Single-Phase Full-Bridge Inverter

Module 6 – Power Electronics Laboratory

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Project Context

This module focuses on building a low-power single-phase full-bridge inverter using:

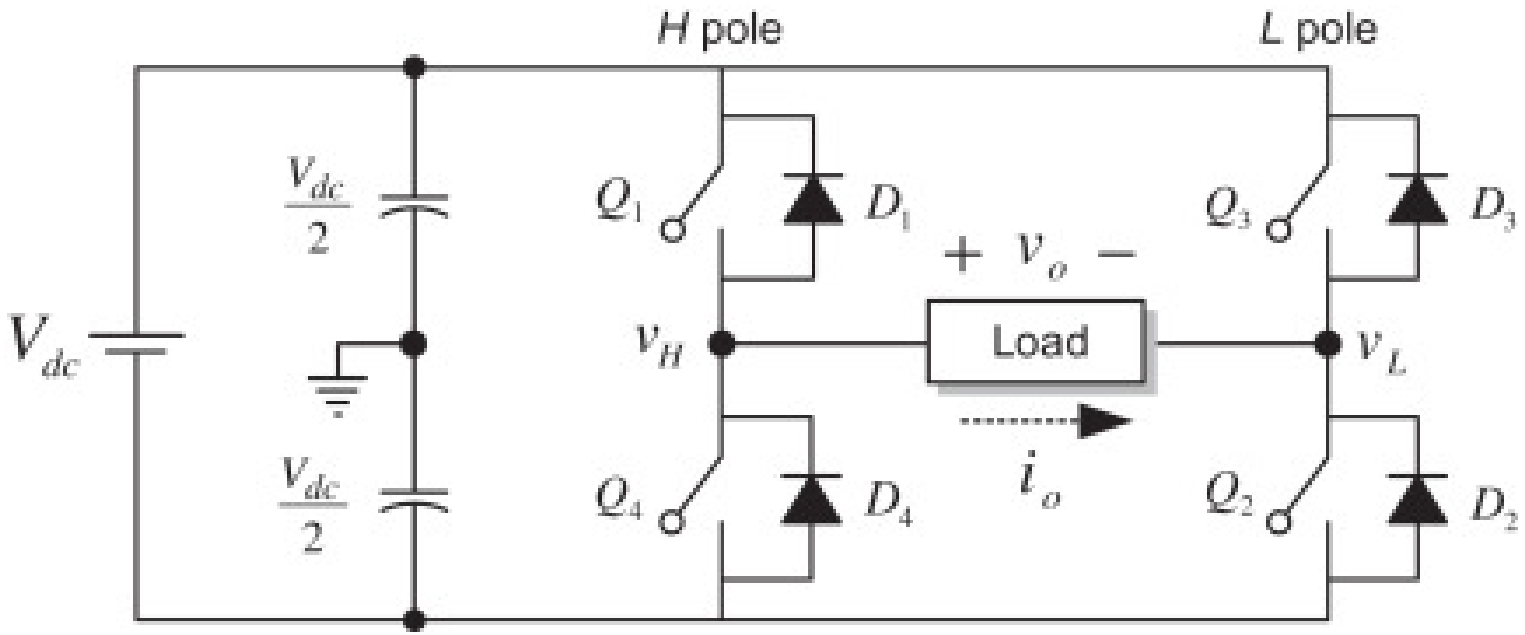
- Arduino-generated SPWM signals,
- IR2110 high/low-side drivers,
- Four N-channel MOSFETs in a full H-bridge.

The goal was to convert a 12 V DC supply into a 120 V AC–shaped waveform using unfiltered SPWM. The implementation followed the reference design exactly.

What is a Full-Bridge Inverter?

A full-bridge inverter is an electronic converter that transforms DC power into AC by switching four power transistors in an H configuration.

- Can generate positive and negative output voltages.
- Forms the basis of UPS systems, motor drives, and renewable energy inverters.
- The output waveform depends on the modulation strategy.



