Design of a Low Cost, 45W Flasher with Short Circuit Protection Using LM2902 (Quad Op-Amp) and CSD18534

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ABSTRACT

This Application note presents the design of a low cost, flasher circuit with short circuit protection. The design incorporates the entire recommended design feature set for two wheeler flashers and includes - low/high voltage operation, half load frequency doubling, and short circuit protection.

A circuit simulation and reference schematic are also provided.

Topic **Page**

1 Introduction

Automobiles utilize flashers for turn indications. Traditionally such control has been through electromechanical devices. However, the same functionality can be implemented using electronics at a fraction of the cost.

This design proposes such a scheme, which can be used for a load of 45 W.

2 Flasher Specifications

Table 1. Specifications

Sl. No.	SPECIFICATIONS	
1	Operating Voltage	9 V to 16 V
2	Flash Rate	85 c/m ± 10 c/m at 12.8 V
3	On time Duty Ratio	35% to 60% at 12.8 V
4	Starting Time	<1 sec.
5	Indication of single Bulb Failure	Flashing Frequency Doubles at 21 W (single bulb load)

3 Design Using LM2902 (Quad Op-Amp) and CSD18534

Figure 1 shows the schematic for the flasher design.

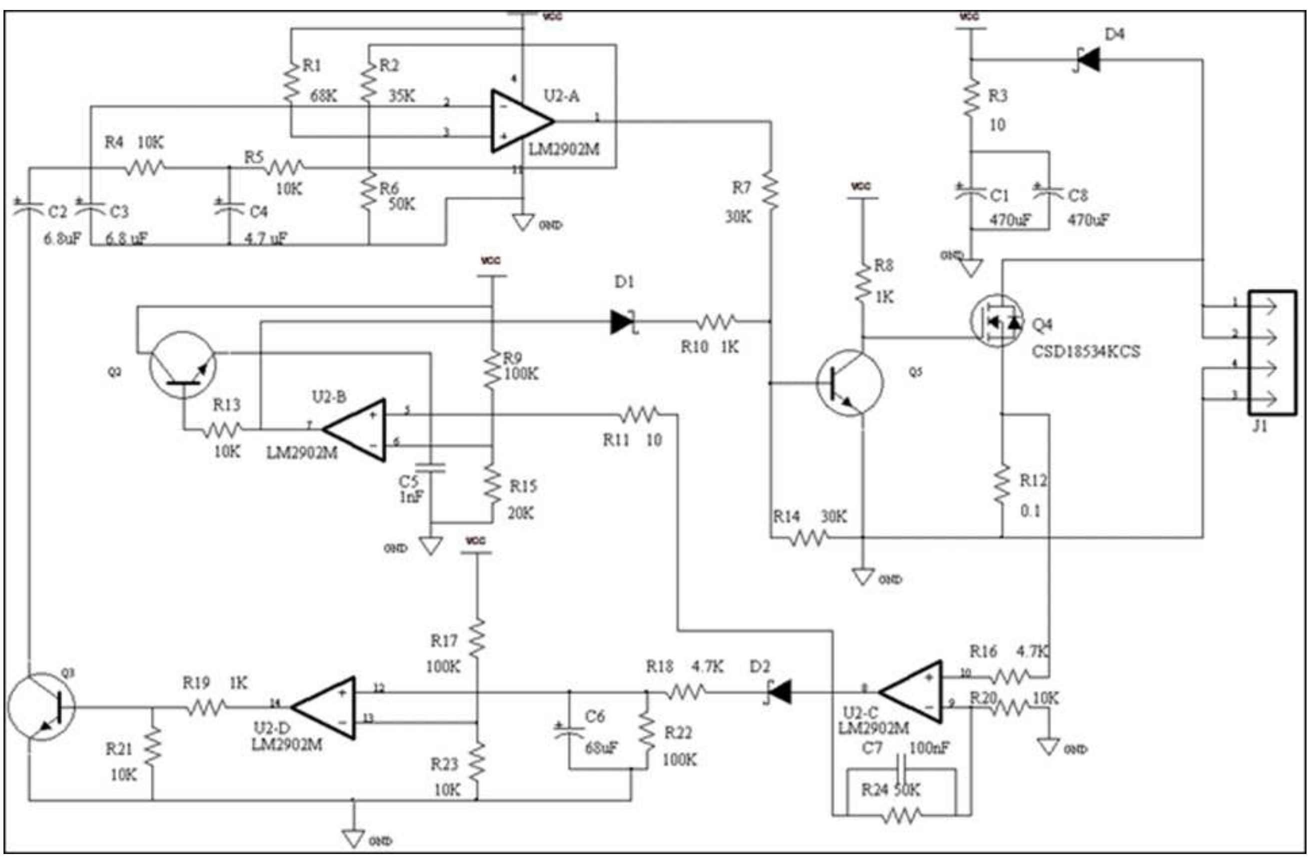


Figure 1. Flasher Schematic

4 Operation

The design of the flasher can be divided into three main segments:

4.1 Ocillator

