Rogowski Coil Current Sensor (used in a larger converter)

Georgia Tech Center for Distributed Energy

System Overview:

✓ Objective

- Achieve **compact size, high efficiency, and wide operating range** while eliminating the need for an intermediate DC link or large passive energy storage elements

✓ System

- 50kW bidirectional home fast charger for home energy power systems
- 250-400 V_{DC} EV Battery
- 120V_{AC} split-phase AC

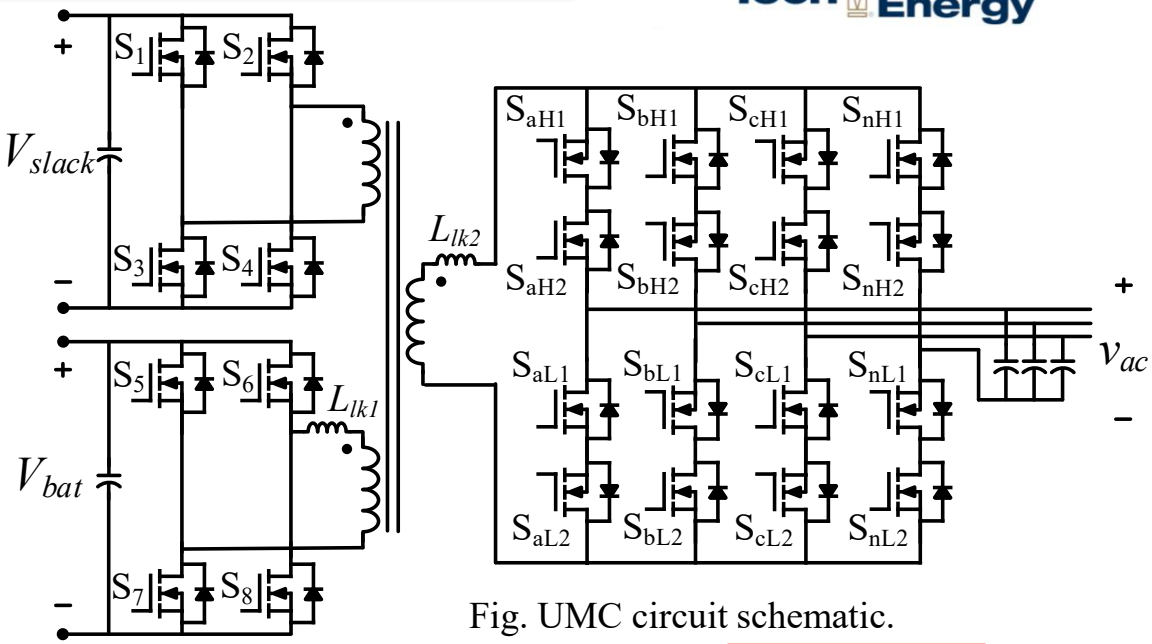
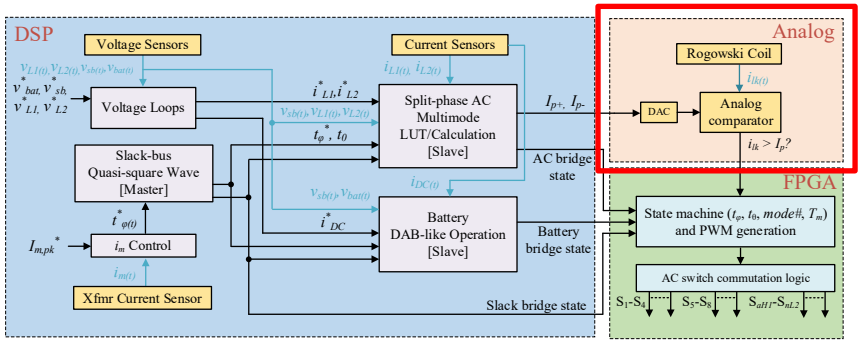


Fig. UMC circuit schematic.



