# MPQ4420A

## 2A, 36V, High-Efficiency, Synchronous, Step-Down Converter AEC-Q100 Qualified

The Future of Analog IC Technology®

## DESCRIPTION

The MPQ4420A is a high-efficiency, synchronous, rectified, step-down, switch-mode converter with built-in power MOSFETs. It offers a very compact solution that achieves 2A of continuous output current with excellent load and line regulation over a wide input supply range.

The MPQ4420A uses synchronous mode operation to achieve higher efficiency over the output current load range. Current-mode operation provides fast transient response and eases loop stabilization.

Full protection features include over-current protection (OCP) and thermal shutdown.

The MPQ4420A requires a minimal number of readily available, standard, external components and is available in a compact, 8-pin, TSOT23 package.

## FEATURES

- Wide 4V to 36V Continuous Operating Input Range
- 90mΩ/55mΩ Low $R_{DS(ON)}$ Internal Power MOSFETs
- High-Efficiency Synchronous Mode Operation
- Default 410kHz Switching Frequency
- Synchronizes to a 200kHz to 2.2MHz External Clock
- High Duty Cycle for Automotive Cold Crank
- Forced CCM
- Internal Soft Start
- Power Good
- Over-Current Protection (OCP) and Hiccup
- Thermal Shutdown
- Output Adjustable from 0.8V
- Available in a TSOT23-8 Package
- Available in AEC-Q100 Grade 1

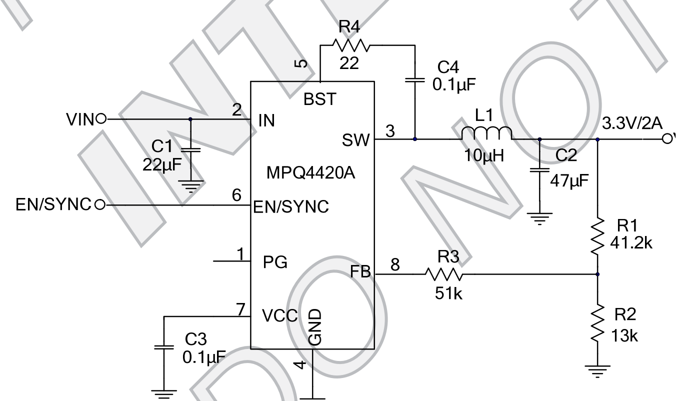
## APPLICATIONS

- Automotive
- Industrial Control System
- Distributed Power Systems



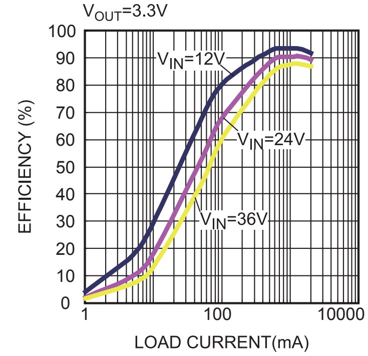


## TYPICAL APPLICATION




**Efficiency vs. Load Current**

$V_{OUT}$=3.3V



## ORDERING INFORMATION

| Part Number* | Package | Top Marking |
|---|---|---|
| MPQ4420AGJ | TSOT23-8 | *See Below* |
| MPQ4420AGJ-AEC1 | TSOT23-8 | |

* For Tape & Reel, add suffix –Z (e.g. MPQ4420AGJ–Z)

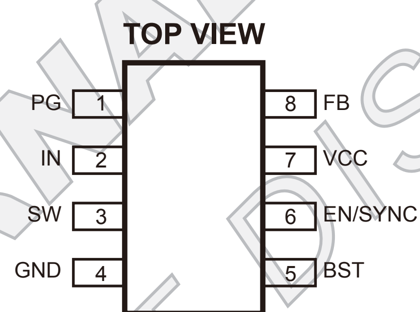
## TOP MARKING

|APJY

APJ: Product code of MPQ4420AGJ and MPQ4420AGJ-AEC1
Y: Year code

## PACKAGE REFERENCE

**TOP VIEW**




**TSOT23-8**

## ABSOLUTE MAXIMUM RATINGS [1]

$V_{IN}$ ..........................................-0.3V to 40V
$V_{SW}$ ..........................................-0.3V to 41V
$V_{BS}$ .......................................... $V_{SW}$ + 6V
All other pins ............................... -0.3V to 6V [2]
Continuous power dissipation ($T_A$ = +25°C) [3]
TSOT23-8 ............................................ 1.25W
Junction temperature ................................150°C
Lead temperature ....................................260°C
Storage temperature .................. -65°C to 150°C

