# CAT3612EVAL1 EVALUATION BOARD FOR CAT3612 CAMERA FLASH LED DRIVER

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## 1. INTRODUCTION

This document describes the CAT3612EVAL1 Evaluation / Demonstration Board for the Catalyst Semiconductor CAT3612, 300mA Flash LED driver with 1-wire interface. The functionality and major parameters of the CAT3612 can be evaluated with the CAT3612EVAL1 board.

The CAT3612 is a 2-channel charge pump that has been designed to provide a regulated output current up to 150mA per channel. The device is operating in either 1x (LDO) mode, or 1.5x mode and it is suitable for driving with high efficiency one or two Flash LEDs. The programmable current and dimming control of LEDs are achieved using a 1-wire interface. The user can set the current from 150mA down to 0mA with approximately 5mA resolution, by toggling the EN/DIM input. Detailed description and electrical characteristics are in the CAT3612 data sheet.

## 2. CAT3612EVAL1 BOARD HARDWARE

The evaluation board contains the CAT3612 in a typical application circuit, driving up to 2 Flash LEDs. The CAT3612 is controlled through 1-wire interface using an 8-bit microcontroller. The board is powered from an attached 3V (2 x 1.5V AA) battery. The board schematic is shown in Figure 1.

The CAT3612 input voltage, VIN, is supplied on board from a +3V voltage, VDD (VBAT = 3V) or from an external variable voltage applied to the VIN EXT (T1) pad. The voltage supplied at the VIN input of the CAT3612 device can be selected using jumper options for the J1 connector.

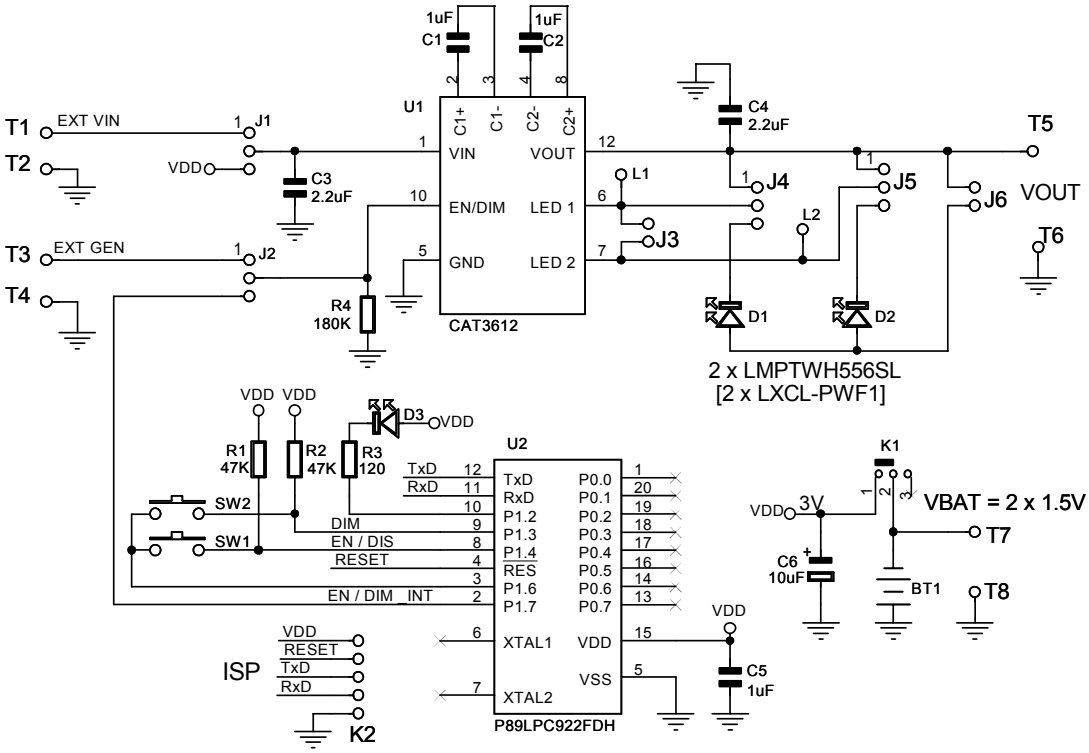


**Figure 1. CAT3612EVAL1 Board Schematic**

The EN/DIM input is controlled on board through the microcontroller (EN/DIM INT) when J2 connector is jumpered between Pin #2 and Pin #3 (jumper shunt – right position). The user interface for controlling the CAT3612 through the microcontroller is provided by two momentary SPST pushbuttons: SW1 (EN/DIS) and SW2 (DIM).