General Operation

The circuit operates by switching MOSFET pairs:

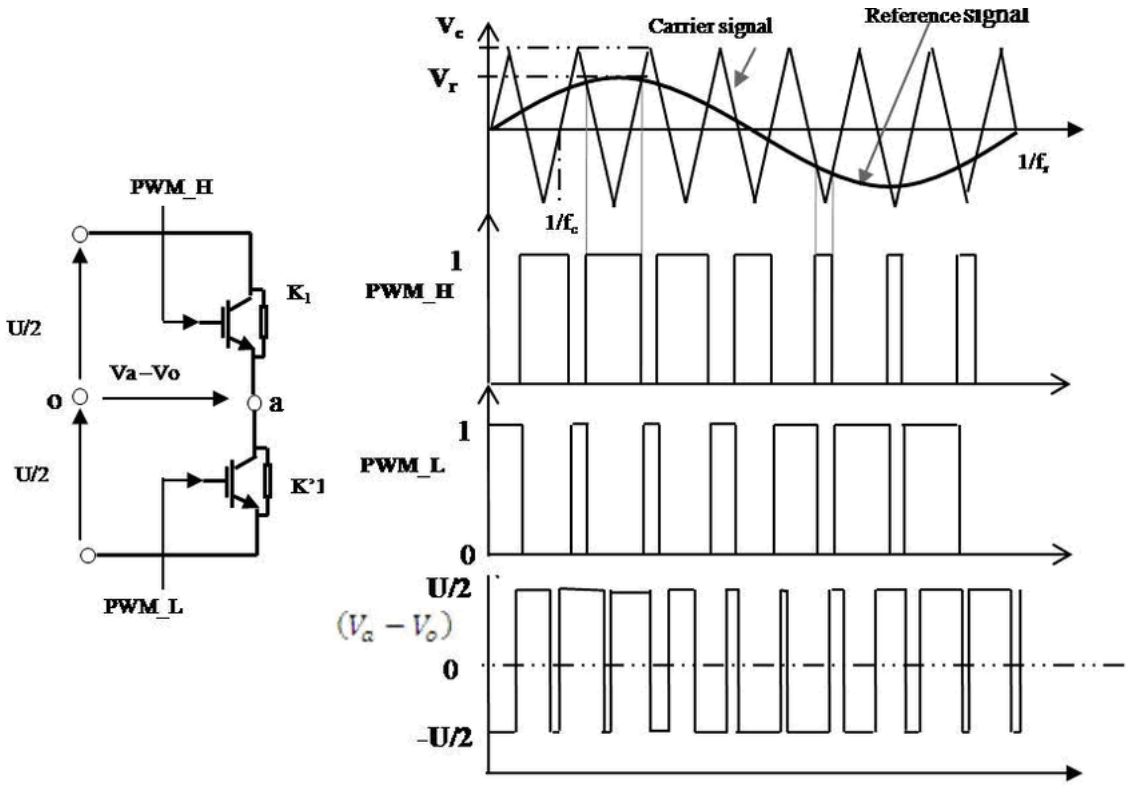
- One pair produces the positive half-cycle.
- The opposite pair produces the negative half-cycle.

The Arduino controls this switching through SPWM pulses whose width follows a sinusoidal pattern, creating an AC waveform from a DC supply.

Sinusoidal PWM (SPWM)

SPWM adjusts the width of each pulse to approximate a sine wave.

