Power Supply Developers Guide

System overview:

A 30V DC power supply is proposed in this project. It takes the input of 110V 50 Hz AC from the home socket, then steps down and converts it into the required DC voltage.

The first block is the transformer, it steps down the AC voltage from 110V to 24V, then the rectifier that converts from AC to DC. Then the filter deals with the pulsating wave issues. In the next part there are voltage and current limiters to ensure safety. Then an arduino controls the desired output automatically and turns on the safety relay. In the end, we have safety sensors such as smoke and temperature, and all the values are read through an LCD.

Electrical Specifications:

- Input Voltage: 110V AC with 50Hz frequency.
- Output channels: 3.
- Channel 1: 0-24V voltage with 0-1.5A current delivery capability.
- Channel 2: 0-24V voltage with 0-1.5A current delivery capability.
- Channel 3: Fixed 5V stable output with 1A max current delivering capability.

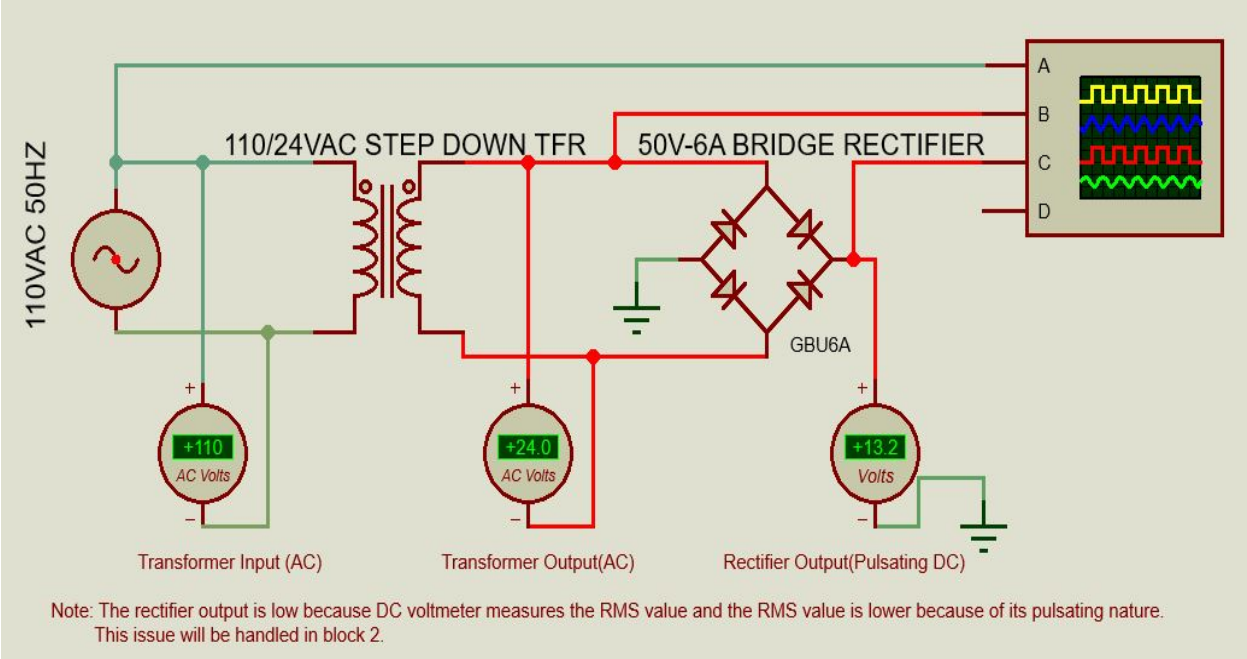
User Guide:

- The system should be set up as per schematics.
- The system should be assembled block by block testing and comparing results from oscilloscopes and multimeters.
- Components of the same values should be used.
- Arduino pins can be configured as per user needs.
- Arduino uno and nano can also be used to make it further compact but for that a different lcd will be used using either spi or l2c communication.
- The enclosure box should not be made by a conducting material.
- The power lines should be handled with gloves and safety equipment.
- The power supply positive and negative terminals should not be short circuited and terminals from different channels should not be connected.
- The power supply has an auto shutdown feature if idle but it should not be left idle to be safe.

