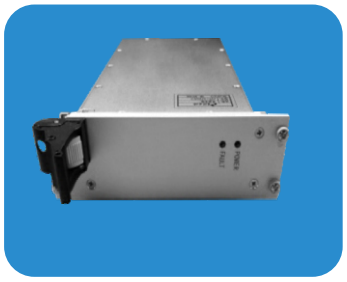
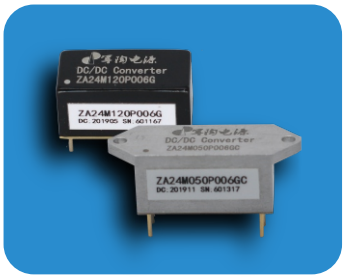
Dr.Power Technologies

Dr. Power
High Reliability Power Solutions





AC-DC & DC-DC Power Conversion Solutions

2020 Product Catalog

Dr.Power Technologies is a China based leader in design and manufacture of high reliable power supply solutions to rugged military and industrial market including aerospace, navy, air force, army, marines, etc.

Dr.Power is one of the most successful power supply companies in China. Since its inception, Dr.Power has been focusing on the power supply for tactical, military and harsh industrial environment. And for over 10 years, Dr.Power has provided thousands of power supply solutions for end customers on avionics, military aircraft, commercial aircraft, radar arrays , electronic warfare , missiles, UAVs, emergency systems, surface ships, submarines. Products covering from 3-watt Micro-power converters to several kilowatt bulk supplies, include DC-DC standard converters, CPCI/VPX/VNX power supplies, and system level custom design AC-DC & DC-DC power supplies.

Headquartered in Shanghai, China, Dr.Power has four engineering design centers in Shanghai, Beijing, Xi'an and Chengdu, two manufacturing facilities in Shanghai （6240 square meters）and Xi'an（2200 square meters）, and more sales and support offices. Both the facilities are ISO9001:2008，ISO14001 and GJB9001B-2009 certified.

More than 150 top power supply experts from Dr. Power will support the sales representative to provide power solutions that best fit to your request.

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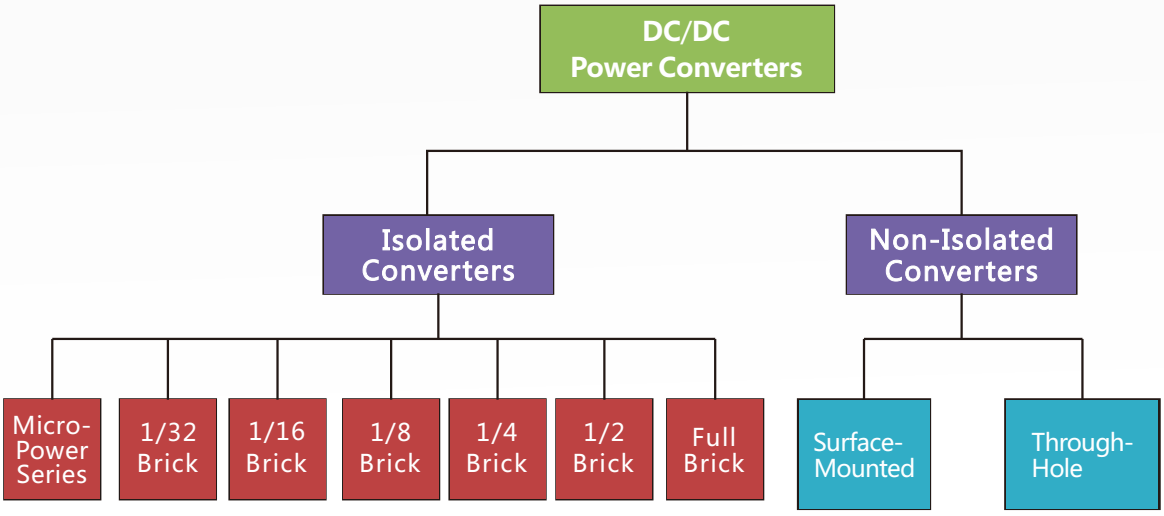
PRODUCT SUMMARY

Product Summary

Brand:Dr.Power



Special Features :

Operating performance	◆ Input voltage range : 9-75V, 180-650V ◆ Efficiency up to 97% at full load ◆ Fixed frequency switching provides predictable EMI ◆ Fixed frequency: around 180-350kHz ◆ No minimum load required , outstanding performance on large output capacitance ◆ Isolation voltage≧1500VDC (Input/ouput)Maximum 4250VDC	**Protection**	◆ Input under voltage lockout ◆ Output over-voltage protection, output over-current/short-circuit protection and thermal shutdown ◆ Active back bias limit ◆ Optional autorecovery or lock-up protection mode ◆ High power converters: current share, redundancy, parallel monitoring, frequency synchronization
Dimension	◆ Multiple options on pin-out, size and package ◆ Open frame size (mm) : › Full-Brick : 113.28*57.91 › Half-Brick : 61.0*57.9 › Quarter-Brick : 57.9*36.8 › Eighth-Brick : 58.42*22.76 › Sixteenth-Brick : 33.0*22.9 › Thirteen-Second-Brick : 23.4*19.1	**Control**	◆ Remote control on/off ◆ Output voltage trim range: 80% to 110% › Some Quarter-Brick and Eighth-Brick converters : 10% to 110% › Some Quarter-Brick and Eighth-Brick converters : 90% to 110%
Comply Standards	Military Standards : ◆ GJB181A-2003, GJB181B-2012 ◆ GJB150-86, GJB150A-2009 ◆ GJB360B-2009, GJB548B-2005 , SJ20668-1998	**Production Compliance**	◆ Meet military standards GJB9001B-2009, GJB9001C-2017 ◆ All components traceable, converters screening ◆ 2/8/48/96 hours burn-in

Thirty-Second-Brick

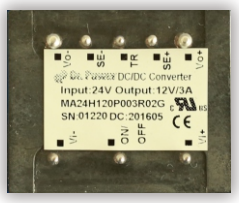
Open-frame

Size：23.6×19.3×10.7 (mm)

Baseplate

Size：25.9×19.3×12.7 (mm)

Encapsulated



Size：26.19×21.7×12.7 (mm)

Flanged Baseplate

Size：37.9×22.1×12.7 (mm)

Special features:

- Leading Thirty-Second-Brick size and feature sets
- Choose M or S grade for operating temperature: -55℃-100℃
- Multiple Package & Heatsink options
- High Efficiency: 87%-92% at full rated load
- Output power as high as 45W
- Output voltage trim range: 80% to 110%
- No minimum load required，outstanding performance on large output capacitance.
- Input under-voltage Lockout, output over-voltage protection, output over-current/short-circuit protection and over temperature protection
- Fixed frequency switching around 180-350kHz provides predictable EMI. Filters or EMI application circuit (compatible with Drpower converters) are provided to comply with military EMI requirements
- Rugged design for harsh environments
- Designed to meet military standards: GJB181A-2003, GJB181B-2012, GJB150-86, GJB150A-2009, GJB360B-2009, SJ20668-1998, GJB548B-2005
- Applications:

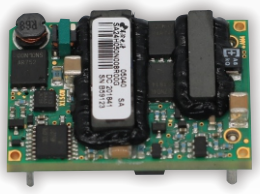
  Military, avionics, ships and submarines

1/32 Brick	3.3V	5.0V	6.0V	8.0V	9.0V	12.0V	15.0V	28.0V
MA18 Series ⑤ (9-36Vin)	7A/23.1W	5A/25W		3A/24W		2A/24W		1A/28W
MB18 Series ⑤ (9-36Vin)		5A/25W				2A/24W		1A/28W
MA24 Series ⑤ (18-36Vin)	10A/33W	8A/40W		5A/40W		3A/36W	3A/45W	1.5A/42W
MB24 Series ⑤ (18-36Vin)	10A/33W	8A/40W				3A/36W		1.5A/42W
MB48 Series ⑥ (36-75Vin)	10A/33W	8A/40W				3A/36W		

Notes: Ordering information and up right notes please refer page 10

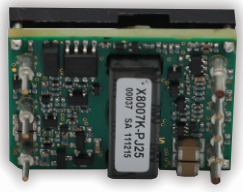
Sixteenth-Brick

Open-frame



Size：33.3×23.1×9.7 (mm)

Baseplate



Size：33.3×23.1×12.7 (mm)

Encapsulated

Size：35.3×25.1×12.7 (mm)

Encapsulated with Fixed Pin

Size：35.3×25.1×12.7 (mm)

Encapsulated

Size：39.0×37.5×12.7 (mm)

Special features:

- Leading Thirty-second-Brick size and feature setsl
- Choose M or S grade for operating temperature: -55℃-100℃
- Multiple Package & Heatsink options
- High Efficiency: 87%-92% at full rated load
- Output power as high as 45W
- Output voltage trim range: 80% to 110%
- No minimum load required，outstanding performance on large output capacitance.
- Input under-voltage Lockout, output over-voltage protection, output over-current/short-circuit protection and over temperature protection
- Fixed frequency switching around 180-350kHz provides predictable EMI. Filters or EMI application circuit (compatible with Drpower converters) are provided to comply with military EMI requirements
- Rugged design for harsh environment
- Designed to meet military standards: GJB181A-2003, GJB181B-2012, GJB150-86, GJB150A-2009, GJB360B-2009, SJ20668-1998, GJB548B-2005
- Applications: Military, avionics, ships and submarines

1/16Brick	3.3V	5.0V	6.0V	8.0V	9.0V	12.0V	15.0V	28.0V
SA18 Series ⑤ (9-36Vin)	10A/33W 15A/49.5W	10A/50W 12A/60W		4A/32W 7A/56W	6A/54W	3A/36W 5A/60W	3A/45W 4A/60W	2A/56W
SA24 Series ⑤ (18-36Vin)	10A/33W 25A/82.5W	12A/60W 17A/85W	10A/60W 12A/72W	8A/64W 11A/88W	6A/54W	3A/36W 7.5A/90W	3A/45W 6A/90W	24V/4A 2.5A/70W
SA36 Series ⑥ (18-75Vin)	10A/33W 15A/49.5W	10A/50W 12A/60W		4A/32W 7A/56W		3A/36W 5A/60W	3A/45W 4A/60W	
SA48 Series ⑥ (36-75Vin)	25A/82.5W	17A/85W	11A/66W	8A/64W		7.5A/90W		2.5A/70W
SA160 Series (90-200Vin)		4A/20W				2A/24W		0.8A/22.4W
SA270 Series ⑩ (180-400Vin)		4A/20W				2A/24W		0.8A/22.4W

Notes: Ordering information and up right notes please refer page 10

Eighth-Brick

Open-frame

Size：58.4×22.8×10.4 (mm)

Baseplate

Size：58.4×22.8×12.7 (mm)

Encapsulated

Size：61.0×25.2×12.7 (mm)

Encapsulated with Fixed Pin

Size：61.0×25.2×12.7 (mm)

Encapsulated

Size：64.5×37.5×12.7 (mm)

Special features:

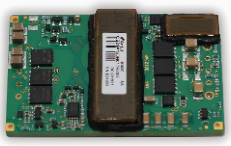
- Leading Eighth-Brick size and feature sets
- Choose M or S grade for operating temperature: -55℃-100℃
- Multiple Package & Heatsink options
- High Efficiency: 89%-95% at full rated load
- Output power as high as 144W
- Output voltage trim range: 80% to 110%. For EA24 28Vout Series, output voltage trim range: 10% to 110%
- No minimum load required，outstanding performance on large output capacitance.
- Input under-voltage Lockout, output over-voltage protection, output over-current/short-circuit protection and over temperature protection
- Fixed frequency switching around 180-350kHz which provides predictable EMI. Filters or EMI application circuit (compatible with Drpower converters) are provided to comply with military EMI requirements
- Rugged design for harsh environment
- Designed to meet military standards: GJB181A-2003, GJB181B-2012, GJB150-86, GJB150A-2009, GJB360B-2009, SJ20668-1998, GJB548B-2005
- Applications:
  Military, avionics, ships and submarines

1/8 Brick	3.3V	5.0V	6.5V	8.0V	9V	12.0V	28.0V	48.0V
EA18 Series ⑤ (9-36Vin)		20A/100W 25A/125W				8A/96W 10A/120W	5A/140W	
EA24 Series ⑤ (18-36Vin)	15A/49.5W 35A/115.5W	10A/50W 25A/125W	19A/123.5W	15A/120W		7A/84W 10A/120W	3A/84W③ 5A/140W③	2A/96W
EA36 Series ⑥ (18-75Vin)	30A/99W	14A/70W 20A/100W		15A/120W		6A/72W 10A/120W	4A/112W 5A/140W	
EA48 Series ⑥ (6-75Vin)	30A/99W	10A/50W 20A/100W	6V/16A	15A/120W		5A/60W 10A/120W	5A/140W	3A/144W
EA160 Series (90-200Vin)		12A/60W	9A/58.5W					
EA270 Series ⑥⑩ (180-400Vin)		20A/100W				8A/96W	3.5A/98W	2A/96W

Notes: Ordering information and up right notes please refer page 10

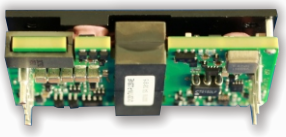
Quarter-Brick

Open-frame



Size：58.2×37.1×10.2(mm)

Baseplate



Size：58.2×37.1×12.7(mm)

Pentagon Plastic Package

Size：60.6×39.4×12.7(mm)

Encapsulated

Size：60.6×39.4×12.7(mm)

Encapsulated with Fixed Pin

Size：60.6×39.4×12.7(mm)

Flanged Baseplate

Size：64.3×51.7×12.7(mm)

Special features:

- Leading Quarter-Brick size and feature sets
- Choose M or S grade for operating temperature: -55℃-100℃
- Multiple Package & Heatsink options
- High Efficiency: 90%-96% at full rated load
- Output power as high as 360W
- Output voltage trim range: 80% to 110%. For QB24 28Vout Series, output voltage trim range: 10% to 110%
- No minimum load required，outstanding performance on large output capacitance.
- Input under-voltage Lockout, output over-voltage protection, output over-current/short-circuit protection and over temperature protection
- Fixed frequency switching around 180-350kHz which provides predictable EMI. Filters or EMI application circuit (compatible with Drpower converters) are provided to comply with military EMI requirements
- Rugged design for harsh environment
- Designed to meet military standards: GJB181A-2003,GJB181B-2012, GJB150-86, GJB150A-2009, GJB360B-2009, SJ20668-1998, GJB548B-2005
- Applications: Military, avionics, ships and submarines

1/4 Brick	3. 3V	5. 0V	6. 0V	8. 0V	12. 0V	15. 0V	28. 0V	48. 0V
QB18 Series ⑤ (9-36Vin)		24A/120W 30A/150W 40A/200W			12A/144W		5A/140W	3A/144W
QB24 Series ⑤ (18-36Vin)	60A/198W	40A/200W	33A/198W	25A/200W	17A/204W	13A/195W	4A/112W ③ 7A/196W	4A/192W
QB30 Series ⑥ (9-75Vin)					7A/84W			
QB36 Series ⑥ (18-75Vin)	60A/198W	40A/200W	30A/180W	25A/200W	17A/204W	13A/195W	5A/140W	2A/96W
QB48 Series ⑥ (36-75Vin)	60A/198W	40A/200W	30A/180W	30A/240W	17A/204W	13A/195W	5A/140W	2A/96W
QA160 Series (90-200Vin)		30A/150W						
QA270 Series⑩ (180-400Vin)		30A/150W 40A/200W			13A/156W		5A/140W	3A/144W
QC24 Series ⑤ (18-36Vin)		50A/250W			25A/300W 30A/360W		11A/308W	6A/288W

Notes: Ordering information and up right notes please refer page 10

Half-Brick

Open-frame

Size：61.2×58.2×10.1 (mm)

HB Series Pentagon Plastic Package

Size：64.2×61.2×12.7 (mm)

Encapsulated

Size：64.0×61.0×12.7 (mm)

HC Series Flanged Baseplate

Size：57.9×55.9×12.7 (mm)

Special features:

- Leading Half-Brick size and feature sets
- Choose M or S grade for operating temperature: -55℃-100℃
- Multiple pPackage & Heatsink options
- High Efficiency: 91.5%-94% at full rated load
- Output power as high as 616W
- Output voltage trim range: 80% to 110%.
- No minimum load required，outstanding performance on large output capacitance.
- Input under-voltage Lockout, output over-voltage protection, output over-current/short-circuit protection and over temperature protection
- Fixed frequency switching around 180-350kHz which provides predictable EMI. Filters or EMI application circuit (compatible with Drpower converters) are provided to comply with military EMI requirements
- Rugged design for harsh environment lDesigned to meet military standards:GJB181A-2003, GJB181B-2012, GJB150-86,GJB150A-2009, GJB360B-2009, SJ20668-1998, GJB548B-2005

Applications:

- Military, avionics, ships and submarines

1/2 Brick	5.0V	6.0V	8.0V	10.0V	12.0V	28.0V	36V	48.0V
HB18 Series ⑤ (9-36Vin)	50A/250W				20A/240W	8A/224W		
HB24 Series ⑤ (18-36Vin)	80A/400W		65A/520W		40A/480W 50A/600W	17A/476W 22A/616W	32.5V/16A⑨	10A/480W 50V/10A
HB36 Series ⑥ (18-75Vin)			40A/320W		30A/360W			
HB48 Series ⑥ (36-75Vin)	80A/400W	6.5V/65A			30A/360W 50A/600W	18A/504W 24V/25A		10A/480W
HB550 Series (400-650Vin)				30A/300W	30A/360W	12.5A/350W 20A/560W	15A/540W 40V/15A⑨	
HB160 Series (90-200Vin)	67A/335W⑨ 80A/400W ⑨					20A/560W ⑨		
HB270 Series⑩ (180-400Vin)	60A/300W			40A/400W	33A/396W	14.5A/406W 18A/504W	11A/396W	
HB400 Series (300-500Vin)	60A/300W				33A/396W	14.5A/406W		
HC270 Series (180-400Vin)						8A/224W		

Notes: Ordering information and up right notes please refer page 10

Full-Brick

FA Series Open-frame

Size：113.3×57.9×10.1 (mm)

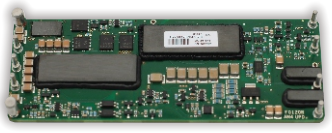
FA Series Encapsulated

Size：116.8×61.2×13.7 (mm)

FB Series Flanged Baseplate

Size：116.9×55.9×12.7 (mm)

FB Series Open-frame



Size：112.0×40.9×10.0 (mm)

Special features:

- Leading standard Eighth-Brick size and feature sets
- Choose M or S grade for operating temperature: -55℃-100℃
- Multiple Package & Heatsink options
- High Efficiency: 91%-96.5% at full rated load
- Output power as high as 144W
- Output voltage trim range: 80% to 110%.
- No minimum load required，outstanding performance on large output capacitance.
- Input under-voltage Lockout, output over-voltage protection, output over-current/short-circuit protection and over temperature protection
- Fixed frequency switching around 180-350kHz which provides predictable EMI. Filters or EMI application circuit (compatible with Drpower converters) are provided to comply with military EMI requirements
- Rugged design for harsh environment
- Designed to meet military standards: GJB181A-2003, GJB181B-2012, GJB150-86, GJB150A-2009, GJB360B-2009, SJ20668-1998, GJB548B-2005
- Applications: Military, avionics, ships and submarines

Full-Brick	5.5V	7.0V	9.0V	12.0V	28.0V	36.0V	48.0V	270V
FA270 Series (180-400Vin)	90A/495W	90A/630W	78A/702W	57A/684W 84A/1008W⑨ 14V/72A⑨	28A/784W 36A/1008W⑨ 43A/1200W⑨ 22V/55A⑨	28A/1008W⑨	17A/816W 21A/1008W⑨	
FA400 Series (300-500Vin)			8.5V/78A	80A/960W⑨	28A/784W 36A/1008W⑨	40V/25A	21A/1008W⑨	
FA500 Series (50-750Vin)					43A/1200W			
FA550 Series (400-650Vin)				57A/684W	28A/784W 36A/1008W⑨	17A/612W 22A/792W	17A/816W 21A/1008W⑨	
FB270 Series ⑩ (180-400Vin)			10.5V/45A	45A/540W	22A/616W		13A/624W	
FA110 Series (66-160Vin)					24V/33A			
FA24 Series (18-36Vin)					24V/25A			4A/1080W

Notes: Ordering information and up right notes please refer page 10

Up Right Figure Notes :

① Fixed output voltage; ② The product is DC-DC power converter with fixed input-output ratio ;

③ The product's output voltage trim range:

a. Wide output voltage range is 10% to 110% with suffix "-V", such as QB24H280P007N23G-V .

b. Standard output voltage range is 80% to 110% such as QB24M280P007R22G

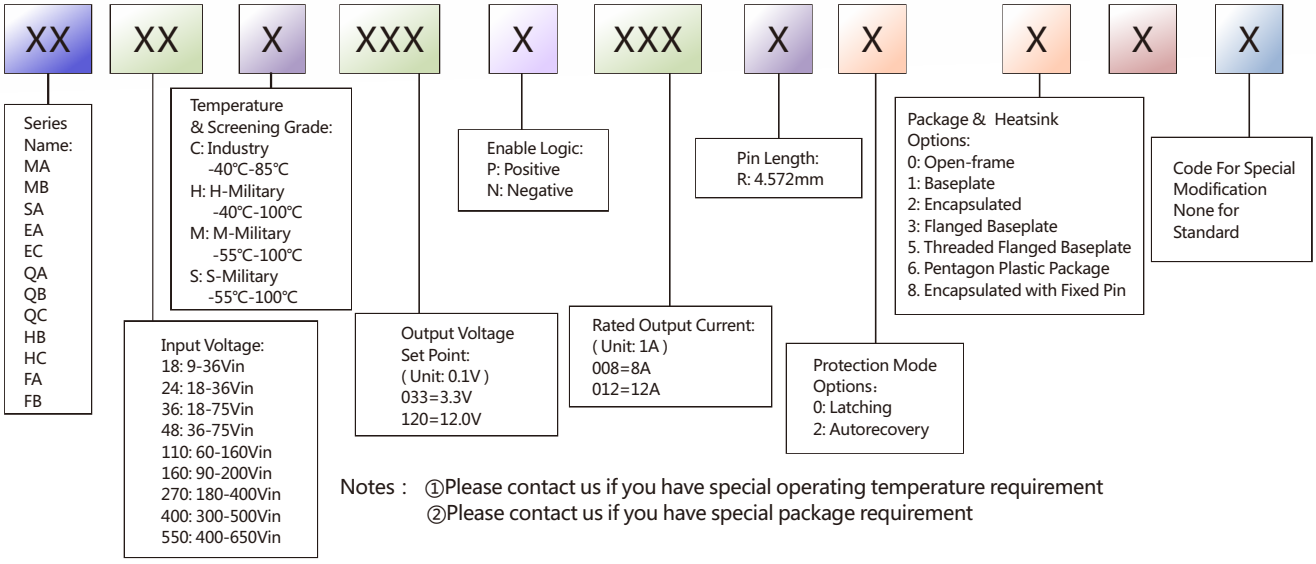
④ The product is not released; ⑤ Input surge withstand 50V/50ms; ⑥ Input surge withstand 80V/50ms;

⑦ Input voltage range 40-60V; ⑧ Detailed input voltage range refer to datasheet; ⑨ Constant output current ;

⑩ The input of some model can be improved to 180-420V, please contact us for more information.

Please contact us if you have some special output voltage trim range requirements.

Ordering Information



Notes : ①Please contact us if you have special operating temperature requirement
②Please contact us if you have special package requirement

Screening Items	Process Description	C Grade	H Grade	M Grade	S Grade
Baseplate operating Temperature		-40℃~85℃	-40℃ ~ 100℃	-55℃ ~ 100℃	-55℃ ~ 100℃
Pre-Cap Inspection	GJB548B method 2017.1	√	√	√	√
Storage Temperature	GJB150.3A				√
Temperature Cycling	GJB548B method 1010.1		√	√	√
Middle Electrical Test	Reference spec		√	√	√
Burn-In	GJB548B method 1015.1		8H	48H	96H
Final Electrical Test	Reference spec	25℃	-40℃,25 ℃,100 ℃	-55℃,25 ℃,100 ℃	-55℃,25 ℃,100 ℃
Visual Inspection	GJB548B method 2009.1	√	√	√	√
Special request: Component DPA、Second Screening, etc					Optional

Micro-Power Converters

IA Series Encapsulated

ZA Series Flanged Baseplate

NA Series Flanged Baseplate

22. 5x10. 8x11. 2 (mm)	3.3V	5V	6V	8V	9V	12V	15V	28V
ZA18 Series (9-36Vin)	1A/3W	1A/5W	0.8A/5W	0.6A/5W		0.4A/5W	0.3A/5W	
ZA24 Series (18-36Vin)	1.2A/4W	1.2A/6W	1A/6W	0.75A/6W		0.5A/6W	0.4A/6W	

25.4x12.7x11. 2 (mm)	3.3V	5V	6V	8V	9V	12V	15V	28V
NA18 Series (9-36Vin)	2A/6W	2A/10W		1.2A/10W		0.8A/10W	0.65A/10W	
NA24 Series (18-36Vin)	3A/10W	3A/15W	2.5A/15W	1.8A/15W		1.2A/15W	1A/15W	0.54A/15W
NA48 Series (36-75Ain)			2.5A/15W					
NB18 Series* (9-36Vin)		2A/10W				0.8A/10W	0.6A/10W	
NB24 Series* (18-36Vin)		3A/15W	2.5A/15W	1.8A/15W		1.2A/15W		

*Notes: Compared with NA series, NB series functionally add over current/short protection (hiccup mode).

25.4x25.4x11.2 (mm)	3.3V	5V	6V	8V	9V	12V	15V	28V	36V
IA18 Series (9-36Vin)	5A/20W	5A/30W	4.2A/25W	3A/25W			1.7A/25W		
IA24 Series (18-36Vin)	6A/20W	6A/30W		3.7A/30W		2.5A/30W	2A/30W	1.1A/30W	
IA48 Series (36-75Vin)			5A/30W						
IB24 Series* (16-40Vin)	6A/20W	6A/30W		3.7A/30W		2.5A/30W	2A/30W	1.1A/30W	0.6A/20W

*Notes: Compared with NA series, NB series functionally add over current/short protection (hiccup mode).

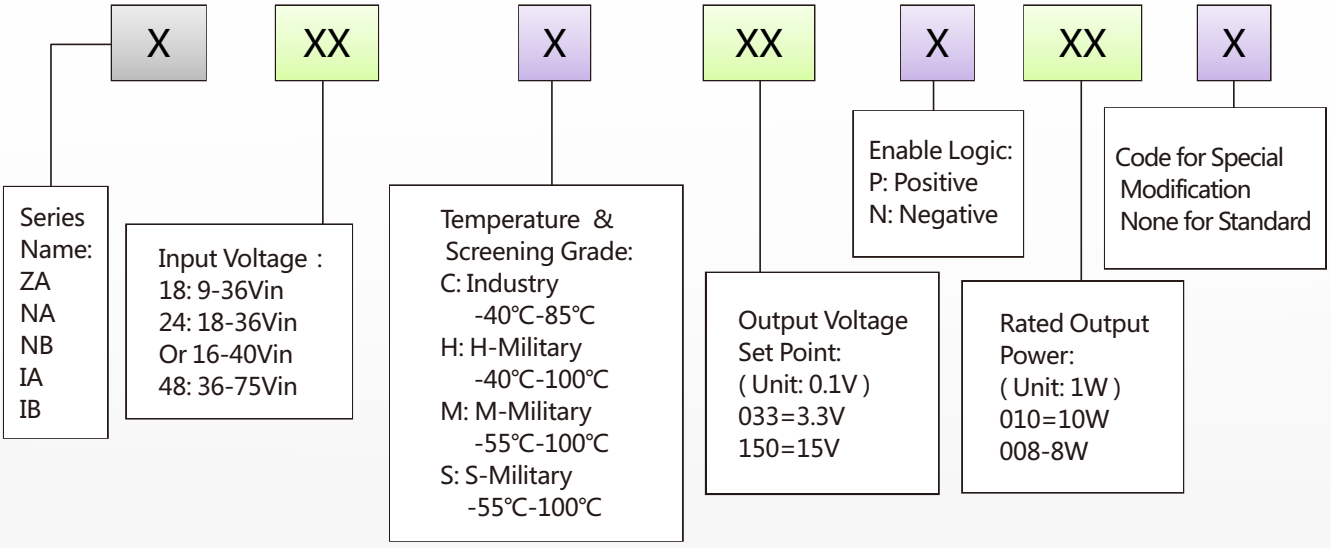
ZPL Series Encapsulated

ZPK Series Encapsulated

21.8x9.5x11.2 (mm)	3.3V	5V	6V	8V	9V	12V	15V	28V	36V
ZPL6-18 Series(6W) (9-36Vin)		1.2A/6W		0.7A/6W		0.5A/6W		0.2A/6W	
ZPL6-24 Series(6W) (16-40Vin)		1.2A/6W		0.7A/6W		0.5A/6W		0.2A/6W	
ZPL9-18 Series(9W) (9-36Vin)		1.8A/9W		1.1A/9W		0.7A/9W		0.3A/9W	
ZPL9-24 Series(9W) (16-40Vin)		1.8A/9W		1.1A/9W		0.7A/9W		0.3A/9W	

31.8x20.3x11.2 (mm)	3.3V	5V	6V	8V	9V	12V	15V	28V	36V
ZPK Series (18-36Vin)	7.6A/25W	5A/25W		3.1A/25W		2.1A/25W		0.9A/25W	

Ordering Information



Screening Items	Process Description	C Grade	H Grade	M Grade	S Grade
Baseplate operating Temperature		-40 ℃ ~ 85 ℃	-40 ℃ ~ 100 ℃	-55 ℃ ~ 100 ℃	-55 ℃ ~ 100 ℃
Pre-Cap Inspection	GJB548B method 2017.1	√	√	√	√
Storage Temperature	GJB150.3A				√
Temperature Cycling	GJB548B method 1010.1		√	√	√
Middle Electrical Test	Reference spec		√	√	√
Burn-In	GJB548B method 1015.1		8H	48H	96H
Final Electrical Test	Reference spec	25 ℃	-40 ℃ ,25 ℃ ,100 ℃	-55 ℃ ,25 ℃ ,100 ℃	-55 ℃ ,25 ℃ ,100 ℃
Visual Inspection	GJB548B method 2009.1	√	√	√	√
Special request: Component DPA、Second Screening, etc					Optional

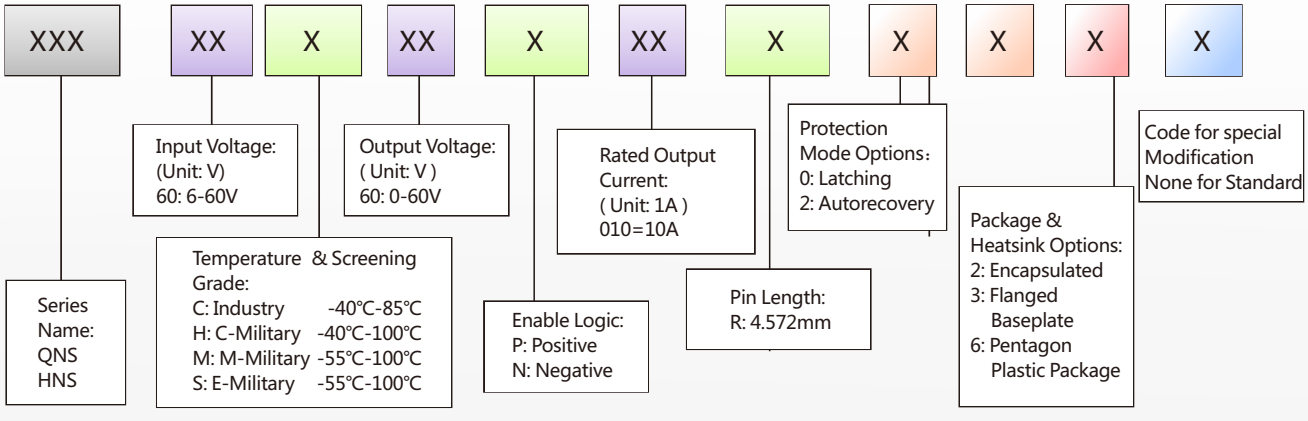
Non-Isolated Quarter Brick & Half-Brick

Special Features :

- Standard Quarter-Brick & Half-Brick size and feature sets
- Choose M or S grade for operating temperature: -55℃-100℃
- Ultra-high efficiency up to 97%
- Output power as high as 2000W
- Output Over-voltage and over-current/short-circuit protection, over temperature protection
- Designed to meet military standard GJB181A-2003, GJB150A-2009

Size	Input Voltage	Output Voltage	Output Current
Quarter-Brick	9-60V	0-60V	20A
Half- Brick	9-60V	0-60V	40A

Ordering Information



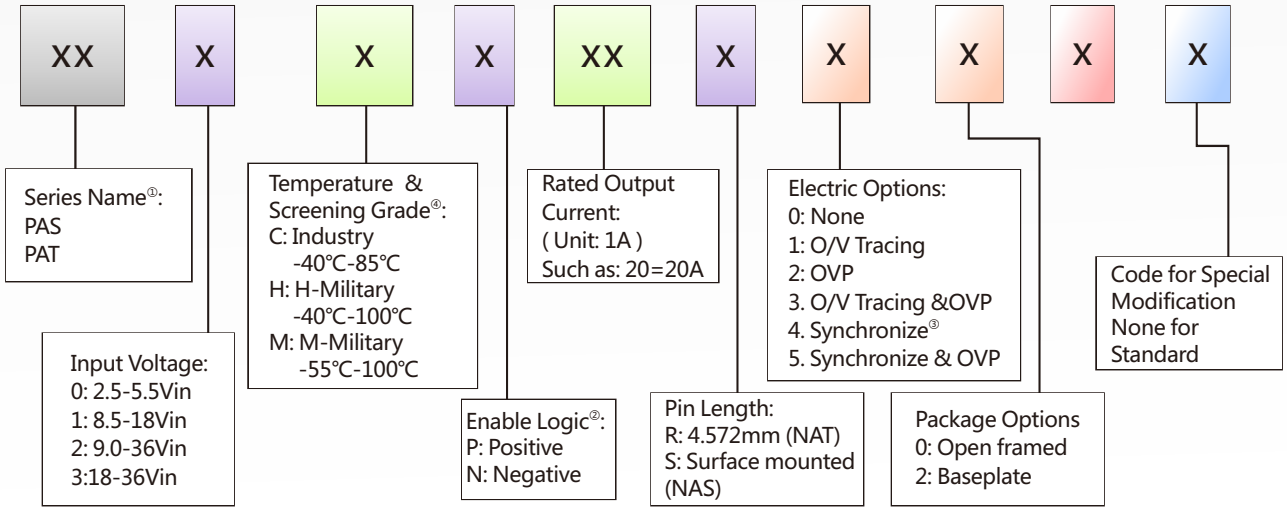
Not-Isolated DC-DC Converters (Point-of-Load)

Selection Guide

	Series Name	Input Voltage	Output Voltage	Output Current	Size(mm)
Surface-Mounting	PAS0	2.5-5.5V	0.75-3.63V	12A,20A	33.1x13.6x6.7
	PAS1	8.5-16V	0.75-5.5V	12A,20A	
	PAS2	9-36V	3-6V	10A	
	PAS3	18-36V	5-15.5V	9A	

	Series Name	Input Voltage	Output Voltage	Output Current	Size(mm)
Through-hole Mounting	PAT0	2.5-5.5V	0.75-3.63V	12A,20A	50.80x12.70x6.35
	PAT1	8.5-16V	0.75-5.5V	12A,20A	
	PAT2	9-36V	3-6V	10A	
	PAT3	18-36V	5-15.5V	9A	
	PCT0	4.5-5.5V	0.75-3.63V	40A,60A	50.80x17.27x6.35 50.80x17.27x10.16
	PCT1	8-16V	3-5.5V	40A,60A	

PAS/PAT Series Ordering Information



Notes :

①The output voltage of standard converter is adjustable, add trim resistor on application board to trim up/down the voltage.

②PAS/PAT series converters operate with on/off pin float.

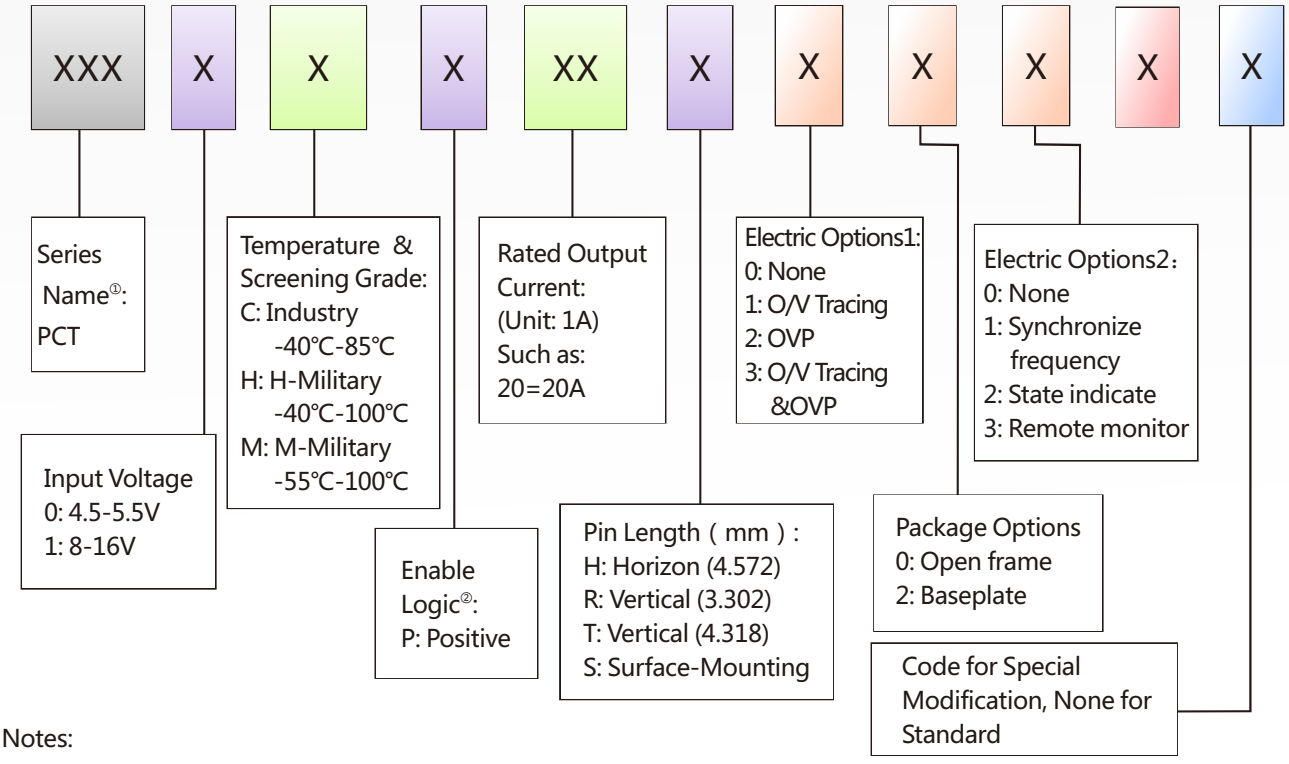
③ Synchronize related option is only available on PAT series.

④ Screening items please refer page 10.

PAS Series (Surface Mounting)						
Part No	PAS0xx12Sxx	PAS0xx20Sxx	PAS1xx12Sxx	PAS1xx20Sxx	PAS2xx10Sxx	PAS3xx09Sxx
Input Voltage	2.5-5.5V		8.5-18V		9.0-36V	18-36V
Output Voltage	0.75-3.63V		0.75-5.5V *		3-6V	5-15.5V
Output Current	12A	20A	12A	20A	10A	9A
Output Power	43W	73W	66W	110W	45W	60W
Efficiency**	94%	96%	92%	91%	88%	94%
PAT Series (Through-hole Mounting)						
Part No	PAT0xx12Rxx	PAT0xx20Rxx	PAT1xx12Sxx	PAT1xx20Rxx	PAT2xx10Rxx	PAT3xx09Rxx
Input Voltage	2.5-5.5V		8.5-18V		9.0-36V	18-36V
Output Voltage	0.75-3.63V		0.75-5.5V *		3-6V	5-15.5V
Output Current	12A	20A	12A	20A	10A	9A
Output Power	43W	73W	66W	110W	45W	60W
Efficiency**	94%	96%	92%	91%	88%	94%

Notes: * The output voltage of the converter can be modified to above 5.5V(as high as 8V).
** The efficiency is measured on full load and within the specification.

PCT Series Ordering Information



Notes:

①The output voltage of standard converter is adjustable, add resistor on application board to trim up/down the voltage.

②PBS series converters operate with on/off pin float.

③ Screening items please refer page 10.

PCT Series (Through-hole Mounting)					
Part No	Input Voltage	Output Voltage	Output Current	Output Power	Efficiency
PCT0xx60xxxx	4.5-5.5V	0.75-3.63V	60A	145W	97%
PCT1xx60xxxx	8-16V	0.8-5V	60A	175W	95%

300-2000W Power Factor Correction Modules ①

Special features:

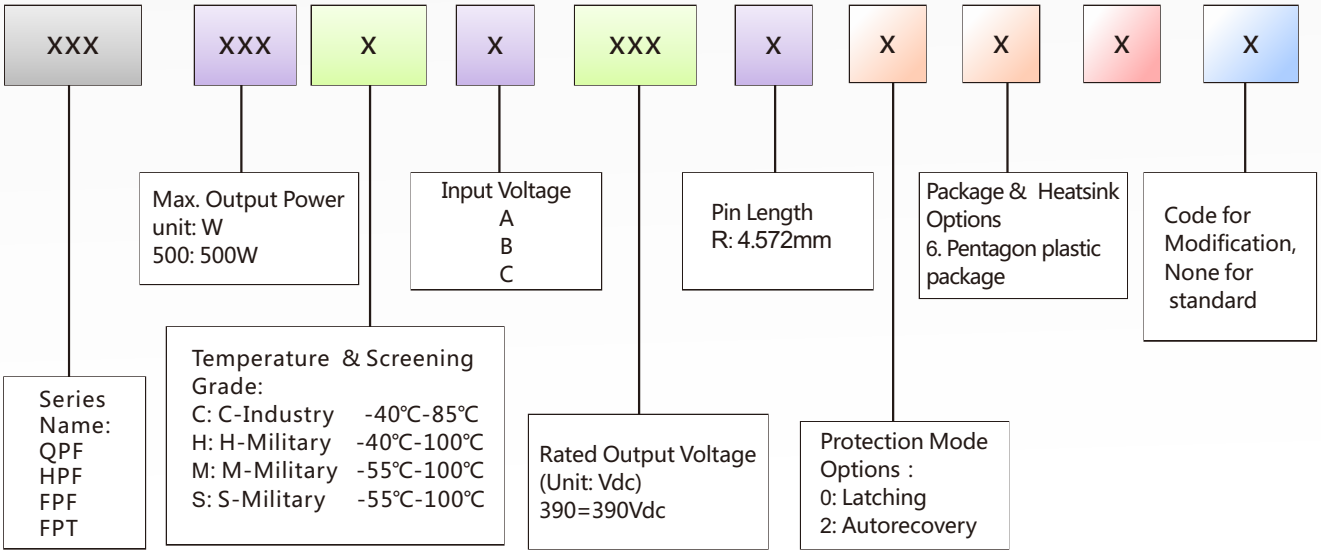
- Output power up to 1500W for single-phase, up to 2000W for 3-phase
- >0.99 Power factor
- Optional input voltage range
- Efficiency as high as 94.5%-97%
- Internal inrush current limit, extremely low inrush current and harmonic current
- Choose M or S grade for operating temperature: -55℃-100℃
- Can be paralleled with current sharing
- Input current limit, input over/under voltage protection; Output under voltage protection, over current protection, short protection
- Optional protection mode: autorecovery or hiccup
- Meet military standard GJB181-86 and GJB298-87 for transient/spike content

Single-Phase PFC Modules	Input Voltage (Single-Phase Vrms)	Output Voltage (Vdc)	Output Power (W)
Quarter-Brick	220Vac	390V	300W
Half-Brick	110Vac	270V	550W
	110Vac/220Vac	390V	500W
	220Vac	390V	700W
Full-Brick	220Vac	390V	1500W

3-Phase PFC Modules	Input Voltage (3-Phase Vrms $_{L-N}$)	Output Voltage (Vdc)	Output Power (W)
Full-Brick	115Vac	270V	1500W
Full-Brick	380Vac	700V	600W
Full-Brick	380Vac	700V	2000W

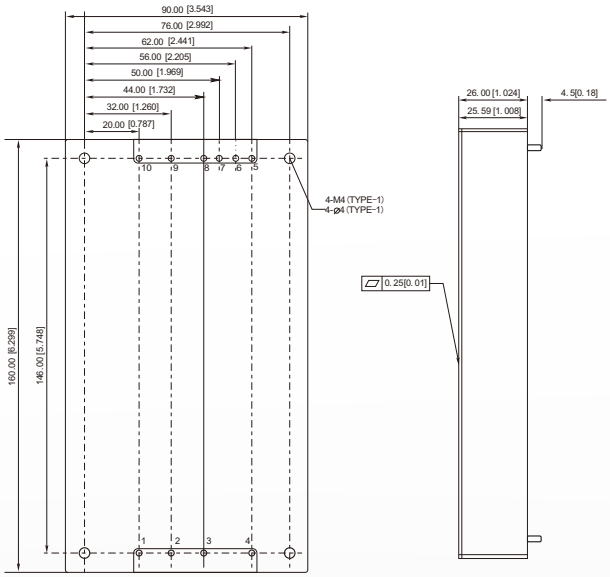
Notes：① Some models are in development and not released , detailed information please contact us

Ordering information



Notes: Screening items please refer page 10

3-Phase 115VAC 5KW Power Factor Correction Modules



Special features:

- Input voltage: 115Vrms L-N 3-Phase
- Input voltage range: 90% ~110%
- Frequency range: 360Hz ~800Hz
- Output voltage: 315VDC
- Output power: 5kW
- Efficiency: 97% at full load
  96% at half load
- Operating temperature up to 100℃
- Over temperature protection, output over voltage protection, output over current protection

Part No	Input Voltage	Input OVP	Output Voltage	Output Current	Parallel Mode
FPT5K0MB315R02G	115VAC±10%	150VAC	315V	16A	Non-Master-Slave
FPT5K0MB315R12G	115VAC±10%	150VAC	315V	16A	Master-Slave

AC-DC Power Converters①

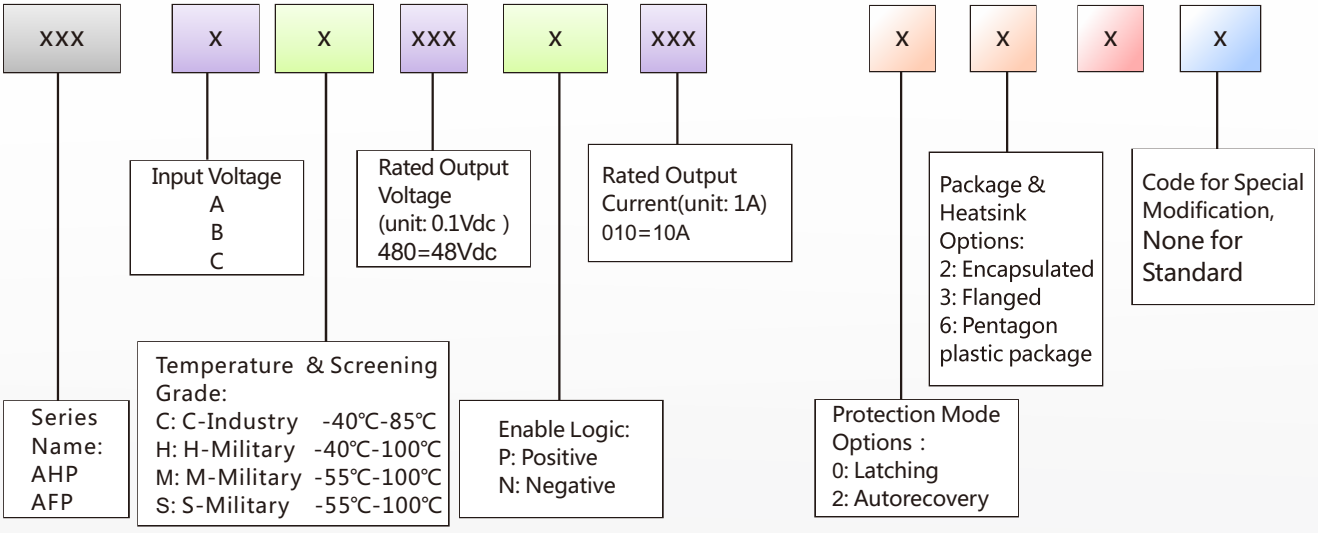
Special features:

- Output power up to 792W
- >0.99 Power factor
- Efficiency up to >93% at full load
- Can be paralleled
- Internal inrush current limit
- Single output: 5V, 12V, 28V
- Optional input voltage
- Choose M or S grade for wide operating temperature range: -55~100℃
- Input over current, over/under voltage protection, output under voltage, over current, short protection
- Optional protection mode: auto-recovery or hiccup
- Meet military standard GJB181-86 and GJB298-87 for transient/spike content

Output Voltage / Package	5V	12V	28V
Half Brick	60A/300W	30A/360W	13A/364W
Full Brick	100A/500W	66A/792W	28A/784W

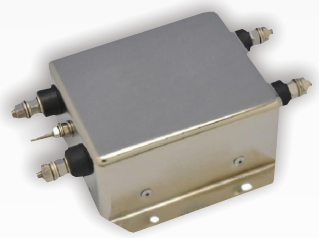
Notes：① Some models are in development and not released , detailed information please contact us

AC-DC Ordering information



Notes: Screening items please refer page 10

DC Filters①



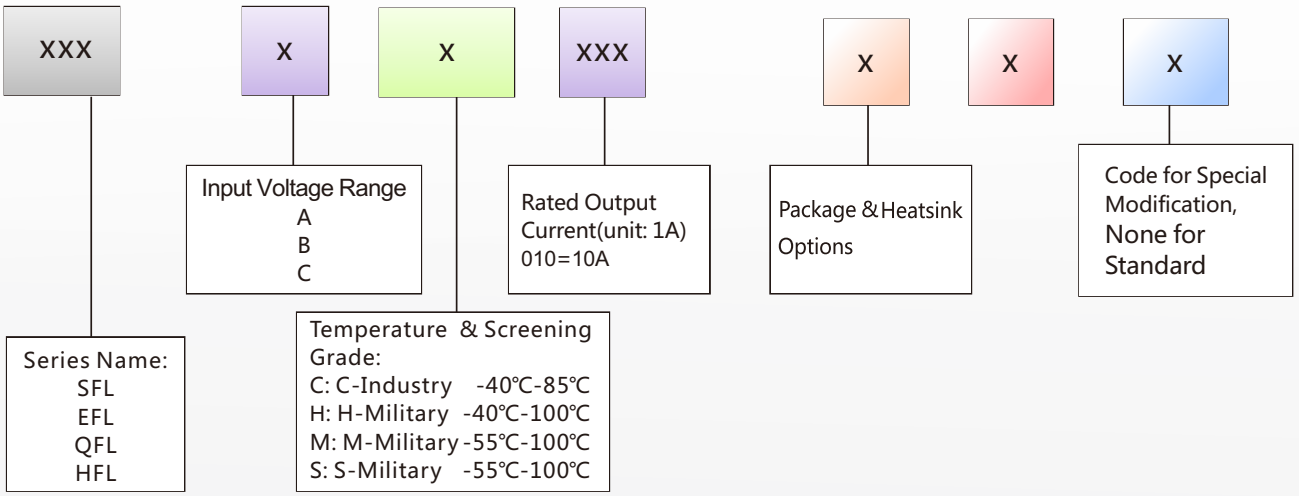
Special features:

- Used on the input of DC-DC converters，provide high levels of differential-mode and common-mode attenuation
- Current up to 40A
- Choose M or S grade for operating temperature: -55℃~100℃
- Designed to use with Dr.Power DC-DC converters to meet EMI standards
- Meet military standard GJB151A-1997/CE102

Size	Input Voltage	Rated current	Compatible with DC-DC converters
Half-Brick	-50~+50VDC	25~40A	HB18、24 series
Quarter-Brick		10~20A	QB18、QB/QC24 series
Eighth-Brick		7A	EA18、24 series，SA18、24 series
Sixteenth-Brick		3A	MA/MB18、24 series
Half-Brick	-100~+100VDC	25A	HB36、48 series
Quarter-Brick		10~20A	QB30、36、48、EA36、48 series
Eighth-Brick		5A	SA36、48、MB48 series
Quarter-Brick	-250~+250VDC	15A	FA110 series
		7A	HB160 series
Half-Brick	-500~+500VDC	7A	FA/FB270、400 series、HB270、400 series
Quarter-Brick		3A	QA/EA/SA270 series
Eighth-Brick		1A	
Quarter-Brick	-800~+800VDC	3A	FA/FB550 series、HB550 series

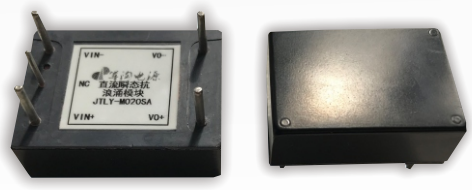
Notes：① Some models are in development and not released , detailed information please contact us

Ordering Information



Notes: Screening items please refer page 10

Surge Protection Module①



Special features:

- Input voltage range: 9 ~ 36Vdc, 18 ~ 36V
- Transient over voltage surge withstand: 100V/50ms、±600V/10uS
- Transient under voltage surge withstand: 8V/50ms
- Operating temperature up to 100℃
- Meet military standard GJB181-86 and GJB298-87 for transient/spike content

1、Over Voltage Surge Protection Module (9～36Vin)

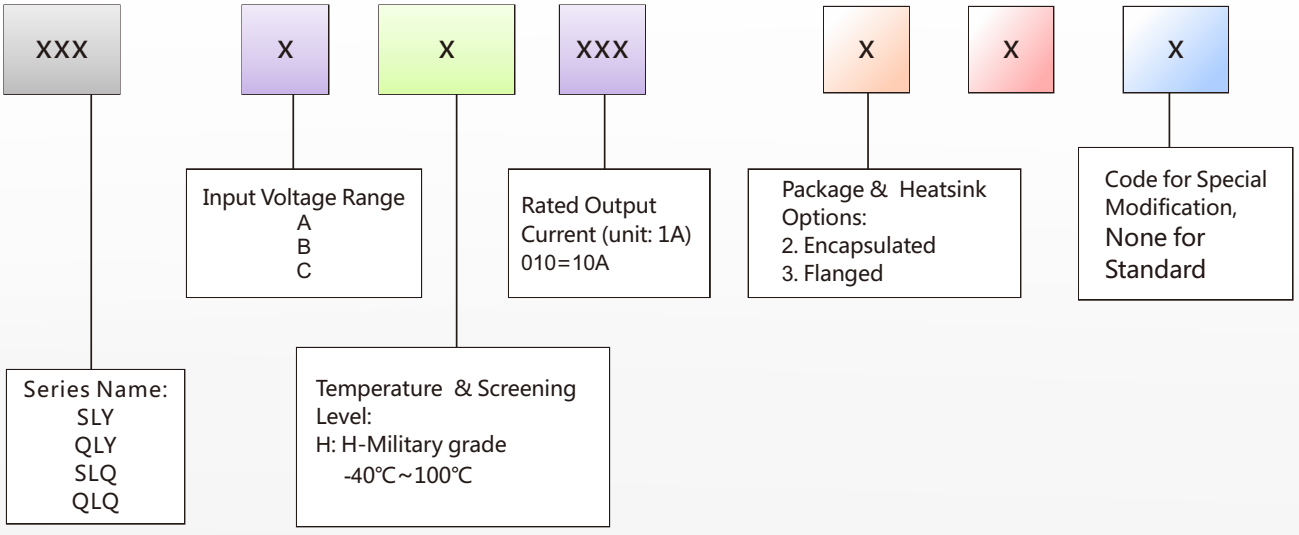
	Current	Withstand over voltage surge	Output with over voltage surge	Voltage spike	Isolation resistance (500Vdc)	Operating temperature
Sixteenth-Brick Quarter-Brick	5A 20A	100V/ 50ms	≤38V (can be modified)	±600V/10us	100MΩ	-40℃～+100℃

2、Over/under Voltage Surge Protection Module (Anti-reverse (Vin≤40V) , 18～36Vin)

	Current	Withstand over voltage surge	Output with over voltage surge	Voltage spike	Output with under voltage surge	Voltage spike	Isolation resistance (500Vdc)	Operating temperature
Sixteenth-Brick Quarter-Brick	5A 20A	100V/50ms	≤38V (can be modified)	8V/50ms	≥16V (can be modified)	±600V/10us	100MΩ	-40 ℃～+100 ℃

Notes：①Some models are in development and not released , detailed information please contact us

Ordering Information



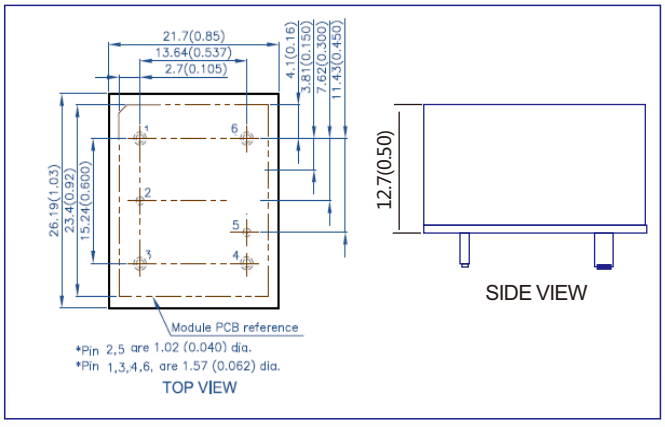
Current Share Module

Special features:

- Output voltage up to 50V, output current up to 60A
- Designed to use with Dr.Power DC-DC converters for current sharing and N+1 redundancy
- Anti-backflow protection
- Low profile, low wire resistance, low power dissipation
- Operating temperature (case)：-55℃~100℃
- Current sharing imbalance （<10 piece）<5%
- Size：26.19×21.70×12.70（mm）

Voltage range	Max. Output current	Redundancy Yes or No	Resistance	Operating Temperature	Size
3 ~ 13V	60A	Yes	<2mΩ	-55℃ ~ +100℃	1/32 Brick
12~50V	30A	Yes	<6mΩ		

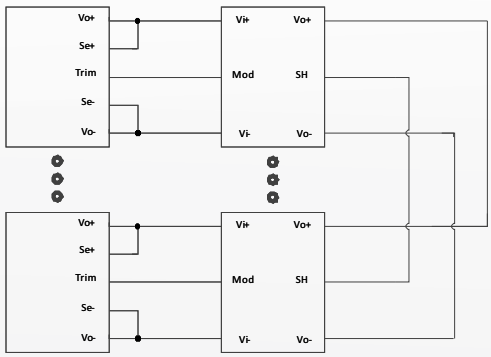
Mechanical Diagram



Detailed information please refer Spec

Pin	Pin Name	Function
1	Vin(+)	Positive input
2	Mod	Output voltage trim for current share
3	Vin(-)	Negative input
4	Vout(-)	Negative output
5	SH	Current share
6	Vout(+)	Positive output

Typical Application-Connection Diagram



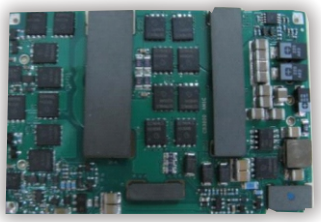
Multiple Output Converters and Custom Converters

16-40Vin，Dual Output 5.0V/1A

Special features:

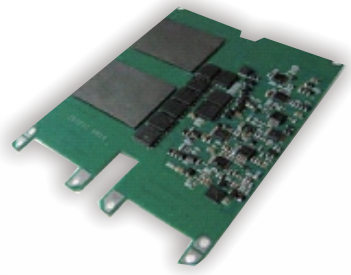
- Input voltage: 16-40V
- Output: 5V/1A, 5V/1A
- Output voltage range: 5V-15V
- Efficiency up to 82%
- High thermal performance
- Input under voltage protection, output over current protection, output short protection and over temperature protection
- Output power up to 30KW
- Package: open-frame, encapsulated
- Size(mm): 38.1x23.6x10.6 / Open framed
  40.5x26.0x12.7/ Encapsulated

Triple Output 600W



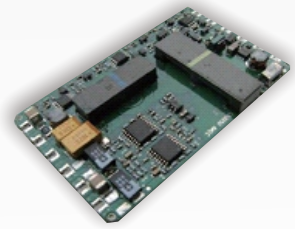
- Input voltage: 42V-55V
- Output: 8V/70A, 5V/5.5A, -12V/1.6A
- High efficiency: 93% at full load & 48Vin
- Input over/under voltage protection, output over current protection, output over voltage protection
- Internal over temperature protection
- Optional enable logic: negative or positive, optional protection mode: autorecovery or lock
- Conduction cooling, baseplate package
- Low profile(mm): 75.00x50.00x10.00

Triple output 220W



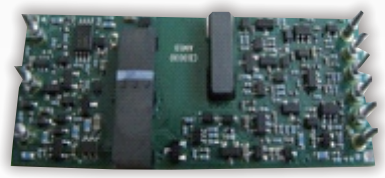
- Input voltage: 24V-42V
- Output: 9V/24A, 5V/2A, -5V/0.2A
- Output over voltage protection, output over current protection
- Input under voltage protection
- Internal over temperature protection
- Size (mm): 56.00x50.00x5.60

Triple Output 50W



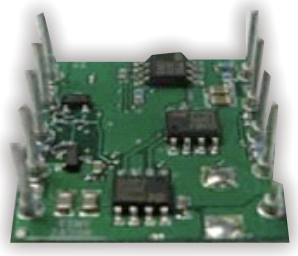
- Input voltage: 24V-42V
- Output voltage: 12V, 5V, 3.3V
- Output over voltage protection, output over current protection
- Input under voltage protection
- Internal over temperature protection
- Size (mm): 56.60x34.50x9.00

Triple Output 8W



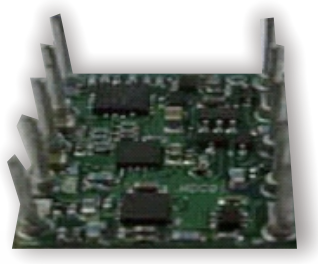
- Input voltage: 18V-36V
- Isolated triple output
- Output: 5V/2.5A, 5V/2.5A, 5V/0.6A
- High efficiency: 87% at full load & 24Vin
- Input under voltage protection
- Output over voltage protection
- Internal over temperature protection
- Optional enable logic: negative or positive, optional protection mode: autorecovery or lock
- Package: open-frame, encapsulated

Triple Output 14W



- Input voltage: 9V-12.6V
- Output voltage: 1.2V, 3.3V, trimmable 1V-3.3V
- Output over current protection
- Internal over temperature protection
- Package: Encapsulated
- Low profile (mm): 30.50x25.50x10.50

Triple Output 9W



- Input voltage: 3V-5.5V
- Output voltage: 1.2V, 3.3V, trimmable 1V-3.3V
- Output over current protection
- Internal over temperature protection
- Package: Encapsulated
- Low profile (mm): 26.50x20.50x10.50

Quad Output Custom ATX Power Board

- Input voltage: 18V-36V
- Output voltage: 5V, 3.3V, 5V, 12V
- Input current: 10A, 5A, 2A, 10A
- Input reverse connecting protection, input/output over voltage protection
- Size (mm): 203.50x90.00

Military VPX Power Supply

The VPX series are compliant with VITA 62.0 and military standard GJB181-86, GJB151A. The power supply mainly consists of EMI filter circuit, inrush limit circuit, DC-DC converter, output filter and controlling circuit. The VPX delivers up to 1000W and with flexible custom design output.

Application: Airborne, Missile-borne, Vehicle, Radar, Weapons, Communication and Controlling System.

Special Features:

1、Input range: DC28V（18V-36V)、AC115V±20% 400Hz、AC220V±20%50Hz、AC220V(85V-264V) 50Hz, meet almost all input voltage standards, provide models of mutiple input

2、Output voltage: +3.3V,+5.0V,+12V,±12V etc, provide several tens of custom design solutions

3、Output: Output power up to 1000W, provide custom design solutions

4、Output control TTL level, failure alarm, voltage monitoring, redundancy, current share.

5、Input under voltage protection, output over current/short protection and over temperature protection

6、High efficiency up to 92%

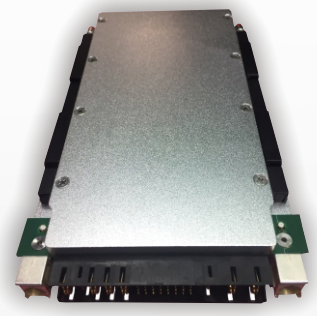
7、Designed to meet VITA 62.0

8、I^2C bus protocol, JTAG (USB) connector, monitoring output voltage, output current and internal temperature

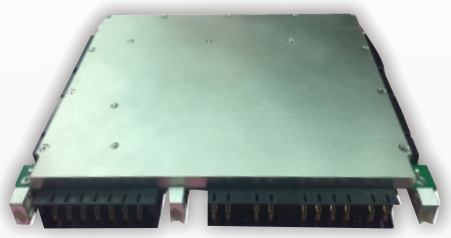
9、High reliability, high performance on EMI

10、Size: Standard 3U, 6U. Provide custom design products

Standard 3U Package Size
(mm: 168x100x24)



Standard 6U Package Size
(mm: 233x168x24)



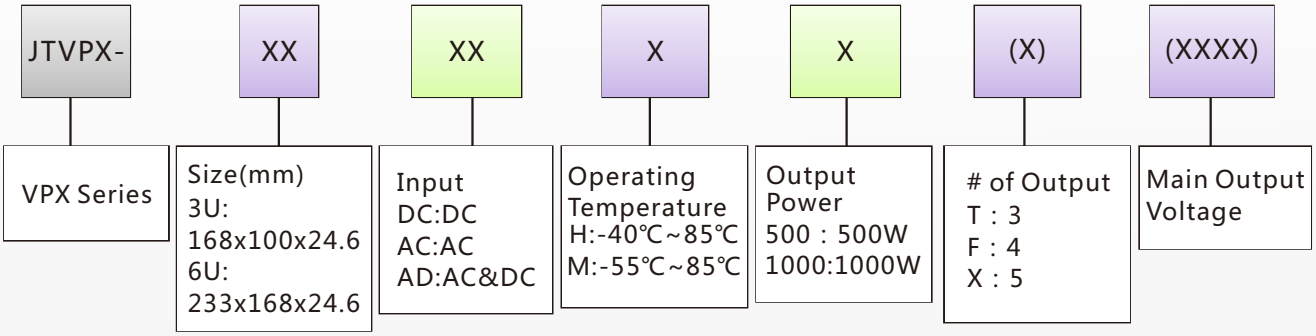
Product Specification(25℃ Ambient Temperature)

Input Voltage	DC28V(18V-36V) AC115V±20% 400Hz AC220V±20% 50Hz AC220V(85V-264V)50Hz	Operating Temperature	H Grade	-40℃~+85℃
			M Grade	-55℃~+85℃
Output Voltage Accuracy	≤1%	Storage Temperature		-55℃~+105℃
Line Regulation	≤0.5%	Isolation Resistance	Input/Case	100MΩ(DC1000V)
Load Regulation	≤2%		Input/Output	100MΩ(DC1000V)
Efficiency	≥90%		Output/Case	100MΩ(DC500V)
		Connector	Standard connector or custom define	

Product Examples

Model Number	Input Voltage	Output	Voltage Ripple	Efficiency	Size(mm)
JTVPX-6UDC28H1000	18-36Vdc	12V/80A,5V/30A,3.3V/15A ±12V/1A	Vp-p≤80mv	≥90%	233*168*24.6
JTVPX-3UDC28H500	18-36Vdc	12V/40A,5V/25A,3.3V/25A 3.3V/6A,±12V/1A	Vp-p≤80mv	≥90%	168*100*24.6
JTVPX-3UAC115H300	AC115/400Hz	12V/25A,5V/25A,3.3V/25A	Vp-p≤80mv	≥87%	168*100*24.6
JTVPX-6UAC220H500	AC220/50Hz	12V/17A,5V/35A,3.3V/15A 3.3V/25A,±12V/3A	Vp-p≤80mv	≥86%	233*168*24.6

Ordering Information



CPCI Power Supply

The CPCI series are designed for a wide range of industrial & military applications and compliant with military standard GJB150A-2009. Dr.Power provides custom design for different requirement. The power supply mainly consists of regulation circuit, EMI filter circuit, inrush limit circuit, DC-DC converter, output filter and controlling circuit.

Application: Airborne, Missile-borne, Vehicle, Radar, Weapons, Communication and Controlling System.

Special Features:

1、Input voltage range: AC115V±20% 400Hz、AC220V±20% 50Hz、AC220V(85V-264V) 50Hz、DC28V(18V-36V)、DC48V(36V-72V);

2、Output voltage: +3.3V,+5.0V,±12V etc, provide custom design solutions

3、Output current: provide several tens of custom design solutions

4、Output control TTL level, and failure alarm, voltage monitoring, redundancy, current share.

5、High efficiency up to 92%

6、Meet PICMG2.11 R1.0（CompactPCI standard）;

7、Input under voltage protection, output over current/short protection and over temperature protection

Standard 3U Package Size
(mm: 160x100x40)

Standard 6U Package Size
(mm: 233x160x40)

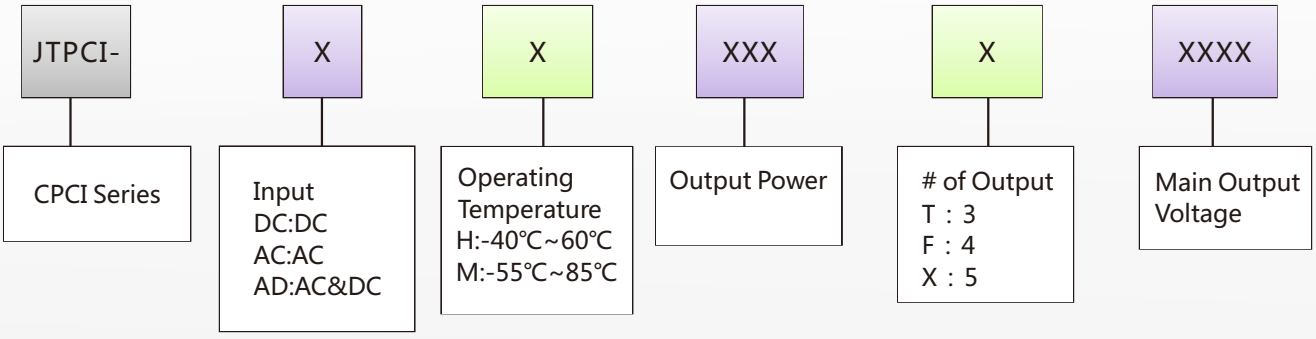
Product Specification(25℃ Ambient Temperature)

Input Voltage	DC24V/DC48V/DC110V AC115V±20% 400Hz AC220V±20% 50Hz AC220V(85V-264V) 50Hz等	Operating Temperature	H Grade	-40℃~+60℃
			M Grade	-55℃~+85℃
Output Voltage Accuracy	≤1%	Storage Temperature		-55℃~+105℃
Line Regulation	≤0.5%	Isolation Resistance	Input/Case	100MΩ(DC1000V)
Load Regulation	≤2%		Input/Output	100MΩ(DC1000V)
Efficiency	≥87%(DC Input)		Output/Case	100MΩ(DC500V)
	≥85%(AC Input)	Connector	Standard P47 connector or custom define	

Product Examples

Model Number	Input Voltage	Output	Voltage Ripple	Efficiency	Size(mm)
JTPCI-DH200F3312	18-36Vdc	12V/7A,5V/10A,3.3V/5A, -12V/1A	Vp-p≤20mv	≥88%	166*100*40
JTPCI-DH250F512	18-36Vdc	12V/10A,5V/20A,-12V/2.5A	Vp-p≤50mv	≥88%	160*100*40
JTPCI-ADH240F524	18-36Vdc 176-264Vdc	12V1/2A,12V2/8A,5V/6A, 24A/4A	Vp-p≤80mv	≥85%	160*100*40
JTPCI-AH270F3312	176-264Vdc	12V/10A,5V/15A,3.3V/20A -12V/1A	Vp-p≤50mv	≥87%	160*100*40
JTPCI-AH550F3312	176-264Vdc &300Vdc	6V/50A,5V/30A,3.3V/25A, -12V/1A	Vp-p≤20mv	≥87%	233*160*40

Ordering Information



AC-DC Power Supply and Power System

The AC-DC power supply and power system are designed for a wide range of industrial & military applications and compliant with military standard GJB150A-2009, GJB151. Dr.Power provides custom design for different requirement. The power supply mainly consists of regulation circuit, EMI filter circuit, inrush limit circuit, DC-DC converter, output filter and controlling circuit.

Application: Airborne, Missile-borne, Vehicle, Radar, Weapons, Communication and Controlling System.

Special Features:

1、Input voltage range: AC115V±20% 400Hz、AC220V±20% 50Hz、AC220V(85V-264V) 50Hz etc, provide multiple input solutions
2、Output voltage: provide custom design products
3、Output current: provide custom design products
4、Output control TTL level, and failure alarm, voltage monitoring, redundancy, current share
5、High efficiency up to 92%
6、Input under voltage protection, output over current/short protection and over temperature protection
7、High reliability, high performance on EMI

Product Specification(25℃ Ambient Temperature)

Input Voltage	AC115V±20% 400Hz AC220V±20% 50Hz AC220V(85V-264V) 50Hz AC380V±10% 50HZ(3-Phase) etc	Operating Temperature		50ms
			H Grade	-40℃~+60℃
			M Grade	-55℃~+85℃
Output Voltage Accuracy	≤1%	Storage Temperature		-55℃~+105℃
Output Voltage Trim	Custom define	Isolation Resistance	Input/Case	100MΩ (DC1000V)
Line Regulation	≤0.5%		Input/Output	100MΩ (DC1000V)
Load Regulation	≤2%		Output/Case	100MΩ (DC500V)
Efficiency	≥85%	Connector	Custom define	
Ripple Vp-p	≤20mV(refer spec)	Shock	6ms，Peak≤100g	

DC-DC Power Supply and Power System

The DC-DC power supply and power system are designed for a wide range of industrial & military applications and compliant with military standard GJB150A-2009, GJB151. Dr.Power provides custom design for different requirement. The power supply mainly consists of regulation circuit, EMI filter circuit, inrush limit circuit, DC-DC converter, output filter and controlling circuit. The output power varied from 6606W to 11W

Application: Airborne, Missile-borne, Vehicle, Radar, Weapons, Communication and Controlling System.

Special Features:

1、Input voltage range: DC28V（18V-36V)、DC48V(36V-75V)、DC110V(66V-160V)、DC550V(400V-650V)，etc, provide multiple input solutions

2、Output voltage: provide custom design products

3、Output current: provide custom design products

4、Output control TTL level, and failure alarm, voltage monitoring, redundancy, current share

5、High efficiency up to 92%

6、Input under voltage protection, output over current/short protection and over temperature protection

7、High reliability, high performance on EMI

Product Specification(25℃ Ambient Temperature)

Input Voltage	DC5V(4.5V-5.5V) DC24V(9V-36V) DC28V(18V-36V) DC48V(36V-75V) DC110V(66V-160V) DC550V(400V-650V)	Start-up Time		20ms
		Operating Temperature	H Grade	-40℃~+60℃
			M Grade	-55℃~+85℃
Output Voltage Accuracy	≤2%	Storage Temperature		-55℃~+105℃
Output Voltage Trim	Custom define	Isolation Resistance	Input/Case	100MΩ(DC1000V)
Line Regulation	≤0.5%		Input/Output	100MΩ(DC1000V)
Load Regulation	≤2%		Output/Case	100MΩ(DC500V)
Efficiency	≥88%	Connector	Custom define	
Ripple Vp-p	≤20mV(refer spec)	Shock	6ms，Peak≤100g	

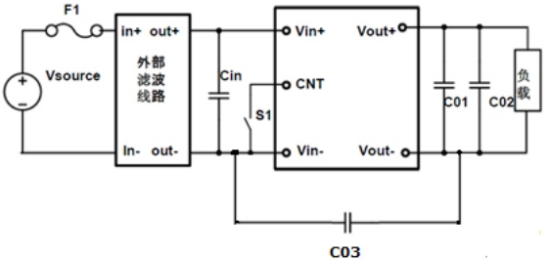
Appendix 1:

Application Notes for DC-DC PowerConverters

Dr.Power Technologies is a China based leader in design and manufacture of high reliable power supply solutions to rugged military and industrial field, and customers have trusted Dr.Power to help them accelerate time-to-market and reduce risk with the highly reliable power conversion products.

This application notes describes how to use the isolated DC-DC power converters of Dr.Power in systems, including typical application structure for DC-DC power module, thermal management, EMI consideration, large capacitive load , paralleling-active current sharing, layout notes, practical evaluation techniques, thermal evaluation. Please contact Dr.Power if there are any more application questions.

Typical Application Sample



F1:25A fuse（fast fuse）
Cin:100μF high frequency low ESR electrolytic capacitor, parallel connect 2.2μF ceramic capacitor
C01: 1μF ceramic capacitor
C02: 470μF E-Cap
C03: 0.01μF /3000Vdc ceramic capacitor.（could paralleling several capacitors

◆ Application Structure For DC-DC Power Module

Figure 1 shown a typical application structure for DC-DC power module. For a DC-DC power module to function properly in a system, the system design should provide a sufficiently low impedance power source （usually the output impedance of power source）to feed the power module, and the output impedance of the power module should be sufficiently low as well for good transient response. Besides the internal design of DC-DC converters and power source, these requirements are usually assured by placing extra capacitors (C1-C4 in Figure1 and figure 2) across the input terminals and the output terminals of the power module.

All standard board-mount DC-DC power modules operate in high frequency switching mode involving fast dv/dt and di/dt, thus generate conducted and radiated EMI. Due to space constraints and ever increasing power density dictated by the system power requirements, there is very limited on-board filtering. For a system to pass EMC regulations, it' s often necessary to add additional filtering components around the DC-DC power module. Except C2, other capacitors are low ESR (equivalent series resistance) and low ESL (equivalent series inductance) ceramic capacitors that provide low impedance loop for high frequency current noises. C1, C3, C4 are differential-mode filter capacitors. C2 represents low ESR and high Capacitance capacitor (such as electrolytic capacitor), the recommended capacitance of C2 for the 36-75V input voltage range (or above range) is 50-100μF per 100W output power. For 18-36V or 18-75V input ranges, the capacitance of C2 shall be significantly higher (such as 200-400μF per 100W) to limit both the power loss in this capacitor and the allowed voltage swing during start-up and load transients. The rating current of C2 should be taken care to meet the requirement of long time operation on high temperature environment and high load. The main function of C2 is to provide sufficiently lower impedance than the input impedance of the power module to keep the power source (line) impedance from interacting the power module input impedance, therefore, secure the stability of the power with module operation. At the same time, C2 provide low impedance loop for input ripple current. C7-C10 are common-mode decoupling capacitors often in the range of 10nF to 0.1μF with voltage rating sufficient to meet the system isolation voltage requirement. In many applications, additional capacitors (C4) are used at the output of DC-DC power modules, often in the range of several hundred to tens of thousands micro-farad (μF). Increasing capacitance of C4 will help to reduce the switching ripple at the output, and reduce the voltage variation during load or input transients. These are also low ESR capacitors (such as ceramic capacitors）.

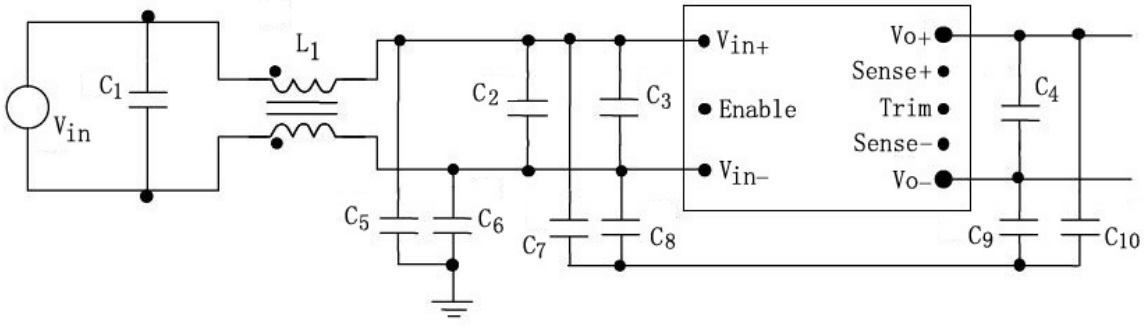


Figure 1 Typical application structure for DC-DC power module

SENSE(+) and SENSE(-) pins should be connected to the point where high precious regulation is desired(usually close to the load). The TRIM pin allows the user to adjust the output voltage set point, the output voltage adjustment range is usually 80% to 110% (some models 10% to 110%) of its specified nominal output voltage. The converter can be turned on and off by changing the voltage between the ON/OFF pin and Vin(-). When remote ON/OFF controlling is not required, the ON/OFF pin should be connected to Vin- (for negative control logic) or left floating (for positive control logic).

Thermal Management

The thermal management of DC-DC power modules is one of the most important application issues as more and more applications demand high power and high current in smaller packages and require the modules to operate under increasingly stringent environment, such as high temperature and low wind speed.

The key factors affecting the thermal performance of a given DC-DC power module are:

- Airflow and Orientation
- Ambient Temperature
- Heat transfer path

Available airflow and its orientation with reference to the power module have great impact on the module's thermal performance. It is recommended that customers place the converter at a location where it receives the maximum available airflow and in the preferred transverse orientation (refer to the thermal derating curve).

The thermal derating curves in the product datasheets provide a guideline for application. The derating curves are based on the data obtained in wind-tunnel tests conducted by power module manufacturers. The derating curves of Dr.Power are generated using industry standard of 125 °C power semiconductor junction temperature. The junction temperature is calculated based on semiconductor's thermal resistance and surface temperature.

Although the derating curves are supposed to be very important for system designs, the performance of a power module in a system often cannot be well represented by these curves, and evaluation at the system level is necessary. The detailed evaluation considerations are illustrated in "Thermal Evaluation" under "Practical Evaluation Techniques" section.

Based on open-frame design, the baseplate and other encapsulation options available on Dr.Power modules provide customers the flexibility in their designs to deal with extreme environments. Dr.Power module's high efficiency, balanced thermal design make sure better performance on extreme environment applications. A baseplate by itself is able to improve the thermal performance of the module. The higher the airflow speed, the more improvement a baseplate will bring. Additional heatsink can be added to some baseplates for enhanced thermal performance.

EMI Consideration

All standard board-mount DC-DC power modules operate in high frequency switching mode involving fast dv/dt and di/dt, thus generate conducted and radiated EMI. Radiated EMI is also affected by the converter's mechanical structure. General the converters apply snubber to reduce the high frequency vibration.

For the metal baseplate converter, connect the baseplate to ground or stable voltage point will bring about a certain shielding effect.

The conducted EMI can be separated into differential-mode (DM) noise and common-mode (CM) noises. The differential mode noises appear between the positive and the negative leads at both input and output terminals, mainly at input. Switch mode or PWM is the root cause of such kind of "noise".

The common mode noises appear between the converter input/output terminals to ground and the system, which are affected by many internal and external factors. Dr.Power's converters have internal input differential -mode L-C filter.

Additional external EMI filter is primarily for suppressing conducted EMI, though it also helps to reduce radiated EMI by containing the radiated EMI sources in a local area. EMI is a system problem, which is affected by many factors outside the converters, such as cabinet design, application PCB layout, etc.

So the external filter's structure and component's parameter may be different according to the different application system.

For Dr.Power converters, the single-stage filter in Figure 1 is generally good for power modules below 150W. For power level above 150W, the two-stage filter structure shown in Figure 2 is recommended.

C1，C2，C3，C4 are differential-mode filter Capacitors. C2 represents low ESR and high capacity capacitor (such as electrolytic capacitor) at the input of the power module and is primarily for holding the energy to keep the stiffness of the input voltage source, thus the proper stability and large signal behaviors of the power module. C1, C3, C4 are low ESR (equivalent series resistance) and low ESL(equivalent series inductance) Cap for EMI filtering and fast load transients, and they should be a combination of ceramic and tantalum types. These capacitors have low ESR and low ESL for good filtering results. The reason of suggesting a combination of ceramic and other types of capacitors is because of the extremely low ERS of the ceramic capacitors, when no other type of relatively higher ESR capacitors present, could cause instability of some power modules.

The recommended capacitance of C2 for the 36-75V input voltage range (or above) is 50-100μF per 100W output power. For 18-36V or 18-75V input ranges, the capacitance of C2 shall be significantly higher (such as 200-400μF per 100W) to limit both the power loss in thiscapacitor and the allowed voltage swing during start-up and load transients. The rating current of C2 should be taken care to meet the requirement of long time operation on high temperature environment and high load. The main function of C2 is to provide sufficiently lower impedance than the input impedance of the power module to keep the power source (line) impedance from interacting with the power module input impedance, therefore, secure the stability of the power module operation. If the power source (line) impedance is low and converter is close to power source, a lower capacitance C2 can be used. Besides securing stability, C2 also provide the loop for the input ripple current.

C7-C10 are common-mode decoupling capacitors often in the range of 10nF to 0.1μF with voltage rating sufficient to meet the system isolation voltage requirement. C7 and C8 are also common-mode decoupling capacitors when the connection to system ground is available.

In many applications, additional capacitors (C4) are used at the output of DC-DC power modules, often in the range of several hundred to tens of thousands micro-farad (μF). Such external output capacitors help to reduce the switching ripple at the output, and reduce the voltage variation during load or input transients. When large amount of ceramic capacitors are used at the output of a power module, it could cause the power module to become unstable due to the very low ESR of these capacitors. This is a complicated matter as it is related to small signal analysis of converter designs, the system board designs, and the characteristics and locations of the capacitors used.

The current mode control scheme adopted in most of Dr.Power's designs makes power modules' stability insensitive to the ESR of the load capacitors. For a robust system design when using large amount of load capacitance, a combination of ceramic capacitors and capacitors with moderate ESR such as tantalum, polymer or electrolytic capacitors often provide satisfactory results.

L1, L2 should be selected based on practical input current and system EMC request, the value varied from several tens of μH to several hundreds of μH. L1, L2 are common-mode inductor. The common-mode inductance and the common mode capacitors together provide the containment of the common-mode noise. The common-mode inductance of L1，L2 are usually below 1mH（several tens of μH to several hundreds of μH）considering its current rating, EMC request and physical size. The leakage inductance of L1, L2 serve as the inductance for differential-mode filtering.

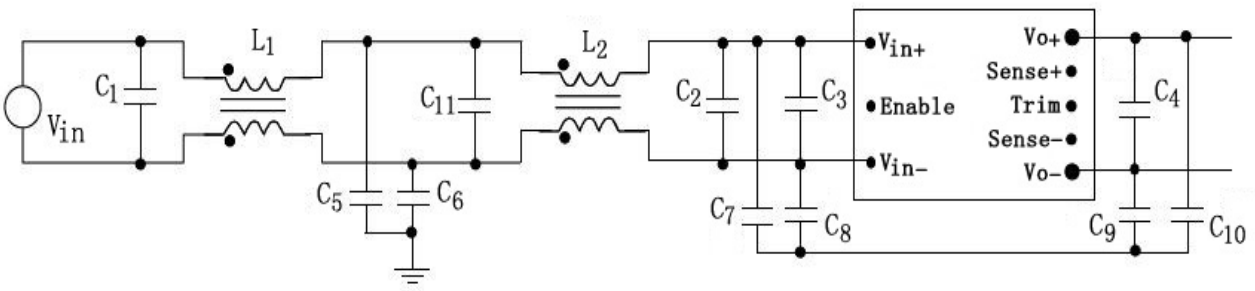


Figure 2 Two-Stage EMI filter structure

The filer structures shown in figure 2 is designed to meet electromagnetic compatibility (EMC) requirements for radiated and conducted EMI per FCC part 15J (47 CFR part 15B) in USA and/or EN55022 (equivalent to CISPR 22) in Europe without considering the system. Considering that module is only part of the application system and both input and output wires/trace are short and lay inside the system, system designs may suppress EMI through proper bypassing, shielding, grounding and system level filter. So the filter structure could be simpler compared to Figure 2.

Large Capacitive Load

In many applications, additional capacitors are used at the output of DC-DC power modules, often in the range of several hundreds to several thousands micro-farad (μF), some application demand even larger capacitance to tens of thousands of μF . Such external output capacitors help to reduce the switching ripple at the output, and reduce the voltage variation during load or input transients. The controlling schemes of DC-DC converters include voltage mode control and current mode control. When large amount of ceramic capacitors are used at the output of a power module, the voltage mode control DC-DC converters could easily be caused to become unstable due to the very low ESR of these capacitors as well as large amount of output capacitance. The current mode control scheme adopted in Dr.Power's designs makes power modules' stability insensitive to the ESR of the load capacitors. Moreover, the voltage overshooting of Dr.Power's modules are only no more than 5% on the specified maximum output capacitance. Customer can change parameter of the application board components to solve the power up failure caused by ultra large amount of output capacitance and can also contact Dr.Power for further support.

Paralleling- Active Current Sharing Notes

1. SHARE pin is noise sensitive and high-impedance network. SHARE pins of converters in parallel shall be tied together with possible shortest wire/trace, it is suggested to have corresponding ground plane on the application board to shield SHARE pin for reducing the ground noise impact on the current share accuracy. The ground plane shall be placed under the converters in parallel to make sure that the current share signals of these converters have the same referencing point. Minimize the loop formed by the current share signal traces and the above mentioned ground plane. Minimize the distance among the converters in parallel.

2. The input capacitor should be as close as possible to the input pin. For 18V-36V input range model, it is recommended to select input capacitor according to 1uF / W. For high input voltage model, it is recommended to select the input capacitor according to 0.5uF / W.

3. Vin (-) is used as the reference ground of the current sharing pin, Vin (-) on each converter should be connected together and don' t need any more components.

4. Y-Cap (value of tens to hundreds of nF) are recommended to add among Vin (-), Vout (-) and ground to improve the EMC performance with voltage rating sufficient to meet the system isolation voltage requirement. These capacitors should have good high frequency performance, such as ceramic capacitors. The trace of Y-Cap should be short and thick. At the same time, the layout trace spacing is recommended to be no less than 2mm.

5. If there is any filter on input side, Vin (+)/Vin (-) of the modules in parallel must be connected accordingly before connecting to filter.

6. If there is any filter on output side, Vout (+)/Vout (-) of the models in parallel must be connected accordingly before connecting to filter.

7. Try to use symmetrical input and output current paths.

8. Ceramic capacitors are recommended to add between Vout (+) and Vout (-) to minimize output ripple and noises.

9. If converters in parallel require to be turned on/off at the same time, it is recommended to use remote ON/OFF pin to control (add optocoupler on controlling if the converters don' t have the same ground reference).

10. Try to arrange the positions of the power converters or the airflow paths so that all converters in parallel can obtain similar airflow and running under similar thermal environment. Make sure the temperature of the case below 100℃.

11. Connect Sense (+) to Vin (+) and connect Sense(-) to Vin (-) for each converter. If system need to accurately regulate the load voltage, the output remote sense leads of all converters in parallel shall be connected to the point where the voltage regulation is required.

12. Leave the TRIM pin floating. If output voltage need to be trimmed up/down, each converter should connect a trim resistor separately. It may cause abnormal operating if all converters connect the same trim resistor.

13. Parallel application is very complicated. Please provide below application information if need the design support from Dr.Power.

Model Name	
Quantity of Converters in Parallel	
Total Output Power	
Is Dynamic Load(Y/N)	
Dynamic Load Parameter (Minimum Load/Duration Time, Maximum Load/ DurationTtime, Interval time(Cycle), Current Slope)	
Output capacitance	

Layout

The system designers shall keep the following guidance in mind when doing system board layout:

▲ The layout (component placement and trace routing) of EMI filter

The component of filter, especially the capacitors should be place as close as possible to the module. Run the positive and negative power paths (both input and output of the power module) as close as possible and better in parallel in a multiple layer PCB, minimizing the loop area and inductance because any loop area will either pick up noise and turning them into conducted noise or radiated noise to pollute other part of the system. This will also provide lower impedance than the input impedance of the power module to secure the stability of the power module operation. It is especially important when the power sourcing is far from the module.

A copper plan should be placed under the power module and coupled to the input and output terminals of the power module through ceramic capacitors of proper voltage rating. These ceramic capacitors also include the components of filter, such as C7-C10 in Figures 1 and figure 2.This helps to contain the radiated noise from the fast dv/dt and di/dt inside the power module. This copper plan should be buried in an internal layer of the system board to prevent possible violation of isolation spacing distances between input and output.

Avoid the coupling of a noisy trace and a quiet trace. This suggests place the filter components and the power module in a straight flow.

Use short paths and minimize loops for capacitor branches in the filter to avoid the trace impedance defeating the purpose of low impedance of the high frequency capacitors. Therefore C3 and C4 in Figure 1 should be placed as close to the power module as possible.

▲ High Current Capacity of the Application Board

As the module's power and current capabilities increasing, it is becoming more and more important to understand the current-carrying capabilities of application boards, especially the current-carrying capabilities of high output currents.

Consideration on current carrying capacity

1. The influence of the voltage drop on the application board trace. When a current of 100A flows through a 2mΩ resistor, a voltage drop of 200mV will be generated. Such a voltage drop may have a great impact on the low-voltage load. The module's remote sense can be used to compensate for such voltage drops, but it should be noted for the compensate range.

3.The temperature rise of the application board caused by high current. The temperature rise allowed by the application board is related to the ambient temperature and the material of the application board. For high reliability designs, the temperature rise should generally not exceed 20 ° C. The thermal characteristics of multi-layer PCBs are quite complicated.

Generally speaking, the IPC-2221 standard can be used as the starting point for analysis reference, the standard includes curves of the several inner/outer trace temperature rise relative to the cross-sectional area and current. According to these curves, temperature rise is 20 ° C for the outer layer of 0.16 mm2 carrying 10A current, while temperature rise is also 20 ° C with the same cross-sectional area of the inner trace carrying 5A current. It means that the inner trace carrying current capacity is about half of the outer trace.

3. Safety considerations. According to the requirements of UL, CSA, TUV and VDE, the primary to secondary side, primary side to ground, and secondary side to Ground must meet a sufficient minimum air separation distance and minimum insulation distance; the specific requirements are determined by the operating voltage, isolation design of primary and secondary sides connected parts, and whether the primary and secondary sides are grounded. In most DC-DC modules applications, if basic isolation is required, the air isolation distance is at least 0.71mm; the insulation isolation distance is at least 1.42mm

DC-DC Practical Evaluation Techniques

Evaluating DC-DC power modules for a specific application is a quite complex and errorprone process, and requires a thorough understanding of the power module and the application environment. To assist customer perform the test, Dr.Power supplies module evaluation board as shown in Figure 3. This board contains practical application circuit similar to that shown in Figure 1. In addition to the connection terminals and test points, there are also probe socket of oscilloscope. Customers can order the evaluation board from Dr.Power. More important tests should be performed on this board or similar devices to ensure the correct results. Below discussion are related to the most commonly and important tests.

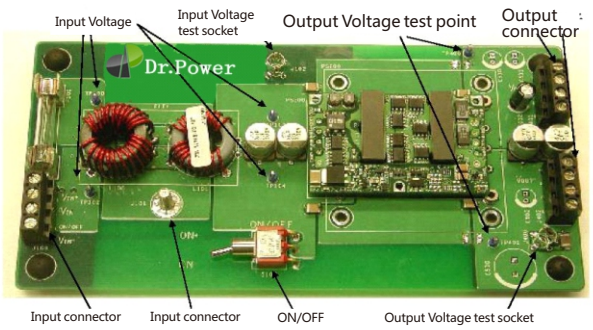


Figure 3 Dr.Power's evaluation board

▲ Efficiency Measurement

Conversion efficiency is a key parameter that is used in evaluating power modules. It' s essential to achieve high efficiency so heat generated inside a moduleis low.

Measuring the efficiency correctly is challenging. Since a 1% discrepancy in efficiency measurement means a significant change in terms of the losses, the accuracy of the measurement about input/output current and voltage becomes critical for any meaningful result.

Below points should be paid attention:

1. If the power converter is plugged into sockets, the contact resistance between the pins and the sockets especially at the output terminals varies with many factors, and can cause significant power losses. Therefore, when using sockets the output voltage readings shall be taken at the pins right above the sockets, not on the system or evaluation board.

2. The input and output currents shall be measured with high-accuracy shunts (accuracy 0.1%). The rated current of the shunts should be defined by the current of the input and output.

3. The multi-meters shall have at least 5-digit accuracy. Since all variables determining the efficiency are dc values, it's important that the meters' reading is not sensitive to the ac ripples that inevitably present in a switched-mode power supply.

4. Such a shunt has a small and well defined resistance to convert a current into a voltage signal normally in the range of mV. However, the measurement of such low amplitude signal is susceptible to switching noises, especially the common-mode noise. Filter capacitors may be used to achieve valid readings (refer figure 1 and figure 2). If good grounding and filtering is not possible, it's recommended to connect an input terminal (usually Vin-) to an output terminal(usually Vo-) together through a short wire or a capacitor to minimize common-mode noise.

5. The typical efficiencies published by Dr.Power as well as most other power module manufacturers are measured at room temperature while the converter is in cold state. For the purpose of comparing the measurements with the published efficiency, the measurement shall be taken quickly once the converter is powered up. In general, the efficiency drops while the component temperature rises. One should use the "hold" button of the multi-meters to hold all four numbers within a few seconds apart.

▲Output Ripple and Noise Measurement

Output ripple is referring to the voltage swing caused by charging and discharging the output capacitors at the switching frequency; while noise is about the ringing at much higher frequencies caused by the turning on and off of the power switches. To separate the ripple and the noise, the output ripple voltage measurements are conducted by limiting the oscilloscope bandwidth to 20-25MHz, while the output noise measurements are taken with full bandwidth of the oscilloscope. The ripple and noise measurement results are sensitive to the measurement setup since extra noise pickup, common-mode noise, and ground-loop noise can easily get into the measurements.

To obtain a correct accurate measurement, special attentions should be paid to these below issues:

1. Ground connection: sometimes poor grounding could cause a lot of noise. A complex grounding loop can be formed by the grounding connections of the power source, the module, the load and the oscilloscope, and also the parasitic capacitive coupling inside the power module. Often, single-point grounding is not easy to obtain at high frequencies. The best way to avoid this problem is to use differential probes. An isolation transformer can also be used to isolate power source to the power converter and the oscilloscope. Resistive load shall be used since it doesn't have any ground connection.

2. A loose connection between power module pins and the sockets or between oscilloscope probes and the test points may cause the measured ripple much higher or lower than it really is. Whenever possible, a soldered connection should be used.

3. A ceramic cap should always be connected at or close to the points where the probe is attached. The probe (probes) should be arranged to minimize extra noise pickup.

4. The scope bandwidth is another factor affecting the readings. The published ripple waveforms by almost all manufacturers are obtained with 20-25MHz bandwidth. For measuring noise, the oscilloscope should be set to full bandwidth to catch the very high frequency components at the input /output terminals.

5. It's highly recommended to measure output ripple voltage with a setup similar to actual application and with filter attached. The filter can reduce the common-mode noise and ground interaction in the measurement. The output voltage ripple is a differential signal by definition, but common-mode noise and ground interaction can distort the measurement. If good grounding and filtering is not possible, it 's recommended to connect an input terminal (usually Vin-) to an output terminal (usually Vo-) together through a short wire or a capacitor.

6. Output ripple voltages could also vary significantly with the input voltage changing. Customers should check the ripple at low, nominal, and high line conditions.

7. Use a BNC connector if possible because oscilloscope probe leads can easily pick up radiated noise to yield misleading readings. If wire connection is used for connecting the BNC to the test point, make sure the two wires are twisted and as short as possible.

▲ Output Voltage Startup Waveform

Today' s complex electronic systems often require their ICs to follow a given sequence during power-up. To accommodate the tolerance of the IC threshold voltages, power modules need to provide a monotonic and fast-rising output voltage during a start up process. There are 2 kinds of start up for the module on application board: 1. Setting remote ON/OFF pin to ON, module will be turned on with lowest input start up voltage. 2. Setting remote ON/OFF pin to OFF and with normal input, module will be turned on with remote on/off change to on.

Please note that load capacitance and load current have significant impact on this waveform. Two extreme corner conditions should be checked: minimum load with minimum output capacitance and maximum load with maximum output capacitance.

Pre-biased start up is another commonly concerned characteristic. In today's electronic systems, multiple voltages are required. Some sophisticated ICs require multiple voltages to power chip. There is often a required sequence for these different voltages to be established for these ICs to work properly. It's often the case that lower voltages are required to be established sooner than the higher voltages. When a lower voltage is established, it could go through some internal paths in an IC or circuits on the system board to pre-charge the output of a higher voltage rail. When the power module for the higher voltage rail starts, its output voltage should be monotonically rising other than dropping down before rising up.

▲Thermal Evaluation

Thermal performance of a power module determines how much current or power it can supply reliably. In many applications power modules are required to operate at a challenging environment. To achieve good thermal performance, a module needs to have high efficiency to reduce its power loss and thus heat generated. The module must also have good heat distribution across the module, as well as a good mechanism to remove the heat out of the module. A module's thermal performance is characterized by its thermal derating curves often found in datasheets.

Thermal derating curves define how many amperes of current a power module can output under various airflow speeds / orientations and ambient temperatures. The derating curves are based on the data obtained in wind-tunnel tests conducted by power module manufacturers.

Among power module manufacturers there are differences in temperature measurement method and location, airflow measurement method and location, construction of the test fixtures, spacing board design and pitch, etc. These differences have significant influence on the resulted derating curves. Because of these differences, the derating curves published by different suppliers cannot be directly compared to determine whether one module is better or worse than another module from a different vendor. It is strongly recommended to evaluate the module's thermal performance in actual systems, or in a condition closely simulating the actual application.

If a thermal coupler is used to measure the temperature on that component, the wire connecting the thermal coupler should be much smaller than the component itself to avoid unintended heat transfer through the wire. Also, the thermal coupler should not be attached to places with high voltage, such as the drain leads of primary power MOSFETs. If an infra-red temperature meter is used, the measurement area of the meter should be significantly smaller than the device's area for meaningful results. A better way to evaluate a power module is to obtain a thermal image of the whole module because such image gives the user much more information than a point on the derating curve. One example image of Dr.Power's modules is shown in Figure 4.

Even if the power module manufacturer has done everything correctly in generating the thermal derating curves, it's very likely that the application environment is different from the supplier's test environment. The user needs to evaluate the module's thermal performance in the system under differen conditions, include some abnormal operating conditions such as fan failure. Performing thermal tests in an early stage is of great value and could save a lot of time and effort later. If the actual thermal environment and/or the maximum load current were unknown, it would be beneficial to select the power module that has effective options for thermal performance enhancement, such as the ability to add a baseplate and/or heatsink.

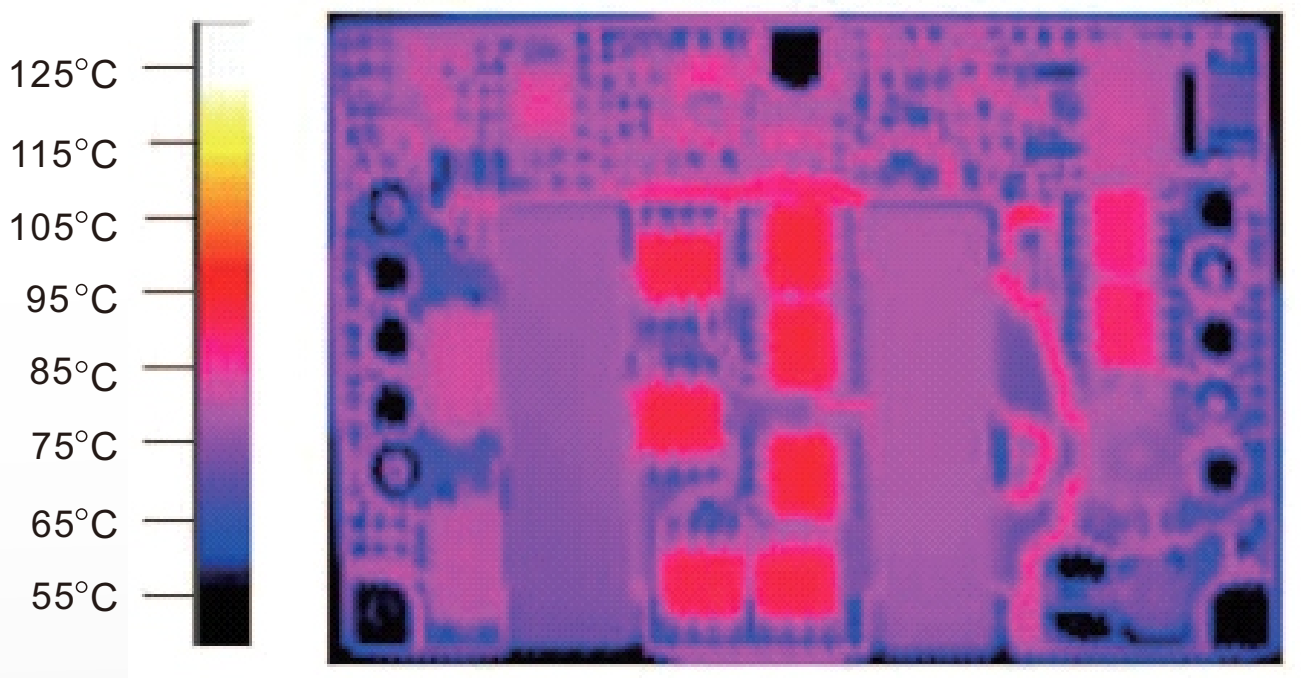
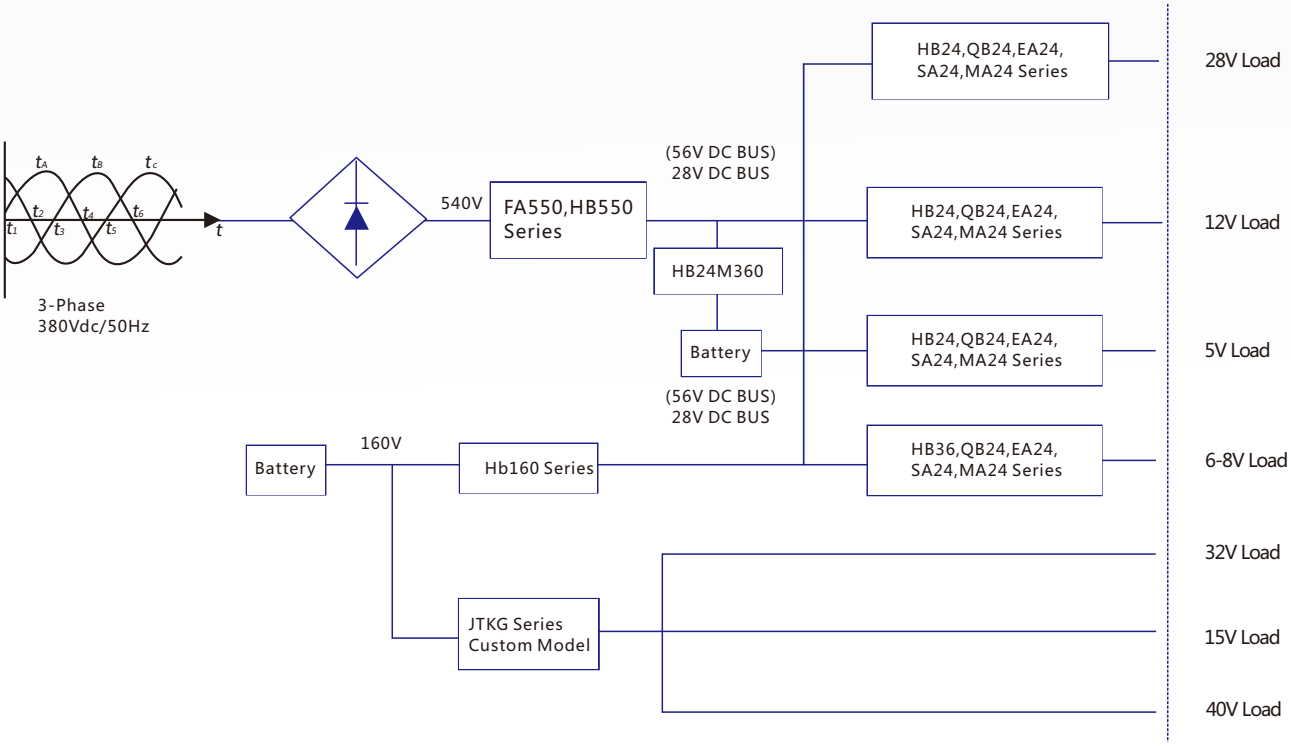


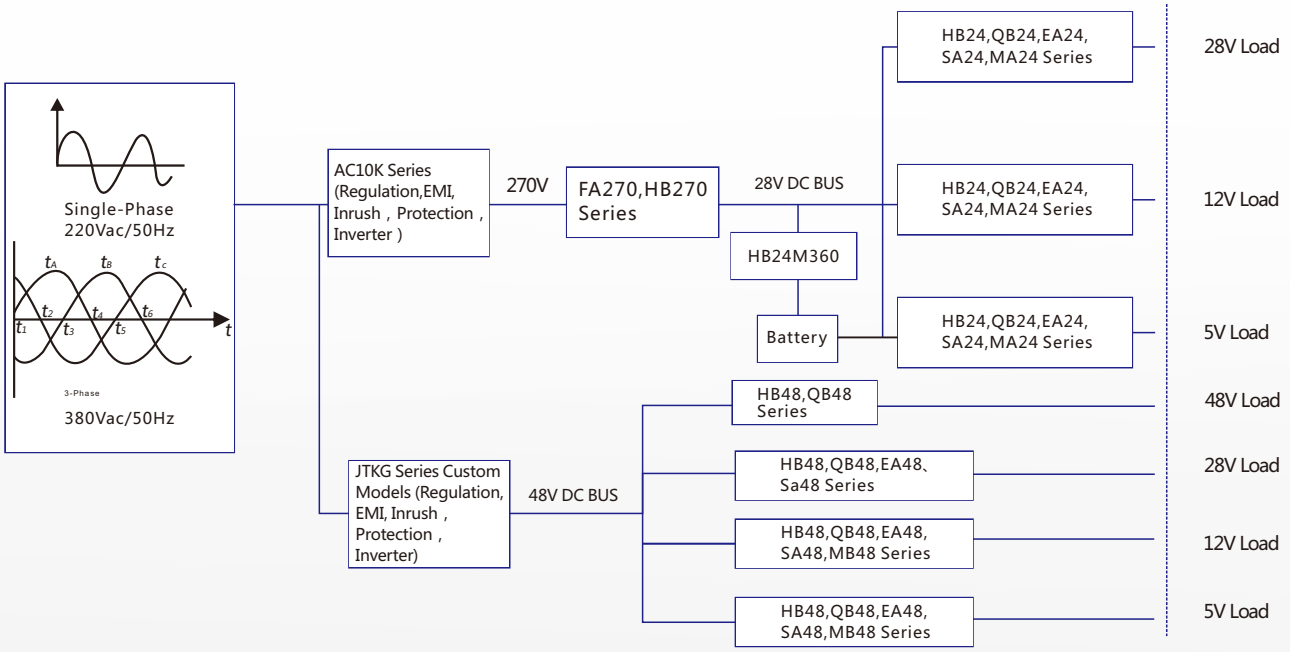
Figure 4 Example thermal image of Dr.Power's module

Appendix 2 :

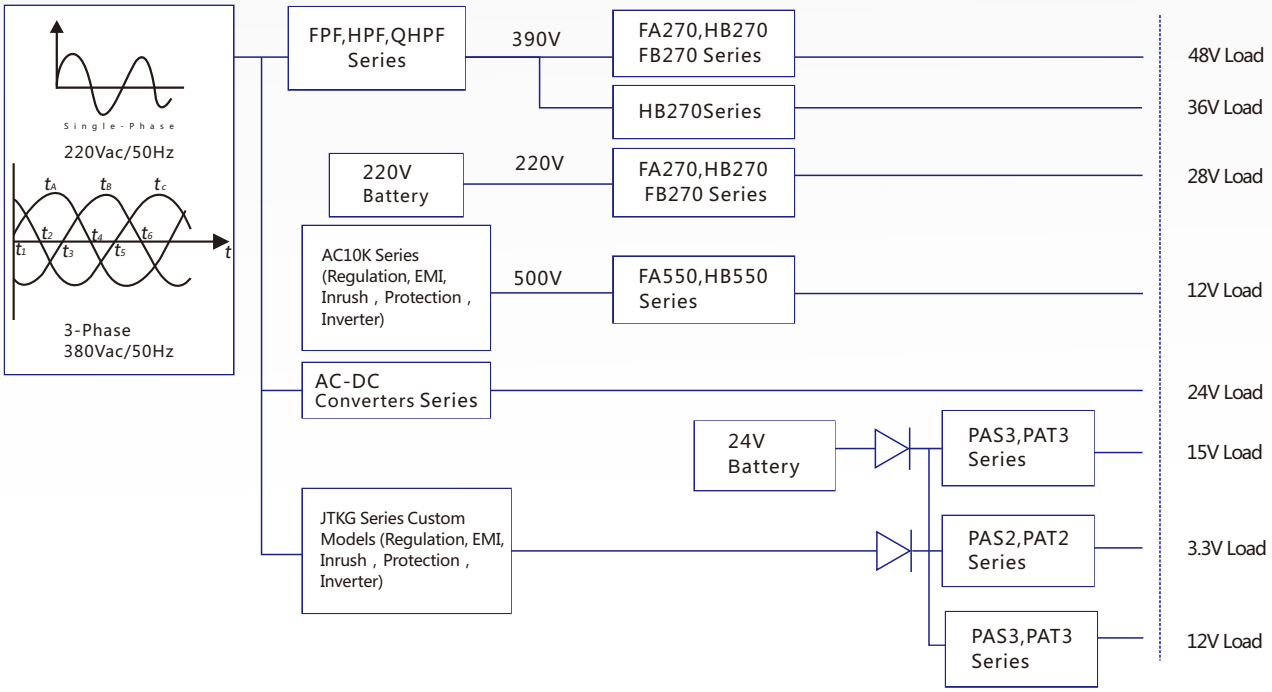
Application Example 1-MissileBorne



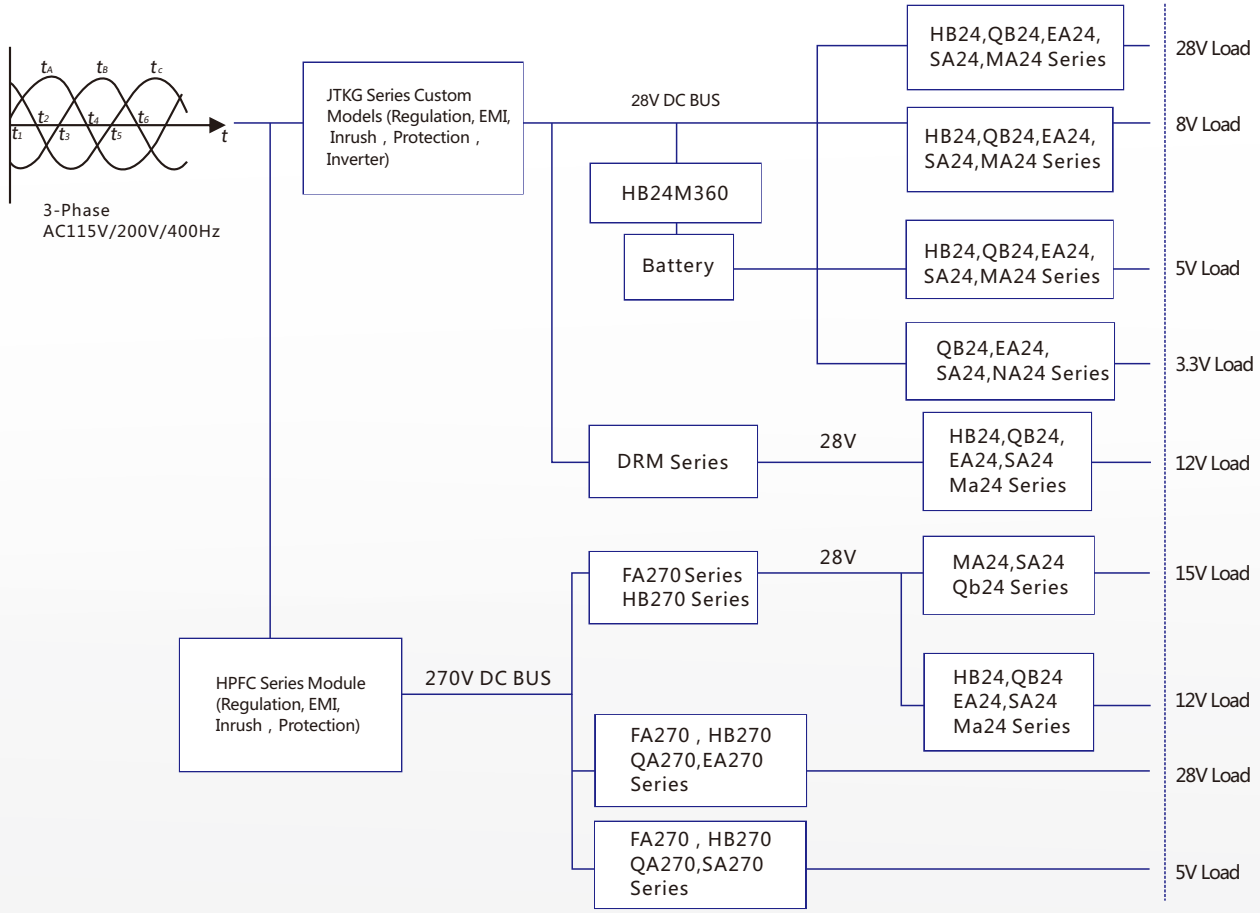
Application Example 2- Vehicle



Application Example 3- Shipborne



Application Example 4- Airborne



Appendix 3 :

Products Weight

Series	Open-frame	Baseplate	Encapsulated	Flanged Baseplate
1/32 Brick	9.5±2g	14.5±2g	23±5g	23±5g
1/16 Brick	16±5g	23±5g	35±5g	40±5g
1/8 Brick	27.5±5g	38.5±5g	65±5g	70±5g
1/8 Brick with Fixed Pin	-	-	76±5g	-
1/4 Brick	45±15g	65±15g	100±10g	105±10g
1/4 Brick with Fixed Pin	-	-	115±10g	-
1/2 Brick	73±5g	105±15g	165±10g	-
1/2 Brick Pentagon Plastic Package			130±10g	
FA Series Full Brick	145±15g	-	310±15g	-
Brick Pentagon Plastic Package	-	-	260±15g	-
FB Series Full Brick	92±15g	-	210±15g	-

Notes: Please refer datasheets for detailed information

Dimension (Please refer datasheets for detailed information)

LengthxWidthxHeight (mm)

		Open-frame	Baseplate	Encapsulated	Flanged Baseplate
1/32	MA	23.6x19.3x10.7	25.9x19.3x12.7	26.19x21.7x12.7	37.9x22.1x12.7
	MB	23.6x19.3x10.7	25.9x19.3x12.7	26.19x21.7x12.7	37.9x22.1x12.7
1/16	SA	33.3x23.1x9.7	33.3x23.1x12.7	35.3x25.1x12.7	39.0x37.5x12.7
1/8	EA	58.4x22.8x10.4	58.4x22.8x12.7	61.0x25.2x12.7	64.5x37.5x12.7
	EC	58.4x22.8x10.4	58.4x22.8x12.7	61.0x25.2x12.7	64.5x37.5x12.7
1/4	QA	58.2x37.1x10.2	58.2x37.1x12.7	60.6x39.4x12.7	64.3x51.7x12.7
	QB	58.2x37.1x10.2	58.2x37.1x12.7	60.6x39.4x12.7	64.3x51.7x12.7
	QC	58.2x37.1x10.6	58.2x37.1x12.7	60.6x39.4x12.7	64.3x51.7x12.7
1/2	HB	61.2x58.2x10.1	61.2x58.2x12.7	64.0x61.0x12.7	-
Full Brick	FA	113.3x57.9x10.1	-	116.8x61.2x13.7	-
	FB	112.0x40.9x10.0	-	-	116.9x55.9x12.7

Dr.Power Technologies

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