

600mA STEP-DOWN DC/DC CONVERTER WITH SYNCHRONOUS RECTIFIER

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Description

The AP3403 is a 2.0MHz fixed frequency, current mode, PWM synchronous buck (step-down) DC-DC converter, capable of driving a 600mA load with high efficiency, excellent line and load regulation. The high efficiency is easily configured by using an inductor, resistors and capacitors as the external components. Current mode control provides fast transient response and cycle-by-cycle current limit.

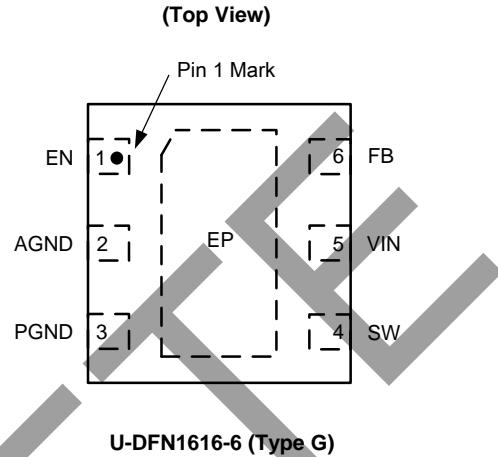
The AP3403 employs complete protection to ensure system security, including input Under Voltage Lock Out, Over Temperature Protection and hiccup mode Short Circuit Protection.

This IC is available in U-DFN1616-6 package.

Features

- High Efficiency Buck Power Converter
- Input Voltage Range: 2.3V to 5.5V
- Output Voltage Range: 0.7V to 5.5V
- Fixed 2.0MHz Oscillator Frequency
- Built-in Soft-start Time
- Built-in Over Current Protection
- Built-in Thermal Shutdown Function
- Built-in UVLO Function
- Hiccup Mode SCP
- Output Current: 600mA
- Package: U-DFN1616-6
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Pin Assignments

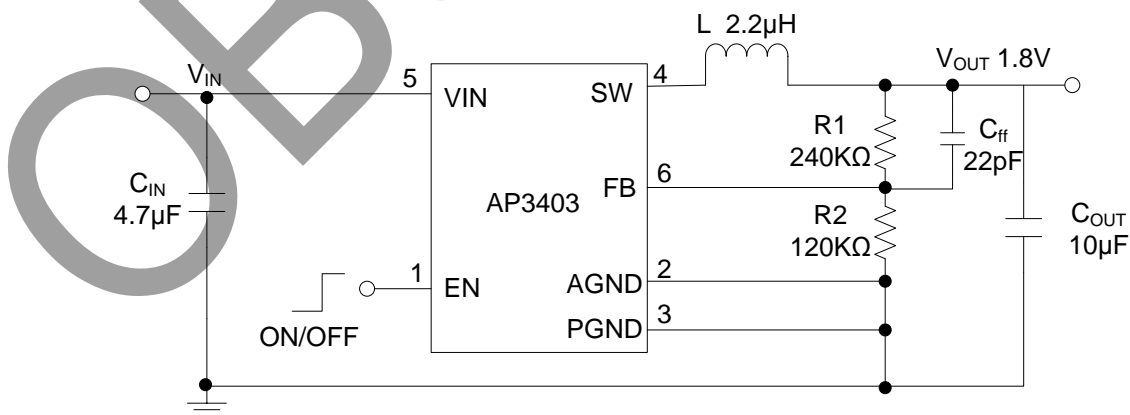


Applications

- Post DC-DC Voltage Regulation
- PDA and Notebook Computer

- 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.

