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## BPI-216 Serial LCD Modules

BPI-216 LCD modules combine a serial interface with a 2-line by 16-character LCD. The combination receives serial data at 2400 or 9600 baud (switch selectable) and displays it on the LCD.

The unit has two modes: text and instruction. It defaults to text mode; any data received appears on the screen. Send the string "HELLO" and "HELLO" appears on the LCD. To distinguish text from instructions (e.g., clear screen, position cursor, etc.), the interface looks for an instruction prefix (ASCII 254). The byte following this prefix is treated as an instruction. After the instruction code, the unit returns to text mode.

This product replaces BPK-series serial LCD modules, which function identically. The primary difference is in the physical layout of the circuit board, which has been optimized for 2x16 LCDs. The LCD Serial<sup>®</sup> board (without an LCD; BPK-000) remains available for other applications.

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• Note: Abusing the module, operating it outside specified limits of power or temperature, or attempting to repair or modify it, voids this warranty. See figure 1 (page 2) and specifications/notes (page 8).

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**Location of Connectors and Controls**

Figure 1 shows the major features and configuration options of the BPI-216 circuit board. Note: The Backlight switch has no effect on non-backlit models. The model (-L for backlit, -N for non-) is marked at the lower-left corner of the interface board.

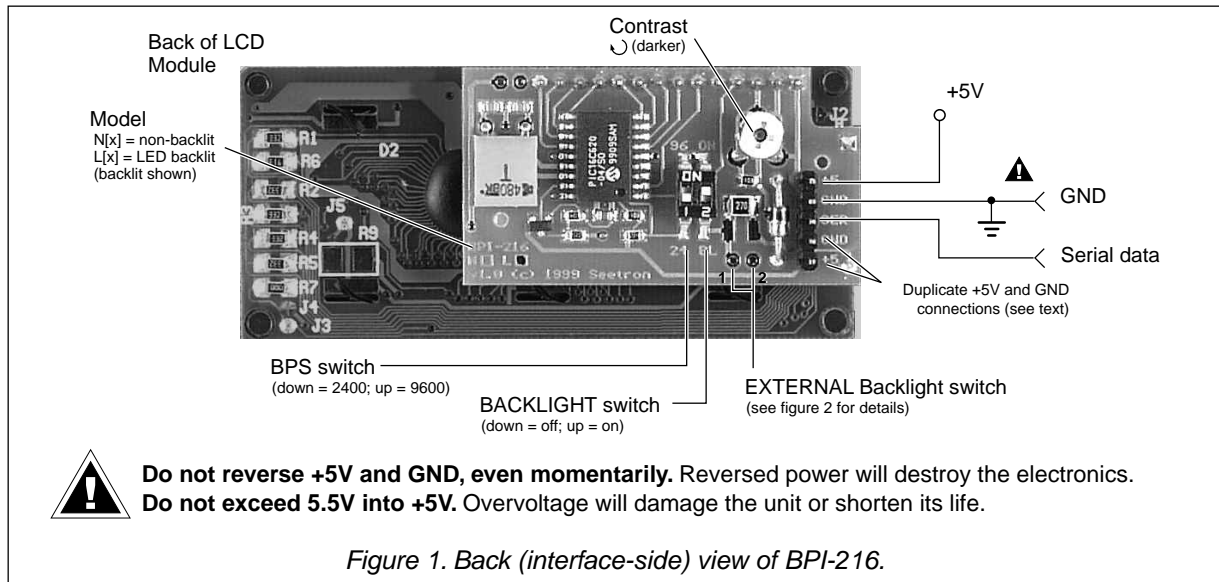


Figure 1. Back (interface-side) view of BPI-216.

