California Instruments

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Ballast Test System
User Manual
[Including -HF Option]

Printed in the USA

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. If this test unit is not used as specified in this manual, the protection provided by this equipment may be impaired. 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 BTS system 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 BTS system unit uses a North-American ferrule type input fuse rated at 0.5A and 250 Volts. (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.

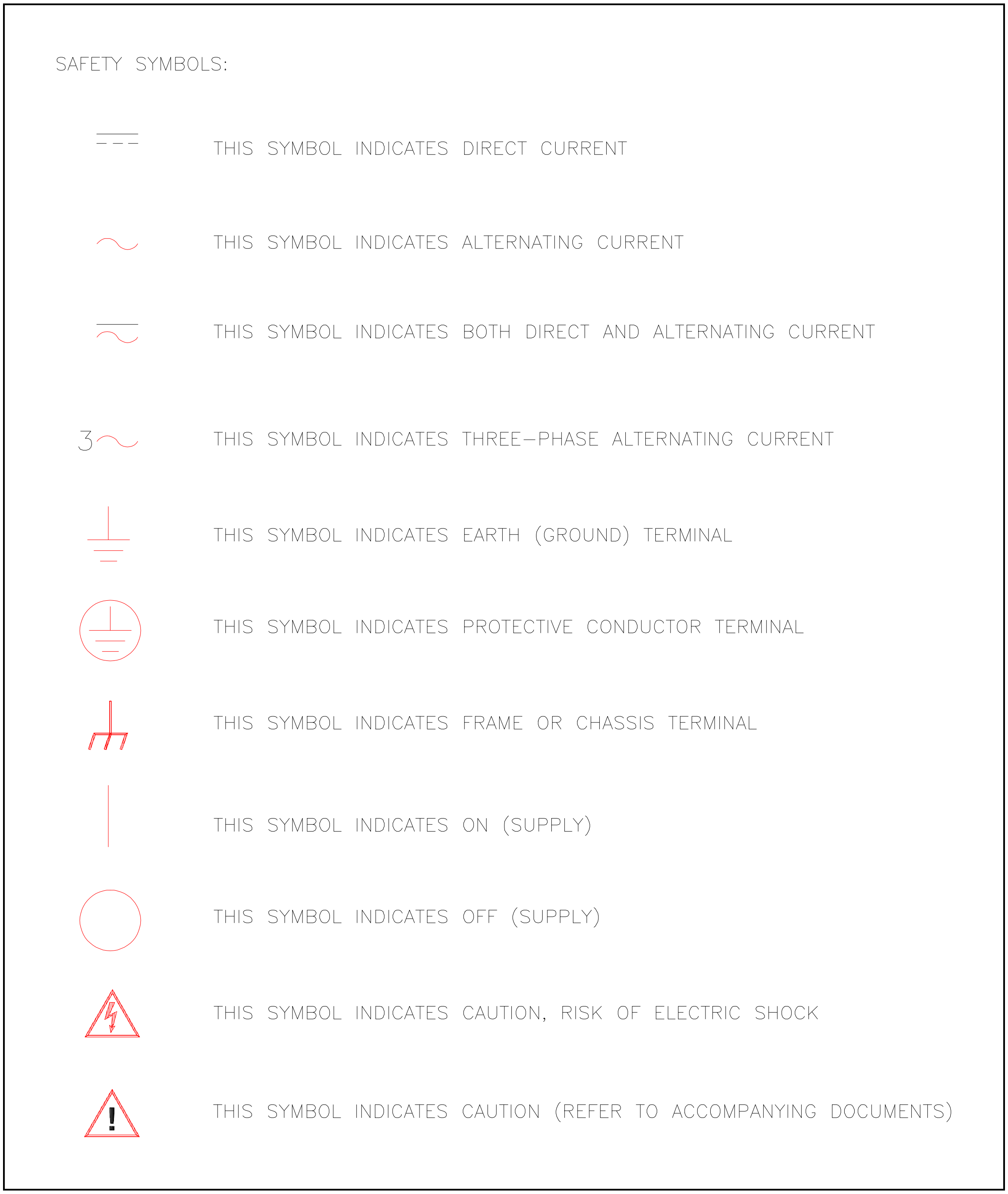

Figure 1-1: Safety Symbols Used in the BTS

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Revision codes on the BTS 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 BTS system may be higher than the software revision number shown below. In this case, the information in the manual still applies.

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

This manual applies to software revision 1.0.

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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1.Introduction

1.1 Manual Organization

This manual describes the operation of the California Instruments Ballast Test System software when used in conjunction with the BTS hardware. Its primary function is as a reference manual. If you have a question about a specific screen or how to perform a certain task, turn to the appropriate section of the manual. The manual is organized in chapters that cover different aspects of BTS system hardware and software operation.

Some assumptions were made when producing this documentation. Specifically, it is assumed that you are familiar with general concepts and terms of lighting ballasts and ballast test requirements. Some background information of the test concepts as used in the BTS system are included in chapter 2.

Furthermore, it is also assumed that you are familiar with operating a personal computer under the Microsoft Windows 95/98™ environment.

The manual is organized as follows:

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

Chapter 2 provides an overview of ballast operation and ballast test principles as implemented in the BTS system.

Chapter 3 covers installation of the hardware and software components that make up a complete BTS system. Proper installation of both hardware and software is essential. This chapter walks the user through the hardware and software installation process one step at a time.

Chapter 4 covers connection schemes for various lamp and ballast configurations. Proper connection of both ballasts and lamp loads to the BTS system is required for correct operation. This chapter covers the various connection diagrams that are required.

Chapter 5 covers the graphical user interface of the BTS software. Test procedures and operator interface concepts are discussed in this chapter.

Chapter 6 provides the technical specifications of the BTS system data acquisition system. For technical specifications on the AC source supplied with the BTS system, refer to the AC source manual provided.

Chapter 7 provides information on performing routine calibration.

Chapter 8 provides service and troubleshooting information on the BTS in case you encounter any difficulties during system operation.

1.2 Ballast Test System Description

The California Instruments Ballast Test System is a complete magnetic or electronic ballast test system that covers many of the test requirements called for in production testing of lighting ballasts.

To ensure maximum flexibility of both the hardware and the software required to create a turn-key test system, the BTS 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 ballast that exhibits a failure. A power-on shorts test is used to detect and reject ballasts that exhibit input over current conditions. The AC source is supplied as an integral part of the test system and is available in various power levels.
- BTS system unit. The BTS system 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. The BTS system unit also contains the necessary relays and the relay control logic used to switch lamp loads under software control.
- PC Based data acquisition system with on-board DSP. 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 BTS software controls all aspects of the A/D card and processes the data for ballast test purposes. For electronic ballasts, the -HF option is required to support the high operating frequencies used in electronic ballasts. For magnetic ballasts operating at 50 or 60 Hz, the standard BTS is used.
- BTS Software. The BTS software implements a common ballast test procedure that includes input short testing, output voltage, filament voltages, line current, lamp current, power factor, THD and ballast factor. For custom test requirements not covered by the supplied BTS software, contact California Instruments.

The AC source output is connected to the rear of the BTS system unit. The user needs to wire the ballast and lamp outputs from the BTS system unit to the test fixture. Details on connections required for various ballast types are covered in chapter 4. All user interaction with the BTS system is accomplished through the BTS GUI software. There are no front panel controls on the BTS system unit required to operate the BTS system.

1.2.1 AC Source

The BTS system is supplied with different programmable AC power sources depending on the configuration. The following AC sources are typically supplied with each BTS system but California Instruments reserves the right to substitute different models if appropriate for the application at hand. Thus, the actual AC source supplied with your BTS system may be different. Consult the AC source user manual supplied separately with the source for specific details on AC source operation and specifications.

Table 1: BTS AC Source Models

Model	VA Power	AC Source
BTS-1	AC Line	none
1251RP-BTS	1250 VA	1251RP-IF
2001RP-BTS	2000 VA	2001RP-OP1
3001iX-BTS	3000 VA	3001iX

1.2.2 BTS System Unit

The BTS system unit provides the required electrical and mechanical interface between the AC source, the user's test fixture and the data acquisition PC system. This allows all signal connections to be made easily and conveniently.

The BTS system unit also contains the relays and relay controls required for switching lamp loads between various phases of the complete ballast test sequence. These relays are mounted on relay sockets to facilitate regular preventive maintenance of the test system which may require periodic replacement of these relays.

The BTS system unit has several AC power input and output connections as well as an interface connector to the PC based data acquisition system. Also, external CT signals and as digital I/O are supported via DB-15 and DB-25 style interface connectors.

Refer to paragraph 3.3 for detailed installation instructions on the BTS system unit.

1.2.3 PC Based Data Acquisition System

All measurements required for ballast 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 BTS system 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 BTS software for further processing. For magnetic ballast test applications, the standard CI400AD card supplied with the system is used. The electronic ballasts -HF option also uses the CI400AD card.

1.2.4 BTS Software Functions

The BTS software application supports turn key ballast testing using an intuitive graphical user-interface from which you can:

- Set up and test limits.
- Collect real-time test data from the BTS System.
- Display and monitor ongoing test results, including a history of passed and failed units.
- Save test results to disk for analysis using other programs.
- Print reports and graphs.

1.2.5 AC Source GUI Functions

If the BTS 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 BTS 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 additional software is provided as a convenience and is not integral to the use of the BTS as a test system. For ballast test operation, complete source controls is implemented in the ballast test program.

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2. Ballast Testing

2.1 About This Chapter

This chapter provides some background information on ballast test methods as implemented in the California Instruments Ballast Test System.

