



General Description

AF7115 is a high efficiency step down DC/DC converter operated with current mode and constant frequency. The internal switch and synchronous rectifier are integrated for high efficiency. External Schottky diodes are not required. The supply current is 30 μ A (typ) during operation and drops to less than 1 μ A in shutdown. AF7115 The device operates from an input voltage range of 2.5V to 6.5V and provides an output voltage from 0.6V to VIN.

The switching frequency is set at 1.5MHz, allowing the use of small surface mount inductors and capacitors. It can run 100% duty cycle for low dropout application. Internal soft-start control circuitry reduces inrush current. Short-circuit and thermal-overload protection improves design reliability. AF7115 is available in a low profile SOT-23-5L package.

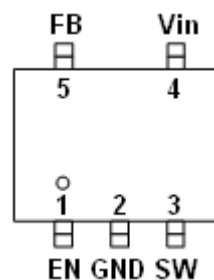
Features

- 1.5A output current
- Current mode operation
- High efficiency up to 96%
- Shutdown current < 1 μ A
- 2.5V to 6.5V supply voltage
- Internal Compensation and Soft-Start
- Thermal shutdown and UVLO
- Constant frequency operation
- Low quiescent current 30 μ A (typ)
- Full duty ratio, 0 – 100% in dropout
- RoHS Compliant and Lead (Pb) Free

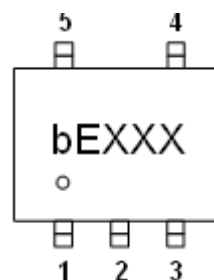
Application

- Cellular phones
- PDAs and smart phones
- MP3 and Mp4 players
- Digital cameras
- Set top boxes
- Wireless and DSL Modems
- USB supplied Devices in Notebooks
- Portable instruments

Pin Define (SOT-23-5L)

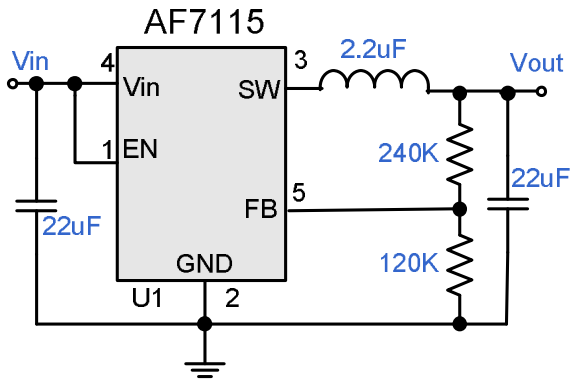


Marking Information

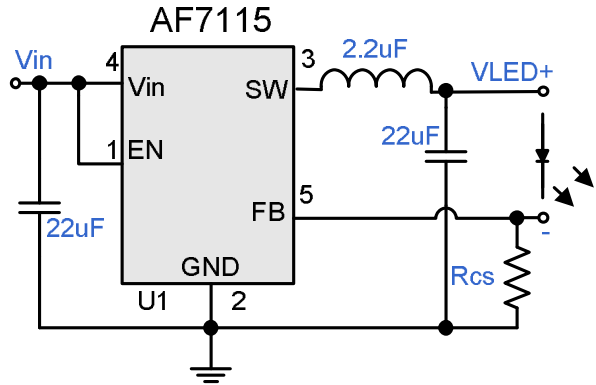




**Typical Application Circuit
DC/DC Buck Converter**



LED Application



Pin Description

| Pin | Symbol | Description |
|-----|--------|--------------------------|
| 1 | EN | Enable control input pin |
| 2 | GND | Ground pin |
| 3 | SW | Power switch output |
| 4 | Vin | Main supply pin |
| 5 | FB | Voltage feedback pin |