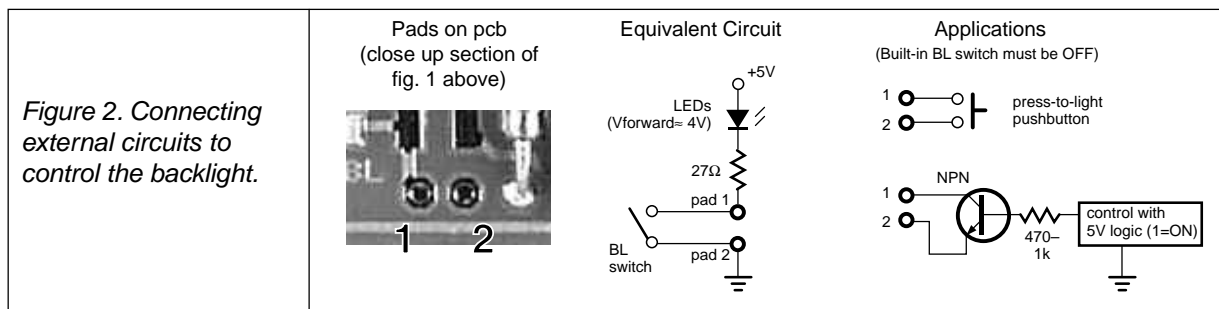
**Quick Checkout and Contrast Adjustment**

You can test the unit for proper operation without a computer/serial port. Temporarily connect the serial input to one of the +5 terminals of J1, then connect power to +5 and GND. The LCD will display a test message.

The contrast control is usually set fully clockwise at the factory. This setting may be too dark. Use a small, flat-blade screwdriver to adjust the contrast control.

**LED Backlight**

On models equipped with an LED backlight (marked **L[x]** in the lower left corner of the interface board), you may turn on the backlight by setting the **BL** switch ON. The backlight will be on whenever power is applied. There is also a pair of solder pads near the backlight switch (see figure 1 above) to allow you to control the backlight with an external switch or circuit. Figure 2 below shows the wiring of the backlight and the pads.



## Setting the Baud Rate

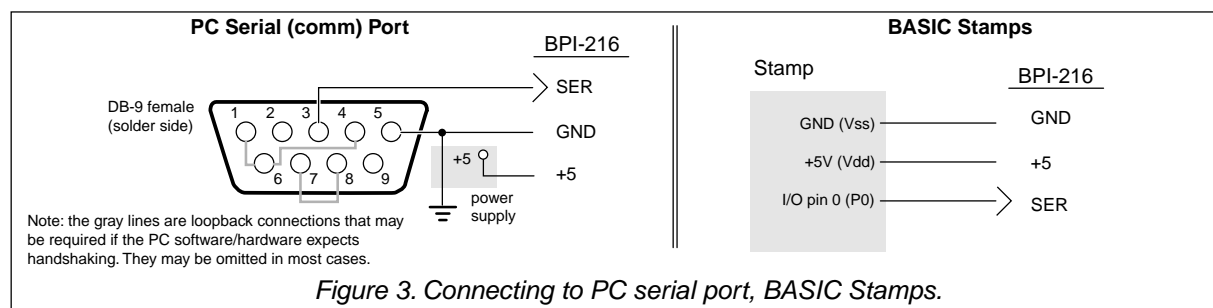
Set the BPS switch down for 2400 baud; up for 9600. At either rate, the serial characteristics are no parity, 8 data bits, 1 stop bit. For more information on serial transmission, see the application note: [www.seetron.com/ser\\_an1.htm](http://www.seetron.com/ser_an1.htm).

NOTE: The interface reads the BPS switch only at startup. Change the BPS setting only with the power off. The Backlight (BL) may be turned on or off at any time.

## Hookup for Use

Figure 3 shows how to connect the BPI-216 to PCs and BASIC Stamp computers in order to run the example programs presented later in this manual. Refer to figure 1 or the markings on the interface for the locations of +5, GND and SER(ial in).

The 5-pin connector has two extra pins for +5 and GND. These pins are arranged in a pallindrome layout. If you make a matching 5-pin connector, the connections will always line up properly regardless of connector orientation. Ready-made wiring harnesses and instructions for making your own hookups are available from [www.seetron.com](http://www.seetron.com). If you do not need a removable connector, you may wire-wrap or solder wires directly to the header posts.



## Basic Operation

Once the BPI-216 is properly connected and configured to match the baud rate of the computer/program that will be talking to it serially, data sent to it will appear on the display. For example, if you send "Hello" then "Hello" appears on the display. The cursor (printing position) automatically moves from left to right.

You can also send instructions to the BPI-216. To identify a particular byte as an instruction, precede it with the instruction prefix character, ASCII 254 (0FE hex, 11111110 binary). The interface treats the byte immediately after the prefix as an instruction, then automatically returns to data mode.

