

## General Description

The AAT2265 is designed for single-cell or dual-cell alkaline, NiMH or NiCd battery-powered applications. It is a high efficiency, synchronous, high frequency, step-up converter with true output disconnect during shutdown ( $<1.0\mu\text{A}$ ), start-up inrush current limit, and limited short-circuit protection.

The high 2MHz switching frequency and completely integrated control circuitry minimize the total solution footprint area while maintaining excellent regulation, ripple, and transient response throughout the full load range.

Light load switching frequency modulation and low quiescent current maintain high efficiency performance for light load and sleep mode conditions.

With a 1A peak switch current limit, the AAT2265 is capable of delivering 100mA to the load with a single AA cell battery or up to 250mA from dual AA cell batteries. The device has a 1.0V start-up voltage with operation down to 0.8V, making it ideal for battery operated consumer products that require higher voltages by replacing two AA batteries with a single AA cell.

The AAT2265 is available in a Pb-free, space-saving 2.0x2.1mm 8-pin SC70JW package and is rated over the  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  temperature range.

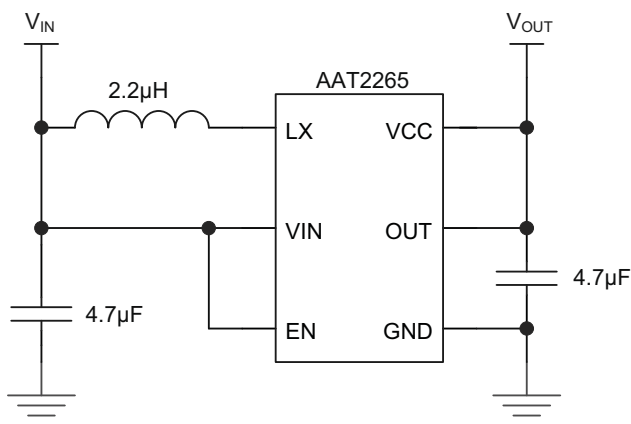
## Features

- 100mA Output from a Single AA Cell Input
- 250mA Output from a Dual AA Cell Input
- $V_{\text{IN}}$  Operation Range: 0.8V to  $V_{\text{OUT}}$
- Up to 93% Efficiency
- Low Start-Up Voltage: 1.0V Typical
- Internal Synchronous Rectifier
- Current Mode Control with Internal Feedback and Compensation
- 2MHz Switching Frequency
- 1A Current Limit
- Maintains High Efficiency Over the Output Current Range for Improved Battery Life
- Low  $65\mu\text{A}$  No Load Bias Current
- True Load Disconnect
- Limited Short-Circuit and Over-Current Protection
- Inrush Current Limit and Current Limited Soft Start
- Low Shutdown Current:  $<1.0\mu\text{A}$
- $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  Temperature Range
- 2.0x2.1mm SC70JW-8 Package

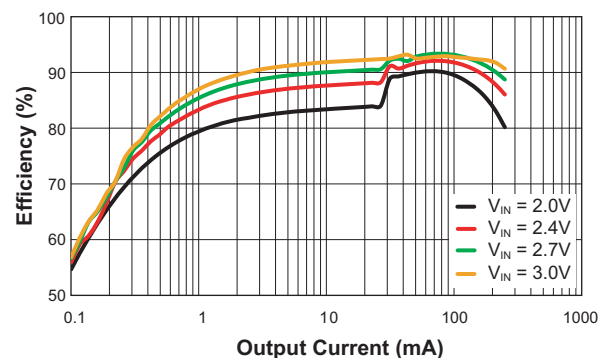
## Applications

- Bluetooth® Headsets
- Digital Cameras
- Medical Instruments
- Mobile Handsets
- MP3 and Portable Music Players
- Single AA Cell Consumer Products

## Typical Application



**Dual-Cell to 3.3V Efficiency vs. Output Current**  
( $V_{\text{OUT}} = 3.3\text{V}$ ;  $L = 2.2\mu\text{H}$ )

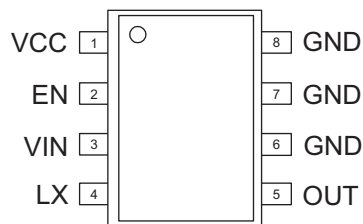


## Pin Descriptions

Pin #	Symbol	Function
1	VCC	Bias supply voltage after start-up and feedback to the output voltage error amplifier.
2	EN	Enable pin. Logic high enables the IC. Logic low disables the IC and disconnects the load from the input. Shutdown current is $<1\mu\text{A}$ .
3	VIN	Battery input voltage. Supplies the IC at start-up.
4	LX	Inductor connection. Ties to the drains of the P-channel synchronous rectifier and the N-channel MOSFET switch.
5	OUT	Boost converter output voltage; connects to the P-channel synchronous MOSFET source. Bypass with ceramic capacitor to GND.
6, 7, 8	GND	Signal and power ground. Connect output capacitor return.

