DIODES INCORPORATED

PART OBSOLETE – CONTACT US

Lead-free Green

AP3405

# 600mA BUCK DCDC CONVERTER WITH SYNCHRONOUS RECTIFIER

Description

The AP3405 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 AP3405 employs complete protection to ensure system security, including input Undervoltage Lockout, Over-Temperature Protection and hiccup mode Short Circuit Protection.

This IC is available in U-DFN2020-8 package.

Pin Assignments

(Top View)

Pin 1 Mark

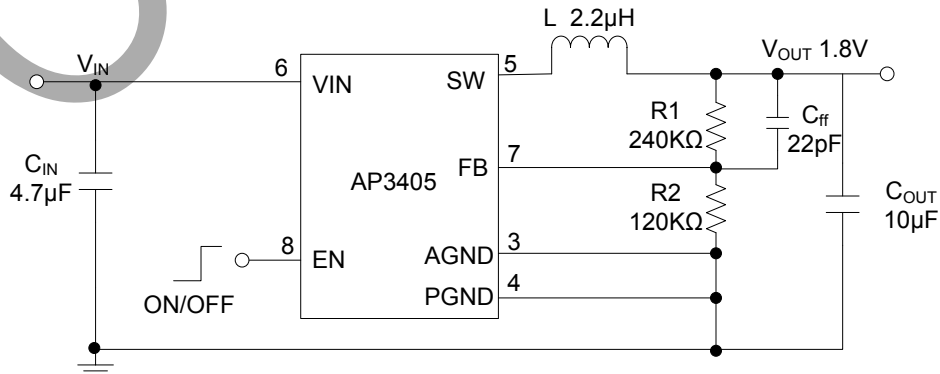| NC | 1 | | EP | | 8 | EN |
NC	2				7	FB
AGND	3				6	VIN
PGND	4				5	SW

U-DFN2020-8 (Type E)
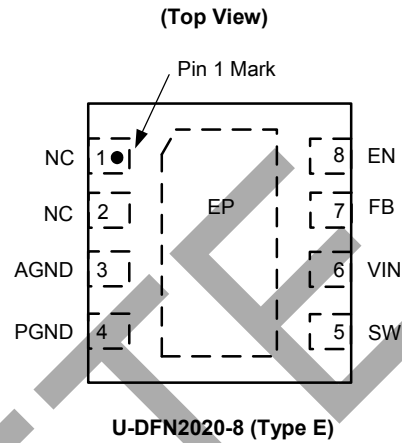
Features

- 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 Overcurrent Protection
- Built-in Thermal Shutdown Function
- Built-in UVLO Function
- Hiccup Mode SCP
- Output Current: 600mA
- Package: U-DFN2020-8 (Type E)
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Applications

- Post DC-DC Voltage Regulation
- Mobile Phones and Wearable Devices

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

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Pin Descriptions

Pin Number	Pin Name	Function
1 , 2	NC	No connection
3	AGND	Signal Ground Pin
4	PGND	Power Ground Pin
5	SW	Power switch output pin. This pin is connected to the inductor.
6	VIN	Supply power input pin. A capacitor should be connected between VIN pin and GND - to keep the input voltage constant.
7	FB	Feedback pin. This pin is connected to an external resistor divider to program the system output voltage.
8	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.

