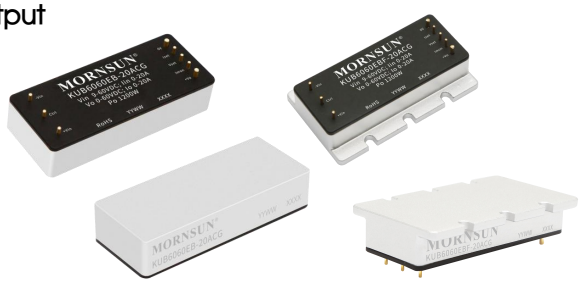
Ultra-wide input, non-isolated, buck-boost single output



Patent Protection RoHS

FEATURES

- Ultra-wide input voltage range: 9 - 60VDC
- Output voltage range: 0 - 60VDC
- High efficiency up to 98.5%
- With output oring-fet inside module
- Protections: input under-voltage, input over-voltage,output over-voltage, short-circuit, output over-current, over-temperature
- Operating ambient temperature range: -40℃ to 100℃(case temperature)
- Industry standard 1/8-Brick package and pin-out

KUB6060EB(F)-10AxG is high efficiency switching regulators. It features ultra-wide input range of 9-60VDC, adjustable output voltage range of 0-60VDC, efficiency up to 98.5%, operating temperature of -40℃ to +100℃, input over-voltage and under-voltage protection, output short-circuit and output over-voltage, over-current, over-temperature protection, remote control, output voltage regulation and remote compensation, current monitor, parallet support and other functions. It is widely used in robotics, communications, battery management, DC-DC distributed power supply and other occasions.

Selection Guide

Certification	Part No.	Input			Output		
		Nominal (Range) (VDC)	Max.① (VDC)	Current② (A) Max.	Voltage (Range) (VDC)	Current② (A) Max.	Power(W) Max.
--	KUB6060EB(F)-10ACG	9-60	60	13	0-60	10	600
	KUB6060EB(F)-10ASG	9-60	60	13	0-60	10	600

Note:
① The input voltage cannot exceed this value, otherwise it may cause permanent irreparable damage;
② Vin>Vo, the maximum output current should not exceed 10A; Vin ≤ Vo, the maximum input current should not exceed 13A;
③ For model "S," the 5th and 7th output terminals are of the Sense- and Sense+ versions; for models with "C," the 5th and 7th output terminals are of the Iset and Imon versions;The F suffix indicates a heat sink package。

Typical input-output Efficiency

Input	Output			Efficiency (%) Typ.
Voltage(VDC)	Voltage(VDC)	Current(A)	Power(W)	
12	48	2.5	120	94
	48	1.25	60	94
	24	5	120	95
	24	2.5	60	95.5
	12	10	120	95.5
	12	5	60	96.5
24	48	5	240	96.5
	48	2.5	120	96
	24	10	240	97.5
	24	5	120	97.5
	12	10	120	95
	12	5	60	95
48	48	10	480	98.5
	48	5	240	98.5
	24	10	240	96
	24	5	120	95.5
	12	10	120	93.5
	12	5	60	92.5

60	60	10	600	98.5
	60	5	300	98.0

Note: For the corresponding 100% Io under each operating condition, please refer to Figure 1 for the power derating curve

Input Specifications

Item	Operating Conditions ②	Min.	Typ.	Max.	Unit
Input Current (no-load)	Vin=12/24/36/48V, Vout=12V, Io=0A	--	65	--	mA
	Vin=12/24/36/48V, Vout=24V, Io=0A	--	75	--	
	Vin=12/24/36/48V, Vout=48V, Io=0A	--	135	--	
Reflected Ripple Current	Vin=48V, Vout=24V, Io=20A	--	150	--	mA
Surge Voltage (1sec. max.)	1sec. max.	--	--	80	VDC
Start-up Voltage		--	--	9	
Under-voltage Protection		6	--	--	
Over-voltage Protection	self-recovery	--	70	--	
Input Filter		Pi filter			
Hot Plug		Unavailable			
Input Reverse Polarity Protection		Unavailable			
Input Current Limit		--	--	13	A
Ctrl ①	Module on	Low level (0-0.8VDC)			
	Module off	Ctrl floating or connected to TTL high level (1.8-5.5VDC)			
	Input current when off	--	2	--	mA

Note:
① The voltage of the Ctrl control pin is relative to the input pin -Vin;
② All performance testing conditions are: ambient temperature of 25 ℃, product surface temperature less than 100 ℃

