1998 and 2000 edition) define criteria for passing and failing the harmonics test. The old standard permits the unit under test to occasionally exceed the 100 % limit, provided the harmonics never exceed 150 % of the limit. In fact, the unit under test is allowed to exceed the 100 % level for 10 % of the test time. The test time for fluctuating loads is to be at least 2.5 minutes, i.e. the harmonics can exceed the 100 % limit for 15 seconds in every 150-second (2.5 min) period. For longer test times, one can perform this test in 2.5 minute "time blocks" but another interpretation is to just take 10 % of the overall test time. Thus, the testing method for fluctuating loads was somewhat subject to interpretation by the test equipment manufacturer.

Pass/Fail criteria under the new Amendment 14 are as follows:

> *The average value for the individual harmonic currents, taken over the entire test observation period shall be less than or equal to the applicable limits.*
>
> *For each harmonic order, all 1,5 s smoothed r.m.s. harmonic current values shall be less than or equal to 150% of the applicable limits.*
>
> *Harmonic currents less than 0,6% of the input current measured under the test conditions, or less than 5 mA, whichever is greater, are disregarded.*
>
> *For the 21st and higher odd order harmonics, the average values obtained for each individual odd harmonic over the full observation period, calculated from the 1,5 s smoothed values may exceed the applicable limits by 50% provided that the following conditions are met:*
>
> - *The measured partial odd harmonic current does not exceed the partial odd harmonic current, which can be calculated from the applicable limits.*
> - *All 1,5 s smoothed individual harmonic current values shall be less than or equal to 150% of the applicable limits.*

2.5.2 IEC 61000-3-2:2000 Test Limits

The actual class limits for all classes have not changed with amendment 14. The measurement of power levels for Class D on which these limits are calculated however and the fundament current and power factor for class C have been changed however.

First of all, the manufacturer is required to declare the rated power (the fundamental current and Power Factor for Class-C) for the product. This “rated power” (current & PF) will be used as the basis for the limit calculation of Class-D (Class-C). Thus, a “rated power” of 150 Watt for example, will yield a third harmonic limit of 150 x 3.4 = 510 mA. Similarly, a rated fundamental current of 0.4 Amp, and a rated PF of 0.98 for an electronic ballast will result in a third harmonic limit of 0.4 x 0.3 x 0.98 = 117.6 mA. Thus, the amendment requires that an automated compliance test system must allow the user to enter this rated power or rated current. Also, the test system must verify the power (fundamental current and PF) because these “rated vales” as declared by the manufacturer must be within +/- 10 % of the actual values. If not, the actually measured values are to be used for the limit calculation. The methods to measure these actual power, fundamental current and PF differ from the “average method” used in existing test systems, and of course differ also from the “dynamic limit method”.

The Pass/Fail criterion is given above. The “10 % of the time over 100 % of the limits” no longer exists. The average harmonic level during the whole test must simply be below the limit, and individual values in each acquisition window (after 1.5 sec filtering) must be below 150 % of the limit. There is also an extra allowance for the higher harmonics from H_{21} - H_{39}.

The PCTS fully supports and implements the requirements of Amendment 14.

2.5.3 Test Time per Amendment 14

Under the new test standard, four test times (observation periods) are allowed depending on the nature of the EUT. All are aimed at ensuring repeatability of test results when tests are performed under the same conditions and on the same test system. Repeatability for this purpose is defined as results that are within 5 %. Available observation periods are shown in the table below.

Table 2-3: Harmonics Amendment 14 Test Times

Type of equipment behavior	**Observation period**
Quasi-stationary	T_{obs} of sufficient duration to meet the requirements for repeatability.
Short cycles (Tcycle < 2.5 min)	T_{obs} > 10 cycles (reference method) or Tobs of sufficient duration or synchronization to meet the requirements for repeatability. 'Synchronization' means that the total observation period is sufficiently close to including an exact integral number of equipment cycles such that the requirements for repeatability are met.
Random	T_{obs} of sufficient duration to meet the requirements for repeatability.
Long cyclic (Tcycle > 2.5 min)	Full equipment program cycle (reference method) or a representative 2.5 min period considered by the manufacturer as the operating period with the highest total harmonic content.

2.6 IEC 61000-3-3 Flicker

Flicker standards are imposed to limit voltage variations caused by loads connected to the low voltage supply network that would cause lights connected to the same circuit to flicker. A complex measurement approach outlined in IEC 868, was devised to correlate voltage fluctuations to a human perceptibility factor (P). The IEC 61000-3-3 standard sets limits for voltage fluctuations caused by electrical apparatus with a current level up to 16 Amps per phase. The standard describes a human flicker perceptibility curve that defines the upper limit for acceptable flicker. This curve plots the percentage of voltage fluctuation against the amount of voltage fluctuations per minute.

As is the case for the Harmonics standards, the Flicker standard dates back several years and was rooted in the IEC 555.3 specification. Today however, the IEC 61000-3-3 standard should be used to evaluate equipment. Note that low power equipment generally does not cause Flicker and therefore often can be exempted from this requirement. The standard permits the equipment manufacturer to prove via analysis that their products are unlikely to cause voltage fluctuations. This analysis becomes part of a Technical Construction File (TCF) which in turn may be used to obtain product certification.

2.6.1 IEC 61000-3-3 Flicker Test AC Source Requirements

As is the case with Harmonics testing, the IEC 61000-3-3 standard imposes requirements on the AC source that is used. Some of these requirements are similar and less severe than those imposed under IEC 61000-3-2. For example, total harmonic distortion of the voltage can be 3 % for Flicker testing as opposed to only 1.25% for harmonics testing. The voltage regulation needs to be better than 2 %, which is not a problem when using a programmable AC source but may be a problem when the utility is used to provide AC power to the EUT. To allow use of the AC line with the PCTS system, the PCTS software monitors the AC line voltage and EUT load current and dynamically compensates for AC line fluctuations that are not the direct results of the EUT load current. This allows the PCTS system to calculate correct flicker results in the absence of a stable AC power source.

To simulate the resistance and inductance of the low voltage distribution systems, the IEC 61000-3-3 requires a specific AC source output impedance to be used. This reference impedance, as specified in IEC-725, is defined in such a way that it approximates a typical distribution network impedance. Individual countries may require the use of a different reference impedance that more closely resembles the actual impedance of that countries' specific distribution network. Most European countries use the specified reference impedance value however.

The required reference impedance for Flicker testing is dynamically synthesized by the PCTS software. As such, no lumped reference impedance is needed or provided. The actual line impedance of the AC source connection point used is determined by the PCTS system software and used during the measurement process to calculate the equivalent effect an IEC-725 lumped impedance would have. This software based implementation also provides greater flexibility to handle other lumped impedance values such as those used for the Japanese flicker standard.

2.6.2 When to Test for IEC 61000-3-3

As mentioned, it may not be necessary to test every product for IEC 61000-3-3. If it can be shown that maximum power consumption of the unit under test is low, and the surge current level at turn-on is limited, it can be shown that the product causes insignificant Flicker levels across the reference impedance. For loads having an rms current draw of more than 5 Amps exhibiting fluctuating power levels, it is generally recommended to verify conformance to IEC 61000-3-3 however.

2.7 References

Additional information on IEC norms and requirements may be obtained from the following sources. You may also check for the latest IEC related information on California Instruments' web site at www.calinst.com.

Document Number	Date of Publ.	Title
IEC 725 (60725)	(1981)	"Considerations on reference impedances for use in determining the disturbance characteristics of household appliances and similar electrical equipment."
IEC 868 (60868)	(1986)	"Flicker meter, Functional and design specifications."
IEC 868 Amendment 1	(1990)	"Flicker meter, Functional and design specifications."
IEC 868-0	(1991)	"Part 0: Evaluation of flicker severity."
IEC 61000-3-2	(2000)	"Part 3: Limits - Section 2: Limits for harmonic current emissions (equipment input current $\leq$ 16 A per phase.)"
IEC 61000-3-3	(1994)	"Part 3: Limits - Section 3: Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current $\leq$ 16 A."
IEC 61000-4-7	(1996)	"General guide on harmonics & inter-harmonics"

Copies of complete IEC standards
may be obtained from at:

International Electrotechnical Commission (IEC)
P.O. Box 131
1211 Geneva 20
Switzerland
Phone: +41 22 919 0300
Fax: +41 22 919 0228
Web: www.iec.ch

or in the USA:

American National Standards Institute (ANSI)
Sales Department
11 West 42nd Street
New York, NY 10036
Phone: +212 642 4900 Fax: +212 302 1286

3 System Installation

3.1 About This Chapter

This chapter provides information on system installation and covers both the hardware connections that need to be made between the various components and the software setup. Proper installation of all hardware components and software modules is required to successfully use the PCTS system. Some experience with AC power systems and PC's running Windows is assumed.

3.2 Hardware Installation

Unpacking

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. DO NOT return an instrument to the factory without prior approval. Do not destroy the packing container until the unit has been inspected for damage in shipment.

AC Line Voltage

The main power requirements for the PCTS are dictated by the power levels that the Equipment Under Test will demand. Maximum RMS current supported by the PCTS is $40A_{RMS}$.

3.3 PACS-1 Unit

The PACS measurement module can be operated on either 115V or 230 V. It requires less than 0.5 Amps to function.

Mechanical Installation

The PACS-1 unit can be used free standing on a bench or mounted in a cabinet. Rack handles are standard, and if the optional rack slides are ordered, then the entire PCTS system may be mounted in a standard 19 inch cabinet. The units are fan cooled, drawing air in from the sides and exhausting at the rear. The sides of the unit must be kept clear of obstruction and a 6 inch (152 mm) clearance must be maintained to the rear for proper cooling.

Wiring

For wiring diagrams see Figure 3:1 and Figure 3:2. The wire size used is dictated by the measured currents and voltages. Any wire used must be rated for the maximum expected current and voltage. The PACS-1 unit is rated for 40A RMS maximum per phase when the rear power terminals are used and therefore AWG 8 is recommended if currents >30A and up to 40A are expected. For currents in the 15 to 30A range AWG 10 is recommended.

In addition, when doing compliance testing from the front panel outlet on a single phase PACS-1 unit, bear in mind the rating of the IEC/77 outlet socket is 16A RMS max.

Caution: Be sure to replace the small rear top cover on the PACS unit after the wiring has been installed, otherwise insufficient cooling of internal components may result.

3.4 Functional Test

If it is desired to perform a functional test of the system upon receipt, the following procedure can be used. However, the AD signal card and the PCTS Software must first be installed for proper operation. See installation instructions beginning with paragraph 3.7.

CAUTION: Work carefully when performing this test, hazardous voltages will be present on the AC input and output connections during this test.

Refer to Figure 3:1 for the test setup. See also Figure 3:2 and Figure 3:3 for detailed installation diagrams.

1. Connect a current transformer to the neutral wire going into the AC input port at TB4 on the rear of the PACS unit. Connect the CT output to a DMM to read the actual input current.
2. Connect a DMM to the line and neutral connections at TB4 inside the rear panel.
3. Connect a 10 Ω load to the front panel outlet, or, use the rear panel AC outlet port at TB3.
4. Connect the AC power input to the PACS unit from the line.
5. Start the **PCTS** software in harmonics mode and measure the load current and voltage from the GUI. Verify the GUI readings and the external DMM readings for current and voltage are within 1% of each other.

In the unlikely event the PCTS system does not pass the functional test, refer to the calibration procedure in Section 9, or, refer to the service procedure in Section 11. If the problem cannot be resolved, call California Instruments' customer satisfaction department at (858) 677-9040 for further assistance or you may write to:

California Instruments Corporation
Attn: Customer Satisfaction Department
9689 Towne Centre Drive
San Diego CA 92121-1964
U.S.A.

