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CT-100B SERIES

SIX-SLOT VXIBUS CHASSIS

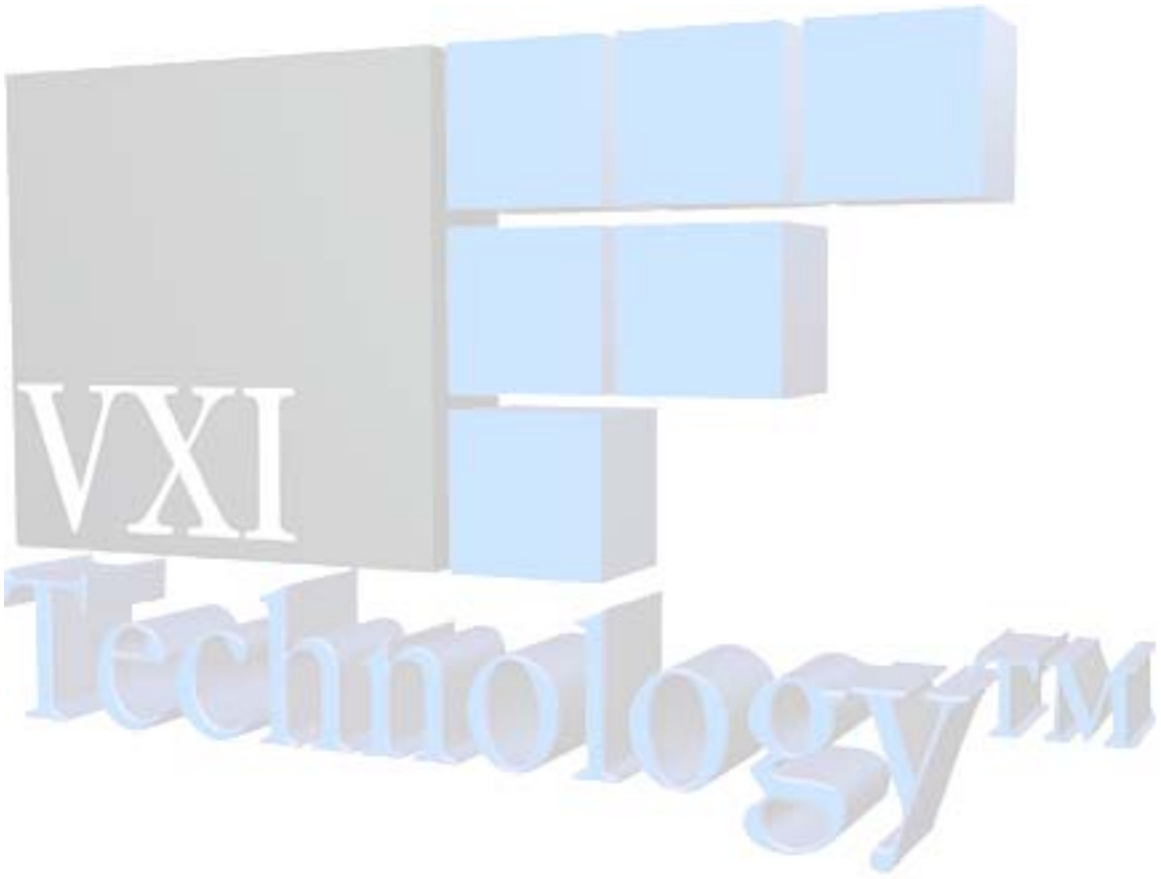
USER'S MANUAL

82-0042-000
Rev. April 7, 2003

VXI Technology, Inc.

2031 Main Street
Irvine, CA 92614-6509
(949) 955-1894

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CERTIFICATION

VXI Technology, Inc. (VTI) certifies that this product met its published specifications at the time of shipment from the factory. VTI further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (formerly National Bureau of Standards), to the extent allowed by that organization's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

The product referred to herein is warranted against defects in material and workmanship for a period of three years from the receipt date of the product at customer's facility. The sole and exclusive remedy for breach of any warranty concerning these goods shall be repair or replacement of defective parts, or a refund of the purchase price, to be determined at the option of VTI.

For warranty service or repair, this product must be returned to a VXI Technology authorized service center. The product shall be shipped prepaid to VTI and VTI shall prepay all returns of the product to the buyer. However, the buyer shall pay all shipping charges, duties, and taxes for products returned to VTI from another country.

VTI warrants that its software and firmware designated by VTI for use with a product will execute its programming when properly installed on that product. VTI does not however warrant that the operation of the product, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The warranty shall not apply to defects resulting from improper or inadequate maintenance by the buyer, buyer-supplied products or interfacing, unauthorized modification or misuse, operation outside the environmental specifications for the product, or improper site preparation or maintenance.

VXI Technology, Inc. shall not be liable for injury to property other than the goods themselves. Other than the limited warranty stated above, VXI Technology, Inc. makes no other warranties, express or implied, with respect to the quality of product beyond the description of the goods on the face of the contract. VTI specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

RESTRICTED RIGHTS LEGEND

Use, duplication, or disclosure by the Government is subject to restrictions as set forth in subdivision (b)(3)(ii) of the Rights in Technical Data and Computer Software clause in DFARS 252.227-7013.

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DECLARATION OF CONFORMITY

Declaration of Conformity According to ISO/IEC Guide 22 and EN 45014

MANUFACTURER'S NAME	VXI Technology, Inc.
MANUFACTURER'S ADDRESS	2031 Main Street Irvine, California 92614-6509
PRODUCT NAME	Six-Slot VXIbus Chassis
MODEL NUMBER(S)	CT-100B
PRODUCT OPTIONS	All
PRODUCT CONFIGURATIONS	All

VXI Technology, Inc. declares that the aforementioned product conforms to the requirements of the Low Voltage Directive 73/23/EEC *and the* EMC Directive 89/366/EEC *(inclusive* 93/68/EEC*) and carries the "CE" mark accordingly. The product has been designed and manufactured according to the following specifications:*

SAFETY	EN61010 (2001)
EMC	EN61326 (1997 w/A1:98) Class A CISPR 22 (1997) Class A VCCI (April 2000) Class A ICES-003 Class A (ANSI C63.4 1992) AS/NZS 3548 (w/A1 & A2:97) Class A FCC Part 15 Subpart B Class A EN 61010-1:2001

I hereby declare that the aforementioned product has been designed to be in compliance with the relevant sections of the specifications listed above as well as complying with all essential requirements of the Low Voltage Directive.

April 2003

CE

Jerry Patton, QA Manager

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GENERAL SAFETY INSTRUCTIONS

Review the following safety precautions to avoid bodily injury and/or damage to the product. These precautions must be observed during all phases of operation or service of this product. Failure to comply with these precautions, or with specific warnings elsewhere in this manual, violates safety standards of design, manufacture, and intended use of the product.

