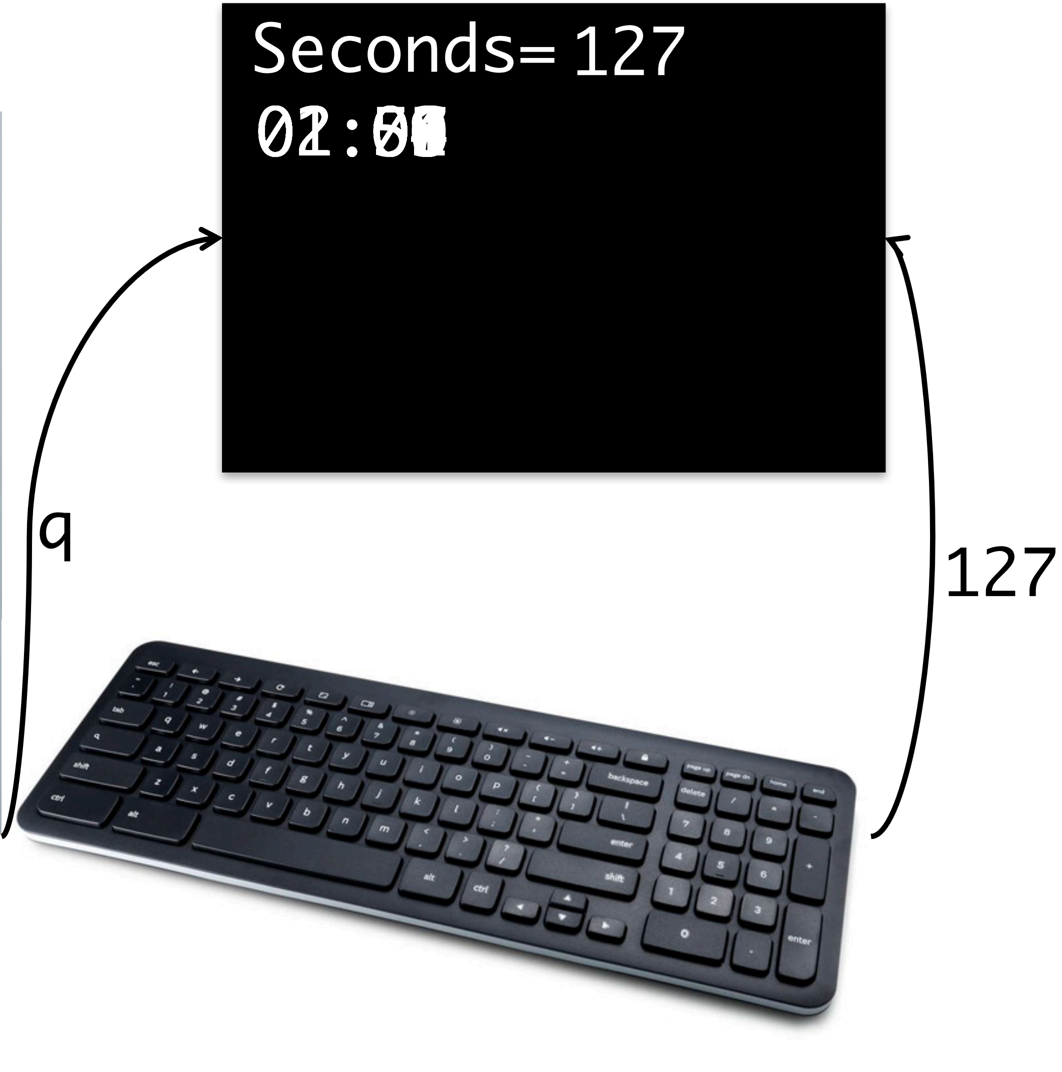
Introduction to Lab # 4: Count-Down Timer

