Description

The AP3602A is a regulated step-up DC/DC converter based on charge-pump technique. The chip has the ability to supply 100mA constant-output current or 250mA peak-output current for 100ms from 3.0V to 5V input, so it can be used as a white LED driver or flash LED driver.

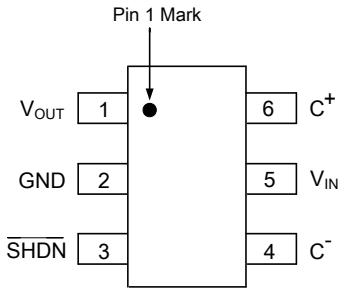
The AP3602A has very-low power dissipation and high efficiency in typical applications. Other features include overtemperature protection and low-temperature coefficient to meet special requirements of handheld battery-powered devices.

Only three external capacitors are required in applications, which help save space and lower cost. The chip also has a disable terminal to turn on or turn off the chip to ease the use.

The AP3602A is available in SOT26 (Type CJ) package.

Pin Assignments

(Top View)



(SOT26 (Type CJ))

Applications

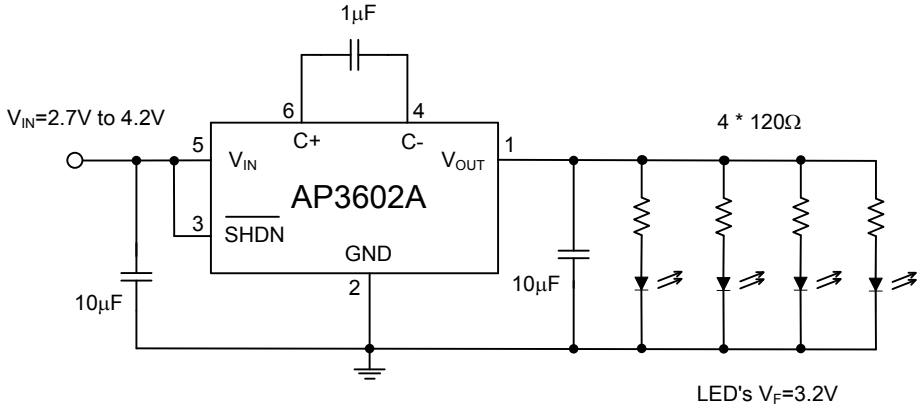
- Mobile Phone Backlight Driver
- Camera Flash LED Driver
- MP3, MP4
- Handheld Device
- Portable Communication Device

Features

- Low-Quiescent Current: 13μA Typical
- Regulated Output Voltage Precision: 4%
- High-Output Current:
  - 100mA when $V_{IN} \geq 3.0V$
  - 50mA when $V_{IN} \geq 2.7V$
- High Frequency up to 1.2MHz
- Low Shutdown Supply Current: <1μA
- High-Output Peak Current: 250mA for 100ms
- Overtemperature Protection
- Operating Temperature Range: -40°C to +85°C
- **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) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ 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.