Service should only be performed by qualified personnel.

TERMS AND SYMBOLS

These terms may appear in this manual:

WARNING Indicates that a procedure or condition may cause bodily injury or death.

CAUTION Indicates that a procedure or condition could possibly cause damage to equipment or loss of data.

These symbols may appear on the product:



ATTENTION - Important safety instructions



Frame or chassis ground

WARNINGS

Follow these precautions to avoid injury or damage to the product:

Use Proper Power Cord To avoid hazard, only use the power cord specified for this product.

Use Proper Power Source To avoid electrical overload, electric shock, or fire hazard, do not use a power source that applies other than the specified voltage.

Use Proper Fuse To avoid fire hazard, only use the type and rating fuse specified for this product.

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WARNINGS (CONT.)

Avoid Electric Shock

To avoid electric shock or fire hazard, do not operate this product with the covers removed. Do not connect or disconnect any cable, probes, test leads, etc. while they are connected to a voltage source. Remove all power and unplug unit before performing any service. ***Service should only be performed by qualified personnel.***

Ground the Product

This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground.

Operating Conditions

To avoid injury, electric shock or fire hazard:

- Do not operate in wet or damp conditions.
- Do not operate in an explosive atmosphere.
- Operate or store only in specified temperature range.
- Provide proper clearance for product ventilation to prevent overheating.
- DO NOT operate if any damage to this product is suspected. ***Product should be inspected or serviced only by qualified personnel.***



Improper Use

The operator of this instrument is advised that if equipment is used in a manner not specified in this manual, the protection provided by this equipment be may be impaired.

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SUPPORT RESOURCES

Support resources for this product are available on the Internet and at VXI Technology customer support centers.



Internet Support

E-mail: support@vxitech.com
Web Address: http://www.vxitech.com

Telephone Support (U.S.)

Tel: (949) 955-1894 **West Coast**
(216) 447-8950 **East Coast**

Fax: (949) 955-3041 **West Coast**
(216) 447-8951 **East Coast**

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SECTION 1

INTRODUCTION

INTRODUCTION

The CT-100B portable C-size VXIbus mainframe provides cost-effective test situations in a small footprint. When using VMIP™ instruments such as DMMs, waveform generators, digitizers, etc., complete test scenarios can easily be configured.



FIGURE 1-1 CT-100B SIX-SLOT CHASSIS

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GENERAL DESCRIPTION

The CT-100B chassis is a portable, C-size, six-slot, VXIbus compatible chassis that conforms fully to VXIbus Specification Revision 1.4. The chassis employs a multi-layer backplane to ensure premium VXIbus and VMEbus performance and provides all power supplies required by the VXIbus specification.

The CT-100B supports conventional existing rack designs through an optional rack mounting kit (see Section 2). The six-slot design minimizes the use of precious rack space and is an economical alternative to a larger chassis when fewer slots are required.

The CT-100B chassis contains six slots in the card cage, five of which are available for use by VXIbus compatible instruments. The sixth slot in the card cage (slot 0) is typically dedicated to the VXIbus Resource Manager.

The CT-100B is designed to operate at line frequencies between 47 Hz and 63 Hz and is factory preset to operate at a nominal line voltage of 115 VAC. The chassis auto selects between a nominal 115 VAC or 220 VAC line, requiring only the fuse be changed to operate at a nominal 220 VAC.

The rear panel provides a connector for 5 V STANDBY. Power supplied to this connector is passed directly to the backplane line +5VSTDBY. This allows properly configured systems to take advantage of an alternate power supply source, i.e., battery backup of memory or energizing high stability reference oscillators.

BACKPLANE

The backplane is a monolithic, multi-layer design, with automatic, solid state daisy-chain jumpering for the interrupt acknowledge and VMEbus grant lines. This eliminates the need for manual jumpering and provides improved reliability over mechanical jumper-less backplane designs. Instrument modules can now be added or removed without concern for the backplane configuration.

PERFORMANCE

The CT-100B uses a pressurized airflow system. As air enters the mainframe from the rear, it is pressurized below the cards and is then evenly distributed across all slots and along the total length of each card slot, avoiding hot spots common in other designs. The air exhausts through the top and away from the user. This cooling approach helps increase MTBF (Mean Time Before Failure) figures and module performance.

High-quality power supplies are used in the CT-100B that are UL, CSA and TUV approved. The power supplies are short-circuit, over-voltage, reverse-voltage and thermal-shutdown protected. Auto-ranging power supplies are used to avoid any concern about the voltage source used. In addition, all supply lines are monitored and displayed on the front panel to provide user feedback of correct operation (see Figure 3-2).

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FLEXIBILITY

The CT-100B is designed to provide flexibility of use in bench-top and rack-mount applications, as well as in portable environments. The outside cover is removable for easy access to the VXIbus modules during bench-top development, troubleshooting or calibration. For rack-mount applications, a rack-mount kit allows the CT-100B to mount flush or be recessed four inches. A latched door is provided with the rack-mount kit, which can be user-modified to accept connectors, switches or indicators. See Section 2 for rack-mount installation.

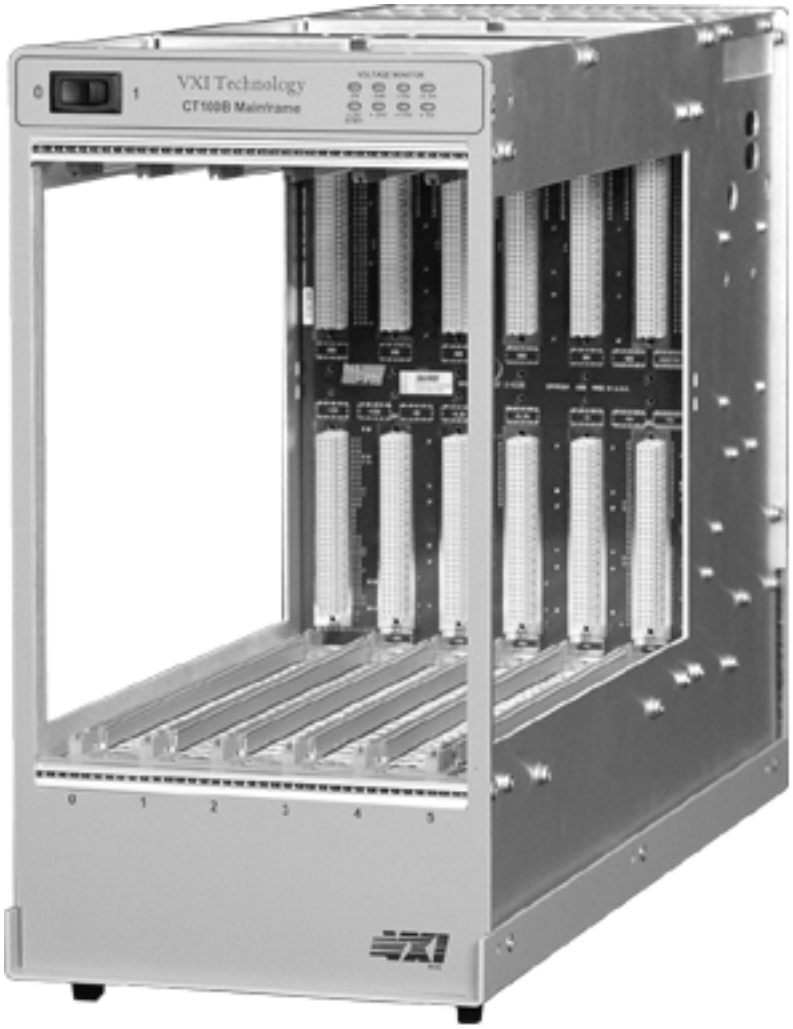


FIGURE 1-2 CT-100B SIX-SLOT CHASSIS - COVERS OFF

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CT-100B Series Specifications