Example: The clear-screen instruction is ASCII 1. To clear the screen, send <254><1> (where the <> symbols mean single bytes set to these values, not text as typed from the keyboard). Table 1 lists the LCD instructions.

## Startup Time

When the BPI-216 is first powered up, it requires about 750 milliseconds (ms) to initialize the LCD and get ready to receive data. Programs should wait about a second after powerup before sending data to the BPI-216.

**Table 1. LCD Instructions**

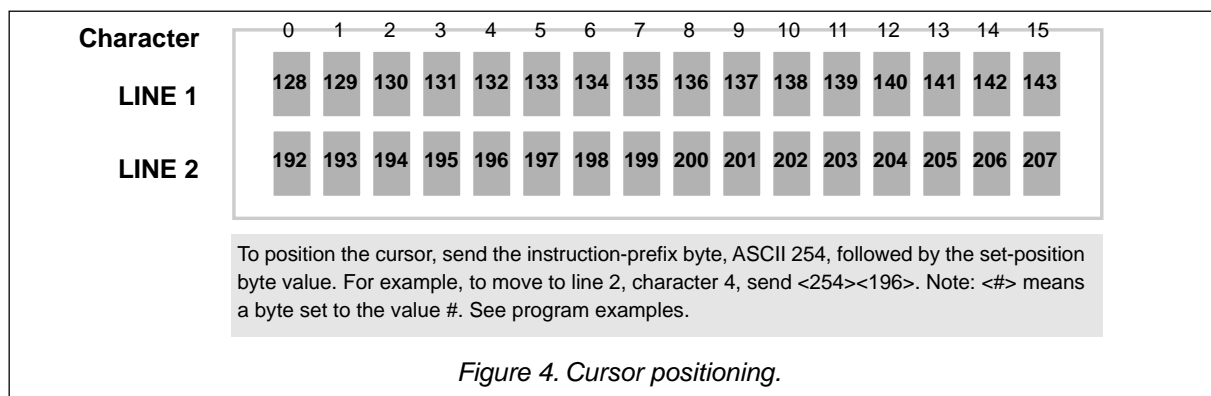
Instruction/Action	Code
✕ Clear Screen	1
Scroll display one character left (all lines)	24
Scroll display one character right (all lines)	28
✕ Home (move cursor to top/left character position)	2
Move cursor one character left	16
Move cursor one character right	20
Turn on visible underline cursor	14
Turn on visible blinking-block cursor	13
Make cursor invisible	12
Blank the display (without clearing)	8
Restore the display (with cursor hidden)	12
Set cursor position (DDRAM address)	128 + addr
Set pointer in character-generator (CG) RAM	64 + addr

✕ These instructions take more than 1 ms for the LCD to execute. At 9600 bps, either pause 1ms after these instructions or follow them with <254><128> (where <#> means a byte set to #). At 2400 bps, no pause or extra instruction is required.

Advanced LCD users: These are the actual LCD instruction codes. When the interface receives the instruction prefix, it clears the register select (RS) bit. The next received byte is written to the LCD with RS low. After writing that byte, it returns RS high (normal data mode). This means that you can send any valid LCD instruction through the interface. Since the interface initializes the LCD at startup, you must **not** send any initialization instructions. If you did not understand the preceding, don't worry. You don't need to know any of this to use this product. The info may be handy to advanced users adapting programs written to drive the BPI-216 to applications that drive an LCD directly through its parallel interface.

### Positioning the Cursor

You can position the cursor anywhere on the screen by sending the proper instruction. Figure 4 shows the layout of the 2x16 LCD screen with the cursor-positioning instruction for each character location.



### Off-Screen Memory (No Line Wrap)

When you print past the end of a line, the next 24 characters do not show up on the screen. They are not lost, they are in an off-screen memory area. All alphanumeric LCD modules have 80 bytes of memory, arranged appropriately for a 2x40 screen. On LCDs with smaller screens (such as this 2x16), text printed past the end of a visible line goes into memory, but can't be seen on the screen. Use cursor-positioning instructions to print to a particular location on the display. Or deliberately print in off-screen memory to temporarily hide text, then send scroll-left instructions to reveal it.

