

OVERVIEW

The Demand Peripherals (DP) BaseBoard4 (BB4) peripheral controller card is a general purpose input/output (I/O) card that is based on a field-programmable gate array (FPGA). This FPGA approach allows the card's functionality to be modified by changing the firmware rather than having to modify the hardware. In the case of the BB4 this allows the user to determine the types and numbers of peripherals that are supported.

DP provides a web based service to configure the custom FPGA firmware image, "DPCore", for the BB4 easily and painlessly. This document describes how to plan for and request a BB4 configuration from that service.

There are four steps to getting a customized FPGA for your BB4:

1. Decide what functionality you want on your BB4
2. Select your features from the Demand Peripherals "Build your FPGA Image" web page (http://www.demandperipherals.com/build_fpga.html)
3. Receive your new FPGA firmware image via your email system.
4. Install the FPGA firmware image on your BB4.

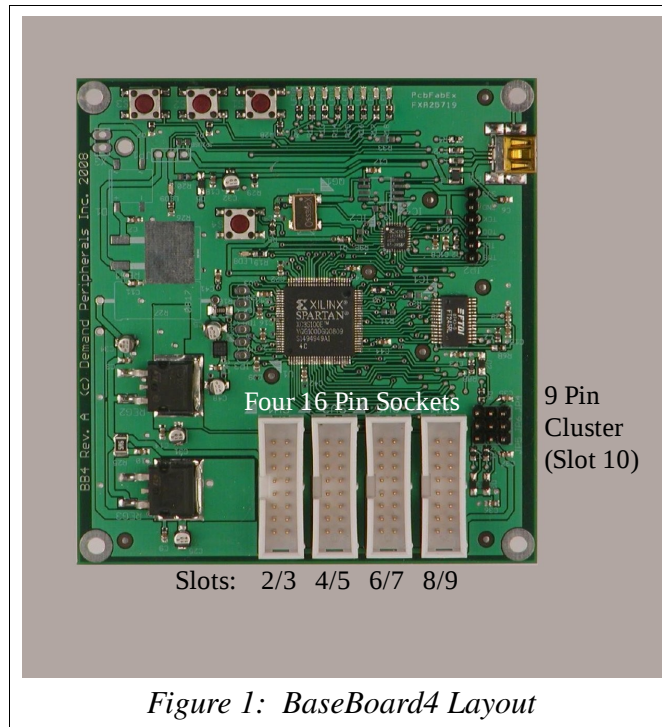
Before walking through the details of these four steps, we will review the overall BB4 layout and its options.

Board Layout

The BB4 supports both input and output devices. We will refer to these devices generically as pin peripherals, or simply peripherals. The BB4 has 5 locations for connecting user peripherals, four 16 pin sockets and a 9 pin cluster (without a socket) to the right of the fourth socket, as shown in Figure 1.

Peripherals connections are mapped to these locations in "slots." Each socket has two slots of 8 pins each (top and bottom) and the pin cluster is its own slot. This totals nine slots available for user peripherals.

Note that the word "peripheral" here does not refer to a single physical peripheral but to a peripheral type. As an example, a single servo peripheral slot will actually support four physical servo devices. This ratio of physical devices per slot varies by peripheral type. The specific ratios are provided below in Table 1, in the "Available Device Types" section.



There are two more slots “built-in” that are not changeable, the “enumerator” slot and the board buttons/LED slot. The enumerator slot is a BB4 internal logic construct that contains the contents of the BB4 configuration in read only memory. The button/LED slot manages the eight LEDs and the three buttons that are installed on the BB4; the user can interact with these buttons and LEDs via this slot.

The slots are referenced by number. The enumerator is Slot 0, the Button/LED is Slot 1, and the top and bottom of the four connectors are Slots 2/3, 4/5, 6/7, 8/9 respectively. The nine pin cluster to the right is Slot 10. The LSB of Slot 10 is the top left pin of the cluster shown in Figure 1.

The purpose of the custom FPGA image is to specify the precise functionality of the nine user defined slots, 2 through 10.

Many peripheral definitions use only one slot (8 pins) but some use two slots (all 16 pins in the connector) for their functionality. As a result, 9 slots may yield 9 peripherals, but if your design includes some double slot peripherals, it may yield fewer than nine.

Device Nomenclature

The BB4 software creates devices in the /dev directory. If you have one BB4 connected, these devices will be in /dev/dp0 directory. A second BB4 will have its devices in /dev/dp1, and so forth for additional boards.

Within the /dev/dp# directory will be directories named as devices numbered by slot. s00 and s01 are the built-in BB4 enumerator and button/LED slots. s02 through s10 are the nine user configured slots. Within these s## directories are further directories and device nodes that are specific to the peripheral type. As an example a servo peripheral will have the following devices:

```
/dev/dp0/s03_servo4/servo0  
/dev/dp0/s03_servo4/servo1  
/dev/dp0/s03_servo4/servo2  
/dev/dp0/s03_servo4/servo3  
/dev/dp0/s03_servo4/servogroup
```

This assumes that the servo peripheral was assigned to the third slot. This actual slot location number varies depending on your specific design, unless you specify the location, as we will discuss below. Note that when there is a number at the end of the peripheral name (servo4) it indicates the number of physical devices supported by this peripheral.

