Beehive

Multi-Board Control Systems Using a PC

Installation and Users Manual

Beta Release Version 1.1

Available exclusively from
PC Control Ltd.
www.pc-control.co.uk

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1. Introduction

The "Bee" range of USB control boards provides many individuals and educational institutions with the ability to explore the world of control , automation and robotics using a PC. All boards are supplied with a DLL (dynamic link library) to allow programmers to write their own programs without the need to get involved with the complexities of USB communication protocols. They are also supplied with standalone application software that allows the non-programmer to create a full control system using all of the facilities of their particular board without the need for actual programming of any sort. This application software also provides programmers with a way to verify their hardware configuration independently of their own program, which can very often save a lot of time. For simplicity, the DLL and application software provided with the board only provides for a single board per PC.

As the users of our boards began to find more and more applications for them, including in the industrial field, there was a growing need for a multi-board environment. In response to the growing number of request for this facility we have developed "Beehive". Beehive is a both a DLL (bee.dll) and a windows application (beehive.exe). It is primarily targeted at programmers who will use the library of functions provide within the DLL to make their programming task easier and to use the application to verify their connected hardware is working correctly, independently of their own program. Beehive allows any number of the same board and any mixture of different boards to be connected to the same PC at the same time. As part of the initialisation process it will "sort out" a unique device number for each of the connected boards which will be used later to communicate with that particular board. This gets round the problem of windows dynamically allocating USB numbers to connected devices.

The use of Beehive opens the door to large and complex control systems using a mixture of boards from our range. For example the WASP analogue input board could provide measurements from analogue sensors such as temperature or humidity, while a MotorBee drives motors to move objects (e.g. window opening) while a MiniBee activates solenoids (e.g. water valves) and a StepperBee performs accurate positioning requirements (eg conveyor belt). All of this can now be under the control of the one program, written by yourself and using the library of functions provided by Beehive.

The Beehive DLL and application software are fully compatible with all of our current range of USB boards including previous versions of those boards.

This manual assumes the reader is already familiar with whichever "Bee" board he already has and does not seek to duplicate the contents of the relevant manual for that board. i.e. this manual should be read in conjunction with the specific manual(s) for the board(s) concerned.

2. Getting Started

Normally it is necessary to install windows device drivers for new USB devices, which would require some explanation as to the installation procedure. However, in the case of our "Bee" range of boards this is unnecessary. Windows XP and Windows2000 already have the drivers installed as part of the operating system (HID device) and as soon as you attach any of these boards to a USB port, Windows will automatically recognise it and configure it's drivers accordingly.

Beehive software does, however, need to be installed. Installation is straightforward and simply needs the installation disk inserting into you CD drive. When inserted the installation software will start automatically and provide you with prompts to guide you through the installation process. If this does not happen when you insert the CD then you can manually start it by going to the root directory of the CD (using windows explorer) and double clicking on the "setup.exe" program.

3. Using Beehive

Beehive software makes it very easy for the beginner to get quickly up and running with multi-board control systems. Installation as described above is painless and easy requiring only a Windows 2000 or Windows XP computer with fairly modest specifications. To run the software double click on the desktop icon provided during installation. The BeeHive environment screen will then appear providing the workspace for multi-board operation. To initialise Beehive and start the main controls dialog click on "Run" in the top menu.

You should now see a "tabbed" dialog type screen display. Each of the tabs is associated with a different type of board and clicking on the tab opens the control page associated with that type of board. The first tabbed page, however, is a general "Control" page which is designed to initialise the system and discover what board(s) you have connected to the PC. This is the page you must use first.

4. Control Page

The control page is used to discover what boards you have connected to your PC and prepare them for use within Beehive. The first thing to do is press the "Scan for Devices" button. Beehive will then scan all of your USB connections looking for attached "Bee" boards. Any boards it finds will be initialise and prepared for use by BeeHive. The total number of boards found in this way will be shown in the box provided as well as the name of the type of each board found shown in the "Board List" display. Each board type found will also be allocated to the relevant page of Beehive for use by that page. For example, to illustrate this process we ill assume that we have connected two WASP's , one MiniBee and three MotorBee's. When we press the "Scan for Devices" button, it will show a total of 6 boards found and the names of each of the boards will be listed in the "Board List" display. As well as this the relevant page for each of the boards will also have been updated. This means that when you go to the WASP control page you will see the total WASP's is shown as two. Similarly the MiniBee page shows one MinBee and the MotorBee page shows three MotorBees.

This is all you need to do on the control page to fully initialise the Beehive environment. If, however, you disconnect a board or connect any additional boards then you must return to this page and press the "Scan for Devices" button again to allow the environment to be updated.

5. MiniBee Page

On entering the MinBee page you will see the total number of MiniBees connected reported in the box provided. Using the arrow keys , you can then select which of the boards available you want to control. Once selected you can use the other controls on the page to manually turn any of the 14 switching outputs on or off. To do this, either press the button or tick the box corresponding to your desired output followed by pressing the "SetOutputs" button. Clicking on the button or the tick box will toggle it between on and off. Pressing the "Set Outputs" button will send the currently displayed combination of on's and off's to the MiniBee selected.

