Highly Integrated 4V to 23V Input, 3A Output Power Module

GENERAL DESCRIPTION

The AKC2603 is a high frequency, highly integrated, and complete DC/DC power module. The module is optimized to operate with minimum external component counts and also optimized to achieve low standby current 45 μA typ.

The AKC2603 devices employ COT mode control providing a fast transient response and supporting both low equivalent series resistance (ESR) output capacitors such as specialty polymer and ultra-low ESR ceramic capacitors with no external compensation components.

The AKC2603 operates with an input range of 4V~23V and delivers 3A of continuous output current with two integrated N-Channel MOSFETs and most of the support components are integrated into one package. At light loads, the regulator operates in low frequency to maintain high efficiency and low output ripples.

The module is available in a 7.5mm x 6.8mm x 5.6mm package.

FEATURES

- AKC2603 3A@21V continuous output current module
- Up to 98% efficiency @ Vin=23V/ Vout=21V/ Io=3A
- Ultra-Fast Transient Response
- Input Voltage Range: 4V to 23V
- Output Voltage: 0.6V to 21V
- 500kHz Switching Frequency
- Low Shutdown Current Less than 5μA
- 1% Feedback Voltage Accuracy (25°C)
- Programmable Fault Protections
  - ▸ Over voltage protection (OVP)_Latch off
  - ▸ Over current protection (OCP)
  - ▸ Over temperature protection (OTP)
  - ▸ Under-voltage Protection (UVP)
- Fixed Soft Start: 400us
- Power good indicator
- Output discharge function
- Available in 7.5mm x 6.8mm x 5.6mm package

APPLICATIONS

- USB PD Type-C Adapters
- Highly Integrated module
- Notebook

TYPICAL APPLICATION CIRCUIT & PACKAGE SIZE

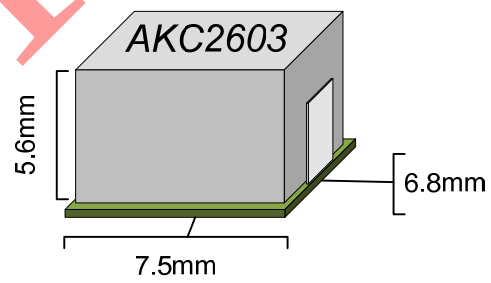


Figure 1 Power Module

ORDER INFORMATION:

Part Number	Ambient Temp. Range (°C)	Package (Pb-Free)
AKC2603A00AAA	-40℃~+85℃	QFN

