S.H.D.S. USER MANUAL

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Comprehensive user manual for the Smoke and Heat Detection System (S.H.D.S) from initial system boot to diagnostic testing.

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INTRODUCTION

This student paper sets out to document the requirements of a user manual for the LabVIEW Smoke and Heat Detection System (S.H.D.S.) program.

It also seeks to document the manual in such a way that a member of staff at Stafford University or an External Examiner could set up and use the system without the need for the author to be present.

LabVIEW

LabVIEW is a graphical programming language that has been widely adopted throughout Industry, Academia and Government labs as the standard for data acquisition, instrument control software and analysis software (Bishop, 2001).

Orientation

1.	COCS50592 Advanced Programming Languages for Computer Systems.
2.	LabVIEW Student Edition 2013.
3.	LabVIEW Student Edition Users Guide.

Table 1 – Orientation documentation

Acronyms

LED	Light emitting diode.
DAQ	Data acquisition.
USB	Universal Serial Bus.
I/O	Input / Output.
PC	Personal Computer.
CD	Compact Disk.

Table 2 - Acronyms

Definitions

Byte	A unit of digital information usually consisting of 8 bits.
Bit	A basic unit of digital information represented as a 1 or 0.

Table 3 - Definitions

PREFACE

The S.H.D.S. program files and this user manual has been specifically designed and written for LabVIEW software version 2013.

If you are a new user, use the 'Getting started with LabVIEW manual' that is bundled with the LabVIEW program to familiarise yourself with the LabVIEW graphical programming environment and the basic LabVIEW features you use to build data acquisition and instrument control applications.

5 Volt Power Supply

The +5 V terminals on the I/O connector can be use as either an output or an input. Both terminals are internally connected on the USB-621x.

+5 V Power as an Output: Because the USB-621x devices are bus powered, there is a 50 mA limit on the total current that can be drawn from the +5 V terminals and the digital outputs. The USB-621x monitors the total current and drops the voltage on all of the digital outputs and the +5 V terminals if the 50 mA limit is exceeded.

+5 V Power as an Input: If you have high current loads for the digital outputs to drive, you can exceed the 50 mA internal limit by connecting an external +5 V power source to the +5 V terminals. These terminals are protected against under voltage and overvoltage, and they have a fuse to protect them from short circuit conditions.

If your USB-621x device has more than one +5 V terminal, you can connect the external power supply to one terminal and use the other as a power source.

Equipment List

You will require the following peripherals in order to correctly set up the S.H.D.S. for external interactive operations.

Number	Item Listing
1	Personal Computer (PC).
2	S.H.D.S. files.
3	Five volt power source.
4	Two Power cables (red and black).
5	One IO box.
6	One DAQ unit (NI USB-6211).
7	One USB DAQ power lead.
8	One digital interface.
9	One Analogue interface with attached sensors.

Table 4 – Equipment list

Graphical Conventions

Conventions used within this user manual.

Graphic	Item Description
	External switch activated.
	External switch deactivated.
	External circuit board – pre-wired with the LDR, Linear IC and Thermistor temperature sensors.
	External LED.

Figure 1 – Document conventions

System Requirements

To correctly run the two LabVIEW files your P.C. needs to comply with the standards specified below.

Windows	Run-Time Engine	Development Environment
Processor	Pentium III/Celeron 866 MHz (or equivalent) or later (32-bit) Pentium 4 G1 (or equivalent) or later (64-bit)	Pentium 4M (or equivalent) or later (32-bit) Pentium 4 G1 (or equivalent) or later (64-bit)
RAM	256 MB	1 GB
Screen Resolution	1024 x 768 Pixels	1024 x 768 Pixels
Operating System	Windows 8.1/8/7/Vista (32-bit and 64-bit) Windows XP SP3 (32-bit) Windows Server 2012 R2 (64-bit) Windows Server 2008 R2 (64-bit) Windows Server 2003 R2 (32-bit)	Windows 8.1/8/7/Vista (32-bit and 64-bit) Windows XP SP3 (32-bit) Windows Server 2012 R2 (64-bit) Windows Server 2008 R2 (64-bit) Windows Server 2003 R2 (32-bit)
Disk Space	500 MB	5 GB (includes default drivers from the NI Device Drivers media)
Colour Palette	N/A	LabVIEW and the *LabVIEW Help* contain 16-bit colour graphics. LabVIEW requires a minimum colour palette setting of 16-bit colour.
Temporary Files Directory	N/A	LabVIEW uses a directory for storing temporary files. National Instruments recommends that you have several megabytes of disk space available for this temporary directory.
Note The following list describes restrictions for using LabVIEW on Windows: • LabVIEW does not support Windows 2000/NT/Me/98/95 or Windows XP x64. • You cannot access LabVIEW using a Guest account on Windows.		

Table 5 – LabVIEW system requirements

INSTALLING THE S.H.D.S.

The S.H.D.S. installation disk contains two LabVIEW files that run in different interactive user modes as detailed below.

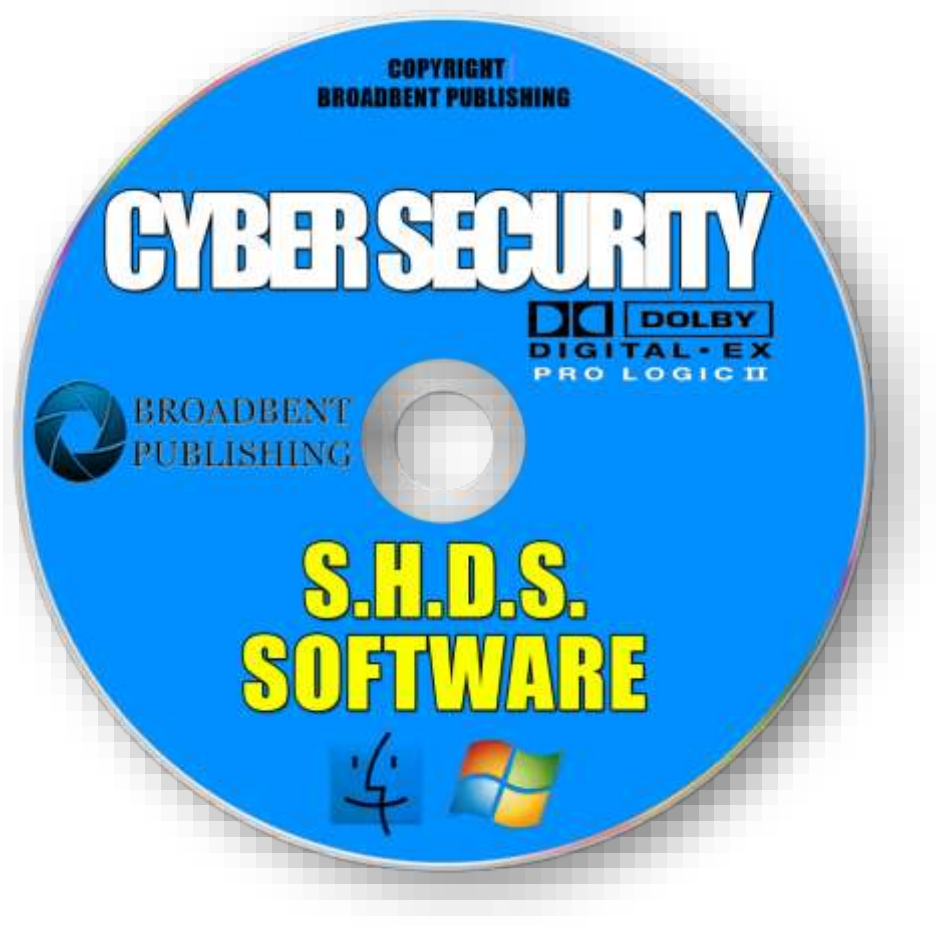

Figure 2 – S.H.D.S. installation disk

[1]. LabVIEW version 2013 - F.S.D.S. MASTER.vi

[2]. LabVIEW version 2013 - DAQS MASTER.vi

Opening the **F.S.D.S. MASTER** file within LabVIEW runs a non-peripheral version of the program where all trigger switches and LED displays are operated and displayed by/to the user via the P.C. display screen only.

Opening the **D.A.Q.S. MASTER** file within LabVIEW runs a peripheral version of the program where all the trigger switches and LED displays are routed to an attached I/O control box via a NI USB-6211 DAQ unit.

In this mode the P.C. display screen only mimics the user interactive settings on the I/O box – see I/O technical operations on page 39 and setting up the DAQ on page 18.

Loading the LabVIEW File

To load the S.H.D.S LabVIEW file follow the instructions shown below:-

[1]. Start the 2013 version of LabVIEW program running on your P.C.

[2]. Select 'Open Existing' option.

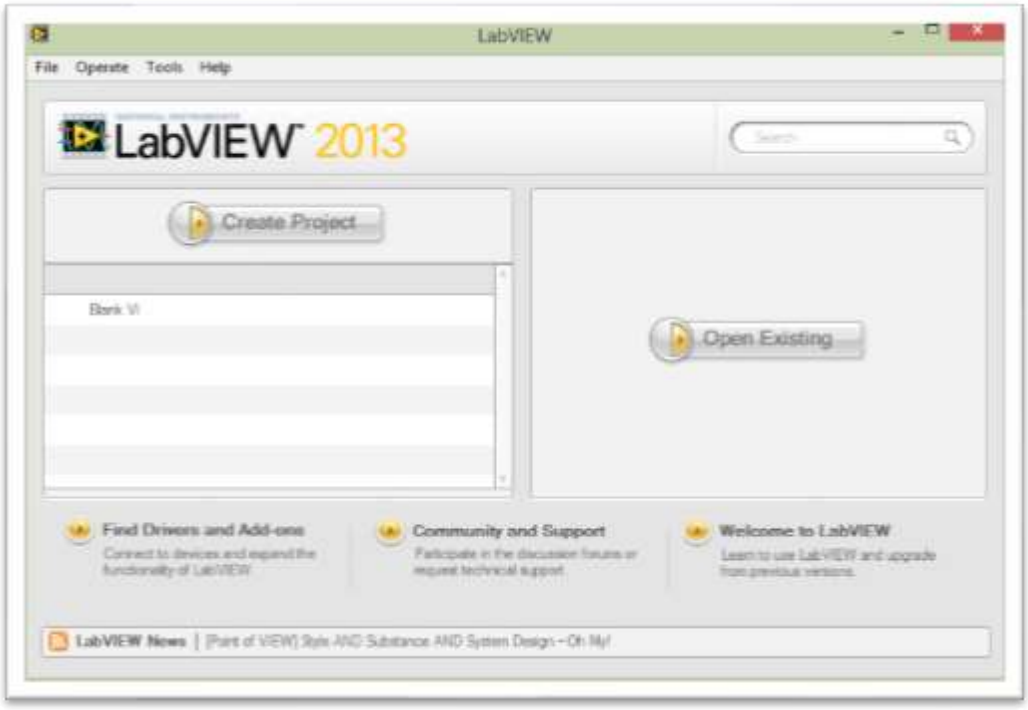

Figure 3 – LabVIEW 2013

[3]. Navigate to the computer directory that contains the two S.H.D.S. files.