The EN/DIS pushbutton allows the user to set the EN input high (the device enabled) or low (the device shutdown). The action of the SW1 pushbutton has a toggle function: first time pressing the switch it sets the EN high and the associated red LED indicator will be on. The second action sets the EN input low.

The DIM pushbutton allows the user to program the LED current. Every time the pushbutton is pressed (short action), an active low pulse (tw < 200 us) is generated on the EN/DIM input of the CAT3612 device. At every falling edge of the pulses provided at EN/DIM input, the LED current is decreased by 5mA step. On the first transition from high to low on EN/DIM, the LED current is set to the maximum value of 150mA. The 32nd pulse sets the ILED = 0mA and the LEDs will be off. The next action of the DIM switch sets the current back to the maximum value of 150mA.

When the DIM (SW2) pushbutton is held down, the microcontroller sends sequentially pulses on the EN/DIM input. As a result the LED current will cycle automatically step by step through whole range of 150mA to 0mA.

The user can also choose to drive the EN/DIM input of the CAT3612 device with an externally provided signal, if the J2 connector has the jumper between Pin #1 and Pin #2 (jumper shunt – left position). The external signal should be connected to T3/GEN test point.

The user can connect or disconnect the CAT3612 outputs to the flash LEDs using the jumper options for J3, J4, J5 and J6 connectors. To connect 2 LEDs to the CAT3612 outputs the J4 and J5 connectors should have the jumper between Pin #2 and Pin #3 (on board shunt – up position) and J6 connector jumpered (J3 connector not jumpered). Any unused LED output pin can be connected to the VOUT pin with the jumper shunt between Pin #1 and Pin #2 (on board shunt - down position) of the corresponding J4, J5 connectors.

To connect both channels together and driving one LED with the 300mA maximum current, remove the jumper shunt from one of J4, J5 connectors (i.e. connect only one LED to the device output) and set the jumper on J3 connector.

The user can evaluate the LED current through each CAT3612 output channel or the total output current with a current meter connected at the J4 to J6 header pin connectors.

Test points T1 to T8 are available to apply the external voltages/signal generator, or to measure the output voltages/signals provided by the CAT3612.

Table 1 shows the component list for this evaluation board. The component placement for the CAT3612EVAL1 and the board picture are shown in Figure 2.

