

### **DESCRIPTION**

The AP64350Q is 3.5A, synchronous buck converter with a wide input voltage range of 3.8V to 40V. The device fully integrates a 75mΩ high-side power MOSFET and a 45mΩ low-side power MOSFET to provide high-efficiency step-down DC/DC conversion.

The AP64350Q device is easily used by minimizing the external component count due to its adoption of peak current mode control.

The AP64350Q design is optimized for Electromagnetic Interference (EMI) reduction. The converter features Frequency Spread Spectrum (FSS) with a switching frequency jitter of  $\pm 6\%$ , which reduces EMI by not allowing emitted energy

to stay in any one frequency for a significant period of time. It also has a proprietary gate driver scheme to resist switching node ringing without sacrificing MOSFET turn-on and turn-off times, which reduces high-frequency radiated EMI noise caused by MOSFET switching.

The device is available in a SO-8EP package.

### **FEATURES**

- Qualified for Automotive Applications
- Wide Input Range: 3.8V-40V
- 3.5A Continuous Output Current
- 0.8V  $\pm 1\%$  Reference Voltage
- 22μA Ultralow Quiescent Current (Pulse Frequency Modulation)
- Programmable Switching Frequency: 100kHz to 2.2MHz
- External Clock Synchronization: 100kHz to 2.2MHz
- Proprietary Gate Driver Design for Best EMI Reduction
- Frequency Spread Spectrum (FSS) to Reduce EMI
- Low-Dropout (LDO) Mode
- Precision Enable Threshold to adjust UVLO
- Protection Circuitry
  - Undervoltage Lockout (UVLO)
  - Output Overvoltage Protection (OVP)
  - Cycle-by-Cycle Peak Current Limit
  - Thermal Shutdown
- Totally Lead-Free & Fully RoHS Compliant
- Halogen and Antimony Free. "Green" Device

### APPLICATIONS

- 5V, 12V, and 24V Distributed Power Bus Supplies
- White Goods and Small Home Appliances
- Home Audio
- Network Systems
- Consumer Electronics
- Cordless Power Tools
- Optical Communication and Networking Systems
- General Purpose Point of Load

