BMS

Objective: To design a voltage measuring module which ca be used for the implementation of BMS(Battery Management System).

List of components used :

Name/Type of Component	Value
ICL7107	1
LM555D	1
7805	1
1N4148	2
Pin Header	2
Potentiometer	1
1K ohm	5
22K ohm	1
47K ohm	1
100K ohm	1
120K ohm	1
1M ohm	1
1G ohm	1
100pF	1

1nF	1
0.1uF	3
220nF	1
47nF	1
0.01uF	1

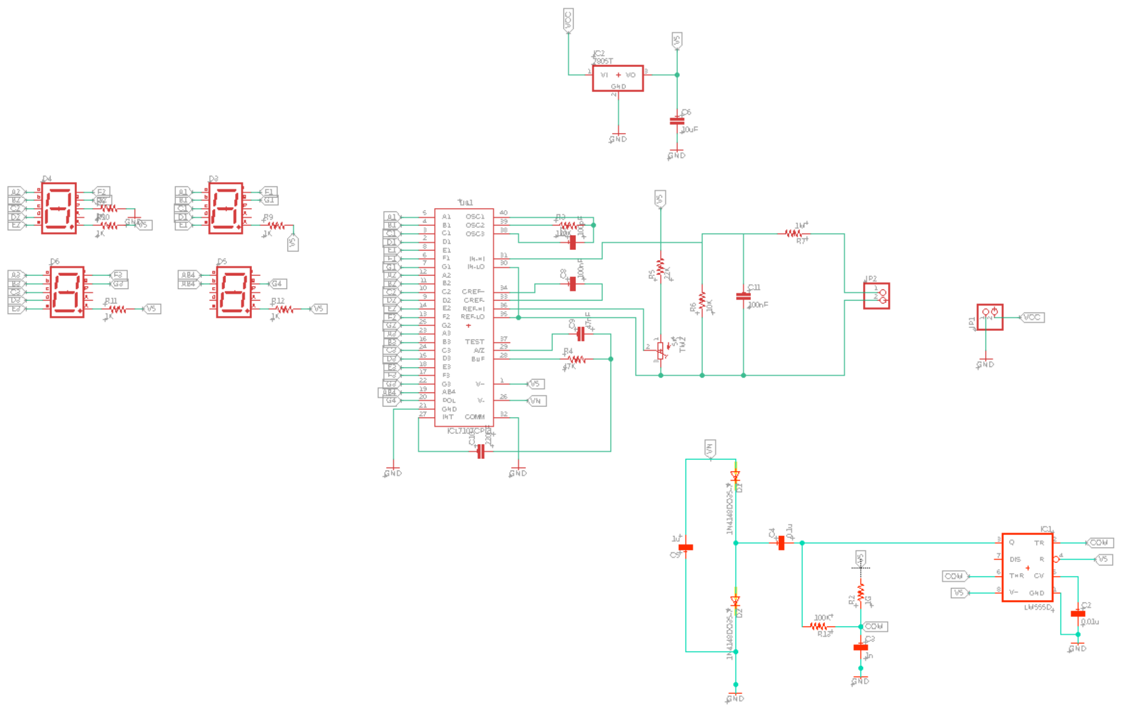
What is BMS?

A Battery Management System (BMS) is an electronic system that monitors and controls rechargeable batteries. It is most commonly found in applications where multiple battery cells are linked together to form a battery pack, such as electric vehicles (EVs), renewable energy storage systems, and portable electronics.

The BMS performs several critical functions to ensure the battery pack's safe and efficient operation. For starters, it keeps track of the voltage, current, and temperature of each individual battery cell in the pack. This data enables the BMS to monitor the battery's state of charge (SOC) and state of health (SOH), which is critical for determining its overall performance and remaining capacity.

