



Bio-Stack™

Applications of an Automated Microplate Stacking Device for HTS and Multi-Instrument Interface

Abstract

Today's microplate automation spans the range from multi-channel pipettes to large, robotic HTS systems. One popular type of automation is the microplate stacker that allows the unattended loading and unloading of microplates to automated devices for batch processing. Unfortunately, most stacker devices are integrated with each device at the time of manufacture, limiting their utility to that single device. To overcome this limitation, BioTek has developed the Bio-Stack™, a stand-alone microplate stacking device that easily integrates with several different products without factory installation or recalibration. The Bio-Stack interfaces directly with the ELx405™ Series microplate washers, the industry standard in 96- and 384-well automated microplate washing technology, as well as the μ Fill™, a continuous, rapid reagent dispenser. Several automated microplate readers are also compatible, including the PowerWave™ Series of scanning absorbance spectrophotometers and the Synergy™HT Series multi-detection readers. This unique stacker can be easily transitioned from one instrument to another in minutes without time-consuming recalibration. The Bio-Stack has been designed around durable and reliable technology, resulting in an extremely small footprint, quiet operation and remarkable speed. It delivers or retrieves a microplate in less than 8 seconds. Each easily removable stack accommodates 30 standard 96- or 384-well microplates. The microplate grippers are spring loaded to prevent dropping plates in the event of an untimely loss of power. During startup, onboard diagnostic routines verify correct positioning of all carriers and motor axes, and during operations, monitors for errors. A PC software interface allows for intuitive programming of reader interface routines, including multiple reading protocols per batch, while the programming of stand-alone devices (e.g., ELx405 washer and μ Fill dispenser) takes place via the device's keypad. The Bio-Stack's diminutive footprint (7" W x 18" L x 25" H) saves precious bench space and fits in most biosafety cabinets or chemical fume hoods.



Figure 1. Bio-Stack™ Microplate Stacker

Overview

The Bio-Stack is a compact microplate stacker capable of holding up to 30 microplates per plate stack (Figure 1). This easy-to-use device has a small footprint and can be integrated with a number of different BioTek products without factory service or calibration (Figures 2 and 3). The easily removable stacks can be swapped in and out to provide continuous processing of microplates. The Bio-Stack uses a lift mechanism to stack and unstack plates to and from the stack columns and microplate carrier. The carrier moves the plate horizontally from the plate stacks to a gripper-claw, which deposits the microplates onto an instrument carrier for processing and retrieves the plate when processing is complete. The Bio-Stack uses stepper motors to drive all motor axis and cams, resulting in rapid, reliable plate movements from one stack to a microplate instrument and back. Typically a plate can be moved from the stacker to an instrument in less than 8 seconds, with the return trip being just as rapid. Onboard sensors ensure completion of each plate movement at every step of the operation.



Figure 2. Bio-Stack™ Microplate Stacker interfaced with a PowerWave™ HT Microplate Spectrophotometer



Figure 3. Bio-Stack™ Microplate Stacker interfaced with an ELx405™ Microplate Washer

The instrument has been designed with reliability in mind. The grippers are spring pre-loaded to remain closed in the event of a power failure, maintaining a grip on the plate despite the lack of power. In addition, the gripper was designed to grab each microplate securely from underneath to further eliminate any chance of dropping or twisting during grip routines. When stacking plates, the plates are addressed from below, providing reliable transport. The use of stepper motors to actuate cams provides not only reliable, but also quiet operation. The precision-ground aluminum base has been designed for heavy use, and all of the linear mechanisms have been designed using proven BioTek automation technology.

The Bio-Stack interfaces with the μ Fill microplate reagent dispenser and ELx405 Series microplate washers directly through the instrument's internal software, with programming taking place via the keypad of the interfaced instrument. (Instruments currently in use can be upgraded for use with the new Bio-Stack.) For microplate reader instrumentation, such as the PowerWave Series or the Synergy HT Series readers that require KC4™ data reduction software running on a remote PC and do not have keypad programming, remote PC Bio-Stack controlling software is used to program the Bio-Stack. This software interacts with KC4 to select reading protocols, as well as sample and plate information.