The Op-amp U2-A acts as an oscillator triggering transistor Q5. This in turn triggers MOSFET Q4. The frequency of oscillation is set to about 85 c/m as required by the specifications.

4.2 Frequency Doubling Circuit

The Op-amps U2-C (Current Sensing Amplifier) and U2-D (Comparator) form a frequency doubling circuit.

U2-C senses the load current across resistor R12, and amplifies it by a factor of 6.

U2-D then compares this amplified voltage with a threshold set by resistors R17 and R23.

4.2.1 Full Load Operation

As long as the amplified sensed voltage is higher than the threshold level, output of the comparator is driven high which keeps the transistor Q3 turned on. This transistor, when turned on, brings the capacitor C2 into action by connecting it to ground.

Thus the effective capacitance seen by the U2-A oscillator is approximately a parallel combination of C2 and C3. It is for this combination that the oscillation frequency is set to 85c/m.

4.2.2 Half Load Operation

When the load is halved (failure of one of the bulbs), the sensed and amplified voltage provided by U2-C falls below the threshold set for U2-D. The output of U2-D comparator goes low thereby turning off the transistor Q3. This disconnects capacitor C2.

Now, the U2-A oscillator sees only C3 which is approximately half of the parallel combination of C2 and C3. This results in doubling of the oscillation frequency.

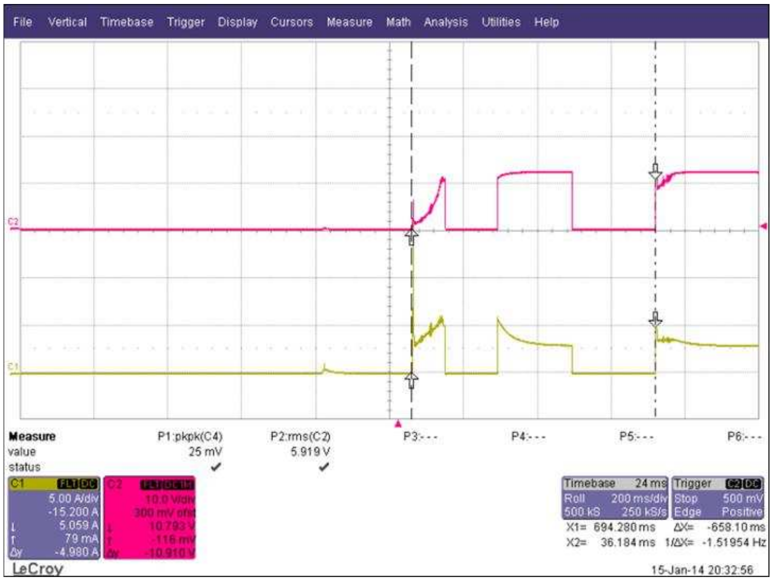
4.3 Short Circuit Protection

The U2-B is another comparator which is used for implementing short circuit protection.