General Specifications	
Size	
	8.2” W x 15” H x 21” D without feet and handle 8.5” W x 17” H x 21” D with feet and handle Six C-Size VXIbus card slots
Weight	
	28 lbs (12.7 kg)
VXIbus Version	
	1.4
MTTR	
	30 min

Environmental Specifications	
Operating Location	
	This chassis should be operated indoors in a controlled environment, protected from exposure to the elements (i.e. direct sunlight, precipitation, wind, etc.).
Temperature	
Operating	0°C to +50°C
Storage	-40°C to +70°C
Humidity	
	5 – 95% (non-condensing)
Altitude	
	Up to 3000 m

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POWER SPECIFICATIONS

USEABLE POWER

450 W at 40°C

DC Supply Voltage

Voltage	Peak Current (I_{MP})	Dynamic Current (I_{MD})
+5 V	35 A	5 A
-5.2 V	25 A	4 A
-2 V	7 A	2 A
+12 V	4 A	2 A
-12 V	4 A	1.5 A
+24 V	4 A	3 A
-24 V	4 A	3 A

Output Voltage

Voltage	Allowed Variation	Ripple/Noise DC Load	Induced Ripple Noise
+5 V	+0.25 V / -0.125 V	50 mV	50 mV
-5.2 V	-0.26 V / +0.125 V	50 mV	50 mV
-2 V	-0.10 V / +0.72 V	50 mV	50 mV
+12 V	+0.60 V / +0.36 V	50 mV	50 mV
-12 V	-0.60 V / +0.36 V	50 mV	50 mV
+24 V	+1.20 V / -0.72 V	150 mV	150 mV
-24 V	-1.20 V / +0.74 V	150 mV	150 mV

POWER INPUT

Input Voltage

AC

115 VAC, nominal 90 – 132 VAC
230 VAC, Nominal 180 – 264 VAC
} Auto Selected

Frequency 47 Hz – 63 Hz

Fuse

115 V Operation 10 A slow blow

220 V Operation 5 A slow blow

+5VSTBY

6 A max, user supplied
Standard banana jack on rear panel, voltage and ground

POWER SUPPLIES (TBD)

UL, CSA, TUV approved
Shout circuit, over-voltage, reverse voltage and thermal shutdown protection

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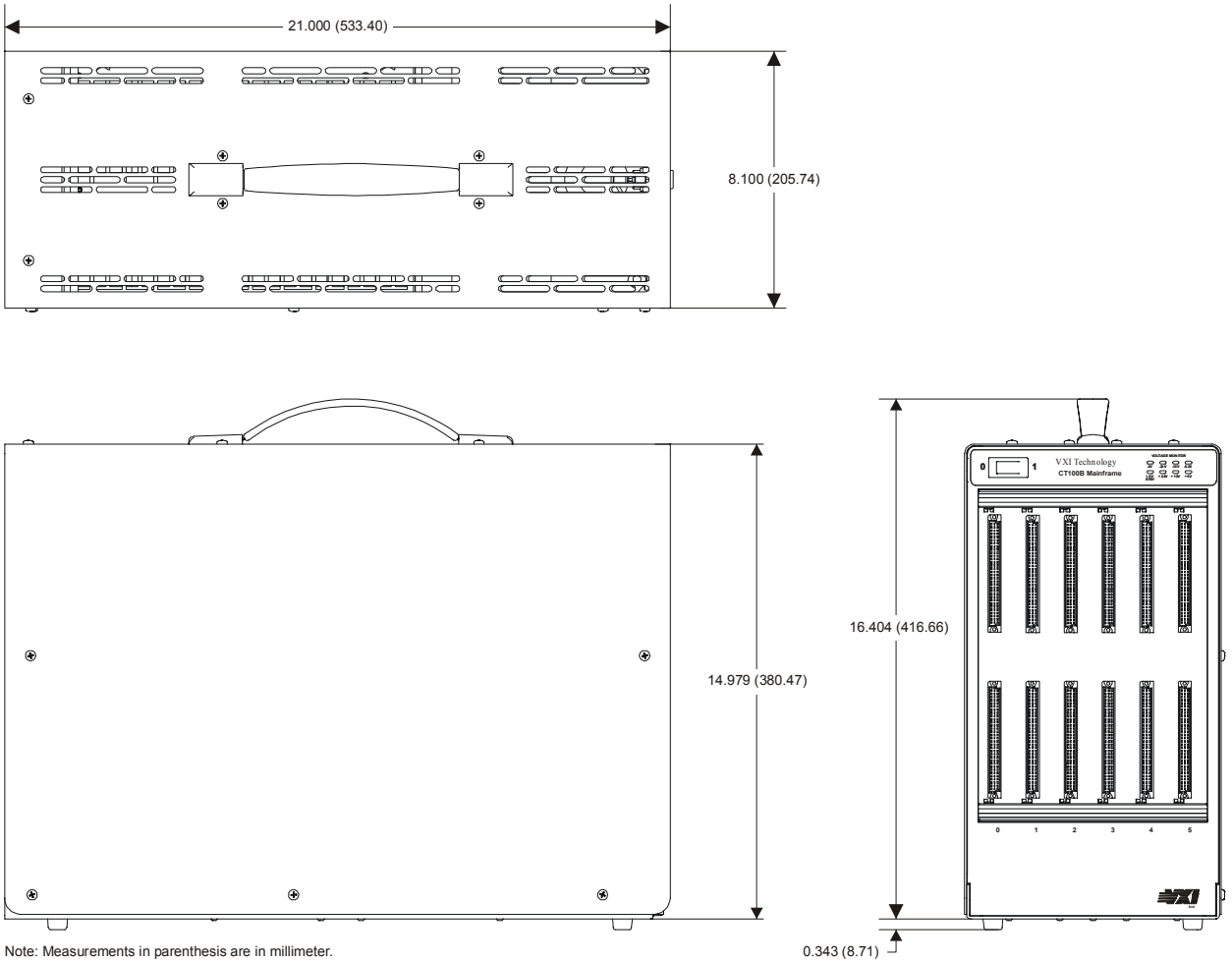
COOLING SPECIFICATIONS	
COOLING REQUIREMENTS (TBD)	
	60 W/slot for a 10°C Rise 80 W/slot for a 15°C Rise
AIR FLOW PATH	
	Air is drawn into the chassis from the rear and is pressurized below the cards. The air is then distributed across all slots along the total length of each slot and is exhausted through the top of the mainframe. When the mainframe is rack mounted, allow approximately 2 inches (50 mm) of clearance at the top and rear for proper airflow.



