PowerWave™

Operator's Manual

BioTek®

PowerWave™

Microplate Spectrophotometer
Operator's Manual

April 2016

Part Number 7281000
Revision I
BioTek® Instruments, Inc.

Notices

BioTek® Instruments, Inc.

Highland Park, P.O. Box 998

Winooski, Vermont 05404-0998 USA

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Contact Information

BioTek® Instruments, Inc.

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Global Service and Support

BioTek instrument service and repair is available worldwide at one of BioTek's International Service Centers and in the field at your location. To arrange for service or repair of your instrument, contact the office nearest you; visit www.biotek.com for up-to-date contact information. For customer service, sales, and technical assistance, refer to the information below.

Customer Service and Sales

Internet:	www.biotek.com
Phone:	888-451-5171 (toll free in the U.S.) 802-655-4740 (outside the U.S.)
Fax:	802-655-7941
E-Mail:	customercare@biotek.com

Service/TAC

Phone:	800-242-4685 (toll free in the U.S.) 802-655-4740 (outside the U.S.)
Fax:	802-654-0638
E-Mail:	tac@biotek.com

European Coordination Center/Authorized European Representative

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Revision History

Revision	Date	Changes
A	12/2001	First issue.
B	2/2002	For the Optical Performance Specifications, changed the maximum allowable Gain on Optics from 6.0 to 10.0 (page 1-5). Replaced Figures 3-1a and 3-1b, Sample Output for the System Test (pages 3-4 and 3-5). Updated technical support contact information (pages iii, 1-6, and 1-7). Made editorial changes.
C	8/2003	Updated TAC information in Preface and Ch. 1, and Customer Service and European contact information, Hazards, Standards, Safety Symbols, Intended Use Statement, and Warranty in Preface. Updated Introduction, Variations, Hardware Features, Software Features, Package Contents, Optional Accessories, and Specifications, Ch. 1. Enhanced Unpacking/Repackaging sections, Ch. 2; added Fig. 2-5, 2-6. Revised Ch. 3 sections: System Test, Universal Plate Test, Liquid Testing. Enhanced Decontamination section; added Cleaning section in App. A. Enhanced section on KC4™, added section on KCjunior™ in App. B, and replaced previous serial control section with a reference to Bio-Tek's serial communication protocol specification 7266201-SP. Replaced Error Codes tables in App. C with more detailed tables from the PowerWave™ HT Service Manual. Added information about the optional barcode scanner in Ch. 1, and added new App. E, Barcode Scanner. Referenced new versions of PowerWave™, PowerWave™ 340, and PowerWave™ HT 340 throughout manual. Included references to KCjunior as an additional primary operating software and substitute for KC4. Included information about the compatibility of the PowerWave with the Bio-Stack™ Automated Microplate Stacking System, and brief paragraphs concerning installation, serial cable connections, error codes, and alignment when operating the PowerWave with the Bio-Stack; referenced the Bio Stack Operator's Manual.
D	5/2006	Updated primarily to support introduction of Gen5™ Software. General: Added Gen5 references and instructions wherever KC4™ and KCjunior™ references and instructions were present. Changed 'Bio-Tek' to 'BioTek,' 'Bio-Stack™ Automated Microplate Stacking System' to 'Bio-Stack Microplate Stacker,'and 'Abs' to 'OD'. Removed 'Scanning' from 'PowerWave™ Microplate Scanning Spectrophotometer'. Cover: Replaced existing cover with new design. Preface: Updated contact information, Warnings, Hazards, Pre-cautions, Safety Symbols. Removed Warranty and Registration Card. Chapter 1, Introduction: Added clarification (in Internal Barcode Scanner section) that some older models of the reader may include the scanner. Updated Package Contents, Optional Accessories, and replaced previous Technical Support pages with a Product Support and Service page.

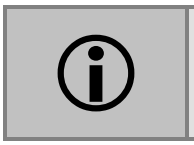
Revision	Date	Changes
(D)		Chapter 2, Installation: Rearranged installation steps to better reflect actual practice. Chapter 3, Performance Verification/Qualification Tests: Added Gen5™ instructions for the Self Test and Absorbance Plate Test. In Recommended Qualification Schedule, moved Absorbance Plate Test and Liquid Tests from IQ to initial/annual OQ, changed PQ semiannual frequency to quarterly, and clarified criteria for running Liquid Tests 1, 2, or 3. Changed 'Universal' to 'Absorbance' in 'Universal Test Plate' and 'Universal Plate Test'. In Liquid Test 1, added BioTek wetting agent (7773002) to list of ingredients. In Liquid Test 3, changed Sigma® 'P 3563 packets' to 'PBS tablets (#4417, or equivalent).' In Liquid Tests 1 and 3, changed 'Analytical balance' to 'Precision balance.' In all Liquid Tests, added 'Corning" to "Costar' (microplates), and added note to shake plate or wait after pipetting and before reading the plate. Appendix A, Decontamination and Cleaning: Corrected dilution mixtures for bleach on page A-3 by changing '20:1' ratio for commercial bleach to '1:20', and '10:1' ratio for household bleach to '1:10'. Appendix B, Computer Control: Added new section, "Controlling the Reader with Gen5."
E	12/2009	Throughout: Removed references to models 'PowerWave' and 'PowerWave HT 340' (PowerWave HT and PowerWave 340 remain). Emphasized use of Gen5 instead of KC4 and KCjunior (which are no longer available from BioTek). Removed references to the ActiveX component. Preface: Updated Trademarks, Intended Use Statement, Hazards, Precautions, CE Mark information, and Safety Symbols. Removed lists of illustrations and tables. Ch 1 Introduction: Removed 'Variations' and 'Internal Barcode Scanner'. Updated Package Contents and Optional Accessories. Ch 2 Installation: Simplified unpacking and setup instructions. Removed Serial Pinout Description. Ch 3 Operation: New chapter. Ch 4 Instrument Qualification: Moved recommendations for optimum performance to new chapter 3. Clarified instructions for the various qualification tasks. Former Appendix B, Computer Control: Deleted this section. Moved Gen5 instructions to new chapter 3. Former Appendices A and C: Changed to Chapters 5 and 6. Former Appendices D and E: Changed to Appendices A and B.
F	5/2011	General: Removed references to outdated software KC4 and KCjunior. Updated Gen5 instructions for Gen5 version 2.x. Introduction: Deleted redundant "Hardware Features" and "Software Features" sections. Liquid Testing: Updated Liquid Test 3; removed instructions for creating the 10x concentration PBS solution. Appendices: Removed former Appendix B: Barcode Scanner.
G	8/2012	*Preface*: Updated date and revision on title page and Notices; added Take3 and Take3 Trio to the trademarks; updated the Intended Use Statement; in "Hazards," added "Service," "Accessories," and "Lubricants" warnings; in "Precautions," added "Spare Parts" caution; in "CE Mark," updated Directives 2004/108/EC, 2006/95/EC, and 98/79/EC. *Chapter 1, Introduction*: In "Optional Accessories," added Absorbance Liquid

Revision	Date	Changes
		Test Solutions and Take3/Take3 Trio plates; added Take3/Take3 Trio plates to specifications. *Chapter 2, Installation*: In "1: Unpack and Inspect the Instrument," added "Improper packaging that results in damage to the instrument may lead to additional charges." *Chapter 4, Instrument Qualification*: Updated the Absorbance Plate Test section.
H	10/2012	*Preface:* Updated CE Mark information to include EN 61010-2-081 and EN61010-2-010. *Chapter 1, Introduction*: Replaced power supply PN 76053 with 76077.
I	2/2016	*General:* Replaced "Return Materials Authorization number" with "Service Call Notice number"; added support for the 340 nm Absorbance Test Plate (7260551). *Preface:* Added "Global Service and Support" to Contact Information, made CE information current. *Chapter 1, Introduction:* Add text to indicate that only the PowerWave XS2 supports the Take3/Take3 Trio, added the 340 nm Absorbance Test Plate and the cuvette adapter to the Optional Accessories. *Chapter 3, Operation:* Added additional items to the Recommendations for Optimum Performance section about understanding the volumetric limits of the plate type used; the use of acids, corrosives, and solvents; and use of partial plates with incubation. *Chapter 4, Instrument Qualification:* Reworked the Recommended Qualification Schedule to include mention of the 340 nm Absorbance Test Plate; replaced existing sample Absorbance Plate Test Report with one from a PowerWave HT. *Chapter 6, Error Codes:* Added description for error code 2500/2502

Document Conventions

This manual uses the following typographic conventions:

	This icon calls attention to important ***safety*** notes.
Warning!	A ***Warning*** indicates the potential for bodily harm and tells you how to avoid the problem.
Caution	A ***Caution*** indicates potential damage to the instrument and tells you how to avoid the problem.
Note:	***Bold*** text is primarily used for emphasis.



This icon calls attention to ***important information***.

Intended Use Statement

- The PowerWave is an eight-channel, automated, benchtop, general-purpose microplate spectrophotometer that performs optical density measurements of samples in a microplate format. The user must evaluate this instrument with PC-based software in conjunction with the specific assay. This evaluation must include the confirmation that performance characteristics for the specific assay are met.
- If the instrument has an "IVD" label, it may be used for clinical and non-clinical purposes, including research and development. If there is no such label, the instrument may be used only for research and development or other non-clinical purposes.

Quality Control

It is considered good laboratory practice to run laboratory samples according to instructions and specific recommendations included in the package insert or standard laboratory protocol for the test to be conducted. Failure to conduct Quality Control checks could result in erroneous test data.

Warranty and Product Registration

Review the Warranty information that shipped with your product. Register your product(s) with BioTek to ensure that you receive important information and updates. Contact the Customer Resource Center (CRC) at www.biotek.com or by calling 888/451-5171 or 802/655-4740.

Repackaging and Shipping

If you need to ship the instrument to BioTek for service or repair, contact BioTek for a **Service Call Notice (SCN)** number, and be sure to use the original packing materials. Other forms of commercially available packaging are not recommended and can void the warranty. If the original packing materials have been damaged or lost, contact BioTek for replacement packing.

Warnings

Operate the instrument on a level, stable surface away from excessive humidity.

Bright sunlight or strong incandescent light can reduce the linear performance range of the instrument.

Measurement values may be affected by extraneous particles (such as dust) in the microplate wells. A clean work area is necessary to ensure accurate readings.

When operated in a safe environment according to the instructions in this document, there are no known hazards associated with the instrument. However, the operator should be aware of certain situations that could result in serious injury; these may vary depending on the instrument model. See **Hazards** and **Precautions**.

Hazards

The following hazard warnings are provided to help avoid injury:

Warning! Power Rating. The instrument's power supply cord must be connected to a power receptacle that provides voltage and current within the specified rating for the system. Use of an incompatible power receptacle may produce electrical shock and fire hazards.

Warning! Electrical Grounding. Never use a plug adapter to connect primary power to the external power supply. Use of an adapter disconnects the utility ground, creating a severe shock hazard. Always connect the power supply directly to an appropriate receptacle with a functional ground.

Warning! Internal Voltage. Always turn off the power switch and unplug the power supply before cleaning the outer surface of the instrument.

Warning! Service. Only qualified technical personnel should perform service procedures on internal components.

Warning! Accessories. Only accessories that meet the manufacturer's specifications shall be used with the instrument.

Warning! Lubricants. Do not apply lubricants to the microplate carrier or carrier track. Lubricant on the carrier mechanism or components in the carrier compartment will attract dust and other particles, which may obstruct the carrier path and cause the instrument to produce an error.

Warning! Liquids. Avoid spilling liquids on the reader; fluid seepage into internal components creates a potential for shock hazard or instrument damage. If a spill occurs while a program is running, abort the program and turn off the instrument. Wipe up all spills immediately. Do not operate the instrument if internal components have been exposed to fluid.

Warning! Unspecified Use. Failure to operate this equipment according to the guidelines and safeguards specified in this manual could result in a hazardous condition.

Warning! Software Quality Control. The operator must follow the manufacturer's assay package insert when modifying software parameters and establishing reading methods. Failure to conduct quality control checks could result in erroneous test data.

Warning! Reader Data Reduction Protocol. No limits are applied to the raw absorbance data. All information exported via computer control must be thoroughly analyzed by the operator.

Warning! Potential Biohazards. Some assays or specimens may pose a biohazard. Adequate safety precautions should be taken as outlined in the assay's package insert. Always wear safety glasses and appropriate protective equipment, such as chemically resistant rubber gloves and an apron.

Precautions

The following precautions are provided to help avoid damage to the instrument:

Caution: Service. The instrument should be serviced by BioTek-authorized service personnel. Only qualified technical personnel should perform troubleshooting and service procedures on internal components.

Caution: Spare Parts. Only approved spare parts should be used for maintenance. The use of unapproved spare parts and accessories may result in a loss of warranty and potentially impair instrument performance or cause damage to the instrument.

