A 3637

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Description

The CAT3637 is a high efficiency fractional charge pump that can drive up to six LEDs programmable by a 1−wire digital interface. The inclusion of a 1.33x fractional charge pump mode increases device efficiency by up to 10% over traditional 1.5x charge pumps with no added external capacitors.

Low noise input ripple is achieved by operating at a constant switching frequency which allows the use of small external ceramic capacitors. The multi−fractional charge pump supports a wide range of input voltages from 2.5 V to 5.5 V.

The EN/SET logic input functions as a chip enable and a digital programming interface for setting the current in the LED channels. The 1−wire pulse−programming interface supports 15 linear steps from zero current to 30 mA full−brightness in 2 mA steps.

The device is available in a tiny 16−pad TQFN 3 x 3 mm package with a maximum height of 0.8 mm.

ON Semiconductor's 1.33x, charge pump switching architecture is patented.

Features

- High Efficiency 1.33x Charge Pump
- Charge Pump: 1x, 1.33x, 1.5x, 2x
- Drives 6 LEDs Between 30 mA and 0 mA Each
- 1−wire EZDim™ Interface with 2 mA Step
- Power Efficiency up to 92%
- Low Noise Input Ripple in All Modes
- "Zero" Current Shutdown Mode
- Soft Start and Current Limiting
- Short Circuit Protection

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HV3 SUFFIX
CASE 510AD

PIN CONNECTIONS

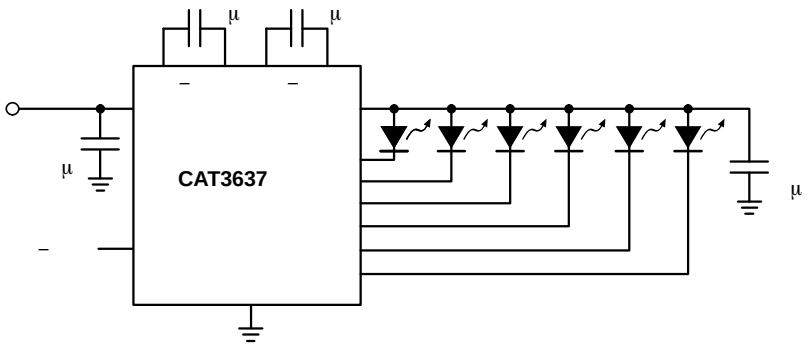

Figure 1. Typical Application Circuit

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Rating	Unit
± ±		
	–	°
	–	°
		°