2.2 System Architecture

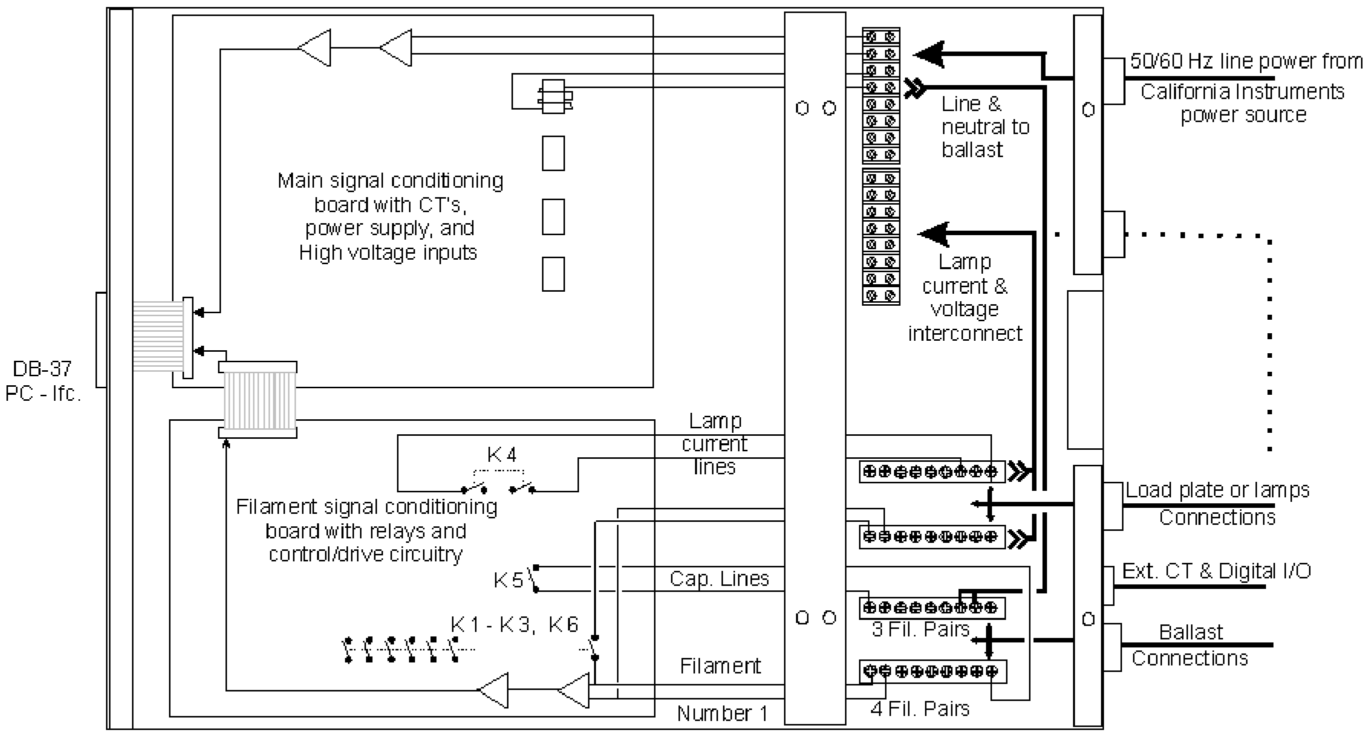

Figure 2-1: BTS System Architecture

The BTS system consists of a combination of measurement channels for voltage and current and a software controlled relay board used to switch lamp loads in or out at the appropriate time. This enables a complete test cycle to be performed on a ballast without any operator intervention. The role of operator is reduced to placing the next ballast on the test fixture when prompted.

All signal conditioning and control is implemented in the BTS system unit which is a 3.5” / 89 mm height 19 inch rack mount chassis that contains two modules:

1. Main signal conditioning board with Current Transformers (CT), power supplies and high voltage input sense.
2. Filament signal conditioning board with relays and control/drive circuitry.

All this measurement and control circuitry is operated through the DB-37 interface to the PC based data acquisition and control card under control of the BTS-GUI software. There are no user accessible controls or readouts on the BTS system unit itself.

2.3 Measurement System

The measurement system in combination with the signal conditioning circuitry is capable of measuring small filament voltages in the presence of high common mode voltages which is a key requirement for performing comprehensive ballast tests.

High impedance, differential input FET operational amplifiers ensure accurate measurements of voltage and current on up to 14 channels to handle a wide variety of ballast / lamp combinations. All voltage and current signals are digitized using a fast A/D converter and streamed to the PC's hard disk for storage and processing. Full time domain analysis of these signals ensure accurate determination of volt rms., current rms. as well as true power, power factor and total harmonic distortion.

Due to the high level of integration of the BTS system, a complete ballast test can be performed in as little as 2 to 3 seconds for most ballast types, resulting in dramatic throughput improvements over conventional rack and stack test systems.

The bundled BTS-GUI software implements a complete ballast test cycle consisting of the following test stages:

Stage	Description
1. Low Voltage Shorts test.	Ensures the primary side of the ballast is not shorted or otherwise defective. Also prevents further damage to an already defective ballast that could occur if full power is applied.
2. Open circuit voltage test.	Tests secondary side of ballast.
3. Filament voltage test.	Checks filament voltage of all ballast outputs.
4. Full load test.	Applies full lamp loads to all ballast outputs and checks lamp current.

Figure 2-2: Ballast Test Stages

Refer to chapter 5 for specific details on the implementation of each of these test phases.

3. System Installation

3.1 About This Chapter

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

3.2 AC Source Installation

Inspect the AC source 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.

For instructions on installing the AC power source that is supplied as part of the BTS system, refer to the User Manual provided with the AC Source. The main power requirements for the BTS are dictated by the AC power source used and the power levels that the Equipment Under Test will demand.

3.3 BTS System Unit Installation

Inspect the BTS system 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.

The BTS measurement module can be operated on either 115V or 230 V. It requires less than 0.5 Amps to function. Before applying power to the BTS system unit, verify the correct voltage input setting.

3.3.1 Mechanical Installation

Both the BTS unit and the AC power source can be used free standing on a bench. Rack handles are standard, and if the optional rack slides (option -RMS) are ordered, the entire BTS 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.

3.3.2 Wiring

For wiring diagrams see **Error! Reference source not found.** and Figure 4-5. 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. For rms. currents in the 10 to 20 A range, AWG 12 is recommended. Most ballast test applications involves relative low rms. currents - 1 to 5 A range - and therefore, wire sizes from AWG 16 to AWG 20 are typically sufficient.

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

3.3.3 HF Option Configuration

If it is desired to change the BTS from standard Low Frequency mode(magnetic ballast) to High Frequency mode(electronic ballast) it will be necessary to access jumpers on the ballast /relay circuit board inside the BTS unit. (Note: If unit is ordered with HF option, then jumpers are pre-set at the factory)

To set HF option proceed as follows:

1. Remove large top cover from BTS unit.
2. On ballast/relay board no. 5004-707 on the right side of the unit, place jumpers as follows:
   W1, W3, W5, W7, W,9, W10, W12, W14 ARE INSTALLED
3. Replace top cover.

3.4 Data Acquisition Card

All measurements in the BTS 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.

3.4.1 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, DB-37 male to DB-37 female connector.
- Software driver disk.

Verify that all components are available. The BTS 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 4 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.

3.4.2 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 3-1.

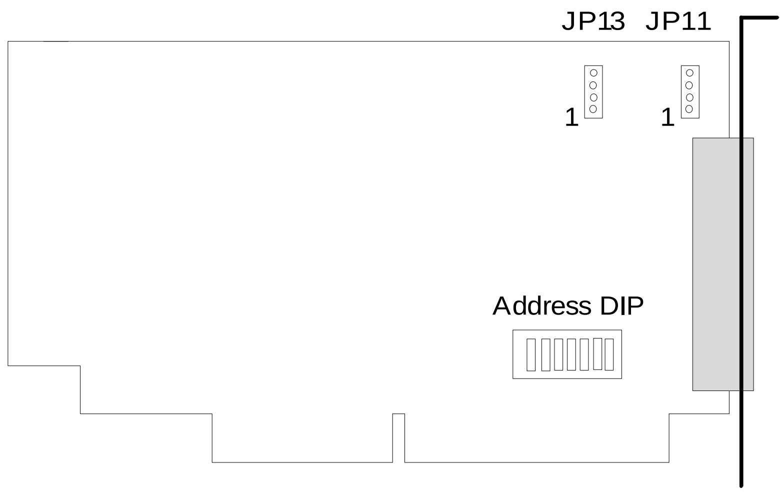

Figure 3-1: Jumper and DIP Switch Location A/D Card

Jumper JP11

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

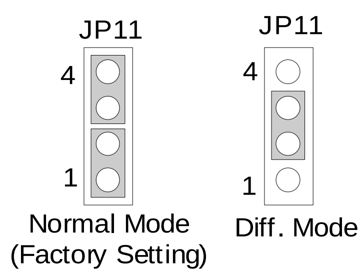

Figure 3-2: A/D Card Jumper JP11 Settings

Jumper JP13

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

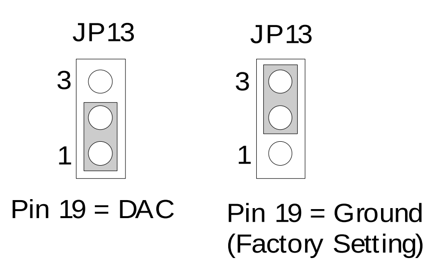

Figure 3-3: A/D Card Jumper JP13 Settings

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.

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)

Table 2: Reserved PC I/O Address Locations

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

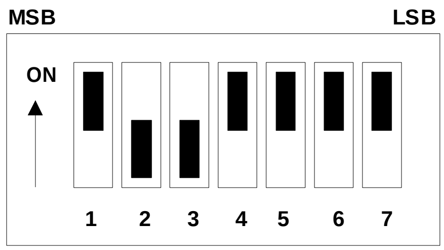

Figure 3-4: A/D Card Base I/O Address DIP

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.

3.4.3 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 mains 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 don't 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 DB-37 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 board software drivers.

3.4.4 Installing the A/D Card Software Driver

The data acquisition card is supplied with its own set of drivers which must be loaded before the BTS software. This is accomplished through the autoexec.bat file. The autoexec.bat file must have the correct base I/O address for the card set. A simple installation utility is provided with the BTS system which allows you to set the correct base I/O address and verify the presence of the A/D card. This utility is installed as part of the BTS software installation and should be run once before you start any of the IEC test modules.

The following CI400AD files are needed in the BTS program directory:

ci400.bat	Batch file
di-400.com	DOS Device driver
di-400.bnm	DSP Program file
W400LDR.EXE	Windows DSP Program Loader

These files will be installed automatically when you install the BTS software. If you have not installed the BTS software, proceed to the next section and return here later.

Once the required files are available on the host PC, you have to setup your autoexec.bat file. To install the A/D board device drivers, proceed as follows:

1. Edit your autoexec.bat file by added the following entries:
   cd c:\ci_bts
   ci400 180 1c
   If you had to set a different base I/O address in section "A/D Card Configuration" on page 16, you have to replace the factory default of 180 with the I/O address in hex that you set on the DIP switch.