### *Recommended Operating Conditions*

Continuous supply voltage ($V_{IN}$)..........4V to 36V
Output voltage ($V_{OUT}$)................0.8V to 0.9 x $V_{IN}$
Operating junction temp. ($T_J$)... -40°C to +125°C

| *Thermal Resistance* [4] | $\theta_{JA}$ | $\theta_{JC}$ | |
|---|---|---|---|
| TSOT23-8 | 100 | 55 | °C/W |

**NOTES:**

1) Absolute maximum ratings are rated under room temperature unless otherwise noted. Exceeding these ratings may damage the device.
2) For details on EN's ABS MAX rating, please refer to the Enable/SYNC Control section on page 14.
3) The maximum allowable power dissipation is a function of the maximum junction temperature $T_J$ (MAX), the junction-to-ambient thermal resistance $\theta_{JA}$, and the ambient temperature $T_A$. The maximum allowable continuous power dissipation at any ambient temperature is calculated by $P_D$ (MAX) = ($T_J$ (MAX)-$T_A$)/$\theta_{JA}$. Exceeding the maximum allowable power dissipation produces an excessive die temperature, causing the regulator to go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.
4) Measured on JESD51-7, 4-layer PCB.

## ELECTRICAL CHARACTERISTICS

**$V_{IN}$ = 12V, $T_J$ = -40°C to +125°C, unless otherwise noted. Typical values are at $T_J$ = +25°C.**

| Parameter | Symbol | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Supply current (shutdown) | $I_{SHDN}$ | $V_{EN}$ = 0V | | | 8 | μA |
| Supply current (quiescent) | $I_Q$ | $V_{EN}$ = 2V, $V_{FB}$ = 1V, no switching | | 0.6 | 0.8 | mA |
| HS switch on resistance | $R_{ON\_HS}$ | $V_{BST-SW}$ = 5V | | 90 | 155 | mΩ |
| LS switch on resistance | $R_{ON\_LS}$ | $V_{CC}$ = 5V | | 55 | 105 | mΩ |
| Switch leakage | $I_{LKG\_SW}$ | $V_{EN}$ = 0V, $V_{SW}$ = 12V | | | 1 | μA |
| Current limit | $I_{LIMIT}$ | Under 40% duty cycle | 3.4 | 5.6 | 7.8 | A |
| Oscillator frequency | $f_{SW}$ | $V_{FB}$ = 750mV | 320 | 410 | 500 | kHz |
| Foldback frequency | $f_{FB}$ | $V_{FB}$ < 400mV | 70 | 100 | 130 | kHz |
| Maximum duty cycle | $D_{MAX}$ | $V_{FB}$ = 750mV, 410kHz | 92 | 95 | | % |
| Minimum on time(5) | $t_{ON\_MIN}$ | | | 70 | | ns |
| Sync frequency range | $f_{SYNC}$ | | 0.2 | | 2.4 | MHz |
| Feedback voltage | $V_{FB}$ | $T_J$ = 25°C | 780 | 792 | 804 | mV |
| | | | 776 | | 808 | |
| Feedback current | $I_{FB}$ | $V_{FB}$ = 820mV | | 10 | 100 | nA |
| EN rising threshold | $V_{EN\_RISING}$ | | 1.15 | 1.4 | 1.65 | V |
| EN falling threshold | $V_{EN\_FALLING}$ | | 1.05 | 1.25 | 1.45 | V |
| EN threshold hysteresis | $V_{EN\_HYS}$ | | | 150 | | mV |
| EN input current | $I_{EN}$ | $V_{EN}$ = 2V | | 4 | 6 | μA |
| | | $V_{EN}$ = 0 | | 0 | 0.2 | μA |
| $V_{IN}$ under-voltage lockout threshold rising | $INUV_{RISING}$ | | 3.3 | 3.5 | 3.7 | V |
| $V_{IN}$ under-voltage lockout threshold falling | $INUV_{FALLING}$ | | 3.1 | 3.3 | 3.5 | V |
| $V_{IN}$ under-voltage lockout threshold hysteresis | $INUV_{HYS}$ | | | 200 | | mV |
| VCC regulator | $V_{CC}$ | $I_{CC}$ = 0mA | 4.6 | 4.9 | 5.2 | V |
| VCC load regulation | | $I_{CC}$ = 5mA | | 1.5 | 4 | % |
| Soft-start period | $t_{SS}$ | $V_{OUT}$ from 10% to 90% | 0.55 | 1.45 | 2.45 | ms |
| Thermal shutdown (5) | | | 150 | 170 | | °C |
| Thermal hysteresis (5) | | | | 30 | | °C |
| PG rising threshold | $PG_{Vth\_RISING}$ | as a percentage of $V_{FB}$ | 86 | 90 | 94 | % |
| PG falling threshold | $PG_{Vth\_FALLING}$ | as a percentage of $V_{FB}$ | 80 | 84 | 88 | % |

