TPS84k +
Nano Module

2012 update

When are modules attractive option?

Customer primarily cares about

Time to Market

Board Space Real Estate

Logistics Cost

Easy-to-Use & "No Headache" Solution

Design Flow Man-Hours Per Step Survey
(Iterations Included)

Discrete DC/DC Converter

	Average
1. Review Regulator Specification vs. Requirement	19.2
2. Select DC-DC Regulator device	13.9
3. Solution Analysis	15.1
4. Select Inductors	9.3
5. Select Capacitor (Input/Output)	16.2
6. Simulate Power Stage/Input/Output Filter	22.1
7. Analyze Control Design - compensation network selection	24.3
8. Verify Time Domain Analysis/Simulation	22.0
9. Schematic Finalized	27.8
10. Custom PCB Layout & Bill of Material	30.2
11. Final BOM: Component Optimization & Trade-offs	25.5
12. System Scope Creep; Requirement Change	37.1
13. PCB Design (Gerbers, untested?)	46.4
14. Prototype Testing	155.2

Total: 464.3 man-hours

DC/DC Module

	Average
1. Review PSiP/MicroModule/PwrSoC Design Flow	18.9
2. Device Selection	17.8
3. Look up Components	18.0
4. System Scope Creep; Requirement Change	45.0
5. PCB Design using standard/tested design files	41.3
6. Prototype Testing	112.8

45% Less!!

Total: 253.8 man-hours

Design flow issues that present themselves: **Noise, Parasitics, Load Change, Stability, & EMI**

"For more complex design (such as higher current), the process could take 20-40% longer."[12]

Source: Ease of Design Comparison for a PSiP/MicroModule/PwrSoC Design Flow Process , A Survey by the Darnell Group – April 2012

Texas Instruments

Materials Comparison

Example: 5V/6A Step Down DC/DC Converter & Module Comparison

A guaranteed working power module at only ~20-50% premium

Materials premium is offset by

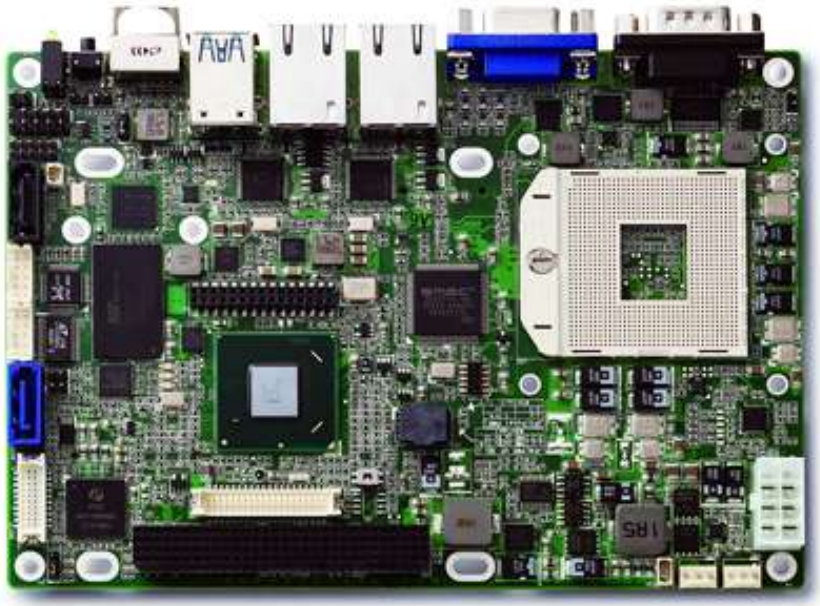
- Design & Development
- Time to Market Opportunity Loss
- Board Space pressures

TPS54618 Discrete	
IC	$2.15
Inductor	$0.80
Cin	$0.40
Cout	$0.25
Other	$0.15
Mounting	$0.40
Total	**$4.15**

TPS84610 Module	
IC	$4.25
Inductor	N/A
Cin	$0.40
Cout	$0.25
Other	$0.03
Mounting	$0.12
Total	**$5.05**

Assumptions
Suggested 10K prices
Small R/C at $0.01 each
$0.02 to mount each component

How much is your board space worth?