## Pin Configuration

**SC70JW-8**  
(Top View)



## Absolute Maximum Ratings

Symbol	Description	Value	Units
V <sub>N</sub>	VIN, OUT, VCC, EN, LX to GND	-0.3 to 6.0	V
T <sub>J</sub>	Junction Temperature Range	-40 to 150	°C
T <sub>OP</sub>	Operating Temperature Range	-40 to 85	°C
T <sub>LEAD</sub>	Maximum Soldering Temperature (at leads, 10 sec)	300	°C

## Thermal Characteristics<sup>1</sup>

Symbol	Description	Value	Units
θ <sub>JA</sub>	Maximum Thermal Resistance	160	°C/W
P <sub>D</sub>	Maximum Power Dissipation	625	mW

1. Mounted on an FR4 board.

## Electrical Characteristics<sup>1</sup>

$V_{IN} = 1.2V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are  $T_A = 25^{\circ}C$ .

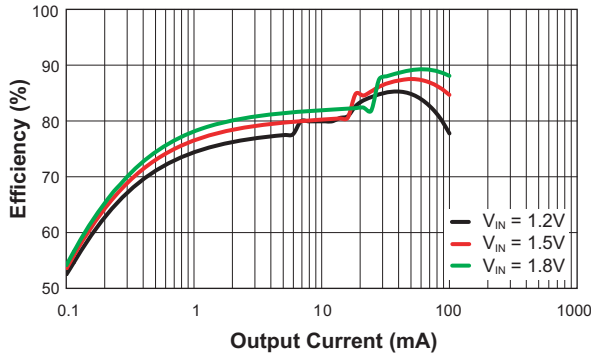
Symbol	Description	Conditions	Min	Typ	Max	Units
$V_{IN}$	Minimum Start-Up Voltage	$I_{LOAD} = 1mA$ ; $V_{OUT} = 3.3V$		1.0		V
	Operating Input Voltage Range	$I_{OUT} \leq 50mA$	0.8		$V_{OUT}$	
$V_{OUT}$	Output Voltage Accuracy	$V_{IN} = 1.0V$ to $2.5V$ , PWM Mode; $V_{OUT} = 3.3V$	$V_{OUT} - 0.1$		$V_{OUT} + 0.1$	V
$I_Q$	Quiescent Supply Current (Light Load Operation) <sup>2</sup>	No Load		65	115	$\mu A$
$I_{SHDN}$	Shutdown Current	$EN = 0V$ , $V_{IN} = 3.3V$			1.0	$\mu A$
$R_{DS(ON)H}$	PMOS On-Resistance	$T_A = 25^{\circ}C$		750		$m\Omega$
$R_{DS(ON)L}$	NMOS On-Resistance	$T_A = 25^{\circ}C$		400		$m\Omega$
$I_{LIMIT}$	NMOS Current Limit		0.6	1.0		A
$I_{PFM}$	PFM Light Load Current Threshold			20		mA
$\eta$	Efficiency	$I_{OUT} = 50mA$ , $L = 2.2\mu H$ , $V_{IN} = 1.8V$		89		%
$\frac{\Delta V_{OUT}}{V_{OUT}}$	Load Regulation	$I_{LOAD} = 0$ to $100mA$		1.5		%
$\frac{\Delta V_{OUT}}{V_{OUT}/\Delta V_{IN}}$	Line Regulation	$V_{IN} = 0.8V$ to $2.5V$ ; $I_{OUT} = 50mA$		0.2		%/V
$F_{OSC}$	Switching Frequency	$T_A = 25^{\circ}C$	1.8	2.0	2.2	MHz
$D_{TYMAX}$	Maximum Duty Cycle			90		%
$V_{TH(L-IN)}$	Logic Input Low Threshold for EN				0.4	V
$V_{TH(H-IN)}$	Logic Input High Threshold for EN		1.0			V

1. The AAT2265 is guaranteed to meet performance specifications over the  $-40^{\circ}C$  to  $+85^{\circ}C$  operating temperature range and is assured by design, characterization, and correlation with statistical process controls.

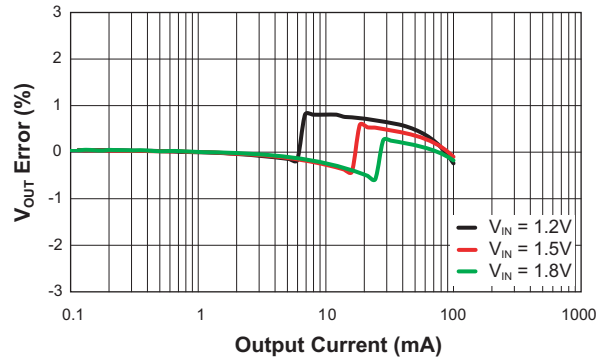
2.  $I_Q = I_{Q\_VOUT} + I_{Q\_VCC}$ .