Functional Block Diagram

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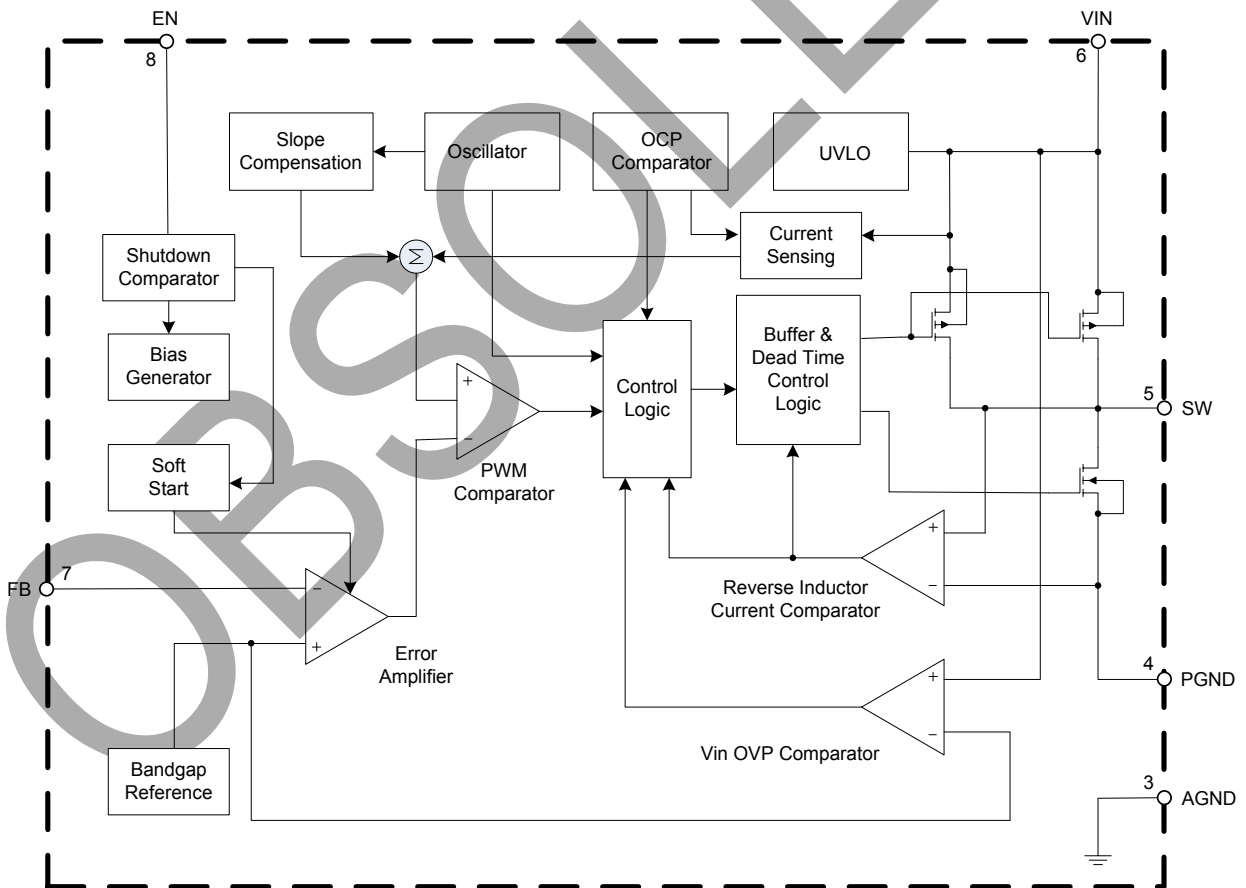
Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified.) (Note 4)

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)	2,000	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

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Electrical Characteristics (V_{IN} = V_{EN} = 3.6V (V_{OUT} ≤ 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°C, and those in boldface type apply over the full operating temperature range (T_A = -40°C to +85°C))

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage	1.0V ≤ V_{OUT}	2.3	–	5.5	V
		0.9V ≤ V_{OUT} < 1.0V	2.3	–	5.25	
		0.7V ≤ 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	–	mΩ
R_{ONL}	Low-Side Switch On-Resistance	V_{IN} = 3.6V I_{SW} = 100mA	–	300	–	mΩ
I_{LIMH}	SW Current Limit	V_{IN} = V_{EN} = 3.6V	800	1,000	–	mA
f_{OSC}	Oscillator Frequency	–	1.7	2.0	2.3	MHz
D_{MAX}	Maximum Duty Cycle	–	100	–	–	%
T_{OTSD}	Thermal Shutdown	–	–	+140	–	°C
T_{HYS}	Thermal Shutdown Hysteresis	–	–	+40	–	°C
t_{SS}	Soft-Start Time	V_{IN} = V_{EN} = 3.6V	–	150	300	µs

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Performance Characteristics (T_A = +25°C, V_{IN} = 3.6V, V_{OUT} = 1.8V, unless otherwise specified.)

