

# Embedded Systems Coursework Specification

## Coursework 2: Brushless Motor Controller

### Functional specifications

1. The motor will spin for a defined number of rotations and stop without overshooting.
2. The motor will spin at a defined maximum angular velocity.
3. The normal precision is:
  - (a) The nearest one rotation for number of rotations
  - (b) The nearest one rotations per second for angular velocity, down to 5 rotations per second
4. Optionally, the motor can operate at high precision:
  - (a) The nearest 0.02 rotations for number of rotations
  - (b) The nearest 0.2 rotations per second for angular velocity, down to 0.5 rotations per second
5. The system will perform a Bitcoin mining task and return candidate nonces as frequently as possible.
6. Optionally, the motor can play a melody while it is spinning by modulating the control voltage

### Implementation specifications

7. The system will be commanded by instructions sent from a host over a serial interface.
8. Each command will end with a carriage return character
9. The syntax for rotation commands is the regular expression  $R-?\backslash d\{1,3\}(\backslash .\backslash d\{1,2\})?$
10. The syntax for maximum speed commands is the regular expression  $V\backslash d\{1,3\}(\backslash .\backslash d)?$   
The command V0 will remove the software limit on speed and allow the motor to spin as fast as possible.
11. The syntax for setting the bitcoin key is the regular expression  $K[0-9a-fA-F]\{16\}$
12. The syntax for melody commands is the regular expression  $T([A-G][\#^]?[1-8])\{1,16\}$  (where # and ^ are characters)
13. The system will be implemented using interrupts and robust threading techniques to leave the maximum possible CPU time for background tasks

### Documentation specifications

The report should contain:

14. A description of the motor control algorithm used.
15. An itemisation of all the tasks that are performed by the system with their minimum initiation intervals and maximum execution times, both theoretical and measured.
16. An analysis of inter-task dependencies to show that there is no possibility of deadlock.
17. A critical instant analysis of the rate monotonic scheduler, showing that all deadlines are met under worst-case conditions
18. A quantification of maximum and average CPU utilisation, excluding bitcoin mining.

## Notes

- Examples of rotation commands are R-100.55 (spin backwards for 100.55 rotations) and R0 (spin forwards forever).
- An example velocity command is V20 (execute rotation commands at a maximum of 20 rotations per second).
- An example melody command is TA4C8G4F#8 (T followed by pairs of notes and durations). At the end of the sequence the melody repeats.
- An example key command is K0123456789ABCDEF.
- The Bitcoin mining task is the computation of SHA-256 hashes of the 64-byte data sequence {<data>, <key>, <nonce>}, where <data> is 48 bytes of static data, <key> is an 8-byte number specified by a host over a serial interface and <nonce> is an 8-byte number that can be freely-chosen. Candidate values of <nonce> are those that result in a hash beginning with 16 binary zeros and they will be returned to the host over the serial port.