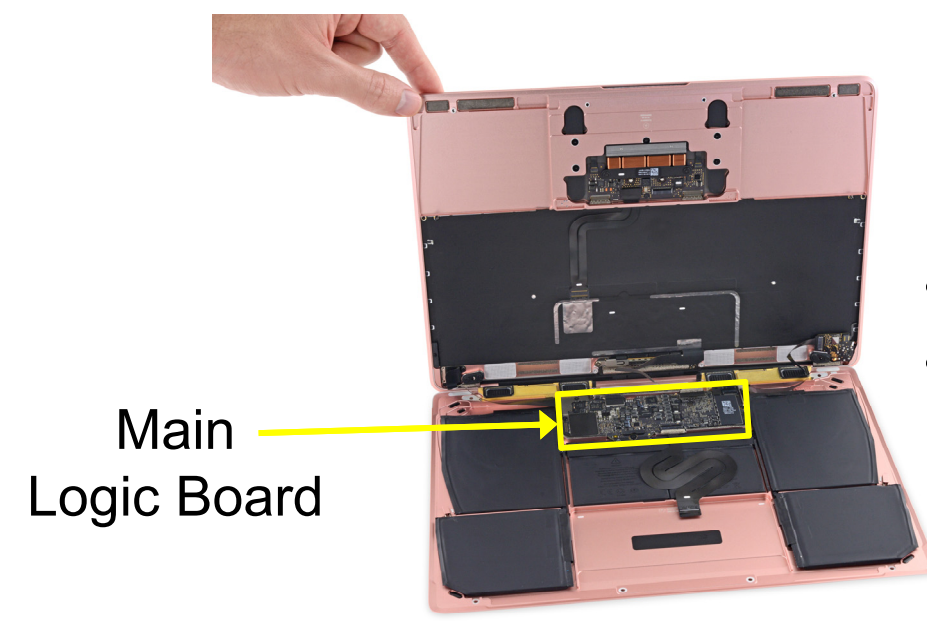


Compact design solution with fully integrated buck regulators

Francesco Cannillo, Holger Petersen

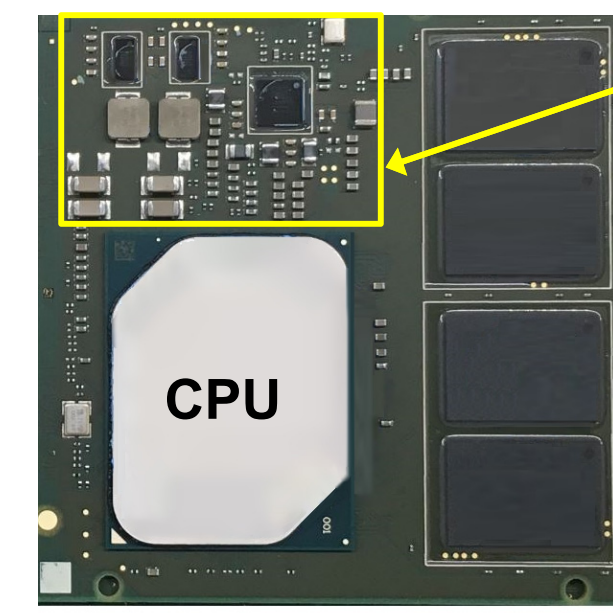
Motivation