6. MaxiBee Page

All controls on the MaxiBee page are identical to those used with the MiniBee page as described above. The only difference on this page is that there are 64 output controls rather than 14.

7. DigiBee Page

In common with the other pages, the DigiBee page will display the total number of DigiBee's connected when you first go to this page. And also in common with the others you need to select which one of any of the available boards you want to control prior to using the control buttons.

The DigiBee has control buttons to toggle the outputs in exactly the same way as the MinBee described above, including the "Set Outputs" button. The DigiBee, however, also has 16 digital inputs. To read these inputs simply press the "Read Inputs" button. This will read the inputs from the selected DigiBee and display them in the tick boxes associated with each input. A tick present corresponds to a digital "High" or "+5v" or "Logic '1' depending on you nomenclature.

Apart from using the "Read Inputs" and "Set Outputs" buttons after each change in the connected hardware, you can use the "Scan" button. This will causae Beehive to repeatedly send the current outputs to DigiBee and also read the current inputs for display on the tick boxes. The update rate for this scan is approximately 10 time per second. This is a convenient way of testing input and output connections. The scan can be stopped at any time by pressing the "Stop" button. Note that the scan is also automatically stopped whenever you leave this page.

8. Digibee + Page

The DigiBee+ page is identical in operation to the DigiBee page described above with the addition of 4 analogue inputs. When the "Read Inputs" button is pressed or when there is a scan operational the current state of the analogue inputs is read and displayed in the vertical slider bars corresponding to each of the analogue inputs.

The sensitivity of the analogue inputs can also be altered between normal and high using the selector box provided, followed by pressing the "Set Sensitivity" button.

9. WASP Page

In common with the other pages, the WASP page will display the total number of WASP's connected when you first go to this page. And also in common with the others you need to select which one of any of the available boards you want to control prior to using the control buttons.

The WASP has control buttons to toggle the outputs in exactly the same way as the MinBee described previously, including the "Set Outputs" button. The WASP, however, also has 4 analogue inputs. When the "Read Inputs" button is pressed, the current state of the analogue inputs is read and displayed in the vertical slider bars.

The sensitivity of the analogue inputs can also be altered between normal and high using the selector box provided, followed by pressing the "Set Sensitivity" button.

Apart from using the "Read Inputs" and "Set Outputs" buttons after each change in the connected hardware, you can use the "Scan" button. This will cause Beehive to repeatedly send the current outputs to WASP and also read the current analogue inputs for display on the sliders. The update rate for this scan is approximately 10 times per second. This is a convenient way of testing input and output connections. The scan can be stopped at any time by pressing the "Stop" button. Note that the scan is also automatically stopped whenever you leave this page.

10. Motor Bee Page

Once your external motors/servo are attached to MotorBee you can check correct operation by driving each of them manually. You should first select the configuration of your attached motors using the Twin/Single options on each pair of outputs. i.e. outputs 1 and 2 on the MotorBee corresponds to the two leftmost vertical slider controls on the screen. If you have one motor attached to these outputs, to be used for bi-directional control then choose the "Single" option from the drop down menu located between the two slider controls. This will confirm the choice of a single motor with forward and reverse control by the displayed motor image for that pair of outputs. If, on the other hand, you have a separate motor attached to each of outputs 1 and 2 and therefore only require forward direction control on each, then select the "Twin" option for the same drop down menu. This will also confirm selection with suitable motor images. These choices should also be made in a similar manner for outputs 3 and 4 according to your configuration of attached motors. It should be noted that even if you forget to select "single" and connect a single motor between a pair of ouputs, then your system will still work correctly as long as you only have one output of the pair on at any one time. This is , in fact, all that the choice of "single" ensures happens.

There is no need to make any configuration choices for the servo control, as there is only one servo output of the standard type.

Once these configuration choices have been made you can directly "drive" your motors/servo. Where you have "Twin" selected, the motors attached can be turned on/off using the tick box at the foot of the corresponding slider control. The slider control provides speed control of that motor. Using the mouse pointer you can alter this setting, very simply, by "left click and drag" the slider up or down. It is graduated in a range of 1-250. This corresponds to a speed of 0 to 100% of the motors maximum speed; (for those who are more curious, it actually corresponds to the mark to space ratio of the applied pulse width modulation signal which is the technique used to control the speed of the motors. i.e. a value of 50 gives a mark to space ratio of 50 high to 200 low). The current position of the slider (and therefore the corresponding speed) is also shown numerically at the foot of the slider.

Where a single motor is connected to a pair of outputs and the "single" option is selected for that pair, you will have the additional option of direction control. Simply click the forward or reverse selector to change direction. Note that when direction is changed the corresponding slider for that direction now controls the speed. This allows individual control of speed in both directions. The speed control not appropriate to that direction is "greyed out". (i.e. non-functional), to make this clear.