PIN CONFIGURATIONS

20-pin 7.5mm x 6.8mm x 5.6mm package

v

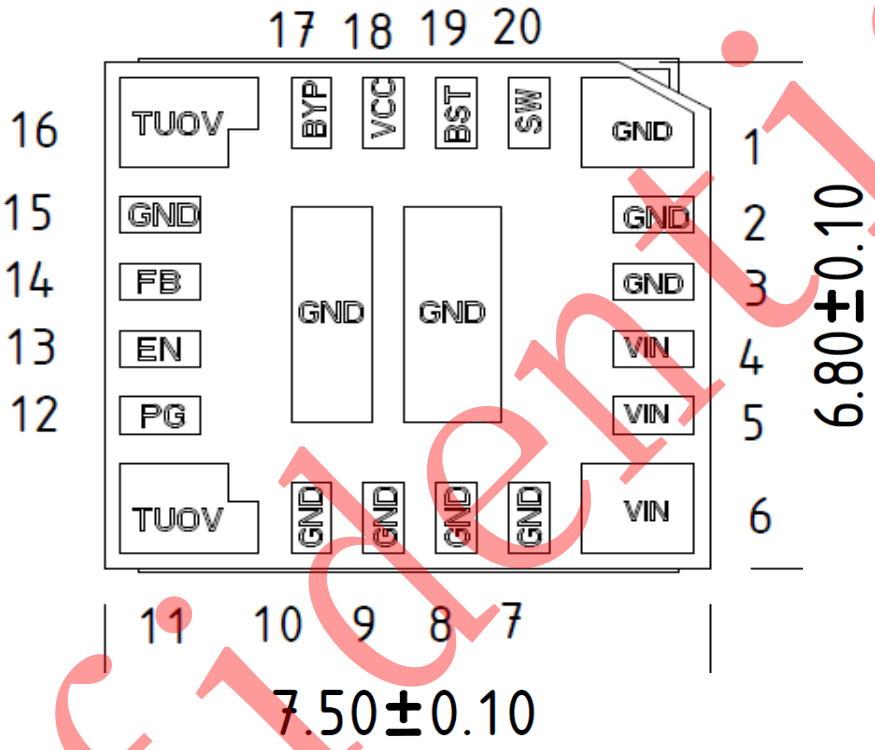
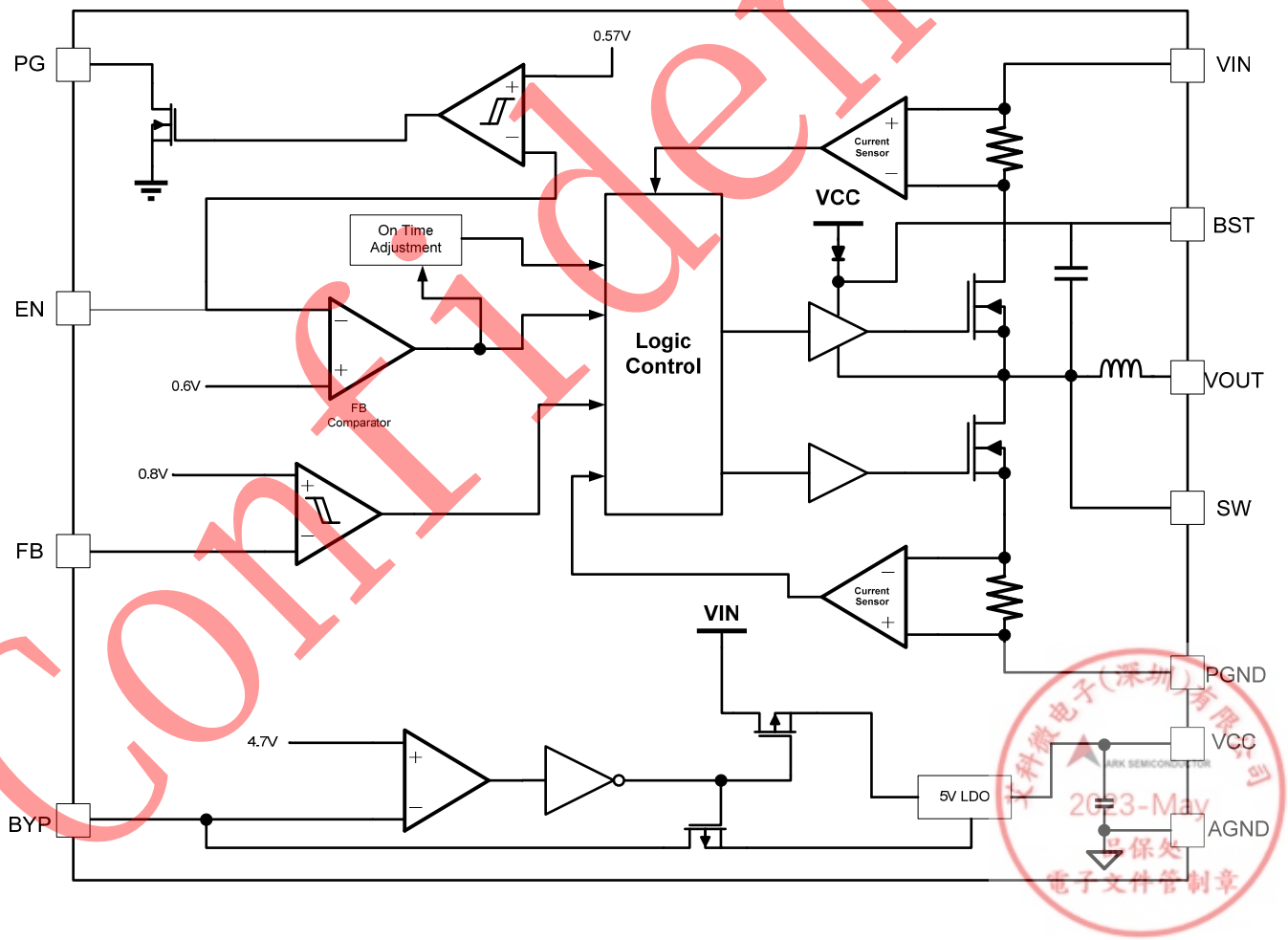


Figure 2 Bottom View

FUNCTIONAL PIN DESCRIPTION

Pin Number	Pin Name	Pin Function
4~6	VIN	Power supply pin
20	SW	SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load
14	FB	Output feedback pin. FB senses the output voltage and is regulated by the control loop to 0.6V. Connect a resistive divider at FB.
19	BST	Bootstrap
18	VCC	Internal 5.0V LDO output. Power supply for internal analog circuits and driving circuits. Internal connect a 2.2uF for Bypass capacitor.
17	BYP	Bypass input for the internal LDO. BYP is externally connected to the output of the switching regulator. When the BYP voltage rises above the bypass switch turn-on threshold, the power supply of the internal LDO regulator changes to the external source.
13	EN	Enable Control. Pull this pin high to turn on the Buck. Do not leave this pin floating.
12	PG	Power good monitor output. Open drain output when the output voltage is within 95% to 120% of the regulation point.
11,16	VOUT	Output Voltage pin. Connect output capacitor.
1~3,7~10	PGND	Power Ground
15	AGND	Ground pin