- Trends towards higher integration in
 - Mobile computing**
 - Automotive**



MacBook

- Smaller/Lighter form factor
- Larger battery

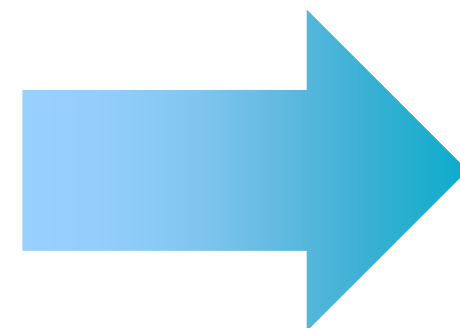


Example of Automotive HDI SoC Board

- Supply
 - 20-100 CPUs per car
 - Multiple sensors
 - Small pitch package

SoC supplies requirements

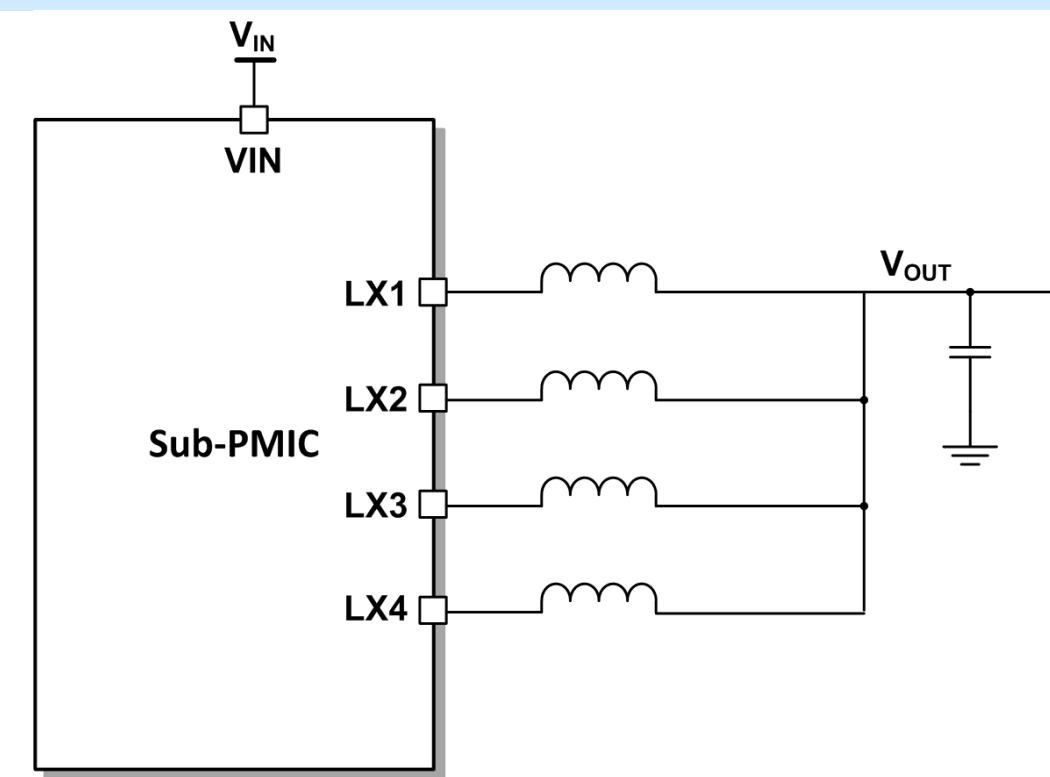
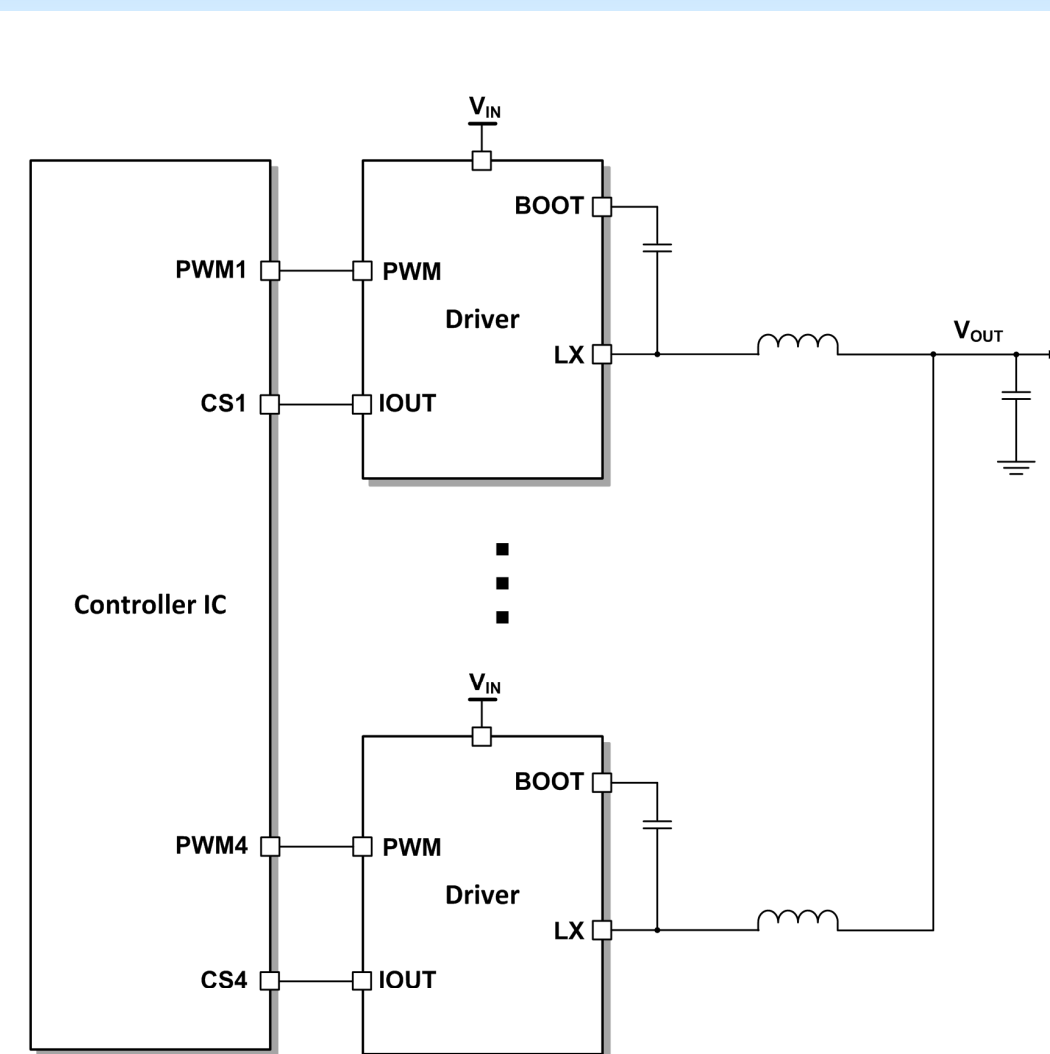