Caution: Environmental Conditions. Do not expose the system to temperature extremes. For proper operation, ambient temperatures should remain within the range listed in the **Specifications** section of Chapter 1. Performance may be adversely affected if temperatures fluctuate above or below this range. Storage temperature limits are broader.

Caution: Sodium Hypochlorite. Do not expose any part of the instrument to the recommended diluted sodium hypochlorite solution (bleach) for more than 20 minutes. Prolonged contact may damage the instrument surfaces. Be certain to rinse and thoroughly wipe all surfaces.

Caution: Power Supply. Only use the power supply shipped with the instrument. Operate this power supply within the range of line voltages listed on it.

Caution: Carrier Shipping Bracket. The microplate carrier shipping bracket must be removed before operating the instrument and reinstalled before repackaging the instrument for shipment.

Caution: Disposal. This instrument contains printed circuit boards and wiring with lead solder. Dispose of the instrument according to Directive 2012/19/EU, "on waste electrical and electronic equipment (WEEE)" or local ordinances.

Caution: Warranty. Failure to follow preventive maintenance protocols may void the warranty. See **Chapter 5** for preventive maintenance procedures.

Caution: Electromagnetic Environment. Per IEC 61326-2-6 it is the user's responsibility to ensure that a compatible electromagnetic environment for this instrument is provided and maintained in order that the device will perform as intended.

Caution: Electromagnetic Compatibility. Do not use this device in close proximity to sources of strong electromagnetic radiation (e.g., unshielded intentional RF sources), because these may interfere with the proper operation.

CE Mark

CE Based on the programs described below and information contained herein, this product bears the CE mark.

❖ See the Declaration of Conformity for more information.

Directive 2014/30/EU: Electromagnetic Compatibility

Emissions—CLASS A

The system has been type-tested by an independent, accredited testing laboratory and found to meet the requirements of EN 61326-1: Class A for Radiated Emissions and Line Conducted Emissions.

Verification of compliance was conducted to the limits and methods of EN 55011—(CISPR 11) Class A. In a domestic environment it may cause radio interference, in which case you may need to mitigate the interference.

Immunity

The system has been type-tested by an independent, accredited testing laboratory and found to meet the requirements of EN 61326-1 and EN 61326-2-6 for Immunity. Verification of compliance was conducted to the limits and methods of the following:

EN 61000-4-2, Electrostatic Discharge
EN 61000-4-3, Radiated EM Fields
EN 61000-4-4, Electrical Fast Transient/Burst
EN 61000-4-5, Surge Immunity
EN 61000-4-6, Conducted Disturbances from RFI
EN 61000-4-11, Voltage Dips, Short Interruptions and Variations

Directive 2014/35/EU Low Voltage (Safety)

The system has been type-tested by an independent testing laboratory and was found to meet the requirements of this Directive. Verification of compliance was conducted to the limits and methods of the following:

EN 61010-1, "Safety requirement for electrical equipment for measurement, control and laboratory use. Part 1, General requirements."

EN 61010-2-081, "Particular requirements for automatic and semi-automatic laboratory equipment for analysis and other purposes."

EN 61010-2-010, "Particular requirements for laboratory equipment for the heating of materials."

Directive 2012/19/EU: Waste Electrical and Electronic Equipment

Disposal Notice: This instrument contains printed circuit boards and wiring with lead solder. Dispose of the instrument according to Directive 2012/19/EU, "on waste electrical and electronic equipment (WEEE)" or local ordinances.

Directive 98/79/EC: In Vitro Diagnostics

- Product registration with competent authorities.
- Traceability to the U.S. National Institute of Standards and Technology (NIST): Optical density measurements are traceable to NIST.
- EN 61010-2-101, "Particular requirements for in vitro diagnostic (IVD) medical equipment."

Electromagnetic Interference and Susceptibility

USA FCC CLASS A

RADIO AND TELEVISION INTERFERENCE

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. Like all similar equipment, this equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause interference, in which case the user will be required to correct the interference at his own expense.

In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and television reception.

Canadian Department of Communications Class A

This digital apparatus does not exceed Class A limits for radio emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le present appareil numerique n'emet pas de bruits radioelectriques depassant les limites applicables aux appareils numerique de la Class A prescrites dans le Reglement sur le brouillage radioelectrique edicte par le ministere des Communications du Canada.

User Safety

This device has been type-tested by an independent laboratory and found to meet the requirements of the following:

- **Underwriters Laboratories UL 61010-1**

  "Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1: general requirements"

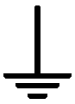
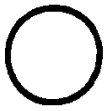
- **Canadian Standards Association CAN/CSA C22.2 No. 61010-1**

  "Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1: general requirements"

- EN 61010 Standards—See CE Mark list

Safety Symbols

Some of these symbols appear on the instrument or accessories:

	Alternating current Courant alternatif Wechselstrom Corriente alterna Corrente alternata		Both direct and alternating current Courant continu et courant alternatif Gleich - und Wechselstrom Corriente continua y corriente alterna Corrente continua e corrente alternata
	Direct current Courant continu Gleichstrom Corriente continua Corrente continua		Earth ground terminal Borne de terre Erde (Betriebserde) Borne de tierra Terra (di funzionamento)
	On (Supply) Marche (alimentation) Ein (Verbindung mit dem Netz) Conectado Chiuso		Protective conductor terminal Borne de terre de protection Schutzleiteranschluss Borne de tierra de protección Terra di protezione
	Off (Supply) Arrêt (alimentation) Aus (Trennung vom Netz) Desconectado Aperto (sconnessione dalla rete di alimentazione)		Caution (refer to accompanying documents) Attention (voir documents d'accompanement) Achtung siehe Begleitpapiere Atención (vease los documentos incluidos) Attenzione, consultare la doc annessa
	Warning, risk of electric shock Attention, risque de choc électrique Gefährliche elektrische schlag Precaución, riesgo de sacudida eléctrica Attenzione, rischio di scossa elettrica		Warning, risk of crushing or pinching Attention, risque d'écrasement et pincement Warnen, Gefahr des Zerquetschens und Klemmen Precaución, riesgo del machacamiento y sejeción Attenzione, rischio di schiacciare ed intrappolarsi
	Warning, hot surface Attention, surface chaude Warnen, heiße Oberfläche Precaución, superficie caliente Attenzione, superficie calda		Warning, potential biohazards Attention, risques biologiques potentiels Warnung! Moegliche biologische Giftstoffe Atención, riesgos biológicos Attenzione, rischio biologico

	In vitro diagnostic medical device Dispositif médical de diagnostic in vitro Medizinisches In-Vitro-Diagnostikum Dispositivo médico de diagnóstico in vitro Dispositivo medico diagnostico in vitro
	Consult instructions for use Consulter la notice d'emploi Gebrauchsanweisung beachten Consultar las instrucciones de uso Consultare le istruzioni per uso

	Separate collection for electrical and electronic equipment Les équipements électriques et électroniques font l'objet d'une collecte sélective Getrennte Sammlung von Elektro- und Elektronikgeräten Recogida selectiva de aparatos eléctricos y electrónicos Raccolta separata delle apparecchiature elettriche ed elettroniche

Chapter 1

Introduction

This chapter introduces the PowerWave Microplate Spectrophotometer, describes its features and specifications, and provides contact information for technical assistance.

Product Description

The PowerWave offers tunable wavelength selection and wavelength scanning without the need for interference filters. The eight-channel reader is computer controlled via BioTek's Gen5 software. Key features include:

- A variety of read methods including endpoint, kinetic, multiwavelength, and spectral scanning
- A monochromator for continuous wavelength selection from 200 to 999 nm (or 340 to 999 nm for the PowerWave 340), in 1-nm increments
- A xenon flash lamp for both UV and visible light absorbance measurements
- Superior optical specifications, with an extended dynamic range of up to 4.000 OD
- Ability to read standard 96- and 384-well (PowerWave HT) microplates, BioTek's patented BioCell quartz vessel for 1 cm measurements, and the Take3 and Take3 Trio Micro-Volume Plates (PowerWave XS2)
- Three reading speeds: normal, rapid, and sweep mode
- A unique 4-Zone temperature control from 4º over ambient to 50ºC that ensures superior temperature uniformity necessary for kinetic assays
- Low, medium, high, and variable plate shake speeds with adjustable durations
- Robot accessible carrier. Compatible with BioTek's BioStack Microplate Stacker

> ❖ If you purchased the BioStack to operate with the PowerWave, refer to the *BioStack Operator's Manual* for installation, setup, and operation instructions. If you are interested in purchasing the BioStack, contact your local BioTek dealer or visit www.biotek.com.

Package Contents

> ❖ Package contents and part numbers are subject to change. Please contact BioTek Customer Care if you have any questions.

- Gen5 Software (PN 5320200)
- Power supply (PN 76077) and power cord (PN varies according to country of use)
- Serial cable (PN 75053)
- *PowerWave Operator's Manual* (PN 7281000) on USB flash drive

Optional Accessories

> ❖ Accessories and part numbers are subject to change. Please contact BioTek Customer Care if you have any questions, or visit www.biotek.com and use the Accessories search feature.

- USB to Serial Adapter (PN 75104)
- 7-filter Absorbance Test Plate for absorbance measurement testing (PN 7260522)
- Absorbance Test Plate for absorbance measurement testing at 340 nm* (PN 7260551)
- BioCell Quartz vessel for 1 cm wavelength fixed pathlength absorbance measurements (PN 7272051); adapter plate for up to eight BioCells (PN 7270512)
- PowerWave Product Qualification (IQ-OQ-PQ) package (7280520)
- Absorbance Liquid Test Solutions:
  - BioTek Wetting Agent Solution (7773002)
  - BioTek QC Check Solution No. 1 (25 mL) (7120779)
  - BioTek QC Check Solution No. 1 (125 mL) (7120782)
  - Phosphate-Buffered Saline (PBS) Tablets (pH 7.2–7.6) (Sigma #P4417)
  - β-NADH Powder (β-Nicotinamide Adenine Dinucleotide, Reduced Form) (Sigma #N6785-10VL or BioTek PN 98233)
- BioStack Microplate Stacker (contact Customer Care)
- Cuvette adapter (PN 7302030)
- Take3 and Take3 Trio Micro-Volume Microplates (TAKE3/Take3Trio) (PowerWave XS2 only)

*The diagnostic feature in Gen5 version 2.08 and higher is compatible with the 340 nm Absorbance Test Plate, BTI PN 7260551. If you are using an earlier Gen5 version, the test plate's instruction sheet explains how to manually conduct the tests and analyze the results.

Specifications

Microplates

- All models accommodate standard 96-well microplates and up to 8 BioCells.
- The PowerWave HT also accommodates standard 384-well microplates.
- The PowerWave XS2 also accommodates the Take3 and Take3 Trio Micro Volume Plate.

Speed of Reading

The plate read time and accuracy are dependent on the method of reading:

- Normal mode is the slowest of the three available modes. After positioning the well over the beam, the instrument waits 100 milliseconds before taking the measurement (8-flash data collection). Note: The 100 ms delay is to allow for more complete fluid settling.
- Rapid mode is faster than Normal mode because the instrument does not wait before taking the measurement (8-flash data collection).
- Sweep is the fastest of the three available modes. The plate carrier sweeps each row past the optics channel without stopping, and collects data with a single flash at each well as it goes by.

  The following read times are based on a single or dual wavelength measurement. Actual reading speeds may vary, depending upon the reading wavelength selected. Each wavelength has a unique location within the monochromator, and the different locations require varying amounts of time to position.

96-Well Read Timing	**630 nm**	**630/450 nm**
Normal Read Mode	Single	Dual
Endpoint	16 to 25 sec.	26 to 44 sec.
Rapid Read Mode	Single	Dual
Endpoint	16 sec.	26 sec.
Sweep Read Mode	Single	Dual
Endpoint	11 sec.	16 sec.

  Kinetics: All three read modes are available in Kinetics mode. Single wavelength reads are limited to the following minimum times.

  20 seconds from A1 to A1 in Normal mode, single wavelength, depending upon density of solution.

  11 seconds from A1 to A1 in Rapid mode, single wavelength.

  5 seconds from A1 to A1 in Sweep mode, single wavelength.

384-Well Read Timing	**630 nm**	**630/450 nm**
Normal Read Mode	Single	Dual
Endpoint	32 to 67 sec.	57 to 129 sec.
Rapid Read Mode	Single	Dual
Endpoint	28 sec.	49 to 51 sec.
Sweep Read Mode	Single	Dual
Endpoint	17 sec.	28 sec.

Kinetics: All three read modes are available in Kinetics mode. Single wavelength reads are limited to the following minimum times.

66 seconds from A1 to A1 in Normal mode, single wavelength, depending upon density of solution.

23 seconds from A1 to A1 in Rapid mode, single wavelength.