Table 2. RECOMMENDED OPERATING CONDITIONS

Parameter	Range	Unit

Table 3. ELECTRICAL OPERATING CHARACTERISTICS

Table 4. RECOMMENDED EN/SET TIMING ≤ ≤ – ° °

Symbol	Name	Conditions	Min	Typ	Max	Units
						µ
						µ

TYPICAL PERFORMANCE CHARACTERISTICS

Figure 3. Efficiency vs. Input Voltage

Figure 4. Efficiency vs. Li−Ion Voltage

Figure 5. LED Current Change vs. Input Voltage

Figure 6. LED Current Change vs. Temperature

TYPICAL PERFORMANCE CHARACTERISTICS

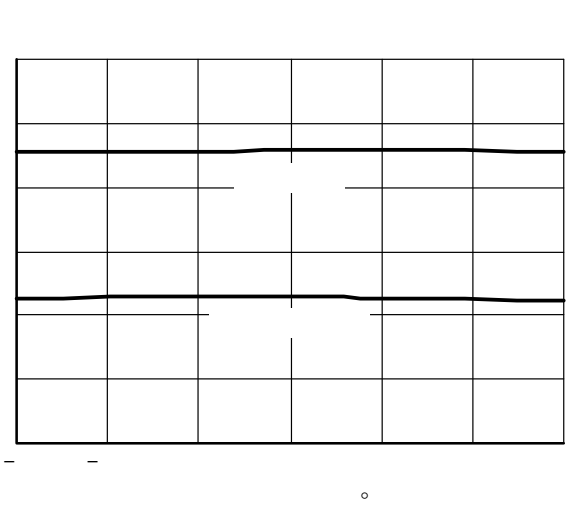

Figure 8. Switching Frequency vs. Temperature

