Reference Design

World of Sensors Design Board

RD001204-0814

Overview

The World of Sensors (WoS) Design Board, a complete and easy-to-use development platform for Zilog's series of Mini-Z™ stamp modules, is designed to provide engineers, students and enthusiasts a simple-to-use platform for developing prototypes and projects incorporating multiple sensors. These sensors range from simple weather terminals to robotics. Engineered to capitalize on the advanced functionality of Zilog's series of Mini-Z modules, the WoS Design Board showcases the interaction of these sensors independent of the module being used, enabling even more creative projects by just swapping out modules.

Although it is designed to work best with Zilog's series of Mini-Z modules, the WoS Design Board is compatible with other vendors' basic stamp modules. In essence, you can begin your project with what you already have and add a Mini-Z Module later when you are ready for its extra features. The WoS Design Board uses a USB-to-serial converter so that you no longer need to find a converter or a serial port.

The WoS Design Board, shown in Figure 1, is based on Zilog's ZNEO Z16F Series MCU. It is designed to be operated by either a 9V battery or an external power supply.

Figure 1. Zilog's World of Sensors Design Board

Figure 2 shows the Board with a battery and a Mini-Z™ Z-PAN® Module mounted onto it. Note the Reset button, which is highlighted in the figure.

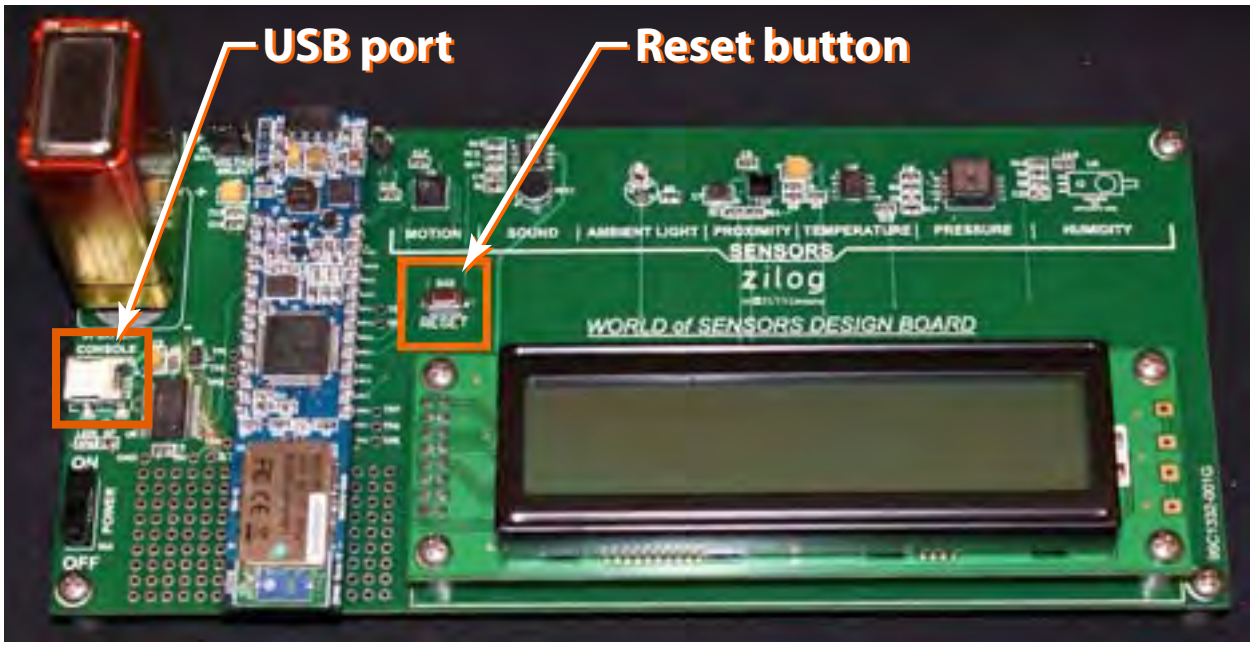

Figure 2. Zilog's World of Sensors Design Board with Module Attached

World of Sensors Features

The World of Sensors Design Board indeed includes a world of sensing technology with which you can easily experiment, including:

- Seven Different Sensors on Different Peripherals
  - Accelerometer
  - Ambient Light Sensor
  - Humidity
  - Microphone
  - Pressure Sensor
  - Proximity Sensor
  - Temperature Sensor
- Serial LCD display
- USB serial communications: no more serial cables required
- Operated by battery or external power

- Compatible with the Parallax Basic Stamp programming boards, the Basic Micro ATOM Pro and Zilog's series of Mini-Z™ modules

The source code, contained in the RD0012-SC01.zip file, is provided for the Shell application; a stand-alone version of this code is contained in the RD0012-SC02.zip file. The stand-alone version requires a Smart Cable (not included in the World of Sensors Design Kit) to flash the Module and monitor all sensors on the LCD display.

This stand-alone code allows a user to take the WoS Design Board anywhere and monitor the sensors without requiring a terminal program or an external connection of any sort. The Shell application source code is also included. For more information, please see the `readme.rtf` that is contained in the root of the RD0012-SC01.zip file.

Potential Applications

Use the World of Sensors Design Board to develop a wide assortment of different applications, including but not limited to:

- Weather stations
- Car alarms
- Wireless monitors
- Robotic sweepers
- Remote control applications

Shell Application

Every Mini-Z™ Module is preloaded with a boot loader and control shell. The shell application provides access to the Module and to the Design Board that the Module attaches to. The Mini-Z Library provides control of the sensors' functionality directly through the shell.

Installing The Shell Application

Observe the following brief procedure to install the shell application.

1. Connect the USB cable from the PC to the WoS Design Board's USB port. The USB port is located adjacent to the battery terminal and is labeled `CONSOLE`, as shown in Figure 2 on page 2.
2. Launch a terminal emulation program (such as HyperTerminal or TeraTerm[1]) and establish a connection to the WoS Design Board. The terminal application's communication settings should reflect the following values:

1. In this document, HyperTerminal is discussed.

- 57600 baud rate
- 8 data bits
- No parity
- 1 stop bit
- No flow control

3. Connect the WoS Design Board to the appropriate power source (9V battery or external supply), and set the Voltage Select jumper (JMPR1) accordingly. Turn on the WoS Design Board using SW1. LED1 should illuminate, and you should see the following command prompt on your terminal:

   ```
   Z16MiniZ>
   ```

Note: The prompt shown above will appear if you are working with the ZNEO Module. If you are instead working with Zilog's WLAN Module, you'll see this prompt portrayed as `WLANMiniZ>`. With the Z-PAN Module, this prompt will appear as `BTMiniZ>`.

4. Enter the following command:

   ```
   Flashapp
   ```

5. Press the **Enter** key. The console will prompt you to transfer the hex file. From the **Transfer** menu in HyperTerminal, select **Send Text File...** (no modem protocol). The Send Text File dialog will appear in Windows.
6. From this dialog, navigate to and select the `wos_app.hex` file, and click **OK** to flash the code to the Module. You may need to change `Files of Type` to `All files (*.*)` at the bottom of the Send Text File window.
7. After the Module has been flashed, the console will return to the command prompt. Enter the following command to execute the application and start the sensor processes:

   ```
   Execapp
   ```

Installation of the shell application is now complete. However, bear in mind that the next time you power on the WoS Board, you must enter the `Execapp` command to once again execute the application and be able to have the WoS commands available to you.

For additional details about the shell application, see the Mini-Z Shell and Flash Loader Reference Manual (RM0061).

World of Sensors Commands

The World of Sensors application currently provides seven sensors that sense several types of environmental conditions or stimuli. However, only four of these commands are

displayed on the console. These four commands are listed in Table 1, and are described following this table.

Table 1. Console-Displayed Sensors and their Commands

Command	Condition/Stimulus
GetPressure	Pressure
GetHumidity	Humidity
GetTemp	Temperature
GetAmbient	Ambient light

Commands Displayed on the Console

GetPressure. This command retrieves the latest reading from the pressure sensor and displays this reading on the console.

Example

```
GetPressure
Pressure Reading:    57 kPa
```

GetHumidity. This command retrieves the humidity sensor's reading and displays on the console.

Example

```
GetHumidity
Humidity:            70%
```

GetTemp. This command retrieves the Temperature sensor's reading and displays on the console.

Example

```
GetTemp
Current Temp:        23 C
```

GetAmbient. This command retrieves the ambient light from the TEPT4000 sensor and displays the ADC reading on the console (0–1023).

Example

```
GetAmbient
Ambient Light:       311
```

Display Commands

Readings from all seven World of Sensors sensors can be viewed on the LCD display in a rotating sequence. To monitor these readings, however, first requires that the LCD display

be activated. There are three such display commands; each of these commands is listed in Table 2 and described following the table.

Table 2. Display Commands

Command	Function
Display	Displays a requested string on the LCD display.
DisplayOff	Turns the LCD display off.
SetBackLight	Sets the intensity of the LCD display.

Display. Parameter 1 is displayed on Line 1, and Parameter 2 is displayed on Line 2. If there are sensors currently being monitored, they are stopped.

Example

```
Z16MiniZ> Display Hello World
```

The LCD will display:

```
Hello
World
```

DisplayOff. This command is a toggle to the Display command; it clears the display, turns it off, and stops any monitoring of sensors.

SetBacklight. This command sets the intensity of the backlight. The range of values is 1 to 8, in which 1 is darkest and 8 is brightest.

An example of a `SetBacklight` parameter is:

Example

```
Z16MiniZ> SetBackLight 1
```

As a result, the LCD will have no backlighting (i.e., will not be illuminated).

Commands Displayed on the LCD

Readings from each of the seven sensing functions are parameters of the Monitor command; any combination of these seven functions can be displayed in rotating sequence on the LCD. An eighth parameter, `All`, can be used to monitor all sensors, if desired, and the duration of appearance of any of these sensor readings can also be controlled. See Table 3.

Table 3. LCD-Displayed Sensors and their Commands

Command	Parameter	Function
Monitor	Ambient	Displays a reading from the ambient light sensor.
	Humidity	Displays a reading from the humidity sensor.
	Motion	Displays a reading from the 3-axis accelerometer
	Pressure	Displays a reading from the pressure sensor.
	Proximity	Displays a reading from the proximity sensor.
	Sound	Displays a reading from the microphone.
	Temp	Displays a reading from the temperature sensor.
	All	Displays all sensors.
MonitorPeriod	Controls the length of time each sensor reading is displayed on the LCD.	

A second parameter, `only`, can be appended to any one of the Monitor commands to present only one sensor reading on the LCD, if desired.

Example

```
Monitor Sound only
```

As a result, the LCD will display only one reading which monitors the microphone.

Monitor. This command starts monitoring a sensor and displays its output on the LCD. `Monitor` is also an additive command, meaning that each time you make a request to monitor a sensor, that sensor is added to the current list of sensors being monitored.

Examples of parameters for the `Monitor` command include:

Monitor Temp

The temperature sensor reading will be shown on the LCD display.

Monitor Motion

The temperature sensor output, followed by the accelerometer output, will display on the LCD.

Monitor Sound only

The sound sensor reading will be the only string shown on the LCD until you add another sensor or stop monitoring.

MonitorPeriod

This command controls how long to monitor each sensor reading on the LCD display before the display rotates to the next sensor reading in the sequence. The values for this parameter range from 5–60. Each monitor period is approximately `value * 2 seconds`. These periods are only relative; they are not deterministic.

Example

```
MonitorPeriod 3
```

As a result, the LCD will display a monitored sensor reading on the LCD display for 6 seconds.

As indicated in Table 3 and in previous sections, the World of Sensors Design Board also provides the following monitoring functionality:

- Use the `ALL` parameter to select and monitor all sensors.
- To monitor only one sensor, use `only` as a second parameter. Adding the `only` parameter will remove any other sensors currently being monitored and list only one sensor.
- To remove all sensors from the list of sensors being monitored, use the `DisplayOff` command.
- Use the `Monitor` command to toggle these sensors back into the list.

The World of Sensors source code files, RD0012-SC01.zip and RD0012-SC02.zip, are available free for download from the Zilog website. These code files also require the Mini-Z™ Library (RD0006-SC01) because the code utilizes the Library's shell functionality for access to ADCs, console I/O, and timing operations. To learn more about these functions, refer to the Mini-Z Shell and Flash Loader Reference Manual (RM0061) and the `Mini-ZLibrary.txt` readme file.