Output Specifications

Item	Operating Conditions	Min.	Typ.	Max.	Unit
Output voltage accuracy ①	3.3V-60V output, 5% Io-100% Iomax	±100mV ±2%*Vout±2%*Vout*Iout/Iomax			
	3.3V-60V output, 0% Io-5% Iomax	±100mV ±3%*Vout ±2%*Vout*Iout/Iomax			
Load Regulation	Nominal input voltage, 5% Io-100% Iomax	±2%*Vout*Iout/Iomax (Typ)			
Transient Response Deviation	Vin=28V, Vout=12V, 25% load step change,0.1A/uS	--	600	--	mV
Transient Recovery Time	Vin=28V, Vout=12V, 25% load step change, 0.1A/uS	--	400	--	uS
Temperature Coefficient	Operating temperature -40℃ to +100℃	--	±0.02	--	%/℃
Ripple & Noise ②	20MHz bandwidth, Vin=36V, Vout=12V, Io=10A	--	50	--	mVp-p
	20MHz bandwidth, Vin=36V, Vout=24V, Io=10A	--	300	--	
	20MHz bandwidth, Vin=36V, Vout=48V, Io=7.5A	--	200	--	
Over-temperature Protection	Maximum surface temperature of the product	--	105	--	℃
Output Over-voltage Protection	Input voltage range, output power range, lockout	--	65	--	VDC
Output Current Limit	Input voltage range, output voltage range	--	12	--	A
Over current &Short-circuit Protection	Input voltage range	constant current			
Iset	Iset foot settings	Refer to the design and precautions for regulating the output current Iset for details			
	Iset's feet are suspended in mid air	--	2.5	--	VDC
	Output current regulation range	0	--	10	A

Vset	Vset foot settings	Refer to the design and precautions for regulating the output voltage Vset for details			
	Vset feet suspended in the air	--	2.5	--	VDC
	Output voltage regulation range	0	--	60	VDC
Sense	Sense foot settings	Please refer to the regulation design and precautions of Sense for details			
	Sense compensation voltage range	--	--	105	%Vo

Note:
①When the output voltage is 0-3.3V, it can work in Non-fixed voltage mode;
②The "parallel cable" method is used for ripple and noise test ;
③test condition：Ta = 25℃, the product surface temperature is less than 100℃

General Specifications

Item	Operating Conditions	Min.	Typ.	Max.	Unit
Isolation	Input/Output - Shell, Electric Strength Test for 1 minute with a leakage current of 1mA max.	1500	--	--	VDC
Operating Temperature①		-40	--	+100	℃
Storage Temperature		-55	--	+125	
Storage Humidity	Non-condensing	5	--	95	%RH
Pin Soldering Resistance Temperature②	Wave-soldering, max. 10 second	255	260	265	℃
	Soldering spot is 1.5mm away from case for 10 seconds	--	--	300	
Pollution Degree		PD 3			
Vibration		10-150Hz, 5g, 0.75mm, 90 Min. along X, Y and Z			
Switching Frequency	Full load, nominal input voltage	--	270	--	kHz
Operating altitude		Altitude: ≤2000m, Atmospheric pressure: 80-110KPa			
MTBF	MIL-HDBK-217F@25℃	500	--	--	k hours

Note:
①Operating temperature refers to the surface temperature of the product.
②The soldering temperature that the pin can withstand is not the actual set temperature of the soldering iron, but the temperature required for a good solder joint. The actual set temperature by the customer needs to be comprehensively set based on the thickness of the PCB, the size of the copper cladding, the power of the soldering iron, and the selection of the soldering iron tip.
③test condition：Ta = 25℃, the product surface temperature is less than 100℃.

Mechanical Specifications

Case Material	Aluminum alloy shell, plastic shell base (UL94V-0)	
Dimensions	KUB6060EB-10ACG、 KUB6060EB-10ASG	60.80 x 25.00 x 12.70 mm
	KUB6060EBF-10ACG、 KUB6060EBF-10ASG	60.80x 36.83x 12.70mm
Weight	KUB6060EB-10ACG、 KUB6060EB-10ASG	53g(Typ.)
	KUB6060EBF-10ACG、 KUB6060EBF-10ASG	58g(Typ.)
Cooling Method	Natural air cooling, forced air cooling, water cooling	

Electromagnetic Compatibility (EMC)

