

# Welcome!

## Texas Instruments New Product Update

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# ACHIEVING POWER-DENSE DESIGNS WITH TI'S NEW BUCK POWER MODULE TPSM63610; SPEED TIME TO MARKET WITH POWER MODULES

## New Product Update

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# Agenda

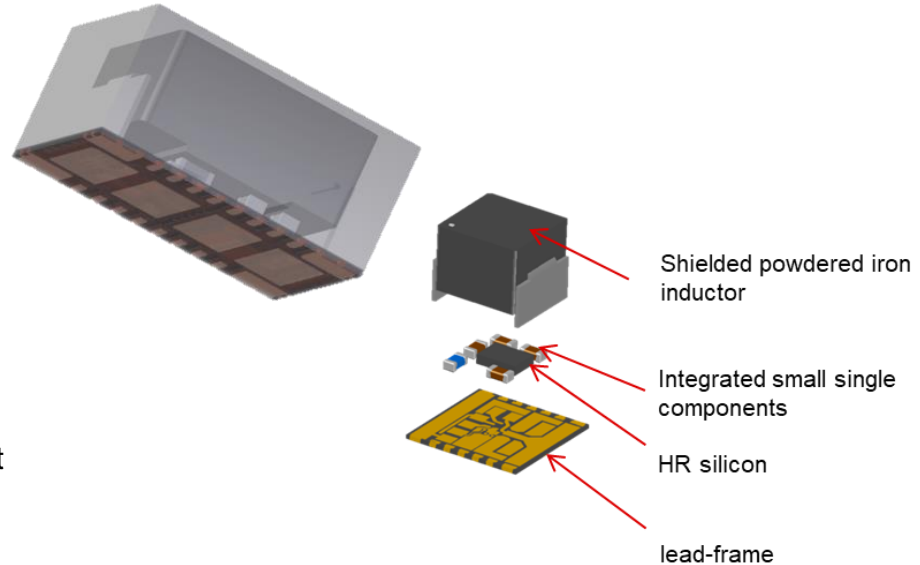
- New Product overview – TPSM63610 (36 V<sub>IN</sub>, 8-A (10-A peak) output current)
- Benefits to using an integrated power module solution versus a standalone converter
- Technological innovation and design of power modules

# TPSM63610 overview

The 36-V, 8-A (10-A peak) TPSM63610 buck module integrates a shielded inductor, high-performance IC die, input and boot capacitors all into one device, enabling engineers to more easily design smaller solution sizes while upholding high performance.

## Key benefits

- **Highest density:** 50% to 80% smaller than similar competitors
- Excellent performance with **95%+ peak efficiency**
- EMI features for **ultra-low EMI** signatures
- **Ultra-low  $I_Q$**  for always-on applications and high efficiency at light load
- Significantly **lower total solution cost** than the closest equivalent competitor



# TPSM63610/08

## High power density & Ultra-low EMI 36 V, 6 A / 8 A (10 A peak) buck modules

### Features

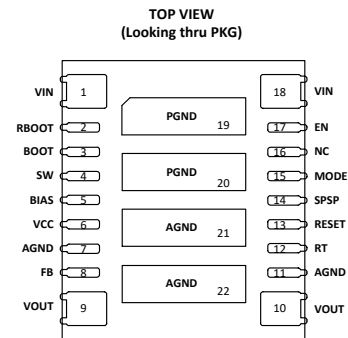
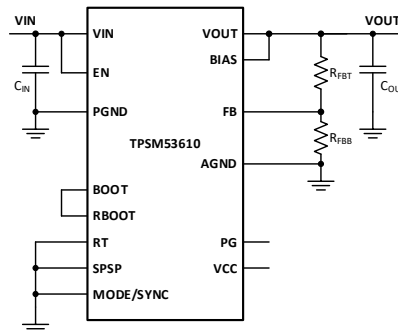
- $V_{IN}$  Range 3.0 V to 36 V (42 V transients), 45-ns minutes on-time
  - Adjustable **output voltage from 1 V to 20 V**
  - Frequency adjustable from 200 kHz to 2.2 MHz
  - On-the-fly **selectable FPWM mode and auto mode**
  - **Low quiescent current at <6  $\mu$ A** typical with no load and 3.3 V
  - **Advanced Frequency Modulation**
    - **Pin configurable DRSS spread-spectrum (SPSP)**
      - Reduces output voltage ripple from SPSP modulation
  - **Adjustable SW node rise time** for EMI reduction (RBOOT pin)
  - **7.5 mm x 6.5 mm** EMI-optimized QFN package
- 
- **High efficiency over temp:**
    - (13.5 V to 5 V) 92% @ 6 A & 2.2 MHz
    - (13.5 V to 5 V) 94% @ 8 A & 400 kHz

