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POWERBOX Industrial Line
PQAE150W Series
Up to 132W 4:1 Single Output
High Performance DC/DC Converter
Manual

Table of Contents

1. Introduction

The PQAE150W series offer 132 watts of output power in an industry standard quarter-brick package and footprint. PAE150W series have 4:1 ultra wide input voltage range, output short circuit protection, over-current protection, over-voltage protection, and adjustable output voltage.

2. DC/DC Converter Features

- Single output to 30A
- Industry standard quarter-brick footprint
- 2.28 x 1.45 x 0.50 inch
- Hich efficiency up to 90%
- Input to output insulation: 2250 VDC
- 4:1 ultra wide input voltage range
- Low standby power consumption
- Adjustable output voltage
- Input under-voltage protection
- Output over-voltage protection
- Output over-current protection
- Output short circuit protection
- Remote on/off
- Remot sense
- Over-temperature protection
- Railway application
- Compliant to RoHS II & REACH
- Compliance to EN50155 and EN45545-2
- Railway standard

3. Technical Specifications

Output Characteristics

Parameters	**Model**	**Min**	**Typical**	**Max**	**Units**
Output voltage					
(Vin(nom); full load; Ta=25 °C)	□□S3P3W	3.267	3.3	3.333	VDC
	□□S05W	4.95	5	5.05	VDC
	□□S12W	11.88	12	12.12	VDC
	□□S15W	14.85	15	15.15	VDC
	□□S24W	23.76	24	24.24	VDC
	□□S30W	29.70	30	30.30	VDC
	□□S48W	47.52	48	48.48	VDC
Output regulation					
Line (Vin(min) to Vin(max); full load)	All	-0.1		+0.1	%
Load (0% to 100% of full load)	□□S3P3W	-0.2		+0.2	%
	□□S05W	-0.2		+0.2	%
	□□S12W	-0.1		+0.1	%
	□□S15W	-0.1		+0.1	%
	□□S24W	-0.1		+0.1	%
	□□S30W	-0.1		+0.1	%
	□□S48W	-0.1		+0.1	%
Output ripple and noise					
Peak to peak (20MHz bandwidth)	□□S3P3W		75	100	mVp-p
With a 22μF/25V X7R MLCC	□□S05W		75	100	mVp-p
	□□S12W		100	125	mVp-p
	□□S15W		100	125	mVp-p
With a 4.7μF/50V X7R MLCC	□□S24W		200	250	mVp-p
	□□S30W		200	250	mVp-p
With a 2.2μF/100V X7R MLCC	□□S48W		300	350	mVp-p
Voltage adjustability					
(Maximum output deviation is inclusive of remote sense)	All	-20		+10	% of Vout
Remote sense					
(If remote sense is not being used, sense pins should connect to the output pins with the same polarity.)	All			10	% of Vout
Temperature coefficient	All	-0.02		+0.02	%/°C
Output voltage overshoot					
(Vin(min) to Vin(max); full load; Ta=25°C)	All		0	5	% of Vout
Dynamic load response					
(Vin(nom); Ta=25°C) load step change from 75% to 100% or 100 to 75% of full load peak deviation	□□S3P3W		350		mV
	□□S05W		450		mV
	□□S12W		700		mV
	□□S15W		700		mV
	□□S24W		750		mV
	□□S30W		1100		mV
	□□S48W		1200		mV
Setting Time (Vo<10% peak deviation)	All		250		μs

Parameters	Model	Min	Typical	Max	Units
Output current	24S3P3W			30	A
	24S05W			24	A
	24S12W			10	A
	24S15W			8	A
	24S24W			5	A
	24S30W			4	A
	24S48W			2.5	A
	48S3P3W			30	A
	48S05W			24	A
	48S12W			10	A
	48S15W			8	A
	48S24W			5	A
	48S30W			4	A
	48S48W			2.5	A
	110S3P3W			30	A
	110S05W			24	A
	110S12W			11	A
	110S15W			8.6	A
	110S24W			5.5	A
	110S30W			4.4	A
	110S48W			2.7	A
Output capacitance load	24S3P3W			91000	µF
	24S05W			48000	µF
	24S12W			8300	µF
	24S15W			5300	µF
	24S24W			2100	µF
	24S30W			1300	µF
	24S48W			520	µF
	48S3P3W			91000	µF
	48S05W			48000	µF
	48S12W			8300	µF
	48S15W			5300	µF
	48S24W			2100	µF
	48S30W			1300	µF
	48S48W			520	µF
	110S3P3W			91000	µF
	110S05W			48000	µF
	110S12W			9170	µF
	110S15W			5730	µF
	110S24W			2290	µF
	110S30W			1470	µF
	110S48W			560	µF
Output over voltage protection					
(Hiccup mode)	All	115		130	% of Vout
Output over current protection					
(% of Iout rated; Hiccup mode)	All	110		140	% of FL
Output short circuit protection	All	Continuous, automatics recovery			

Input Characteristics

Parameters	**Model**	**Min**	**Typical**	**Max**	**Units**
Operating input voltage					
Continuous	24S□□W	8.5	24	36	VDC
	48S□□W	16.5	48	75	VDC
	110S□□W	40	110	160	VDC
Transient (1sec,max)	24S□□W			50	VDC
	48S□□W			100	VDC
	110S□□W			185	VDC
Input standby current					
Typ. value at Vin(nom); no load)	24S3P3W		25		mA
	24S05W		25		mA
	24S12W		25		mA
	24S15W		25		mA
	24S24W		25		mA
	24S30W		25		mA
	24S48W		25		mA
	48S3P3W		15		mA
	48S05W		15		mA
	48S12W		15		mA
	48S15W		15		mA
	48S24W		15		mA
	48S30W		15		mA
	48S48W		15		mA
	110S3P3W		8		mA
	110S05W		8		mA
	110S12W		8		mA
	110S15W		8		mA
	110S24W		8		mA
	110S30W		8		mA
	110S48W		8		mA
Under voltage lockout turn-on threshold	24S□□W			9	VDC
	48S□□W			18	VDC
	110S□□W			43	VDC
Under voltage lockout turn-off threshold	24S□□W	7.3		8.1	VDC
	48S□□W	15.5		16.3	VDC
	110S□□W	33.0		36.0	VDC
Input reflected ripple current	All		50		mAp-p
Start up time					
(Vin(nom) and constant resistive load) Power up	All		75	100	ms
Remote on/off	All		75	100	ms
Remote on/off control					
(The Ctrl pin voltage is referenced to negative input)					
Negative logic (standard)					
On/Off pin low voltage (remote ON)	□□S□□W		Short or 0 ~ 1.2VDC		
On/Off pin high voltage (remote OFF)			Open or 3 ~ 12VDC		
Positive logic (option)					
On/Off pin high voltage (remote ON)	□□S□□W-P		Open or 3 ~ 12VDC		
On/Off pin low voltage (remote OFF)			Short or 0 ~ 1.2VDC		
Input current of remote control pin	All	-0.5		1	mA
Remote off state input current	All		3		mA

General Specifications

Parameters	**Model**	**Min**	**Typical**	**Max**	**Units**
Efficiency					
(Vin(nom); Full Load; Ta=25°C)	24S3P3W		88		%
	24S05W		89		%
	24S12W		88		%
	24S15W		89		%
	24S24W		88		%
	24S30W		89		%
	24S48W		88		%
	48S3P3W		88		%
	48S05W		89		%
	48S12W		89		%
	48S15W		90		%
	48S24W		90		%
	48S30W		90		%
	48S48W		90		%
	110S3P3W		88		%
	110S05W		89		%
	110S12W		88		%
	110S15W		89		%
	110S24W		89		%
	110S30W		89		%
	110S48W		89		%
Isolation voltage (1 minute; basic insulation)					
Input to output	All	2250			VDC
Input (output) to base-plate	All	2250			VDC
Isolation resistance	All	1			GΩ
Isolation capacitance	All			1500	pF
Switching frequency	All	270	300	330	kHz
Weight	All		64		g
MTBF MIL-HDBK-217F Tc=70°C, full load	All		3.684×10^5		hours
Safety meets	All	IEC60950-1,UL60950-1, EN60950-1			
Case material	All	Aluminum base-plate with plastic case			
Potting material	All	Silicone (UL94 V-0)			

Environmental Characteristics

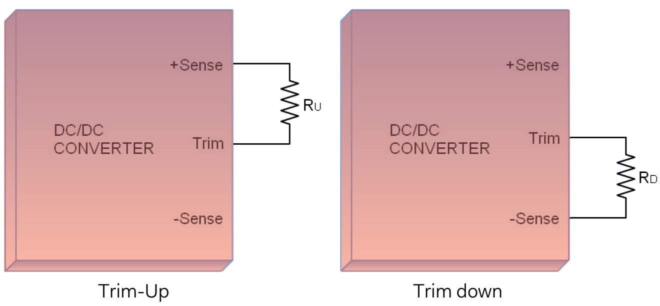
Parameters	Model	Min	Typical	Max	Units
Operating base-plate temperature	All	-40		100	°C
Storage temperature	All	-55		125	°C
Over temperature protection	All		110		°C
Thermal impedance (vertical direction; 20LFM)					
Without heat-sink	□□S□□W		9		°C/W
	□□S□□W -HS		7.1		°C/W
With 0.24" height heat-sink	□□S□□W -HS2		7.1		°C/W
	□□S□□W -HS1		5.5		°C/W
With 0.5" height heat-sink	□□S□□W -HS3		5.5		°C/W
Only mount on 2U iron base-plate	□□S□□W		2.8		°C/W
*2U iron base-plate dimension is 19" X 3.5" X 0.063"					
Relative humidity	All	5		95	% RH
Thermal shock	All		MIL-STD-810F		
Shock	All		EN61373, MIL-STD-810F		
Vibration	All		EN61373, MIL-STD-810F		

EMI Characteristics

Parameters	Standard	Condition		Level
EMI (for further information, please contact Powerbox)	EN55011 EN55022	With external input filter		Class A, Class B
ESD	EN61000-4-2	Air Contact	±8kV ±6kV	Perf. Criteria A
Radiated immunity	EN61000-4-3	20V/m		Perf. Criteria A
Fast transient	EN61000-4-4	±2kV		Perf. Criteria A
Surge	EN61000-4-5	EN55024 EN50155	±2kV ±2kV	Perf. Criteria A
Conducted immunity	EN61000-4-6	10V r.m.s		Perf. Criteria A
Power frequency magnetic field	EN61000-4-8	100A/m continuous; 1000A/m 1 second		Perf. Criteria A

4. Output Voltage Adjustment

Output voltage is adjustable for 10% trim up or -20% trim down of nominal output voltage by connecting an external resistor between the Trim pin and either the +Sense or -Sense pins. With an external resistor between the Trim and -Sense pin, the output voltage set point decreases. With an external resistor between the Trim and +Sense pin, the output voltage set point increases. Maximum output deviation is +10% inclusive of remote sense. The value of external resistor can be obtained by equation or trim table shown in next page. The external TRIM resistor needs to be at least 1/8W of rated power.



Output voltage adjustment configurations

Trim Equation

$$R_U = \left(\frac{5.11 V_{OUT}(100 + \Delta\%)}{1.225\Delta\%} - \frac{511 + 10.22\Delta\%}{\Delta\%} \right) k\Omega$$

$$R_D = \left(\frac{511}{\Delta\%} - 10.22 \right) k\Omega$$

Trim Table

□□S3P3W	**Trim-Up**										
Trim-Up	**(%)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	3.333	3.366	3.399	3.432	3.465	3.498	3.531	3.564	3.597	3.630
RU	(kΩ)	869.117	436.331	292.07	219.939	176.66	147.808	127.198	111.742	99.72	90.103

□□S05W	**Trim-Up**										
Trim-Up	**(%)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	5.05	5.10	5.15	5.20	5.25	5.30	5.35	5.40	5.45	5.50
RU	(kΩ)	1585.35	797.994	535.542	404.316	325.58	273.09	235.596	207.476	185.605	168.109

□□S12W	**Trim-Up**										
Trim-Up	**(%)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	112.12	12.24	12.36	12.48	12.60	12.72	12.84	12.96	13.08	13.20
RU	(kΩ)	4534.55	2287.19	1538.08	1163.52	938.78	788.956	681.939	601.676	539.25	489.309

□□S15W	**Trim-Up**										
Trim-Up	**(%)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	15.15	15.30	15.45	15.60	15.75	15.90	16.05	16.20	16.35	16.50
RU	(kΩ)	5798.49	2925.42	1967.73	1488.89	1201.58	1010.04	873.229	770.619	690.812	626.966

□□S24W	**Trim-Up**										
Trim-Up	**(%)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	24.24	24.48	24.72	24.96	25.20	25.44	25.68	25.92	26.16	26.40
RU	(kΩ)	9590.32	4840.11	3256.7	2465	1989.98	1673.3	1447.1	1277.45	1145.5	1039.94

□□S30W	**Trim-Up**										
Trim-Up	**(%)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	30.3	30.6	30.9	31.2	31.5	31.8	32.1	32.4	32.7	33
RU	(kΩ)	12118.2	6116.57	4116.02	3115.74	2515.58	2115.47	1829.68	1615.33	1448.62	1315.25

□□S48W	**Trim-Up**										
Trim-Up	**(%)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	48.48	48.96	49.44	49.92	50.40	50.88	51.36	51.84	52.32	52.80
RU	(kΩ)	19701.9	9945.94	6693.96	5067.97	4092.38	3441.99	2977.42	2628.99	2357.99	2141.19

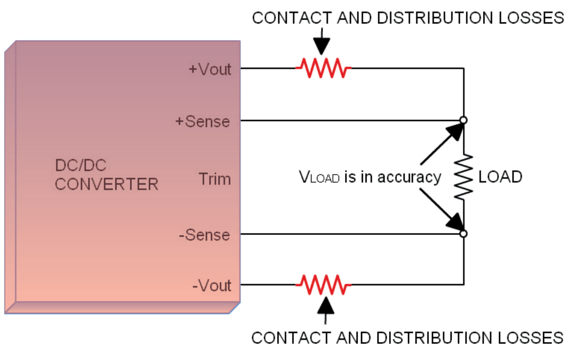
□□S□□W	**Trim-Down**										
Trim-Down	**(%)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
RD	(kΩ)	500.78	245.28	160.113	117.53	91.98	74.947	62.78	53.655	46.558	40.88
Trim-Down	(%)	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
RD	(kΩ)	36.235	32.363	29.088	26.28	23.847	21.718	19.839	18.169	16.675	15.33

5. Remote Sense

To minimum the effects of distribution losses by regulating the voltage at the Remote Sense pin. The voltage between the Sense pin and OUTPUT pin must not exceed 10% of Vout, i.e.

[+Vout to –Vout] – [+Sense to –Sense] ≤ 10% Vout

The voltage between +Vout and –Vout terminals must not exceed the minimum output overvoltage protection threshold. This limit includes any increase in voltage due to remote sense compensation and trim function. If not using the remote sense feature to regulate the output at the point of load, then connect +Sense to + Vout and –Sense to –Vout.

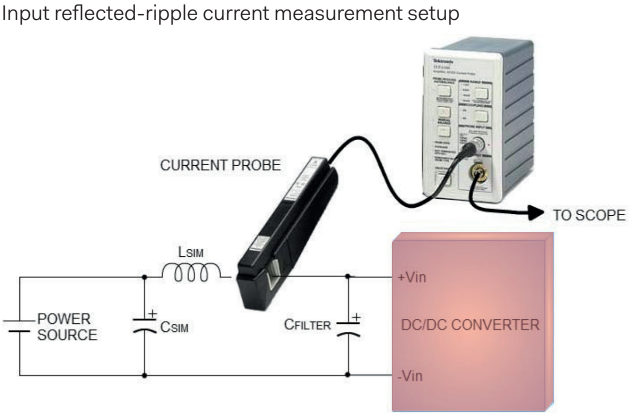


6. Input Source Impedance

The power modules will operate as specifications without external components, assuming that the source voltage has a very low impedance and reasonable input voltage regulation. Highly inductive source impedances can affect the stability of the power module. Since real-world voltage source has finite impedance, performance can be improved by adding external filter capacitor The PQAE150-24S□□W and PQAE150-48S□□W recommended Nippon Chemi-con KY series, 100μF/100V. The PQAE150-110S□□W recommended Ruby-con BXF series, 39μF/200V.

Install CSIM and LSIM to simulate the impedance of power source. External input capacitors CFILTER serve primarily as energy-storage elements, minimizing line voltage variations caused by transient IR drops in conductors from backplane to the DC/DC. The capacitor must as close as possible to the input terminals of the power module for lower impedance. For the input reflected-ripple current measurement configuration is shown as below:

Input reflected-ripple current measurement setup



PQAE150-24S□□W

Component	Value	Voltage	Reference
LSIM	11μH	----	Inductor
CSIM` CFILTER	220μF	50V	Nippon chemi-con KY-series

PQAE150-48S□□W

Component	Value	Voltage	Reference
LSIM	11μH	----	Inductor
CSIM` CFILTER	100μF	100V	Nippon chemi-con KY-series

PQAE150-110S□□W

Component	Value	Voltage	Reference
LSIM	20μH	----	Inductor
CSIM` CFILTER	120μF	200V	Ruby-con BXF series

7. Output Over Current Protection

When excessive output currents occur in the system, circuit protection is required on all power supplies. Normally, overload current is maintained at approximately 110~140 percent of rated current for PQAE150W Series. Hiccup-mode is a method of operation in a power supply whose purpose is to protect the power supply from being damaged during an over-current fault condition. It also enables the power supply to restart when the fault is removed. There are other ways of protecting the power supply when it is over-loaded, such as the maximum current limiting or current fold-back methods.

One of the problems resulting from over current is that excessive heat may be generated in power devices; especially MOSFET and Schottky diodes and the temperature of those devices may exceed their specified limits. A protection mechanism has to be used to prevent those power devices from being damaged.

The operation of hiccup is as follows. When the current sense circuit sees an over-current event, the controller shuts off the power supply for a given time and then tries to start up the power supply again. If the over-load condition has been removed, the power supply will start up and operate normally; otherwise, the controller will see another over-current event and shut off the power supply again, repeating the previous cycle. Hiccup operation has none of the drawbacks of the other two protection methods, although its circuit is more complicated because it requires a timing circuit. The excess heat due to overload lasts for only a short duration in the hiccup cycle, hence the junction temperature of the power devices is much lower.

The hiccup operation can be done in various ways. For example, one can start hiccup operation any time an over-current event is detected; or prohibit hiccup during a designated start-up is usually larger than during normal operation and it is easier for an over-current event is detected; or prohibit hiccup during a designated start-up interval (usually a few milliseconds). The reason for the latter operation is that during start-up, the power supply needs to provide extra current to charge up the output capacitor. Thus the current demand during start-up is usually larger than during normal operation and it is easier for an over-current event to occur. If the power supply starts to hiccup once there is an over-current, it might never start up successfully. Hiccup mode protection will give the best protection for a power supply against over current situations, since it will limit the average current to the load at a low level, so reducing power dissipation and case temperature in the power devices.

8. Output Short Circuitry Protection

Continuous, hiccup and auto-recovery mode. During short circuit, converter still shut down. The average current during this condition will be very low and the device can be safety in this condition.

9. Output Over Voltage Protection

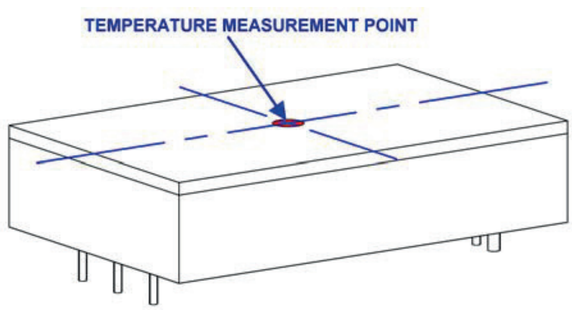
The output over-voltage protection consists of circuitry that monitors the voltage on the output terminals. If the voltage on the output terminals exceeds the over-voltage protection threshold, then the module enter the non-latch hiccup mode.

10. Over Temperature Protection

Sufficient cooling is needed for the power module and provides more reliable operation of the unit. If a fault condition occurs, the temperature of the unit will be higher. And will damage the unit. For protecting the power module, the unit includes over-temperature protection circuit. When the temperature of the Aluminum base-plate is to the protection threshold, the unit enters "Hiccup" mode. And it will auto restart when the temperature is down.

11. Thermal Considerations

The power module operates in a variety of thermal environments. However, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convection, and radiation to the surrounding Environment. Proper cooling can be verified by measuring the point as the figure below. The temperature at this location should not exceed 100°C. When Operating, adequate cooling must be provided to maintain the test point temperature at or below 100°C. Although the maximum point Temperature of the power modules is 100°C, you can limit this Temperature to a lower value for extremely high reliability.

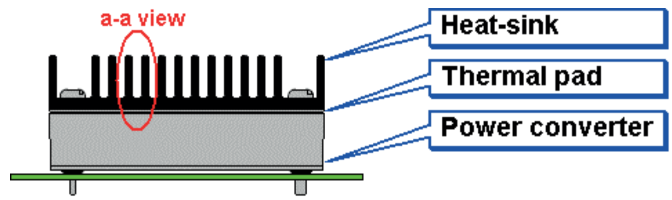


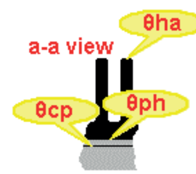
TOP VIEW

The suggested heat dissipation modes as below:

1. Add the heat-sink

The main function of heat-sink is to add the touch surface of heat source for air. Under the suitable air convection condition (including natural convection), that can reduce the heat resistance θ_{ca} apparently.
After combination of the heat resistance θ_{ca}, it's the sub-total of θ_{cp}, θ_{ph} and θ_{ha}. Because the air gets big heat resistance under no air convection, the θ_{ha} which touch the air is the main heat resistance.
Suggestions as below:
(1) $\theta_{ca}=\theta_{cp}+\theta_{ph}+\theta_{ha}$. In order to let the heat-sink reducing the θ_{ha} in big range, we suggest to use the thermal pad with good heat conduction and flushing performance.
(2) The best layout for heat-sink is to put the fin of the heat-sink vertical to the air, and this will cause a good "stack effect". So, we can have the best natural air convection condition. When there's no force air to help the heat dissipation, this point is critical.



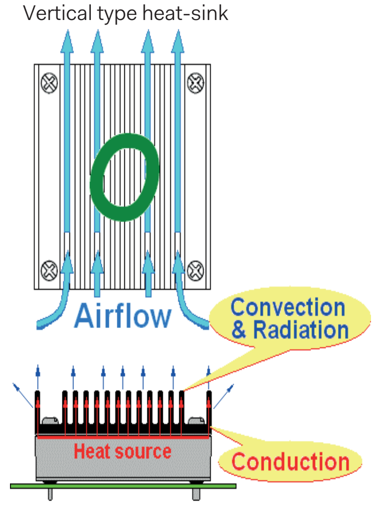


2. Force Air

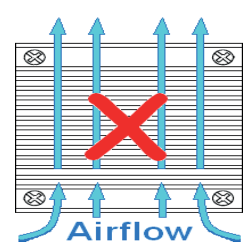
Normally, we use the fan for the force air. By the air movement rapidly, it can bring the heat energy from the case surface. This is a good solution to reduce the heat resistance θ_{ca} of the module. When the air speed is bigger, the heat resistance is smaller, and the heat dissipation performance is better. We need to note, the air direction not to be in vertical with the module's frame. Or, the heat dissipation performance will be worse.

If there's heat-sink and force air in the same system, the direction for heat-sink and force air should be followed as illustrate in below left chart. So we can get the best performance of heat dissipation. In below right chart, it's wrong direction. The air can't go through, the performance is not good.

Vertical type heat-sink



Horizontal type heat-sink

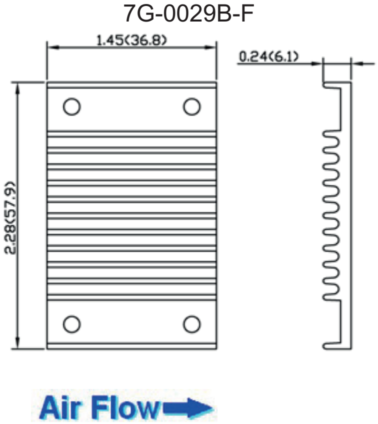


12. Heat-Sink Considerations

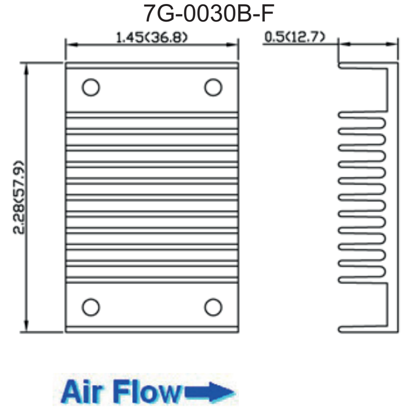
Equip heat-sink for lower temperature and higher reliability of the module. Considering space and air-flow and choose which heat-sink is needed. There are four types of heat-sink as the below for optional order.

Part No.	Suffix
Without heat-sink	--
7G-0029B-F	HS
7G-0030B-F	HS1
7G-0031B-F	HS2
7G-0032B-F	HS3

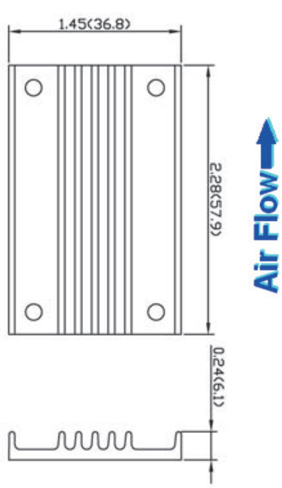
7G-0029B-F



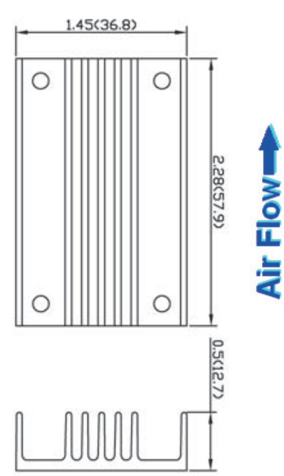
7G-0030B-F



7G-0031B-F



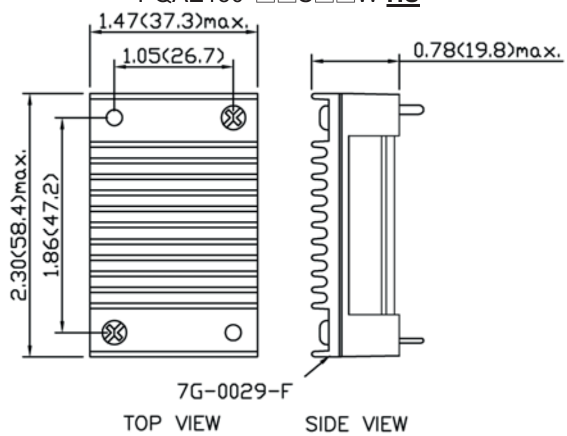
7G-0032B-F



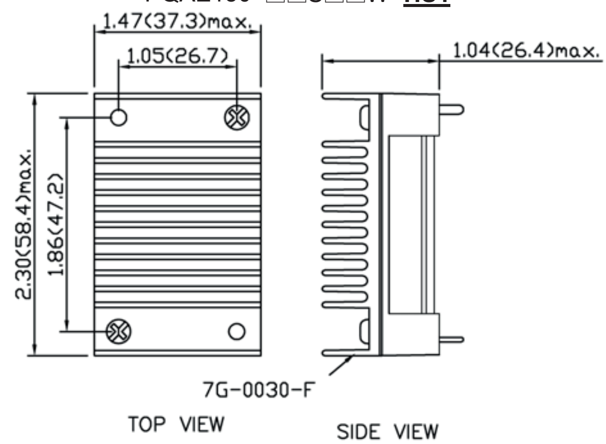
1. All dimensions in inch (mm)
2. Tolerance : x.xx±0.02 (x.x±0.5)

The heat-sink type mechanical drawing

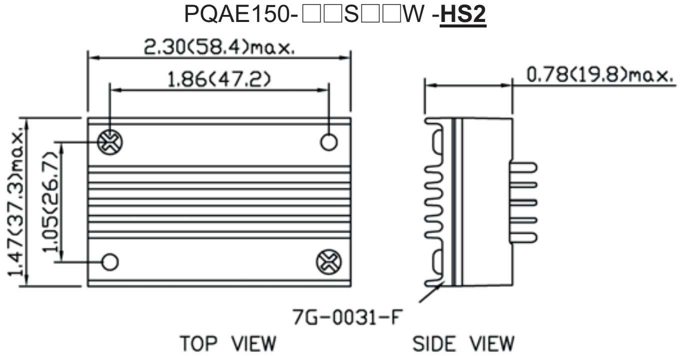
PQAE150-□□S□□W-**HS**



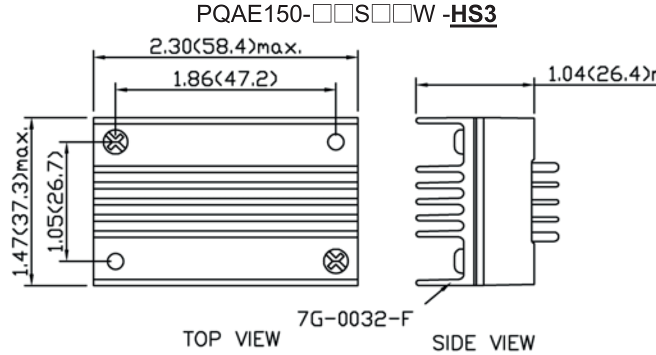
PQAE150- □□S□□W -**HS1**



PQAE150-□□S□□W -**HS2**



PQAE150-□□S□□W -**HS3**

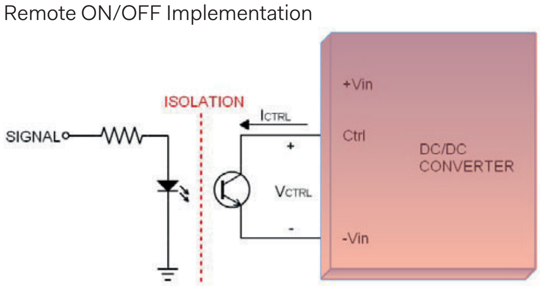


1. All dimensions in inch (mm)
2. Tolerance : x.xx±0.02 (x.x±0.5)

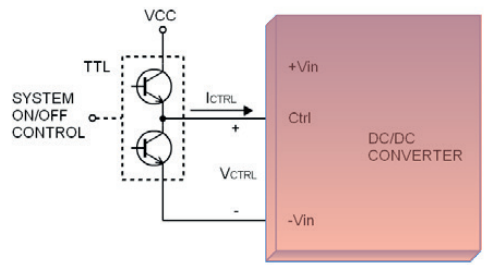
13. Remote On/Off Control

The Ctrl Pin is controlled DC/DC power module to turn on and off, the user must use a switch to control the logic voltage high or low level of the pin referenced to -Vin. The switch can be open collector transistor, FET and Photo-Coupler. The switch must be capable of sinking up to 1 mA at low-level logic voltage. High-level logic of the Ctrl pin signal maximum voltage is allowable leakage current of the switch at 12V is 0.5 mA.

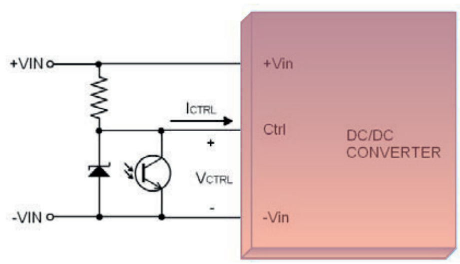
Remote ON/OFF Implementation



Isolated-Closure Remote ON/OFF



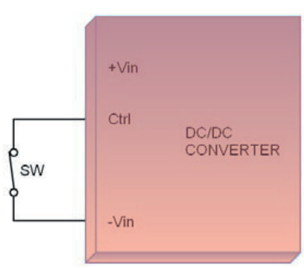
Level Control Using TTL Output



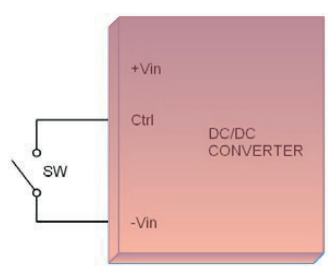
Level Control Using Line Voltage

There are two remote control options available, positive logic and negative logic.

a. The positive logic structure turned on of the DC/DC module when the Ctrl pin is at high-level logic and low-level logic is turned off it.

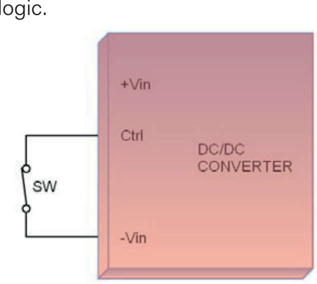


When PQAE150W module is turned off at Low-level logic

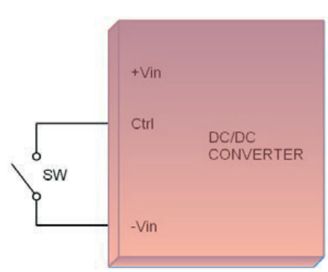


When PQAE150W module is turned on at High-level logic

b. The negative logic structure turned on of the DC/DC module when the Ctrl pin is at low-level logic and turned off when at high-level logic.



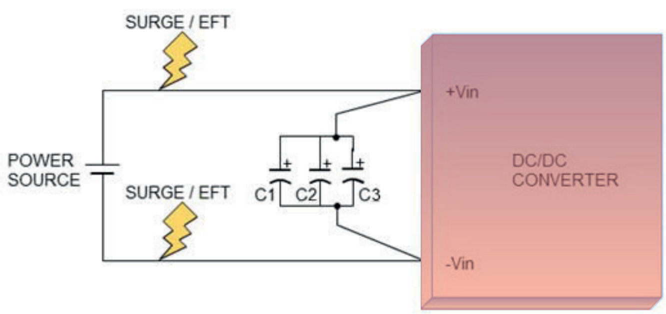
When PQAE150W module is turned on at Low-level logic



When PQAE150W module is turned off at High-level logic

14. EMS Considerations

The PQAE150W series can meet Fast Transient EN61000-4-4 and Surge EN61000-4-5 performance criteria A with external components connected to the input terminals of the module. Please see the following schematics as below.



