



**PicoBlaze**<sup>TM</sup> (KCPSM3)

# Reference Design

## Digital Clock and Spartan-3 Starter Board Test Monitor



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With thanks to Stephan Neuhold (Xilinx Ltd)

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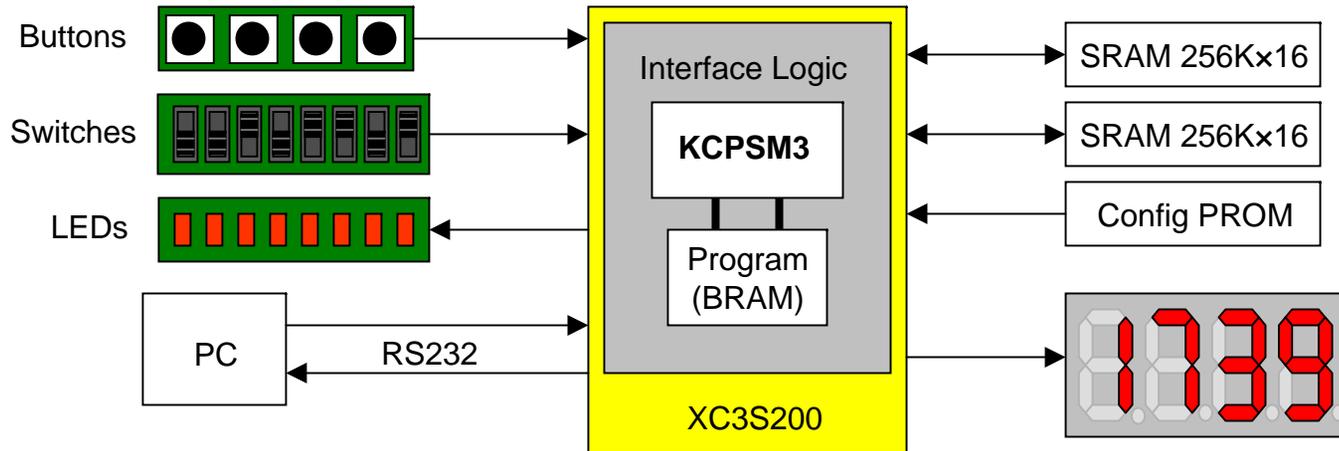
Any problems or items felt of value in the continued improvement of KCPSM3 or this reference design would be gratefully received by the author.

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The author would also be pleased to hear from anyone using KCPSM3 or the UART macros with information about your application and how these macros have been useful.

# Overview

The design will transform your board into a digital clock and enable you to test the majority of the features provided using a simple terminal program on your PC. The design consists of a single PicoBlaze 8-bit processor (KCPSM3) and interface logic. All operations are controlled by PicoBlaze using a program contained in a single block memory within the Spartan-3 device.



Resource summaries from the MAP report. PicoBlaze itself accounts for 96 slices.

Number of occupied Slices:	267 out of	1,920	13%
Number of Block RAMs:	1 out of	12	8%
Number of GCLKs:	1 out of	8	12%