Hardware Description

This section briefly describes the hardware attributes of each of the WoS sensors.

Accelerometer

The accelerometer included on the WoS Design Board is a 3-axis ADXL312 Digital Accelerometer. On the Board, the accelerometer is interfaced through a 4-wire SPI bus. The accelerometer also provides interfaces for 3-wire SPI and I^2C buses.

Ambient Light Sensor

A TEPT4400 ambient light sensor is used to detect visible light. The sensor is connected to the ADC peripheral of the Module. Sensor readings are retrieved from the ADC on the Module that is connected to a light-dependent voltage divider.

Humidity Sensor

A NHD-0220D3Z-FL-GBW humidity sensor is connected to the ADC peripheral of the Module and, due to this device's light sensitivity, is placed under the Board. The humidity sensor detects humidity levels in areas local to the location of the WoS.

Microphone

A WM-64PN microphone is connected to the ADC peripheral of the Module. The sound level of the local environment is derived from a simple Goertzel algorithm.

Pressure Sensor

A MP3H6115A pressure sensor is connected to the ADC peripheral of the Module.

Proximity Sensor

A VCNL4000 proximity sensor is a fully-integrated proximity and ambient light sensor that supports the I^2C bus communication interface.

Temperature Sensor

A DS18S20 temperature sensor is a 1-wire device that is implemented through a single GPIO port on the Module.

LCD

The serial LCD is controlled through a unidirectional software UART, utilizing a single GPIO pin.

Port-to-WoS Sensors Mapping

The World of Sensors Design Board is controlled by Zilog's Z16F2810 MCU. Table 4 lists the sensor channels that correspond to each Z16F2810 MCU port.

Table 4. Port to WoS Sensors Mapping

Port	Peripheral	Sensor
P0	Microphone	ADC—ANA0
P1	Humidity	ADC—ANA1
P2	Pressure	ADC—ANA2
P6/P7	Proximity	I^2C
P8	LCD	SW UART GPIO
P9	Temperature	OneWire GPIO
P10–P13	Accelerometer	SPI
P16	Ambient Light	ADC—ANA10
P3, P4, P5, P14, P15, P17, P18, P19	Available GPIOs	N/A

Pin Assignments

The World of Sensors Design Board is a development platform for multiple Mini-Z modules that are controlled by the Z16F2810 MCU; this MCU is based on Zilog's ZNEO CPU. Table 5 lists the port that corresponds to each of the Mini-Z modules' pins.

Table 5. Mini-Z Module Pin Assignments

Pin	Port
1	S_{OUT}
2	S_{IN}
3	DTR
4	V_{SS}
5	P0
6	P1
7	P2
8	P3
9	P4
10	P5
11	P6
12	P7
13	P16
14	P17
15	P18
16	P19
17	P8
18	P9
19	P10
20	P11
21	P12
22	P13
23	P14
24	P15
25	V_{CC} I/O
26	Reset
27	V_{SS}
28	V_{IN}

Electrical Characteristics

Table 6 lists the electrical characteristics of the Mini-Z™ World of Sensors Design Board and reflects all available data as a result of testing prior to qualification and characterization. As such, the data presented in Table 6 is subject to change.

Note: Stresses greater than those listed in Table 6 may cause permanent damage to the device. These ratings are stress ratings only. Operation of the device at any conditions outside those indicated in the operational sections of these specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect device reliability. For improved reliability, unused pins must be tied to one of the supply voltages (V_{DD} or V_{SS}).

Table 6. Electrical Specifications for the World of Sensors Design Board

Parameter	Min	Max	Units	Notes
V_{IN} range	5.5	17	Volts	Module-dependent
Max. voltage range on all other pins	–0.3	5.5	Volts	I/O pins and Reset. ADC pins are not 5V-tolerant.
Max. current for I/O pin connection points	–25	25	mA	
Max. V_{IN} current	–	1	A	
Ambient temperature	–40	105	°C	
Storage temperature	–65	150	°C	

Table 7 lists the electrical characteristics of the WoS LCD Display. For more information, please refer to the NHD-0220D3Z-FL-GBW data sheet from Newhaven Display website.

Table 7. Electrical Specifications for the WoS LCD Display

Parameter	Symbol	Min	Typ	Max	Unit
Operating Temperature Range	T_{OP}	–20	–	70	°C
Storage Temperature Range	T_{ST}	–30	–	80	°C
Supply Voltage	V_{DD}	4.7	5.0	5.5	V
Supply Current	I_{DD}	–	245	–	mA
Supply for LCD (contrast)	V_{DD}–V_O		–	–	V
"H" Level Input (Schmitt Trigger)	V_{IH}	0.8 * V_{DD}	–	V_{DD}	V
"L" Level Input (Schmitt Trigger)	V_{IL}	V_{SS}	–	0.2 * V_{DD}	V
"H" Level output	V_{OH}	–	–	–	V
"L" Level output	V_{OL}	–	–	–	V
Backlight Supply Current	I_{LED}	–	120	–	mA

Table 8 lists the electrical characteristics of the WoS accelerometer. For more information, please refer to the ADXL312 Digital Accelerometer data sheet from the Analog Devices website.

Table 8. Electrical Specifications of the WoS Accelerometer

Parameter	Conditions	Min	Typ	Max	Unit
Operating voltage		2.0	–	3.6	Volts
Interface voltage range		1.7	–	V_S	Volts
Supply current	Data rate > 100Hz	100	170	300	µA
Turn-on time		–	1.4	–	ms
Operating temperature		–40	–	105	°C

Table 9 lists the electrical characteristics of the WoS Ambient Light Sensor. For more information, please refer to the TEPT4400 data sheet from the Vishay Semiconductors website.

Table 9. Electrical Specifications of the WoS Ambient Light Sensor

Parameter	Conditions	Min	Typ	Max	Unit
Collector emitter breakdown voltage	I_C = 0.1mA	6	–	–	Volts
Collector dark current	V_{CE} = 5V, E = 0	20	–	16,000	Hz
Collector emitter capacitance	V_{CE} = 0V, f = 1MHz, E = 0	–	–	500	pF
Wavelength of peak sensitivity		–	570	–	nm
Collector emitter saturation voltage	E_V = 20lx, CIE illuminant A, IPCE = 1.2µA	–	0.1	–	V

Table 10 lists the electrical characteristics of the WoS Humidity Sensor. For more information, please refer to the HIH-5030 data sheet from the Honeywell website.

Table 10. Electrical Specifications of the WoS Humidity Sensor

Parameter	Symbol	Min	Typ	Max	Unit
Voltage supply	V_S	2.7	–	5.5	Volts
Current supply	V_I	–	200	500	µA
Voltage output	$V_{OUT} = (V_{SUPPLY})$ * [0.00636(sensorRH) + 0.1515], typical at 25°C				
Operating temperature	T_O	–40	–	85	°C

Table 11 lists the electrical characteristics of the WoS Microphone. For more information, please refer to the WM-64PN data sheet from the Panasonic website.

Table 11. Electrical Specifications of the WoS Microphone

Parameter	Min	Typ	Max	Unit
Operating voltage	2.0	–	10	Volts
Frequency	20	–	16,000	Hz
Supply current	–	–	500	µA
Sensitivity reduction	Within –3dB @ 1.5V			
S/N ratio	More than 58dB			

Table 12 lists the electrical characteristics of the WoS Pressure Sensor. For more information, please refer to the MP3H1165A data sheet from the Freescale Semiconductor website.

Table 12. Electrical Specifications of the WoS Pressure Sensor

Parameter	Symbol	Min	Typ	Max	Unit
Pressure range	POP	15	–	115	k_{PA}
Supply voltage	V_S	2.7	3.0	3.3	V_{DC}
Supply current	I_O	–	4.0	8.0	mA
Sensitivity	V/P	–	27	–	mV/k_{PA}
Response time	t_R	–	1.0	–	ms
Minimum pressure offset @ V_S = 3.0V	V_{OFF}	0.779	0.12	0.161	V_{DC}
Full scale output @ V_S = 3.0V	V_{FSO}	2.780	2.82	2.861	V_{DC}
Full scale span @ V_S = 3.0V	V_{FSS}	2.660	2.70	2.741	V_{DC}

Table 13 lists the electrical characteristics of the WoS Proximity Sensor. For more information, please refer to the VCNL4000 data sheet from the Vishay Semiconductors website.

Table 13. Electrical Specifications of the WoS Proximity Sensor

Parameter	Min	Typ	Max	Unit
Supply voltage V_{DD}	2.5	–	3.6	Volts
Supply voltage IR anode	2.5	–	5.0	Volts
I^2C Bus H-level range	1.7	–	5	Volts
I^2C Clock rate range			3400	kHz
Ambient light resolution		0.25		I_X
Ambient light output		400		Counts

Table 14 lists the electrical characteristics of the WoS Temperature Sensor. For more information, please refer to the DS18S20 data sheet from the Maxim website.

Table 14. Electrical Specifications of the WoS Temperature Sensor

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply voltage	V_{DD}	Local Power	3.0	–	5.5	Volts
Pull–up supply voltage	VPU		3.0	–	V_{DD}	Volts
Sink current	I_L	VI/O = 0.4V	4.0	–	–	mA
Standby current	I_{DDS}		–	750	1000	nA
Active current	I_{DD}	V_{DD} = 5V	–	1	1.5	mA

Packaging

Figure 3 shows a top view of the World of Sensors Design Board.

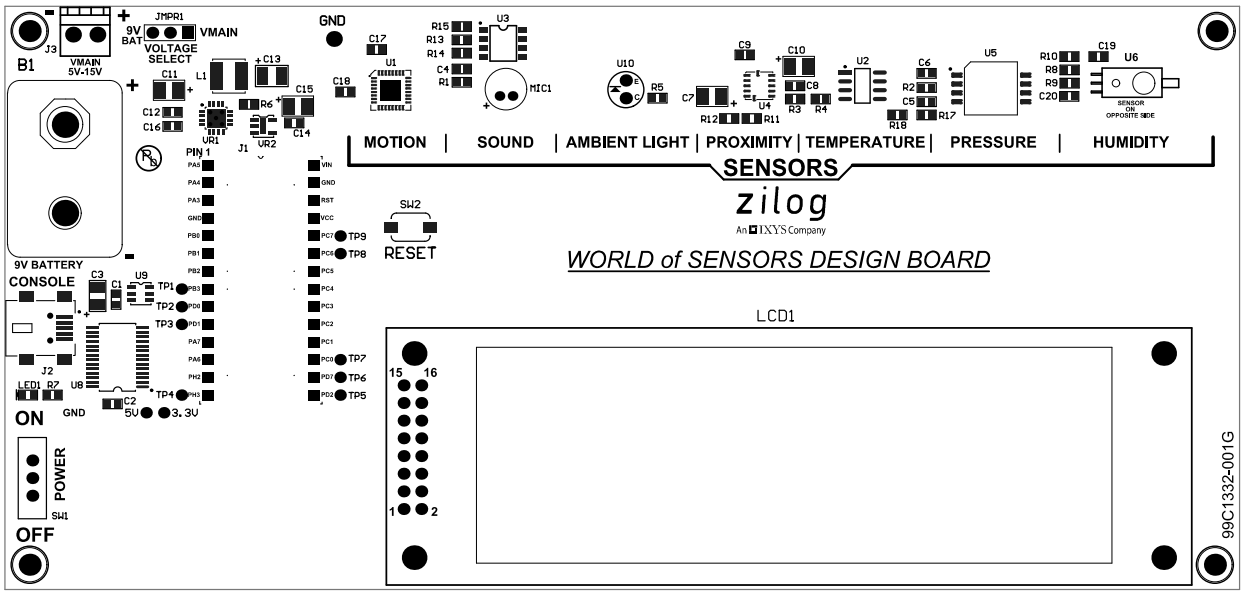

Figure 3. World of Sensors Design Board Pin Assembly Diagram, #1 of 2

Mechanical Profile

Figure 4 displays the top- and side-view dimensions of the World of Sensors Design Board.