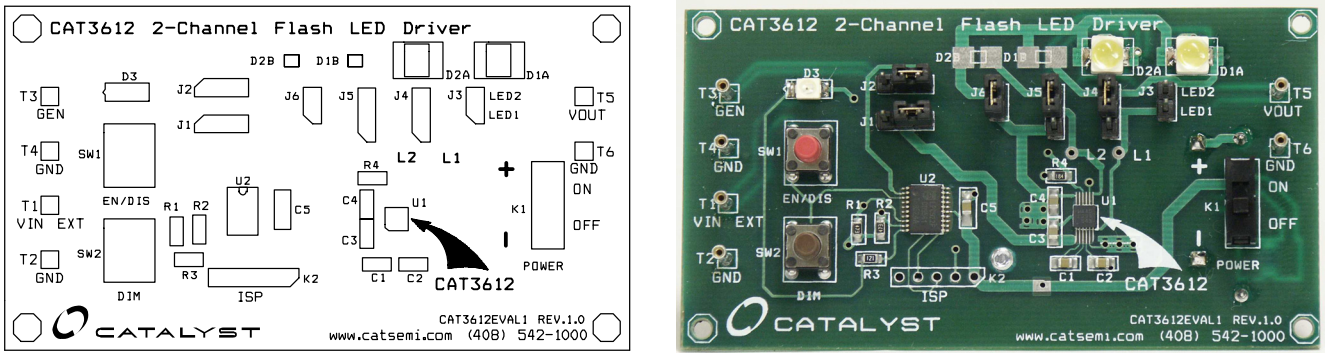


**Figure 2. CAT3612EVAL1 Board**

**Table 1. Cat3612EVAL1 Board List of Components**

| Name | Manufacture | Description | Part Number | Unit |
|---|---|---|---|---|
| U1 | Catalyst | 1-Wire 300mA Flash LED Driver, TDFN-12 | CAT3612HV2 | 1 |
| U2 | Philips | 8- bit flash microcontroller TSSOP20 | P89LPC922FDH | 1 |
| C1, C2, C5 | AVX | Ceramic Capacitor 1µF / 10V, 10%, X5R, Size 0603 | 0603ZD105KAT2A | 3 |
| C3, C4 | AVX | Ceramic Capacitor 2.2µF / 10V, 10%, X5R, Size 0805 / 0603 | 0805ZD225KAT2A (or 06036D25KAT2A) | 2 |
| C6 | Kemet | Tantalum Capacitor,10µF / 16V, SMD | T491B106K016AS | 1 |
| R1, R2 | Yageo | SMT Resistor 1/8W, 47K, 1%, Size 0805 | Digi-Key 311-47.0KCCT-ND | 2 |
| R3 | Yageo | SMT Resistor 1/8W, 120ohm, 1%, Size 0805 | Digi-Key 311-120CCT-ND | 1 |
| R4 | Yageo | SMT Resistor 1/8W,180Kohm, 1%, Size 0805 | Digi-Key 311-180KCCT-ND | 1 |
| D1, D2 | Lumimicro | 350mA Power LED | LMPTWH556SL | 2 |
| D3 | LiteOn | Red LED, SMT | LTST-T970KRKT | 1 |
| SW1, SW2 | HDT | Momentary Contact Switch SPST (on)-off | Schukat Electronic DTS67R | 2 |
| K1 | E-Switch | Slide Switch, SPDT | EG1218 (Digi-Key EG1903-ND) | 1 |
| J1, J2, J4, J5 | | 3-pin Header Connector, 0.1", Single Strip | Digi-Key S1012-03-ND (or equiv) | 4 |
| J3, J6 | | 2-pin Header Connector, 0.1", Single Strip | Digi-Key S1012-02-ND (or equiv) | 2 |
| T1 to T8 | Mil-Max | Pin Receptacle (Test Points) | #0149-0-15-01-30-14-04-0 (or equiv) | 8 |
| BTH | Keystone | Battery Holder 2 x AA 1.5V | Digi-Key 2462K-ND | 1 |

## 3. CAT3612 EVALUATION

The CAT3612EVAL1 gives the user a way to evaluate the CAT3612 in a typical application of driving one or two Flash LEDs. The user can connect up to 2 LEDs to the CAT3612 output, using the jumper options for J3, J4, J5 and, J6 header-pin connectors.

The following steps are an example of how the user can evaluate the CAT3612 white LED driver:

**1) Driving LEDs, Shutdown Mode and Quiescent Current**

a) Connect the LEDs to the CAT3612 output.

- Connect VOUT to the LEDs anode terminal using a jumper at J6 header-pin connector.
- Connect each LED cathode terminal to the CAT3612 outputs, LED1, LED2, using the jumper options (Pin #2 and Pin #3) for J4 and J5 header pin connectors.

b) Connect a jumper shunt between Pin #2 and Pin #3 (on board shunt - right position) of J2 header-pin connector. That will control the EN/DIM input from on-board microcontroller.

c) Set the jumper shunt for the J1 connector to the left position (Pin #1 and Pin #2) to supply externally provided voltage at the VIN input of the CAT3612 device. Apply the external voltage supply, Vext (3.0 < VIN < 5.0V) between VIN (T1) and GND (T2).

d) Turn “ON” the on-board POWER switch. That provides the power to the microcontroller which drives the EN/DIM input.

e) The CAT3612 is in the **shutdown mode** (EN pin is held low) if the SW1 switch (EN/DIS) is not pressed and the associated LED (red) is not ON.

- Connect a current meter, IM1, between Vext and VIN (T1) pad to measure the shutdown current: IQSHDN << 1µA

f) Set EN high (EN = “1”) by pressing the EN/DIS pushbutton (one time). The white LEDs connected to the CAT3612 outputs will remain OFF (IOUT = 0mA). The device operates in 1x mode.

– The current measured by IM1 meter (IIN) is the **quiescent current** in **1x mode** of operation:
IQ (1x mode) = 0.5mA to 0.7mA for VIN ranges between 3V and 5V

g) Toggle EN/DIM input by pressing the DIM pushbutton (short action) 32 times. The LED current will change from the max value (150mA) to 0mA (LED OFF).

– The input current measured by the IM1 meter represents the **quiescent current** in **1.5x mode**:
IQ (1.5x mode) = 2.7mA to 3.4mA for VIN between 3.0V and 3.6V

***Note:*** *The values measured at f) and g) include also 16 µA current through the R4 pull-down resistor at EN/DIM input.*

h) The unused LED channels should be connected to VOUT pin in order to optimize the CAT3612 functionality.

