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POWERBOX Industrial Line PAE150W Series Up to 182W 4:1 Wide Input, Single Output DC/DC Converter Manual

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1. Introduction

The PAE150W series DC/DC converters provide up to 182 watts of output power in an industry standard half-brick package and footprint. All models feature a wide input range, adjustable output voltage.

2. DC/DC Converter Features

Single output up to 43A

Industry standard half-brick footprint

2.40x2.28x0.50 inch (61.0x57.9x12.7 mm)

Six-sided continuous shield for 24Vin and 48Vin module

High power density of 66.5W/inch³

High efficiency up to 91%

Input to output basic insulation: 2250 VAC

4:1 ultra wide input voltage range

Adjustable output voltage

No minimum load required

Output over-voltage protection

Over-current protection

Output short circuit protection

Remote on/off

Railway application

Compliant to RoHS II & REACH

3. Technical Specifications

Output Characteristics

Parameters	Model	Min	Typical	Max	Units
<i>Output voltage</i>					
(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
	□□S28W	27.72	30	28.28	VDC
	□□S48W	47.52	48	48.48	VDC
<i>Output regulation</i>					
Line (Vin(min) to Vin(max); full load)	All	-0.1		+0.1	%
Load (0% to 100% of full load)		-0.2		+0.2	%
<i>Output ripple and noise</i>					
Peak to peak (20MHz bandwidth)	□□S3P3W		75	100	mVp-p
With a 1μF/25V X7R MLCC & a 22μF/25V D-type POS-CAP	□□S05W		75	100	mVp-p
	□□S12W		100	125	mVp-p
	□□S15W		100	125	mVp-p
	□□S24W		200	250	mVp-p
With a 4.7μF/50V X7R MLCC	□□S28W		200	250	mVp-p
	□□S48W		300	350	mVp-p
<i>Voltage adjustability</i>					
(Maximum output deviation is inclusive of remote sense)	All	-20		+10	% of Vout
Temperature coefficient	All	-0.02		+0.02	%/°C
<i>Output voltage overshoot</i>					
(Vin(min) to Vin(max); full load; Ta=25°C)	All		0	5	% of Vout
<i>Dynamic load response</i>					
(Vin(nom); Ta=25°C) load step change from 75% to 100% or 100 to 75% of full load peak deviation	□□S3P3W		300		mV
	□□S05W		600		mV
	□□S12W		900		mV
	□□S15W		900		mV
	□□S24W		900		mV
	□□S28W		1100		mV
	□□S48W		1200		mV
Setting Time (Vo<10% peak deviation)	All		200		μS

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Parameters	Model	Min	Typical	Max	Units
Output current	24S3P3W	0		40	A
	24S05W	0		28	A
	24S12W	0		12	A
	24S15W	0		9.5	A
	24S24W	0		6	A
	24S28W	0		5	A
	24S48W	0		3	A
	48S3P3W	0		40	A
	48S05W	0		30	A
	48S12W	0		13	A
	48S15W	0		10	A
	48S24W	0		6.5	A
	48S28W	0		5.5	A
	48S48W	0		3.2	A
	110S3P3W	0		43	A
	110S05W	0		32	A
	110S12W	0		15	A
	110S15W	0		12	A
	110S24W	0		7.5	A
	110S28W	0		6.5	A
	110S48W	0		3.8	A
Output capacitance load	24S3P3W			121000	μF
	24S05W			56000	μF
	24S12W			10000	μF
	24S15W			6300	μF
	24S24W			2500	μF
	24S28W			1700	μF
	24S48W			620	μF
	48S3P3W			121000	μF
	48S05W			60000	μF
	48S12W			10800	μF
	48S15W			6600	μF
	48S24W			2700	μF
	48S28W			1900	μF
	48S48W			660	μF
	110S3P3W			130000	μF
	110S05W			64000	μF
	110S12W			12500	μF
	110S15W			8000	μF
	110S24W			3100	μF
	110S28W			2300	μF
	110S48W			790	μF
<i>Output over voltage protection</i>					
(Hiccup mode)	□□S3P3W	3.795		4.29	VDC
	□□S05W	5.75		6.50	VDC
	□□S12W	13.80		15.60	VDC
	□□S15W	17.25		19.50	VDC
	□□S24W	27.60		31.20	VDC
	□□S28W	32.20		36.40	VDC
	□□S48W	55.20		62.40	VDC

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Output over current protection

(% of lout rated; Hiccup mode)	24S□□W	120		150	% of FL
	48S□□W	120		150	% of FL
	110S□□W		150		% of FL
Output short circuit protection	All	Continuous, automatics recovery			

Input Characteristics

Parameters	Model	Min	Typical	Max	Units
<i>Operating input voltage</i>					
Continuous	24S3P3W	9	24	36	VDC
	24S05W	9	24	36	VDC
	24S12W	8.5	24	36	VDC
	24S15W	8.5	24	36	VDC
	24S24W	8.5	24	36	VDC
	24S28W	8.5	24	36	VDC
	24S48W	8.5	24	36	VDC
	48S□□W	16.5	48	75	VDC
	110S□□W	43	110	160	VDC
Transient (1sec,max)	24S□□W			50	VDC
	48S□□W			100	VDC
	110S□□W			185	VDC
<i>Input standby current</i>					
Typ. value at Vin(nom); no load)	24S3P3W		20		mA
	24S05W		25		mA
	24S12W		25		mA
	24S15W		25		mA
	24S24W		25		mA
	24S28W		25		mA
	24S48W		35		mA
	48S3P3W		15		mA
	48S05W		15		mA
	48S12W		20		mA
	48S15W		20		mA
	48S24W		20		mA
	48S28W		20		mA
	48S48W		25		mA
	110S3P3W		10		mA
	110S05W		10		mA
	110S12W		10		mA
	110S15W		10		mA
	110S24W		10		mA
	110S28W		10		mA
	110S48W		10		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

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Input reflected ripple current	All	50		mAp-p
<i>Start up time</i>				
(Vin(nom) and constant resistive load) Power up	All	75	100	ms
Remote on/off	All	75	100	ms
<i>Remote on/off control (the Ctrl pin voltage is referenced to negative input)</i>				
<i>Negative logic (standard)</i>				
On/Off pin low voltage (remote ON)	□□S□□W	Short or 0 ~ 1.2		VDC
On/Off pin high voltage (remote OFF)	□□S□□W-L	Open or 3 ~ 12		VDC
<i>Positive logic (option)</i>				
On/Off pin high voltage (remote ON)	□□S□□W-P	Open or 3 ~ 12		VDC
On/Off pin low voltage (remote OFF)	□□S□□W-S	Short or 0 ~ 1.2		VDC
Input current of remote control pin	All	-0.5	1	mA
Remote off state input current	All	3		mA
SYNC pin output signal	All	-0.3	5.6	VDC

General Specifications

Parameters	Model	Min	Typical	Max	Units
<i>Efficiency</i>					
(Vin(nom); Full Load; Ta=25°C)	24S3P3W		88		%
	24S05W		90		%
	24S12W		90		%
	24S15W		91		%
	24S24W		90		%
	24S28W		90		%
	24S48W		90		%
	48S3P3W		89		%
	48S05W		91		%
	48S12W		91		%
	48S15W		91		%
	48S24W		91		%
	48S28W		91		%
	48S48W		91		%
	110S3P3W		88		%
	110S05W		90		%
	110S12W		90		%
	110S15W		90		%
	110S24W		90		%
	110S28W		90		%
	110S48W		90		%
<i>Isolation voltage (1 minute; basic insulation)</i>					
Input to output	All	2250			VDC
Input (output) to base-plate	All	1600			VDC
Isolation resistance	All	1			GΩ
Isolation capacitance	All			2500	pF
Switching frequency	All	225	250	275	kHz
Weight	All		105		g
MTBF MIL-HDBK-217F Tc=70°C, full load	All		3.500 x 10 ⁵		hours

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Safety meets	All	IEC60950-1, UL60950-1, EN60950-1, EN50155
Case material	24S□□W 48S□□W 110S□□W	Metal Metal Aluminum base-plate with plastic case
Base Material	24S□□W 48S□□W	FR4 PCB FR4 PCB
Potting material	All	Silicone (UL94 V-0)

Environmental Characteristics

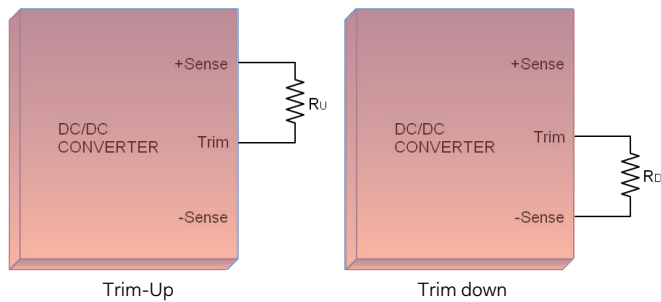
Parameters	Model	Min	Typical	Max	Units
Operating case temperature	All	-40		115	°C
Storage temperature	Terminal block Others	-40 -55		105 125	°C
Over temperature protection	All		120		°C
<i>Thermal impedance (vertical direction; 20LFM)</i>					
Without heat-sink	□□S□□ □□S□□W -HS1		6.1 5.1		°C/W
With 0.24" height heat-sink	□□S□□W -HS2 □□S□□W -HS		5.1 4.6		°C/W
With 0.45" height heat-sink	□□S□□W -HS3		4.6		°C/W
Only mount on 2U iron base-plate *2U iron base-plate dimension is 19" X 3.5" X 0.063"	□□S□□		2.8		°C/W
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
	EN55011 EN55022	With external input filter	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

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

$$R_U = \left(\frac{V_{OUT}(100 + \Delta\%)}{1.225\Delta\%} - \frac{100+2\Delta\%}{\Delta\%} \right) k\Omega$$

$$R_D = \left(\frac{100}{\Delta\%} - 2 \right) k\Omega$$

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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)	170.082	85.388	57.156	43.041	34.571	28.925	24.892	21.867	19.515	17.633

□□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)	310.245	156.163	104.803	79.122	63.714	53.442	46.105	40.602	36.322	32.898

□□S12W		Trim-Up									
Trim-Up	(%)	1	2	3	4	5	6	7	8	9	10
Vout	(V)	12.12	12.24	12.36	12.48	12.60	12.72	12.84	12.96	13.08	13.20
RU	(kΩ)	887.388	447.592	300.993	227.694	183.714	154.395	133.452	117.745	105.528	95.755

□□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)	1134.735	572.490	385.075	291.367	235.143	197.660	170.886	150.806	135.188	122.694

□□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)	1876.776	947.184	637.320	482.388	389.429	327.456	283.190	249.990	224.168	203.510

□□S28W		Trim-Up									
Trim-Up	(%)	1	2	3	4	5	6	7	8	9	10
Vout	(V)	28.28	28.56	28.84	29.12	29.40	29.68	29.96	30.24	30.52	30.80
RU	(kΩ)	2206.571	1113.714	749.429	567.286	458.000	385.143	333.102	294.071	263.714	239.429

□□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)	3855.551	1946.367	1309.973	991.776	800.857	673.578	582.665	514.480	461.447	419.020

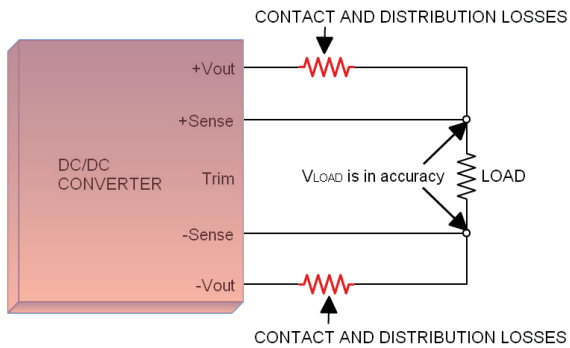
□□□□W		Trim-Down									
Trim-Down	(%)	1	2	3	4	5	6	7	8	9	10
RD	(kΩ)	98.000	48.000	31.333	23.000	18.000	14.667	12.286	10.500	9.111	8.000
Trim-Down	(%)	11	12	13	14	15	16	17	18	19	20
RD	(kΩ)	7.091	6.333	5.692	5.143	4.667	4.250	3.882	3.556	3.263	3.000

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 V_{out} , i.e.

$$[+V_{out} \text{ to } -V_{out}] - [+Sense \text{ to } -Sense] \leq 10\% V_{out}$$

The voltage between $+V_{out}$ and $-V_{out}$ 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 $+V_{out}$ and $-Sense$ to $-V_{out}$.



6. Input Source Impedance

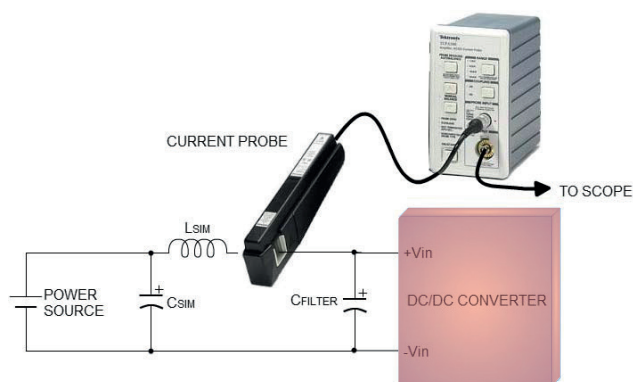
The power modules will operate as specifications without external components, assuming that the source voltage has a very low impedance and reasonable input voltage regulation. Highly inductive source impedances can affect the stability of the power module. Since real-world voltage source has finite impedance, performance can be improved by adding external filter capacitor.

The PAE150-24S□□W and PAE150-48S□□W recommended Nippon Chemi-con KY series, 100 μ F/100V.

The PAE150-110S□□W recommended Ruby-con BXF series, 68 μ F/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



PAE150-24S□□W

Component	Value	Voltage	Reference
LSIM	12 μ H	----	Inductor
CSIM` CFILTER	330 μ F	50V	Nippon chemi-con KY-series

PAE150-48S□□W

Component	Value	Voltage	Reference
LSIM	12 μ H	----	Inductor
CSIM` CFILTER	220 μ F	100V	Nippon chemi-con KY-series

PAE150-110S□□W

Component	Value	Voltage	Reference
LSIM	12 μ H	----	Inductor
CSIM` CFILTER	68 μ F	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 120~150 percent of rated current for PAE150W 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 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

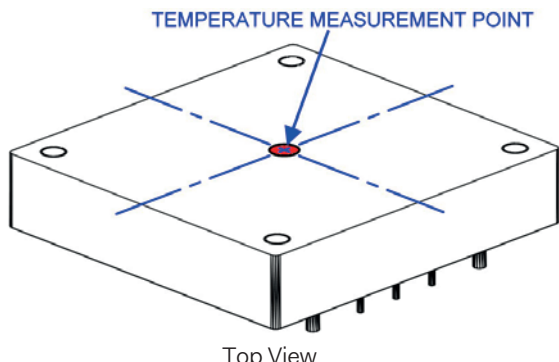
The output over-voltage protection consists of circuitry that monitors the voltage on the output terminals. If the voltage on the output terminals exceeds the over-voltage protection threshold, then the module enter the non-latch hiccup mode.

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 115°C. When Operating, adequate cooling must be provided to maintain the test point temperature at or below 115°C. Although the maximum point Temperature of the power modules is 115°C, you can limit this Temperature to a lower value for extremely high reliability.

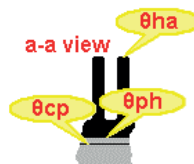
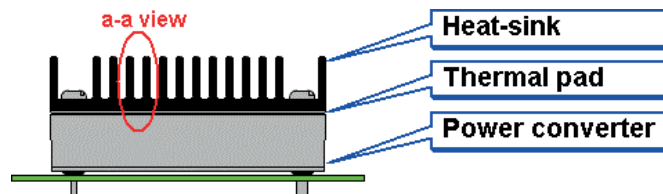


The suggested heat dissipation modes as below:

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:

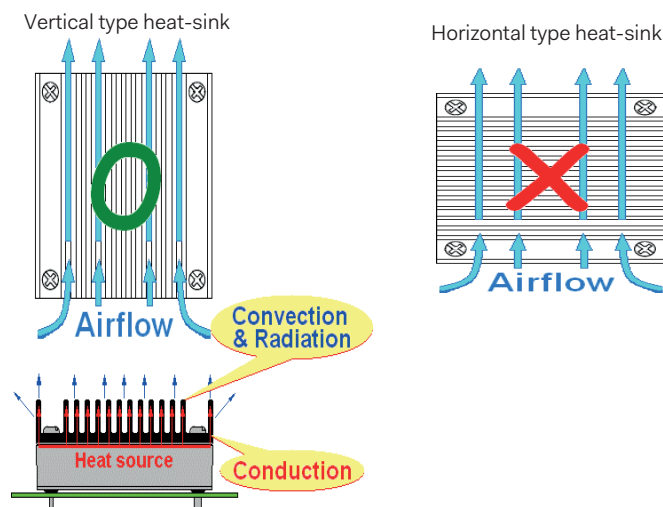
- (1) $\theta_{ca} = \theta_{cp} + \theta_{ph} + \theta_{ha}$. In order to let the heat-sink reducing the θ_{ha} in big range, we suggest to use the thermal pad with good heat conduction and flushing performance.
- (2) The best layout for heat sink is to put the fin of the heat-sink vertical to the air, 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.

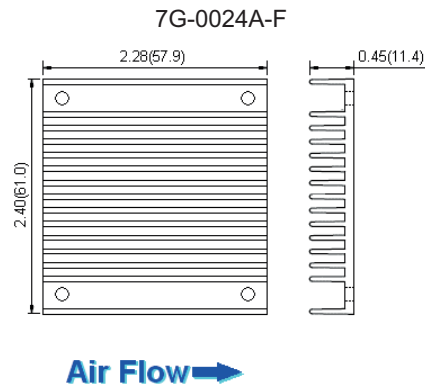
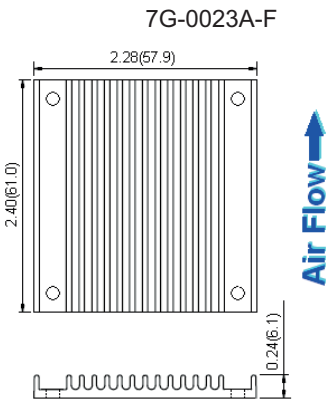
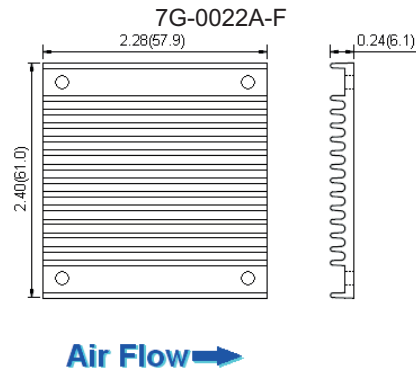
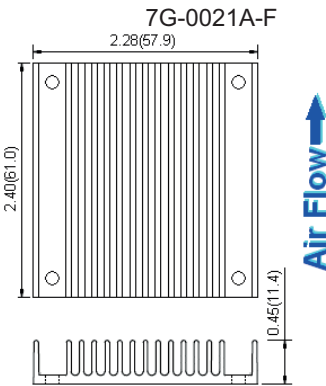
If there's heat-sink and force air in the same system, the direction for heat-sink and force air should be followed as illustrate in below left chart. So we can get the best performance of heat dissipation. In below right chart, it's wrong direction. The air can't go through, the performance is not good.



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.

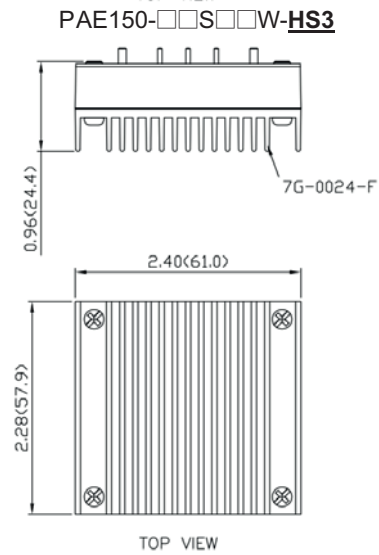
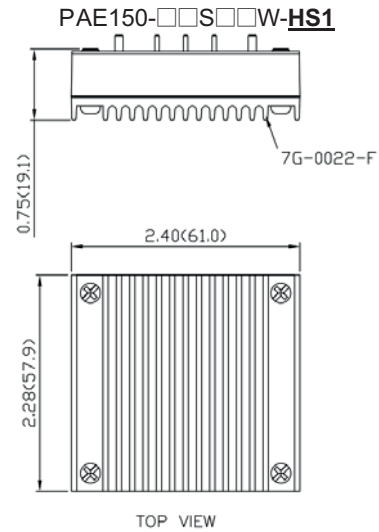
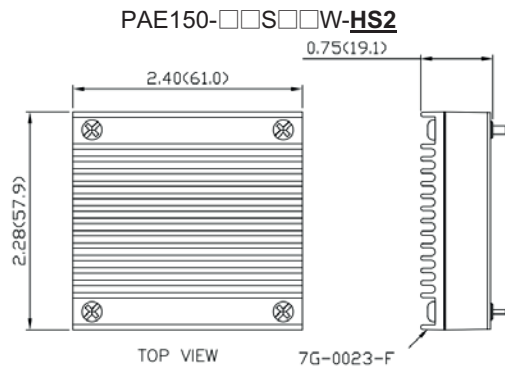
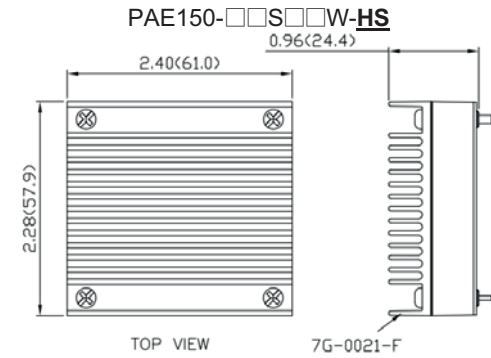
Part No.	Suffix
Without heat-sink	--
7G-0021A-F	HS
7G-0022A-F	HS1
7G-0023A-F	HS2
7G-0024A-F	HS3



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

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The heat-sink type mechanical drawing

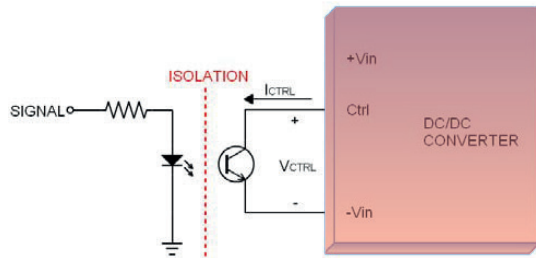


1. All dimensions in inch (mm)
2. Tolerance : $x.xx \pm 0.02$ ($x.x \pm 0.5$)

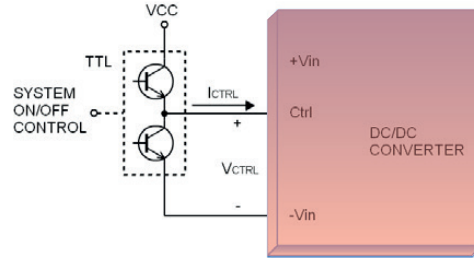
13. Remote On/Off Control

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.

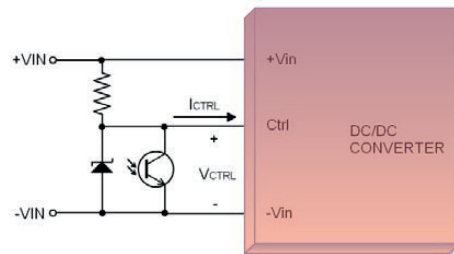
Remote ON/OFF Implementation



Isolated-Closure Remote ON/OFF



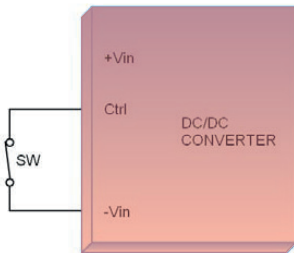
Level Control Using TTL Output



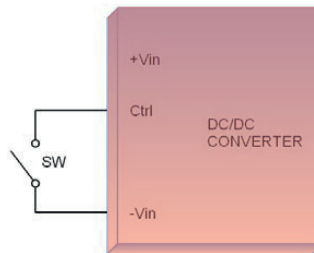
Level Control Using Line Voltage

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.

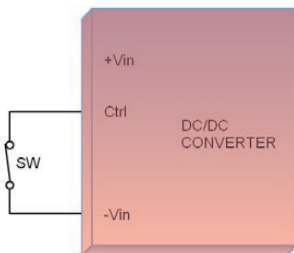


When PAE150W module is turned off at Low-level logic

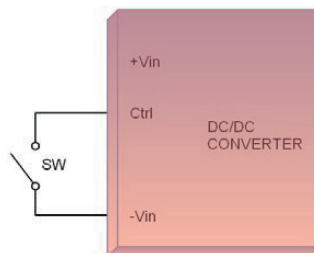


When PAE150W module is turned on at High-level logic

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.



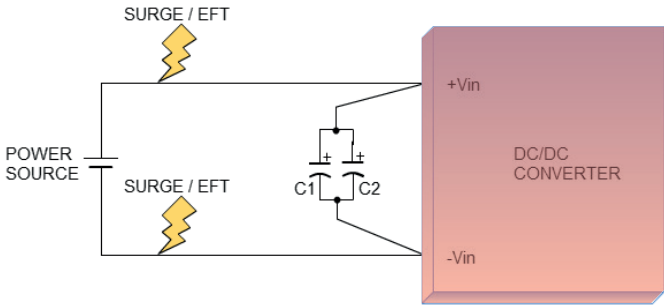
When PAE150W module is turned on at Low-level logic



When PAE150W module is turned off at High-level logic

14. EMS Considerations

The PAE150W 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

PAE150-24S□□W

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

PAE150-48S□□W

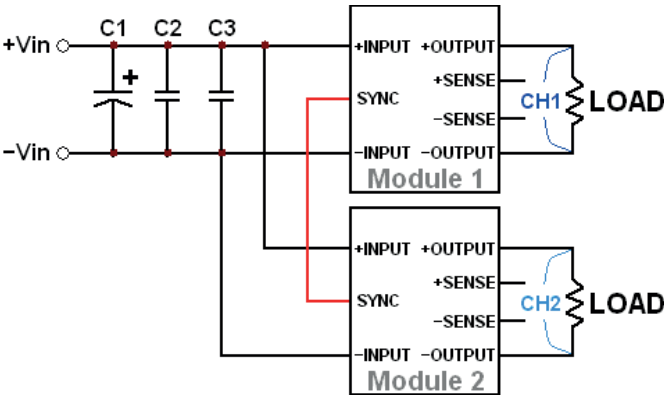
Component	Value	Voltage	Reference
C1` C2	220μF	100V	Nippon chemi-con KY-series

PAE150-110S□□W

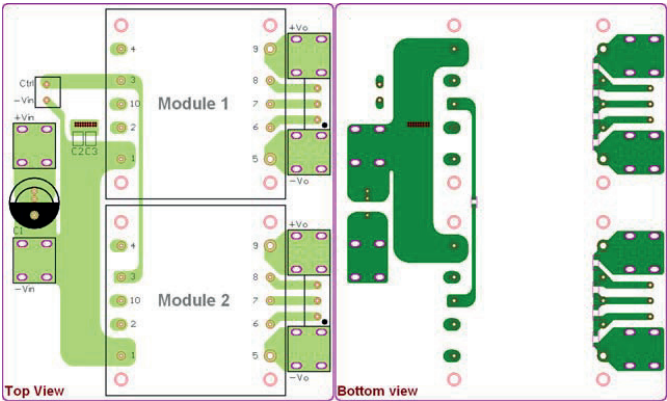
Component	Value	Voltage	Reference
C1` C2`	150μF	200V	Nippon chemi-con KXJ-series

15. Synchronous Pin

Multiple PAE150W series module can be synchronized together simply by connecting the module SYNC pins together.



Synchronous Circuits



Recommended Layout

PAE150-24S□□W-Y` PAE150-48S□□W -Y

Component	Value	Voltage	Reference
C1	220μF	100V	Nippon chemi-con KY-series
C2` C3	2.2μF	100V	1812 MLCC

PAE150-110S□□W -Y

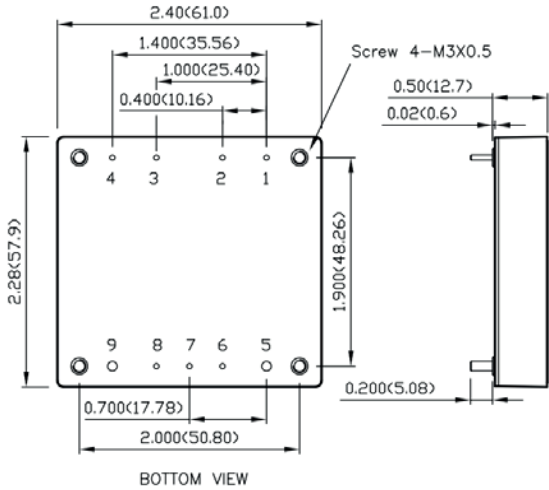
Component	Value	Voltage	Reference
C1	150μF	200V	Nippon chemi-con KXJ-series
C2` C3	1μF	250V	1812 MLCC

Note:

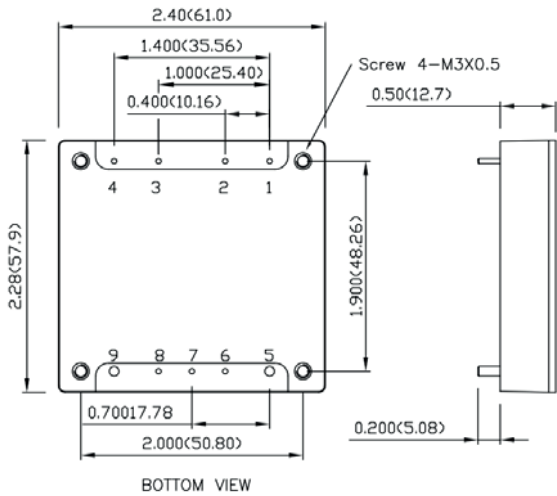
- (1) Care should be taken to ensure the ground potential differences between modules are minimized.
- (2) In this configuration all of the modules will be synchronized to the highest frequency module.
- (3) Up to three modules can be synchronized using this technique.

16. Mechanical Drawing

PAE150-24S□□W` PAE150-48S□□W



PAE150-110S□□W



Pin	Define	Diameter
1	- Vin	0.04 Inch
2	Case	0.04 Inch
3	Ctrl	0.04 Inch
4	+Vin	0.04 Inch
5	-Vout	0.08 Inch
6	-Sense	0.04 Inch
7	Trim	0.04 Inch
8	+Sense	0.04 Inch
9	+Vout	0.08 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. Mounting screws should always be used.
6. The screw locked torque: MAX 5.0kgf-cm(0.49N-m)

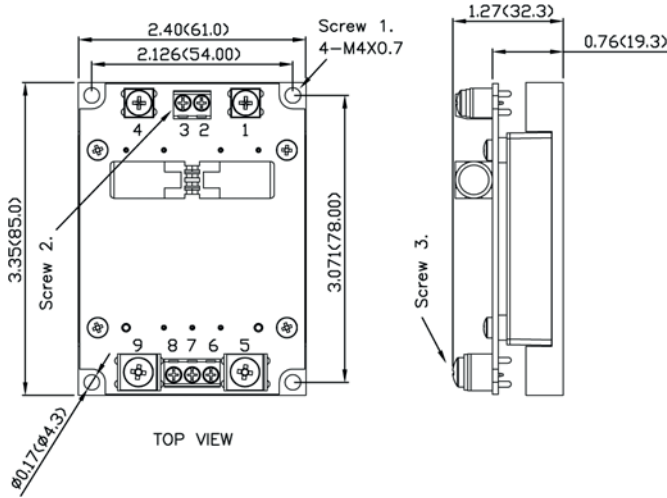
Pin	Define	Diameter
1	- Vin	0.04 Inch
2	Case	0.04 Inch
3	Ctrl	0.04 Inch
4	+Vin	0.04 Inch
5	-Vout	0.08 Inch
6	-Sense	0.04 Inch
7	Trim	0.04 Inch
8	+Sense	0.04 Inch
9	+Vout	0.08 Inch

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. Mounting screws should always be used.
6. The screw locked torque: MAX 3.5kgf-cm(0.34N-m)

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PAE150-□□S□□W-T

Terminal block without EMC filter, suffix: -T

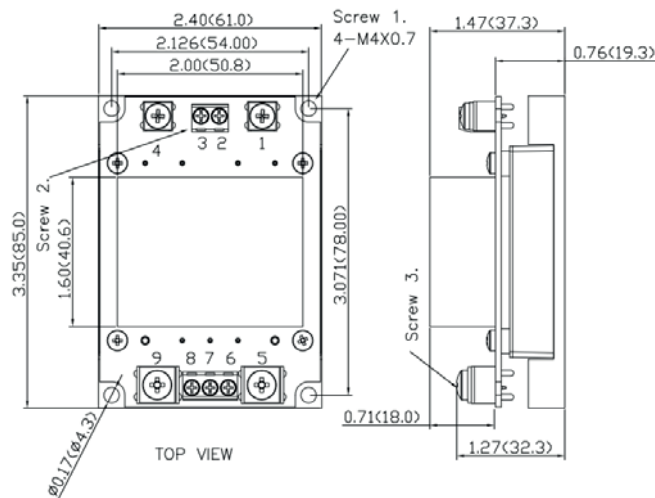


Pin	Define	Wire Range
1	- Vin	14AWG to 16AWG
2	NC	NA
3	Ctrl	14AWG to 18AWG
4	+Vin	14AWG to 16AWG
5	-Vout	10AWG to 12AWG
6 -	Sense	14AWG to 18AWG
7	Trim	14AWG to 18AWG
8	+Sense	14AWG to 18AWG
9	+Vout	10AWG to 12AWG

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. The screw 1 locked torque: MAX 11.2kgf-cm(1.10N-m)
4. The screw 2 locked torque: MAX 5.2kgf-cm(0.51N-m)
5. The screw 3 locked torque: MAX 12kgf-cm(1.18N-m)

PAE150-□□S□□W-TF

Terminal block with EMC filter (EN55022 Class A), suffix: -TF

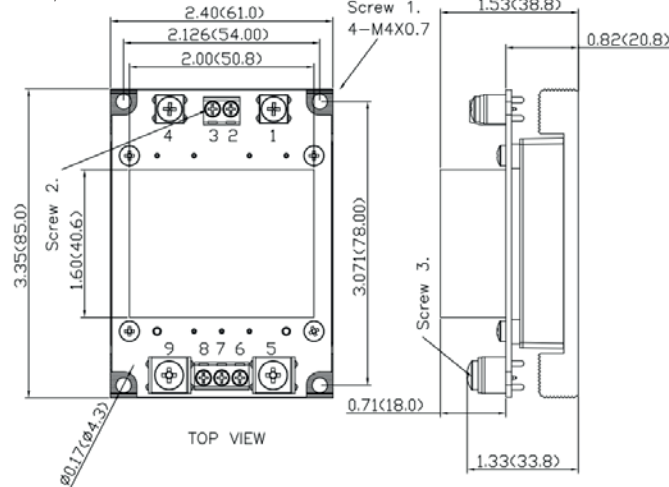


Pin	Define	Wire Range
1	- Vin	14AWG to 16AWG
2	NC	NA
3	Ctrl	14AWG to 18AWG
4	+Vin	14AWG to 16AWG
5	-Vout	10AWG to 12AWG
6 -	-Sense	14AWG to 18AWG
7	Trim	14AWG to 18AWG
8	+Sense	14AWG to 18AWG
9	+Vout	10AWG to 12AWG

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. The screw 1 locked torque: MAX 11.2kgf-cm(1.10N-m)
4. The screw 2 locked torque: MAX 5.2kgf-cm(0.51N-m)
5. The screw 3 locked torque: MAX 12kgf-cm(1.18N-m)

PAE150-□□S□□W-TF1

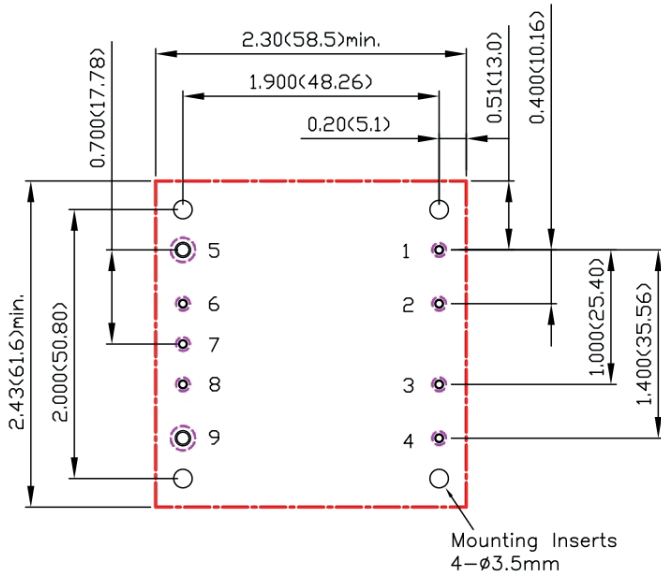
Terminal block with EMC filter (EN55022 Class A) can be connected to PE⊕, suffix: -TF1



Pin	Define	Wire Range
1	- Vin	14AWG to 16AWG
2	NC	NA
3	Ctrl	14AWG to 18AWG
4	+Vin	14AWG to 16AWG
5	-Vout	10AWG to 12AWG
6 -	-Sense	14AWG to 18AWG
7	Trim	14AWG to 18AWG
8	+Sense	14AWG to 18AWG
9	+Vout	10AWG to 12AWG

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. The screw 1 locked torque: MAX 11.2kgf-cm(1.10N-m)
4. The screw 2 locked torque: MAX 5.2kgf-cm(0.51N-m)
5. The screw 3 locked torque: MAX 12kgf-cm(1.18N-m)

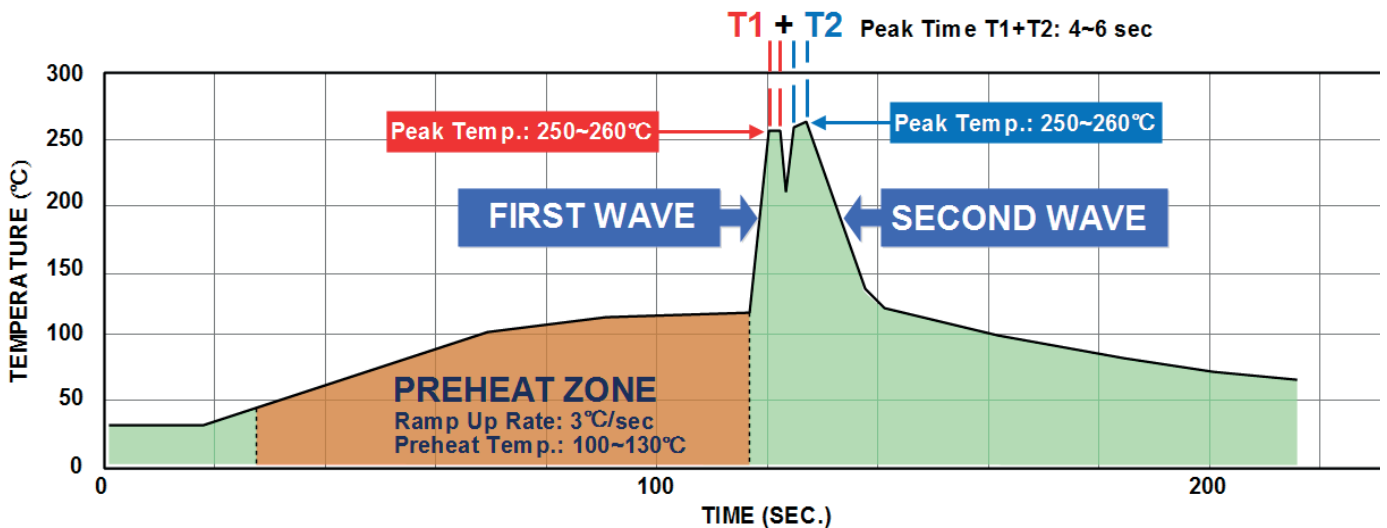
17. Recommended Pad Layout



All dimensions in inch(mm)
 Pad size(lead free recommended)
 Through hole PIN1,2,3,4,6,7,8: $\varnothing$ 0.051($\varnothing$ 1.30)
 Through hole PIN5,9: $\varnothing$ 0.091($\varnothing$ 2.30)
 Top view pad PIN1,2,3,4,6,7,8: $\varnothing$ 0.064($\varnothing$ 1.63)
 Top view pad PIN5,9: $\varnothing$ 0.113($\varnothing$ 2.88)
 Bottom view pad PIN1,2,3,4,6,7,8: $\varnothing$ 0.102($\varnothing$ 2.60)
 Bottom view pad PIN5,9: $\varnothing$ 0.142($\varnothing$ 3.60)

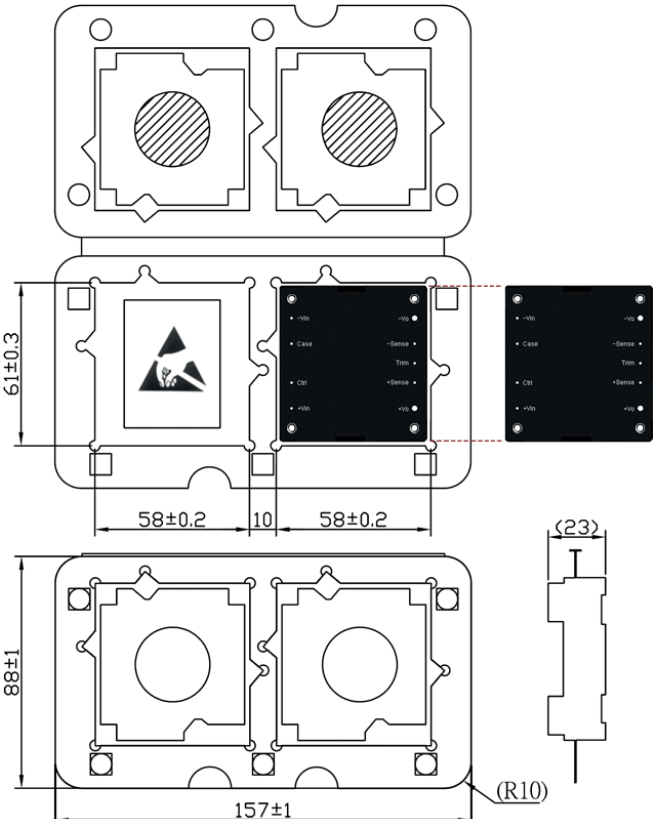
18. Soldering and Reflow Considerations

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 °C

19. Packaging Information



20. 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
PAE150-24S□□W	25	Fast-Acting
PAE150-48S□□W	15	Fast-Acting
PAE150-110S□□W	8	Fast-Acting

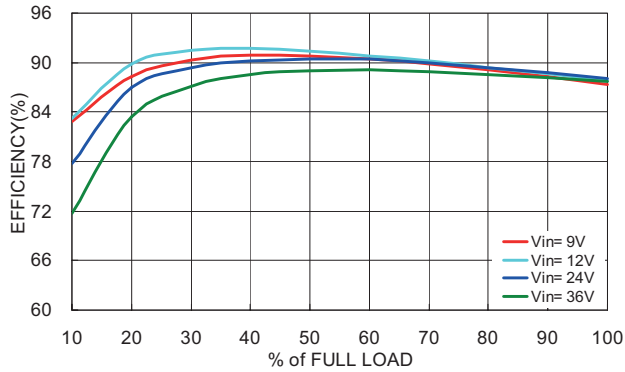
Based on the information provided in this data sheet on inrush energy and maximum dc input current at low Vin. If customer have another used condition and need more information. Please contact Powerbox.

21. MTBF and Reliability

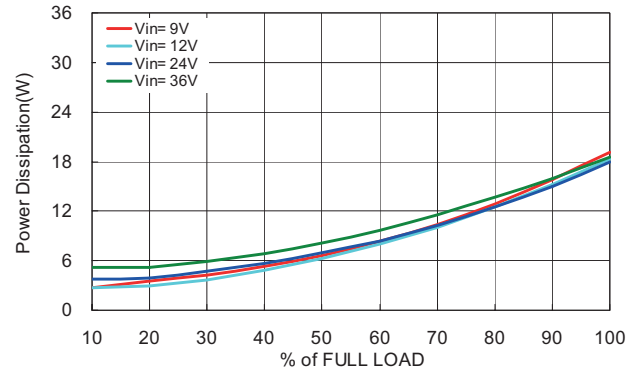
The MTBF of HAE150W series has been calculated using MIL-HDBK 217F NOTICE2 FULL LOAD, Tc=70°C. The resulting figure for MTBF is 3.500×105 hours.

22. Characteristic Curves

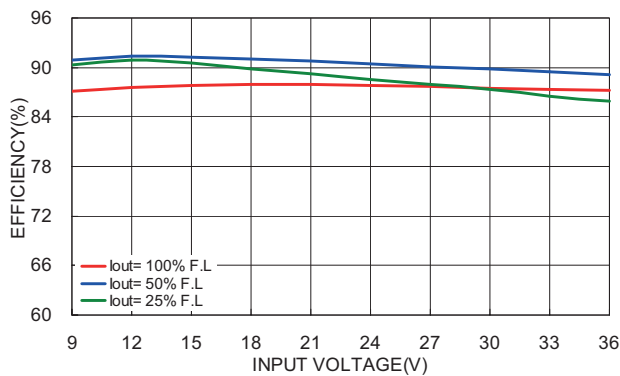
All test conditions are at 25°C. The figures are identical for PAE150-24S3P3W



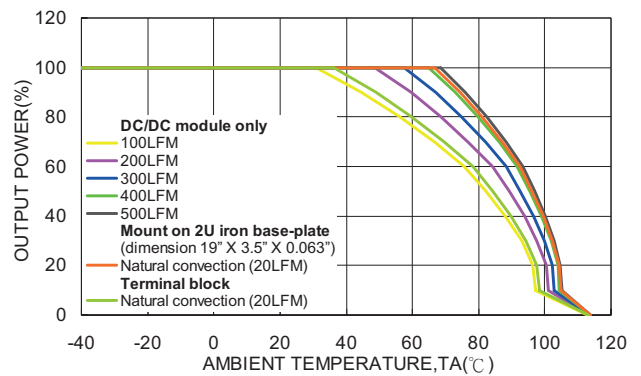
Efficiency versus Output Current



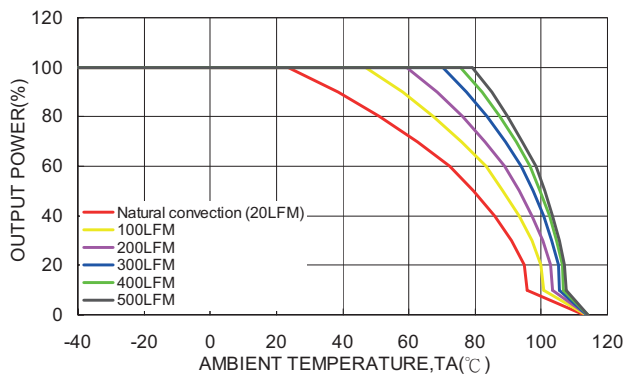
Power dissipation versus Output Current



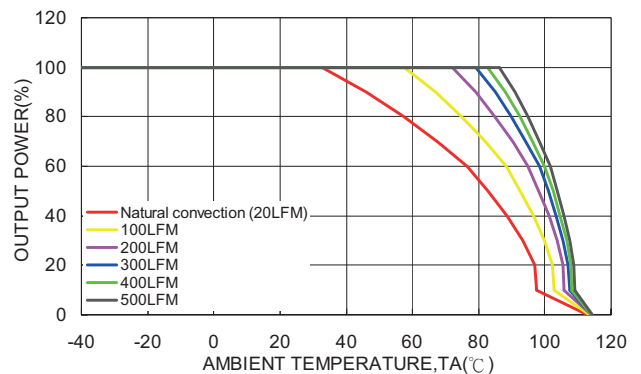
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

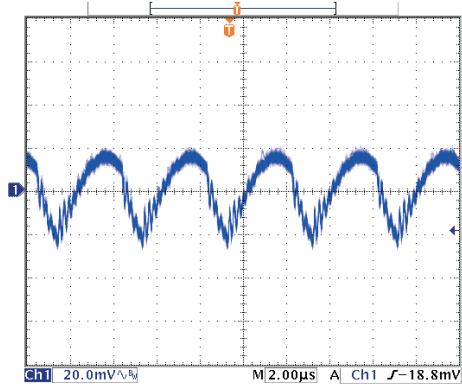


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink, Vin(nom)

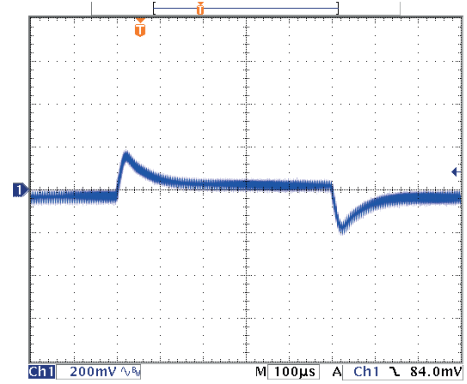


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink, Vin(nom)

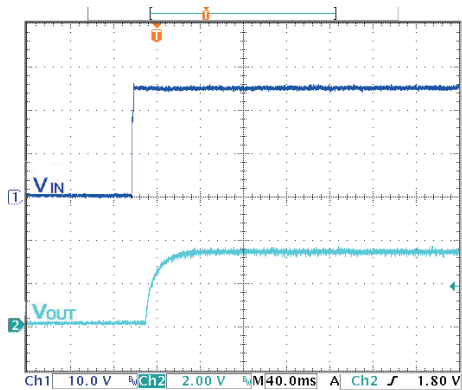
All test conditions are at 25°C. The figures are identical for PAE150-24S3P3W



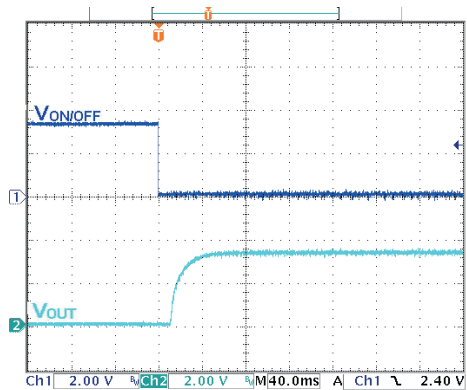
Typical Output Ripple and Noise.
 $V_{in}(nom)$; Full Load



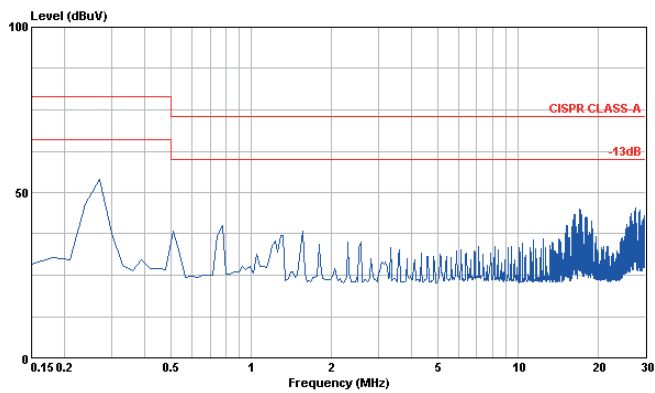
Transient Response to Dynamic Load Change from
 100% to 75% to 100% of Full Load; $V_{in}(nom)$



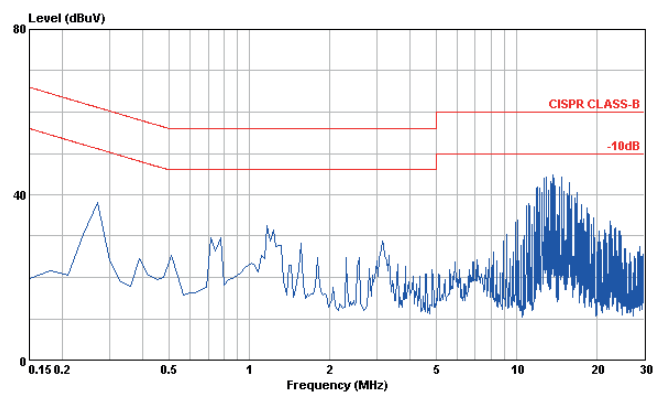
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load

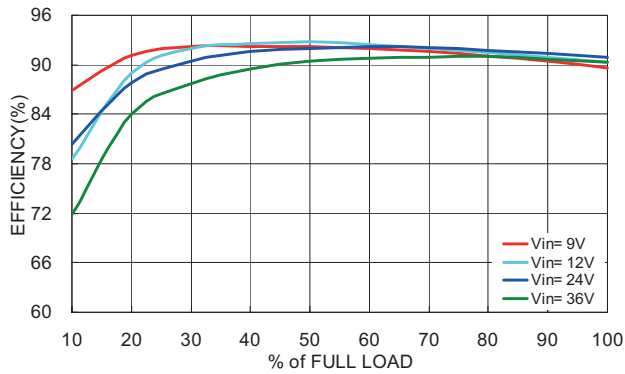


Conduction Emission of EN55022 Class A
 $V_{in}(nom)$; Full Load

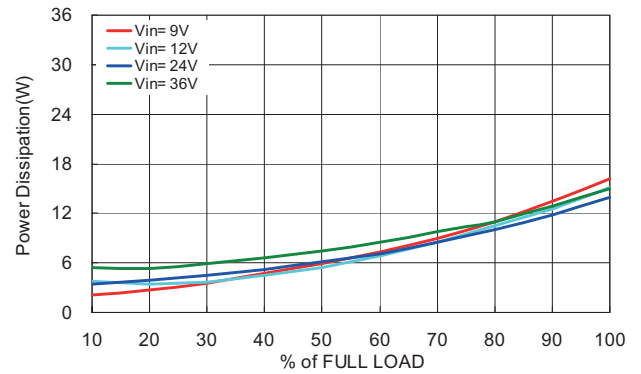


Conduction Emission of EN55022 Class B
 $V_{in}(nom)$; Full Load

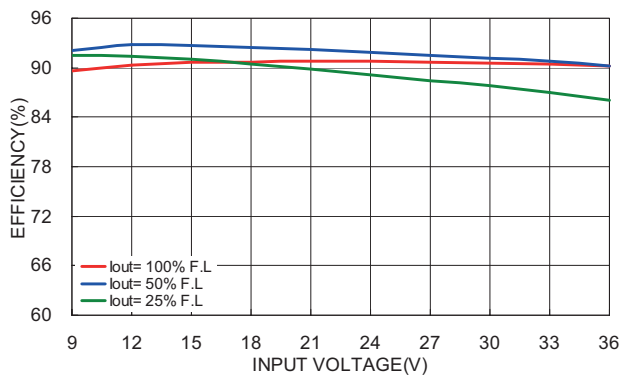
All test conditions are at 25°C. The figures are identical for PAE150-24S05W



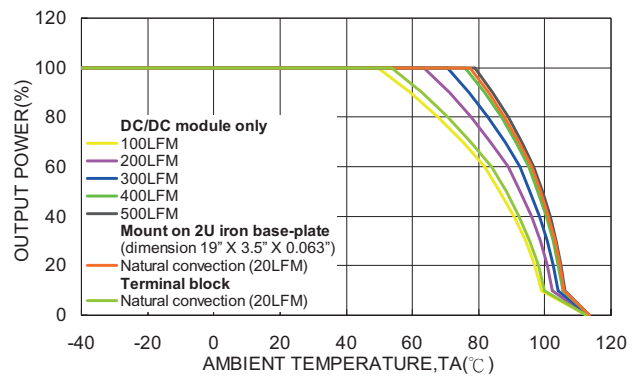
Efficiency versus Output Current



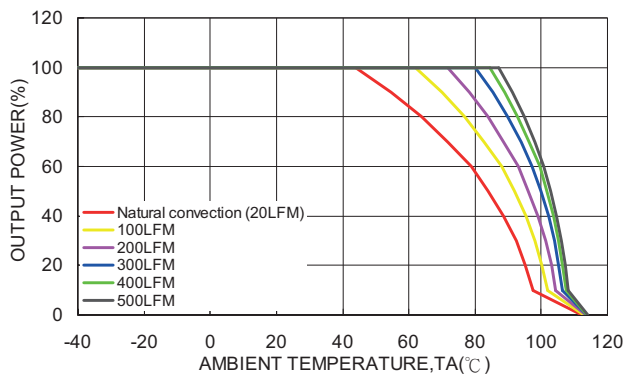
Power dissipation versus Output Current



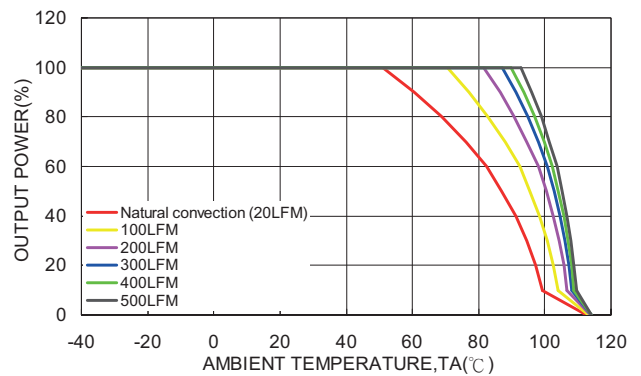
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

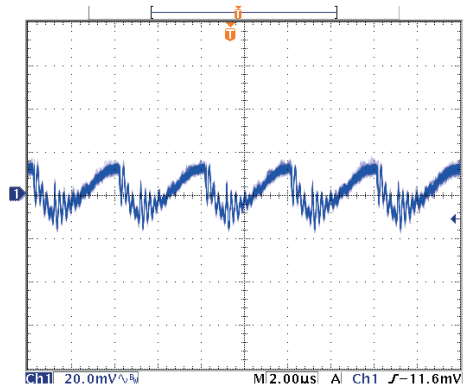


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink, Vin(nom)

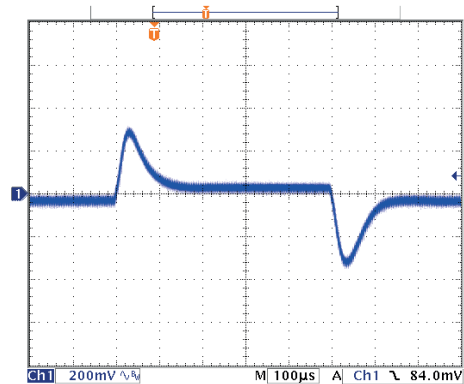


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink, Vin(nom)

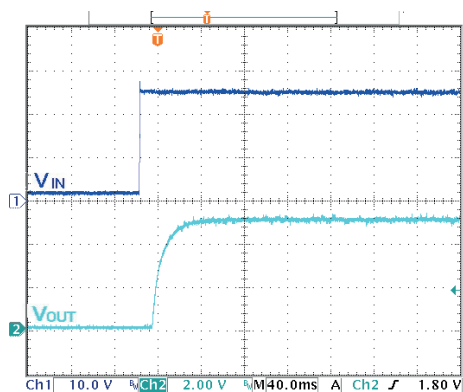
All test conditions are at 25°C. The figures are identical for PAE150-24S05W



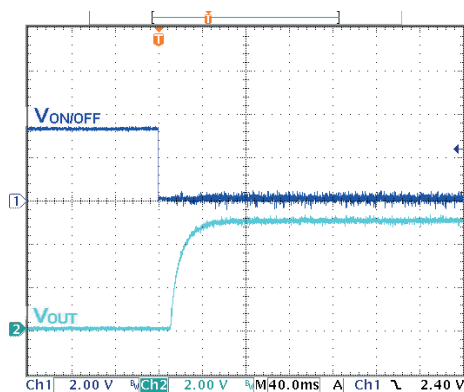
Typical Output Ripple and Noise.
 $V_{in}(\text{nom})$; Full Load



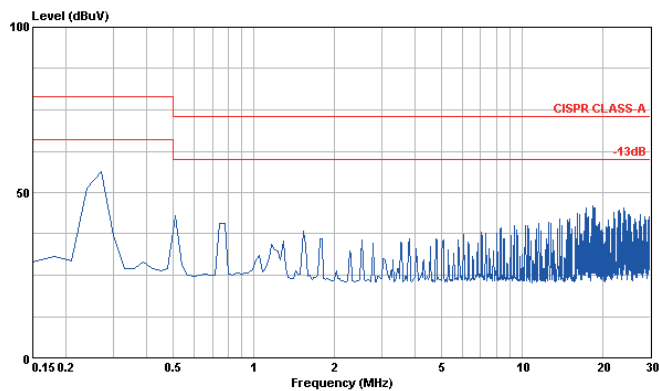
Transient Response to Dynamic Load Change from
 100% to 75% to 100% of Full Load; $V_{in}(\text{nom})$



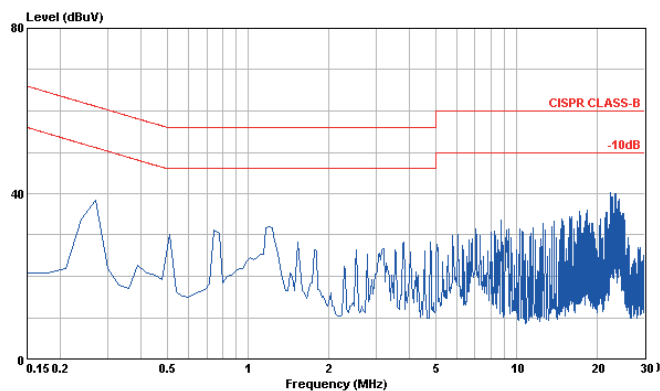
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}(\text{nom})$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in}(\text{nom})$; Full Load

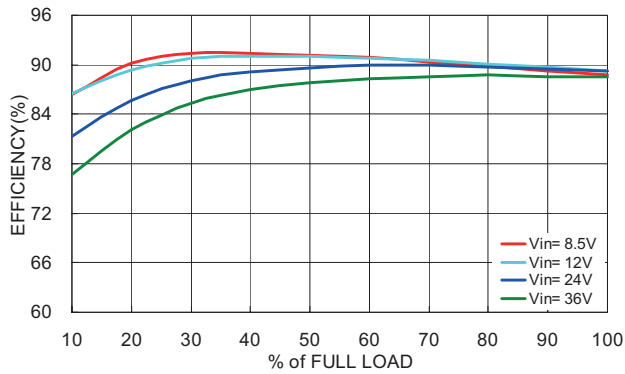


Conduction Emission of EN55022 Class A
 $V_{in}(\text{nom})$; Full Load

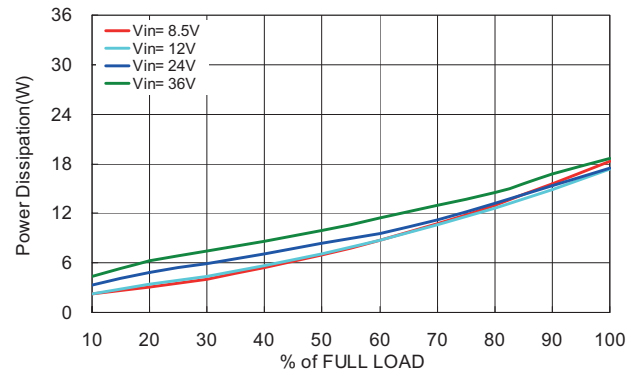


Conduction Emission of EN55022 Class B
 $V_{in}(\text{nom})$; Full Load

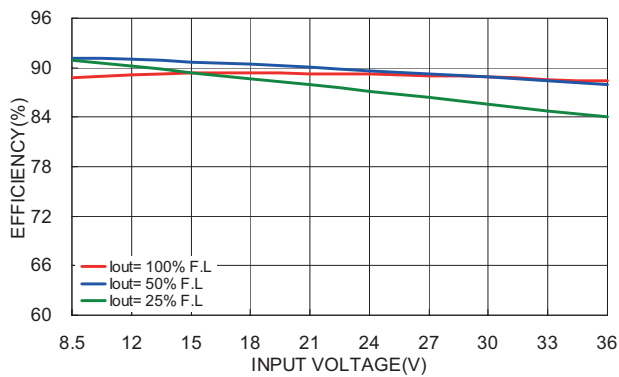
All test conditions are at 25°C. The figures are identical for PAE150-24S12W



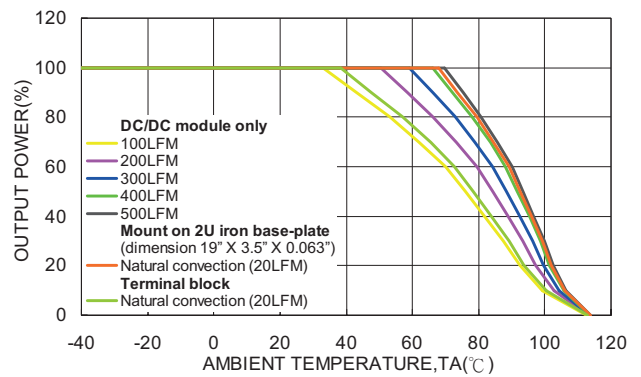
Efficiency versus Output Current



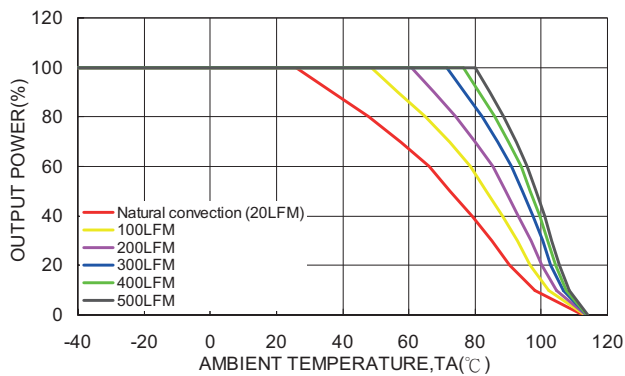
Power dissipation versus Output Current



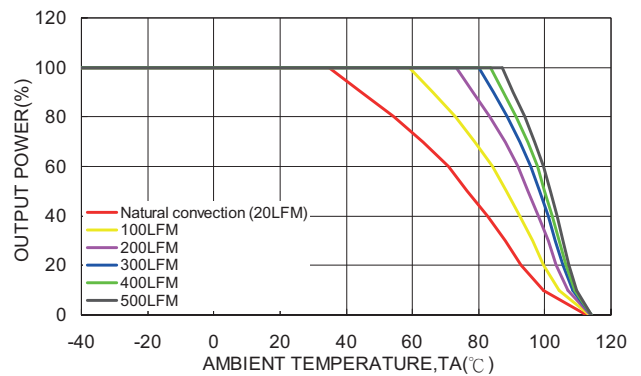
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

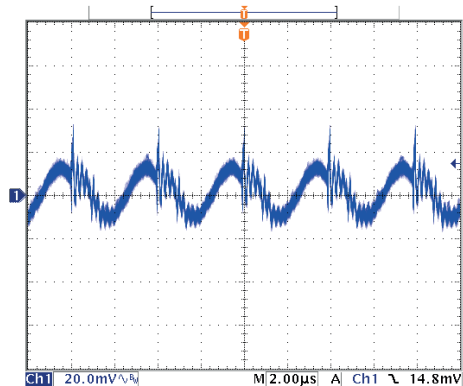


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink, Vin(nom)

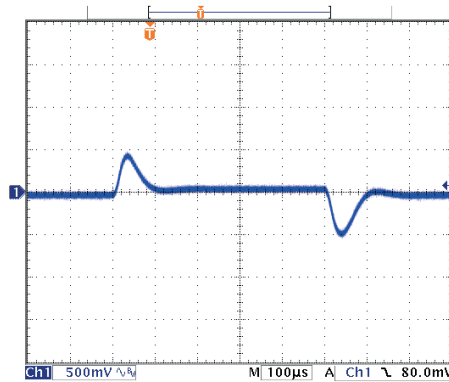


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink, Vin(nom)

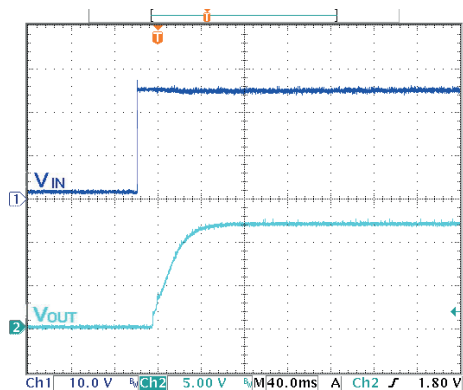
All test conditions are at 25°C. The figures are identical for PAE150-24S12W



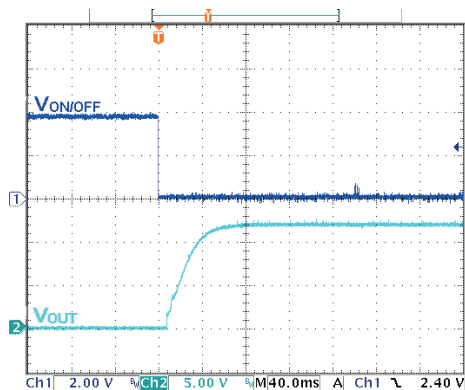
Typical Output Ripple and Noise.
 $V_{in}(nom)$; Full Load



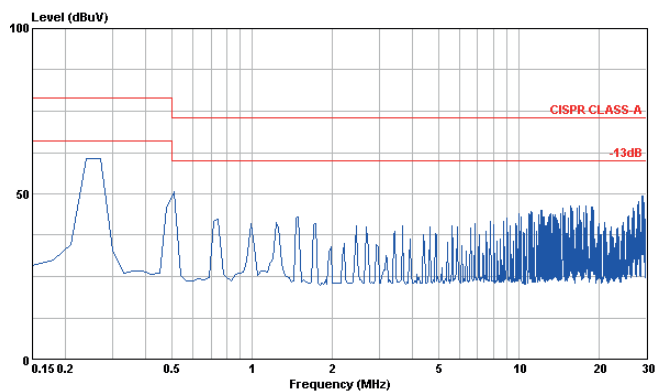
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; $V_{in}(nom)$



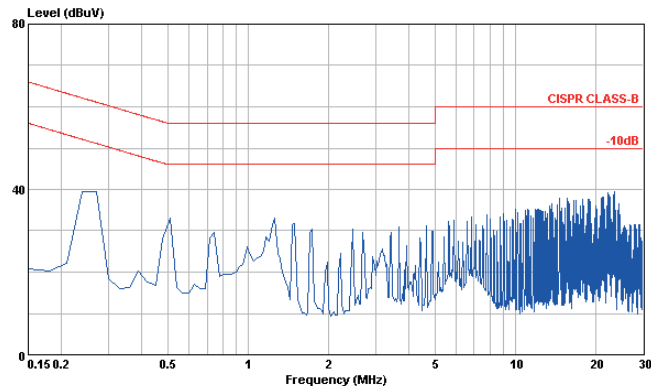
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load

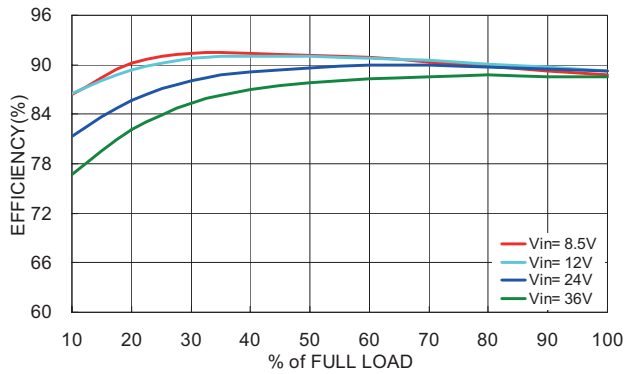


Conduction Emission of EN55022 Class A
 $V_{in}(nom)$; Full Load

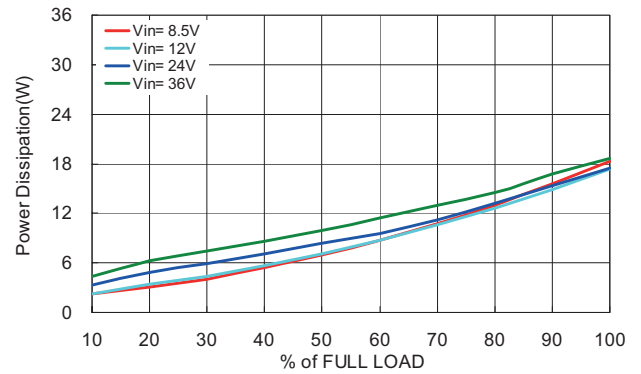


Conduction Emission of EN55022 Class B
 $V_{in}(nom)$; Full Load

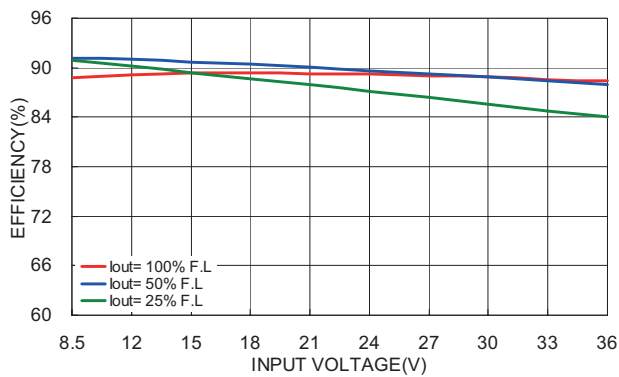
All test conditions are at 25°C. The figures are identical for PAE150-24S15W



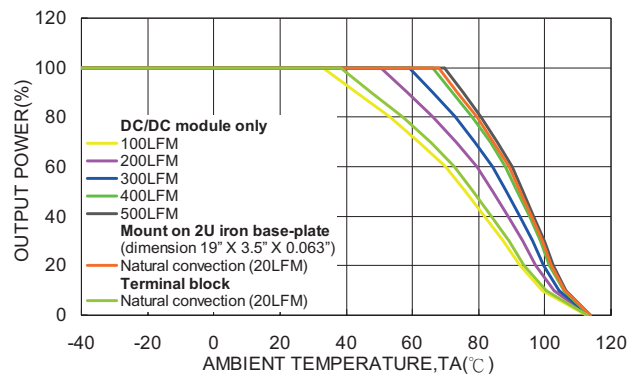
Efficiency versus Output Current



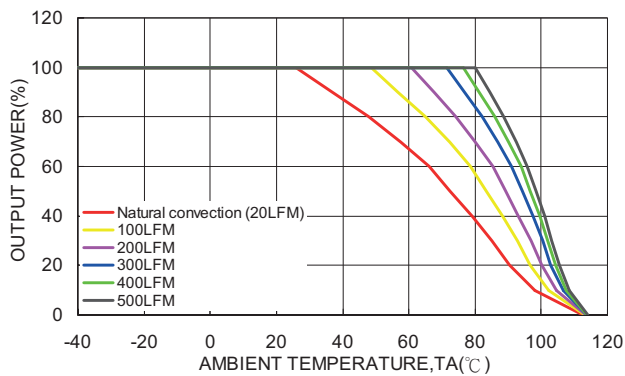
Power dissipation versus Output Current



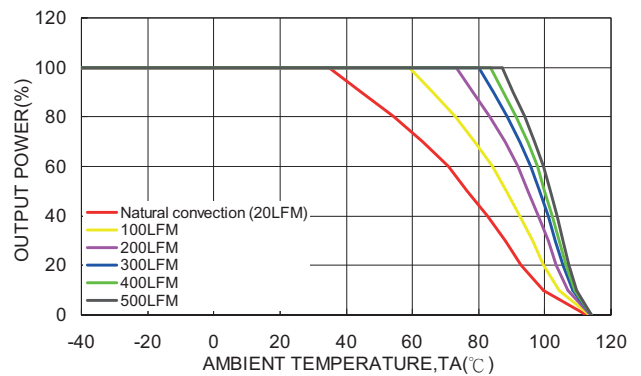
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

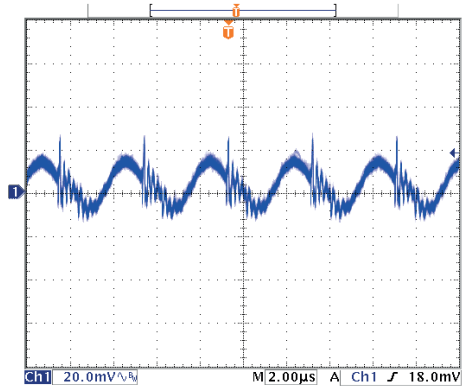


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink, Vin(nom)

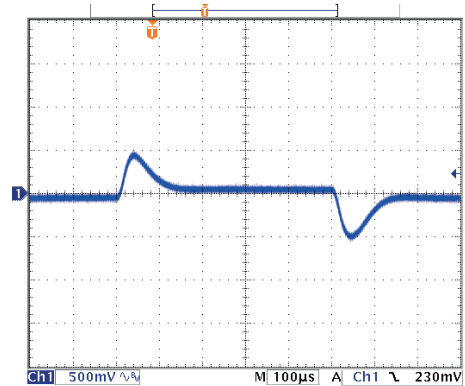


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink, Vin(nom)

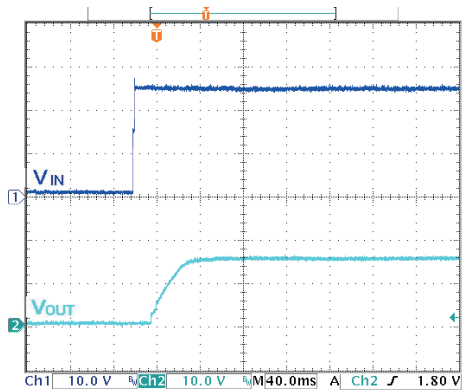
All test conditions are at 25°C. The figures are identical for PAE150-24S15W



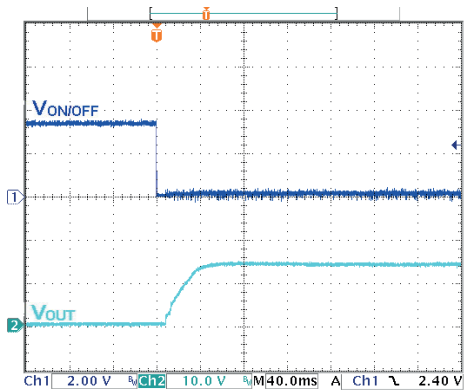
Typical Output Ripple and Noise.
 $V_{in}(\text{nom})$; Full Load



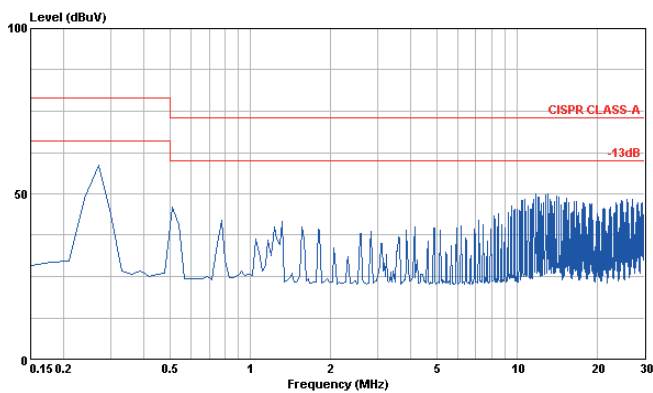
Transient Response to Dynamic Load Change from
 100% to 75% to 100% of Full Load; $V_{in}(\text{nom})$



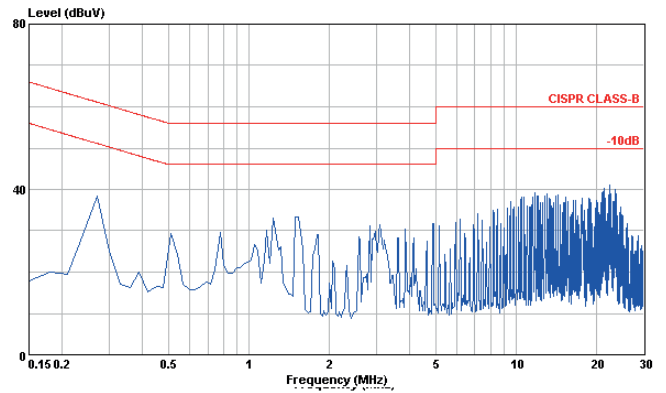
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}(\text{nom})$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in}(\text{nom})$; Full Load



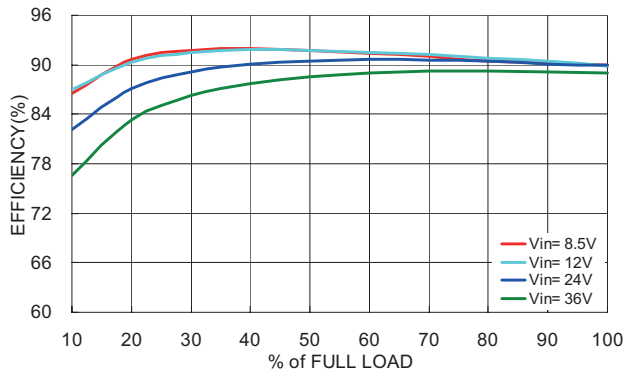
Conduction Emission of EN55022 Class A
 $V_{in}(\text{nom})$; Full Load



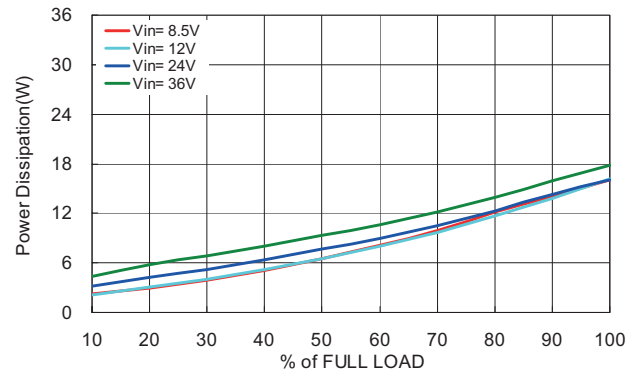
Conduction Emission of EN55022 Class B
 $V_{in}(\text{nom})$; Full Load

POWERBOX Industrial Line
PAE150W Series
Up to 182W 4:1 Wide Input, Single Output
DC/DC Converter
Manual

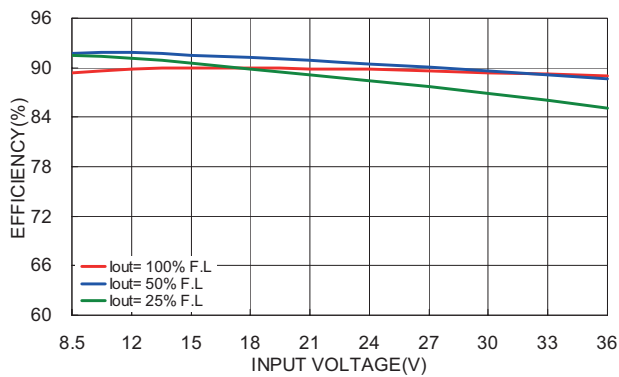
All test conditions are at 25°C. The figures are identical for PAE150-24S24W



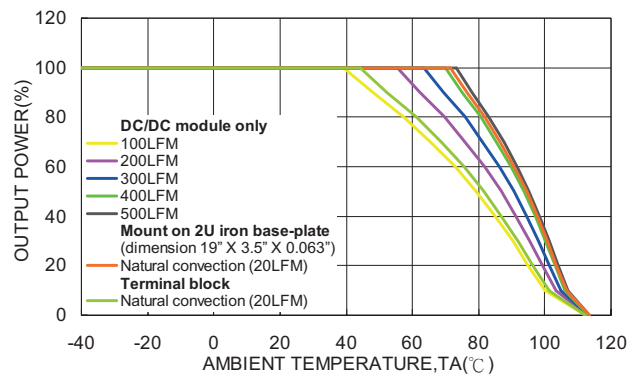
Efficiency versus Output Current



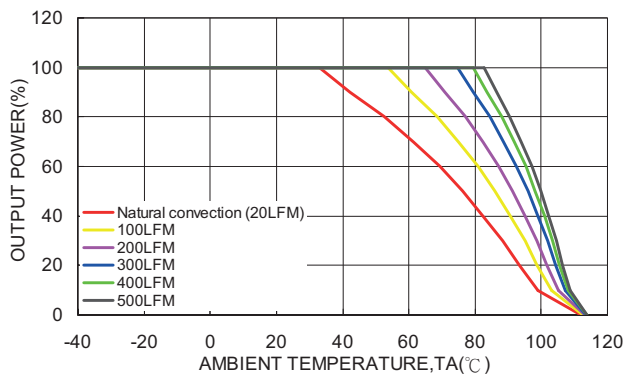
Power dissipation versus Output Current



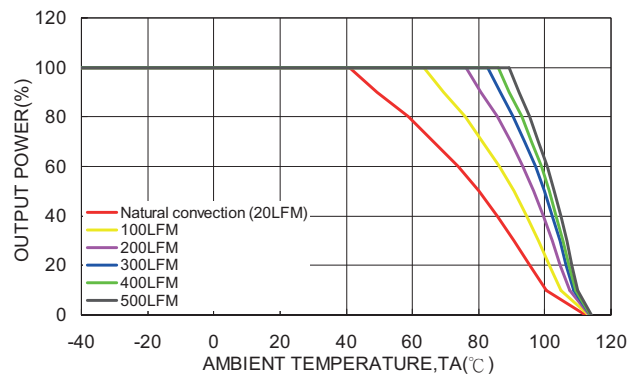
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

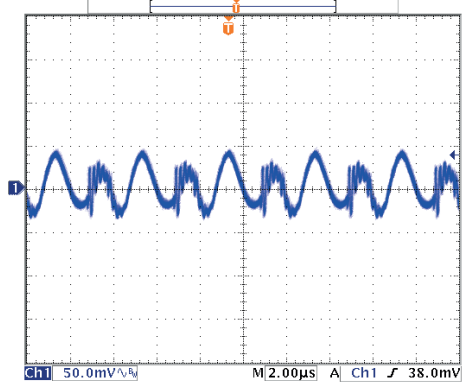


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

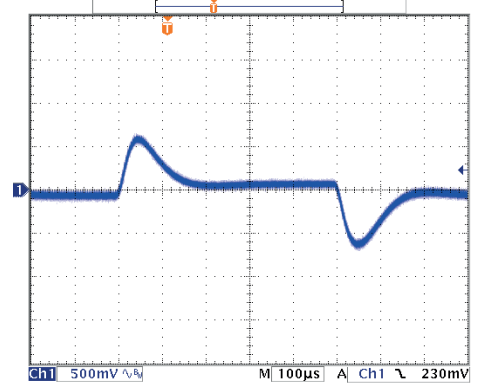


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink , Vin(nom)

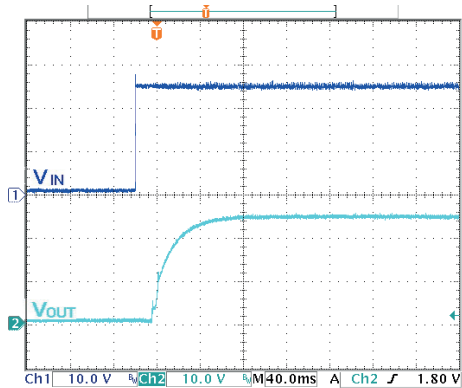
All test conditions are at 25°C. The figures are identical for PAE150-24S24W



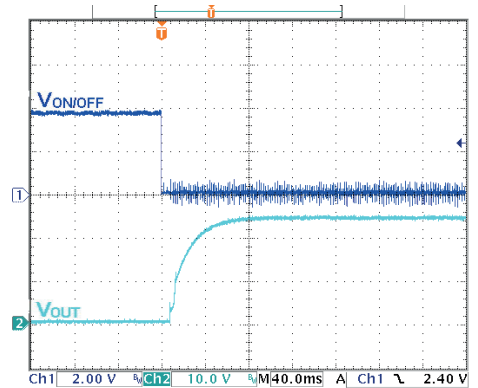
Typical Output Ripple and Noise.
 $V_{in}(nom)$; Full Load



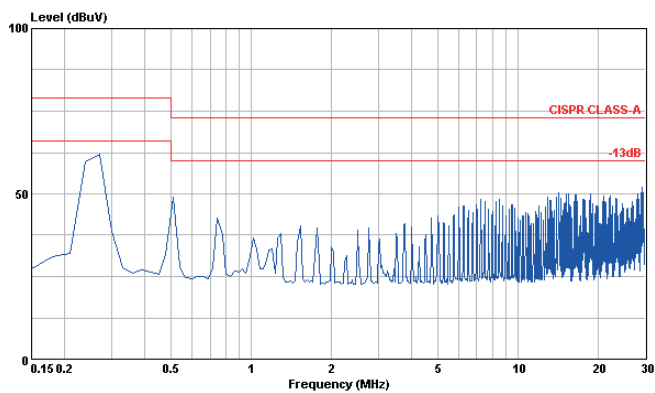
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; $V_{in}(nom)$



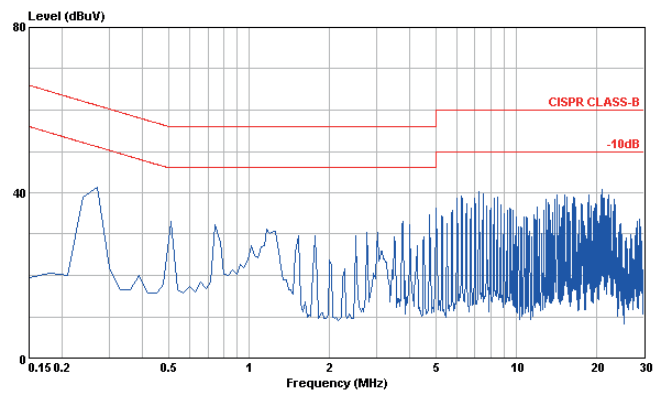
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load

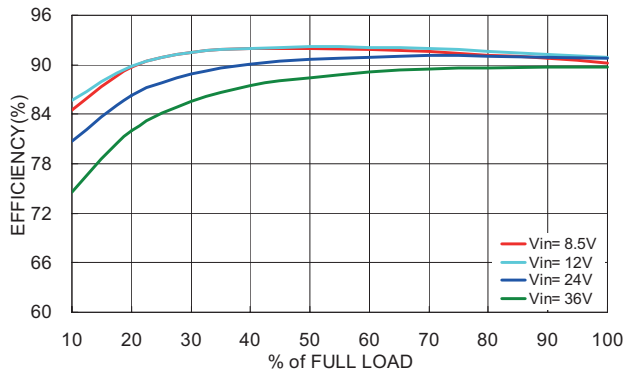


Conduction Emission of EN55022 Class A
 $V_{in}(nom)$; Full Load

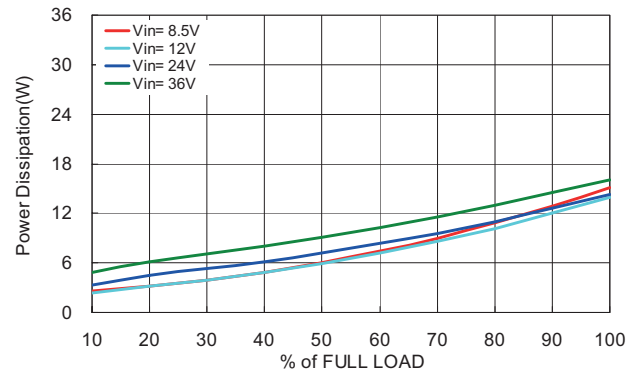


Conduction Emission of EN55022 Class B
 $V_{in}(nom)$; Full Load

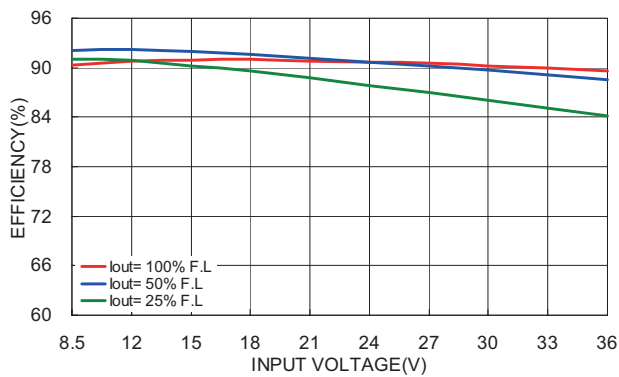
All test conditions are at 25°C. The figures are identical for PAE150-24S28W



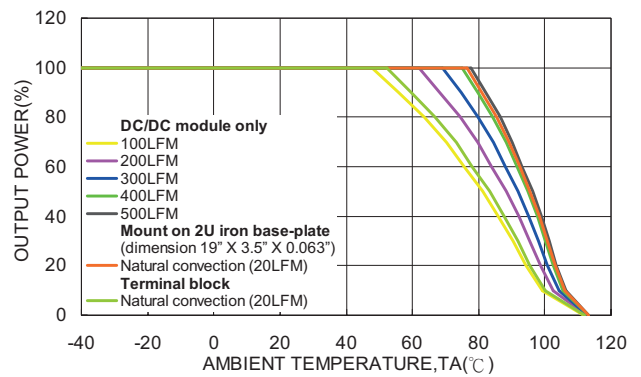
Efficiency versus Output Current



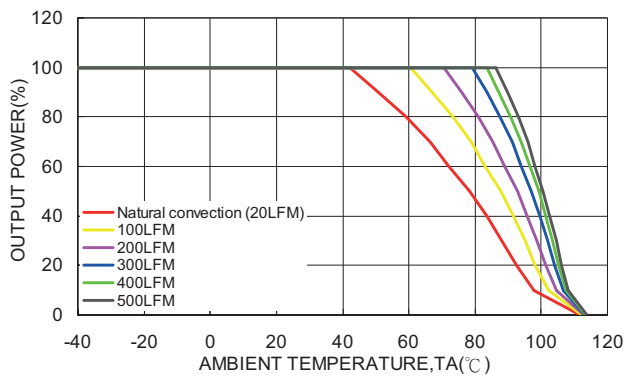
Power dissipation versus Output Current



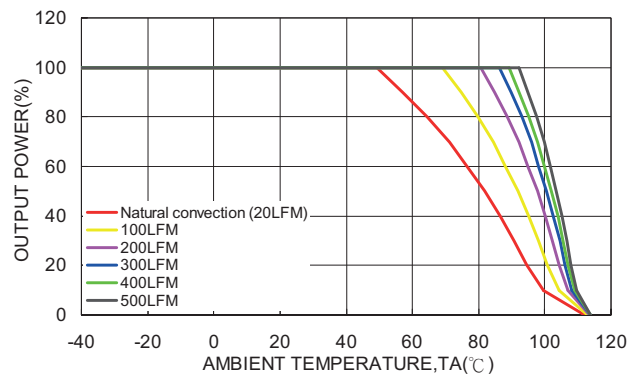
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

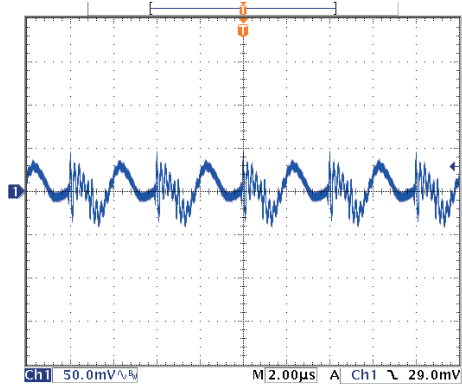


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink, Vin(nom)

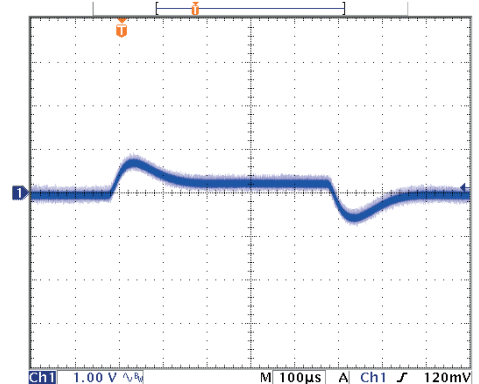


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink, Vin(nom)

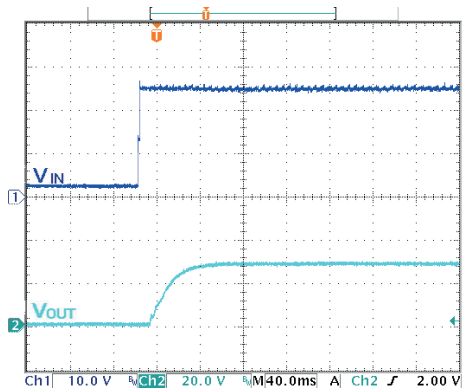
All test conditions are at 25°C. The figures are identical for PAE150-24S28W



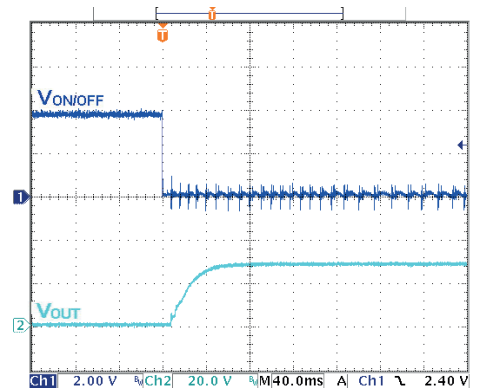
Typical Output Ripple and Noise.
Vin(nom); Full Load



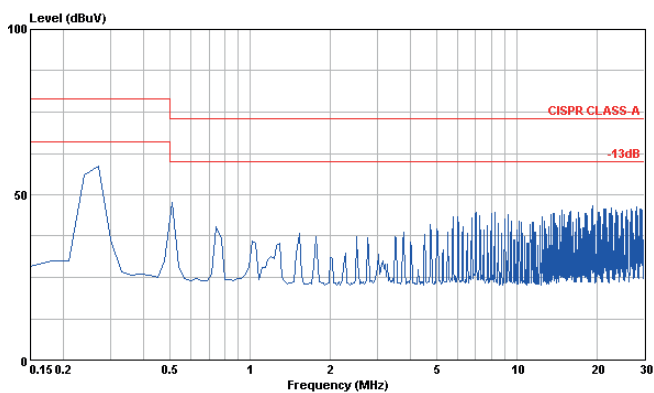
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



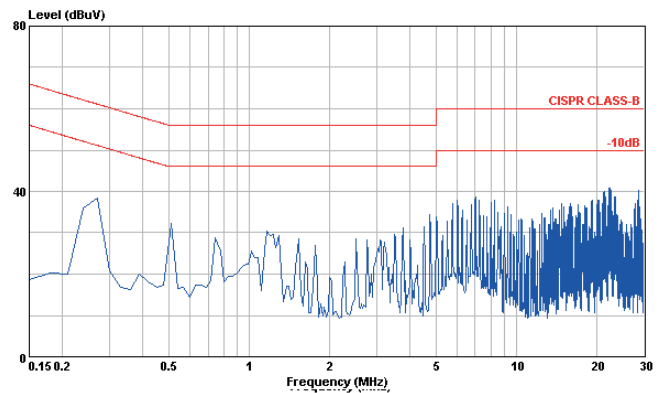
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

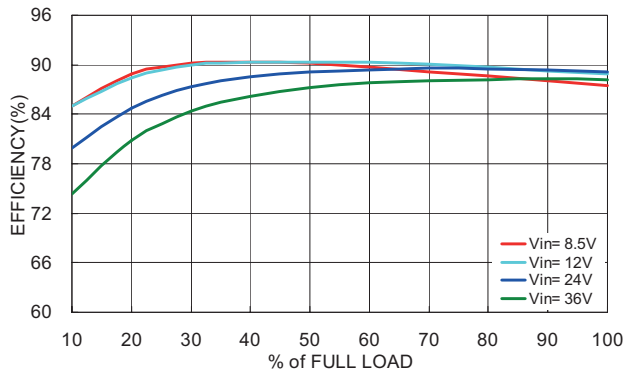


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

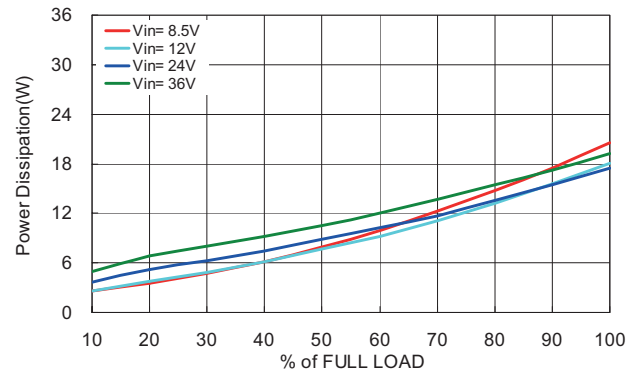


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

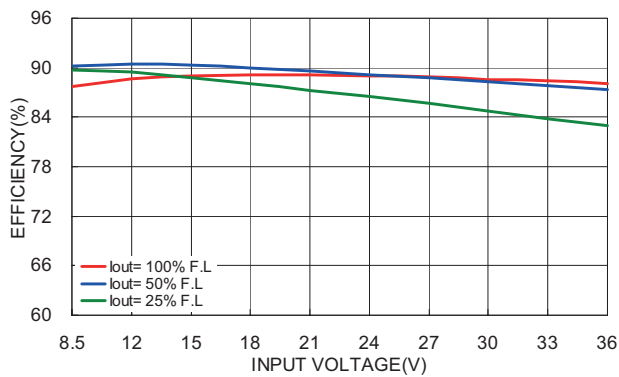
All test conditions are at 25°C. The figures are identical for PAE150-24S48W



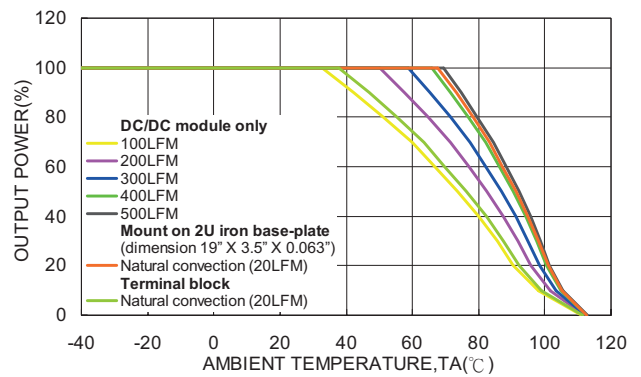
Efficiency versus Output Current



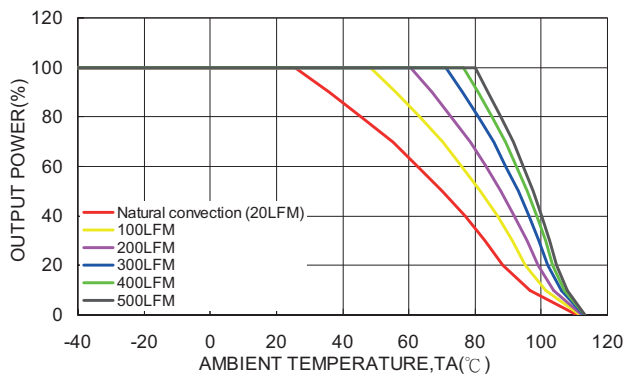
Power dissipation versus Output Current



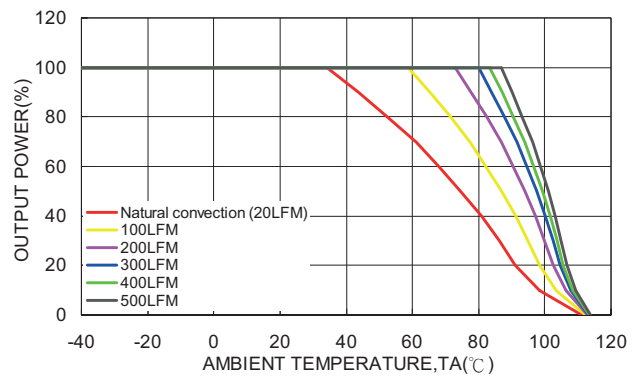
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

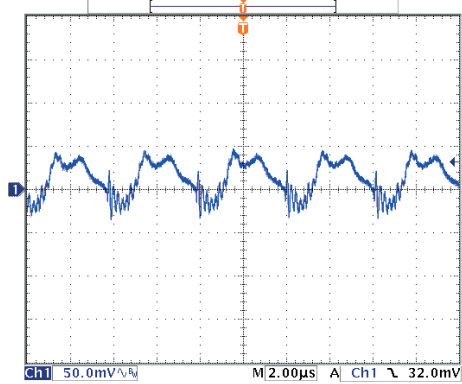


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

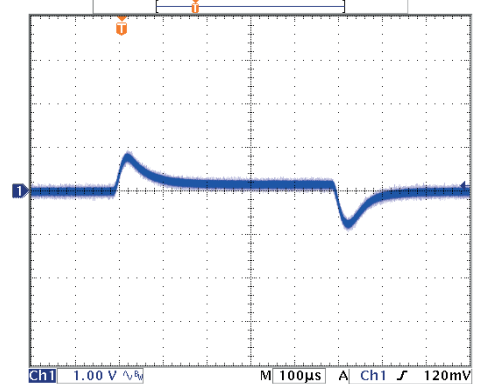


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink , Vin(nom)

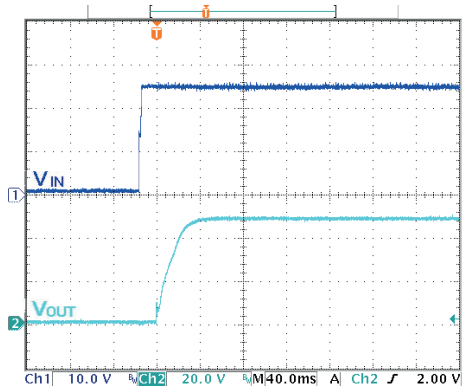
All test conditions are at 25°C. The figures are identical for PAE150-24S48W



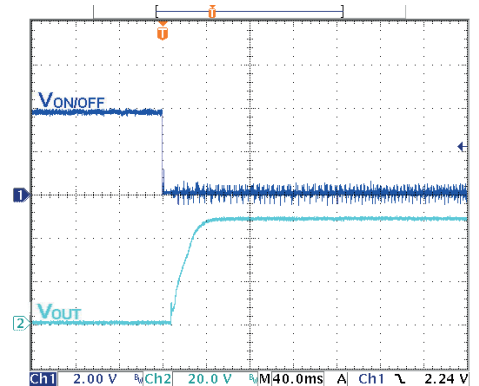
Typical Output Ripple and Noise.
Vin(nom); Full Load



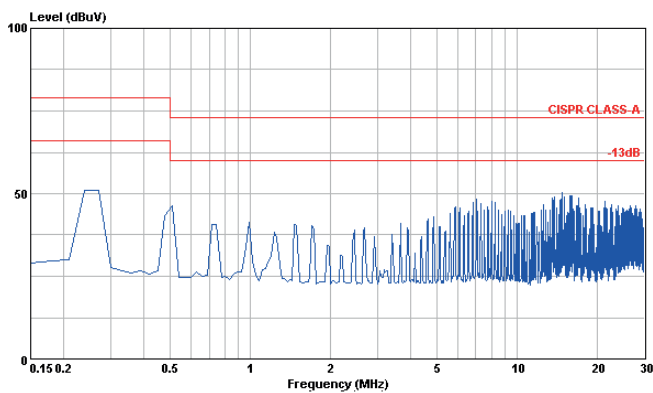
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



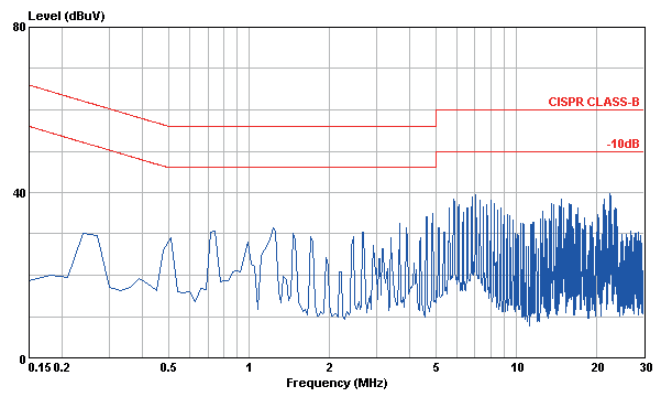
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

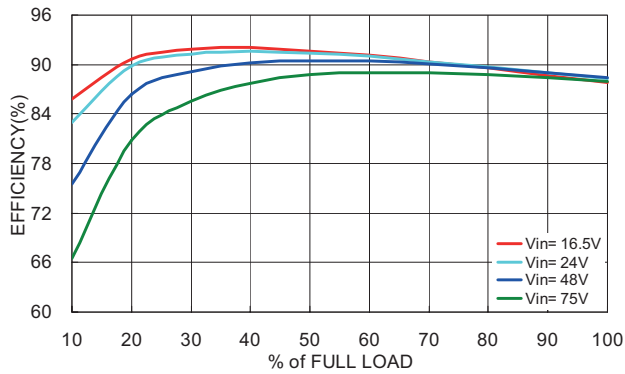


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

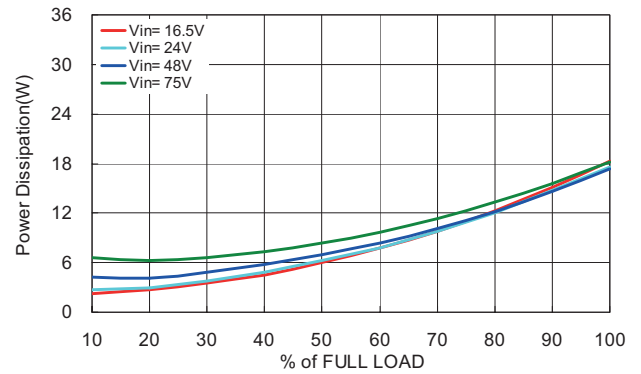


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

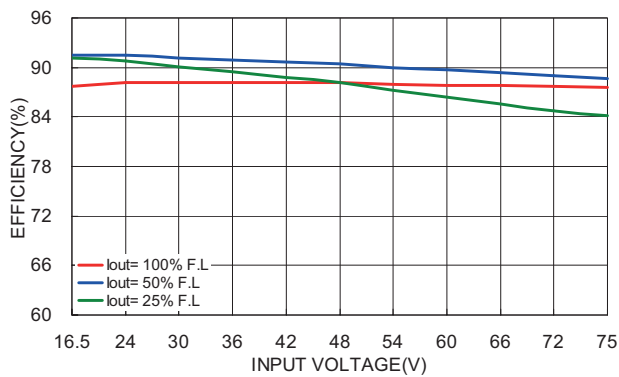
All test conditions are at 25°C. The figures are identical for PAE150-48S3P3W



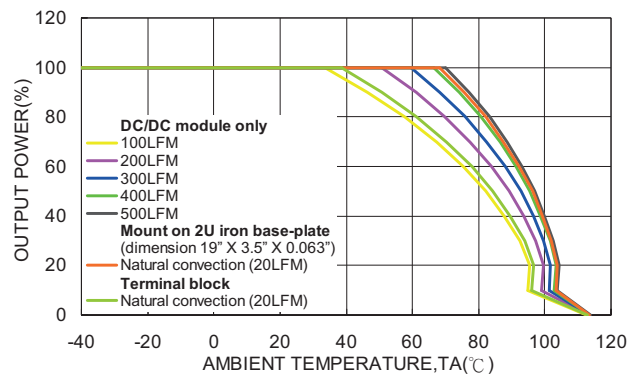
Efficiency versus Output Current



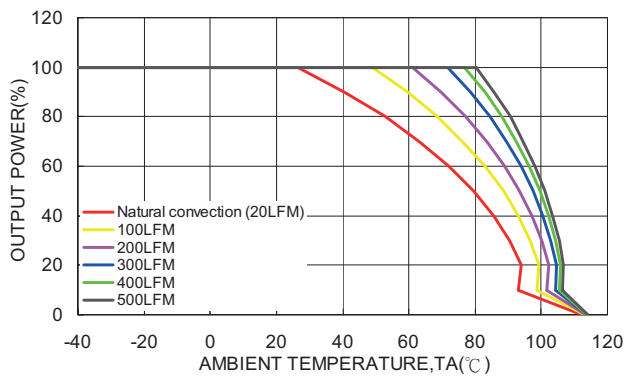
Power dissipation versus Output Current



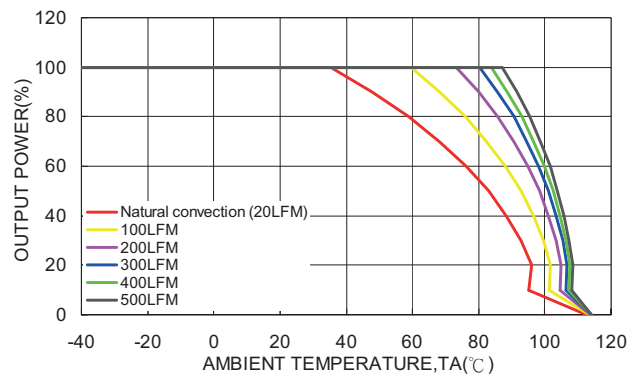
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

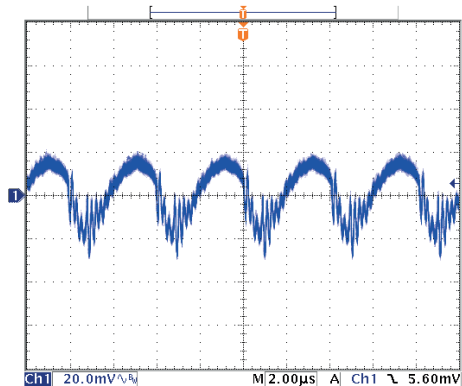


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink, Vin(nom)

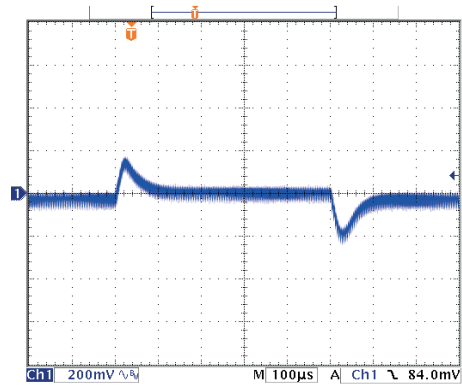


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink, Vin(nom)

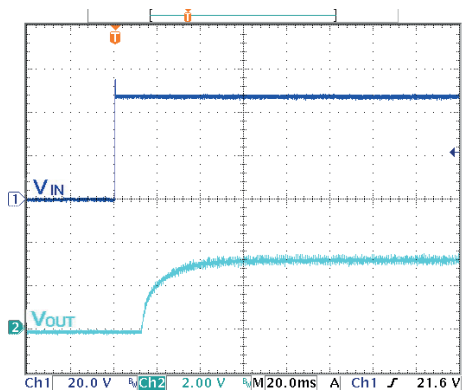
All test conditions are at 25°C. The figures are identical for PAE150-48S3P3W



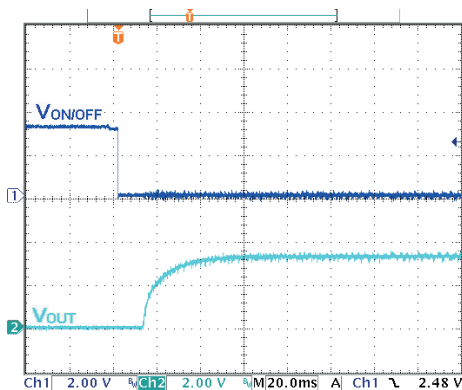
Typical Output Ripple and Noise.
 $V_{in}(nom)$; Full Load



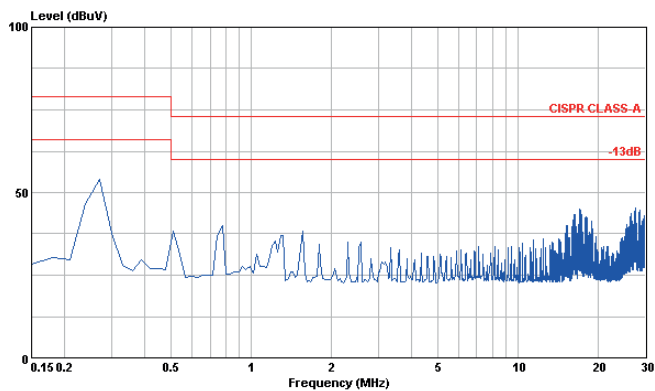
Transient Response to Dynamic Load Change from
 100% to 75% to 100% of Full Load; $V_{in}(nom)$



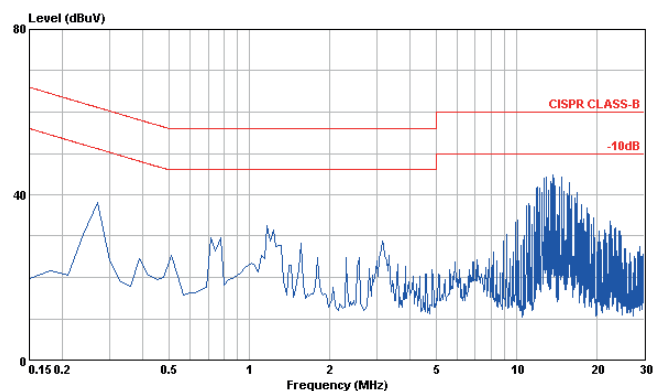
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load



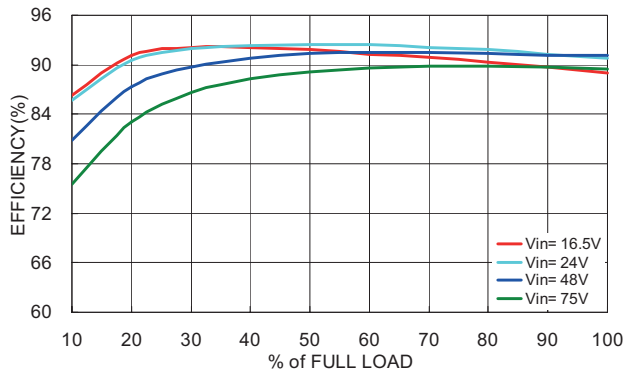
Conduction Emission of EN55022 Class A
 $V_{in}(nom)$; Full Load



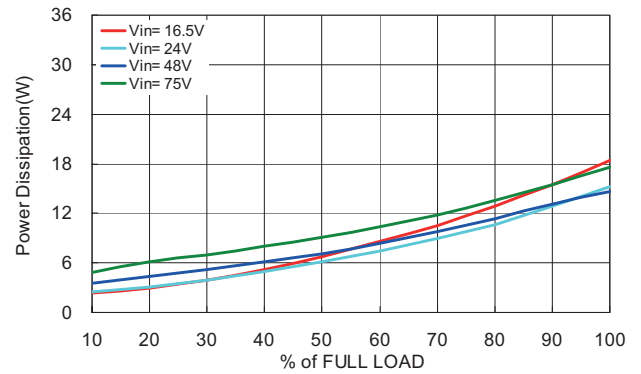
Conduction Emission of EN55022 Class B
 $V_{in}(nom)$; Full Load

POWERBOX Industrial Line
PAE150W Series
Up to 182W 4:1 Wide Input, Single Output
DC/DC Converter
Manual

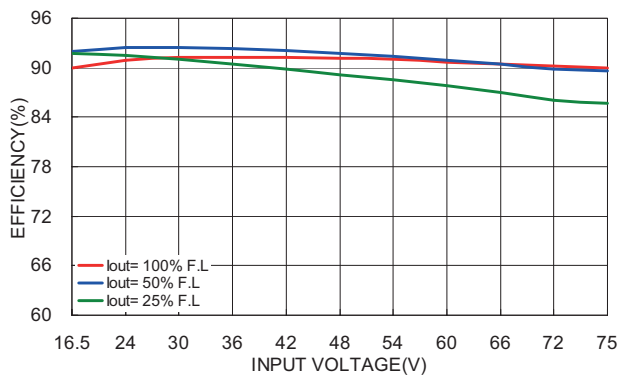
All test conditions are at 25°C. The figures are identical for PAE150-48S05W



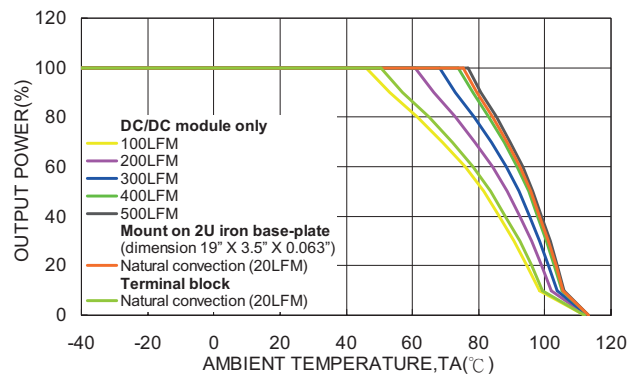
Efficiency versus Output Current



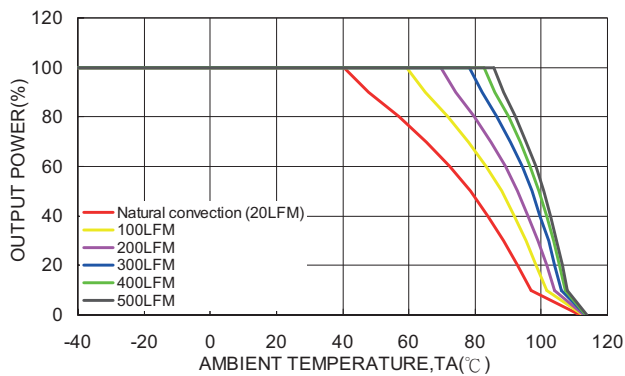
Power dissipation versus Output Current



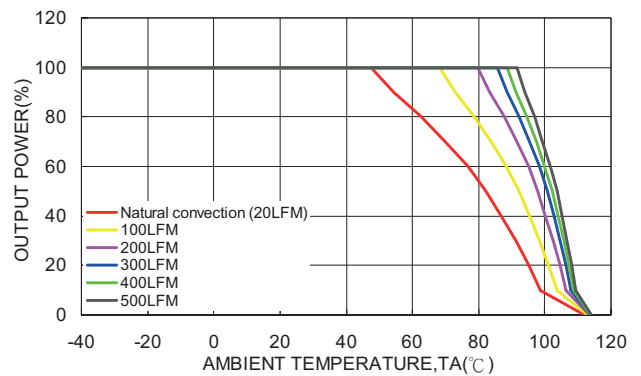
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

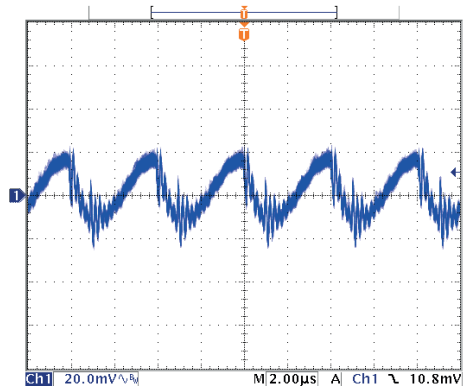


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink, Vin(nom)

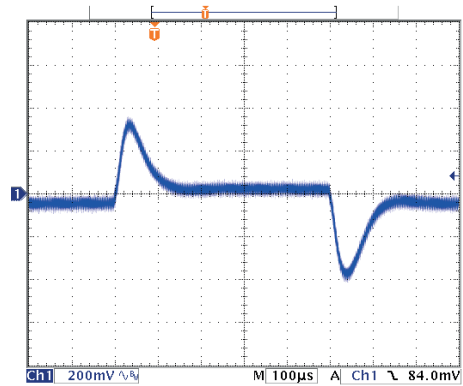


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink, Vin(nom)

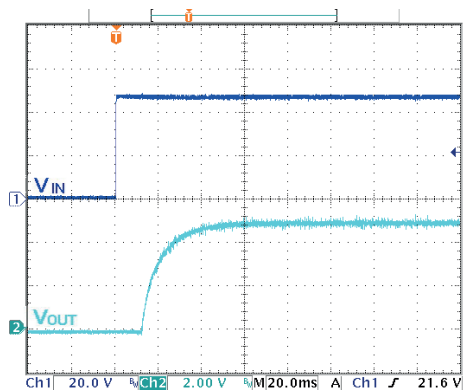
All test conditions are at 25°C. The figures are identical for PAE150-48S05W



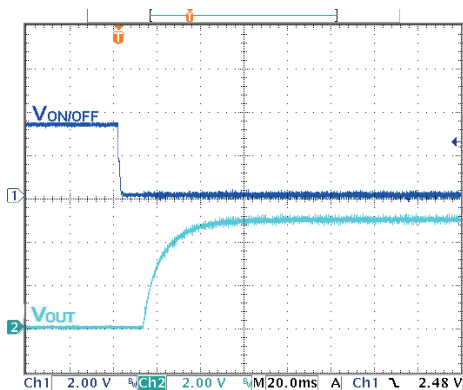
Typical Output Ripple and Noise.
Vin(nom); Full Load



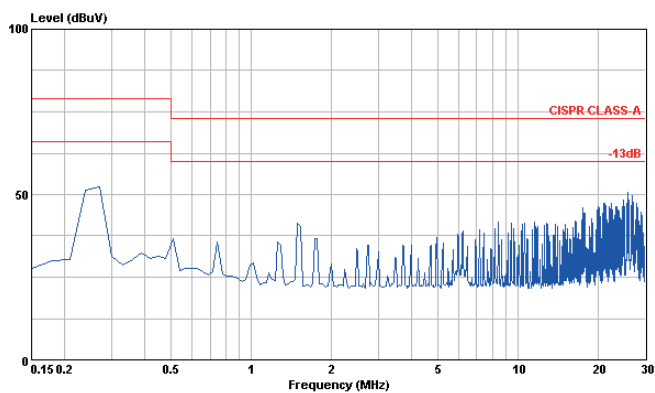
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



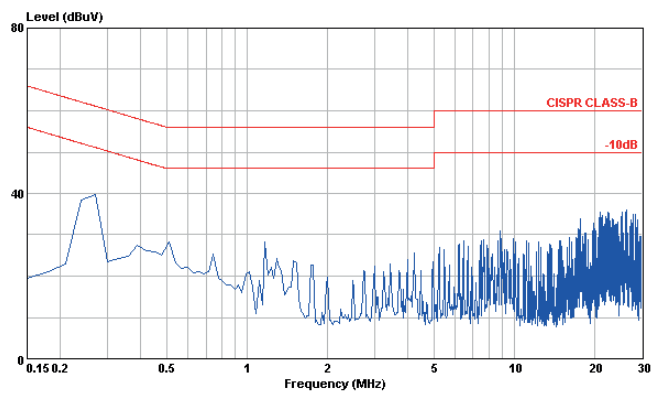
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

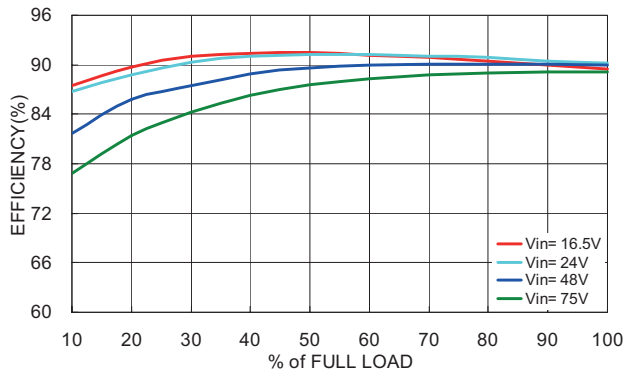


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

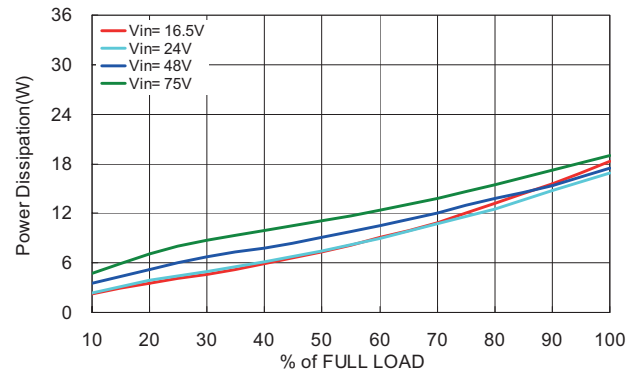


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

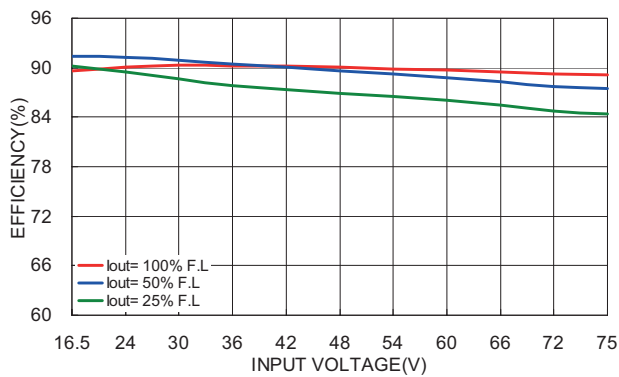
All test conditions are at 25°C. The figures are identical for PAE150-48S12W



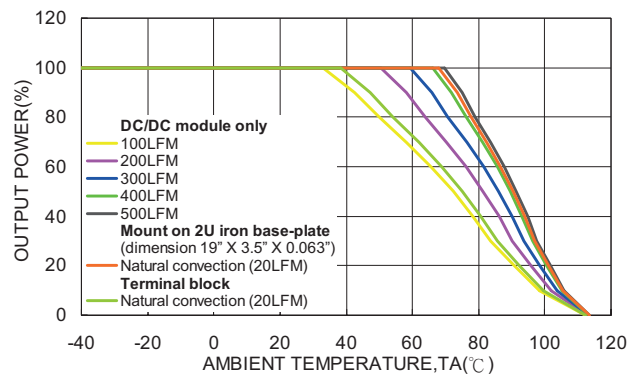
Efficiency versus Output Current



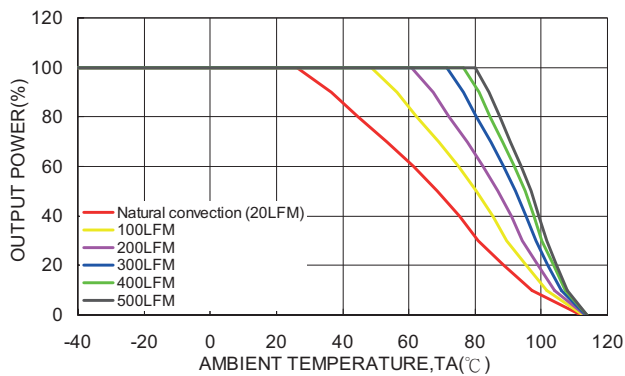
Power dissipation versus Output Current



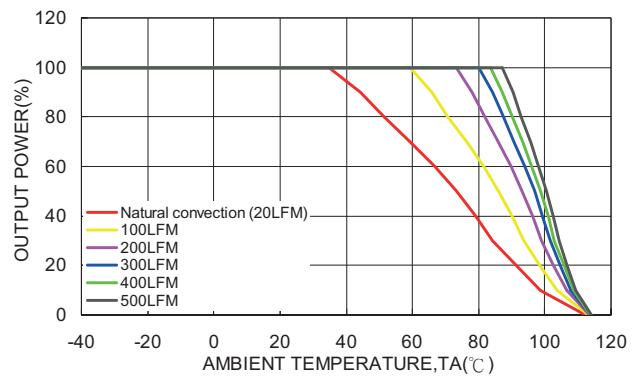
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

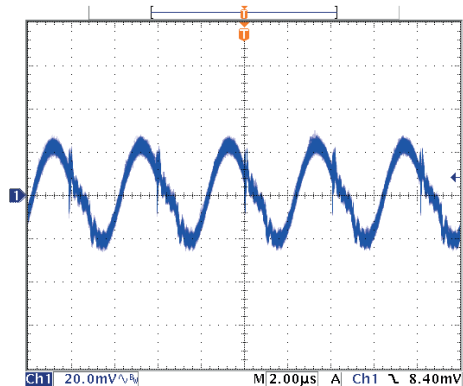


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink, Vin(nom)

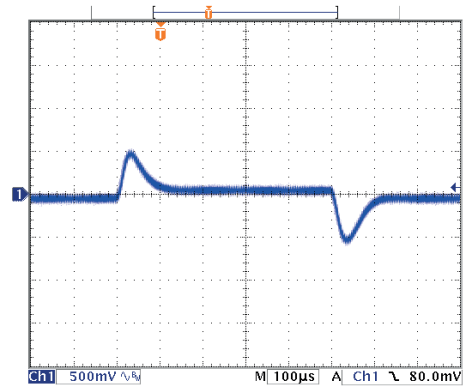


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink, Vin(nom)

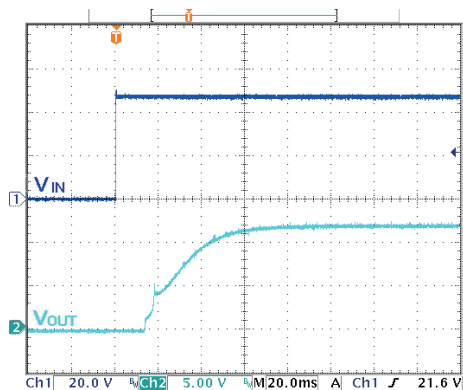
All test conditions are at 25°C. The figures are identical for PAE150-48S12W



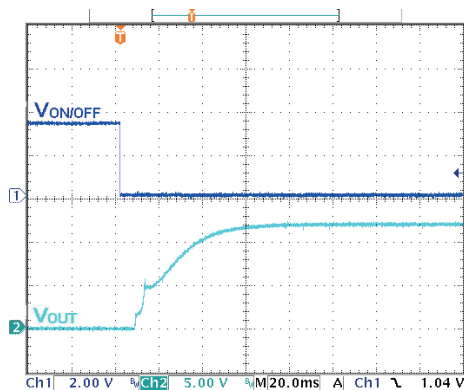
Typical Output Ripple and Noise.
Vin(nom); Full Load



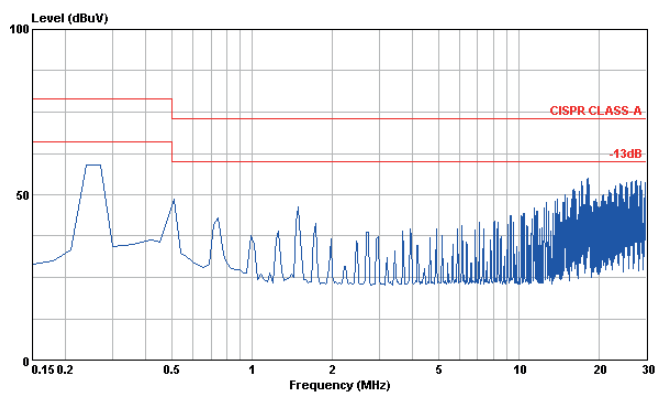
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



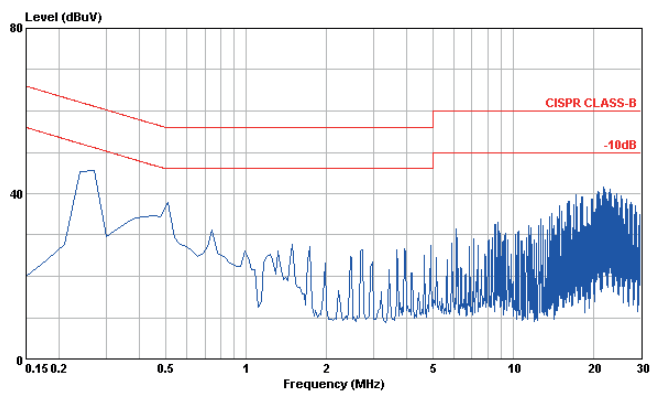
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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



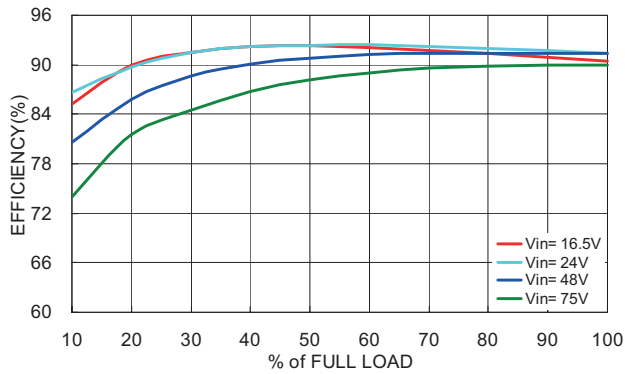
Conduction Emission of EN55022 Class A
Vin(nom); Full Load



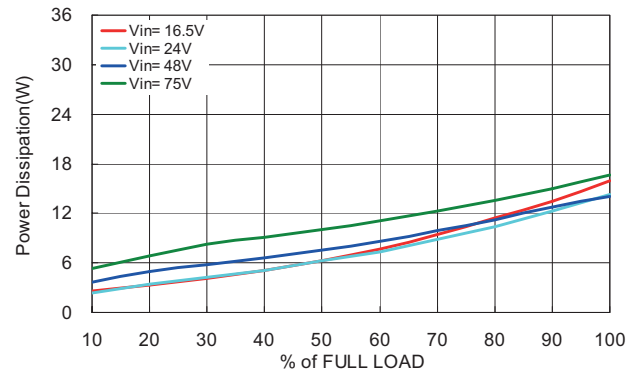
Conduction Emission of EN55022 Class B
Vin(nom); Full Load

POWERBOX Industrial Line
PAE150W Series
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DC/DC Converter
Manual

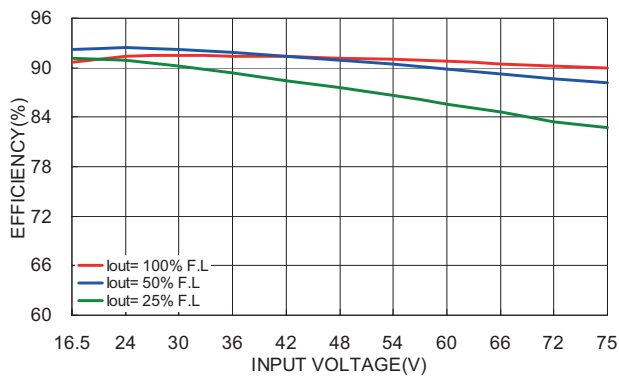
All test conditions are at 25°C. The figures are identical for PAE150-48S15W



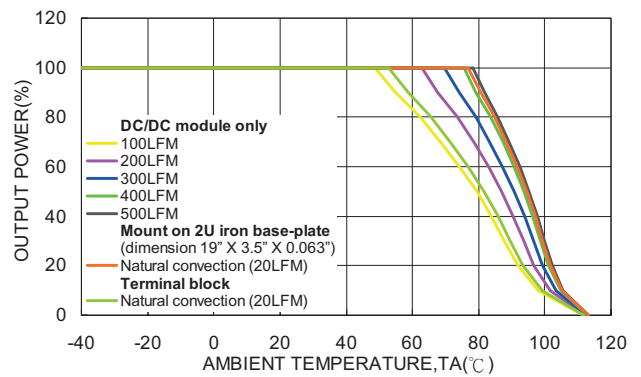
Efficiency versus Output Current



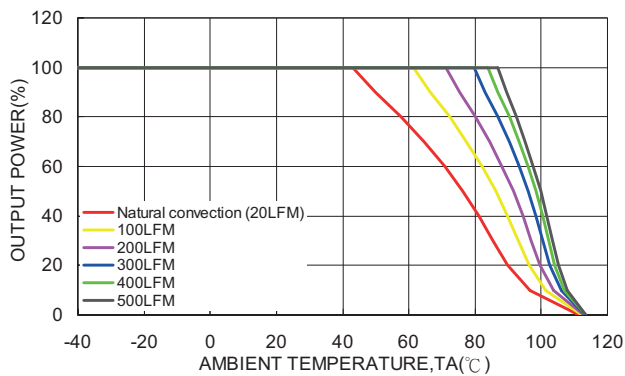
Power dissipation versus Output Current



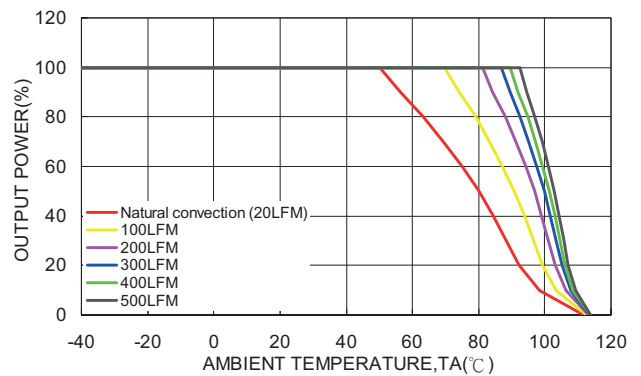
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

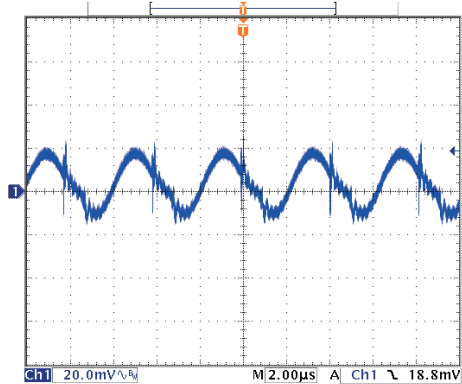


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

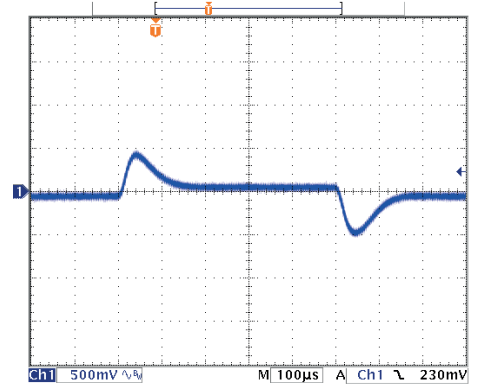


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink , Vin(nom)

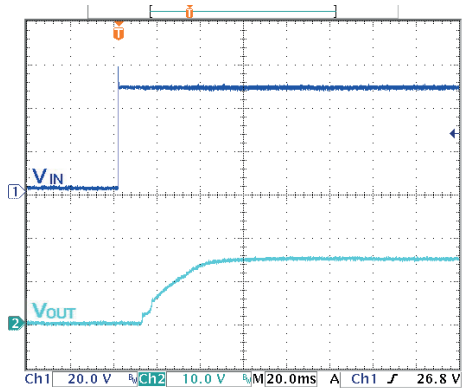
All test conditions are at 25°C. The figures are identical for PAE150-48S15W



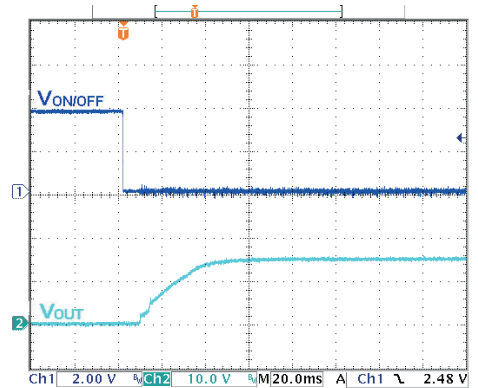
Typical Output Ripple and Noise.
 $V_{in}(nom)$; Full Load



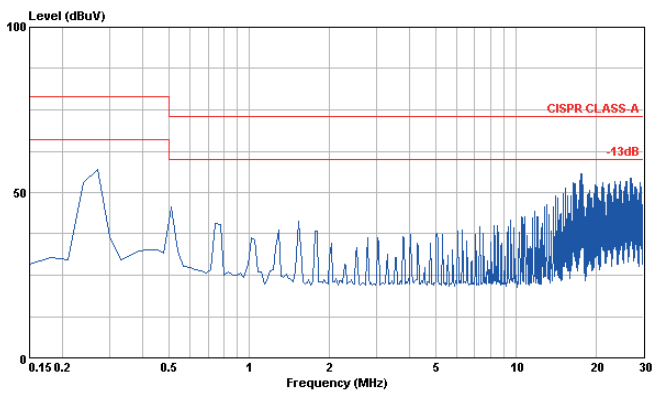
Transient Response to Dynamic Load Change from
 100% to 75% to 100% of Full Load; $V_{in}(nom)$



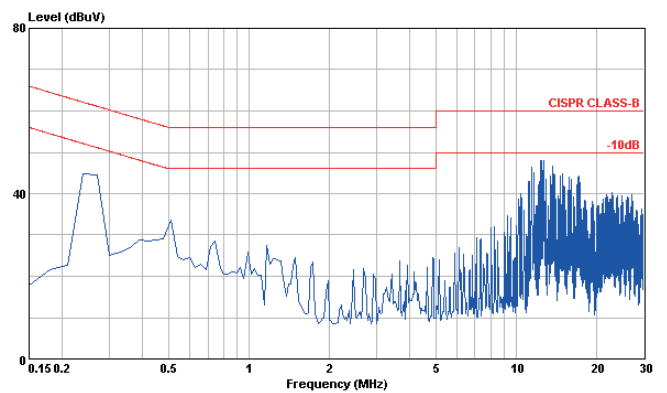
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load

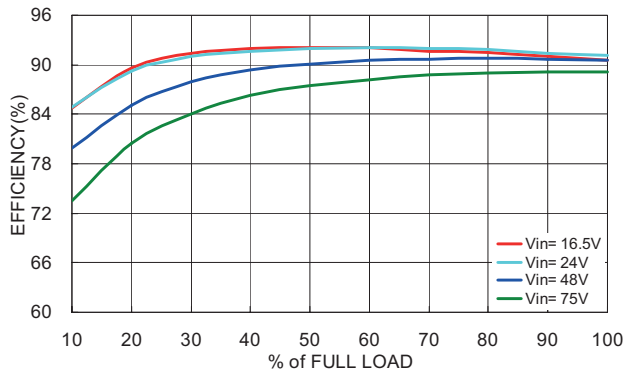


Conduction Emission of EN55022 Class A
 $V_{in}(nom)$; Full Load

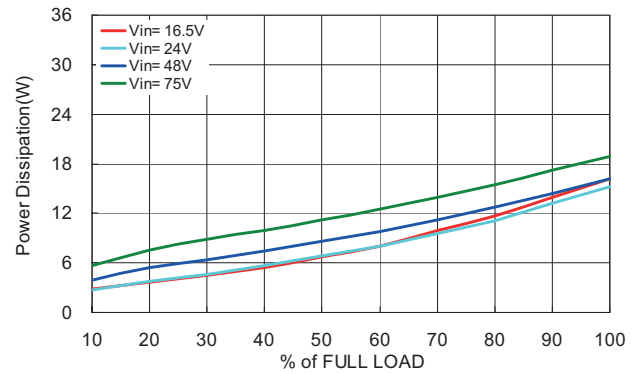


Conduction Emission of EN55022 Class B
 $V_{in}(nom)$; Full Load

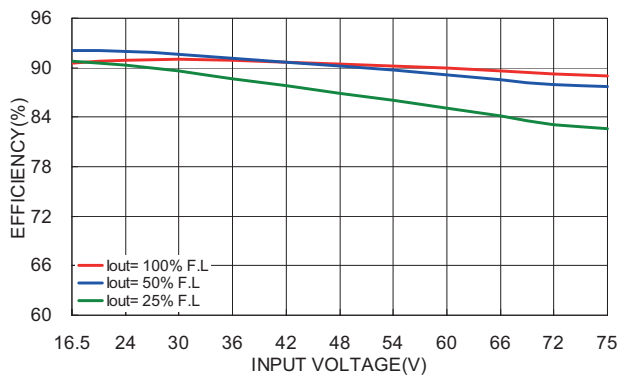
All test conditions are at 25°C. The figures are identical for PAE150-48S24W



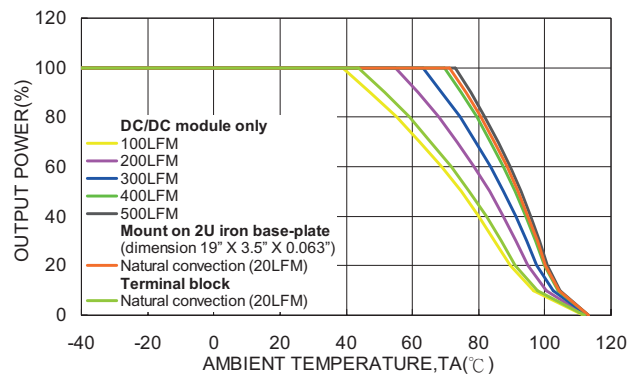
Efficiency versus Output Current



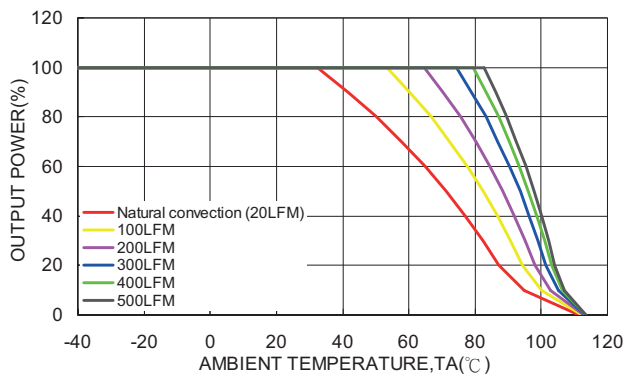
Power dissipation versus Output Current



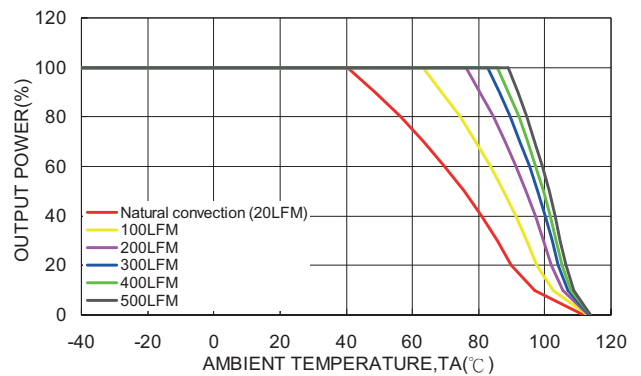
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

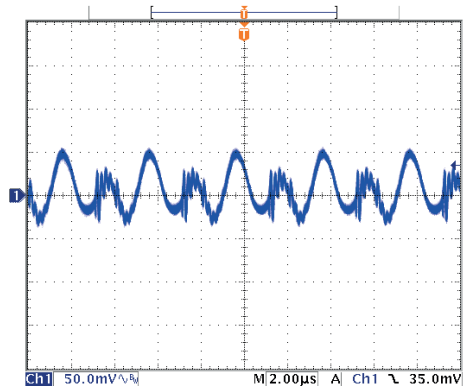


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink, Vin(nom)

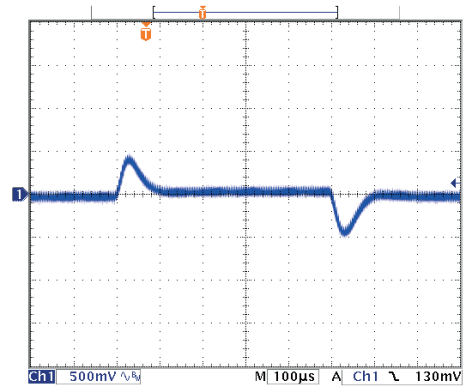


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink, Vin(nom)

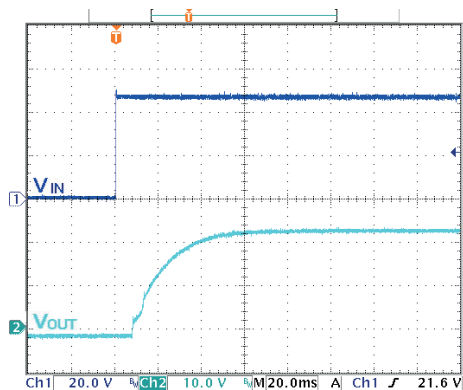
All test conditions are at 25°C. The figures are identical for PAE150-48S24W



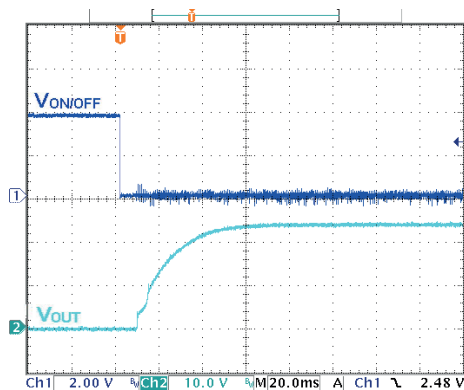
Typical Output Ripple and Noise.
Vin(nom); Full Load



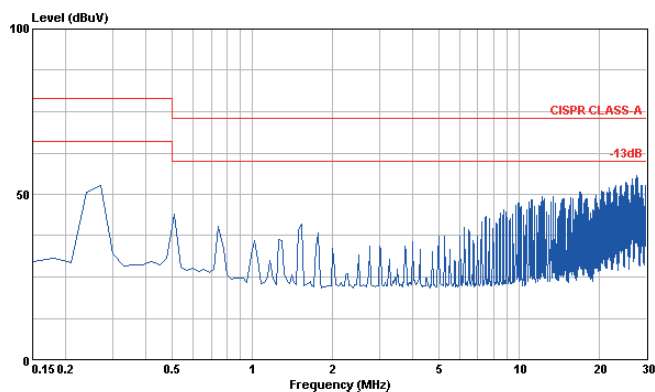
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



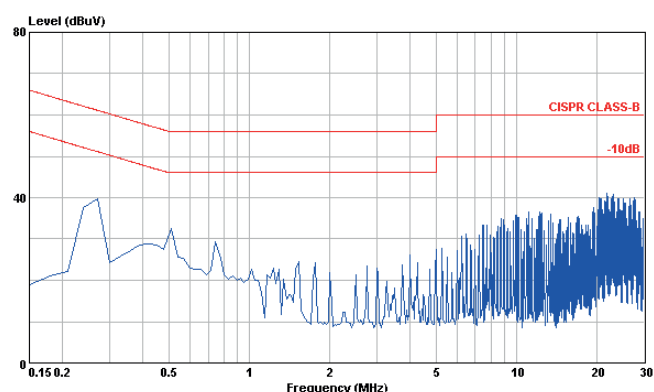
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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



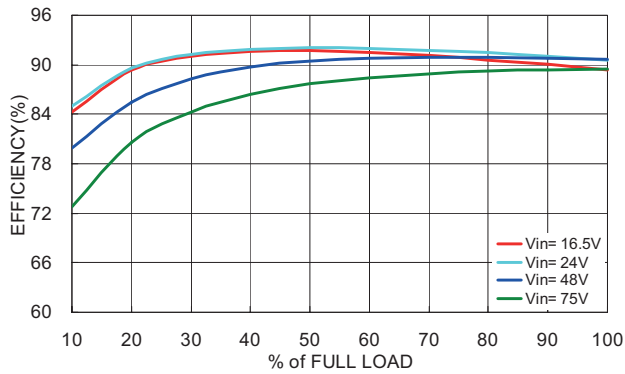
Conduction Emission of EN55022 Class A
Vin(nom); Full Load



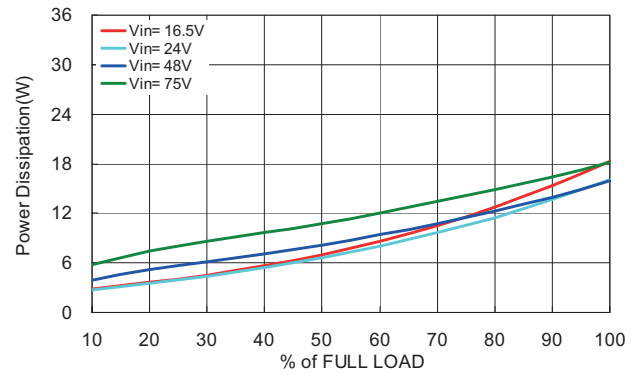
Conduction Emission of EN55022 Class B
Vin(nom); Full Load

POWERBOX Industrial Line
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DC/DC Converter
Manual

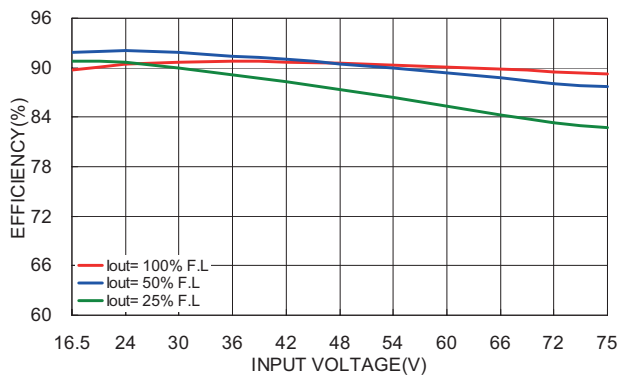
All test conditions are at 25°C. The figures are identical for PAE150-48S28W



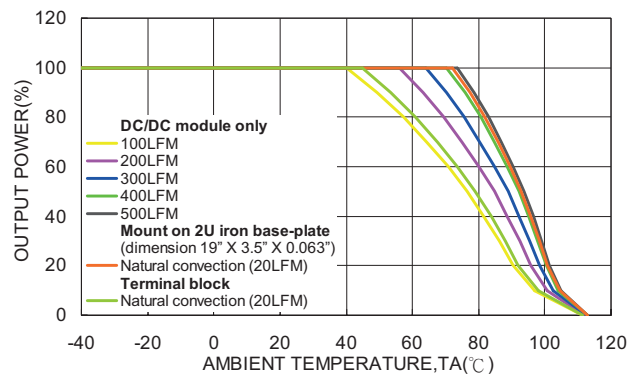
Efficiency versus Output Current



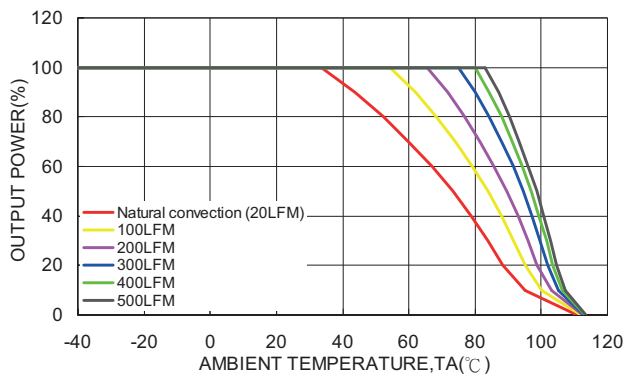
Power dissipation versus Output Current



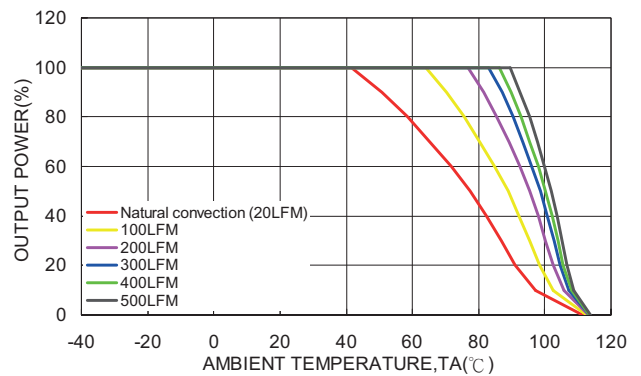
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

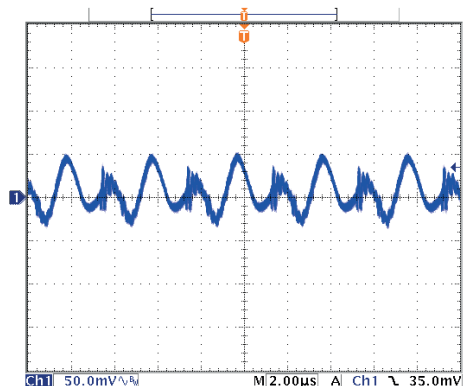


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

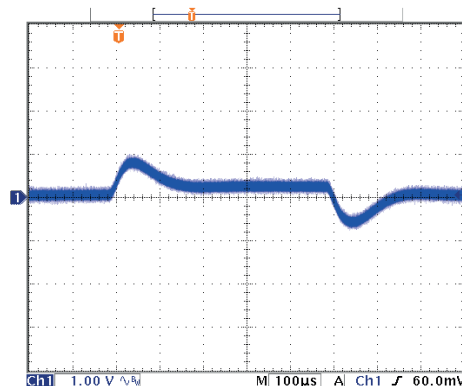


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink , Vin(nom)

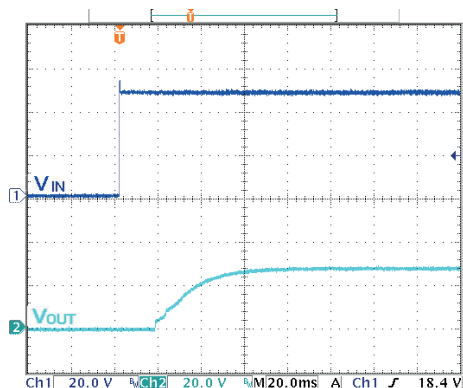
All test conditions are at 25°C. The figures are identical for PAE150-48S28W



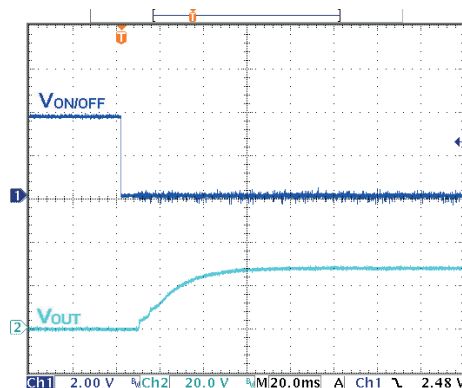
Typical Output Ripple and Noise.
 $V_{in}(\text{nom})$; Full Load



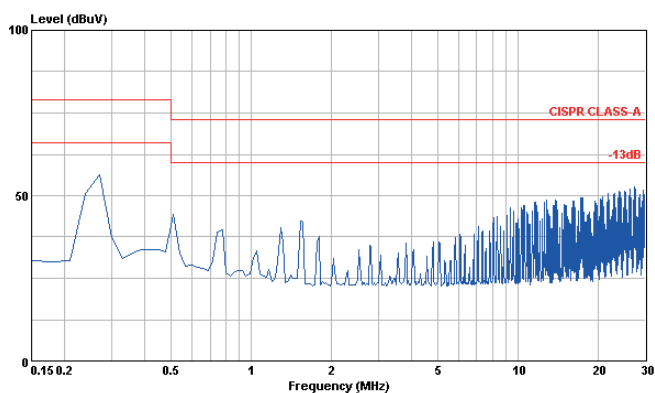
Transient Response to Dynamic Load Change from
 100% to 75% to 100% of Full Load; $V_{in}(\text{nom})$



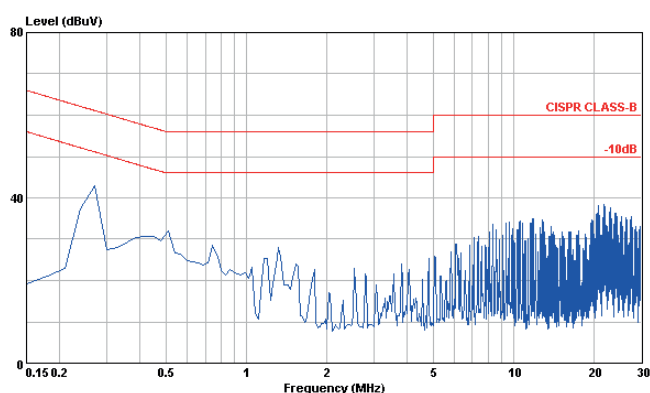
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}(\text{nom})$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in}(\text{nom})$; Full Load



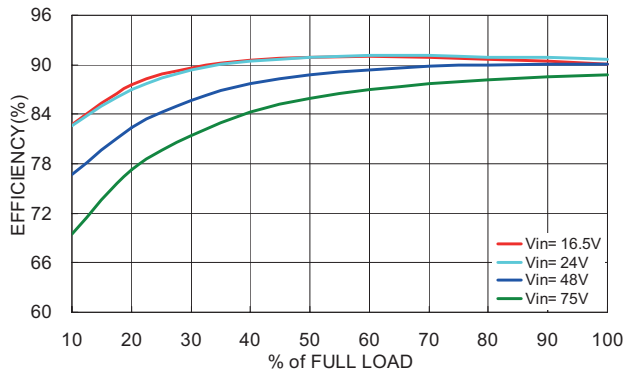
Conduction Emission of EN55022 Class A
 $V_{in}(\text{nom})$; Full Load



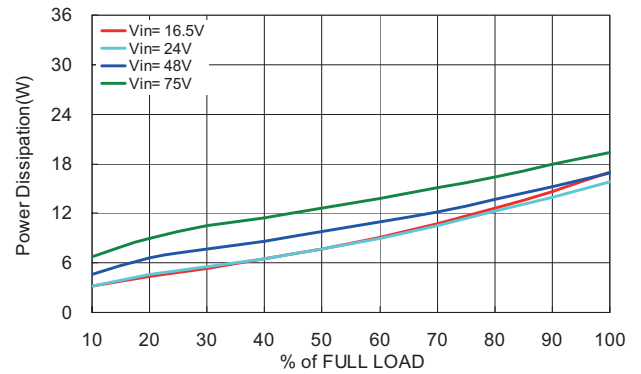
Conduction Emission of EN55022 Class B
 $V_{in}(\text{nom})$; Full Load

POWERBOX Industrial Line
PAE150W Series
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DC/DC Converter
Manual

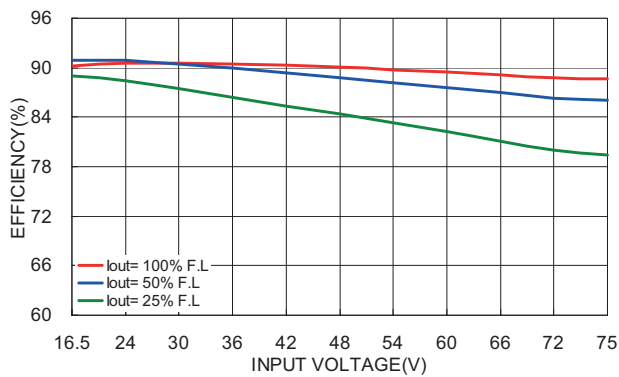
All test conditions are at 25°C. The figures are identical for PAE150-48S48W



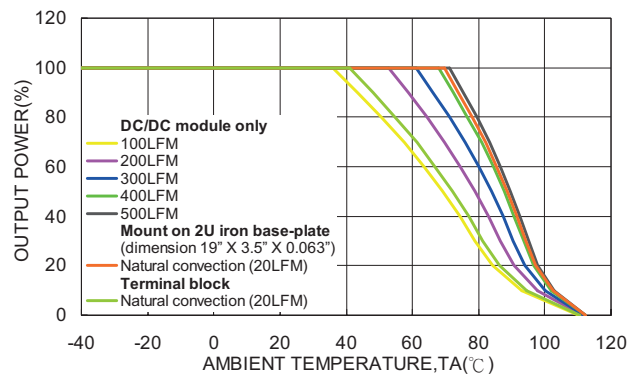
Efficiency versus Output Current



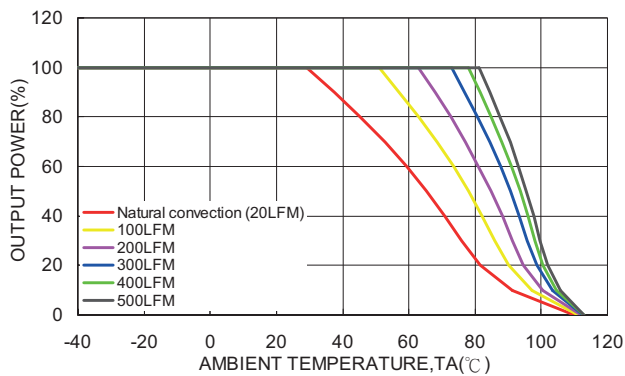
Power dissipation versus Output Current



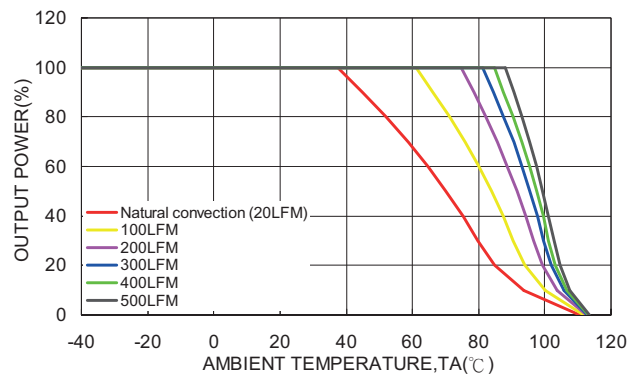
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

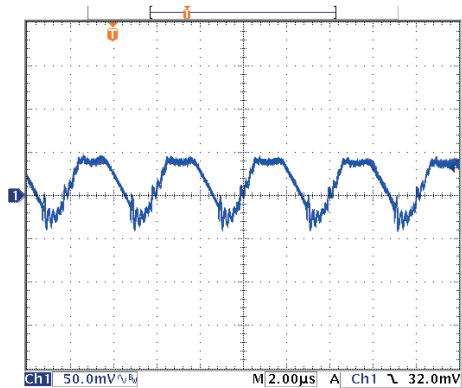


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

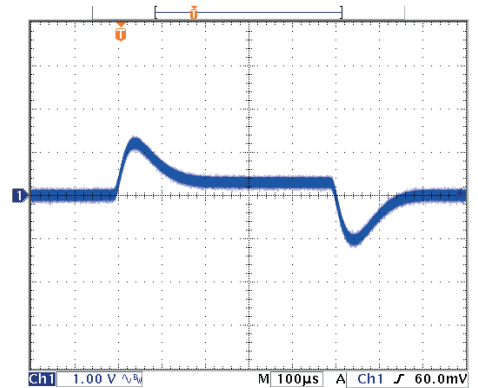


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink , Vin(nom)

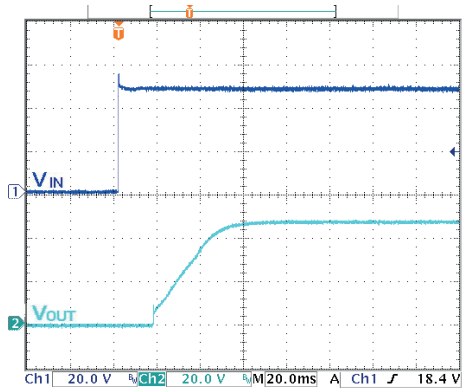
All test conditions are at 25°C. The figures are identical for PAE150-48S48W



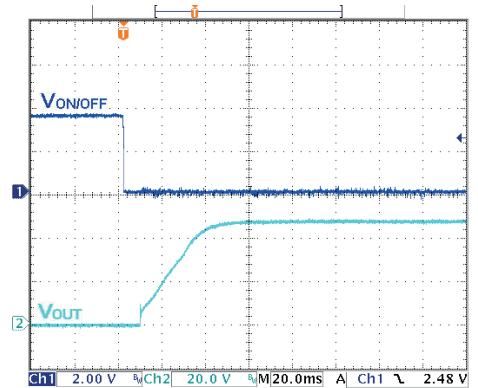
Typical Output Ripple and Noise.
Vin(nom); Full Load



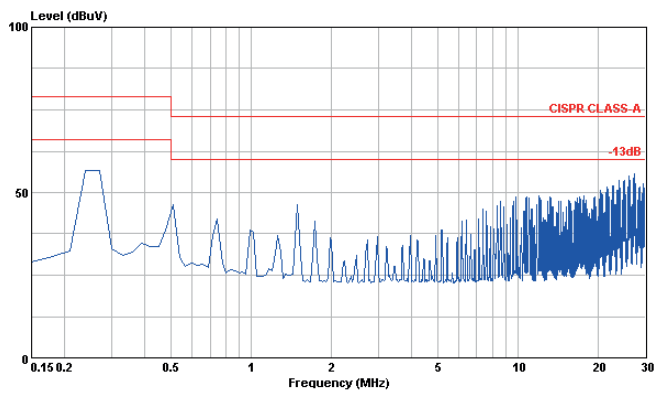
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



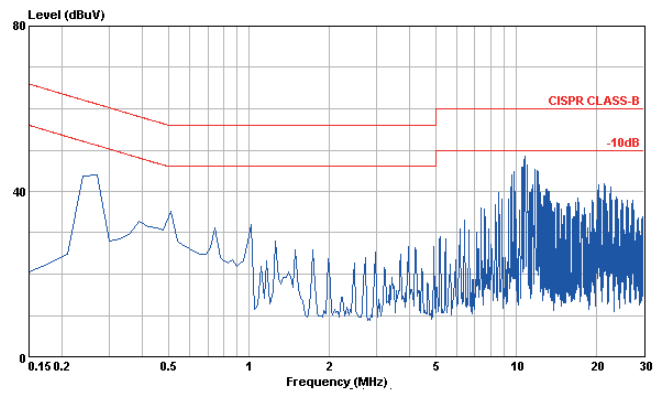
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

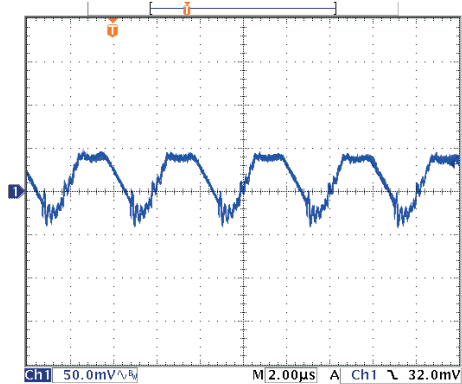


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

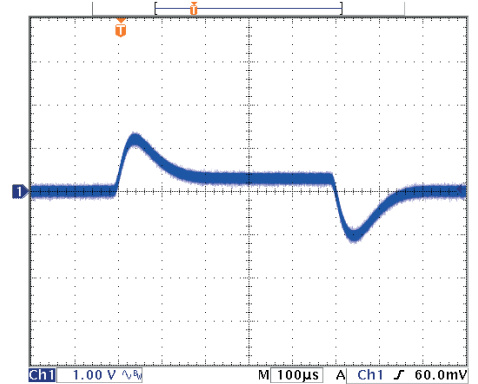


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

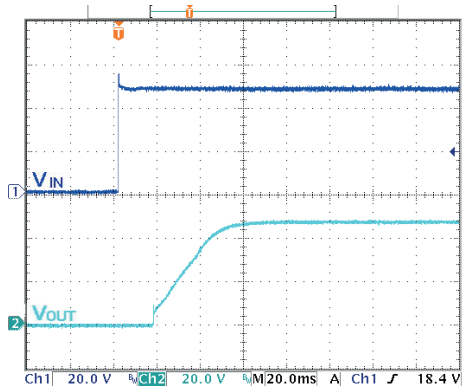
All test conditions are at 25°C. The figures are identical for PAE150-48S48W



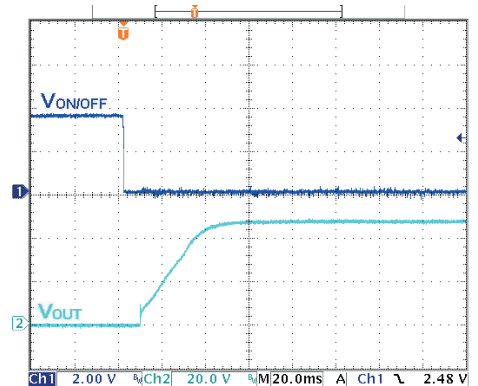
Typical Output Ripple and Noise.
 $V_{in}(nom)$; Full Load



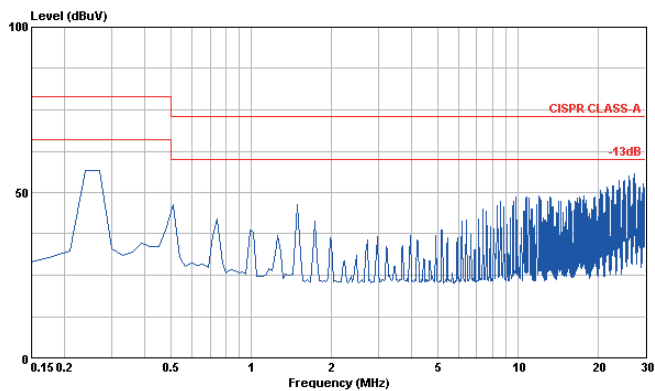
Transient Response to Dynamic Load Change from
 100% to 75% to 100% of Full Load; $V_{in}(nom)$



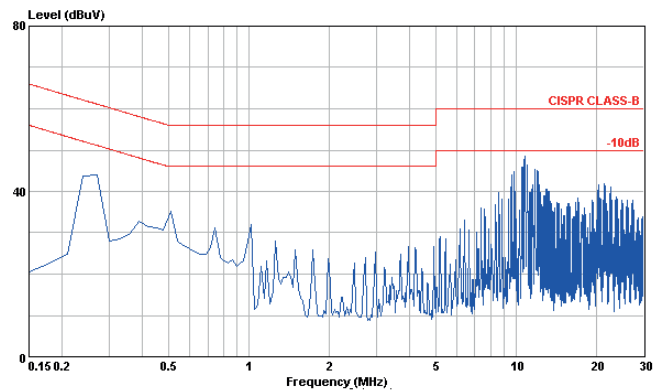
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load

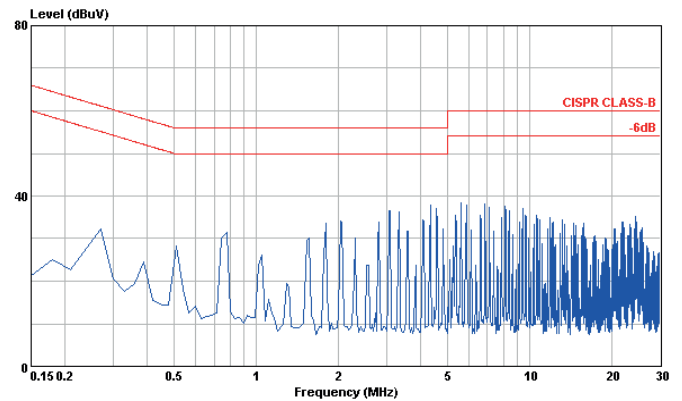
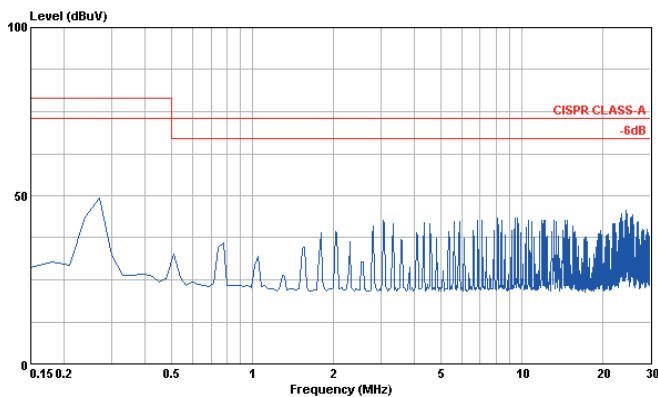
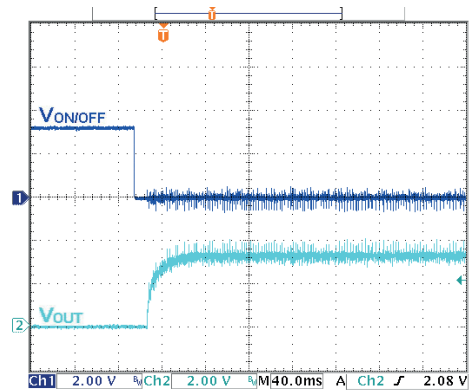
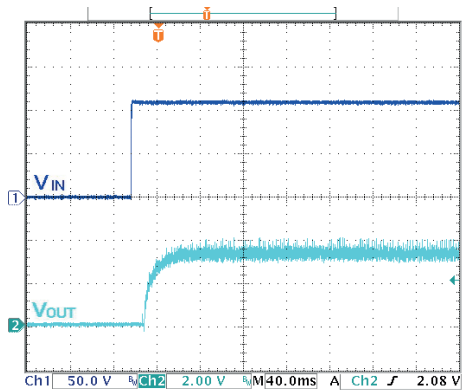
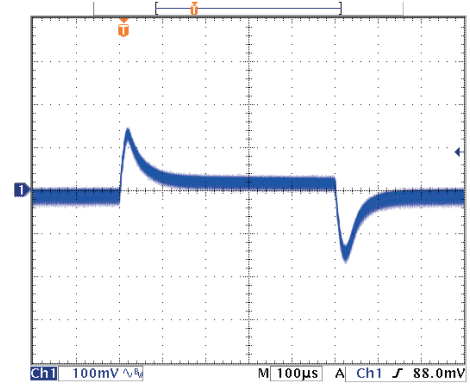
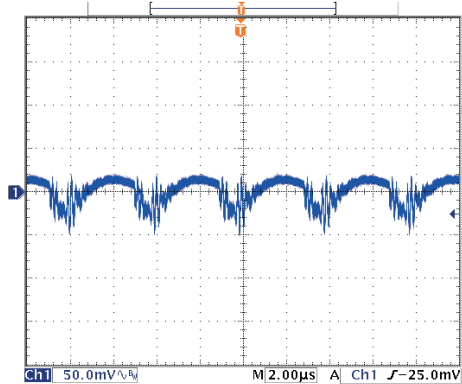


Conduction Emission of EN55022 Class A
 $V_{in}(nom)$; Full Load

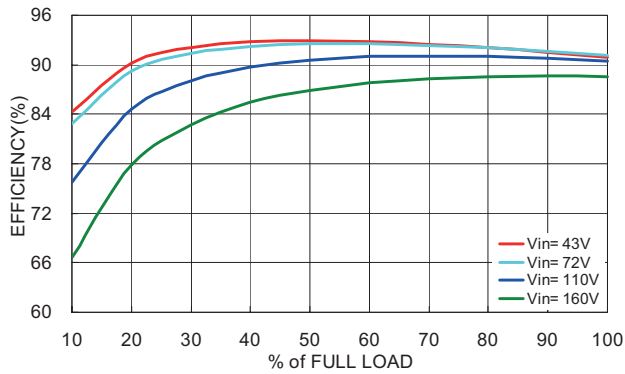


Conduction Emission of EN55022 Class B
 $V_{in}(nom)$; Full Load

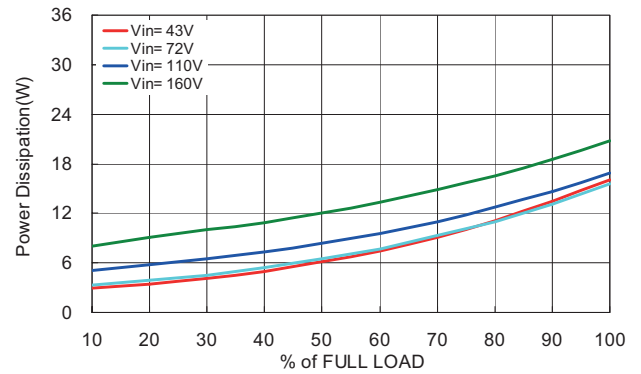
All test conditions are at 25°C. The figures are identical for PAE150-110S3P3W



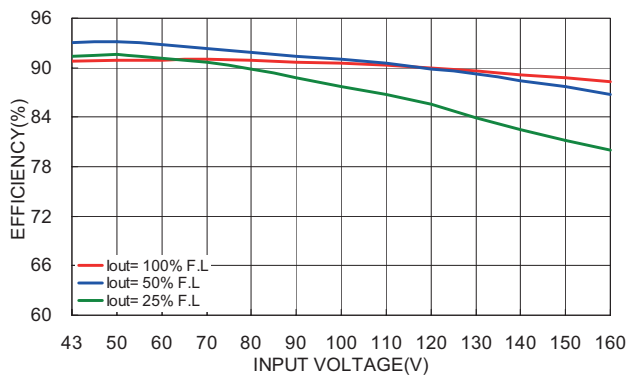
All test conditions are at 25°C. The figures are identical for PAE150-110S05W



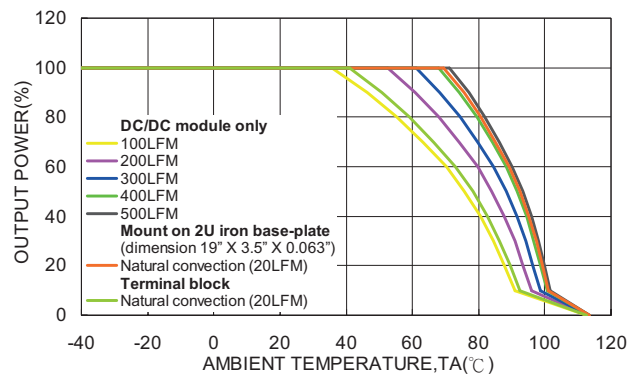
Efficiency versus Output Current



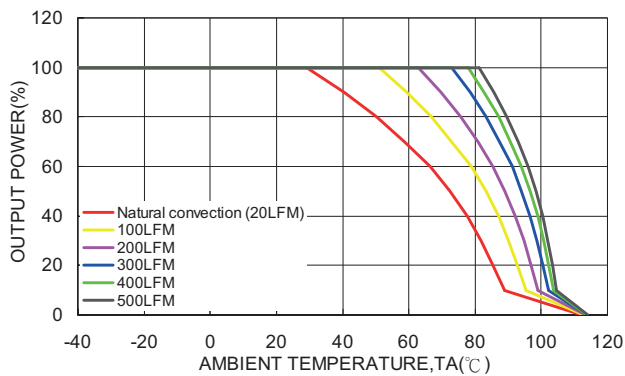
Power dissipation versus Output Current



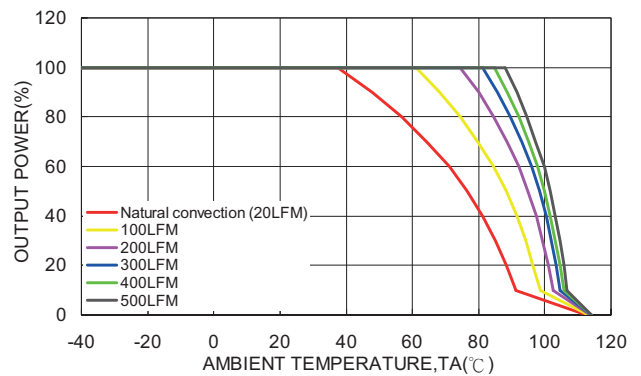
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

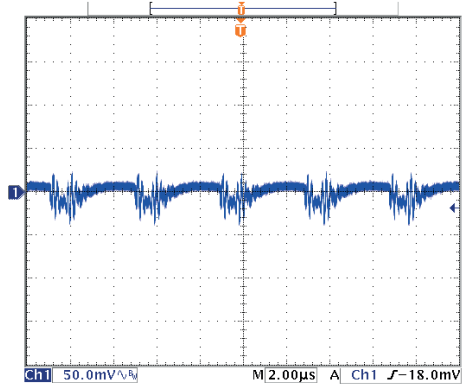


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

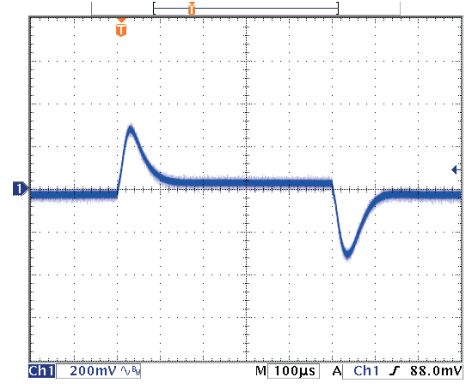


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink , Vin(nom)

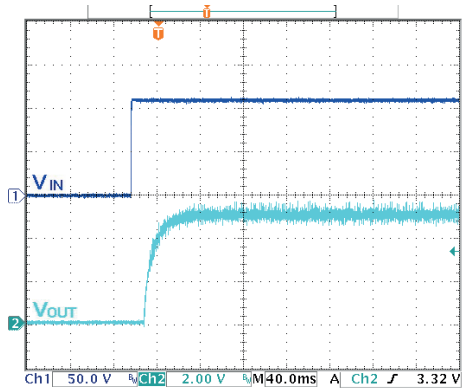
All test conditions are at 25°C. The figures are identical for PAE150-110S05W



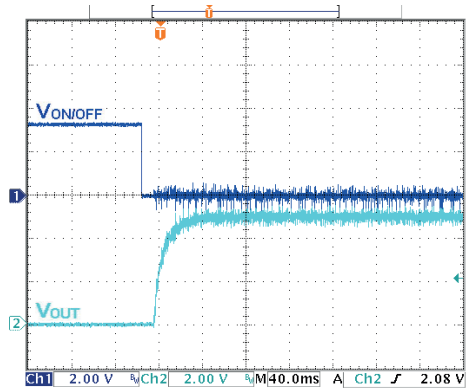
Typical Output Ripple and Noise.
Vin(nom); Full Load



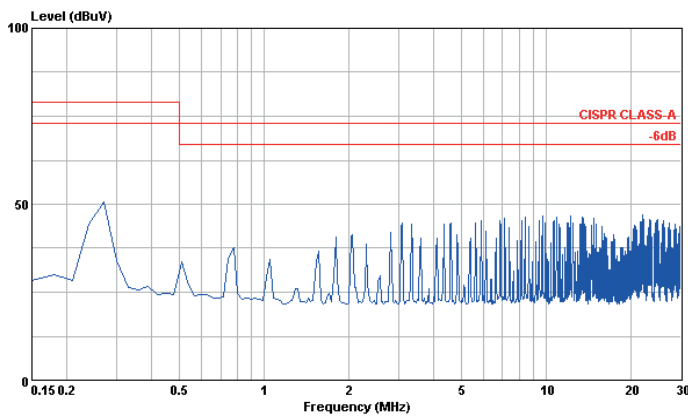
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



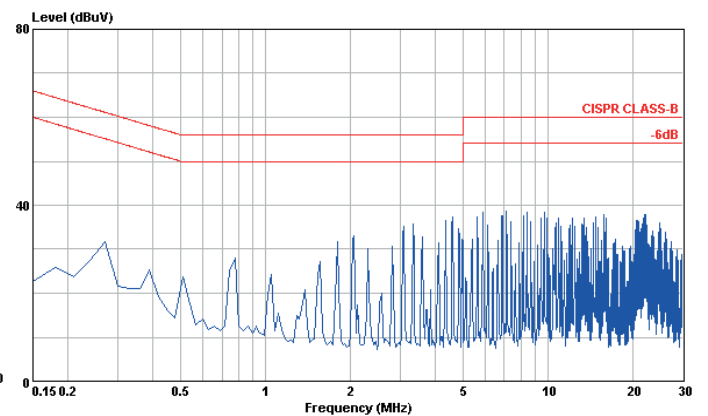
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

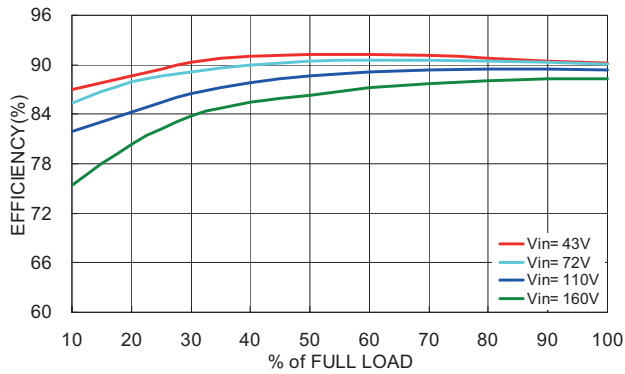


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

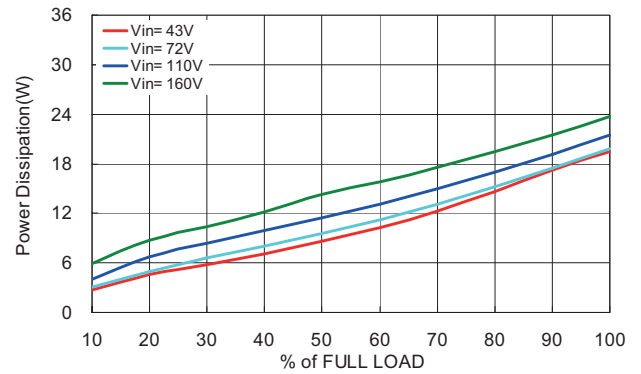


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

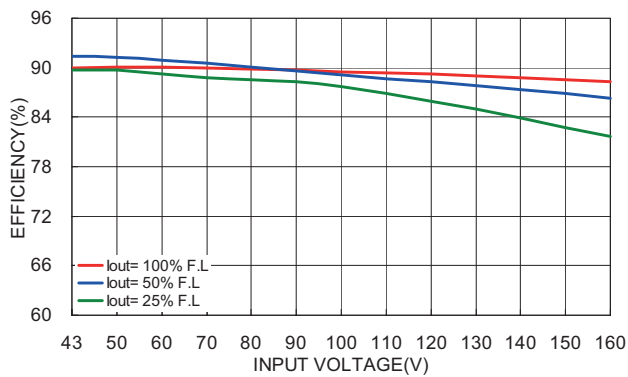
All test conditions are at 25°C. The figures are identical for PAE150-110S12W



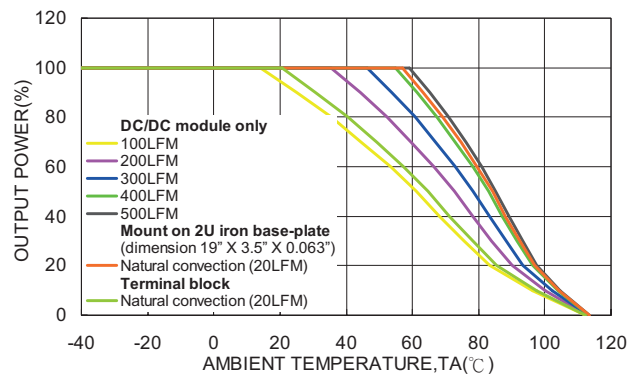
Efficiency versus Output Current



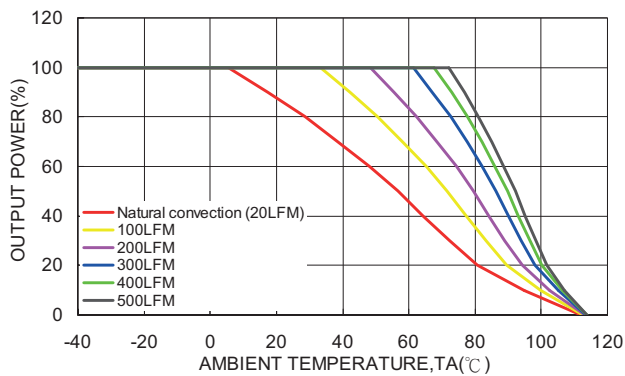
Power dissipation versus Output Current



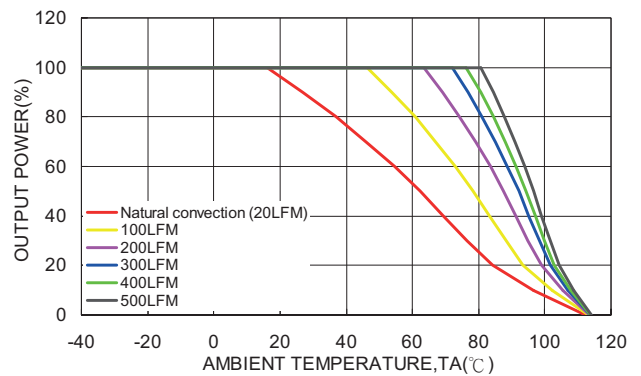
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

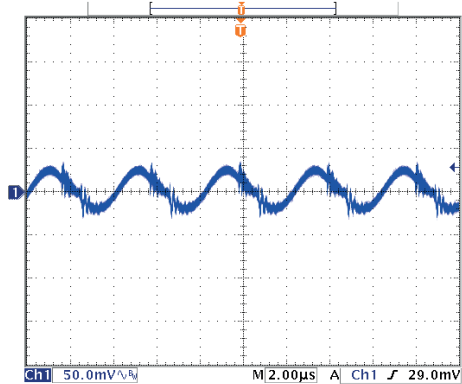


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink, Vin(nom)

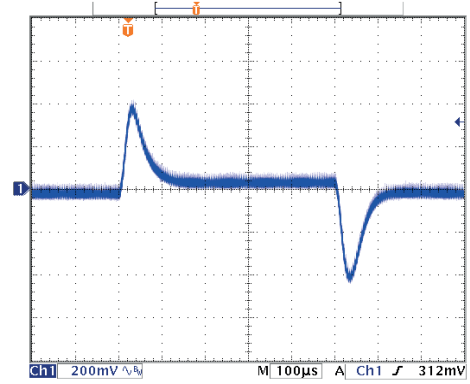


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink, Vin(nom)

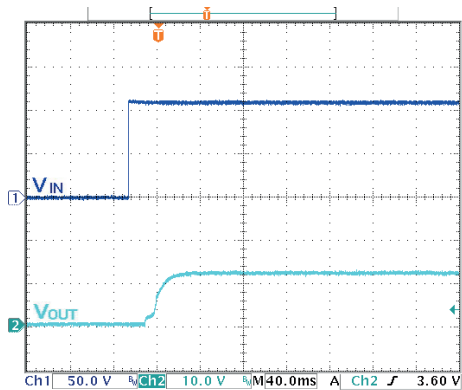
All test conditions are at 25°C. The figures are identical for PAE150-110S12W



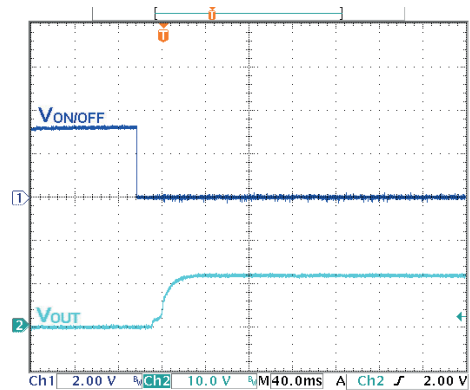
Typical Output Ripple and Noise.
 $V_{in}(nom)$; Full Load



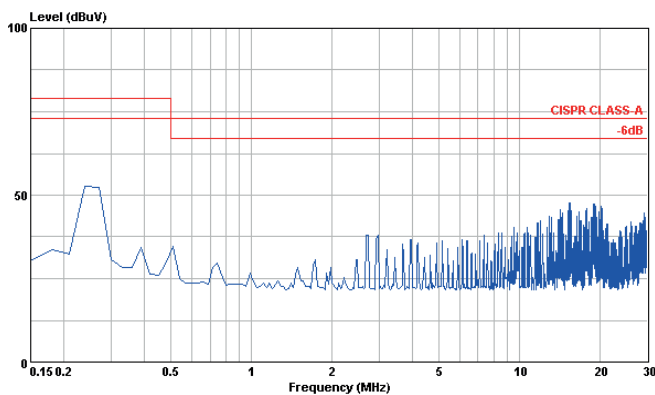
Transient Response to Dynamic Load Change from
 100% to 75% to 100% of Full Load; $V_{in}(nom)$



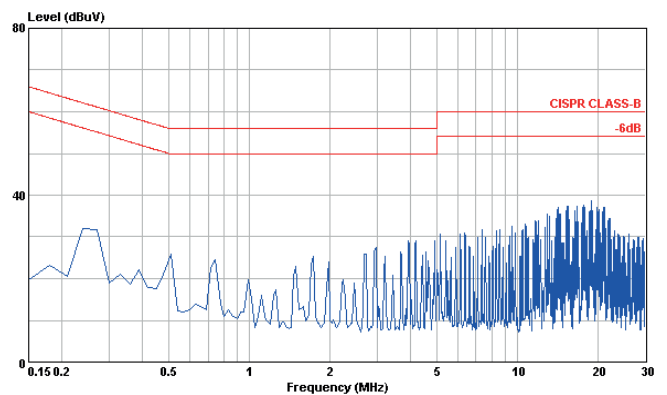
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load

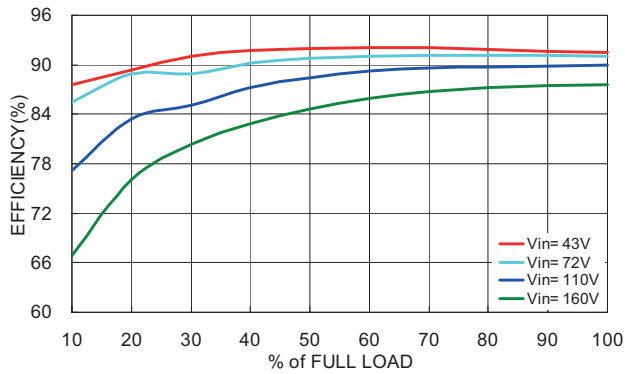


Conduction Emission of EN55022 Class A
 $V_{in}(nom)$; Full Load

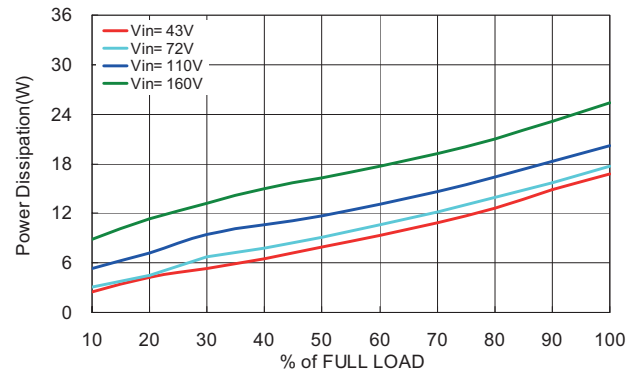


Conduction Emission of EN55022 Class B
 $V_{in}(nom)$; Full Load

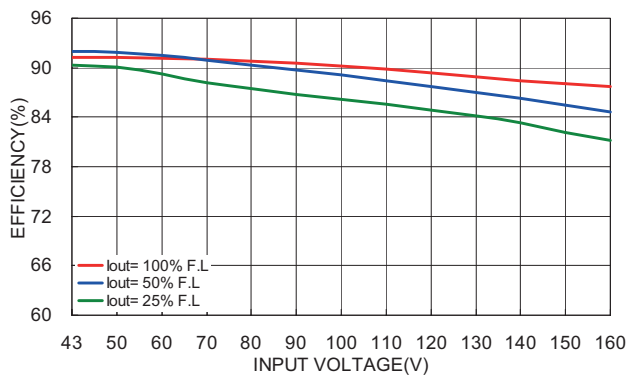
All test conditions are at 25°C. The figures are identical for PAE150-110S15W



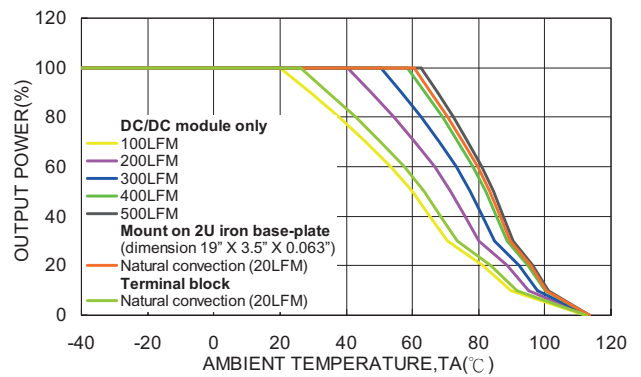
Efficiency versus Output Current



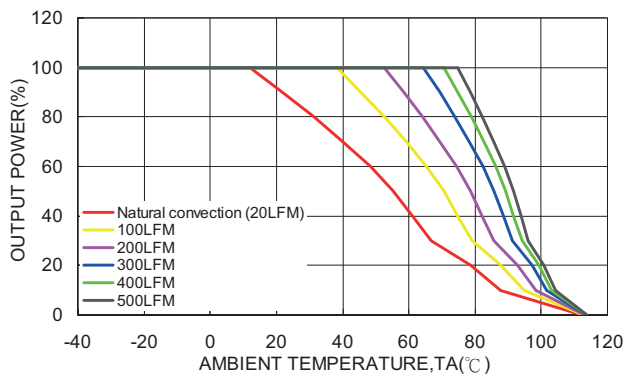
Power dissipation versus Output Current



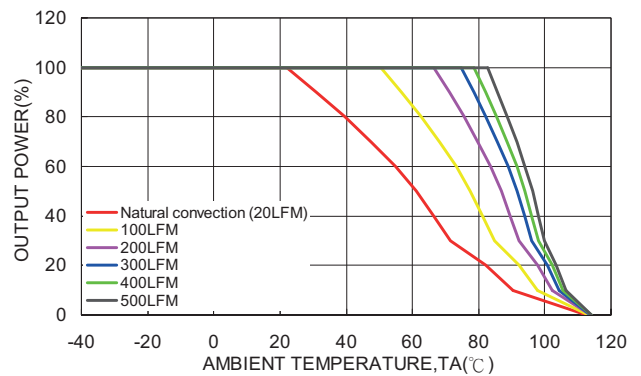
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

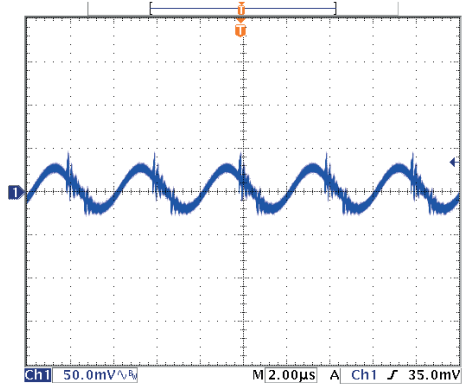


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink, Vin(nom)

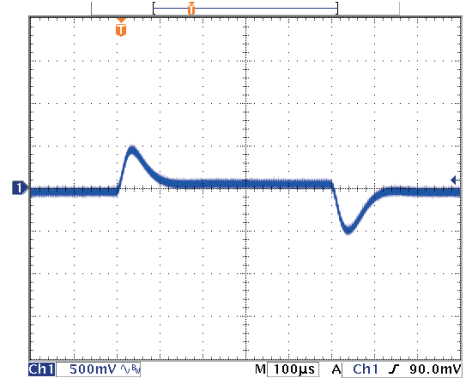


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink, Vin(nom)

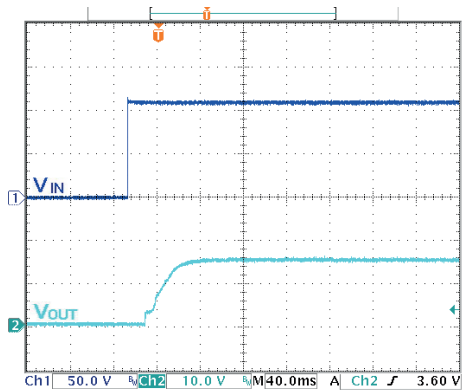
All test conditions are at 25°C. The figures are identical for PAE150-110S15W



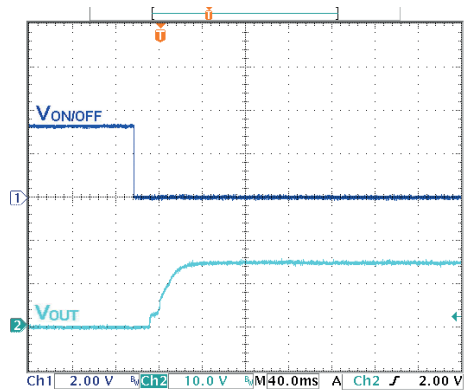
Typical Output Ripple and Noise.
 $V_{in(nom)}$; Full Load



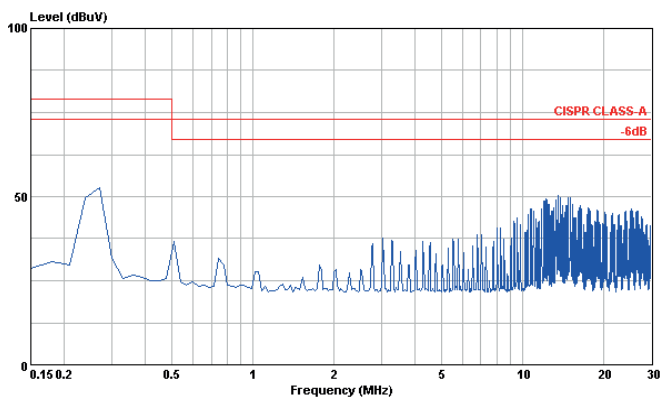
Transient Response to Dynamic Load Change from
 100% to 75% to 100% of Full Load; $V_{in(nom)}$



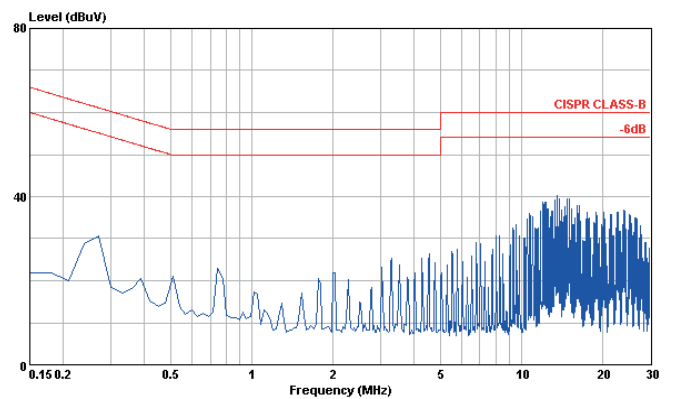
Typical Input Start-Up and Output Rise Characteristic
 $V_{in(nom)}$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in(nom)}$; Full Load

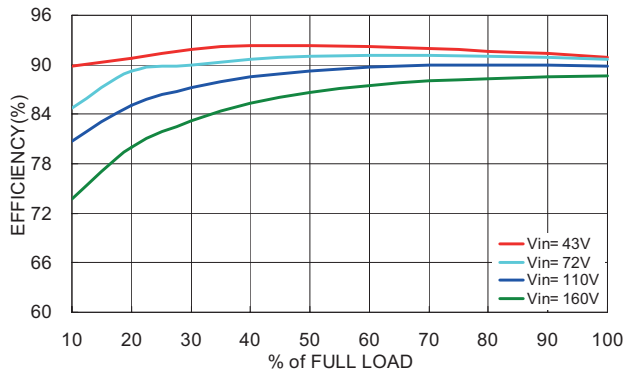


Conduction Emission of EN55022 Class A
 $V_{in(nom)}$; Full Load

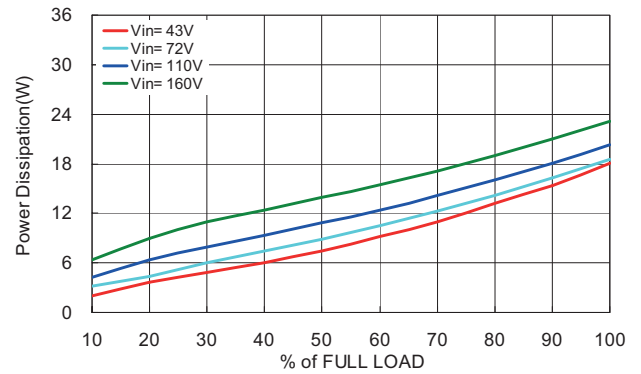


Conduction Emission of EN55022 Class B
 $V_{in(nom)}$; Full Load

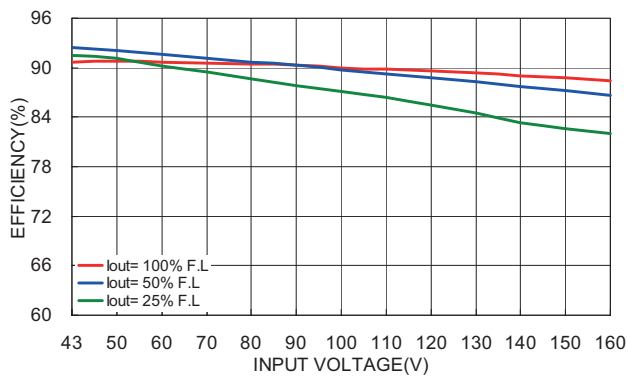
All test conditions are at 25°C. The figures are identical for PAE150-110S24W



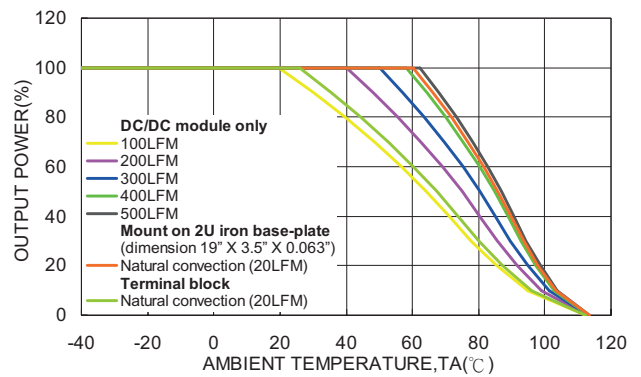
Efficiency versus Output Current



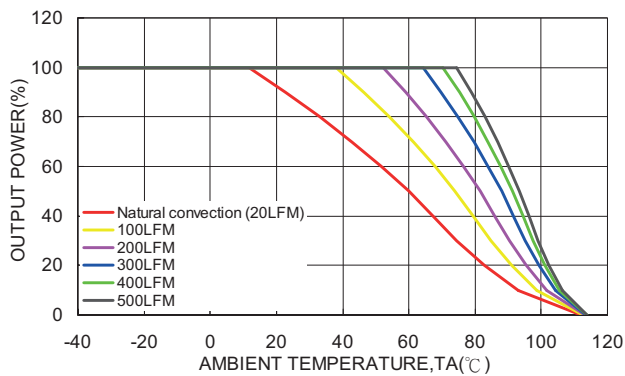
Power dissipation versus Output Current



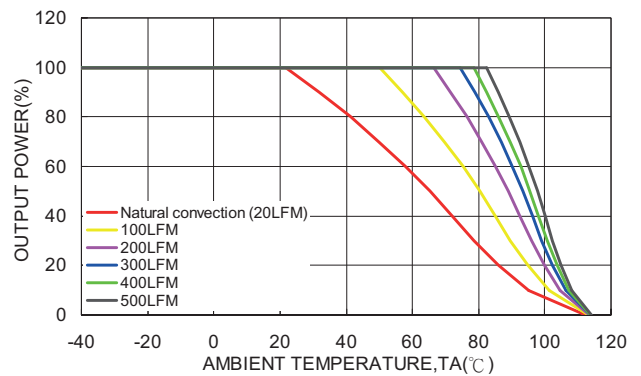
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

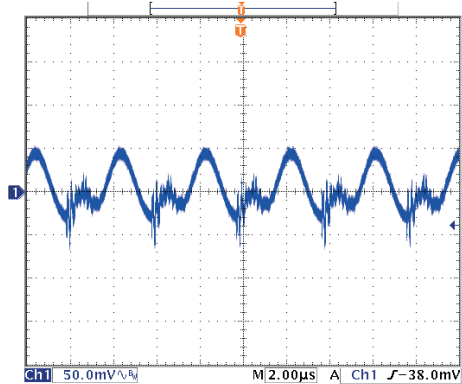


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink, Vin(nom)

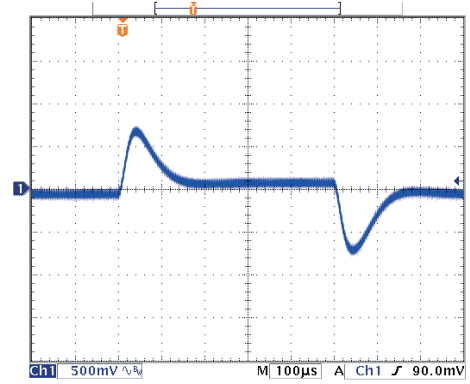


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink, Vin(nom)

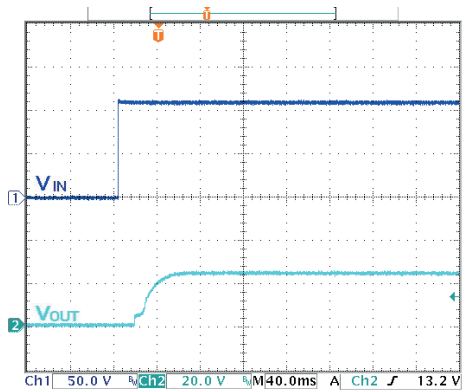
All test conditions are at 25°C. The figures are identical for PAE150-110S24W



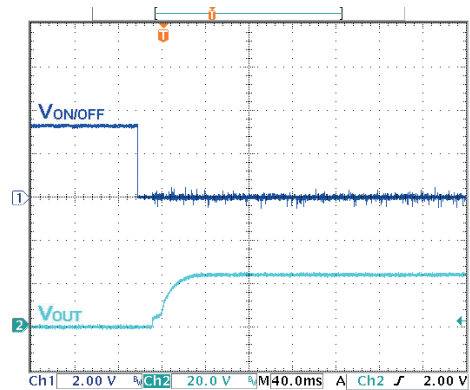
Typical Output Ripple and Noise.
 $V_{in}(\text{nom})$; Full Load



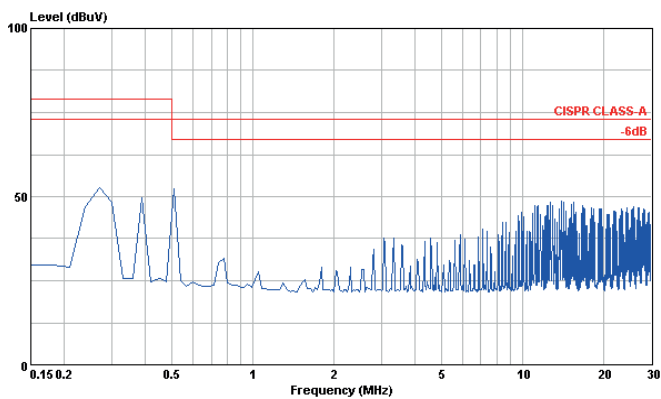
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; $V_{in}(\text{nom})$



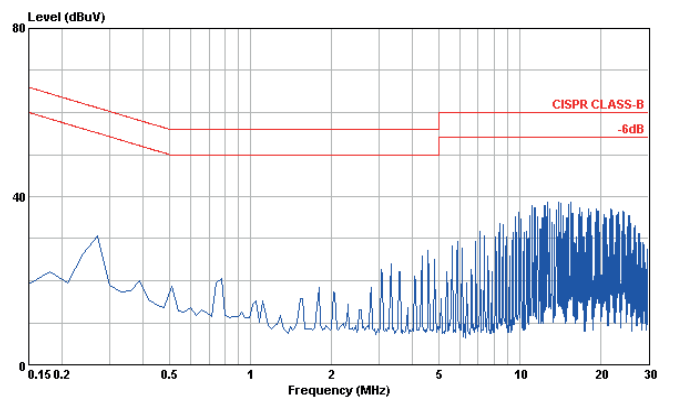
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}(\text{nom})$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in}(\text{nom})$; Full Load



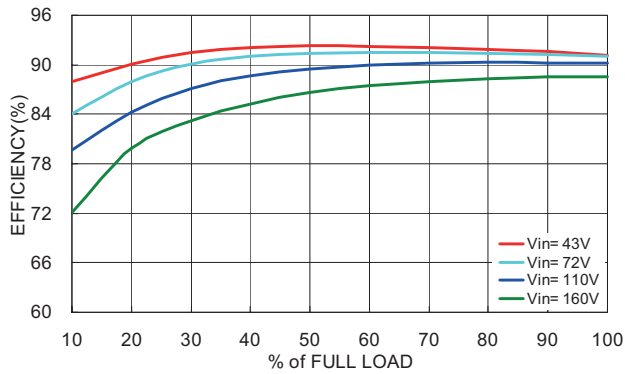
Conduction Emission of EN55022 Class A
 $V_{in}(\text{nom})$; Full Load



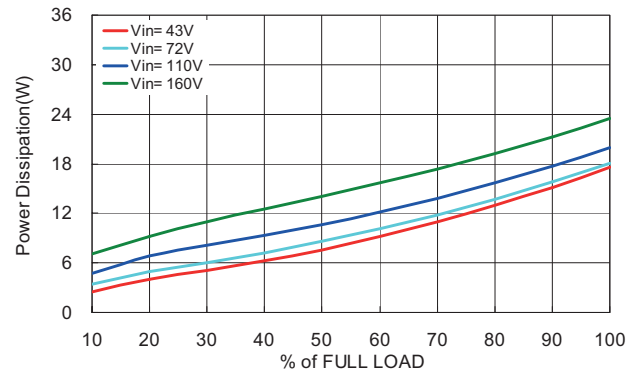
Conduction Emission of EN55022 Class B
 $V_{in}(\text{nom})$; Full Load

POWERBOX Industrial Line
PAE150W Series
Up to 182W 4:1 Wide Input, Single Output
DC/DC Converter
Manual

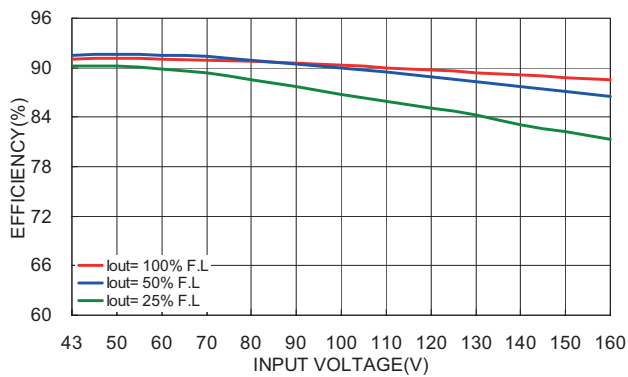
All test conditions are at 25°C. The figures are identical for PAE150-110S28W



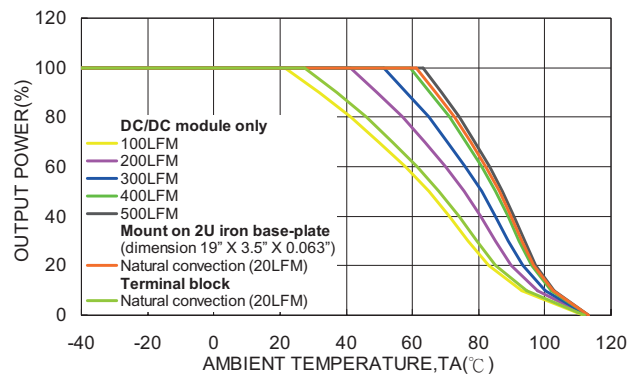
Efficiency versus Output Current



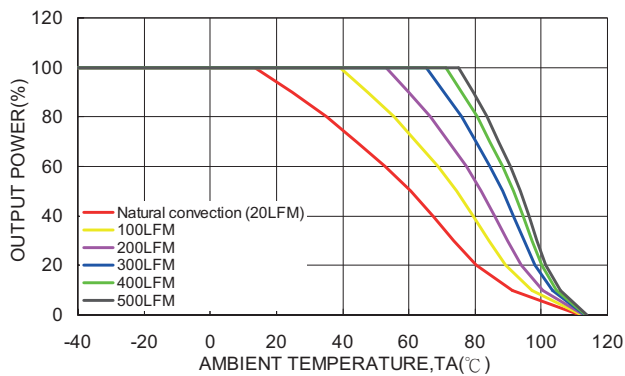
Power dissipation versus Output Current



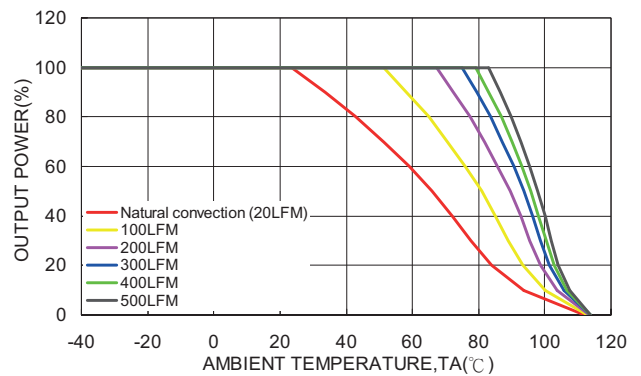
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

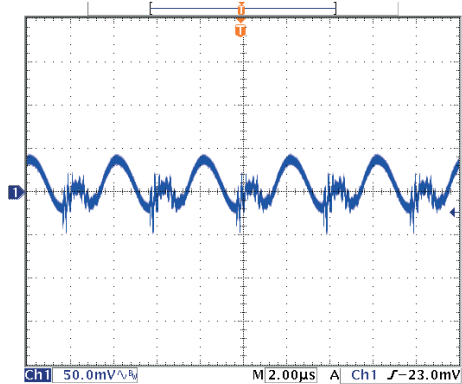


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink, Vin(nom)

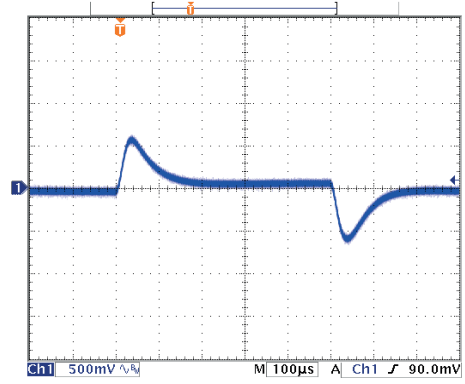


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink, Vin(nom)

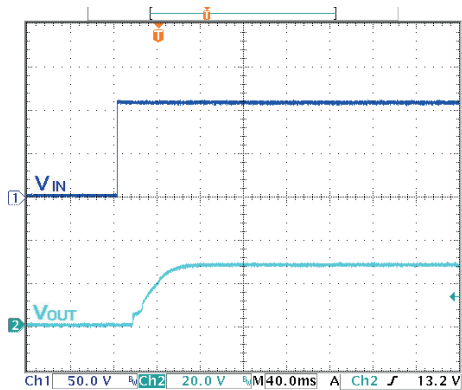
All test conditions are at 25°C. The figures are identical for PAE150-110S28W



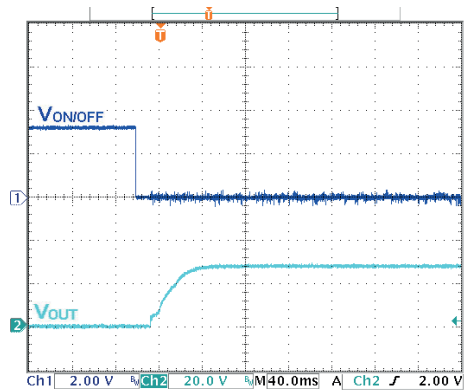
Typical Output Ripple and Noise.
 $V_{in(nom)}$; Full Load



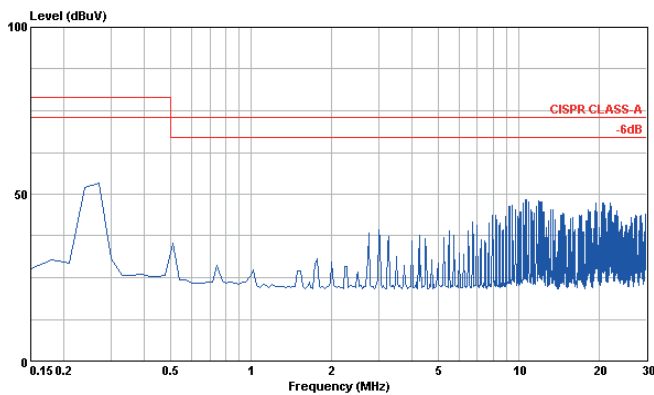
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; $V_{in(nom)}$



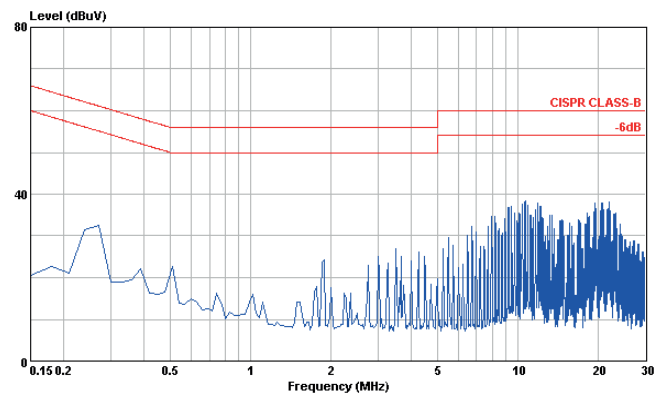
Typical Input Start-Up and Output Rise Characteristic
 $V_{in(nom)}$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in(nom)}$; Full Load



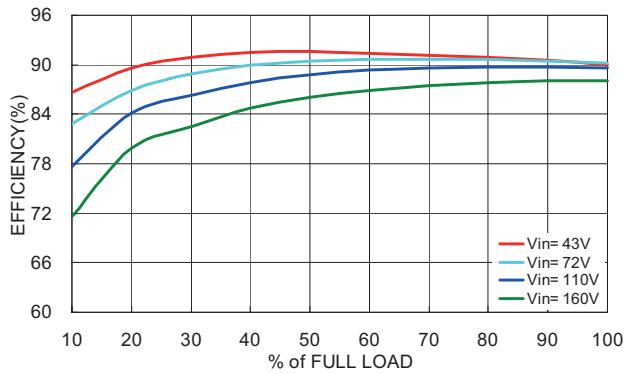
Conduction Emission of EN55022 Class A
 $V_{in(nom)}$; Full Load



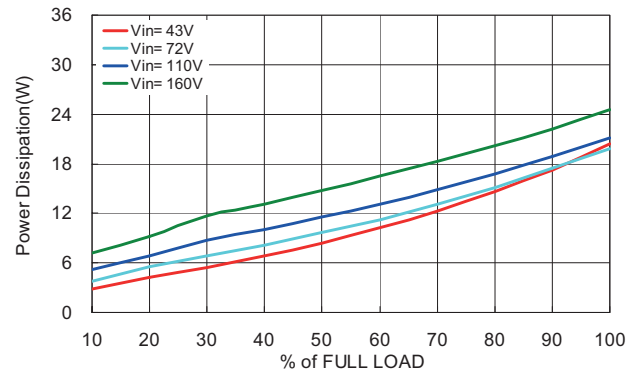
Conduction Emission of EN55022 Class B
 $V_{in(nom)}$; Full Load

POWERBOX Industrial Line
PAE150W Series
Up to 182W 4:1 Wide Input, Single Output
DC/DC Converter
Manual

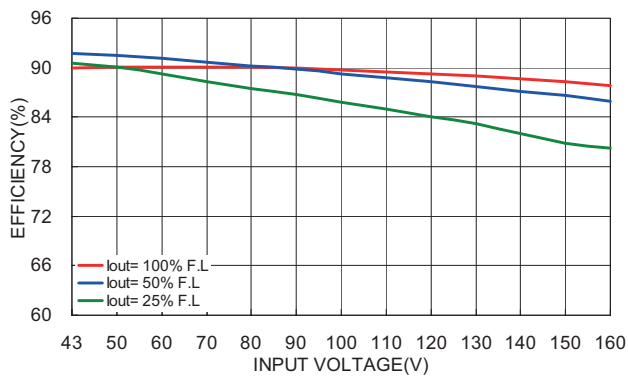
All test conditions are at 25°C. The figures are identical for PAE150-110S48W



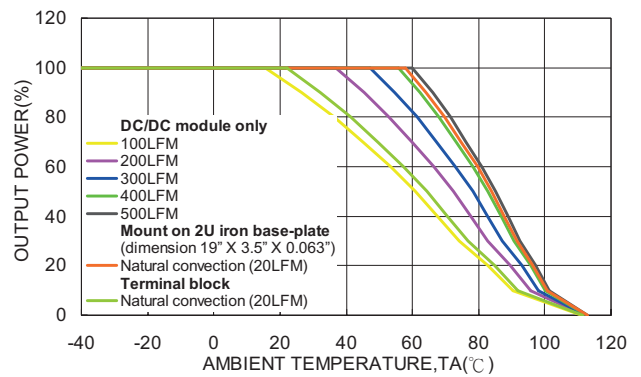
Efficiency versus Output Current



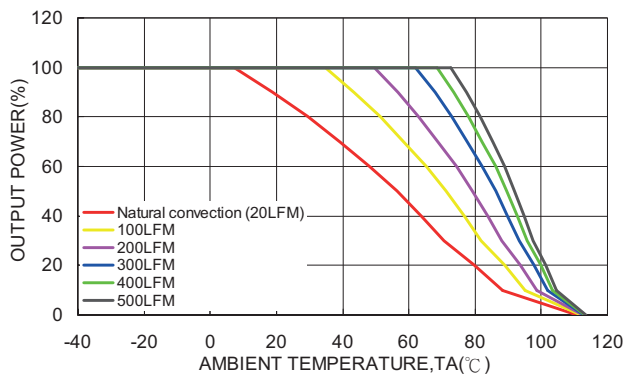
Power dissipation versus Output Current



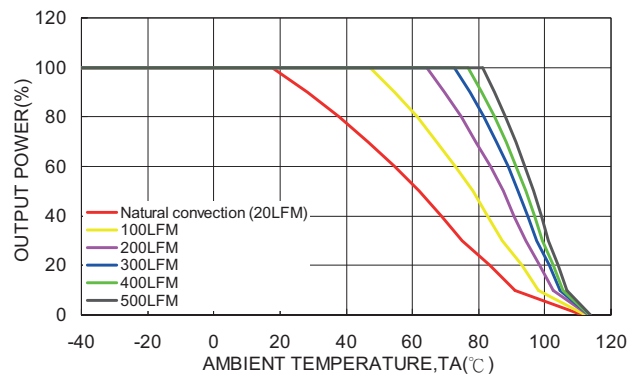
Efficiency versus Input Voltage
Full Load



Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

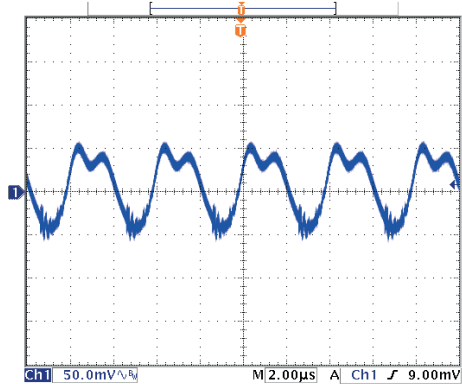


Derating Output Current versus Ambient Temperature and Airflow
With 0.24" Heat-Sink , Vin(nom)

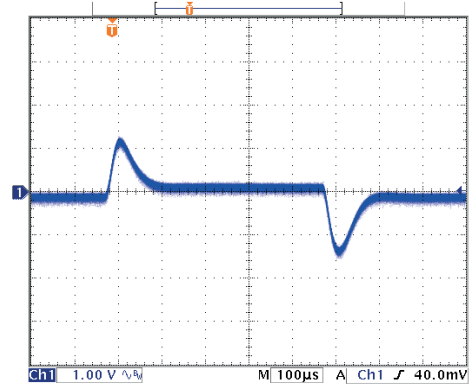


Derating Output Current versus Ambient Temperature and Airflow
With 0.45" Heat-Sink , Vin(nom)

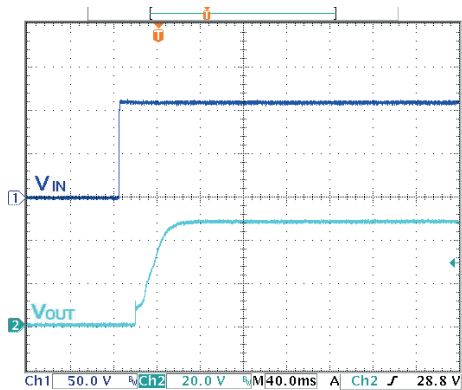
All test conditions are at 25°C. The figures are identical for PAE150-110S48W



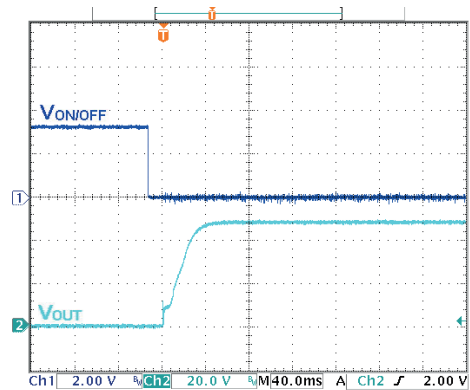
Typical Output Ripple and Noise.
 $V_{in}(nom)$; Full Load



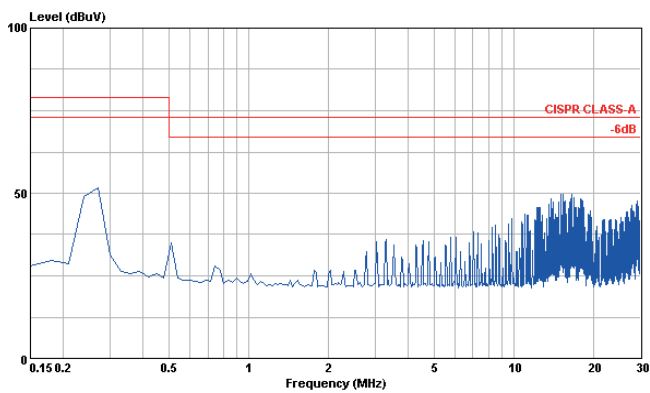
Transient Response to Dynamic Load Change from
 100% to 75% to 100% of Full Load; $V_{in}(nom)$



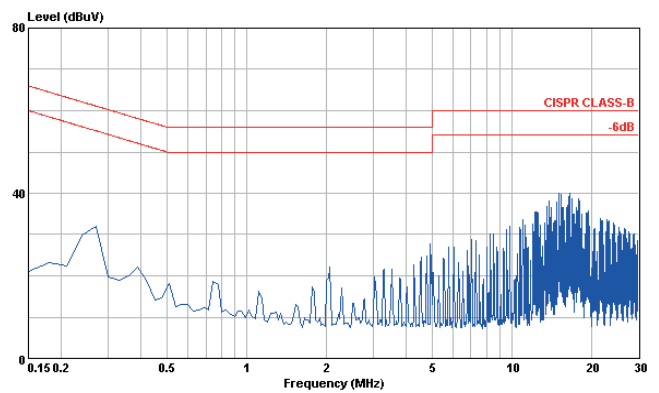
Typical Input Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
 $V_{in}(nom)$; Full Load



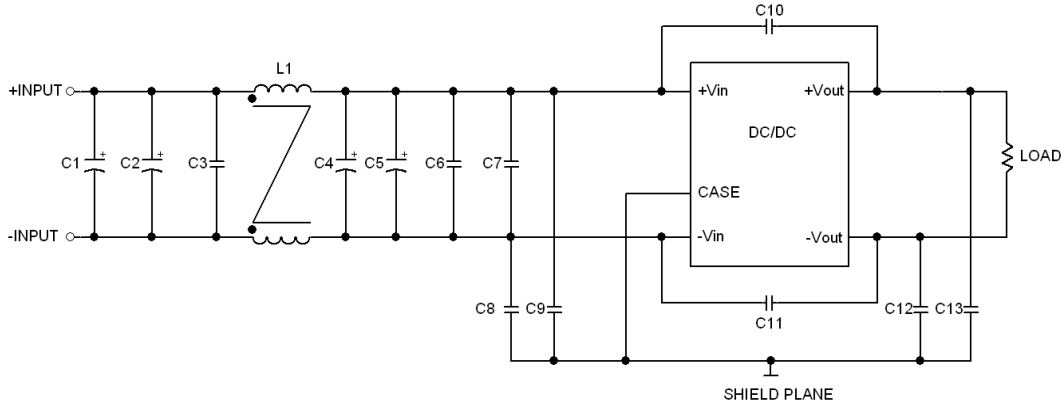
Conduction Emission of EN55022 Class A
 $V_{in}(nom)$; Full Load



Conduction Emission of EN55022 Class B
 $V_{in}(nom)$; Full Load

23. Recommended External EMI Filter

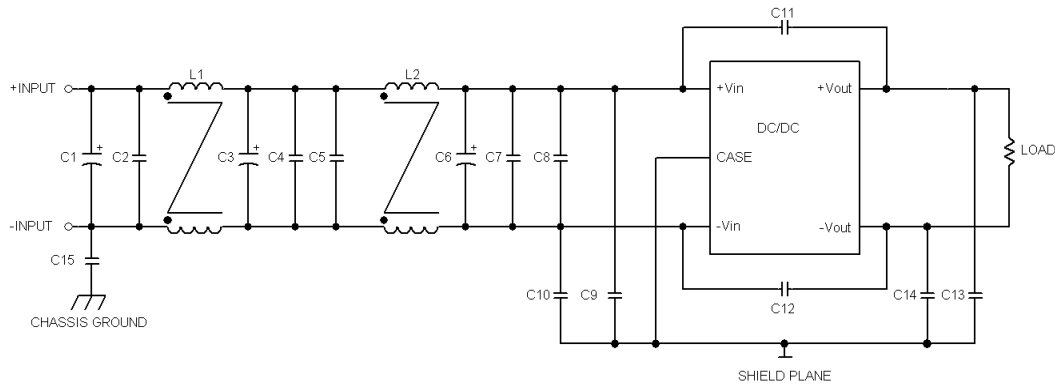
Recommended external EMI filter for EN55022 Class A



Model	C1, C2, C4	C3, C6, C7	C8, C9, C10, C11, C13	C12	L1
PAE150-12S□□	470μF/50V	4.7μF/50V	1000pF/3kV	3300pF/3kV	156μH
PAE150-24S□□	Al Cap.	1812 MLCC	1808 MLCC	1808 MLCC	Common Choke
PAE150-24S□□W	(lie down) Chemi-con KY				PMT-086
PAE150-48S□□	220μF/100V	2.2μF/100V	1000pF/3kV	1000pF/3kV	224μH
PAE150-48S□□W	Al Cap. (lie down) Chemi-con KY	1812 MLCC	1808 MLCC	1808 MLCC	Common Choke
					PMT-087
PAE150-110S□□W	150μF/200V	1μF/250V	1000pF/3kV	1000pF/3kV	521μH
	Al Cap. (lie down) Chemi-con KXJ	1812 MLCC	1808 MLCC	1808 MLCC	Common Choke
					PMT-088

*C5: N/A

Recommended external EMI filter for EN55022 Class B



Model	C1, C3, C6	C2, C4, C5, C7, C8	C9, C10	C11	C12	C13, C14	C15	L1, L2
PAE150-12S□□	470μF/50V	4.7μF/50V	10nF/2kV	1000pF/3kV	4700pF/3kV	10nF/2kV	N/A	156μH
PAE150-24S□□	Al Cap.	1812 MLCC	1812 MLCC	1808 MLCC	1808 MLCC	1812 MLCC		Common Choke
PAE150-24S□□W	(lie down) Chemi-con KY					PMT-086		
PAE150-48S□□	220μF/100V	2.2μF/100V	10nF/2kV	2200pF/3kV	4700pF/3kV	10nF/2kV	1000pF/3kV	224μH
PAE150-48S□□W	Al Cap. (lie down) Chemi-con KY	1812 MLCC	1812 MLCC	1808 MLCC	1812 MLCC	1812 MLCC	1808 MLCC	Common Choke
								PMT-087
PAE150-110S□□W	150μF/200V	1μF/250V	2200pF/3kV	2200pF/3kV	2200pF/3kV	1000pF/3kV	1000pF/3kV	521μH
	Al Cap. (lie down) Chemi-con KXJ	1812 MLCC	1808 MLCC	1808 MLCC	1808 MLCC	1808 MLCC	1808 MLCC	Common Choke
								PMT-088

*C5: N/A