Model DAISYCHAINBOX

Product Manual

Big Bear Automation, Inc.
Fremont, CA USA 94538
Tel: 510-333-4338
Fax: 925.397.3148
Email: Sales@BigBearAutomation.com
Web: www.BigBearAutomation.com

Manual Version: 1
Manual Date: FEB 2 2018

Copyright © 2018 Big Bear Automation, Inc.
Description

Congratulations on your purchase of Big Bear Automation’s Daisy Chain Box 16 Shaker Extender for Microplate Orbital Shakers. This device will provide years of reliable operation for you. The DAISYCHAINBOX control is designed to provide simultaneous control of 16 or more RS232 data version microplate orbital shakers using a single RS232 or USB communications port typically found on a PC.

Features

- Control of 1-16 model HT-91100 RS232 shakers with one host communications port.
- Uses a single RS232 port or a USB 1/2/3 port on your PC.
- Links with any controller capable of RS232 communications, including laptops, desktops, tablets, custom machinery.
- Easy interfacing using built-in commands and features of the existing shakers.
- Full and rich ASCII command set.
- Allows individual addressing of a specific shaker on the chain.
- Allows simultaneous control commands to all shakers at once.
- Easy RJ-11 connectors interface directly with existing shaker RJ-11 cabling. No need for extra cabling or wiring of any kind.
- Easy selection of which shakers to use on the daisy chain using DIP switches.
- DIP switches allow a shaker to be bypassed easily to isolate programming issues during debugging.
- An LED indicates receipt of RS232 data from the host, pulse elongated so you can see the instance. Useful for debugging your equipment.
- A second LED indicates transmission of RS232 data to the shakers from the host, useful for debugging.
- 24 VDC power for safe and easy integration with other automation. Green power LED.
- Multiple daisy chain boxes can be linked for control of up to 64 shakers at once.

Proper Usage & Precautions

The DAISYCHAINBOX is designed to be used in conjunction with its AC power adapter module to supply the 24 volts DC needed at the unit. Your ESD protection may be impaired and the warranty may be affected if used in a manner not normally associated with typical usage.
## Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shakers controlled</td>
<td>1 to 16 shakers in daisy chain mode</td>
</tr>
<tr>
<td>USB Port</td>
<td>Compatible with USB 1.0 and USB 2.0 interface. Included driver software on the red USB thumb drive configures the PC USB port to act as an RS232 port, allowing direct contact with the shakers.</td>
</tr>
<tr>
<td>Power Required</td>
<td>24 VDC, 200 mA. 100-240 VAC 50-60 Hz power adapter included. DC power receptacle on end of unit.</td>
</tr>
<tr>
<td>RS-232 Port</td>
<td>9600, 8, 1, no hardware data control. ASCII text characters with &lt;CR&gt; for end of line. RJ-11 connection on end of unit. Standard RJ-11 telephone cable, 6 foot, included. RJ-11 to 9 pin D-type PC serial interface connector supplied.</td>
</tr>
<tr>
<td>Base Dimension</td>
<td>4.70&quot; (119 mm) width, 7.375&quot; (187 mm) length, 1.50&quot; (38 mm) height</td>
</tr>
<tr>
<td>Weight</td>
<td>1.0 pounds (453 g)</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>0° F to 160° F (-17.5° C to 71.0° C), non-condensing, RH to 90%</td>
</tr>
<tr>
<td>LED Indicators</td>
<td>Three: Green power indicator, yellow for TxD, blue for RxD</td>
</tr>
<tr>
<td>Material</td>
<td>Aluminum, black powder coat painted</td>
</tr>
<tr>
<td>Warranty</td>
<td>Two year limited replacement warranty.</td>
</tr>
</tbody>
</table>
**What is Daisy Chain Mode?**

The shakers can be configured for operating in a daisy-chained, individually addressable, single serial port mode. This mode allows many shakers to share a single serial port on your PC. This configuration requires that the cables at the end of each RJ-11 shaker interconnect be connected together in a manner where the serial output from one shaker connects to the serial input of the next shaker, and on and on. Up to 64 shakers can be connected together in this configuration, and the mode will also work with only one shaker.

This DAISYCHAINBOX allows a single host PC to control up to 16 shakers on this one box. In daisy chain mode, each shaker is initiated automatically with its own discreet address. When you send a command to the shakers on the daisy chain, you address a specific shaker using this discreet address character. The addresses are assigned in the order in the chain that they are plugged together, so the first shaker gets assigned the address ‘1’, while the second shaker gets assigned ‘2’, and so on. The daisy chain works by receiving the command from the host, and passing it on to the next shaker in the chain if it is not addressed to it. Once a shaker is selected and commanded, that shaker responds and the remaining shakers on the chain pass along its response back to the host.

Since there are only three wires used in the communications for these shakers, it is easy to assemble a cable or connector box for the daisy-chaining configuration. The DAISYCHAINBOX performs this function for you in a clean and simple manner.
What’s In the Box?

The box contains items:

- Daisy Chain Unit
- AC Adapter with connected cord
- AC power plug for adapter
- USB cable for connecting DaisyChainBox directly to a laptop or PC
- RS232 cable for connecting DaisyChainBox directly to an RS232 9-pin D-type connector on your PC
- Thumb drive holding the documentation for the product, plus the drivers for the USB port to shaker interface
Features and Switches on the DAISYCHAINBOX

9-pin female D-type connector matches PC RS232 for direct connection to PC host computer

RJ-11 connector for connection to PC host computer using shaker standardized RS232 connector interface

USB 2.0 for direction connection to PC host

24 VDC power plug from AC adapter
There are 16 RJ-11 connector receptacles on the box. Each shaker gets plugged into one of these receptacles starting at the one marked ‘1’. There are two DIP switches peeking through holes on the panel. One DIP switch controls the usage of shakers 1-8, while the other DIP switch controls the usage of shakers 9-16. You slide an individual DIP switch to “ON” if there is no shaker in the receptacle with that number designation, which bypasses that shaker and connects the daisy chain without that shaker.
DIP switch performs bypass option or shaker #1

DIP switch in ON position, in direction of arrow, bypasses that shaker position, meaning don’t use this shaker socket in the Daisychain.

DIP switch in OFF position, in direction of arrow, allows this shaker socket to be in use and active in the Daisychain. You need a DIP switch in the OFF position for the shaker to be used.
On top of the box there is one function switch and three LED indicators.

