ECE 431/531 Lab Session

April 9, 11th @Teer 216

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Objectives

1. Understanding working principle of PWM controller UC2823
2. Building a boost converter
3. Implementing open loop control on boost converter
4. Implementing closed loop control on boost converter

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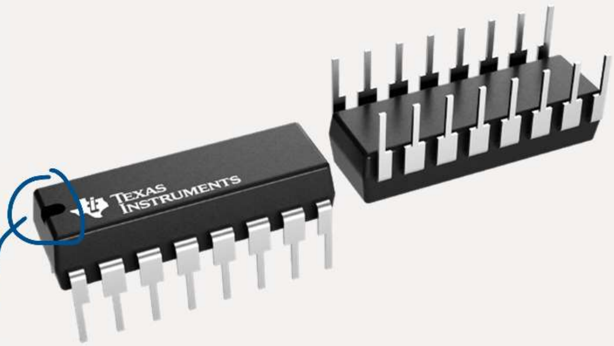
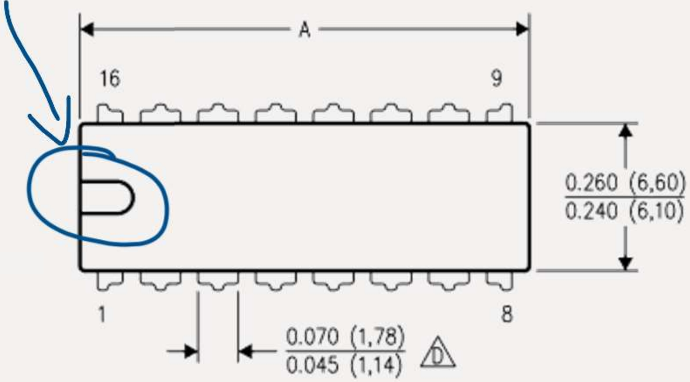
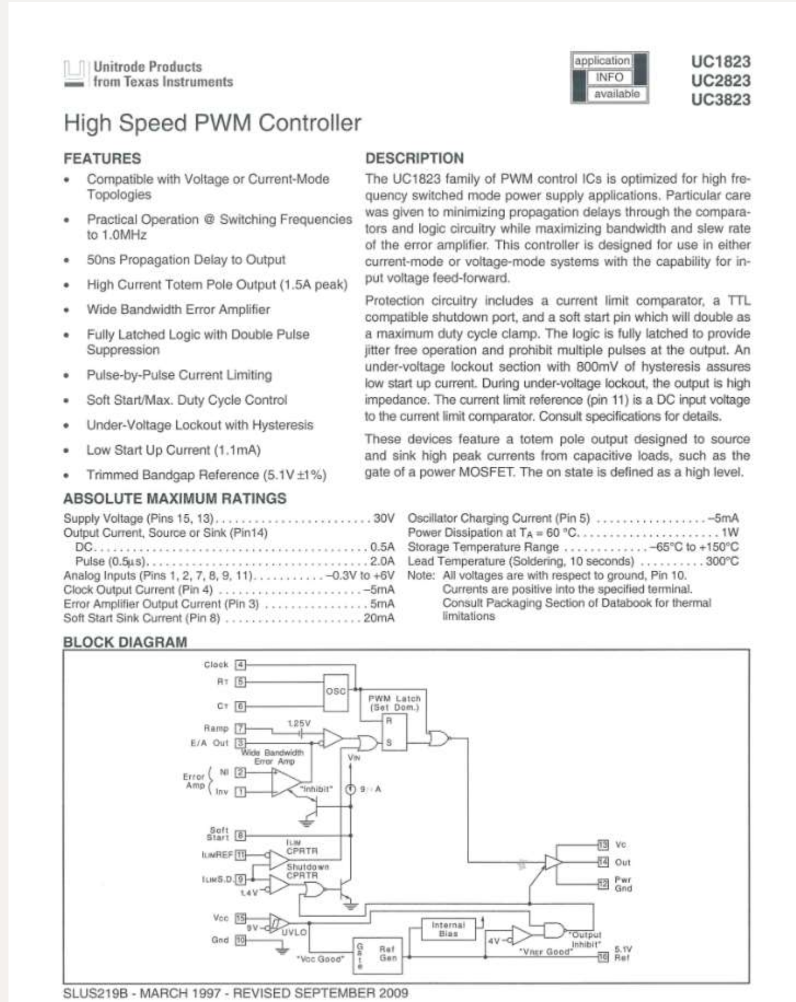
Introduction: PWM IC



NOTCH





Unitrode Products from Texas Instruments

application INFO available

UC1823
UC2823
UC3823

High Speed PWM Controller

FEATURES

- Compatible with Voltage or Current-Mode Topologies
- Practical Operation @ Switching Frequencies to 1.0MHz
- 50ns Propagation Delay to Output
- High Current Totem Pole Output (1.5A peak)
- Wide Bandwidth Error Amplifier
- Fully Latched Logic with Double Pulse Suppression
- Pulse-by-Pulse Current Limiting
- Soft Start/Max. Duty Cycle Control
- Under-Voltage Lockout with Hysteresis
- Low Start Up Current (1.1mA)
- Trimmed Bandgap Reference (5.1V ±1%)

DESCRIPTION

The UC1823 family of PWM control ICs is optimized for high frequency switched mode power supply applications. Particular care was given to minimizing propagation delays through the comparators and logic circuitry while maximizing bandwidth and slew rate of the error amplifier. This controller is designed for use in either current-mode or voltage-mode systems with the capability for input voltage feed-forward.

Protection circuitry includes a current limit comparator, a TTL compatible shutdown port, and a soft start pin which will double as a maximum duty cycle clamp. The logic is fully latched to provide jitter free operation and prohibit multiple pulses at the output. An under-voltage lockout section with 800mV of hysteresis assures low start up current. During under-voltage lockout, the output is high impedance. The current limit reference (pin 11) is a DC input voltage to the current limit comparator. Consult specifications for details.

