# VL603: Electronic System Packaging
# MICROINVERTER PCB PROJECT

**Guided By: Prof. Kurian Polachan**

## GROUP-1

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## ■ MICROINVERTER PROJECT ONEDRIVE LINK:

ESP_Project_GROUP1_MICROINVERTER.zip

**ONLY LINK:**

**https://iiitbac-my.sharepoint.com/:x:/g/personal/solanki_pratikkumar_iiitb_ac_in/EV0kx5-S1rFGtkSiLPQYzJ8B3xvYnlYM9xqGkJuaqikoag?e=T2mFtz**

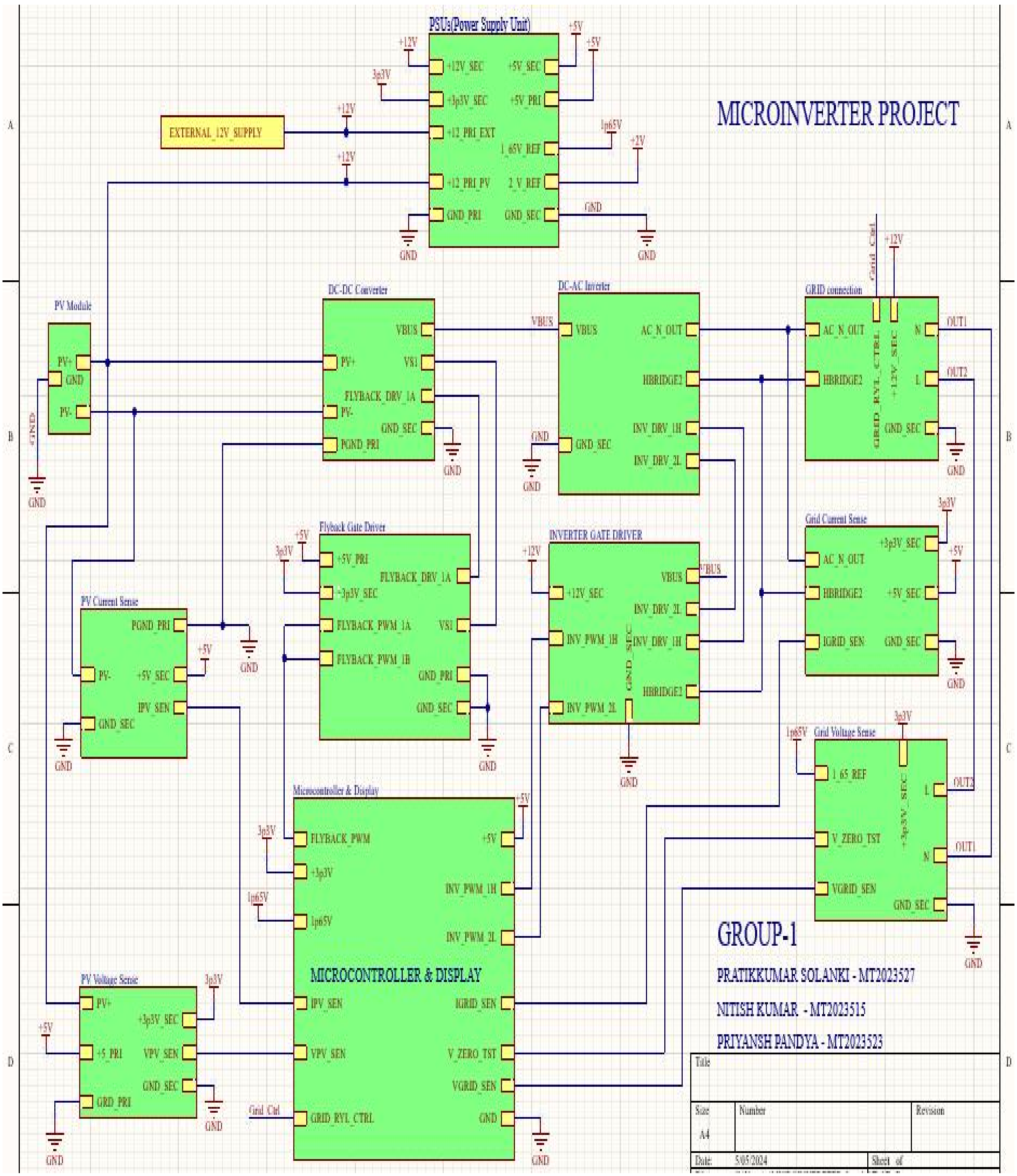
- **LINK OF EXCEL IS PROVIDED FOR BOM EXCEL SHEET**

MICROINVERTER_BOM_FINAL.xlsx

**ONLY LINK:**

**https://iiitbac-my.sharepoint.com/:u:/g/personal/solanki_pratikkumar_iiitb_ac_in/EWbhS59NQCJDj-pyuf14wp8BuakpP8yibndrHgibZGZwjg?e=pwC8iX**

## Schematic Level 1 MICROINVERTER:



## ■ Blocks & Functionality:

### PV Voltage Sense

| | |
|---|---|
| Functionality | Measures PV module voltage |
| Input(s) | Voltage: 0 - 25V |
| Output(s) | Voltage: 0 - 3.3V (proportional to PV voltage) |

### PV Current Sense

| | |
|---|---|
| Functionality | Measures PV current |
| Input(s) | Current: -3 to 3A |
| Output(s) | Voltage: 0 - 3.3V |

### DC/DC Converter

| | |
|---|---|
| Functionality | Boost PV voltage to grid voltage. |
| Input(s) | Power: 180 - 200W; Voltage: 0 - 25V; Current: 0 - 10A;<br>Control: ~12V PWM Signal |
| Output(s) | Power: 180 - 200W; Voltage: 180V; Current: 1A |

### DC/AC Inverter

| | |
|---|---|
| Functionality | Convert DC grid voltage to AC grid voltage |
| Input(s) | Power: 180 - 200W; Voltage: 180Vdc; Current: 1A;<br>Control: ~12V PWM Signal |
| Output(s) | Power: 180 - 200W; Voltage: 170Vpk; Current: 1A |

## Grid Connection

| | |
|---|---|
| Functionality | Filter and control inverter output |
| Input(s) | Power: 180 - 200W; Voltage: 170Vpk; Current: 1A; Unfiltered Signal |
| Output(s) | Power: 180 - 200W; Voltage: 170Vpk; Current: 1A; Filtered Sine Wave |

## Grid Voltage Sense

| | |
|---|---|
| Functionality | Measures Grid Voltage |
| Input(s) | Voltage: 0 - 170 Vpk |
| Output(s) | Voltage: 0 - 3.3V (proportional to Grid voltage) |

## Grid Current Sense

| | |
|---|---|
| Functionality | Measures Grid current |
| Input(s) | Current: -3 to 3A |
| Output(s) | Voltage: 0 - 3.3V |

## Flyback Gate Driver

| | |
|---|---|
| Functionality | Controls switches in the DC/DC Converter and isolates MCU from microinverter. |
| Input(s) | +3.3V PWM signal |
| Output(s) | +12V PWM signal |

## Inverter Gate Driver

| | |
|---|---|
| Functionality | Controls switches in the DC/AC Inverter and isolates MCU from microinverter. |
| Input(s) | +3.3V PWM signal |
| Output(s) | +12V PWM signal |

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**Power Supply Units**

| | |
|---|---|
| Functionality | Provide voltage sources for microinverter. |
| Input(s) | PV power or external power |
| Output(s) | Primary Side: +12V, +5V<br>Secondary Side: +12V. +5V, +3.3V, +2.5V, +1.65V |

**Microcontroller & Display**

| | |
|---|---|
| Functionality | Control microinverter operation. Sensing, MPPT, PWM control. |
| Input(s) | ADC input: 0 - 3.3V |
| Output(s) | PWM output: 0 - 3.3V<br>GPIO output: 0 - 3.3V |

# ■ Frequent Asked Question:

**(Q) What is Microinverter?**

**Solution:** A microinverter is a device used in solar power systems to convert the direct current (DC) electricity generated by a single solar panel into alternating current (AC) electricity suitable for use in homes or businesses or any other application.

- A microinverter extracts and converts energy from PV module and to boost efficiency, microinverters employ Maximum Power Point Tracking (MPPT), optimizing the PV module's operating voltage for peak efficiency under any conditon.

**(Q) How is Power Supply Unit(PSU) is connected and its Flow?**

**Solution**: The Power Supply Unit have the inputs from external supply and from PV module(pin PV+) generated output of upto 24V so it can use any of the input and generate the output of +12V,+5V for primary circuit and generates secondary outputs of +12V, + 5 and it uses +2V , +1.65V as reference voltage for Voltage Regulator with High PSRR and Shunt Regulator and capacitor banks circuits.

## ■ Connection & Flow & I/O Pins of Level 1 MICROINVERTER:

- **PV Module**: Converts solar irradiance into electrical energy of DC of range 0-25V, providing voltage and current based on sunlight intensity as an output to through PV+ and PV- Terminals

- **PV Voltage Sense:** Measures PV voltage using PV+ providing sensed value by VPV_SEN output pin to Microcontroller of 3.3V output and to Display the reading using microcontroller and also the input voltages of 5V primary , 3.3V secondary are input use for operating this block from PSUs.

- **PV Current Sense**: It uses the PV- pin for reading the current value generated by PV module and for operating this block we use 5V secondary input from PSUs and the sensed output reading are send to Microcontroller and Display block by IPV_SEN pin.

- **DC-DC Converter:** It is 1:4 Boost converter which step up 0-24V,0-10A maximum input through pin PV+ and PV- to 180V, 1A output which is almost the voltage ranges we use for generation of AC output for Grid Level through pin VBUS.Also it uses 12V PWM signal for Duty cycle and MPPT algorithm signal through pins FLYBACK_DRV_1A and VS1.

- **DC/AC Inverter**: It converts DC power through input pin VBUS to AC through pin HBRIDGE2 and AC_N_OUT for grid-tied operation, supported by the Inverter Gate Driver and microcontroller using duty cycle for operating Q3,Q4,Q5,Q6 Transistor through pin INV_DRV_1H and pin INV_DRV_2L. also it uses LCL Filter because the output is not perfect sine from this transistor.

- **Grid Connection**: Allows electricity AC through input pin HBRIDGE2 and AC_N_OUT from the inverter to be fed into the Grid through output pins N and L.Also its readings are sense by microcontroller from GRID_RLY_CTRL pin to Display it. And it uses +12V_SEC DC from PSU to its internal circuits.

- **Flyback Gate Driver:** Provides isolation and controls the DC/DC converter's switching operation  and its inputs pins are received from FLYBACK_PWM_1A and FLYBACK_PWM_1B through microcontroller block by MPPT Algorithm Tracking.The input power pins to circuitry of this block are +5V Primary and 3.3V Secondary . Also the generated output are received to output by pins VS1 and FLYBACK_DRV_1A for DC-DC Converter.

- **Inverter Gate Driver:** It provide the PWM signal from microcontroller by input pins INV_PWM_1H and INV_PWM_2L to DC-AC Inverter block using output pins of  INV__1H and INV_DRV_2L and it is powered by +12V Secondary and the VBUS voltage value is also sense by this block to send information to microcontroller and display it .

- **Grid Voltage Sense:**  Measures grid voltage using pins L and N  and for the circuit operation we need to use reference voltage of 3.3V and 1.65V  with the zero crossing detector to output pin V_ZERO_TST to finally produce frequency count and readings for output through pin VGRID_SEN  which is given to microcontroller and display

- **Grid Current Sense:**  Measures grid current using input pins HBRIDGE2 and AC_N_OUT  and for the circuit operation we need to use 5V and 3.3V secondary from PSU.  And the output generated at pin IGRID_SEN  which is given to microcontroller and display to produce present value of AC Grid

- **Microcontroller & Display** :  It is the main control block of the system to sense the DC inputs of  PV,DC-DC Converter, DC-AC Inverter, Grid AC Voltage and current values and produce the Display Reading and also to produce the ouput PWM signal for Flyback Gate driver circuits and Inverter Gate driver Circuit using internally USB Port so that by MATLAB or other software we can run the MPPT Algorithm software as there is processing IC FT2232HQ-REEL is used along with ATMEGA 328P IC which will produce the Duty cycle and by processing through I2C lines of SCL,SDA,SCK we would get the readings on Display of all the Inputs and Outputs

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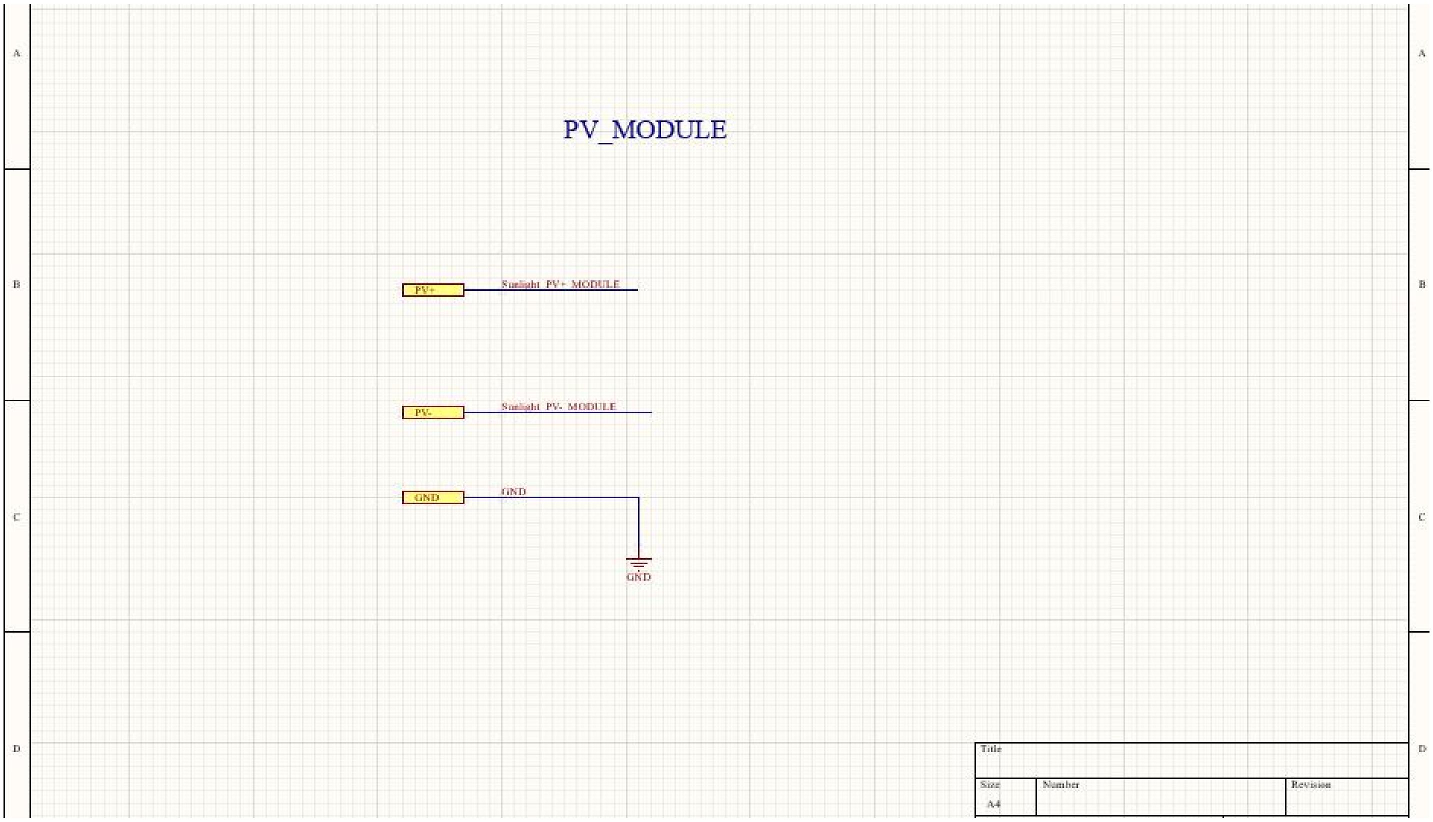
# ■ LEVEL 2 MICROINVERTER:

## ■ PV Module:




The Solar Sunlight generated produces the DC Voltage from each solar module which is connected to the PV+ and PV-  pin of this circuits. The voltage generated is directly proportional to irradiance ,intensity and reflection absorbed by the solar plates.We are assuming here the fact that each Solar module can produce 180W of power supply we add the series and parallel plates according to the our need.