Functional Block Diagram



ELECTRICAL SPECIFICATIONS

Parameter	Description	Min.	Typ.	Max.	Unit.
● **Absolute Maximum Ratings[1)]**					
VIN, EN, PG, SW, ILM		-0.3		24	V
VIN to SW (100ns)		-0.5		26	V
SW to GND (100ns)		-0.5		26	V
BST		SW-0.3		SW+5	V
All other Pins		-0.3		6	V
Junction Temp			150		
ESD Susceptibility	Human Body Model			2	KV
● **Recommendation Operating Ratings[2)]**					
VIN	Input Supply Voltage	4		23	V
VOUT	Output Voltage	0.6		21	V
Ta	Ambient Temperature Range	-40		85	
● **Thermal performance[3)]**					
Rth(ja)	Thermal resistance from junction to ambient		30.3		C/W

1. Do not operate at or near the absolute maximum rating listed for extended periods of time. This stress may adversely impact product reliability and result in failures outside of the warranty.
2. The device is not guaranteed to function outside of its operating conditions.
3. Measured on JESD51-7, 4-layer PCB.

ELECTRICAL SPECIFICATIONS(Cont.)

Conditions: TA = 25 ºC, unless otherwise specified.
Test Board Information: 30mm× 30mm× 1.6mm, 4 layers 2 oz. The output ripple and transient response measurement is short loop probing and 20MegHz bandwidth limited. Cin =10uF/35V/1210/X7R MLCC * 2 pcs, Cout = 22uF/35V/1210/X7R MLCC * 2 pcs.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit.
● **Input Characteristics**						
V_{IN_MIN}	VIN Under Voltage Lockout Threshold	V_{IN} rising	2.7	2.91	3.12	V
		V_{IN} falling	2.45	2.7	2.95	V
$V_{IN\_MIN\_HYST}$	VIN Under voltage Lockout Hysteresis			180		mV
I_{SD}	Shutdown Current	V_{EN}=0V		2	5	uA
I_Q	Supply Current	V_{EN}=5V, V_{BYP}=5V		45	70	uA
● **Output Characteristics**						
$IOUT_{(DC)}$	Output continuous current range			3		A
ΔVOUT/ΔVIN	Line regulation	V_{IN} =4V to 23V, V_{OUT}=5.0V, I_{OUT} =3A		3		%
ΔVOUT/ΔIOUT	Load regulation	V_{OUT}=5.0V, I_{OUT}=0.5~3A		1		%
Vo, set	Output voltage set point	V_{IN} =12V, V_{OUT}=5.0V with 0.1% resistor	-1		+1	%V, set
● **Control Characteristics**						
V_{EN_H}	EN Rising Threshold		0.8			V
V_{EN_L}	EN Falling Threshold				0.4	V
V_{FB}	Feedback Voltage	4V<V_{IN}<23V	594	600	606	mV
$R_{DS(ON)T}$	Top Switch Resistance[4)]			20		mΩ
$R_{DS(ON)B}$	Bottom Switch Resistance[4)]			10		mΩ
I_{LEAK_TOP}	Top Switch Leakage Current	V_{IN}=23V, V_{SW}=0V			1	uA
I_{LEAK_BOT}	Bottom Switch Leakage Current	V_{IN}=23V, V_{SW}=23V			2	uA
I_{LIM}	Bottom Switch Current Limit	Valley	8			A
T_{ON_MIN}	Minimum On Time[4)]			100		ns
T_{OFF_MIN}	Minimum Off Time	V_{FB}=0.4V		100		ns
Fs	Switching Frequency[4)]			500		kHz
R_{DIS}	Discharge FET Ron			50		Ω
T_{SS}	Soft-Start Time[4)]			400		us
VCC	VCC regulator	V_{IN}=12V	4.7	5	5.25	V
P_{GD_TH}	Power Good Threshold	V_{FB} Rising	92.5%	95%	98.5%	V_{REF}
P_{GD_HYS}	Power Good Hysteresis[4)]			5%		V_{REF}
P_{GD_DLY}	Power Good Delay Time[4)]	Low to high		300		us
		High to low		10		us
I_{PG}	Power Good Sink Current [4)]	PG=0.5V	2			mA
V_{BYP_ON}	Bypass Switch Turn-on Voltage		4.47	4.7		V
V_{BYP_HYS}	Bypass Switch Switchover Hysteresis			0.2		V
● **Fault Protection**						
OVP	Output Over-voltage Threshold	V_{FB} Rising	115%	120%	125%	V_{REF}
$OVP_{\_HYS}$	Output Over-voltage Hysteresis[4)]			5%		V_{REF}
$OVP_{\_Delay}$	Output Over-voltage Delay Time[4)]			20		us
UVP	Output Under-voltage Threshold[4)]	V_{FB} Falling	55%	60%	65%	V_{REF}
T_{TSD}	Thermal Shutdown[4)]			150		℃
T_{TSD_HYS}	Thermal Shutdown hysteresis[4)]			15		℃

4. Guaranteed by design.

TYPICAL PERFORMANCE CHARACTERISTICS: (5 VOUT)

Conditions: TA = 25 ºC, unless otherwise specified. Test Board Information: 30mm×30mm×1.6mm, 4 layers 2Oz.
VIN=23V, Cin =10uF/35V/1210/X7R MLCC * 2 pcs, Cout = 22uF/35V/1210/X7R MLCC * 2 pcs.
The following figures provide the typical characteristic curves at 5.0Vout.

