Features

- Wide Supply Voltage: 4.5-V to 36-V
- Internal Power FET：180mΩ and 100mΩ
- 0.6V Reference Voltage with 1% Accuracy
- High-Efficiency Synchronous-Mode Operation
- Fixed 500-kHz / 2.2-MHz Switching Frequency
- Low 2-μA Shutdown, 70-μA Quiescent Current
- Internal Light Load Power-Save Mode for High Efficiency at Light Load / Force PWM Mode
- Internal 2-ms Soft-Start
- Internal Loop Compensation
- Over-Current Protection with Hiccup Mode
- Output Over Voltage Protection
- Thermal Shutdown
- Small outline package TSOT23-6
- –40°C to 125°C Operation Ambient Temperature Range

Description

The TPP36208 is a simple, easy to use, 2-A output, synchronous, step-down, switch-mode converter with internal power MOSFETs.

The TPP36208 integrated low-$R_{DS(ON)}$ power transistors in TSOT23-6 package with internal soft-start, compensation and protection features. TPP36208 offers a very compact solution to achieve a 2-A continuous output current over a wide input supply range, with excellent load and line regulation.

TPP36208 has different versions of switching frequency at 500-kHz and 2-MHz, also supports light load PSM to save quiescent current and Force PWM mode to maintain fixed switching frequency.

The devices are available in 6-pin TSOT23-6 package with support of wide operation ambient temperature range from –40 °C to 125 °C.

Applications

- 12-V, 24-V Distributed Power Supply
- Industrial Applications
- General Purpose

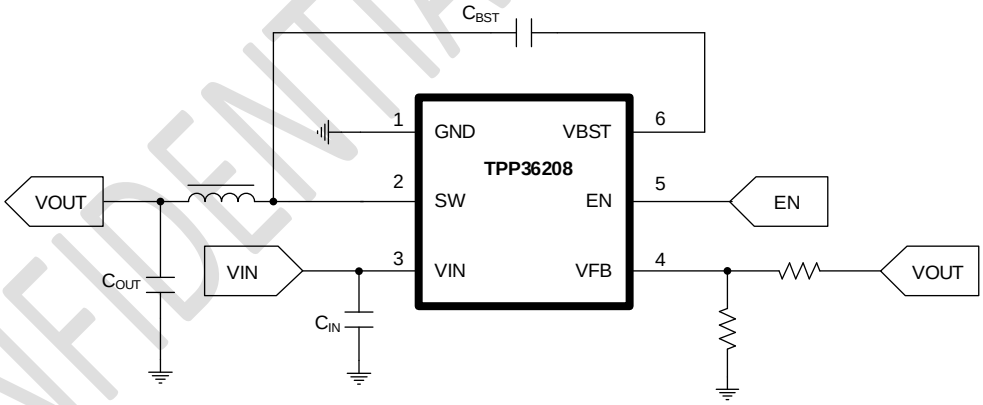

Table of Contents

Revision History

Date	Revision	Notes
2021/10/31	Rev. Pre	Initial Version
2022/2/25	Rev. Pre.1	Misc. updated

Pin Configuration

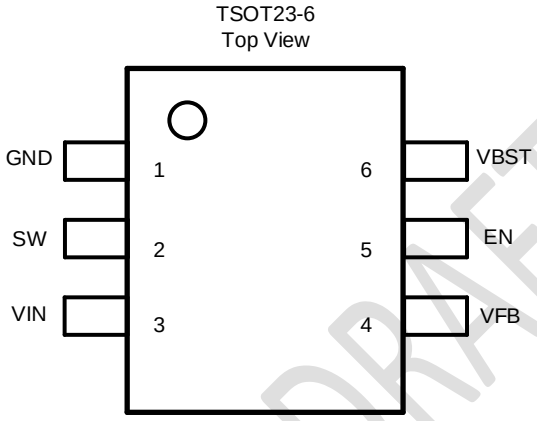

Figure 1 Pin function

PIN		DESCRIPTION
NAME	NO.	
GND	1	Ground pin. Power and controller circuit ground. Use star connection to GND pin with good contact
SW	2	Switching node pin. Voltage switching between high-side FET and low-side FET.
VIN	3	Supply input pin. Connect decoupling 2×10-µF and 1×0.1-µF capacitors between VIN and GND pins.
VFB	4	Voltage feedback pin. Connect to output voltage with feedback resistor divider.
EN	5	Enable input. Active high. Internally weak pull-down resistors.
VBST	6	High-side MOSFET gate supply pin. Connect 0.1-µF between VBST and SW pins.

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity
TPP362080-T6TR	−40 to 125°C	TSOT23-6	320	3	Tape and Reel, 3000
TPP362081-T6TR	−40 to 125°C	TSOT23-6	321	3	Tape and Reel, 3000
TPP362082-T6TR	−40 to 125°C	TSOT23-6	322	3	Tape and Reel, 3000
TPP362083-T6TR	−40 to 125°C	TSOT23-6	323	3	Tape and Reel, 3000

Absolute Maximum Ratings Note 1

Parameters	Rating
Supply Voltage, VIN	− 0.3 V to 36 V
Switching Node Voltage, SW	− 0.3 V to VIN + 0.3 V
Bootstrap Voltage, VBST – SW	− 0.3 V to 6.5 V
Feedback Voltage, FB	− 0.3 V to 6.5 V
Enable Input, EN	− 0.3 V to 36 V
Maximum Junction Temperature	150°C
Operating Temperature Range	–40 to 125°C
Storage Temperature Range	–65 to 150°C
Lead Temperature (Soldering, 10 sec)	260°C

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: The inputs are protected by ESD protection diodes to each power supply. If the input extends more than 300mV beyond the power supply, the input current should be limited to less than 10mA.