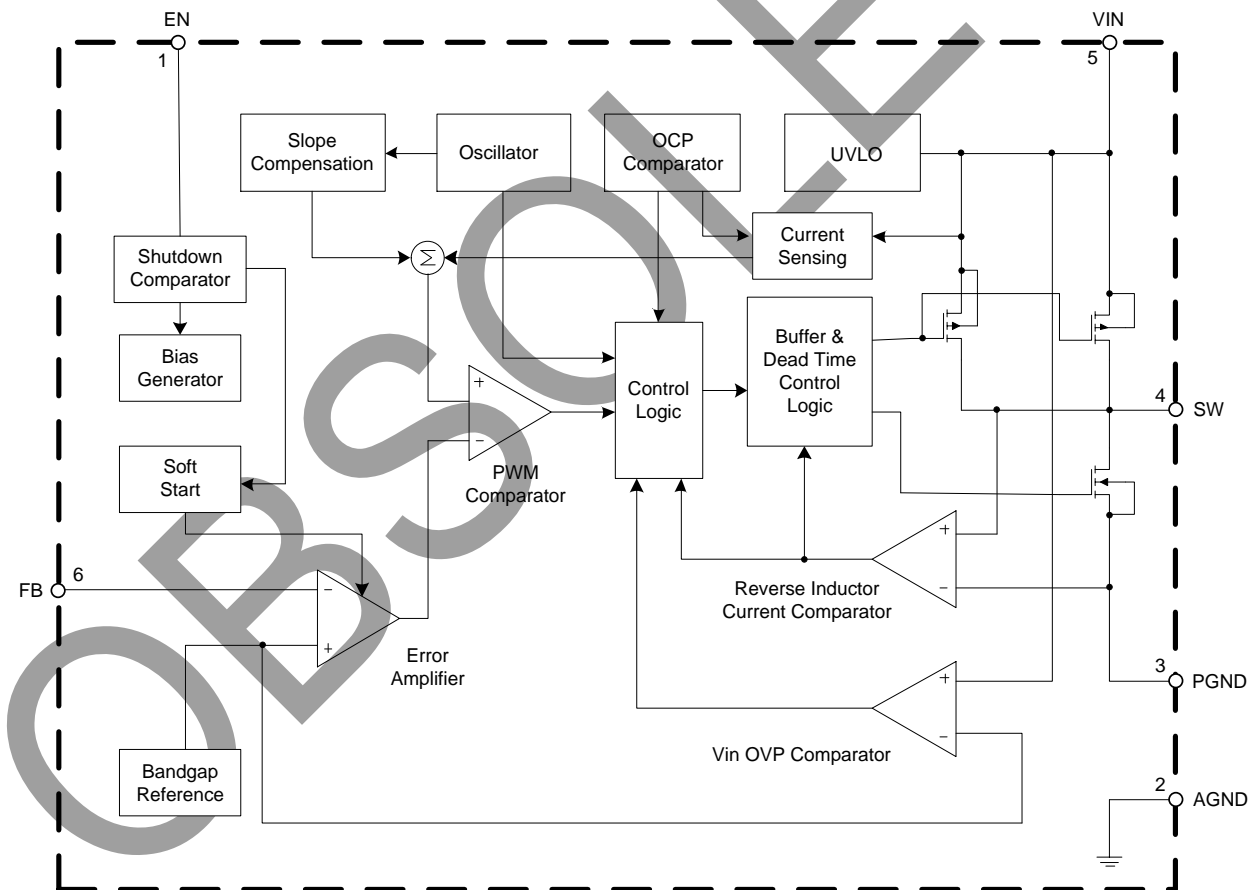
Typical Applications Circuit



Pin Descriptions

Pin Number	Pin Name	Function
1	EN	Control input pin. EN is a digital input that turns the regulator on or off. Drive EN high to turn the regulator on. Drive low to turn the regulator off.
2	AGND	Signal Ground Pin
3	PGND	Power Ground Pin
4	SW	Power switch output pin. This pin is connected to the inductor.
5	VIN	Supply power input pin. A capacitor should be connected between VIN pin and GND - to keep the input voltage constant.
6	FB	Feedback pin. This pin is connected to an external resistor divider to program the system output voltage.

Functional Block Diagram



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Absolute Maximum Ratings (Note 4)

Symbol	Parameter	Rating	Unit
V _{IN}	VIN Input Voltage	-0.3 to 6.5	V
V _{SW}	SW Pin Voltage	-0.3 to V _{IN} + 0.3	V
V _{EN}	EN Pin Input Voltage	-0.3 to 6.5	V
V _{FB}	VFB Pin Voltage	-0.3 to 6.5	V
I _{SW}	SW Pin Output Current	1	A
P _D	Power Dissipation (Standard Land Pattern)	640	mW
T _{STG}	Storage Temperature Range	-55 to +125	°C
V _{HBM}	ESD (Human Body Model)	2000	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.

