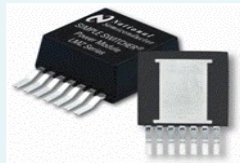
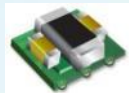


Power Modules...

How we build them and why you need them

Steve Goacher, s-goacher@ti.com

www.ti.com/powermodules



Agenda

- Why Modules?
- Module Technology Deep Dive
- Design Tools
- Latest Products
- Q&A

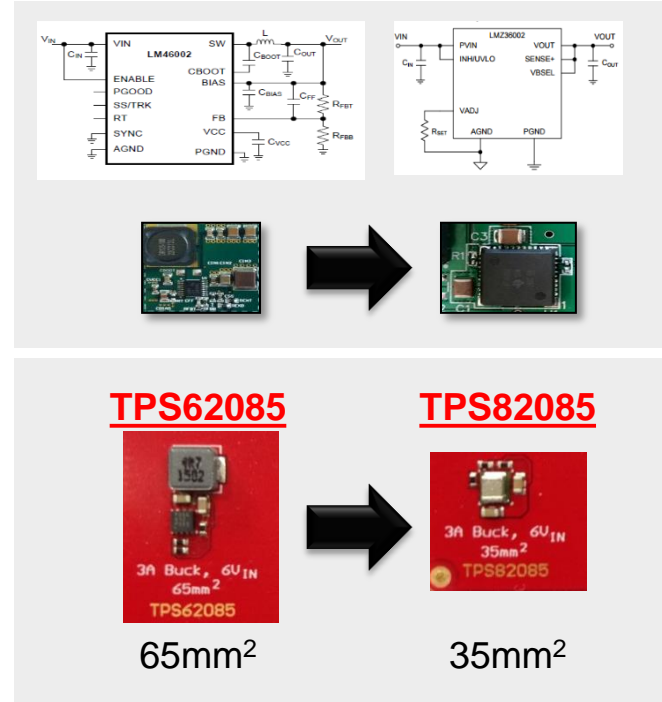
What are Power Modules?

DC/DC Converter that integrates Controller, FETs and Inductor into single package

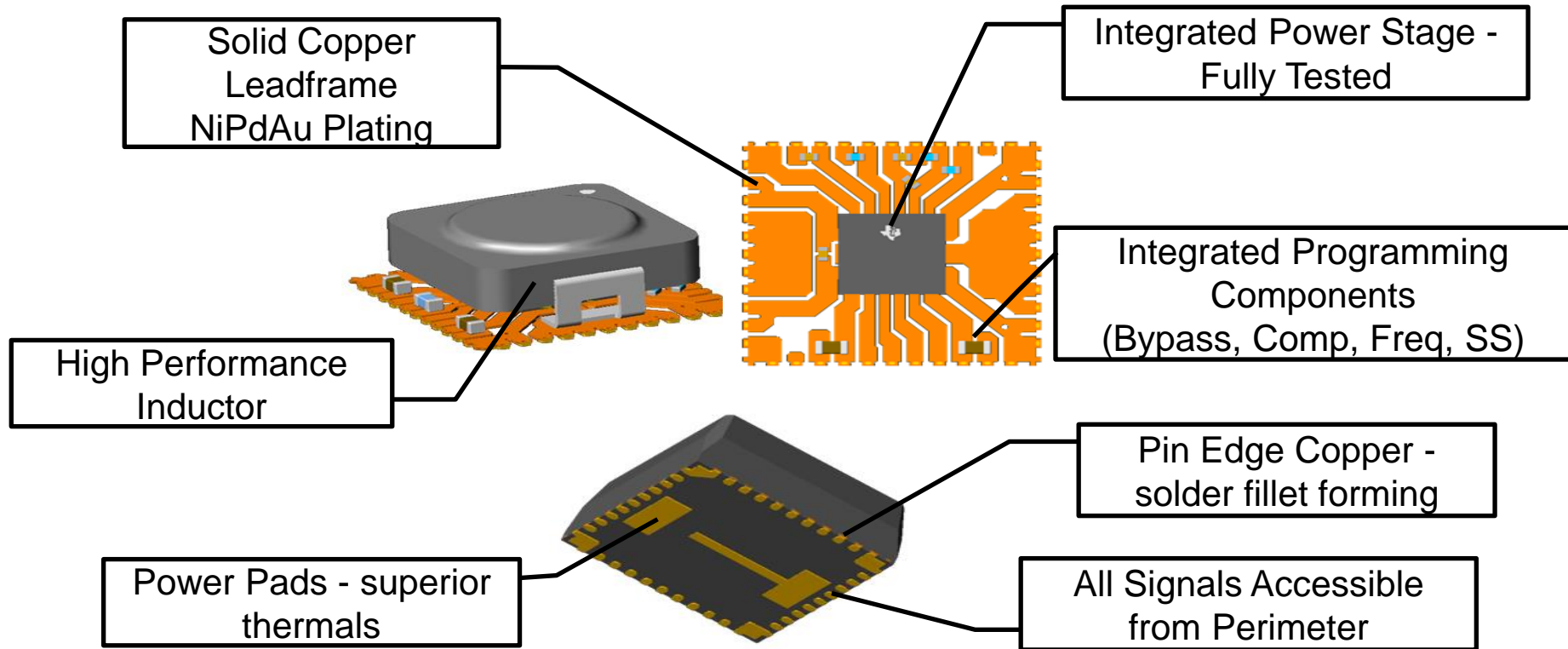
- Simplifying and reducing BOM

Simplifies Power Management design

- Faster time to market
- Do not need to be Power Expert
- Guaranteed Performance to critical specs
- Smaller Solution Size
- Fewer parts to procure
- Reliable w/ proven specs, EMI, MTBF

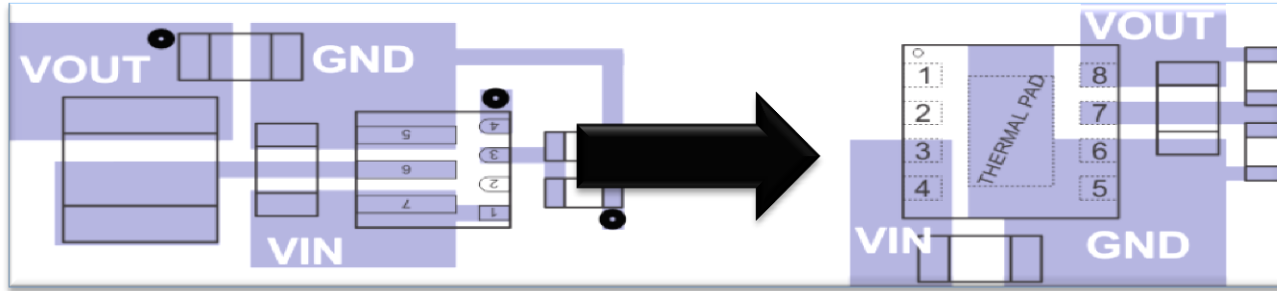


What is a Power Module: LMZ36002 example



Modules Save Up to 40% Board Area

Discrete → Module



TPS62085

TPS82085

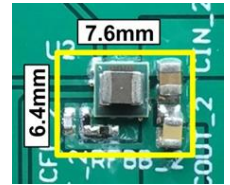
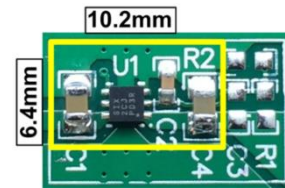
LM46002

LMZ36002

TPS7A37

LMZ20501

LDO



65mm²

35mm²

288mm²

196mm²

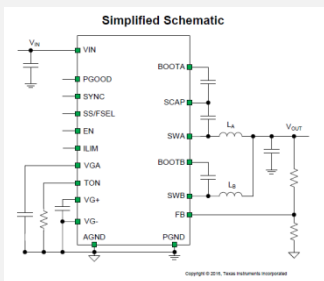
65mm²

49mm²

Easy to Use

- No inductor selection or design equations
- Lower BOM count
- Optimized PCB layout with little effort
- Thermal performance already characterized
- EMI tested

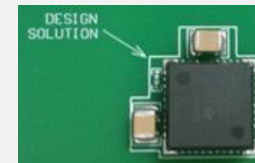
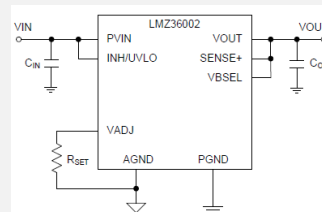
TPS54A20