*** Covers all slots, unrestricted**

FIGURE 1.3 COOLING CAPACITY FOR CT-100B (TYPICAL)

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Note: Measurements in parenthesis are in millimeter.

FIGURE 1.2 CT-100B DIMENSIONAL DIAGRAM

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SECTION 2

INSTALLATION

INTRODUCTION

When the CT-100B is unpacked from its shipping carton, the contents should include the following items:

(1) CT-100B Six-Slot Chassis
(1) CT-100B Module User's Manual (this manual)
(2) Replacement fuses, one 10 A slow blow, one 5 A slow blow
(1) Power cord

All components should be immediately inspected for damage upon receipt of the unit.

LINE VOLTAGE SELECTION

The CT-100B provides auto-ranging power supplies, which automatically sense the line power value and set themselves accordingly. Ensure that the fuse is correctly rated for the selected line voltage (the CT-100B is factory configured with a 10 A/115 V fuse). The fuse is located in fuse-holder F1 on the rear panel of the chassis. The correct fuse ratings are:

115 V operation	10 A slow blow
220 V operation	5 A slow blow

See Figure 2-1 for the location of the line fuse.

CAUTION **Do not attempt to change the fuse with the line cord connected. Ensure that power is off and that the unit is unplugged before changing the fuse.**

BACKPLANE

The CT-100B has a jumper-less auto-configurable backplane using active-automatic daisy chaining for the VME Interrupt acknowledge and bus grant daisy chain signal lines. This eliminates the need to manually configure the backplane.

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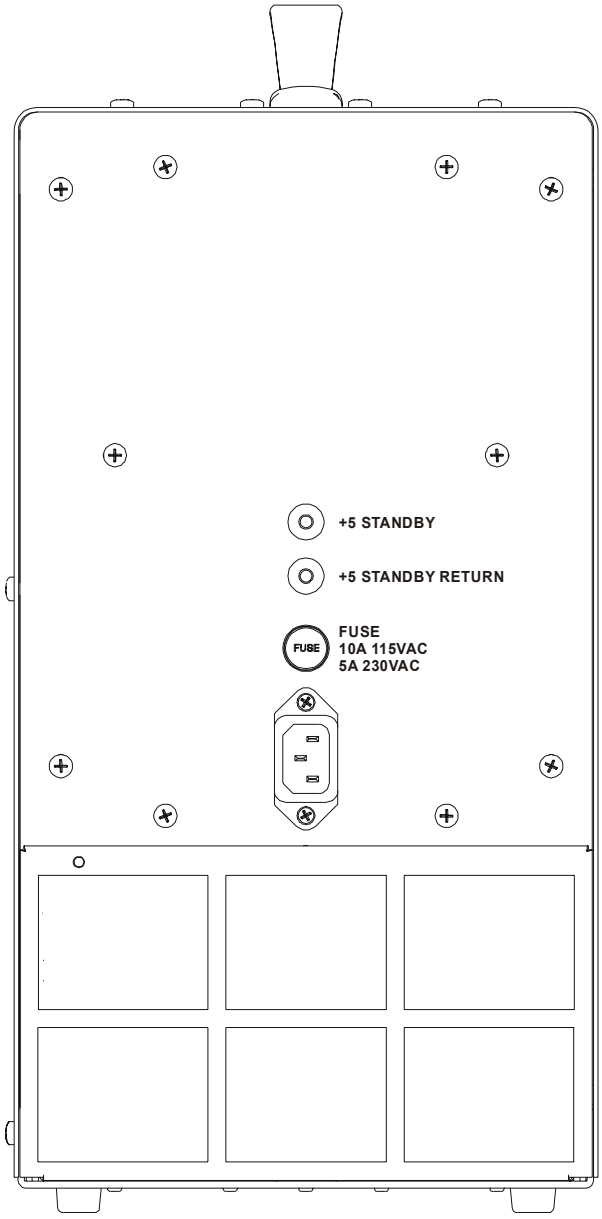


FIGURE 2-1 CT-100B BACK PANEL

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RACK MOUNT OPTION INSTALLATION

OVERVIEW

This section contains the procedures for installing a CT-100B chassis in a standard 19" relay rack. The available rack mounting options are:

Option 52 – Rack Mount Ear Kit
Option 53 – Rack Mount Door Kit
Option 57 – 20" Slide Kit
Option 58 – 24" Slide Kit

The rack mount ear kit provides the basic hardware necessary to rack mount the CT-100B chassis. Because the chassis is only 15" wide, standard rack support rails cannot provide mechanical support to the chassis. If the equipment mounted below the CT-100B cannot provide mechanical support to the chassis, either 20" or 24" slides will be required to support the chassis in the rack. The rack mounting ears are designed to allow the chassis to be flush mounted in the rack or recessed 4".

The rack mount door kit provides the necessary hardware to install either a 1/8" thick aluminum door or a 1/8" thick acrylic door in front of the rack mounted chassis. These options require that the rack mount ear kit also be installed and configured for recessed mounting. The door may be customer modified to hold connectors, controls, indicators and similar components.

The 20" and 24" slide kits provide the ability to easily remove the chassis from the rack for servicing and provides mechanical support for the chassis when installed in the rack. The 20" slide kit is used when the chassis is flush mounted in the rack. If the chassis is to be recess mounted, then the 24" slides are required.

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RACK MOUNT KIT INSTALLATION

The rack mount kit (Option 59) provides the basic hardware necessary to rack mount the CT-100B chassis. With the chassis being only 15" wide, standard rack support rails cannot provide mechanical support to the chassis. If the equipment mounted below the CT-100B cannot provide mechanical support to the chassis, either 20" or 24" rack slides will be required to support the chassis when installed into the rack. The rack mounting ears are designed to allow the chassis to be flush mounted in the rack or recessed 4".

REQUIRED TOOLS

1. #2 Phillips Screwdriver

PARTS LIST

QTY	ITEM	VTI P/N
4	Screw, 6-32 x 1/2", Phillips/Sems	37-0028-050
1	Bracket, Rack Flange w/ hinge mounting holes	41-0135-000
1	Bracket, Rack Flange	41-0135-001

ASSEMBLY PROCEDURE

1. Remove the four (4) black plastic feet from the bottom of the chassis.

2. Lay the chassis on a protected work surface on its long side with the voltage monitor LEDs of the chassis facing front with the power switch toward the top.