Efficiency vs. Output Current
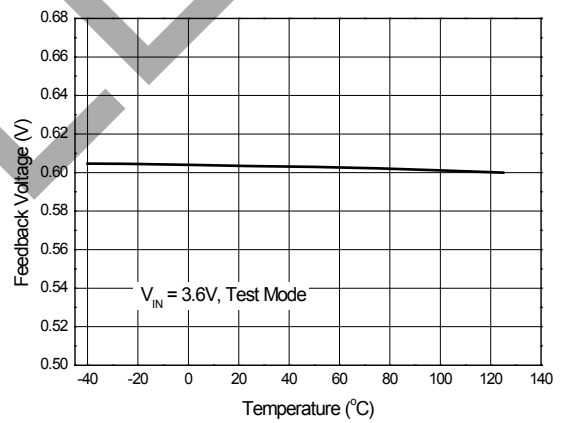
V_{OUT} = 1.8V
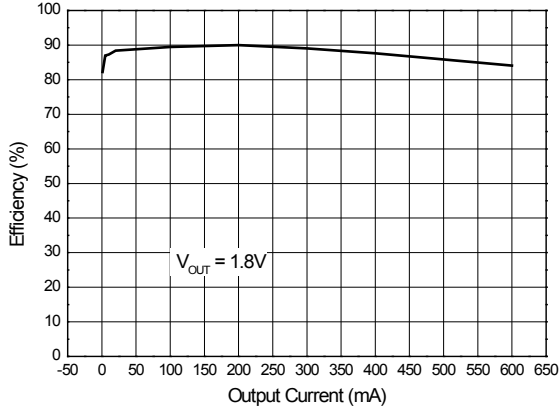
Output Voltage vs. Output Current
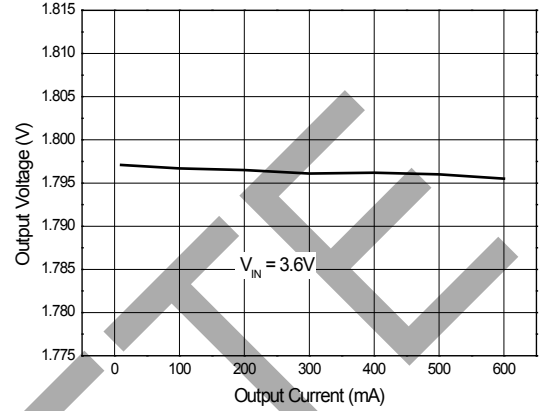
V_{IN} = 3.6V

Supply Current vs. Input Voltage
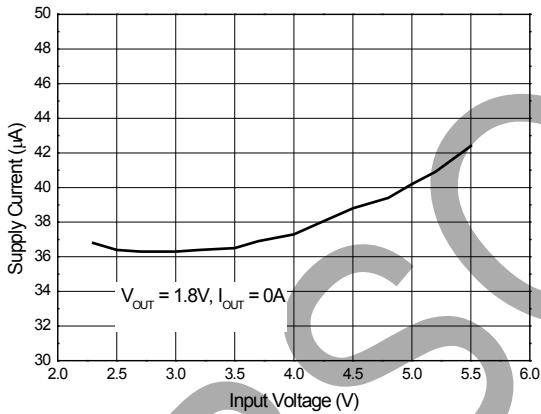
V_{OUT} = 1.8V, I_{OUT} = 0A