TPSM84A21



LMZ36002

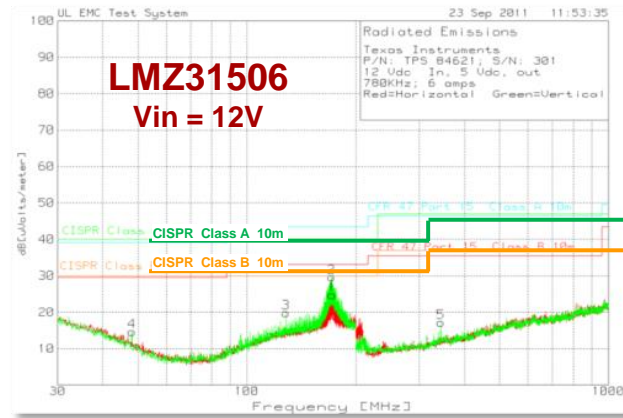
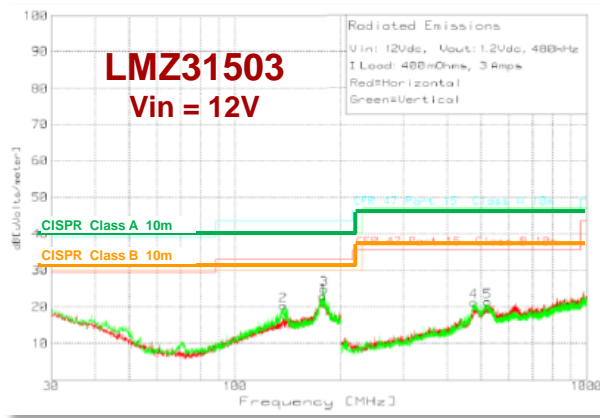
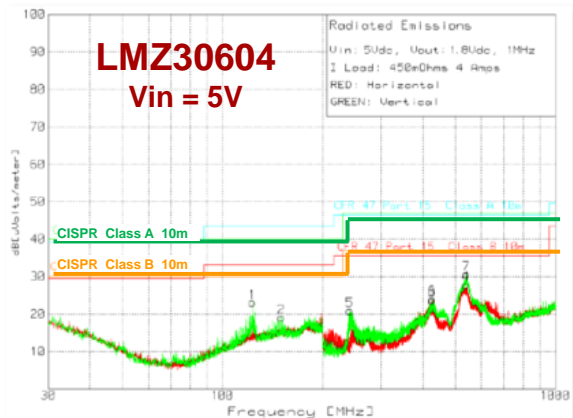


EMI Performance

Modules Compliant with EN55022 Class B radiated emissions without additional filtering

Use shielded inductor

Graphs include the plots of the antenna in the horizontal and vertical positions.



Product Quality

Attractive MSL Rating and Reflow Temp

3X Reflow

Quality & environmental data

Part #	Eco Plan*	Lead / Ball Finish	MSL Rating / Peak Reflow	Details	DPPM / MTBF / FIT Rate
LMZ31710RVQR	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	View	View
LMZ31710RVQT	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	View	View

Lead Free/Green Product

DPPM/MTBF/FIT Rate Provided

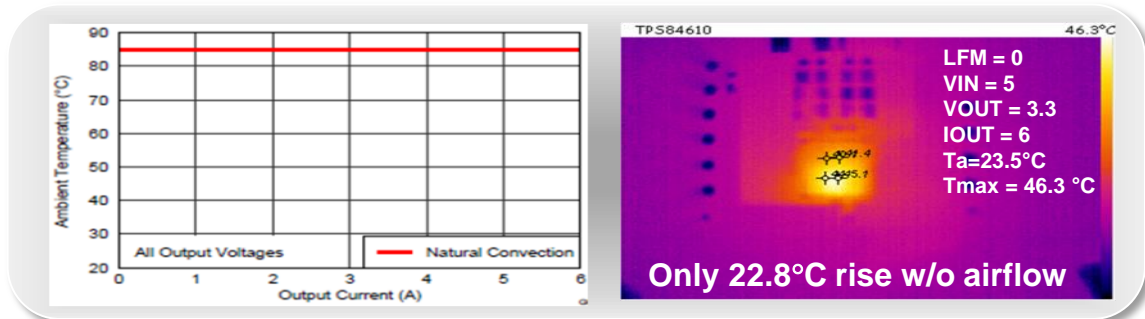
The following failure rates are summarized by technology and mapped to the associated material part numbers. The failure rates are highly dependent on the number of units tested, therefore, it is not recommended to compare failure rates.

Part number	Early life failure rate	MTBF / FIT		Early life failure rate supporting data				MTBF / FIT supporting data						
	ELFR-DPPM	MTBF	FIT	Conf level (%)	Test temp (°C)	Sample size	Fails	Usage temp (°C)	Conf level (%)	Activation energy (eV)	Test temp (°C)	Test duration (hours)	Sample size	Fails
LMZ31707RVQR	19	1x 10 ¹⁰	0.1	60	125	48872	0	55	60.0	0.7	125	1000	136916	0

Thermal Performance

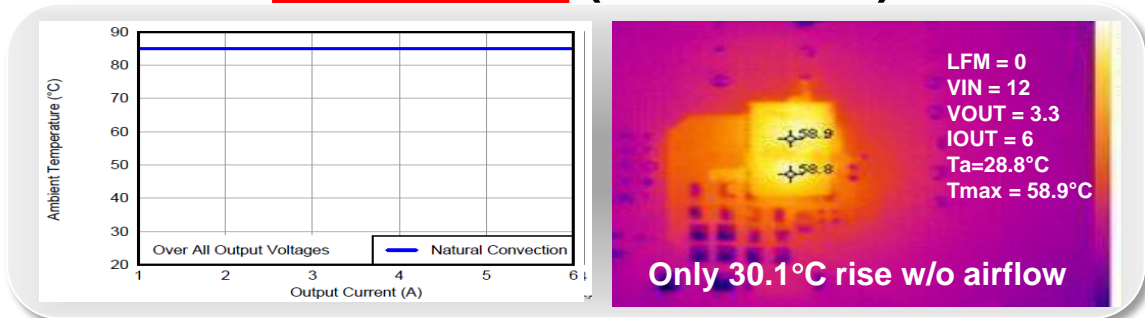
- Full-Rated Current Available at $T_a = 85^\circ\text{C}$
- Low Thermal Resistance (Theta-JA): $12\text{--}13^\circ\text{C/W}$

LMZ30606 (Low-Vin 6A)



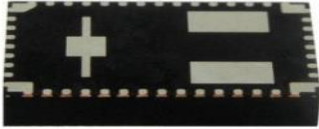
- Low Temp Rise
 - LMZ30606: 22.8 $^\circ\text{C}$ rise (5V – 3.3V @ 6A, no airflow)
 - LMZ31506H: 30.1 $^\circ\text{C}$ rise (12V – 3.3V @ 6A, no airflow)

LMZ31506H (Mid-Vin 6A)

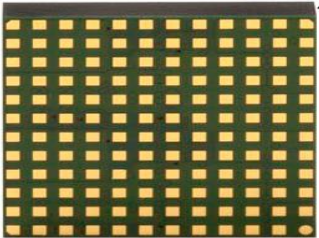


QFN Advantages vs. LGA & BGA

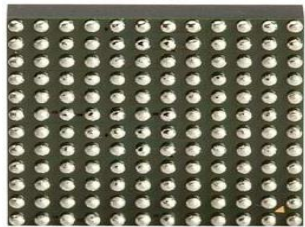
QFN



LGA



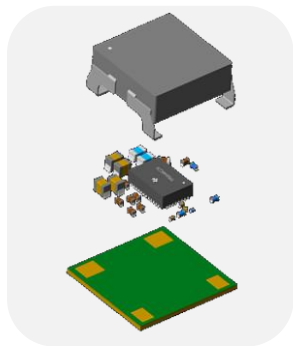
BGA



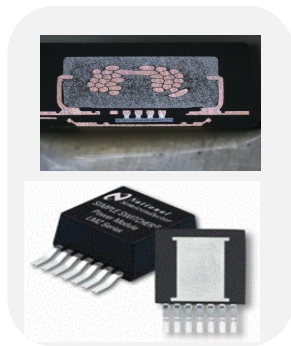
- **Better Thermal Efficiency in 40% Smaller Package**
- **Access to Signal Pins**
 - Pins on Outside
 - Easy to route Signals, Vias, Power
 - Easy to inspect solder joints
- **High Temp Reflow**
 - QFN capability for 260°C