R. Hao, **S. Manjrekar**, A. Marellapudi, J. Benzaquen and D. Divan, "A Multiport Bidirectional HF-Link Split-Phase DC/DC/AC Universal Minimal Converter," 2025 IEEE Energy Conversion Conference Congress and Exposition (ECCE), Philadelphia, PA, USA, 2025, pp. 1-6, doi: 10.1109/ECCE58356.2025.11259542.

Rogowski Coil Current Sensor - Objectives

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Objective:

- Design an effective peak-current detection circuit to achieve I_{pk} control of UMC.
- Tolerate system non-idealities such as transmission delay, sensor delay, errors, and DSP computational delay.

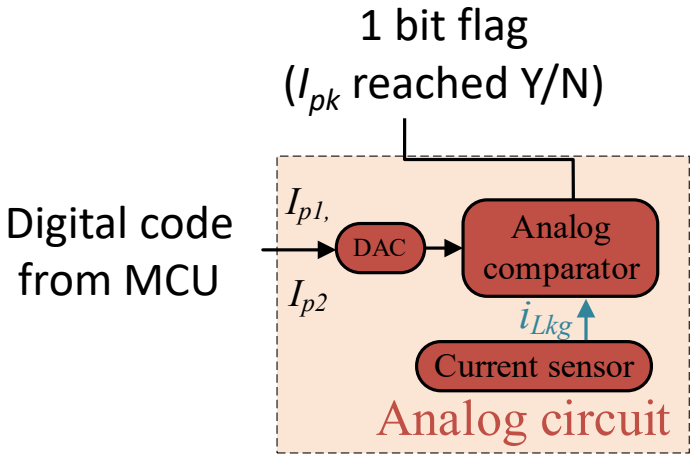
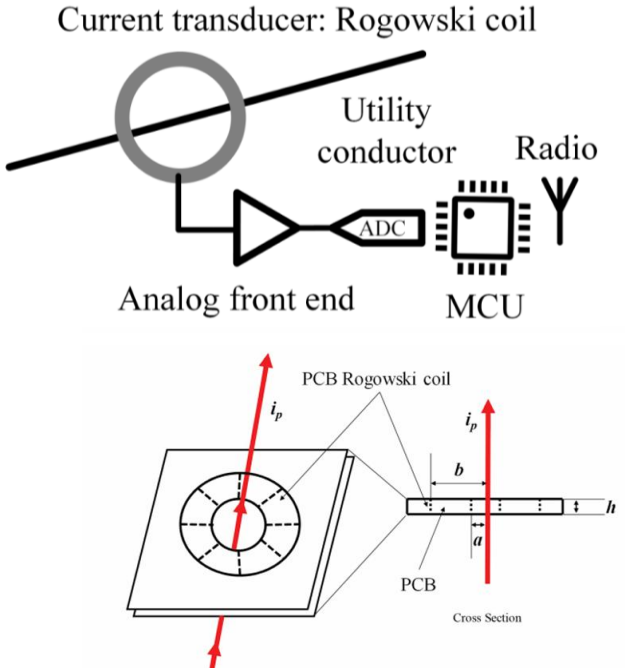