Recommended Operating Conditions (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Min	Max	Unit
V _{IN}	Input Voltage	2.3	5.5	V
T _A	Operating Ambient Temperature	-40	+85	°C

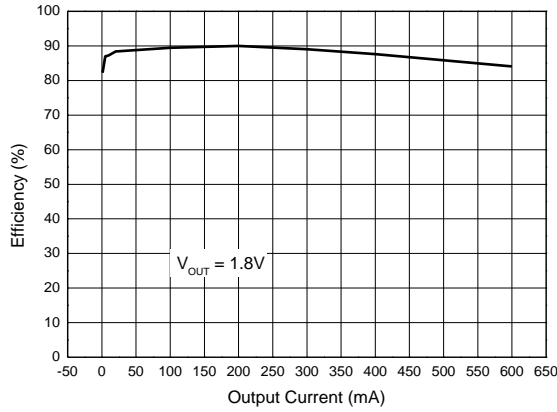
Electrical Characteristics ($V_{IN} = V_{EN} = 3.6V$ ($V_{OUT} \leq 2.6V$), $V_{IN} = V_{EN} = V_{OUT}+1V$ ($V_{OUT} > 2.6V$), unless otherwise specified. Specification with standard typeface are for $T_A = +25^\circ C$, and those in **boldface** type apply over the full operating temperature range ($T_A = -40^\circ C$ to $+85^\circ C$))

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage	$1.0V \leq V_{OUT}$	2.3	–	5.5	V
		$0.9V \leq V_{OUT} < 1.0V$	2.3	–	5.25	
		$0.7V \leq V_{OUT} < 0.9V$	2.3	–	4.5	
I_{DD}	Supply Current	$V_{IN} = V_{EN} = V_{FB} = 3.6V$	–	32	45	μA
I_{STDB}	Standby Current	$V_{IN} = 5.5V, V_{EN} = 0V$	–	0	5	μA
V_{UVLO}	Input UVLO Threshold	V_{IN} Rising	2.0	2.1	2.2	V
V_{HYS}	Input UVLO Hysteresis	–	–	0.1	–	V
V_{ENH}	EN Active Threshold Voltage	$V_{IN} = 5.5V$	1.0	–	–	V
V_{ENL}	EN Shutdown Threshold Voltage	$V_{IN} = 2.3V$	–	–	0.4	V
V_{FB}	Feedback Voltage	$V_{IN} = V_{EN} = 3.6V$	0.591	0.600	0.609	V
I_{FBH}	FB High Input Current	$V_{IN} = V_{FB} = 5.5V$ $V_{EN} = 0V$	-1	0	1	μA
I_{FBL}	FB Low Input Current	$V_{EN} = V_{FB} = 0V$ $V_{IN} = 5.5V$	-1	0	1	μA
R_{ONH}	High-side Switch On-resistance	$V_{IN} = 3.6V$ $I_{SW} = 100mA$	–	380	–	$m\Omega$
R_{ONL}	Low-side Switch On-resistance	$V_{IN} = 3.6V$ $I_{SW} = 100mA$	–	300	–	$m\Omega$
I_{LIMH}	SW Current Limit	$V_{IN} = V_{EN} = 3.6V$	800	1000	–	mA
f_{OSC}	Oscillator Frequency	–	1.7	2.0	2.3	MHz
D_{MAX}	Max. Duty Cycle	–	100	–	–	%
T_{OTSD}	Thermal Shutdown	–	–	+140	–	$^\circ C$
T_{HYS}	Thermal Shutdown Hysteresis	–	–	+40	–	$^\circ C$
t_{SS}	Soft-start Time	$V_{IN} = V_{EN} = 3.6V$	–	150	300	μs

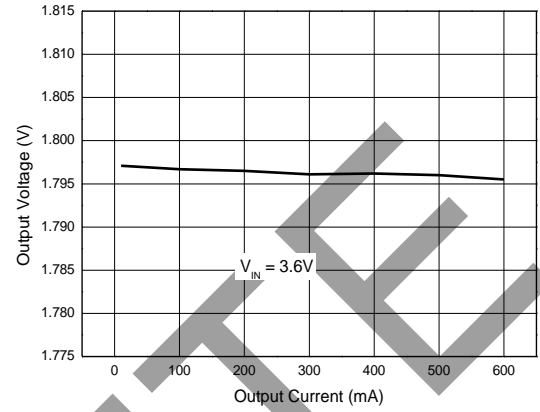
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Performance Characteristics ($T_A = +25^\circ\text{C}$, $V_{IN} = 3.6\text{V}$, $V_{OUT} = 1.8\text{V}$, unless otherwise specified.)