3. Locate and remove four black plastic feet on the side of the chassis and four black plastic feet on the bottom of the chassis. Retain the feet if restoring the chassis to its original portable use is anticipated.

4. Find two threaded holes on each side of the chassis (the plastic feet were attached to two of these holes) towards the front of the unit.

5. Line up the rack mount ears with the threaded holes selecting the flush or recessed position as desired. Refer to the rack mount ear installation diagram for visual assistance.

6. Secure the rack ears using the supplied #8-32 hardware.

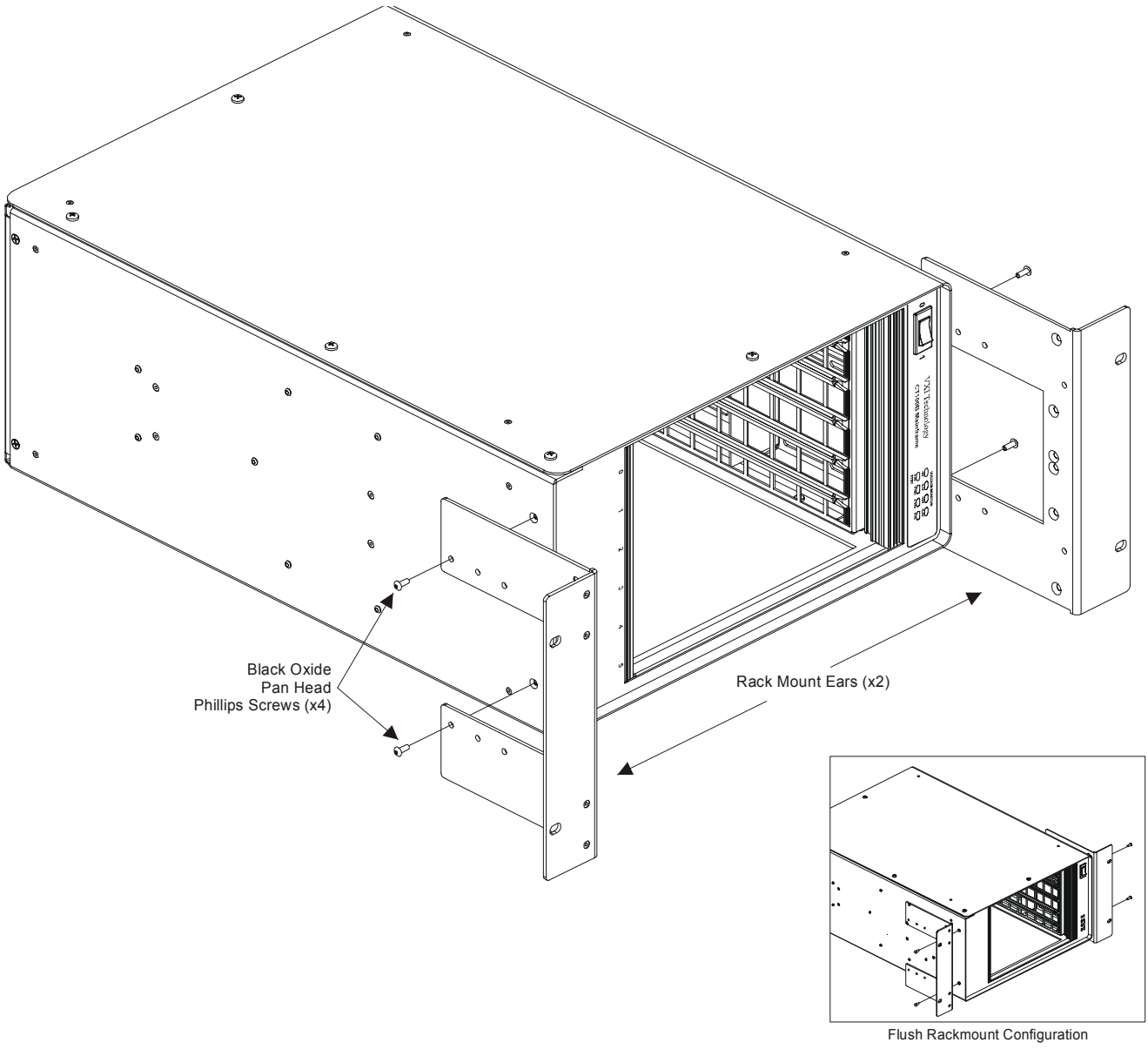
Before installing the chassis into an EIA switch rack, the chassis handle should be removed. This can be done by doing the following:

1. Remove the four screws located near the handle.

2. Remove the two black decorative covers at each end of the carrying handle using the flat blade screwdriver. Place a piece of paper under the screwdriver blade to prevent scratching the chassis cover.

3. Remove the four Phillips screws holding the handle in place and then remove the handle itself. Retain the carrying handle components if there may be some need to restore the chassis to its original portable use in the future.

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* Recessed Rack Mount Installation Shown

FIGURE 2.2: RACK MOUNT EAR INSTALLATION DIAGRAM

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RACK SLIDE INSTALLATION (20” AND 24”)

The 20” and 24” slide hardware kits (Options 63 and 64, respectively) provide standard flanges to mount the slides into standard EIA relay racks. It should be noted that the slide flanges in the front should be installed behind the rack’s front panel mounting rails. This will allow the rack mounting ears to sit flush with the front of the rack. It should also be noted that although the hardware provided in this kit will provide all the necessary components to successfully install the CT-100B into a rack, there are many variations in how EIA relay racks are designed and additional adapter hardware may be required to install the chassis. Please refer to the relay rack manufacture’s catalog for additional options.

This procedure provides instructions for installing the 20” or 24” slide kits. Note that the 20” and 24” slide kits are identical except for the length of the slide units. A 20” slide kit is used when the chassis is flush mounted and a 24” slide kit is used when the chassis is recess mounted.

REQUIRED TOOLS

1. #2 Phillips Screwdriver
2. 1/8" Flat Blade Screwdriver

PARTS LIST

QTY	ITEM	VTI P/N
2	Slide, Rack Mount, Steel, 20”	37-0054-020
	- or -	
2	Slide, Rack Mount, Steel, 24”	37-0054-024
1	Hardware Kit, Rack Mount Slide, Steel	37-0055-000
6	Screw, 8-32 x 3/8” Pan Head Phillips, Sems Zinc	37-0073-037
6	Screw, 8-32 x 1/4” Pan Head Phillips, Steel/Zinc	37-0074-025
4	Screw, 8-32 x 3/8”, F/H Undercut Phillips, Zinc	37-0115-037
2	Bracket, Slide, Front	41-0108-000
1	Bracket, Slide, Top Side	41-0131-000
1	Bracket, Slide, Bottom	41-0132-000

ASSEMBLY INSTRUCTIONS

1. Lay the chassis on a protected work surface on its long side with the voltage monitor LEDs of the chassis facing front with the power switch toward the top.