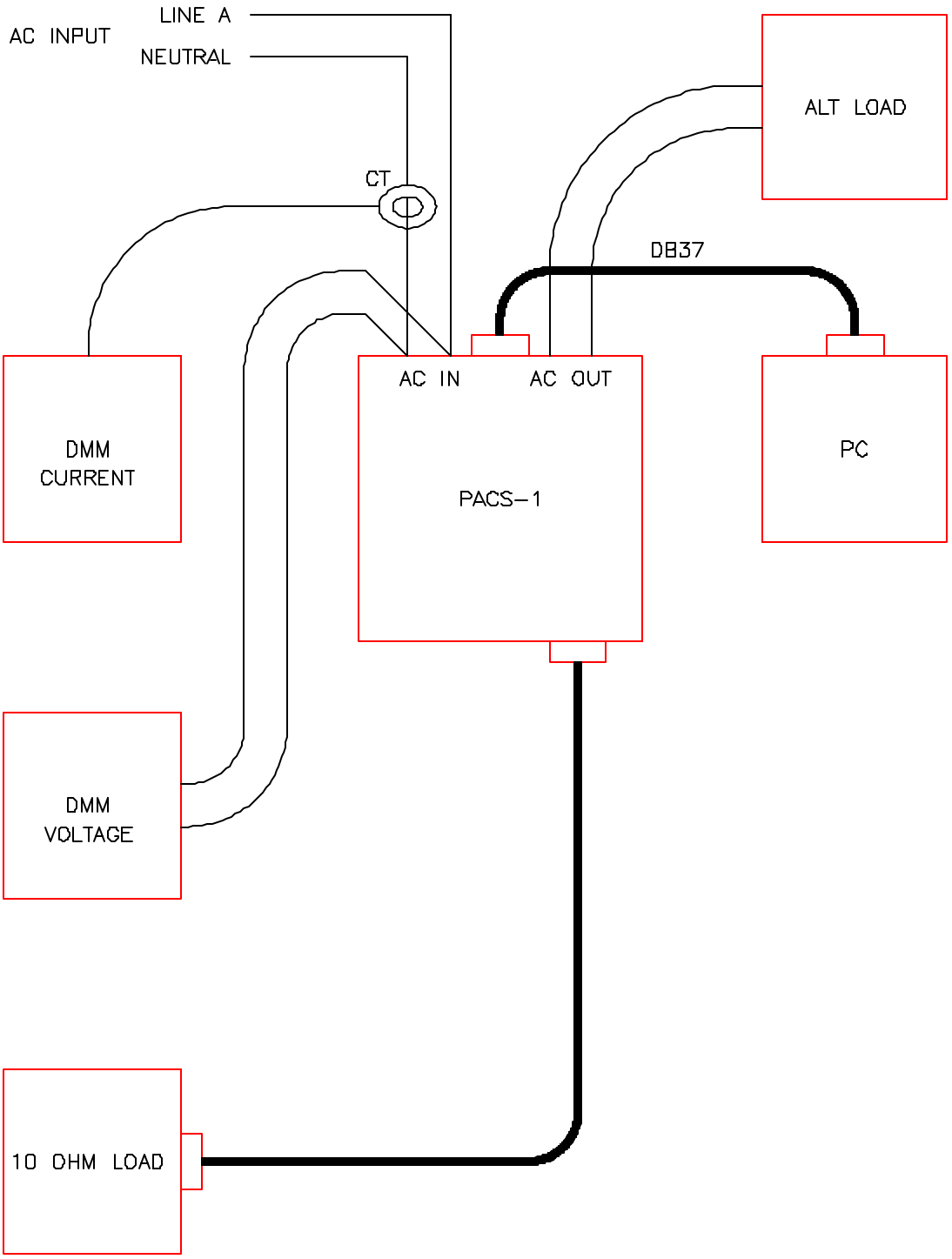


Figure 3:1: Functional Test Setup

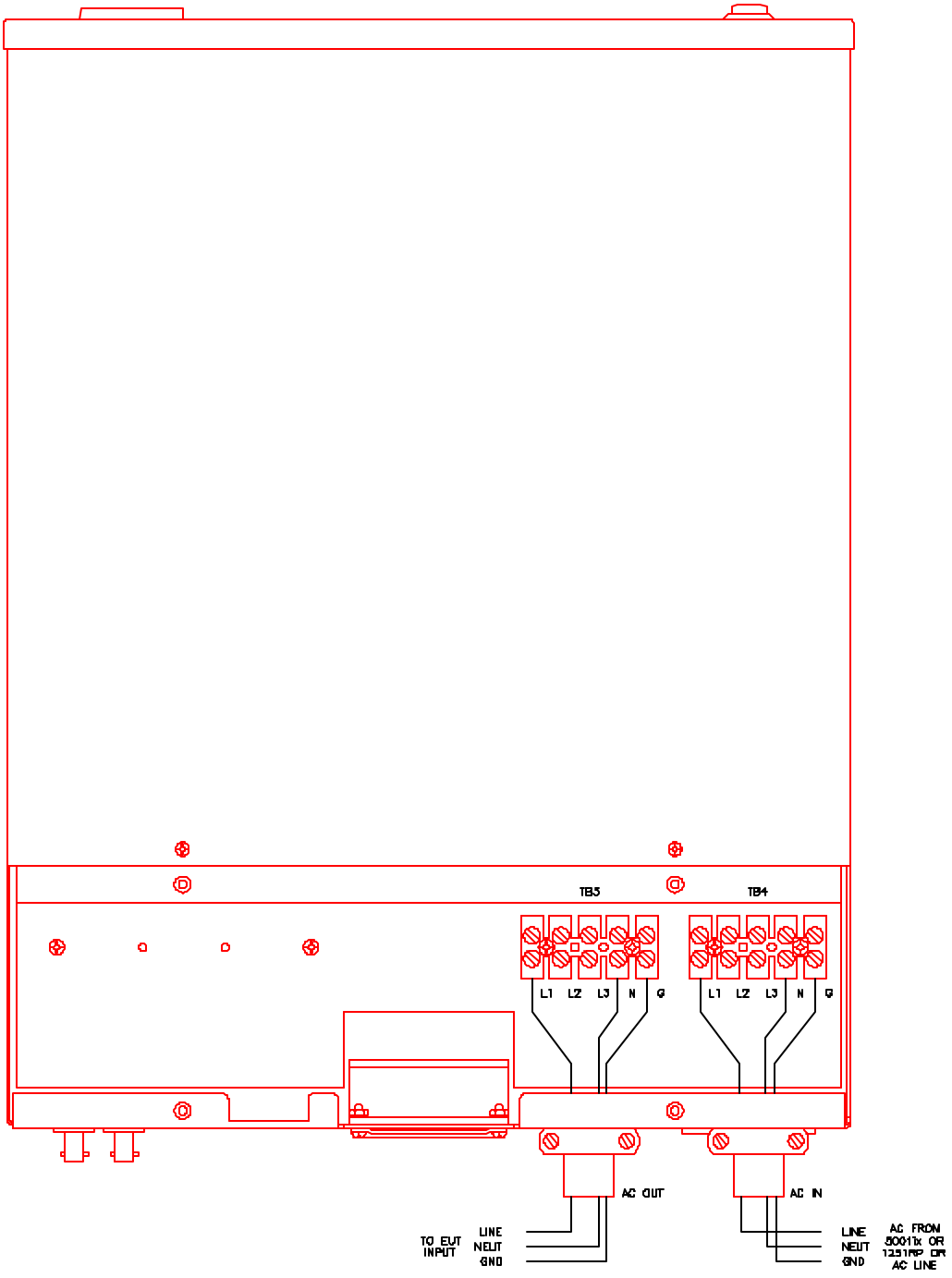


Figure 3:2: Power Connections for PACS-1.

3.5 Front Panel Connections and Controls

The front panel incorporates three functional areas:

- Output Sockets/Connectors
- Status Indicator lights
- Switch/Button controls

3.5.1 Output Sockets/ Connectors

The PC Interface Connector located on front panel is in parallel with the rear panel connector. Use the front panel interface connector if rear panel access is difficult.

An output socket is located on the right side of the front panel. It provides connection to a European IEC/77 plug. This socket is connected to the same point as the rear panel AC output connector TB3. Keep in mind that this socket is rated for 16A only, while the rear terminals at TB3 are rated for $40A_{RMS}$.

3.5.2 Status Indicator Lights

The “ON “ LED indicates The PACS module is powered up. Note: Even if the PACS unit is powered down, the AC input terminals may still carry high voltages if the applied AC line or source has not been shut off.

The BYPASS LED is permanently lit.

The FLICKER LED is always off in PCTS systems as there is no internal flicker reference impedance. Instead, the PTCS-1 software synthesizes the effect of the reference impedance.

Also, the flicker/bypass button will have no effect.

3.5.3 Switch/Button Controls

The front panel power switch located on the left hand side of the PACS unit energizes the measurement circuits. The flicker/bypass button will have no effect.

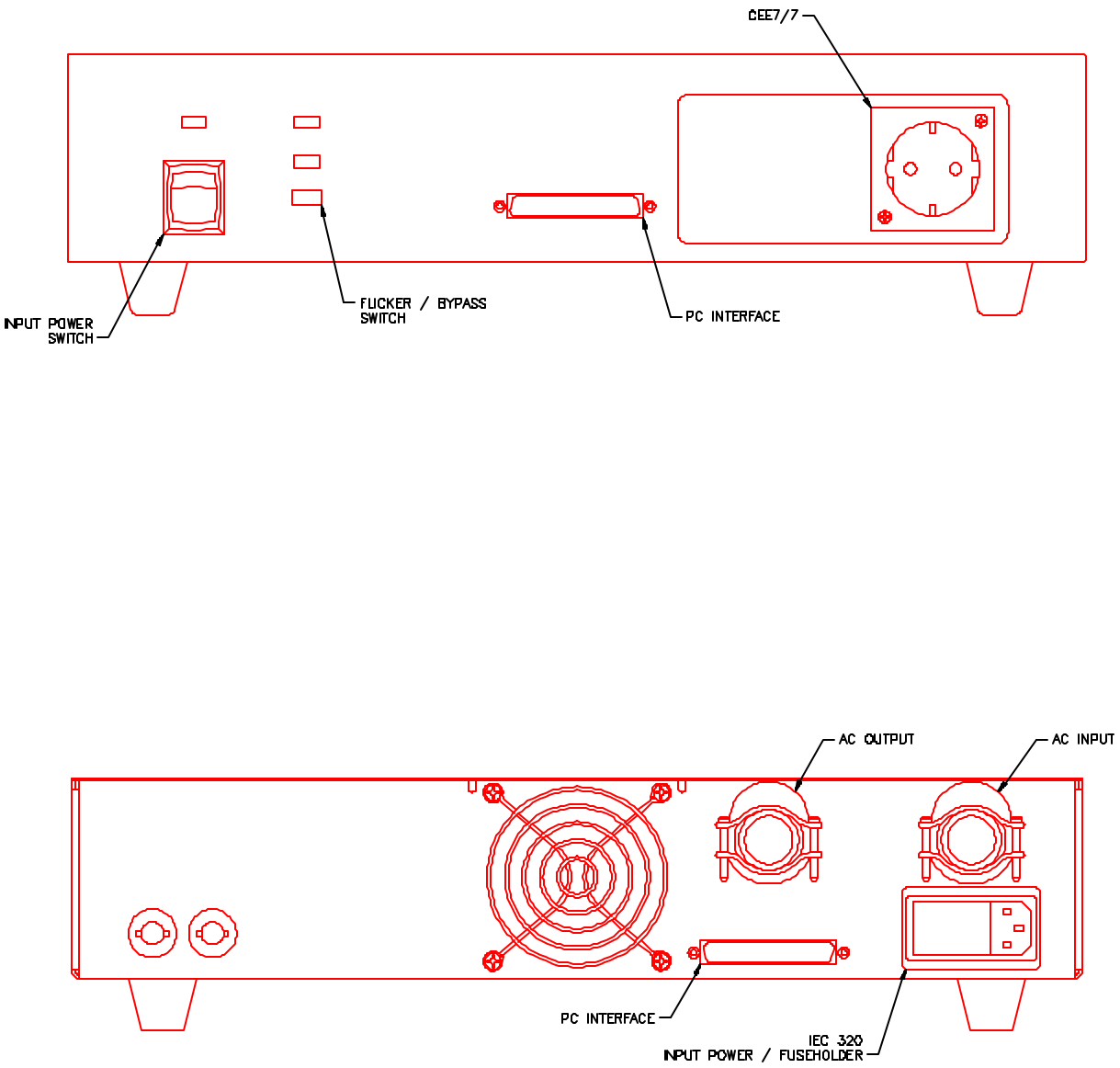


Figure 3:3: Front and Rear Panel Views of the PACS-1 Module.

3.6 Rear Panel Connections and Controls

The rear panel incorporates three functional areas

- PACS AC input supply.
- Measurement input/output connections.
- PC interface, Clock and Lock interface.

3.6.1 PACS AC Input Supply

The AC input to the PACS unit is on the right side of the rear panel. The molded cord plugs into the combination range change/ fuse holder assembly.

The AC power input module has a red plastic fuse holder that also serves as the input voltage range-selecting device. The selected voltage range (115V or 230V) is displayed through a small rectangular window.

To change the fuse:

1. Remove power cord from input module.
2. Pry cover loose with a small screwdriver.
3. Pull out fuse holder, prying with a screwdriver will be necessary.
4. Replace ½A fuse and reassemble in reverse order.

To change input range:

1. Remove power cord from input module.
2. Pry cover loose with a small screwdriver.
3. Pull out fuse holder, prying with a screwdriver will be necessary.

   Orient the red fuse holder so that the desired voltage shows through the window. While holding the two fuses in the holder, reinsert the fuse module and close the cover.

3.6.2 Measurement Input / Output Connections

The AC power input to be measured must pass through the cable strain relief clamp at AC INPUT and then to connector TB4, located just behind the rear panel. Similarly, the wires from TB3 are routed through the cable clamp at AC OUTPUT to the Equipment Under Test. To gain access to power connectors TB3 and TB4 the access panel located on the top rear of the unit must be removed. Remove the four screws holding the connector access panel in place and remove the panel. Once input and output wiring is complete, reattach the connector access panel.

3.6.3 PC Interface, Clock and Lock Interface

The PC interface connector accepts the DB-37 to DB-68 (model CI68C, P/N 5004-225-1) interface cable that goes to the PC with the AD Card and the PCTS Software.

The CLOCK and LOCK BNC connectors are available for future interface capabilities to CI power sources.

3.7 Data Acquisition Card Installation - PCI Card Version

All measurements in the PCTS system are performed through a dedicated data acquisition card that needs to be installed in the host PC. The PC that this card is being installed in must have at least 64 Mbyte of RAM memory and a processor speed ≥ 300 MHz for Windows 98™ and Windows ME™ (≥ 500 MHz for Windows NT™ and Windows 2000™) for the card and software program to work correctly. This section provides the necessary installation procedure for both hardware and software of the PCI version A/D Card. The PCI card is a Windows compliant Plug-n-Play card that requires a single PCI slot in the test system PC. The card driver must be installed with the PCTS software.

3.7.1 Unpacking and Handling

The following items are included as part of the PCI Card:

- A/D conversion board, PCI card. (CI400PCI, P/N 250742)
- 68 to 37 pin adapter cable, DB68 male to DB37 male connector. (CI68C, P/N 5004-225-1)

Verify that all components are available. The PCTS system will not operate if any of these items are missing. If any item is missing or visibly damaged, contact California Instruments customer service department immediately. Refer to page 3 for details on contacting California Instruments. Retain the original packaging material for the card and its accessories in the event you ever need to return the PCI A/D card to California Instruments.

Keep the PCI card in its protective anti-static bag until you are ready to install it in an available PCI slot of the host PC. This will minimize the chance of damage due to electrostatic discharge. When you finally do remove the card from the bag, make sure you are wearing a wrist ground strap and hold the card by its edge to avoid touching any of the components.

There are no jumpers of DIP-switch settings on the PCI A/D card as all configuration data is retained in EEPROM.

3.7.2 Installing the PCI Card Driver Software - Step 1

Insert the PCTS distribution CD-ROM in the CD ROM drive. The CI_SWCD.exe program should start if the CD ROM drive is configured for AutoStart. If not, double click on the CI_SWCD.exe progam to bring up the CD Browser program.

From the Browser, select the relevant PCTS system configuration in the left hand pane and click on the GUI Software Tab if it is not already selected.

Select the Windows 95/98/NT (32 bit version) and click on the Execute Selection button. This will bring up the PCTS installer.

From the PCTS installer, select the A/D Card Driver Installation as shown here and click on the Run Setup button.

Follow the installation prompts for the Driver installation to install the A/D Card drivers.

3.7.3 Installing the PCTS Software - Step 2

Once the card drivers have been installed, the PCTS software can be installed next. This can be done using the same PCTS installer program that should still be open.

Select the PCTS System Software Installation (PCI/PCMCIA) to start the installation process for the PCTS software. Follow the on screen prompts to complete the installation.

The PC that this card is being installed in must have at least 64 Mbyte of RAM memory and a processor speed ≥ 300 MHz for the card and software program to work correctly.

3.7.4 Installing the PCI A/D Card

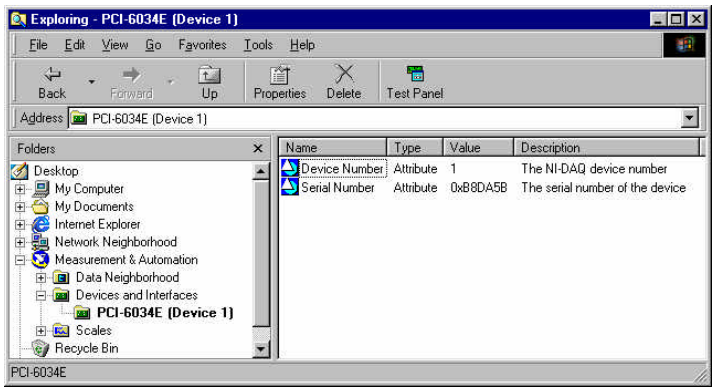
Follow the procedure outlined below to install the PCI card in the test system PC:

1. Disconnect your PC from any main power.
2. If possible, wear a grounded wrist strap to prevent ESD damage to the PC and the A/D Card and place the PC cabinet on a firm ESD safe working surface.
3. Remove the cover of the PC cabinet following the directions provided by the PC manufacturer.
4. Locate the PC's PCI bus expansion slots. The CI400PCI requires a single 32 bit PCI slot.
5. Using a suitable screwdriver (typically Phillips #2), remove the cover plate for the slot you opted to use in step 4. The A/D card has its own cover plate so the one you remove may be saved or discarded at your own discretion.
6. Carefully remove the PCI card from its protective bag and hold it along the top edge. Take care not to touch the gold finger edge connectors at the bottom.
7. Insert the card carefully in the selected slot making sure the DB68 connector clears the slot in the back of the PC. Press down firmly along the top edge of the board to make sure the board is seated properly in the PCI slot connector. It may help to rock the board gently or start from one end of the edge connector.
8. Install the screw you removed in step 5 and secure the PCI board to the PC slot by its cover plate.
9. If you plan to use an IEEE-488 Controller to communicate with the optional AC Source and have not installed one in the host PC yet, now would be a good time to do so. Follow the Bus Controller manufacturer's instructions for installation.
10. Replace the PC's cover following the directions provided by the PC manufacturer.

