


```
' Display pre-defined custom characters: "\" (custom-character-0) and  
' "~" (custom-character-1).
```

```
SEROUT 14, 84, [0, 1]
```

Defining (and Redefining) Custom Characters

The Parallax Serial LCD's custom characters are stored in its RAM. To define one of its eight custom characters, your **SEROUT** command has to tell the LCD which of the eight custom characters you are defining and then describe the on/off states of each pixel in the character.

Figure 1-14 shows the define commands you can send the LCD to tell it which custom character you are about to define. You can also think about it like this - to tell the LCD which custom character you are defining, send the value of the custom character plus 248. For example, if you want to define custom character 0, send 248, if you want to define custom character 1, send 249, and so on up to 255 for custom character 7.

Figure 1-14 Custom Character Define Commands

								
Custom Characters	0	1	2	3	4	5	6	7
Define Commands	248	249	250	251	252	253	254	255

After sending the code that tells the LCD which custom character you are about to define, you have to then send eight bytes that describe the character. The LCD uses the lowest five bits of each byte it receives to describe each five pixel wide line in the character. Figure 1-15 shows an example of defining custom character 0 to be an hourglass that's just been turned upside down. Notice how each successive value in the **SEROUT** command corresponds to a row of pixels in the custom character. Notice also how the 1s correspond to black pixels, and the 0s correspond to white.

Figure 1-15 Redefining Custom Character 0

```
SEROUT 14, 84, [248,
%00000,
%11111,
%11111,
%01110,
%00100,
%01010,
%10001,
%11111]
```

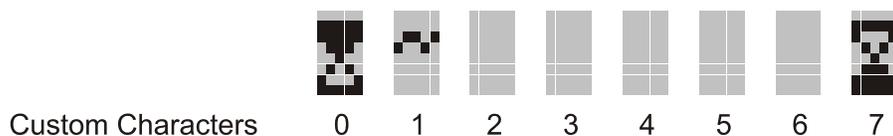
 **The SEROUT custom character definitions are not permanent.** Each time the LCD's power is turned on and off the custom characters are erased. Since the BASIC Stamp and LCD share the same power supply, the BASIC Stamp's program also restarts when the power is reset. It's a good practice to define custom characters you plan to use at the beginning of a program, so that the BASIC Stamp can define the custom characters every time it's power is connected.

Here is another custom character definition of an hourglass with the sand drained into its bottom chamber. This definition uses 255 to tell the LCD to define it as custom character 7. It also uses a technique for drawing the characters with asterisks in the comments to the right of the **SEROUT** command. Start with a **SEROUT** command with all the binary values set to %00000, then draw the character with asterisks in the comment to the right. After it looks right, use the asterisks to dictate which zeros should be changed to ones.

```
SEROUT 14, 84, [255,
%00000,
%11111,
%10001,
%01010,
%00100,
%01110,
%11111,
%11111] ' Define custom character 7
'
' * * * * *
' * * * * *
' * * * * *
' * * * * *
' * * * * *
' * * * * *
' * * * * *
```

Figure 1-16 shows how the two SEROUT commands just discussed will redefine the LCD's custom characters.

Figure 1-16 After Defining Custom Characters 0 and 7



Custom characters are sometimes defined with hexadecimal values. You will even see this in example programs available for download from the Parallax Serial LCD product pages at www.parallax.com. For information on how hexadecimal character definitions work, try the activity in Appendix B: Hexadecimal Character Definitions.

With these new custom character definitions, you can write a loop to make the hourglass toggle between empty and full, indicating that the user should wait. The `DO...LOOP` below does this by first placing the cursor on the character 5 in the LCD. Then it displays custom character 0, the hourglass that was just turned upside down. After a brief **PAUSE**, the program sends the backspace command (8) to get the cursor back to character 5. Then, it sends custom character 7, the hourglass with the sand drained into the base. By repeating this sequence, it looks as though the hourglass is turned upside-down, drained, turned again, drained again, and so on.