You will have to reboot your computer for these changes to take effect.

3.5 BTS Software Installation

The BTS system software is supplied on one or more CD ROM's and a Cal data floppy disk. These distribution disks contain compressed versions of all the programs and files needed to operate the BTS 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 the CD ROM disk should be used to install all the files.

Before you proceed, you need to 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.

3.5.1 Installing the BTS Software Under Windows 95™ or Windows 98™

This section covers installation of the BTS software under Windows 95™ or Windows 98™. If you are using a PC with Windows NT 4.0™, refer to Section 3.5.2.

To install the BTS software under Windows 95™ or Windows 98™, proceed as follows:

1. Insert the installation CD ROM in the CD ROM drive of your PC.
2. From the CD ROM root menu, select **Setup and select the BTS Software.**
3. Click on Execute Selection.
4. The setup program will now run and display and guide you through the remainder of the installation process.
5. Halfway through the installation process, you may be asked for the next/last distribution disk.
6. If so, remove the previous setup disk and insert the next/last disk that came with the system.
7. Click on the OK button after you have inserted the next/last disk to let the install process continue.
8. At the end of the installation process, a message will be displayed indicating the installation is complete. You will have the option of reading the readme file supplied with the distribution of the program. MAKE SURE TO FOLLOW ANY INSTALLATION INSTRUCTIONS PROVIDED IN THE README FILE AT THE END OF THE INSTALLATION PROCESS. Additional steps may be needed to finish the software installation completely.
9. When done, remove the last installation disk when done and save the original distribution disks in a safe place.

The installation program will create a new entry in the Programs Menu called Ballast Test System. This menu has two entries, one for the actual run test BTS module and one for the BTS File Replay module.

3.5.2 Installing the BTS Software Under Windows NT™

The present version of the BTS system can be installed on a Windows NT 4.0 system through the use of the WinNT setup kit and driver. This kit is available from California Instruments on request but may not be distributed with the BTS program. If this is the case, contact California Instruments for information on obtaining this setup kit.

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4. Connection Details

4.1 About This Chapter

The California Instruments Ballast Test system requires several interconnections between the ballast under test, the test system and the lamps or lamp loads. These interconnections are best made through a fixture that allows for easy swapping of the ballasts to be tested. Lamps or lamp loads may be hard wired to the test system if no changes are required on a regular basis.

Different ballast types will require different wiring schemes however. This chapter covers various commonly used ballast types and their wiring requirements. If the ballast type does not conform to any of the configurations covered in this chapters, contact California Instruments for assistance on setting up the BTS system correctly.

4.2 BTS System Unit Connectors

The BTS system unit has a variety of connectors located on the front and rear panels. Some rear panel connectors are only accessible by removing the rear cover panel. This does not require the entire top cover to be removed, only the small access panel located at the rear top of the BTS system unit.

The location of each connector is shown in the diagram below. A brief description of the function of each connector and its pin out assignments follow.

4.2.1 Front Panel Connector and Controls

The front panel has a single power on/off switch with a power on state indicator. The BTS system unit must be powered up during normal operation. The green LED on the front panel indicates the power on state of the BTS system unit.

The DB-37 connector located on the front panel provides an alternative connection between the

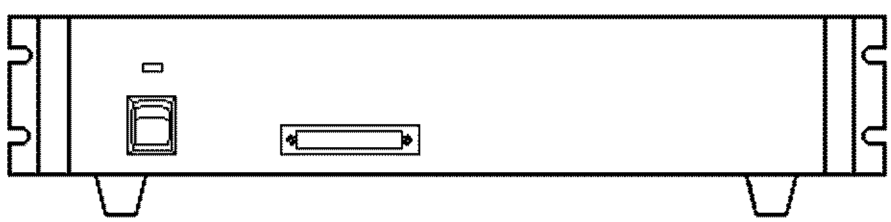


Figure 4-1: BTS System Unit Front Panel

BTS system unit and the CI400AD card located inside the PC. The same connector is replicated on the rear panel. At all times, only one of these two DB-37 connectors may be used at the same time.

4.2.2 Rear Panel Connectors

Not all rear panel connectors are accessible from the rear panel itself. Most AC power related connections are located behind the top cover rear access panel. This provides an added layer of protection as these connections can only be accessed using the proper tools. Note that if the BTS system unit is rack mounted, the top panel cover may not be accessible without sliding the entire unit forward. This requires sufficient slack in the wires between the BTS system unit and the ballast test fixture.

Additional low level signal connectors are located on the rear panel itself and can be accessed from the rear without using any tools.

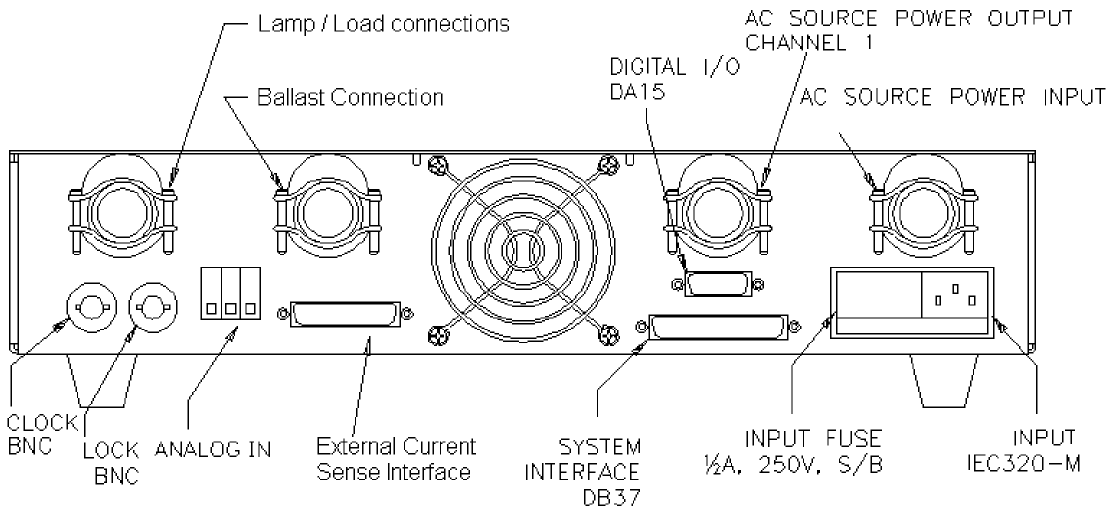


Figure 4-2: BTS System Unit Rear Panel Connectors

4.2.3 PC Interface Connector

This 37 pin D shell, DB-37 connector provides the interface between the BTS system unit signals and the PC based data acquisition system. This cable is available on both the front and rear panel of the BTS system unit. Only one connector may be used at a time. A five feet long DB-37 to DB-37 shielded cable is included with each BTS system. Longer cable lengths up to 15 feet may be used if the distance between the PC and the BTS system unit exceeds 5 feet.

Pin out DB-37

PIN#	CI400AD	Signal
1	n/c	n/c
2	DI5	Lock
3	DO3	DO3
4	DO1	DO1
5	DI3	DI3
6	DI1	DI1
7	n/c	n/c
8	DO6	CAP byp. Relay
9	n/c	n/c
10	DO5	FLMTLD-relay
11	CH15	AUX2
12	CH14	AUX1
13	CH13	FLMT7
14	CH12	FLMT6
15	CH11	FLMT5
16	CH10	FLMT4
17	CH9	FLMT3
18	CH8	FLMT2
19	A Gnd	Analog Ground

PIN#	CI400AD	Signal
20	DI4	Clock
21	DI6	X1
22	DO2	DO2
23	DO0	DO0
24	DI2	DI2
25	DI0	DI0
26	DO4	I range 1
27	DO7	Lamp / Irange 2
28	n/c	n/c
29	DI7	X256
30	CH7	FLMT1
31	CH6	I Neutral
32	CH5	I3
33	CH4	V3
34	CH3	I2
35	CH2	V2
36	CH1	I1
37	CH0	V1

Table 3: PC Interface Connector Pin Out

4.2.4 Digital I/O Connector

The digital I/O connector is a 15 pin D shell, DB-15 connector that provides a digital input and output signal interface to the PC based data acquisition system. Digital I/O may be used to interface to the ballast text fixture, external Pass/Fail enunciators, and/or handler system. This may require customization of the Ballast test GUI software.

Drive capability

- The 24 V DC output is provided for driver external relays. Maximum current draw should not exceed 100 mA.
- The digital outputs DO3 through DO0 can be used to drive up to 10 mA. The lines can be used to drive external relays using appropriate buffer circuitry.

Digital I/O pin assignments through BTS GUI

The BTS system unit uses a total of eight digital inputs and eight digital outputs. Some of these I/O signals are used internally do drive the control/relay board. Specifically, the following assignments are made when using the BTS GUI software.

Output #	Signal
DO7	Drives relay K4 on the internal Control/Relay board. Relay K4 connects the lamp loads to the output. A logic low de-energizes (opens) the relay.
DO6	Drives relay K5 on the internal Control/Relay board. Relay K5 connects the Cap. A logic low de-energizes (opens) the relay.
DO5	Drives relays K1, K2, K3 and K6 on the internal Control/Relay board. These relays connect the lamp filaments. A logic low de-energizes (opens) the relay.
DO4	This signal controls the current range sensitivity. A logic low selects the low current range (12.2 A peak). If the external current sense option is used, the following current range sensitivities apply: High range: 102.15 mV / A Low range: 408.6 mV / A
DO3	This output is available on the DB-15 connector at the rear panel and signals the PASS or FAIL status of the ballast under test. A logic low indicates a FAIL condition. A logic high indicates a PASS condition.
DO2	This signal mirrors the status of DO7. It may be used to drive an external relay for switching the CAP. The status of this output may also be used to monitor test completion. The end of each ballast test is indicated by a ON, OFF sequence plus a 100 msec delay to allow for data processing.
DO1	This signal mirrors the status of DO6. It may be used to drive an external relay for switching the lamp CAP.
DO0	This signal mirrors the status of DO5. It may be used to drive external relays for switching the lamp filaments.

Pin out DB-15

PIN#	Signal
1	DO0
2	DO1
3	DO2
4	DO3
5	DI0
6	DI1
7	DI3
8	n/c

PIN#	Signal
9	+ 24 V DC (100 mA max)
10	Analog Gnd
11	Digital Gnd
12	n/c
13	n/c
14	DI2
15	n/c

4.2.5 External Sense Connector

The external sense connector is a 25 pin D shell, DB-25 connector that provides allows the current transformers to be placed closer to the ballast under test in test setups where the distance between the BTS system unit and the ballast is too great. Optional single or dual channel external CT sense boards are available for this purpose as accessories (ECT1 and ECT2). The user must provide his own wiring between the external current transformers and the DB-25 connector.