Surge/Fast transient

PQAE150-24S□□W

Component	Value	Voltage	Reference
C1`C2	220μF	100V	Nippon chemi-con KY-series

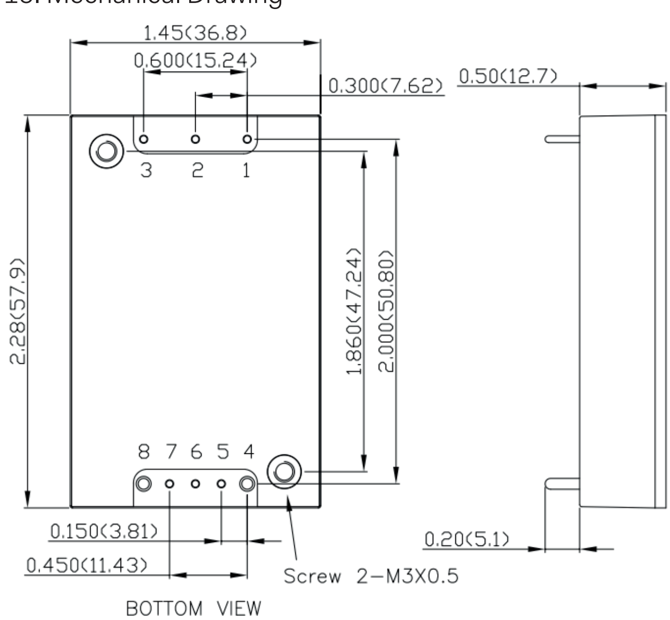
PQAE150-48S□□W

Component	Value	Voltage	Reference
C1`C2	220μF	100V	Nippon chemi-con KY-series

PQAE150-110S□□W

Component	Value	Voltage	Reference
C1`C2`C3	100μF	250V	Ruby-con BXF series

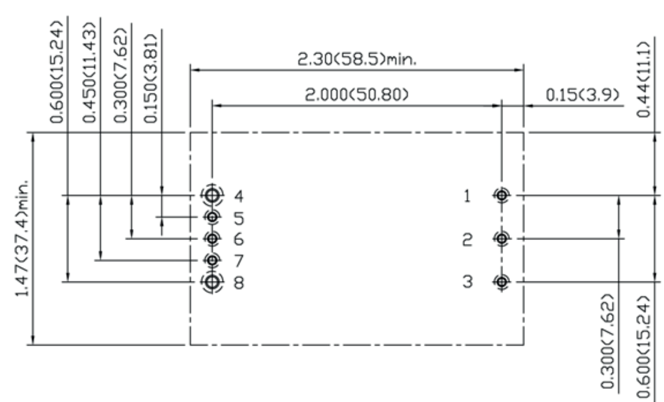
15. Mechanical Drawing



Pin	Define	Diameter
1	- Vin	0.04 Inch
2	Ctrl	0.04 Inch
3	+Vin	0.04 Inch
4	-Vout	0.06 Inch
5	-Sense	0.04 Inch
6	Trim	0.04 Inch
7	+Sense	0.04 Inch
8	+Vout	0.06 Inch

1. All dimensions in Inch (mm)
2. Tolerance: X.XX±0.02 (X.X±0.5) X.XXX±0.01 (X.XX±0.25)
3. Pin pitch tolerance ±0.01 (0.25)
4. Pin dimension tolerance ±0.004 (0.1)
5. The screw locked torque: MAX 3.5kgf-cm(0.34N-m)

16. Recommended Pad Layout



All dimensions in inch(mm)
Pad size(lead free recommended)
Through hole 1.2.3.5.6.7:ø0.051(ø1.30)
Through hole 4.8:ø0.075(ø1.90)
Top view pad 1.2.3.5.6.7:ø0.064(ø1.63)
Top view pad 5.9:ø0.094(ø2.38)
Bottom view pad 1.2.3.5.6.7:ø0.102(ø2.60)
Bottom view pad 5.9:ø0.150(ø3.80)

1. All dimensions in Inch (mm)
2. Tolerance: X.XX±0.02 (X.X±0.5) X.XXX±0.01 (X.XX±0.25)
3. Pin pitch tolerance ±0.01 (0.25)
4. Pin dimension tolerance ±0.004 (0.1)

17. Line Protection & EMC Considerations

Typical Application

- Below shows some blocks connected between power source and DC/DC module. Install the circuit of the block which is required.
- Each block has individual function and should be placed on the corresponding location.
- If CEMI is an Aluminum electrolytic capacitor and connected in parallel with CEMS, The capacitance we recommended for meeting EMS requirements could be CEMS pluses CEMI.

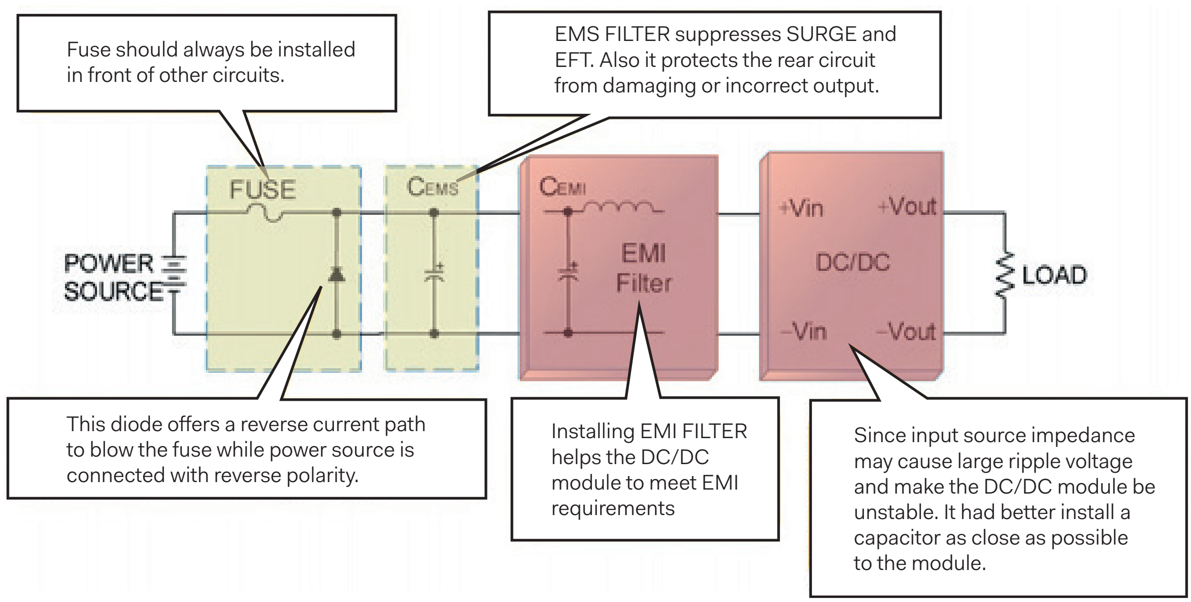


Fig 17-1 Typical application

- Input source impedance: The power modules will operate as specifications without external components, assuming that the source voltage has a very low impedance and reasonable input voltage regulation. Highly inductive source impedances can affect the stability of the power module. Since real-world voltage source has finite impedance, performance can be improved by adding external filter capacitor. The PQAE150-24SXXW and PQAE150-48SXXW recommended Nippon Chemi-con KY series, 100μF/100V. The PQAE150-110SXXW recommended Ruby-con BXF series, 39μF/200V.

18. Line Protections

Fuse

- The DC/DC converter is not internally fused. An input line fuse must always be used.
- Fuses should be installed in front of each module when multiple DC/DC converters connect to the same power source.

Model	Fuse Rating (A)	Fuse Type
PQAE150-24S□□W	25	Fast-Acting
PQAE150-48S□□W	12	Fast-Acting
PQAE150-110S□□W	6.3	Slow-Blow

Table 18-1 Fuse selection

- According to actual current value, calculating fuse ratings base on the following equations:

$I_{FUSE} \geq I_{in}$ /(rerating x safety margin)

Melting $I^2t = I^2_{PULSE,act} \cdot t / 0.22$

Where

I_{FUSE} is current rating of fuse.

I_{in} is actual value of input current.

Rerating is percentage of fuse rating base on ambient temperature. Fuse rating is variety under different ambient temperature.

Safety margin is percentage of fuse rating set by user.

Melting I^2t is pulse energy rating of fuse.

$I_{PULSE,act}$ is actual input pulse current.

t is the width of the input pulse current.

Reverse Input Voltage Protection

- Avoid the reverse polarity input voltage; otherwise, it will damage the DC/DC converter.
- It is likely to protect the module from the reverse input voltage by installing an external diode.
- The diode can block reverse voltage or blow the line fuse to protect DC/DC converter.
- Recommend using Schottky diode for reverse input voltage protection

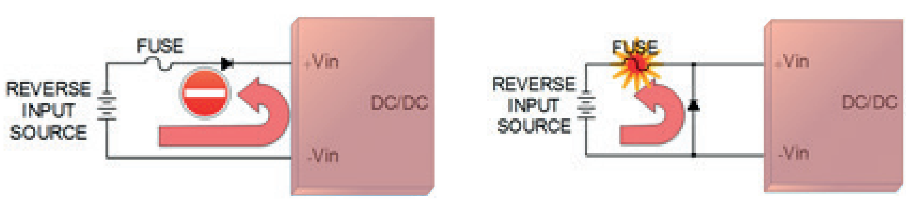


Fig 18-1 Reverse input voltage protection

Model	Voltage Rating of the Diode	Current Rating of the Diode
PQAE150-24S□□W	60V	1~1.5 x Fuse Rating
PQAE150-48S□□W	100V	1~1.5 x Fuse Rating
PQAE150-110S□□W	200V	1~1.5 x Fuse Rating

Fig 18-2 Reverse protection diode selection

19. EMS Considerations

- The module can meet EMS requirements as below.
- An external input filter capacitor is required if the module has to meet EN61000-4-4, EN61000-4-5

Parameter	Conditions		Level
ESD	EN61000-4-2	Air ±8kV and Contact ±6kV	Perf. Criteria A
Radiated immunity	EN61000-4-3	20V/m	Perf. Criteria A
Fast transient	EN61000-4-4	±2kV	Perf. Criteria A
Surge	EN61000-4-5	EN55024 ±2kV and EN50155 ±2kV	Perf. Criteria A
Conducted immunity	EN61000-4-6	10Vr.m.s	Perf. Criteria A

Table 19-1 EMS requirements

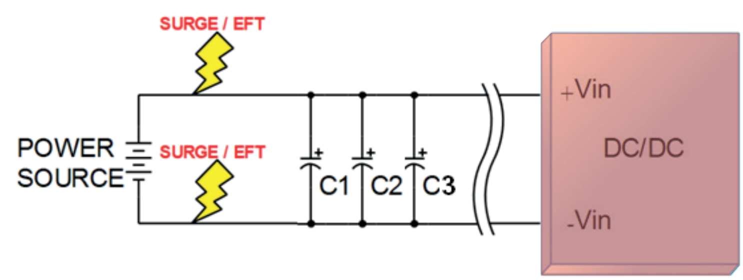


Fig 19-1 Surge & EFT protections

- It should be noticed that the current path of the PCB trace. Wrong PCB layout reduces ability of suppressing SURGE or EFT.

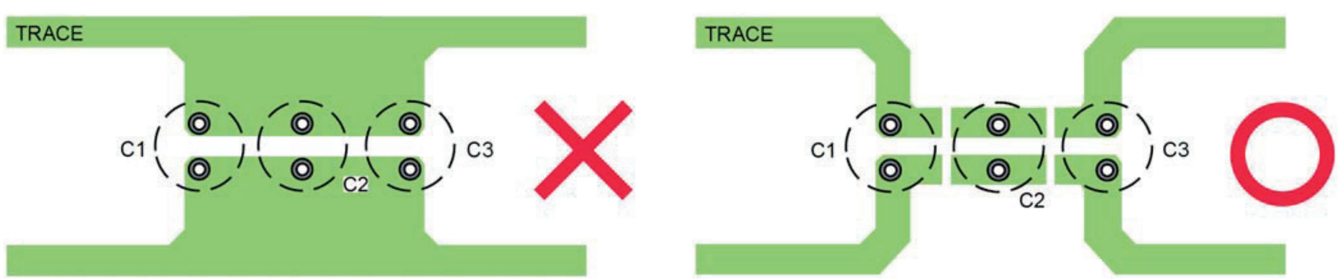


Fig 19-2 PCB trace

Model	Component	Specification	Reference
PQAE150-24S□□W PQAE150-48S□□W	C1, C2	220μF/100V	Nippon Chemi-con KY series
PQAE150-110S□□W	C1, C2, C3	100μF/250V	Ruby-con BXF series

Table 19-2 Surge & EFT filter

20. EMI Considerations

Recommended External EMI Filter for EN55032 Class A

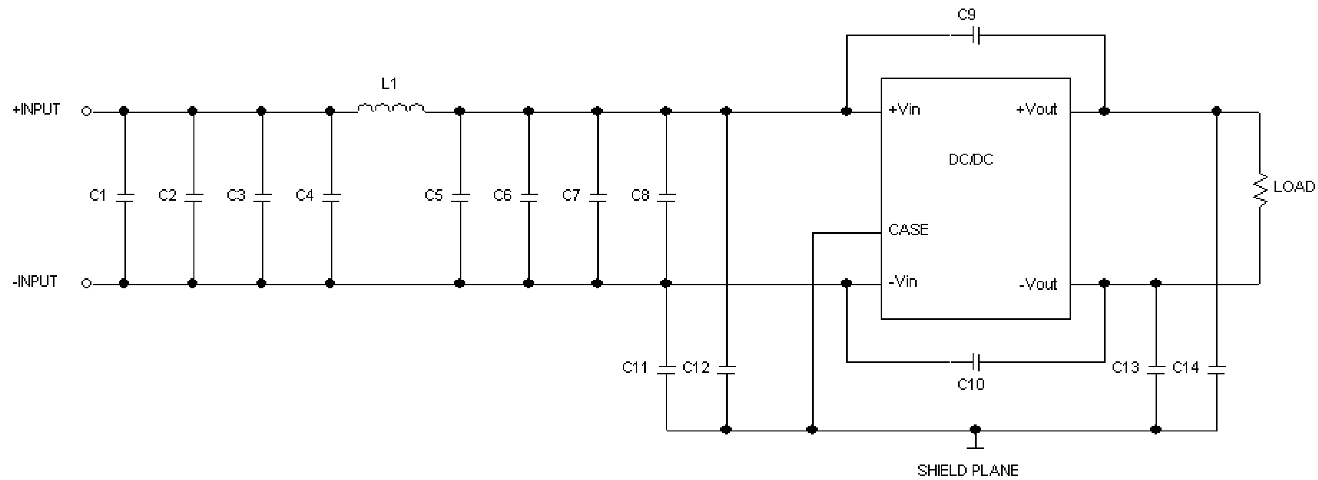
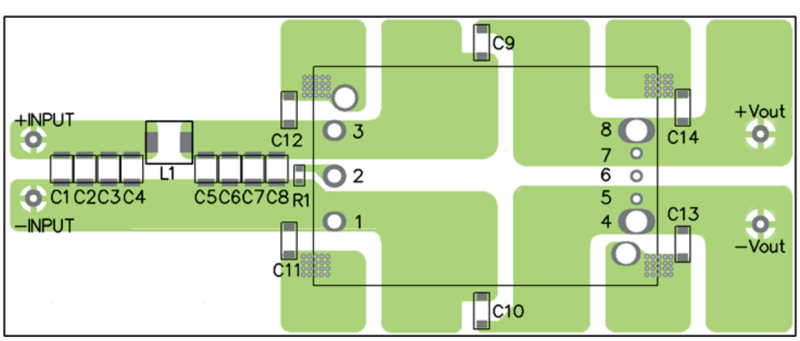


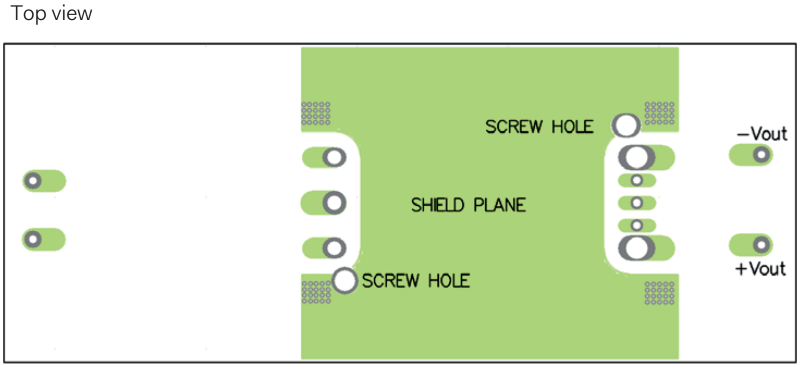
Fig 20-1 Recommended EMI filter for EN55032 Class A

MODEL	C1	C2`C3`C4	C5	C6`C7`C8	C9`C10`C11`C12`C13`C14	L1
PQAE150-24S□□W	N/A	6.8µF/50V 1812 MLCC	N/A	6.8µF/50V 1812 MLCC	1000pF/3kV 1808 MLCC	0.68µH; 17A SMD Inductor PMT-114
PQAE150-48S□□W	4.7µF/100V 1812 MLCC	4.7µF/100V 1812 MLCC	4.7µF/100V 1812 MLCC	4.7µF/100V 1812 MLCC	1000pF/3kV 1808 MLCC	3.3µH; 10A SMD Inductor PMT-102

Table 20-1 B.O.M. of external EMI filter



Top view



Bottom view

Fig 20-2 Recommended layout pattern

Recommended External EMI Filter for EN55032 Class A

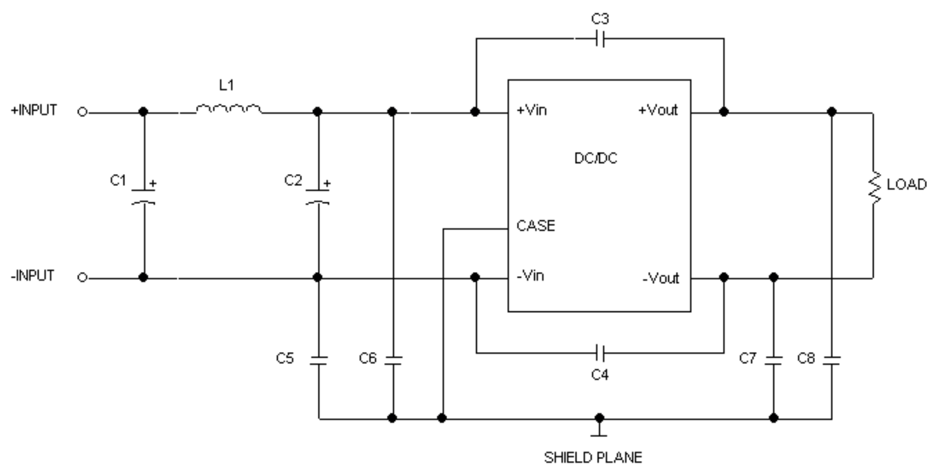
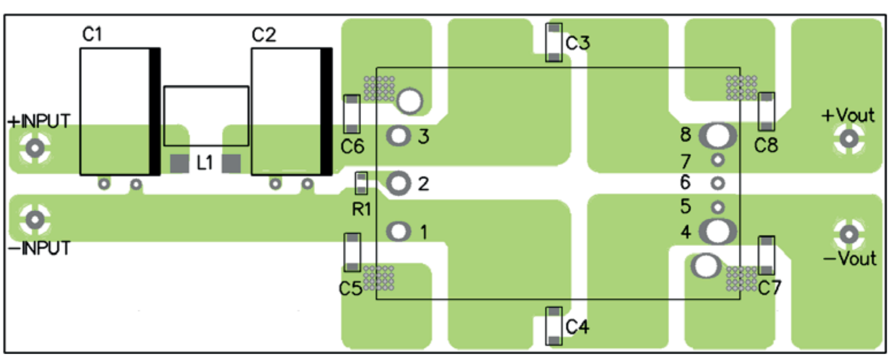


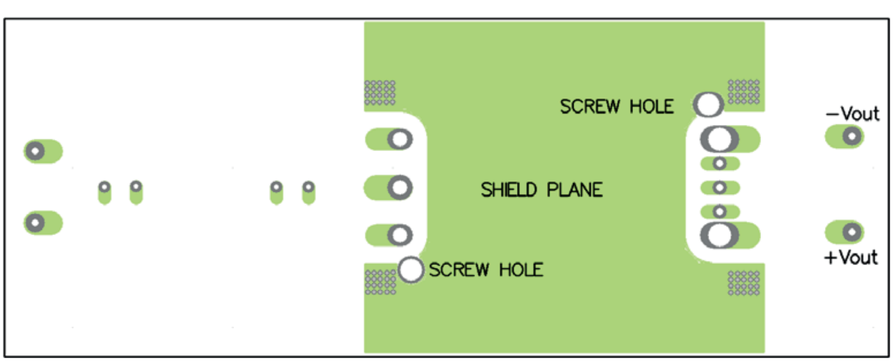
Fig 20-3 Recommended EMI filter for EN55032 Class A

Model	C1`C2	C3`C4`C5`C6`C7`C8	L1
PQAE150-110S□□W	39μF/250V Al Cap. (lie down) Rubycon BXF	1000pF/3kV 1808 MLCC	30μH; 5A SMD Inductor PMT-104

Table 20-2 B.O.M. of external EMI filter



Top view



Bottom view

Fig 20-4 Recommended layout pattern

Recommended External EMI Filter for EN55032 Class B

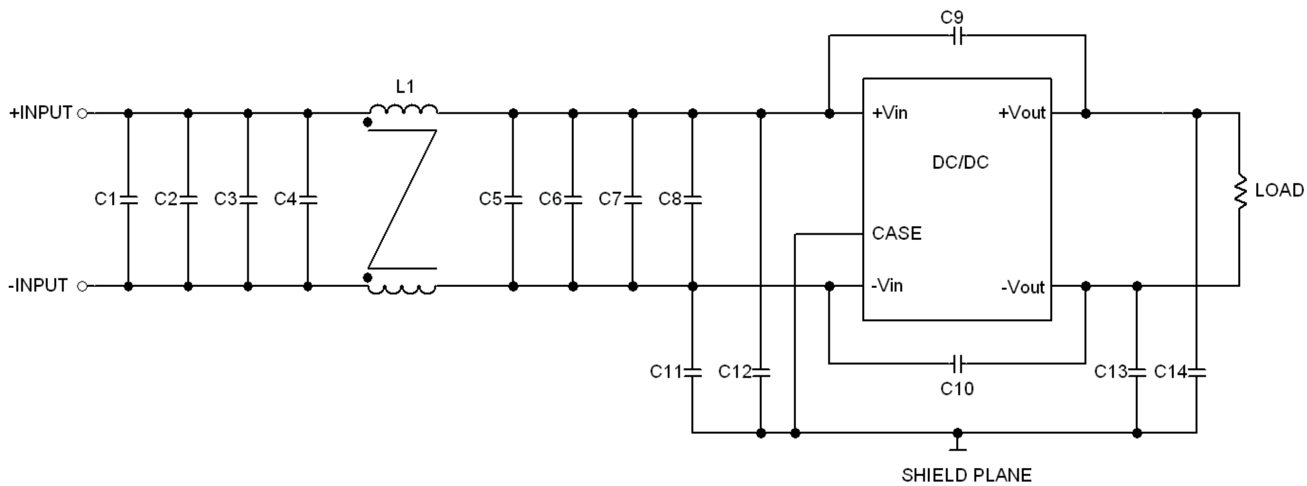
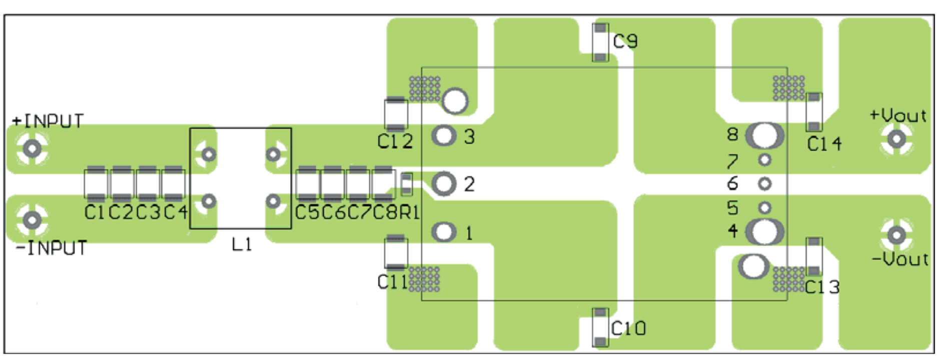


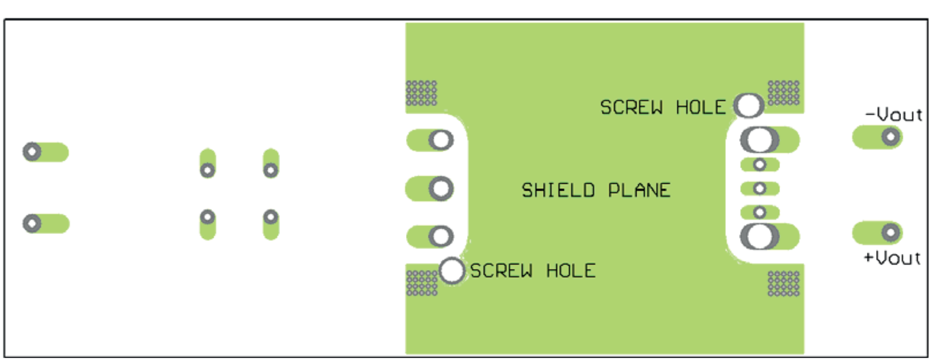
Fig 20-5 Recommended EMI filter for EN55032 Class B

Model	C1`C2`C3`C4	C5`C6`C7`C8	C9`C10`C13`C14	C11`C12	L1
PQAE150-24S□□W	10μF/50V 1812 MLCC	10μF/50V 1812 MLCC	1000pF/3kV 1808 MLCC	2200pF/3kV 1812 MLCC	285μH Common Choke PMT-103

Table 20-3 B.O.M. of external EMI filter



Top view



Bottom view

Fig 20-6 Recommended layout pattern

Recommended External EMI Filter for EN55032 Class B

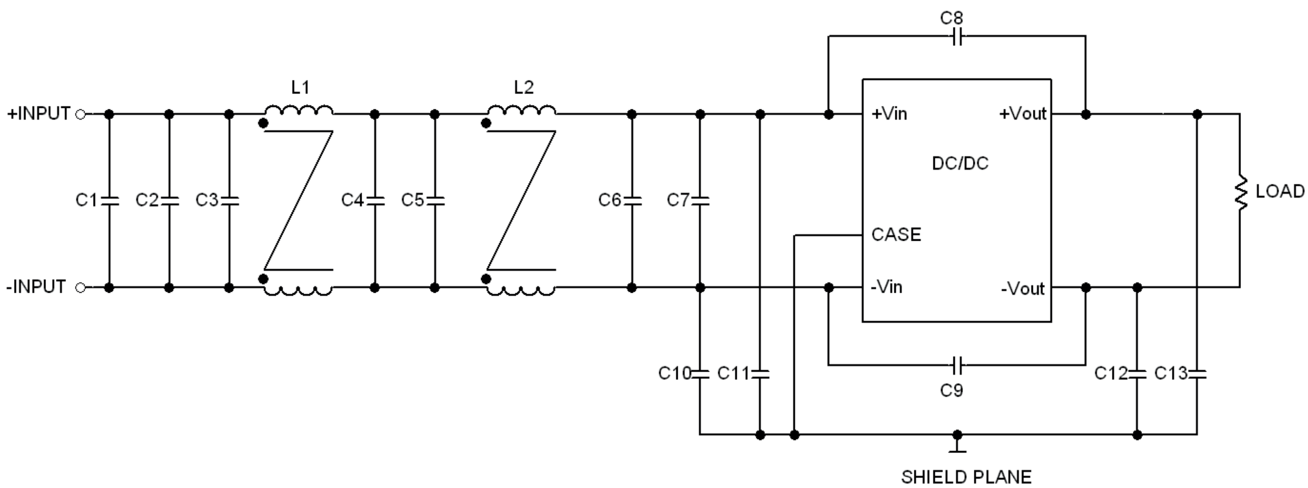
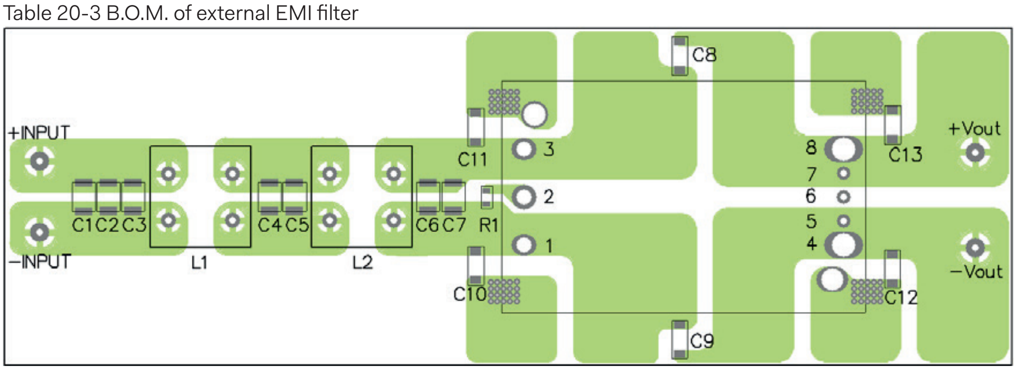


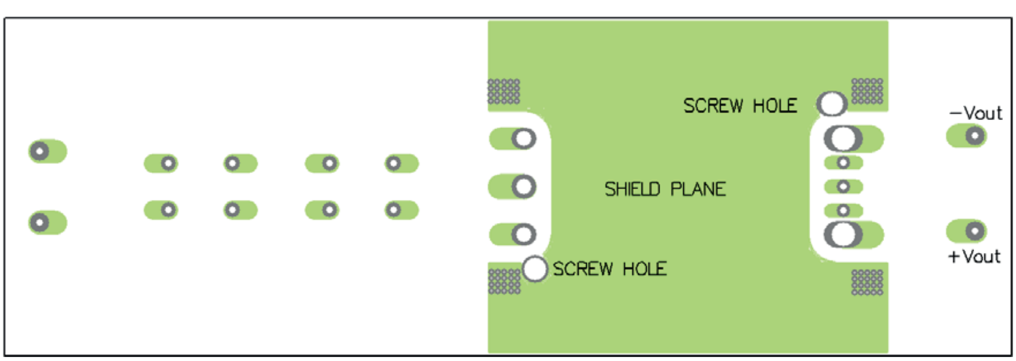
Fig 20-5 Recommended EMI filter for EN55032 Class B

Model	C1`C2`C3`C4`C5`C6`C7	C8`C9`C10`C11`C12`C13	L1	L2
PQAE150-48S□□W	4.7μF/100V 1812 MLCC	1000pF/3kV 1808 MLCC	620μH Common Choke PMT-067	285μH Common Choke PMT-103

Table 20-3 B.O.M. of external EMI filter



Top view



Bottom view

Fig 20-6 Recommended layout pattern

Recommended External EMI Filter for EN55032 Class B

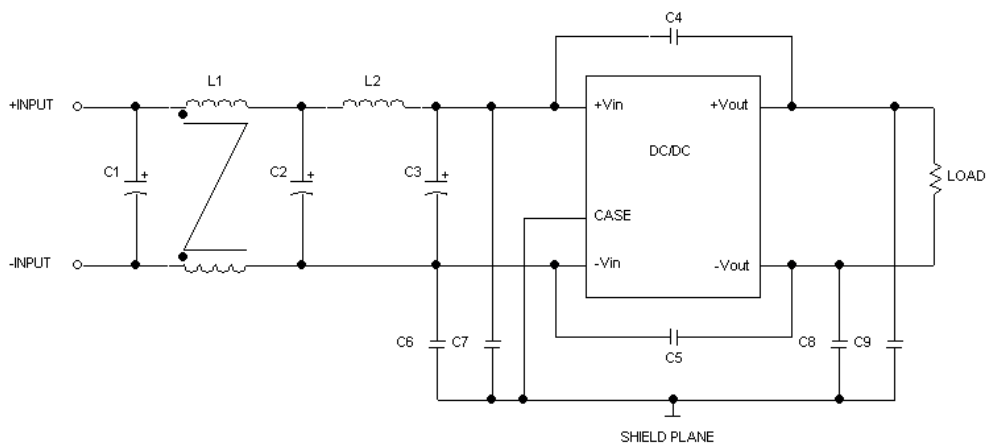
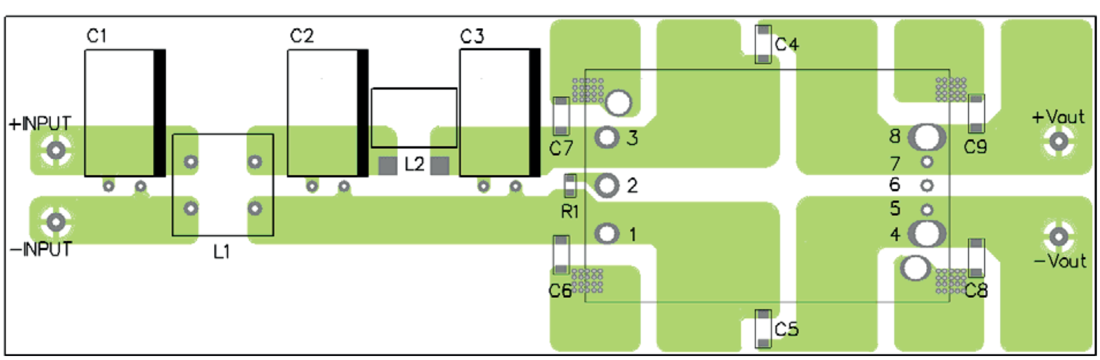


Fig 20-7 Recommended EMI filter for EN55032 Class B

Model	C1`C2`C3	C4`C5`C6`C7`C8`C9	L1	L2
PQAE150-110S□□W	39μF/250V Al Cap. (lie down) Rubycon BXF	1000pF/3kV 1808 MLCC	735μH Common Choke PMT-105	30.1μH; 5A SMD Inductor PMT-104

Table 20-4 B.O.M. of external EMI filter

Top view



Bottom view

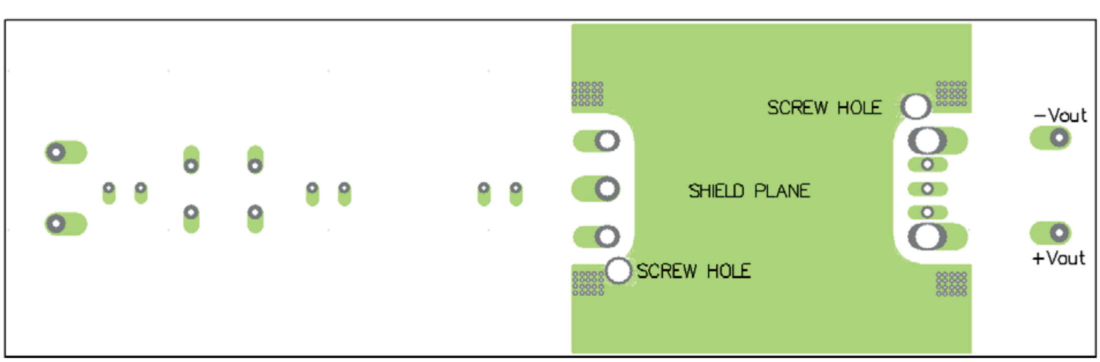
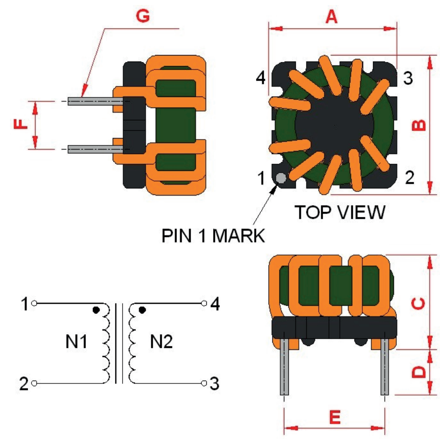


Fig 20-8 Recommended layout pattern

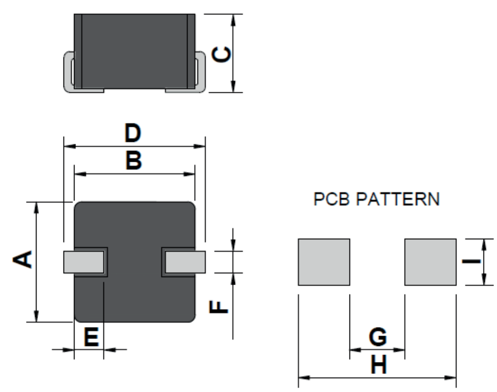
Specifications of Common Mode Choke and Differential Inductor

Part number:	**PMT-067**	
Inductance:	620μH ±35% (100kHz/ 100mV)	
DCR:	25 mΩ	
Rated current:	7.5A, max.	
Dimensions (mm):	A	16.0, max.
	B	16.0, max.
	C	15.0, max.
	D	4.0 ±0.3
	E	10.0 ±0.3
	F	7.4 ±0.3
	G	ϕ0.8 ±0.1