Feedback Voltage vs. Temperature

V_{IN} = 3.6V, Test Mode

PMOS R_{DSON} vs. Temperature

I_{SW} = 100mA

NMOS R_{DSON} vs. Temperature

I_{SW} = 100mA

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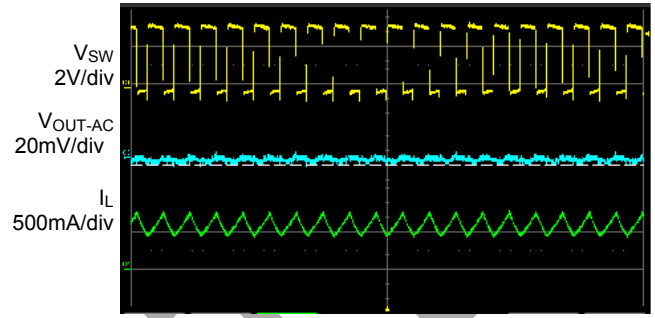
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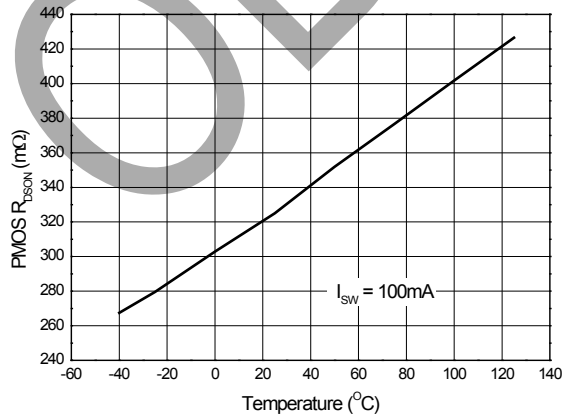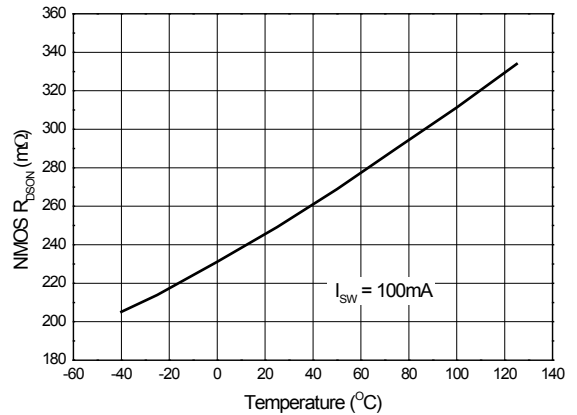
Performance Characteristics (continued) (T_A = +25°C, V_{IN} = 3.6V, V_{OUT} = 1.8V, unless otherwise specified.)

Output Ripple (I_{OUT} = 0A)

V_{SW}
5V/div

V_{OUT-AC}
20mV/div

I_L
500mA/div
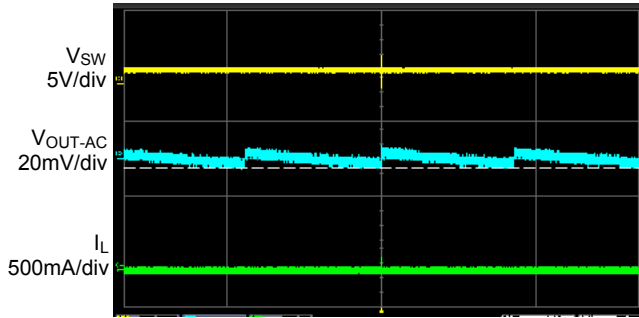
Time 1.6ms/div

Output Ripple (I_{OUT} = 0.6A)

