MP2234S

High-Efficiency, 2A, 16V, 800kHz Synchronous, Step-Down Converter

The Future of Analog IC Technology

DESCRIPTION

The MP2234S is a high-frequency, synchronous, rectified, step-down, switch-mode converter with built-in power MOSFETs. It offers a compact solution to achieve a 2A continuous output current with excellent load and line regulation over a wide input-supply range. The MP2234S has synchronous mode operation for higher efficiency over the output current load range.

Current-mode operation provides fast transient response and eases loop stabilization.

Full protection features include over-current protection (OCP) and thermal shut down (TSD).

The MP2234S requires a minimal number of readily-available standard external components, and is available in a space-saving 8-pin TSOT23 package.

FEATURES

- Wide 4.5V-to-16V Operating Input Range
- 140mΩ/60mΩ Low $R_{DS(ON)}$ Internal Power MOSFETs
- High-Efficiency Synchronous Mode Operation
- Fixed 800kHz Switching Frequency
- Synchronizes from a 300kHz-to-2MHz External Clock
- Power-Save Mode at Light Load
- External Soft-Start
- Over Current Protection and Hiccup
- Thermal Shutdown
- Output Adjustable from 0.804V
- Available in a 8-pin TSOT-23 Package

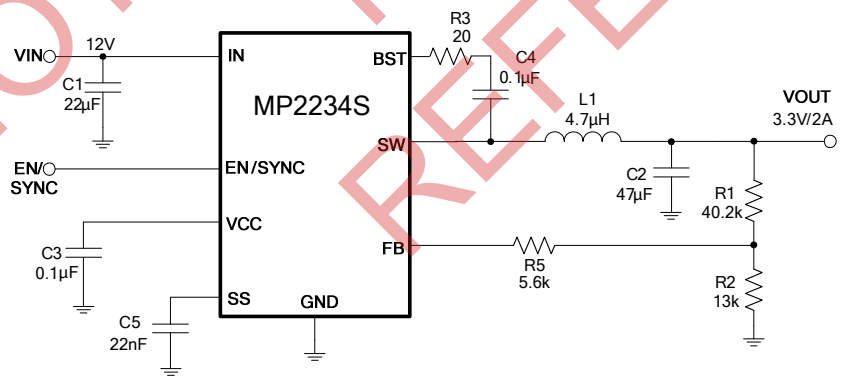
APPLICATIONS

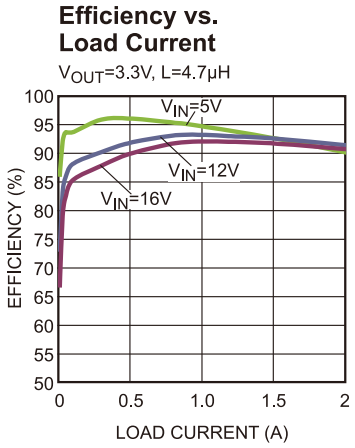
- Notebook Systems and I/O Power
- Digital Set-Top Boxes
- Flat-Panel Television and Monitors
- Distributed Power Systems

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TYPICAL APPLICATION





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ORDERING INFORMATION

Part Number*	Package	Top Marking
MP2234SGJ	TSOT-23	*See Below*

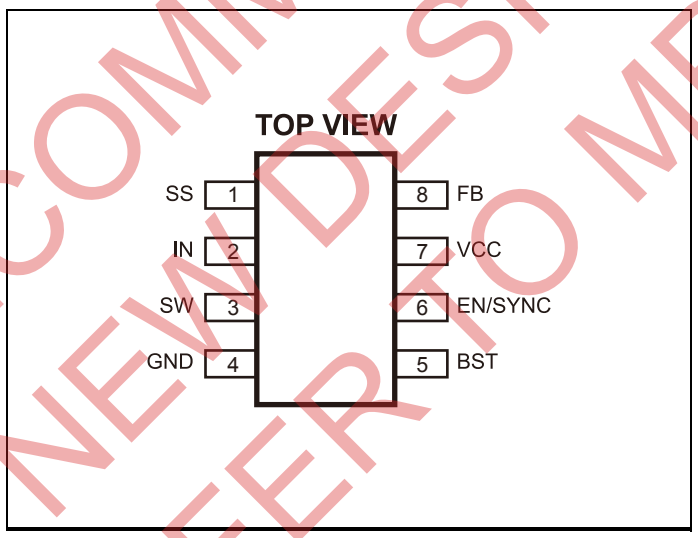
* For Tape & Reel, add suffix –Z (e.g. MP2234SGJ–Z).

TOP MARKING

|ALZY

ALZ: product code of MP2234SGJ;
Y: year code;

PACKAGE REFERENCE



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ABSOLUTE MAXIMUM RATINGS (1)

V_{IN} ..... -0.3V to 17V
V_{SW} .....
-0.3V (-5V for <10ns) to 17V (19V for <10ns)
V_{BST} ..... V_{SW}+6V
All Other Pins.....-0.3V to 6V (2)
Continuous Power Dissipation (T_A = +25°C) (3)
.....1.25W
Junction Temperature.....150°C
Lead Temperature .....260°C
Storage Temperature.....-65°C to 150°C

Recommended Operating Conditions (4)

Supply Voltage V_{IN} ..... 4.5V to 16V
Output Voltage V_{OUT}..... 0.804V to V_{IN} x D_{MAX}
Operating Junction Temp. (T_J). -40°C to +125°C

Thermal Resistance (5)	θ_{JA}	θ_{JC}
TSOT23-8	100	55 °C/W

Notes:

1) Exceeding these ratings may damage the device.
2) About the details of EN pin's ABS MAX rating, please refer to Page 12, Enable/SYNC control section.
3) The maximum allowable power dissipation is a function of the maximum junction temperature T_J (MAX), the junction-to-ambient thermal resistance θ_{JA}, and the ambient temperature T_A. The maximum allowable continuous power dissipation at any ambient temperature is calculated by P_D (MAX) = (T_J (MAX)-T_A)/θ_{JA}. Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.
4) The device is not guaranteed to function outside of its operating conditions.
5) Measured on JESD51-7, 4-layer PCB.

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ELECTRICAL CHARACTERISTICS

V_{IN}=12V, T_J=-40°C to +125°C(6), typical value is tested at T_J=+25°C, unless otherwise noted.

Parameter	Symbol	Condition	Min	Typ	Max	Units
Supply Current (Shutdown)	I_{IN}	V_{EN} = 0V, T_J=+25°C			1	μA
		V_{EN} = 0V, T_J=-40°C to +125°C			5	μA
Supply Current (Quiescent)	I_q	V_{EN} = 2V, V_{FB} = 1V		0.5	1	mA
HS Switch-On Resistance	HS_{RDS-ON}	V_{BST-SW}=5V		140		mΩ
LS Switch-On Resistance	LS_{RDS-ON}	V_{CC} =5V		60		mΩ
Switch Leakage	SW_{LKG}	V_{EN} = 0V, V_{SW} =12V or 0V			1	μA
Current Limit	I_{LIMIT}	Under 40% Duty Cycle	3	4		A
Oscillator Frequency	f_{SW}	V_{FB}=0.75V,T_J=+25°C	620	800	900	kHz
		V_{FB}=0.75V,T_J=-40°C to +125°C	550	800	900	kHz
Fold-Back Frequency	f_{FB}	V_{FB}<400mV		0.5		f_{SW}
Maximum Duty Cycle	D_{MAX}	V_{FB}=700mV		92		%
Minimum On Time(7)	T_{ON_MIN}			40		ns
Sync Frequency Range	f_{SYNC}		0.3		2	MHz
Feedback Voltage	V_{FB}	T_J =25°C	788	804	820	mV
		T_J=-40°C to +125°C	784	804	824	mV
Feedback Current	I_{FB}	V_{FB}=830mV		10	50	nA
EN Rising Threshold	V_{EN_RISING}		1	1.4	1.8	V
EN Hysteresis	$V_{EN\ Hysteresis}$			150		mV
EN Input Current	I_{EN}	V_{EN}=2V		2		μA
		V_{EN}=0		0		μA
EN Turn-Off Delay	EN_{td-off}			10		μs
VIN Under-Voltage Lockout Threshold—Rising	$INUV_{Vth}$		3.5	3.9	4.3	V
VIN Under-Voltage Lockout Threshold—Hysteresis	$INUV_{HYS}$			700		mV
VCC Regulator	V_{CC}		4.6	5	5.4	V
VCC Load Regulation		I_{CC}=5mA		2		%
Soft-Start Current	I_{SS}		8	11	14	μA
Thermal Shutdown (7)				150		°C
Thermal Hysteresis (7)				20		°C

Notes:

6) Not tested in production. Guaranteed by over-temperature correlation.

