Simple Power Solutions for Industrial Communication's Equipment

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Power Requirements for Industrial Solutions

With the increasing complexity of industrial systems, there is a growing demand for flexible power solutions.

High Efficiency

Wide Input and Output voltage range

Operating Temp range of 125C

±1% Output Voltage Accuracy

QFN package

TI TPS63070 and TPS62135/6

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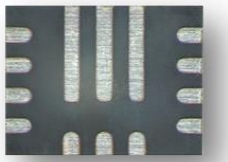
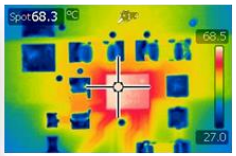
TPS63070 – Buck-Boost Converter

Features

- Input Voltage: 2V to 16V
- Output Voltage: 2.5V to 9V
- 2A Output Current - 3.6A Switch Current Limit
- 95% Efficiency in Buck & Boost Mode
- Positive and Negative Average Current Limit
- 2.5 x 3mm QFN package

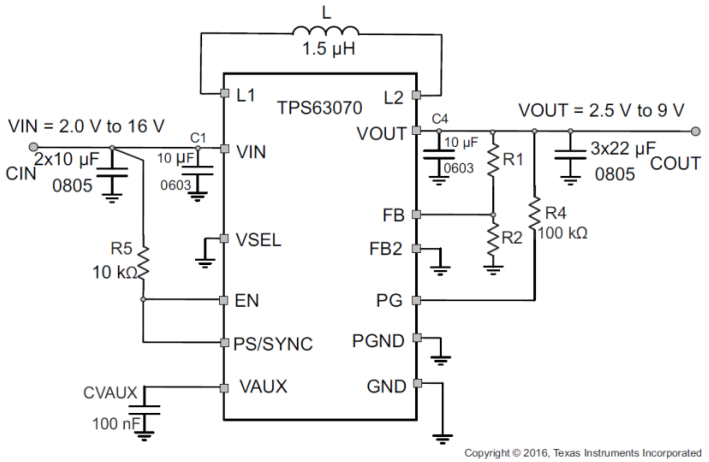
- ✓ Easy-to-Use QFN
- ✓ Low Resistance
- ✓ Good thermals





Benefits

- Optimized for highest flexibility and multiple power sources
- No droop in efficiency during the buck-boost transition where VIN=VOUT
- Enables longer battery life with higher than 85% efficiency when operating at light loads
- High switching frequencies allows the use of a small 1µH inductor



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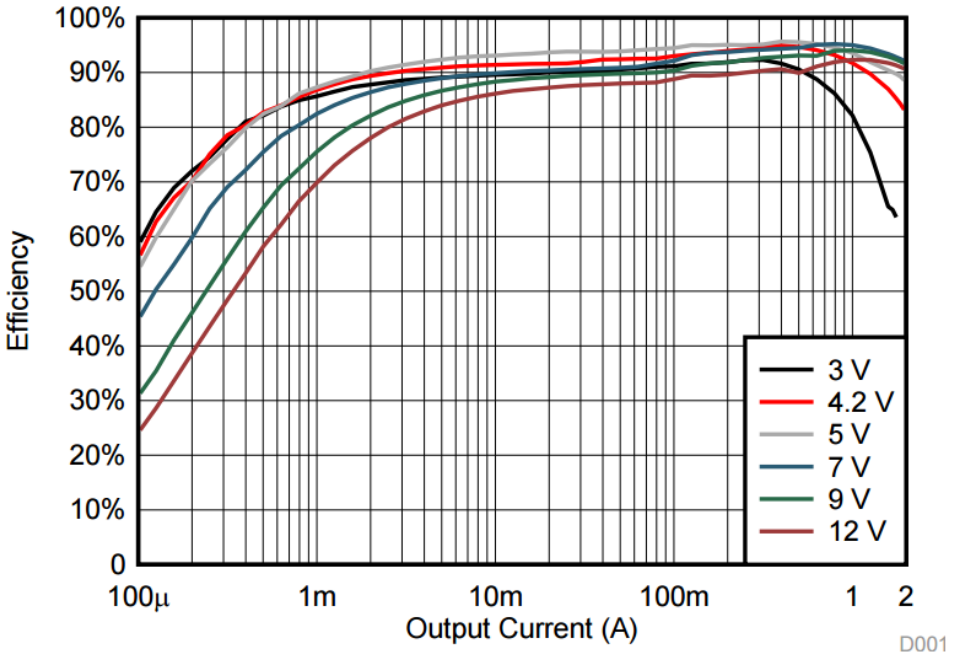
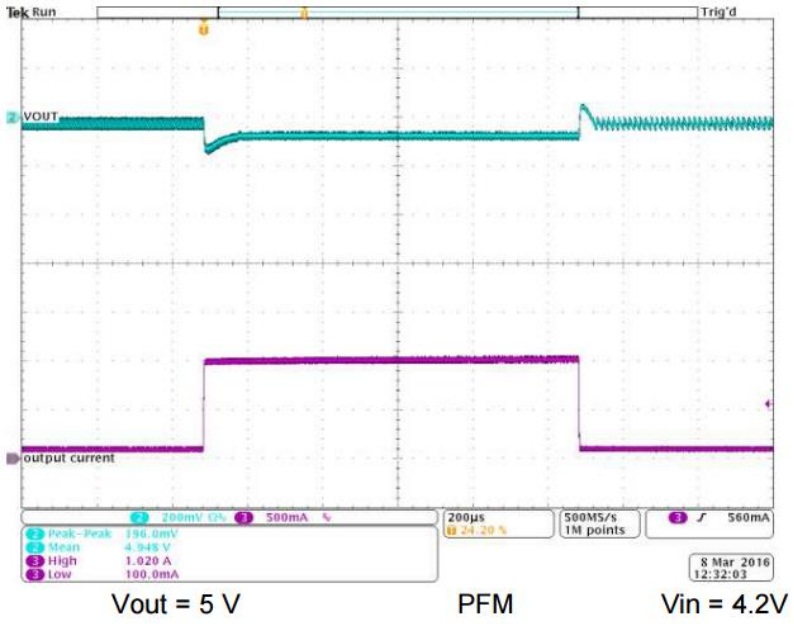
TPS63070 – Buck-Boost Converter