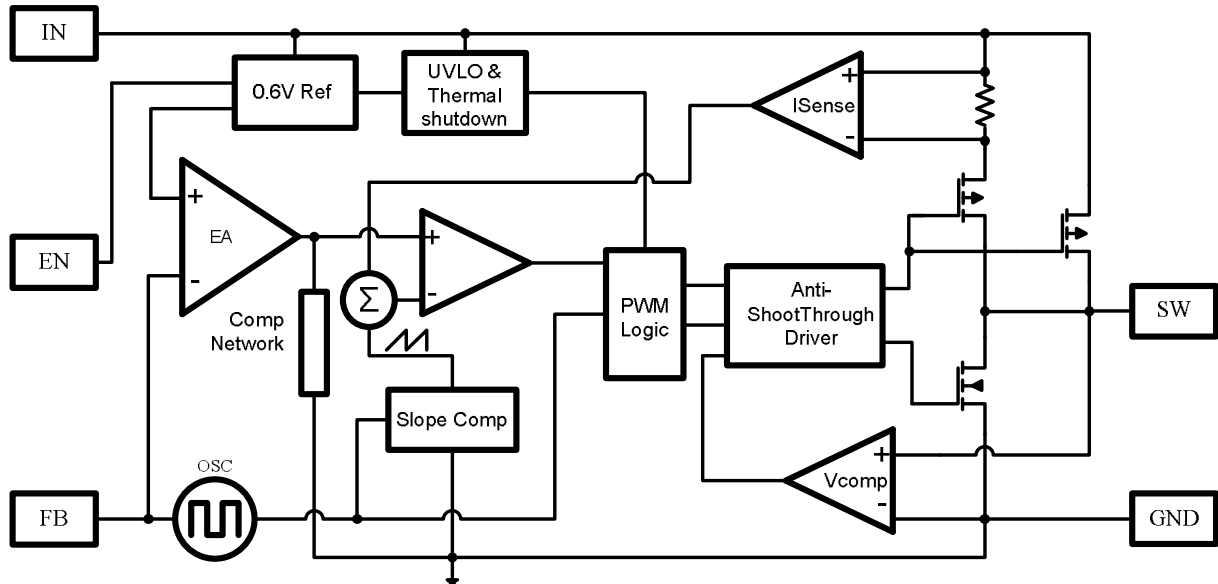
Ordering Information

| Part Ordering No. | Output Voltage | Part Marking | Package | Unit | Quantity |
|-------------------|----------------|--------------|-----------|-------------|----------|
| AF7115S25RG | Adj | bEYMD | SOT-23-5L | Tape & Reel | 3000 EA |

- ※ bE parts code
- ※ Y year code
- ※ M month code
- ※ D Date code
- ※ AF7115S25RG : Tape Reel ; Pb- Free ; Halogen- Free



Block Diagram



Absolute Maximum Ratings ($T_A=25^{\circ}\text{C}$ Unless otherwise noted)

The following ratings designate persistent limits beyond which damage to the device may occur.

| Symbol | Parameter | Value | Unit |
|---------------|----------------------------------|-------------------------|-----------------------------|
| V_{IN} | Vin to GND | -0.3 to +7.5 | V |
| V_{SW} | SW to GND | - 0.3 to $V_{IN} + 0.3$ | V |
| V_{EN} | EN to GND | - 0.3 to V_{IN} | V |
| V_{FB} | FB/Vout to GND | - 0.3 to V_{IN} | V |
| I_{SW} | SW Peak Current | 3.0 | A |
| ESD | ESD Classification | Class 2 | Level |
| J_T | Maximum Junction Temperature | 125 | $^{\circ}\text{C}$ |
| L_T | Lead Temperature (Soldering 10s) | 260 | $^{\circ}\text{C}$ |
| θ_{JA} | Thermal Resistance | 96.16 | $^{\circ}\text{C}/\text{W}$ |
| θ_{JC} | Thermal Resistance | 61.81 | $^{\circ}\text{C}/\text{W}$ |
| T_{OPR} | Operating Temperature Range | - 40 to + 85 | $^{\circ}\text{C}$ |
| T_{STG} | Storage Temperature Range | - 40 to + 150 | $^{\circ}\text{C}$ |

Caution:

Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.



