



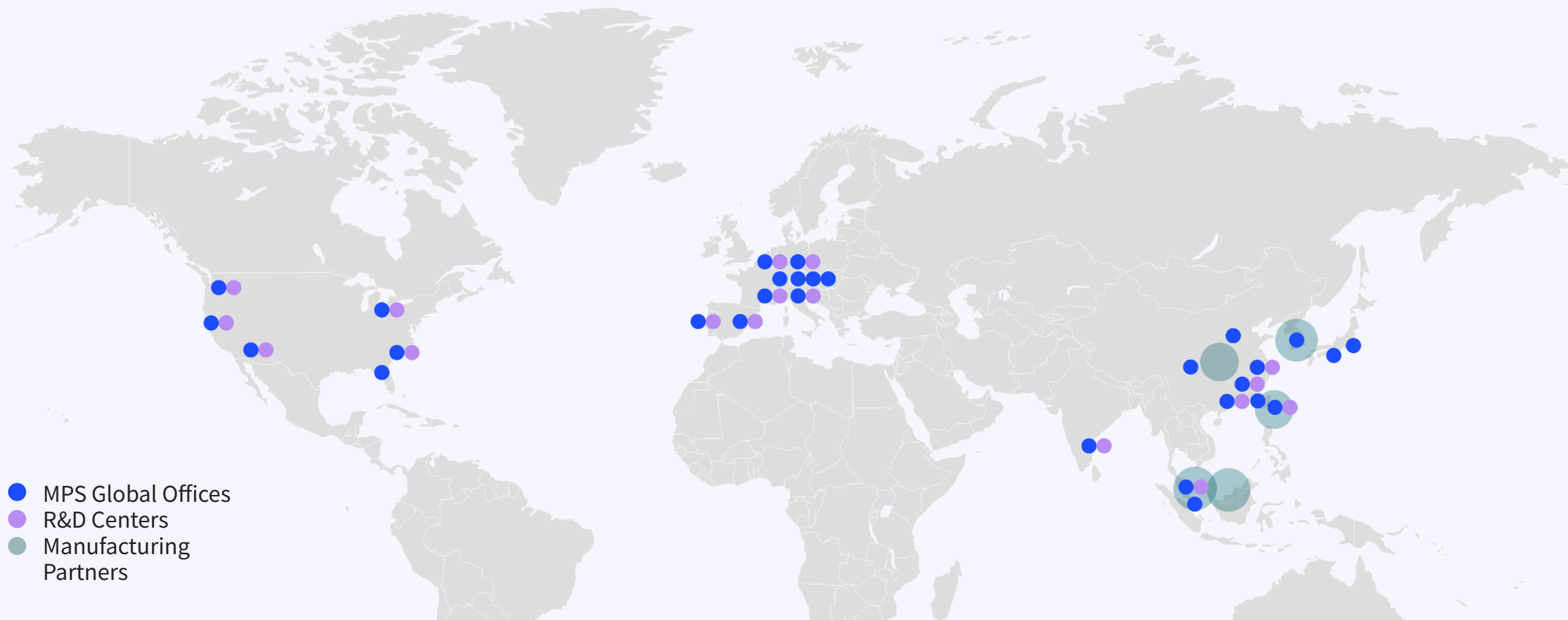
MPS Power Modules for Drones

Cris Yang , Product Market Engineer at MPS

Aug 2026



我们的全球布局：



Kirkland, WA USA



San Jose, CA USA



Munich, Germany



Barcelona, Spain



Ettenheim, Germany



Chengdu, China

AC/DC Power Conversion

- High-Voltage Buck Regulators
- High-Voltage LDOs
- Flyback Controllers
- Flyback Synchronous Rectifiers
- Active PFC Controllers
- LLC Resonant Converter Controllers
- LLC Synchronous Rectifiers
- PFC & LLC Combo Controllers
- X-Capacitor Bleeders

Display Backlighting Power

- Backlight Drivers
- Electroluminescent Drivers
- Photo Flash Drivers
- LCD Power Supplies

AI & Computing Power

- CPU & GPU Core Power
- High-Current DrMOS
 - 90A DrMOS 4mmx6mm Package
- 60A POL Module 6mmx6mm Package
- 60V Intermediate Bus Converter Modules
- Z-Axis Power Delivery (ZPD™) Multi-Phase Modules

DC/DC Power Conversion

- Step-Up (Boost)
- Step-Down (Buck)
- Buck-Boost
- PMICs
- Power over Ethernet (PoE)
 - Power-Sourcing Equipment (PSE)
 - Powered Devices

Power Magnetics

- Molded Inductors
- Semi-Shielded Inductors

E-Fuse, USB & Load Switches

- Configurable Current Limit, Up to 50A per Device
- Adjustable Slew Rate
- Reverse Current Blocking
- Output Discharge (Load Switches)
- Integrated Auto-Detection
- Pin-to-Pin Compatible
- Parallelable Up to 10 Devices
- Digital Interface Command and Control
- USB Type-C and USB PD

Motor Drivers, Position & Current Sensors

- Brushless DC (BLDC) Motor Drivers
- Stepper Motor Drivers
- Brushed DC Motor/Solenoid Drivers
- Half-Bridge/Full-Bridge/Three-Phase Power Stages
- Magnetic Angular and 3D Position Sensors
- Isolated, Integrated Current Sensors, 5A to 400A

Automotive (AEC-Q100) & Industrial

- DC/DC
- LED Lighting
- Power Modules
- Motor Drivers
- Angular Position and 3D Position Sensors
- USB Charging
- Wireless Charging
- Display Backlighting
- Precision Analog
- ADAS Core Power
- Supervisors
- Load Switches
- Isolated, Integrated Current Sensors, 5A to 400A
- Class-D Audio
- E-Fuses, High-Side Switches

Class-D Audio

- Digital Controllers and Processors
- Analog Input Class-D Amplifiers
- PWM Input Power Stages

Isolated Solutions

- Isolated Gate Drivers
- Isolated Power Modules
- Digital Isolator with Integrated Power
- Digital Isolators
- Integrated Current Sensors, 5A to 400A
- Totem-Pole PFC/LLC Controllers

Power Modules

- 6V, 600mA to 100A
- 16V, 600mA to 1000A+
- 36V, 600mA to 24A
- 55V, 1A to 3A
- 80V, 600mA

LED Lighting & Illumination

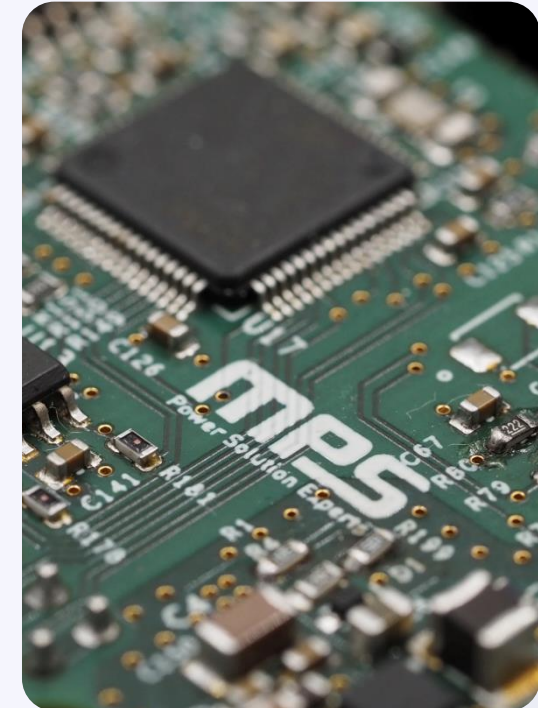
- TRIAC-Dimmable AC/DC LED Controllers
- PWM and Analog Dimmable AC/DC LED Controllers
- DC/DC LED Controllers: Buck, Boost, Buck-Boost
- LED Protection ICs
- IR LED Drivers

Battery Management

- Battery Monitors & Protectors
- Fuel Gauges
- Active Balancers
- Switching Chargers: Buck, Boost, Buck-Boost
- Linear Chargers

Precision Analog

- Analog-to-Digital Converters (ADCs)
- Analog Switches
- Current-Sense Amplifiers
- Operational Amplifiers
- Voltage Reference





“电源”背后的秘密

无人机供电面临的挑战：

1. 空间限制
2. 效率
3. 设计简洁性
4. 热性能与电磁兼容性能
5. FPGA 功耗的需求



Space Constraints

MPS – 电源模块 – 什么是电源模块

特色功能:

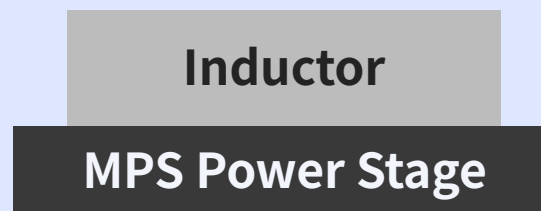
- 高效率
- 高功率密度
- 低输出噪声
- 简洁物料清单
- 广泛的应用范围

空间节省:

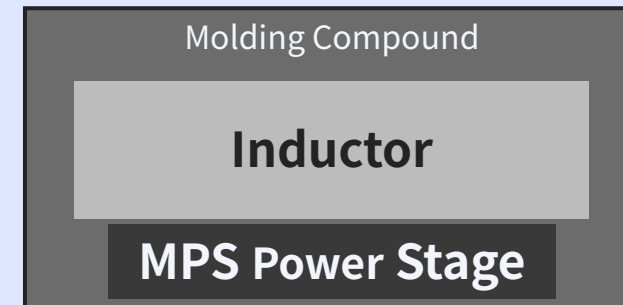
紧凑的封装设计

最大限度地压缩尺寸

开放架构模块



全塑封模块



低输入电压系列 – MPM3816C/26C/36C/46C

Features

- 1A/2A/3A/4A Pin Compatible
- Wide 2.7V to 5.5V Operating Input Range
- Adjustable Output from 0.4V
- 100% Duty Cycle in Dropout
- FCCM Available
- 2.4MHz Frequency
- Enable (EN) and Power Good (PG) for Power Sequencing
- Output Discharge
- Constant On-Time (COT) Control

