New Product Update

Buck Converter vs. Power Module Performance Comparison

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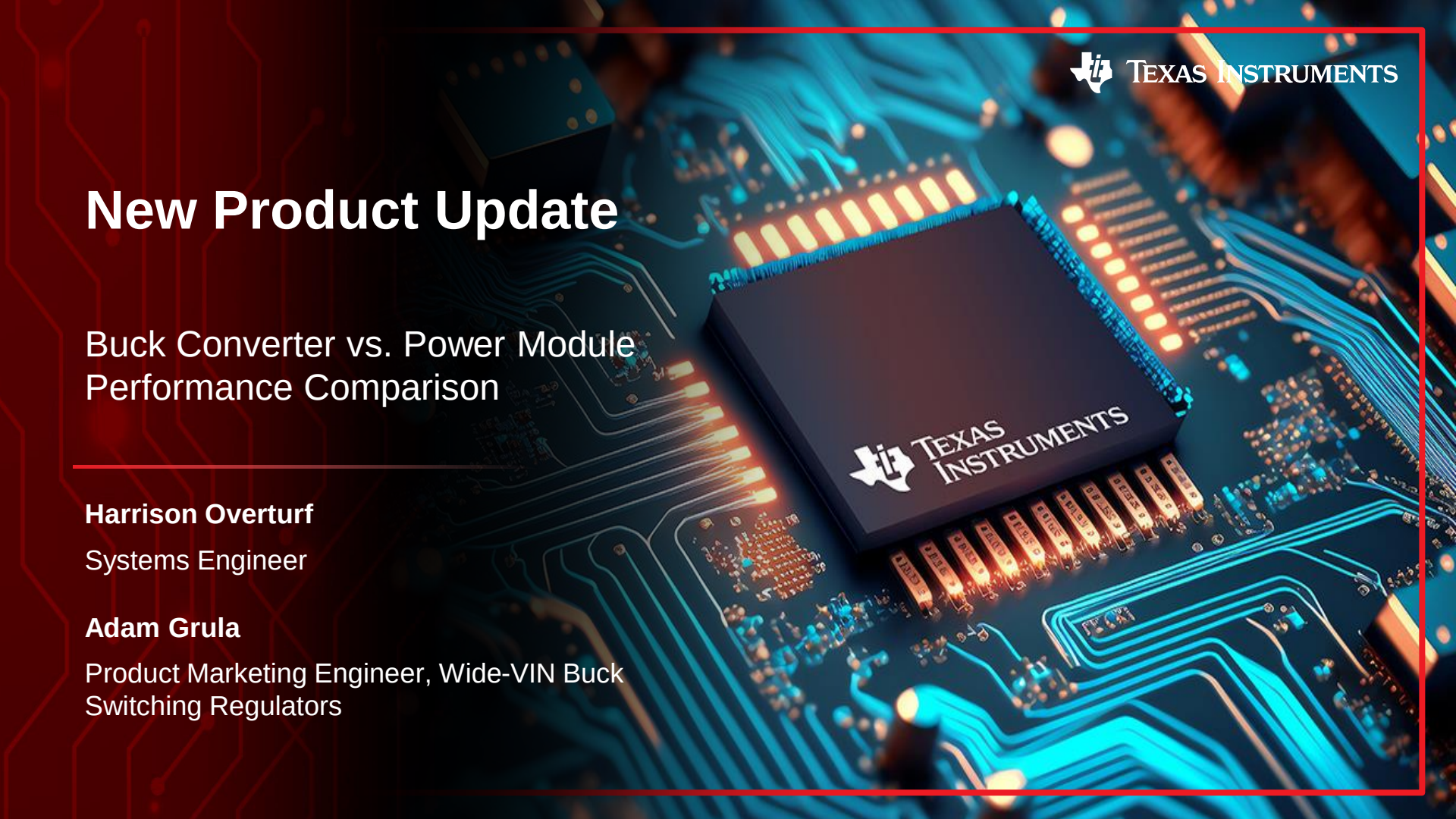
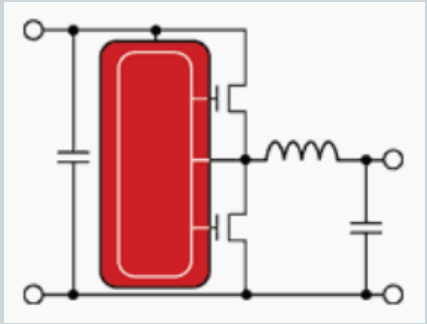
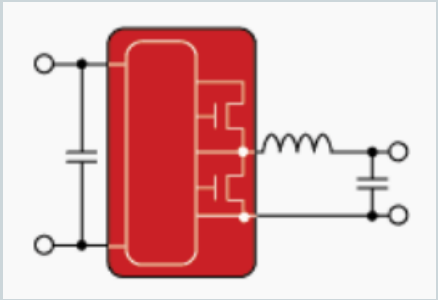
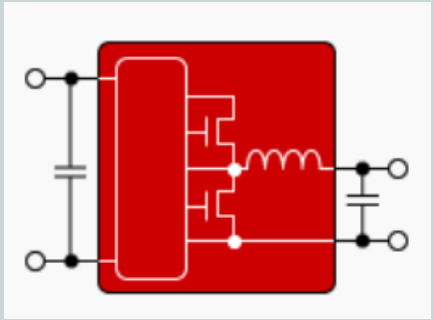