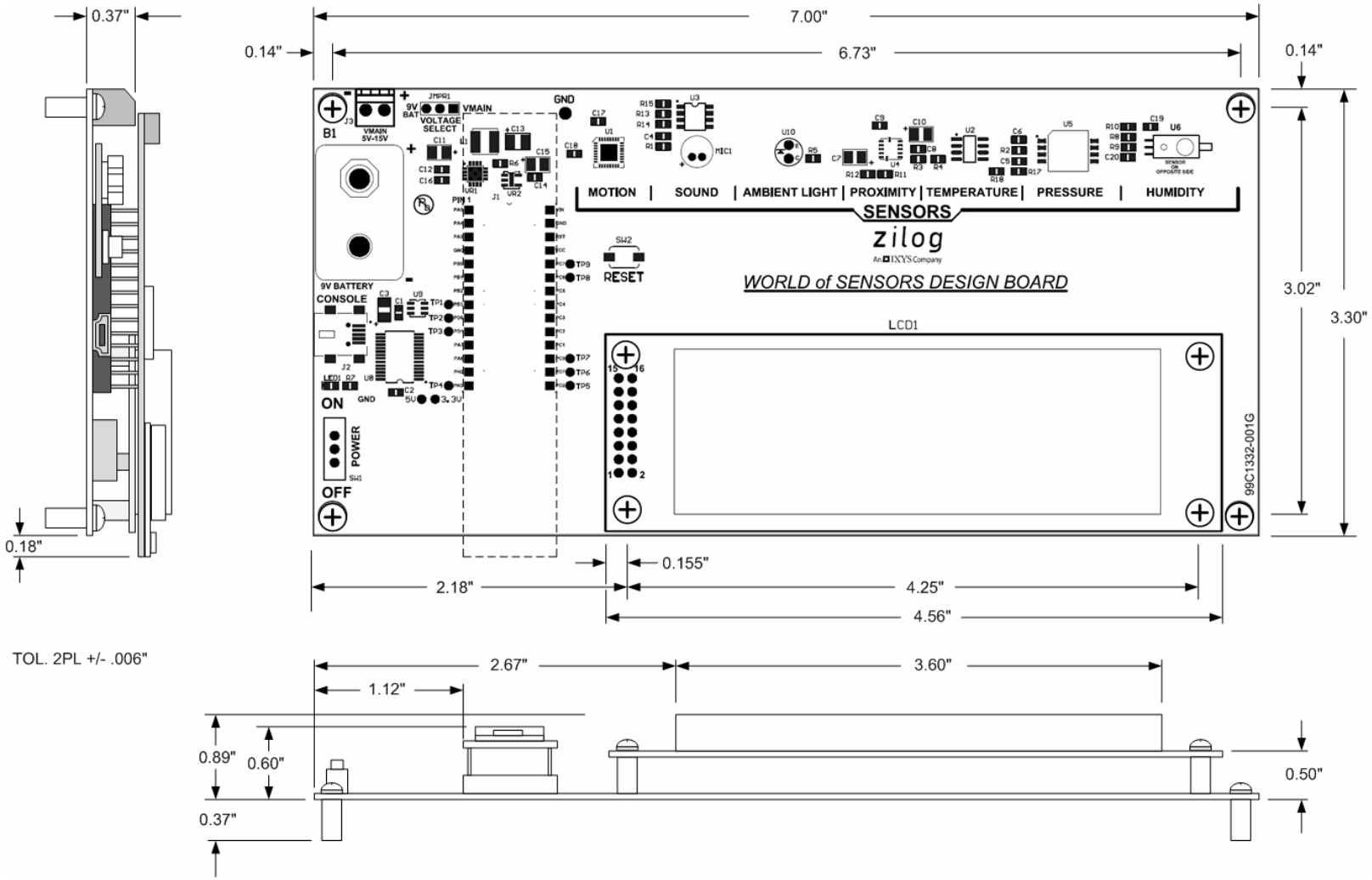

Figure 4. World of Sensors Design Board Physical Dimensions

Ordering Information

The World of Sensors Design Board can be purchased from the Zilog Store – simply click the Store Product IDs listed in Table 15.

Table 15. World of Sensors Design Board Ordering Information

Part Number	Description	Store Product ID
Z16F28WS100ZRDG	World of Sensors Design Board	RD10018
Z16F28WS100KITG	World of Sensors Design Kit	RD10019
Z16F2800100MODG	Mini-Z ZNEO 28-Pin Module	RD10002
Z16F28WF100MODG	Mini-Z WLAN 28-Pin Module	RD10003
Z16F28ZP100MODG	Mini-Z Z-PAN 28-Pin Module	RD10008
Z16F28ZP100KITG	Mini-Z Z-PAN SSR Kit	RD10009

Kit Contents

The World Of Sensors Design Board (Zilog part number Z16F28WS100MODG) is comprised of the following two items; Mini-Z modules are sold separately.

- World Of Sensors Design Board
- USB cable (A to Mini-B Male)

The World Of Sensors Design Kit (Zilog part number Z16F28WS100KITG) includes everything you need to start working with your Board right out of the box, including the following items:

- World of Sensors Design Board
- Mini-Z ZNEO Module
- USB Smart Cable
- Mini-Z to Smart Debug Cable adapter
- USB cable (A to Mini-B Male)
- DIP Extractor

Related Documentation

The documents associated with the World of Sensors Design Board are listed in Table 16. Each of these documents can be obtained from the Zilog website by clicking the link associated with its Document Number.

Table 16. World of Sensors Documentation

Document Number	Description
RD0012	This Mini-Z World of Sensors Design Board document
RD0012-SC01	World of Sensors application source code
RD0012-SC02	Stand-alone source code
RD0006	Mini-Z ZNEO 28-Pin Module Reference Design document
RD0006-SC01	Mini-Z Library
RM0061	Mini-Z Shell and Flash Loader Reference Manual
PS0220	ZNEO Z16F Series Product Specification
UM0188	ZNEO CPU Core User Manual
UM0181	USB Smart Cable User Manual

Schematic Diagram

Figure 5 shows a schematic diagram of the World of Sensors Design Board.

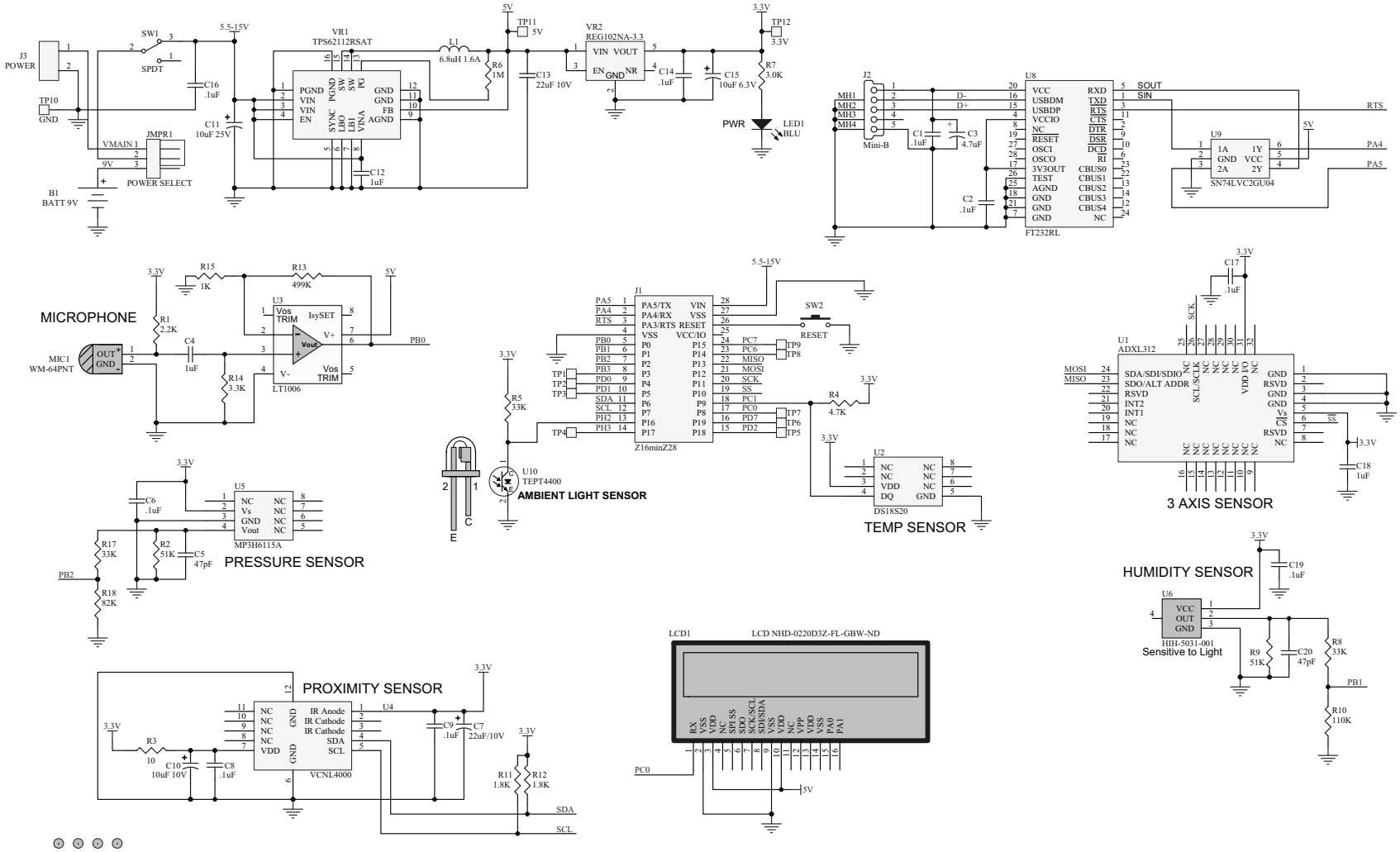

Figure 5. World of Sensors Design Board Schematics

Appendix A. Sensor Functions

This appendix presents the WoS stand-alone code as a reference.

The primary function of the World of Sensors Design Board is to provide a simple user interface to access all of the Board's sensors without being required to attach it to a PC. Additionally, the Board's ambient light sensor is used as a switch to navigate around the menu displayed on the LCD.

Accelerometer

The accelerometer can be accessed by initializing first the SPI of the ZNEO CPU. This prepares the ZNEO for reading and writing data from and to the accelerometer. Using the functions mentioned on the SPI section, accelerometer is initialized through `AXL_init()` and starts the measurement. Part of the accelerometer initializations, `AXL_init()`, are presented in Table 17.

Table 17. Accelerometer Functions

Function	Description
AXL_readDeviceID()	Reads the accelerometer device ID. It is used to identify the SPI device to be accessed. Because there is only one SPI device on the Board, use of this function is optional.
AXL_writeDataFormat()	Used to set the accelerometer to 4-wire SPI mode, 10-bit resolution, right justified data reading, 1.5g range and disables self test.
AXL_writeFIFO ()	Sets the accelerometer to hold latest 32 samples of X, Y and Z axes data.
AXL_writePowerCtrl()	Disables the accelerometer's Automatic Sleep Mode and sets it to Measuring Mode.

Table 18 presents the functions use to read accelerometer data from the X, Y and Z axes.

Table 18. Accelerometer Axis Read Functions

Function	Description
AXL_readXAxisData ()	Reads X-axis data from the accelerometer.
AXL_readYAxisData ()	Reads Y-axis data from the accelerometer.
AXL_readZAxisData ()	Reads Z-axis data from the accelerometer.

Ambient Light Sensor

The ambient light sensor interfaces with the Mini-Z stamp via ANA10 configured to run in polled mode. A predefined threshold voltage serves to detect low lighting conditions.

Table 19 presents the functions to determine ambient light levels and to identify the states of the switch.

Table 19. Ambient Light Sensor Functions

Function	Description
ucALS_IsLowLight()	Determines whether the ambient light sensor goes beyond the predefined threshold voltage. Returns true if the sensor goes beyond the threshold voltage. Otherwise, it returns false.
eALS_SwitchState ALS_ScanSwitch()	Uses a 1-sec timer to identify 3 states of the switch, namely - not pressed, a short press, and a long press.

Humidity Sensor

The humidity sensor reads the humidity level and outputs a voltage directly proportional to the humidity level, as presented in Table 20.

Table 20. Humidity Sensor Functions

Function	Description
Get_Humidity()	Get ADC samples from ANA1 and compute for the corresponding humidity level.
AveFilter()	Calculate the average of the humidity level.
Print_Humidity()	Display the average humidity level to Serial LCD.

