TABOR ELECTRONICS

PROTEUS
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LUCID SERIES

PXE21100 User Manual

Rev. 1.0 *Preliminary*

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Document Revision History

Table 1.1 Document Revision History

Revision	Date	Description	Author
1.0	09-May-2024	• Original preliminary version.	Jakob Apelblat

Acronyms & Abbreviations

Table 1.2 Acronyms & Abbreviations

Acronym	Description
µs or us	Microseconds
ADC	Analog to Digital Converter
AM	Amplitude Modulation
ASIC	Application-Specific Integrated Circuit
ATE	Automatic Test Equipment
AWG	Arbitrary Waveform Generators
AWT	Arbitrary Waveform Transceiver
BNC	Bayonet Neill–Concelm (coax connector)
BW	Bandwidth
CW	Carrier Wave
DAC	Digital to Analog Converter
dBc	dB/carrier. The power ratio of a signal to a carrier signal, expressed in decibels
dBm	Decibel-Milliwatts. E.g., 0 dBm equals 1.0 mW.
DDC	Digital Down-Converter
DHCP	Dynamic Host Configuration Protocol
DSO	Digital Storage Oscilloscope
DUC	Digital Up-Converter
ENoB	Effective Number of Bits
ESD	Electrostatic Discharge
EVM	Error Vector Magnitude
FPGA	Field-Programmable Gate Arrays
GHz	Gigahertz
GPIB	General Purpose Interface Bus
GS/s	Giga Samples per Second
GUI	Graphical User Interface
HP	Horizontal Pitch (PXIe module horizontal width, 1 HP = 5.08mm)
Hz	Hertz
IF	Intermediate Frequency
I/O	Input / Output
IP	Internet Protocol
IQ	In-phase Quadrature
IVI	Interchangeable Virtual Instrument
JSON	JavaScript Object Notation
kHz	Kilohertz
LCD	Liquid Crystal Display

Acronym	Description
LO	Local Oscillator
MAC	Media Access Control (address)
MDR	Mini D Ribbon (connector)
MHz	Megahertz
MIMO	Multiple-Input Multiple-Output
ms	Milliseconds
NCO	Numerically Controlled Oscillator
ns	Nanoseconds
PC	Personal Computer
PCAP	Projected Capacitive Touch Panel
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
PRBS	Pseudorandom Binary Sequence
PRI	Pulse Repetition Interval
PXI	PCI eXtension for Instrumentation
PXIe	PCI Express eXtension for Instrumentation
QC	Quantum Computing
Qubits	Quantum bits
RADAR	Radio Detection And Ranging
R&D	Research & Development
RF	Radio Frequency
RT-DSO	Real-Time Digital Oscilloscope
s	Seconds
SA	Spectrum Analyzer
SCPI	Standard Commands for Programmable Instruments
SFDR	Spurious Free Dynamic Range
SFP	Software Front Panel
SMA	Subminiature version A connector
SMP	Subminiature Push-on connector
SPI	Serial Peripheral Interface
SRAM	Static Random-Access Memory
TFT	Thin Film Transistor
T&M	Test and Measurement
TPS	Test Program Sets
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus
VCP	Virtual COM Port
Vdc	Volts, Direct Current
V p-p	Volts, Peak-to-Peak
VSA	Vector Signal Analyzer
VSG	Vector Signal Generator
WDS	Wave Design Studio

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1 General

1.1 Scope

The scope of this manual is to describe the setup, operating procedures, and specifications of the Tabor Electronics PXE21100 PXIe based (PCI Express eXtension for Instrumentation) 21 slot Gen 4 x 8 chassis.

1.2 Related Documentation

- Wave Design Studio User Manual
- Proteus Programming Manual
- Proteus Module User Manual
- Lucid-X PXIe User Manual
- PXI-5 PXI Express Hardware Specification

1.3 Maintenance

1.3.1 Preventive Maintenance

No periodic preventive maintenance is required.