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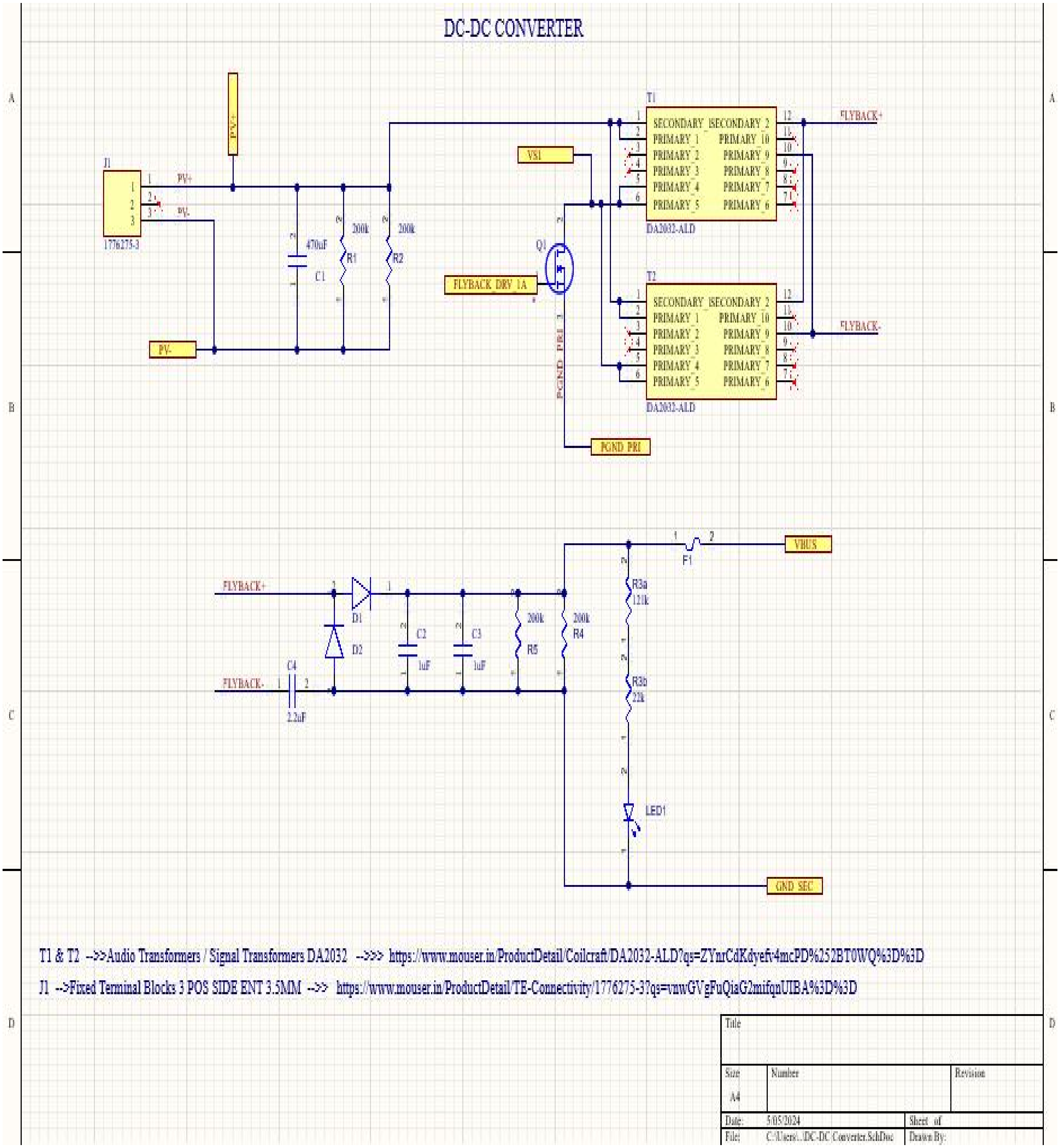
## ■ DC-DC Converter:



On the primary side of the switching converter, IRFB4310 MOSFETs are utilized due to their advantageous characteristics, including a low R_DS-On (5.6mΩ), high V_DS (100V), and a current rating of 130A. These specifications are crucial for enhancing the efficiency of the DC/DC converter, facilitating the passage of up to 200W of power through this section. The NA5919-AL transformers employed are 1:4 flyback transformers, is chosen to elevate the voltage output from the PV module.

Transitioning to the secondary side of the DC/DC Converter, a voltage doubler circuit and the DC link capacitor are prominent features. The voltage doubler circuit comprises a 2µF capacitor, chosen based on previous simulations, along with two MSRF1560G power rectifier diodes. These diodes boast a low forward voltage (1.5V), coupled with high voltage (600V) and current (15A) ratings, ensuring efficient energy conversion and robust performance.

An indicator neon bulb (LED1) is incorporated on the secondary side to provide a visual indication of voltage presence, typically over approximately 60V on the DC link capacitors. A resistor value of R5 is 150KΩ was selected based on the specifications provided in the datasheet for the neon indicator bulb.

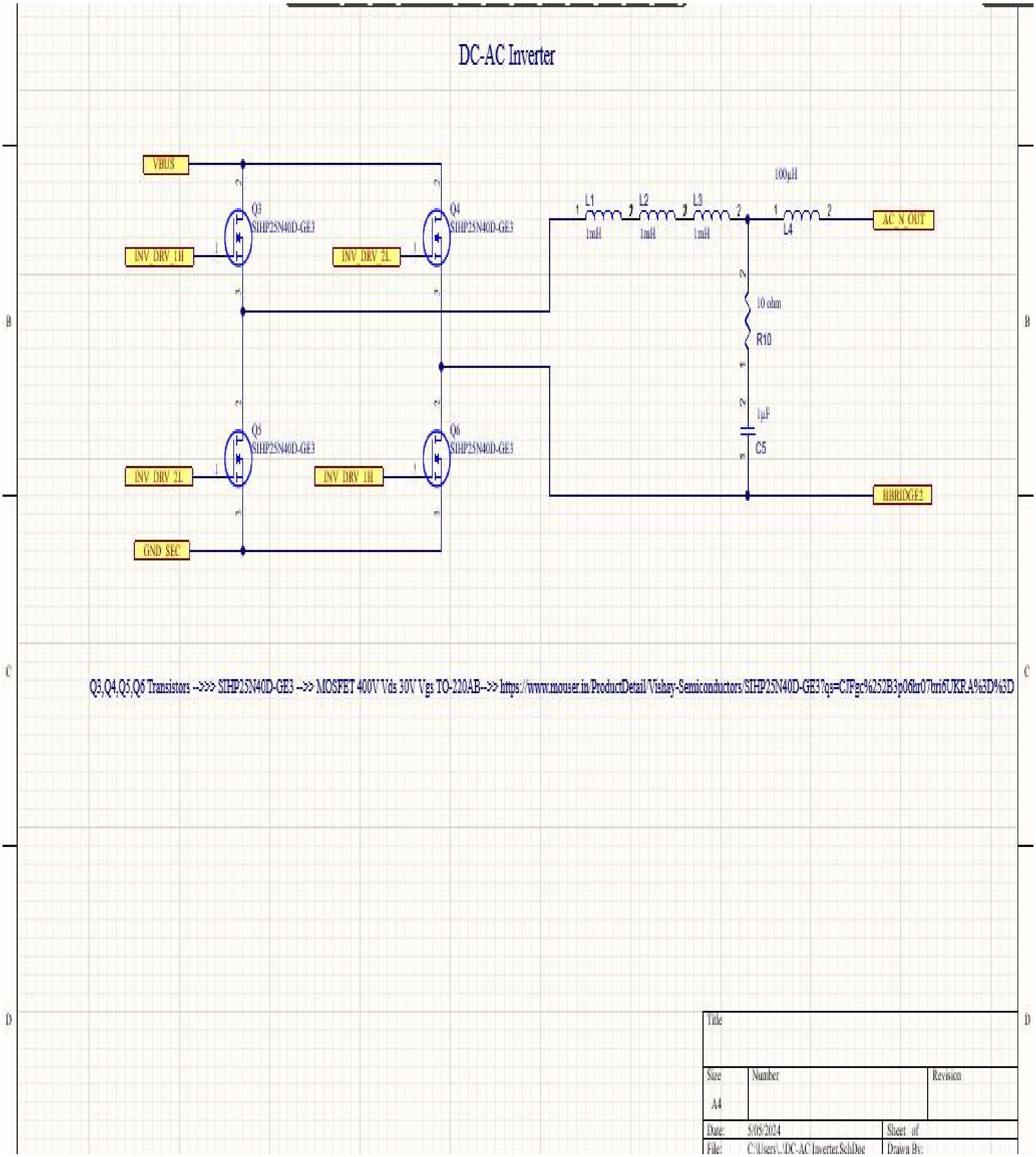
Furthermore, FUSE1 plays a pivotal role in isolating the converter section from the inverter section when independent testing of the converter section is required. This fuse acts as a protective measure, preventing potential damage to the converter or inverter components and ensuring safe operation during testing procedures.

Main Components & Mouser URLs:

T1 & T2-->> Audio Transformers / Signal Transformers DA2032 Cap Chrgr For Linear LT3750-->>> https://www.mouser.in/ProductDetail/Coilcraft/DA2032-ALD?qs=ZYnrCdKdyefv4mcPD%252BT0WQ%3D%3D

J1-->Fixed Terminal Blocks 3 POS SIDE ENT 3.5MM-->> https://www.mouser.in/ProductDetail/TE-Connectivity/1776275-3?qs=vnwGVgFuQiaG2mifqnUIBA%3D%3D

# DC-AC Inverter:



The DC/AC inverter section of the microinverter is comprised of two essential components: an H-Bridge and an LCL filter. This section plays a pivotal role in converting the direct current (DC) output from the DC/DC converter into alternating current (AC) suitable for powering electrical devices.

At the core of the H-Bridge circuit are SIHP25N40D Power MOSFETs, meticulously chosen for their robust characteristics, including a high drain-source voltage (V_DS) rating of 450V and a significant drain current (I_DS) capacity of 24A. These MOSFETs facilitate efficient switching operations within the H-Bridge configuration, ensuring seamless conversion of DC to AC power.

In conjunction with the H-Bridge, the LCL filter (comprised of inductors L1 and L2, resistor R6, and capacitor C6) serves to refine the output waveform and mitigate harmonic distortions. These components are meticulously selected and precisely tuned to optimize the performance of the microinverter, enhancing its overall efficiency and reliability.

The utilization of the SIHP25N40D MOSFETs in the H-Bridge, coupled with the carefully designed LCL filter, underscores the meticulous engineering and attention to detail employed in the design of the microinverter. Together, these components work harmoniously to ensure the seamless conversion of DC power from the solar panels into clean and reliable AC power for residential or commercial applications.

Main Components & Mouser URLs:

Q3,Q4,Q5,Q6 Transistors -->>> SIHP25N40D-GE3 -->> MOSFET 400V Vds 30V Vgs TO-220AB
-->> [https://www.mouser.in/ProductDetail/Vishay-Semiconductors/SIHP25N40D-GE3?qs=CJFgc%252B3p06hr07bri6UKRA%3D%3D](https://www.mouser.in/ProductDetail/Vishay-Semiconductors/SIHP25N40D-GE3?qs=CJFgc%252B3p06hr07bri6UKRA%3D%3D)

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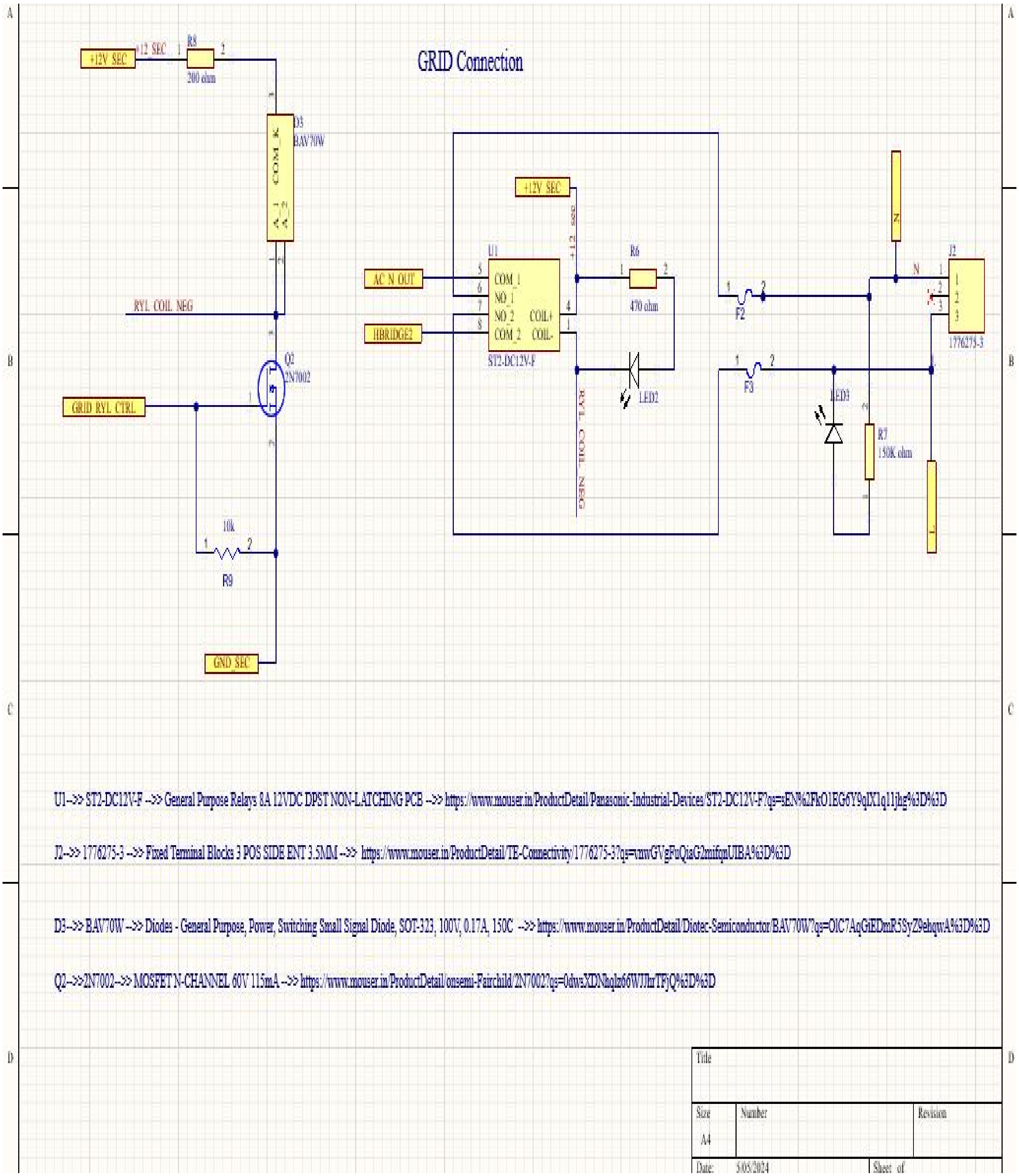
## ■ Grid Connection:



The grid connection circuit facilitates the seamless integration or disconnection of the microinverter with/from the grid. This action is taken in the event that the microinverter is not functioning as intended or if abnormal conditions are detected on the grid. A ST2-DC12V-F relay, under the control of the microcontroller and the grid current limiting circuitry, governs this process. The activation of the relay is indicated by LED2. To ensure the LED operates within safe parameters, resistor R7 limits the current flowing through it.

