AlteraBot Self-Test User Manual
A Hardware Evaluation Guide for ECE 2031

Prepared For
ECE 2031 Students

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Table of Contents

1.   **Scope**

1.1   Introduction

Welcome to the AlteraBot Self-Test (ABST) user manual. This manual is designed to provide a comprehensive description of all parts of the ABST. Each test is broken down into seven sections:

1. Title
2. Test prerequisites
3. General description
4. Hardware photo
5. Step-by-step instructions
6. Expected results
7. Possible error codes and conditions

1.2   System Overview

The AlteraBot is composed of an ActivMedia AmigoBot controlled by an Altera UP2 board fitted with a daughterboard containing eight infrared emitters and receivers. This UP2 board is controlled using a Simple Computer (SCOMP). The AmigoBot contains eight sonar units, two independently driven wheels with a third swiveling support wheel. It requires a 12V power supply which charges the robot's internal battery. This battery simultaneously powers the UP2 board when in operation.

1.3   Purpose of Test

The purpose of the ABST is to ensure that all systems and components of the AlteraBot are fully functional. The need for this self-test arose as a result of student complaints in ECE2031. These complaints pertaining to the AlteraBot hardware are often due to bad software. The ABST provides a means of verifying the accuracy of these complaints. A compilation of helpful software tips are included in Appendix C if problems are problems are proven false by the ABST.

2. **Test Equipment**

These test procedures require the use of:

1. An ActivMedia AmigoBot with the following equipment installed:
    a. Altera UP2 development board with a FLEX 10K EPF10K70 device
    b. Daughterboard containing IR emitters and detectors

2. Test Computer with the following applications and configurations
    a. Windows 2000 or XP
    b. MAX + plus II software

3. Cables
    a. 12V AmigoBot Power supply
    b. Byte-blaster cable
    c. 25-pin Male to Female Serial Cable

⚠️ **Shocking Hazard!**
The sonar uses a 12V charge. Be careful carrying the AmigoBot where your hand may short circuit any sonar connection.

3. **Test Overview**

The ABST is a series of menu-selectable test procedures which allows the user to identify problems with the AlteraBot and daughterboard. The tests are broken into four systems:

1. UP2 board functions and Initial Tests
2. Odometry and accuracy
3. IR
4. Sonar

These four systems are shown below as located on the AlteraBot.
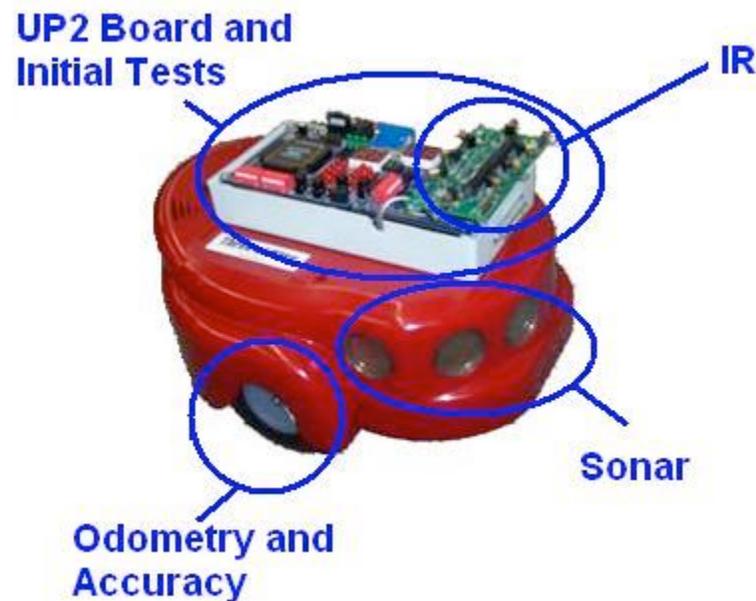
3.1 UP2 Board Functions and Initial Tests

- LED Test – Verifies the seven segment LED display works properly.
- SCOMP Test – Ensure Simple Computer correctly performs mathematical and logical operations.
- Dipswitch Test – Ensures that all dipswitches can read up and down positions.
- Communications Test – Verifies communication between the AmigoBot and Altera controller.
- Battery Test – Ensure battery voltage is at least 11.1V.

