

Description

The AP3171 is a constant voltage (CV), constant current (CC) and synchronous rectification buck converter compatible with Qualcomm Quick Charge 2.0.

AP3171 combines PWM controller, high/low side power MOSFETs, CC/CV control and Qualcomm QC 2.0 decoder in one package so as to achieve high performance with compact profile. According to different D+/D- signal combinations, the AP3171 will set the output voltage and full current capabilities to 5V/2A, 9V/2A or 12V/1.5A respectively. The AP3171 automatically provides 5V/2A output configuration to backwards compatible to the existing devices that are not compatible to Qualcomm QC 2.0.

AP3171 has a fixed switching frequency of 120kHz at heavy load, while at light load and no load, its zero current detection (ZCD) function takes effect to have the system enter into discontinuous current mode (DCM) to improve power conversion efficiency.

The AP3171 has versatile protection functions to guarantee a safe operation, including input voltage under voltage lock-out (UVLO), output voltage over voltage protection (OVP) and under voltage protection (UVP), inductor peak current limit and Internal over temperature protection (OTP).

Furthermore, AP3171 has cable compensation and it is adjustable by the external resistor.

The AP3171 is available in SO-8EP package.

Features

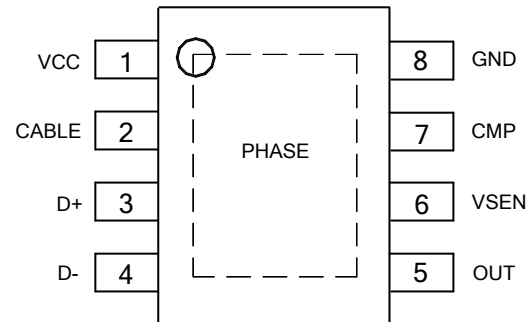
- 8.7V to 40V Input Voltage Range
- Fixed 120k Operating Frequency
- Integrated Two MOSFETs for Synchronization Rectification
- Quick Charge Function Compatible with Qualcomm QC 2.0 Protocol
- Input Protection – UVLO
- Output Protection – UVP/OVP
- OCP Function
- Adjustable Cable Compensation
- Output CC/CV Mode Function
- Reference Accuracy :
CV $\pm 1.5\%$ CC $\pm 4\%$ (5V)
CV $\pm 2.5\%$ CC $\pm 5\%$ (9V/12V)
- Output power: 5V/10W, 9V/18W, 12V/18W
- Internal OTP Function
- **Totally Lead-free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Notes:

1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Pin Assignments

(Top View)



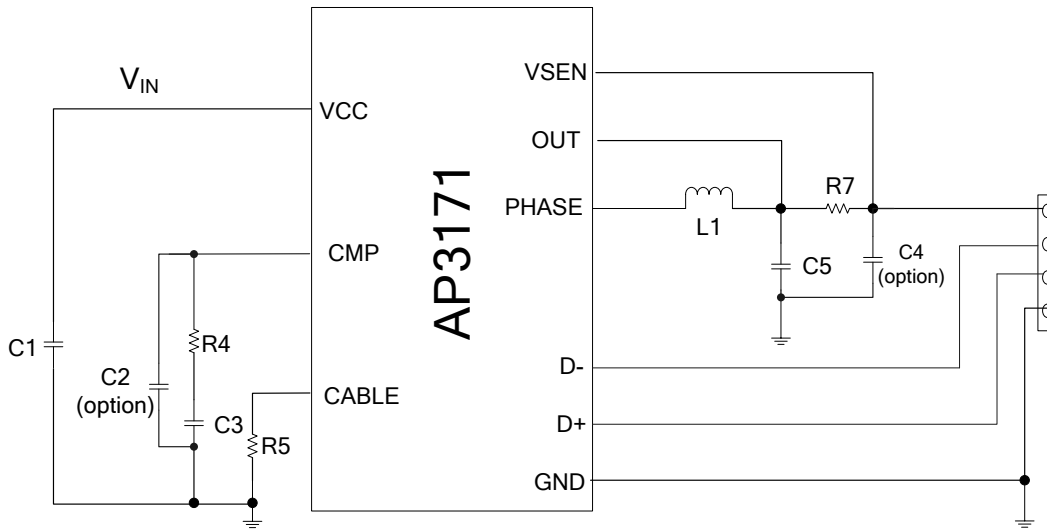
Note: The PHASE pin of BUCK converter is exposed PAD, which is at bottom of the IC (the dashed box).