These devices feature a totem pole output designed to source and sink high peak currents from capacitive loads, such as the gate of a power MOSFET. The on state is defined as a high level.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (Pins 15, 13) 30V
Output Current, Source or Sink (Pin14)
DC 0.5A
Pulse (0.5μs) 2.0A
Analog Inputs (Pins 1, 2, 7, 8, 9, 11) . . . . . –0.3V to +6V
Clock Output Current (Pin 4) . . . . . –5mA
Error Amplifier Output Current (Pin 3) 5mA
Soft Start Sink Current (Pin 8) 20mA
Oscillator Charging Current (Pin 5) . . . . . –5mA
Power Dissipation at T_A = 60 °C 1W
Storage Temperature Range . . . . . –65°C to +150°C
Lead Temperature (Soldering, 10 seconds) . . . . . 300°C
Note: All voltages are with respect to ground, Pin 10.
Currents are positive into the specified terminal.
Consult Packaging Section of Databook for thermal limitations

BLOCK DIAGRAM

SLUS219B - MARCH 1997 - REVISED SEPTEMBER 2009

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What you will need

- 2 pairs of banana-plug wires for power supply
- 1 pair of banana-plug wires for multimeter
- Two voltage probes
- 1 current probe kit
- Components

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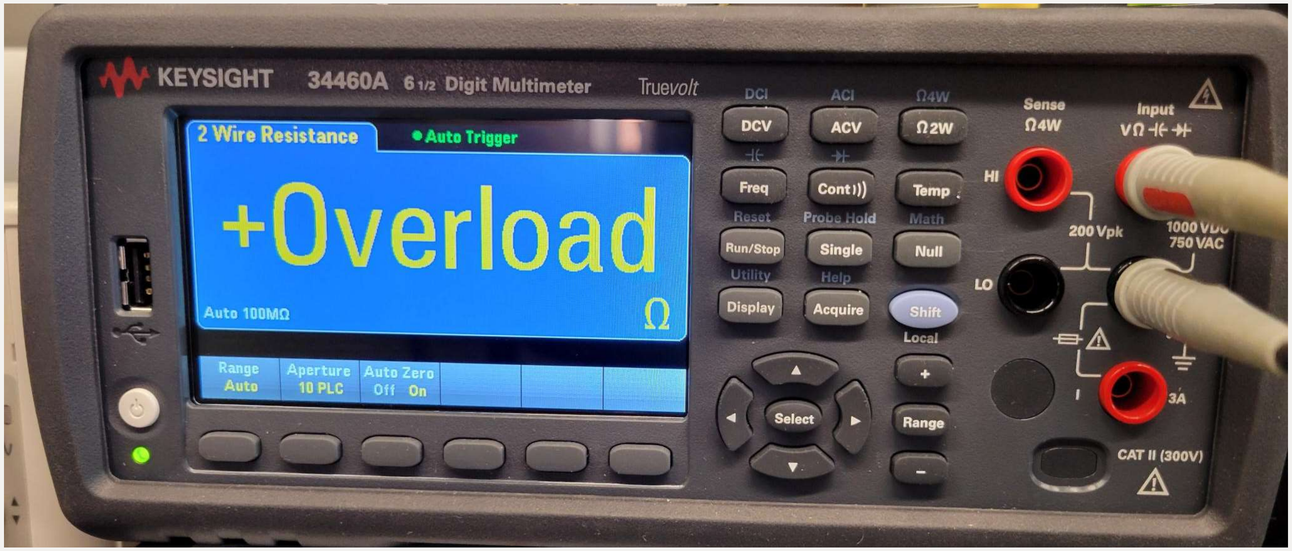
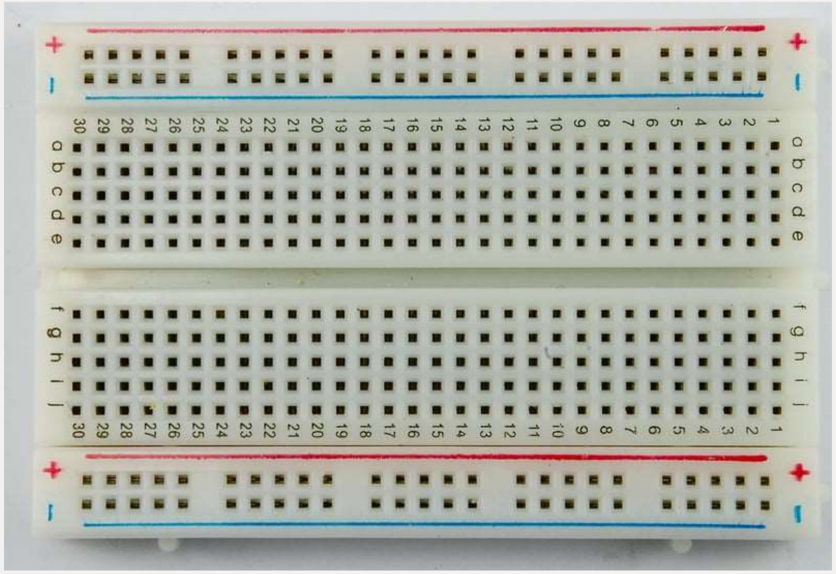
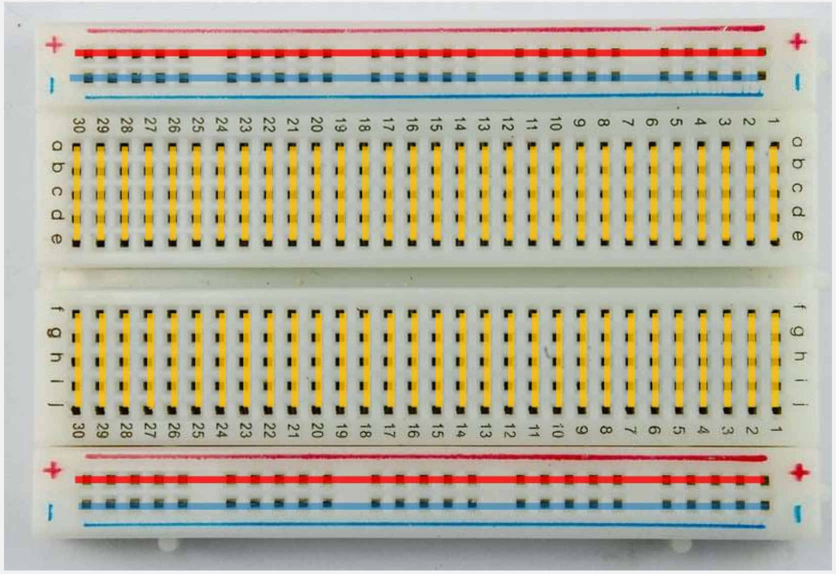
Introduction: Multimeter



Introduction: Breadboard



breadboard



connection

- ❑Test connection with multimeter. Use jumper wire to connect to breadboard contacts.

