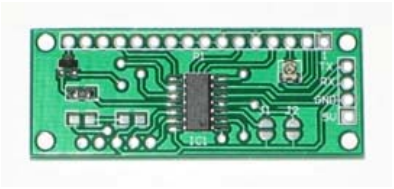
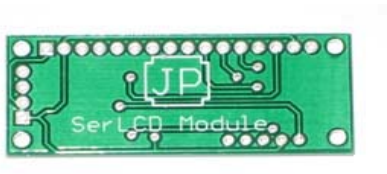
JP Serial LCD Module





JP serial LCD module is a simple and cost effective interface controller module. It supports 16x2, 16x4, 20x2 and 20x4 LCD display base on HD44780 controller. Also it will work with any microcontroller capable of accepting asynchronous serial data.

SPECS

Power: 5V VDC <10mA (not include LCD display Backlight)
Size: 50mm x 20mm (2.0" x 0.75")
Speed: 4800 or 19200 Baud.

PIN FUNCTIONS

P1 Connector: P1 connector will be connected to a 16x2, 16x4, 20x2 or 20x4 LDC Display.

Pin1:	GND
Pin2:	Vcc
Pin3	Vee
Pin4:	RS
Pin5:	R/W
Pin6:	En
Pin7 – Pin14:	D0 – D7
Pin15	LED+
Pin16	LED-

P2 Connector: P2 connector will be connected to power and a MCU

RX: Serial input connection to JP Module. The module allows 4800 or 19200 baud based on J1 settings.

TX: Serial output connection to JP Module. The module allows 4800 or 19200 baud based on J1 settings.

J1 Settings:

J1	J2	Baud
x	n/a	4800
-	n/a	19200

- = connected

x = disconnected

GND: Power supply and serial ground. This MUST also be connected to ground on the device to allow the serial data to be sent to the module.

5V: Supply voltage to module. Vin may be 5.0V (±0.5V), with 10 milliamps of current.

JP Serial LCD Module Commands:

Those commands are ASCII value between 1 and 30. It needs a pause to be pressed.

Commands	Dec	Hex
CGRam 1 Address	1	01

CGRam 2 Address	2	02
CGRam 3 Address	3	03
CGRam 4 Address	4	04
CGRam 5 Address	5	05
CGRam 6 Address	6	06
CGRam 7 Address	7	07
CGRam 8 Address	8	08
CGRam 1 setting	9	09
CGRam 2 setting	10	0A
CGRam 3 setting	11	0B
CGRam 4 setting	12	0C
CGRam 5 setting	13	0D
CGRam 6 setting	14	0E
CGRam 7 setting	15	0F
CGRam 8 setting	16	10
Clear Display	17	11
Return cursor to home	18	12
Turn cursor off	19	13
Turn underline cursor on	20	14
Turn blink cursor on	21	15
Move cursor left	22	16
Move cursor right	23	17
Turn LCD Display on	24	18
Turn LCD Display off	25	19
Shift Display left	26	1A
Shift Display right	27	1B
Turn backlight on	28	1C
Turn backlight off	29	1D

New command for Chart Bar Function (Since 4-1-2013)

Command(hex)	Command	Description	
SEB	235	Load Horizontal Chart to CGRAM	None
$EC	236	Load Horizontal round edge Chart to CGRAM	None
$ED	237	Load vertical Chart to CGRAM	None
$EE	238	Load Horizontal round edge Chart to CGRAM	None
$EF	239	H-Function(Line number, Start position, End position, Bar volume)	None
$F0	240	V-Function(Line start position, Line number, Start position, End position, Bar volume[x])	None
$F1	241	Set LCD 2 x 16 or 4 x16	None
$F2	242	Set LCD 2 x 20 or 4 x 20	None
$F3	243	Set JP Logo On	None
$F4	244	Set JP Logo Off	None

JP Serial LCD Module Characters:

JP Serial LCD Module supports all of ASCII value between 32 – 127.

JP Serial LCD Module out put row and column:

JP Serial LCD Module output row and column control number are between 128 and 234.

HD44780 the addresses of the first position of Lines 1 & 2 are 0 and 64, respectively. The first position of Line 3 and Line 4 are extension of the addresses of Line 1 and Line 2.

