Internal Circuit Analysis OF LM7809 Voltage Regulator

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Contents

***Abstract*—This manual provides the IC analysis for the LM7809 voltage regulator.**

1 Equivalent Circuit of LM7809

1.1 abcd

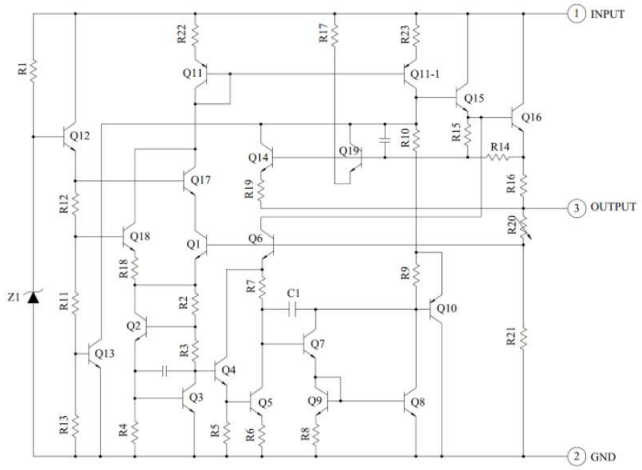

Fig. 1.1: LM7809 Regulator

2 Components of the regulator:

2.1 Analyse and Divide the circuit based on it's functionality
Solution: The internal circuit predominantly consists of 1 zener diode, 1 cap,19 transistors and 23 resistors

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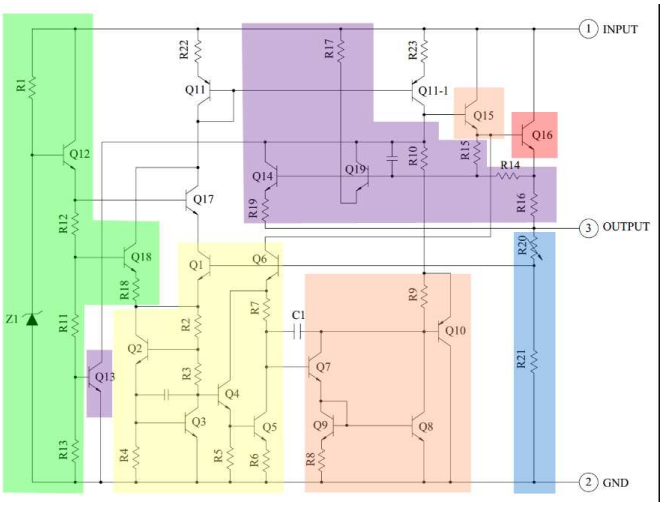

Fig. 2.1: LM7809 Regulator

2.2 State the function of each colour coded circuit in Fig 2.1
Solution: Based on the functionality, the internal circuit is divided into 6 parts namely:
1. Band gap Reference
2. Startup
3. Protection
4. Error Amplifier
5. Voltage Divider
6. Output

3 Band gap Reference

3.1 The circuit coded by yellow colour perdorms band gap reference operations

3.2 What is the input of Band gap reference part of the circuit?
Solution: The circuit takes scaled output voltage as input at Q1 and Q6 transistor.

3.3 What is the output of the circuit?
Solution: It provides an error signal as output and sends it to Q7 as an error signal indicating if the voltage is too high or too low.

3.4 What is the importance of the circuit?
Solution: It stabilises the output voltage and

provides a stable and accurate reference, even as the chip's temperature changes.

4 Startup

4.1 The circuit coded by green colour denotes the part of circuit that provides Startup to the circuit

4.2 Band gap circuits usually have two stable voltages - the desired voltage and 0 volts.

4.3 To keep the band gap from getting stuck at 0 volts, a startup circuit will "push" the band gap away from 0 volts so it will settle at the desired voltage.

5 Protection

5.1 The circuit coded by purple colour denotes the part of circuit that provides protection to the circuit

5.2 Which transistors in the circuit provide protection?
Solution: (Q13) - Protection against Overheating
(Q19) - Protection against excessive input voltage
(Q14) - Protection against excessive output current

5.3 How does the circuit ensure Protection?
Solution: If there is a fault, these circuits reduce the output current or shut down the regulator, protecting it from damage.

6 Error amplifier

6.1 The circuit coded by pink colour

6.2 The error signal from the band gap reference is amplified by the error amplifier.

6.3 Why do we need to amplify the error signal?
Solution: The error signal needs to be amplified so it can control the output voltage through the Q15 transistor

7 Voltage Divider

7.1 Denoted by blue color code

7.2 The voltage divider scales down the voltage on the output pin for use by the band gap reference

7.3 For any general LM78XX regulator, a simple change to the position of the variable contact increases the resistance of R20 and thus the output voltage of the chip.

8 Output

8.1 Q16 controls the current between the input and output, and thus controls the output voltage.