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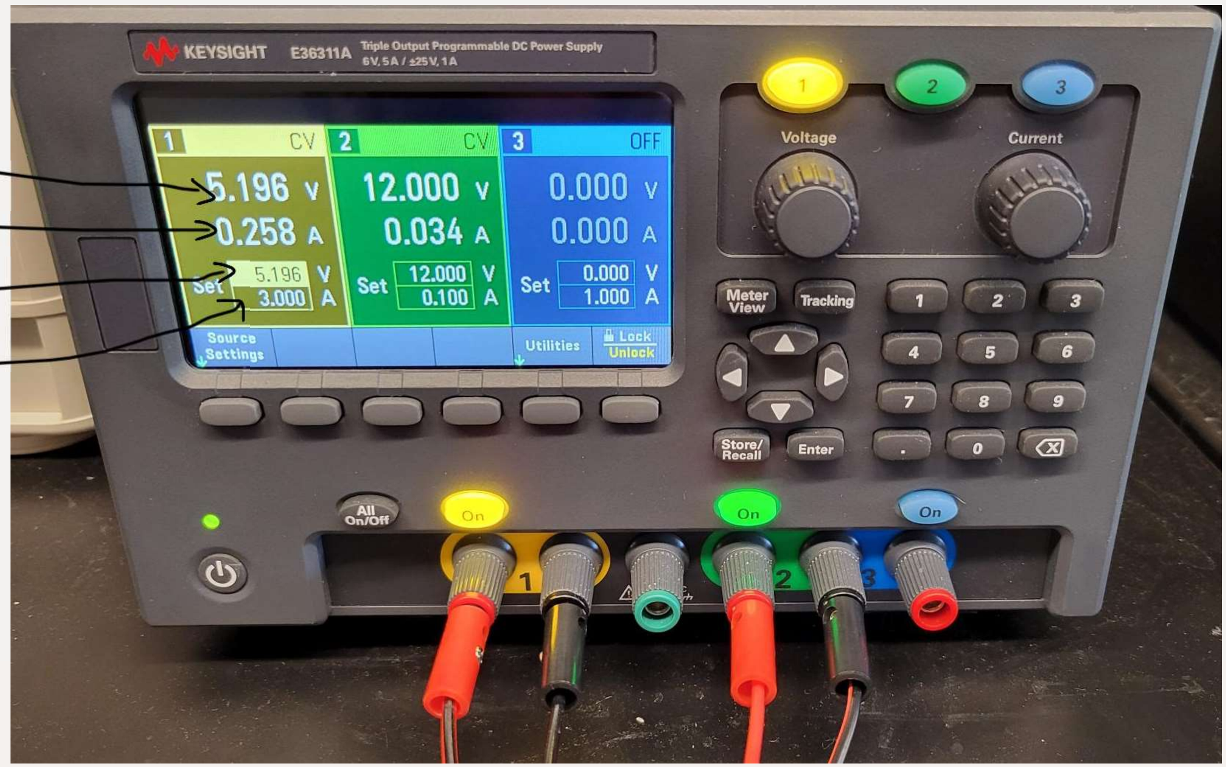
Introduction: Power supply

Actual output voltage

Actual output current

Set output voltage

Set output current limit



Set

- ❑Channel 1: 1 V, 3A
- ❑Channel 2: 12 V, 0.1A
- ❑Channel 3: DO NOT USE

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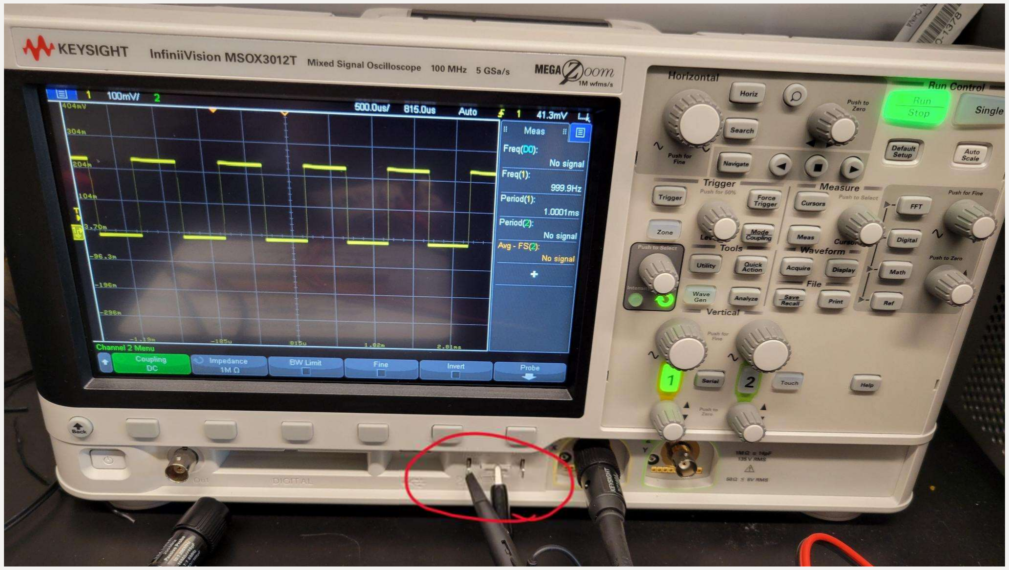
- ❑Turn on Channel 1 and 2 of power supply. Use `DCV` function of the multimeter to test their output.
- ❑Turn off channels 1 and 2 of power supply.

