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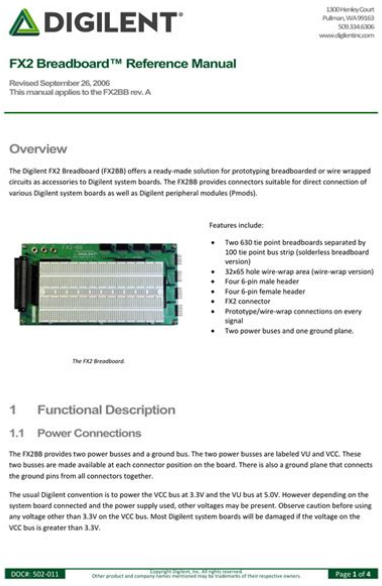
DIGILENT

FX2 Breadboard™ Reference Manual

Revised September 26, 2006
This manual applies to the FX2BB rev. A

Overview

The Digilent FX2 Breadboard (FX2BB) offers a ready-made solution for prototyping breadboarded or wire wrapped circuits as accessories to Digilent system boards. The FX2BB provides connectors suitable for direct connection of various Digilent system boards as well as Digilent peripheral modules (Pmods).

Features include:

- Two 630 tie point breadboards separated by 100 tie point bus strip (solderless breadboard version)
- 32x65 hole wire-wrap area (wire-wrap version)
- Four 6-pin male header
- Four 6-pin female header
- FX2 connector
- Prototype/wire-wrap connections on every signal
- Two power buses and one ground plane.

The FX2 Breadboard.

1 Functional Description

1.1 Power Connections

The FX2BB provides two power busses and a ground bus. The two power busses are labeled VU and VCC. These two busses are made available at each connector position on the board. There is also a ground plane that connects the ground pins from all connectors together.

The usual Digilent convention is to power the VCC bus at 3.3V and the VU bus at 5.0V. However depending on the system board connected and the power supply used, other voltages may be present. Observe caution before using any voltage other than 3.3V on the VCC bus. Most Digilent system boards will be damaged if the voltage on the VCC bus is greater than 3.3V.

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Book Descriptions:

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In this tutorial, you will learn a little bit about what breadboards are, why they are called breadboards, and how to use one. Once you are done you should have a basic understanding of how breadboards work and be able to build a basic circuit on a breadboard. Who knew it would bring so much frustrationThe number of different options, terms, and names of connectors can make selecting one, or finding the one you need, daunting. This article will help you get a jump on the world of connectors. Dont know what a circuit is. Were here to help. Click here, and become schematicliterate today! Wire wrap is a process that involves wrapping wires around conductive posts attached to a perfboard a.k.a. a protoboard . As you can see, the process can get rather complex very quickly.Although this method is still used today, there is something that makes prototyping much easier, breadboards! You wouldn't be too far off either. Many years ago, when electronics were big and bulky, people would grab their mom's breadboard, a few nails or thumbtacks, and start connecting wires onto the board to give themselves a platform on which to build their circuits. However, we are stuck with the confusing name.These are great units for making temporary circuits and prototyping, and they require absolutely no soldering. If you aren't sure how a circuit will react under a given set of parameters, it's best to build a prototype and test it out. That is the real beauty of breadboardsthey can house both the simplest circuit as well as very complex circuits. As youll see later in this tutorial, if your circuit outgrows its current breadboard, others can be be attached to accommodate circuits of all sizes and complexities. When you are trying to figure out how a part works and constantly rewiring things, you don't want to have to solder your connections each time.http://www.cargoaircon.ru/userfiles/craftsman-power-washer-parts-manual.xml

