General Description

The AAT1150 is a step-down, SwitchReg™, switching converter ideal for applications where high efficiency, small size, and low ripple are critical. Able to deliver 1A with internal power MOSFETs, the current-mode controlled IC provides high efficiency using synchronous rectification. Fully internally compensated, the AAT1150 simplifies system design and lowers external parts count.

The AAT1150 is available in a Pb-free, MSOP-8 package and is rated over the -40°C to +85°C temperature range.

Features

- \( V_{\text{in}} \) Range: 2.7V to 5.5V
- Up to 95% Efficiency
- 110mΩ \( R_{\text{DS(ON)}} \) MOSFET Switch
- <1.0μA of Shutdown Current
- 1MHz Switching Frequency
- Adjustable \( V_{\text{out}} \): 1.0V to 4.2V
- High Initial Accuracy: ±1%
- 1.0A Peak Current
- Integrated Power Switches
- Synchronous Rectification
- Internally Compensated Current Mode Control
- Constant PWM Mode for Low Output Ripple
- Internal Soft Start
- Current Limit Protection
- Over-Temperature Protection
- MSOP-8 package
- -40°C to +85°C Temperature Range

Applications

- Cable/DSL Modems
- Computer Peripherals
- High Efficiency Conversion From 5V or 3.3V Supply
- Network Cards
- Set-Top Boxes

Typical Application

\[
\begin{align*}
V_{\text{in}} & : 2.7V - 5.5V \\
100\Omega & \\
10\mu F & \\
0.1\mu F & \\
\text{AAT1150} & \\
VP & \\
VCC & \\
ENABLE & \\
SGND & \\
LX & \\
LX & \\
FB & \\
PGND & \\
4.1\mu H & \\
3x22\mu F & \\
6.3V & \\
V_{\text{out}} & : 1.0V - 4.2V \\
\end{align*}
\]
Pin Descriptions

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Symbol</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FB</td>
<td>Feedback input pin. This pin is connected to an external resistive divider for an adjustable output.</td>
</tr>
<tr>
<td>2</td>
<td>SGND</td>
<td>Signal ground.</td>
</tr>
<tr>
<td>3</td>
<td>EN</td>
<td>Enable input pin. When connected high, the AAT1150 is in normal operation. When connected low, it is powered down. This pin should not be left floating.</td>
</tr>
<tr>
<td>4</td>
<td>VCC</td>
<td>Power supply. It supplies power for the internal circuitry.</td>
</tr>
<tr>
<td>5</td>
<td>VP</td>
<td>Input supply voltage for converter power stage.</td>
</tr>
<tr>
<td>6, 7</td>
<td>LX</td>
<td>Inductor connection pins. These pins should be connected to the output inductor. Internally, Pins 6 and 7 are connected to the drains of the P-channel switch and N-channel synchronous rectifier.</td>
</tr>
<tr>
<td>8</td>
<td>PGND</td>
<td>Power ground return for the output stage.</td>
</tr>
</tbody>
</table>

Pin Configuration
AAT1150

IMHz 1A Step-Down DC/DC Converter

**DATA SHEET**

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCC, VP</td>
<td>VCC, VP to GND</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>VLX</td>
<td>LX to GND</td>
<td>-0.3 to VP + 0.3</td>
<td>V</td>
</tr>
<tr>
<td>VFB</td>
<td>FB to GND</td>
<td>-0.3 to VCC + 0.3</td>
<td>V</td>
</tr>
<tr>
<td>VEN</td>
<td>EN to GND</td>
<td>-0.3 to 6</td>
<td>V</td>
</tr>
<tr>
<td>TJ</td>
<td>Operating Junction Temperature Range</td>
<td>-40 to 150</td>
<td>°C</td>
</tr>
<tr>
<td>VESD</td>
<td>ESD Rating² - HBM</td>
<td>3000</td>
<td>V</td>
</tr>
</tbody>
</table>