11 seconds from A1 to A1 in Sweep mode, single wavelength.

Optical Specifications

λ range:	200 to 999 nm (PowerWave HT) 340 to 999 nm (PowerWave 340)
λ accuracy:	± 2 nm
λ repeatability:	± 0.2 nm
λ bandpass:	5 nm

Optical Performance

Flat- and round-bottom full-well plates

Absorbance Measurement Range: 0.000 to 4.000 OD

Accuracy:

0.000 to 2.000 OD ± 1.0% ± 0.010 OD Normal and Rapid modes, all plates
2.000 to 2.500 OD ± 3.0% ± 0.010 OD Normal and Rapid modes, all plates
2.500 to 3.000 OD ± 3.0% ± 0.010 OD Normal 96-well plates only
0.000 to 1.000 OD ± 1.0% ± 0.010 OD Sweep mode, all plates

Linearity:

0.000 to 2.000 OD ± 1.0% Normal and Rapid modes, 96-well plates
0.000 to 2.000 OD ± 2.0% Normal and Rapid modes, 384-well plates
2.000 to 2.500 OD ± 3.0% Normal and Rapid modes, all plates
2.500 to 3.000 OD ± 3.0% Normal mode, 96-well plates only
0.000 to 1.000 OD ± 1.0% Sweep mode, all plates

Repeatability:

0.000 to 2.000 OD ± 1.0% ± 0.005 OD Normal and Rapid modes, 96-well plates
0.000 to 2.000 OD ± 2.0% ± 0.010 OD Normal and Rapid modes, 384-well plates
2.000 to 2.500 OD ± 3.0% ± 0.005 OD Normal and Rapid modes, all plates
2.500 to 3.000 OD ± 3.0% ± 0.005 OD Normal mode, 96-well plates only
0.000 to 1.000 OD ± 2.0% ± 0.010 OD Sweep mode, all plates

For the above performance, the Gain on Optics test should be below 10.0.

Hardware and Environmental Specifications

Light Source:	Xenon flash light source - 10 W max. average power - Life: 1 billion flashes
Dimensions:	16.0" deep x 8.5" wide x 8.5" high (40.6 cm deep x 21.6 cm wide x 21.6 cm high)
Weight:	24 lb. (10.9 kg)
Environment:	Operational temperature 18° - 40°C
Humidity:	10% to 80%, non-condensing
Power Source:	24-volt external power supply compatible with 100-240 V~ ± 10% @50-60 Hz
Power Consumption:	100 VA max
Temperature Control:	4°C over ambient to 50°C
Temperature Variation:	± 0.5C across the plate @ 37°C (250 µL per well with the plate sealed)

Product Support & Service

Contacting the Technical Assistance Center

If your instrument(s) or software fails to function properly, if you have questions about how to use or maintain your products, or if you need to send an instrument to BioTek for service or repair, please contact our Technical Assistance Center (TAC).

The TAC is open from 8:30 AM to 5:30 PM (EST), Monday through Friday, excluding standard U.S. holidays.

Phone: (800) 242-4685 or (802) 655-4740 **Fax:** (802) 654-0638 **E-Mail:** tac@biotek.com **Web:** www.biotek.com

Please be prepared to provide the following information:

- Your name and company information, along with a daytime phone or fax number, and/or an e-mail address
- The product name, model, and serial number
- The onboard software part number and version (available via Gen5 by selecting **System > Reader/Instrument Control > Information**)
- Gen5 software version information (**Help > About Gen5**)
- For troubleshooting assistance or instruments needing repair, the specific steps that produce your problem and any error codes displayed in Gen5 (see also ***Chapter 6***)

Returning Instruments for Service/Repair

If you need to return an instrument to BioTek for service or repair, please contact the TAC for a Service Call Notice (SCN) number and the shipping address. Repackage the instrument properly (see Chapter 2), write the SCN number on the shipping box, and ship to BioTek.

Chapter 2

Installation

This chapter provides instructions for unpacking and setting up the PowerWave.

Product Registration

Register your product(s) with BioTek to ensure that you receive important information and updates. Register online through BioTek's Customer Resource Center (CRC) at www.biotek.com or by contacting BioTek Customer Care.

1: Unpack and Inspect the Instrument

Save all packaging materials. If you need to ship the instrument to BioTek for repair or replacement, you must use the original materials. Using other forms of commercially available packaging, or failing to follow the repackaging instructions, may void the warranty. Improper packaging that results in damage to the instrument may lead to additional charges. If the original materials have been damaged or lost, replacements are available from BioTek (PN 7283000).

During the unpacking process, inspect the packaging, instrument, and accessories for shipping damage. If the instrument is damaged, notify the carrier and your BioTek representative. Keep the shipping boxes and the packaging materials for the carrier's inspection. BioTek will arrange for repair or replacement of your instrument immediately.

Carefully unpack the reader and accessories. Retain the packing materials for future use.

Inspect the shipping box(es), reader, and accessories for signs of damage.

If the reader is damaged, notify the carrier and your manufacturer's representative. Keep the shipping cartons and packing material for the carrier's inspection. The manufacturer will arrange for repair or replacement of your reader.

See **Preparing the PowerWave for Shipment** at the end of this chapter for repacking and shipping instructions.

2: Remove the Carrier Shipping Bracket

Important! The PowerWave ships with a microplate carrier shipping bracket that must be removed before the reader is used. See **Figure 1**.

1. On the front of the reader, pull down the door to the carrier compartment.
2. Using a screwdriver, remove the three screws that secure the shipping bracket.
3. Secure the bracket to the back of the reader for storage.

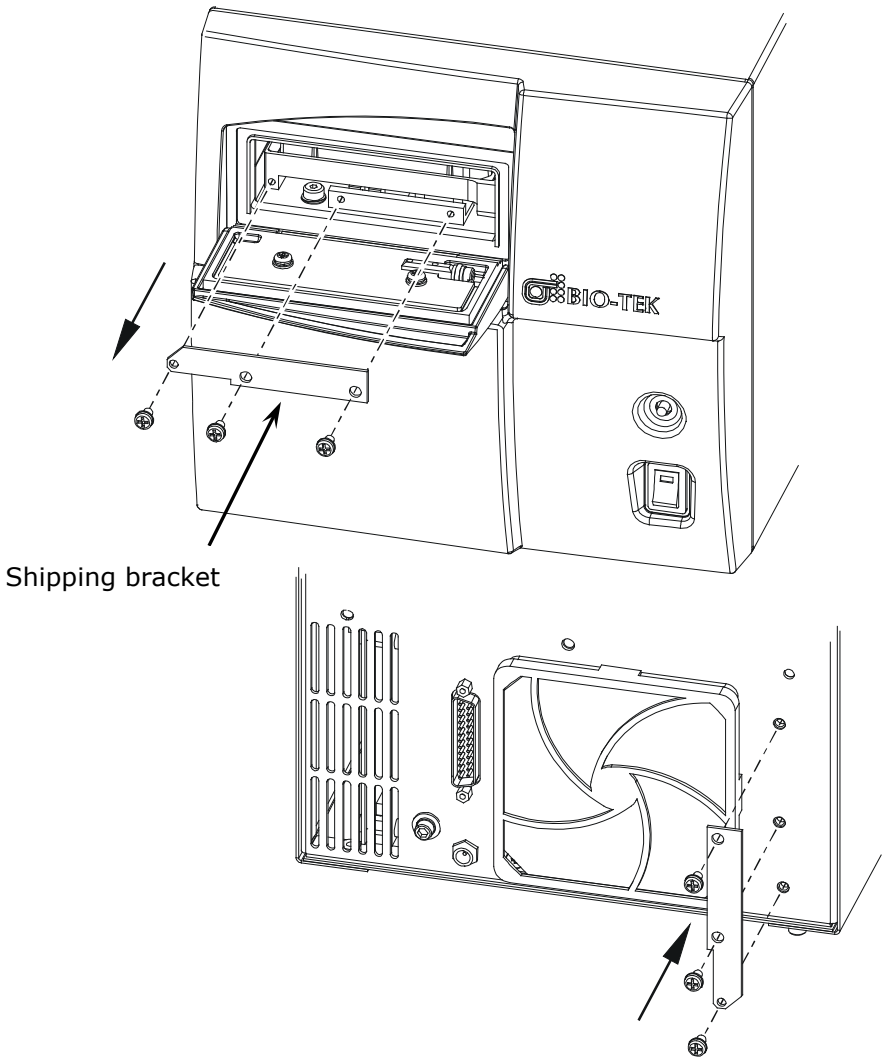


Figure 1: Remove the carrier shipping bracket and store it on the back of the reader

3: Select an Appropriate Location

Install the reader on a level surface in an area where ambient temperatures remain between 18°C (64°F) and 40°C (104°F). The reader is sensitive to extreme environmental conditions; avoid these conditions:

- **Excessive humidity:** Condensation directly on the sensitive electronic circuitry can cause the reader to fail internal self-checks.
- **Excessive ambient light:** Strong light can reduce the linear performance range of the reader.
- **Dust:** Optical density readings may be affected by extraneous particles in the microplate wells. A clean work area is necessary to ensure accurate readings.

4: Connect the Power Supply

Warning! Power Rating. The power supply must be connected to a power receptacle that provides voltage and current within the specified rating for the system. Use of an incompatible power receptacle may produce electrical shock and fire hazards.

Warning! Electrical Grounding. Never use a plug adapter to connect primary power to the power supply. Use of an adapter disconnects the utility ground, creating a severe shock hazard. Always connect the power supply cord directly to an appropriate receptacle with a functional ground.

1. Connect the power cord to the power supply.
2. Locate the power inlet on the back of the reader. Insert the power supply's plug into the reader's inlet. Tighten the plug barrel.
3. Plug the cord into an appropriate power receptacle.

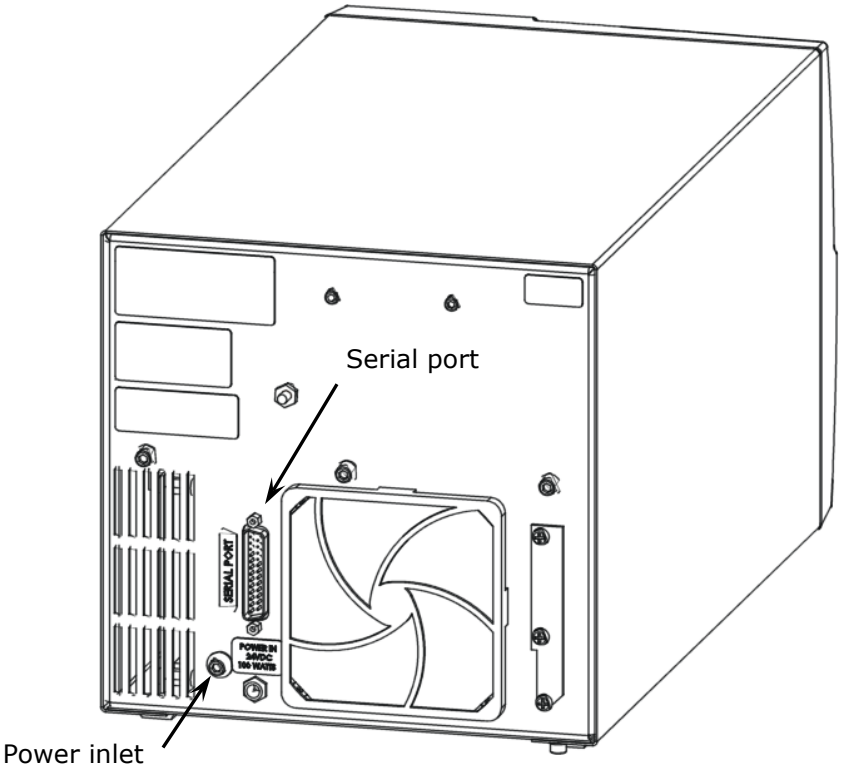


Figure 2: Serial port and power supply inlet

5: Connect the Host Computer

1. Turn the computer off. If the reader is on, turn it off.
2. Connect one end of the supplied serial cable to an appropriate port on the computer.

   ❖ BioTek offers a USB to Serial Adapter (PN 75104) to connect the serial cable to a USB port on your computer. Contact BioTek Customer Care.

3. Connect the other end of the cable to the serial port on the back of the reader.

6: Install Gen5

The PowerWave is controlled by Gen5 software running on a host computer. There is a certain sequence of events that *must* be followed to ensure that the software is properly installed and configured. Please follow the instructions provided in ***Gen5 Getting Started Guide*** to install the software.