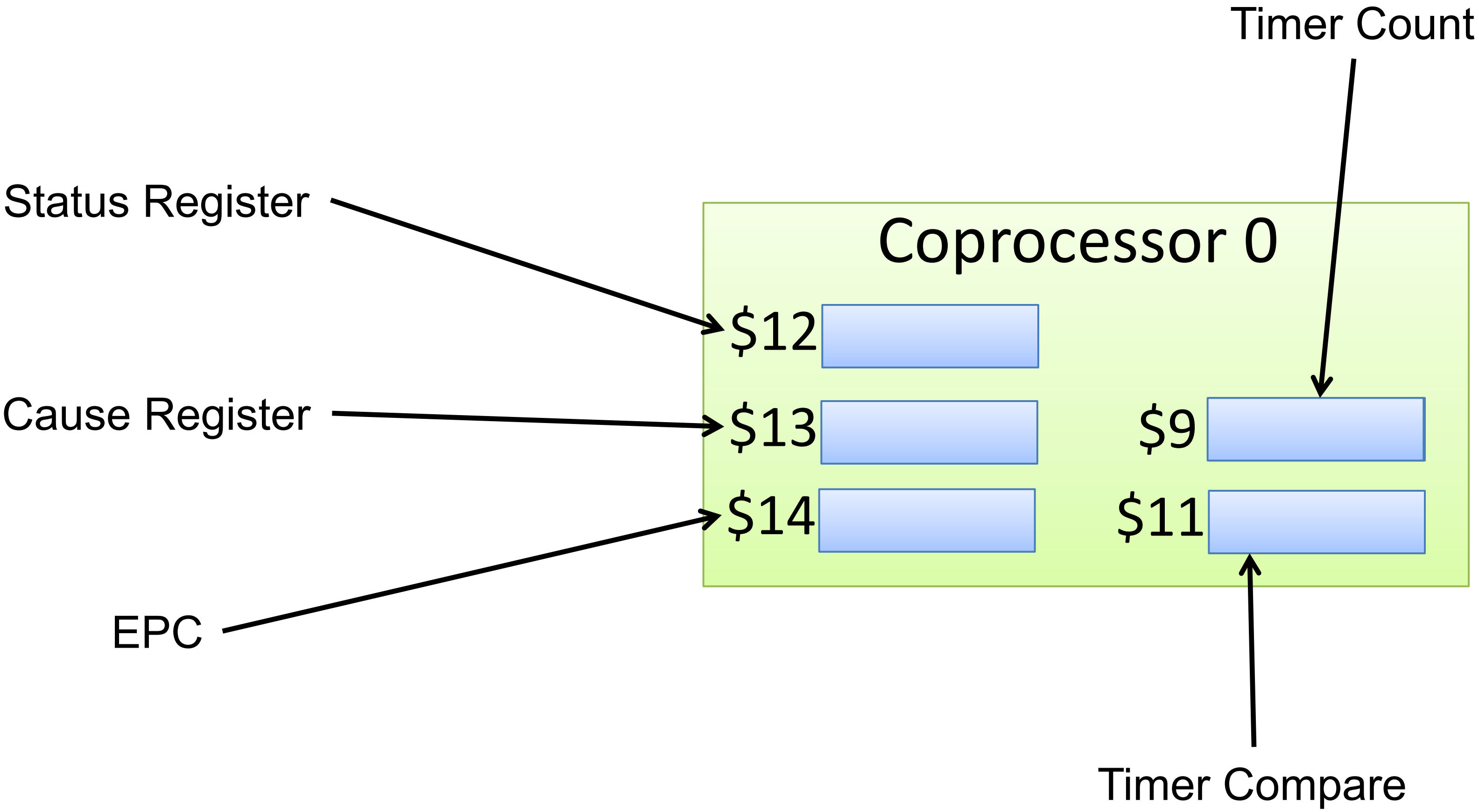
José Nelson Amaral

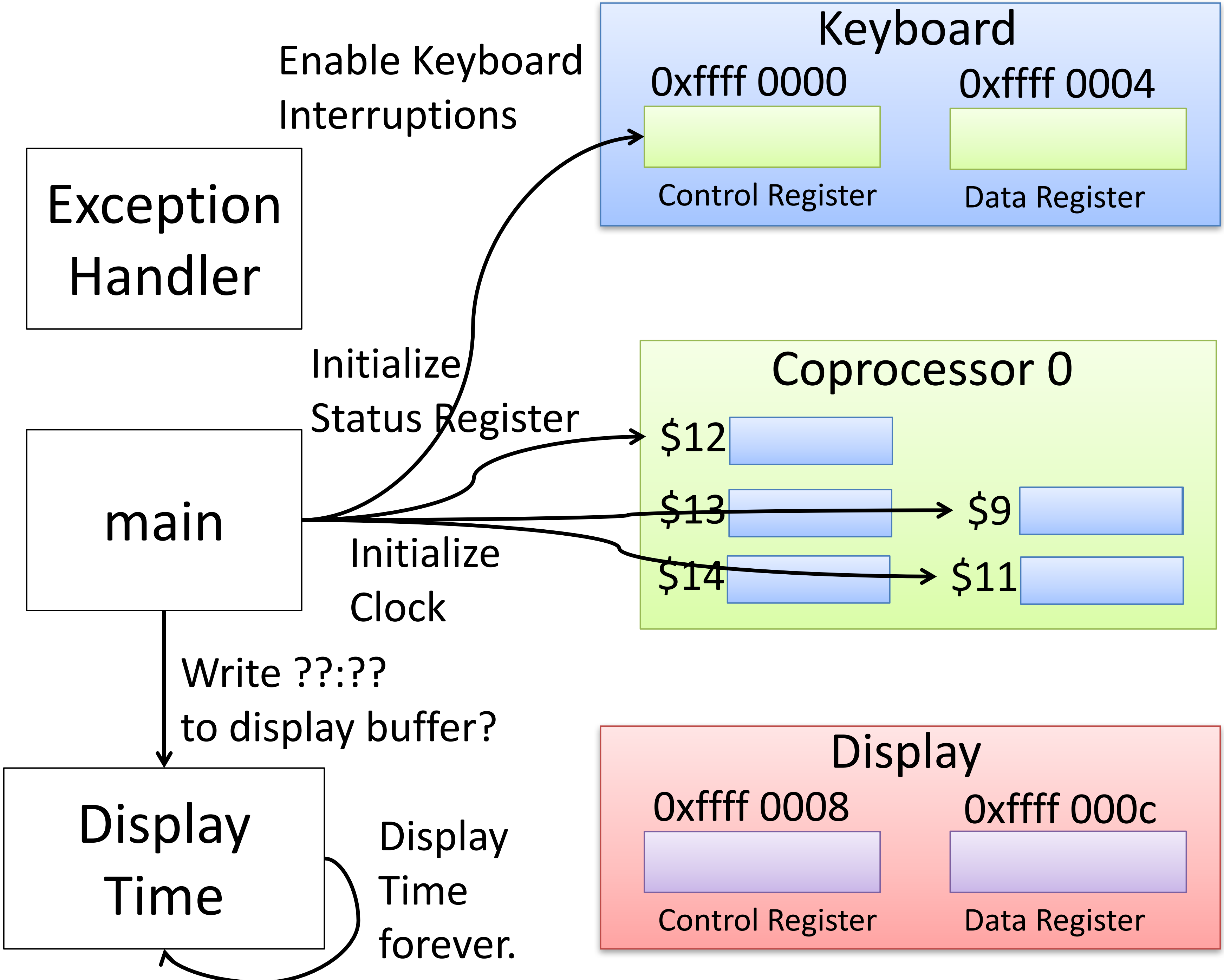
A Digital Count-Down Timer

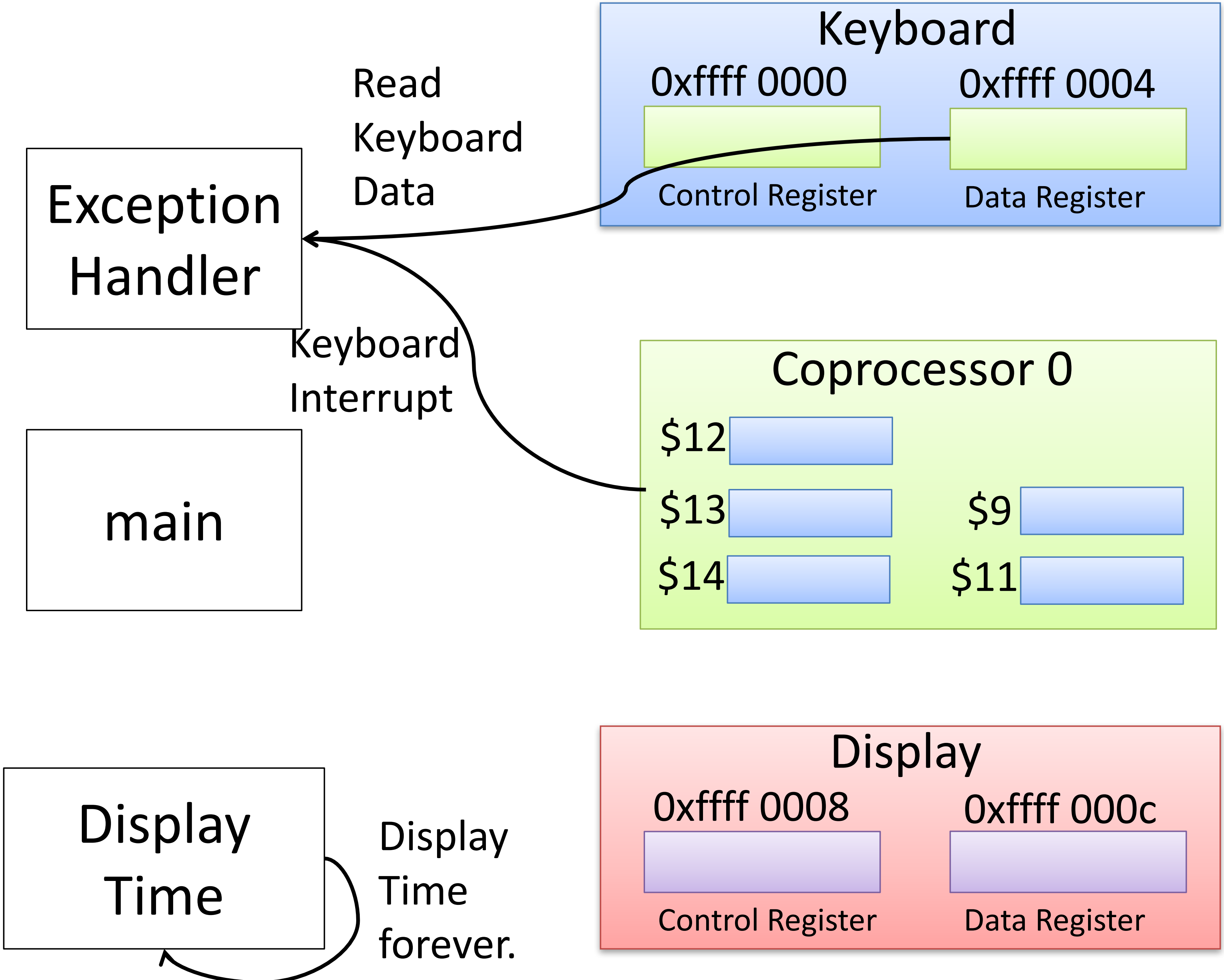

Seconds= 127

02:07

Coprocessor 0




Enable Keyboard Interruptions
Keyboard
0xffff 0000
0xffff 0004
Control Register
Data Register
Exception Handler
Initialize Status Register
Coprocessor 0
$12
$13
$9
$14
$11
main
Initialize Clock
Write ??:?? to display buffer?
Display
0xffff 0008
0xffff 000c
Control Register
Data Register
Display Time
Display Time forever.



Keyboard

0xffff 0000

Control Register

0xffff 0004

Data Register

Read Keyboard Data

Exception Handler

Keyboard Interrupt

Coprocessor 0

$12

$13

$14

$9

$11

main

Display Time

Display Time forever.