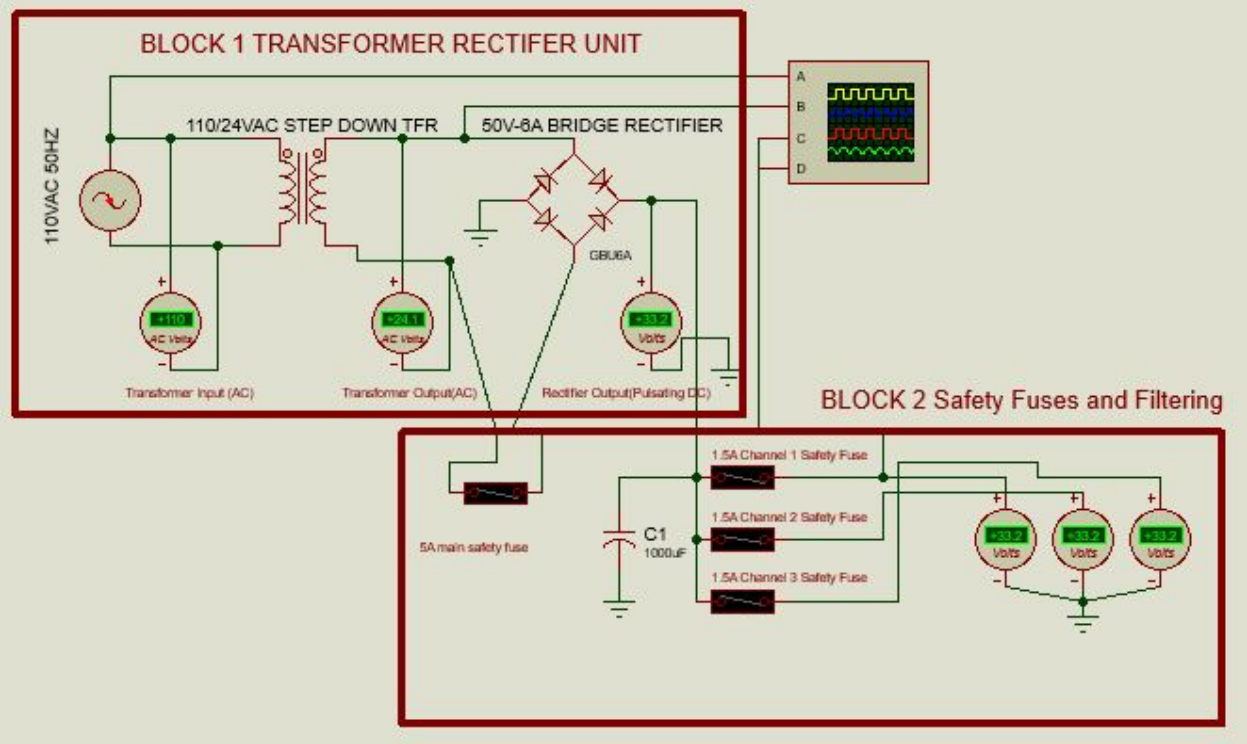
- While operating, make sure that the opening for the cooling fan on the back of the box is dust free and not blocked.
- In case of auto shutdown of the system, take out the wall outlet cutting off the power supply input totally, then do not turn it on if the LCD shows smoke alarm or high temperature alarm, give the power supply 15 minutes to rest and cross check whether the cooling fan opening is blocked or not. If blocked, open the enclosure and clean the board with a blower. Avoid touching the power supply components, especially the capacitor even when it's off.
- All screw terminal blocks should be tightened and no loose connections should be there. They create a spark and thus may damage equipment or users.
- 7805 regulator provides further filtering so any low power sensitive equipment like arduinos, cell phones etc should be connected to channel 3.
- Proper heat sinks must be used at 7805 and lm317 regulators otherwise they will burn due to overheating.

