

**DESCRIPTION**

The AP64351 is 3.5A synchronous buck converters with wide input voltage, ranging from 3.8V to 40V, which integrates an 80mΩ high-side MOSFET and a 50mΩ low-side MOSFET. The AP64351, adopting the peak current mode control, supports the Pulse Skipping Modulation (PSM) with typical 25uA low quiescent current which assists the converter on achieving high efficiency at light load or standby condition.

The AP64351 features programmable soft-start time with 570kHz switching frequency. The converter allows power conversion from high input voltage to low output voltage with a minimum 100ns on-time of high-side MOSFET. It also supports Low Drop-Out LDO operation at low voltage difference from input to output condition.

The AP64351 is an Electromagnetic Interference (EMI) friendly buck converter with implementing optimized design for EMI reduction. The AP64351 features Frequency Spread Spectrum FSS with  $\pm 6\%$  jittering span of the 570kHz switching frequency and modulation rate 1/512 of switching frequency to reduce the conducted EMI.

The AP64351 offers cycle-by-cycle current limit and hiccup over current protection, thermal shutdown protection, output over-voltage protection and input voltage under-voltage protection. The device is available in an 8-pin thermally enhanced SOP-8 package.

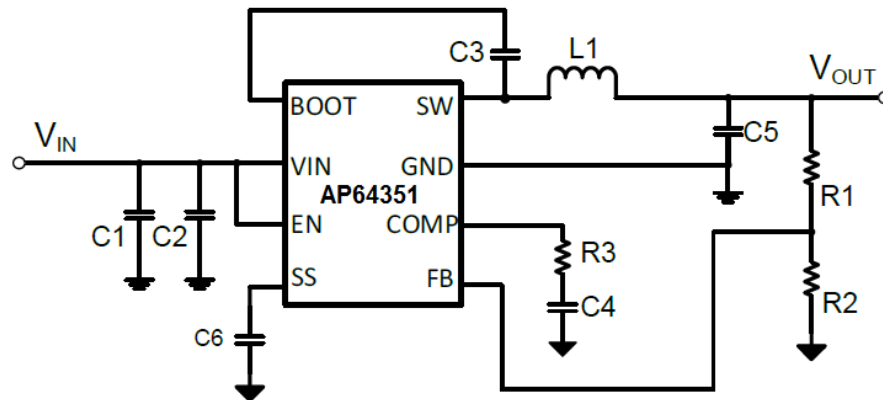
**FEATURES**

- Wide Input Range: 3.8V-40V
- Up to 3.5A Continuous Output Current
- 0.8V  $\pm 1\%$  Feedback Reference Voltage
- Integrated 80mΩ High-Side and 50mΩ Low-Side Power MOSFETs
- Pulse Skipping Mode (PSM) with 25uA Quiescent Current in Sleep Mode
- 100ns Minimum On-time
- Programmable Soft-start Time
- Frequency Spread Spectrum (FSS) Modulation for EMI Reduction
- Precision Enable Threshold for Programmable Input Voltage Under-voltage Lock Out Protection (UVLO) Threshold and Hysteresis
- Low Dropout Mode Operation
- Derivable Inverting Voltage Regulator
- Over-voltage and Over-Temperature Protection
- Available in an ESOP-8 Package
- Totally Lead-Free & Fully RoHS Compliant
- Halogen and Antimony Free. "Green" Device

### APPLICATIONS

- Battery Pack Powered System - Cordless Power Tools, Cordless Home Appliance, Drone, Aero Modelling, GPS Tracker etc.
- Cigarette Lighter Adapters, Chargers
- LCD Display
- USB Type-C Power Delivery, USB Charging
- Industrial and Medical Distributed Power Supplies
- Optical Communication and Networking System
- Automotive Systems