**Thermal Characteristics**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΘJA</td>
<td>Maximum Thermal Resistance</td>
<td>150</td>
<td>°C/W</td>
</tr>
<tr>
<td>PD</td>
<td>Maximum Power Dissipation (TA = 25°C)³</td>
<td>667</td>
<td>mW</td>
</tr>
</tbody>
</table>

**Recommended Operating Conditions**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Rating</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>Ambient Temperature Range</td>
<td>-40 to +85</td>
<td>°C</td>
</tr>
</tbody>
</table>

1. Stresses above those listed in Absolute Maximum Ratings may cause permanent damage to the device. Functional operation at conditions other than the operating conditions specified is not implied.
2. Human body model is a 100pF capacitor discharged through a 1.5kW resistor into each pin.
3. Mounted on a demo board.
4. Derate 6.7mW/°C above 25°C.
**Electrical Characteristics**

$V_{IN} = V_{CC} = V_s = 5V, T_A = -40^\circ C$ to $+85^\circ C$, unless otherwise noted. Typical values are at $T_A = 25^\circ C$.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>Input Voltage Range</td>
<td></td>
<td>2.7</td>
<td>5.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Output Voltage Tolerance</td>
<td>$V_{IN} = V_{OUT} + 0.3$ to $5.5V, I_{OUT} = 0$ to $1A$</td>
<td>-4.0</td>
<td>4.0</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>$\Delta V_{OUT} / (\Delta V_{IN})$</td>
<td>Load Regulation</td>
<td>$V_{IN} = 4.2V, I_{LOAD} = 0$ to $1A$</td>
<td>3.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta V_{OUT} / V_{OUT}$</td>
<td>Line Regulation</td>
<td>$V_{IN} = 2.7V$ to $5.5V$</td>
<td>0.2</td>
<td></td>
<td></td>
<td>%/V</td>
</tr>
<tr>
<td>$V_{IL,O}$</td>
<td>Under-Voltage Lockout</td>
<td>$V_{IN}$ Rising</td>
<td></td>
<td>2.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{IL,F}$</td>
<td>Under-Voltage Lockout</td>
<td>$V_{IN}$ Falling</td>
<td></td>
<td></td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>$V_{UVLO(HYS)}$</td>
<td>Under-Voltage Lockout Hysteresis</td>
<td></td>
<td>250</td>
<td></td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>$I_Q$</td>
<td>Quiescent Supply Current</td>
<td>$V_{EN} = 0V, V_{IN} = 5.5V$</td>
<td>160</td>
<td>300</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$I_{SHDN}$</td>
<td>Shutdown Current</td>
<td>$V_{EN} = 0V, V_{IN} = 5.5V$</td>
<td></td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{ILM}$</td>
<td>Current Limit</td>
<td>$T_A = 25^\circ C$</td>
<td></td>
<td>1.2</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>$R_{DS(OH)}$</td>
<td>High Side Switch On Resistance</td>
<td>$T_A = 25^\circ C$</td>
<td></td>
<td>110</td>
<td>150</td>
<td>mΩ</td>
</tr>
<tr>
<td>$R_{DS(OL)}$</td>
<td>Low Side Switch On Resistance</td>
<td></td>
<td></td>
<td>100</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>$\eta$</td>
<td>Efficiency</td>
<td>$V_{IN} = 5V, V_{OUT} = 3.3V, I_{OUT} = 600mA$</td>
<td>93</td>
<td></td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>$V_{EN(L)}$</td>
<td>Enable Low Voltage</td>
<td>$V_{IN} = 2.7V$ to $5.5V$</td>
<td></td>
<td>0.6</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{EN(H)}$</td>
<td>Enable High Voltage</td>
<td></td>
<td></td>
<td></td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>$I_{EN}$</td>
<td>Enable Pin Leakage Current</td>
<td>$V_{EN} = 5.5V$</td>
<td></td>
<td>1.0</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$F_{OSC}$</td>
<td>Oscillator Frequency</td>
<td>$T_A = 25^\circ C$</td>
<td>700</td>
<td>1000</td>
<td>1200</td>
<td>kHz</td>
</tr>
<tr>
<td>$T_{SD}$</td>
<td>Over-Temperature Shutdown Threshold</td>
<td></td>
<td></td>
<td>140</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>$T_{HYS}$</td>
<td>Over-Temperature Shutdown Hysteresis</td>
<td></td>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Typical Characteristics