Microphone

Table 21 lists the microphone functions as a sound sensor that identifies the current sound intensity of an environment. It is interfaced to the ANA0 port of the Mini-Z stamp and is used in interrupt mode.

Table 21. Microphone Functions

Function	Description
MIC_Init()	Initializes the Timer1 for microphone data sampling time.
MIC_GetNoiseLevel()	Acquires sound samples at fixed interval and performs computations on the current sound level.

Pressure Sensor

The pressure sensor senses atmospheric pressure in Kilo Pascals (kPa) and outputs a voltage directly proportional to relative absolute pressure; see Table 22.

Table 22. Pressure Sensor Functions

Function	Description
Get_Pressure()	Get ADC samples from ANA2 and compute for the corresponding pressure reading.
print_Pressure()	Display the actual pressure value to Serial LCD.

Proximity Sensor

The proximity sensor is actually a combined proximity sensor and ambient light sensor. It is an I^2C device that can be accessed by first initializing the I^2C block of the ZNEO CPU. This initialization process prepares the ZNEO CPU for writing and reading data to and from the proximity sensor. Table 23 presents the functions for initialization of proximity sensor, start of measurement, and reading proximity and ambient light data.

Table 23. Proximity Sensor FunctionsTable 21

Function	Description
PROXIMITY_readDeviceID()	This reads the proximity sensor device ID. It is used to identify the I^2C device to be accessed. Because there is only one I^2C device on the Board, this is optional to use.
PROXIMITY_init()	This function sets the proximity measurement signal frequency to 781.25KHz, modulator timing to DEFAULT values, enable offset compensation and set ambient light averaging function to 32 conversions. Also, part of this function is the Proximity_readDeviceID().
PROXIMITY_startMeasurement()	This function sends command to proximity sensor to start measurement for proximity and ambient light and then results are available for reading. It is executed first before PROXIMITY_readProxData() and PROXIMITY_readAmbientData().
PROXIMITY_readProxData()	Reads proximity value from the proximity sensor device.
PROXIMITY_readAmbientData()	Reads ambient light value from the proximity sensor device.

Temperature Sensor

The temperature sensor is interfaced to a single GPIO, which must first be initialized before reading and writing data to the 1-wire temperature sensor. After the temperature sensor is initialized, temperature measurements follow. Commands to control the temperature sensor are listed in Table 24.

Table 24. Temperature Sensor Functions

Function	Description
ONEWIRE_Init()	This function initializes the 1-wire device and it contains the following transaction sequences: ONEWIRE_Reset() and ONEWIRE_WriteByte(SKIP_ROM).
ONEWIRE_Reset()	This function resets the devices and checks if the device is present.
ONEWIRE_WriteByte(SKIP_ROM)	This command addresses the device without sending the ROM code information.
ONEWIRE_WriteByte(CONVERT_T)	Initiates a single temperature conversion.
ONEWIRE_ReadTemperature()	Read the actual temperature data. It sends command to 1-wire device to start the proper writing and reading of data. The gathered data will be displayed on the Serial LCD.

LCD Display

Table 25 presents the Serial LCD functions used to display readings of all the sensors in the WoS Kit.

Table 25. Serial LCD Functions

Function	Description
LCD_Init()	Initialize serial LCD.
display_clear()	Clear LCD display and set the cursor to home.
go_home()	Set the cursor to home.
turn_off_lcd()	Turn OFF LCD.
turn_on_lcd()	Turn ON LCD.
turn_off_cursor()	ON LCD cursor.
turn_on_cursor()	OFF LCD cursor.
change_contrast(unsigned char x)	Change the contrast level x, x can be 1–50, with 50 being the highest contrast.
Set_cursor(unsigned char ln, unsigned char col)	Set the cursor position using Line(ln) and Column(col), Line equal 1 or 2, Column equal any of 1–20.
move_cursor_right()	Move the cursor 1 place to the right.
move_cursor_left()	Move the cursor one place to the left.
blink_cursor()	Blink cursor on.

Table 25. Serial LCD Functions (Continued)

Function	Description
unblink_cursor()	Blink cursor off.
back_cursor()	Move cursor to the previous position.
change_baud(unsigned char x)	Change the baud rate using x.

ADC

The ADC peripheral block of the Mini-Z stamp is used by four of the sensors in the World of Sensors Design Board, namely: microphone, humidity sensor, pressure sensor, and ambient light sensor. The ADC is configured to use the 2V internal V_{REF} of the Mini-Z stamp. Table 26 presents the functions for ADC initialization and reading values.

Table 26. ADC Functions

Function	Description
ADC_Init()	Initializes the ADC ports used by the World of Sensors Design Board.
ADC_Read(UINT8 ch)	Reads the ADC channel specified by ch via polled mode.1
ADC_ReadInterrupt(UINT8 ch, UINT16 *buffer, UINT16 size)	Reads the ADC channel specified by ch via interrupt mode. This routine waits until buffer is full before returning to the calling function. This will prevent other sensors using the ADC to interfere with the ADC data gathering.

Timer

The Timer0 function of the Mini-Z stamp is configured to interrupt every 1ms. Timer0 is used for the overall timing requirements of the WoS firmware, and uses several count-down timer variables that are updated at each timer interrupt to adhere to several timing requirements of the application. Table 27 presents the Timer0 functions.

Table 27. Timer Functions

Function	Description
TMRMT_Init()	Initializes the Timer0 and the counters used for variable counting.
TMRMT_StartTimer(eTMRMT_Channels ch, UINT16 time)	Starts the specified timer channel with the specified time.
TMRMT_StopTimer(eTMRMT_Channels ch)	Stops the timer channel ch.
bTMRMT_IsTimeout(eTMRMT_Channels ch)	Checks if a timeout event has occurred at the specified timer channel.

SPI

The SPI block of the Mini-Z stamp is used by the accelerometer. It is configured as a Master, and data transfer is controlled by software polling. Accessing the accelerometer is performed by the functions listed in Table 28.

Table 28. SPI Functions

Function	Description
SPI_Read_SingleByte (UCHAR ucSPI_deviceReg)	This function sends the register address to the accelerometer and reads its content.
SPI_Write_SingleByte (UCHAR ucSPI_deviceReg, UCHAR ucSPI_cmdData)	This function sends the register address to the accelerometer and the data to be written on it.

I^2C

The I^2C block of the Mini-Z stamp is used by the proximity sensor. It is configured as a Master, and data transfer is controlled by software polling. Accessing the proximity sensor is performed by the functions listed in Table 29.

Table 29. I^2C Functions

Function	Description
I2C_readByte (UCHAR ucI2C_deviceReg)	This function sends the register address to the proximity sensor and reads its content.
I2C_writeByte (UCHAR ucI2C_deviceReg, UCHAR ucI2C_cmdData)	This function sends the register address to the proximity sensor and the data to be written on it.

Appendix B. Replacing the Application Code with Stand-Alone Code

The stand-alone code contained in the RD0012-SC02 file allows a user to take the WoS Design Board anywhere and monitor the sensors without requiring a terminal program or an external connection of any sort. Users can replace the default Mini-Z application source code with this stand-alone code by observing the following procedure.

1. Power up the WoS Design Board with Mini-Z attached to its socket.
2. Connect the Mini-Z Module to a PC using the USB Smart Cable.
3. Open ZDSII – ZNEO on the PC.
4. In ZDSII – ZNEO, open the WoS project.
5. Compile, build and download the project to the Mini-Z Module on the WoS Board.
6. Disconnect the USB Smart Cable from the WoS Board.
7. Press the Reset button on the WoS Board (see Figure 2 on page 2 to determine the location of the Reset button).
8. Readings from the accelerometer, proximity sensor, humidity sensor, pressure sensor, sound sensor and temperature sensor will be displayed sequentially on the LCD.

Appendix C. Flow Charts for the Stand-Alone Code

This appendix illustrates the flow of each of the World of Sensors Design Board's stand-alone software algorithms contained in the RD0012-SC02.zip file. Figure 6 shows the flow of the Main function.

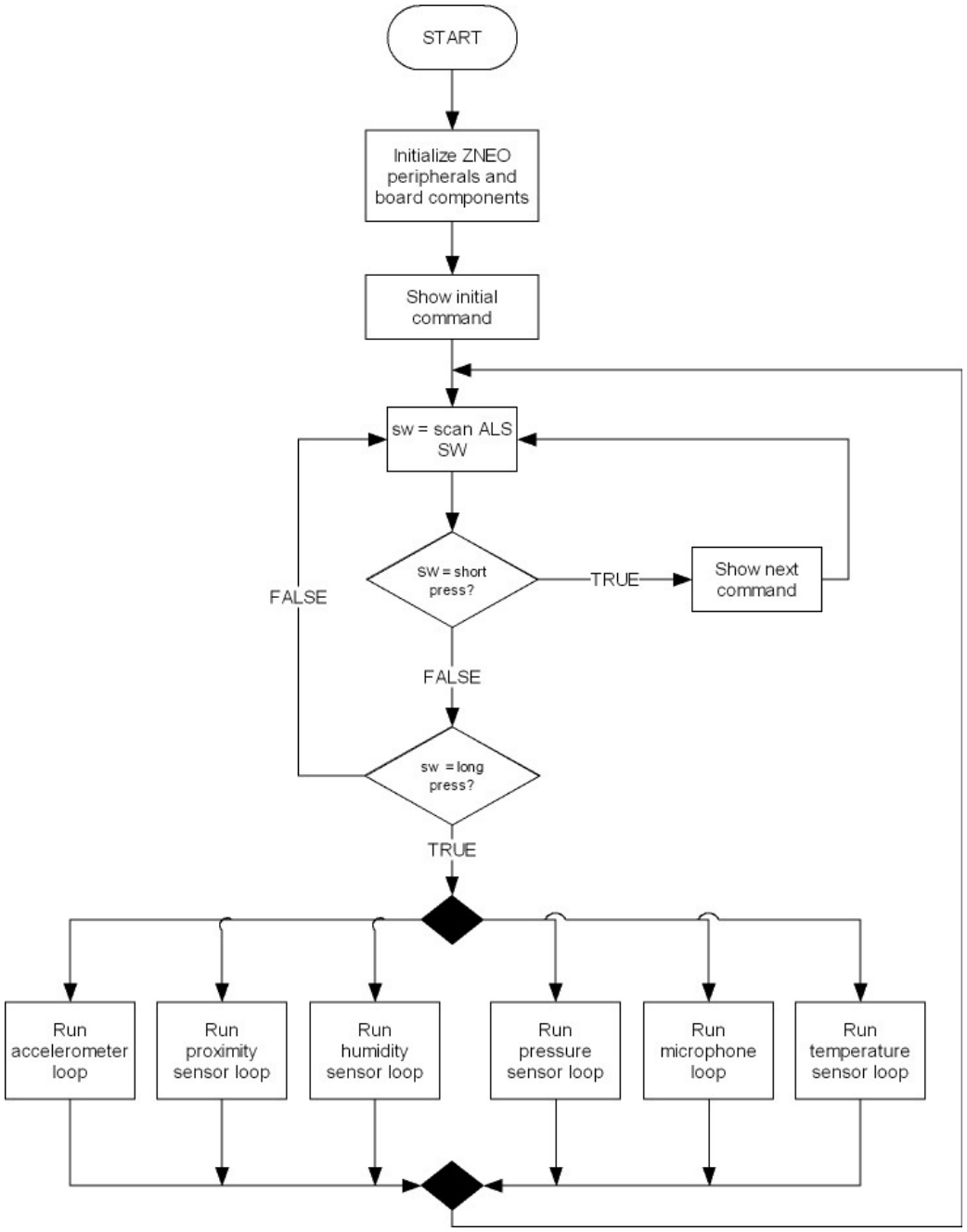

Figure 6. Flow of the Main Function

Figure 7 shows the flow of the Ambient Light Sensor function.