Electrical Characteristics

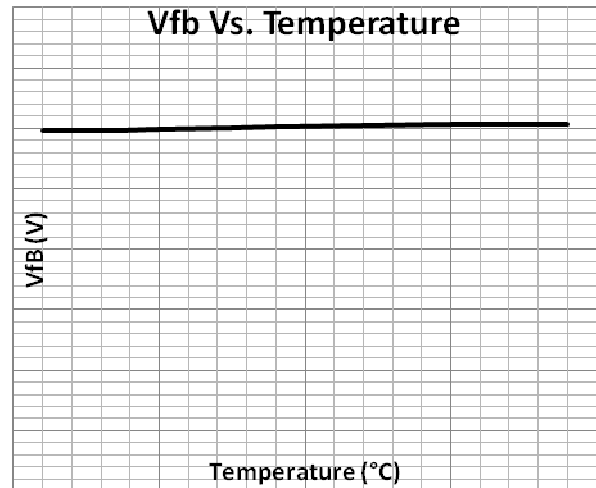
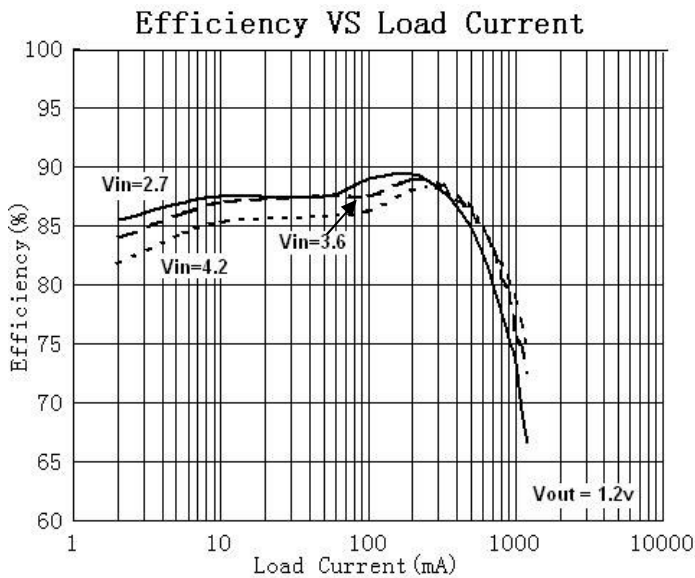
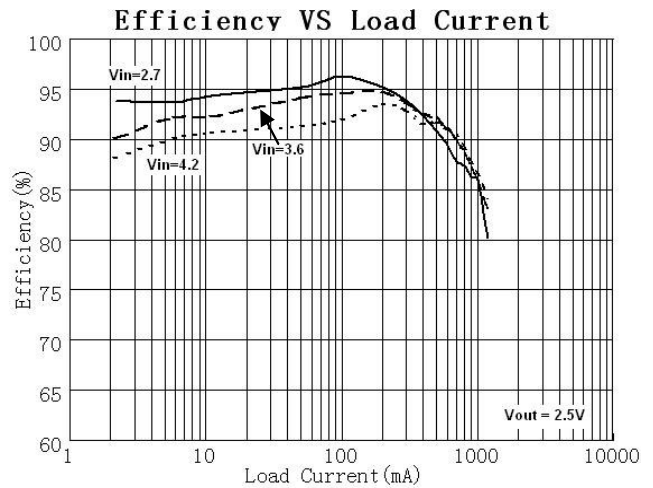
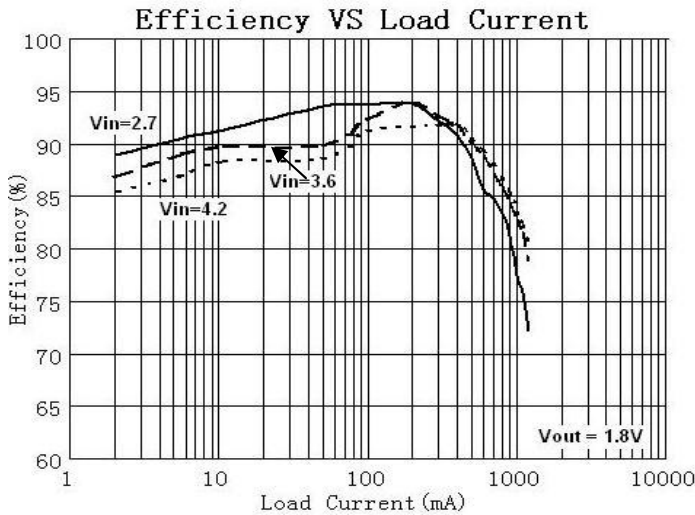
($V_{in} = 5V$, Typical values are at $T_A = +25^\circ C$, unless otherwise noted)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------|--------------------------|---|-------|------|-------|------|
| VDD | Input Voltage Range | | 2.5 | | 6.5 | V |
| Vref | Feedback Voltage | | 0.585 | 0.6 | 0.615 | V |
| I _{fb} | Feedback Leakage current | | | 0.1 | 0.4 | uA |
| I _q | Quiescent Current | Active, V _{fb} =0.65V, No Switching | | 30 | | uA |
| | | Shutdown | | | 1 | uA |
| LnReg | Line Regulation | V _{in} =2.5V to 6.5V | | 0.04 | 0.2 | %/V |
| LdReg | Load Regulation | I _{out} =0.01 to 1.5A | | 0.1 | 0.2 | %/A |
| F _{sw} | Switching Frequency | | | 1.5 | | MHz |
| R _{dsonP} | PMOS R _{dson} | | | 400 | 600 | mohm |
| R _{dsonN} | NMOS R _{dson} | | | 250 | 400 | mohm |
| I _{limit} | Peak Current Limit | | 1.7 | | | A |
| I _{swlk} | SW Leakage Current | V _{out} =5.5V, V _{SW} =0 or 5.5V, EN=0V | | | 10 | uA |
| I _{enlk} | EN Leakage Current | | | | 1 | uA |
| V _{h_en} | EN Input High Voltage | | 1.5 | | | V |
| V _{l_en} | EN Input Low Voltage | | | | 0.4 | V |