Agenda

- Overview of controllers, converters and modules
- Tradeoffs when selecting a converter vs. a module
- Key considerations when designing with modules
- Performance comparison between LMR36506 and TPSM365R6

Please feel free to “chat” Adam Grula, Product Marketing Engineer who is available to answer any questions you have throughout this presentation.

Step-down (buck) switching regulators

Controller	Converter	Power module
		
- External FETs - External inductor	- Internal FETs - External inductor	- Internal FETs - Internal inductor - Internal caps and resistors*

LMR36506/03

Industry's smallest, highest power density & lowest IQ 65V, 600mA/300mA synchronous Step-down DC-DC converter

Features

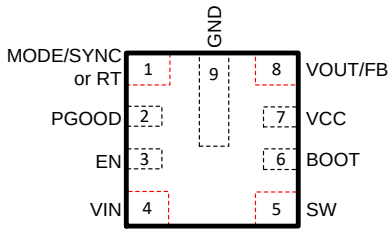
- Wide VIN range: 3.6V – 65V (Abs. Max = 70V)
- **2mm x 2mm HotRod™ package; -40C to 150C T_J operation**
- <6µA Low Iq (Standby) with VOUT/BIAS
- Adjustable Fsw with RT variant(200kHz – 2.2MHz)
  - PFM and FPWM versions available
- Peak current mode control with internal compensation
- Precision EN/UVLO and PGOOD with delay
- Fixed (3.3V/5V) and Adj. VOUT options available
- Module option: TPSM365R6/R3

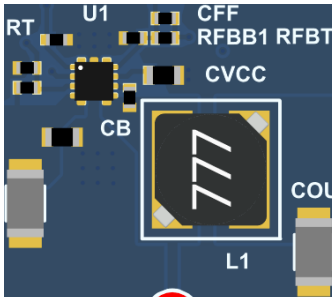
Applications

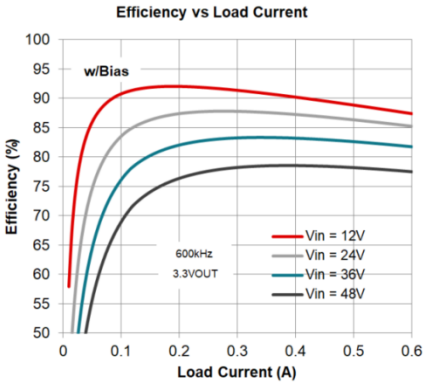
- PLC
- Position sensor
- Analog I/O module
- Digital I/O module

Benefits

- Allows ultra small solution size suitable for space constrained applications
- Capable of handling **input transients up to 70V**
- **Fixed frequency** (with adjustable option) and ultra low output voltage ripple over entire load range
- Best in class Wide-V_{IN} TI solution for <10uA standby current requirements
  - Typ. Industrial (~**87%**@24Vin, 3.3VOUT @300mA 600KHz)