When the output of U2-C exceeds the threshold set by R9 and R15, the output of U2-B goes high. The transistor Q2 latches this high output. The diode D1 provides a unidirectional path for this high output to latch Q6 which in turn latches off MOSFET Q4. This latching action is reversed only by resetting the circuit (disconnecting V_{CC}).

Capacitor C5 connected on the positive terminal of U2-B, introduces a delay in the triggering of U2-B. This is used to avoid false triggering due to high inrush current during cold start. Figure 2 shows the worst case cold start condition with 12.8V battery voltage. The circuit starts up within 1 second and avoids false detection of the initial current spike as a short circuit. The capacitor C5 takes care of the same.

The start up time is measured to be 658 ms.



Startup time: 658 ms

Figure 2. Worst Case Cold Start Condition

The design is first simulated in TINA software to fine tune the oscillator, frequency doubler and short circuit protection components. Figure 3. shows a simulation of the same using LM324 as the quad op-amp.

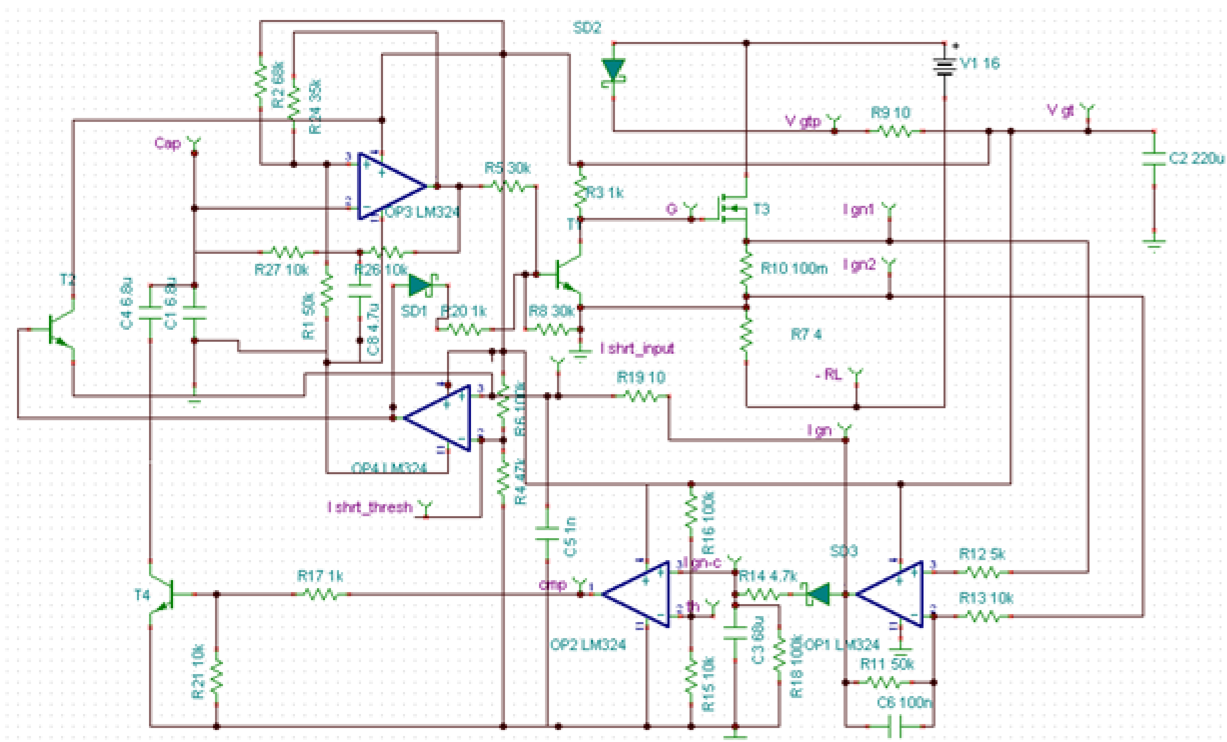


Figure 3. Circuit Simulation in TINA

5 Test Results

Test results for the circuit are divided into two categories: Operating Voltage and Short Circuit Test.

