

TSC 4145B Ultraclean Oscillator Operations and Maintenance Manual



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TSC 4145B Ultraclean Oscillator Operations and Maintenance Manual

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Revision History

Revision	Description	Date	Approved
A	Initial Release	11/04/02	TLE
B	Minor corrections	2/11/03	TLE
C	Updates for CE requirements	4/1/04	TLE
D	Add 5 MHz phase Specification	7/15/06	TLE

Table of Contents

1: Introduction.....	5
1.1 About This Manual	5
1.2 Symbols.....	6
1.2.1 Conventions	7
1.3 4145B Overview	8
2: Installing and Setting Up the 4145B.....	9
2.2 Unpacking.....	9
2.3 Cleaning.....	10
2.4 Installing the 4145B.....	10
2.4.1 Required Materials for Installation	10
2.4.2 Making Connections	10
2.4.2.1 Input Power.....	10
2.4.2.2 Input Signal.....	11
2.4.2.3 Output Signals.....	11
2.4.3 Operations	11
3: Monitoring the 4145B.....	12
3.2 RS-232 Interface	12
4: Procedures/Troubleshooting the 4145B.....	14
4.1 Replacing Fuses	14
4.2 Troubleshooting Operational Problems	14
4.3 Procedures.....	17
4.3.1 Disabling External Battery Fault Monitoring	17
4.3.2 Manual Tuning of BVA Oscillator	17
5: Warranty and Shipping Information.....	20
5.1 Warranty Information	20
5.2 Shipping Information.....	20
5.2.1 Packing Instructions.....	20
6: Declaration of Conformity.....	22
Appendix A: Specifications	24
A.1 Electrical Specifications.....	24
A.2 Typical Performance.....	25
A.3 Environment Specifications	26
A.4 Physical Specifications.....	26
Glossary	27
Index	28

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1: Introduction



NOTE: FIRST READ THIS MANUAL THOROUGHLY!

This is especially true for the sections regarding **Safety** and **Installation**.

1.1 About This Manual

This manual tells you how to install, set up, monitor, and troubleshoot the 4145B.

“[Chapter 1, Introduction](#)”, on page 4, explains symbols that appear in the manual and on the unit as well as documentation conventions. The chapter also briefly describes the 4145B.

“[Chapter 2, Installing and Setting Up the 4145B](#)”, on page 8, contains important safety information and describes how to install the 4145B, and assign a fixed IP address.

“[Chapter 3, Monitoring the 4145B](#)”, on page 13, describes how to monitor alarms.

“[Chapter 4, Troubleshooting the 4145B](#)”, on page 15, describes how to replace fuses and verify operational problems.










“[Chapter 5, Warranty and Shipping Information](#)”, on page 17, explains how to contact Timing Solutions Corporation for warranty service and provides shipping guidelines.

“[Chapter 6, Declaration of Conformity](#)”, on page 19, provides the information pertaining to CE marking of this product.

“[Appendix A, Specifications](#)”, on page 21, contains the detailed specifications for the 4145B.

1.2 Symbols

These symbols appear throughout the manual as well as on the unit itself.

Symbol	Description
	This symbol means the following information is a note that gives you important information that may affect how you use the 4145B.
	Caution – Refer to manual. Read all instructions in manual before using this product.
	CE marking, attesting compliance to applicable European Directives.
	Caution – Risk of electrical shock.
	Fuse symbol.
	Mains Power is ON.
	Mains Power is OFF.
10101	Serial Port connection, DO NOT CONNECT TO TELECOM CONNECTIONS THAT CARRY HAZARDOUS VOLTAGES.
	Earth terminal symbol: Used to indicate an earth ground connection to chassis.
	Chassis ground.

1.2.1 Conventions

This manual uses several typographical conventions to help explain how to use the 4145B.

Convention	Definition
Bold	Words in bold show: <ul style="list-style-type: none">■ Buttons and icons to click■ Menu options to select■ Commands to type■ Non-variable information displayed in response to commands
<i>Italics</i>	Words in <i>italics</i> show: <ul style="list-style-type: none">■ Names of windows and dialog boxes■ Variable information displayed in response to commands

1.3 4145B Overview

The TSC 4145B Ultra-clean phase-locked oscillator filters the output from a high performance Cs frequency standard, improving both the phase noise and Allan deviation. The TSC 4145B is the best choice when you need improved short and medium-term performance than a Cs provides.