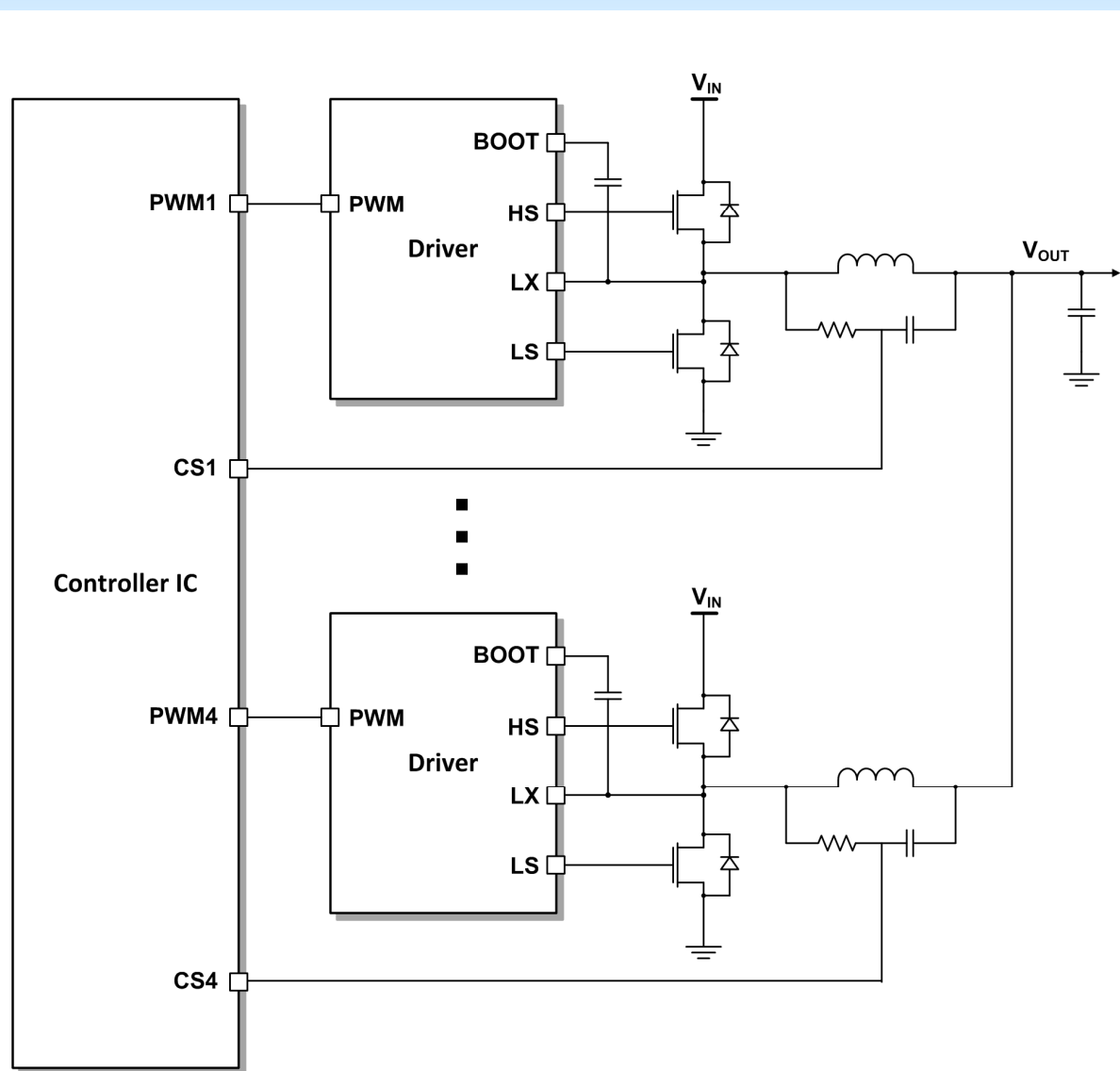
- High current (>10 A) rails
- Fast load transients
- Complex power sequences with multiple power states
- Small board area
- Meet thermal limits