7) Guaranteed by design.

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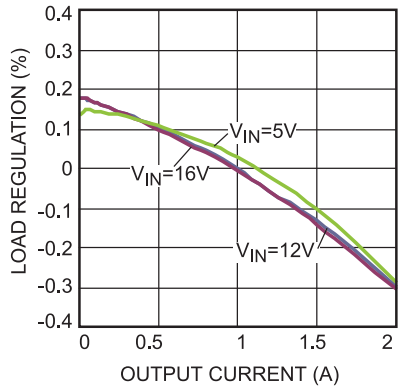
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TYPICAL CHARACTERISTICS

Performance waveforms are tested on the evaluation board of the Design Example section.
V_{IN} = 12V, V_{OUT} = 3.3V, L=4.7µH, T_A = 25°C, unless otherwise noted.

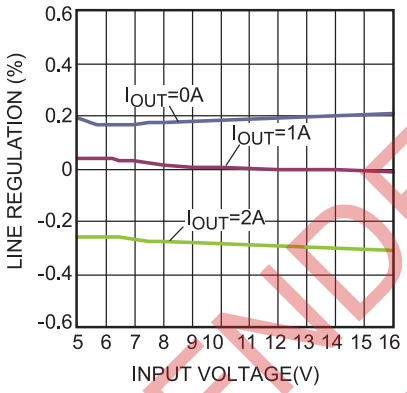
Load Regulation

V_{OUT}=3.3V, L=4.7µH

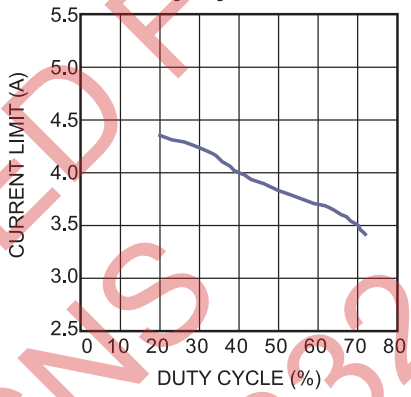


Line Regulation

V_{OUT}=3.3V, L=4.7µH

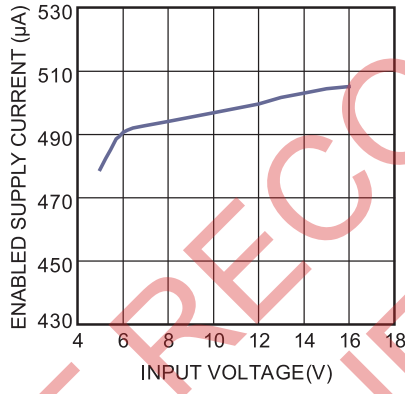


Inductor Peak-Current Limit vs. Duty Cycle



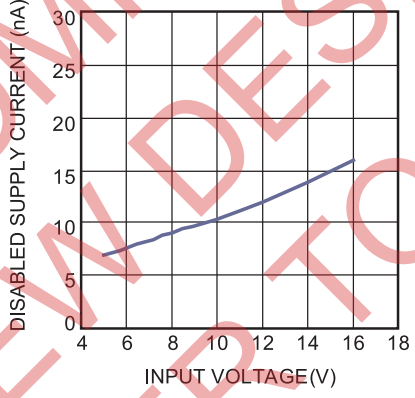
Enabled Supply Current vs. Input Voltage

V_{EN}=2V, V_{FB}=1V

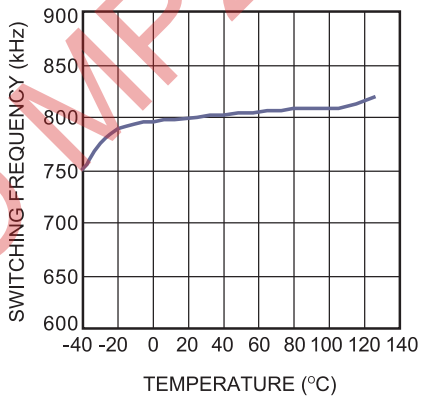


Disabled Supply Current vs. Input Voltage

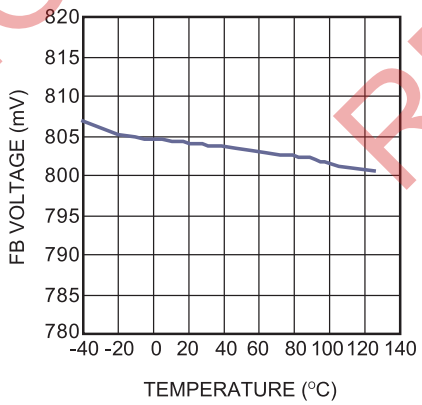
V_{EN}=0V



Switching Frequency vs. Temperature



FB Voltage vs. Temperature



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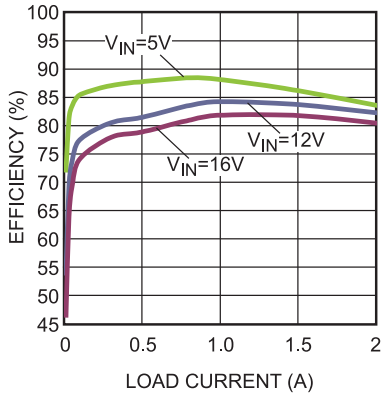
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TYPICAL PERFORMANCE CHARACTERISTICS

Performance waveforms are tested on the evaluation board of the Design Example section.
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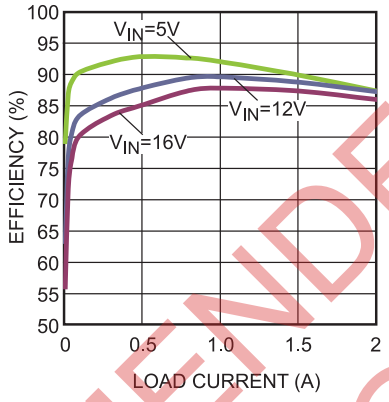
Efficiency vs. Load Current

