CAB202 Assignment:

Student Name: James Wyatt

Student Number: N8040478

Introduction

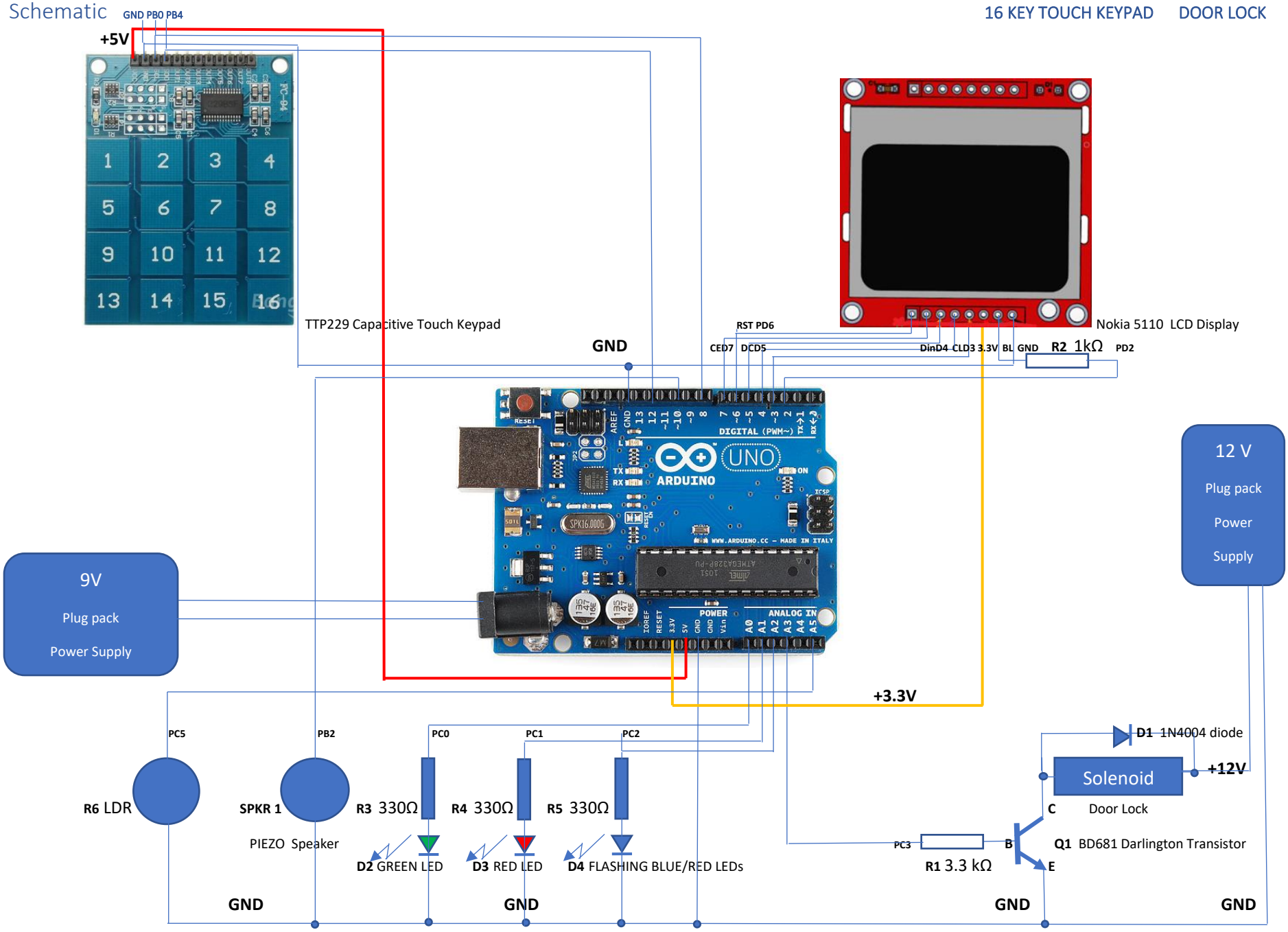
This report describes a project useful in-home automation. This application uses a large range of functionality of the ATmega328 – microcontroller. A home door lock has been designed, built, documented and is fully functional with a wide range of features. This door lock will be compatible with other modern home automation devices, through future serial communications.

It uses the Arduino Uno to control a numerical keypad, LED indicator lights for visual feedback, Piezo speaker for audio feedback, an LCD display to display a warning message, an instruction message, and the entered key numbers – some of which are not shown for security reasons. It also incorporates an ambient light detector to measure the current light level and turn on the back light on the LCD screen if it is too dark. The door lock is implemented by a solenoid, driven by a power transistor controlled by the Uno.