- Customer's Product value
  - = IP developed to improve functionality
  - ≠ Power supply design
- Experienced power designer required to match board space of today's overmolded power modules
- If discrete designs not routed and optimized properly = noise & EMI problems

TI's Power Module Step-Down Portfolio

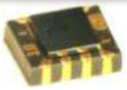
TPS84k™ Modules
- Frequency Sync & Adj Fsw
- Integrated Compensation
- Remote Sense, PG, INH
- Adj. UVLO & Adj. Soft Start
- Small QFN Package

SIMPLESWITCHER™ Modules
- Precision Enable (LMZ1/2)
- Soft Start (LMZ1/2)
- Frequency Sync (LMZ2)
- Current Sharing (8/10A versions) up to 60A (LMZ2)
- Leaded PMOD package

PTH08T2xx "T2" Modules
- Auto-Track ™ Sequencing
- Frequency Sync
- TurboTrans™ Reduces Cout
- Remote Sense, EN, Adj. UVLO, Adj. Soft Start
- Current Sharing (50A version)

Blue → 24V Rail
Green → 5/12V Rail
Red→ 3.3/5V Rail

Nano Module



µSIP Module

*EVMs & Samples now

Texas Instruments

TPS84k™ Module Roadmap

High Vin
7V – 50V

TPS84250
2.5A
Samples NOW
RTM Aug '12

TPS84259
15W, Neg Out
Samples NOW
RTM Aug '12

9 x 11 x 2.8mm
Survives 65V Line Transients

Mid Vin
4.5V – 14.5V

TPS84320
3A

TPS84621
6A

9 x 15 x 2.8mm
Same Footprint

Available

Smallest 10A

TPS84A20
10A
Samples Sept '12
RTM Nov '12

10 x 10 x 4.3mm

Low Vin
2.95V – 6V

TPS84210
2A

TPS84410
4A

TPS84610
6A

9 x 11 x 2.8mm
Same Footprint

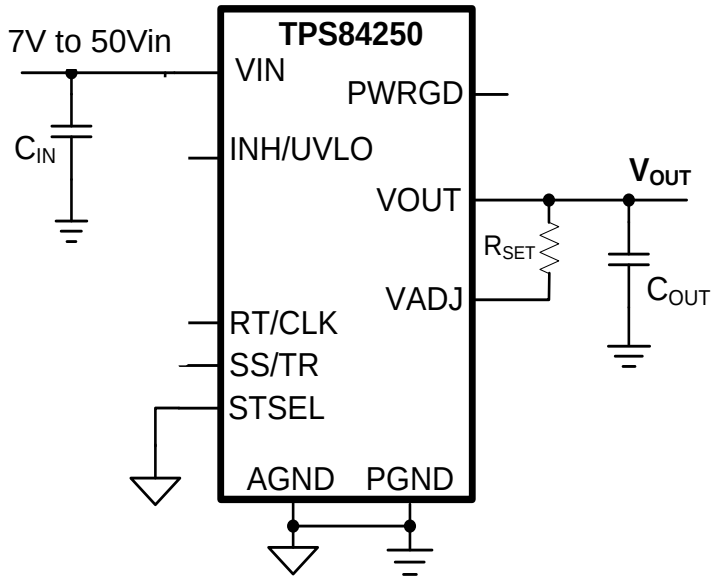
Available

Higher Current & Smaller Footprint

3Q2012 **4Q2012** **1H2013**

TPS84250
Modules for Industrial Applications

Smallest 2.5-A Power Module Survives 65-V Line Transients



Withstands Line Transients from:

- AC Line
- Motors & Inductive Loads
- Switching Relays

Small Solution Size

- Integrated Inductor & Passive Components
- Easy to Mount 9 x 11 x 2.8mm QFN Package

Low Noise for Sensitive Analog Circuitry

- Meets EN55022 Class B Emissions
- Frequency Synchronization Eliminates Beat Noise

Cost Effective Solution

Applications

Industrial and Motor Control
Factory Automation
Automated Test and Measurement
Medical & Imaging

