∭ California Instruments

Compliance Test System
User Manual
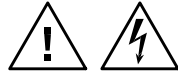
 SAFETY SUMMARY

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.

CTS Software License

Your CTS Test System was shipped with one copy of the CTS software. This software - model number CIC455 (Single phase version) or CIC456 (Three phase version) - is owned by California Instruments and is protected by United States copyright laws and international treaty provisions. Therefore, you must treat the software like any other copyrighted material.

Software Revisions

Revision codes on the CTS software screen 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 CTS 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 1.7.

Printing History

The manual printing date indicates the current edition. The printing date changes with each new edition or update. Update packets or change sheets may be issued between editions to correct or add information. Minor corrections incorporated at reprint do not cause a new edition.

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PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, including the model number and serial number. On receipt of this information, service information or a Return Material Authorization (RMA) number will be given. Add RMA number to shipping label. Pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No. or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS 9689 Towne Centre Drive, San Diego, CA 92121-1964. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested when it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

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**1
Introduction**

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Manual Organization

This manual describes the operation of 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, simply 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 EN 61000-3-2 and EN 61000-3-3 regulations and their requirements. Some background information of the IEC standards covered by the CTS system are 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 3.1® or Windows 95® environment.

The manual is organized as follows:

Chapter 1   describes the organization of the user manual and provides a brief overview of the CTS system components.

Chapter 2   provides an overview of the relevant IEC regulations and how compliance testing to these regulations is implemented in the CTS software.

Chapter 3   covers installation of the hardware and software components required to operate the CTS system. Proper installation of both hardware and software is essential. This chapter walks the user through the hardware setup and the software installation process one step at a time.

Chapter 4   covers IEC 1000-3-2 harmonics testing. This chapter provides step by step instructions on how to call up the correct program module and perform the necessary steps to perform a Quasi stationary Harmonics test on the EUT.

Chapter 5   covers IEC 1000-3-3 Voltage fluctuations testing. This chapter provides step by step instructions on running a voltage fluctuation or flicker test.

Chapter 6   covers IEC 1000-4-11 Voltage Dips and Variations immunity testing.

Chapter 7   covers IEC 1000-4-14 draft standard Voltage Fluctuations immunity testing.

Chapter 8   covers IEC 1000-4-28 draft standard Frequency Variations immunity testing.

Chapter 9   covers IEC 1000-4 customization to allow for future revisions of these standards and to accommodate different product categories.

Chapter 10 provides the technical specifications for the Power Analysis and Conditioning System (PACS) unit, which is a key component of the CTS system. For technical specifications on the AC source supplied with the CTS system, refer to the AC source manual provided.

Chapter 11 provides software calibration and configuration procedures.

Chapter 12 provides theory of operation information.

Chapter 13 provides service troubleshooting procedures.

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 powered equipment.

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

- Programmable AC power source. The AC source provides precise, isolated and low distortion AC power at the user specified frequency and voltage. The AC source also offers over current protection to avoid damaging a load that exhibits a failure. The AC source can either be a single phase or three phase unit.

- 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 ISA slot in the user's PC. The CTS software controls all aspects of the A/D card and processes the data for IEC test purposes.

- CTS Software. The CTS software implements the harmonics and flicker IEC tests. In addition to the CTS software, the California Instruments CIGUI program is used to control the AC source used and to implement those IEC tests that run on the AC source. (IEC 1000-4 tests).

The AC source output 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. For three phase applications the rear terminals are used. All user interaction with the CTS system is accomplished through the CTS and CIGUI software. There are virtually no front panel controls required to operate the CTS system.

AC Source

The CTS system is supplied with different programmable AC power sources depending on the configuration. The following AC sources are supplied with each CTS system:

Table 1: CTS AC Source models

Model	VA Power	AC Source	IEC 1000-4	PACS model
Single Phase Systems				
PACS-1	AC Line	none	-	PACS-1
1251RP-CTS	1250 VA	1251RP	-	PACS-1RP
3001iX-CTS	3000 VA	3001iX	√	PACS-1
5001iX-CTS	5000 VA	5001iX	√	PACS-1
5001iX-CTS-400	5000 VA	5001iX-400	√	PACS-1
Three Phase Systems				
PACS-3	AC Line	none	-	PACS-3
15003iX-CTS	15000 VA	15003iX	√	PACS-3
15003iX-CTS-400	15000 VA	15003iX-400	√	PACS-3

If you plan to use the AC line and are using a PACS-1 or PACS-3 system, you can skip this paragraph as there is no AC source included with the system. If you are using any of the other CTS configurations, the AC source includes its own user manual. We recommend you familiarize yourself with the operation of the AC source and the included Windows Graphical User Interface for it before you start using the CTS system.

PACS Unit

The Power Analysis and Conditioning System provides the required electrical and mechanical interface between the AC 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 can be single phase or three phase, depending on the CTS system configuration in use. Single phase PACS units may also contain the required reference impedance for making flicker measurements when a power source without programmable impedance is used. PACS units with the reference impedance built-in have a Bypass and Flicker mode that can be toggled using the push button on the front panel of the PACS unit. The mode of operation (Bypass for harmonics measurements and Flicker for flicker measurements) is indicated with a set of LED's. The bypass and Flicker mode can also be selected remotely from the host PC running the CTS software.

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

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 ISA slot and the software needs to be installed. All signal connections between the PC and the PACS unit are made with a single 37 pin cable supplied with the system.

The data acquisition system samples all voltage and current channels at a high sampling rate and provides the data to the CTS software for further processing. The PACS provides a single voltage input channel and three current input channels for each phase, 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.

CTS Software Functions

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

- Set up and run compliance-level tests. The setting up of many IEC details is facilitated through the use of embedded standards expertise.

- Collect real-time test data from the CTS System.

- Display and monitor ongoing test results.

- Save test results to disk for analysis using other programs.

- Print reports and graphs.

AC Source GUI Functions

If the CTS system in use was supplied with an AC source, it also includes an AC source control software package. This Graphical User Interface program can be used to control the AC source from the same PC using either the RS232C or IEEE-488 interface. An IEEE-488 interface is not included with the CTS system. The PC must have an available RS232C port to use the RS232C control interface to the source.

In the absence of a suitable interface, the user can operate the AC source from the front panel. This does not affect the ability to run harmonics and flicker tests. It does however preclude the use of the IEC 1000-4 tests which are only available through the AC source control GUI[1].

Note on RS232C conflicts:

If the CIGUI program is set up to use the serial port to communicate with the AC source, it is not possible to have both the CTS software and the CIGUI software running at the same time. This is due to the fact that both programs use the same serial interface to control the AC source. If this is the case, close one program before opening the other.

If IEEE-488 is used to control the AC source with the CIGUI, both programs can be open at the same time but care should be taken not to control the source from both programs at the same time.

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[1] IEC 1000-4 tests are not available on the 1251-CTS.

2
IEC Testing

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 which the CTS system is capable of testing, specifically:

- IEC 1000-3-2 Quasi Static and Transitory Harmonics

- IEC 1000-3-3 Flicker

- IEC 1000-4-11 Voltage Dips and Variations

- IEC 1000-4-13 Interharmonics and Harmonics Immunity Test

- IEC 1000-4-14 Voltage Fluctuations (Draft)

- IEC 1000-4-28 Frequency Variations (Draft)

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 effects 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 1000-3-2 and IEC 1000-3-3 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.

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. 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 1000-3-2 and IEC 1000-3-3.

IEC 1000-3-2 Harmonics Standard

The purpose of enforcing the IEC 1000-3-2 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 1000-3-2 and 1000-3-3 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 and 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 1000-3 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. In general, manufacturers of professional equipment up to 600 W have until January 1, 2001 to comply with IEC 1000-3-2. All other electrical devices have to comply effective January 1, 1996.

IEC 1000-3-2 Test Classes

The standard divides products to be tested in to 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: IEC 1000-3-2 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.

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 is harder to meet as the power factor decreases. Neither class C nor D devices have to meet even current harmonics limits.

Since class C and D limits are load dependent, the power level and power factor have to be determined for each test. In case of fluctuating power levels, it may be necessary to measure the power level during the test and adjust the limits used to pass or fail the unit under test dynamically.

IEC 1000-3-2 Test Limits

The following table summarizes the current harmonic limits for each device class. The limits are generally built into IEC test software programs such as California Instruments' CTS Test System software.

Table 3: IEC 1000-3-2 Class Limits

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

Steady State versus Transitory Harmonics

Two types of harmonics testing are called for in the IEC 1000-3-2 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 prints, have fluctuating power demands and may require transitory harmonics testing.

IEC 1000-3-3 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 1000-3-3 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 1000-3-3 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.

IEC 1000-3-3 Flicker Test AC Source Requirements

As is the case with Harmonics testing, the IEC 1000-3-3 standard imposes requirements on the AC source that is used. Some of these requirements are similar and less severe than those imposed under IEC 1000-3-2. 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 for most AC sources. In rare cases, the line voltage may even be used for this purpose. More often than not, however, the use of an AC source with well defined specifications is recommended to obtain repetitive test data and eliminate the possibility of flicker caused by line fluctuations, not load current fluctuations. California Instruments offers AC power sources in both single and three phase configurations that meet these requirements. The same AC power source described under IEC 1000-3-2 (Harmonics) AC source requirements can be used for Flicker test applications.

To simulate the resistance and inductance of the low voltage distribution systems, the IEC 1000-3-3 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 either built into the PACS unit of the single phase CTS systems or provided through a programmable output impedance. This is determined

by the AC Source used. Optionally, a lumped reference impedance option is available for customers who prefer to use this approach over the programmable output impedance method.

Note that the lumped reference impedance option for the CTS system is exactly matched to the California Instruments' power source output impedance with which they are used. Do not use third party reference impedance networks with the CTS system as the combined AC source and network impedance may not match the IEC 1000-3-3 requirement. The 1251RP-CTS is always supplied with a lumped reference impedance built in to the PACS-1 unit as the 1251RP AC Source does not offer programmable output impedance.

When to test for IEC 1000-3-3

As mentioned, it may not be necessary to test every product for IEC 1000-3-3. 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, it is generally recommended to verify conformance to IEC 1000-3-3 however.

IEC 1000-4-11 Voltage Dips and Variations

The IEC 1000-4-11 is an immunity test for low voltage equipment to ensure reliable operation when connected to the public distribution system. This test requires an AC source that is capable of generating specific voltage variations and voltage dips. The unit under test must not sustain any damage from such occurrences nor cause unsafe conditions.

Table 4: Average public utility disturbances per annum in Europe

DEPTH	DURATION			
(Voltage drop in % of nominal Ut)	10 to < 100 ms	100 to < 500 ms	500 ms to 1 sec	1 sec to > 3 sec
10 %o < 30 %	61	66	12	6
30 % < 60 %	8	36	4	1
60 % < 100 %	2	17	3	2
100 %	0	12	24	5
	Number of disturbances per year			

The need to test for immunity of products against voltage dips and interruptions was prompted by studies of electric utility availability. The results shown in Table 4 were found in this study (UNIPEDE study 91 en 50.02). From this data it is clear that most disruptions are short in nature (about 5 to 10 periods) and no more than 60 % below nominal. Occasionally however, extended periods of complete power loss occur. It is suggested that this test data also be used as a guide in selecting appropriate test levels.

Why do you have to test?

The IEC 1000-4-11 affects a large set of products, specifically; *"Electrical and electronic equipment having a rated input current not exceeding 16 A per phase."* Thus, most single and three phase AC powered equipment used in domestic and light industrial settings fall in this category. In fact, around 95 % of all electrical equipment in household and light industrial applications, require no more than 16 A per phase. In Europe, this implies real apparent levels of 230 V * 16 A = 3680 VA, with real power either at the same or a lower level. Specifically excluded

are all DC powered products (battery operated devices) and 400 Hz AC equipment. (Avionics) These products will be covered in future IEC standards. At this time the IEC 1000-4-11 standard is not yet mandatory to obtain the CE Mark, required to market products in the European Union. It is advisable to test new product per IEC1000-4-11 however, as the standard will go into mandatory effect in the near future.

California Instruments' CTS system supports IEC 1000-4-11 testing using an i Series or ix Series AC power source. The IEC 1000-4-11 test is implemented in the CIGUI Windows® software (Version 2.0 or higher). To accommodate changes in the specification, test levels and duration can be changed easily if needed.

IEC 1000-4-13 Interharmonics and Harmonics Immunity Test

The IEC 1000-4-13 is presently only in draft form and the implementation used in the CTS system uses applies to the first draft of the immunity test specification. The purpose of this test is to verify a EUT's immunity to signaling frequencies that may be present on the AC line. These signaling frequencies are not always harmonically related to the fundamental frequency. As such, this test applies both harmonics and interharmonic frequencies in addition to the fundamental AC voltage.

The generation of interharmonics requires the addition of an independent signal generator in the iX Series AC power source. If this optional -413 interharmonics generator hardware option is not present in the iX Series AC source, this IEC 1000-4-13 test windows will not be available from the CIGUI program.

This option can be installed at a later time in existing CTS systems based on the iX Series AC power source family. Note that non-iX Series based CTS systems do not support IEC 1000-4-13 testing.

The IEC 1000-4-13 draft specification calls out test levels for three product classes, class 2, 3 and X. Class X involved user defined test levels. Test levels for class 2 and 3 are implemented in the CIGUI while test levels for class X may be set by the user in the IEC413.413 file.

Note that IEC 1000-4-13 is presently only in draft form and as such, hardware and/ or software changes to this test option may be required at a future date.

IEC 1000-4-14 Voltage Fluctuations

The IEC 1000-4-14 is aimed at testing a product for immunity against voltage fluctuations that can occur on the public utility. The nature of the voltage fluctuations is different from those tested under IEC 1000-4-11 however. The fluctuations covered in this standard are less severe and involve typical high and low line conditions.

While presently only in draft form, California Instruments' CTS system supports IEC 1000-4-14 testing using an i Series or ix Series AC power source. The IEC 1000-4-14 test is implemented in the CIGUI Windows® software (Version 2.0 or higher). To accommodate changes in the specification, test levels and duration can be changed easily if needed. This early implementation allows compliance testing against this upcoming standard with a high degree of confidence.

IEC 1000-4-28 Voltage Frequency Variations

While presently only in draft form, California Instruments supports IEC 1000-4-28 testing using an i Series or ix Series AC power source. The IEC 1000-4-28 test is implemented in the CIGUI Windows® software (Version 2.0 or higher). To accommodate changes in the specification, test levels and duration can be changed easily if needed. This early implementation allows compliance testing against this upcoming standard with a high degree of confidence. (PC required to run CIGUI).

References

Additional information on IEC norms and requirements may be obtained from the following sources.

IEC 725	(1981)	"Considerations on reference impedances for use in determining the disturbance characteristics of household appliances and similar electrical equipment."
IEC 868	(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 1000-3-2	(1995)	"Part 3: Limits - Section 2: Limits for harmonic current emissions (equipment input current $\leq$ 16 A per phase.)"
IEC 1000-3-3	(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 1000-4-7	1996	"General guide on harmonics & inter-harmonics" Draft revision

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

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

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 CTS system. Some experience with AC power systems and PC's running Windows is assumed.

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 Source

Refer to the User Manual provided with the AC Source.

The main power requirements for the CTS are dictated by the AC power sources used and the power levels that the Equipment Under Test will demand. If the 1251RP is used in a single phase application, up to 15A at 120V may be required. If the 5001iX power source is used, 30A at 208V 3-phase may be required.

For three-phase CTS applications using the 15003iX 3-phase system, as much as 90A per phase at 208V may be required.

PACS 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 unit, the 1251RP power source and the 5001iX power source can be used free standing on a bench. Rack handles are standard, and if the optional rack slides are ordered, then the entire CTS 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 single phase wiring diagrams see Figures 2, 3 and 4. For three phase systems see Figures 5 and 6. The wire size used is basically dictated by the measured currents and voltages. Any wire used must be rated for the maximum expected current and voltage. The PACS unit is rated for 40A rms 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, bear in mind the rating is 16A rms. *Caution*: Be sure to replace the small rear cover on the PACS unit after the wiring has been installed, otherwise insufficient cooling of internal components may result.

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 CTS software must first be installed for proper operation. See installation instructions later in this section beginning on page 26.

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

Refer to Figure 1 for the test setup. See also Figure 2 through Figure 6 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. Enable the AC power input to the PACS unit, whether from the line or from a power source. Apply 120Volts AC at 60Hz.

5. Start the **Class-A SS** software module 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.

6. For a 3-phase system repeat steps 2 through 5 but use the **3-phase Class A Transitory** program and connect the load to phase B and phase C in sequence and verify each phase separately.

In the unlikely event the power source does not pass the functional test, refer to the calibration procedure in Section 11, or, refer to the service procedure in Section 13. If the problem cannot be resolved, call California Instruments' customer satisfaction department for further assistance.

AC INPUT

LINE A

NEUTRAL

ALT LOAD

CT

DB37

DMM
CURRENT

AC IN   AC OUT

PC

PACS-1

DMM
VOLTAGE

10 OHM LOAD
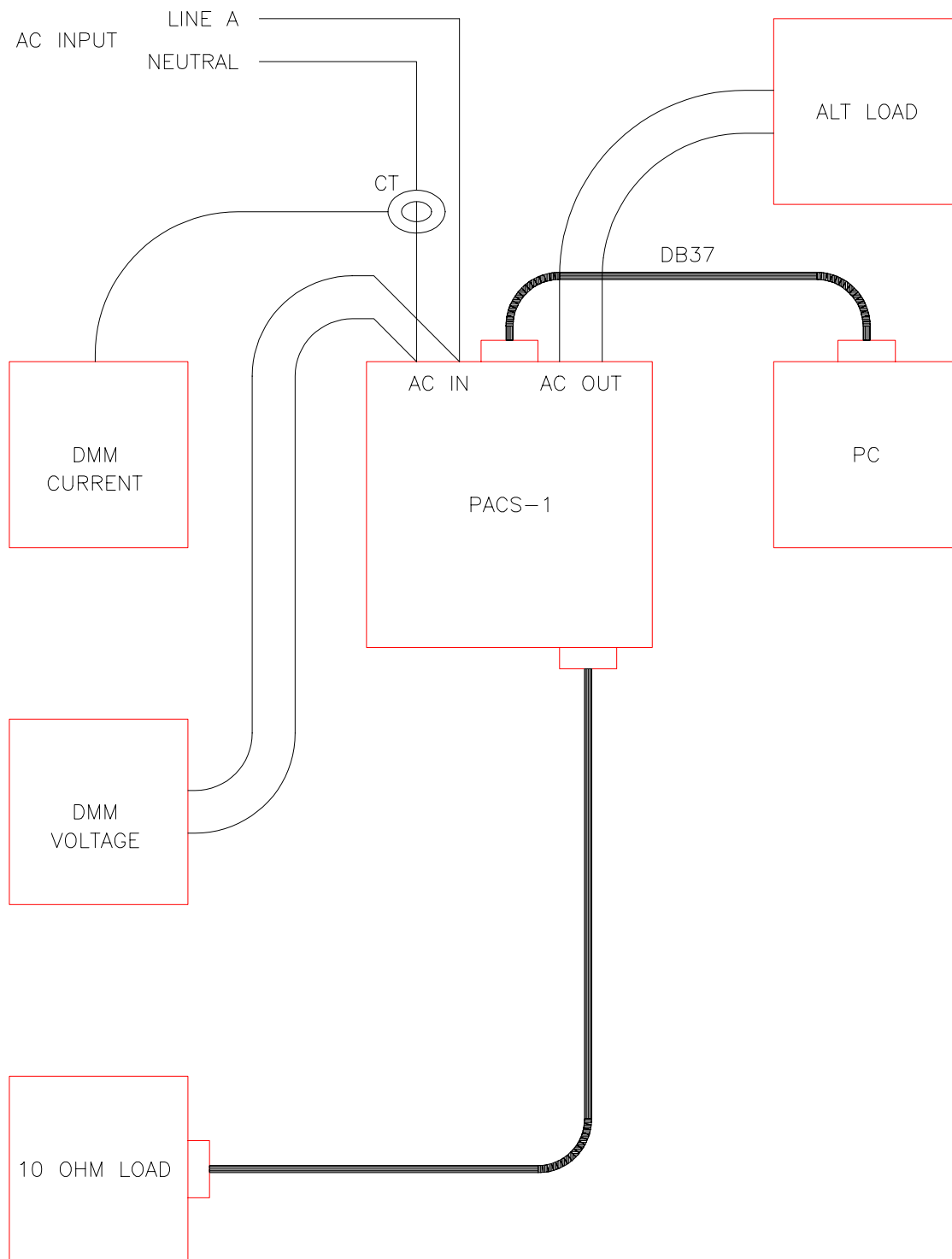
Figure 1: Functional Test Setup

California Instruments
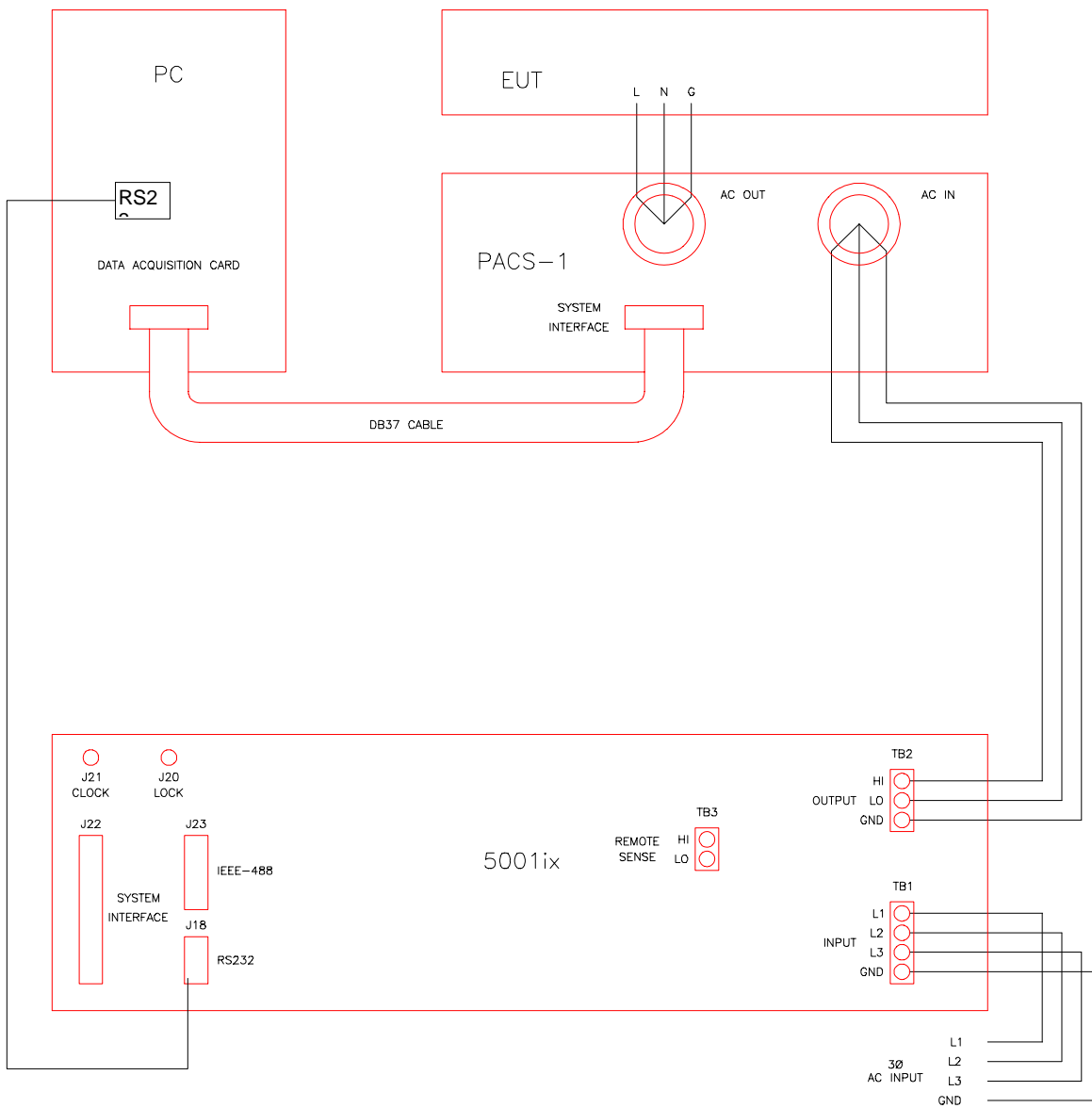
Figure 2: 1-phase CTS Configuration with the PACS-1 Module and 5001iX Source
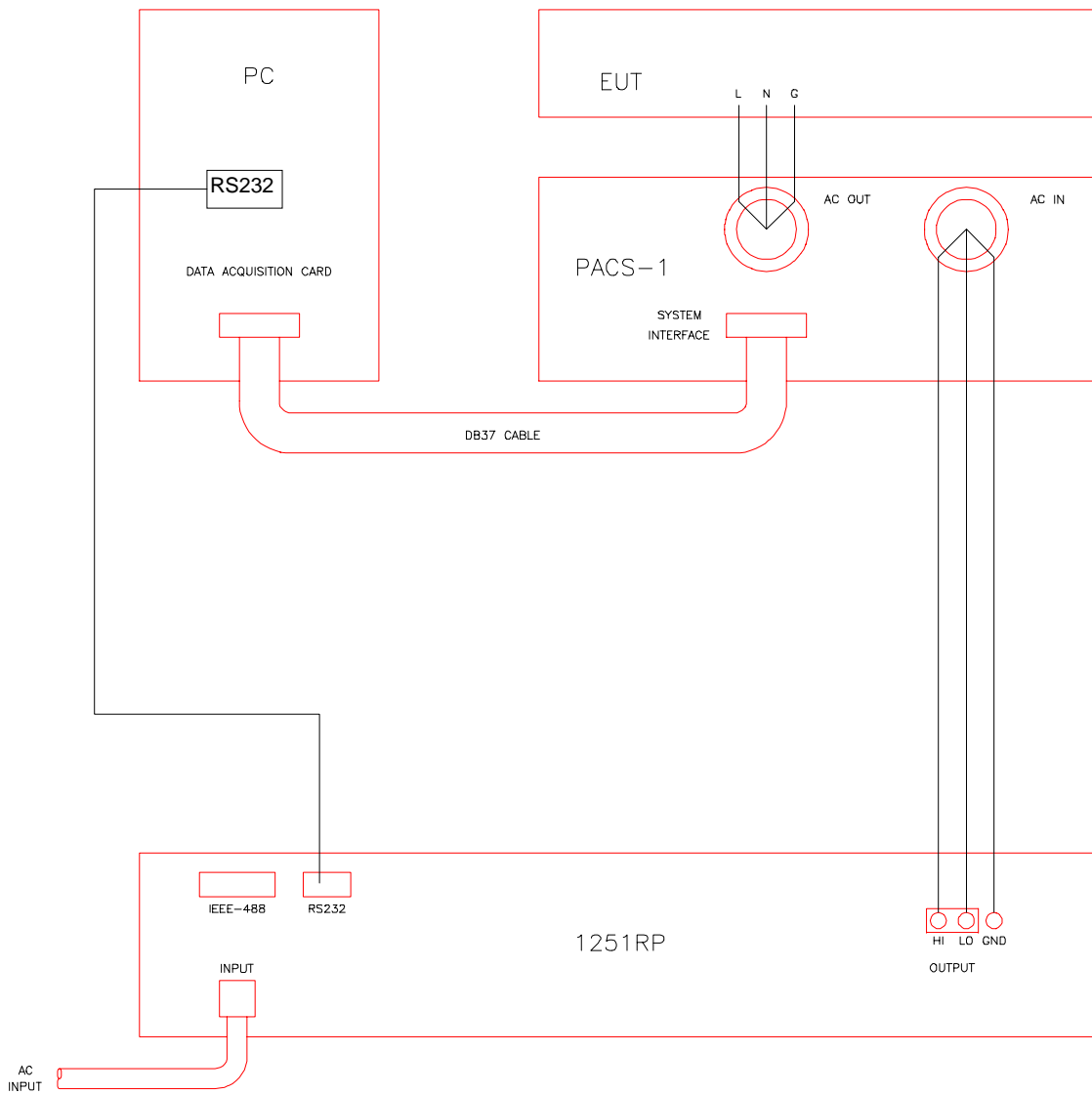
Figure 3: 1-phase CTS configuration with the PACS-1 module and 1251RP Source
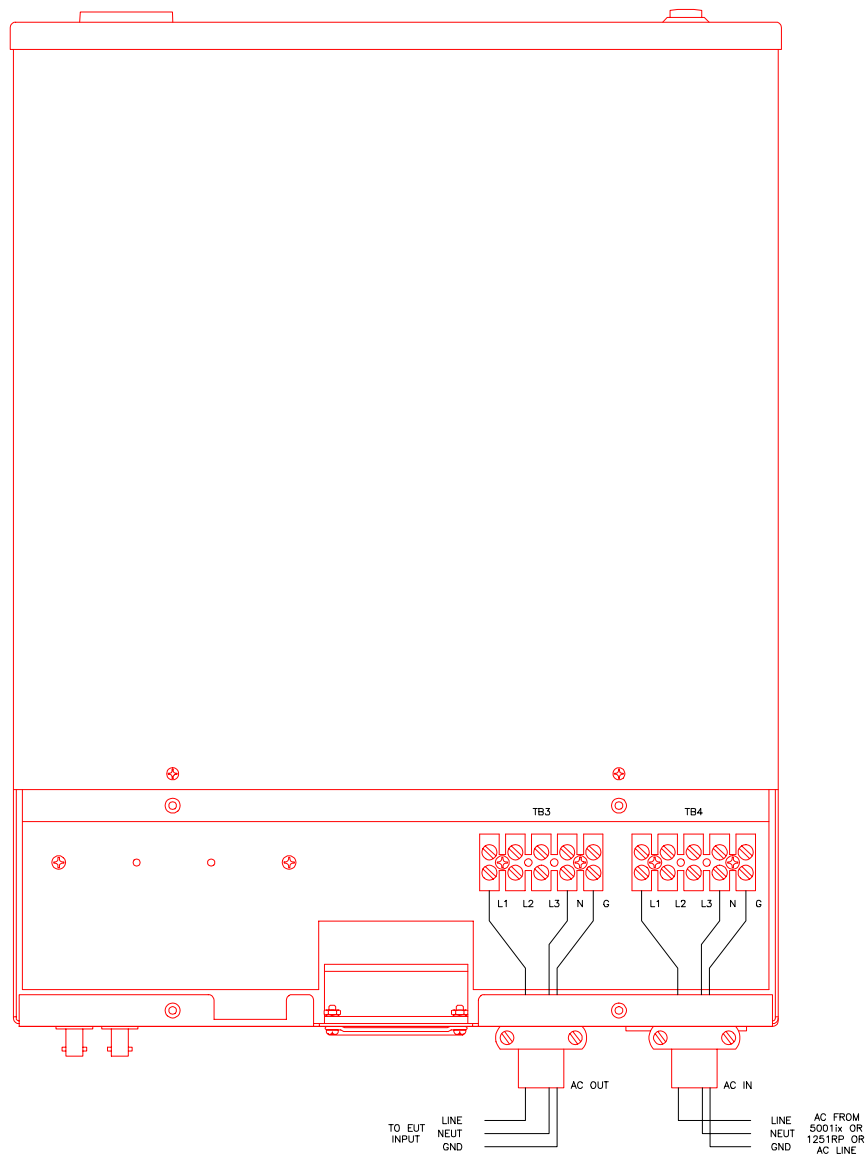
Figure 4: Power Connections for PACS-1 in the 1-phase CTS.
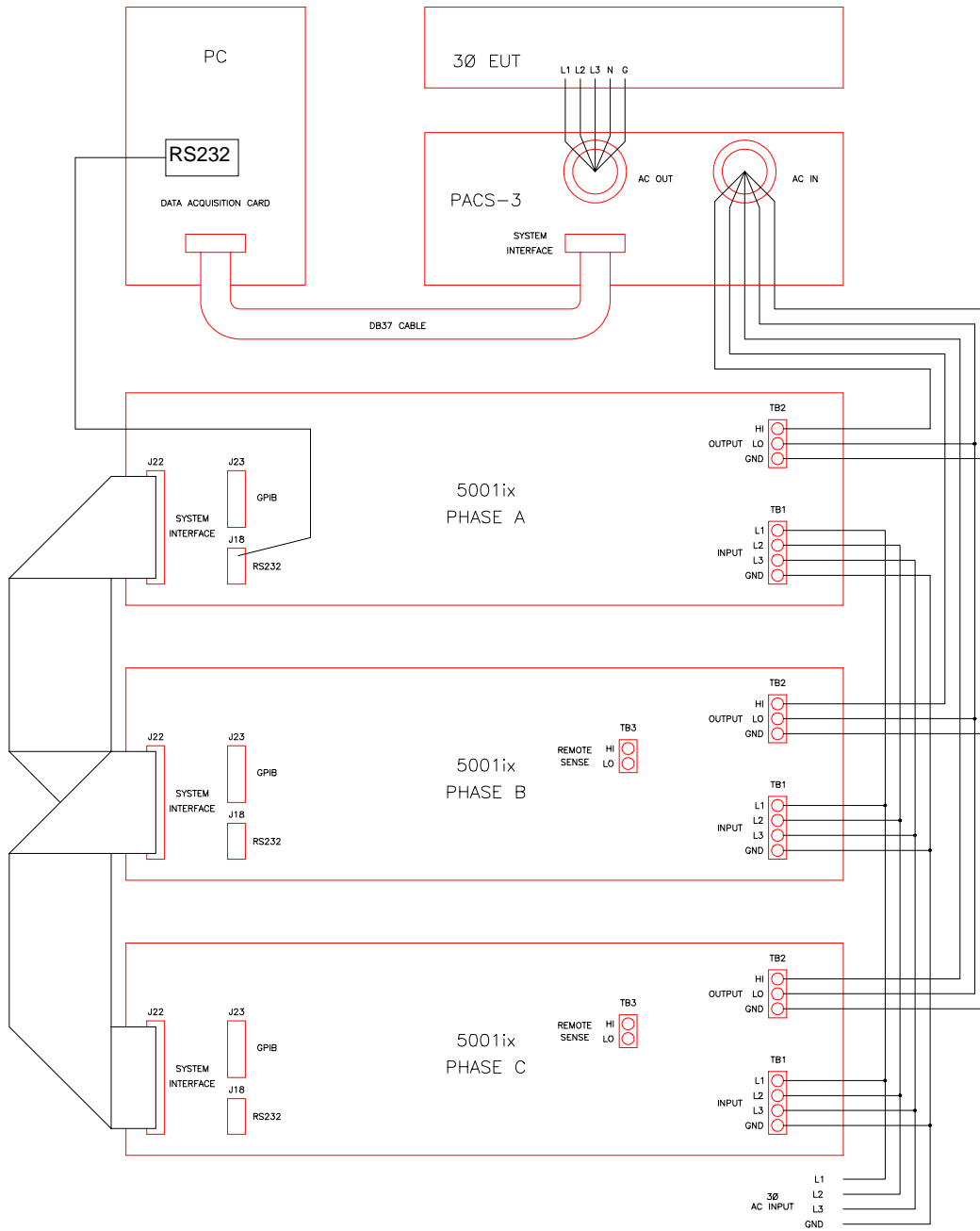
Figure 5: 3-phase CTS Configuration with the PACS-3 and the 15003iX Power Source