### TYPICAL APPLICATIONS CIRCUIT

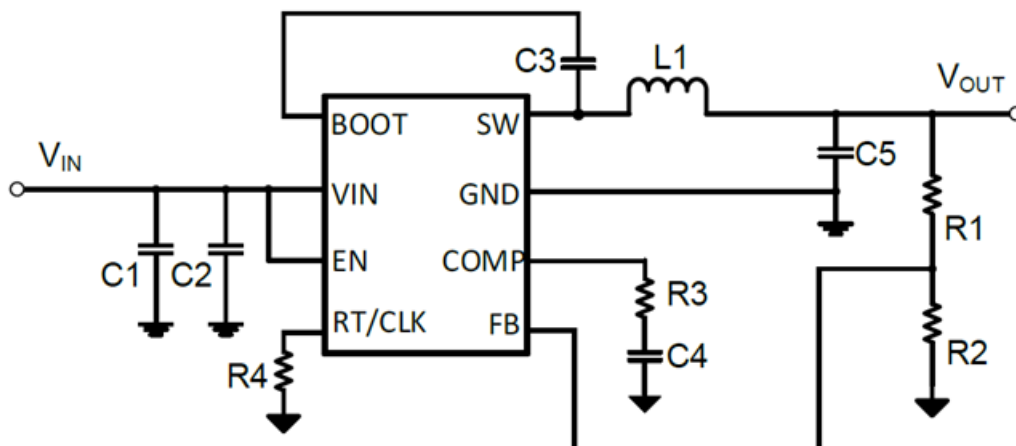


Figure 1. Typical Application Circuit

### ABSOLUTE MAXIMUM RATINGS

| Symbol              | Parameter                | Rating                                         | Unit |
|---------------------|--------------------------|------------------------------------------------|------|
| VIN                 | Supply Pin Voltage       | -0.3 to +42.0 (DC)                             | V    |
|                     |                          | -0.3 to +45.0 (400ms)                          |      |
| V <sub>BST</sub>    | Bootstrap Pin Voltage    | V <sub>SW</sub> - 0.3 to V <sub>SW</sub> + 6.0 | V    |
| V <sub>EN</sub>     | Enable/UVLO Pin Voltage  | -0.3 to +42.0                                  | V    |
| V <sub>RT/CLK</sub> | RT/CLK Pin Voltage       | -0.3 to +6.0                                   | V    |
| V <sub>FB</sub>     | Feedback Voltage         | -0.3V to +6.0                                  | V    |
| V <sub>COMP</sub>   | Compensation Pin Voltage | -0.3 to +6.0                                   | V    |
| V <sub>SW</sub>     | Switch Node Voltage      | -0.3 to VIN + 0.3 (DC)                         | V    |
|                     |                          | -2.5 to VIN + 2.0 (20ns)                       |      |
| T <sub>J</sub>      | Junction Temperature     | +160                                           | °C   |
| T <sub>L</sub>      | Lead Temperature         | +260                                           | °C   |

## RECOMMENDED OPERATING CONDITIONS

| Symbol           | Parameter                            | Min | Max             | Unit |
|------------------|--------------------------------------|-----|-----------------|------|
| V <sub>IN</sub>  | Supply Voltage                       | 3.8 | 40              | V    |
| V <sub>OUT</sub> | Output Voltage                       | 0.8 | V <sub>IN</sub> | V    |
| T <sub>A</sub>   | Operating Ambient Temperature Range  | -40 | +125            | °C   |
| T <sub>J</sub>   | Operating Junction Temperature Range | -40 | +150            | °C   |