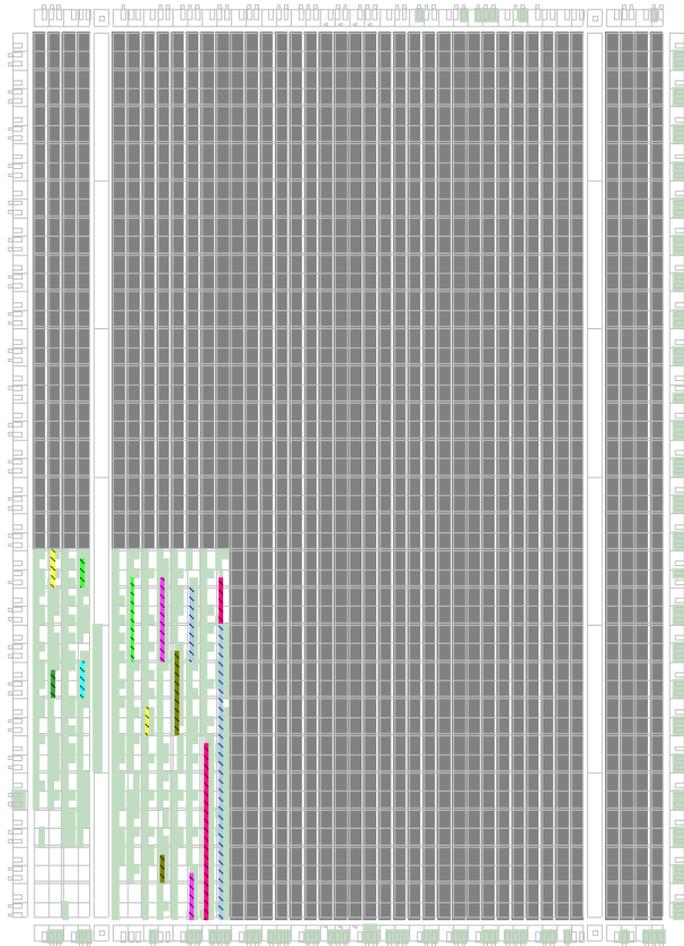
Total equivalent gate count for design: 81,205  
Additional JTAG gate count for IOBs: 4,608

This design clearly demonstrates that a great deal can be achieved with the XC3S200 device given that only 13% of the device is currently used. The efficiency of the PicoBlaze design methodology is reflected in the equivalent gate count. If the remainder of the device was used to a similar degree of efficiency, the XC3S200 would yield well in excess of 500K gates. Indeed, it is not unusual for engineers to include multiple PicoBlaze processors in their designs.

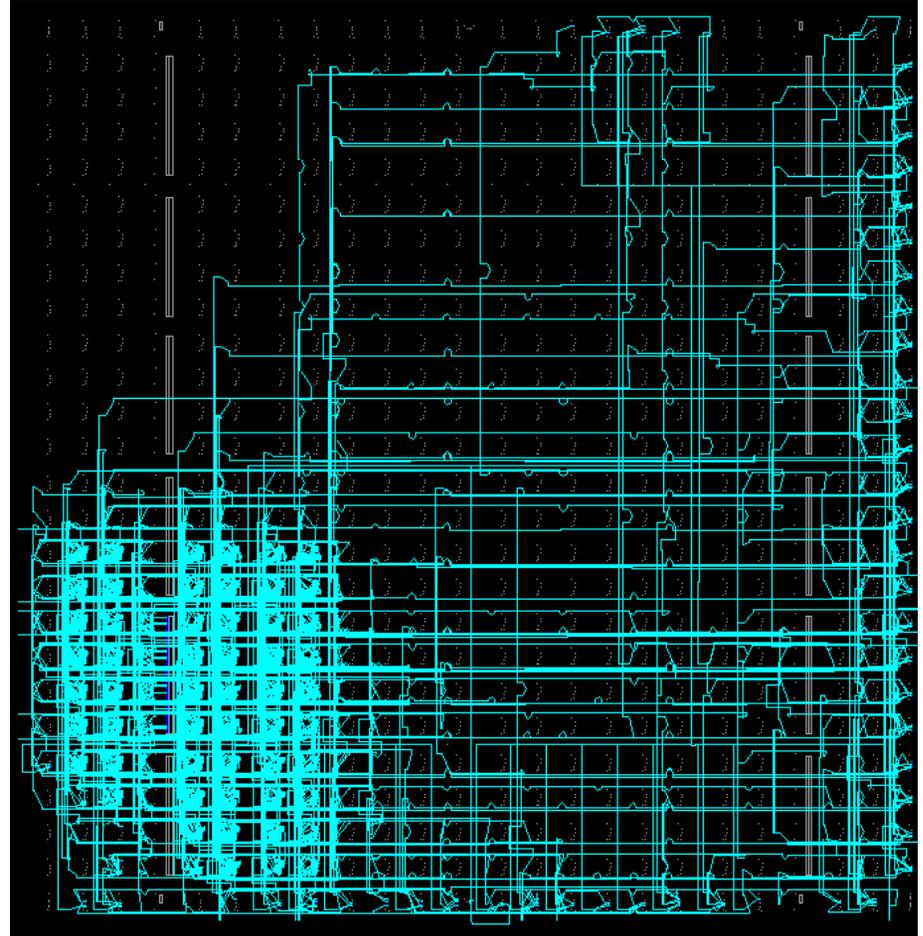
# Design Resources

The design uses one Block RAM and 220 Logic slices. This is less than 12% of the XC3S200 device resources.