## Typical Characteristics

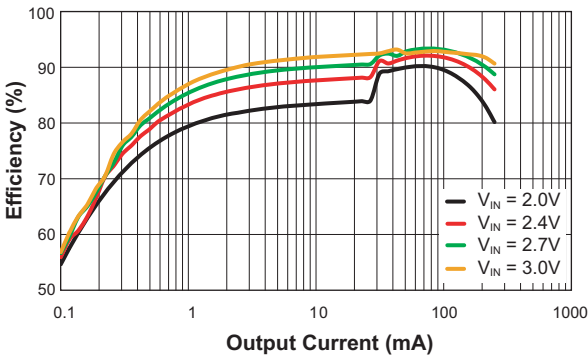
**Single-Cell to 3.3V Efficiency vs. Output Current**  
( $V_{OUT} = 3.3V$ ;  $L = 2.2\mu H$ )



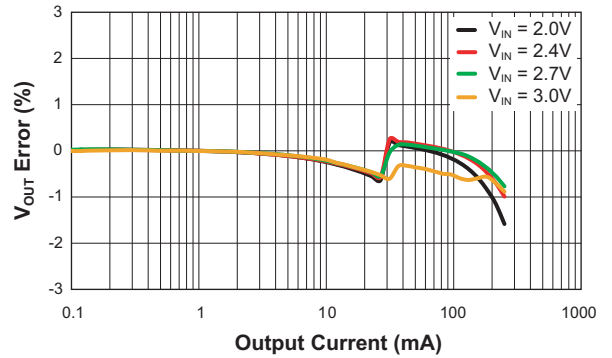
**Single-Cell to 3.3V Load Regulation**  
( $V_{OUT} = 3.3V$ ;  $L = 2.2\mu H$ )



**Dual-Cell to 3.3V Efficiency vs. Output Current**  
( $V_{OUT} = 3.3V$ ;  $L = 2.2\mu H$ )

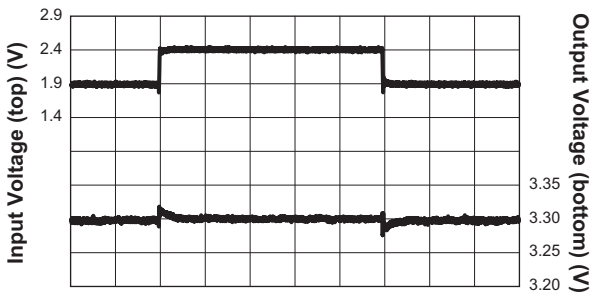


**Dual-Cell to 3.3V Load Regulation**  
( $V_{OUT} = 3.3V$ ;  $L = 2.2\mu H$ )



**Line Transient Response**

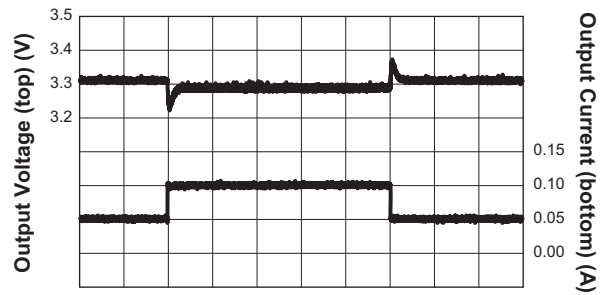
( $V_{IN} = 1.9V$  to  $2.4V$ ;  $V_{OUT} = 3.3V$ ;  $I_{OUT} = 50mA$ ;  $C_{OUT} = 4.7\mu F$ )



Time (100µs/div)

**Load Transient Response**

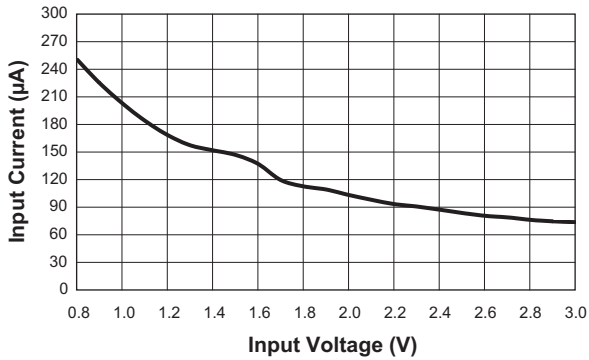
( $V_{IN} = 1.2V$ ;  $V_{OUT} = 3.3V$ ;  $I_{OUT} = 50mA$  to  $100mA$ ;  $C_{OUT} = 4.7\mu F$ )