V_{OUT}=1.2V, L=1.5µH



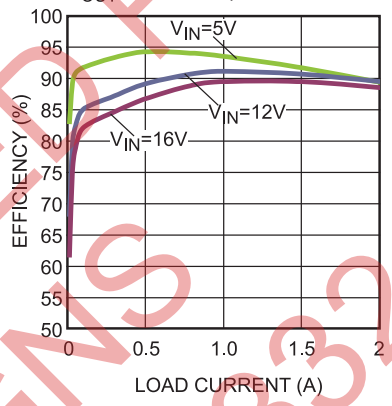
Efficiency vs. Load Current

V_{OUT}=1.8V, L=3.3µH



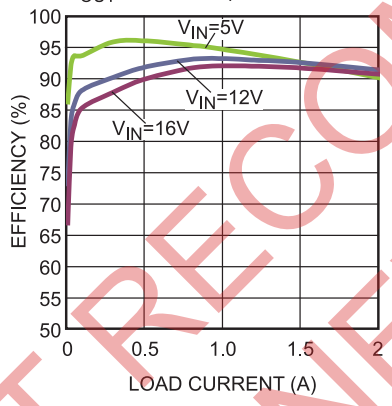
Efficiency vs. Load Current

V_{OUT}=2.5V, L=3.3µH



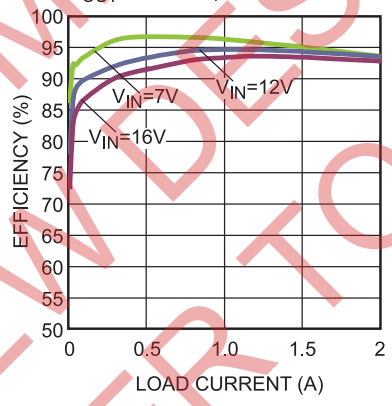
Efficiency vs. Load Current

V_{OUT}=3.3V, L=4.7µH



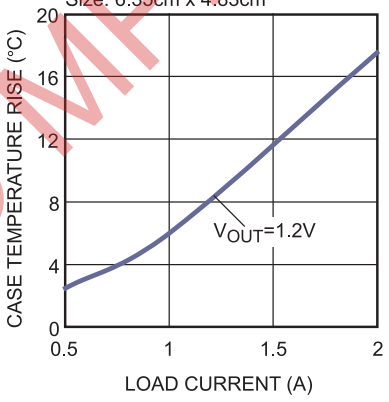
Efficiency vs. Load Current

V_{OUT}=5V, L=4.7µH



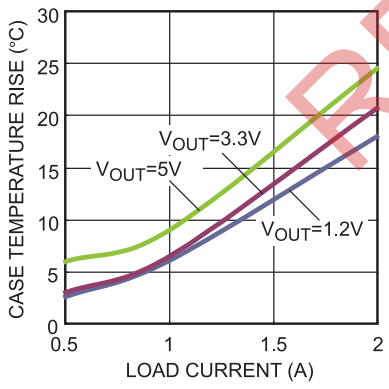
Case Temperature Rise vs. Output Current

V_{IN}=5V, 2 Layers PCB,
Size: 6.35cm x 4.83cm



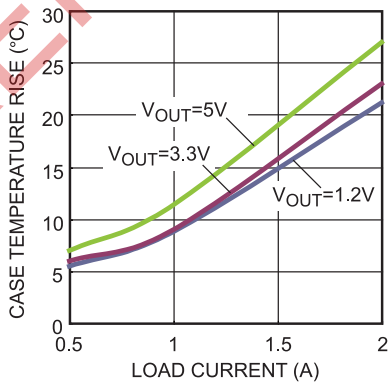
Case Temperature Rise vs. Output Current

V_{IN}=12V, 2 Layers PCB,
Size: 6.35cm x 4.83cm



Case Temperature Rise vs. Output Current

V_{IN}=16V, 2 Layers PCB,
Size: 6.35cm x 4.83cm



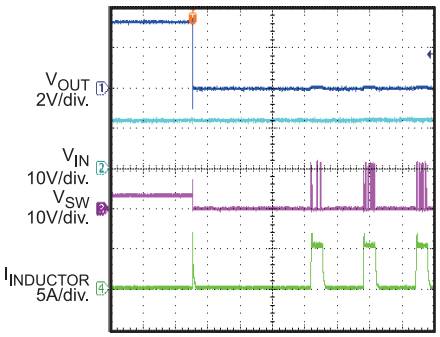
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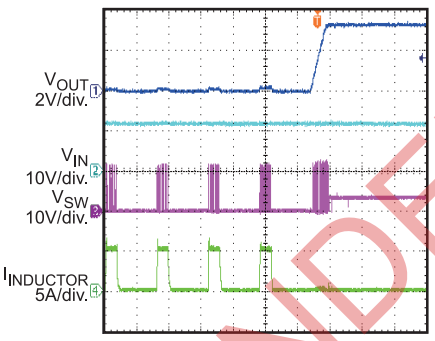
TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

Performance waveforms are tested on the evaluation board of the Design Example section.
V_{IN} = 12V, V_{OUT} = 3.3V, L=4.7µH, T_A = 25°C, unless otherwise noted.

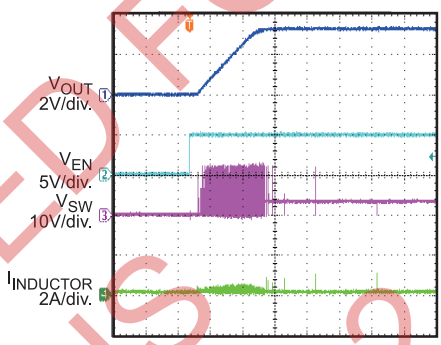
Short Entry
I_{OUT}=0A



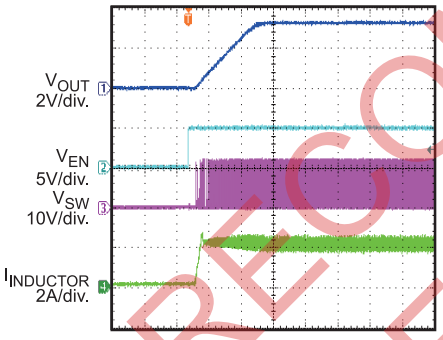
Short Recovery
I_{OUT}=0A



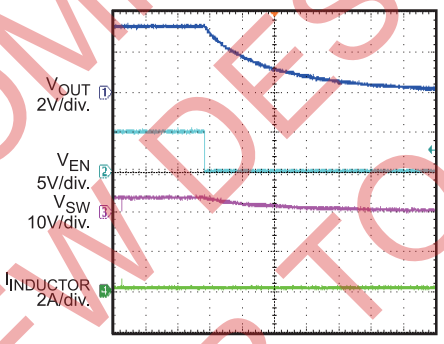
Startup through Enable
I_{OUT}=0A



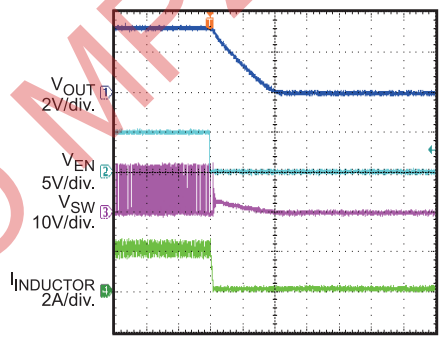
Startup through Enable
I_{OUT}=2A



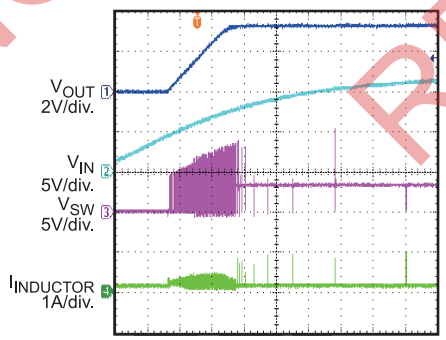
Shutdown through Enable
I_{OUT}=0A



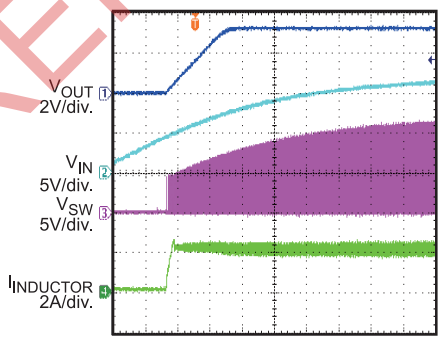
Shutdown through Enable
I_{OUT}=2A



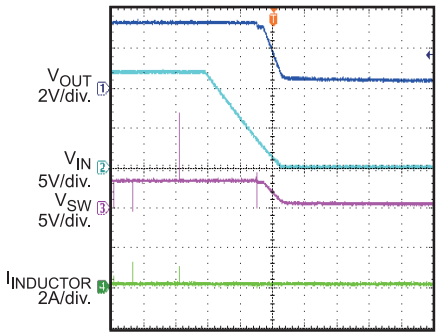
Startup through Input Voltage
I_{OUT}=0A