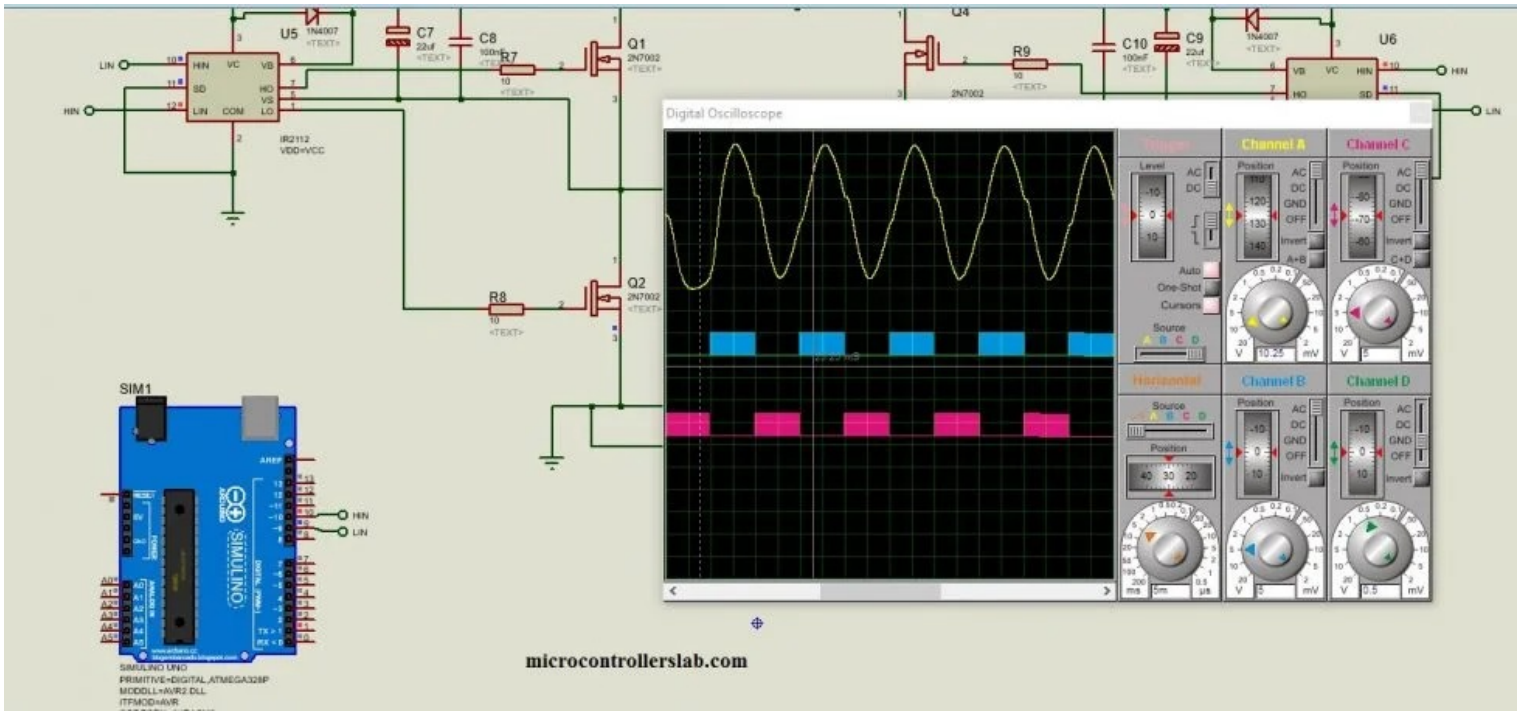
- Simple, efficient, widely used in power electronics.
- Arduino generates two complementary SPWM outputs.
- The output load receives a high-frequency pulse train whose envelope resembles a sine wave.



Arduino Uno

The Arduino Uno acts as the SPWM generator.

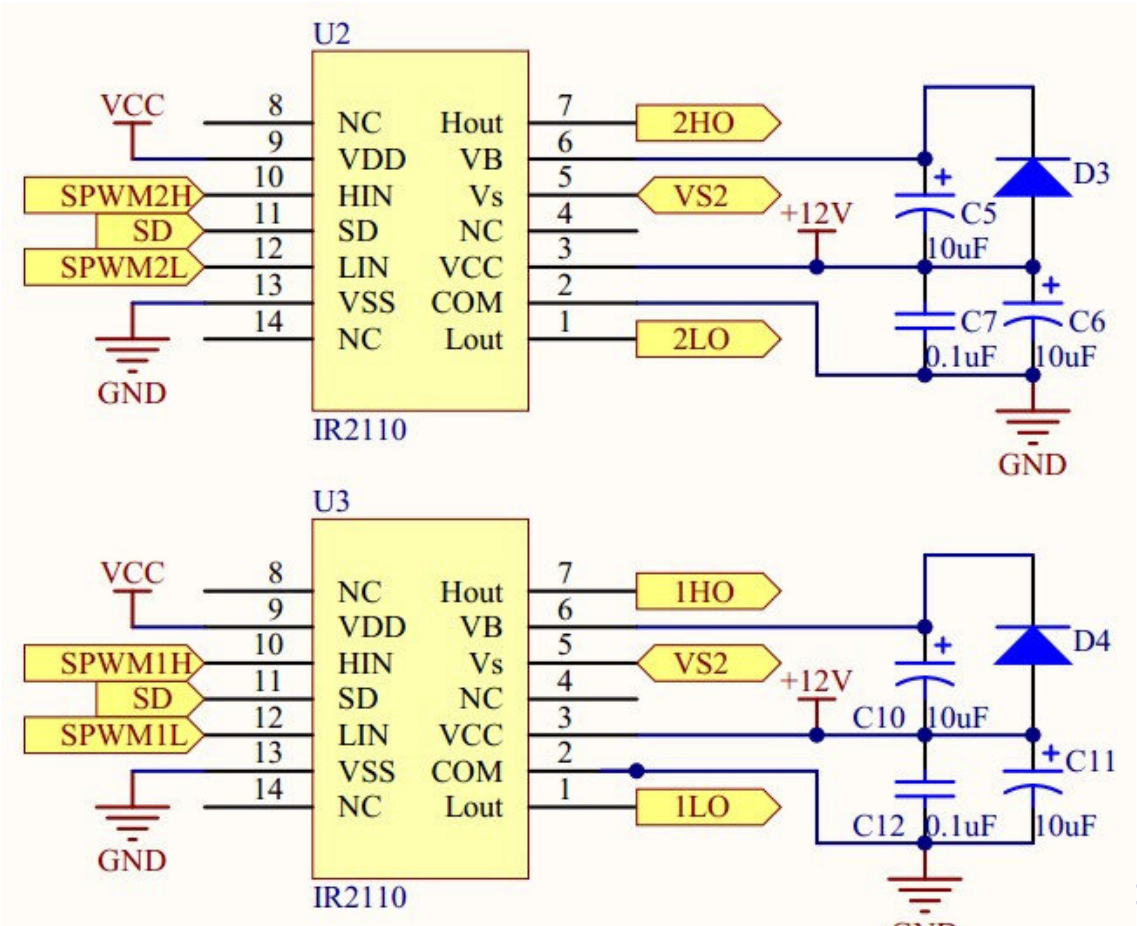
- Produces the pulse sequence for both half-cycles.
- Provides timing control.
- Includes a start-up delay to avoid undefined states.