Additionally, a neon indicator bulb, LED3, serves to indicate the presence of high voltage (>60V) on the grid connection. LED3 shares the same series resistance of 150K as the neon indicator bulb across the DC link capacitor, represented by resistor R8. FUSE2 and FUSE3 act as protective measures for the microinverter, ensuring its safety if more than 3A is drawn from the grid, which could occur due to a malfunction.

The GRID_RLY_CTRL signal, originating from the overcurrent protection section and controlled by the microcontroller, triggers a MOSFET. This MOSFET permits current flow from the secondary +12V rail through the relay coil, through the MOSFET, and into the ground. To safeguard the MOSFET from potential damage caused by voltage spikes resulting from the inductive load of the relay coil, a freewheeling diode, D3, has been incorporated.

Main Components and Mouser URLs:

U1-->> ST2-DC12V-F -->> General Purpose Relays 8A 12VDC DPST NON-LATCHING PCB -->> https://www.mouser.in/ProductDetail/Panasonic-Industrial-Devices/ST2-DC12V-F?qs=sEN%2FkO1EG6Y9qlX1q11jhg%3D%3D

J2-->> 1776275-3 -->> Fixed Terminal Blocks 3 POS SIDE ENT 3.5MM -->> https://www.mouser.in/ProductDetail/TE-Connectivity/1776275-3?qs=vnwGVgFuQiaG2mifqnUIBA%3D%3D

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D3-->> BAV70W -->> Diodes - General Purpose, Power, Switching Small Signal Diode, SOT-323, 100V, 0.17A, 150C -->> https://www.mouser.in/ProductDetail/Diotec-Semiconductor/BAV70W?qs=OlC7AqGiEDmR5SyZ9ehqwA%3D%3D

Q2-->>2N7002-->> MOSFET N-CHANNEL 60V 115mA -->> https://www.mouser.in/ProductDetail/onsemi-Fairchild/2N7002?qs=0dwsXDNhqlz66WJJhrTFjQ%3D%3D

## ■ PV Voltage Sense:

This voltage sensing circuit comprises several key features, including a voltage divider, an isolation amplifier, and voltage clamping mechanisms.

Voltage division is achieved using two resistors, R3 and R1. The scaled-down voltage is set to 0.006 of the voltage at PV+, the PV voltage. This scaling ensures that the maximum input voltage to the isolation amplifier, which is 150mV, falls within the specified voltage range of the amplifier input (250mV).

An isolation amplifier, specifically the AMC1200SDUB, is utilized to maintain separation between the primary and secondary grounds of the circuit. This isolation minimizes the introduction of noise into the voltage measurements. The output of the isolation amplifier, VPV_SEN, represents the voltage to be read by the microcontroller for measuring the PV voltage.

To protect the microcontroller, a Schottky diode array (D1) is employed, preventing VPV_SEN from exceeding the 0V to 3.3V range of the microcontroller's ADC.

Furthermore, additional capacitors have been strategically placed throughout the circuit to mitigate noise occurring on the amplifier's supply rails and inputs. Two test points, IN_VPVSEN and OUT_VPVSEN, are included to measure the voltage on each side of the amplifier.

Resistor R2 serves to limit the current flowing to the MCU in the event of an overvoltage condition on the voltage sense circuit. Capacitors C1-4 act as decoupling capacitors, effectively reducing noise in the circuit

Main Components and Mouser URLs:

U4-->>AMC1200SDUBR-->>Isolation Amplifiers 4kV peak Iso Amp-->> https://www.mouser.in/ProductDetail/Texas-Instruments/AMC1200SDUBR?qs=Nxfnlnd%252BiAcMKGpoVxsKlg%3D%3D

D4-->> BAT54S-->> Schottky Diodes & Rectifiers SOT23 0.2A 30V Schottky Dblr -->> https://www.mouser.in/ProductDetail/Rectron/BAT54S?qs=7pEAo90IqNGRiqD7TkybWA%3D%3D

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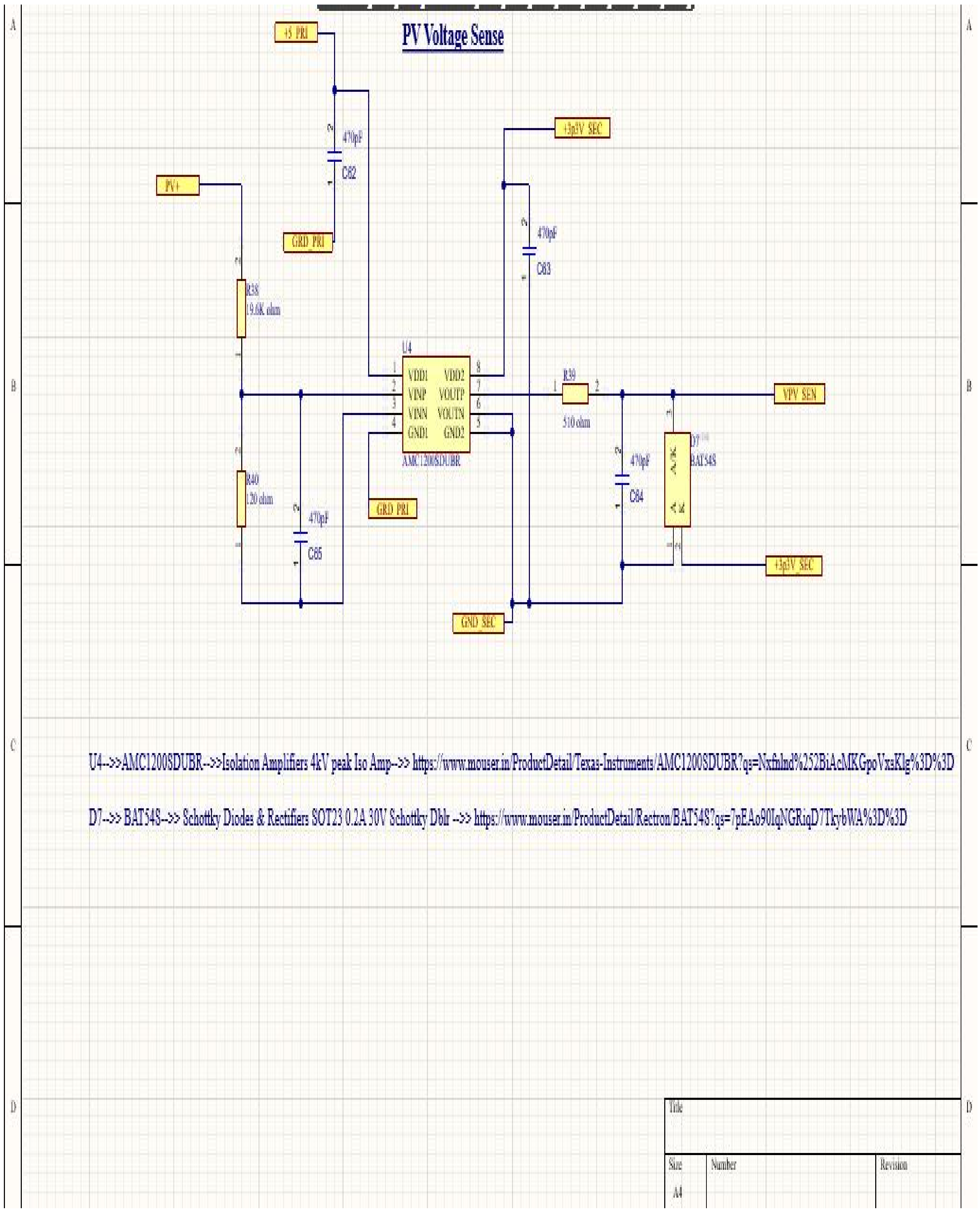
PV Voltage Sense
+5_PRI
470pF
C82
GRD_PRI
PV+
R38
19.6K ohm
+3p3V_SEC
470pF
C83
U4
VDD1
VINP
VINN
GND1
VDD2
VOUTP
VOUTN
GND2
AMC1200SDUBR
R39
510 ohm
VPV_SEN
D7
BAT54S
470pF
C84
R40
120 ohm
470pF
C85
GRD_PRI
+3p3V_SEC
GND_SEC
U4-->>AMC1200SDUBR-->>Isolation Amplifiers 4kV peak Iso Amp-->> https://www.mouser.in/ProductDetail/Texas-Instruments/AMC1200SDUBR?qs=Nxfnlnd%252BiAcMKGpoVxsKlg%3D%3D
D7-->> BAT54S-->> Schottky Diodes & Rectifiers SOT23 0.2A 30V Schottky Dblr -->> https://www.mouser.in/ProductDetail/Rectron/BAT54S?qs=7pEAo90IqNGRiqD7TkybWA%3D%3D
Title
Size
A4
Number
Revision

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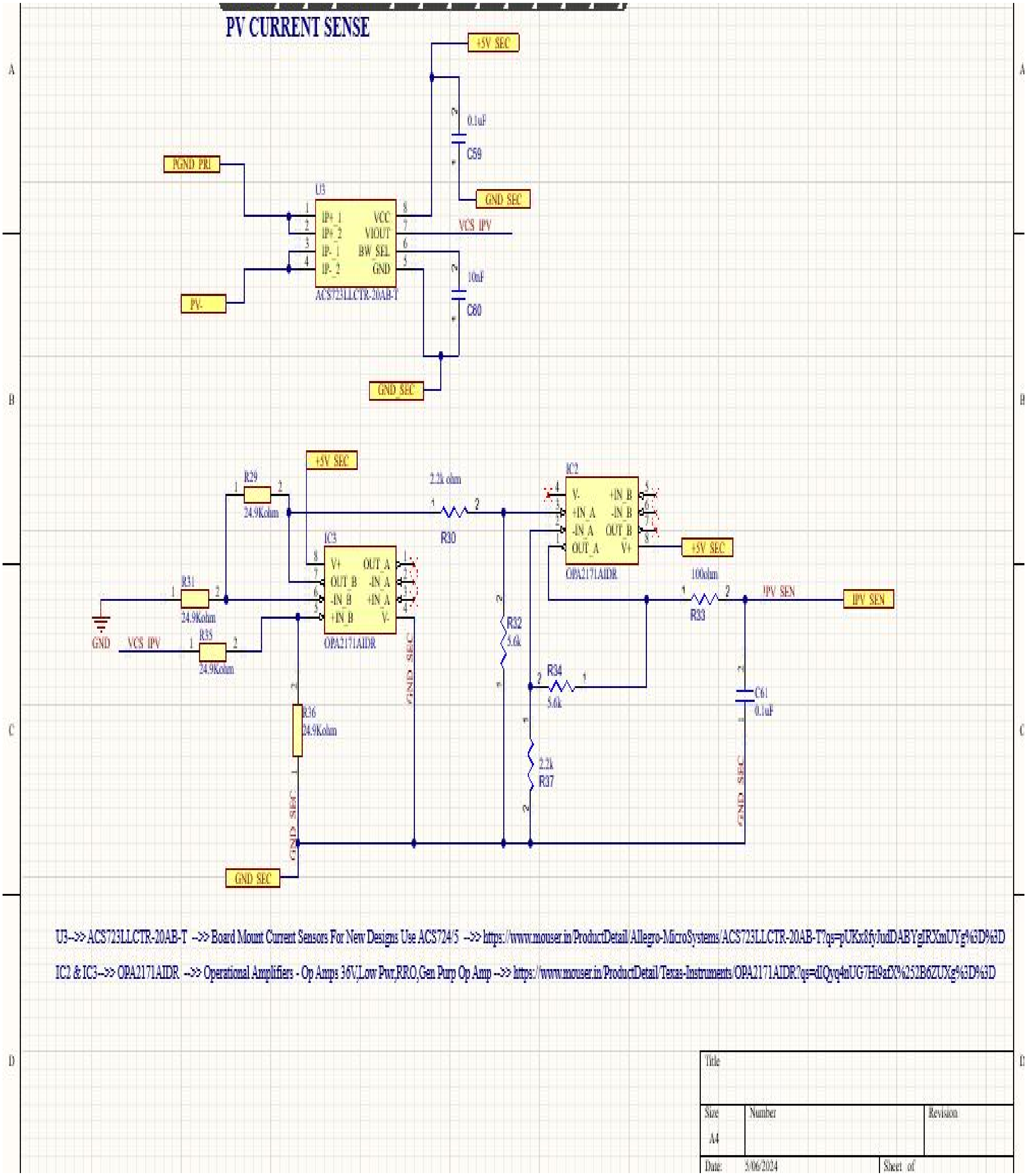
## ■ PV Current Sense:



To sense the amount of current coming from the PV module, the PV current measurement circuit in Figure 5.12 is utilized. The component responsible for current measurements is an ACS723, which is a Hall-effect, galvanically isolated current sensor. The ACS723 outputs a voltage proportional to the amount of current passing through PV- and PGND_PRI, with the output voltage scaled by 100mV/A and centered at 2.5V when there is no current flowing. Capacitors C1 and C2 serve as decoupling capacitors to filter noise in the +5V_SEC and GND_SEC lines.