SCHEMATICS

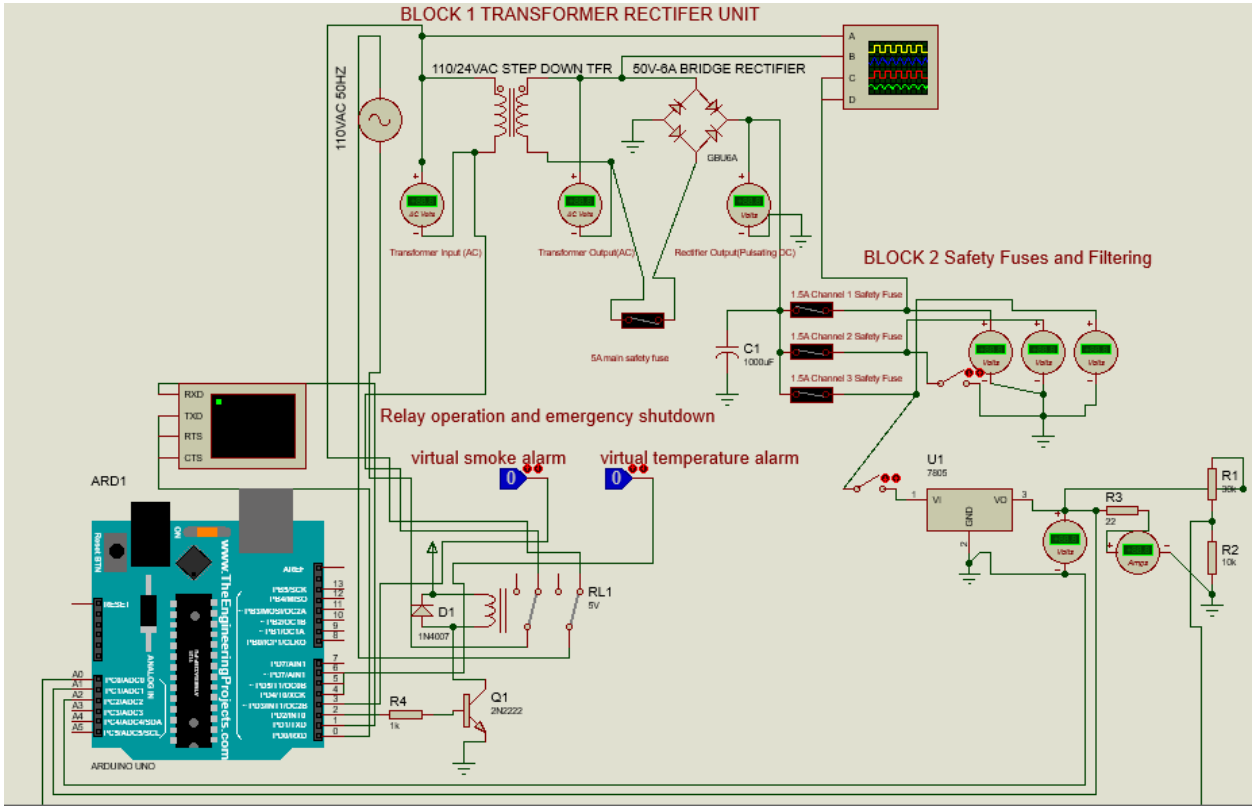
Transformer Rectifier Unit



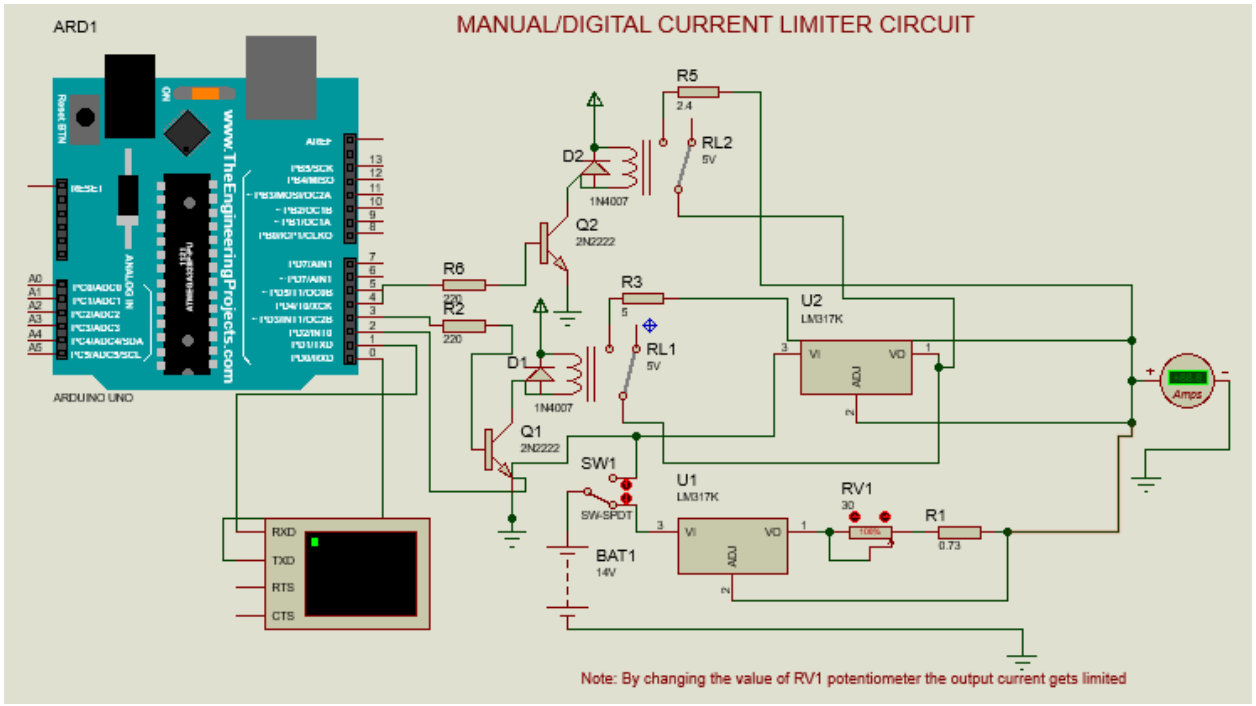
Safety Fuses and Ripple Filtering


BLOCK 1 TRANSFORMER RECTIFER UNIT
110VAC 50HZ
110/24VAC STEP DOWN TFR
50V-6A BRIDGE RECTIFIER
GBU6A
A
B
C
D
Transformer Input (AC)
Transformer Output(AC)
Rectifier Output(Pulsating DC)
BLOCK 2 Safety Fuses and Filtering
5A main safety fuse
C1
1000uF
1.5A Channel 1 Safety Fuse
1.5A Channel 2 Safety Fuse
1.5A Channel 3 Safety Fuse