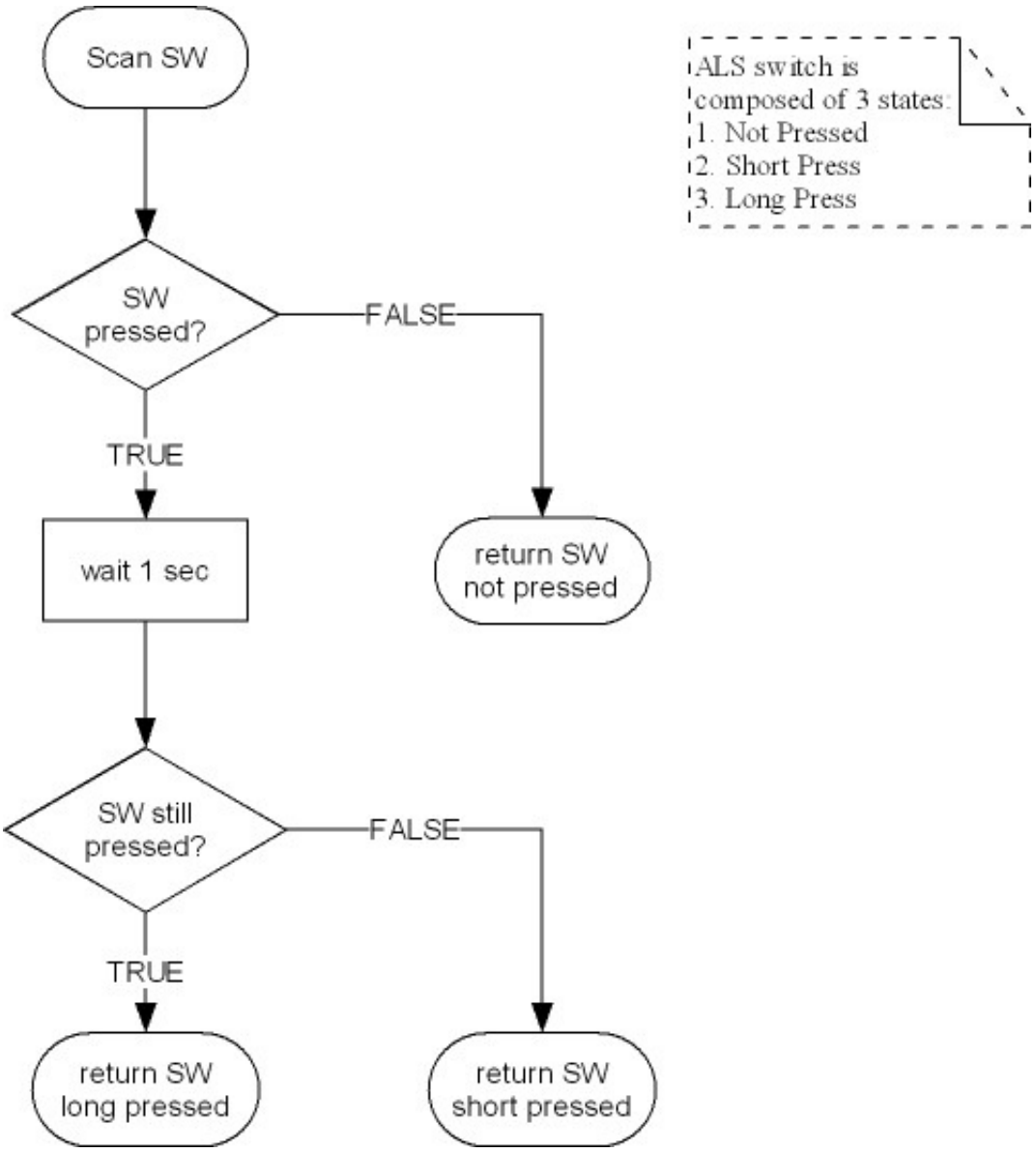

Figure 7. Flow of the Main Function

Figure 8 shows the flow of the SPI initialization function.

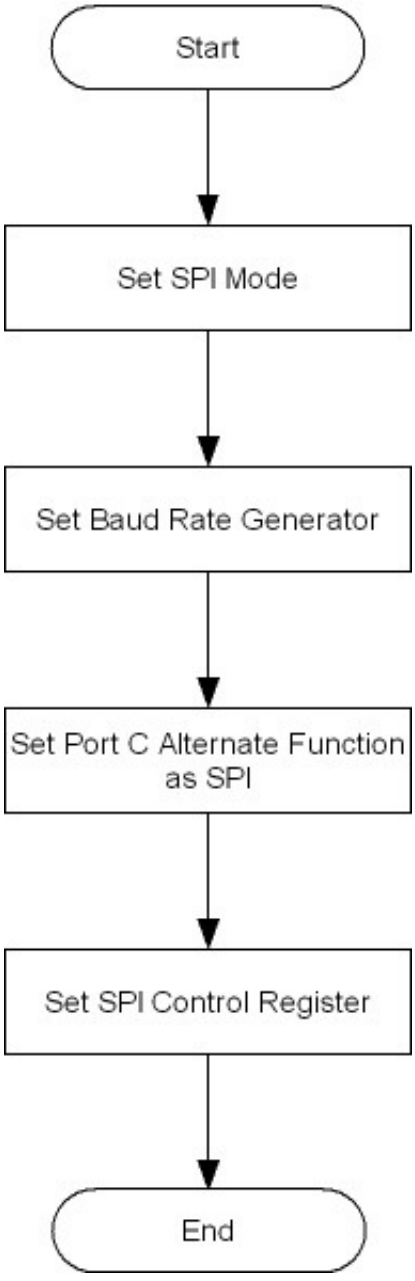

Figure 8. Flow of the SPI Initialization Function

Figure 9 shows the flow of the accelerometer initialization function.

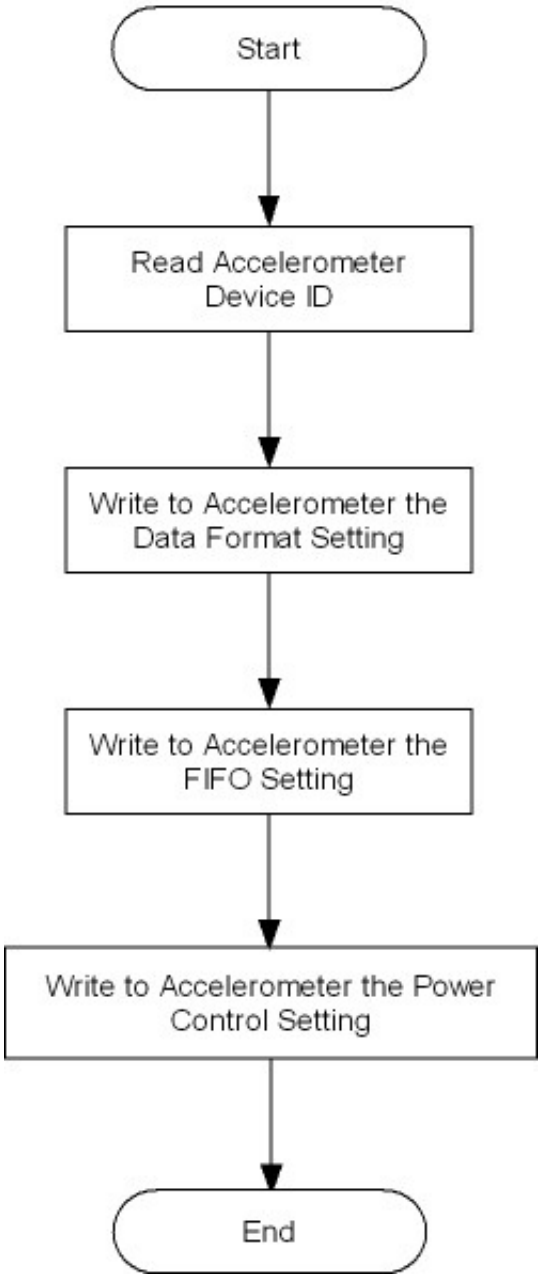

Figure 9. Flow of the Accelerometer Initialization Function

Figure 10 shows the flow of the accelerometer loop.

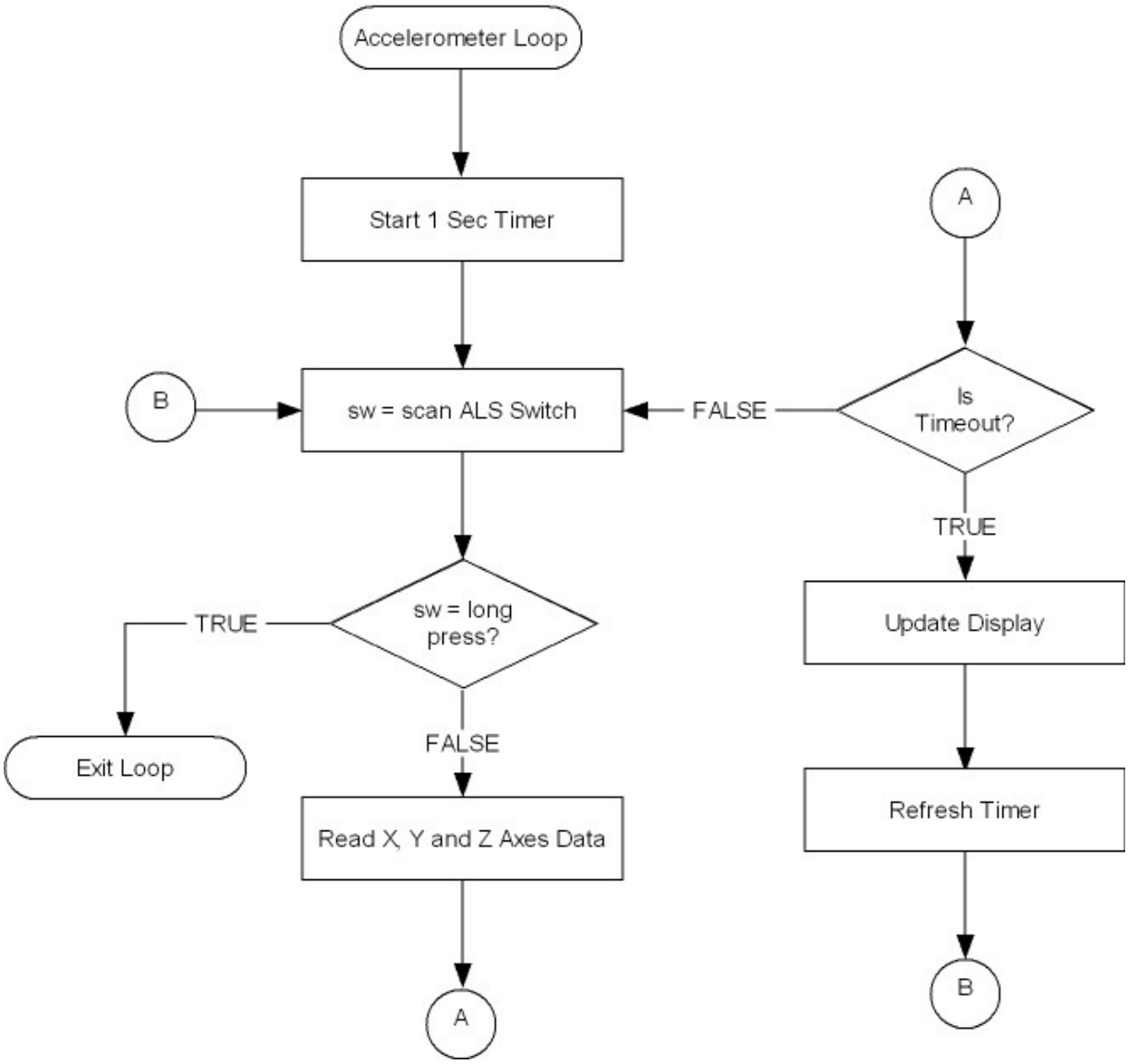

Figure 10. Flow of the Accelerometer Loop

Figure 11 shows the flow of data writes to the accelerometer.

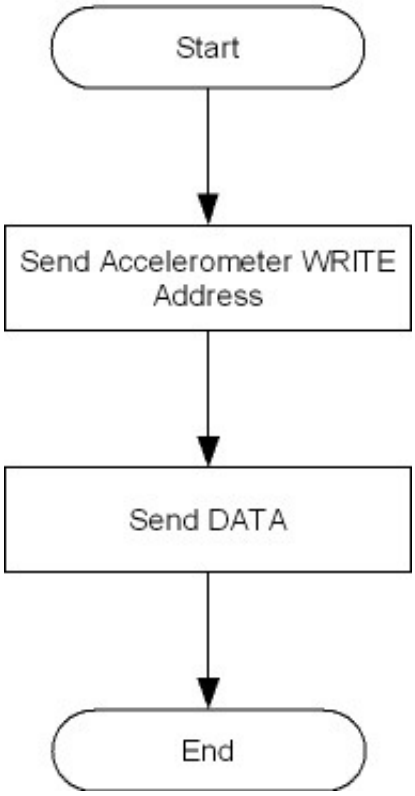

Figure 11. Flow of Data Writes to the Accelerometer

Figure 12 shows the flow of data reads from the accelerometer.