### Applications

- Industrial transport
- Avionics
- Test equipment
- Industrial PC, PLC controller

### Benefits

- Low EMI eases design and qualification of noise sensitive industrial designs
  - Reduced external power conditioning circuitry
    - Load dump and cold crank transient conditions
    - Transient protection in harsh industrial environments
  - Low standby current minimizes backup power
  - Wide output-voltage range allows a wide range of industrial applications
- 
- Compact design, low cost BOM - Save board space, simplify design, and speed time to market



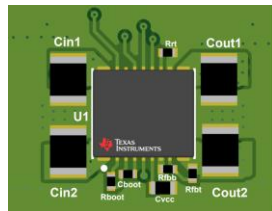
# TPSM63610 device variants

GPN	OPN	I <sub>OUT</sub>	Output voltage	FPWM/PFM	Frequency/Fsync	Spread spectrum
TPSM63610	TPSM63610RDFR	8.0 A / 10 PK	1 V to 20 V (Adj)	Pin selectable	Adjustable/Yes	Pin selectable
TPSM63610E	TPSM63610EXTRDFR	8.0 A / 10 PK	1 V to 20 V (Adj)	Pin selectable	Adjustable/Yes	Pin selectable
TPSM63608	TPSM63608RDFR	6.0 A / 8 PK	1 V to 20 V (Adj)	Pin selectable	Adjustable/Yes	Pin selectable
TLVM13610	TLVM13610RDFR	8.0 A / 10 PK	1 V to 9 V (Adj)	Pin selectable	Adjustable/No	No

# Integrated capacitors and inductors: *QUIET MODULES & EASY LAYOUT*

## TPSM63610

- ✓ Shielded inductor
- ✓ High-performance IC die
  - ✓ High efficiency
  - ✓ Spread spectrum
  - ✓ Switch slew rate control
- ✓ Input capacitor integration
  - ✓ Smallest possible high di/dt input loop
- ✓ Boot capacitor integration
  - ✓ Smallest possible high di/dt gate drive loop
- ✓ Symmetrical pinout – good pin FMEA
- ✓ Functional Safety Capable
- ✓ Configurable in buck and inverting buck boost



Ultra small 8-A solutions!  
Down to 108 mm<sup>2</sup>  
total solution size

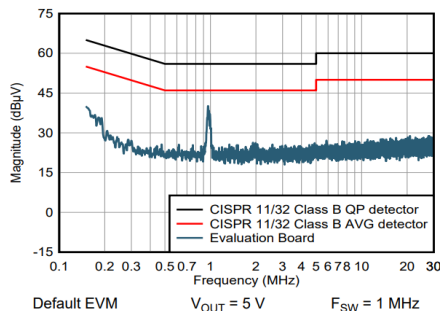
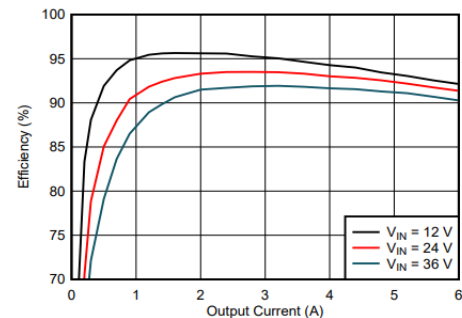