16x4 LCD: Line 1 = 0, Line 2 = 64, Line 3 = 16, Line 4 = 80
20x4 LCD: Line 1 = 0, Line 2 = 64, Line 3 = 20, Line 4 = 84

Those address must be used the LCD Command $80, or 128.

16x4 LCD: Line 1 = 128 + 0, Line 2 = 128 + 64, Line 3 = 128 + 16, Line 4 = 128 + 80
20x4 LCD: Line 1 = 128 + 0, Line 2 = 128 + 64, Line 3 = 128 + 20, Line 4 = 128 + 84

16x2 LCD Display Character Address Code: (128 + Position number)

Display Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DD RAM Address	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DD RAM Address	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79

20x2 LCD Display Character Address Code: (128 + Position number)

Display Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
DD RAM Address	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
DD RAM Address	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83

16x4 LCD Display Character Address Code: (128 + Position number)

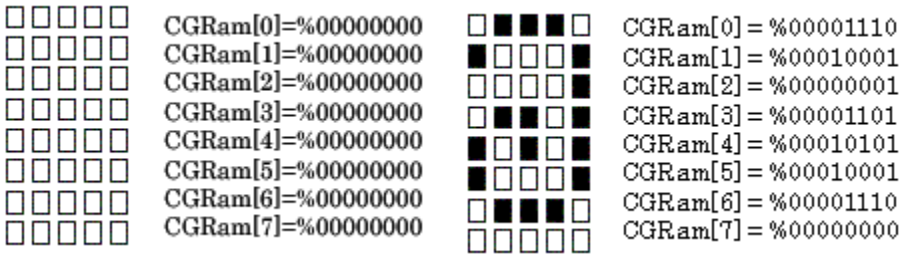
Display Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DD RAM Address	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DD RAM Address	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
DD RAM Address	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
DD RAM Address	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95

20x2 LCD Display Character Address Code: (128 + Position number)

Display Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
DD RAM Address	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
DD RAM Address	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83
DD RAM Address	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
DD RAM Address	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103

Custom user Characters:

First of all, an 8 bytes array must be created. (CGRam[8])



Usually, Bottom row is empty for underline.
Then CGRam command and this array are sent to JP Serial LCD Module. You will see a Character that you made on the LCD screen. (See sample code for detail)

JP Serial LCD Module Default setting (internal):

A. Cursor is turned off.
B. Backlight is turned on.

SERIAL DATA FORMAT

The serial data format is eight data bits, no parity and 1 stop bit (8N1). Characters are sent using standard ASCII values. Baud rate may be 4800 and 19200 depending on the settings of J1.

LIABILITY WARNING

This device should be used only for experimental purposes. It has **NOT** gone through extensive testing and it could erase or corrupt some or all data on media cards that are inside the device. You assume to take your own risk when you purchase this device, and release the responsibility and liability from the manufacturer with no harm.

REGULATORY WARNING

This device is intended solely for experimental purpose, it is not in finished product form and is NOT FCC approved. If you wish to install these modules into non-experimental final finished products, you will be responsible to have the modules approved by the FCC at your own cost.