Introduction: Oscilloscope



- Use the internal reference waveform to test the function of scope and probe.

❑Capture a square waveform.

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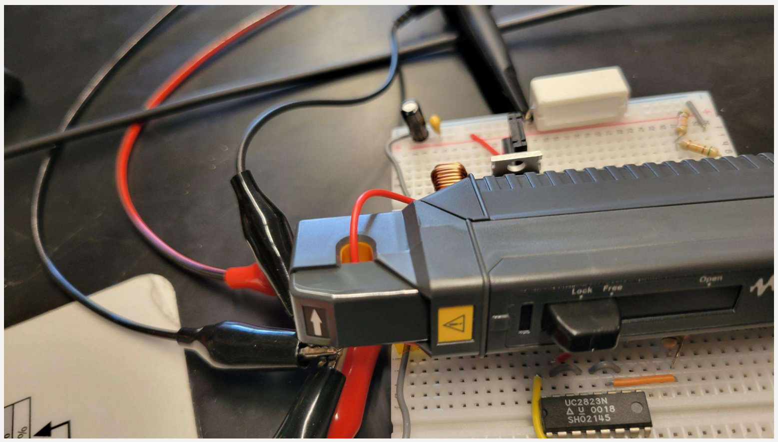
Introduction: Current probe



Example: Clamp the conductor to measure the current.

Make sure the clamp is in **lock** position to measure.

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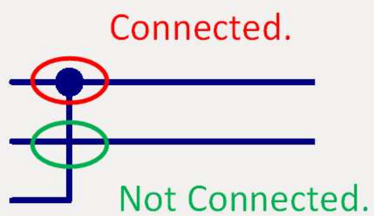
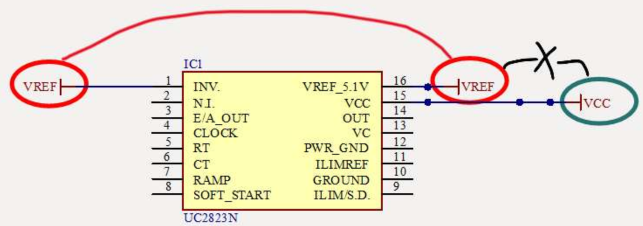
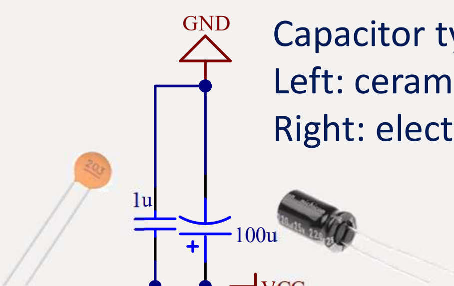
Introduction: Schematics standards



Crossing lines: if the cross point is marked with a dot, the wires are connected; otherwise, no.

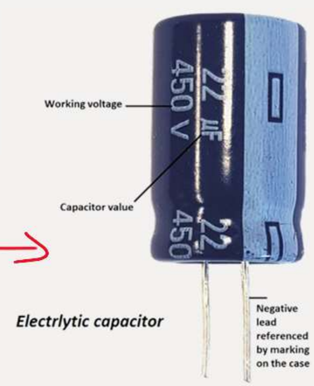


Power ports (labels): if they have the same name, they are wired together; otherwise, no.



Capacitor types:
Left: ceramic capacitors
Right: electrolytic capacitors

White mark of electrolytic capacitor is negative



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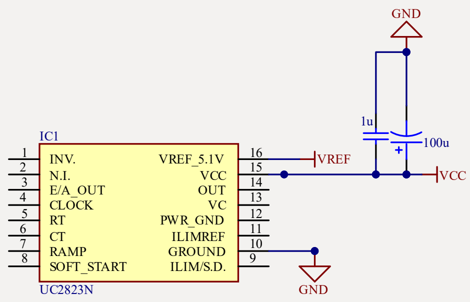
Step 1



- Install capacitors for VCC (pin 15). Connect 12 V power supply to VCC (pin 15), GND of power supply to GND (pin 10). Measure the reference voltage of VREF (Pin 16) with either multimeter or oscilloscope.

❑You should be able to capture a 5.1 V voltage on VREF (pin 16)

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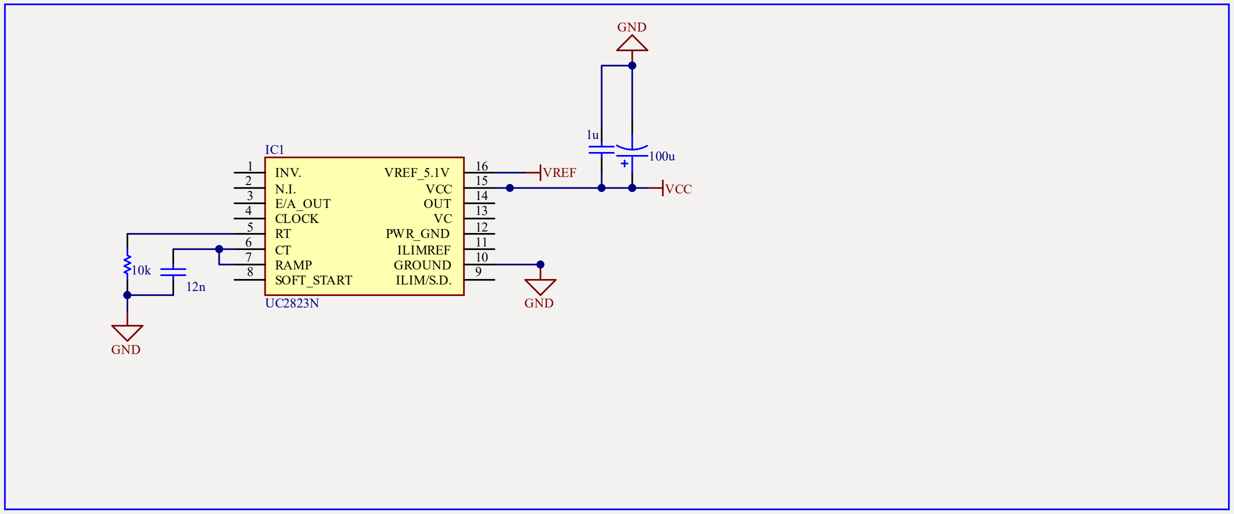
Step 2



- Configure clock. Pick your choice of R_T, C_T and install them to pin 5, 6. Observe waveforms on C_T (pin 6) with oscilloscope.