7: Turn on the Reader

1. Locate the power on/off switch on the front of the instrument, below the carrier eject button. See **Figure 3** on the next page. Turn on the power. The reader will perform an internal self-test and carrier homing sequence.
2. Verify that the following occur while the reader performs the self-test:
   - The carrier should eject outside the PowerWave, then retract to its home position inside the reader before it ejects again.
   - The LED light on the switch should remain illuminated while the power is on.
3. Press the carrier eject button. The carrier should retract and the door should close. Press it again; the carrier should eject.
4. If the test completes successfully, the reader is ready for use.
5. If the test fails, the reader will "beep" continuously. Press the carrier eject button to stop the beeping. Run a System Test using Gen5 to retrieve an error code (see Chapter 6). If the test continues to fail, contact BioTek.

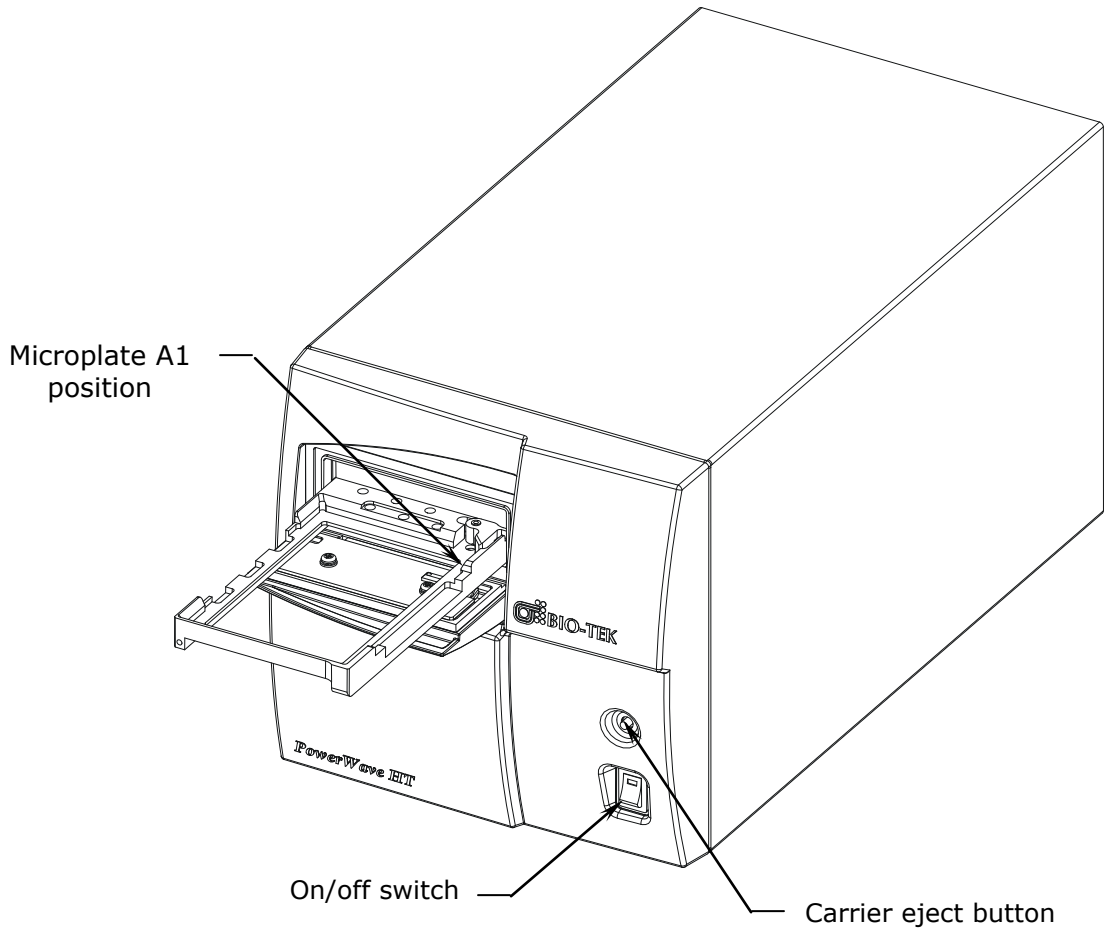


Figure 3: Power on/off switch and carrier eject button

Operational/Performance Qualification

Your PowerWave Microplate Spectrophotometer was fully tested at BioTek prior to shipment and should operate properly following the successful completion of the installation and setup procedures described throughout this chapter.

If you suspect that problems occurred during shipment, if you received the reader back from BioTek following service or repair, and/or if regulatory requirements dictate that Operational/Performance Qualification is necessary, turn to ***Chapter 4, Instrument Qualification*** now to learn about BioTek's recommended OQ/PQ procedures for the PowerWave.

- An Installation/Operational/Performance Qualification (IQ/OQ/PQ) package for the PowerWave is available for purchase (PN 7280520). Contact your local BioTek dealer for more information.

Repackaging and Shipping Instructions

Important! Please read all of the information provided below before preparing the PowerWave for shipment.

	If the reader has been exposed to potentially hazardous material, decontaminate it to minimize the risk to all who come in contact with the reader during shipping, handling, and servicing. Decontamination prior to shipping is required by the U.S. Department of Transportation regulations. See ***Chapter 5*** for decontamination instructions. Remove the microplate from the carrier before shipment. Spilled fluids can contaminate the optics and damage the instrument.
	The instrument's packaging design is subject to change. If the instructions in this section do not apply to the packaging materials you are using, please contact BioTek's Technical Assistance Center for guidance. Replace the shipping hardware before repackaging the reader. Please contact BioTek if you have misplaced the microplate carrier shipping bracket (PN 7282014) or mounting screws (3, PN 19186). If you need to ship the reader to BioTek for service or repair, be sure to use the original packaging materials. Other forms of commercially available packaging are not recommended and can **void the warranty**. The shipping materials are designed to be used no more than five times. If the original materials have been damaged, lost, or used more than five times, contact BioTek to order replacements.

1. Contact BioTek's Technical Assistance Center for an **SCN** (Service Call Notice) number and the shipping address before returning equipment for service.
2. Decontaminate the reader according to the instructions provided in ***Chapter 4***.
3. Install the carrier shipping bracket (refer to ***Remove the Carrier Shipping Bracket*** on page 30):
   - If the carrier is extended, press the carrier eject button to retract it.
   - Turn off the reader.
   - Disconnect the power supply and serial cable from the back of the reader.

- Refer to **Figure 1** on page 30. Using a screwdriver, remove the carrier shipping bracket and screws from the back of the reader.
- Pull down the door to the carrier compartment.
- Install the carrier shipping bracket to the front of the carrier and mounting block.

Refer to **Figure 4** on page 37 when performing these steps:

1. Place two foam caps into the bottom of the shipping container.
2. Slide the accessories box into the shipping container.
3. Place the reader inside its plastic bag and carefully lower it into the two foam caps in the bottom of the box. Note the orientation of the reader in the box.
4. Place two foam caps over the reader.
5. Place the power supply, cord, and communication cables into the accessories box.
6. Close the top of the box and secure it with shipping tape. When finished, write the SCN number on the outside of the box and ship the box to BioTek.

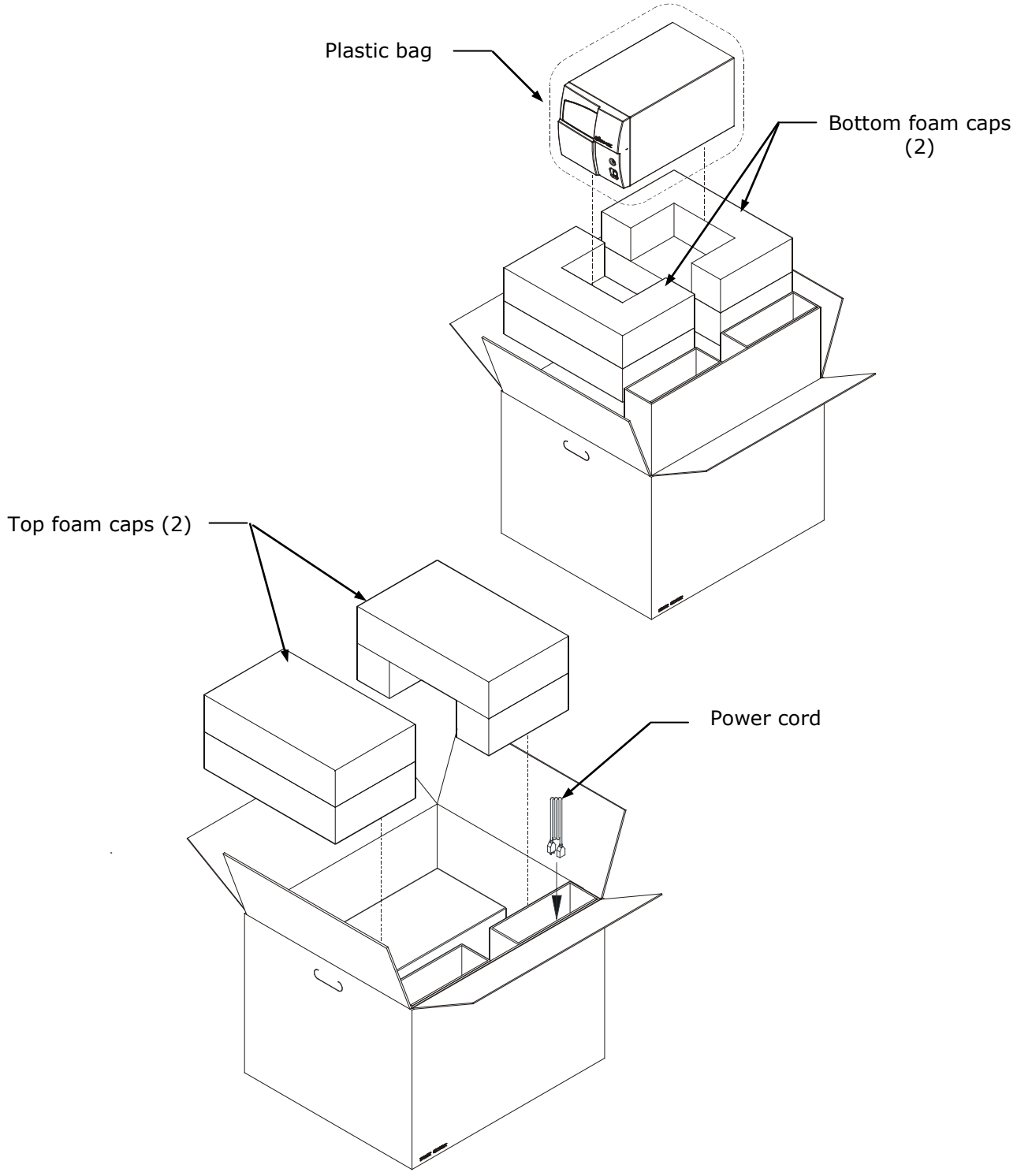


Figure 4: Packing the PowerWave

Chapter 3

Operation

This chapter briefly describes how to use BioTek's Gen5 software to operate the PowerWave. It also contains recommendations for achieving optimum performance.

Operating the PowerWave

Most users will operate the PowerWave using BioTek's Gen5 software. If you have not already done so, please follow the instructions in **Chapter 2** and the *Gen5 Getting Started Guide* for connecting the host computer and installing Gen5.

- For custom applications, BioTek provides a serial communication protocol (PN 7266201-SP). Contact your BioTek dealer.

Getting Started with Gen5

These instructions briefly describe how to create and run an Experiment in Gen5. For more information, or if the instructions below do not match what you see in Gen5, refer to the ***Gen5 Getting Started Guide*** and help system.

For Gen5 version 2.x:

1. Start Gen5.
2. If the Task Manager appears, select **Read Now > New** and skip to step 4. Otherwise, select **File > New Task** from the main view.
3. Select **Read Now > New**. Gen5 will open the procedure dialog. Skip to step 4.

For Gen5 version 1.x:

1. Start Gen5. If the Welcome screen appears, select **Read a Plate** and skip to step 4. Otherwise, select **File > New Experiment** from the main view.
2. Select **Default Protocol** and click **OK**. Gen5 will open the Experiment workspace, which includes the Protocol menu tree and Plate screen.
3. Select **Plate > Read** or click the Read Plate icon. The Procedure dialog will open. Go to step 4.

For any version:

4. Select a **Plate Type**.
5. Click **Read** to open the Read Step dialog.
6. Select a **Read Type**.
7. Select or enter the wavelength(s) at which the plate will be read.
8. Define other reading parameters as desired. Click the **Help** button for assistance.
9. When complete, click **OK** to return to the Procedure dialog.
10. Click **OK** to save and close the Procedure dialog.

- Gen5 version 1.x only: The Plate Reading dialog will open. Enter any desired information, place the plate on the carrier, and then click **READ** to begin the plate read. If the Save As dialog opens, enter a File name, choose a file location (Save in:) and click Save.

11. Click **OK** when the Load Plate dialog appears. The plate will be read.
    - To view the raw data results, use the Data drop-down arrow in the Plate screen to select one wavelength. The results will be displayed for the selected wavelength. Repeat, for other wavelengths.
    - To analyze, manipulate, or print results, Protocol parameters should be defined. Refer to the Gen5 Help system for instructions.

