

## AUTOMOTIVE-COMPLIANT, 40V, 3.5A SYNCHRONOUS BUCK WITH INTERNAL COMPENSATION

### DESCRIPTION

The AP64352Q is an automotive-compliant, 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 AP64352Q device is easily used by minimizing the external component count due to its adoption of peak current mode control along with its integrated loop compensation network.

The AP64352Q design is optimized for Electromagnetic Interference (EMI) reduction. The device 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. AP64352Q also 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.

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

### FEATURES

- AEC-Q100 Qualified with the Following Results
  - Device Temperature Grade 1: -40°C to +125°C TA Range
  - Device HBM ESD Classification Level H2
  - Device CDM ESD Classification Level C5
- VIN: 3.8V to 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
- Programmable Soft-Start Time
- Up to 85% Efficiency at 5mA Light Load
- 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

**TYPICAL APPLICATIONS CIRCUIT**

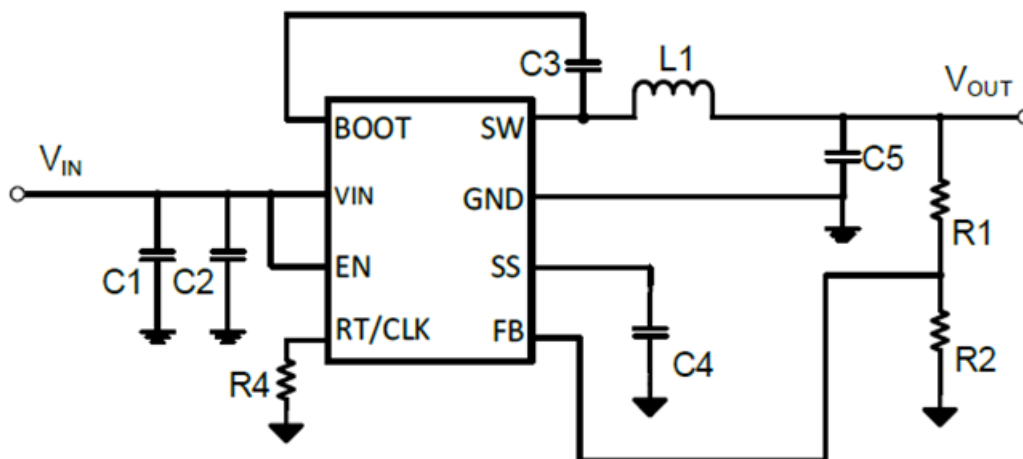


Figure 1. Typical Application Circuit

**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>SS</sub>	Soft-Start 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	39	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