UP2 Board Hardware
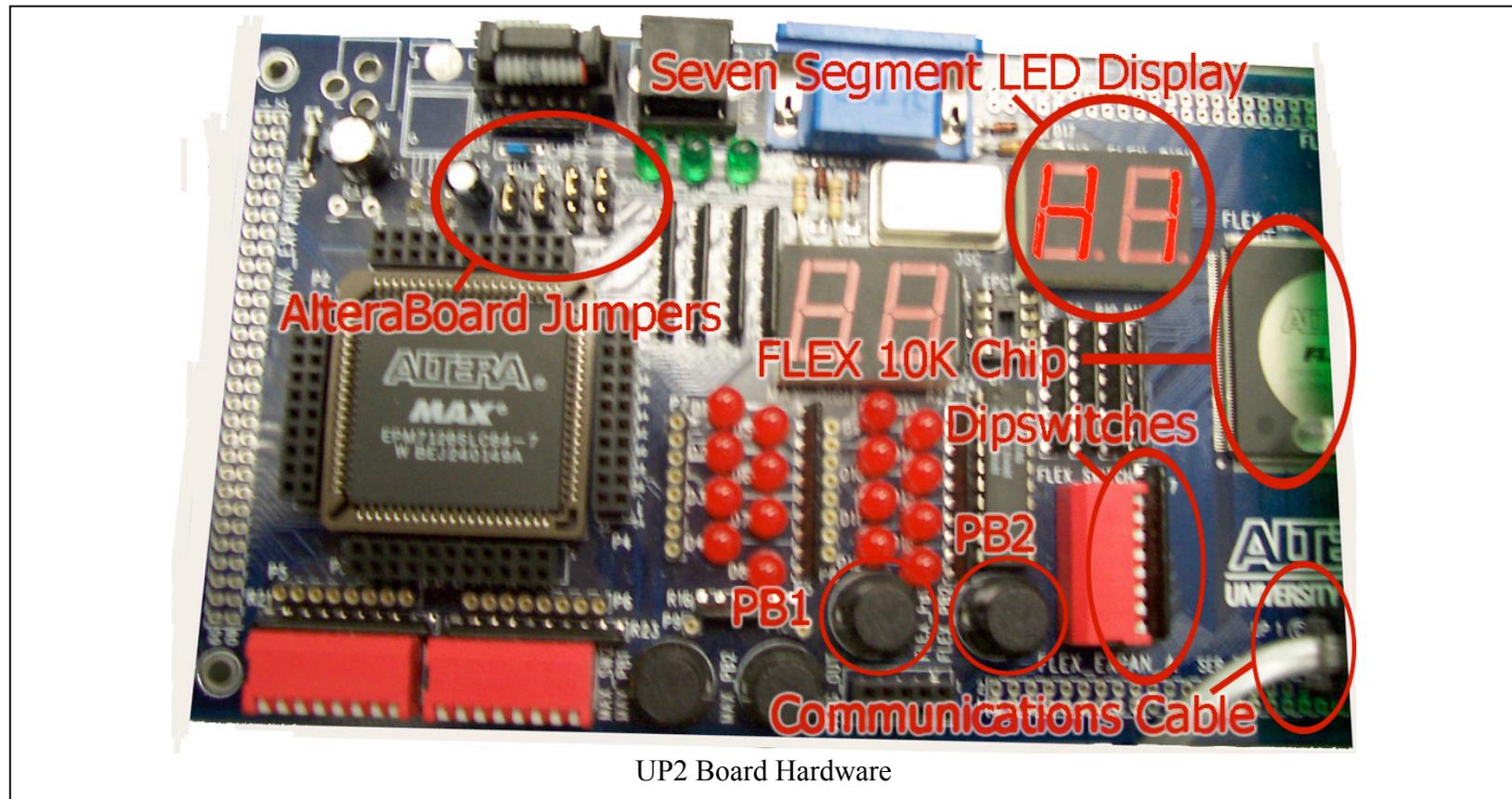
3.2 Odometry and Accuracy Tests

- Wheels Test – Verifies each wheel is independently controllable and responsive in the forward and backward directions.
- L-Test – Ensures sensor and wheel accuracy as well as proper alignment of the coordinate plane.