Pin out DB-25:

PIN#	Signal
1	+15V
2	A1 GND(power gnd)
3	-15V
4	A GND (signal gnd)
5	n/c
6	EXT CT1 (I1)
7	EXT CT2 (I2)
8	EXT CT3 (I3)
9	n/c
10	n/c
11	n/c
12	n/c
13	n/c

PIN#	Signal
14	A1 GND (power gnd)
15	A1 GND(power gnd)
16	n/c
17	A GND (signal gnd)
18	EXT V1
19	EXT V2
20	EXT V3
21	EXT CT4 (I4)
22	n/c
23	n/c
24	n/c
25	n/c

Table 4: External Sense Connector Pin Out

4.2.6 Analog Input Signal Connector

The analog Input connector consists of a three position terminal block which provides two auxiliary analog inputs and a common ground. These inputs may be used to expand the capabilities of the BTS, such as measuring signals from Lumen or ballast temperature sensors.

Pin out A3

PIN#	Signal
1	AUX 1 Input
2	AUX 2 Input
3	Common

4.2.7 AC Input Connector

A standard IEC320-M AC input block is provided for 115 V or 230 V AC input to the BTS system unit. Make sure the nominal AC line voltage setting matches the line voltage present in the locale. The input setting can be changed by pulling the fuse holder and turning it over. The set rating can be read from the back of the unit. A standard US AC line cord is included with each BTS system unit. Optional country specific line cords are available.

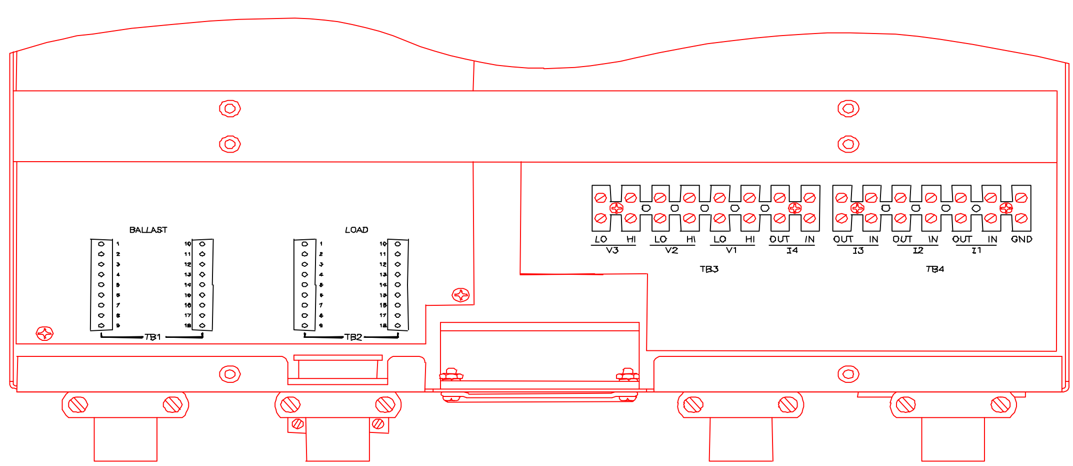
4.2.8 Clock and Lock BNC Connectors

The Clock and Lock BNC connectors are provided for future expansion and should be left unconnected.

4.3 Top Access Connectors

The top cover provides access to the AC input from the AC source for channel 1 on the left (when facing the front of the BTS system unit) and the ballast and lamp filament connections for channel 2 on the right. The top cover can be removed by using a Phillips screw driver to remove the four top screws and the two screws on the side. Always turn off the AC source output when accessing these connections as the AC input connectors will be exposed.

Figure 4-3: Top Access Connectors



4.3.1 Channel 1 AC Input Connectors - TB 3 and TB 4

Terminal block TB3

PIN#	Signal
1	V3 LO
2	V3 HI
3	V2 LO
4	V2 HI
5	V1 LO
6	V1 HI
7	I4 OUT
8	I4 IN

Table 5: TB3 Input Connector Pin Out

Terminal block TB4

PIN#	Signal
1	I3 OUT
2	I3 IN
3	I2 OUT
4	I2 IN
5	I1 OUT
6	I1 IN
7	Ground

Table 6: TB4 Input Connector Pin Out

Notes:

For most ballast test applications, only single phase voltage connections are required on TB3. Connect the Hi output (Line) of the AC source to TB3-2 and the low output (Neutral) to TB3-1.

Load current must be routed through channel I1 using TB4-5 and TB4-6 for the AC input side of the ballast under test. See **Error! Reference source not found.**.

4.3.2 Channel 2 Ballast Connectors - TB1

Terminal blocks TB1:

PIN#	Signal
1	FLMT1/LAMP1
2	FLMT1
3	FLMT2
4	FLMT2
5	FLMT3
6	FLMT3
7	FLMT4
8	FLMT4
9	CAP termination

PIN#	Signal
10	FLMT5
11	FLMT5 - LAMP2
12	FLMT6
13	FLMT6
14	FLMT7
15	FLMT7
16	LINE
17	NEUT
18	n/c

Table 7: Filament Sense Input Connector Pin Out

Notes:

Terminal 1 must be connected to the filament winding that is also used for one end of the lamp voltage. Designated LAMP1.

Terminal 11 must be connected to the filament winding that is also used for the other end of the lamp voltage. Designated LAMP2

4.3.3 Channel 2 Lamp / Load Connectors - TB 2

Terminal blocks TB2:

PIN#	Signal
1	FLMTLD1
2	FLMTLD1
3	FLMTLD2
4	FLMTLD2
5	FLMTLD3
6	FLMTLD3
7	FLMTLD4
8	FLMTLD4
9	CAP

PIN#	Signal
10	FLMTLD5/CAP
11	FLMTLD5
12	FLMTLD6
13	FLMTLD6
14	FLMTLD7
15	FLMTLD7
16	LAMP
17	n/c
18	LAMP

Table 8: Ballast Load Connector Pin Out

Notes:

The test capacitor must be connected between terminals 9 and 10. Terminal 10 is the filament winding opposite the LAMP2 connection. (LF only. Typically, HF ballast do not use the capacitor.)

The lamp load resistor string must be broken in the middle and connected to terminal 16 and terminal 18.

4.4 External CT Option Connector

If the external CT option - ECT1 or ECT2 - is used, the user must provide a suitable cable between the ECT1/ECT2 six position terminal strip TB1 and the External Sense DB-25 connector on the rear panel of the BTS system unit. For electronic ballasts, operating at higher frequencies, it is recommended to use individual twisted shielded pairs for each of the ground/signal lines for CT1 and CT2. Also, a twisted shielded pair may be used to connect the +/- 15 Volt DC. The shield should be grounded at the DB-25 side, i.e. at the BTS main unit .

The TB1 connection details for both the ECT1 (single CT) and ECT2 (dual CT) are shown in the table below.

ECT1 / ECT2 Terminal block TB1:

PIN#	Signal
1	+ 15 Vdc
2	- 15 Vdc
3	CT1 ground

PIN#	Signal
4	CT1 sense
5	ECT1: n/c ECT2: CT2 ground
6	ECT1: n/c ECT2: CT2 sense

Table 9: ECT1 / ECT2 Accessory Connector Pin Out

4.5 Connection Wiring Examples

This section provides examples of wiring the BTS system unit to a typical 2-lamp ballast. If the ballast type you are planning to test does not match any of the samples covered here, contact California Instruments for assistance.

Keep in mind that on units with the HF option, current channels I3 and I4 are hardware configured to read high frequency currents only in excess of 10 kHz. Attempting to read LF magnetic ballast currents with this option will give inaccurate readings.

4.5.1 AC Source and Ballast Connection

All test setups must route the AC input power from the AC source to the V1 and I1 channels on the BTS system unit. See **Error! Reference source not found.** below for typical ballast primary input connections through the BTS. Also see Figure 4-5 for detailed connections on a 2-lamp magnetic ballast. The HF electronic ballast will have the same connections except for the missing capacitor.