TB3   TB4

L1 L2 L3 N G   L1 L2 L3 N G

AC OUT   AC IN

L1
L2
TO EUT   L3
INPUT   NEUT
GND

L1
L2   AC FROM
L3   15003ix
NEUT   OR
GND   3Ø LINE
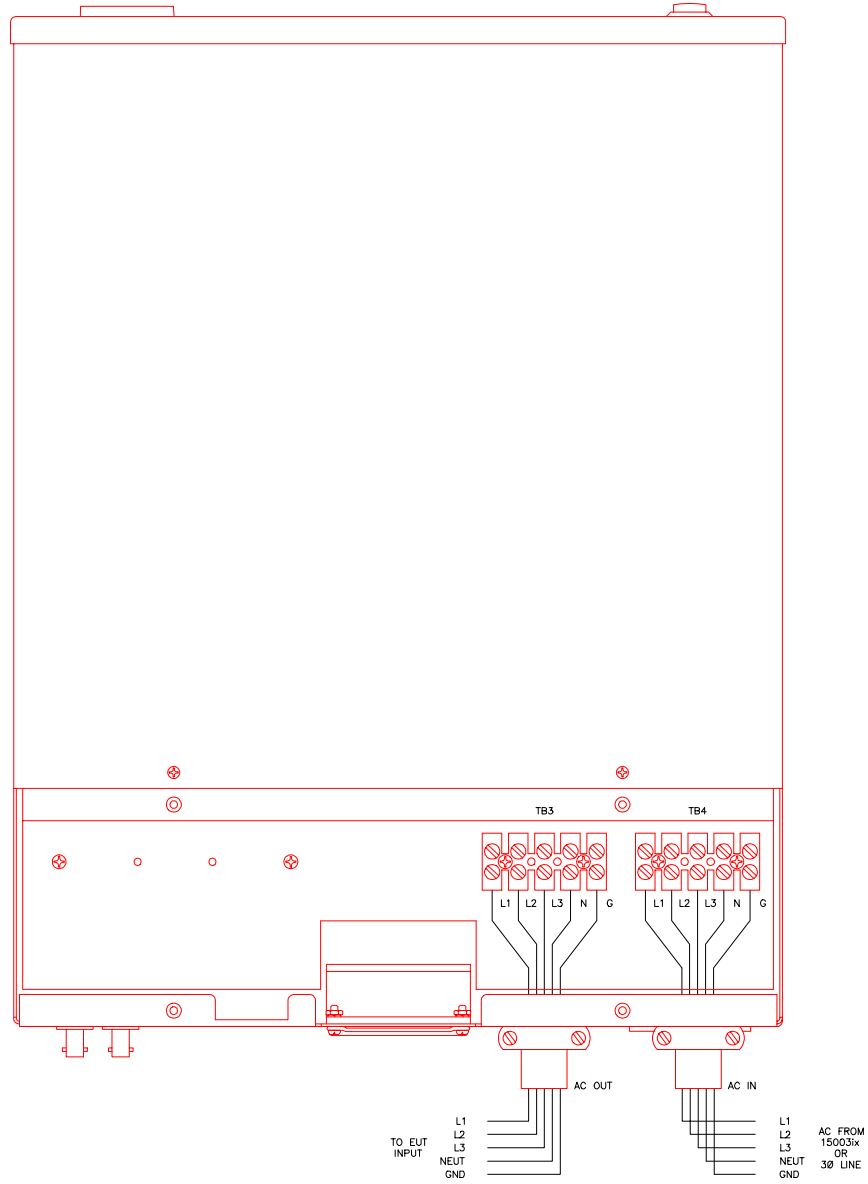
Figure 6: Power Connections for PACS-3 in the 3-phase CTS.

Front Panel Connections and Controls

The front panel incorporates three functional areas:

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

Output Sockets/ Connectors

PACS-1 and PACS-3

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

PACS-1 ONLY

The Output Socket is located on the right side of the front panel. It provides connection to a European CEE7/7 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.

Status Indicator Lights

PACS-1 and PACS-3

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 be live if the applied source has not been shut down.

PACS-1 and PACS-1RP

The BYPASS LED indicates the internal test impedance network is bypassed with relays.

The FLICKER LED indicates the internal test impedance is connected to the output for compliance testing.

Note: If the PACS-1 does not have the optional reference impedance installed, then the bypass LED will stay lit permanently and the flicker/bypass button will have no effect.

Switch/Button Controls

PACS-1 and PACS-3

The front panel power switch located on the left hand side of the PACS unit energizes the measurement circuits.

PACS-1

The Flicker/Bypass button toggles the internal impedance on and off, the FLICKER and BYPASS LEDs indicate which state the circuit is in.

Keep in mind that the internal impedance network can be switched in or out manually from the front panel, or, remotely by the flicker software. The default setting for the flicker relay control is remote via the DB37 connector.

Should it be desired to enable the front panel flicker control, it will be necessary to remove the top cover of the PACS-1 unit and set selector switches S1-1and S1-2. This light blue switch assembly is located on the AC Sensor board towards the front and left hand side of the PACS unit. See Figure 33 on page 105 for circuit board orientation . See figures on next page for proper switch orientation.

S1
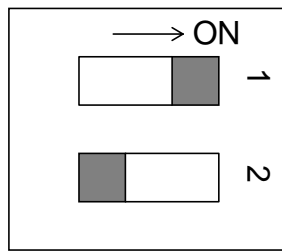
Figure 7: Switch Settings for Remote Impedance Control (Factory Default)

S1
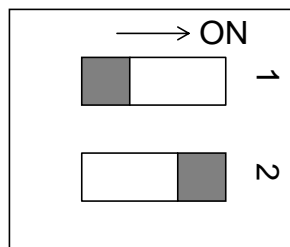
Figure 8: Switch Settings for Manual Impedance Control
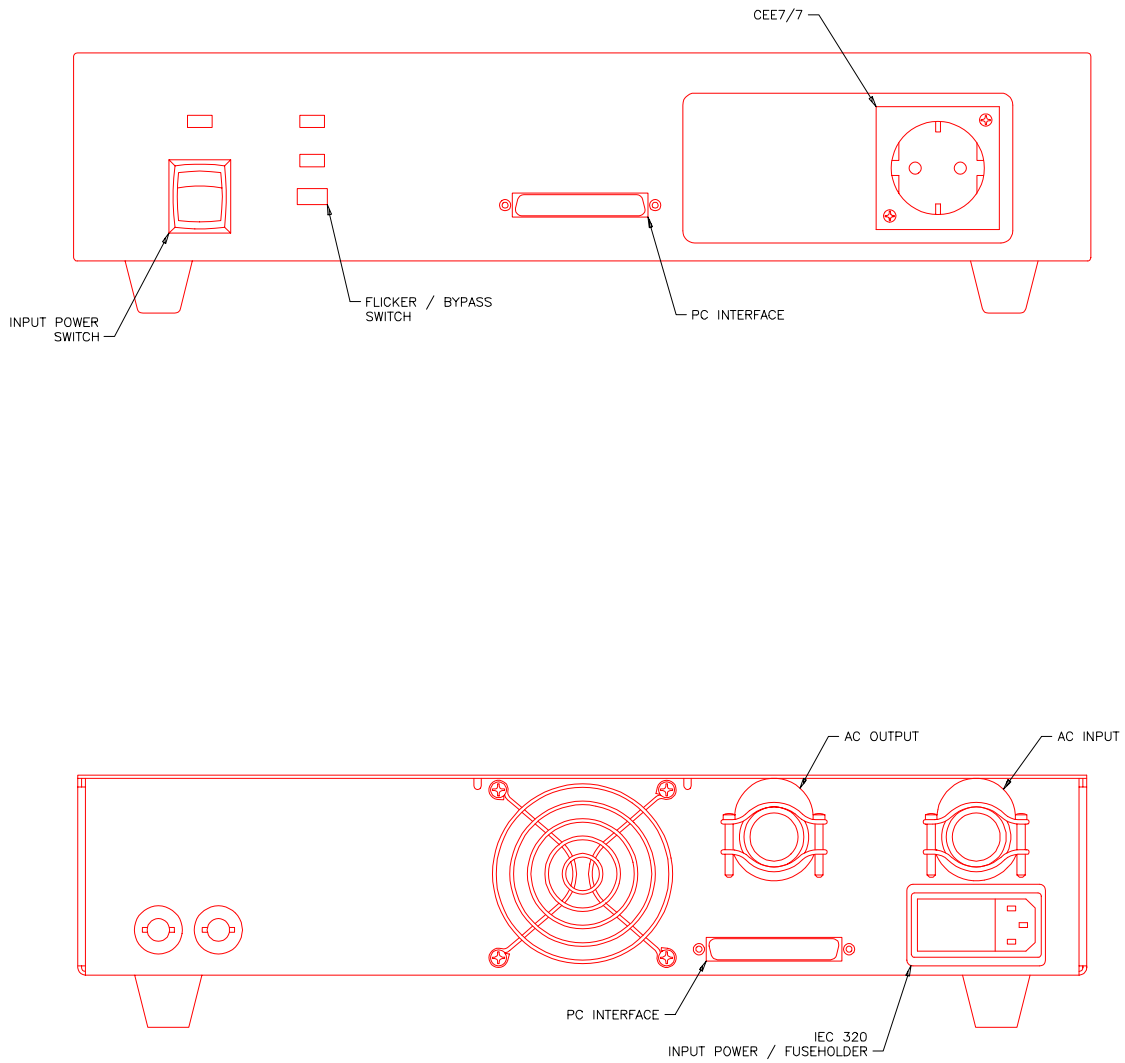
Figure 9: Front and Rear Panel Views of the PACS-1 Module.

INPUT POWER
SWITCH

PC INTERFACE

AC OUTPUT   AC INPUT

PC INTERFACE

IEC 320
INPUT POWER / FUSEHOLDER
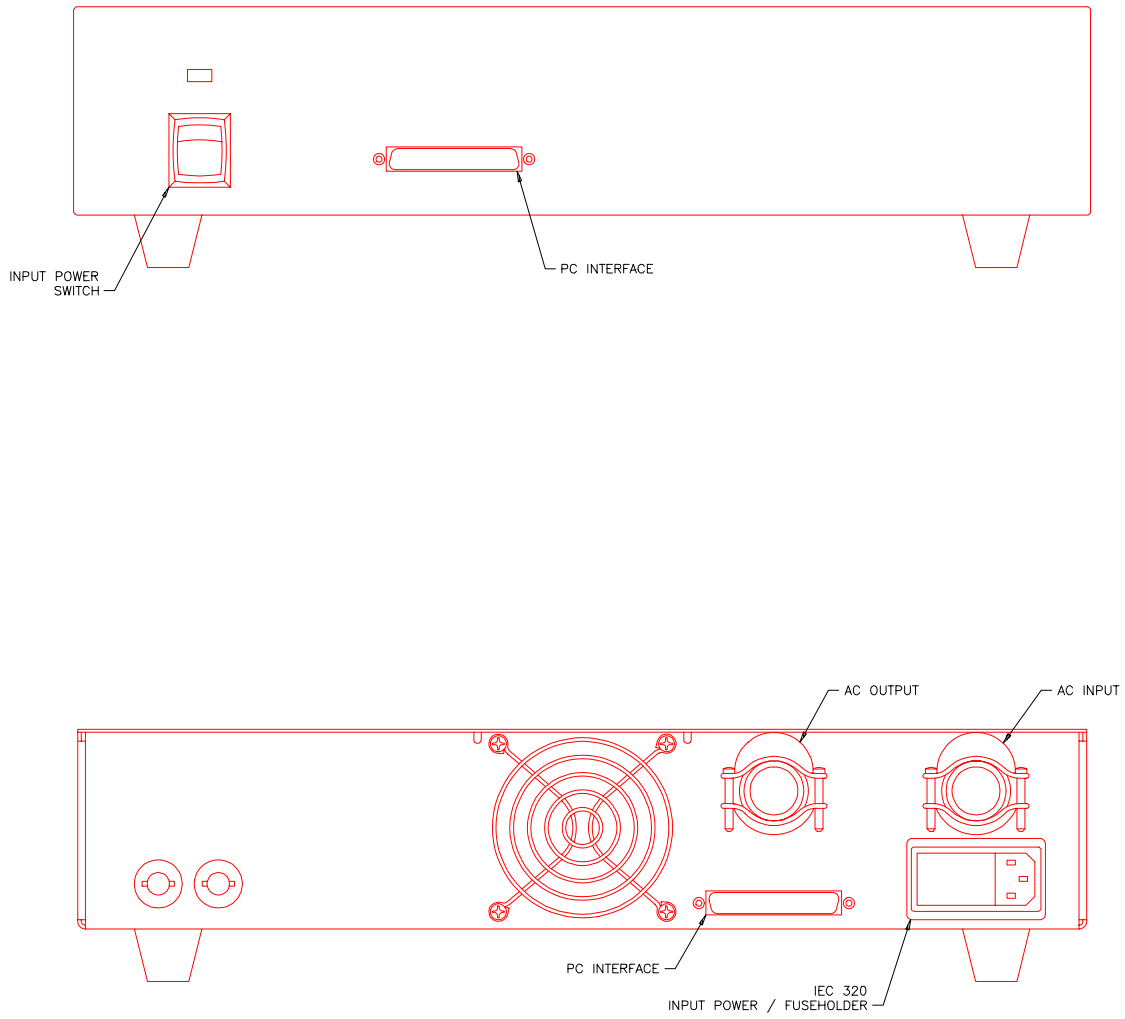
Figure 10: Front and Rear Panel Views of the PACS-3 Module.

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.

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 ½ A 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.

4.   Orient the red fuse holder so that the desired voltage shows through the window. It is necessary that the fuse always sits on the top side of the fuse holder when it is re-inserted into the module. Likewise, the shorting clip must always be on the bottom of the fuse holder.

For example, if the input voltage is being changed from 115 to 230, the fuse holder must first be removed, and then the clip and the fuse must swap location. The fuse assembly can then be inserted back into the input module.

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.

PC Interface, Clock and Lock Interface

The PC interface connector accepts the DB-37 interface cable that goes to the PC with the AD Card and the CTS software.

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

Data Acquisition Card Installation

All measurements in the CTS System are performed through a dedicated data acquisition card that needs to be installed in the host PC. This section provides the necessary installation procedure for both hardware and software of the CI400AD model A/D Card.

Unpacking and Handling

The following items are included as part of the CI400AD:

- A/D conversion board, 3/4 size ISA card.
- 37 pin cable, DB37 male to DB37 female connector.

Verify that all components are available. The CTS system will not operate if any of these items is missing. If any item is missing or visibly damaged, contact California Instruments customer service department immediately. Refer to page **Error! Bookmark not defined.** 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 CI400AD A/D card to California Instruments.

Keep the CI400AD card in its protective anti-static bag until you are ready to install it in an available ISA 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 strip and hold the card by its edge to avoid touching any of the components.

A/D Card Configuration

The CI400AD card has two jumpers that must be set in the correct position before the board is installed in the host PC. Also, the base I/O address of the CI400AD card is set by means of a DIP switch. This switch must be set to a suitable I/O address that does not conflict with any other I/O peripherals in the host PC.

The location of the jumpers and the I/O address DIP switch are shown in Figure 11.
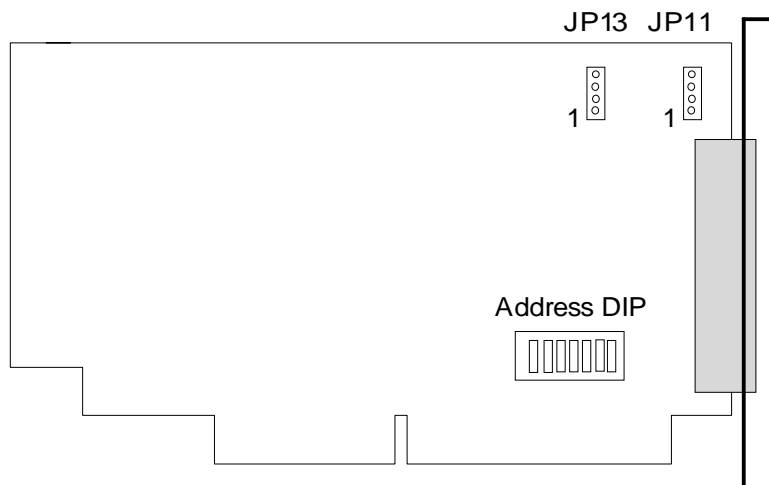
Figure 11: Jumper and DIP switch location on the A/D Card
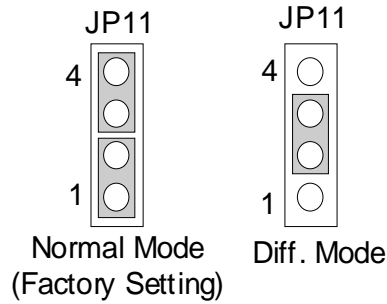
Figure 12: A/D Card JMP 11 Settings
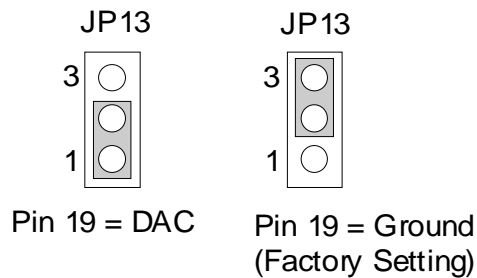
Figure 13: A/D Card JMP 13 Settings

Jumper JP11

Jumper JP11 selects between differential or single ended input channel mode and should be set to single ended mode for the CTS system. The correct setting is shown in Figure 12. Pin 1 and 2 are jumpered together as are pins 3 and 4. This is the setting in which the board is shipped from the factory and you should not have to change it.

Jumper JP13

Jumper JP13 affects the purpose of pin 19 on the 37-pin connector that interfaces to the PACS unit. For CTS operation, this pin must be analog ground and this jumper must connect pin 2 and 3.

DIP Switch - Base I/O Address

The DIP switch located on the CI400AD sets the base I/O address in the host PC I/O space. The factory configuration is port address 0x180. In most cases, this port address is available (not used by other PC peripherals) and no changes to this setting are needed.

If you do have a conflict with another device in your PC, you will have to reconfigure the base I/O address of the CI400AD. The CI400AD uses 8 contiguous I/O port addresses. Each peripheral must have a unique I/O address and no overlap can exist. The PC architecture reserves 1024 bytes of I/O space for general purpose I/O boards. However, not all of this space is generally available. The following table shows a list of commonly used I/O addresses. Use this table to locate an I/O space that is available in the host PC.

Table 5: Reserved PC I/O Address Locations

Hex I/O Range	Typically used by
170-177	Fixed disk controller #2
1F0-1F7	Fixed disk controller #1
200-207	Joystick Game Port
238-23C	Bus Mouse
23C-23F	Alternate Bus Mouse
278-27F	Parallel Printer Port (LPT)
2B0-2DF	EGA Display Adapter.
2E0-2E7	GPIB Controller card
2E8-2EF	Serial Port (COM)
2F8-2FF	Serial Port (COM)
300-31F	Prototype Card
320-32F	Hard Disk Controller (PC-XT)
360-36F	Reserved
370-377	Floppy Disk Controller #2
378-37F	Parallel Printer Port (LPT)
380-38F	Serial Data Link Controller
3A0-3AF	Serial Data Link Controller
3B0-3BB	Monochrome Display Adapter
3BC-3BF	Parallel Printer Port (LPT)
3C0-3CF	VGA, EGA Display Adapter
3D0-3DF	CGA Display Adapter
3E8-3EF	Serial Port (COM)
3F0-3F7	Floppy Disk Controller #1
3F8-3FF	Serial Port (COM)

The CI400AD base I/O address is set using the DIP switch. The DIP switch positions 1 through 7 correspond to bits 9 through 3 of the I/O address. This allows a range of 0x100 to 0x3F8 in eight byte increments. A switch in the ON position signifies the address line is 0 for the bit it represents. A switch in the OFF position signifies a 1 for the bit it represents. The following figure shows the bit mapping and the default factory setting of 0x180.

HEX:	1		8			0			
VALUE:	0	1	1	0	0	0	0	X	X	X
BIT:	9	8	7	6	5	4	3	2	1	0

MSB   LSB

ON

1   2   3   4   5   6   7
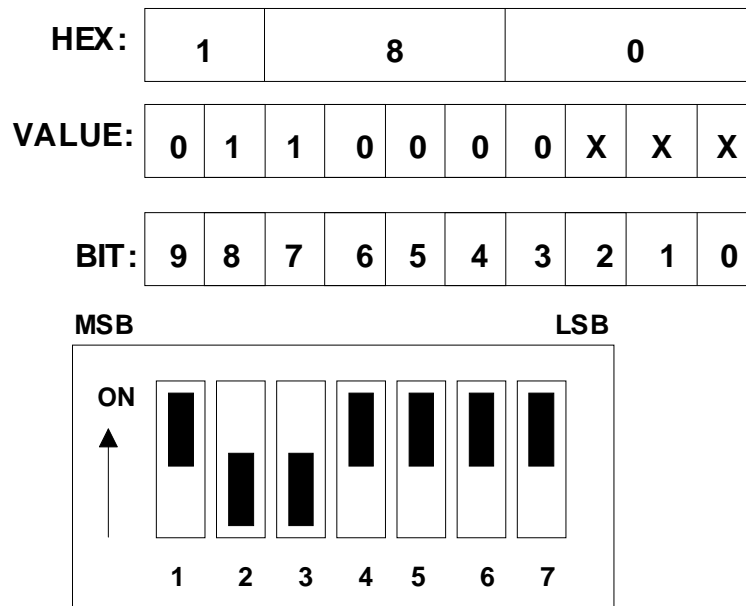
Figure 14: A/D Card Base I/O Address DIP

If you need to change the factory default I/O address to a different value to avoid conflicts with other I/O boards in your PC, you must note down the new address and pass it as a parameter when setting up the software driver later.

Installing the A/D Card

After you have configured the jumpers and the DIP switch on the A/D card (if factory defaults are not usable), you are ready to install the CI400AD in your PC. Following the procedure outlined below:

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 ISA bus expansion slots. The CI400AD requires a single 16 bit ISA slot. Note that these slots have two edge connectors.
5. Using a suitable screwdriver (typically Phillips #2), remove the cover plate for the slot you opted to use in step 4. The CI400AD has its own cover plate so the one you remove may be saved or discarded at your own discretion. You will need to re-use the screw however, so make sure you do not loose it.
6. Carefully remove the CI400AD 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 DB37 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 ISA slot connectors. 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 CI400AD board to the PC slot by its cover plate.
9. If you plan to use an IEEE-488 Controller to communicate with the 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.

This completes the board installation. You are now ready to install the CTS software.

CTS Software Installation

The CTS system software is supplied on a set of standard 1.44 Mbytes, 3.5 inch floppy disks. These distribution disks contain compressed versions of all the programs and files needed to operate the CTS system. Since these files are in compressed form, they should not be copied to your PC's hard disk since they will not function in this form. Instead, the setup program that is included on this first disk should be used to install all the files.

Installing the CTS Software Under Windows 95®

This section covers installation of the CTS software under Window 95®. If you are using Windows 3.1® or Windows for Workgroups 3.11® , refer to their respective installation sections. If you are using a networked PC, it is recommended that any networking be disabled to ensure optimal performance.