Figure 1.1 shows the 4145B's front panel, and Figure 1.2 shows the 4145B's rear panel.



Figure 1.1 - Front Panel



Figure 1.2 - Rear Panel

2: Installing and Setting Up the 4145B

2.1 Safety First!



CAUTION:

- This unit is for INDOOR USE ONLY! It is not protected against a harmful ingress of moisture.
- Do not attempt to install or operate this equipment if you have not first acquired proper training.
- Equipment is intended to be installed in an enclosed or open type equipment rack
- Ensure that all cables are properly connected. The power cord must be easy to remove from the back.
- Verify that input line voltage and current capacity are within specifications before turning on power to the unit.
- Disconnect all sources of input power before removing the top cover of this unit.
- Operating and maintenance personnel must receive proper training before installing or maintaining electrical equipment.

2.2 Unpacking

To unpack the TSC 4145B unit:

- 1) Unpack and carefully inspect the unit.
- 2) Check for physical damage.
- 3) If no physical damage is apparent, then proceed with making appropriate connections.
 - If physical damage is observed, then immediately contact Timing Solutions and the carrier.
- 4) Save the shipping container for submitting any necessary claims to the carrier.

2.3 Cleaning

Clean the main chassis with a soft cloth dampened with a mild soap and water solution.



CAUTION: Do not spray or use too much liquid when cleaning the unit. Liquid can enter the unit and damage sensitive electronic components.

2.4 Installing the 4145B

The 4145B is shipped ready for installation into a standard 19" (48.3 cm) rack.

2.4.1 Required Materials for Installation

- 1) North American or European IEC power cord. One or the other will be supplied with the unit.
- 2) Customer supplied double-shielded RG223 cables with BNC connectors from source, and to next device(s) in system.
- 3) Rack-mount chassis support brackets, Bud Industries, CSB-1353 & CSB-1351
- 4) Rack mounting screws.
- 5) Philips screwdriver for the rack mount screws, and slide as needed.
- 6) 10-32" screw for chassis ground located on the rear of the chassis.

2.4.2 Making Connections

2.4.2.1 Input Power

AC INPUT POWER - The input power to the unit is supplied through a detachable 3-prong power cable. First plug the female end into the male IEC-320 plug on the rear of the unit. Then plug the male end of the cable into a 100V~ to 240V~, 50/60 Hz power source.

Battery Back-Up Power Cable – A connector is provided on the rear panel to utilize the DC back-up capability of this product. The external wiring to this connector must be at least 1.5mm² (14 AWG), including a fuse or circuit breaker of not more than 15A. A 20A circuit breaker may be used if the external wiring is jacketed 14 AWG, with maximum length of 20 feet.



CAUTION: Ensure that this power supply cord is connected to a properly grounded mains receptacle to ensure safety.



CAUTION: In addition to the Power Switch on the rear panel, the appliance Inlet Connector and the Plug on the detachable type power supply cord are all considered to be suitable Disconnect Means for disconnecting the unit from the AC Mains Supply. If the rear of the unit is not accessible after installation in the instrument rack, the User is responsible for the provision of a suitable external AC Disconnect Means for the unit.

2.4.2.2 Input Signal

Connect the 5 MHz input signal cable to the **5 MHz Input SMA** connector on the back of the unit.

2.4.2.3 Output Signals

The TSC 4145B supplies 2 copies of **5 MHz and 10 MHz via SMA** connectors on the back of the unit.

2.4.3 Operations

The 4145B factory default settings expect a DC input voltage along with the AC Mains Supply. This setting can be changed if DC will not be applied to the 4145B. Refer to Procedures/Troubleshooting, Section 4.3.1 of this manual.

Once the 4145B is turned on and a 5 MHz signal is applied, the initial warm up time for proper operations is approximately 24 hours. If the 4145B has not acquired lock (**CONTINUOUS OPERATIONS** indicator **GREEN**) within 36 hours, verify the mechanical tuning is set correctly. Refer to Procedures/Troubleshooting, Section 4.3.2 of this manual.



NOTE: The TSC-4145B may need manual tuning after the warm up period. Refer to Procedures/Troubleshooting, Section 4.3.2 of this manual.