Module Design Techniques Reduce Solution Size

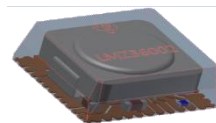
- Several different techniques used to put the Inductor over the top of the IC and discrete components
 - Reduces X/Y Area
 - Typically something that is difficult to do in system design
- MicroSiP devices have IC Embedded into PCB



Open Frame QFN



Leaded



Overmold QFN

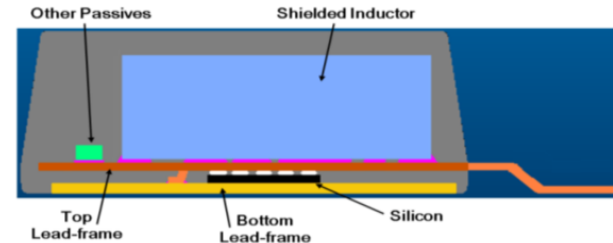
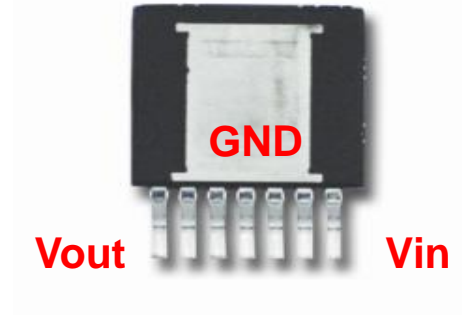


Embedded

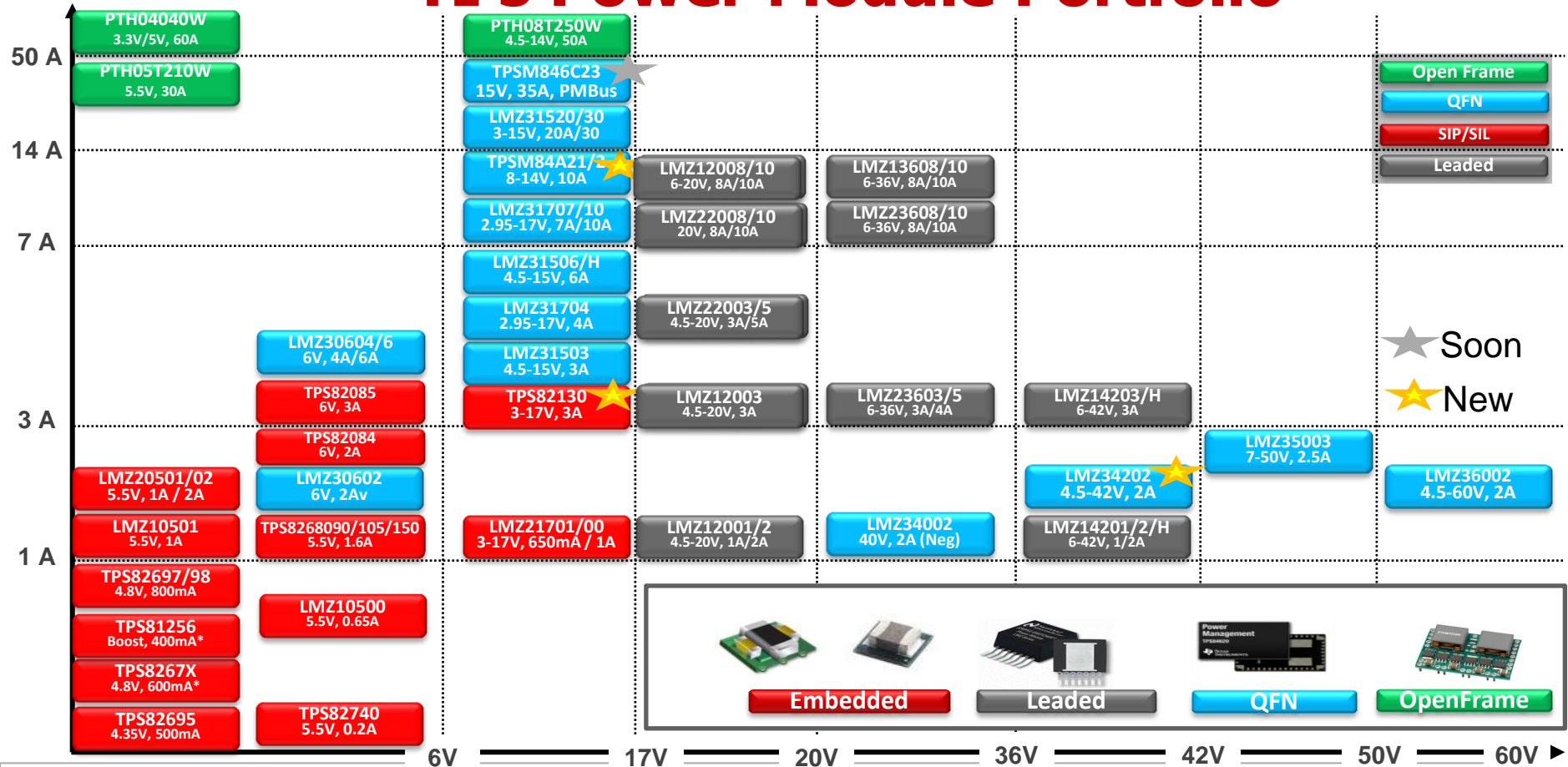
Leaded Power Module Package Details

Ease of Prototyping and Manufacturing

- Standard size and lead pitch
 - Same pick and place manufacturing as TO-263 package
 - 7 & 11 Pin Families
- Simpler mounting for customer
 - Easier to mount than BGA, etc.
 - Single DAP allows easy prototyping in lab with a single soldering iron
- Logical Pin-out makes good PCB layout easy
- Enclosed, molded package
 - Moisture, particle immune
- Higher Reliability
 - Fewer External Components
 - Excellent Thermal Performance (lower Temp = higher reliability)



TI's Power Module Portfolio



Featured Power Modules

TPS82084/TPS82085



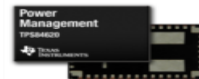
- ✓ V_{in} Range: 2.5 to 6Vin
- ✓ I_{out} Range: 2A/3A
- ✓ Package Size: 2.8 x 3.0 x 1.3mm
- ✓ Efficiencies to 95%

TPS82130



- ✓ V_{in} Range: 3.0 to 17Vin
- ✓ I_{out} Range: 3A
- ✓ Package Size: 2.8 x 3.0 x 1.5mm
- ✓ Light Load efficient

LMZ31704/LMZ31707/ LMZ31710



- ✓ V_{in} Range: 4.5 to 17Vin
- ✓ I_{out} Range: 4A/7A/10A
- ✓ Package Size: 10 x 10 x 4.3mm
- ✓ Parallelable. Light Load Eff

TPSM84A21/TPSM84A22



- ✓ V_{in} Range: 8 to 14Vin
- ✓ I_{out} Range: 10A
- ✓ Package Size: 9 x 15 x 2.3mm
- ✓ Only 1 external component (Vset)

LMZ23608/LMZ23610



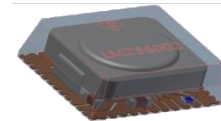
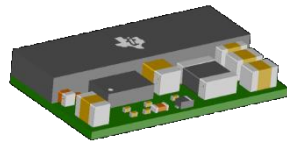
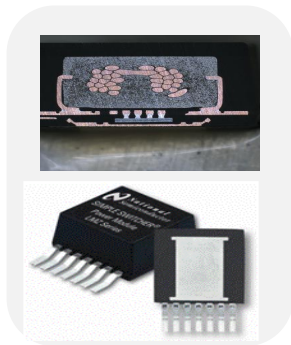
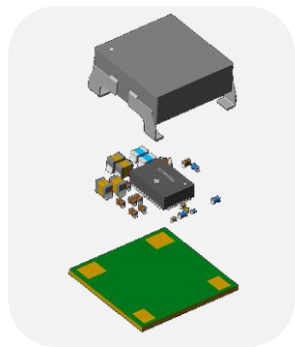
- ✓ V_{in} Range: 6 to 36V
- ✓ I_{out} Range: 8A/10A
- ✓ Package Size: 15 x 15 x 4.6mm
- ✓ Simple PCB Layout