The 4 digital outputs on the MotorBee may be "toggled" on and off by clicking on the tick boxes in the digital outputs section. While these are being written to the MotorBee the 6 digital inputs are also read and updated in the "Digital Inputs" section. For testing you can also choose to update the digital inputs continuously by ticking the "scan" tick box. Unticking this box will stop the scan, as will leaving the MotorBee page.

The servo control system is designed to control the vast majority of standard servos available on the domestic, hobbyist and light industrial market. It provides a standard control signal output which , when connected to servo, causes the servo to move to that absolute position. The slider control on the right side of the screen

performs this control. As users familiar with servos will know, the control signal used to specify the absolute position required is a pulse whose width varies between 1 and 2 milliseconds in duration. This pulse is repeated every 20ms. A pulse of width 1.5ms corresponds to a servo position of exactly midway in its range of travel. This also corresponds to a slider position half way up. Again the range of the slider is 1 to 255 so midway is 128. As the slider is moved away from this position the servo will move to its new position in response. Although the vast majority of servos adopt the 1.5ms standard for midway, the figures used for either extremity of travel is less well defined. In some servos the extreme left position is specified by 1.25ms and the extreme right by 1.75ms. In others these are represented by 1.0ms and 2.0ms respectively. It is for this reason that no judgement has been made in Beehive as to the absolute position of the attached servo, or its range of travel, when moving the slider. All that can be said is that the control signal will vary from 1.0ms to 2.0ms over the full range of slider movement. As a general rule of thumb a typical servo will turn through 180 degrees over it's full range of travel and since our slider has a range of 1 to 255 with perhaps the middle 80% of travel within the servo range, you can assume a rough correspondence of 1 degree of servo movement for each slider change of 1. (128 corresponding to the 90 degrees position)

When you choose your servo for this application you should avoid driving it beyond it's recommended range of travel. This can sometimes cause the servo to overheat and may cause damage. In practice, though, they are usually quite tolerant of short durations beyond their specified limits.

11. Stepper Bee Page

On entry to the StepperBee page you will see the number of StepperBee's attached reported in the box. If you have more than one StepperBee attached you should first select the one to be controlled using the "Select StepperBee" box.

Using the controls provided, each motor can be given an individual "task" to perform, which will be executed immediately. The task is pre-specified in terms of number of steps, time interval between steps and direction (forward or reverse) and then "sent" to the StepperBee to "Run".

There is a separate section for each motor. Looking at Motor 1 on the left the number of steps required can be entered into the "Steps" box. This number must be in the range 1 – 16000. The time interval that each step will take should be entered into the "Interval" box. This should also be a number in the range 1 – 16000 and corresponds to the time in milliseconds (ms) for each step. Note that these are approximate figures for guidance only. Absolute accuracy of step interval timings is not guaranteed.

The direction is implied to be forward unless the "Reverse" tick box is ticked. In addition to specifying the step movement of the motor as just described, it is also possible to specify what the digital outputs should do during that step by ticking the appropriate boxes 1-3. When the box is ticked the corresponding output will be on (i.e. logic '1' or "+5v"). This output will hold this state for the duration of the specified step. Once the specifications of the task have been entered it can be executed by the StepperBee by clicking on the "Run" button. The task will then run to completion as specified and then stop automatically. If you need to abort a task before it has been completed then simply press the stop button. This will send an abort command to the StepperBee and terminate the task immediately. Note that the outputs will hold the state they were in at the time the stop command was issued.

Within the status section of manual controls, the current status of both motors and the digital inputs can be examined by clicking on the "Get Status" button. This will send a request to StepperBee which will return the current status. If, for example, motor 1 is still active the "Motor 1 Active" tick box will be ticked and the number of steps remaining to be completed will be shown in the box labelled "M1 Left". Similarly for motor 2 using "Motor 2 Active" and "M2 Left".

When using stepper motors there are a number of options for the pattern of pulses required to move the motor in the specified direction at the specified speed for the given number of steps. The most common two are "Full Step" and "Wave Step". Without going into the precise details of the timing differences of these options we can summarise by saying that Wave Step uses less power for energising the motor windings but delivers less torque to the load, whereas Full Step uses more power but provides the motor with significantly more torque.

Beehive provides you with the choice of step method using the selection boxes on the bottom of the screen. The step method can be different for each motor. To set the step mode, select the option from the drop down box for each motor and then press the "Set Step Mode" button. The step mode will then be set for any subsequent operations.

12. Minimum PC System Requirements

Beehive software does not require a high spec PC for correct operation, but the following system is suggested as a sensible Minimum

Processor	500MHz Pentium
Memory	64MB
HDD	10MB free space required
Screen Resolution	1024x768 (256 colours)
Interface	One free USB socket (1.0 or 2.0)
Operating System	Windows 2000, XP or Vista

WARNING: The Bee adaptor boards are intended for low voltage operation (less than 30 volts). It should not be connected directly to mains voltages under any circumstances.

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