* Recommended through hole: ϕ1.0 mm

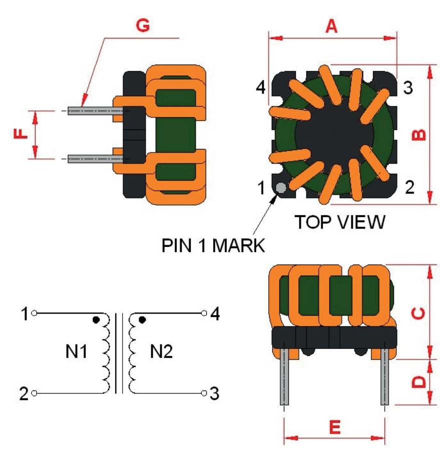


Part number:	**PMT-102**	
Inductance:	3.3μH ±20% (100kHz/250mV)	
DCR:	18 mΩ	
Rated current:	10A, max.	
Dimensions (mm):	A	6.5 ±0.3
	B	6.5 ±0.3
	C	4.2, max.
	D	7.6, max.
	E	1.5 ±0.3
	F	1.2 ±0.3
	G	3.0
	H	8.5
	I	2.5

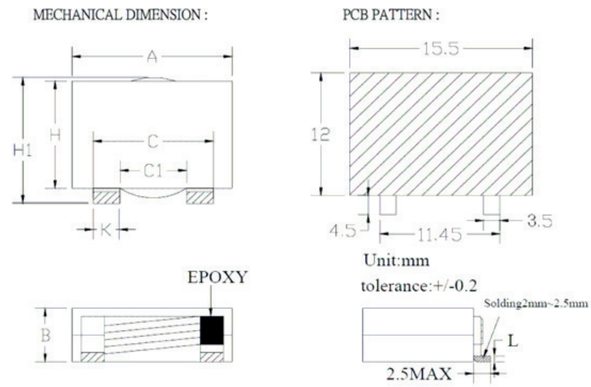


Part number:	**PMT-103**	
Inductance:	285μH ±35% (100kHz/ 100mV)	
DCR:	5.5 mΩ	
Rated Current:	16A, max	
Dimensions (mm):	A	16.0, max.
	B	16.0, max.
	C	15.0, max.
	D	3.6 ±0.3
	E	10.0 ±0.3
	F	7.4 ±0.3
	G	ϕ0.8 ±0.1

* Recommended through hole: ϕ1.0 mm
All dimensions in mm

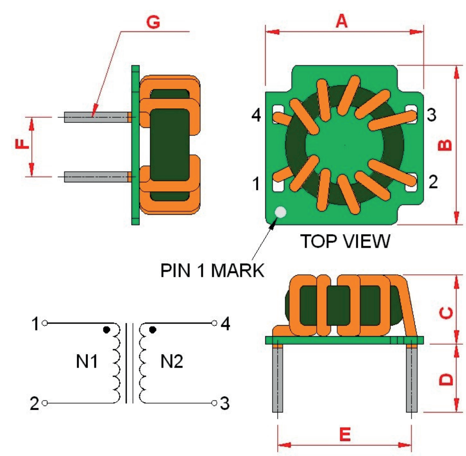


Part number:	**PMT-104**	
Inductance:	30.1µH ±10% (100kHz/ 100mV)	
DCR:	40 mΩ	
Rated current:	5A, max.	
Dimensions (mm):	A	13.5, max.
	B	5.8, max.
	C	10.9, max.
	C1	5.2, min.
	H	10.0, max.
	H1	14.3, max.
	K	2.3 ±0.2
	L	0.2 ±0.2



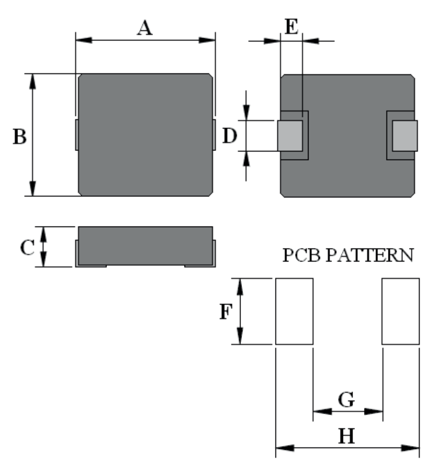
Part number:	**PMT-105**	
Inductance:	735µH ±35% (100kHz/ 100mV)	
DCR:	19 mΩ	
Rated current:	5.6A, max.	
Dimensions (mm):	A	16.0, max.
	B	16.0, max.
	C	15.0, max.
	D	4.0 ±0.3
	E	10.0 ±0.3
	F	7.4 ±0.3
	G	ϕ0.8 ±0.1

* Recommended through hole: ϕ1.0 mm

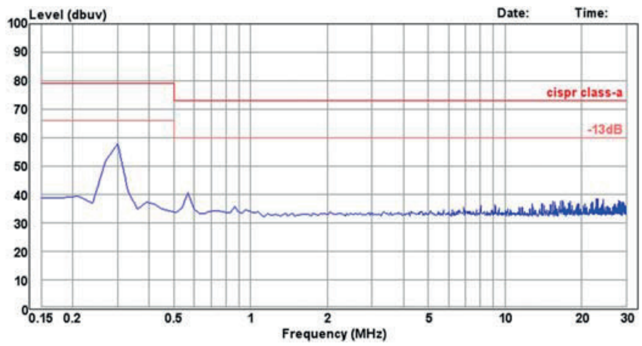


Part number:	**PMT-114**	
Inductance:	0.68µH ±20% (100kHz/250mV)	
DCR:	3.8 mΩ	
Rated Current:	17 A, max	
Dimensions (mm):	A	7.8, max.
	B	7.0, max.
	C	4.2, max.
	D	2.0 ±0.5
	E	1.2 ±0.3
	F	3.5
	G	3.7
	H	8.0

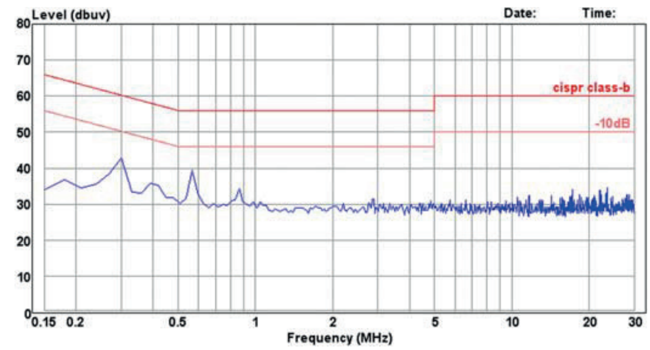
* Recommended through hole: ϕ1.6 mm
All dimensions in mm



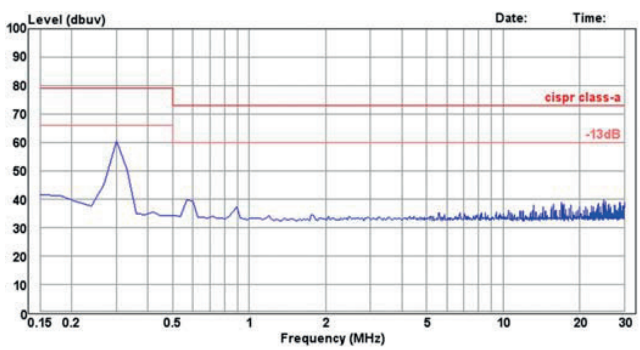
21. EMI Test Results



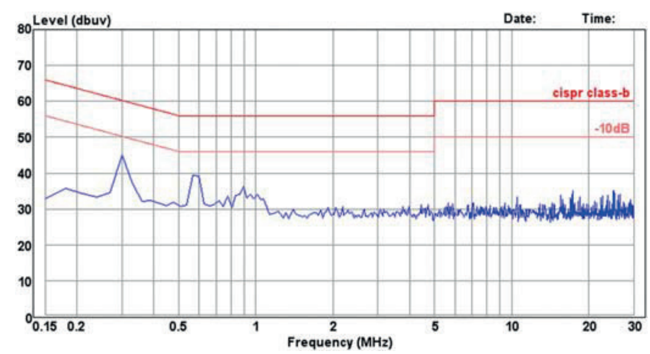
EN55022 Class A Conducted Emission
PQAE150-24S3P3W
Vin (nom); Full load.



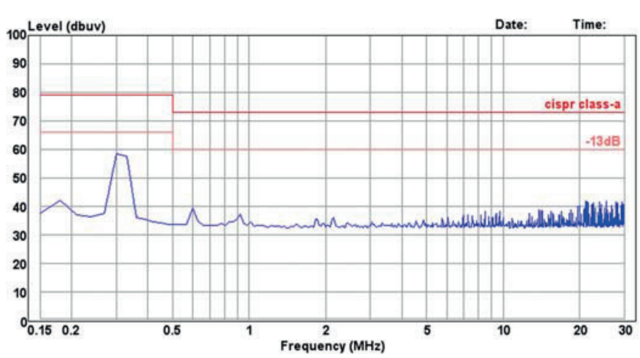
EN55022 Class B Conducted Emission
PQAE150-24S3P3W
Vin (nom); Full load.



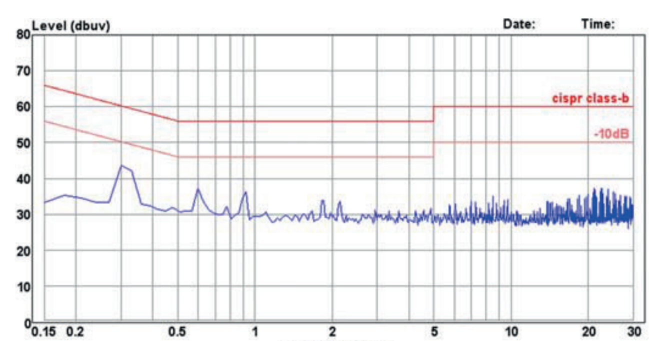
EN55022 Class A Conducted Emission
PQAE150-24S05W
Vin (nom); Full load.



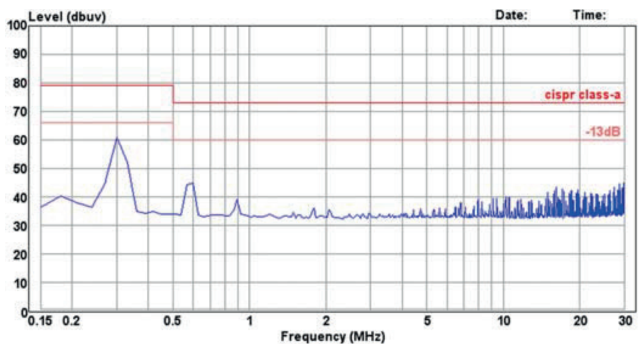
EN55022 Class B Conducted Emission
PQAE150-24S05W
Vin (nom); Full load.



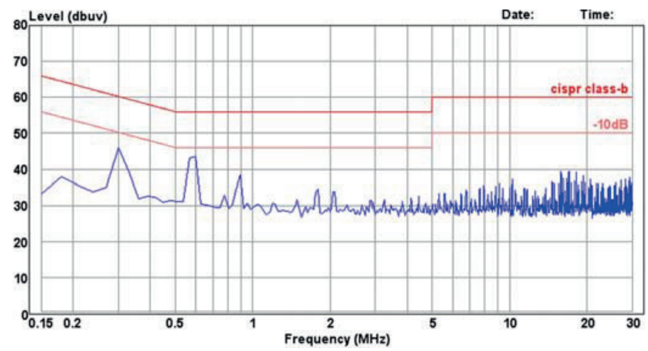
EN55022 Class A Conducted Emission
PQAE150-24S12W
Vin (nom); Full load.



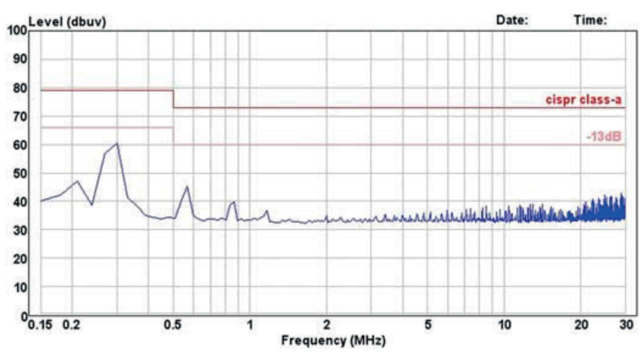
EN55022 Class B Conducted Emission
PQAE150-24S12W
Vin (nom); Full load.



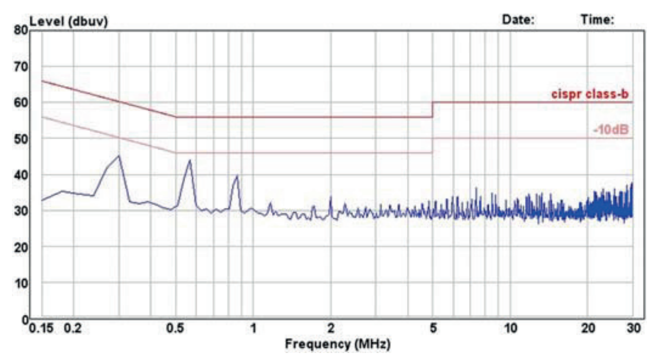
EN55022 Class A Conducted Emission
PQAE150-24S15W
Vin (nom); Full load.



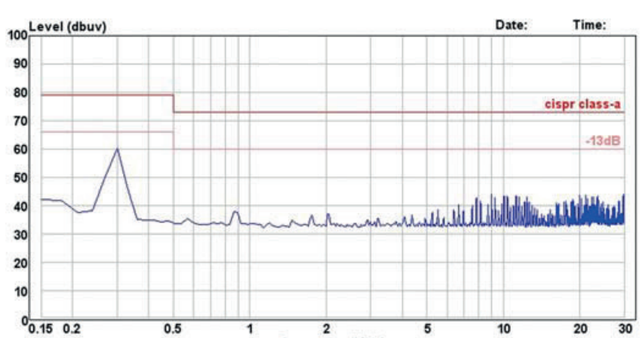
EN55022 Class B Conducted Emission
PQAE150-24S15W
Vin (nom); Full load.



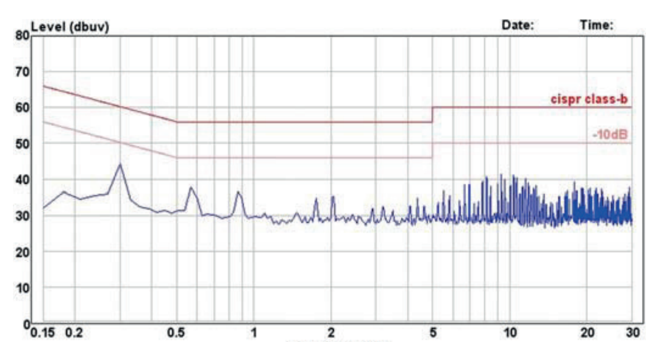
EN55022 Class A Conducted Emission
PQAE150-24S24W
Vin (nom); Full load.



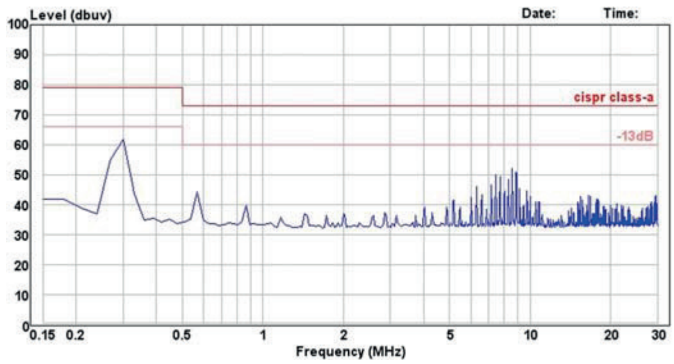
EN55022 Class B Conducted Emission
PQAE150-24S24W
Vin (nom); Full load.



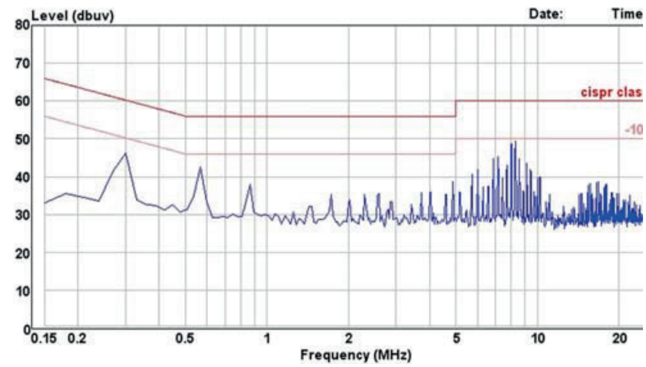
EN55022 Class A Conducted Emission
PQAE150-24S30W
Vin (nom); Full load.



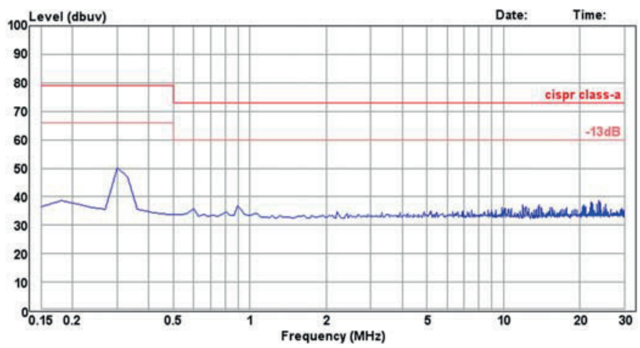
EN55022 Class B Conducted Emission
PQAE150-24S30W
Vin (nom); Full load.



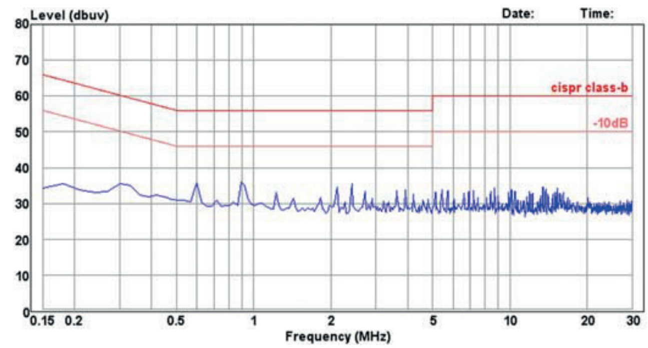
EN55022 Class A Conducted Emission
PQAE150-24S48W
Vin (nom); Full load.



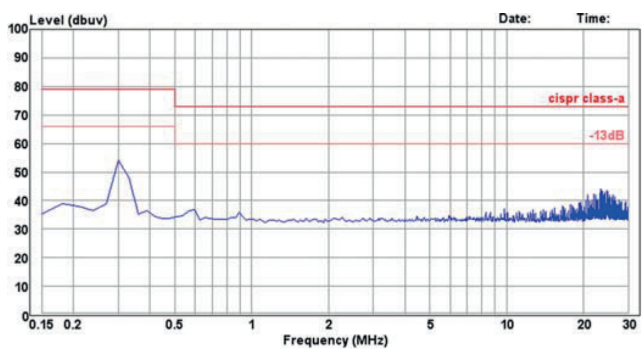
EN55022 Class B Conducted Emission
PQAE150-24S48W
Vin (nom); Full load.



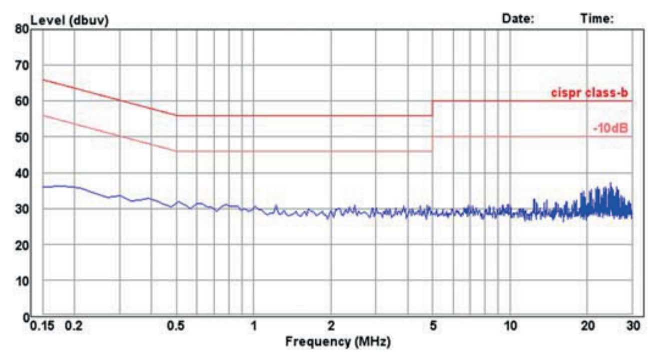
EN55022 Class A Conducted Emission
PQAE150-48S3P3W
Vin (nom); Full load.



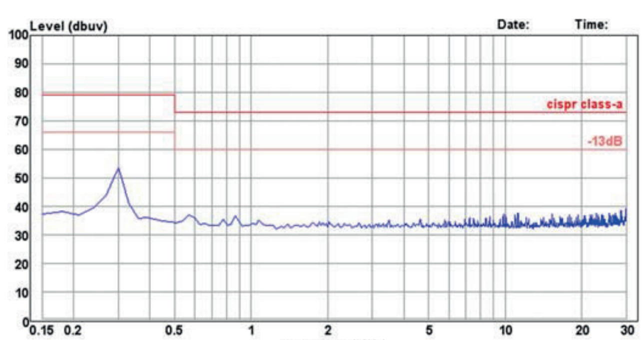
EN55022 Class B Conducted Emission
PQAE150-48S3P3W
Vin (nom); Full load.



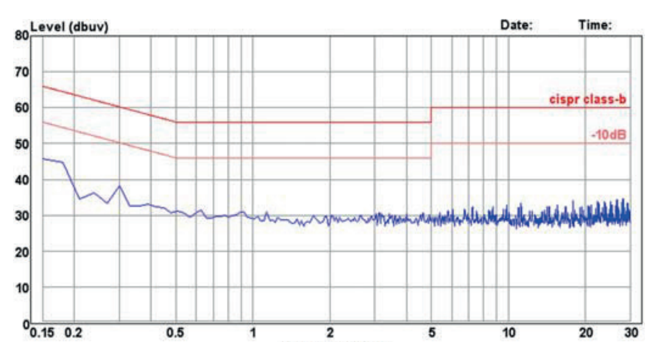
EN55022 Class A Conducted Emission
PQAE150-48S05W
Vin (nom); Full load.



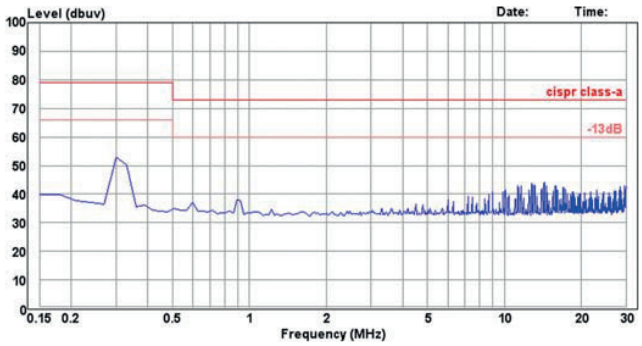
EN55022 Class B Conducted Emission
PQAE150-48S05W
Vin (nom); Full load.



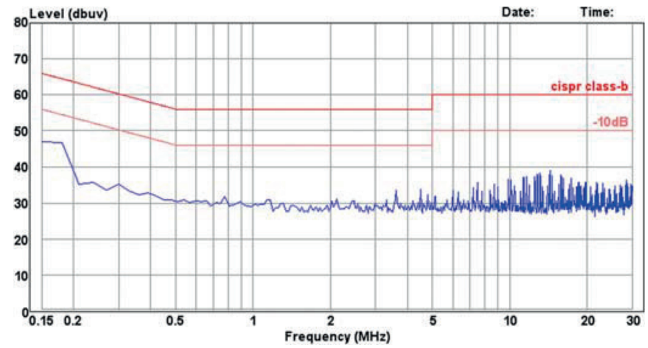
EN55022 Class A Conducted Emission
PQAE150-48S12W
Vin (nom); Full load.



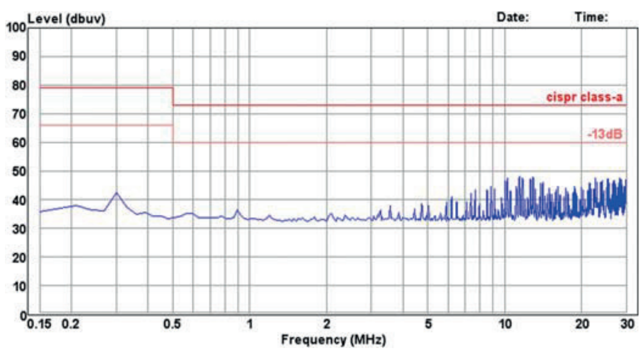
EN55022 Class B Conducted Emission
PQAE150-48S12W
Vin (nom); Full load.



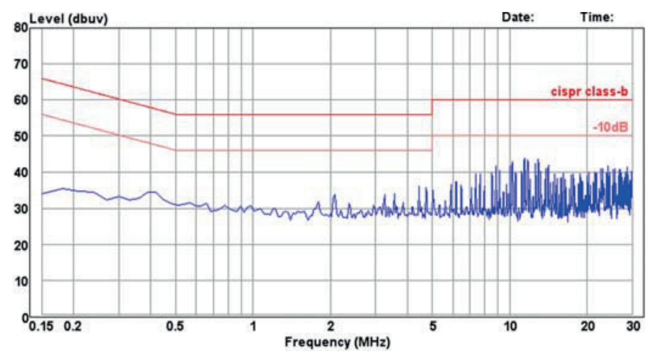
EN55022 Class A Conducted Emission
PQAE150-48S15W
Vin (nom); Full load.



EN55022 Class B Conducted Emission
PQAE150-48S15W
Vin (nom); Full load.



EN55022 Class A Conducted Emission
PQAE150-48S24W
Vin (nom); Full load.



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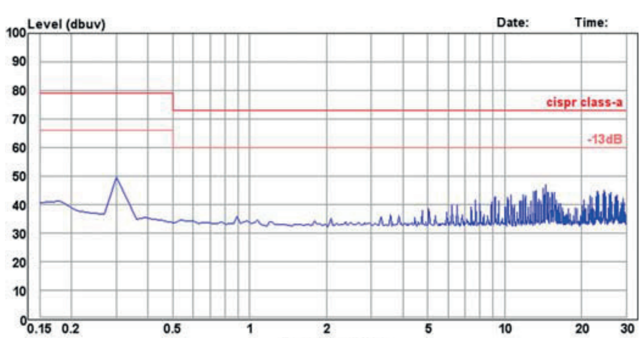
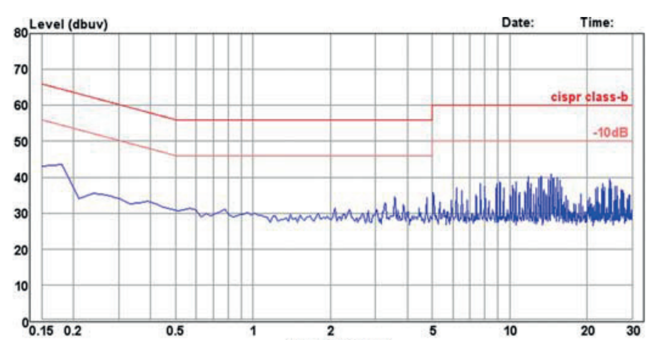
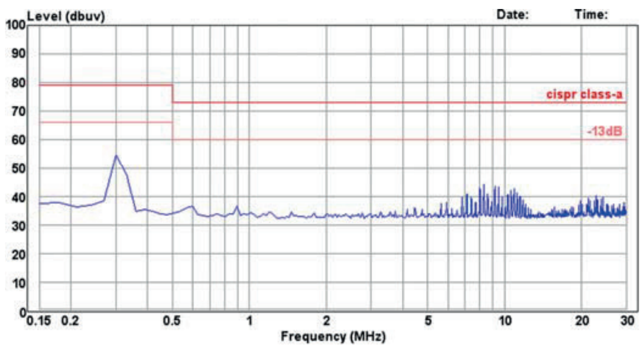
PQAE150-48S24W
Vin (nom); Full load.



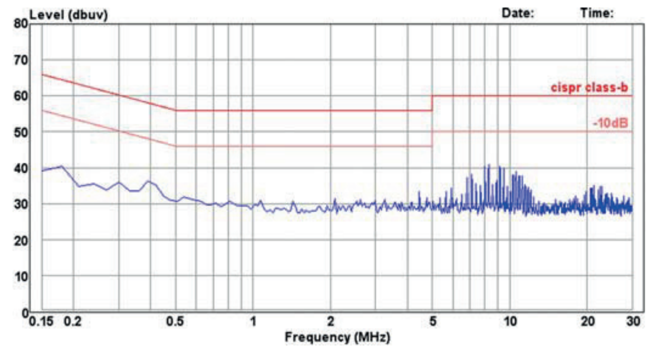
EN55022 Class A Conducted Emission
PQAE150-48S30W
Vin (nom); Full load.



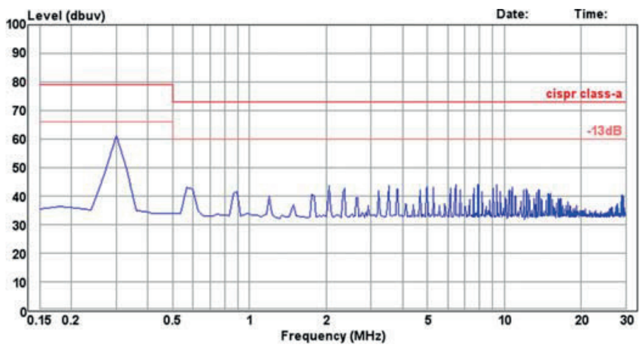
EN55022 Class B Conducted Emission
PQAE150-48S30W
Vin (nom); Full load.



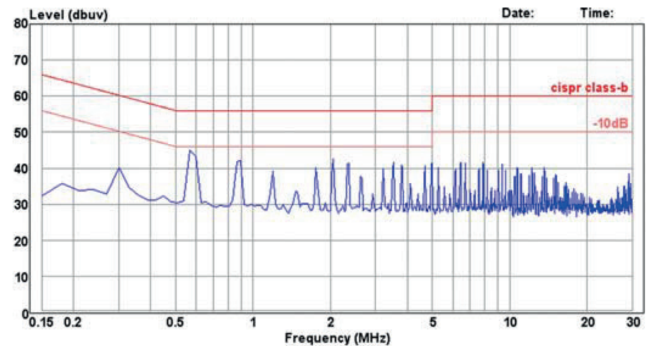
EN55022 Class A Conducted Emission
PQAE150-48S48W
Vin (nom); Full load.



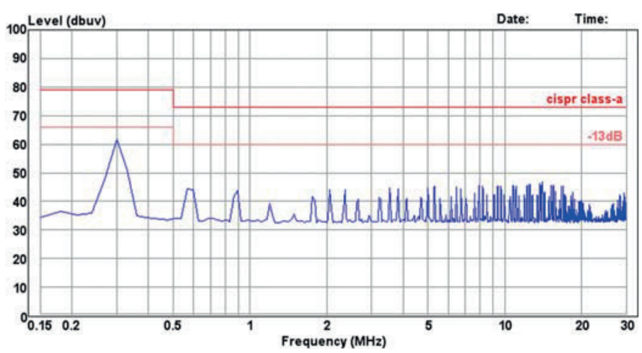
EN55022 Class B Conducted Emission
PQAE150-48S48W
Vin (nom); Full load.



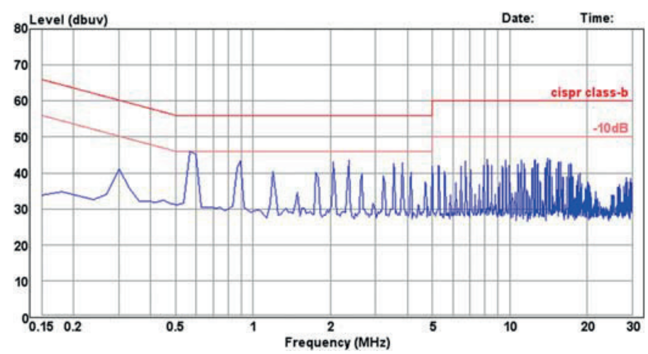
EN55022 Class A Conducted Emission
PQAE150-110S3P3W
Vin (nom); Full load.



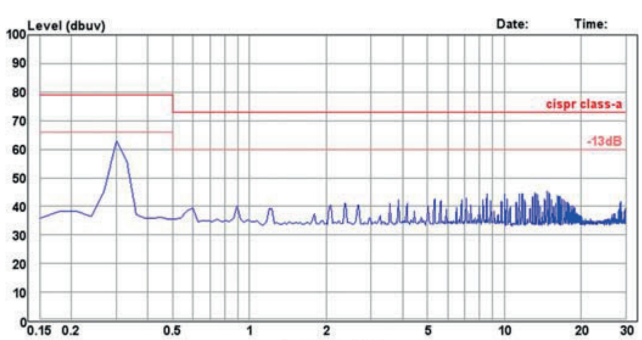
EN55022 Class B Conducted Emission
PQAE150-110S3P3W
Vin (nom); Full load.



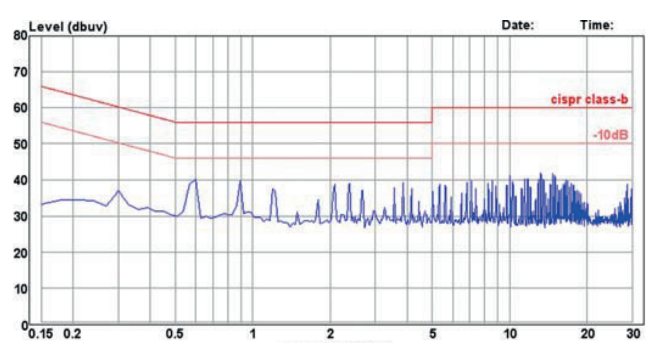
EN55022 Class A Conducted Emission
PQAE150-110S05W
Vin (nom); Full load.



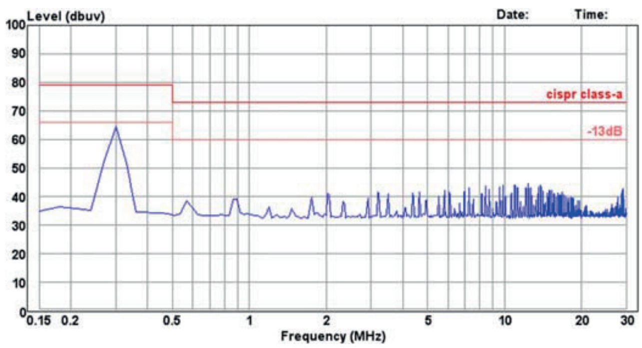
EN55022 Class B Conducted Emission
PQAE150-110S05W
Vin (nom); Full load.



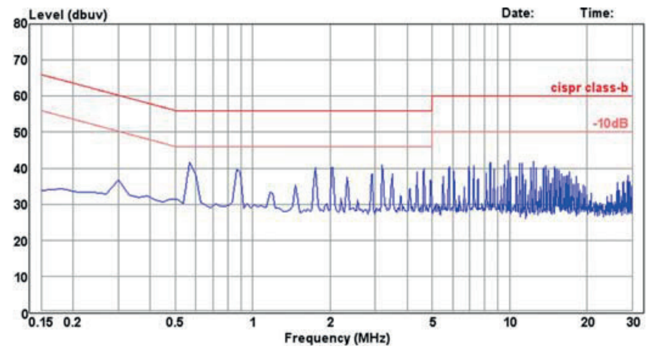
EN55022 Class A Conducted Emission
PQAE150-110S12W
Vin (nom); Full load.



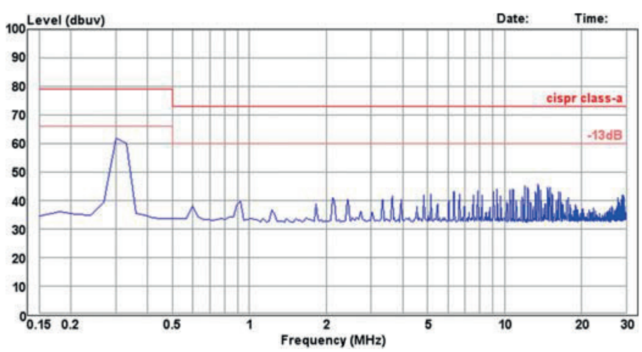
EN55022 Class B Conducted Emission
PQAE150-110S12W
Vin (nom); Full load.