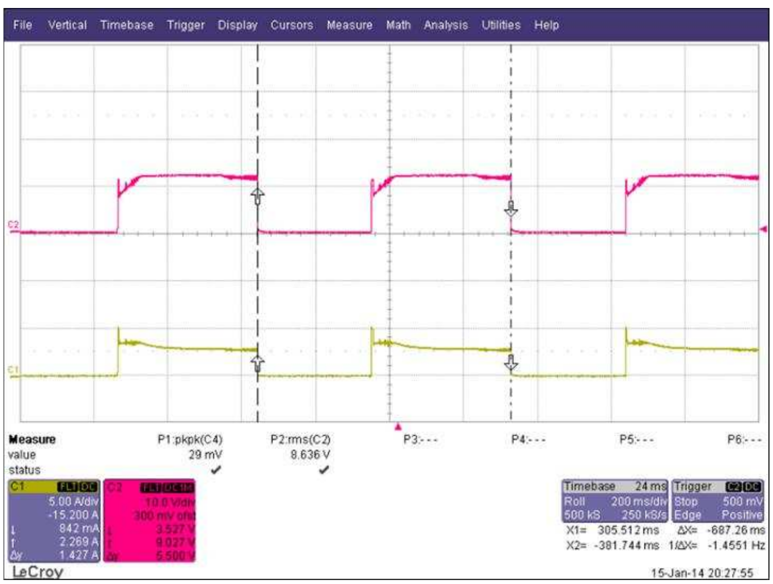
5.1 Operating Voltage

Operating Voltage	Load
12.8 V	21 W
12.8 V	45 W
9 V	21 W
9 V	45 W
16 V	21 W
16 V	45 W

5.2 Short Circuit Test

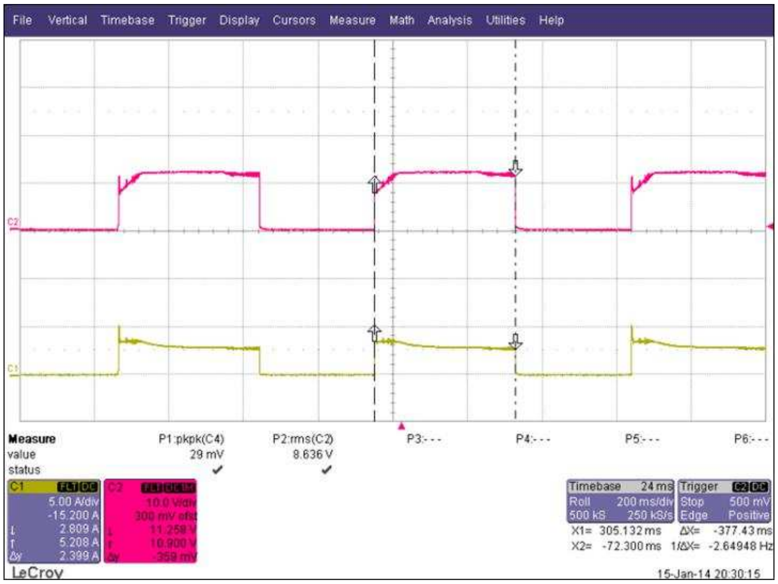
Figure 12 shows the waveform of load current in the event of a short circuit.

Note: In all the measured waveforms that follow, Ch1 (Yellow) is the load current and Ch2 (Pink) is the voltage across the load.



