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MOTORS DRIVING UNIT FOR A SMALL AIRSHIP

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Abstract: *In the framework of desinging an Autonomous Monitoring System at Tomas Bata University in Zlin we solved a problem of driving dc motors for RC models by a microcontroller. For this purpose we made a testing kit employing an L298 double full-bridge driver. In this article we would like to describe the design of this kit as it was found suitable for driving motors of a small airship. In the future this circuit will be integrated into a complex driving board.*

Key words: *autonomous, airship, motor, microcontroller, driver*

1. INTRODUCTION

This unit has been developed as a part of an Autonomous Monitoring System which is a project that is being solved at Tomas Bata University dealing with a problem of attaching a small airship with some monitoring equipment. This airship is then capable of an independent operation inside an enclosed hall, monitoring its neighbourhood. The motion of the airship is ensured by 3 motors. Two of them are mounted under the bladder of the airship. They provide the main power to move the airship in a forward direction. Because they can be skewed by a servo, they can also drive the airship in a vertical plane. The third motor is mounted at the tail of the airship and is responsible for its rotation in a horizontal plane. All of these motors are standard types being used in RC models. The continuous power of them is around 25 W per each. The geometric description of the airship was introduced by Bestaoui, 2005. This concept and mainly the location of the motors, depicted in the Fig.1., was accepted for the small airship.

2. PROBLEM DEFINITION

The problem is that the modeller motors are usually connected to standardized drivers that are discriminative to signals of radio controllers. In the case of the monitoring system we do not drive the motors by RC transmitter, but we need to drive it by a microcontroller held on the airship. For this purpose we designed a peripheral circuit that can be connected to any TTL compatible microcontroller. By means of this circuit the microcontroller can drive up to 2 motors in both directions (the main motors are connected in a parallel way) and change the skew of the main motors carrier.

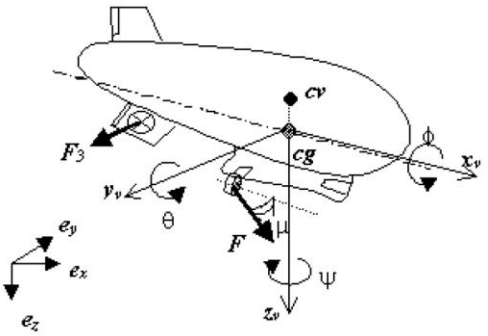

Fig. 1. Geometric description of an airship (Bestaui, 2005)

3. DESCRIPTION OF THE CIRCUIT

The circuit was first built as an external module to be proved for its reliability prior being integrated to a complex airship driving unit.

In the Fig. 2 we can see a block diagram of motors driving unit published previously by Pospisilik & Adamek. Because in a trial operation the airship tended forward to be unstable in a horizontal plane (the mass forces made it rotate around the z-axis according to Fig. 1), it was decided to provide the hardware unit with an autonomous correction algorithm that gathers data from analog accelerometers that can provide coarse information about the tail rotation. Moreover the unit can accept data from other external unit or it can be driven by several buttons mounted on the PCB of the unit.

In the Fig. 3 there is a schematics diagram of the circuit. The heart of the circuit is a microcontroller IC101. It is a Freescale type with Motorola HC08 core, MC9RS08KA8. The motors are driven by a dual full-bridge driver IC102, L298 that is connected to the microcontroller via a parallel bus. A set of logical gates IC1 ensures free-running of the motors. The power driver distinguishes between free-running and retardative mode. The free-running mode is preferred in order we could control the power of the motors by a PWM modulation. Moreover, some external devices are used to ensure current limiting. The current flowing through motors must flow through resistors R107 and R113. As soon as the voltage drop exceeds a threshold voltage of transistors T101 to T104 (depending on the channel and the polatiry of the current), the proper transistor is opened connecting the ENABLE inputs to the ground. By the value of R107 and R113 the current limit has been set to 1 A for both channels. This current is sufficient for driving the tail motor, for the main motors it should be increased slightly because they are working in a parallel way.

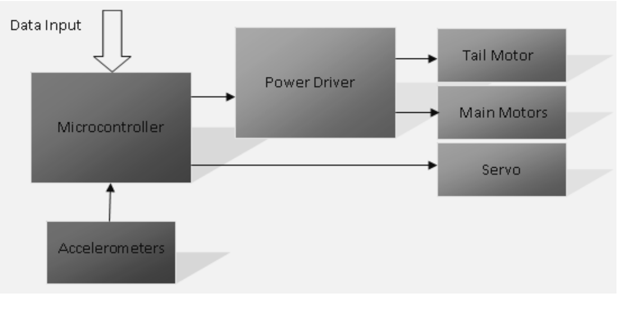

Fig. 2. Block diagram of motors driving unit (Pospisilik & Adamek 2010)