3.7.5 Testing the PCI Card

PCTS must be installed first before performing a A/D card testing. After PCTS is installed, the PC must be rebooted. The new hardware should be detected automatically at boot by the Windows™ operating system. Follow the on-screen prompts to finish installation of the A/D card.

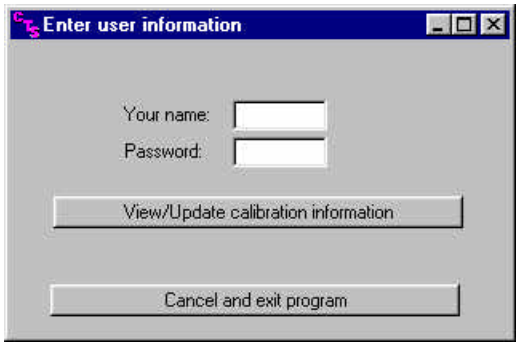
Once the PCI A/D card is installed. You should see a "Measurement and Automation" icon on the desktop. Double click on it and expand the Devices and Interfaces tree, you will see the PCI card you installed as shown in the screen below.



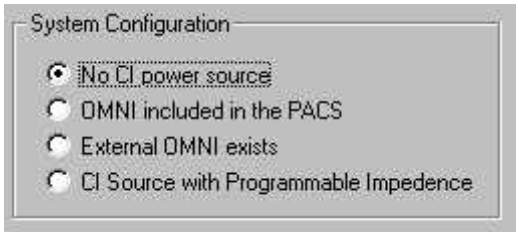
3.7.6 Checking Configuration Settings

Once the new software has been installed, it is important to check the configuration settings for the flicker reference impedance. This can be done by running the Configuration program located in the Compliance Test System program group.

Start the configuration program. A user name and password entry box will appear. The user name is used to track changes made to the calibration and configuration data. To check the settings, no user name or password is needed. Click on the View/Update Calibration information button to display the current settings.



Check the selection of the System Configuration in the lower right hand corner. Make sure this selection is set to "No CI power source" as shown below.



If the setting is incorrect, close the configuration screen and re-launch the configuration program. This time you will have to unlock the settings so you can make the relevant change. Enter your user name and the following password:

CAL_LOCK followed by the Enter Key.

You can now open the configuration screen again and change the flicker impedance setting to the correct one.

When done, close the screen to save the new settings.

4 PCTS Program Menus

4.1 About this Chapter

This chapter provides an overview of the PCTS program menus. You may read this chapter to familiarize yourself with the menus available in the program for harmonics and flicker testing or proceed directly to the relevant chapter for the test you want to run and use this chapter only as a reference.

4.2 Main Menus

Many of the PCTS capabilities are accessible through the menus located at the top of the main window. These menus are organized in the following groupings. Click on any menu to view the sub menu items.

MENU	DESCRIPTION
File	Open, close and save test setups and data files. Also allows printing of test reports
Edit	Used to cut and paste graphs to other Windows programs or edit the report header text.
View	Allows test setups or a list of all tests performed with the system to be displayed.
Options	Several run-time settings can be controlled from this menu.
Test	Starts a new test, or displays harmonics information of the most recent test.
Help	On line help and Program information.

Note: When a test is in progress, the menus are not available until after the test is completed. This prevents the test from being suspended while the user pulls down a menu, which is one of the unavoidable Windows operating system issues.

4.3 File Menu

The File menu offers the following sub-menu choices.

SUB MENU	DESCRIPTION
New Test	Clears all data and brings up the test setup screen to start a new harmonics or flicker test.
Open Setup File	Opens a setup file. This allows a new test to be run with the exact same setup parameters. The setup file can either be created through “Save Test Setup” menu action or extracted from an existing test data.

SUB MENU	DESCRIPTION
Save Test Setup	Saves only the setup information in effect. The setup file name depends on the setup. For example, a steady state Class D test would have a name of Steady_D.cts_setup.
Save Test Data	Saves all data from the most recent test run. A test must be run first with data saving enabled. When data saving is enabled, a test will produce a binary file H-xxxxxx.cts_data (harmonics) or F-xxxxxx.cts_data (Flicker) where xxxxxx is the test number. Save test data menu action actually makes a copy of that binary file to the specified file name and location. The file name used will be the same as used for the previous save operation unless this is the first save after a test run. In that case, the user will be prompted for a file name.
Save Test Data As	Saves a copy of the most recent test run binary data to a new file name. The user will be prompted for a name to use.
Report	Generate data needed for a test report and if MS Word is installed on the PC used, allows producing/viewing/printing a test report in MS Word.
Report Preview	Previewing a test report in MS Word. MS Word must be installed on the PC used.
Print Report	Printing a test report in MS Word. MS Word must be installed on the PC used.
Exit	Terminates and exits the PCTS program

4.4 Edit Menu

The Edit menu offers the following sub-menu choices.

SUB MENU	DESCRIPTION
Copy Top Graph	Copies a bitmap image of the top graph displayed to the Windows Clipboard. From there, it can be pasted into other Windows programs.
Copy Bottom Graph	Copies a bitmap image of the bottom graph displayed to the Windows Clipboard. From there, it can be pasted into other Windows programs.
Edit Header	The Header is printed at the top of each report page. This sub menu brings up a dialog box that allows the header to be edited. For testing on behalf of a third party, this feature allows the test lab name to be printed on each report page.

4.5 View Menu

The View menu offers the following sub-menu choices.

SUB MENU	DESCRIPTION
Test Setup	Brings up an overview of all selected test setting for the current test. This is a display window only and no fields can be changed in this mode. To change setup options, close the active test window and select Perform a new Test from the Test menu.
Test List	Brings up a display grid showing all tests ran to date on the test system PC. For each test, a time stamp, test type and pass fail result is shown.
Calibration Info	Displays a summary window of the Card serial number, PACS serial number, frequency calibration and last calibration date.

4.6 Options Menu

The Options menu offers the following sub-menu choices.

SUB MENU	DESCRIPTION
Get a new reference for each test	For Harmonics tests with a limit set that is a function of the power level or current of the EUT, a new reference can be established for each test run. Alternatively, the last used reference can be preserved for subsequent test. This menu entry toggles between these two available modes.
Generate ASCII Files at the end of test	When selected, this option causes tab delimited ASCII files to be generated at the end of the test from the binary data files recorded during the test run. ASCII files take up more space but can be opened using other application programs. All the ASCII files will be in the sub directory “ASCII_files”. Please note that even if this item is not selected, conversion from a binary test file to ASCII files can also be accomplished using the ASCII converter program (Convert data to ASCII) supplied as part of the PCTS program suite.
Show Banner at the end of test	When selected, this option causes a large banner (Green when PASS, Red when FAIL) to appear on the screen of the PC. This banner can be seen from across the room to notify a lab operator that the test run has been completed.

4.7 Test Menu

The Test menu offers the following sub-menu choices.

SUB MENU	DESCRIPTION
Perform a new test	Clears the existing test data from memory and brings up the test setup screen for both Harmonics and Flicker test.
Select a test setup from Test List	Allows test setup information from any test in the test list to be copied to a new test setup.
Edit/View Fixed references	Allows editing of power level or current for test limits that are a function of EUT power and or EUT current. See Get new reference entry under Options menu.
Current Harmonics	Displays a table with current harmonics data of the most recent test.
Voltage Harmonics	Displays a table with voltage harmonics data of the most recent test.
Parameters Data	Displays a table with parameters of the most recent test.

5 Harmonics Testing

5.1 About This Chapter

This chapters covers testing a device for compliance with both of the IEC 61000-3-2 Harmonics standards supported by the PCTS system. A review of the possible EUT classes is provided to assist the user in determining the appropriate device class to use.

5.2 Test Standard Selection

Before running any Harmonics test, you must decide if you want to test to the old harmonics standard (IEC 61000-3-2:1998) or the new one. (IEC 61000-3-2:2000, Amendment 14). Both may be used up to January 2004 after which time only the new standard should be used. The standard selection is made in the lower right hand corner of the setup screen. Once selected, some options may be grayed out. For example, Amendment 14 combines transitory and steady state testing into one common method, so the quasi-stationary selection is disabled. Note that the acquisition window over which the evaluation of current harmonics is made differs under both standards. Per the IEC 61000-4-7 referenced in Amendment 14, which replaces the Annex B of the 1998 standard, the evaluation window for Amendment 14 is 10 cycles at 50 Hz or 12 cycles at 60 Hz. The 1998 standard is based on an evaluation window of 16 cycles for 50 Hz. (same 16 cycles is used when using 60 Hz). Selecting the desired test standard automatically configures the PCTS for the correct acquisition window.

5.3 Device Classes

The IEC 61000-3-2 categorizes products in one of four product classes. Using the correct class is important as the harmonic current limits for each class are different. Choosing the wrong class can mean rejecting a product that otherwise would have passed (False Negative) or passing a product that normally would have failed (False Positive). Either outcome is undesirable.

The following device classes are defined:

Class A All motor driven equipment, most “domestic” appliances and virtually all 3 phase equipment (<16 A rms per phase).

Class B All portable electric tools.

Class C All lighting products, including dimmers, with an active input power above 25 Watts.

Class D Products having a power range from 75 to 600 Watts AND a current waveform that has a special wave shape. For testing to IEC 61000-3-2:2000, Amendement 14, the special waveshape does not apply and only TV's PC's and PC Monitors with power levels between 75 and 600 W are considered class D. All other products are either one of the other test classes A, B or C.

5.3.1 Class D Special Current Waveshape

If you elected to test to the IEC 61000-3-2:1998 standard, a unit is considered to be class D equipment if it meets the power consumption limits listed above and its current waveform matches at least 95 % of a specified wave shape template. This template is aimed at 'capturing' high crest factor loads that are known to generate high harmonic currents. The wave shape template consists of three time domain sections, one for each 1/3 period of the signal during a positive or negative half-cycle of the input voltage. The center section is normalized to, and centered on the peak current value. The other two sections have a 0.35 times Ipeak amplitude limit. The actual template is shown in Figure 5:1.

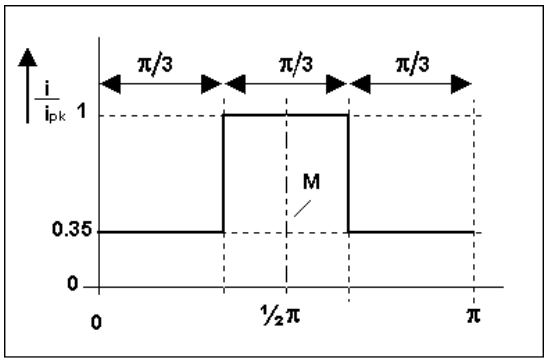


Figure 5:1: Class D Current Wave Shape Template for IEC 61000-3-2:1998 only

The exact IEC 61000-3-2:1998 standard text is as follows:

"..equipment shall be deemed to be Class D if, under the test conditions given in Annex C, the input current waveshape of each half period - referred to its peak value i_{pk} - is within the envelope shown in the following figure for at least 95 % of the duration of each half period; this implies that waveforms having small peaks outside the envelope are considered to fall within the envelope. The center line M, coincides with the peak value of the input current."

A device that does not meet these class D requirements defaults to a class A device and should be tested against the class A limits.

The flowchart shown in Figure 5:2 can be used to determine the class of the device to be tested.

When selecting IEC 61000-3-2:1998 mode with a Class D device, the PCTS Software will display the current waveshape and the special waveform template. The percentage that fails within the template is displayed as well. If the waveform is not class D, the user will be given an indication. The test can still be run however. In Class A testing, the special waveform check is also performed to prevent a "False Positive".

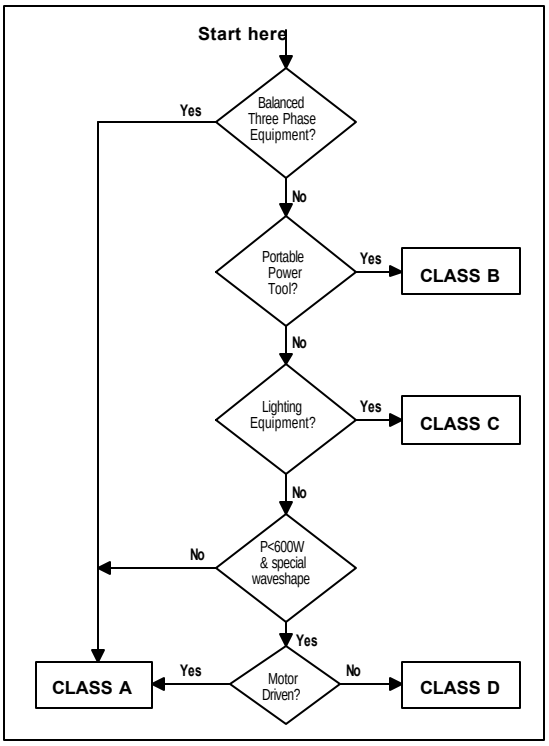


Figure 5:2: EUT Class Determination Flowchart

If the PCTS Software indicates that the current waveform does not meet the Class D requirements, the user should switch to Class A instead.

5.3.2 Dynamic Class C and D Limits

Harmonic current limits for Class D are a function of the EUT power level. This poses an interesting problem, especially if the device has a fluctuating power draw pattern. This means the test limits change with the power consumption of the EUT. While there is some discussion in the IEC community regarding the practicality of using such dynamic test limits, the PCTS Software is fast enough to dynamically recalculate the test limits applied to the current harmonics for each acquisition window of 16 signal periods. As such, the PCTS system fully implements the IEC standard with respect to class D.

The same issue applies to the third harmonic limit for Class C products, which is a function of the fundamental current and power factor (λ). The PCTS Software determines the fundamental current and power factor of the load for each acquisition window and dynamically determines the correct 3rd harmonic current limit for Class C devices.

If you select to test to Amendment 14, you will have to enter the manufacturer rated power for Class D (TV's, PC's and PC Monitors) or the fundamental current and power factor for Class C (lighting products) instead. The rated values will be used to calculate the Class C and D limits as long as the actual measured values do not differ from the rated values by more than 10 % during the test. You may also opt to let the PCTS use measured power (current-PF) to determine the class D (class C) limit values. In this case the system determines the power using the 1.5 sec. Filter method as given in Amendment 14.

