4.2V－60V、0.6A 超小型同步降压转换器

特性

- 高达 66V 的输入瞬态保护
- 结温范围为 –40°C 至 +150°C
- 保护功能：热关断、输入欠压锁定、逐周期电流限制和断续短路保护
- 在 0.6A 负载下具有 0.2V 压降（典型值）
- 适合可扩展的工业电源
  - 与以下器件引脚兼容：
    - SR36015（60V、1.5A）
    - SR33620/SR33630（36V、2A 或 3A）
  - 1MHz、2.1MHz 频率选项
- 在整个负载范围内具有低功率耗散
  - 1MHz（24V_{IN}、5V_{OUT}、0.6A）时的效率为 87%
  - 1MHz（12V_{IN}、5V_{OUT}、0.6A）时的效率为 92%
  - 在 PFM 模式中提高了轻负载效率
  - 低至 26μA 的工作静态电流
- 小型 2mm × 3mm HotRod™ 封装
- 解决方案只需很少的外部组件
- SR36006 具有 450kHz 和2.1MHz 频率、可调节输出和固定的 3.3V_{OUT}

应用领域

- 现场发送器和传感器、PLC 模块
- 恒温器、视频监控、HVAC 系统
- 交流和伺服驱动器、旋转编码器
- 工业运输、资产跟踪

概述

SR36006 稳压器是一款易于使用的同步降压直流/直流转换器。该器件具有集成高侧和低侧功率 MOSFET，可在 4.2V 至 60V 的宽输入电压范围内提供高达 0.6A 的输出电流。容差高达 66V。这种瞬态电压耐受能力降低了防止过压所需的设计工作量，并满足 IEC 61000-4-5 的浪涌抗扰度要求。

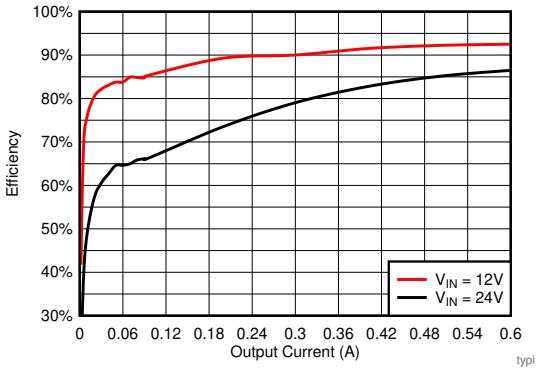
SR36006 采用峰值电流模式控制机制来提供最佳的 效率和输出电压精度。精密使能支持直接连接到宽输入电压或对器件启动和关断进行精确控制，因此提供了灵活性。附带内置滤波和延迟功能的电源正常状态标志可提供系统状态的真实指示，免去了使用外部监控器的麻烦。

SR36006 采用 HotRod™ 封装，实现了低噪声、更高的效率和最小的封装裸片比率。 此器件需要极少外部组件，其引脚设计可实现简单的 PCB 布局。

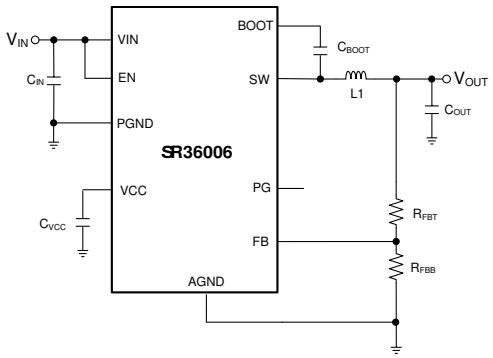
SR36006 的小解决方案尺寸和功能集旨在简化各种 终端设备的实施，这些终端设备包括超小型现场发送器和视觉传感器等具有严苛空间要求的 应用 。