Efficiency vs. Output Current
(Vout = 1.5V)

Efficiency vs. Output Current
(Vout = 3.3V)

High Side RDS(ON) vs. Temperature

Low Side RDS(ON) vs. Temperature

RDS(ON) vs. Input Voltage

Enable Threshold vs. Input Voltage

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Typical Characteristics

Oscillator Frequency Variation vs. Supply Voltage

Oscillator Frequency Variation vs. Temperature $(V_{IN} = 3.6V)$

Output Voltage vs. Temperature $(I_{OUT} = 900mA; V_{OUT} = 1.5V)$

Line Regulation $(V_{OUT} = 1.5V)$

Load Regulation $(V_{OUT} = 1.5V; V_{IN} = 3.6V)$

Load Regulation $(V_{OUT} = 3.3V; V_{IN} = 5.0V)$
Typical Characteristics

Efficiency vs. Input Voltage
(V<sub>out</sub> = 1.5V)

![Efficiency vs. Input Voltage Graph](image)

AAT1150 Loop Gain and Phase
(C<sub>0</sub> = 22μF; V<sub>o</sub> = 1.5V; V<sub>in</sub> = 3.6V; I<sub>o</sub> = 1A)

![AAT1150 Loop Gain and Phase Graph](image)

No Load Input Current vs. Temperature
(V<sub>cc</sub> = V<sub>p</sub>)

![No Load Input Current vs. Temperature Graph](image)

Non-Switching I<sub>o</sub> vs. Temperature
(FB = 0V; V<sub>p</sub> = V<sub>cc</sub>)

![Non-Switching I<sub>o</sub> vs. Temperature Graph](image)

Switching Waveform
(V<sub>in</sub> = 3.6V; V<sub>out</sub> = 1.5V; I<sub>out</sub> = 1.2A)

![Switching Waveform Graph](image)

Transient Response
(V<sub>in</sub> = 3.6V; V<sub>out</sub> = 1.5V; I<sub>load</sub> = 0.25 to 1.2A)

![Transient Response Graph](image)
Typical Characteristics

Output Ripple
\( \text{VIN} = 3.6V; \text{VOUT} = 1.5V; \text{IOUT} = 0A \)

\[
\begin{align*}
\text{VOUT} & \quad 5\text{mV/div} \\
\text{BW} & \quad = 20\text{MHz} \\
\text{LX} & \quad 2\text{V/div} \\
\text{Time (500ns/div)}
\end{align*}
\]

Output Ripple
\( \text{VIN} = 3.6V; \text{VOUT} = 1.5V; \text{IOUT} = 1A \)

\[
\begin{align*}
\text{VOUT} & \quad 5\text{mV/div} \\
\text{BW} & \quad = 20\text{MHz} \\
\text{LX} & \quad 2\text{V/div} \\
\text{Time (500ns/div)}
\end{align*}
\]

Output Ripple
\( \text{VIN} = 5.0V; \text{VOUT} = 3.3V; \text{IOUT} = 0A \)

\[
\begin{align*}
\text{VOUT} & \quad 5\text{mV/div} \\
\text{BW} & \quad = 20\text{MHz} \\
\text{LX} & \quad 2\text{V/div} \\
\text{Time (500ns/div)}
\end{align*}
\]