To install the CTS software under Windows 95®, proceed as follows:

1. From the Start menu, select **Settings**.

2. From the Settings options, select **Control Panel**

3. In the control panel folder, locate the **Add/Remove Programs** icon

4. Double click on the Add/Remove Programs icon to launch the Windows 95$^{®}$ Add/Remove Programs property dialog.

5. Click on the Install button located in the top right corner of this dialog box.

6. Insert the first installation disk in drive A and click on the <u>N</u>ext button at the bottom of the dialog box.

7. The program will locate the SETUP.EXE program on the first distribution disk and ask for confirmation.

8. Click on Finish to start the installation process.

9. The setup program will now run and display a dialog box that shows the default directory for the CTS system software that is IEC1000 on the current drive. At this time you can accept the default directory by clicking on the OK button or enter a different directory. If the directory you enter does not already exist, it will be created.
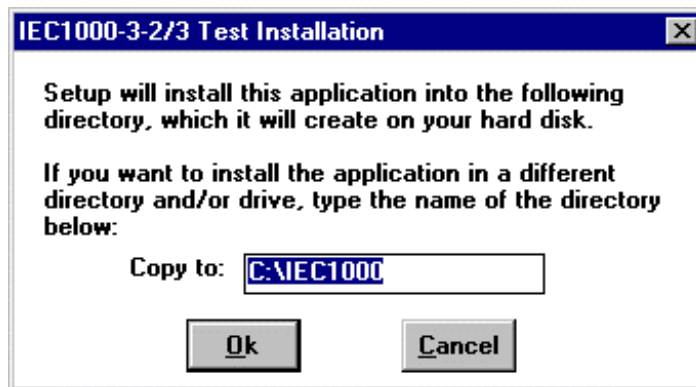
10. Next, the setup program will proceed by de-compressing the program and support files and copying them to the destination directory.
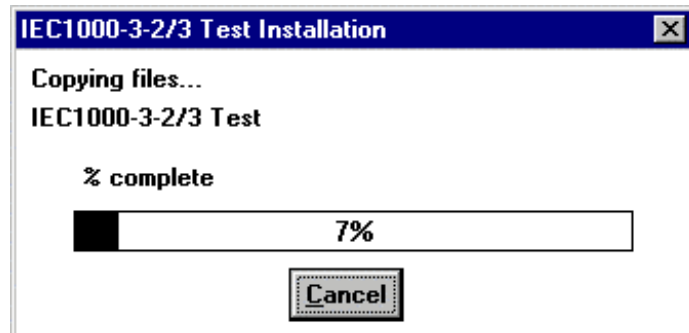
11. Halfway through the installation process, you will be asked for the next/last distribution disk.
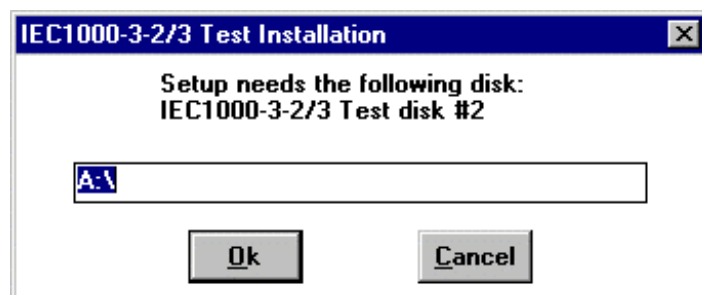
12. Remove the previous setup disk and insert the next/last disk that came with the system.

13. Click on the OK button after you have inserted the next/last disk to let the install process continue.

14. At the end of the installation process, a message will be displayed indicating the installation is complete.
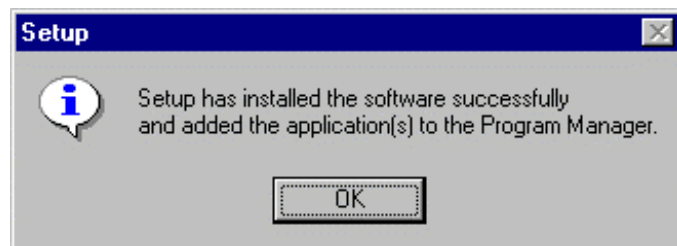
15. You can now remove the last installation disk

The installation program will create a new entry in the Programs Menu called **IEC1000-3-2&3 Test** as shown in Figure 15. This menu has 12 sub-menu entries, one for each test module. For three-phase systems, the CTS program menu will contain additional sub-menu entries for 3-phase Class-A, Class-B and Class-C testing. We recommend you keep the distribution disks in a safe place in case you ever need to re-install the CTS software.
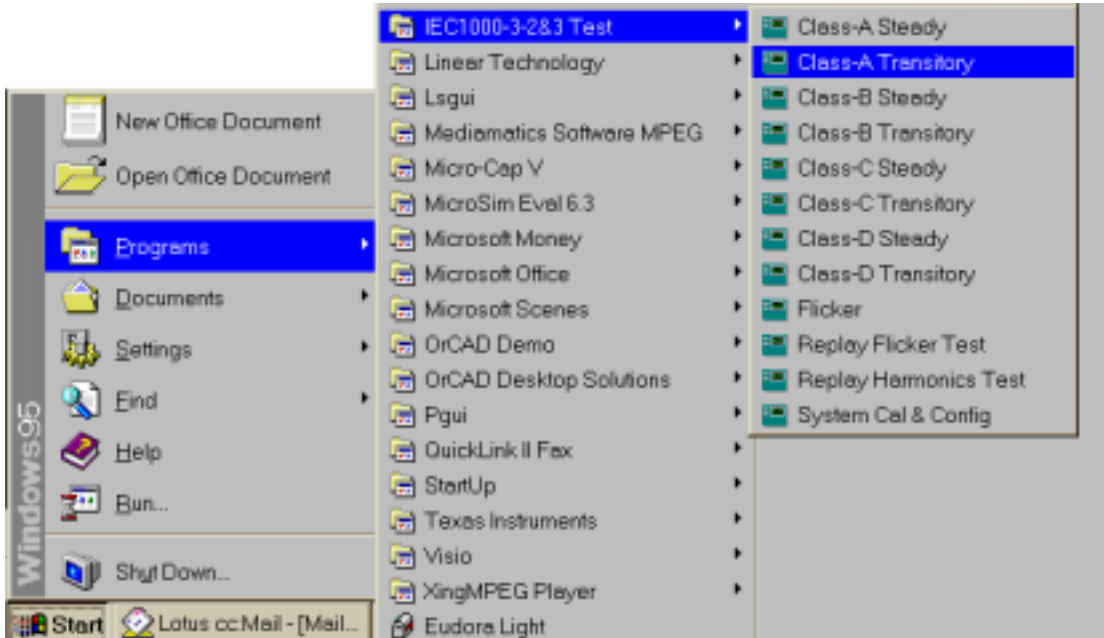
Figure 15: CTS Start Program menu entries

System Config Note: To operate the AC source through the RS232 interface, it may be necessary to set the correct COM port number using the System Cal & Config module. Refer to Section 11 for details.

Installing the CTS Software Under Windows NT®

The present version of the CTS system is not supported under Windows NT®. Contact California Instruments for information on software upgrades.

Installing the A/D Card Software Driver

The data acquisition card is supplied with its own set of drivers that must be loaded before the CTS software is started. Loading the drivers is accomplished through the autoexec.bat file. The autoexec.bat file must have the correct base I/O address for the card set.

The following CI400AD files are needed in the IEC1000 directory:

CI400.bat	Batch file
di-400.com	DOS Device driver
di-400.bmn	DSP Program file
400ldr.exe	DOS DSP Program Loader
w400ldr.exe	Windows DSP Program Loader

These files are installed automatically when you install the CTS software.

Once the required files are installed on the host PC by the setup program, you have to set up your autoexec.bat file. If your computer does not have an autoexec.bat file in the root directory of drive C:\ you will have to create one using a text editor such as Notepad. To set autoexec.bat to load up the device drivers, proceed as follows:

1. Edit your autoexec.bat file by adding the following entries:
   cd \iec1000
   ci400.bat 180
   If you had to set a different base I/O address in section "A/D Card Configuration" on page 35, you have to replace the factory default of 180 with the I/O address in hex that you set on the DIP switch. Make sure the ci400.bat file is located in the IEC1000 directory.

2. Add the IEC1000 directory to the DOS path that is commonly located in the autoexec.bat file, e.g.
   path=c:\windows;c:\iec1000.

3. Do not forget to Save the Autoexec.bat file. Now, every time the computer is started, the device drivers will be loaded up.

After the autoexec.bat file has been set up, you will have to reboot your computer for these changes to take effect. After rebooting, the IEC100-2-3-2 directory should be ready to run the test modules.

AC Source Control Software Installation

If the CTS system you purchased contains a California Instruments AC power source, it will have included additional AC source control software as well. If you purchased a PACS-1 or PACS-3, you can skip this section of the manual and proceed to the next chapter.

Note:	The AC source control software is not required to perform harmonics and flicker tests. It is required to perform any of the IEC 1000-4 tests however. This software is supplied with its own user manual and we recommend you familiarize yourself with this user manual also when electing to use the AC source control software.

The AC source control software is supplied on either two or three standard 1.44 Mbyte, 3.5 inch floppy disks. The actual software included depends on the AC source model included with the system. For the 1251RP-CTS, the PGUI32 program is included. All other CTS configurations include the CIGUI or PGUI32 or CIGUI32 program.

These distribution disks contain compressed versions of all the programs and files needed to operate the AC source. Since these files are in compressed form, they should not be copied to your PC's hard disk since they will not function in this form. Instead, the setup program that is included on this first disk should be used to install all the files.

Before you proceed, you need the determine the operating system that resides on the PC that you plan to use. The installation process will be slightly different for each operating system supported. Proceed to the relevant operating installation section in this chapter.

Installing the AC Source Control Software Under Windows 95®

This section covers installation of the AC source control software under Window 95®.

To install the AC source control software under Windows 95®, proceed as follows:

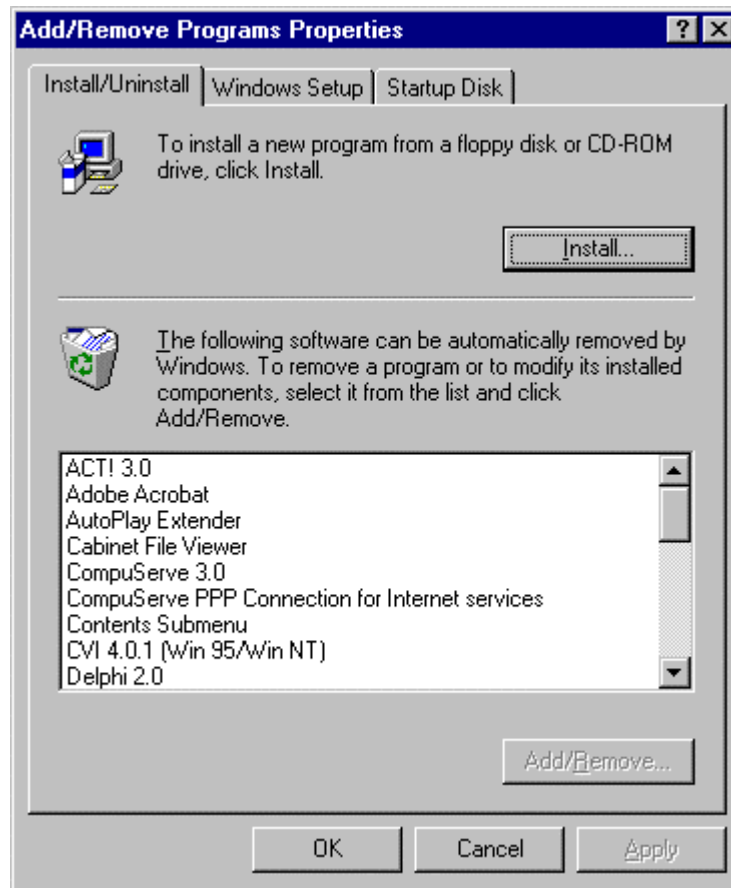1. From the Start menu, select **Settings**.

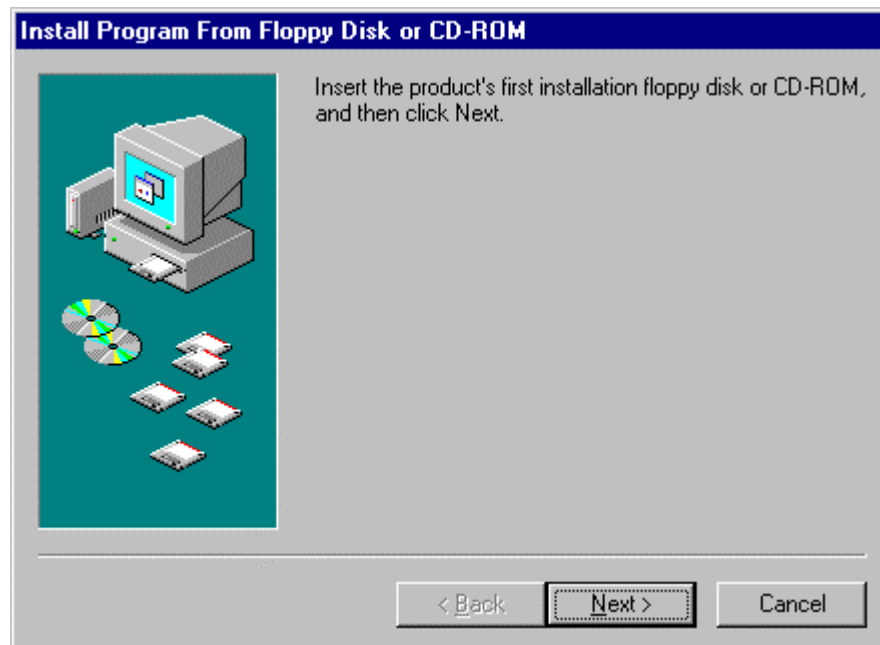2. From the Settings options, select **Control Panel**

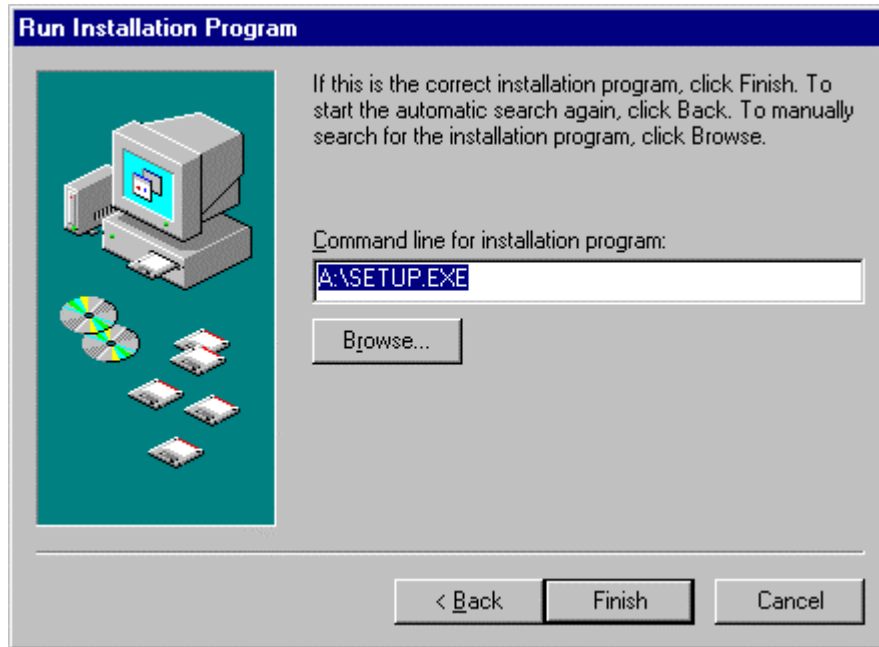3. In the control panel folder, locate the **Add/Remove Programs** icon

4. Double click on the Add/Remove Programs icon to launch the Windows 95™ Add/Remove Programs property dialog.


5. Click on the Install button located in the top right corner of this dialog box.

6. Insert the first installation disk in drive A and click on the <u>N</u>ext button at the bottom of the dialog box.

7. The program will locate the SETUP.EXE program on the first distribution disk and ask for confirmation.

8. Click on Finish to start the installation process.

9. The setup program will now run and display a dialog box that shows the default directory for the AC source control software that is CIGUI on the current drive. At this time you can accept the default directory by clicking on the OK button or enter a different directory. If the directory you enter does not already exist, it will be created.

10. The remainder of the installation procedure is identical to the one shown in the previous section. Refer to CTS software installation section on page 33.

4
Harmonics Testing

About This Chapter

This chapters covers testing a device for compliance with the IEC 1000-3-2 Harmonics standard. A review of the possible EUT classes is provided to assist the user in determining the appropriate device class to use. Once the device class has been established, the appropriate test module is used to perform the tests. A review of the available test reports and data file formats produced by the Harmonics modules concludes this chapter.

Device Classes

The IEC 1000-3-2 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.

Class D Special Current Waveshape.

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 waveshape template. This template is aimed at 'capturing' high crest factor loads that are known to generate high harmonic currents. The waveshape 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 around the peak current value. The other two sections have a 0.35 times Ipeak amplitude limit. The actual template is shown in Figure 16.
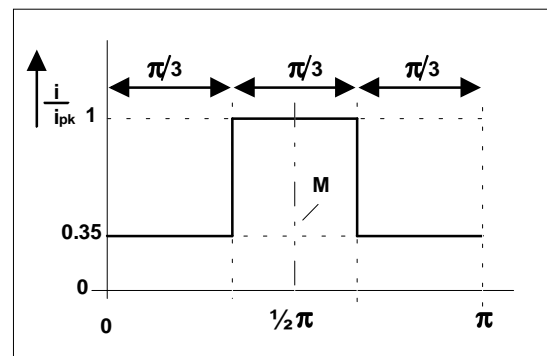
Figure 16: Class D Current Waveshape Template

The exact IEC 1000-3-2 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 17 can be used to determine the class of the device to be tested.

When selecting a Class D device, the CTS 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".

If the CTS software indicates that the current waveform does not meet the Class D requirements, the user should switch to Class A instead.
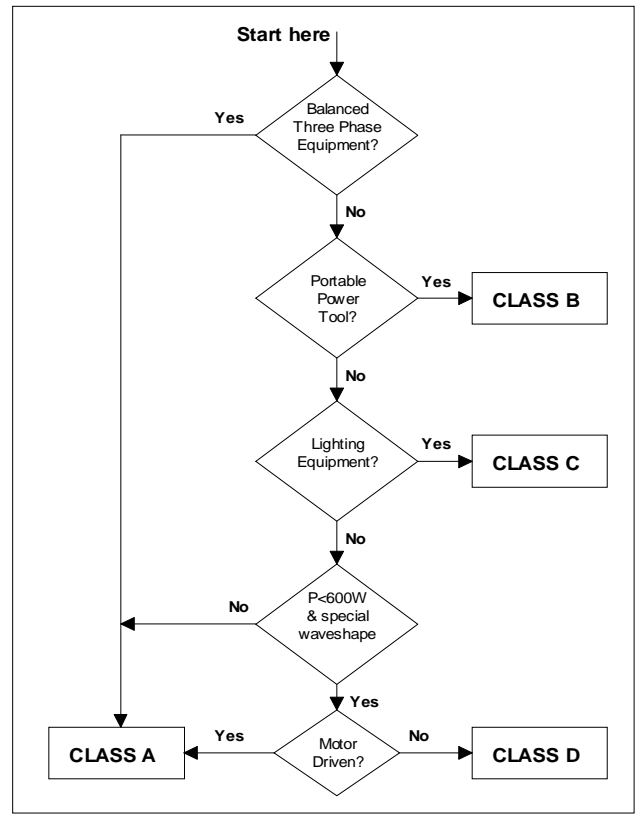
Figure 17: EUT Class Determination Flowchart

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 CTS 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 CTS 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 power factor (λ). The CTS software determines the power factor of the load for each acquisition window and dynamically determines the correct 3rd harmonic current limit for Class C devices.

Stationary or Transitory Harmonics Test

The IEC 1000-3-2 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 CTS 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.

Running a Harmonics Test

To perform a stationary harmonics test on the Equipment Under Test (EUT), first determine its class using the information provided at the start of this chapter and then double click on the correct type and class icon (Windows 3.1® users) or select the correct test from the Start Menu, Programs, IEC 1000-3-2_3 Test menu. The screens used in this chapter are for the stationary test on a Class D device.

Starting any of the harmonic test modules brings up the main harmonics test window. This window automatically sizes to a Super VGA display resolution of 800 x 600 pixels, assuming the PC on which you installed the CTS software supports this resolution. If it does not, horizontal and vertical scroll bars will be visible that can be used to scroll any portion of the test window into view. Larger screen resolutions are supported but the controls on the main window will not size to any resolution above 800 x 600.

It is recommended to use small fonts when running the CTS software. If large fonts are used some screen labels may not line up correctly or may be partially obscured. Font size can be selected from the Display Properties applet in the Win95 Control Panel.

Note:	Since both the Harmonics and Flicker modules use the same Com port to control the AC source, it is important that the Flicker program module not be open while trying to run the Harmonics module. Having both programs open at the same time could cause an interface conflict. The same applies to the CIGUI program if it is configured to use the RS232 Com port.
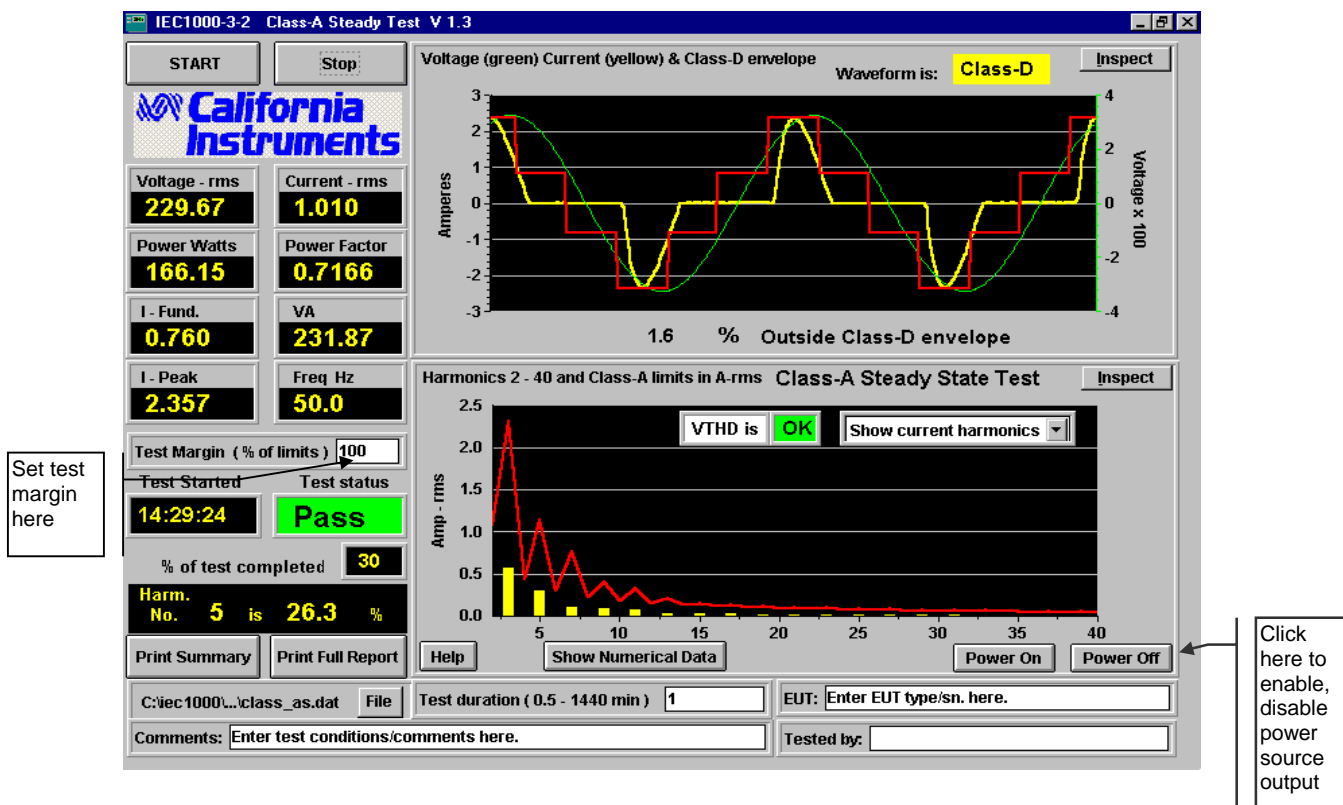
Figure 18: Harmonics Test Window

Main Harmonics Test Window Fields and Controls

The harmonic 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
Power On button	Lower right corner	Click on Power On to enable the power source output voltage, unless power source is already programmed to 230V. The configuration module can be set to turn off the power after every test, in that case therefore, the user will have to click Power On before starting the test.
Power Off button	Lower right corner	Click on Power Off to disable the power source output.
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. The user will be prompted for the data file to use.
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 reports will indicate if the test completed normally or was aborted by the user.
Help button	Lower center	Click here for on-screen help files.

Field / Control	Location	Description
Voltage - rms	Left panel	Displays the Root Mean Square voltage of the AC source output for each acquisition window. Acquisition windows are 320 ms for 50 Hz EUT's and 266.67 ms for 60 Hz EUT's.
Current - rms	Left panel	Displays the Root Mean Square current to the EUT for each acquisition window. Acquisition windows are 320 ms for 50 Hz EUT's and 266.67 ms for 60 Hz EUT's.
Power - Watts	Left panel	Displays the real power consumption of the EUT for each acquisition window. Acquisition windows are 320 ms for 50 Hz EUT's and 266.67 ms for 60 Hz EUT's.
Power Factor	Left panel	Displays the ratio between real power and VA power of the EUT for each acquisition window. Acquisition windows are 320 ms for 50 Hz EUT's and 266.67 ms for 60 Hz EUT's.
I Fund	Left panel	Displays the rms value of the fundamental current to the EUT for each acquisition window. Acquisition windows are 320 ms for 50 Hz EUT's and 266.67 ms for 60 Hz EUT's. 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.
VA Power	Left panel	Displays the apparent power consumption of the EUT for each acquisition window. Acquisition windows are 320 ms for 50 Hz EUT's and 266.67 ms for 60 Hz EUT's.
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.
Freq - Hz	Left panel	Displays the AC signal frequency in Hz. The AC source must be set to either 50 Hz or 60 Hz otherwise the harmonics test will not run. Instead, the frequency display will show the word "Adjust" on a red background to notify the user that the AC frequency is out of specifications.
Test Margin	Left panel	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 Started	Left panel	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" field next.
% 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 Status	Left panel	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 %.
Harm no.	Left panel	While a test is in progress, this field displays the highest current

Field / Control	Location	Description
		harmonic number with respect to it's IEC limit and its amplitude as a percentage of its limit. Thus, if this field shows "Harm. no 13 is 47.6% of Limit" it means the 13th current harmonic is 47.6 % of the allowable 100 % test limit. At the end of the test, this field will display the highest harmonic number and its percentage of the IEC limits that occurred during the entire test run.
Print Summary	Left panel	The Print Summary button generates a summary test report to the selected Windows printer. This summary report contains both the voltage and current waveform and the harmonics display graph. It also includes a copy of the Numerical Data report.
Show (Clear) Numerical Data	Lower center	This button generates a condensed report window that shows the numerical results of all 40 harmonics. It gives "pass" or "fail" indication and it complements the graphical report from the Print Summary button. Click on Clear button a second time to close the window.
Print Full Report	Left panel	The Print Full Report button generates a comprehensive test data report to the selected Windows printer. This report contains all of the test data written to the test data file.
Test File	Bottom panel	This field shows the currently selected test data file. If also provides a File button which can be used to change the selected test data file. The test data file is the file to which new data will be written while a test is running. Once a test is started, this button in disabled as the test data file cannot be changed while it is in use by the program. Note that the actual file name may be too long to fit in the space provided on screen. If this is the case, use the File button to display the file dialog box which will allow you to see the entire path and file name.
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) for stationary tests and 2.5 minutes (150 seconds) to 1440 minutes (24 hours) for transitory tests. This value should be set before starting the test as it cannot be changed while a test is in progress.
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.
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 green, the current in yellow. For Class D tests, 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. Note that voltage waveform data is shown for reference only and is NOT saved to disk. Current waveform data

Field / Control	Location	Description
		on the other hand is logged to disk using the same filename but a different file extension as the test data file.
Harmonics Graph	Bottom right panel	The Harmonics graph panel can be used to display the current harmonics (yellow) and test limits (red) during the test. It is also possible to toggle this display to show the AC voltage harmonics. Regardless of which display is visible, a Vthd indication is given to notify the user of a possible problem with the AC source voltage distortion which may invalidate the test results. The test will not be aborted however if the voltage distortion is too high. The drop down control in the top right corner of the Harmonics graph panel can be used to select the desired display mode. At the end of the test, this panel always switches back to display the worst case current harmonic values that occurred during the test.

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 CTS 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 are automatically added based on the PC's real-time clock.

Selecting the Test Period

If a stationary harmonics test is performed, the default test time is 30 seconds. For transitory tests, the default test time is 2.5 minutes. This is also the minimum test time for each type test.

You can increase the test time 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. This is particularly important for the transitory harmonics tests.

Test Data Files

The CTS software always logs test data to a file specified by the user. The file format used consists of Tab delimited fields for voltage, current, power, peak current and all the current harmonics. For short test times - less than 2.5 minutes - this data is recorded in real-time or three to four 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. Each record in a harmonics test data file occupies about 466 bytes of data and three records are written each second at 50 Hz and four records per second at 60 Hz. Current waveform data files occupy about three times the number of bytes as compared to the test data file. Thus, the total hard disk storage requirements is approximately 6 Kbytes/sec.

Once the selected test time exceeds 2.5 minutes (150 seconds), the rate at which data is written to disk is decreased to avoid excessive file sizes. In this case, data is only written to disk once for every 10 acquisition windows or less. If a failure occurs however, 10 acquisition windows are written to disk in real time to provide detailed information around the time of the failure.

It is important to note this file update behavior as it may affect the manner in which the data file is used for data analysis. A test data file of a test that lasted longer than 2.5 minutes will not have a linear time scale if any failures occurred during the test.