The op-amp circuit shown in Figure 5.13 is employed to scale the output voltage of the current sensor to within the range of the microcontroller ADC. The first op-amp circuit removes the 2.5V bias introduced by the current sensor, while the second op-amp circuit scales the voltage to fit within the full range of the ADC. Using Equation 5.2, with Rf = 24.9kΩ, Rin = 24.9kΩ, V2 = 2.5-3.5V, and V1 = 2.5V, the expected output voltage of the first op-amp falls between 0V and 1V. For the second op-amp, with Rf = 4.87kΩ, Rin = 2.2kΩ, V2 = 0-1V, and V1 = 0V, the expected output ranges between 0V and 2.21V, serving as the input to IPV_SEN.

Main Component and  Mouser URLs:

U3-->> ACS723LLCTR-20AB-T  -->>  Board Mount Current Sensors For New Designs Use ACS724/5  -->>  https://www.mouser.in/ProductDetail/Allegro-MicroSystems/ACS723LLCTR-20AB-T?qs=pUKx8fyJudDABYgIRXmUYg%3D%3D

IC2 & IC3-->> OPA2171AIDR  -->> Operational Amplifiers - Op Amps 36V,Low Pwr,RRO,Gen Purp Op Amp --> https://www.mouser.in/ProductDetail/Texas-Instruments/OPA2171AIDR?qs=dIQyq4nUG7Hi9afX%252B6ZUXg%3D%3D

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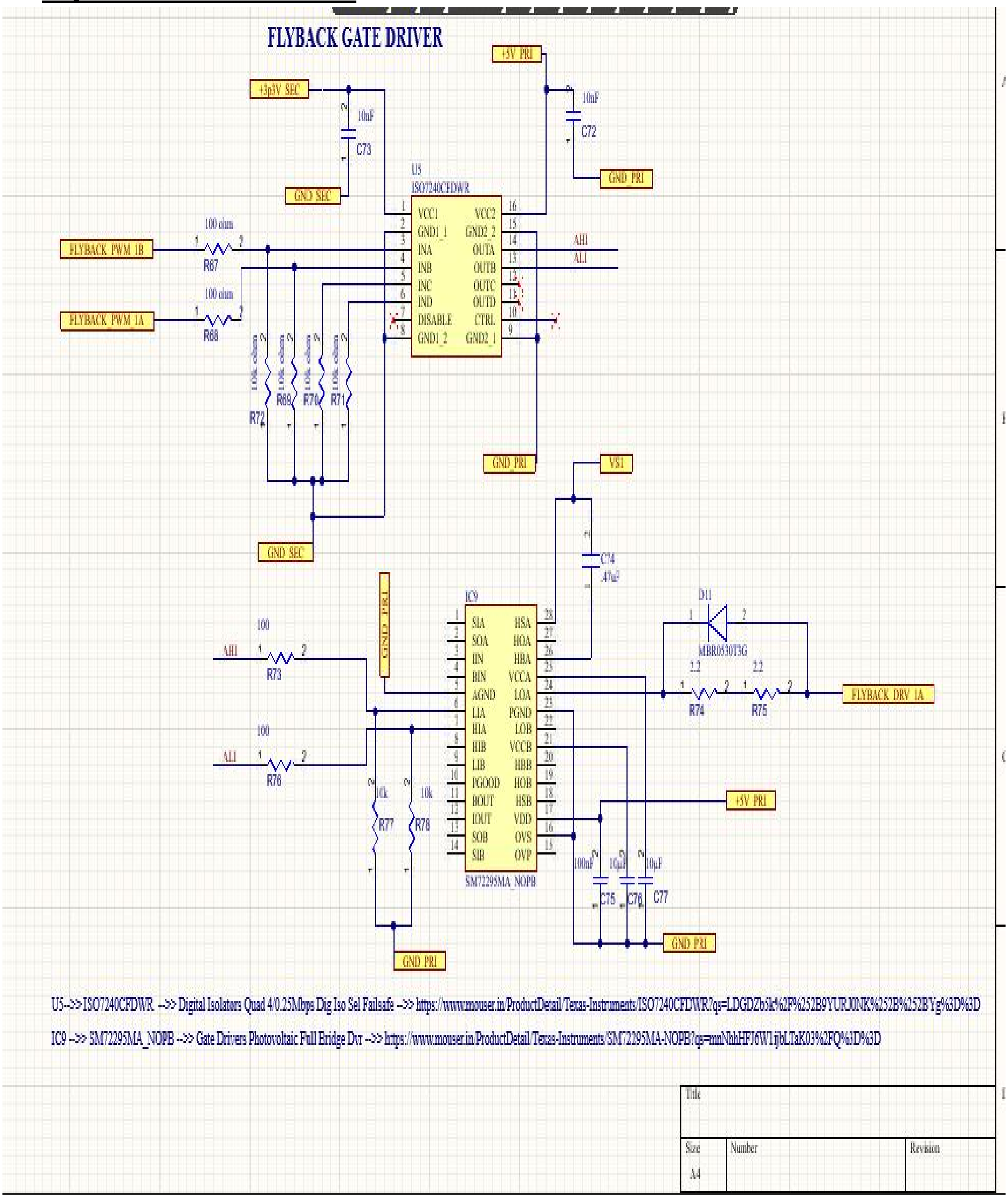
## ■ Flyback Gate Driver:



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The flyback gate driver comprises two major component sections: an isolation IC and a gate driving IC. The circuit depicted the isolation circuit, which employs an ISO7240 isolation IC. This chip plays a crucial role in maintaining separation between the primary and secondary grounds while still transmitting the PWM signal to the gate driver.

To prevent noise from inadvertently triggering the outputs, pulldown resistors (R1-R4) are included on each input of the isolation IC, even for unused inputs. Additionally, resistors R5-R6 are utilized to limit current flowing to or from the PWM signal in the event of an overvoltage condition.

For the gate driving section, an SM72295 Photovoltaic Full Bridge Driver is employed. This IC boosts the voltage sent to the MOSFET gates in the flyback converter. It provides a +12V gate voltage with respect to the source of each MOSFET being driven, utilizing a bootstrap configuration to elevate the gate voltage of the clamping MOSFET with respect to that MOSFET source.

Pull-down resistors (R11-12) are utilized to prevent the PWM input pins on the SM72295 from floating, while resistors R13-14 serve to limit the current to or from the ISO7240 in case of an overvoltage condition. Diodes D1-2 and resistors R7-10 are incorporated to decrease the turn-off time of the MOSFET, enhancing the overall efficiency and performance of the gate driver circuit.

Main Component and Mouser URLs:

U5-->> ISO7240CFDWR -->> Digital Isolators Quad 4/0.25Mbps Dig Iso Sel Failsafe -->> https://www.mouser.in/ProductDetail/Texas-Instruments/ISO7240CFDWR?qs=LDGDZb5k%2F%252B9YURJ0NK%252B%252BYg%3D%3D

IC9 -->> SM72295MA_NOPB -->> Gate Drivers Photovoltaic Full Bridge Dvr -->> https://www.mouser.in/ProductDetail/Texas-Instruments/SM72295MA-NOPB?qs=mnNhhHFJ6W1ijbLTaK03%2FQ%3D%3D

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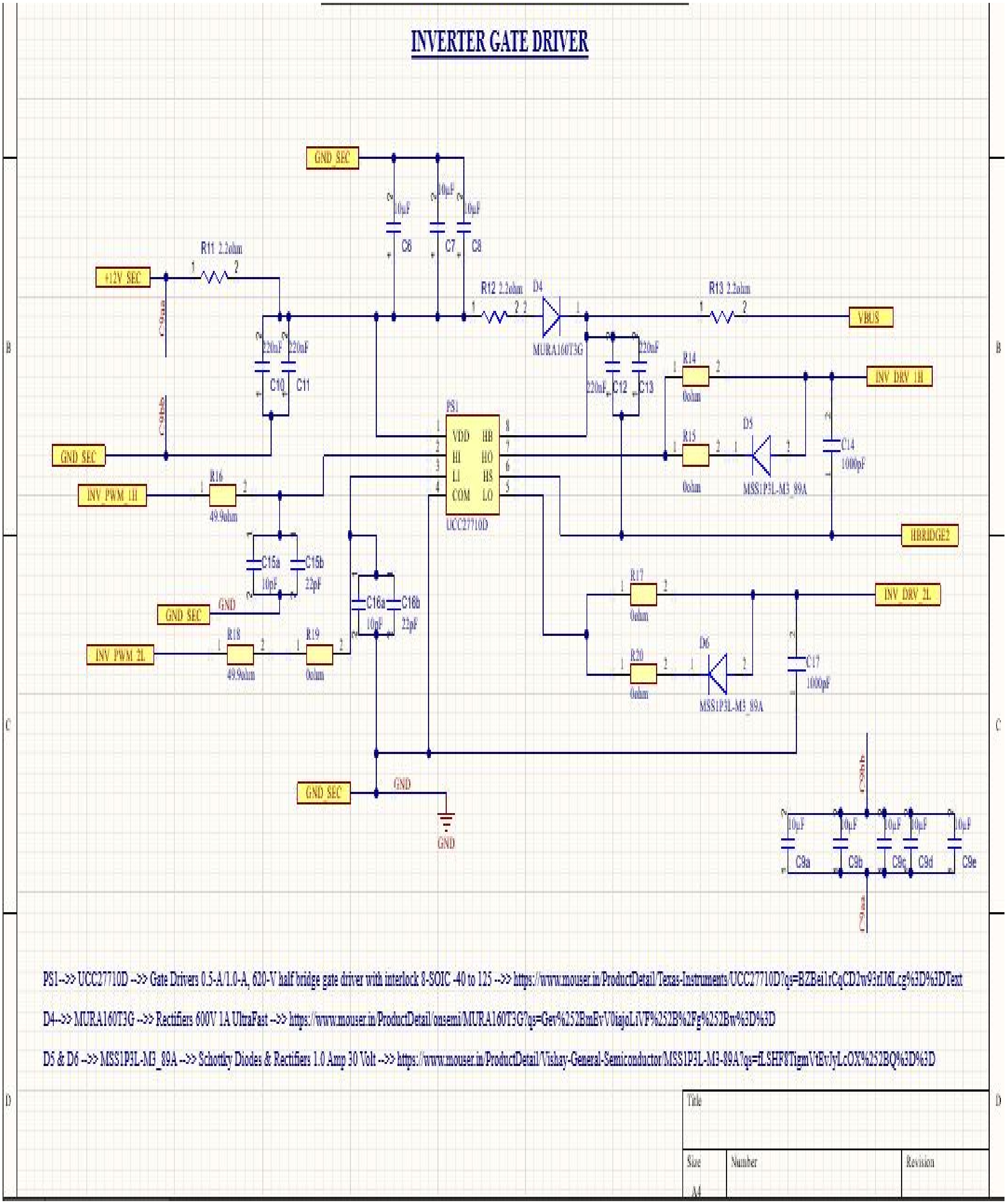
## ■ Inverter Gate Driver:



For the inverter gate driver section, two types of driver circuits are utilized: a low-side and a high-side driver circuit. This arrangement is necessary due to the gate voltages being referenced to different sources. While the low-side MOSFET source is the secondary ground, the high-side MOSFET source is on the grid.

In the low-side driver circuit, a UCC27324 Low-Side MOSFET driver IC is employed to enhance the efficiency of switching the low-side MOSFETs by providing high peak current. This IC takes the PWM signals for the low-side MOSFETs, INV_PWM_1L and INV_PWM_2L, and outputs them on INV_DRV_1L and INV_DRV_2L. Pull-down resistors (R1 and R2) prevent the inputs to the UCC27324 from floating, while diodes (D3 and D4) clamp the output voltage to ground in the event of a negative voltage appearing on the outputs of U1 due to undershooting or ringing. Resistors (R3-4) and diodes (D1-2) are employed to decrease the turn-off time of the low-side MOSFETs.

For the high-side driver circuit, due to the reference source voltage of the high-side MOSFET being different from the secondary ground, an isolation IC and a MOSFET gate driver IC are utilized. This isolation is essential to keep VGS high enough with respect to the source of the high-side MOSFET to drive it effectively. The ISO7420D isolation IC maintains separation between the secondary ground and the source of the MOSFETs, while the UCC27531 MOSFET driver IC efficiently drives the MOSFETs with high peak current. The circuit is designed to drive one of the high-side MOSFETs. A separate, but identical circuit, is employed to drive the other high-side MOSFET. Resistors (R5 and R6) are used to dampen oscillations on the MOSFET, and capacitors (C1-3) act as decoupling capacitors to filter noise.

Revisions were made to the circuit design due to issues discovered with the original design. Primarily, the footprint for the UCC27531 component on the PCB was incorrect, and even when corrected, the circuit was not providing a PWM output. To address these issues, a new design based on the bootstrap driver topology was implemented instead of the isolated driver topology of the original design. Two UCC27710 ICs are now employed, one for each high-low side MOSFET pair, driving the MOSFETs in isolation.

Main Component and  Mouser URLs:

PS1-->> UCC27710D -->> Gate Drivers 0.5-A/1.0-A, 620-V half bridge gate driver with interlock 8-SOIC -40 to 125 -->> https://www.mouser.in/ProductDetail/Texas-Instruments/UCC27710D?qs=BZBei1rCqCD2w93rIJ6Lcg%3D%3D

D4-->> MURA160T3G -->> Rectifiers 600V 1A UltraFast -->> https://www.mouser.in/ProductDetail/onsemi/MURA160T3G?qs=Gev%252BmEvV0iajoLiVF%252B%2Fg%252Bw%3D%3D

D5 & D6 -->> MSS1P3L-M3_89A -->> Schottky Diodes & Rectifiers 1.0 Amp 30 Volt -->> https://www.mouser.in/ProductDetail/Vishay-General-Semiconductor/MSS1P3L-M3-89A?qs=fLSHF8TigmVtEvJyLcOX%252BQ%3D%3D

