NEXT GENERATION ENERGY STORAGE APPLICATION USING SUPER CAPACITORS

Dr. P. Ravi babu
Professor
Department of Electrical & Electronics Engineering, Sreenidhi Institute of Science & Technology, Yamnampet, Ghatkesar, Medchal-Malkajgiri Dist., Telangana, India – 501301

A.L.V.Narasimha Rao
Students
Department of Electrical & Electronics Engineering, Sreenidhi Institute of Science & Technology, Yamnampet, Ghatkesar, Medchal-Malkajgiri Dist., Telangana, India – 501301

M.Chandrakanth
Students
Department of Electrical & Electronics Engineering, Sreenidhi Institute of Science & Technology, Yamnampet, Ghatkesar, Medchal-Malkajgiri Dist., Telangana, India – 501301

Sathvick Kumar Reddy
Students
Department of Electrical & Electronics Engineering, Sreenidhi Institute of Science & Technology, Yamnampet, Ghatkesar, Medchal-Malkajgiri Dist., Telangana, India – 501301

A.Nayan Sumanth
Students
Department of Electrical & Electronics Engineering, Sreenidhi Institute of Science & Technology, Yamnampet, Ghatkesar, Medchal-Malkajgiri Dist., Telangana, India – 501301

Abstract - The project deals about the ability of super capacitor to charge quickly and discharge slowly .The super capacitor is used to store the charge with its ability of quick charging this also shows how a super capacitor is different from normal capacitor in its construction and working. The super capacitor is used in connection with the battery and inverter to provide uninterrupted supply. This project also uses solar energy as a parallel source of dc supply for the charging of super capacitor in the absence on the normal 220V supply.

Keywords - Super Capacitors, Arduino Pro Mini, Relay, charge and discharge profiles of Super- Capacitors.

I. INTRODUCTION

The project utilizes an AC supply and Solar vitality. The circuit is planned so that at whatever point there is sun oriented vitality, the power is drawn from the sunlight based board, or else drawn from the principle supply. The vitality acquired is put away to a super capacitor through a hand-off. The Super capacitor has the fast charging ability which can charge in 1-10 seconds. The Super capacitor is utilized to charge the battery framework. The battery supply is encouraged to beat generator and thus to a MOSFET which is fit for producing ON/OFF beats of various frequencies. This is encouraged to venture up transformer to create a low voltage AC. This is sustained to a Step up transformer to produce a low voltage AC. This AC is sustained to electrical machine.

The Charging and Discharging cycles of Super capacitor are constrained by the microcontroller through a transfer. At whatever point the super capacitor is

completely charged, the hand-off turns OFF, the release happens by charging the battery associated with it. This improves the productivity of the battery charging unit just as improve the general power exchange by using the speedy charging and moderate releasing Super capacitors.

By using Super capacitors (otherwise called ultra capacitors) are DC vitality sources should be interfaced to the electric matrix with a static power conditioner, giving 60-Hz yield. A super capacitor gives control amid brief term intrusions and voltage hangs. By consolidating a super capacitor with a battery-based uninterruptible power supply framework, the life of the batteries can be broadened. The batteries give control just amid the more drawn out intrusions, lessening the cycling obligation on the battery. Little super capacitors are industrially accessible to expand battery life in electronic hardware, yet huge super capacitors are still being developed, however may before long become a suitable segment of the vitality stockpiling field. The most noteworthy favorable position super capacitors have over batteries is their capacity to be charged and released ceaselessly without corrupting like batteries do.

Super capacitors converged with batteries (half and half battery) will turn into the new super battery. Pretty much everything that is presently fueled by batteries will be improved by this greatly improved vitality supply. They can be made in most any size, from postage stamp to crossover vehicle battery pack. Their light weight and ease make them appealing for most convenient gadgets and telephones, just as air ship and vehicles. The new ones are adaptable and biodegradable and can be controlled by body liquids. (Since body liquids can go about as an electrolyte, the battery can be utilized for therapeutic gadgets and could be introduced into a patient completely charged yet get and feed dry organic liquids to enable it to re-power and release vitality. Utilization of inserted innovation makes this framework effective and solid. This undertaking utilizes 12V supply from the rectifier. 7805 three terminal voltage controller is utilized for voltage guideline as power supply for microcontroller. Extension type full wave rectifier is utilized to amend the air conditioner yield of optional of 230/12V advance down transformer.