[4]. Select the file version you wish to run and press 'OK'.

Alternatively double click on the version of the file you wish to run using File Explorer.

You should now be presented with the screen display as shown below, name dependent on the S.H.D.S. file version you have chosen to load.

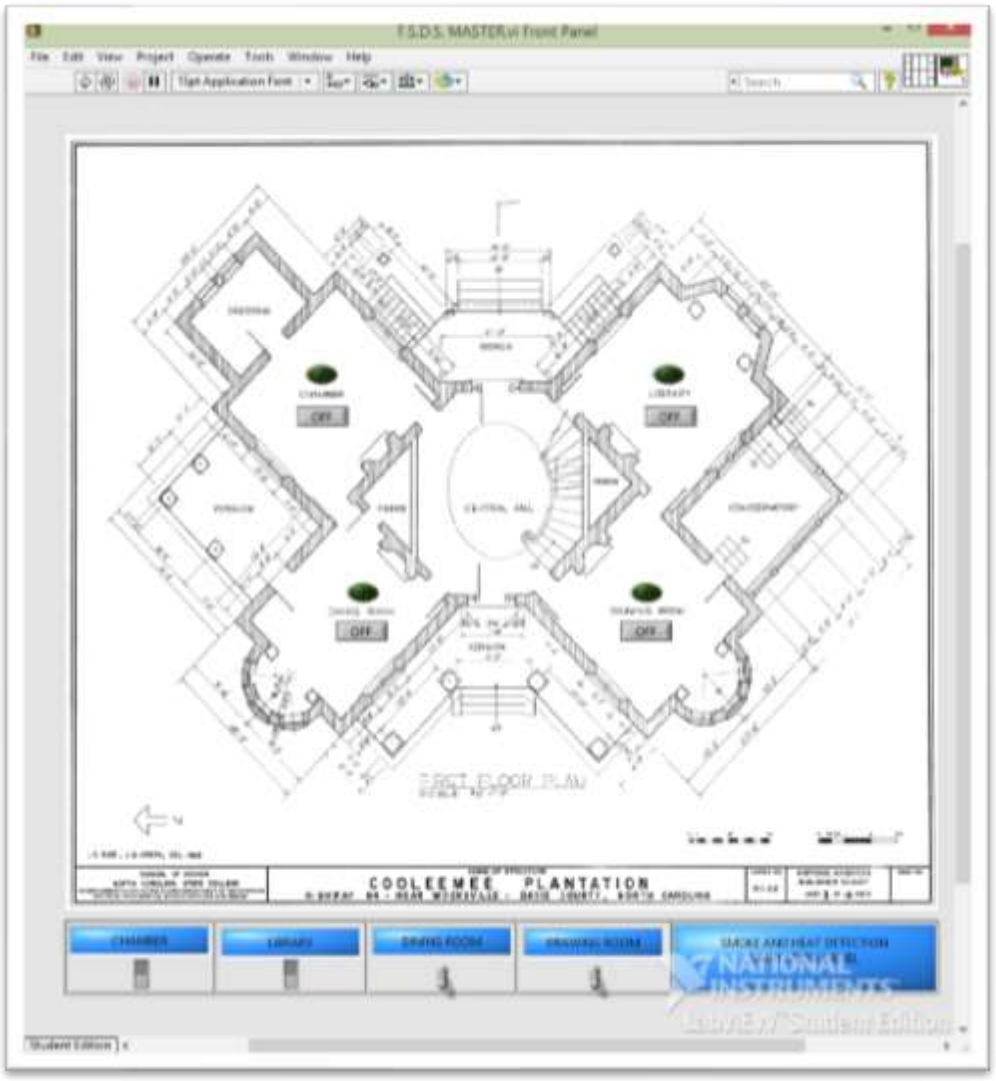

Figure 4 – F.D.D.S. Master

[5]. Select the run option  from the LabVIEW main menu.

The S.H.D.S. program should now be running on your P.C. and the run option icon reformed  indicating that you can now interact with the program.

To stop the program at any time select the stop button  on the LabVIEW main menu.

Loading Error Message

During the loading procedure if you see a system error message similar to the one displayed below – it is highly likely that you are trying to load the **DAQS MASTER** file without the DAQ unit being correctly connected to your P.C.

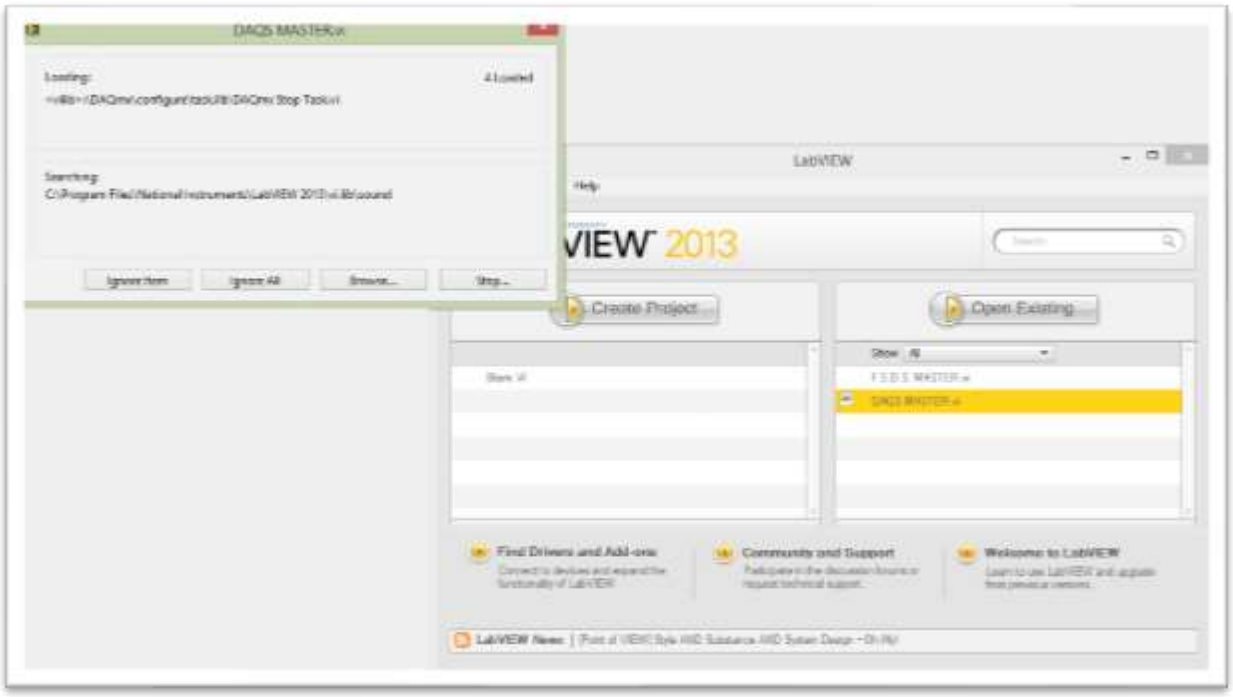

Figure 5 – Loading error message 1

To correct this error simply follow the instructions shown below.

[1]. First select the Stop  button.

You should now be presented with the screen display overleaf.

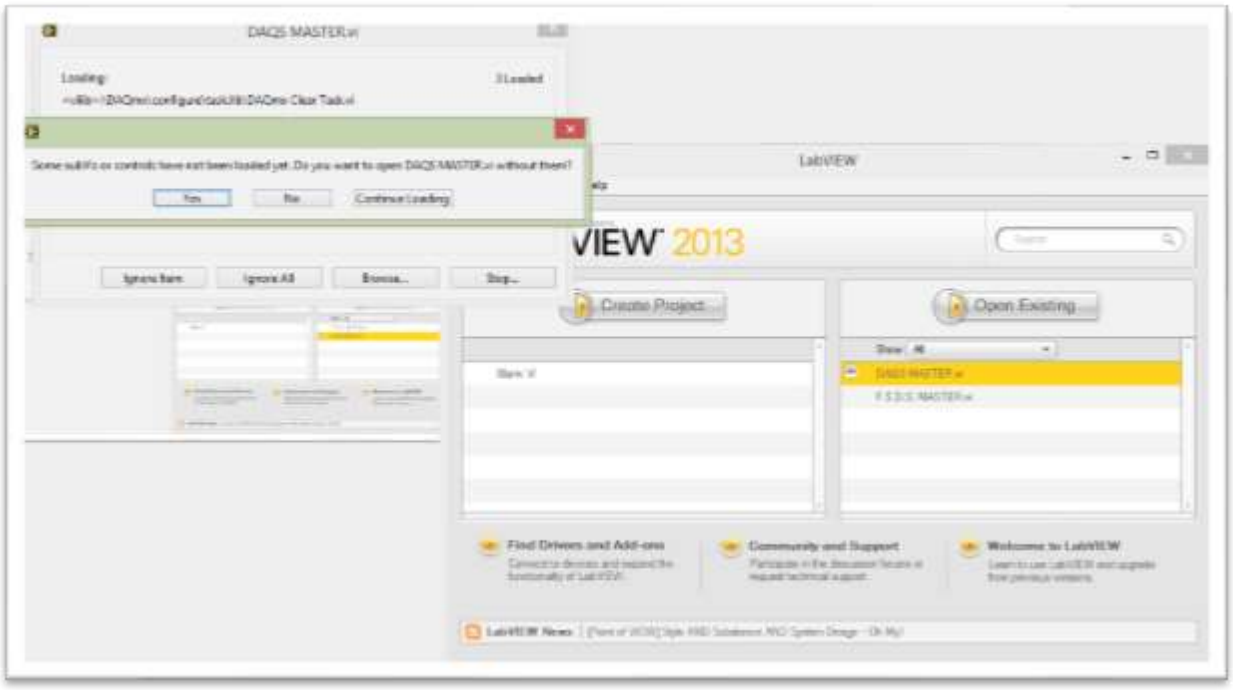

Figure 6 - Loading error message 2

[2]. Select the No button and then close the LabVIEW program completely.

[3]. Now follow the instructions shown overleaf with respect to setting up a DAQ unit on your P.C.

[3]. Re-start the loading procedure again from the beginning.

SETTING UP THE DAQ

Before attaching the DAQ unit to your P.C. to interface with the S.H.D.S. LabVIEW program – First check you have all the following equipment available.

Figure 7 – Digital leads

The digital leads comprise of 4 blue male connectors, 4 yellow male connectors a black ground connector and DAQ digital interface. These digital leads are used by the S.H.D.S. program to capture data outputted from external peripheral triggers and export data to external peripherals devices such as LED displays.