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When trying to duplicate a customer's problem, SparkFun's Technical Support team will often use breadboards to build, test, and analyze the circuit. They can connect the parts the customer has, and once they've gotten the circuit setup and figured out the problem, they can take everything apart and put it aside for the next time they need to do some troubleshooting. Using a smaller breadboard it's easier to see just how they function. You can see lots of horizontal rows of metal strips on the bottom of the breadboard. This is because the metal rows are conductive and allow current to flow from any point in that strip. This is typical on almost all breadboards. Thus, you can only have up to five components connected in one particular section of the breadboard. The row has ten holes, so why can you only connect five components. You'll also notice that each horizontal row is separated by a ravine, or crevasse, in the middle of the breadboard. This ravine isolates both sides of a given row from one another, and they are not electrically connected. We'll discuss the purpose of this in just a bit, but, for now, just know that each side of a given row is disconnected from the other, leaving you with five spots for components on either side. Notice how each leg of the LED is placed on either side of the ravine. This prevents the connections to the LED from being shorted. Aside from horizontal rows, breadboards usually have what are called power rails that run vertically along the sides. When building a circuit, you tend to need power in lots of different places. The power rails

give you lots of easy access to power wherever you need it in your circuit.Keep in mind that the markings are there just as a reference.This ravine serves a very important purpose. Many integrated circuits, often referred to as ICs or, simply, chips, are manufactured specifically to fit onto breadboards.http://bamor.org/userfiles/craftsman-powershot-stapler-manual.xml

In order to minimize the amount of space they take up on the breadboard, they come in what is known as a Dual inline Package, or DIP. Since each leg on the IC is unique, we don't want both sides to be connected to each other. That is where the separation in the middle of the board comes in handy. Thus, we can connect components to each side of the IC without interfering with the functionality of the leg on the opposite side. These dont serve any purpose other than to help guide you when building your circuit. Circuits can get complicated quickly, and all it takes is one misplaced leg of a component to make the entire circuit malfunction or not work at all. If you know the row number of the connection you are trying to make, it makes it much simpler to plug a wire into that number rather than eyeballing it. Many books and guides have circuit diagrams for you to follow along while building your circuit. Just remember that the circuit you're building doesn't have to be in the exact same location on the breadboard as the one in the book. In fact, it doesn't even have to look similar. As long as all the electrical connections are being made, you can build your circuit any way you'd like! These posts allow you to connect all kinds of different power sources to your breadboard. Well cover these more in the next section. Some circuits will require a lot more space. Many breadboards have little nubbins and slots on the sides, and some even have them on the tops and bottoms. These allow you to connect multiple breadboards together to form the ultimate prototyping surface. These can come in handy if you want to attach your breadboard to the inside on an enclosure or other project case. This is convenient if you have two different voltages with which you need to power your circuit, such as 3.3V and 5V. However, if you're unaware whether the power rails are or aren't isolated, it can often lead to issues while building your circuit.

It's always a good idea to use a multimeter to check for the absence or presence of continuity in your breadboard's power rails. The Arduino has multiple power and ground pins that you can connect to the power rails or other rows on a breadboard. Now any leg or wire connected to that row will also be connected to Ground. Although it would seem that the posts are connected to the breadboard, they are not. If they were, you would be limited to where you could and couldn't provide power. As we've seen, breadboards are meant to be totally customizable, so it would make sense that the binding posts are no different. To do that, unscrew the post until the hole going through it is exposed. Slide the stripped end of your jumper wire through the hole, and screw the post back down until the wire is firmly connected. If you need an alternate power source, you can use the third post. You can use many different methods to connect power to the posts, and, thus, to the breadboard. Using a banana connector you can provide power from the supply to the binding posts. This is a more advanced technique, and it requires some intermediate soldering skills. If your breadboard doesnt have binding posts, you could just plug the wires from the barrel jack directly into the power rails. SparkFun carries a number of kits and boards that you can use to plug power directly into your breadboard. Some allow you to plug a wall wart directly into the breadboard. Others allow you to pull power directly from your computer via the USB connections. And, almost all of them have the capability to adjust the voltage, giving you a full range of the common voltages needed when building circuits. We are going to start with a simple circuit. If you have other electronic bits and pieces, feel free to use them and change the circuit up. Remember, there is often more ways than one to build any given circuit. Some even have dozens of different ways that you can build them. The same is true with the hookup wire.