**Defining Custom Symbols**

Most of the LCD characters (figure 6) cannot be changed because they are stored in ROM. However, the first eight symbols, corresponding to ASCII 0 through 7, are stored in RAM. By writing new values to the character-generator (CG) RAM, you can alter these characters. Changing a symbol is easy; just point to the beginning of the symbol's RAM location, then write eight bytes whose bits form the desired pattern. Then position the cursor onto the screen. See figure 5.

Manipulating custom characters allows you to create special effects, like simple animations. See serial display application notes at www.seetron.com for examples and a handy visual character editor.

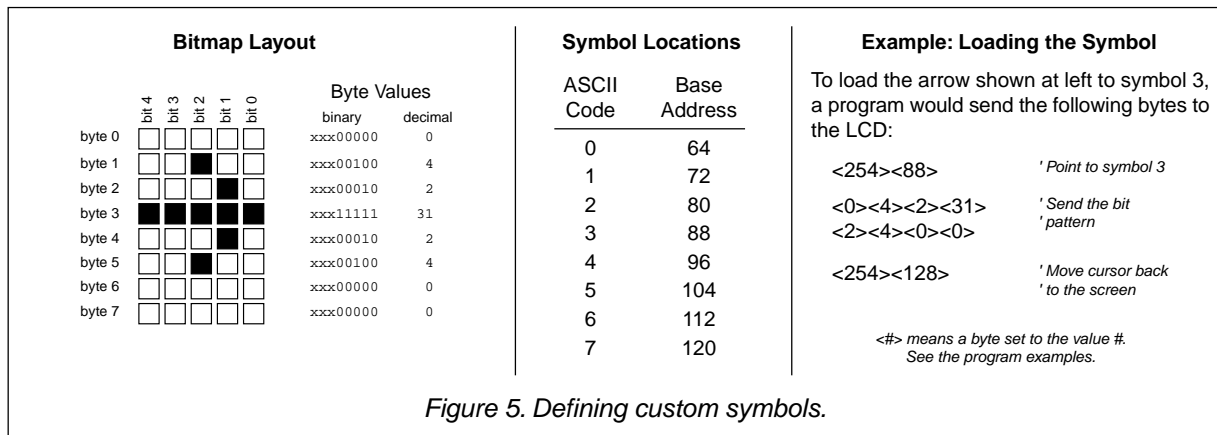
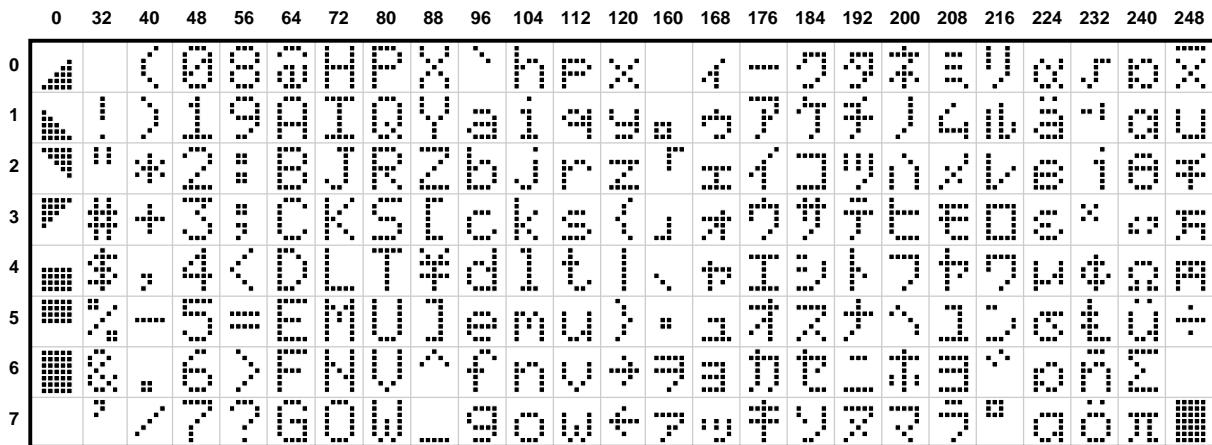


Figure 5. Defining custom symbols.