## EVALUATION BOARD

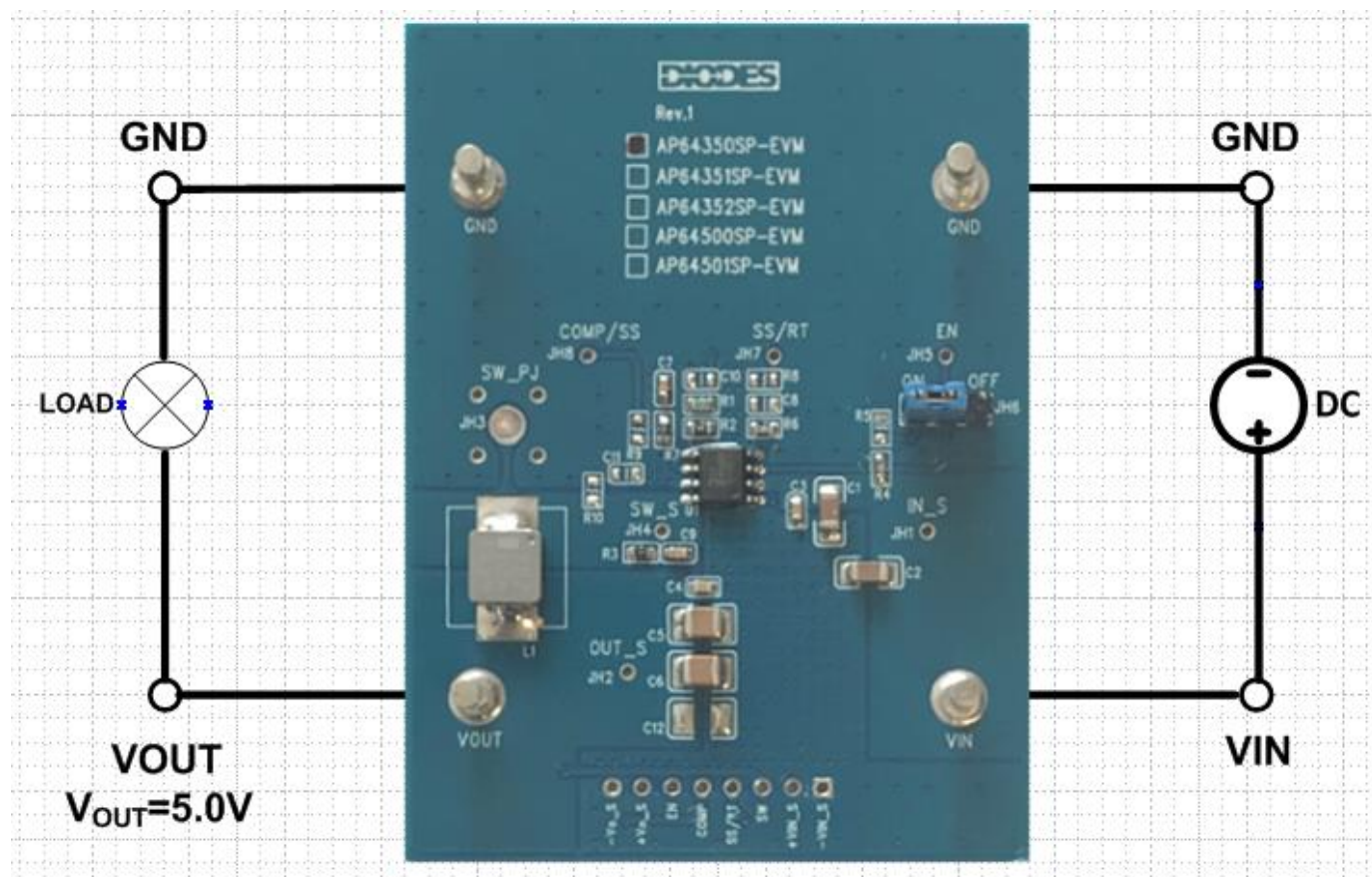


Figure 2. AP64350QSP-EVM

### QUICK START GUIDE

The AP64350QSP-EVM has a simple layout and allows access to the appropriate signals through test points. To evaluate the performance of the AP64350QSP, 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.

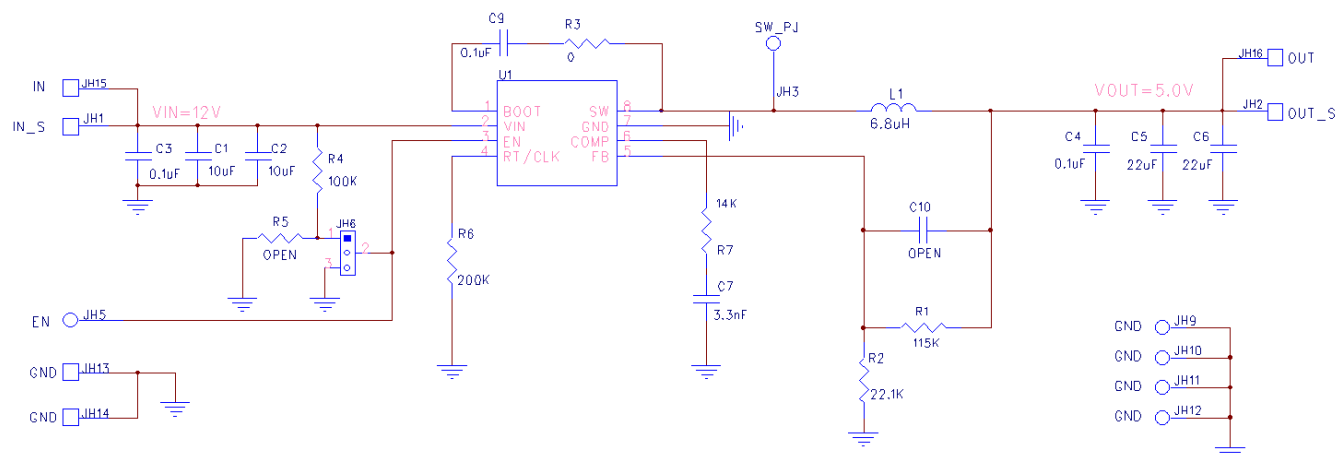
### SETTING OUTPUT VOLTAGE:

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

| VOUT | R1             | R2             | L1          | R7             | C7    | C1, C2       | C5, C6       |
|------|----------------|----------------|-------------|----------------|-------|--------------|--------------|
| 1.2V | 11K $\Omega$   | 22.1K $\Omega$ | 3.3 $\mu$ H | 3.32K $\Omega$ | 3.3nF | 2x10 $\mu$ F | 2x22 $\mu$ F |
| 1.5V | 19.6K $\Omega$ | 22.1K $\Omega$ | 3.3 $\mu$ H | 4.22K $\Omega$ | 3.3nF | 2x10 $\mu$ F | 2x22 $\mu$ F |
| 1.8V | 27.4K $\Omega$ | 22.1K $\Omega$ | 3.3 $\mu$ H | 4.99K $\Omega$ | 3.3nF | 2x10 $\mu$ F | 2x22 $\mu$ F |
| 2.5V | 47.5K $\Omega$ | 22.1K $\Omega$ | 4.7 $\mu$ H | 6.98K $\Omega$ | 3.3nF | 2x10 $\mu$ F | 2x22 $\mu$ F |
| 3.3V | 69.8K $\Omega$ | 22.1K $\Omega$ | 4.7 $\mu$ H | 9.31K $\Omega$ | 3.3nF | 2x10 $\mu$ F | 2x22 $\mu$ F |
| 5.0V | 115K $\Omega$  | 22.1K $\Omega$ | 6.8 $\mu$ H | 14K $\Omega$   | 3.3nF | 2x10 $\mu$ F | 2x22 $\mu$ F |
| 12V  | 309K $\Omega$  | 22.1K $\Omega$ | 10 $\mu$ H  | 33.2K $\Omega$ | 3.3nF | 2x10 $\mu$ F | 2x22 $\mu$ F |