– Connect D1 LED at the LED1 output: jumper shunt between Pin #2 and Pin #3 at the associated header pin connector, J4 (up position).
– Disconnect D2 LED from the LED2 output of the CAT3612 and connect it to the VOUT pin: jumper shunt between Pin #1 and Pin #2 for J5 connector (down position).
– Observe the output sink current for the disabled channel measured by the current meter connected between the Pin #1 and Pin #2 of the corresponding header pin connector (J5).
– Repeat the measurements with LED1 channel disabled and LED2 (D2) connected. The disabled channel current is about 500µA typically.

VIN = 3.3V; I_unused_ch: 473µA (LED1); 465µA (LED2) (for ILED active set to 150mA to 5mA)

VIN = 4.2V; I_unused_ch: 498µA (LED1); 489µA (LED2) (for ILED active set to 150mA to 5mA)

### 2) Efficiency Evaluation

The efficiency is evaluated according to the following equation:

$$\text{Efficiency}\% = \frac{\Sigma \text{VFi} \times \text{ILEDi}}{\text{IIN} \times \text{VIN}} \times 100,$$

where VFi = VOUT – VLEDi is the voltage dropout across the LEDi, ILEDi is the current through one LED; i = 1 to 2.

### 2.1) Efficiency Evaluation versus Line Voltage

a) Set the configuration for 2 LEDs connected to the CAT3612 outputs.

b) Insert a current meter, IM1, between input supply voltage, Vext, and VIN pad (or use an embedded power supply current meter) and monitor the input current.

c) Set the input voltage for the initial value VIN = 3V. Monitor VIN at VIN (T1) test point with a voltage meter.

d) Set the LEDs ON at ILED = 150mA:
EN/DIS = ON, Toggle 1 time the EN/DIM input through DIM Pushbutton.

e) Measure the output voltage on VOUT (T5).

f) Measure VLED1 and VLED2 at L1 and L2 test points.

g) Repeat all the above measurements for VIN increase between 3V and 5.0V.

h) Repeat the same measurements for VIN decrease from 5.0V to 3.0V.

***Note:*** *It is recommended to turn Off/On (EN/DIS) the device and set the LED current ILED = 150mA every time when you change the VIN voltage, or at least around the switching point from 1.5x mode to 1x mode.*

Figure 3 and Figure 4 respectively, show the CAT3612 input current (IIN) and output voltage (VOUT) versus the line voltage using 2 LEDs driven at 150mA each.

The switching point between 1x mode and 1.5x mode happens at the same VIN voltage value (3.42V – 3.45V), both for increasing and decreasing the input voltage. As a result the values measured for VIN increase (named with "+") and values measured for VIN decrease (named with "-") are the same.

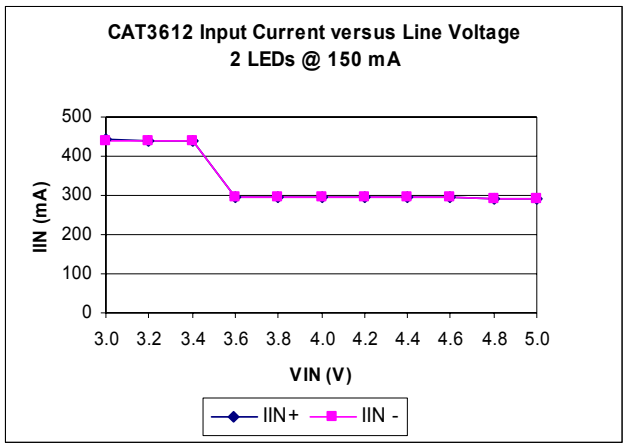


**Figure 3. Input Current versus Line Voltage**

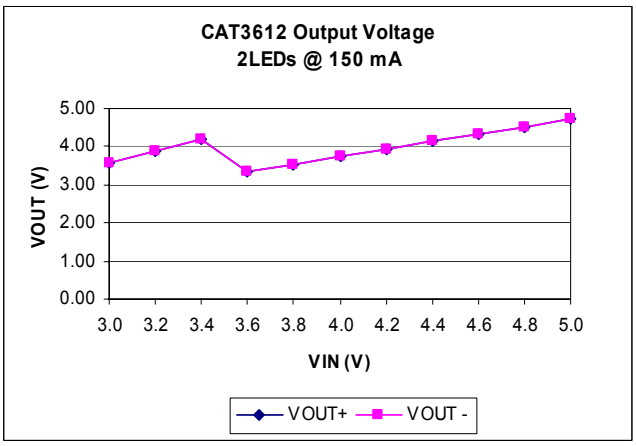


**Figure 4. Output Voltage versus Line Voltage**

The internal switch frequency, typical 1 MHz, is shown in the waveforms from the Figure 5; CH2: signal measured on the C2+ pad, CH1: output voltage, VOUT (1.5x mode, VIN = 3.3V).