5.4 Stationary or Transitory Harmonics Test

The IEC 61000-3-2:1998 standard distinguishes between two types of tests, stationary for equipment that exhibits constant power consumption and transitory for equipment that exhibits fluctuating power consumption patterns. While the harmonic current limits applied to each type of EUT are identical, equipment that produces transitory harmonics is allowed to exceed the limit levels by 50 % as long as such excessive levels last less than 10 % of the total time during any 2.5 minute period. This is equivalent to 15 seconds of the total period (2.5 minutes = 150 seconds, 10 % of 150 seconds = 15 seconds).

The user should determine the nature of the EUT based on his knowledge of the product. As a rule, the transitory harmonics standard is easier to pass as there is some margin (up to 50 %) compared to the stationary harmonics test. In case of doubt, it is always possible to run a stationary harmonics test on the EUT first. If the stationary test passes, you are done; a unit that passes the stationary harmonics test will always pass the transitory harmonics test. The reverse is not true however. If a unit fails the stationary harmonics test, it may still pass the transitory harmonics test as long as the current harmonics do not exceed 1.5 times the class limits and do so less than 15 seconds in any 2.5 minute period.

It should be noted that the user must ensure that the total test time applied is sufficient to cover a complete operating cycle of the EUT. Many devices are stationary in nature but notable exceptions exists. For example, a laser printer that periodically draws higher currents to heat the fuser may exhibit fluctuating harmonics and may require a test time that is sufficiently long to cover such an event. The same applies to microwave cookers and washing machines.

Note: The user is responsible for selecting the correct test method for the EUT. The PCTS system does not attempt to determine if the EUT exhibits stationary or transitory harmonic currents. If in doubt, select the stationary test method as it is the most stringent of the two.

If you selected the IEC 61000-3-2:2000 Amendment 14 standard, evaluation of current harmonics is always done using the transitory method so no user selection is provided. See section 2.5.3 for details on selecting the correct test time.

5.5 Running a Harmonics Test

Starting the PCTS main program brings up the test setup screen. This PCTS main program window automatically sizes to a Super VGA display resolution of 800 x 600 pixels. Larger screen resolutions are supported but the controls on the main window will not size to any resolution above 800 x 600.

For correct harmonics and flicker measurement operation, please note the following setup guidelines:

1. **Make sure that the PACS and PC are operated from the same supply line and the data cable between the PACS and the PC is plugged in.**
2. **Make sure that the AC input is connected to the EUT through the PACS unit.**

A harmonics test is always started by selecting the desired test standard and setting the EUT class. Other settings involve selecting the available nominal voltage and frequency. The figure below shows the typical settings for a class A test.

Please note the six fields at the bottom of the set up screen are grouped as Default user input. The values you entered in these fields are not necessarily for the particular test you are about to perform. When you click OK, you will be presented with a measurement screen where you can enter similar information that is specific for the test. The Default User Input here is intended to facilitate the situations where a group of tests are to be performed where the information in Default User Input are applicable to all the tests in the group.

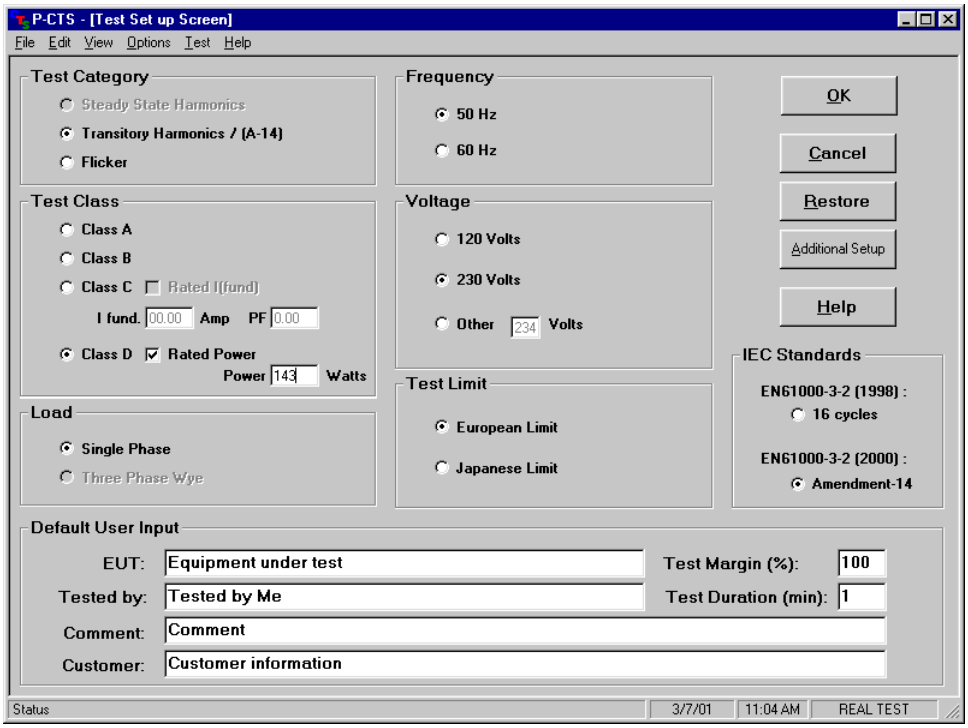


Figure 5:3: Typical Class D test setup

The following checklist shows all available setup options for a Harmonics test.

Field	Description / Purpose
IEC Standard	This option may be used to select the test standard to be used. Available options are IEC 61000-3-2:1998 or IEC 61000-3-2:2000, Amendment 14. The 1998 standard requires the use of a 16 period acquisition window. The 2000 standard mandates 10 periods at 50 Hz and 12 periods at 60 Hz for a 200 msec at either line frequency.
Test Category	When selecting IEC Standard IEC 61000-3-2:2000 Amendment 14, the only available test categories are Transitory Harmonics or Flicker. When selecting IEC 61000-3-2:1998, stationary harmonics may be selected as well. EUT's that have a constant load pattern may be tested using the steady state mode under the old standard.
Frequency	Choose 50 Hz or 60 Hz. This choice will be used to check the AC line frequency. The measured frequency is checked against the user setting and an error message is generated if a discrepancy is detected. For IEC compliance testing, 50 Hz should be used.
Test Class	Select the appropriate test class for the equipment under test. See paragraph 2.4 for test class selection.
Voltage	Select the correct line voltage. Default choices are 120 and 230 V RMS Line to neutral. A user-defined value may be entered by selecting the "Other" option. This setting is used to inform the program what AC line voltage to expect. The operator is responsible for ensuring the correct line voltage is applied to the EUT.
Load	Selects single or three phase mode. Only single phase mode is available on the PCTS system.
Test Limit	The PCTS retains a database of harmonic current test limits. This setting selects the limit set to use. Available options are European and Japanese. For normal IEC testing, the European option should be selected.
EUT	This field may be used to enter information about the equipment under test.
Tested by	This field may be used to enter operator information.
Comment	Comment field for general use.
Customer	If the test is performed on behalf of a third party, information about the entity for which the test is performed may be entered here.
Test Margin	Determines at what scale factor the harmonic test limits will be applied. For most situations, this value should be set to 100 %. If testing is done for pre-compliance, setting a lower margin will provide an extra margin of safety against system tolerances of different test systems.
Test Duration	Enter the total test time. For Steady State Harmonics, the default test time is 1.0 minutes. For Transitory Harmonics, the default test time is 2.5 minutes. For flicker tests, the default time is 10 minutes. Maximum test time is 1440 minutes or 24 hours.

Table 5-1 : IEC Harmonics Setup Parameters

5.6 Additional Setup Parameters for Harmonics

If this is your first time using the PCTS system, it may be necessary to check the Additional Setup settings. These settings can be displayed by clicking on the "Additional Setup" button on the right hand side of the main setup window.

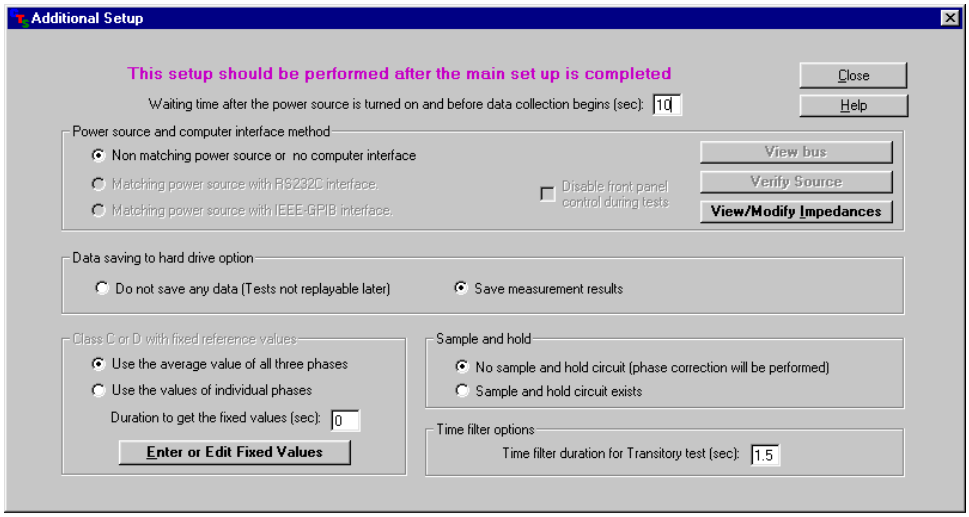


Figure 5:4: Additonal Settings for Harmonics Test

The following settings are available from this dialog window:

Setting	Description
Pre test time	This is the time during which to apply power to the EUT before starting the harmonics measurements. This capability may be used to skip any startup behavior of the EUT that may affect the outcome of the test. High EUT inrush currents can result in high voltage distortion. This would invalidate the test. The Pre-test time setting can be used to hold off measurements until after the EUT has reached a steady state condition. (Default is 10 seconds)
Source Control	Not available on the PCTS.
Data Saving	Test data for each test can be saved to disk for later use. For most situations, it is recommended to save the test data. For debugging sessions, it may be acceptable to turn off this option to preserve disk space.
Class C and D Test Limits	Test limits for class C and D are not fixed but rather depend on the EUT power level (Class D) or fundamental current and or power factor (Class C). The PCTS uses this information in one of two ways, depending on the test standard selected: For IEC 61000-3-2:2000 Amendment 14 tests, the rated power for class D or rated fundamental current and power factor for class C is used to determine the class limits as long as the measured power, current or PF is within 10 % of the rated value(s) entered. For IEC 61000-3-2:1998 tests, normally a dynamic test limit calculation method to determine the correct limits for each acquisition window is used. Using the settings in this frame however, the operator may override this implementation and set a fixed limit for Class D and C. The time for which to acquire power and

Setting	Description
	or power factor data from the EUT can be set in the Duration field in seconds. The actual rated values may be entered by clicking on the "Enter or Edit fixed values" button or directly from the basic test setup screen.
Sample and Hold	Not applicable in PCTS systems. This setting must be left on "No sample and hold"
Time filter duration for transitory harmonics filtering.	This value should be set for 1.5 seconds to comply with both IEC 61000-3-2 standards. Future standard changes may require this value to be changed.

Table 5-2 : IEC Harmonics Advanced Setup Parameters

5.7 Main Harmonics Test Window Operation

Upon closing the Main setup window, the harmonics test window will appear. Tests are executed from this window and test results are displayed in real-time. This main harmonics test window has a limited number of controls; the function of each is explained in the table below.

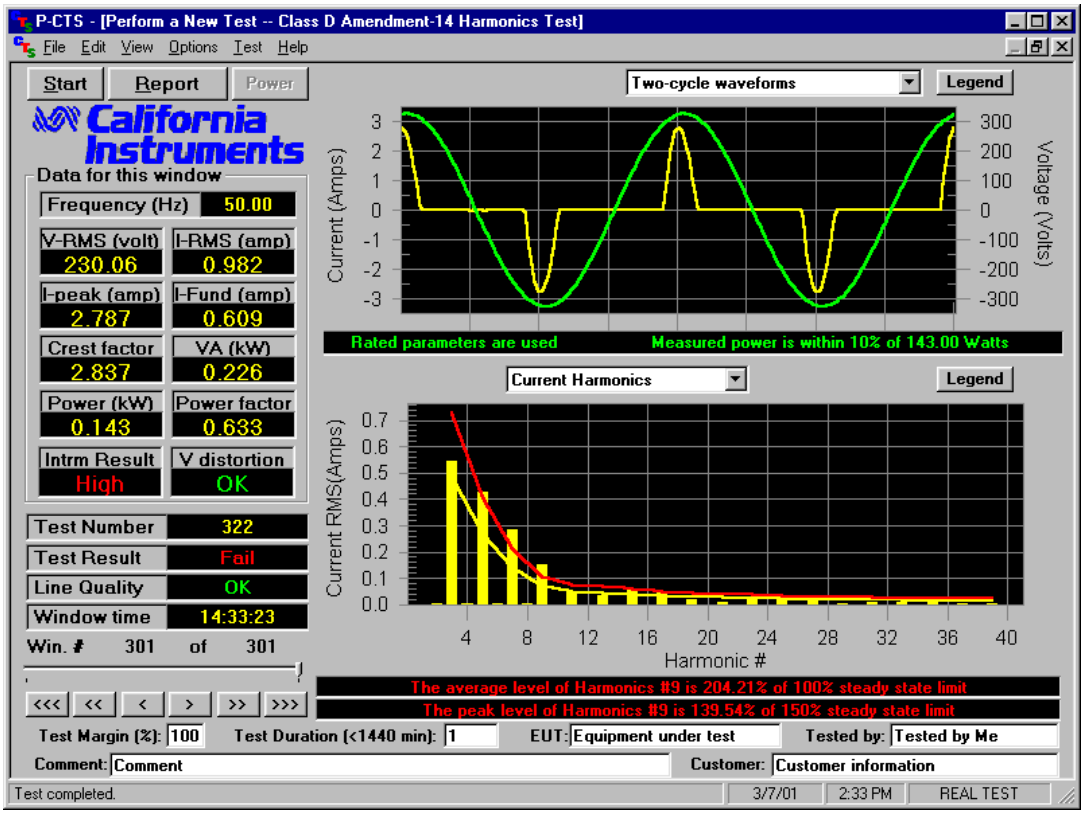


Figure 5:5: Harmonics Test Window

Field / Control	Location	Description
Start button	Upper left corner	Starts harmonics test using presently selected parameters. Once a test is running, parameters cannot be changed. Starting a test also causes data to be written to the test data file if data recording is enabled. Each time a test is run, a new sequential 'Test Number' is assigned. Results for each test are automatically logged. Data for each test is only recorded if this option is selected in the Additional Setup screen. Once a test is running, the Start button changes to a Stop button. Also, all menus will be disabled while a test is in progress as pulling down a menu under Windows will cause the application to halt which would result in data loss.
Stop button	Upper left corner	Stop the acquisition process. The Stop button can be used to abort a test prematurely. The data files will be closed and will only contain data up to the point at which the test was aborted. Test log will indicate if the test completed normally or was aborted by the user.
Report button	Upper left corner	The Print Summary button generates a test report in an MS Word doc file. This report contains both the voltage and current waveform and the harmonics display graph. It also includes the current and voltage harmonics in absolute values and as a percentage of the applied IEC limits.
Data frame	**Left Panel**	The data in the frame on the left side of the main harmonics screen applies to successive acquisition buffers. Acquisition buffers are 320 ms for 50 Hz EUT's and 266.67 ms for 60 Hz EUT's if the 16 Cycle window size is selected. If the 10/12 cycle window size is selected, the buffer size is 200 msec.
Frequency - Hz	Left panel	Displays the AC signal frequency in Hz. If the frequency is not 50 or 60 HZ, "F???" will appear in the field of V Distortion and Source Qual. The test will continue however but the results may not be valid.
Voltage - RMS	Left panel	Displays the Root Mean Square voltage of the AC source output for each acquisition buffer.
Current - RMS	Left panel	Displays the Root Mean Square current to the EUT for each acquisition window.
I peak	Left panel	Displays the peak current value of the EUT current. If the EUT produces no harmonic currents, the peak current is $\sqrt{2}$ times the RMS current.
I Fund	Left panel	Displays the value of the fundamental current of the EUT for each acquisition window. The fundamental current is the current at 50 Hz or 60 Hz only, without any contributions from higher order harmonic currents. If the EUT produces no harmonic currents, the fundamental current will be the same as the rms current.
Crest Factor	Left panel	Displays the crest factor of the EUT current. Crest factor is the ratio between the peak current and the RMS current.
VA Power	Left panel	Displays the apparent power consumption of the EUT for each acquisition window.
Power - Watts	Left panel	Displays the real power consumption of the EUT for each acquisition window.
Power Factor	Left panel	Displays the ratio between real power and VA power of the EUT for each acquisition window.
Window Result	Left panel	Indicates if the present acquisition buffer current harmonics exceed the selected EUT current limits. If one or more acquisition buffers report a failure, the overall test result will fail. This field will typically

