

Volume

1

A-WIT TECHNOLOGIES INC.

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IDQ Line Following Kit Reference Guide Manual

Version 1.0

A-WIT TECHNOLOGIES INC.

IDQ Line Following Kit Reference Manual

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Introduction to the IDQ Line Following Kit

This manual covers the basics of robotics line following using CS491000 IDQ contrast sensors and the BOL-BOT™. Just one of the many activities that can be performed with the BOL-BOT is line following. IDQs are inexpensive and great for line following because you can adjust their position, and use them in different ways depending on the course. The IDQs were specially developed for the A-WIT BOL-BOT. The IDQ sensors can be use in an analog fashion to detect shades of grey or in a digital manner by setting a threshold. However, their versatility does not stop there; you can also add any hysteresis capability that you need depending on your environment. When operating as a digital device, a HIGH voltage signifies a white color, and a LOW signifies black.

The IDQ positions can be adjusted for different sizes and types of lines. This manual demonstrates how the IDQs can be used for digital line following on a 3/4-inch wide electrical tape course with a white background.

Reference Material

The “C Stamp Syntax and Reference Guide Manual” is an essential reference for all C Stamp related projects and activities. It contains information on the C Stamp microcomputer module, software development tools, programming language, kits, Boards of Learning (BOLs), and accessories.

Users will also find very useful performing the design activities outlined in the “CS710XXX (BOL-BOT) Reference Guide Manual”.

The “CS491000 Contrast Sensor Reference Guide Manual” also offers more specific details about the IDQ sensors.

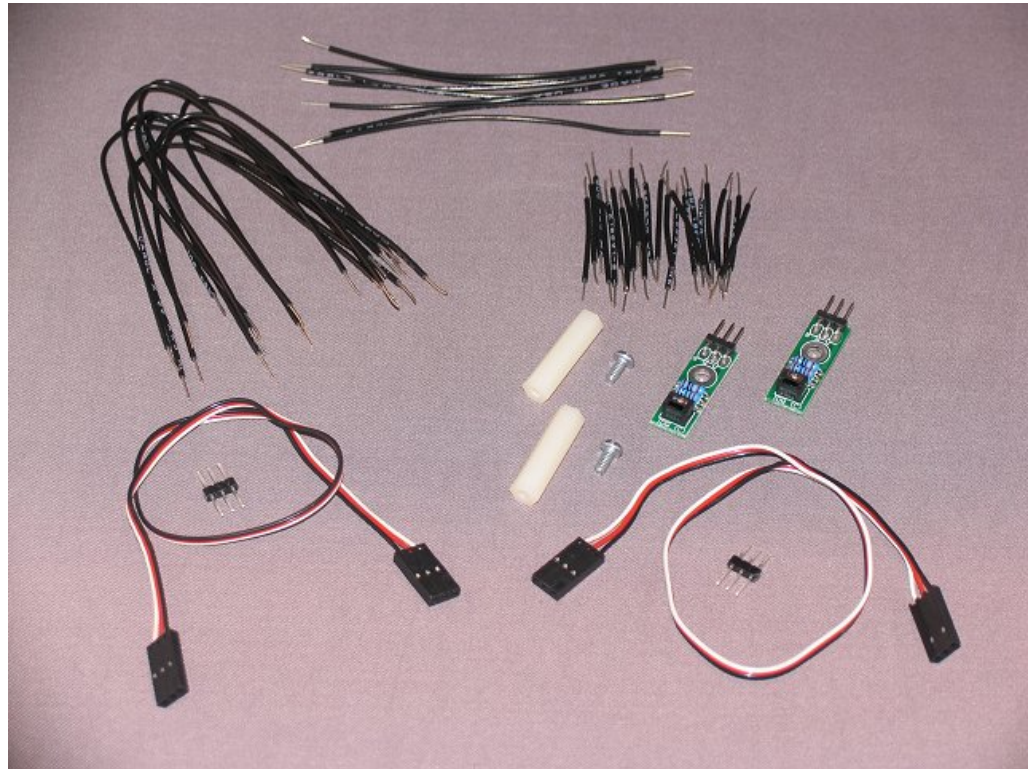
Registering Your C Stamp or C Stamp Related Product

At A-WIT Technologies we respect your privacy; however, we do ask you to register your C Stamp or C Stamp related product, so you can receive free of charge product updates. The registration procedure is simple. Just send an e-mail to tech_support@awit.com with the word “REGISTRATION x” in the subject line, where “x” is the product number that you purchased. If you purchased more than one product, send an e-mail for each different product.