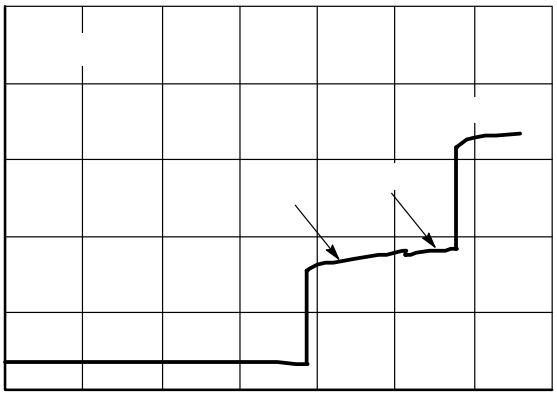

Figure 9. Output Resistance vs. Input Voltage

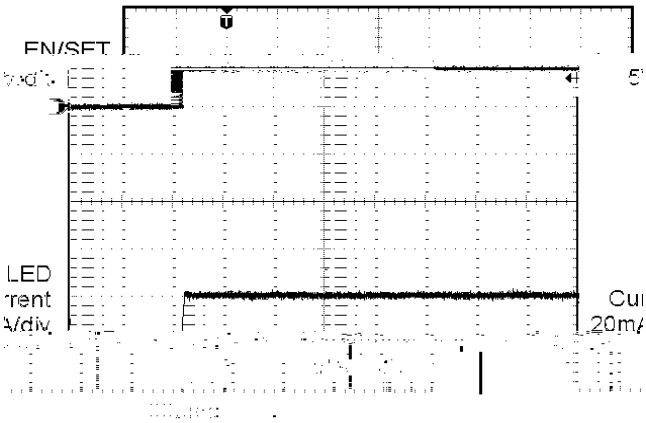

Figure 10. Power Up in 1x Mode

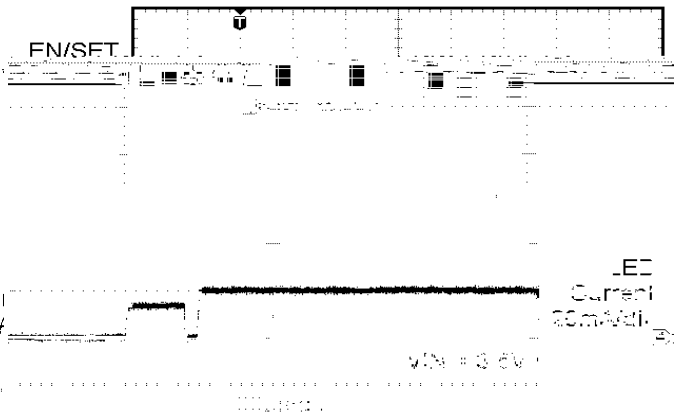

Figure 11. Power Up in 1.33x Mode

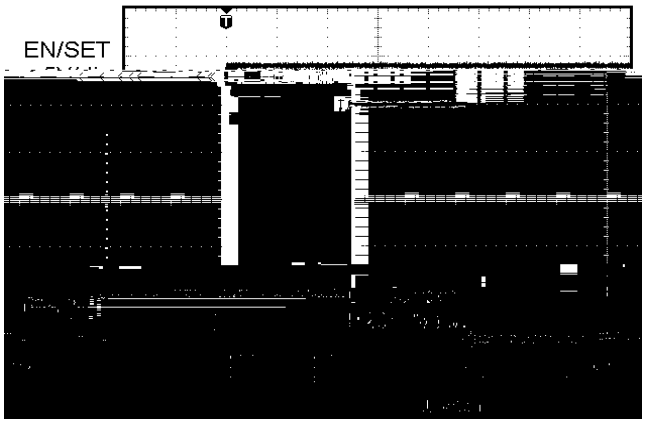

Figure 12. Power Up in 1.5x Mode

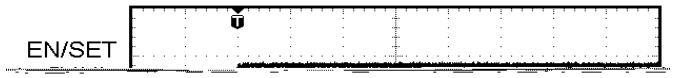

Figure 13. Power Up in 2x Mode

TYPICAL PERFORMANCE CHARACTERISTICS

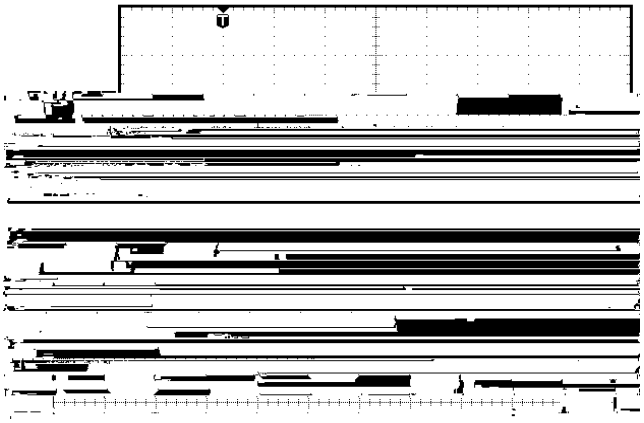

Figure 14. Power Up Delay (1x Mode)

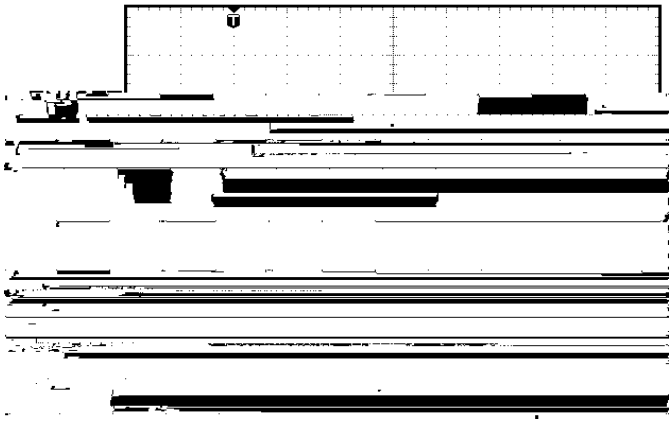

Figure 15. Power Down Delay (1x Mode)