Note 3: A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

ESD Rating

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001	2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002	1.5	kV

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
TSOT23-6	100	67	°C/W

Electrical Characteristics

All test condition is V_{IN} = 12 V, T_A = −40°C to 125°C, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Power Supply						
V_{IN}	Supply voltage range		4.5		36	V
I_Q	Operating supply current	Non-switching, EN = 5 V, V_{FB} = 1 V		70		μA
I_{QSD}	Shut down supply current	EN = GND		2		μA
V_{UVLO_rising}	UVLO rising threshold		3.9	4.2	4.4	V
$V_{UVLO\_falling}$	UVLO falling threshold		3.7	3.9	4.1	V
Enable						
V_{ENH}	EN input rising threshold			1.28	1.35	V
V_{ENL}	EN input falling threshold		1	1.17		V
Feedback and Power Stage						
V_{FB}	V_{FB} feedback voltage	T_A = 25°C	588	600	612	mV
$R_{ds(on)\_HSD}$	High-side FET on-resistance	I_{SW} = 1 A		180		mΩ
$R_{ds(on)\_LSD}$	Low-side FET on-resistance	I_{SW} = 1 A		90		mΩ
f_{SW}	Switching frequency	TPP362080/2	390	500	590	kHz
		TPP362081/3		2.2		MHz
t_{ss}	Soft-start time			2		ms
I_{skip}	Pulse-skip mode peak inductor current threshold	VIN = 12 V, VOUT = 5 V, L = 15 μH		300		mA
Current Limit						
I_{Limit_HS}	Highside current limit	Inductor peak current	2.5	3.2	3.9	A
I_{Limit_LS}	Lowside current limit	Inductor valley current		2.5		A
$I_{Limit\_LS\_neg}$	Negative lowside current limit			0.9		A
Diagnostics and Protection						
$V_{FB\_UVP\_rising}$	FB under voltage protection rising ratio			33		%
$V_{FB\_UVP\_falling}$	FB under voltage protection falling ratio			40		%
$V_{FB\_OVP\_rising}$	FB over voltage protection rising ratio			108		%
$V_{FB\_OVP\_falling}$	FB over voltage protection falling ratio			107		%
t_{HIC_wait}	Hiccup protection wait time			128		Cycles
$t_{HIC\_restart}$	Hiccup protection restart time			30		ms
Thermal Shutdown						
T_{SD}	Thermal shut down temperature			170		°C
T_{SD_hys}	Thermal hysteresis			10		°C