Floorplanner view



FPGA Editor view



Notes: Constraints were used to stop the logic being spread all over the device! Such constraints are only required to make nice pictures!  
CLB Packing Factor was set to 1 (default value is 100) to achieve 220 slices.

# Using the Design

The design is provided as a file ready for immediate programming of the XCF02S Platform FLASH configuration PROM mounted on the Spartan-3 Starter Board produced by Digilent Inc. Details of the design files are provided in the file 'Read\_me.txt'.

## Setup

- 1) Program the XCF02S device with the file "new\_s3\_clock\_pcb\_monitor.mcs".
- 2) Ensure the JUMPERS (links) are inserted for M0, M1 and M2 of JP8 to ensure design will configure from PROM.
- 3) Insert JUMPER (link) in JP1 (near XCF02S device) so that the configuration PROM can be read. It does not matter which position the link is in to configure the Spartan device, so initially insert it in either position. Later you will discover that the design expects the link to be in a particular position and you may need to change it.
- 4) Connect an RS232 cable from J2 to your PC. You will need a cable with 9-way male connector (Spartan-3 board end) and 9-way female connector (PC end). The connections through be straight through (pin 1 to pin 1, pin 2 to pin 2 and pin 3 to pin 3).
- 5) Open a HyperTerminal session on your PC (or other suitable program). Configure this as shown on the next 2 pages.
- 6) Turn on your Spartan-3 board or press the PROG button to configure the Spartan XC3S200 device.

The 7-segment display should be indicating 1200 hours with a flashing decimal point.  
Your PC terminal should be giving you a 'KCPSM3>' prompt.

You are now ready to use the PicoBlaze Digital Clock and Board Monitor design.

# HyperTerminal Setup

HyperTerminal can typically be located on your PC at Programs -> Accessories -> Communications -> HyperTerminal.

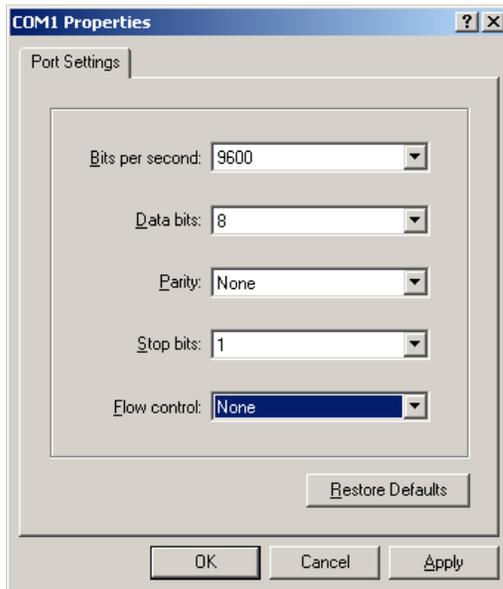


1) Begin a new session with a suitable name.



2) Select the appropriate COM port (typically COM1 or COM2) from the list of options.

Don't worry if you are not sure exactly which one because you can change it later.



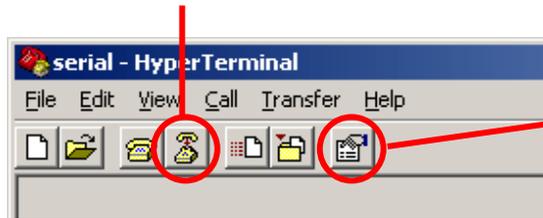
3) Set serial port settings.