TPS84259
Modules for Industrial Applications

No-Fuss Negative-Output Module with Low EMI

TPS84259 – Industry's First

- 4.5V to 40V Input
- -3V to -17V Output up to 15W
- Meets EN55022 Class B Emissions
- Small 9 x 11 x 2.8mm QFN Package

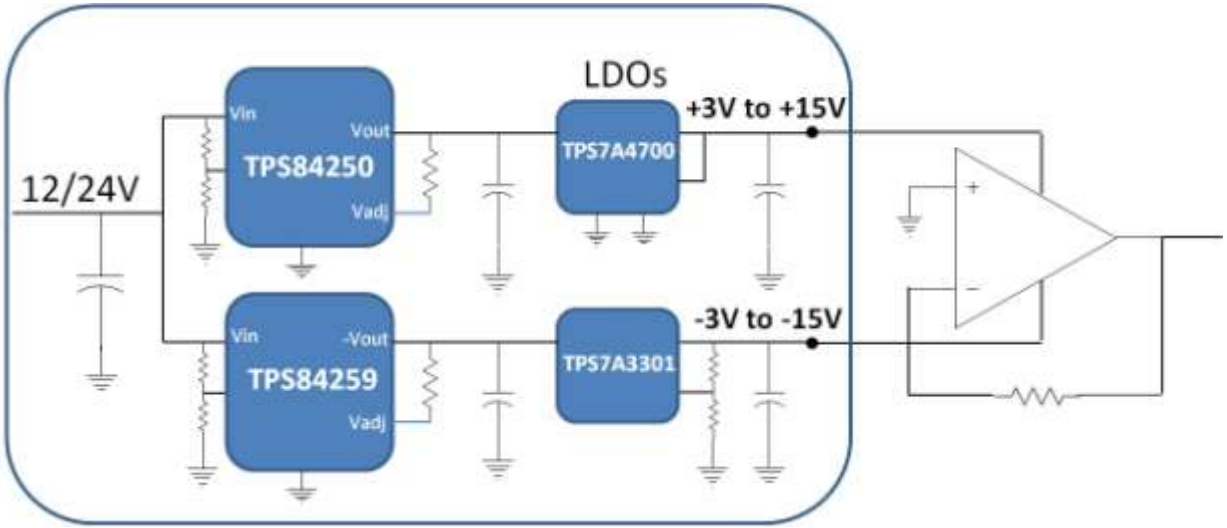
Negative Vout for Analog

Audio Amplifiers

Data Converters

Operational Amplifiers

Negative Bias Voltage



Reference Design

PMP8372 Design and Test Report on Web

+/-3V to +/-15V Outputs

Up to 500mA

Includes Newest Low Noise LDOs

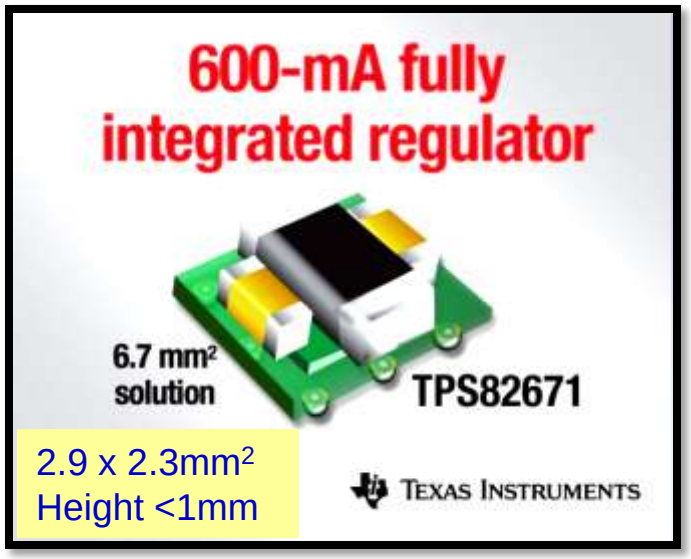
Easy Implementation & Few Components

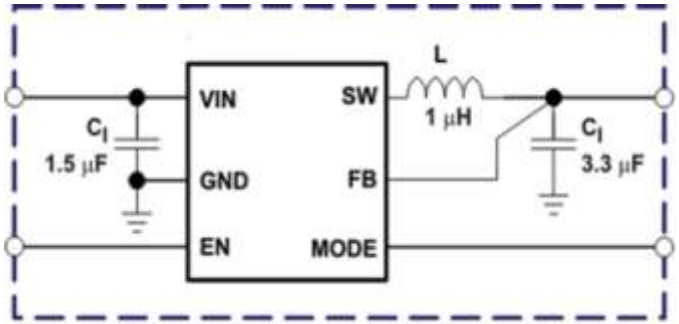
Texas Instruments

NANO MODULES

TPS826xx – High Frequency & Integrated Inductor enables µSIP

Smallest integrated 600-mA system-in-package regulator





- Simplicity of a 3-pin regulator