Recommendations for Optimum Performance

- Microplates should be perfectly clean and free of dust or bottom scratches. Use new microplates from sealed packages. Do not allow dust to settle on the surface of the solution; use microplate covers when not reading the plate. Filter solutions to remove particulates that could cause erroneous readings.
- Although the PowerWave supports most flat, U-bottom, and V bottom microplates, the reader achieves optimum performance with optically clear, flat-bottomed wells.
- Non uniformity in the optical density of the well bottoms can cause loss of accuracy, especially with U- and V-bottom polyvinyl microplates. Check for this by reading an empty microplate. Dual wavelength readings can eliminate this problem, or bring the variation in density readings to within acceptable limits for most measurements.
- Inaccuracy in pipetting has a large effect on measurements, especially if smaller volumes of liquid are used. For best results, use at least 100 µL per well in a 96-well plate and 25 µL in a 384-well plate (if supported).
- Pipetting solution into 384-well plates often traps air bubbles in the wells, which may result in inaccurate readings. A dual-wavelength reading method usually eliminates these inaccuracies; however, for best results, remove the air bubbles by degassing the plate in a vacuum chamber before reading.
- The inclination of the meniscus can cause loss of accuracy in some solutions, especially with small volumes. Agitate the microplate before reading to help bring this problem within acceptable limits. Use Tween 20, if possible (or some other wetting agent) to normalize the meniscus. Some solutions develop menisci over a period of several minutes. This effect varies with the brand of microplate and the solution composition. As the center of the meniscus drops and shortens the light path, the density readings change. The meniscus shape will stabilize over time.
- It is the user's responsibility to understand the volumetric limits of the plate type in use as it applies to the assay being run.

- Use of liquids with concentrations of acids, corrosives, or solvents of 3% and greater can begin attacking the materials inside the instrument's chamber. Running multiple plates with concentrations < 3% in long kinetic experiments may also have a destructive effect. If the experiment is incubated, it will accelerate the deterioration of chamber components. When in doubt about the use of acids, corrosives, or solvents, please contact TAC@biotek.com.

Incubation and Partial Plates

When performing a partial plate read that includes an incubation step, the following recommendations can reduce the effects of evaporation of your samples:

- Use microplate lids.
- Fill unused wells with fluid.
- Cluster your sample wells rather than spacing them throughout the plate.
- Place your sample wells in the center of the plate. This placement may lead to less evaporation than if you place the samples in wells on the edge of the plate.

Where to Go Next

- Refer to the *Gen5 Getting Started Guide* and help system to learn more about using Gen5 to operate the PowerWave.
- Review the remaining chapters in this Operator's Manual to learn how to test the performance of the PowerWave, clean and maintain the reader, and troubleshoot problems.

Chapter 4

Instrument Qualification

This chapter discusses procedures for qualifying the reader's initial and ongoing performance.

Overview

This chapter contains BioTek Instruments' recommended Installation Qualification (IQ), Operational Qualification (OQ), and Performance Qualification (PQ) procedures for the PowerWave Microplate Spectrophotometer.

Every PowerWave reader is fully tested at BioTek prior to shipment and should operate properly upon initial setup. If you suspect that a problem occurred during shipment, if you have received the equipment after returning it to the factory for service, and/or if regulatory requirements dictate that you qualify the equipment on a routine basis, you should perform the procedures outlined in this chapter.

Recommended Qualification Schedule

This schedule defines the factory-recommended intervals for qualifying a PowerWave used two to five days a week. The actual frequency, however, may be adjusted depending on your usage of the instrument. This schedule assumes the reader is properly maintained as outlined in ***Chapter 5***.

> ❖ The risk factors associated with your tests may require that the Operational and Performance Qualification procedures be performed more or less frequently than indicated here.

	Installation Qualification	**Operational Qualification**	**Performance Qualification**	
	Initially	*Initially/ Annually*	*Monthly*	*Quarterly*
System Test	✓	✓	✓	
Absorbance Plate Test		✓	✓	
Liquid Test 1 or Liquid Test 2*		✓		✓
(Optional) Liquid Test 3 or 340 nm Absorbance Plate Test (using BTI #7260551)		✓		✓

* If you have Absorbance Test Plate PN 7260522, perform Liquid Test 1. Otherwise, perform Liquid Test 2.

Qualification Procedures

Your reader was fully tested at BioTek prior to shipment and should operate properly upon initial setup. If you suspect that problems occurred during shipment or if regulatory requirements dictate that Operational and/or Performance Qualification is necessary, you should perform the following tests.

- **System Test:** Verifies proper gains, bulb operation, low electronic noise, and incubator functionality. The test report includes the reader's serial number and basecode software part number and version number.
- **Absorbance Plate Test:** Uses BioTek's Absorbance Test Plate to confirm the mechanical alignment, optical accuracy/linearity, repeatability, channel-to-channel variation, and wavelength accuracy of the instrument.
- BioTek's **Absorbance Test Plate PN 7260551** can be used to confirm optical density accuracy, linearity, and repeatability at 340 nm and is offered as an alternative to conducting Liquid Test 3.
- **Liquid Tests:** Uses liquid solutions in a microplate to confirm mechanical alignment, optical accuracy/linearity, repeatability, and channel-to-channel variation of the instrument.

System Test

The PowerWave automatically runs the System Test each time it is powered on. The test can also be run (and a report generated) using Gen5. The System Test report should be printed to document periodic testing and for troubleshooting purposes. See a sample System Test report on page 46.

If the power-up System Test fails, the reader will beep. If this happens, press the carrier eject button to stop the beep and then attempt to run the System Test using Gen5 to retrieve an error code from the instrument.

See ***Chapter 6*** for a list of possible error codes and their probable causes.

1. Adjust the wavelength table, if required:
    - From Gen5's main screen, select **System > Reader/Instrument Configuration**.
    - Highlight the PowerWave and click **View/Modify > Setup**.
    - Click the **Absorbance** tab.
    - Enter the desired wavelength values and click **Send Wavelengths** to download them to the reader.
2. Run the test:
    - Select **System > Diagnostics > Run System Test**.
    - The test will run and results will appear in a pass/fail format.

Sample System Test Report

```
Reader:                         Powerwave  (Serial Number: 193726)
Basecode:                       P/N 7280201  (v1.21)
Gen5 Version:                   3.00.8
Date and Time:                  3/21/2016 1:21:11 PM
User:                           Administrator
Company:                        BioTek Instruments, Inc.
Comments:

Test Results
Operator ID:_____________________________________________________________________

Notes:___________________________________________________________________________

_________________________________________________________________________________

                            SYSTEM SELF TEST

7280201  Version 1.21       193726
Lambda: 260  Gain:  1.75  Resets: 2
Channel:      Ref      1      2      3      4      5      6      7      8
Air:        25860  35427  36702  39859  30979  37475  35885  30235  33222
Dark:        9839   9812   9825   9843   9839   9846   9871   9848   9829
Delta:      16021  25615  26877  30016  21140  27629  26014  20387  23393

Lambda: 280  Gain:  1.68  Resets: 1
Channel:      Ref      1      2      3      4      5      6      7      8
Air:        25717  35755  36399  39852  30975  37367  35990  30410  33385
Dark:        9837   9804   9821   9844   9837   9851   9886   9854   9825
Delta:      15880  25951  26578  30008  21138  27516  26104  20556  23560

Lambda: 405  Gain:  1.83  Resets: 2
Channel:      Ref      1      2      3      4      5      6      7      8
Air:        25561  35470  36817  39865  31242  37592  36488  30205  33842
Dark:        9840   9810   9825   9843   9839   9846   9872   9848   9829
Delta:      15721  25660  26992  30022  21403  27746  26616  20357  24013

Lambda: 450  Gain:  1.95  Resets: 2
Channel:      Ref      1      2      3      4      5      6      7      8
Air:        25608  35388  37094  39940  31483  37866  36568  30306  33973
Dark:        9839   9808   9824   9844   9839   9846   9874   9848   9828
Delta:      15769  25580  27270  30096  21644  28020  26694  20458  24145

Lambda: 490  Gain:  2.37  Resets: 4
Channel:      Ref      1      2      3      4      5      6      7      8
Air:        25267  35247  36917  39843  30985  37310  36783  29722  33803
Dark:        9841   9807   9823   9844   9839   9843   9869   9845   9828
Delta:      15426  25440  27094  29999  21146  27467  26914  19877  23975

Lambda: 630  Gain:  2.61  Resets: 1
Channel:      Ref      1      2      3      4      5      6      7      8
Air:        25569  35095  37559  39795  31849  37952  36631  30465  34086
Dark:        9834   9783   9810   9844   9836   9855   9909   9862   9815
Delta:      15735  25312  27749  29951  22013  28097  26722  20603  24271
```

```
Channel:      Ref      1      2      3      4      5      6      7      8
Noise Max:   9844   9705   9766   9849   9831   9839   9935   9845   9791
Noise Min:   9842   9704   9765   9848   9830   9838   9934   9844   9789
Delta:          2      1      1      1      1      1      1      1      2


INCUBATOR SELF TEST

Temperature Setpoint:  0.0     Current Average: 21.3      A/D Test: PASS

Zone 1: 21.3   Min: 21.3   Max: 21.3     Range: PASS    Thermistor: PASS
Zone 2: 21.3   Min: 21.2   Max: 21.3     Range: PASS    Thermistor: PASS
Zone 3: 21.4   Min: 21.4   Max: 21.4     Range: PASS    Thermistor: PASS
Zone 4: 21.3   Min: 21.2   Max: 21.3     Range: PASS    Thermistor: PASS


AUTOCAL ANALYSIS

Upper Left Corner:  x=  1680  y= 8900
Lower Left Corner:  x=  2488  y= 8780
Lower Right Corner: x= 11180  y= 8756
Upper Right Corner: x= 10368  y= 8848
Delta 1:  1680 - 2488=  -808
Delta 2: 10368 -11180=  -812
Delta 3:  8848 - 8900=   -52
Delta 4:  8756 - 8780=   -24

Middle Sensor:      x= 13856
Tested:                13852
Delta:                    -4


SYSTEM TEST PASS
0000
```

Absorbance Plate Test

This test uses BioTek's Absorbance Test Plate (PN 7260522) to confirm the mechanical alignment, optical density accuracy/linearity, repeatability, channel-to-channel variation, and wavelength accuracy of the PowerWave. The test compares the reader's optical density and wavelength measurements to NIST-traceable values.

> ❖ An alternate method for confirming accuracy, linearity, and repeatability is Liquid Test 2.

Test Plate Certificates

To run this test, you will need BioTek's Absorbance Test Plate (PN 7260522), with its accompanying data sheet.

- The Absorbance OD Standards section contains NIST-traceable standard OD values for the filters at several different wavelengths. We recommend testing at six wavelengths; those at or close to the wavelengths used in your assays.
- The Wavelength Accuracy Standards section contains Expected Peak wavelength values for the filter in position C6 on the plate. Each value has a valid test range associated with it. For example, an Expected Peak value may be 586 nm with tolerance values of –6/+4 (or a test range of 580 to 590 nm).

> ❖ BioTek's Absorbance Test Plate PN 7260551 can be used to confirm optical density, accuracy, linearity, and repeatability at 340 nm and is offered as an alternative to conducting Liquid Test 3. The diagnostic feature in Gen5 versions 2.08 and higher is compatible with this test plate. If you are using an earlier version of Gen5, refer to the test plate's instruction sheet to manually conduct the test and analyze results.
>
> ❖ The instructions provided below and on the following page are guidelines. Refer to the Gen5 Help system for more information.

Define Absorbance Test Plate Parameters

> ❖ Gen5 version 1.07 and earlier users only: The Gen5 Reader Diagnostics Utility must be installed to run the Absorbance Plate Test.
>
> ❖ Before the Absorbance Plate Test can be performed, the standard OD and peak wavelength values must be entered into Gen5. You will enter and save these values once initially, and then update them each time the test plate is recertified by BioTek (typically annually).

1. Obtain the data sheet that came with the Test Plate.
2. Start Gen5, select **System > Diagnostics > Test Plates > Add/Modify Plates**.
3. Click **Add**.

> ❖ Gen5 versions 2.07 and earlier do not support select of Test Plate PN 7260551.

4. Select the Plate Type and enter the Serial Number.
5. Click the **Help** button for guidance with entering the standard OD values and setting up the peak wavelength tests. If you need to add, change, or delete any wavelength values, click **Wavelength List**.

Run the Absorbance Plate Test

1. From Gen5's main screen, select **System > Diagnostics > Test Plates > Run**. If prompted, select the desired Test Plate and click **OK**.

