



# System Test Plan

## Unit Testing

### Beacon Transmitter

The verification of proper beacon signals will be performed in stages.

The first stage occurs during assembly of components by connecting a series of set input voltages and taking measurements through an oscilloscope to ensure that the circuitry performs as it is designed for.

First, it is verified that it is generating the proper signal carrier wave with a neutral input to the VCO. Next is to ensure that a varying input to VCO generates an appropriately shifted frequency in the output. Throughout this stage it should be verified that the frequency is close to the desired frequency and is stable.

In the second stage, the test is to verify that the microcontroller generates the proper digital signal by replacing the set input voltages with the microcontroller. The microcontroller should be commended to send a signal (at extremely slow bit rate) and the changes in frequency should be observable on the oscilloscope.

In the third stage, the test is to verify that the ultrasonic signal carries the correct encoded analog signal shape within the desired frequency range and is stable. This is done so by adding in the ultrasonic transducer and measuring the signal through a separate ultrasonic sensor at close range.

In the final stage, the test is to verify that the encoded ultrasonic signal maintains its integrity over the desired range. This is performed by displacing the transmitting and sensing components by various distances.

### Position Calculator

The verification of proper position detection consists of three parts.

The first part is to ensure that the signal integrity is maintained from beacon to handheld (essentially, the last stage of beacon transmitter testing but performing the detection through the handheld's hardware.

Furthermore, the decoded signal needs to yield the original signal encoding. To accomplish this, the decoded signal is compared against list of accepted codes (registered beacons in the room map). Invalid beacon signals should be rejected and excluded from distance calculations.

The second part to position calculation testing is to perform time-of-flight calculation from synchronized clocks for distance from each recognized beacon. To verify, place the beacon and handheld at a known distance apart and verify the calculated distance to be within tolerance for an overall +/- 5% in location.



## Design Specification for an Indoor Direction Finder for the Visually Impaired

The final step to position calculation testing is to verify that the position determined by trilateration is within the required  $\pm 5\%$ . To verify, compare the computed location with the actual location.

### Path Calculator

The verification of proper path determination involves finding a reasonable path to the destination that avoids known obstacles (encoded into the room map). This is partitioned into two stages.

For the first stage, position the handheld device directly in front of an obstacle blocking a straight path to the destination. Test to ensure that the device produces a path that navigates around the obstacle and back on track to the destination.

The second stage is to position the handheld and destination such that it requires turning a blind corner (the handheld does not have a direct path to the destination) and pass by intermediate destinations (the corner). The verification is in ensuring that the directions accurately point towards the intermediate destination before pointing towards the final destination.

### Collision Calculator

Collision prediction and detection leverages the pre-programmed room-map and the fact that ultrasonic transducer pairs can also be used as proximity sensors. To verify, gradually move the handheld device towards walls as well as unlabeled obstacles to trigger a notification that the user is too close to an obstacle.

### Voice Recognition/UI

The voice recognition and control software is to be tested against a library of recognized words (the commands for manually dictating a destination, listing the available locations, requesting a repeat of the last issued direction, numbers, and letters) for accuracy and real world error tolerance with noise, different accents and intonation.

The second part to voice recognition and user interfacing testing is to ensure that the software flow follows the design and that the user does not become stuck in any of the software states.

### Sound Output

Sound output testing is to be tested for loudness and clarity in the spoken prompts to the user.

## Normal Use Testing

### Case 1 - List Destinations by Voice

Setup procedure:

Be in the centre of a building with sufficient beacon coverage.

Steps to follow:

- 1) Power ON handheld
- 2) Speak "list"



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- 3) Choose a destination by voice and confirm
- 4) Follow spoken directions

Expected results:

- 1) Handheld powered ON
- 2) Handheld lists all available locations one by one
- 3) Handheld prompts for confirmation and proceeds
- 4) User reaches destination

### **Case 2 - List Destination by Button**

Setup procedure:

Be in the centre of a building with sufficient beacon coverage.

Steps to follow:

- 1) Power ON
- 2) Navigate to and enter list locations mode with hardware buttons
- 3) Choose a destination by hardware buttons and confirm
- 4) Follow spoken directions

Expected results:

- 1) Handheld powered ON
- 2) Handheld lists all available locations one by one
- 3) Handheld prompts for confirmation and proceeds
- 4) User reaches destination

### **Case 3 - Manually Input Destination Accomplished Purely by Voice**

Setup procedure:

Be in the centre of a building with sufficient beacon coverage.

Steps to follow:

- 1) Power ON
- 2) Speak "find"
- 3) Speak a valid location and confirm
- 4) Follow spoken directions

Expected results:

- 1) Handheld powered ON
- 2) Handheld prompts for a user-defined destination
- 3) Handheld prompts for confirmation and proceeds
- 4) User reaches destination

### **Case 4 - Manually Input Destination Accomplished with Hardware Button Navigation**

Setup procedure:

Be in the centre of a building with sufficient beacon coverage.



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Steps to follow:

- 1) Power ON
- 2) Navigate to and enter manual-input destination mode with hardware buttons
- 3) Speak a valid location and confirm
- 4) Follow spoken directions

Expected results:

- 1) Handheld powered ON
- 2) Handheld prompts for a user-defined destination
- 3) Handheld prompts for confirmation and proceeds
- 4) User reaches destination

### **Case 5 - Navigate to Complex Destination (Requires Turning Corner)**

Setup procedure:

Be in the centre of a building with sufficient beacon coverage.

Steps to follow:

- 1) Power ON
- 2) Navigate to and enter list locations mode with hardware buttons
- 3) Choose a complex destination (one requiring a corner turn) by hardware buttons and confirm
- 4) Follow spoken directions

Expected results:

- 1) Handheld powered ON
- 2) Handheld lists all available locations one by one
- 3) Handheld prompts for confirmation and proceeds
- 4) User reaches destination

## **Extreme Case Testing**

### **Case 1 - Outside of Building but Still Receiving Signals**

Setup procedure:

Be outside of a building and still have sufficient beacon coverage.

Steps to follow:

- 1) Power ON
- 2) Navigate to and enter list locations mode with hardware buttons
- 3) Choose any destination
- 4) Listen for voice prompts (if any)

Expected results:

- 1) Handheld powered ON
- 2) Handheld lists all available locations one by one
- 3) Handheld prompts for confirmation and proceeds
- 4) Handheld determines that the user is off the room-map and alerts that the user is out of range



### **Case 2 - Purposely Broadcast Improper Signal from One Beacon to Cause Them to Be Insufficient**

Setup procedure:

Be in the centre of a building with a single bad beacon that otherwise has sufficient coverage.

Steps to follow:

- 1) Power ON
- 2) Navigate to and enter list locations mode with hardware buttons
- 3) Choose any destination
- 4) Listen for voice prompts (if any)

Expected results:

- 1) Handheld powered ON
- 2) Handheld lists all available locations one by one
- 3) Handheld prompts for confirmation and proceeds
- 4) Handheld determines that there is insufficient coverage to reliably compute location and directions and alerts user

### **Case 3 - Purposely Broadcast an Extra Unencoded Signal from One Extra Beacon**

Setup procedure:

Be in the centre of a building with sufficient coverage + an extra beacon with unencoded signal.

Steps to follow:

- 1) Power ON
- 2) Navigate to and enter list locations mode with hardware buttons
- 3) Choose any destination
- 4) Listen for and follow voice prompts (if any)

Expected results:

- 1) Handheld powered ON
- 2) Handheld lists all available locations one by one
- 3) Handheld prompts for confirmation and proceeds
- 4) Handheld determines that the extra beacon is useless and proceeds to provide correct directions