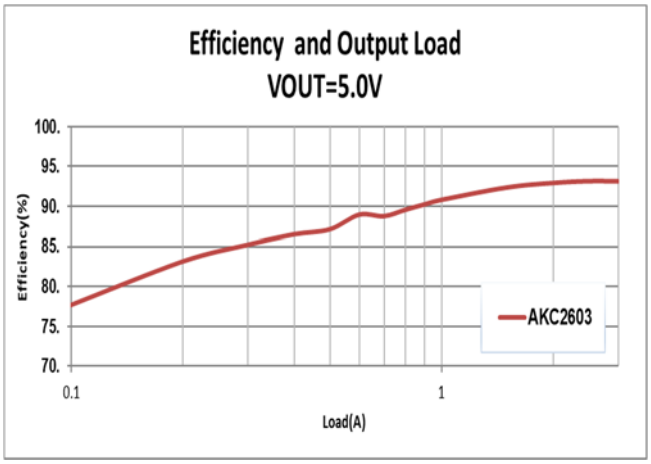


Figure 3 Efficiency V.S. Load Current

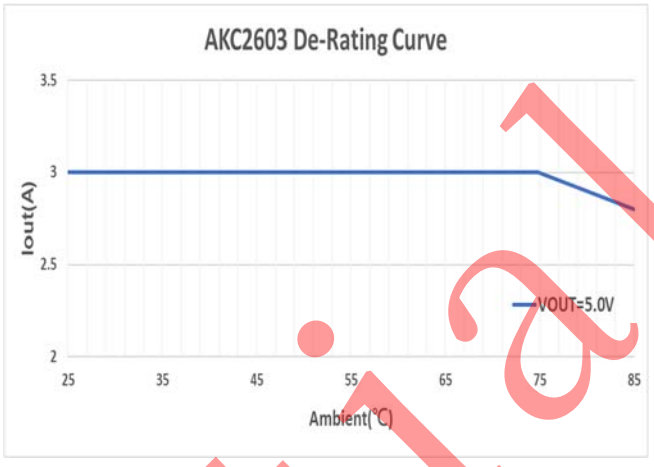


Figure 4 De-rating Curve

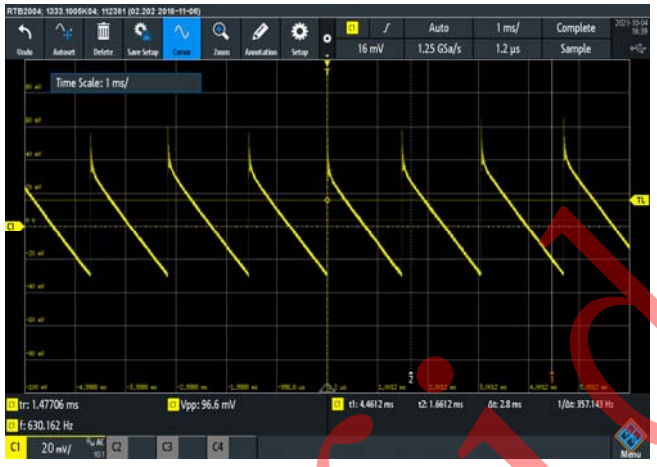


Figure 5 Output Ripple (Light Load

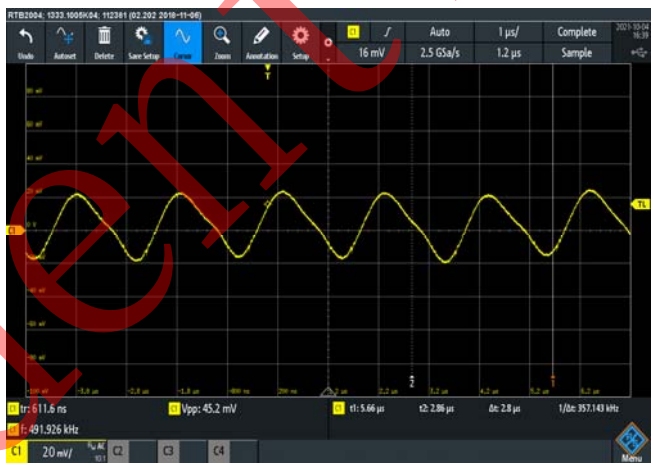


Figure 6 Output Ripple (Full Load)

Figure 7 Transient Response(0A~3A)