Setting the test margin

The CTS 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.

The range for this field is from 50 % to 150 % with 100 % being the default value.

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. This brings up a dialog box displaying the test data file that will be used to store the test data.

If you want to use the selected test data file, click on Cancel and the test will commence. If you want to save the data to a different file, select it using the files and folders controls and then click on the OK 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 CTS 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.

Voltage and Current Waveform Graph

The top graph continuously displays two signal periods of the AC voltage (green) and current (yellow) waveforms. For Class D tests, it also shows the special current waveshape template in red. Current waveform data is also written to disk for every acquisition window. This allows you to

call up the current waveform for the time slot at which the maximum harmonic current limit violation occurred.

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.

Note: The voltage harmonic limits apply to the AC source qualification and may indicate that the current harmonics are affected due to excessive AC voltage distortion. In this case, a yellow "V_{THD} out of spec" is shown.

When displaying the current harmonics, the actual harmonic currents from the second through the fortieth for each acquisition window are shown in yellow. 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 56). 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.

Once the test is completed, the bottom graph displays the worst case values for current harmonics 2 through 40. The display window on the left displays the highest current harmonic number in percent of limit. Also, the current waveform, occurring at the same moment in time, is displayed.

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.

Three Phase Testing

Three phase harmonics testing is limited to Class-A, Class-B and Class-C only. Class-D limits apply to power levels of 600 Watts or less and it is unlikely that a 3-phase system would be used for such a low power level. Three phase testing is similar to single phase testing described above except that three line voltages and three line currents are being measured simultaneously and displayed in the CTS software GUI. See Figure 19. When the three-phase Harmonics screen is open there is one additional feature to consider; the waveform display window can now be selected to display one phase at a time or all three voltages and currents simultaneously.

Note: When doing three-phase transitory testing the data transfer rate and the computational speed of the PC in use may become an issue. Due to the heavy overhead when scanning 12 AD channels in 3-phase mode it is possible that gaps in the data may occur with a 200MHz machine. This is usually not a problem when running Steady State tests, however, when running 3-phase Transitory harmonics testing at 60Hz, it has been observed that some computers fail to keep up with the data recording process after a few minutes. If this should become a problem, it is recommended to use a 233MHz or faster computer when doing 60Hz transitory testing. IEC testing at 50Hz has a lower data throughput and is not subject to this limitation.

Click here to select which phase to view.
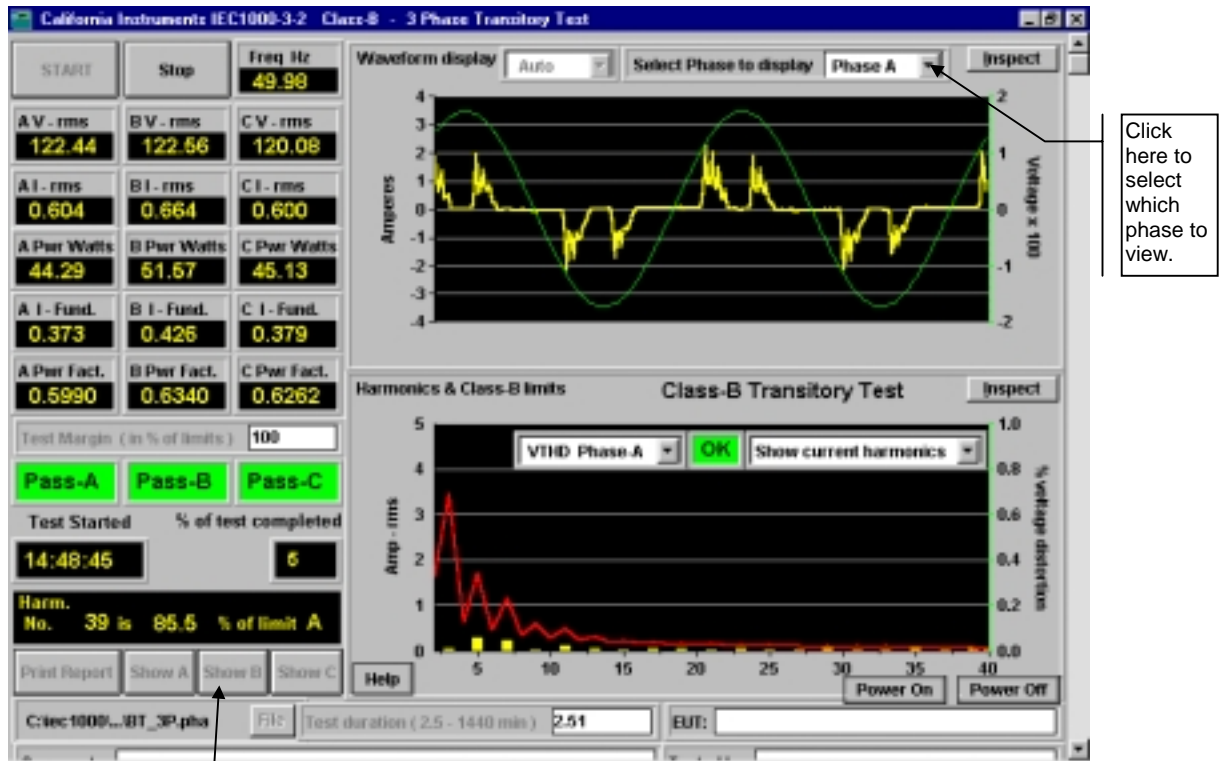
Click these buttons to display worst case harmonics for each phase.

Figure 19: 3-phase Transitory test screen

The three phase screens are virtually identical in function and form to the single phase screens. The user can view one phase at a time, or all three phases simultaneously. Also, to view the worst case harmonic content of each phase, click on Show A, Show B or Show C to view the worst case harmonics data in the lower window.

Special Graph Functions

Inspecting Graphs

The Graphs used to display voltage, current and harmonics can be "inspected" in more detail using the Inspect button located in the top right hand corner of each graphs. This brings up a separate window with a copy of the graph picture. While the data in this windows is not updated, it can be zoomed and copied to the Windows Clipboard as a table of data.
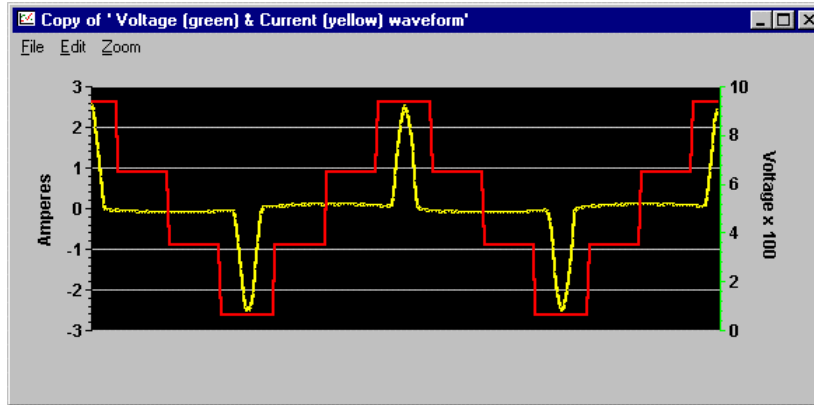
Figure 20: Graph Inspect Window

The Inspect window offers the following menu choices:

Menu	Sub menu	Purpose
File	Print	Prints the displayed graph to the selected Windows printer
	Print Setup...	Brings up the common Windows printer dialog and allows you to select a different printer and change the printer orientation from landscape to portrait.
	Close Window	Closes this window and returns to the CTS main test window.
Edit	Copy	The data table that results from an Edit, Copy operation of the Window shown in Fig. 19 is shown here. Note that the first column is the x coordinate which ranges from 0 through 255. The second column displays the voltage values, the third column the current values and the last column the special current waveshape template values. This data can be pasted to other Windows applications such as spreadsheets. 0 424.2 2.552 2.61 1 423.1 2.397 2.61 2 422.3 2 2.61 254 421.1 2.106 2.61 255 424.8 2.415 2.61
Zoom		Allows you to zoom In or Out or select Autoscale. Using the zoom function, you can see signal details by zooming and scrolling to the desired portion of the graph.

Changing Graph Parameters

Individual data sets can be displayed on screen from the Inspect window by double clicking with the mouse on any of the data sets on the graph. In case of the voltage and current graph, three data sets are available, one for voltage, one for current and one for the current template. Double clicking on the current (yellow) line brings up the Plot Parameters for the current data set.

The default line type used is Line+Symbol with the symbols in Black so they do not show against the black background. The Data.. button provides access to the data table for the selected parameter. This data can be copied using the Copy menu. This allows you to extract an individual set of data values from any of the Graphs.
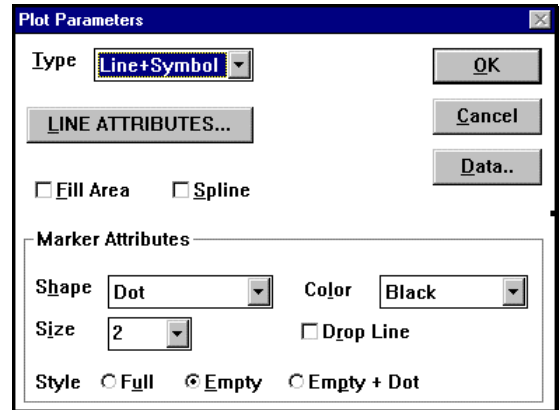
To close the parameter Data Set window, click on the Close button in the caption bar or select Close from the Control menu.

The Inspect window can be closed using the File, Close Window menu entry.

Graph Axis Scaling

The CTS software normally uses auto scaling on the vertical axis of both graphs to provide the best possible display of the data values involved. On occasion however, you may want to change the graph scaling or graph colors. This can be accomplished from the Graph Settings dialog. The Graph Settings dialog is called up by double clicking anywhere on the graph for which you want to change the Axis scaling.
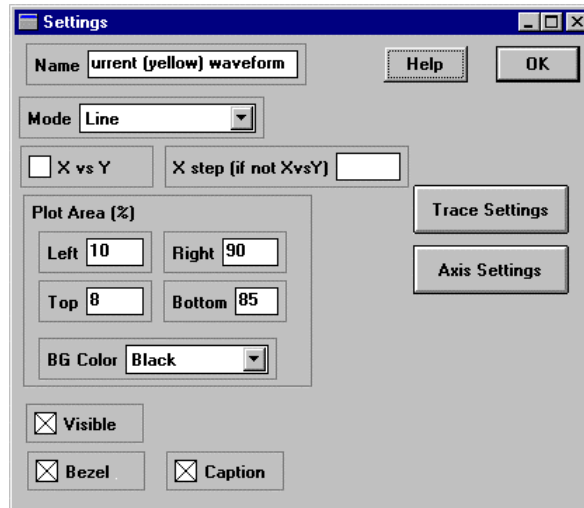
Figure 21: Graph Settings Dialog

The Axis scaling is available by clicking on the Axis Settings buttons. The additional fields and controls present in this dialog are not relevant and should no be changed.
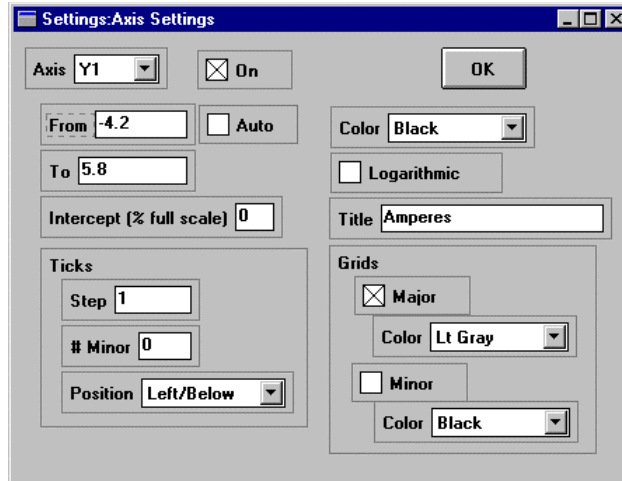
Figure 22: Graph Axis Settings Dialog

To manually set the upper and lower limit for the selected Axis (X is the horizontal axis and should be left at 0 to 255), turn off the Auto check box and enter new values in the From and To fields. The From field contains the minimum value, the To field contains the maximum value. For the top graph, the From and To values should normally be the same except for the sign. This is due to the fact that no DC offset is present in the input signals.

For the bottom graph (Harmonics), the From value should normally be left at zero (0) since the harmonic amplitudes, expressed in RMS values, are always positive.

Note: Any user changes made to the graph settings will be erased as soon as the program is
         closed. The CTS software always programs all graph settings when it is loaded. Thus,
         any changes made only remain in effect while the program is open and cannot be saved.

Printing Results

The CTS software offers various print formats for graphs and data. The various reporting and printing capabilities of the harmonics modules are described in this section.

Print Summary - Short Form Test Reports

The Print Summary button allows you to print both on-screen graphs displays and summary test result data to a single page report. This provides a single page, short form 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.

An actual screen print of the main window can be obtained from the Main Window control box by selecting the Print Panel entry. This screen print has most of the same information as the short form report. The short form report is available at the end of a test run or any time a test is aborted with the Stop button.

Show Numerical Data - Condensed Numerical Format

The Show Numerical Data button displays a condensed version of the long form test data that is sent to the hard disk during a test. The worst case harmonics measurements are selected from the data file and displayed along with the test limits and a Pass/Fail indication.

Print Full Report - Long Form Test Reports

The Print Full Report button generates a comprehensive test report that includes most of the data recorded in the test data file. Long form test reports can take up to 40 pages for a 2.5 minute test. Shorter tests (possible only for Stationary harmonics) will produce less pages. As the test time is increased, data will be written to disk at a reduced rate to keep both files size and report size under control. (Refer to Test Data Files on next page)

Any data not contained in the Long Form Report can be printed from the test data file using a suitable program such as a spreadsheet. This involves mainly the relative harmonic values which are stored in the test data file but not included in the full report to reduce the number of pages required to print a full report.

Print from Test Data File

Existing test data files can be opened using other windows programs and then printed using that programs printer capabilities. The Tab delimited format of the test data file allows it to be easily imported into a spreadsheet program such as MS Excel®. From there, it can be printed using the File, Print menu.

Alternatively, the File replay module supplied as part of the CTS software suite can be used to play back and print harmonic test data files.

Single Phase File Formats - Harmonics Test Files

The harmonics test modules all use a common test data file format. Three different file types are saved to disk when a harmonics test is executed. This first type contains all the measured data for the voltage and current harmonics and uses a ".DAT" extension.

The second type only saves current waveform data and uses a ".WFD" extension.

The third type contains numerical test data that is used to display the Numerical Data window after a test has finished. This file uses a ".TXT" extension and can also be imported into other programs for printing. All three files use Tab delimited fields and Carriage Return delimited records for easy import into other programs.

Data Files

The data files contain the following information:

Area	Record	Field 1	Field 2	Field 3	Field 4	Field 5
Header	1	California Instruments IEC1000-3-2 Test Data.				
	2	Harmonics H1 - H40 in A-rms, and H2 - H40 in % of Class-A Limits				
	3	Test date:	*Date*		Test start:	*Start Time*
	4	Test per Class - A Steady State				
	5	Test margin:	margin used (50% - 150%)			
	6	EUT: user provided information				
	7	Tested by: user provided information				
	8	Comments: user provided information				
	9	always empty record				
	10	Column headings: Time.	Power	Freq	PF	Volt
	11	always empty record				
Data	12	time stamp	*data*	*data*	*data*	*data*
	...					
	...					
	n	time stamp	*data*	*data*	*data*	*data*
Footer	n+1	End of test data file.				
	n+2	Test ended:	End Time			
	n+3	Test result	empty	THE EUT PASSED		

Text Files

The text files contain the following information:

Area	Record	Field 1	Field 2	Field 3	Field 4	Field 5
Header	1	California Instruments IEC1000-3-2 Test Data.				
	2	EUT: Enter EUT type/ sn here. *User information*				
	3	Tested by: *User information*				
	4	Test per Class-A Steady State	European Limits		Test margin:100%	
	5	Test Date: April 7, 1998	Test start: hh:mm:ss		Test ended: hh:mm:ss	
	8	Comments: Enter test conditions/comments here.				
	9	Voltage (V rms):	*data*			
	10	Power (Watts):	*data*			
	11	Power Factor:	*data*			
	12	I-fund. (A rms)	*data*			
	13	Empty record.				

Area	Record	Field 1	Field 2	Field 3	Field 4	Field 5
	14	Test result		THE EUT PASSED		
	15	Empty record.				
	16	Harm No..	Level A rms	Limit A rms	% of Limit	Status
	17	Empty record.				
Data	18	2	*data*	*data*	*data*	*data*
	19	3	*data*	*data*	*data*	*data*
	20	4	*data*	*data*	*data*	*data*
		…….				
		…….				
	56	40	*data*	*data*	*data*	*data*
		Empty record				
		Empty record				
Header	59	California Instruments IEC1000-3-2 Voltage Source Verification Data■				
	60	EUT: Enter EUT type/ sn here. *User information*				
	61	Tested by: *User information*				
	62	Test per Class-A Steady State	European Limits		Test margin:100%	
	63	Test Date: April 7, 1998	Test start: hh:mm:ss		Test ended: hh:mm:ss	
	64	Comments: Enter test conditions/comments here.				
	65	Voltage (V rms):	*data*			
	66	Power (Watts):	*data*			
	67	Power Factor:	*data*			
	68	I-fund. (A rms)	*data*			
	69	Empty record.				
	70	Source quality was OK during the test.				
	71	Empty record.				
Data	72	Harm No..	Dist. %	Limit %	Status	
	73	Empty record.				
	74	2	*data*	*data*	*data*	
	75	3	*data*	*data*	*data*	
	76	4	*data*	*data*	*data*	
		…….				
		…….				
	112	40	*data*	*data*	*data*	

Waveform Files

The waveform data file is synchronized to the test data file. This means that each record (row) in the waveform file corresponds to the same record in the test data file. Consequently, the waveform data file does not have its own time stamp field. The data in the waveform file consists of 256 current samples taken over two signal periods or 128 samples per period. Each record provides a snapshot of the current waveform for which the current harmonics were calculated and stored in the test data file.

The waveform files contain the following information:

Area	Record	Field 1	Field 2	Field 3	Field 4	Field 5
Header	1	California Instruments CTS Waveform Data				
	2	Test date:	*Date*			
	3	Test start	*Start Time*			
	4	Test per Class - A Steady State				
	5	EUT: user provided information				
	6	Tested by: user provided information				
	7	Comments: user provided information				
	8	The waveform data includes two cycles per row.				
	9	Each row represents a complete data-set.				
	10	always empty record				
	11	always empty record				
Data	12	*data*	*data*	*data*	*data*	*data*
	...					
	...					
	n	*data*	*data*	*data*	*data*	*data*
Footer	n+1	End of test data file.				
	n+2	Test ended:	End Time			
	n+3	Test result	empty	THE EUT PASSED		

Three Phase File Formats - Harmonics Test Files

Three phase file formats are identical to the single phase formats described above except the three phase data files have one additional label in field 9 which identifies the file as phase A,B or C data.

The file names are:

AT_3P.pha	For Class-A	
AT_3P.phb	Transitory	
AT_3P.phc	testing	
AS_3P.pha	For Class-A	
AS_3P.phb	Steady State	
AS_3P.phc	testing	
WFA.pha	3-phase	
WFB.phb	waveform	
WFC.phc	files	
TXA.pha	3-phase	
TXB.phb	text	
TXC.phc	files	

5
Flicker Testing

About This Chapter

This chapters covers testing a device for compliance with the IEC 1000-3-3 Flicker standard. The relevant IEC Flicker test module is described in detail. A review of the available test reports and data file formats produced by the Harmonics modules concludes this chapter.

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 mseconds, 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 200 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.

Running a Flicker Test

To perform a flicker test on the Equipment Under Test (EUT), select the IEC 1000-3-3 Flicker Test icon or Start menu entry to start the Flicker test module of the CTS software.

Starting the Flicker test module brings up a the main Flicker test window. This window automatically sizes to a Super VGA display resolution of 800 x 600 pixels, assuming the PC on which you installed the CTS software supports this resolution. If it does not, horizontal and vertical scroll bars will be visible which can be used to scroll any portion of the test window into view. Larger screen resolutions are supported but the controls on the main window will not size to any resolution above 800 x 600.

It is recommended to use small fonts when running the CTS software. If large fonts are used some screen labels may not line up correctly or may be partially obscured. Font size can be selected from the Display Properties applet in the Win95 Control Panel.

Note: Since the Harmonics and Flicker modules both use the same com port to control the AC source, it is important that the Flicker program module not be open while trying to run the Harmonics module. Having both programs open at the same time could cause an interface conflict. The same applies to the CIGUI program if it is configured to use the RS232 com port.

Note: To guarantee proper timing of Flicker tests, ALL other Windows applications on the PC must be closed. This is particularly true for screen saver programs that may be enabled. Any screen saver must be completely disabled or the Flicker test timing cannot be guaranteed.
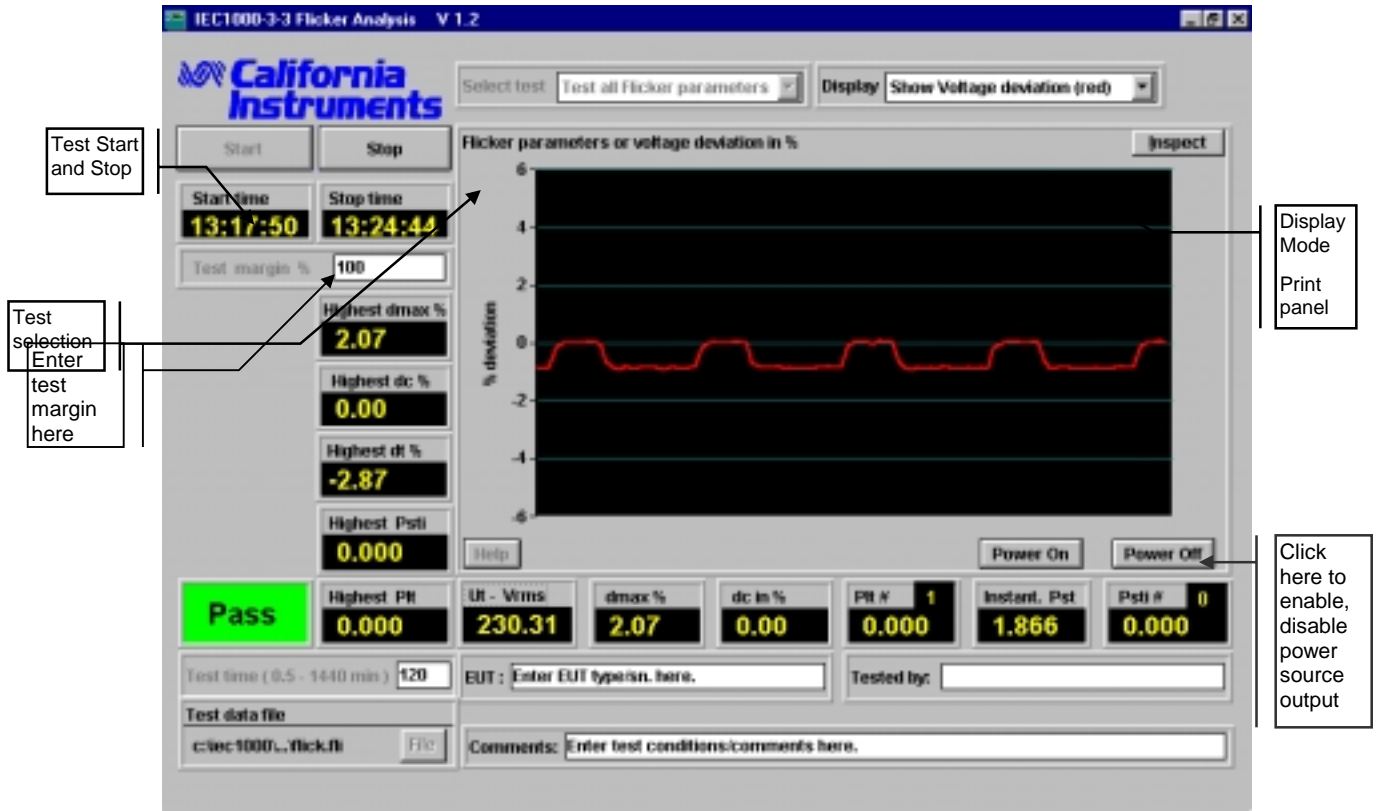
Figure 23: Flicker Test Window

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
Power On button	Lower right corner	Click on Power On to enable the power source output voltage, unless power source is already programmed to 230V. The Flicker module can be configured to turn off the power after every test, in that case therefore, the user will have to click Power On before starting the test.
Power Off button	Lower right corner	Click on Power Off to disable the power source output.
Start button	Upper left corner	Starts the flicker test using presently selected parameters. Once a test is running, parameter cannot be changed. Starting a test also causes data to be written to the test data file. The user will be prompted for the data file to use.
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 reports will indicate if the test completed normally or was aborted by the user.

Field / Control	Location	Description
Help button	Lower center	Click here for on-screen help files.
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.
Current/Stop Time	Left panel	This field shows the current time based on the PC's real time clock as long as the test is in progress. Once the test completes, this field will show the Stop time of the test run.
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 %.
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	Displays the present Relative Steady State voltage change (d_c) in

Field / Control	Location	Description
	panel	%. 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 graph panel is used to display either d_c and d_t or Ut rms as a function of time. The user can change display modes using the Graph mode drop down box located directly above the graph itself.
Graph mode	Display mode / Print panel	The Flicker module allows the user to toggle between two display modes. One mode shows the dc and dt as a function of time. The other mode shows the Ut rms value as a function of time. Each mode shows a time windows of about 2 seconds and is updated once every 2 seconds.
Test File	Bottom panel	This fields shows the currently selected test data file. If also provides a File button which can be used to change the selected test data file. The test data file is the file to which new data will be written while a test is running. Once a test is started, this button in disabled as the test data file cannot be changed while it is in use by the program. Note that the actual file name may be too long to fit in the space provided on screen. If this is the case, use the File button to display the file dialog box which will allow you to see the entire path and file name.
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	This field can be used to enter any information about the test. The

Field / Control	Location	Description
	panel	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.

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 CTS 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.

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 1000-3-3.

Test Data Files

The CTS software always logs test data to a file specified by the user. The file format used consists of Tab delimited fields of rms voltage. This data is recorded in real-time every 10 msec and stored to disk in 1 second intervals. Thus, each file record of the "Flicker.fli" file will contain 100 rms measurement values in addition to the calculated flicker parameters.

Setting the test margin

The CTS 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.

The range for this field is from 50 % to 150 % with 100 % being the default value.

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 programmed on the AC source.

A test run is started by clicking on the Start button. This brings up a dialog box displaying the test data file that will be used to store the test data.

If you want to use the selected test data file, click on Cancel and the test will commence. If you want to save the data to a different file, select it using the files and folders controls and then click on the OK button.

During test execution, the Current/Stop Time field on the left of the main window displays the present time. Once the user selected test time expires, this field will seize to change and will display the time at which the test terminated. If you click on the Stop button instead, it will display the time at which the test was aborted.

During the test execution, the CTS 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.

Special Graph Functions

Inspecting Graphs

The Graphs used to display d_c, d_t and Ut can be "inspected" in more detail using the Inspect button located in the top right hand corner of each graphs. This brings up a separate window with a copy of the graph picture. While the data in this windows is not updated, it can be zoomed and copied to the Windows Clipboard as a table of data.

For details on using the Graph Inspect function, refer to the previous chapter on Harmonics testing which covers this topic in detail.

Printing Results

The CTS software offers various print formats for graphs and data. The various reporting and printing capabilities of the Flicker module are described in this section.

Note that the Print Report button does not appear until after the end of the test. It uses the same space as is normally used for the Graph Display mode drop down box. This also reflects the fact that data cannot be printed until the test run has completed or is aborted by the user.

Print Report- Test Reports

The Print Report feature allows you to print summary data to a single page report. This provides a single page, short form test report that displays the test setup, the Pass or Fail result and a d_c, d_t or rms voltage graph.

An actual screen print of the main window including the graphs can be obtained from the Main Window control box by selecting the Print Panel entry. This screen print has most of the same information as the short form report.

The short form report is available at the end of a test run or any time a test is aborted with the Stop button.

Print from Test Data File

Existing Flicker test data files can be opened using other windows programs and then printed using that programs printer capabilities. The Tab delimited format of the test data file allows it to be easily imported into a spreadsheet program such as MS Excel®. From there, it can be printed using the File, Print menu.

Alternatively, the File replay module supplied as part of the CTS software suite can be used to play back and print Flicker test data files.

Single Phase File Formats - Flicker Test Files

The Flicker test module uses a test data file format similar to that of the harmonics test modules. Flicker test data files use a ".FLI" extension to distinguish them from the harmonic test data files.

Data Files

The data files contain the following information:

Area	Record	Field 1	Field 2	Field 3	Field 4	Field 5
Header	1	California Instruments IEC1000-3-2 Test Data.				
	2	Harmonics H1 - H40 in A-rms, and H2 - H40 in % of Class-A Limits				
	3	Test date:	*Date*	Test start:	*Start Time*	
	4	Test per Class - A Steady State				
	5	Test margin:	margin used (50% - 150%)			
	6	EUT: user provided information				
	7	Tested by: user provided information				
	8	Comments: user provided information				
	9	always empty record				
	10	Column Headings: Time.	Power	Freq	PF	Volt
	11	always empty record				
Data	12	time stamp	*data*	*data*	*data*	*data*
	...					
	...					
	n	time stamp	*data*	*data*	*data*	*data*
Footer	n+1	End of test data file.				
	n+2	Test ended:	End Time			
	n+3	Test result	empty	THE EUT PASSED		

Three Phase File Formats - Flicker Test Files

Three phase file formats are identical to the single phase formats described above, with one exception.