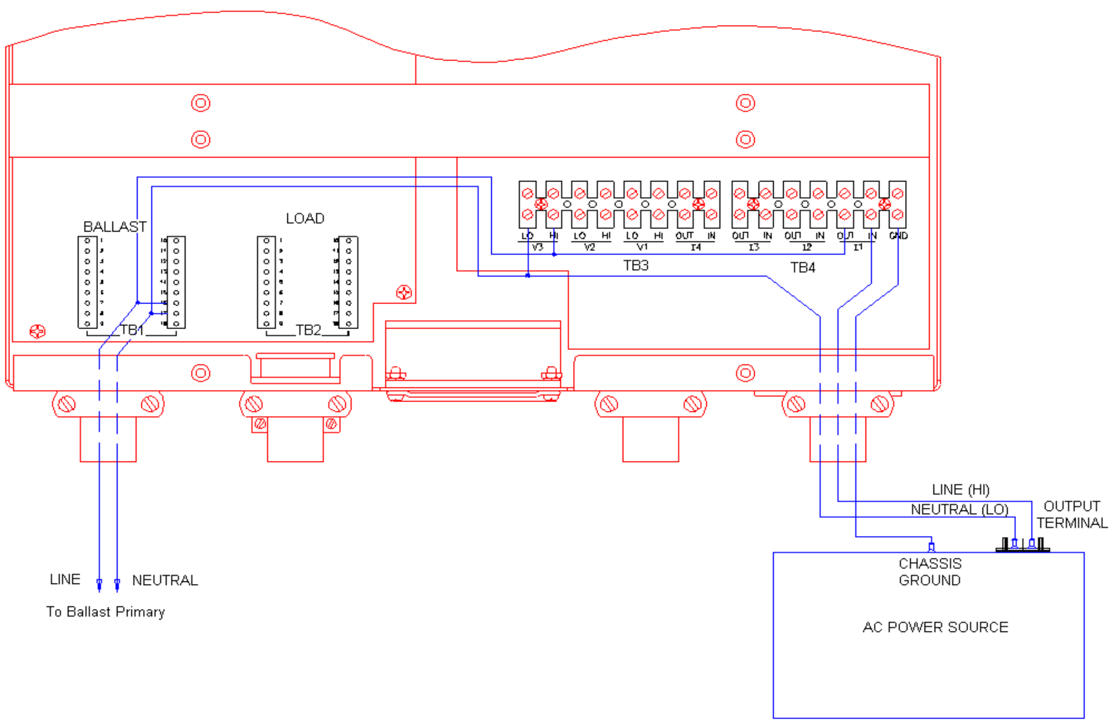


Figure 4-4: Ballast Input Connections With 1 Phase AC Source

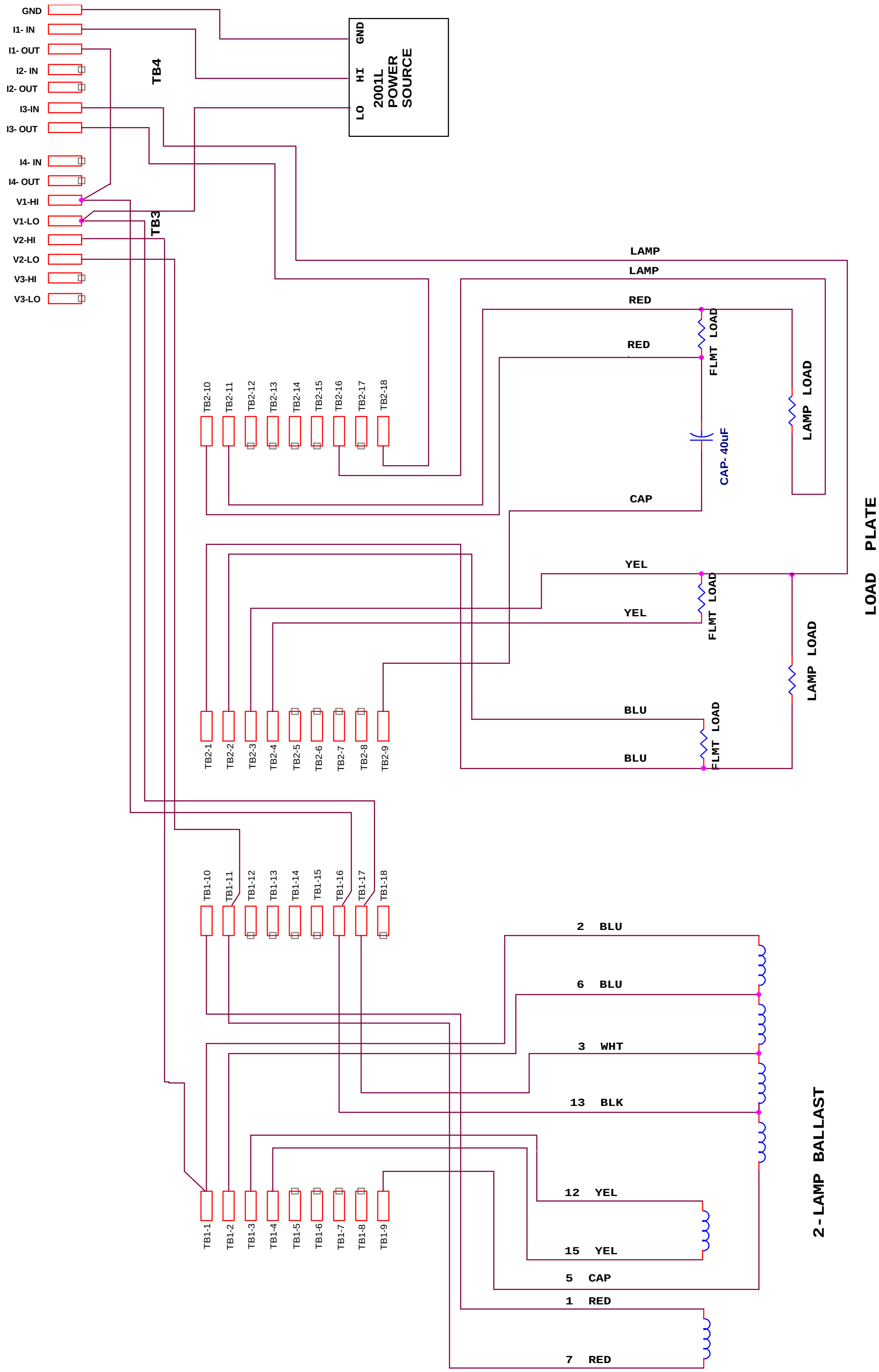


Figure 4-5: Typical 2-Lamp Magnetic Ballast Hook-Up

5. BTS Graphical User Interface

5.1 About This Chapter

This chapter covers the operation of the standard ballast test graphical user interface (GUI) which is supplied with each BTS system. The GUI may be used to set performance limits for Pass / Fail determination. Limits may only be set and changed through password access. The operator of the GUI is presented with a single screen that displays test progress, test data and history pass and fail data. All measurements are logged to tab delimited ASCII text files that may be used for data collection and SPC purposes.

5.2 Running a Ballast Test

To perform a generic ballast test on the Equipment Under Test (EUT), first ensure that all necessary hardware connections have been made and the first ballast is loaded on the test fixture.

The BTS-GUI can be started from the Windows 95/98™ start menu or from a desktop shortcut. Once started, the BTS-GUI will display the main BTS test window. Refer to Figure 5-1. This window automatically sizes to a Super VGA display resolution of 800 x 600 pixels, assuming the PC on which you installed the BTS 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.

All operator interactions with the BTS-GUI software are accomplished from this single screen using the mouse or the function keys on the PC keyboard. The function keys provide a more convenient method of control if room for a mouse is not available.

For the example given in 5.2.1, a typical 2 lamp ballast test screen is used. The various limits and measured data apply to this example only, and do not necessarily reflect real product performance parameters.

5.2.1 Main Ballast Test Window Fields and Controls

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

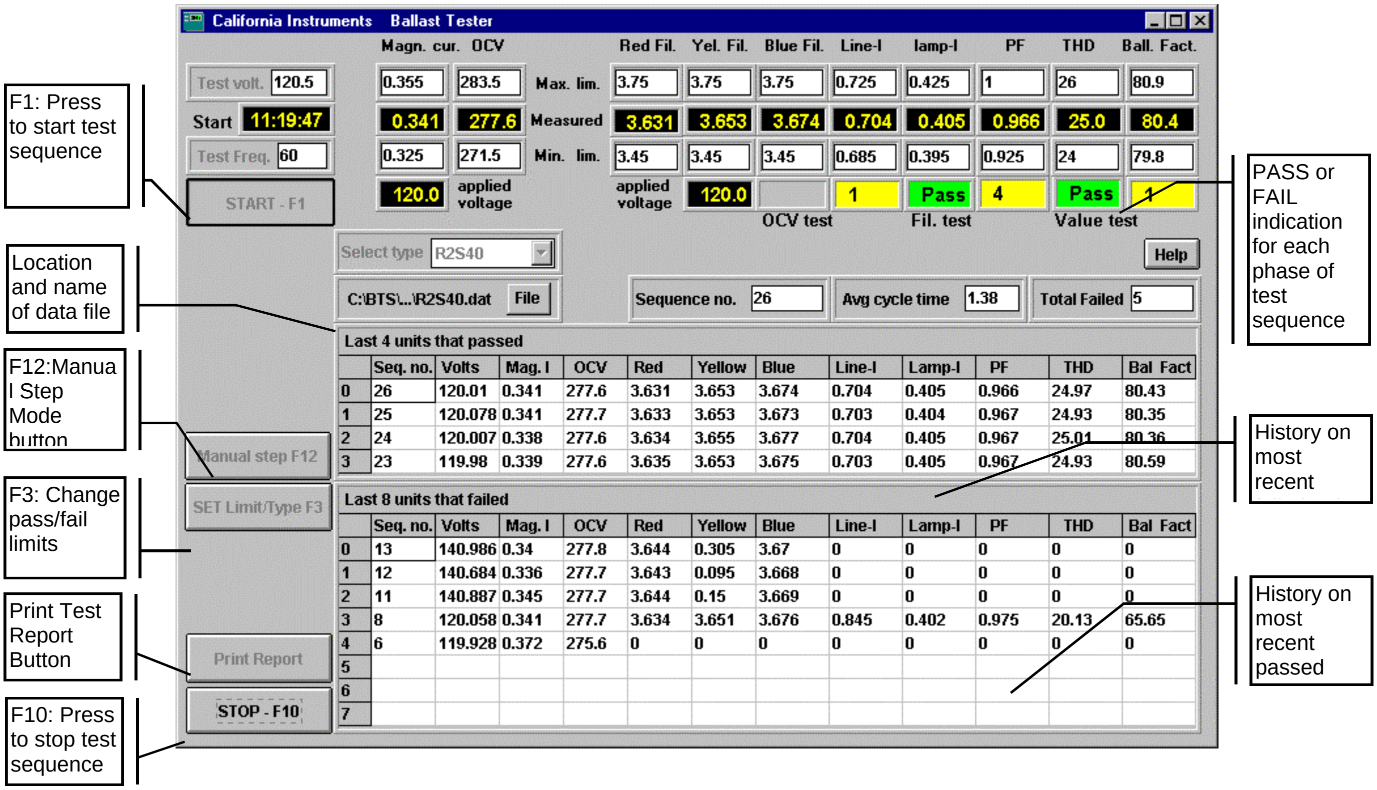


Figure 5-1: Main BTS-GUI Test Window

Field / Control	Location	Description
Start button F1	upper left corner	Starts the ballast test sequence using presently set test limits. Once a test is running, test limits cannot be changed. Starting a test also causes data to be written to the test data file specified in the data file field. Function key F10