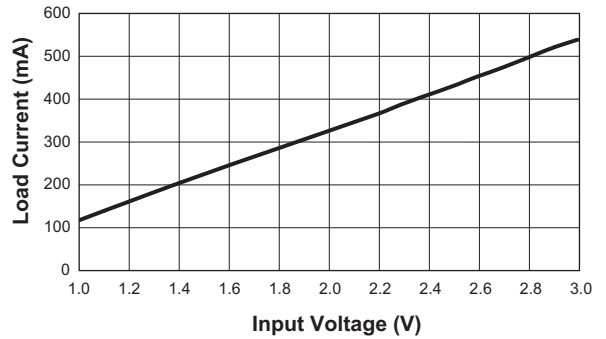
Time (200µs/div)

Typical Characteristics

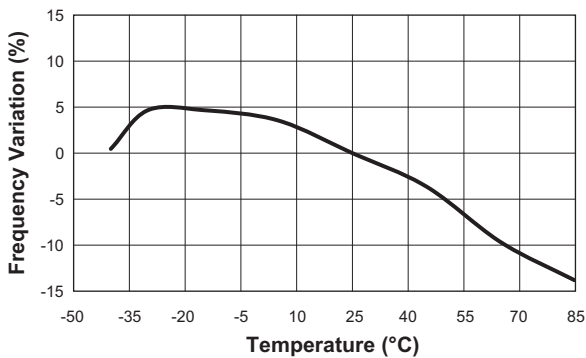
**No Load Input Current vs. Input Voltage**  
( $V_{EN} = V_{IN}$ ;  $V_{OUT} = 3.3V$ )



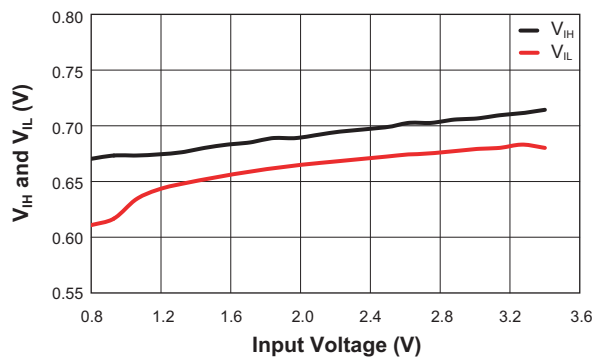
**Maximum Load Current Capability for a 4% Drop in Output Voltage vs. Input Voltage**  
( $V_{OUT} = 3.3V$ )



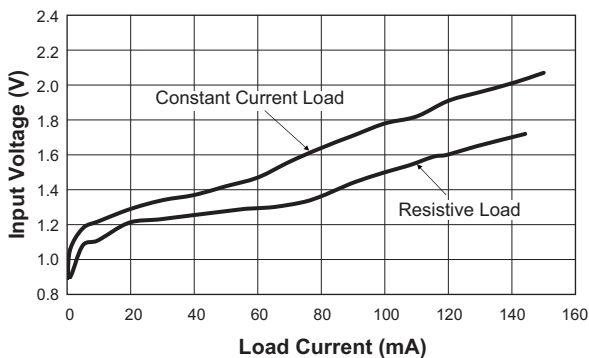
**Switching Frequency vs. Temperature**  
( $V_{IN} = 2V$ ;  $I_{OUT} = 100mA$ )



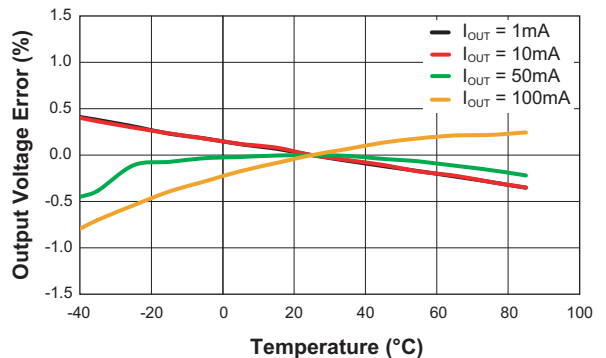
**$V_{IH}$  and  $V_{IL}$  vs. Input Voltage**