Emissions	CE	CISPR32/EN55032 CLASS A (see Fig. 9 for recommended circuit)	
	RE	CISPR32/EN55032 CLASS A (see Fig. 9 for recommended circuit)	
Immunity	ESD	IEC/EN 61000-4-2 Contact ±6kV	perf. Criteria B
	RS	IEC/EN 61000-4-3 10V/m	perf. Criteria A
	EFT	IEC/EN 61000-4-4 ±2kV (see Fig. 9 for recommended circuit)	perf. Criteria B
	Surge	IEC/EN 61000-4-5 line to line ±2kV (see Fig. 9 for recommended circuit)	perf. Criteria B
	CS	IEC/EN 61000-4-6 10Vr.m.s	perf. Criteria A

Typical Characteristic Curves

Power derating curve

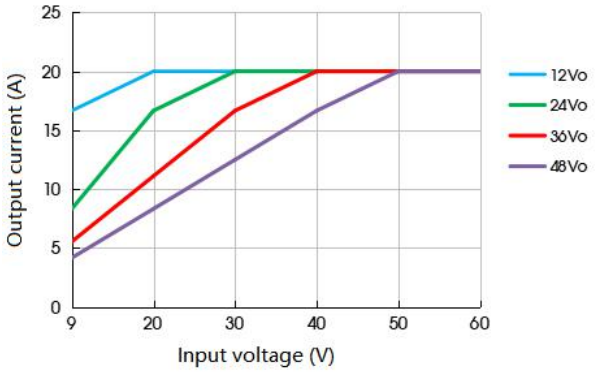
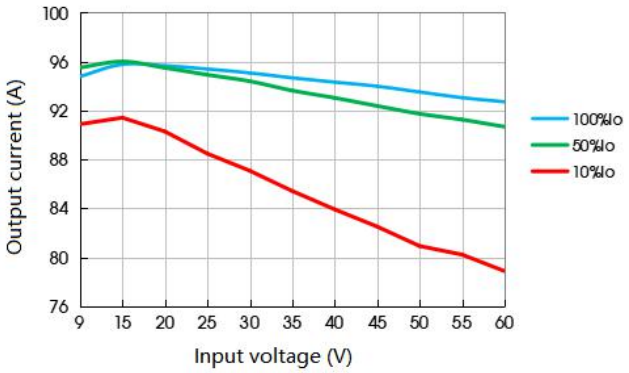
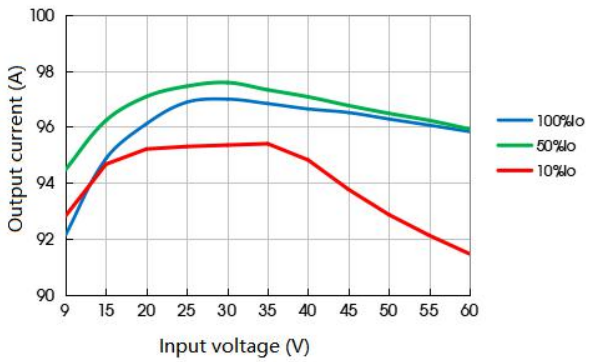


Figure 1

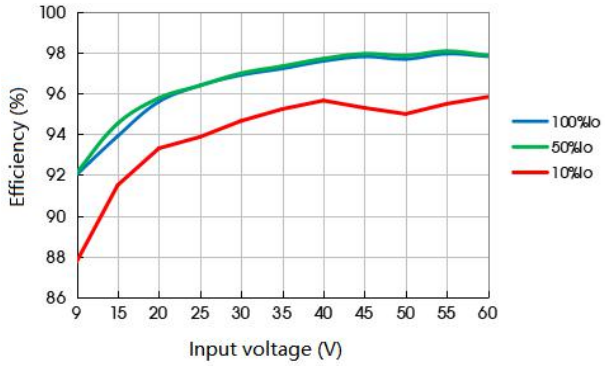
Efficiency VS Input Voltage (Vo=12V)



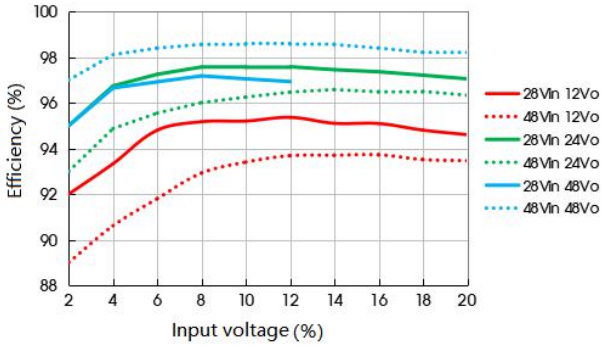
Efficiency VS Input Voltage (Vo=24V)