Accessory kits are available that provide all of the required alignment hardware and necessary software for integration of the Bio-Stack to any of the compatible BioTek products. Changing the Bio-Stack from one device to another merely requires the use of the appropriate interface kit; no factory installation is required.

Plate Movement Process

Plates to be processed are loaded into one of the interchangeable stacks and then the stack is located in the input position of the Bio-Stack. If the instrument is either a Synergy HT Series or a PowerWave Series reader, specific reader protocols from KC4 are associated with each plate by means of the Bio-Stack PC control software. These protocols, which identify reading parameters, plate layout, and data reductions specific to the assay, need to be previously created and saved within the KC4 data reduction software

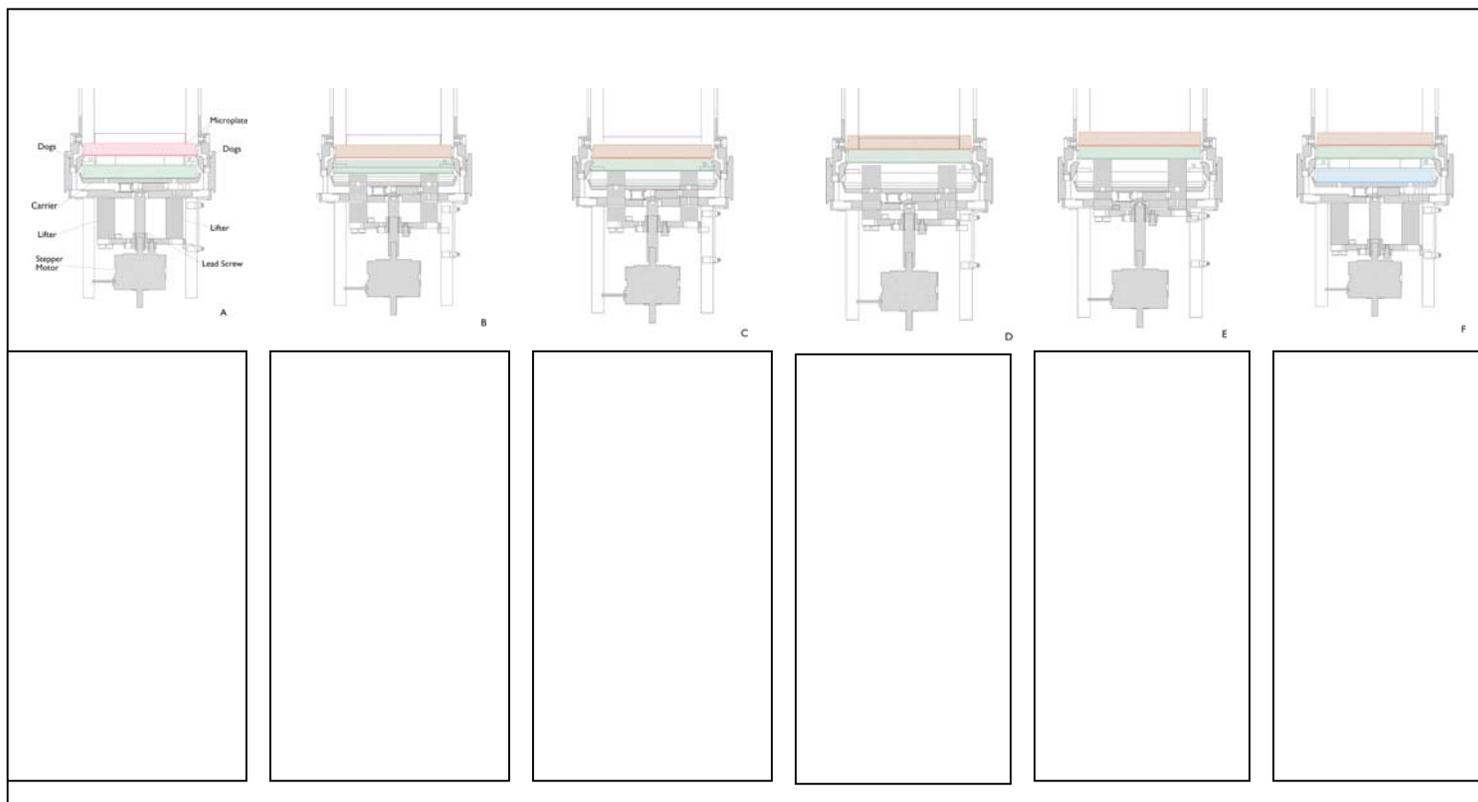


Figure 4. Cross Sectional View of Bio-Stack Demonstrating the Mechanics of Plate Stacking

Once the batch has been initiated, the carrier moves under the input or source stack (Figures 4A, 4F). Next, the input stack lift mechanism moves upward and lifts the entire stack off the "dogs" that are engaged to support the plates within the stack (Figure 4B). The dogs are then opened and the lift is lowered such that the lowest plate is below the dogs, but the lip of the next plate is not (Figure 4C). The dogs are closed slightly to engage the next plate. When the stack is lowered further, the bottom plate will rest on the carrier, while the plates above will remain stacked on top of the closed dogs. The carrier with the released plate is moved to the plate sensor to verify that a plate is actually present. If a plate is not present, an error message is generated.