Three phase data files have one additional label in field 9 which identifies the file as phase A, B or C data.

The file names are: FLICK3.FLA   for phase A

FLICK3.FLB   for phase B

FLICK3.FLC   for phase C

6
IEC1000-4-11 Voltage Dips and Variations Immunity Testing

About This Chapter

This chapters covers testing a device for compliance with the IEC 1000-4-11 Voltage Dips and Variations test standard. This test is supported through the CIGUI AC source control program. If you purchased a 100-CTS or 300-CTS test system which does not include a California Instruments AC source, you will not be able to perform these tests.

The CIGUI supports two implementations of the IEC 1000-4-11 test standard, one based on the firmware option available for the i-Series and one implemented in the CIGUI program itself that runs on any supported AC source. If you are using an i Series AC source, check your configuration window to see if this option is installed. The CIGUI will automatically choose the right implementation. This section covers the software implementation. If the AC source you are using is an i Series with the -411 option, refer to the i Series AC source manual instead.

Voltage Dips and Interruptions Immunity Test
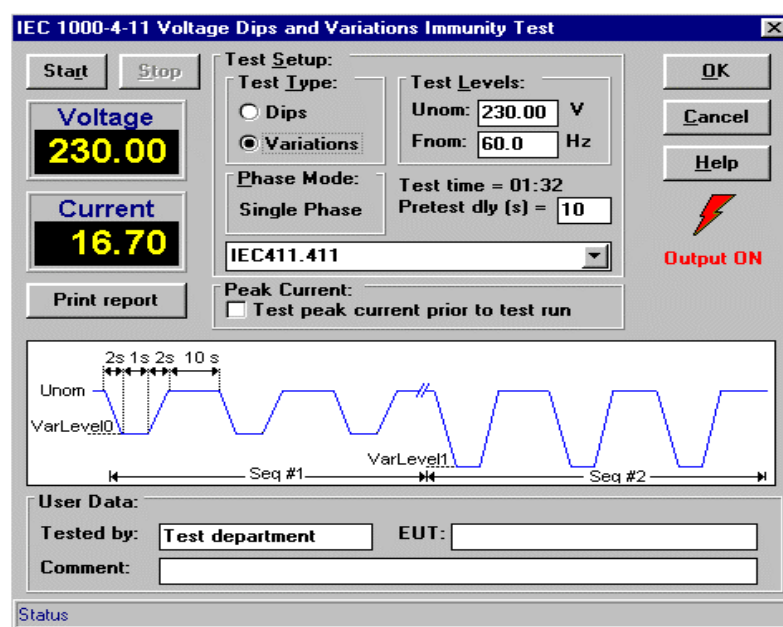
Figure 24: IEC 1000-4-11 Test Window

The CIGUI software implementation of the IEC 1000-4-11 test suite consists of two types of tests:

Dips and Interruptions   Simulates short interruptions in AC supply

Voltage Variations   Simulates slow changes in AC supply

The user must select the desired test type before executing the test. Since both test types require a number of test parameters, it is imperative that at least one *filename*.411 file is present in the CIGUI application directory.

Note that the IEC 1000-4-11 specification is based on common types of AC line disturbances found on the European utility network. The test voltage levels and dip durations required to perform IEC 1000-4-11 tests is not clearly defined. Instead, different test levels and durations are allowed for various product categories. These test levels are set by product committees. For this reason, the test parameters used by the CIGUI for the IEC 1000-4-11 test sequences can be specified in an initialization file such as the *filename*.411 supplied with the software. This allows unlimited customization of both voltage interruptions and voltage variations tests. Up to 31 sequences of voltage dips at various levels, phase angles and duration can be specified. Voltage variations can be defined by level, rise time, fall time and hold time. Refer to Figure 25 for an illustration of how these parameters affect the V rms output.
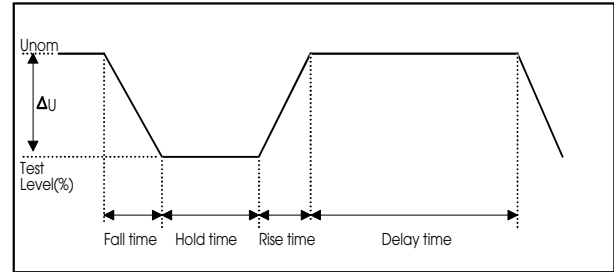
Figure 25: IEC 1000-4-11 Voltage Variation specification

Test Setup

The following parameters and controls are available for executing the IEC 1000-4-11 test:

Nominal voltage	Opening this window will set this parameter to the present steady state voltage setting of the AC source. If required, a new value can be entered to be used during the test. At the end of the test, the AC source will remain at this voltage level. If needed, the program will switch the AC source to the high voltage range and close the output relay when the test is started.
Nominal frequency	Opening this window will set this parameter to the present steady state frequency setting of the AC source. If required, a new value can be entered to be used during the test. At the end of the test, the AC source will remain at this frequency.
Test Type	Available test types are Dips and Variations..
Phase Mode	The phase mode used is shown below the class selection. This mode cannot be changed from this window. To change phase mode, close this window and use the main front panel control window to select the desired phase mode first.
Peak Current Mode	User can select this option to verify that the test is valid. If the peak current is over the limit of the power source, a message will appear and the user can select abort or continue running the test
Run	Starts the IEC 1000-4-11 test using the parameters set by the user. Test progress is shown at the bottom of the window. The sequence numbers shown correspond to those in the illustration.
Abort	Aborts test in progress.

Test Results

There is no way for the CIGUI to determine the outcome of this test as a clear definition of a failure can not be given. The draft standard called out the following possible test results:

"The test results shall be classified on the basis of the operating conditions and functional specifications of the equipment under test, as in the following, unless different specifications are given by product committees or product specifications.

a) Normal performance within the specification limits

b) Temporary degradation or loss of function or performance which is self-recoverable.

c) Temporary degradation or loss of function or performance which requires operator intervention or system reset.

d) Degradation or loss of function which is not recoverable due to damage of equipment (components) or software, or loss of data.

As a general rule, the test result is positive if the equipment shows its immunity, for the duration of the application of the test, and at the end of the tests the EUT fulfills the functional requirements established in the technical specification."

The user has to make this determination by observing the unit under test.

Report Format- 411 Test Files

The 411 test module produces a test report that is sent to a printer when the Print Report button is clicked. A sample test report follows:

```
California Instruments IEC 1000-4-11 Test Report


--------------------------------------------------------------------------------
 Print Date        = 03-20-1998 10:12:39
 Program version     = AC Source GUI; 3.01  -  March 6, 1998
--------------------------------------------------------------------------------
IEC TEST RESULT       = PASS
--------------------------------------------------------------------------------
 Time test started    = Friday, March 20, 1998 9:42:25 AM
 Time test completed  = Friday, March 20, 1998 9:53:35 AM
 Selected test file   = IEC411.411
 Selected test type   = Voltage Dips Test
 Test operator        = Test department
--------------------------------------------------------------------------------
TEST CONDITIONS:
--------------------------------------------------------------------------------
 Current Peak value   = Not tested.
 Nominal voltage (Un) = 230.00 V rms.
 Nominal freq. (Fn)   = 50.00 Hz.
 Equipment under test description :
 1251P
 User comment regarding this test :
 EUT at 50% load
--------------------------------------------------------------------------------
TEST SEQUENCE EXECUTED:
--------------------------------------------------------------------------------
[IEC-1000-4-11]
PreTest = 3
SeqRepeat = 3
SeqDuration = 10
InterSeqDelay = 1
```

```
UserPrompt = User intervention required. Press OK when ready to continue
SeqNumberDips = 21
MeasUpdateRate = 1000
CycleTime0 = 0.5
StartPhase0 = 0
TestLevel0 = 0
GapDelay0 = -1
CycleTime1 = 0.5
StartPhase1 = 180
TestLevel1 = 0
GapDelay1 = 2
CycleTime2 = 1
StartPhase2 = 0
TestLevel2 = 0
GapDelay2 = 5
…………..
…………..
…………..
….test……..
….sequence
…………..
…………..
CycleTime20 = 50
StartPhase20 = 0
TestLevel20 = 70
FallTimeVar = 2
HoldTimeVar = 1
RiseTimeVar = 2
VarLevel0 = 40
VarLevel1 = 0
----------------------------------------------------------------------------
Program is AC Source GUI
Version is 3.01  -  March 6, 1998
```

Measurements

During the test run, both voltage and current are measured at regular intervals (specified by the MeasUpdateRate parameter). This allows the user to determine if the EUT continues to operate. There may be effects on the EUT such as reboots or processor lockups that cannot be seen by observing the EUT load current. Frequency is not measured as it remains at the nominal frequency specified.

Compliance Statement:

Based on the hardware specifications of the AC source in use, not all requirements for IEC 1000-4-11 test generators may be met. In particular, the 1 to 5 microsecond rise and fall time called out in the specification is not met by most AC sources. This is unlikely to have any effect on the outcome of the test however. A unit that fails a voltage dropout with a 80 microsecond rise and fall time will not likely pass the same dropout performed at 5 microseconds rise and fall times and vice versa.

However, the -EOS option available for the ix series AC sources may be added to meet the IEC 1000-4-11 source rise and fall times.

Also, the 500 Amps inrush current capability is not met. This requirement does not have to be met if the unit under test does not draw more inrush current than the AC source can deliver. The peak current pre-test option may be used to verify inrush capability of the source for the unit under test.

IEC 1000-4-11 for i or iX Series only

The CIGUI supports two implementations of the IEC 1000-4-11 test standard, one based on the firmware option available for the i/iX-Series and one implemented in the CIGUI program itself that runs on any supported AC source. If you are using a i/iX Series AC source, check your configuration window to see if this option is installed. The CIGUI will automatically choose the right implementation. This section covers the i/iX Series firmware option based implementation. If the AC source you are using is not an i/iX Series or is an i/iX Series without the -411 option, refer to the Voltage Dips and Interruptions Immunity Test section instead.

Voltage Dips and Interruptions Immunity Test

The IEC 1000-4-11 test suite consists of two types of tests:

Dips and Interruptions	Simulates short interruptions in AC supply
Voltage Variations	Simulates slow changes in AC supply

Figure 26: IEC1000-4-11 i or iX Seroes Test Window
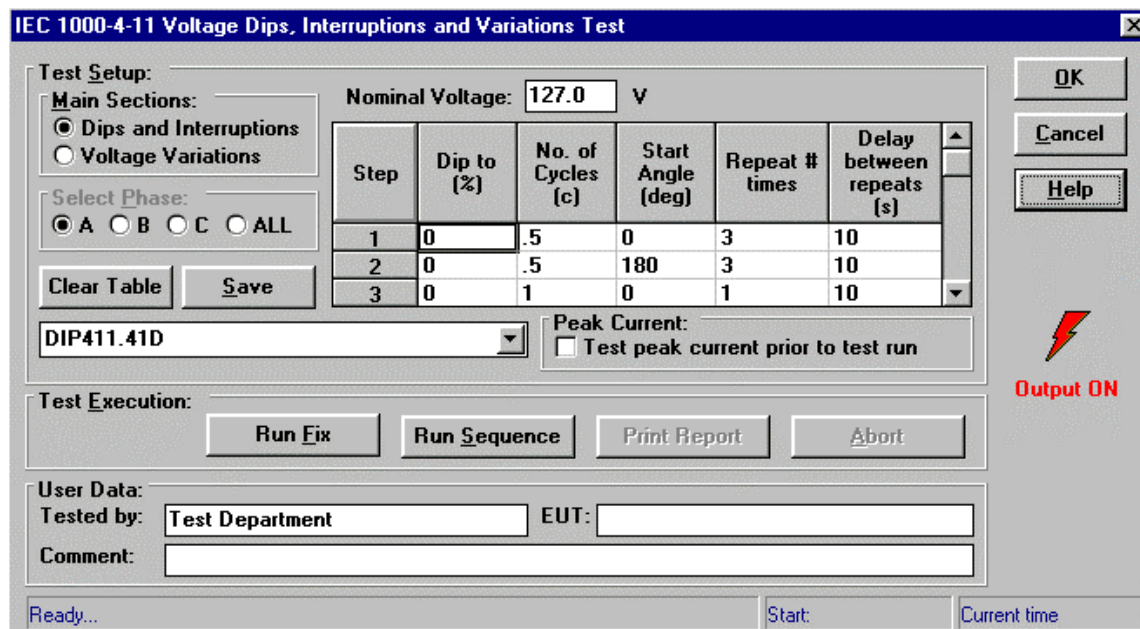
Each section can be selected for complete execution. The Run Fix option allows all steps in the test to be executed in sequence.

 Each section can be selected for complete execution. The Run Fix option allows all steps in the test to be executed in sequence. These steps are stored in the file DIP411.41D for the Dips and Interruptions or VAR411.41V for the Voltage Variations test.

It is also possible to select a single step. In this case, the step parameters can be set by the user. This allows any combination of parameters to be set and saved to disk. The user can enter 99 different steps and each step can be repeated. The Run Sequence will run all the steps setup from those files. The file extension for the Dips and Interruptions is .41D and the extension for the Voltage Variations is .41V.

Peak current pre-test:

When checked, this option runs a series of peak current measurements to make sure the AC source can provide adequate inrush current to the EUT. This test consists of four steps. For two of these steps, the output is programmed to zero volts for 5 minutes before power is applied for a 1 minute period. Turn on occurs at 90 and 270 degrees of the waveform respectively for each step. The other two steps program the voltage to nominal for 1 minute and then turn off for 5 seconds. The power is then reapplied at 90 and 270 degrees of the waveform respectively for each step.

At each step, the inrush current is measured and the highest of the four readings is used to determine the suitability of the AC source. This test will take 14 minutes to run.

If the peak current is over the limit of the AC Source, a message will pop-up asking the user if the -411 test should continue or not. This result will be included in the test report.

Note:

 - The IEC 1000-4-11 specification is based on common types of AC line disturbances found on the European utility network. The number of tests required to perform IEC 1000-4-11 tests is not clearly defined so there is room for interpretation. For this reason, the Run Single option was provided so that individual steps can be set by the user. For more elaborate customized IEC 1000-4-11 test sequences, the transient capability of the AC source can be used.

 - If the EOS option is installed, the Voltage Dip % and the Voltage Variation reduce % is limited to 100%, 70%, 40% or 0%.

Test Results

There is no way for the CIGUI to determine the outcome of this test as a clear definition of a failure can not be given. The draft standard called out the following possible test results:

"The test results shall be classified on the basis of the operating conditions and functional specifications of the equipment under test, as in the following, unless different specifications are given by product committees or product specifications.

a) Normal performance within the specification limits

b) Temporary degradation or loss of function or performance which is self-recoverable.

c) Temporary degradation or loss of function or performance which requires operator intervention or system reset.

d) Degradation or loss of function which is not recoverable due to damage of equipment (components) or software, or loss of data.

As a general rule, the test result is positive if the equipment shows its immunity, for the duration of the application of the test, and at the end of the tests the EUT fulfills the functional requirements established in the technical specification."

The user has to make this determination by observing the unit under test.

Note: **Refer to the user manual or manual addendum for specific details on IEC 1000-4-11 test steps implemented in the IEC 1000-4-11 firmware option.**

Compliance Statement

Based on the hardware specifications of the AC source in use, not all requirements for IEC 1000-4-11 test generators may be met. In particular, the 1 to 5 microsecond rise and fall time called out in the specification is not met by most AC sources. This is unlikely to have any effect on the outcome of the test however. A unit that fails a voltage dropout with a 80 microsecond rise and fall time will not likely pass the same dropout performed at 5 microseconds rise and fall times and vice versa.

Also, the 500 Amps inrush current capability is not met. This requirement does not have to be met if the unit under test does not draw more inrush current than the AC source can deliver. Check your hardware specifications to determine the maximum current capability of the source you are using.

Note   *For 15003i users:* **Due to the three controller implementation of the 15003i, 4-11 tests run in three phase mode will not result in synchronized execution between phases when using the firmware option. To perform 4-11 tests with synchronized dips and interruptions on a 15003i, the IEC 1000-4-11 software implementation is used instead.**
The 15003iX uses a three phase controller and may be used for three phase IEC 1000-4-11 test applications.

IEC 1000-4-11 (Firmware option) Test Reports

At the end of a test run, the operator can generate a test report to the selected Windows printer by clicking on the "Print report" button. IEC 1000-4-11 test reports include all test setup information and test results. User provided information at the bottom of the 4-11 screen is included as well. A sample IEC 1000-4-11 test report is shown below.

```
California Instruments IEC 1000-4-11 (Firmware option) Test Report
---------------------------------------------------------------------
  Print Date           = 01-22-1998 15:46:30
  Program version      = AC Source GUI; 3.00 (Alpha) -  Jan 21, 1998
---------------------------------------------------------------------
IEC TEST SETUP
---------------------------------------------------------------------
  Selected test file   = DIP411.41D
  Selected test type   = Voltage Dips and Interruptions
  Test operator        = Test department
---------------------------------------------------------------------
TEST CONDITIONS:
---------------------------------------------------------------------
  Current Peak value   = Not tested.
  Nominal voltage (Un) = 230.00 Vrms.
  Equipment under test description :
  VGA Monitor
  User comment regarding this test :
  Model XFQ-414 serial nr 000345
---------------------------------------------------------------------
IEC TEST RESULT         = PASS
---------------------------------------------------------------------
  Time test started    = Thursday, January 22, 1998 3:39:47 PM
  Time test completed  = Thursday, January 22, 1998 3:40:32 PM


---------------------------------------------------------------------
TEST SEQUENCE EXECUTED:
```

```
----------------------------------------------------------------------
Dip to          No. of cycles    Start angle        Repeat        Delay
 (%)                (c)             (deg)            # times         (s)
----------------------------------------------------------------------
0                   .5              0                3             10
0                   .5              180              3             10
0                   1               0                1             10
0                   1               45               1             10
0                   1               90               1             10
0                   5               45               1             10
0                   5               90               1             10
0                   5               135              1             10
0                   10              90               1             10
0                   10              135              1             10
0                   10              180              1             10
0                   25              180              1             10
0                   25              225              1             10
0                   25              270              1             10
0                   50              270              1             10
0                   50              315              1             10
0                   50              0                1             10
40                  .5              0                3             10
40                  .5              180              3             10
40                  1               0                1             10
40                  1               45               1             10
40                  1               90               1             10
40                  5               45               1             10
40                  5               90               1             10
40                  5               135              1             10
40                  10              90               1             10
40                  10              135              1             10
40                  10              180              1             10
40                  25              180              1             10
40                  25              225              1             10
40                  25              270              1             10
40                  50              270              1             10
40                  50              315              1             10
40                  50              0                1             10
70                  .5              0                3             10
70                  .5              180              3             10
70                  1               0                1             10
70                  1               45               1             10
70                  1               90               1             10
70                  5               45               1             10
70                  5               90               1             10
70                  5               135              1             10
70                  10              90               1             10
70                  10              135              1             10
70                  10              180              1             10
70                  25              180              1             10
70                  25              225              1             10
70                  25              270              1             10
70                  50              270              1             10
70                  50              315              1             10
70                  50              0                1             10
----------------------------------------------------------------------
Program is AC Source GUI
Version is 3.00 -  Jan 21, 1998
======================================================================
```

7
IEC 1000-4-13 Frequency Harmonics and Interharmonics Immunity Test

The IEC 1000-4-13 implementation in the CIGUI is based on a first edition of the IEC 1000-4-13 standard. This test window is available only if the iX Series unit connected has the -413 option installed.

Test Setup
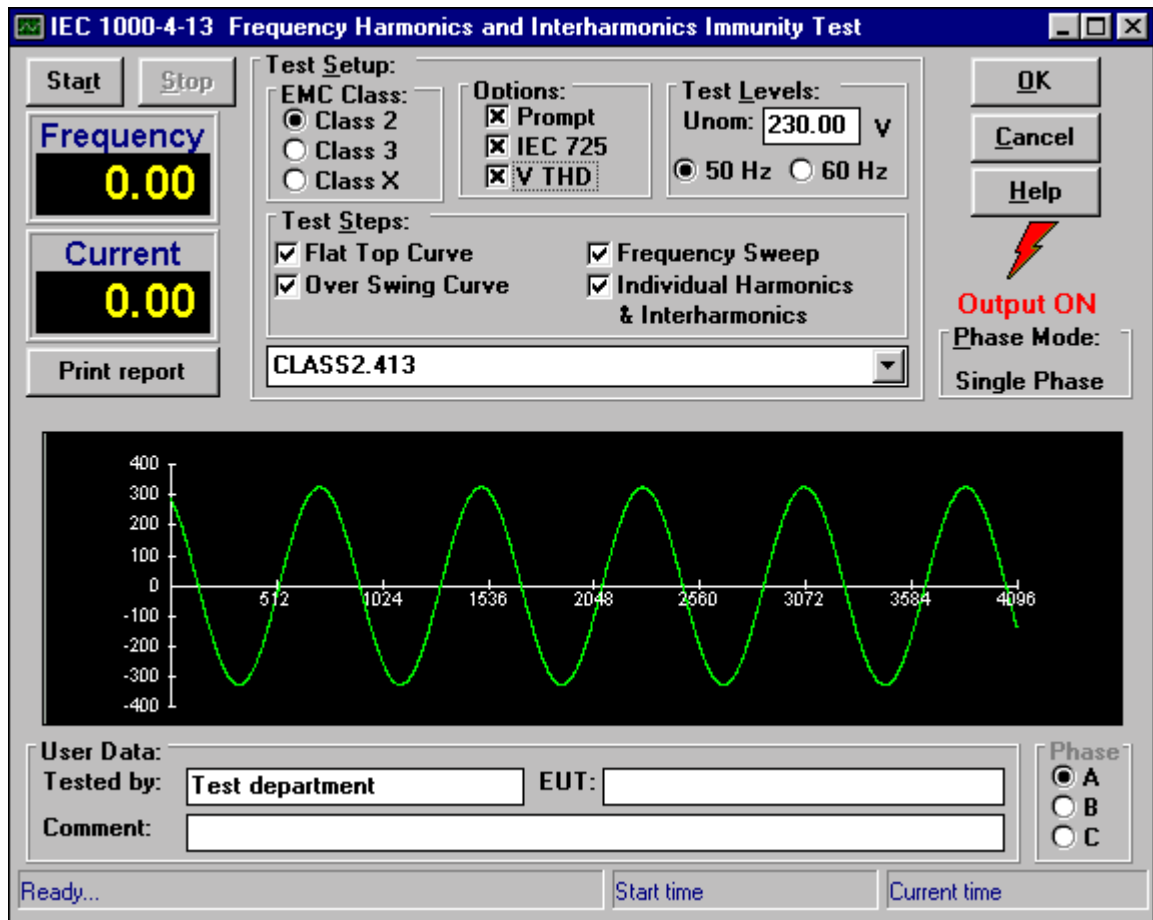
Figure 27: IEC 1000-4-13 Test Window

The following parameters and controls are available for executing the IEC 1000-4-13 test:

Nominal voltage	Opening this window will set this parameter to the present steady state voltage setting of the AC source. If required, a new value can be entered to be used during the test. At the end of the test, the AC source will remain at this voltage level. If needed, the program will switch the AC source to the high voltage range and close the output relay when the test is started.
Nominal frequency	The user can choose between 50 Hz or 60 Hz. At the end of the test, the AC source will remain at this frequency.
EMC Class	The Class level used is determined by the UUT class.
Options	- Prompt: stop after each test to let the user determine the state of the UUT.
	- IEC 725: program the Flicker impedance on the iX or use the external OMNI if installed.
	- V THD: Measure Volt Total Harmonic Distortion. The terminal voltage is monitored by the iX's measurement system prior to the test. The VTHD report will show results checked for limit. The user can print for viewing immediately. The same data will also be printed in the test report.
Phase Mode	The phase mode used is shown below the class selection. This mode cannot be changed from this window. To change phase mode, close this window and use the main front panel control window to select the desired phase mode first.
Start	Starts the IEC 1000-4-13 test using the parameters set by the user. Test progress is shown at the bottom of the window.
Abort	Aborts test in progress.

Test sequence

The IEC 1000-4-13 test suite consists of four types of tests:

Test type	Description
Flat top Curve	Simulates specific waveform at the nominal voltage and frequency
OverSwing Curve	Simulates specific waveform at the nominal voltage and frequency
Frequency Sweep	Simulates frequency swept or stepped at a rate no less than 5 minutes per decade
Individual harmonics & Interharmonics	Simulates sinusoidal voltage superimposed on the fundamental voltage for 5 second at each frequency in a range from 2X to 40X fundamental

The user must select the desired EMC Class and test type before executing the test. If choosing class X, the user can change any parameters using the IEC 1000-4-13 Editor form but the levels have to be at least as high as those for Class 2.

The total test time using the default dwell times called out in the .413 file is as follows:

- Flat Top Curve test: Dwell time = 120 sec
                                                 Pause time =   5 sec
- OverSwing Curve test: Dwell time = 120 sec
                                                 Pause time =   5 sec
- Frequency Sweep test: Dwell time = 300 sec (per decade) *2.5 = 750 sec
- Individual harmonics: Dwell time = 5 sec (per harmonic) * 40 = 200 sec
                                               Pause time = 1 sec (per harmonic * 40 = 40 sec
- Interharmonics: Dwell time = 5 sec (per harmonic) * 40 = 200 sec
                                               Pause time = 1 sec (per harmonic) * 40 = 40 sec

Total time = 1480 sec ~ 25 minutes.
The test can be aborted by clicking on the Abort button.

Figure 28: IEC 1000-4-13 Flow Chart
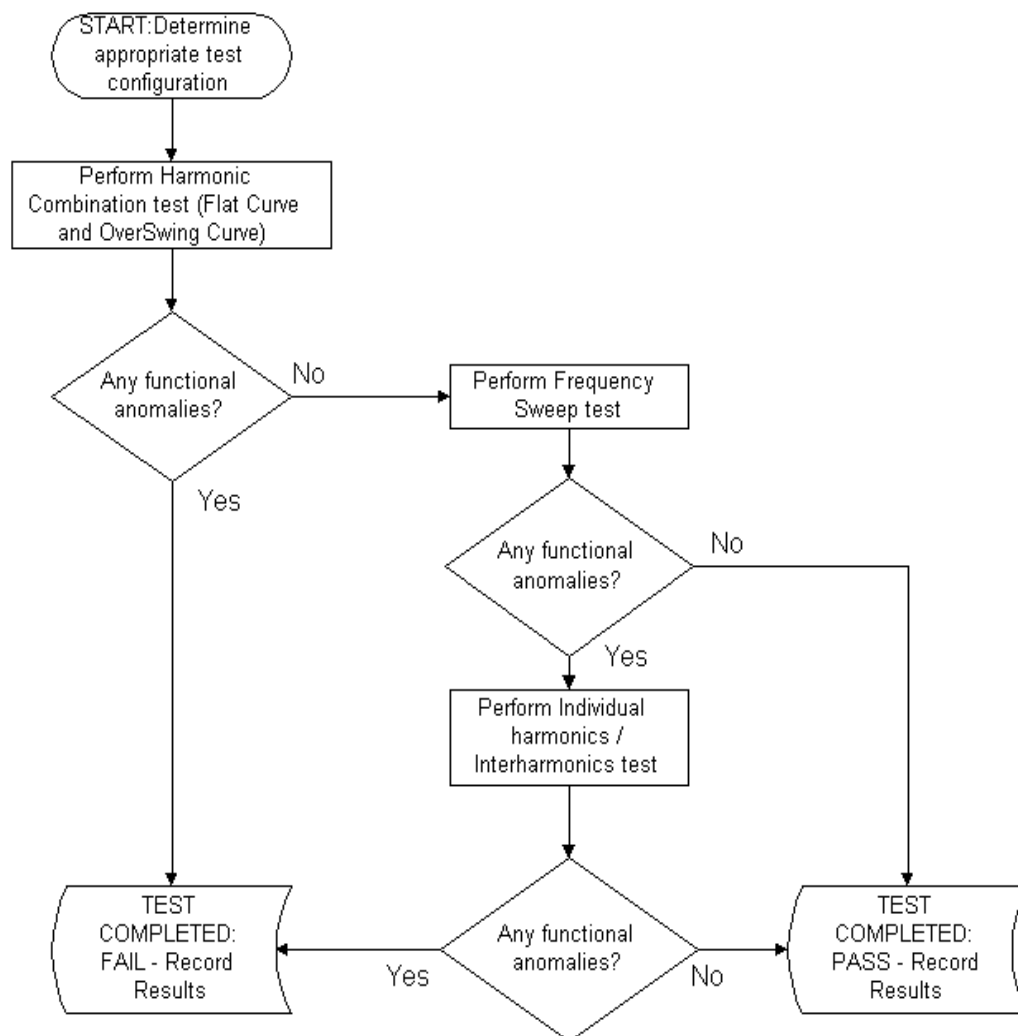
Test Flow Process

Once the required level changes and dwell times have been made using the Editor window, the user can save the file with the extension .413. When closing this form, the drop down list on the IEC 1000-4-13 form will include this file and the user can select it before starting the test.
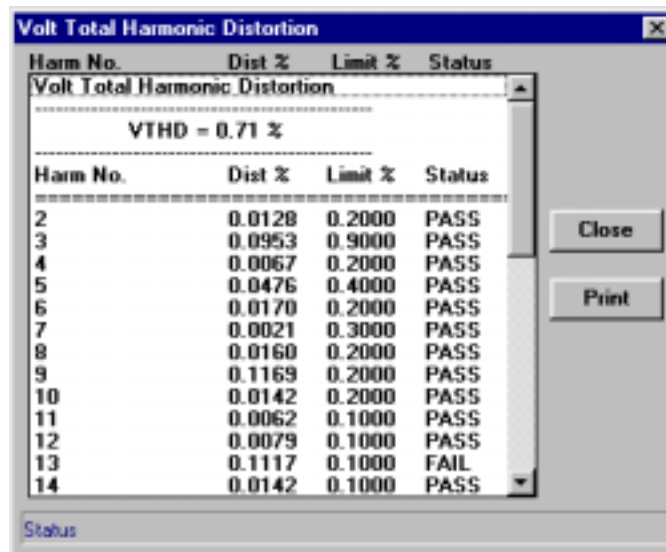
If the user has selected a different EMC Class than the default class 2 and has used the Editor form to change the Dwell time or any parameters, the following dialog box will appear to ask the user if the file selected is the correct one.
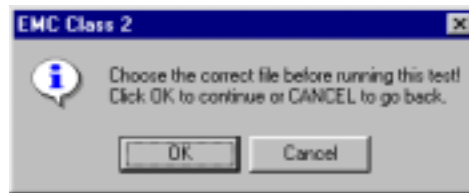
There are three .413 files distributed with the CIGUI program. The Class2.413 and Class3.413 files are read-only files and can not be edited or changed. These files contain all parameters which are determined by the product standard. When using the Editor to change the Dwell and Pause times for Class 2 or Class 3, the user has to save the file under a different name. The third file is IEC413.413 and this file has the same level as Class 3 specifications and can be edited and saved using the Editor.