Startup through Input Voltage
I_{OUT}=2A



Shutdown through Input Voltage
I_{OUT}=0A



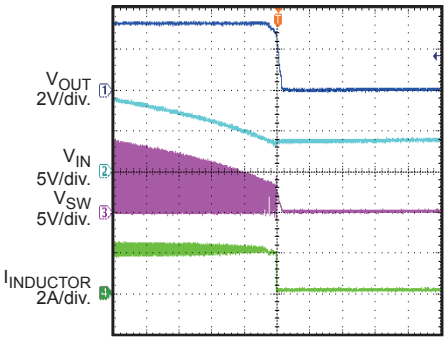
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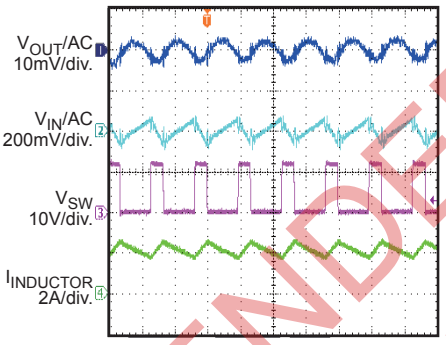
TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

Performance waveforms are tested on the evaluation board of the Design Example section.
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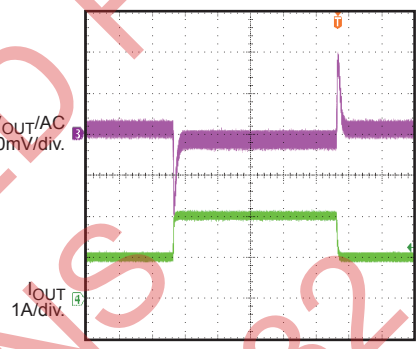
Shutdown through Input Voltage
I_{OUT}=2A



Input / Output Ripple
I_{OUT}=2A



Load Transient Reponse
I_{OUT}=1A to 2A



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PIN FUNCTIONS

Package Pin #	Name	Description
1	SS	Soft-Start. Connect an external capacitor to program the soft start time for the switch mode regulator.
2	IN	Supply Voltage. The IN pin supplies power for internal MOSFET and regulator. The MP2234S operates from a +4.5V to +16V input rail. Requires a low-ESR, and low-inductance capacitor (C1) to decouple the input rail. Place the input capacitor very close to this pin and connect it with wide PCB traces and multiple vias.
3	SW	Switch Output. Connect to the inductor and bootstrap capacitor. This pin is driven up to V_{IN} by the high-side switch during the PWM duty cycle ON time. The inductor current drives the SW pin negative during the OFF time. The ON resistance of the low-side switch and the internal body diode fixes the negative voltage. Connect using wide PCB traces and multiple vias.
4	GND	System Ground. Reference ground of the regulated output voltage. PCB layout Requires extra care. For best results, connect to GND with copper and vias.
5	BST	Bootstrap. Requires a capacitor connected between SW and BST pins to form a floating supply across the high-side switch driver.
6	EN/SYNC	Enable/Synchronize. EN/SYNC=high to enable the MP2234S. Apply an external clock change the switching frequency. For automatic start-up, connect EN/SYNC pin to V_{IN} with a 100kΩ resistor.
7	VCC	Internal 5V LDO output. Powers the driver and control circuits. Decouple with 0.1μF to 0.22μF capacitor. Do not use a capacitor ≥0.22μF.
8	FB	Feedback. Connect to the tap of an external resistor divider from the output to GND to set the output voltage. The frequency fold-back comparator lowers the oscillator frequency when the FB voltage is below 400mV to prevent current limit runaway during a short circuit fault. Place the resistor divider as close to the FB pin as possible. Avoid placing vias on the FB traces.

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FUNCTIONAL BLOCK DIAGRAM

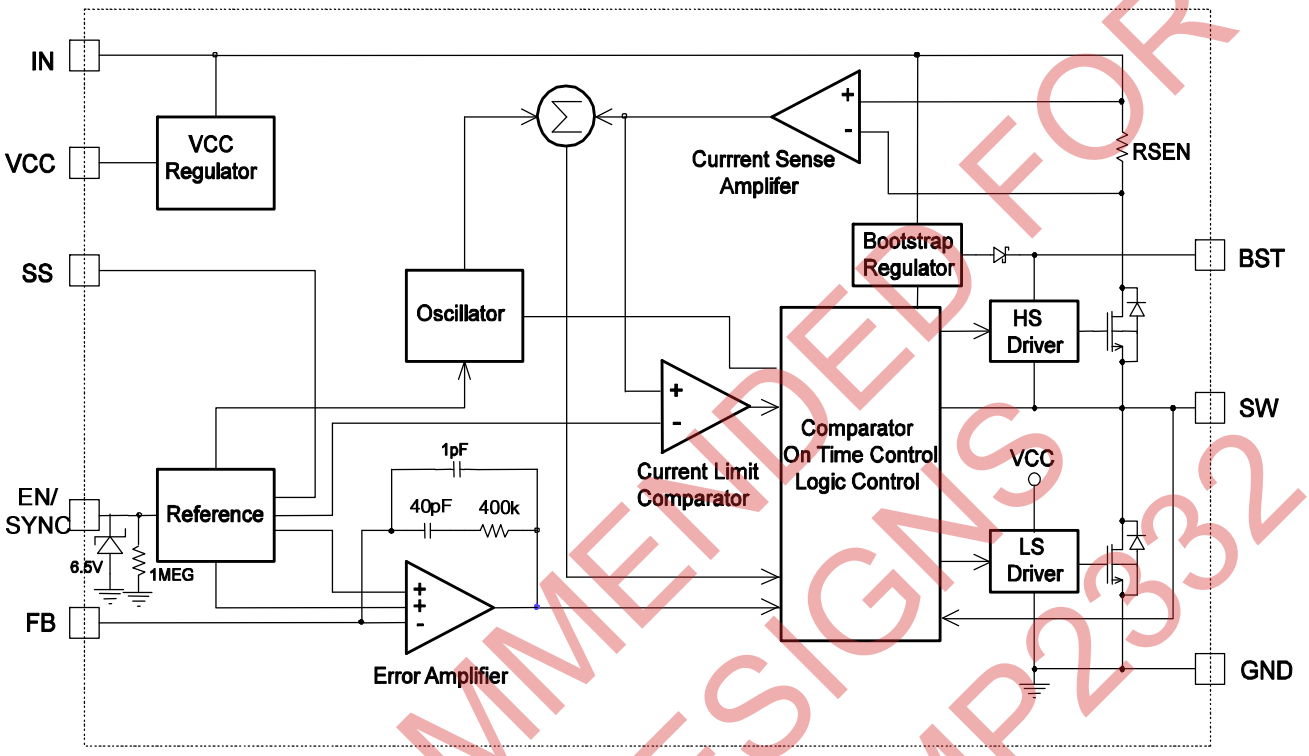


Figure 1. Functional Block Diagram

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OPERATION

The MP2234S is a high-frequency, synchronous, rectified, step-down, switch-mode converter with built-in power MOSFETs. It offers a compact solution that achieves a 2A continuous output current with excellent load and line regulation over 4.5V to 16V input-supply range.

The MP2234S has three working modes: advanced asynchronous modulation (AAM) mode, discontinuous conduction mode (DCM), and continuous conduction mode (CCM). The load current increases as the device transitions from AAM mode to DCM to CCM.

AAM Control Operation

In a light-load condition, MP2234S works in advanced asynchronous modulation (AAM) mode (see Figure 2). The V_{AAM} is an internal fixed voltage when input and output voltages are fixed. V_{COMP} is the error-amplifier output (which represents the peak inductor-current information). When V_{COMP} is lower than V_{AAM}, the internal clock is blocked. This causes the MP2234S to skip pulses, achieving the light-load power save. Refer to AN032 for additional details.