Typical Applications Circuit

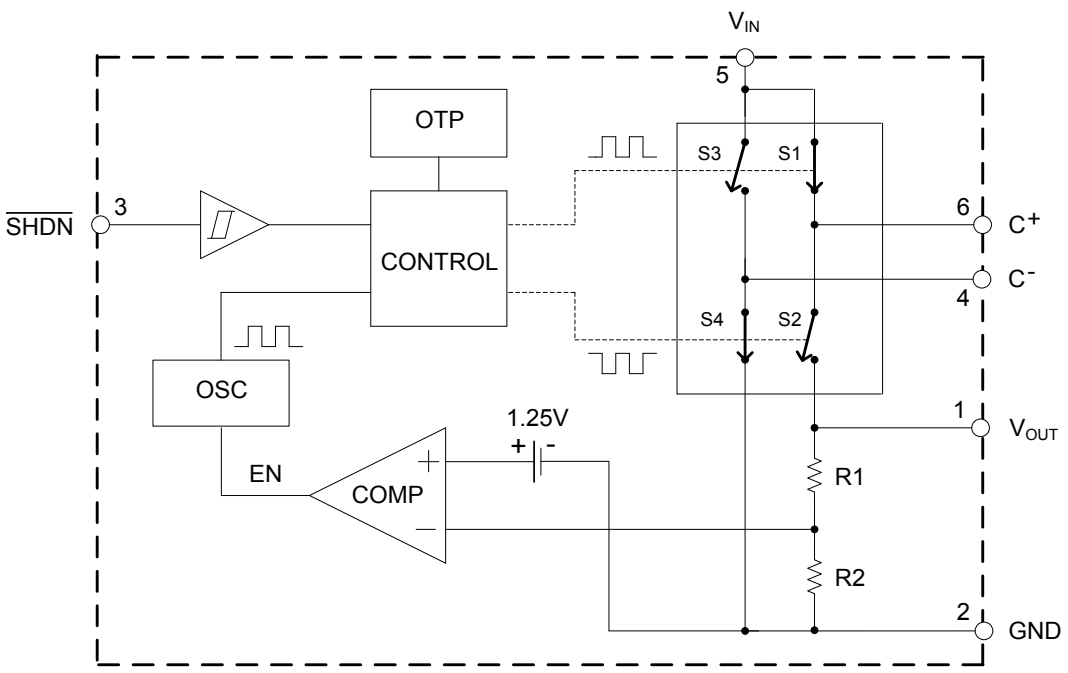


AP3602A Typical Application Circuit

Pin Descriptions

Pin Number	Package Name	Function
1	V_{OUT}	Regulated Output Voltage. V_{OUT} should be bypassed with a 1μF to 22μF low ESR ceramic capacitor, which is placed as close to the pin as possible for best performance
2	GND	Ground. GND should be tied to a ground plane for best performance. The C_{OUT} and C_{IN} should be placed as close to this pin as possible
3	$\overline{SHDN}$	Active Low Shutdown Input. A low signal on $\overline{SHDN}$ disables the AP3602A, while a high signal enables the AP3602A. $\overline{SHDN}$ pin must not be allowed to float
4	C	Flying Capacitor Negative Terminal. The flying capacitor should be placed as close to this pin as possible
5	V_{IN}	Input Supply Voltage. V_{IN} should be bypassed with a 1μF to 22μF low ESR ceramic capacitor which is placed as close to the pin as possible for best performance
6	C^+	Flying Capacitor Positive Terminal. The flying capacitor should be placed as close to this pin as possible

Functional Block Diagram



Absolute Maximum Ratings (Note 4)

Symbol	Parameter	Value	Unit
V_{IN}	Input Voltage	7	V
V_O	Output Voltage	7	V
$V_{\overline{SHDN}}$	$\overline{SHDN}$ Pin Voltage	7	V
Θ_{JA}	Thermal Resistance (Junction to Ambient, no Heat sink)	300	°C/W
T_J	Operating Junction Temperature	+150	°C
T_{STG}	Storage Temperature Range	-65 to +150	°C
T_{LEAD}	Lead Temperature (Soldering, 10s)	+260	°C
–	ESD (Human Body Model)	2000	V

Note 4. Stresses greater than those listed under *Absolute Maximum Ratings* can 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.

