ELECTRICAL & ELECTRONIC ENGINEERING
STELLENBOSCH UNIVERSITY

Design (E) 314
Technical Report

Hot Water Geyser Controller/Monitor System

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May 2, 2018

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Abstract

This will be where you write your abstract, eg:

New York (NY), central processing units (CPUs) and United Nations (UN) are abbreviations whereas The number of angels per unit area (a), The number of angels per needle point (N) and The area of the needle point (A) are part of the symbols. Repeat after me: NY, CPUs and UN are abbreviations whereas a, N and A are part of the symbols.

Contents

List of Figures

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List of Abbreviations

CPU central processing unit

NY New York

UN United Nations

List of Symbols

A The area of the needle point

a The number of angels per unit area

N The number of angels per needle point

1 Introduction

Here you describe your overall project briefly, context, requirements, aims etc. For more details on the marks that will be awarded per section see the, *Design (E) 314 -2018 Report Marking Scheme* document.

2 System description

Here you will describe your system, eg: The system blocks are shown in Figure 1, with the major components listed in Table 1.

Table 1: Your table caption

Component	Operating Voltage
RL78-Stick	2.0 V-5.5 V
FX230 UART	3.3 V
PC 1601 - LCD Module	5.0 V

3 Hardware design and implementation

Here you will describe your design motivations, calculations and implementation, also using equations where applicable, eg: A player faces a dynamic optimization problem of 5 periods. Let a_t denote the player's action in period t,

$$a_t \in \{P, N\} \tag{1}$$

3.1 Power supply

This section describes a sub-circuit/component of your design. Circuit diagram (schematic) or description, with relevant requirements, assumptions, design details, motivations and calculations. $V_{GS} = V_{OUT} \times \frac{R1}{R_{Tot}} = 24.12345 = 24.12\,\Omega$ (to two significant digits after the decimal point).

3.2 UART communications

The Universal Asynchronous Receive Transmit (UART) communications is the protocol which the Geyser Controller use to debug the system if physical inspection is needed.

The Geyser Controller implements a communications command structure where the Geyser Controller acts as a slave in the UART communcations. The Geyser Controller will only respond to valid commands which starts with a '$' and ends with a two character sequence, the carriage return character and the line feed character. The Geyser Controller will only transmit over the UART if a request is received.

The communication command structure will have a format as seen in shown in Figure **??** and all response from the Geyser Controller will have the format as shown in Figure **??**.

The Geyser Controller has a hard real-time deadline to respond to each received command within 50ms.

The hardware design of the UART communication is based of the schematic shown in Figure **??**. The chip responsible to convert the serial communication with the Geyser Controller is the FTX230XS USB to Serial. The only values to be designed are resistors R6 and R10. These resistor values are designed to ensure the maximum ratings of both the STM32Fxxx pins and FTX230XS chip will not be exceeded. These maximum of the respective pins are shown in Table **??**.

Thus the maximum ratings will only occur if the both pins output a high or low respectively. This sets the minumum value of the resistors as

$$R6 = R10 = \frac{5V - 0V}{I_{max}} = something\Omega$$

The capacitors are their to reduce reflection within the circuit.

3.3 ADC interfaces

The geyser controller will be indicating to the clients how much power they are saving by using this system. Thus it is of importance to calculate the power usage of the geyser. This section will cover how the power usage of the geyser will be captured.

The power usage of the geyser will be achieved by sampling the voltage and current that is supplied to the geyser through a Current Transformer (CT) and Voltage Transformer (VT).This CT and VT will convert the time-varying -220V and +220V signal to a -1V and +1V with a frequency of 50Hz. The CT will represent the -13A and +13A between -1V and +1V signal.

This two time varying signals will be sampled by using the embedded Analog-to-Digital Converter (ADC) to represent the continuous time varying signal as a discrete time-series.

The embedded ADC of the STM32xxx uses capacitors to sample the signal. Switching to fast between these channel will cause the internal capacitor to be depleted. When sampling the desired signal while this internal capacitor is charging will cause a erroneous sampling value. Allowing the internal capacitor to recharge without affecting the sampled value, an 100nF ceramic capacitor is placed between the ADC pin and ground. (Another method in software is to increase the sampling period and the number of sampling cycles.)

Mentions about sampling theorem, Nyquist frequency, specifications,

3.4 Geyser Flow-meter interface

3.5 Temperature Measurement interface

3.6 Flow and Valve control interface

4 Software design and implementation

Discuss top-level software design and implementation.