NOTE: Custom characters occupy ASCII 0—7  
 Backpack loads patterns shown at startup.  
 ASCII 8—31 repeat the custom characters  
 ASCII 128—160 are blanks

To find the ASCII code for a given character, add the row and column numbers. For example, capital D is in the column marked 64 in row 4, so its ASCII code is 68. Use the reverse procedure to determine the symbol for a given code. For example, ASCII code 244 produces the symbol Ω, found at column 240, row 4.

Figure 6. LCD character set.

## Program Examples

Any computer/programming language that can produce serial output (2400 or 9600 bps, N81) can talk to the BPI-216. The examples here are in BASIC, chosen because of its popularity and readability. Don't be put off by the size of the programs—they are mostly comments.

See [www.seetron.com](http://www.seetron.com) for Windows® programming examples and an easy-to-use DLL that works well with Visual BASIC®.

```
' Program: BPKDEMO.BAS
' This program demonstrates fundamental techniques of driving
' BPI-216 serial LCDs in BASIC (compatible with QBASIC, Quick BASIC,
' First BASIC, and Power BASIC). First BASIC, an excellent shareware
' compiler, is available from www.powerbasic.com.

' Start by defining some useful constants for the Backpack
I = 254           ' Instruction prefix value.
CLR = 1          ' LCD clear-screen instruction.
LINE1 = 128      ' Address of first character of 1st line.
LINE2 = 192      ' Address of first character of 2nd line.

' Open the serial port (com1) for output at 9600 baud. Make sure BPS
' is also set for 9600. Turn off all handshaking (CD, CS, DS) by
' setting to zero (0).
OPEN "COM1:9600,N,8,1,CD0,CS0,DS0" FOR OUTPUT AS #1

' Once the port is open, we can print to it. Start by clearing the screen
' in case there's text left from a previous run of this program. Note that
' at 9600 baud, you need a delay after clearing the screen. To create a
' delay, you can use a timing instruction such as First/Power BASIC's
' DELAY or QBASIC's SLEEP, or you can send an unnecessary instruction,
' such as <254><128>. That sequence moves the cursor to the beginning of
' line 1, which is where it already is, thanks to clear-screen.
PRINT #1, CHR$(I); CHR$(CLR); ' Send <254><1> to clear screen.
PRINT #1, CHR$(I); CHR$(LINE1); ' Time delay (for 9600 baud).

' Now print some text. PRINT statements should end with ; to
' prevent unnecessary carriage return/line feeds (which the Backpack
' doesn't understand, and displays as junk characters).
PRINT #1, "Hello world!";

' Positioning the cursor requires sending the instruction prefix (ASCII
' 254, which we've assigned the name "I") followed by an address. We've
' assigned names to ASCII 128 (1st character of line 1) and 192 (1st
' character of line 2). We'll position the cursor to the start of
' line 2 and print some more.
PRINT #1, CHR$(I); CHR$(LINE2); "press return";

' Wait for a keypress (at PC) before continuing.
CLS : INPUT "PRESS RETURN TO CONTINUE", X$

' Now we'll simulate a common application by printing a label on the
' screen, then updating some data by positioning the cursor. Each
' time you press return on the PC, the program will add 1 to the
' count and update the value on the screen. Notice that to position
' the cursor at character 6 of line 1, we give the position value of
' LINE1 + 6. This is easier to read than 134, which is the address of
' line 1, character 6. Also note that we print several spaces after
' the number. It's not needed here, but in programs in which a number
' could be lower than the previously displayed value, the spaces
' would erase any leftover digits.
PRINT #1, CHR$(I); CHR$(CLR); CHR$(I); CHR$(LINE1);
PRINT #1, "Count: "; CHR$(I); CHR$(LINE2); "press return";
theCount = 0
Again:
  PRINT #1, CHR$(I); CHR$(LINE1 + 6); theCount; " ";
  INPUT "ENTER TO CONTINUE, Q-ENTER TO QUIT ", X$
  IF UCASE$(X$) = "Q" THEN END
  theCount = theCount + 1
GOTO Again
```



### Quickie Program

Want fast results? All you need are these two lines of code. The first opens the serial port for output; the second 'prints' text to it. Type and run these lines in QBASIC or Power BASIC and "Hello World!" appears on the display.