Multi-phase DC-DC regulators

- High efficiency
- Fast transient response due to parallel inductors
- Better thermal performance than equivalent buck regulator

Multi-Phase Buck regulators



Fully Integrated Multi-Phase Buck:

- Integrated drivers and power stages → Higher efficiency / Better transient
- Loss-less current sensing to balance current among phases
- Switching frequency >1 MHz → Small inductors

Conventional Multi-Phase Buck:

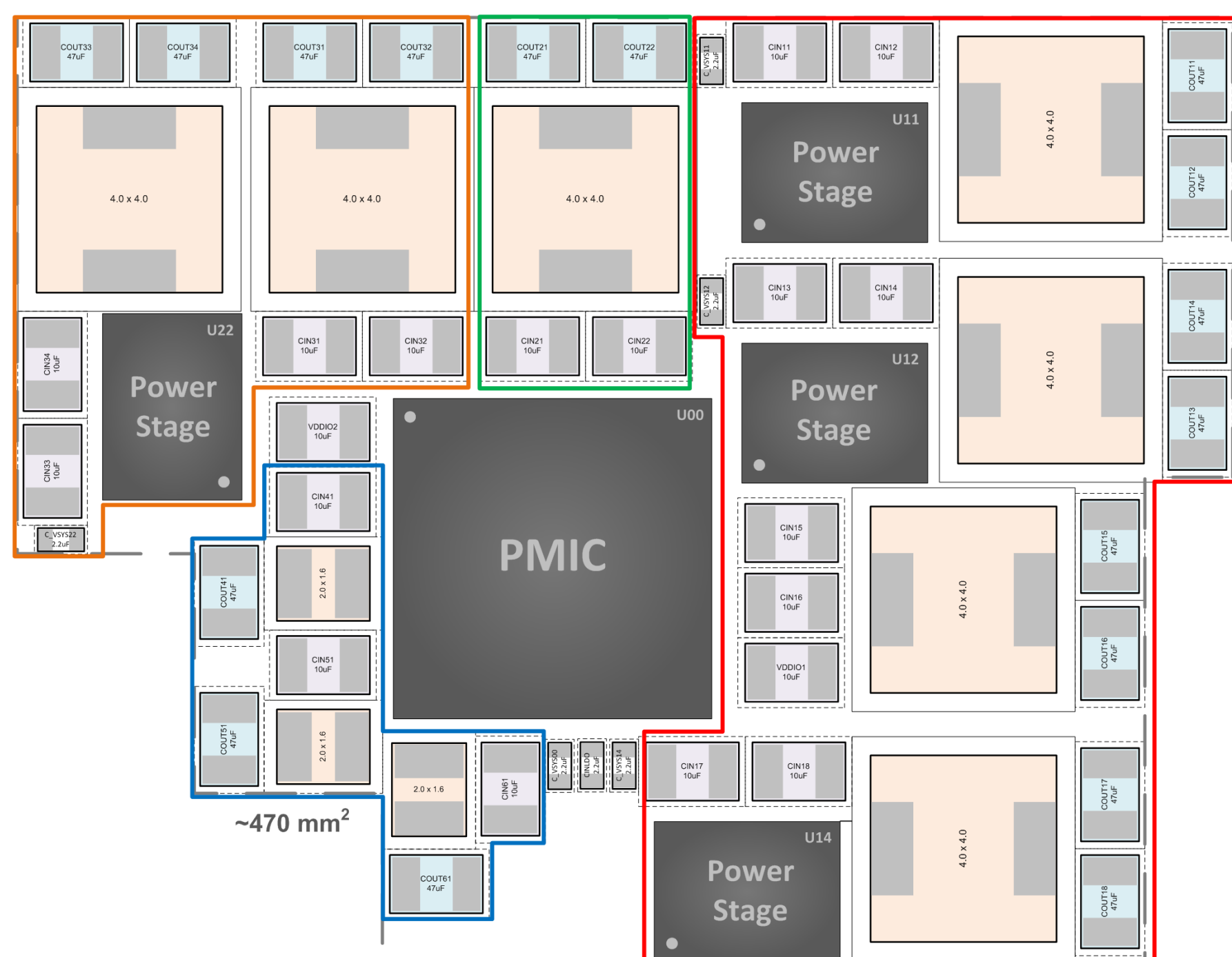
- Controller + external power stages (w/ or w/o integrated drivers)
- Extra components for current sensing to balance current among phases
- Switching frequency <1 MHz because of parasitics → Large inductors

Dialog IC	Outputs	Phases/ Output	Maximum Output Current [A]	L [uH]	f _{sw} [MHz]	C _{OUT} [uF] per output
DA9210*	1	4	12	0.47	3	4 x 47
DA9211	1	4	12			4 x 22
DA9212	2	2	2 x 6	0.22	3	2 x 22
DA9213	1	4	20			4 x 22
DA9214	2	2	2 x 10	0.1	4	2 x 22
DA9215	2	1 / 3	5 / 15			1 x 22 / 3 x 22
DA9122	2	2	2 x 5			2 x 10