Typical Performance Characteristics

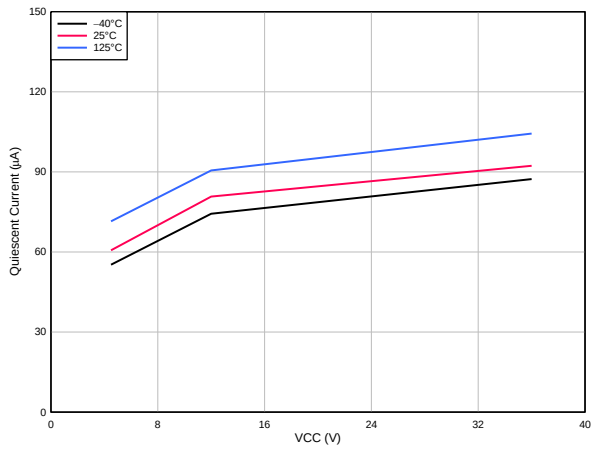

Figure 2. Quiescent Current vs. Supply Voltage

T_A = 25 °C

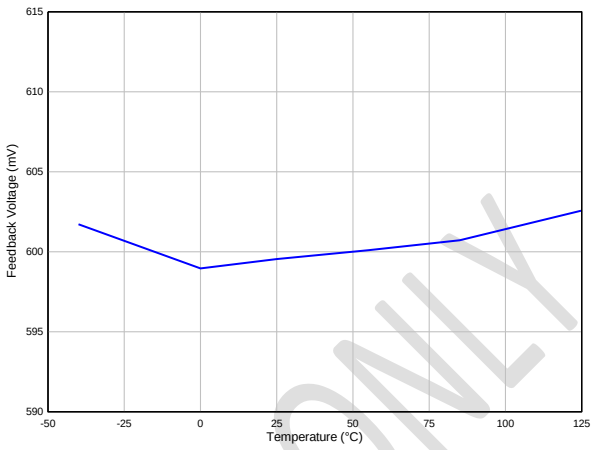

Figure 3. Feedback Voltage vs. Temperature

VIN = 12 V

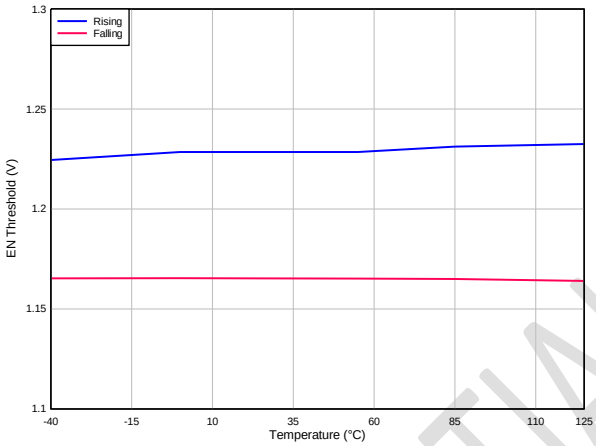

Figure 4. EN Threshold vs. Junction Temperature

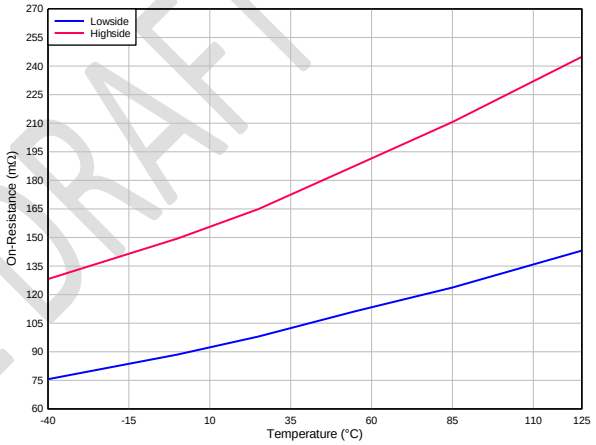

Figure 5. On-Resistance vs Temperature

V_{IN} = 12 V, I_{OUT} = 0.5 A

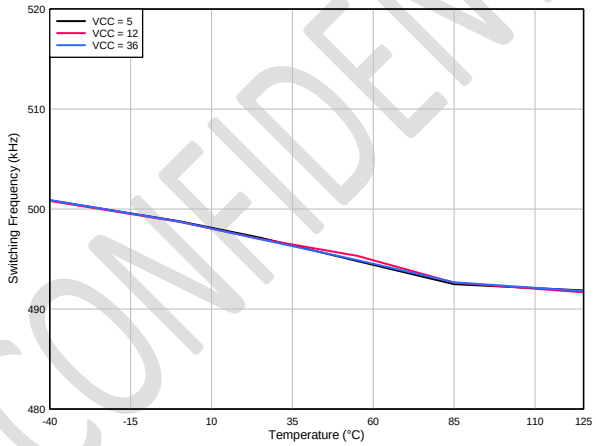

Figure 6. Switching Frequency vs. Temperature

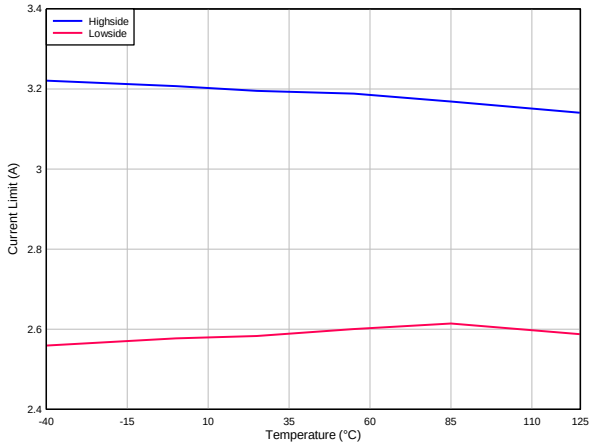

Figure 7. Current Limit vs. Temperature

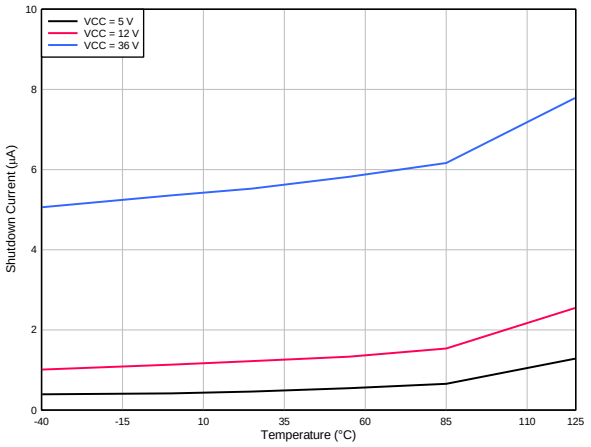

Figure 8. Shutdown Current vs Junction Temperature