The 4145B can be run at 4 different loop control Time Constants; 50, 100, 200 and 400 seconds. For best output performance, it is recommended that the user configure the unit for 400 seconds. A time constant can be selected by pressing the **TIME CONSTANT** button on the front panel unit the desired time constant **LED** is illuminated.

3: Monitoring the 4145B

Once the 4145B is properly installed, it is designed not to require any intervention. However, if a troubleshooting problem arises, the 4145B does provide two interfaces to assist the User.

- 1) Summary fault alarm.
- 2) RS-232 interface.

3.1 Summary Fault Alarm

The summary fault alarm (Status phone jack) on the rear of the TSC 4145B is an indicator that there is a problem with the unit. The summary alarm is a normally open relay that stays low unless any of the following happens and then transitions to a high.

Engaged:

- 1) If the power indicator is red or flashing red upon power up.
- 2) If the **CONTINUOUS OPERATIONS** light is anything other than **GREEN**, even upon power up.
- 3) Any of the time constant **LED**'s are flashing.

The summary fault does not reset until the user corrects the fault and then depresses "reset" on the front panel.

3.2 RS-232 Interface

The TSC 4145B supports a RS-232 data interface on the rear of the unit. The data connector is a RJ-11 female (left side) and is configured the same as a computer RS-232 port. Therefore, a crossover cable (null modem cable) must be used to connect to a PC with a communications port. Table 3.1 depicts the wiring required and Table 3.2 outlines the port settings. Table 3.3 defines the command structure for obtaining status information from the TSC 4145B.

TABLE 3.1 – NULL MODEM WIRELIST

DB-9 CONNECTOR	RJ – 11 CONNECTOR
Pin 2	Pin 3
Pin 3	Pin 5
Pin 5	Pin 4

TABLE 3.2 – RS-232 PORT SETTINGS

FORMAT	ASCII
BAUD RATE	9600
BITS	8
PARITY	None
STOP BIT	1
FLOW CONTROL	None

TABLE 3.3 – R2-232 COMMAND SUMMARY

a	Simple communications test, returns current firmware revision
s	Sends short status message of: Power status/BVA temp/Heater control/Input Level/Lock status

The following commands are for factory use only: b, c, h, and t.

Examples for commands are detailed below:

‘a’ Unit responds with the current version of firmware, e.g. ‘B’

‘s’ Unit responds with the following:

PS=2 BVA Temp=0053 Heater Control Volt=01b0 Input Level=26 L

Where:

PS = 0, 1 or 2.

0 = AC and DC power OK

1 = DC OK/AC power missing

2 = AC OK/DC power missing

BVA Temp is an A/D value for temperature of the BVA Oscillator

Heater Control Volt is an A/D value for the control voltage going to the BVA Oscillator

Input Level is an A/D value for the input power level of the 5 MHz input. 26 is approximately equal to +12 dBm.

L = Ultraclean Oscillator is locked to the 5 MHz input.

NL = Ultraclean Oscillator is not locked is not locked to the 5 MHz input.



NOTE: The commands may differ in older versions of this unit. Please contact Timings Solutions Corporation for details.

4: Procedures/Troubleshooting the 4145B

Perform all of the following procedures before returning the unit for service. If the unit still appears to have a problem, then call Timing Solutions Corporation and request technical support. Have the serial number of your unit ready to provide to a technical representative.



CAUTION: Performance of these procedures are restricted to trained or authorized personnel knowledgeable of the electrical risks involved. Lethal voltages are exposed in the chassis where you will be working. These voltages are not marked and you **MUST** disconnect AC and Battery Back-up during this procedure.

4.1 Replacing Fuses

If you know that a local event caused blown fuses throughout a rack, you can replace the fuses in each 4145B power entry module.

Required for this procedure:

- Small flat-head screwdriver
- Replacement fuse for a standard IEC 320 power entry module with fuse (5 x 20 mm, 1.6 A 250 V~ Time lag fuse)

To replace a fuse:

- 1) Disconnect the power cable from the back of the 4145B.
- 2) Using a small screwdriver, open the fuse cover on the back of the 4145B.
- 3) Replace the old fuses as necessary.
- 4) Close the fuse cover.
- 5) Reconnect the power cable to the back of the 4145B.