IR2110 Gate Driver

The IR2110 allows an Arduino (5 V logic) to control MOSFETs on both low- and high-side positions.

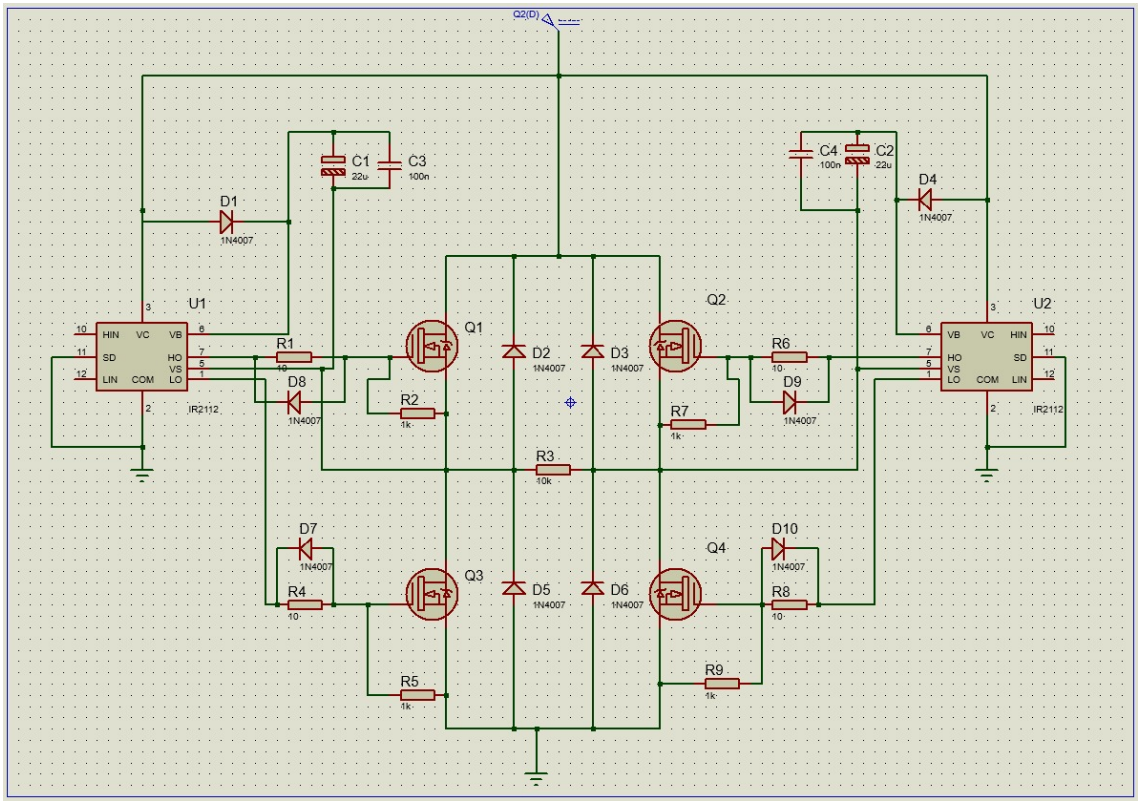
- Provides proper gate voltage levels.
- Uses bootstrap capacitors for high-side MOSFETs.
- Ensures fast and safe switching.