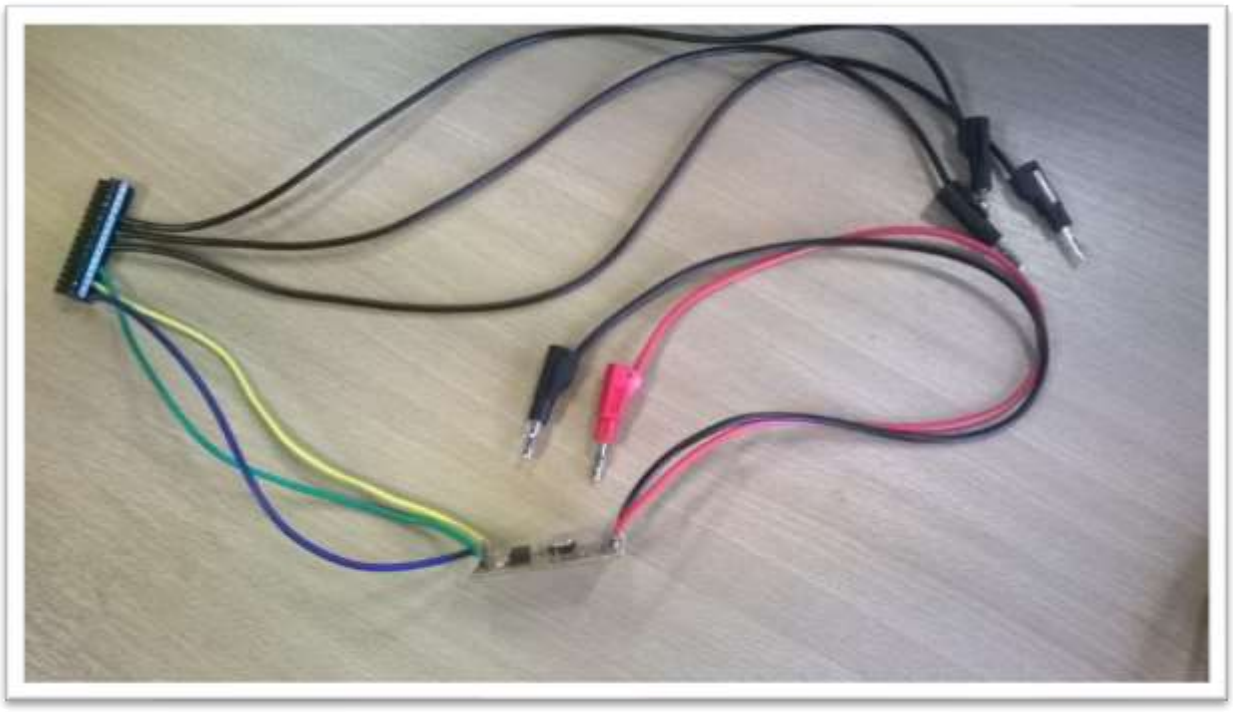

Figure 8 – Analogue leads

The analogue leads comprise of 2 black male connectors, 2 male power connectors (red and black) a black ground connector and DAQ digital interface. Also attached is a small circuit board pre-configured with the following sensors:

[1]. LDR sensor.

[2]. Linear IC temperature sensor.

[3]. Thermistor.

These analogue leads are used by the S.H.D.S. program to capture data outputted from external peripheral triggers and variable data from the sensors.

Figure 9 – USB power lead

A black USB power cable for the DAQ unit.

Figure 10 – DAQ unit

A DAQ unit (NI USB-6211).

Figure 11 – I/O box

An I/O box used for triggering the sensors within the S.H.D.S. LabVIEW program and for displaying external LED flash rates. The I/O box requires a 5 volt power supply to work correctly and contains 8 yellow female connectors, 8 blue female connectors, 8 red LEDs, 8 switches and 2 power connectors (red and black).

DAQ Interface Connectors

Shown below are the digital and analogue connectors for the DAQ unit.

Figure 12 – Digital DAQ interface

Figure 13 – Analogue DAQ interface

Each DAQ connector has been pre-assigned a unique label – IMPORTANT CONNECT THE DAQ UNIT TO THE I/O BOX AS SHOWN BELOW:

DAQ DIGITAL MALE CABLES			
IN	IN	IN	IN
PFI3	PFI2	PFI1	PFI0
I/O BOX BLUE FEMALE CONNECTORS			
3	2	1	0

Table 6 – Digital trigger connections

DAQ ANALOGUE MALE CABLES			
AI5	AI4		
I/O BOX BLUE CONNECTORS			
5	4		

Table 7 – Analogue trigger connections

DAQ DIGITAL MALE CABLES			
OUT	OUT	OUT	OUT
PFI7	PFI6	PFI5	PFI4
I/O YELLOW CONNECTORS			
3	2	1	0

Table 8 – Digital LED connections

DAQ DIGITAL MALE CABLES	DAQ ANALOGUE MALE CABLES		
DGND	BOARD LIVE	BOARD GND	AI GND
I/O BOX			
EARTH	RED LIVE	EARTH	EARTH

Table 9 – Ground connections

Insert the digital lead connector to the DAQs digital I/O interface.

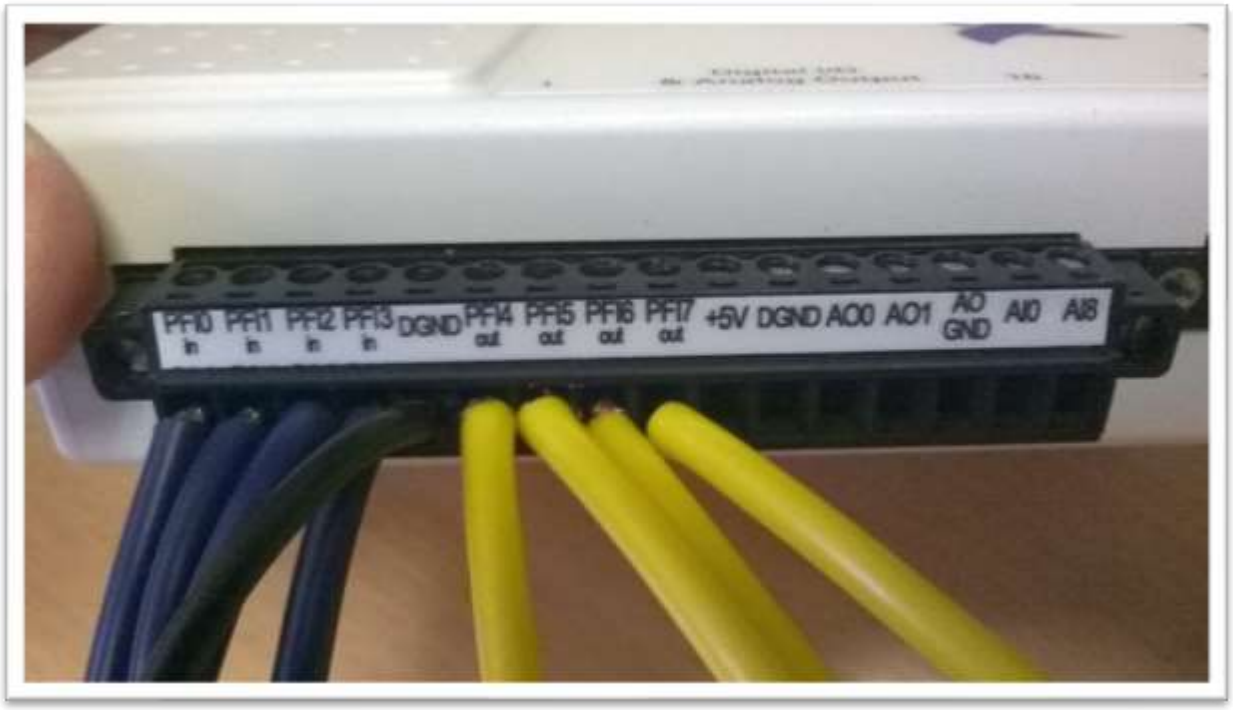

Figure 14 – Connecting the digital I/O

Next insert the yellow connectors into the I/O box as detailed in Table 7.

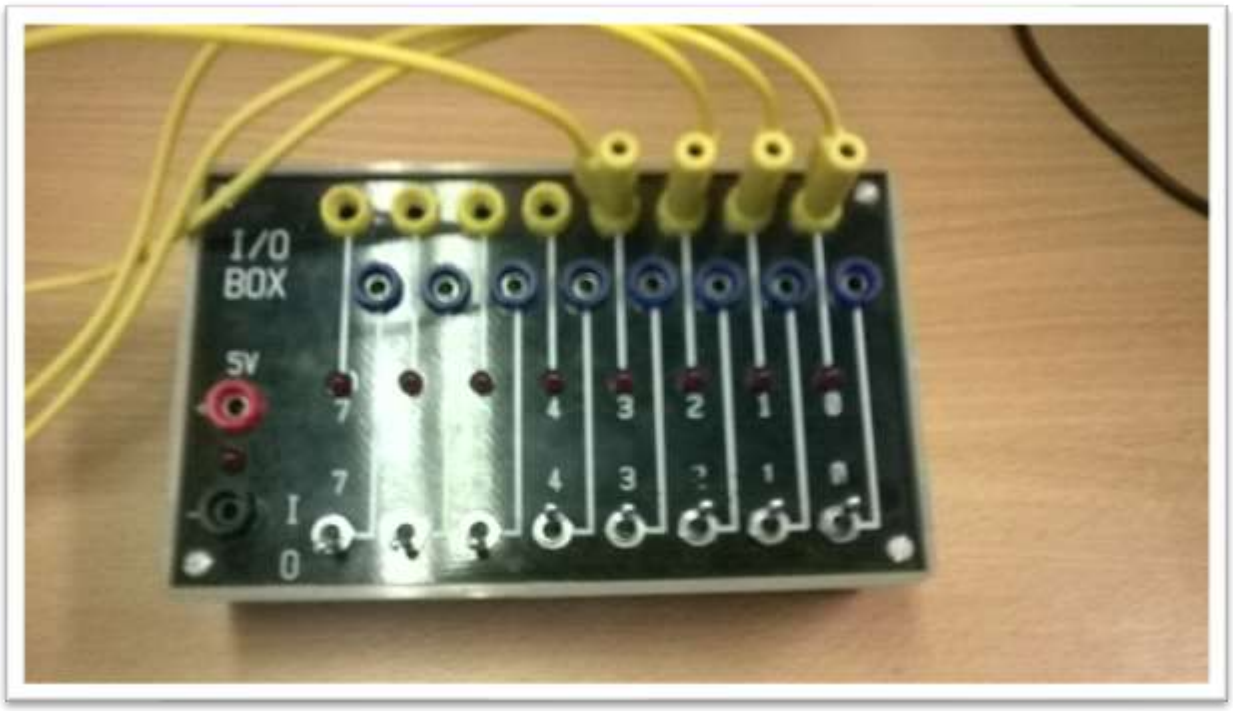

Figure 15 – LED connections on I/O box

Next insert the blue connectors into the I/O box as detailed in Table 5.