Output Ripple
\( \text{VIN} = 5.0V; \text{VOUT} = 3.3V; \text{IOUT} = 1A \)

\[
\begin{align*}
\text{VOUT} & \quad 5\text{mV/div} \\
\text{BW} & \quad = 20\text{MHz} \\
\text{LX} & \quad 2\text{V/div} \\
\text{Time (500ns/div)}
\end{align*}
\]

Inrush Limit
\( \text{VIN} = 3.6V; \text{VOUT} = 1.5V; \text{I}_L = 1A \)

\[
\begin{align*}
\text{Enable} & \quad 2\text{V/div} \\
\text{VOUT} & \quad 1\text{V/div} \\
\text{I}_L & \quad 0.5\text{A/div} \\
\text{Time (200\mu s/div)}
\end{align*}
\]
Applications Information

Control Loop
The AAT1150 is a peak current mode buck converter. The inner wide bandwidth loop controls the peak current of the output inductor. The output inductor current is sensed through the P-channel MOSFET (high side) and is also used for short-circuit and overload protection. A fixed slope compensation signal is added to the sensed current to maintain stability. The loop appears as a voltage-programmed current source in parallel with the output capacitor.

The voltage error amplifier output programs the current loop for the necessary inductor current to force a constant output voltage for all load and line conditions. The feedback resistive divider is external, dividing the output voltage to the error amplifier reference voltage of 1.0V. The error amplifier does not have a large DC gain typical of most error amplifiers. This eliminates the need for external compensation components while still providing sufficient DC loop gain for load regulation. The crossover frequency and phase margin are set by the output capacitor value only.

Soft Start/Enable
Soft start increases the inductor current limit point in discrete steps when the input voltage or enable input is applied. It limits the current surge seen at the input and eliminates output voltage overshoot. The enable input, when pulled low, forces the AAT1150 into a low power, non-switching state. The total input current during shutdown is less than 1μA.
Power and Signal Source

Separate small signal ground and power supply pins to isolate the internal control circuitry from the noise associated with the output MOSFET switching. The low pass filter R1 and C7 in schematic Figures 1 and 2 filters the noise associated with the power switching.

Current Limit and Over-Temperature Protection

For overload conditions, the peak input current is limited. Figure 3 displays the current limit characteristics. As load impedance decreases and the output voltage falls closer to zero, more power is dissipated internally, raising the device temperature. Thermal protection completely disables switching when internal dissipation becomes excessive, protecting the device from damage. The junction over-temperature threshold is 140°C with 15°C of hysteresis.

Figure 1: Lithium-Ion to 1.5V Converter.

Figure 2: 5V Input to 3.3V Output Converter.
The output inductor is selected to limit the ripple current to some predetermined value, typically 20% to 40% of the full load current at the maximum input voltage. Manufacturer's specifications list both the inductor DC current rating, which is a thermal limitation, and the peak current rating, which is determined by the saturation characteristics. The inductor should not show any appreciable saturation under normal load conditions. During overload and short-circuit conditions, the average current in the inductor can meet or exceed the $I_{\text{LIMIT}}$ point of the AAT1150 without affecting converter performance. Some inductors may have sufficient peak and average current ratings yet result in excessive losses due to a high DCR. Always consider the losses associated with the DCR and its effect on the total converter efficiency when selecting an inductor.

For a 1.0A load and the ripple set to 30% at the maximum input voltage, the maximum peak-to-peak ripple current is 300mA. The inductance value required is $3.9\mu\text{H}$.

$$L = \frac{V_{\text{OUT}}}{I_{\text{O}} \cdot k \cdot F_{\text{s}}} \left(1 - \frac{V_{\text{OUT}}}{V_{\text{IN}}}ight)$$

$$L = \frac{1.5\text{V}}{1.0\text{A} \cdot 0.3 \cdot 830\text{kHz}} \left(1 - \frac{1.5\text{V}}{4.2\text{V}}\right)$$

$$L = 3.9\mu\text{H}$$

The factor "k" is the fraction of full load selected for the ripple current at the maximum input voltage. The corresponding inductor RMS current is:

$$I_{\text{RMS}} = \sqrt{\frac{I_{\text{O}}^2 + \Delta I^2}{2}} \approx I_{\text{O}} = 1.0\text{A}$$