MOSFET H-Bridge

Four N-channel MOSFETs form the full H-bridge:

- High efficiency
- Low conduction losses
- Provide the AC polarity reversal



Materials Used

Control and Drivers

- Arduino Uno R3
- IR2110 drivers (2×)
- Bootstrap capacitor + diode network

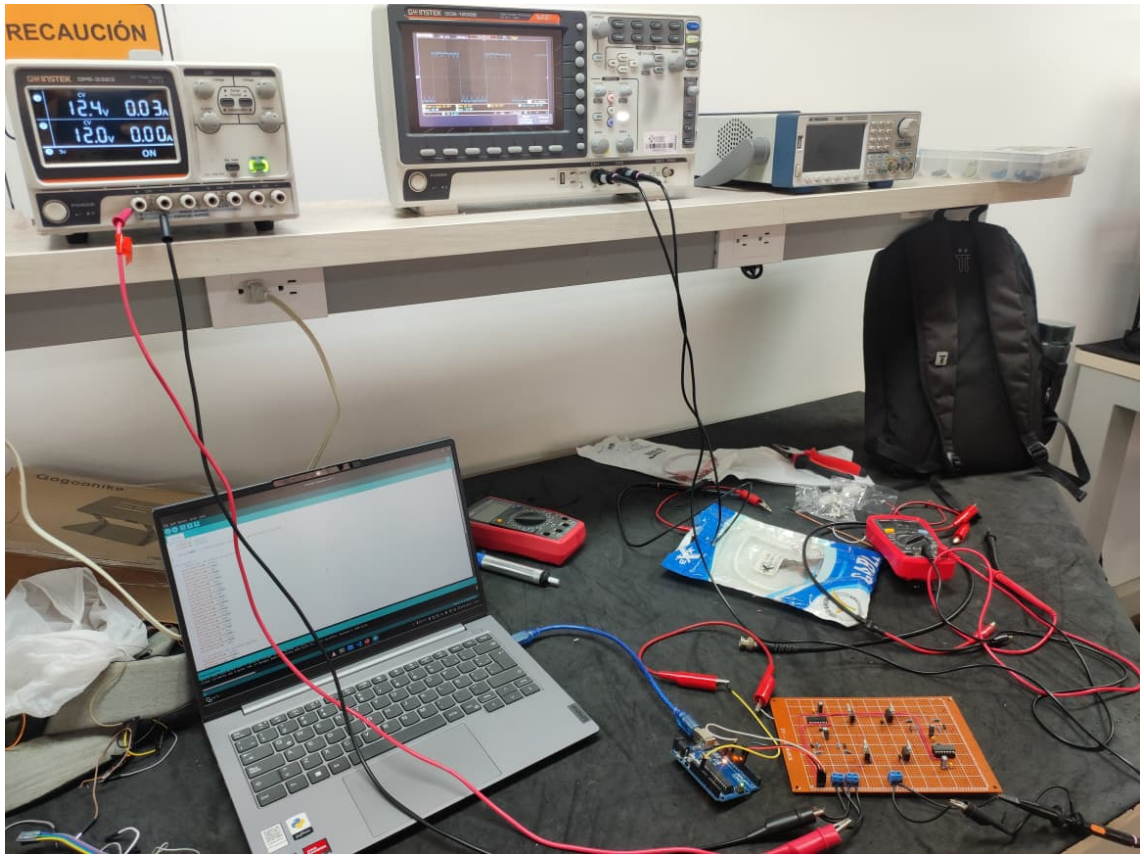
Power Stage

- 4 MOSFETs (IRF3205 or equivalent)
- 150 gate resistors
- 1 k pull-down resistors

