VEX a Detailed Look
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There had been rumors for a long time that Radio Shack would be distributing a new robotics platform for experimenters. My local Radio Shack eventually confirmed this. When I first heard about it I thought to myself. YARK !!! Yet another robot kit. In any case I waited patiently for the first units to arrive in the store. When they finally did arrive, I think the Radio Shack personel were as happy as I was in that they no longer had to look my face peering through the window.

I knew the starter kit was going to cost $300, but when I picked up the box I couldn't believe how heavy it was. I had put down over $500 for other robot kits and none had the beef this one did. I reluctantly gave up the $300 and proceeded to rush home so I could try out my new toy, uh, I mean equipment.

Upon opening the box, my first observation was how well the items were packed. Each and every part had a nice station cut out in the Styrofoam. I proceeded to carefully remove each item and inspected each piece. As an avid robot builder I felt like a kid in a candy store. I could only imagine how I was going to use each piece to build the perfect bot.

Bot: Roboteer slang for Robot
Roboteer: One who builds bots

Just about every component in the starter kit can be purchased as a separate component. This has an added bonus: we builders now have a place we can go to get robot parts without having to resort to mail order. How many times have you had your hands deep in the guts of a robot project and realized you needed a few more gears or another servo. Now if I need a servo or motor, I can run down to any of the eight Radio Shacks in my area and pick one up.

In the old days we could refer to Radio Shack part numbers for electronic components. This meant it was very easy to standardize projects for various publications and books. One of my pet peeves for many years has been the lack of ability for many to duplicate the results in published projects. Now with the VEX series and all the VEX components available locally we can do just that.

In this article, I'm going to concentrate on the various VEX components so you can get a feel for what is available. In future articles we will look at various techniques, as well as a few fancy projects.

Without further ado let's get started.


Figure G1

Gears

The VEX gears will allow you to transfer your servo and motor movements so they can be utilized to move arms, levers, and wheels. The starter kit comes with all the gears shown in Figure G1, except for the 2 large 84-tooth gears. They are only included as part of the gear kit.

Each gear has a small square hole in the center that measures 1/8" x 1/8". These are the same size holes used on the wheels and the drivers for the motors. They are designed to be used with the 1/8" x 1/8" square bars that the VEX system uses for building drive trains.

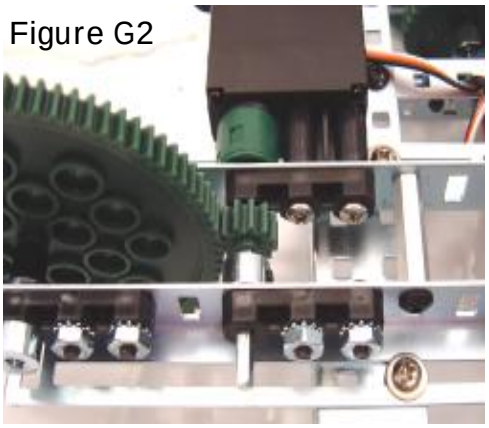


Figure G2

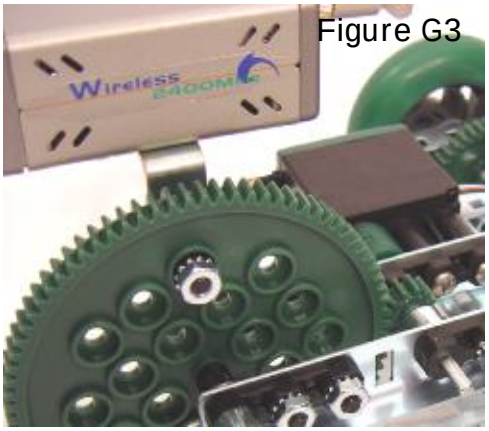


Figure G3

You will use the various gears to transfer the power of a motor or servo. Figure G2 shows the smallest gear transferring power to the largest gear. This creates several pounds of torque at the axel of the large gear.

The larger gears have mounting holes so you can attach various bars or brackets. In this case, we have attached a small camera. The slower speed created by the small 12-tooth gear driving the 84-tooth gear creates a 7 to 1 speed reduction. This makes the camera movement very smooth.

Wheels

Figure W1

Wheels are how we put our bots in motion. The wheels shown in Figure W1 are what you get in the VEX wheel kit. All of these wheels are included in the starter kit as well.

Let's take a closer look at the wheels:

2, 1.5" Intake Rollers
Not sure what these are used for. They are very pliable and could possibly be used to pull something into a mechanism.