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You dont need that much or all those colors, but if you keep playing with circuits, it could come in handy. Also, the breadboard power supply doesnt have headers, if you know how to solder and have

the tools, solder the headers on yourself. If not, solderless headers have been included in the wishlist as well. The red board you see is the Breadboard Power Supply Stick with headers soldered to the PCB. The breadboard power supply stick regulates voltage from a 9V wall wart to either 5V or 3.3V to the power rails. However, it is a very important part of building circuits, so it will be covered here in short. Every electronic component has a very unique schematic symbol. These symbols are then assembled into circuits using a variety of programs. You could also draw them out by hand. If you want to dive deeper in the world of electronics and circuit building, learning to read schematics is a very important step in doing so. Power assuming the switch is flipped to the 5V side is represented by the arrow at the top. It then goes to the LED the triangle and line with arrows emitting out of it. The LED is then connected to the resistor the squiggly line. That is connected to the button the latchlooking symbol. Last the button is connect to ground the horizontal line at the bottom. Schematics allow people from different nationalities and languages to build and collaborate on circuits designed by anyone. As mentioned, you can build a circuit in many different ways, but, as this schematic shows, there are certain connections that must be made. Diverging from this schematic will give you an entirely different circuit. One very common program used by SparkFun is Fritzing. Fritzing is a free program that allows you to build your own circuits on a virtual breadboard. It also provides schematic views for all the circuits you build. Here we can see the same circuits as above built using Fritzing. Some are free, and some are paid.

Some will even allow you to build a circuit and test its functionality through simulations. Go explore the internet, and find the tools that work best for you. The Sparkfun Inventors Kit includes everything you need to complete 16 different circuits. Who knew it would bring so much frustrationCheck out the following jumper wires. These are 155mm long jumpers terminated as male to female.These are 155mm long jumpers with male connectors on both ends.These are 155mm long jumpers with female connectors on both ends.Now the real fun begins. Weve barely scratched the surface of building circuits on breadboards. Here are some other tutorials you can check out to learn more about components and how to integrate them into your breadboard circuits. If you leave JavaScript disabled, you will only access a portion of the content we are providing. Heres how. What is a breadboard, and how do you use it. This tutorial video will give you a basic introduction to breadboards and explain how to use them in beginner electronics projects; you can also read more details and see more examples in the text sections. How do they work These holes let you easily insert electronic components to prototype meaning to build and test an early version of an electronic circuit, like this one with a battery, switch, resistor, and an LED lightemitting diode. To learn more about individual electronic components, see our This makes breadboards great for beginners who are new to electronics. You can use breadboards to make all sorts of fun electronics projects, from different types of robots or an electronic drum set, to an electronic rain detector to help conserve water in a garden, just to name a few.The term breadboard comes from the early days of electronics, when people would literally drive nails or screws into wooden boards on which they cut bread in order to connect their circuits.

Luckily, since you probably do not want to ruin all your cutting boards for the sake of an electronics project, today there are better options.Most breadboards also come with tabs and notches on the sides that allow you to snap multiple boards together. However, a single halfsized breadboard is sufficient for many beginnerlevel projects.Soldering pronounced SAWdering is a method where electronic components are joined together by melting a special type of metal called solder. Electronic components can be soldered directly together, but more commonly they are soldered onto printed circuit boards PCBs. PCBs are what you will see if you take the cover off many electronic devices, like a computer or cell phone. Frequently, engineers will use solderless breadboards to

prototype and test a circuit before building the final, permanent design on a PCB. This image shows the same circuit battery, switch, resistor, and LED built three different ways on a solderless breadboard left, with the components soldered directly together middle, and on a printed circuit board rightThe rest of this tutorial will focus on solderless breadboards, but you can read our Sometimes, shorter metal legs are referred to as pins instead. Almost all components with leads will work with a breadboard to learn more about these components and which types work with a breadboard, see the They will be held in place snugly enough that they will not fall out even if you turn the breadboard upsidedown, but lightly enough that you can easily pull on them to remove them.However, many electronic components are very tiny, and you may find them difficult to handle. A pair of miniature needle nose pliers or tweezers may make it easier to pick up small components.This is what the clips look like when they are removed from a breadboard.The backing is typically a layer of sticky, doublesided tape covered by a protective layer of paper.