Bits per second : 9600  
Data bits: 8  
Parity: None  
Stop bits: 1  
Flow control: None

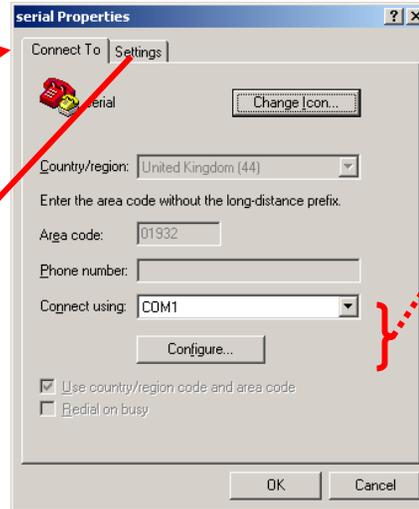
The HyperTerminal window will then be active and may appear to start working, but there is a bit more to set up yet.....

# HyperTerminal Setup

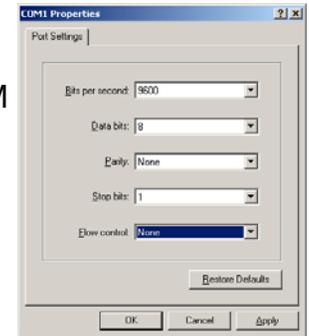
4 - Disconnect



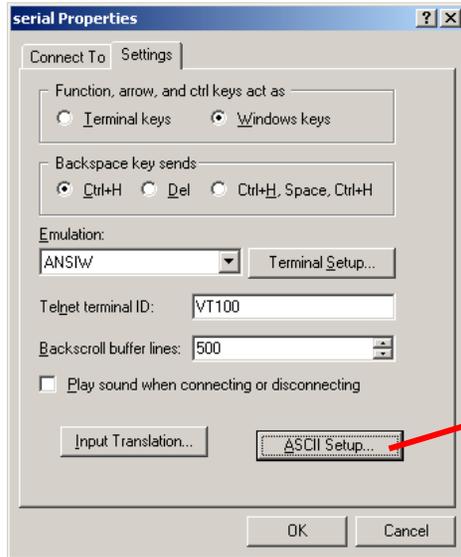
5 - Open the properties dialogue



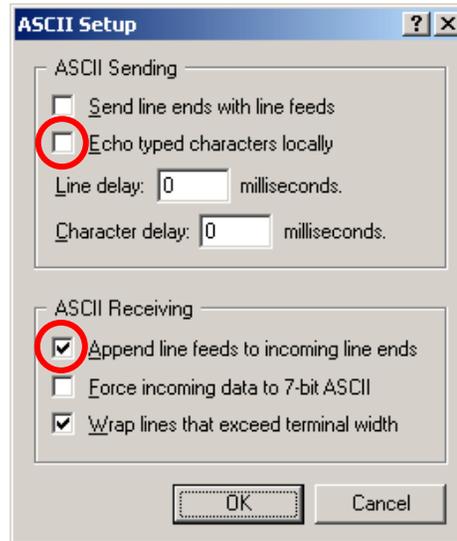
To select a different COM port and change settings (if not correct).



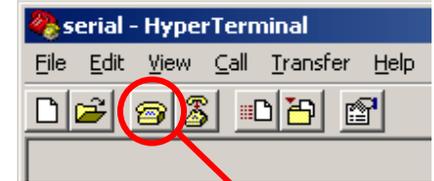
6 - Open Settings



7 - Open ASCII Setup



8 - Connect



Ensure boxes are filled in as shown.

The design will echo characters that you type so you do not need the 'Echo typed characters locally' option.

The design transmits carriage return characters ( $OD_{HEX}$ ) to indicate end of line so you do need the 'Append line feeds to incoming line ends' option to be enabled.

# Talking to PicoBlaze

```
serial - HyperTerminal
File Edit View Call Transfer Help

KCPSM3> ————— The 'KCPSM3' prompt should appear and repeat each time you hit carriage return.

KCPSM3>

KCPSM3>time ————— PicoBlaze interprets 'Backspace' to implement a 16 character line editor.
11:55:39                               The command is only executed when you hit carriage return.

KCPSM3>led1 on ————— You need to be precise with command format (single spaces).

KCPSM3>wa 1e3f2 18BA ————— Commands and values can be typed in upper or lower case.

KCPSM3>RA 1E3F2
18BA

KCPSM3>button
Button0 ON ————— PicoBlaze responds with information or performs action on the Spartan-3 board.
Button1 OFF
Button2 OFF
Button3 OFF

KCPSM3>wb 56400 12CD
Invalid Address ————— PicoBlaze provides feedback when you get things wrong.

KCPSM3>_

Connected 2:40:57  ANSIWI  9600 8-N-1  SCROLL  CAPS  NUM  Capture  Print echo
```



# Commands

The commands are shown here using upper case, but the PicoBlaze program is able to interpret upper and lower case characters by converting commands to upper case before analysing them.