1.3.2 Long Term Storage or Repackaging For Shipment

If the instrument is to be stored for a long period of time or shipped immediately, proceed as directed below. If you have any questions, contact your local Tabor Electronics representative or the Tabor Electronics Customer Service Department.
Repack the instrument using the wrappings, packing material and accessories originally shipped with the unit. If the original container is not available, purchase replacement materials. Be sure the carton is well sealed with strong tape or metal straps. Mark the carton with the model and serial number. If it is to be shipped, show sending and return address on two sides of the box. If the instrument is to be shipped for service or repair, the following information must be included with the shipment:

- Name and address of the owner.
- Record the model and serial number of the instrument, options, and firmware version.
- Note the problem and symptoms – detailed information will help in verifying the problem
  - What was the instrument setup, such as the run mode, arbitrary/task mode, task table etc.
  - Did the unit work; then fail or was it dead on arrival.
  - What other equipment was connected to the generator when the problem occurred, such as external trigger or clock.
- The name and telephone number of someone familiar with the problem who can be contacted by Tabor Electronics if any further information is required.

- Show the returned authorization order number (RMA) as well as the date and method of shipment.

Note

Always obtain a return authorization number from the factory before shipping the instrument to Tabor Electronics.

1.4 Safety

To avoid electrical shock, fire or personal injury:

- Use only the proper power cord and certified for the country of use.
- This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, the grounding conductor must be connected to the ground. Before connecting to the power input or output, ensure that the product is properly grounded.
- Do not operate this product with removed covers or panels.
- Observe all the ratings and markings on the product. Search this manual for further rating information, before connecting to it. Do not apply potential that is higher than the maximum rating.
- Do not operate in dark or wet conditions.
- Do not operate in an explosive environment. Keep product clean and dry.

2 Introduction

The Tabor Electronics' PXE21100, 21 slot PXIe based chassis is designed to support Tabor's current and future PXIe based products as well as 3rd party PXIe compliant modules . With a powerful and built-in controller inside the chassis it is the market's first chassis to offer 21 PXIe slots, as well as the first to support up to PCIe Gen 4 x 8 interfaces. With an advanced cooling design, the 21-slot, 4U chassis, utilizes every inch of a 19" rack space, enabling the highest PXIe slot count within a single chassis. The chassis delivers the performance, scalability and reliability for the most advanced and demanding applications.

Highlights

- Maximize rack space with the 21-slot PXIe chassis.
- Hosts the Tabor Lucid-X family of analog signal generators, the Proteus family of AWG/AWTs, and the TE320x family of PXIe RF amplifiers.
- Fastest available data transfer speeds with Gen 4 x 8 PCIe support.
- Advanced, powerful, and upgradeable built-in controller that eliminates the need for a high-performance external PC.
- Easy synchronization and scaling to hundreds of channels of Tabor Proteus series.
- Scale to large systems with multiple synchronized chassis.

Dedicated Tabor Product Support

The new chassis supports Tabor's Proteus AWG/AWT series and new LucidX RF signal generators series as well as the PXIe based RF amplifiers. Easily scale up to tens of synchronized channels in a single chassis without the need for external equipment or cabling. With its proprietary backplane design simply slide in multiple Proteus series models and all the synchronization is done using simple SCPI commands.

Scale to Multiple Chassis

For advanced applications such as quantum computing or phased array radar, where hundreds of channels are needed, it is possible to connect multiple chassis for a fully synchronized and phase coherent system. The dedicated PXE21106, synchronization unit, can synchronize up to 6 chassis and enables data transfer between modules in different chassis. For more than 6 chassis simply connect multiple PXE21106 units.

Figure 2.1 PXE21100 21 Slot PXIe Chassis

2.1 Front Panel

Below is the front panel of the PXE21100 chassis:

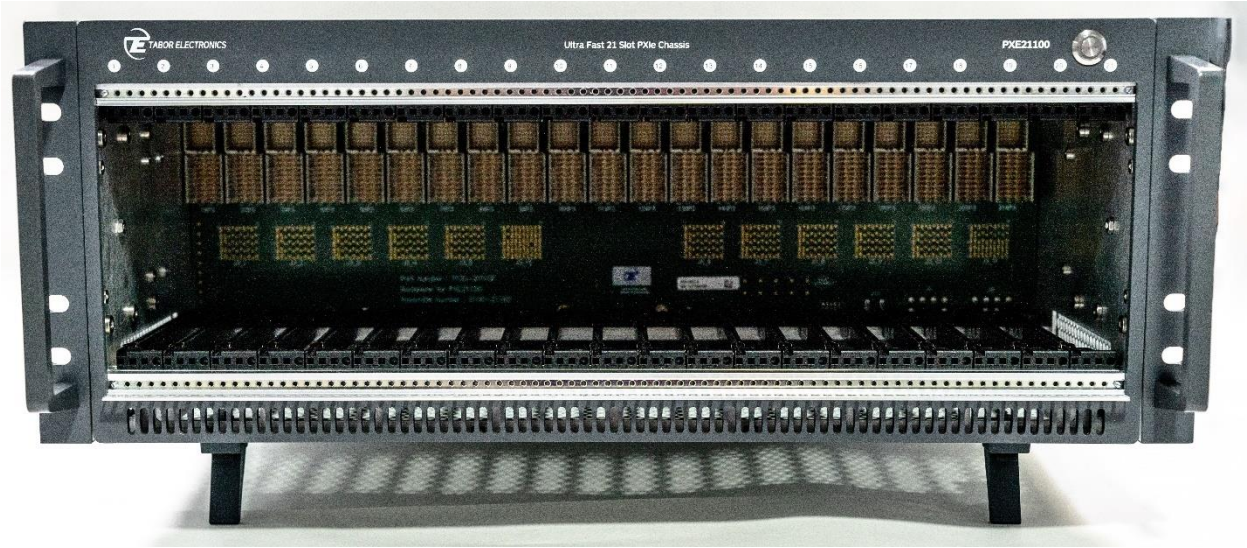

Figure 2.2 PXE21100 Front Panel

- **PXIe Gen4 8 Lanes Slot –** 21 slots for Proteus/Lucid-X modules.
- **1 – 21** – PXIe slot numbering.
- **LED/Power Button** — On/off power button. Green light indicates power on.

Note

Connector pin assignments of the PXI Express Peripheral Slots comply with the default pin assignments as defined in PXI-5 PXI Express hardware specification Rev.1.0.

2.2 Rear Panel

Below is the rear panel of the PXE21100 chassis:

Figure 2.3 PXE21100 Rear Panel

- – Display Port for connecting an external display.
- **LAN**–2.5GbE RJ45 connector for connecting a control PC via the LAN.
- **USB Host** – 2 x 2 x USB Type A (3 x USB 2.0, 1 x USB 3.2) interface for connecting a USB device such as a memory device (FAT32) for storing and recalling instrument setups, keyboard, or mouse.
- **SYNC IN** – Chassis sync in. D-Sub 9-Pin connector that is used to transfer the Tabor internal hardware and software signals between chassis.
- **SYNC OUT** – Chassis sync out. D-Sub 9-Pin connector that is used to transfer the Tabor internal hardware and software signals between chassis.
- **MESH CONTROL** – D-Sub 25-pin that connects the chassis to the external PXE21106 mesh device. This interface transfers the qubit decision bus to and from the mesh device.
- **FAN SPEED** –
  - **AUTO** — The fan speed is controlled by the chassis' hardware monitor IC.
  - **HIGH** — The fan speed is set to maximum regardless the temperature state.
- **REF IN** – 100 MHz, external reference in, SMA connector. This connector receives a 100MHz clock for synchronization purpose. You can select between the external reference clock and the internal 100 MHz oscillator.
- **TRIG IN** – Trigger input pulse from a 62.5MHz-150MHz clock, SMA connector. This signal is used as the synchronization trigger for multi chassis synchronization.
- **CLOCK IN** – 62.5 MHz – 150 MHz from the CLOCK OUT of another PXE21100, SMA connector. The signal is used as the synchronization clock for multi chassis synchronization.

- **CLOCK OUT** – Outputs clock of 62.5 MHz-150 MHz, SMA connector. The signal is used as the synchronization clock for daisy chain multi chassis synchronization.

Note

Only star connection with PXE21106 mesh device is supported.

- **MAINS INPUT** – 3 Pins IEC320 C14 inlet power plug socket, 100 - 240 VAC, 50/60 Hz. Internal fuse 16A.

3 Installation

3.1 Installation Overview

This chapter contains information and instructions necessary to prepare the PXE21100 chassis for operation. Details are provided for initial inspection, grounding safety requirements, repackaging instructions for storage or shipment, and installation information.

3.2 Unpacking and Initial Inspection

Unpacking and handling of the device requires normal precautions and procedures applicable to handling of sensitive electronic equipment. The contents of all shipping containers should be checked for included accessories and certified against the packing slip to determine that the shipment is complete.
The PXE21100 chassis is supplied with:

- Power cord with a plug according to customer country standard.
- USB Type A cable for connecting a control PC to the instrument.