2, 4" All-Purpose Wheels
These are flat wheels with hard tires. They don't have very good traction on smooth surfaces but will work nicely on carpet.

2, 5.1" Knobby Wheels
These are the largest of the wheels, with hard knobby tires. These make very nice outside tires.

4, 2.75" Wheels with removable rubber tire (Figure W2)
While all the tires, are removable these are made of a soft rubber that is easy to remove. One application might be to use the plastic wheels without the tires for a front or rear support that can slip as the bot turns.

Figure W2

Figure W3 shows a typical wheel configuration. Notice the small collars used to keep the wheels from slipping off the drive shafts.

All of the wheels have a small square 1/8" x 1/8" hole just like the gears. This allows them to mount on the same shafts.

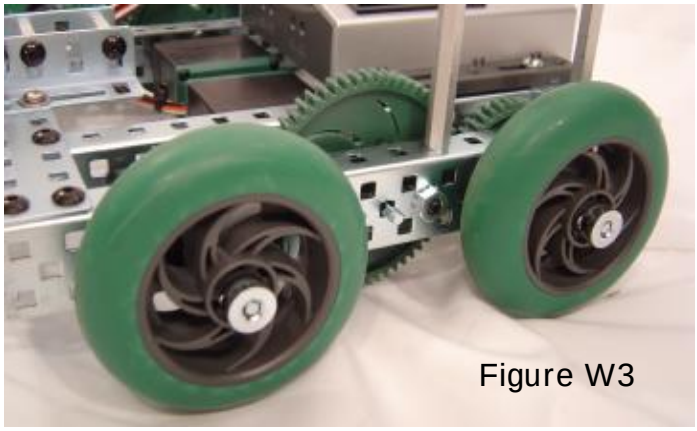


Figure W3

Radio

The radio used with the VEX system is first class. This is a very rugged 6-channel 75Mhz FM radio system. All you folks using 6-channel 72 MHz helicopter radios for your robots are violating FCC rules. This radio is a true 75 MHz surface radio so you will be in total compliance with FCC rules.

Figure R1

The radio shown in Figure R1 comes with a power pack that holds eight batteries; which is used in the transmitter. The receiver shown gets its power from the VEX microcontroller. You get a radio system with the VEX starter kit. You can also purchase a VEX radio kit separately as well.

While the receiver unit is proprietary and must be used with the VEX controller unit, I found that the transmitter is compatible with any FM 75Mhz radio. I used the transmitter to control my 3-channel Airtronics M8 radio. At some point in the future I will look into the actual interface the receiver is using to see if it can be used with other microcontrollers.

Let's take a closer look at the transmitter and some of its features.

The back of the radio shown here in Figure R2 has four buttons. These are used to control channels 5 and 6. The transmitter crystal is also accessible from the back, as is the battery pack. There is also a tether connector to connect the radio directly to the microcontroller so you can test and setup your

bot without having to transmit over the air.

The front of the transmitter shown in Figure R3 is where all the action is. Channels 1 through 4 are controlled via the two, 2-axis joysticks. Each axis has its own digital trim so you can tweak the position of that servo or the neutral point on your motor. You can also set various parameters and mixing options of the various channels, and save them in memory. You can actually save six different configurations.

The manual that comes with the radio is not very good. It briefly explains some of the modes of operation, but that's about it. Also, at this point, Radio Shack is not selling receivers alone so you will have to remove the receiver from one bot to install it on another, or purchase a complete radio system.

Figure R2

Power System

The starter kit comes with the 7.2v battery holder shown in Figure P1. It holds six AA cells. You may ask why do I say 7.2v instead of 9v? The VEX system requires that you use rechargeable batteries.

As a bot builder, you may have discovered that a NiCad or NIMH rechargeable battery can deliver more power at a given time then its alkaline counter part. By using rechargeable batteries, you will keep the onboard microcontroller from resetting during power surges. Also note that rechargeable alkaline batteries are not acceptable. You must use rechargeable NiCad or NIMH batteries.

The battery holder has mounting flanges, so it is very easy to incorporate into your bot design. With the cover on the holder, you can actually mount the batteries on the underside of your bot.