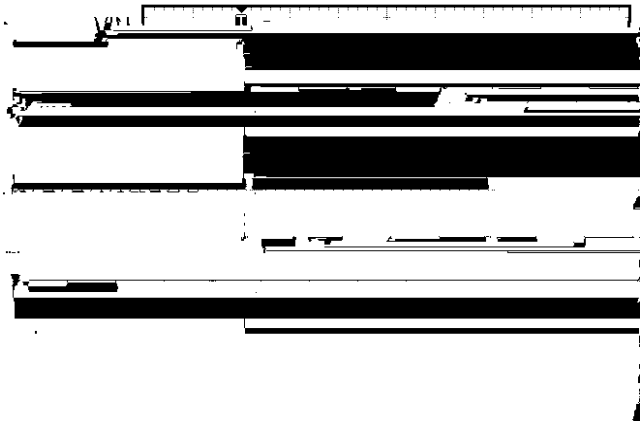

Figure 16. Operating Waveforms in 1x Mode

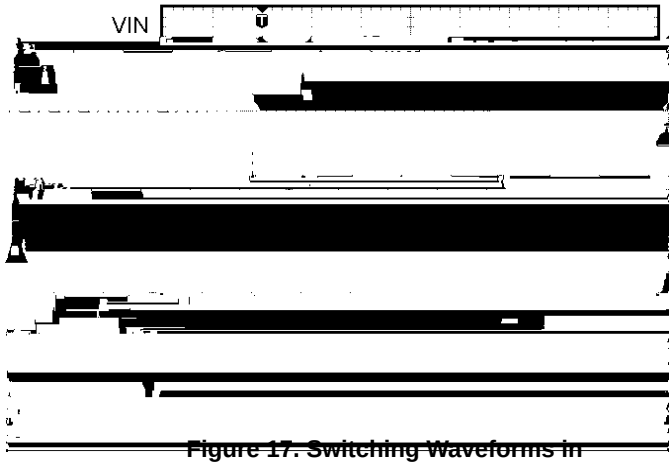

Figure 17. Switching Waveforms in 1.33x Mode

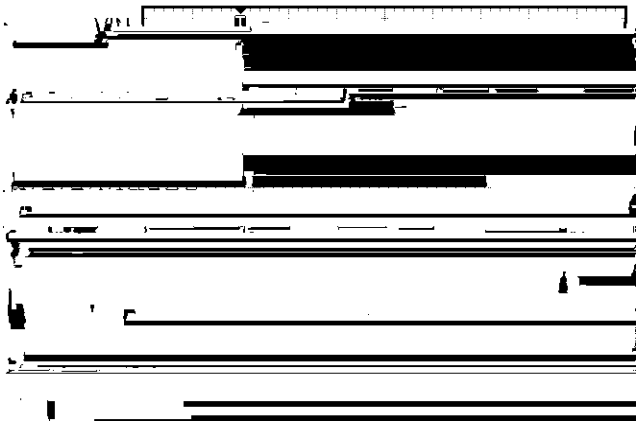

Figure 18. Switching Waveforms in 1.5x Mode

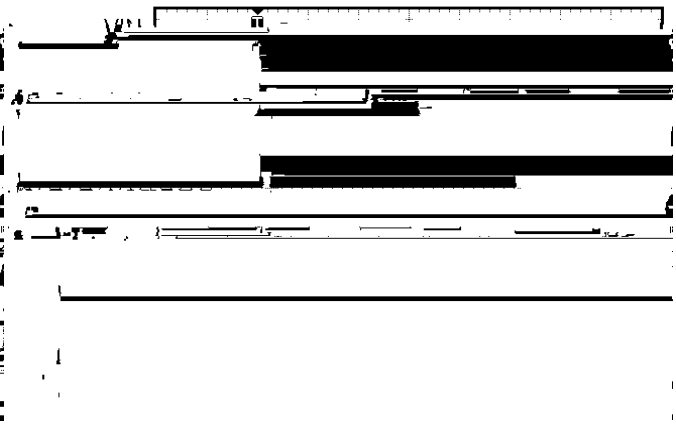

Figure 19. Switching Waveforms in 2x Mode

TYPICAL PERFORMANCE CHARACTERISTICS

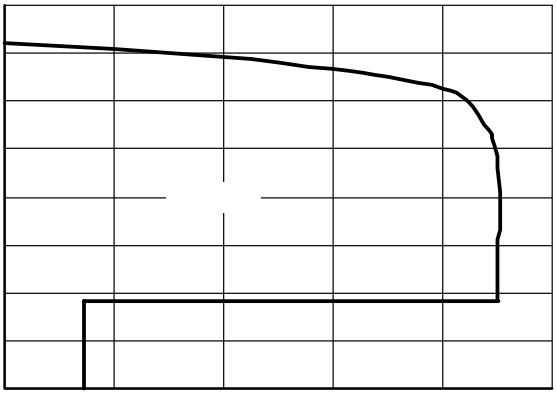

Figure 20. Foldback Current Limit

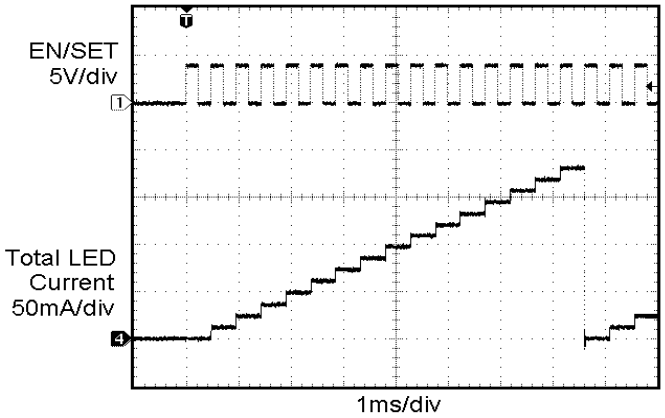

Figure 21. LED Brightness Levels

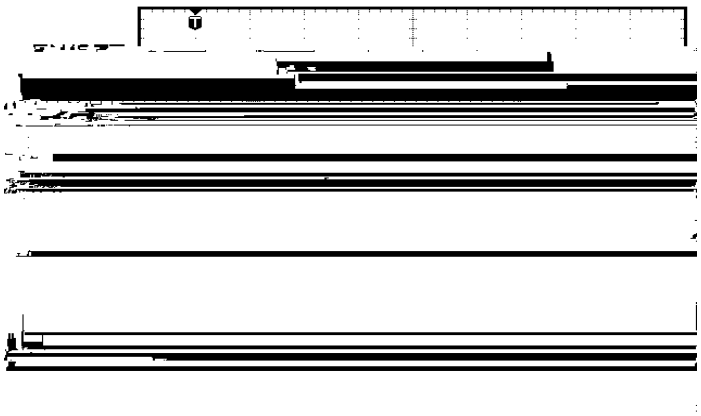

Figure 22. LED Settling Time

Table 5. PIN DESCRIPTION

Pin #	Name	Function
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	−	

Pin Function