Caution!
The PXE21100 chassis ships in an antistatic package to prevent damage from electrostatic discharge (ESD). When storing the unit, use the antistatic case.

3.3 Safety Precautions

This product is intended for use by qualified persons who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. The following sections contain information and cautions that must be observed to keep the device operating in a correct and safe condition.

Caution
For maximum safety, do not touch the product, test cables, or any other instrument parts while power is applied to the circuit under test. ALWAYS remove power from the entire test system before connecting cables or jumpers, installing, or removing cards from the chassis. Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always keep your hands dry while handling the instrument.

Caution
Carefully read the Safety Precautions instructions that are supplied with your test fixtures. Any adjustment, maintenance, and repair of an opened, powered-on instrument must be performed by authorized service personnel.

3.4 Operating Environment

The device is intended for indoor use and should be operated in a clean, dry environment with an ambient temperature within the range of 0°C to 55°C.

> **Warning**
> The PXE21100 chassis must not be operated in explosive, dusty, or wet atmospheres. Avoid installation of the module close to strong magnetic fields.

The design of the device has been verified to conform to EN 61010-1 safety standard per the following limits: Installation (Overvoltage) Category I (Measuring terminals) Pollution Degree 2 Installation (Overvoltage) Category I refers to signal level, which is applicable for equipment measuring terminals that are connected to source circuits in which measures are taken to limit transient voltages to an appropriately low level. Pollution Degree 2 refers to an operating environment where normally only dry non-conductive pollution occurs. Occasionally a temporary conductivity caused by condensation must be expected.

3.5 Power Requirements

The chassis may be operated from a wide range of mains voltage from 100 to 240 VAC. Voltage selection is automatic and does not require switch setting. The chassis operates over the power mains frequency 50/60 Hz. Always verify that the operating power mains voltage is the same as that specified on the rear panel.
The device should be operated from a power source with neutral or near ground (earth potential). The instrument is not intended for operation from two phases of a multi-phase ac system or across the legs of a single-phase, three-wire AC power system. Crest factor (ratio of peak voltage to RMS) should be typically within the range of 1.3 to 1.6 at 10% of the nominal RMS mains voltage.

3.6 Grounding Requirements

To ensure the safety of operating personnel, the U.S. O.S.H.A. (Occupational Safety and Health) requirement and good engineering practice mandate that the instrument panel and enclosure be “earth” grounded.

3.7 Performance Checks

The chassis has been inspected for mechanical and electrical performance before shipment from the factory. It is free of physical defects and in perfect electrical order. Check the instrument for possible damage in transit and perform the electrical procedures outlined in the section entitled Unpacking and Initial Inspection.

3.8 Long Term Storage or Repackaging for Shipment

If the instrument is to be stored for a long period of time or shipped immediately, proceed as directed below. If you have any questions, contact your local Tabor Electronics representative or the Tabor

Electronics customer service department.

- Repack the instrument using the wrappings, packing material and accessories originally shipped with the unit. If the original container is not available, purchase replacement materials.
- Be sure the carton is well sealed with strong tape or metal straps.
- Mark the carton with the model and serial number. If it is to be shipped, show sending and return address on two sides of the box.

Note

If the instrument is to be shipped to Tabor Electronics for calibration or repair, attach a tag to the instrument identifying the owner. Note the problem, symptoms, and service or repair desired. Record the model and serial number of the instrument. Show the returned material authorization (RMA) order number as well as the date and method of shipment. Always obtain an RMA number from the factory before shipping the instrument to Tabor Electronics.

3.9 Installation

The chassis must be installed in a way that clears air passage to its cooling fans. For inspection and normal bench operation, place the instrument on the bench so it is clear of any obstructions to the rear fan to ensure proper airflow.

3.9.1 Rack Mounting

The chassis is supplied with front tilt stands and rear fixed feet. These are used for benchtop operation. If the chassis need to be stacked in a 19” cabinet, the feet must be removed before mounting in the rack. You can use a Phillips screwdriver to remove the feet.