In this picture, the breadboard on the right has had its backing removed completely so you can see all the metal clips. The breadboard on the left still has its sticky backing, with one corner of the paper layer peeled up.What does all that mean. While their exact appearance might vary from breadboard to breadboard, the general purpose is always the same. These labels help you locate certain holes on the breadboard so you can follow directions when building a circuit. Row numbers and column letters help you identify individual holes in the breadboard, just like cells in a spreadsheet.Similarly, negative bus and ground bus both refer to one next to the blue or black line with the minus sign. Sound confusing Use this table to help you remember—there are different ways to refer to the buses, but they all mean the same thing. Do not worry if you see them referred to by different names in different places for example, in different Science Buddies projects or other places on the internet.The labels just make it easier to organize your circuit, similar to colorcoding your wires.For example, that means hole A1 is electrically connected to holes B1, C1, D1, and E1. It is not connected to hole A2, because that hole is in a different row, with a separate set of metal clips. Unlike all the main breadboard rows, which are connected in sets of five holes, the buses typically run the entire length of the breadboard but there are some exceptions. This image shows which holes are electrically connected in a typical halfsized breadboard, highlighted in yellow lines.Typically, to make power and ground available on both sides of the breadboard, you would connect the buses with jumper wires, like this. Make sure to connect positive to positive and negative to negative see the section on buses if you need a reminder about which color is which.

Some breadboards have the buses broken in half along the length of the breadboard useful if you need to supply your circuit with two different voltage levels.Some breadboards have the positive buses on the left and the negative buses on the right, and on other breadboards, this is reversed.For example, the directions for this circuit might sayThere are different ways to change the physical layout of a circuit on a breadboard without actually changing the electrical connections. For example, these two circuits are electrically identical; even though the leads of the LED have moved, there is still a complete path called a closed circuit for electricity to flow through the LED highlighted with yellow arrows.As long as the circuit is electrically equivalent, it will still work.They have stiff ends that are easy to push into the breadboard holes. There are several different options available when purchasing jumper wires.These wires usually come in packs of varying colors. This makes it easy to colorcode your circuit see the section on colorcoding .The kits are available in larger and smaller sizes. These kits are very convenient because they come with wires of many different precut lengths. The disadvantage is that there is typically only one length of each color. This can make it difficult to colorcode your circuit for example, you might want a long black wire, but your kit might only have short black wires. Your circuit will still work just fine, but colorcoding

can help you stay more organized again, see the section on colorcoding for more information. Notice how this circuit looks much less messy than the previous one, since the wires are shorter.This is the best longterm option if you plan on doing lots of electronics projects, because you can cut wires to the exact length you need, and pick which colors you want. It is also much more costeffective per length of wire. Buying a kit of six different colors is a good place to start.

It is important to buy solid core wire which is made from a single, solid piece of metal and not stranded wire which is made from multiple, smaller strands of wire, like a rope. Stranded wire is much more flexible, so it is very hard to push into a breadboards holes. You also need to purchase the right wire gauge, which is a way of measuring wire diameter. 22 AWG American Wire Gauge is the most common gauge used for breadboards. To learn more about wire gauge and how to strip wire, see the Science Buddies Wire Stripping Tutorial. Notice how in this circuit, red and black are used for all the connections to the buses see the section on colorcoding to learn more.Colorcoding is a matter of convenience in that it can help you stay more organized, but using different color wires will not change how your circuit works. Important This statement only applies to jumper wires. Some circuit components, like battery packs and certain sensors, come with colored wires already attached to them. Keeping track of these colors does matter for example, do not get the red and black leads on a battery pack mixed up. All jumper wires, however, are just metal on the inside with colored plastic insulation on the outside. The color of the plastic does not affect how electricity flows through the wire.For example, there are a few different ways you could wire this circuit with red, green, blue, and yellow LEDs, but they will all work exactly the sameThe three circuits in this image will all work exactly the same the LEDs will light up when the battery pack is turned on even though they have different color wires. If a breadboard diagram shows a blue wire and you use an orange wire instead, nothing will be wrong with your circuit.This will give you a chance to doublecheck all your connections before you turn your circuit on for the first time.