Utilization of implanted innovation makes this framework effective and solid. Smaller scale controller (ATMEGA328) permits dynamic and quicker control. Arduino Pro scaled down is the core of the circuit as it controls every one of the capacities.

Table 1.Energy Storage Technologies

Technology	Power	Energy density	Back-up time	Response time	Efficiency	Lifetime(years)
Pumped hydro	100 MW – 2 GW	400 MWh – 20 GWh	hours	12 minutes	70 - 80 %	50
CAES	110 MW – 290 MW	1.16 GWh - 3 GWh	hours	12 minutes	90 %	< 50
BESS	100 W – 100 MW	1 kWh - 200 MWh	hours	seconds	60 - 80 %	< 10
Flywheels	5 kW – 90 MW	5 kWh - 200 kWh	minutes	12 minutes	80 - 85 %	20
SMES	170 kW – 100 MW	110 Wh - 27 kWh	seconds	milliseconds	95%	30
Supercapacitors	< 1 MW	1 Wh- 1kWh	seconds	milliseconds	>95%	>10

Table.1 gives the data about various energy storage technologies available and compares their performance regarding Power Capacity, Energy density, Back up time, Response time, Efficiency & lifetime (years).Of all these technologies, Super Capacitors have majority of the qualities and there easy access is quite helpful in recent developments of Electrical and Electronics Engineering.

II. CIRCUIT DIAGRAM AND WORKING

In this Project, we are utilizing rectifier circuit to give control supply to the circuit, the sunlight based board goes about as a backup power supply. The super capacitor is associated crosswise over battery terminals. The inverter circuit changes over DC supply from battery to AC for providing to the heap.

The smaller scale controller utilized is ATMEGA328P on Arduino Pro little advancement board which is a High exhibition Low power CMOS 8-bit microcontroller.

8 bit microcontroller implies CPU or ALU can process 8-bit information at once, i.e., it needs to take 8 bit information from memory. In this way every area in memory is 8-bit and information transport is likewise 8 bit. Registers in RAM must be 32Kbytes of In-System Flash program memory. Our program is singed into blaze memory. It is having a 6-channel PWM (beat width balance) channel. A Relay is associated with the microcontroller whose yield switches the super capacitor supply ON/OFF.

The Super Capacitor is associated in parallel with the batter, this improves the elements of the battery and builds its pinnacle control abilities. The Super capacitor-based capacity supports a cycle life of 1 million cycles, instead of battery cycle life of 4000 to 5000 cycles. The expense of the super capacitor bases stockpiling is marginally higher than the expense of lithium particle on a for each kWh premise. Kilowatt labs is additionally offering vitality server which is a power electronic stage – equipment that has programming incorporated with it.
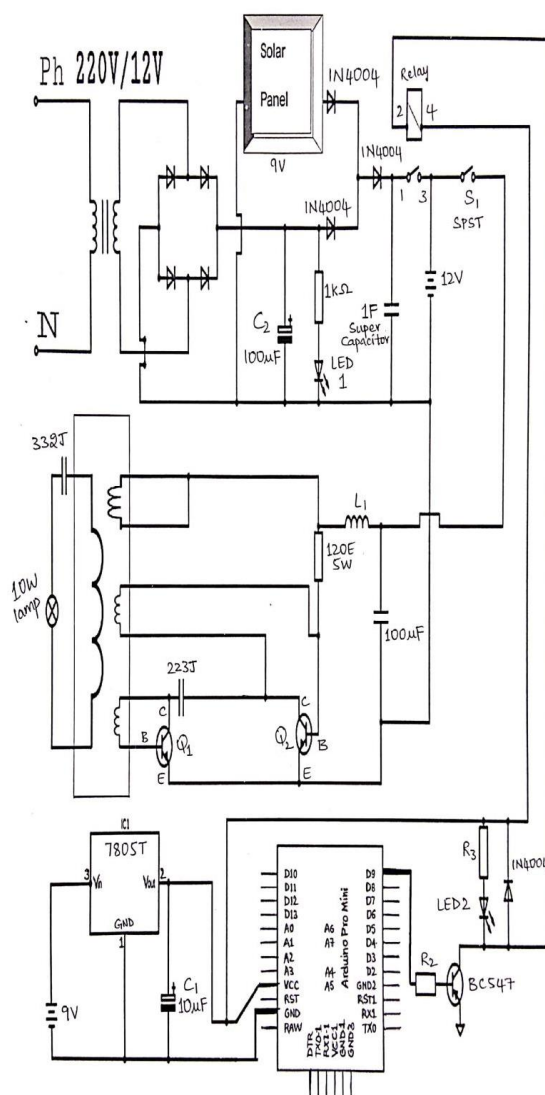