LMZ36002

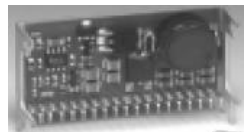


- ✓ V_{in} Range: 4.5 to 60Vin
- ✓ I_{out} Range: 2A
- ✓ Package Size: 10 x 10 x 4.3mm
- ✓ Guaranteed EMI

Module Packages from TI



TI POL Module Evolution



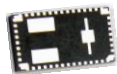
PT6725
62x31x10.6mm

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, Edge Wound Wire Self Term



LMZ31506
15 x 9 x 2.8 mm

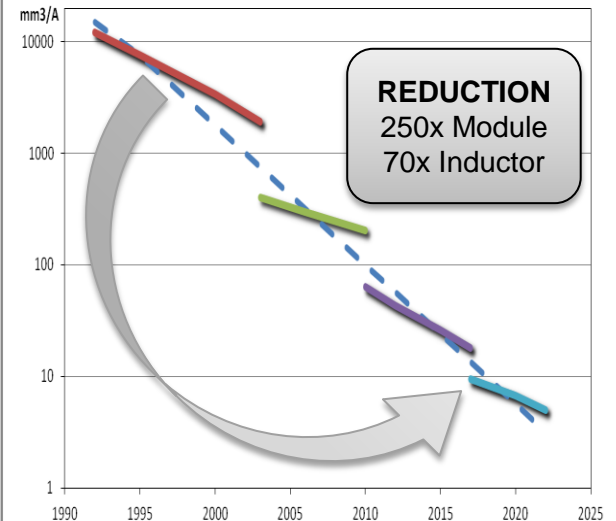
Inductor = 25% volume
7x6.5x2.1mm
500kHz, 13mΩ, 1.1uH
Molded Powder Iron, Round Wire on LF Term



TPS82130
2.8 x 3 x 1.5 mm

Inductor = 45% volume
3.0 x 2.8 x 1.5 mm
2MHz, 35mΩ, 1.0uH
Molded Powder Iron, Flat Wire, Plated Term

Module Density Over Time



INTEGRATION

FREQUENCY

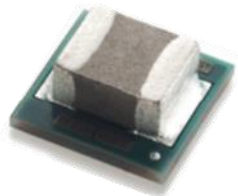
MAGNETICS

PACKAGING

Deep Dive: Embedded (uSIP, Nano)

Process Flow

Embed → SMT



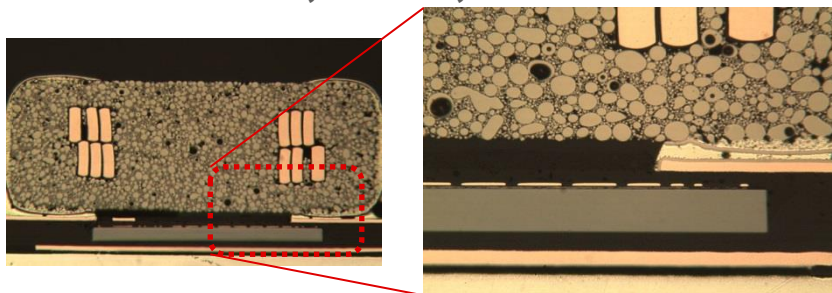
TECH CHOICE

Open Frame, FR Laminate
Embedded, Die up or Die down
SMT components
MultiLayer or Molded inductor
0.1-3A (so far...)

TPS82085, TPS82130

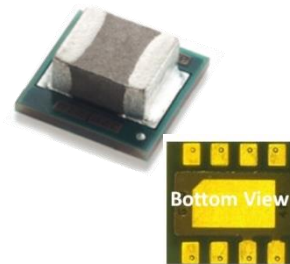
2.8 x 3 x 1.3 / 1.5 mm

2.5-6V, 2.7-17V, 3A



CUSTOMER IMPACT

3D, low to mid cost assembly
MSL2/3, 260°C
uSIP LGA, 0.65mm pitch
 $\theta_{JA} = \sim 70^{\circ}\text{C/W}$
2.8mm²/A, 4.2mm³/A



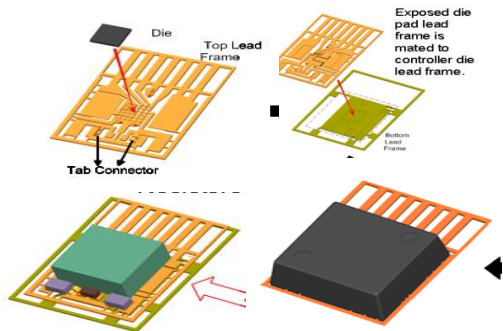
Cost	Green
Density	Green
EOU	Yellow
Eff	Green
Thermal	Yellow
EMI	Green
Rel	Green

Ultra High Density. Much smaller vs Discrete

Deep Dive: Leaded

Process Flow

FCOL → LF Bond → SMT → Mold

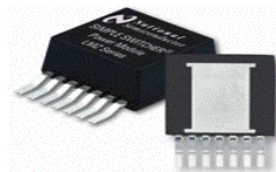


TECH CHOICE

Overmold 200um dual LF
High flux thermal pad
FCOL between leadframes
SMT components (on top LF)
Molded inductor
1-10A+

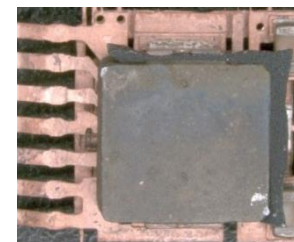
LMZ14203

10 x 14 x 4.3 mm
6 - 42V, 3A



CUSTOMER IMPACT

3D, mid-cost assembly
MSL3, 245°C
TO Style, 1.27mm pitch
 $\theta_{JA} = 19.3^{\circ}\text{C/W}$
46mm²/A, 200mm³/A (wide Vin)



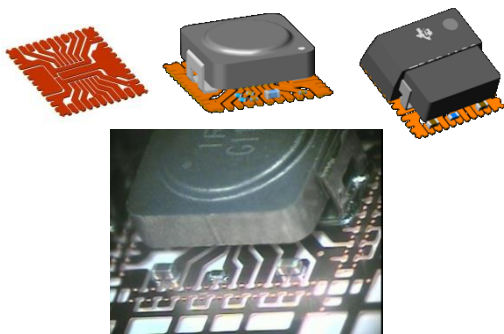
Cost	Yellow
Density	Light Green
EOU	Light Green
Eff	Light Green
Thermal	Yellow
EMI	Light Green
Rel	Light Green

Extreme High Ease of Use. 3D Construction reduces solution size vs discrete

Deep Dive: Leadframe based QFN

Process Flow

Leadframe → SMT → Mold

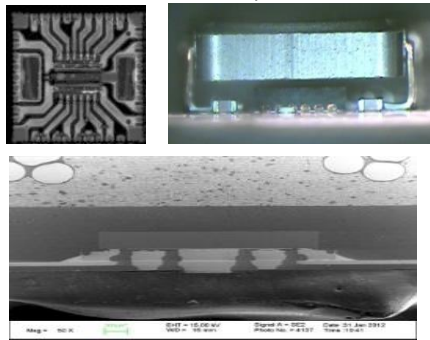


TECH CHOICE

Overmold, 200um LF,
High thermal flux customer pads
Pre-packaged, tested silicon
SMT components
Molded inductor (2D and 3D)
3-30A+

LMZ31710

10 x 10 x 4.3 mm
2.7-17V, 10A

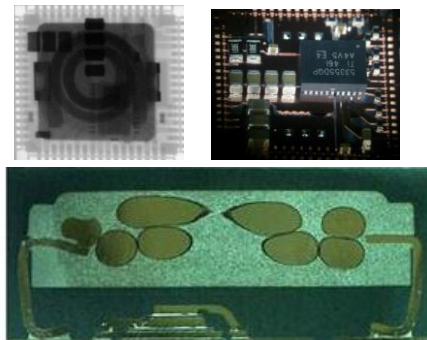


CUSTOMER IMPACT

3D, low cost assembly
MSL3, 260°C
QFN, 0.8mm pitch
 $\theta_{JA} = 13.3^{\circ}\text{C/W}$
10mm²/A, 43mm³/A