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input Voltage	2.7	5	V
T_A	Operating Temperature	-40	+85	°C

Electrical Characteristics (@C_{FLY} = 1μF, C_{IN} = C_{OUT} = 10μF, T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage	V_O = 5V	2.7	—	V_O	V
I_Q	Quiescent Current	V_{IN} = 2.7V to 5.0V, I_O = 0mA, $V_{\overline{SHDN}}$ = V_{IN}, Not Switching	—	13	30	μA
V_O	Output Voltage	2.7V < V_{IN} < 5V, I_O ≤ 50mA	4.8	5.0	5.2	V
		3.0V < V_{IN} < 5V, I_O ≤ 100mA	4.8	5.0	5.2	
$I_{\overline{SHDN}}$	Shutdown Supply Current	2.7V < V_{IN} < 3.6V, I_O = 0, $V_{\overline{SHDN}}$ = 0V	—	0.01	1	μA
		3.6V < V_{IN} < 5.0V, I_O = 0, $V_{\overline{SHDN}}$ = 0V	—	—	2.5	
V_{RIPPLE}	Ripple Voltage	V_{IN} = 2.7V, I_O = 50mA	—	25	—	mV_{PP}
		V_{IN} = 3V, I_O = 100mA	—	30	—	
η	Efficiency	V_{IN} = 2.7V, I_O = 50mA	—	92	—	%
f_{OSC}	Frequency	Oscillator free running	—	1.2	—	MHz
V_{IH}	$\overline{SHDN}$ Input Threshold High	—	1.4	—	—	V
V_{IL}	$\overline{SHDN}$ Input Threshold Low	—	–	—	0.3	
I_{IH}	$\overline{SHDN}$ Input Current High	$V_{\overline{SHDN}}$ = V_{IN}	-1	—	1	μA
I_{IL}	$\overline{SHDN}$ Input Current Low	$V_{\overline{SHDN}}$ = GND	-1	—	1	
t_{ON}	V_{OUT} Turn-on Time	V_{IN} = 3V, I_O = 0mA	—	0.2	—	ms
I_{SC}	Short-Circuit Current	V_{IN} = 3V, V_O = GND, $V_{\overline{SHDN}}$ = 3V	—	300	—	mA

Application Information

Operating Principles

The AP3602A uses a switched-capacitor charge pump to boost the input voltage to a regulated-output voltage. Regulation is achieved by sensing the chip output voltage through an internal-resistor divider network. Controlled by an internal comparator (refer to the functional block diagram), the charge-pump circuit is enabled when the divided output voltage is below a preset trip point.

The charge pump operates at 1.2MHz with 50% duty cycle. Conversion consists of a two-phase operation. In the first phase, switches S2 and S3 are opened, and S1 and S4 are closed. During this time, C_{FLY} charges to the voltage on $V_{IN,}$ and load current is supplied by C_{OUT}. During the second phase, S2 and S3 are closed, and S1 and S4 are opened. This action connects C_{FLY} low side to V_{IN} and C_{FLY} high side to V_{OUT} then a voltage of about 2 × V_{IN} is used to charge C_{OUT} and supply the load current. For each cycle, charge is transported from V_{IN} to V_{OUT} to maintain the output voltage in its nominal value.

This process breaks when the V_{OUT} is high enough for the reason of higher input voltage or lower load then the divided voltage at the control comparator exceeds the internal trip point high level, which compels the charge-pump circuit enter to the idle mode in which the switching cycle stops (pulse skipping), and the output voltage is continually decreased because it is maintained by the discharging of C_{OUT} only. In idle mode, the feedback circuit continues sensing V_{OUT}. If the divided voltage at the control comparator drops below the preset trip point, the comparator starts the switching cycle again.

In idle mode, the AP3602A's quiescent current is about 13μA. In shutdown mode, all internal circuitry is turned off, and the AP3602A draws only leakage current from V_{IN}, which is less than 1μA. So, the shutdown power loss for AP3602A is very low, which is beneficial to the battery supplied systems.