2. When the Absorbance Test Plate Options dialog appears, select **Perform Peak Wavelength Test**, if it is not already selected.
3. Highlight the wavelength(s) to be included in the test.
4. You need to select only those wavelengths most appropriate for your use of the reader.
5. (Optional) Enter any **Comments**.
6. Click **Start Test**.
7. Place the Test Plate in the carrier so that well A1 is in the right-rear corner of the carrier.
8. Click **OK** to run the test.
9. When the test is complete, the results report appears. Scroll down through the report; every test should show "PASS". See page 51 for information on results and troubleshooting tips in the event of failures.
    - A sample test report is shown next.
    - Gen5 stores the results in a database; they can be retrieved and printed at any time. We recommend you print and save the report to document that the test was performed.

Sample Absorbance Plate Test Report

```
                        Absorbance Test Plate Results

Reader:                         PowerWave HT  (Serial Number: 192769)
Basecode:                       P/N 7090202  (v2.25)
Date and Time:                  2/11/2016 10:45:33 AM
Absorbance Plate:               7 Filter Test Plate (P/N 7260522) - S/N 284627
Last Plate Certification:       March 2015
Next Plate Certification Due: March 2016
User:                           Administrator
Comments:

Peak Absorbance Results

Well        C6
Reference   406
Tolerance   3
Read        407
Result      PASS

Alignment Results

Wells       A1          A12         H1          H12
Read        0.001       0.001       0.001       0.000
Tolerance   0.015       0.015       0.015       0.015
Result      PASS        PASS        PASS        PASS
```

Wavelength = 405 nm

Accuracy Results

Wells	C1	E2	G3	H6	F5	D4
Reference	0.142	0.647	1.127	1.878	2.137	2.773
Min Limit	0.119	0.614	1.084	1.820	2.032	2.642
Max Limit	0.165	0.680	1.170	1.936	2.242	2.904
Read 1	0.141	0.648	1.218	1.879	2.142	2.779
Result	PASS	PASS	FAIL	PASS	PASS	PASS

Repeatability Results

Wells	C1	E2	G3	H6	F5	D4
Read 1	0.141	0.648	1.218	1.879	2.142	2.779
Min Limit	0.135	0.637	1.201	1.855	2.073	2.691
Max Limit	0.147	0.659	1.235	1.903	2.211	2.867
Read 2	0.141	0.648	1.218	1.880	2.143	2.785
Result	PASS	PASS	PASS	PASS	PASS	PASS

Wavelength = 490 nm

Accuracy Results

Wells	C1	E2	G3	H6	F5	D4
Reference	0.141	0.598	1.123	1.732	1.848	2.394
Min Limit	0.118	0.566	1.081	1.677	1.791	2.278
Max Limit	0.164	0.630	1.165	1.787	1.905	2.510
Read 1	0.140	0.597	1.121	1.730	1.847	2.392
Result	PASS	PASS	PASS	PASS	PASS	PASS

Repeatability Results

Wells	C1	E2	G3	H6	F5	D4
Read 1	0.140	0.597	1.121	1.730	1.847	2.392
Min Limit	0.134	0.586	1.105	1.708	1.824	2.315
Max Limit	0.146	0.608	1.137	1.752	1.870	2.469
Read 2	0.140	0.597	1.121	1.730	1.848	2.392
Result	PASS	PASS	PASS	PASS	PASS	PASS

Wavelength = 620 nm

Accuracy Results

Wells	C1	E2	G3	H6	F5	D4
Reference	0.155	0.596	1.120	1.726	1.745	2.296
Min Limit	0.132	0.564	1.078	1.671	1.690	2.184
Max Limit	0.178	0.628	1.162	1.781	1.800	2.408
Read 1	0.154	0.597	1.121	1.728	1.749	2.271
Result	PASS	PASS	PASS	PASS	PASS	PASS

```
Repeatability Results

Wells       C1          E2          G3          H6          F5          D4
Read 1      0.154       0.597       1.121       1.728       1.749       2.271
Min Limit   0.147       0.586       1.105       1.706       1.727       2.198
Max Limit   0.161       0.608       1.137       1.750       1.771       2.344
Read 2      0.155       0.597       1.121       1.727       1.748       2.267
Result      PASS        PASS        PASS        PASS        PASS        PASS

Reviewed/Approved By: _____   Date: _____
```

Results and Troubleshooting Tips

> ❖ For the Accuracy, Linearity, Repeatability, and Channel-to-Channel Variation tests, there may not be a pass/fail indication for filter values that are beyond the specified accuracy range of the instrument.

- **Mechanical Alignment:** This portion of the test measures the alignment of the microplate carrier with the optical path. A reading greater than 0.015 OD represents an out-of-alignment condition. If the test fails:
  - Ensure that the Test Plate is correctly seated in the microplate carrier.
  - Check all of the plate's corner alignment holes to ensure they are clear of debris.
  - Check the microplate carrier to ensure it is clear of debris.
- **Accuracy/Linearity:** Accuracy is a measure of the absorbance (optical density) of Test Plate wells C1, D4, E2, F5, G3, and H6 as compared with known standard values contained in the plate's Standards Certificate. Linearity of the optical density readings is confirmed by default if the readings are accurate. To further verify this, perform a regression analysis on the Test Plate OD values in a program such as Microsoft Excel. An R Square value of at least 0.9900 is expected. If the reader fails the accuracy test:
  - Check the neutral-density filters in the Test Plate to ensure they are clean. If necessary, clean them with lens paper. Do not remove the filters from the test plate, and do not use alcohol or other cleaning agents.
  - Verify that the filter calibration values entered in Gen5 are the same as those on the Test Plate data sheet.
  - Verify that the Test Plate is within its calibration certification period. The calibration sticker is affixed directly to the plate. If it is out of date, contact BioTek to schedule a recertification.
- **Repeatability:** Repeatability is a measure of the instrument's ability to read the same well with minimum variation between the two reads with the well in the same location. If the test fails:
  - Check the neutral-density filters on the Test Plate to ensure there is no debris that may have shifted between readings and caused changes.
  - Check the microplate carrier to ensure it is clear of debris.

- **Channel-to-Channel Variation:** This test ensures that selected channels read the same value for a filter as their paired channel when the plate is rotated 180° in the plate carrier. The channel/well "pairs" for the turnaround test are: C1/F12; D4/E9; E2/D11; F5/C8; G3/B10; H6/A7.
- **Wavelength Accuracy:** If **Perform peak wavelength test** is enabled as part of the Absorbance Plate Test (PN 7260522), the C6 filter is scanned across a specified wavelength range in 1-nm increments. The wavelength of the maximum absorbance is compared with the peak wavelength value(s) entered in the software. The accuracy of the wavelength should be ± 3 nm (± 2 nm instrument, ± 1 nm filter allowance). If the test fails:
  - Check the C6 filter to make sure it is clean. If needed, clean it with lens paper. Important! Do not remove the filter from the Test Plate, and do not use alcohol or other cleaning agents.
  - Make sure the information entered into Gen5 matches the information on the Test Plate data sheet.
  - Make sure the Test Plate is within its calibration certification period. The calibration sticker is affixed directly to the plate. If it is out of date, contact BioTek to schedule a recertification.
  - Check the microplate carrier to ensure it is clear of debris.

Absorbance Liquid Testing

Conducting Absorbance Liquid Tests confirms the reader's ability to perform to specification with liquid samples. Liquid testing differs from testing with the Absorbance Test Plate in that liquid in the wells has a meniscus, whereas the Test Plate's neutral density glass filters do not. The optics characteristics may differ in these two cases, thus alerting the operator to different types of problems.

- **Liquid Test 1** confirms repeatability and alignment of the reader when a solution is used in the microplate. If these tests pass, then the lens placement and optical system cleanliness are proven.
- **Liquid Test 2** can be used to test the alignment, repeatability, and linearity of the reader if an Absorbance Test Plate is not available.
- **(Optional) Liquid Test 3** is provided for verifying reader performance at 340 nmThis test is optional because the reader has good "front end" linearity throughout its wavelength range.

> ❖ BioTek Absorbance Test Plate PN 7260551 is offered as an alternative to conducting Liquid Test 3.

- BioTek offers a dye solution (PN 7120779, 25 mL; or 7120782, 125 mL) that may be used in the stock solution formulation for Liquid Tests 1 and 2, or, if you prefer, you may use Solution A described on the next page. The purpose of the formulation is to

create a solution that absorbs light at approximately 2.000 OD full strength when dispensed at 200 µL in a flat-bottom microplate well.

- Alternatively, any solution that gives a stable color will suffice. (This includes substrates incubated with an enzyme preparation and then stopped with an acidic or basic solution.) Some enzyme/substrate combinations that may be used as alternates to the described dye are shown below.

Typical Enzyme-Substrate Combinations and Stopping Solutions

Enzyme	Substrate	Stopping Solution
Alkaline Phosphate	o-nitrophenyl phosphate	3N sodium hydroxide
beta-Galactosidase	o-nitrophenyl -beta-D galactopyranoside	1M sodium carbonate
Peroxidase	2,2'-Azino di-ethylbenzothiazoline-sulfonic acid (ABTS)	citrate-phosphate buffer, pH 2.8
Peroxidase	o-phenylenediamine	0.03N sulfuric acid

Absorbance Liquid Test 1

Materials

❖ Manufacturer part numbers are subject to change.

- New 96-well, clear, flat-bottom microplate (Corning Costar #3590 recommended)
- Stock Solution A or B, which may be formulated by diluting a dye solution available from BioTek (A) or from the ingredients listed below (B).

Solution A

- BioTek QC Check Solution No. 1 (PN 7120779, 25 mL; PN 7120782, 125 mL)
- Deionized water
- 5-mL Class A volumetric pipette
- 100-mL volumetric flask

1. Pipette a 5-mL aliquot of BioTek QC Check Solution No. 1 into a 100-mL volumetric flask.
2. Add 95 mL of DI water; cap and shake well. The solution should measure approximately 2.000 OD when using 200 µL in a flat-bottom microwell.

Solution B

- Deionized water
- FD&C Yellow No. 5 dye powder (typically 90% pure)

- Tween 20 (polyoxyethylene (20) sorbitan monolaurate) **or** BioTek wetting agent (PN 7773002) (a 10% Tween solution)
- Precision balance with capacity of 100g minimum and readability of 0.001g
- Weigh boat
- 1-liter volumetric flask

1. Weigh out 0.092 g of FD&C Yellow No. 5 dye powder into a weigh boat.
2. Rinse the contents into a 1-liter volumetric flask.
3. Add 0.5 mL of Tween 20, or 5 mL of BioTek's wetting agent.
4. Fill to 1 liter with DI water; cap and shake well. The solution should measure approximately 2.000 OD when using 200 µL in a flat-bottom microwell.

Prepare the Plate

❖ Be sure to use a new microplate because fingerprints or scratches may cause variations in readings.

1. Using a freshly prepared stock solution (Solution A or B), prepare a 1:2 dilution using deionized water (one part stock, one part deionized water; the resulting solution is a 1:2 dilution).
2. Pipette 200 µL of the concentrated solution into the first column of wells in the microplate.
3. Pipette 200 µL of the diluted solution into the second column of wells.

❖ **Important!** After pipetting the diluted test solution into the microplate and *before* reading the plate, we strongly recommend shaking the plate at Variable speed for four minutes. This will allow any air bubbles in the solution to settle and the meniscus to stabilize. Alternatively, wait 20 minutes after pipetting the diluted test solution before reading the plate.

Read the Plate

1. Using Gen5, read the microplate five times at 405 nm using the Normal read mode, single wavelength, no blanking ("Normal" plate position). Save the data after each read.
2. Without delay, rotate the microplate 180 degrees so that well A1 is now in the H12 position. Read the plate five more times ("Turnaround" plate position), saving the data after each read.
3. Print out the ten sets of raw data, or export them to an Excel spreadsheet.

Calculations

1. Calculate the mean value for each physical well location in columns 1 and 2 for the five plates read in the Normal position, and then again for the five plates read in the Turnaround position. This will result in 32 mean values.
2. Perform a mathematical comparison of the mean values for each microwell in its Normal and Turnaround positions (A1/H12, A2/H11, B1/G12, B2/G11, and so on). In order to pass this test, the differences in the compared mean values must be within the accuracy specification for the instrument.

   For Example:

   If the mean value for well A1 in the Normal position is 1.902, where the specified accuracy is ± 1.0% ± 0.010 OD, then the expected range for the mean of the same well in its Turnaround (H12) position is 1.873 to 1.931 OD.

   1.902 * 0.01 + 0.010 = 0.029; 1.902 – 0.029 = **1.873**; 1.902 + 0.029 = **1.931**

   If any set of mean values is out of the expected range, review the other three sets of mean values for the same channel pair. For example, if the A1/H12 comparison fails (the wells are not within the expected range of each other), review the comparisons of A2/H11, H1/A12, and H2/A11. If two or more sets of mean values for a channel pair are out of the expected range, there is a problem with one of the eight read channels. If only one of the four mean values results in a failure, check the well for debris and the plate for scratches or fingerprints.