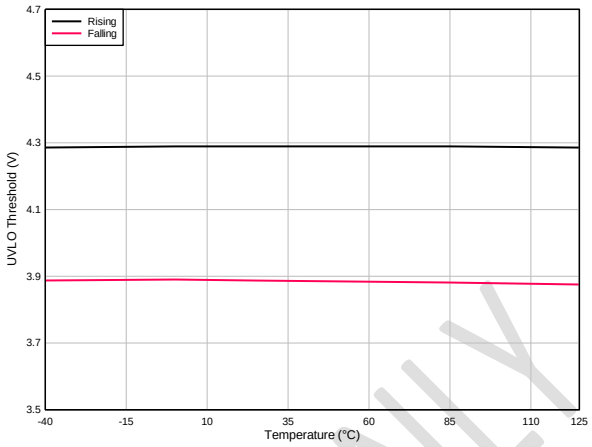

Figure 9. UVLO Threshold vs Temperature

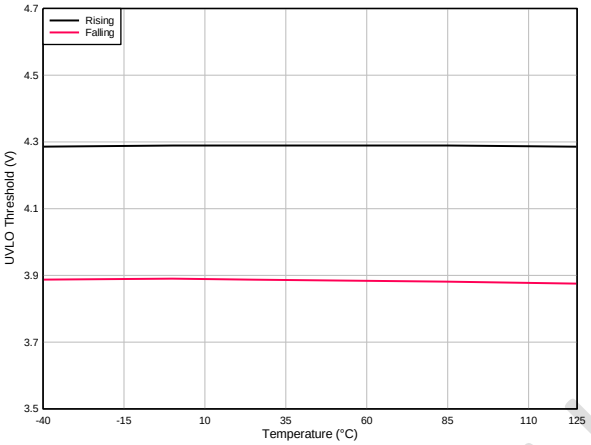

Figure 10. Efficiency vs. Output Current, V_{OUT} = 1.05 V, L = 2.2 µH

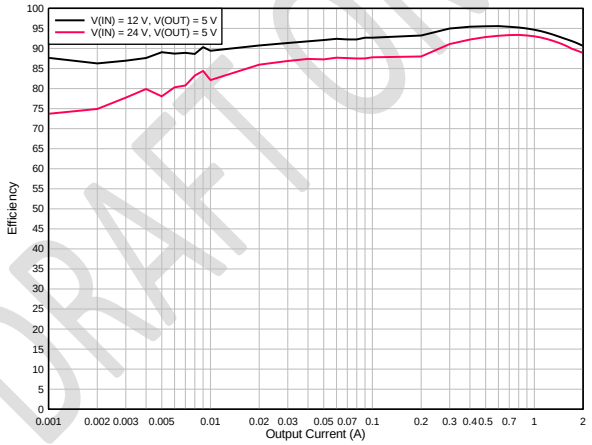

Figure 11. Efficiency vs. Output Current, V_{OUT} = 5 V, L = 2.2 µH

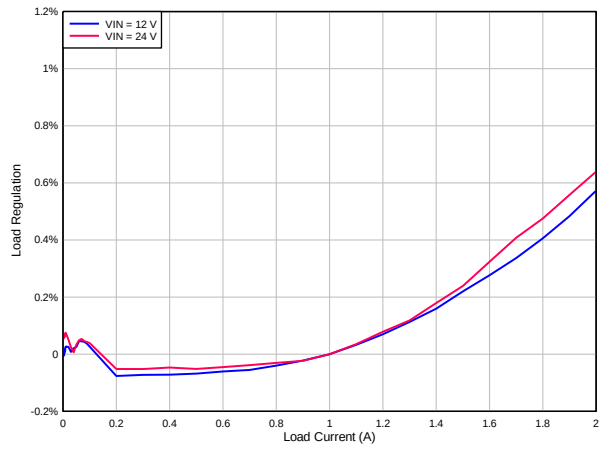

Figure 12. Load Regulation

V_{OUT} = 5 V

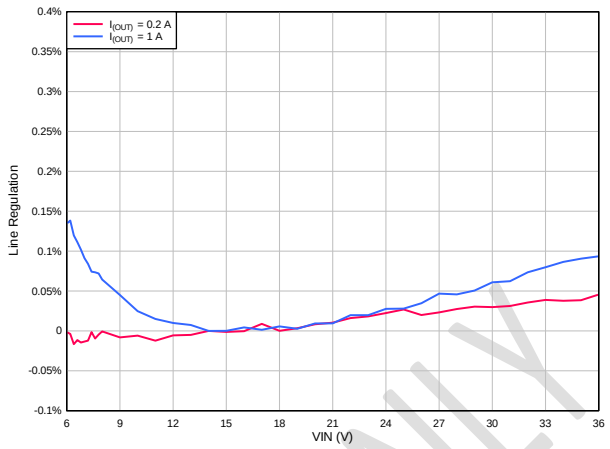

Figure 13. Line Regulation

V_{OUT} = 5 V

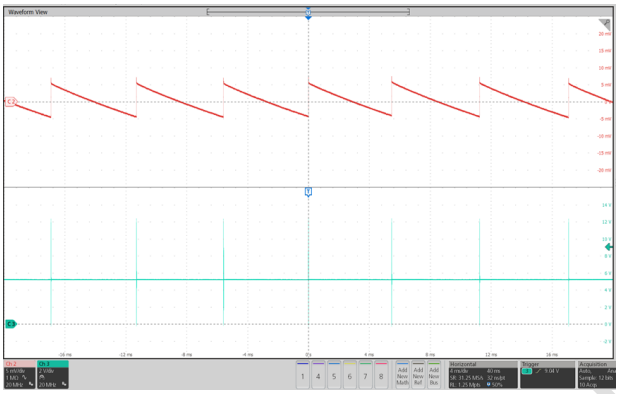

Figure 14. Pulse Skip Mode Output Voltage Ripple
CH2: SW CH3: V_{OUT} Ripple

V_{IN} = 12 V V_{OUT} = 5 V I_L = 0 A

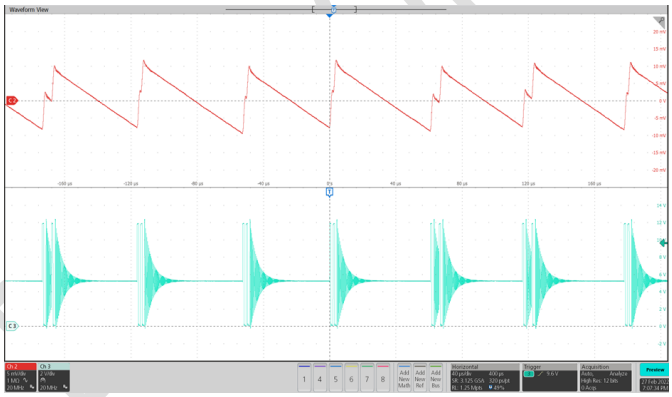