The internal clock re-sets every time V_{COMP} is higher than V_{AAM}. At the same time, the high-side MOSFET (HS-FET) turns on and remains on until $V_{ILsense}$ reaches the value set by V_{COMP}.

The light-load feature in this device is optimized for 12V input applications.

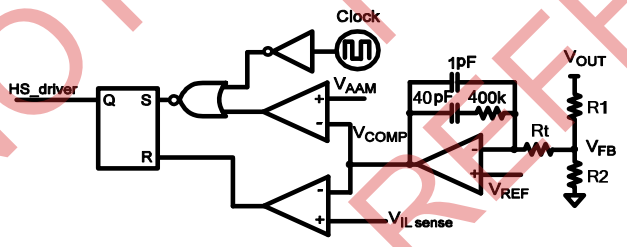


Figure 2. Simplified AAM Control Logic

DCM Control Operation

The V_{COMP} voltage ramps up as the output current increases. When its minimum value exceeds V_{AAM}, the device enters discontinuous conduction mode (DCM). In DCM, the internal clock initiates the PWM cycle, the HS-FET turns on and remains on until $V_{ILsense}$ reaches the value set by V_{COMP} (after a period of dead time), and the low-side MOSFET (LS-FET) turns on and remains on until the inductor-current value decreases to zero. The device repeats the same operation in every clock cycle to regulate the output voltage (see Figure 3).

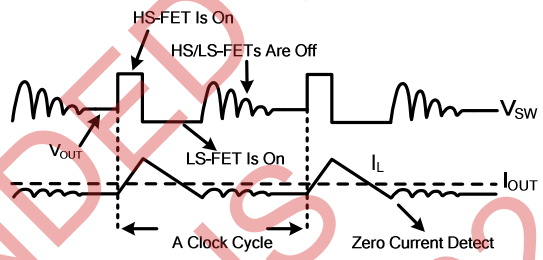


Figure 3. DCM Control Operation

CCM Control Operation

The device enters continuous conduction mode (CCM) from DCM once the inductor current no longer drops to zero in a clock cycle. In CCM, the internal clock initiates the PWM cycle, the HS-FET turns on and remains on until $V_{ILsense}$ reaches the value set by V_{COMP} (after a period of dead time), and the LS-FET turns on and remains on until the next clock cycle begins. The device repeats the same operation in every clock cycle to regulate the output voltage.

If $V_{ILsense}$ does not reach the value set by V_{COMP} within 92% of one PWM period, the HS-FET is forced off.

Internal Regulator

A 5V internal regulator powers most of the internal circuitries. This regulator takes V_{IN} and operates in the full V_{IN} range. When V_{IN} exceeds 5.0V, the output of the regulator is in full regulation. When V_{IN} is less than 5.0V, the output decreases, and the part requires a 0.1µF ceramic decoupling capacitor.

Error Amplifier (EA)

The error amplifier compares the FB pin voltage to the internal 0.804V reference (V_{REF}) and outputs a current proportional to the difference between the two. This output current then charges or discharges the internal compensation network to form the COMP voltage, which controls the power MOSFET current. The optimized internal compensation

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network minimizes the external component counts and simplifies the control loop design.

Enable/SYNC Control

EN/SYNC is a digital control pin that turns the regulator on and off. Drive EN high to turn on the regulator; drive it low to turn it off. An internal 1MΩ resistor from EN/SYNC to GND allows EN/SYNC to be floated to shut down the chip. The EN/SYNC pin is clamped internally using a 6.5V series-Zener-diode (see Figure 4). Connecting the EN/SYNC input pin through a pull-up resistor to the voltage on the IN pin limits the EN input current to less than 100μA.

For example, with 12V connected to IN, R_{PULLUP} ≥ (12V – 6.5V) ÷ 100μA = 55kΩ.

Connecting the EN pin directly to a voltage source without any pull-up resistor requires limiting the amplitude of the voltage source to ≤6V to prevent damage to the Zener diode.

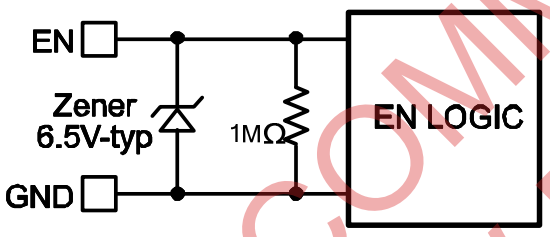


Figure 4. 6.5V Zener Diode Connection

For external clock synchronization, connect a clock with a frequency range between 300kHz and 2MHz 2ms after the output voltage is set: The internal clock rising edge will synchronize with the external clock rising edge. Select an external clock signal with a pulse width less than 1μs.

Under-Voltage Lockout (UVLO)

The MP2234S has under-voltage lock-out protection (UVLO). When the VCC voltage exceeds the UVLO rising threshold voltage, the device begins to power-up. It shuts off when the VCC voltage drops below the UVLO falling threshold voltage. This is non-latch protection.

The MP2234S is disabled when the input voltage falls below 3.2V (Typ). If an application requires a higher under-voltage lockout (UVLO) threshold, use the EN pin to adjust the input voltage UVLO by using two external resistors (see Figure 5). For best results, set the UVLO falling threshold (VSTOP) above 4.5V using the enable resistors. Set the rising threshold (VSTART) to provide enough hysteresis to allow for input-supply variations.

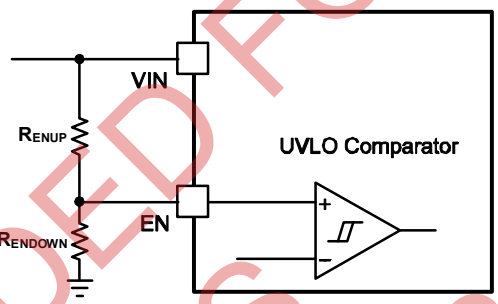


Figure 5. Adjustable UVLO

Soft-Start (SS)

Adjust the soft-start time by connecting a capacitor from SS pin to ground. When the soft-start begins, an internal 11μA current source charges the external capacitor. The soft-start capacitor connects to the non-inverting input of the error amplifier. The soft-start period continues until the voltage on the soft-start capacitor exceeds the 0.804V reference. Then the non-inverting amplifier takes the reference voltage as the input. Use the following equation to calculate the soft-start time:

$$t_{SS}(ms) = \frac{0.804V \times Css(nF)}{11\mu A}$$

Over-Current-Protection (OCP) and Hiccup

The MP2234S has a cycle-by-cycle over-current limit when the inductor current peak value exceeds the set current limit threshold. Meanwhile, the output voltage drops until V_{FB} is below the Under-Voltage (UV) threshold—typically 50% below the reference. Once UV is triggered, the MP2234S enters hiccup mode to periodically restart the part. This protection mode is especially useful when the output is dead-shorted to ground, and greatly reduces the average short circuit current to alleviate thermal issues and protect the regulator. The MP2234S exits the hiccup mode once the over-current condition is removed.

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Thermal Shutdown (TSD)

Thermal shutdown prevents the chip from operating at exceedingly high temperatures. When the silicon die reaches temperatures that exceed 150°C, it shuts down the whole chip. When the temperature drops below its lower threshold, typically 130°C, the chip is enabled again.

Floating Driver and Bootstrap Charging

An external bootstrap capacitor powers the floating power MOSFET driver. This floating driver has its own UVLO protection. This UVLO's rising threshold is 2.2V with a hysteresis of 150mV. The bootstrap capacitor voltage is regulated internally by V_{IN} through D1, M1, R3, C4, L1 and C2 (see Figure 6). If (V_{IN}- V_{SW}) exceeds 5V, U1 will regulate M1 to maintain a 5V BST voltage across C4. A 20Ω resistor placed between SW and BST cap is strongly recommended to reduce SW spike voltage.

