About this manual.

Congratulations! You are the proud owner of a TekBot™ a Platform for Learning™ originally designed at Oregon State University, and under continual development at many universities worldwide. You can see a list of partner universities at the TekBots webpage listed in the appendix.

This manual covers the basic elements of the ‘analog TekBot base.’ The manual is divided into sections with each section helping to better understand the various systems on the boards and some basic concepts in electronics.

This manual is not intended to teach basic electronics by itself. To learn basic electronics effectively this manual should be used in conjunction with other methods of learning (school lectures, at home courses, internship, etc…)

Important Symbols

<table>
<thead>
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<th>Symbol</th>
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<tr>
<td>📚</td>
<td>Supplemental information that will make things go more smoothly.</td>
</tr>
<tr>
<td>⚠️</td>
<td>This symbol indicates precautionary information. If ignored, damage may occur.</td>
</tr>
<tr>
<td>✔️</td>
<td>The checkmark symbol marks a thought or idea you want to remember to make things easier to accomplish.</td>
</tr>
<tr>
<td>💡</td>
<td>The innovation symbol indicates an opportunity to advance beyond what is required.</td>
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Section 1

tiny26.0 Board Assembly
Section Overview

Welcome to the tiny26.0 assembly manual. For many of you this may be your first time ever soldering or assembling an electrical system so this manual will assume that you, the assembler, has very little knowledge of these skills.

Preparation

For this assembly, and in general when assembling electronics, there are a few things that will make your life much easier.

1. Start with a clean work space. Often times the electronic components you are working with are very small, and if dropped could be easily lost among your usual desktop clutter. Put away papers, keyboards, mice, clothing, etc…

2. Keep your parts neat. Often times, parts come neatly packaged and ready for use. Don’t just dump all of these parts together in a box or similar. Instead, if parts come separated, try to keep them that way. When you do have parts out of their packages, you may want to have a small container to keep them in, rather then spreading them out across the desk. Some people use ice cube trays, kitchen bowls, or other containers designed for this use.

3. Care for your tools. The quality of our electronics assembly is based on your own experience, and on the tools you use for the assembly. Keeping your tools in the best condition as possible. When using your cutting tools, try not to cut things they should not cut. Very important is that you take care of your soldering iron properly. We will talk more about soldering irons in a few minutes.

4. Make sure you have everything you will need. There is nothing more annoying when working with electronics (and many other things) than not having the parts you need and having to stop what you are doing to go find them. You can help prevent this by double checking you have what you need before you start. This includes manuals, tools, components, pens, and paper.

Procedure

How to build the tiny26 board efficiently

Since this is possibly your first ever assembly of an electronic system, this guide will show you step by step the order of assembly. If you have multiple boards, you should assemble one, test it, and then assemble the next one. This prevents any mistakes you make from propagating. As we assemble the board, we will explain why we solder each part when we do, and how it is oriented and why. Pay attention to these reasons, in later courses, we won’t tell you what to do, so you will want this information.
A good rule of thumb is to assemble circuits in an order that allows you to test it in pieces before the whole thing is assembled. If the circuit is very small, you might solder the whole thing before you test the first time, but in general you should assemble in sections.

**Step 1 – Capacitors**

Figure 1: Bare tiny26.0 printed circuit board

Figure 1 shows a tiny26 printed circuit board before any assembly is done. For reference, top refers to the long edge of the board that is at the top when the writing is visible, and the left side would be the side with component J2 on it.

The first step is to solder in the capacitors for the system. These capacitors are a type called ‘ceramic disc.’ They are called this because their insides are made of ceramics, and they are shaped kind of like a disc under their epoxy coating. The capacitors have writing on both sides of them that helps to identify them. One side has information about the manufacturing date, while the other side has the value of the capacitor. Refer to the parts list at the end of this document to find out what capacitors go where. To help you out, refer to the side box to find out what the numbers mean on the side of the capacitors.

- .1uF – code ‘104’
- .33uF – code ‘334’
- 1nF – code ‘102’
Once you know what capacitors go where, the next step is to solder them into place. You can find a variety of different soldering tutorials online. Some suggested links are below, and can be found on the recitation webpage.

Ceramic capacitors are ‘non-polarized.’ This means that they can be inserted with either wire (lead) in either hole and still work as expected. Other capacitors can not do this, and we will learn about them in later courses. Figure 2 shows the PCB after the capacitors have been soldered into place.

**Step 2 – Resistors**

The next step is to install the resistors. This is again a part that is not very tall, and is not very sensitive to static energy, so it can be soldered in early in the construction phase. You only have on in your kit, a 100KΩ. Resistors do not have a polarity, so you can insert it in any orientation you would like to. Figure 3 shows the tiny26 PCB after the resistor is soldered into place.

**Step 3 – Connectors**

The next things to solder into place are the connectors J1 and J2. one the is power connector, while the other is the programming connector.

These are taller parts, but we want to solder them in before we solder in the integrated circuits, to avoid damaging the circuits when we solder.