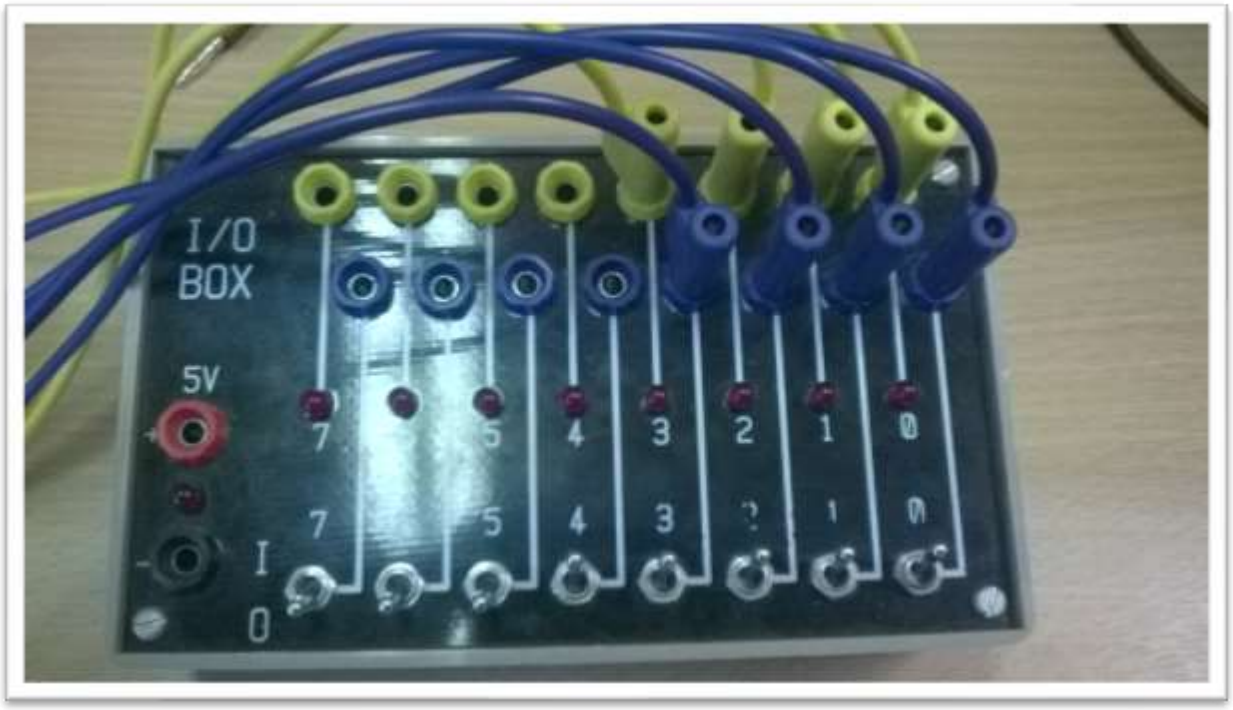

Figure 16 – Trigger connections on I/O box

Finally, connect the black ground cable to the ground connector on the I/O box as detailed in table 8.

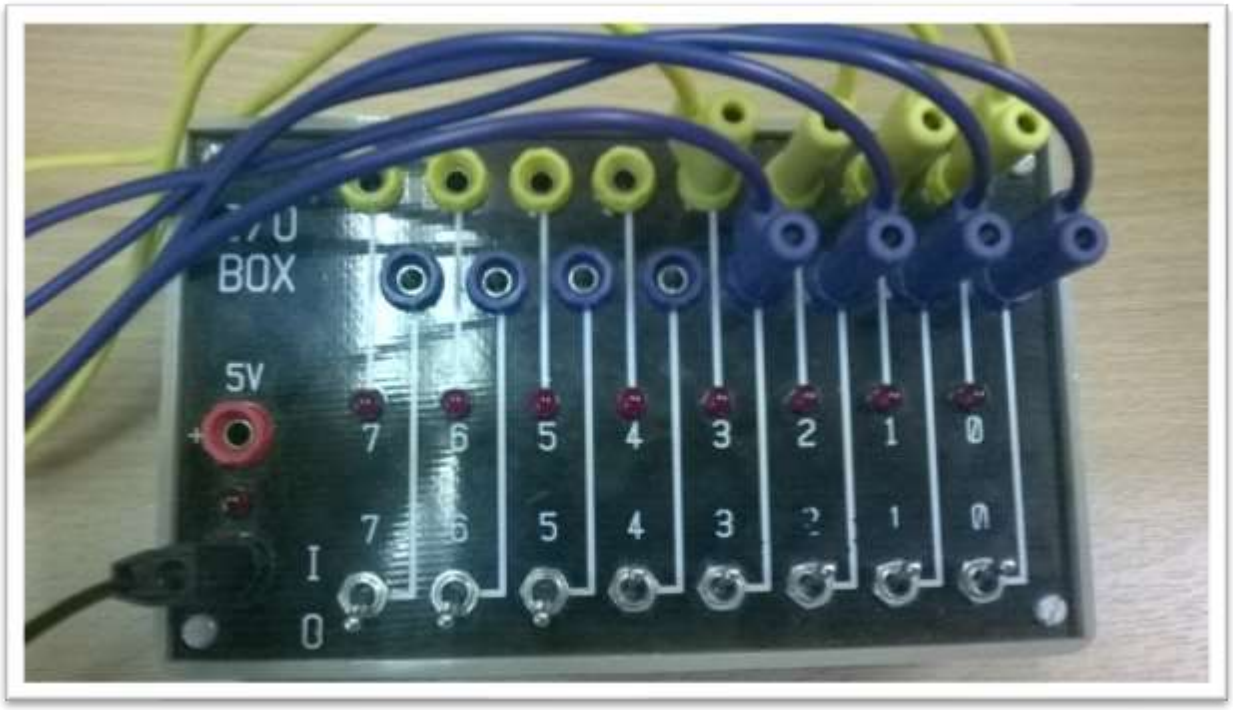

Figure 17 – Ground connection on I/O box

Insert the analogue lead connector to the DAQs analogue I/O interface.

Figure 18 - Connecting the analogue I/O

Next connect the black ground cable to the ground connector on the I/O box as detailed in table 8.

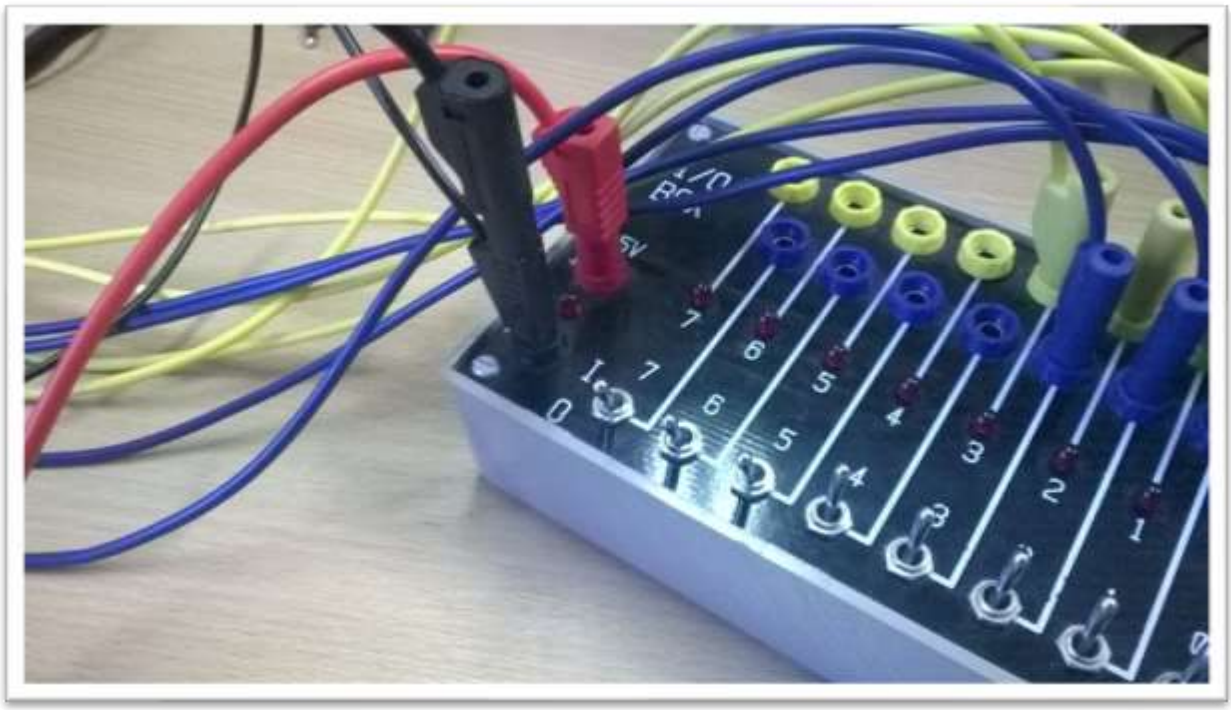

Figure 19 – Ground connection on I/O box

Now connect the circuit board ground to the ground connector on the I/O box and the circuit board live to the I/O Box live as detailed in table 8.

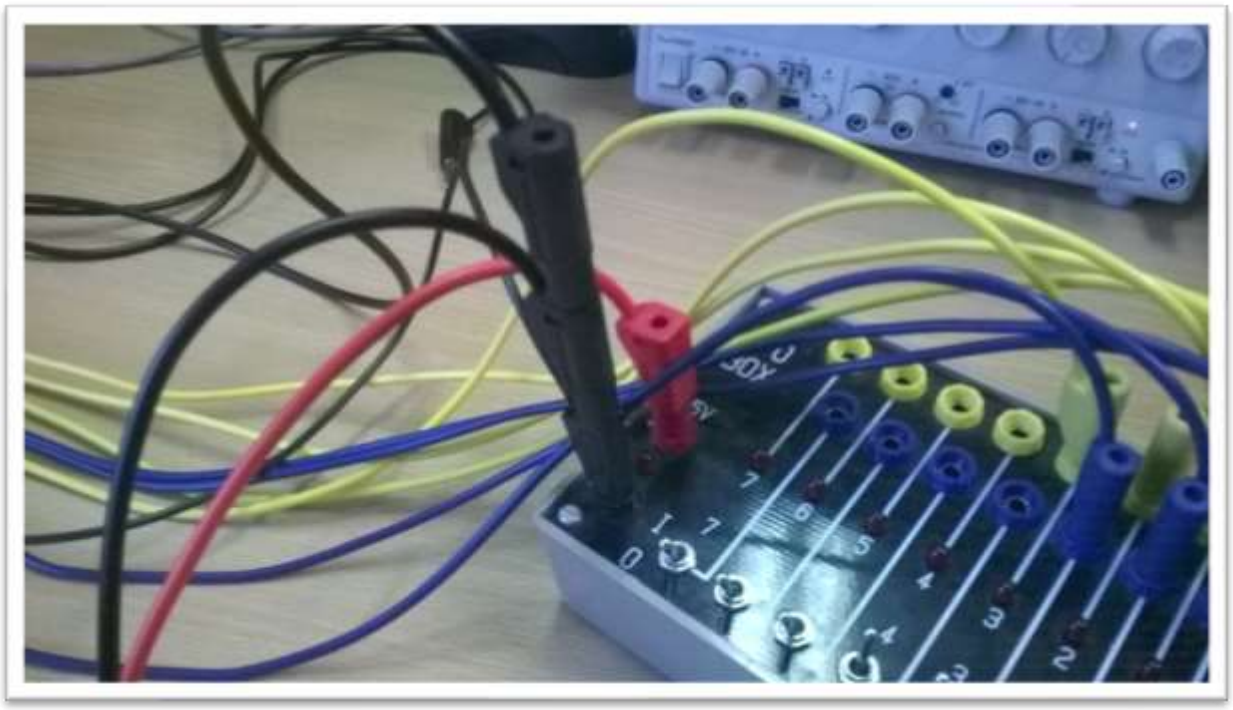

Figure 20 – Circuit board ground

Finally, connect the two analogue switches to the I/O box as detailed in table 6.