Efficiency VS Input Voltage (Vo=48V)



Efficiency VS output load



Temperature derating curve

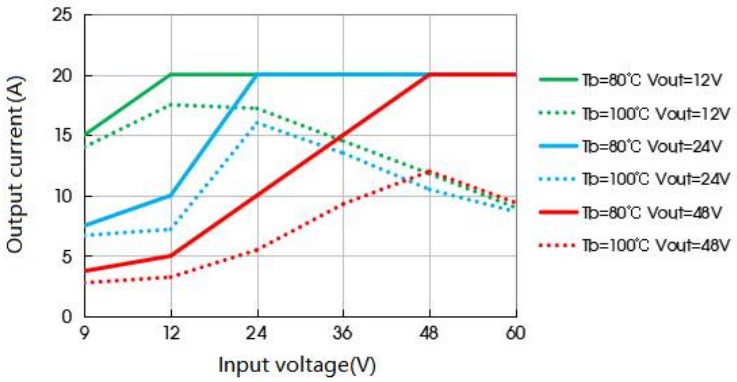
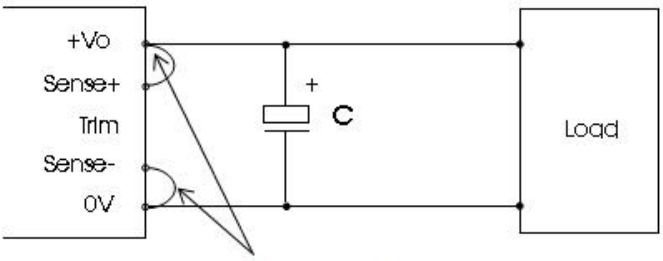


Figure 2

Remote Sense Application

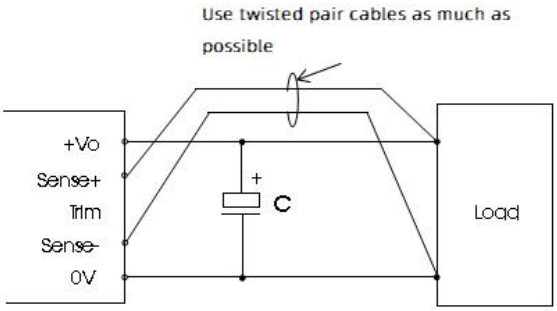
1、When remote compensation is not used



Wiring should be as short as possible

Notes:
① When remote compensation is not used, ensure that"+Vo"is short circuited to"Sense+"and"0V"is short circuited to"Sense-"
② The connection between"+Vo"and"Sense+","0V"and"Sense-"should be as short as possible and close to the terminal. Avoid forming a large loop area, as noise entering this loop may cause instability of the module.

2、When using remote compensation



Notes:
① When using remote compensation, the output voltage range should not exceed 0-60VDC;
② If the lead wire used for remote compensation is relatively long, it may cause unstable output voltage. If longer remote compensation leads must be used, please contact our technical personnel;
③ If using remote compensation, please use twisted pair or shielded wire and make the lead as short as possible;
④ Please use wide PCB leads or thick wires between the power module and the load, and keep the line voltage drop below 0.3V to ensure that the output voltage of the power module remains within the specified range;
⑤ The impedance of the lead may cause output voltage oscillation or significant ripple. Please conduct sufficient evaluation before use.

Design and Precautions for Output Voltage Vo Adjustment Using Vset Pin

The impedance between the control pin Vset and 0V can adjust the output voltage within the range of 0-60Vdc. The output voltage can be adjusted by either adjusting the resistor or driving it with an external power source。

1、When the Vset pin is connected to an external power source for adjustment:

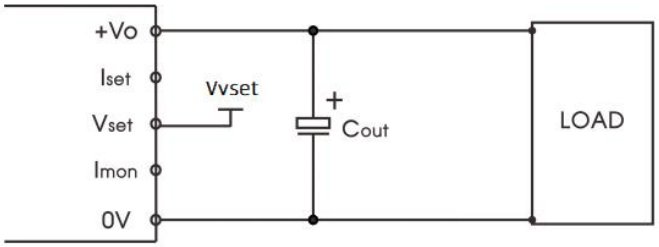


Fig. 3

External power drive, wiring method as shown in Figure 3, Vset voltage calculation formula:

$$Vvset(Vset) = \left[2.366 - 2.316\frac{Vset}{V\,\max}\right](V)$$

Notes:

1. Vset is the expected output voltage, with an adjustable range of 0-60V
2. Vmax is 60V
3. External power supply range: 0V-2.5V
4. The Vset pin cannot be suspended

2、When the Vset pin is connected to an external resistor for adjustment:

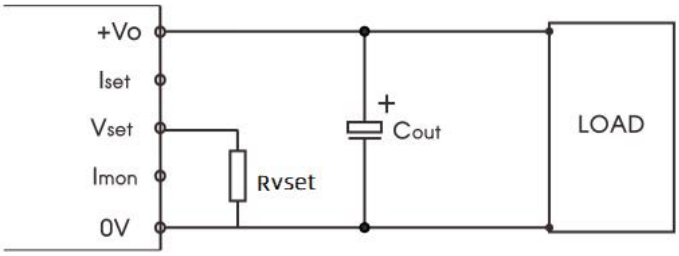


Figure 4

External adjustment resistor R (Vset), wiring method shown in Figure 4, R (Vset) resistance calculation formula:

$$Rvset(Vset)=\left[\left(\frac{11830\times V\max}{Vset+0.058\times V\max}\right)-10912\right](\Omega)$$

Notes:

1. Vo is the desired output voltage, with an adjustable range of 0-60V
2. R (Vset) is measured in K Ω
3. Vmax is 60V

Vo/V	3.3	5	12	15	20	24	36	48	60
RVset/KΩ	93.78	72.79	34.94	27.50	19.32	14.92	7.07	2.88	0.27

Design and Precautions for Output Voltage Io Adjustment Using Iset Pin

The module contains an output overcurrent protection circuit, which controls the impedance between pin Iset and 0V to limit the output current within the range of 0-10A. The output current can be adjusted by adjusting the resistor or driving it with an external power supply. When the Iset pin is suspended, its voltage is 2.5V, and the overcurrent point defaults to 110% * 10A.

1、When adjusting the Iset pin with external voltage Vf:

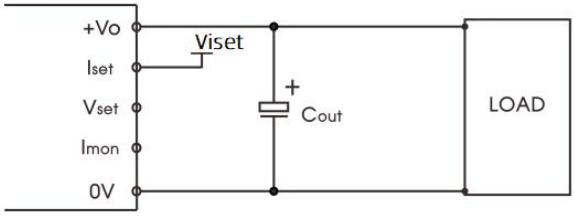


Figure 5

Calculation formula for output current regulation:

$$Viset(Iset)=(0.0953+2.085*Iset/\mathrm{Im}ax)\ (\mathrm{V})$$

Notes:

1.The output current regulation range of Iset is 0-10A

2.Imax is 10A

3.External voltage range: 0V-2.5V, Vf voltage is relative to the output pin 0V

2、When the Iset pin is connected to an external resistor for adjustment:

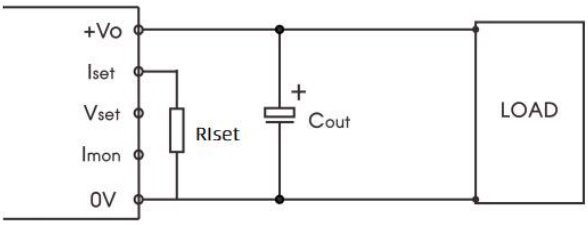


Figure 6

Calculation formula for output current regulation:

$$RIset(Iset)=\left[\left(\frac{0.0469\,\mathrm{Im}ax+Iset}{1.153\,\mathrm{Im}ax-Iset}\right)*10200-10\right]\ (\Omega)$$

Notes:

1.The output current regulation range of Iset is 0-10A

2. Imax is 10A

Io/A	1	2	4	6	8	10
Riset/KΩ	1.41	2.63	6.04	11.92	24.46	69.78

Output current detection Imon curve and precautions

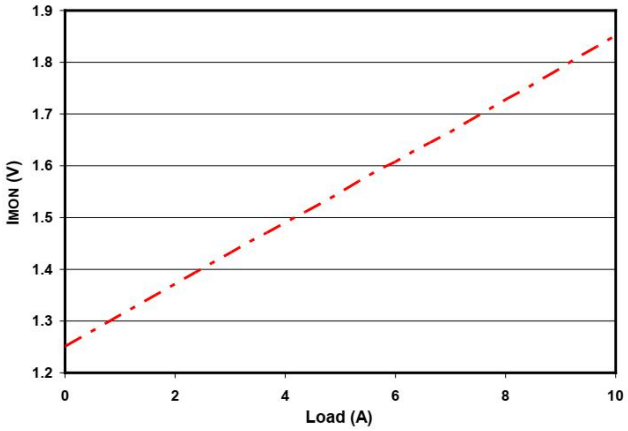


Figure 7

The calculation formula for the output current detection Imon pin voltage and output current is as follows:

$$V_{Imon} = 0.06Io + 1.25$$

Notes:
① VImon is the voltage at the Imon pin, which is relative to the output pin 0V and measured in volts;
② Io is the output current, measured in A.