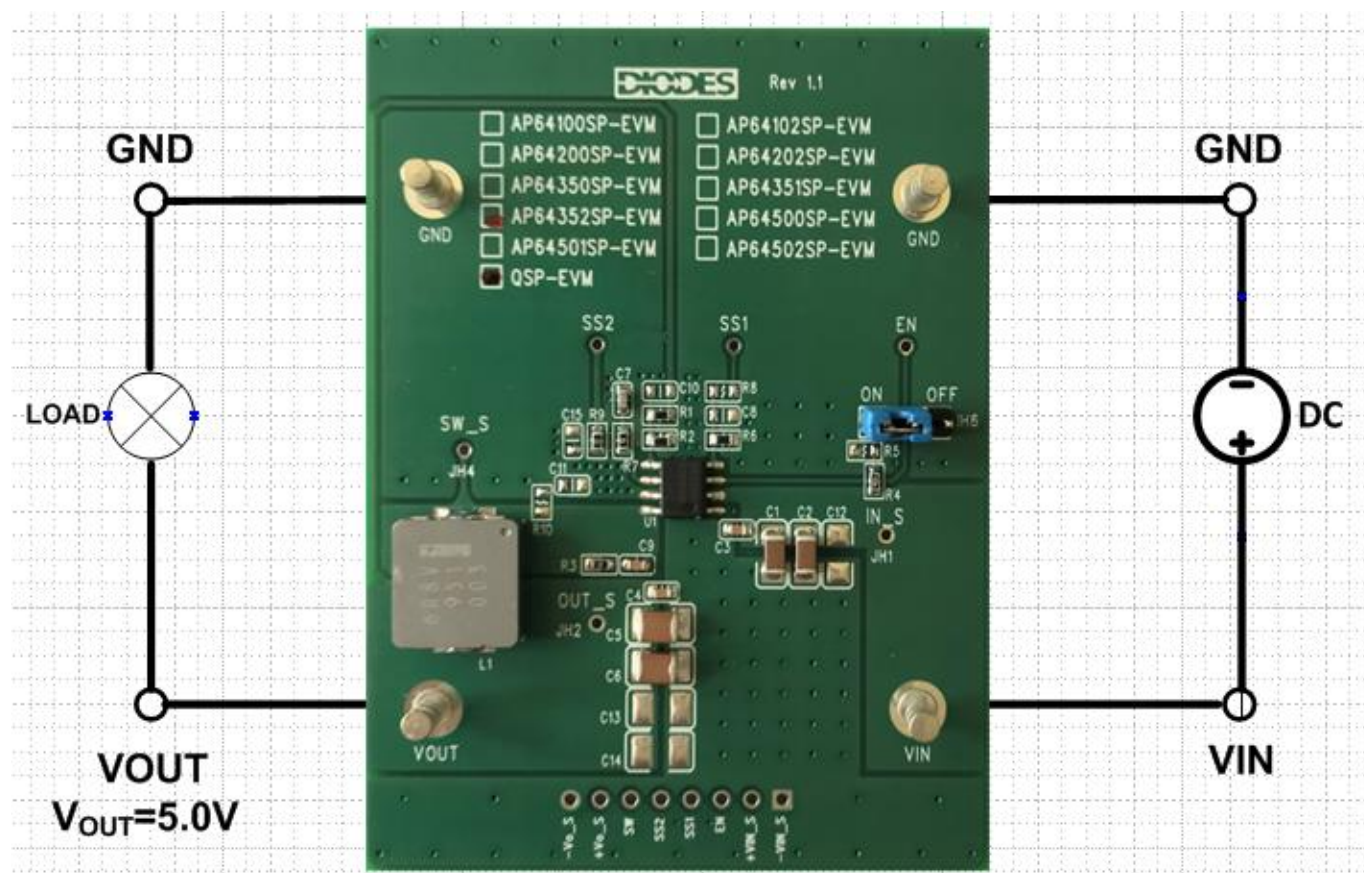


Figure 2. AP64352QSP-EVM

### QUICK START GUIDE

The AP64352QSP-EVM has a simple layout and allows access to the appropriate signals through test points. To evaluate the performance of the AP64352QSP, follow the procedure below:

1. Connect a power supply to the input terminals VIN and GND. Set VIN to 12V.
2. Connect the positive terminal of the electronic load to VOUT and negative terminal to GND.
3. For Enable, place a jumper at JH6 to "ON" position to connect EN pin to VIN 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 VOUT and GND. Measurement can also be done with a multimeter with the positive and negative leads between VOUT 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	C1, C2	C5, C6
1.2V	4.99K $\Omega$	10K $\Omega$	3.3 $\mu$ H	2x10 $\mu$ F	2x22 $\mu$ F
1.5V	8.66K $\Omega$	10K $\Omega$	3.3 $\mu$ H	2x10 $\mu$ F	2x22 $\mu$ F
1.8V	12.4K $\Omega$	10K $\Omega$	3.3 $\mu$ H	2x10 $\mu$ F	2x22 $\mu$ F
2.5V	21.5K $\Omega$	10K $\Omega$	4.7 $\mu$ H	2x10 $\mu$ F	2x22 $\mu$ F
3.3V	31.6K $\Omega$	10K $\Omega$	4.7 $\mu$ H	2x10 $\mu$ F	2x22 $\mu$ F
5.0V	52.3K $\Omega$	10K $\Omega$	6.8 $\mu$ H	2x10 $\mu$ F	2x22 $\mu$ F
12V	140K $\Omega$	10K $\Omega$	10 $\mu$ H	2x10 $\mu$ F	2x22 $\mu$ F