- If the V THD (under Options) is checked, the CIGUI will perform a harmonic analysis of the voltage at the source terminals and check the results against the applicable limits. The following form will appear to let the user study the outcome or print the data for future reference.

Figure 29: IEC 1000-4-13 VTHD window

- After the Frequency Sweep test, if there are some resonant point(s), the display will show a graph of the current vs. the frequency data points. The following screen will also appear and let the user see the list of data points:
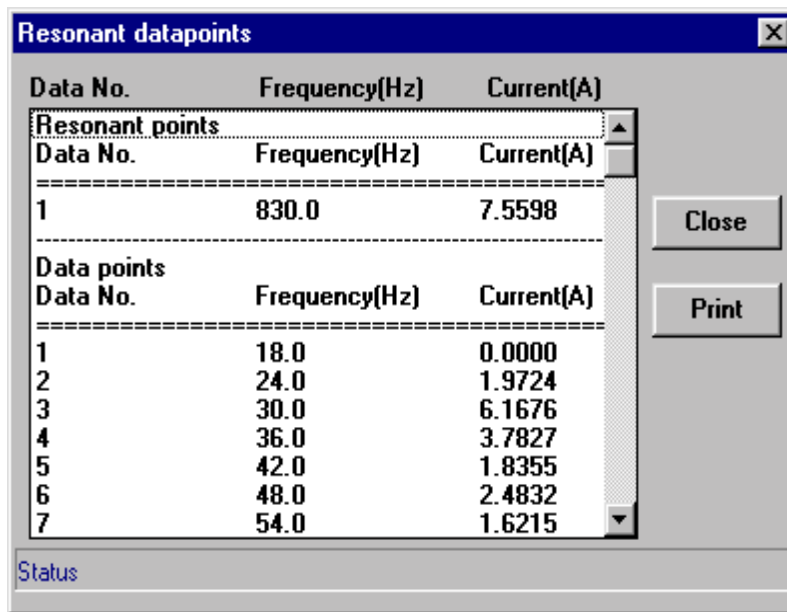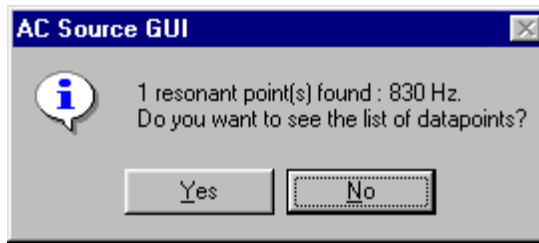
Figure 30: Resonant data points

Editor Window

Figure 31: IEC 1000-4-13/Class X Editor

- Class 2 & Class 3 (Dwell & Pause Time Change): For these two classes, the levels can not be changed and the user has no access to these areas. They are pre-defined by the IEC 1000-4-13 specification. The user can only change the Dwell time and the Pause time, but there still are limits on these values. If the values entered is lower than the limits, the CIGUI will let the user either RETRY the new value or CANCEL to restore the previous values when saving the file.
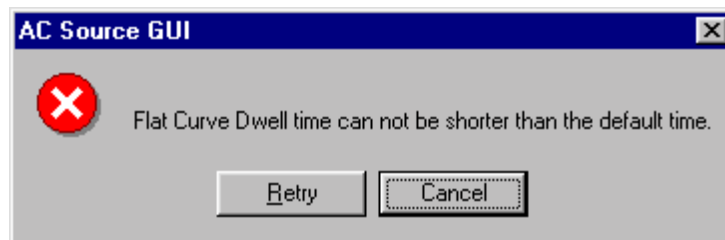
- Class X: This class defaults to the values defined for class 3 by the IEC 1000-4-13 specification. The user can change all values but they can not be lower than the levels of class 2. When saving the file, the Class2.413 file (class 2 default) will be loaded and compared with the entered values. If any of them is out of limit, the CIGUI will let the user RETRY the error values or CANCEL to restore the limit of class 3.

Test Results

There is no way for the CIGUI to determine the outcome of this test as a clear definition of a failure can not be given. The draft standard calls out the following possible test results:

> *"The test results shall be classified on the basis of the operating conditions and functional specifications of the equipment under test, as in the following, unless different specifications are given by product committees or product specifications.*
> *a) Normal performance within the specification limits*
> *b) Temporary degradation or loss of function or performance which is self-recoverable.*
> *c) Temporary degradation or loss of function or performance which requires operator intervention or system reset.*
> *d) Degradation or loss of function which is not recoverable due to damage of equipment (components) or software, or loss of data.*
> *As a general rule, the test result is positive if the equipment shows its immunity, for the duration of the application of the test, and at the end of the tests the EUT fulfills the functional requirements established in the technical specification."*

The user has to make this determination by observing the unit under test. At the end of the test, the GUI will pop up a dialog box asking the operator to assess the state of the EUT. If the EUT is still functional, the operator may answer Yes when prompted. If not, he should answer no. The response to this query is incorporated as a PASS or FAIL result in the test report.
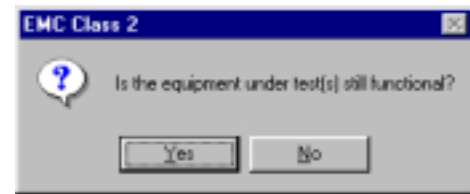
Measurements

During the test run, current is measured at regular intervals (every 20 seconds), the voltage waveform is also updated at the same interval except during the Frequency Sweep test at which time all measurements are disabled. This allows the user to determine if the EUT continues to operate. There may be effects on the EUT such as reboots or processor lockups that cannot be seen by observing the EUT load current. Frequency is not measured as it remains at the nominal frequency specified.

IEC 1000-4-13 Test Reports

At the end of a test run, the operator can generate a test report on the selected Windows printer by clicking on the "Print report" button. IEC 1000-4-13 test reports include all test setup information and test results. User provided information at the bottom of the 4-13 screen is included as well. A sample section of an IEC 1000-4-13 test report is shown below.

```
California Instruments IEC 1000-4-13 Test Report
-------------------------------------------------------------------------------
  Print Date           = 06-15-1998 10:50:38
  Program version      = AC Source GUI; 3.04 -  June 15, 1998
-------------------------------------------------------------------------------
IEC TEST SETUP
-------------------------------------------------------------------------------
  Selected test file   = Class2.413
  Selected test type   = EMC Class 2
  Selected test option =
             - User prompt
             - IEC 725
             - Volt Total Harmonic Distortion
```

```
  Test operator        = Test department
--------------------------------------------------------------------------------
TEST CONDITIONS:
--------------------------------------------------------------------------------
  Nominal voltage (Un) = 230.00 Vrms.
  Nominal freq. (Fn)   = 50.00 Hz.
  Equipment under test description :
  VGA Monitor
  User comment regarding this test :
  Model XFQ-414 serial nr 000345
--------------------------------------------------------------------------------
IEC TEST RESULT         = PASS
--------------------------------------------------------------------------------
  Time test started    = Tuesday, June 16, 1998, 1:09:38 PM
  Time test completed  = Tuesday, June 16, 1998, 1:27:52 PM
  Selected test step   =
                * Flat Top Curve Test     : PASS
                * Over Swing Curve Test    : PASS
                * Frequency Sweep Test     : PASS
                   Resonant frequency      : 830
                   Resonant current        : .21345
                * Ind. & Interharmonics    : PASS
--------------------------------------------------------------------------------
TEST SEQUENCE EXECUTED:
--------------------------------------------------------------------------------
[IEC-1000-4-13 / Class 2]
[Flat Curve test]
FCURV_LEV=90
FCURV_DWE=120
FCURV_PAU=5

[Over Swing Curve test]
OSWCURV_DWE=120
OSWCURV_PAU=5
OSWCURV3_LEV=6
OSWCURV3_PHS=180
OSWCURV5_LEV=4
OSWCURV5_PHS=0

[Sweep Frequency test]
SWEFREQ1_LEV=3
SWEFREQ2_LEV=10
SWEFREQ3_LEV=5
SWEFREQ4_LEV=5
SWEFREQ5_LEV=2
SWEFREQ_DWE=300
SWEFREQ1_STP=5
SWEFREQ2_STP=10
SWEFREQ3_STP=10
SWEFREQ4_STP=10
SWEFREQ5_STP=25

[Individual Harmonic test]
INDHARM2_LEV=3
INDHARM2_PHS=0
INDHARM3_LEV=8
INDHARM3_PHS=0
INDHARM4_LEV=1.5
INDHARM4_PHS=No test
INDHARM5_LEV=9
INDHARM5_PHS=0
INDHARM6_LEV=No test
INDHARM6_PHS=No test
INDHARM7_LEV=7.5
INDHARM7_PHS=0
INDHARM8_LEV=No test
INDHARM8_PHS=No test
INDHARM9_LEV=2.5
INDHARM9_PHS=No test
INDHARM10_LEV=No test
INDHARM10_PHS=No test
INDHARM11_LEV=5
INDHARM11_PHS=No test
INDHARM12_LEV=No test
INDHARM12_PHS=No test
```

```
INDHARM13_LEV=4.5
INDHARM13_PHS=No test
INDHARM14_LEV=No test
INDHARM14_PHS=No test
INDHARM15_LEV=No test
INDHARM15_PHS=No test
INDHARM16_LEV=No test
INDHARM16_PHS=No test
INDHARM17_LEV=3
INDHARM17_PHS=No test
INDHARM18_LEV=No test
INDHARM18_PHS=No test
INDHARM19_LEV=2
INDHARM19_PHS=No test
INDHARM20_LEV=No test
INDHARM20_PHS=No test
INDHARM21_LEV=No test
INDHARM21_PHS=No test
INDHARM22_LEV=No test
INDHARM22_PHS=No test
INDHARM23_LEV=2
INDHARM23_PHS=No test
INDHARM24_LEV=No test
INDHARM24_PHS=No test
INDHARM25_LEV=2
INDHARM25_PHS=No test
INDHARM26_LEV=No test
INDHARM26_PHS=No test
INDHARM27_LEV=No test
INDHARM27_PHS=No test
INDHARM28_LEV=No test
INDHARM28_PHS=No test
INDHARM29_LEV=1.5
INDHARM29_PHS=No test
INDHARM30_LEV=No test
INDHARM30_PHS=No test
INDHARM31_LEV=1.5
INDHARM31_PHS=No test
INDHARM32_LEV=No test
INDHARM32_PHS=No test
INDHARM33_LEV=No test
INDHARM33_PHS=No test
INDHARM34_LEV=No test
INDHARM34_PHS=No test
INDHARM35_LEV=1.5
INDHARM35_PHS=No test
INDHARM36_LEV=No test
INDHARM36_PHS=No test
INDHARM37_LEV=1.5
INDHARM37_PHS=No test
INDHARM38_LEV=No test
INDHARM38_PHS=No test
INDHARM39_LEV=No test
INDHARM39_PHS=No test
INDHARM40_LEV=No test
INDHARM40_PHS=No test
INDHARM_DWE=5
INDHARM_PAU=1

[Interharmonics test]
INTERHARM1_LEV=2.5
INTERHARM2_LEV=5
INTERHARM3_LEV=3.5
INTERHARM4_LEV=2
INTERHARM5_LEV=1.5
INTERHARM_DWE=5
INTERHARM_PAU=1
================================================================================
California Instruments IEC 1000-4-13 resonant Data Report
--------------------------------------------------------------------------------
            Resonant point(s) :
Data No.  Frequency (Hz)      Current (A)
--------------------------------------------------------------------------------
1             830             0.2311
--------------------------------------------------------------------------------
```

```
               Data Point(s) :
Data No.   Frequency (Hz)      Current (A)    |   Data No.  Frequency (Hz)   Current (A)
1              15.0              0.0000        |   77          670.0           6.5788
2              20.0              0.2340        |   78          680.0           5.5788
3              25.0              0.0000        |   79          690.0           5.0788
4              30.0              0.2340        |   80          700.0           4.8788
5              35.0              0.0000        |   81          710.0           6.5788
6              40.0              0.2340        |   82          720.0           5.5788
7              45.0              0.0000        |   83          730.0           5.0788
8              50.0              0.2340        |   84          740.0           4.8788
9              55.0              0.0000        |   85          750.0           6.5788
10             60.0              0.2340        |   86          750.0           5.5788
11             65.0              0.0000        |   87          760.0           5.0788
12             70.0              0.2340        |   88          770.0           4.8788
13             75.0              0.0000        |   89          780.0           6.5788
14             80.0              0.2340        |   90          790.0           5.5788
15             85.0              0.0000        |   91          800.0           5.0788
16             90.0              0.2340        |   92          810.0           4.8788
17             95.0              0.0000        |   93          820.0           6.5788
18            100.0              0.2340        |   94          830.0           5.5788
19            100.0              0.0000        |   95          840.0           5.0788
20            110.0              0.2340        |   96          850.0           4.8788
21            120.0              0.0000        |   97          860.0           6.5788
22            130.0              0.2340        |   98          870.0           5.5788
23            140.0              0.0000        |   99          880.0           5.0788
24            150.0              0.2340        |  100          890.0           4.8788
25            160.0              0.2340        |  101          900.0           5.5788
26            170.0              0.0000        |  102          910.0           5.0788
27            180.0              0.2340        |  103          920.0           4.8788
28            190.0              0.0000        |  104          930.0           6.5788
29            200.0              0.2340        |  105          940.0           5.5788
30            210.0              0.0000        |  106          950.0           5.0788
31            220.0              0.2340        |  107          960.0           4.8788
32            230.0              0.0000        |  108          970.0           6.5788
33            240.0              0.2340        |  109          980.0           5.5788
34            250.0              0.0000        |  110          990.0           5.0788
35            260.0              0.2340        |  111         1000.0           4.8788
36            270.0              0.0000        |  112         1000.0           6.5788
37            280.0              0.2340        |  113         1025.0           5.5788
38            290.0              0.0000        |  114         1050.0           5.0788
39            300.0              0.2340        |  115         1075.0           4.8788
40            310.0              0.2340        |  116         1100.0           4.8788
41            320.0              0.2340        |  117         1125.0           5.5788
42            330.0              0.0000        |  118         1150.0           5.0788
43            340.0              0.2340        |  119         1175.0           4.8788
44            350.0              0.0000        |  120         1200.0           6.5788
45            360.0              0.2340        |  121         1225.0           5.5788
46            370.0              0.0000        |  122         1250.0           5.0788
47            380.0              0.2340        |  123         1275.0           4.8788
48            390.0              0.0000        |  124         1300.0           6.5788
49            400.0              0.2340        |  125         1325.0           5.5788
50            410.0              0.0000        |  126         1350.0           5.0788
51            420.0              0.2340        |  127         1375.0           4.8788
52            430.0              0.0000        |  128         1400.0           6.5788
53            440.0              0.2340        |  129         1425.0           5.5788
54            450.0              0.0000        |  130         1450.0           5.0788
55            460.0              0.2340        |  131         1475.0           4.8788
56            470.0              0.2340        |  132         1500.0           4.8788
57            480.0              0.0000        |  133         1525.0           6.5788
58            490.0              0.2340        |  134         1550.0           5.5788
59            500.0              0.0000        |  135         1575.0           5.0788
60            500.0              0.2340        |  136         1600.0           4.8788
61            510.0              0.2340        |  137         1625.0           4.8788
62            520.0              0.2340        |  138         1650.0           5.5788
63            530.0              0.0000        |  139         1675.0           5.0788
64            540.0              0.2340        |  140         1700.0           4.8788
65            550.0              0.0000        |  141         1725.0           6.5788
66            560.0              0.2340        |  142         1750.0           5.5788
67            570.0              0.0000        |  143         1775.0           5.0788
68            580.0              0.2340        |  144         1800.0           4.8788
69            590.0              0.0000        |  145         1825.0           6.5788
70            600.0              0.2340        |  146         1850.0           5.5788
71            610.0              0.0000        |  147         1875.0           5.0788
72            620.0              0.2340        |  148         1900.0           4.8788
73            630.0              0.0000        |  149         1925.0           6.5788
```

```
74              640.0          0.2340      | 150     1950.0      5.5788
75              650.0          0.0000      | 151     1975.0      5.0788
76              660.0          0.2340      | 152     2000.0      4.8788
===============================================================================
California Instruments IEC 1000-4-13 / Harmonic Distortion Report
-------------------------------------------------------------------------------
Volt Total harmonic distortion = 0.02 %
-------------------------------------------------------------------------------
Harm No.            Dist %          Limit %         Status
-------------------------------------------------------------------------------
2                   0.1980          0.2000          PASS
3                   0.7980          0.9000          PASS
4                   0.1020          0.2000          PASS
5                   0.2980          0.4000          PASS
6                   0.0080          0.2000          PASS
7                   0.1280          0.3000          PASS
8                   0.1020          0.2000          PASS
9                   0.0380          0.2000          PASS
10                  0.1380          0.2000          PASS
11                  0.0880          0.1000          PASS
12                  0.0020          0.1000          PASS
13                  0.0090          0.1000          PASS
14                  0.0080          0.1000          PASS
15                  0.0280          0.1000          PASS
16                  0.0020          0.1000          PASS
17                  0.0380          0.1000          PASS
18                  0.0880          0.1000          PASS
19                  0.0020          0.1000          PASS
20                  0.0090          0.1000          PASS
21                  0.0080          0.1000          PASS
22                  0.0280          0.1000          PASS
23                  0.0020          0.1000          PASS
24                  0.0380          0.1000          PASS
25                  0.0880          0.1000          PASS
26                  0.0020          0.1000          PASS
27                  0.0090          0.1000          PASS
28                  0.0080          0.1000          PASS
29                  0.0280          0.1000          PASS
30                  0.0020          0.1000          PASS
31                  0.0380          0.1000          PASS
32                  0.0280          0.1000          PASS
33                  0.0020          0.1000          PASS
34                  0.0380          0.1000          PASS
35                  0.0880          0.1000          PASS
36                  0.0020          0.1000          PASS
37                  0.0090          0.1000          PASS
38                  0.0080          0.1000          PASS
39                  0.0280          0.1000          PASS
40                  0.0020          0.1000          PASS
===============================================================================
Program is AC Source GUI
Version is 3.04 -  June 15, 1998
```

8
Voltage Fluctuations Immunity Testing

About This Chapter

This chapters covers testing a device for compliance with the IEC 1000-4-14 Voltage Fluctuations test standard. This test is supported through the CIGUI AC source control program. If you purchased a 100-CTS or 300-CTS test system which does not include a California Instruments AC source, you will not be able to perform these tests.

IEC 1000-4-14 Voltage Fluctuations Immunity Test

Figure 32: IEC 1000-4-14 Test Window
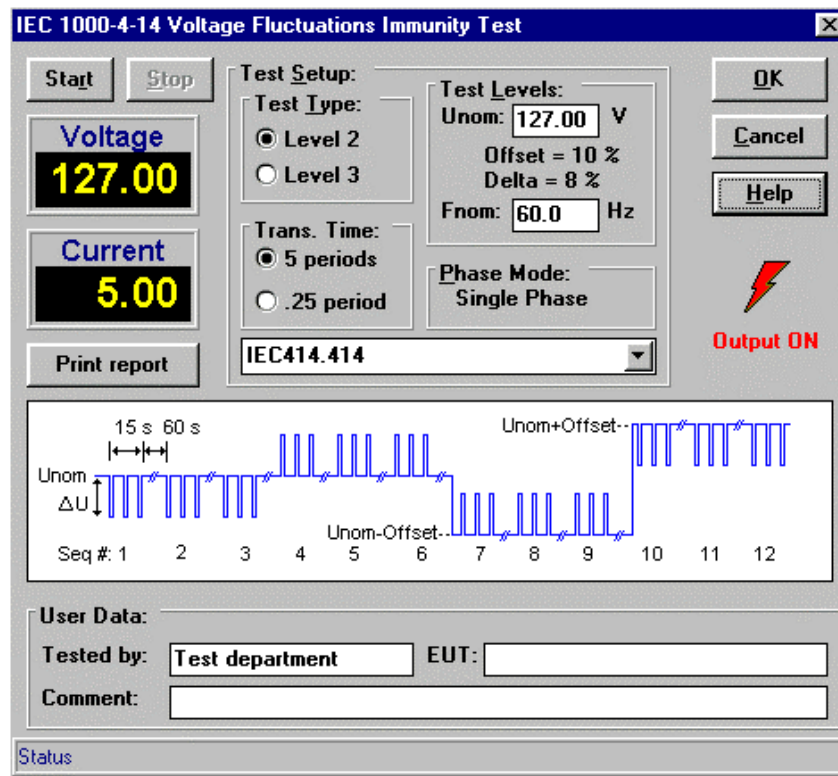
The IEC 1000-4-14 implementation in the CIGUI is based on a draft version of the IEC 1000-4-14 standard dated March 15, 1996. Changes to this draft are possible before it becomes an official standard. This test is offered as a convenience at this time. Once the draft becomes an official standard, registered users will be able to upgrade the CIGUI software. In the meantime, test parameters can be changed if needed through use of .414 test setup files. These files have a .414 extension and use the Windows INI file structure. More than one .414 file may reside in the working directory. The GUI will display a dropdown box with all .414 test files available so the operator may choose the one to run.

Test Setup

The following parameters and controls are available for executing the IEC 1000-4-14 test:

Nominal voltage   Opening this window will set this parameter to the present steady state voltage setting of the AC source. If required, a new value can be entered to be used during the test. At the end of the test, the AC source will remain at this voltage level. If needed, the program will switch the AC source to the high voltage range and close the output relay when the test is started.

Nominal frequency   Opening this window will set this parameter to the present steady state frequency setting of the AC source. If required, a new value can be entered to be used during the test. At the end of the test, the AC source will remain at this frequency.

EUT Class   The test levels used is determined by the EUT class. The levels used are shown below the nominal voltage data entry box.

Phase Mode   The phase mode used is shown below the class selection. This mode cannot be changed from this window. To change phase mode, close this window and use the main front panel control window to select the desired phase mode first.

Run   Starts the IEC 1000-4-14 test using the parameters set by the user. Test progress is shown at the bottom of the window. The sequence numbers shown correspond to those in the illustration.

Abort   Aborts test in progress.

Test Sequence

The test sequence implemented by this test consists of a series of voltage fluctuations consistent with commonly found phenomena on the public utility power grid. The objective of this test is to evaluate a product for immunity from such fluctuations. Fluctuations are repeated 3 times (specified by SeqRepeat) and last for 5 seconds each. (specified by SeqDuration). Each fluctuations consists of stepping the voltage up or down in five steps of one signal period each (20 msec for 50 Hz, 16.6 ms for 60 Hz) and holding the voltage at this altered level for a 2 second period and stepping it back up or down to its nominal value. This sequence is repeated 3 times and thus takes 3 * 5 = 15 seconds.

There are two type of tests:

1/ Voltage fluctuation for 5 periods:

Fluctuations are repeated 3 times (specified by SeqRepeat) and last for 5 seconds each (specified by SeqDuration). Each fluctuation consists of stepping the voltage up or down in five steps of one signal period each (20 msec for 50 Hz, 16.6 ms for 60 Hz) and holding the voltage at this altered level for a 2 second period and stepping it back up or down to its nominal value. This sequence is repeated 3 times and thus takes 3 * 5 = 15 seconds.

Figure 33: IEC 1000-4-14 Voltage fluctuation specification

A time delay of 60 seconds (specified by InterSeqDelay) is inserted between each sequence of voltage fluctuations. Each sequence is run three times. Voltage is changed both up and down from the nominal value. Next, the nominal voltage is changed by subtracting an offset (specified by Offset) and a positive delta voltage sequence is ran three times again. Finally, the nominal
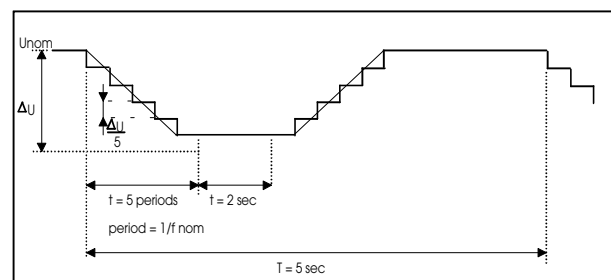
voltage is changed by adding the offset value and a negative delta voltage sequence is ran three times. This results in a total of 12 sequences as shown in the diagram. The total test time using the default test parameters called out in the draft specification equals 12 * 75 sec = 15 minutes. The test can be aborted by clicking on the Abort button.

2/ Voltage fluctuation for .25 period:

Fluctuations are repeated 3 times (specified by SeqRepeat) and last for 5 seconds each (specified by SeqDuration). Each fluctuation consists of stepping the voltage up or down for .25 period at 90 degree angle and holding the voltage at this altered level for 2 second period and stepping it back up or down to its nominal value. This sequence is repeated 3 times and thus takes 3 * 5 = 15 seconds.

A time delay of 60 seconds (specified by InterSeqDelay) is inserted between each sequence of voltage fluctuations. Each sequence is run three times. Voltage is changed both up and down from the nominal value. Next, the nominal voltage is changed by subtracting an offset (specified by Offset) and a positive delta voltage sequence is ran three times again. Finally, the nominal voltage is changed by adding the offset value and a negative delta voltage sequence is ran three times. This results in a total of 12 sequences as shown in the diagram. The total test time using the default test parameters called out in the draft specification equals 12 * 75 sec = 15 minutes. The test can be aborted by clicking on the Abort button.

Test Results

There is no way for the CIGUI to determine the outcome of this test as a clear definition of a failure can not be given. The draft standard called out the following possible test results:

> *"The test results shall be classified on the basis of the operating conditions and functional specifications of the equipment under test, as in the following, unless different specifications are given by product committees or product specifications.*
> *a) Normal performance within the specification limits*
> *b) Temporary degradation or loss of function or performance which is self-recoverable.*
> *c) Temporary degradation or loss of function or performance which requires operator intervention or system reset.*
> *d) Degradation or loss of function which is not recoverable due to damage of equipment (components) or software, or loss of data.*
> *As a general rule, the test result is positive if the equipment shows its immunity, for the duration of the application of the test, and at the end of the tests the EUT fulfills the functional requirements established in the technical specification."*

The user has to make this determination by observing the unit under test.

Report Format- 414 Test Files

The 414 test module produces a test report that is sent to a printer when the Print Report button is clicked.
A sample test report follows.

```
California Instruments IEC 1000-4-14 Test Report


--------------------------------------------------------------------------------
 Print Date          = 04-10-1998 16:07:33
 Program version     = AC Source GUI; 3.01  -  March 6, 1998
--------------------------------------------------------------------------------
IEC TEST RESULT       = PASS
--------------------------------------------------------------------------------
```

```
Time test started   = Friday, April 10, 1998 4:03:05 PM
Time test completed = Friday, April 10, 1998 4:06:34 PM
Selected test file  = IEC414.414
Selected test type  = Level 1 Test
Test operator       = Test department
------------------------------------------------------------------------------
TEST CONDITIONS:
------------------------------------------------------------------------------
 Nominal voltage (Un) = 230.00 V rms.
 Nominal freq. (Fn)   = 50.00 Hz.
 Equipment under test description :
 1001P
 User comment regarding this test :
 89% Load
------------------------------------------------------------------------------
TEST SEQUENCE EXECUTED:
------------------------------------------------------------------------------
[IEC-1000-4-14]
SeqRepeat = 3
SeqDuration = 5
InterSeqDelay = 6
MeasUpdateRate = 1000
DeltaLevel1 = 8
DeltaLevel2 = 12
Offset = 10
------------------------------------------------------------------------------
Program is AC Source GUI
Version is 3.01  -  March 6, 1998
```

Measurements

During the test run, both voltage and current are measured at regular intervals (specified by the MeasUpdateRate parameter). This allows the user to determine if the EUT continues to operate. There may be effects on the EUT such as reboots or processor lockups that cannot be seen by observing the EUT load current. Frequency is not measured as it remains at the nominal frequency specified.

9
Frequency Variations Immunity Testing

About This Chapter

This chapters covers testing a device for compliance with the IEC 1000-4-28 Frequency Variations test standard. This test is supported through the CIGUI AC source control program. If you purchased a 100-CTS or 300-CTS test system which does not include a California Instruments AC source, you will not be able to perform these tests.