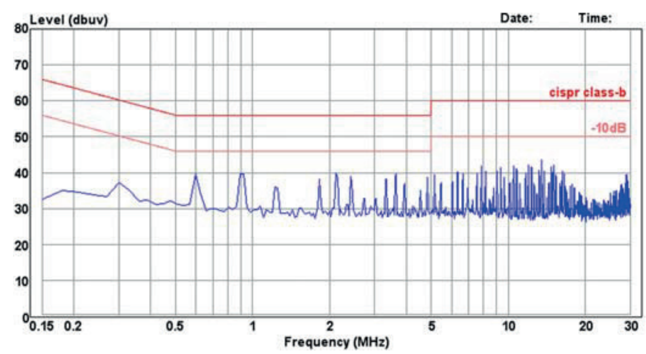
EN55022 Class A Conducted Emission
PQAE150-110S15W
Vin (nom); Full load.



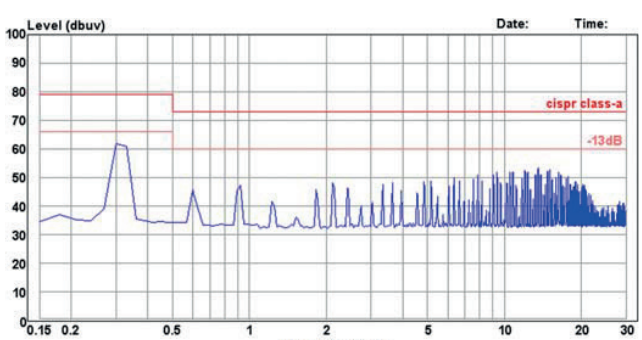
EN55022 Class B Conducted Emission
PQAE150-110S15W
Vin (nom); Full load.



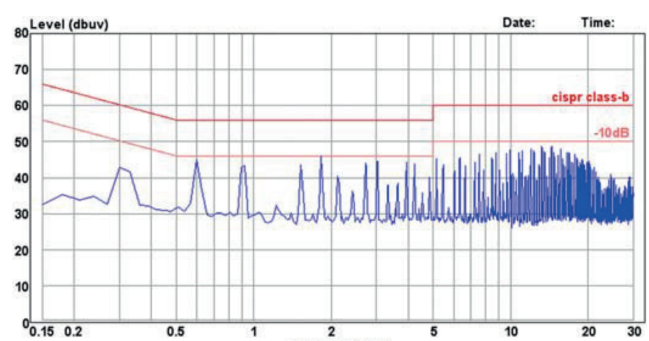
EN55022 Class A Conducted Emission
PQAE150-110S24W
Vin (nom); Full load.



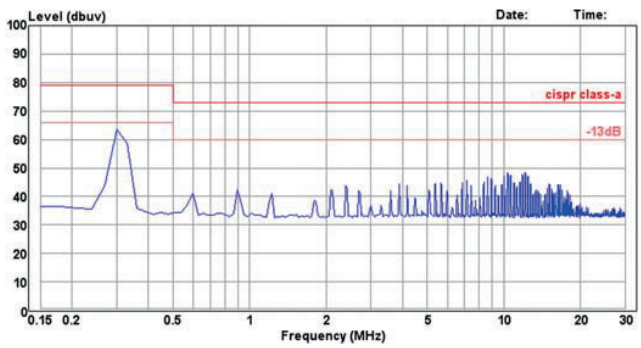
EN55022 Class B Conducted Emission
PQAE150-110S24W
Vin (nom); Full load.



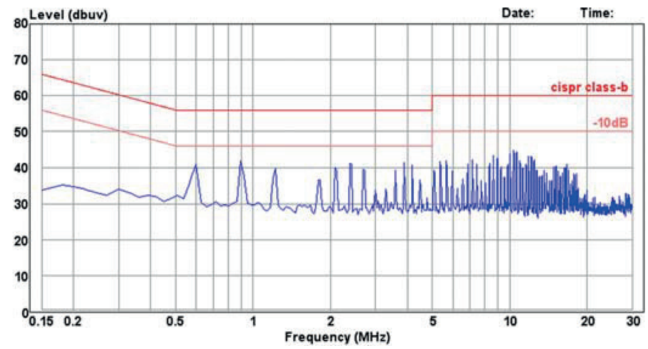
EN55022 Class A Conducted Emission
PQAE150-110S30W
Vin (nom); Full load.



EN55022 Class B Conducted Emission
PQAE150-110S30W
Vin (nom); Full load.



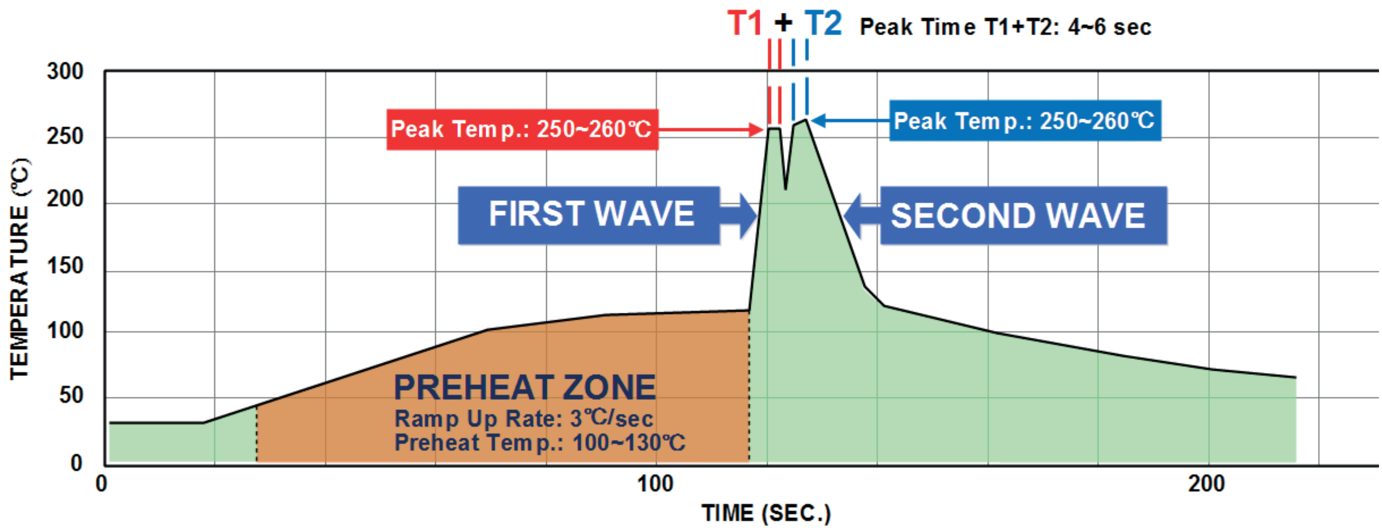
EN55022 Class A Conducted Emission
PQAE150-110S48W
Vin (nom); Full load.



EN55022 Class B Conducted Emission
PQAE150-110S48W
Vin (nom); Full load.

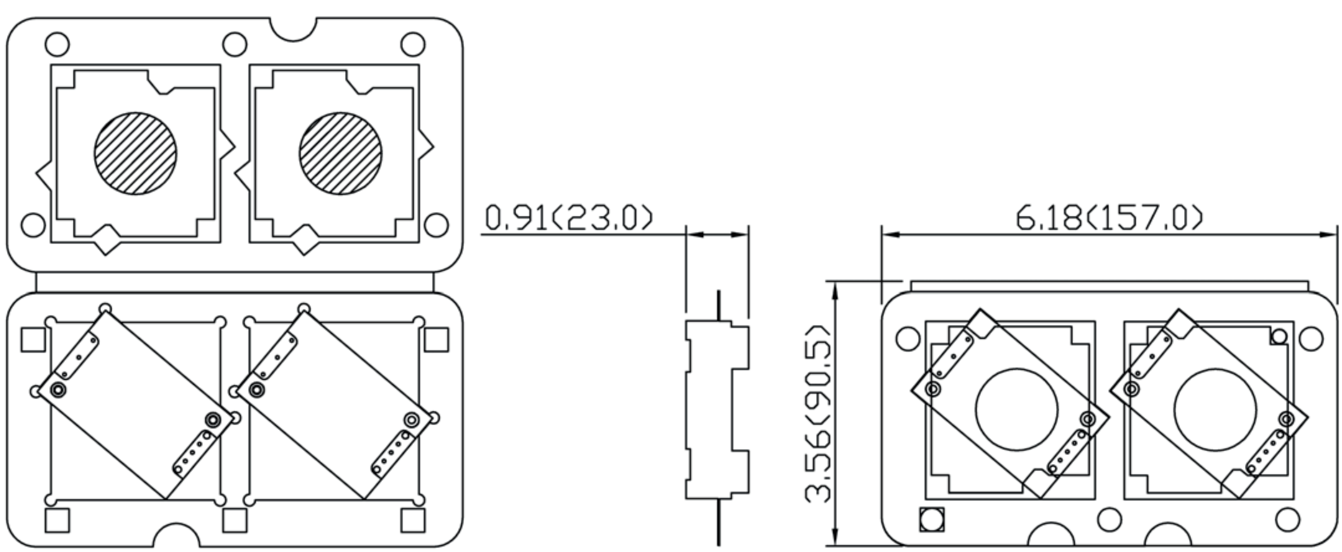
22. Soldering Considerations

Lead free wave solder profile



Reference Solder :Sn-Ag-Cu; Sn-Cu
Hand Welding (Reference):
Soldering iron:Power 150W
Welding Time:20~30 sec
Temp :410~430℃

23. Packaging Information



All dimensions in inch (mm)

24. Safety and Installation Instruction

Fusing Consideration:

Caution: This power module is not internally fused. An input line fuse must always be used. This encapsulated power module can be used in a wide variety of applications, ranging from simple stand-alone operation to an integrated part of sophisticated power architecture. To maximum flexibility, internal fusing is not included; however, to achieve maximum safety and system protection, always use an input line fuse. The input line fuse suggest as below:

Model	Fuse Rating (A)	Fuse Type
PQAE150-24S□□W	25	Fast-Acting
PQAE150-48S□□W	12	Fast-Acting
PQAE150-110S□□W	6.3	Slow-Blow

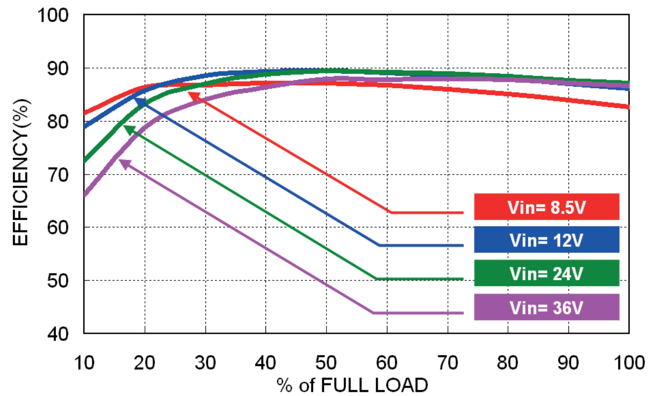
Based on the information provided in this data sheet on inrush energy and maximum dc input current at low Vin. If customer have another used condition and need more information. Please contact Powerbox.

25. MTBF and Reliability

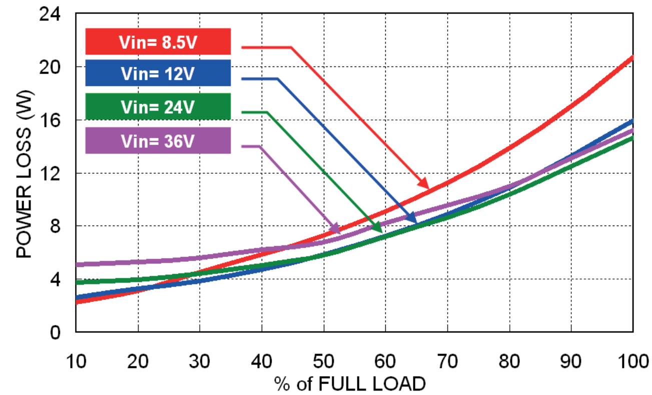
The MTBF of PQAE150W series of DC/DC converters has been calculated using MIL-HDBK 217F NOTICE2 FULL LOAD, Tc=70°C.
The resulting figure for MTBF is 3.684×105 hours.

26. Characteristic Curves

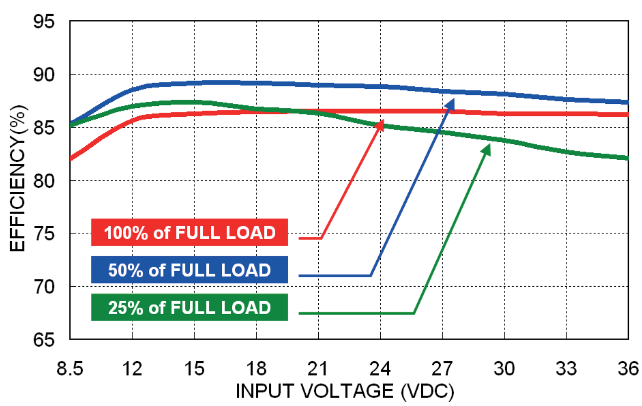
All test conditions are at 25°C.The figures are identical for PQAE150-24S3P3W



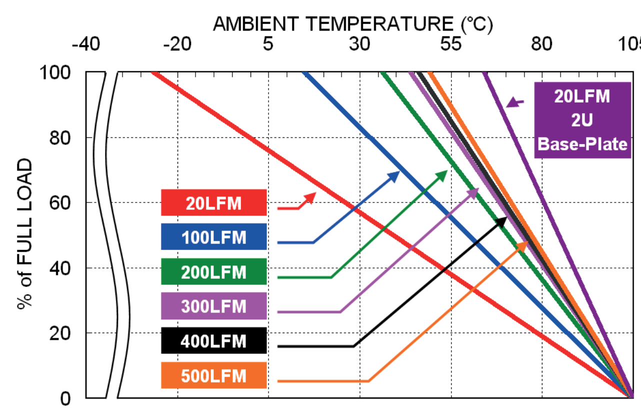
Efficiency versus Output Load



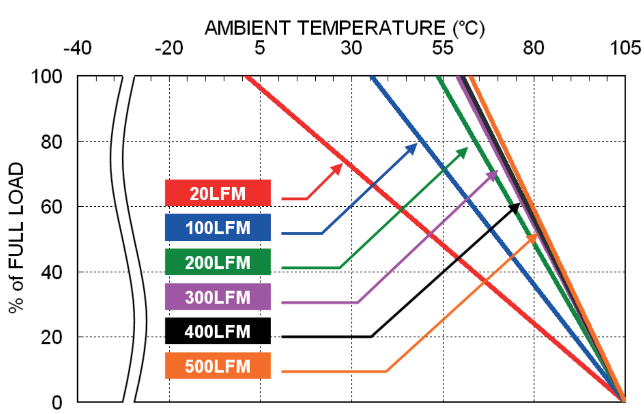
Power dissipation versus Output Load



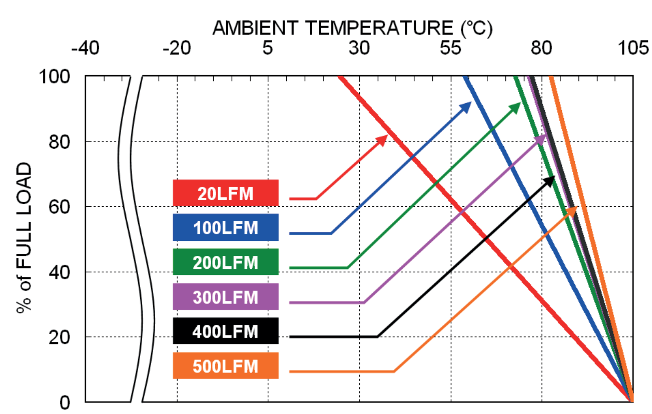
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19” X 3.5” X 0.063”

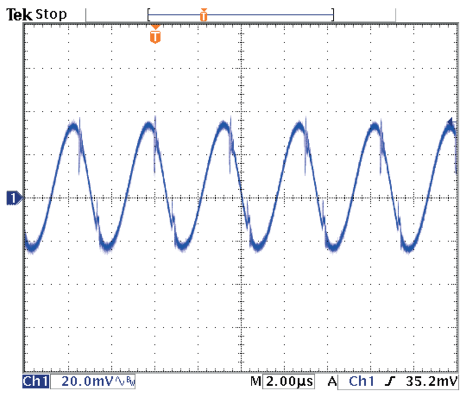


Derating Output Load versus Ambient Temperature and Airflow
With 0.24” Heat-Sink , Vin(nom)

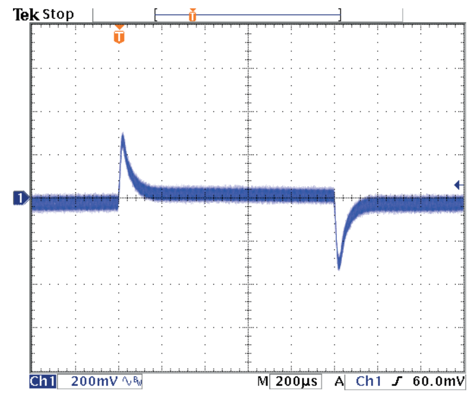


Derating Output Load versus Ambient Temperature and Airflow
With 0.5” Heat-Sink , Vin(nom)

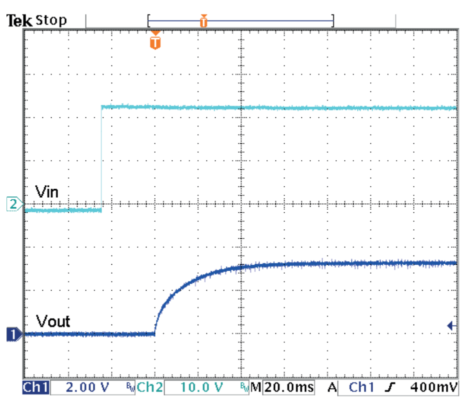
All test conditions are at 25°C.The figures are identical for PQAE150-24S3P3W



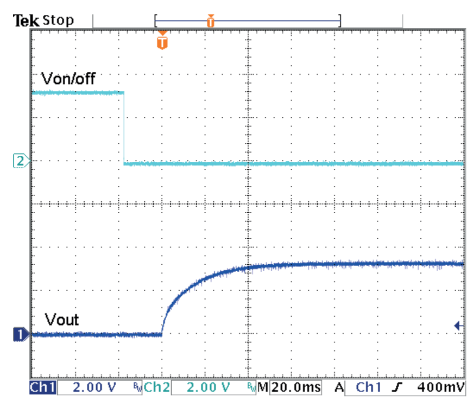
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

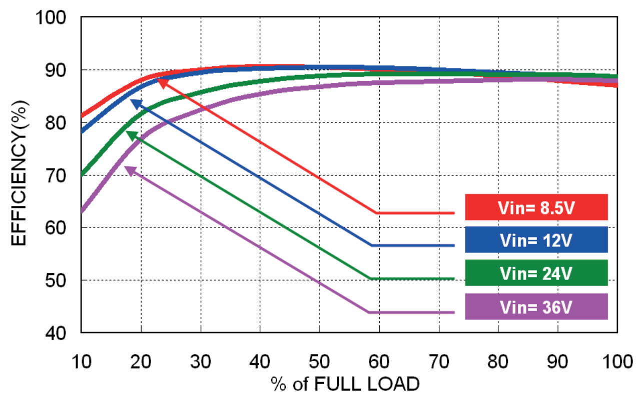


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

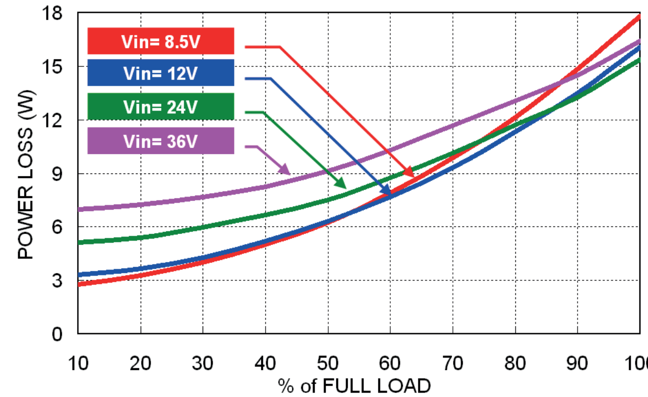


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

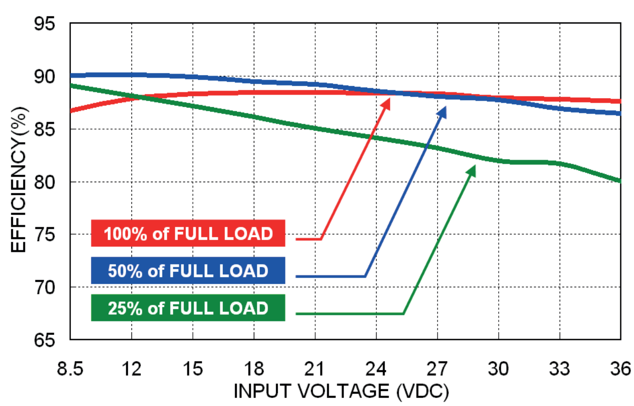
All test conditions are at 25°C.The figures are identical for PQAE150-24S05W



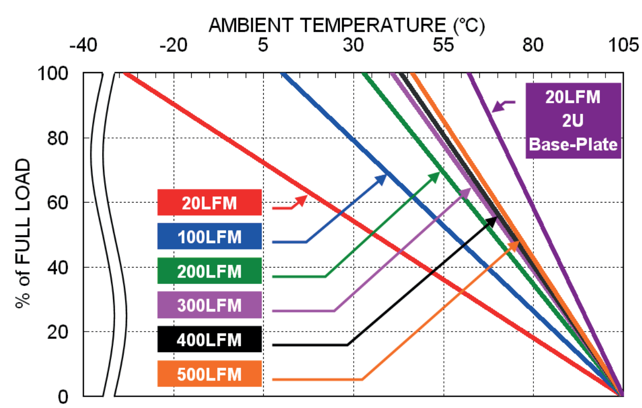
Efficiency versus Output Load



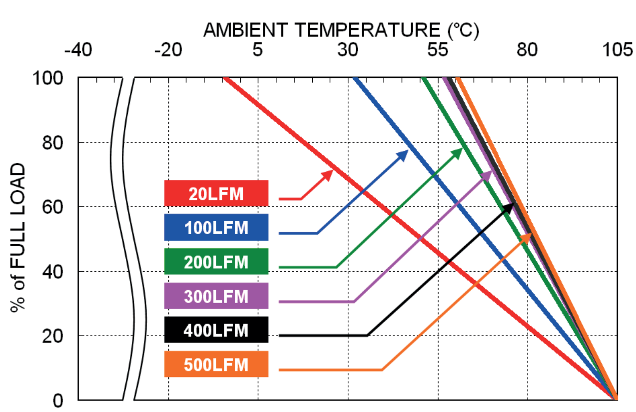
Power dissipation versus Output Load



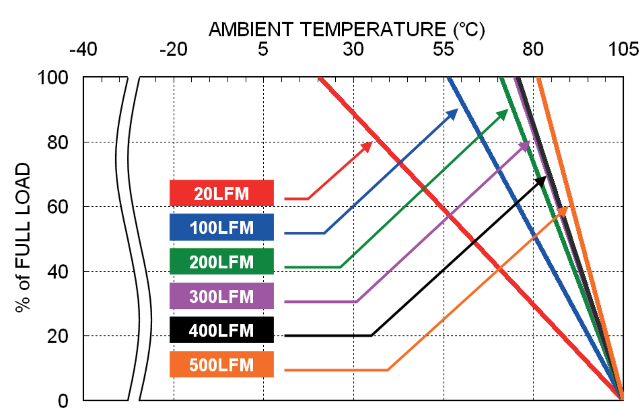
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19" X 3.5" X 0.063"

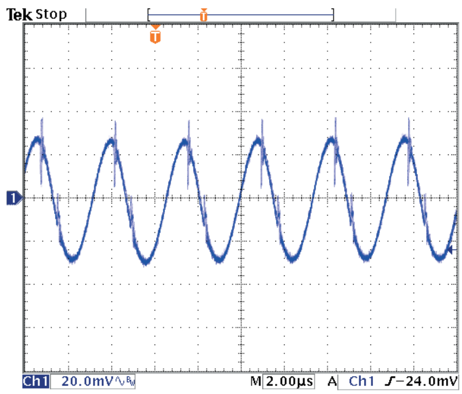


Derating Output Load versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

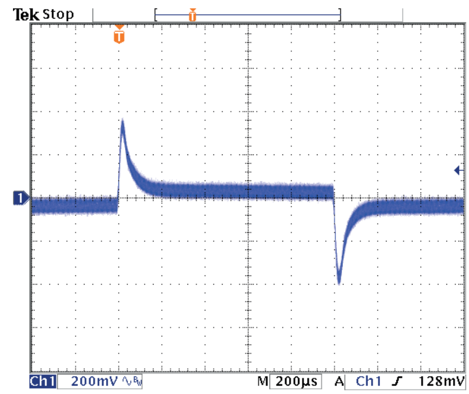


Derating Output Load versus Ambient Temperature and Airflow
With 0.5" Heat-Sink , Vin(nom)

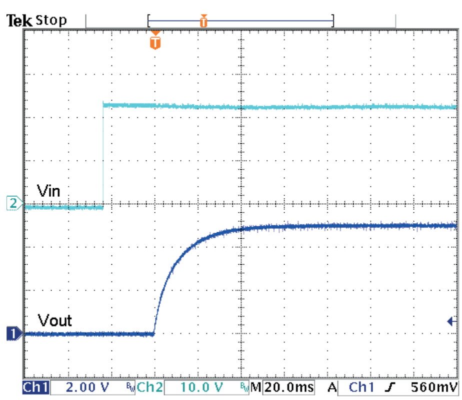
All test conditions are at 25°C.The figures are identical for PQAE150-24S05W



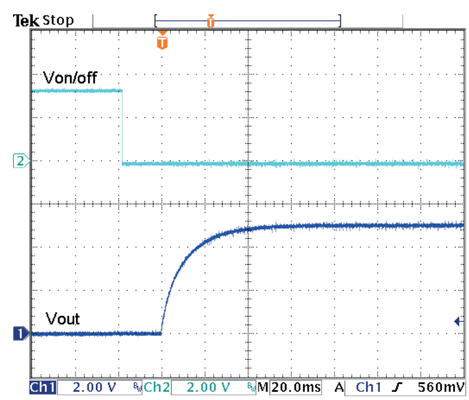
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

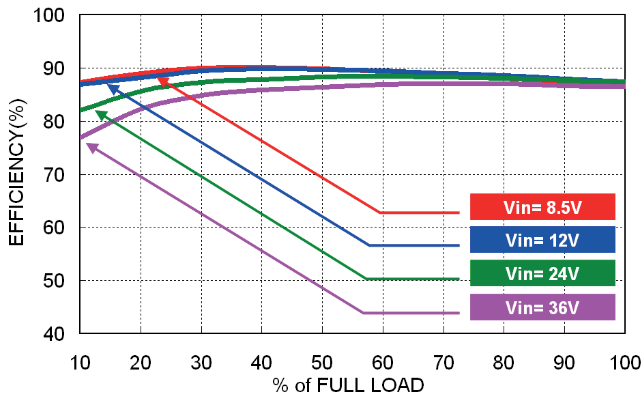


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

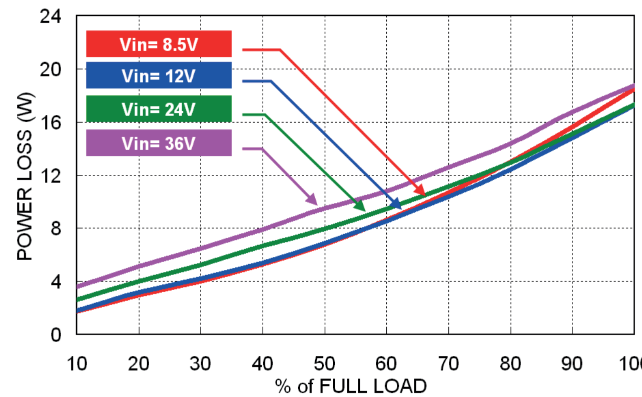


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

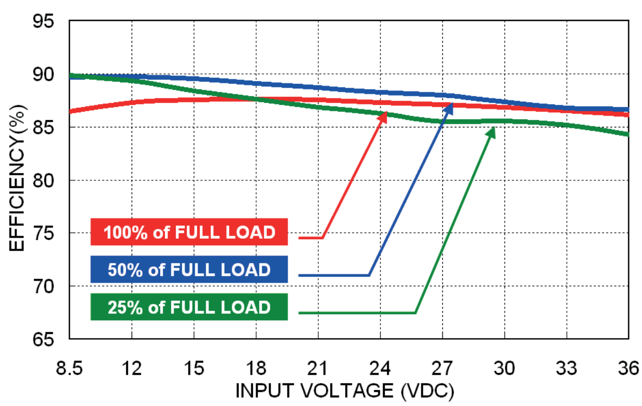
All test conditions are at 25°C.The figures are identical for PQAE150-24S12W



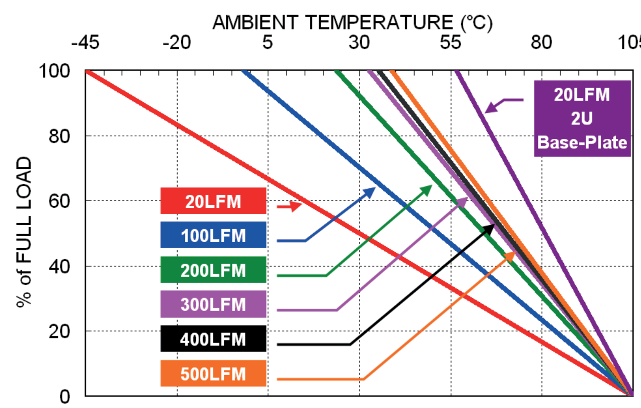
Efficiency versus Output Load



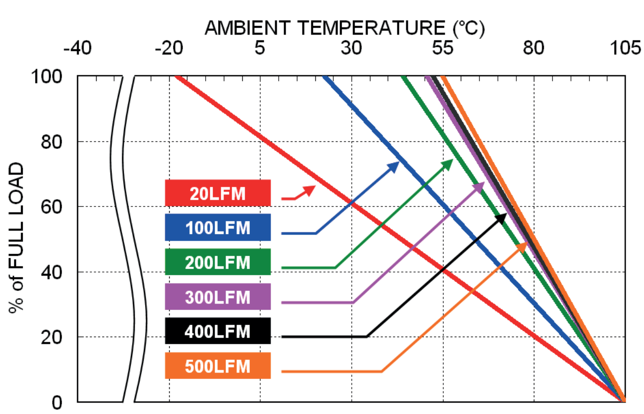
Power dissipation versus Output Load



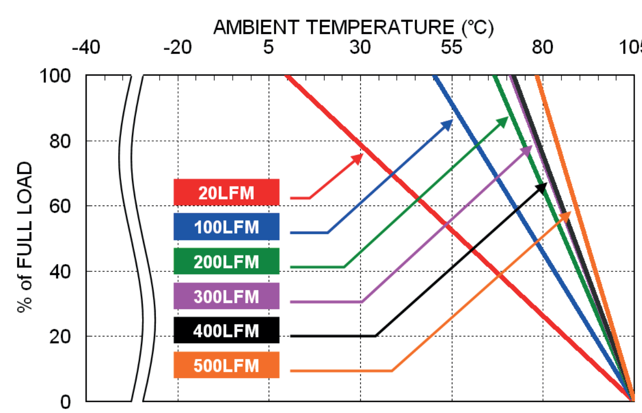
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19" X 3.5" X 0.063"

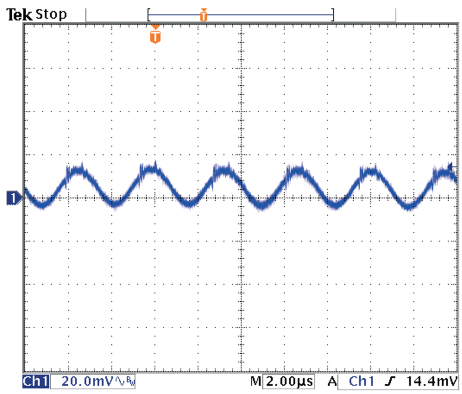


Derating Output Load versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

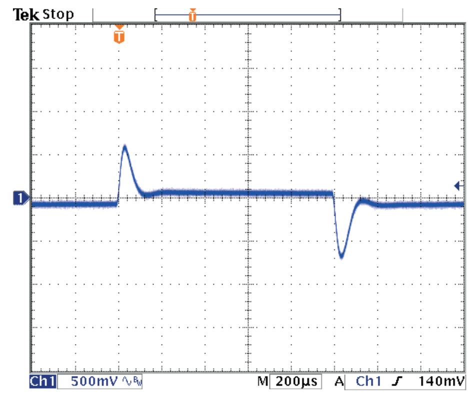


Derating Output Load versus Ambient Temperature and Airflow
With 0.5" Heat-Sink , Vin(nom)

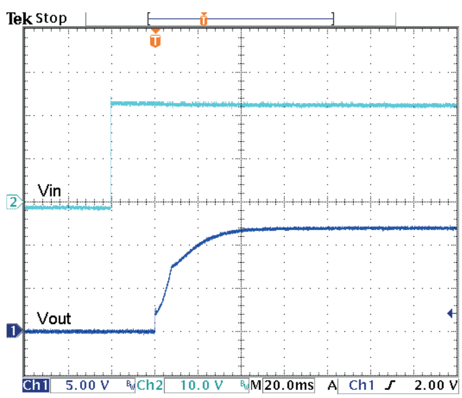
All test conditions are at 25°C.The figures are identical for PQAE150-24S12W



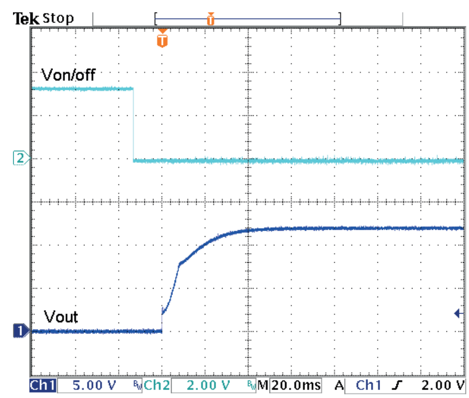
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

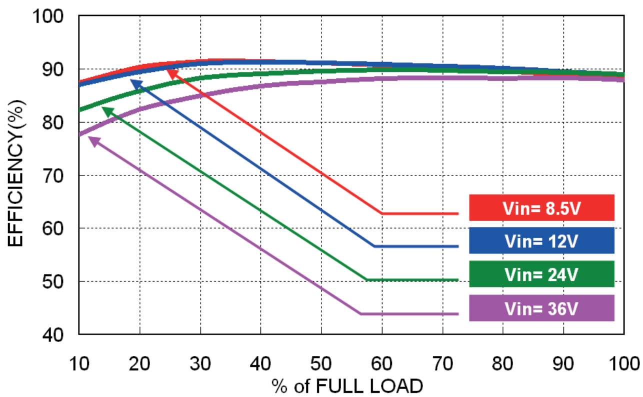


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

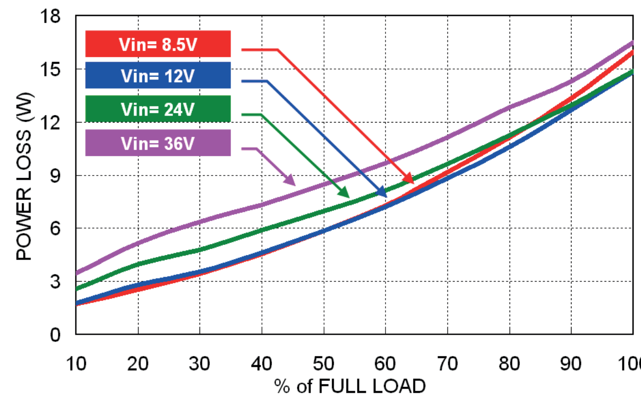


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

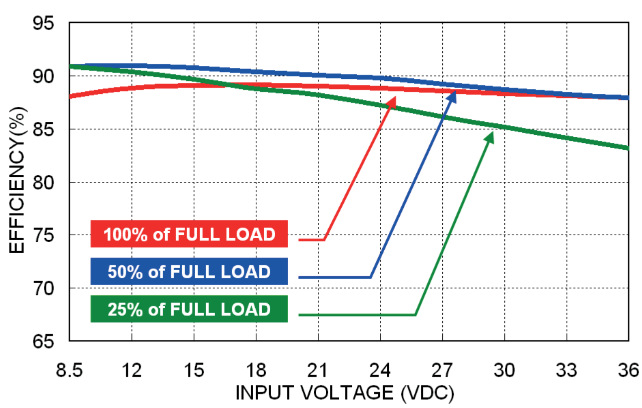
All test conditions are at 25°C.The figures are identical for PQAE150-24S15W



