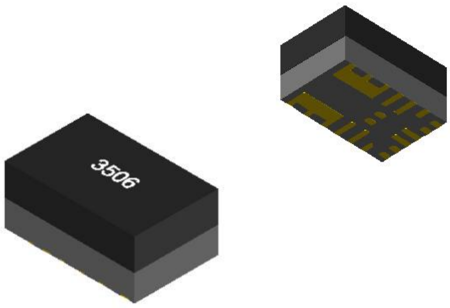
DC DC POWER MODULES

4.7V to 36V input, 0.6A output DC-DC Ceramic substrate adjustable buck module



1 Features

- **0.6A output current**
- **Wide input voltage range: 4.7V-36V**
- **Output Voltage: Adjustable above 0.8V**
- **Switching Frequency: 2MHz**
- **Internal Soft Start**
- **Short-circuit protection and thermal protection**
- **Small size, surface mount package:**

  LGA (5mm×3.2mm×2.2mm)

2 Applications

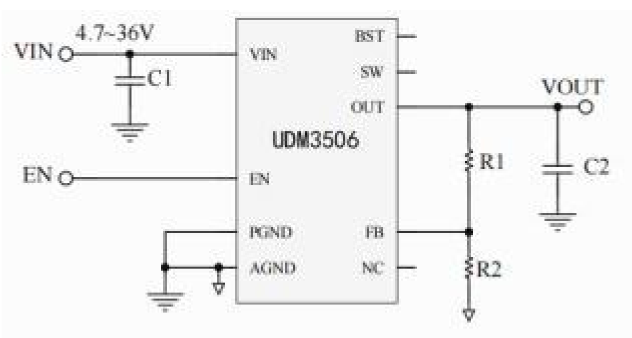
- **Industrial control**
- **Medical imaging equipment**
- **Telecommunications and network applications**
- **Alternative to linear regulators (LDO)**
- **Miniaturized applications**

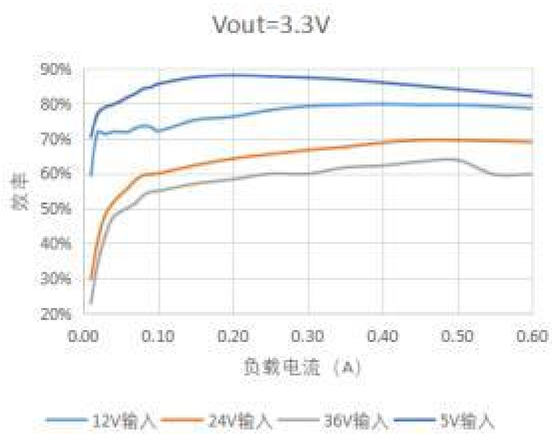
3 Description

The UDM3506 is a DC-DC buck power module with synchronous rectification control. It integrates an inductor, power MOSFETs, and filtering capacitors. The UDM3506 provides a complete power solution, requiring only a few external passive components to achieve a wide input voltage range of 4.7V to 36V, a rated output current of 0.6A, adjustable output voltage, and excellent load and line regulation.

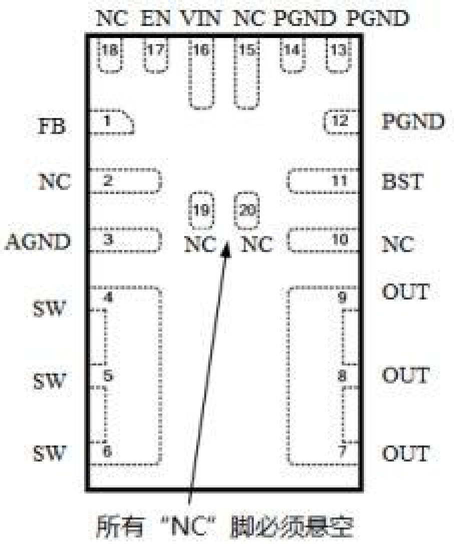
The UDM3506 features comprehensive protection functions, including overcurrent protection, short-circuit protection, undervoltage protection, and overtemperature protection. The UDM3506 minimizes the use of external components and is packaged in an LGA-20 (5mm × 3.2mm × 2.2mm) package.