3.3 IR Test

- Verifies all detectors are capable of receiving transmitted codes.
- Verifies all emitters are capable of transmitting codes.

IR Emitter/Detector Pair Numbers

IR Emitters and Detectors
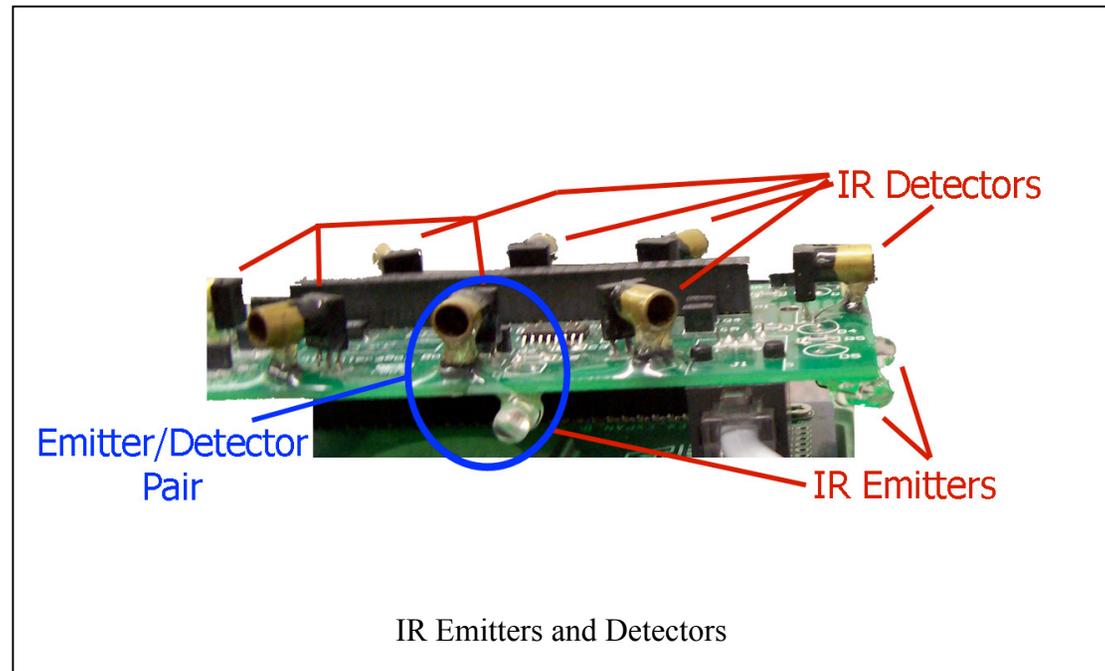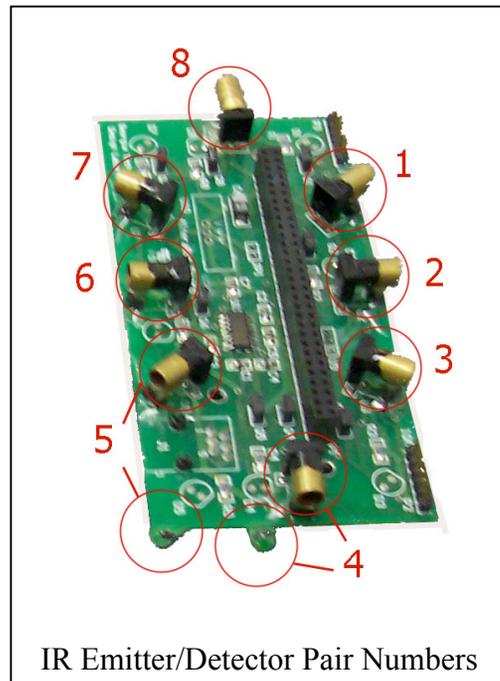
3.4 Sonar Test

- Ensures all sonar units are capable of receiving a reading of 1m.

