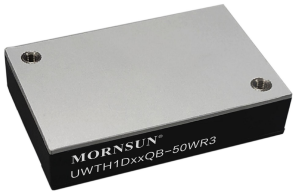
DC/DC Converter

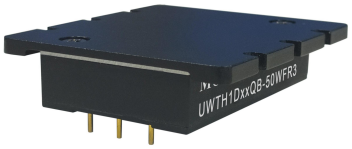
UWTH1D_QB-50W(H/F)R3 Series

MORNSUN®

50W isolated DC-DC converter

Ultra-wide input and regulated single output





Patent Protection RoHS

FEATURES

- Ultra-wide 12:1 input voltage range: 14 -160VDC
- High efficiency up to 90%
- Reinforced insulation, I/O isolation test voltage 3k VAC
- Operating ambient temperature range -40℃ to +105℃
- Input under-voltage protection, output over–voltage, over-current, short-circuit protection, over-temperature protection
- Industry standard 1/4-Brick package and pin-out
- Meets EN50155, AREMA and EN/UL/IEC62368 standards
- Meets EN45545 fire & smoke compliance

The UWTH1D_QB-50W(H/F)R3 series is a high-performance product specifically designed for a variety of railway applications. The output power can reach at 50W. It features wide input voltage of 14-160VDC, which is compatible with nominal input type of 24V, 48V, 72V, 96V and 110V. Meets EN50155 standard for voltage fluctuations. The reinforced high insulation 3000VAC/2100VAC ensures that the system can still be used safely in high altitude applications. The allowable operating temperature is up to 105° C. It integrates multiple protection functions to ensure the safety and high reliability of the system, with functions of remote control and compensation, output voltage adjustment, etc., which perfectly matches the requirements of line loss and special voltage in the application. It is widely used in vehicle-mounted switches, train control systems, traction control systems and associated equipment.

Selection Guide

Certification	Part No.①	Input Voltage (VDC)		Output		Full Load Efficiency③ (%)Min./Typ.	Capacitive Load (μF)Max.
		Nominal (Range)	Max.②	Voltage(VDC)	Current (mA) Max./Min.		
--	UWTH1D03QB-50W(H/F)R3	110 (14-160)	165	3.3	10000/0	85/87	20000
	UWTH1D05QB-50W(H/F)R3			5	10000/0	88/90	20000
	UWTH1D12QB-50W(H/F)R3			12	4166/0	87/89	3500
	UWTH1D15QB-50W(H/F)R3			15	3333/0	87/89	2200
	UWTH1D24QB-50W(H/F)R3			24	2083/0	88/90	1000
	UWTH1D48QB-50W(H/F)R3			48	1041/0	87/89	240
	UWTH1D54QB-50W(H/F)R3			54	926/0	87/89	200

Note:
①Use "F/H" suffix for heat sink mounting. We recommend to choose modules with a heat sink for enhanced heat dissipation and applications with extreme temperature requirements;
②Exceeding the maximum input voltage may cause permanent damage;
③Efficiency is tested at nominal voltage and full load at +25℃ ambient;
④When the input voltage is 14V~16.8V or 160V-200V, the working time should be <0.1S and <1s respectively.

Input Specifications

Item	Operating Conditions		Min.	Typ.	Max.	Unit
Input Current (full load)	24V input voltage	3.3V output	--	1636	1676	mA
		5V, 24V output	--	2422	2480	
		12V, 15V, 48V, 54V output	--	2450	2510	
	36V input voltage	3.3V output	--	1053	1078	
		5V, 24V output	--	1543	1578	
		12V, 15V, 48V, 54V output	--	1560	1596	
	48V input voltage	3.3V output	--	791	809	
		5V, 24V output	--	1158	1184	
		12V, 15V, 48V, 54V output	--	1171	1198	

Input Current (full load)	72V input voltage	3.3V output	--	526	539	mA
		5V, 24V output	--	771	789	
		12V, 15V, 48V, 54V output	--	780	798	
	96V input voltage	3.3V output	--	395	404	
		5V, 24V output	--	578	591	
		12V, 15V, 48V, 54V output	--	585	598	
	110V input voltage	3.3V output	--	348	357	
		5V, 24V output	--	516	528	
		12V, 15V, 48V, 54V output	--	522	534	
Reflected Ripple Current			--	100	--	
Surge Voltage (1sec. max.)			-0.7	--	200	VDC
Start-up Voltage			--	--	14	
Input Under-voltage Protection			10	--	--	
Start-up Time			--	--	100	ms
No-load Input Power	Ctrl pin open or pulled high DC-DC ON (14V-160V Input)		--	1.2	2.2	W
Input Power During Remote OFF	Ctrl pin pulled low to -Vin DC-DC OFF (14V-160V Input)		--	1.0	1.7	
Ctrl①	Module on		Ctrl pin open or pulled high (3.5-12VDC)			
	Module off		Ctrl pin pulled low to -Vin (0-1.2VDC)			

Note: ①The Ctrl pin voltage is referenced to input -Vin.

Output Specifications

Item	Operating Conditions		Min.	Typ.	Max.	Unit
Voltage Accuracy	Nominal input voltage, 10%-100% load		--	--	±2	%
Linear Regulation	Input voltage variation from low to high at full load		--	--	±0.5	
Load Regulation	Nominal input voltage, 10%-100% load		--	±0.5	±1	
Transient Recovery Time	25% load step change @25℃		--	300	500	μs
Transient Response Deviation		3.3VDC, 5VDC output	--	±4	±8	%
		Others	--	±3	±5	%
Temperature Coefficient	Nominal input voltage, full load		--	--	±0.03	%/℃
Ripple & Noise①	20MHz bandwidth, 5%-100%load	3.3V, 5V, 12V, 15V output	--	150	200	mVp-p
		Others	--	200	300	
Trim			90	--	110	%Vo
Sense			--	--	105	
Over-temperature Protection	Product surface max. temperature		--	105	115	℃
Over-voltage Protection	Input voltage range (14V-160V)		110	--	160	%Vo
Over-current Protection			110	--	260	%Io
Short-circuit Protection			Hiccup, continuous, self-recovery			

Note: ①For ripple and noise measuring method, please refer to Fig. 3 .