Application Design Reference

1. Application circuit

(1) When testing and applying the product, please follow the recommended testing circuit in Figure 8; Ensure at least one external electrolytic capacitor Cin (≥ 1000 μ F) is connected to suppress potential surge voltages at the input terminal;

(2) If a circuit with high transient energy is connected in parallel at the input end of the product (such as a parallel motor drive circuit), it may cause the input voltage of the product to be pulled low. At this time, attention should be paid to the fluctuation of the input voltage of the product. It is recommended to increase the capacitance of the electrolytic capacitor Cin at the input end appropriately to ensure the stability of the input voltage and avoid the situation where the input voltage is lower than the undervoltage protection point and the product is repeatedly started;

(3) If the output terminal of the product is an inductive load (such as a relay or motor), it is recommended to increase the output capacitance Cout and add TVS tubes to filter out voltage spikes;

(4) To further reduce input and output ripple, the external capacitors Cin and Cout can be appropriately increased or external capacitors with lower series equivalent impedance can be selected.

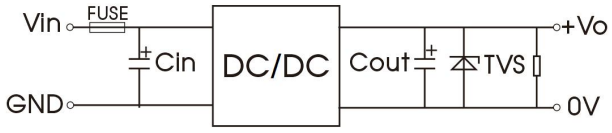


Figure 8

Fuse (optional)	Cin*	Cout	TVS tube (optional)
30A，Slow circuit breaker	1000μF/100V	100μF/100V	Select based on output voltage

Note: During the use of external capacitors, attention should be paid to the ambient temperature of the product. In low temperature conditions, the capacitance value of the electrolytic capacitor should be increased to at least twice the original parameter.

2. EMC Solution - Recommended Circuit

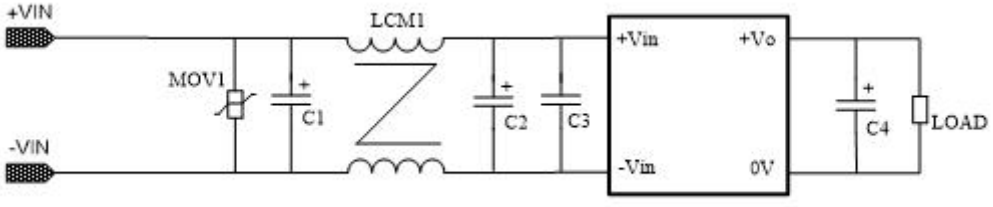


Figure 9

MOV1	101K（SFV10D101K）
C1、C2	1000uF/100V
C4	100uF/100V
C3	4.7uF/100V
LCM1	90uH， Recommend using our common mode inductor FL2D-A0-900

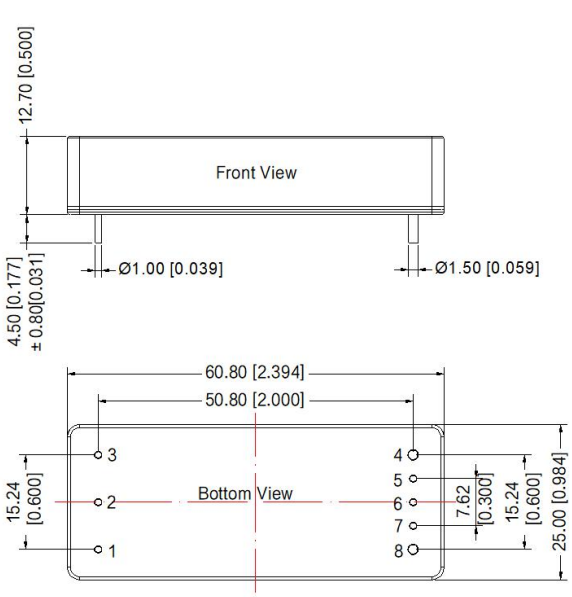
3. The product does not support the use of parallel output to increase power

