

P14418

Failed Linear Regulator Test Summary

What was being tested: The initial design to regulate voltage for the BWM generation unit called for a linear regulator to be used. The linear regulator chosen was the LM7815 which is made by several different companies. The regulator provides a constant 15V output when the input voltage is above 15V. The test entailed running the regulators with an open circuit load. Then, if that test was a success the regulator was used to power the pump and bulb unit directly. This second test requires the regulator to pass almost 2A of current.

Initial design for high current (this was not tested):

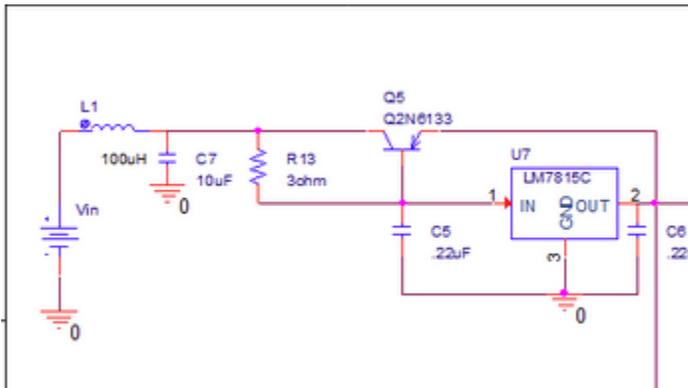


Figure 1: Initial design for the LM7815 that is configured to pass high currents.

Seen in figure 1 is the original intended design. This is a high current design since the LM7815 chip by itself is only rated for 1A max. The Q2N6133 power BJT and R13 provide a parallel path for current to flow that takes some load off of the LM7815 and allows current of greater than 1A to pass while the voltage is still being regulated at 15V. This design was not tested because it was overlooked that R13 needs to be a 3Ω power resistor. Power resistors are large and expensive. Also, the above design adds inefficiency. This makes the circuit in figure 1 not a viable alternative to the existing regulation circuit already used in the BWM.

Alternative design (this is what was tested):

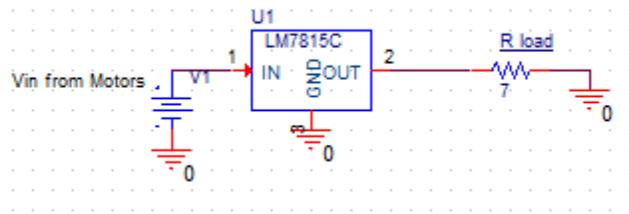


Figure 2: LM7815 being tested with no supporting circuitry to help pass current.

Figure 2 shows the circuit that was tested. This circuit was not to be expected to pass the required current for extended periods of time. But, since the BWM is used in short periods, the idea was that running this regulator by itself may be sufficient for that type of usage. As you can see in figure 2 there is no supporting circuitry for the LM7815 that helps it pass more current.

Result:

Circuit shown in figure 1: As stated above the circuit in figure 1 was never built or tested.

Circuit shown in figure 2 open circuit test results: The circuit in figure 2 was constructed on a breadboard. The first test was an open circuit test. In this test the regulator was required to pass 0A of current, the test only determines that the chip can successfully regulate the voltage under no load. The test was a success; the voltage was regulated to ~15V and a max of 24V input was tested.

Test with load: The circuit in figure 2 was then directly hooked up to the pump and bulb unit and the input voltage was provided from a power supply. The test required the regulator to pass almost 2A of current. The test was a failure. The chip could not successfully regulate the voltage once the current draw reached 1.4A.

Conclusion: There is no feasible 15V linear regulator that can be used for this project. Linear regulators are inefficient and at high currents there is simply too much wasted power that gets converted to heat and causes the chip to fail. The high current design shown in figure 1 is also not feasible because of cost, power loss, and size concerns. Considering that there is already a working regulator circuit in the current BWM there is no need to build such a circuit as shown in figure 1.

Future plans: A switching regulator will be built in the coming weeks using the LM2576T-15G chip. This chip is rated to cap the voltage at 15V and can pass 3A. This chip also is rated for 88% efficiency per the data sheet. Once the circuit is constructed on breadboard, it will be tested the same way as above.