Figure R3

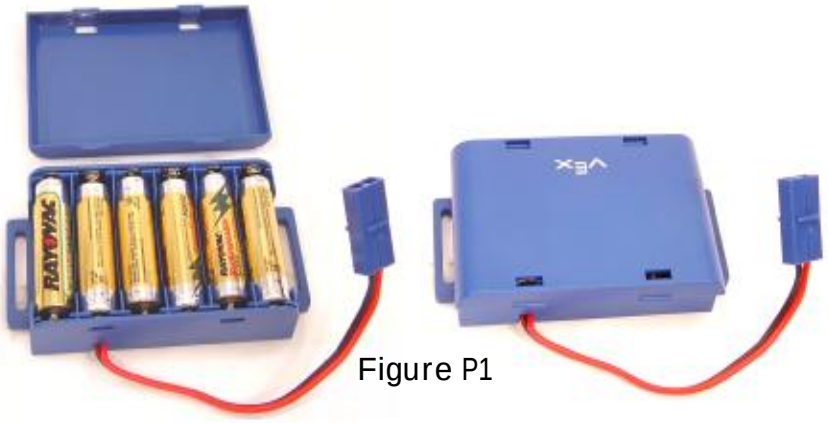


Figure P1

As an option, you can purchase the VEX power pack system shown in Figure P2. Before you balk at the $50 price tag consider this:

You are going to have to purchase 6 rechargable batteries for the microcontroller. You will need a charger for these as well. Now add the 8 batteries needed for the transmitter and the $50 price tag is not that bad.

The power pack comes with a 7.2v, 6-cel, 2000 mAh pack for your bot, and a 9.6v, 8-cell, 1000 mAh pack for your transmitter. The charger is a smart charger and while you can plug both batteries into the charger, it will only charge one at a time. This is a nice time saver, as you can place both batteries on the charger and leave it for the evening and it will shut off when both batteries are charged.

The charger is for NiCad batteries only. I have not been able to get it to work with NIMH batteries. The documentation states the following capacities:

7.2v pack 1000-2000 mAh will charge at 1 - .5C in 1.4 to2.8 Hours

Figure P2

9.6v pack 700-1000 mAh will charge at 1 - .7C in 1.4 to 2.0 Hours.

I used the charger to charge all my old RC batteries, and the only ones it didn't like seemed to be bad.

There are a few form factor issues you must consider when using the 7.2v stick pack vs. the rechargeable battery holder. As you can see in Figure P3, they are not the same size. In some cases, you may have to completely redesign your bot to accommodate the stick pack. Also, the stick pack has no mounting flanges. You must use the reusable tie wraps supplied with the power kit to attach the stick pack to the bot.

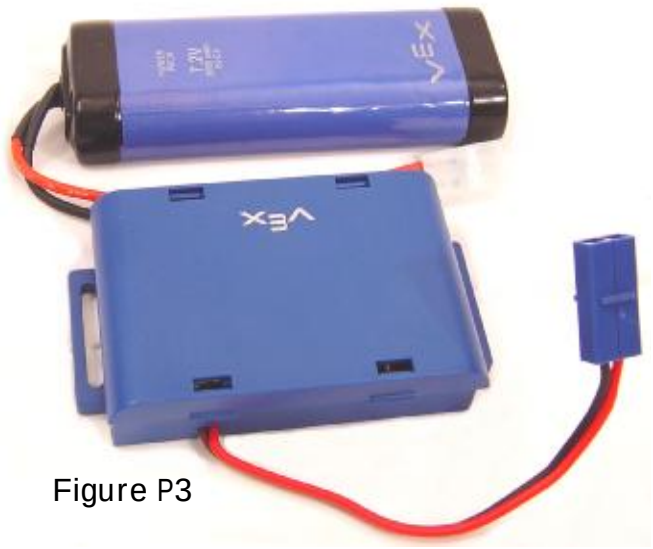


Figure P3

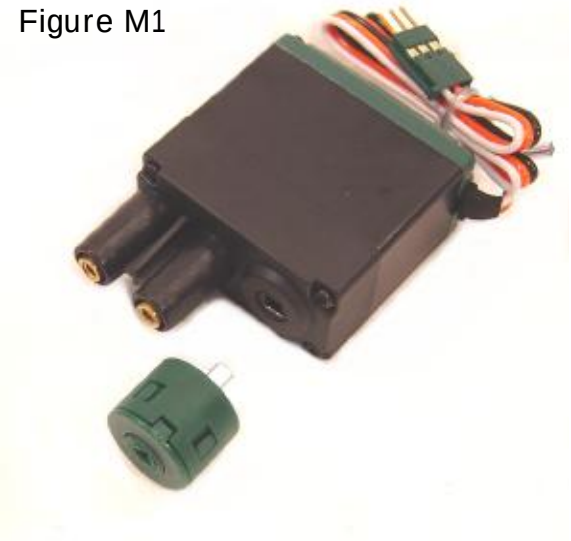
Motors and Servos

Both the VEX motors and VEX servos come in the same form-factor. You actually have to look at the writing on the bottom of the motor or servo to tell which one is which. The motors are simply servos in a full rotation setup. They take the same PWM signal that the servos use to control the speed and direction. All VEX servos and motors come with a special clutch that helps to keep you from stripping the gears. Each kit also comes with an extra set of replacement gears.