Typical Characteristics

($T_A=25^\circ\text{C}$, unless otherwise noted)





Detail Description

The AF7115 high-efficiency switching regulator is a small, simple, DC/DC converter capable of delivering up to 1.5A of output current. The device operates in pulse-width modulation (PWM) at 1.5MHz from a 2.5V to 6.5V input voltage and provides an output voltage from 0.6V to V_{IN} , making the AF7115 ideal for on-board post-regulation applications. An internal synchronous rectifier improves efficiency and eliminates the typical Schottky free-wheeling diode. Using the on resistance of the internal high-side MOSFET to sense switching currents eliminates current-sense resistors, further improving efficiency and cost.

Loop Operation

AF7115 uses a PWM current-mode control scheme. An open-loop comparator compares the integrated voltage-feedback signal against the sum of the amplified current-sense signal and the slope compensation ramp. At each rising edge of the internal clock, the internal high-side MOSFET turns on until the PWM comparator terminates the on cycle. During this on-time, current ramps up through the inductor, sourcing current to the output and storing energy in the inductor. The current mode feedback system regulates the peak inductor current as a function of the output voltage error signal. During the off cycle, the internal high-side P-channel MOSFET turns off, and the internal low-side N-channel MOSFET turns on. The inductor releases the stored energy as its current ramps down while still providing current to the output.

Current Sense

An internal current-sense amplifier senses the current through the high-side MOSFET during on time and produces a proportional current signal, which is used to sum with the slope compensation signal. The summed signal then is compared with the error amplifier output by the PWM comparator to terminate the on cycle.

Current Limit

There is a cycle-by-cycle current limit on the high-side MOSFET of 1.7A(min). When the current flowing out of SW exceeds this limit, the high-side MOSFET turns off and the synchronous rectifier turns on. AF7115 utilizes a frequency fold-back mode to prevent overheating during short-circuit output conditions. The device enters frequency fold-back mode when the FB voltage drops below 200mV, limiting the current to 1.7A (min) and reducing power dissipation. Normal operation resumes upon removal of the short-circuit condition.

Soft-Start

AF7115 has a internal soft-start circuitry to reduce supply inrush current during startup conditions. When the device exits under-voltage lockout (UVLO), shutdown mode, or restarts following a thermal-overload event, the I soft-start circuitry slowly ramps up current available at SW.

UVLO and Thermal Shutdown

If I_N drops below 2.4V, the UVLO circuit inhibits switching. Once I_N rises above 2.4V, the UVLO clears, and the soft-start sequence activates. Thermal-overload protection limits total power dissipation in the device. When the junction temperature exceeds $T_J = +160^\circ\text{C}$, a thermal sensor forces the device into shutdown, allowing the die to cool. The thermal sensor turns the device on again after the junction temperature cools by 15°C , resulting in a pulsed output during continuous overload conditions. Following a thermal-shutdown condition, the soft-start sequence begins.



Design Procedure

Setting Output Voltages

Output voltages are set by external resistors. The FB₋ threshold is 0.6V.

$$R_{TOP} = R_{BOT} [(V_{OUT} / 0.6) - 1]$$

Input Capacitor Selection

The input capacitor in a DC/DC converter reduces current peaks drawn from the battery or other input power source and reduces switching noise in the controller. The impedance of the input capacitor at the switching frequency should be less than that of the input source so high-frequency switching currents do not pass through the input source. The output capacitor keeps output ripple small and ensures control-loop stability. The output capacitor must also have low impedance at the switching frequency. Ceramic, polymer, and tantalum capacitors are suitable, with ceramic exhibiting the lowest ESR and high-frequency impedance. Output ripple with a ceramic output capacitor is approximately as follows:

$$V_{RIPPLE} = I_{L(PEAK)} [1 / (2\pi \times f_{OSC} \times C_{OUT})]$$

If the capacitor has significant ESR, the output ripple component due to capacitor ESR is as follows:

$$V_{RIPPLE(ESR)} = I_{L(PEAK)} \times ESR$$

Output Capacitor and Inductor Selection

Follow the below table for Inductor and Output cap selection:

| | | | | | |
|------------------|-------|-------|-------|-------|-------|
| V _{OUT} | 1.2V | 1.5V | 1.8V | 2.5V | 3.3V |
| C _{OUT} | 33μF | 33μF | 22μF | 22μF | 10μF |
| L | 1.5μH | 1.5μH | 2.2μH | 3.3μH | 4.7μH |