器件信息

器件型号	封装	封装尺寸（标称值）
SR36006RNXR	VQFN-HR -12P	2.00mm x 3.00mm

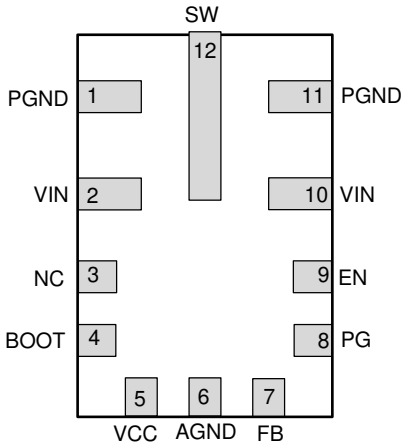


典型应用电路



Pin Configuration and Functions /引脚定义与功能描述

VQFN-HR-12P
Top View



Pin Functions

NO.	NAME	TYPE	DESCRIPTION
1, 11	PGND	G	Power ground terminal. Connect to system ground and AGND. Connect to C_{IN} with short wide traces.
2, 10	VIN	P	Input supply to regulator. Connect to C_{IN} with short wide traces.
3	NC	—	Connect the SW pin to NC on the PCB. This simplifies the connection from the C_{BOOT} capacitor to the SW pin. This pin has no internal connection to the regulator.
4	BOOT	P	Boot-strap supply voltage for internal high-side driver. Connect a high-quality 100-nF capacitor from this pin to the SW pin. Connect the SW pin to NC on the PCB. This simplifies the connection from the C_{BOOT} capacitor to the SW pin.
5	VCC	P	Internal 5-V LDO output. Used as supply to internal control circuits. Do not connect to external loads. Can be used as logic supply for power-good flag. Connect a high-quality 1-µF capacitor from this pin to GND.
6	AGND	G	Analog ground for regulator and system. Ground reference for internal references and logic. All electrical parameters are measured with respect to this pin. Connect to system ground on PCB.
7	FB	A	Feedback input to regulator. Connect to tap point of feedback voltage divider. DO NOT FLOAT. DO NOT GROUND.
8	PG	A	Open drain power-good flag output. Connect to suitable voltage supply through a current limiting resistor. High = power OK, low = power bad. Goes low when EN = Low. Can be open or grounded when not used.
9	EN	A	Enable input to regulator. High = ON, low = OFF. Can be connected directly to VIN; DO NOT FLOAT.
12	SW	P	Regulator switch node. Connect to power inductor. Connect the SW pin to NC on the PCB. This simplifies the connection from the C_{BOOT} capacitor to the SW pin.
A = Analog, P = Power, G = Ground			

Specifications/技术参数

Absolute Maximum Ratings / 极限参数

Over operating junction temperature range of -40°C to 150°C (unless otherwise noted)

		MIN	MAX	UNIT
Input voltage	VIN to PGND	–0.3	66	V
Input voltage	EN to AGND	–0.3	66.3	V
Input voltage	FB to AGND	–0.3	5.5	V
Input voltage	PG to AGND	–0.3	22	V
Input voltage	AGND to PGND	–0.3	0.3	V
Output voltage	SW to PGND	–0.3	66.3	V
Output voltage	SW to PGND less than 10-ns transients	–3.5	66.3	V
Output voltage	CBOOT to SW	–0.3	5.5	V
Output voltage	VCC to AGND	–0.3	5.5	V
Junction Temperature T_J		-40	150	°C
Storage temperature, T_{stg}		–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

ESD Ratings / 静电放电参数

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM)	±2500	V
$V_{(ESD)}$	Electrostatic discharge	Charged-device model (CDM)	±750	V

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions / 推荐操作条件

Over the recommended operating junction temperature range of –40 ℃ to 150 ℃ (unless otherwise noted)

		MIN	MAX	UNIT
Input voltage	VIN to PGND	4.2	60	V
	EN to PGND	0	60	V
	PG to PGND	0	18	V
Output current	I_{OUT}	0	0.6	A

(1) Recommended operating conditions indicate conditions for which the device is intended to be functional, but do not ensure specific performance limits. For ensured specifications, see *Electrical Characteristics.*
(2) The voltage on this pin must not exceed the voltage on the VIN pin by more than 0.3 V.

Thermal Information / 热性能信息

THERMAL METRIC		SR36006 RNX (VQFN-HR) 12 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	72.5	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	35.9	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	23.3	°C/W
ψ_{JT}	Junction-to-top characterization parameter	0.8	°C/W
ψ_{JB}	Junction-to-board characterization parameter	23.5	°C/W