4.2 Troubleshooting Operational Problems

First verify that:

- The correct power is applied to the rear of the 4145B
- The fuses are good

The 4145B incorporates the **TIME CONSTANT** and **CONTINUOUS OPERATION LED**'s as fault indicators. The following codes describe their specific fault indication:

TABLE 4.1 - CONTINUOUS OPERATION LED MODES:

Off	Unit was in lock but is currently out of lock.
Blinking once every second	Unit was in lock but lost lock and is currently in lock. Press RESET button to change to green.
Blinking twice every 4 seconds	Loss of external reference (No 5 MHz input).
Blinking three times every 4 seconds	Unit was in lock and is trying to establish lock after cycle loss.
Blinking four times every 4 seconds	Unit is locked after restart with cycle loss. Press RESET button to change to green.
Blinking five times every 4 seconds	Unit is in Mechanical Tuning mode. See Mechanical Tuning Procedure.
Blinking once every four seconds	Unit has never been in lock. Will change to green when unit locks.
Green	Unit is in lock and has not been out of lock.
Any TIME CONSTANT LED: Blinking once per second	Mechanical tuning procedure needs to be performed.
Power Status LED: Green	AC and DC are good.



NOTE: The next 2 faults are only relevant when configured for external battery and JP1 S7 jumper is disabled.

TABLE 4.1 - CONTINUOUS OPERATION LED MODES (continued)

Red flashing light	Loss of AC Input power, unit is operating from battery power.
Red	AC is on, battery voltage is below minimum operating voltage of 20 volts DC.

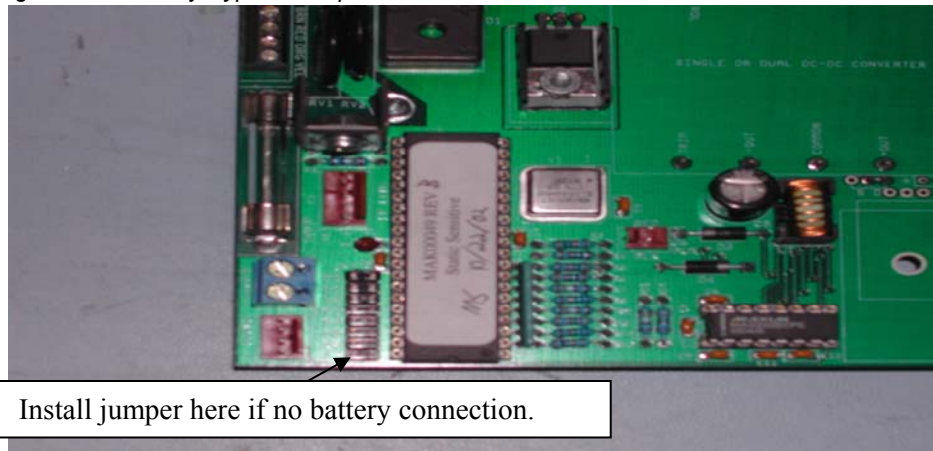
4.3 Procedures

4.3.1 Disabling External Battery Fault Monitoring

The 4145B has the capability to disable the front panel alarm indicator when DC Input power is not supplied. To disable the alarm indicator perform the following steps:

- 1) Ensure power is turned off the 4145B.
- 2) Remove the six screws on the top panel to access the power supply board.
- 3) Locate the main power supply board.
 - a. The main power supply is mounted on the right side of the 4145B when the front panel is facing you.
 - b. Locate JP1. JP1 is located in the lower left corner of the power supply PCB.
 - c. Install jumper onto S7.
- 4) Replace the top cover removed in step 2.

Figure 4.1 - Battery Bypass Jumper Location



4.3.2 Manual Tuning of BVA Oscillator

The TSC-4145B oscillator control voltage is nearing its limits when the time constant light begins to blink. Shortly after the light begins to blink, the TSC-4145B needs to be mechanically tuned.



CAUTION: Performing the following procedure will cause the Ultra-Clean Oscillator output to go out-of spec. Switch to alternate TSC-4145B during this procedure



NOTE: Do not place the TSC-4145B Ultra-Clean Oscillator on a fixed operation schedule based on the first year of operation. Intervals between tuning will vary based as the oscillator ages.