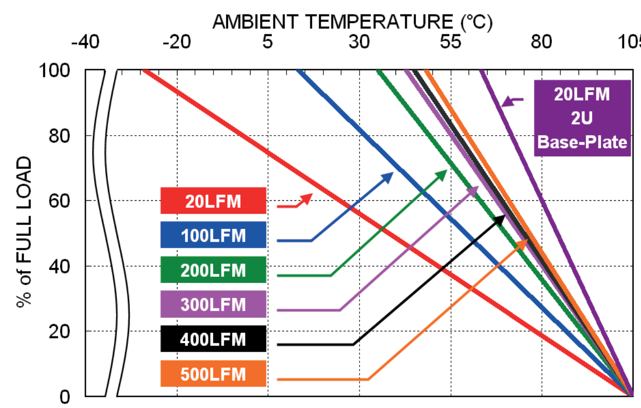
Efficiency versus Output Load



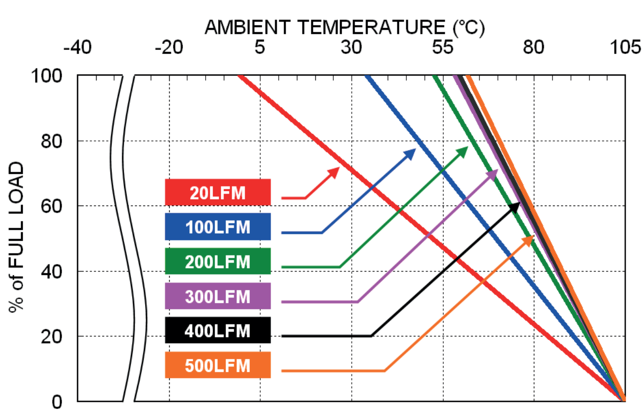
Power dissipation versus Output Load



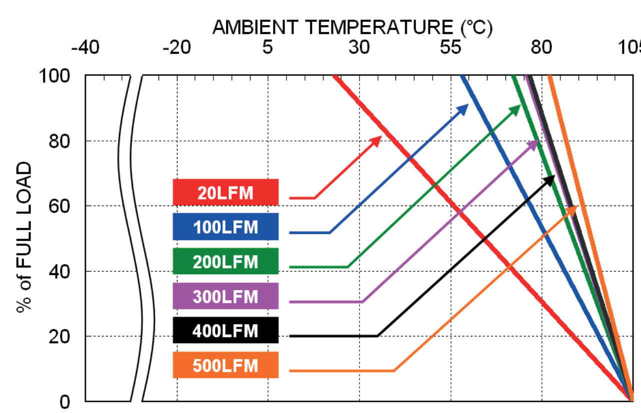
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19” X 3.5” X 0.063”

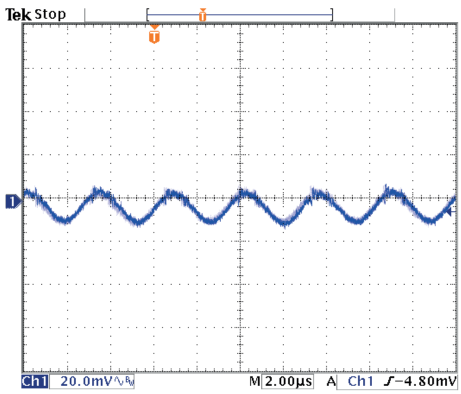


Derating Output Load versus Ambient Temperature and Airflow
With 0.24” Heat-Sink , Vin(nom)

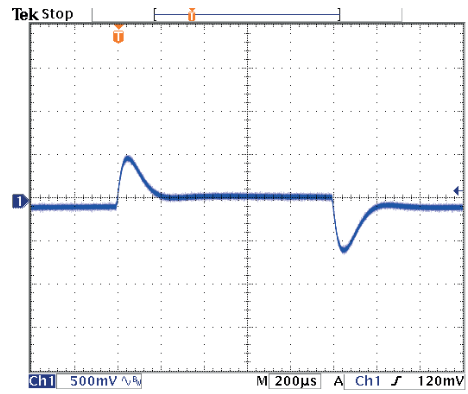


Derating Output Load versus Ambient Temperature and Airflow
With 0.5” Heat-Sink , Vin(nom)

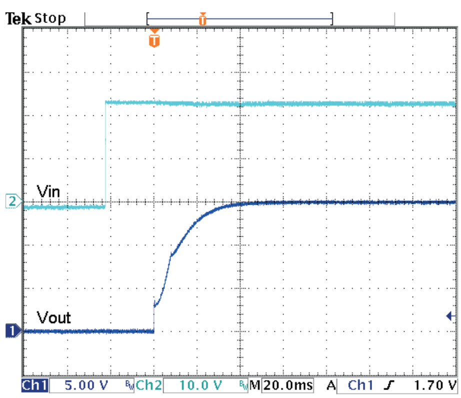
All test conditions are at 25°C.The figures are identical for PQAE150-24S15W



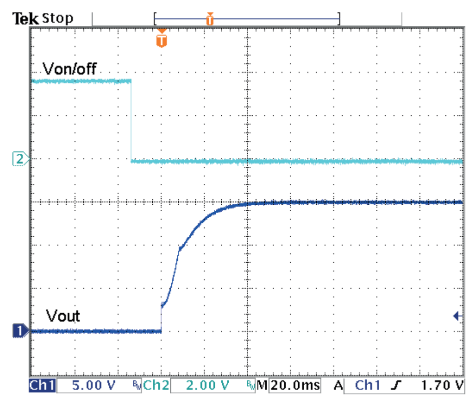
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

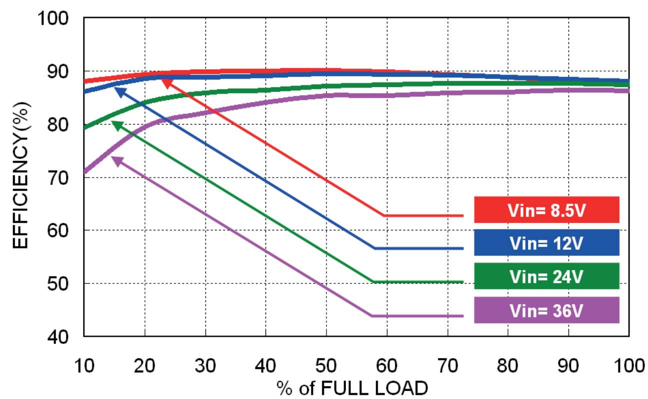


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

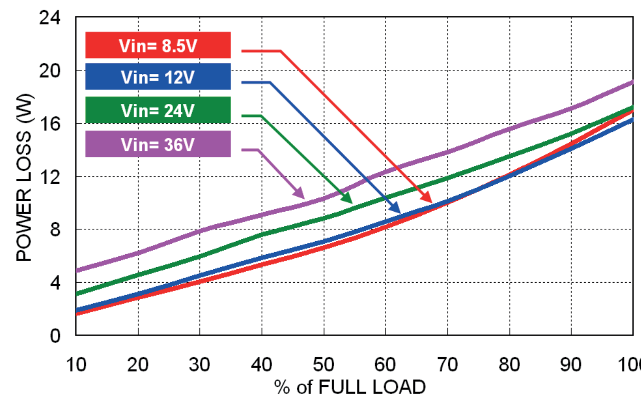


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

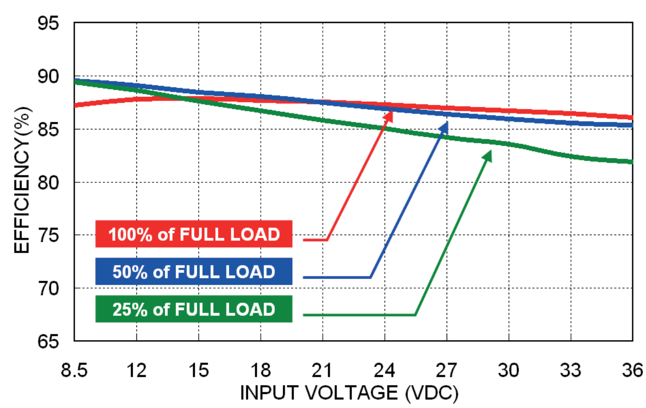
All test conditions are at 25°C.The figures are identical for PQAE150-24S24W



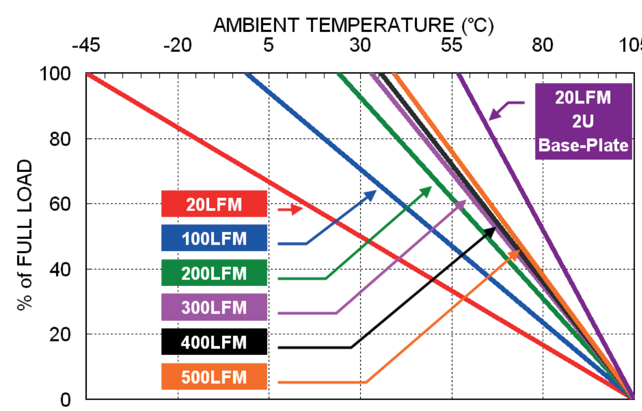
Efficiency versus Output Load



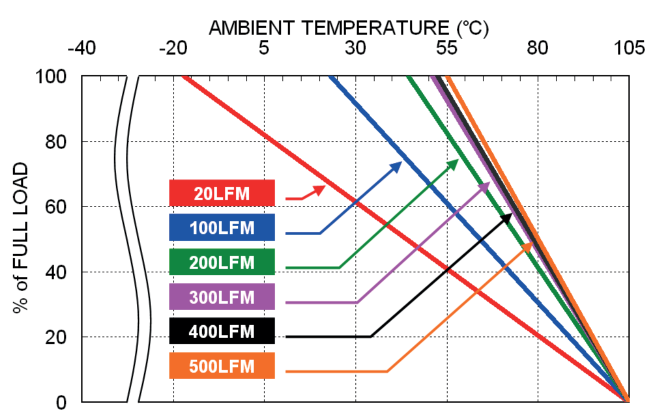
Power dissipation versus Output Load



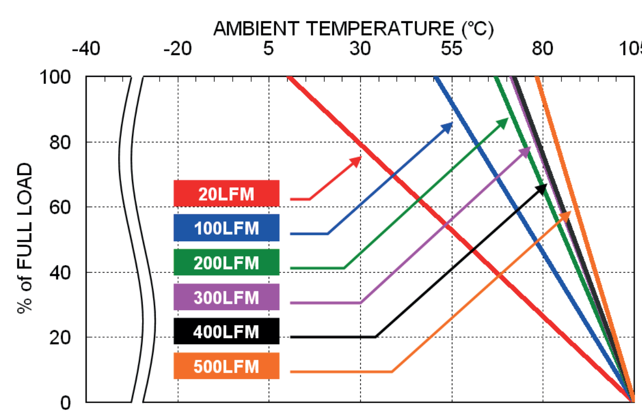
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19” X 3.5” X 0.063”

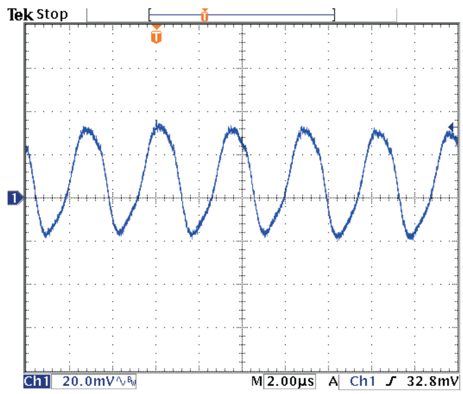


Derating Output Load versus Ambient Temperature and Airflow
With 0.24” Heat-Sink , Vin(nom)

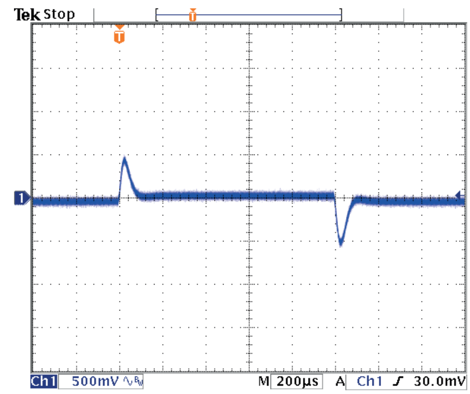


Derating Output Load versus Ambient Temperature and Airflow
With 0.5” Heat-Sink , Vin(nom)

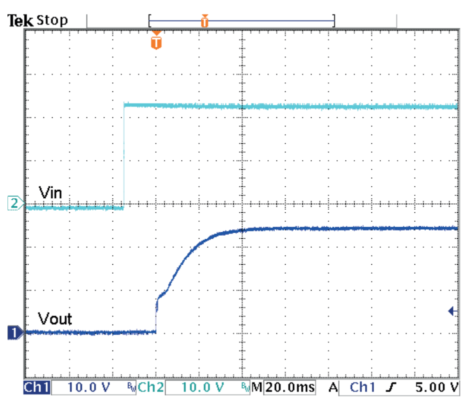
All test conditions are at 25°C.The figures are identical for PQAE150-24S24W



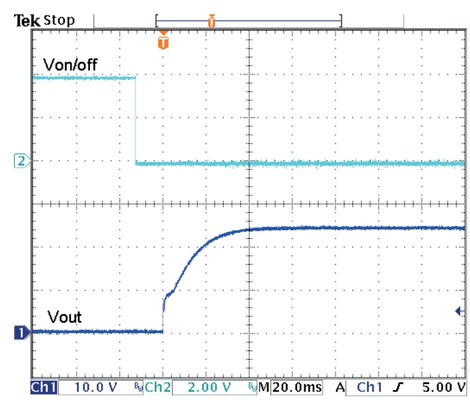
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

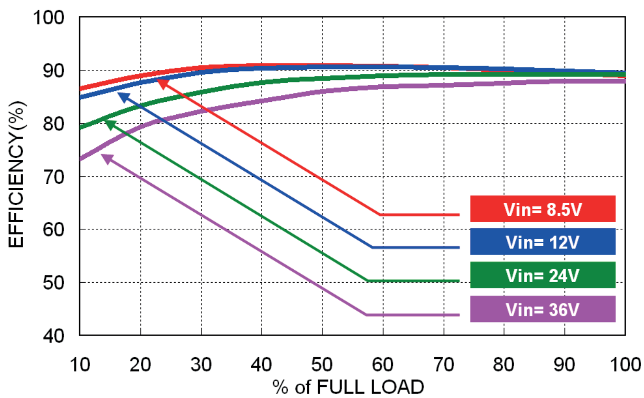


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

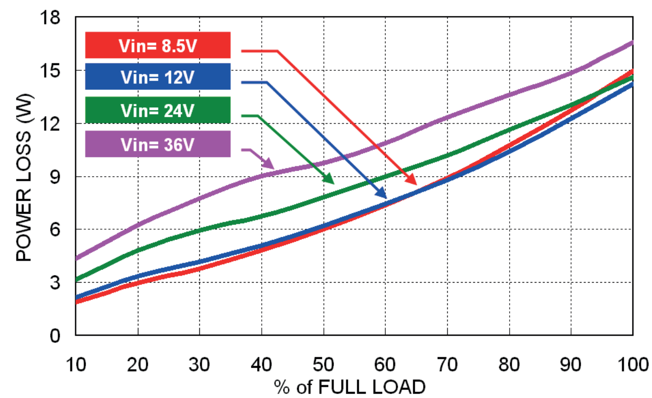


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

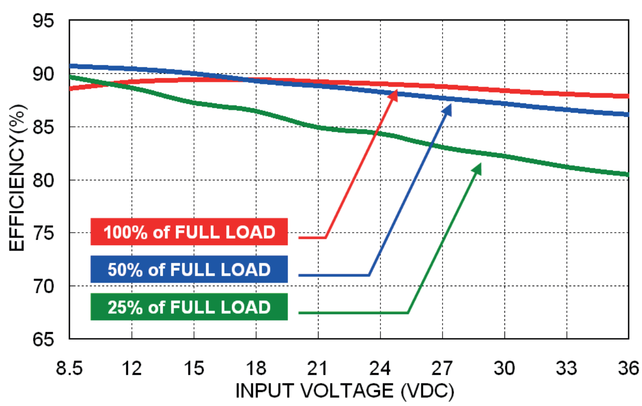
All test conditions are at 25°C.The figures are identical for PQAE150-24S30W



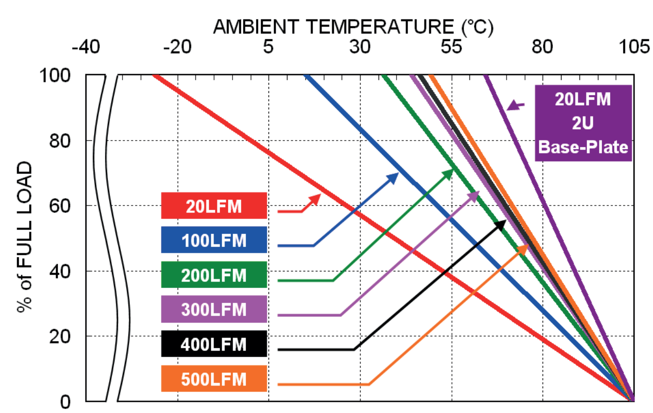
Efficiency versus Output Load



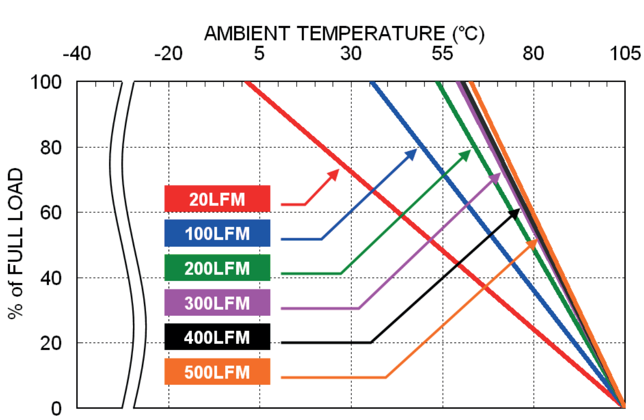
Power dissipation versus Output Load



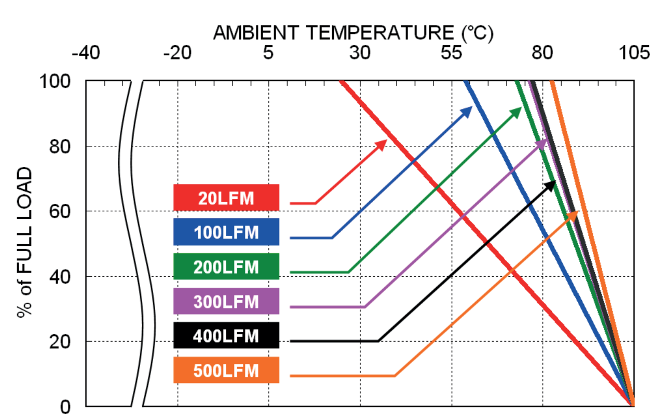
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19” X 3.5” X 0.063”

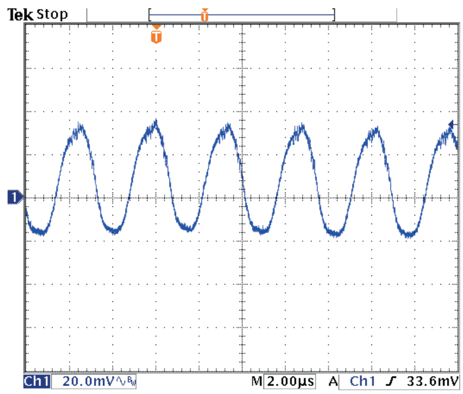


Derating Output Load versus Ambient Temperature and Airflow
With 0.24” Heat-Sink , Vin(nom)

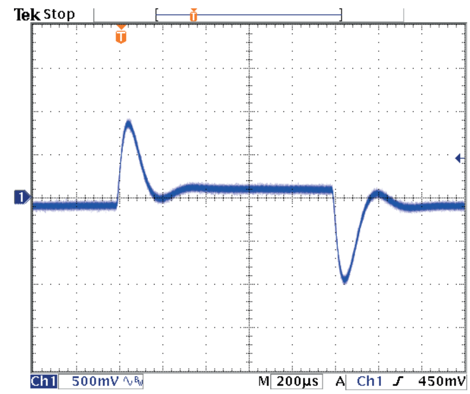


Derating Output Load versus Ambient Temperature and Airflow
With 0.5” Heat-Sink , Vin(nom)

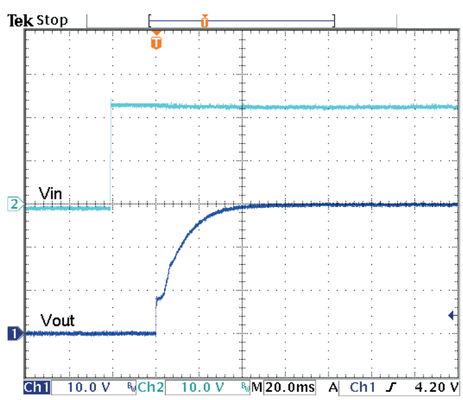
All test conditions are at 25°C.The figures are identical for PQAE150-24S30W



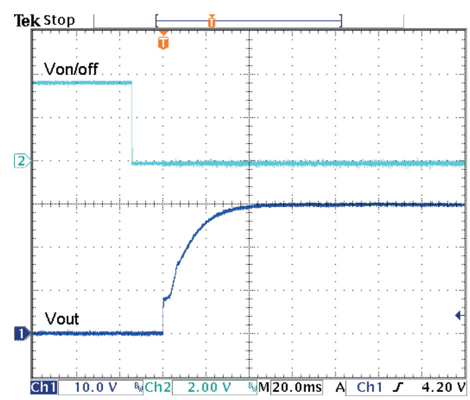
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

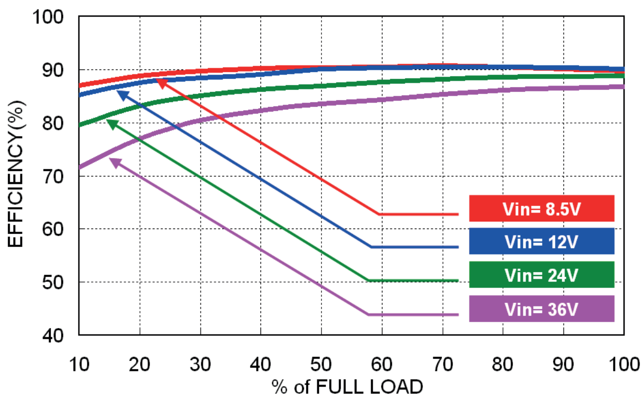


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

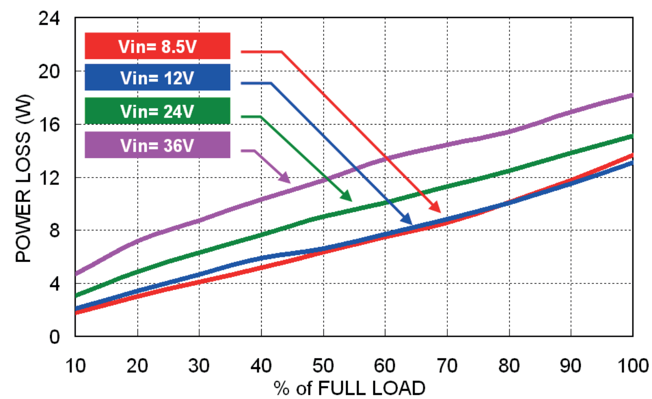


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

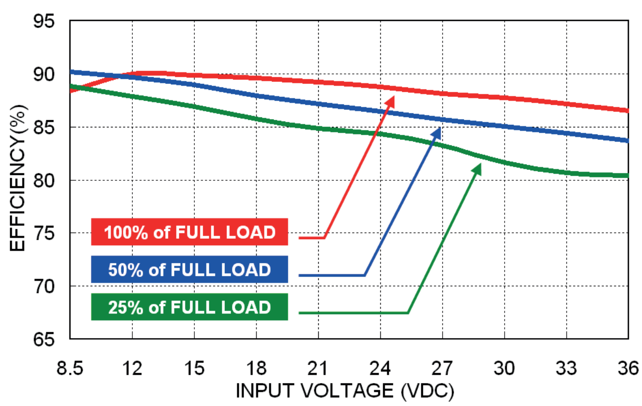
All test conditions are at 25°C.The figures are identical for PQAE150-24S48W



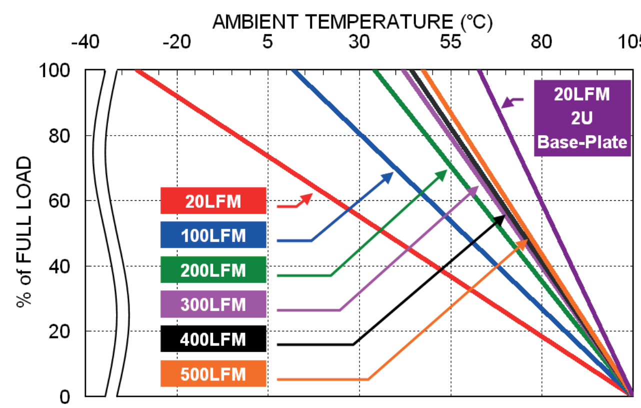
Efficiency versus Output Load



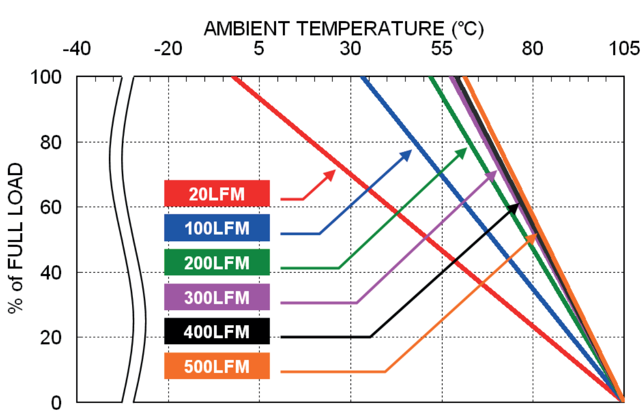
Power dissipation versus Output Load



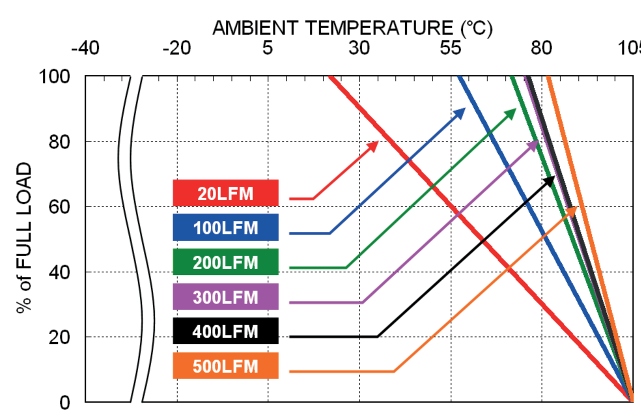
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19" X 3.5" X 0.063"

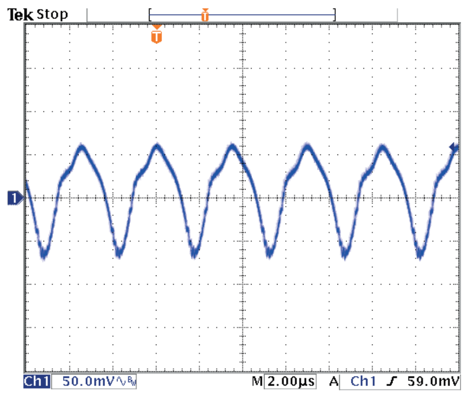


Derating Output Load versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

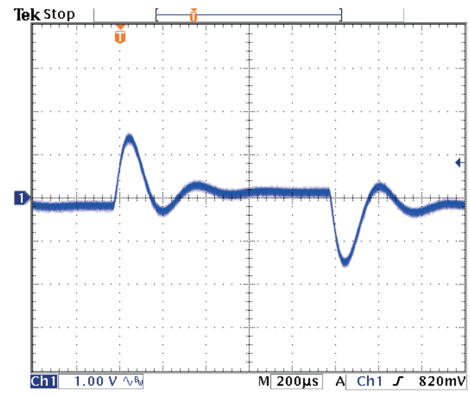


Derating Output Load versus Ambient Temperature and Airflow
With 0.5" Heat-Sink , Vin(nom)

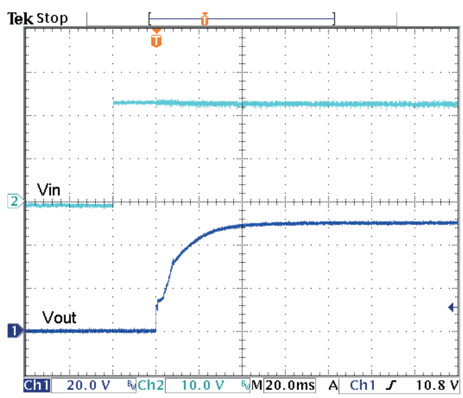
All test conditions are at 25°C.The figures are identical for PQAE150-24S48W



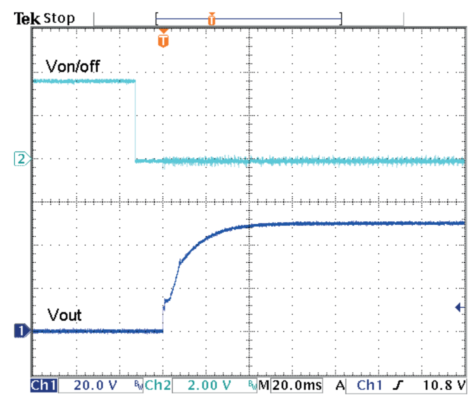
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

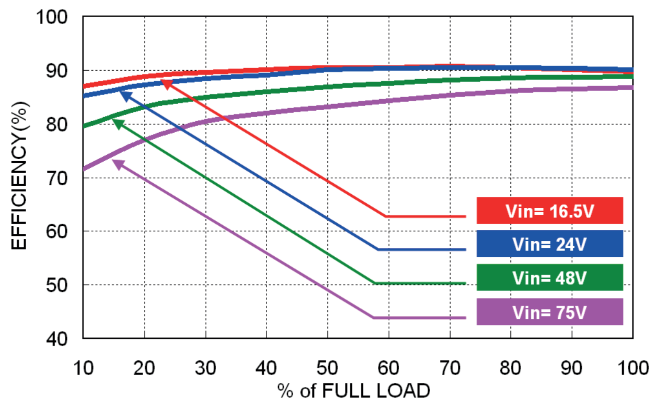


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

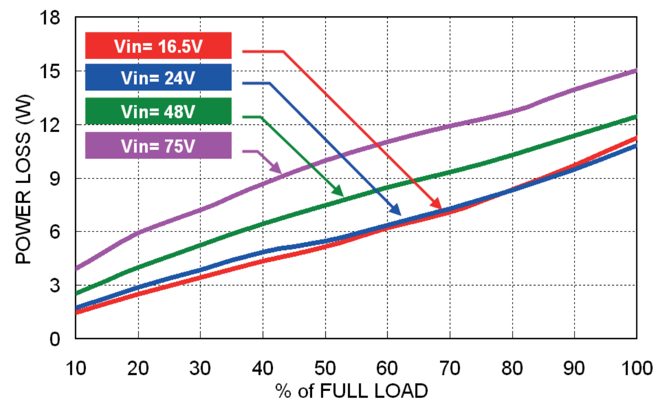


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

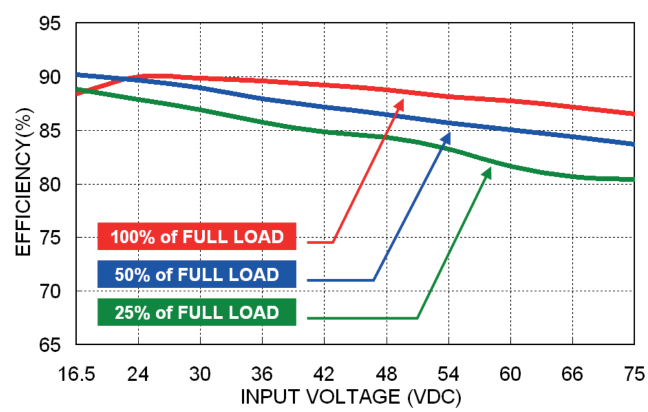
All test conditions are at 25°C.The figures are identical for PQAE150-48S3P3W



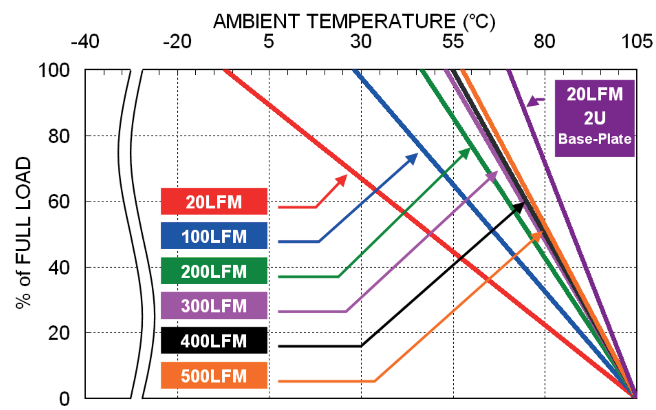
Efficiency versus Output Load



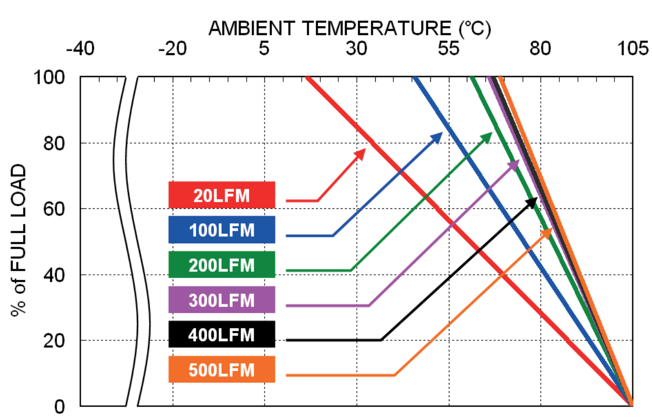
Power dissipation versus Output Load



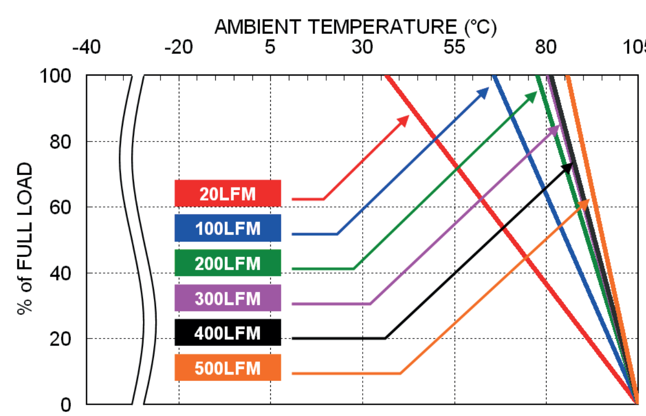
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19” X 3.5” X 0.063”

