Increase power density and simplify designs using 3-D SiP modules

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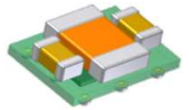
2019 IEEE PELS/PMSA Phoenix

- PwrPACK 2019 Arizona State University

Summary of topics

- IC Packaging technology trends
  - Cross pollination across eco-systems
- **Power** module technologies
  - Inductor types
  - Modules
    - Molded leadframe based
    - MicroSiP™ embedded die modules

T Power module packaging technology



- IC Packaging technology trends
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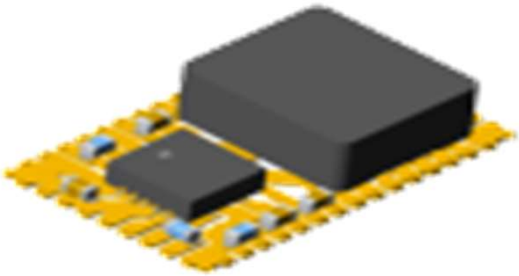
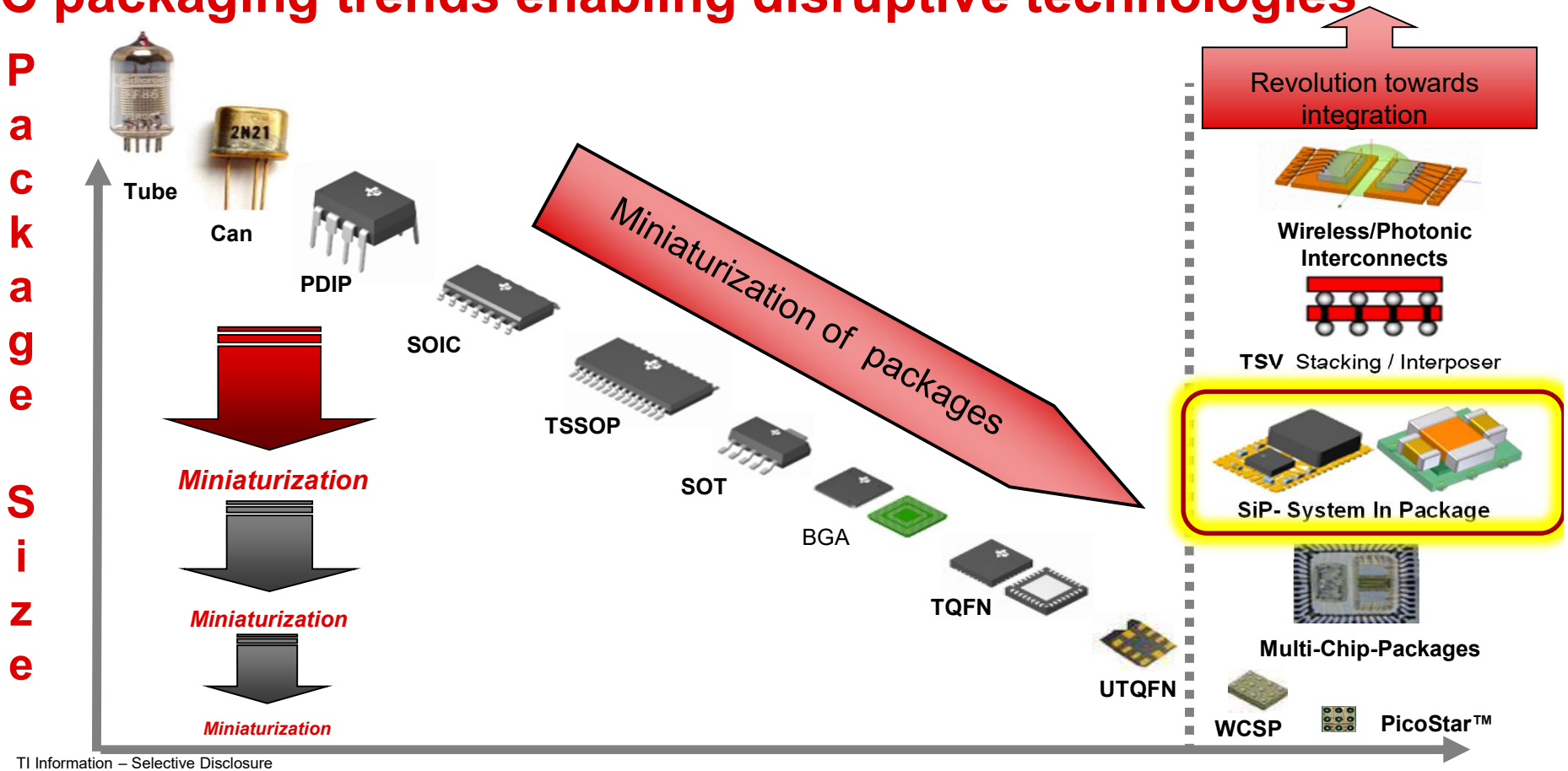
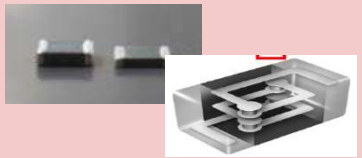
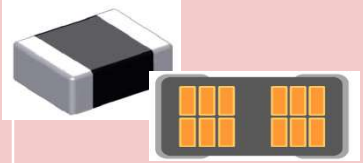