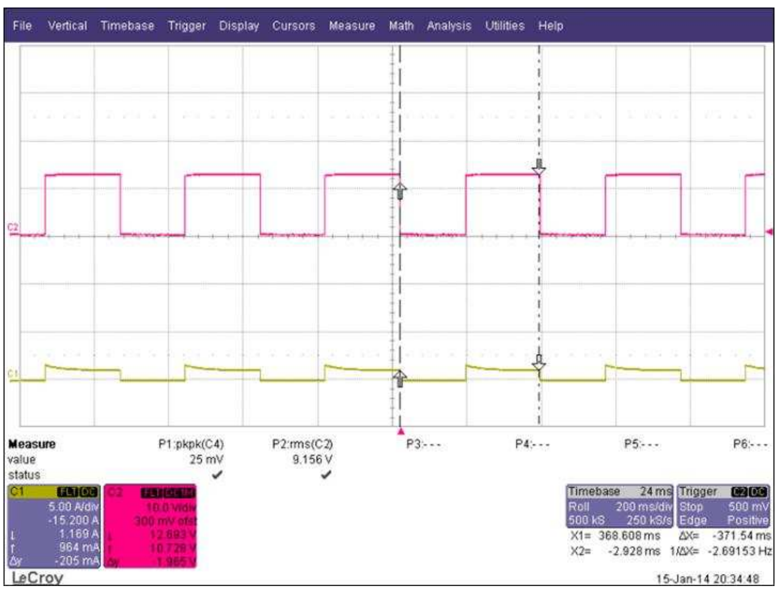
V_{IN} = 12.8 V Load = 45 W Time Period = 687 ms Frequency = 87 Cyles/min

Figure 4.



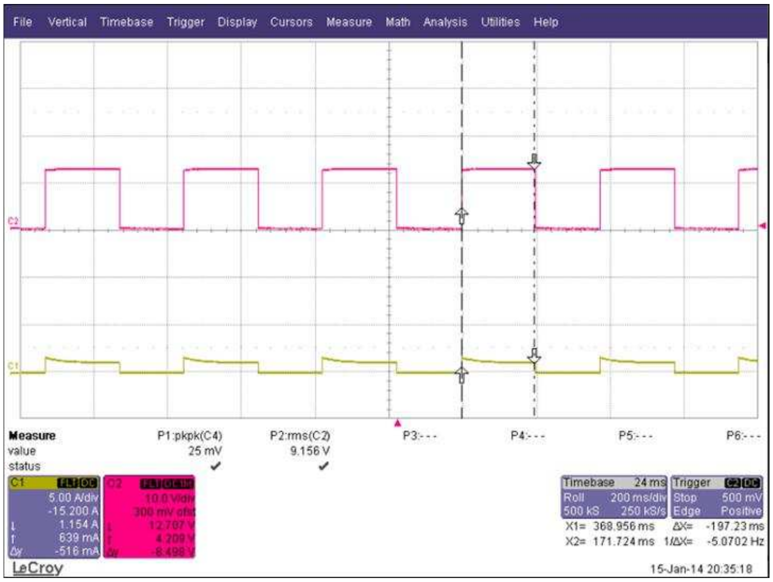
V_{IN} = 12.8 V Load = 45 W On Time = 377 ms Duty Cycle = 55%

Figure 5.