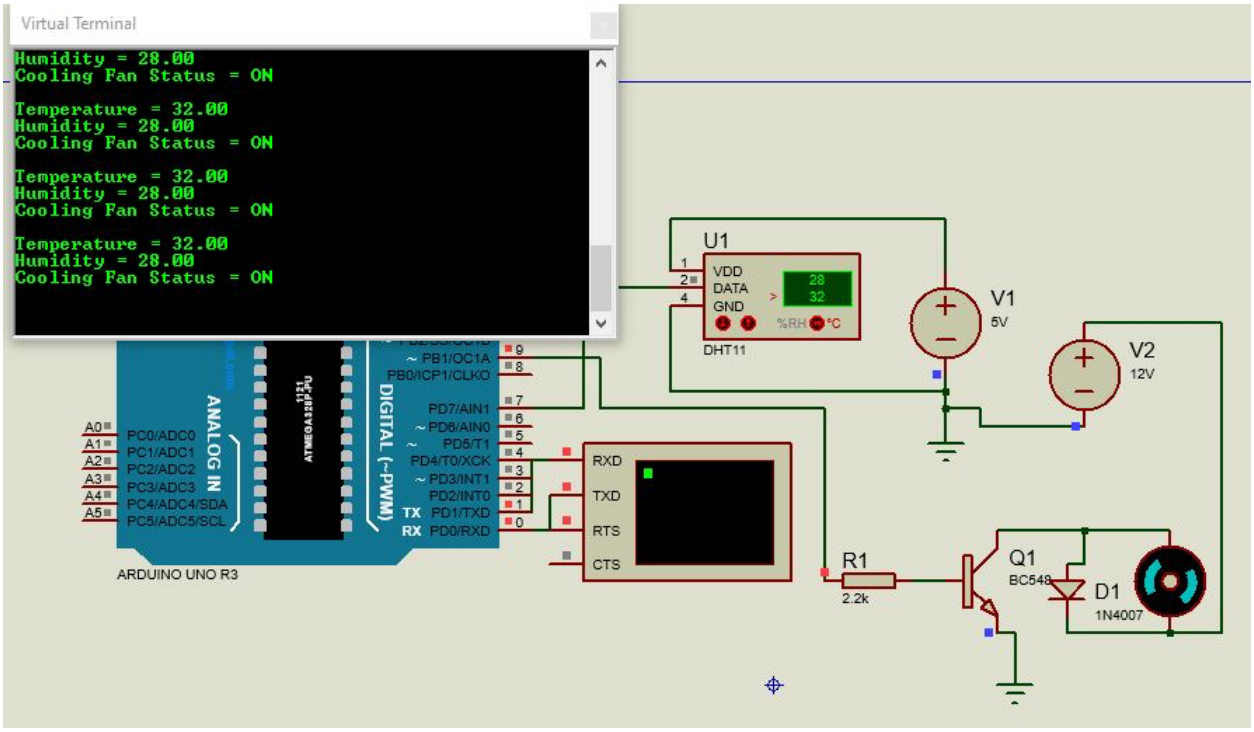
Current Measuring, Voltage Measuring, Emergency Shutdown Mechanism, System Idle timeout and Decisions upon High smoke and Temperature