4.1 7-Segment driver

For each driver code segment discuss requirements, design, assumptions, describe/explain implemented code functionality (do not give a code listing!). Use applicable diagrams/charts to communicate detail eg: The flowchart of the 7-Segment driver is shown in Figure 1.

4.2 Timers and timing ... etc.

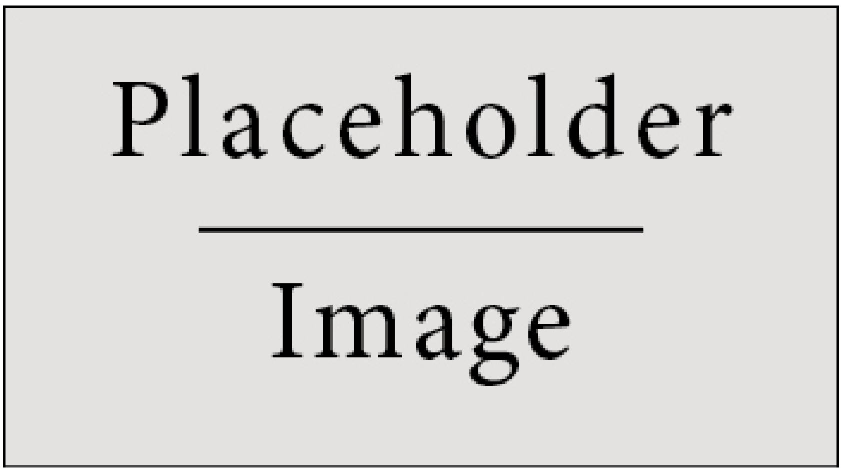

Figure 1: Figure caption.

Listing 1: Useless code

```c
#include <stdio.h>
void main (void)
{
    //This will probably not work.
    a = a + 1;
    b = bear;
}
```

5 Measurements and Results

Describe your measurements and results to determine where your system meets, or don't meet the requirements/specifications. A fake discussion follows as partial example: A fake discussion follows as example:

The accepted value (periodic table) is $24.3\,\mathrm{g\,mol^{-1}}$ [1]. The percentage discrepancy between the accepted value and the result obtained here is 1.3%. Because only a single measurement was made, it is not possible to calculate an estimated standard deviation.

The most obvious source of experimental uncertainty is the limited precision of the balance. Other potential sources of experimental uncertainty are: the reaction might not be complete; if not enough time was allowed for total oxidation, less than complete oxidation of the magnesium might have, in part, reacted with nitrogen in the air (incorrect reaction); the magnesium oxide might have absorbed water from the air, and thus weigh "too much". Because the result obtained is close to the accepted value it is possible that some of these experimental uncertainties have fortuitously cancelled one another.

6 Conclusions

Use experimental results, design limitations and system performance, explain your conclusions drawn.

6.1 Chemistry

1. The *atomic weight of an element* is the relative weight of one of its atoms compared to C-12 with a weight of 12.0000000…, hydrogen with a weight of 1.008, to oxygen with a weight of 16.00. Atomic weight is also the average weight of all the atoms of that element assuming:
   - we are working with nature
   - all measurements are calibrated
2. The *units of atomic weight* are two-fold, with an identical numerical value. They are g/mole of atoms (or just g/mol) or amu/atom.
3. *Percentage discrepancy* between an accepted (literature) value and an experimental value is

$$\frac{\text{experimental result} - \text{accepted result}}{\text{accepted result}} \tag{2}$$

6.1.1 Code efficiency

A fake discussion follows as example.

The code is not very efficient if it takes 50s to write "Hello World" over the UART. Future designs should focus on improving the code listed in listing 1, to execute in less than 20ms.

6.1.2 Notes on references

Don't forget to reference all references in text using IEEE Documentation Style [2].

All applicable documents should be in references list, specifically datasheets, like the LMT01 datasheet [3] and FT230X datasheet [4], used as references for designs, explanations of device operation etc.

References

[1] J. M. Smith and A. B. Jones, *Chemistry*, 7th ed. Publisher, 2012.

[2] D. Graffox. (2009, Sep.) Ieee citation reference. [Online]. Available: https://www.ieee.org/documents/ieeecitationref.pdf

[3] *LMT01-Q1 0.5C Accurate 2-Pin Digital Output Temperature Sensor with Pulse Count Interface*, LMT01-Q1 datasheet, Texas Instruments, Nov. 2016.

[4] *FT230X USB to Basic UART IC*, FT230X Datasheet, Future Technology Devices International Ltd, 2016.