Figure 15. Pulse Skip Mode Output Voltage Ripple
CH2: V_{OUT} Ripple CH3: SW

V_{IN} = 12 V V_{OUT} = 5 V I_L = 10 mA

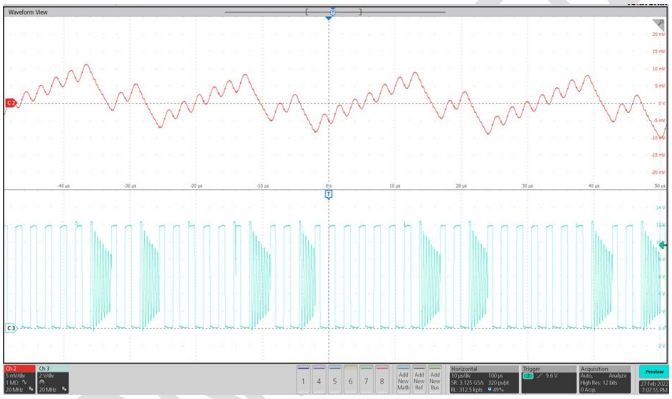

Figure 16. Pulse Skip Mode Output Voltage Ripple
CH2: V_{OUT} CH3: SW

V_{IN} = 12 V V_{OUT} = 5 V I_L = 0.1 A

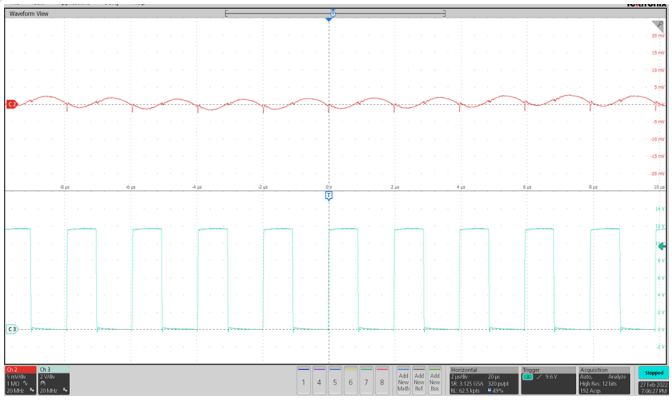

Figure 17. Output Voltage Ripple
CH2: V_{OUT} CH3: SW

V_{IN} = 12 V V_{OUT} = 5 V I_L = 1 A

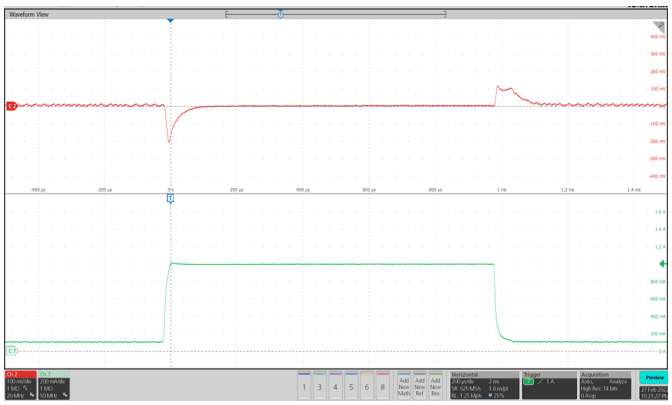

Figure 18. Load Transient
CH2: V_{OUT} CH4: Load Current
V_{IN} = 12 V V_{OUT} = 5 V I_L = 0.1 A to 1 A

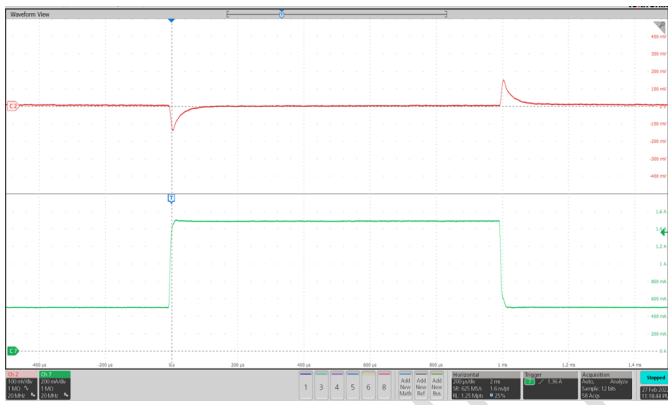

Figure 19. Load Transient
CH2: V_{OUT} CH4: Load Current
V_{IN} = 12 V V_{OUT} = 5 V I_L = 0.5 A to 1.5 A