### TYPICAL APPLICATIONS CIRCUIT



### ABSOLUTE MAXIMUM RATINGS

| Symbol         | Parameter              | Rating        | Unit |
|----------------|------------------------|---------------|------|
| $V_{VIN}$      | Supply Voltage         | -0.3 to +40.0 | V    |
| $V_{EN}$       | Enable Voltage         | -0.3 to +40.0 | V    |
| $V_{BOOT}$     | Bootstrap Voltage      | -0.3 to +46.0 | V    |
| $V_{SW}$       | Switch Node Voltage    | -0.3 to +40.0 | V    |
| $V_{BOOT-SW}$  | BOOT to SW Pin Voltage | -0.3 to +6.0  | V    |
| All other pins |                        | -0.3 to +6.0  | V    |
| $T_J$          | Junction Temperature   | +150          | °C   |
| $T_L$          | Lead Temperature       | +260          | °C   |
| HBM            | Human Body Mode        | 2000          | V    |
| CDM            | Charged Device Model   | 500           | V    |

### RECOMMENDED OPERATING CONDITIONS

| Symbol   | Parameter                      | Min | Max  | Unit |
|----------|--------------------------------|-----|------|------|
| $V_{IN}$ | Supply Voltage                 | 3.8 | 40   | V    |
| $T_A$    | Operating Junction Temperature | -40 | +125 | °C   |

### EVALUATION BOARD

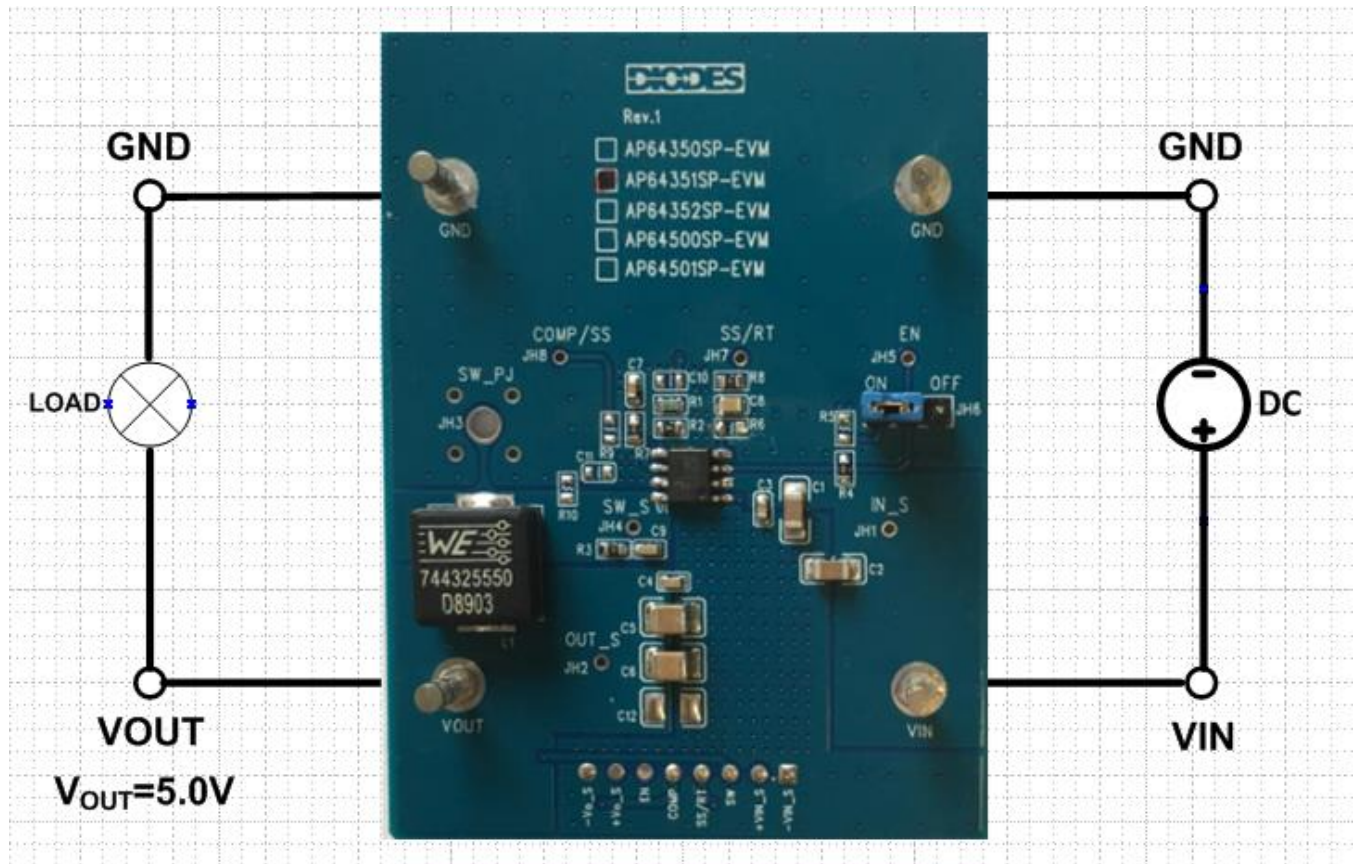
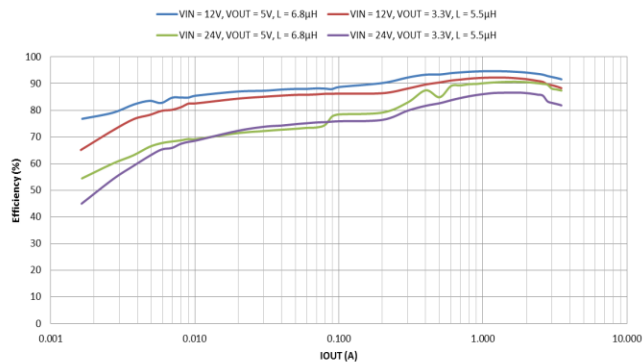