IC packaging trends enabling disruptive technologies

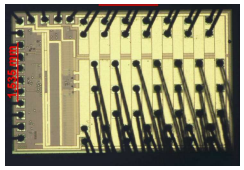


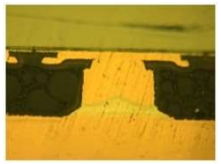
Inductor technology matrix

	Chip (MultiLayer)	Chip (Molded)	Molded	Assembled
Image				
Use	Low I, <50V Low Cost	Low-Mid I, <20V	5-50A	Low Cost
Features	Sintered Ceramic with silver electrode windings	Flat Wire Winding, pressed magnetic powders with organic binders, chip format	Flat Wire Winding w/pressed magnetic powders & organic binders	Sintered or pressed metal cores with wound wire coils.
Efficiency		Low DCR, Soft Saturation	Low DCR, Soft Saturation	
Density		Compressed	Compressed	
EMI	Good	Good	Good	Fair/Poor
Cost/other				Lowest Cost

Defining power modules

Combine Silicon..

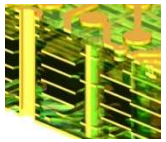




...Plus Components...

...On a Carrier...

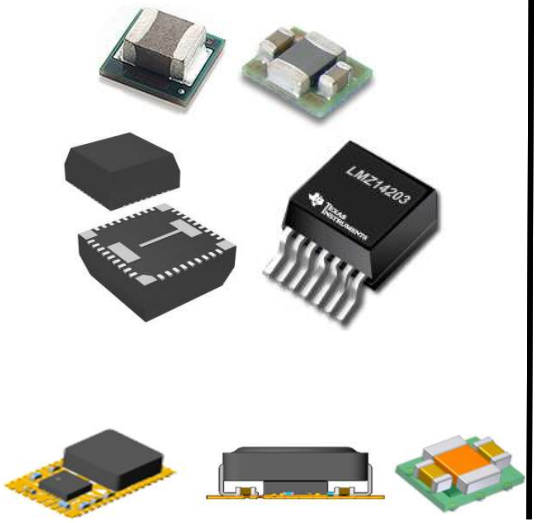
Leadframe



Laminate

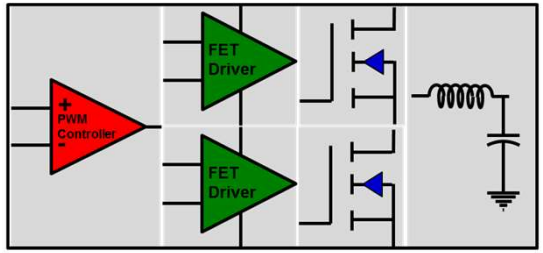
...to Create a POWER MODULE

Vin to Vout Complete System in Package



Focus on POL

DC / DC
Non-Isolated
PE, Comms, Industrial, Enterprise

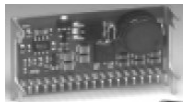


DC/DC Controller

DC/DC Converter

DC/DC Power Module

TI POL module — Continued integration over time



PT6725
62x31x10.6mm

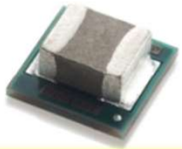
Inductor = 11% volume
18x15x8.4mm
350kHz, 10mΩ, 2.2uH
Ferrite Drum, Round Wire Self Term

PTH12050
22 x 13 x 8.5 mm

Inductor = 11% volume
7x7x5mm
350kHz, 6mΩ, 1.5uH
Powder Iron EI, Edge Wound Wire Self Term