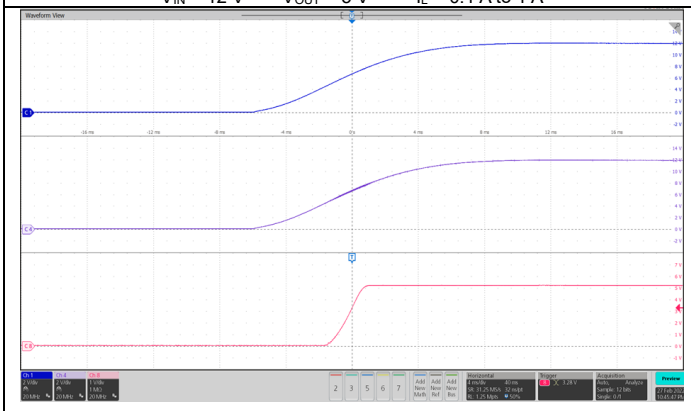

Figure 20. Start up by VIN
CH1: V_{IN} CH4: EN CH8: V_{OUT}

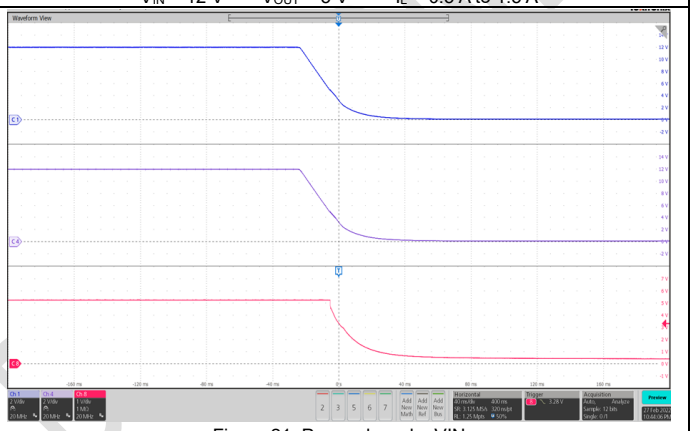

Figure 21. Power down by VIN
CH1: V_{IN} CH4: EN CH8: V_{OUT}

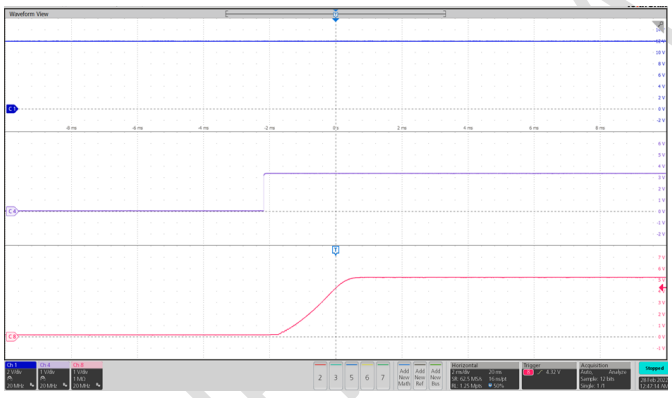

Figure 22. Start up by EN
CH1: V_{IN} CH4: EN CH8: V_{OUT}

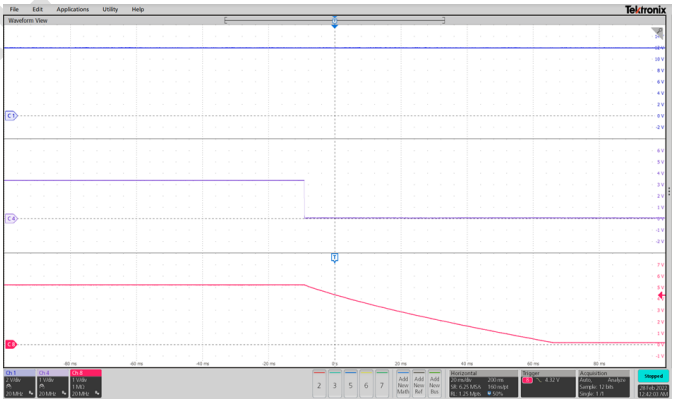

Figure 23. Power-Down by EN
CH1: V_{IN} CH4: EN CH8: V_{OUT}

Detailed Description

Overview

The TPP36208x are 2-A synchronous step-down converters. The Current Mode control topology provides fast transient response and supports low ESR output capacitors, such as specialty polymer capacitors and multi-layer ceramic capacitors, without extra compensation circuitry.

Device	Frequency	Low Output Current Mode
TPP362080-T6TR	500 kHz	Pulse-Skip Mode
TPP362081-T6TR	2.2 MHz	Pulse-Skip Mode
TPP362082-T6TR	500 kHz	Force-PWM Mode
TPP362083-T6TR	2.2 MHz	Force-PWM Mode

Functional Block Diagram

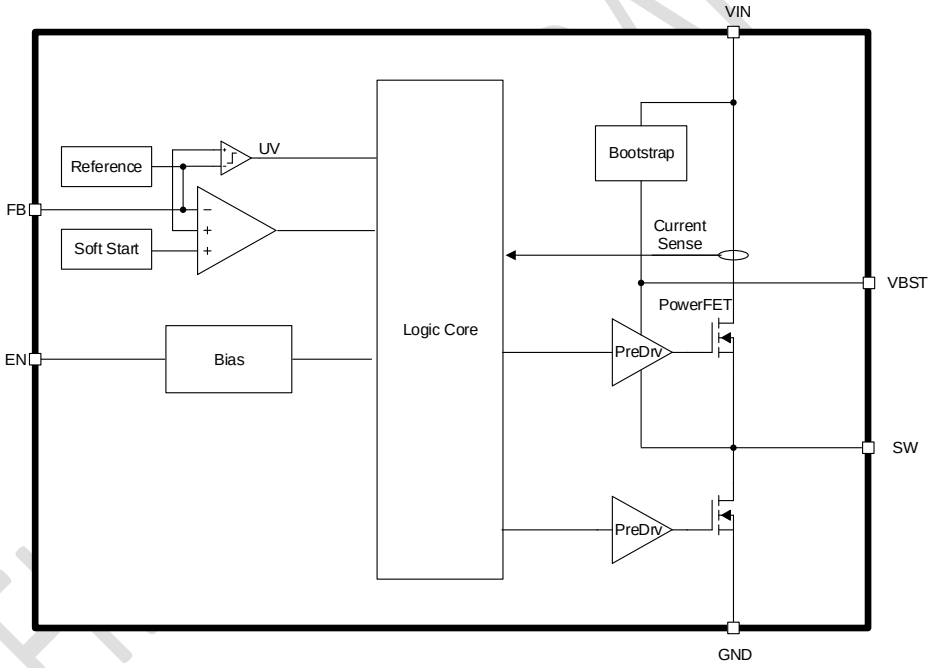

Figure 24 Functional Block Diagram

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Feature Description

Current Mode Control

The TPP36208x uses current mode control topology. The current mode topology supports fixed frequency operation thus optimizes ripple performance. With integrated low $R_{ds(on)}$, the device can achieve high efficiency in small physical footprint.

Pulse-Skip Mode

To improve light load efficiency, the TPP362080/2 will automatically enter improved light-load mode when inductor ripple valley current reaches zero. The controller keeps the on-time of high-side switch the same. With light-load, the decay of voltage takes longer time and lowers switching frequency accordingly.

Forced-PWM Mode

The TPP362081/3 has Forced-PWM mode to support low-noise applications. When the device output current is low, the device will automatically enter forced-PWM Mode with fixed switching frequency. In this mode, negative current limit of low-side FET is enabled. In this mode, the efficiency is lower than pulse-skip mode device due to continuous switching and could pump reverse current to supply during power-down scenarios.

Soft-Start with Pre-Biased Capability

Once EN becomes high, the device ramps up its internal reference voltage with fixed 1-ms risetime. When the output capacitor is pre-charged, the soft-start ramp will only enable output switching after internal reference ramps above FB voltage.

Over Current Protection

The device has cycle-by-cycle current limit. During OFF state, once over current is detected at ripple current valley by measuring low-side FET current, the device keeps the low-side FET OFF until the current falls below over current protection (OCP) threshold.

Output Undervoltage Hiccup Protection

When the device output voltage falls below hiccup voltage threshold, the device gets into hiccup mode by turning off the device restarts after hiccup timer (typically 10ms) expires.

Undervoltage Lockout (UVLO) Protection

Once the input voltage falls below UVLO threshold, the device is shut off. Once the device recovers above the UVLO threshold, the device returns to normal operation.

Over Temperature Shutdown

Once the junction temperature rises across internal over temperature shutdown threshold, the device shuts off and recovers when temperature falls below threshold with hysteresis.