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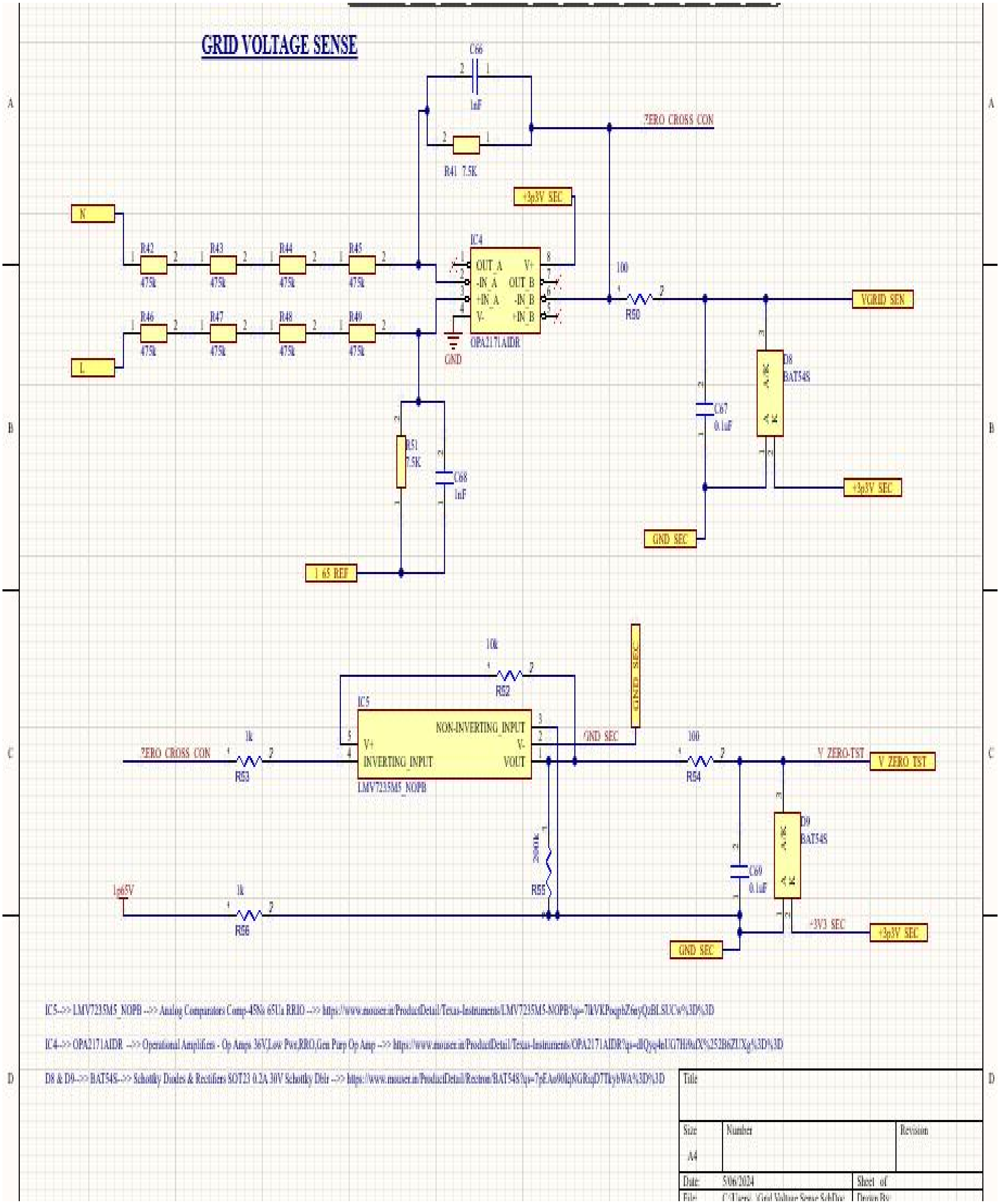
## Grid Voltage Sense:



To measure the grid voltage, the DC link voltage measurement circuit was slightly modified and reused. The significant change made to the grid voltage measurement circuit compared to the DC link voltage measurement is the adjustment of the Rf value for the voltage divider, which is set to 7.5K (compared to 15K for the DC link voltage).

This adjustment is necessary because the grid voltage has both positive and negative values, being an AC source. For the non-inverting input, since the grid voltage is an AC voltage, a 1.65V reference voltage (1_65V_REF) is utilized instead of GND_SEC to bias the input to the op-amp to 1.65V. Consequently, the output voltage of the op-amp falls between 0.86V to 2.44V.

An important aspect of the grid voltage sensing circuitry is the zero-cross detection system, based on the LMV7235M5. This system toggles a digital input pin on the microcontroller when the grid voltage crosses the zero point. This action can trigger an interrupt on the microcontroller, enabling precise measurement of the frequency and phase of the grid AC voltage. This synchronization ensures that the output of the inverter remains in sync with the grid voltage, a critical requirement for a system capable of feeding power back into the grid.

The comparator is configured in an inverting configuration with hysteresis. High and low threshold voltages of 1.6582V and 1.6418V, respectively, are set using resistors R13 and R14. Resistor R12 serves as input protection to limit current in the case of overvoltage, while resistor R16 acts as a pull-up resistor, and R15 provides input protection for the MCU. Capacitor C4 serves as a decoupling capacitor for filtering purposes, ensuring stable operation of the circuit.

`

Main Component and  Mouser URLs:

IC5-->> LMV7235M5_NOPB -->> Analog Comparators Comp-45Ns 65Ua RRIO -->> https://www.mouser.in/ProductDetail/Texas-Instruments/LMV7235M5-NOPB?qs=7lkVKPoqpbZ6nyQzBLSUCw%3D%3D

IC4-->> OPA2171AIDR  -->> Operational Amplifiers - Op Amps 36V,Low Pwr,RRO,Gen Purp Op Amp -->>  https://www.mouser.in/ProductDetail/Texas-Instruments/OPA2171AIDR?qs=dIQyq4nUG7Hi9afX%252B6ZUXg%3D%3D

D8 & D9-->> BAT54S-->> Schottky Diodes & Rectifiers SOT23 0.2A 30V Schottky Dblr -->>
https://www.mouser.in/ProductDetail/Rectron/BAT54S?qs=7pEAo90IqNGRiqD7TkybWA%3D%3D

## ■ Grid Current Sense:

To measure the amount of current going into the grid, the microinverter utilizes an LTSR6-NP current transducer [28]. This component outputs a voltage proportional to the current passing through the transducer on VCS_IOUT. When there is zero current on the grid, the transducer outputs a voltage of 1.65V, using IGRID_SEN_REF as the zero-current voltage, with the voltage varying by 104.16mV/A. It was connected using one of the recommended configurations in the part's datasheet. R1 is employed to limit current in the case of an overvoltage condition, and Capacitor C1 acts as a decoupling capacitor to limit noise.

The op-amp circuit utilized to scale the output voltage of the current transducer to within the range of the microcontroller ADC. The first op-amp circuit removes the 1.65V bias introduced by the current transducer, while the second op-amp circuit scales the voltage to fit within the full range of the ADC. The first op-amp circuit, , uses Rf = Rin = 24.9kΩ, with V2 = 1.65V and V1 = 1.34V-1.96V. Therefore, the

expected output at VCS_TPT_INTMD is between 1.34V to 1.96V. For the second op-amp circuit, with Rf = 3.32kΩ, Rin = 1.47kΩ, V2 = 1.34V to 1.96V, and V1 = 0V, resulting in an output voltage ranging from 3.03V to 4.43V
The op-amp circuit serves to adjust the output voltage of the current transducer to fall within the range of the microcontroller's ADC. The first op-amp circuit functions to eliminate the 1.65V bias introduced by the current transducer. Subsequently, the second op-amp circuit scales the voltage to fit within the full range of the ADC.

In the first op-amp circuit, Rf = Rin = 24.9kΩ, with V2 = 1.65V and V1 = 1.34V - 1.96V. Consequently, the expected output at VCS_TPT_INTMD is anticipated to be within the range of 1.34V to 1.96V.

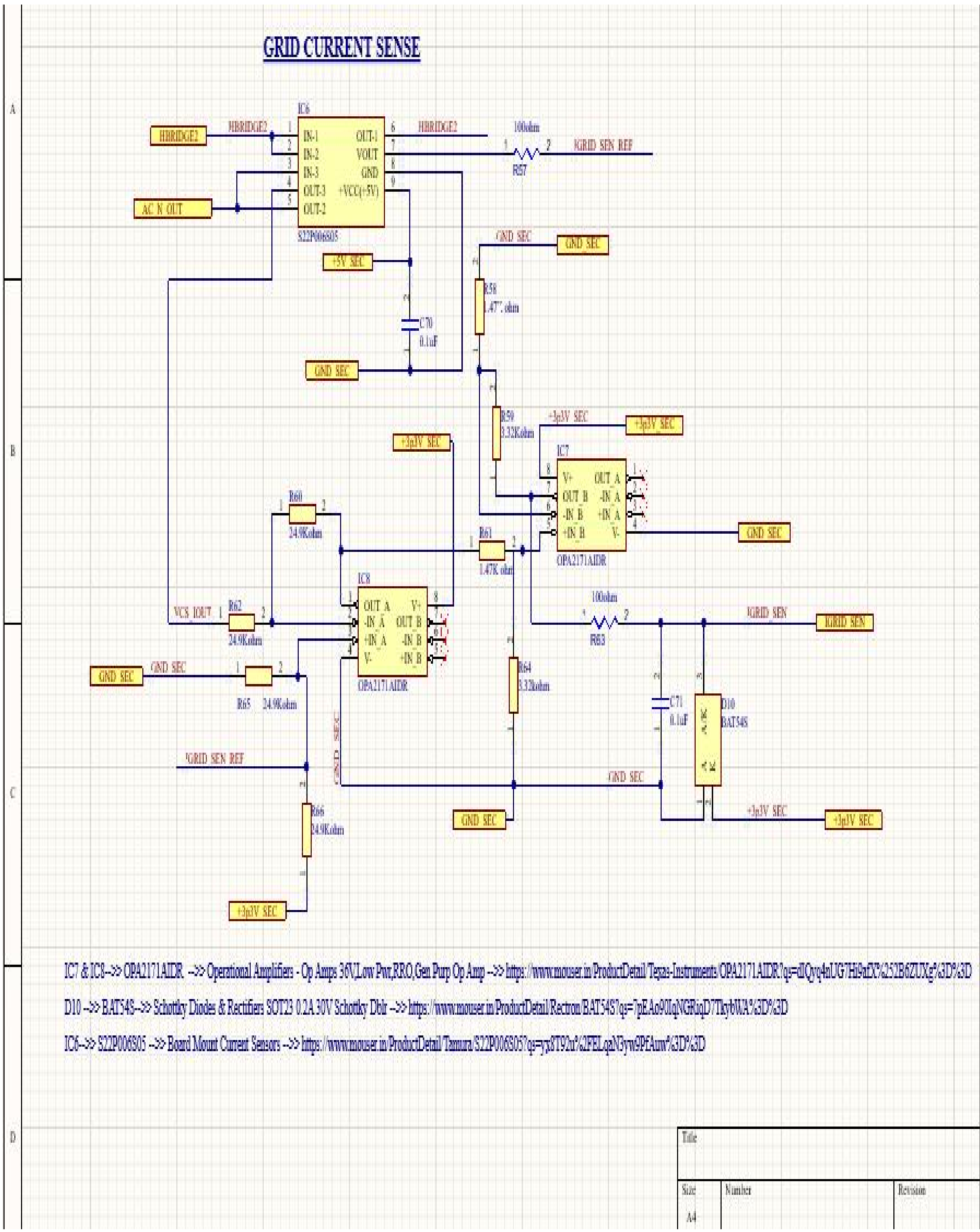
For the second op-amp circuit, Rf = 3.32kΩ, Rin = 1.47kΩ, V2 = 1.34V to 1.96V, and V1 = 0V. As a result, the output voltage is in range between 3.03V and 4.43V

Main Component and Mouser URLs:

IC6-->> S22P006S05 -->> Board Mount Current Sensors -->> https://www.mouser.in/ProductDetail/Tamura/S22P006S05?qs=yx8T92u%2FELqaN3yw9PfAuw%3D%3D

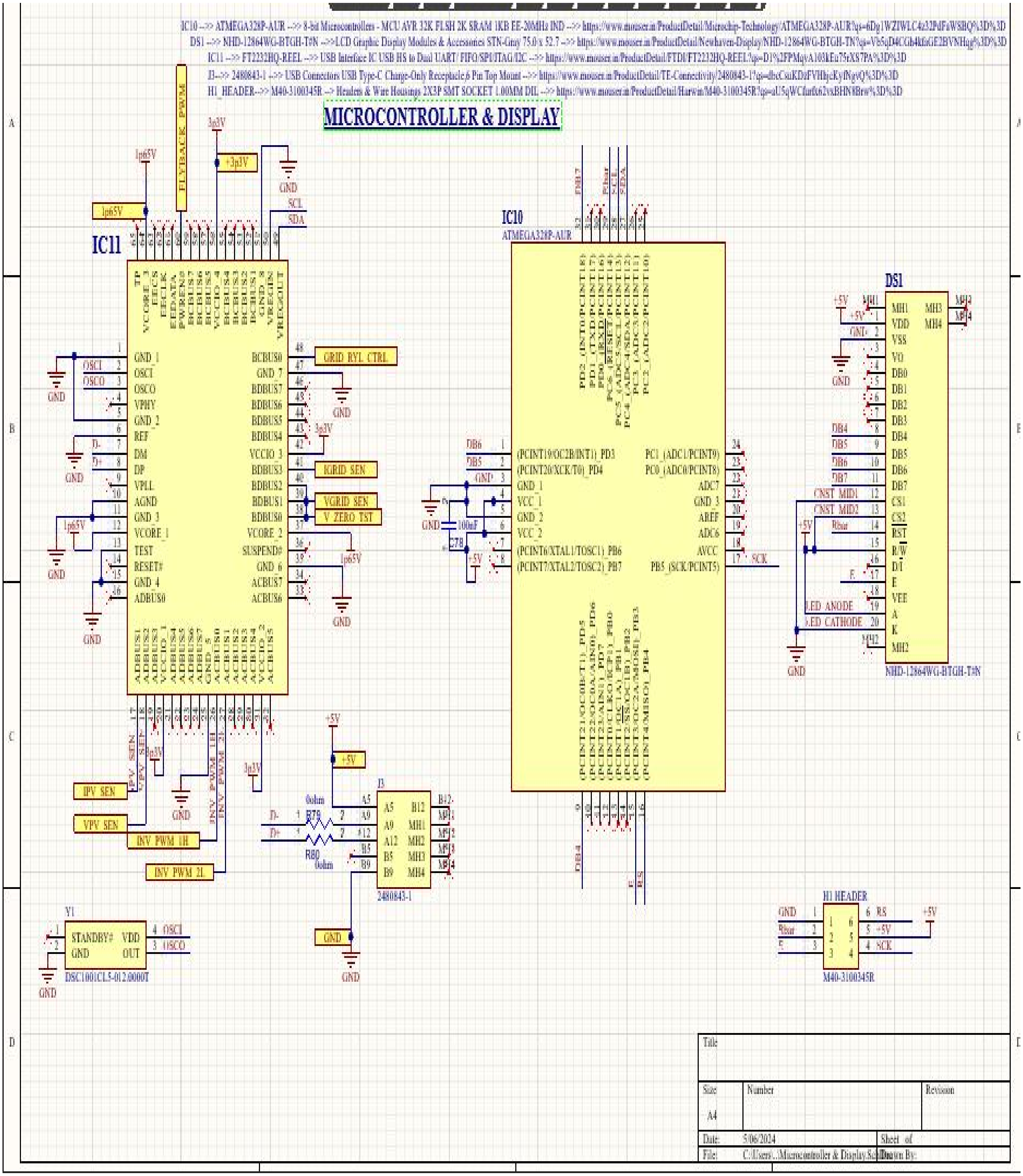
IC7 & IC8-->> OPA2171AIDR -->> Operational Amplifiers - Op Amps 36V,Low Pwr,RRO,Gen Purp Op Amp -->> https://www.mouser.in/ProductDetail/Texas-Instruments/OPA2171AIDR?qs=dIQyq4nUG7Hi9afX%252B6ZUXg%3D%3D

- D10 -->> BAT54S-->> Schottky Diodes & Rectifiers SOT23 0.2A 30V Schottky -->> https://www.mouser.in/ProductDetail/Rectron/BAT54S?qs=7pEAo90IqNGRiqD7TkybWA%3D%3D


GRID CURRENT SENSE
IC6
HBRIDGE2
IN-1
IN-2
IN-3
OUT-3
OUT-2
OUT-1
VOUT
GND
+VCC(+5V)
S22P006S05
AC N OUT
100ohm
R57
IGRID SEN REF
GND SEC
+5V SEC
C70
0.1uF
R58
1.47' ohm
R59
3.32Kohm
+3p3V SEC
IC7
V+
OUT B
-IN B
+IN B
OUT A
-IN A
+IN A
V-
OPA2171AIDR
R60
24.9Kohm
R61
1.47K ohm
IC8
VCS IOUT
R62
24.9Kohm
R65
24.9Kohm
R63
IGRID SEN
R64
3.32kohm
C71
0.1uF
D10
BAT54S
R66
24.9Kohm
IC7 & IC8-->> OPA2171AIDR -->> Operational Amplifiers - Op Amps 36V,Low Pwr,RRO,Gen Purp Op Amp -->> https://www.mouser.in/ProductDetail/Texas-Instruments/OPA2171AIDR?qs=dIQyq4nUG7Hi9afX%252B6ZUXg%3D%3D
D10 -->> BAT54S-->> Schottky Diodes & Rectifiers SOT23 0.2A 30V Schottky Dblr -->> https://www.mouser.in/ProductDetail/Rectron/BAT54S?qs=7pEAo90IqNGRiqD7Tkyb0A%3D%3D
IC6-->> S22P006S05 -->> Board Mount Current Sensors -->> https://www.mouser.in/ProductDetail/Tamura/S22P006S05?qs=yp8T92n%2FELqaN3yw9PfAuw%3D%3D
Title
Size
A4
Number
Revision

`

# ■ Microcontroller & Display :



The microcontroller serves as the central control unit for the microinverter. It collects measurements from the voltage and current measurement blocks and utilizes them to execute an MPPT algorithm, enabling adjustments to be made to the microinverter's operation. Subsequently, the microcontroller generates PWM signals to control the Flyback and inverter gated driver blocks.