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TPSM365R6/3

65V, 600mA/300mA synchronous step-down DC-DC power module

Features

- Adj. output voltage range of **1V to 13V** and **Fixed 3.3V, 5V** variants
- **Low Iq solution** - 4µA at 24Vin to 3.3Vout (fixed output option)
- **SYNC/MODE with fixed output.**
  - FPWM (Fixed frequency operation at no load)
  - PFM (Improved light load efficiency at light load)
- **BIAS input with fixed VOUT** to enable high efficiency for wide vin operation
- **RT pin** for adjustable output. Configurations:
  - RT -> GND = 1MHz, RT -> VCC = 2.2MHz, Resistor program = 400kHz-2.2MHz
- **Low EMI solution** with PSRR spread spectrum and FCOL package
- Pin spacing complies with IPC2221A(L)
- **FCOL package 4.5mmx3.5mmx2.0mm**

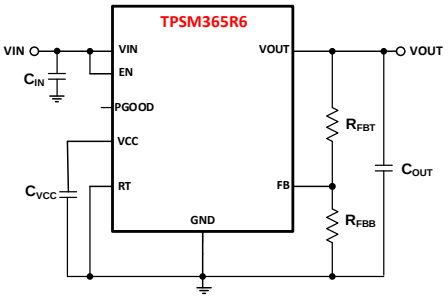
Applications

- Control/field transmitters
- Application specific test equipment
- PLC, DCS

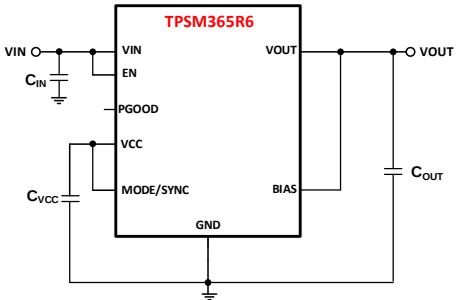
Benefits

- Wide input for applications with unregulated 24V bus. No input protection needed.
- Mode pin to enable fixed frequency and ultra low ripple over entire load range. PFM mode for applications which require high efficiency at light loads
- Adjustable frequency to enable a wide VOUT range.
- Bias input for fixed VOUT options to improve efficiency over load
- Ease of power sequencing with PGOOD

Adjustable VOUT



Fixed VOUT



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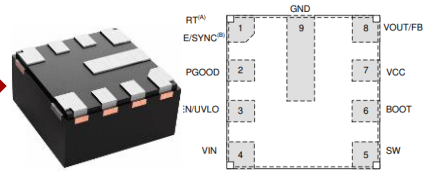
Scalable converter/module solution

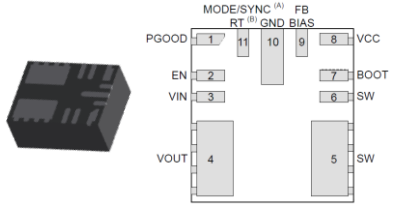
2mm × 2mm pin-to-pin compatible VQFN-HR 9-pin package solution from 50mA to 2A

65Vin	65Vin	65Vin	36Vin
0.05A	**0.15A**	**0.6A**	**2A**
LMR36500	LMR36501/02	LMR36503/06	LMR43610/20



4.5mm × 3.5mm × 2mm pin-to-pin compatible HR-QFN 11-pin package solution from 50mA to 2.5A

65Vin	65Vin	36Vin
0.15A	**0.6A**	**2.5A**
TPSM365R0/R1	TPSM365R3/R6	TPSM33615/25



Tradeoffs between LMR36506 & TPSM365R6

LMR36506	TPSM365R6

• Higher efficiency is possible
  • Better thermal performance
• Greater flexibility when designing
  • Wider output voltage range
• More precise control over switching frequency
	• Integrated Passives reduce component count
	  • Inductor (10µH)
	  • Boot capacitor
	• Smaller solution size
	  • Easier layout – no need to route SW node
	• Includes MODE/SYNC variant
	• Includes spread spectrum

How to decide between converter and module?

1. What are my desired operating conditions? [VIN, VOUT, IOUT, TA, fsw]
2. Do my operating conditions violate the recommended operating conditions of the converter or the module?
    1. See Table 8.3 and Table 9.6 in TPSM365R6 datasheet
    2. See Table 7.3 in LMR36506 datasheet
3. Does my design have special requirements?
    1. Is solution size a big concern?
    2. Is there a frequency band of interest I need to avoid?
    3. Do I need to synchronize to an external clock frequency?
    4. What's my maximum ambient frequency?
    5. Do I plan to reuse this device for future designs?