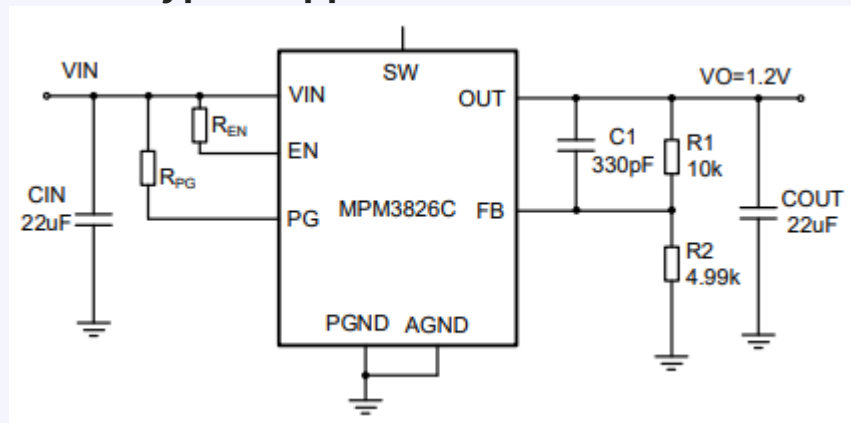
MPM38x6C
2mm×2.2mm

2mm×2.5mm

MPM38x4C
2.5mm×2.5mm

Size Comparison
(in actual scale)

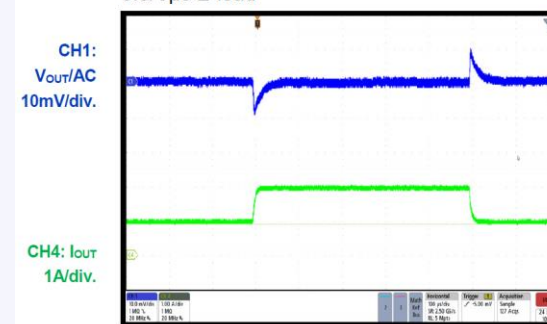
Typical Application Circuit



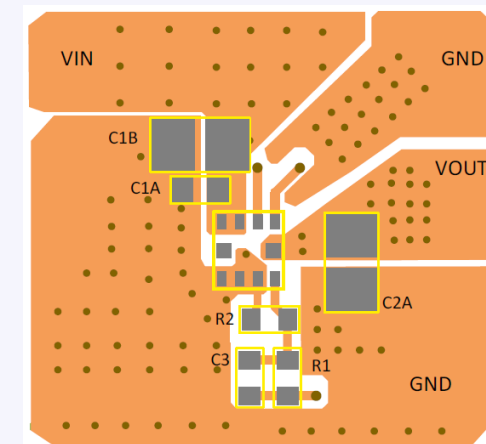
Excellent Transient Response with COT

Load Transient

V_{IN} = 3.3V, V_{OUT} = 1.2V, I_{OUT} = 1A to 2A,
0.8A/μs E-load



Simplified Layout



Available in an Ultra Small
ECLGA-10 (2x2.2x1.2mm) Package

Common Footprint from 1A to 4A



分立方案 vs 多通道输出电源模块 MPM54304

分立解决方案的尺寸:

Width-to-Height Ratio: 33.5mm x 20.65mm

Total Area Used: ~691.78 mm²

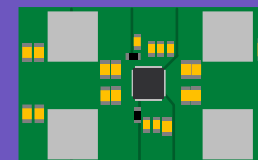
多通道输出电源模块尺寸:

Width-to-Height Ratio: 11.25mm x 11.25mm

Total Area Used: ~126.5 mm²

**多通道输出电源模块节省了近81%的
布板面积**

Estimated Solution Size
using PMIC IC



Estimated Solution Size
using MPM54304

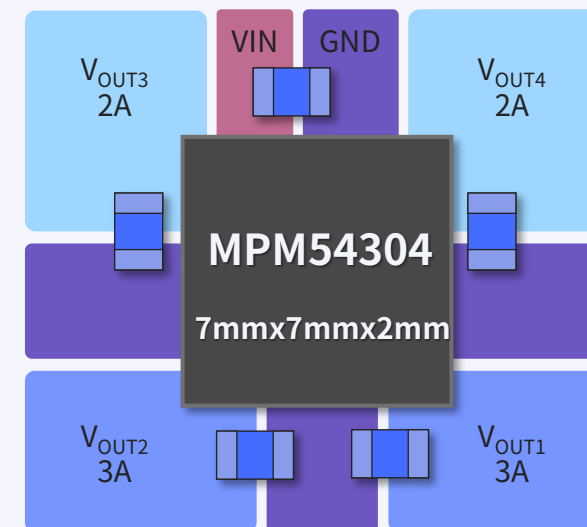
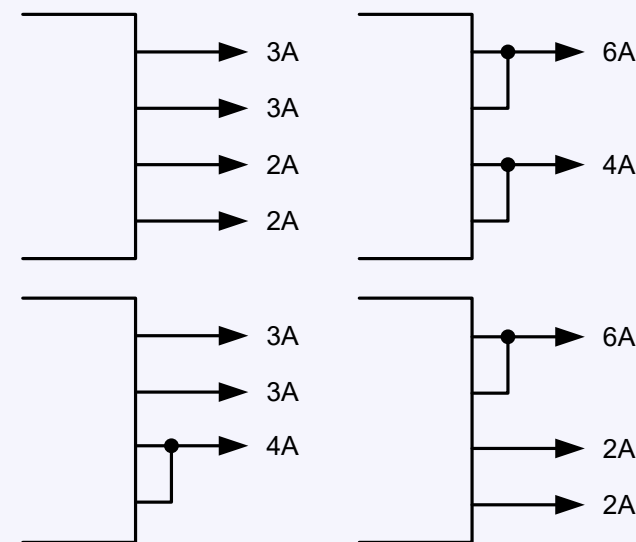
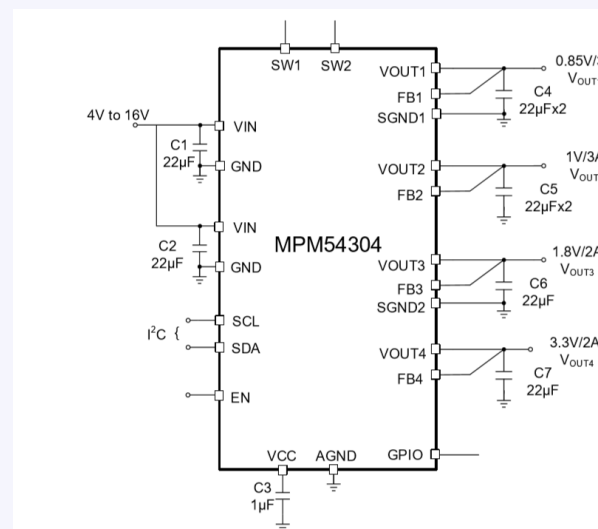


MPM54304 – Quad 3A, 3A, 2A, 2A Power Module

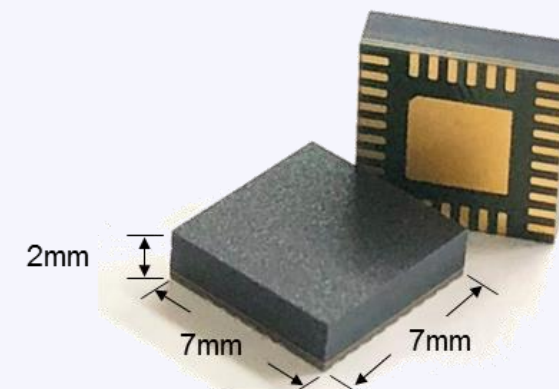
Key Advantages:

- 4V to 16V Operating Input Voltage (V_{IN}) Range
- Wide Output Voltage (V_{OUT}) Range:
 - I²C-Configurable: 0.55V to 5.4V
 - External Resistor Divider: 0.6V to 7V or $V_{IN} \times DMAX$ if $V_{IN} < 7V$
- Continuous Current:
 - Channels 1 and 2: 3A Continuous Current
 - Channels 3 and 4: 2A Continuous Current
- Interleaved Operation, Configurable, Multi-Functional GPIO Pin
- Rails Can Be Combined
- **Adjustable Power-On/Off Sequence**
- **Power Good (PG) and Enable (EN)**
- Total Loss Allowed: 2.75W
- 2-Time Multiple-Time Programmable (MTP) Memory and I²C Function
- I²C-Configurable Parameters:
 - Paralleling Channel 1 and 2, Paralleling Channel 3 and 4
 - Switching Frequency (f_{SW})
 - V_{OUT}
 - Over-Current Protection (OCP) and Over-Voltage Protection (OVP) Threshold
 - Power-On and Power-Off Sequencing
 - Forced Pulse-Width Modulation (PWM) or Auto-PWM/Pulse-Frequency Modulation (PFM)
- **Available in an Ultra-Thin LGA-33 (7mmx7mmx2mm) Package**