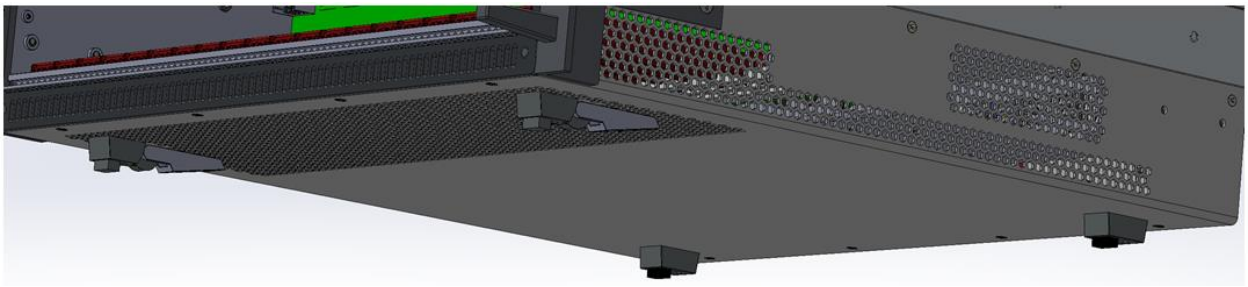

Figure 3.1 PXE21100 Rear Feet

When the chassis is mounted in a rack, you must use the rear rack mounting wings and the rear mounting wings extender to support the weight of the box from the rear end. The full rack mounting kit is shown in the figure below (feet removed).

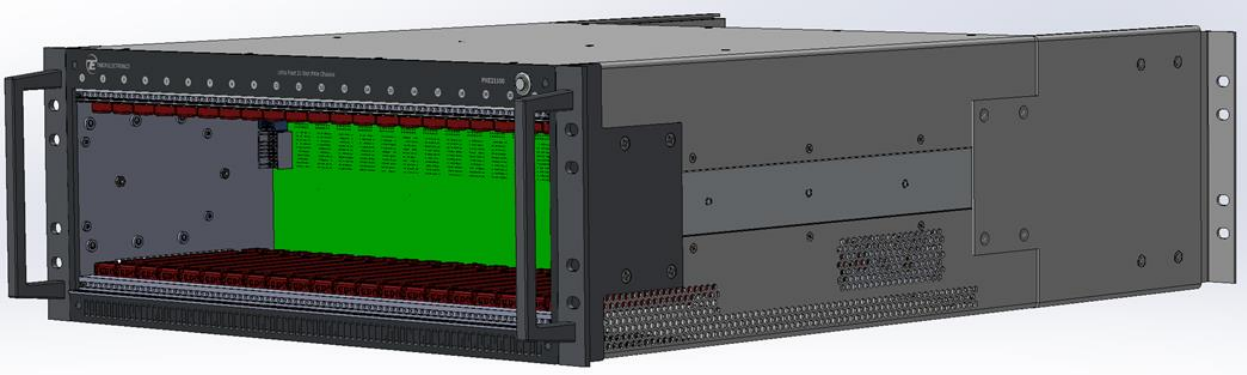

Figure 3.2 PXE21100 with Full Rack Mounting Kit

The optional rack mounting kit comes with a rear rack mounting extenders that fits a 630.0 mm (24.803”) distance between the front and rear mounting rods. For deeper cabinets one must specify with the order the exact measure between the mounting rods. See figure below.