Electrical Characteristics / 电气特性

Limits apply over operating junction temperature (T_J) range of –40°C to +150°C, unless otherwise stated. Minimum and Maximum limits are specified through test, design or statistical correlation. Typical values represent the most likely parametric norm at T_J = 25°C, and are provided for reference purposes only. Unless otherwise stated, the following conditions apply: V_{IN} = 24 V.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SUPPLY VOLTAGE (VIN PIN)						
$I_{Q\text{-}nonSW}$	Operating quiescent current (non-switching)	V_{EN} = 3.3 V (PFM variant only)	18	26	36	µA
I_{SD}	Shutdown quiescent current; measured at VIN pin	V_{EN} = 0 V		5		µA
ENABLE (EN PIN)						
$V_{EN\text{-}VCC\text{-}H}$	Enable input high level for V_{CC} output	V_{ENABLE} rising			1.14	V
$V_{EN\text{-}VCC\text{-}L}$	Enable input low level for V_{CC} output	V_{ENABLE} falling	0.3			V
$V_{EN\text{-}VOUT\text{-}H}$	Enable input high level for V_{OUT}	V_{ENABLE} rising	1.157	1.231	1.3	V
$V_{EN\text{-}VOUT\text{-}HYS}$	Enable input hysteresis for V_{OUT}	Hysteresis below $V_{ENABLE\text{-}H}$; falling		110		mV
$I_{LKG\text{-}EN}$	Enable input leakage current	V_{EN} = 3.3V		0.2		nA
INTERNAL LDO (VCC PIN)						
V_{CC}	Internal V_{CC} voltage	6 V ≤ V_{IN} ≤ 60 V	4.75	5	5.25	V
$V_{CC\text{-}UVLO\text{-}Rising}$	Internal V_{CC} undervoltage lockout	V_{CC} rising	3.6	3.8	4.0	V
$V_{CC\text{-}UVLO\text{-}Falling}$	Internal V_{CC} undervoltage lockout	V_{CC} falling	3.1	3.3	3.5	V
VOLTAGE REFERENCE (FB PIN)						
V_{FB}	Feedback voltage		0.985	1	1.015	V
$I_{LKG\text{-}FB}$	Feedback leakage current	FB = 1 V		0.2		nA
CURRENT LIMITS AND HICCUP						
I_{SC}	High-side current limit		0.8	1	1.2	A
$I_{LS\text{-}LIMIT}$	Low-side current limit		0.6	0.8	0.95	A
$I_{L\text{-}ZC}$	Zero cross detector threshold	PFM variants only		0.02		A
$I_{PEAK\text{-}MIN}$	Minimum inductor peak current			0.18		A

(1) MIN and MAX limits are 100% production tested at 25℃. Limits over the operating temperature range verified through correlation using Statistical Quality Control (SQC) methods. Limits are used to calculate Average Outgoing Quality Level (AOQL).
(2) This is the current used by the device open loop. It does not represent the total input current of the system when in regulation.
(3) The current limit values in this table are tested, open loop, in production. They may differ from those found in a closed loop application.

Electrical Characteristics (continued) / 电气特性(继续)

Limits apply over operating junction temperature (T_J) range of –40°C to +150°C, unless otherwise stated. Minimum and Maximum limits are specified through test, design or statistical correlation. Typical values represent the most likely parametric norm at T_J = 25°C, and are provided for reference purposes only. Unless otherwise stated, the following conditions apply: V_{IN} = 24 V.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER GOOD (PGOOD PIN)						
$V_{PG-HIGH-UP}$	Power-Good upper threshold - rising	% of FB voltage	105%	107%	110%	
$V_{PG-LOW-DN}$	Power-Good lower threshold - falling	% of FB voltage	90%	93%	95%	
V_{PG-HYS}	Power-Good hysteresis (rising & falling)	% of FB voltage		2%		
T_{PG}	Power-Good rising/falling edge deglitch delay		80	140	200	µs
$V_{PG-VALID}$	Minimum input voltage for proper Power-Good function				2	V
R_{PG}	Power-Good on-resistance	V_{EN} = 2.5 V		80	165	Ω
R_{PG}	Power-Good on-resistance	V_{EN} = 0 V		35	90	Ω
OSCILLATOR						
F_{OSC}	Internal oscillator frequency	2.1-MHz variant	1.95	2.1	2.35	MHz
F_{OSC}	Internal oscillator frequency	1-MHz variant	0.85	1	1.15	MHz
MOSFETS						
$R_{DS-ON-HS}$	High-side MOSFET ON-resistance	I_{OUT} = 0.5 A		225	435	mΩ
$R_{DS-ON-LS}$	Low-side MOSFET ON-resistance	I_{OUT} = 0.5 A		150	280	mΩ

Timing Requirements / 时间需求

Limits apply over operating junction temperature (T_J) range of –40°C to +150°C, unless otherwise stated. Minimum and Maximum limits are specified through test, design or statistical correlation. Typical values represent the most likely parametric norm at T_J = 25°C, and are provided for reference purposes only. Unless otherwise stated, the following conditions apply: V_{IN} = 24 V.