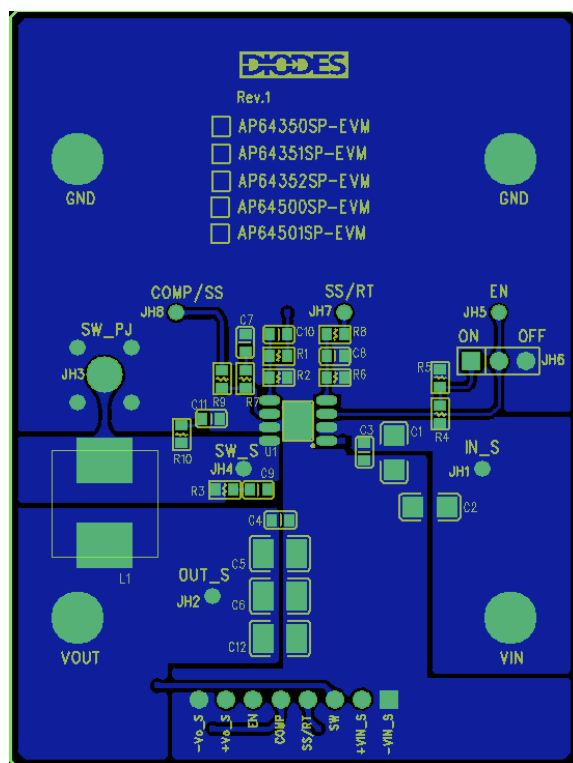
**Table 1. Common Output Voltages**

## EVALUATION BOARD SCHEMATIC



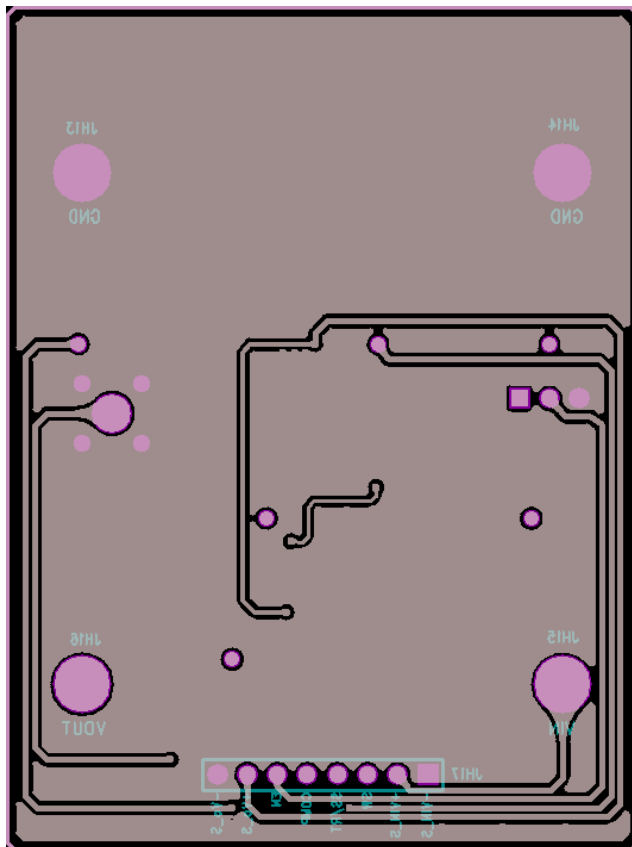
### Figure 3. AP64350QSP-EVM Schematic

## PCB TOP LAYOUT



**Figure 4. AP64350QSP-EVM – Top Layer**

**PCB BOTTOM LAYOUT**



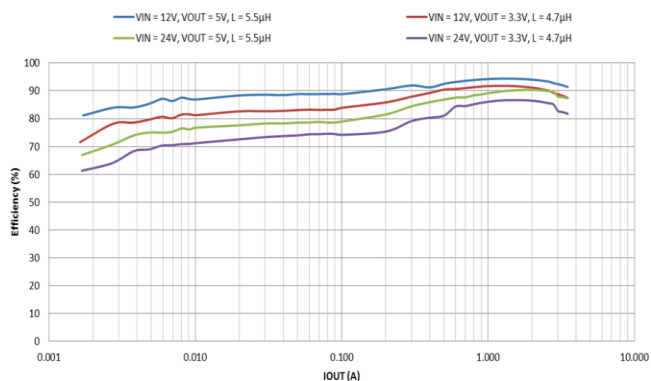
**Figure 5. AP64350QSP-EVM – Bottom Layer**