Use the following procedure to align the unit:

- 1) Press both the **SELECT** and **RESET** buttons until the **CONTINUOUS OPERATION LED** begins to flash rapidly 5 times every four seconds. (The buttons will need to be pushed continuously about 10 seconds. Releasing the buttons before the **CONTINUOUS OPERATION LED** begins to blink does not cause a problem. If you release the buttons, simply start pushing the two buttons again.) Release the two buttons to continue the procedure.
- 2) Remove the one-inch long plastic screw from the rear of the chassis to access the mechanical tuning adjustment screw. Use a long thin flat blade screwdriver to reach the adjustment screw. The mechanical tuning adjustment screw is approximately 2.5 inches behind the rear panel.
- 3) The 50, 100, and 200 Second **TIME CONSTANT LED**'s indicate how far the oscillator must be tuned. The 400 Second light indicates whether the mechanical tuning screw should be turned clockwise or counterclockwise. Adjust until all four **TIME CONSTANT (TC) LED**'s are off. See Table below:

TC 50 Green	Adjust mechanical tuning until off
TC 100 Green	Adjust mechanical tuning until off
TC 200 Green	Adjust mechanical tuning until off
TC 400 Green	Turn mechanical tuning counter clockwise
TC 400 Off	Turn mechanical tuning clockwise

- 4) If the **TIME CONSTANT 400** light is on, turn the mechanical tuning screw clockwise (viewed from the rear of the chassis).
- 5) If the **TIME CONSTANT 400** light is off, turn the mechanical tuning screw counterclockwise (viewed from the rear of the chassis).
- 6) To exit the alignment procedure, press both the **RESET** and **SELECT** buttons until the **CONTINUOUS OPERATION LED** turns on continuously. Unit will then proceed to lock to input.
- 7) Set **TIME CONSTANT** to desired Value.



NOTE:

- The plastic screw must be installed to mechanically seal off the Mechanical Tuning hole. Not installing the plastic screw will degrade the performance of the TSC-4145B.
- Adjusting the mechanical tuning changes the oscillator frequency in a manner that may take several minutes to settle out. If the 50 and/or 400 lights come on after the adjustment is complete, one may either tweak the adjustment until both lights are off or, leave it as is.

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5: Warranty and Shipping Information

This chapter provides information on how to contact Timing Solutions Corporation for warranty service, as well as shipping guidelines for the 4145B.

5.1 Warranty Information

The 4145B carries a warranty from Timing Solutions Corporation for a period of 1 year from date of shipment.

For repairs, contact Timing Solutions Corporation:

- Phone (303) 939-8481
- Fax (303) 443-5152

Address written correspondence to:

Timing Solutions Corporation
4775 Walnut Street, Suite 1B
Boulder, CO 80301
USA

5.2 Shipping Information

If you need to ship this system for any reason, including returning equipment to Timing Solutions for warranty service, follow these shipping instructions. Failure to follow these instructions may damage your system.

5.2.1 Packing Instructions

- Always ship the 4145B appropriately packaged to protect it from damage, preferably in the package in which it was originally shipped.
- No cables or connectors may be attached to the rear of the chassis.
- Wrap the chassis in plastic to protect against moisture.

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6: Declaration of Conformity

EC Declaration of Conformity

In accordance with EN 45014:1998

We Timing Solutions Corporation

Of: 4775 Walnut Drive Suite 1B
Boulder, CO 80301
USA

declare that:

Equipment: Ultraclean Oscillator
Model Number **TSC 4145B**
Product Options: NONE

in accordance with the following Directives:

73/23/EEC The Low Voltage Directive
and its amending directives

89/336/EEC The Electromagnetic Compatibility Directive
and its amending directives

has been designed and manufactured to the following specifications:

Safety: EN61010-1: 2001
Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory
Use - Part 1: General Requirements

EMC: EN61326-1: 2001
Electrical Requirements for Electrical Equipment for Measurement, Control and
Laboratory Use - Part 1: General Requirements
EN 55011 Class A
Radiated Emissions

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The unit complies with all essential requirements of the Directives.

