

Serial 7-Segment Display

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Overview

The Serial 7-Segment Display turns the thirteen pins necessary to control a 4-digit 7-segment display into just one or three. The display will give you full control of all digits, decimal points, the colon and the apostrophe. At the heart of the display is an ATmega328 which both listens to the serial commands and controls the 7-segment display.

Features

- 4 digit alpha-numeric display with serial or SPI interface
- Display numbers, most letters, and a few special characters.
- Individual control of decimal points, apostrophe, and colon.
- Selectable brightness.
- Baud rate and brightness values retained in non-volatile memory.
- Individual segment control for each digit.

Interface Specifications

The Serial 7-Segment Display can be controlled in one of two ways: (1) serial TTL communication or (2) SPI serial communication. Regardless of which method you use to communicate with the display, you must always send your display data in 4-byte packets, and special commands in 2-byte packets.

Displaying Numbers

The first byte you send will correspond to the left-most digit on the display, the second byte corresponds to the second digit and so on.

The display can represent all numbers 0-9 and letters A-F. To display a number, you can send either the binary or ASCII representation.

Example: To Display '12AB'

The user can send numbers in binary representation:

(0x01)(0x02)(0x0A)(0x0B)

ASCII representation: (0x31)(0x32)(0x41)(0x42)

Any combination of the two will work as well.

To display a blank digit send the special character 'x' (0x78).

Example: To Display '42'

(Blank followed by 42 followed by blank) send (0x78)(0x04)(0x02)(0x78).

NOTE: You must always send your data in 4-byte packets

Displayed Character	Command
0	0x00, "0", "O"
1	0x01, "1", "I"
2	0x02, "2"
3	0x03, "3"
4	0x04, "4"
5	0x05, "5", "s", "S"
6	0x06, "6"
7	0x07, "7"
8	0x08, "8"
9	0x09, "9", "g"
A	0x10, "A", "a"
B	0x11, "B", "b"
C	0x12, "C"
c	"c"
D	0x13, "D", "d"
E	0x14, "E"
e	"e"
F	0x15, "F", "f"
G	"G"
H	"H"
h	"h"
I	"I", "i"
J	"J", "j"
L	"L"
n	"N", "n"
o	"o"
P	"p", "P"
q	"q", "Q"
r	"R", "r"
t	"T", "t"
U	"U"
u	"u"
y	"Y", "y"
-	"-"
"	"'"
'	"'"
=	"="

Table 1

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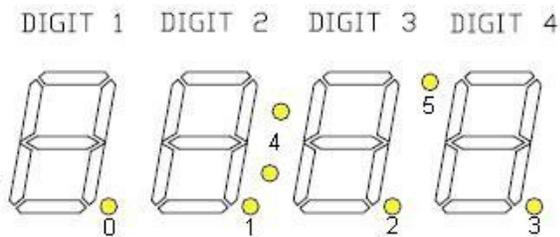
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Special Commands

There are eight special commands that can be sent to the Serial 7-Segment Display. Each special command consists of sending a command character followed by a data byte. After sending a special command, the characters previously on the display will be restored.

Decimal Point Command

To turn on or off any of the decimal points, colons, or apostrophes on the Serial 7-Segment Display, first send the special command character 0x77, followed by a data byte. Each of the six least significant bits in the data byte represent one decimal point (or two in the case of the colon); a 1 will turn the decimal point on, a 0 will turn it off. The most significant bits in the data byte has no effect on the display. The two colon LEDs are connected internally and cannot be controlled individually. The following figure shows the bit representation for each decimal point; 0 is the least significant bit.



Example: To turn solely the colon and apostrophe on, first send the special character 0x77. The 4th and 5th bits in the data byte should be 1, everything else should be 0, the byte would look like: 00110000. So, send: (0x77)(0x30).

To turn the colon and apostrophe off, send the special character, 0x77, and set all bits in the data byte to 0. So, send: (0x77)(0x00).