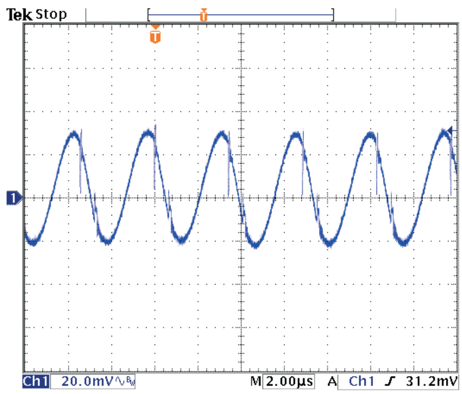


Derating Output Load versus Ambient Temperature and Airflow
With 0.24” Heat-Sink , Vin(nom)

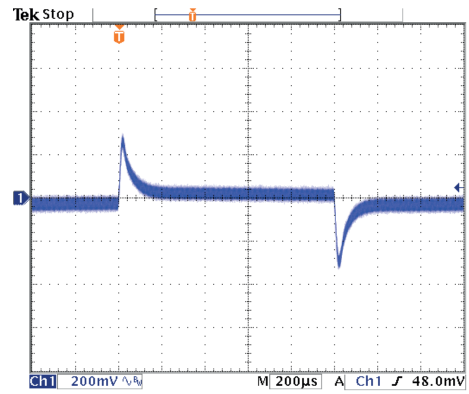


Derating Output Load versus Ambient Temperature and Airflow
With 0.5” Heat-Sink , Vin(nom)

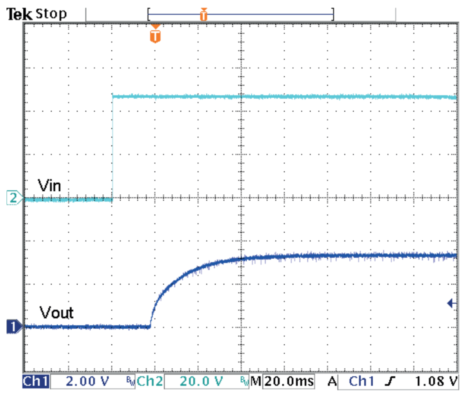
All test conditions are at 25°C.The figures are identical for PQAE150-48S3P3W



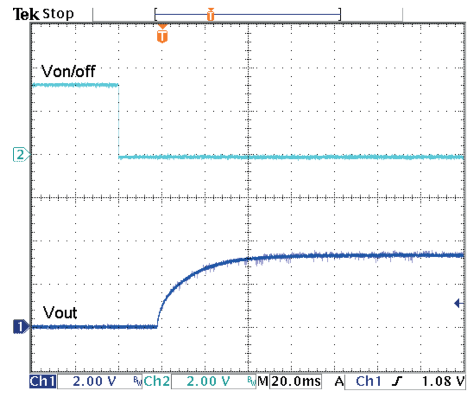
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

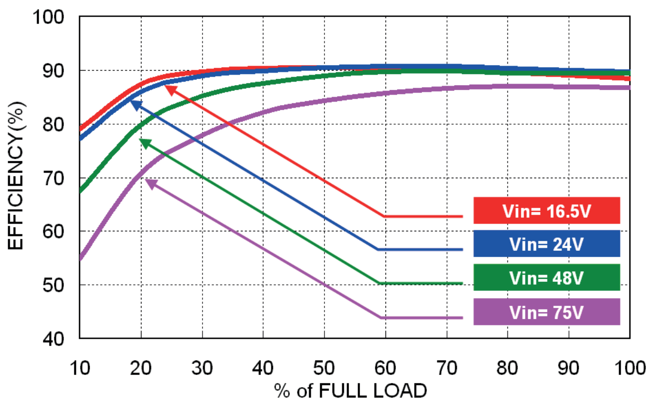


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

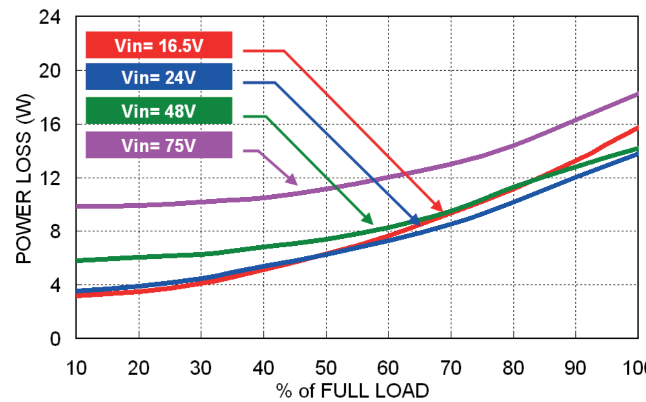


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

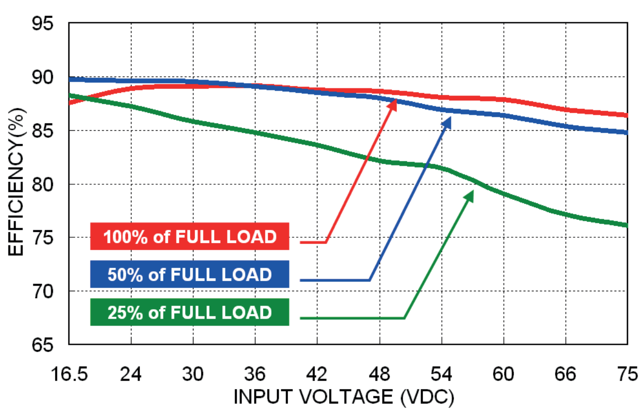
All test conditions are at 25°C.The figures are identical for PQAE150-48S05W



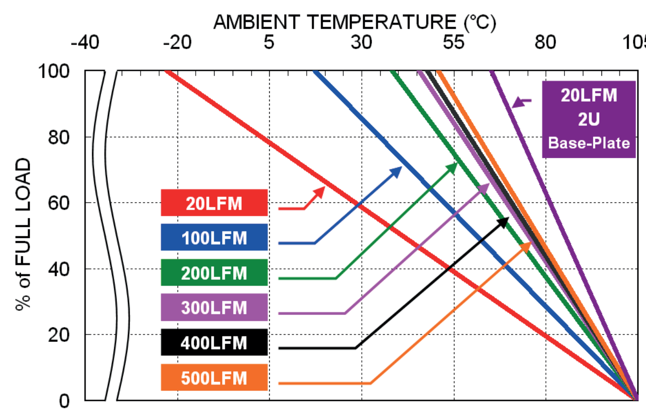
Efficiency versus Output Load



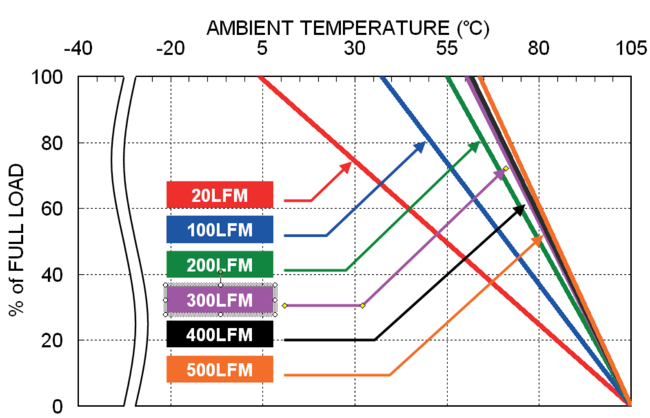
Power dissipation versus Output Load



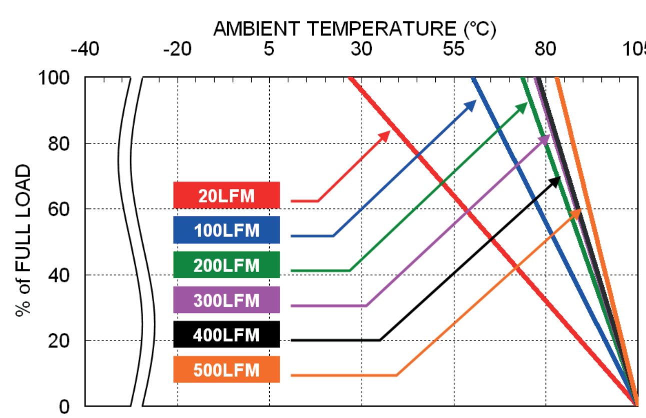
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19” X 3.5” X 0.063”

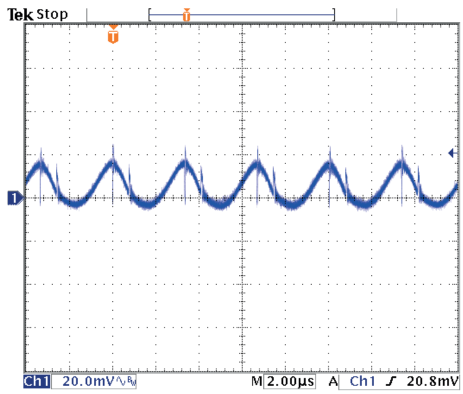


Derating Output Load versus Ambient Temperature and Airflow
With 0.24” Heat-Sink , Vin(nom)

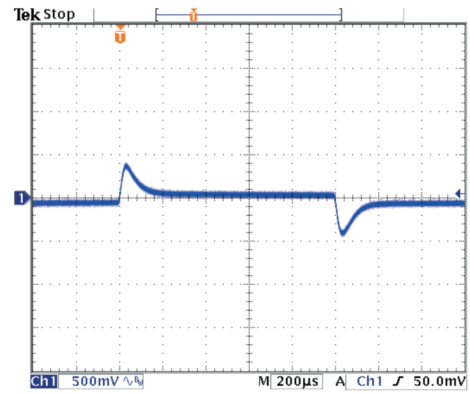


Derating Output Load versus Ambient Temperature and Airflow
With 0.5” Heat-Sink , Vin(nom)

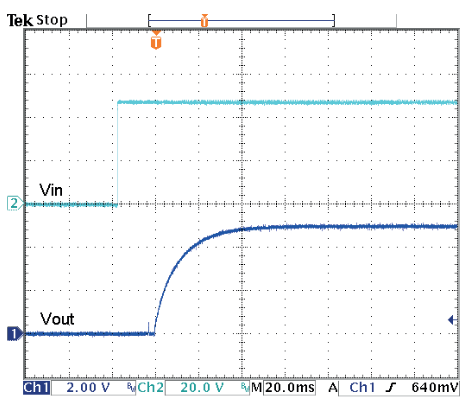
All test conditions are at 25°C.The figures are identical for PQAE150-48S05W



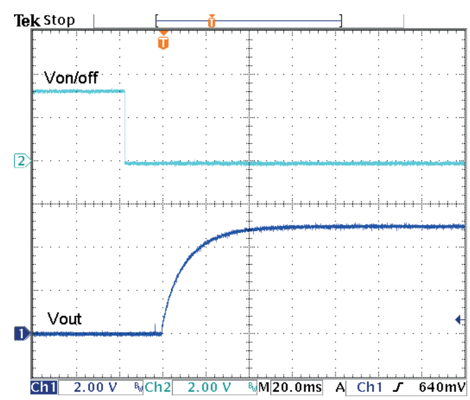
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

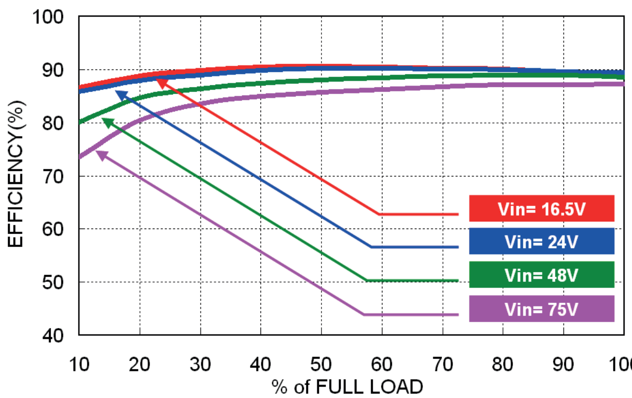


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

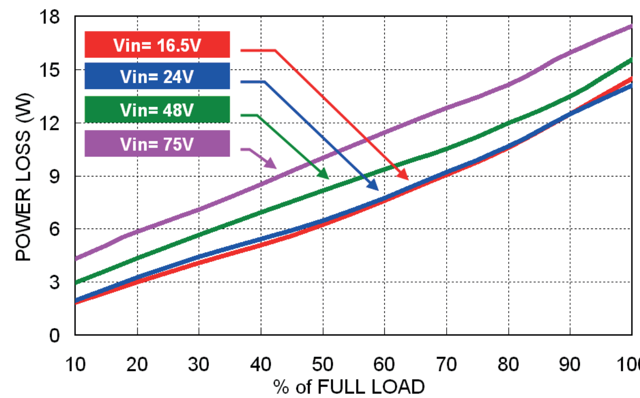


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

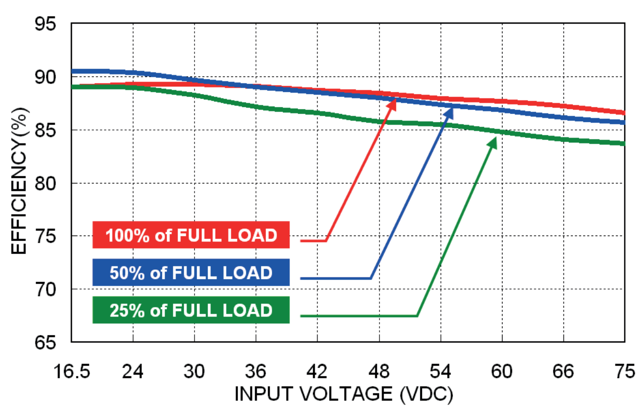
All test conditions are at 25°C.The figures are identical for PQAE150-48S12W



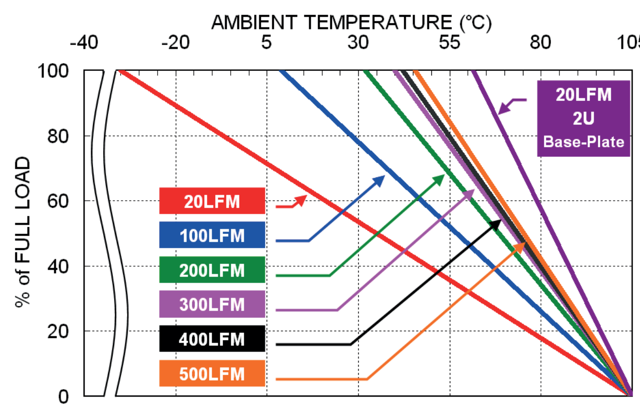
Efficiency versus Output Load



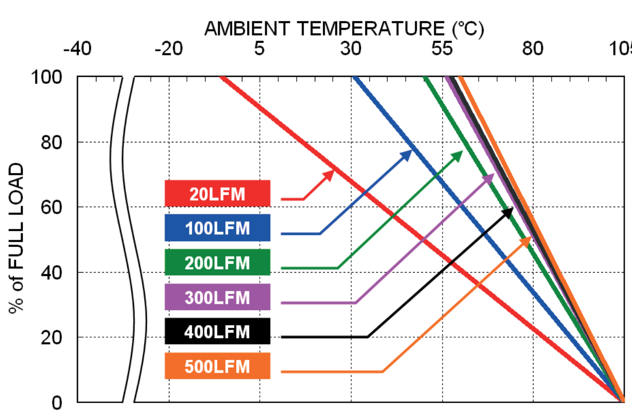
Power dissipation versus Output Load



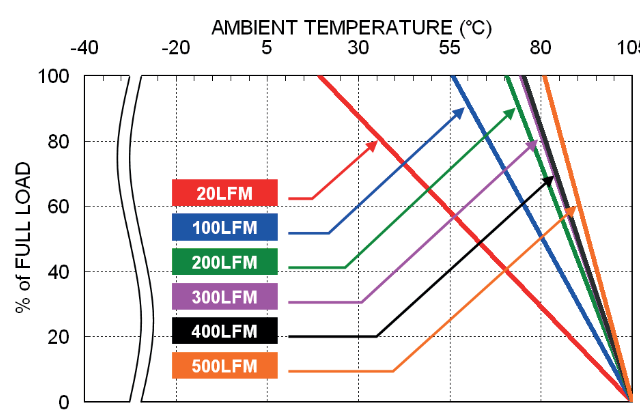
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19” X 3.5” X 0.063”

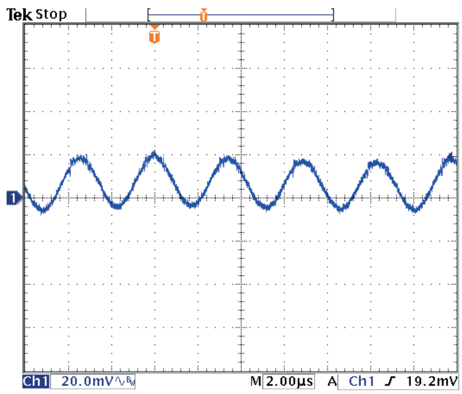


Derating Output Load versus Ambient Temperature and Airflow
With 0.24” Heat-Sink , Vin(nom)

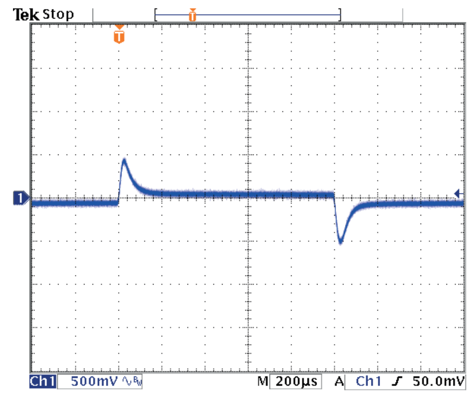


Derating Output Load versus Ambient Temperature and Airflow
With 0.5” Heat-Sink , Vin(nom)

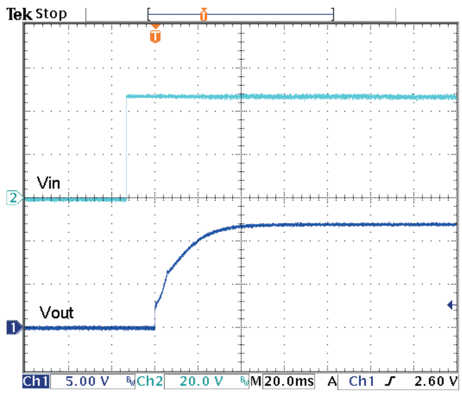
All test conditions are at 25°C.The figures are identical for PQAE150-48S12W



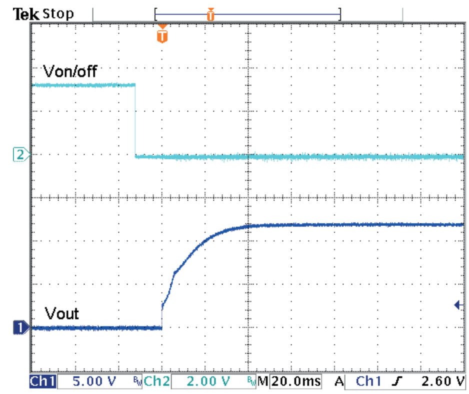
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

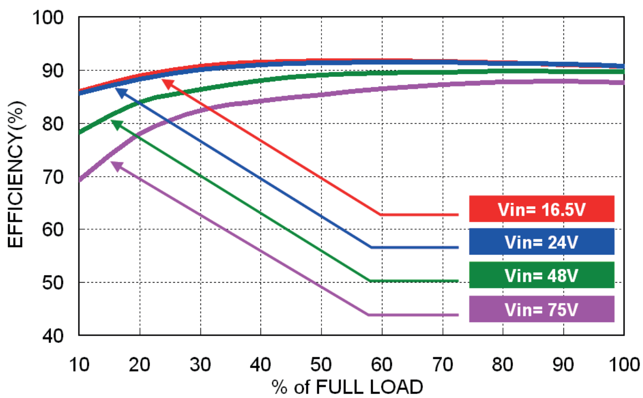


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

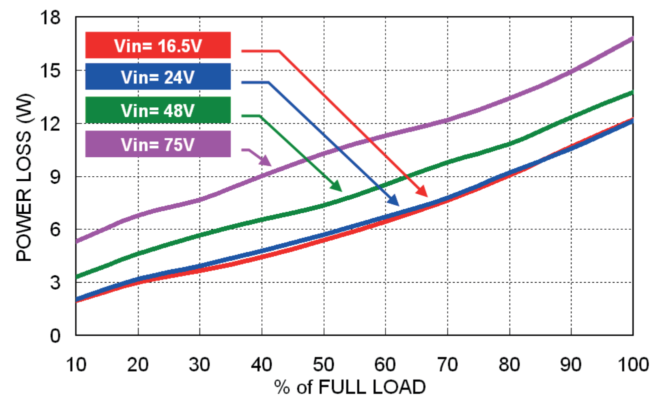


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

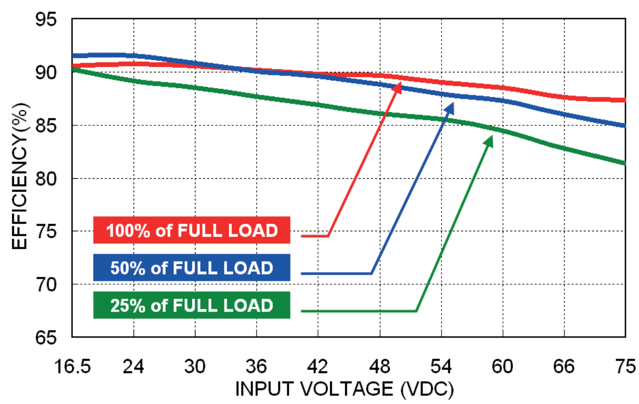
All test conditions are at 25°C.The figures are identical for PQAE150-48S15W



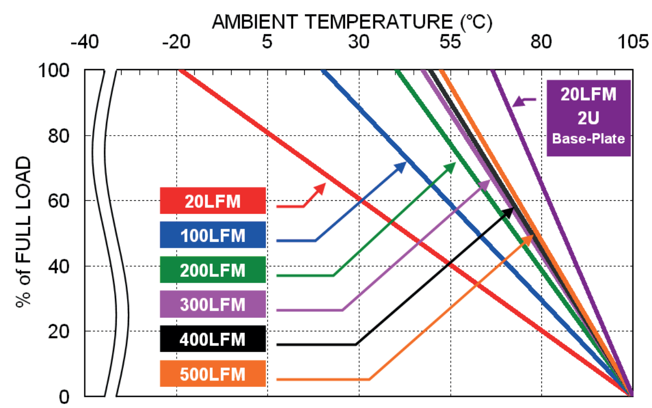
Efficiency versus Output Load



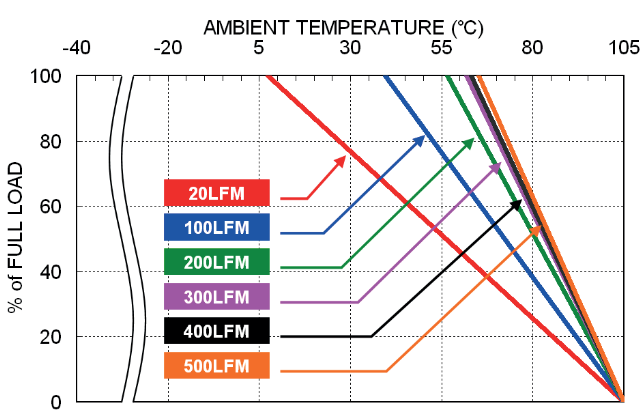
Power dissipation versus Output Load



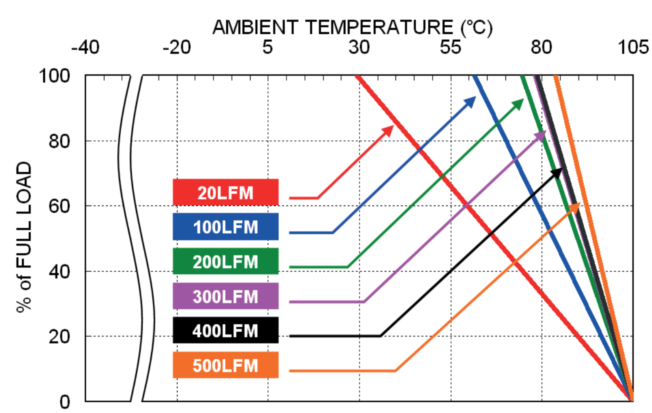
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19” X 3.5” X 0.063”

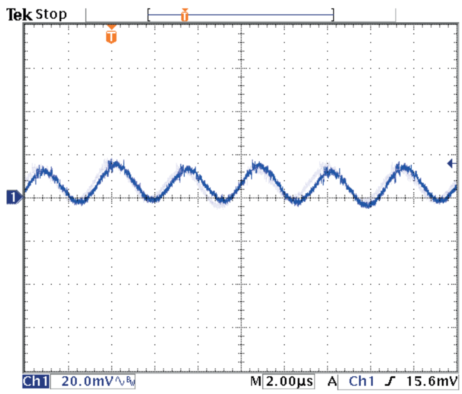


Derating Output Load versus Ambient Temperature and Airflow
With 0.24” Heat-Sink , Vin(nom)

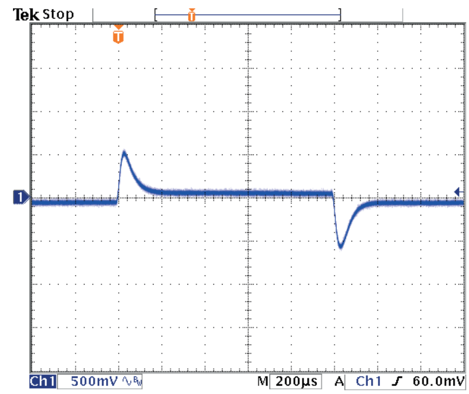


Derating Output Load versus Ambient Temperature and Airflow
With 0.5” Heat-Sink , Vin(nom)

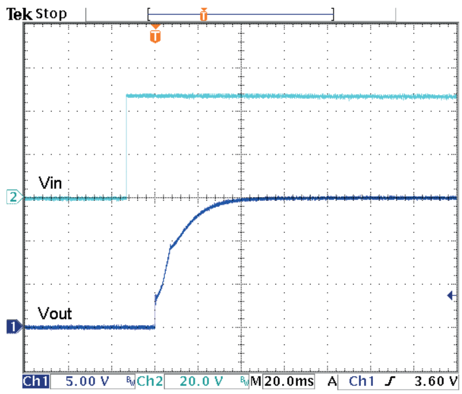
All test conditions are at 25°C.The figures are identical for PQAE150-48S15W



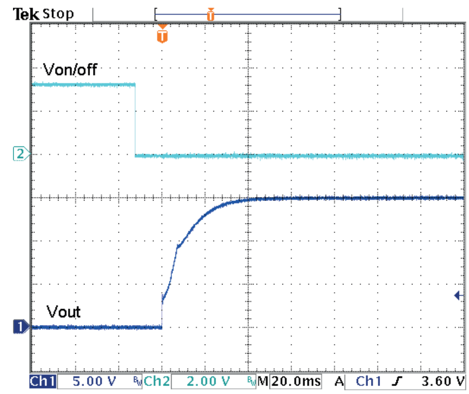
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

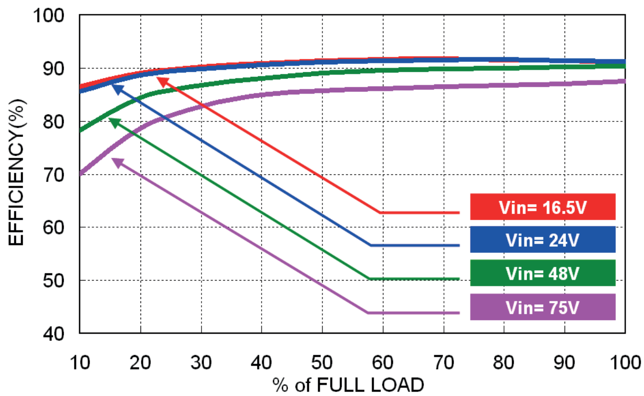


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

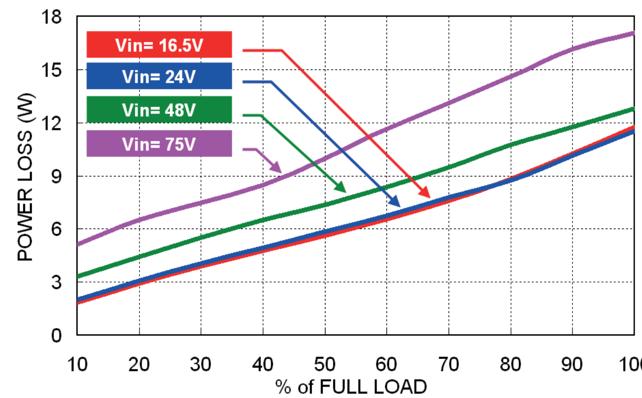


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

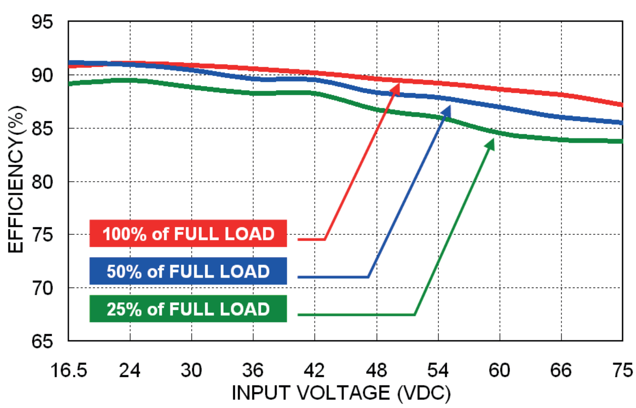
All test conditions are at 25°C.The figures are identical for PQAE150-48S24W



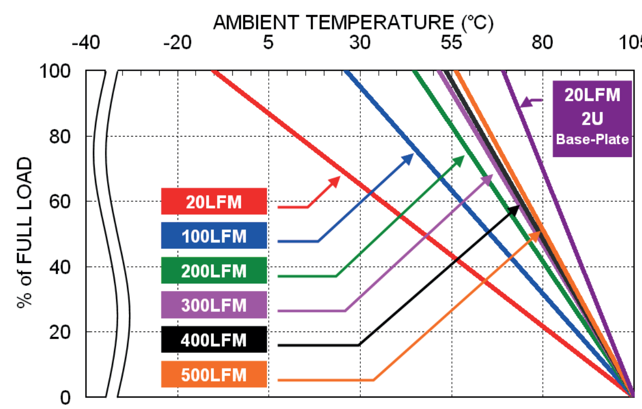
Efficiency versus Output Load



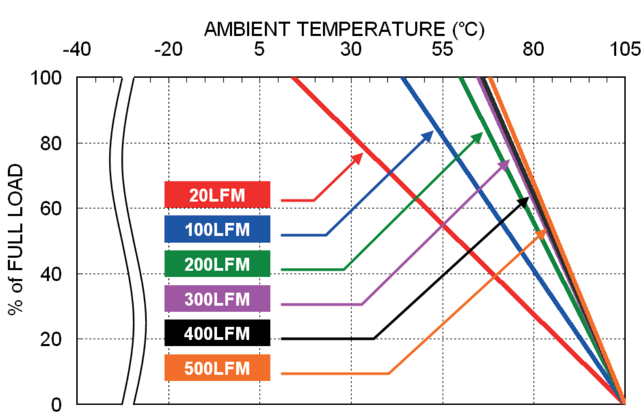
Power dissipation versus Output Load



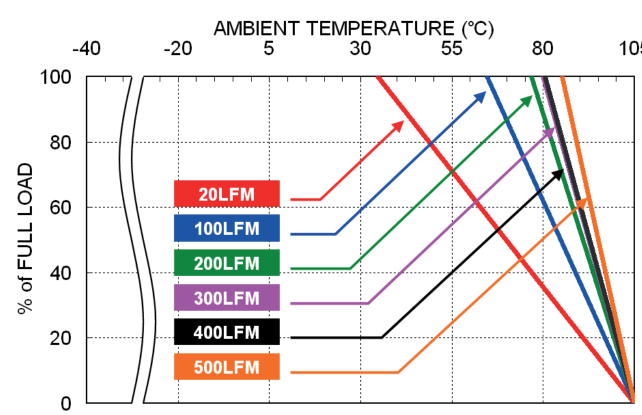
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19" X 3.5" X 0.063"

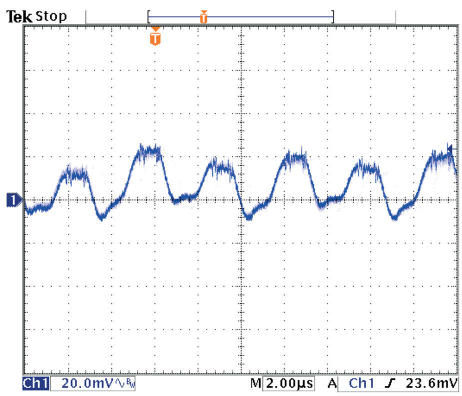


Derating Output Load versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

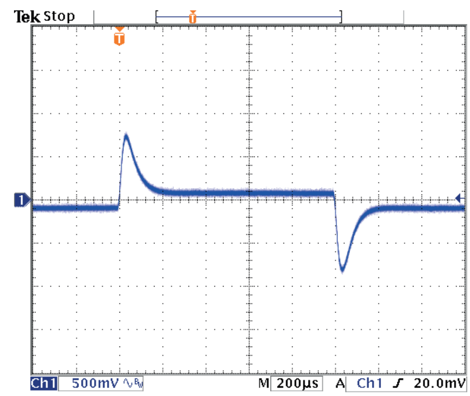


Derating Output Load versus Ambient Temperature and Airflow
With 0.5" Heat-Sink , Vin(nom)

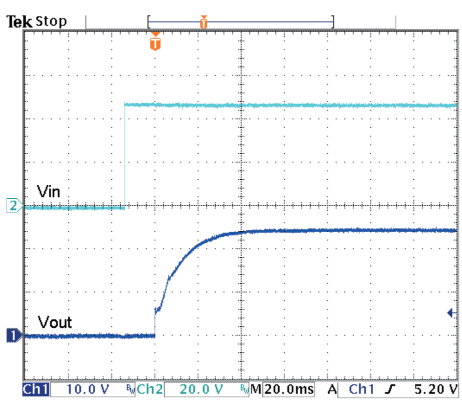
All test conditions are at 25°C.The figures are identical for PQAE150-48S24W



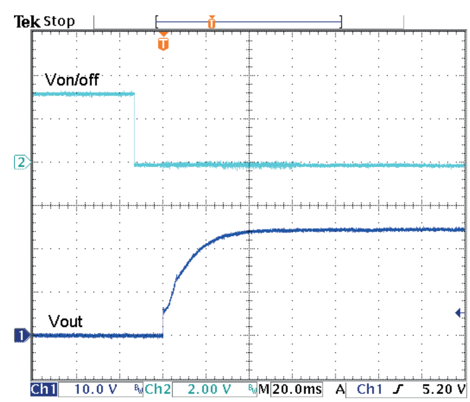
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