   Accuracy Specification:

   For comparison in this test, the following accuracy specifications are applied, using Normal/Standard read mode and a 96-well microplate.

   ± 1.0% ± 0.010 OD from 0.000 to 2.000 OD
   ± 3.0% ± 0.010 OD from 2.000 OD to 3.000 OD

Absorbance Liquid Test 2

Materials

- A new 96-well, flat bottom microplate (Corning Costar #3590 is recommended)
- Ten test tubes, numbered consecutively, set up in a rack
- Calibrated hand pipette (Class A volumetric pipette recommended)
- Solution A or B (these are the same solutions as for Liquid Test 1)
- A 0.05% solution of deionized water and Tween 20

Prepare the Dilutions

Create a percentage of dilution series, beginning with 100% of the original concentrated stock solution (A or B) in the first tube, 90% of the original solution in the second tube, 80% in the third tube, all the way to 10% in the tenth tube. Dilute using the 0.05% solution of deionized water and Tween 20. This solution can also be made by diluting the BioTek wetting agent 200:1.

Test Tube Dilutions

Tube Number	1	2	3	4	5	6	7	8	9	10
Volume of Original Solution (mL)	20	18	16	14	12	10	8	6	4	2
Volume of 0.05% Tween solution (mL)	0	2	4	6	8	10	12	14	16	18
Absorbance expected if original solution is 2.000 OD at 200 µL	2.0	1.8	1.6	1.4	1.2	1.0	0.8	0.6	0.4	0.2

❖ The choice of dilutions and the absorbance of the original solution can be varied. Use this table as a model for calculating the expected absorbances of a series of dilutions, given a different absorbance of the original solution.

Prepare the Plate

1. Pipette 200 µL of the concentrated solution from tube 1 into each well of the first column, A1 to H1, of a new flat-bottom microplate.
2. Pipette 200 µL from each of the remaining tubes into the wells of the corresponding column of the microplate (tube 2 into wells A2 to H2, etc.).

❖ After pipetting the diluted test solution into the microplate and *before* reading the plate, we strongly recommend shaking the plate at Variable speed for four minutes. This will allow any air bubbles in the solution to settle and the meniscus to stabilize. Alternatively, wait 20 minutes after pipetting the diluted test solution before reading the plate.

Linearity and Repeatability Tests

1. Using Gen5, read the microplate prepared above five times using Normal mode, dual wavelength at 450/630 nm.

❖ Save the data after each read. Retain the plate for the Alignment test.

2. Print out the five sets of Delta OD data, or export them to an Excel spreadsheet.

3. Calculate the results for Linearity:
   - Calculate the mean absorbance for each well, and average the means for each concentration.
   - Perform a regression analysis on the data to determine if there is adequate linearity.

     Since it is somewhat difficult to achieve high pipetting accuracy when conducting linear dilutions, an R Square value of at least 0.99 is considered adequate.
4. Calculate the results for Repeatability:
   - Calculate the mean and standard deviation for the five readings taken in Step 1 at each concentration. Only one row of data needs to be analyzed.
   - For each mean below 2.000 OD, calculate the allowed deviation using the repeatability specification for a 96-well plate of ± 1.0% ± 0.005 OD. If above 2.000 OD, apply the ± 3.0% ± 0.005 specification.
   - The standard deviation for each set of readings should be less than the allowed deviation.

     Example: Absorbance readings of 1.950, 1.948, 1.955, 1.952, and 1.950 will result in a mean of 1.951, and a standard deviation of 0.0026. The mean (1.951) multiplied by 1% (1.951 * 0.010) = 0.0195, which, when added to the 0.005 (0.0195 + 0.005) = 0.0245 OD, which is the allowable deviation. Since the standard deviation is less than this value, the reader meets the test criteria.

     Repeatability Specification:

     ± 1% ± 0.005 OD from 0.000 OD to 2.000 OD

     ± 3% ± 0.005 OD from 2.000 OD to 3.000 OD

Alignment Test

1. Using the plate prepared for the tests above, conduct a turnaround test by reading the plate with the A1 well in the H12 position five times. This test results in four comparisons of each channel to its corresponding channel, two in column 1, and two in column 2.
2. Calculate the means of the wells in columns 1 and 2 in the normal plate position (data is from the tests above) and in the turnaround position (from Step 1 above). Compare the mean reading for well A1 to its mean reading when in the H12 position.
3. Compare the mean values for the other wells to their corresponding mean values with the well in the turnaround position. (Compare B1 to G12, C1 to F12, D1 to E12, E1 to D12, F1 to C12, G1 to B12, H1 to A12, A2 to H11, and B2 to G11, etc.). The difference in the values for any two corresponding wells should be within the accuracy specification for the instrument.

For example: If the mean of well A1 in the normal position is 1.902, where the specified accuracy is ± 1.0% ± 0.010 OD, then the expected range for the mean of the same well in the H12 position is 1.873 to 1.931 OD. (1.902 * 1% = 0.019 + 0.010 = 0.029, which is added and subtracted from 1.902 for the range.)

If any set of well values is out of the expected range, review the other three sets for the same channel pair. Thus, if A1 and H12 are not within range of each other, review the compliance of H1 to A12, A2 to H11, and H2 to A11.

This will confirm that there is a problem in one of the eight read channels, or indicate that the result of one set of wells was in error. If any two sets of well values for a channel pair are out of the allowed accuracy range, there may be contamination on, or a problem with, one of the lenses.

If the four corner wells are within the accuracy range, the reader is also in alignment.

Absorbance Liquid Test 3 (Optional)

Materials

- A new 96-well, flat-bottom microplate (Corning Costar #3590 is recommended)
- Calibrated hand pipette(s)
- Beakers and graduated cylinder
- Precision balance with a readability of 0.01 g
- Buffer solution as described below

Buffer Solution

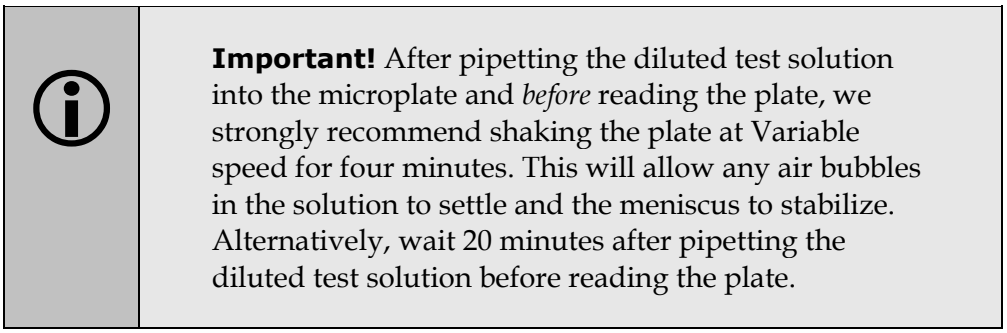
- Deionized water
- Phosphate-buffered saline (PBS), pH 7.2-7.6, Sigma tablets #P4417 (or equivalent)
- β-NADH Powder (β-Nicotinamide Adenine Dinucleotide, Reduced Form) Sigma bulk catalog number N 8129, or preweighed 10-mg vials, Sigma number N6785-10VL (or BioTek PN 98233). Store the powder according to the guidelines on its packaging.

1. Prepare a PBS solution using Sigma tablets.
2. In a beaker, mix 50 mL of the PBS solution with 10 mg of the β-NADH powder and mix thoroughly. This is the **100% Test Solution**.

Prepare the Plate

1. Prepare the 75% Test Solution by mixing 15 mL of the 100% Test Solution with 5 mL of the PBS solution.

2. Prepare the 50% Test Solution by mixing 10 mL of the 100% Test Solution with 10 mL of the PBS solution.
3. Pipette the three solutions into the new 96-well microplate:
   - 150 µL of the 100% Test Solution into all wells of columns 1 and 2
   - 150 µL of the 75% Test Solution into all wells of columns 3 and 4
   - 150 µL of the 50% Test Solution into all wells of columns 5 and 6



Important! After pipetting the diluted test solution into the microplate and *before* reading the plate, we strongly recommend shaking the plate at Variable speed for four minutes. This will allow any air bubbles in the solution to settle and the meniscus to stabilize. Alternatively, wait 20 minutes after pipetting the diluted test solution before reading the plate.

Read the Plate

1. Using Gen5, read the microplate five times using Normal mode, single wavelength at 340 nm, no blanking (or blank on air).
2. Print the five sets of raw data or export them to an Excel spreadsheet using Gen5.

Analyze the Results

1. For each well, calculate the mean and standard deviation of the five readings.
2. For each mean calculated in step 1, calculate the allowed deviation using the repeatability specification for a 96-well plate of ± 1.0% ± 0.005 OD (mean * 0.01 + 0.005).
3. For each well, compare the standard deviation calculated in step 1 with the allowed deviation calculated in step 2. The standard deviation should be less than the allowed deviation.

   Example: Five readings in well A1 of 0.802, 0.802, 0.799, 0.798, and 0.801 will result in a mean of 0.8004, and a standard deviation of 0.0018. The mean multiplied by 1.0% (0.8004 * 0.010) = 0.008, which, when added to the 0.005 (0.008 + 0.005) = 0.013, which is the allowable deviation for well A1. Since the standard deviation for well A1 is less than 0.013, the reader meets the test criteria.
4. Calculate the results for Linearity:
   - For each of the three dye concentrations, calculate the mean absorbance for the wells containing that solution (mean of wells A1 to H2, A3 to H4, and A5 to H6).

- Perform a regression analysis on the data to determine if there is adequate linearity.

  Expected Results: Since it is somewhat difficult to achieve high pipetting accuracy when conducting linear dilutions, an R-Square value greater than or equal to 0.990 is considered adequate.

Chapter 5

Maintenance

This chapter contains procedures for cleaning and decontaminating the PowerWave.

Purpose

Any laboratory instrument that has been used for research or clinical analysis is considered a biohazard and requires decontamination prior to handling. Intact skin is generally considered an effective barrier against infectious organisms; however, small abrasions and cuts may not always be visible.

Decontamination minimizes the risk to all who come in contact with the instrument during shipping, handling, and servicing. Decontamination is required by the U.S. Department of Transportation regulations.

Persons performing the decontamination process must be familiar with the basic setup and operation of the instrument.

	BioTek Instruments, Inc. recommends the use of the following decontamination solutions and methods based on our knowledge of the instrument and recommendations of the Centers for Disease Control and Prevention (CDC). Neither BioTek nor the CDC assumes any liability for the adequacy of these solutions and methods. Each laboratory must ensure that decontamination procedures are adequate for the biohazard(s) they handle.

	**Warning! Internal Voltage.** Turn off and disconnect the PowerWave from its power supply for all cleaning and decontamination operations.
	**Warning!** Wear prophylactic gloves when handling contaminated instruments. Gloved hands should be considered contaminated at all times; keep gloved hands away from eyes, mouth, nose, and ears. Eating and drinking while decontaminating instruments is not advised.

	**Warning!** Mucous membranes are considered prime entry routes for infectious agents. Wear eye protection and a surgical mask when there is a possibility of aerosol contamination. Intact skin is generally considered an effective barrier against infectious organisms; however, small abrasions and cuts may not always be visible. Wear protective gloves when handling contaminated instruments.
	**Important!** Do not immerse the instrument, spray it with liquid, or use a dripping-wet cloth. Do not allow water or other cleaning solution to run into the interior of the instrument. If this happens, contact BioTek's Technical Assistance Center.

Clean Plate Carrier and Exposed Surfaces

	**Important!** Turn off the PowerWave and disconnect it from the power supply for the cleaning procedure.

A regular cleaning regimen is recommended to keep the instrument free of dust and particulates that can cause erroneous readings. Exposed surfaces may be cleaned (not decontaminated) with a cloth moistened (not soaked) with water or water and a mild detergent. You will need:

- Deionized or distilled water
- Clean lint-free cotton cloths
- Mild detergent (optional)

1. Turn on the PowerWave and press the carrier eject button to eject the microplate carrier.
2. Turn off and unplug the reader from the power supply.
3. Moisten a clean, lint-free cloth with water, or with water and the mild detergent, then thoroughly wring out the cloth so that liquid does not drip from it.
4. Wipe the plate carrier and all exposed surfaces of the instrument.
5. If detergent was used, wipe all surfaces with a cloth moistened with water.
6. Use a clean, dry lint-free cloth to dry all wet surfaces.

Decontamination

Tools and Supplies

- Sodium hypochlorite (NaClO, or bleach)
- Deionized or distilled water
- Safety glasses
- Surgical mask
- Protective gloves
- Lab coat
- Biohazard trash bags
- 125-mL beakers
- Clean, lint-free cotton cloths

Warning! The bleach solution is caustic; wear gloves and eye protection when handling the solution.