Figure 21 – Connecting the two analogue switches

The peripheral devices should now look like this.

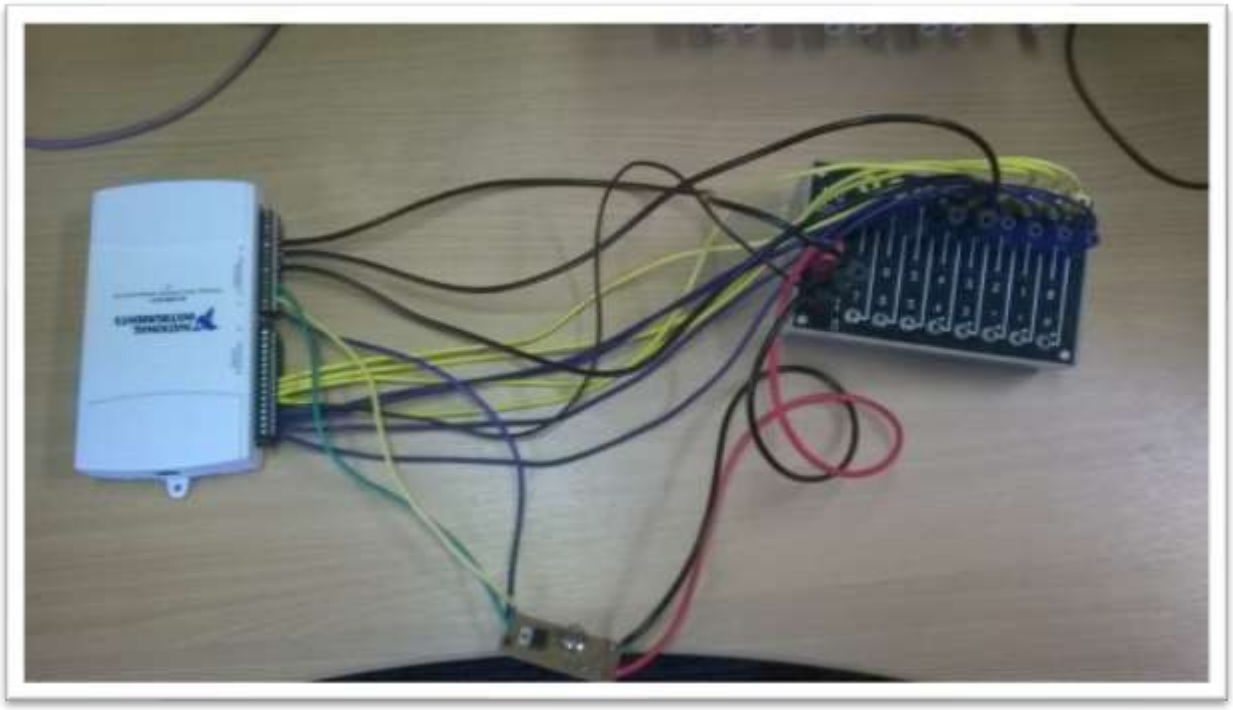

Figure 22 – Peripheral devices

You are now ready to power up the I/O box and DAQ unit.

Figure 23 – Power cables

Connect one end of a cable (black) to the ground connector on the I/O and to the ground on your 5 Volt power source. Connect one end of another cable (red) to the live connector on the I/O box and to the live on your 5 Volt power source.

You can now power on your 5 Volt power source.

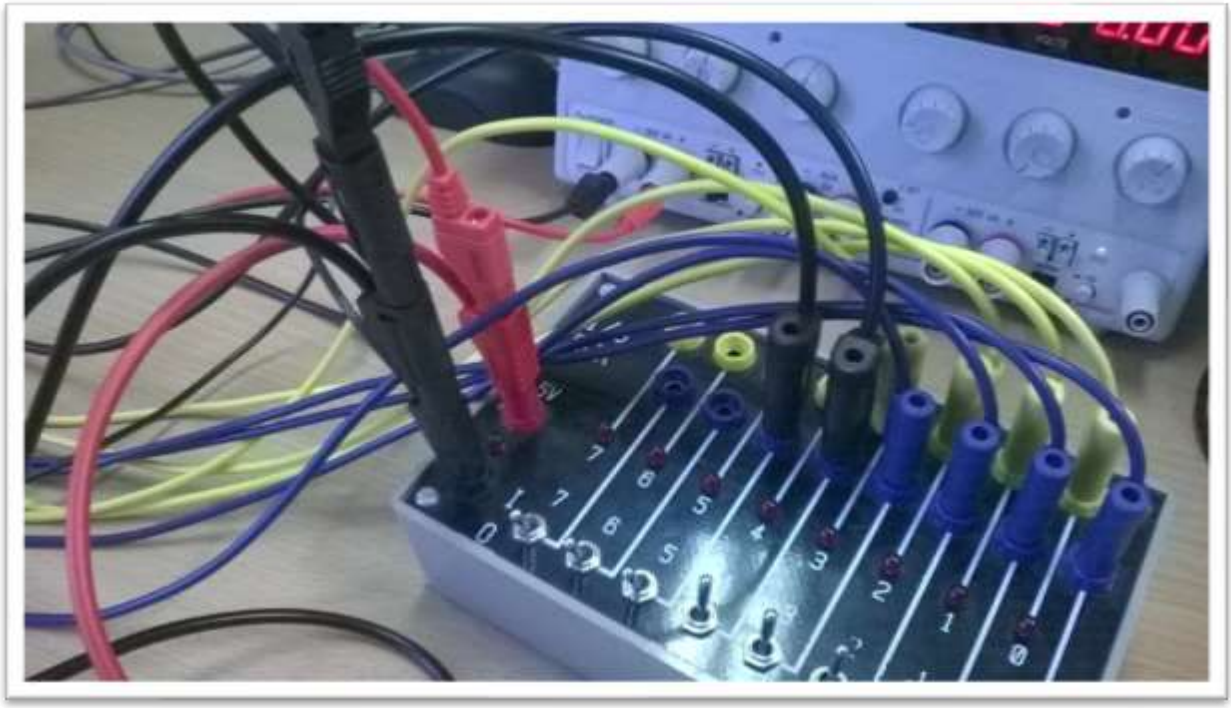

Figure 24 – 5 Volt power source

Connect the square USB connector to the DAQ unit and the plug the other end into your computers USB port. The green LED on the DAQ unit will continually flash while connecting and connected.

Figure 25 – USB DAQ power source

Finally, unless you have re-connected the exact same DAQ unit (see numbering system on the base of the DAQ - in this case number 6) you will have to manually refresh all the digital and analogue connections.

This is a far simpler task to achieve than it sounds:-

[1]. Within the LabVIEW program select 'Windows' then 'Show block diagram' (alternatively press Ctrl +E).

[2]. Now right click on all the DAQ assist icons  located at the base of the **DAQ MASTER** wiring chart diagram.

[3]. Select the 'Properties' option - You will now be presented with a screen display similar to the one shown in figure 26 overleaf.

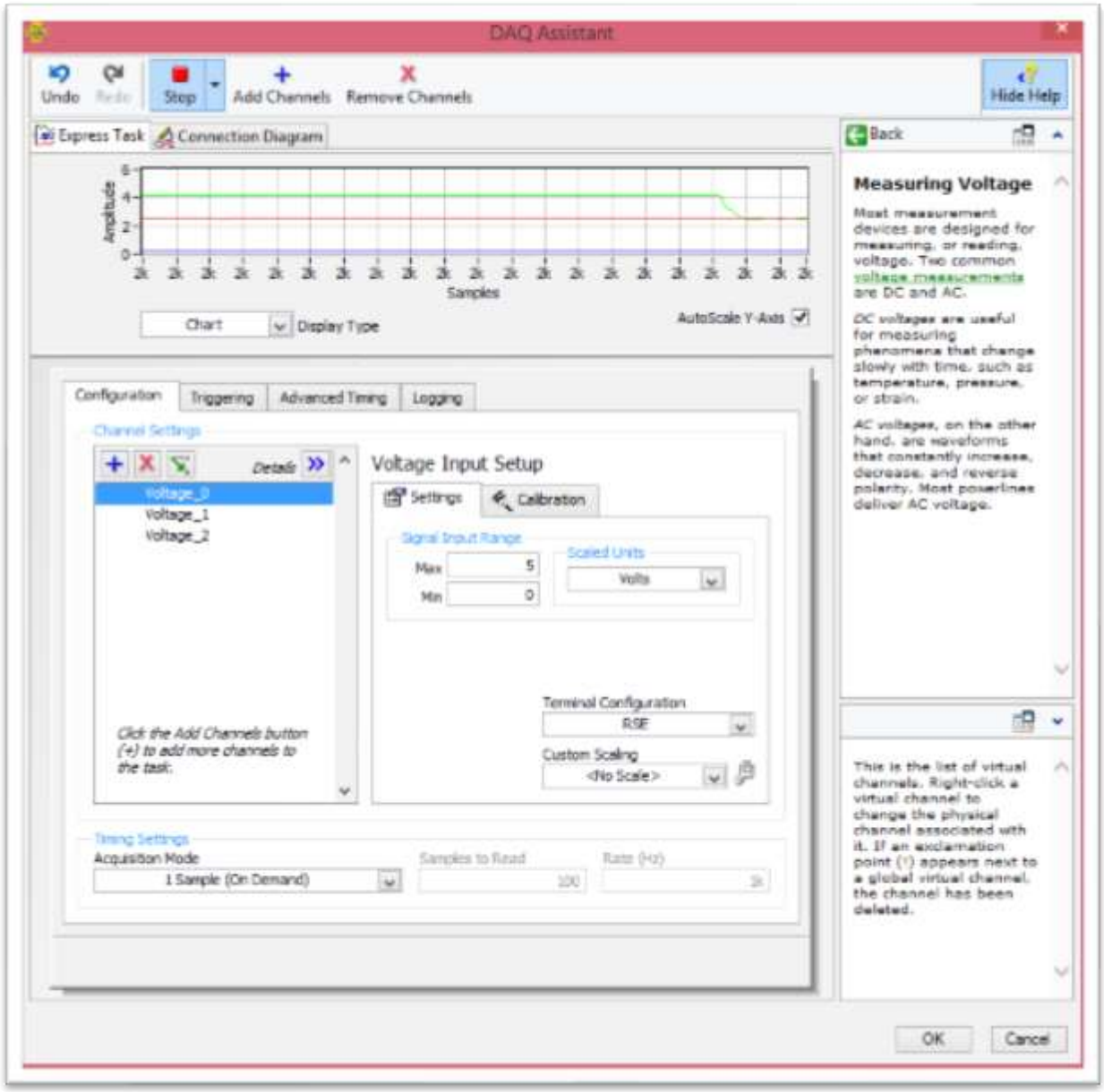

Figure 26 – DAQ properties option

[4]. The DAQ unit will now auto-configure so all you need to do is press OK.