## ELECTRICAL CHARACTERISTICS *(continued)*

**$V_{IN}$ = 12V, $T_J$ = -40°C to +125°C, unless otherwise noted. Typical values are at $T_J$ = +25°C.**

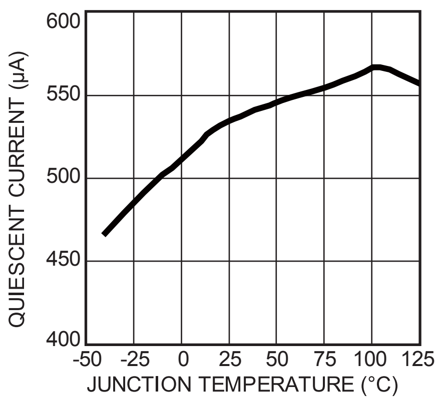
| Parameter | Symbol | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| PG threshold hysteresis | $PG_{Vth\_HYS}$ | as a percentage of $V_{FB}$ | | 6 | | % |
| PG rising delay | $PG_{Td\_RISING}$ | | 40 | 90 | 160 | μs |
| PG falling delay | $PG_{Td\_FALLING}$ | | 30 | 55 | 95 | μs |
| PG sink current capability | $V_{PG}$ | Sink 4mA | | 0.1 | 0.3 | V |
| PG leakage current | $I_{LKG\_PG}$ | | | 10 | 100 | nA |

**NOTE:**

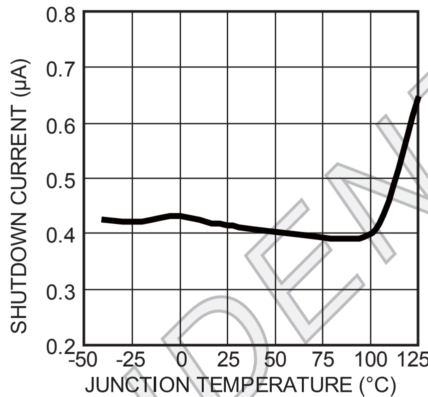
5) Derived from bench characterization. Not tested in production.

## TYPICAL CHARACTERISTICS

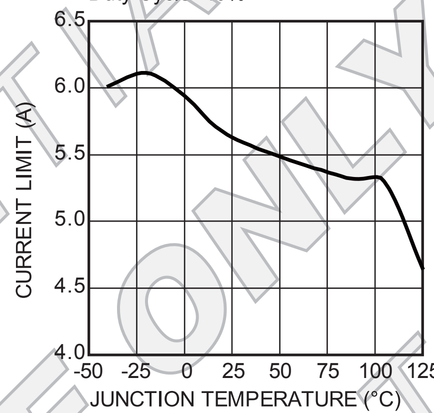
**Quiescent Current vs. Junction Temperature**
$V_{IN}$=12V