$\Delta I$ is the peak-to-peak ripple current which is fixed by the inductor selection above. For a peak-to-peak current of 30% of the full load current, the peak current at full load will be 115% of the full load. The 4.1$\mu\text{H}$ inductor selected from the Sumida CDRH5D18 series has a 57m$\Omega$ DCR and a 1.95A DC current rating. At full load, the inductor DC loss is 57mW which amounts to a 3.8% loss in efficiency.

**Input Capacitor**

The primary function of the input capacitor is to provide a low impedance loop for the edges of pulsed current drawn by the AAT1150. A low ESR/ESL ceramic capacitor is ideal for this function. To minimize stray inductance, the capacitor should be placed as closely as possible to the IC. This keeps the high frequency content of the input current localized, minimizing radiated and conducted EMI while facilitating optimum performance of the AAT1150. Ceramic X5R or X7R capacitors are ideal for this function. The size required will vary depending on the load, output voltage, and input voltage source impedance characteristics. A typical value is around 10$\mu$F. The input capacitor RMS current varies with the input voltage and the output voltage. The equation for the RMS current in the input capacitor is:

$$I_{\text{RMS}} = I_{\text{O}} \cdot \sqrt{\frac{V_{\text{O}}}{V_{\text{IN}}}} \left(1 - \frac{V_{\text{O}}}{V_{\text{IN}}}ight)$$

The input capacitor RMS ripple current reaches a maximum when $V_{\text{IN}}$ is two times the output voltage where it is approximately one half of the load current. Losses associated with the input ceramic capacitor are typically minimal and are not an issue. Proper placement of the input capacitor can be seen in the reference design layout shown in Figures 4 and 5.
Output Capacitor

Since there are no external compensation components, the output capacitor has a strong effect on loop stability. Larger output capacitance will reduce the crossover frequency with greater phase margin. For the 1.5V 1.0A design using the 4.1μH inductor, three 22μF 6.3V X5R capacitors provide a stable output. In addition to assisting stability, the output capacitor limits the output ripple and provides holdup during large load transitions.

The output capacitor RMS ripple current is given by:

\[ I_{RMS} = \frac{1}{2\sqrt{3}} \cdot \frac{V_{OUT} \cdot (V_{IN} - V_{OUT})}{L \cdot F_S \cdot V_{IN}} \]

For a ceramic capacitor, the dissipation due to the RMS current of the capacitor is not a concern. Tantalum capacitors, with sufficiently low ESR to meet output voltage ripple requirements, also have an RMS current rating much greater than that actually seen in this application.

Adjustable Output

For applications requiring an output other than 1V, the AAT1150 can be externally programmed. Resistors R3 and R4 of Figure 6 force the output to regulate higher than 1V. R4 should be 100 times less than the internal 1MΩ resistance of the FB pin. Once R4 is selected, R3 can be calculated. For a 1.25V output with R4 set to 10.0kΩ, R3 is 2.55kΩ.

\[ R3 = (V_O - 1) \cdot R4 = 0.25 \cdot 10.0k\Omega = 2.55k\Omega \]

Layout Considerations

Figures 4 and 5 display the suggested PCB layout for the AAT1150. The most critical aspect of the layout is the placement of the input capacitor C1. For proper operation, C1 must be placed as closely as possible to the AAT1150.