Typical Application Circuit





Pin Configuration



Top view

Pin	Symbol	Description
1	FB	Output voltage adjustment pin; connect a resistor with a precision of 1% or better to GND
2,10,15, 18,19,20	NC	No connection required; leave floating
3	GND	Analog ground. Internally connected to PGND; no external connection to PGND is required.
4,5,6	SW	Switching output. Lay out large copper areas on pins 4, 5, and 6 to enhance heat dissipation.
7,8,9	VOUT	Module voltage output pin; connect directly to the positive terminal of the load. An external output filter capacitor must be connected to PGND.
11	BST	Bootstrap pin. The module internally integrates a bootstrap capacitor; no external connection is required, leave floating.
12,13,14	PGND	Power ground. Reference ground for the module's input and output voltages. Special attention should be paid to PCB design. It is best to use copper pour and via designs.
16	VIN	Input voltage positive terminal. Provides power input to the internal power and control circuits. Operating voltage range is 4.5V to 18V. Low ESR and ESL capacitors should be used for decoupling and filtering, and the capacitors should be placed as close as possible to the module's VIN pin, using wide traces and multiple vias where possible.
17	EN	Enable pin. Connecting the pin to a high logic level enables the module, while grounding the pin disables the module output. The pin must not be left floating.

Ordering Information

Product Model	Input		Output	Dimensions and Package	Packaging
	Input Range	Nominal Input			
UDM3506	4.7V~36V	--	0.8V~	5mm×3.2mm×2.2mm (LGA)	Tape and reel

Electrical Characteristics

Absolute Maximum Ratings	Conditions	Minimum Value	Nominal Value	Maximum Value	Units
V_{IN}, EN		-0.3		44	V
V_{SW}		-0.3		**V_{IN}+0.3**	V
V_{BST}		-0.3		Vsw+5	V
V_{FB}		-0.3		6	V
Storage Temperature		-65		+150	℃
Reflow Soldering Temperature				+245	℃
Electrical characteristics	**Conditions**	**Minimum Value**	**Nominal Value**	**Maximum Value**	**Units**
Input Voltage Range		4.7		40	V
Output Voltage Range		0.8		32	V
Input Undervoltage Lockout threshold (Rising)			4.3		V
Input Undervoltage Lockout hysteresis	4.7V<V_{IN}<36V		250		mV
Shutdown current	V_{IN}=12V,V_{EN}=0		0.1	1	μA
Quiescent current	V_{EN} =5V, V_{FB} =1.2V		40	60	μA
Input current at no load	V_{IN}=12V， V_{OUT}=3.3V， I_{OUT}=0A		150		μA
FB voltage	4.7V<V_{IN}<36V	776	800	820	mV
Upper switch current limit	Minimum duty cycle		1		A
Switching Frequency			2		MHz
Minimum on-time			80		ns
Minimum off-time	V_{FB} =0V		100		ns
EN shutdown threshold (Rising)	V_{FB} =0V	1.18	1.3	1.42	V
EN shutdown hysteresis			40		mV
Efficiency	V_{IN} =5V， V_{OUT} =3.3V， I_{OUT}=0.6A			82	%
Line regulation	V_{OUT}=3.3V， 5V < V_{IN}< 36V， I_{LOAD} = 0.6A			±2	%
Load regulation	V_{IN}=12V， V_{OUT}=3.3V,0A < I_{LOAD} ≤ 0.6A			±2.5	%
Ripple and noise	V_{IN} =12V， V_{OUT} =3.3V， I_{OUT}=0.6A, C_{out}=66uF, Bandwidth:20MHz		60		mV
Dynamic load response	50-100% ILOAD， di/dt=2A/μS， C_{out}=66uF		100		mV
Thermal shutdown			135		℃
Thermal shutdown hysteresis			15		℃

Electrical Characteristics (continued)