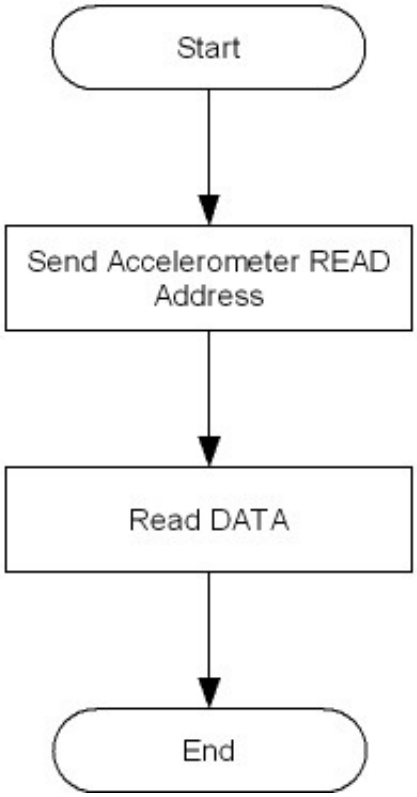

Figure 12. Flow of Data Reads from the Accelerometer

Figure 13 shows the flow of the I^2C initialization function.

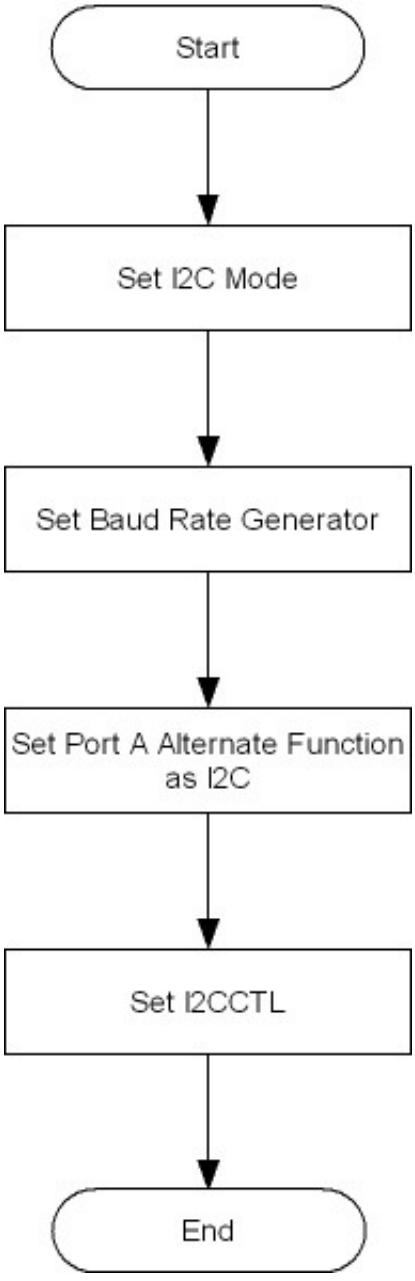

Figure 13. Flow of the I^2C Initialization Function

Figure 14 shows the flow of the proximity sensor function.

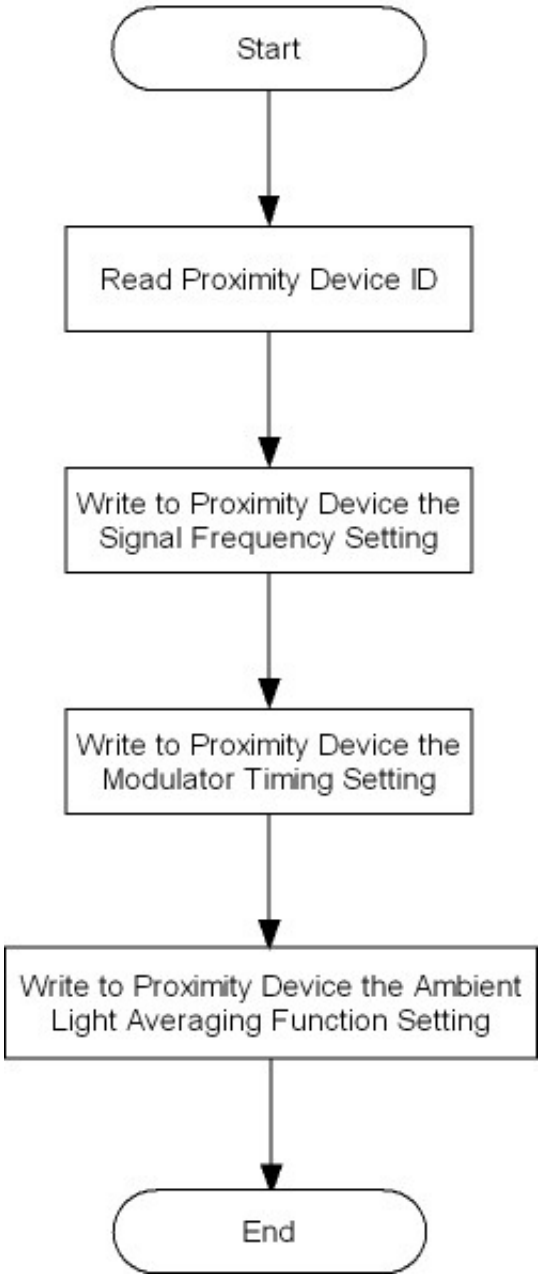

Figure 14. Flow of the Proximity Sensor Function

Figure 15 shows the flow of the proximity sensor loop.

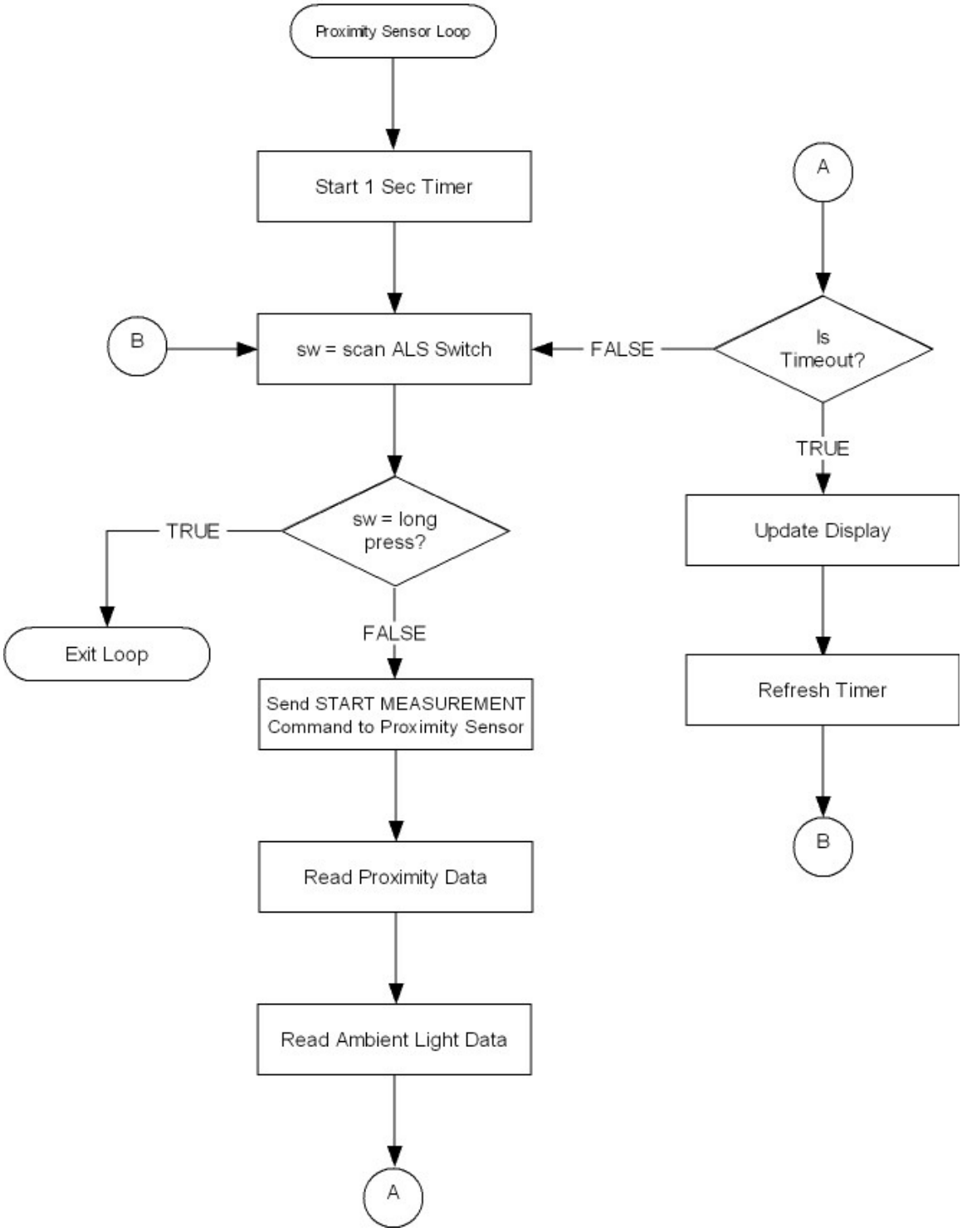

Figure 15. Flow of the Proximity Sensor Loop

Figure 16 shows the flow of data writes to the proximity sensor.

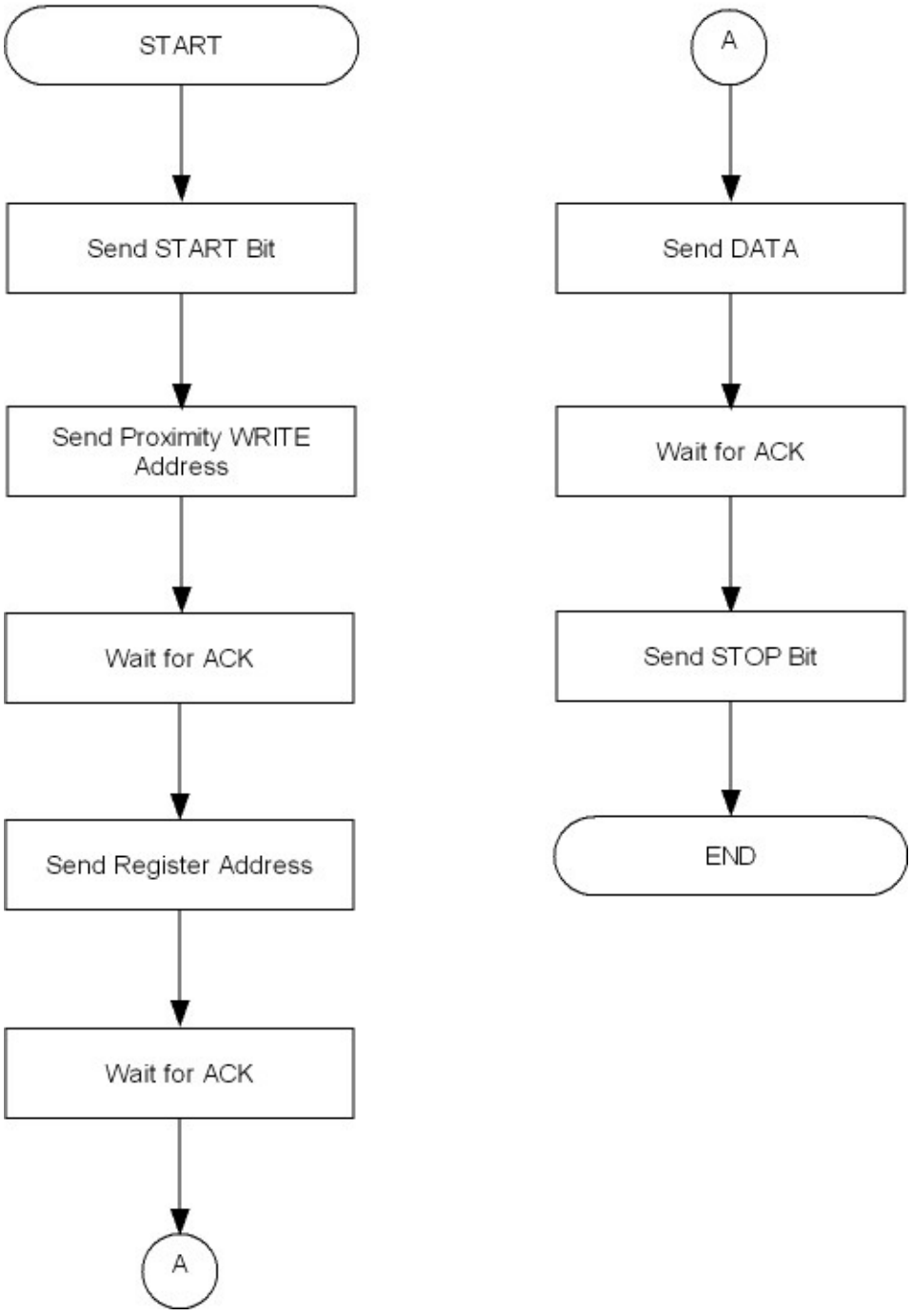

Figure 16. Flow of Data Writes to the Proximity Sensor

Figure 17 shows the flow of data reads from the proximity sensor.