Basic Stamp ® Example Programs

```
'=====================================================
' File........JP Serial LCD Module Test.BSP
' Purpose.....This test code for JP SerLCD Module
' Auther......Jianping Sun
' Website.....www.JianpingUSA.com
' Email.......JP@JianpingUSA.com
' Started.....Aug 08, 2009
' Updated.....
'=====================================================
‘{$STAMP BS2sx}
‘{$PBASIC 2.5}

SOUT     PIN        0                    ' serial output for JP SerLCD Module
TXT      VAR        Byte (13)
```

```
i           VAR       Byte
j           VAR       Byte
CGRam   VAR       Byte (8)

#SELECT $STAMP
  #CASE BS2, BS2E, BS2PE
    T1200      CON    813
    T2400      CON    396
    T4800      CON    188
    T9600      CON    84
    T19K2      CON    32
    T38K4      CON    6
  #CASE BS2SX, BS2P
    T1200      CON    2063
    T2400      CON    1021
    T4800      CON    500
    T9600      CON    240
    T19K2       CON    110
    T38K4       CON    45
  #CASE BS2PX
    T1200      CON    3313
    T2400      CON    1646
    T480       CON    813
    T9600      CON    396
    T19K2       CON    188
    T38K4       CON    84
#ENDSELECT

Inverted       CON    $4000
Baud           CON    T4800 '+ Inverted

TXT(0) = "H"
TXT(1) = "E"
TXT(2) = "L"
TXT(3) = "L"
TXT(4) = "O"
TXT(5) = ","
TXT(6) = " "
TXT(7) = "W"
TXT(8) = "O"
TXT(9) = "R"
TXT(10) = "L"
TXT(11) = "D"
TXT(12) = "!"

'=============================================================
'                                    Main program
'=============================================================
Main:
   PAUSE 3000
   GOSUB ScreenTest
   PAUSE 2000
   GOSUB LcdDisplay_on_off
   PAUSE 1000
   GOSUB BacklightTest
   PAUSE 100
```

```
   GOSUB CousorTest
   PAUSE 500
   GOSUB CGRamTest1
   PAUSE 2000
   GOSUB CGRamTest2
   PAUSE 1000
   GOSUB ShiftTest
END
'=============================================================
'                                  Full Screen Test
'=============================================================
ScreenTest:
   SEROUT SOUT, Baud, [18]                      ' Clear screen
   PAUSE 5
   SEROUT SOUT, Baud, ["  JianpingUSA   "]
   SEROUT SOUT, Baud, [128 + 64]                ' Move sursor to 2nd row
   PAUSE 5
   SEROUT SOUT, Baud, [" JP Serial LCD  "]
   SEROUT SOUT, Baud, [128 + 16]                ' Move sursor to 3rd row
   PAUSE 5
   SEROUT SOUT, Baud, [" Module testing "]
   SEROUT SOUT, Baud, [128 + 80]                ' Move sursor to 4th row
   PAUSE 5
   SEROUT SOUT, Baud, [" (16x4 or 20x4) "]
   PAUSE 500
RETURN
'=============================================================
'              LCD Display turn on/off
'=============================================================
LCDDisplay_on_off:
   SEROUT SOUT, Baud, [17]                      ' Clear screen
   PAUSE 5
   SEROUT SOUT, Baud, [128 + 64]                ' Move sursor to 2nd row
   PAUSE 5
   SEROUT SOUT, Baud, ["  LCD Display   "]
   SEROUT SOUT, Baud, [128 + 16]                ' Move sursor to 3rd row
   PAUSE 5
   SEROUT SOUT, Baud, ["Turn on/off test"]
   PAUSE 500
   FOR i = 0 TO 5
     SEROUT SOUT, Baud, [25]                    ' Turn LCD Display off
     PAUSE 500
     SEROUT SOUT, Baud, [24]                    ' Turn LCD Display on
     PAUSE 500
   NEXT
RETURN
'=============================================================
'                 Create Custemer CGRam
'=============================================================
CGRamTest2:

   SEROUT SOUT, Baud, [17]                      ' Clear screen
   PAUSE 5
   SEROUT SOUT, Baud, [19]                      ' Turn cousor off
   PAUSE 5                                      ‘ First char
   CGRam(0) = %00000000
```

```
  CGRam(1) = %00000000
  CGRam(2) = %00000000
  CGRam(3) = %00010000                    ' X
  CGRam(4) = %00000000
  CGRam(5) = %00000000
  CGRam(6) = %00000000
  CGRam(7) = %00000000                    'This row empty FOR underline
  SEROUT SOUT, Baud, [9]                  ' 1st character set number
  PAUSE 5
  FOR i = 0 TO 7
    SEROUT SOUT, Baud, [CGRam(i)]
  NEXT
  PAUSE 5
'-------------------------------------------------------------------------------------------------------
                                          '  Second char
  CGRam(0) = %00000000
  CGRam(1) = %00000000
  CGRam(2) = %00010000                    'X
  CGRam(3) = %00011000                    'XX
  CGRam(4) = %00010000                    'X
  CGRam(5) = %00000000
  CGRam(6) = %00000000
  CGRam(7) = %00000000                    'this row empty FOR underline