Figure 9-10. CISPR 11/32 Class B Conducted Emissions:  $V_{IN} = 24$  V, SPSP ON



Typical Efficiency,  $V_{OUT} = 5$  V,  $F_{SW} = 1$  MHz

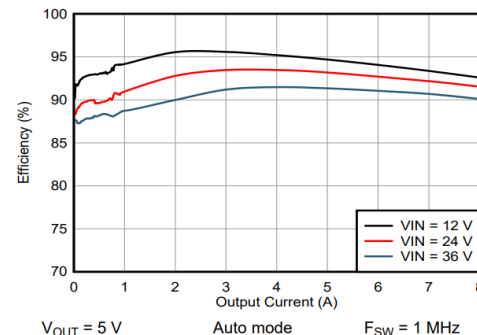


Figure 9-3. Efficiency for  $V_{OUT} = 5$  V

# Internal portfolio positioning

	TPSM63608/10	TPSM63606	LMZM33606	LMZ23608	LMZ13608
Vin range	3 V to 36 V	3 V to 36 V	3.5 V to 36 V	6 V to 36 V	6 V to 36 V
Iout max	6 A / 8 A	6 A	6 A	8 A	8 A
Vout range	1 V to 20 V	1 V to 16 V	1 V to 20 V	0.8 V to 6 V	0.8 V to 6 V
Package	7.5 x 6.5 x 4 mm (48.75 mm <sup>2</sup> )	5 x 5.5 x 4 mm(25 mm <sup>2</sup> )	16 x 10 x 4 mm (160 mm <sup>2</sup> )	15 x 15 mm (225 mm <sup>2</sup> )	15 x 15 mm (225 mm <sup>2</sup> )
	3L RLF-QFN	B3QFN	QFN	NDY	NDY
Adjustable Fsw	Yes (V <sub>OUT</sub> Dependent)	Yes	Yes	Yes (up to 600 kHz)	No
Sync Fsw	Yes	Yes	Yes	Yes	No
FPWM/PFM	Yes (PIN)	Yes	Yes	No	No
Integrated Cin, Cvcc, Cboot	Yes	Yes	No	No	No
Spread spectrum	Yes (PIN)	Yes (Orderable)	No	No	No
Efficiency (24Vin, 5.0Vout)	~94% (5 A 400 K), 90.5% (2.2 M)	~92.5% (5 A 1 MHz)	~89%(5 A 500 kHz)	~81%(8 A, 359 kHz, 3.3 V <sub>OUT</sub> )	~81%(8 A, 359 kHz, 3.3 V <sub>OUT</sub> )
1ku price	\$7.50(8A)	\$6.55	\$6.06	\$13.358	\$12.39



# Designing with power modules

# Design factors to consider

## Total solution cost consist of:

- Material cost a.k.a. “BOM” price
  - IC price
  - Inductor, capacitors, resistors, etc.
- PCB costs
  - Footprint area
  - Via costs
  - Individual component placement cost
- Design time
  - R&D cost, time sensitivity of market



## Benefits to using a module

- Materials
  - Less needed passives and less sourcing of material
  - TI offers competitive pricing which may offer you a better deal on materials
- PCB costs
  - Modules enable smaller footprints and easier layouts
- Design time
  - Less validation and research needed when selecting components
  - Faster and easier designs allow for engineers to focus on other critical challenges and speed time to market

# Design factors to consider

## General design challenges:

- Control architecture influences
- Layout challenges
- Inductor and passive sourcing
- Lab prototyping
- Validation of components
- Selecting BOM components that are optimal for the design

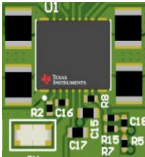
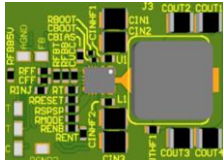


## Benefits to using a module

TI module designer does the heavy lifting!