The connector used in J1 does not have a polarity, but J2 does. You will notice a small notch in the silkscreen border of J2. This should line up with the notch of the 2x5 male header piece that goes into J2.

Often, if a part is polarized, it will have some indication on the silkscreen telling the assembler which way it should be inserted. These indications can vary, but a common one
Step 4 – Integrated Circuits

The final step is to install the two integrated circuits for the board. Integrated circuits can come in a wide variety of different packages. The two circuits you have are a ‘20 pin Through Hole Dual Inline Package’ (20pin DIP) and a ‘TO-92 3 pin’ package. You can start with either one, but pay attention to the polarity. The DIP package will have either a small half circle, or dot at one end of the chip. This denotes the end with the first pin of the circuit. For an example, look at figure 4 to see the pin out of the Attiny26 chip, and the LM78L05 IC.

When inserting the 78L05, you will notice that one end of the IC has a flat side, be sure this lines up with the flat side of the silkscreen outline on the circuit board. Once these have both been installed, your board should be complete, figure 6.
Step 5 – 9V Battery Connector

Some people like to install ‘headers’ into the external connection pins, making for easier prototyping. This is not required, and is sometimes not desirable when the tiny26 will be put into a permanent assembly.

The tiny26 board has ‘on-board power regulation’ that allows you to connect it to voltages from 7V DC through 18V DC and it will convert the voltage as needed. This allows you to connect the board to the TekBots power system easily. If you do not have a TekBot system yet, a 9V battery clip is included for your use.

Before you make use of the 9V clip, you first need to connect a piece of 1x4 male header to the leads of the battery clip.

The power connector on the tiny26 is a TekBots standard connector. It is a 1x4 female header with a pin out shown in figure 7. The reason that four pins are used is that if accidentally the power connector was plugin backwards, nothing would happen. If only two pins were used, then the power and ground lines would be reversed, a bad situation.

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<tr>
<td>1</td>
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<td>Voltage</td>
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<tr>
<td>3</td>
<td>Not Connected</td>
</tr>
<tr>
<td>4</td>
<td>Not Connected</td>
</tr>
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Figure 7: Pinout of a Standard TekBots power connector
Solder the battery clip leads as shown in figure 8 to the 1x4 male header in the kit. Be sure the black wire is soldered to the outside pin, and the red wire to the one next to it.

![Male header soldered to the 9V battery clip.](image)

This completes the physical assembly of the tiny26 board. Next you should move on to testing, and if everything works then, you can assemble other tiny26 kits with confidence.

**Study Questions**

1. You have just soldered together a simple board. This type of hand soldering is good for prototyping systems, but is very expensive for large quantities of boards. Search and find two ways that parts are soldered to boards in large scale production. Identify the name and explain in at least a paragraph for each method how each one operates.

2. Soldering can be used for making one-of-a-kind things (prototyping) but there are many other ways. Find two other ‘ways’ of prototyping electronics circuits.
Section 2: tiny26 Programming and Testing
Setting up and Installing CodeVision

The tiny26 can be programmed in both C and assembly. Nearly any tool for programming you can find that works on the ‘Atmel AVR’ series of chips will work.

A very basic and easy to use program is called CodeVision AVR. This tool is probably already installed in your lab, but we will go through the process of installing and the needed libraries for simple tiny26 usage.

1. Step one is to download the evaluation version of CodeVision. At the time of this writing, the evaluation is full featured, except you have a limited code space you can use. You can locate the latest version at http://www.hpinfootech.ro or download a version from the class webpage.

2. Run the setup program and follow the onscreen prompts to install the software. It is recommended that you install to a directory without any spaces in it. We will assume that you use the default directory of ‘c:\cvarveval’ for the rest of these steps.

3. Once the program is installed, you will need to copy the ‘ece111.h’ library file to the correct directory on your machine so that CodeVision can use it. You can locate this file on your lab webpage. Copy this file to ‘C:\cvavreval\inc’.

4. You have now setup the CodeVision software for use. Proceed to the next steps for writing and compiling your programs.

Your First tiny26 Project

The tiny26 board is programmable in the C language using the CodeVision software. To help with rapid and easy development for entering students, or people new to programming, a set of library functions were written that allow the user to quickly produce simple but cool lighting effects. These functions are contained in the ece111.h file you installed earlier.

Also to make your entry into this software easier, a template or skeleton project is available for your use.

1. First download the skeleton project to your computer. You can find the zip file on your class webpage. Unzip it to a location without any spaces in the directory names. For example, z:\ece_111’ not ‘:\ece 111’. Once this is done, open CodeVision

2. In CodeVision, use File -> Open and select the ‘.prj’ file you just unzipped. This should cause CodeVision to do a bunch of things, and you will end up with a text entry window waiting for your entry.

3. Scroll down the file until you see a comment saying ‘Insert your code here’, This is where you will put your program for testing the tiny26.