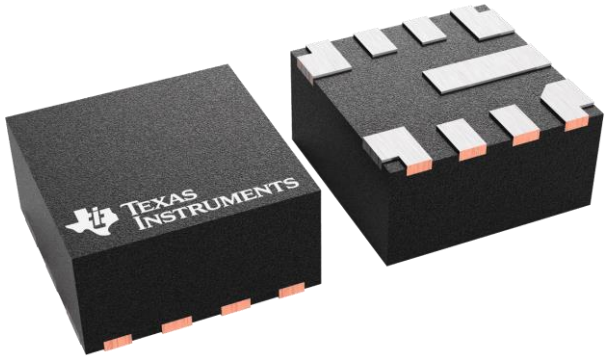
Key considerations for power modules

Benefits	Tradeoffs

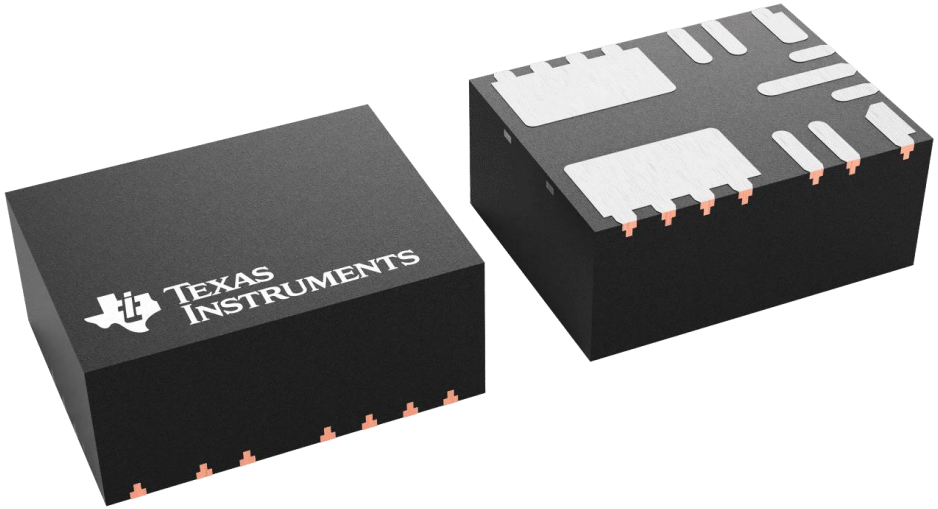
• BoM count reduction
• Ease of design
  • Don’t need to worry about sizing of SW node layout
  • No need for Boot cap placement
  • No need to select inductor
• Smaller solution size
	• Fixed inductor
	  • Output voltage range is limited(usually to <16V)
	  • Slightly lower efficiency due to fixed inductor
	  • Less control over switching frequency

LMR36506 vs. TPSM365R6 package

LMR36506



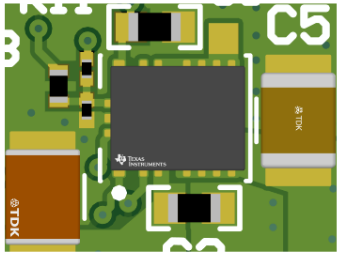
TPSM365R6



TPSM365R6 solution size

Module (TPSM365R6)

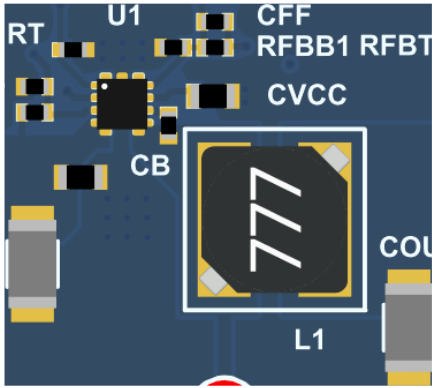
7.8mm



13.7mm

IC (LMR36506)