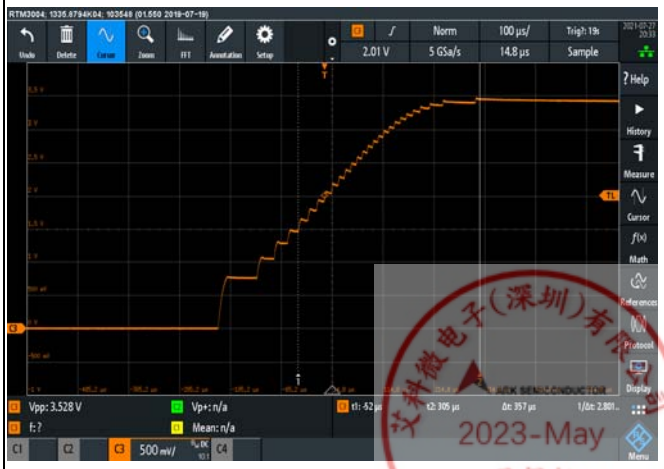


Figure 8 Turn-on

REFERENCE CIRCUIT FOR GENERAL APPLICATION:

Test condition:

VIN: 12V VOUT: 3.3V IOUT: 0~3A

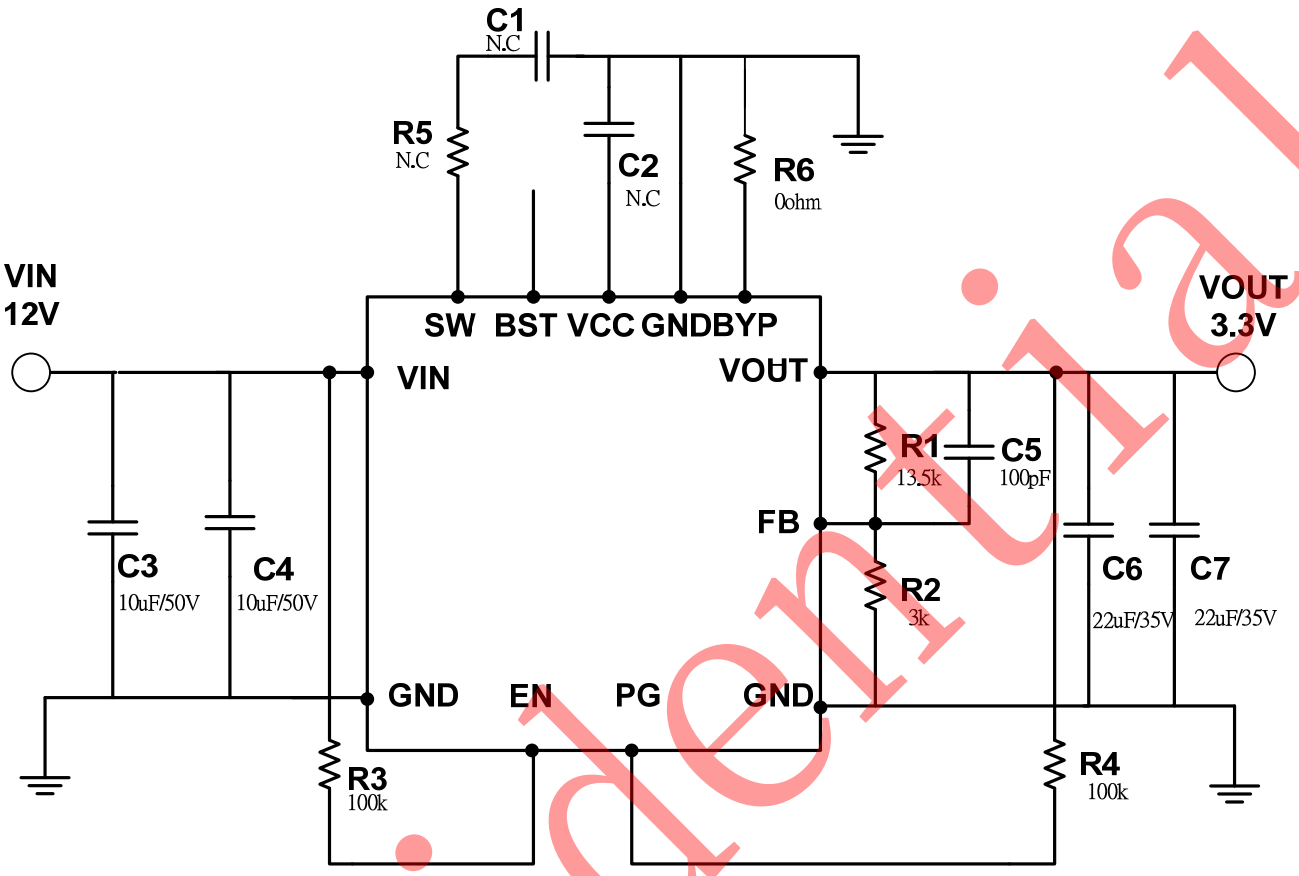


Figure 9 Reference circuit

APPLICATIONS INFORMATION:

Input Filtering:

The module should be contacted to as low AC impedance source supply and a highly inductive source or line inductance can affect the stability of the module. An input capacitor must be placed directly to the input pin of the module, to minimize input ripple voltage and ensure module stability.