  SEROUT SOUT, Baud, [10]                 ' 2nd character set number
  PAUSE 5
  FOR i = 0 TO 7
    SEROUT SOUT, Baud, [CGRam(i)]
  NEXT
  PAUSE 5
'-------------------------------------------------------------------------------------------------------
                                          ' 3rd char
  CGRam(0) = %00000000
  CGRam(1) = %00010000                    'X
  CGRam(2) = %00011000                    'XX
  CGRam(3) = %00011100                    'XXX
  CGRam(4) = %00011000                    'XX
  CGRam(5) = %00010000                    'X
  CGRam(6) = %00000000
  CGRam(7) = %00000000                    ' This row empty FOR underline
  SEROUT SOUT, Baud, [11]                 ' 3rd character set number
  PAUSE 5
  FOR i = 0 TO 7
    SEROUT SOUT, Baud, [CGRam(i)]
  NEXT
  PAUSE 5
'-------------------------------------------------------------------------------------------------------
                                          ' 4th char
  CGRam(0) = %00010000                    'X
  CGRam(1) = %00011000                    'XX
  CGRam(2) = %00011100                    'XXX
  CGRam(3) = %00011110                    'XXXX
  CGRam(4) = %00011100                    'XXX
  CGRam(5) = %00011000                    'XX
  CGRam(6) = %00010000                    'X
  CGRam(7) = %00000000                    ' This row empty FOR underline
  SEROUT SOUT, Baud, [12]                 ' 4th character set number
```

```
   PAUSE 5
   FOR i = 0 TO 7
      SEROUT SOUT, Baud, [CGRam(i)]
   NEXT
   PAUSE 5
'-------------------------------------------------------------------------------------------------------
                                                  ' 5th char
   CGRam(0) = %00011000                           'XX
   CGRam(1) = %00011100                           'XXX
   CGRam(2) = %00011110                           'XXXX
   CGRam(3) = %00011111                           'XXXXX
   CGRam(4) = %00011110                           'XXXX
   CGRam(5) = %00011100                           'XXX
   CGRam(6) = %00011000                           'XX
   CGRam(7) = %00000000                           ' this row empty FOR underline
   SEROUT SOUT, Baud, [13]                       ' 5th character set number
   PAUSE 5
   FOR i = 0 TO 7
      SEROUT SOUT, Baud, [CGRam(i)]
   NEXT
   PAUSE 5
'--------------------------------------------------------------------------------------------------------
                                                  ' 6th char
   CGRam(0) = %00011100                           'XXX
   CGRam(1) = %00011110                           'XXXX
   CGRam(2) = %00011111                           'XXXXX
   CGRam(3) = %00011111                           'XXXXX
   CGRam(4) = %00011111                           'XXXXX
   CGRam(5) = %00011110                           'XXXX
   CGRam(6) = %00011100                          'XXX
   CGRam(7) = %00000000                           'this row empty FOR underline
   SEROUT SOUT, Baud, [14]                        ' 6th character set number
   PAUSE 5
   FOR i = 0 TO 7
      SEROUT SOUT, Baud, [CGRam(i)]
   NEXT
   PAUSE 5
'---------------------------------------------------------------------------------------------------------
                                                  ' 7th char
   CGRam(0) = %00011110                           ' XXXX
   CGRam(1) = %00011111                           ' XXXXX
   CGRam(2) = %00011111                           ' XXXXX
   CGRam(3) = %00011111                           ' XXXXX
   CGRam(4) = %00011111                           ' XXXXX
   CGRam(5) = %00011111                           ' XXXXX
   CGRam(6) = %00011110                           ' XXXX
   CGRam(7) = %00000000                           ' this row empty FOR underline
   SEROUT SOUT, Baud, [15]                        ' 7th character set number
   PAUSE 5
   FOR i = 0 TO 7
      SEROUT SOUT, Baud, [CGRam(i)]
   NEXT
   PAUSE 5
'--------------------------------------------------------------------------------------------------------
                                                  ' 8th char
   CGRam(0) = %00011111                           ' XXXXX
```

```
   CGRam(1) = %00011111                    ' XXXXX
   CGRam(2) = %00011111                    ' XXXXX
   CGRam(3) = %00011111                    ' XXXXX
   CGRam(4) = %00011111                    ' XXXXX
   CGRam(5) = %00011111                    ' XXXXX
   CGRam(6) = %00011111                    ' XXXXX
   CGRam(7) = %00000000                    ' this row empty FOR underline