Short Circuit and Thermal Protection

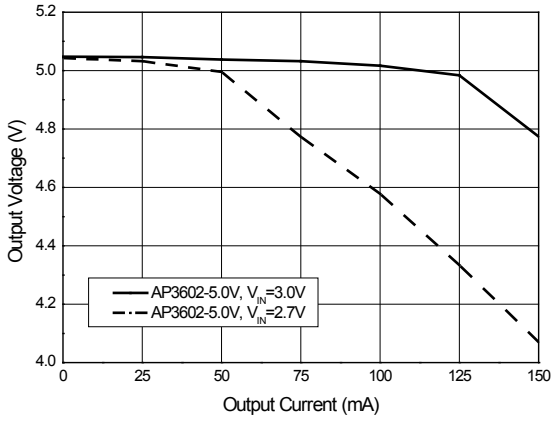
The AP3602A has a thermal protection and shutdown circuit that continuously monitors the IC junction temperature.

When output short-circuit occurs, the short-circuit current is about 300mA (Typical). Under this condition, the I_{IN} is about 2 × Iout, which causes about 1.8W instant power dissipation on AP3602A that causes a rise in the internal IC junction temperature. If the thermal-protection circuit senses the junction temperature exceeding approximately +160°C, the thermal-shutdown circuit disables the charge-pump switching circuit. The thermal hysteresis is about +10°C, which means that the charge-pump circuit can be active when the short circuit is removed, and the junction temperature drops below +150°C.

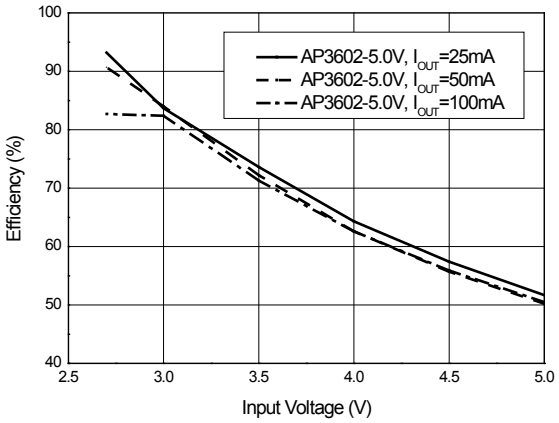
The thermal shutdown protection cycles on and off if an output short-circuit condition persists. This allows the AP3602A to operate on a short-circuit condition without latch up or damage to the device.

Performance Characteristics (Unless otherwise noted, V_{IN} = 3.0V, C_{IN} = C_{OUT} = 10µF, C_{FLY} = 1µF Ceramic Cap, T_A = +25°C)