Output Filtering:

To reduce output ripple and improve the dynamic response to step load change, the additional capacitor at the output must be used. Low ESR polymer and ceramic capacitors are recommended to improve the output ripple and dynamic response of the module.

UVLO (Under voltage Lockout):

When EN is HIGH, the under-voltage lockout keeps the module from operating until the input supply voltage rises high enough to properly operate. This ensures no misbehavior of the module during startup or shutdown.

Soft Start

The device has an internal soft start function that limits inrush current during start-up. The nominal soft start is 400 uS.

Enable

When EN is LOW, all circuits are off, and the module draws ~0.1uA of current. When EN is HIGH

and Vin is above its UVLO threshold, the module begins a soft-start cycle. For proper operation, the EN pin must be terminated to logic high and not left floating.

Power Good

The module has power-good (PG) output. The PG pin is the open drain of a MOSFET. Connect to VCC or another voltage source through a resistor. It is high if the output voltage is higher than 95% and lower than 120% of the nominal voltage.

Output Voltage Set

The output voltage is determined by the resistor divider connected at the FB pin, and the voltage ratio is:

$$V_{FB} = V_{OUT} * \frac{R_2}{(R_1 + R_2)})$$

where VFB is the feedback voltage and VOUT is the output voltage Choose R2 around 3k and R1 can be calculated by:

$$R_1 = R_2 * (\frac{V_{OUT}}{0.6} - 1)$$

The R2 resistance following table lists the recommended values.

VOUT	R_1	R_2
3.3V	13.5k	3K
5.0V	22k	3K
9.0V	42k	3K
15V	72k	3K

Linear Regulator (VCC)

The AKC2603 integrates a 5V linear regulator (VCC). When the input voltage of the BYP pin is lower than the switch over threshold of 4.7V, the VCC regulator steps down the input voltage to supply both internal circuitry and gate drivers. When the input voltage of BYP pin is higher than the switch over threshold 4.7V, an automatic circuit will change the power source of the linear regulator from VIN path to external path, therefore the power dissipation of A linear regulator will be decreased.