Typical Application



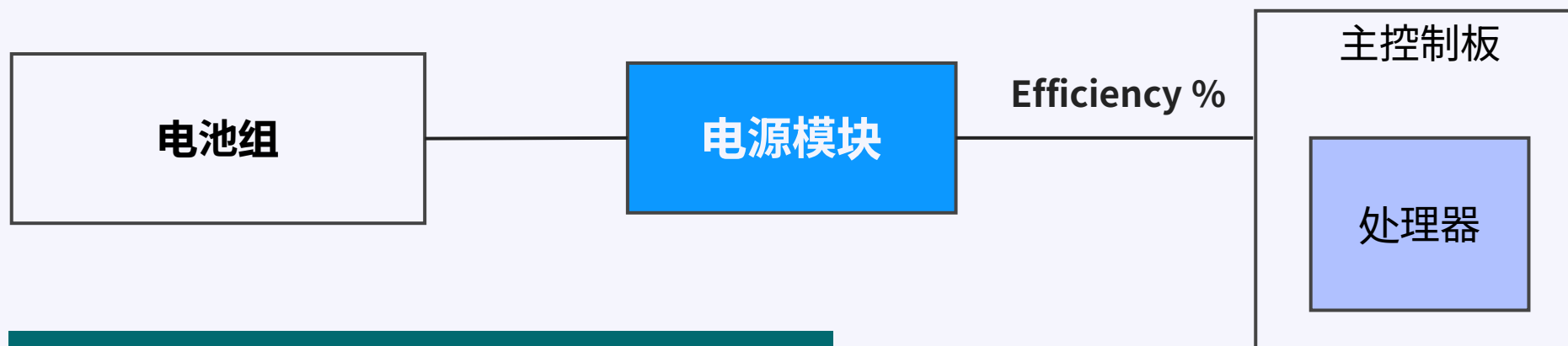
Ultra-Thin LGA-33 (7mmx7mmx2mm) Package



Efficiency

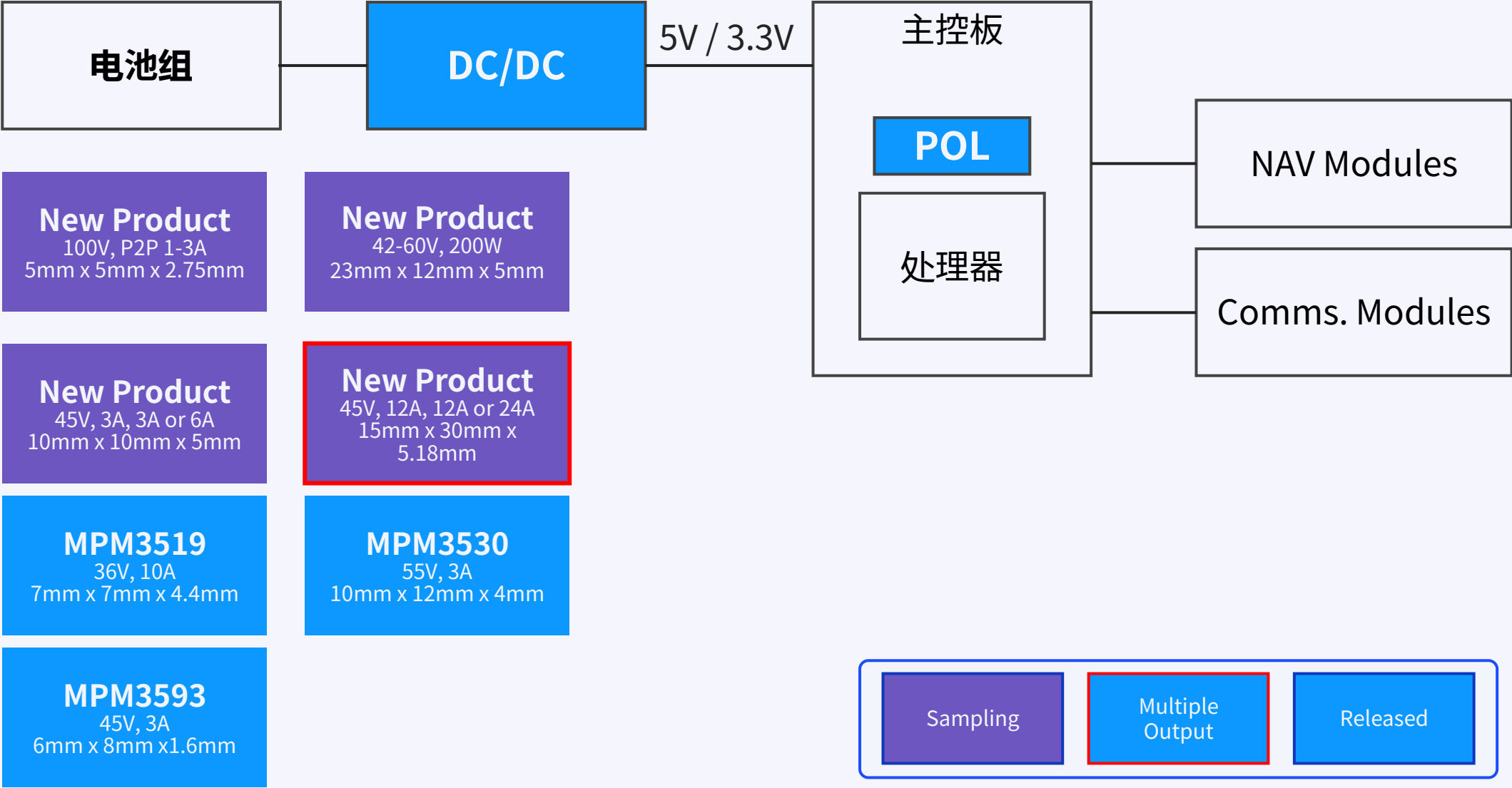
Designers need:

无人机的生产力随着电池寿命的增加而提高 => 直接受到DC/DC转换和电力传输效率的影响。



无人机大多由电池供电

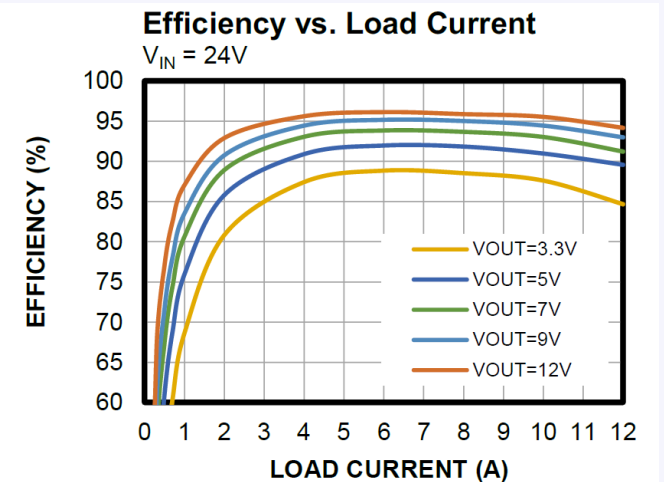
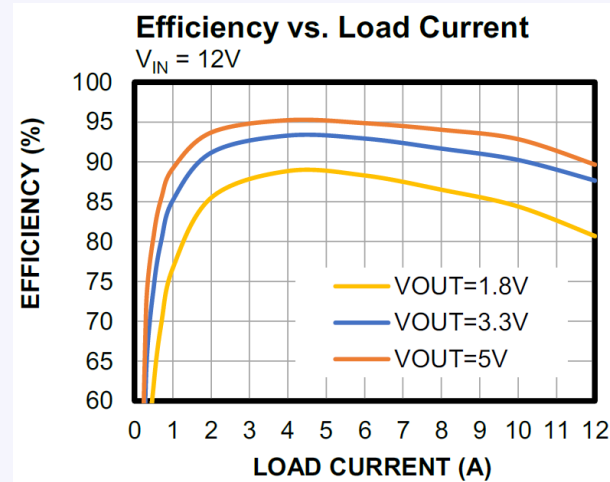
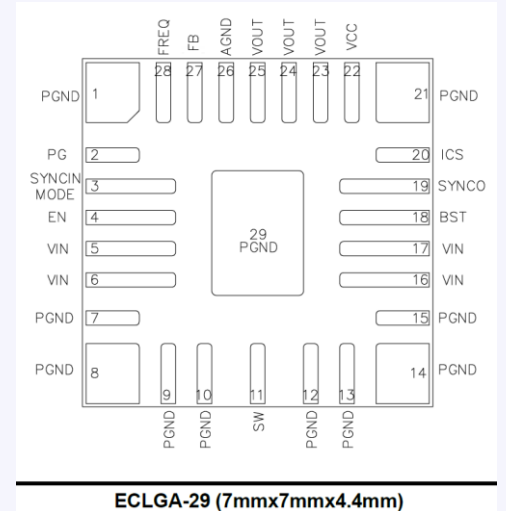
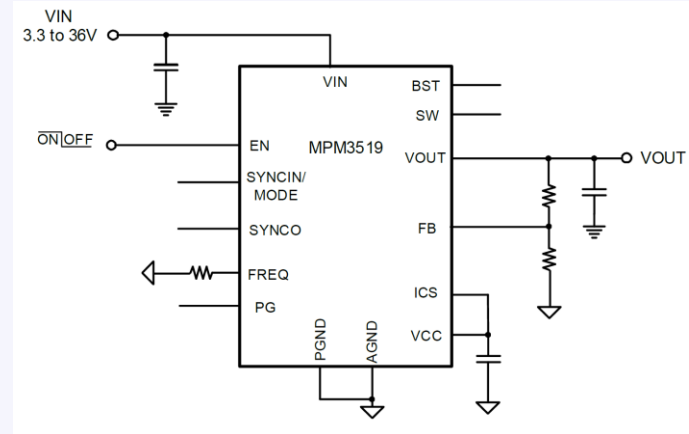
DC/DC 转换器 (通用)



Features

- Vin range 3.3V to 36V
- Vout range 0.6V to 12V
- 10A continuous Output Current and 12A Peak Output Current
- Multi-Phase Capable up to 8-Phase and current sharing
- 200kHz to 2.5MHz Programmable Frequency
- Frequency Spread Spectrum Modulation
- Synchronization to an External Clock
- Symmetric VIN Pinout Placement for low EMI
- ECLGA 7mm x 7mm x 4.4mm package