For the microcontroller, a FT2232HQ is employed. Several factors contributed to the selection of this microcontroller.

Simulink offers a package for generating CCS projects from Simulink blocks, streamlining the firmware development process for the microinverter and enhancing accessibility for future development efforts.
The FT2232HQ boosts sufficient digital I/O to support the microinverter and additional peripherals, such as USB connectivity to a laptop for external MPPT execution. This robust feature set makes it well-suited for controlling the complex operations of the microinverter.

Display: The microinverter is furnished with a display to facilitate the quick viewing of crucial data such as the PV module voltage, current, and power, along with the current operating mode. For this purpose, a 128x64 pixel monochrome dot matrix LCD has been chosen as the display unit.

This selection offers several advantages: the display's capacity to present large amounts of information simultaneously and its flexibility surpass those of other common display types such as seven-segment LED displays.

Moreover, this display, accompanied by four push-button switches in close proximity, enables the implementation of a simple graphical user interface (GUI). With this interface, various parameters and operating modes can be adjusted without the need to reprogram the microcontroller. The schematic for implementing this 128x64 pixel display typically shows the parallel data interface.

An additional printed circuit board was designed and fabricated to accommodate the LCD and accompanying ATMEGA328P microcontroller on the main microinverter PCB, replacing the original dot matrix LCD. This adapter board features a 6-pin ICSP header, enabling the programming of the ATMega328P microcontroller.

A simple user interface was implemented using the display and the four push buttons, allowing for the operating mode of the inverter and the displayed information to be changed on the fly. Every screen capable of being displayed on the LCD is predefined in the ATMega328P code.

The main MCU sends each piece of data to be displayed on the LCD, as well as control state information, as a separate packet over the I2C bus to the interface MCU. In the event that this communication is unsuccessful, an error message is displayed on the LCD to prevent outdated information from being mistaken for correct information.

Main Component and  Mouser URLs:

IC10 -->> ATMEGA328P-AUR -->> 8-bit Microcontrollers - MCU AVR 32K FLSH 2K SRAM 1KB EE-20MHz IND -->> https://www.mouser.in/ProductDetail/Microchip-Technology/ATMEGA328P-AUR?qs=6Dg1WZIWLC4z32PdFaWSBQ%3D%3D

DS1 -->> NHD-12864WG-BTGH-T#N -->>LCD Graphic Display Modules & Accessories STN-Gray 75.0 x 52.7 -->> https://www.mouser.in/ProductDetail/Newhaven-Display/NHD-12864WG-BTGH-TN?qs=Vb5qD4CGh4kfaGE2BVNHqg%3D%3D

IC11 -->> FT2232HQ-REEL -->> USB Interface IC USB HS to Dual UART/ FIFO/SPI/JTAG/I2C -->> https://www.mouser.in/ProductDetail/FTDI/FT2232HQ-REEL?qs=D1%2FPMqvA103kEu75rXS7PA%3D%3D

J3-->> 2480843-1 -->> USB Connectors USB Type-C Charge-Only Receptacle,6 Pin Top Mount -->> https://www.mouser.in/ProductDetail/TE-Connectivity/2480843-1?qs=dbcCsuKDzFVHhjcKyfNgvQ%3D%3D

H1_HEADER-->> M40-3100345R --> Headers & Wire Housings 2X3P SMT SOCKET 1.00MM DIL -->> https://www.mouser.in/ProductDetail/Harwin/M40-3100345R?qs=aU5qWCfurfx62vxBHN8Brw%3D%3D

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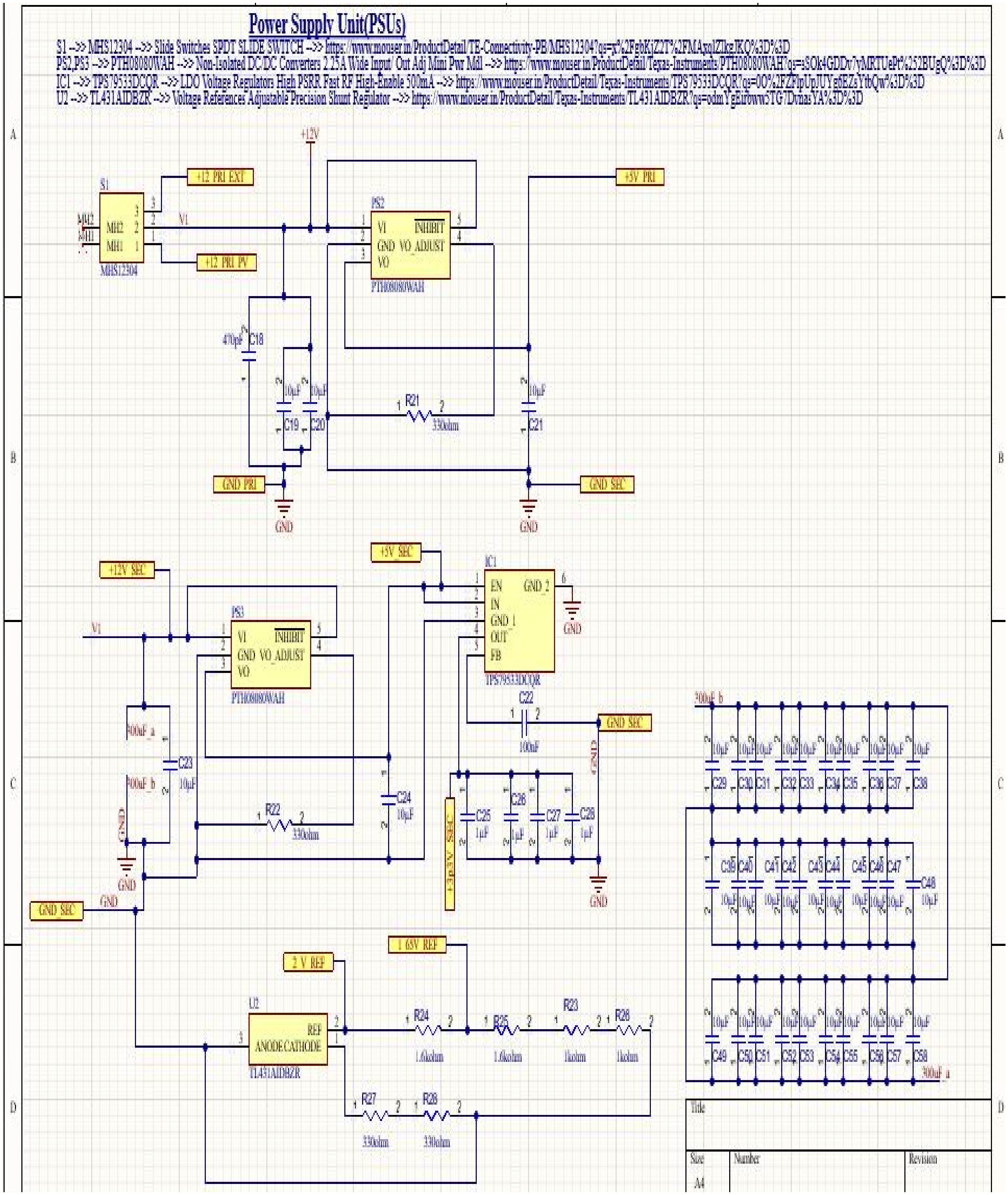
## ■ Power Supply Units(PSUs):



To provide power to the microinverter, multiple circuits are employed to generate reference voltages and power supplies.

For the primary side components, the circuit is utilized. To supply a +12V primary voltage, a slide switch is incorporated to allow for switching between +12V from the PV module or +12V from an external power supply.

Additionally, to provide a +5V primary supply, a PTH08080WAH switching voltage regulator is employed to step down +12V to +5V . Resistor R2 is chosen to be 330Ω to ensure the output voltage is precisely 5V. Capacitors C6-7 are included to ensure the input capacitance is at least 100µF, and C10 serves as a decoupling capacitor on the output to filter noise.

To power the secondary side components, the circuit depicted is employed. The +12V secondary and +5V secondary supplies are provided in the same manner as those utilized for the primary supplies.

For the +3.3V secondary supply, a TPS79533DCQR linear regulator is utilized. Capacitors C3-C5 serve as decoupling capacitors to filter noise.

To provide a 2.5V reference, a TL431AIDBZR shunt regulator is employed. Resistor R3 is calculated to be 510Ω to ensure 1.5mA can be used by the 2.5V reference. For the 1.65V reference, a voltage divider is employed with the 2.5V reference

Main Components & Mouser URLs:

S1 -->> MHS12304 -->> Slide Switches SPDT SLIDE SWITCH -->> https://www.mouser.in/ProductDetail/TE-Connectivity-/MHS12304?qs=x%2FgbKjZ2T%2FMAxqlZIkgJKQ%3D%3D

PS2,PS3 -->> PTH08080WAH -->> Non-Isolated DC/DC Converters 2.25A Wide Input/ Out Adj Mini Pwr Mdl -->> https://www.mouser.in/ProductDetail/Texas-Instruments/PTH08080WAH?qs=sSOk4GDDv7yMRTUePt%252BUgQ%3D%3D

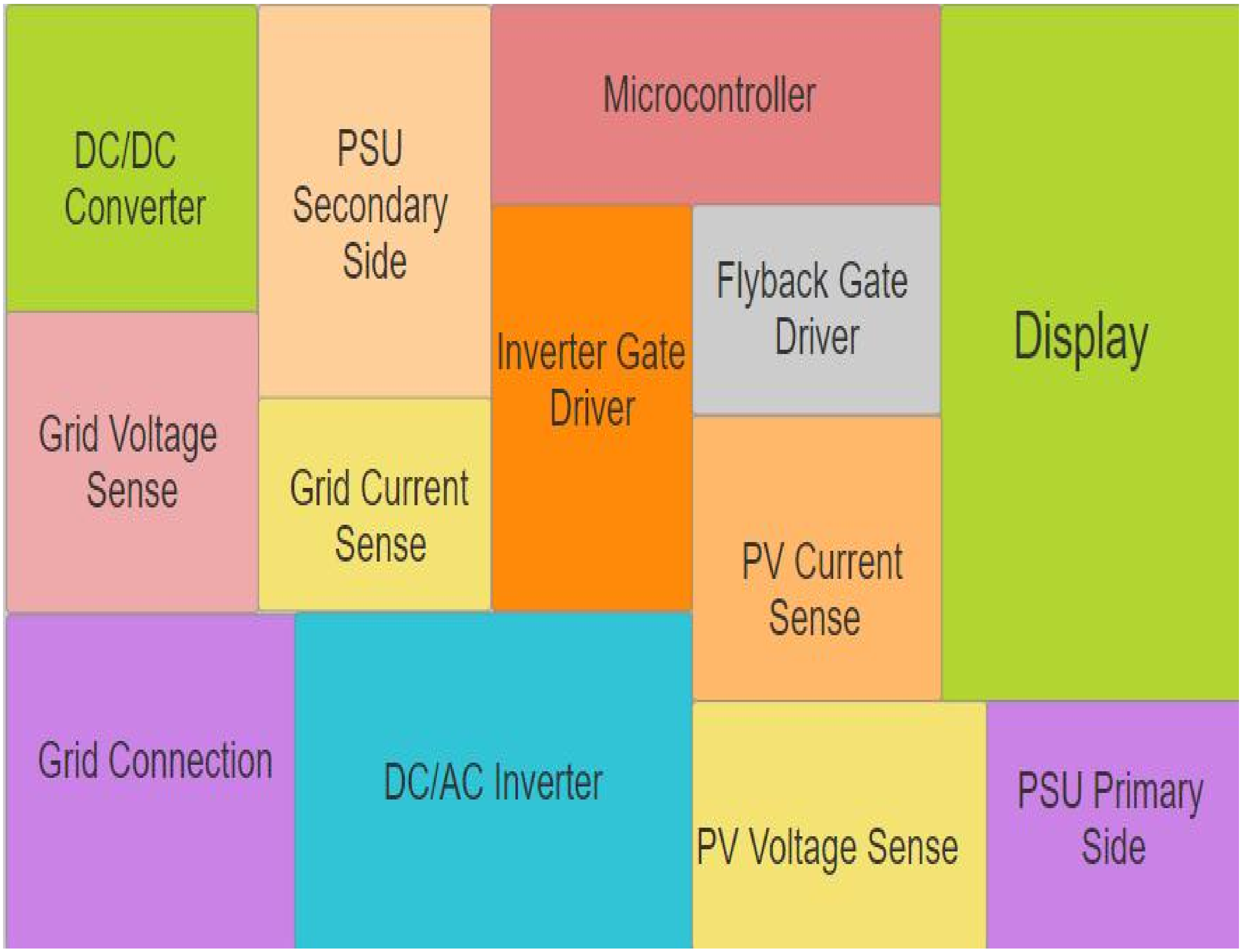
IC1 -->> TPS79533DCQR -->> LDO Voltage Regulators High PSRR Fast RF High-Enable 500mA -->> https://www.mouser.in/ProductDetail/Texas-Instruments/TPS79533DCQR?qs=0O%2FZFlpUpJUYg6EZsYtbQw%3D%3D

U2 -->> TL431AIDBZR -->> Voltage References Adjustable Precision Shunt Regulator -->> https://www.mouser.in/ProductDetail/Texas-Instruments/TL431AIDBZR?qs=odmYgEirbww5TG7DvnasYA%3D%3D

## ■ PCB Board Design And Layout Room:

- While Designing the PCB we have use size of PCB with Width 172.085mm and Height of 115.57mm and the track width was 0.254mm
- Also we had validated the project Schematic before moving to Layout and we removed all schematic validation error also.
- And the DRC Violation were coming zero after using altium rules provided by Prof.Kurian
- We had done polygon poured on both sides of PCB.