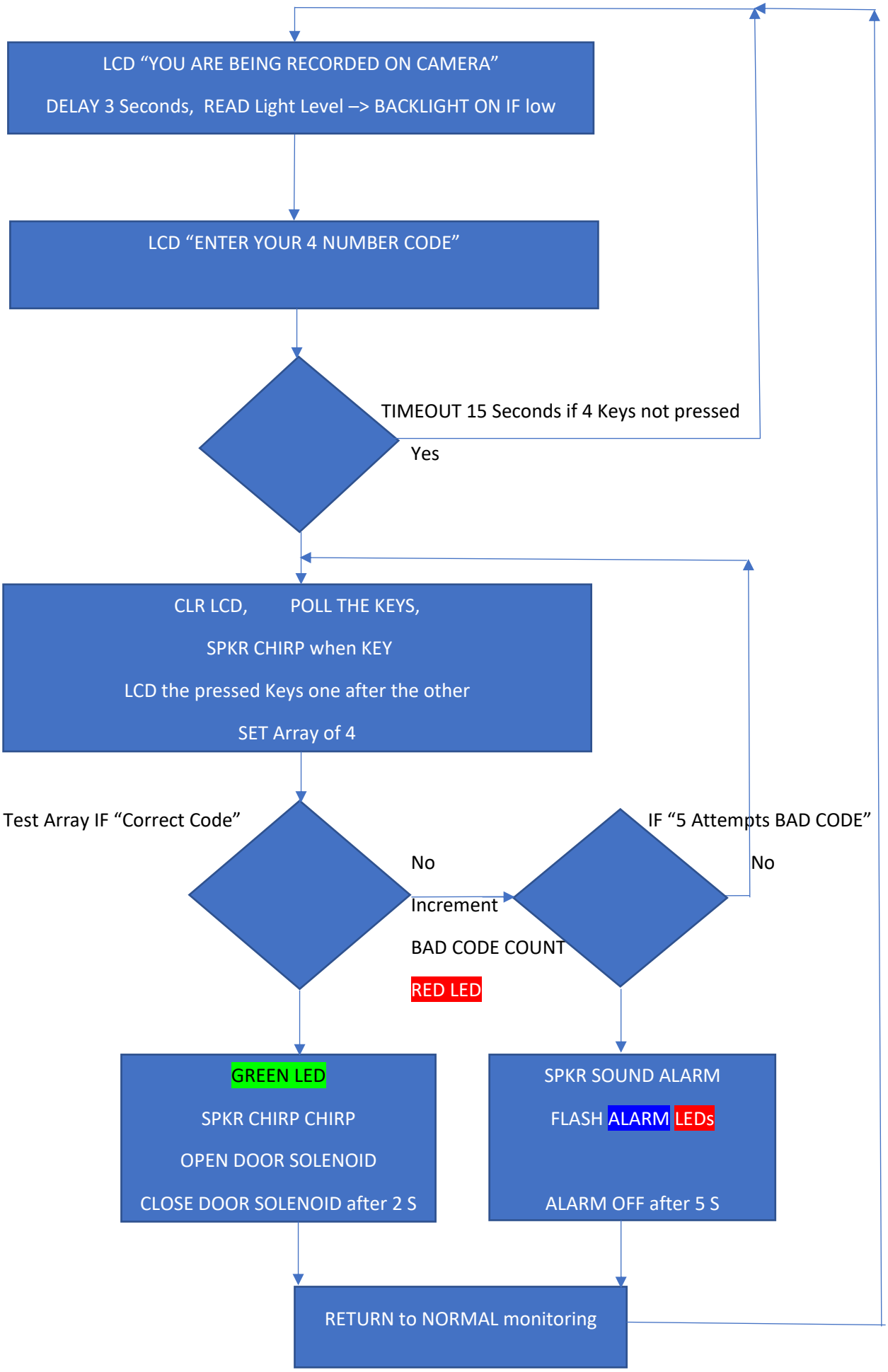
Digital I/O - Switch	*Uses a modern 16 key capacitive touch keypad as the input keypad switch. A correct 4 number code must be entered for the lock to open. The entered-key array is compared to the correct-key array.*
Digital I/O – Interrupt-based Debouncing	*This keypad features bounce-less keys and utilises reliable digital communication with the Uno. The Read Keypad function clocks the keypad and reads the state of the data pin for the latest touched key. No external library was needed.*
Digital I/O – LED	*Used green LED for visual key entry and correct code. Used red LED to indicate incorrect 4 number code. Used flashing blue/red LEDs to indicate if the wrong code is entered 5 times.*
Analog Input – ADC	*ADC Init and ADC Read functions were developed to read the value of a light dependent resistor (LDR) to control the backlight of the LCD display. An internal pullup resistor was used in conjunction with the LDR to provide a voltage divider at the input of the analog port.*
Analog Output – PWM	*PWM was implemented through bit-banging functions to provide 50% duty cycle square waves output to the Piezo speaker. Several functions were written to "chirp" key entries, "chirp-chirp" door open, "growl" incorrect key entries, and "eeeh-awwh" alarm after multiple wrong keys.*
Serial I/O – UART	*The uart_init, uart_putchar and uart_putstring functions were developed to debug parts of the program to display on the connected putty console – used to view the timer, key entry and LDR values . A useful future application of this function will be to interface to other home automation devices.*
LCD	*The Nokia LCD display provides warning and instruction messages cycling through after the 4 key presses. Pressed keys are displayed. The LCD display was also used to debug the early development of keypad entries and ADC function of light levels from the LDR.*
Timers (other than debouncing or PWM)	*The Door Lock also has a useful Timeout feature, if only a few keys are pressed and the person walks away. A timer function ISR was developed to establish a 15 second count after any key pressed and returns to beginning if exceeded. This timer function uses Timer0 with an overflow counter.*