SO-8EP

Applications

- Car Charger
- Automotive Power application
- General DC/DC Application Need CC/CV Mode

Typical Applications Circuit

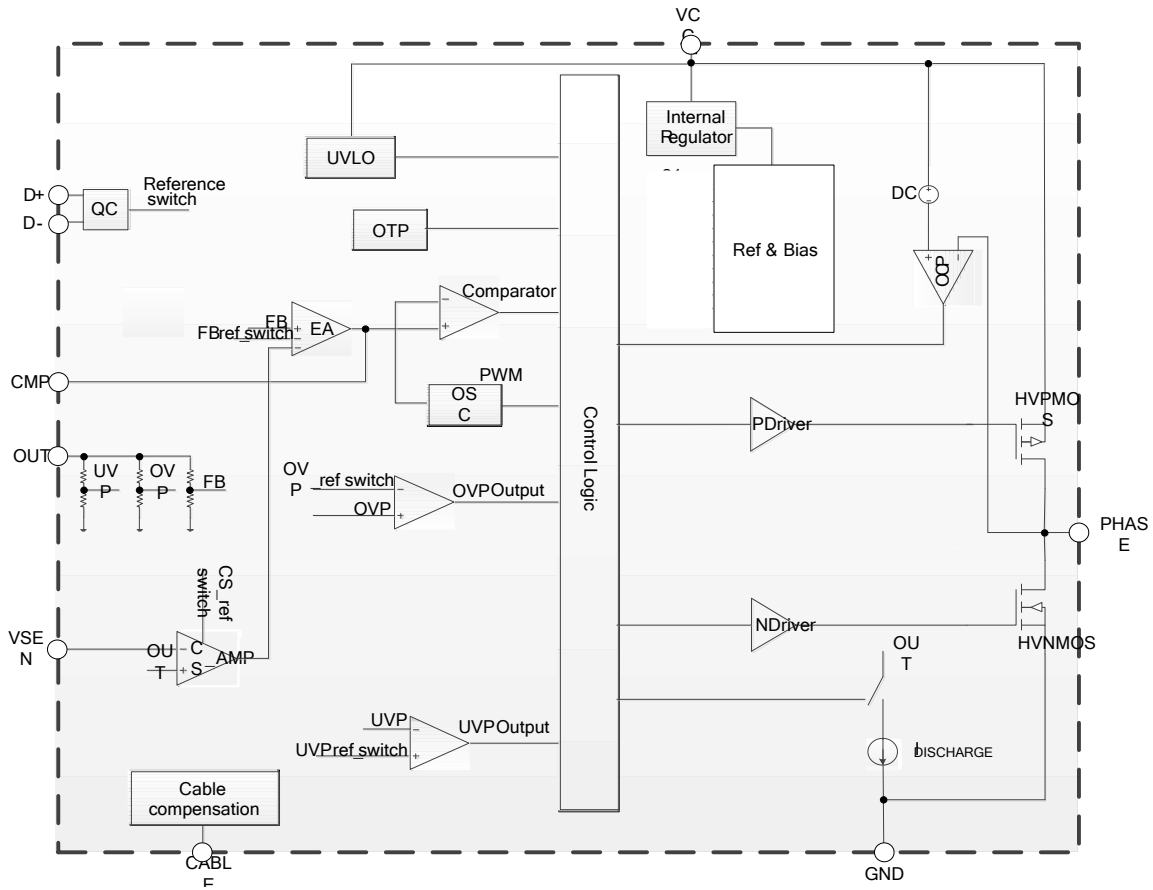


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Pin Descriptions

| Pin Number | Pin Name | Function |
|-------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | VCC | IC voltage supplier and input voltage for power conversion; Decoupling cap is required to be placed to this pin and GND pin as close as possible |
| 2 | CABLE | Connected to the external resistor to set the cable compensation value |
| 3 | D+ | Connected to USB D+ |
| 4 | D- | Connected to USB D- |
| 5 | OUT | Sense the output voltage; connected to the input of current sense resistor |
| 6 | VSEN | Sense the output current; connected to the output of current sense resistor |
| 7 | CMP | The EA output pin to compensate the loop |
| 8 | GND | Ground return for the power stage and controller |
| Exposed PAD | PHASE | Connected to the input of external output inductor |