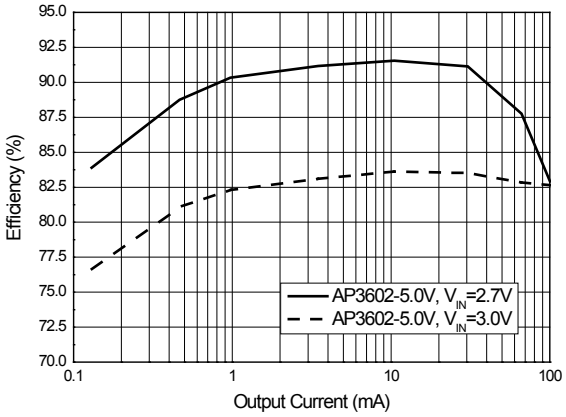
Output Voltage vs. Output Current



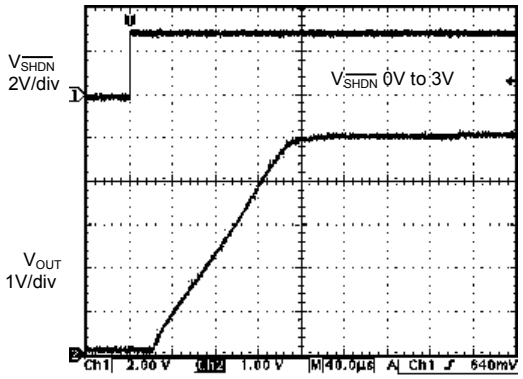
Efficiency vs. Input Voltage



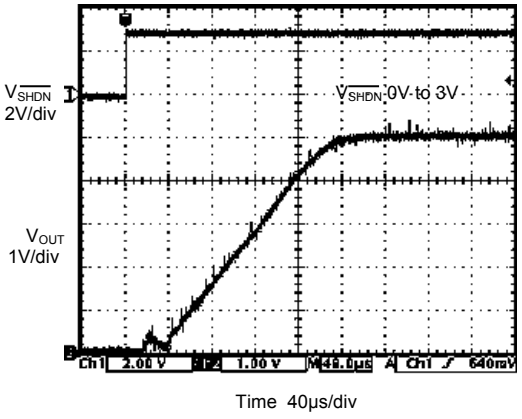
Efficiency vs. Output Current



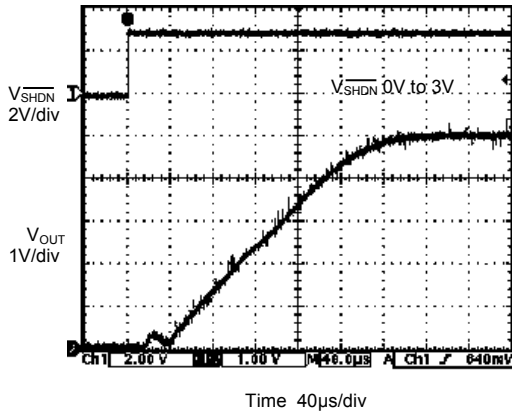
V_{OUT} Start Up Time, @ No Load



V_{OUT} Start Up Time, @50mA Load

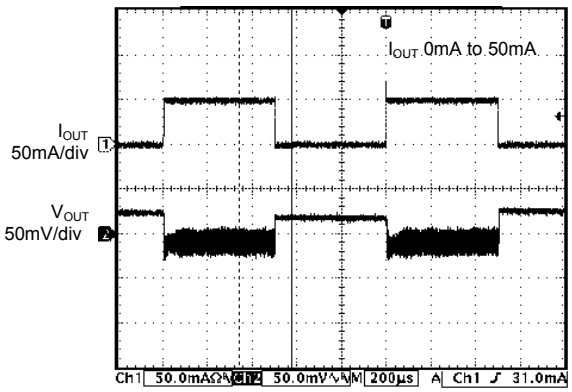


V_{OUT} Start Up Time, @100mA Load



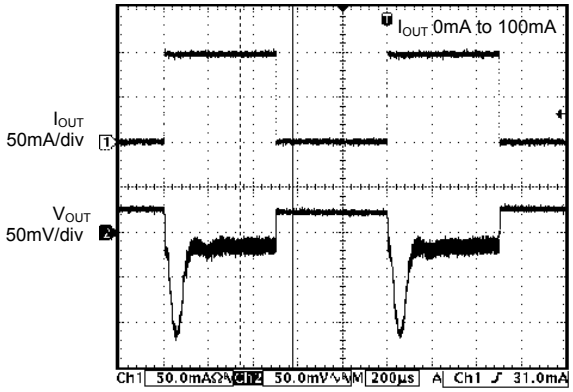
Performance Characteristics (cont.) (Unless otherwise noted, V_{IN} = 3.0V, C_{IN} = C_{OUT} = 10μF, C_{FLY} = 1μF Ceramic Cap, T_A = +25°C)