   SEROUT SOUT, Baud, [16]                 ' 8th character set number
   PAUSE 5
   FOR i = 0 TO 7
      SEROUT SOUT, Baud, [CGRam(i)]
      PAUSE 5
   NEXT
   PAUSE 5

   SEROUT SOUT, Baud, ["  Custom Chars  "]
   PAUSE 500
   SEROUT SOUT, Baud, [128 + 68]
   PAUSE 5
'-----------------------------------------------------------------------------------------------------
   FOR i = 1 TO 8
      SEROUT SOUT, Baud, [i]
   NEXT
   PAUSE 5
'-----------------------------------------------------------------------------------------------------
   FOR i = 1 TO 3
      SEROUT SOUT, Baud, [128 + 16]
      PAUSE 100
      SEROUT SOUT, Baud, [i]
   NEXT

FOR j = 0 TO 15
   FOR i = 4 TO 5
      SEROUT SOUT, Baud, [128 + 16 + j]
      PAUSE 50
      SEROUT SOUT, Baud, [i]
   NEXT

   FOR i = 6 TO 8
      SEROUT SOUT, Baud, [128 + 16 + j]
      PAUSE 5
      SEROUT SOUT, Baud, [i]
      SEROUT SOUT, Baud, [i - 5]
      PAUSE 50
   NEXT
NEXT
'-----------------------------------------------------------------------------------------------------
   FOR i = 1 TO 3
      SEROUT SOUT, Baud, [128 + 80]
      PAUSE 100
      SEROUT SOUT, Baud, [i]
   NEXT

FOR j = 0 TO 15
   FOR i = 4 TO 5
      SEROUT SOUT, Baud, [128 + 80 + j]
```

```
      PAUSE 50
      SEROUT SOUT, Baud, [i]
   NEXT

   FOR i = 6 TO 8
      SEROUT SOUT, Baud, [128 + 80 + j]
      PAUSE 5
      SEROUT SOUT, Baud, [i]
      SEROUT SOUT, Baud, [i - 5]
      PAUSE 50
   NEXT
NEXT

RETURN
'============================================================
'                          Cursor test
'============================================================

CousorTest:

   SEROUT SOUT, Baud, [17]                          ' Clear screen
   PAUSE 5
   SEROUT SOUT, Baud, [20]                          ' Turn underline cursor on
   PAUSE 5
   SEROUT SOUT, Baud, ["Move cursor from"]
   SEROUT SOUT, Baud, [128 + 64]
   PAUSE 5
   SEROUT SOUT, Baud, [" left to right  "]

   SEROUT SOUT, Baud, [128 + 16]
   PAUSE 5
   SEROUT SOUT, Baud, ["Move cursor from"]
   SEROUT SOUT, Baud, [128 + 80]
   PAUSE 5
   SEROUT SOUT, Baud, [" right to left  "]
   SEROUT SOUT, Baud, [128 ]
   PAUSE 1000
   FOR i = 1 TO 15
      SEROUT SOUT, Baud, [23]
      PAUSE 500
   NEXT
   SEROUT SOUT, Baud, [21]                           ' Turn Blink cursor ON
   PAUSE 5
   SEROUT SOUT, Baud, [128 + 32 ]
   PAUSE 1000
   FOR i = 0 TO 15
      SEROUT SOUT, Baud, [22]
      PAUSE 500
   NEXT
   SEROUT SOUT, Baud, [19]                           ' Turn off cursor
RETURN
'============================================================
'                          Backlight test
'============================================================
BacklightTest:
   SEROUT SOUT, Baud, [17]                          ' Clear screen
```

```
   PAUSE 5
   SEROUT SOUT, Baud, [128 + 64]
   PAUSE 5
   SEROUT SOUT, Baud, [" Backlight test "]
   FOR i = 0 TO 5
      SEROUT SOUT, Baud, [29]                    'Turn backlight off
      PAUSE 500
      SEROUT SOUT, Baud, [28]                    'Turn backlight on
      PAUSE 500
   NEXT
RETURN

'=====================================================================
'             Display defualt CDRam Characters
'=====================================================================
CGRamTest1:
   SEROUT SOUT, Baud, [17]                        ' Clear screen
   PAUSE 5
   SEROUT SOUT, Baud, [18]                  ' Return cursor to home position, return a shifted
                                            ' diaplay to original position. Dispaly data RAM is
                                            ' unaffected
   PAUSE 5
   SEROUT SOUT, Baud, ["JP SerLCD Module"]
   SEROUT SOUT, Baud, [128 + 64]
   PAUSE 5
   SEROUT SOUT, Baud, [" Default Chars  "]
   SEROUT SOUT, Baud, [128 + 20]
   PAUSE 5
   FOR i = 1 TO 8
      SEROUT SOUT, Baud, [i]
      PAUSE 10
   NEXT
RETURN

'=====================================================================
'                    Shift test
'=====================================================================
ShiftTest:
   SEROUT SOUT, Baud, [17]                        ' Clear screen
   PAUSE 5
   SEROUT SOUT, Baud, [128 + 64 + 14]             ' Move sursor to 2nd row, 12 col
   PAUSE 5
   FOR i = 0 TO 12
      SEROUT SOUT, Baud, [26]                    ' Shift dispaly left
      PAUSE 5
      SEROUT SOUT, Baud, [128 + 64 + 14 + i]     ' Move sursor to 2nd row, 12 col
      PAUSE 5
      SEROUT SOUT, Baud, [txt(i)]
      PAUSE 200
   NEXT
RETURN
'=====================================================================
```