14.8mm

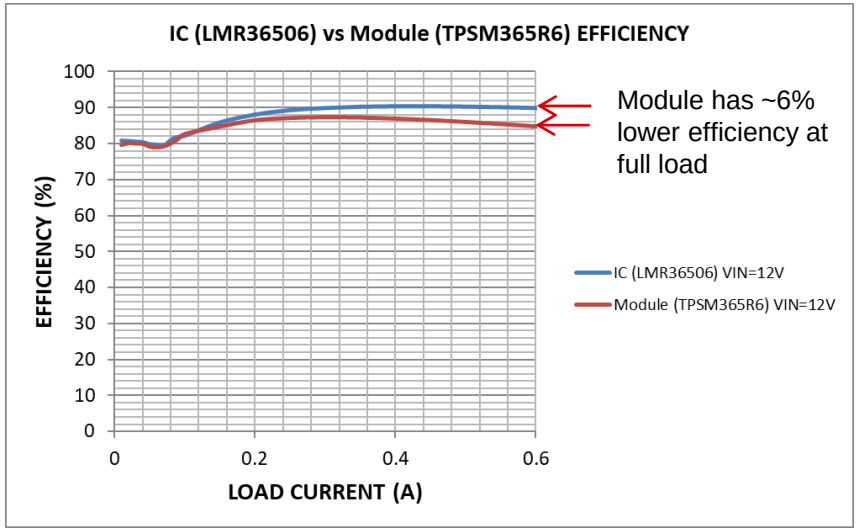


16.8mm

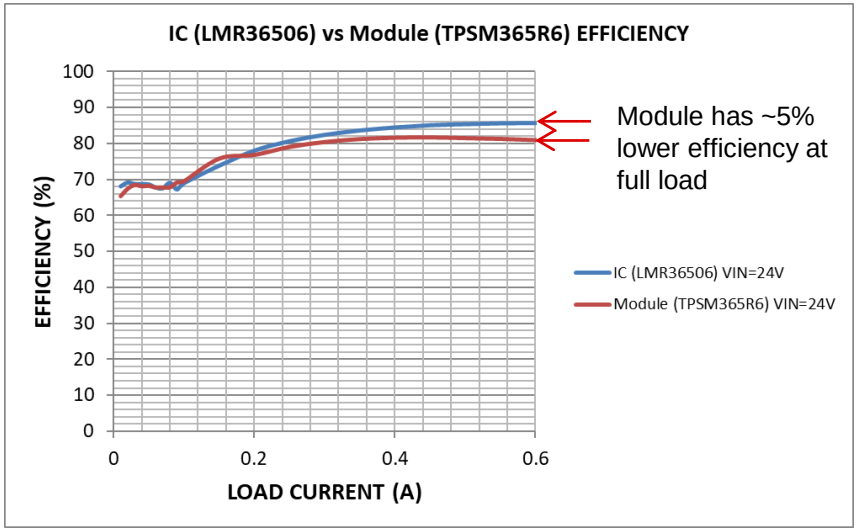
Smaller footprint. Tradeoff is usually lower efficiency vs IC.

TPSM365R6 electrical performance

Efficiency 12V input 5V output



Efficiency 24V input 5V output

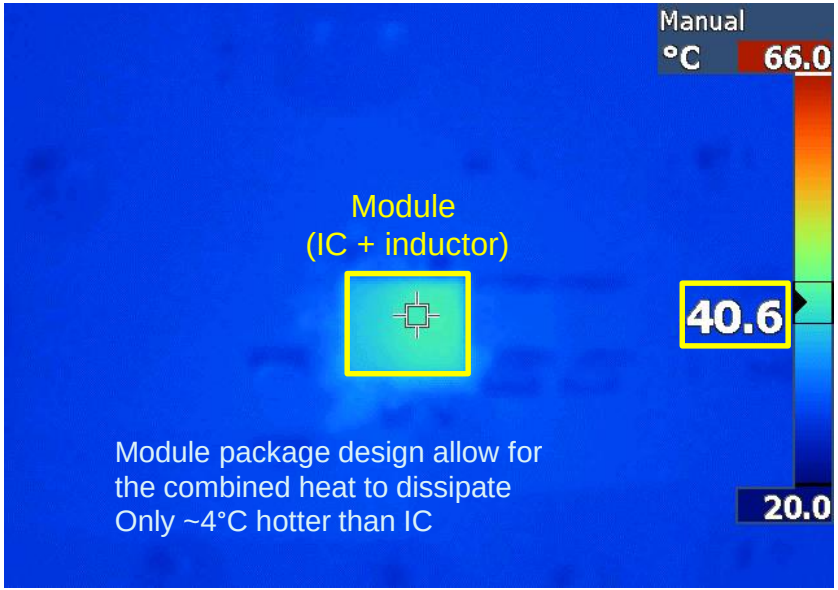


Efficiency tradeoff is understood, but what about thermal performance?