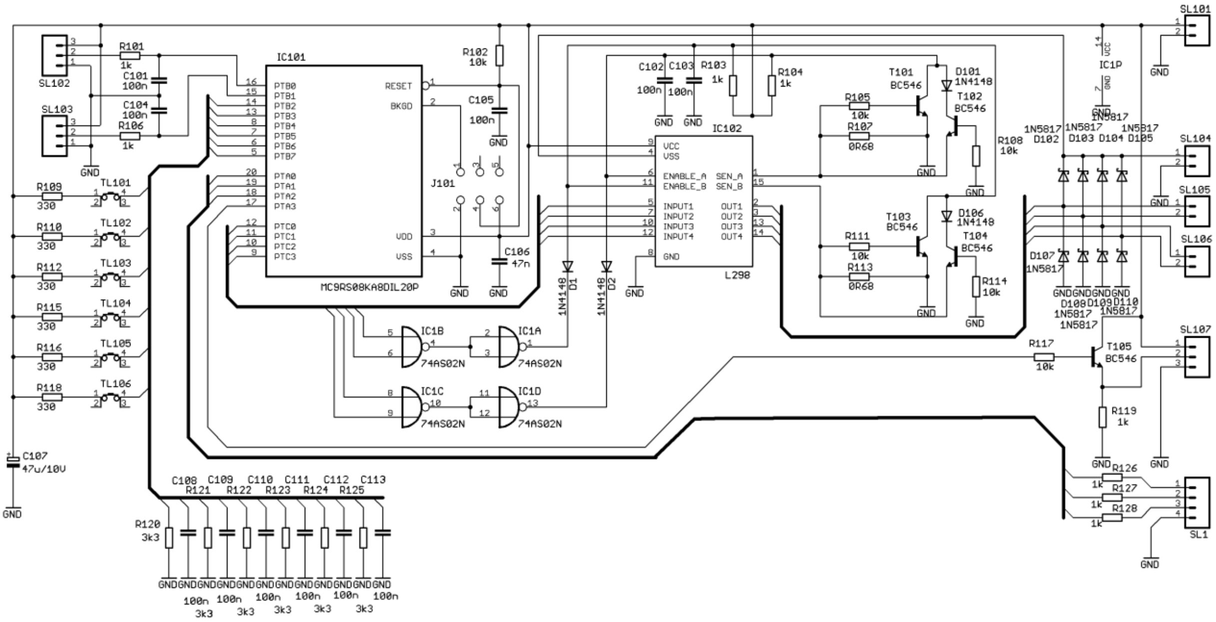

Fig. 3. Circuit diagram of the unit

The current flowing through the motor is determined by many factors, mostly by the propeller effectivity.

The propeller effectivity is dependent on the flight velocity and many other factors, which leads to inaccurate results when trying to evaluate it theoretically. Once the otput current is exceeded, the driver goes to the free-running mode. The time delay is set by capacitors C102 and C103 so when the motors are short-circuited or overloaded, it stays oscillating and the output current is not exceeded.

The 5 V power supply is connected to SV1 clamps while the power for the motors is delivered directly from the supply accumulator via clamps SL104. The main motors are connected to SL105 and the tail motor is connected to SL106. SL107 clamps serve to connect a servo that can skew the main motors carrier. It is an ordinary modeller servo needing a power supply and time pulses of the defined length. The length of the pulses defines the angle of the skew. The pulses are generated by a program loop in a microcontroller every 20 ms, according to Novak, 2007. The clamps SL102 and SL103 are provided with simple low-pass filters and can be used to connect analog accelerometers. Moreover, the program running in the microcontroller can distinguish commands from a manual input that is modelled by 6 buttons TL101 – TL106. An external unit can be connected to SL1 clamps to settle up a serial data communication for transferring the commands.

4. RESULTS

The motors driving unit has been proved with motors of the airship for autonomous monitoring system (Pospisilik & Adamek, 2009). The performance of the circuit was satisfactory. On this unit we also tried communication with ultrasonic detectors testing module (Pospisilik & Adamek, 2009) and a simple algorithm based on evaluating data from the ultrasonic detectors according to which the motors are driven in order the airship moved independently without any collisions with surrounding objects. Currently, this algorithm is based on threshold determination but it can be further expanded with other methods. Ideally, the algorithm should include corrections resulting from the motion model of the airship. This model is, according to Bestaoui, 2005, quite complex and is a subject of further research, employing data from accelerometer mounted around the bladder of the airship.

5. CONCLUSION

This module proved the acceptability of the dual full-bridge driver L298 for driving the motors of the autonomous airship according to the algorithm running in a microcontroller. In the project “Autonomous monitoring system” that has been introduced by Pospisilik & Adamek in 2009 we propose integration of several hardware units into one complex circuit that is driven by one microcontroller. The design must be done in consideration of the fact that the units held by the small airship must be small and lightweight. Most devices of the circuit can be substituted with their small SMD equivalents and the circuitry can be integrated on a PCB of the final autonomous airship driver solution.

The unit is suitable for debugging airship controlling algorithms.

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6. ACKNOWLEDGEMENT

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