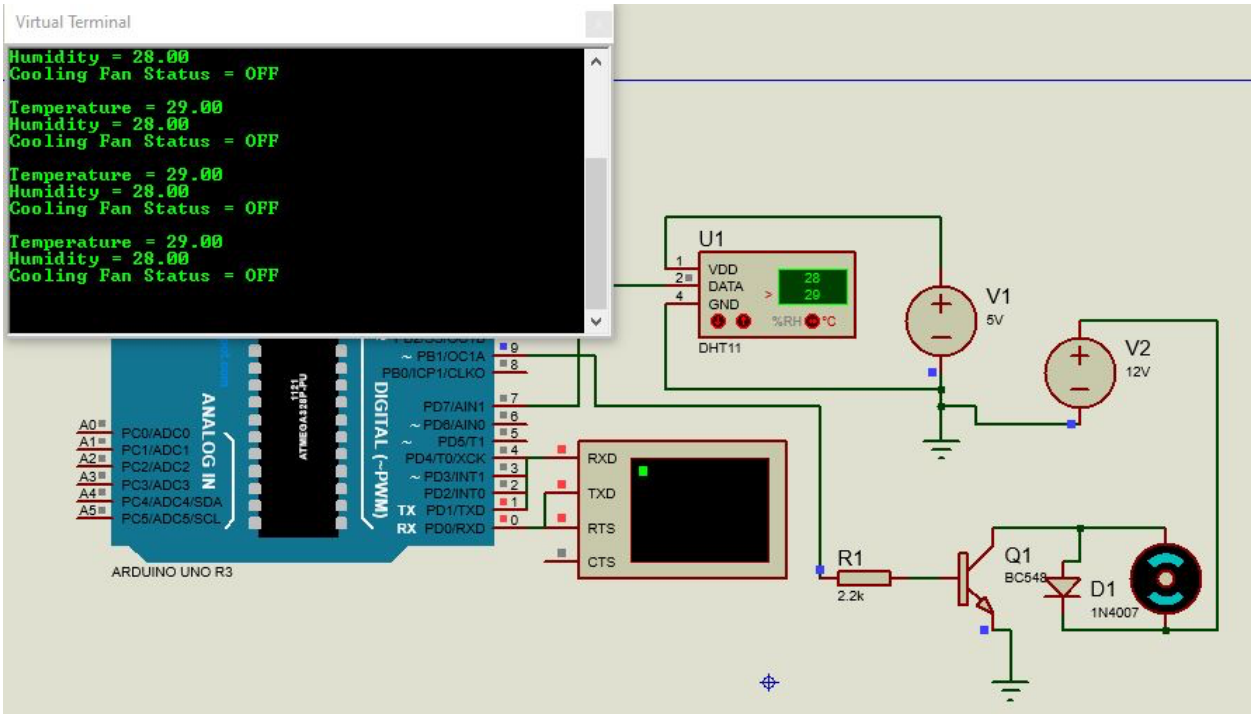


Manual/Digital Current Limiter Circuit

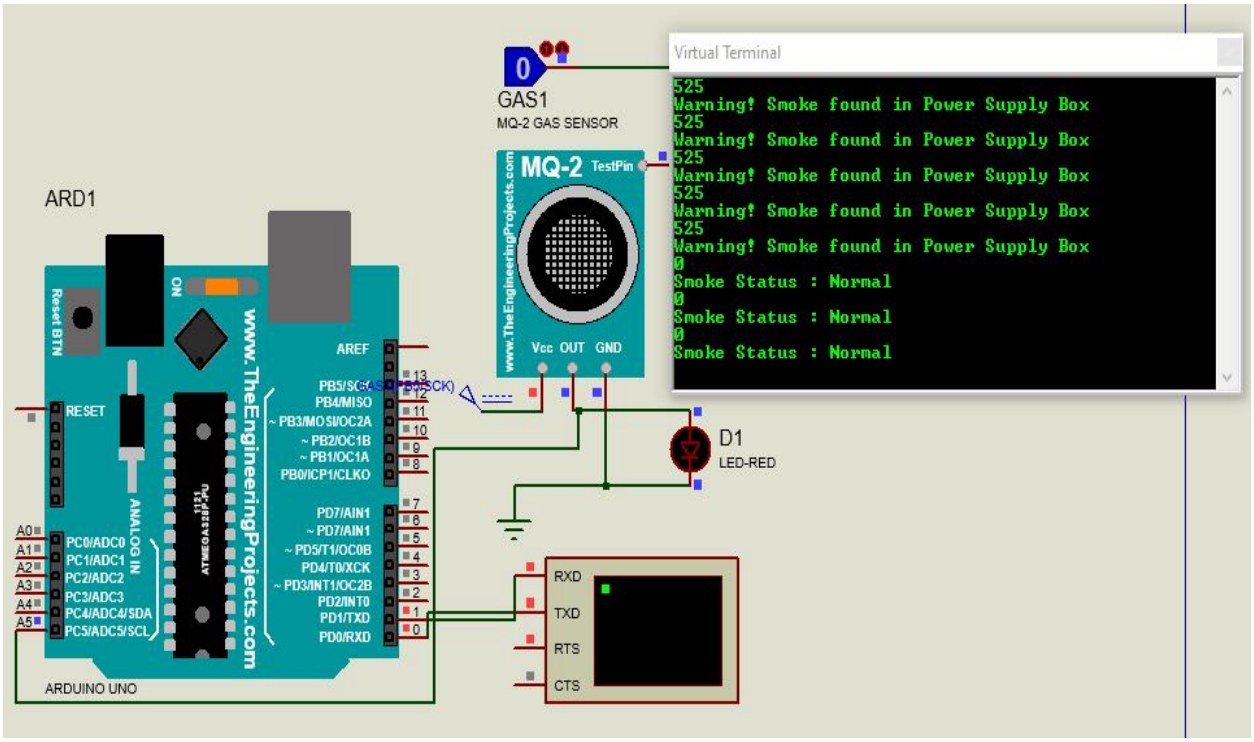


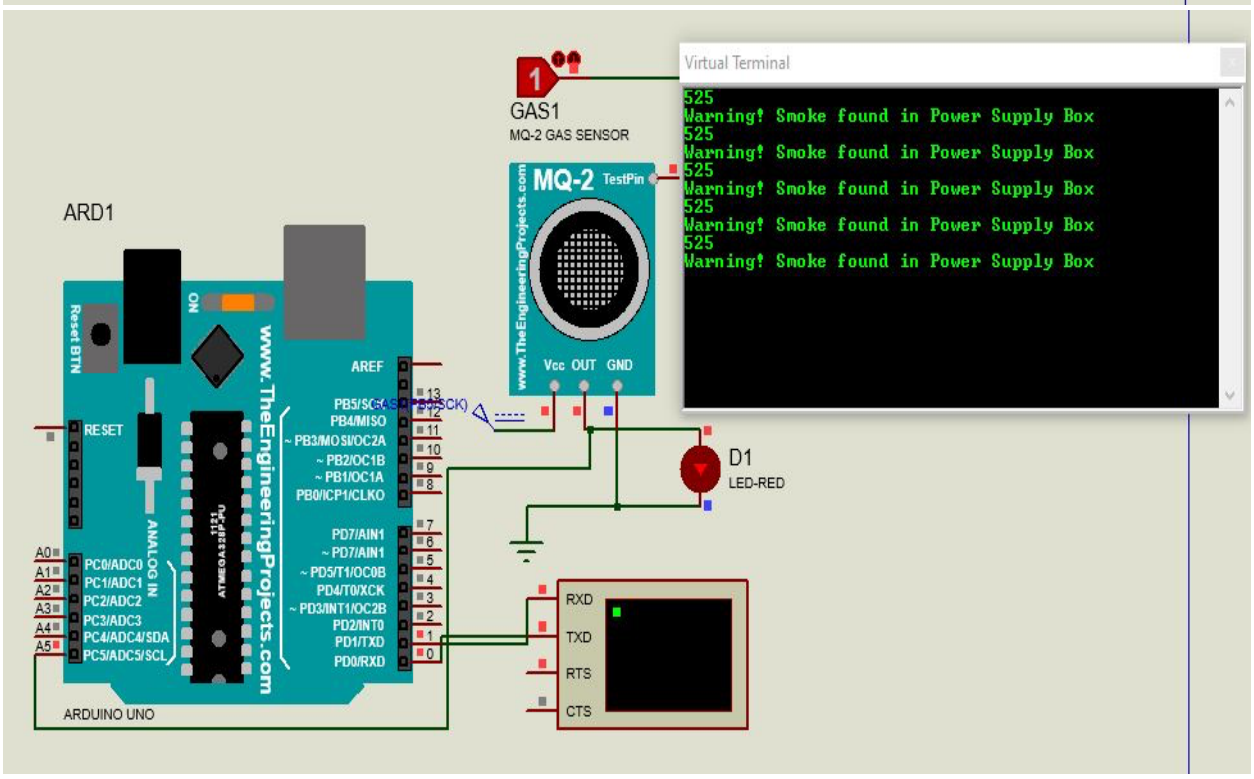
Temperature/Humidity Sensor Interfacing & Cooling Fan Interfacing & Speed Control