**Minimum Start-Up Input Voltage vs. Load Current**

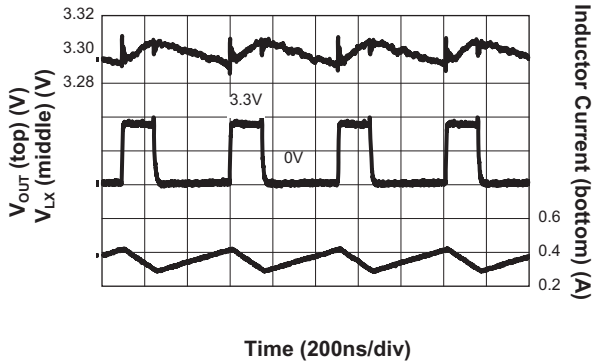


**Output Voltage Error vs. Temperature**  
( $V_{IN} = 1.5V$ ;  $V_{OUT} = 3.3V$ )

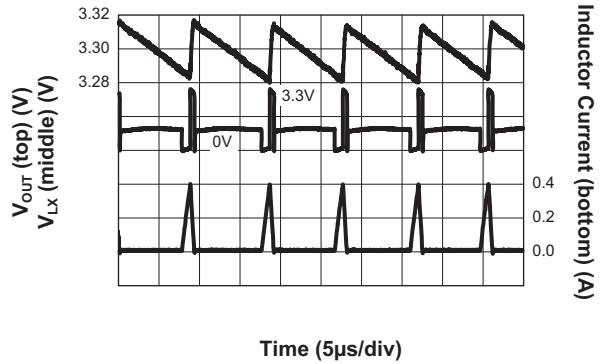


Typical Characteristics

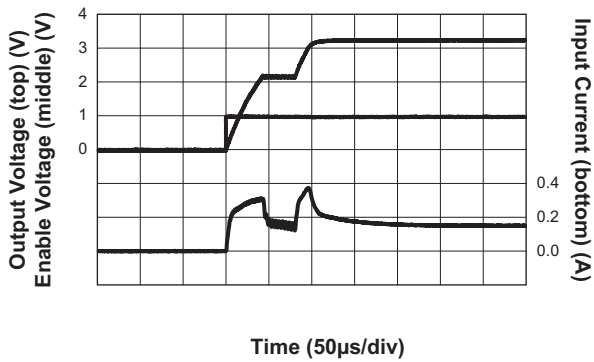
**Full Load Output Ripple**  
( $V_{IN} = 1.2V$ ;  $V_{OUT} = 3.3V$ ;  $I_{OUT} = 100mA$ )



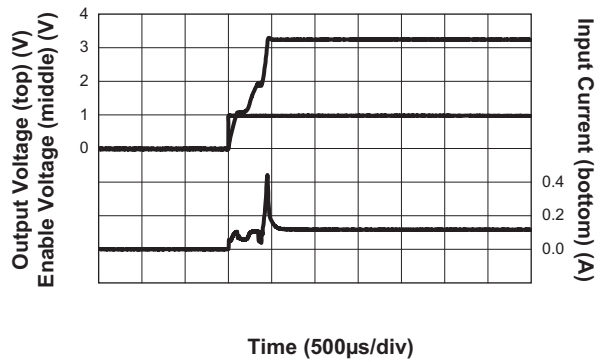
**Light Load Output Ripple**  
( $V_{IN} = 1.2V$ ;  $V_{OUT} = 3.3V$ ;  $I_{OUT} = 10mA$ )



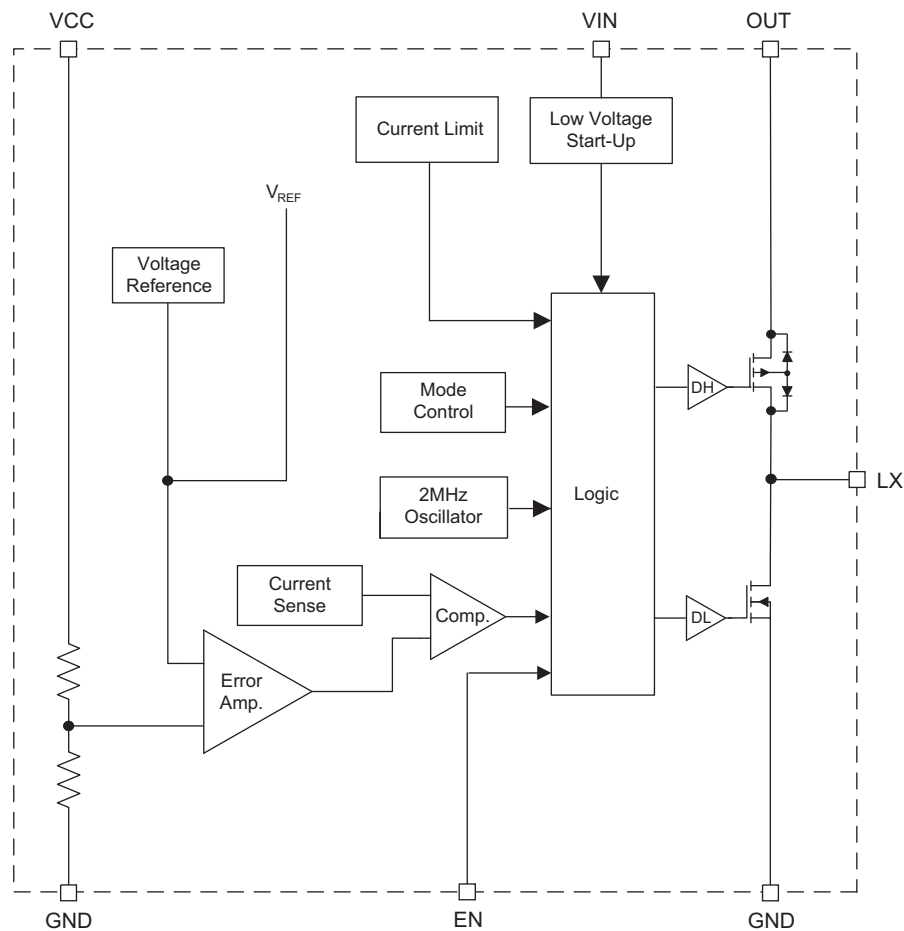
**Soft-Start Inrush Current**  
( $V_{IN} = 2.4V$ ;  $V_{OUT} = 3.3V$ ;  $I_{OUT} = 100mA$ )