Field / Control	Location	Description
		toggle between good and fail during the test run.
V Distortion	Left panel	Indicates if the present acquisition buffer has a voltage distortion that exceeds the IEC limit and may thus cause current harmonics that affect the test. If so, the PCTS software will automatically compensate for this to ensure the harmonic current measurements and thus the outcome of the test will not be affected. If the measured line voltage deviates from the value selected in the test setup screen by more than 10 %, an indication of V???? will appear in red in this field.
Test Number	Bottom Left	Each test run is assigned a sequential test number. The number for the current test is displayed in this field. This allows individual test results to be tracked.
Test Result	Bottom Left	This field provides a visual indication of the test result. A Green field with Pass indicates the EUT current harmonics are below the limit, a Red field with Fail indicates the EUT current harmonics are above the limit. Note that the condition of this field is affected by the user selected test margin. To use the actual IEC test limits, the test margin should be set to 100 %. This field depends on the “Window results” of all the windows up to this test time and if any “Window result” is failed during a test. At the end of the test the final limit calculation and maximum harmonics will be compared to determine the final best result.
Source Qualification	Bottom Left	This field displays overall AC line voltage distortion status for the test so far. At the end of the test, this field indicates if the AC line exceeded the IEC source distortion limit at any time during the test. The V Distortion indication is given to notify the user of a possible problem with the AC line voltage distortion. Since the PCTS software automatically compensates for source voltage distortion however, the test results will not be affected.
Start Time	Bottom Left	This field always shows the start time of the test in progress. The test duration is shown in the bottom panel. See also the “% of test completed” indication and the progress bar below the Start Time field.
% of test completed	Left panel	During test execution, this field displays the percentage of the test that has been completed. Once this number reaches 100 %, the test will terminate normally. If the user clicks on the Stop button instead, it will display the point at which the test was aborted.
Test Margin	Bottom	The test margin can be set by the user if a pre-compliance test is needed and the user wants to set more stringent limits. The test margin number defaults to 100 % to use the exact IEC limits. A lower percentage will means the EUT has to pass lower test limits (more stringent). The value of this field ranges from 50 % to 150 %. Note that the limit lines in the Graph always display the 100 % IEC limits. The test margin is only used for Pass or Fail determination.
Test Duration	Bottom	The test duration is the total test time selected by the user. This value can be set from 0 to 1440 minutes (24 hours). This value should be set before starting the test, as it cannot be changed while a test is in progress. If the duration is 0 minutes, then only one window will be acquired.
EUT	Bottom	This field can be used to enter information about the unit under test. The EUT field contents will be included in the test data file and in any

Field / Control	Location	Description
		reports that are printed.
Comments	Bottom	This field can be used to enter any information about the test. The Comments field contents will be included in the test data file and in any reports that are printed.
Tested by	Bottom	This field can be used to enter information about the operator. The "Tested by" field contents will be included in the test data file and in any reports that are printed.
Customer		This field can be used to enter information on a customer if you are running tests for a third party. The "Customer" field contents will be included in the test data file and in any reports that are printed.
Voltage and Current Graph	Top right panel	This graph displays the AC voltage and current waveforms. At all times, two periods of the AC signal are displayed. The voltage is shown in yellow, the current in green. If the IEC 61000-3-2:1998 test mode is selected and a Class A or D test is run, the special waveshape template is displayed in the same graph using red. The percentage of the EUT current outside the template is shown directly below the graph. If the IEC 61000-3-2:2000 Amendment 14 mode is selected, this template will not appear as it does not apply in this mode.
Harmonics Graph	Bottom right panel	The Harmonics graph panel can be used to display the current harmonics (green) and test limits (red) during the test. It is also possible to toggle this display to show the AC voltage harmonics. The drop down control located at the top of the Harmonics graph panel can be used to select alternate display modes.
Legend buttons	Graph panels	The Legend buttons can be used to display a pop-up window that shows the color-coding used in each graph.

5.7.1 Entering User and/or Customer Data

Prior to running a test, you should enter information concerning the EUT, the person or department performing the test and any other information that may be relevant to interpreting or using the test results obtained from the PCTS system. For example, the fact that rated parameters are used for the EUT power could be entered in this field. Several fields are provided for this purpose along the bottom of the main test window. If the test is performed on behalf of a third party, the customer data field may be used to document the customer name.

The information entered in these fields is added to the test data file and any reports that are printed. The date and time of the test run are automatically added based on the PC's real-time clock.

5.7.2 Selecting the Test Period

The test period should be set appropriately for the test mode selected and the EUT at hand. For details on setting the correct harmonics test time, refer to paragraph 2.4.2 for IEC 61000-3-2:1998 mode or paragraph 2.5.3 for IEC 61000-3-2:2000 mode. For flicker tests, the default is 10 minutes. You can increase the test time up to 24 hours if needed.

5.7.3 Setting the Test Margin

The PCTS system offers the user the choice of setting a test margin around the IEC limits. This means a user specified factor can be applied to the IEC test limits. The default value used is 100 %, which essentially means the actual IEC limits are applied to determine a pass or fail result. This is the mode to use for actual compliance testing.

Setting this margin to a value below 100 % can be useful for pre-compliance testing. Selecting a lower margin means the test is more stringent. If the EUT can pass the more stringent test, it is more than likely to pass when submitted to an independent test lab. Setting the margin above 100 % means you are “loosening” the limits allowing EUT’s to pass that would normally fail. This mode is not recommended.

5.8 Running the Harmonics Test

Before starting a test, make sure all user fields are set correctly. Changes to these fields are no longer possible once a test is in progress. Also make sure the EUT is connected to the AC output of the PACS unit and the correct AC line voltage is programmed on the AC source.

A test run is started by clicking on the Start button. During test execution, the “% of test completed” field on the left of the main window displays the percentage of the test that has been completed. Once this number reaches 100 %, the test will terminate normally. If you click on the Stop button instead, it will display the point at which the test was aborted.

During the test execution, the PCTS software will continuously evaluate the EUT current harmonics against the appropriate class limits. The Pass or Fail indication is updated in real-time. If the test fails early in a long test period, you may elect to abort the test prematurely rather than waiting till the end.

5.8.1 Voltage and Current Waveform Graphs

The top graph continuously displays two signal periods of the AC voltage (yellow) and current (green) waveforms. Depending on the test standard selected, additional information is shown below the graph as well. Alternate display modes can be selected from the drop down combo at the top of the graph.

IEC 61000-3-2:2000 Mode
For class C and D EUT tests, the information line directly below the voltage and current graphs shows the status of the rated fundamental current and power factor for Class C and the same for rated power in class D. If the measured value is outside a 10 % tolerance of the rated value, the actual measured value is used instead to calculate the class limits. This condition will be indicated on the right hand side below this graph.

IEC 61000-3-2:1998 Mode
For Classes A and D tests, the voltage and current graph also shows the special current wave shape template in red. The amount in which the current waveform is outside this template is shown directly below the graph in percentage. The actual EUT class based on power level and current wave shape may change between class A and D and is indicated as such above this graph.

5.8.2 Voltage and Current Harmonics Graphs

The bottom graph serves a dual purpose. During the test run, it can be used to show either the current or the voltage harmonics. In either mode, the IEC test limits are displayed using a red line for the current harmonic limits and a green line for the voltage harmonic limits.

When displaying the current harmonics, the actual harmonic currents from the second through the fortieth for each acquisition window are shown in green. The IEC test limits are shown using a red line. Note that this red line always displays the 100 % IEC test limits during Steady State testing, regardless of the user specified test margin which is used for the Pass or Fail determination. (see “Setting the Test Margin” on page 49). However, after a transitory test is completed the graph will display the 100% limit as well as the 150% limit (permitted for 10% of the test time).

Note: The fundamental current is not shown in the harmonics graphs as there is no test limit for the fundamental.

5.8.3 Aborting a Test

Tests in progress can be aborted at any time by clicking on the Stop button. Aborted test data files will be marked as incomplete.

5.9 Printing Results and Report Formats

The Report button allows you to print both on-screen graphs displays and current and voltage harmonics test result data to an MS Word™document. This provides a test report that displays the test setup, the Pass or Fail result and a graph of the voltage and current waveform as well as the worst-case values for each of the current harmonics. The Report button is available at the end of a test run or any time a test is aborted with the Stop button.

The harmonics test report contains three pages. The first page provides general information on test setup and EUT at the top of the page. This information is repeated on all three pages of the report. Optionally, additional pages may be added to these test reports. See the System Administration manual, Sections 4.4.1 and 4.4.2 for details.

The first page also contains a graph of the voltage and current waveform recorded during the test and a bar chart of the current harmonics. The bottom chart also shows relevant harmonic current limits for the selected class.

Directly below the harmonics current bar chart graph, the highest harmonic found will be shown.

The second page contains a tabular printout of all current harmonics.

For IEC 61000-3-2:2000, both the average current harmonics and the maximum peak harmonics are displayed along with the 100 % and 150 % class limits and the harmonic currents as a percentage of these limits. This page also includes information on measured power (Class D) and (I_f) fundamental current and (PF) power factor (Class C).

For IEC 61000-3-2:1998 mode, the report format will be different for transitory and stationary harmonics.

The third page contains a tabular printout of the highest voltage harmonics recorded during the test. This information is provided to check the source voltage quality during the test. If the source quality of the AC line or source falls below the IEC requirement, the PCTS will automatically compensate for this when evaluating harmonic currents. The report however, will always show the actual voltage distortion.

All PCTS reports are generated using MS Word and result in MS Word documents being created in the C:\Program Files\California Instruments\CTS\report_files directory. For information on customizing test report templates, see the PCTS System Administration Manual.

5.10 Harmonics Test Data Files

The PCTS Software can be configured to log test data to a file. The file format used is proprietary but can be converted at the end of the test to an ASCII text file with tab delimited fields for voltage, current, power, peak current and all the current harmonics. This data is recorded in real-time or three to five times a second.

Longer test times will result in larger test data files and reports. If you increase the test time, make sure you have sufficient hard disk space available to accommodate these long test files. The rate at which data is written to disk can be decreased to avoid excessive file sizes. The point at which the program will reduce the rate of data storage can be set in the configuration. Should a test failure occur while the PCTS program is in this reduced data rate-recording mode, full rate data recording resumes for a specified number of acquisition buffers. This always provides detailed information around the time of the failure. These recording rate settings can be set in the miscellaneous section

of the configuration program. See the PCTS Administrator Manual for details on configuration settings.

6 Flicker Testing

6.1 About This Chapter

This chapter covers testing a device for compliance with the IEC 61000-3-3 Flicker standard. The relevant IEC Flicker test part is described in detail.

6.2 Principle of Operation

The CTS Flicker software acquires, stores, processes and analyzes the EUT data in real-time and provides continuous display updates on all Flicker parameters. Voltage time domain data is collected, the RMS voltage value is calculated for each half period of the signal or every 10 msecs, and the measurement data is written to disk for 100 consecutive acquisition periods or once every second.

This allows the operator to monitor the progress of the flicker test and, should a failure occur before the end of the test run, abort the test if needed. Since flicker test can run for several hours, this will avoid needless waiting for tests to finish on a EUT that already failed the IEC requirements.

In order to run the real-time Flicker test, you need a 300 MHz Pentium PC or better. This is caused by the amount of data that needs to be processed to perform flicker evaluation. Slower PC's will not be able to process the data in real-time.

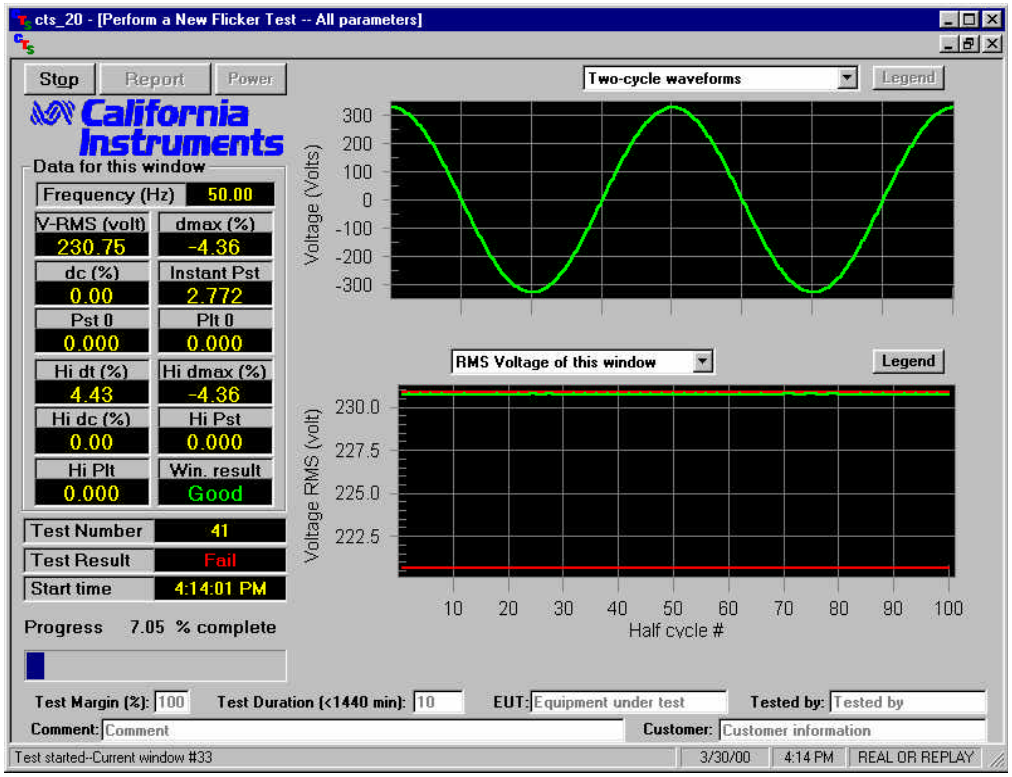


Figure 6:1: Flicker Test Window

6.3 Running a Flicker Test

Running a flicker test is similar to running a harmonics test. Launch PCTS and select flicker test in the set up screen. Then select appropriate test parameters and click OK to continue. You will be presented with a test screen similar to that of harmonics.