4. Recommended solution for thermal testing

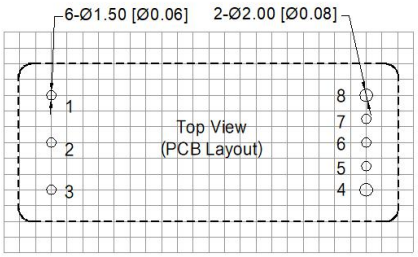
During the application process, the thermal design of the product can be evaluated by combining the temperature derating curve of the product; Alternatively, the stable working range of the product can be determined by the temperature at point A in the following test chart. When the temperature at point A is below 100 ℃, it is the stable working range of the product

5. For additional information please refer to DC-DC converter application notes on www.mornsun-power.com

KUB6060EB-10ACG Dimensions and Recommended Layout



THIRD ANGLE PROJECTION

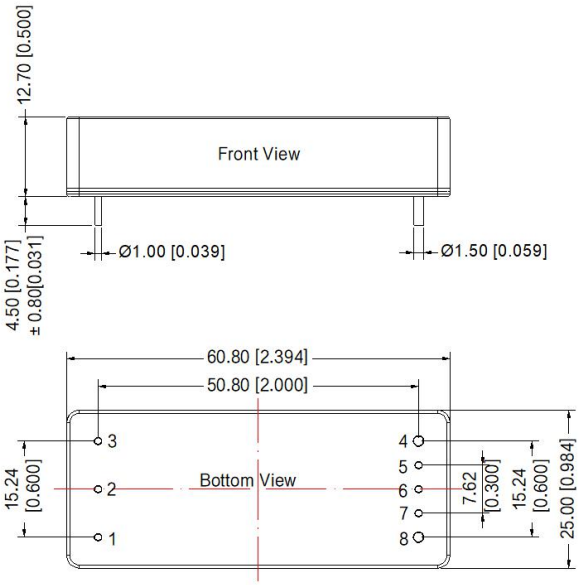


Note: Grid 2.54*2.54mm

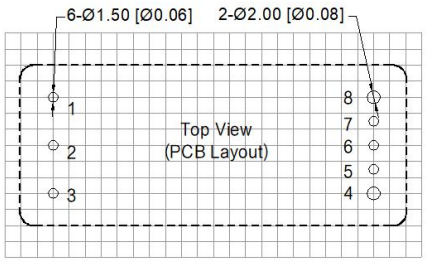
Note:
Unit: mm[inch]
Pin1,2,3,5,6,7 diameter: 1.00[0.039]
Pin4,8 diameter: 1.50[0.059]
Pin diameter tolerances: ± 0.10[± 0.004]
General tolerances: ± 0.50[± 0.020]

Pin-Out			
Pin	Mark	Pin	Mark
1	+Vin	5	Iset
2	Ctrl	6	Vset
3	-Vin	7	Imon
4	0V	8	+Vo

KUB6060EB-10ASG Dimensions and Recommended Layout



THIRD ANGLE PROJECTION

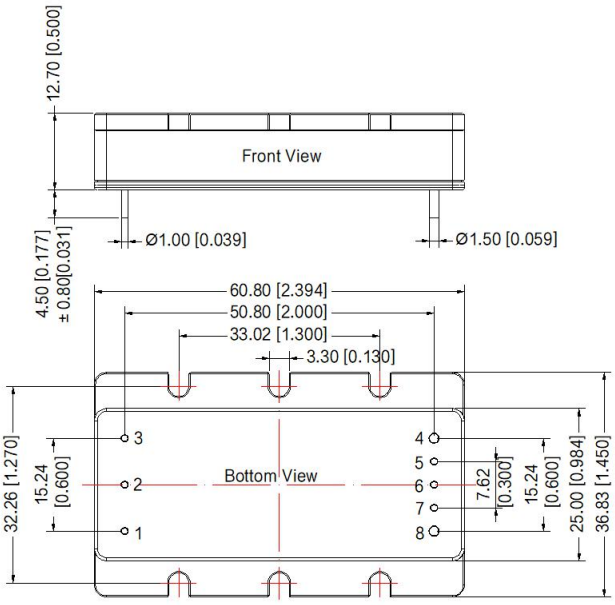


Note: Grid 2.54*2.54mm

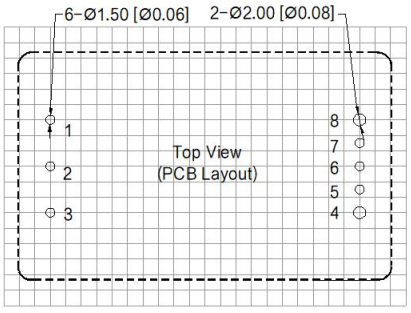
Pin-Out			
Pin	Mark	Pin	Mark
1	+Vin	5	Sense−
2	Ctrl	6	Vset
3	−Vin	7	Sense+
4	0V	8	+Vo