Load Transient Response



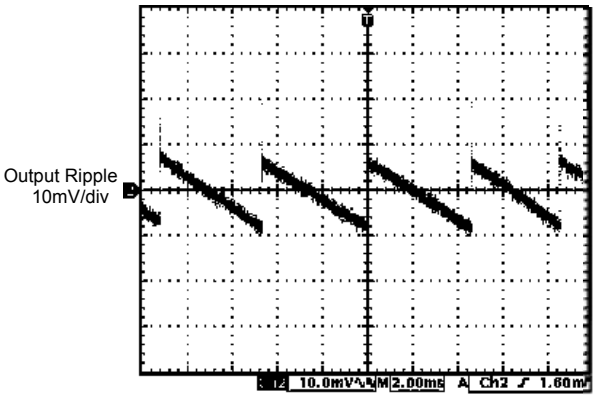
Time 200μs/div

Load Transient Response



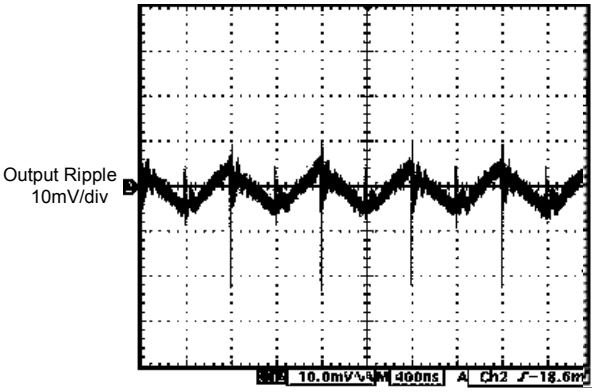
Time 200μs/div

Output Ripple @ V_{IN} = 2.7V, I_{OUT} = 0mA



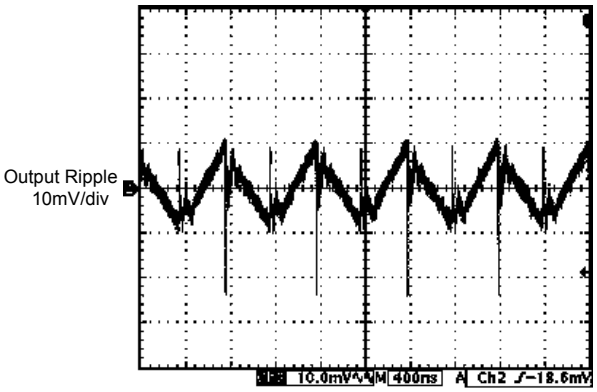
Time 2ms/div

Output Ripple @ V_{IN} = 2.7V, I_{OUT} = 50mA



Time 400ns/div

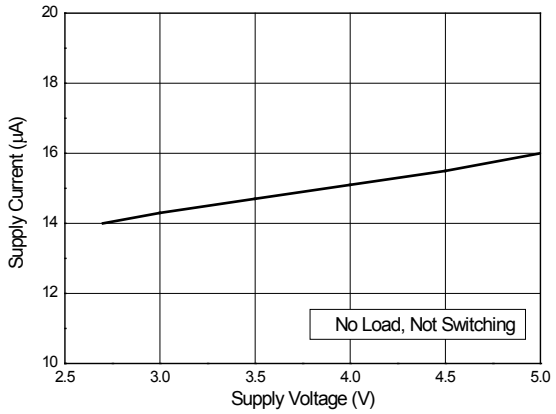
Output Ripple @ V_{IN} = 2.7V, I_{OUT} = 100mA



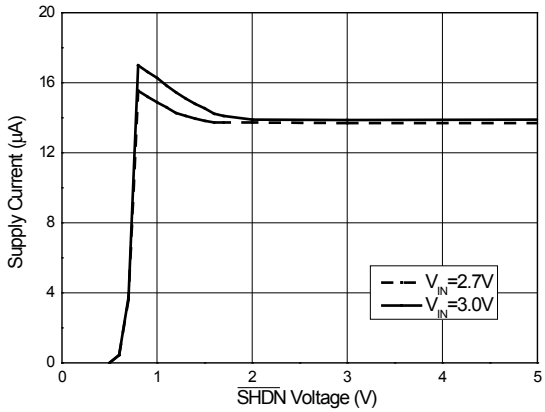
Time 400ns/div

Performance Characteristics (cont.) (Unless otherwise noted, V_{IN} = 3.0V, C_{IN} = C_{OUT} = 10μF, C_{FLY} = 1μF Ceramic Cap, T_A = +25°C)