- No ext. components required
- More than 45% smaller compared to discrete solution

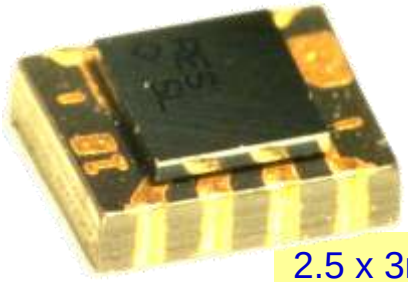
- 2.3 – 4.8VIN (TPS8267x) / 2.3 – 4.35VIN (TPS8269x)
- Low PFM Ripple (LPFMR), Spread Spectr. Mod. (SSM), Outp. Disch. (OD), low Iq: 17µA (TPS8267x) / 24µA (TPS8269x)
- η > 90/95%, Auto PFM / PWM or forced PWM via MODE-pin

Device	F (MHz) η (%)	I_{OUT} (mA)	V_{OUT} (V)	SSM	LPFMR	OD
TPS82670	5.5 90	600	1.86	√	√	√
TPS82671			1.8	√	√	–
TPS82672			1.5	√	√	–
TPS82673			1.26	√	√	√
TPS82674			1.2	√	√	√
TPS82675			1.2	√	√	–
TPS82676			1.1	√	√	√
TPS82677			1.2	–	–	√
TPS82678			1.35	√	–	√
TPS826711			1.8	√ Preview	√	√
TPS82690	4 95	500	2.85		√	√
TPS82695			2.5		√	√
TPS82696			2.9		√ Preview	√
TPS82697			2.8		√	√

Texas Instruments

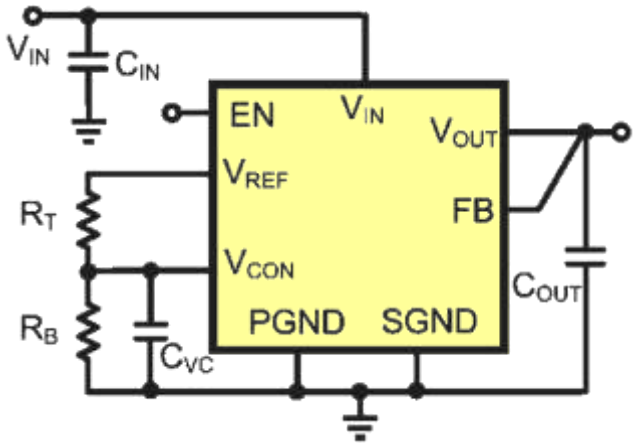
LMZ1050x – Nano Modules w/ full Flexibility