		MIN	NOM	MAX	UNIT
t_{ON-MIN}	Minimum switch on-time		55	83	ns
$t_{OFF-MIN}$	Minimum switch off-time		53	73	ns
t_{ON-MAX}	Maximum switch on-time		7	12	µs
t_{SS}	Internal soft-start time	3	4.5	6	ms

(1) MIN and MAX limits are 100% production tested at 25℃. Limits over the operating temperature range verified through correlation using Statistical Quality Control (SQC) methods. Limits are used to calculate Average Outgoing Quality Level (AOQL).

System Characteristics / 系统特性

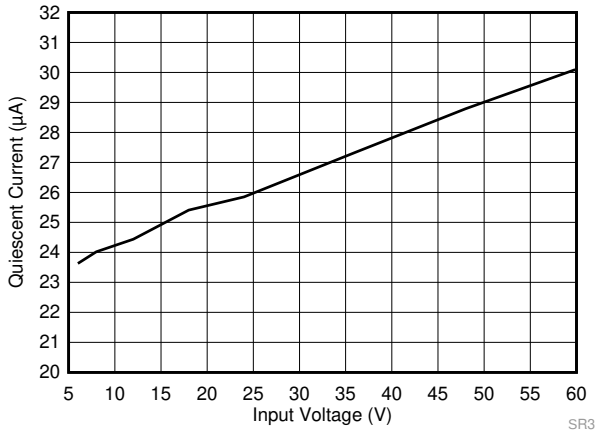
The following specifications apply to a typical application circuit with nominal component values. Specifications in the typical (TYP) column apply to T_J = 25℃ only. Specifications in the minimum (MIN) and maximum (MAX) columns apply to the case of typical components over the temperature range of T_J = –40℃ to 150℃. *These specifications are not ensured by production testing.*

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IN}	Operating input voltage range		4.2		60	V
V_{OUT}	Adjustable output voltage regulation	PFM operation	–1.5%		2.5%	
I_{SUPPLY}	Input supply current when in regulation	V_{IN} = 24 V, V_{OUT} = 3.3 V, I_{OUT} = 0 A, R_{FBT} = 1 MΩ, PFM variant		26		μA
D_{MAX}	Maximum switch duty cycle			98%		
V_{HC}	FB pin voltage required to trip short-circuit hiccup mode			0.4		V
t_{HC}	Time between current-limit hiccup burst			94		ms
t_D	Switch voltage dead time			2		ns
T_{SD}	Thermal shutdown temperature	Shutdown temperature		170		°C
T_{SD}	Thermal shutdown temperature	Recovery temperature		158		°C

(1) Deviation in V_{OUT} from nominal output voltage value at V_{IN} = 24 V, I_{OUT} = 0 A to 0.6A
(2) In dropout the switching frequency drops to increase the effective duty cycle. The lowest frequency is clamped at approximately: $F_{MIN} = 1 / (t_{ON\text{-}MAX} + t_{OFF\text{-}MIN})$. $D_{MAX} = t_{ON\text{-}MAX} /(t_{ON\text{-}MAX} + t_{OFF\text{-}MIN})$.

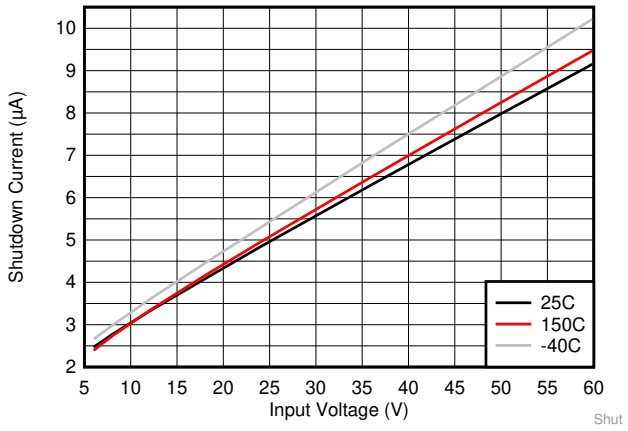
Typical Characteristics / 典型特性

Unless otherwise specified the following conditions apply: T_A = 25°C. V_{IN} = 24 V.