2. If the rack mount ears were installed flush, remove the rack mount ears and install the front slide bracket to them as shown in the assembly drawing using a flat head screw driver. If the rack mount ears were installed recessed, simply install the slide brackets onto the ears as shown on the following page.

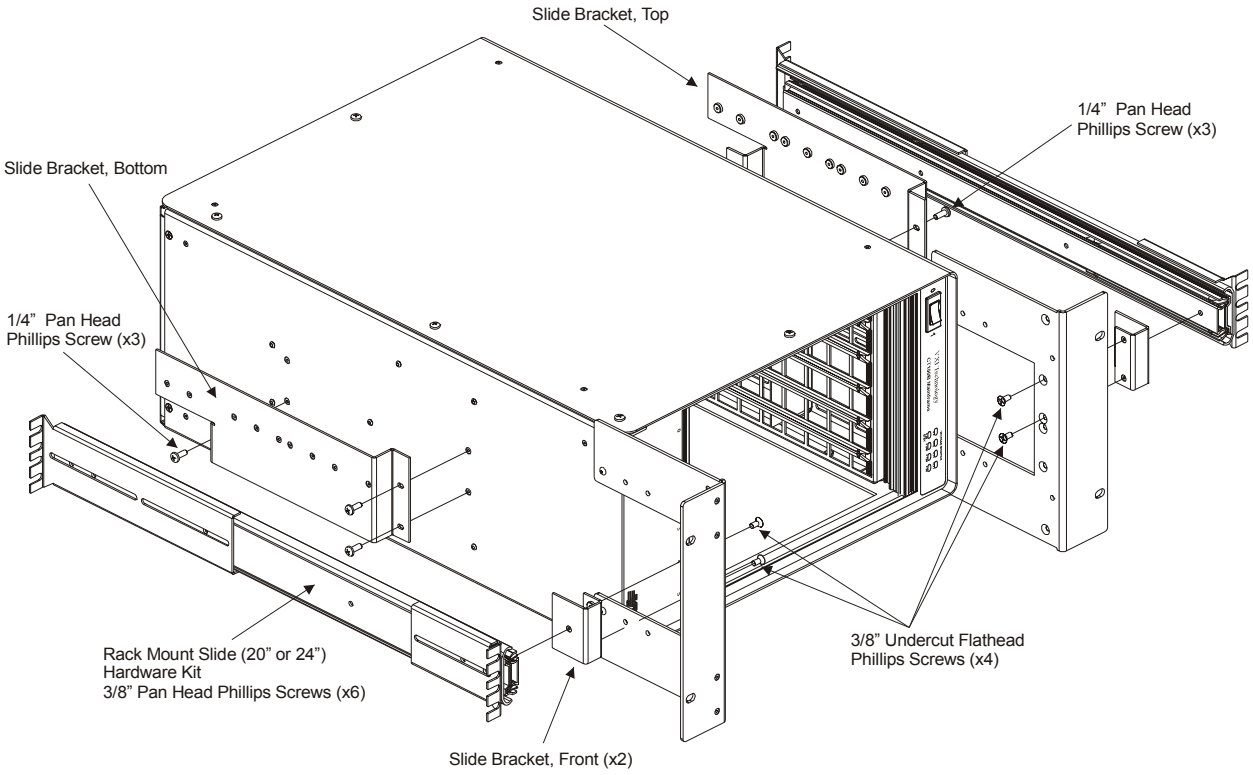
3. Reinstall the rack mount ears (if necessary).

4. Install the top and bottom slide brackets using 1/4” Phillips pan head screws. Note that the slide mounting holes should be oriented below the centerline of the chassis.

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5. Locate the slide hardware kit provided. Install the rack flanges to the slides as required by the application using the hardware in the kit. Note that the screws are inserted from the inside of the slides and the nuts would show on the outside.

6. Install the slides to the mounting brackets already installed on the chassis using the provided hardware.



* Recessed rack slide configuration shown

FIGURE 2.3: RACK SLIDE INSTALLATION DIAGRAM

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RACK MOUNT DOOR KIT INSTALLATION

The rack mount door kit (Option 60) provides the necessary hardware to install a 1/8" thick aluminum door in front of the rack mounted chassis. This option requires that the rack mount ear kit also be installed and configured for recessed mounting. The door may be customer modified to hold connectors, controls, indicators and similar components.

REQUIRED TOOLS

1. #2 Phillips Screwdriver
2. 1/8" Flat Blade Screwdriver
3. 11/32" Open Ended Wrench

PARTS LIST

QTY	ITEM	VTI P/N
2	Slide, Rack Mount, Steel, 20"	37-0054-020
1	Hardware Kit, Rack Mount Slide, Steel	37-0055-000
6	Screw, 8-32 x 3/8" Pan Head Phillips, Sems Zinc	37-0073-037
6	Screw, 8-32 x 1/4" Pan Head Phillips, Steel/Zinc	37-0074-025
4	Screw, 8-32 x 3/8", F/H Undercut Phillips, Zinc	37-0115-037
2	Bracket, Slide, Front, 5 Slot Chassis, CT-100B	41-0108-000
1	Bracket, Slide, Top Side, CT-100B	41-0131-000
1	Bracket, Slide, Bottom, CT-100B	41-0132-000

ASSEMBLY PROCEDURE

1. Lay the chassis on a protected work surface on its long side with the voltage monitor LEDs of the chassis facing front with the power switch toward the top.

2. Locate two rackmount (cross) braces. Install one each along the front of the flanges (one on top and one on the bottom) using four (two ea.) #8 flathead screws. The lip along the long edge of each brace goes toward the front and pointing inside. The braces fit over the flanges and the screws are placed from the inside going through the flange and then into the brace.

3. Locate the front door and two hinges. Install the two hinges to the front door using four black screws provided.

4. Locate the latch kit and install it into the door from the side where the hinges are mounted.

5. Locate the door latch bracket and install it on the rack mount ear opposite the end where the hinges will be installed. Use the rack mount door installation diagram below as a reference.