With the plate successfully positioned on the carrier and verified as such, the carrier moves horizontally, positioning itself below the claw/gripper assembly on the front of the Bio-Stack (Figure 5). The grippers on the claw are opened against the spring-tension that normally keeps them closed when not powered, and the claw/gripper is lowered to the plate. With the claw lowered, the gripper arms are then closed to their "depowered" position, which grips the plate along both sides of its long axis. At this point the Bio-Stack, using the plate sensor located in the gripper, checks that the plate is present.

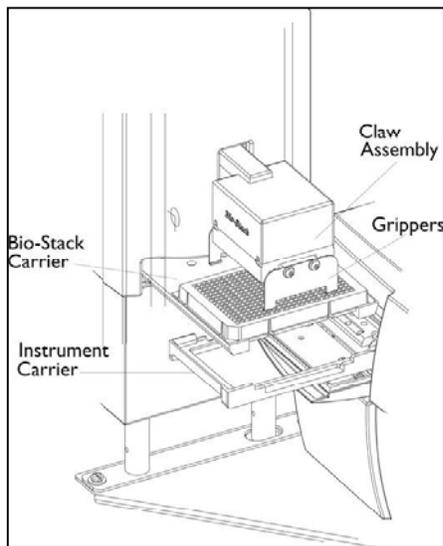


Figure 5. Gripper-head Assembly with a Plate on the Carrier. The plate carrier, with a microplate, has been extended out the front of the Bio-Stack™. The microplate is positioned below the gripper head, which moves downward and grips the plate, allowing the carrier to retract. The gripper head then lowers the microplate to the instrument carrier located below.

The claw, with the plate in its gripper, is then raised slightly allowing the carrier to retract. After the carrier is retracted, the claw is then lowered to the instrument carrier position below. The grippers are opened, releasing the plate to the instrument. The claw is then lifted; the gripper sensor ensures that there is no longer a plate present. The instrument is then allowed to perform its task.

After the instrument has completed its task and the carrier is returned to the original position, the gripper arms are opened and the claw lowered to retrieve the plate. The gripper arms are closed around the plate and the presence of a plate verified. The claw, with the plate in the gripper arms, is lifted above the level of the carrier. The carrier is then extended, the claw lowers the plate onto the carrier, and the gripper is released.