Signed by:

Name: S.R. Stein
Position: President

Done at Boulder, Colorado U.S.A on 1 June 2004

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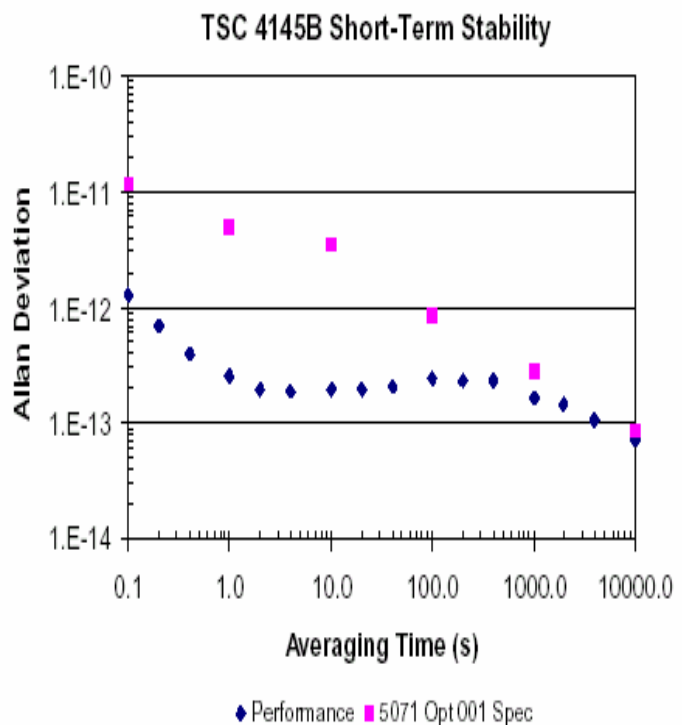
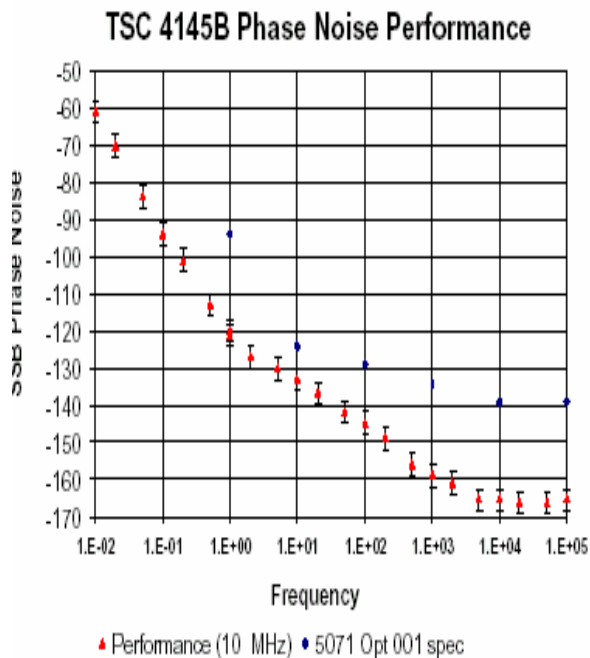
Appendix A: Specifications

A.1 Electrical Specifications

Item	Specification									
Protection Class	Class I (Grounded Type)									
Power Requirements	Input Voltage: 100 - 240 V~ 50/60 Hz 1.2 A Input DC Voltage: 24 - 30 VDC \pm 10 %, 3.0 A Power Consumption: 60 W (Max) <p style="text-align: center;">Note: Fluctuations not to exceed \pm 10% of nominal supply voltage.</p>									
Power Inlet Type	IEC 60320 sheet C14									
AC Power Supply Cord Set	18 AWG (0.75 mm ² minimum)									
DC Power Supply Cord Set	14 AWG (1.5mm ²), including a fuse or circuit breaker of not more that 15A. A 20A circuit breaker may be used if the external wiring is jacketed 14 AWG, with maximum length of 20 feet.									
Power Mains Fuse	(2) - 250V~1.6A Time lag 5x20 mm									
Signal Input	<ul style="list-style-type: none"> ■ Impedance: 50 Ω ■ 10-16 dBm, 5 MHz sine 									
Connectors	<ul style="list-style-type: none"> ■ Input: 1 SMA ■ Output: 4 SMA ■ Alarm Monitor: Phonejack ■ Serial Monitor: RJ-11 									
Output Signal Characteristics	<ul style="list-style-type: none"> ■ 15.5 dBm \pm 1dB ■ Output Impedance: 50 Ω 									
Allan Deviation	<table style="border: none; width: 100%;"> <tr> <td style="width: 10%;">τ</td> <td style="width: 10%;"></td> <td style="width: 80%;">$\sigma_y(\tau)$</td> </tr> <tr> <td>1s</td> <td></td> <td>3×10^{-13}</td> </tr> <tr> <td>100s</td> <td></td> <td>3×10^{-13}</td> </tr> </table>	τ		$\sigma_y(\tau)$	1s		3×10^{-13}	100s		3×10^{-13}
τ		$\sigma_y(\tau)$								
1s		3×10^{-13}								
100s		3×10^{-13}								