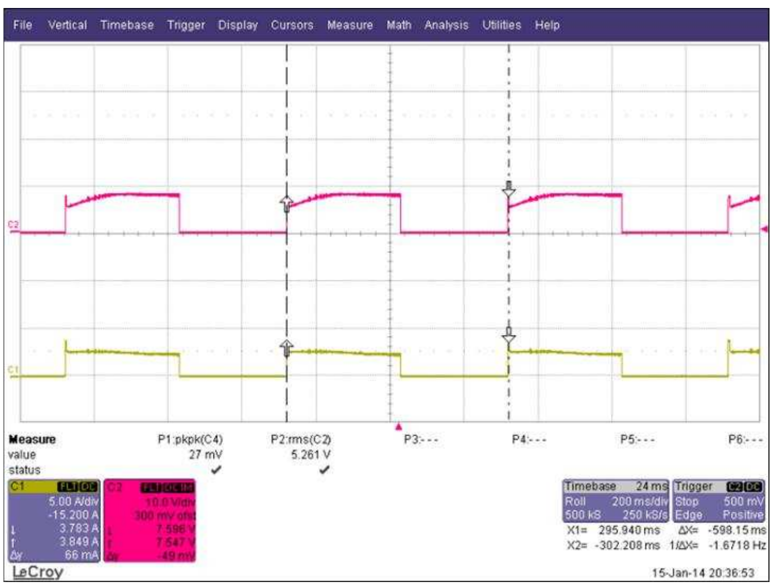
V_{IN} = 12.8 V Load = 21 W Time Period = 371 ms Frequency = 162 Cyles/min

Figure 6.



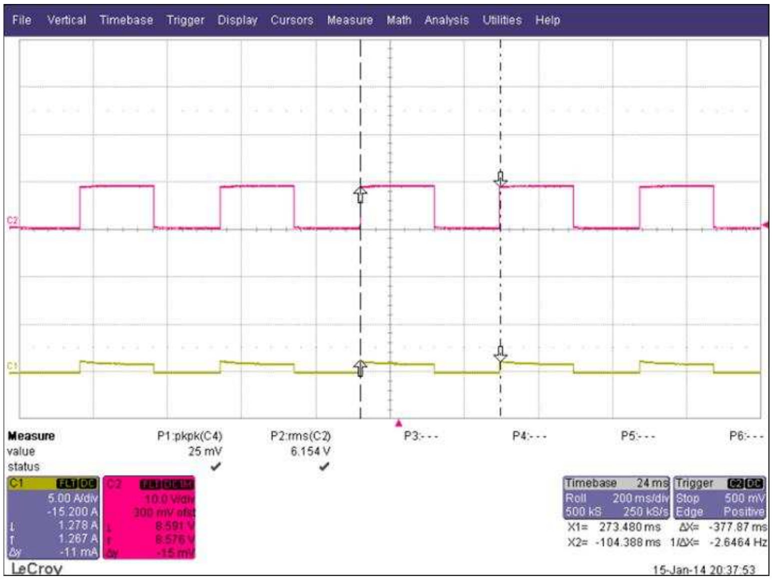
V_{IN} = 12.8 V Load = 21 W On Time = 197 ms Duty Cycle = 53%

Figure 7.



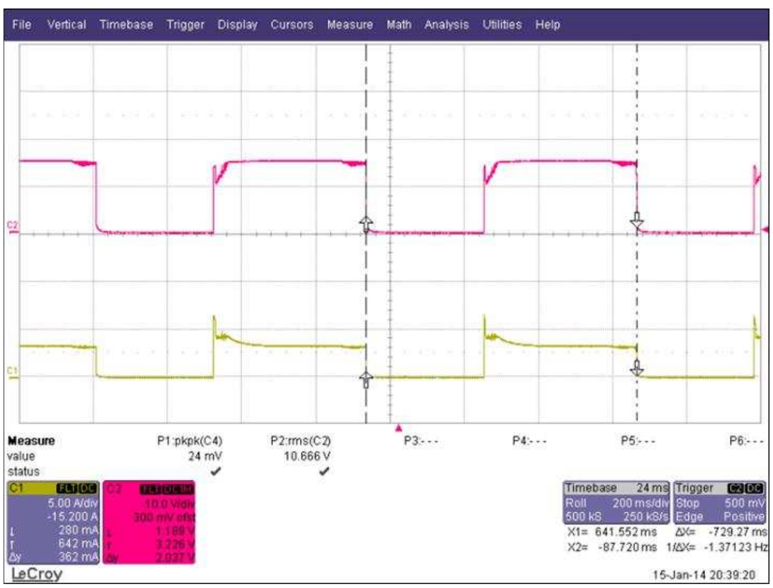
V_{IN} = 9 V Load = 45 W

Figure 8.