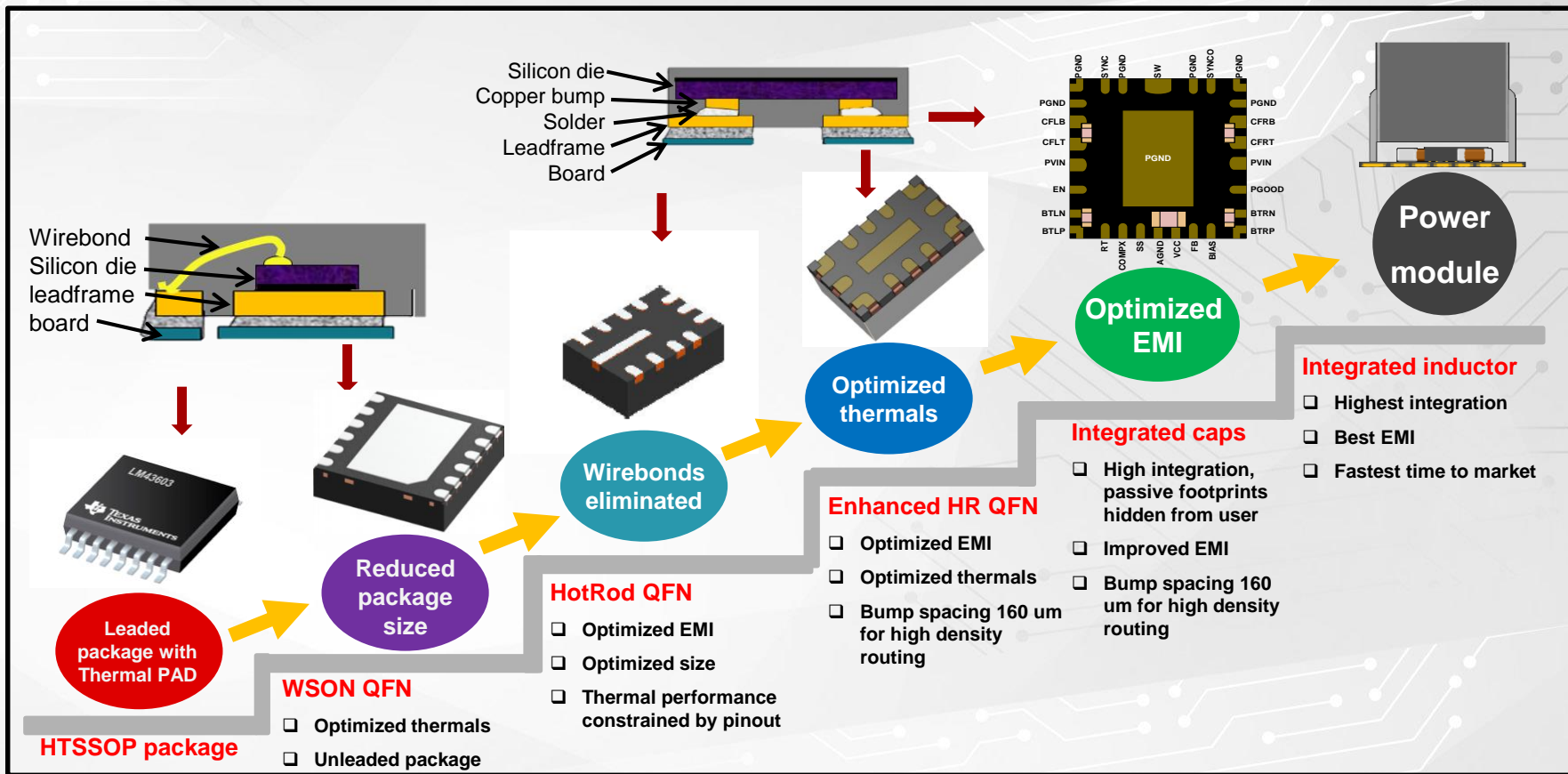
- Optimal converter is selected to cover design specifications
- Selects BOM components that are optimal for the converter
- Characterizes solution across corner cases
- Leverages latest technology to meet market requirements
- Rigorous vetting of internal BOM components – not every inductor or capacitor is created equal!