Structural Characteristics	Conditions	Minimum Value	Nominal Value	Maximum Value	Units
Dimensions	5mm×3.2mm×2.2mm				mm
Weight					g
Environmental Adaptability	**Conditions**	**Minimum Value**	**Nominal Value**	**Maximum Value**	**Units**
Operating temperature (junction temperature)		-40		135	℃
High-Temperature Storage (Ambient Temperature)	+125℃， 48h			125	℃
High-Temperature Operation (Ambient Temperature)	+85℃， 24h; Low Input Voltage, Nominal Input Voltage, High Input Voltage, 8 hours each; V_{IN} =60V， V_{OUT} =12V， I_{OUT}=2.4A			85	℃
Low-Temperature Storage (Ambient Temperature)	-55℃， 24h	-55			℃
Low-Temperature Operation (Ambient Temperature)	-40℃， 24h; Low Input Voltage, Nominal Input Voltage, High Input Voltage, 8 hours each	-40			℃
Humid Heat	High-Temperature and High-Humidity Stage: 60℃， 95%; Low-Temperature and High-Humidity Stage: 30℃， 95%; 0 cycles of 24h each	30		60	℃
Temperature Shock	High Temperature: 125℃, Low Temperature: -55℃, High and low temperatures of one hour each for a cycle, a total of 32 cycles of testing	-55		125	℃

Note 1: Stress above the values listed in the "Absolute Maximum Ratings" section may cause permanent damage to the device. Exposure to any absolute maximum rating condition for extended periods may affect the reliability and lifespan of the device.

Note 2: The maximum continuous output current may be derated due to the junction temperature of the UDM3506.

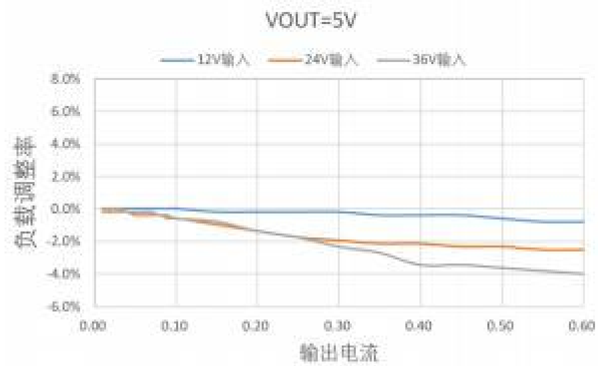
Note 3: The performance specifications of the UDM3506 are guaranteed over the entire internal operating stability range of -40°C to 125°C. Note that the maximum internal temperature is determined by specific operating conditions, PCB layout, the package's rated thermal resistance, and other environmental factors.

Typical characteristics

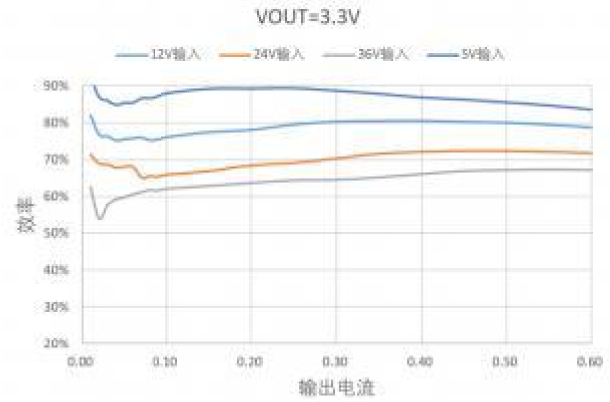
Unless otherwise noted, test conditions are VIN=12V, VOUT=3.3V, TA=25°C.