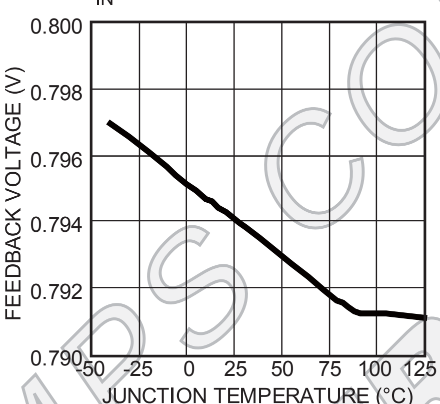

**Shutdown Current vs. Junction Temperature**
$V_{IN}$=12V



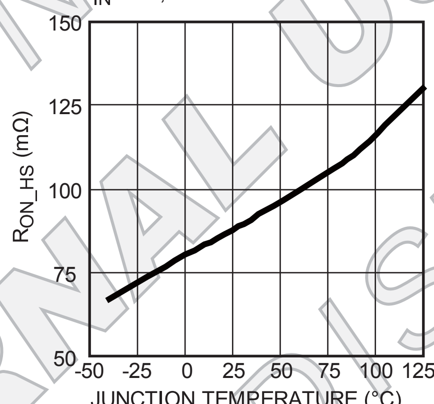

**Current Limit vs. Junction Temperature**
Duty Cycle=40%



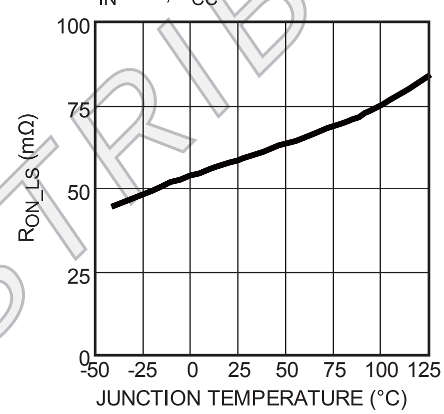

**Feedback Voltage vs. Junction Temperature**
$V_{IN}$=12V



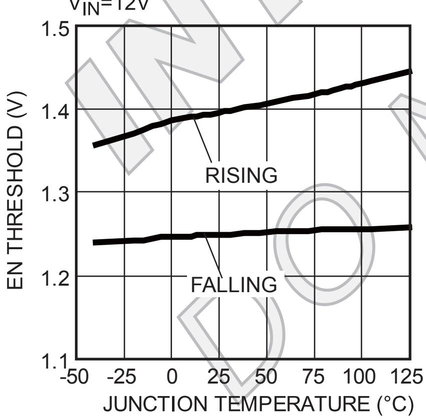

**$R_{ON\_HS}$ vs. Junction Temperature**
$V_{IN}$=12V, BST-SW=5V



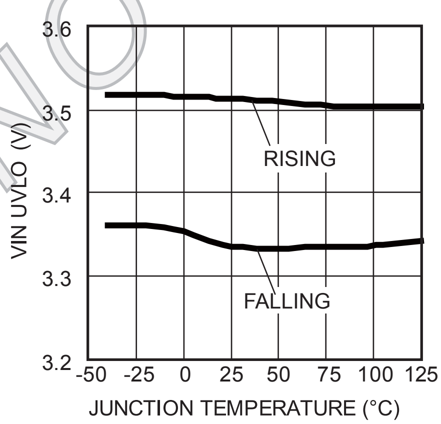

**$R_{ON\_LS}$ vs. Junction Temperature**
$V_{IN}$=12V, $V_{CC}$=5V



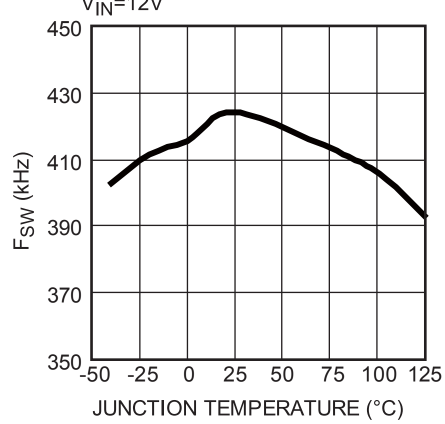

**EN Threshold vs. Junction Temperature**
$V_{IN}$=12V