Thermal Calculations

There are two types of losses associated with the AAT1150 output switching MOSFET: switching losses and conduction losses. Conduction losses are associated with the \( R_{DS(ON)} \) characteristics of the output switching device. At full load, assuming continuous conduction mode (CCM), a simplified form of the total losses is:

\[ P_{LOSS} = \frac{I_O^2 \cdot (R_{DS(ON)H} \cdot V_O + R_{DS(ON)L} \cdot (V_{IN} - V_O))}{V_{IN}} + t_{sw} \cdot F_S \cdot I_O \cdot V_{IN} + I_O \cdot V_{IN} \]

Once the total losses have been determined, the junction temperature can be derived from the \( \theta_{JA} \) for the MSOP-8 package.
**AAT1150**

*1MHz 1A Step-Down DC/DC Converter*

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**Figure 4:** AAT1150 Evaluation Board Layout Top Layer.

**Figure 5:** AAT1150 Evaluation Board Layout Bottom Layer.

---

**Figure 6:** 3.3V to 1.25V Converter (Adjustable Output).

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C1 Murata 10μF 6.3V X5R GRM42-6X 5R106K6.3
C2, C3, C4 Murata 22μF 6.3V GRM21BR60J226ME39L X5R 0805
L1 Sumida CDRH4D28-2R7μH

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Design Example

Specifications

\( I_{\text{OUT}} = 1.0 \text{A} \)
\( I_{\text{RIPPLE}} = 30\% \text{ of Full Load at Max } V_{\text{IN}} \)
\( V_{\text{OUT}} = 1.5 \text{V} \)
\( V_{\text{IN}} = 2.7 \text{V to 4.2V (3.6V nominal)} \)
\( F_s = 830 \text{kHz} \)

Maximum Input Capacitor Ripple

\[
I_{\text{RMS}} = I_o \cdot \sqrt{\dfrac{V_o}{V_{\text{IN}}} \cdot \left(1 - \dfrac{V_o}{V_{\text{IN}}} \right)} = \dfrac{I_o}{2} = 0.5A_{\text{RMS}}, V_{\text{IN}} = 2 \cdot V_o
\]

\[
P = \text{ESR}_{\text{COUT}} \cdot I_{\text{RMS}}^2 = 5m\Omega \cdot 0.5^2 A = 1.25mW
\]

Inductor Selection

\[
L = \dfrac{V_{\text{OUT}}}{I_o \cdot k \cdot F_s} \cdot \left(1 - \dfrac{V_{\text{OUT}}}{V_{\text{IN}}} \right) = \dfrac{1.5V}{1.0A \cdot 0.3 \cdot 830kHz} \cdot \left(1 - \dfrac{1.5V}{4.2V} \right) = 3.9\mu H
\]

Select Sumida inductor CDRH5D18, 4.1\mu H, 57m\Omega, 2.0mm height.

\[
\Delta I = \dfrac{V_o}{L \cdot F_s} \cdot \left(1 - \dfrac{V_o}{V_{\text{IN}}} \right) = \dfrac{1.5V}{4.1\mu H \cdot 830kHz} \cdot \left(1 - \dfrac{1.5V}{4.2V} \right) = 280mA
\]

\[
I_{PK} = I_{\text{OUT}} + \dfrac{\Delta I}{2} = 1.0A + 0.14A = 1.14A
\]

\[
P = I_o^2 \cdot \text{DCR} = 57mW
\]

Output Capacitor Dissipation

\[
I_{\text{RMS}} = \dfrac{1}{2 \cdot \sqrt{3}} \dfrac{V_{\text{OUT}} \cdot (V_{\text{IN}} - V_{\text{OUT}})}{L \cdot F_s \cdot V_{\text{IN}}} = \dfrac{1}{2 \cdot \sqrt{3}} \cdot \dfrac{1.5V \cdot (4.2V - 1.5V)}{4.1\mu H \cdot 830kHz \cdot 4.2V} = 82mA_{\text{RMS}}
\]

\[
P_{\text{ESR}} = \text{ESR}_{\text{COUT}} \cdot I_{\text{RMS}}^2 = 5m\Omega \cdot 0.082^2 A = 33\mu W
\]
AAT1150 Dissipation