The function switch is for you to tell the box what type of host connection is being used, either the USB port or the RS232 port. Simply snap the lever switch to the type of host input you are configured with.

The green LED indicates 24 VDC power is applied.

The yellow and blue LEDs are simply for use during debugging. They indicate the presence of any data on the RxD or the TxD RS232 data lines. Since the data stream command is only a few milliseconds and the resulting visible LED would be so short as to be unobservable, there is circuitry to extend the length of the LED flash, making a strong dash of bright LED light visible for each tiny spurt of data. These are useful for observing and verifying data packets going to and from the shakers and your host PC.
Connecting to the DAISYCHAINBOX

Your PC or laptop is the Host. It connects to the DAISYCHAINBOX using either the USB or RS232 port. Your PC may be an existing industrial computer running a lab instrument and may already have existing RS232 ports with standardized 9-pin D-type connectors available. You may find only USB ports available on laptops, tablets and newer PCs. You'll use one of the two included interconnect cables to plug together your PC host and the DAISYCHAINBOX.

Every Model HT-91100 Microplate Orbital Shaker comes with an RJ-11 cable to interface the data stream. That RJ-11 phone cable connects each shaker to the DAISYCHAINBOX.
How to Engage Daisy Chain Mode at the Shakers

To enter this mode, send the command ‘U’ to the single shaker serial line. This should be the very first command sent to the shakers after powering up the units. The first shaker in the daisy-chain will assign itself the address of value ‘1’, then send on the re-order command to the next shaker. That next shaker will then assign itself an address value of ‘2’ and then send on the command. At the end of the chain, you will receive back at the original host serial port the string data ‘UX’, where the ‘x’ is the last address designation of the last shaker on the chain. As an example, if there are 4 shakers on one serial line, the response string back at your PC will be ‘U4’. The shakers automatically assign themselves the next character in the chain, so if there are 8 shakers connected, they will assign themselves the addresses of ‘1’ through ‘8’. If there are more than 9 shakers on the chain, the tenth shaker will have the address ‘A’. Subsequent shakers will continue to use the rest of the ASCII character set such as ‘B’ through ‘Z’. You can even have more shakers on the chain and they will be addressed starting with the next ASCII character '['.

After entering this mode by sending the ‘U’ command, you will be required to preface any command with the address of the shaker you wish to talk to. You must use the ‘@’ character, followed by the address character for that shaker, followed by the command you wish to execute at that shaker. For example, to query shaker number 8 for its serial number, send the string value ‘@8Y’ followed by the normal <CR> for all message strings. To stop shaking the 12th shaker on the chain, send the string value ‘@CS’ (‘C’ is the address designation for the 12th unit). To set the velocity value for shaker 3 send the string ‘@3V=1000’.

All data responses from all shakers coming back to your PC’s serial port receive line will be prefaced with the ‘,’ (comma) character while in this daisy-chain mode. For example, the typical response when not in daisy-chain mode to a query for a product ID command such as ‘Z’ would be ‘HT-91100’. When in daisy chain mode, this same query will result in the data string ‘,HT-91100’. Your software should strip any comma as the first received character when querying any shaker while in daisy-chain mode.

Daisy chain mode is not reversible. All shakers will revert back to the original default mode when powered-off, thus the need for resending the ‘U’ command at every power up. All of the normal commands sent to the shaker without the ‘@x’ address preface will be ignored completely when in daisy chain mode.

Finally, while in daisy chain mode, the shaker feature that automatically reports textual status of shaking, such as ‘RUN’, ‘RAMP’ or ‘STOP’, will not work, and that data is not automatically sent. Instead, you will need to poll or query an individual shaker for that data using the ‘Q’ command. For example, to stop a shaker on a chain, send the command ‘@5S’, then begin to continuously query that shaker with the command ‘@5Q’. You will receive the data ‘,RAMP’ while shaker number 5 decelerates, and when finally stopped you will receive the data string ‘,STOP’. Again, note that each string received is prefaced with the ‘,’ (comma) character, and can be stripped as you receive it.
In general, each shaker microcontroller is able to handle a new communication stream every 8-15 milliseconds. We recommend that there is a 20 msec delay between every command sent down the daisy chain serial line to be completely error free. If more than two or three command strings get sent out without delays, there is a probability that the RS232 buffers at the first shaker will overrun and data may be corrupted. The shaker’s control software is configured to accept and pass on any command in real-time, even while it is handling its own shaking operation. If you send a request for a query type of command, such as a ‘@6Y’, you should wait for the response before sending on another command or request. This will allow the serial chain to pass on the result from that one addressed shaker, so you can match that result to the query you have just sent.
Do not immerse the shaker in water or any liquid. The shaker is not considered waterproof and damage may occur if the internal control components experience excessive moisture.

Ensure any wellplate in use is pushed fully onto the surface plate and that the wellplate is secured by the plastic clips. Failure to secure wellplate may result in the wellplate being removed from the shaker during high speeds.

For almost all applications, the shaker should be bolted down to a solid surface to prevent vibrational walking. There are threaded mounting holes on the underside of the shaker for securing.

**Care and Maintenance**

Your shaker can be cleaned easily with a wipe-down using most cleaners and a paper towel or soft cloth. The shaker’s bright nickel plated surface withstands alcohol, solvents, bleaches and hexanes. Glass cleaner works especially well in cleaning and restoring the bright finish.

There are no user maintainable components inside the shaker. It is designed to last for many years of high performance operation. Do not disassemble the shaker in any manner.
Set-up the PC Interface Program

Included with your package for the HT-91100 Shaker is a test program for interfacing the Shaker with a PC. It allows you to test all of the features available on your new shaker with a simple-to-use interface Window. All of the source code is also included, so you may use portions of it in your own programming interfaces.

To set-up the program, simply load the CDROM into your PC and it will start the setup program automatically. If it does not begin, start the setup.exe manually by double-clicking that file on the CD.

Once loaded onto your computer, navigate to the Program Group now on your computer called OrbitalShaker, and execute the program called HT91100Test.

First, you must select whether you have just a single shaker connected to a single PC serial port. If so, select the top radio button. If you have multiple shakers configured in a daisy-chain mode connected to a single serial port, choose the bottom radio button.
The program will now automatically scan all of your PC’s serial ports (or simulated RS232 ports using USB ports), and this automated process runs through all of the serial ports on your PC and attempts to establish communication with the Shaker. If it finds a Shaker on a serial port, it will automatically assign that com port to the Shaker, and the rest of the test program’s features will be enabled. The basic information about the shaker is acquired automatically, such as the serial number and firmware revision number. If you have multiple shakers installed on a daisy-chain, at least the first four shaker’s information will be displayed.