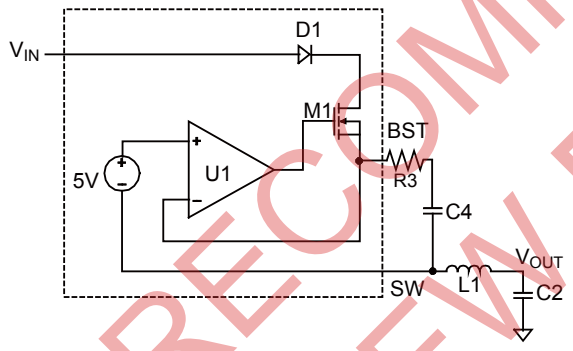


Figure 6. Internal Bootstrap Charging Circuit

Startup and Shutdown

If both V_{IN} and V_{EN} exceed their respective thresholds, the chip starts. The reference block starts first, generating stable reference voltage and currents, and then the internal regulator is enabled. The regulator provides a stable supply for the remaining circuitries.

Three events can shut down the chip: V_{EN} low, V_{IN} low and thermal shutdown. During the shutdown procedure, the signal path is first blocked to avoid any fault triggering. The COMP voltage and the internal supply rail are then pulled down. The floating driver is not subject to this shutdown command.

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APPLICATION INFORMATION

Setting the Output Voltage

The external resistor divider sets the output voltage (see Typical Application on page 1).

Choose R1 around 40kΩ for V_{OUT}>1.2V, R2 is then given by:

$$R2 = \frac{R1}{\frac{V_{OUT}}{0.804V} - 1}$$

The T-Type network is recommended highly (see Figure 7)

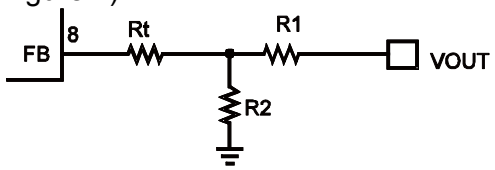


Figure 7. T-Type Network

Table 1 lists the recommended resistors and compensation values for common output voltages.

Table 1: Resistor Selection for Common Output Voltages(8)

V_{OUT} (V)	R1 (kΩ)	R2 (kΩ)	Rt (kΩ)
1	20.5	84.5	34
1.2	30.1	61.9	24
1.8	40.2	32.4	15
2.5	40.2	19.1	6.8
3.3	40.2	13	5.6
5	40.2	7.68	2

Notes:

8) The recommended parameters are based on a 800kHz switching frequency; a different input voltage, output-inductor value, and output-capacitor value may affect the selection of R1, R2, and Rt. For additional component parameters, please refer to the "Typical Application Circuits" section on pages 17 and 18.

Selecting the Inductor

Use a 1μH-to-22μH inductor with a DC current rating of at least 25% percent higher than the maximum load current for most applications. For highest efficiency, use an inductor with a DC resistance less than 15mΩ. For most designs, the inductance value can be derived from the following equation.

$$L_1 = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_{OSC}}$$

Where ΔI_L is the inductor ripple current.

Choose the inductor ripple current to be approximately 30% of the maximum load current. The maximum inductor peak current is:

$$I_{L(MAX)} = I_{LOAD} + \frac{\Delta I_L}{2}$$

Use a larger inductor for improved efficiency under light-load conditions—below 100mA.

Selecting the Input Capacitor

The input current to the step-down converter is discontinuous, therefore requires a capacitor is to supply the AC current to the step-down converter while maintaining the DC input voltage. Use low ESR capacitors for the best performance. Use ceramic capacitors with X5R or X7R dielectrics for best results because of their low ESR and small temperature coefficients. For most applications, use a 22μF capacitor.

Since C1 absorbs the input switching current, it requires an adequate ripple current rating. The RMS current in the input capacitor can be estimated by:

$$I_{C1} = I_{LOAD} \times \sqrt{\frac{V_{OUT}}{V_{IN}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)}$$

The worst case condition occurs at $V_{IN} = 2V_{OUT}$, where:

$$I_{C1} = \frac{I_{LOAD}}{2}$$

For simplification, choose an input capacitor with an RMS current rating greater than half of the maximum load current.

The input capacitor can be electrolytic, tantalum or ceramic. When using electrolytic or tantalum capacitors, add a small, high quality ceramic capacitor (e.g. 0.1μF) placed as close to the IC as possible. When using ceramic capacitors, make sure that they have enough capacitance to provide sufficient charge to prevent excessive voltage ripple at input. The input

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voltage ripple caused by capacitance can be estimated as:

$$\Delta V_{IN} = \frac{I_{LOAD}}{f_S \times C1} \times \frac{V_{OUT}}{V_{IN}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

Selecting the Output Capacitor

The output capacitor (C2) maintains the DC output voltage. Use ceramic, tantalum, or low-ESR electrolytic capacitors. For best results, use low ESR capacitors to keep the output voltage ripple low. The output voltage ripple can be estimated as:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_S \times L_1} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \times \left(R_{ESR} + \frac{1}{8 \times f_S \times C2}\right)$$

Where L_1 is the inductor value and R_{ESR} is the equivalent series resistance (ESR) value of the output capacitor.

For ceramic capacitors, the capacitance dominates the impedance at the switching frequency, and the capacitance causes the majority of the output voltage ripple. For simplification, the output voltage ripple can be estimated as:

$$\Delta V_{OUT} = \frac{V_{OUT}}{8 \times f_S^2 \times L_1 \times C2} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

For tantalum or electrolytic capacitors, the ESR dominates the impedance at the switching frequency. For simplification, the output ripple can be approximated as:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_S \times L_1} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \times R_{ESR}$$

The characteristics of the output capacitor also affect the stability of the regulation system. The MP2234S can be optimized for a wide range of capacitance and ESR values.

External Bootstrap Diode

In particular conditions, BST voltage may become insufficient (see equations below). During these conditions an external bootstrap diode can enhance the efficiency of the regulator and avoid insufficient BST voltage at light-load PFM operation. Insufficient BST voltage is more likely to occur during either of the following conditions:

- V_{OUT} is 5V or 3.3V; and
- Duty cycle is high: D= $\frac{V_{OUT}}{V_{IN}}$ >65%

If the BST voltage is insufficient, the output-ripple voltage may become extremely large during a light-load condition. If this occurs, add an external BST diode from VCC to BST (see Figure 8).

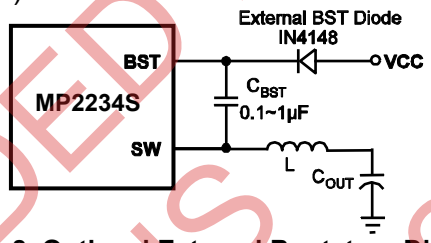


Figure 8. Optional External Bootstrap Diode to Enhance Efficiency

The recommended external BST diode is IN4148, and the BST capacitor value is 0.1μF to 1μF.

PC Board Layout (9)

PCB layout is very important to achieve stable operation especially for VCC capacitor and input capacitor placement. For best results, refer to Figure 9 and the guidelines below:

1. Use large ground plane directly connect to GND pin. Add vias near the GND pin if bottom layer is ground plane.
2. Place the VCC capacitor to VCC pin and GND pin as close as possible. Make the trace length of VCC pin-VCC capacitor anode-VCC capacitor cathode-chip GND pin as short as possible.
3. Place the ceramic input capacitor close to IN and GND pins. Keep the connection of input capacitor and IN pin as short and wide as possible.
4. Route SW, BST away from sensitive analog areas such as FB.
5. Place the T-type feedback resistor R5 close to chip to ensure the trace which connects to FB pin as short as possible.

Notes:

9) The recommended layout is based on the Figure 10 Typical Application circuit on page 17.