Available Device Types (Pin Peripherals)

Table 1 provides a list of the BB4 pin peripherals available as of 8/2010. Demand Peripherals is continuously adding new devices, so check their web site for the current complete list (<http://www.demandperipherals.com/home.html>). Table 1 also shows the number of slots required for each peripheral and the number of physical devices supported by each. The specific slot number for a give peripheral will vary for different combinations of peripherals. Two-slot peripherals will always occupy a single connector, using both the top and bottom slots; a two-slot peripheral cannot span two connectors or be assigned to slot 10.

Pin Peripheral Name	Slots Used	Number of Devices
Dual DC Motor	1	2
H-Bridge Controller	1	1
Dual H-Bridge Controller	2	2
Bipolar Stepper Controller	1	1
Unipolar Stepper Controller	1	1
Quad Servo Controller	1	4
Octal Servo Controller	2	8
Dual Quadrature Decoder	1	2
Maxbotix Range Sensor	1	2
Ping))) Range Sensor	1	4
IR Receiver	1	1
IR Transmitter	1	1
RC Receiver	1	1
Quad PWM Input	1	4
Quad PWM Output	1	4
Octal PWM Output	2	8
Quad Counter	1	4
Quad Bidirectional IO	1	4
Octal Bidirectional IO	2	8
Watchdog Timer	1	2

Table 1: Available Pin Peripherals

ORDERING YOUR CUSTOM FPGA IMAGE

Step 1: Determine What Functionality You Want

The FPGA image creation process requires that you define peripherals for all nine slots. That will result in nine or fewer peripherals, since some peripherals use two slots. Use Table 1 to keep track of the number of slots you are using.

Your initial selections should be straight forward, based on your specific application. Keep in mind that a single peripheral may handle multiple devices, so, as an example, one servo4 peripheral provides control of up to four separate servos.

Once your mandatory device needs have been met, you have free rein to pick peripherals that you might use at some future date. The turn-around time on your new FPGA image is 24 hours or less, so there is no pressure for you to come up with the optimum selections the first time. It is quick and easy to change the FPGA image on the BB4.

If you have an extra slot to fill, take a look at the “Watchdog Timer” peripheral. For autonomous operation, like robots, this can provide a fail-safe mechanism (e.g., via a relay that cuts power).

Once you have filled your nine slots, the final consideration is whether you care which peripheral is assigned to which slot. If you don't specify the locations, the FPGA image generator will assign them with its own rules. For most applications this is fine, but in some cases you may want some peripherals in particular locations. This is mostly a question of cabling efficiency and the physical location of your devices. As an example, I put my servos on slot 10 because I have only two servos (remember slot ten can only manage three devices) and the slot ten pins are set up to match the typical hobby servo connectors. I have a pwwin4 and pwwout4 in the same slot because their devices are at the front of my vehicle, so I can route a single cable bundle to their location.

Step 2: Order Your Image Via The Web

With your notes from Step 1 in hand, use your web browser to go to: http://www.demandperipherals.com/build_fpga.html.

This web page lists all of the available peripherals with simple pull-down boxes to select the number desired. Make your selections and click on “Continue.” If you have selected too many or too few peripherals you will be prompted to go back and try again. The input screen does not show the running total of slots, so it is up to you to multiply peripherals times slots and add them.

The next web page shows the “Pin Peripheral Slot Assignment” which is the mapping of your peripherals to specific slots. For most applications this will be fine as is, but if you determined in Step 1 that you want specific locations for some of your peripherals, make notes now about the changes you will need. Click on Continue.

The final web page requires your name, your email address, your agreement to the license terms, and your “Build Notes.” The Build Notes are where you describe any specific peripheral-to-slot assignments that you have. In my case that includes writing: “Please put the serv04 peripheral on Slot 10.” You can also include a “Thank You.” to the FPGA generator.

Step 3: Receive Your Image Via Email

Within 24 hours, you will receive an email with the FPGA image attached as “DPCore.bin.” When you save this file consider renaming it uniquely, as any future images you request will have the same file name. The email will also include in the text portion a list of the peripherals that you selected.

DPCore.bin is a binary file but the top portion is in clear text. You can read this text to verify the contents of the file. As an example, in Linux you can execute from the command line “head -19 DPCore.bin” to see the top 19 lines of the file. The clear text includes your email address, the date of the image, and a list of the included peripherals. (Note: Depending on the number of peripherals you chose, you may also see some binary symbols with head -19.) Don't edit DPCore.bin, as you risk making it unusable.

Step 4: Install Your Image On The BB4

The new image is installed with the standard BB4 procedure. Assuming you have already followed the initial BB4 installation steps at : <http://www.demandperipherals.com/dpdquickstart.html> , attach your B4 to the computer and:

```
modprobe fanout
modprobe proxy
stty --file=/dev/ttyUSB0 -opost
cat DPCore.bin > /dev/ttyUSB0 # BB4 green LED comes on
dpdaemon /dev/ttyUSB0
```

Of course if you have rename DPCore.bin, use the new name in the cat command.

If your board is already attached and working you may be able to install the new image with nothing more than the:

```
cat DPCore.bin > /dev/ttyUSB0
```

Once the new image is installed on the board and dpdaemon is running by can list the resulting device nodes. At the Linux command line a “ls /dev/dp0” will show you all of your peripherals and their slot assignments, using the nomenclature described above in the “Nomenclature Definitions” section (the 'dp0' assumes that this is the first BB4 on your system). There are detailed documents for each peripheral at the Demand Peripherals website: <http://www.demandperipherals.com/home.html> .