If much smaller values are used, inductor current rises, and a larger output capacitance may be required to suppress output ripple. Larger values than L_{IDEAL} can be used to obtain higher output current, but typically with larger inductor size.

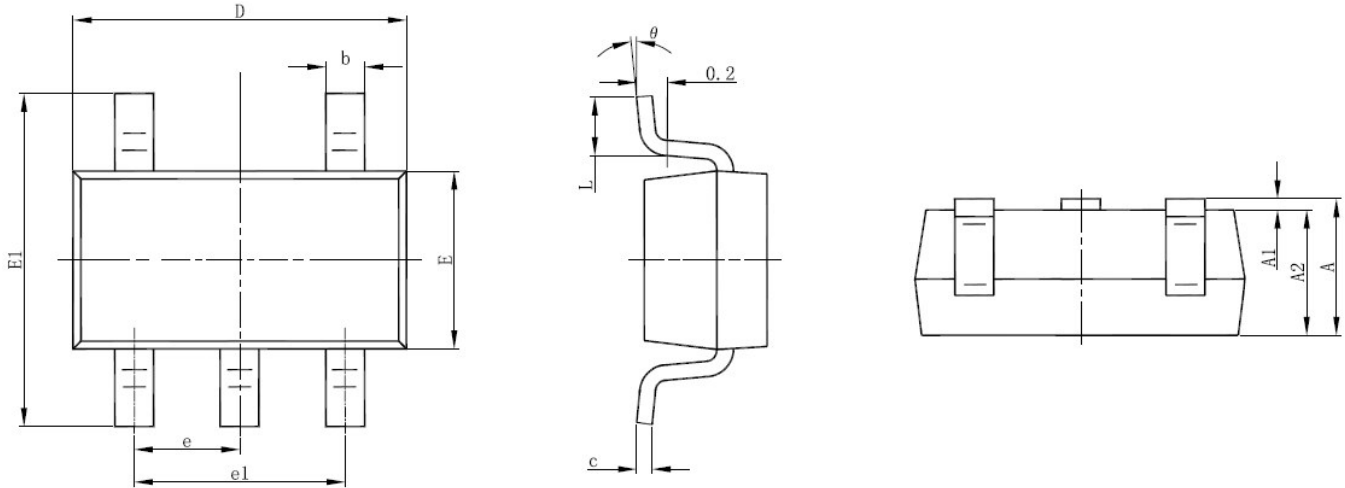
Application Information

Layout is critical to achieve clean and stable operation. The switching power stage requires particular attention. Follow these guidelines for good PC board layout:

- 1) Place decoupling capacitors as close to the IC as possible
- 2) Connect input and output capacitors to the same power ground node with a star ground configuration then to IC ground.
- 3) Keep the high-current paths as short and wide as possible. Keep the path of switching current (C1 to IN and C1 to GND) short. Avoid vias in the switching paths.
- 4) If possible, connect IN, SW, and GND separately to a large copper area to help cool the IC to further improve efficiency and long-term reliability.
- 5) Ensure all feedback connections are short and direct. Place the feedback resistors as close to the IC as possible.
- 6) Route high-speed switching nodes away from sensitive analog area.



Package Information (SOT-23-5L)



| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|---------------------------|-------|----------------------|-------|
| | Min | Max | Min | Max |
| A | 1.050 | 1.250 | 0.041 | 0.049 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 1.050 | 1.150 | 0.041 | 0.045 |
| b | 0.300 | 0.500 | 0.012 | 0.020 |
| c | 0.100 | 0.200 | 0.004 | 0.008 |
| D | 2.820 | 3.020 | 0.111 | 0.119 |
| E | 1.500 | 1.700 | 0.059 | 0.067 |
| E1 | 2.650 | 2.950 | 0.104 | 0.116 |
| e | 0.950(BSC) | | 0.037(BSC) | |
| e1 | 1.800 | 2.000 | 0.071 | 0.079 |
| L | 0.300 | 0.600 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 8° |

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