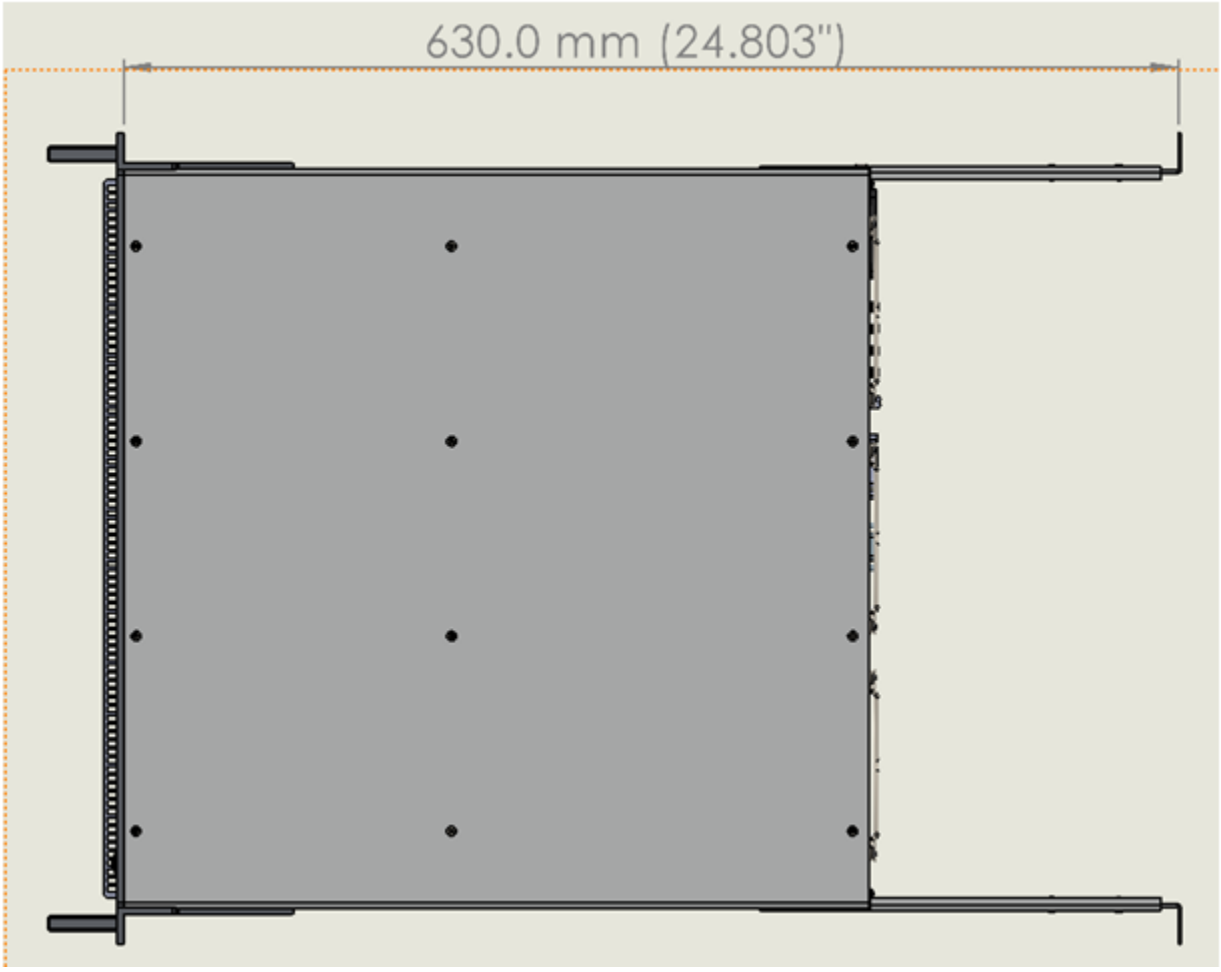

Figure 3.3 PXE21100 with Rear Rack Mounting Extenders

Warning

Once the chassis is installed in the chassis cover all remaining open slots to ensure proper airflow. Using the device without proper airflow will result in damage to the instrument. It is also recommended to use the highest fan setting available on the chassis to ensure proper cooling of the PXE21100 chassis.

3.9.2 Installing Instrument Drivers

The PXE21100 chassis necessary installation drivers, control software and relevant documentation can be downloaded from the Tabor Electronics website at http://www.taborelec.com/downloads. Follow the instructions below to install all the necessary drivers and DLLs on your PC to communicate and control you Proteus device.

Note

Check the Tabor Electronics website for the most recent software, driver, firmware, and documentation updates. www.taborelec.com/downloads.

3.9.3 Installing Proteus/Lucid Modules

The PXE21100 supports up to 21 modules.

1. Select an available slot (1 to 21)
2. Depress the module's latch and align the module's top and bottom edges with the card guides.
3. Carefully slide the module into the chassis.
4. Lift the latch until the module is securely seated in the chassis' backplane.
5. Tighten the screws on the module's front panel.

Note

To improve efficiency of heat dissipation, you should install filler plates for all unused slots.

3.10 Chassis Cooling

The PXE21100 has three 224 CFM (Cubic Feet per Minute)) fans that provide a total airflow of up to 672 CFM. These fans are mounted on the chassis rear panel and exhaust air out the rear of the chassis. The air intakes are in the front, and sides of the chassis.