LMZ31530

15 x 16 5.8 mm
4.5-15V, 30A



CUSTOMER IMPACT

3D, low cost assembly
MSL3, 260°C
QFN, 0.8mm pitch
 $\theta_{JA} = 8.6^{\circ}\text{C/W}$
8mm²/A, 46mm³/A

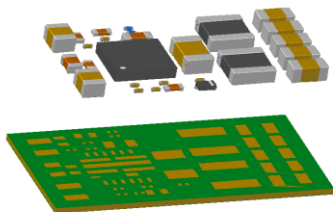
Cost	
Density	
EOU	
Eff	
Thermal	
EMI	
Rel	

High Ease of Use and High Density vs Discrete Solution

Deep Dive: Laminate based QFN

Process Flow

Leadframe → SMT → Mold

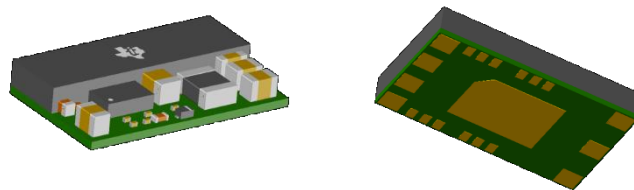


TECH CHOICE

Overmold, 500um Laminate,
Thermal flux customer pads
Pre-packaged, tested silicon
SMT components
Molded inductor (2D and 3D)

TPSM84A21/TPSM84A22

15 x 9 x 2.3 mm
8.0-14V, 0.55 – 2.05V, 10A



CUSTOMER IMPACT

2D, low cost assembly, Integrated
Cin/Cout, MSL3, 260°C
QFN, 0.8mm pitch,
 $\theta_{JA} = 14.9^{\circ}\text{C/W}$
13.5mm²/A, 31mm³/A

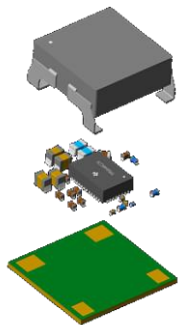
Cost	Green
Density	Green
EOU	Yellow
Eff	Green
Thermal	Yellow
EMI	Green
Rel	Green

Ultra High Density. Large Number of integrated components

Deep Dive: Laminate Open Frame QFN

Process Flow

Leadframe → SMT → Mold



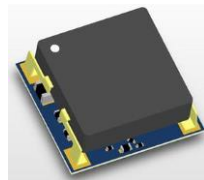
TECH CHOICE

500um Laminate,
Thermal Flux Customer Pads
Pre-packaged, tested silicon
SMT components
Molded inductor (3D)

TPSM84C23

15 x 16 x 5.9 mm

4.5 – 15V, 0.35 – 2.0V, 35A (70A), PMBus



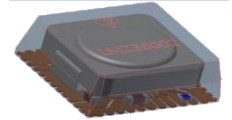
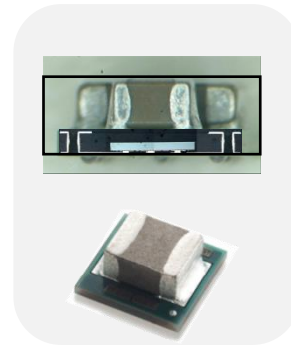
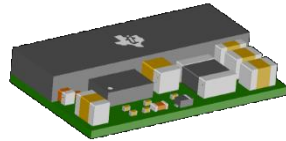
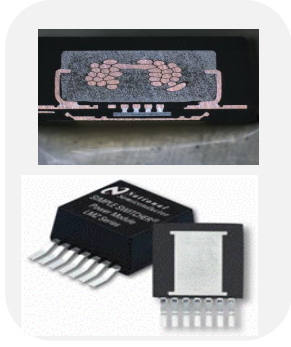
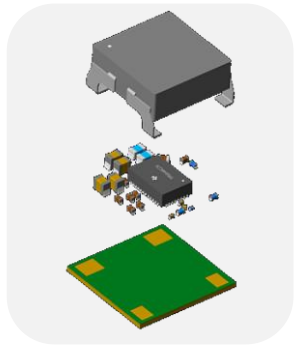
CUSTOMER IMPACT

3D, low cost assembly,
MSL3, 260°C
QFN, 0.8mm pitch
 $\theta_{JA} = 8.7^{\circ}\text{C/W}$
6.9mm²/A, 40mm³/A

Cost	Green
Density	Green
EOU	Yellow
Eff	Green
Thermal	Green
EMI	Green
Rel	Green

High Ease of Use and High Density vs Discrete Solution

A Range of Module Options



- Several different types of manufacturing approaches to choose from when developing a new module
- All offer the ability for reduced X/Y area by stacking the Inductor
- All offer excellent MSL3 or better and most support 260°C reflow capability

Design Tools...

The [NEW] Modules SITE on TI.com



Innovative DC/DC power modules to fit design constraints

TI's broad portfolio of DC/DC modules integrate inductors, FETs, compensation, and other passive components into a single package to simplify prototyping, design, and manufacturing. Using a module reduces engineering time for design and verification to help speed development cycles for many applications, including personal electronics, industrial, and communications.

Browse by input voltage level

Battery

[Browse products >](#)

3.3 V & 5 V

[Browse products >](#)

12 V

[Browse products >](#)

24 V+

[Browse products >](#)

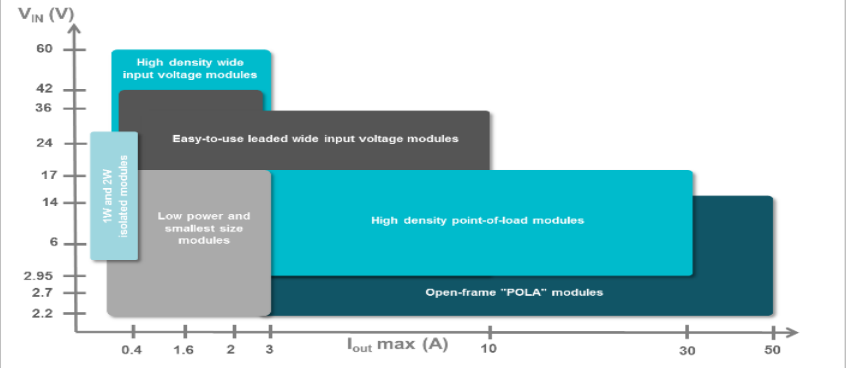
Isolated

[Browse products >](#)

New and Improved Landing Page

TI power module portfolio

Click the portfolio to learn more about the different product families and to find the best device for your design



1W and 2W Miniature Isolated DC/DC Converters

Product Selector Guide

Device	Input Voltage	Output Voltage	Output Current	Efficiency	Temp. Range	Package
LM2575	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2576	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2577	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2578	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2579	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2580	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2581	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2582	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2583	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2584	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2585	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2586	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2587	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2588	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2589	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2590	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2591	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2592	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2593	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2594	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2595	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2596	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2597	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2598	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2599	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23
LM2600	3.3V	5.0V	0.1A	85%	-40 to 125°C	SOT-23

Design Summary for MicroSiP-enabled TPS8267xSiP

TI.com

Featured Documents

Support & training

LMZ36002 Features

- Enhanced thermal performance: 14°C/W
- CISPR 22 Class-B EMI standards
- Adjustable switching

Tools & software

10G SFP+ LR Optical Module for fiber networks

This Texas Instruments Reference Design was designed to demonstrate the optical performance of the ONET1151L Laser Driver, the ONET8551T high gain Transimpedance Amplifier (TIA) and the ONET1151P Limiting Amplifier.

Design support

Ask questions, share knowledge, explore ideas.

WEBENCH+ Designer

Filters: Sensors, Interface, Reference

Power: EPQA/JP, LED, Clocks

Enter your power supply requirements:

Max: 22.0 V, 2.0 A, 30 °C

Power Architect | Start Design

TI Designs, videos, blogs and more!

SIMPLE SWITCHER

Design discusses the first industry DC/DC isolated

Simplify Your Design

Learn how 25 years of

Compact Power TP

Compact Power TPS02

Space Optimized Wide Vin Triple-Output Power Module Reference Design

The TIDA-00783.1 reference design is a triple output wide Vin power module design. It provides 3.3V, 1.8V and 1.2V output, at 6W total power. The layout is optimized for space constrained applications.

Learn more



TI Designs

Power Management Reference Designs

Search over 1,000 designs!

Enter values below to retrieve your results.