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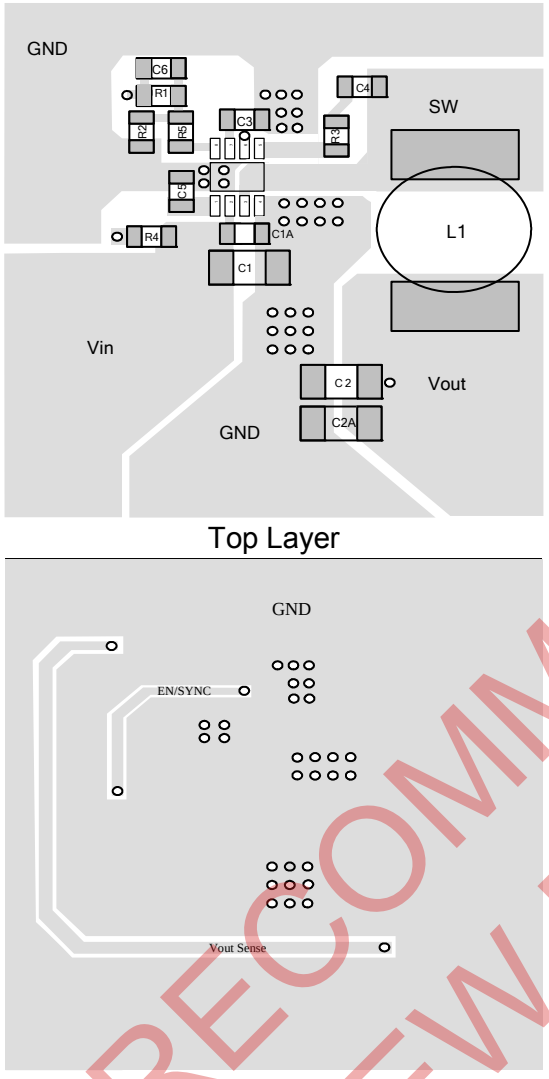


Figure 9. Recommended PCB Layout

Design Example

Below is a design example following the application guidelines for the specifications:

Table 2: Design Example

V_{IN}	12V
V_{OUT}	3.3V
I_{OUT}	2A

The detailed application schematic is shown in Figure 11. The typical performance and circuit waveforms have been shown in the Typical Performance Characteristics section. For more device applications, please refer to the related Evaluation Board Datasheets.

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TYPICAL APPLICATION CIRCUITS