General Specifications

Item	Operating Conditions		Min.	Typ.	Max.	Unit
Isolation	Input-output (Reinforced insulation)	Electric Strength Test for 1 minute with a leakage current of 5mA max	3000	--	--	VAC
	Input-case		2100	--	--	
	Output-case		2100	--	--	
Insulation Resistance	Input-output resistance at 500VDC		1000	--	--	MΩ
Isolation Capacitance	Input-output capacitance at 100kHz/0.1V		--	1100	--	pF
Operating Temperature			-40	--	105	℃

Storage Temperature		-55	--	125	
Pin Soldering Resistance Temperature	Soldering spot is 1.5mm away from case for 10 seconds	--	--	300	
Storage Humidity	Non-condensing	5	--	95	%RH
Switching Frequency	PWM mode	--	170	--	kHz
MTBF	IEC 61709 @25℃	1000	--	--	k hours
Cooling Test		EN60068-2-1			
Dry Heat		EN60068-2-2			
Damp Heat		EN60068-2-30			
Shock and Vibration Test		IEC/EN61373 Class B			
Pollution Level		PD 3			
Fire & Smoke Compliance		EN45545-2, HL3			
Salt Mist Test		EN60068-2-11, Ka			
Cyclic Damp Heat Test		EN60068-2, Db variant 2			
Altitude①		5000m			
Low Temperature Start-up and Storage Test		EN60068-1, Ad and Ab			

Note: ①When the altitude is above 2000m, the product surface max. temperature must be below 105℃.

Mechanical Specifications

Case Material	Aluminum alloy case; Black plastic bottom, flame-retardant and heat-resistant (UL94 V-0)	
Dimension	Without heat sink	57.90 x 36.80 x 12.70mm
	With H heat sink	57.90 x 36.80 x 25.40mm
	With F heat sink	62.00 x 56.00 x 14.50mm
Weight	Without heat sink	75g (Typ.)
	With H heat sink	106g (Typ.)
	With F heat sink	105g (Typ.)
Cooling Method	Conduction cooling or forced air cooling Free air convection cooling with addtional heat sink	

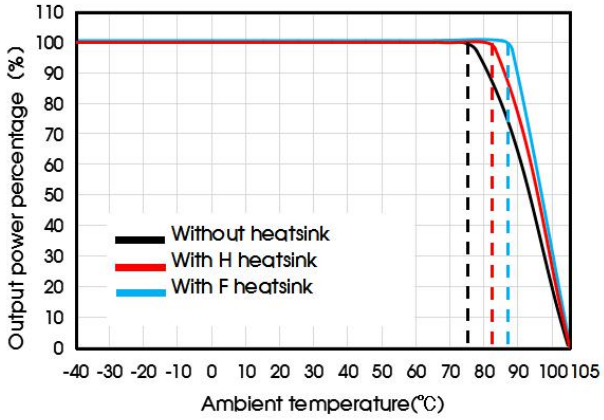
Electromagnetic Compatibility (EMC) (EN50155: EN50121-3-2)

Emissions	CE	EN50121-3-2	150kHz-500kHz 99dBuV (see Fig. 7 for recommended circuit) 500kHz-30MHz 93dBuV (see Fig. 7 for recommended circuit)	
	RE	EN55011	30MHz-230MHz 40dBuV/m at 10m (see Fig. 7 for recommended circuit) 230MHz-1GHz 47dBuV/m at 10m (see Fig. 7 for recommended circuit) 1GMHz-6GHz 47dBuV/m at 10m (see Fig. 7 for recommended circuit)	
Immunity	ESD	EN61000-4-2	Contact ±6kV, Air ±8kV	perf. Criteria A
	RS	EN61000-4-3	80 – 800MHz 20V/m 800 – 1000MHz 20V/m 1400 – 2000MHz 10V/m 2000 – 2700MHz 5V/m 5100 – 6000MHz 3V/m	perf. Criteria A
	EFT	EN61000-4-4	±2kV 5/50ns 5kHz (see Fig. 6, Fig. 7 for recommended circuit)	perf. Criteria A
	Surge	EN61000-4-5	line to line ±1kV (42Ω, 0.5μF) line to ground ±2kV (42Ω, 0.5μF) (see Fig. 6, Fig. 7 for recommended circuit) line to line ±1kV (2Ω, 18μF) line to ground ±2kV (12Ω, 9μF) (see Fig. 6, Fig. 7 for recommended circuit) line to line ±2kV (2Ω, 18μF) line to ground ±2kV ((2Ω, 18μF) (see Fig. 6, Fig. 7 for recommended circuit)	perf. Criteria A
	CS	EN61000-4-6	0.15MHz-80MHz 10V r.m.s	perf. Criteria A

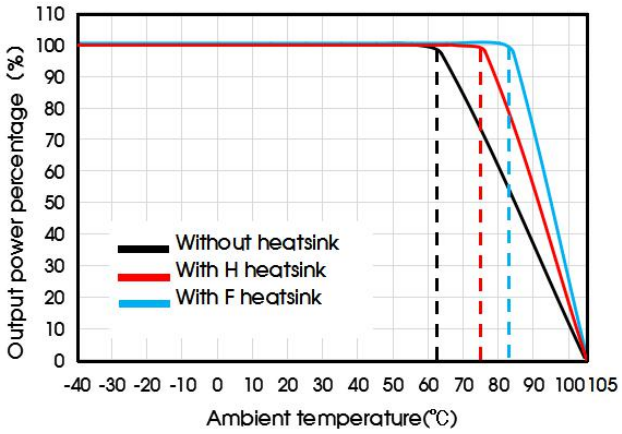
Electromagnetic Compatibility (EMC) (AREMA)