Voltage is a basic parameter that reflects the amount of energy stored in a battery cell. The BMS can balance the cells in the pack by monitoring the voltage of each individual cell. Different cells may have slightly different voltages due to manufacturing tolerances and variations. This imbalance can worsen over time and cause uneven charging or discharging, reducing the overall capacity and lifespan of the battery pack.

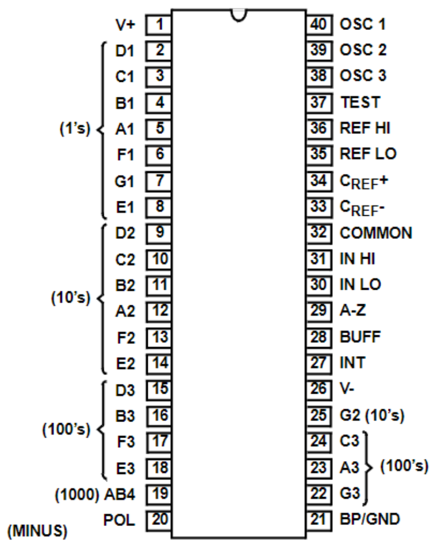
<u>Function of the Circuit created</u> :



The circuit which has been designed here is solely focused on the voltage reading function with a precision of 0.1 V and a range of 0.0V to **19.9 V**. This circuit can work as a separate module which can be used to realize the entire BMS or it also can be used independently by itself simply for measuring voltage.

The purpose of having such a separate module with specific function is to make debugging the circuit easier. Since, if the entire BMS is modular like this then by the nature of any specific problem itself we can locate the site of origin of that problem easily.

ICL7107 :



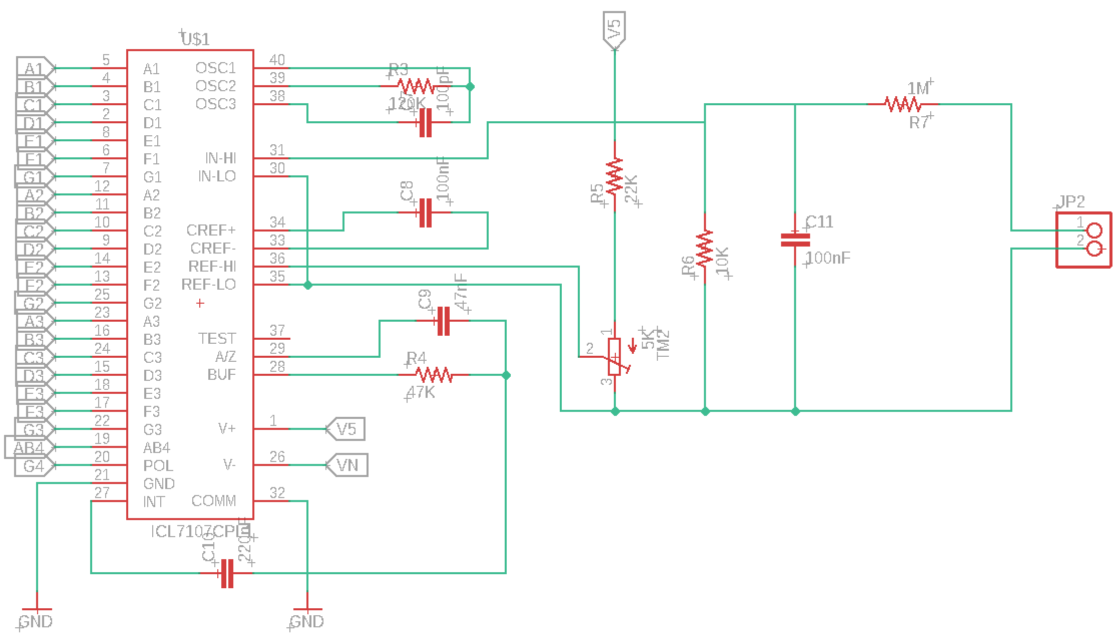
The ICL7107 is a highly versatile integrated circuit that is the foundation of my digital voltmeter circuit design. This IC enables me to measure analogue voltages accurately and display the corresponding digital readings on a 7-segment LED display. The ICL7107 has proven to be an excellent choice for achieving precise voltage measurements due to its numerous features and capabilities.