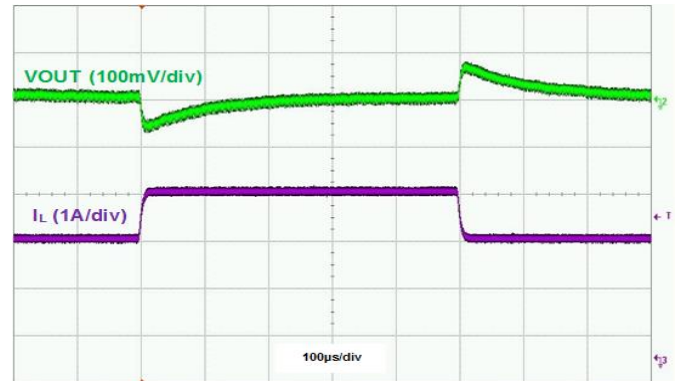
Figure 1. AP64351SP-EVM

### TYPICAL PERFORMANCE CHARACTERISTICS

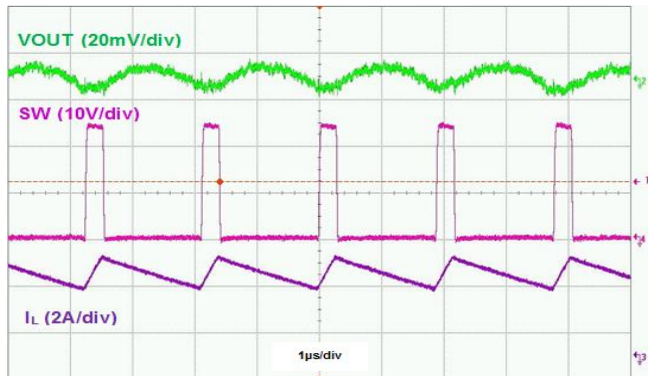
**Figure 1. Efficiency vs Output Current**



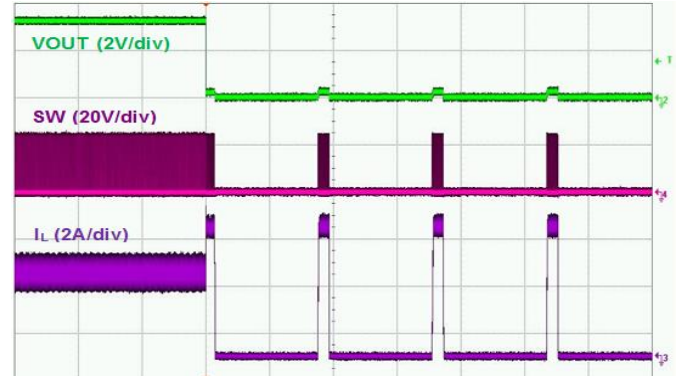
**Figure 2. Load Transient 2.5A to 3.5A**