**$V_{IN}$ UVLO vs. Junction Temperature**

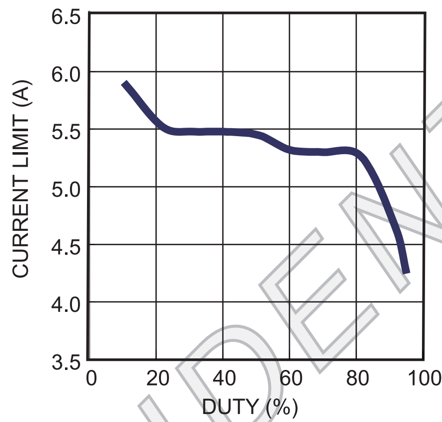



**$F_{SW}$ vs. Junction Temperature**
$V_{IN}$=12V



## TYPICAL CHARACTERISTICS *(continued)*

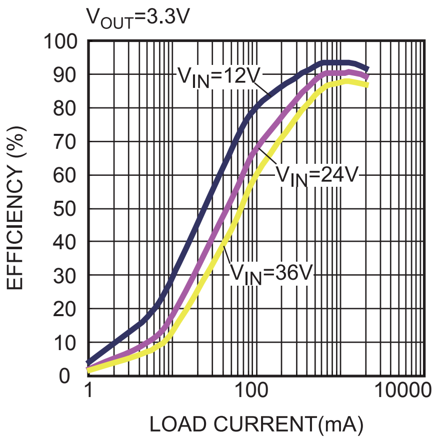
**Current Limit vs. Duty**



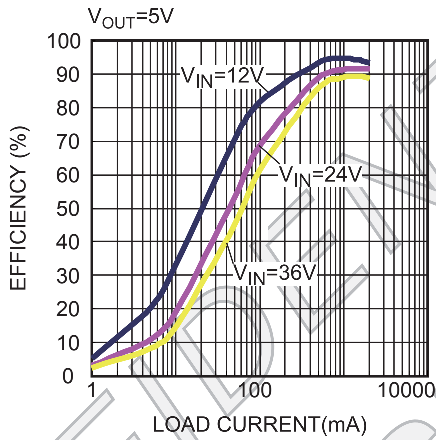
## TYPICAL PERFORMANCE CHARACTERISTICS

**$V_{IN}$ = 12V, $V_{OUT}$ = 3.3V, L = 10µH, $R_{BST}$ = 20Ω, $T_A$ = +25°C, unless otherwise noted.**

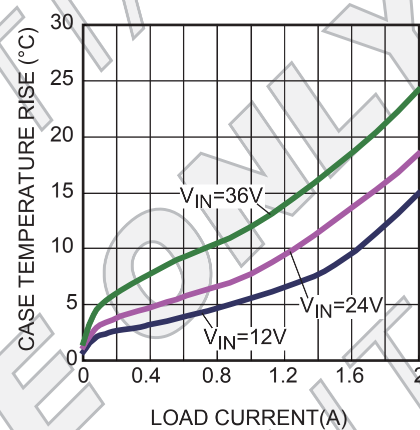
**Efficiency vs. Load Current**



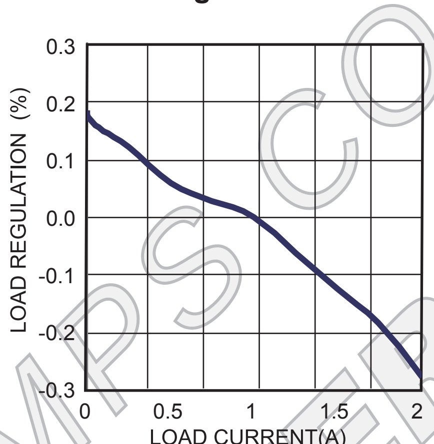

**Efficiency vs. Load Current**




**Thermal Rise**




**Load Regulation**




**Line Regulation**