One of the key advantages of the ICL7107 is its high-resolution analog-to-digital conversion. With its 3.5-digit resolution, it can accurately convert analog voltages into a digital format, providing a measurement range from 0 to 1999 (including the sign bit for negative values). This level of precision ensures that I can obtain accurate voltage readings for a wide range of applications.

The ICL7107 also has a handy display driver circuitry. With this built-in driver circuit, I can easily connect and drive a 7-segment LED display directly from the IC. Using this feature, I can easily display digital voltage readings on the display, ensuring clear and concise visualization of the measurements.

<u>Circuit Design</u> :

- ***<u>ICL7107</u>***



- ICL7107 has an internal oscillator which behaves like clock signal, the frequency of this clock signal is decided by the RC network attached to OSC1,2 and 3 respectively. From the datasheet of IC itself, this frequency is given as **0.45/(R*C)**.

- The voltage to be measured is applied between In-HI and In-Low using the voltage divider circuit. In our circuit, it is supplied by passing it through a voltage divider circuit. This is the most crucial step as it decides the range of measurement of the battery's voltage. To increase our range by a factor of 10 by increasing R5 by a factor of 10 i.e for R5 = 100K ohm. The output count against Vin holds the relationship of :

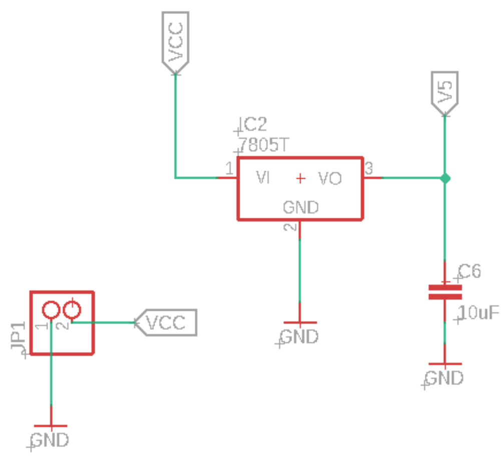
$$\text{COUNT} = 1000 \times \frac{V_{IN}}{V_{REF}}$$

- A reference capacitor of value 0.1uF as suggested by the datasheet is used. This reference capacitor in the ICL7107 is required to stabilize the reference voltage, filter out noise, maintain stability over time, and bypass internal resistance and parasitic capacitance, ensuring accurate and reliable analog-to-digital conversions.

- Providing a reference voltage to the ICL7107 is crucial as it serves as a known and stable voltage against which the input analog voltage is compared during the ADC conversion process. The reference voltage provided to the IC can be changed using the potentiometer given in the circuit.

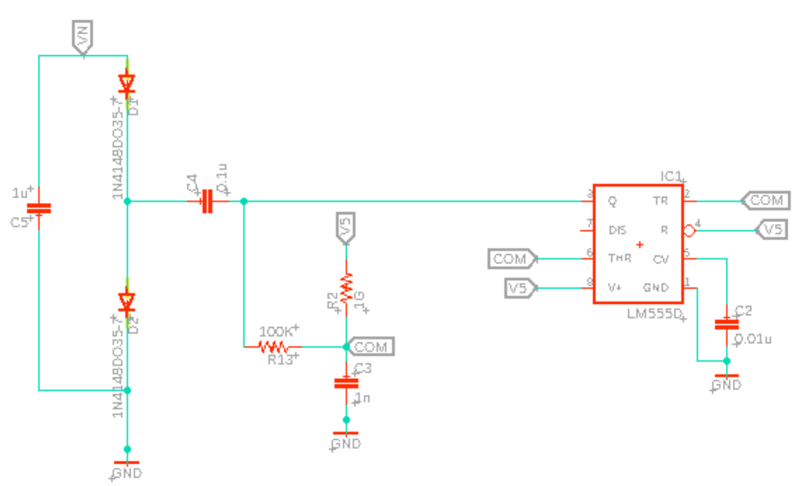
- The supply voltage for the IC is insured by using a voltage regulator for V+(+5 V is supplied) and using a 555 timer, whose own supply has been insured by the same voltage regulator, for V-(-5 V is supplied).