Min V_{in}: [] V, Max V_{in}: [] V

Select an application: []

Select a topology: []

Get Results

Access WEBENCH From TI.com



LMZ36002 (ACTIVE)
SIMPLE SWITCHER® 4.5V to 60V, 2A Step-Down Power Module in QFN Package
SIMPLE SWITCHER 4.5-V to 60-V Input, 2-A Power Module (Rev. A)

In English
Alert me

Description & parameters Online datasheet Technical documents Tools & software Order Now Compare Quality & packaging Support & training

Description Features Parametrics Diagrams Related end equipment Companion products

Recommended alternative parts

- LMZ34202 - This device is pin and footprint compatible with the LMZ34202, a 42V/2A step-down power module

Description

The LMZ36002 SIMPLE SWITCHER® power module is an easy-to-use integrated power supply that combines a 2-A DC-DC converter with a shielded inductor and passives into a low profile, QFN package. This total power solution allows as few as three external components while still leaving the ability to adjust key parameters to meet specific design requirements.

The QFN package is easy to solder to a printed circuit board, allows reflow profiles up to 260°C, and has excellent power dissipation capability. The LMZ36002 offers flexibility with many features and is ideal for powering a wide range of devices and systems.

Features

- Complete Integrated Power Solution Allows Small Footprint, Low-Profile Design
- 10 mm × 10 mm × 4.3 mm Package
- Wide-Output Voltage Adjust (2.5 V to 7.5 V)
- Adjustable Switching Frequency (200 kHz to 1 MHz)

Parametrics Compare all products in Step-Down (Buck) Module

	LMZ36002	LMZ14202	LMZ14201	LMZ14203	LMZ14204
Iout (Max) (A)	2	2	2	2	2
Vin (Min) (V)	4.5	6	6	6	6
Vin (Max) (V)	60	42	42	42	42
Vout (Min) (V)	2.5	0.8	5	0.8	5
Vout (Max) (V)	7.5	6	24	6	24
Soft Start	Adjustable	Adjustable	Adjustable	Adjustable	Adjustable
Special Features	EMI Tested Enable Frequency Synchronization Light Load Efficiency Power Good Remote Sense	EMI Tested Enable Tracking	EMI Tested Enable Tracking	EMI Tested Enable Tracking	EMI Tested Enable Tracking
Regulated Outputs (#)	1	1	1	1	1
Package Size: mm2:W x L (PKG)		7TO-PMOD: 140 mm2: 13.77 x 10.16(TO-PMOD)	7TO-PMOD: 140 mm2: 13.77 x 10.16(TO-PMOD)	7TO-PMOD: 140 mm2: 13.77 x 10.16(TO-PMOD)	7TO-PMOD: 140 mm2: 13.77 x 10.16(TO-PMOD)
Switching Frequency (Max) (kHz)	1000	1000	1000	1000	1000
Switching Frequency (Min) (kHz)	200	200	200	200	200

Enter Power Requirements

Press here for Device/Device Comparisons

Featured tools and software

- TINA-TI Transient Spice Model (Export from WEBENCH) (Rev. A) (Simulation Models)
- LMZ36002 Power Module Evaluation Board (Evaluation Modules & Boards)
- Space Optimized Wide Vin Triple-Output Power Module Reference Design **TIDesigns**
- Space-optimized DC/DC Inverting Power Module Reference Design with Minimal BOM Count **TIC**
- View All tools and software for LMZ36002

New! Interactive Design
Click to instantly view a schematic, charts, Bill of Materials, and Operating Values.

WEBENCH® Designer LMZ36002

Min Max Range
Vin 10.00 60.00 V 4.5 to 60.0V
Vout 5 V 2.5 to 7.5V
Iout 2 A ≤2A
Ambient Temp 30 °C -40 to 105°C

Lowest BOM Cost
Smallest Footprint
Highest Efficiency

Footprint BOM Cost Efficiency
206.0mm² \$7.5 76.0%

Open Design Simulate Now

WEBENCH®
Interactive Design
Precision Design

Select Power Supply Solution

Select your power supply solution

Module
Easiest to use
Low EMI
[Choose Part](#)

Integrated
Easy to use
Cost effective
[Choose Part](#)

Controller
Maximum flexibility
High performance
[Choose Part](#)

Or

[Compare All Part Types](#)

Do not show this again

For this example click here

Narrow results further by applying additional filters

The screenshot displays the WEBENCH Optimizer interface. At the top, there are three main sections: WEBENCH Optimizer, Change Parameters, and Feature Filters. The WEBENCH Optimizer section includes a gauge for balancing BOM Cost, Footprint, and Efficiency, with current values of 288, \$3.00, and 88% respectively. The Change Parameters section shows input values: Vin Min: 18V, Vin Max: 42V, Vout: 5V, Iout: 2A, and Amb. Temp: 30°C. The Feature Filters section includes checkboxes for various features like 'Regulator', 'Control Mode', 'WEBENCH Tools', and 'Topology'. A 'Regulator' box highlights the 'Regulator' filter, and a 'Module' box highlights the 'Module' filter. A 'Synchronous rectification' box highlights the 'Synchronous rectification' filter. The bottom section shows a 'Solutions' table with columns for Part, Create, WEBENCH, Schematic, BOM Images, Design Considerations, BOM Footprint, BOM Cost, Eff (%), BOM Count, Freq (kHz), and Vout p-p (mV).

Part	Create	WEBENCH	Schematic	BOM Images	Design Considerations	BOM Footprint (mm ²)	BOM Cost (1ku)	Eff (%)	BOM Count	Freq (kHz)	Vout p-p (mV)
LM46002-Q1	Open Design				SIMPLE SWITCHER Buck Regulator	288	\$3.33	88%	13	500	2.92
TPS54240-Q1	Open Design				Automotive Catalog Step Down Converter with Eco-Mode Fast Transient	361	\$2.98	84%	16	384	2.50


LMZ36002 and LM46002 Comparison

Enter Your Design Inputs

	Min	Max	Range
Vin	18.0	42.0 V	4.5 – 60.0 V
Vout		5.0 V	2.5 – 7.5 V
Iout		2.0 A	≤ 2.0 A
Amb. Temp		30 °C	-40 - 125 °C

Update Interactive Design

Close

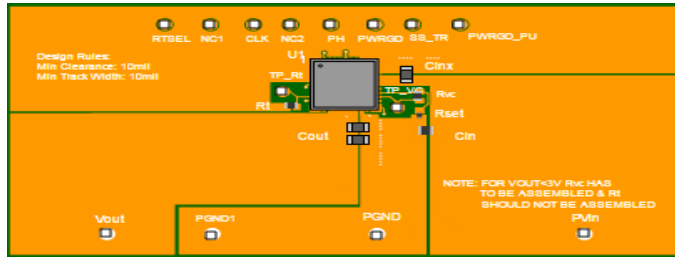
Lowest BOM Cost  **Highest Efficiency**

Smallest Footprint 1 5

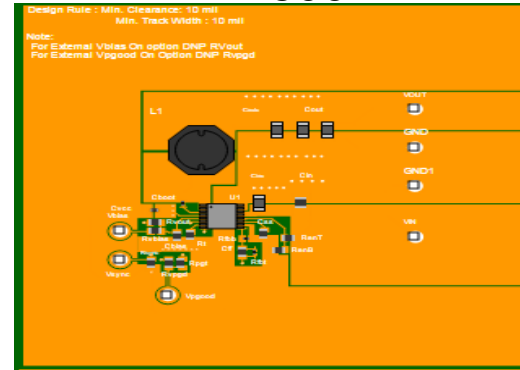
<< >>

	Footprint	BOM Cost	Efficiency
LMZ36002	196 mm ²	\$8.87	80.7%
LM46002	288 mm ²	\$3.00	88.0%

LMZ36002



LM46002



Some Great Products...