Efficiency



Vout = 5 V PFM T = 25 °C

Load Transient



Vout = 5 V PFM Vin = 4.2V

100mA to 1A

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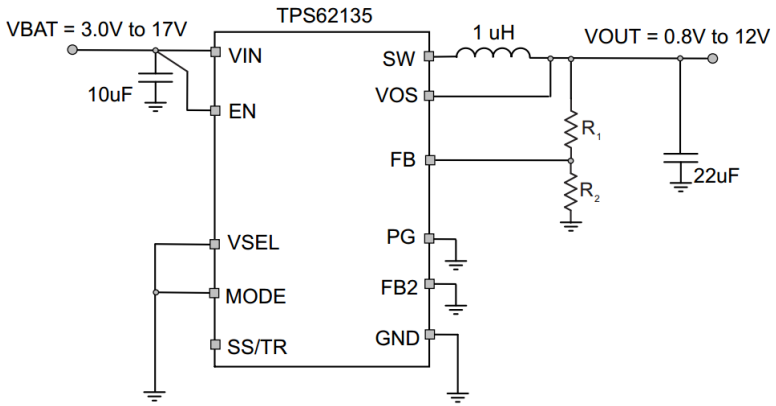
TPS62135/6 – Buck Converter

Features

- Input Voltage: 3V to 17V
- Output Voltage: 2.5V to 12V
- Output Current: 4A
- Up to 95% Efficiency
- Forced PMW mode
- Output Voltage Accuracy ± 1% (PWM mode over full temperature)
- Precise Enable
- SoftStart / Tracking function
- Tj = -40 to 125C
- 2 x 3mm QFN package
- DCS-Control: www.ti.com/lit/an/slyt531/slyt531.pdf

Benefits

- Optimized for highest flexibility and multiple power sources
- Power save mode with AEE enables high efficiency over whole operation range
- Two different switching frequencies result in high flexibility of Efficiency, Ripple and Solution Size:
  - TPS62135: 2.5Mhz
  - TPS62136: 1Mhz



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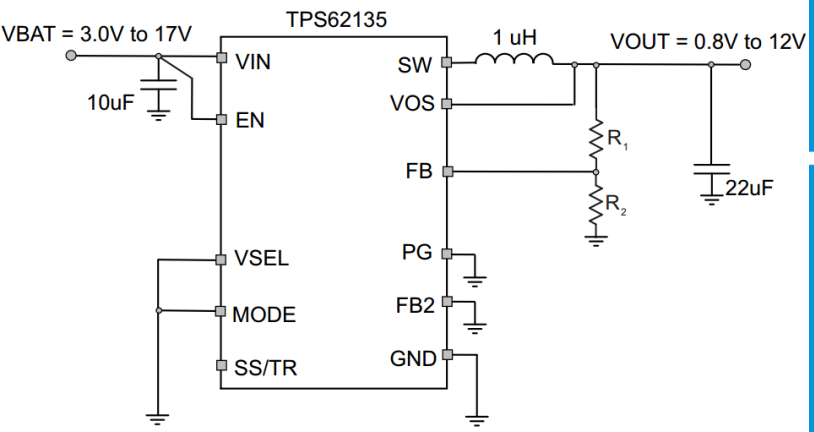
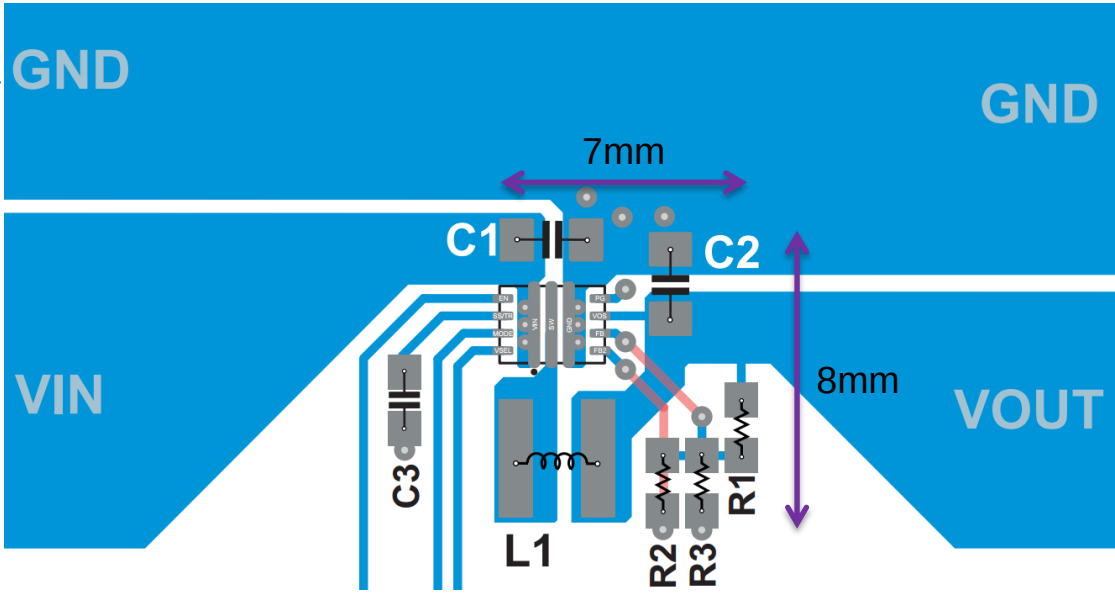
TPS62135/6 – Buck Converter