VIN is the supply pin for the charge pump. A small 1 μF ceramic bypass capacitor is required between the VIN pin and ground near the device. The operating input voltage range is from 2.5 V to 5.5 V. Whenever the input supply falls below the under−voltage threshold (2 V) all the LED channels will be automatically disabled and the device register are reset to default values.

EN/SET is the enable and one wire addressable control logic input for all LED channels. Guaranteed levels of logic high and logic low are set at 1.3 V and 0.4 V respectively. When

Simplified Block Diagram

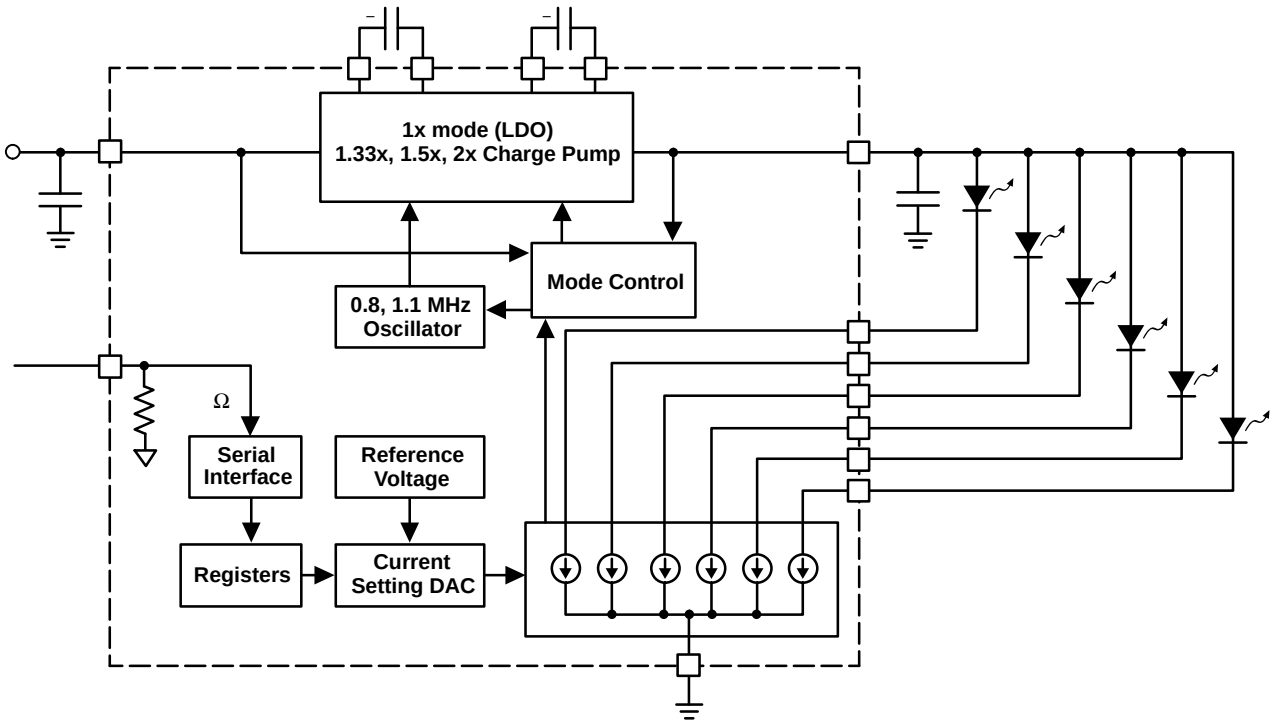

Figure 23. CAT3637 Functional Block Diagram

Basic Operation

At power−up, the CAT3637 starts operating in 1x mode where the output will be approximately equal to the input supply voltage (less any internal voltage losses). If the output voltage is sufficient to regulate all LED currents, the device remains in 1x operating mode.