1. Turn on the PowerWave and press the carrier eject button to eject the carrier.
2. Turn off and unplug the instrument from the power supply.
3. Prepare an aqueous solution of 0.5% sodium hypochlorite (NaClO, or bleach).

❖ Check the % NaClO of the bleach you are using; this information is printed on the side of the bottle. Commercial bleach is typically 10% NaClO; if this is the case, prepare a 1:20 dilution. Household bleach is typically 5% NaClO; if this is the case, prepare a 1:10 dilution.

4. Moisten a clean, lint-free cloth with the bleach solution, then thoroughly wring out the cloth so that liquid does not drip from it.
5. Wipe the plate carrier and all exposed surfaces of the instrument.
6. Allow the instrument to dry for 20 minutes for thorough decontamination by the bleach.
7. Moisten a cloth with deionized or distilled water and wipe all surfaces of the instrument that have been cleaned with the bleach solution.
8. Use a clean, dry lint-free cloth to dry all wet surfaces.
9. Discard the used gloves and cloths, using a Biohazard trash bag and an approved Biohazard container.

Chapter 6

Error Codes

This chapter lists error codes that may appear during operation of the PowerWave, and provides troubleshooting tips.

Error Codes

An error code is displayed in the software as a four-digit identifier. The first digit will be 0, 1, 2, 3, or A.

- 0, 1, 2, or 3 denote a noncritical error, which means it is still possible for the PowerWave to communicate with the controlling software and run a reader system test (see below). See **General Errors** starting on page 67.
- "A" denotes a more serious error with the memory or processing, which requires the reader to be turned off/on before any diagnostics can be performed. If the error reappears, contact BioTek TAC for troubleshooting assistance (see page 26). See **Fatal Errors** on page 71.
- If an error code is displayed in Gen5, run a System Self-Test for diagnostic purposes:
- From the main screen, select **System > Diagnostics > Run System Test**.

Error Codes During Operation with the BioStack

Error codes may appear in Gen5 during operation of the PowerWave with the BioStack Microplate Stacker.

- Gen5 error codes display in a negative value format, for example: -8, -100.

Refer to the *BioStack Operator's Manual* for a list of error codes and their descriptions.

❖ See Product Support and Service in Chapter 1 for contact information for BioTek's Technical Assistance Center ("TAC").

General Errors

Code	Description and Probable Causes
0200	**X-axis opto sensor failed to transition.** This error indicates that a motor was not able to move to its "home" position, as registered by feedback from an optical sensor, or it failed to transition after moving away from the home position. • Dirty x-axis rail or dry bearings are causing too much friction. • Defective or broken optical sensor. • Defective motor controller PCB.
0201	**Order sorting (bandpass) filter wheel did not home.** • Filter wheel is loose. • Filter wheel is obstructed by too close proximity to the motor gear. • Defective or broken optical sensor. • Defective motor, motor controller PCB, or cable.
0202	**Y-axis opto sensor failed to transition.** This error indicates that a motor was not able to move to its "home" position, as registered by feedback from an optical sensor, or it failed to transition after moving away from the home position. • Dirty y-axis rail or dry bearings are causing too much friction. • Defective or broken optical sensor. • Defective motor controller PCB. Note: In cases where a sensor is not functioning, the motor will drive the axis to its mechanical stop and generate substantial noise.
0303	**Monochromator did not find home.** During the instrument initialization, the monochromator is homed by rotating the monochromator mirror until the white light (full light) is detected. This requires a fully functional flash lamp/detection system. • Defective analog PCB. • Defective flash lamp and or flash lamp power supply (inconsistent flashes) (high probability). • Defective motor/power PCB. • Defective monochromator (low probability).
0400	**Carrier x-axis failed positional verify.** Motor x-axis failed to reach the same position when moved a known number of steps from the home position and back. • Dirty rail or dry bearings are causing too much friction.
0401	**Order sorting (bandpass) filter wheel failed positional verify.** • Filter wheel obstructed by motor gear. • Motor gear loose on motor shaft.
0402	Carrier y-axis failed positional verify. • Dirty rail or dry bearings are causing too much friction.

Code	Description and Probable Causes
0403	**Monochromator failed to find the zero order position (white light).** The order sorting (bandpass) filter wheel is homed and moved to the open hole position. The monochromator is moved until the optical system detects saturation (home). It is then moved to a known number of steps away from home and then moved back the same number of steps, expecting to see light saturation point. The error is indicating the saturation did not clear or appear. • Flash lamp is missing flashes or is not flashing. • The optic system does not detect the saturation. • Defective monochromator.
0500	**Measurement or reference channel is saturated during a spectral scan.** This error indicates the light signal level in one of the channels reached 65,535 counts during Lambda calibration within the spectral scan.
0501-0508	**Measurement or reference channel is saturated during a spectral scan.** This error indicates the light signal level in the channel indicated by the last digit (1 through 8) of the error code reached 65,535 counts during the spectral scan or calibration. • The lamp is not properly aligned and there is too much light. • The A/D reference voltage is not at the 4.5 V. • The analog PCB is defective. • Order sorting filter has degraded.
0503	**Monochromator failed positional verify due to saturation.** This error indicates that, during initialization, the monochromator failed positional verify, or channel 3 failed during calibration or spectral scan.
0511-0568	**Measurement channel A/D signal saturated.** This error indicates the light signal level reached 65,535 counts for one of the lambda values in the table after calibration, prior to a read, or during a read or optics test.
0600	**Gain out of range for the target air readings. Reference channel = hot channel.** This error indicates that the measurement channel signal gain is out of range necessary to ensure the reader's performance to specifications. During reader calibration, the gain selected is 36.56. • Flash lamp • Monochromator • Lamp power supply
0701-0708	**Channel failed noise test greater than 20 counts during optics test.** This error indicates significant variations in background electronic noise were detected, when blocking the light and increasing the gain to maximum. • Electrical noise may be penetrating the measurement chamber. The bottom and top shrouds are part of the electrical shielding. • The coaxial cable ground may be floating or disconnected. • There may be an ambient light leak. Ensure that the plate carrier door is properly closed. • Analog PCB failure; noisy photo-detector. • Internal electronic noise may be caused by a faulty analog PCB or faulty internal grounding.
0801-0808	**Channel failed noise offset < 10 and > 2000 during optics test.** This error indicates that background electronic signal detected is outside of acceptable limits at maximum gain when blocking the light. • The photo-detector is not connected or is defective, yielding a noise reading of zero. • The photo-detector is too noisy and is defective.
0901-0908	**Channel dark range is < 100 or > 20000 during calibration, or < 100 during a filter test.**

Code	Description and Probable Causes
0911-0968	**Measurement channel dark range is < 100 during a read in enhanced mode (64 flashes), or prior to a read or optics test.** The reference channel dark current value has changed since the last optics test measurement by more than 10%, or the dark value is less than 100. The last number in the error code is the channel number used during the failure. • The photo-detector is more sensitive to temperature changes. • Ambient light leakage during the read.
0A00-0A68	**Measurement channel air / blank out of range prior to a read.** This error is indicating the air reading at the time of the plate read was 50% less than the air reading at the time of the optic test. The last number of the error code represents the channel at the time of failure.
0A10	**Reference channel air / blank out of range for the first wavelength in a scan, or filter / reference channel air / blank out of range prior to a read.** This error is indicating the air reading at the time of the plate read was 50% less than the air reading at the time of the optic test. The last number of the error code represents the channel at the time of failure. • Flash lamp has missed flashes during the read. • Dirty optics or spilled substance on the optics.
0F00-0F08	**Channel Delta out of range during calibration.** The Delta of the air / dark is out of range during the calibration at a wavelength reference channel < 500 or measurement channel < 8000.
0F10	**Reference channel out of range during a spectral scan.** Reference channel < 500 during a spectral scan and only checking the first wavelength.
0F10-0F60	**Reference channel out of range during a read.** Reference channel < 500 during a read. This error indicates that the reading has failed. The last number of the error code represents the channel.
0F10-0F68	**Channel out of range prior to a read.** Reference channel < 500 or measurement channel < 8000 during an optics test or prior to a read. Reference channel out of range (< 50% or > 200%). • The flash lamp may be out of alignment. • The order sorting (bandpass) filter is degraded, and does not allow enough light energy to pass through. • Damaged reference channel optic spray. • The reference channel photodiode detection circuit is defective.
1100-1101	**Failed configuration checksum test for reader protocol or system configuration prior to a read or optics test. Last digit can be either a 0 or 1.** • The flash memory on the PCB is defective or corrupt. The basecode software and/or assays may need to be re-downloaded.
1200	**Lambda calibration data missing prior to a spectral scan, or autocalibration data is missing.** The instrument calibration values are not loaded into the flash memory. • The PCB was changed and the flash memory does not have the calibration values loaded. • Failure in Main PCB memory. Contact BioTek TAC for more information.
1201-1206	**Lambda table calibration data missing from reader.** This error occurs when the controlling PC requests the Lambda wavelength calibration data, and one of the wavelengths does not have calibration data in memory (not calibrated). The last digit represents the Lambda.

Code	Description and Probable Causes
1300	**Carrier not homed in the x-axis.** This error is only seen if an error 0200 is ignored. See the probable causes for 0200.
1301	**Order sorting (bandpass) filter wheel not homed.** This error is only seen if an error 0201 is ignored. See the probable causes for 0201.
1302	**Carrier not homed in the y-axis.** This error is only seen if an error 0202 is ignored. See the probable causes for 0202.
1501-1504	**Temperature zone out of range (the last digit is the zone number failing).**
1511-1514	**Thermistor failed – resistance out of range (the last digit is the zone number).**
1520	**A/D converter failed; incubator PCB defective.**
1600	**Computer control assay definition error.** This error will occur for the following definitions: Well set, Wave scan, Checksum at the protocol sent from computer, Plate geometry, Filter(s), Features available, Mono
1700	**Kinetic interval too short for selected options, or kinetic interval = 0.** This error indicates that the kinetic interval in the current assay is too short. Increase the kinetic interval.
1900	**Memory allocation failed.** This error is typically used only for software development purposes. If it occurs, however, try turning the instrument off and then on again after a wait of 30 seconds. If the error persists, contact BioTek Technical Support.
1C00	**A/D calibration standby signal on the analog board never went low, or A/D calibration standby line went low but never transitioned to a high.** This error indicates there is a failure with the absorbance analog board initialization, or the cable to the PCB is defective.
2000	**Barcode scanner did not see 10 characters from barcode.** • Barcode positioned incorrectly on plate. • Insufficient carbon black in barcode label. • Barcode label not in Code 39 format.
2100	**Invalid parameter value selected.** This error can occur only during computer control, indicating that one of the following invalid assay configurations was sent to the instrument: • Temperature out of range • Wavelength not in ASCII format • Incorrect plate geometry • Incorrect row range or column range selected • Kinetic interval = 0 • Incorrect range or order selected for start wavelength / end wavelength • Incorrect well selected for scanning
2400	**Middle sensor position incorrect.** This error occurs when homing to the middle sensor and the optical flag is in a different position since the last autocalibration was performed.
2500 2502	**Sweep mode read missed well location; last digit is the motor number.** • The specified kinetic interval is too short for the specified wells in the sweep mode. If **Validate** is selected in the Gen5 procedure, a too-short kinetic interval will be flagged as an error. • Defective flash lamp power supply. Check by reading a 384-well plate in sweep mode

Code	Description and Probable Causes
	using a kinetic interval of 12 seconds for 5 reads. • Defective analog board.
2800-2803	**Motor currently in use; last digit indicates motor.**
2F00	**Results data being is sent not acknowledged by host PC.** This error indicates the handshaking between the host PC software and the reader did not complete. This is a lost data condition.
3200-3201	**Never saw A/D ready transition.** This error indicates there is a failure with the absorbance analog board or the cable to the PCB is defective.

Fatal Errors

Fatal errors indicate conditions that require immediate attention. If a fatal error is displayed, contact BioTek's Technical Assistance Center for further instructions.

Code	Description
A100	Task control block not available.
A200	Read already in progress.
A300	Motors not available.
A301	Real time clock not available.
A302	Display not available.
A303	Flash not available.
A400	Failed code checksum test on power-up.
A600	Data flash write timed out.
A700	Data flash readback did not match write.
A800	Code flash write timed out.
A900	Memory allocation heap corrupted.

Chapter 7

Instrument Dimensions

This chapter contains the PowerWave's dimensions, for use with robotic interfaces.

Instrument Dimensions

The figure below shows the location of the microplate carrier in reference to the exterior surfaces of the PowerWave, and the mounting holes on the bottom of the reader. This should facilitate system setup with a robotic unit.

If you purchased the BioStack to operate with the PowerWave, alignment hardware is included for positioning the instruments. For more information, refer to the BioStack Operator's Manual.