Schematic

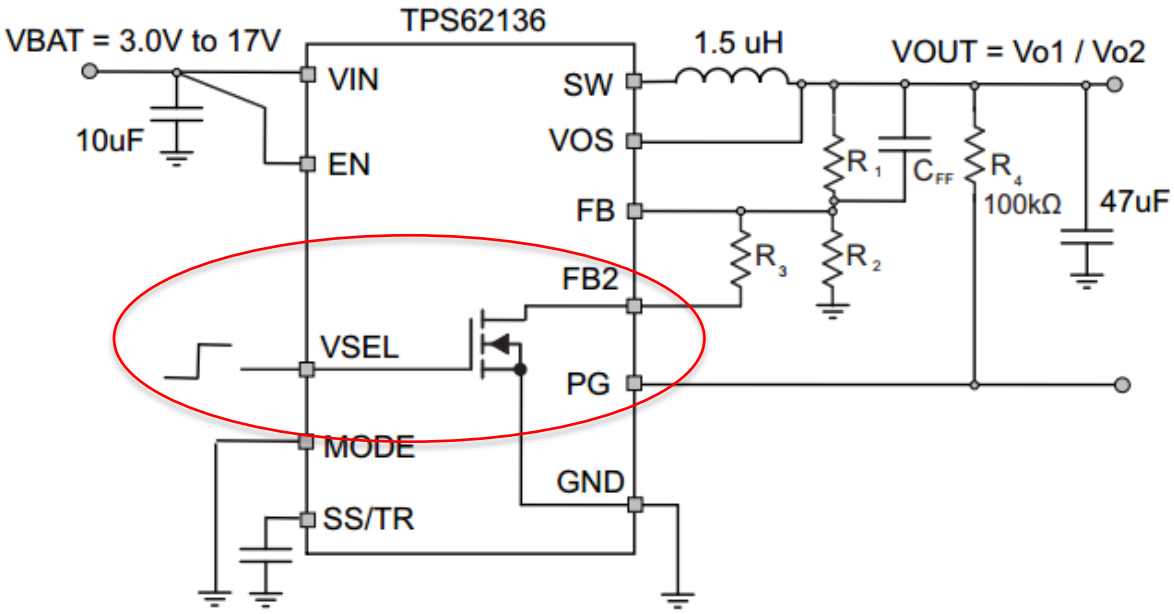


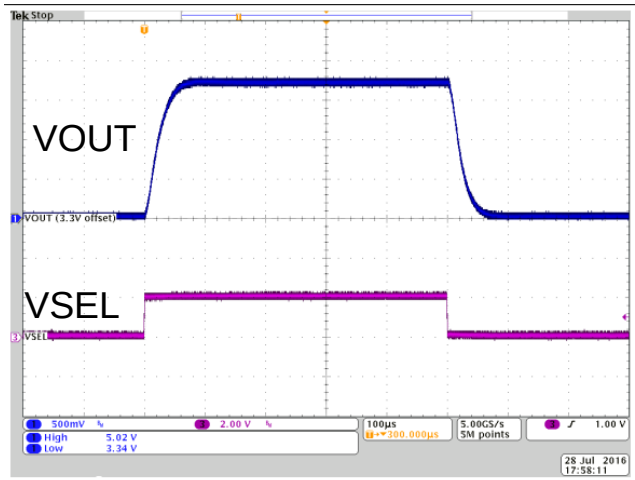
Layout



TPS62135/6 – Buck Converter

Vsel feature



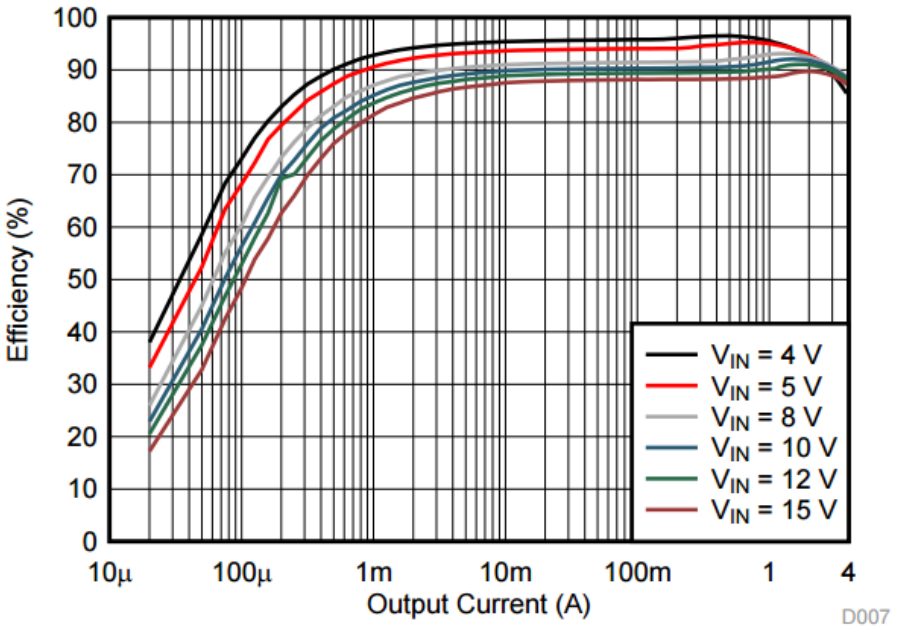


Output Voltage Change from 3.3 V to 5 V in PWM with 20 Ω load resistance

VSEL allows to switch between two output voltages by changing the output voltage divider ratio

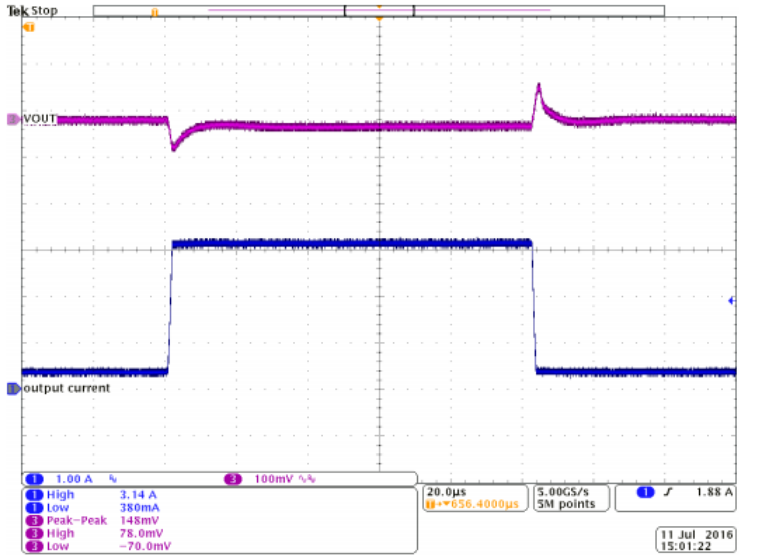
TPS62135/6 – Buck Converter

Efficiency



Vout = 3.3 V PFM T_A = 25°C

Load Transient



Vin = 12 V; PWM Io = 350 mA to 3.1 A

Vout = 1.2 V T_A= 25 °C

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TPS62136 Inductor Selection

Inductor Selection

Option 1:
Calculate the steady state inductor peak current
(Does not include transients)

$$I_{L(max)} = I_{OUT(max)} + \frac{\Delta I_{L(max)}}{2}$$

Option 2:
Use the max current limit value of the DS
(Recommended and most conservative way)

TPS62136	Min	Typ	Max
I_{LIMH}	4.8A	5.6A	6.5A

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Inductor Design Requirements

- For high efficiencies, the inductor should have a low dc resistance to minimize conduction losses.
- Especially at high switching frequencies, the core material has a higher impact on efficiency. When using small chip inductors, the efficiency is reduced mainly due to higher inductor core losses. This needs to be considered when selecting the appropriate inductor.
- Design calls for 1.5uH inductor.
- Steady state working conditions: Irms 4A - 20% ripple – 1MHz.
- Maximum inductor current: 6.5A (Load Transient / Short circuit)

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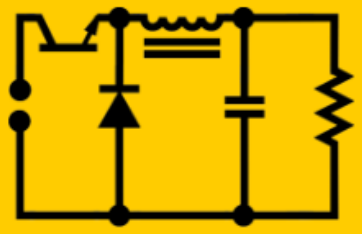
Inductor Selection Process

Power Inductor Finder Tools

I know the **converter topology** I want to use

Start



I know the **specific IC** I want to use

Start

I know the **inductor specifications** that I need

Start

I want to **compare inductors** I've already chosen

Start

www.coilcraft.com/apps/power_tools/

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Inductor Selection Process

Power Inductor Finder

- Find all the power inductors that meet your exact requirements
- Search for the nominal inductance or the actual inductance at your operating current