In general, you should follow this procedureIs it supposed to flash lights, make noise, somehow respond to a sensor like a motion or light sensor, or make a robot move.If you see or smell smoke, turn off or disconnect the power supply immediately. This means you have a short circuit. See the common mistakes section for things you should check. However, when we turn the battery packs on, only the LED on the left lights up. What is wrongThe circuit should match this diagramCarefully compare the two pictures to the breadboard diagram. Can you spot what is wrong. If you still cannot tell, click on the image to reveal the problem.In the circuit on the left, the red jumper wire goes from the positive bus to hole J10, which matches the breadboard diagram. In the circuit on the right, it goes from the positive bus to hole J9. Remember from the section on how the holes are connected that holes in different rows are not electrically connected to each other. So, with the jumper wire in row 9 and the LED in row 10, there is no way for electricity to flow to the LED. However, it only takes one misplaced wire or component lead to stop a circuit from working completely. This is why you should always carefully check and doublecheck your wiring before you test a circuit. If your circuit is not working, carefully doublecheck all your connections and make sure to count the row numbers.Can you spot the difference between these two circuits. Only the LED on the left lights up.Can you spot what is wrong. Click on the image to reveal the problem.In the photo on the right, it goes to the negative bus.Again, only the LED on the left lights up. Remember that unlike with jumper wires, the colors of battery pack leads do matter. Red is used for positive and black is used for negative.On other breadboards this is reversed. Be careful when you switch between breadboards since the leftright positions of the buses may change.

Sometimes students will only push leads partially into a breadboard hole, instead of pushing them down firmly all the way until they cannot go any farther. This can result in loose connections that lead to strange circuit behavior, like an LED flickering on and off. Take a look at these two sidebyside images. The image on the left shows leads that have not been pushed into the breadboard

all the way. The picture on the right shows leads that are properly pushed into the breadboard as far as they can go. Other components, like precut jumper wires, typically have leads cut to the right length, so they fit flush up against the breadboard.Some components have polarity, meaning they have a positive side and a negative side that must be connected correctly. Other components have multiple pins that all serve different functions. Putting these components into your circuit backwards or facing the wrong way will prevent your circuit from functioning properly. If your circuit is not working and it involves any of these components, check to make sure they are inserted the right way.The metal lead for the anode is longer than the lead for the cathode. The cathode side also usually has a flat edge on the plastic part of the LED. They are usually small cylinders marked with a band or stripe on one end this is the direction electricity can flow toward. Transistors generally have three pins. Putting a transistor in a breadboard backwards will reverse the order of the pins and prevent it from working.For example, jumper wires and resistors work the same in both directions. Look closely at these two images. Even though the jumper wire and resistor have been flipped around in the picture on the right the jumper wire has a black mark on one end so you can tell which end is which, and the resistor has colored bands, the LED still lights up. Electrically, nothing has changed in the circuit.