Up to 650-mA / 1A Output Current Capability



2.5 x 3mm²
Height 1.2mm

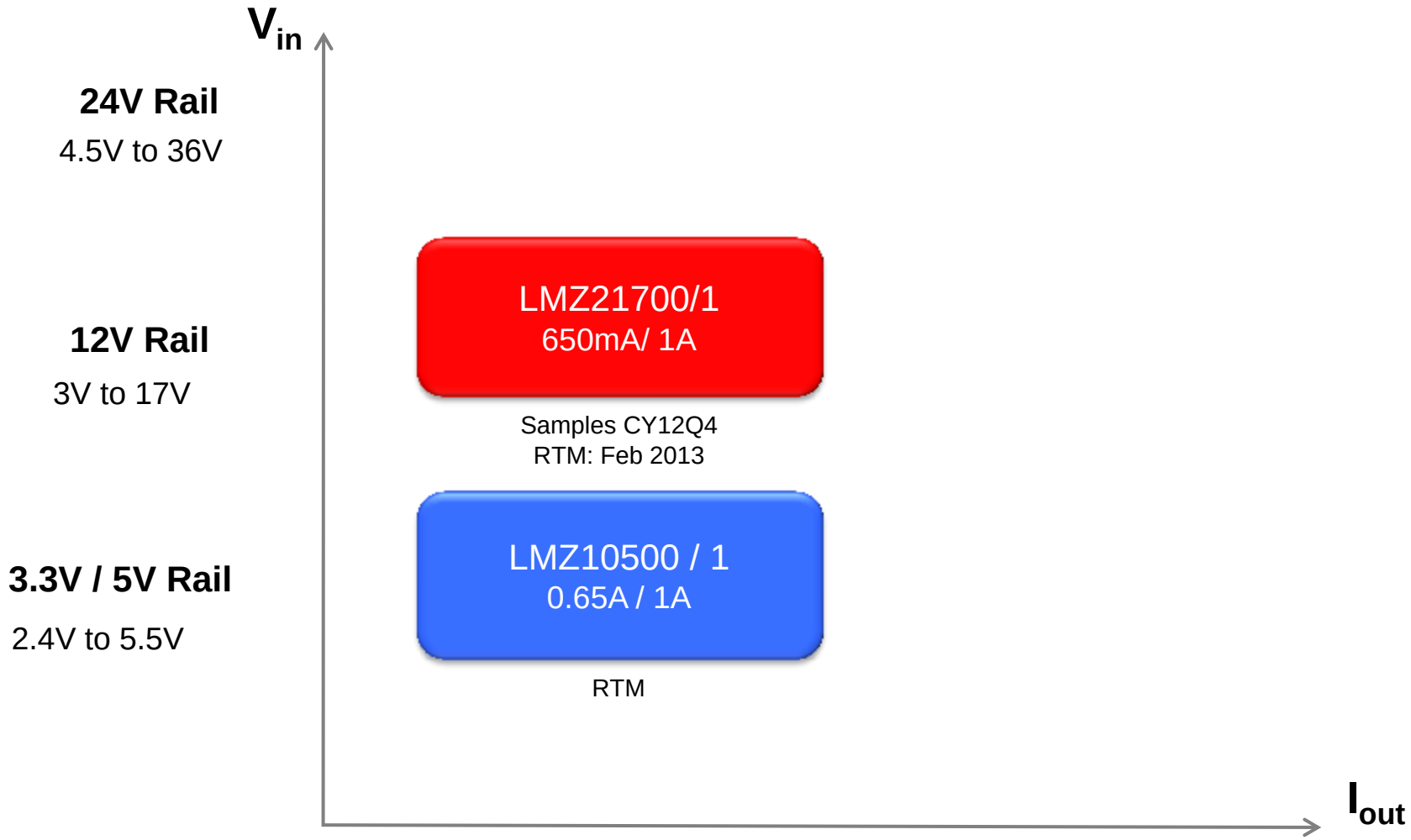
- Integrated inductor
- 2.7 – 5.5V Input
- Adjustable VOUT: 0.6 – 3.6V
- Always operating in CCM
- 6.5mA Iq
- VCON-Pin usable for DVS (Dynamic Voltage Scaling)



Standard Application

Device	F (MHz) η (%)	I_{OUT} (mA)	V_{OUT} (V)	DVS
LMZ10500	2 95	650	0.6 – 3.6	√
LMZ10501		1000		√

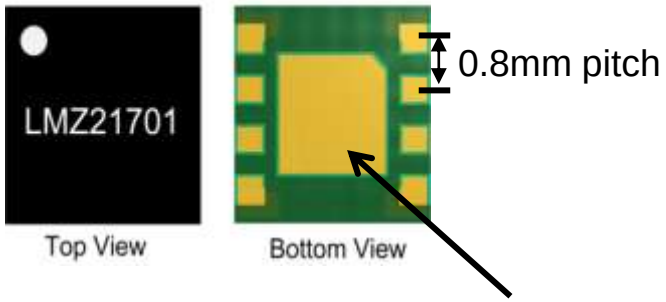
Nano Module Roadmap



New Packaging!