If it did not automatically find the Shaker, the available com ports on your PC will be displayed in black, and the unavailable ports, or those ports not present on your PC, will be displayed in grayed-out color. You may reconfigure your PC if necessary and try again.

After a serial port has been located that detects the presence of a shaker, all of the menus will be visible. There will be separate tabbed selections available based on if the configuration is a single shaker, or daisy-chained multiple shakers.

Most of the features of the Shaker interfacing is accessible on this program window. You can read in detail all of the Shaker features in the following sections.

The test program provides a real-time display of the incoming RS-232 text from the Shaker. You can monitor the Shaker’s responses to your data queries there.

As a simple example of operation, in the Set Parameters frame, fill in the number of Seconds in the text box acceleration and press the Set Acceleration button to send it to the Shaker, do the same for the RPM you want to achieve and press the Set Velocity button, then simply press the Go button in the Motion Commands frame. The Shaker will start ramping up to the desired velocity. You'll notice the status text strings being sent from the Shaker as it ramps up and finally reaches speed. Press the Stop button and the Shaker decelerates at the same rate back to zero, and a homing action will finally occur very quickly.

When you have selected the multiple shakers in a daisy chain configuration mode and the serial port with the shakers has been found, you will see this window. In the upper left portion of the screen is blue lettering showing Daisy-CHAINed Multiple Shakers. To the right of the photo image of the shaker is the selection frame for specifying which shaker in the chain is to be controlled with the rest of the menu. Use the arrow buttons to increase or decrease the shaker to be controlled. The designation range is ‘1’-‘9’, then ‘A’ through ‘Z’.

Once you select a shaker on the chain, you can control just that shaker completely using the rest of the menu. You can then select another shaker, and send a different set of commands just to that shaker. In this manner, you can independently control all of the shakers on the chain.

In daisy-chain mode, there is a ‘,’ (comma) character that precedes all incoming data (see separate section for this discussion), and this comma is stripped off here to display all of the other characters in the From Shaker RS232 text box.
Full Menu Shaker Test Window in Single Shaker Per Serial Port Mode
Another feature present on the test program is the factory adjustment for the top speed of the Shaker. The Shaker is specified at 3570 RPM for the highest speed, and this is adjusted and calibrated at the factory at a potentiometer on the microcontroller’s printed circuit card inside the Shaker unit. By clicking the Set Top RPM button of the test program under Diagnostic Tests, another frame pops up displaying the adjustments required as the Shaker runs at its top speed. If the speed is too high or too low, a small rotation picture shows which way the potentiometer must be adjusted. The correct speed calibration will show only the green bar lit. It is normal to have some small amount of data bounce about this exact speed. Press the Stop button or the Done button when you are finished, and the Shaker will decelerate back to a stop.

On the CDROM you will also find this manual under the filename HT91100Manual.pdf. All of the source code in MS Visual Basic 6 is also under a subdirectory called SourceCode.
Interfacing to the DAISYCHAINBOX Using RS-232

Interfacing with the DAISYCHAINBOX uses the serial communication ports available on almost all PCs. The interface hardware on your PC is usually a 9-pin D-type connector. We have supplied you a connector module for this type.

In the event you are using an industrial computer with multiple serial ports, any available serial port can be used. The test program works through the first twenty serial ports on a PC. Beyond that, you will need to write your own code to interface serially with the DAISYCHAINBOX.

On many modern PCs, an RS232 serial port does not exist. In this case, obtain a USB-to-Serial-Adapter cable. This is a short cable that has a standard USB plug on one end, and an RS232 9-pin D-type connector on the other. We offer a tested unit, see our website for info. It will require a quick setup with its own driver disk after you plug it into a port on your PC. Once you have it installed, the shaker application program will automatically scan available PC serial ports and locate the interface adapter for use.

Communication protocol with the Shakers is 9600 baud rate, 1 stop bit, no parity bits and no hardware flow control. Only three lines are used, TxD, RxD and ground. The shaker uses its own RS-232 transceiver chip to generate the proper RS-232 signal levels.

Shaker Signal Connections on the D-Type Connector

<table>
<thead>
<tr>
<th>Signal Description</th>
<th>Signal</th>
<th>9-pin D-type</th>
<th>25-pin D-type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitted Data</td>
<td>TxD</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Received Data</td>
<td>RxD</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Signal Ground</td>
<td>Ground</td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>

We have designed the Shaker programming interface to be as simple as possible, using single character commands attached directly to any data you send. Most data coming from the Shaker is completely automatic, and you may optionally turn off automated status strings if it interferes with your code that accepts incoming RS-232 data.
Installing USB Virtual Com Port Driver

To interface this shaker with a PC or a Windows based operating system using USB, you must install a USB virtual Com Port driver. This driver is included with your package and is a file on the red USB drive in the red plastic baggie. The file is a driver that allows the DAISYCHAINBOX’s USB port to act as a virtual serial Com port.

In simplest instructional terms, plug in the red colored USB drive, navigate to the files on this drive, and then choose the ShakerUSBInstaller_x64.exe for PCs with 64 bit processors, or choose the ShakerUSBInstaller_x86.exe for older PCs with 32 bit processors. Follow the instructions and allow the driver software to install, and you are done. You can plug in and use the DAISYCHAINBOX in just a few moments.

Detailed instructions follow for each step needed to install:

Insert the red USB drive into your computer. Generally, a window will pop up to allow you to open the files on the device. Open the device files, or navigate to the USB drive, and look for the two .exe files.

If you have a newer PC with a 64-bit operating system, then choose the file ShakerUSBInstaller_x64.exe, and execute it by clicking it twice. If you have a slightly older PC with a 32-bit operating system, then choose the file ShakerUSBInstaller_x86.exe, and execute it by clicking it twice.
You may see this pop-up message window, press **Yes** to continue.

Press **Next** to continue after the welcome screen for this driver installation.
Again, continue installation by pressing the selection *Install this driver software anyway*.

Press the **Finish** button to complete installation of the driver.