You have now successfully configured the peripheral trigger switches, LEDs and DAQ unit.

OPERATING THE S.H.D.S.

The S.H.D.S. is now ready for operation depending on the LabVIEW files you have chosen to load.

The following details the **F.S.D.S. MASTER** program with further instructions on how to use the **DAQ MASTER** program on page 38 – Peripheral devices.

Program Interface

Both LabVIEW files have been designed to be initiative and simple as is reasonable possible for user interaction. The four monitoring zones include the following rooms:-

[1]. Chamber – which contains a heat sensor.

[2]. Library – which contains a heat sensor.

[3]. Dining Room – which contains a smoke sensor.

[4]. Drawing Room – which contains a smoke sensor.

Each room can be activated by selecting the corresponding local trigger detailed at the base of the screen display on the switch menu panel.

The following pages examine all the interactive possibilities that exist within the S.H.D.S. program.

Screen Display

Shown below is the initial screen display presented to the user at boot. To start the LabVIEW program running, press the run button  located to the top left of the screen.

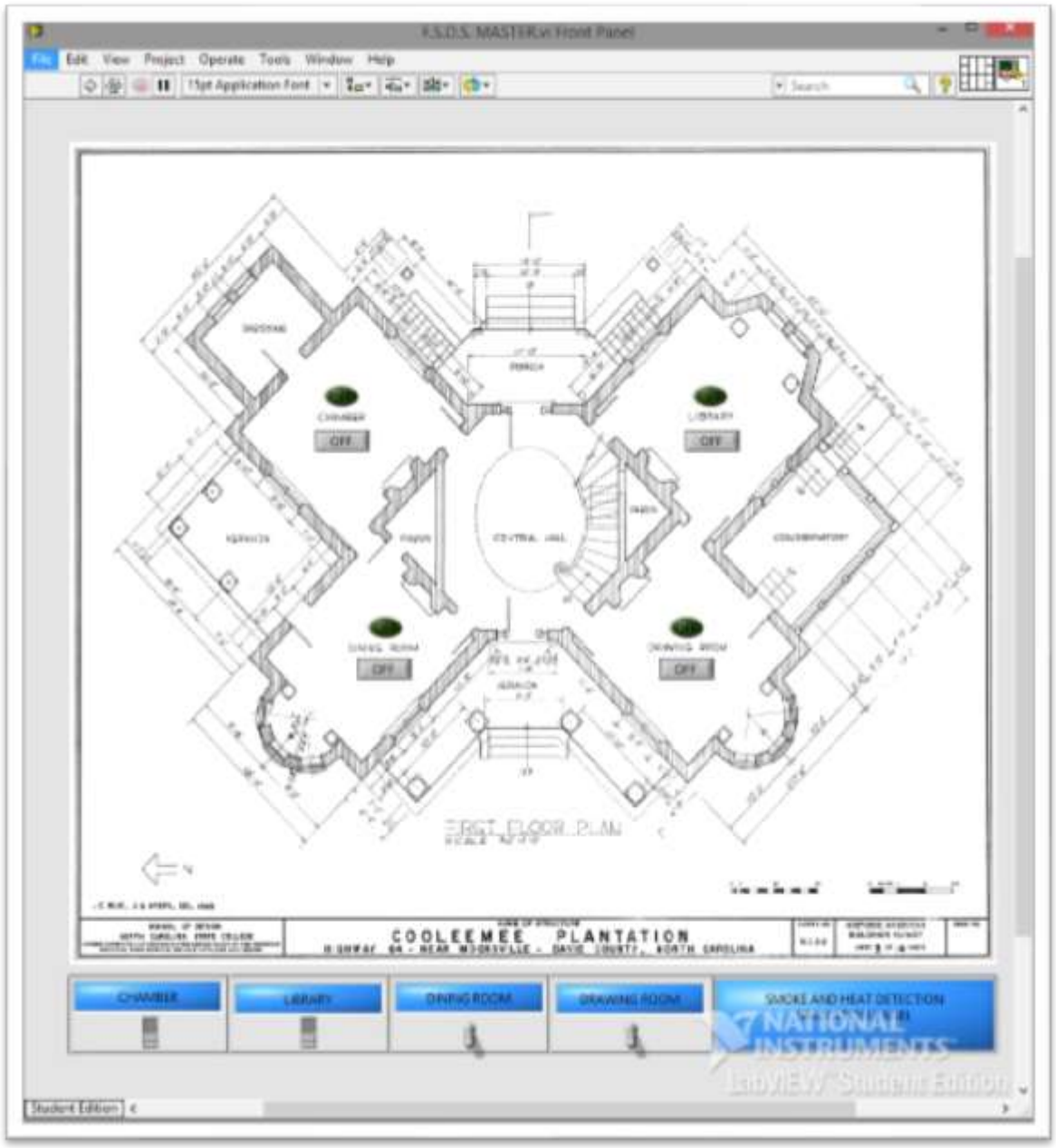

Figure 27 – Screen display

Note: The default boot setting for any room is  indicated by its associated LED being extinguished.

Arming Zones

Zones or rooms are individually 'Armed' by pressing the OFF button located directly under the associated rooms LED. The button display will then change to confirm ARMED the action taken by the user.

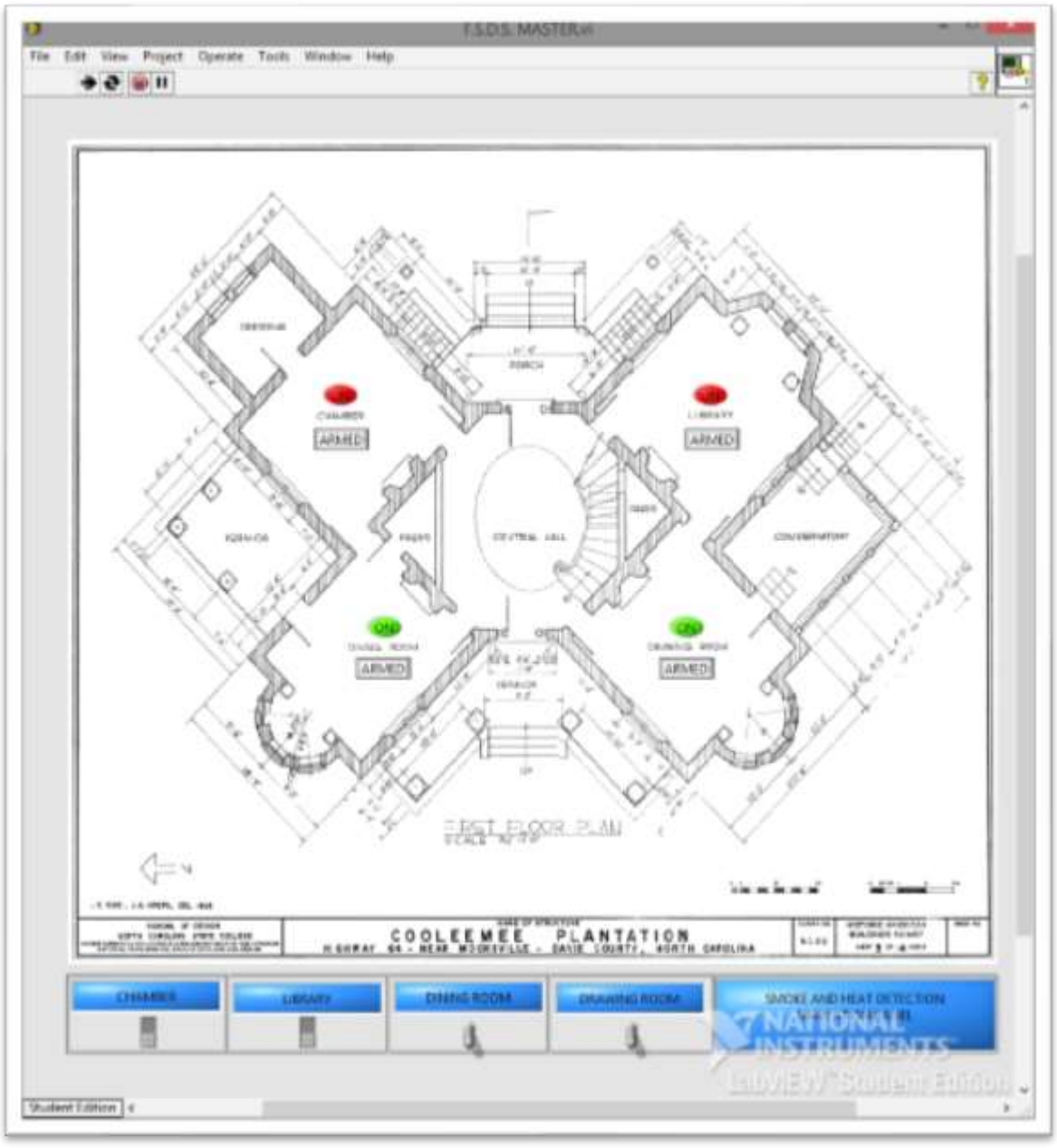

Figure 28 – Arming zones

Note: The rooms LED will now continously flash at a rate of 2000 milliseconds on and 500 milliseconds off – indicating that the room is now 'armed'.

Local Triggers (Smoke)

In figure 3 below we can see that the 'Drawing Room' has been armed ARMED and its 'local' *Smoke* trigger activated. All the other zones are switched off and their associated 'local' smoke and heat triggers inactive.