### AUTOMOTIVE BILL OF MATERIALS for AP64350QSP-EVM @V<sub>OUT</sub>=5V

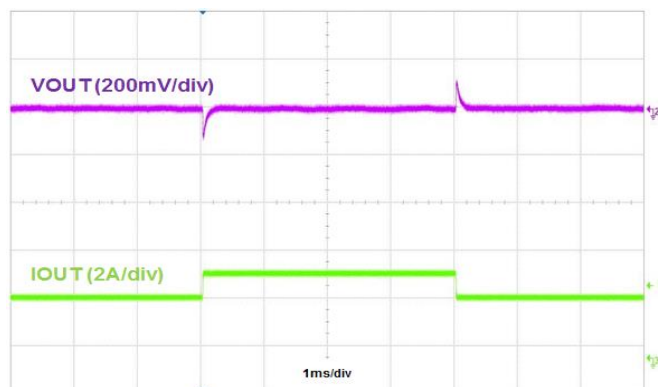
| Ref                             | Value          | Description                                         | Qty | Size              | Vendor Name             | Manufacturer PN      |
|---------------------------------|----------------|-----------------------------------------------------|-----|-------------------|-------------------------|----------------------|
| C1, C2                          | 10 $\mu$ F     | Ceramic Capacitor, 50V                              | 2   | 1206              | TDK                     | CGA5L1X7R1H106K160AC |
| C3, C4, C9                      | 0.1 $\mu$ F    | Ceramic Capacitor, 50V                              | 3   | 0603              | TDK                     | CGA3E3X8R1H104K080AB |
| C5, C6                          | 22 $\mu$ F     | Ceramic Capacitor, 16V                              | 2   | 1210              | TDK                     | CGA6P1X8L1C226M250AC |
| C7                              | 3.3nF          | Ceramic Capacitor, 50V                              | 1   | 0603              | TDK                     | CGA3E2NP01H332J080AA |
| R1                              | 115K $\Omega$  | RES SMD                                             | 1   | 0603              | Panasonic               | ERJ-3RED1153V        |
| R2                              | 22.1K $\Omega$ | RES SMD                                             | 1   | 0603              | Panasonic               | ERJ-3RBD2212V        |
| R3                              | 0 $\Omega$     | RES SMD                                             | 1   | 0603              | Panasonic               | ERJ-3GEY0R00V        |
| R4                              | 100K $\Omega$  | RES SMD                                             | 1   | 0603              | Panasonic               | ERJ-3RBD104V         |
| R6                              | 200K $\Omega$  | RES SMD                                             | 1   | 0603              | Panasonic               | ERJ-S03F2003V        |
| R7                              | 14K $\Omega$   | RES SMD                                             | 1   | 0603              | Panasonic               | ERJ-3EKF1402V        |
| L1                              | 6.8 $\mu$ H    | DCR=18.5m $\Omega$ ,<br>I <sub>r</sub> =8.9A        | 1   | 10.0x10.7x<br>4mm | Panasonic               | ETQP4M6R8KVC         |
| JH6                             |                | PCB Header, 40<br>POS                               | 1   | 1X3               | 3M                      | 2340-6111TG          |
| JH13,<br>JH14,<br>JH15,<br>JH16 | 1598           | Terminal Turret<br>Triple 0.094" L<br>(Test Points) | 4   | Through-<br>Hole  | Keystone<br>Electronics | 1598-2               |
| U1                              | AP64350Q       | Sync DC/DC<br>Buck Converter                        | 1   | SO-8EP            | Diodes Inc              | AP64350QSP           |

## TYPICAL PERFORMANCE CHARACTERISTICS

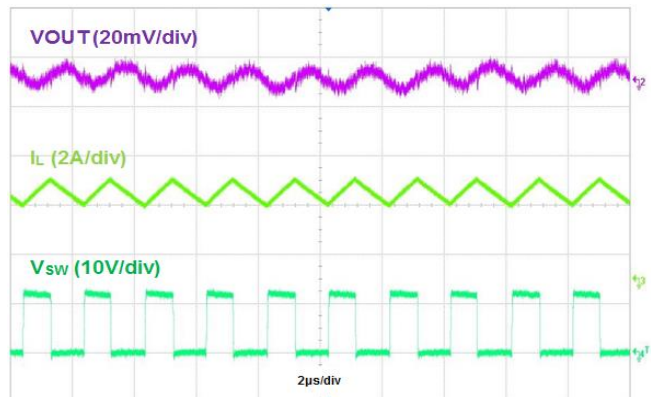
**Figure 6. Efficiency vs Output Current**



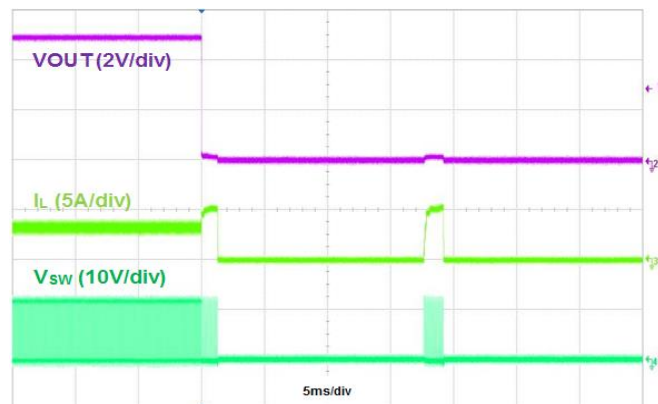
**Figure 7. Load Transient 2A to 3.5A**



**Figure 8. Output Voltage Ripple, IOUT=3.5A**



**Figure 9. Output Short Protection, IOUT=3.5A**





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