Efficiency

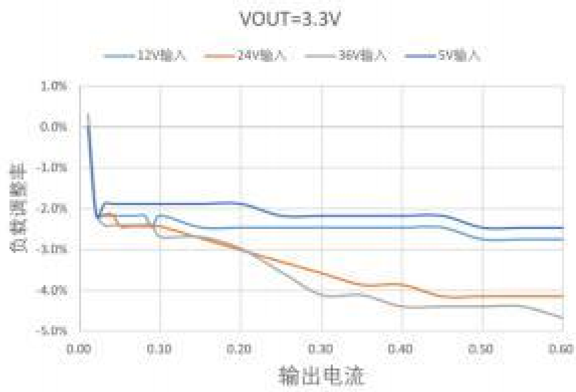
Load regulation



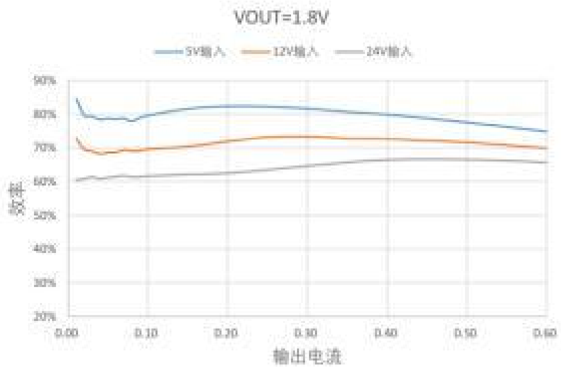
Efficiency



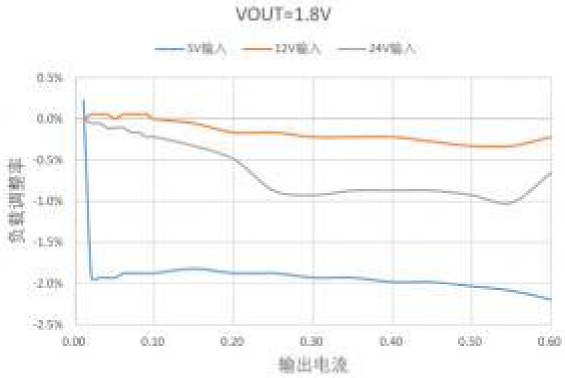
Load regulation



Efficiency



Load regulation



Operating principle

Summary

The UDM3506 is a DC-DC buck power module with synchronous rectification control. It integrates an inductor, power MOSFETs, and filtering capacitors. The UDM3506 provides a complete power solution, requiring only a few external passive components to achieve a wide input voltage range of 4.7V to 36V, a rated output current of 0.6A, adjustable output voltage, and excellent load and line regulation.

The UDM3506 features comprehensive protection functions, including over current protection (OCP), under voltage protection (UVP), and over temperature protection (OTP). The UDM3506 minimizes the use of external components and is packaged in a QFN-20 (5mm × 3.2mm × 2.2mm) package.

Current Mode Control

The UDM3506 uses current mode control to regulate the output voltage. The output voltage is divided by a resistive divider and fed back to the FB pin, where the error is amplified by an internal transconductance error amplifier. The output of the internal error amplifier is compared with the internally sampled switch current to control the output current.

PFM Mode

The UDM3506 operates in PFM mode under light load conditions. In PFM mode, when the load current decreases, the switching frequency is reduced to minimize switching losses and improve power efficiency at light loads. When the load current increases, the switching frequency is increased to minimize output voltage ripple.

Shutdown Mode

When the voltage on the EN pin drops below 0.3V, the UDM3506 will shut down. The entire regulator is in shutdown mode, and the power consumption of the UDM3506 is reduced to less than 1μA.

Under voltage Lockout Protection (UVLO)

Under voltage Lockout protection (UVLO) ensures that the module stops operating when the input voltage is insufficient. This is achieved by connecting a resistive divider between Vin and ground, with the center tap connected to the EN pin. When Vin drops to the preset value, the voltage on the EN pin falls below 1.2V, triggering the input Under voltage Lockout protection

Output Current Runaway Protection

During startup, due to the high input voltage and low output voltage, it is easy to establish the current inertia in the output inductor, leading to a higher output current at startup. The UDM3506 is designed with a valley current limit, which ensures that the upper switch turns on only when the output current is below the valley current limit. This control mechanism effectively manages the output current during startup.

Output Short-Circuit Protection

When the output is shorted to ground, the output current quickly reaches its peak current limit, causing the upper switch to turn off and the lower switch to immediately turn on and remain on until the output current falls below the valley current limit. When the output current drops below the valley current limit, the upper switch will turn on again. If the short circuit still exists, the upper switch will turn off and the lower switch will turn on again when the peak current limit is reached. This cycle continues until the short circuit is removed and the regulator returns to normal operation.