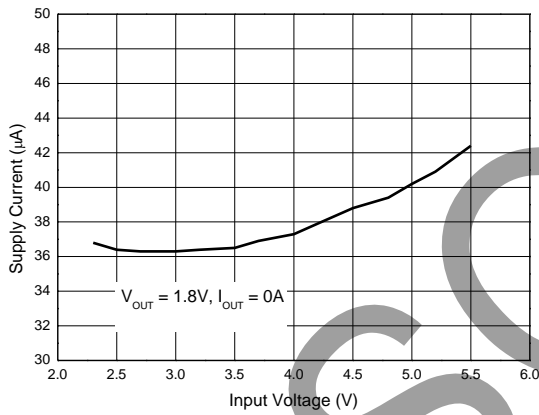
Efficiency vs. Output Current



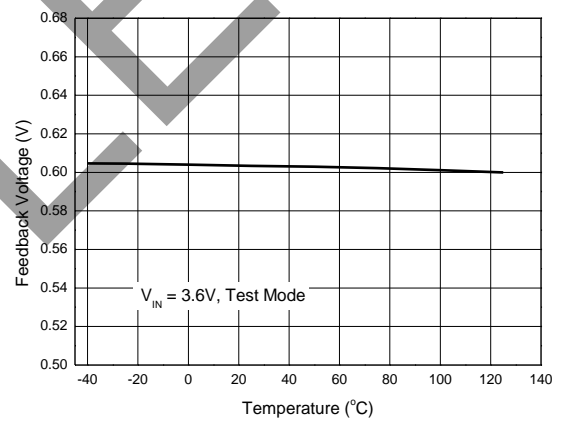
Output Voltage vs. Output Current



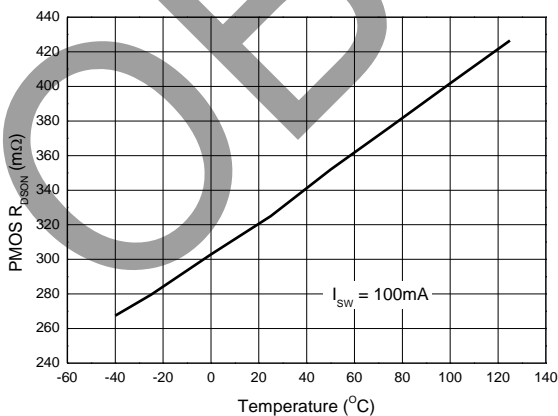
Supply Current vs. Input Voltage



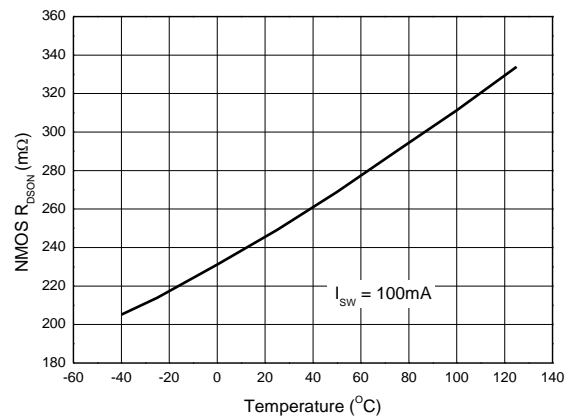
Feedback Voltage vs. Temperature



PMOS $R_{DS(on)}$ vs. Temperature



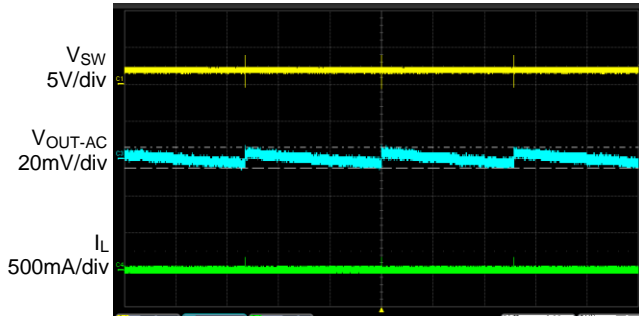
NMOS $R_{DS(on)}$ vs. Temperature



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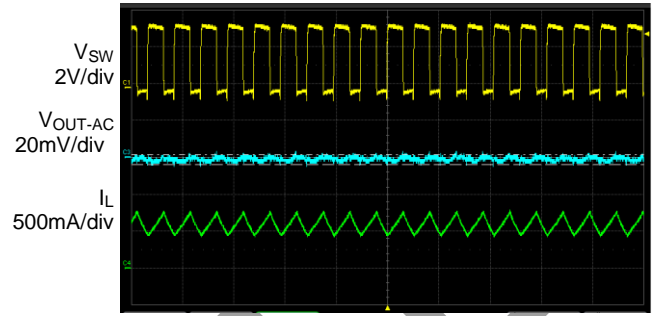
Performance Characteristics (Cont. $T_A = +25^\circ\text{C}$, $V_{IN} = 3.6\text{V}$, $V_{OUT} = 1.8\text{V}$, unless otherwise specified.)