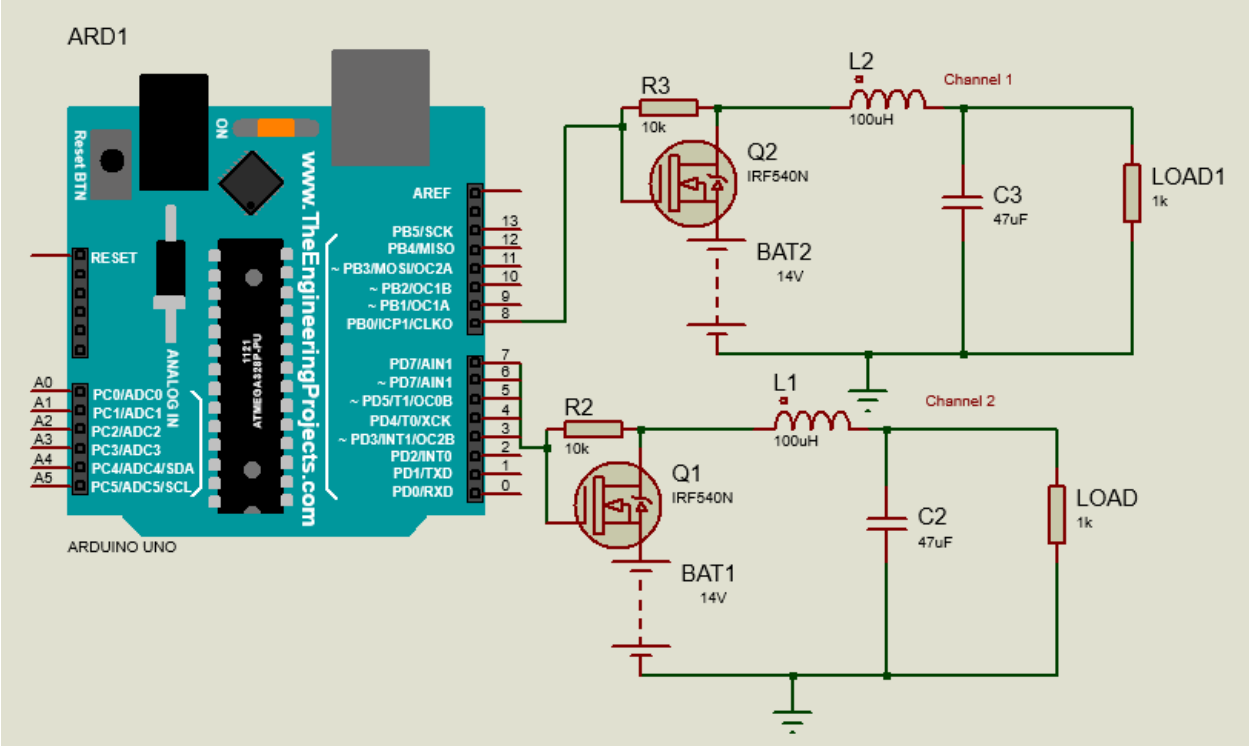


Smoke Sensor Interfacing and Smoke alarm LED





Buck Convertor Variable Voltage Regulator for Ch1 & Ch2

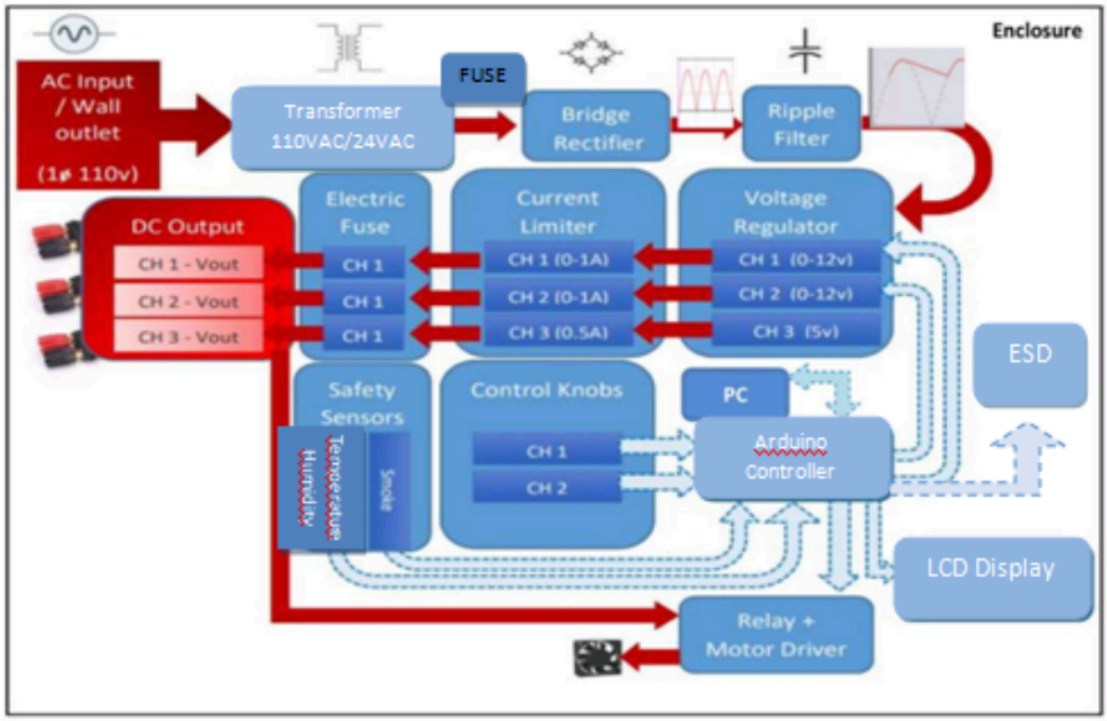


The schematics are drawn on proteus 8.9 professional suite after detailed research and analysis. The simulations for every block were performed separately as proteus was unable to simulate at real time due to intensive CPU usage. The input and output parameters for all blocks however were taken realistic in order to avoid any problems once the blocks are combined into one unit in hardware.

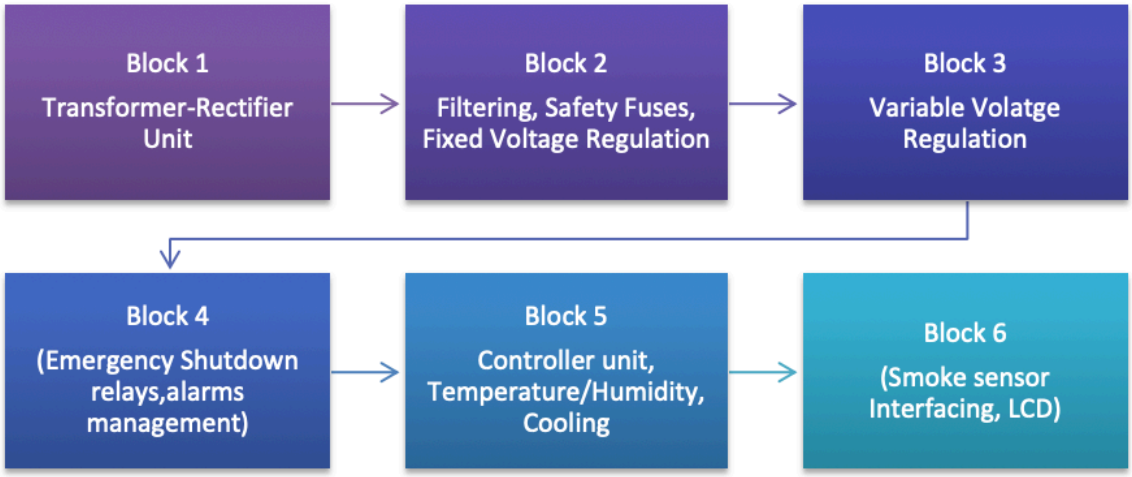
3d model. The 3d model for this project doesn't contain much as it is a pure electrical project and it doesn't involve any moving or mechanical parts other than cooling fan and electromechanical relay switches.

Block Diagram

Current Top-Level Block Diagram



Project Implementation Block Diagram



Block diagram.
The project is primarily distributed into 6 blocks covering all perspectives of an intelligent digital power supply. The blocks are interlinked in a sequence starting from filtering to final dc voltage output. Then comes the security feature blocks which involve fuses, relays, and mechanism. After that comes the automation or control unit blocks which take values from environment parameters using different instrumentation for temperature, smoke, humidity, current, voltage and idle time of power supply. After the linkage of all these blocks together a complete singular unit is created which not only works as a power supply providing dc voltage, it rather applies intelligence to the unit to maintain its productivity and user's safety

Interface Definitions

Overall Interface Definition

Equipment	Definition
Input Supply	Single Phase, 2 pin power jack with 5 amp safety fuse.