4. __Test Page Usage__

On every test page, there are seven items of interest. Each page starts with the test title located in the upper left hand corner of the page. Immediately below, there is a list of any prerequisite tests which must be performed before the named test may be executed. Below this is a description of the test to be performed. To the right is a picture of the relevant hardware under test. The table lists step-by-step instructions along with expected results and any error codes or conditions.

Example of a typical test page

4.1 <u>How to use error codes</u>:

When an error is encountered, the seven segment LED will rotate through 1 or 2 numbers along with the error indicator "0B." These numbers will flash at 1 second intervals. The hexadecimal numbers which appear correspond to the following values

1. An index for the test which failed (see appendix A for all error codes and recommended solutions)
2. If present, this hexadecimal number represents how much the test failed by.

Error Codes Example

1: If the sonar test fails it may rotate through the codes "0B," "73," then "1D." The "0B" indicates that the test failed. The "73" indicates that the failure was in sonar unit three (as per appendix A). The "1D" indicates a failure by 1D units defined by the AmigoBot reference. In the case of sonar, this is in mm, so the sonar would have failed by 29mm (in decimal).

4.2 <u>How to use the menu system</u>:

The menu system is controlled through the dipswitches and PB2. Each test may be entered through this system by setting the switches into a combination of "ups" and "downs." Refer to appendix B or the test information for dipswitch combinations.

Menu Example

1: If the L-Test is desired, the corresponding menu code is "00000110." Place dipswitches two and three in the up position and all other dipswitches in the down position. Press PB2 to begin testing

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5. <u>Test Procedures</u>

5.1 UP2 Board Functions and Initial Tests

See page 4 for hardware details

Prerequisite Tests: None

Testing of the primary and most commonly used functions on the AlteraBot's UP2 board is the first step in the robot self-test procedure as it helps assure the user that his AlteraBot can relay basic information via the onboard seven-segment display and Dipswitches. The initial tests also verify working Simple Computer as well as proper communication between UP2 and robot.

UP2 Board Functions and Initial Tests			
Step	Actions	Expected Results	Possible Error Codes
1	**Visual Inspection and Software Download** *See appendix D		
2	**Seven Segment LED Test**	Visually verify that the Seven Segment LEDs cycle through: 11,22,33,44,55,66,77,88,99,AA,BB, CC,DD,FF at one half second intervals	

UP2 Board Functions and Initial Tests			
Step	Actions	Expected Results	Possible Error Codes
3	**SCOMP Function Test**	"0A" displayed on seven segment display	"14"
4	**Dipswitch Test**	A "02" will be displayed on seven segment display	
5	Set all dipswitches down Press PB2	A "03" will be displayed on seven segment display	"10"
6	Set all Dipswitches up Press PB2	"0A" appears	"11"
7	**Robot Communications Test**	"0A" appears	"13"
8	**Battery Level Test**	"0A" appears	"05"
9	Robot enters menu system	"AA" appears on seven segment display	

5.1 **<u>Odometry and Accuracy</u>**

5.1.1 <u>Wheels Test</u>

Prerequisite Tests: UP2 Board Functions and Initial Tests

The wheel test verifies that each wheel is capable of moving independently as well as together in the forward and backward directions.