Over temperature Shutdown Protection (OTP)

To prevent damage from overheating, the UDM3506 stops switching when the internal chip temperature exceeds 135°C. The module will resume operation only when the core temperature drops below 120°

Application information

Output voltage setting

The module's output voltage can be set by external pull-up and pull-down resistors connected to the FB pin relative to VOUT and GND. The reference calculation formula is as follows:

The output voltage is set by an external resistor divider (refer to the typical application on the front page). First, select R1, and then calculate R2 using equation (1):

$$R_1 = R_2\left(\frac{V_{OUT}}{0.8} - 1\right) \quad (1)$$

Figure 1 and Table 1 provide recommended parameters for common output voltages in the feedback network.

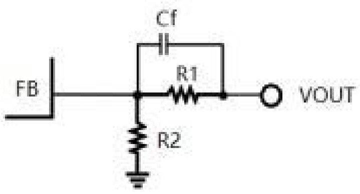


Figure 1 Feedback Network

Table 1 Recommended Parameters for Common Output Voltages

VOUT (V)	R2 (kΩ)	R1 (kΩ)
2.5	4.99	11
3.3	4.22	13.3
5	2.1	11.2

Input Capacitor Selection

Since the input current of the buck module is discontinuous, it is necessary to design an input capacitor in the application. The input capacitor maintains the DC input voltage while providing AC current. The input capacitor must have sufficient ripple current capability. The ripple current of the input capacitor can be calculated using equation (2):

$$I_{C1} = I_{LOAD} \bullet \sqrt{\frac{V_{OUT}}{V_{IN}} \bullet \left(1 - \frac{V_{OUT}}{V_{IN}}\right)} \quad (2)$$

Where ILOAD is the load current, VOUT is the output voltage, and VIN is the input voltage.

When the input ripple voltage is determined, the input capacitance can be calculated using the formula:

(3) Estimate.

$$C_1 = \frac{I_{LOAD}}{f_S \bullet \Delta V_{IN}} \bullet \frac{V_{OUT}}{V_{IN}} \bullet \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \quad (3)$$

Where C1 is the input capacitance, fs is the switching frequency, and ΔVIN is the input ripple voltage.

Using low ESR capacitors can provide better performance. In most cases, it is recommended to use 4.7μF ceramic capacitors with X5R or X7R dielectrics. X5R and X7R type ceramic capacitors maintain stable performance over a wide range of temperatures and voltages, effectively reducing the input voltage ripple.

Output Capacitor Selection

An output capacitor is required to maintain the DC output voltage. It is recommended to use ceramic, tantalum, or low ESR electrolytic capacitors. For optimal performance, it is advised to use low ESR capacitors to minimize output voltage ripple. The output voltage ripple can be estimated using equation (4):

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_S \bullet L} \bullet \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \bullet \left(R_{ESR} + \frac{1}{8 \bullet f_S \bullet C_2}\right) \quad (4)$$

Where fs = 2 MHz, L = 1.5 μH, RESR is the equivalent series resistance (ESR) of the output capacitor, and C2 is the output capacitance. The output capacitor also affects system stability and transient response. In typical applications, a 10 μF ceramic capacitor is recommended.

Where ILOAD is the load current, VOUT is the output voltage, and VIN is the input voltag

Application information(continued)

PCB Layout Guidelines

Since the UDM3506 highly integrates the components required for power conversion, it eliminates most of the tricky issues related to PCB layout. However, it is still necessary to optimize the PCB routing to ensure proper operation. Even with high integration, you need to ensure good grounding and thermal management when using the module. The recommended layout is shown in Figure 4:

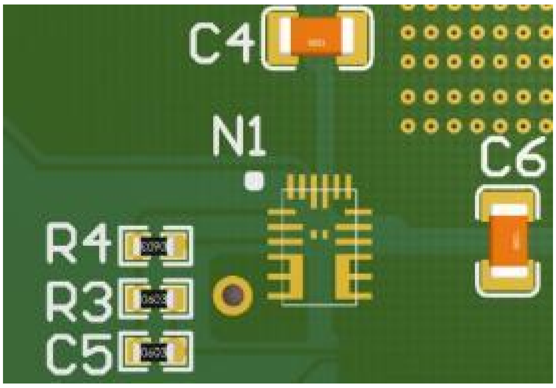


Figure 2 PCB Layout Diagram

1. Place the RFB resistors used for feedback voltage division as close as possible to their corresponding FB pins.

2. Place the Cin capacitors as close as possible to the Vin and PGND connections of the UDM3506.

3. Place the Cout capacitors as close as possible to the Vout and PGND connections of the UDM3506.

4. Connect all PGND pins to the largest possible copper area on the top layer to avoid breaking the ground connection between external components and the UDM3506.