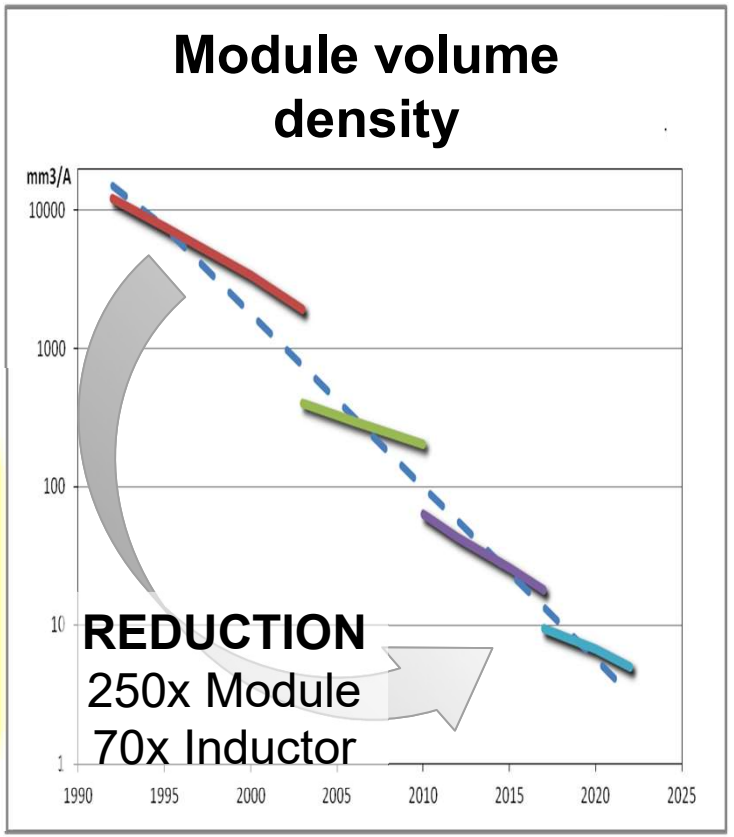
LMZ31506
15 x 9 x 2.8 mm

Inductor = 25% volume
7x6.5x2.1mm
500kHz, 13mΩ, 1.1uH
Powder Iron Molded, Round Wire Weld on LF



TPS82130
2.8 x 3 x 1.5 mm

Inductor = 45% volume
2.5 x 2.0 x 1.2 mm
1MHz, 10mΩ, 0.6uH
Powder Iron, Edge Wound Flat Wire Plated Termination

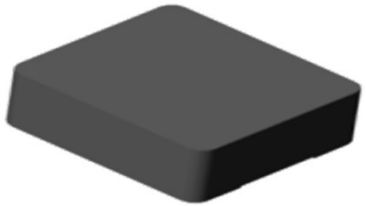


Leadframe-based passive integration

15-mm x 9-mm x 2.8-mm QFN

Resistors

Capacitors

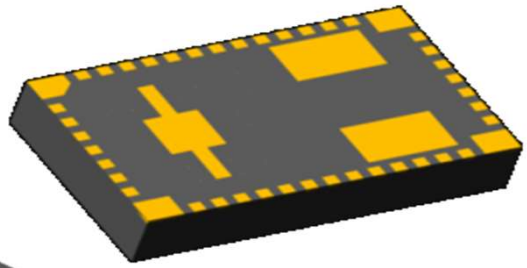


Inductor

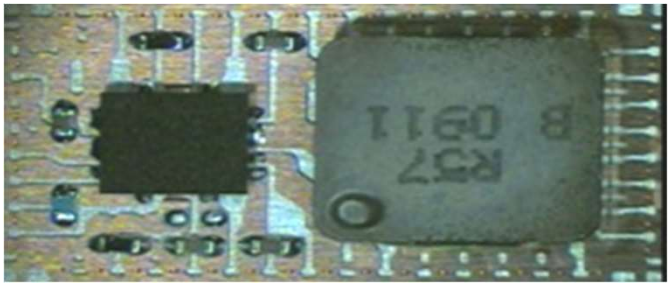
Integrated Controller + FETs in a QFN pkg

Sub Assembly

TI Leadframe

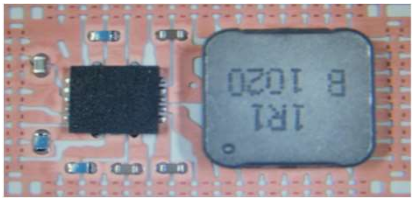


System-In-Package

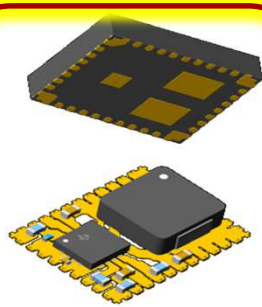


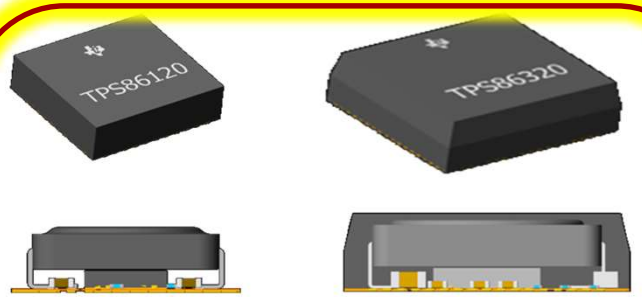
http://www.ti.com/ww/en/analog/tps84620/index-B.shtml?DCMP=hpa_pwr_tps84&HQS=Sample+BA+tps84-bp