Fig.1 Circuit diagram of the project

III. MAJOR COMPONENTS

Super Capacitors: The super capacitor, otherwise called ultra capacitor or twofold layer capacitor, varies from a customary capacitor in that it has an exceptionally high capacitance. A capacitor stores vitality by methods for a static charge rather than an electrochemical response. Applying a voltage differential on the positive and negative plates charges the capacitor. This is like the development of electrical charge

when strolling on a rug. Contacting an item discharges the vitality through the finger.

We bunch capacitors into three family types and the most fundamental is the electrostatic capacitor, with a dry separator. This capacitor has an extremely low capacitance and is utilized to channel flags and tune radio frequencies. The size extents from a couple pico-farad (pf) to low microfarad (uF). The following part is the electrolytic capacitor, which is utilized for power sifting, buffering and coupling. Evaluated in microfarads (uF), this capacitor has a few thousand times the capacity limit of the electrostatic capacitor and utilizations a damp separator. The third kind is the super capacitor, appraised in farads, which is again a large number of times higher than the electrolytic capacitor. The super capacitor is perfect for vitality stockpiling that experiences visit charge and release cycles at high present and brief length.

Farad is a unit of capacitance named after the English physicist Michael Faraday. One farad stores one coulomb of electrical charge while applying one volt. One microfarad is one million times littler than a farad, and one pico-farad is again one million times littler than the microfarad.

Specialists at General Electric previously tried different things with the electric twofold layer capacitor, which prompted the improvement of an early sort of super capacitor in 1957. There were no known business applications at that point. In 1966, Standard Oil rediscovered the impact of the twofold layer capacitor coincidentally while chipping away at trial energy unit structures. The organization did not popularize the creation but rather authorized it to NEC, which in 1978 promoted the innovation as "super capacitor" for PC memory reinforcement. It

was not until the 1990s that progresses in materials and assembling techniques prompted improved execution and lower cost.

The cutting edge super capacitor isn't a battery fundamentally yet crosses the limit into battery innovation by utilizing exceptional cathodes and electrolyte. A few kinds of cathodes have been attempted and we center around the twofold layer capacitor (DLC) idea. It is carbon-based, has a natural electrolyte that is anything but difficult to produce and is the most widely recognized framework being used today.

All capacitors have voltage limits. While the electrostatic capacitor can be made to withstand high volts, the super capacitor is kept to 2.5– 2.7V. Voltages of 2.8V and higher are conceivable however they would diminish the administration life. To accomplish higher voltages, a few super capacitors are associated in arrangement. This has hindrances. Sequential association decreases the absolute capacitance, and strings of multiple capacitors require voltage adjusting to keep any phone from going into over-voltage. This is like the assurance circuit in lithium-particle batteries.

The particular vitality of the Super capacitor is low and ranges from 1 to 30Wh/kg. Albeit high contrasted with a standard capacitor, 30Wh/kg is one-fifth that of a buyer Li-particle battery. The release bend is another hindrance. Though the electrochemical battery conveys an unfaltering voltage in the usable power band, the voltage of the super capacitor diminishes on a straight scale from full to zero voltage. This diminishes the usable power range and a significant part of the put

away vitality is deserted. Think about the accompanying model.

Take a 6V control source that is permitted to release to 4.5V before the gear cuts off. With the direct release, the super capacitor achieves this voltage edge inside the main quarter of the cycle and the staying seventy five percent of the vitality save become unusable. A DC-to-DC converter could use a portion of the lingering vitality, however this would add to the expense and acquaint a 10 with 15 percent vitality misfortune. A battery with a level release bend, then again, would convey 90 to 95 percent of its vitality hold before achieving the voltage limit. Table 1 contrasts the Super capacitor and an ordinary Li-particle.

As opposed to working as an independent vitality stockpiling gadget, Super capacitors function admirably as low-upkeep memory reinforcement to connect short power intrusions. Super capacitors have likewise made basic advances into electric power trains. The excellence of ultra-quick charging and conveyance of high current on interest makes the Super capacitor a perfect competitor as a pinnacle load enhancer for mixture vehicles, just as energy unit applications.