If the output voltage is insufficient or falls to a level where the regulated current cannot be maintained, the device automatically switches into 1.33x mode (after a fixed delay time of about 120 μs). In 1.33x mode, the output voltage is approximately equal to 1.33 times the input supply voltage (less any internal voltage losses).

If the output voltage is still insufficient or falls to a level where the regulated currents cannot be maintained, the device will automatically switch to the 1.5x mode (after a fixed delay time of about 400 μs). In 1.5x mode, the output is approximately equal to 1.5 times the input supply voltage (less any internal voltage losses).

If the output voltage is still insufficient to drive the LEDs, it will automatically switch into 2x mode where the output is approximately equal to 2 times the input supply voltage (less any internal voltage losses).

If the device detects a sufficient output voltage to drive all LED currents in 1x mode, it will revert back to 1x mode. This only applies for changing back to the 1x mode.

LED Current Setting

The current in each of the six LED channels is programmed through the 1−wire EN/SET digital control input. At the initial power−up and once the EN/SET is set high, the LED current remains at zero in all channels. On the first EN/SET pulse (positive edge), the current is set to 2 mA in all channels. On each consecutive pulse, the current is incremented by 2 mA. On the 15th pulse, the current is equal to the full scale of 30 mA. On the following pulse (16th pulse), the current goes back to zero and the previous sequence can be repeated. The EN/SET pin can be pulsed at high frequency 15 times to decrement the current by 2 mA or to program the current from 0 mA to 30 mA. The maximum EN/SET signal frequency for programming the LED current is 2.5 MHz.

To power−down the device and turn−off all current sources, the EN/SET input should be kept low for a duration T_{OFF} of 1.5 ms or more. The driver typically powers−down with a delay of about 1 ms.

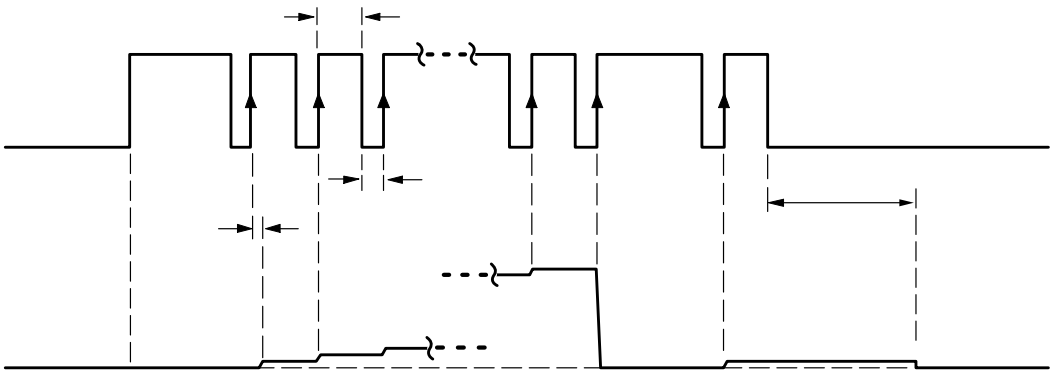

Figure 24. EN/SET One Wire Addressable Timing Diagram

Figure 25. EN/SET Program Increasing / Decreasing LED Current by 2 mA

Unused LED Channels

For applications with 5 LEDs or less, unused LEDs can be disabled by connecting the LED pin directly to VOUT, as shown on Figure 26. If LED pin voltage is within 1 V of VOUT, then the channel is switched off and a 200 μA test current is placed in the channel to sense when the channel

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