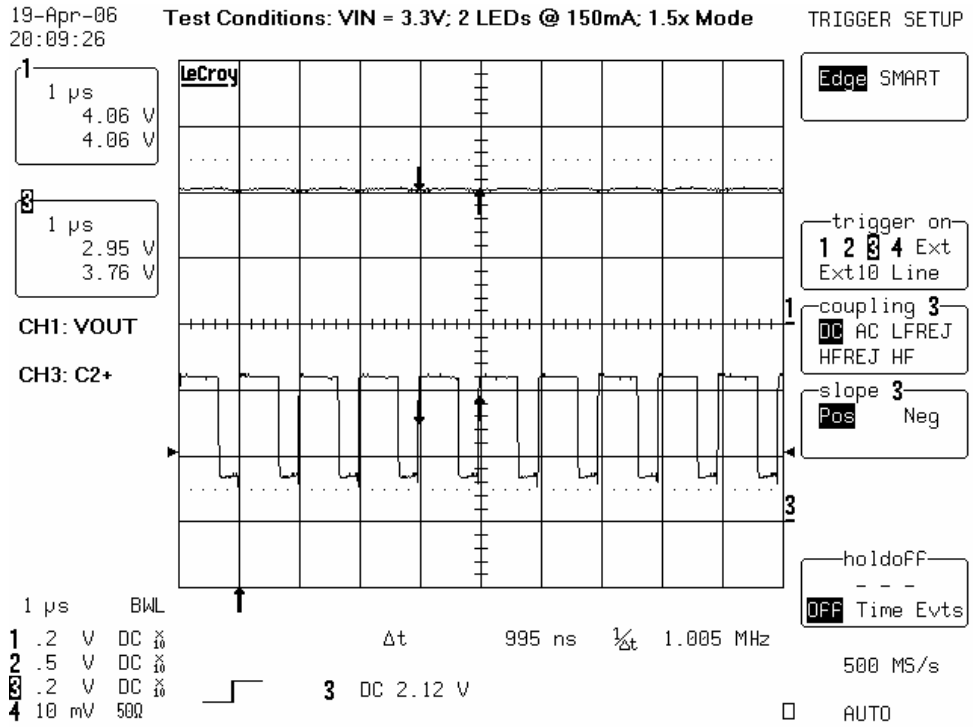


**Figure 5. CAT3612 Internal Switch and Output Voltage (VIN = 3.3V, 2 LEDs @ 150mA)**

The CAT3612 efficiency versus line voltage with 2 LEDs driven at 150mA, is shown in Figure 6.

The CAT3612 efficiency is optimized for Li-Ion battery applications. At the nominal battery voltage value, the CAT3612 operates in 1x mode providing a high efficiency. The efficiency value is dependable on the LED forward voltage, VF. The 1x mode of operation is provided until VIN drops below 3.5V typically. At this point the device switches to 1.5x operation mode. The efficiency values are the same both for VIN increase (Eff+) and VIN decrease (Eff-).

The above measurements can be repeated with only one LED driven at the maximum output current: disconnect D2 from the LED2 output (J5 connector not jumpered) and connect together the CAT3612 output channels, LED1 and LED2 (set a jumper on J3 connector). The CAT3612 efficiency versus input voltage driving 1 (one) LED at 300mA is shown in Figure 7.