# Converter vs Module

Design specifications: $V_{IN}$ (nominal) = 24 V $V_{OUT} = 5\text{ V} \mid I_{OUT} = 8\text{ A} \mid F_{sw} = 450\text{ kHz}$	Module TLVM13610 36 V <sub>IN</sub> , 8 A, 6.5-mm x 7.5-mm QFN	Converter alternative LM61480 36 V <sub>IN</sub> , 8 A, 4.5-mm x 3.5-mm VQFN
Optimized layout (EVM)		
Efficiency [24 V to 5 V, 8 A]	94.7%	93.3%
Solution area	113 mm <sup>2</sup>	200 mm <sup>2</sup>
Solution component count	15	16
1-ku Web price	\$4.083*	\$1.911
1-ku BOM cost**	\$6.07	\$5.09

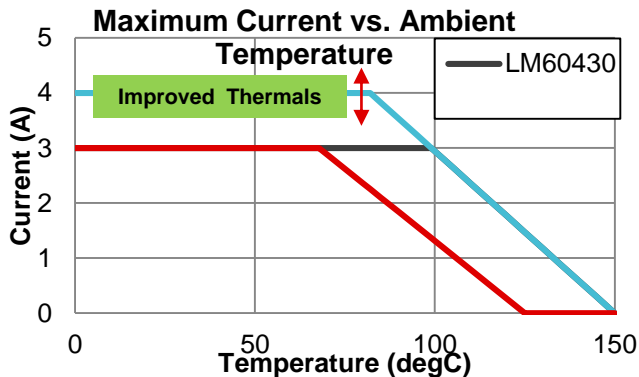
# Innovating with power modules

# Package evolution



# Enhanced HotRod QFN: Optimized EMI & thermals

## Optimized for EMI and thermals



# Enhanced QFN | Optimized thermals



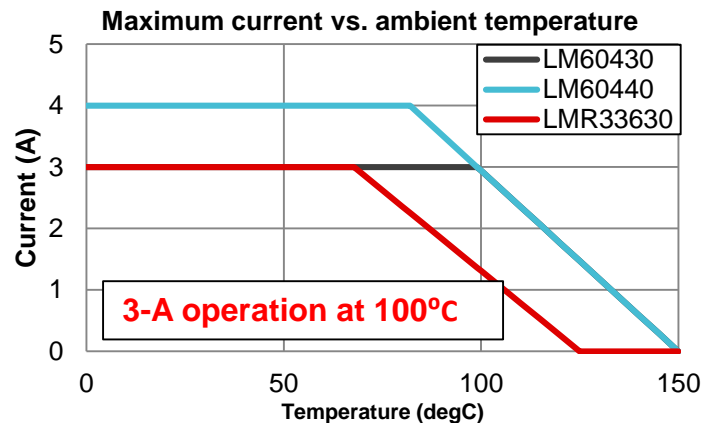
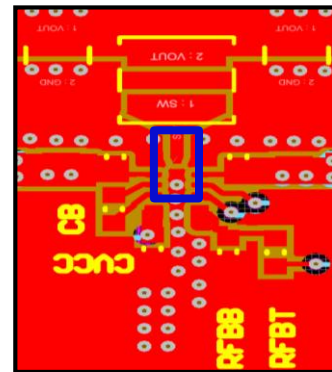
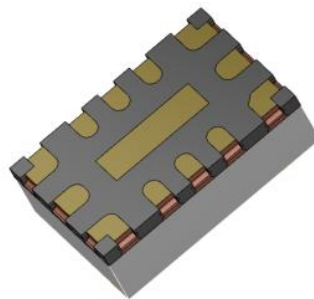
External DAP for optimized layout