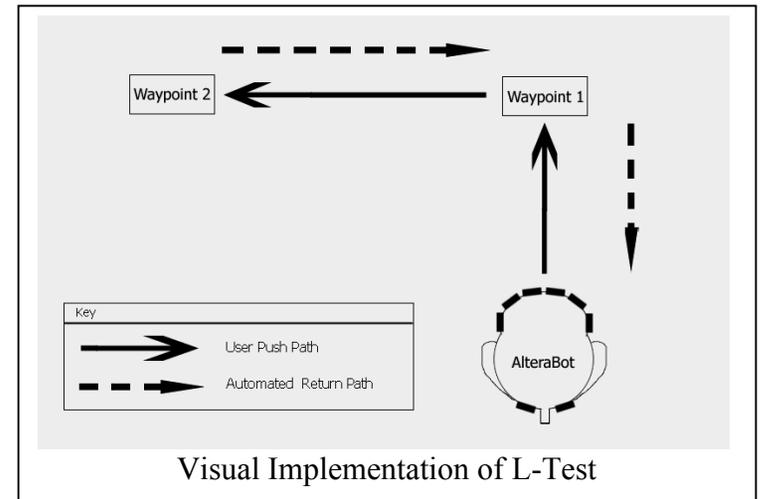| Wheels Test			
Step	Actions	Expected Results	Possible Error Codes
1	**Wheels Test**: While in menu system place dipswitches "00000011" Press PB2	Right wheel goes forward Left wheel goes forward Both wheels go forward Left wheel goes in reverse Right wheel goes in reverse Both wheels go in reverse	
2	Robot enters menu system	"AA" appears on seven segment display	

5.1.2 L-Test

Prerequisite Tests: UP2 Board Functions and Initial Tests,
Wheels Test

The L-test verifies that the X, Y, and Theta sensor are reading and are accurate.

Visual Implementation of L-Test

L-Test			
Step	Actions	Expected Results	Possible Error Codes
1	**L-Test**: While in menu system place dipswitches "00000110" Press PB2	"E1" displayed on seven segment display.	
2	Move robot forward one robot length Press PB2	"E2" displayed on seven segment display	"40" "41"
3	Rotate robot 90 degrees counter-clockwise Press PB2	"E3" displayed on seven segment display	"42" "43"
4	Move robot forward one robot length Press PB2	Robot will then return to its initial starting position	"44" "45"
5	Verify robot returns to initial position		
6	Robot enters menu system	"AA" appears on seven segment display	

5.1.3 <u>Bumpers Test</u>

Prerequisite Tests: UP2 Board Functions and Initial Tests,
Wheels Test

The bumpers test verifies that each bumper is capable of receiving a wheel stall indicator implemented both in the forward and reverse directions.

Visual Implementation of Bumpers Test
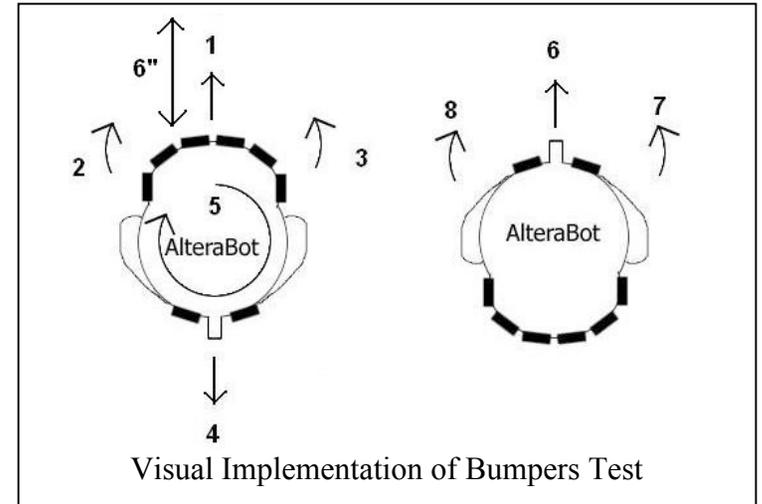
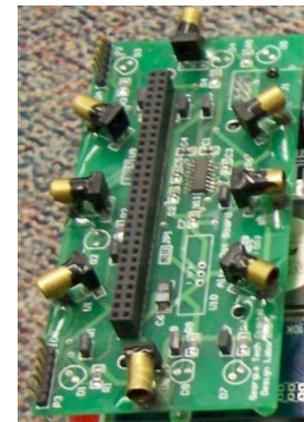| Bumpers Test			
Step	Actions	Expected Results	Possible Error Codes
1	**Bumpers Test:** Place the robot within six inches of a wall, facing forward		
2	While in menu system place dipswitches "00000101" Press PB2	Robot performs bumper test (see note 1)	"62" through "67"
3	Robot enters menu system	"AA" appears on seven segment display	