Table 1. Common Output Voltages

### EVALUATION BOARD SCHEMATIC

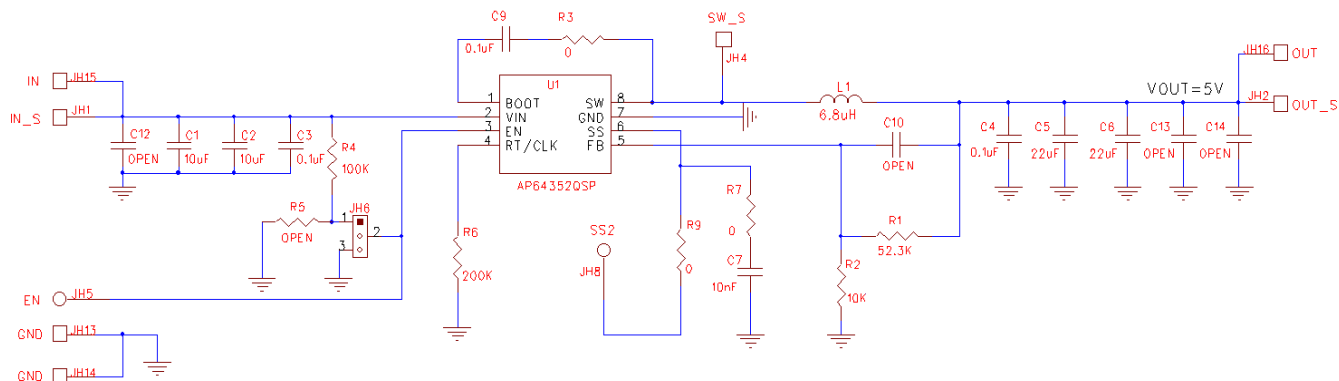


Figure 3. AP64352QSP-EVM Schematic

### PCB TOP LAYOUT

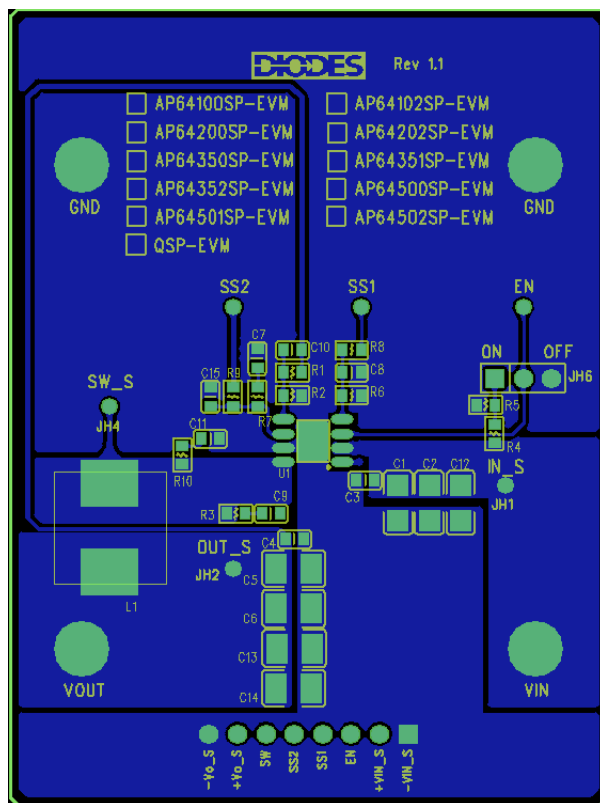


Figure 4. AP64352QSP-EVM – Top Layer

## PCB BOTTOM LAYOUT

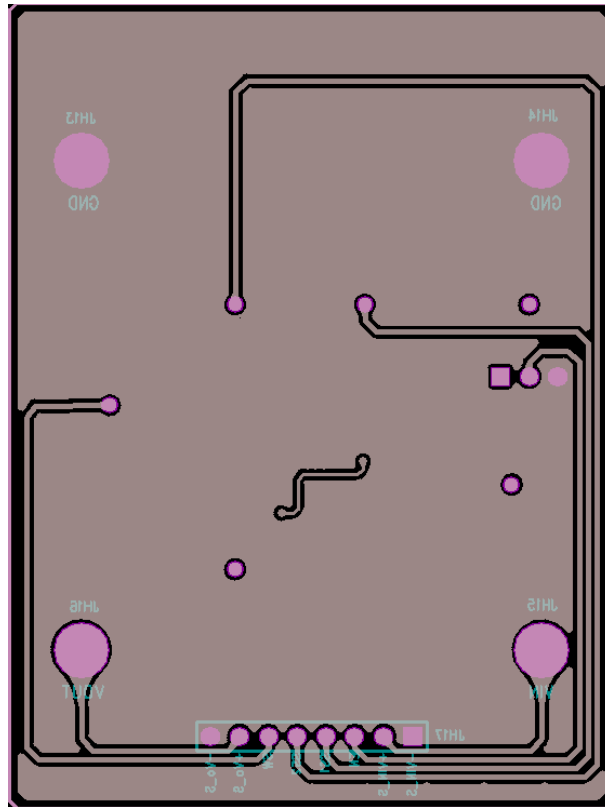


Figure 5. AP64352QSP-EVM – Bottom Layer

### AUTOMOTIVE BILL OF MATERIALS for AP64352QSP-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	10nF	Ceramic Capacitor, 50V	1	0603	TDK	CGA3E2NP01H103J080AA
R1	52.3K $\Omega$	SMD Resistor, 1%	1	0603	Panasonic	ERJ-3EKF5232V
R2	10K $\Omega$	SMD Resistor, 1%	1	0603	Panasonic	ERJ-3EKF1002V
R3, R7, R9	0 $\Omega$	SMD Resistor, 1%	3	0603	Panasonic	ERJ-3GEY0R00V
R4	100K $\Omega$	SMD Resistor, 1%	1	0603	Panasonic	ERJ-3EKF1003V
R6	200K $\Omega$	SMD Resistor, 1%	1	0603	Panasonic	ERJ-S03F2003V