\[
P = I_O^2 \cdot \left( R_{DS(ON)H} \cdot V_O + R_{DS(ON)L} \cdot (V_{IN} - V_O) \right) \cdot \frac{V_{IN}}{V_{IN}} + (t_{sw} \cdot F_S \cdot I_O + I_Q) \cdot V_{IN} \]

\[
= \frac{(0.14\Omega \cdot 1.5V + 0.145\Omega \cdot (3.6V - 1.5V))}{3.6V} + (20\text{ns} \cdot 830kHz \cdot 1.0A + 0.3mA) \cdot 3.6V = 0.203W
\]

\[
T_{J(MAX)} = T_{AMB} + \Theta_{JA} \cdot P_{LOSS} = 85^\circ C + 150^\circ C/W \cdot 0.203W = 115^\circ C
\]

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Part Number</th>
<th>Value</th>
<th>Max DC Current</th>
<th>DCR</th>
<th>Size (mm)</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taiyo Yuden</td>
<td>NPO5DB4R7M</td>
<td>4.7μH</td>
<td>1.4A</td>
<td>0.038</td>
<td>5.9 x 6.1 x 2.8</td>
<td>Shielded</td>
</tr>
<tr>
<td>Toko</td>
<td>A9148YW-3R5M-D52LC</td>
<td>3.5μH</td>
<td>1.34A</td>
<td>0.073</td>
<td>5.0 x 5.0 x 2.0</td>
<td></td>
</tr>
<tr>
<td>Sumida</td>
<td>CDRH5D28-4R2</td>
<td>4.2μH</td>
<td>2.2A</td>
<td>0.031</td>
<td>5.7 x 5.7 x 3.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CDRH5D18-4R1</td>
<td>4.1μH</td>
<td>1.95A</td>
<td>0.057</td>
<td>5.7 x 5.7 x 2.0</td>
<td></td>
</tr>
<tr>
<td>Murata</td>
<td>LQH55DN4R7M03</td>
<td>4.7μH</td>
<td>2.7A</td>
<td>0.041</td>
<td>5.0 x 5.0 x 4.7</td>
<td>Non-Shielded</td>
</tr>
<tr>
<td></td>
<td>LQH66SN4R7M03</td>
<td>4.7μH</td>
<td>2.2A</td>
<td>0.025</td>
<td>6.3 x 6.3 x 4.7</td>
<td>Shielded</td>
</tr>
</tbody>
</table>

Table 1: Surface Mount Inductors.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Part Number</th>
<th>Value</th>
<th>Voltage</th>
<th>Temp. Co.</th>
<th>Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murata</td>
<td>GRM40 X5R 106K 6.3</td>
<td>10μF</td>
<td>6.3V</td>
<td>X5R</td>
<td>0805</td>
</tr>
<tr>
<td></td>
<td>GRM42-6 X5R 106K 6.3</td>
<td>10μF</td>
<td>6.3V</td>
<td>0805</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GRM21BR60J226ME39L</td>
<td>22μF</td>
<td>6.3V</td>
<td>X5R</td>
<td>1206</td>
</tr>
<tr>
<td></td>
<td>GRM21BR60J106ME39L</td>
<td>22μF</td>
<td>6.3V</td>
<td>0805</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Surface Mount Capacitors.
AAT1150

IMHz 1A Step-Down DC/DC Converter

Ordering Information

<table>
<thead>
<tr>
<th>Output Voltage</th>
<th>Package</th>
<th>Marking</th>
<th>Part Number (Tape &amp; Reel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0V (Ad) V_{OUT} ≥ 1.0V</td>
<td>MSOP-8</td>
<td>JZXYY</td>
<td>AAT1150IKS-1.0-T1</td>
</tr>
</tbody>
</table>

- Skyworks Green™ products are compliant with all applicable legislation and are halogen-free.
- For additional information, refer to Skyworks Definition of Green™, document number SQ04-0074.

Package Information

MSOP-8

All dimensions in millimeters.

1. XYY = assembly and date code.
2. Sample stock is held on part numbers listed in BOLD.

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