6. Locate the four tapped holes on the front surface of the rack mount ear to which the door is to be attached.

7. Install the door by its hinges to the rack mount ear using four black screws provided with the option kit.

8. Test that the door opens and closes smoothly and adjust the latch as necessary to secure the door when latched close.

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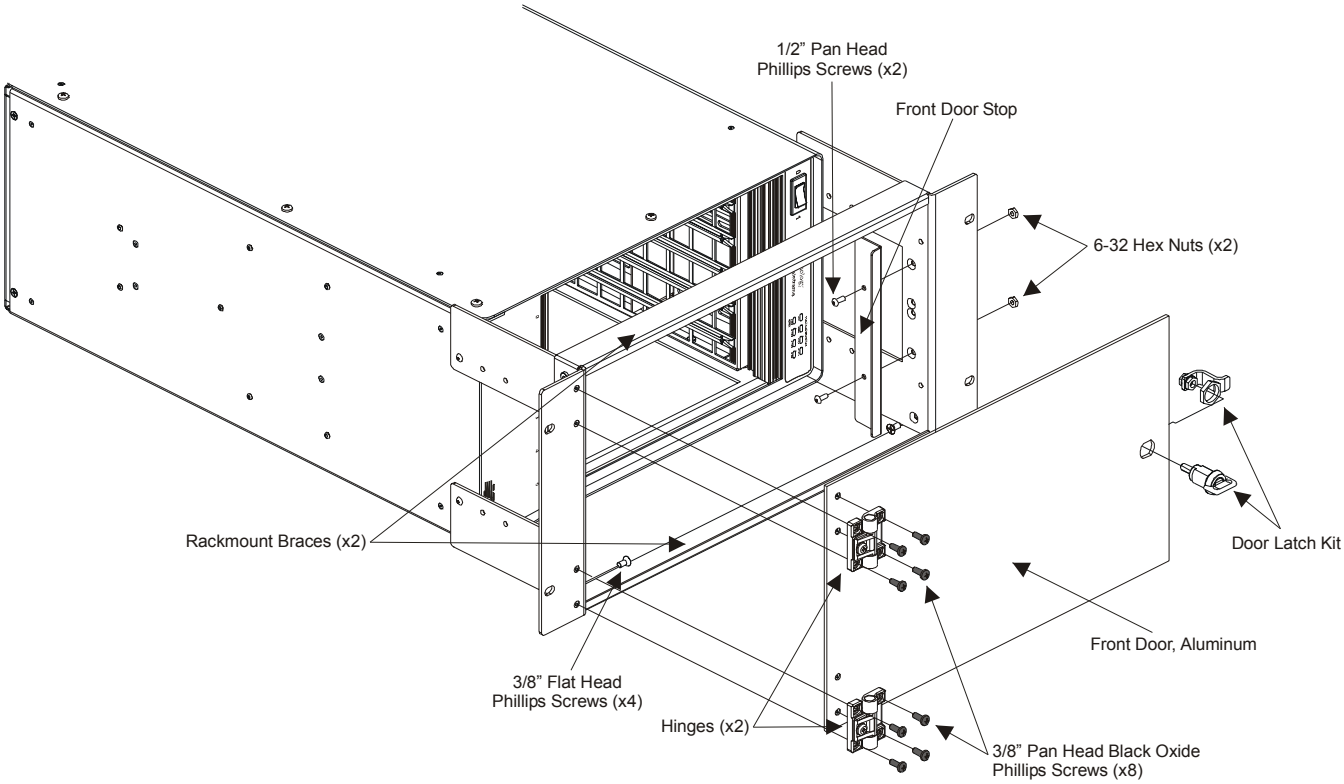


FIGURE 2.4: RACK DOOR INSTALLATION DIAGRAM

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ACRYLIC RACK MOUNT DOOR KIT INSTALLATION

An acrylic rack mount door is offered as an alternative to the aluminum rack mount door. The kit (Option 65) provides the necessary hardware to install a 1/8" thick acrylic door in front of the rack mounted chassis. An installation diagram is provided on the following page for ease of assembly. This option requires that the rack mount ear kit also be installed and configured for recessed mounting.

REQUIRED TOOLS

1. #2 Phillips Screwdriver
2. 1/8" Flat Blade Screwdriver
3. 11/32" Open Ended Wrench

PARTS LIST

QTY	ITEM	VTI P/N
2	Screw, 6-32 x 1/2" Pan Head Phillips, Sems Zinc	37-0028-050
2	Nut, Hex, 6-32, Zinc/Steel	37-0030-632
1	Latch, Vise Action, Knob Style, Black	37-0065-000
2	Hinge, Adjustable Damping, Black	37-0066-000
4	Screw, 8-32 x 3/8" Pan Head Phillips, Black Oxide	37-0079-037
1	Stop, Front Door, CT-100B	41-0133-000
1	Door, Front, CT-100, Acrylic	41-0303-000
2	Brace, Rackmount, CT-100B	41-0136-000
4	Nut, Hex, 8-32, Zinc/Steel	37-0030-832
4	Washer, Split Lock, 8-32 Zinc	37-0013-008
4	Washer, Flat 8-32, Zinc	37-0012-008
4	Screw, 8-32 x 1/2" Pan Head Phillips, Black Oxide	37-0079-050
4	Screw, 8-32 x 3/8" Flat Head Phillips, Zinc	37-0080-037

ASSEMBLY PROCEDURE

1. Lay the chassis on a protected work surface on its long side with the voltage monitor LEDs of the chassis facing front with the power switch toward the top.

2. Locate two rack mount (cross) braces. Install one each along the front of the flanges (one on top and one on the bottom) using four (two ea.) #8 flathead screws. The lip along the long edge of each brace goes toward the front and pointing inside. The braces fit over the flanges and the screws are placed from the inside going through the flange and then into the brace.

3. Locate the front door and two hinges. Install the two hinges to the front door using four 1/2" black oxide pan head screws through the holes of the hinge with the flat washer in contact with the door and with the split lock washer between the hex nut and the flat washer.

4. Locate the latch kit and install it into the door from the side where the hinges are mounted.

5. Locate the door latch bracket and install it on the rack mount ear opposite the end where the hinges will be installed. Use the rack mount door installation diagram below as a reference.

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6. Locate the four tapped holes on the front surface of the rack mount ear to which the door is to be attached.

7. Install the door by its hinges to the rack mount ear using four 3/8” black pan head screws provided with the option kit.