Required Inputs			Optional Inputs						
Inductance		Frequency	Current	Ripple pk-pk	DCR max	Length max	Height max	Construction	AEC-Q200
1.5 to option μH nH	L at current L nominal	1 kHz MHz	4 A peak rms	20 % 0,8 A	Ω mΩ	mm in	mm in	SMT Shielded Leaded	Grade 1 (125°) Grade 3 (85°)

Optimize for

Use your mouse to move the most important factors to the top of the list

- Footprint
- DCR
- Losses
- Height
- Current
- Price

FIND

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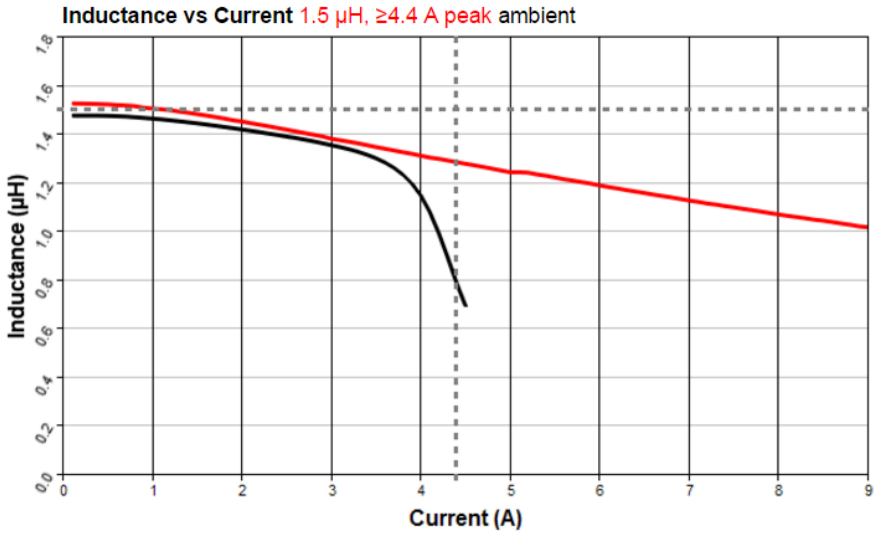
Selection Process Result Analysis

XAL4020 vs. XFL4020

- XFL offers the best DCR
- XFL feature low losses material
- XAL provides the highest Isat
- XAL features soft saturation

	Inductance	DCR max	Isat (30%)
XAL4020	1.5µH	23.6 mΩ	7.1 A
XFL4020	1.5µH	15.8 mΩ	4.6 A



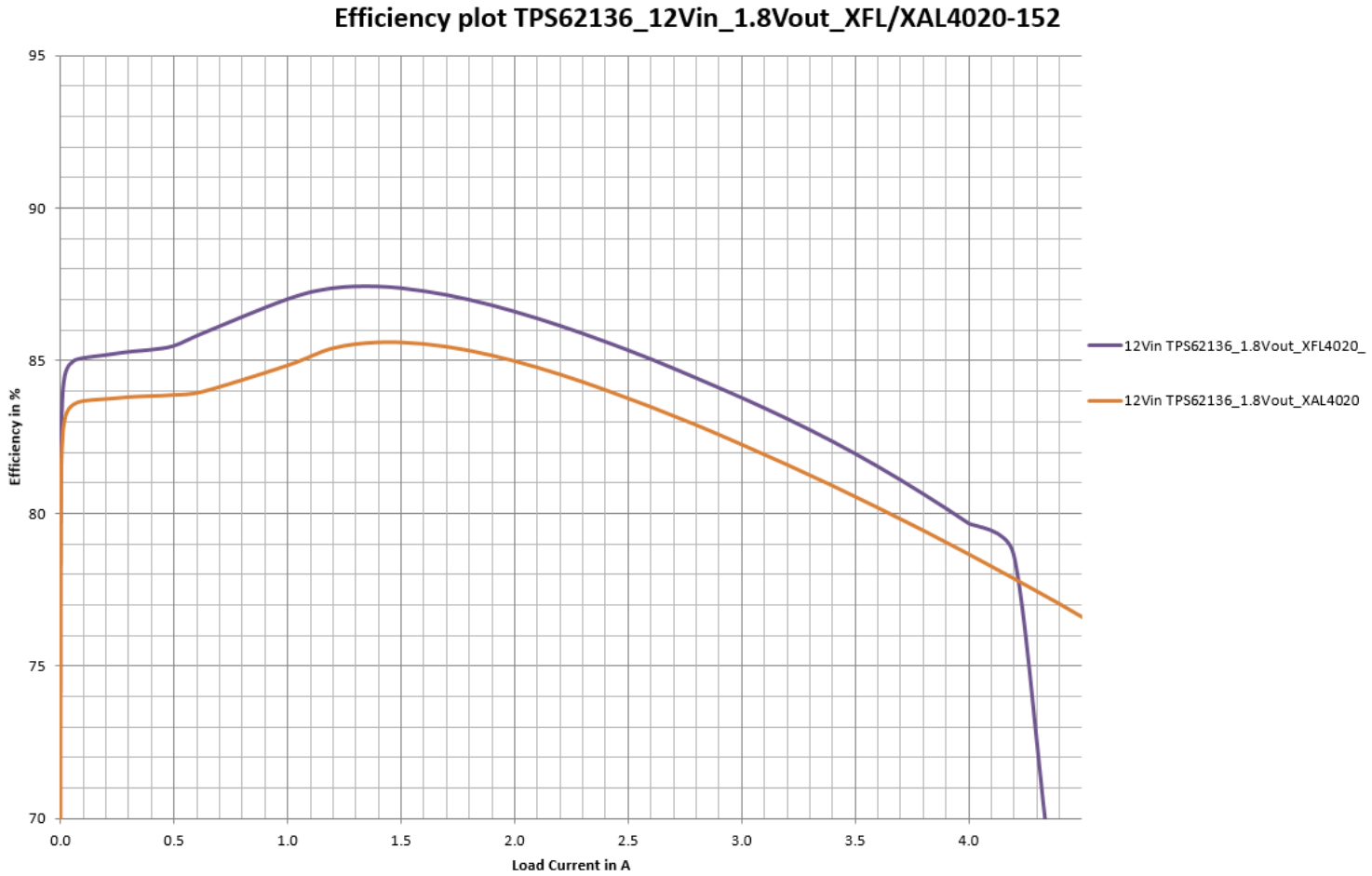
Losses/Efficiency Evaluation @25ºC

Inductor losses and temperature rise at 1 MHz, 4 A rms, 0.8 A pk-pk

Part number	Total losses (Core + AC winding loss / DCR loss)	Part temperature at 25°C ambient
XAL4020-152	373 mW	37°C (165°C Max)
XFL4020-152	252 mW	33°C (165°C Max)