Item	Specification	
Phase Noise	f	$\mathcal{A}(f)$ at 5 MHz
	1 Hz	-120 dBc/Hz
	10 Hz	-135 dBc/Hz
	100 Hz	-143 dBc/Hz
	1 kHz	-150 dBc/Hz
	10 kHz	-150 dBc/Hz
	100 kHz	-150 dBc/Hz
Phase Noise	f	$\mathcal{A}(f)$ at 10 MHz
	1 Hz	-120 dBc/Hz
	10 Hz	-130 dBc/Hz
	100 Hz	-140 dBc/Hz
	1 kHz	-155 dBc/Hz
	10 kHz	-160 dBc/Hz
	100 kHz	-160 dBc/Hz

A.2 Typical Performance



A.3 Environment Specifications



CAUTION:

- Ordinary protection: This unit is for **INDOOR USE ONLY**. It is not protected against a harmful ingress of moisture.
 - Equipment intended to be installed in an Enclosed/Open type equipment rack
- Pollution Degree 2 per EN61010-1
 - Installation (Over-Voltage) Category II for transient over-voltages per EN 61010-1
 - Equipment suitable for continuous operation

Table 4 lists the environmental specifications for the 4145B.

Table 4: Environment specifications

Item	Temperature	Relative Humidity	Altitude
In Use	0°C to 35°C	0% to 90% (non-condensing)	3,000 meters (9,843 feet)
Storage	-30°C to 70°C	0% to 90% (non-condensing)	
Transportation	-30°C to 70°C	0% to 90% (non-condensing)	

A.4 Physical Specifications

Table 5 lists the physical specifications for the 4145B.

Table 5: Physical specifications

Item	Specification
Width	Standard 19-inch rack mount
Height	Standard 3U
Depth	55.88 cm or 22 inches
Weight	Approximately 4.1 kg

Glossary

\n	Line feed
\r	Carriage return
CNR	Command and Response
DHCP	Dynamic Host Configuration Protocol
ESD	electrostatic discharge
LED	light-emitting diode
LSB	least significant bit
MSB	most significant bit
PDF	portable document format
PWA	printed wiring assembly
RF	radio frequency
TSC	Timing Solutions Corporation

Index

Numerics

4145B
 alarms 12
 cleaning 10
 command interface 12
 front panel 8
 installing 9
 monitoring 13
 overview 8
 rear panel 8
 required cables 10
 specifications 24
 standards 25
 unpacking 9

A

alarms
 checking 16

C

cables
 required 10
 CE marking
 symbol 6
 checking
 alarms 12
 input type 13
 software version 13
 system status 13
 cleaning
 a 4145B 10
 Command-And
 Response Port
 explained 11
 commands
 system 12
 connections
 input power 10
 input signal 11
 output signal 11

D

Declaration of
 conformity 22

F

fuse
 replacing 14
 symbol 6

I

information
 shipping 20
 warranty 20
 input
 connector 10
 LEDs 16
 input power
 connecting 10
 input signal
 connecting 11
 installing
 a 4145B 10
 instructions
 packing 20
 safety 26

L

LEDs
 input 16
 output 15
 power 16

M

model number
 checking 13
 monitoring
 a 4145B 12

O

operational problems
 troubleshooting 14
 output
 connectors 11
 LEDs 15
 output signal
 connecting 11

P

packing
 instructions 20
 panels
 front 8
 rear 8
 power
 connector 10
 LED 16
 procedures
 troubleshooting 14

R

replacing
 a fuse 14

S

safety
 directive 26
 instructions 9
 shipping
 information 20
 software version
 checking 13
 specifications
 electrical 24
 environment 26
 physical 26
 standards
 applicable to
 4145B 25
 symbols
 CE marking 6
 fuse 6
 input plug 6
 system
 commands 13
 system status
 checking 12

T

troubleshooting
 procedures 14

U

unpacking
 a 4145B 9

W

warranty
 information 20