The flicker test window has several user accessible fields and controls. The following table briefly describes the purpose of each field and control.

Field / Control	Location	Description
Start button	Upper left corner	Starts the flicker test using presently selected parameters. Once a test is running, parameters cannot be changed. Starting a test also causes data to be written to the test data file.
Stop button	Upper left corner	Stop the acquisition process. The Stop button can be used to abort a test prematurely. The data files will be closed and will only contain data up to the point at which the test was aborted.
Report button	Upper left corner	Used to produce a test report in MS Word™. A copy of MS Word™ must be installed to generate the report.
Frequency	Left Panel	Displays signal frequency
Vrms (volt)	Left Panel	Displays Voltage rms value
Test Start Time	Left panel	This field always shows the start time of the test in progress. The test duration is shown in the bottom panel.
Highest d_c %	Left panel	Displays the highest Relative Steady State voltage change (d_c) in % found so far during the test. This represents the difference between two adjacent steady-state voltages relative to the nominal voltage. The standard requires that d_c must be less than or equal to 3 % for the EUT to PASS. *
Highest d_{max} %	Left panel	Displays the highest Maximum relative voltage change (d_{max}) in %. found so far during the test. This represents the difference between the maximum and minimum rms values of the voltage change characteristic relative to the nominal voltage. The standard requires that d_{max} must be less than or equal to 4 % for the EUT to PASS. *
Highest d_t %	Left panel	Displays the highest Relative voltage change characteristic (d_t). This value represents the change in rms voltage, relative to the nominal voltage, as a function of time and between periods when the voltage is a steady state condition for at least 1 second. The standard requires that d_t must be less than 3 % for the EUT to PASS, although it is permitted to be between 3 and 4 % for less than 200 msec. *
Highest Psti	Left panel	Displays the highest Short Term Flicker value found so far during the test. Each Short Term Flicker severity is evaluated over period of 10 minutes. The threshold of irritability is Pst = 1 and this value is used as the PASS/FAIL limit.
Highest Plt	Left panel	Displays the highest Long Term Flicker value (Plt) found so far during the test. The Plt period is 120 minutes and is calculated using successive Psti values. The threshold of irritability for long term flicker is 0.65 and this value is used as the PASS/FAIL limit.
Test Status	Center panel	This field provides a visual indication of the test result. A Green field with Pass indicates the EUT passes the Flicker test, a Red field with Fail indicates the EUT causes too much flicker. Note that the condition of this field is affected by the user selected test margin. To use the actual IEC test limits, the test margin should be set to 100 %.

Field / Control	Location	Description
Voltage - rms (Ut)	Center panel	Displays the Root Mean Square voltage of the AC source output for each acquisition window. Acquisition windows are 10 ms for 50 Hz EUT's and 8 ms for 60 Hz EUT's.
d_{max} %	Center panel	Displays the present Maximum relative voltage change (d_{max}) in %. This represents the difference between the maximum and minimum rms values of the voltage change characteristic relative to the nominal voltage. The standard requires that d_{max} must be less than or equal to 4 % for the EUT to PASS. *
d_c in %	Center panel	Displays the present Relative Steady State voltage change (d_c) in %. This represents the difference between two adjacent steady-state voltages relative to the nominal voltage. The standard requires that d_c must be less than or equal to 3 % for the EUT to PASS. *
Plt # n	Center panel	Displays the present Long Term Flicker value for Pst period number n. The Plt period is 120 minutes and is calculated using successive Psti values. The threshold of irritability for long term flicker is 0.65 and this value is used as the PASS/FAIL limit.
Instant. Pst	Center panel	Displays the instantaneous Short Term Flicker value. At the end of each 10 minute period, this value will be the Pst for the period.
Psti #n	Center panel	Displays the present Short Term Flicker value for period n. The Short Term Flicker severity is evaluated over a period of 10 minutes. The threshold of irritability is Pst = 1 and this value is used as the PASS/FAIL limit.
Select Test	Test selection	This combo box allows one of three test modes to be selected: • Test all Flicker parameters • Test dc and dt only • Test Pst only *
Test Margin	Test Margin	This field allows the user to set the test margin from 50 % to 150 %. Additional information on setting a test margin is shown later in this chapter.
Graph Display	Graph panel	The top graph panel shows two cycles of the voltage waveform. The lower graph panel is used to display any of the Flicker parameters as a function of time. The user can change display modes using the Graph mode drop down box located directly above the graph itself.
Test Duration	Bottom panel	The test duration is the total test time selected by the user. This value can be set from 0.5 minutes (30 seconds) to 1440 minutes (24 hours). Note that a Pst and/or all parameter test requires a test time of at least 10 minutes. The default test time is set to 10 minutes.
EUT	Bottom panel	This field can be used to enter information about the unit under test. The EUT field contents will be included in the test data file and in any reports that are printed.
Comments	Bottom panel	This field can be used to enter any information about the test. The Comments field contents will be included in the test data file and in any reports that are printed.
Tested by	Bottom panel	This field can be used to enter information about the operator. The "Tested by" field contents will be included in the test data file and in any reports that are printed.

* Update for amendment to Flicker standard

6.3.1 Entering User Data

Prior to running a test, you should enter information concerning the EUT, the person or department performing the test and any other information that may be relevant to interpreting or using the test results obtained from the PCTS system. Several fields are provided for this purpose along the bottom of the main test window.

The information entered in these fields is added to the test data file and any reports that are printed. The date and time of the test run is automatically added based on the PC's real-time clock.

6.3.2 Selecting the Test Period

The default test time for Flicker tests is 120 minutes which provides 12 short term flicker values of 10 minutes each. The user can set the test time anywhere from 0.5 minutes to 1440 minutes or up to 24 hours if needed. The test period needs to be set long enough to cover the entire operating cycle of the unit under test. If a test time less than 120 minutes is entered, the Plt will be evaluated using 12 Psti values and deeming the non measured 10 minute periods to have a zero Psti.

Equipment that is unlikely to produce long term flicker based on its typical operating cycle need not be tested for Plt. This can significantly reduce the test time. If you are unsure however of the EUT's behavior, you are advised to perform a 2 hour test (120 minutes) to verify compliance with IEC 61000-3-3.

6.3.3 Test Data Files

The PCTS Software can save the flicker test waveform and result during the test if the saving option is enabled. The file will be saved in the data_files subdirectory. For test #25, the file will be F-000025.cts_data.

6.3.4 Setting the Test Margin

The PCTS system offers the user the choice of setting a test margin around the IEC limits. This means a user specified factor can be applied to the IEC test limits. The default value used is 100 % which essentially means the actual IEC limits are applied to determine a pass or fail result. This is the mode to use for actual compliance testing.

Setting this margin to a value below 100 % can be useful for pre-compliance testing. Selecting a lower margin means the test is more stringent. If the EUT can pass the more stringent test, it is more than likely to pass when submitted to an independent test lab.

Setting the margin above 100 % means you are "loosening" the limits allowing EUT's to pass that would normally fail. This mode is not recommended.

6.3.5 Running the Flicker Test

Before starting a test, make sure all user fields are set correctly. Changes to these fields are no longer possible once a test is in progress. Also make sure the EUT is connected to the AC output of the PACS unit and the correct AC line voltage is applied to the PACS AC input on TB4.

A test run is started by clicking on the Start button.

During the test execution, the PCTS Software will continuously evaluate EUT Flicker against the appropriate IEC limits. The Pass or Fail indication is updated in real-time. If the test fails early in a long test period, you may elect to abort the test prematurely rather than wait till the end.

6.4 Printing Results

The PCTS Software can produce a MS Word™ based report. At the end of test, the report button will be enabled. Clicking on the Report button will generate information needed for a report and present an option to generate a report in MS Word™.

6.5 Flicker Test Data Files

The PCTS Software can be configured to log test data to a file. The file format used is proprietary but can be converted at the end of the test to an ASCII text file with tab delimited fields for voltage, pst, plt, dc, dt and dmax. This data is recorded in real-time every second. Each data records contains 100 Vrms readings conform the 10 msec acquisition window. (for 50 Hz).

Longer test times will result in larger test data files and reports. If you increase the test time, make sure you have sufficient hard disk space available to accommodate these long test files. The rate at which data is written to disk can be decreased to avoid excessive file sizes. The point at which the program will reduce the rate of data storage can be set in the configuration. Should a test failure occur while the PCTS program is in this reduced data rate-recording mode, full rate data recording resumes for a specified number of acquisition buffers. This always provides detailed information around the time of the failure. These recording rate settings can be set in the miscellaneous section of the configuration program. See the PCTS Administrator Manual for details on configuration settings.

7 Specifications

7.1 About This Chapter

This chapters provides the technical specifications of the PCTS measurement system and the Power Analysis and Conditioning System unit (PACS).

Note: All specifications listed in the manual are valid at an ambient temperature of 23° ± 5° and apply after a 15 minute warm-up period.

7.2 Measurement System Specifications

The PCTS measurement system is implemented using a high speed Analog to Digital PCI plug in board. This board needs to be installed properly in order to function according to the specification listed here.

Measurement		Specification	Unit
Bandwidth			
	Anti Aliasing	> 60 dB at 5 KHz	
	Bandpass ripple	< 2 % up to 2.5 KHz	%
Volts			
	Range	0.01 - 312.00	V_{rms}
	Max. input	1000	V_{peak}
	Max. crest factor	5:1	
	Accuracy	± 0.1 % ± 0.05 % FS ± 3 mV	mV
	Resolution	10	mV
	Voltage CMRR	80	dB
RMS Current			
	Current ranges (Auto ranging)	4,16,40	A_{rms}
	Highest range	40.00	A_{rms}
	Max. input [permanent, no damage if < 200 A_{peak}]	40.00	A_{rms}
	Max. Crest Factor [High Range]	5:1	
	Max. Crest Factor [Low Range]	20:1	
	Accuracy	± 0.1 % ± 0.05 % FS ± 3 mA	mA
	Resolution	1	mA

Measurement			Specification	Unit
Power				
	Range		0.1 - 12,500	W/ph
	Accuracy		± 0.25 % ± 0.25 % FS ± 20mW	mW
	Resolution		0.1	W
Apparent Power				
	Range		0.01 - 12,500	VA/ph
	Accuracy		± 0.15% ± 0.15% FS ± 20	mVA
	Resolution		0.01	VA
Power Factor				
	Range		0.00 - ± 1.00	
	Accuracy		± 0.05	
	Resolution		0.01	
Crest Factor				
	Range		20:1	
	Accuracy		± 0.005	
	Resolution		0.001	
Frequency				
	Range		45 - 65	Hz
	Accuracy		0.1 % of reading	Hz
	Resolution		0.1	Hz
Harmonic Analysis				
	Range		Fundamental to 40th	
	Accuracy Fundamental		±0.05% FS±0.05%/kHz	
	Accuracy Harmonics		±0.1 %±0.1%/kHz	
	Measurement window		10, 12 or 16 periods	
	Smoothing filter		1.5	sec
Flicker				
	Pst	Range	0.1 - 10	Pst
		Accuracy	3	%
		Resolution	0.01	
		Integration time	10	min
	Plt	Range	0.1 - 10	
	d_{max}	Range	0 - 100	%
	d_c	Range	0.1 - 100	%
	d_t	Range	0.1 - 100	%
	d_t over3%(4%)	Range	0 - 1000	ms

7.3 PACS-1 Specification

The PACS unit creates the mechanical and electrical interface between the AC source, the EUT and the PC. It provides the necessary isolation and signal conditioning to perform the measurements needed. The following specifications apply to the PACS-1 unit.

PACS Model:		**PACS-1**
Number of phases		1
Channels	Voltage and Current	1 and 3
Connector Style	Front panel	CEE/77 front
	Rear panel	terminal block
Maximum Voltage	Front panel	240 Vac
	Rear panel	312 Vac
Maximum Current	Front panel	16A rms
	Rear panel	40A rms
Reference Impedance		Software synthesis
Input Voltage	Rear panel IEC 320	115V / 230V Nominal ± 10%
Input Frequency		50 / 60Hz
Input Current		less than .6A (115v) less than .3A (230v)
Dimensions	HxWxD inch	3.5 x 16.8 x 22
	HxWxD mm.	89 x 427 x 560
Weight	Lbs / kg	12 / 5.4

Voltage Range: The input voltage range is 0 to 312V rms.

The 1-phase voltage is applied to input terminal block TB4.

Current Range: The input current is 0 to 40A rms.

The input current rating applies to TB4 only.

PACS-1 Front panel outlet current rating is 16A rms. only.

Voltage can be 0 to 312V rms.

Frequency may not be 50Hz depending on AC line or power source used and application.

7.4 Environmental

Parameter	Specification
Operating Temp:	0 degrees to +40 degrees Celsius.
Storage Temp:	0 degrees to +70 degrees Celsius.
Humidity:	
Operating:.	≤90% RH up to 40° C
Storage:	≤90% RH up to 40° C, ≤75% RH up to 70° C.
Creepage and	
Clearance:	Rated for Pollution Degree 2.
Insulation:	Rated to Installation Category(Overvoltage Category) II
Vibration:	Designed to meet NSTA 1A transportation levels.
Shock:	Designed to meet NSTA 1A transportation levels.

7.5 Regulatory

Parameter	Specification
Electromagnetic Emissions and Immunity:	Designed to meet EN50081-1 and EN50082-1 European Emissions and Immunity standards as required for the “CE” mark.
Acoustic Noise:	60 dBA maximum. Measured at one meter.
Safety:	Designed to meet EN61010-1 European safety standards as required for the “CE” mark.

8 Configuration Options

8.1 About this Chapter

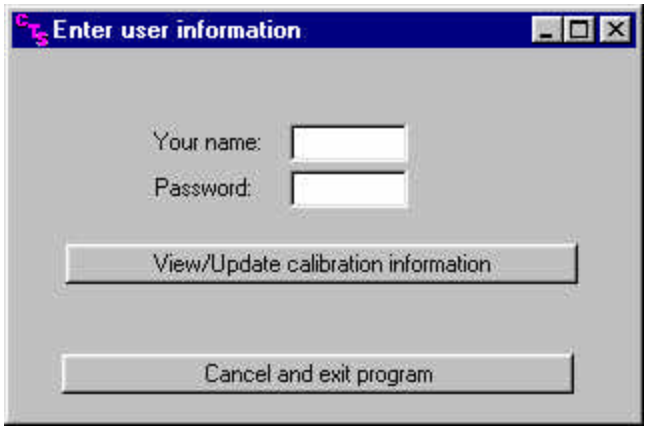
The PCTS software allows many parameters and operational characteristics to be customized to meet changing test standards and standard interpretations. Rather than providing a rigid programmed method, most of the operational characteristics such as IEC test limits, test window times and filter characteristics are data base driven.