Follow the format of the commands using a single space where required to separate fields and follow the last character of a command immediately with a carriage return. Incorrect commands will result in an error message, so don't be afraid to experiment and see how much the PicoBlaze program can do. Although it is unlikely to occur when using HyperTerminal, an "Overflow Error" message will be generated if commands are transmitted faster than the design can process them.

## Digital Clock

The digital clock is displayed on the 7-segment displays of the board and can also be interrogated and controlled via the remote terminal using the following commands.

<b>TIME</b>	The current time will be displayed in the form hh:mm:ss
<b>TIME hh:mm:ss</b>	Allows the time to be set. The values of 'hh', 'mm' and 'ss' must provide a valid time using a 24-hour clock. The new time will then be displayed and the 7-segment display will reflect the new time.
<b>ALARM</b>	The current alarm time will be displayed in the form hh:mm:ss together with the current status of the alarm (OFF, ON, or Active)
<b>ALARM hh:mm:ss</b>	Allows the alarm time to be set. The values of 'hh', 'mm' and 'ss' must provide a valid time using a 24-hour clock. The new alarm time and current status will then be displayed.
<b>ALARM ON</b>	Enables the alarm to become active at the appropriate time. The current alarm time and status will be displayed. The alarm condition will be indicated on the Spartan-3 board by the illumination of all decimal points on the 7-segment display.
<b>ALARM OFF</b>	Disables the alarm from becoming active and will cancel the alarm if already active (decimal points turned off). The current alarm time and status will be displayed.

# Commands

## LEDs

The Spartan-3 board has 8 LEDs labeled LD0 to LD7. The following commands allow you to control them.

<b>LED</b>	Displays the status of all 8 LEDs.
<b>LEDn ON</b>	Turn the specified LED on. The value of 'n' must be in the range 0 to 7.
<b>LEDn OFF</b>	Turn the specified LED off. The value of 'n' must be in the range 0 to 7.

## Switches and Buttons

The Spartan-3 board has 8 switches and 4 buttons. The following commands allow you to observe them.

<b>SWITCH</b>	Displays the status of all 8 switches.
<b>BUTTON</b>	Displays the status of all 4 buttons (remember to press one!).

## Configuration PROM

After configuration of the Spartan-3 device, the remaining space in the PROM can be accessed to retrieve further useful data. Please read XAPP694 for more details. The following command demonstrates this design possibility.

<b>PROM</b>	Displays a message stored in the PROM containing further information about this technique. Note that this is why the JUMPER (link) should be installed in a particular position of JP1. The PROM needs to be enabled after configuration to access the data stored in it. If you got it in the wrong place PicoBlaze will tell you to. If you got it wrong, move it and see what happens!
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# Commands

## Memory

The Spartan-3 board has two asynchronous CMOS static RAM devices each providing 256K locations of 16 bits. The following commands allow you to read and write to these memories

### **Rx aaaaa**

Display the 16-bit value stored in the specified memory and location.

'x' specifies the memory to be read as a letter 'A' for IC10 or letter 'B' for IC11.

'aaaaa' specifies the address as a 5 digit hexadecimal value in the range 00000 to 3FFFF.

### **Wx aaaaa dddd**

Write the 16-bit provided to the specified memory and location.

'x' specifies the memory to be written as a letter 'A' for IC10 or letter 'B' for IC11.

'aaaaa' specifies the address as a 5 digit hexadecimal value in the range 00000 to 3FFFF.

'dddd' specifies the data as a 4 digit hexadecimal value in the range 0000 to FFFF.

# Block Diagram