5. To achieve good thermal performance, use vias to connect the PGND copper areas to the internal ground plane of the PCB, providing a good ground connection and a thermal path to the PCB plane. Since they are close to the internal power-handling components, the UDM3506 can benefit from good thermal dissipation through these vias that connect to the internal GND plane of the PCB. The optimal number of thermal vias depends on the PCB design. For example, if the PCB uses very small vias, more thermal vias may be needed to ensure adequate heat dissipation.

Typical Application Circuit

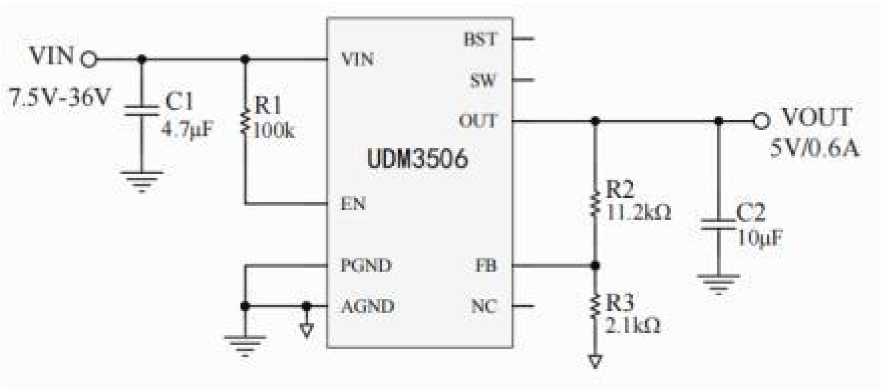


Figure3 VOUT=5V,IOUT=0.6A

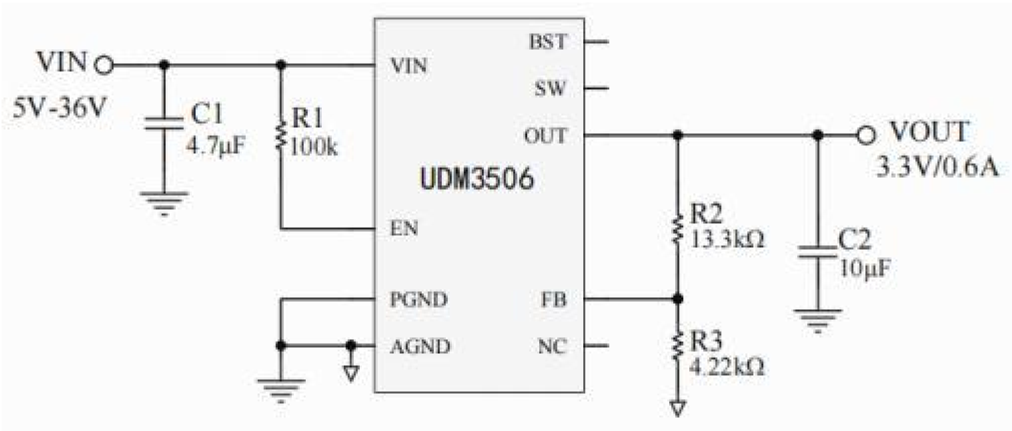


Figure4 VOUT=3.3V,IOUT=0.6A

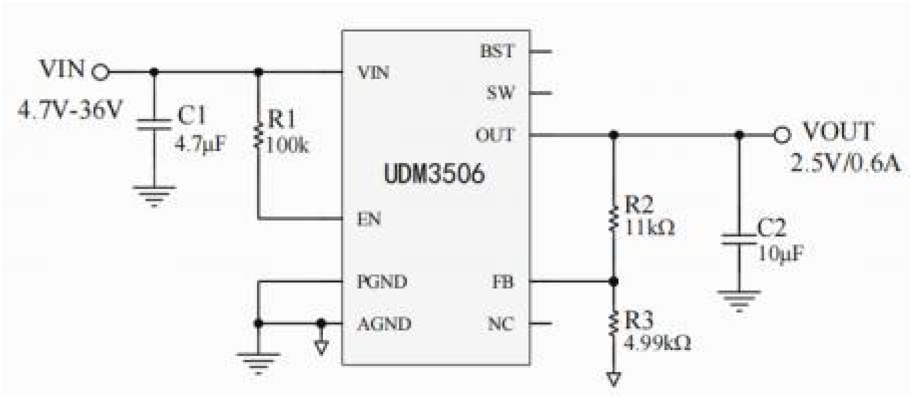
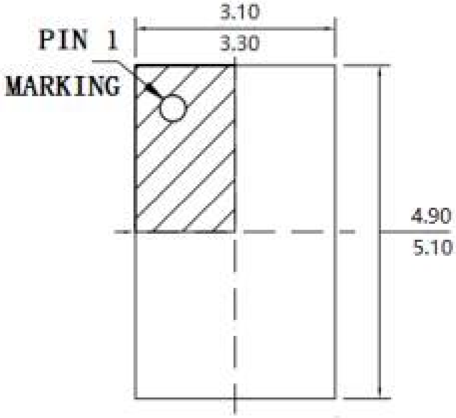


Figure5 VOUT=2.5V,IOUT=0.6A