The mounting of the servo/motors is a bit unique in that the mounts are in the front, beside the drive clutch.

You use small bushings to mount the motors and servos. In most cases, you must use a mounting technique similar to the one shown in Figure M2. This allows the lateral force to be placed on the bushings, not the motor or servo. It is a bit awkward at first, but makes for a very stable and rugged bot.

Figure M1



Both the motors and servos are standard servos, as I effectively used them with a different RC radio system. I also used a standard $7 servo on the VEX microcontroller. Just keep in mind that standard servos have male connectors and VEX servos and motors have female connectors.

The starter kit comes with two motors and one servo. You can also purchase a servo or motor kit separately for around $20 each.

Hardware

You get quite a bit of actual construction hardware with the VEX starter kit. You can also purchase a $80 kit that replaces all the hardware in the starter kit. That includes all bushings, nuts, bolts, standoffs, collars, and axles.

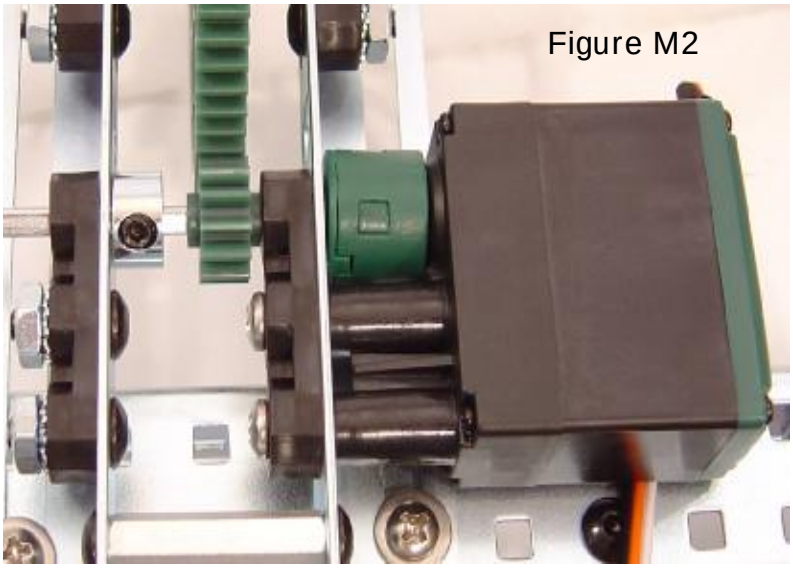


Figure M2

One problem I had with the hardware is that I ran out of the nuts and bolts for my own projects. I also didn't like that you must use a hex wrench. I prefer a good old philips or slotted screwdriver. All the nuts and bolts are 6-32 and 8-32, so you should be able to pick up some normal nuts and bolts from a third party source.

Many of the parts are meant to be bent and cut, so you are encouraged to do so.

Some of the more specialized hardware pieces are shown in Figure H2. In many cases, several of each piece are included in the hardware kit. For instance,

you get sixteen of the threaded locking collars and sixteen of the bushings that I mentioned earlier.


Figure H1

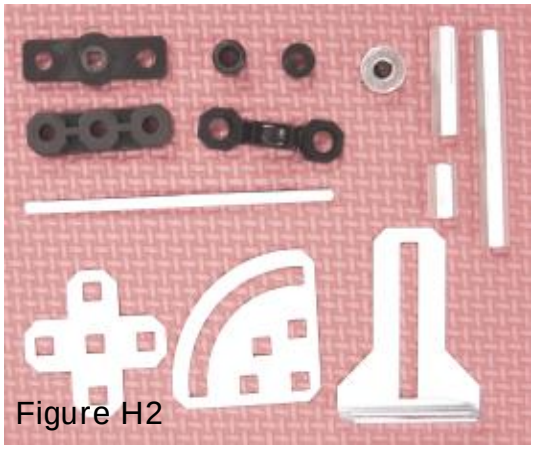


Figure H2

Micro Controller Module

The microcontroller you use to give your bot a brain is one of the most important components in the system. Unfortunately, I can't say a lot about the VEX microcontroller module, as the programming interface is not yet available. Currently, it is limited to some very basic servo and motor functions.