A skilled operator may access the data in this database and customize the system to his or her specific needs. Furthermore, if changes occur in one or more of the applicable test standards, it is possible to incorporate such changes without the need to upgrade the software version.

The Calibration and Configuration module is a separate program utility which is distributed as part of the PCTS software suite and may be used to access the configuration data base. It is located in the PCTS program directory. This chapter covers the configuration parameters only. For information on calibration settings and periodic calibration, refer to Chapter 9.

8.2 Accessing the Calibration and Configuration Database

The Configuration utility is provided to allow the operator to view calibration and configuration parameters contained in this database. Only authorized users can change any of these values if properly logged in. Upon launching the Configuration.exe program, you will be prompted for your name and password. A history of all users and dates at which the configuration data has been changed is retained for audit purposes.

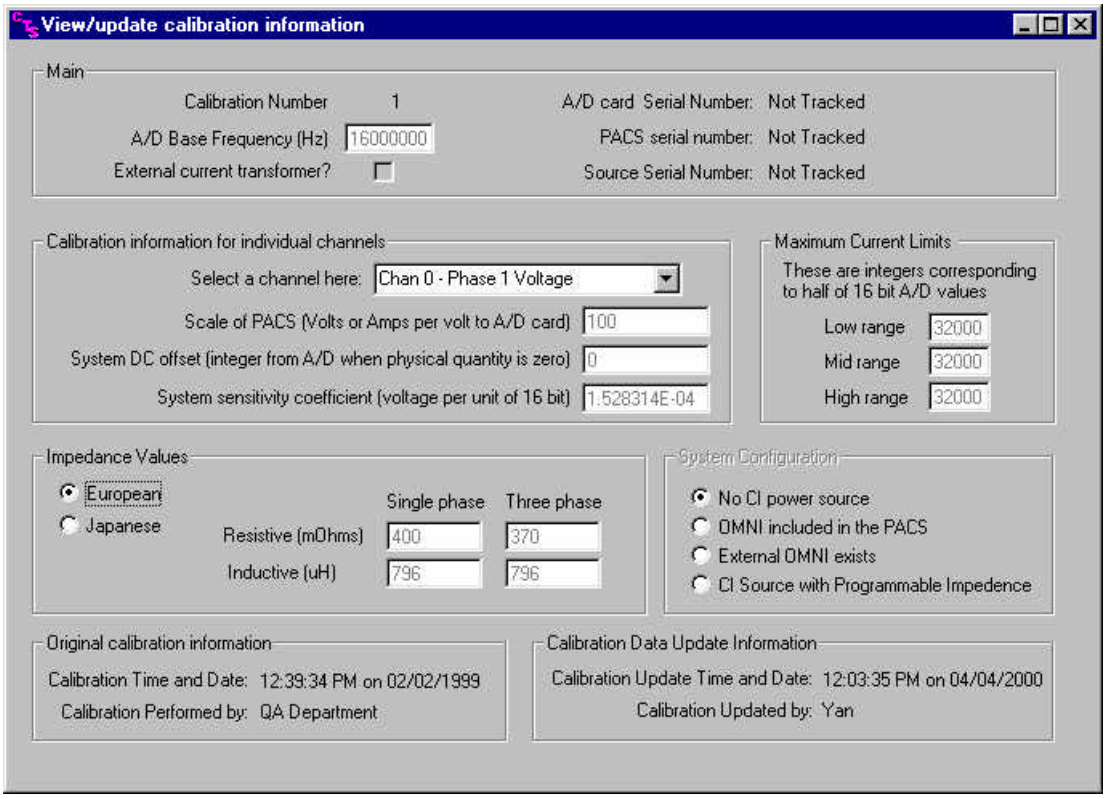


The correct password is "cal_lock". If no password or an incorrect password is specified, the operator can only view configuration data but not change any of it. After entering the correct name and password, the data can be both viewed and changed if needed. Click on the View/Update Limit Information button to access the configuration database.

For further details on changing key operating parameters or test limits on the PCTS system, refer to the PCTS Administrator Manual supplied on CD ROM with the PCTS system.

8.2.1 Calibration and Configuration Data

The following calibration and configuration data is available to the user. If the correct password has been entered, this information can be updated. If not, it can only be viewed. Any changes will be logged and time stamped so an audit trail is available.



Field	Description
Main	Displays information on the A/D card and base sampling frequency.
Calibration information	Individual voltage and current channels have calibration coefficients, which are calculated automatically when running the Calibration module. (See section 9) Normally, there is no need to edit these values.
Maximum Current Limits	The PCTS system uses three current ranges for maximum resolution and accuracy of current harmonics measurements. The range coefficients are used to set the cross over points of these current ranges. These values should not be changed by the user.
Impedance	The PCTS uses dynamic impedance synthesis in software. The data in these fields is not used. See the System Administrator manual for details on setting the impedance value.
System Configuration	This setting determines if a reference impedance is used and if so, which type. For PCTS, this selection is always "No CI power source".
No CI power source	This is the only available option on the PCTS system and is selected by default.

Field		Description
	OMNI included with PACS	This option is not supported on the PCTS System
	External OMNI	This option is not supported on the PCTS System
	CI Source with programmable impedance	This option is not supported on the PCTS System
Original Calibration Information		Shows original calibration date of PCTS system.
Calibration Data Update Information		Shows the last date the system calibration data was changed and by whom.

9 Calibration

9.1 About This Chapter

This chapter covers two basic functions: System calibration and system configuration. Calibration is covered first. System configuration is then covered detailing the steps to properly set up the PCTS system.

9.2 Calibration

The PCTS system uses a precision measurement system that requires periodic calibration. The recommended calibration interval is one year. All PCTS systems are factory calibrated before shipment, so adjustment should not be needed until after the first year of use.

Note: For calibration at the factory, the A/D card must be returned with the PACS.

A special calibration program is included in the PCTS Software suite to facilitate calibration and store the calibration constants. This module is called "**Calibration**" and is available by clicking on the **PCTS** menu selection. The program screen is shown on the next page. Make appropriate selections before clicking on the Calibrate button. Upon Clicking the Calibration button, you will be given step-by-step instructions to complete the calibration. At the end of a calibration, the Accept button will be available. Clicking on it will cause the software to save the calibration data and printout a calibration log file.

9.2.1 Required Calibration Equipment

To perform the PCTS measurement system calibration, the following equipment is required:

Equipment	Description
Digital AC Multimeter	Fluke 8840A or equivalent with traceable calibration.
Resistive Load Bank	Avtron K565 or equivalent. The load resistor range must be able to handle 2 - 30A rms and be rated for the power levels used.
Current Shunt	Isotek 50A Current shunt or Pearson Current transformer.

Table 9-1: Required Calibration Equipment

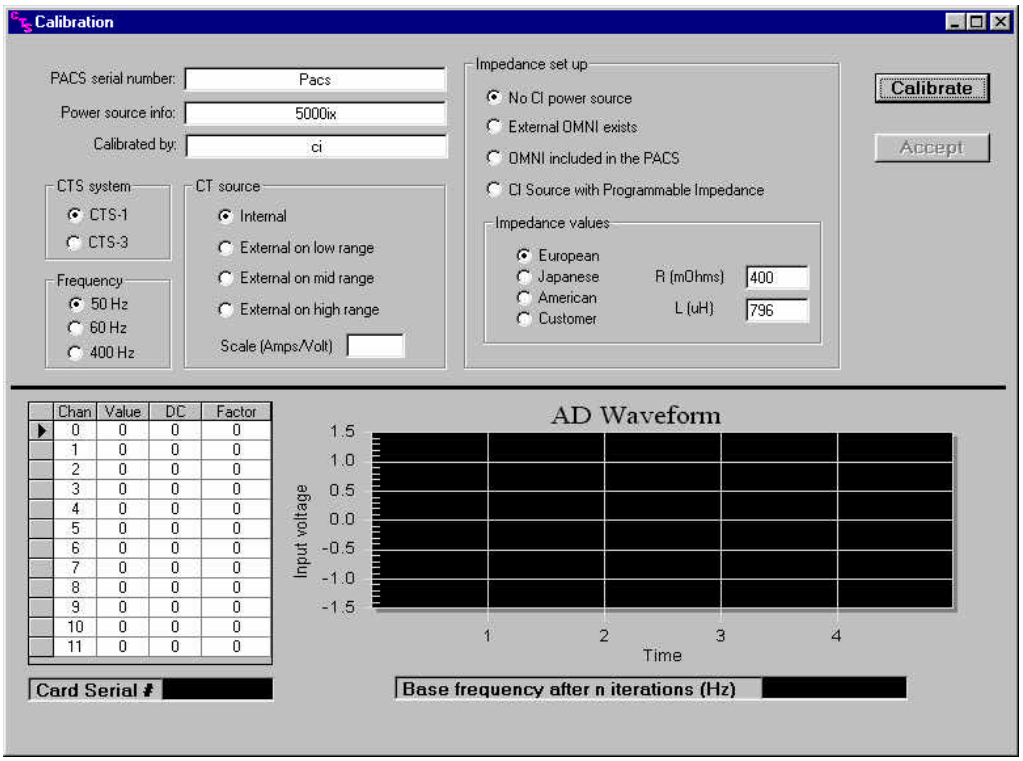


Figure 9:1 : PCTS Calibration Program Main Screen

9.3 Install A/D Card in PC

For PCTS systems to be shipped with a PCI A-D card, the PACS-1 unit must be tested with the provided (#250742) signal acquisition card along with the DB37-DB68F (#5004-225-1) interconnect cable. Install the A/D card into the test computer and connect it to the rear terminal of the PACS-1 with the DB37-DB68 cable.

9.4 PCTS Calibration Setup

To calibrate the PCTS measurement system, proceed as follows:

1. Configure the test set-up as shown in Figure 9:2. Please note that a single-phase A/C source is needed to calibrate a PACS unit.
2. Connect the current shunt or current transformer in series with the neutral wire between the PACS unit and the load bank.
3. Connect the Voltage DMM at the AC IN terminals on the PACS unit. (TB4)

9.5 Configuration Procedure

1. Start the Calibration module located in the **PCTS** Program group called **Calibration** (See Figure 9:1).
2. Fill in the information for PACS serial #, Power source to be used for the calibration, and your name or ID. Make all other appropriate selections before clicking on the Calibrate button.
3. Once the Calibrate button is clicked, the software will prompt you to fill in a table recording the equipment and measurement instruments to be used for this calibration. When this is completed, the program will provide you with the step by step instructions. Follow these instructions until the Accept button is enabled. If you did not follow the instructions during the calibration or the software is aborted for some other reason, you may have to redo the entire calibration. Please note that the calibration data is not saved until the Accept button is pressed.
4. When calibrating the voltage channel, you will be asked to provide a 230V/50Hz input. However, when calibrating the current channels, it is not necessary to keep the voltage input at the same level. In addition, the calibration on current channels is in the sequence of 40Arms/200App, 8Arms/40App, and 2Arms/10App. The software does not do auto ranging in the process. This means that even if you apply 2 Arms when you are doing 40Arms/200App range channel(s), the software will still perform the corresponding calibration. The drawback of doing so is that the calibration accuracy may be compromised.
5. When the Accept button becomes available and is clicked at the end of calibration, the software will save the data in text file with the name of “C:\Cts_calibration.dat”. In addition, it will generate “calibrate.log” in the PCTS directory and print out a hardcopy of this file automatically. It will also save the calibration information in a database. Further, it will ask you if you want to copy the calibration data to floppy and back up the files. If you answer yes, it will perform all the copying and backup for you automatically. The back up directory is that stored in log_dir.txt file and a sub directory of PACS's information you entered before you clicked on the calibrate button.
6. If you copied the calibration data to the floppy, remove disk from drive and write the PACS serial number on the floppy disk.

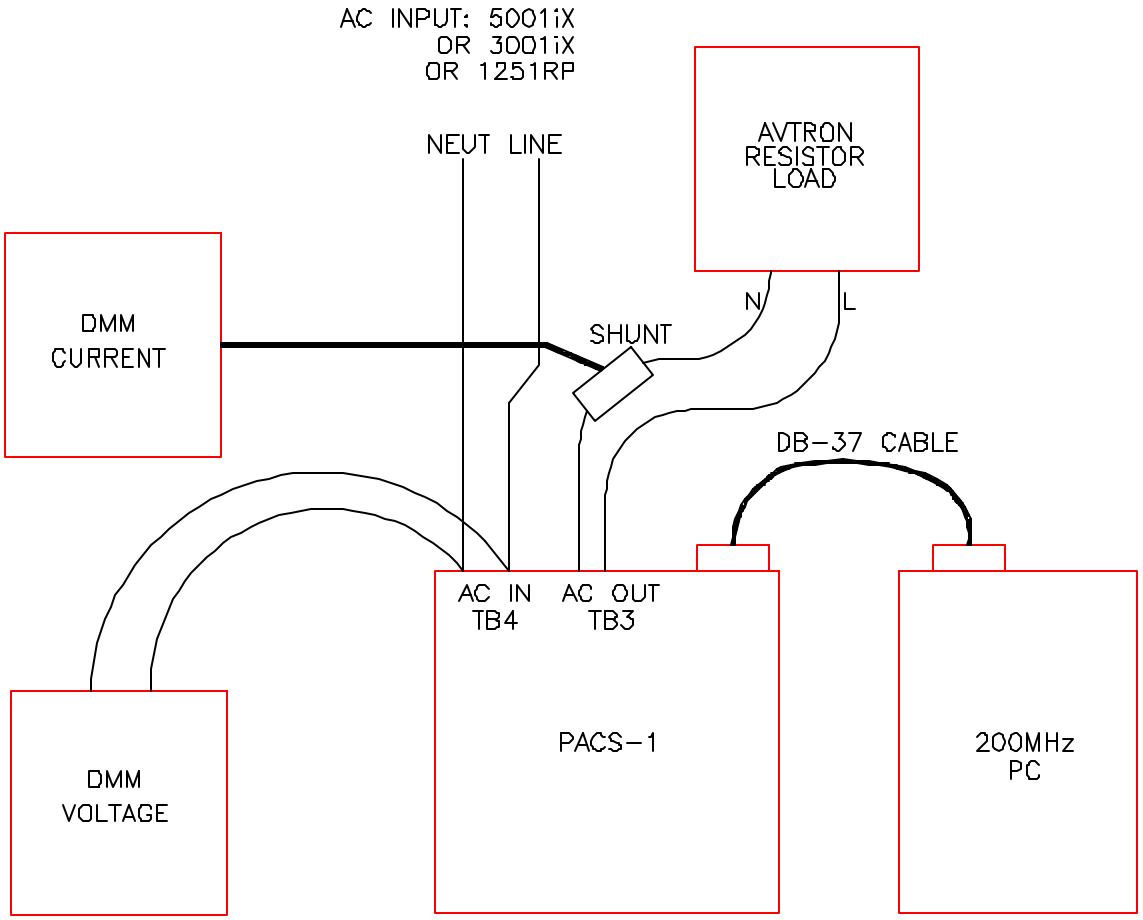


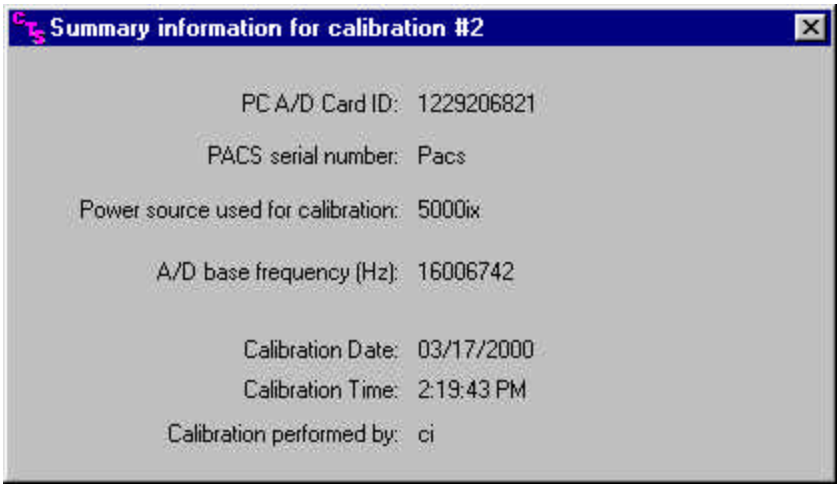
Figure 9:2: Calibration Setup

9.6 Installing New PCTS Calibration Data

If you have send in the PCTS system for calibration at a remote calibration lab or at California Instruments, the PC normally used to run the PCTS system will typically not have the new calibration on it when you receive the PACS and A/D card back. The new calibration data will be received on a floppy disk or emailed to you as an alternative.