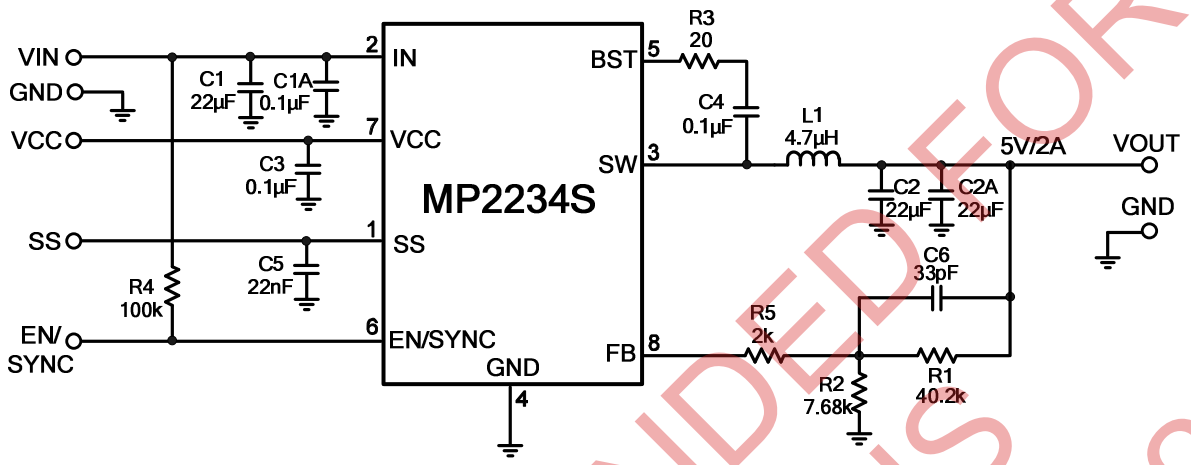


Figure 10. 12V$_{IN}$, 5V/2A Output

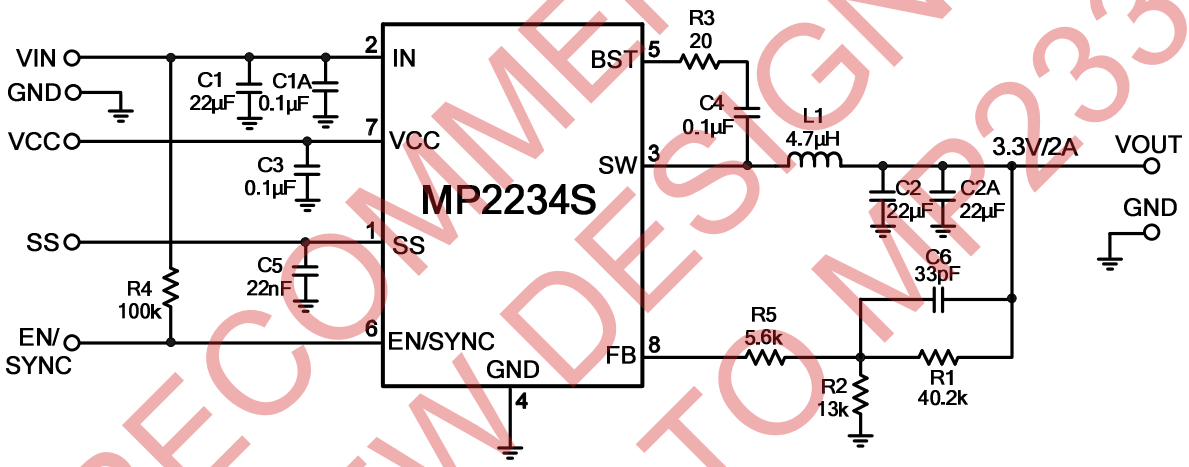


Figure 11. 12V$_{IN}$, 3.3V/2A Output

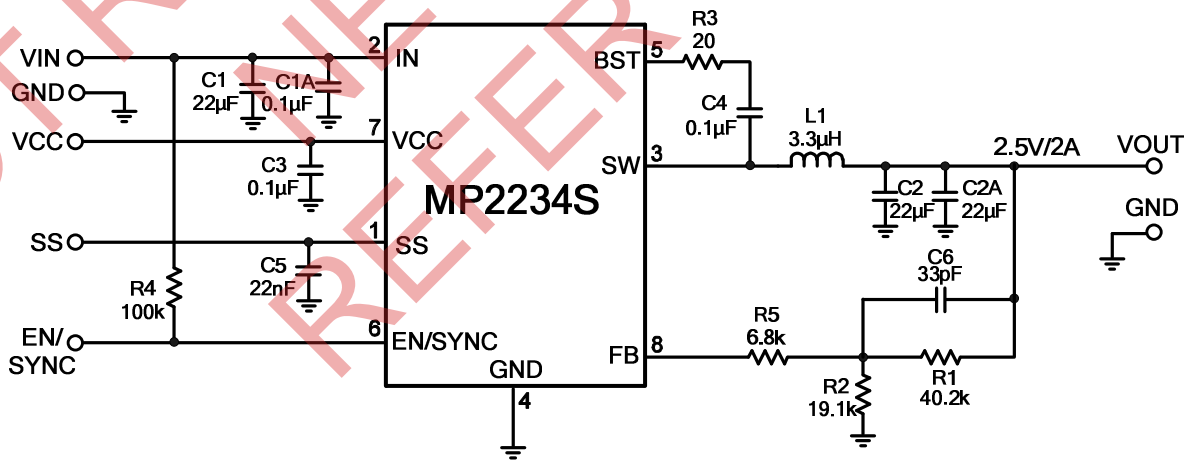


Figure 12. 12V$_{IN}$, 2.5V/2A Output

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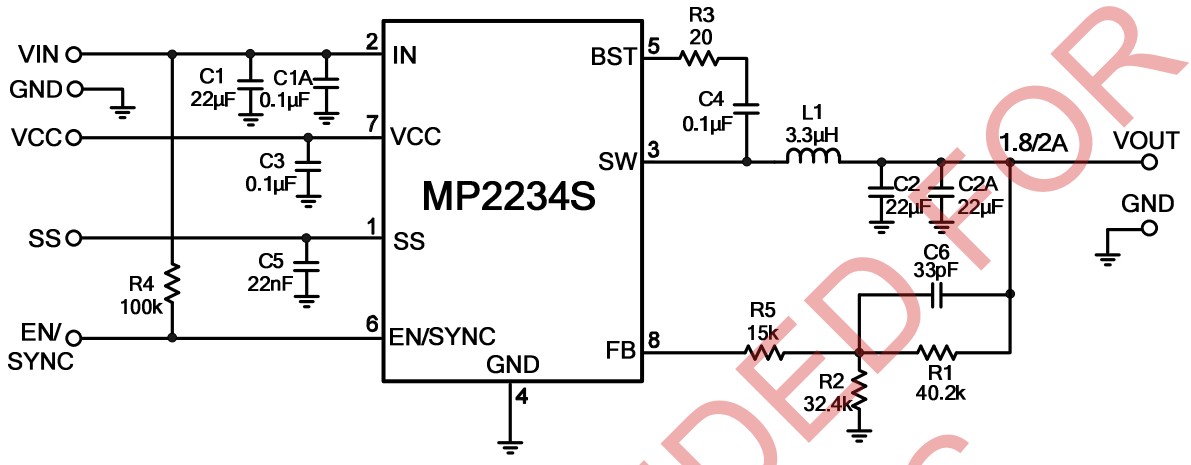


Figure 13. 12V_{IN}, 1.8V/2A Output

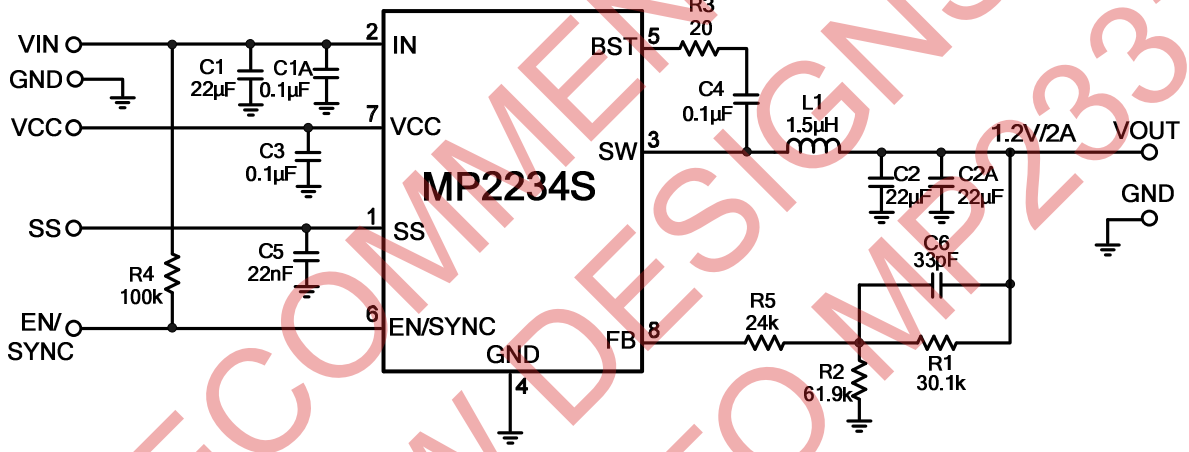


Figure 14. 12V_{IN}, 1.2V/2A Output

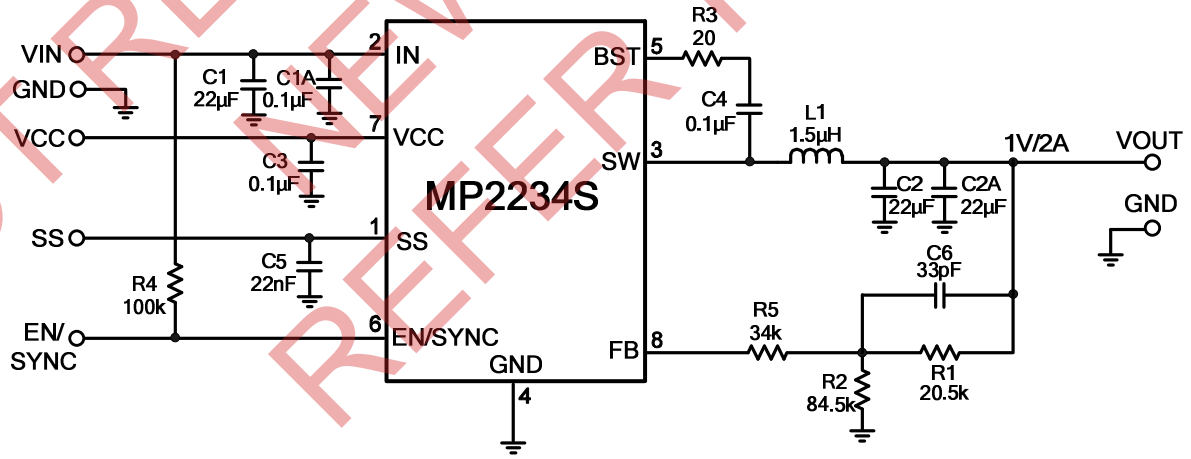


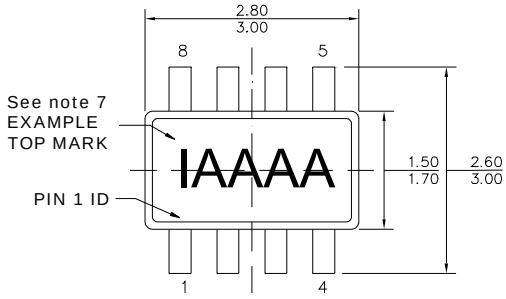
Figure 15. 12V_{IN}, 1V/2A Output

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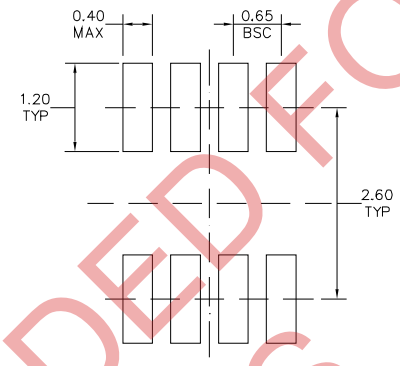
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PACKAGE INFORMATION

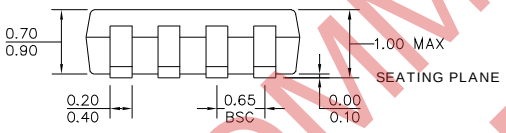
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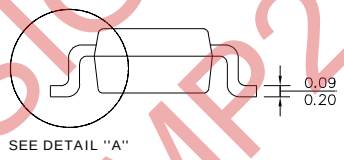
TOP VIEW



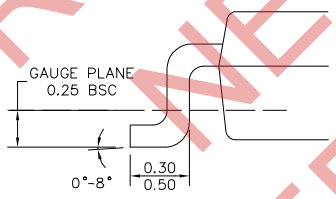
RECOMMENDED LAND PATTERN



FRONT VIEW



SIDE VIEW



DETAIL "A"

NOTE:

1) ALL DIMENSIONS ARE IN MILLIMETERS.
2) PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSION OR GATE BURR.
3) PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION.
4) LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.10 MILLIMETERS MAX.
5) JEDEC REFERENCE IS MO-193, VARIATION BA.
6) DRAWING IS NOT TO SCALE.
7) PIN 1 IS LOWER LEFT PIN WHEN READING TOP MARK FROM LEFT TO RIGHT, (SEE EXAMPLE TOP MARK)

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