Note:
Unit: mm[inch]
Pin1,2,3,5,6,7 diameter: 1.00[0.039]
Pin4,8 diameter: 1.50[0.059]
Pin diameter tolerances: ± 0.10[± 0.004]
General tolerances: ± 0.50[± 0.020]

KUB6060EBF-10ACG Dimensions and Recommended Layout



THIRD ANGLE PROJECTION

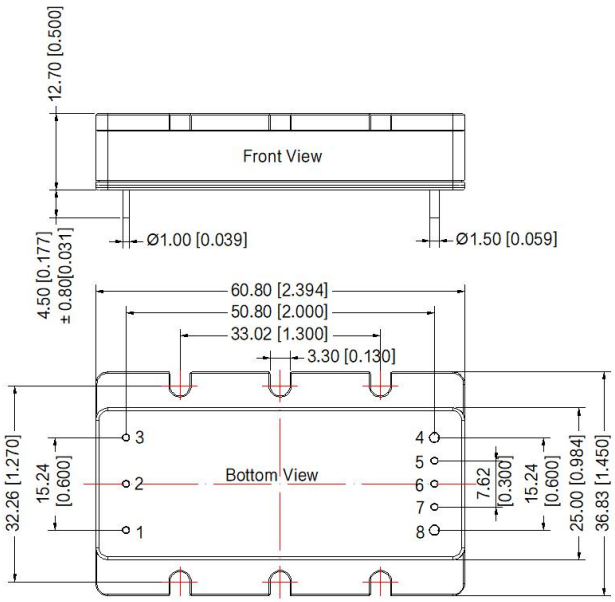


Note: Grid 2.54*2.54mm

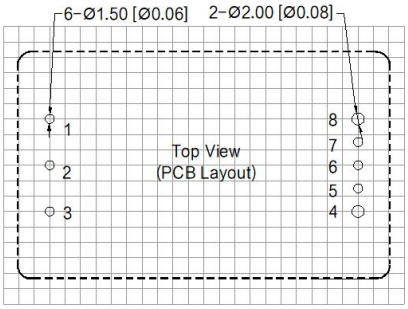
Pin-Out			
Pin	Mark	Pin	Mark
1	+Vin	5	Iset
2	Ctrl	6	Vset
3	−Vin	7	Imon
4	0V	8	+Vo

Note:
Unit: mm[inch]
Pin1,2,3,5,6,7 diameter: 1.00[0.039]
Pin4,8 diameter: 1.50[0.059]
Pin diameter tolerances: ± 0.10[± 0.004]
General tolerances: ± 0.50[± 0.020]

KUB6060EBF-10ASG Dimensions and Recommended Layout



THIRD ANGLE PROJECTION



Note: Grid 2.54*2.54mm

Pin-Out			
Pin	Mark	Pin	Mark
1	+Vin	5	Sense-
2	Ctrl	6	Vset
3	-Vin	7	Sense+
4	0V	8	+Vo

Note:
Unit: mm[inch]
Pin1,2,3,5,6,7 diameter: 1.00[0.039]
Pin4,8 diameter: 1.50[0.059]
Pin diameter tolerances: ± 0.10[± 0.004]
General tolerances: ± 0.50[± 0.020]

Notes:

1. For additional information on Product Packaging please refer to www.mornsun-power.com. Packaging bag number: 58010124;
2. The maximum capacitive load offered were tested at nominal input voltage and full load;
3. Unless otherwise specified, parameters in this datasheet were measured under the conditions of Ta=25℃, humidity<75%RH with nominal input voltage and rated output load;
4. All index testing methods in this datasheet are based on our company corporate standards;
5. We can provide product customization service, please contact our technicians directly for specific information;
6. Products are related to laws and regulations: see "Features" and "EMC";
7. Our products shall be classified according to ISO14001 and related environmental laws and regulations, and shall be handled by qualified units.

MORNSUN Guangzhou Science & Technology Co., Ltd.
Address: No. 8 Nanyun 4th Road, Huangpu District, Guangzhou, China
Tel: 86-20-38601850 Fax: 86-20-38601272 E-mail: info@mornsun.cn www.mornsun-power.com