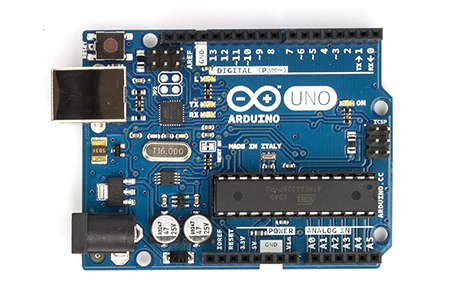
**5.2.1 ARDUINO UNO**

**Arduino Uno:**

Arduino/Genuino Uno is a microcontroller board based on the [ATmega328P](http://www.atmel.com/Images/doc8161.pdf). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.



"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

You can find [here](https://www.arduino.cc/en/Main/warranty) your board warranty informations.

Getting Started

You can find in the [Getting Started section](https://www.arduino.cc/en/Guide/HomePage) all the information you need to configure your board, use the [Arduino Software (IDE)](https://www.arduino.cc/en/Main/Software), and start tinker with coding and electronics.

Need Help?

* On the Software [on the Arduino Forum](https://forum.arduino.cc/index.php?board=63.0)
* On Projects [on the Arduino Forum](https://forum.arduino.cc/index.php?board=3.0)
* On the Product itself through [our Customer Support](https://store.arduino.cc/index.php?main_page=contact_us&language=en)

Technical specs

|  |  |
| --- | --- |
| Microcontroller | [ATmega328P](http://www.atmel.com/Images/doc8161.pdf) |
| Operating Voltage | 5V |
| Input Voltage (recommended) | 7-12V |
| Input Voltage (limit) | 6-20V |
| Digital I/O Pins | 14 (of which 6 provide PWM output) |
| PWM Digital I/O Pins | 6 |
| Analog Input Pins | 6 |
| DC Current per I/O Pin | 20 mA |
| DC Current for 3.3V Pin | 50 mA |
| Flash Memory | 32 KB (ATmega328P) of which 0.5 KB used by bootloader |
| SRAM | 2 KB (ATmega328P) |
| EEPROM | 1 KB (ATmega328P) |
| Clock Speed | 16 MHz |
| Length | 68.6 mm |
| Width | 53.4 mm |
| Weight | 25 g |



Power

The Arduino/Genuino Uno board can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector.

The board can operate on an external supply from 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may become unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

* Vin. The input voltage to the Arduino/Genuino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
* 5V.This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.
* 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
* GND. Ground pins.
* IOREF. This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.

Memory

The ATmega328 has 32 KB (with 0.5 KB occupied by the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the [EEPROM library](https://www.arduino.cc/en/Reference/EEPROM)).

Input and Output

See the mapping between Arduino pins and ATmega328P ports. The mapping for the Atmega8, 168, and 328 is identical.

Each of the 14 digital pins on the Uno can be used as an input or output, using [pinMode()](https://www.arduino.cc/en/Reference/PinMode),[digitalWrite()](https://www.arduino.cc/en/Reference/DigitalWrite), and [digitalRead()](https://www.arduino.cc/en/Reference/DigitalRead) functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller.

In addition, some pins have specialized functions:

* Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
* External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
* PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.
* SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.
* LED: 13. There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
* TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.

The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function.  
There are a couple of other pins on the board:

* AREF. Reference voltage for the analog inputs. Used with analogReference().
* Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Communication

Arduino/Genuino Uno has a number of facilities for communicating with a computer, another Arduino/Genuino board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, [on Windows, a .inf file is required](https://www.arduino.cc/en/Guide/Windows#toc4). The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A [SoftwareSerial library](https://www.arduino.cc/en/Reference/SoftwareSerial) allows serial communication on any of the Uno's digital pins.

The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino Software (IDE) includes a Wire library to simplify use of the I2C bus; see the [documentation](https://www.arduino.cc/en/Reference/Wire) for details. For SPI communication, use the [SPI library](https://www.arduino.cc/en/Reference/SPI).

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino/Genuino Uno board is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino Software (IDE) uses this capability to allow you to upload code by simply pressing the upload button in the interface toolbar. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

The Uno board contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see [this forum thread](http://forum.arduino.cc/index.php/topic,22974.0.html) for details.