Package Features

- 3.5 x 3.5 x 1.9 mm
- LGA - 8 Footprint
- Embedded die in PCB substrate
- Fully encapsulated
- Single DAP package
- Θ_{JA} = 49 ºC/W



Small + Easy + High Performance

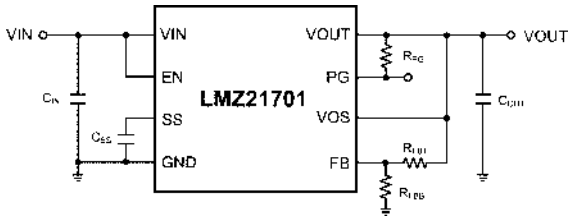
Tiny Packaging

- Completely encapsulated
- 3.5 x 3.5 x 1.9 mm footprint
- MSL3, 260ºC reflow capable
- Single DAP

Compact PCB Layout

12Vin, 1A POL solution in 36mm²

Easy Design



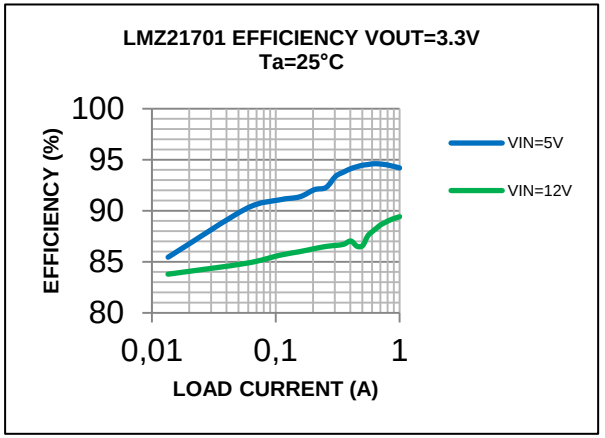
- Integrated inductor
- Low BOM count
- Internal compensation

WEBENCH® Enabled

- Layout & Schematic Guidelines
- Gerbers Available

High Performance

- Wide input voltage range
- Tight output accuracy
- Adjustable output voltage
- High light-load efficiency
- Power good (PG) pin
- Low output ripple
- Low EMI



LMZ21700 / 01

650mA / 1A SIMPLE SWITCHER® Nano Module with 17V Maximum Input Voltage

Features

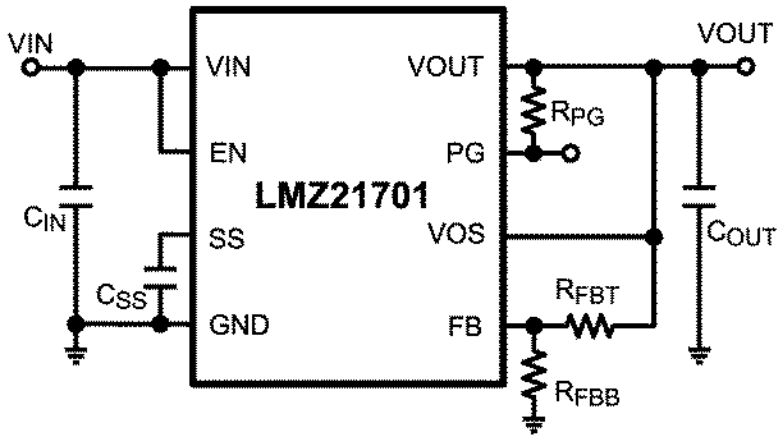
- Integrated Inductor
- 3.5 x 3.5 x 1.9 mm Packaging
- Input voltage range 3V to 17V
- Output voltage range 0.9V to 6V
- No compensation
- Starts into pre-biased loads
- Enable pin
- Power good pin
- Adjustable soft-start
- 1 uA shutdown current
- 17uA quiescent current
- Seamless transition to power-save mode