❑You should be able to see a sawtooth waveform on C_T (pin 6), fluctuating from 1 V to 3 V.

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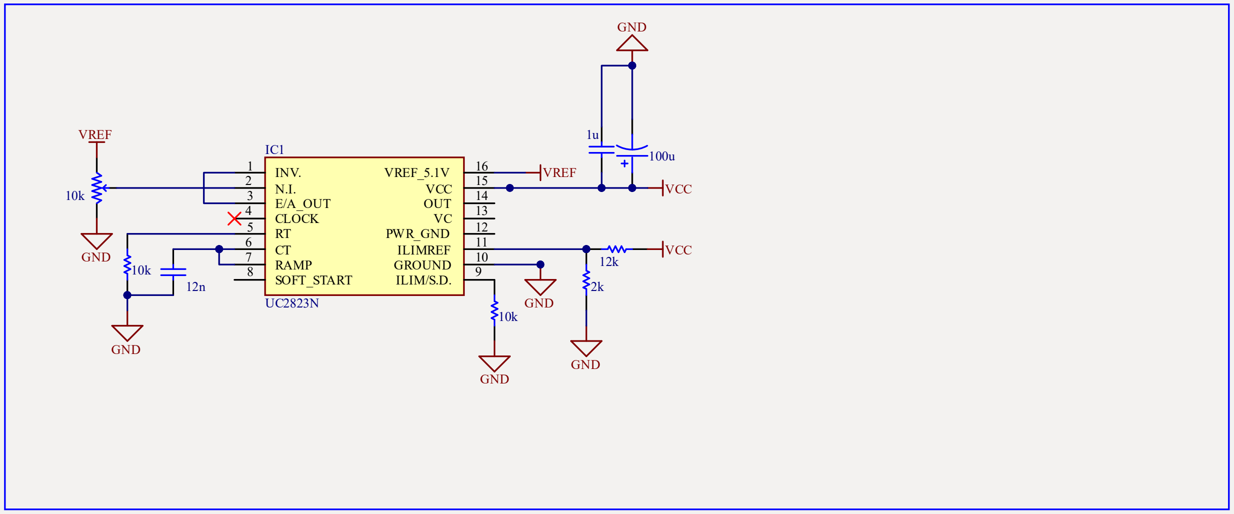
Step 3



- Configure the $I_{LIMREF}, I_{LIM\ S.D.}$(This is necessary to enable the internal OPA). Build a voltage follower with the internal OPA. Change the trimmer potentiometer. Measure its voltage.
- You should be able to see the voltage change of pin 3.

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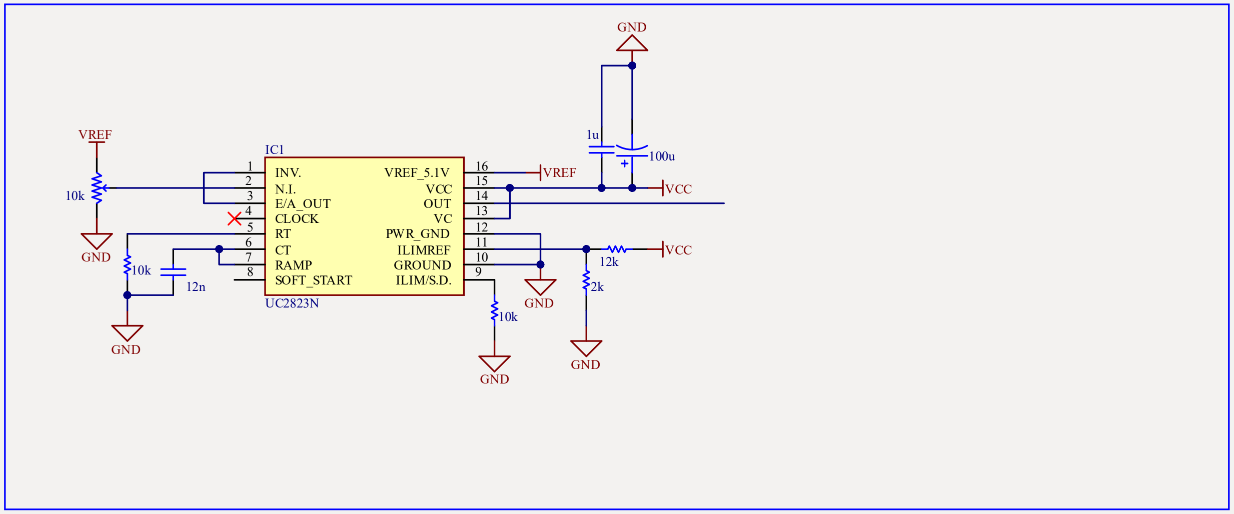
Step 4



- Connect V_{CC} (pin 15) to V_C(pin 13), GND (pin 10) to PWR_GND (pin 12). Measure the output signal on pin 14.

❑You should be able to see PWM waveforms (square waves jumping between 0 and 12 V). Change the potentiometer, you should be able to see the duty ratio changing.