The charge time of a Super capacitor is around 10 seconds. The charge trademark is like an electrochemical battery and the charge current is, to a huge degree, restricted by the charger. The underlying charge can be made exceptionally quick, and the garnish charge will take additional time. Arrangement must be made to restrain the underlying current inrush while charging a vacant Super capacitor. The Super capacitor can't go into cheat and does not require full-charge identification; the current just quits streaming when the capacitor is full.

The Super capacitor can be charged and released for all intents and purposes a boundless number of times. In contrast to the electrochemical battery, which has a characterized cycle life, there is little mileage by cycling a Super capacitor. Nor ages influence the gadget, as it would a battery. Under ordinary conditions, a super capacitor blurs from the first 100 percent ability to 80 percent in 10 years. Applying higher voltages than determined abbreviates the life. The Super capacitor works well at hot and cold temperatures.

Oneself release of a Super capacitor is generously higher than that of an electrostatic capacitor and to some degree higher than the electrochemical battery. The natural electrolyte adds to this. The put away vitality of a Super capacitor diminishes from 100 to 50 percent in 30 to 40 days. A nickel-based battery self-releases 10 to 15 percent for every month. Li-particle releases just five percent for each month.

Super capacitors are costly regarding expense per watt. Some structure engineers contend that the cash for the Super capacitor would should be spent on a bigger battery. We have to understand that the Super capacitor and compound battery are not in rivalry; rather they are diverse items serving remarkable applications.
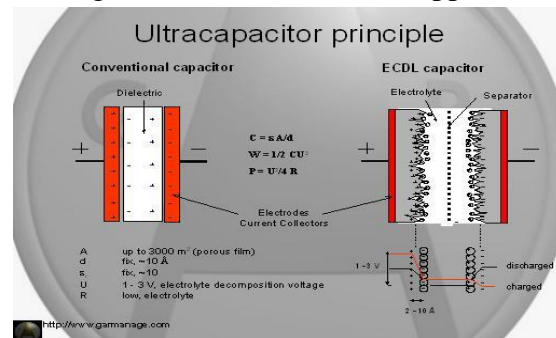

Fig.2 Capacitor Vs Super Capacitor

The electrolyte's nature may be either organic or aqueous. The amount of energy the super capacitor can store is measured in µF (microfarads) or nano farads or even pico farads for smaller.

In practice, super capacitors are especially used as a replacement for the electrochemical battery, for standby power and memory backup devices as well as in filtering of pulsed load currents. The charging time for super capacitor varies from a few seconds for low impedance devices to several minutes. The quick charging ability of the ultra capacitors is used to store the charge for certain amount of time and deliver it to the battery and its further charging.

The battery is further fed to the inverter and this converts the dc to the ac supply with the certain frequency and is used for regular electric usage and appliances.
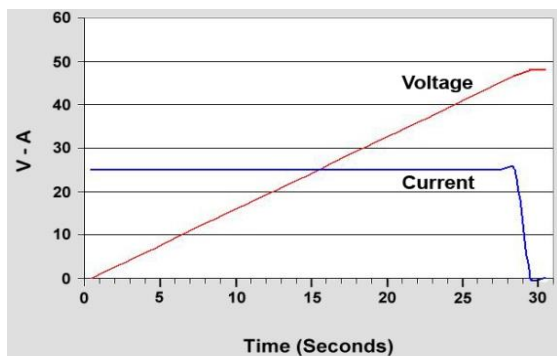

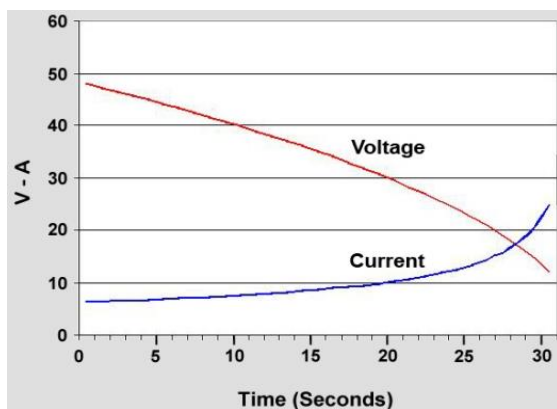**Fig.3 Super Capacitor Charging profile**

Fig.4 Super Capacitor Discharge profile

Arduino IDE: Arduino integrated development environment (IDE), which is a cross-stage application written in the programming language Java. It started from the IDE for the dialects Processing and Wiring. It incorporates a code editorial manager with highlights, for example, content reordering, seeking and supplanting content, programmed indenting, support coordinating, and sentence structure featuring, and gives straightforward a single tick components to accumulate and transfer projects to an Arduino board. It additionally contains a message region, a content comfort, a toolbar with catches for basic capacities and a chain of command of activity menus.