Functional Block Diagram



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Absolute Maximum Ratings (Note 4)

| Parameter | Symbol | Rating | Unit |
|--------------------------------|--------------------|-------------|------|
| Supply Voltage | V _{CC} | -0.3 to 42 | V |
| Voltage From PHASE to GND | V _{PHASE} | -0.3 to 42 | V |
| Voltage From OUT to GND | V _{OUT} | -0.3 to 20 | V |
| Voltage on Other Separate Pins | – | -0.3 to 6 | V |
| Thermal Resistance (Note 5) | θ _{JA} | 63 | °C/W |
| Operating Junction Temperature | T _J | -40 to +125 | °C |
| Storage Temperature | T _{STG} | -65 to +150 | °C |
| ESD (Human Body Model) | – | 2000 | V |
| ESD (Machine Model) | – | 200 | V |

Note: 4. Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.
5. Device mounted on FR-4 substrate PC board, 2oz copper, with 1 square inch pad layout.

Recommended Operating Conditions

| Symbol | Parameter | Min | Max | Unit |
|-----------------|---------------------|-----|-----|------|
| V _{CC} | Supply Voltage | 10 | 40 | V |
| T _A | Ambient Temperature | -40 | +85 | °C |

Electrical Characteristics (@T_A = +25°C, V_{CC} = 16V, unless otherwise specified.)

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-----------------------------------|--------------------------------------------------------------|-------------------------------------------------------------|-------|-------|-------|------|
| Supply Voltage | | | | | | |
| V _{ST} | Startup Voltage | – | 8.4 | 8.7 | 9.0 | V |
| – | UVLO | – | 6.75 | 7.00 | 7.25 | V |
| I _{NO-LOAD} | I _{CC} @ No-load Condition | – | – | 2 | – | mA |
| CV/CC Control | | | | | | |
| V _{REF_12V} | Voltage Control Loop Reference | – | 11.7 | 12.0 | 12.3 | V |
| V _{REF_9V} | | – | 8.77 | 9.00 | 9.23 | V |
| V _{REF_5V} | | – | 4.92 | 5.00 | 5.08 | V |
| V _{CABLE} | Cable Compensation | R _{CABLE} = 17.6k, R _{SENSE} = 27.27mΩ | – | 400 | – | mV |
| V _{CS_12V} | Current Control Loop Reference | – | 41.0 | 45.0 | 49.0 | mV |
| V _{CS_9V} | | – | 57.0 | 60.0 | 63.0 | mV |
| V _{CS_5V} | | – | 57.6 | 60.0 | 62.4 | mV |
| Internal MOSFET | | | | | | |
| R _{DS(ON)_UP} | High Side MOSFET R _{DS(ON)} | – | – | 100 | – | mΩ |
| R _{DS(ON)_LOW} | Low Side MOSFET R _{DS(ON)} | – | – | 45 | – | mΩ |
| PWM And Oscillation | | | | | | |
| f _S | Switching Frequency | – | – | 120 | – | kHz |
| D _{MAX} | Maximum Duty | – | – | 95 | – | % |
| I _{DIS} | Discharge Current@ OUT Pin | – | – | 100 | – | mA |
| Protection | | | | | | |
| V _{OVP_5V} | Output OVP Threshold @5V | Note 6 | 5.63 | 5.80 | 5.97 | V |
| V _{OVP_9V} | Output OVP Threshold @9V | | 10.13 | 10.44 | 10.75 | V |
| V _{OVP_12V} | Output OVP Threshold @12V | | 13.51 | 13.92 | 14.33 | V |
| V _{UVP_5V} | Output UVP Threshold @5V | – | 3.13 | 3.30 | 3.47 | V |
| V _{UVP_9V} | Output UVP Threshold @9V | – | 5.63 | 5.94 | 6.24 | V |
| V _{UVP_12V} | Output UVP Threshold @12V | – | 7.51 | 7.92 | 8.33 | V |
| I _{PK_MAX} | MOSFET Maximum I _{PEAK} Limitation | – | – | 4.0 | – | A |
| Internal OTP | | | | | | |
| – | Internal OTP Trigger Temperature | – | – | +160 | – | °C |
| – | Internal OTP Recovery Temperature | – | – | +140 | – | °C |
| QC 2.0 protocol definition | | | | | | |
| V _{DAT_REF} | Data Detect Voltage | – | 0.25 | 0.325 | 0.40 | V |
| V _{SEL_REF} | V _{SEL_REF} (Reference for Selecting HVDCP Voltage) | – | 1.8 | 2 | 2.2 | V |
| t _{GLITCH_BC_DONE} | D+ High Glitch Filter Time | – | 1 | 1.25 | 1.5 | s |
| t _{GLITCH_DM_LOW} | D- Low Glitch Filter Time | Note 7 | 1 | 2.5 | – | ms |