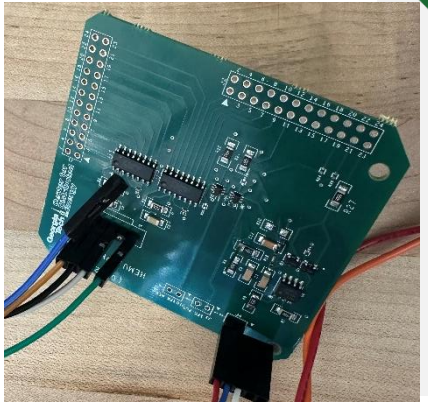
Fig. 1. Analog I_{pk} detection circuit

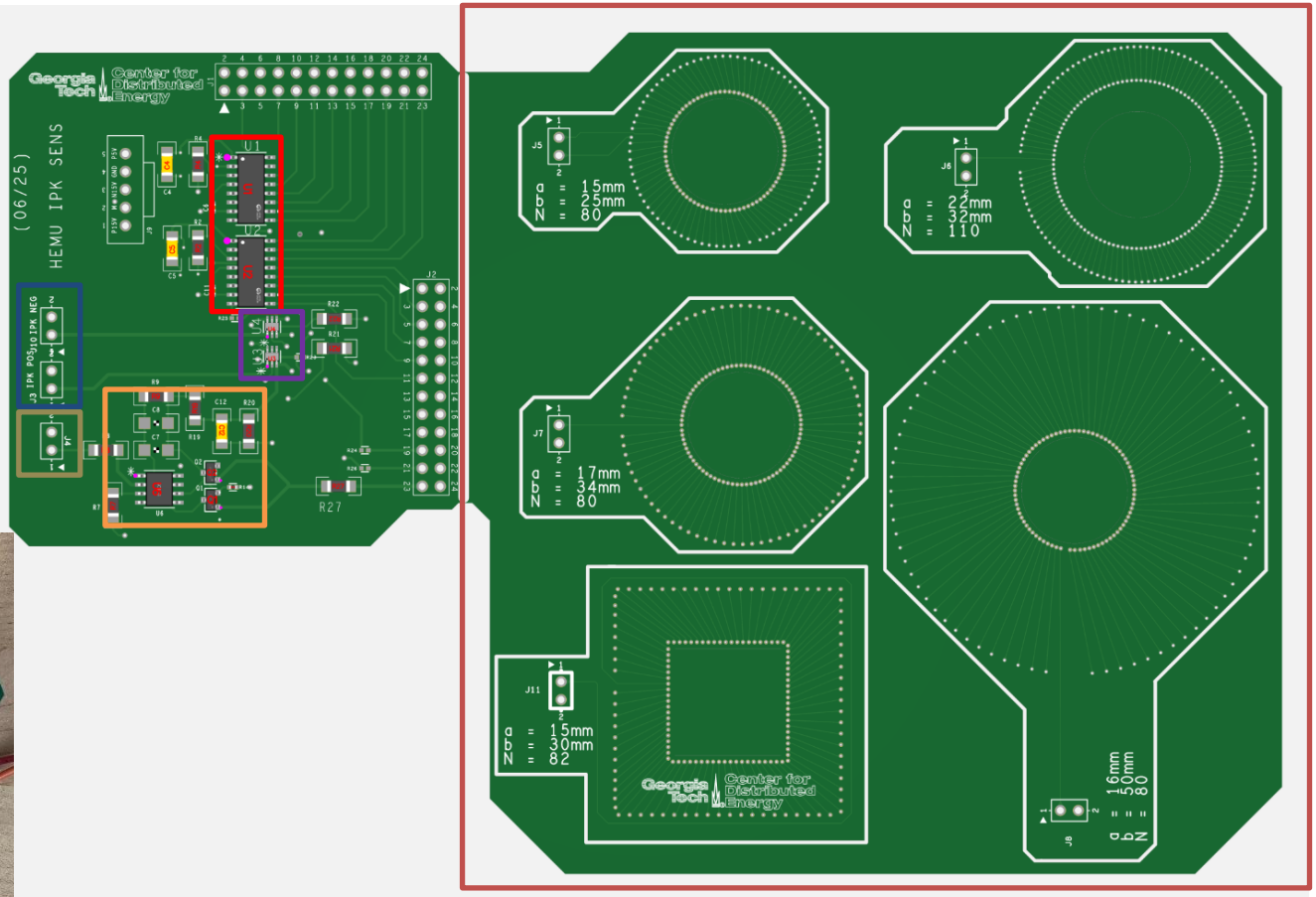


Rogowski Coil Current Sensor - Objectives

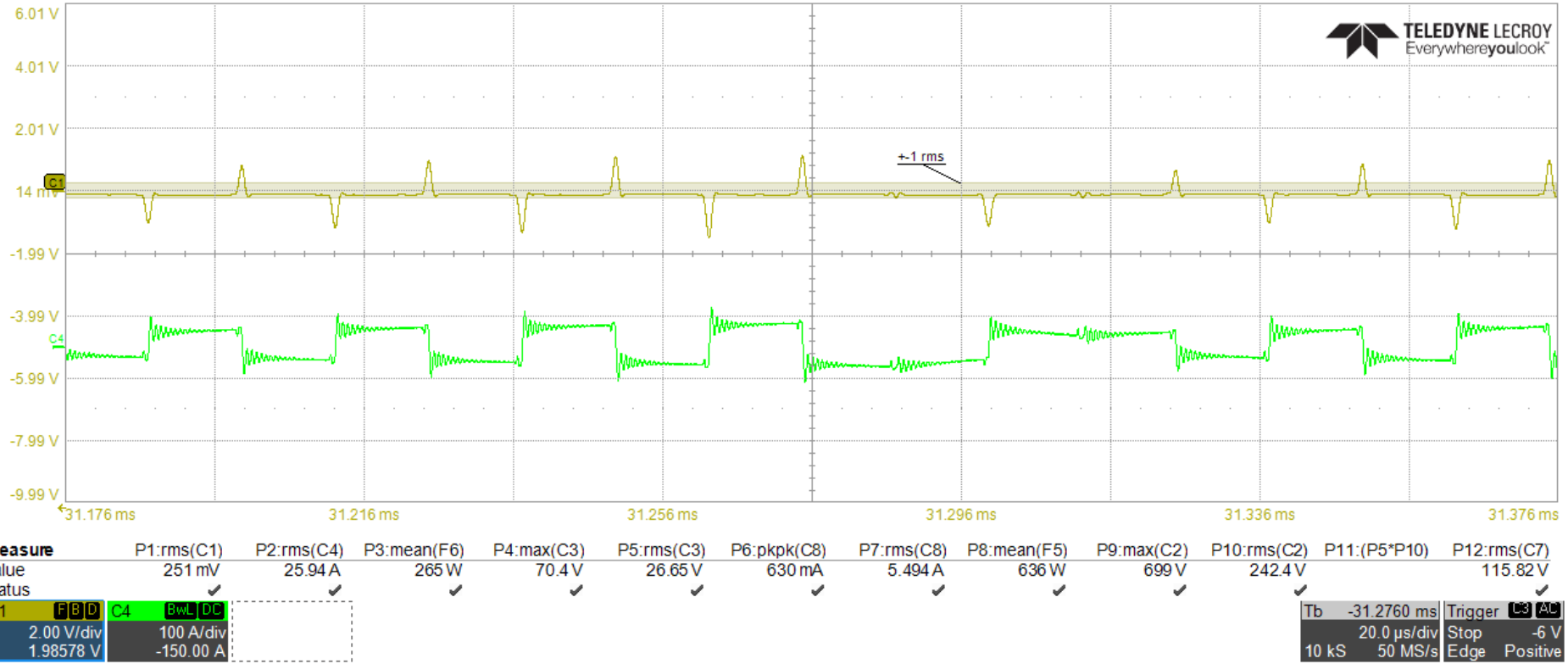
Board Description

- ✓ Analog Integrator
- ✓ Rogowski Coil Input
- ✓ +/- 1-bit flag header
- ✓ 8-bit DAC
- ✓ Analog Comparator
- ✓ Various Coils





Hardware Results – Coil Voltage Response w/ Square Current



Measure	P1:rms(C1)	P2:rms(C4)	P3:mean(F6)	P4:max(C3)	P5:rms(C3)	P6:pkpk(C8)	P7:rms(C8)	P8:mean(F5)	P9:max(C2)	P10:rms(C2)	P11:(P5*P10)	P12:rms(C7)
value	251 mV	25.94 A	265 W	70.4 V	26.65 V	630 mA	5.494 A	636 W	699 V	242.4 V		115.82 V
status	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔

C1 F B D
2.00 V/div
1.98578 V

C4 BwL DC
100 A/div
-150.00 A

Tb -31.2760 ms
20.0 µs/div
10 kS 50 MS/s

Trigger C3 AC
Stop -6 V
Edge Positive

Hardware Prototype – Sensed vs Real Current Comparison

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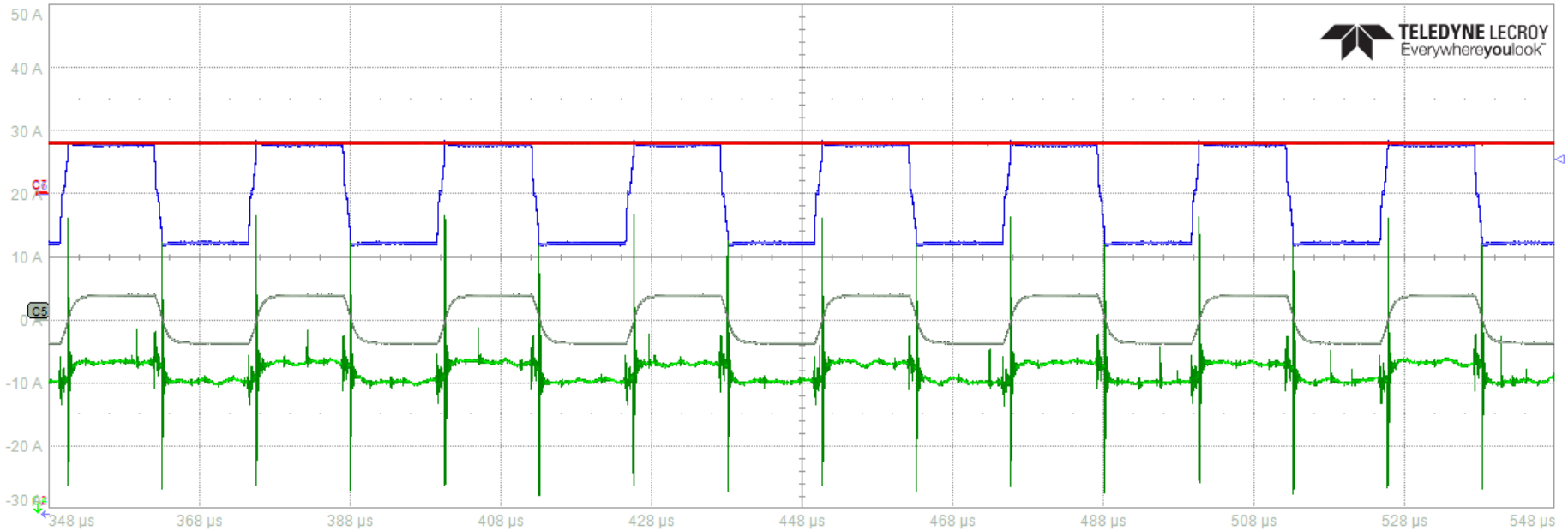

Measure	P1:mean(C7)	P2:rms(C6)	P3:rms(C5)	P4:top(C2)	P5:- - -	P6:- - -	P7:- - -	P8:- - -	P9:- - -	P10:- - -	P11:- - -	P12:- - -
value	79.09 V	75.88 V	3.488 A	< 1.3193 V								
status	✔	✔	✔									

C2 BwL DC	C4 FLT DC1M	C5 BwL DC	C6 BwL DC	C7 BwL DC
100 mV/div	50.0 mV	10.0 A/div	100 V/div	100 V/div
-1.80375 V	-1.67000 V	-10.000 A	99.52 V	100.53 V

Tbase -448.0 µs	Trigger C6 DC
20.0 µs/div	Stop 55 V
500 kS 2.5 GS/s	Edge Positive