Output Ripple ($I_{OUT} = 0\text{A}$)



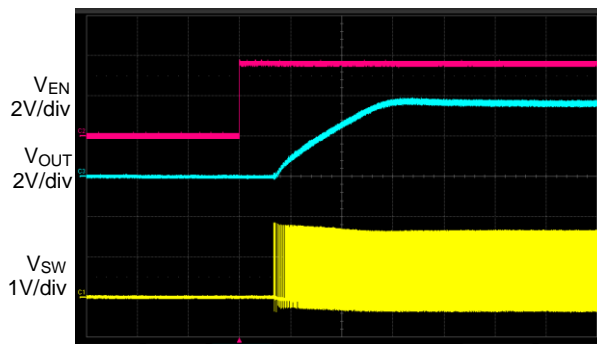
Time 1.6ms/div

Output Ripple ($I_{OUT} = 0.6\text{A}$)



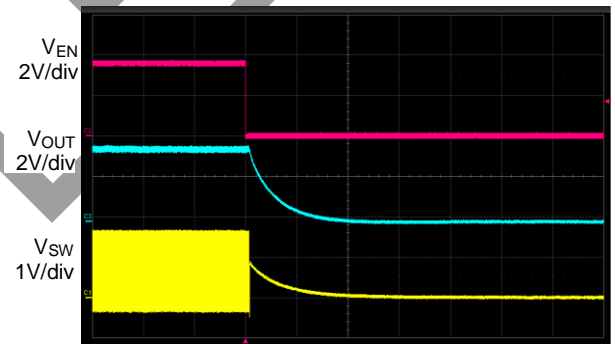
Time 1 μs /div

Enable Turn on Characteristic
(Resistance Load, $R_{LOAD} = 3\Omega$)



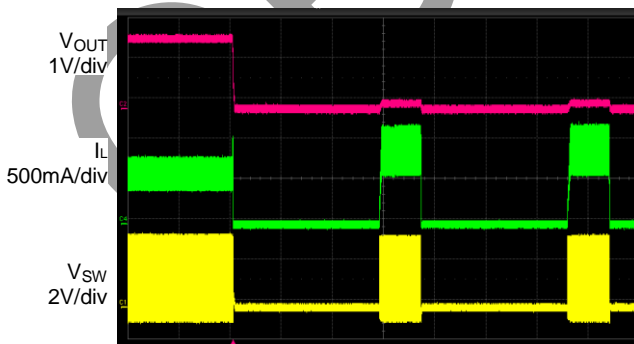
Time 50 μs /div

Enable Turn off Characteristic
(Resistance Load, $R_{LOAD} = 3\Omega$)



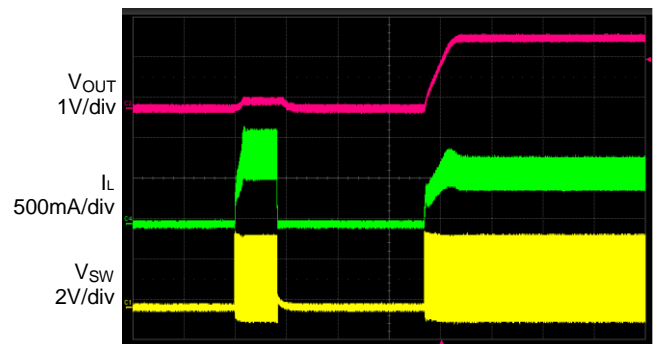
Time 50 μs /div

Short Current Protection
(Resistance Load, $R_{LOAD} = 3\Omega$)



Time 200 μs /div

SCP Recovery
(Resistance Load, $R_{LOAD} = 3\Omega$)



Time 200 μs /div

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Application Information

Please refer to the Typical Applications Circuit, and to set the circuit parameters please refer to the following descriptions.

Under Voltage Lockout (UVLO) Circuit

When the V_{IN} drops lower than the UVLO detector threshold, the UVLO circuit starts to operate, V_{REF} stops, and high-side switch and low-side switch built-in switch transistors turn "OFF". As a result, V_{OUT} drops according to the C_{OUT} capacitance value and the load. When the V_{IN} is rising higher than UVLO released voltage, the IC will restart the operation.

