

IOWA STATE UNIVERSITY  
ELECTRICAL ENGINEERING DEPARTMENT

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**CPRE 488**

**HOMEWORK 0**

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Douglas Zuercher

## Contents

<b>1</b>	<b>Solutions . . . . .</b>	<b>3</b>
1.1	Problem 1 . . . . .	3
1.2	Problem 2 . . . . .	3

# 1 SOLUTIONS

## 1.1 Problem 1

I am familiar with the embedded system used by PrISUm Solar Car on our Moduleboards for our battery protection system (BPS). The embedded system that runs on each of the 42 Moduleboards is responsible for collecting data from temperature and voltage sensors and communicating that data via CAN back to a central node when requested. The embedded system on each Moduleboard fits into the class definition because it:

- Is “embedded” in a deeper system. The embedded code running on a Moduleboard is one part of a larger BPS system, which itself is only a small part of the car.
- Is specialized. The embedded code ran on a Moduleboard cannot be used to do anything except monitor sensor outputs and transmit them via CAN.
- Runs on a small microcontroller with limited computational resources and in which reliability is critically important.

## 1.2 Problem 2

### Part A

A 25MHz clock has a period of 40ns. The number of clock cycles needed for each VGA signal timing is computed by taking the ceiling of the time divided by the clock period. The ceiling is taken because an operation cannot take a fractional clock cycle.

$$N = \left\lceil \frac{T}{40\text{ns}} \right\rceil$$

The table has been filled out accordingly.

Symbol	Parameter	Time	# Clocks
$T_S$	Synchronization time	$32\mu\text{s}$	800
$T_{fp}$	Front Porch	$640\text{ ns}$	16
$T_{pw}$	Sync pulse width	$3.84\mu\text{s}$	96
$T_{bp}$	Back porch	$1.92\mu\text{s}$	48
$T_{disp}$	Display time	$25.6\mu\text{s}$	640

**Table 1:** Symbol Timings and Clock Cycles**Part B**

Achieving a 60 Hz refresh rate implies that all rows must be scanned horizontally, and the beam must return from the bottom row to the top row, 60 times a second. In other words, one scan of all rows plus one return to the top row must be completed in approximately 16.6667 ms.

From Table 1, we know that it takes  $32\mu\text{s}$  to complete one row scan. If this is performed for all 480 rows, it will take 15.360 ms to draw one frame. If one frame must take 16.6667 ms to draw, then the vertical sync time can only last for 1.3067 ms.

Therefore, for a 60 Hz refresh rate, the vertical sync time ( $T_S^V$ ) must be approximately 1.3067 ms long. This is equivalent to 32,668 clock cycles or about  $41 T_S^H$ .