The driver is now completely installed. Plug in the USB cable to the DAISYCHAINBOX now. There will be a moment while the software driver installs, and then the DAISYCHAINBOX is ready to be used.
What just happened? The DAISYCHAINBOX uses an IC on its printed circuit board that links to the USB standard. This chip is a Silicon Labs 2102 device. The driver you just installed allows the computer to access this USB channel as if it were a much simpler RS232 serial port. This is called a Virtual Com Port, where the Com Port is not an actual hardware port, but instead a software driver access to the USB channel. The DAISYCHAINBOX can now be accessed as if it were a serial port. Many programs on PCs can easily access a Com Port to control the DAISYCHAINBOX and connected shakers now, including the Shaker Interface application, which you can load from the other yellow USB drive in your DAISYCHAINBOX package. That app allows you to control the shakers and all of its most basic functions so you can debug it quickly when integrating to your own equipment.

When looking at the Device Manager reporting, you will find the new DAISYCHAINBOX USB port listed as a Silicon Labs CP210x USB to UART Bridge (COMx), where the x value was just assigned automatically by your PC.
Summary of RS-232 Commands

Axx  Set acceleration value in range 0 to 10 seconds.
B    Immediate, uncontrolled brake action.
C    Disable finding of shaft home feature.
D    Disable motor driver, motor will free coast to a stop.
E    Enable the finding of home feature after the motor stops (default).
F    Find the home sensor.
G    Go, start the motor, using set velocity and acceleration.
Hxx  Set acceleration in range 0-10 for Cycle 1.
Ixxyy Set velocity in RPM for Cycle 1, range 60-3570.
Jxxxxx Set time, in seconds, that Cycle 1 lasts, range 0-30,000.
Kxx  Set acceleration in range 0-10 for Cycle 2.
Lxxxxx Set velocity in RPM for Cycle 2, range 0-3570.
Mxxxxx Set time, in seconds, that Cycle 2 lasts, range 0-30,000.
N    Begin continuous cycling between the two speeds set in Cycle 1 and 2.
O    Enable status text automatically sent over RS232 after a change (default).
P    Disable status text sent automatically, nothing is sent.
S    Stop the motor using deceleration values, then find home if okay to use.
T    Test the reflective optical sensor that finds the home index mark.
Vxxxxx Set the velocity for the next motion, in range 60 to 3570 RPM.
+    CW rotation motion (default).
-    CCW rotation motion.
@    Enter daisy-chain mode and re-order multiple shakers.
(    Preface character for daisy-chain addressing.
)    Turn off and disable usage of the LED indicator on the side of the shaker.
!    Turn on and enable the LED indicator.
~    Re-suspension protocol, breaks up stubborn sediment.

Summary of RS-232 Data Requests

?    Request this list in its entirety, with the descriptions listed here per command.
?A   Shaker responds with A=xx, the currently set acceleration value, 0-10.
?V   Shaker responds with V=xxxx, currently set velocity, range 0-3570 RPM.
?R   Shaker responds with R=xxxx, measured RPM of the motor shaft.
Q    Request text status, unit responds with RAMP+, RUN, STOP, BUZZ.
?W   Shaker responds with W=xxxx, internal commanded current velocity.
X    Shaker responds with the firmware version of the microprocessor, x.xx.
Y    Shaker responds with the serial number of the unit, A1234 (xxxxx).
Z    Shaker responds with model number, HT-91100.
$    Responds with a high speed data packet of status, commanded and measured RPM.
RS-232 Communication Rules

Common RS-232 serial communication rules that the shaker uses are:

- Characters “=” (Equal Sign), “ “ (Space) and the Linefeed character are ignored by the shaker unit. Therefore, the command that you send “V=100” is the same as “V100”.

- All commands or data request strings sent to the shaker must be terminated by a <CR>, Carriage Return, decimal value 12, hexadecimal value 0xD.

- Since the <LF>, Linefeed character, decimal value 10, hexadecimal value 0xA, is ignored, you may safely send a <LF><CR> command termination at the end of every string line if you are using a PC port testing program such as HyperTerminal.

- After the shaker sends out all data, it terminates the string with a single <CR>, Carriage Return.

- Only data request type of commands initiate the shaker to send data. For all other commands, the shaker does not send a response. You can request the shaker to always respond with the special mode command “~”.

- If the shaker receives an unknown data request, it responds with “?:”, followed by the command values that you sent, followed by a <CR>.

- If you do not terminate a command string with a <CR>, subsequent strings will accumulate in the shaker. If the shaker receives a command string longer than 20 characters, or if the accumulated buffer reaches 20 characters, the shaker responds immediately at the 20th character with “?:”, followed by the current command string buffer, followed by a <CR>.

- All commands you send the shaker and data sent from the shaker will be upper case characters only. Lower case characters will not be recognized.

- The shaker accepts and responds to RS-232 commands at any time, even while executing another command or motion. Therefore, you may request information on current velocity at any time, or you can even request a new acceleration and velocity motion to be executed before the last has ended. A Stop command can be sent at any time and will be executed immediately.

- After you power up the shaker, all values are internally defaulted. If you wish certain features disabled, you must resend these commands to perform these actions before you use the shaker in your application.

- You may send values with leading zeros if your programming is easier to accommodate. For example, the command “V=0500” is the same as a command of “V500”.

Overview of Shaker Control Features

There are a number of features that can be commanded, as well as options that can be enabled or disabled. Some basic features are:

**Basic speed, start and stop commands:** Set the RPM you want to achieve by setting the Vxxxx command to any value in the range 0 to 3570. Use Axx to set the number of seconds to reach that velocity in range 0-10, then begin the shaking motion to that velocity with the G go command. When you want to stop the shaking, send an S command to stop.

**Alternating speeds mode:** In the alternating speed mode, you set the acceleration, velocity and dwell time for speed number 1, set the same conditions for speed number 2, then start the shaker. It works on its own, alternating between these two speeds indefinitely. For speed 1, use Hxx for acceleration, Ixxxx for RPM velocity value, and Jxxxxx for the number of dwell seconds, in range 0-30,000, that the shaker stays at this speed. For the alternate speed 2, use Kxx for acceleration, Lxxxx for speed 2 velocity, and Mxxxxx for the dwell time. Start this mode using the N command. Use S for stopping normally, using the most recently set acceleration value for ramping down to zero velocity.

**Timed speed mode:** Use this mode to set a velocity Ixxxx, an acceleration Jxx, and a total amount of dwell time Jxxxxx in seconds that this speed runs. You must specifically set the velocity value of the alternating mode’s speed 2 value of Lxxxx to 0, as in “L=0”. Then start the timed dwell time with the N command. The shaker will ramp up to whatever speed value you have set, then it will wait at that speed for the amount of seconds you have specified. After this dwell time is reached, the shaker decelerates and finally stops automatically. You may also terminate the dwell time and shaking at anytime by stopping the unit with the S command.