This can happen from putting components into the wrong rows or buses, or from letting exposed metal parts bump into each other. For example, resistors and LEDs have long metal leads; if you are not careful, these leads could bump into each other and cause a short circuit. If your circuit has components with long, exposed leads, always make sure the leads are not touching each other.They may just prevent the circuit from functioning properly until they are located and fixed. Short circuits between the power and ground buses are especially important to avoid, because they can get hot enough to burn you and even melt the plastic on the breadboard. In this picture, the red and black wires from a 4xAA battery pack have both been inserted into the ground bus, instead of one into the ground bus and one into the power bus. This causes the breadboard and wire insulation to start melting.You should immediately disconnect the battery pack.Many ICs come in something called a dual inline package, or DIP, meaning they have two parallel rows of pins. The gap in the middle of a breadboard between columns E and F is just the right width for an IC to fit, straddling the gap, with one set of pins in column E, and one set of pins in column F. Projects that use ICs will always tell you to connect them to the breadboard in this manner.Circuit diagrams, as opposed to breadboard diagrams, are used by professional engineers when designing circuits, and they are much more convenient for more complicated circuits. You may be introduced to basic circuit diagrams in a high school physics class. For example, this circuit diagram shows a basic circuit with a battery, a switch, an LED, and a resistor.They do not necessarily correspond to the physical layout of the components on a breadboard. For example, even though it looks different, this circuit diagram is identical to the previous one.

These components have long metal leads that are designed to be inserted through holes in a printed circuit board PCB that are plated with a thin copper coating, which allows the components leads to be soldered to the board.These components have short, flat pins on their sides that are designed to be soldered to the surface of a printed circuit board, instead of through holes.You can tell from looking at the thumbnails that this part is through hole and this part is surface mount. While most Science Buddies projects will link to exactly what parts you need to buy for a project, be careful if you are buying parts for your own project. If you are using a breadboard, make sure you buy throughhole parts and not surface mount.When printing this document, you may NOT modify it in any way. For any other use, please contact Science Buddies. Best of all it is reusable. It was designed by Ronald J Portugal of EI Instruments Inc. in 1971. Building or prototyping circuits on a breadboard is also known as breadboarding .In this instructable I will guide you how to use a modern breadboard to make simple circuits. Add Tip Ask Question Comment Download Step 1 Types of Breadboard There are various types of breadboard.Breadboard can be found in various sizes and

functions.Early amateur radio hobbists used cutting board for bread to prototype there radios thus the name breadboard came. Some breadboards got builtin powersupply,some got power supply rail and some got only the prototyping section. Add Tip Ask Question Comment Download Step 2 How It Works Basically, a bread board is an array of conductive metal clips encased in a box made of white ABS plastic, where each clip is insulated with another clips. There are a number of holes on the plastic box, arranged in a particular fashion. A typical bread board layout consists of two types of region also called strips. Bus strips and socket strips. Bus strips are usually used to provide power supply to the circuit.

It consists of two columns, one for power voltage and other for ground. Socket strips are used to hold most of the components in a circuit. Generally it consists of two sections each with 5 rows and 64 columns. Every column is electrically connected from inside. Nickel Silver clips hold the components. You can find more over here Add Tip Ask Question Comment Download Step 3 Lets Make Something !! circuit 1 Okay enough talking, now we gonna learn how to practically use it.We will built some circuits and learn how a bread board practically works. For our first circuit we will be using resistor networks. Things we will need 1.Breadboard 2.resistors 4x100ohm brown,black,brownR1,R2,R3,R4 3.Multimeter Step 1 Take R1 and put one lead in A5 and another lead in A15.Take R2 and put its leads to B15 and B25. Now two resistors are in series mode Step 2 Now take your multimeter and set to measure resistence.Then put one lead on A5 another on A15.It should measure 100ohm.Now move the lead on A15 to A25 it should measure 200ohm. Step 3Take R3 and put one lead in D5 another in D15 and put R4 in E15 and E25. Step 4 Now measure from D5 and D15.It will be 50ohm and measure D5 and E25.It should measure 100ohm SO what does it mean It means R1 and R2 are series because they arent in the same lane and R1 and R3 are parallel because they are in the same lane. Please take a look at all the pictures if you are having confusion. Add Tip Ask Question Comment Download Step 4 Simple LED Circuit Now with LEDs !!! What we will need 1. GOOGLE it !! Add Tip Ask Question Comment Download Step 5 Closing Words I am hoping that you can now understand how the breadboard works and also how to use one.If you are having problems or have any request leave a comment. ENJOY !! Add Tip Ask Question Comment Download Share it with us! I Made It!