V_{SW}
2V/div

V_{OUT-AC}
20mV/div

I_L
500mA/div

Time 1μs/div

**Enable Turn on Characteristic
(Resistance Load, R_{LOAD} = 3Ω)**

V_{EN}
2V/div

V_{OUT}
2V/div

V_{SW}
1V/div
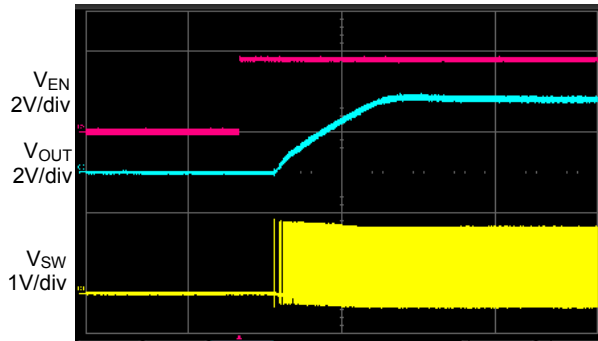
Time 50μs/div

**Enable Turn off Characteristic
(Resistance Load, R_{LOAD} = 3Ω)**

V_{EN}
2V/div

V_{OUT}
2V/div

V_{SW}
1V/div
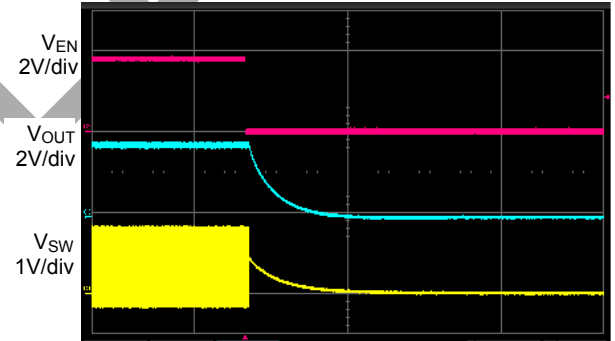
Time 50μs/div

**Short Current Protection
(Resistance Load, R_{LOAD} = 3Ω)**

V_{OUT}
1V/div

I_L
500mA/div

V_{SW}
2V/div
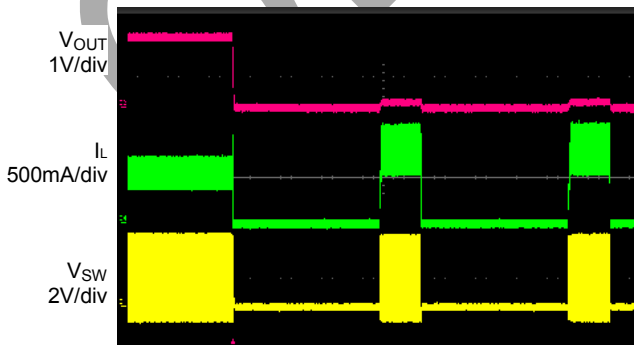
Time 200μs/div

**SCP Recovery
(Resistance Load, R_{LOAD} = 3Ω)**

V_{OUT}
1V/div

I_L
500mA/div

V_{SW}
2V/div

Time 200μs/div

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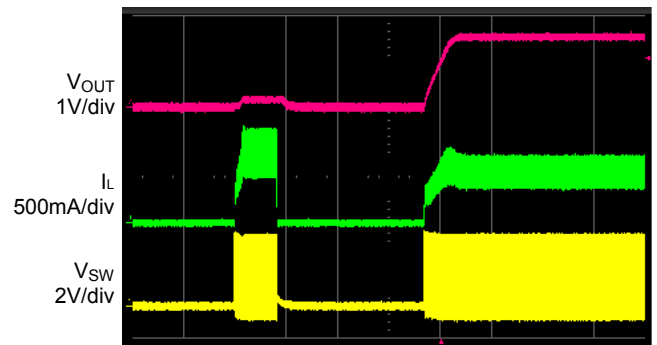
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Application Information

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

Undervoltage 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 AP3405 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 AP3405 recovers to normal operation again. If the AP3405 reaches OCP threshold while short circuit, the AP3405 will enter cycle-by-cycle current limit mode until the current under OCP threshold.