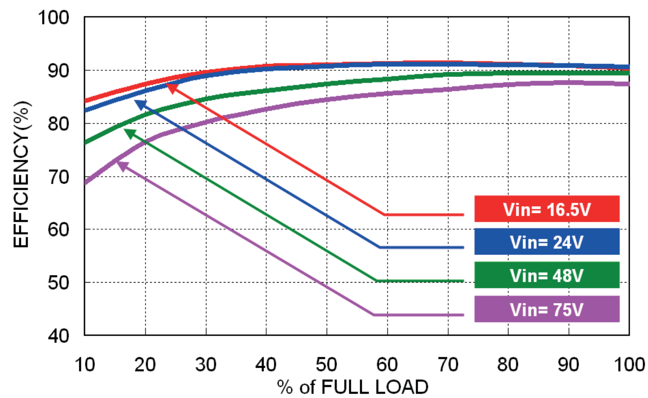


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

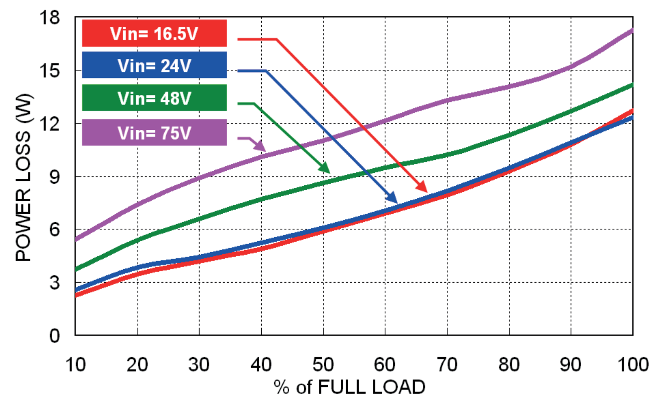


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

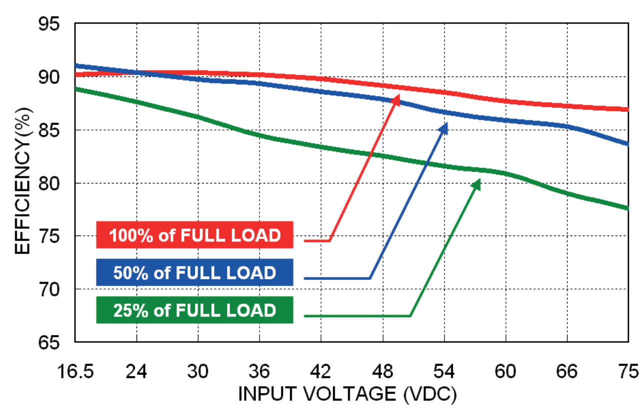
All test conditions are at 25°C.The figures are identical for PQAE150-48S30W



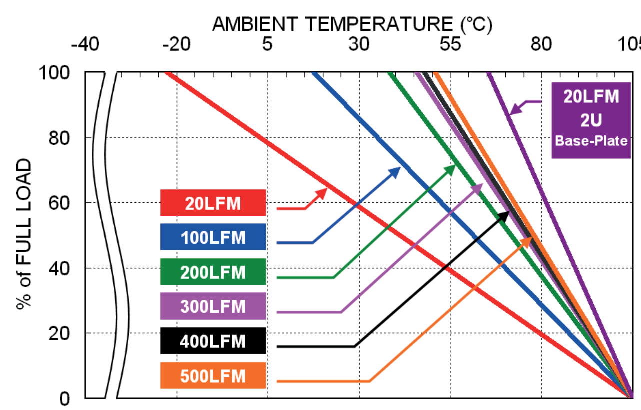
Efficiency versus Output Load



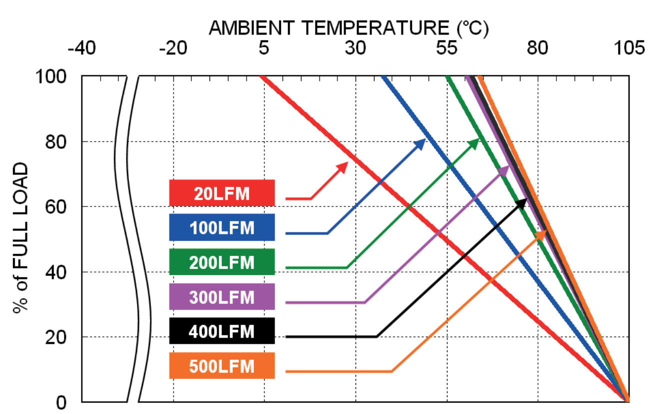
Power dissipation versus Output Load



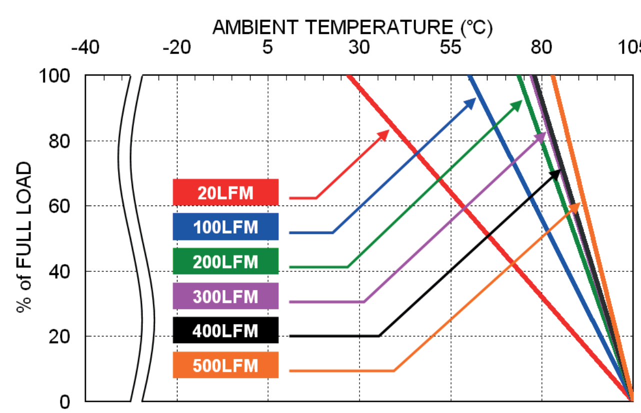
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19” X 3.5” X 0.063”

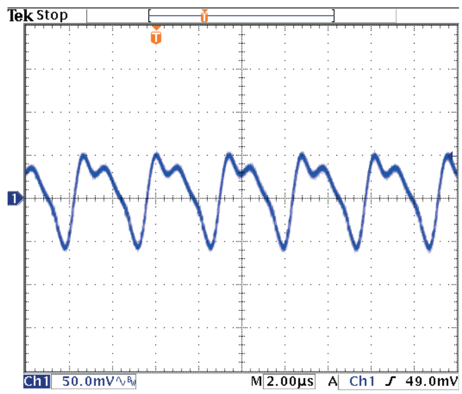


Derating Output Load versus Ambient Temperature and Airflow
With 0.24” Heat-Sink , Vin(nom)

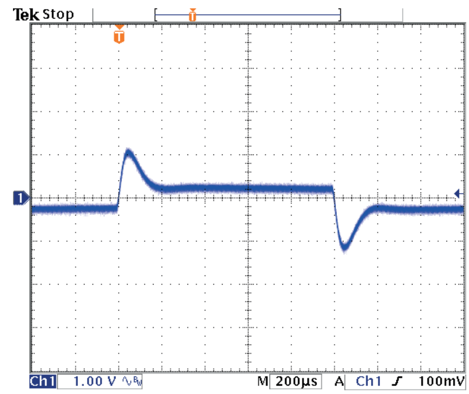


Derating Output Load versus Ambient Temperature and Airflow
With 0.5” Heat-Sink , Vin(nom)

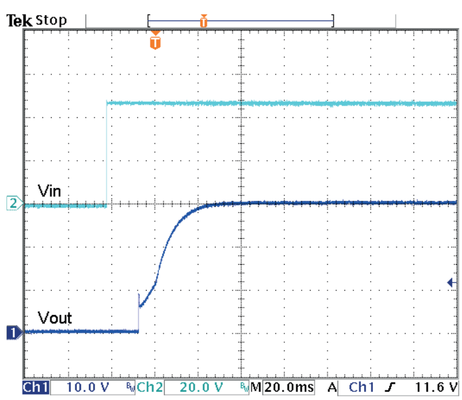
All test conditions are at 25°C.The figures are identical for PQAE150-48S30W



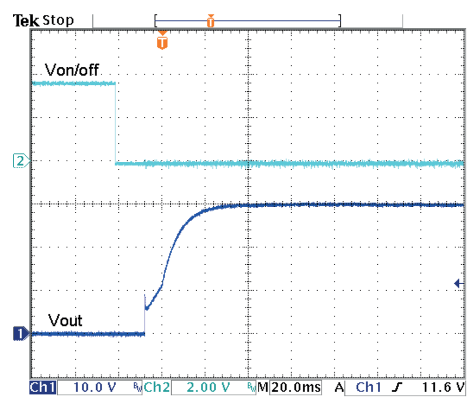
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

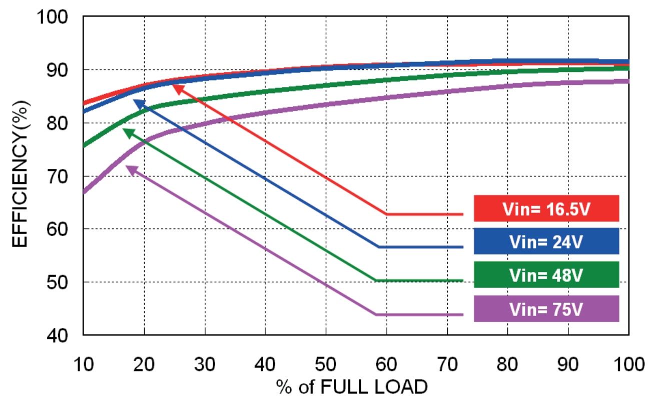


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

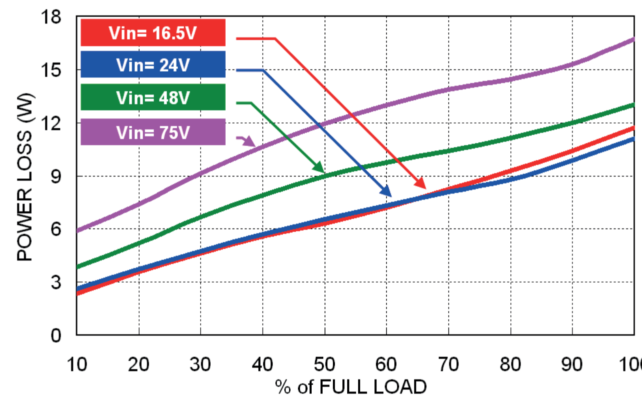


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

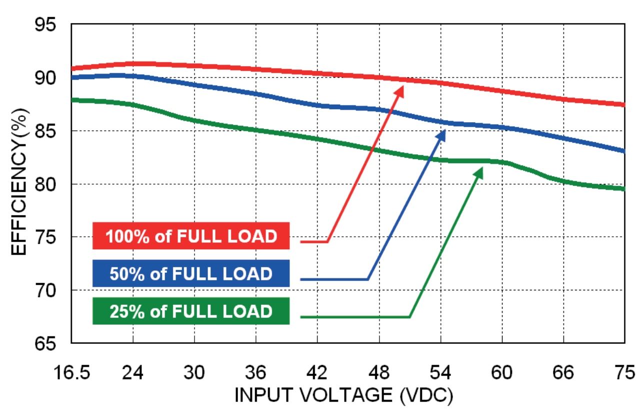
All test conditions are at 25°C.The figures are identical for PQAE150-48S48W



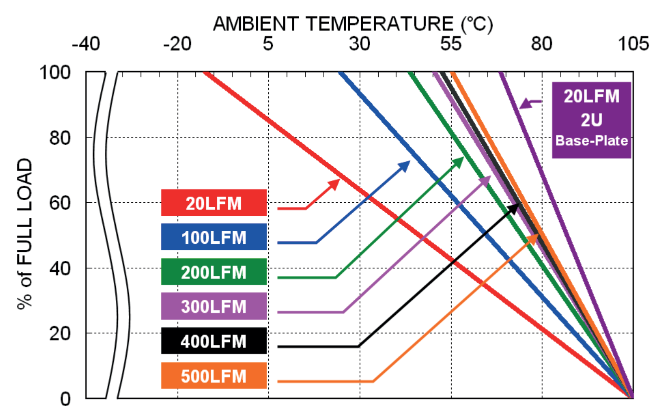
Efficiency versus Output Load



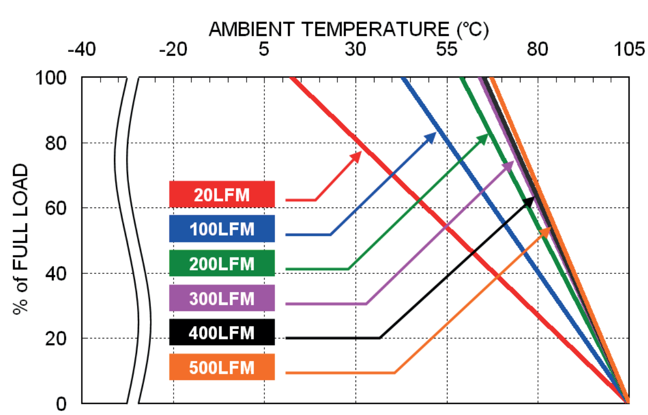
Power dissipation versus Output Load



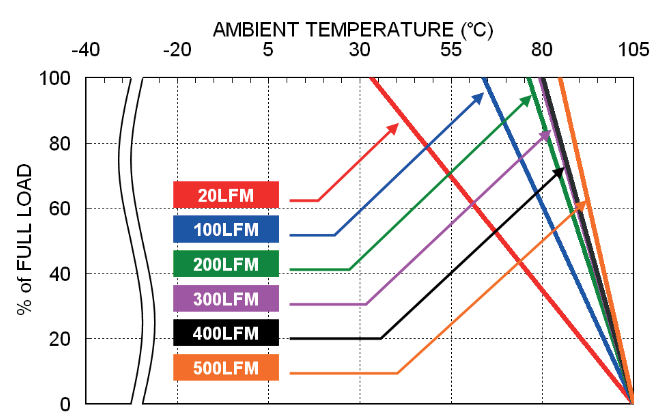
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19" X 3.5" X 0.063"

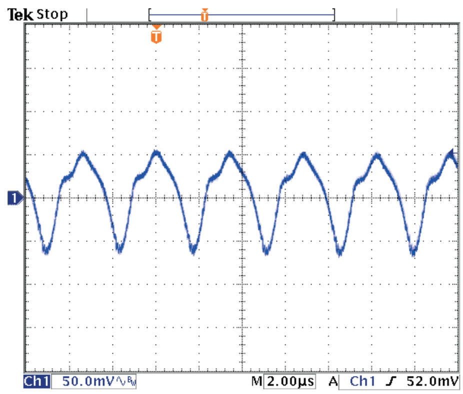


Derating Output Load versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

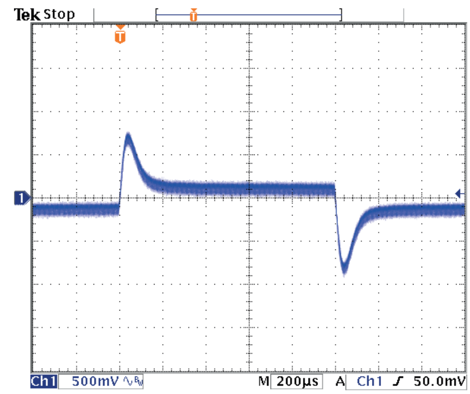


Derating Output Load versus Ambient Temperature and Airflow
With 0.5" Heat-Sink , Vin(nom)

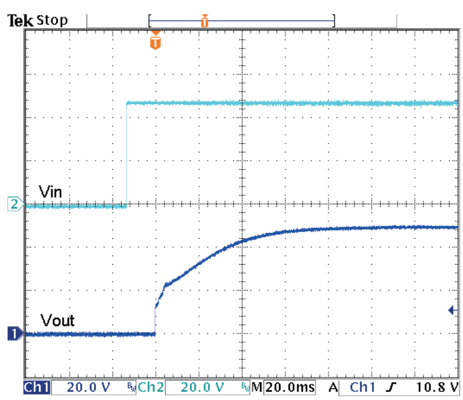
All test conditions are at 25°C.The figures are identical for PQAE150-48S48W



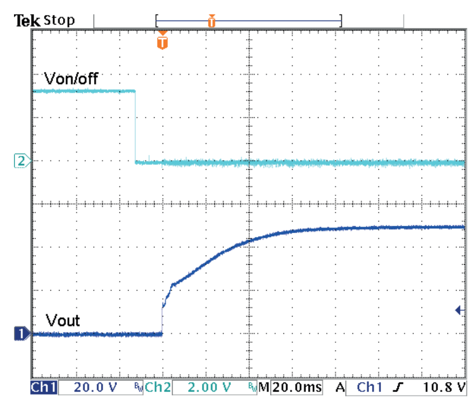
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

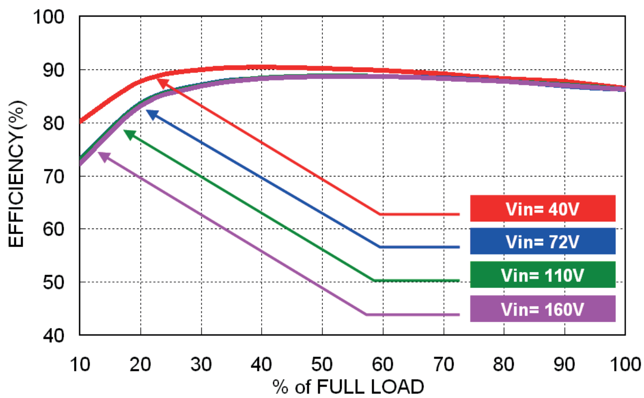


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

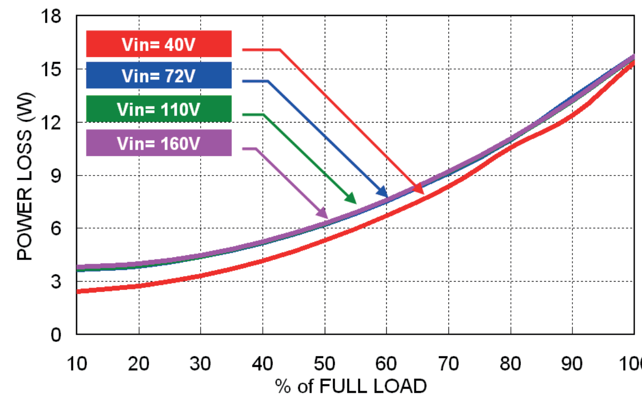


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

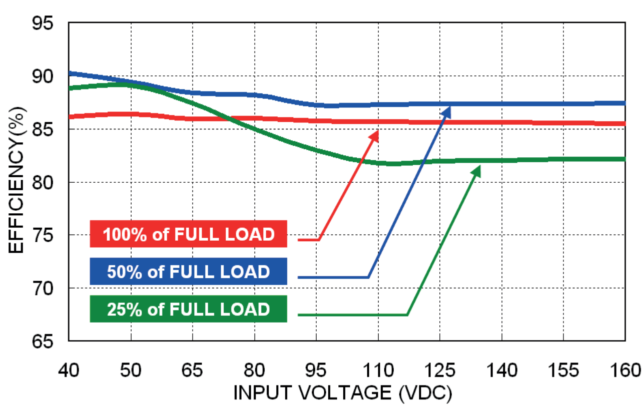
All test conditions are at 25°C.The figures are identical for PQAE150-110S3PW



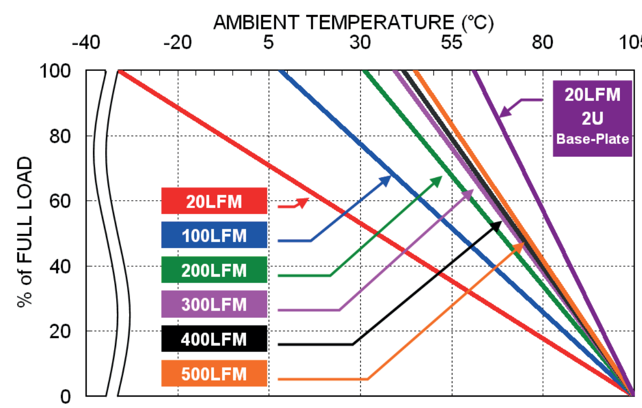
Efficiency versus Output Load



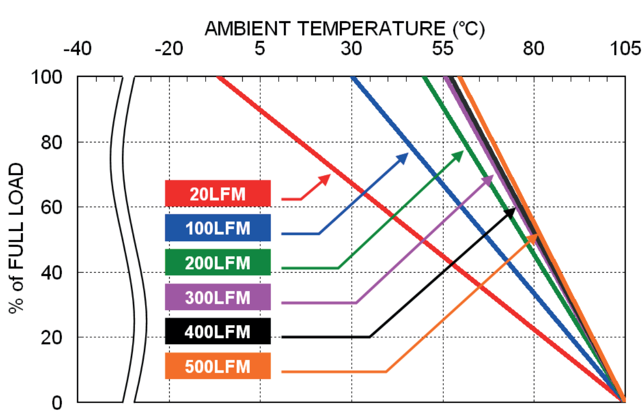
Power dissipation versus Output Load



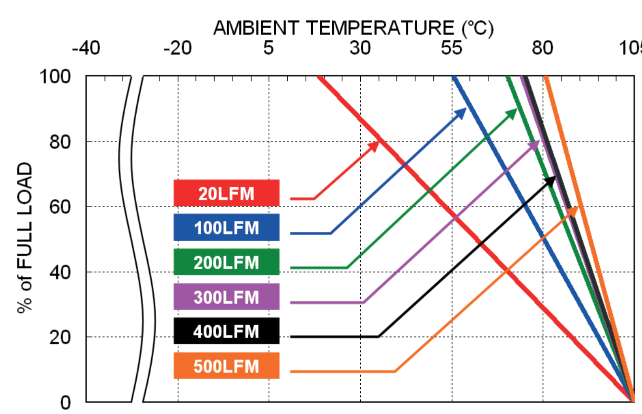
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19" X 3.5" X 0.063"

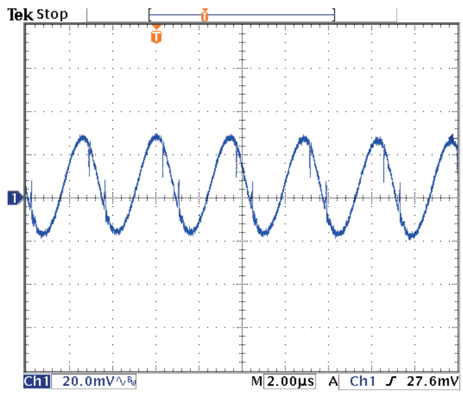


Derating Output Load versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

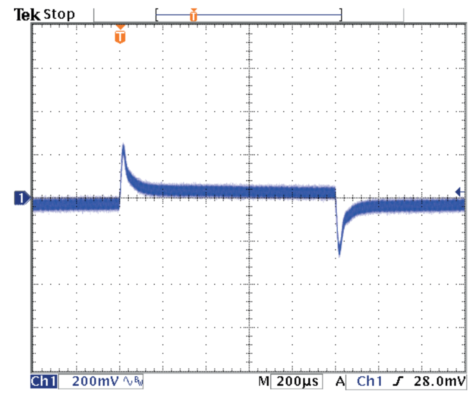


Derating Output Load versus Ambient Temperature and Airflow
With 0.5" Heat-Sink , Vin(nom)

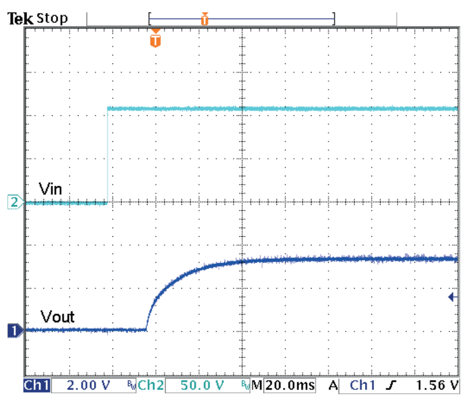
All test conditions are at 25°C.The figures are identical for PQAE150-110S3P3W



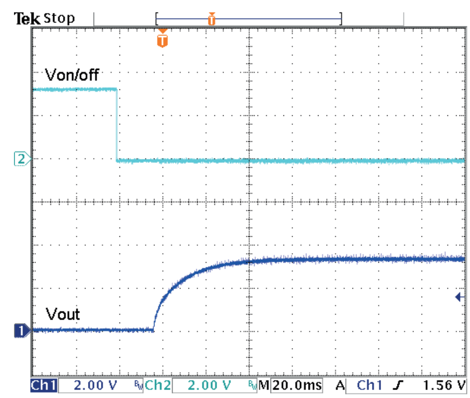
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

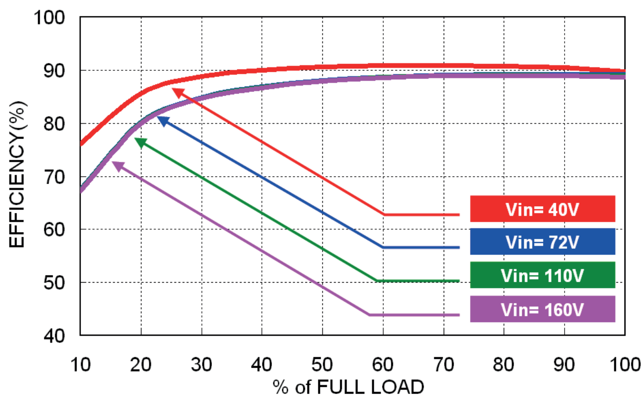


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

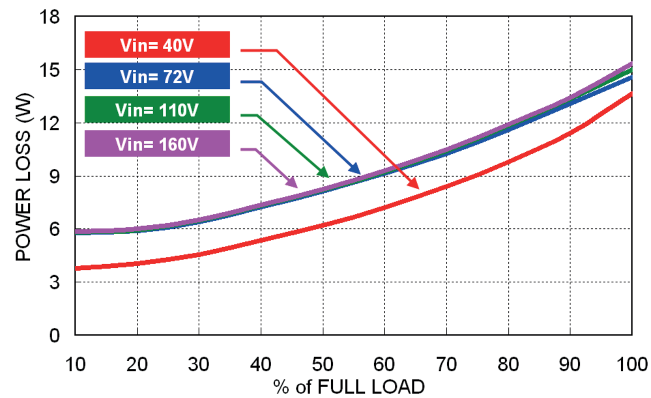


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

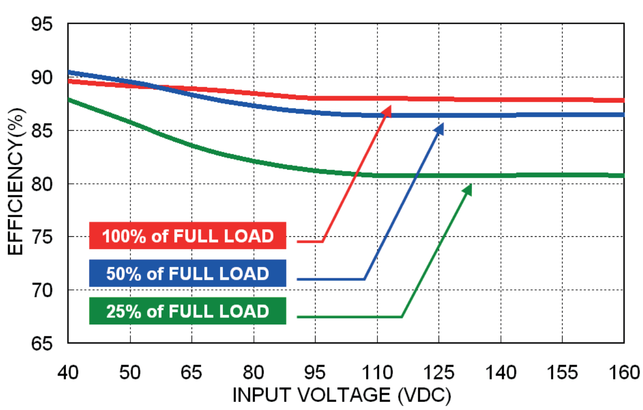
All test conditions are at 25°C.The figures are identical for PQAE150-110S05W



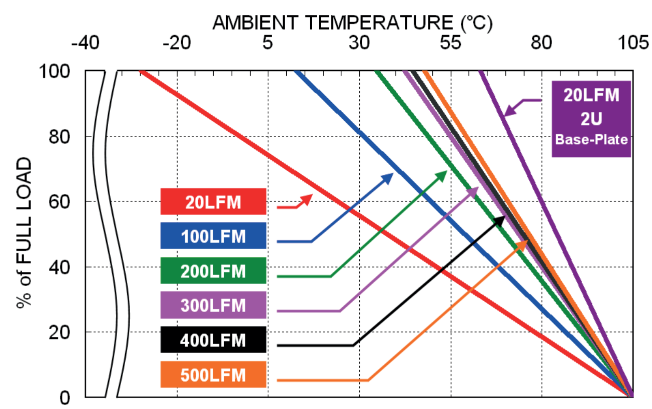
Efficiency versus Output Load



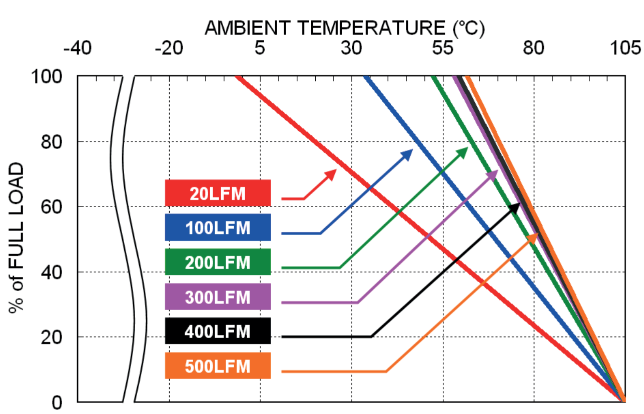
Power dissipation versus Output Load



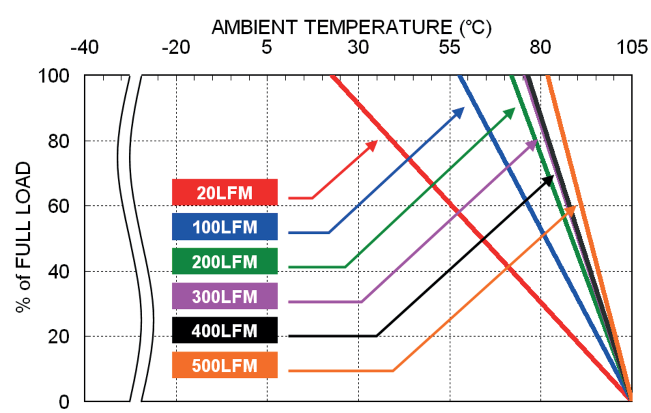
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19" X 3.5" X 0.063"

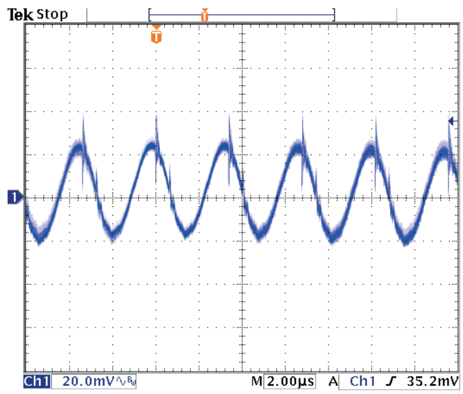


Derating Output Load versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

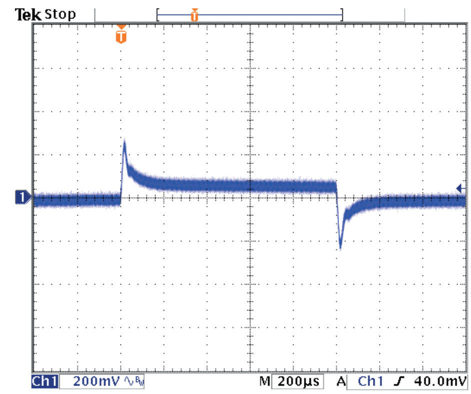


Derating Output Load versus Ambient Temperature and Airflow
With 0.5" Heat-Sink , Vin(nom)

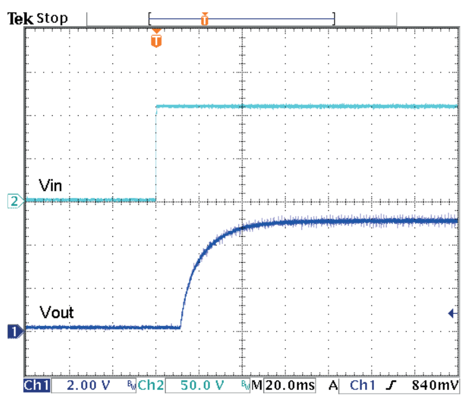
All test conditions are at 25°C.The figures are identical for PQAE150-110S05W



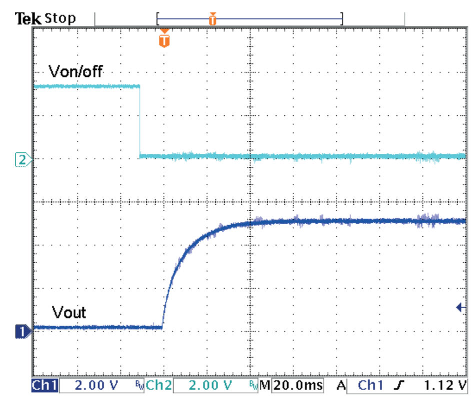
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

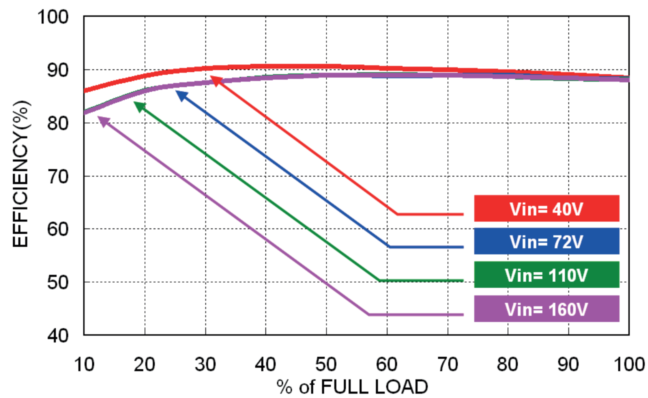


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

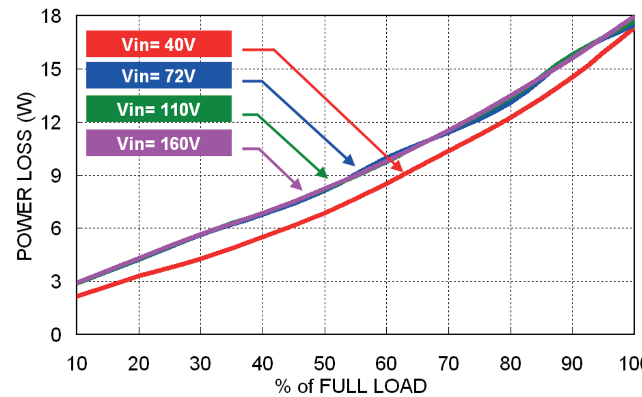


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

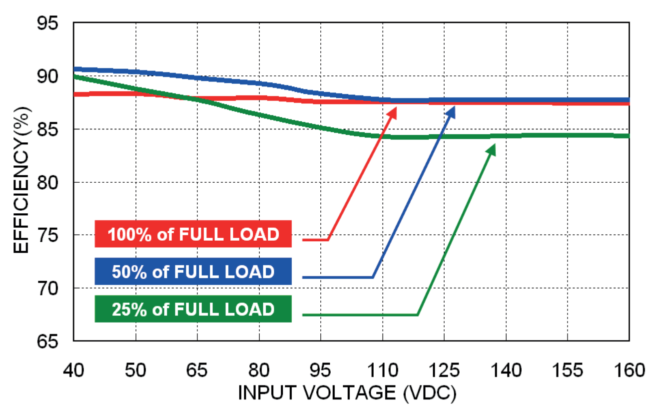
All test conditions are at 25°C.The figures are identical for PQAE150-110S12W



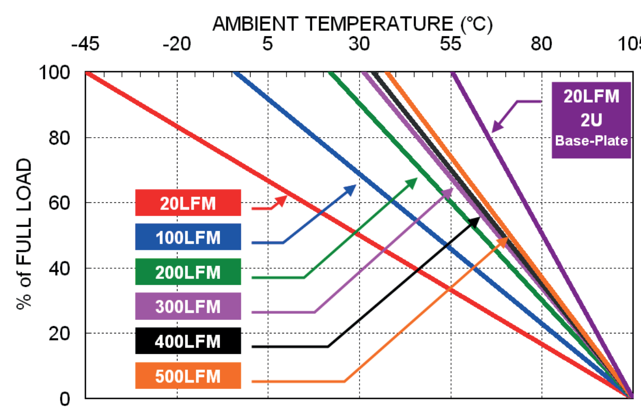
Efficiency versus Output Load



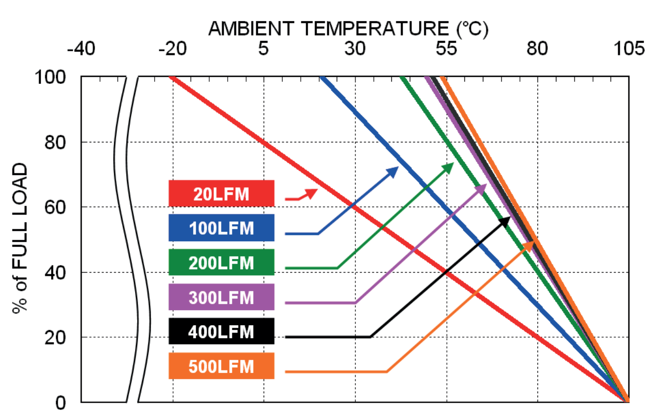
Power dissipation versus Output Load



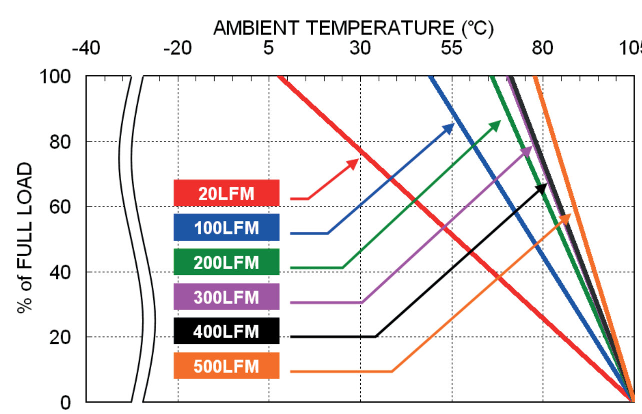
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19" X 3.5" X 0.063"