JP SerLCD Module Chart Bar Test Code For Arduino

```
/*=============================================================
 File........JP Serial LCD Module Test code for Arduino
 Purpose.....This test code for JP SerLCD Module
 MCU.........Arduino Mega 2560
 Auther......Jianping Sun
 Website.....www.JianpingUSA.com
 Email.......JP@JianpingUSA.com
 Started.....April. 1, 2013
 Updated.....
 Note: The module Rx <===> Tx of Arduino
=============================================================*/
char Bar_Data[20];   // Bar Data Parameter
byte cmd;            // Command Parameter
byte c1;             // Bar Parameter1
byte c2;             // Bar Parameter2
byte c3;             // Bar Parameter3
byte c4;             // Bar Parameter4
byte c5;             // Bar Parameter5
byte counter;
void setup()
{
  // initialize the serial communication: Note: Serial One!
  Serial1.begin(4800);
  //Serial.begin(19200);
  delay(1000);
  V_Chart_Bar_Screen();
  V_Chart_Bar_Test1();
  V_Chart_Bar_Test2();
  V_Chart_Bar_Test3();
  V_Chart_Bar_Test4();
  V_Chart_Bar_Test5();
  V_Chart_Bar_Test6();
  V_Chart_Bar_Test7();
  V_Chart_Bar_Test8();
  V_Chart_Bar_Test9();
  V_Chart_Bar_Test10();
  H_Chart_Bar_Screen();
  H_Chart_Bar_Test1();
  H_Chart_Bar_Test2();
  End_Screen();
}

void parameter_4() {
    Serial1.write(cmd);                // Command
    Serial1.write(c1);                 //  Bar Parameter
    Serial1.write(c2);                 //  Bar Parameter
    Serial1.write(c3);                 //  Bar Parameter
    Serial1.write(c4);                 //  Bar Parameter
}
//======================== Horizontal Chart Bar test ====================
void H_Chart_Bar_Test1(){
     Serial1.write(17);               // Clear screen
     delay(100);
     Serial1.write(235);      // load Horizontal Chart to CGRAM
     delay(100);
     counter = 0;
     do
     {
     cmd = 239; c1 = 1; c2 = 1; c3 = 16; c4 = random(80);
     parameter_4();
     delay(50);
     cmd = 239; c1 = 2; c2 = 1; c3 = 16; c4 = random(80);
     parameter_4();
     delay(50);
     cmd = 239; c1 = 3; c2 = 1; c3 = 16; c4 = random(80);
     parameter_4();
     delay(50);
     cmd = 239; c1 = 4; c2 = 1; c3 = 16; c4 = random(80);
```

```
     parameter_4();
     delay(50);
     ++ counter;
     }
     while (counter < 50);
}
void H_Chart_Bar_Test2(){
       Serial1.write(17);               // Clear screen
       delay(100);
       Serial1.write(235);             // load Horizontal Chart to CGRAM
      delay(100);
      Serial1.write(18);               // Move cursor to home
      delay(10);
      Serial1.write("b1=");
      Serial1.write(192);            // 128+64,Move sursor to 2nd row
      delay(10);
      Serial1.write("b2=");
      Serial1.write(144);            // 128+16,Move sursor to 3rd row
      delay(10);
      Serial1.write("b3=");
      Serial1.write(208);            // 128+80,Move sursor to 4th row
      delay(10);
      Serial1.write("b4=");
      delay(50);
      counter = 0;
     do
     {
     cmd = 239; c1 = 1; c2 = 4; c3 = 16; c4 = random(80);
     parameter_4();
     delay(50);
     cmd = 239; c1 = 2; c2 = 4; c3 = 16; c4 = random(80);
     parameter_4();
     delay(50);
     cmd = 239; c1 = 3; c2 = 4; c3 = 16; c4 = random(80);
     parameter_4();
     delay(50);
     cmd = 239; c1 = 4; c2 = 4; c3 = 16; c4 = random(80);
     parameter_4();
     delay(50);
     ++ counter;
     }
     while (counter < 50);
 }
//======================== Vertical Chart Bar test ====================
void V_Chart_Bar_Test1(){