Reference Schematic



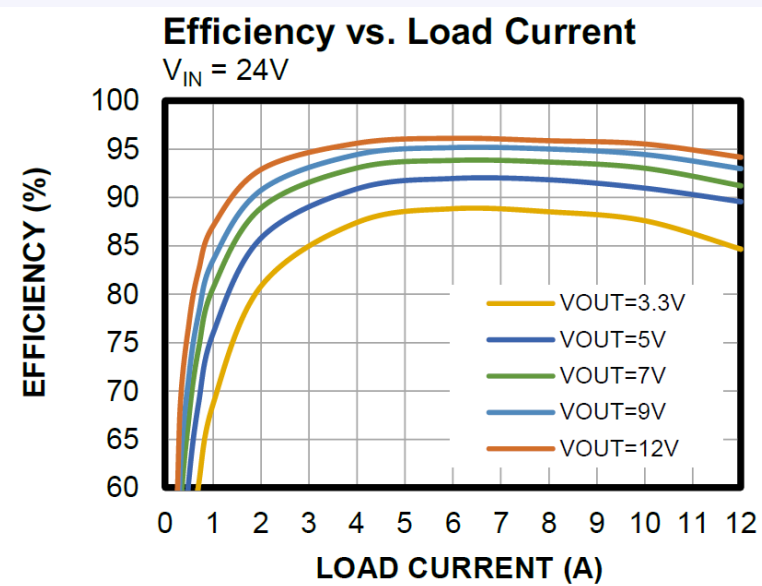
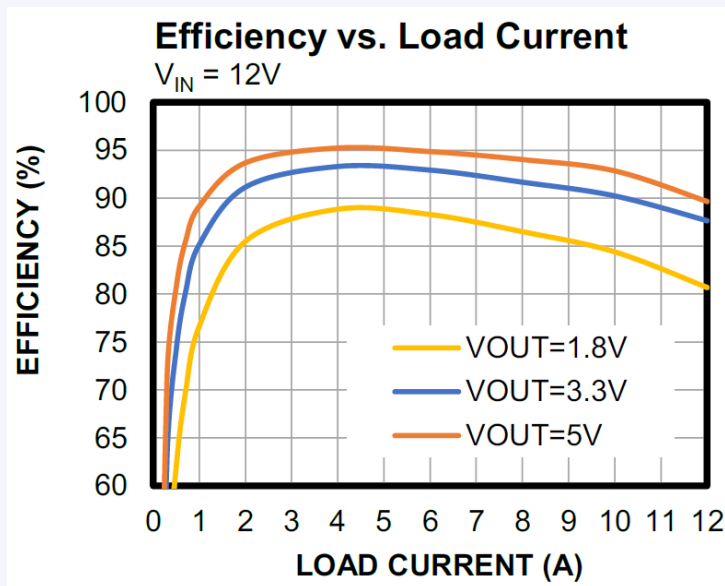
电源模块效率测试:

测试方法:

- 自动化测试脚本
- 同类型测试条件:
 - 相同的测试条件 (温度、气流、环境)
 - 相同的测试设备 (电源、直流负载、万用表)
 - 相同的定制 (双绞线) 电缆, 带开尔文连接和远程感应
- 标准化数据格式



Efficiency Results: up to 85-95% efficiency for various operating conditions

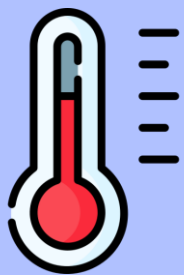


电源模块效率测试：

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环境温度



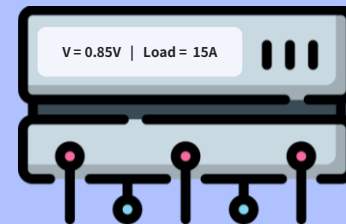
气流速度



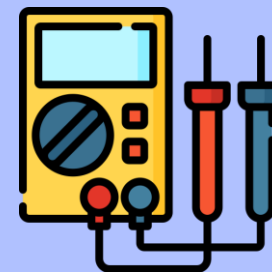
测试环境



电源供应



直流负载



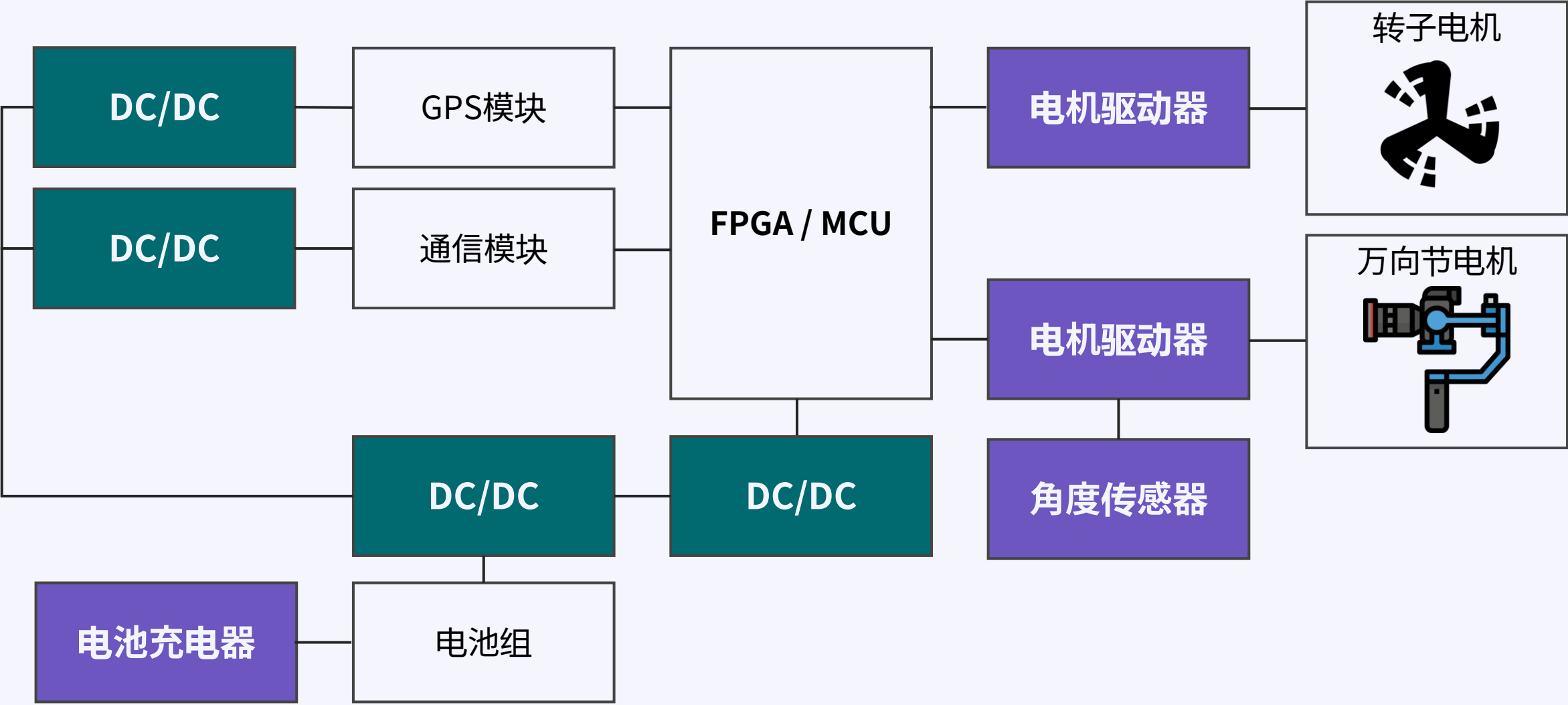
数字万用表



定制电缆

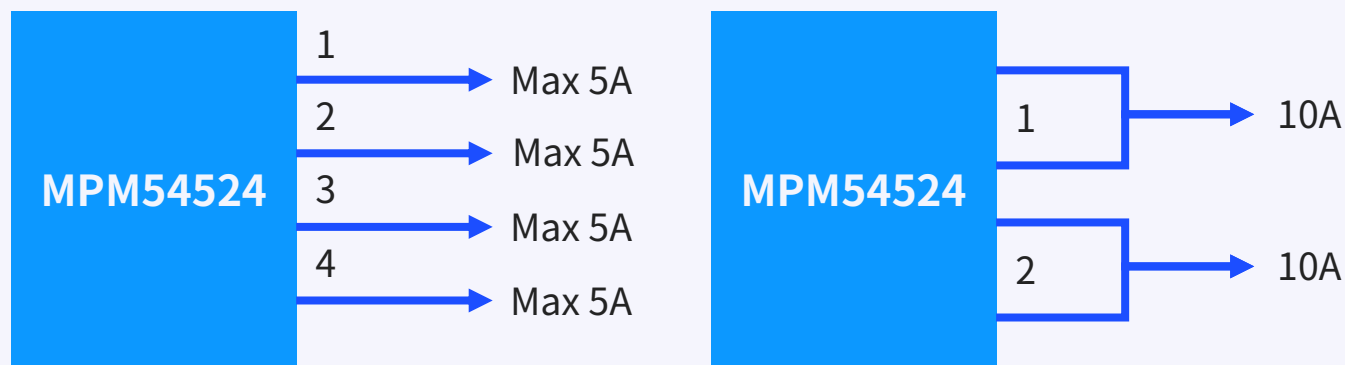
Design Simplicity

无人机应用框图



Designers Need:

- 小尺寸解决方案和设计
- 更简易



MPS PMIC 电源模块

MPM54304

3A, 3A, 2A, 2A,
7mmx7mmx2mm

MPM54322

3A, 3A, I²C,
5mmx5.5mmx
1.85mm

MPM54532

6A, 6A, I²C,
5mmx5.5mmx
1.94mm

MPM54522

6A, 6A, I²C,
5mmx6.5mmx
2.76mm

MPM54313

Triple 3A, I²C,
8mmx9mmx
2.58mm

MPM54524

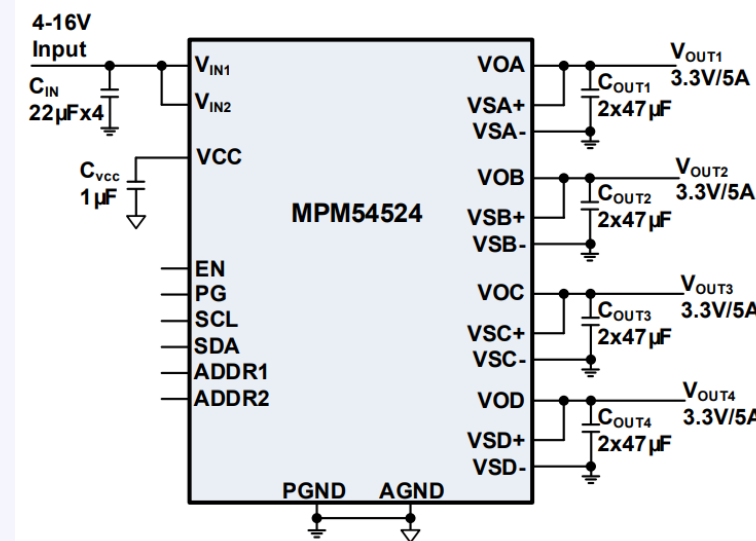
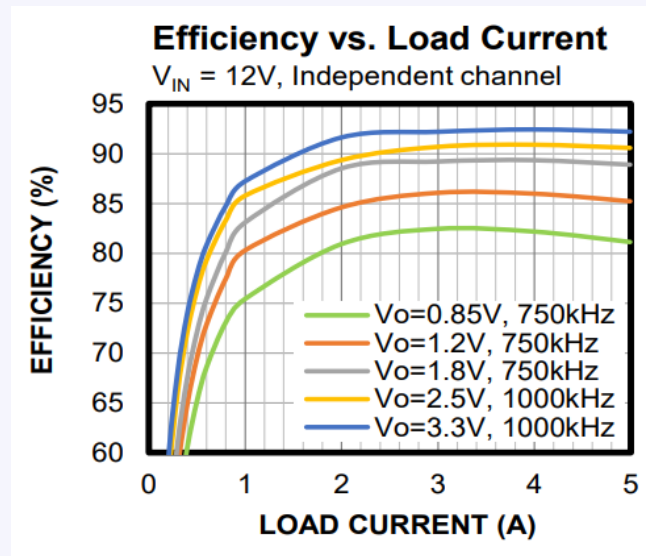
4x 5A, I²C,
8mmx8mmx
2.9mm

MPM54524 – Quad 5A Power Module

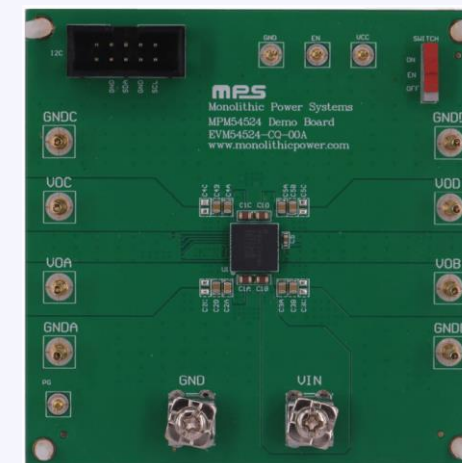
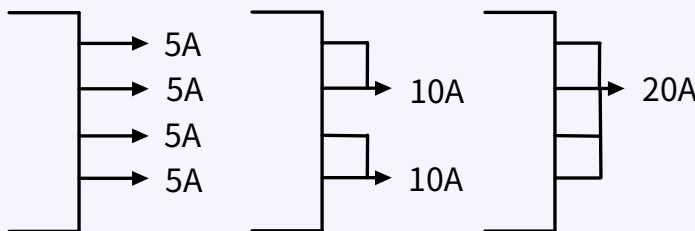


Key Advantages:

- **Wide 4V to 16V Input Voltage (V_{IN}) Range**
- **Adaptive COT for Ultra-Fast Transient Response**
- Channels A/B and C/D Support Up to 10A of Continuous Current in Parallel Mode
- Configurable Active Load Line (Droop Resistance) Up to 100m Ω
- Differential Output Voltage (V_{OUT}) Remote Sense
- I²C Target Address Programmable via the Multiple-Time Programmable (MTP) Memory
- I²C-Configurable Reference Voltage, Switching Frequency, Current Limit, **Power Sequencing**, Soft Start, and Pulse-Width Modulation (PWM)/Pulse-Frequency Modulation (PFM)
- **1MHz Default Switching Frequency**
- V_{OUT} , Output Current (I_{OUT}), and Junction Temp (T_J) Monitoring via the I²C
- Open-Drain Power Good (PG) Indication
- Over-Current Protection (OCP), Under-Voltage Lockout (UVLO), Under-Voltage Protection (UVP), Over-Voltage Protection (OVP), and Thermal Shutdown



Available in an 8mm x 8mm x2.9mm ECLGA Package



使用 Virtual Bench Pro 4 轻松配置参数

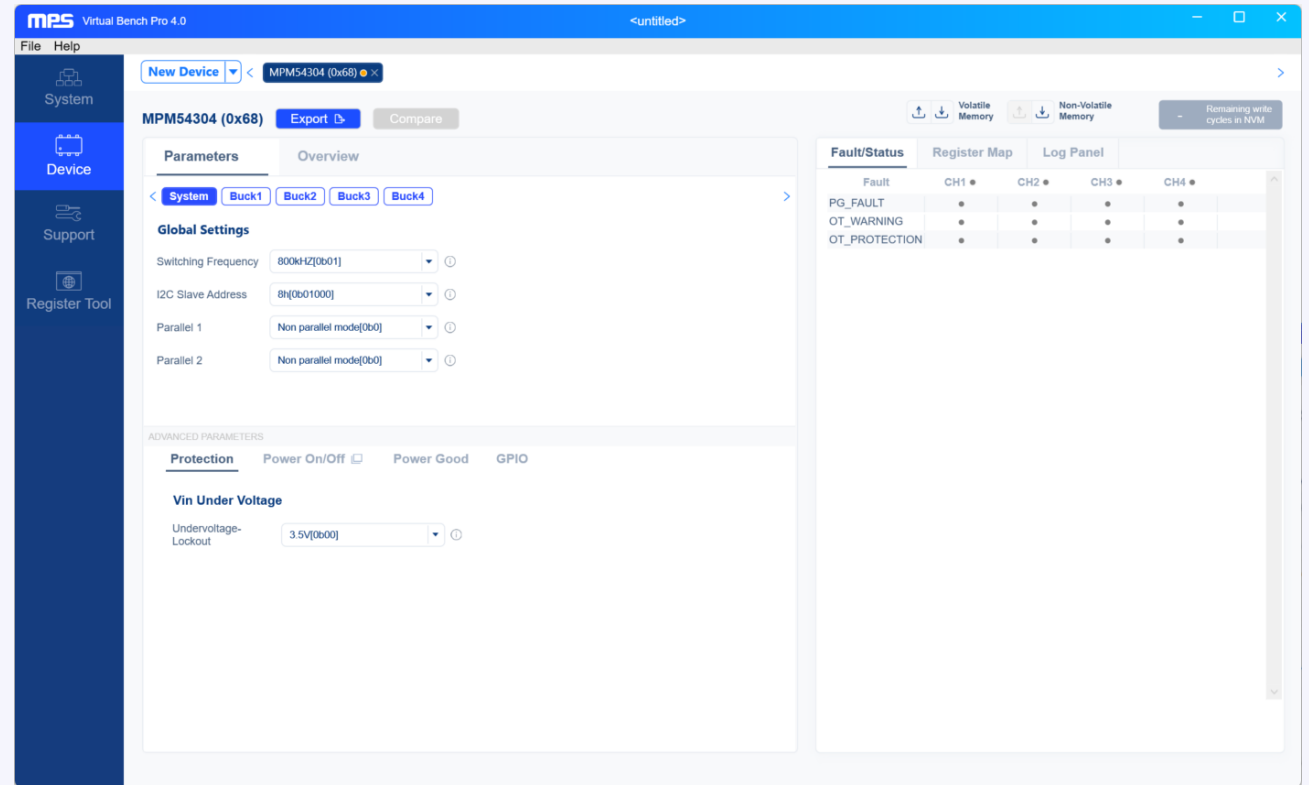
特点:

- Supports I²C and PMBus Standard Protocol
- Tips for Parameter Configuration
- Monitor Real-Time Data (V_{IN}, V_{OUT}, I_{OUT}, Temp)
- Waveforms of the Main Signals
- Evaluate MPS Devices in Offline Mode

Once the Device Is Configured:

- Export Your Settings
- Purchase Your Custom Preconfigured Parts

Results → **Fast Evaluation and Prototyping**



使用 Virtual Bench Pro 4 轻松配置参数

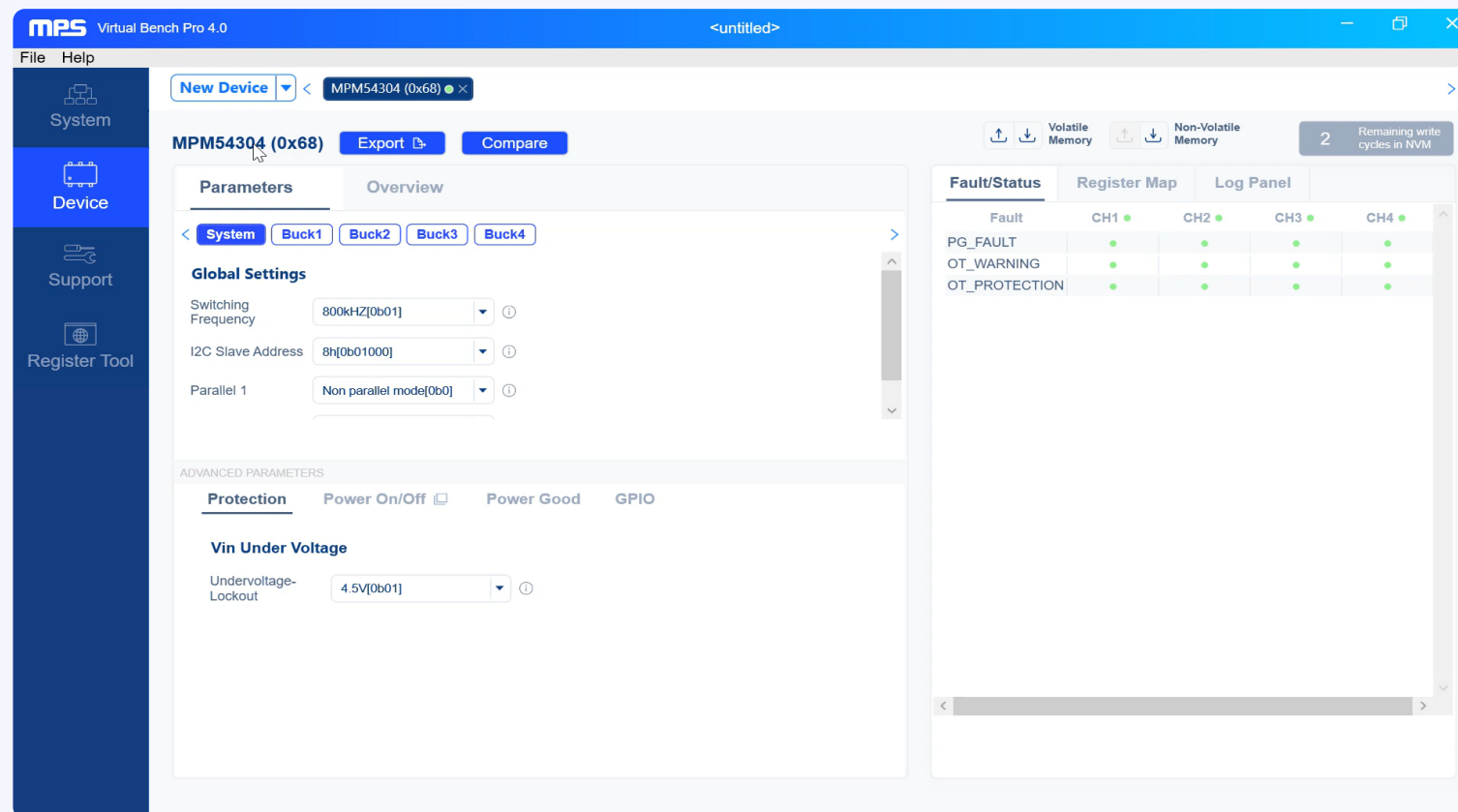
Test Conditions:

$V_{IN} = 12V$, $V_{OUT1} = 0.85V$, $V_{OUT2} = 0.85V$

- V_{OUT1} Soft-Start Time = 1ms
- V_{OUT2} Soft-Start Time = 3ms

Set-Up Algorithm for MPM54304:*

- Launch **MPS Virtual Bench Pro GUI**.
- **Scan** for connected devices.
- **Select** the part number from the list.
- **Select** the required output (buck).
- **Go to** the “Power On/Off” menu.
- In the “ V_{OUT} Soft Start” section **select the desired soft-start delay time** from the list.
- After selecting the desired soft-start time, **write (save) the configuration to the RAM**.
- **Read the RAM** to verify that the new configuration has been saved correctly.
- **Write the non-volatile memory (NVM)** by pressing the corresponding button.



*Note: Depending on the IC, the menu names may be different

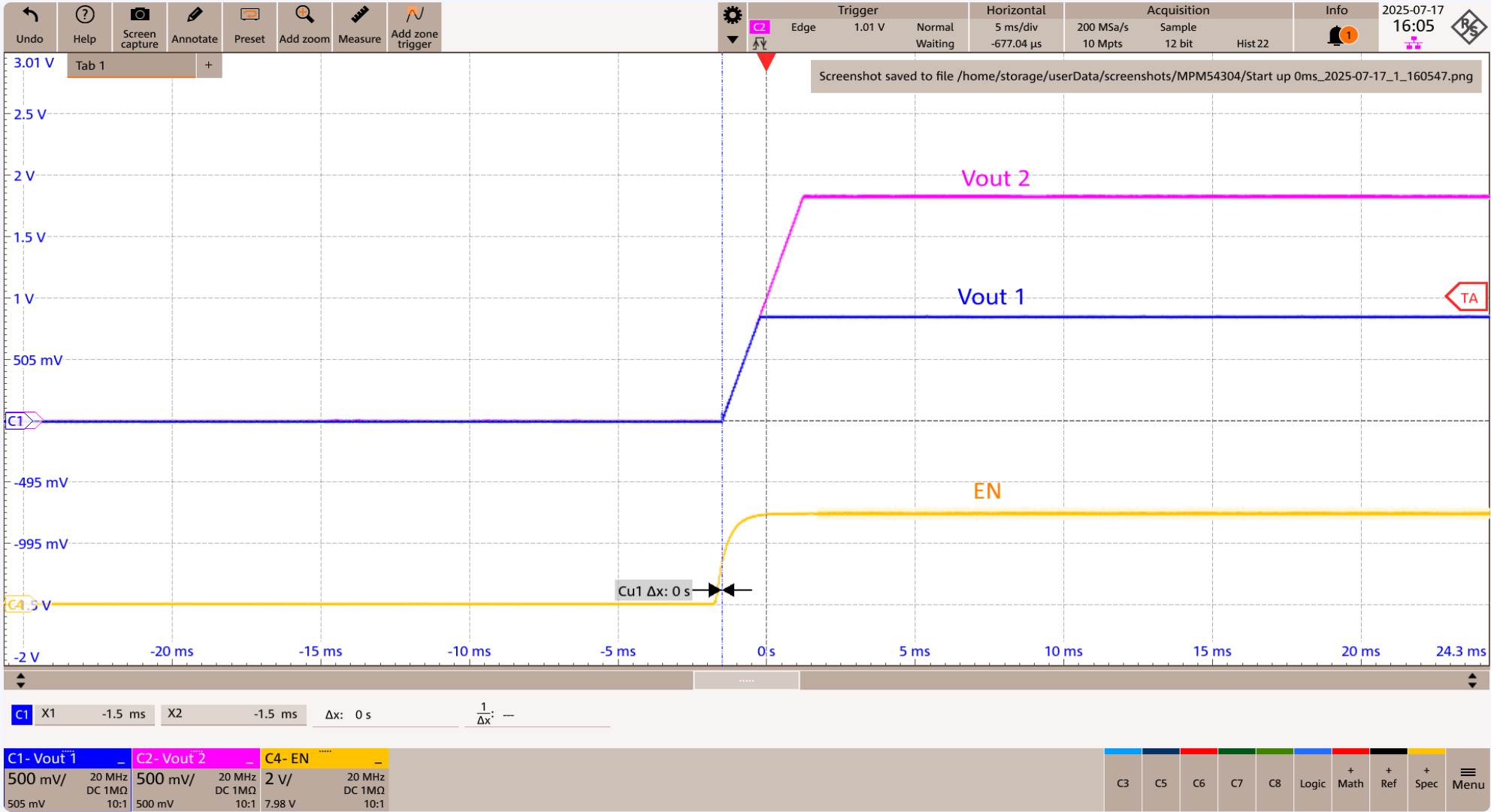
使用 Virtual Bench Pro 4 轻松配置参数



Test Conditions:

$V_{IN} = 12V$
 $V_{OUT1} = 0.85V$
 $V_{OUT2} = 1.8V$
EN

 $t_{SS1} = 0ms$
 $t_{SS2} = 0ms$



使用 Virtual Bench Pro 4 轻松配置参数



Test Conditions:

$V_{IN} = 12V$
 $V_{OUT1} = 0.85V$
 $V_{OUT2} = 1.8V$
EN

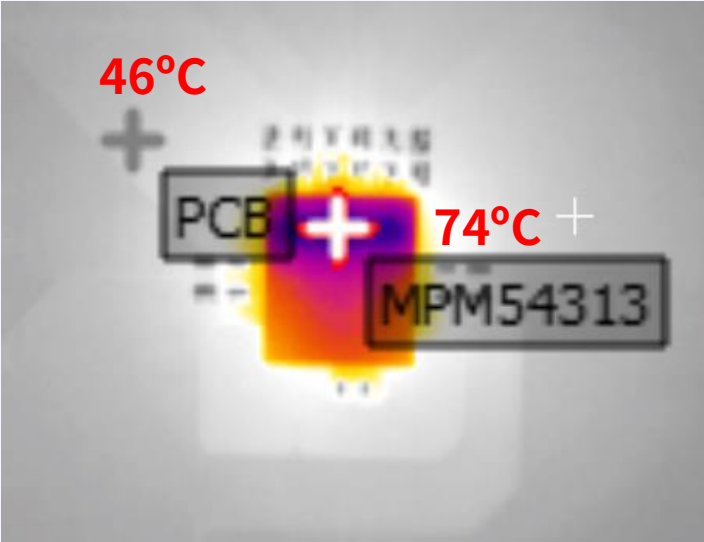
 $t_{SS1} = 1ms$
 $t_{SS2} = 3ms$



Thermals & EMC Testing

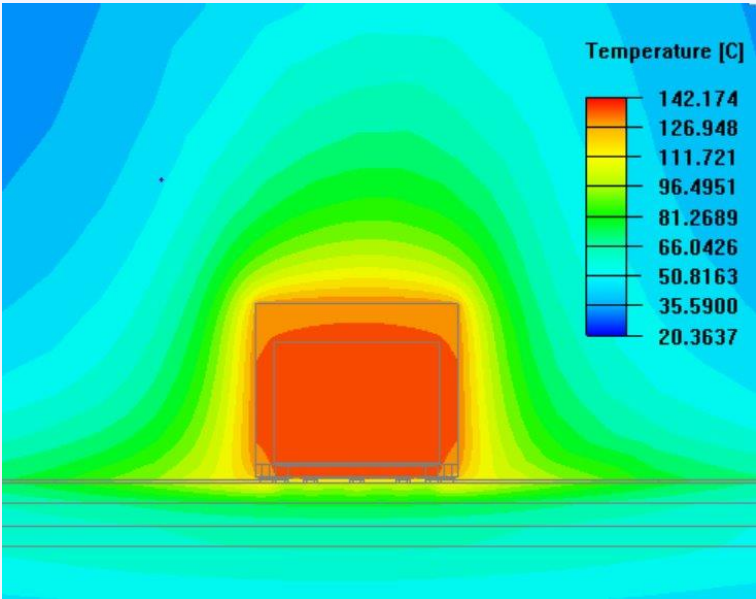
为高效而设计

$3 \times 3.3V_{OUT}, 3 \times 3A, P_{OUT} = 30W$



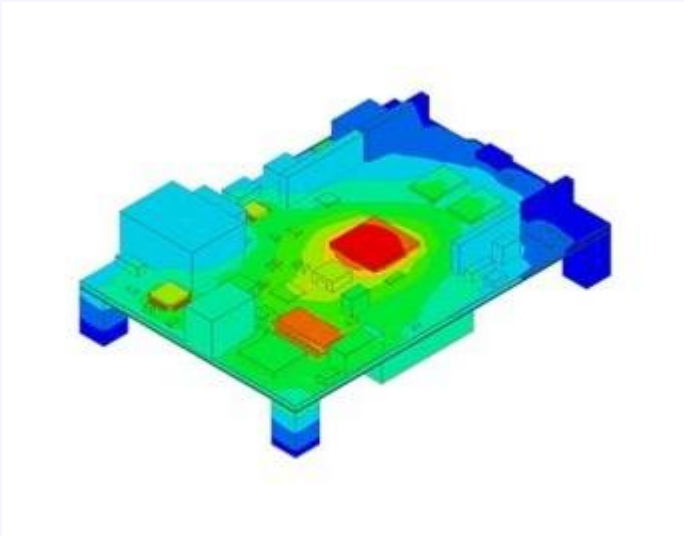
- 高集成
- 高效率
- 定制磁性材料

热特性分析



$R_{\theta ja}$ (°C/W)	ϕ_{jt} (°C/W)	ϕ_{jb} (°C/W)
$R_{\theta jb}$ (°C/W)	$R_{\theta jc_top}$ (°C/W)	$R_{\theta jc_bot}$ (°C/W)