150°C Junction temperature



High efficiency, 400-kHz operation





# Better thermal performance in smaller Power module package

TPSM53604  
3.8 V to 36 V  
4 A  
5 x 5.5 mm  
RLF QFN

Area = 27.5 mm<sup>2</sup>

Thermal contact  
42% of package area

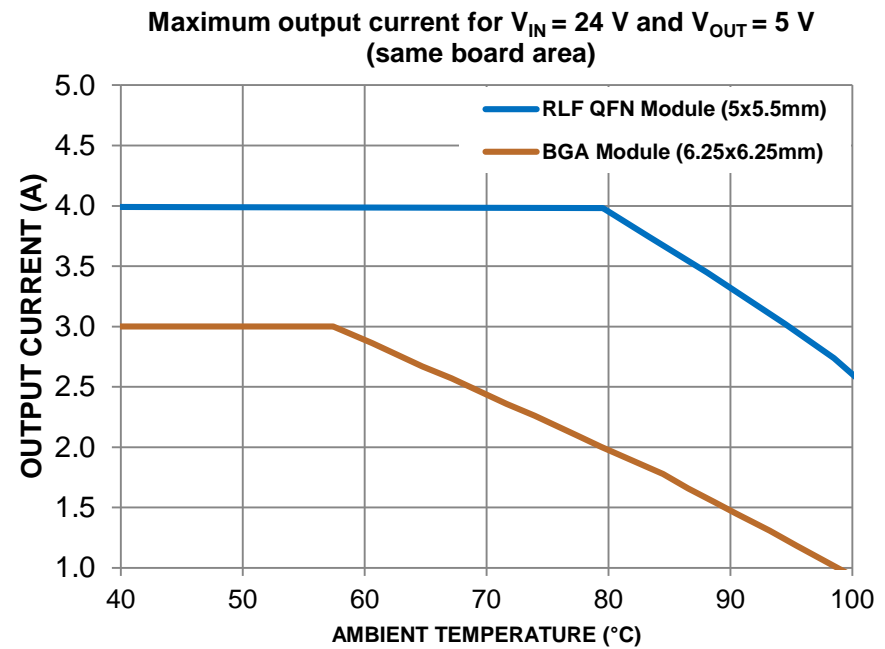
RLF QFN

Competitor  
3.4 V to 40 V  
3.5 A “peak”  
6.25 x 6.25 mm  
BGA

Area = 39 mm<sup>2</sup>

Thermal contact  
18% of package area

BGA



# Achieving power dense products

TEXAS INSTRUMENTS [www.ti.com/power/modules](http://www.ti.com/power/modules)

Step-Down	V <sub>in</sub>	V <sub>out</sub>	I <sub>out</sub>	Pkg
TPS82740x	2.2-5.5V	1.8-3.3V	0.2A	SIP8
TPS8269x	2.3-4.3V	2.5-2.9V	0.5A	SIP8
TPS8267xx	2.3-4.8V	1.0-1.9V	0.6A	SIP8
LMZ21700	3-17V	0.9-6V	0.65A	SIL8F
TPS8269xx	2.3-4.8V	2.2-3V	0.8A	SIP8
LMZ20501	2.7-5.5V	0.6-3.6V	1A	SIL8F
LMZ21701	3-17V	0.9-6V	1A	SIL8F
LMZ1200x	4.5-20V	0.8-6V	1-3A	NDW
LMZ1420x	6-42V	0.8-6V	1-3A	NDW
TPS8268xx	2.5-5.5V	0.9-1.8V	1.6A	SIP8
TPS82084	2.5-6V	0.8-6V	2A	SIL8C
LMZ20502	2.7-5.5V	0.6-3.6V	2A	
LMZ30602	2.95-6V	0.8-3.6V	2A	
LMZ34202	4.5-42V	2.5-7.5V	2A	
LMZ36002	4.5-60V	2.5-7.5V	2A	
LMZ35003	4.5-50V	2.5-15V	2.5A	
TPS82085	2.5-6V	0.8-6V	3A	
TPS82130	3-17V	0.9-5V	3A	
LMZ31503	4.5-15V	0.8-5.5V	3A	
PTN78060	7-36V	2.5-12.6V	3A	
LMZ1050x	3-5V	0.8-5V	3-5A	
LMZ1200x	4.5-20V	0.8-6V	3-5A	
LMZ2360x	6-36V	0.8-6V	3-5A	
LMZ30604	2.95-6V	0.8-3.6V	4A	
LMZ31704	2.95-17V	0.6-5.5V	4A	