IEC 1000-4-28 Frequency Variations Immunity Test

Figure 34: IEC 1000-4-28 Test window
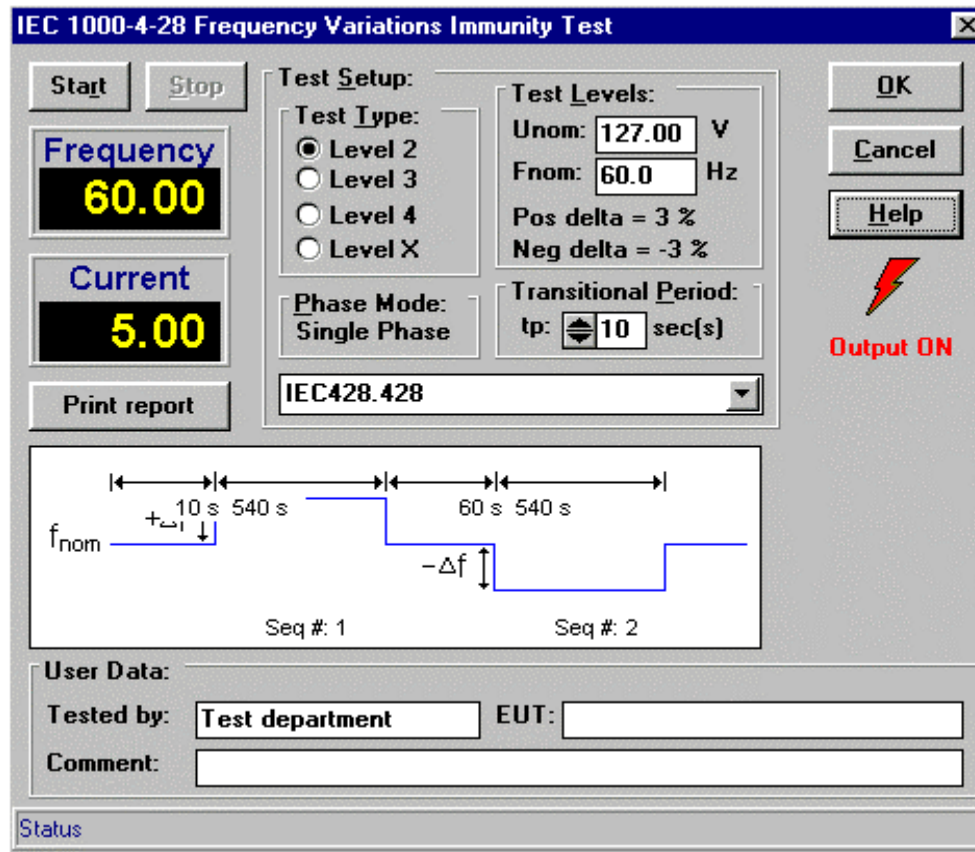
The IEC 1000-4-28 implementation in the CIGUI is based on a draft version of the IEC 1000-4-28 standard dated March 15, 1996. Changes to this draft are possible before it becomes an official standard. This test is offered as a convenience at this time. Once the draft becomes an official standard, registered users will be able to upgrade the CIGUI software. In the meantime, test parameters can be changed if needed through use of .428 test setup files. These files have a .428 extension and use the Windows INI file structure. More than one .428 file may reside in the working directory. The GUI will display a dropdown box with all .428 test files available so the operator may choose the one to run.

Test Setup

The following parameters and controls are available for executing the IEC 1000-4-28 test:

Nominal voltage	Opening this window will set this parameter to the present steady state voltage setting of the AC source. If required, a new value can be entered to be used during the test. At the end of the test, the AC source will remain at this voltage level. If needed, the program will switch the AC source to the high voltage range and close the output relay when the test is started.
Nominal frequency	Opening this window will set this parameter to the present steady state frequency setting of the AC source. If required, a new value can be entered to be used during the test. At the end of the test, the AC source will remain at this frequency.
EUT Class	The test levels used is determined by the EUT class. The levels used are shown below the nominal frequency data entry box.
Phase Mode	The phase mode used is shown below the class selection. This mode cannot be changed from this window. To change phase mode, close this window and use the main front panel control window to select the desired phase mode first.
Run	Starts the IEC 1000-4-28 test using the parameters set by the user. Test progress is shown at the bottom of the window. The sequence numbers shown correspond to those in the illustration.
Abort	Aborts test in progress.

Test sequence

Frequency variations are applied at different levels for different product categories. The user must determine the product class and select the appropriate test level. During the test run, frequency changes are applied at a specific phase angle of the waveform (specified by the StartAngle parameter, default = 0 degrees). Variations are repeated 3 times (specified by SeqRepeat). Each variation consists of stepping the frequency up or down in the transitional period given. A transitional period for level 2 & 3 is 10 seconds from the nominal frequency to the test frequency, for level 4 is 1 second. User can change the transitional period for level X from 1 to 60 seconds. The default transitional period for level X will be 1 second. After the frequency reaches their test level it will stay for 120 seconds (specified by SeqDuration). A delay of 60 seconds (specified by InterSeqDelay) is inserted between each variation and between the up and the down shift sequence. This is illustrated by the figure. Test levels are determined by the IEC4xx.4xx file. If no such file is found, all class levels are set to +3% and -3%. The time of the test consists of:

((Transitional period + 120 seconds hold + Transitional period + 60 seconds delay) * 3 times) * 2 sequences) ~ 20 minutes.

Test Results

There is no way for the CIGUI to determine the outcome of this test as a clear definition of a failure can not be given. The draft standard called out the following possible test results:

> *"The test results shall be classified on the basis of the operating conditions and functional specifications of the equipment under test, as in the following, unless different specifications are given by product committees or product specifications.*
> *a) Normal performance within the specification limits*
> *b) Temporary degradation or loss of function or performance which is self-recoverable.*
> *c) Temporary degradation or loss of function or performance which requires operator intervention or system reset.*
> *d) Degradation or loss of function which is not recoverable due to damage of equipment (components) or software, or loss of data.*
> *As a general rule, the test result is positive if the equipment shows its immunity, for the duration of the application of the test, and at the end of the tests the EUT fulfills the functional requirements established in the technical specification."*

The user has to make this determination by observing the unit under test.

Report Format- 428 Test Files

The 428 test module produces a test report that is sent to a printer when the Print Report button is clicked.
A sample test report follows.

```
California Instruments IEC 1000-4-28 Test Report-----------------------------------------------------------------
---
 Print Date        = 03-19-1998 15:38:51
 Program version      = AC Source GUI; 3.01  -  March 6, 1998
-----------------------------------------------------------------------------
IEC TEST RESULT       = PASS
-----------------------------------------------------------------------------
 Time test started    = Thursday, March 19, 1998 3:37:42 PM
 Time test completed  = Thursday, March 19, 1998 3:38:27 PM
 Selected test file   = IEC428.428
 Selected test type   = Level 1 Test
 Test operator        = Test department
-----------------------------------------------------------------------------
TEST CONDITIONS:
-----------------------------------------------------------------------------
 Nominal voltage (Un) = 230.00 V rms.
 Nominal freq. (Fn)   = 50.0 Hz.
 Equipment under test description :
 3001iX
 User comment regarding this test :   EUT fully loaded
-----------------------------------------------------------------------------------------------------------
TEST SEQUENCE EXECUTED
-----------------------------------------------------------------------------------------------------------
[IEC-1000-4-28]
SeqRepeat = 1
SeqDuration = 6
InterSeqDelay = 12
StartAngle = 0
MeasUpdateRate = 1000
```

```
TransitionalPeriod1 = 10
TransitionalPeriod2 = 1
PosDeltaLevel1 = 3
NegDeltaLevel1 = -3
PosDeltaLevel2 = 4
NegDeltaLevel2 = -6
PosDeltaLevel3 = 15
NegDeltaLevel3 = -15
PosDeltaLevel4 = 20
NegDeltaLevel4 = -20
-----------------------------------------------------------------------------------
Program is AC Source GUI
Version is 3.01  -   March 6,  1998
==================================================
```

Measurements

During the test run, both frequency and current are measured at regular intervals (specified by the MeasUpdateRate parameter). This only occurs during the delay period between successive frequency changes. Thus, once a transient program is started to change frequency at the specified phase angle, no frequency or current measurements are performed during this period. The programmed frequency is shown instead.

At the end of the test, the user must determine if the EUT continues to operate. There may be effects on the EUT such as reboots or processor lockups that cannot be seen by observing the EUT load current. Voltage is not measured as it remains at the nominal voltage specified.

10
Customizing IEC 1000-4 Test Parameters

About This Chapter

This chapters covers describes how to modify aspects of IEC 1000-4 immunity testing to accommodate different product committee requirements.

Both the IEC 1000-4-14 and IEC 1000-4-28 tests implemented in the CIGUI program are based on drafts of the actual standard. This implies that changes to these tests are possible before they become final. To allow for some level of customization, the CIGUI will accept different test parameters that can be edited by the user. Also, the IEC 1000-4-11 test is an official standard but different test levels are allowed for various product categories. Since these test levels are set by product committees, they are not hard coded into the CIGUI, instead, test setup files are provided that the user can modify to accommodate changing test requirements.

IEC 1000-4 Test File Defaults

Three test files are used in the CIGUI program, they are: *filename*.411 for the IEC1000-4-11 test, *filename*.414 for the IEC1000-4-414 test and *filename*.428 for the IEC1000-4-28 test. These files can be edited to create additional test formats if needed. Three setup files are included with the CIGUI but bear in mind that these files can be changed by the user to cover multiple EUTs. The defaults in the setup files shown below are currently provided in the CIGUI and are based on IEC draft standards dated March 15, 1996.

IEC411.411 File

[IEC-1000-4-11]	IEC 1000-4-11 section header
	Parameters that apply to both Dips and Variations
SeqRepeat = 3	Number of times each voltage fluctuation is repeated. Range 1 to 60.
SeqDuration = 10	Time between successive dips and variations. The standard specifies this time to be no less than 10 seconds.
InterSeqDelay = 1	Time between each run of dips or variations. This time should be at least 1 second and no more than 60 seconds.
UserPromt=	"User intervention required. Press OK when ready to continue"*(message displayed when GapDelay0 <0)*
MeasUpdateRate = 1000	Interval for updating measurement data in milliseconds. Range 100 to 60000 milliseconds.
	Parameters that apply only to Voltage Dips
SeqNumberDips = 21	Number of sets of dips. Each set consists of SeqRepeat dips. Each set has its own set of three parameters which follow. each parameter has a sequence number from 0 through SeqNumberDips-1. They do not have to be entered in any order.
CycleTime0 = 0.5	For each set number 0 through SeqNumberDips-1, the duration of the dip in AC cycles.
StartPhase0 = 0	For each set number 0 through SeqNumberDips-1, the start phase angle of the dip
TestLevel0 = 0	For each set number 0 through SeqNumberDips-1, the voltage level to dip to in % of U nominal
GapDelay0=-1	-1 sets the user prompt. If >0 it sets the delay between dips.
	Parameters that apply to Voltage Variations
FallTimeVar = 2	Voltage fall time in seconds. Must be between 1 and 999 seconds
HoldTimeVar = 1	Voltage hold time in seconds. Must be between 1 and 999 seconds
RiseTimeVar = 2	Voltage rise time in seconds. Must be between 1 and 999 seconds

VarLevel0 = 40   First voltage level to change to in percent of U nominal
VarLevel1 = 0   Second voltage level to change to in percent of U nominal

Note on user prompt: Some EUT will require resetting and readjustment when the power dips or is interrupted for a long period. If this is the case, then set GapDelay0 = -1. This will cause the test sequence to halt and wait for user intervention. When ready to resume test press "OK".

IEC413.413 File

[IEC-1000-4-13]	**IEC 1000-4-13 section header**
	Parameters that apply only to Flat Top Curve
Fcurv_lev = 90	Flat Curve Level at 90%
Fcurv_dwe = 120	Flat Curve Dwell time in seconds
Fcurv_pau = 5	Flat Curve Pause in seconds
	Parameters that apply only to Over Swing Curve
Oswcurv_dwe = 120	Over Swing Curve Dwell time in seconds
Oswcurv_pau = 5	Over Swing Curve Pause in seconds
Oswcurv3_lev = 6	Over Swing Curve of third harmonic level at 6%
Oswcurv3_phs = 180	Over Swing Curve of third harmonic phase test of 180 degrees
Oswcurv5_lev = 4	Over Swing Curve of fifth harmonic level at 4%
Oswcurv5_phs = 0	Over Swing Curve of fifth harmonic phase test of 0 degree
	Parameters that apply to Frequency Sweep
Swefreq1_lev = 3	Sweep Frequency Level of first range at 3%
Swefreq2_lev = 10	Sweep Frequency Level of second range at 10%
Swefreq3_lev = 5	Sweep Frequency Level of third range at 5%
Swefreq4_lev = 5	Sweep Frequency Level of fourth range at 5%
Swefreq5_lev = 2	Sweep Frequency Level of fifth range at 2%
Swefreq_dwe = 300	Sweep Frequency Dwell time in seconds
Swefreq1_stp = 5	Sweep Frequency Step size of first range in Hz
Swefreq2_stp = 10	Sweep Frequency Step size of second range in Hz
Swefreq3_stp = 10	Sweep Frequency Step size of third range in Hz
Swefreq4_stp = 10	Sweep Frequency Step size of fourth range in Hz
Swefreq5_stp = 25	Sweep Frequency Step size of fifth range in Hz
	Parameters that apply only to Individual Harmonics
Indharm2_lev = 3	Individual harmonics Level for nth (second) harmonic in %
Indharm2_phs = 0	Individual harmonics Phase for nth (second) harmonic in degree
Indharm_dwe = 5	Individual harmonics Dwell time in second
Indharm_pau = 5	Individual harmonics Pause in second
	Parameters that apply only to Interharmonics
Interharm1_lev = 2.5	Interharmonics Level for first range at 2.5%
Interharm2_lev = 5	Interharmonics Level for second range at 5%
Interharm3_lev = 3.5	Interharmonics Level for third range at 3.5%
Interharm4_lev = 2	Interharmonics Level for fourth range at 2%
Interharm5_lev = 1.5	Interharmonics Level for fifth range at 1.5%
Interharm_dwe = 5	Interharmonics Dwell time in second
Interharm_pau = 1	Interharmonics Pause in second

IEC414.414 File

[IEC-1000-4-14]	IEC 1000-4-14 section header
SeqRepeat = 3	Number of times each voltage fluctuation is repeated. Range 1 to 60.
SeqDuration = 5	Sequence duration in seconds. Number of repeats must be set to not exceed the SeqDuration time. Each repeat is at least 10 periods of the AC signal or 200 ms for 50 Hz and 167 ms for 60 Hz. Range is based on SeqRepeat value. Product of SeqRepeat and SeqDuration must be between 1 and 60.
InterSeqDelay = 6	Time between successive runs in seconds. Range 1 to 60 sec
MeasUpdateRate = 1000	Interval for updating measurement data in milliseconds. Range 100 to 60000 milliseconds.
DeltaLevel1 = 8	Voltage change in % for Level 1 class product test. Range 0 to 100 %
DeltaLevel2 = 12	Voltage change in % for Level 2 class product test. Range 0 to 100 %
Offset = 10	Nominal voltage offset in %. Range 0 to 100 %.

IEC428.428 File

[IEC-1000-4-28]	IEC 1000-4-28 section header
SeqRepeat = 1	Number of times each the frequency variation is repeated. Range 1 to 60
SeqDuration = 6	Sequence duration in seconds. Range is based on SeqRepeat value. Product of SeqRepeat and SeqDuration must be between 1 and 60.
InterSeqDelay = 12	Time between successive frequency variations.
StartAngle = 0	Start phase angle for frequency variation. Range is ± 360 degrees with 1 degree resolution.
MeasUpdateRate = 1000	Interval for updating measurement data in milliseconds. Range 100 to 60000 milliseconds.
TransitionalPeriod1 = 10	Slew rate for frequency variation. This value is default for level 2 and level 3.
TransitionalPeriod2 = 1	Slew rate for frequency variation. This value is default for level 4 and level X.
PosDeltaLevel1 = 3	Positive Frequency change value for Level 1 class products. Range 0 to 100 %.
NegDeltaLevel1 = -3	Negative Frequency change value for Level 1 class products. Range 0 to -68 %. The -68 % level is set to avoid frequencies below 16 Hz when fnom = 50 Hz. 16 Hz is lower frequency limit for most AC sources.
PosDeltaLevel2 = 4	Positive Frequency change value for Level 2 class products. Range 0 to 100 %.
NegDeltaLevel2 = -6	Negative Frequency change value for Level 2 class products. Range 0 to -68 %.
PosDeltaLevel3 = 15	Positive Frequency change value for Level 3 class products. Range 0 to 100 %.
NegDeltaLevel3 = -15	Negative Frequency change value for Level 3 class products. Range 0 to -68 %.
PosDeltaLevel4 = 20	Positive Frequency change value for user Level class products. Range 0 to 100 %.
NegDeltaLevel4 = -20	Negative Frequency change value for user Level class products. Range 0 to -68 %.

Sample File IEC411.411

Following is a listing of the default IEC411.411 file shipped with the CIGUI program. If for some reason your 411 file is lost or you would like to restore it to its original condition, use the values shown here.

[IEC-1000-4-11]

PreTest = 3

SeqRepeat = 3

SeqDuration = 10

InterSeqDelay = 1

UserPrompt = User intervention required. Press OK when ready to continue

SeqNumberDips = 21

MeasUpdateRate = 1000

CycleTime0 = 0.5

StartPhase0 = 0

TestLevel0 = 0

GapDelay0 = 2

CycleTime1 = 0.5

StartPhase1 = 180

TestLevel1 = 0

GapDelay1 = 2

CycleTime2 = 1

StartPhase2 = 0

TestLevel2 = 0

GapDelay2 = 5

CycleTime3 = 5

StartPhase3 = 0

TestLevel3 = 0

GapDelay3 = 2

CycleTime4 = 10

StartPhase4 = 0

TestLevel4 = 0

GapDelay4 = 2

CycleTime5 = 25

StartPhase5 = 0

TestLevel5 = 0

GapDelay5 = 2

CycleTime6 = 50

StartPhase6 = 0

TestLevel6 = 0

GapDelay6 = 2

CycleTime7 = 0.5

StartPhase7 = 0

TestLevel7 = 40

GapDelay7 = 2

CycleTime8 = 0.5

StartPhase8 = 180

TestLevel8 = 40

GapDelay8 = 2

CycleTime9 = 1

StartPhase9 = 0

TestLevel9 = 40

GapDelay9 = 2

CycleTime10 = 5

StartPhase10 = 0

TestLevel10 = 40

CycleTime11 = 10

StartPhase11 = 0

TestLevel11 = 40

CycleTime12 = 25

StartPhase12 = 0

TestLevel12 = 40

CycleTime13 = 50

StartPhase13 = 0

TestLevel13 = 40

CycleTime14 = 0.5

StartPhase14 = 0

TestLevel14 = 70

CycleTime15 = 0.5

StartPhase15 = 180

TestLevel15 = 70

CycleTime16 = 1

StartPhase16 = 0

TestLevel16 = 70

CycleTime17 = 5

StartPhase17 = 0

TestLevel17 = 70

CycleTime18 = 10

StartPhase18 = 0

TestLevel18 = 70

CycleTime19 = 25

StartPhase19 = 0

TestLevel19 = 70

CycleTime20 = 50

StartPhase20 = 0

TestLevel20 = 70

FallTimeVar = 2

HoldTimeVar = 1

RiseTimeVar = 2

VarLevel0 = 40

VarLevel1 = 0

Sample File IEC413.413

Following is a listing of the default IEC411.413 file shipped with the CIGUI program. If for some reason your 413 file is lost or you would like to restore it to its original condition, use the values shown here.

[IEC-1000-4-13 / Class 2]

[Flat Curve test]
FCURV_LEV=90
FCURV_DWE=120
FCURV_PAU=5

[Over Swing Curve test]
OSWCURV_DWE=120
OSWCURV_PAU=5
OSWCURV3_LEV=6
OSWCURV3_PHS=180
OSWCURV5_LEV=4
OSWCURV5_PHS=0

[Sweep Frequency test]
SWEFREQ1_LEV=3
SWEFREQ2_LEV=10
SWEFREQ3_LEV=5
SWEFREQ4_LEV=5
SWEFREQ5_LEV=2
SWEFREQ_DWE=300
SWEFREQ1_STP=5
SWEFREQ2_STP=10
SWEFREQ3_STP=10
SWEFREQ4_STP=10
SWEFREQ5_STP=25

[Individual Harmonic test]
INDHARM2_LEV=3
INDHARM2_PHS=0
INDHARM3_LEV=8
INDHARM3_PHS=0
INDHARM4_LEV=1.5

INDHARM4_PHS=No test
INDHARM5_LEV=9
INDHARM5_PHS=0
INDHARM6_LEV=No test
INDHARM6_PHS=No test
INDHARM7_LEV=7.5
INDHARM7_PHS=0
INDHARM8_LEV=No test
INDHARM8_PHS=No test
INDHARM9_LEV=2.5
INDHARM9_PHS=No test
INDHARM10_LEV=No test
INDHARM10_PHS=No test
INDHARM11_LEV=5
INDHARM11_PHS=No test
INDHARM12_LEV=No test
INDHARM12_PHS=No test
INDHARM13_LEV=4.5
INDHARM13_PHS=No test
INDHARM14_LEV=No test
INDHARM14_PHS=No test
INDHARM15_LEV=No test
INDHARM15_PHS=No test
INDHARM16_LEV=No test
INDHARM16_PHS=No test
INDHARM17_LEV=3
INDHARM17_PHS=No test
INDHARM18_LEV=No test
INDHARM18_PHS=No test
INDHARM19_LEV=2
INDHARM19_PHS=No test
INDHARM20_LEV=No test
INDHARM20_PHS=No test
INDHARM21_LEV=No test

INDHARM21_PHS=No test

INDHARM22_LEV=No test

INDHARM22_PHS=No test

INDHARM23_LEV=2

INDHARM23_PHS=No test

INDHARM24_LEV=No test

INDHARM24_PHS=No test

INDHARM25_LEV=2

INDHARM25_PHS=No test

INDHARM26_LEV=No test

INDHARM26_PHS=No test

INDHARM27_LEV=No test

INDHARM27_PHS=No test

INDHARM28_LEV=No test

INDHARM28_PHS=No test

INDHARM29_LEV=1.5

INDHARM29_PHS=No test

INDHARM30_LEV=No test

INDHARM30_PHS=No test

INDHARM31_LEV=1.5

INDHARM31_PHS=No test

INDHARM32_LEV=No test

INDHARM32_PHS=No test

INDHARM33_LEV=No test

INDHARM33_PHS=No test

INDHARM34_LEV=No test

INDHARM34_PHS=No test

INDHARM35_LEV=1.5

INDHARM35_PHS=No test

INDHARM36_LEV=No test

INDHARM36_PHS=No test

INDHARM37_LEV=1.5

INDHARM37_PHS=No test

INDHARM38_LEV=No test

INDHARM38_PHS=No test

INDHARM39_LEV=No test

INDHARM39_PHS=No test

INDHARM40_LEV=No test

INDHARM40_PHS=No test

INDHARM_DWE=5

INDHARM_PAU=1

[Interharmonics test]

INTERHARM1_LEV=2.5

INTERHARM2_LEV=5

INTERHARM3_LEV=3.5

INTERHARM4_LEV=2

INTERHARM5_LEV=1.5

INTERHARM_DWE=5

INTERHARM_PAU=1

Sample File IEC414.414

Following is a listing of the default IEC414.414 file shipped with the CIGUI program. If for some reason your 414 file is lost or you would like to restore it to its original condition, use the values shown here.

[IEC-1000-4-14]

SeqRepeat = 3

SeqDuration = 5

InterSeqDelay = 6

MeasUpdateRate = 1000

DeltaLevel1 = 8

DeltaLevel2 = 12

Offset = 10

Sample File IEC428.428

Following is a listing of the default IEC428.428 file shipped with the CIGUI program. If for some reason your 428 file is lost or you would like to restore it to its original condition, use the values shown here.

[IEC-1000-4-28]

SeqRepeat = 1

SeqDuration = 6

InterSeqDelay = 12

StartAngle = 0

MeasUpdateRate = 1000

PosDeltaLevel1 = 3

NegDeltaLevel1 = -3

PosDeltaLevel2 = 4

NegDeltaLevel2 = -6

PosDeltaLevel3 = 15

NegDeltaLevel3 = -15

PosDeltaLevel4 = 20

NegDeltaLevel4 = -20

<div align="right">

**11
Specifications**

</div>

About This Chapter

This chapters provides the technical specifications of the CTS measurement system and the Power Analysis and Conditioning System unit (PACS). If the CTS system you have includes an AC power source, refer to the separate AC source user manual that shipped with the AC source.

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.

Measurement System Specifications

The CTS measurement system is implemented using a high speed Analog to Digital ISA 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		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	%

Measurement			Specification	Unit
	d_c	Range	0.1 - 100	%
	d_t	Range	0.1 - 100	%
	d_t over3%(4%)	Range	0 - 1000	ms

PACS 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.

PACS units are available in single and three phase configurations. Single phase CTS systems are supplied with a PACS-1 single phase unit, three phase CTS systems are supplied with a PACS-3 three phase unit.

The following specifications apply to the PACS units.

PACS Model:		PACS-1	PACS-3
Number of phases		1	3
Channels	Voltage and Current	2	6
Connector Style	Front panel	CEE/77 front	none
	Rear panel	terminal block	terminal block
Maximum voltage	Front panel	240 Vac	n/a
	Rear panel	312 Vac	480 Vac
Maximum current	Front panel	16A rms	n/a
	Rear panel	40A rms	40A rms/phase
Reference Impedance	1251RP-CTS	internal	n/a
	iX-CTS configuration	option	option OMNI3-8ix
Dimensions	HxWxD inch	3.5 x 16.8 x 22	3.5 x 16.8 x 22
	HxWxD mm.	89 x 427 x 560	89 x 427 x 560
Weight	Lbs / kg	12 / 5.4 PACS-1RP: 21 / 9.5	12 / 5.4

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

The 1-phase or 3-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 power source used and application.

Environmental

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.

Regulatory

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. (PACS-X or 1251RP)
	75 dBA maximum. Measured at one meter. (5001iX)
Safety:	Designed to meet EN61010-1 European safety standards as required for the "CE" mark.

Flicker Reference Impedance

Flicker measurements require the use of a reference impedance according to IEC 725. Since this reference impedance has to be matched to the output of the AC source used, the PACS-1 is available in three versions to accommodate the different AC sources that may be part of the CTS system. The following PACS-1 models are available.

Model	phases	Flicker Impedance
PACS-1	1	for single phase iX Series
PACS-1RP	1	for RP-Series
PACS-3	3	for three phase iX Series

Single Phase Reference Impedance

The CTS systems based on the ix Series use a programmable output impedance to meet the flicker reference impedance requirements. All non-ix Series based CTS systems require the use of an external reference impedance. Consult the factory for configuration information.

If the CTS system was supplied with a PACS-1RP (1251RP-CTS), the required single phase reference impedance is built into the PACS-1RP unit. In this case, you can select the reference impedance by putting the PACS unit in the Flicker mode by pressing the Mode switch on the front panel of the PACS unit. The LED will indicate Flicker (for Flicker testing) or Bypass (for Harmonics testing) mode. If the PACS-1 unit is configured for remote actuation of the flicker function, then the CTS software will switch from bypass to flicker automatically depending on what test is being run.

Reference Impedance	
Phases	1
Flicker Mode:	
Max. Current	18.5 A
Useable range	2.0 - 18.5 A
Bypass Mode:	
Max. Current	40.0 A
Impedance @ 50 Hz in Flicker Mode:	
Phase	$0.24 + j0.15 \ \Omega$
Neutral	$0.16 + j0.10 \ \Omega$
Accuracy	< 5 %
Controls and Indicators	
	Flicker On/Off push button
	Power Led
	Bypass mode Led
	Flicker mode Led

Three Phase Reference Impedance

Three phase CTS systems always use the *iX* Series programmable impedance . Optionally, the OMNI-3-18iX lumped impedance can be used. This separate 3.5 inch high rack mount unit needs to be connected between the output terminals of the AC source and the input terminals of the PACS-3 unit. The OMNI-3-18iX can be controlled from its front panel or from the CTS software. Refer to the OMNI-3-18iX user manual for details.
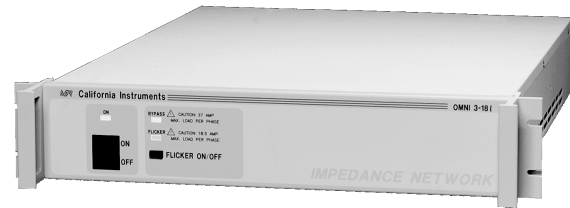
12
Calibration and Configuration

About This Chapter

This chapter covers two basic functions: System calibration and system configuration. Single phase calibration is covered first and additional steps for three phase calibration are also covered. System configuration is then covered detailing the steps to properly set up the AC power source.

If the CTS system you have includes an AC power source, refer to the separate user manual that shipped with the AC source for service and calibration information.

Calibration

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

A special calibration program is included in the CTS software suite to facilitate calibration and store the calibration constants. This module is called "**System Cal & Config**" and is available by clicking on the **IEC1000-3-2&3 Test** menu selection. The program screen is shown on the next page.