TPSM365R6 thermal performance

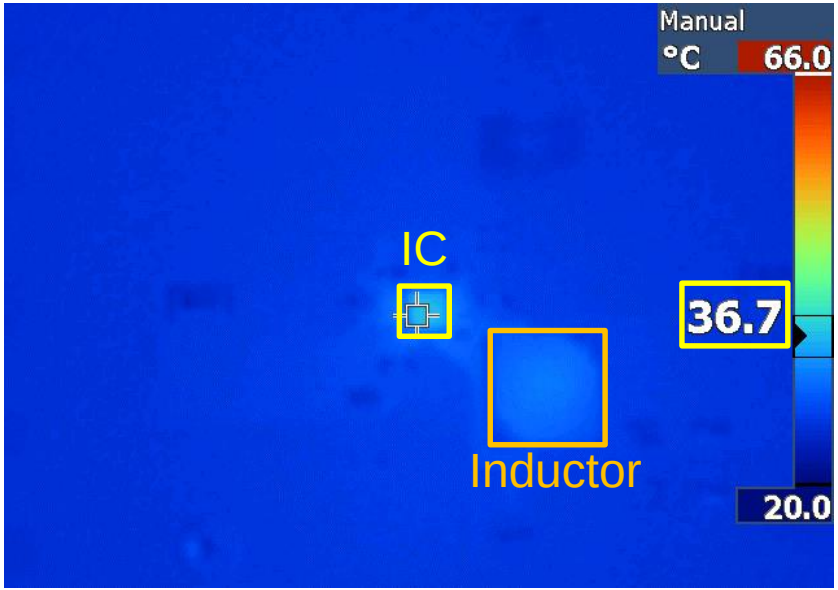
Module (TPSM365R6)

VIN=24V VOUT=5V IOUT=0.5A, standard EVM



IC (LMR36506)

VIN=24V VOUT=5V IOUT=0.5A, standard EVM



Derating curve (VIN=24V)

Suitable for most industrial applications without current derating

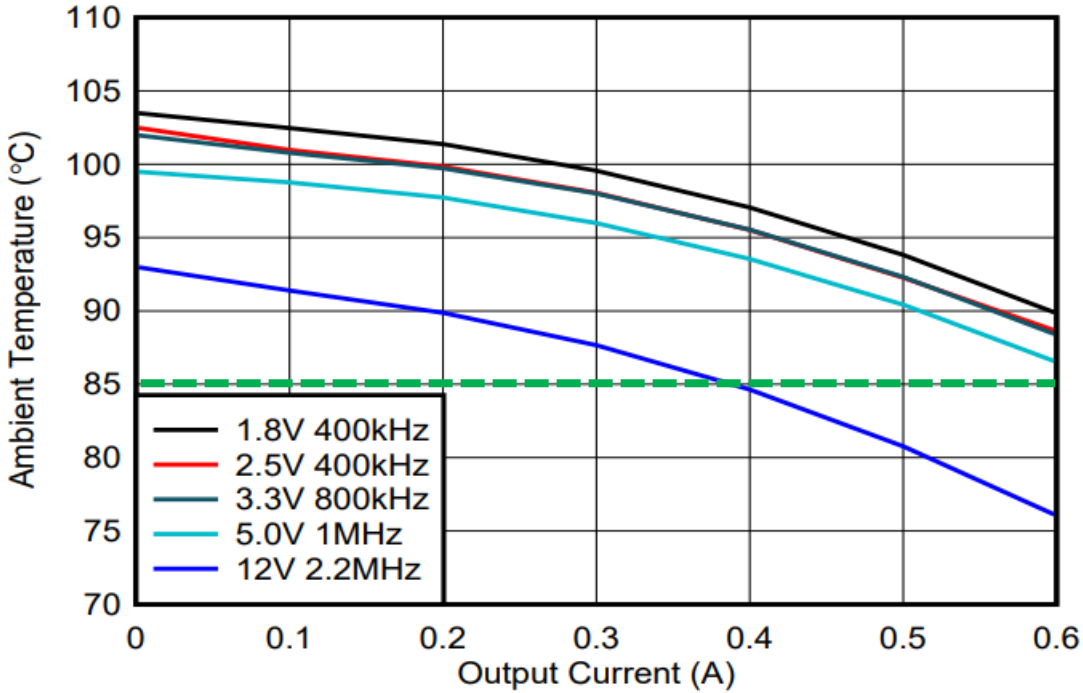
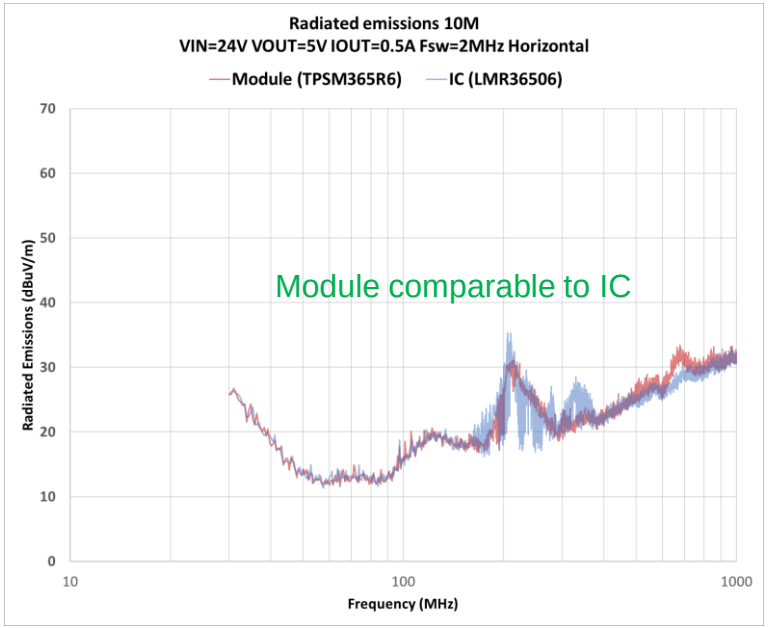