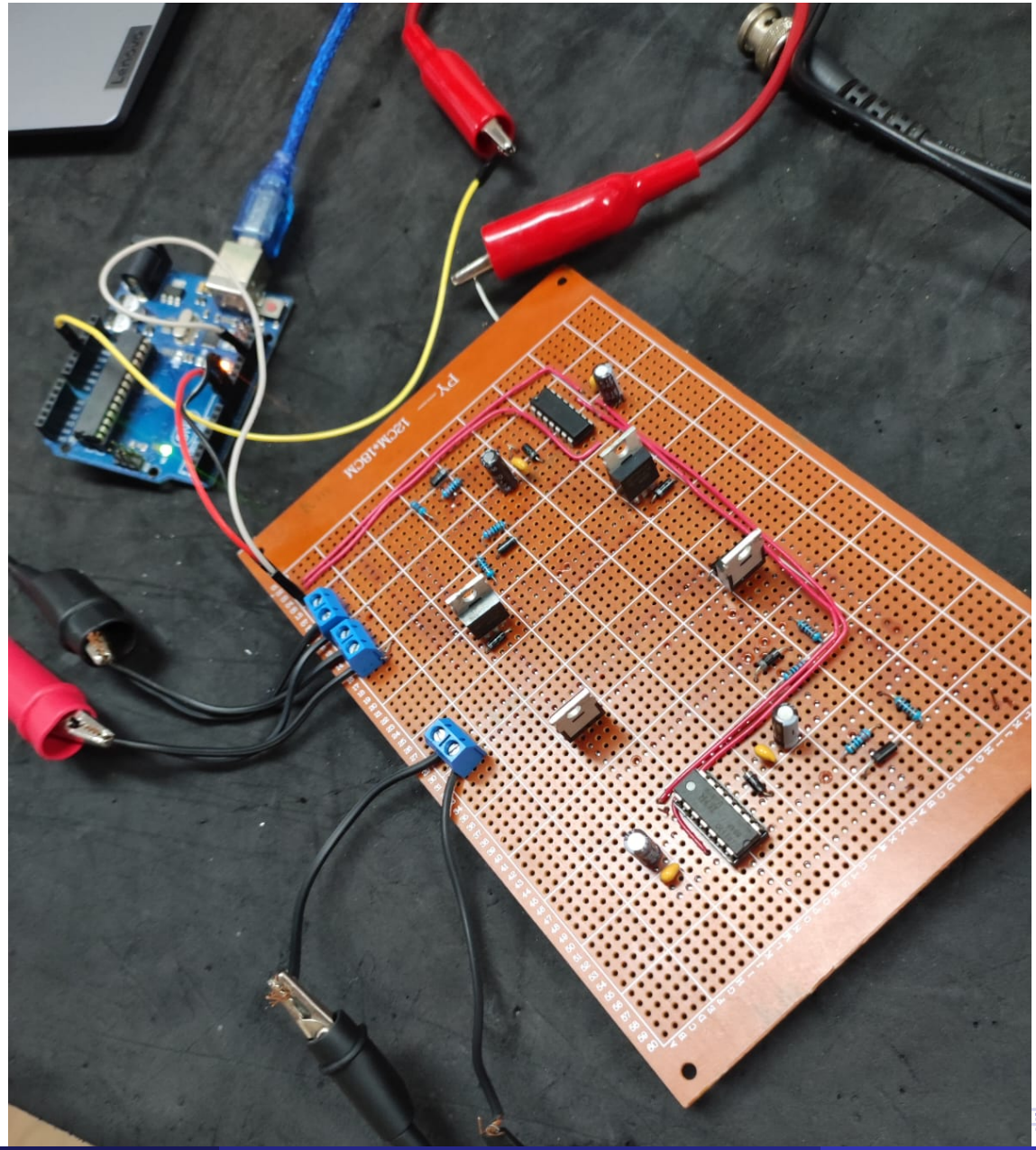
Equipment

- 12.4 V bench supply
- Oscilloscope, multimeter

Laboratory



Laboratory Setup



Observations

- Correct SPWM signals at Arduino outputs.
- IR2110 showed stable high/low-side operation.
- MOSFETs switched without cross-conduction.
- Output waveform matched simulation and theory.
- Supply during tests: approx. 12.4 V.

Conclusions

The full-bridge inverter prototype worked as expected. SPWM modulation successfully produced the pseudo-sinusoidal output, and the driver stage operated reliably. Future improvements:

- Add LC filtering
- Implement feedback control
- Power the inverter from a rectifier stage

References

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