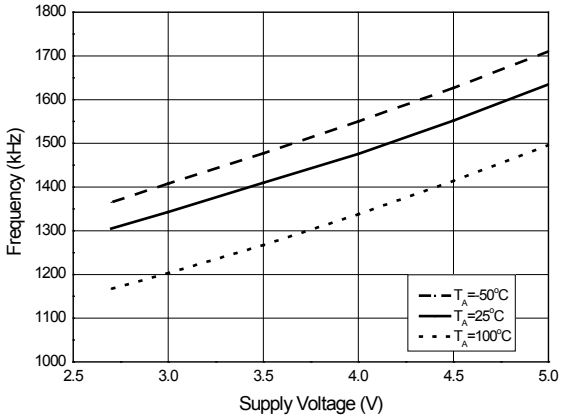
Supply Current vs. Supply Voltage



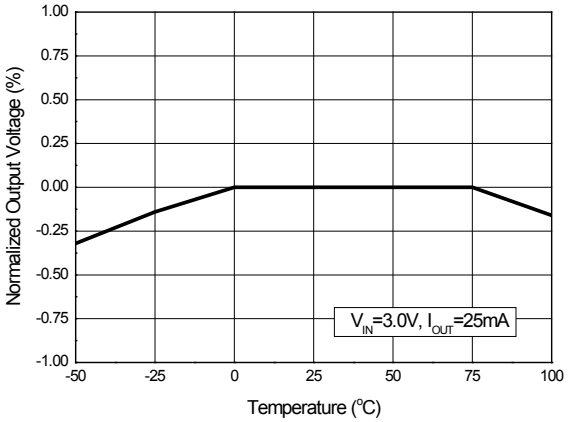
Supply Current vs. $\overline{SHDN}$ Voltage



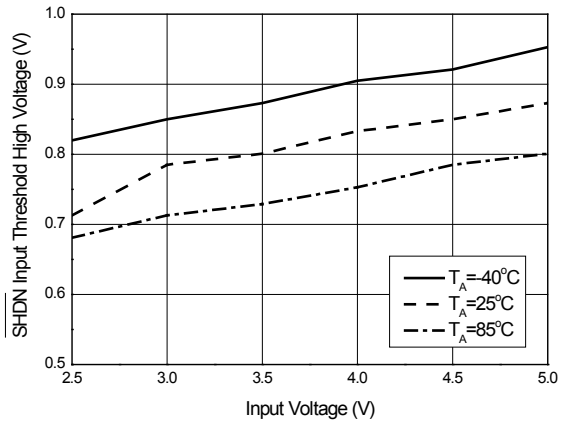
Oscillator Frequency vs. Supply Voltage



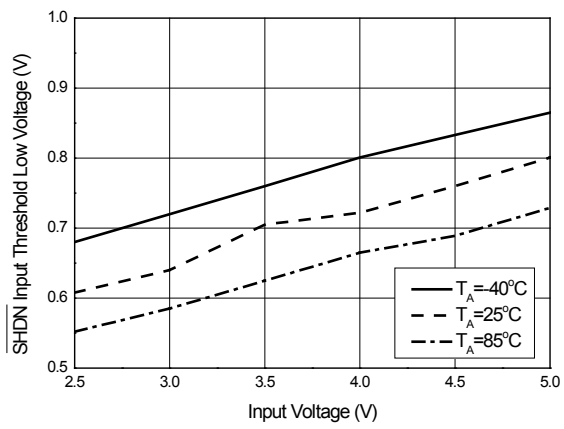
Normalized Output Voltage vs. Temperature