     Serial1.write(17);               // Clear screen
     delay(100);
     Serial1.write(237);      // load Horizontal Chart to CGRAM
     delay(100);
     counter = 0;
     do
     {
     cmd = 240; c1 = 4; c2 = 4; c3 = 1; c4 = 16;
     parameter_4();
     //delay(100);
     for (int i = 0; i <= (c4 - c3); i++){
         Serial1.write(random(32));
     }
     delay(100);
     ++ counter;
     }while (counter < 50);
     }
//============================================================
void V_Chart_Bar_Test2(){
     Serial1.write(17);               // Clear screen
     delay(100);
     Serial1.write(237);      // load Horizontal Chart to CGRAM
     delay(100);
     counter = 0;
     do
     {
```

```
     cmd = 240; c1 = 4; c2 = 4; c3 = 3; c4 = 14;
     parameter_4();
     //delay(100);
     for (int i = 0; i <= (c4 - c3); i++){
         Serial1.write(random(32));
     }
     delay(100);
     ++ counter;
     }while (counter < 50);
     }
//============================================================
void V_Chart_Bar_Test3(){
     Serial1.write(17);               // Clear screen
     delay(100);
     Serial1.write(237);      // load Horizontal Chart to CGRAM
     delay(100);
     counter = 0;
     do
     {
     cmd = 240; c1 = 4; c2 = 4; c3 = 6; c4 = 11;
     parameter_4();
     //delay(100);
     for (int i = 0; i <= (c4 - c3); i++){
         Serial1.write(random(32));
     }
     delay(100);
     ++ counter;
     }while (counter < 50);
     }
//====================================================================
void V_Chart_Bar_Test4(){
     Serial1.write(17);               // Clear screen
     delay(100);
     Serial1.write(237);      // load Horizontal Chart to CGRAM
     delay(100);
     counter = 0;
     do
     {
     cmd = 240; c1 = 4; c2 = 4; c3 = 1; c4 = 8;
     parameter_4();
     //delay(100);
     for (int i = 0; i <= (c4 - c3); i++){
         Serial1.write(random(32));
     }
     delay(100);
     ++ counter;
     }while (counter < 50);
     }
//============================================================
void V_Chart_Bar_Test5(){
     Serial1.write(17);               // Clear screen
     delay(100);
     Serial1.write(237);      // load Horizontal Chart to CGRAM
     delay(100);
     counter = 0;
     do
     {
     cmd = 240; c1 = 4; c2 = 4; c3 = 1; c4 = 16;
     parameter_4();
     //delay(100);
     for (int i = 0; i <= (c4 - c3); i++){
         Serial1.write(random(32));
     }
     delay(100);
     ++ counter;
     }while (counter < 50);
     }
//====================================================================
 void V_Chart_Bar_Test6(){
     Serial1.write(17);               // Clear screen
     delay(100);
```

```
    Serial1.write(237);      // load Horizontal Chart to CGRAM
    delay(100);
    counter = 0;
    do
    {
    cmd = 240; c1 = 4; c2 = 3; c3 = 1; c4 = 16;
    parameter_4();
    //delay(100);
    for (int i = 0; i <= (c4 - c3); i++){
        Serial1.write(random(24));
    }
    delay(100);
    ++ counter;
    }while (counter < 50);
    }
 //================================================================
 void V_Chart_Bar_Test7(){
    Serial1.write(17);               // Clear screen
    delay(100);
    Serial1.write(237);      // load Horizontal Chart to CGRAM
    delay(100);
    counter = 0;
    do
    {
    cmd = 240; c1 = 4; c2 = 2; c3 = 1; c4 = 16;
    parameter_4();
    //delay(100);
    for (int i = 0; i <= (c4 - c3); i++){
        Serial1.write(random(16));
    }
    delay(100);
    ++ counter;
    }while (counter < 50);