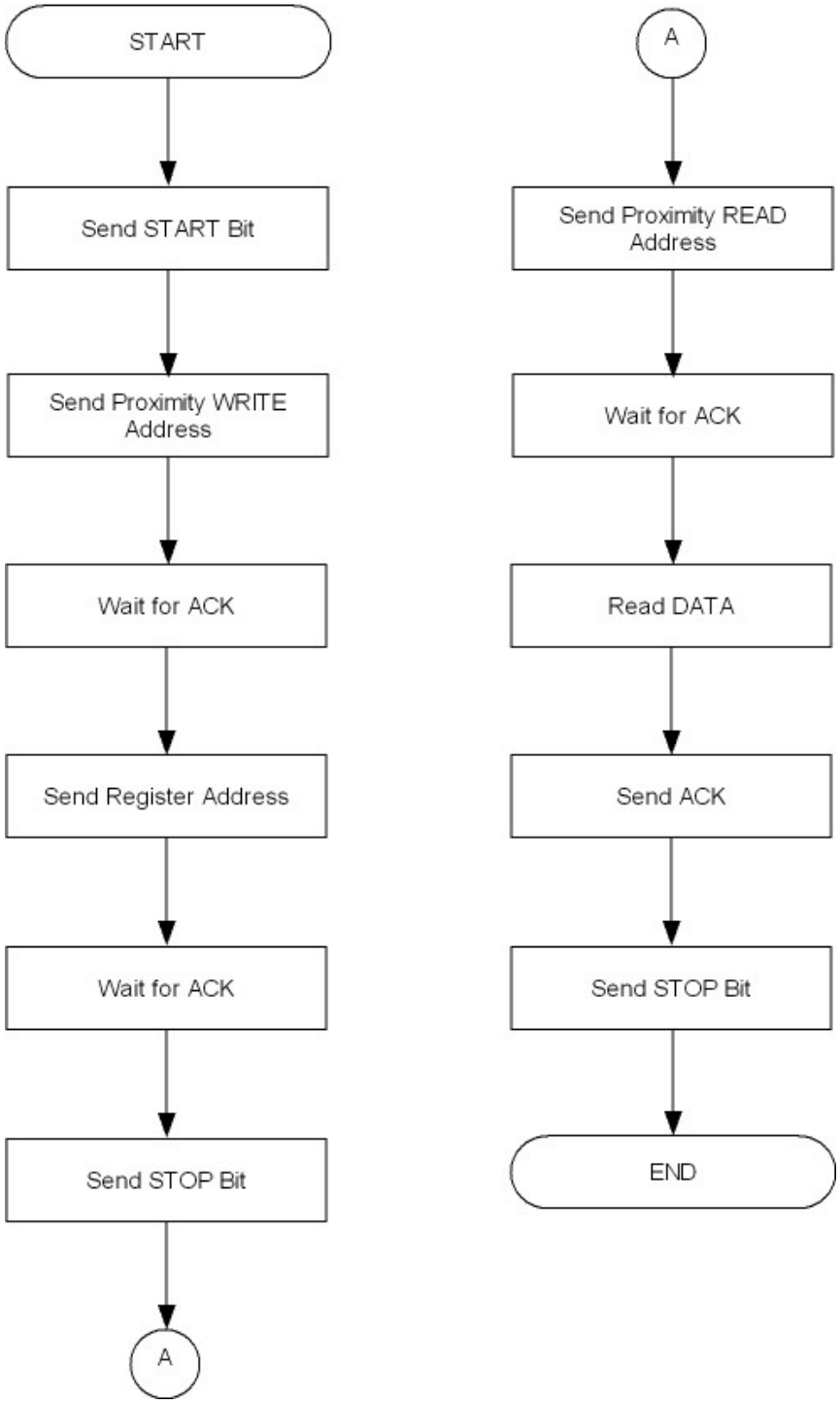

Figure 17. Flow of Data Writes to the Proximity Sensor

Figure 18 shows the flow of the humidity sensor loop.

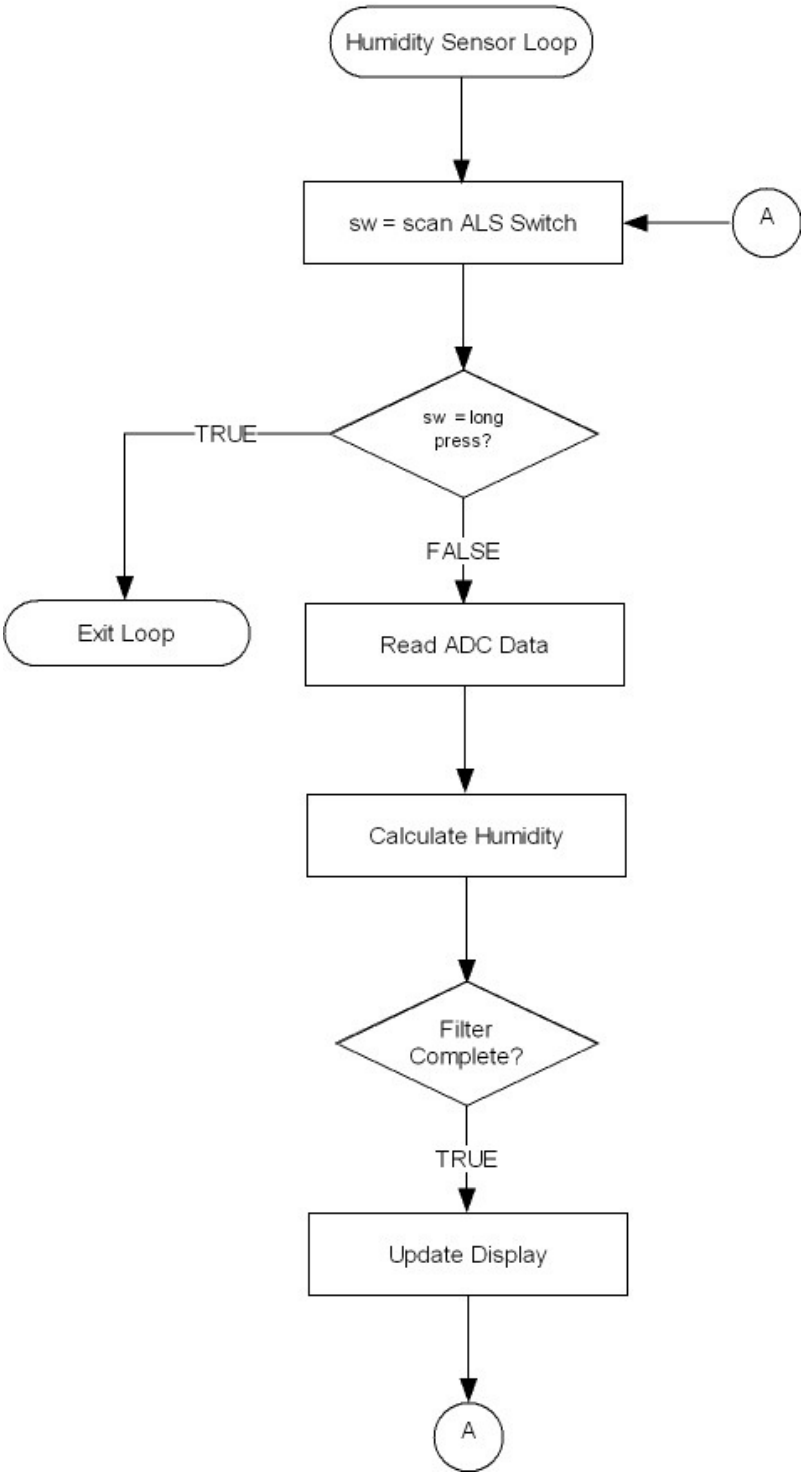

Figure 18. Flow of the Humidity Sensor Loop

Figure 19 shows the flow of the pressure sensor loop.

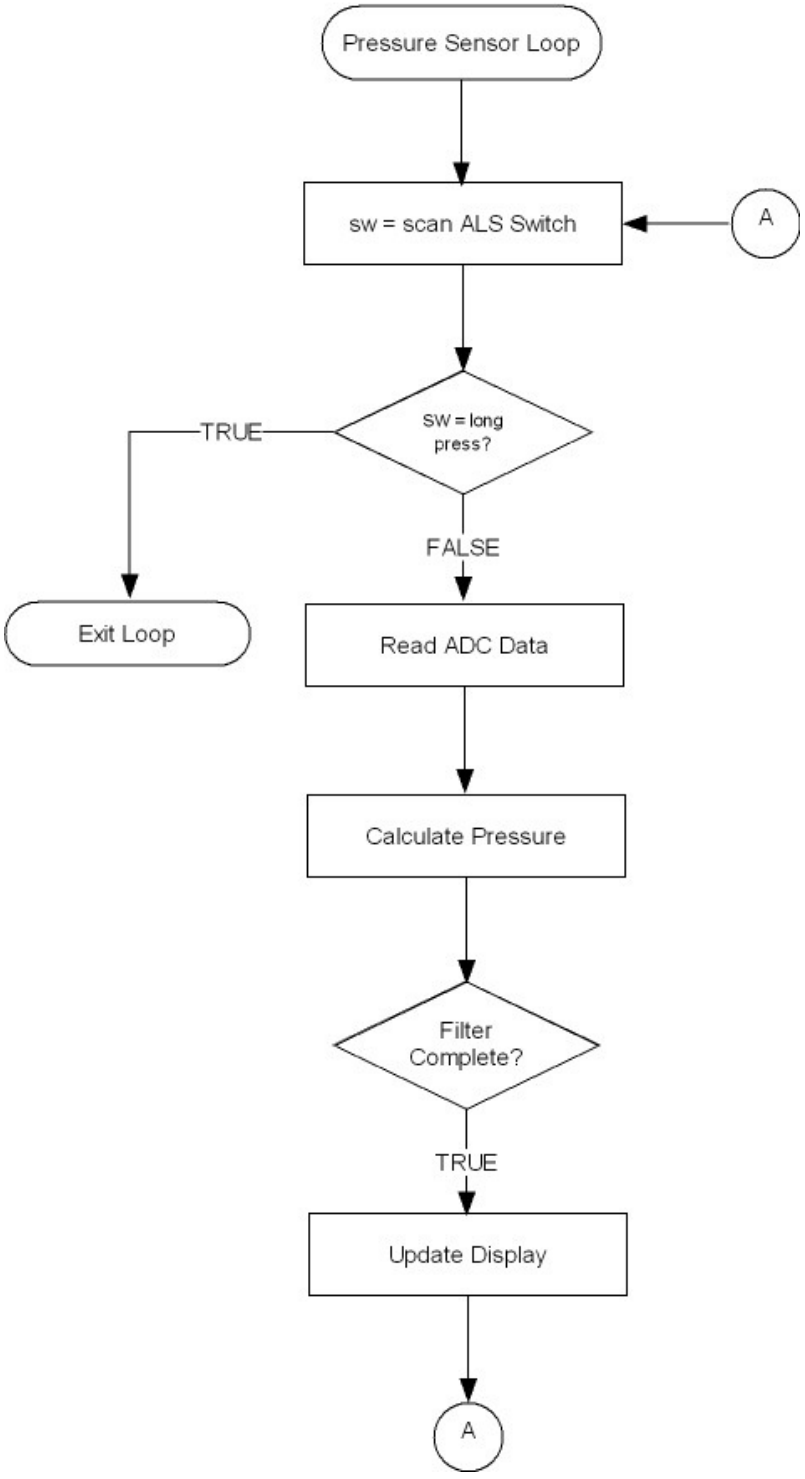

Figure 19. Flow of the Pressure Sensor Loop

Figure 20 shows the flow of the microphone sensor loop.