Schematic

16 KEY TOUCH KEYPAD DOOR LOCK



Project Flowchart

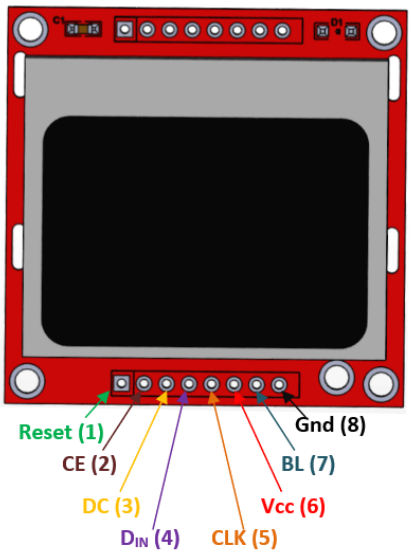


Wiring Instructions

1. Arduino Uno

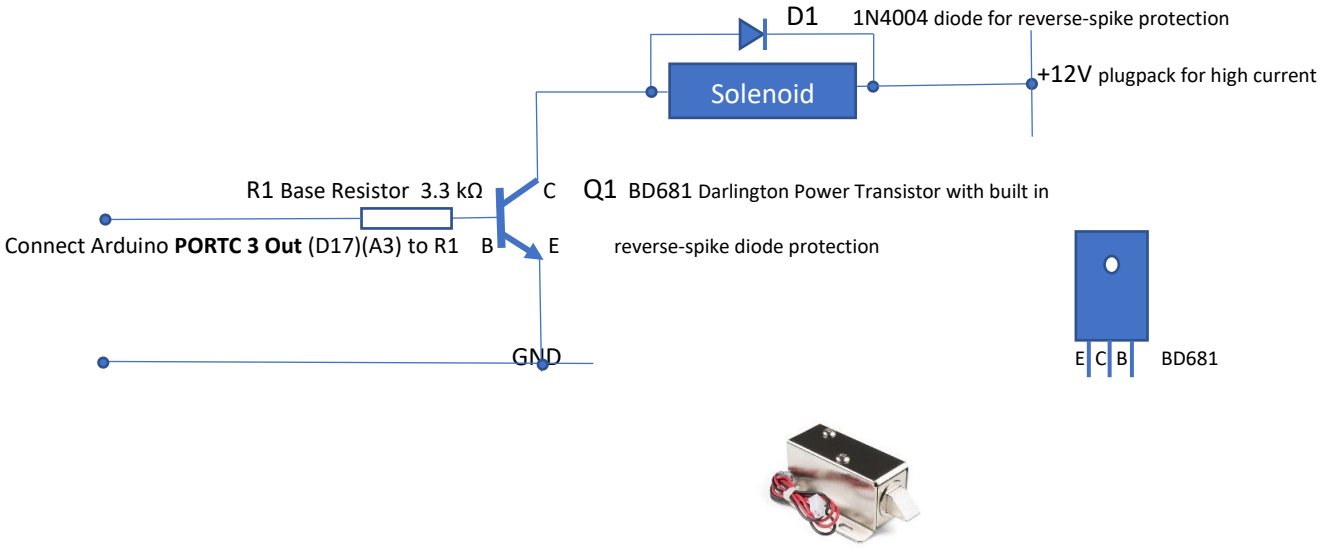
Connect Arduino GND Pin to Breadboard GND (Blue Line).
Connect Arduino +5V Pin to Breadboard +5V (Red Line). Arduino can be powered by USB port or 9 V plug pack.