 Bumpers Test Notes

1: The robot uses both wheels, then the right wheel then the left wheel to push against the wall. It then reverses and rotates 180° and performs this procedure in reverse.

4.3 Infrared Test

Prerequisite Tests: UP2 Board Functions
Required Items: Piece of White Paper

Testing of both the IR emitters and IR receivers located on the daughterboard connected to the AlteraBoard

See page 5 for hardware details

Infrared Test			
Step	Actions	Expected Results	Possible Error Codes
1	**Infrared Test:** Place the robot on the ground, within three inches of a flat, smooth wall, in a corner if possible.		
2	Set the dipswitches to "00001000" Press PB2	"03" Displayed on seven segment display	
3	Set the dipswitches to the IR emitters which will emit the code Press PB2 *See note 1 on next page	The emitters will begin sending out a signal, which will bounce off nearby objects.	

Infrared Test			
Step	Actions	Expected Results	Possible Error Codes
4	Use piece of paper to reflect IR emitters not facing wall	The seven segment LED will begin to show the hexadecimal code corresponding to verified receivers *See note 2 below	
5	Wait 30 seconds		
6	Write hexadecimal code on seven segment LED in binary. Use note 2 below to decode		
7	To change emitters being used, see note 3		
8	To exit IR test and return to menu, place all dipswitches down and release PB2	"AA" is displayed on the seven segment display	

Infrared Test Notes

1: If wanting to emit from emitters 2 and 3 set the dipswitch to "00000110"

2: If 4F (binary 01001111) appears on the seven segment LED, this indicates that receivers 1, 2, 3, 4, and 7 were able to correctly detect the code. If all receivers are able to detect the code, FF (binary 11111111) will appear.

3: Hold down PB2 and place all dipswitches down. A "03" will be displayed indicating a change of emitters. Set the dipswitches to the IR emitters which will emit the code (see note 1). Release PB2 to begin testing at step 4.

4.4 Sonar Test

Prerequisite Test: UP2 Board functions and Initial Tests

Upon placing the robot 1m from the wall, the sonar test automatically rotates in place and verifies that each sonar unit receives the correct reading.

Sonar Test			
Step	Actions	Expected Results	Possible Error Codes
1	**Sonar Test** Set sonar 1 facing wall at 1m. Press PB2	Robot will turn to Sonar 2.	"71"
2	Wait 30 seconds	Robot will continue to rotate verifying each sonar's accuracy.	"72" through "78"
3	Press PB2 to return to menu	"AA" displayed on seven segment display.	

Appendix A
Error Codes and Recommended Solutions

Error Code	Code Explanation	Recommended Solutions
5	Battery charge below +11.1 V	Charge Battery
10	Dipswitch low test failure	Report dipswitch failure to TA
11	Dipswitch high test failure	Report dipswitch failure to TA
13	Communications test failure	Verify telephone cable connected to J1 on Altera board. Charge battery
14	SCOMP functions test failure	Re-download test files
40	X-position not changing	
41	X-position not accurate within 10%	Re-run test
42	Theta-position not changing	
43	Theta-position not accurate within 10%	Re-run test
44	Y-position not changing	
45	Y-position not accurate within 10%	Re-run test
50	Sonar non-constant reading	Charge Battery Adjust sonar accuracy control
51	Sonar #1 not accurate within 10% of 1 meter	Charge Battery Adjust sonar accuracy control
52	Sonar #2 not accurate within 10% of 1 meter	Charge Battery Adjust sonar accuracy control
53	Sonar #3 not accurate within 10% of 1 meter	Charge Battery Adjust sonar accuracy control
54	Sonar #4 not accurate within 10% of 1 meter	Charge Battery Adjust sonar accuracy control
55	Sonar #5 not accurate within 10% of 1 meter	Charge Battery Adjust sonar accuracy control
56	Sonar #6 not accurate within 10% of 1 meter	Charge Battery Adjust sonar accuracy control
57	Sonar #7 not accurate within 10% of 1 meter	Charge Battery Adjust sonar accuracy control
58	Sonar #8 not accurate within 10% of 1 meter	Charge Battery