Figure 3.4 PXE21100 Front and Side Air Intake

Figure 3.5 PXE21100 Rear Fan Exhaust

4 Wave Design Studio (WDS)

The Wave Design Studio (WDS) is a software package that enables full control and programming of your Tabor Electronics devices. It runs on a PC and provides a user-friendly graphical user interface. Use the TE Update Tool to update the Proteus device FPGA. The programs and the user manual can be downloaded from the Tabor Electronics website at http://www.taborelec.com/downloads.

5 PXE21100 Specifications

5.1 Characteristics

Table 5.1 Characteristics

Parameter	Description
Input Voltage Range	100 to 240 VAC
Operating Voltage Range	90 to 264 VAC
Input Frequency	50/60 Hz
Over Current Protection	Internal 16A fuse in line
Power Consumption	
180 V-220 V Input Voltage	52 W max per slot
100 V-180 V Input Voltage	42 W max per slot
85 V-99 V Input Voltage	33 W max per slot
PXIe	21 slot PXIe Gen 4 x 8 lanes providing 128 Gb/s bandwidth per slot
PXIe Pin Assignment	PXI-5 PXI Express hardware specification Rev.1.0
Max. DC Current Consumption Per Slot	+3.3 V 6 A, +5 V 2 A,+12 V 4 A
CPU	Intel i5-13500E, 24 CPU threads, 24 MB Cache, 4.6 GHz (upgradeable)
Memory	8 GB (upgradeable)
Storage	128 GB SSD (upgradeable)
Operating System	Windows 10 IOT
USB	2 x 2 x USB Type A (3 x USB 2.0, 1 x USB 3.2)
Lan (Base-T)	1 x RJ-45 2.5GbE
Display	1 x Display Port

5.2 Reference Input

Table 5.2 Reference Input Specifications

Parameter	Description
Input Frequency	100 MHz external or 10 MHz internal
Lock Range	± 1 MHz
Input Level	+3 dBm to +14.5 dBm, 0.9-3.3 Vpp
Impedance	50Ω, AC coupled (nom.)
Connector	SMA (female)

5.3 Trigger Input

Table 5.3 Trigger Inputs Specifications

Parameter	Description
Input level	LVCMOS 3.3 V
Input impedance	Hi-Z
Input trigger destination	PXI_Trig0 - PXI_Trig7
Input threshold	LVCMOS 3.3 V
Minimum swing	LVCMOS 3.3 V
Connector	SMA (female)

5.4 Clock Input

Table 5.4 Clock Input Specifications

Parameter	Description
Input Frequencies	62.5 MHz – 150 MHz configurable
Input Level Range	0.4 Vpp to 4 Vpp
Damage Level	4 Vpp
Input Impedance	50Ω nom., AC coupled
Connector	SMA (female)

5.5 Clock Output

Table 5.5 Clock Output Specifications

Parameter	Description
Source	Selectable, internal DDS or external CLK_IN
Frequency Range	62.5 MHz – 150 MHz configurable
Output Amplitude	700 mVpp
Impedance	50Ω (nom.), AC coupled
Connector	SMA (female)

5.6 General

Table 5.6 General

Parameter	Description
Weight	
Without Package	TBD
Shipping Weight	TBD
Dimensions	
With feet	438.8 x 191.7x 449.5 mm (W x H x D)
Without feet	438.8 x 176.0 x 449.5 mm (W x H x D)
Temperature	
Operating	0°C to +55°C
Storage	-40°C to +70°C
Altitude	
Operating	Up to 9,482 ft (2890 m)
Storage	Up to 15,000 ft (4572 m)
Relative Humidity Non-Condensing	10% to 90%
Safety:	CE Marked, EC61010-1:2010
EMC:	IEC 61326-1:2013

5.7 Ordering Information

Table 5.7 Ordering Information

Model	Description
PXE21100	21 slot PXIe based chassis with embedded controller
PXE21106	1 U, 19" mesh controller for synchronizing up to 6 PXE21100 chassis

5.8 Ordering Information Options

Table 5.8 Ordering Information Options

Option	Description
COMP2	Upgrade for PXE21100 to i9-13900E Intel CPU, 32 CPU threads, 5.2 GHz, cache 36 MB, RAM 32 GB, 960 GB SSD
PXE21 RACKMOUNT KIT	Rear rack mounting wings and rear mounting wings extender for 630.0 mm (24.803”) deep rack