ICE Tetrix Workshop Demonstration – Base Robot Model

In this manual, you will construct the robot used for instructional purposes by Georgia Tech’s Institute for Computing Education. This robot requires a Lego Tetrix Robotics kit and Lego NXT controller to operate. Before we begin to build the robot chassis, we will establish some hardware nomenclature so everyone is thinking of the same pieces.

First-the fasteners:

There are two industry acronyms we will use to identify two different types of screw:

- **SHC SCREWS** – socket head cap screw
  
  ![Figure 2 socket head cap screw](image)

- **BHC SCREWS** – button head cap screw
  
  ![Figure 3 button head cap screw](image)
The rest of the fasteners are addressed and identified by their length. From left to right these are the fasteners we will use today:

- Motor mount screw - note the longer thread count (there should be very few of these in the kit)
- Long screw – has a non-threaded neck like the motor mount screw.
- Medium screw
- Short screw - SHC screw
- Short screw – BHC screw

Also, this is the only nut used in the assembly:

It's called a kep nut and has metal ridges that apply spring tension and grip to the surface when tightened to help prevent the nut from becoming loose.

*Motor apparatus:*

![Figure 4 Types of Screws used in this Tetrix assembly](image)

![Figure 5 Kep nut](image)

![Figure 6 Axle](image)
Note the following picture shows two parts that look very similar but are different and have different functions. Especially note the difference in the diameter of the central hole. The DC motor axles fit into the larger diameter hub, whereas the other axles fit the smaller diameter hub.

*Structural Elements:*
Figure 9 L Bracket

Figure 10 U channel

Figure 11 Standoff – this is basically a large spacer. We have two different lengths: long and short.

Figure 12 Plate
Figure 13 This is a starburst pattern. *We will designate the length of many structural elements by counting how many of these patterns appear on in a row on a structural element.*

Great! Now let’s begin building:

**Step 1: Robot base**

Figure 14 Completed robot base chassis.

When you are finished with this step, you will have created the above!
Required materials for Step 1:

- U Channel (5 starburst length) 4
- Short SHC screws 16
- Nuts 16

Assemble a rectangular frame from the 4 U channel sections at the indicated distance away from the channel edges. This should be in a cross pattern surrounding the third hole inwards from the outermost channel edge.

Screw pattern at each attachment point. Note distance from edge.
Figure 17 The U channel should always open inwards.

Next, we will attach a plate to hold the electrical equipment.

![Plate](image)

**Figure 18**

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plate</td>
<td>1</td>
</tr>
<tr>
<td>Short Screw – SHC screws</td>
<td>4</td>
</tr>
<tr>
<td>Nut</td>
<td>4</td>
</tr>
</tbody>
</table>
Figure 19 Attach the plate with one screw starting at the innermost hole on the third star burst pattern (from bottom to top) and ending at the innermost hole on the non starburst pattern immediately following the third starburst pattern.

Attach plate at distance indicated in the above picture.

Figure 20 Only one screw and nut is needed at each attachment point.

Next, we will add attachment points for a set of wheels.
Required materials:

- Figure 21. Driven wheel holder subassembly.

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>U channel (single starburst)</td>
<td>2</td>
</tr>
<tr>
<td>Short screw (SHC screws)</td>
<td>4</td>
</tr>
<tr>
<td>Nut</td>
<td>4</td>
</tr>
</tbody>
</table>

Figure 22. Driven wheel holder subassembly attached to chassis. Affix to frame as shown.
Step 2: Drive wheels

Required Materials:

![Drive wheel components](image)

Figure 23 Drive wheel components.

Motor hub 2
Motor mount 2
DC motor 2
Drive wheels 2
Motor mount screw 2

(slightly longer than long SHC SCREWS; the rightmost two of the four long screws in the picture)

Long SHC screws 2

(slightly shorter than motor mount screw; the leftmost two of the four long screws in the picture)

Medium SHC screw 4
Nuts 4

First, insert DC motor into motor mount, making sure to keep edges flush and rotated so that the axle is as close to the base of the mount as possible.

Then, fix motor mount to position shown on u channel (overlapping first and third startburst patterns from the outside in). The motor mount screw is used to secure the tallest part of the motor mount, show in the picture below on the right hand side. A regular long screw threads into the motor mount on the left.
Figure 24. To complete the sub assembly, place motor hub on axle and then slide on the wheel. Tighten with two screw/nut pairs per wheel. Note: the hub's set screw must be tightened against the flattened portion of the axle (so that the wheel may rotate when the axles turns!).

Figure 25. Mount motor hub as close to edge of the axle as you can (to avoid interference with the robot chassis)

Figure 26. Repeat steps for opposite wheel.
Step 3: Driven wheels

Required Materials:

![Driven wheel components.](image)

- Omni wheels: 2
- Copper bushings: 4
- Axles: 2
- Axle hub: 2
- Collar: 2
- Medium SHC screws: 4

Insert copper bushings as shown.

![Copper bushings face each other inside the single starburst pattern u channel bracket.](image)
Use two medium screws to attach axle hub to omni wheel. Attach hub and wheel assembly to axle - tighten set screw. Attach collar on opposite side - tighten its set screw.

Repeat for opposite wheel.

**Step 4: Electrical Mounts**

**Required Materials:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>L bracket</td>
<td>2</td>
</tr>
<tr>
<td>Standoff (long)</td>
<td>7</td>
</tr>
<tr>
<td>Short SHC screws</td>
<td>4</td>
</tr>
<tr>
<td>Medium SHC screws</td>
<td>7</td>
</tr>
<tr>
<td>Nut</td>
<td>4</td>
</tr>
</tbody>
</table>
Attach L brackets in between wheels with short SHC screws.

Next attach the four long standoffs to the L brackets and u channel in between the drive and driven wheel on the side indicated in the picture below with medium length SHC screws. This will hold the battery in place.

On the opposite side, attach the three short standoffs in the pattern shown below with medium length SHC screws. This will hold the NXT brick.
Finally, using short SHC screws attach the pre-assembled gripper to the front of the chassis at the four attachment points shown below. You should need four nuts and four short SHC screws.
Now we will go over some electrical safety and show you how to install the heart and brain of the robot!

Figure 35. Electrical components (not including the NXT brick).