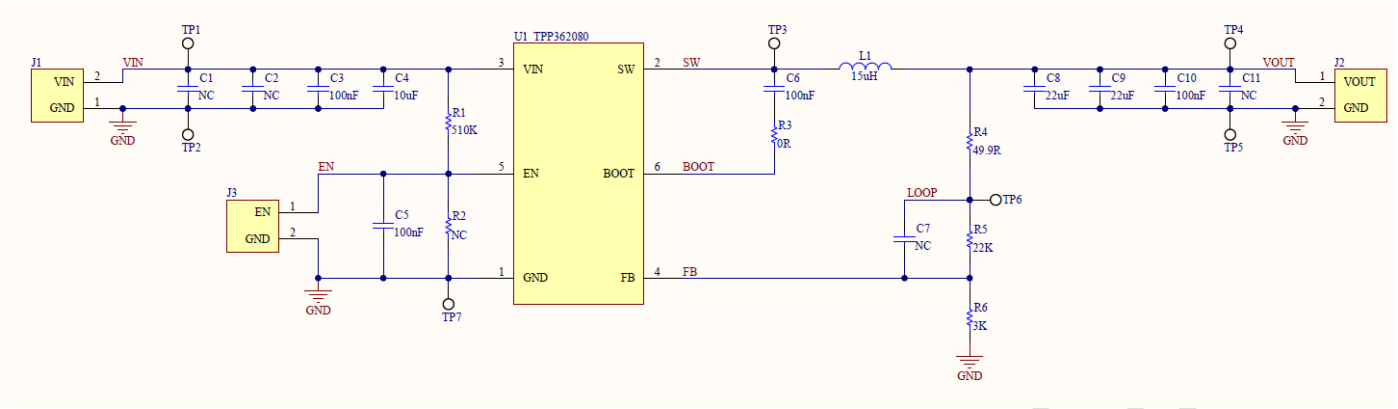
Application

Application Information

As an easy-to-use step-down voltage regulator, also known as buck regulator, TPP36208 usually coverts a higher input voltage to the desired output voltage set by VFB resistor divider. The maximum output current is 2 A. Below section depicts a simplified design flow of circuitry for TPP36208.

Typical Application

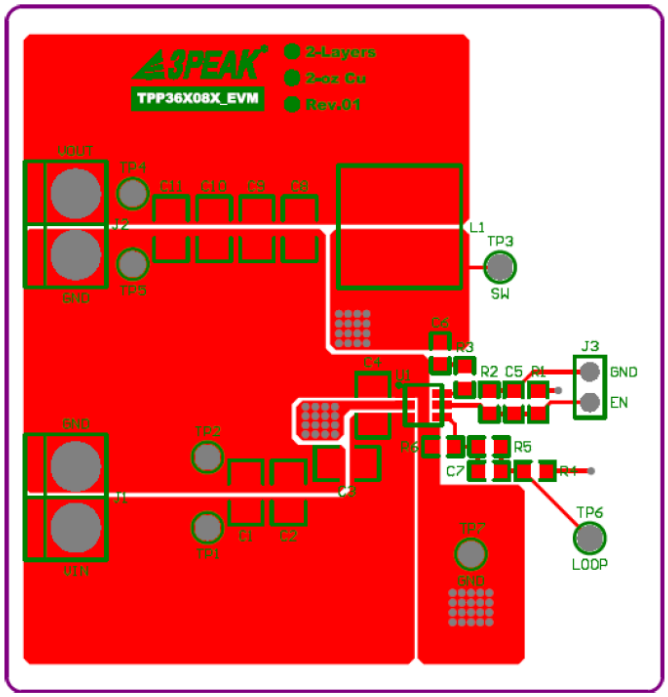
In most 12-V system, lower voltage rail such as 5 V / 3.3V is a typical need for microcontrollers, I/Os and other low voltage components. Below application lists the typical schematic for a 5-V buck regulator.



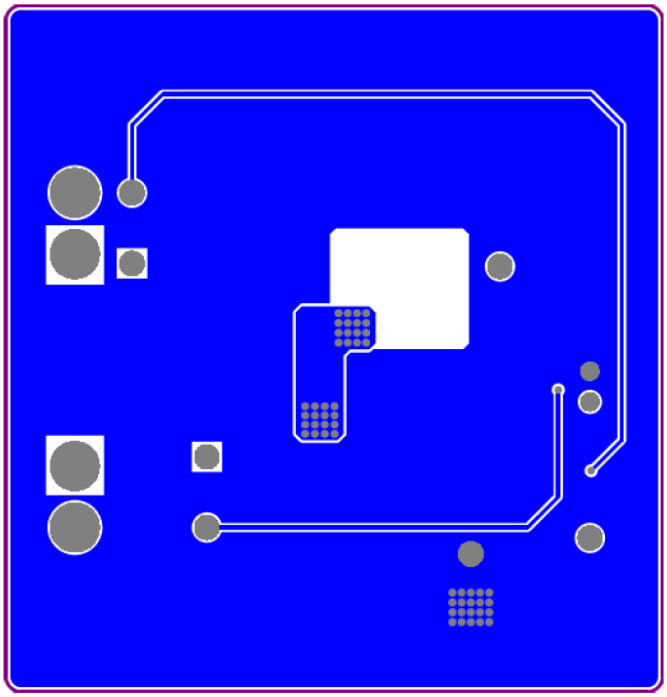
Component Selection

	EVM1: F_{sw}=500kHz, MODE = PFM, IOUT = 2A, t_{SS} = 1ms, V_{OUT} = 5V					
Designator	Value	Quantity	Part No.	Package	Manufacturer	Description
U1	TPP362080A2	1	TPP362080-T6TR	SOT23-6	3PEAK	Buck Converter, 36V, 2A, 500kHz, PFM
C1	NC	0				
C2	NC	0				
C3	100nF	1	GGD21BR71H104KA02	0805	muRata	Capacitor, 100nF, 50VDC, X7R, ±15%
C4	10uF	1	GCM32EC71H106MA03L	1210	muRata	Capacitor, 10uF, 50VDC, X7S, ±22%
R1	510K	1	ARG03FTC5103	0603	Viking	Resistor, 510K, ±1%, 0.1W
C5	NC	0				
R2	100K	1	ARG03FTC1003	0603	Viking	Resistor, 100K, ±1%, 0.1W
C6	100nF	1	GRM188R71C104KA01D	0603	muRata	Capacitor, 100nF, 16VDC, X7R, ±15%
C7	NC	0				
R3	0R	1	ERJ-3GEY0R00V	0603	Panasonic	Resistor, 0Ω, 5%, 0.1W
L1	15uH	1	7447714150	10mm×5mm×10mm	Wurth Elektronik eiSos	Inductor, 15uH, 3.5A, 36ohm, ±20%
C8	22uF	1	GRM32ER71E226ME15L	1210	muRata	Capacitor, 22uF, 25VDC, X7R, ±15%
C9	22uF	1	GRM32ER71E226ME15L	1210	muRata	Capacitor, 22uF, 25VDC, X7R, ±15%
C10	100nF	1	GGD21BR71H104KA02	0805	muRata	Capacitor, 100nF, 50VDC, X7R, ±15%
C11	NC	0				
R4	49.9R	1	ARG03FTC49R9	0603	Viking	Resistor, 49.9Ω, ±1%, 0.1W
R5	22K	1	ARG03FTC2202	0603	Viking	Resistor, 22K, ±1%, 0.1W
R6	3K	1	ARG03FTC3001	0603	Viking	Resistor, 3K, ±1%, 0.1W