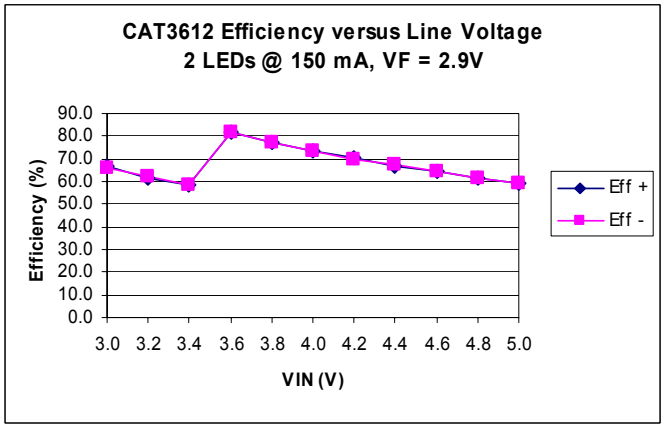


**Figure 6. Efficiency versus Line Voltage with 2 LEDs @ 150mA**

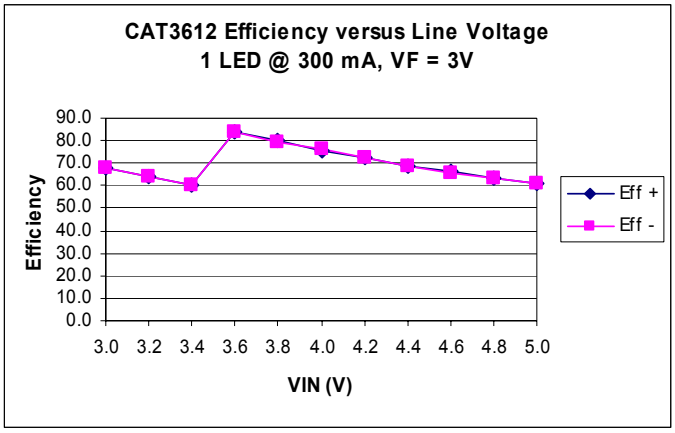


**Figure 7. Efficiency versus Line Voltage with 1 LED @ 350mA**

### 2.2) Efficiency Evaluation versus Load

The CAT3612 efficiency can also be evaluated versus the total output current driven through the LEDs. The following steps are an example of efficiency measurements for different output current values at two input voltage values.

a) Set the configuration for 1 LED (D1) driven by the CAT3612 device, LED1 and LED2 connected together.

b) Insert a current meter, IM1, between input supply voltage, Vext, and VIN pad (or use the embedded power supply current meter) and monitor the input current, IIN.

c) Set the input voltage for VIN = 3.2V. Measure the input voltage at VIN (T1) test point with a voltage meter.

d) Set the ILED current using EN/DIS and DIM switches: turn Off/ON (EN/DIS) and Toggle DIM; set initial value ILED = 150mA with 1 pls on DIM (IOUT = 2 x 150mA = 300mA).

e) Observe the IIN current on the IM1 meter.

f) Measure the output voltage on VOUT (T5) pin.

g) Measure the LED output voltage at L1 test point, VLED1= VLED2.

h) Repeat steps d) to g) for the total output current IOUT = 250mA (6 pls), 200mA (11 pls), 150mA (16 pls), 100mA (22 pls) and 50mA (27 pls).

***Note:*** *For every IOUT setting, turn the LEDs Off/On using the EN/DIS pushbutton. After enabling the device, set the desired ILED value toggling the DIM switch.*

All the above steps can also be performed for the other input voltage, i.e. VIN = 4.2V.

Figure 8 shows the CAT3612 efficiency versus the total output current for VIN = 3.2V and VIN = 4.2V. The efficiency has been calculated according to the following expression:

$$Eff = \frac{IOUT \times VF}{IIN \times VIN},$$

where VF = VOUT – VLED1

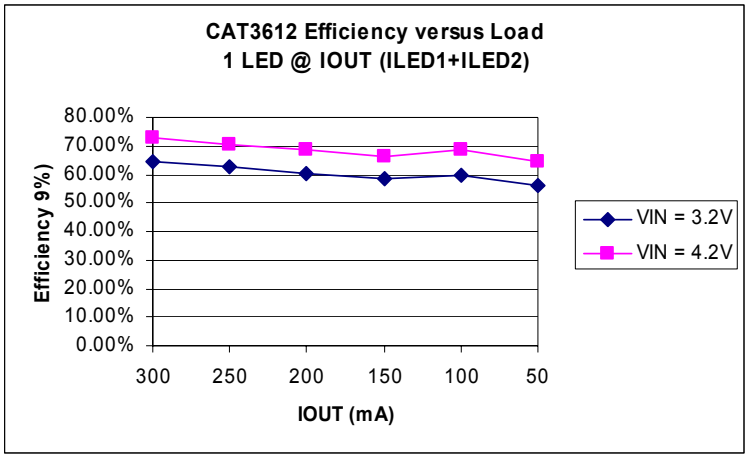


**Figure 8. CAT3612 Efficiency versus Load**

## REVISION HISTORY

| Date | Rev. | Reason |
|---|---|---|
| 05/30/06 | A | Initial Issue |
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