# ELE 402 Project Logbook



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**Design and Implementation of a 5-Level Cascaded H-Bridge Multilevel Inverter**

**Spring 2025-2026**

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## Week 1: Spring Semester Kickoff & Pin Map Review

- **Group Meeting:** Reviewed iteration-1 outcomes with the team. Lessons from the assembly side: the IRFZ44N TO-220 packages were tight for the bench-soldering iron in some routings.
- **Individual Work:** Re-reviewed my STM32F303-RE pin map document from Fall. Confirmed the firmware was using the as-wired pins, not the build-guide-v3.1 pins.
- **Decision:** Started drafting a pin map errata note for the team file.
- **Outcome:** Iteration-2 assembly plan defined.

## Week 2: Iteration 2 Component Preparation

- **Sourcing:** Inventoried iteration-2 components with Ahmet. Some parts (TLP250 sockets, 100 nF ceramic decoupling caps) needed top-up.
- **Procurement:** Placed restock order at Motorobit. Restock arrived within 4 days.
- **Preparation:** Pre-installed DIP-8 sockets on the iteration-2 boards before active component placement - reduces thermal stress on the TLP250 during assembly.
- **Outcome:** Iteration-2 boards prepped for assembly.

## Week 3: Iteration 2 Assembly

- **Assembly:** Populated iteration-2 boards with Ahmet across two evenings.
- **Bench Session:** Attended the iteration-2 first power-up. Helped with the supply ramp and supply-side monitoring while Ahmet ran the scope.
- **Observation:** Noted the bootstrap-cap-sag distortion at MI > 0.9 visually (output looked 'softer' at high MI) before Furkan's firmware analysis confirmed the cause.
- **Documentation:** Updated the assembly notes with two iteration-2 gotchas: TLP250 orientation must be checked before powering (LED side toward MCU); snubber resistor wattage matters for the 22 ohm 2 W spec.

## Week 4: Pin Map Document Update

- **Documentation:** Drafted v2 of my STM32 pin map document. Explicitly called out the v3.1 build-guide pin errors (PWM_1L, MCP3201, 78L05).
- **Cross-reference:** Confirmed each documented error against the STM32F303RE datasheet alternate-function table.
- **Validation:** Compared the corrected pin map against the firmware's GPIO setup code with Furkan. All consistent.
- **Outcome:** Pin map document ready for incorporation into Build Guide v4.

## Week 5: Iteration 3 Component Sourcing

- **Sourcing:** With Ahmet, identified the new iteration-3 components: 4x B0515S, 8x 6N137, 4x 78L05, plus passives for the isolated supply.
- **Procurement:** Placed orders at Motorobit + Direnc.net. All parts in stock domestically; no international shipping or customs friction.
- **Receipt:** Parts arrived within 6 days.
- **Inventory:** Catalogued and stored the parts for iteration-3 assembly.

## Week 6: Foundations for PWM Documentation Update

- **Documentation:** Updated my 'Foundations for PWM Generation' document with the iteration-evolved understanding of TIM1 / TIM8 setup.
- **Cross-reference:** Added a note about the BDTR.OSSI bit - keeping outputs in safe state on MOE = 0 was something I'd flagged early but the team's full understanding came from the iteration bring-up sessions.
- **Group Coordination:** Shared the updated doc with Furkan for inclusion in the firmware repo.
- **Outcome:** Foundational MCU documentation maintained.

## Week 7: Iteration 3 Assembly

- **Assembly:** Populated iteration-3 boards with Ahmet. The 6N137 + B0515S placement was tighter than iteration-2 - had to be careful about heat dissipation during soldering.
- **Bench Session:** Attended the iteration-3 first power-up. Confirmed assembly visually with Ahmet before powering up.
- **Observation:** Watched the intermittent SENSOR_LOST events from the bench. Initially we wondered if assembly was the cause; quick re-inspection ruled that out - it was layout-level coupling, not solder joints.
- **Outcome:** Iteration-3 assembly clean, but board has the grounding issue documented separately.

## Week 8: Iteration 3 Re-bring-up Support

- **Assistance:** Helped Ahmet with the grounding-issue diagnosis. Ran probe-and-scope sweeps to localise the coupling paths.
- **Observation:** The marginal optocoupler creepage was visible under magnification - input and output pads of the 6N137 had < 2 mm of clearance in places. Probably acceptable on a 2-layer board with clean ground separation; not acceptable with the continuous inner-plane pour.
- **Decision:** With the team, agreed that an iteration-4 board redesign was the right call.
- **Documentation:** Recorded the iteration-3 grounding observations in the project notes.

## Week 9: Iteration 4 Architecture Discussion

- **Group Meeting:** Participated in the iteration-4 architectural discussion. Backed Ahmet's 4-layer stack-up proposal and the IRFB4110 MOSFET substitution.
- **Sourcing:** Started identifying the iteration-4 BOM changes - IRFB4110 at Motorobit, heatsinks adapted for the new MOSFET's gate-charge profile (per Faruk's dead-time recalculation).
- **Outcome:** Iteration-4 BOM finalised.

## Week 10: Iteration 4 Procurement

- **Procurement:** Placed the IRFB4110 order at Motorobit. Confirmed in-stock; ordered 16x (8 for the project + 8 spares).
- **Inventory:** Verified the rest of the iteration-4 BOM was in stock from previous orders. Just needed the MOSFET swap.
- **Group Coordination:** Coordinated with Ahmet on JLCPCB order timing - aimed for boards + parts to arrive in the same week if possible.
- **Outcome:** Iteration-4 procurement complete, all parts secured.

## Week 11: Bench Setup Preparation

- **Bench Prep:** Cleaned and prepped the bench for iteration-4 sessions. Verified scope calibration, supply current limits, isolated bench supplies.
- **Cable Audit:** Inventoried the bench cables - some had developed intermittent shorts from previous sessions. Replaced four.
- **Heatsink Prep:** Pre-attached TO-220 clip-on heatsinks to the IRFB4110 inventory so assembly was faster on the bench-population day.
- **Outcome:** Bench fully ready for iteration-4 boards.

## Week 12: Iteration 4 Assembly

- **Assembly:** Spent two full evenings populating iteration-4 boards with Ahmet. Two identical single-bridge modules + spares.
- **Verification:** Cross-checked every assembled board against the BOM and the schematic before power-up. Caught one missing decoupling cap on module 2 during the cross-check.
- **Bench Session:** Attended the iteration-4 first power-up. Ran the supply ramp while Ahmet monitored the scope.
- **Outcome:** Both iteration-4 boards assembled successfully, no rework needed beyond the missed decoupling cap.

## Week 13: Full Bench Sessions

- **Bench Session:** Attended the full cascade bring-up sessions. Helped with cable management, supply coordination, and quick component swaps when needed.
- **Observation:** Touched the MOSFET cases during sustained PSC operation - both bridges felt the same temperature, confirming Faruk's simulation prediction of symmetric switching loss under PSC.
- **Coordination:** Helped Furkan capture scope screenshots for the documentation.
- **Outcome:** Bench validation phase complete.

## Week 14: Demonstration + Final Documentation

- **Demo:** Attended demo day. Helped with cabling, supply setup, and quick swap-outs on the demo bench.
- **Documentation:** Contributed assembly notes to Build Guide v4 - especially around the IRFB4110 substitution and the heatsink mounting procedure.
- **Future Work:** Wrote up the bench setup recommendations for future student groups - cable inventory, supply ramping procedure, scope calibration checks.
- **Deliverable:** Final logbook complete.