Once the plate has been released and the claw is lifted, the carrier is free to retract underneath the destination stack. The position of the carrier is then verified, and the output stack lift is raised, lifting the plate such that it slightly lifts all of the plates present in the stack. The dogs are retracted slightly and the entire stack of plates is lifted above the dogs (Figure 4D). The dogs are then retracted inward and the lift lowered so the entire stack, with the newest plate located on the bottom, is now resting securely on the dogs (Figure 4E).

At this point the Bio-Stack is able to repeat the process with the next assigned microplate. When the batch has been completed, the plates will be in the reverse order from where they started in the input stack. If enabled, the Bio-Stack has the capability to restack the plates by moving them from the output stack back to the input stack, which results in re-establishing the order of the original stack.

Software

PC Control Software is available for the Bio-Stack when interfacing with the BioTek PowerWave Series scanning absorbance spectrophotometers and the Synergy HT Series multi-detection readers. The Bio-Stack PC control software allows the user to select a specific reader protocol for each plate on the input stack. The software graphically indicates the plate ID and location within the stack (Figure 6). In addition, the user can select the assay protocol name, import file name (if used) or plate barcode (if used) to be displayed in conjunction with the plate number in the stack. As plates are completed by the instrument and returned to the output stack, their location is identified with similar choices (Figure 7). The software enables the user to pause the batch in order to add the additional plates or remove plates that have already been processed.

Plates can be added to an existing batch of plates, to either the top of the stack where it will be processed in order, or to the bottom of the stack where it will be processed next. At any time during the run, the user can identify a specific plate in either the input or output stack and inquire about non-displayed information. If it is a non-processed plate in the input stack, the user can also elect to modify its parameters including the reader protocol (Figure 8). If large numbers of plates with the same protocol are to be run, a continuous mode can be enabled that eliminates the need to identify each plate specifically. The automatic plate-numbering feature allows the user to keep track of plates on a daily basis or keep a running total. When batches have been completed, the Bio-Stack can be configured to restack the completed plates so they are located at the same position vertically in the stack as they were when the batch started. During setup, a configuration routine is provided that allows the user to select serial ports, and vertically align the claw and gripper so the plate is placed smoothly on the instrument carrier. As with all BioTek software, a fully informative context-sensitive help system is available to provide a conceptual overview of the Bio-Stack plate stacker system and to answer any questions that may arise (Figure 9).

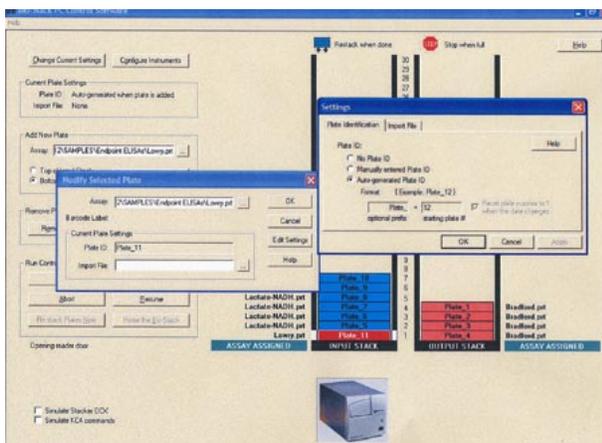


Figure 6. Defining Plates with Bio-Stack™ PC Control Software. PC software is used to control the Bio-Stack™ when it is used with the Synergy™ HT or PowerWave™ readers. Several plates (up to 30) can be programmed to run. Note that different reader protocols can be identified on a plate-by-plate basis on the input stack.