4. Into this area, enter the text below. This will cause all of the pins on PORT A to turn off and on about once a second once the program is downloaded to the tiny26 board.
PORTA=blink(0b11111111, 0b11111111, 200);

**Compiling and Downloading Code**

1. To compile and download your program, press ‘Shift+F9’ on your keyboard (two keys at once) this will cause CodeVision to save, compile, link and then give you a report. If there are no errors, press ‘Enter’ again, and CodeVision will try to program the chip.
2. Before you press Enter to program, be sure your tiny26 board is connected to the programming cable at your desk, and that it has power being supply. If the programming succeeds, you will see a blue bar scroll on the screen, and then about 5 second later your tiny26 will be gin to work.

**Making sure it worked**

The tiny26, will not give you any indication about how your program is working unless you connect some type of indicator. The easiest is to use a digital multimeter to measure the voltage on the different pins. This will tell you if the pin is ‘on’ (5 volts) or ‘off’ (0 volts).

Another thing that can be done, is to connect LEDs to each of the pins in series with a resistor. This would let the LED turn on when the pin is on and be off when the pin is off.

**Study Questions**

1. Connect one LED to your tiny26 board on pin A0. Make the pin do each of the following, and have your TA verify that it works.
   - The LED fades in and out 1 time a second  
     TA Signature: _______________________
   - The LED blinks 5 times a second  
     TA Signature: _______________________
   - The LED stays on  
     TA Signature: _______________________
   - The LED stays off while the tiny26 board is powered.  
     TA Signature: _______________________
   - The LED randomly turns off and on.  
     TA Signature: _______________________

2. Connect a wire to pin B2 and make a program that turns on the LED on pin A0 when wire in B2 is connected to 5 volts, and off when the wire is connected to ground (0 volts). Have your TA sign.

   TA Signature: ______________________
3. Turn in a copy of your lab notes that you may have made during this lab. Remember that keeping a record of when you think of different things can be very useful in both helping you remember and proving who has ownership of an idea.
Section 3: Troubleshooting
Q: When I connect my battery, nothing happens and the tiny26 IC gets really hot.

A:

Q: When I connect my battery and try to program the tiny26, nothing happens.

A:

Q: I have successfully programmed the tiny26, but my program does not seem to run correctly.

A:
# tiny26.0 Board

<table>
<thead>
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<th>Qty</th>
<th>Description</th>
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<td>A</td>
<td>TekBots</td>
<td>tiny26.0</td>
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<td>B</td>
<td>Mouser</td>
<td>SR205E104MAA</td>
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<td>C</td>
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<td>D</td>
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<td>E</td>
<td>Digikey</td>
<td>LM78L05ACZFS-ND</td>
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<td>10 pin Shrouded .1” Male 2x5 Connector</td>
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Section 4: Parts List
Appendix A: Schematics

**tiny26.0**

**Power Regulation**

**ISP Programming**

**Figure 53: Schematic of the tiny26.0**
Figure 55: Silk screen for the tiny26.0
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<th>Address</th>
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<th>Website</th>
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<tr>
<td>DigiKey</td>
<td>701 Brooks Ave. South, Thief River Falls, MN 56701-0677</td>
<td>(800) 344-4539</td>
<td><a href="http://www.digikey.com">http://www.digikey.com</a></td>
</tr>
<tr>
<td>Mouser Electronics</td>
<td>1000 N. Main Street, Mansfield, TX 76063</td>
<td>(800) 346-6873</td>
<td><a href="http://www.mouser.com">http://www.mouser.com</a></td>
</tr>
<tr>
<td>Allied Electronics</td>
<td>6700 SW 105th St, Suite 106, Beaverton, OR 97008</td>
<td>(800) 433-5700</td>
<td><a href="http://www.alliedelec.com">http://www.alliedelec.com</a></td>
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<tr>
<td>TekBots</td>
<td>1148 Kelly Engineering Center, Oregon State University, Corvallis, OR 97331</td>
<td><a href="mailto:tekbots_support@eecs.oregonstate.edu">tekbots_support@eecs.oregonstate.edu</a></td>
<td><a href="http://eecs.oregonstate.edu/tekbots">http://eecs.oregonstate.edu/tekbots</a></td>
</tr>
<tr>
<td>Solarbotics</td>
<td>179 Harvest Glen Way N.E., Calgary, Alberta, Canada T3K 4J4</td>
<td>(866) B-ROBOTS</td>
<td><a href="http://www.solarbotics.com">http://www.solarbotics.com</a></td>
</tr>
<tr>
<td>McMaster-Carr</td>
<td>P.O. Box 7690, Chicago, IL 60680-7684</td>
<td>(562) 692-5911</td>
<td><a href="http://www.mcmaster.com">http://www.mcmaster.com</a></td>
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<tr>
<td>Jameco Electronics</td>
<td>1355 Shoreway Rd, Belmont, CA 94002</td>
<td>(800) 831-4242</td>
<td><a href="http://www.jameco.com">http://www.jameco.com</a></td>
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