Losses@25C ambient	Core+AC	DCR	Total	Self heating
XAL4020	30	343	373	12° C
XFL4020	22	230	252	8° C

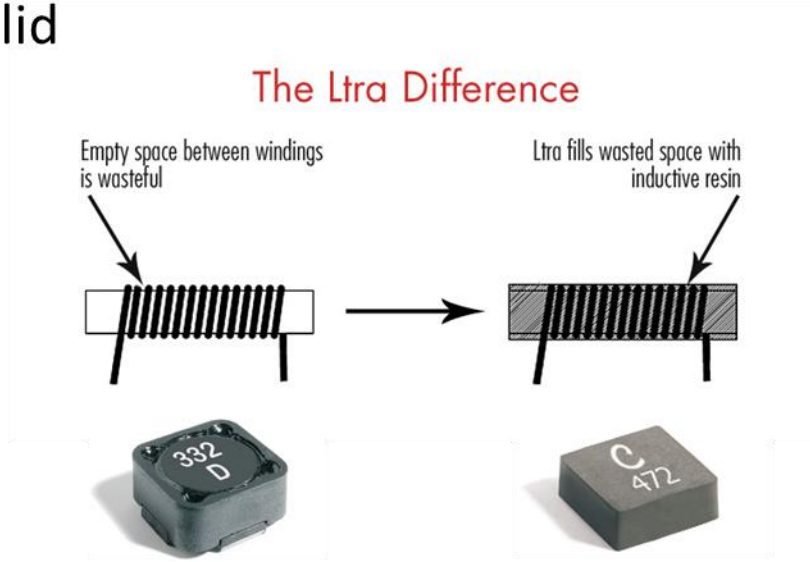
Efficiency comparison



Product & Technology Advancements

What are Ltra Molded Style Inductors?

- Ltra is a different way of making an inductor using magnetic materials to form a solid combination body shape
- Eliminates wasted space between windings
- Provides better Isat and DCR in the same size part.



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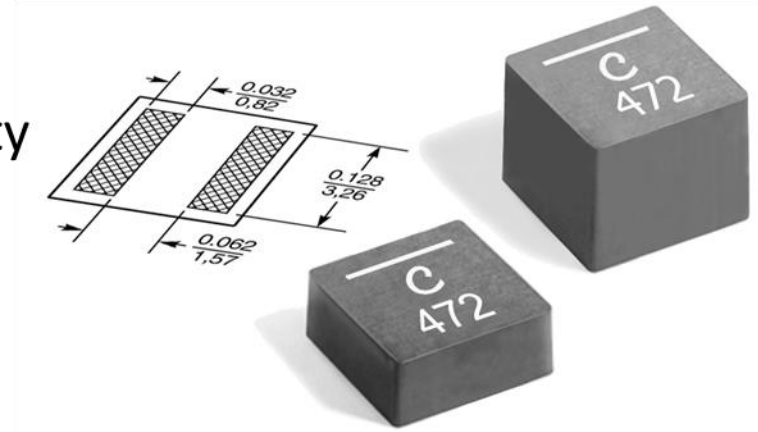
Product & Technology Advancements

Ltra Means Reliability

- Large terminal/soldering areas provide:
  - Best possible solder joint strength and thermal management
  - High current ratings without hot spots
- Elimination of hot spots allows parts to run cooler, increasing long-term reliability
- Inductors can be packaged more closely, reducing overall solution size



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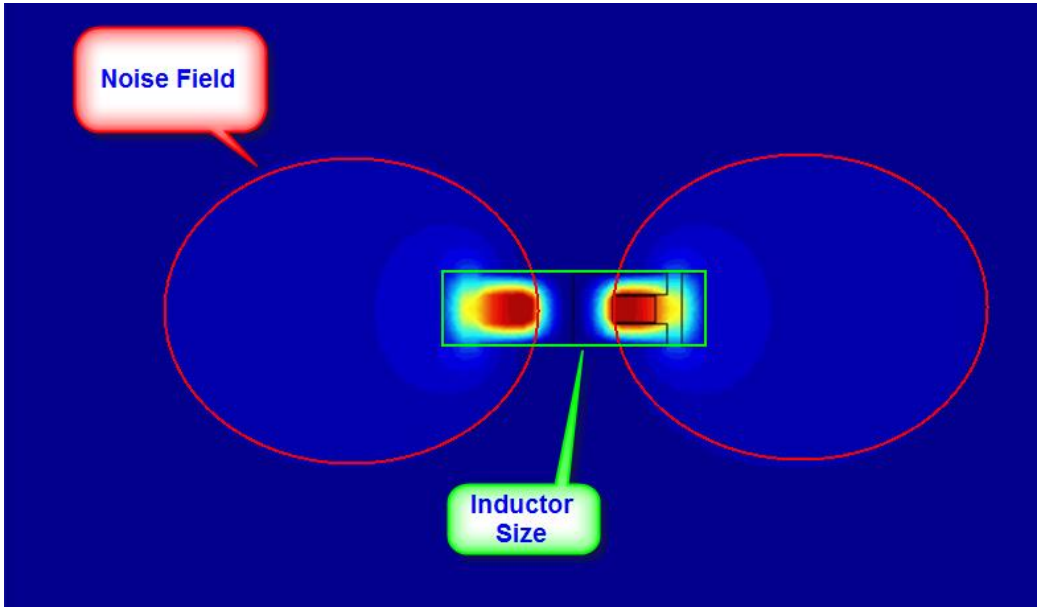
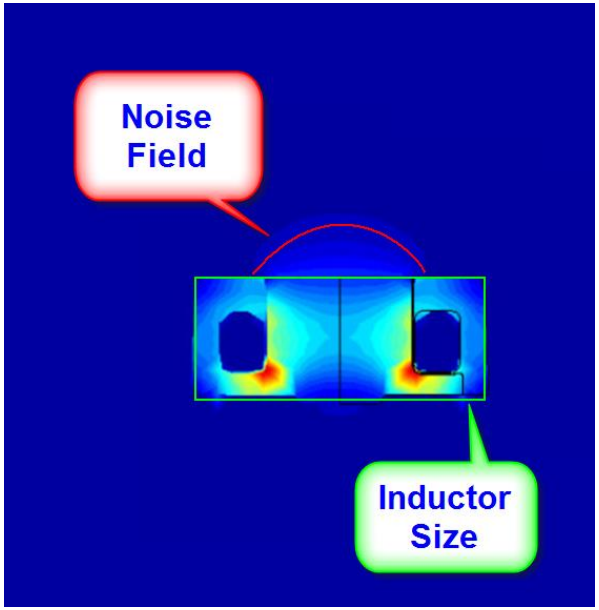
Radiated EMI Reduction