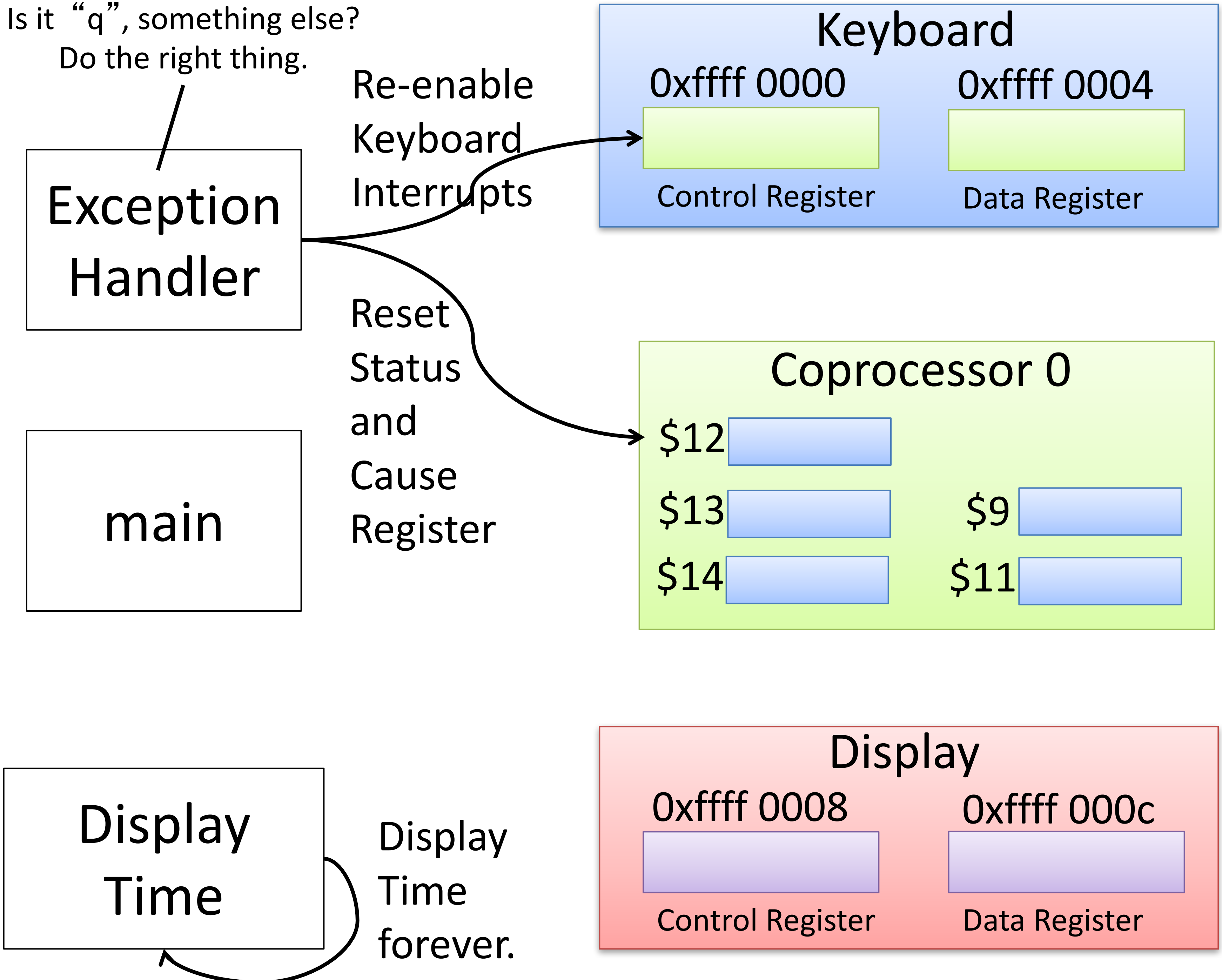
Display

0xffff 0008

Control Register

0xffff 000c

Data Register



Is it “q”, something else?
Do the right thing.

Exception Handler

Re-enable Keyboard Interrupts

Reset Status and Cause Register

main

Display Time

Display Time forever.