Required Calibration Equipment

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

- 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.
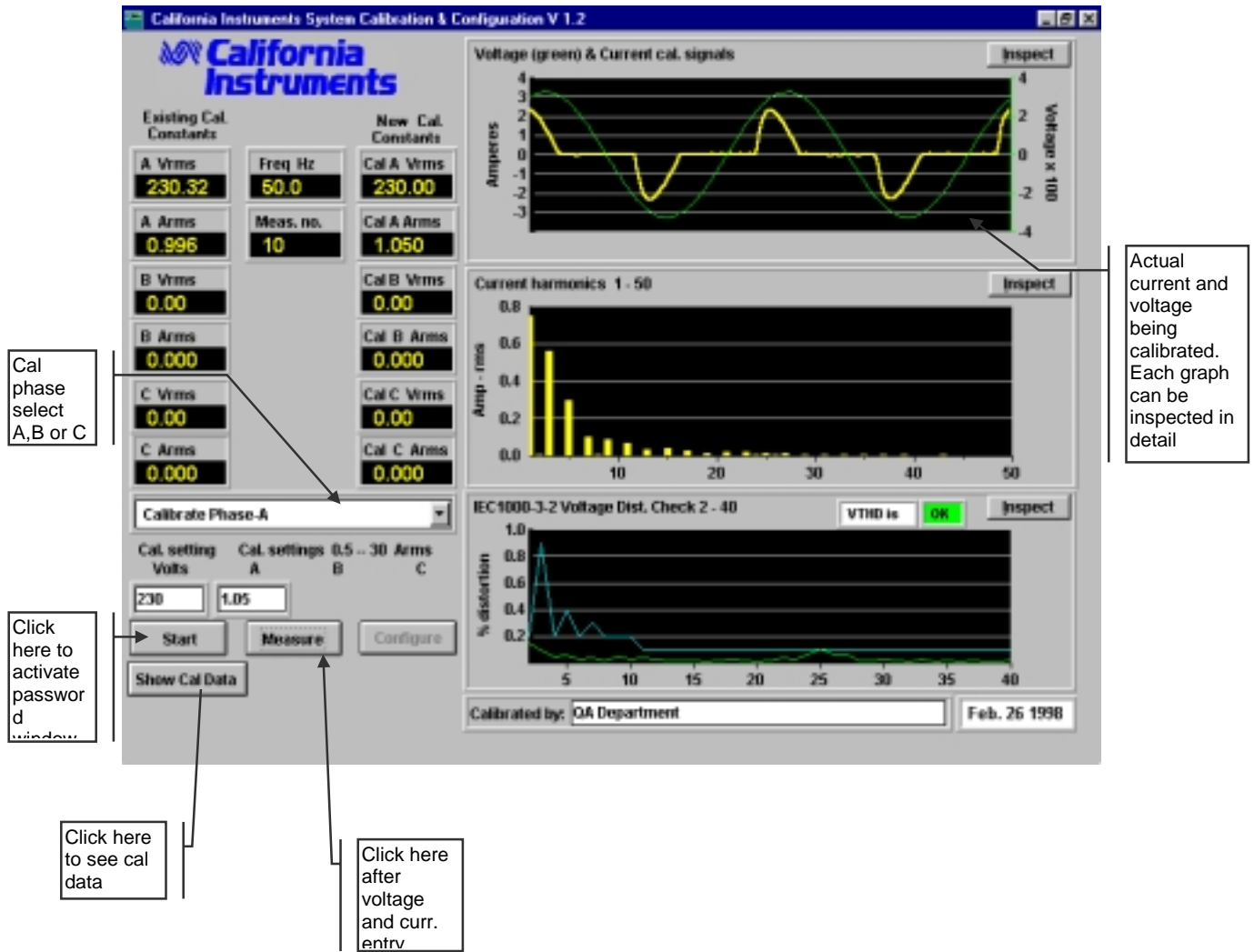
Figure 35: System Calibration Window
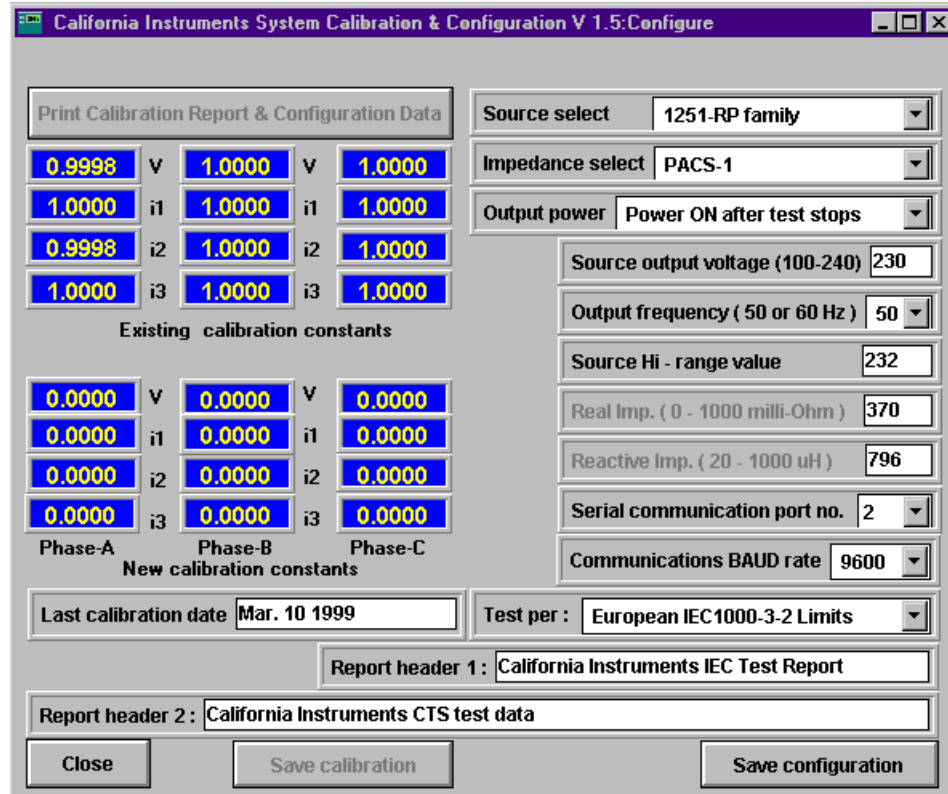
Figure 36: Cal Constants and Configuration Screen

The System Cal & Config module is supplied as part of the CTS software suite with all CTS systems. The same Cal & Config module is used for both single phase and three phase CTS systems. A shortcut for the Cal & Config module is provided in the IEC 1000-3-2&3 Test program group.

The same module can be used to perform a routine system calibration or change the system configuration settings.

Field / Control	Location	Description
Start button	Left panel	Click this button first after starting "**System Cal & Config**" to enable the password field. Enter cal_lock or CAL_LOCK , then hit keyboard **enter**
Calibrate Phase Select	Left panel	Click this button to select the phase for calibration. In single phase applications always select **Calibrate Phase-A.** (default). In three-phase applications select each phase in sequence.
Cal setting: Volts, A rms	Left panel	Click on these fields to enter the actual measured voltage and current using the external DMM reference instruments.
Measure	Left Panel	Click this button after the measured voltage and current has been entered into the appropriate fields.
Inspect	Right panel	Click here to inspect the three calibration graphs.
Show Cal Data	Lower left panel	Click this button after the 10 measurement cal cycle is complete, the new cal constants will be displayed.
Save Calibration	Lower left panel	Important! Click here to save the new cal constants. If screen is closed without saving, the cal sequence will have to be repeated.
Field /	**Location**	**Description**

Control		
Close	Lower Left Panel	Closes cal-constant, configuration screen and reverts to calibration entry screen.
Print Calibration Report & Configuration Data	Upper left panel	If it is desired, the cal-constant, configuration data can be copied to a printer for documentation or future reference.

Single Phase Calibration Procedure

To calibrate the CTS measurement system, proceed as follows:

Note: The CTS is rated for currents up to 40A rms and it should be calibrated in three ranges. However, some of the companion sources may not source 30A or more in order to calibrate the 40A range. Therefore, in many cases only the two lower ranges will be calibrated and the factory default cal constant for the 40A range will be used which will still yield good accuracy.

1. For test set-up refer to Figure 1. For detailed single-phase system hook-up see Figures 2, 3 and 4.

2. Connect the current shunt in series with the neutral wire. If you are using a current transformer, clamp it over the neutral wire between the PACS unit and the power source.

3. Connect the Voltage DMM at the AC IN terminals on the PACS unit. (TB4)

4. Start the Calibration module located in the **IEC 1000 -3-2&3** Program group called "**System Cal & Config** See Figure 29.

5. Click on the **Start** button in order to activate the password field. Click on the password field and enter the calibration password The calibration password is: **"CAL_LOCK"** or **"cal_lock"** Press the keyboard ENTER key to unlock the control buttons.

6. Program the AC source to low range, 120 Volts rms at 50 Hz.

7. (5001iX only. 3001iX or 1251RP skip to step 12.)

Apply a resistive load to the AC OUT terminals at TB3 on the PACS unit. Resistance should be 3.5 to 4 Ω in order to get 30A rms or more to flow.

8. Click on the **Cal settings Ph A** field and enter the current shunt DMM measurement to three decimal places .

Click on the **Cal settings Volts** field and enter the voltage reading to two decimal places.

9. Click on the **Measure** button. The Calibration module will do 10 measurements and calculate new calibration coefficients.

10. Now click on the **Show Cal Data** button. The screen in Fig. 30 will appear.

11. Click on the **Save calibration** button to store the new cal constants. This completes one current range cal cycle. Now click on the **Close** button to revert back to the previous cal entry screen.

12. Apply a resistive load to the AC OUT terminals at TB3 on the PACS unit. Resistance should be 11-13Ω in order to get 9-11A rms to flow.

13. Repeat cal entry steps 8 through 11 above.

14. Set the power source to the high output range. Program 230Vac at 50Hz and apply a resistive load to the AC OUT terminals at TB3 on the PACS unit. Resistance should be 50 - 60Ω in order to get 3.8 to 4.5A rms to flow.

15. Repeat cal entry steps 8 through 11 above.

16. Single phase calibration is now complete, program power source down and exit "**System Cal & Config"**

Three Phase Calibration Procedure

3-phase calibration is done by repeating the above procedure three times.

1. For detailed three-phase hook-up, see Figures 5 and 6. Also see Figure. 1.

2. Perform above Phase A calibration procedure. Steps 2-15 only.

3. Click on the phase select button and select **Calibrate Phase-B**

4. Repeat steps 6-15 above.

5. Click on the phase select button and select **Calibrate Phase-C**

6. Repeat steps 6-15 above.

7. Three-phase calibration is now complete, program power source down and exit "**System Cal & Config"**.

Configuration

The CTS software is designed to work with the companion CI power source used to power the test system. In order to make compliance testing as easy as possible, the "**System Cal & Config**" program module is also able to configure the power source so it will be properly set up for whatever test is selected.

The configuration screen is on the right side of the cal-constants screen and it is activated just like the calibration feature except a separate password is used. See next page for Calibration screen details and instructions.
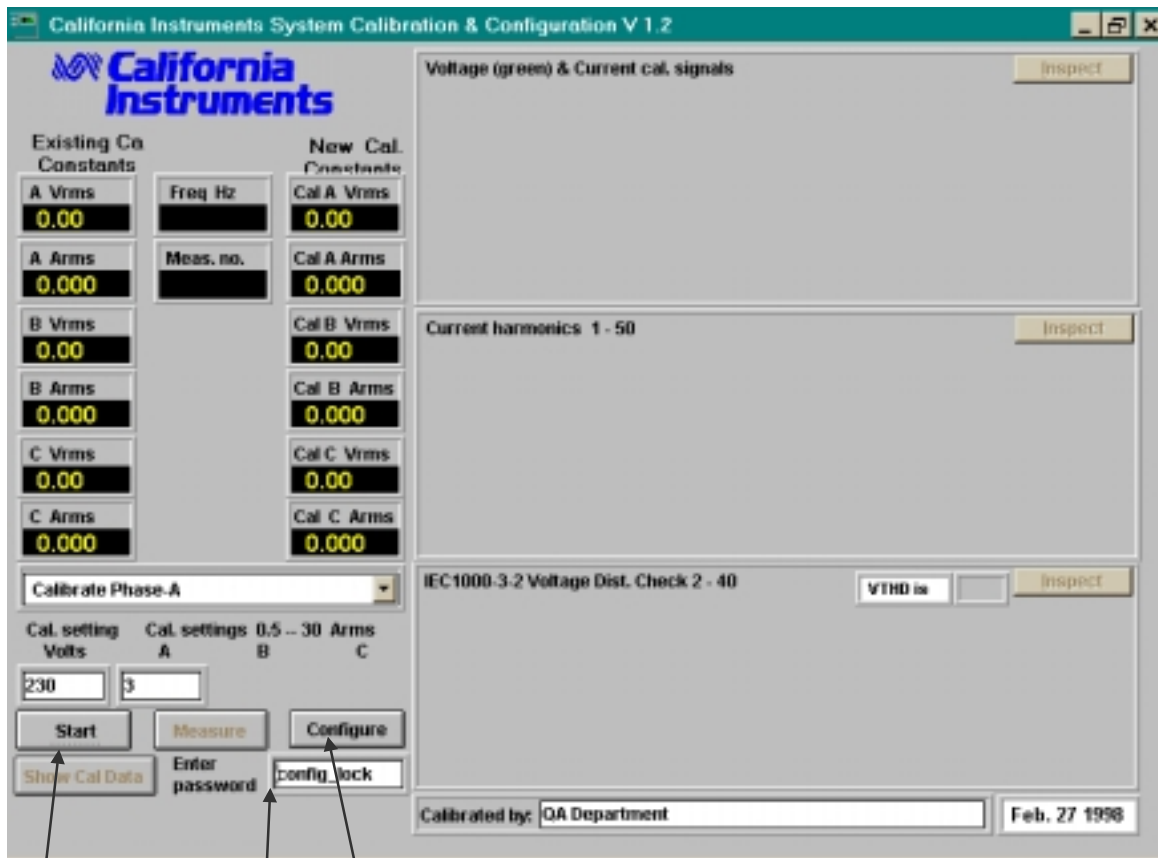
Figure 37: Configuration Button Enabled
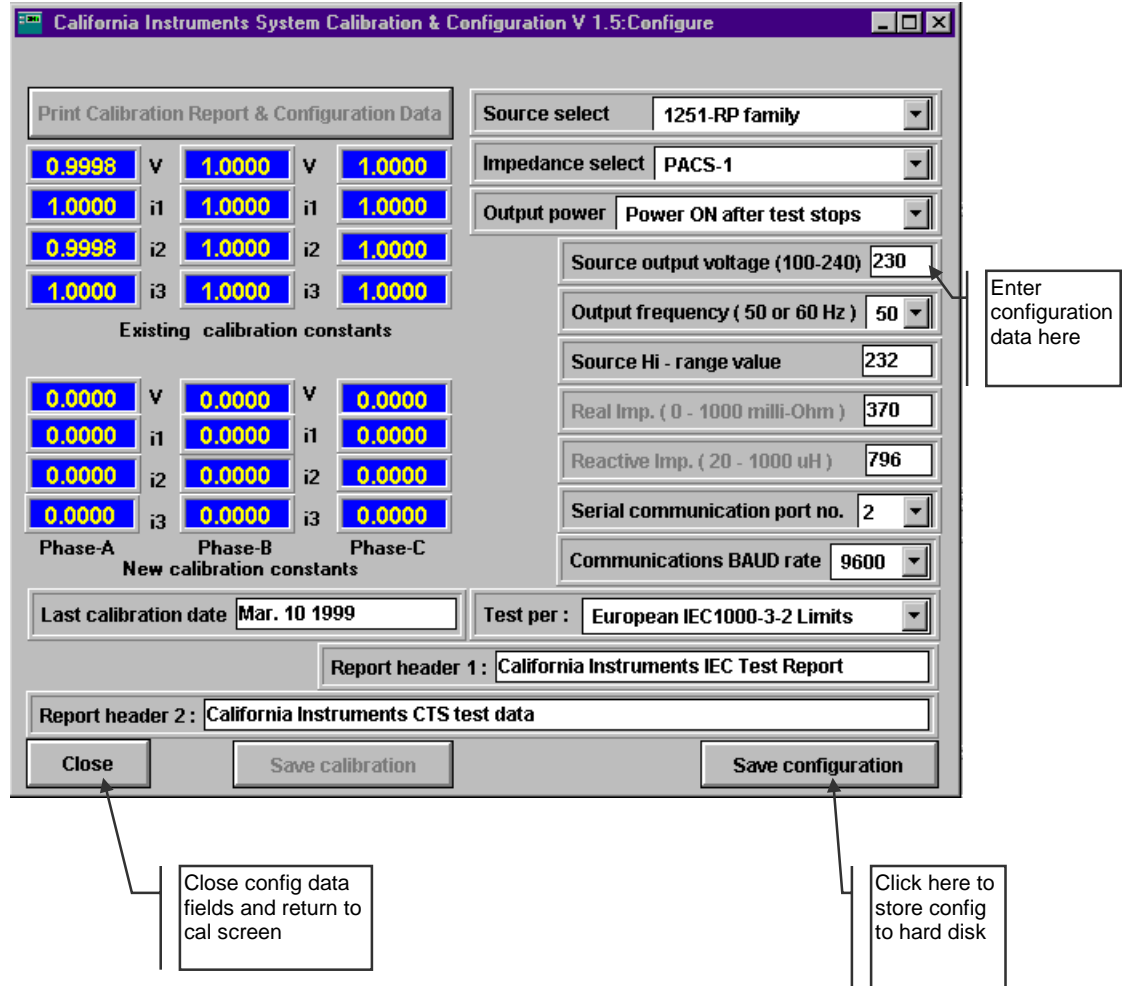
Figure 38: Configuration Fields Enabled.

The system configuration window(s) has several user accessible fields and controls. The following table briefly describes the purpose of each field and control.

Table 6: CTS Configuration Choices

Field / Control	Location	Description
Source select	Right screen	Selects the source used in the CTS. Typically, the *ix* series will be used in most systems.
Impedance select	Right screen	Selects between lumped passive impedance built into the PACS-1 unit, or, an external impedance network built into an OMNI unit, or, the programmable output impedance of the *ix* series.
Output power	Right screen	Lets the user select whether to turn off power source output voltage after a test has finished.
Source output voltage	Right screen	Selects the programmed output voltage for a test. The default voltage for all IEC testing is 230 V rms.
Output frequency	Right screen	Selects the output frequency. Default is 50 Hz.
Source Hi-range value	Right screen	Selects the source high output voltage range. This is typically 270V or 300V. Set to match the power source. For 1251RP set to 272V.
Real Imp. (0 - 1000milli-ohm)	Right screen	This sets the eal portion of the output impedance. The test standard calls for 400 milliohms. The normal setting for this is 380 milliohms, with the remaining 20 milliohms made up by the system wiring.
Reactive Imp. (20 - 1000uH)	Right screen	This sets the inductive reactance of the output impedance. The test standard calls for 796uH which implies j250milliohms at 50Hz. This value is adjusted somewhat during factory calibration and the proper value stored in the calibration file shipped with the system software.
Serial COM. Port no.	Right screen	Selects serial Com. Port used to communicate with the power source. COM1 - COM4 is available.
Baud Rate	Right screen	Selects Com port baud rate. 9600 - 38400. Computer and power source controller baud rate must be the same. If the CIGUI is also going to be used set it to the same rate as the CTS software.
Test per:	Right screen	Selects between European or Japanese IEC1000 3-2 limits.
Report Header 1		This field can be used to enter the first line of a user defined report header. This header information will be printed at the top of every harmonics or flicker report in bold font. This feature can be used to provide test reports to customers that show the company name and address information. The first report header line is limited to 40 characters. Note that the footer on each report will display the California Instruments CTS name. The footer cannot be changed by the end-user.
Report Header 2		This field can be used to enter the second line of a user defined report header. This header information will be printed at the top of every harmonics or flicker report in bold font. This feature can be used to provide test reports to customers that show the company name and address information. The second report header line is limited to 100 characters. Note that the footer on each report will display the California Instruments CTS name. The footer cannot be changed by the end-user.
Save configuration.	Bottom screen	IMPORTANT! Click this button after all configuration data is entered.

Field / Control	Location	Description
Close	Bottom screen	Click here to revert back to the calibration program screen.

Configuration Procedure

Configuration involves setting the power source to provide the correct testing parameters for voltage, frequency and output impedance.

1. Start the Calibration module located in the **IEC 1000 -3-2&3** Program group called "**System Cal & Config.** See *Figure 31.*

2. Click on the **Start** button in order to activate the password field. Click on the password field and enter the calibration password. The calibration password is: **"CONFIG_LOCK"** or **"config_lock"**
Press the keyboard ENTER key to unlock the control buttons.

3. Click on the **Configure** button to go to the configuration window. See *Figure 32.*

4. Click on the various fields and select the appropriate parameters for your system. See *Table 6* on previous page for descriptions of field choices. Also see *Table 7* below for factory system configuration values.

5. Important ! When configuration fields are set up properly, click on **Save configuration** button to permanently store data to hard disk.

6. Click on **Close** to revert to the calibration entry screen and then exit "**System Cal & Config"**

Table 7: CTS Factory Configuration Values.

Field / Control	System Model				
	PACS-1 PACS-3	1251RP-CTS	3001iX-CTS 5001iX-CTS	5001iX-CTS w. LR1 option	15003iX-CTS
Source select	No source control	1251-RP family	1 phase iX series	1 phase iX series	3 phase iX series
Impedance select	No imp. Control	PACS-1	Program iX impedance	External OMNI	Program iX impedance
Output power	na	Power OFF after test stops	Power OFF after test stops	Power OFF after test stops	Power OFF after test stops
Source output voltage	230	230	230	230	230
Output frequency	50	50	50	50	50
Source Hi-range value	na	272	300 (set to match source)	300 (set to match source)	300 (set to match source)
Real Imp.	na	na	380	na	380

Field / Control	System Model				
	PACS-1 PACS-3	**1251RP-CTS**	**3001iX-CTS 5001iX-CTS**	**5001iX-CTS w. LR1 option**	**15003iX-CTS**
(0 - 1000milli-ohm)					
Reactive Imp. (20 - 1000uH)	na	na	790	na	790
Serial COM. Port no.	na	2	2	2	2
Baud Rate	na	19200	19200	19200	19200
Test per:	European IEC1000-3-2 limits	European IEC1000-3-2 limits	European IEC1000-3-2 limits	European IEC1000-3-2 limits	European IEC1000-3-2 limits

**13
Principle Of Operation**

General

The Compliance Test System is a power measurement and power analyzer system.

The three basic building block are:

- **AC power**, either line power or, typically, a CI power source to provide the proper voltage and frequency for the test at hand.

- **PACS-1 or PACS-3** 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.

- **CTS 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.

AC Power

The AC power is the most flexible of the building blocks. It can be 1-phase or 3-phase and in some cases the users available line power is adequate. However, if more precise control of voltage and frequency is needed, as in IEC regulatory testing, the California Instruments mating power sources provide the proper accuracy and programmability for this task.

PACS1 or PACS3 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 uses 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.

The PACS-1 module also has circuits that switch the built in impedance in and out of circuit for flicker compliance testing. If this optional impedance is not installed, the "flicker/bypass" button control has no function.

CTS Software

The CTS 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.
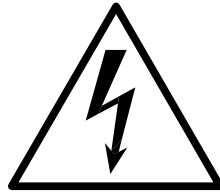
CAUTION

VOLTAGES UP TO 480 VAC AND 650 VDC MAY BE PRESENT IN CERTAIN SECTIONS OF THE COMPANION POWER SOURCES. THIS EQUIPMENT GENERATES POTENTIALLY LETHAL VOLTAGES.

DEATH

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

14
Service

Cleaning

The exterior of the power source or 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.

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*

Basic Operation

No Power To EUT

CONDITION	POSSIBLE CAUSE, REMEDY
No power to EUT	Line voltage or power source not at expected value. Verify power line voltage is correct. Verify power source voltage is at programmed value
AC source voltage OK. No power to EUT.	Incorrect input wiring at TB4. Check for wrong terminals or poor connections.
AC source 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

Power Source Shuts Down

CONDITION	POSSIBLE CAUSE, REMEDY
The power source shuts down when the EUT load is applied	If the companion power source shuts down when the EUT load is applied, it is very likely that the power source is being severely overloaded. Any severe overload will cause the 1251RP or the 5001iX to immediately program itself to zero volts
The power source shuts down immediately when it is programmed to the test voltage	Another possible cause of shutdown is a short circuit in the EUT wiring or EUT load. Make sure neutral and line wires don't form a short circuit.

Power Source Overload Light On

CONDITION	POSSIBLE CAUSE, REMEDY
Overload light on power source is on	When the overload light is on, the power source is close to faulting or folding back the output voltage. Adjust EUT loading if possible to keep power source within its ratings.

No Signal To PC Interface

CONDITION	POSSIBLE CAUSE, REMEDY
EUT is being driven properly and voltage and current is present, but the CTS 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 DB-37 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.
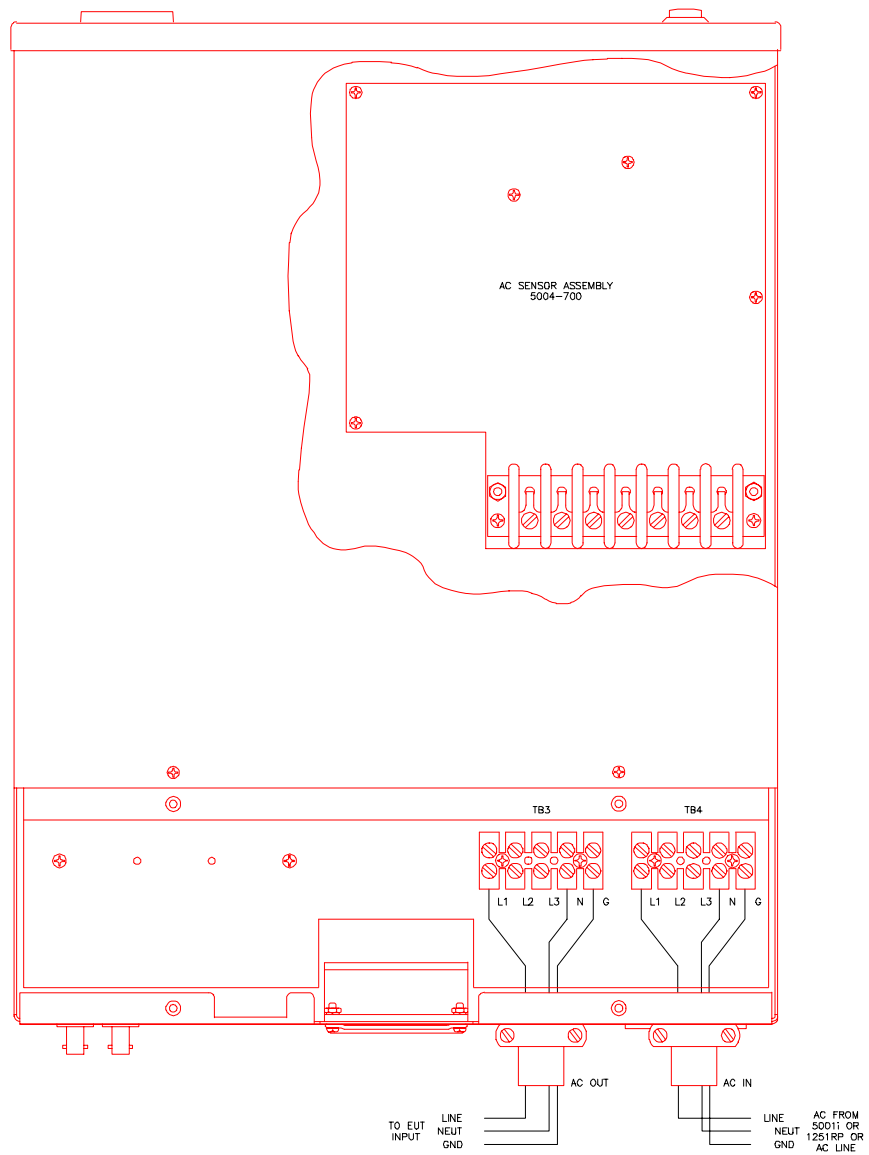
Figure 39: Location of AC Sensor Assy. 5004-700 in PACS-x

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. See Figure 33 for location.

⚡ *CAUTION: VOLTAGES UP TO 312 VAC ARE 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 other 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 other 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 other 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.

PACS-3 ONLY

5. Connect the other DMM lead to TP3. This is the phase B voltage sense output

6. Apply a test voltage to the PACS input terminals TB4. Use Neutral and ph- B

7. The reading at TP3 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 TP3.

8. Connect the other DMM lead to TP4. This is the phase C voltage sense output

9. Apply a test voltage to the PACS input terminals TB4. Use Neutral and ph- C

10. The reading at TP4 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 TP4.

11. If any of these test points do not have the correct voltage on them, the board is malfunctioning and it must be serviced.

Power-On Troubleshooting - Current Sense

1. Connect the DMM common to TP1.

2. Connect the other 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.

PACS-3 ONLY

5. Connect the other DMM lead to TP8. This is the phase B current sense output.

6. Apply a 4A test current to the PACS input terminals TB4. Use Neutral and ph- B.

7. The reading at TP8 should be 496mV/ Amp of input current. For example, with 4.0A rms applied at TB4, then there should be 1.984V rms at TP8.

8. Connect the other DMM lead to TP10. This is the phase C current sense output.

9. Apply a 4A test current to the PACS input terminals TB4. Use Neutral and ph- C.

10. The reading at TP10 should be 496mV/ Amp of input current. For example, with 4.0A rms applied at TB4, then there should be 1.984V rms at TP10.

11. If these sense voltages are not obtained then the board is malfunctioning and it must be serviced.

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