**Soft-Start Inrush Current**  
( $V_{IN} = 1.2V$ ;  $V_{OUT} = 3.3V$ ;  $I_{OUT} = 40mA$ )



## Functional Block Diagram



## Functional Description

The AAT2265 synchronous step-up converter is targeted for single- or dual-cell alkaline, NiMH and NiCd battery applications. It has a 1V typical start-up voltage with operation after start-up to 0.8V.

The high 2MHz switching frequency of the AAT2265 facilitates output filter component size reduction for improved power density and reduced overall footprint. It also provides greater bandwidth and improved transient response over other lower frequency step-up converters. The compensation and feedback is integrated with only three external components ( $C_{IN}$ ,  $C_{OUT}$ , L).

Low  $R_{DS(ON)}$  synchronous power switches provide high efficiency for heavy load conditions. Switching frequency modulation and low quiescent current maintains this high efficiency for light load and sleep mode conditions.

In addition to the improved efficiency, the synchronous boost has the added performance advantage of true load disconnect during shutdown ( $<1\mu A$  shutdown current), inrush current limit, and short-circuit protection.

## PWM / Light Load Control

The AAT2265 is a high frequency PWM peak current mode control step-up converter. For light load conditions (10 to 20mA and below), the converter transitions to a variable frequency (Light Load) mode to reduce the dominant switching losses. In addition to Light Load operation, a zero current comparator blocks reverse current in the P-channel synchronous MOSFET, forcing DCM operation at light load. These controls, along with very low quiescent current, help to maintain high efficiency over the complete load range without the compromise of increased output voltage ripple during light load conditions.



### Start-up and Inrush Current Limit

The start-up sequence of the AAT2265 varies depending upon whether the input voltage is greater than or less than 2V. Above 1V, a start-up oscillator operating at 25% duty cycle controls the synchronous power stage and charges the output to 2V. For an input voltage greater than 2V, the output is charged at a constant current of 300mA until the output reaches a voltage level just below the input voltage. The step-up converter then takes control and continues to charge the output to the steady-state voltage. The step-up converter N-channel switch current is limited to 1A and the typical start-up time is approximately 1ms dependant upon load conditions.

### Shutdown and Output Disconnect

A typical synchronous step-up (boost) converter has a conduction path from the input to the output via the body diode of the P-channel MOSFET. The AAT2265 design disconnects this body diode from the output and eliminates this conduction path. This enables the AAT2265 to provide true load disconnect during shutdown and inrush current limit at turn-on.

### Short-Circuit Protection

The AAT2265 is designed to function from a single AA cell battery which is typically in the range of 1.5V to 0.8V during discharge. The part is guaranteed to operate at 0.8V with less than 50mA load current because the control circuitry is powered off the output of the boost. This unique mode of operation allows the device to run down to very low input voltages while maintaining control of regulation, temperature and short circuit protection. The P-channel synchronous MOSFET body diode disconnect feature also gives the AAT2265 the ability to provide limited output short-circuit current protection. However, when the output is shorted directly to ground, there is a loss of control circuitry, so the short circuit protection is limited by the current source of the battery. For single cell AA, the device can withstand a dead short. But since the control circuitry is not functional during the short circuit event, the part can be damaged if a source greater than an AA battery is used to power the device. A resistive short where the output does not go below approximately 2V will be short circuit protected even at higher than 1.5V input voltage levels.

### Applications Information

#### Inductor Selection

The AAT2265 is designed to operate with a 2.2μH inductor for all input/output voltage combinations. The inductor saturation current rating should be greater than the NMOS current limit specification listed in the Electrical Characteristics table. If necessary, the peak inductor current can exceed the saturation level by a small amount with no significant effect on performance. Table 1 provides a list of some suggested inductor manufacturers and their part numbers.