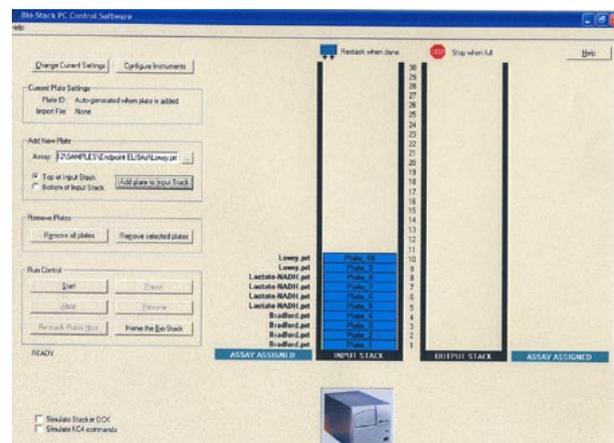


Figure 7. Completed Plates in the Output Stack. PC Control software for the Bio-Stack™ tracks completed plates to the Output stack. Note that the reader protocol associated with the completed plate is indicated to the right of the plate in the stack. This user-selectable parameter can also be changed to indicate plate barcode or import file.

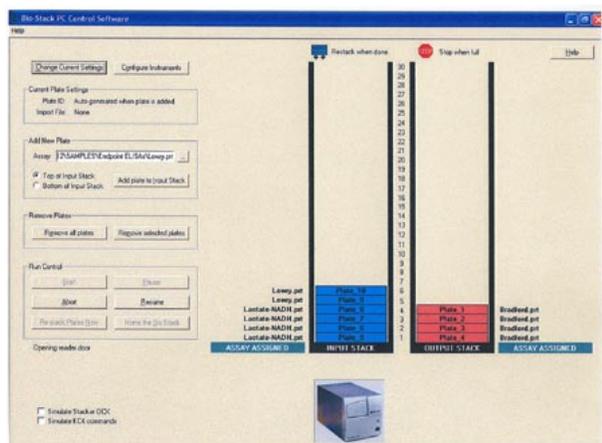


Figure 8. Modifying Plate Parameters. At any time during a batch, specific plates can be identified and more detailed plate parameters displayed. Non-processed plates in the input stack can even have the reader protocol changed.

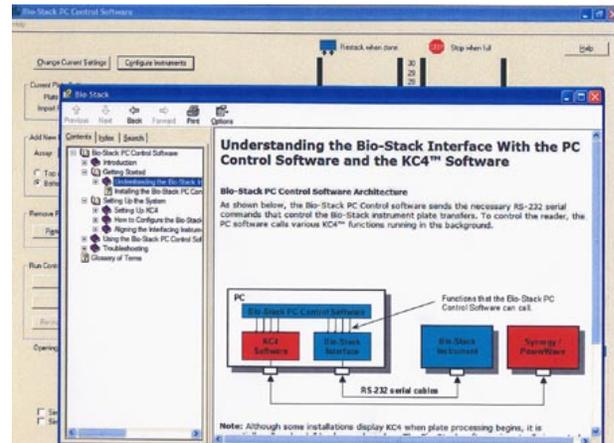


Figure 9. Detailed Help System is Available. If questions arise when using the PC control software, answers are only a mouse click away with the detailed and context-sensitive help system.

Compatible Instruments

- ELx405™ Microplate Washer
- µFill™ Reagent Microplate Dispenser
- PowerWave™ HT Microplate Spectrophotometer
- PowerWave™ XS Microplate Spectrophotometer
- Synergy™ HT Multi-Detection Microplate Reader

Features

- 30 microplates per stack
- Simple to use
- Small footprint
- Full regulatory compliance
- Easy alignment of stacks
- Stepper motor design provides quiet and reliable operation
- Onboard diagnostics
- Durable precision-ground aluminum base
- Speedy plate delivery (8 seconds)
- Removable and interchangeable stacks
- Flexible PC software
- The gripper incorporates rack and pinion drive for synchronous movements
- Grippers are preloaded with springs, preventing plate dropping in the event of power loss

For more information, please contact BioTek Customer Service at 888-451-5171 or visit our Web site at www.biotek.com.

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