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```
' Program: BPKDEMS1.BAS
' This program demonstrates fundamental techniques of driving
' BPI-216 serial LCDs in BASIC from the BASIC Stamp I. It assumes
' that the BPI-216 is connected to I/O pin 0 of the Stamp, and
' that it is set for 2400 bps.
```

```
' Start by defining some useful constants for the BPI-216.
SYMBOL I      = 254  ' Instruction prefix value.
SYMBOL CLR    = 1    ' LCD clear-screen instruction.
SYMBOL LINE2  = 192  ' Address of 1st char of 2nd line.
SYMBOL Ll_C7  = 135  ' Address of line 1, character 7.
```

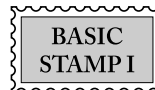
```
' Now clear the screen in case there's text left from a previous
' run of the program. Note that there's a 1-second PAUSE prior to
' sending any data to the Backpack. This gives the unit plenty
' of time to initialize the LCD after power up.
```

```
pause 1000
serout 0,n2400,(I,CLR)      ' Clear the LCD screen.
serout 0,n2400,("Hello World!") ' Print message.
```

```
' Positioning the cursor requires sending the instruction prefix (ASCII
' 254, assigned the symbol "I") followed by an address.
serout 0,n2400,(I,LINE2, ".line 2") ' Move to line 2 and print.
```

```
' Now we'll simulate a common application by printing a label on the
' screen and updating some data by positioning the cursor.
```

```
pause 2000      ' Wait 2 secs.
serout 0,n2400,(I,CLR) ' Clear the LCD screen.
serout 0,n2400,("Count:") ' Print the label.
Again:
  serout 0,n2400,(I,Ll_C7) ' Move to line 1, character 7.
  serout 0,n2400,(#b2," ") ' Print value of b2 followed by 2 spaces.
  b2 = b2+1 ' Increment b2.
  pause 200 ' Slow the loop down.
goto Again ' Repeat endlessly.
```



### Quickie Program

Type and run just this line in PBASIC 1 and "Hello World!" appears on the display.

```
' Program: BPKDEMS2.BS2
' This program demonstrates fundamental techniques of driving
' BPI-216 serial LCDs in BASIC from the BASIC Stamp II. It assumes
' that the BPI-216 is connected to I/O pin P0 of the Stamp, and
' that it is set for 9600 bps.
```

```
' Start by defining some useful constants for the Backpack.
N9600 con $4054 ' Baudmode-9600 bps inverted. Use $40F0 for BS2-SX.
I con 254 ' Instruction prefix value.
CLR con 1 ' LCD clear-screen instruction.
LINE2 con 192 ' Address of 1st char of 2nd line.
Ll_C7 con 135 ' Address of line 1, character 7.
```

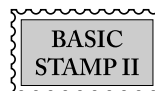
```
' Now clear the screen in case there's text left from a previous
' run of the program. Note that there's a 1-second PAUSE prior to
' sending any data to the Backpack. This gives the Backpack plenty
' of time to initialize the LCD after power up.
```

```
pause 1000
serout 0,n9600,[I,CLR] ' Clear the LCD screen.
pause 1
serout 0,n9600,["Hello World!"] ' Print message.
```

```
' Positioning the cursor requires sending the instruction prefix (ASCII
' 254, assigned the symbol "I") followed by an address.
serout 0,n9600,[I,LINE2, ".line 2"] ' Move to line 2 and print.
```

```
' Now we'll simulate a common application by printing a label on the
' screen and updating some data by positioning the cursor.
```