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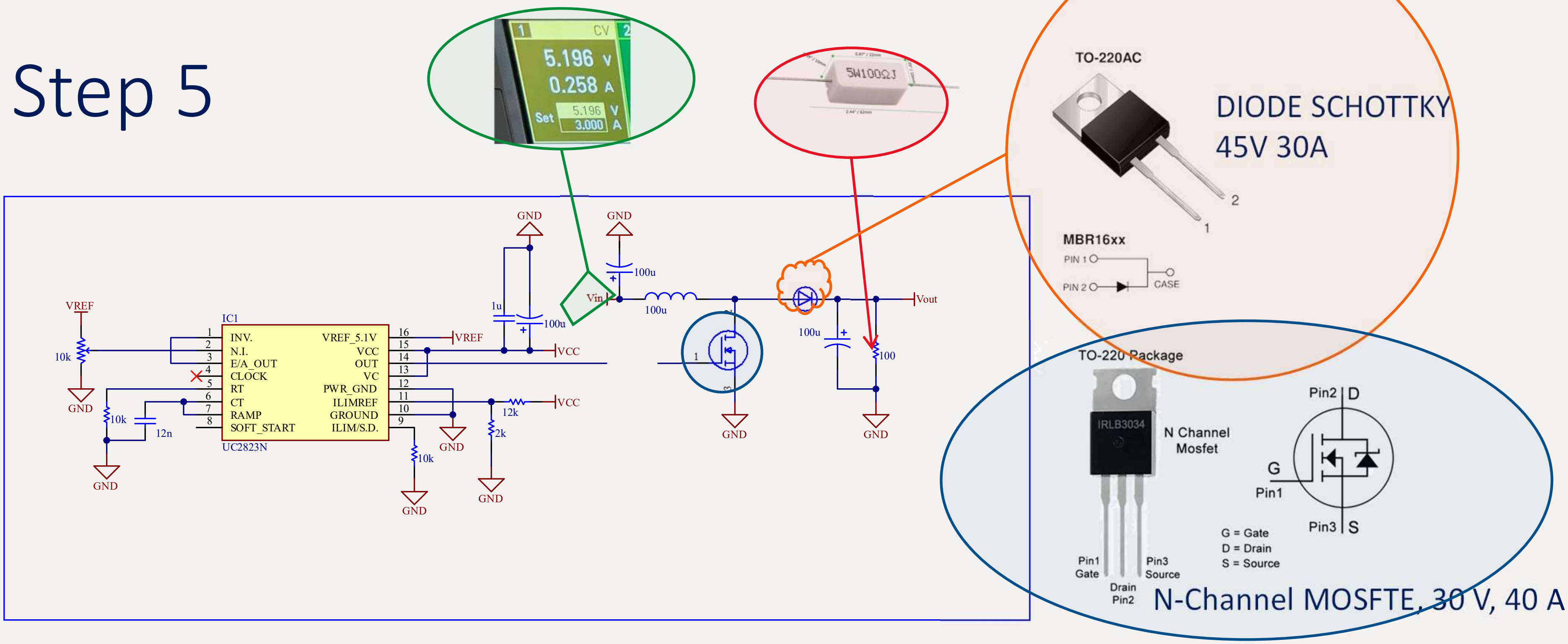
Step 5



- Install power circuit. Refer to the pin mapping of MOSFET and DIODE as above. Make sure using the power resistor as load. And use Channel 1 (< 5V) as the input for boost converter.

❑Check connection with multimeter `cont` function. 

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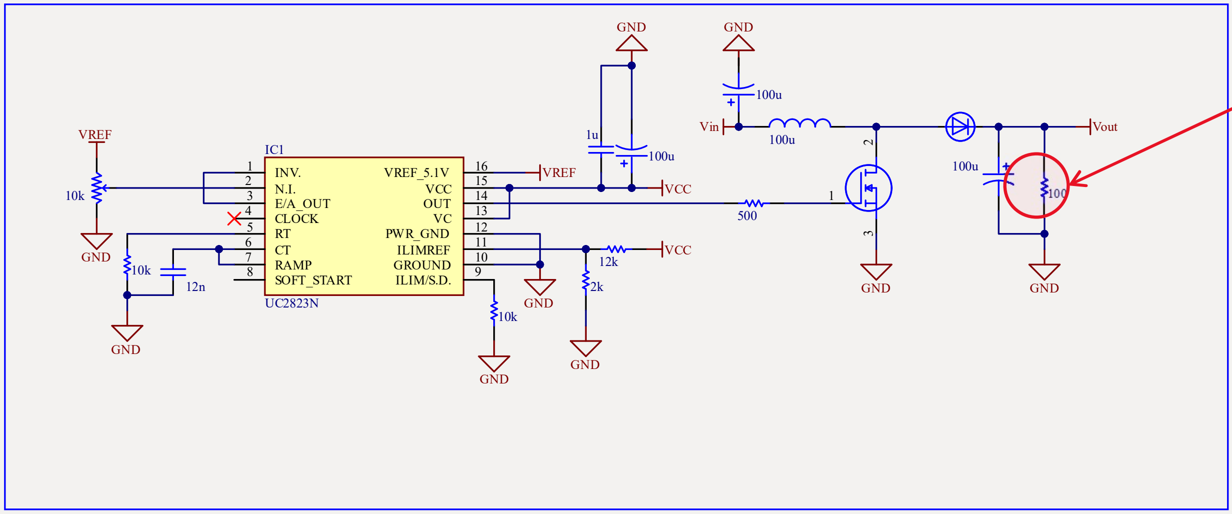
Step 6



CAUTION!
The output resistor may get hot!
Don't touch it.

- Connect control board to power board, they should be as close to each other as possible. Perform open loop control of boost circuit. Adjust the potentiometer, check the output voltage.

❑Capture an output voltage varying with the potentiometer.