Field / Control	Location	Description
Manual step button F12	Left center	Normally the BTS software executes each step in the ballast test sequence at maximum speed. There may be situations like initial production ramp up or debugging of a new ballast type when it is desirable to stop the test sequence at specific points. This is the function of the Manual step - F12 button. The Manual step button can be used to single step through a subset of steps of the test sequence. This mode is normally used in actual production mode. In the file replay mode, this button may be used to step through the test data at a much slower pace. Each test sequence is cut in three discrete steps as follows: 1. Short circuit and OCV Test 2. Full voltage Filament Test and full load tests 3. Post test result data for present sequence number to Data tables. These points in the test sequence are set to prevent damage to a ballast under test by stopping the test sequence at a time during which the ballast is stressed. It is not desirable to stop in the middle of specific test steps so more than one step is run, each time the Manual step is advanced.
SET Limits F3	Left center	This button is only active when no test is in progress. Pressing F3 or clicking on this button brings up a password dialog box. If the operator enters the correct password, the Max. limit and Min. limit fields at the top of the main program windows are enabled for editing. New limit values may be entered at this time. New limit values thus entered will take effect as soon as a new test sequence is started. Once a test is started, the new limit values are locked until the F3 edit cycle is entered again.
Print Report	Left bottom	Once a test run has been stopped by the operator, a summary test report can be printing by clicking the “Print Report” button. The test report contains data on the number of ballasts tested, the percentage of passed and failed ballast (by failure category) and the average test cycle time.
Stop button F10	Left bottom	Stops the acquisition process. The Stop button is used to abort a test sequence in progress. The test data files will be closed and will only contain data up to the ballast test during which the test was aborted. Test data for the last ballast tested may be incomplete as a result of stopping the test..
Test File	Center	This fields shows the currently selected test data file. It 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 all data will be written while a test sequence 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. During the test run, two files are created, one for all tested ballasts and one for all failed ballasts. Both files are created automatically

Field / Control	Location	Description
Ballast Type Selection	Top Left	This drop down list box allows different ballast types to be selected by the operator. Ballast type selection must be done prior to starting a test. Once a test is running, this control is disabled. Each ballast type uses its own unique set of test limits.
Magn Current	top row	Displays the rms. line current during OCV test.
OCV	top row	Displays the open circuit voltage at the secondary side of the ballast.
Red Fil.	top row	Displays the filament voltage at the lamp for the red wire.
Yel Fil.	top row	Displays the filament voltage at the lamp for the yellow wire.
Blue Fil.	top row	Displays the filament voltage at the lamp for the blue wire.
Line I	top row	Displays the rms. line current of the loaded ballast
Lamp I	top row	Displays the lamp current
PF	top row	Displays the ballast power factor
THD	top row	Displays the total harmonic voltage distortion of the line current.
Ball. Fact.	top row	Displays the ballast factor.
OCV Test	Top Right	Displays the pass (Green) or fail (Red) condition for the open circuit voltage test of the ballast being tested. The second field (Yellow) displays the number of failed OCV tests.
Fil. Test	Top Right	Displays the pass (Green) or fail (Red) condition for the filament voltage tests of the ballast being tested. The second field (Yellow) displays the number of failed Filament voltage tests.
Full load Test	Top Right	Displays the pass (Green) or fail (Red) condition for the full load voltage tests of the ballast being tested. The second field (Yellow) displays the number of failed full load tests.
Test Started	Top Left	This field always shows the start time of the test in progress.
Applied Voltage.	Top Left	Displays the actual AC source output voltage to ballast primary input.
Test Volts	Top Left	Displays the nominal test voltage (rms.) used for the OCV and full load testing sequence.
Test Freq	Top Left	Displays the nominal frequency of the AC line voltage to the ballast primary input.
Sequence Number	Center Right	Displays the number in the sequence for the ballast being tested. Each time the F1: Start button is pressed, this value is reset to zero. Data in the test data file is indexed using this same sequence number in the first column.
Total Fail.	Center Right	Displays the total number of ballast that have been rejected based on one or more of the set limits.
Cycle time	Center Right	Displays the average total test time per ballast so far. This time may vary with the number of failed ballasts as the test time is cut short for any ballast that fails one of the tests applied to it.
Total Failed	Center Right	Displays the total number of ballasts that failed one or more test criteria up to this moment in time. Once the test has been stopped, this number represents the total number of ballasts that failed.

Field / Control	Location	Description
Last 4 units passed	Top Grid	This data grid shows the data for the last four ballasts in the sequence that passed all tests.
Last 8 units failed	Bottom Grid	This data grid shows the data for the last eight ballasts in the sequence that failed the test. Once a ballast fails, the remainder of the test sequence for that ballast is aborted and zero data values will be shown for tests that did not run.

5.3 Test Sequence Steps

The standard BTS-GUI implements a series of test steps aimed at evaluating all the electrical performance characteristics of a standard magnetic or electronic ballast. Measured data is compared against user specified limits to determine a pass or fail conditions. The following test steps are implemented as part of the overall ballast test sequence:

5.3.1 Shorts Test

Prior to applying full power to the ballast under test, the BTS-GUI program applies a 20V rms output to the ballast primary and measures the load current. If the current exceeds the pre-set limits as a result of a short or other anomaly on the input winding, the ballast is rejected and the test is aborted. This low input voltage ensures no further damage to the ballast.

If the shorts test passes, the test sequence proceeds to the open circuit voltage test.

5.3.2 Open Circuit Voltage Test

The open circuit voltage (OCV) test applies full nominal voltage to the ballast primary and measures the line (magnetizing) current and secondary output voltage (OCV) with no lamp load connected to the ballast secondary. For this test, the power factor correction capacitor is bypassed. If the measured output voltage is within specified limits, control passed to the next step in the sequence.

5.3.3 Filament Voltage Test

The filament voltage test measures the individual lamp filament voltages for all the lamps supported by the ballast. The BTS system can handle up to 7 filaments for 8 lamp ballasts. Filaments are identified using the standard wire color schemes. All filament voltages must be within specification for control to pass to the next step in the sequence.

5.3.4 Full Load Test

During the final test step, the lamp load or load resistor network connected to TB-2 is switched in through the built in relay board. This applies full load to the ballast. The lamp voltage and current is measured under full load condition. At the same time, a fast Fourier transformation of the input current is performed to determine the line THD of the loaded ballast. Line and lamp current are determined as is the power factor at the input and the overall ballast factor. All parameters are compared against user specified limits to determine pass or fail conditions.

5.4 Entering New Limit Data

Ballasts are either accepted (Pass) or rejected (Fail) based on comparing actual measured values against user specified limits. Both an upper and lower limit can be set on any parameter that is tested.

Pass or fail criteria for each ballast can be set by the test engineer or QA manager. To edit ballast limits against which the data acquired from each ballast is compared, the operator must know the limit password. Test limits are unique to a specific ballast type and are saved in a separate limit file. (extension .lim)

To facilitate the creation of these test limit files, the BTS GUI software suite includes a learn module that allows multiple test runs on the same ballast while recording minimum and maximum values for all parameters. This min/max data set forms the basis for a limit file. It is typically necessary to increase the test tolerances by increasing the maximum values and/or decreasing the minimum values in order to avoid false negatives. Test tolerances should be set at the discretion of the QA manager.

Alternatively, the desired upper and lower limit values for a given ballast type may be entered directly by placing the standard BTS test program in the Edit mode. To enter the Edit mode, proceed as follows:

- Click on the SET Limit/Type button or press the F3 function key
- A Password entry box appears in the center of the test screen
- Enter the correct password and press the ENTER key to enable the edit mode.
- For this file replay version of the BTS software, the password is PASSWORD.
- Once entered, the upper and lower limits for all test parameters can be changed.
- After all desired changes have been made, the new test limit data must be saved using the SAVE Limits button or by pressing the F4 key.

Test limits are stored by ballast type in a file that has the ballast type as the file name and a .lim extension. Up to 16 different ballast types are supported.

5.5 Test Data Files

The BTS software always logs test data to a set of two data files specified by the user. The file format used consists of Tab delimited fields for all parameters measured for each ballast. Thus, each record in the file represents data for a single ballast. The ballast is identified using a sequence number that is automatically incremented after each ballast has been tested.

File format for all ballast test data, and for failed ballast data are identical. The only difference is in the second record of the file which is either “All units data” or “Failed units data”. Also, the Status field which is the second field in each record will show either Pass or Fail in the passed data file and will show the type of test that failed in the failed data file.

The record structure is shown below. The file size is only limited by the available hard disk space. Each ballast tested will result in a new record being added at the end of the file.

The default directory for all test data files is C:\CI_BTS\TESTDATA.

5.5.1 Data Format - Data on all Ballasts

California Instruments Ballast Test Data													
Passed units data.													
Test date:	Jun. 26 1998		Test start:		10:22:07								
Test voltage:	120.2		Freq:		60.0Hz								
Time	Status	Seq.#	Test V	I Exc.	OCV	Red-fil	Yel-fil	Blu-fil	I-Line	I-lamp	PF	THD	BFact
10:22:11	Pass	1	120.06	1.77	808.6	4.364	4.45	4.157	3.03	0.559	0.947	12.11	0.751
10:22:13	Pass	2	120.05	1.77	808.6	4.358	4.45	4.152	3.002	0.554	0.958	11.03	0.744
10:22:16	Pass	3	119.99	1.78	808.3	4.355	4.449	4.15	3.013	0.557	0.952	11.55	0.748
10:22:18	Pass	4	120	1.76	808.3	4.367	4.449	4.159	3	0.558	0.957	11.1	0.749
10:22:20	Pass	5	120.06	1.78	808.5	4.36	4.445	4.155	3.013	0.556	0.955	11.27	0.745
10:22:22	Pass	6	120.09	1.75	808.7	4.36	4.454	4.156	3.011	0.556	0.956	11.26	0.746
10:22:24	Pass	7	120.05	1.75	808.8	4.364	4.444	4.159	3.022	0.555	0.95	11.91	0.746
10:22:26	Pass	8	119.97	1.76	808.4	4.366	4.451	4.161	3.02	0.557	0.95	11.75	0.747

10:22:35	Pass	932	119.98	1.75	808.4	4.365	4.459	4.163	3.006	0.556	0.959	11.02	0.745
10:22:37	Pass	933	120.04	1.78	808.5	4.375	4.438	4.168	3.011	0.556	0.959	10.97	0.743
10:22:40	Pass	934	119.98	1.75	808.4	4.359	4.45	4.158	3.011	0.558	0.96	10.99	0.745
10:22:42	Pass	935	120.07	1.77	808.8	4.357	4.444	4.156	3.027	0.558	0.958	11.14	0.744
10:22:44	Pass	936	119.99	1.76	808.5	4.375	4.435	4.168	3.043	0.558	0.953	11.51	0.742
End of test data file.													
Test end: 10:37:53 Jun. 26 1998													

5.5.2 Data Format - Data on Failed Ballasts Only

California Instruments Ballast Test Data													
Failed units data.													
Test date:	Jun. 26 1998		Test start:		10:22:07								
Test voltage:	120.2		Freq:		60.0Hz								
Time	Status	Seq.#	Test V	I Exc.	OCV	Red-fil	Yel-fil	Blu-fil	I-Line	I-lamp	PF	THD	BFact
10:22:11	Fil F	47	119.96	1.77	808.5	0.816	4.45	4.157	0	0	0	0	0
10:22:13	Load F	361	120.21	1.77	809.3	4.358	4.45	4.152	2.815	0.625	0.976	14.39	0.731
10:22:16	Load F	487	119.99	1.78	808.9	4.355	4.449	4.15	2.811	0.623	0.975	14.52	0.73
10:22:18	Load F	874	120.11	1.76	808.9	4.367	4.449	4.159	3.454	0.544	0.964	10.08	0.624
10:22:20	Fil F	985	120.06	1.82	801.7	0.764	4.445	4.155	0	0	0	0	0
10:22:22	Fil F	995	120.09	1.79	806.3	4.33	4.454	0.762	0	0	0	0	0
End of test data file.													
Test end: 10:37:53 Jun. 26 1998													

Note:

The Status field can have one of the following values:

- OCV F unit failed open circuit voltage test
- Fil F unit failed one or more filament voltage tests
- Load F unit failed one or more full load tests.