L1	6.8 $\mu$ H	DCR=18.5m $\Omega$ , I <sub>r</sub> =8.9A	1	10.0x10.7x 4mm	Panasonic	ETQP4M6R8KVC
JH6		PCB Header, 36 POS	1	1X3	Amphenol	78511-136HLF
JH13, JH14, JH15, JH16	1598	Terminal Turret Triple 0.094" L (Test Points)	4	Through-Hole	Keystone Electronics	1598-2
U1	AP64352Q	Sync DC-DC Buck Converter	1	SO-8EP	Diodes Incorporated (Diodes)	AP64352QSP

### TYPICAL PERFORMANCE CHARACTERISTICS

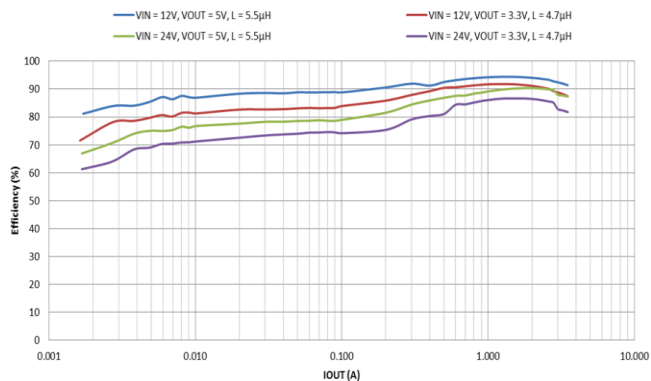


Figure 6. Efficiency vs. Output Current

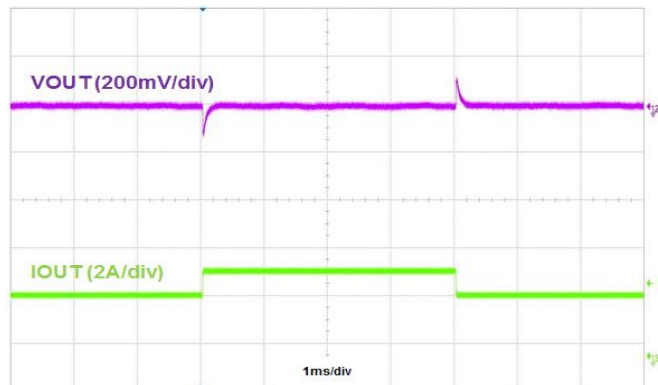


Figure 7. Load Transient 2A to 3.5A

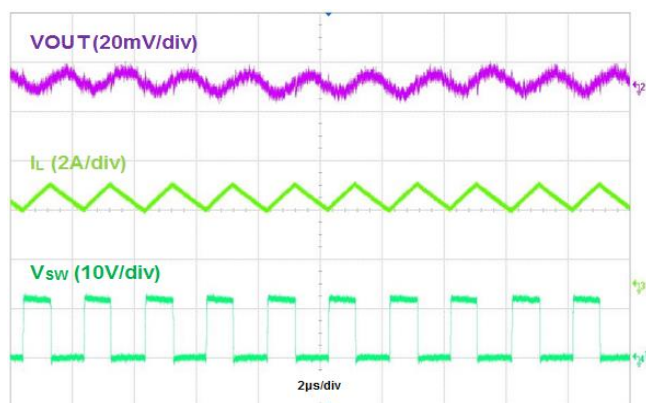


Figure 8. Output Voltage Ripple, IOUT=3.5A

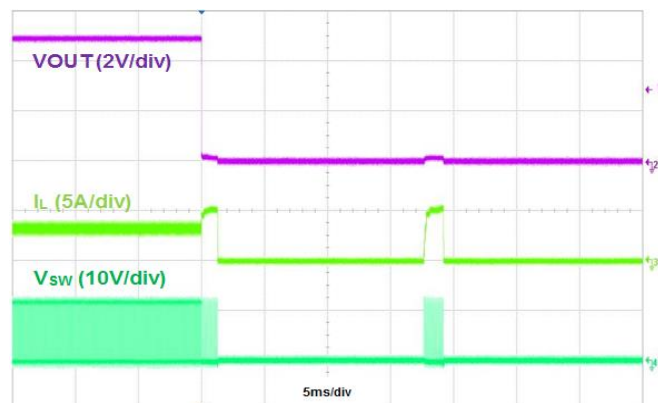


Figure 9. Output Short Protection, IOUT=3.5A



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