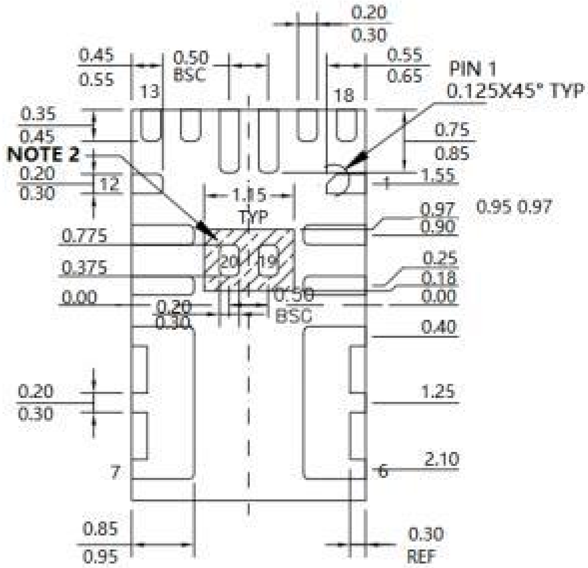
Package Information

LGA Package

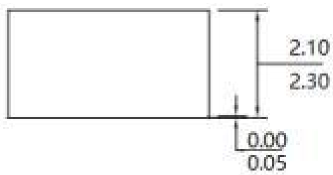
20Pins（5mm×3.2mm×2.2mm）



Top View



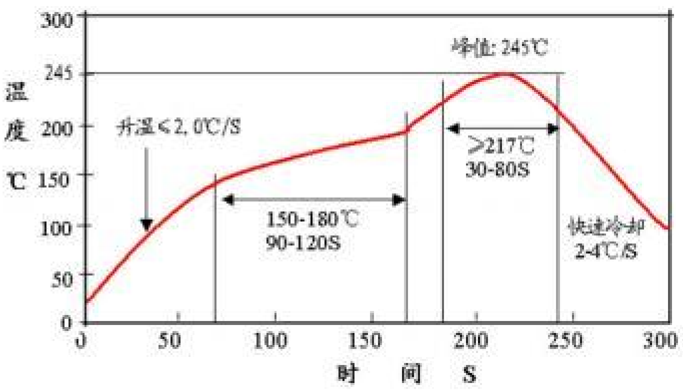
Bottom View



Side View

Soldering and Storage Precautions

Recommended Reflow Soldering Profile



Note:

1. Due to the size of the module, do not place the module on the bottom side of the board for reflow soldering to avoid module drop.

2. For bulk and unpackaged products, store them in a dry box (the relative humidity in the dry box should be kept below 10%). For products that are still in their original packaging, store them in a dry box whenever possible.

3. Before mounting on the board, strictly follow the baking conditions to dry the samples: bake at 125°C for more than 48 hours, and control the reflow soldering temperature to within 245°C.