8. Test that the door opens and closes smoothly and adjust the latch as necessary to secure the door when latched close.

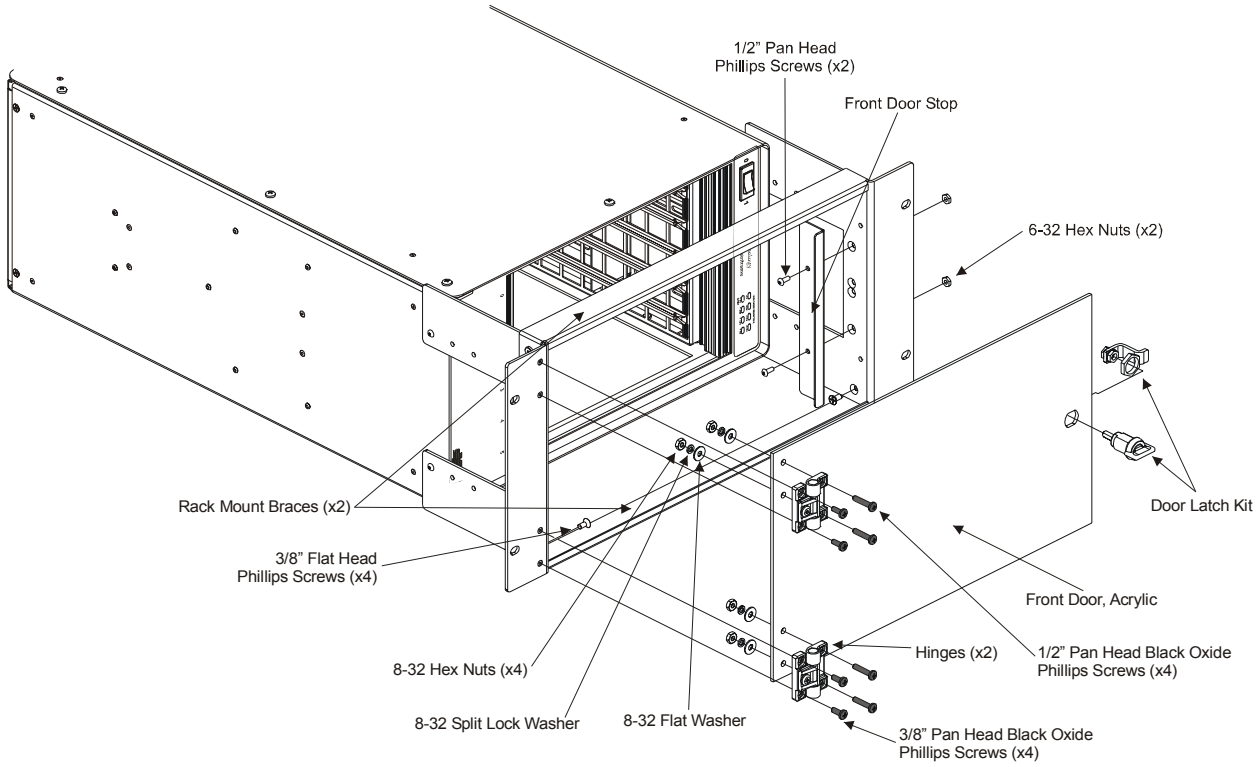


FIGURE 2.5: ACRYLIC RACK DOOR INSTALLATION DIAGRAM

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SECTION 3

OPERATION

INTRODUCTION

There are no operating instructions required for the CT-100B VXIbus chassis. After the chassis is installed, operation is completely transparent to the operator. Just plug in the instruments then power up the chassis. The power supply lines are monitored and displayed on the front panel to provide user feedback of correct operation (see Figure 3-2).



FIGURE 3-1 CT-100B SIX-SLOT CHASSIS W/ INSTALLED INSTRUMENTS

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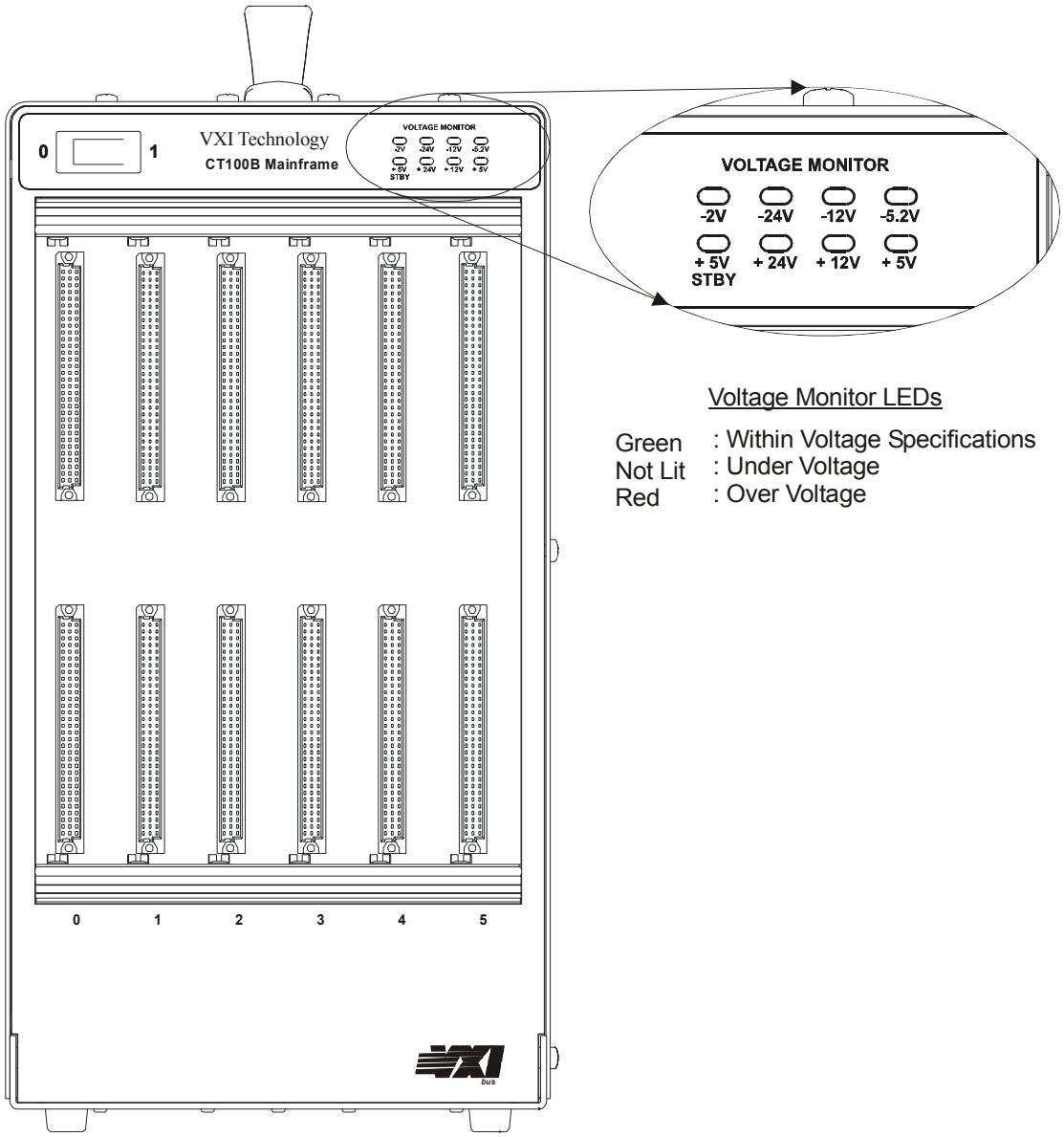


FIGURE 3-2 FRONT PANEL VOLTAGE INDICATORS

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