5.5.3 Data Format – Ballast Types

The BTS GUI software can support up to 16 different ballast types. Each ballast type must be identified using a unique name up to 8 characters long. Ballast types for which a name has been assigned and limits are defined can be selected by the user from the Select Type drop down control.

The names of the ballast types defined are stored in the type.fil file located in the Bts\Testdata directory. This is a simple ASCII text file.

5.5.4 Data Format – Limit File

Each ballast type defined is associated with a test limit file. The test limit file contains the upper and lower limit values for all parameters tested. This file uses the same name as the ballast type definition provided by the user. (Maximum 8 characters).

The file extension for these files is .lim and they are all located in the Bts\Testdata directory. This is a simple ASCII text file.

5.6 Aborting a Test Run

Tests in progress can be aborted at any time by pressing the F10 key or by clicking the Stop button.

5.7 Printing a Test Report

At the end of test run, it is possible to print a summary test report of the most recently completed test sequence. Ballast test reports consist of a single page listing the number of ballasts tested and the percentages and types of ballast failures. A sample test report is shown in the figure below. A printer must be connected to the controlling PC or through a network connection in order to print test reports.

```
California Instruments Ballast Test Replay         16:34 Apr. 02, 1999

Standard 2 lamp magnetic ballast test report

        Ballast type : R2S40

        Replay started : 16:34:07       Apr. 02 1999
        Stopped: 16:34:48

        Test conditions and limits

        Test voltage:  120.5  V rms     Frequency:  60  Hz
        Parameter             Min.      Max.
        OCV current           0.325     0.355     A-rms.
        OCV voltage           271.5     283.5     V-rms.
        Red filament          3.45      3.75      V-rms.
        Yellow filament       3.45      3.75      V-rms.
        Blue filament         3.45      3.75      V-rms.
        Line current          0.685     0.725     A-rms.
        Lamp current          0.395     0.425     A-rms.
        THD in %              24        26          %
        Power factor          0.925     1
        Ballast factor        79.8      80.9

        Total units tested:  22
        Total failures:  5
        Total failures in percent of tested units: 22.727  %

        Open circuit test failures :1
        Open circuit failures in percent of tested units:  4.545  %

        Filament voltage failures:4
        Filament voltage failures in percent of tested units :  18.181  %

        Full load failures:  1
        Full load failures in percent of tested units :  4.545  %

        Average test time per unit:     1.37   seconds

        All test data stored in :   C:\BTS\testdata\R2S40.dat
        Failure data only stored in :  C:\BTS\testdata\R2S40.bad
```

5.8 Creating New Ballast Types

New ballast types can be added only in the Edit Test limit mode by clicking on an available entry in the Defined Types table and typing in a new name or model. Names can be up to eight characters long. Press the ENTER key after typing in the new name.

The names of the ballast types defined are stored in the type.fil file located in the BTS\Test data directory.

Once a new ballast type name has been entered, test limits must be defined and saved before the new ballast type can be used for actual test runs.

5.9 Digital I/O Use

The BTS GUI makes uses of several digital output drive signal to control the internal relays used for switching the external load. The digital outputs, some of which are brought out through the DB-15 connector on the rear panel are all controlled by the BTS GUI program. If custom software is used to control the BTS system unit, output DO3 through DO0 may be assigned at will for any purpose desired. Output DO7 through DO4 however are hardwired internally per the table below and should not be used for any other purpose.

Drive capability

- The 24 V DC output is provided for driving external relays. Maximum current draw must not exceed 100 mA.
- The digital outputs DO3 through DO0 can be used to drive up to 10 mA. The lines can be used to drive external relays using appropriate buffer circuitry.

Digital I/O pin assignments through BTS GUI

The BTS system unit uses a total of eight digital inputs and eight digital outputs. Some of these I/O signals are used internally do drive the control/relay board. Specifically, the following assignments are made when using the BTS GUI software.

Output #	Signal
DO7	Drives relay K4 on the internal Control/Relay board. Relay K4 connects the lamp loads to the output. A logic low de-energizes (opens) the relay.
DO6	Drives relay K5 on the internal Control/Relay board. Relay K5 connects the Cap. A logic low de-energizes (opens) the relay.
DO5	Drives relays K1, K2, K3 and K6 on the internal Control/Relay board. These relays connect the lamp filaments. A logic low de-energizes (opens) the relay.
DO4	This signal controls the current range sensitivity. A logic low selects the low current range (12.2 A peak). If the external current sense option is used, the following current range sensitivities apply: High range: 102.15 mV / A Low range: 408.6 mV / A
DO3	This output is available on the DB-15 connector at the rear panel and signals the PASS or FAIL status of the ballast under test. A logic low indicates a FAIL condition. A logic high indicates a PASS condition.
DO2	This signal mirrors the status of DO7. It may be used to drive an external relay for switching the CAP. The status of this output may also be used to monitor test completion. The end of each ballast test is indicated by a ON, OFF sequence plus a 100 msec delay to allow for data processing.
DO1	This signal mirrors the status of DO6. It may be used to drive an external relay for switching the CAP.
DO0	This signal mirrors the status of DO5. It may be used to drive external relays for switching the lamp filaments.

5.10 Special Graph Functions

The BTS-GUI may be expanded to include graphical representations of various parameters. This capability is most suitable for use in R&D applications. If any graphs are used in the BTS-GUI software supplied with your BTS system, the following general graphing capabilities apply. If the software supplied with your system does not incorporate graphs, proceed to Chapter 6.

5.10.1 Inspecting Graphs

Any graphs used to display voltage, current or any other ballast parameter can be "inspected" in more detail using the Inspect button located in the top right hand corner of each graph area. 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.

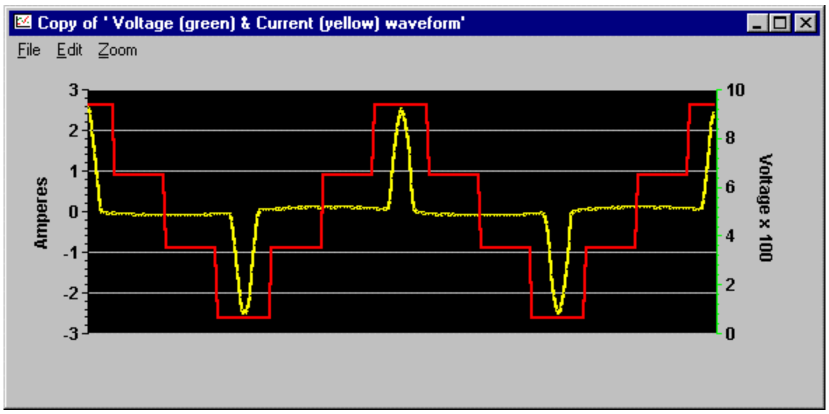
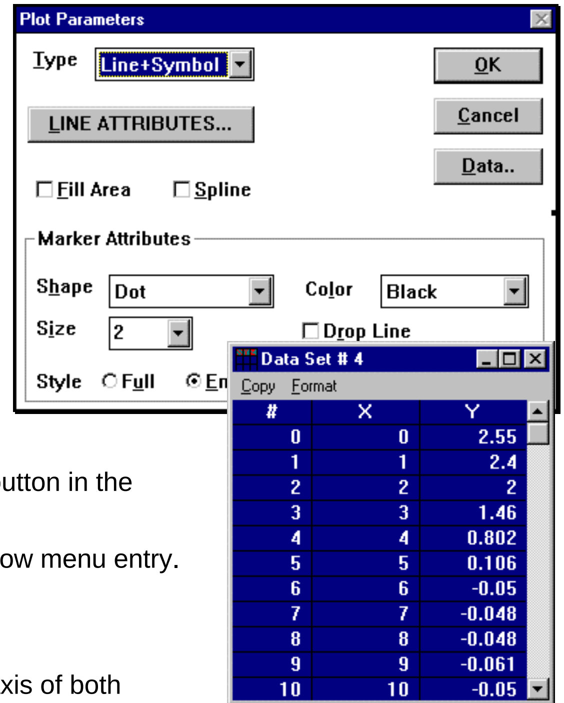


Figure 5-2: Graph Inspect Window

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 BTS main test window.
Edit	Copy	The data table that results from a Edit, Copy operation of the Window shown in 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.

5.10.2 Changing Graph Parameters



Individual data sets can be displayed on screen from the Inspect window by double clicking with the mouse of 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.

5.10.3 Graph Axis Scaling

The BTS software normally user 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.

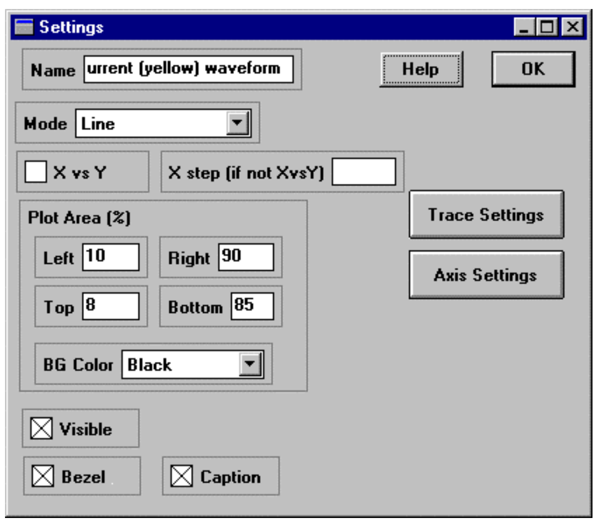


Figure 5-3: Graph Settings Dialog

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.