Integrated power module integration trend



2D
Side by Side





2.5D
Stacked
Inductor

Pkg X & Y	11x9mm, 15x9mm	10x10mm	16x15mm
Pkg Height	2.8mmt	4.3mmt	5.8mmt
Current	2A-6A	10A, 6A, 4A	30A, 20A, 15A
Availability	Released	Released	Released

Package thickness progression enabling embedded solutions

SOIC
1.75 mm

TSSOP
1.2 mm

QFN
1 mm

MicroStar
1 mm

WCSP (NanoStar)
0.6/0.5 mm

Thin QFN
0.8 mm

TWCSP
0.4/0.3 mm

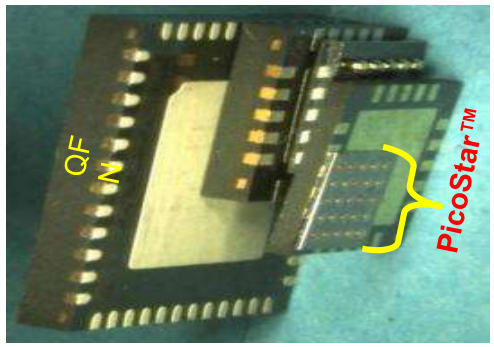
U*CSP
0.4mm

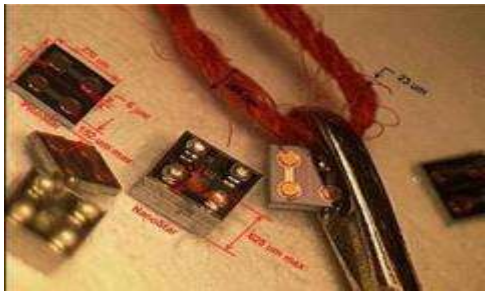
PicoStar™
0.15/0.1 mm

X-QFN
0.4 mm

PicoStar™-2G
0.075mm

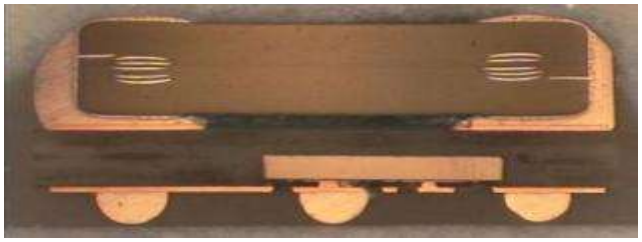
Invisible to naked eye
~0.04 mm

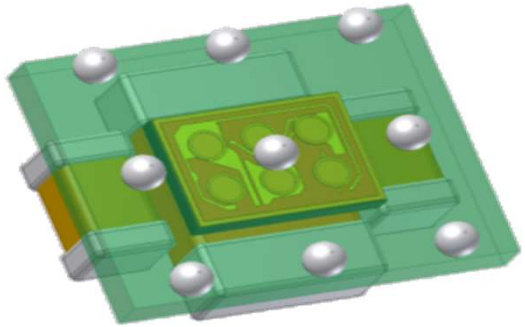


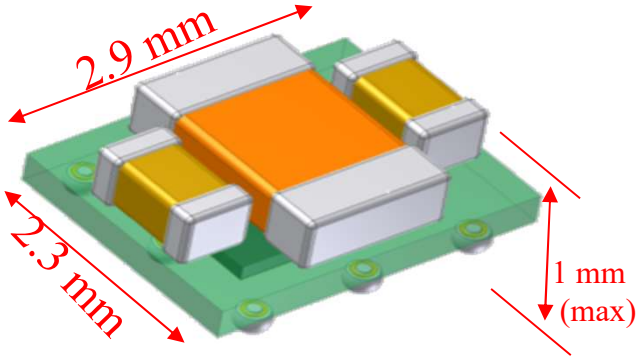


MicroSiP™ DC/DC converter

- PCB (substrate)
- Embedded PicoStar™ DC/DC converter
- Integrated passives (L, CIN, COUT)
- Released to market







http://www.ti.com/ww/en/analog/tps82671/index.shtml?DCMP=hpa_pwr_tps82&HQS=Sample+BA+tps82-bp

0402 Caps, 2012 Inductor

Conclusions

- 3D SiP Modules offer simplicity
  - Plug and play Vin to Vout
  - Volumetric power density
- 3D assembly techniques are advancing
  - Embedded PicoStar™
  - Stilted inductor
- Inductor customization offers electrical and volumetric performance
  - 3D stacking
  - Future-tuned, high frequency multiphase performance

THANK YOU