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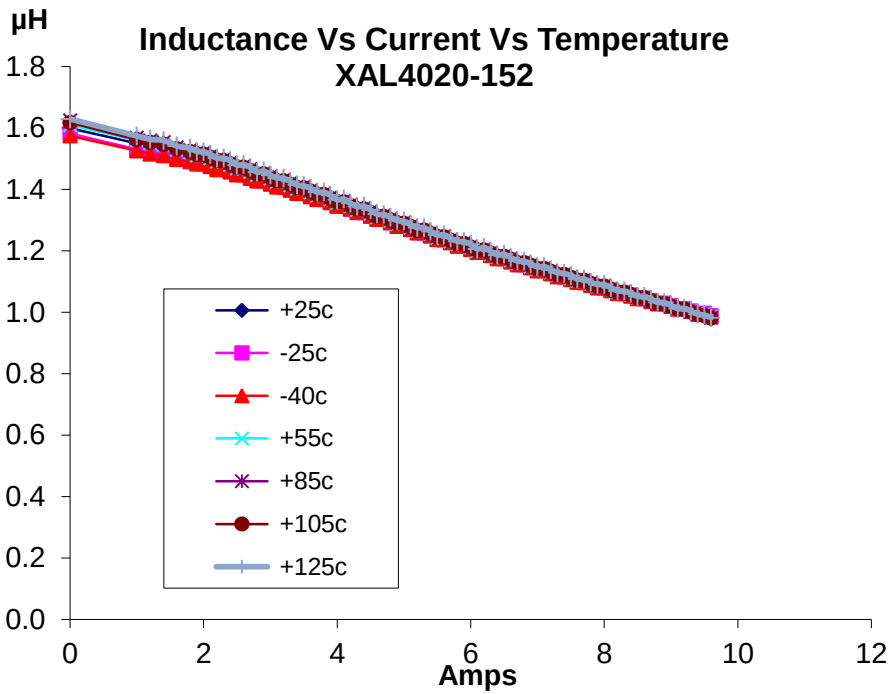
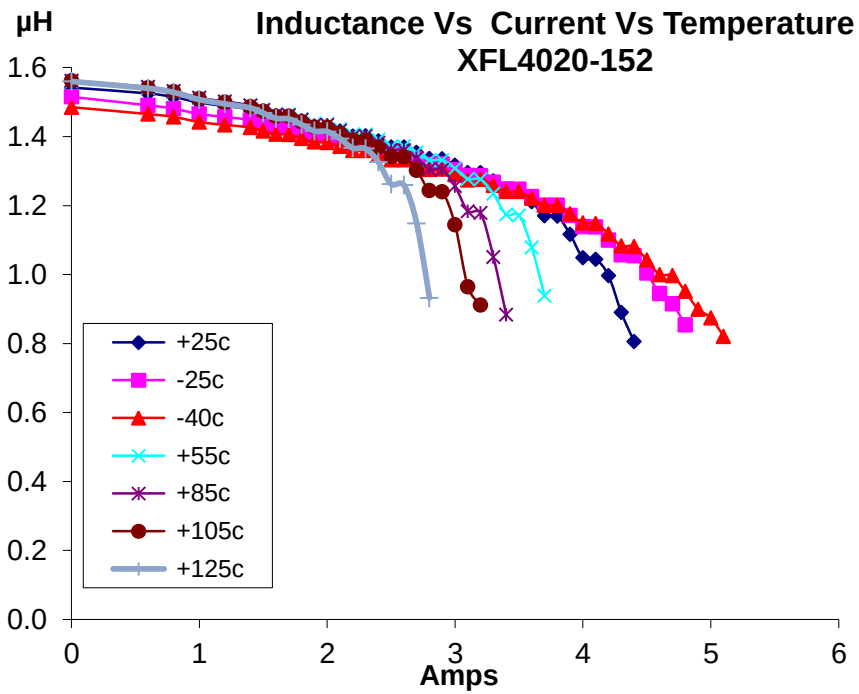
Temperature Stability





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New Technology Advancements Outlook

XEL Family Inductors: Key Features

- Extremely low DC and AC losses for high switch frequencies (2 to 5+ MHz)
- High saturation current
- No thermal aging issue
- High operating temperature range (–40°C to +125°C ambient)
- AEC-Q200 Grade 1 qualified