Keyboard

0xffff 0000

Control Register

0xffff 0004

Data Register

Coprocessor 0

$12

$13

$9

$14

$11

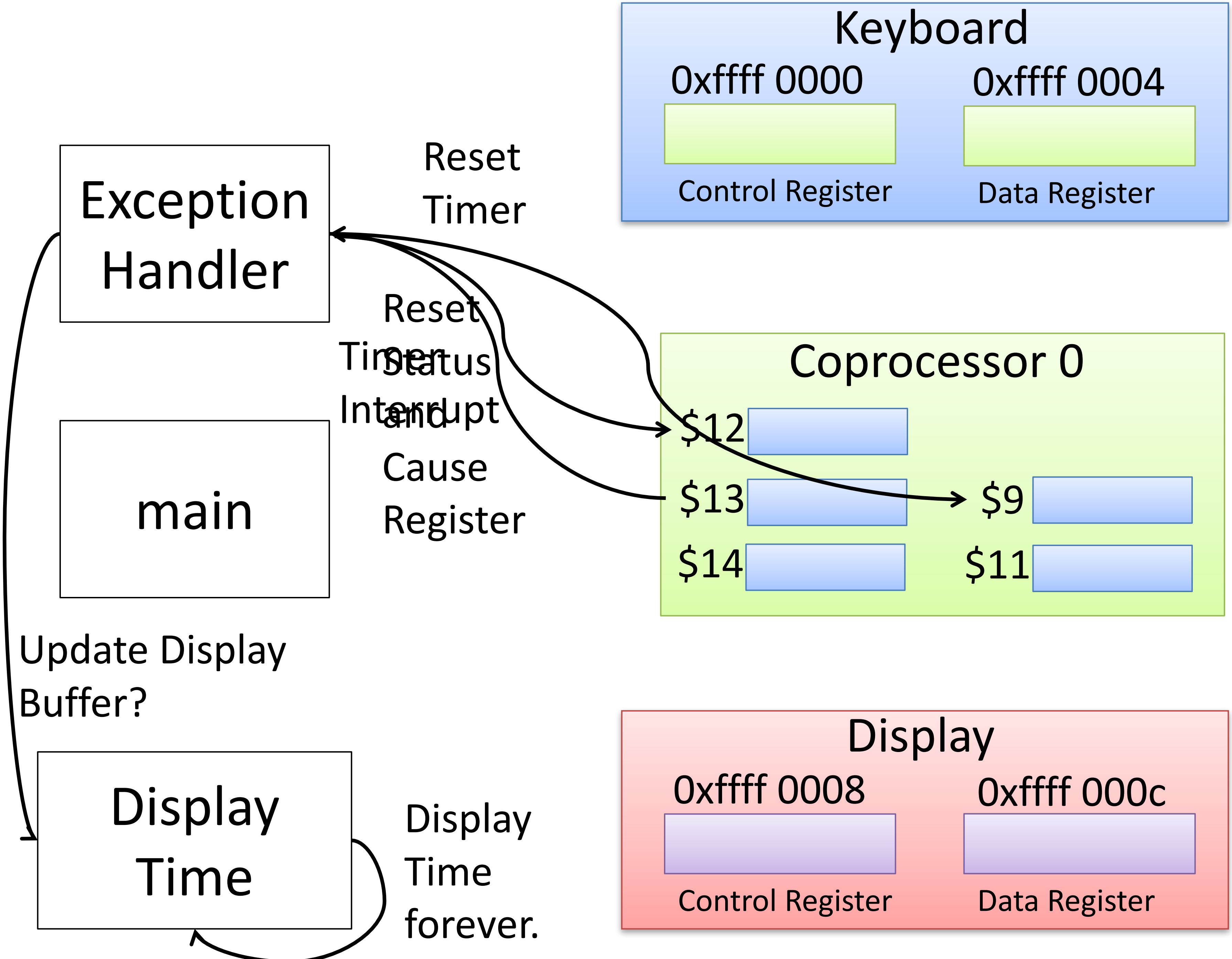
Display

0xffff 0008

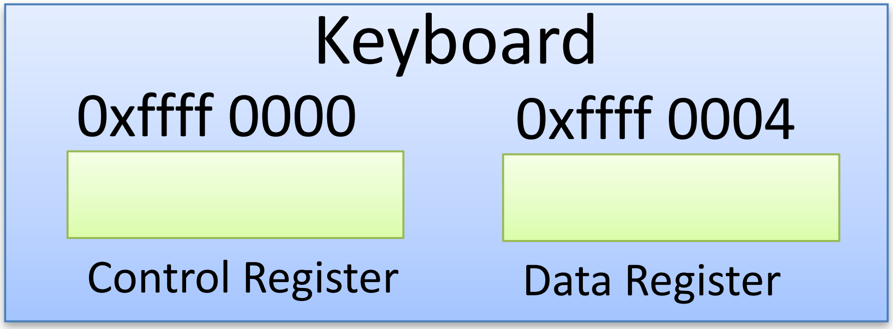
Control Register

0xffff 000c

Data Register

Keyboard
0xffff 0000
0xffff 0004
Control Register
Data Register
Exception Handler
Reset Timer
Reset Timer Interrupt
Status and Cause Register
Coprocessor 0
$12
$13
$14
$9
$11
main
Update Display Buffer?
Display Time
Display Time forever.
Display
0xffff 0008
0xffff 000c
Control Register
Data Register

```
FOREVER:
   p = address of first character
```