TPSM84A21/TPSM84A22

V_{IN} 8 - 14V, V_{OUT} 0.55 - 2.05V @ 10A 4MHz Output, Fully Integrated
SWIFT™ Step-Down Module



Features

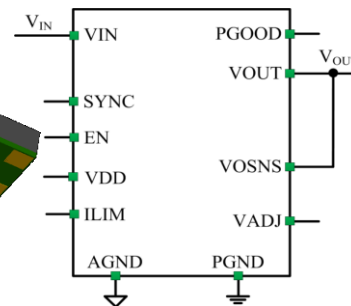
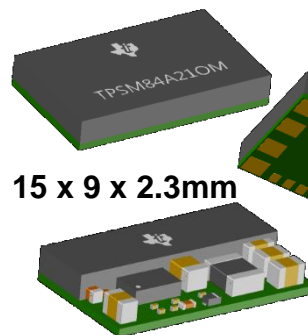
- 4 MHz effective switching frequency
- Integrated Input and output capacitors
- Adjustable output voltage using VADJ pin with a single resistor
- Fast transient response with less than 3% total V_{OUT} deviation
- Fixed frequency steady-state operation
- Low EMI & external SYNC capability
- Adjustable current limit; hiccup restart
- 15 x 9 x 2.3mm power module size

Applications

- Backside board mounting (<2.3mm height)
- Telecom base station and communications infrastructure equipment
- Storage, SSD, DDR memory, switches, hubs, routers & other networking equipment

Benefits

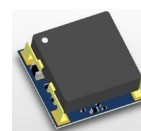
- High power density
- Easy to Use: Only One External Component
- Low profile supports backside board mounting
- Meets Class B EN55022 Emissions



P/N	Adj. V_{OUT} Range
TPSM84A21	0.55 – 1.35V
TPSM84A22	1.2 – 2.05V

TPSM846C23

4.5V-15Vin, 35A Stackable SWIFT™ Power Module with Differential Remote Voltage Sense: Options with PMBus™



In-Development
RTM: 2Q17

15 x 16 x 5.8mm

Features

- Input Voltage Range **4.5V-15V**
- Output Voltage Range 0.35V to 2V
- 2X stackable with current sharing: **35A per Phase**
 - **Full 35A w/ natural convection at 50°C Ambient**
- Voltage mode control with input feed forward
- **Fully differential remote voltage sense**
- CLK Sync-in/Sync-out capability
- **PMBus v1.3 Command Set with Telemetry**
- **64-pin QFN Pkg– 15 x 16 x 5.8mm**

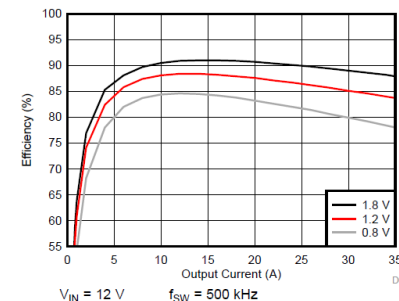
Applications

- Telecommunication & Networking Equipment
- Industrial, Test & Measurement
- Enterprise Storage and Video Broadcasting
- ASIC, FPGA and DSP Power

Benefits

- Supports 5V and 12V Input Supplies
- Optimized for low core voltage requirements
- Modular, scalable power up to 70A
- Fast Line transient response
- 0.5% Vref accuracy 0 to 85°C Tj; 1% -40 to 125C Tj
- Fixed Frequency and Low EMI/EMC
- Maximum configurability & Design flexibility via PMBus
- +/-15% Iout; +/-2% Vout & +/-5°C Internal Temp

P/N	PMBus
TPSM846C23	Yes



LMZ36002 & LMZ34202 (based on LM46002)

4.5V to 60V Input, 2-A Synchronous Buck Module



10 x 10 x 4.3 mm



Features

- Small **10 x 10 x 4.3mm QFN package**
- **Integrated shielded inductor** and passives encapsulated on leadframe
- Adjustable Fsw 200kHz – 1MHz, Soft-Start, UVLO
- Inhibit, Pre-bias Startup, Frequency Sync, Power Good
- Pin-Pin Compatible 42V and 60V Vin Options
- **Meets EN55022 Class B Emissions**
- -40C to 105C Ambient

Benefits

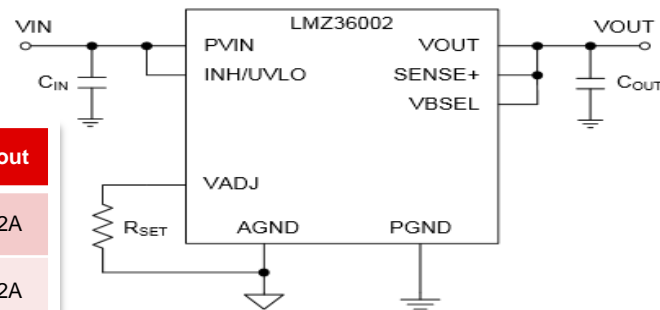
- Simple Design Procedure – **Only 3 External Components** Required
- Small Integrated Inductor Solution: **Total Solution size as low as 205mm²**
- Low Power Dissipation with only 14°C/W Θ_{JA}
- Provides Design Flexibility of a Discrete Solution
- LMZ36002: Efficient 24/48V systems w/ 60V max surge

Applications

Wide Range of Applications

- Automated Test and Measurement
- Medical & Imaging
- Industrial and Motor Control
- High Density Power Systems

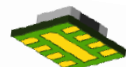
Part #	Vout	Iout
LMZ36002	2.5V – 7.5V	2A
LMZ34202	2.5 – 7.5V	2A



TPS82085 & TPS82084

3A/2A Buck Converter with Integrated Inductor

3.0 x 2.8 x 1.3 mm



Features

- 3.0 x 2.8 x 1.3mm package with integrated inductor
- $V_{IN} = 2.5V$ to $6V$ / $V_{OUT} = 0.8V$ to V_{IN} (adjustable)
- 100% Duty Cycle
- 17 μ A Quiescent Current, 0.7 μ A Shutdown Current
- Up to 95% Efficiency w/ Power Save Mode for Light Load Efficiency
- 1% V_{REF} accuracy
- Power Good Output plus Capacitor Discharge
- -40°C to 125°C module operating temperature range

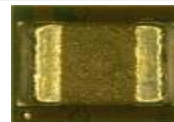
Applications

- Easy to use Point of Load
- Datacom / Telecom & Wireless Infrastructure
- Storage/ SSD
- Test & Measurement
- Portable industrial and medical

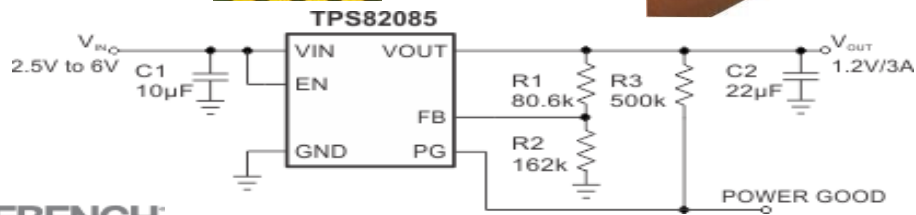
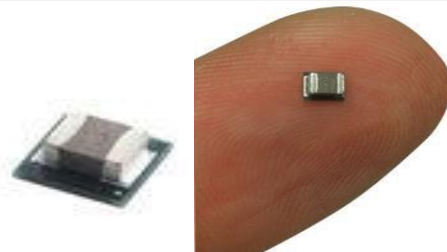
Benefits

- Small, low profile solution for small form factor applications
- Easy to use, proven solution
- DCS-Control Topology maintains an accurate output voltage at fast line and load transients plus a seamless transition between PWM and power save mode

TOP



Bottom



WEBENCH
Design Center

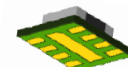


TEXAS INSTRUMENTS

TPS82130

12V 3A Step Down Converter with Integrated Inductor

3.0 x 2.8 x 1.5 mm



Features

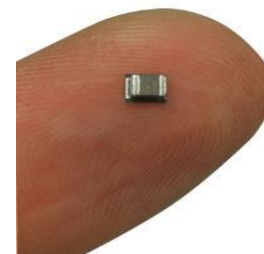
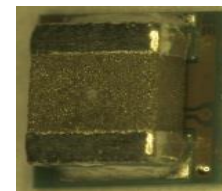
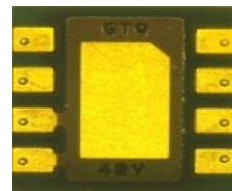
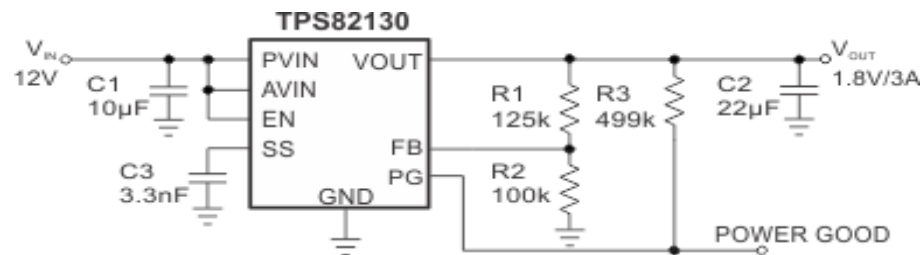
- 3.0 x 2.8 x 1.5mm MicroSiP™ package with integrated inductor
- 3V to 17V Input Voltage Range
- DCS-Control™ Topology
- Power Save Mode for Light Load Efficiency
- 100% Duty Cycle
- 20µA Quiescent Current
- Power Good Output plus Capacitor Discharge
- Adjustable Output Voltage & Programmable Soft Startup
- -40°C to 125°C operating temperature range

Applications

- General Purpose POL
- Data Card
- Network Switcher, Line Cards
- SSD

Benefits

- Small, low profile solution
- Save 50% PCB area, comparing with discrete solution
- Easy to use



Thank You...