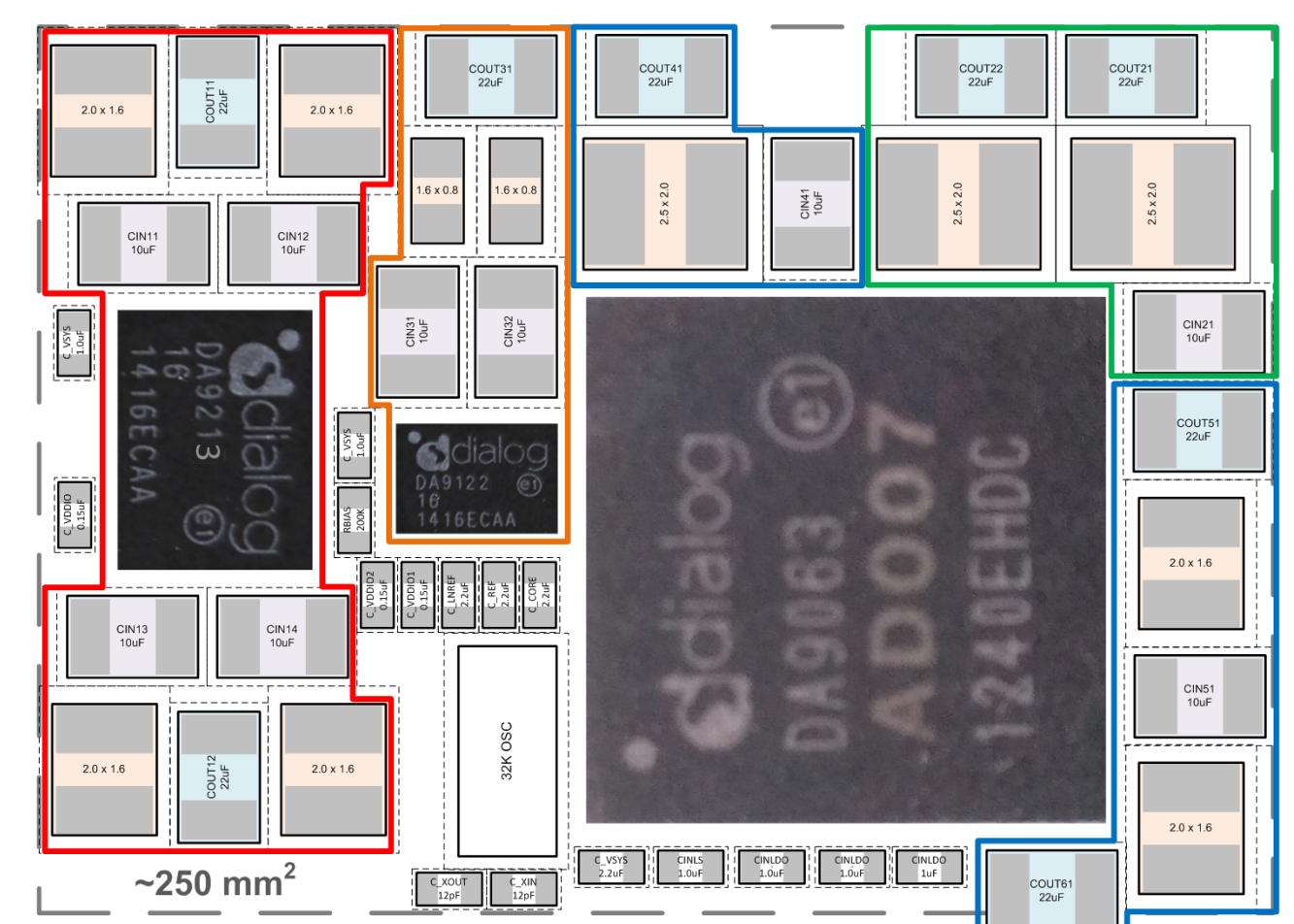
*supports master-slave operation up to 24A

Study case: Supply for Automotive SOC platform

Competition: Main PMIC + External Power Stages*



Proposed: Main PMIC (DA9063) + Fully Integrated Multi-Phase Sub-PMICs



x1/2 Area

*External Power Stages (5 A, f_{sw}=2MHz) include driver, power stage and current sensing

Buck #	I _{OUT} [A]	Competition	Dialog IC
1	20	PMIC (1 buck + 3 controllers) + 3 Ext. Power Stgs	DA9213
2	4	PMIC (1 buck)	DA9063
3	10	PMIC (1 buck + 1 controller) + 1 Ext. Power Stg	DA9122
4	2.5	PMIC (1 buck)	DA9063
5	1.5	PMIC (1 buck)	DA9063
6	1.5	PMIC (1 buck)	DA9063