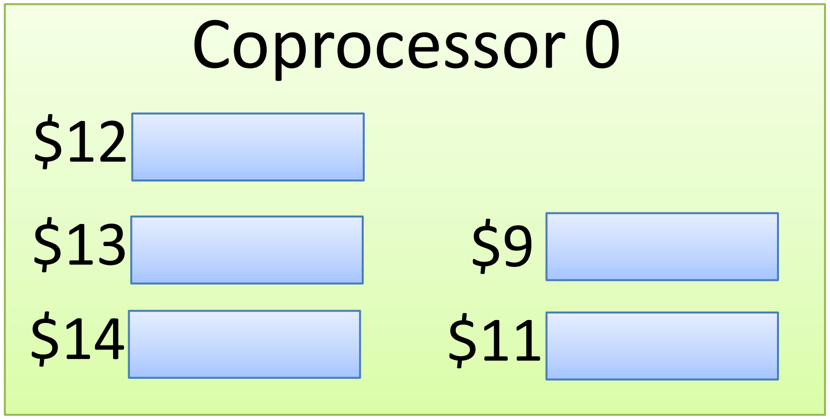

Keyboard

0xffff 0000

Control Register

0xffff 0004

Data Register


Coprocessor 0

$12

$13

$14

$9

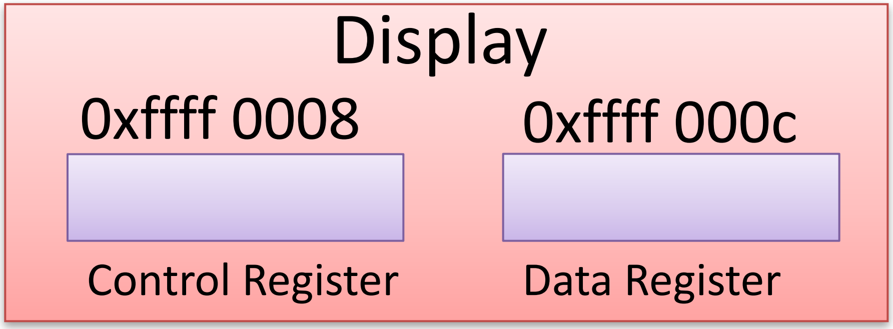
$11

If the routine above is used to display the time, here is an example of the type of string that would be in the display buffer:

8 is the backspace character in ASCII

Display Buffer:

‘0’	‘0’	‘:’	‘0’	‘0’	8	8	8	8	8	0


Display

0xffff 0008

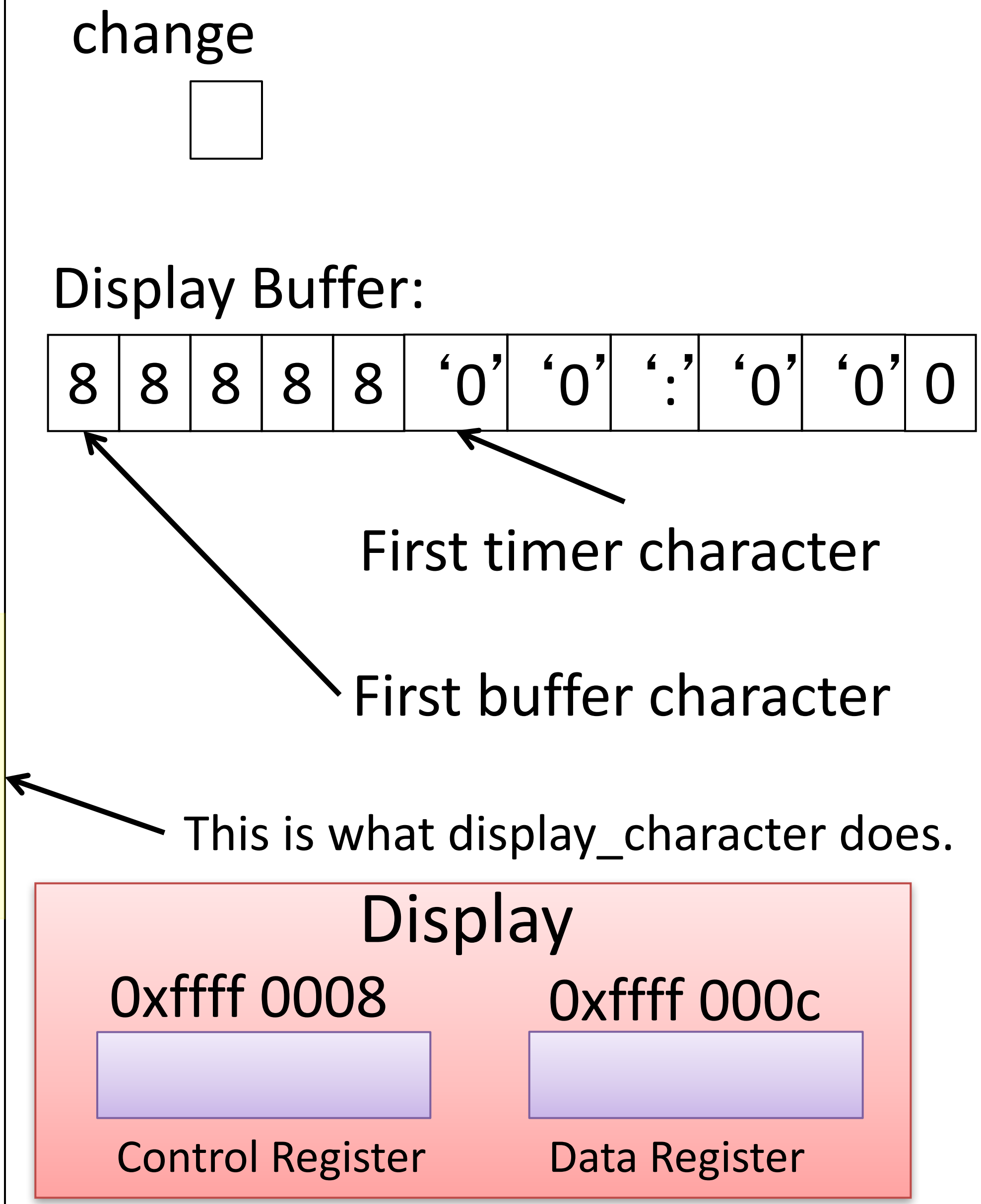
Control Register

0xffff 000c

Data Register

With this solution the timer will be blinking.

```
   change = 0
   q = address of first clock character
NEXT1:
   display_character(q)
   q++
   if *q != NULL
      goto NEXT1
FOREVER:
```



change

Display Buffer:

8	8	8	8	8	‘0’	‘0’	‘:’	‘0’	‘0’	0

First timer character

First buffer character

This is what display_character does.

Display

0xffff 0008

0xffff 000c

Control Register

Data Register

```
   change = 0
   q = address of first clock character
NEXT1:
   display_character(q)
   q++
   if *q != NULL
      goto NEXT1
FOREVER:
   if change = 0
      goto FOREVER
   change = 0
   p = address of first buffer character
NEXT2:
   display_character(p)
   p++
   if *p != NULL
     goto NEXT2
   go to FOREVER
```

change

□

Display Buffer:

8	8	8	8	8	‘0’	‘0’	‘:’	‘0’	‘0’	0

These two segments are the same.

```
display_character(c):
POLL:
   read Display Control Register
   if not ready
      go to POLL
   write *c to Display Data Register
return
```

```
  q = address of first clock character
  display_string(q)
FOREVER:
  if change = 0
     goto FOREVER
  change = 0
  p = address of first buffer character
  display_string(p)
  go to FOREVER
```

change

□

There is only one call to display_character. Thus we may inline it.

Display Buffer:

8	8	8	8	8	‘0’	‘0’	‘:’	‘0’	‘0’	0

```
display_string(s):
NEXT1:
  display_character(s)
  s++
  if *s != NULL
     goto NEXT1
return
```

```
display_character(c):
POLL:
  read Display Control Register
  if not ready
     go to POLL
  write *c to Display Data Register
return
```

```
  change = 0
  q = address of first clock character
  display_string(q)
FOREVER:
  if change = 0
     goto FOREVER
  change = 0
  p = address of first buffer character
  display_string(p)
  go to FOREVER
```

This solution does not work well with xterm (the backspace character prints as ^H). Try to use a different terminal such as xfce4-terminal.

change

□

There is only one call to display_character. Thus we may inline it.

Display Buffer:

8	8	8	8	8	‘0’	‘0’	‘:’	‘0’	‘0’	0

```
display_string(s):
POLL:
  read Display Control Register
  if not ready
     go to POLL
  write *s to Display Data Register
  s++
  if *s != NULL
     goto POLL
return
```

Need to fix the exception handler so that it updates “change” when there is a new time to display.