Layout Recommendations

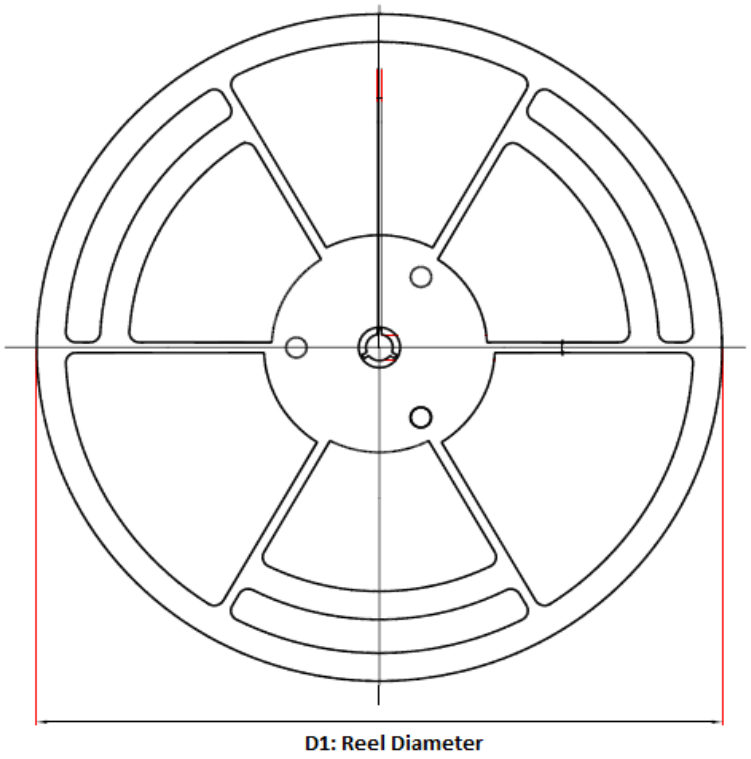


Top Layer



Bottom Layer

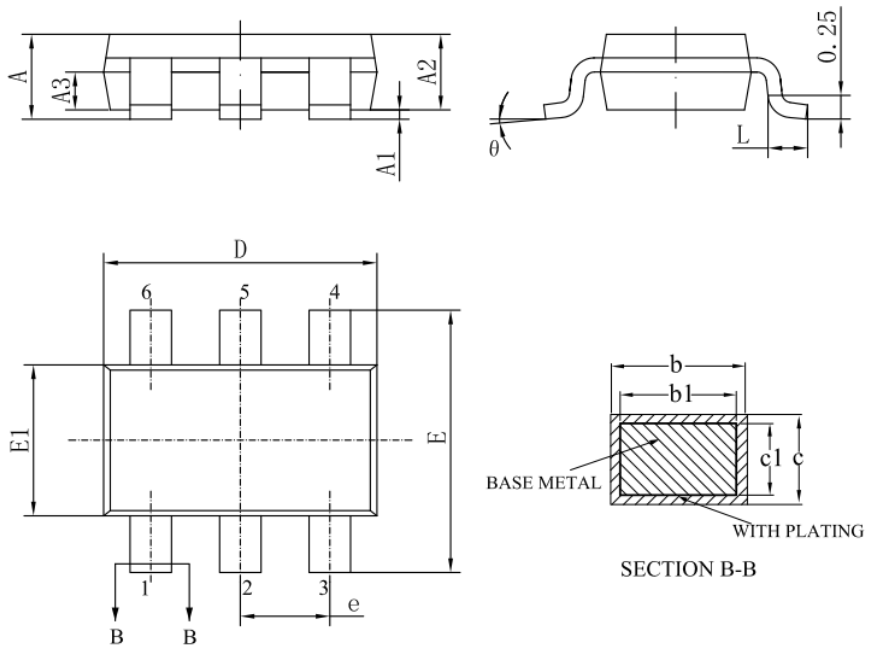
Tape and Reel Information



Order Number	Package	D1	W1	A0	B0	K0	P0	W0	Pin1 Quadrant
TPP362080-T6TR	TSOT23-6	178.0	12.3	3.2	3.2	1.4	4.0	8.0	Q3
TPP362081-T6TR	TSOT23-6	178.0	12.3	3.2	3.2	1.4	4.0	8.0	Q3
TPP362082-T6TR	TSOT23-6	178.0	12.3	3.2	3.2	1.4	4.0	8.0	Q3
TPP362083-T6TR	TSOT23-6	178.0	12.3	3.2	3.2	1.4	4.0	8.0	Q3

Package Outline Dimensions

TSOT23-6



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	0.95
A1	0	—	0.10
A2	0.75	0.80	0.85
A3	0.35	0.40	0.45
b	0.30	0.44	0.50
b1	0.30	0.40	0.45
c	0.11	0.16	0.20
c1	0.11	0.13	0.15
D	2.70	2.90	3.10
E	2.60	2.80	3.00
E1	1.50	1.60	1.70
e	0.95BSC		
L	0.30	0.40	0.50
θ	0	—	8°