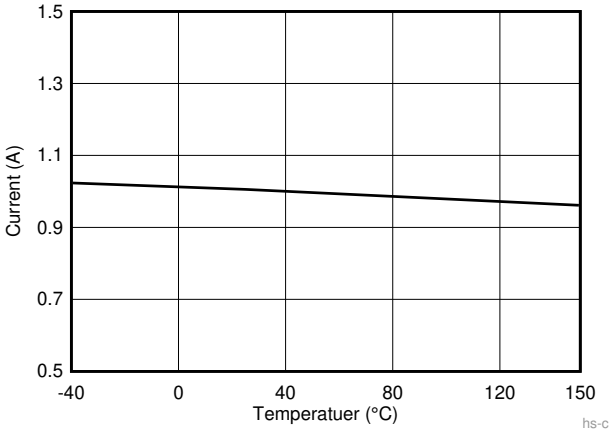
V_{FB} = 1 V

1. Non-Switching Input Supply Current



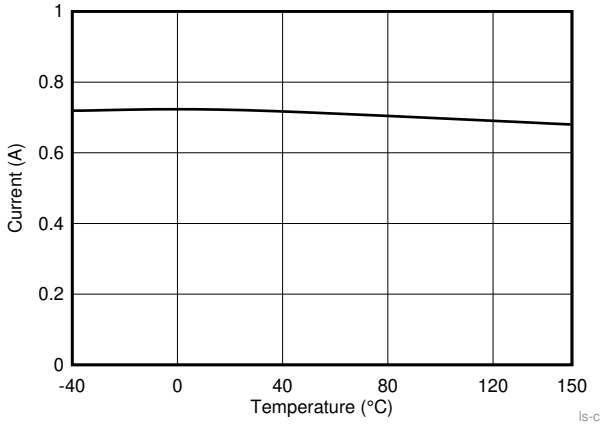
EN = 0 V

2. Shutdown Supply Current



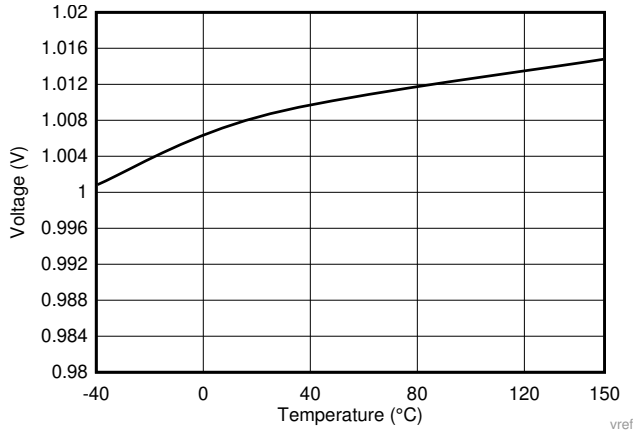
V_{IN} = 24 V

3. High Side Current Limit

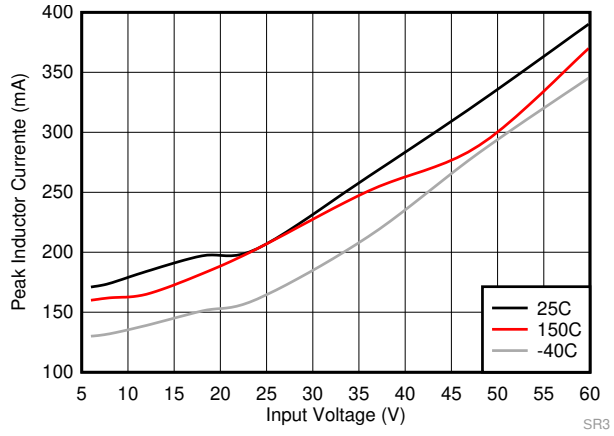


V_{IN} = 24 V

4. Low Side Current Limit



5. Reference Voltage Drift



I_{OUT} = 0 A V_{OUT} = 3.3 V f_{SW} = 1000 kHz

6. $I_{PEAK-MIN}$