**Precision home search:** The shaker uses an optical retroreflective sensor to watch for an index mark on the spinning motor shaft that runs the shaker table. When it finds this index mark, it immediately brakes the unit at a very specific position each time this feature activates, within only a few rotational degrees each time (within 0.01mm of X-Y shaker table position). The speed of the home search is preprogrammed. It can occur at least once every revolution. By default, the home searching is on, or you may enable it with the E Command. When enabled, the home search occurs after every stop S command, after the shaker has decelerated to a stop. It adds about 0.75 seconds to the completion of the stop function. You can force the home feature to activate, if it is enabled, with the F command. You can disable this feature with the C command.

**LED indicator:** The tricolor LED on the end of the shaker units indicates current status. A green light indicates that the shaker is at a constant velocity value or is at rest. A yellow lamp indicates the shaker is transitioning or ramping between velocity values. A red lamp occurs when the shaker is searching for its home position. You can turn off the LED usage with the ( command, and turn it back on with a ) command.

**Shaker status requests:** There are a number of methods of retrieving the status of the shaker. By default, the shaker automatically sends out over the serial line a string value of “RUN” and a
<CR> if the shaker has achieved a stable velocity. If sends out “STOP” after the shaker has reached zero velocity and a home search is completed. It sends out “RAMP+” if the unit is in the process of accelerating to a new higher RPM, or it sends out “RAMP-” when decelerating to a lower RPM or stopping. When the shaker is executing the re-suspension protocol feature, the shaker sends out “BUZZ”.

You can disable this default text sending condition by sending the P command, and the shaker will not send out these string commands at all. You can turn it back on using the O command. The text status can also be queried at any time by sending the Q data request command, and the shaker will send out one of these status strings immediately, even if the automatic text status is disabled.

You can request the current acceleration value the shaker will use by sending the “?A” data request, and the shaker responds with “A=xx”. Use “?V” for the commanded velocity “V=xxxx” you have requested that the shaker achieve. Use “?W” to get a value of “W=xxxx”, which is the value of the real-time internally commanded velocity that the shaker is achieving at that moment, and this value will change up or down as the shaker decelerates and accelerates.

**Shaking orbital direction:** By default, the shaker orbits clockwise (CW). To change the shaker to orbit counter clockwise (CCW) use the “-” command. To set it back to use CW motion, use the “+” command.

**Product and unit information:** Send the “Z” command to get the product model number of the shaker, currently “HT-91100”. Use “X” to receive the software version in the microcontroller inside the shaker unit, such as “1.00”. Use the “Y” command to get the unique factory programmed serial number of this unit, 5 characters always, such as “A1234”.
Command List, Alphabetically

Axx
Set acceleration value in range 0 to 10 seconds.

The acceleration of a motion can be set by this command. The range is whole numbers of 0 through 10, and is the number of seconds requested for the shaker to go from its current velocity to the new velocity. If you set this value greater than 10, it will be clipped to the top acceleration of 10 RPM. If there are errors in the value you send with this command, such as non-numeric characters, the value is set to the top acceleration value of 10. This value is stored in the shaker unit and is used at the next Go or Stop command. If you do not set the value of the acceleration, the default value used is 5 seconds. The deceleration of a motion also uses this acceleration value. Typically, the shaker will need at least 0.5 second to reach top speed from a stopped condition, so if you set the acceleration to a value of 0, it will still take just a bit more than a quarter second or more to reach top speed.

B
Uncontrolled brake action.

Used only for hardware troubleshooting purposes. It provides for an instant and immediate braking action of the motor controller. There is no deceleration, no home finding or any other useful function at this time. It will probably throw liquid contents off the microplate. Send a G go command again to release the motor and resume normal operations.

C
Disable home search feature.

By default, the shaker uses the home feature searching after coming to a stop from shaking. You can turn off this feature using this C command. Although the stopping function total time may be decreased by about 0.5 seconds, the shaker table will eventually stop in any random orbital position. See command E to turn this feature back on.

D
Disable motor driver.

Used only for hardware troubleshooting purposes. It provides for an immediate decoupling of the motor driver from the shaker table. It results in uncontrolled short-term deceleration. There is no controlled deceleration, no home finding or any other useful function at this time. Send a G go command again to engage the motor and resume normal operations.
E
Enable home search feature.

By default, the shaker uses the home feature searching after coming to a stop from shaking. If it had been turned off with the C command earlier, you can enable this default feature again with this E command.

F
Force the home search feature.

Use this command to force the home search feature function immediately. Homing works by braking the unit for 0.25 seconds, then spinning the shaft at 200 RPM until the motor index mark is seen twice using a retro-reflective optical sensor, and then braking again. The LED status indicator is red during this function. If the status text is enabled, the shaker will send the “STOP” string after the home search is performed. If the home feature has been disabled using the C command, this command will be ignored completely.

G
Go command, starts the shaker.

Once the shaker receives the G command, the shaker uses the values you have set in the acceleration and velocity commands, or the defaults if not yet set, to calculate the amount of RPM change per millisecond, then begin the acceleration or deceleration to reach this new velocity. If the status text is enabled, the shaker will immediately send the “RAMP+” string if the unit must accelerate, or “RAMP-” string if decelerating. You may send the G command anytime to begin shaking at a new velocity. For example, if the unit is accelerating up to 1000 RPM over 10 seconds, and half way through this time period you reset the velocity value to 500 and then send the G go command, the shaker will recalculate ramping from the point it is currently at to go to the 500 RPM value. If you send the G command without changing the velocity value, the velocity will not change, and the status string will be “RAMP”. See the S stop command also.

Hxx
Set acceleration in range 0-10 for Cycle 1.

Sets the acceleration of the speed number 1 cycle when using the alternating speed mode, or the acceleration for the timed mode. See command N for a full description of these modes.
Ixxxx
Set velocity in RPM for Cycle 1, range 60-3570.

Sets the velocity of the speed number 1 cycle when using the alternating speed mode, or the acceleration for the timed mode. See command N for a full description of these modes.

Jxxxxx
Set time, in seconds, that Cycle 1 lasts, range 0-30,000.