Emissions	CE	CISPR16-2-1	150kHz-500kHz	79dBuV	CLASS A (see Fig. 7 for recommended circuit) CLASS B (see Fig. 6 for recommended circuit)
		CISPR16-1-2	500kHz-30MHz	73dBuV	CLASS A (see Fig. 7 for recommended circuit) CLASS B (see Fig. 6 for recommended circuit)
	RE	CISPR16-2-3	30MHz-230MHz	40dBuV/m at 10m	CLASS A (see Fig. 7 for recommended circuit) CLASS B (see Fig. 6 for recommended circuit)
			230MHz-1GHz	47dBuV/m at 10m	CLASS A (see Fig. 7 for recommended circuit) CLASS B (see Fig. 6 for recommended circuit)
Immunity	ESD	IEC61000-4-2	Contact ±6kV, Air ±8kV		perf. Criteria A
	RS	IEC61000-4-3	80 – 1000MHz 10V/m 160 – 165MHz 20V/m 450 – 470MHz 20V/m 800 – 960MHz 20V/m 1400 – 2000MHz 20V/m 2100 – 2500MHz 5V/m		perf. Criteria A
	EFT	IEC61000-4-4	±2kV 5/50ns 5kHz (see Fig. 6, Fig. 7 for recommended circuit)		perf. Criteria A
	Surge	IEC61000-4-5	line to line ±1kV (42Ω, 0.5μF) line to ground ±2kV (42Ω, 0.5μF) (see Fig. 6, Fig. 7 for recommended circuit) line to line ±1kV (2Ω, 18μF) line to ground ±2kV (12Ω, 9μF) (see Fig. 6, Fig. 7 for recommended circuit) line to line ±2kV (2Ω, 18μF) line to ground ±2kV (2Ω, 18μF) (see Fig. 6, Fig. 7 for recommended circuit)		perf. Criteria A
	CS	IEC61000-4-6	0.15MHz-80MHz	10V r.m.s	perf. Criteria A
	MS	IEC61000-4-8	60Hz 100A/m (see Fig. 6, Fig. 7 for recommended circuit) 60Hz 300A/m (see Fig. 6, Fig. 7 for recommended circuit)		perf. Criteria A

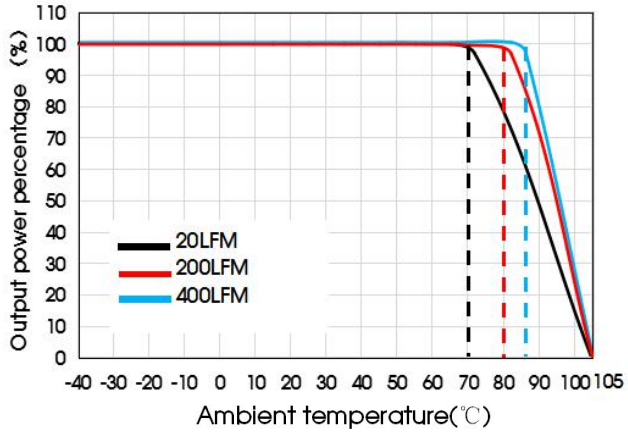
Typical Performance Curves

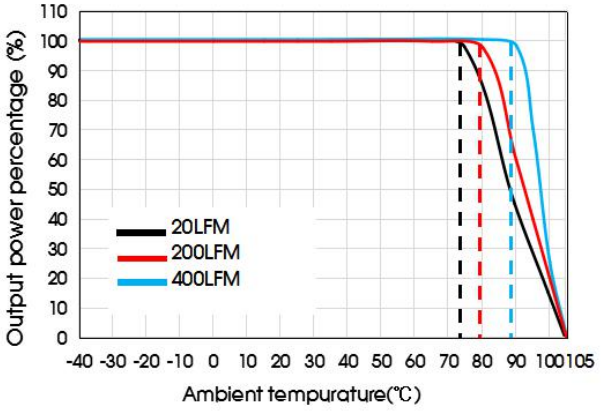


UWTH1D12QB-50W(H/F)R3 Temperature derating curve
(Vin=48V, 20LFM)

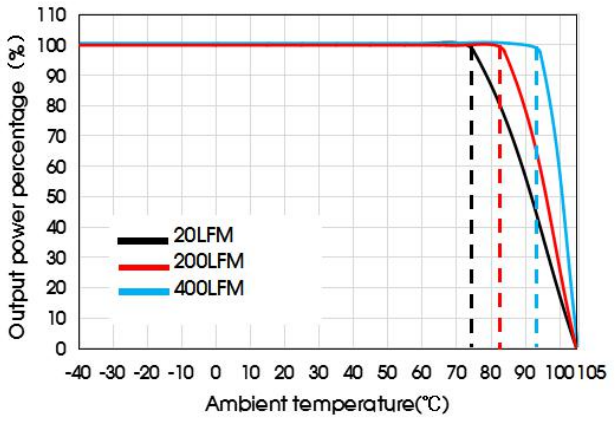


UWTH1D12QB-50W(H/F)R3 Temperature derating curve
(Vin=110V, 20LFM)

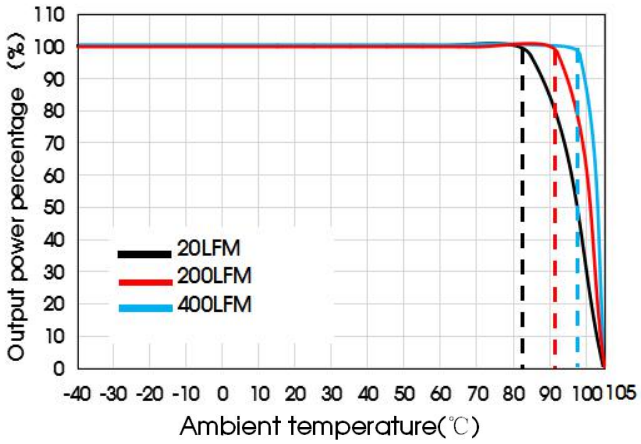




UWTH1D12QB-50WR3 Temperature derating curve
(Vin=48V, without heatsink)

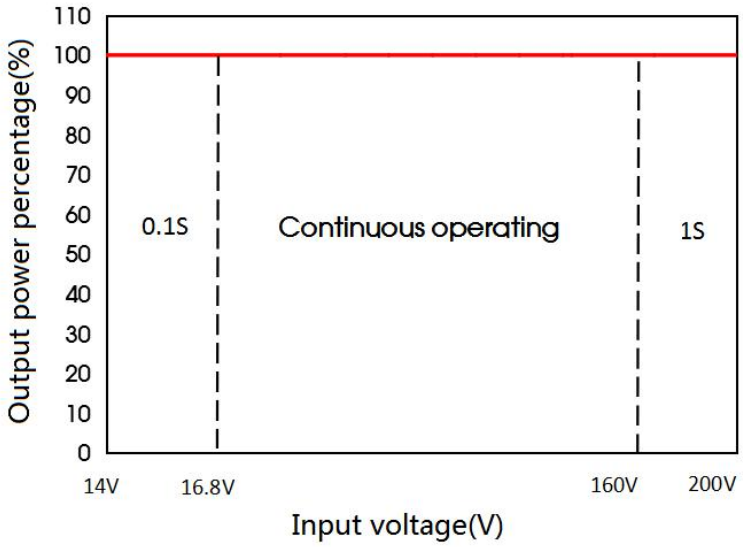


UWTH1D03QB-50WR3 Temperature derating curve
(Vin=48V, without heatsink)

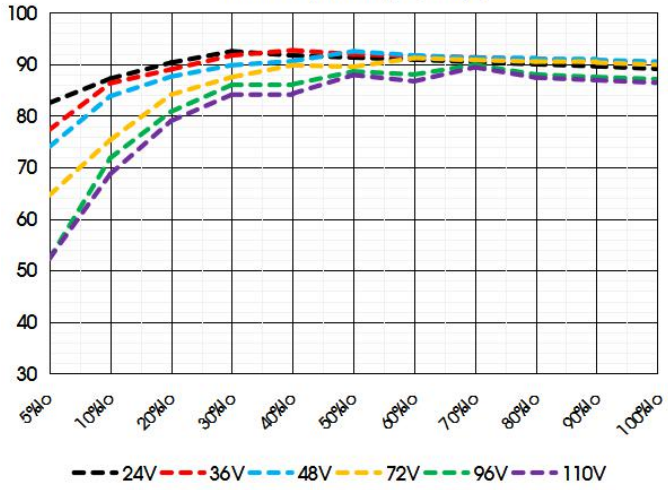


UWTH1D05QB-50WR3、UWTH1D12QB-50WR3、UWTH1D15QB-50WR3
Temperature derating curve(Vin=48V, without heatsink)

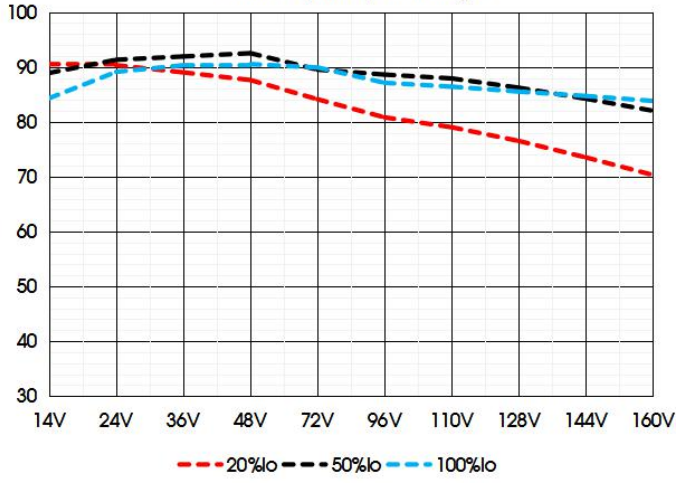
UWTH1D48QB-50WR3, UWTH1D54QB-50WR3
Temperature derating curve(Vin=48V, without heatsink)



Efficiency vs. Output Load



Efficiency vs. Input Voltage



Remote Sense Application

1. Remote Sense Connection if not used

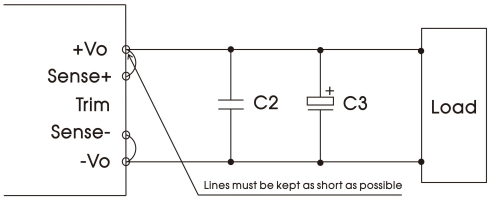


Fig.1

Notes：

(1) If the sense function is not used for remote regulation the user must connect the +Sense to +Vo and -Sense to 0V at the DC-DC converter pins and will compensate for voltage drop across pins only.

(2) The connections between Sense lines and their respective power lines must be kept as short as possible, otherwise they may be picking up noise, interference and/or causing unstable operation of the power module.

2. Remote Sense Connection used for Compensation

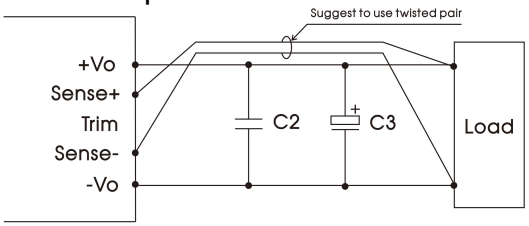


Fig.2

Notes:

(1) Using remote sense with long wires may cause unstable output, please contact technical support if long wires must be used.

(2) PCB-tracks or cables/wires for Remote Sense must be kept as short as possible. Twisted pair or shielded wairs are suggested for remote compensation and must be kept as short as possible.

(3) We recommend using adequate cross section for PCB-track layout and/or cables to connect the power supply module to the load in order to keep the voltage drop below 0.3V and to make sure the power supply's output voltage remains within the specified range.

(4) Note that large wire impedance may cause oscillation of the output voltage and/or increased ripple. Consult technical support or factory for further advice of sense operation.

Design Reference

1. Ripple & noise

All the DC-DC converters of this series are tested before delivery using the recommended circuit shown in Fig. 3.

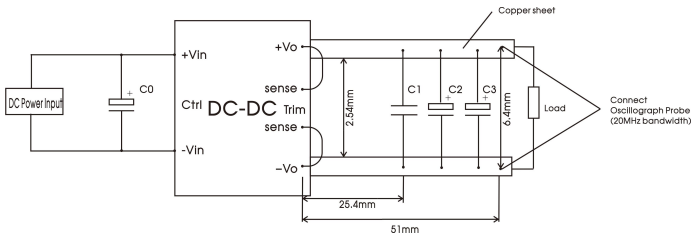


Fig.3

Capacitors value / Output voltage	C0(μF)	C1(μF)	C2(μF)	C3(μF)
3.3VDC	100μF /250V	1μF/6.3V	10μF/35V	330uF/ 35V
5VDC		1μF/6.3V		
12VDC		1μF/16V		
15VDC		1μF/25V		
24VDC		1μF/50V		
48VDC		1μF/100V	10μF/63V	330uF/ 63V
54VDC		1μF/100V		

2. Typical application

We recommended using Mornsun's EMC circuit, otherwise please ensure that at least a 100μF electrolytic capacitors is connected at the input in order to ensure adequate voltage surge suppression and protection.

Input and/or output ripple can be further reduced by appropriately increasing the input & output capacitor values Cin and Cout and/or by selecting capacitors with a low ESR (equivalent series resistance). Also make sure that the capacitance is not exceeding the specified max. capacitive load value of the product.

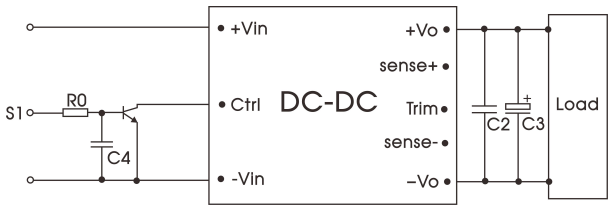
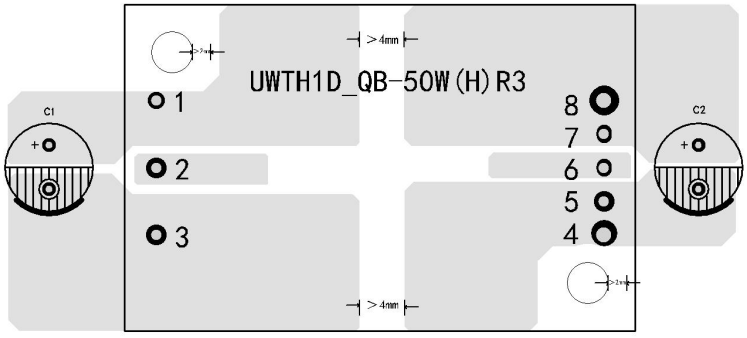


Fig.4

Capacitors value / Output voltage	C2(μF)	C1(μF)
3.3V, 5V, 12V, 15, 24V	330uF/35V	100uF/250V
48V, 54V	330uF/63V	



Product recommended PCB layout

3. EMC compliance circuit

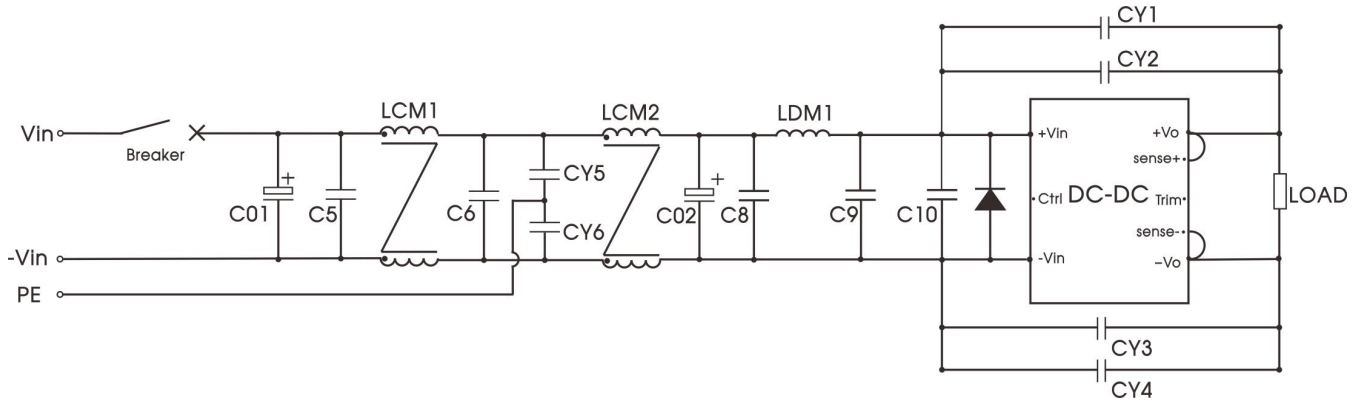


Fig.6

Components	Value	Recommended Component
Breaker	10A	10A, slow fusing
C01, C02	100uF	Voltage≥250V
CY5, CY6	1000pF/400VAC	Y1 safety capacitor
C5, C6, C8, C9, C10	2.2uF	Voltage≥250V
LDM1	2.2uH	Shielded inductance
LCM1	1.45mH	FL2D-30-222-DT
LCM2	1.0mH	FL2D-30-102
CY1, CY2, CY3, CY4	2200pF/400VAC	Y1 safety capacitor
D1	20A/250V	Schottky Diode

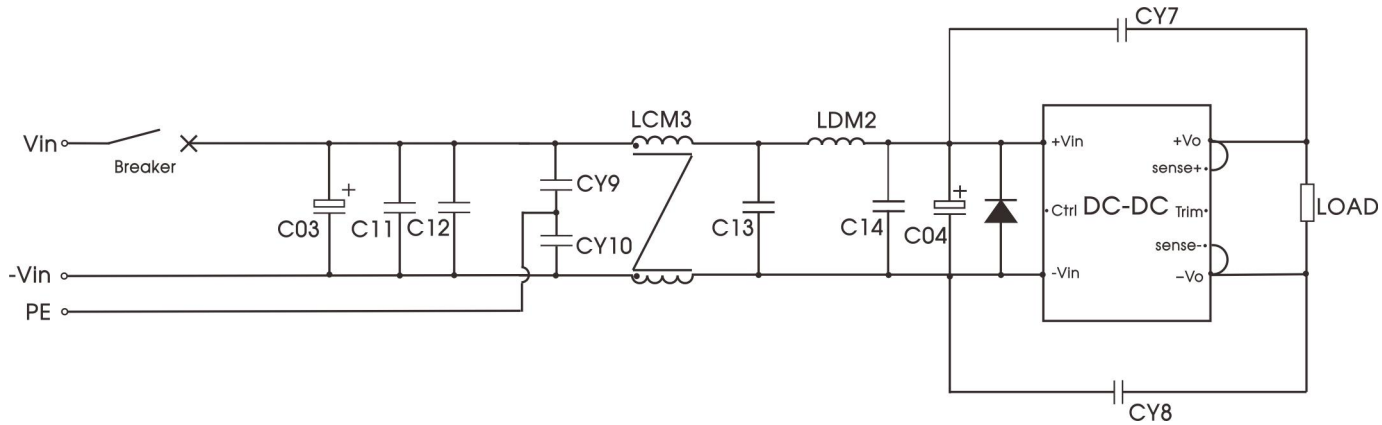


Fig.7

Components	Value	Recommended Component
C03	27uF	Voltage≥250V
C11, C12, C13, C14	2.2uF	Voltage≥250V
LDM2	4.7uH	Shielded inductance
LCM3	1.45mH	FL2D-30-222-DT
CY7, CY8, CY9, CY10	1000 pF /400VAC	Y1 safety capacitor
D1	20A/250V	Schottky Diode

Surge Standards	Components	Value	Recommended Component
line to line ±1kV (42Ω, 0.5μF) line to ground ±2kV (42Ω, 0.5μF)	C04	100uF	Voltage≥250V
line to line ±1kV (2Ω, 18μF) Line to ground ±2kV (12Ω, 9μF)	C04	100uF	Voltage≥250V
line to line ±2kV (2Ω, 18μF) line to ground ±2kV (2Ω, 18μF)	C04	220uF	Voltage≥250V

4. Trim Function for Output Voltage Adjustment (open if unused)

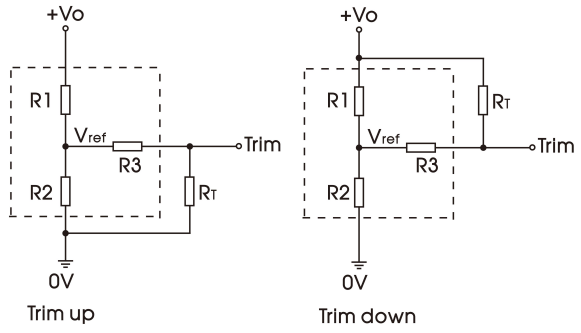


Fig.5
Trim resistor connection (dashed line shows internal resistor network)

Calculation formula of Trim resistance:

$$\text{Trim up}: R_T = \frac{a * R_2}{R_2 - a} - R3 \quad a = \frac{V_{ref} * R_1}{V_o - V_{ref}}$$

$$\text{Trim down}: R_T = \frac{b * R_1}{R_1 - b} - R_3 \quad b = \frac{(V_0 - V_{ref}) * R_2}{V_{ref}}$$

Note:
For R1, R2, R3 and Vref values refer to table 1.
RT = Trim Resistor value;
a = self-defined parameter;
Vo'= desired output voltage.

Table.1

Vo / resistance	3.3(VDC)	5(VDC)	12(VDC)	15(VDC)	24(VDC)	48(VDC)	54(VDC)
R1(kΩ)	4.83	8.8	11	14.62	24.87	68.72	77.76
R2(kΩ)	2.87	2.87	2.87	2.87	3.75	3.75	3.75
R3(kΩ)	9.66	11	6.6	11	21	11	11
Vref(V)	1.24	1.24	2.5	2.5	2.5	2.5	2.5

Vout	Vout adjustable value(V)	RT(kΩ)
3.3	Up: 3.63	5.32
	Down: 2.97	13.75
5	Up: 5.5	12.7
	Down: 4.5	43.9
12	Up: 13.2	17.98
	Down: 10.8	64.7
15	Up: 16.5	17.81
	Down: 13.5	81.68
24	Up: 26.4	16.65
	Down: 21.6	175.5
48	Up: 52.8	27.4
	Down: 43.2	532
54	Up: 59.4	27.32
	Down: 48.6	625

Practical Example trim up +10% for 12V output:

$$a = \frac{2.5*11}{13.2-2.5} = 2.57$$

$$R_T = \frac{2.57*2.87}{2.87-2.57} - 6.6 = 17.98K\Omega$$

R_T according to equation≈18kΩ

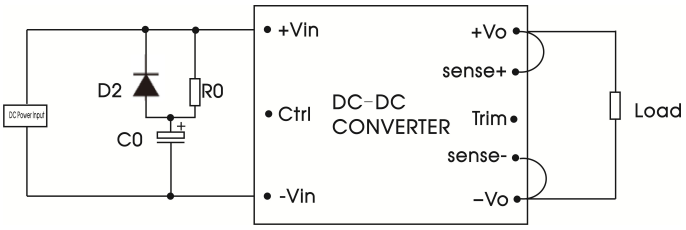
Practical Example trim up -10% for 12V output:

$$b = \frac{(10.8-2.5)*2.87}{2.5} = 9.53$$

$$R_T = \frac{9.53*11}{11-9.53} - 6.6 = 64.7K\Omega$$

R_T according to equation≈65kΩ

5. Hold-up time setup capacitor



Calculation formula of hold-up time setup capacitor :

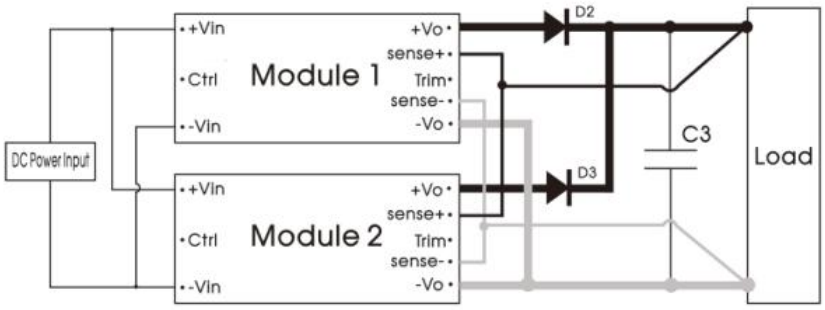
$$C_0 = \frac{2P_O\Delta t}{(V_{input}^2 - V_{shutdown}^2)\bullet\eta} \times 10^3$$

Note:
PO(W): Output power;
η : efficiency;
△t(ms): Hold-up time.

For the hold-up time of 10ms and 30ms, please refer to table blow:

Vin (V)		24	36	48	72	96	110
Po (W)		50	50	50	50	50	50
Shutdown Voltage (V)		14	14	14	14	14	14
D2		10A/250V					
R0		200Ω/10W					
C0 (uF)	△t: 10ms	4000	1500	670	270	150	120
	△t: 30ms	12000	4500	2000	810	450	360

6. Application circuits in multiple module parallel redundancy design



Note:

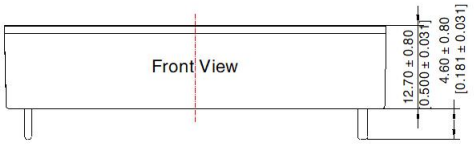
1、The function of capacitor C3 is filtering, and the value is 330uF. It is used for margin design and cannot be used to increase power;

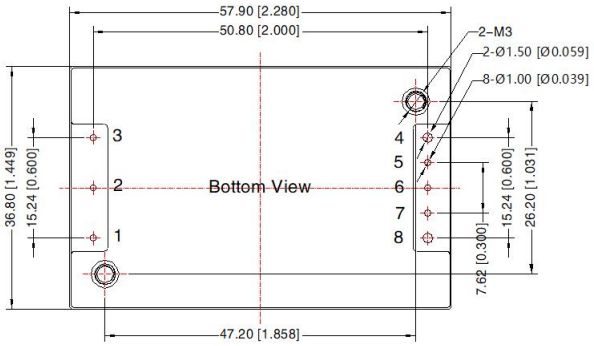
2、The diodes D2 and D3 are used to protect the power module. In actual use, the user can choose the parameters of the diode or MOSFET according to the output current;

3、Because the output impedance of the two modules is different, the output power of each module cannot be guaranteed to be equal; Pload = P1 + P2 <Pmax (50W).

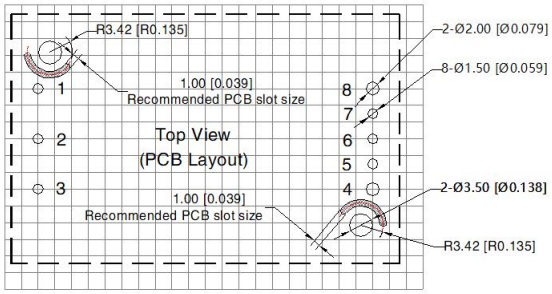
7. For additional information please refer to DC-DC converter application notes on www.mornsun-power.com

Dimensions (without heatsink)



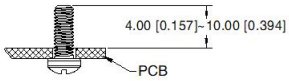


THIRD ANGLE PROJECTION



Note: Grid 2.54*2.54mm

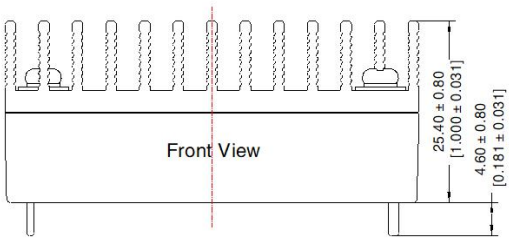
Recommended screw length

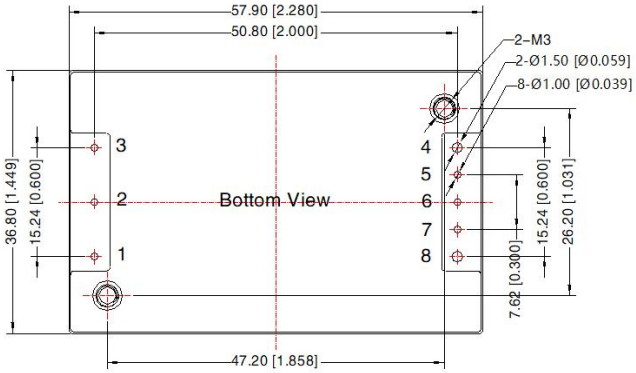


Pin–Out			
Pin	Mark	Pin	Mark
1	+Vin	5	Sense–
2	Ctrl	6	Trim
3	–Vin	7	Sense+
4	–Vo	8	+Vo

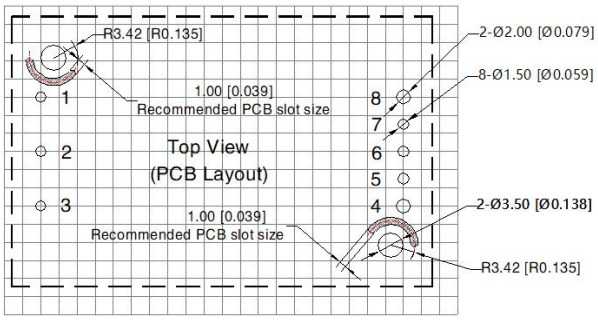
Note:
Unit: mm[inch]
Pin1, 2, 3, 5, 6, 7's diameter: 1.00 [0.039]
Pin4, 8's diameter: 1.50 [0.059]
Pin diameter tolerances: ± 0.10 [± 0.004]
General tolerances: ± 0.50 [± 0.020]
Mounting hole screwing torque: Max 0.4 N · m

Dimensions (With H heatsink)



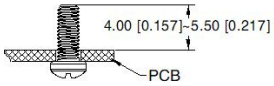


THIRD ANGLE PROJECTION



Note: Grid 2.54*2.54mm

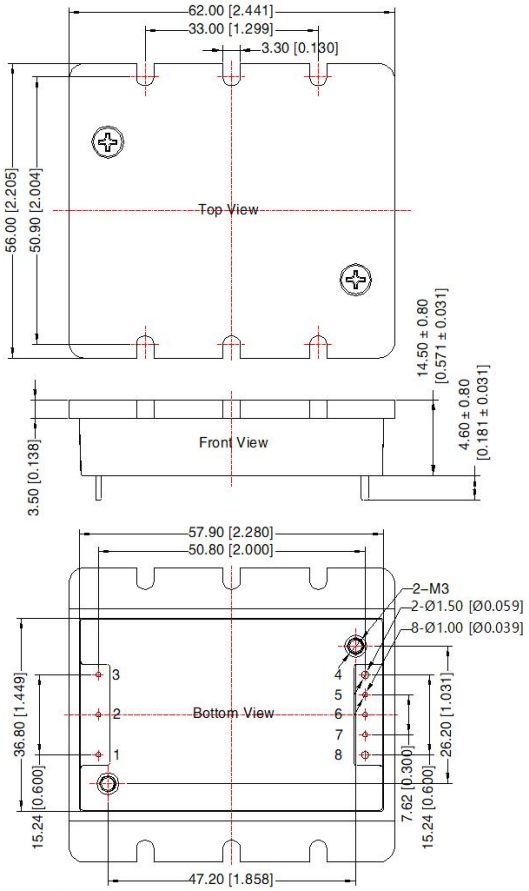
Recommended screw length



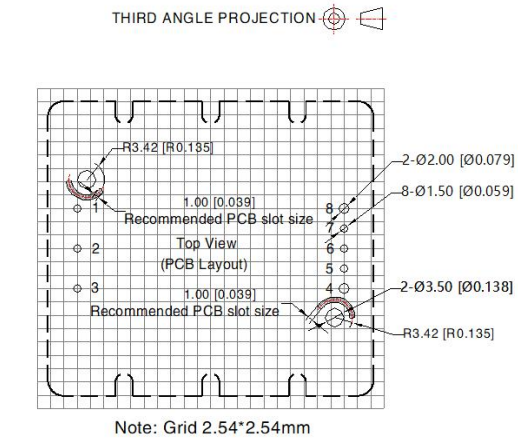
Pin–Out			
Pin	Mark	Pin	Mark
1	+Vin	5	Sense–
2	Ctrl	6	Trim
3	–Vin	7	Sense+
4	–Vo	8	+Vo

Note:
Unit: mm[inch]
Pin1, 2, 3, 5, 6, 7's diameter: 1.00 [0.039]
Pin4, 8's diameter: 1.50 [0.059]
Pin diameter tolerances: ± 0.10 [± 0.004]
General tolerances: ± 0.50 [± 0.020]
Mounting hole screwing torque: Max 0.4 N・m

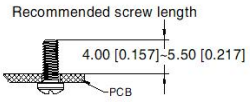
Dimensions (With F heatsink)



Note:
Unit: mm[inch]
Pin1, 2, 3, 5, 6, 7's diameter: 1.00 [0.039]
Pin4, 8's diameter: 1.50 [0.059]
Pin diameter tolerances: ± 0.10 [± 0.004]
General tolerances: ± 0.50 [± 0.020]
Mounting hole screwing torque: Max 0.4 N • m



Note: Grid 2.54*2.54mm



Pin–Out			
Pin	Mark	Pin	Mark
1	+Vin	5	Sense–
2	Ctrl	6	Trim
3	–Vin	7	Sense+
4	–Vo	8	+Vo

Note:
1. For additional information on Product Packaging please refer to www.mornsun-power.com. Packaging bag number: 58010113(UWTH1DxxQB-50WR3); 58220017(UWTH1DxxQB-50WHR3); 58200069(UWTH1DxxQB-50WFR3);
2. The maximum capacitive load offered were tested at input voltage range and full load;
3. Unless otherwise specified, data in this datasheet should be tested under the conditions of Ta=25℃, humidity<75%RH with nominal input voltage and rated load;
4. All index testing methods in this datasheet are based on our company corporate standards;
5. Product customization is available, please contact below email directly for specific needs;
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.

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