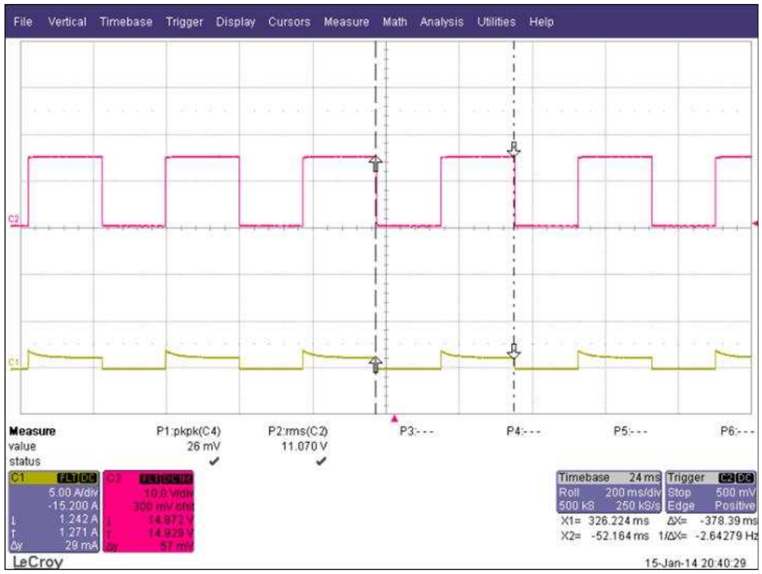
V_{IN} = 9 V Load = 21 W

Figure 9.



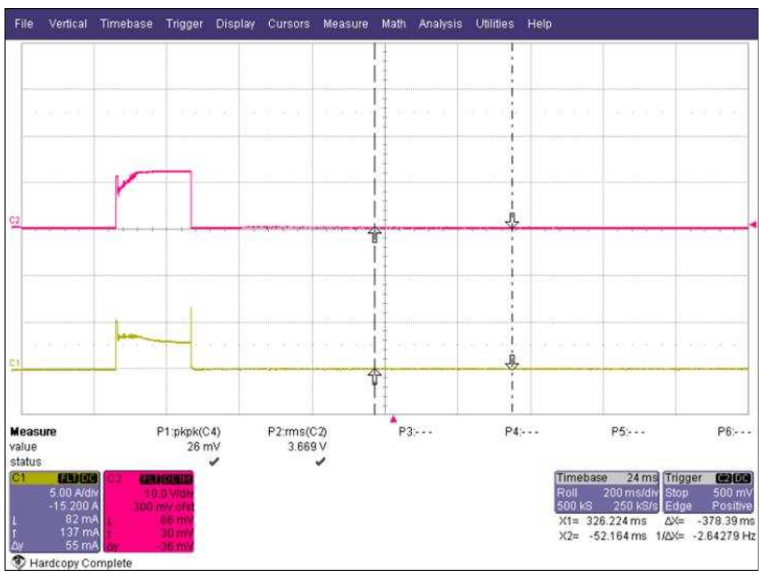
V_{IN} = 16 V Load = 45 W

Figure 10.



V_{IN} = 16 V Load = 21 W

Figure 11.



V_{IN} = 12.8 V Load = 45 W (Before Being Shorted)

Figure 12. Short Circuit Test

6 Conclusion

The design, simulation, and schematic of a low cost flasher have been presented. The design has been tested for all the required specifications which include short circuit protection, and bulb failure detection among others.

7 References

1. LM2902 datasheet: http://www.ti.com/product/lm2902
2. CSD18534 datasheet: http://www.ti.com/product/csd18534kcs