Benefits

- Smallest 12V, 1A Power Supply – Complete solution in 36mm^2
- Low BOM count for reduced complexity
- Wide Vin range allows for use as standard 3.3V/5V/12V rail regulator
- High efficiency at light loads
- Power-good pin allows for easy sequencing

Applications

- Standard POL Rails
- Space constrained applications
- LDO replacements



LMZ21701 Solution Comparison

A guaranteed working power module at only 25-30% premium

Materials premium is offset by

- Design & Development
- Time to Market Opportunity Loss
- Board Space pressures

12V/1A Comparison	LMZ21701 Module	TPS62150 Regulator	Enpirion Module
Solution Size	36mm^2	119mm^2	No Equivalent Solution!
Total cost at 10ku	$1.72	$1.24	
IC price	*$1.44*	*$0.80*	
Inductor	*$0.0*	*$0.12*	
I/O Caps	*$0.12*	*$0.12*	
Other	*$0.04*	*$0.04*	
Mounting	*$0.12*	*$0.16*	
Efficiency 12V→3.3V	88%	89%	
EMI	Guaranteed	Layout dependent	

Assumptions
Suggested 10K prices
Small R/C at $0.01 each
$0.02 to mount each component

SUCCESS STORIES

Success Story: LMZ23605 DIN

36V, 5A Power Module with Frequency Sync in Oscilloscope

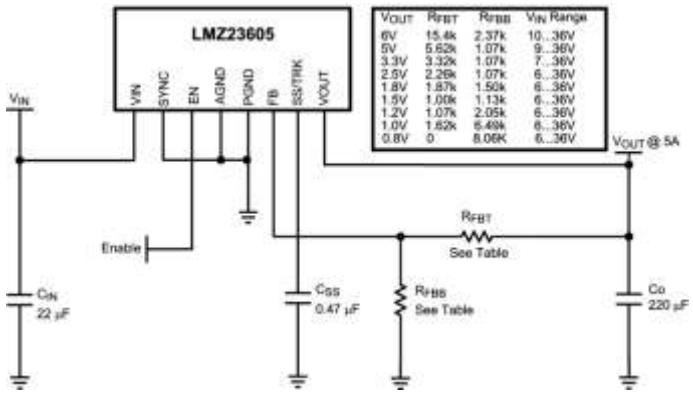
Application Need

- Powering a differential analog front-end
- Low noise in sensitive differential analog front-end to avoid performance degradation of the signals
- Low ripple and transient conducted noise was most critical, low EMI emissions was also important

TI Product Benefits

- "The very low EMI of the LMZ23605 solved the switching interference problem we were experiencing with a competitive product," said Peter Algert, hardware engineering manager at LeCroy Corp., "it not only eliminated the noise problem, but the package with a single die-attach pad was much easier to solder and cool."
- From Press Release: http://www.national.com/news/en/0,1735,1521,00.html

Product Configuration



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Success Story: LMZ14203H DIN

42V, 3A High Output Voltage Power Module in ATM

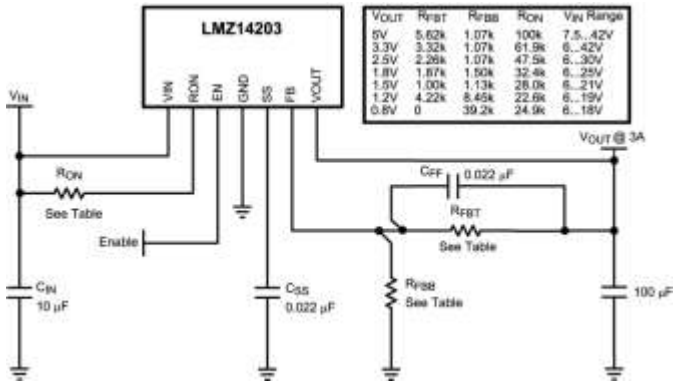
Application Need

- 24Vin to 12Vout at 3A
- 12Vin to 5Vout at 3A
- Wanted 1 product for both conversions to ease supply chain logistics
- Easy to use solution