- ***Voltage Regulator***



The Vcc which will be provided by us is stabilized to +5V by the use of voltage regulator 7805. This reduces the risk of any fluctuations which cause any error in the circuit. The voltage regulator is set-up according to its datasheet.

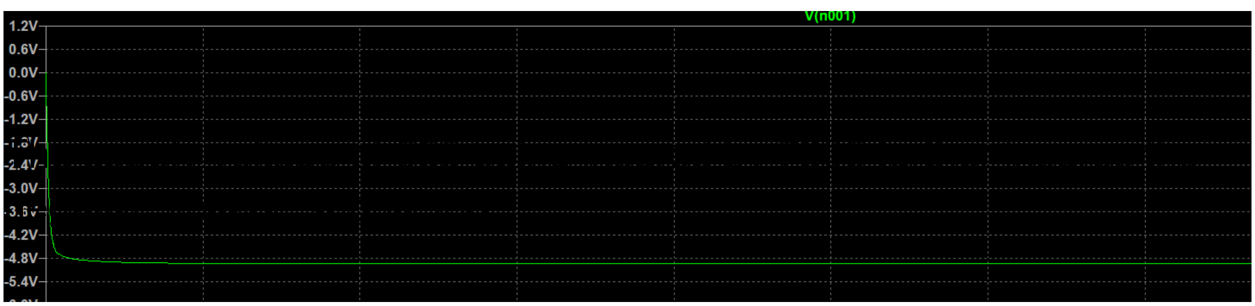
- ***Negative voltage generator***



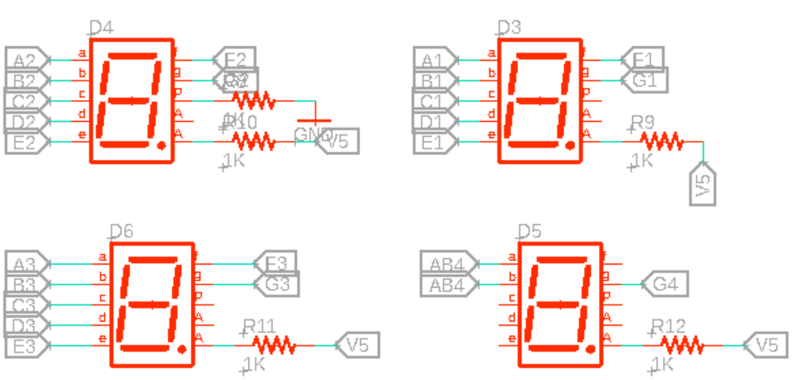
When there is a positive peak at output current flows through C4 ,D2 to the ground while charging up C4. During this time, D1 remains reverse-biased.

When the output falls down to 0 V, the current direction will change and now it will start flowing from C5 ➡ D1 ➡ C4 and forward. During this C3 discharges while C4 starts charging and hence building voltage across it.

The voltage across C4 will be negative with respect to ground.



- ***The Display***



The measured voltage is shown using 4 seven segment displays, which are driven by ICL7107. The display for units digit place has its P pulled down to ground using a 1K resistor, as the display has an accuracy of 0.1V. The 4 displays used are common-anode displays.

Challenges faced while designing :

The method of supplying negative voltage to the IC was an issue. Though it could be easily solved by using an external -DC supply voltage, that is not something which is always available. In working conditions, that is while practical use, negative DC supply is seldom present. Therefore the method of producing negative voltage using 555 proved a efficient way,