Introduction to the CS950000 IDQ Line Follower Kit for the BOL-BOT

The CS950000 is a kit that uses IDQ contrast sensors to easily enhance the line following capabilities of your BOL-BOT™ Robot. The IDQ sensors mount underneath the BOL-BOT front caster, and they pivot to be positioned and adjusted for different line widths. Because of the superior processing power of the C Stamp, and its Analog-to-Digital conversion capabilities, two IDQ sensors can provide a smooth line following motion. The kit has a total of 47 pieces. This kit includes all the circuit and sensor hardware you need to add IDQs to your BOL-BOT, and the connection of the kit is compact, breadboard friendly, and compatible with the C Stamp signal and power levels.

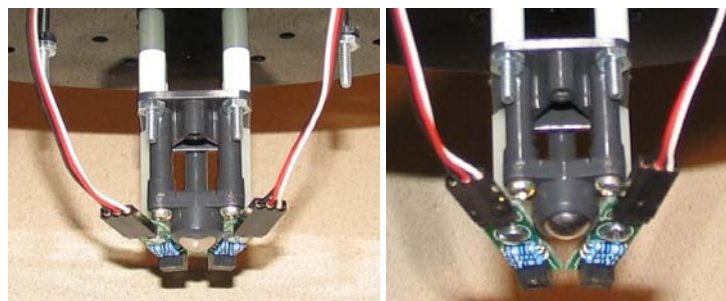
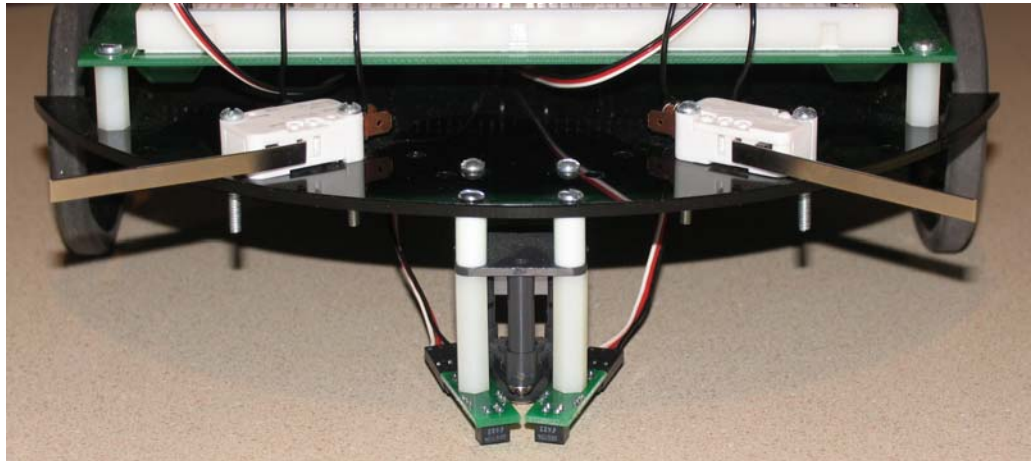
The following figure and table show the contents of the kit.



<i>Contents Description</i>	<i>Minimum Quantity</i>
10-inch Extension Cables	2
3-Pin Headers	2
IDQ Contrast Sensors	2
Spacing Standoffs	2
Standoff-Sensor Screws	2
4 cm hook-up wires	20
10 cm hook-up wires	7
17 cm hook-up wires	10

Assembling the Kit onto the BOL-BOT

This chapter describes and illustrates the steps to follow to assemble the IDQs line following kit onto the BOL-BOT. In terms of tools, you will only need small flat screwdriver. During the subsequent projects, you will learn how to calibrate and program the BOL-BOT for line following. When you finish putting together IDQ sensors on the BOL-BOT, it should look like the figures below.



Assembling the Kit

Follow the following steps to assemble and connect the kit.

1. Remove the two nuts from the two front screws at the front caster.
2. Attach the spacing standoffs to these screws.
3. Connect the extension cables to the sensors paying attention to the color codes.
4. Connect the small end of the headers to the other end of the cables.
5. Attach the sensor to the lower end of the spacing standoffs with the small screws in the kit.
6. Thread the extension cables through the center hole of the BOL-BOT chassis, and toward the front, so you can connect the headers into the BOL breadboard.
7. Use breadboard connection and appropriate jumper wires to connect the black wires of the cables to ground, the white wires to I/O pins, and the red wires to channels of the Analog to Digital converter in the C Stamp.
8. Adjust the sensors for their final positions, according to the line you have.