Short Circuit Protection and Recovery

When the AP3403 output node is shorted to GND, as V_{FB} drops under 0.3V, the chip will enter hiccup mode to protect itself, when short circuit is removed, and V_{FB} rises over 0.4V, the AP3403 recovers to normal operation again. If the AP3403 reaches OCP threshold while short circuit, the AP3403 will enter cycle by cycle current limit mode until the current under OCP threshold.

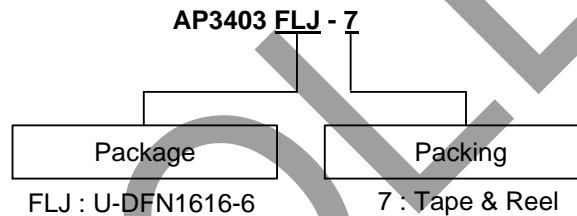
Input Over Voltage Protection

When input voltage of AP3403 is near 6.25V, the IC will enter Input-Over-Voltage-Protection. It would be shut down and there will be no output voltage in this state. As the input voltage goes down below 6V, it will leave input OVP and recover the output voltage.

Over Temperature Protection

The internal thermal temperature protection circuitry is provided to protect the integrated circuit in the event that the maximum junction temperature is exceeded. When the junction temperature exceeds +140°C, it shuts down the internal control circuit and switching power MOSFET. The AP3403 will restart automatically under the control of soft start circuit when the junction temperature decreases to +100°C.

Ordering Information

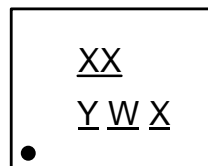


Part Number	Package Code	Packaging	7" Tape and Reel	
			Quantity	Part Number Suffix
AP3403FLJ-7	FLJ	U-DFN1616-6	3000/Tape & Reel	-7

Marking Information

U-DFN1616-6 (Type G)

(Top View)



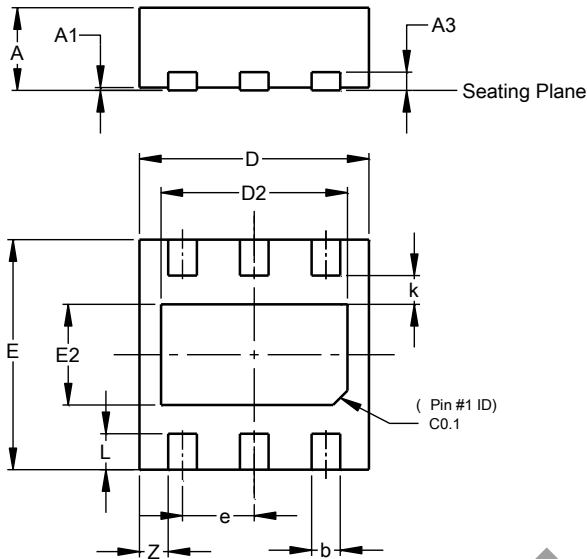
- XX : Identification Code
- Y : Year : 0~9
- W : Week : A~Z : 1~26 week;
a~z : 27~52 week; z represents 52 and 53 week
- X : Internal Code

Part Number	Package	Identification Code
AP3403FLJ-7	U-DFN1616-6	DE

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

Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.

(1) Package Type: U-DFN1616-6 (Type G)

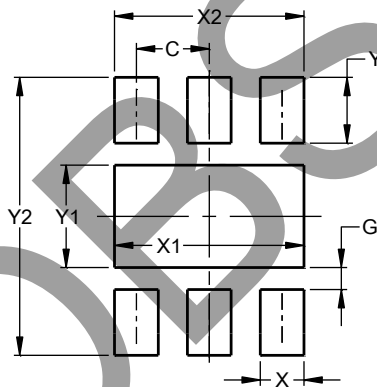


U-DFN1616-6 (Type G)			
Dim	Min	Max	Typ
A	0.50	0.60	0.56
A1	0.00	0.05	0.02
A3	--	--	0.203
b	0.15	0.25	0.20
D	1.55	1.65	1.60
D2	1.20	1.40	1.30
e	--	--	0.50
E	1.55	1.65	1.60
E2	0.60	0.80	0.70
k	--	--	0.20
L	0.20	0.30	0.25
z	--	--	0.20
All Dimensions in mm			

Suggested Pad Layout

Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.

(1) Package Type: U-DFN1616-6 (Type G)



Dimensions	Value (in mm)
C	0.500
G	0.150
X	0.300
X1	1.300
X2	1.300
Y	0.450
Y1	0.700
Y2	1.900

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