DO

```
SEROUT 14, 84, [133]           ' Cursor -> Line 1, char
SEROUT 14, 84, [0]             ' Display custom character 0
PAUSE 1250                      ' Delay for 1.25 seconds
SEROUT 14, 84, [8]             ' Backspace
SEROUT 14, 84, [7]             ' Display custom character 7
PAUSE 1500                      ' Delay for 1.50 seconds
```

LOOP

Example Program: Hourglass.bs2

This program defines and displays the hourglass custom characters just discussed.

- ✓ Enter, save, and run the program.
- ✓ Verify that it alternately displays the two hourglass characters at the sixth character in the LCD's top row.

```
' -----[ Title ]-----
```

```

' Example Program - Hourglass.bs2
' Define and display custom characters.

' {$STAMP BS2}           ' Target device = BASIC Stamp 2
' {$PBASIC 2.5}        ' Language      = PBASIC 2.5

' -----[ Initialization ]-----

PAUSE 250                ' Debounce power supply

SEROUT 14, 84, [248,    ' Define custom character 0
    %00000,
    %11111,
    %11111,
    %01110,
    %00100,
    %01010,
    %10001,
    %11111]

SEROUT 14, 84, [255,    ' Define custom character 7
    %00000,
    %11111,
    %10001,
    %01010,
    %00100,
    %01110,
    %11111,
    %11111]

SEROUT 14, 84, [22, 12] ' Turn on display and clear
PAUSE 5                ' 5 ms delay for clearing display

' -----[ Main Routine ]-----

DO

    SEROUT 14, 84, [133] ' Cursor -> Line 1, char
    SEROUT 14, 84, [0]  ' Display custom character 0
    PAUSE 1250          ' Delay for 1.25 seconds
    SEROUT 14, 84, [8]  ' Backspace
    SEROUT 14, 84, [7]  ' Display custom character 7
    PAUSE 1500          ' Delay for 1.50 seconds

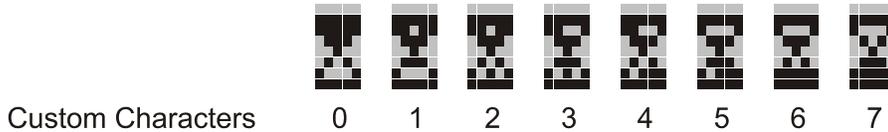
LOOP

```

Your Turn

Figure 1-17 shows the custom characters depicting the grains of sand in the hourglass moving from the top to the bottom.

Figure 1-17 Figure with Drawing Canvas



- ✓ Save Hourglass.bs2 as HourGlassYourTurn.bs2.
- ✓ Expand the initialization routine so that it defines all eight custom characters as shown in Figure 1-17.
- ✓ Modify that main routine so that it gives an animated hourglass effect as the grains of sand fall from top to bottom.

Here is a main routine you can also try for animating the eight custom characters once you have updated the initialization:

DO

```
' Place cursor at character 5, and display custom character 0.
SEROUT 14, 84, 100, [133, 0]
PAUSE 750                                ' 0.750 second delay

' Backspace, custom character 1, backspace, custom character 2, etc.
' optional pacing argument of 100 sends each value every 1/10 of a second.
SEROUT 14, 84, 100, [8, 1, 8, 2, 8, 3, 8, 4, 8, 5, 8, 6, 8, 7, 8]
PAUSE 750
```

LOOP

- ✓ Try it!



Even though the LCD only stores 8 custom characters at a time, your program can store as many as you need. Remember, your program can redefine any of the custom characters at any time. This means, if your application needs twenty custom characters, your PBASIC program can store 20 custom characters and redefine custom characters as needed.

You can display the hourglass with just one custom character. The entire hourglass animation can be done with just one custom character. The trick is to redefine the custom character between each time the display is updated.