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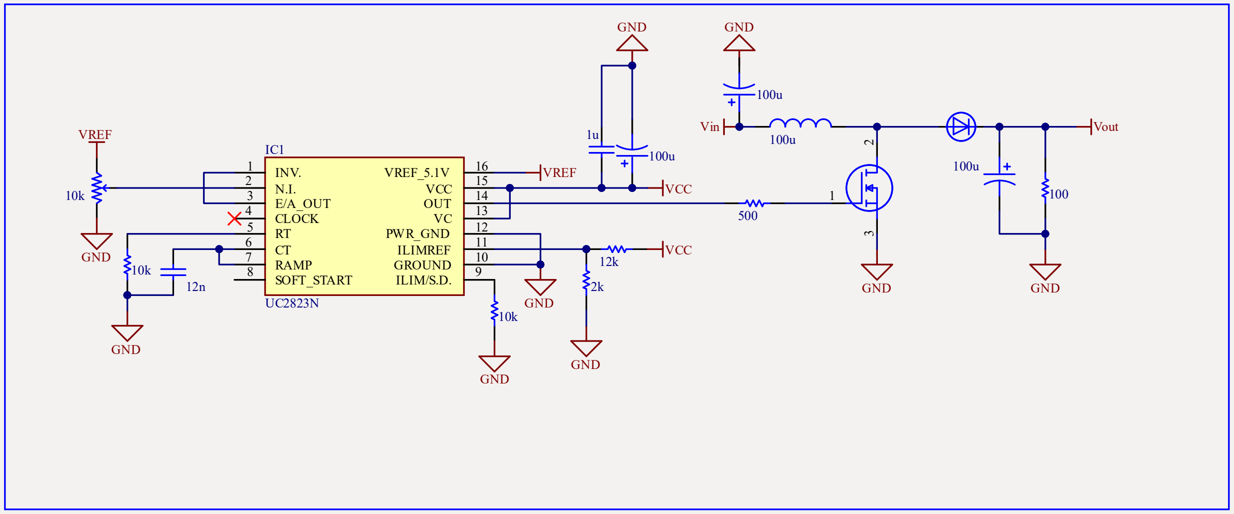
Step 7



- Measure the inductor current with current probe. Play with R_T, C_T (change both or either), explore configurations for CCM, DCM.
- ❑You should be able to capture CCM and DCM current waveforms with different sets of C_T, R_T. Measure with current probe.

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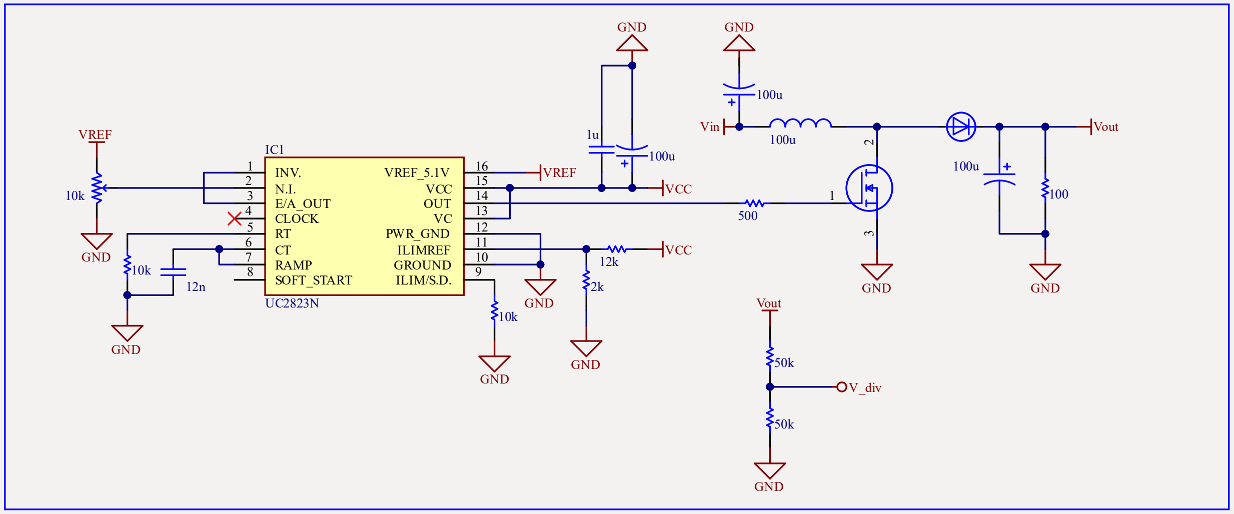
Step 8



- Run circuit in CCM. Build voltage divider for output voltage. We aim for 10.2 V output voltage, so the voltage divider shall be ½. Observe the output voltage and the divided voltage.

❑You should be able to see that the divided voltage is exactly half of the output voltage.

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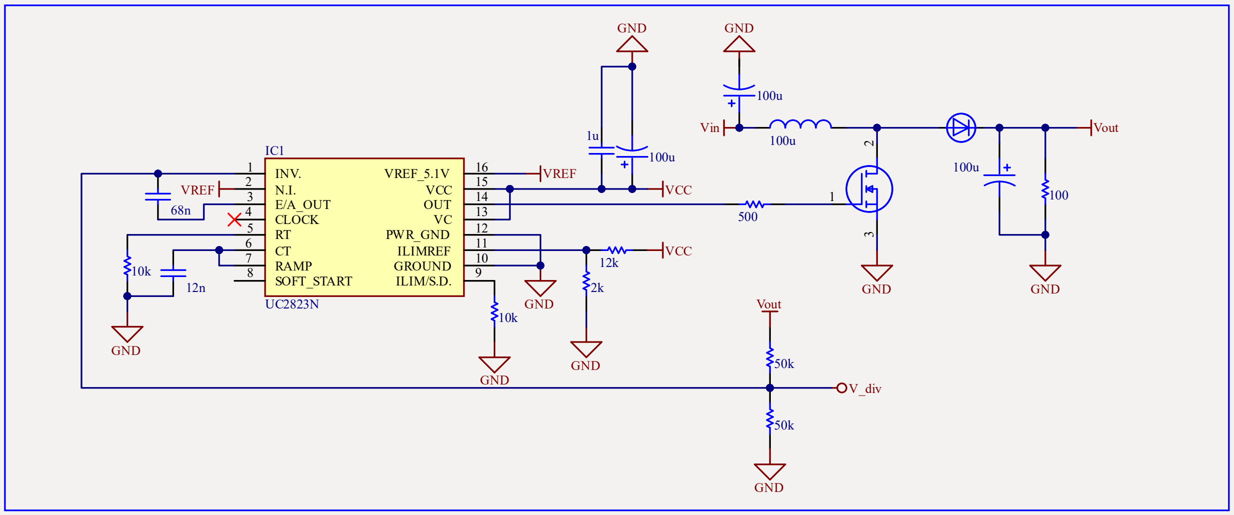
Step 9



- Remove the voltage follower setup. Connect your sampled (divided) output voltage to the N.I. of OPA (pin 2). Connect VREF (pin 16) to INV of OPA (pin1). Insert your compensator. Tune your compensator (if necessary) to stabilize the output of OPA (pin 3).