A program composed with the IDE for Arduino is known as a sketch Sketches are saved money on the improvement PC as content records with the document augmentation .ino. Arduino Software (IDE) pre-1.0 spared draws with the augmentation .pde.

The Arduino IDE bolsters the dialects C and C++ utilizing uncommon principles of code organizing. The Arduino IDE supplies a product library from the Wiring venture, which gives numerous normal info and yield methodology. Client composed code just requires two essential capacities, for beginning the sketch and the primary program circle, that are accumulated and connected with a program stub fundamental into an executable cyclic official program with the GNU tool chain, additionally included with the IDE appropriation. The Arduino IDE utilizes the program avrdude to change over the executable code into a content document in hexadecimal encoding that is stacked into the Arduino board by a loader program in the board's firmware.
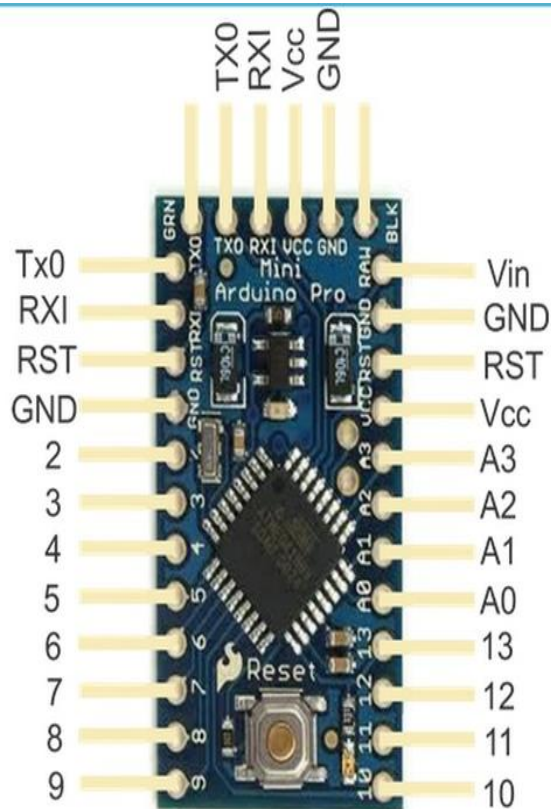
Fig.5 Arduino Pro Mini Pin Out

Fig.6.Supply on_Load on_ Relay on

IV. PROGRAM CODE

```
int relay = 9;
void setup() {  pinMode(relay,OUTPUT); }
void loop() {
  // Charge the Super capacitor
  digitalWrite(relay, HIGH);
  delay(7000);
  // Discharge the Super capacitor
  digitalWrite(relay, LOW);
  delay(5000);
}
```

V.RESULT

The charging time of the super capacitor and the discharging time of the super capacitor is studied.

Total charge time of battery = A-h rating of battery / charger rating (A)

Always add 10 percent to the value obtained for approximate values.

Hence, $(7Ah/2A)+ (0.1*7/2)=3.85$ h is the approximate full charge time.

Since, 24 V-A ,220V/12V step down transformer which implies, 24VA/12V = 2A is the charger rating.

VI. CONCLUSION

With a mix of the quick charging rate of Super capacitors and the high vitality thickness of suppose Lithium Ion Batteries (LIB), a novel super capacitor – battery combination vitality stockpiling framework, likewise called hybrid super capacitor (HSC) might be the eventual fate of vitality for transport applications, which is relied upon to have the best highlights of both Super tops and LIBs. HSCs are made out of a capacitor-type anode and a lithium particle battery-type terminal in a Li salt containing natural electrolyte. The mix of two unique sorts of terminal would result in the capacity of more energy because of the a lot more extensive working voltage window of the natural electrolyte and the extraordinary explicit limit of the battery-type cathode.

The charge– release rate can in any case stay at a quick degree (charging in minutes)

due to the EDLC type cathode. In this way, the way for creating a superior HSC is to couple both fitting anode materials in the gadget. In any case, for matrix applications, improved and adjusted stream batteries will be the best choice sooner rather than later.

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