Transformer	Type: Step Down Tapping: Normally Tapped Input: 50Hz, 110V AC Output: 24V AC Input Pins: 2 Output Pins: 2
Rectifier	Configuration: 4 pin, GBU6A Input: 24V AC Output: 33V DC (Pulsating) Type: Full Wave Rectification
Filter	Type: Capacitive Value: 1000uF Function: Ripple smoothening from pulsating dc input
Controller	Type: Arduino Input Voltage: 5v DC Model: Mega Processor: ATmega2560 Coding Platform: Arduino IDE

	Coding Language: C++
PC communication	Protocol: USB to RS232 two way Type: USB type A PC front-end: Arduino Serial Monitor
Cooling fan + motor driver using BC548NPN transistor	Operating voltage:12v dc Speed control: PWM from Arduino
Enclosure	Material: Black Acrylic Shape: Rectangular-prism Conductivity: Nil
Voltage Regulator	Types used: Buck convertor for var(2) and LM7805 for fix(1) Variable regulation mechanism: Switching Transistor
Current Limiter	Type: LM317 Configuration: 1.5A for ch1 & ch2, 0.5A for ch3
Safety Fuses	Main Input Fuse 5 Amp Nominal Resistance 0.1 ohm Channel 1 and 2 fuses: 1.5 Amp Nominal Resistance 0.1 ohm Channel 3 fuse: 1.5 Amp
Temperature/Humidity Sensor	DHT11 Operating Voltage: 5V Output logic: 0-5 TTL
Smoke Sensor	MQ-2 Gas Sensor Operating Voltage: 5V Output logic: analog

	Alarm Threshold: 450
Simulation Tool	Proteus Design Suite 8.9
Relays	Coil Excitation: 5V SPST: For Current limiters SPDT: For ESD Safety Diode: 1N4007 Logic Transistor: 2N2222
Resistors	Tolerance: 10% Power Rating: 0.5Watts
Idle Time	Configurable in Code
ESD	Smoke ,High Temp, Idle Timeout
LCD	3.2” TFT Display Pinout: Arduino Mega Shield mounted Operating Voltage: 3.3V Power Source: Arduino Resolution: 320x480 Library: ILI9341

Interface definitions:

This document contains the complete information about the components/parts of this project involving their types, operating voltages, output types (analog, digital) and any further necessary information required to understand the interface better.