0.5-0.8A SIP8 (2.3x2.9mm)  
0.2-1.6A SIP9 (2.3x2.9mm)  
2-3A SIL8C (2.8x3.0mm)  
0.65-2A SIL8F (3.5x3.5mm)  
2-6A RKG (9x11mm)  
2-10A RUQ (10x10mm)  
3-6A RUQ (9x15mm)  
1-5A NDW (10x14mm)  
1-2H Isolated DVB (11x20mm)  
20-30A RLG (15x16mm)  
8-10A NDY (15x18mm)

Converters

LMR336x0-Q1 36V 1A/2A QFN  
LMR3650x-Q1 65V 0.3A/0.6A QFN  
LMQ664x0 36V 1A/2A/3A QFN  
LM536x5-Q1 36V 1.5A/2.5A/3.25A HSON  
LM6x4x0-Q1 36V 3A/4A/6A QFN  
LM6x460/80/95-Q1 36V 6A/8A/10A QFN  
LM6x460-Q1 36V 6A QFN  
LMR514x0 36V 2A/3A SOT  
LM(2)518x-Q1 PSR NO-OPTO FLYBACK HSON  
LM512/3/LM5163/4/8/9-Q1 100V/120V 0.3A...3.5A HSOIC  
LMR380x0-Q1 80V 2A/3A HSOIC  
LM636x5-Q1 36V 1.5A/2.5A/3.25A HTSSOP

Modules

LMZM23600/1 36V 0.5A/1A uSIP  
TPSM265R1 65V 0.1A uSIP  
TPSM365R3/6 65V 0.3A/0.6A QFN  
TPSM33615/25 36V 1.5A/2.5A QFN  
TLVM13620/30 36V 2A/3A QFN  
TPSM63602/3 36V 2A/3A QFN  
TPSM560R6/1R5 60V 0.6A/1.5A QFN  
TPSM53602/3/4 36V 2A/3A/4A QFN  
TPSM63604/6 36V 4A/6A QFN

Controllers

LM2514x-Q1 42V AEF QFN  
LM5146-Q1 100V QFN  
LM5143-Q1 2-PHASE QFN

TEXAS INSTRUMENTS

# Getting started

You can start evaluating this device leveraging the following:

Content type	Content title	Link to content or more details
Product folder	TPSM63610	<a href="https://www.ti.com/product/TPSM63610">https://www.ti.com/product/TPSM63610</a>
Training video	Exploring the value of modules	<a href="https://training.ti.com/exploring-value-power-modules">https://training.ti.com/exploring-value-power-modules</a>
Technical blog content or white paper	<ul style="list-style-type: none"><li>Addressing factory automation challenges with innovations in power design</li><li>Enabling Small, Cool and Quiet Power Modules with Enhanced HotRod™ QFN Packaging</li></ul>	<a href="https://www.ti.com/lit/pdf/slyy212">https://www.ti.com/lit/pdf/slyy212</a> <a href="https://www.ti.com/lit/pdf/slyy181">https://www.ti.com/lit/pdf/slyy181</a>
Selection and design tools and models	WEBENCH® enabled	<a href="#">Webench design link</a>
Development tool or evaluation kit	TPSM63610EVM	<a href="https://www.ti.com/tool/TPSM63610EVM">https://www.ti.com/tool/TPSM63610EVM</a>

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