#### Output and Input Capacitor Selection

Surface mount X5R or X7R ceramic capacitors are suggested for both the output and the input. For the output capacitor (C1 in Figure 4) a 4.7μF, 10V, X5R ceramic capacitor is necessary for stability, transient response, and ripple performance. The same 0805 sized capacitor is used for the input (C2 of Figure 4). If desired, a smaller, 0603 sized, 4.7μF, 6.3V, X5R ceramic capacitor can be substituted for the input capacitor (C2). Suggested ceramic capacitor suppliers are listed in Table 1.

#### PCB Layout Guidelines

Figures 1, 2, and 3 display the evaluation board layout and suggested component placement. Due to the high switching speed of the AAT2265, it is important that the evaluation board layout be followed. Even the best switch-mode power supply design cannot overcome the problems that can be caused by a poor layout.

For the AAT2265, it is necessary that C1 and C2 be placed as close as possible to the IC with a good low impedance path to the GND pins of the IC. It is also good practice to minimize the length of the trace from the OUT pin to the output inductor. This prevents switching noise from radiating into other high noise sensitive, high impedance circuits.

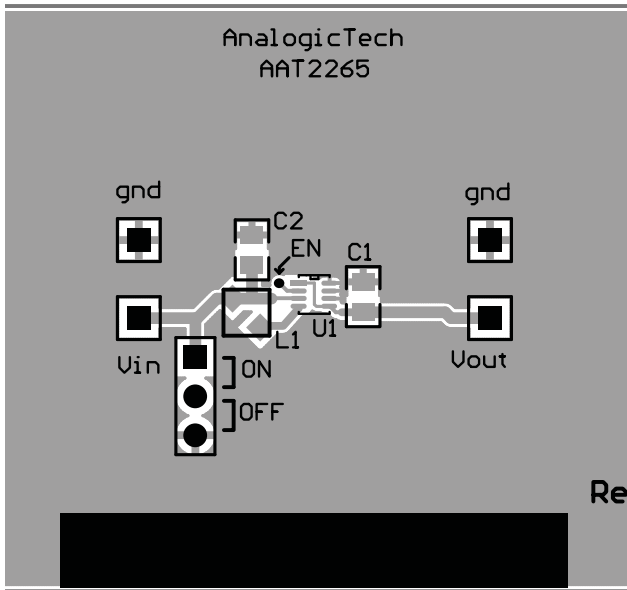


Figure 1: AAT2265 Evaluation Board Top Side.

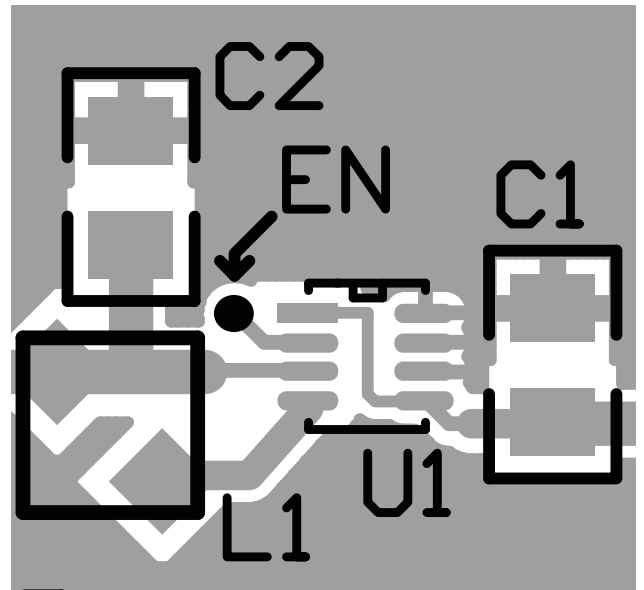


Figure 2: Component Placement.

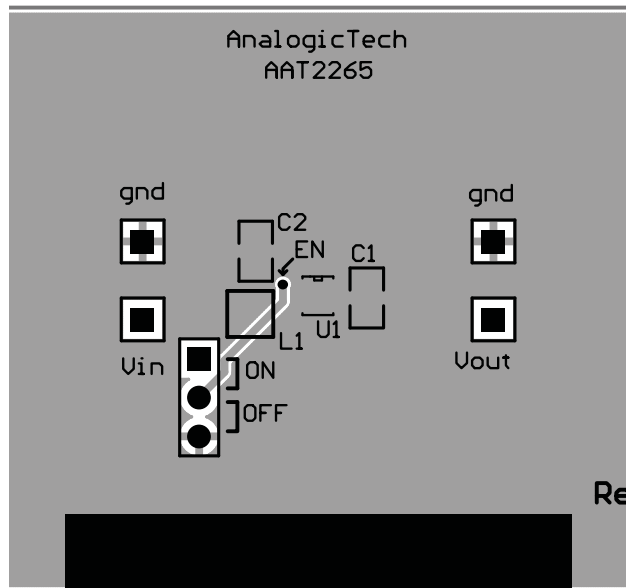


Figure 3: AAT2265 Evaluation Board Bottom Side.