The white wires of the sensors activate the IR LEDs in the sensors. The red wires output a voltage directly proportional to the level of darkness. For the activities in this manual, the following connections are used. Remember that we define the sides of the BOL-BOT as if you were seating in it in a driving position.

<i>Sensor Connection</i>	<i>C Stamp Connection</i>
Left sensor white wire	Pin 10
Left sensor red wire	Pin 19, Analog Channel 0
Right sensor white wire	Pin 8
Right sensor red wire	Pin 18, Analog Channel 1

IDQ Sensors Projects and Activities

This chapter describes projects and activities that can be done with a line following BOL-BOT. They involve following a 3/4-inch wide electrical tape course with a white background. The material in this chapter is written at a very fundamental level, so depending on the present level of expertise, not all the material will have to be reviewed by all readers. While this manual is generally written in a variable size font, code and its comments are written with a “fixed font”. Additionally, keywords, functions, and commands of the WC language are in “**bold**”. Generic syntax is in a “***bold and italics fixed font***”.

Project 3.1: Calibrating the IDQ Sensors

In this project, we will construct a program to calibrate the IDQ sensors and determine what threshold and hysteresis levels we should use to detect black and white colors.

Project 3.1: Solution

The following program can be used to determine the voltage levels detected by the sensors. The level of the left sensor will be displayed first in the HyperTerminal, and then the level of the right sensor. This program uses HyperTerminal of 4800 baud, 8 data bits, and no parity. Enter, download, and run the following program while connecting to the BOL-BOT via the HyperTerminal.

```
#include "CS110000.h"

void main(void)
{
// TYPE YOUR CODE HERE AFTER THIS LINE
RAM BYTE LED8 = 39; // on board LED8 pin
RAM BYTE DL = 10, DR = 8, QL = 19, QR = 18;
RAM float VIN;
RAM BYTE VINS[9], VINS1, t[] = "\t", r[] = "\r";
```

```

STPIND(LED8, HIGH); // program is alive

while(TRUE) {
  SEROUT(0, 0, 4.8, 0, 8, 0, 0, r, 1);
  STPIND(DL, HIGH); PAUSE(1);
  VIN = ANALOGIN(QL, 2, 0, 0, 0); STPIND(DL, LOW);
  VINS1 = WCftoa(VIN, VINS);
  SEROUT(0, 0, 4.8, 0, 8, 0, 0, VINS, VINS1-1);
  SEROUT(0, 0, 4.8, 0, 8, 0, 0, t, 1);
  STPIND(DR, HIGH); PAUSE(1);
  VIN = ANALOGIN(QR, 2, 0, 0, 0); STPIND(DR, LOW);
  VINS1 = WCftoa(VIN, VINS);
  SEROUT(0, 0, 4.8, 0, 8, 0, 0, VINS, VINS1-1);
  SEROUT(0, 0, 4.8, 0, 8, 0, 0, r, 1);
  PAUSE(100);
}

```

By placing the sensors on the black tape and the white surface, we can see what kind of voltages we are getting from the sensors. If we define the voltage detected by the left and right sensors over a white surface as VH_L and VH_R respectively; and the voltages over a black surface as VL_L and VL_R ; then we can follow the following equations to determine our threshold level and amount of hysteresis. The threshold level is

$$V_{Th} = \frac{VH + VL}{2}$$

where

$$VH = \text{MIN}(VH_L, VH_R)$$

and

$$VL = \text{MAX}(VL_L, VL_R)$$

We also choose a safe hysteresis amount of 0.5 V, so that our high and low threshold points are the threshold level \pm half the amount of hysteresis. So

$$V_{ThH} = V_{Th} + 0.25 \text{ V}$$

and

$$V_{ThL} = V_{Th} - 0.25 \text{ V}$$

We use these results in our next activity, where we construct the line following program.