热模拟模型



Icepak 和 Flotherm 模型，
可根据需求提供

设计师的需求:

- 强大的测试能力
 - 效率
 - 热测试
 - EMI/EMC
 - FFT 噪声

Detroit, MI



Internal

External

Customer Applications

Ettenheim, Germany



Internal

External

Customer Applications

Hangzhou, China



Internal

External

Customer Applications



EMC 测试

IEC 61000-6-3 (emission) and **IEC 61000-6-1** (immunity)
– for residential/commercial environments

IEC 61000-6-4 (emission) and **IEC 61000-6-2** (immunity)
– for industrial environments

Product EMC Standards

CISPR 11 (emission) Industrial, scientific and medical equipment

CISPR 14-1 (emission) and **CISPR 14-2** (immunity) - for household appliances, electric tools and similar apparatus

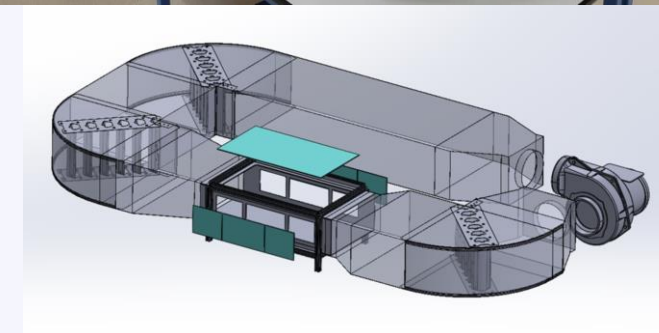
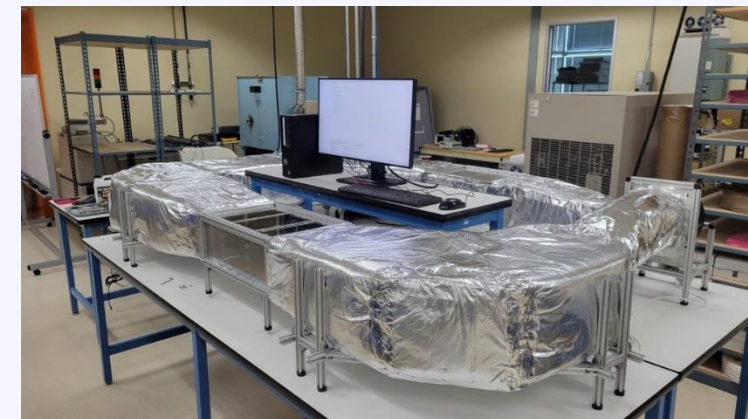
CISPR 25 (emission) Industrial, scientific and medical equipment

CISPR 32 (emission) and **CISPR 35** (immunity) – for Electromagnetic Compatibility of multimedia equipment