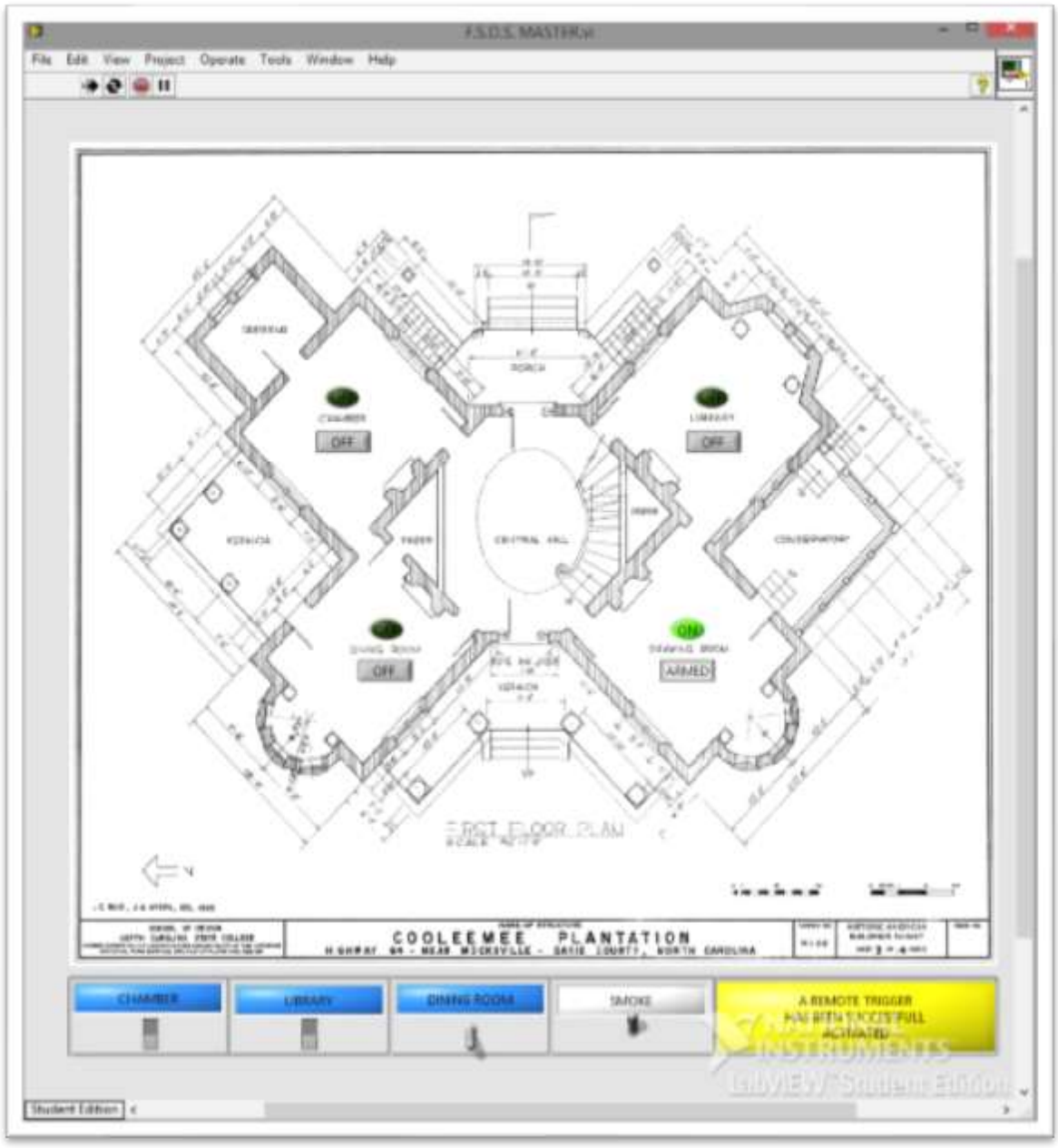

Figure 29 – Local triggers (smoke)

Note: The Drawing Rooms LED will now continously flash at a rate of 250 milliseconds on and 250 milliseconds off indicating that smoke is present. Confirmation that this action has also sent a remote trigger pulse to the other zones is also displayed to the user - Yellow message screen to bottom right.

Local Triggers (Heat)

In figure 4 below we can see that the 'Chamber' has been armed ARMED and its 'local' *Fire* trigger activated. All the other zones are switched off and their associated 'local' smoke and heat triggers inactive.

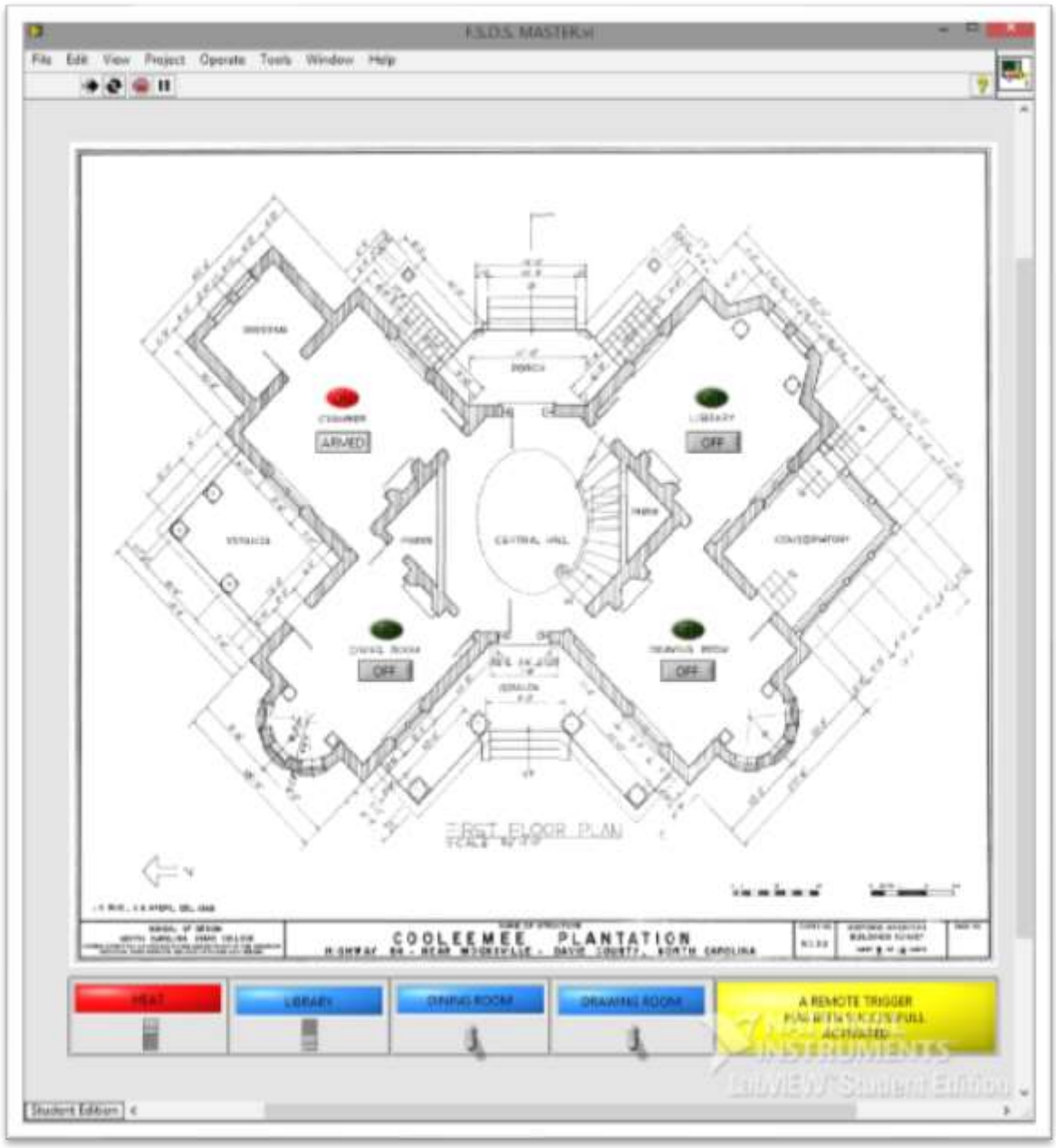

Figure 30 – Local triggers (heat)

Note: The Drawing Rooms LED will now continously flash at a rate of 250 milliseconds on and 250 milliseconds off indicating that a heat source is present. Confirmation that this action has sucessfully sent a remote trigger pulse to the other zones is also displayed.

Remote Triggers I

In figure 5 below we can see that the 'Drawing Room' has been armed ARMED but this time a 'remote' *Smoke* trigger has been activated for the 'Dining Room'.

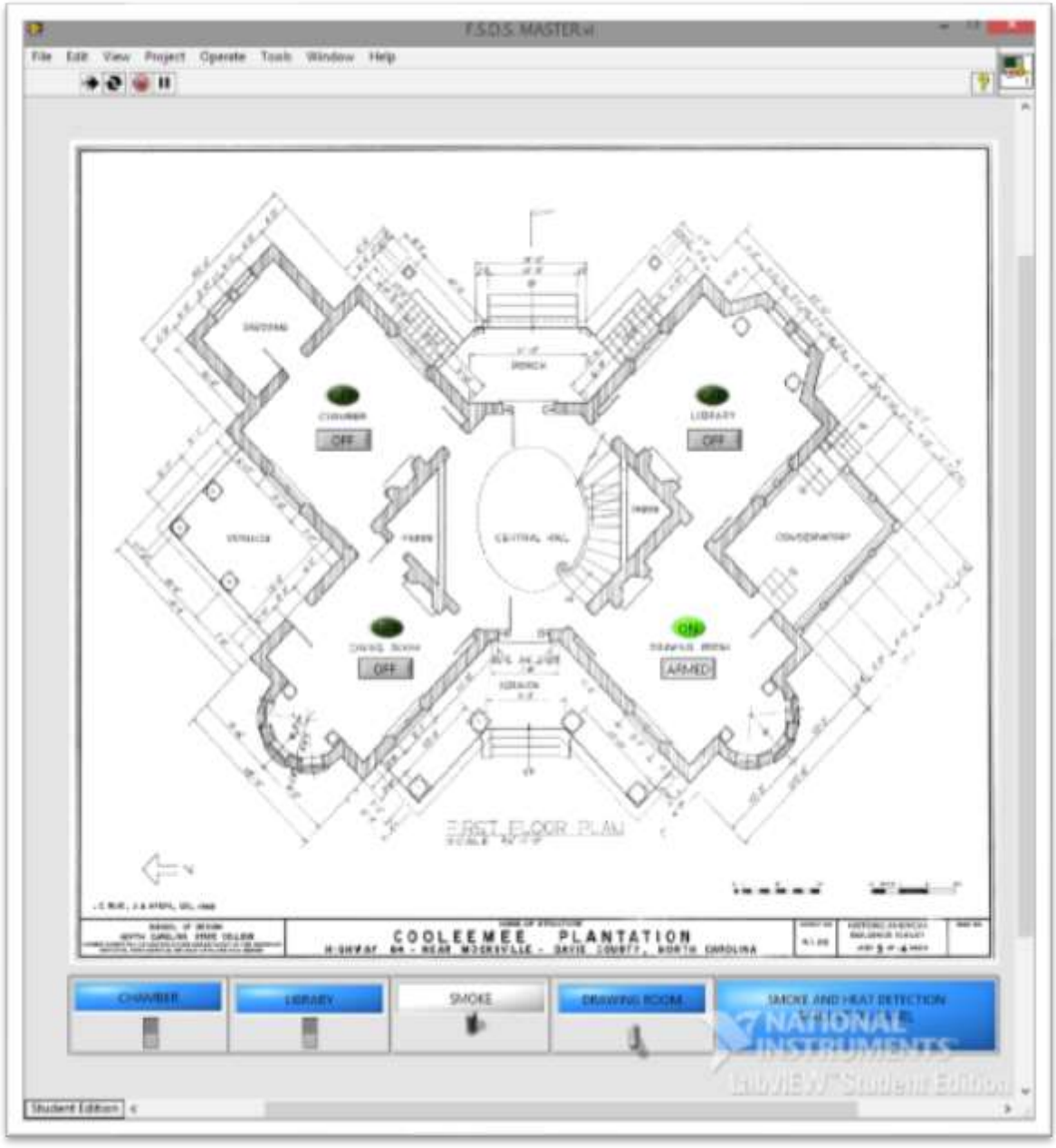

Figure 31 – Remote triggers I

Note: The Drawing Rooms LED will continously flash at a rate of 2000 milliseconds on and 500 milliseconds off – indicating that the room is 'armed' but not triggered. Further, no remote trigger pulse will be sent to the other zones. This is because the Dining Room sensor is not switched on.