Sets the dwell time of cycle 1 when using the alternating speed mode, or the acceleration for the timed mode. Value range is 0-30,000 seconds, which is a maximum of 500 minutes, or 8.33 hours. Do not put commas in the string value you send to the shaker. See command N for a full description of these modes.

Kxx
Set acceleration in range 0-10 for Cycle 2.

Sets the acceleration of the speed number 2 cycle when using the alternating speed mode, or the acceleration for the timed mode. See command N for a full description of these modes.

Lxxxx
Set velocity in RPM for Cycle 2, range 60-3570; 0 if timed mode.

Sets the velocity of the speed number 2 cycle when using the alternating speed mode. If you want to use a timed mode, setting the value of L0 tells the shaker to use a timed mode for cycle 1 only, then it stops automatically after cycle 1 dwell time completes. See command N for a full description of these modes.

Mxxxxx
Set time, in seconds, that Cycle 2 lasts, range 0-30,000.

Sets the dwell time of cycle 2 when using the alternating speed mode, or the acceleration for the timed mode. Value range is 0-30,000 seconds, which is a maximum of 500 minutes, or 8.33 hours. Do not put commas in the string value you send to the shaker. See command N for a full description of these modes.
N
Begin continuous cycling mode between the two speeds set in Cycle 1 and 2; or begin timed mode.

Begins immediate execution of the alternating cycle mode, using values previously programmed into the shaker using commands H, I, J, K, L, and M. In operation, this mode accelerates up to the speed programmed in cycle 1, then dwells at this speed for a period of time. Then the shaker ramps to the cycle 2 speed using cycle 2 acceleration, and dwells another period of time for cycle 2. This process then repeats indefinitely, until you send a S stop command, acceptable at any time. Use this feature to stir microplate contents gently for a long period of time, then burst mix for a short period of time, then repeat. There is also a timed mode feature. You select this mode by setting the cycle 2 velocity value to 0, as in L0. You do not need to set the other two parameters of cycle 2 (commands K and M). The value of L0 tells the shaker to ignore the alternating cycle mode and perform a single timed cycle mode function. It executes the values of cycle 1 to the RPM value, then dwells for the amount of time set in cycle 1. After this dwell time, the shaker simply decelerates to a stop by itself. During these continuous alternating cycles or timed mode transitions, the text status output will be sent if it is enabled.

O
Enable status text automatically sent over RS232 after a change (default).

This is the default mode of the shaker sending textual status to the host computer. The possible strings that can be sent are RUN, RAMP, RAMP+, RAMP-, STOP and BUZZ. The string RUN occurs when the shaker reaches intended velocity. RAMP, RAMP+ and RAMP- indicate acceleration or deceleration initiation. STOP occurs after the unit stops and a home search completes, if enabled. BUZZ occurs when the re-suspension protocol feature mode is started. These strings are sent out automatically. They are terminated with a <CR>. See commands P and Q also.

P
Disable status text sent automatically, nothing is sent.

Disables the automatic sending of text status strings during shaker operation. No status data strings are sent at all after this P command is received. See command O also.

S
Stop the motor using deceleration values, then find home if okay to use.

Send the S command at any time to stop the shaker from whatever it is doing. It always uses the current acceleration value as the deceleration value to ramp down to a zero velocity. After reaching zero, the home search feature is activated, if it is enabled. The S command also resets the alternate cycling modes, and terminates and resets the timed mode.
**T**

Test the reflective optical sensor that finds the home index mark.

Begins a diagnostic test that continually runs to check the operation of the retro-reflective optical sensor. The motor shaft slowly rotates, and the sensor is monitored detecting the home index mark. When the index mark is not present, the LED is green. When the index mark is visible, the LED turns RED. If all is well, the LED alternates between green and red every shaker table orbit. Use the **S** stop command to terminate the test.

**U**

Enter daisy-chain multiple shakers mode and re-order addresses.

Changes operating mode immediately to the daisy-chained multiple shakers on a single serial line. Also re-orders all shakers on the chain with discreet addresses. Returns a **Ux** at the completion with x indicating how many shakers are present on the chain. See separate manual section discussing daisy chain mode.

**Vxxxx**

Set the velocity for the next motion, in range 60 to 3570 RPM

The velocity of a motion can be set by this command. The range is whole numbers of 0 through 3570, and is the number of seconds requested for the shaker to go from its current velocity to the new velocity. In actual usage, the shaker will not go below 60 RPM, so values less than 60 RPM and greater than 0 RPM will still result in a 60 RPM speed. If you set this value greater than 3570, it will be clipped to the top speed of 3570 RPM. If there are errors in the value you send with this command, such as non-numeric characters, the value is set to the top speed value of 3570. This value is stored in the shaker unit and is used at the next **G** go command. If you do not set the value of the velocity after powering on the unit, the default value used is 500 RPM.

**X**

Shaker responds with the firmware software version of the microprocessor, x.xx.

The shaker responds to this data request command **X** with a four character code corresponding to the firmware software version of the C code in the microcontroller inside the shaker. Typical response is “1.00”.
**Y**

Shaker responds with the serial number of the unit, A1234 (xxxxx).

There is a unique serial number programmed into each shaker unit’s microcontroller. Use this data request command **Y** to access this information. It is always 5 characters. Sample response is “A1234”.

**Z**

Shaker responds with model number, HT-91100.

The data request command **Z** returns the shaker’s product model number, current sample is “HT-91100”.

**+**

**CW rotation motion (default).**

Normally by default the shaker orbits in a clockwise direction. If the shaker had been placed in a counter clockwise (CCW) orbiting motion, this command “+” will set the unit back to a clockwise (CW) orbit.

**-**

**CCW rotation motion.**

You can change the orbital direction motion of the shaker table from the default of clockwise (CW) to a counter clockwise (CCW) motion by sending the “-” command. Note that you can send either the “+” or “-” command at anytime, even while the shaker is in motion. It is even a valid protocol option to inject extra energy into a microplate well while the shaker is at full speed.

**()**

**Turn off and disable usage of the LED.**

After power-on default, the LED indicator at the end of the shaker enclosure is used to indicate status. It is a tri-color, red, yellow and green lamp. By sending the “(“ command, the LED is turned off and is not used again. Use this command to turn off any light at the shaker, for those shaking protocols requiring darkness.
Turn on and enable usage of the LED.

Reverses the "(" command and re-enables usage of the LED. The LED resumes whatever state it would normally show at this instant.

Initiate the re-suspension protocol feature.