**Figure 3. Output Voltage Ripple, I<sub>OUT</sub>=3.5A**



**Figure 4. Output Short Protection, I<sub>OUT</sub>=3.5A**



### QUICK START GUIDE

The AP64351SP-EVM has a simple layout and allows access to the appropriate signals through test points. To evaluate the performance of the AP64351SP, follow the procedure below:

1. Connect a power supply to the input terminals  $V_{IN}$  and GND. Set  $V_{IN}$  to 12V.
2. Connect the positive terminal of the electronic load to  $V_{OUT}$  and negative terminal to GND.
3. For Enable, place a jumper at JH6 to "ON" position to connect EN pin to  $V_{IN}$  through 100K $\Omega$  resistor to enable IC. Jump to "OFF" position to disable IC.
4. The evaluation board should now power up with a 5.0V output voltage.
5. Check for the proper output voltage of 5.0V ( $\pm 1\%$ ) at the output terminals  $V_{OUT}$  and GND. Measurement can also be done with a multimeter with the positive and negative leads between  $V_{OUT}$  and GND.
6. Set the load to 3.5A through the electronic load. Check for the stable operation of the SW signal on the oscilloscope. Measure the switching frequency.

### MEASUREMENT/PERFORMANCE GUIDELINES:

- 1) When measuring the output voltage ripple, maintain the shortest possible ground lengths on the oscilloscope probe. Long ground leads can erroneously inject high frequency noise into the measured ripple.
- 2) For efficiency measurements, connect an ammeter in series with the input supply to measure the input current. Connect an electronic load to the output for output current.

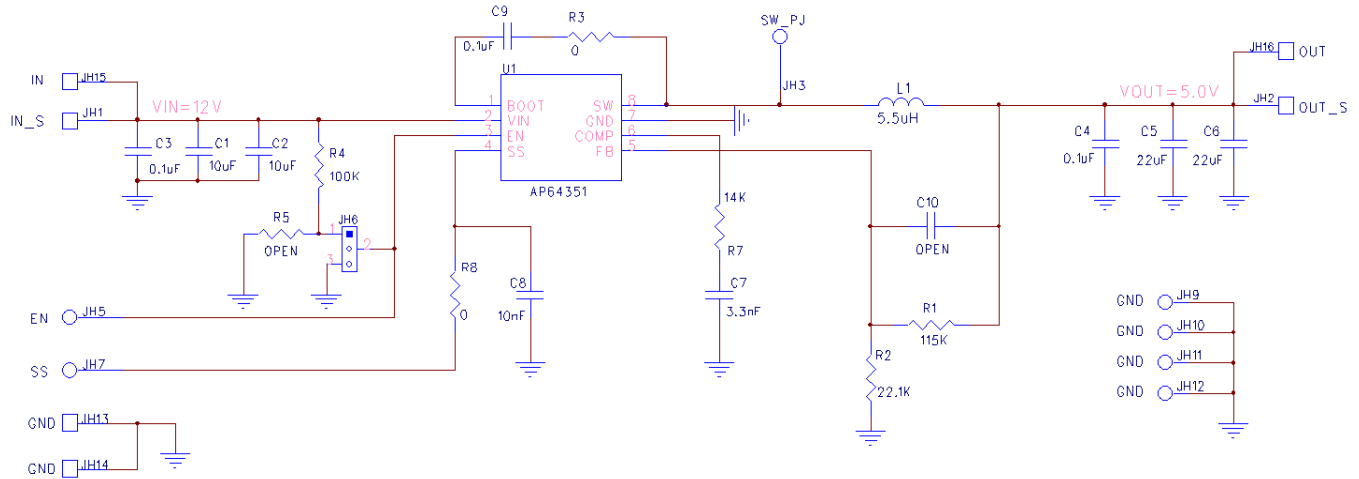
### SETTING OUTPUT VOLTAGE:

Table 1 shows a list of recommended component selections for common output voltages.

| $V_{OUT}$ | R1             | R2             | L1          | R7             | C7    |
|-----------|----------------|----------------|-------------|----------------|-------|
| 1.2V      | 11K $\Omega$   | 22.1K $\Omega$ | 3.3 $\mu$ H | 3.32K $\Omega$ | 3.3nF |
| 1.5V      | 19.6K $\Omega$ | 22.1K $\Omega$ | 3.3 $\mu$ H | 4.22K $\Omega$ | 3.3nF |
| 1.8V      | 27.4K $\Omega$ | 22.1K $\Omega$ | 3.3 $\mu$ H | 4.99K $\Omega$ | 3.3nF |
| 2.5V      | 47.5K $\Omega$ | 22.1K $\Omega$ | 4.7 $\mu$ H | 6.98K $\Omega$ | 3.3nF |
| 3.3V      | 69.8K $\Omega$ | 22.1K $\Omega$ | 4.7 $\mu$ H | 9.31K $\Omega$ | 3.3nF |
| 5.0V      | 115K $\Omega$  | 22.1K $\Omega$ | 5.5 $\mu$ H | 14K $\Omega$   | 3.3nF |
| 12V       | 309K $\Omega$  | 22.1K $\Omega$ | 10 $\mu$ H  | 33.2K $\Omega$ | 3.3nF |