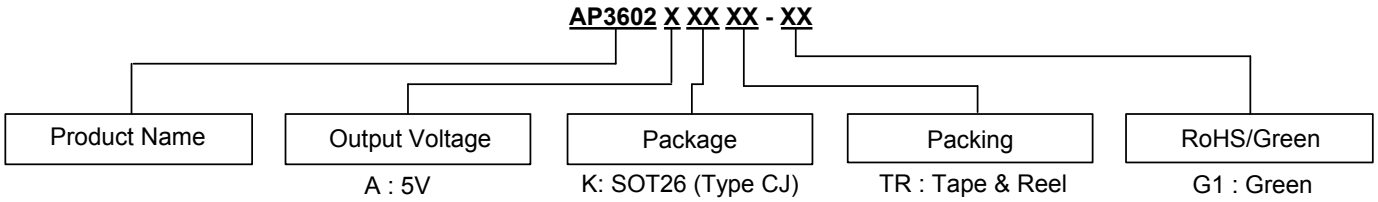
V_{IH} vs. V_{IN}



V_{IL} vs. V_{IN}



Ordering Information

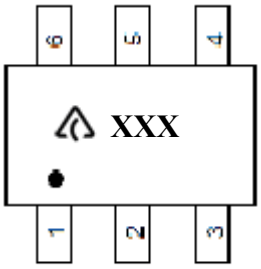


Diodes IC's Pb-free products with "G1" suffix in the part number, are RoHS compliant and green (HF).

Package	Temperature Range	Part Number	Marking ID	Packing
SOT26 (Type CJ)	-40°C to +85°C	AP3602AKTR-G1	G7T	3000/7" Tape & Reel

Marking Information

(Top View)

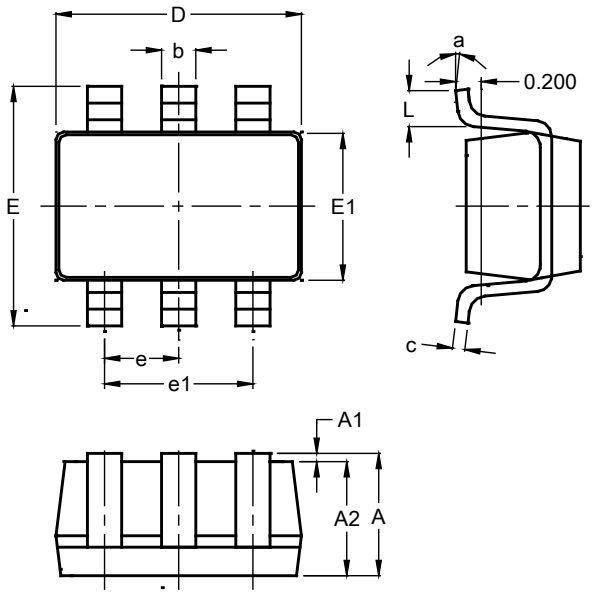


: Logo
XXX: Marking ID (See Ordering Information)

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

Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT26 (Type CJ)

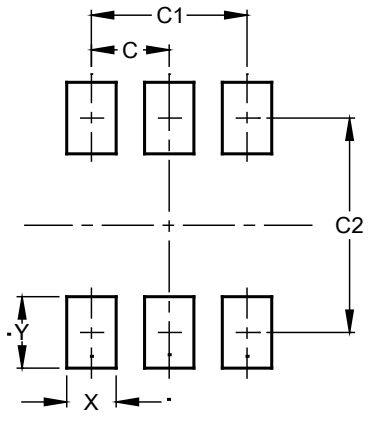


SOT26 (Type CJ)			
Dim	**Min**	**Max**	**Typ**
A	1.050	1.250	--
A1	0.00	0.10	--
A2	1.050	1.150	--
b	0.300	0.500	--
c	0.100	0.200	--
D	2.820	3.020	--
E	2.650	2.950	--
E1	1.500	1.700	--
e	0.950BSC		
e1	1.800	2.000	--
L	0.300	0.600	--
a	0°	8°	--
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT26 (Type CJ)



Dimensions	Value (in mm)
C	0.95
C1	1.90
C2	2.40
X	0.60
Y	1.00

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