Losses/Efficiency Evaluation @25ºC

Inductor losses and temperature rise at 1 MHz, 4 A rms, 0.8 A pk-pk

Part number	Total losses (Core + AC winding loss, DCR loss)	Part temperature at 25°C ambient	
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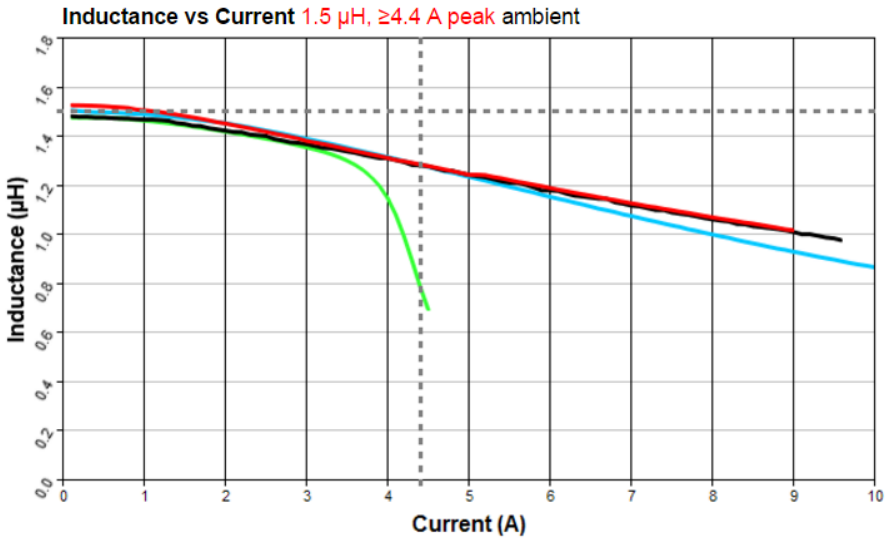
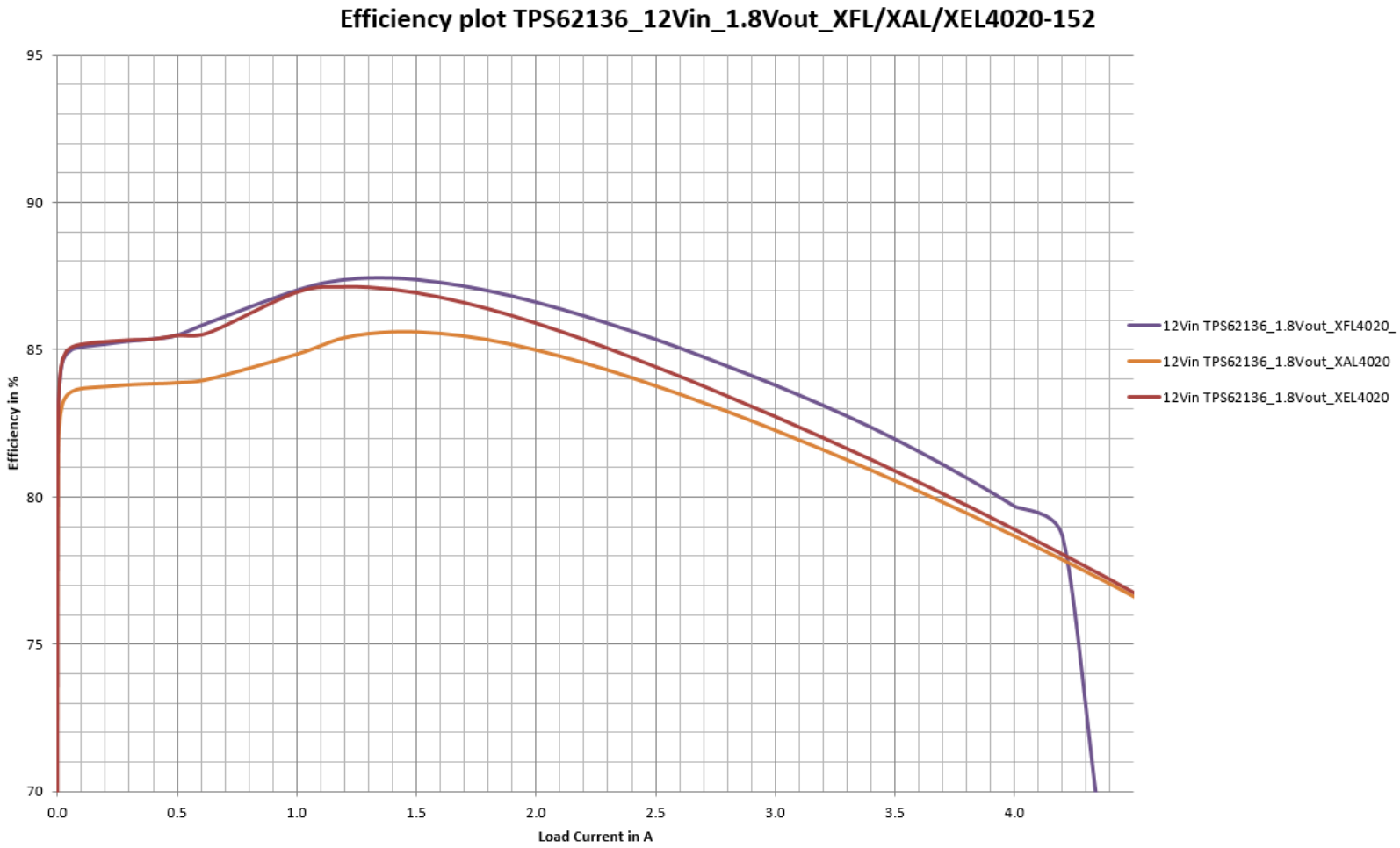
XAL4020-152	373 mW	37°C	165°C Max
XFL4020-152	252 mW	33°C	165°C Max
XEL4030-152	264 mW	36°C	165°C Max



Efficiency comparison



Efficiency comparison

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Simple Low-Power TEC Driver Reference Design

Solution Features

- Up to 2A Continuous TEC current
- Source and sink current capability to drive a TEC
- Positive & Negative Current limit

- **Featured Applications**:
  - Optical Networks
  - Industrial / Medical

Solution Benefits

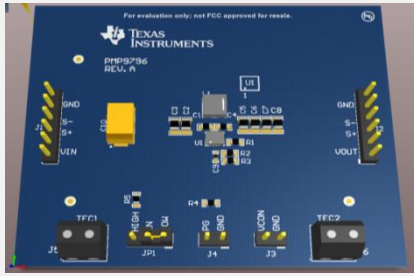
- Simple Design with low BOM count
- Single Device Solution
- Flexible Design, Easy Adaptable to Different System Energy Requirements
- <100mm^2 Total Solution Size

Tools & Resources

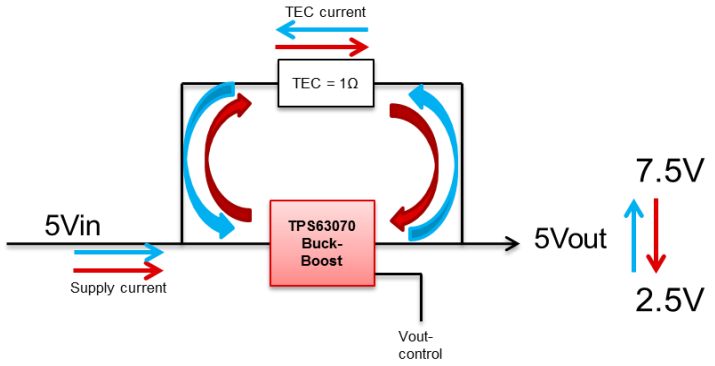
TI Designs Number: PMP9796

BOM:

IC: TPS63070
(16Vin, 3.6A sync buck-boost)
Inductor: XAL4020



Block Diagram



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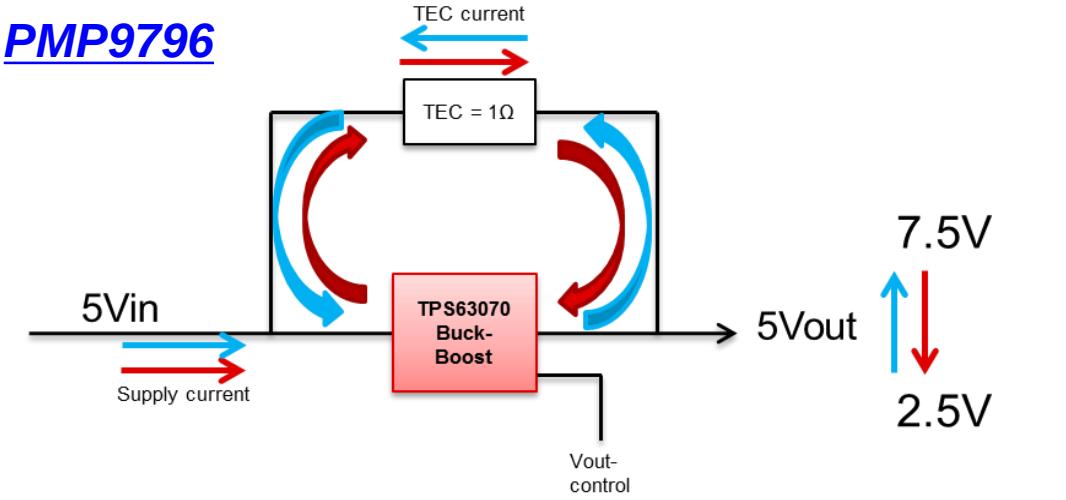
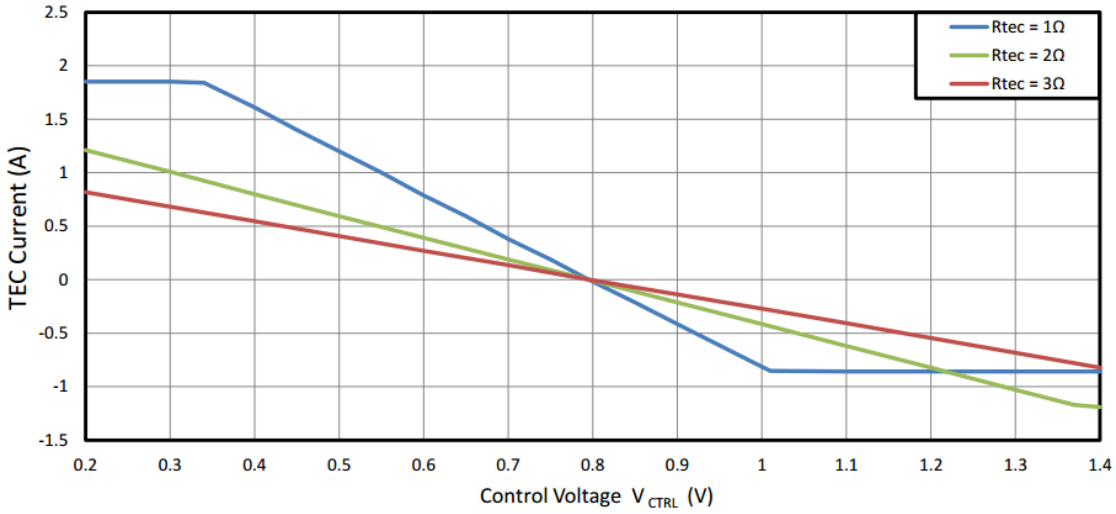
Simple Low-Power TEC Driver Reference Design

TI Designs Number: PMP9796





Simple Low-Power TEC Driver Reference Design

TI Designs Number: PMP9796

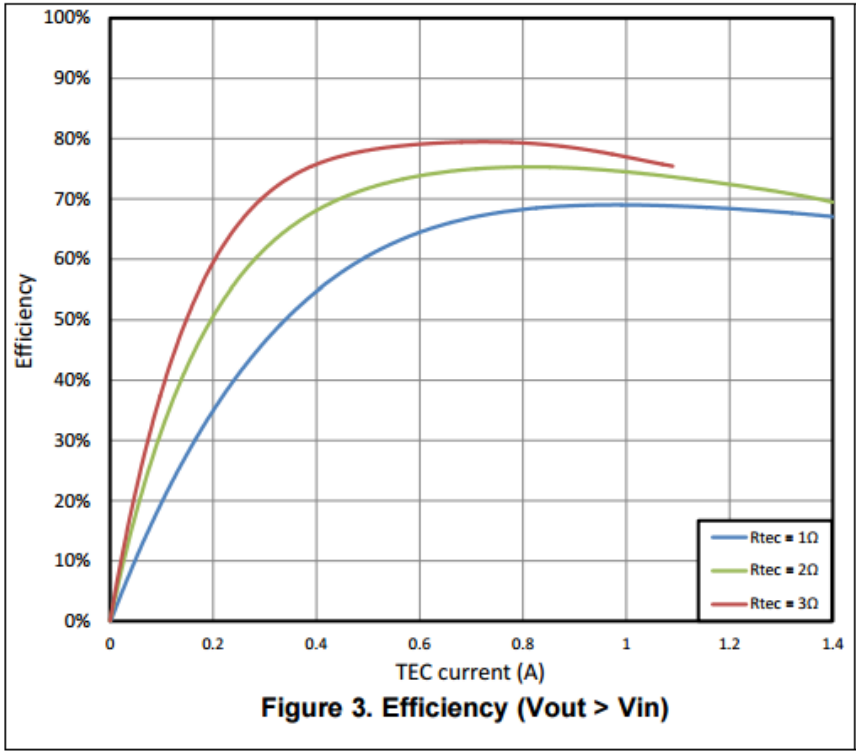


Figure 3. Efficiency (Vout > Vin)

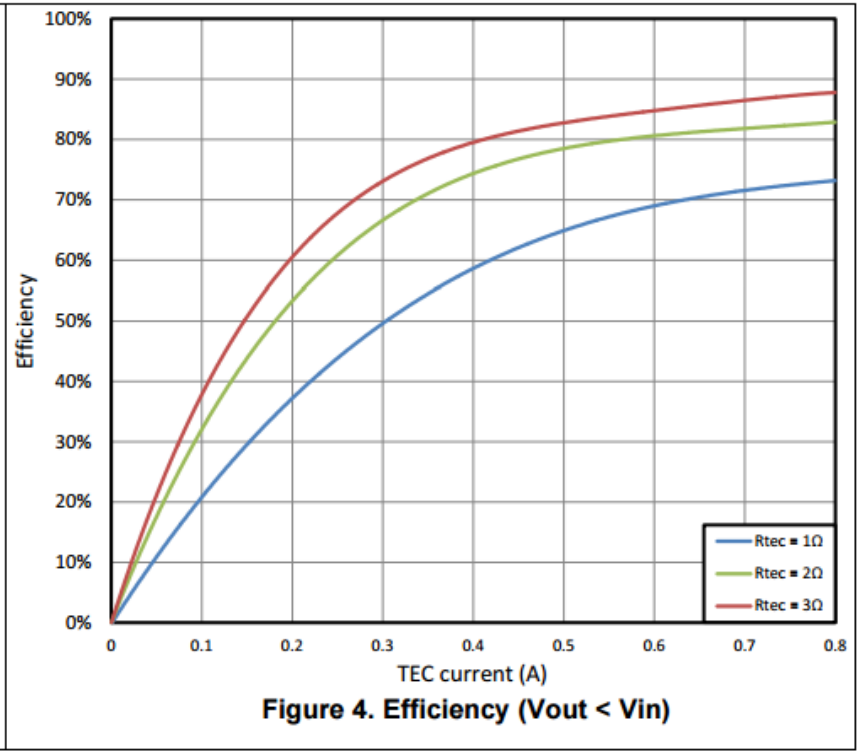


Figure 4. Efficiency (Vout < Vin)

Thank you!