Bill Of Materials

Serial No.	Component Name	Price (USD)	Quantity	Total Cost	Purchase link
1	110Vac to 24Vac step down	18.33	1	18.33	https://www.amazon.com/Goodman-0130M00140S-Transformer-120V-
2	GBU6A Rectifier IC	2.38	1	2.38	https://www.amazon.com/s?k=gbu6a&ref=nb_sb_noss_2
3	Arduino Mega 2560	36.99	1	36.99	https://www.amazon.com/ARDUINO-MEGA-2560-REV3-A000067/dp/B0046AMGW0/ref=sr_1_2?dchild=1&keywords=
4	DC 12V CPU Fan	8.38	1	8.38	https://www.amazon.com/Security-01-Bearing-Brushless-Cooling-AV-
5	BC548 NPN Transistor	0.5	1	0.5	https://www.amazon.com/ILS-Pieces-92-Transistor-Transistors/dp/B07PWNR5LX/ref=sr_1_5?dchild=1&keywords=
6	LM7805 voltage regulator	0.2	2	0.4	https://www.amazon.com/s?k=7805&ref=nb_sb_noss_2
7	Safety Fuse 5A	0.3	1	0.3	https://www.amazon.com/MCIGICM-Fast-Blow-Glass-Fuses-5x20mm/dp/B07TS6RG8M/ref=sr_1_1_sspa?dchild=1&keywor
8	Safety Fuse 1.5A	0.3	3	0.9	https://www.amazon.com/MCIGICM-Fast-Blow-Glass-Fuses-5x20mm/dp/B07TS6RG8M/ref=sr_1_1_sspa?dchild=1&keywor
9	2n2222 NPN Transistor	0.5	7	3.5	https://www.amazon.com/Adafruit-NPN-Bipolar-Transistors-PN2222/dp/B00XW2OK7M/ref=sr_1_2?dchild=1&keywords=2
10	Diode 1N4007	0.117	7	0.8155	https://www.amazon.com/Install-Bay-Diodes-Amp-Pack/dp/B0068AEU0W/ref=sr_1_4?dchild=1&keywords=1n400
11	SPST Relays	1.13	6	6.78	https://www.amazon.com/uxcell-10Pcs-Power-Electromagnetic-
12	SPDT Relays	1.13	1	1.13	https://www.amazon.com/uxcell-10Pcs-Power-Electromagnetic-
13	LM317	0.4	6	2.4	https://www.amazon.com/MCIGICM-15pcs-lm317t-Voltage-Regulator/dp/B07BKW7RPG/ref=sr_1_1?dchild=1&keywords=l
14	Potentiometer 30 ohm	2.2	2	4.4	https://www.amazon.com/uxcell-Encoder-Digital-Potentiometer-D-
15	DHT11 Sensor	3	1	3	https://www.amazon.com/Temperature-Humidity-Digital-3-3V-5V-
16	MQ-2 Gas sensor	8	1	8	https://www.amazon.com/Butane-Hydrogen-Sensor-Detector-Module/dp/B07MKQW9NB/ref=sr_1_3?dchild=1&keywords=
17	Leds	0.05	3	0.15	https://www.amazon.com/MCIGICM-Circuit-Assorted-Science-Experiment/dp/B07S6951YS/ref=sr_1_5?dchild=1&keywords=
18	IRF540N	0.9	2	1.8	https://www.amazon.com/10PCS-IRF540N-MOSFET-220AB-IRF540NPBF/dp/B07VKGMCJ3/ref=sr_1_1?dchild=1&keywords
19	Inductor 100uH	6.35	2	12.7	https://www.amazon.com/Uxcell-a13070600ux0394-Radial-Leaded-
20	Capacitors 47uF	0.5	2	1	https://www.amazon.com/PoiLee-Capacitor-Radial-Electrolytic-6x11mm/dp/B07KPWC3PB/ref=sr_1_2?crid=TTZICVXX25AC&d
21	Capacitor 1000uF	2	1	2	https://www.amazon.com/pcs-Panasonic-FM-Capacitors-1000uf/dp/B073YQ7Q7X/ref=sr_1_4?dchild=1&keywords=100
22	3.2" TFT LCD with Arduino Mega shield	12	1	12	https://www.amazon.com/WINGONEER%C2%AE-Screen-Display-ILI9341-
				127.8555	

Bill of materials.

Due to the current covid-19 situation it was difficult to procure the components required for power supply here and amazon was still not working. Some of the components can also be taken from local electronics stores and the rest from amazon later on. The pricing is done by normalizing amounts to one component at a time. The prices are taken from amazon and links to the components are also attached in the BOM document. The prices are however subject to change.

User Guide