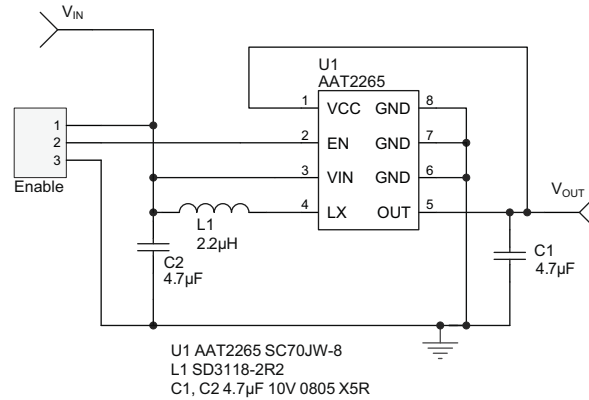


Figure 4: AAT2265 Evaluation Board Schematic.

Manufacturer	Value	Part	Voltage	Case Size	Part Number	
Murata www.murata.com	4.7µF	Output or Input Capacitor	10V	0805	GRM21BR61A475KA73L	
		Input Capacitor	6.3V	0603	GRM188R60J475KE19D	
TDK www.tdk.com	4.7µF	Output or Input Capacitor	10V	0805	C2012X5R1A475K	
		Input Capacitor	6.3V	0603	C1608X5ROJ475K	
Taiyo Yuden www.t-yuden.com	4.7µF	Output or Input Capacitor	10V	0805	LMK212BJ475MG	
		Input Capacitor	6.3V	0603	JMK107BJ475MA	
Manufacturer	Value	Part	I <sub>SAT</sub>	DCR	Case Size	Part Number
Sumida www.sumida.com	2.2µH	Inductor	1.50A	75mΩ	3.2 x 3.2 x 1.55	CDRH2D14-2R2
Cooper Electronics www.cooperet.com	2.2µH	Inductor	1.62A	69mΩ	3.1 x 3.1 x 1.85	SD3118-2R2

Table 1: Suggested Component Selection.

## Ordering Information

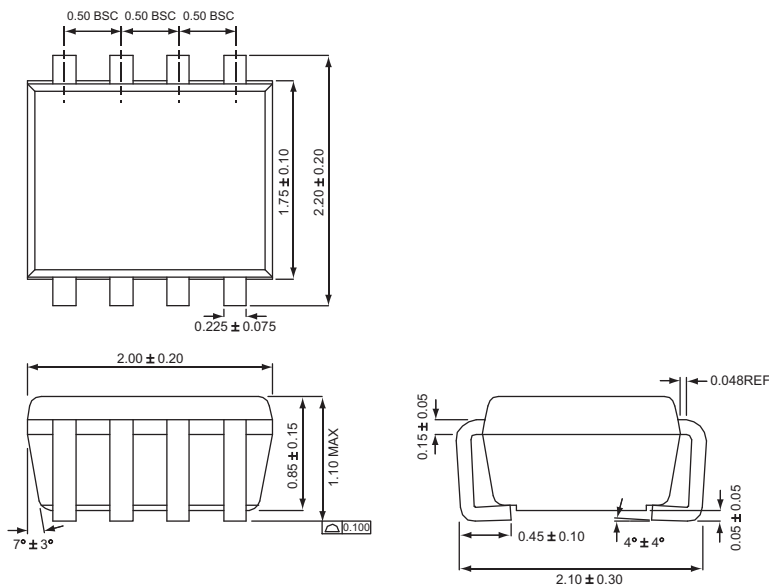
Voltage	Package	Marking <sup>1</sup>	Part Number (Tape and Reel) <sup>2</sup>
3.0V	SC70JW-8		AAT2265IJS-3.0-T1
3.3V	SC70JW-8	ZIXYY	<b>AAT2265IJS-3.3-T1</b>
3.6V	SC70JW-8		AAT2265IJS-3.6-T1
5.0V	SC70JW-8		AAT2265IJS-5.0-T1



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## Package Information

SC70JW-8



All dimensions in millimeters.

1. XYY = assembly and date code.
2. Sample stock is generally held on part numbers listed in **BOLD**. Other output voltages can be factory programmed in 100mV intervals from 2.5V to 5.0V. Contact your local sales representative for availability and minimum order quantities.

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