质量报告

- 高温寿命测试
- 湿度/回流敏感性分类
- 温度循环
- 静电放电
- 焊点强度和焊接指导
- 高加速温湿度应力测试
- 冲击与振动测试



温度测试

- 工业温度等级
 - -40C to +125C
- 定制热风洞舱
 - 测量模块在不同环境条件下的封装温度：空气速度和环境温度

CISPR25 – 测试舱

根据汽车标准进行的辐射发射和抗干扰测试

SAC3 -测试舱

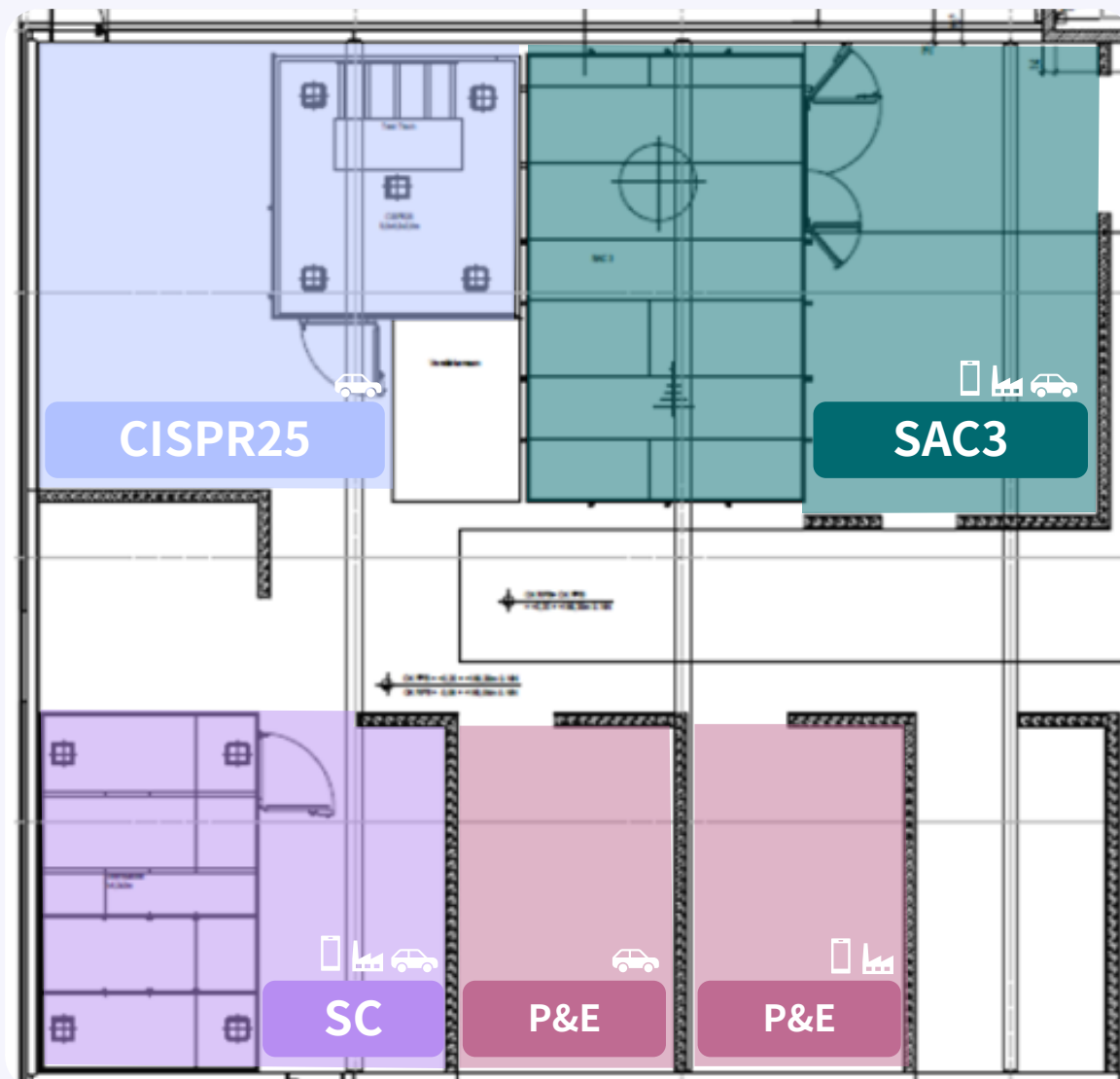
根据汽车、工业和消费品标准进行的辐射发射和抗干扰测试

Shielded-测试舱

根据汽车、工业和消费品标准进行的传导发射和抗扰度测试

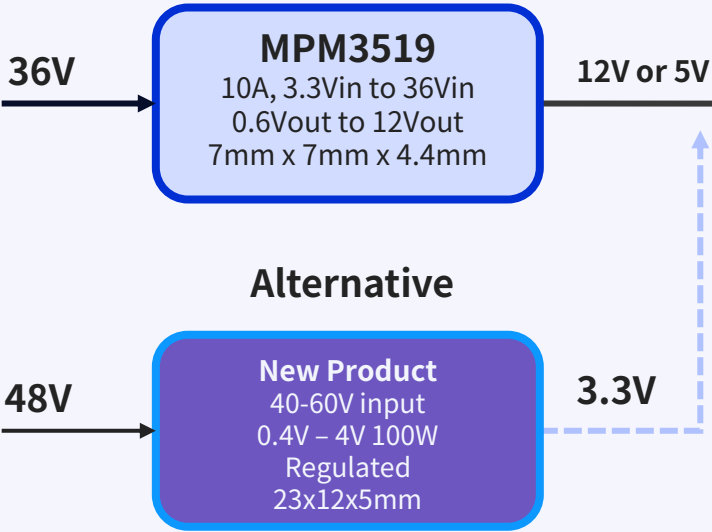
脉冲与电气测试

按照汽车和工业标准进行电气测试

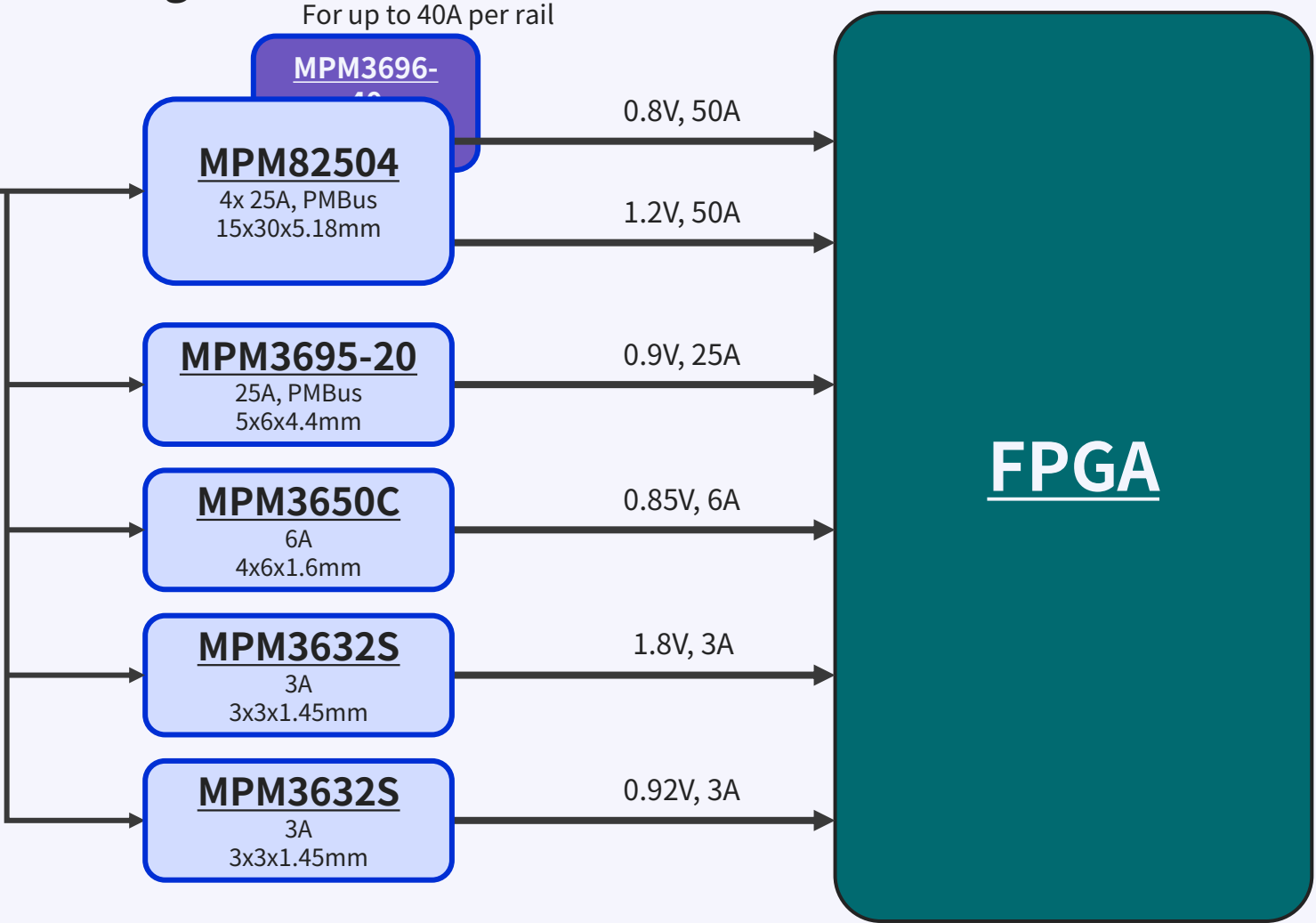


Accurate Voltage Regulation

Stage 1



Stage 2



Xilinx Power Partner

- ✓ High Efficiency
- ✓ Ultra-Fast Transient Response
- ✓ Small Footprint
- ✓ Full Reference Designs

[Browse our Reference designs](#)

设计需求:

- 精确电压调节

Rail Requirement	Core	Transceiver	Auxiliary	
Accuracy	3%	3%	5%	5%
Low Ripple Specification		10 mV peak-peak 10 kHz - 80 MHz		
Transient (typical)	50% load ≤1 A/μs	50% load ≤1 A/μs	50% load ≤1 A/μs	50% load ≤1 A/μs
Sequencing order	First	Simultaneous with VCCINT	Second	Third
FPGAs Rail Power Requirements:				

FPGA Rails	Voltage (V)	Tolerance
V _{CCINT}	0.72 / 0.85 / 0.9	+/- 3%
V _{CCBRAM} , V _{CCINT_IO}	0.85	+/- 3%
V _{CCAUX} , V _{CCAUX_IO} , V _{CCADC}	1.2	+/- 3%
V _{CCO_1V8}	1.8	+/- 5%
V _{CCO_3V3}	3.3	+/- 5%

MPM3696-40 输出纹波

Test conditions:

$$V_{IN} = 12V;$$

$$V_{OUT} = 0.85V;$$

$$I_{load} = 40A$$

$$BW = 1GHz / 20MHz$$

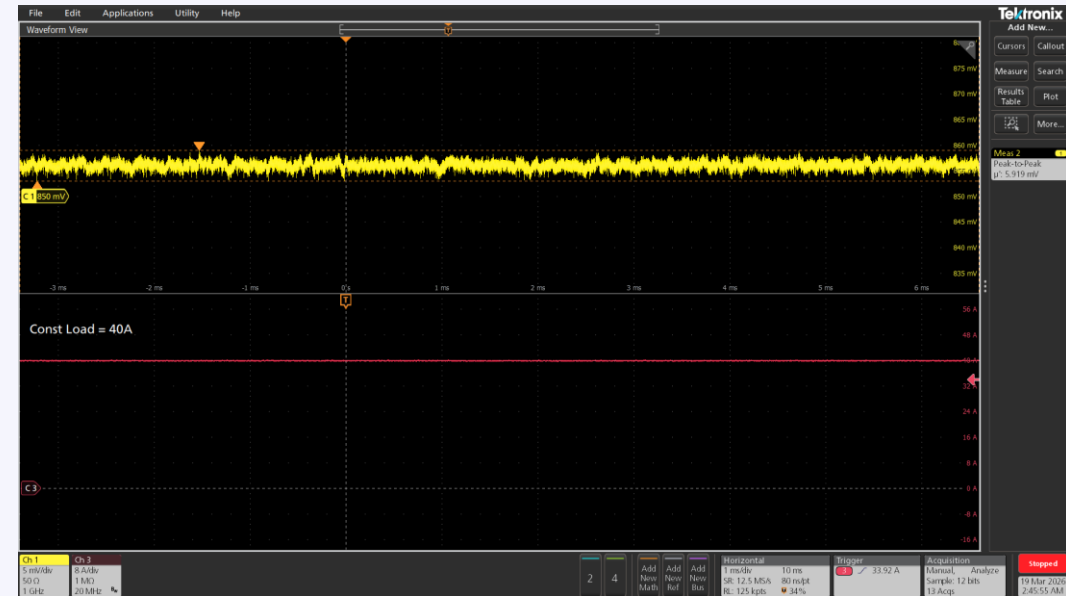
Output Capacitors & VOUT

- $C_{OUT} = 12 \times 47\mu F + 2 \times 330\mu F (POSCAP)$
- $V_{OUT_1} = 0.85V$
- $V_{PP} = \text{within } +/-3\%$

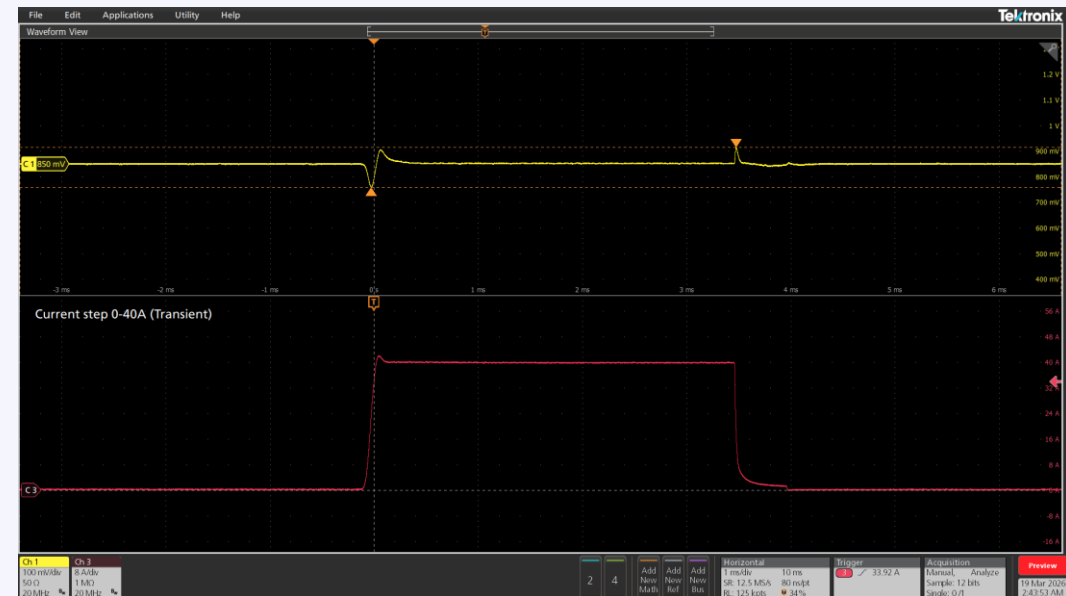
Key Advantages:

- Reduced Output Capacitance
- Fast Transient response
- Stable Output voltage

Steady State



Load Transient



Summary



“电源”背后的秘密

无人机供电面临的挑战：

1. 空间限制
2. 效率
3. 设计简洁性
4. 热性能与电磁兼容性能
5. FPGA 功耗的需求





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MPSNow: <https://www.monolithicpower.com/mpsnow>

Q&A

Resource links

- MPS Webinars: <https://www.monolithicpower.com/en/support/webinars.html>
- MPS Power Modules: <https://www.monolithicpower.com/en/products/power-modules.html>