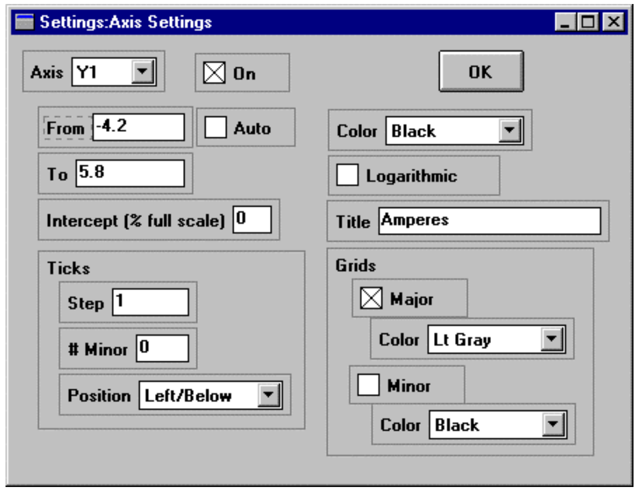


Figure 5-4: Graph Axis Settings Dialog

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 BTS 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.

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6. Specifications

6.1 About This Chapter

This chapters provides the technical specifications of the BTS measurement system and the BTS system unit. If the BTS 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.

6.2 Measurement System Specifications

The BTS 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 specifications listed here.

Measurement		Specification	Unit
Frequency - Standard (Magnetic Ballasts)			
	Range	45.0 - 440.0	Hz
	Accuracy and Resolution	0.1	Hz
Frequency - HF Option (Electronic Ballasts)			
	Range	10.0 - 150.0	KHz
	Accuracy and Resolution < 1 kHz	0.01	KHz
	> 1 kHz	0.1	KHz
Volts-Line and Lamp			
	Input Range (nominal)	0.00 - 700.00	V_{rms}
	Max. input (nominal)	1000	V_{peak}
	Max. input (transient)	1500	V_{peak}
	Max. crest factor	5:1	
	Accuracy	±0.1 % ± 0.05 % FS	
	Resolution	10	MV
	Voltage CMRR	80	DB
Volts – Filament			
	Input Range (selectable)	0.001 - 4.000 / 8.000	V_{rms}
	Accuracy	± 0.5 / 1.0 % FS	Typ/./Max
	Resolution	1	MV
	Voltage CMRR	80	dB
RMS Current			
	Current range	0.00 – 20.00	A_{rms}
	Peak current	0.00 – 40.00	A
	Max. input [permanent, no damage if < 200 A_{peak}]	50.00	A
	Crest Factor	20:1	
	Accuracy	±0.1 % ± 0.05 % FS	mA
	Resolution	10	mA
Power			
	Range	0.1 – 3000	W
	Accuracy	±0.25 % ± 0.25 % FS	
	Resolution	0.1	W

Measurement		Specification	Unit
Apparent Power			
	Range	0.1 - 3000	VA
	Accuracy	±0.15% ± 0.15% FS	mVA
	Resolution	0.1	VA
Power Factor			
	Range	± 1.000	
	Accuracy	± 0.01 ± 0.001/kHz	
	Resolution	0.001	
Harmonic Analysis			
	Range	Fundamental to 50^{th}	
	Accuracy Fundamental	±0.05% FS±0.05%/kHz	
	Accuracy Harmonics	±0.1 %±0.1%/kHz	

6.3 BTS System Unit Specification

The BTS system unit creates the mechanical and electrical interface between the AC source, the EUT and the PC. It provides the necessary isolation and signal conditioning to perform the measurements needed.

The following specifications apply to the BTS system unit.

BTS Model:	Connector	BTS-1
Number of phases		1
Channels	Voltage and Current	16
Connector Style	Front panel	DB-37
	Rear panel	terminal blocks TB1 - 4 DB-37 DB-25 DB-15
Maximum voltage	TB3	700 Vrms
Maximum current	TB4	20 Arms
Dimensions	HxWxD	3.5 x 16.8 x 22
	HxWxD	89 x 427 x 560

Voltage Range: The input voltage range is 0 to 1000 V peak. The voltage is applied to input terminal block TB3. (V1, V2, V3)

Current Range: The input current is 0 to 20 A rms. The input current rating applies to TB4 only. (I1, I2, I3, I4)

6.4 External CT and Aux Input Specifications

Measurement		Specification	Unit
CT Volt			
	Max. input	± 25	V_{peak}
CT Scaling			
	Low current range	102.15	mV / A
	High current range	408.6	mV / A

6.5 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 (Over voltage Category) II
Vibration:	Designed to meet NSTA 1A transportation levels.
Shock:	Designed to meet NSTA 1A transportation levels.

6.6 Regulatory

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

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7. Routine Calibration

7.1 About This Chapter

This chapter provides calibration service information on the BTS measurement system. If the BTS system you have includes an AC power source, refer to the separate AC source user manual that shipped with the AC source for service and calibration information of the AC source.

7.2 Calibration

The BTS system uses a precision measurement system that requires periodic calibration. The recommended calibration interval is one year. All BTS systems are calibrated when shipped so calibration should not be needed until after the first year of use.

If it is suspected that calibration is required on the BTS measurement unit, contact the factory for calibration assistance and information.

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CAUTION

VOLTAGES UP TO 700 VAC AND 350 VDC MAY BE PRESENT IN CERTAIN SECTIONS OF THE BTS SYSTEM UNIT AND COMPANION POWER SOURCE. 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.

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8. Service and Troubleshooting

8.1 Cleaning

The exterior of the power source or the BTS system 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.

8.2 General

This section describes the suggested maintenance and troubleshooting procedure. The troubleshooting procedure is divided into two sections. The first section deals with basic operation and connection of the equipment. The second section requires opening the BTS system 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 700 VAC MAY BE PRESENT IN CERTAIN SECTIONS OF THE BTS 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

8.3 Basic Operation

8.3.1 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 TB3 or TB4. Check for wrong terminals or poor connections.
AC source voltage OK. Input wiring is OK. Still no power to EUT	1. Incorrect output wiring from TB3 to ballast primary. 2. Defective plug and cable from front panel outlet on BTS system unit.

8.3.2 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 ballast load is applied, it is very likely that the power source is being severely overloaded. Any severe overload will cause the AC source to immediately program its output to zero volts and open the output relay.
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 ballast primary wiring or load. Make sure neutral and line wires don't form a short circuit.

8.3.3 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.

8.3.4 No Signal To PC Interface

CONDITION	POSSIBLE CAUSE, REMEDY
EUT is being driven properly and voltage and current is present, but the BTS-GUI software shows zero current or zero voltage.	1. The BTS system unit front panel power switch is not on. Turn on switch, check ON LED. 2. The ½ Amp input fuse is open. Replace fuse. 3. The DB-37 interface cable is not seated in its mating connectors. Reinsert connectors. 4. The Sensor Circuit board assembly inside the BTS system unit is defective. See next section.

8.4 Troubleshooting Hints

This section addresses possible problems that may be encountered during the installation and/or use of the BTS system hardware and software. While every attempt was made to cover as many possible scenario's as possible, it is possible that the symptoms you are experiencing are not covered in this chapter. Should this be the case, contact California Instruments using the contact information provided in front of this manual.

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

CAUTION:VOLTAGES UP TO 1000 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

8.4.1 Switch Off Unit, Disconnect High Voltage

Switch off the BTS 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.

8.4.2 Removing Top Cover

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

8.4.3 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 5004-706 to the front and rear panels.

8.4.4 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 5004-706 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 CR6.
2. Switch on the BTS unit with the front panel switch.
3. Verify the DC voltage at CR6-cathode is +15V.
4. Connect the DMM lead to the anode of diode CR7.
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.

8.4.5 Power-On Troubleshooting - Voltage Sense

1. Connect the DMM common to TP1.
2. Connect the other DMM lead to TP6. This is the V1 voltage sense output.
3. Apply a test voltage to the BTS system unit input terminals TB3. Use V1 Hi and Lo.
4. The reading at TP6 should be 1/100 of the input voltage. For example, if 120 V rms. is applied at TB3, then there should be 1.20V rms. at TP6.
5. Connect the other DMM lead to TP7. This is the V2 voltage sense output
6. Apply a test voltage to the BTS input terminals TB3. Use V2 Hi and Lo.
7. The reading at TP7 should be 1/100 of the input voltage. For example, if 120 V rms. is applied at V2, then there should be 1.20V rms. at TP7.
8. Connect the other DMM lead to TP8. This is the V3 voltage sense output
9. Apply a test voltage to the BTS input terminals TB3. Use V3 Hi and Lo.
10. The reading at TP8 should be 1/100 of the input voltage. For example, if 120 V rms. is applied at V3, then there should be 1.20V rms. at TP8.
11. If any of these test points do not have the correct voltage on them, the board is malfunctioning and it must be repaired or returned for service.

8.4.6 Power-On Troubleshooting - Current Sense

1. Connect the DMM common to TP1.
2. Connect the other DMM lead to TP2. This is the I1 current sense output.
3. Apply a 4A test current to the BTS input terminals TB4. Use I1 In and Out.
4. The reading at TP2 should be 408 mV/ Amp of input current. For example, with 4.0A rms. applied at I1, then there should be 1.632 V rms. at TP2.
5. Connect the other DMM lead to TP3. This is the I2 current sense output.
6. Apply a 4A test current to the BTS input terminals TB4. Use I2 In and Out.
7. The reading at TP3 should be 408 mV/ Amp of input current. For example, with 4.0A rms. applied at I2, then there should be 1.632 V rms. at TP3.
8. Connect the other DMM lead to TP4. This is the I3 current sense output.
9. Apply a 4A test current to the BTS input terminals TB4. Use I3 In and Out.
10. The reading at TP4 should be 408 mV/ Amp of input current. For example, with 4.0A rms. applied at I3, then there should be 1.632 V rms. at TP4.
11. Connect the other DMM lead to TP5. This is the I4 current sense output.
12. Apply a 4A test current to the BTS input terminals. Use I4 In and Out.
13. The reading at TP5 should be 408mV/ Amp of input current. For example, with 4.0A rms. applied at I4, then there should be 1.632 V rms. at TP5.
14. If these sense voltages are not obtained, then the board is malfunctioning and it must be repaired or returned for service.

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