Figure C1

The VEX controller can accept commands from two separate radio receivers. This means it's possible to build a very complicated bot. You could have one person controlling the movement and another person controlling the weaponry, such as flippers.

I opened up the VEX microcontroller and found 2 18F8520 PIC chips (Figure C3), so I can assure you that once the program module is available, we will see some very powerful programs. Interestingly enough, the 18F8520 is essentially a 18F452 chip with more IO ports and memory. This chip runs at 10 mips when clocked at the full speed of 40Mhz.

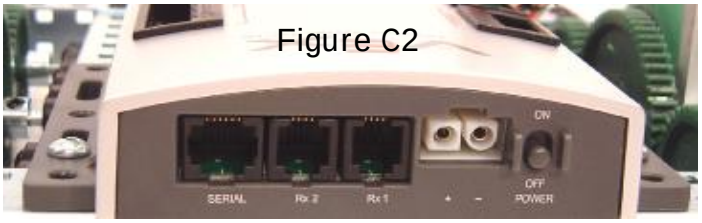


Figure C2

Figure C3

Just to set expectations, I must reiterate that the VEX starter kit does not come with a programming interface. I was told the programming module will be available in August as an additional purchase. The programming language will be C and Assembly. I am a bit disappointed that they will not be releasing some sort of Basic language. The lack of Basic will keep a great number of budding robot enthusiasts from programming the VEX.

Sensors

The microcontroller will be able to sense both analog and digital signals. The PIC 18F8520 has several 10bit AtoD ports, and the VEX will make use of them.

On the digital side, the VEX currently has two sensor types available. The bump sensors shown in Figure S1 are used to detect when the bot bumps into something.

The limit switches shown in Figure S2 can be used in conjunction with motors and servos to sense when a particular point is reached.

While both these sensors have three leads, only the black and white leads are used. When plugged into the VEX

microcontroller, the sensor will pull the white sensor lead to ground when the contact is closed. The microcontroller itself will use a pullup resistor to keep the sensor lead high until it's pulled low.

The VEX starter kit comes with two bump sensors and two limit switches. They can be purchased in pairs as well.

Look for other sensors in the future; if not from VEX, then from third parties.

Figure S1

Sum it up

There was a lot to cover, but I think I touched a little on each VEX sub system. For my first bot I made some basic changes to the squarebot pointed out in the manual, and added a 2.4 Ghz wireless camera. I was able to chase the cats around the house until they got wise and made themselves scarce. Check out the Kronos Robotics web site for a few videos I made as the bot scurried around the basement.

Figure S2

In future articles I will show you techniques using the various VEX components, as well as how to use some common items found at your local hardware store.

As soon as the program module is available, we will also delve into that aspect of the VEX system.

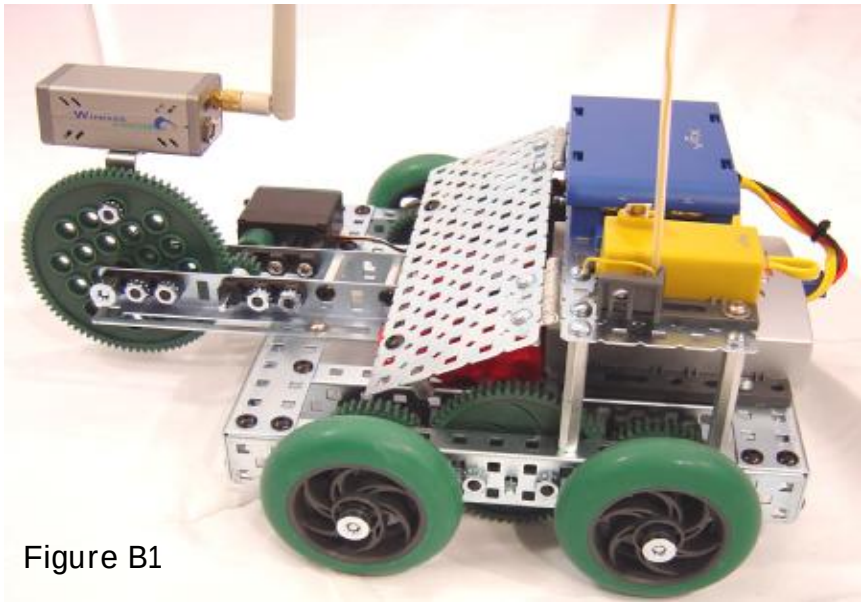


Figure B1