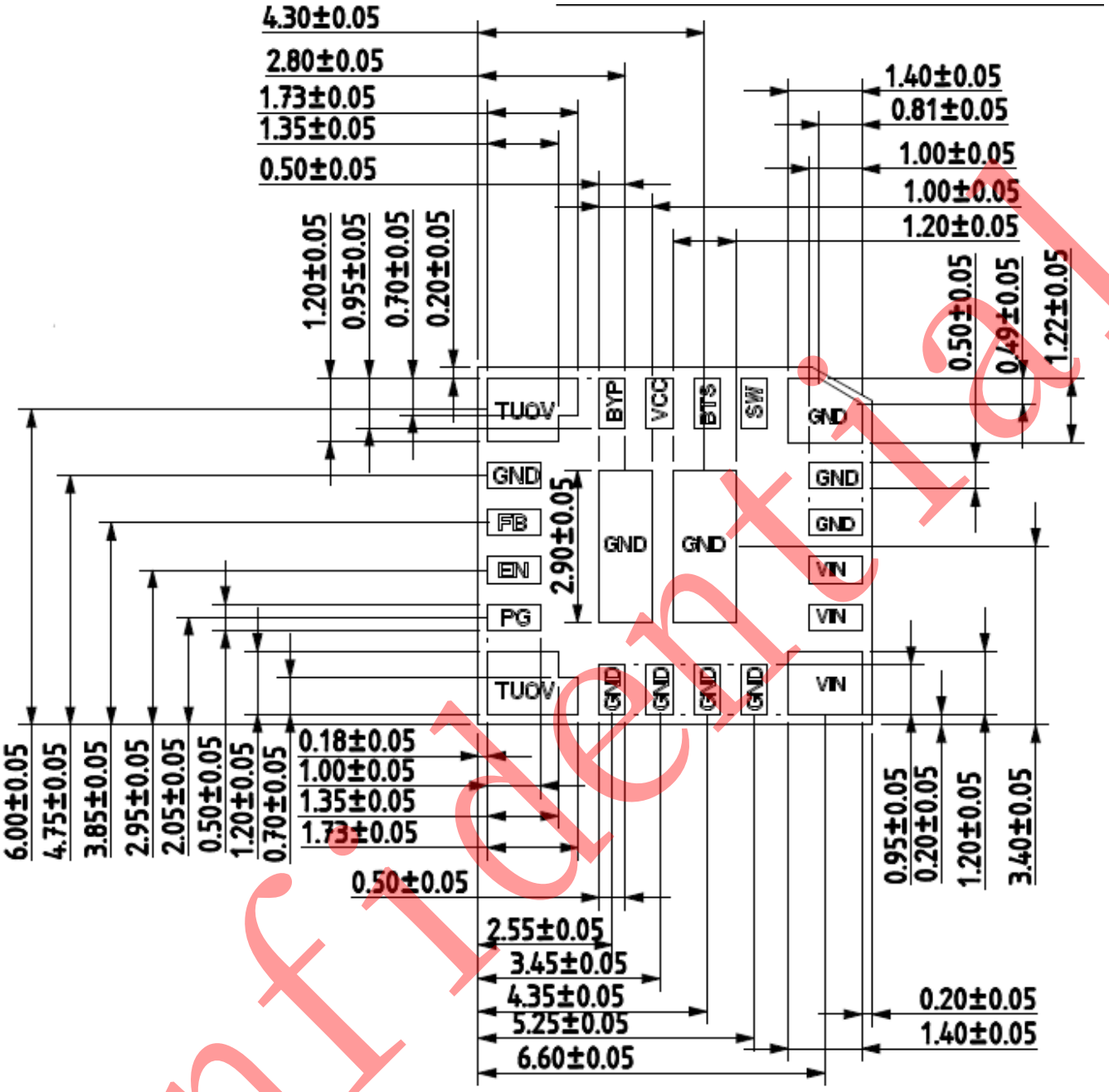
Feedforward Capacitor

To minimize the ripple of the output voltage at load transient, a feedforward capacitor in series with a resistor should be in parallel to the upper divider resistor. Choose R1 around 13.5kΩ and C5 around 470pF or 180pF.

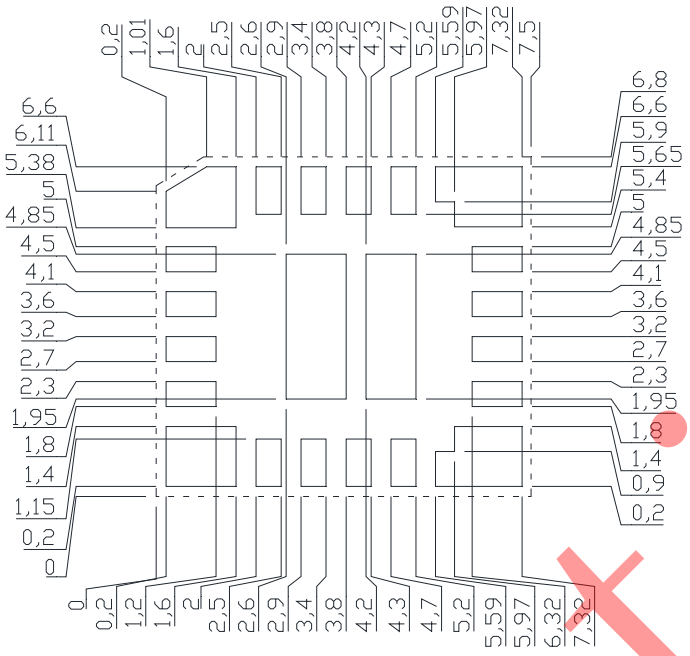
Thermal Protection

When the temperature of the AKC2603 rises above 150°C, it is forced into thermal protection (OTP). The AKC2603 uses latch-off mode in OTP. When the protection function is triggered, the module will shut down. To restart operation, toggle EN or power the module off and then on again.

OUTLINE DIMENSION

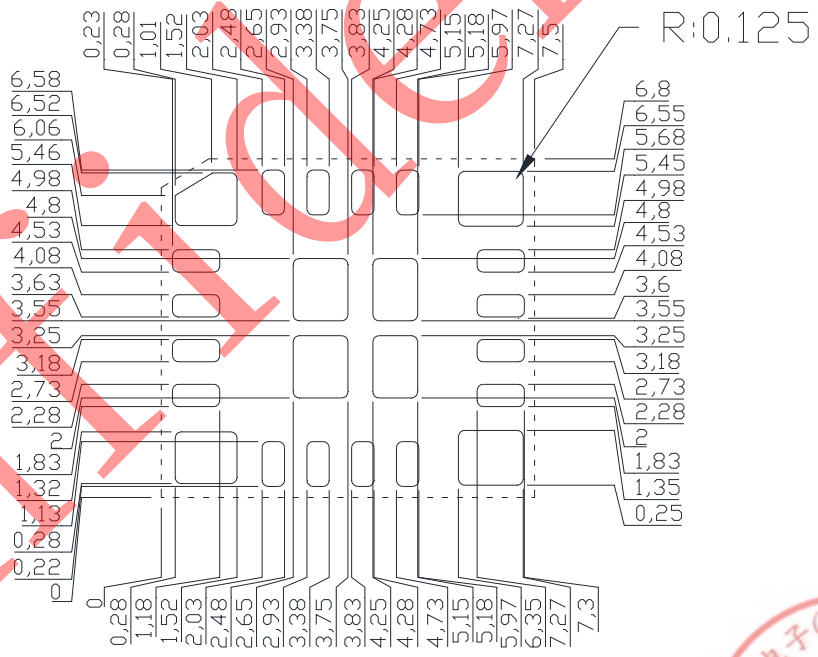


LAND PATTERN REFERENCE:



TOP VIEW

TYPICAL RECOMMENDED LAND PATTERN



TOP VIEW

STENCIL PATTERN WITH PADS (STENCIL t=100μm)

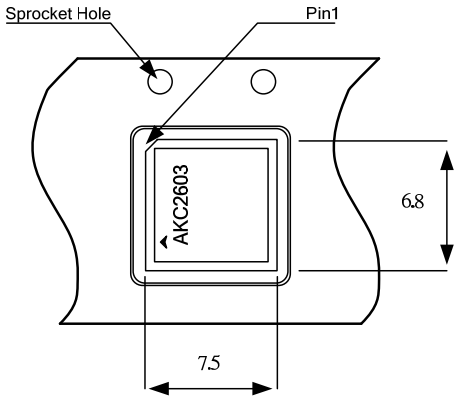
Unit: mm

General Tolerances:± 0.2mm

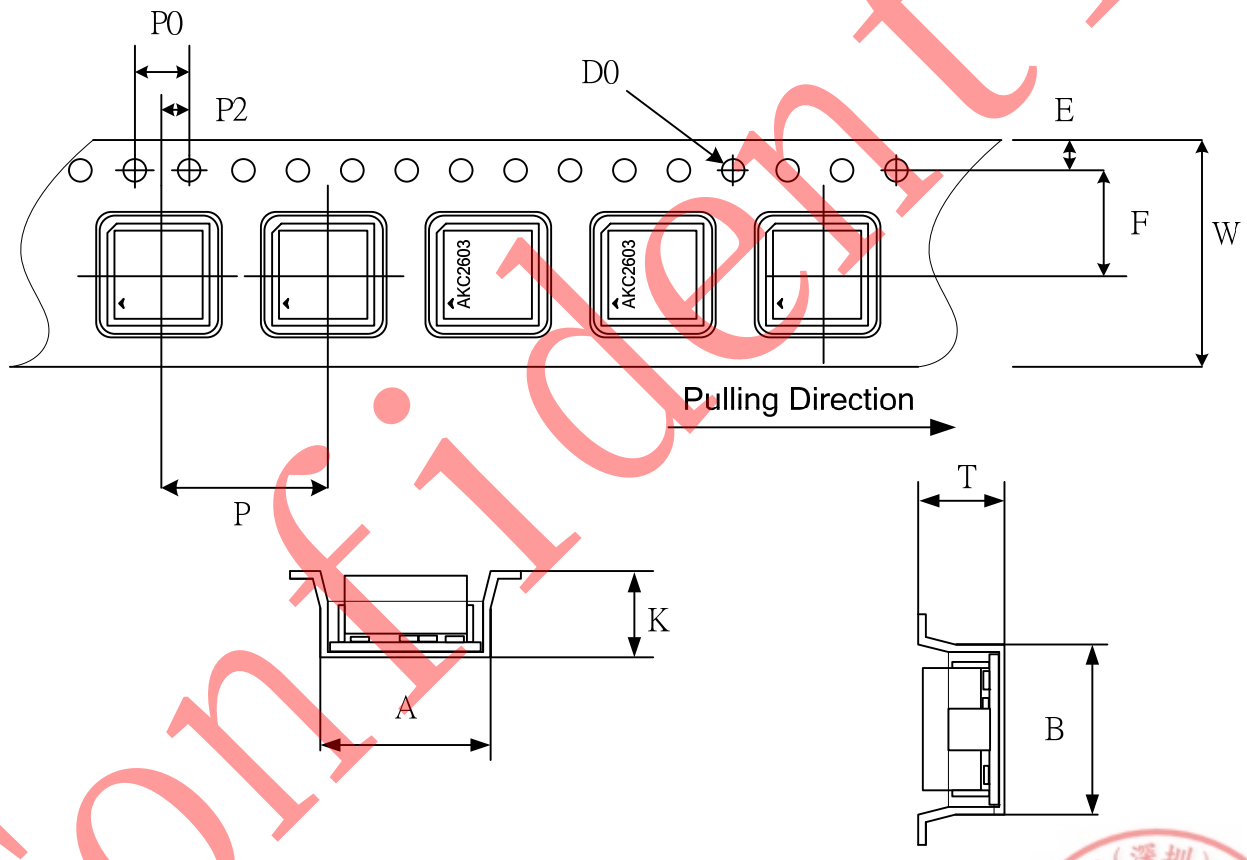
PACKING REFERENCE:

Unit: mm

Package In Tape Loading Orientation



Tape Dimension



D0	1.50±0.1	W	24.00±0.3
P	12.00±0.1	A	8.50±0.15
P0	4.00±0.1	K	5.80±0.1
P2	2.00±0.1	T	5.80±0.1
E	1.75±0.1	B	7.80±0.15
F	11.50±0.1		

Packing Reference