```
pause 2000      ' Wait 2 secs.
serout 0,n9600,[I,CLR] ' Clear the LCD screen.
pause 1
serout 0,n9600,["Count:"] ' Print the label.
Again:
  serout 0,n9600,[I,Ll_C7] ' Move to line 1, character 7.
  serout 0,n9600,[DEC b2," "] ' Print value of b2 followed by 2 spaces.
  b2 = b2+1 ' Increment b2.
  pause 200 ' Slow the loop down.
goto Again ' Repeat endlessly.
```



### Quickie Program

Type and run just these lines in PBASIC 2 and "Hello World!" appears on the display.



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### Dimensions

The drawing below gives the primary dimensions of the 2x16 LCDs sold with our BPI-216N and BPI-216L products. Three LCD manufacturers are listed, Truly, Data Vision (DV), and Powertip (PT), since we have at times used LCDs from each of these companies. Powertip is our primary supplier.

	Truly	DV	PT	
A	y offset pcb edge to hole ctr	2.50	2.50	2.50
B	y pcb height	36.00	36.00	36.00
C	y hole spacing	31.00	31.00	31.00
D	y screen opening	13.80	16.10	16.20
E	y character size	4.35	4.89	5.94
F	x character size	2.95	2.78	2.95
G	x offset pcb edge to hole ctr	2.50	2.50	3.55
H	x screen frame	73.70	71.20	71.00
I	x screen opening	64.50	62.50	66.00
J	x hole spacing	75.00	75.00	75.00
K	x pcb width	80.00	80.00	80.00
L	y frame height	24.80	26.20	25.00
-	mounting hole diameter	2.50	2.50	2.50
-	frame depth, non-backlit	5.00	4.70	5.00
-	frame depth, LED-backlit	8.50	9.40	8.50

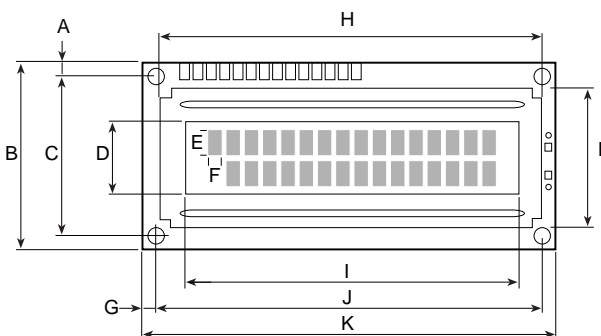


Figure 7. Physical dimensions.

- All dimensions in mm.
- Worst-case tolerance for any dimension is  $\pm 0.50\text{mm}$ .
- Maximum depth (from front of screen frame to tips of interface header posts) is 26mm.
- Dimensions based on information provided by manufacturers—subject to change without notice.

**Important Notes on Handling, Installation, and Mounting**

LCDs are precision-made devices that should last a lifetime of normal use. They are vulnerable to damage from mishandling, however. Our warranty excludes damage from abuse, so it is very important that you handle and mount your LCD with care. Here are some tips:

- Handle in a static-safe manner
- Do not drop or strike
- Do not attempt to disassemble, repair, or modify
- Do not drill, cut, notch, grind, etc.
- Mount with machine screws in corner holes
- Do not attempt to enlarge mounting holes
- Do not use glue, epoxy, or paint on this unit
- Protect from water, solvents, oils
- Do not bend, warp, or stress
- Install behind a protective transparent window
- Protect from strong electrical fields, ESD
- Protect from reverse-power hookup

### Differences from BPK-series Devices, Basic Specifications

BPI-216N/L is functionally identical to the previous BPK-216N/L series. The main differences are in the circuit-board layout, which in the BPI-216 has been tailored specifically for 2x16 LCDs. The BPK-series is a more generic layout, suitable for installation on many LCD types. BPI-216N/L replaces BPK-216N/L, but the BPK-000 (interface without LCD) is still available. The table at right sums up the differences between the two.

Feature	BPK	BPI
Interface board sold w/out LCD	YES	no
Backlight switch/series resistor	no	YES
LINES switch for 1-line LCDs	YES	no
Sold with LCD installed	no	YES
Low, < 1mA current draw (interface)	YES	YES
LCD-based serial protocol	YES	YES
Reversible 5-pin power/signal header	YES	YES

**Table 3. Basic Specifications**

Power requirements (backlight off)	4.8 to 5.2 Vdc @ 3 mA
Power requirements (backlight on)	4.8 to 5.2 Vdc @ 40 mA
User connector	Five 0.025" pins on 0.10" centers
Connector pinout	+5 GND SER GND +5
Serial input	RS-232, or inverted TTL/CMOS, 2400 or 9600, N81
Operating temperature	0° to 50°C (32° to 122°F)
Storage temperature	-10° to 60°C (14° to 140°F)
LCD type	Supertwist (STN), yellow-green
Optimum viewing direction	6 o'clock