TI Product Benefits

- Excellent thermals: θJA= 16 C/W, operates up to 70 ambient temperatures
- High power density: 36W in 100mm^2 package
- High efficiency: 93% for 24V→12V conversion
- Integrated inductor solution for quick time to market/ease of use

Product Configuration



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Success Story: LMZ10501 DIN

5.5V, 1A Nano Module in Solid State Drive

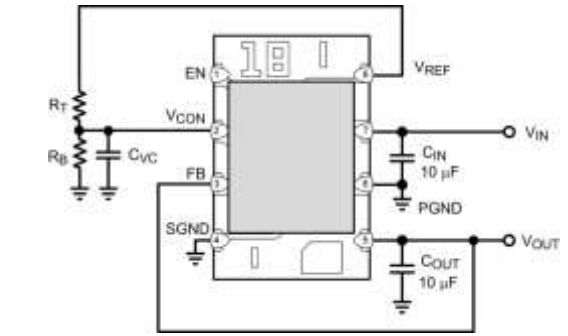
Application Need

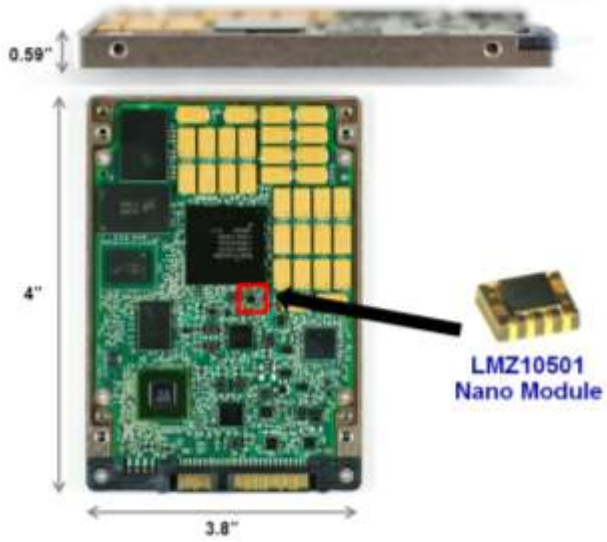
- <2mm height restriction
- Small solution size
- Quick time to market (band-aid solution)

TI Product Benefits

- Smallest 1A package in the market at 2.5 x 3 x 1.2 mm
- High efficiency up to 97%
- Low noise <10 mV peak to peak
- Only 5 components needed for complete solution

Product Configuration





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Success Story: How the **TPS84250** was DIN Industrial Printer Head

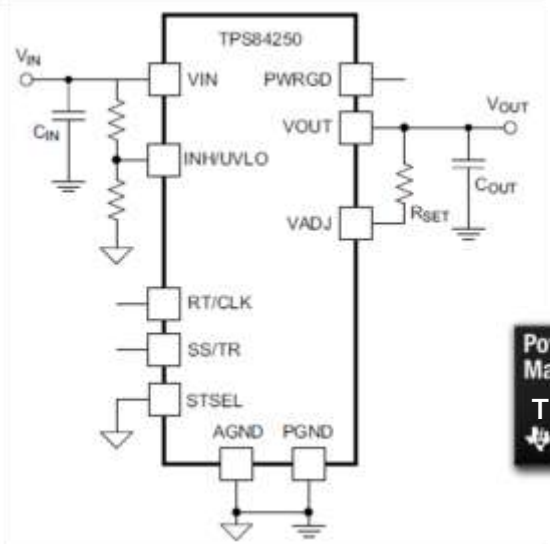
Application Need

- 40V input, 16 output rails
- Small Solution Size. Board space critical
- Easy to Use & Flexible. Engineers needed easy layout to fit on small board
- Good Efficiency
- Good Pricing

TI Product Benefits

- High Power Density – less than170mm^2 with 2.8mm height including passives
- Small device & low passive count allowed customer to fit all 16 rails with good layout, excellent thermals, and high reliability
- Able to meet pricing requirements for 400ku/yr opportunity

Product Configuration



Thank you!

Questions?