2. Nokia 5110 display



5110 LCD display Pin:		Arduino Pin:
Pin 1 Reset	(Resets when LOW)	Connect to Arduino Pin **PORTD 6** (D6)
Pin 2 CE	(Chip Enable when LOW)	Connect to Arduino Pin **PORTD 7** (D7)
Pin 3 DC	(Pixel Data when HIGH, Command when LOW)	Connect to Arduino Pin **PORTD 5** (D5)
Pin 4 Din	(Serial In, pixels if DC is 1, command if DC 0)	Connect to Arduino Pin **PORTD 4** (D4)
Pin 5 CLK	(Clock source from Arduino)	Connect to Arduino Pin **PORTD 3** (D3)
Pin 6 Power	(Supply voltage is from 2.7V to 3.3V)	Connect to Arduino Pin **3.3V**
Pin 7 BL	(Backlight supply 3.3V maximum)	Connect to Arduino Pin **PORTD 2** (D2) for Backlight control via 1000 Ohm resistor to drop PORTD 2 OUTPUT HIGH from 5V to 3.3V
Pin 8 GND	(Ground)	Connect to **GND** line on Breadboard

3. Door Lock Pull Solenoid 12V DC



Core Electronics P/N ROB-15324 – Stroke 10 mm used as door lock

Connect +12V from plugpack to connector on breadboard, GND from plugpack to GND of breadboard. Connect Solenoid to Collector C of Q1, with D1 in parallel and cathode at +12V end to +12V. Connect Emitter E of Q1 to GND. Connect Base B of Q1 to other end of R1.

+12V was applied in the test above, to power the Solenoid. Its current was 600 milliAmps at 12V in the datasheet specifications. Therefore the Darlington power transistor was easily turned on with a Base Current of 1 milliAmp. Dropping from 5V output HIGH at the Arduino, to the Base drive voltage of the Darlington needed a Base Resistor of (5–1.4) / 1 milliAmp ≈ 3300 Ohms. Operation was tested before connecting to the Uno.

4. Output Indicators

Three LEDs are used, connected via 330 Ohm resistors.

Connect
PORTC 0 ~~(D14)(A0)~~ to R3 330 Ω then to anode of D2, cathode to GND — GREEN Correct Entry LED D2

Connect
PORTC 1 ~~(D15)(A1)~~ To R4 330 Ω then to anode of D3, cathode to GND — RED Incorrect Entry LED D3

Connect
PORTC 2 ~~(D16)(A2)~~ To R5 330 Ω then to anode of D4, cathode to ~~GND~~ — BLUE/RED Flashing Alarm LED D4

A piezo Speaker is used as an audible keypress indicator, and as an intruder Alarm.

Connect
PORTB 2 ~~(D10 PWM)~~ to piezo speaker other end to GND

5. Input Keypad

16 key touch interface, based on the TTP229 capacitive touch sensor IC. Keypad is configured to 16 key active low mode by shorting pads P1-3 together.

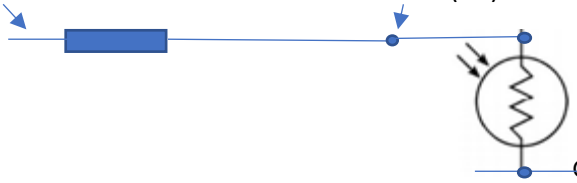
Arduino Pin:	**Keypad Module:**
Connect **+5V VCC Power** on breadboard to Keypad	**VCC**
Connect **GND** on breadboard to Keypad	**GND**
Connect **PORTB 0** (D8) Output to Keypad	**SCL** Serial Clock
Connect **PORTB 4** (D12) Input to Keypad	**SDO** Serial Data Out

6. Backlight Control – Ambient Light Sensor (Light Dependent Resistor)

Originally it was intended to use the BH1750 module, to control the LCD Backlight, however a simpler and cheaper method would be a Light Dependent Resistor using an internal 20 kΩ Pullup resistor on an Analog Input port. The ADC value then controls the ON/OFF state of the Backlight between night and day.

LDR Jaycar P/N RD 3485

Connect PORTC 5 to LDR, then LDR to GND. Arduino Internal +5V — 20 kΩ Internal R — **PORTC 5** (A5) ADC INPUT PIN



Measured resistance of LDR:
Normal room in daylight = 1000 Ohms. Dark room = 1,000,000 Ohms. So measured voltage at PORTC 5 Input would be approx. 5 Volts at night, and (1/21) x 5 = 0.24 Volts daylight. LCD Backlight on PORTD 2 is then turned ON or OFF.