Notes: 6. The value in table is only for I_O=0A. If I_O is not zero, the over voltage protection value needs to add cable compensation voltage.
7. Guaranteed by design.

Operation Description

Qualcomm QC 2.0 Protocol Operation

| Decoder | V _{D+} (V) | V _{D-} (V) | Charger Output Voltage/Full Current Capability |
|------------------------------------------------------------|---------------------|---------------------|------------------------------------------------|
| Qualcomm Quick Charge 2.0 Protocol Class A: 5V, 9V, 12V | 0.6 | 0.6 | 12V/1.5A |
| | 3.3 | 0.6 | 9V/2A |
| | 0.6 | 3.3 | Keep Present V1/V2 Status Unchanged |
| | 3.3 | 3.3 | Keep Present V1/V2 Status Unchanged |
| | 0.6 or 3.3 | GND | 5V/2A |
| | GND | 0.6 or 3.3 or GND | 5V/2A (Protocol Handshake Reset) |

Constant Current Operation

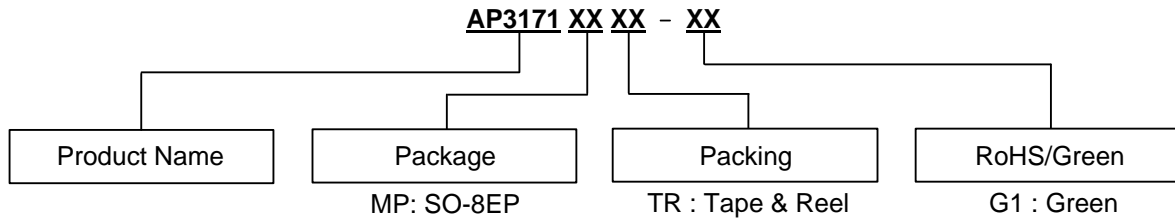
The AP3171 can work in constant-current (CC) mode. The output current is sensed by a current sense resistor R_{SENSE}. As output current increases, the voltage drop across R_{SENSE} will be limited to a reference voltage (V_{CS}) to accomplish CC function. The default R_{SENSE} is 27.27mΩ to get the typical CC point of 110% full output current.

Cable Compensation

The cable compensation can be calculated as below:

$$V_{CABLE} = I_o * R_{SENSE} * 129.5k / R_{CABLE}$$

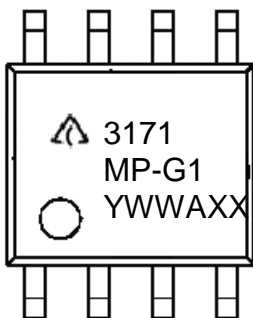
Ordering Information



| Package | Part Number | Marking ID | Packing |
|---------|---------------|------------|-------------------|
| SO-8EP | AP3171MPTR-G1 | 3171MP-G1 | 4,000/Tape & Reel |