This feature works by using the currently set velocity to begin spinning the motor in the clockwise direction for 400 msec. After this, the motor is instantly reversed to a counter clockwise motion, at the same pre-set velocity for another 400 msec. This cycle of aggressive energy dispersion in the wells repeats for 20 times. It allows you to tailor the amount of energy injected into the well by changing the preset velocity. Its function serves to break up and re-suspend stubborn packed particles or material in the bottom of the wells. If the status text is enabled, the shaker will immediately send the “BUZZ” string. After completion, the shaker will respond with a “STOP” string. The LED indicator is yellow during this feature activation.

Preface character when addressing individual shakers when in the daisy-chain mode.

Send this character, followed by a numeric (1-9) or ASCII (A-Z) character, then followed by the command you wish to execute at that shaker. As an example, the serial string “@8Y” queries shaker number 8 in the daisy-chain for it’s serial number.

Put shaker into a mode to always respond to all commands.

Normally, after power-up default, the shaker does not respond to any command that does not expect a response. For example, setting the velocity with a “V1000” command does not elicit any further response from the shaker. This response mode is an alternative to always have the shaker respond to every command sent. In our example, after setting the velocity, the shaker will respond with a “~” (tilde) character, followed by the normal <CR>. All commands get a response of “~”, unless it is a query command that expects a typical response, such as when requesting the firmware version. In that case, the firmware version string will be returned, and the “~” character will not be returned. Use this mode to ensure that every command you send to the shaker has been acknowledged and received.

In daisy chain mode, the “~” response request allows you to send off a command to a particular shaker, and wait for the “,~” response (note the comma preface for all daisy chain responses)
back at your PC before sending on the next command. Use this instead of waiting for a particular inter-command delay period, so you can send commands as fast as they are acknowledged at the string of shakers. To initiate this mode in daisy chain, do not preface it with any “@” character or the shaker address. This command, once initiated with simply sending the “~” command to the set of daisy chained shakers, ripples through all the shakers on the daisy chain by itself, and all of the shakers will be in this response mode thereafter. If you are going to use this mode in daisy chain mode, send this “~” command after you have successfully sent the “U” command.

Once you send the “~” command, it may not be revoked, and can only be reset to an off condition by a power-off reset.

?  
Shaker responds with all available RS232 commands.

This data request command ? instructs the shaker to send out the entire summary list of all possible commands and requests, along with their descriptions. Not active in daisy-chain mode.

?A  
Shaker responds with A=xx, the currently set acceleration value, 0-10.

This data request command ?A requests the current acceleration value set in the shaker. This value will have been set by you with the Axx command earlier. If the value was not set previously, the default value inside the shaker is 5. The shaker sends out the string “A=xx”, where xx is in the range 0-10.

?V  
Shaker responds with V=xxxx, currently set velocity, range 0-3570 RPM.

This data request command ?V requests the current velocity value set in the shaker. This value will have been set by you with the Vxxxx command earlier. If the value was not set previously, the default value is 500. The shaker sends out the string “V=xxxx”, where xxxx is in the range 0-3570.

?R  
Shaker responds with R=xxxx, measured speed of the motor shaft.

This data request command ?R requests the current measured velocity value of the spinning motor shaft. The value is a raw program variable and does not correspond to actual RPM engineering units. The value returned requires further math manipulation to correspond to actual RPM values. This variable is intended for factory usage only. One example of the use of this
variable is the fact that at 3570 RPM, or the top specified speed of the shaker, the value returned will be 161, and the printed circuit card potentiometer can easily be adjusted and calibrated to match this speed. Returned values are in the range 50-8000.

To convert the returned value to an actual RPM figure, use the following formula:

$$\text{RPM} = \frac{1}{(\text{ReturnedValue} \times 0.000049913)} \times 30$$

\(Q\)

Request text status, unit responds with RAMP, RUN, STOP, BUZZ.

This data request command \(Q\) queries the shaker for an immediate textual status. The possible strings that can be sent are RUN, RAMP, RAMP+, RAMP-, and STOP. The string RUN is sent if the velocity of the shaker is currently over 0 RPM and stable. RAMP, RAMP+ and RAMP- indicate acceleration or deceleration phases. STOP is sent if the shaker is currently stopped.

BUZZ occurs for the re-suspension feature. By default, these text commands are sent out automatically when one of these conditions occurs. And that automatic sending of status strings can be disabled using the \(P\) command. However, the \(Q\) data request command always returns a string value, even if the automatic sending of strings is disabled. See commands \(O\) and \(P\) also.

\(?W\)

Shaker responds with W=xxxx, internal commanded current velocity.

This data request command \(?W\) requests the current internal real-time commanded velocity value in the shaker. This value is computed by the shaker microcontroller while acceleration and deceleration occurs. You may query the shaker to see what the current RPM value the shaker is trying to achieve at that moment in time. In contrast to the \(?V\) data request, which responds with the velocity value you had set for this orbital motion, \(?W\) returns the changing value of the shaker motion, as it ramps up and down. When the shaker velocity reaches the speed you have set in Vxxxx, the data request commands \(?W\) and \(?V\) will return the exact same value. The response is “W=xxxx” where xxxx corresponds to the range of 0-3570.

\($)\)

Shaker responds with a high speed data packet

During final testing, the shakers undergo a reliability testing procedure where they are continuously queried at high speed for their status, their expected RPM, and their actual measured RPM. You can fire this command to any shaker, even on a daisy chain, as fast as the shaker responds. The shaker responds with 11 characters, example “1010000997”. Typical response time is 25 msec.
The first character is an ASCII value in the range of ‘0’ to ‘@’, representing a status condition value of 0 through 16. Typically, a value of 0 indicates a stopped condition, a 1 indicates running, a 4 or 5 indicates a ramping state, and a value of 11 is for the re-suspension mode state.

The next five characters comprise the expected RPM value that is being calculated by the shaker for that moment. For instance, if the shaker is commanded to reach 1000 RPM over a 10 second period, this value will change every few moments to the RPM value that the motor should be following for that instant along the upwards velocity linear ramp. In a range of xxxxx RPM, examples are: “00250”, “01450”, “03500”.

The last 5 characters are the measured value in the range of “00050” to “08000” corresponding to the internally measured speed of the motor shaft at this moment in time. This value is the same as is received with the ?R command request, and needs further math manipulation for it to correspond to a proper recognized engineering value.