To install the new calibration data, proceed as follows:

1. Insert the calibration disk received into floppy drive A
2. Open your Windows Explorer and select drive A.
3. Copy the cts_Calibration.cts file located in the floppy root directory
4. Paste this file to the C:\ root of the PC that operates the PCTS system.
5. Run the PCTS program. Upon launch, the PCTS program will detect the calibration data file, which should have a newer date and time stamp than the calibration data currently in use. If so, the program will automatically read the new cal file and update its calibration database.
6. You can verify that the new calibration data has been loaded by selecting the "View, Calibration Info" menu.



You can save the calibration disk if needed although annual re-calibration of the system is recommended.

10 Principle Of Operation

10.1 General

The Pre-Compliance Test System is a power measurement and power analyzer system. The three basic building blocks are:

- **AC power**, specifically 50 Hz line power to provide the proper voltage and frequency for the test at hand. Presently, IEC tests have to be performed at 50 Hz. If your locale only provides 60 Hz AC line power, you may need to upgrade to a complete California Instruments CTS system by adding a 5001iX or equivalent AC power source.
- **PACS-1** measurement unit. This device measures the actual current and voltages under test and conditions the signals to be compatible with the Analog to Digital data conversion card.
- **PCTS Software**. The software is the final link to the user. It translates the data from the AD card into viewable and readable measurements in a GUI format.

10.2 AC Power

AC power to both the unit under test and the PACS-1 unit itself is provided from the line through two separate input connections. The EUT power must be connected at TB4 by removing the top rear cover. The EUT can then be plugged in the IEC/77 receptacle on the front panel of the PACS-1 unit or taken from TB3 instead. (NOTE that neither this receptacle nor TB3 is switched and thus always live). The mains power for the PACS-1 unit bias supplies is connected using a standard IEC320 line cord. Check the correct setting of this line input. It must be set for 230 V. The PCTS software will automatically compensate for line distortion that is present in most public utility power grids so there will be no effect on the test results. The software will also adjust the line impedance to model the correct IEC 725 Flicker reference impedance during flicker testing.

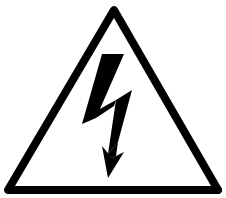
10.3 PACS Measurement Unit

The PACS measurements module uses Hall Effect current sensors to isolate and scale a sense voltage that is an accurate and linear function of the current being measured. The sensing amplifiers use differential sensing to reduce common mode noise pick-up before it is sent to the interface connector for transmission to the host PC.

To sense the applied voltage, another set of differential amplifiers are used together with high precision sense resistors to provide high CMRR. The sense resistors are of high enough impedance to limit any leakage current to under 0.5mA.

10.4 PCTS Software

The PCTS Software is designed to work with the data acquisition card's digital samples of voltage and current. Numerous data channels are scanned sequentially and the software then calculates many parameters using Fast Fourier Transforms and displays them in the Graphical User Interface. In addition to numerical outputs of voltage current, power etc., the software also displays real time graphics of voltage and current.



CAUTION

VOLTAGES UP TO 312 VAC MAY BE PRESENT IN CERTAIN SECTIONS OF THE PACS WHILE IN USE.

DEATH

ON CONTACT MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS. DO NOT TOUCH ELECTRONIC CIRCUITS WHEN POWER IS APPLIED.

11 Service

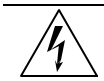
11.1 Cleaning

The exterior of the PACS unit may be cleaned with a cloth dampened with a mild detergent and wrung out. Disconnect mains power before cleaning. Do not spray water or other cleaning agents directly at the equipment.

11.2 General

This section describes the suggested maintenance and troubleshooting procedure. The troubleshooting procedure is divided into two sections. The first section deals with basic operation and connection of the equipment. The second section requires opening the PACS unit and using the Test Points and a simple Digital Multimeter to troubleshoot the unit down to the circuit level. Only a qualified electronic technician should attempt this level of troubleshooting.

CAUTION: VOLTAGES UP TO 312 VAC MAY BE PRESENT IN CERTAIN SECTIONS OF THE PACS MEASUREMENT UNIT.



WARNING: THIS EQUIPMENT CONTAINS POTENTIALLY LETHAL VOLTAGES. DEATH ON CONTACT MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS. DO NOT TOUCH ELECTRONIC CIRCUITS WHEN POWER IS APPLIED

11.3 Basic Troubleshooting

No Power To EUT

CONDITION	POSSIBLE CAUSE, REMEDY
No power to EUT	Line voltage not at expected value. Verify power line voltage is correct and connected properly.
AC Line voltage OK. No power to EUT.	Incorrect input wiring at TB4. Check for wrong terminals or poor connections.
AC Line voltage OK. Input wiring is OK. Still no power to EUT	Incorrect output wiring from TB3. Defective plug and cable from front panel outlet on PACS 1. Check output wiring from TB3, or, verify cable and plug going to EUT is good

No Signal To PC Interface

CONDITION	POSSIBLE CAUSE, REMEDY
EUT is being driven properly and voltage and current is present, but the PCTS Software GUI shows zero current or zero voltage.	The PACS front panel power switch is not on. Turn on switch, check ON LED. The ½ Amp input fuse is open. Replace fuse. The CI 68C (#5004-225-1) interface cable is not seated in its mating connectors. Reinsert connectors. The Sensor Circuit board assembly inside the PACS module is defective. See next section.

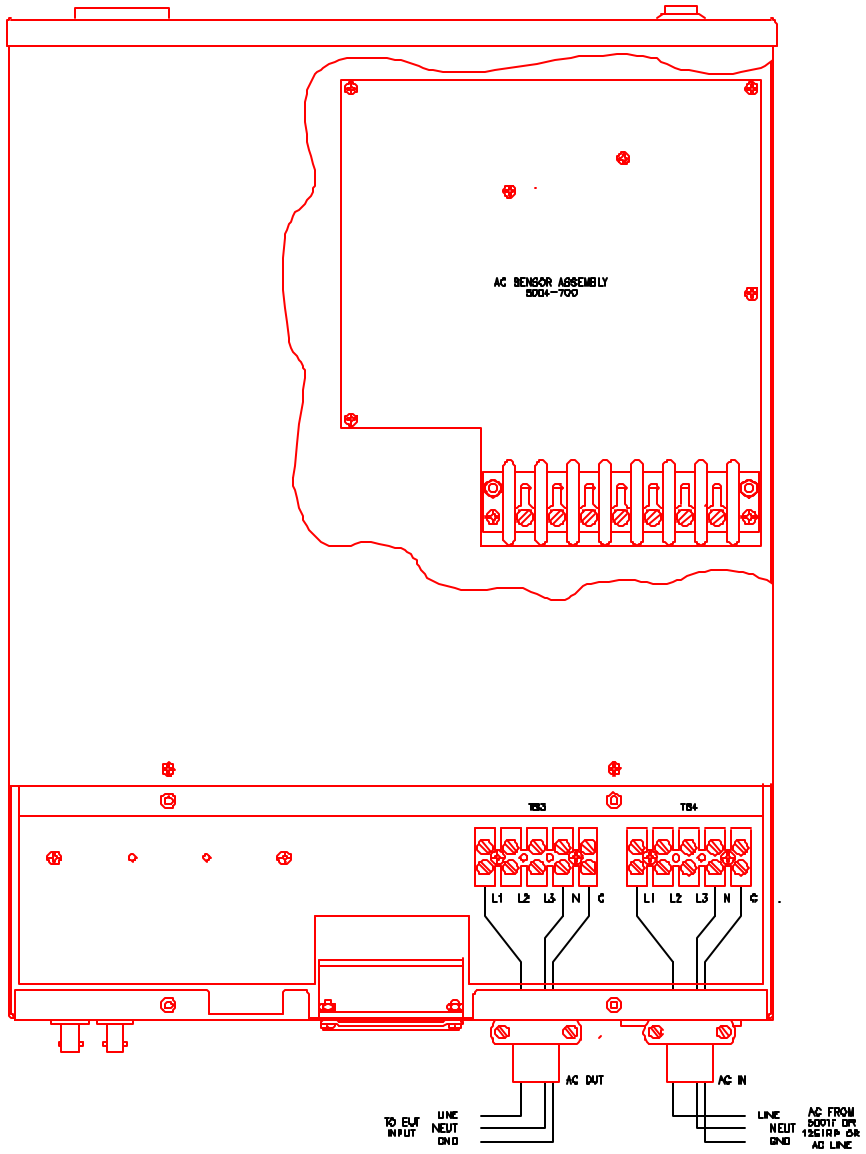


Figure 11:1: Location of AC Sensor Assy. 5004-700 in PACS

11.4 Advanced Troubleshooting

If it is suspected that the AC sensor circuit board inside the PACS unit is defective it will be necessary to remove the top cover of the unit and perform some basic tests to determine if the circuit is functioning properly.

CAUTION: VOLTAGES UP TO 312 VAC MAY BE PRESENT IN CERTAIN SECTIONS OF THIS POWER EQUIPMENT.

WARNING: THIS EQUIPMENT CONTAINS POTENTIALLY LETHAL VOLTAGES. DEATH ON CONTACT MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS. DO NOT TOUCH ELECTRONIC CIRCUITS WHEN POWER IS APPLIED

Switch Off Unit, Disconnect High Voltage

Switch off the PACS unit with the front panel power on/off switch. Also disconnect or remove any AC voltage applied to the rear connection terminals TB3 and TB4.

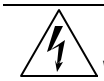
Removing Top Cover

Remove the screws securing the top cover and remove the top cover.

Initial Inspection

Perform a visual inspection of the unit and ensure all the connectors are properly mated and there are no loose or broken wires. Check the interface cable going from the AC sensor assembly 5004-700 to the front and rear panels.

Power-On Troubleshooting - DC Supplies



WARNING: Do not touch any parts inside the unit during these tests as they will be live and dangerous. Always wear safety glasses.

1. Connect a DMM common test lead to TP1 on the 5004-700 AC sensor assembly. TP1 is the circuit common for all DC supplies and test signals. Connect the high input DMM lead to the cathode of diode CR4.
2. Switch on the PACS unit with the front panel switch.
3. Verify the DC voltage at CR4-cathode is +15V.
4. Connect the high input DMM lead to the anode of diode CR5.
5. Verify the DC voltage is -15V.
6. If either of these voltages are not as specified, the board will not function properly and will need to be serviced.

Power-On Troubleshooting - Voltage Sense

1. Connect the DMM common to TP1.
2. Connect the high input DMM lead to TP2. This is the phase A voltage sense output.
3. Apply a test voltage to the PACS input terminals TB4. Use Neutral and ph- A
4. The reading at TP2 should be 1/100 of the input voltage. For example, if 120 V rms is applied at TB4, then there should be 1.20V rms at TP2.

Power-On Troubleshooting - Current Sense

1. Connect the DMM common to TP1.
2. Connect the high input DMM lead to TP6. This is the phase A current sense output.
3. Apply a 4A test current to the PACS input terminals TB4. Use Neutral and ph- A.
4. The reading at TP6 should be 496mV/ Amp of input current. For example, with 4.0A rms applied at TB4, then there should be 1.984V rms at TP6.

12 Index

A/D card 63
abort 49
AC Source 11
Acoustic 59
acquisition system 12
acquisition window 37
AD card
  specifications 56
Amendment 14 14
assumptions 9
Calibration 63
  Procedure 64
  Required equipment 63
CE mark 59
class A devices 37
class B devices 37
class C devices 37
class D devices 37
Class D wave shape 38
Classes
  IEC 1000-2-3 17
    1998 15
    2000 15
components 10
Configuration
  Changing 60
  PCTS 60
contents 6
controls
  flicker window 52
Copyright 5
CTS
  components 10
  description 10
  software 9
current
  fundamental 48
description
  CTS 10
device class 37
display
  resolution 41
Emissions 59
ESD 30
European Union 14
fields
  flicker window 52
Flicker 20
  standard 20
front panel 27
graph
  current harmonics 48
  voltage and current 48
  voltage harmonics 48
harmonic current limits
  dynamic 39
harmonics
  device class 37
  fluctuating 17
  quasi stationary 17
  stationary 17, 40
  testing 37
  transitory 17, 40
IEC 13
  address 22
  ANSI address 22
  directive 13
IEC 555-2 14
IEC 555-3 20
IEC 61000-3-2 14
IEC 61000-3-3 20
IEEE-488
  Bus Controller 31
Immunity 59
impedance
  flicker 20
  reference 20
installation 23
LED indicators 70
limits
  dynamic 39
  harmonic current 16, 18
  IEC 61000-3-2 ..... 16, 18
main window
  flicker 52
maintenance 70
manual

organization 9
Manual
History 3
measurements
specifications 56
PACS 10, 11
specifications 58
printing
reports 49
Printing 3
reference impedance 20
references 21
resolution
display 41
Safety 59
Shock 59
Software
License 3
Revision 3
Software license 3
specifications 56
measurements 56
PACS 58
status 27
Temperature
operating,storage 59
template 38
test
classes 15, 17
test data file
flicker 55
harmonics 49
test margin
flicker 54
harmonics 47
test time
flicker 54
harmonics 47
top cover
removal 73
troubleshooting 70
user data
flicker 54
harmonics 47
VGA
resolution 41
Vibration 59
Warranty 5
wave shape
class D 38
window
flicker 52