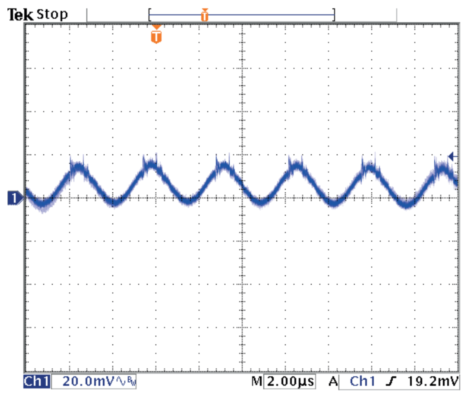


Derating Output Load versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

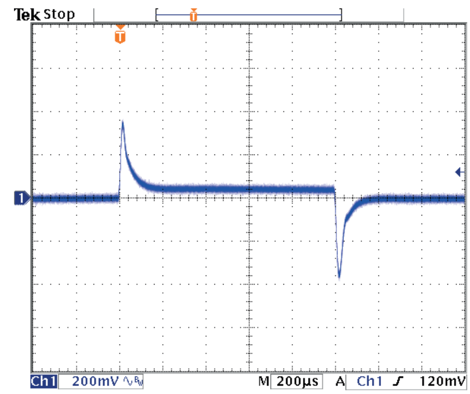


Derating Output Load versus Ambient Temperature and Airflow
With 0.5" Heat-Sink , Vin(nom)

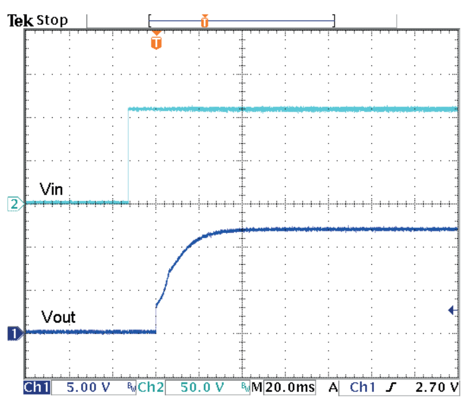
All test conditions are at 25°C.The figures are identical for PQAE150-110S12W



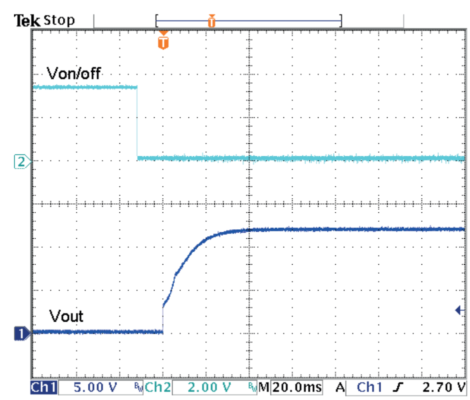
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

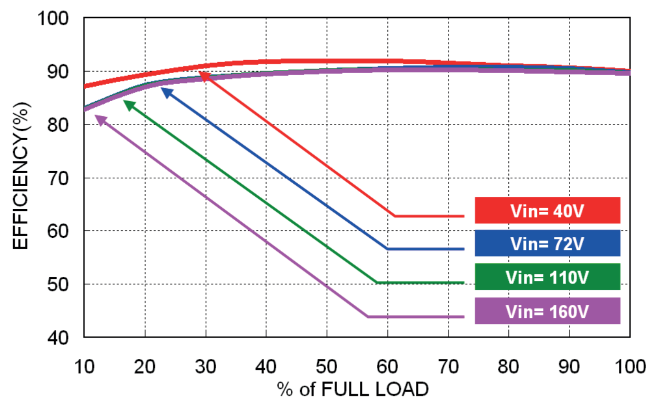


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

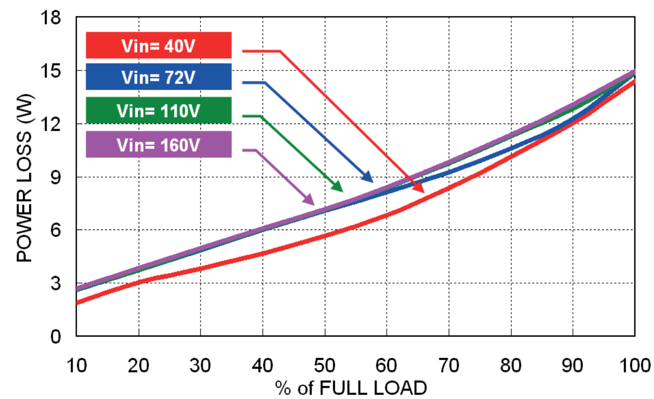


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

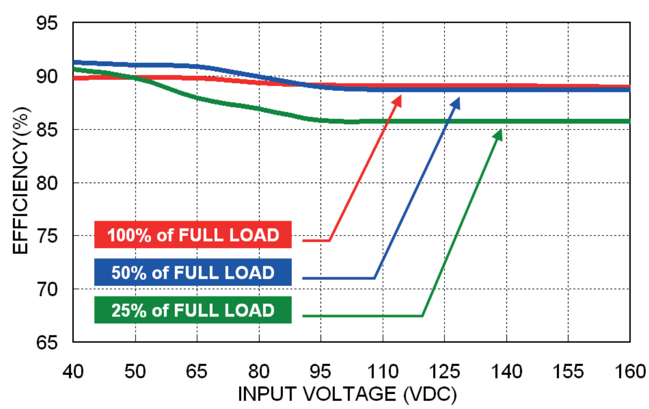
All test conditions are at 25°C.The figures are identical for PQAE150-110S15W



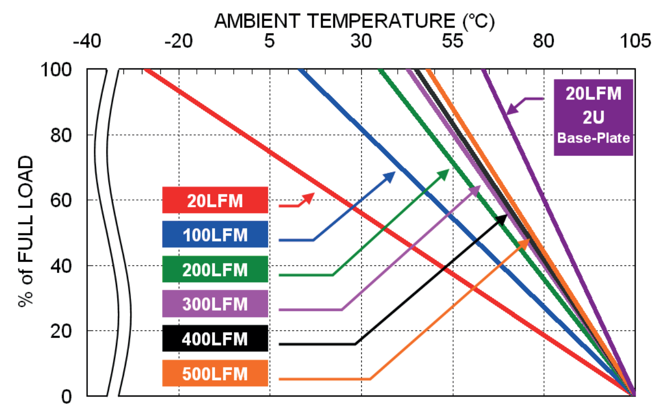
Efficiency versus Output Load



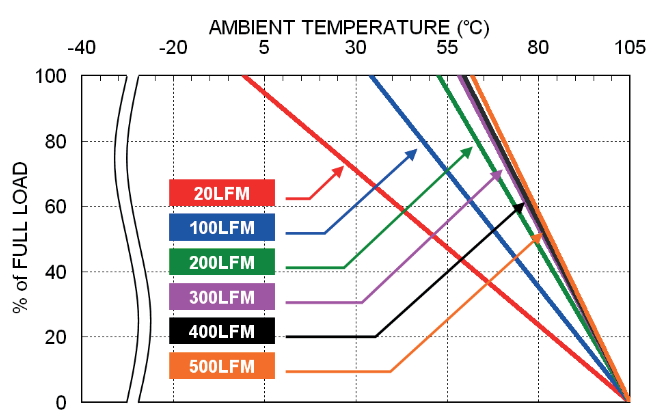
Power dissipation versus Output Load



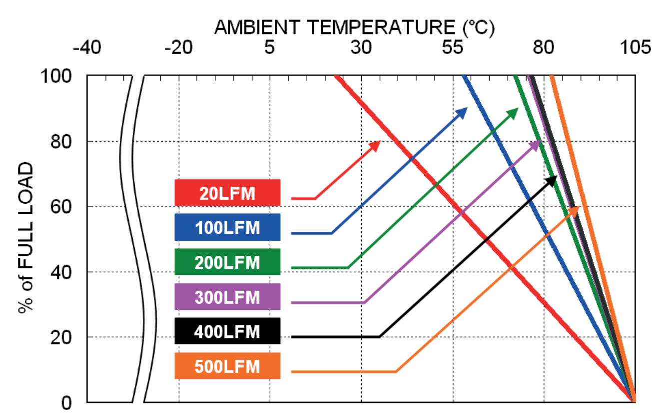
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19” X 3.5” X 0.063”

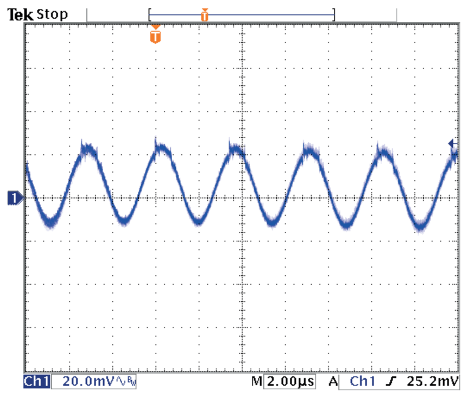


Derating Output Load versus Ambient Temperature and Airflow
With 0.24” Heat-Sink , Vin(nom)

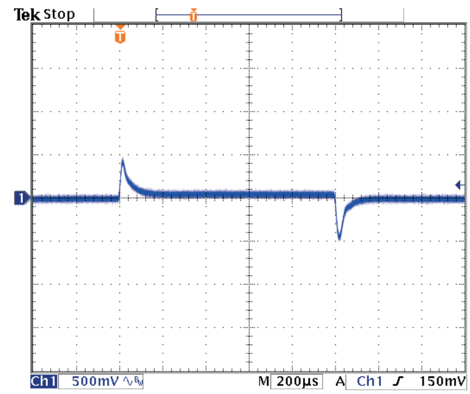


Derating Output Load versus Ambient Temperature and Airflow
With 0.5” Heat-Sink , Vin(nom)

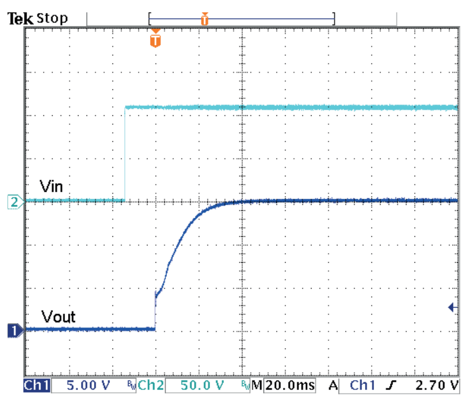
All test conditions are at 25°C.The figures are identical for PQAE150-110S15W



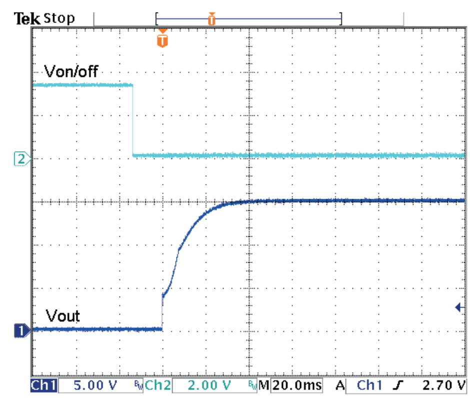
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

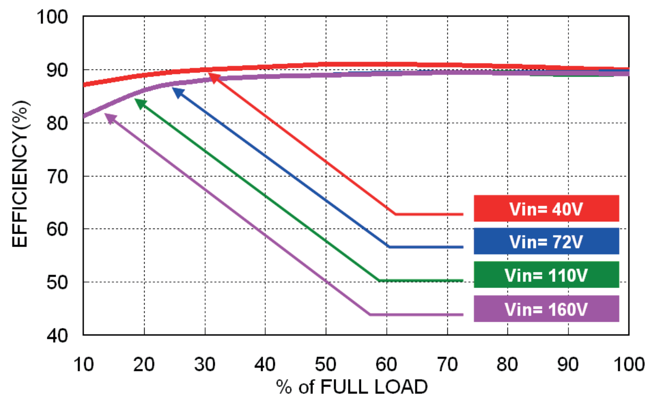


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

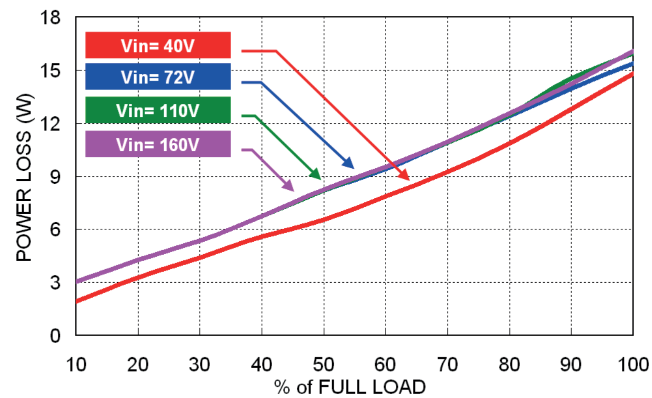


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

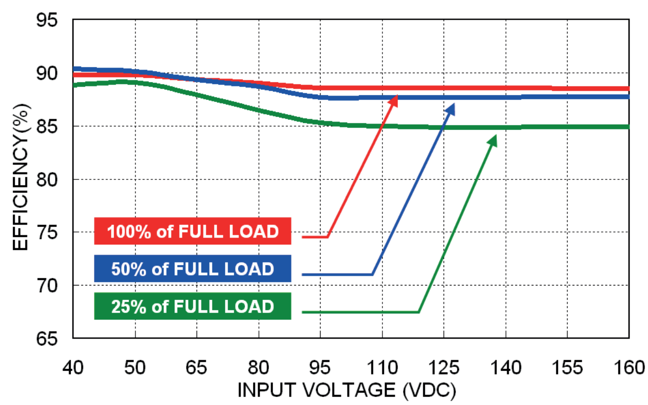
All test conditions are at 25°C.The figures are identical for PQAE150-110S24W



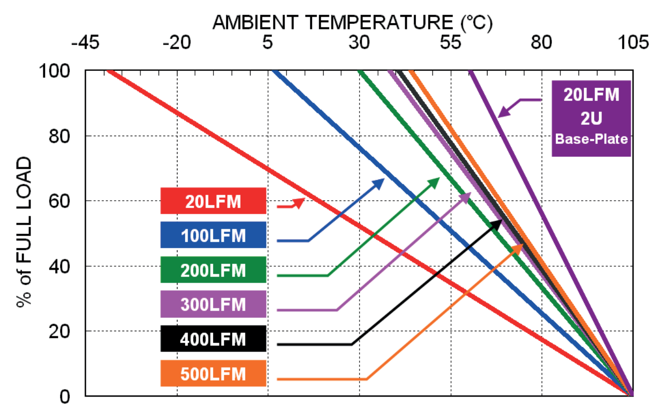
Efficiency versus Output Load



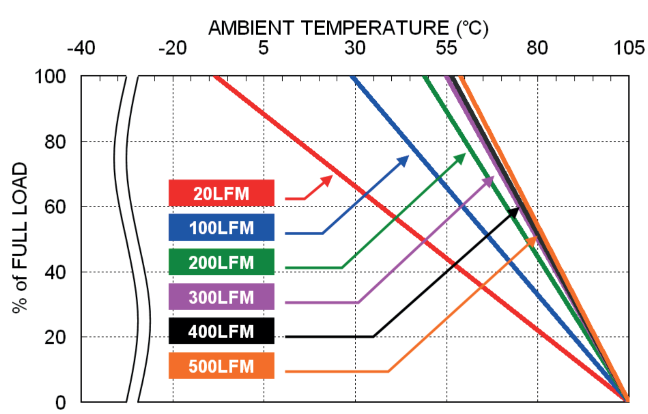
Power dissipation versus Output Load



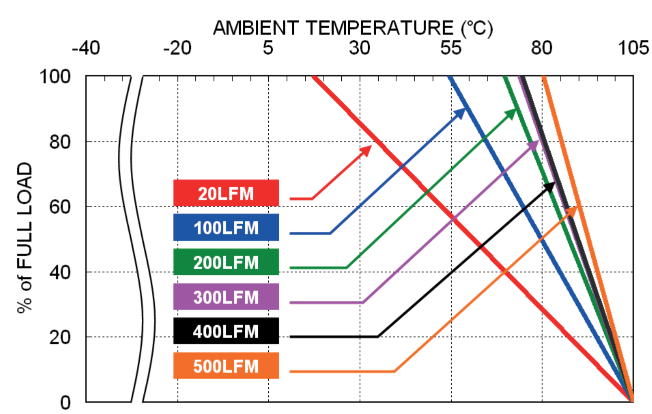
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19” X 3.5” X 0.063”

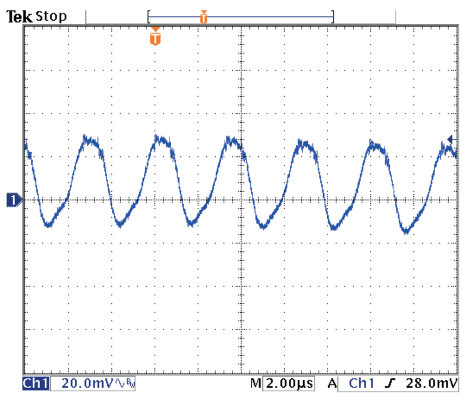


Derating Output Load versus Ambient Temperature and Airflow
With 0.24” Heat-Sink , Vin(nom)

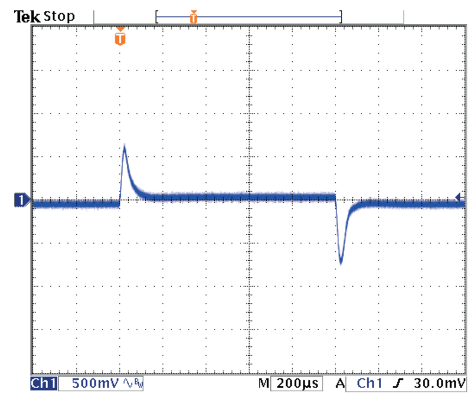


Derating Output Load versus Ambient Temperature and Airflow
With 0.5” Heat-Sink , Vin(nom)

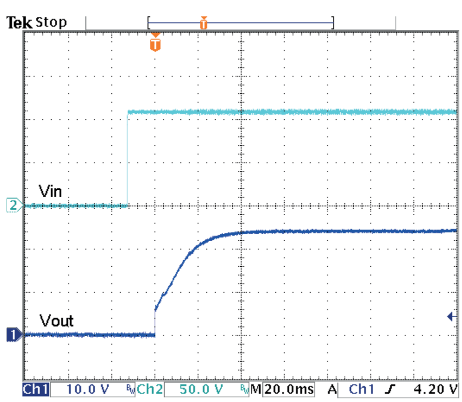
All test conditions are at 25°C.The figures are identical for PQAE150-110S24W



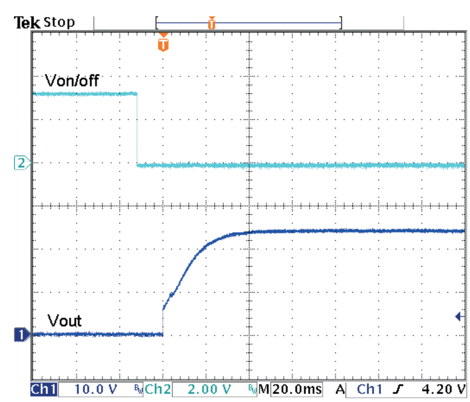
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

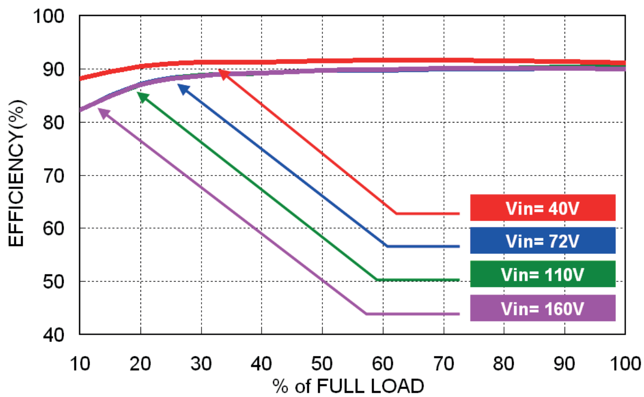


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

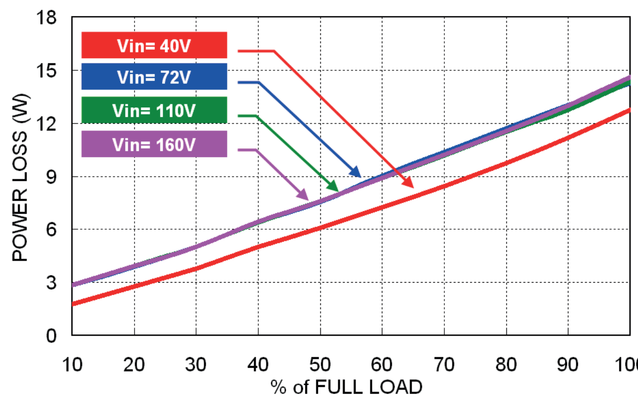


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

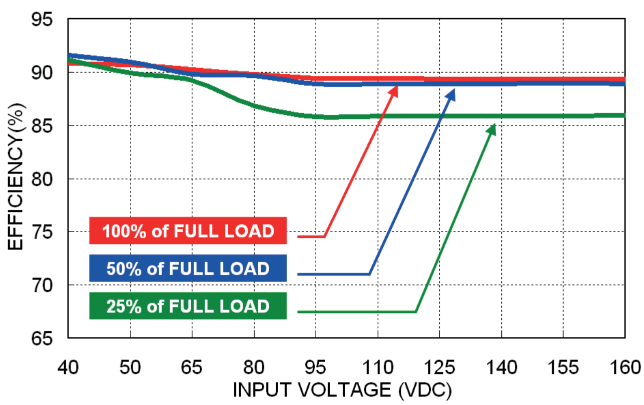
All test conditions are at 25°C.The figures are identical for PQAE150-110S28W



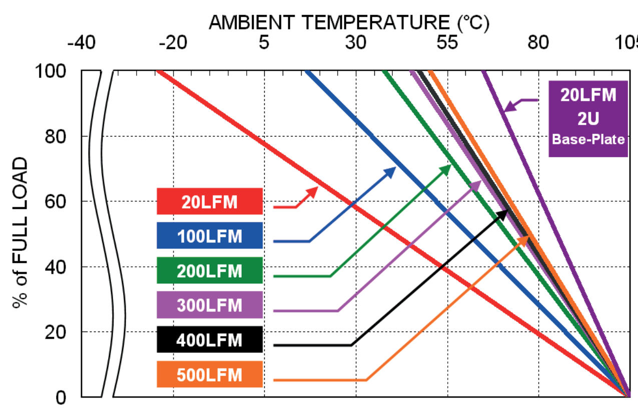
Efficiency versus Output Load



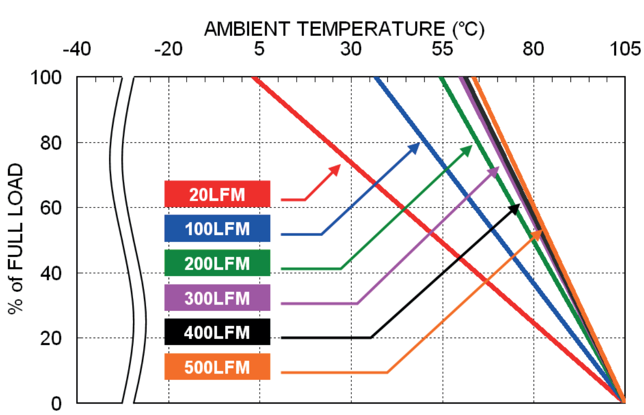
Power dissipation versus Output Load



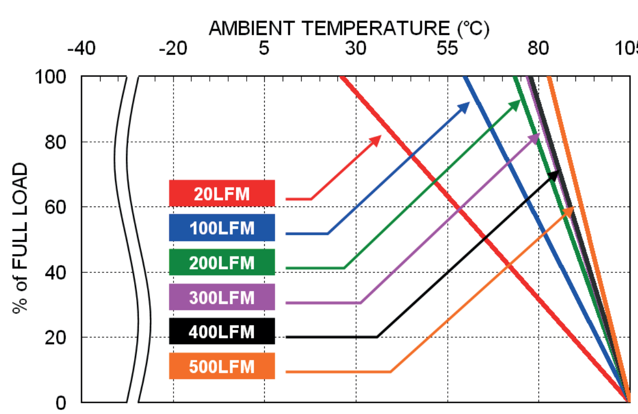
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19” X 3.5” X 0.063”

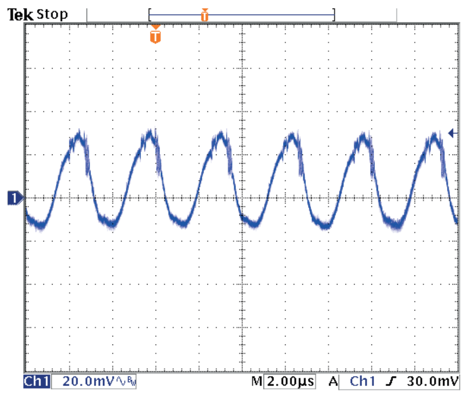


Derating Output Load versus Ambient Temperature and Airflow
With 0.24” Heat-Sink , Vin(nom)

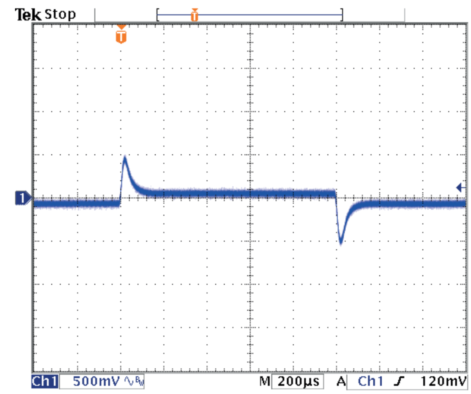


Derating Output Load versus Ambient Temperature and Airflow
With 0.5” Heat-Sink , Vin(nom)

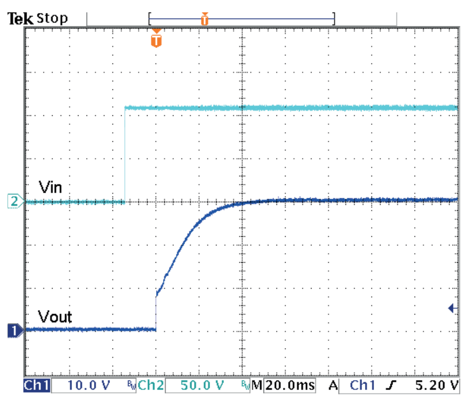
All test conditions are at 25°C.The figures are identical for PQAE150-110S28W



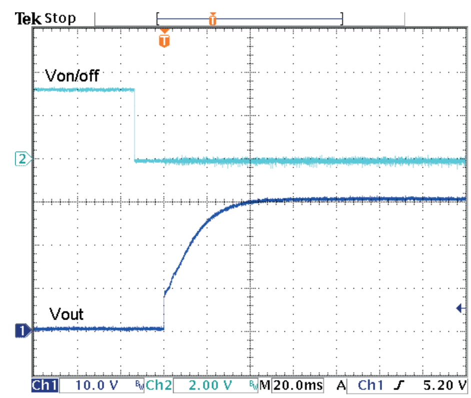
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)

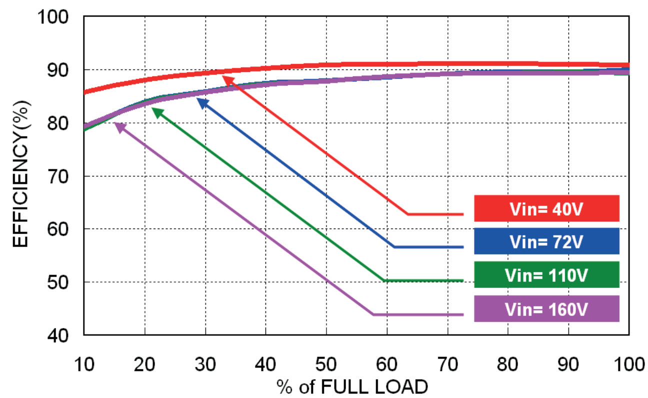


Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load

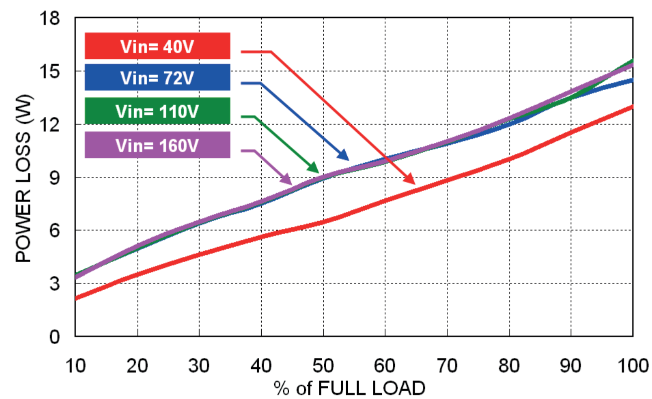


Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

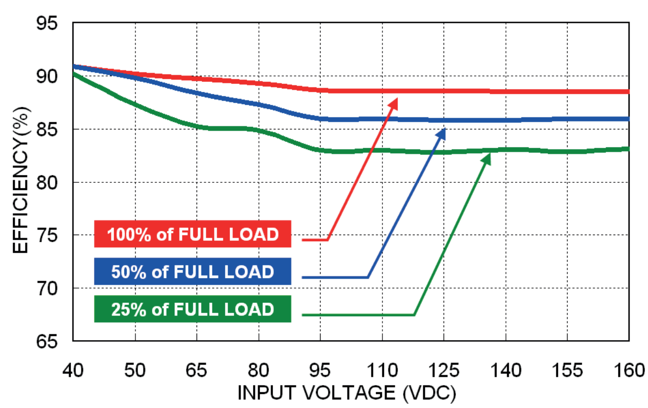
All test conditions are at 25°C.The figures are identical for PQAE150-110S48W



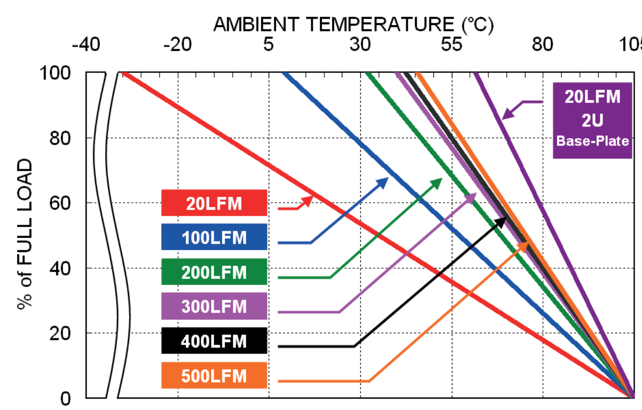
Efficiency versus Output Load



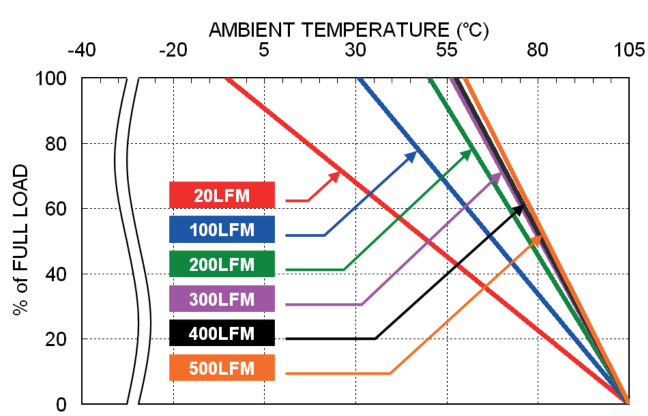
Power dissipation versus Output Load



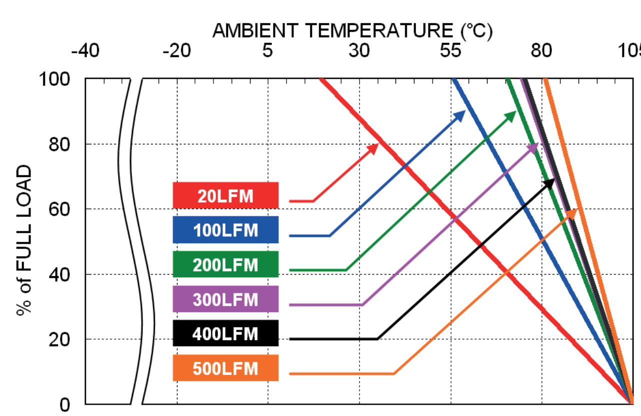
Efficiency versus Input Voltage
Full Load



Derating Output Load versus Ambient Temperature and Airflow
Vin(nom)
* Mount on 2U Iron Base-Plate Dimension is 19” X 3.5” X 0.063”

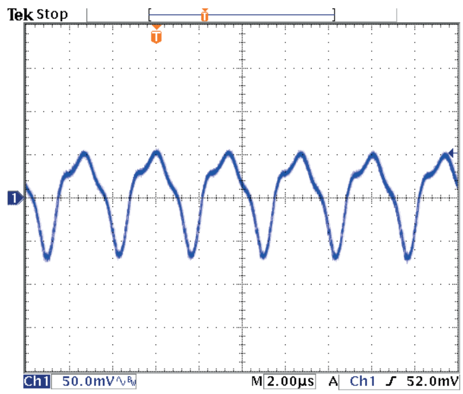


Derating Output Load versus Ambient Temperature and Airflow
With 0.24” Heat-Sink , Vin(nom)

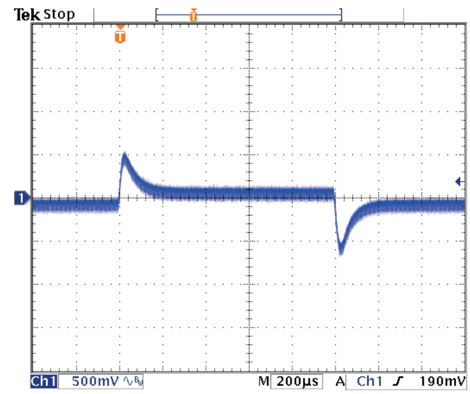


Derating Output Load versus Ambient Temperature and Airflow
With 0.5” Heat-Sink , Vin(nom)

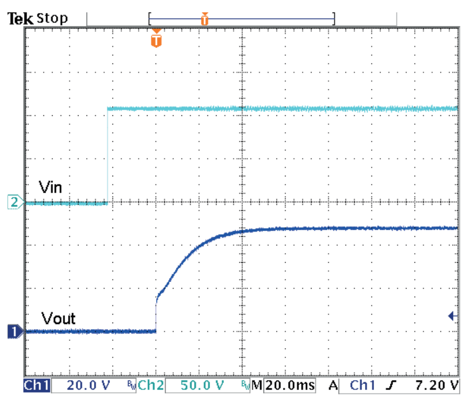
All test conditions are at 25°C.The figures are identical for PQAE150-110S48W



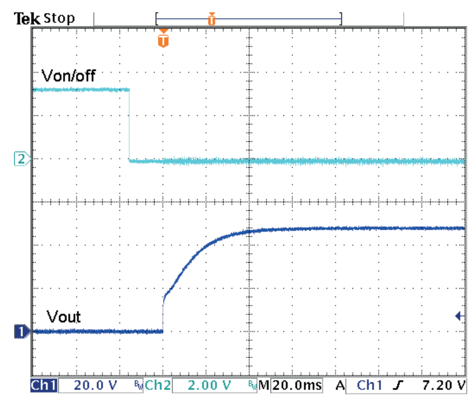
Typical Output Ripple and Noise.
Vin(nom); Full Load



Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load