Revisions

Revision 3 of the board has the following new features:  
1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible with both the board that uses the AVR, which operates with 5V and with the Arduino Due that operates with 3.3V. The second one is a not connected pin, that is reserved for future purposes.

* Stronger RESET circuit.
* Atmega 16U2 replace the 8U2.

**5.2.2 LCD DISPLAY**

**INTRODUCTION:**

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal.

An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle.

One each polarisers are pasted outside the two glass panels. These polarisers would rotate the light rays passing through them to a definite angle, in a particular direction

When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarisers, which would result in activating / highlighting the desired characters.

The LCD’s are lightweight with only a few millimeters thickness. Since the LCD’s consume less power, they are compatible with low power electronic circuits, and can be powered for long durations. The LCD’s don’t generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD’s have long life and a wide operating temperature range. Changing the display size or the layout size is relatively simple which makes the LCD’s more customer friendly. The LCDs used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics. The LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications.

POWERSUPPLY:

The power supply should be of +5V, with maximum allowable transients of 10mv. To achieve a better / suitable contrast for the display, the voltage (VL) at pin 3 should be adjusted properly.

A module should not be inserted or removed from a live circuit. The ground terminal of the power supply must be isolated properly so that no voltage is induced in it. The module should be isolated from the other circuits, so that stray voltages are not induced, which could cause a flickering display.

**HARDWARE:**

Develop a uniquely decoded ‘E’ strobe pulse, active high, to accompany each module transaction. Address or control lines can be assigned to drive the RS and R/W inputs.

Utilize the Host’s extended timing mode, if available, when transacting with the module. Use instructions, which prolong the Read and Write or other appropriate data strobes, so as to realize the interface timing requirements.

If a parallel port is used to drive the RS, R/W and ‘E’ control lines, setting the ‘E’ bit simultaneously with RS and R/W would violate the module’s set up time. A separate instruction should be used to achieve proper interfacing timing requirements.

**MOUNTING:**

Cover the display surface with a transparent protective plate, to protect the polarizer. Don’t touch the display surface with bare hands or any hard materials. This will stain the display area and degrade the insulation between terminals. Do not use organic solvents to clean the display panel as these may advesely affect tape or with absorbant cotton and petroleum benzene. The processing or even a slight deformation of the claws of the metal frame will have effect on the connection of the output signal and cause an abnormal display. Do not damage or modify the pattern wiring, or drill attachment holes in the PCB. When assembling the module into another equipment, the space between the module and the fitting plate should have enough height, to avoid causing stress to the module surface. Make sure that there is enough space behind the module, to dissipate the heat generated by the ICs while functioning for longer durations.

When an electrically powered screwdriver is used to install the module, ground it properly. While cleaning by a vacuum cleaner, do not bring the sucking mouth near the module. Static electricity of the electrically powered driver or the vacuum cleaner may destroy the module.

**ENVIRONMENTAL PRECAUTIONS:**

Operate the LCD module under the relative condition of 40°C and 50% relative humidity. Lower temperature can cause retardation of the blinking speed of the display, while higher temperature makes the overall display discolor. When the temperature gets to be within the normal limits, the display will be normal. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and humidity. Contact with water or oil over a long period of time may cause deformation or colour fading of the display. Condensation on the terminals can cause electro-chemical reaction disrupting the terminal circuit.

### TROUBLE SHOOTING

**INTRODUCTION:**

When the power supply is given to the module, with the pin 3 (VL) connected to ground, all the pixels of a character gets activated in the following manner: All the characters of a single line display, as in CDM 16108. The first eight characters of a single line display, operated in the two-line display mode, as in CDM 16116.

The first line of characters of a two-line display as in CDM 16216 and 40216. The first and third line of characters of a four-line display operated in the two-line display mode, as in CDM 20416. If the above mentioned does not occur, the module should be initialized by software. Make sure that the control signals ‘E’ , R/W and RS are according to the interface timing requirements.