❑You should be able to see that the output (pin 3) of OPA be stable instead of jumping drastically.

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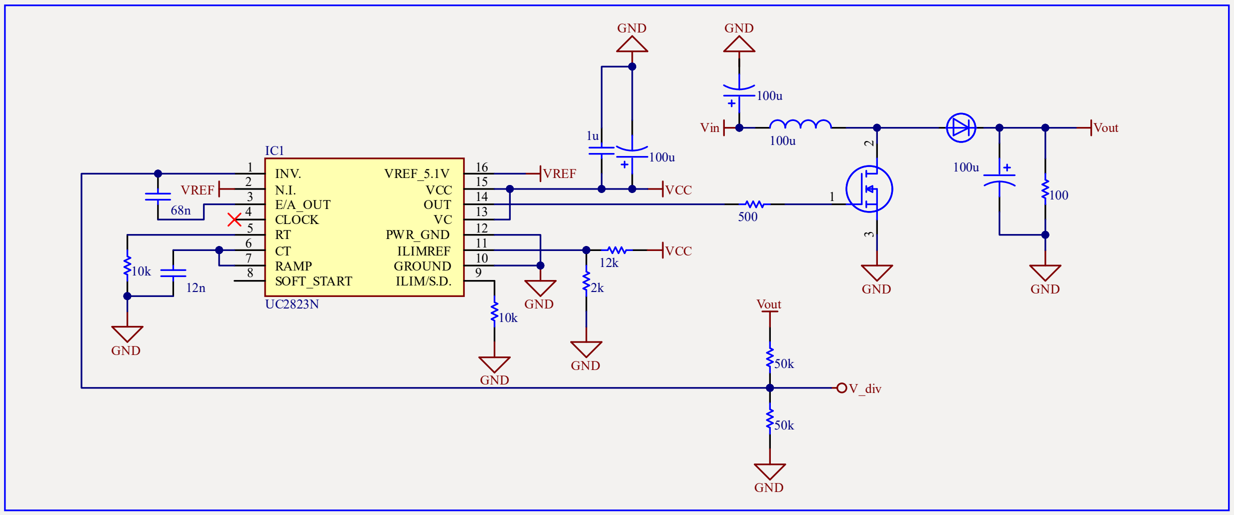
Step 10



❑Change input voltage, the output voltage should stabilize itself. Record a video if you have a phone.

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GOOD JOB!

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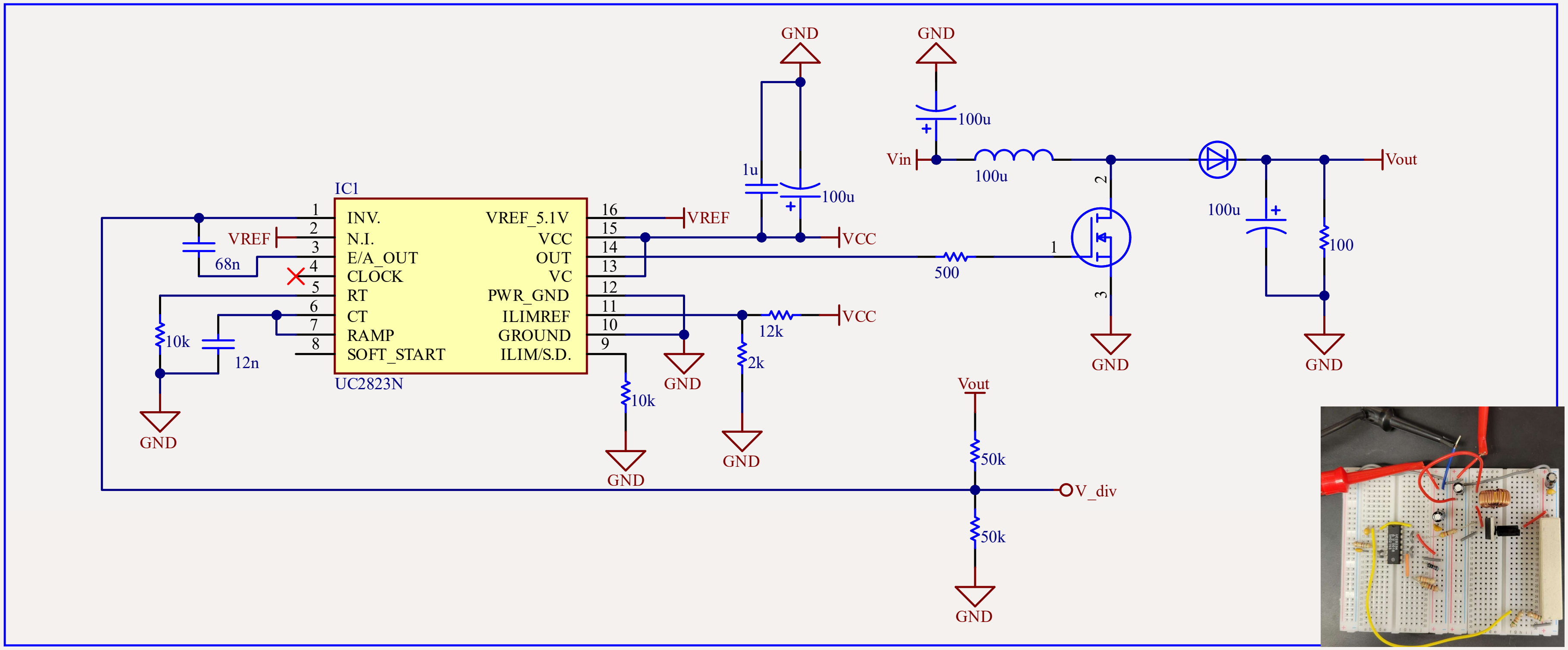
Reference schematic & prototype



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