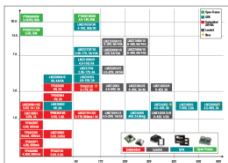
Power Modules Simplify Design

Small Solution Size



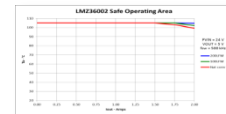
- ✓ Smaller solution size vs discrete
- ✓ Minimal external components

Broad Portfolio



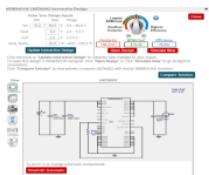
- ✓ Input Voltages up to 60V
- ✓ Output Currents up to 50A

Easy to Use



- ✓ Simple Design
- ✓ Best in Class Thermals
- ✓ Reliability Data

Design Tools



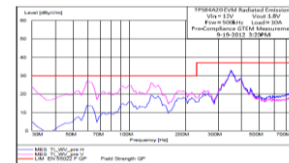
- ✓ WEBENCH Enabled
- ✓ FPGA Power Architect Enabled

High Density Solutions



- ✓ High Density QFN & SIL/SIP Pkg
- ✓ Rugged Leaded Packaging
- ✓ Pin-to-Pin Compatible Families

Proven EMI Performance



- ✓ Meet EN55022 Class B Emissions

Primary Power Module Technologies

Embedded Solution



- Power IC integrated into PCB
- Smallest solution size
 - As small as 2.3x2.9x1.1mm
- Vin up to **17V**
- Iout from **200mA to 3A**

Leaded Module



- SIMPLE SWITCHER products
- Ease of Prototyping and Manufacturing
- Standard Size/Leadpitch
- Vin up to **42V**
- Iout up to **10A**

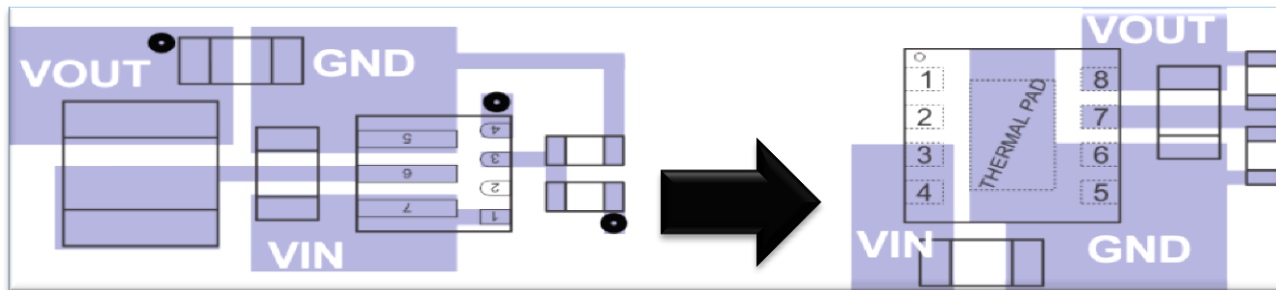
QFN Module



- Standard QFN Package
- 'Feature Rich and Flexible' solutions
- Vin up to **60V**
- Iout up to **35A (70A w/2)**

High Density

Discrete → Module



TPS62085



65mm²

TPS82085



35mm²

LM46002



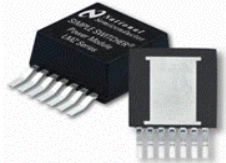

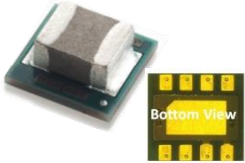
288mm²

LMZ36002



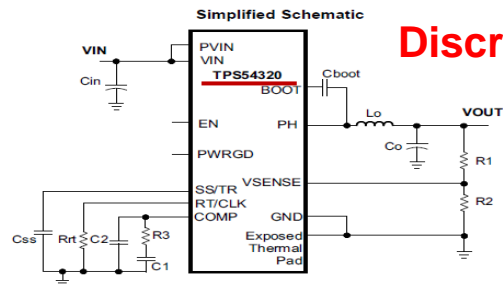
196mm²

TI Module Packages

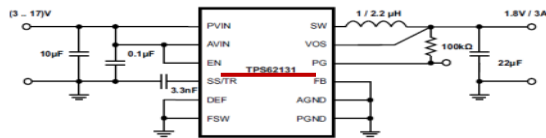
	Leaded	QFN	Embedded
Family	LMZ1 / LMZ2	LMZ_3 / TPS_84	TPS_82, LMZ_1 / LMZ_2
Package Outline	TO-Style 	QFN Style 	BGA / LGA (QFN-like) 
Description	TO-Style pinned package Dual Copper Leadframe 7 and 11 pin versions Large Single Thermal Pad	QFN-Style pinless package Single Copper Leadframe Size optimized package Multiple Thermal Pads	LGA QFN sim'd pinless package Embedded die in FR Laminate Highest density package LGA or BGA pads
Strengths	All Signals Accessible Family group Pin to Pin Compatibility Superior Thermals / Product Lifetime EMI-Friendly (EN55022 Class B)		
	Hand Solder Prototyping	High Density	Ultra High Density

TPS82130

Discrete Solution vs Module



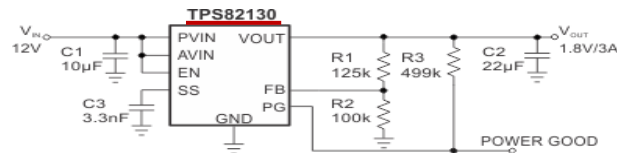
Discrete Solutions



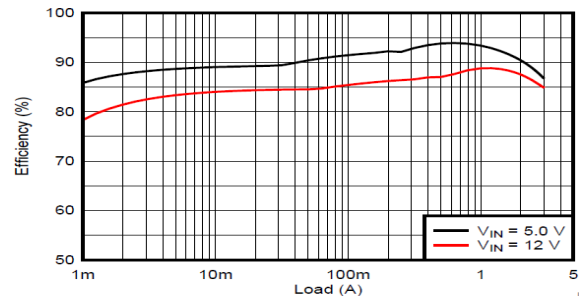
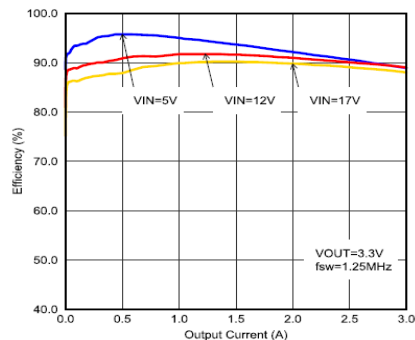
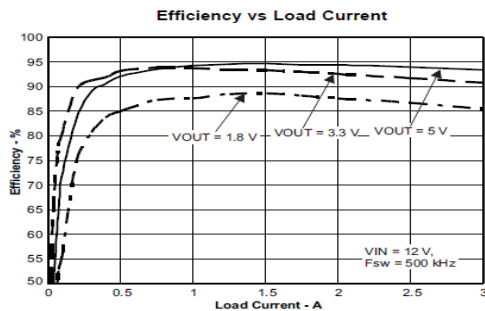
Solution size: 227 mm²

Solution size: 95 mm²

Module Solution



Solution size: 42 mm²



Lower Switching Frequency and external compensation allows optimizing the efficiency at one particular sweet spot

Efficiency is compromised a little for smaller solution size. Using same inductors would provide a similar efficiency.