## LAYOUT ROOMS FOR EACH BLOCKS:



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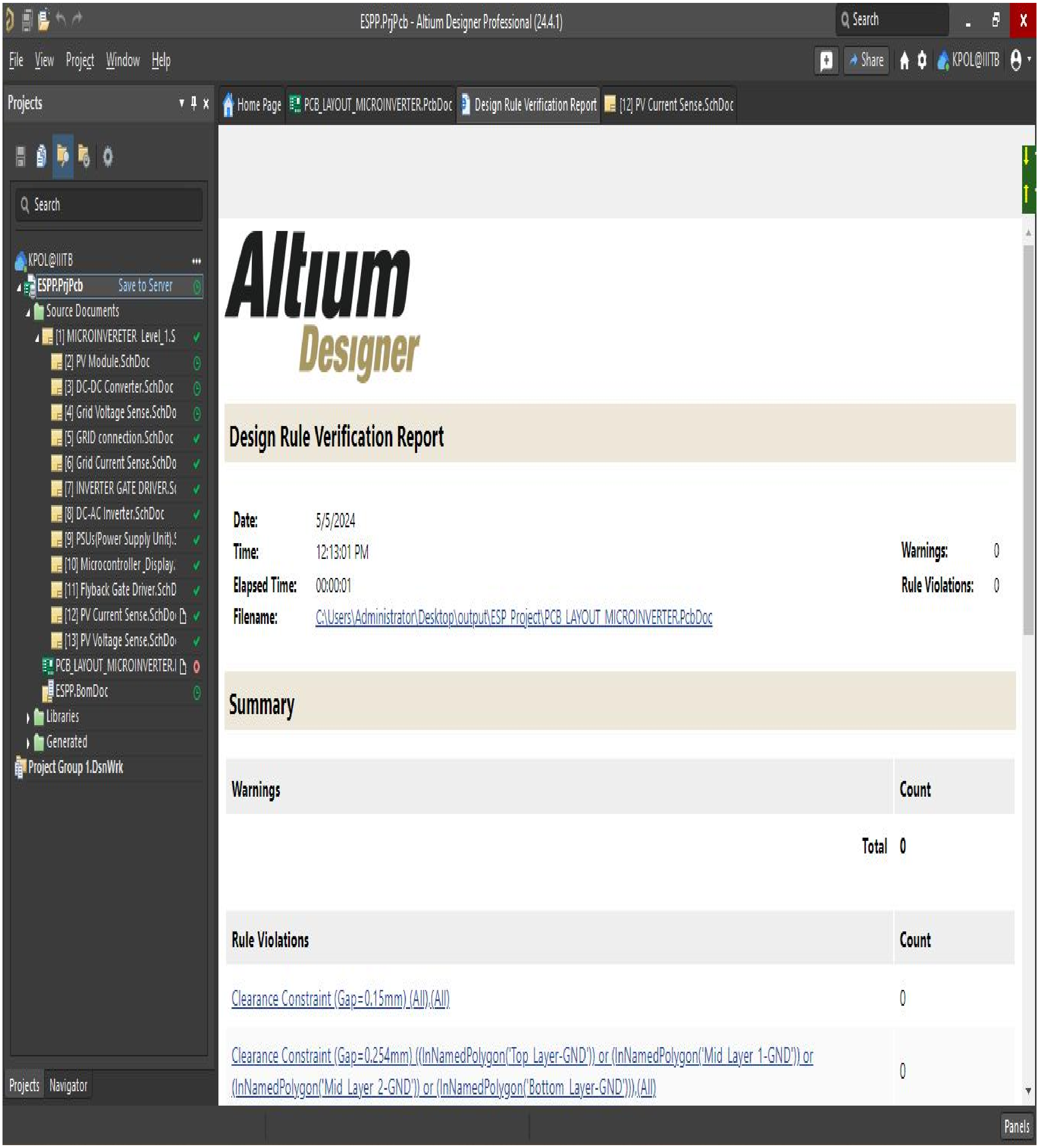
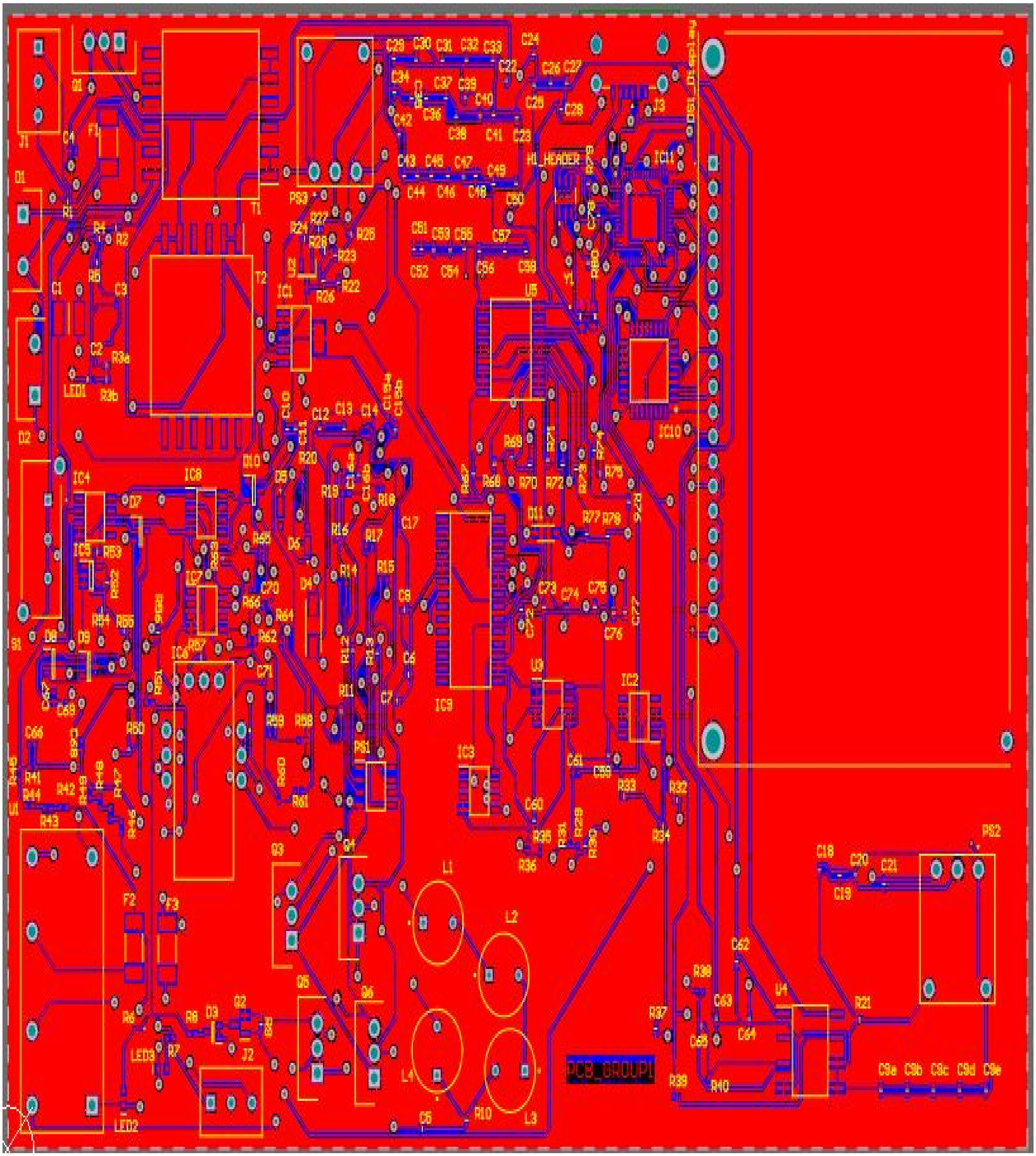
## ZERO DRC VIOLATION:



## ■ **POLYGON POUR TOP LAYER:**



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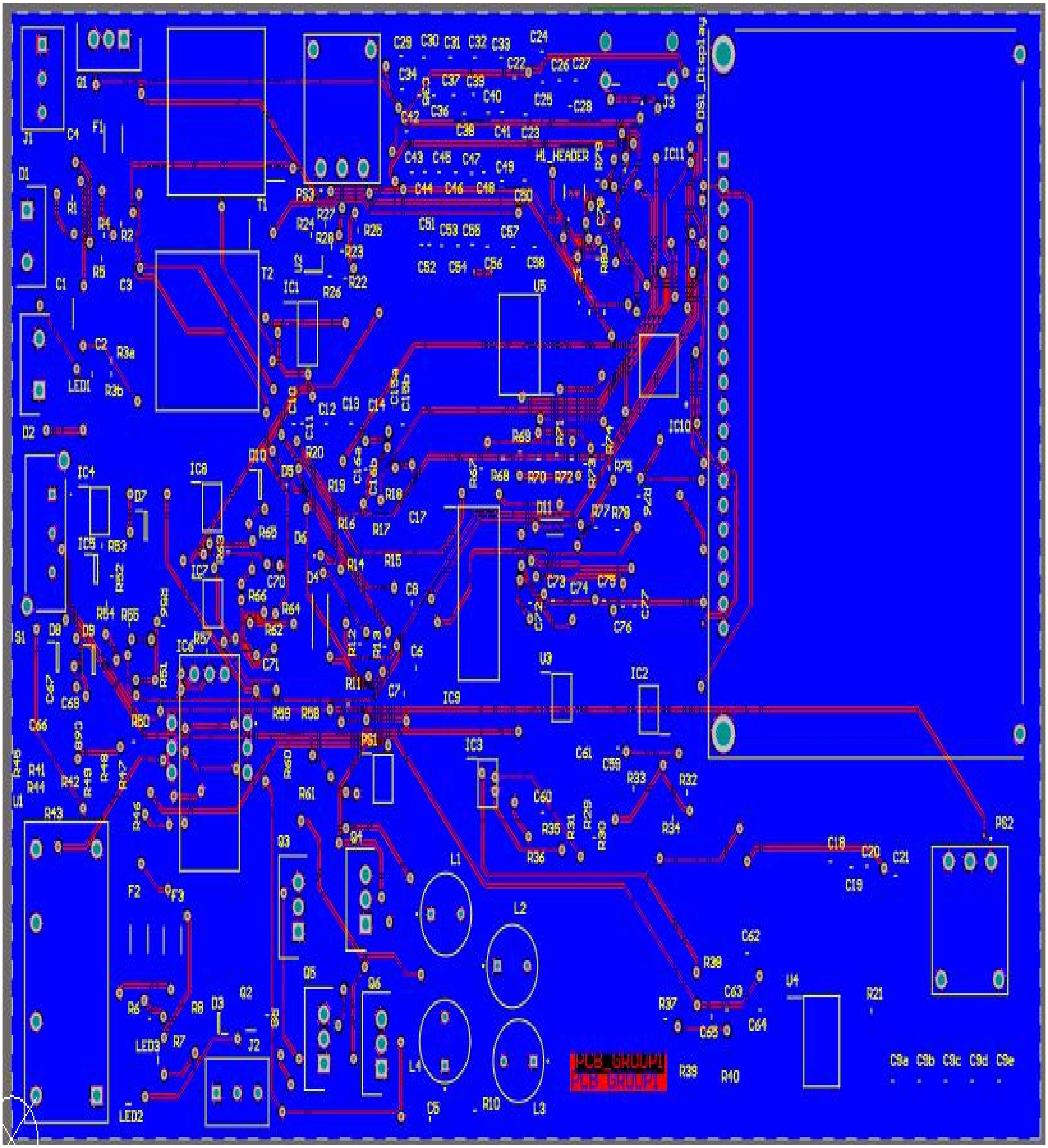
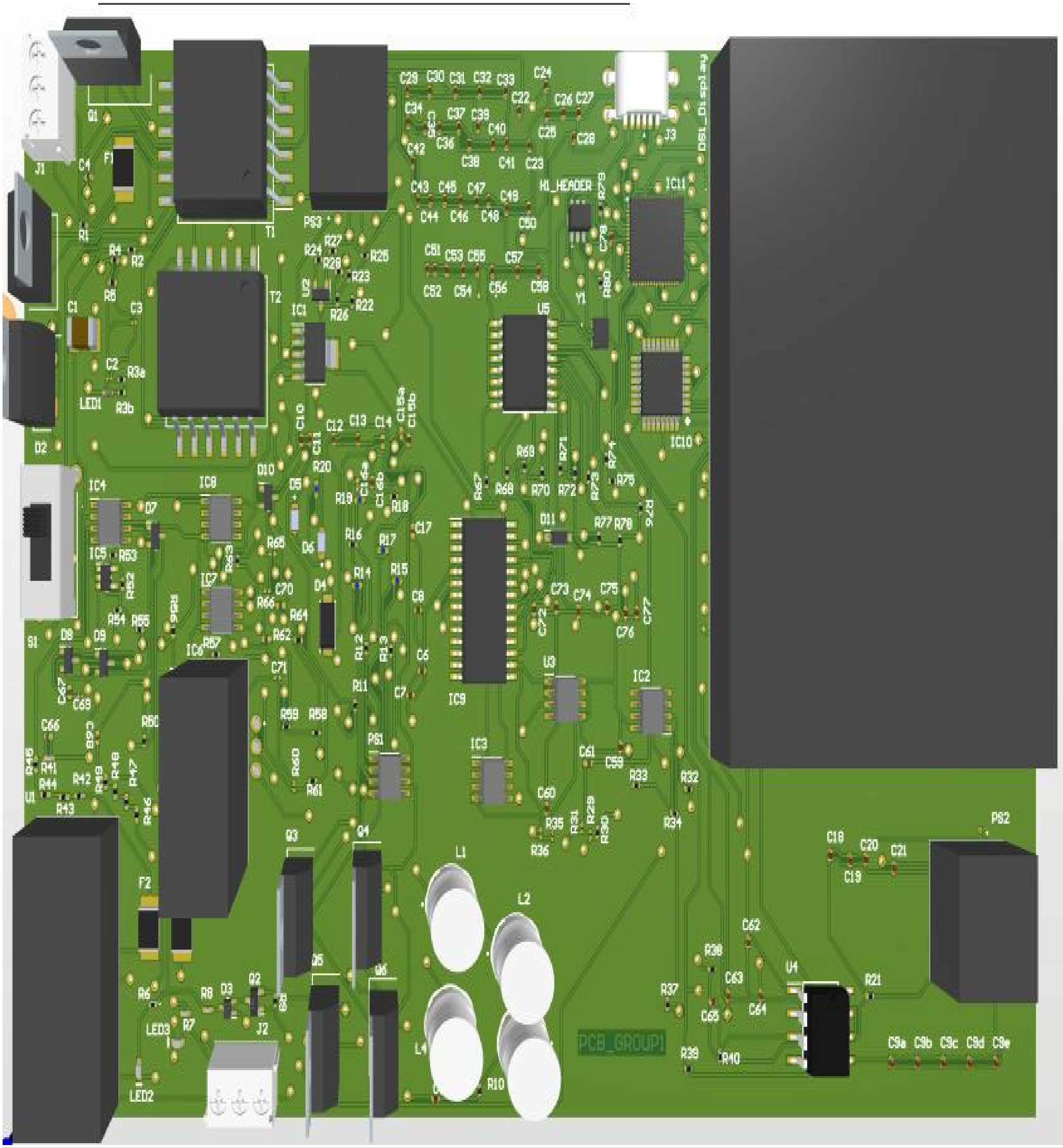
## ■ POLYGON POUR BOTTOM LAYER:



## ■ PCB 3D DESIGN:



## ■ BOM SHEET:

| Name | Designator | Quantity | Manufacturer 1 | Manufacturer Part Number 1 | Supplier Part Number 1 | Supplier Subtotal 1 |
|---|---|---|---|---|---|---|
| 470uF | C1 | 1 | Kyocera AVX | TPSE477K010R0050 | 581-TPSE477K010R0050 | 21.79 |
| 1uF | C2, C3 | 2 | Murata | GRM55DR72E105KW01L | 1828845 | 16.42 |
| 2.2uF | C4 | 1 | Murata | GRM188R71A225KE15D | 81-GRM188R71A225KE15 | 13.34 |
| Capacitor 1µF +/-10% 10V 0402 | C5, C25, C26, C27, C28 | 5 | KEMET | C0402C105K8PACTU | 1903036 | 15.43 |
| Capacitor 10µF +/-40% 6.3V 0402 | C6, C7, C8, C9a, C9b, C9c, C9d, C9e, C19, C20, C21, C23, C24, C29, C30, C31, C32, C33, C34, C35, C36, C37, C38, C39, C40, C41, C42, C43, C44, C45, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57, C58, C76, C77 | 45 | Murata | GRM155R60J106ME15D | 81-GRM155R60J106ME15D | 347.64 |
| Capacitor 220nF +/-10% 10V 0402 | C10, C11, C12, C13 | 4 | Yageo | CC0402KRX5R6BB224 | 6894632 | 2 |
| 1000pF | C14, C17 | 2 | Murata | GRM155R71H102KA01D | 81-GRM36X102K50 | 13.34 |
| Capacitor 10pF +/-0.25pF 50V 0402 | C15a, C16a | 2 | Kyocera AVX | 04025A100JAT2A | 1740671 | 14.96 |
| Capacitor 22pF +/-10% 50V 0402 | C15b, C16b | 2 | Vishay | VJ0402A220JXACW1BC | 8804499 | 2.33 |
| Capacitor 470pF +/-10% 50V 0402 | C18, C62, C63, C64, C65 | 5 | Vishay | VJ0402Y471KXACW1BC | 8804533 | 3.34 |
| Capacitor 100nF +/-10% 50V 0402 | C22, C59 | 2 | Murata | GRM155R71H104KE14D | 81-GRM155R71H104KE14D | 12.51 |
| Capacitor 10nF +/-10% 50V 0402 | C60, C72, C73 | 3 | Yageo | CC0402KRX7R9BB103 | 4046377 | 7.5 |
| 0.1uF | C61, C67, C69, C70, C71 | 5 | Murata | GRM155R71C104KA88D | 4185953 | 2.5 |
| 1nF | C66, C68 | 2 | Kyocera AVX | 0603SC102KAT2A | 581-0603SC102K | 16.68 |
| 47uF | C74 | 1 | KEMET | T491D476K025AT | 80-T491D476K025 | 129.24 |
| Capacitor 100nF +/-10% 10V 0402 | C75, C78 | 2 | Yageo | CC0402KRX5R6BB104 | 6894630 | 0.3352 |
| MUR1560G | D1, D2 | 2 | ON Semiconductor | MUR1560G | 1558073 | 138.41 |
| BAV70W | D3 | 1 | ON Semiconductor | BAV70WT1G | 4580563 | 1.33 |
| MURA160T3G | D4 | 1 | ON Semiconductor | MURS160T3G | 863-MURS160T3G | 38.35 |
| VSS1P3L-M3_89A | D5, D6 | 2 | Vishay Semiconductors | VSS1P3L-M3/89A | VSS1P3L-M3/89AGICT-ND | 51.7 |
| BAT54S | D8, D9, D10, D7 | 4 | Diodes | BAT54S-7-F | 3130041 | 42.69 |
| MBR0530T1G | D11 | 1 | ON Semiconductor | MBR0530T1G | 4109993 | 3.92 |
| NHD-12864WG-BTGH-TWN | DS1 | 1 | Newhaven Display | NHD-12864WG-BTGH-TWN | 763-12864WG-BTGH-TN | 2121.3 |
| 1812L050PR | F1, F2, F3 | 3 | Littelfuse | 1812L050PR | 1804786 | 66.54 |
| M40-3100345R | H1 HEADER | 1 | Harwin | M40-3100345R | 855-M40-3100345R | 158.42 |
| TPS79533DCQR | IC1 | 1 | Texas Instruments | TPS79533DCQR | 595-TPS79533DCQR | 21.79 |
| OPA2171AIDR | IC2, IC3, IC4, IC7, IC8 | 5 | Texas Instruments | OPA2171AIDR | 595-OPA2171AIDR | 928.84 |
| LMV7235M5_NOPB | IC5 | 1 | TI National Semiconductor | LMV7235M5/NOPB | 926-LMV7235M5/NOPB | 193.44 |
| S22P006S05 | IC6 | 1 | Tamura | S22P006S05 | 838-S22P006S05 | 1188.17 |
| SM72295MA_NOPB | IC9 | 1 | TI National Semiconductor | SM72295MA/NOPB | 926-SM72295MA/NOPB | 923.62 |
| ATMEGA328P-AUR | IC10 | 1 | Microchip | ATMEGA328P-AUR | 8798111 | 227.63 |
|  | IC11 | 1 | Microchip | AT42QT2160-MMUR | 2775948 | 281.22 |
| 1776275-3 | J1, J2 | 2 | TE Connectivity | 1776275-3 | 1795368 | 22.18 |
| 2400843-1 | J3 | 1 | TE Connectivity | 2400843-1 | 571-2400843-1 | 131.74 |
| ST2-DC12V-F | K1 | 1 | Panasonic | ST2-DC12V-F | 1065844 | 657.04 |
| RL622-101K-RC | L1, L2, L3 | 3 | Bourns | SDR0403-102KL | 0491891 | 42.52 |
| RL622-101K-RC | L4 | 1 | Bourns | SRN8040-101M | SRN8040-101MCT-ND | 38.35 |
| QBLP595-R | LED1 | 1 | QT-Brightek | QBLP595-R | 1516-1217-1-ND | 28.35 |
| LTW-C191TS5 | LED2, LED3 | 2 | Vishay Lite-On | LTW-C191TS5 | 6102050 | 75.04 |

| | | | | | | |
|---|---|---|---|---|---|---|
| UCC27710D | PS1 | 1 | Texas Instruments | UCC27710D | 296-47513-ND | 149.25 |
| PTH08080WAH | PS2, PS3 | 2 | Texas Instruments | PTH08080WAH | 595-PTH08080WAH | 142.49 |
| IRFB4310PBF | Q1 | 1 | Infineon | IRFB4310PBF | 4785275 | 155.92 |
| 2N7002 | Q2 | 1 | Infineon | 2N7002 | 4798193 | 3.59 |
| SIHP25N40D-GE3 | Q3, Q4, Q5, Q6 | 4 | Vishay Siliconix | SIHP25N40D-GE3 | 78-SIHP25N40D-GE3 | 977.22 |
| Resistor 200K +/-1 % 0402 63 mW | R1, R2, R4, R5, R55 | 5 | Bourns | CR0402-FX-2003GLF | 3SAK7319 | 0.8358 |
| Resistor 12.1K +/-1 % 0402 63 mW | R3a | 1 | Panasonic | ERJ-2RKF1212X | 7376473 | 0.33152 |
| Resistor 22K +/-1 % 0402 63 mW | R3b | 1 | Panasonic | ERJ-2RKF2202X | 5368363 | 0.50028 |
| 470ohm | R6 | 1 | Vishay | CRCW0402470RFKED | 7206795 | 0.4169 |
| 150K ohm | R7 | 1 | Panasonic | ERJ-U2VF1503V | 6495332 | 0.58366 |
| 200ohm | R8 | 1 | Vishay | CRCW0603200RFKEA | 6135360 | 0.8358 |
| Resistor 10K +/-1 % 0402 63 mW | R9, R52, R69, R70, R71, R72, R77, R78 | 8 | Bourns | CR0402-FX-1002GLF | 2045113 | 5.84 |
| Resistor 10R +/-1% 0402 63 mW | R10 | 1 | Bourns | CR0402-FX-10R0GLF | 2928203 | 6.07 |
| Resistor 2R2 +/-5% 0402 63 mW | R11, R12, R13, R74, R75 | 5 | Bourns | CR0402-JW-2R2GLF | 652-CR0402-JW-2R2GLF | 4.17 |
| 0ohm | R14, R15, R17, R19, R20 | 5 | Yageo | RC0805JR-100RL | 603-RC0805JR-100RL | 12.51 |
| 49.9ohm | R16, R18 | 2 | Bourns | CAT16-49R9F4LF | 6134708 | 2.83 |
| Resistor 330R +/-5 % 0402 63 mW | R21, R22, R27, R28 | 4 | Vishay Dale | CRCW0402330RJNED | 5996728 | 1 |
| Resistor 1K +/-5 % 0402 63 mW | R23, R26, R53 | 3 | Bourns | CR0402-JW-102GLF | 3SAK7361 | 0.25014 |
| Resistor 1K6 +/-5 % 0402 63 mW | R24, R25 | 2 | Yageo | RC0402JR-071K6L | 603-RC0402JR-071K6L | 9.17 |
| 24.9Kohm | R29, R31, R35, R36, R60, R62, R65, R66 | 8 | Panasonic | ERJ-2RKF2492X | 7376498 | 1.33 |
| Resistor 2K2 +/-5 % 0402 63 mW | R30, R37 | 2 | Vishay Dale | CRCW04022K20JNED | 5996710 | 0.50028 |
| Resistor 5K6 +/-5 % 0402 63 mW | R32, R34 | 2 | Panasonic | ERJ-2GEJ562X | 5394172 | 0.50028 |
| Resistor 100R +/-1 % 0402 63 mW | R33, R50, R54, R57, R63, R67, R68 | 7 | Yageo | RC0402FR-07100RL | 9BK7495 | 1.17 |
| 19.6K ohm | R38 | 1 | TE Connectivity | RP73PF1J19K6BTDF | A110763CT-ND | 40.21 |
| 51.0ohm | R39 | 1 | Vishay | CRCW060351R0FKEA | 5208896 | 0.4169 |
| 120ohm | R40 | 1 | Panasonic | ERJ-3EKF1200V | 6495313 | 0.33152 |
| 7.5K | R41, R51 | 2 | Aumann | V8X8V | AE10831-ND | 151.86 |
| 475 | R42, R43, R44, R45, R46, R47, R48, R49 | 8 | Panasonic | ERA-6AEB475V | 667-ERA-6AEB475V | 65.87 |
| 1K82J | R56 | 1 | Rohm | KTR18EZPJ182 | RHM1.8KPCT-ND | 14.17 |
| 1.47K ohm | R58, R61 | 2 | TE Connectivity | RP73PF1J1K47BTDF | A110751CT-ND | 78.38 |
| 3.32Kohm | R59 | 1 | Panasonic | ERJ-3EKF3321V | P3.32KHCT-ND | 695.23 |
| 3.32kohm | R64 | 1 | Panasonic | ERJ-3EKF3321V | P3.32KHCT-ND | 695.23 |
| 100R2F | R73, R76 | 2 | Bivar | R2F-1.0-BLU | 749-R2F-1.0-BLU | 920.52 |
| 0R2J | R79, R80 | 2 | TT Welwyn | W21OR2J | 98K3140 | 196.78 |
| VCS0402H100D0Z100 | R? | 1 | Vishay BComponents | VCS0402H100D0Z100 | 594-VCS0402H100D0Z21 | 64.2 |
| MHS12304 | S1 | 1 | TE Connectivity | MHS12304 | 505-MHS12304 | 195.94 |
| DA2033-ALD | T1, T2 | 2 | Coilcraft | DA2033-ALD | 994-DA2033-ALD | 1495.82 |
| TL431AIDBZR | U2 | 1 | Texas Instruments | TL431AIDBZR | 595-TL431AIDBZR | 20.18 |
| ACS723LLCTR-20AB-T | U3 | 1 | Allegro Microsystems | ACS723LLCTR-20AB-T | 620-1644-1-ND | 476.93 |
| AMC1200SDUBR | U4 | 1 | Texas Instruments | AMC1200SDUBR | 595-AMC1200SDUBR | 990.22 |
| ISO7240CFDWR | U5 | 1 | Texas Instruments | ISO7240CFDWR | 595-ISO7240CFDWR | 416.91 |
| DSC1001CL5-012.0000T | Y1 | 1 | Microchip | DSC1001CL5-012.0000T | 998-1001CL5012.0000T | 213.46 |

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## ■ ROLE OF EACH MEMBER:

- **Pratikkumar Solanki:** LEVEL 1 Presentation and Project selection was done by him. In Level2 Schematics of Project, 3 Blocks in which Microcontroller and Display was difficult block which was taken care and made by him and PV Module and DC-DC converter were made by him .
- PCB Layout component positioning and arranging in Rooms of each blocks in Layout was done and One Block Room connection was done by him also DRC Final errors which was difficult to detect was Removed by him after trying for 2days .
- Also the Footprint error after moving files was lastly not resolving was solved by him. Also added more perfection to project by validating the project generating one pdf sheet for BOM was done by him.
- As well as the Report making for presentation 1 and final presentation was done by him and also he only presented the presentation mostly in class and final submission was made by him through Onedrive after editing and adding URL of ICs in all sheets as once told by professor in class.

- **Nitish Kumar:** Material and resources of project was helped by him online. Level 1 help in schematic and Level 2 total 5 block were made by him of DC-AC Inverter, PV Voltage Sense, PV Current Sense,Flyback Gate Driver, Inverter Gate Driver.
- Also Layout connection manual of all other block rooms except 1 block room were done by him with resolving most of DRC errors which were of overlay and Vias. Also Lastly the Footprint component library change and component replacement were done by him from SCH Library.

- **Priyansh Pandya:** Final Resource for project was searched by him and that resource was used for this project.Also the LEVEL 2 Schematics of the circuit 4 block made by him were PSU(Power Supply Unit), Grid Connection ,Grid Current Sense, Grid Voltage sense were  made by him.He prepare layout structure image online to add into report.
- Also the BOM of the Project was created by him.

## REFERENCES:


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