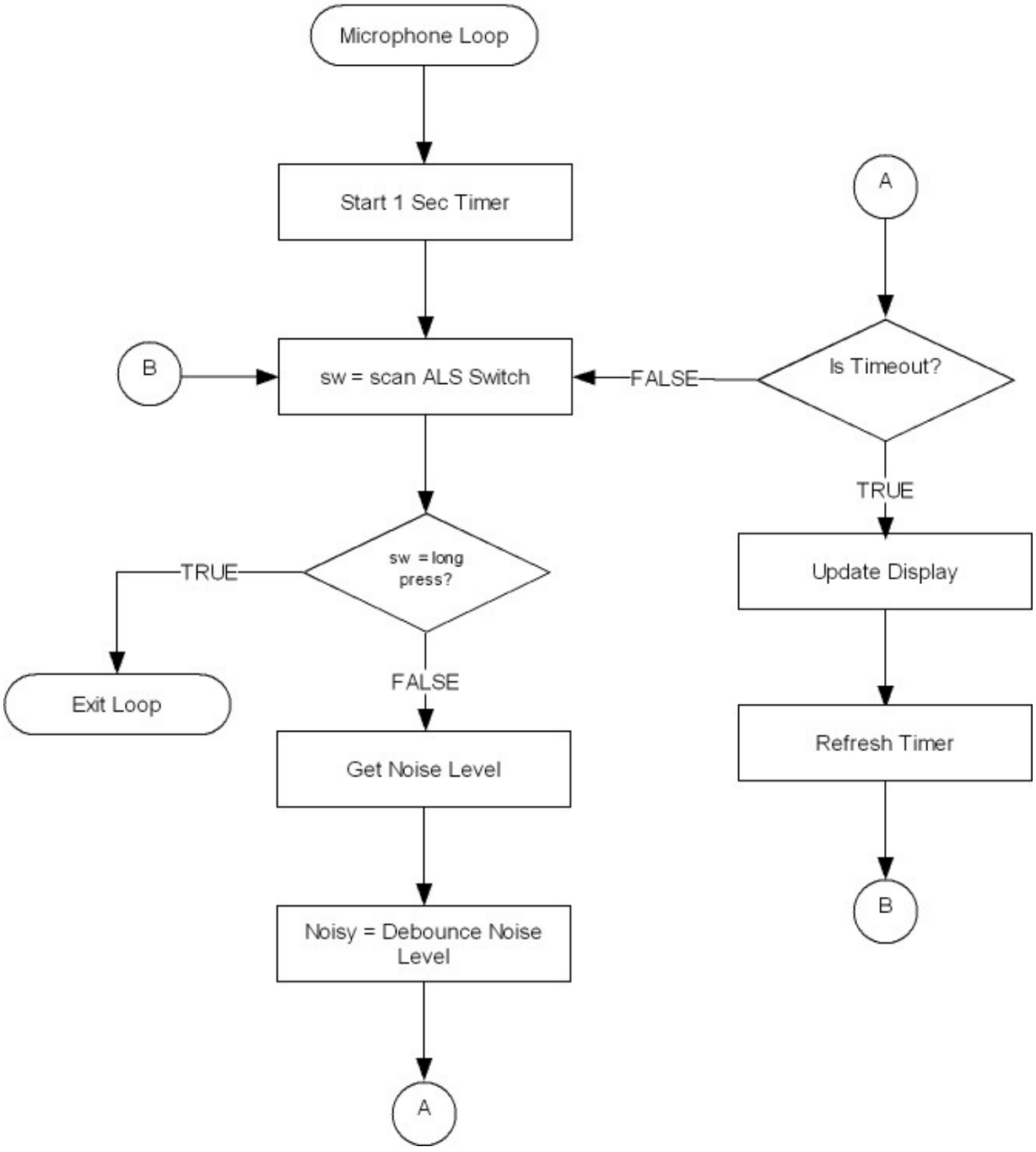

Figure 20. Flow of the Microphone Sensor Loop

Figure 21 shows the flow of the temperature sensor loop.

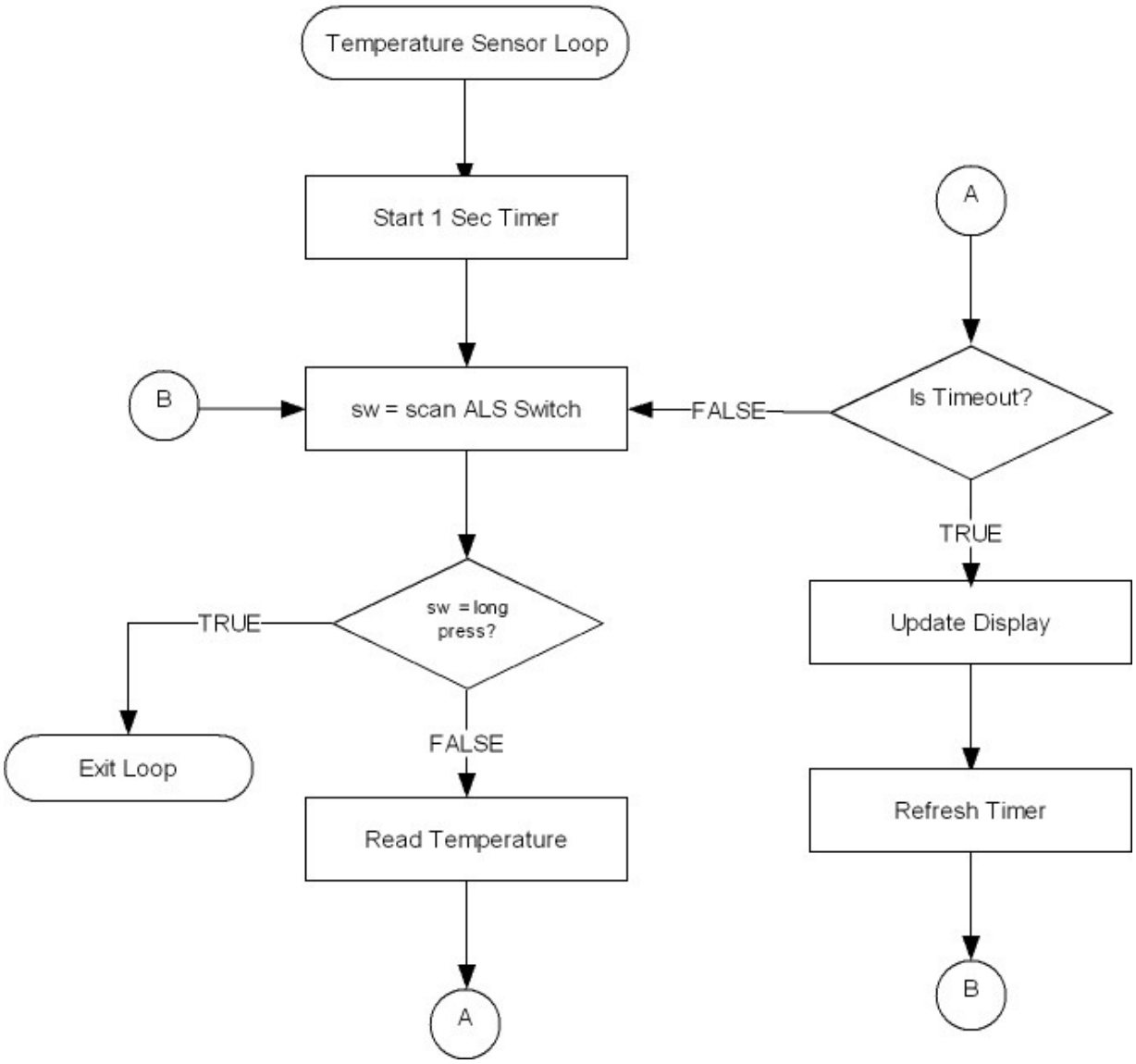

Figure 21. Flow of the Temperature Sensor Loop

Figure 22 shows the flow of the serial LCD function.

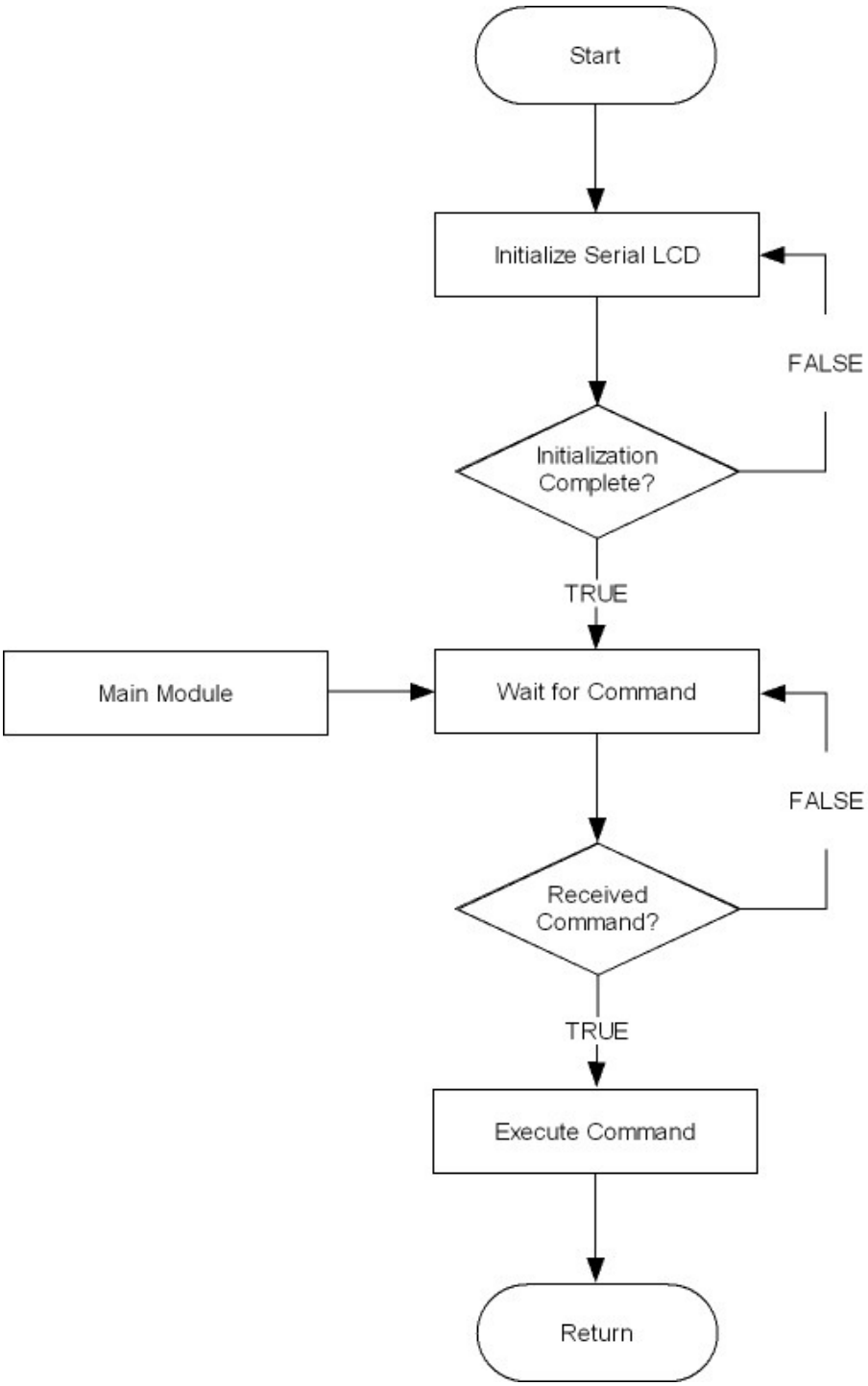

Figure 22. Flow of the Serial LCD Function

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