		Adjust sonar accuracy control
62	Forward bumpers failure	Ensure robot strikes wall
63	Left wheel bumpers failure	Ensure robot strikes wall
64	Right wheel bumpers failure	Ensure robot strikes wall
65	Reverse bumpers failure	Ensure robot strikes wall
66	Right wheel backwards failure	Ensure robot strikes wall
67	Left wheel backwards failure	Ensure robot strikes wall

Appendix B
Menu System Dipswitch Configurations

Dipswitch Code	Test to be Executed
00000001	Battery Test
00000011	Wheel Test
00000101	Bumpers Test
00000110	L-Test
00000111	IR Test
00001010	Sonar Accuracy Test

Appendix C
## Common Coding Issues and Recommendations

Appendix D
Visual Inspection and Software Download

Visual Inspection of the AmigoBot

1. Turn on the robot using the "On/Off" switch located under robot.
   - Verify the power LED located on the top of the robot lights up.
2. Locate the emitters and detectors on the daughterboard connected to the UP2 board. Ensure that all eight emitters and detectors are present. Use the IR information on page 5 for locations of IR units.
3. Verify the daughterboard is fully connected to the UP2 board by pushing lightly down.
4. Visually locate the Altera MAX chip located on the UP2 board to ensure its presence.
5. Locate all three wheels on the AmigoBot. There are two on the sides which are powered and one in the back which acts as a swiveling
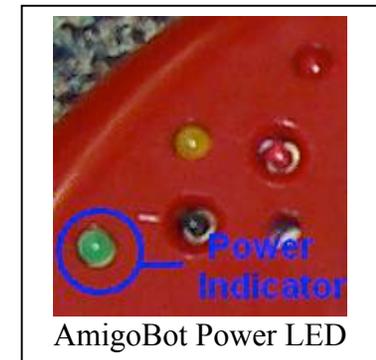

AmigoBot Power LED

Altera MAX Chip

support wheel. Verify that all wheels rotate freely and that the back wheel swivels. If these wheels do not rotate freely, they may be jammed. Report this to your TA.

6. Locate the telephone jack connector on the UP2 board, labeled J1 on the daughterboard. Verify that the cable is fully inserted.

7. Locate the four jumpers as seen in the "UP2 Board Hardware" picture located on page 4. Make sure the first two jumpers are on the lower two pins, next to the Altera MAX chip and the last two jumpers are located on the upper two pins, next to the UP2 board LEDs.
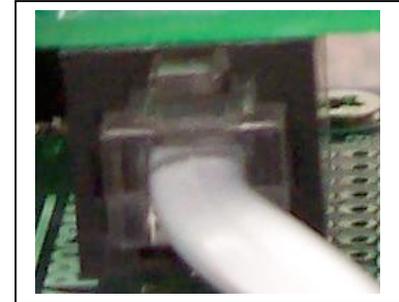
Self-test Download Instructions

1. Open the file top_scomp.gdf in the MAX+Plus II software suite by selecting "File" and then "Open."

2. Connect the parallel cable to the AlteraBot and verify that it is also plugged into back of the workstation.

3. Turn on the robot using the "On/Off" switch located on the bottom of the AmigoBot.

4. Open the built-in MAX+Plus II programmer by selecting "MAX+Plus II" and then "Programmer."

5. Verify the programmer window has loaded the top_scomp.sof file to send to the AlteraBot.

6. Click the "Configure" button to program the AlteraBot and start the ABST.