Input Overvoltage Protection

When input voltage of AP3405 is near 6.25V, the IC will enter Input-Overvoltage-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 AP3405 will restart automatically under the control of soft start circuit when the junction temperature decreases to +100°C.
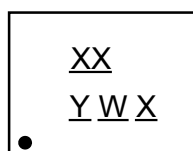
Ordering Information

AP3405<u>SHE</u> - <u>7</u>

Package
U-DFN2020-8

Packing
7 : Tape & Reel
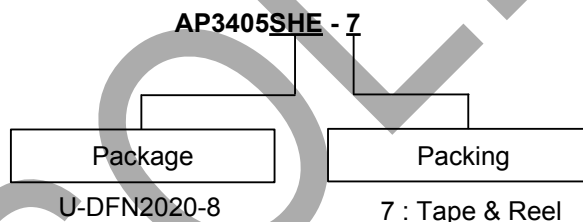
Device	Package Code	Packaging	7" Tape and Reel	
			Quantity	Part Number Suffix
AP3405SHE-7	SHE	U-DFN2020-8	3,000/Tape & Reel	-7

Marking Information

U-DFN2020-8 (Type E)

(Top View)

<u>XX</u>

<u>Y</u> <u>W</u> <u>X</u>

●

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

Part Number	Package	Identification Code
AP3405SHE	U-DFN2020-8	2V

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Package Outline Dimensions (All dimensions in mm.)

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

(1) Package Type: U-DFN2020-8 (Type E)
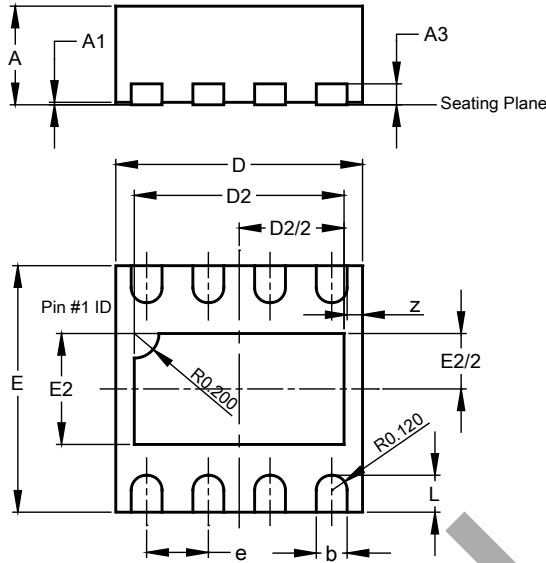
U-DFN2020-8 (Type E)			
Dim	**Min**	**Max**	**Typ**
A	0.50	0.60	0.56
A1	0.00	0.05	0.02
A3	-	-	0.203
b	0.20	0.30	0.25
D	1.950	2.075	2.00
D2	1.60	1.80	1.70
e	0.500 BSC		
E	1.950	2.075	2.00
E2	0.80	1.00	0.90
L	0.25	0.35	0.30
z	-	-	0.125
All Dimensions in mm			

Suggested Pad Layout

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

(1) Package Type: U-DFN2020-8 (Type E)
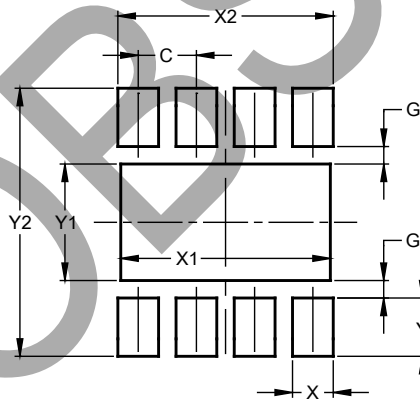
Dimensions	Value (in mm)
C	0.500
G	0.150
X	0.350
X1	1.800
X2	1.850
Y	0.500
Y1	1.000
Y2	2.300

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