    }
//================================================================
    void V_Chart_Bar_Test8(){
    Serial1.write(17);               // Clear screen
    delay(100);
    Serial1.write(237);      // load Horizontal Chart to CGRAM
    delay(100);
    counter = 0;
    do
    {
    cmd = 240; c1 = 4; c2 = 1; c3 = 1; c4 = 16;
    parameter_4();
    //delay(100);
    for (int i = 0; i <= (c4 - c3); i++){
        Serial1.write(random(8));
    }
    delay(100);
    ++ counter;
    }while (counter < 50);
    }
//============================================================
     void V_Chart_Bar_Test9(){
    Serial1.write(17);               // Clear screen
    delay(100);
    Serial1.write(237);      // load Horizontal Chart to CGRAM
    delay(100);
    counter = 0;
    do
    {
    cmd = 240; c1 = 3; c2 = 3; c3 = 1; c4 = 16;
    parameter_4();
    //delay(100);
    for (int i = 0; i <= (c4 - c3); i++){
        Serial1.write(random(24));
    }
    delay(100);
    ++ counter;
    }while (counter < 50);
```

```
     }
//=========================================================
      void V_Chart_Bar_Test10(){
     Serial1.write(17);                // Clear screen
     delay(100);
     Serial1.write(237);      // load Horizontal Chart to CGRAM
     delay(100);
     counter = 0;
     do
     {
     cmd = 240; c1 = 2; c2 = 2; c3 = 1; c4 = 16;
     parameter_4();
     //delay(100);
     for (int i = 0; i <= (c4 - c3); i++){
         Serial1.write(random(16));
     }
     delay(100);
     ++ counter;
     }while (counter < 50);
     }
//================ Text Screen For Horizontal ====================
void V_Chart_Bar_Screen(){
  Serial1.write(17);                // Clear screen
  Serial1.write(18);                // Move cursor to home
  delay(10);
  Serial1.write("  JianpingUSA  ");
  Serial1.write(192);         // 128+64,Move sursor to 2nd row
  delay(10);
  Serial1.write(" JP Serial LCD  ");
  Serial1.write(144);         // 128+16,Move sursor to 3rd row
  delay(10);
  Serial1.write(" Chart Bar Test ");
  Serial1.write(208);         // 128+80,Move sursor to 4th row
  delay(10);
  Serial1.write(" ( Vertical )  ");
  delay(3000);
}
//============== Text Screen For Horizontal ====================
void H_Chart_Bar_Screen(){
  Serial1.write(17);                // Clear screen
  Serial1.write(18);                // Move cursor to home
  delay(10);
  Serial1.write("  JianpingUSA  ");
  Serial1.write(192);         // 128+64,Move sursor to 2nd row
  delay(10);
  Serial1.write(" JP Serial LCD  ");
  Serial1.write(144);         // 128+16,Move sursor to 3rd row
  delay(10);
  Serial1.write(" Chart Bar Test ");
  Serial1.write(208);         // 128+80,Move sursor to 4th row
  delay(10);
  Serial1.write(" ( Horizontal ) ");
  delay(3000);
}
//=================== Text Screen For End ========================
void End_Screen(){
  Serial1.write(17);                // Clear screen
  Serial1.write(18);                // Move cursor to home
  delay(10);
  Serial1.write("  JianpingUSA  ");
  Serial1.write(192);         // 128+64,Move sursor to 2nd row
  delay(10);
  Serial1.write(" JP Serial LCD  ");
  Serial1.write(144);         // 128+16,Move sursor to 3rd row
  delay(10);
  Serial1.write(" Chart Bar Test ");
  Serial1.write(208);         // 128+80,Move sursor to 4th row
  delay(10);
  Serial1.write("Thanks for watch");
  delay(3000);
}
```

```
//========================== System loop function ======================
void loop()
{
}
```

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