**IMPROPER CHARACTER DISPLAY:**

When the characters to be displayed are missing between, the data read/write is too fast. A slower interfacing frequency would rectify the problem. When uncertainty is there in the start of the first characters other than the specified ones are rewritten, check the initialization and the software routine. In a multi-line display, if the display of characters in the subsequent lines does’nt take place properly, check the DD RAM addresses set for the corresponding display lines.

When it is unable to display data, even though it is present in the DD RAM, either the display on/off flag is in the off state or the display shift function is not set properly. When the display shift is done simultaneous with the data writa operation, the data may not be visible on the display. If a character not found in the font table is displayed, or a character is missing, the CG ROM is faulty and the controller IC have to be changed If particular pixels of the characters are missing, or not getting activated properly, there could be an assembling problem in the module. In case any other problems are encountered you could send the module to our factory for testing and evaluation.

### CRYSTALONICS DISPLAY

**INTRODUCTION:**

Crystalonics dot –matrix (alphanumeric) liquid crystal displays are available in TN, STN types, with or without backlight. The use of C-MOS LCD controller and driver ICs result in low power consumption. These modules can be interfaced with a 4-bit or 8-bit micro processor /Micro controller.

The built-in controller IC has the following features:

* Correspond to high speed MPU interface (2MHz)
* 80 x 8 bit display RAM (80 Characters max)
* 9,920 bit character generator ROM for a total of 240 character fonts. 208 character fonts (5 x 8 dots) 32 character fonts (5 x 10 dots)
* 64 x 8 bit character generator RAM 8 character generator RAM 8 character fonts (5 x 8 dots) 4 characters fonts (5 x 10 dots)
* Programmable duty cycles

1/8 – for one line of 5 x 8 dots with cursor

1/11 – for one line of 5 x 10 dots with cursor

1/16 – for one line of 5 x 8 dots with cursor

* Wide range of instruction functions display clear, cursor home, display on/off, cursor on/off, display character blink, cursor shift, display shift.
* Automatic reset circuit, that initializes the controller / driver ICs after power on.

**BUSY FLAG:**

When the busy flag is1, the controller is in the internal operation mode, and the next instruction will not be accepted.

When RS = 0 and R/W = 1, the busy flag is output to DB7.

The next instruction must be written after ensuring that the busy flag is 0.

**ADDRESS COUNTER:**

The address counter allocates the address for the DD RAM and CG RAM read/write operation when the instruction code for DD RAM address or CG RAM address setting, is input to IR, the address code is transferred from IR to the address counter. After writing/reading the display data to/from the DD RAM or CG RAM, the address counter increments/decrements by one the address, as an internal operation. The data of the address counter is output to DB0 to DB6 while R/W = 1 and RS = 0.

**DISPLAY DATA RAM (DD RAM)**

The characters to be displayed are written into the display data RAM (DD RAM), in the form of 8 bit character codes present in the character font table. The extended capacity of the DD RAM is 80 x 8 bits i.e. 80 characters.

**CHARATCER GENERATOR ROM (CG ROM)**

The character generator ROM generates 5 x 8 dot 5 x 10 dot character patterns from 8 bit character codes. It generates 208, 5 x 8 dot character patterns and 32, 5 x 10 dot character patterns.

**CHARACTER GENERATOR RAM (CG RAM)**

In the character generator RAM, the user can rewrite character patterns by program. For 5 x 8 dots, eight character patterns can be written, and for 5 x 10 dots, four character patterns can be written.

**INTERFACING THE MICROPROCESSOR CONTROLLER:**

The module, interfaced to the system, can be treated as RAM input/output, expanded or parallel I/O.Since there is no conventional chip select signal, developing a strobe signal for the enable signal (E) and applying appropriate signals to the register select (RS) and read/write (R/W) signals are important.The module is selected by gating a decoded module – address with the host – processor’s read/write strobe. The resultant signal, applied to the LCDs enable (E) input, clocks in the data.The ‘E’ signal must be a positive going digital strobe, which is active while data and control information are stable and true. The falling edge of the enable signal enables the data / instruction register of the controller. All module timings are referenced to specific edges of the ‘E’ signal. The ‘E’ signal is applied only when a specific module transaction is desired.The read and write strobes of the host, which provides the ‘E’ signals, should not be linked to the module’s R/W line. An address bit which sets up earlier in the host’s machine cycle can be used as R/W.When the host processor is so fast that the strobes are too narrow to serve as the ‘E’ pulse