Remote Triggers II

In figure 6 below we can see that both the 'Chamber' and 'Drawing Room' have been armed ARMED. Further the 'local' *Smoke* trigger has been activated for the 'Drawing Room' which in turn has acted a 'remote' trigger for the 'Chamber'.

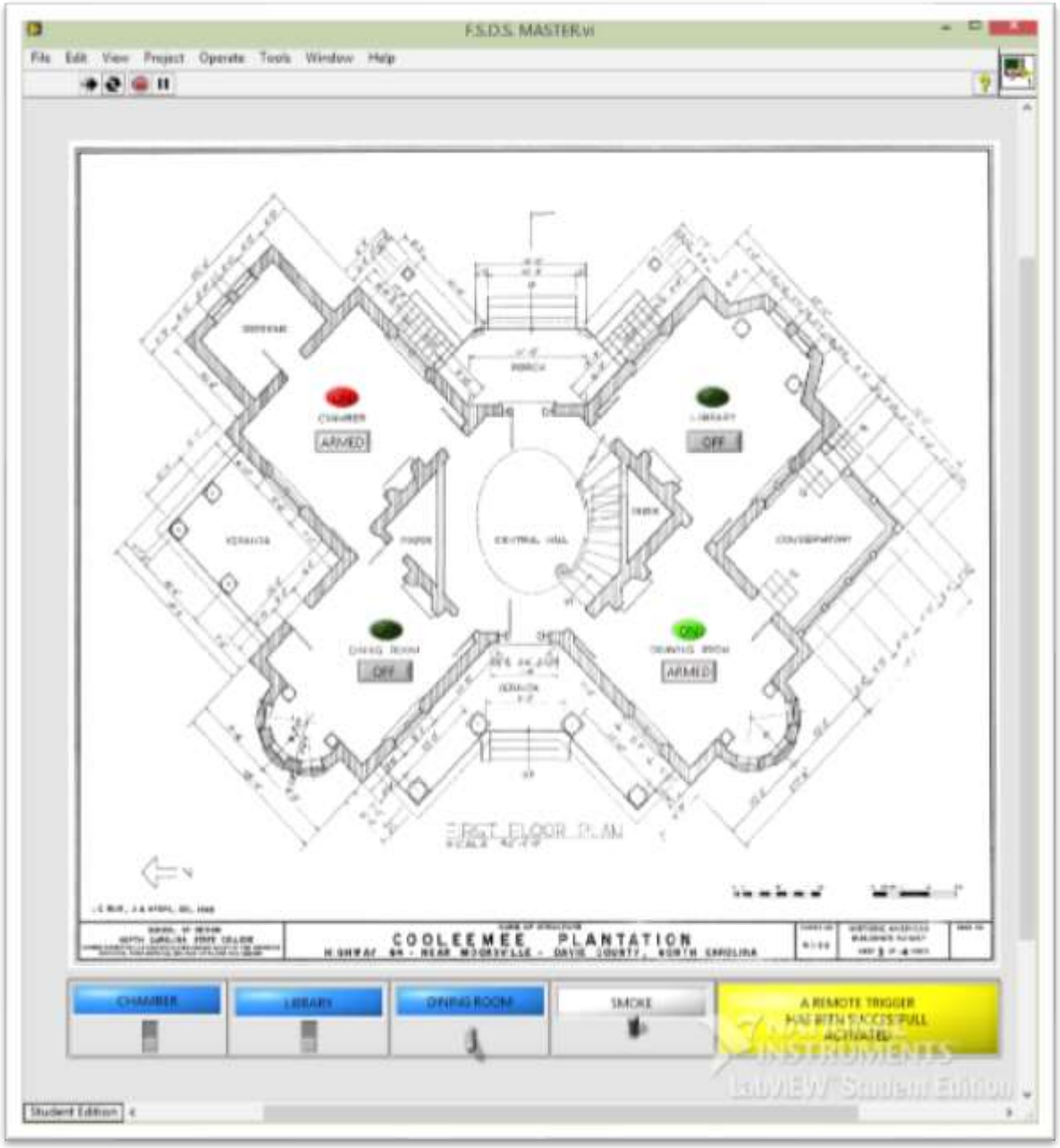

Figure 32 – Remote triggers II

Note: The Drawing Room will now continuously flash at a rate of 250 milliseconds on and 250 milliseconds off. The Chamber room however, will flash continuously at 500 milliseconds on and 500 milliseconds off indicating that it has been remotely trigged by another zone – in this case the Drawing Room.

PERIPHERAL DEVICES

If a DAQ unit has been successfully connected to the P.C. the I/O box replaces the physical role of the virtual switches, flashing LEDs and triggers within the LabVIEW S.H.D.S. program.

Figure 33 – Peripheral devices

Note: The screen display will still show the user interaction actions taken on the display screen but you will not be able to interact with them on the screen - See overleaf for a listing of the technical operations for the I/O control box.

I/O Box Technical Operations

Listed below are all the possible interactions that the user can make with the I/O control box to govern the S.H.D.S. program display via the DAQ unit.

Triggering switch '0' to the 'I' position will ARM the Chamber.

Triggering switch '1' to the 'I' position will ARM the Library.

Triggering switch '2' to the 'I' position will ARM the Dining Room.

Triggering switch '3' to the 'I' position will ARM the Drawing Room.

Triggering switch '4' to the 'I' position will ACTIVATE the Local smoke alarm for the Drawing Room.

Triggering switch '5' to the 'I' position will ACTIVATE the Local smoke alarm for the Dining Room.

Triggering switch '0' to the 'O' position will switch OFF the Chamber.

Triggering switch '1' to the 'O' position will switch OFF the Library.

Triggering switch '2' to the 'O' position will switch OFF the Dining Room.

Triggering switch '3' to the 'O' position will switch OFF the Drawing Room.

Triggering switch '4' to the 'O' position will switch OFF the Local smoke alarm for the Drawing Room.

Triggering switch '5' to the 'O' position will switch OFF the Local smoke alarm for the Dining Room.

Interacting with the Lm35 or Thermistor sensors located on the circuit board will activate the Local heat alarm for the Chamber and the Local heat alarm for the Library viz-a-viz.

The red LEDs 0 – 3 match the above room locations and will flash in symmetry with the display screen output.

S.H.D.S. DIAGNOSTICS

Within LabVIEW there is a facility to use 'execution highlighting'  to view an animation of the execution of the block diagram. Execution highlighting shows the movement of data on the block diagram from one node to another using bubbles that move along the wires. Use execution highlighting in conjunction with single-stepping to see how data moves from node to node through a VI (Wells, 2005).

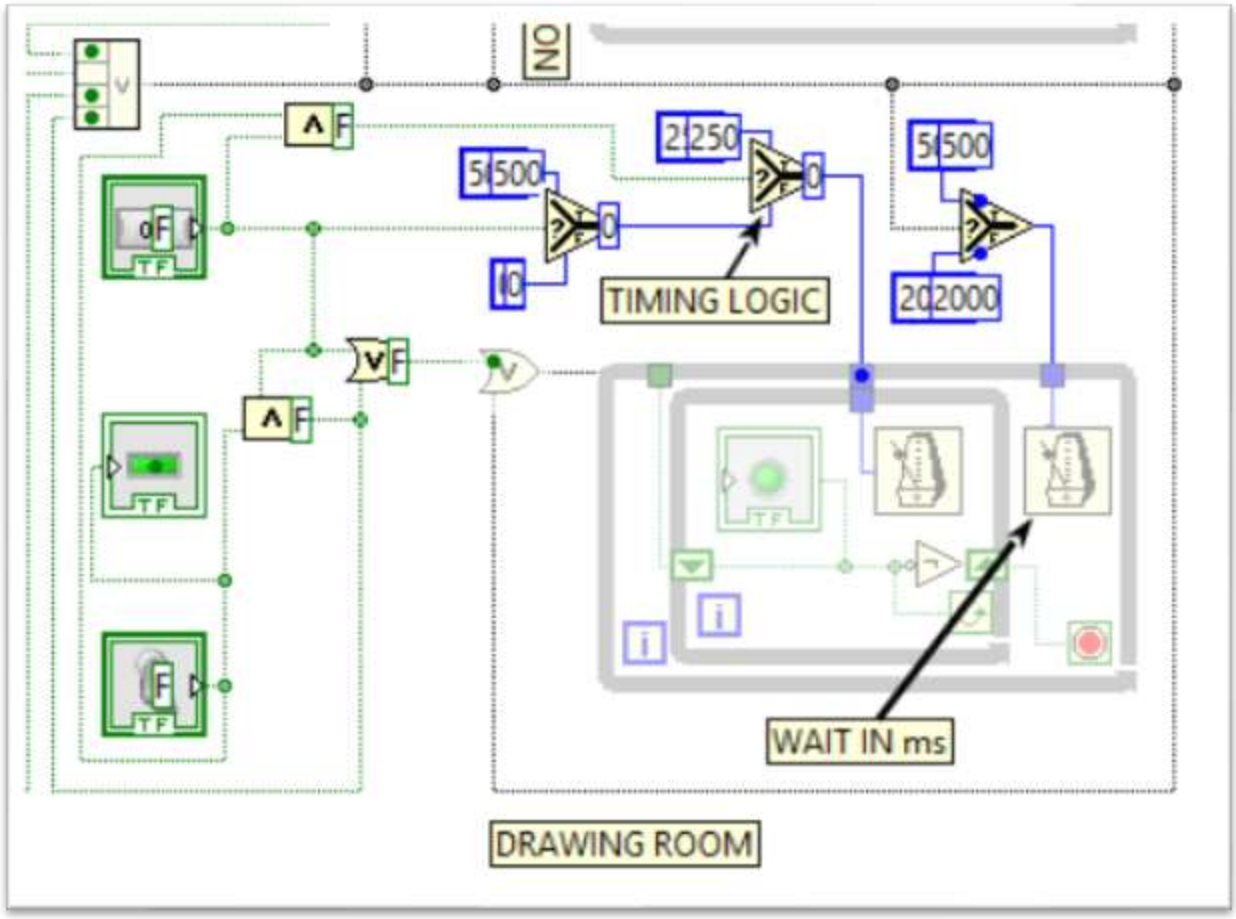

Figure 34 – Diagnostic mode

REFERENCES

Bishop, R. H. (2001). *LabVIEW STudent Edition.* USA: Prentice-Hall.

Wells, L. K. (2005). *The LabVIEW Student Edition User;s Guide.* USA: Prentice-Hall Inc.