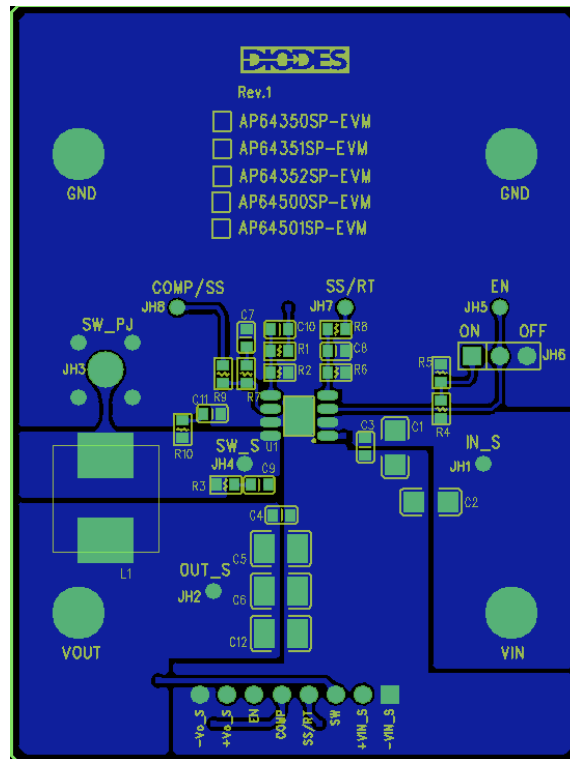
**Table 1. Common Output Voltages**

**EVALUATION BOARD SCHEMATIC**



**Figure 2. AP64351SP-EVM Schematic**

**PCB TOP LAYOUT**



**Figure 3. AP64351SP-EVM – Top Layer**

## PCB BOTTOM LAYOUT

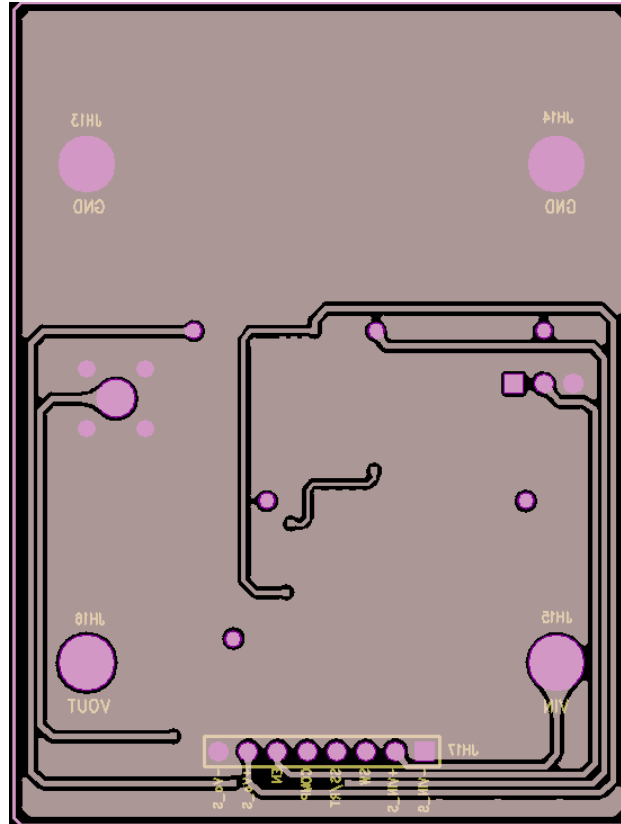


Figure 4. AP64351SP-EVM – Bottom Layer



### BILL OF MATERIALS for AP64351SP-EVM

| Ref                    | Value          | Description                                   | Qty | Size          | Vendor Name          | Manufacturer PN    |
|------------------------|----------------|---|-----|---------------|----------------------|--------------------|
| C1, C2                 | 10 $\mu$ F     | Ceramic Capacitor, 50V, X7R, 10%              | 2   | 1206          | Samsung              | CL31B106KBHNNNE    |
| C3, C4                 | 0.1 $\mu$ F    | Ceramic Capacitor, 50V, X7R, 10%              | 2   | 0603          | Würth Electronics    | 885012206095       |
| C5, C6                 | 22 $\mu$ F     | Ceramic Capacitor, 16V, X7R                   | 2   | 1210          | Samsung              | CL32B226KOJNNNE    |
| C7                     | 3.3nF          | Ceramic Capacitor, 25V, X7R                   | 1   | 0603          | Würth Electronics    | 885012206062       |
| C8                     | 10nF           | Ceramic Capacitor, 25V, X7R                   | 1   | 0603          | Würth Electronics    | 885012206065       |
| C9                     | 0.1 $\mu$ F    | Ceramic Capacitor, 25V, X7R                   | 1   | 0603          | Würth Electronics    | 885012206071       |
| R1                     | 115K $\Omega$  | RES SMD 1% 1/8W                               | 1   | 0603          | Panasonic            | ERJ-3EKF1153V      |
| R2                     | 22.1K $\Omega$ | RES SMD 1% 1/8W                               | 1   | 0603          | Stackpole            | RNCP0603FTD22K1    |
| R3                     | 0 $\Omega$     | RES SMD 1% 1/10W                              | 1   | 0603          | Vishay               | CRCW06030000Z0EAC  |
| R4                     | 100K $\Omega$  | RES SMD 1% 1/10W                              | 1   | 0603          | Yageo                | RC0603FR-07100KL   |
| R7                     | 14K $\Omega$   | RES SMD 1% 1/10W                              | 1   | 0603          | Bourns Inc           | CR0603-FX-1402ELF  |
| R8                     | 0 $\Omega$     | RES SMD 1% 1/10W                              | 1   | 0603          | Vishay               | MCT06030Z0000ZP500 |
| L1                     | 5.5 $\mu$ H    | DCR=10.3m $\Omega$ , Ir=10A                   | 1   | 10.2x10.2x5mm | Würth Electronics    | 744325550          |
| JH6                    |                | PCB Header, 40 POS                            | 1   | 1X3           | 3M                   | 2340-611TG         |
| JH13, JH14, JH15, JH16 | 1598           | Terminal Turret Triple 0.094" L (Test Points) | 4   | Through-Hole  | Keystone Electronics | 1598-2             |
| U1                     | AP64351        | Sync Buck DC/DC Converter                     | 1   | SO-8EP        | Diodes Inc           | AP64351SP          |



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