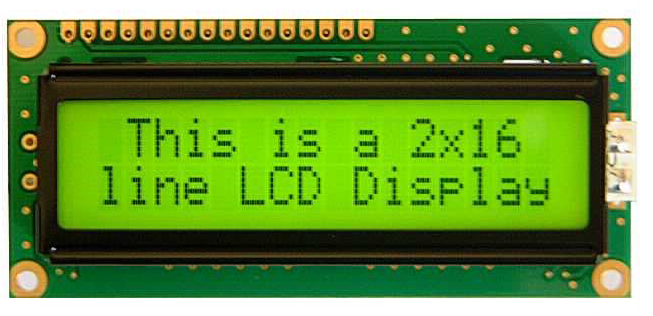
1. Prolong these pulses by using the hosts ‘Ready’ input
2. Prolong the host by adding wait states
3. Decrease the Hosts Crystal frequency.

Inspite of doing the above mentioned, if the problem continues, latch both the data and control information and then activate the ‘E’ signal

When the controller is performing an internal operation he busy flag (BF) will set and will not accept any instruction. The user should check the busy flag or should provide a delay of approximately 2ms after each instruction.The module presents no difficulties while interfacing slower MPUs.The liquid crystal display module can be interfaced, either to 4-bit or 8-bit MPUs.

For 4-bit data interface, the bus lines DB4 to DB7 are used for data transfer, while DB0 to DB3 lines are disabled. The data transfer is complete when the 4-bit data has been transferred twice.

The busy flag must be checked after the 4-bit data has been transferred twice. Two more 4-bit operations then transfer the busy flag and address counter data.For 8-bit data interface, all eight-bus lines (DB0 to DB7) are used.



A **liquid crystal display** (**LCD**) is a thin, flat [electronic visual display](http://en.wikipedia.org/wiki/Electronic_visual_display) that uses the light modulating properties of [liquid crystals](http://en.wikipedia.org/wiki/Liquid_Crystals) (LCs). LCs do not emit light directly.

They are used in a wide range of applications including: [computer monitors](http://en.wikipedia.org/wiki/Computer_monitor), [television](http://en.wikipedia.org/wiki/Television), instrument panels, [aircraft cockpit displays](http://en.wikipedia.org/wiki/Flight_instruments), [signage](http://en.wikipedia.org/wiki/Signage), etc. They are common in consumer devices such as video players, gaming devices, [clocks](http://en.wikipedia.org/wiki/Clock), watches, [calculators](http://en.wikipedia.org/wiki/Calculator), and [telephones](http://en.wikipedia.org/wiki/Telephone). LCDs have displaced [cathode ray tube](http://en.wikipedia.org/wiki/Cathode_ray_tube)(CRT) displays in most applications. They are usually more compact, lightweight, portable, less expensive, more reliable, and easier on the eyes. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they cannot suffer image burn-in.LCDs are more energy efficient and offer safer disposal than CRTs. Its low electrical power consumption enables it to be used in [battery](http://en.wikipedia.org/wiki/Battery_%28electricity%29)-powered [electronic](http://en.wikipedia.org/wiki/Electronics) equipment. It is an [electronically-modulated optical device](http://en.wikipedia.org/wiki/Electro-optic_modulator) made up of any number of [pixels](http://en.wikipedia.org/wiki/Pixel) filled with [liquid crystals](http://en.wikipedia.org/wiki/Liquid_crystal) and arrayed in front of a [light source](http://en.wikipedia.org/wiki/Light#Light_sources) ([backlight](http://en.wikipedia.org/wiki/Backlight)) or [reflector](http://en.wikipedia.org/wiki/Reflector_%28photography%29) to produce images in colour or [monochrome](http://en.wikipedia.org/wiki/Monochrome). The earliest discovery leading to the development of LCD technology, the discovery of liquid crystals, dates from 1888. By 2008, worldwide sales of televisions with LCD screens had surpassed the sale of CRT units