Marking Information

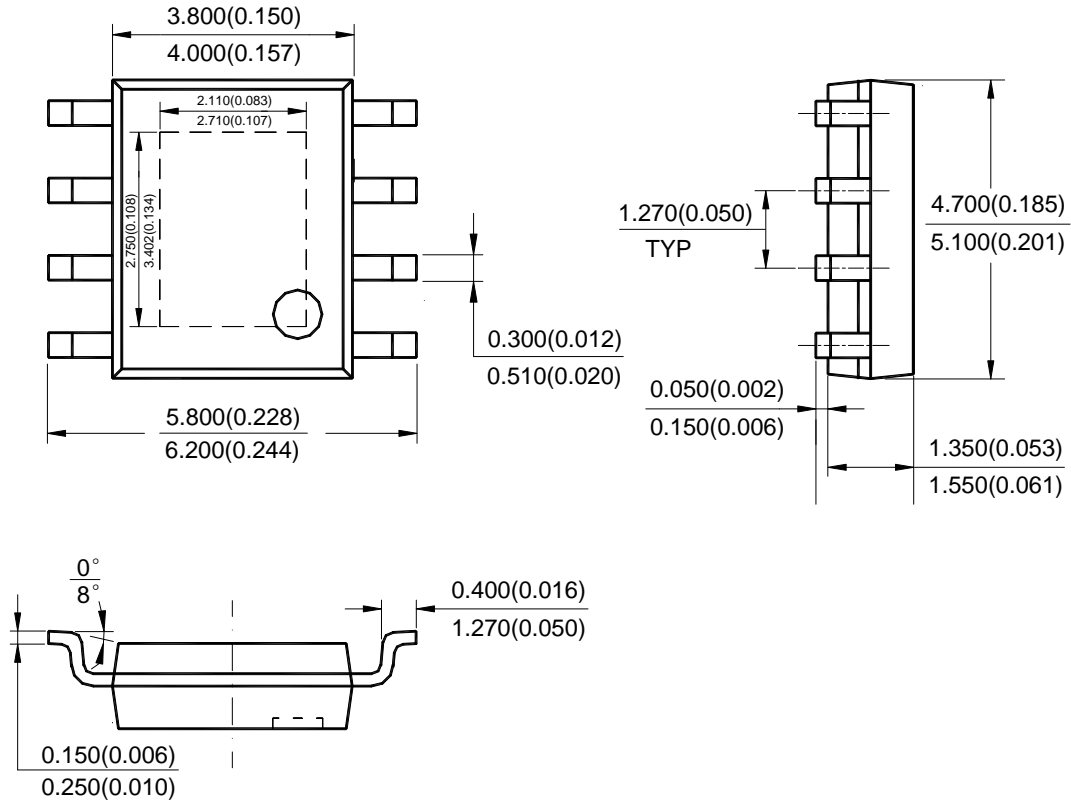
(Top View)



First and Second Lines: Logo and Marking ID
 Third Line: Date Code
 Y: Year
 WW: Work Week of Molding
 A: Assembly House Code
 XX: 7th and 8th Digits of Batch No.

Package Outline Dimensions (All dimensions in mm(inch).)

(1) Package Type: SO-8EP

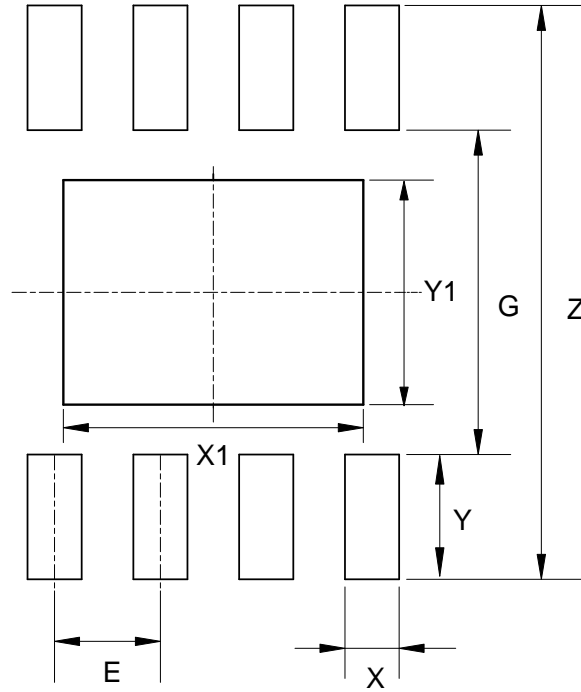


Note: Eject hole, oriented hole and mold mark is optional.

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Suggested Pad Layout

(1) Package Type: SO-8EP



| Dimensions | Z (mm)/(inch) | G (mm)/(inch) | X (mm)/(inch) | Y (mm)/(inch) | X1 (mm)/(inch) | Y1 (mm)/(inch) | E (mm)/(inch) |
|------------|------------------|------------------|------------------|------------------|-------------------|-------------------|------------------|
| Value | 6.900/0.272 | 3.900/0.154 | 0.650/0.026 | 1.500/0.059 | 3.600/0.142 | 2.700/0.106 | 1.270/0.050 |

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