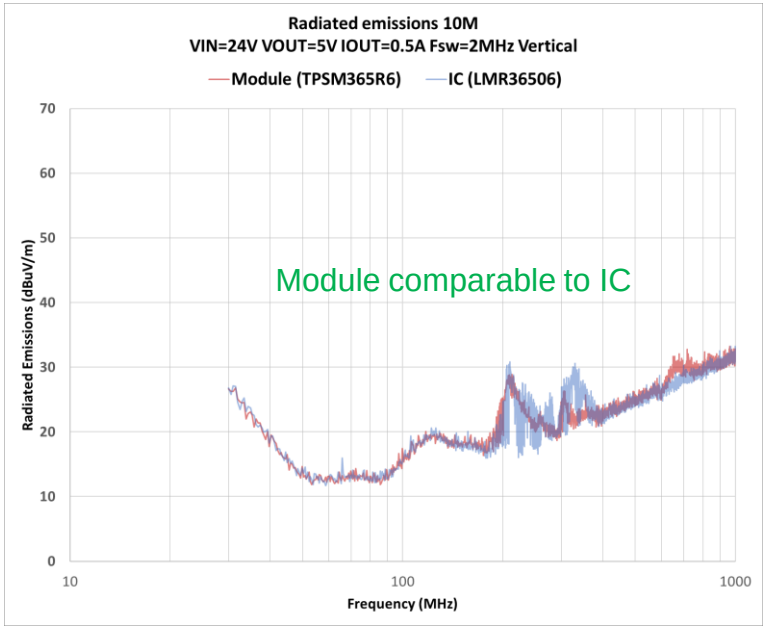
Figure 8-11. Safe Operating Area (Standard EVM Layout and Board Size)

TPSM365R6 EMI performance (with same setup)

Horizontal



Vertical



Getting started

You can start evaluating this device leveraging the following:

Content type	Content title	Link to content or more details
Product folder	TPSM365R6 LMR36506	https://www.ti.com/product/TPSM365R6 https://www.ti.com/product/LMR36506
Reference design	400W GaN-based MPPT charger controller and power optimizer reference design	https://www.ti.com/tool/TIDA-010042
Technical blog content or white paper	Bi-polar Fly-buck-Boost Solution for Analog Output Modules	https://www.ti.com/lit/an/snvaa84/snvaa84.pdf
Selection and design tools and models	TPSM365R6 Design Tools LMR36506 Design Tools	https://www.ti.com/product/TPSM365R6#design-tools-simulation https://www.ti.com/product/LMR36506#design-tools-simulation
Development tool or evaluation kit	TPSM365R6EVM LMR36506RREVM	https://www.ti.com/tool/TPSM365R6EVM https://www.ti.com/tool/LMR36506RREVM

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