Brightness Command

To control the brightness of the Serial 7-Segment Display, first send the special command character 0x7A, followed by a data byte. The data byte can be a number between 0 and 254; the lower the number the brighter the display.

After the screen receives the brightness command the

brightness value is written into the processor's non-volatile memory, so it will retain the same brightness level upon power cycling.

Example: to set the display to its dimmest level, send the special character, 0x7A, followed by 254. So send: (0x7A)(0xFE)

Baud rate control

By default the UART baud rate of the Serial 7-Segment Display will be 9600. This can be adjusted by first sending the special command character 0x7F, followed by a binary number between 0 and 6. The table below shows corresponding baud rates to data bytes:

Baud Rate	Data Byte Value
2400	0
4800	1
9600	2
14400	3
19200	4
38400	5
57600	6

If the data byte is not between 0 and 6 nothing will be changed.

After the baud rate is adjusted the value is written into the processors non-volatile memory, so it will retain the same rate upon power cycling.

Example: to change the baud rate to 4800 first enter the special command character 0x7F, followed by the binary number 1. So, send: (0x7F)(0x01)

3.4 Reset Display

Sending the reset display command, 0x76, will clear the display and set the cursor to the first digit. This command is useful if the position of the cursor is unknown. There is no data byte for this command, and it can be sent at any time, regardless of cursor

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position.

3.5 Single Character Control

Single character control allows you to control each LED of each digit individually. Four special commands are used for single character control, one for each digit: 0x7B controls digit 1, 0x7C controls digit 2, 0x7D controls digit 3, and 0x7E controls digit 4. The special command will be followed by one data byte. Similar to decimal point control, each bit in the data byte represents a single LED; a 1 will turn the digit on, a 0 will turn it off. The most significant bit of the data byte has no effect on the display.

The following figure shows the bit representation for each decimal point; 0 is the least significant bit:
Example: To illuminate the B, E, and G segments of the third digit, first send the digit 3 single character control command (0x7D) followed by a data byte with the 1st, 4th and 6th bits set (0x52). So, send: (0x7D) (0x52)

Table 3: Special Command Summary

Special Command	Command Byte (ASCII Character)	Data Byte Value
Decimal Point Control	0x77 ("w")	Each bit controls individual Decimal points
Brightness Control	0x7A ("z")	0-254, higher numbers mean dimmer display
Baud Rate Control	0x7F (DEL)	0-6
Reset Display	0x76 ("v")	NONE
Digit 1 Control	0x7B ("{"	Each bit controls individual segments
Digit 2 Control	0x7C (" ")	Each bit controls individual segments
Digit 3 Control	0x7D ("}")	Each bit controls individual segments
Digit 4 Control	0x7E ("~")	Each bit controls individual segments

4. Hardware Specifications

There are two methods of sending serial data to the Serial 7-Segment Display, TTL level serial communication or SPI.

4.1 TTL Level Serial Communication

When using this method of communication only one wire is needed to interface with the display – RX. RX is a serial input of the display. By default, communications will occur at 9600bps, with 8 data bits, no parity, and 1 stop bit. The baud rate is adjustable, as discussed above in section 3.3.

4.2 SPI Communications

When using SPI to communicate with the display, three wires are used – MOSI, CSN, SCK. CSN, selects the display in a multiple slave SPI bus, SCK is the serial data clock, and MOSI is the data line between the master and slave. MOSI, CSN and SCK are all inputs. The Serial 7-Segment Display is configured to be the SPI slave.

The maximum speed of the SPI clock input is 250kHz. The display is configured to use SPI mode 0 (CPOL = 0, CPHA = 0), so the clock line should idle low and data is sampled on the rising edge.

5. Electrical Characteristics

The backbone of the Serial 7-Segment Display is Atmel's ATmega168, and as such, most of the electrical specifications are derived from that. The display can be powered at anywhere between 2.6 to 5.5V, however, there is no on-board voltage regulator, so anything outside that range could damage the display. A logical high voltage on all serial lines should not exceed VCC+0.5 V.