Project 3.2: Line Following Program

This activity develops a line following program for the BOL-BOT using the IDQ sensors kit. The result of this program can be viewed in the video at

<http://www.c-stamp.com/movies/BOTm9.wmv>

Project 3.2: Solution

The program for line following is shown below, and the comments embedded in it offer more clarifications. This program operates as follows. First, it lights up LED8 in the BOL to signal that the program is alive. Then it waits for the utility button in the BOL to be pushed to continue. When this button is pushed, it lights up BOL LED7 and waits 4 seconds to continue. Then the main loop of the program starts, and is executed continuously. In the main loop of the program, the program always assumes that the BOL-BOT is correctly following the black line and perfectly centered over it. Then it energizes the IR LED for the left IDQ sensor, reads the input voltage, and turns off the IR LED. This sequence of steps is also repeated for the right sensor. After the sensor voltage levels are collected, **if** statements decide the appropriate movement given the voltage levels from the sensors with respect to the threshold points. After the necessary movement has been determined, a **switch** construct drives the servos accordingly.

```
#include "CS110000.h"

void main(void)
{
// TYPE YOUR CODE HERE AFTER THIS LINE
RAM BYTE LED8 = 39; // on board LED8 pin
RAM BYTE DL = 10, DR = 8, QL = 19, QR = 18;
RAM float VINL, VINR;
RAM BYTE lp = 16; // left servo pin
RAM BYTE rp = 17; // right servo pin
RAM BYTE LED7 = 40; // on board LED7 pin
RAM BYTE B = 37; // pin for button
RAM NIBBLE movement;
RAM float VINThH = 0.975; // 0.25 V hysteresis
RAM float VINThL = 0.725;
RAM BYTE T = 10;

STPIND(LED8, HIGH); // program is alive
```

```

while(GTPIND(B)) ;

STPIND(LED7, HIGH); // start moving
PAUSE(4000); // wait 7 seconds before moving

while(TRUE){
    movement = 1; // Forward
    STPIND(DL, HIGH); PAUSE(1);
    VINL = ANALOGIN(QL, 2, 0, 0, 0); STPIND(DL, LOW);
    STPIND(DR, HIGH); PAUSE(1);
    VINR = ANALOGIN(QR, 2, 0, 0, 0); STPIND(DR, LOW);

// Left
    if(VINL >= VINThH && VINR <= VINThL) movement = 2;
// Right
    if(VINL <= VINThL && VINR >= VINThH) movement = 3;
// Stop
    if(VINL <= VINThL && VINR <= VINThL) movement = 0;

    switch(movement){
        case 0: // Stop
            STOP();
        case 1:
            PULSOUT(lp, 800, 1, 1);
            PULSOUT(rp, 400, 1, 1);
            PAUSE(T-3);
            break;
        case 2:
            PULSOUT(rp, 400, 1, 1);
            PAUSE(T-1);
            break;
        case 3:
            PULSOUT(lp, 800, 1, 1);
            PAUSE(T-2);
    }
}
}

```

Terms and Conditions

Quality Assurance

A-WIT has stringent quality control procedures in place to insure the best quality products.

90-Day Limited Warranty

A-WIT Technologies, Inc warrants its products against defects in materials and workmanship for a period of 90 days. If you discover a defect, A-WIT Technologies, Inc. will, at its option, repair, replace, or refund the purchase price. After 90 days, products can still be sent in for repair or replacement, but there will be a \$10.00USD minimum inspection/labor/repair fee (not including return shipping and handling charges).

14-Day Money-Back Guarantee

If, within 14 days of having received your product, you find that it does not suit your needs, you may return it for a refund. A-WIT will refund the purchase price of the product in the form of a check, excluding shipping/handling costs, once the product is received. This refund does not apply if the product has been altered or damaged. If you decide to return the products after the 14-day evaluation period, a 20% restocking fee will be charged against a credit.

Disclaimer

Warranty does not apply if the product has been altered, modified, or damaged. A-WIT makes no other warranty of any kind, expressed or implied, including any warranty of merchantability, fitness of the product for any particular purpose even if that purpose is known to A-WIT, or any warranty relating to patents, trademarks, copyrights or other intellectual property. A-WIT shall not be liable for any injury, loss, damage, or loss of profits resulting from the handling or use of the product shipped.

How to Return a Product

When returning, you must first e-mail sales@a-wit.com for a Return Merchandise Authorization number. No packages will be accepted without the RMA number clearly marked on the outside of the package. After inspecting and testing, we will return your product, or its replacement using the same shipping method used to ship the product to A-WIT within 30 days. In your package, please include a daytime telephone number and a brief explanation of the problem.

Please contact our Sales Department at sales@a-wit.com if you have any questions regarding our warranty policy or if you are requesting an RMA number.