This command can be useful to carefully and accurately track the current orbital speed of the shaker, to ensure the shaker is linear in its operation, and to watch for a specific motion state. Also, a shaker always responds to this command, so subsequent commands sent to a daisy chained set of shakers can occur again as soon as you receive this $ response, ensuring you are requesting data as fast as the daisy chain allows. The shaker always responds immediately to this command, regardless of current operating state.
Daisy Chain Mode

The shaker unit can be configured for operating in a daisy-chained, individually addressable, single serial port mode. This mode allows many shakers to share a single serial port on your PC. This configuration requires that the cable D-type connector modules at the end of each RJ-11 shaker interconnect cables be connected together in a manner where the serial output from one shaker connects to the serial input of the next shaker, and on and on. Up to 50 shakers can be connected together in this configuration, and the mode will also work with only one shaker.

Since there are only three wires used in the communications for these shakers, it is easy to assemble a cable or connector box for the daisy-chaining configuration. Certainly our factory can arrange for any required hardware to perform this function for you.

To enter this mode, send the command ‘U’ to the single shaker serial line. This should be the very first command sent to the shakers after powering up the units. The first shaker in the daisy-chain will assign itself the address of value ‘1’, then send on the re-order command to the next shaker. That next shaker will then assign itself an address value of ‘2’ and then send on the command. At the end of the chain, you will receive back at the original serial port the string data ‘UX’, where the ‘x’ is the last address designation of the last shaker on the chain. As an example, if there are 4 shakers on one serial line, the response string back at your PC will be ‘U4’. The shakers automatically assign themselves the next character in the chain, so if there are 8 shakers connected, they will assign themselves the addresses of ‘1’ through ‘8’. If there
are more than 9 shakers on the chain, the tenth shaker will have the address ‘A’. Subsequent shakers will continue to use the rest of the ASCII character set such as ‘B’ through ‘Z’. You can even have more shakers on the chain and they will be addressed starting with the next ASCII character ‘1’.

After entering this mode by sending the ‘U’ command, you will be required to preface any command with the address of the shaker you wish to talk to. You must use the ‘@’ character, followed by the address character for that shaker, followed by the command you wish to execute at that shaker. For example, to query shaker number 8 for its serial number, send the string value ‘@8Y’ followed by the normal <CR> for all message strings. To stop shaking the 12th shaker on the chain, send the string value ‘@CS’ (‘C’ is the address designation for the 12th unit). To set the velocity value for shaker 3 send the string ‘@3V=1000’.

All data responses from all shakers coming back to your PC’s serial port receive line will be prefaced with the ‘,’ (comma) character while in this daisy-chain mode. For example, the typical response when not in daisy-chain mode to a query for a product ID command such as ‘Z’ would be ‘HT-91100’. When in daisy chain mode, this same query will result in the data string ‘,HT-91100’. Your software should strip any comma as the first received character when querying any shaker while in daisy-chain mode.

Daisy chain mode is not reversible. All shakers will revert back to the original default mode when powered-off, thus the need for resending the ‘U’ command at every power up. All of the normal commands sent to the shaker without the ‘@x’ address preface will be ignored completely when in daisy chain mode.

Finally, while in daisy chain mode, the shaker feature that automatically reports textual status of shaking, such as ‘RUN’, ‘RAMP’ or ‘STOP’, will not work, and that data is not automatically sent. Instead, you will need to poll or query an individual shaker for that data using the ‘Q’ command. For example, to stop a shaker on a chain, send the command ‘@5S’, then begin to continuously query that shaker with the command ‘@5Q’. You will receive the data ‘,RAMP-’ while shaker number 5 decelerates, and when finally stopped you will receive the data string ‘,STOP’. Again, note that each string received is prefaced with the ‘,’ (comma) character, and can be stripped as you receive it.

In general, each shaker microcontroller is able to handle a new communication stream every 8-15 milliseconds. We recommend that there is a 20 msec delay between every command sent down the daisy chain serial line to be completely error free. If more than two or three command strings get sent out without delays, there is a probability that the RS232 buffers at the first shaker will overrun and data may be corrupted. The shaker’s control software is configured to accept and pass on any command in real-time, even while it is handling its own shaking operation. If you send a request for a query type of command, such as a ‘@6Y’, you should wait for the response before sending on another command or request. This will allow the serial chain to pass on the result from that one addressed shaker, so you can match that result to the query you have just sent.
Model DAISYCHAINBOX
16 Shaker Extender for Orbital Shaker with RS-232 Control
Product Manual

Ordering Information

Part Number: Model DAISYCHAINBOX

What’s In The Box

Box size: 9.5" x 8.0" x 3.25" (241mm x 203mm x 82.5mm).
Box weight: 2.36 lbs. (1.070kg).
One each Model DAISYCHAINBOX
One each 6 foot USB cable, male A to male B connectors
One 6-foot cable 9-pin D-type male to 9-pin D-type female connectors
One each 100-240 VAC 50/60Hz power adapter, 24 VDC 1.5 A output, CE approval, US plug 6 foot cord
One each FlashDrive with PC Windows App to control and monitor shaker immediately, also has all product line manuals, interface code, includes all source code in VB6.
One each FlashDrive with Virtual RS232 Driver for USB Setup.
Certifications

CE Certified

CE certified for EMC testing to standards:
- EN 61326-1:2006
- EN 61326-1
- EN 61000-4-2
- EN 61000-4-3
- EN 61000-4-4
- EN 61000-4-5
- EN 61000-4-6
- EN 61000-4-11

CE certified for laboratory product safety testing to:
- EN 61010

RoHS Compliance – Lead-Free Products

This shaker product is compliant to the RoHS DIRECTIVE 2002/95/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 January 2003 (RoHS) on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
# Contact & Support

Big Bear Automation offers excellent support if you ever need it. There are a variety of methods to contact us:

<table>
<thead>
<tr>
<th>Method</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>By email:</td>
<td><a href="mailto:Support@BigBearAutomation.com">Support@BigBearAutomation.com</a></td>
</tr>
<tr>
<td>By phone:</td>
<td>1.510.333.4338 or 1.408.203.9539</td>
</tr>
<tr>
<td>By fax:</td>
<td>1.925.397.3148</td>
</tr>
<tr>
<td>Online</td>
<td><a href="http://www.bigbearautomation.com/orbitalshaker.htm">http://www.bigbearautomation.com/orbitalshaker.htm</a></td>
</tr>
</tbody>
</table>

Online you can find full product information, pricing, documentation, accessories and downloads: