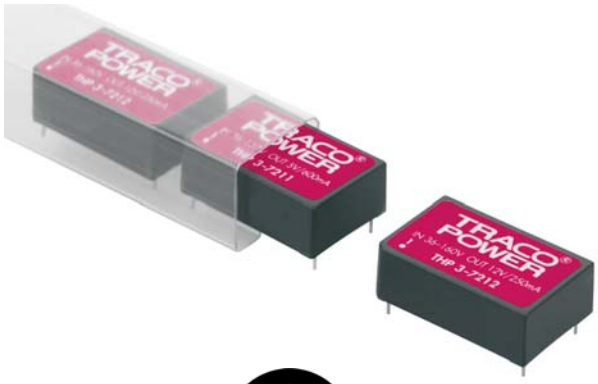
THP 3 Series

Application Note

DC/DC Converter 9 to 40Vdc, 18 to 80Vdc or 36 to 160Vdc Input
5.0Vdc & 12Vdc Single Outputs and ±12 & ±15Vdc Dual Outputs, 3W



226037

Complete THP 3 datasheet can be downloaded at:
http://www.tracopower.com/products/thp3.pdf

Features

- Single output up to 600mA
- Dual output up to ±125mA
- 3 watts maximum output power
- 4:1 wide input voltage range of 9-40, 18-80Vdc and 36-160VDC
- High efficiency up to 83%
- Complies with EN 55022 class A
- Input to output isolation: 4000Vac for 1 minute
- Reinforced insulation based on 300Vac working voltage
- Low leakage current
- Low input to output isolation capacitance
- Large operating temperature range from –40°C up to +85°C
- Output short circuit protection
- Approved according to IEC/EN/UL 60950-1
- Approved according to IEC/EN/UL 60601-1
- Approved according to EN 50124-1 & EN 50124-2

Applications

- Distributed power architectures
- Workstations
- Computer equipment
- Communications equipment

General Description

The Tracopower THP 3-Series power modules are specially designed to provide ultra-high levels of isolation 4000Vac (5600Vdc) for 1 minute in a low profile 24-pin DIP package. Operating input voltage ranges of 9-40Vdc, 18-80Vdc and 36-160Vdc which provide precisely regulated output voltages of 5Vdc, 12Vdc, ±12Vdc and ±15Vdc.

The -40℃ to +85℃ operating ambient temperature range makes it ideal for data communication equipments, mobile battery driven equipments, distributed power systems, telecommunication equipments, mixed analog/digital subsystems, process/machine control equipments, computer peripheral systems and industrial robot systems.

The modules has 3W maximum output power rating and at full-load a typical efficiency of 83%, continuous short circuit protected, complies with EN 55022 Class A conducted noise compliance to minimize design-in time, cost and eliminate the need for external filtering.

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Absolute Maximum Rating				
Parameter	**Model**	**Min**	**Max**	**Unit**
Input Voltage	THP 3-24xx	-0.7	50	Vdc
Input Surge Voltage (1 second)	THP 3-48xx	-0.7	100	
	THP 3-72xx	-0.7	180	
Operating Ambient Temperature	All			°C
Without Derating		-40	+70	
With Derating		-40	+85	
Operating Case Temperature	All	-40	+95	°C
Storage Temperature	All	-40	+125	°C

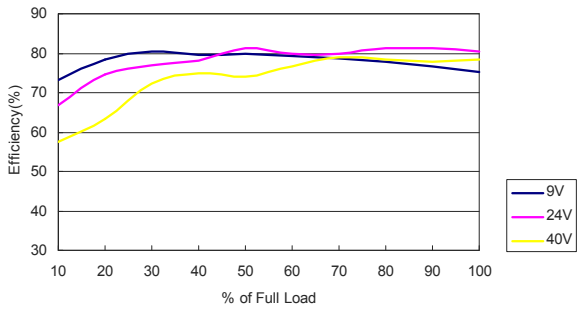
Output Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Output Voltage	THP 3-xx11	4.95	5	5.05	Vdc
(V_{in} = $V_{in\ nom}$; Full Load; T_A = 25°C)	THP 3-xx12	11.88	12	12.12	
	THP 3-xx22	±11.88	±12	±12.12	
	THP 3-xx23	±14.85	±15	±15.15	
Output Regulation					
Line ($V_{in\ min}$ to $V_{in\ max}$ at Full Load)		---	±0.3	±0.5	%
Load (25% to 100% of Full Load)		---	±0.5	±1.0	%
Output Ripple & Noise					mV pk-pk
Peak-to-Peak (20MHz bandwidth)	5V output models	---	75	100	
	All other models	---	100	150	
Temperature Coefficient	All	---	±0.02	±0.05	%/°C
Dynamic Load Response (V_{in} = $V_{in\ nom}$; T_A = 25°C Load step change from 75% to 100% or 100% to 75% of full Load)	All				
Peak Deviation		---	±3	±6	%
Recovery Time (V_{out} < 10% peak deviation)		---	150	500	µS
Output Current	THP 3-xx11	90.0	---	600	mA
	THP 3-xx12	37.5	---	250	
	THP 3-xx22	±18.8	---	±125	
	THP 3-xx23	±15.0	---	±100	
Output Over Current Protection	All	120	---	---	%FL
Output Short Circuit Protection	All	Continuous			

Input Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Operating Input Voltage	THP 3-24xx	9	24	40	Vdc
	THP 3-48xx	18	48	80	
	THP 3-72xx	36	110	160	
Under Voltage Lockout Turn-on Threshold	THP 3-24xx	8	8.5	9	Vdc
	THP 3-48xx	13	15	17	
	THP 3-72xx	26	30	34	
Under Voltage Lockout Turn-off Threshold	THP 3-24xx	---	---	8.5	Vdc
	THP 3-48xx	---	---	16	
	THP 3-72xx	---	---	32	
Input reflected ripple current (20MHz bandwidth)	THP 3-24xx	---	15	---	mA pk-pk
(Measured with a inductor 4.7µH and Capacitance 220µF	THP 3-48xx	---	8	---	
ESR < 1.0Ω at 100KHz to simulated source impedance)	THP 3-72xx	---	3	---	
Input Current	THP 3-2411	---	160	---	mA
(V_{in} = $V_{in\ nom}$; Full Load)	THP 3-2412	---	151	---	
	THP 3-2422	---	151	---	
	THP 3-2423	---	151	---	
	THP 3-4811	---	80	---	
	THP 3-4812	---	75	---	
	THP 3-4822	---	75	---	
	THP 3-4823	---	75	---	
	THP 3-7211	---	35	---	
	THP 3-7212	---	33	---	
	THP 3-7222	---	33	---	
	THP 3-7223	---	33	---	
Input No Load current	THP 3-2411	---	20	---	mA
(V_{in} = $V_{in\ nom}$; No Load)	THP 3-2412				
	THP 3-2422				
	THP 3-2423				
	THP 3-4811	---	10	---	
	THP 3-4812				
	THP 3-4822				
	THP 3-4823				
	THP 3-7211	---	5	---	
	THP 3-7212				
	THP 3-7222				
	THP 3-7223				

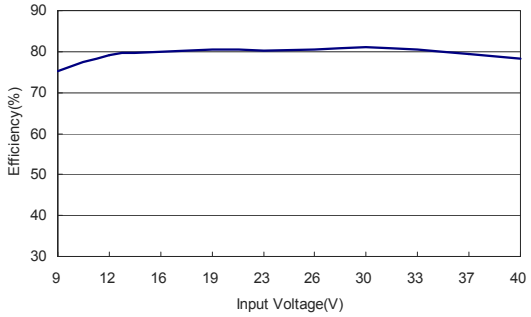
General Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Efficiency (V_{in} = $V_{in\ nom}$; Full Load; T_A = 25°C)	THP 3-2411	---	78	---	%
	THP 3-2412	---	83	---	
	THP 3-2422	---	83	---	
	THP 3-2423	---	83	---	
	THP 3-4811	---	78	---	
	THP 3-4812	---	83	---	
	THP 3-4822	---	83	---	
	THP 3-4823	---	83	---	
	THP 3-7211	---	78	---	
	THP 3-7212	---	83	---	
	THP 3-7222	---	83	---	
	THP 3-7223	---	83	---	
Isolation Voltage Input to Output (for 60 seconds)	All	4000	---	---	Vac
Isolation Resistance	All	10	---	---	GΩ
Isolation Capacitance	All	---	7	13	pF
Switching Frequency	All	---	150	---	KHz
MTBF MIL-STD-217F, T_A = 25°C	All	1'000	---	---	K Hours

Characteristic Curves

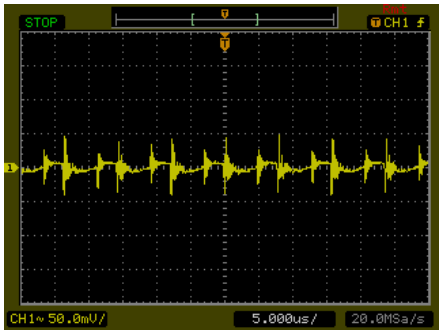
All test conditions are at 25°C. The figures are identical for THP 3-2411



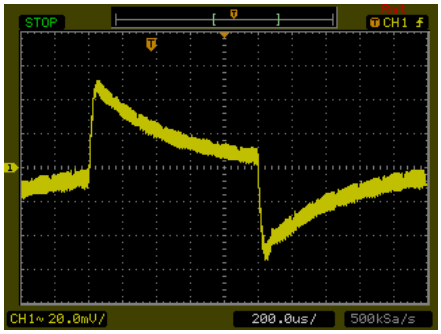
Efficiency Versus Output Current



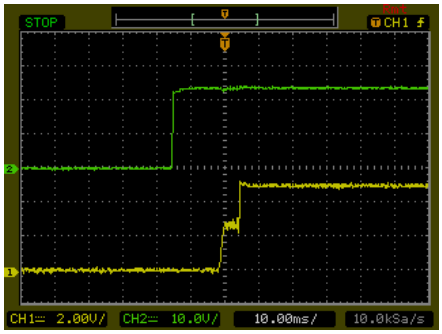
Efficiency Versus Input Voltage. Full Load



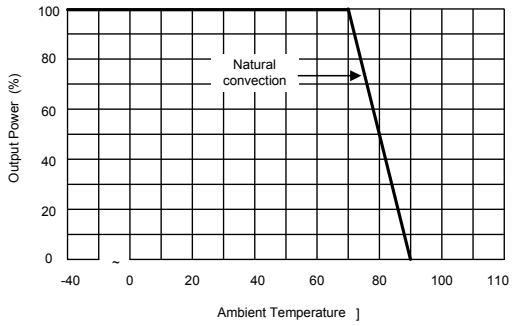
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A = +25°C



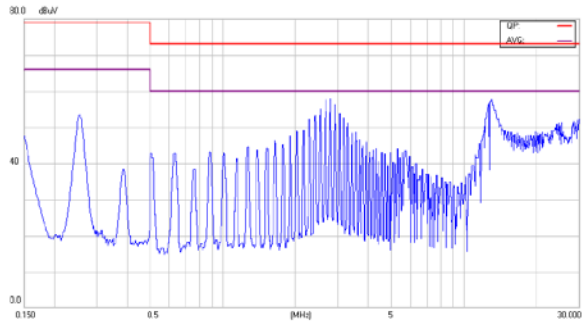
Transient Response to Dynamic Load Change from 100% to 75% of Full Load; V_{in} = $V_{in\ nom}$



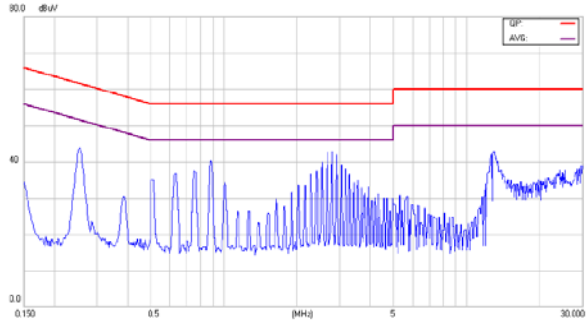
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow V_{in} = $V_{in\ nom}$



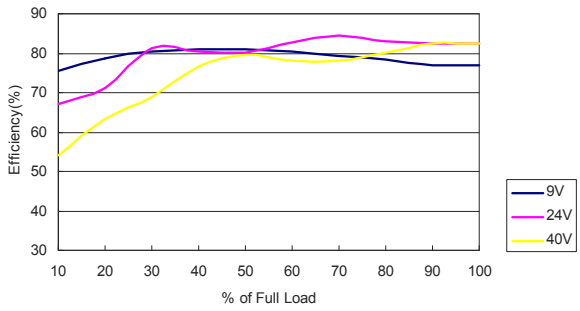
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\ nom}$; Full Load



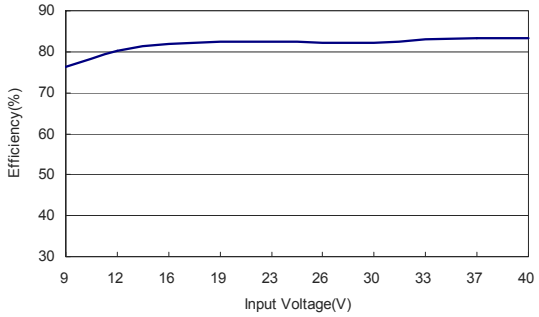
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

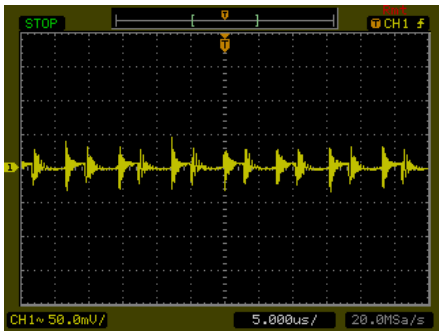
All test conditions are at 25°C. The figures are identical for THP 3-2412



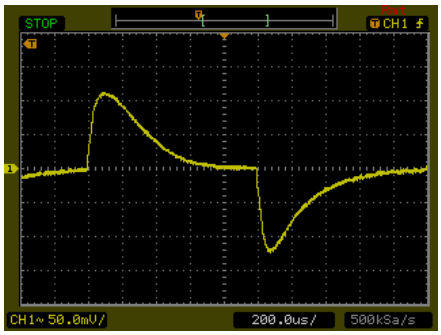
Efficiency Versus Output Current



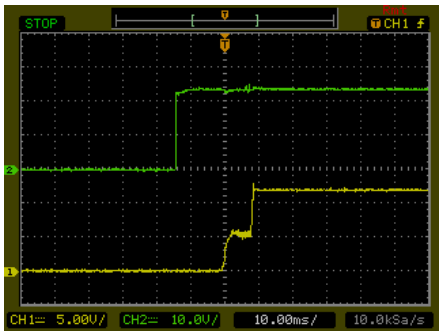
Efficiency Versus Input Voltage. Full Load



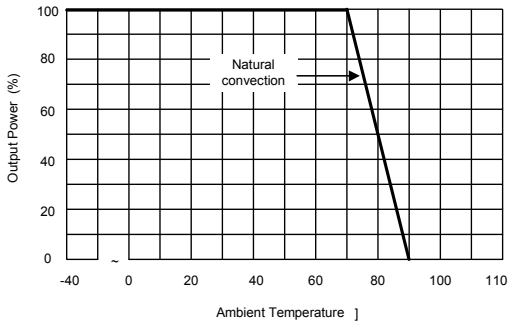
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A = +25°C



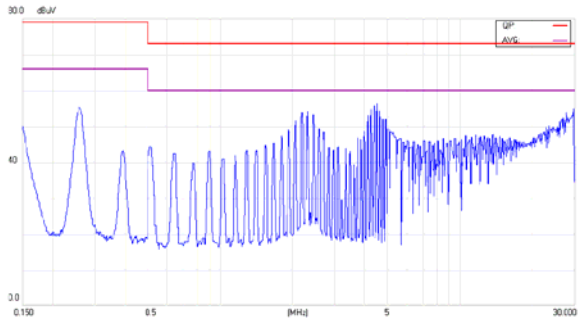
Transient Response to Dynamic Load Change from 100% to 75% of Full Load; V_{in} = $V_{in\ nom}$



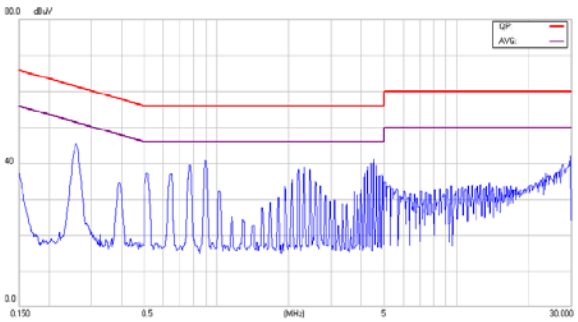
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow; V_{in} = $V_{in\ nom}$



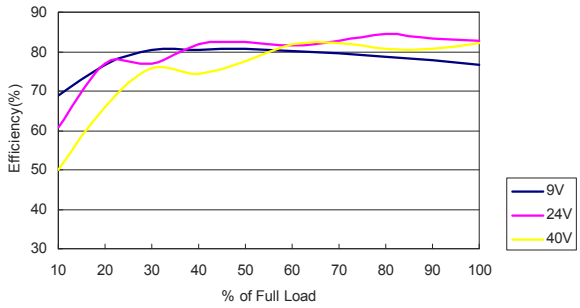
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\ nom}$; Full Load



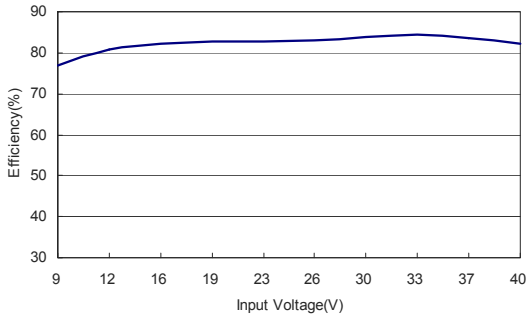
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

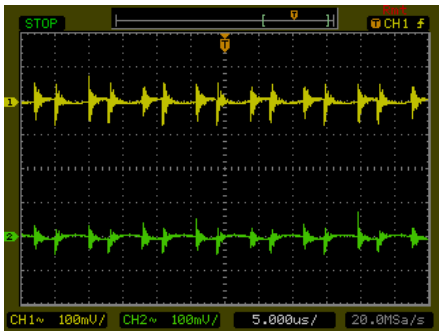
All test conditions are at 25°C. The figures are identical for THP 3-2422



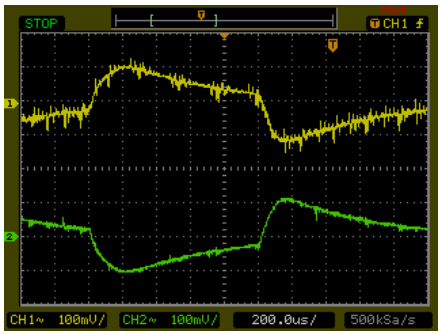
Efficiency Versus Output Current



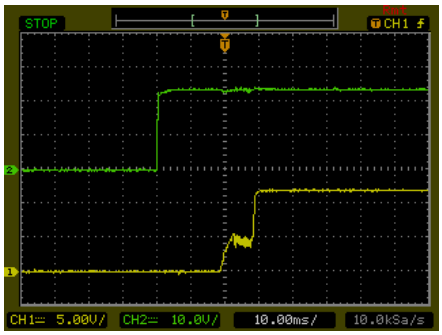
Efficiency Versus Input Voltage. Full Load



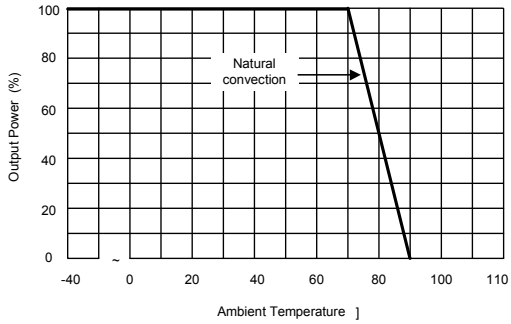
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A = +25°C



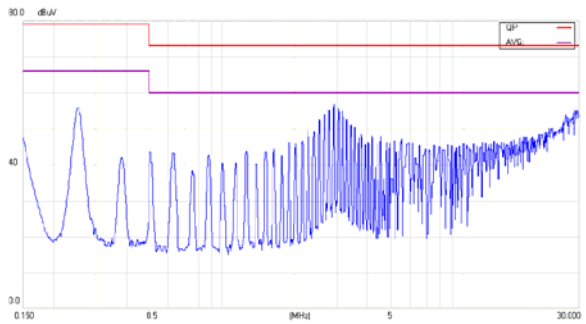
Transient Response to Dynamic Load Change from 100% to 75% of Full Load; V_{in} = $V_{in\ nom}$



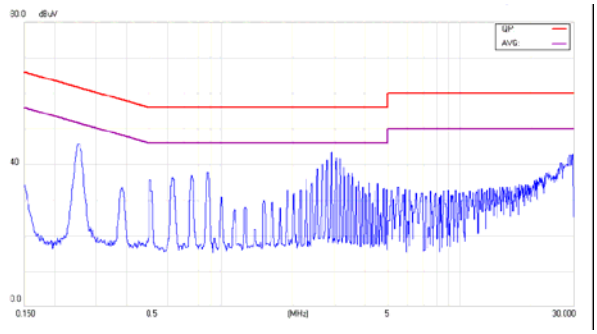
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow; V_{in} = $V_{in\ nom}$



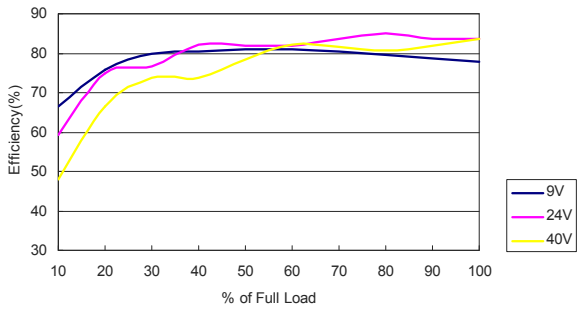
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\ nom}$; Full Load



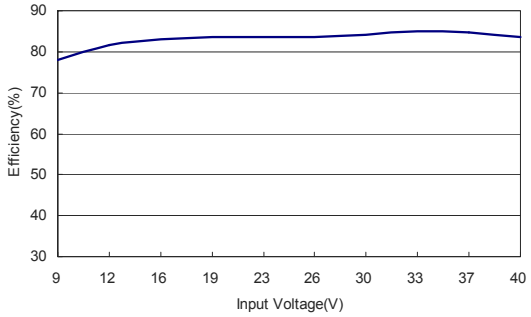
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

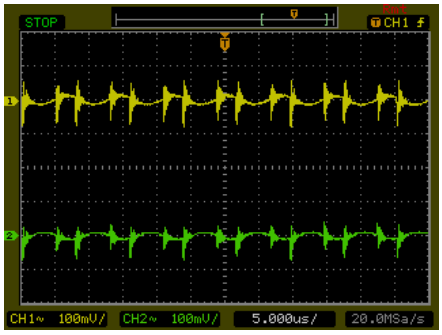
All test conditions are at 25°C. The figures are identical for THP 3-2423



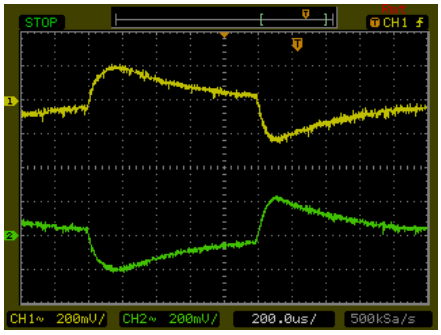
Efficiency Versus Output Current



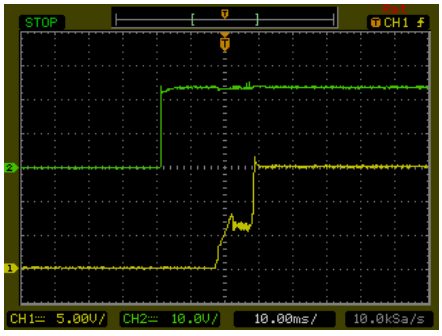
Efficiency Versus Input Voltage. Full Load



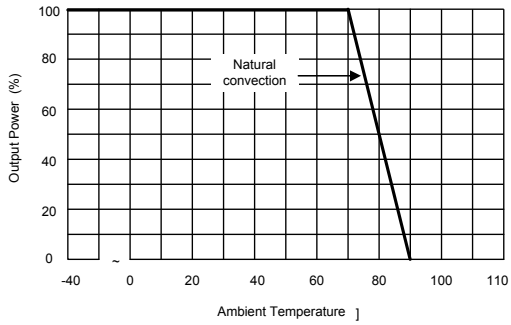
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A = +25°C



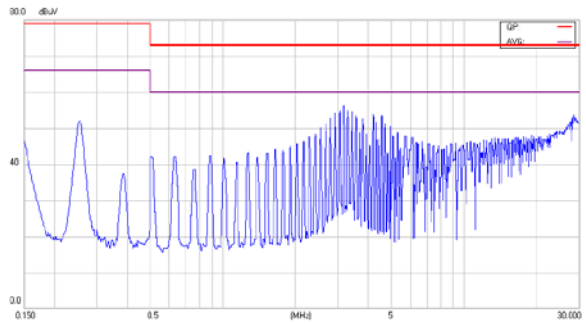
Transient Response to Dynamic Load Change from 100% to 75% of Full Load; V_{in} = $V_{in\ nom}$



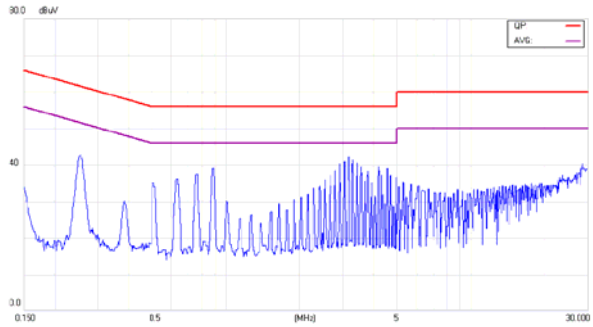
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow; V_{in} = $V_{in\ nom}$



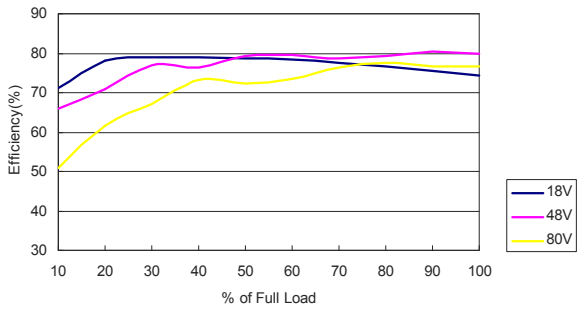
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\ nom}$; Full Load



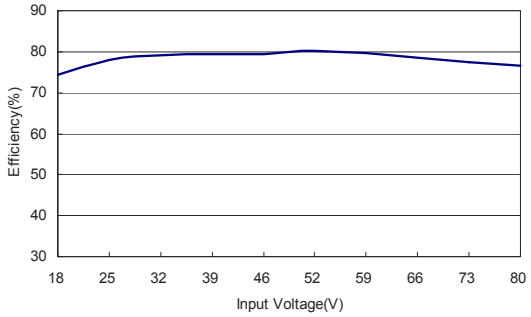
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

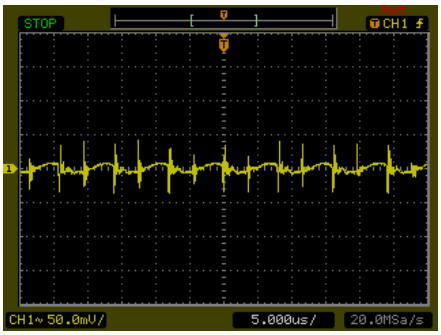
All test conditions are at 25°C. The figures are identical for THP 3-4811



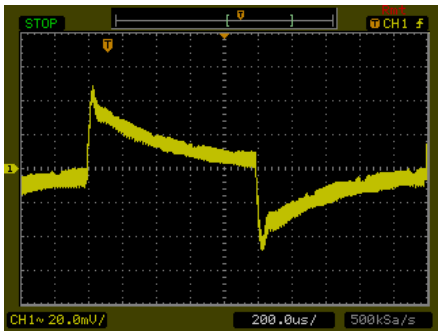
Efficiency Versus Output Current



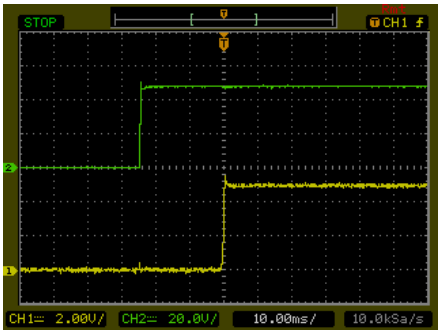
Efficiency Versus Input Voltage. Full Load



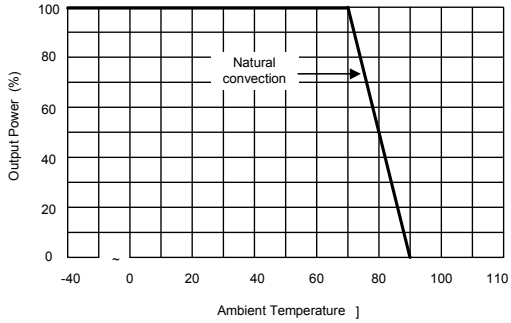
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A = +25°C



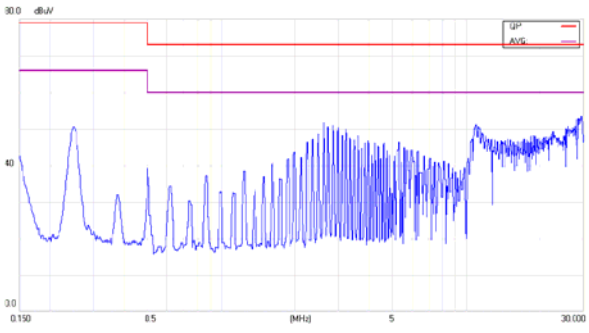
Transient Response to Dynamic Load Change from 100% to 75% of Full Load; V_{in} = $V_{in\ nom}$



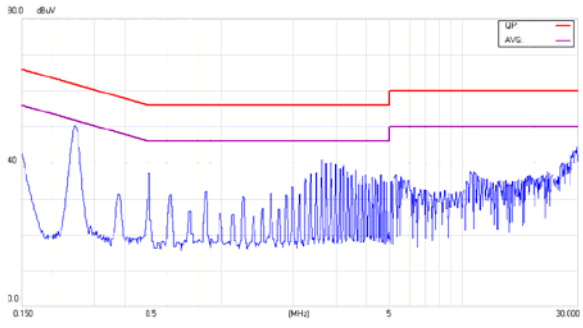
Typical Input Start-Up and Output Rise Characteristic



Derating Output Current Versus Ambient Temperature and Airflow; V_{in} = $V_{in\ nom}$



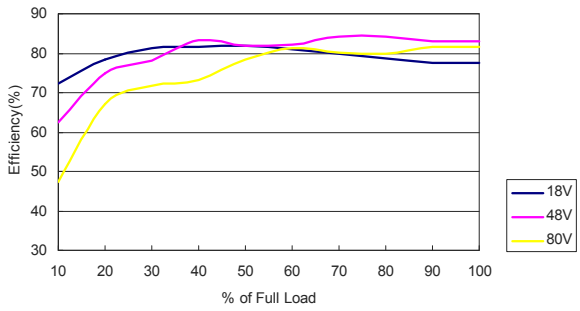
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\ nom}$; Full Load



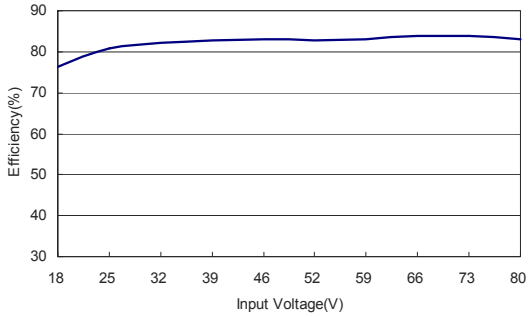
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

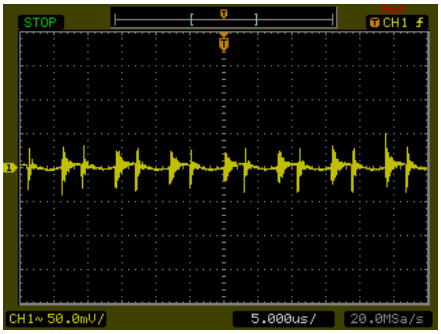
All test conditions are at 25°C. The figures are identical for THP 3-4812



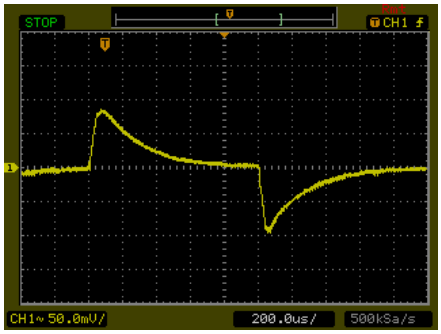
Efficiency Versus Output Current



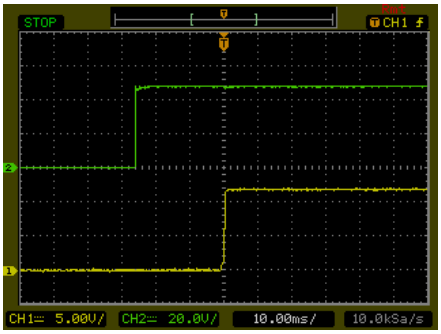
Efficiency Versus Input Voltage. Full Load



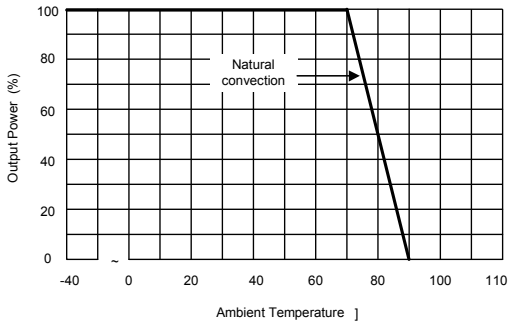
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A = +25°C



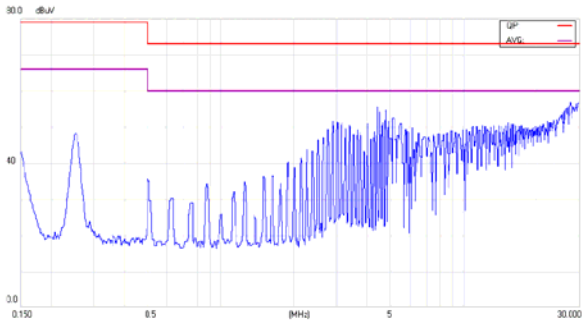
Transient Response to Dynamic Load Change from 100% to 75% of Full Load; V_{in} = $V_{in\ nom}$



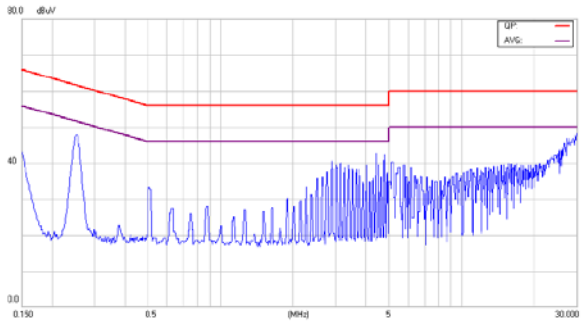
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow; V_{in} = $V_{in\ nom}$



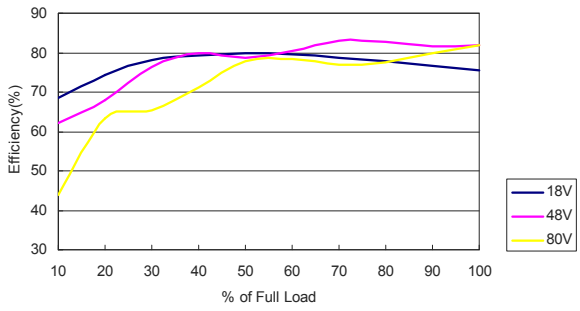
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\ nom}$; Full Load



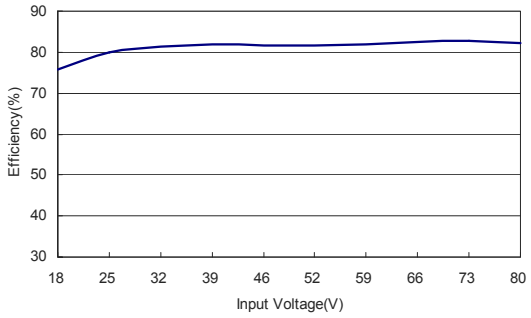
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

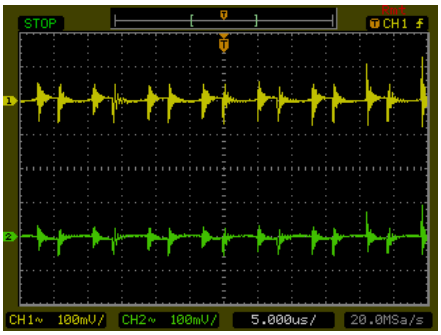
All test conditions are at 25°C. The figures are identical for THP 3-4822



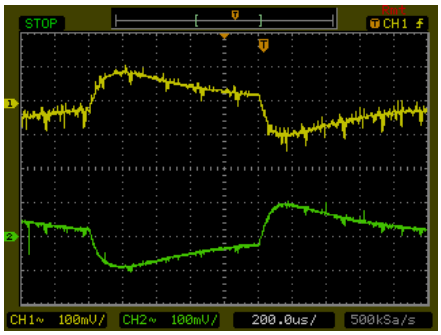
Efficiency Versus Output Current



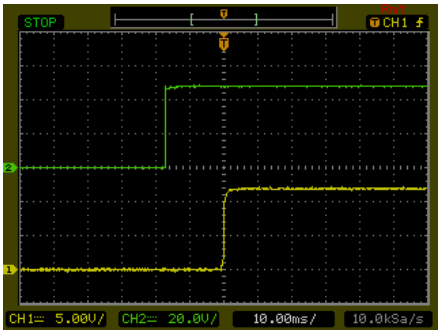
Efficiency Versus Input Voltage. Full Load



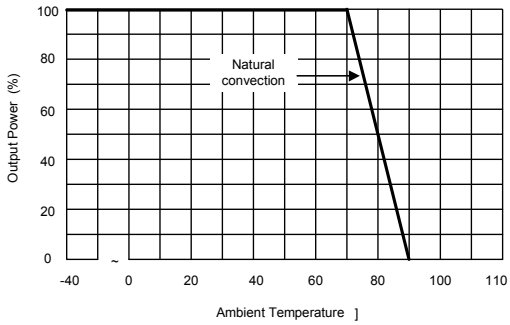
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A = +25°C



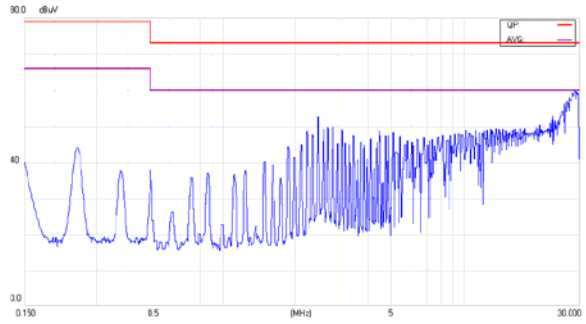
Transient Response to Dynamic Load Change from 100% to 75% of Full Load; V_{in} = $V_{in\ nom}$



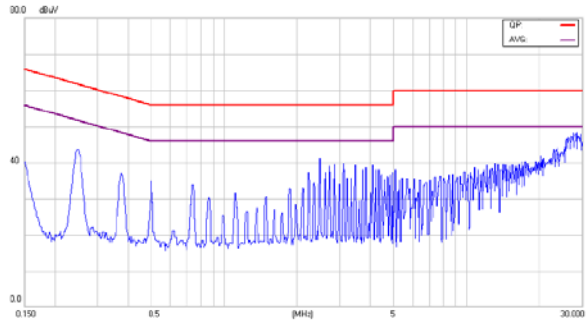
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow; V_{in} = $V_{in\ nom}$



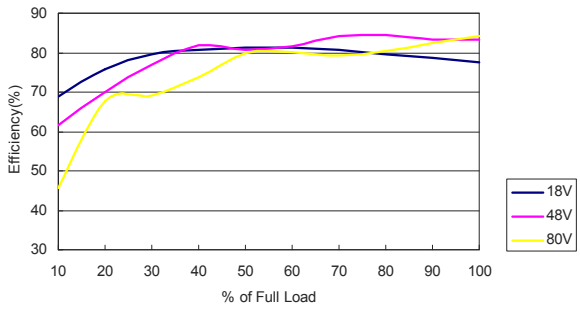
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\ nom}$; Full Load



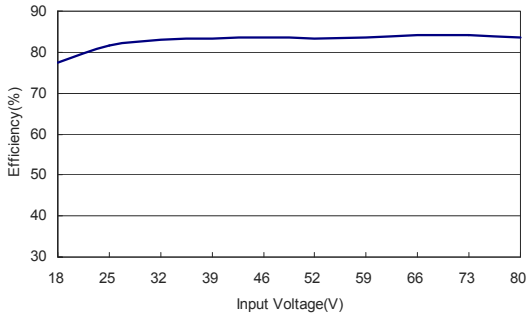
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

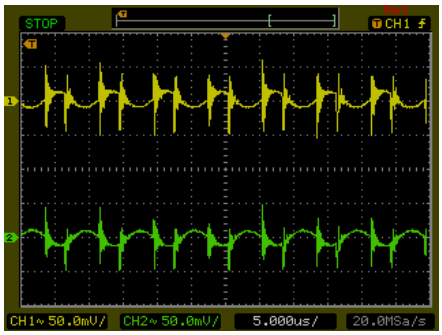
All test conditions are at 25°C. The figures are identical for THP 3-4823



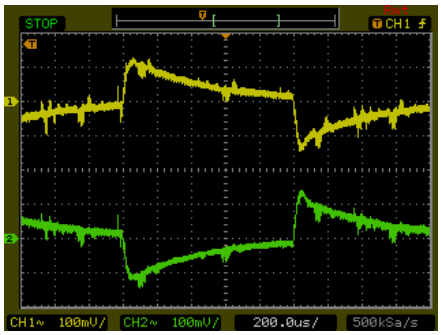
Efficiency Versus Output Current



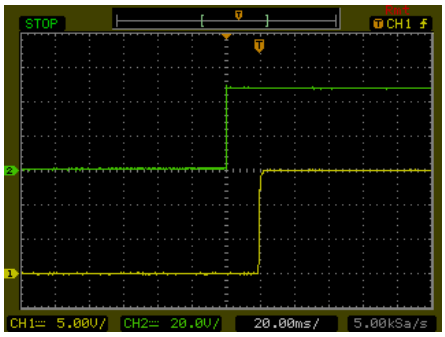
Efficiency Versus Input Voltage. Full Load



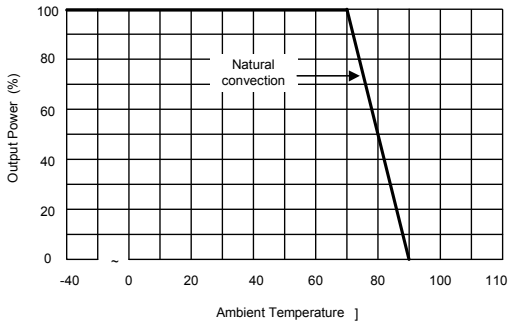
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A = +25°C



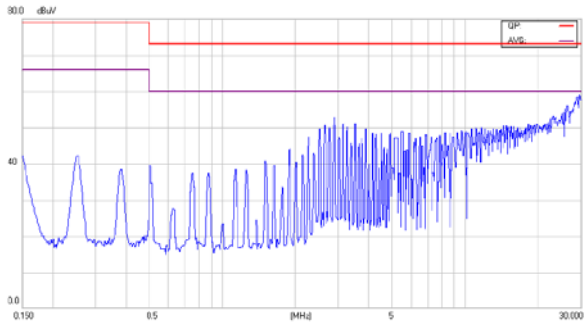
Transient Response to Dynamic Load Change from 100% to 75% of Full Load; V_{in} = $V_{in\ nom}$



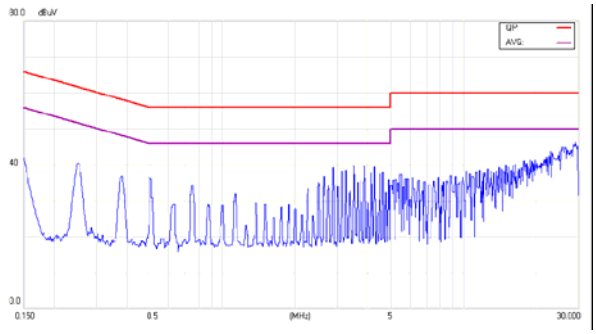
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow; V_{in} = $V_{in\ nom}$



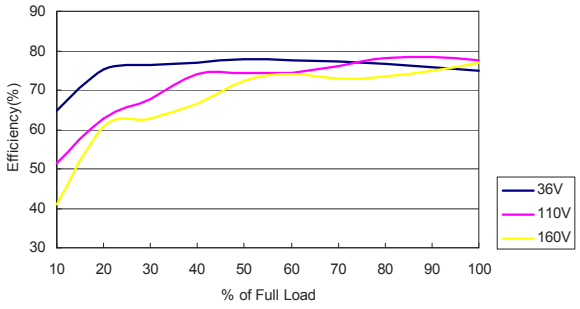
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\ nom}$; Full Load



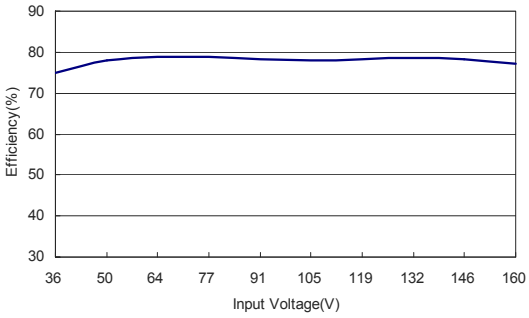
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

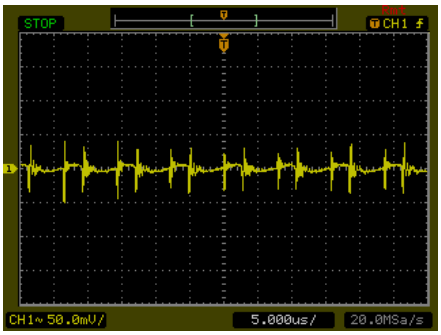
All test conditions are at 25°C. The figures are identical for THP 3-7211



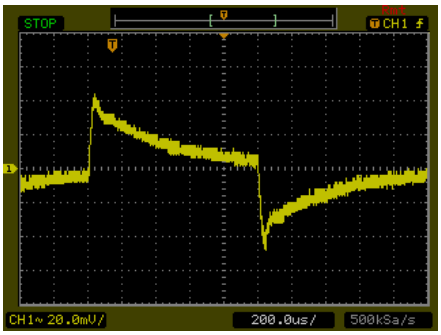
Efficiency Versus Output Current



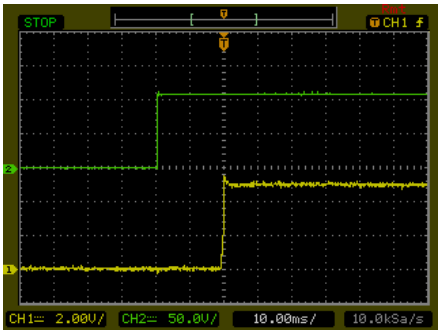
Efficiency Versus Input Voltage. Full Load



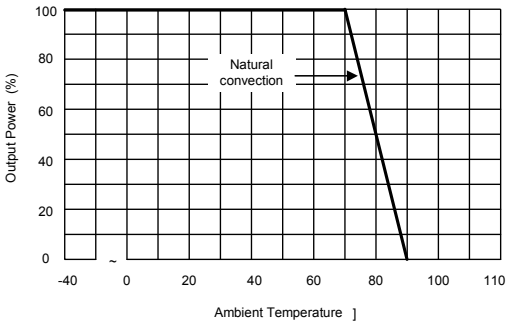
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A = +25°C



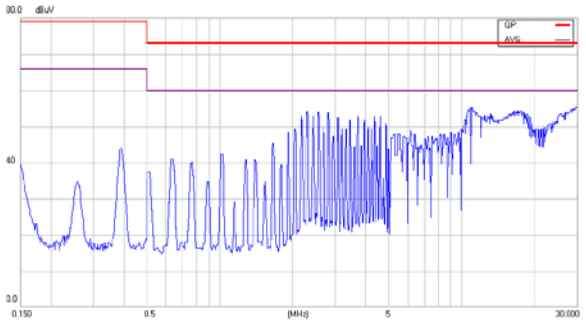
Transient Response to Dynamic Load Change from 100% to 75% of Full Load; V_{in} = $V_{in\ nom}$



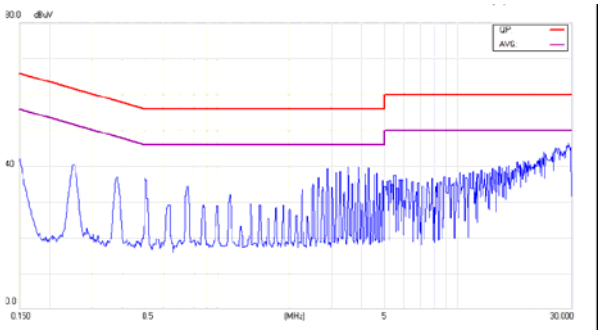
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow; V_{in} = $V_{in\ nom}$



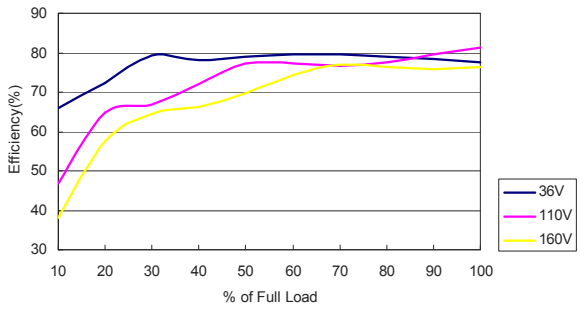
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\ nom}$; Full Load



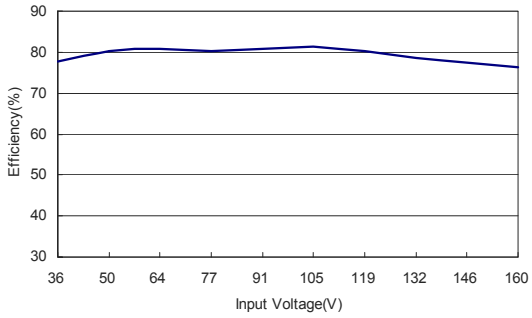
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

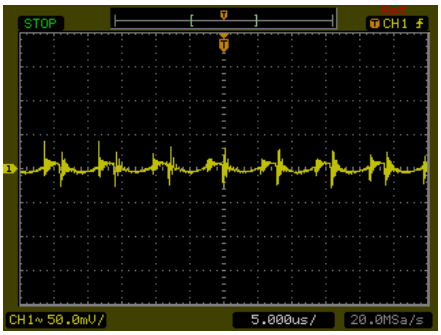
All test conditions are at 25°C. The figures are identical for THP 3-7212



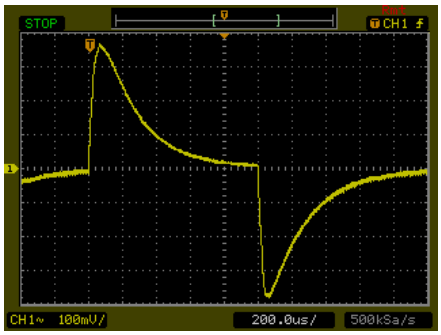
Efficiency Versus Output Current



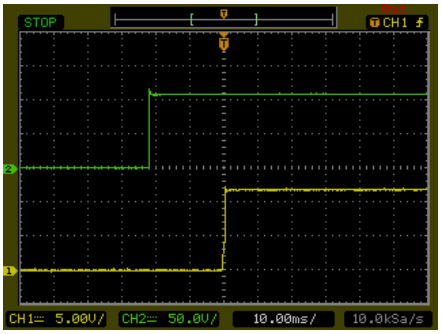
Efficiency Versus Input Voltage. Full Load



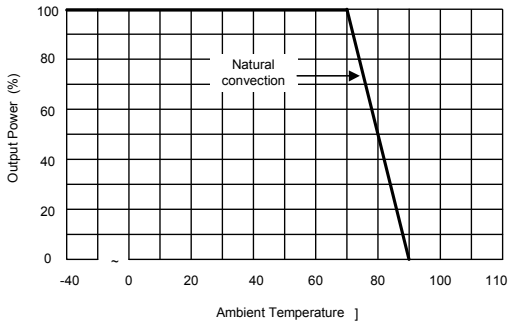
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A = +25°C



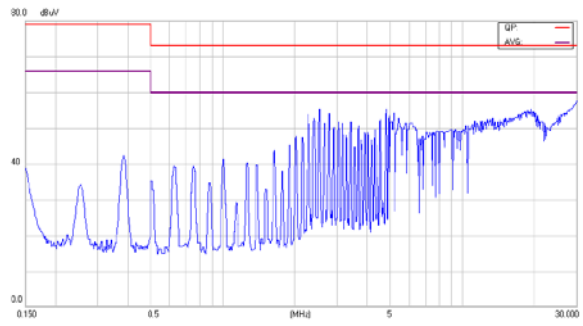
Transient Response to Dynamic Load Change from 100% to 75% of Full Load; V_{in} = $V_{in\ nom}$



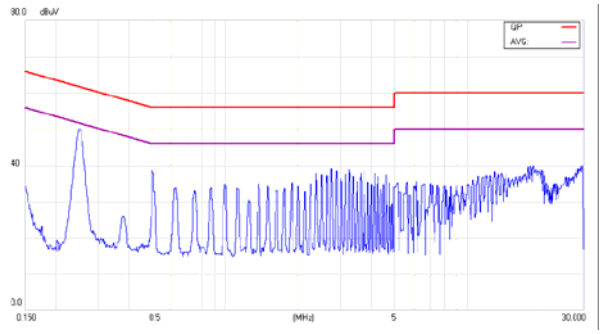
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow; V_{in} = $V_{in\ nom}$



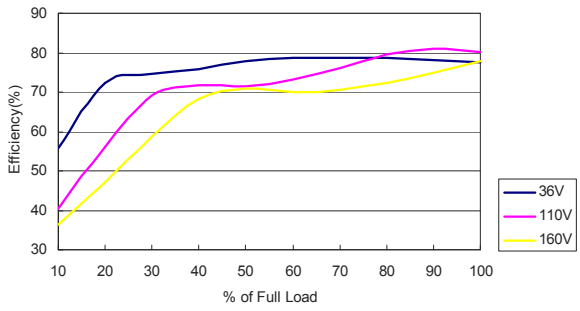
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\ nom}$; Full Load



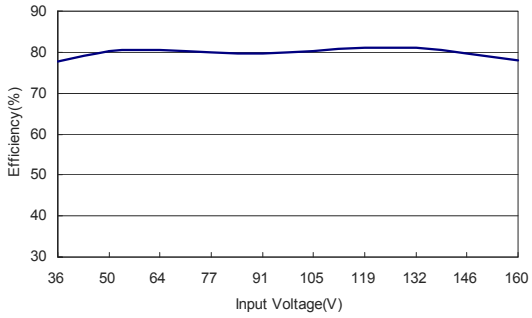
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

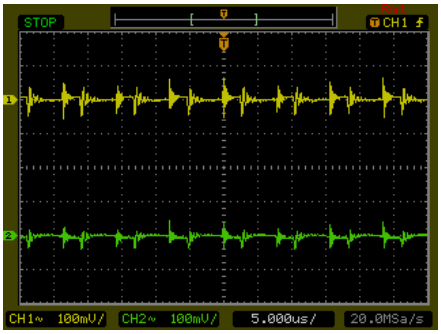
All test conditions are at 25°C. The figures are identical for THP 3-7222



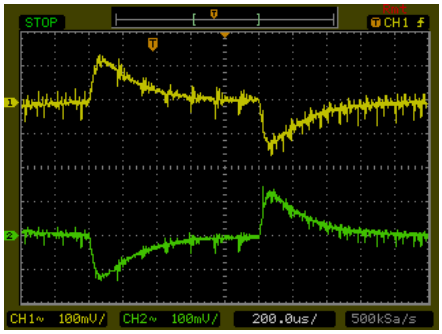
Efficiency Versus Output Current



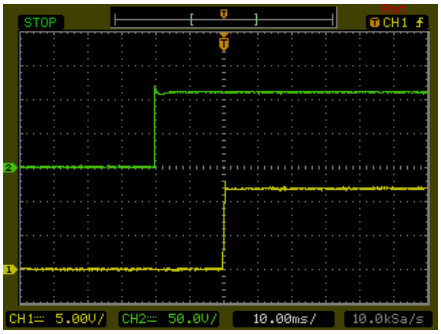
Efficiency Versus Input Voltage. Full Load



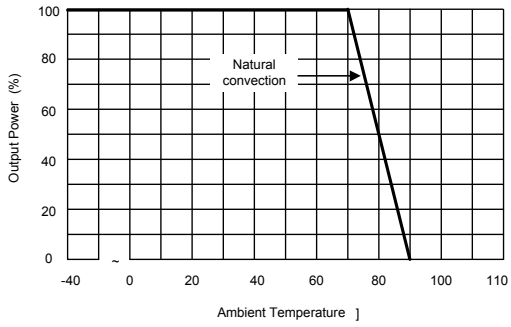
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A = +25°C



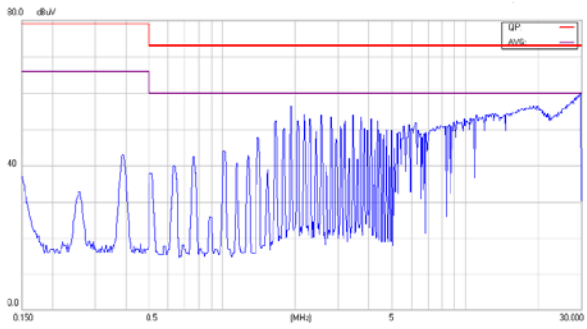
Transient Response to Dynamic Load Change from 100% to 75% of Full Load; V_{in} = $V_{in\ nom}$



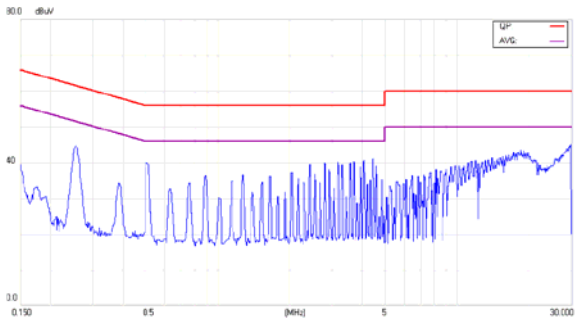
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow; V_{in} = $V_{in\ nom}$



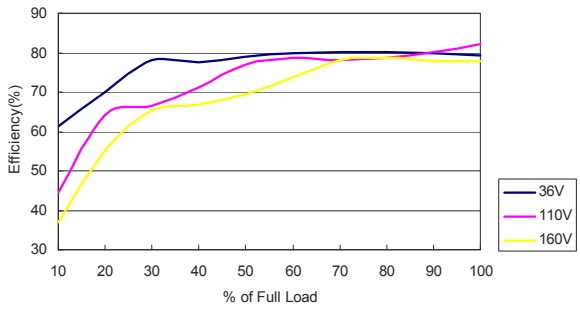
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\ nom}$; Full Load



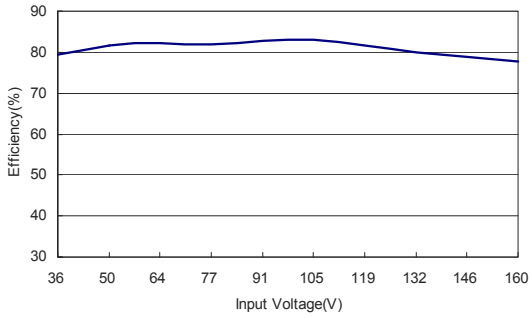
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

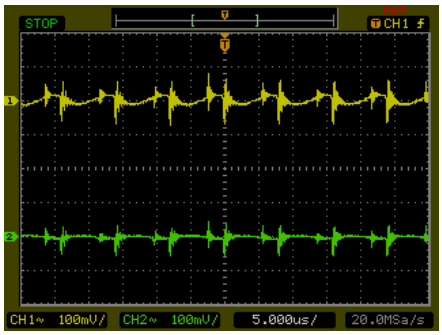
All test conditions are at 25°C. The figures are identical for THP 3-7223



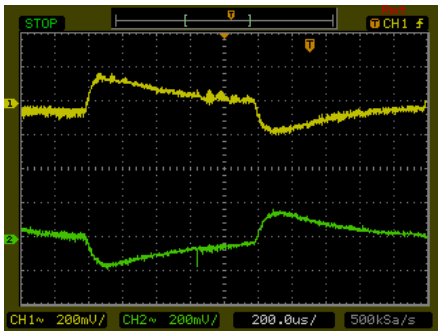
Efficiency Versus Output Current



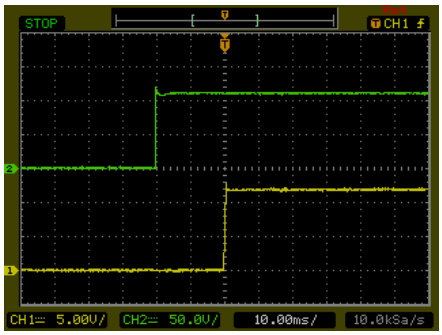
Efficiency Versus Input Voltage. Full Load



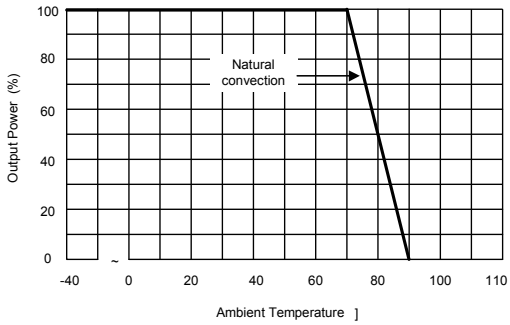
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A = +25°C



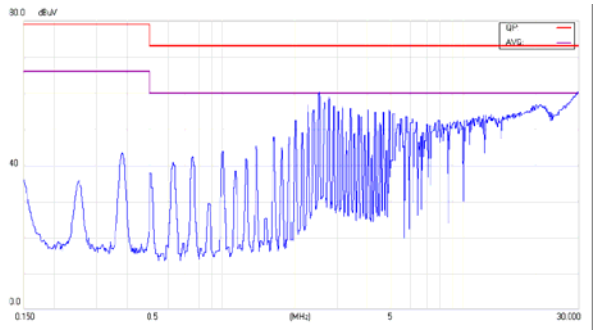
Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} = $V_{in\ nom}$



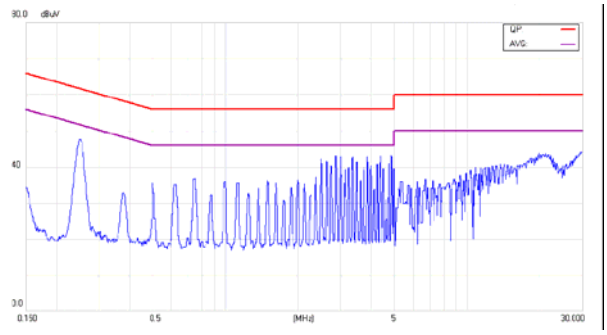
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow; V_{in} = $V_{in\ nom}$



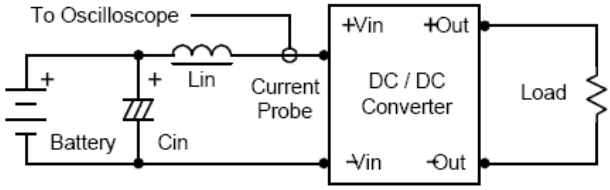
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\ nom}$; Full Load



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

Testing Configurations

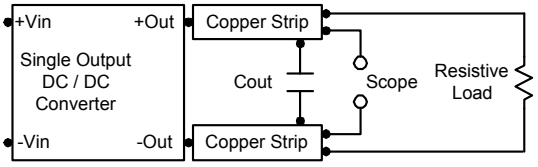
Input reflected-ripple current measurement test set up

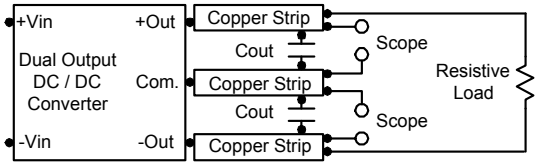


Component	Value	Reference
L	4.7uH	-----
C	220uF (ESR<1.0Ω at 100KHz)	Aluminum Electrolytic Capacitor

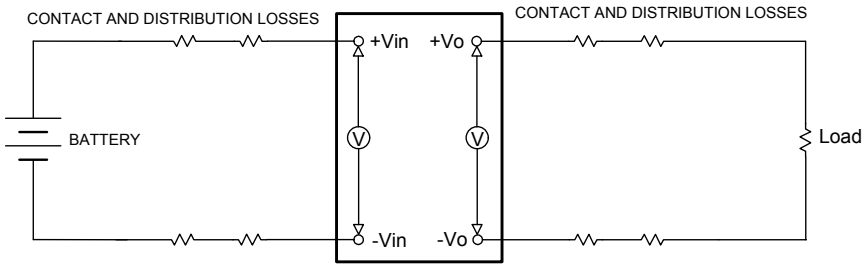
Peak-to-peak output ripple & noise measurement test up

Use a Cout 0.47µF ceramic capacitor. Scope measurement should be made by using a BNC socket, measurement bandwidth is 0-20 MHz. Position the load between 50mm and 75mm from the DC/DC Converter.





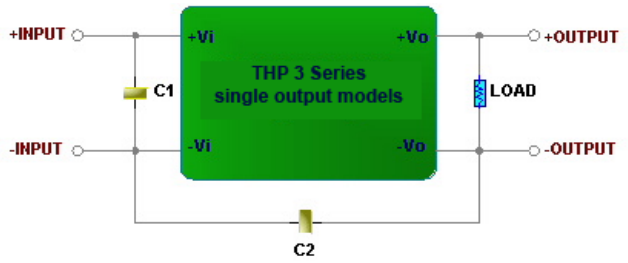
Output voltage and efficiency measurement test set up



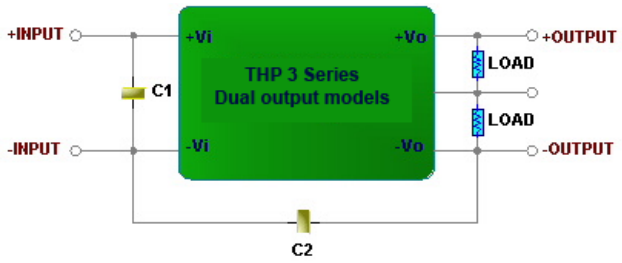
$$Efficiency = \left(\frac{V_{out} \times I_{out}}{V_{in} \times I_{in}} \right) \times 100\% = [\%]$$

EMC considerations

Recommended circuit to comply EN55022 Class B Limits

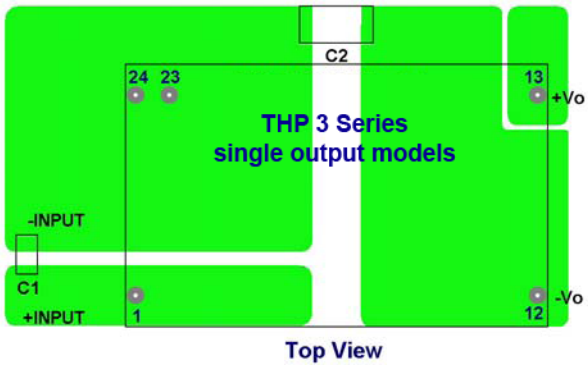


Single Output

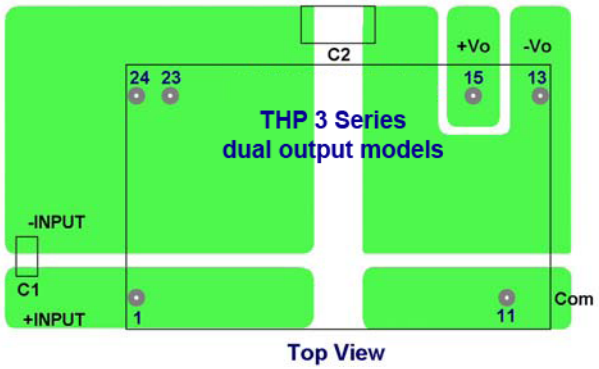


Dual Output

Recommended PCB Layout with Input Filter



Single Output



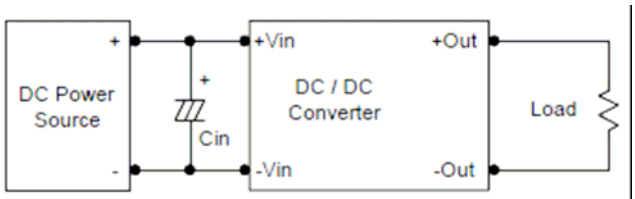
Dual Output

To: comply with EN55022 CLASS B following components are needed:

Model	Component	Value
THP 3-24xx	C1	2.2µF/50V 1206 MLCC
	C2	100pF/6KV 2211 MLCC
THP 3-48xx & THP 3-72xx	C2	100pF/6KV 2211 MLCC

Input Source Impedance

The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module.
In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor on the input to insure startup.
By using a good quality low Equivalent Series Resistance (ESR < 1.0Ωat 100 kHz) capacitor of a 4.7μF for the 24V input devices and a 2.2μF for the 48V devices, capacitor mounted close to the power module helps ensure stability of the unit.



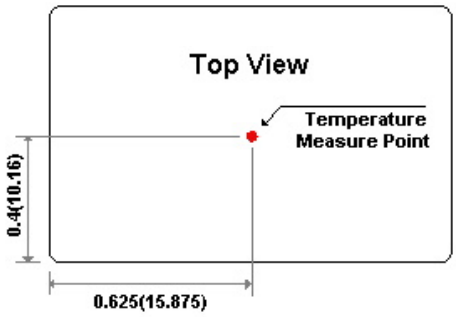
Short Circuitry Protection

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 will be safe in this condition.

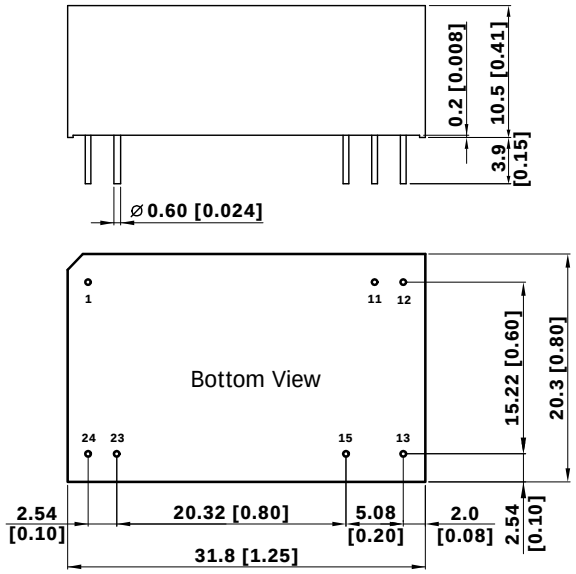
Thermal Consideration

The converter is designed to operate in a variety of thermal environments and sufficient cooling must be provided to ensure reliable operation. Heat is removed by conduction from the pins to the PCB board, and by convection through airflow across the converter. Proper cooling can be verified by measuring the point as the figure below. The temperature at this location should not exceed 95°C. When operating, adequate cooling must be provided to maintain the test point temperature at or below 95°C. Although the maximum point temperature of the power module is 95°C, you can limit this temperature to a lower value for extremely high reliability.



Measurement shown in inches(mm)

Mechanical Dimensions

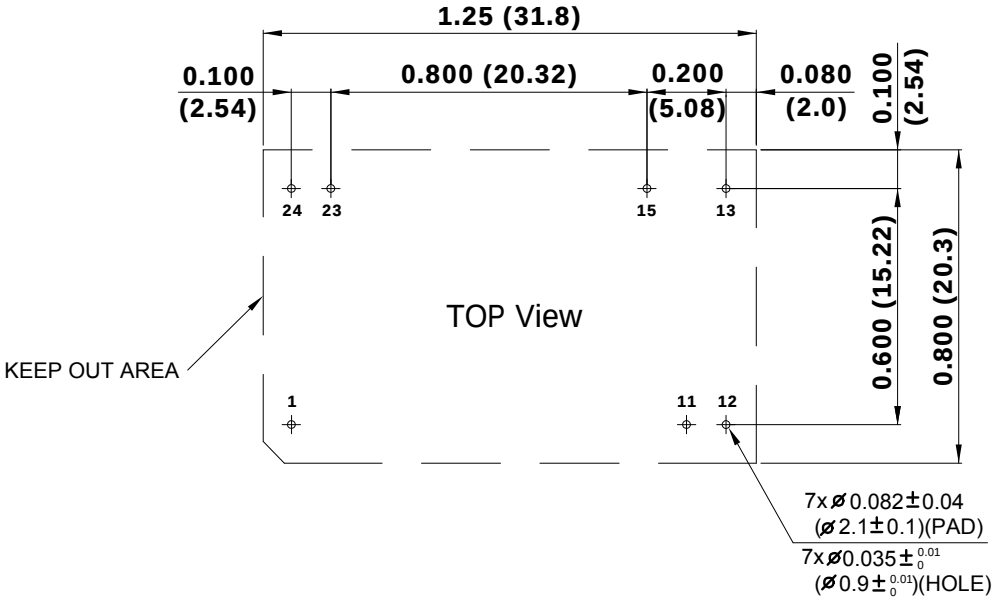


Weight: 16.2g

Pin Connections		
Pin	Single Output	Dual Output
1	+Vin	+Vin
11	No Pin	Common
12	-Vout	No Pin
13	+Vout	-Vout
15	No Pin	+Vout
23	-Vin	-Vin
24	-Vin	-Vin

1. All dimensions in mm (inches)
   Tolerance: X.X ±0.25 (X.XX ±0.01")
   X.XX ±0.13 (X.XXX ±0.005")
2. Pin pitch tolerance: ±0.25 (±0.01")
3. Pin dimension tolerance: ±0.1 (±0.004")

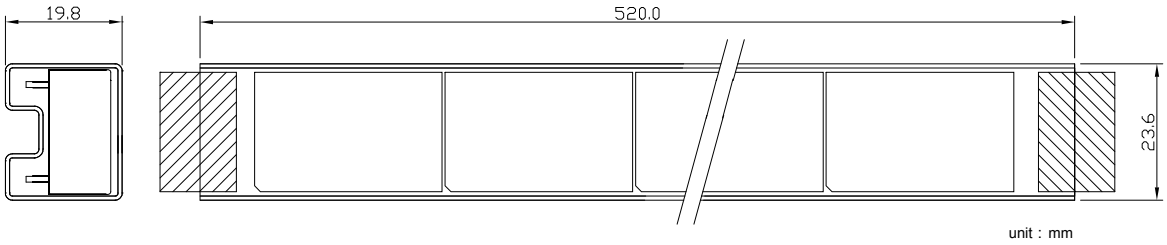
Recommended Pad Layout for Single & Dual Output Converter



1. All dimensions in Inches (mm)
   Tolerance: x.xx ±0.02" (x.x ±0.5mm)
   x.xxx ±0.01" (x.xx ±0.25mm)
2. Pin pitch tolerance: ±0.01" (±0.25mm)
3. Pin dimension tolerance: ±0.004" (±0.1mm)

Packaging Information

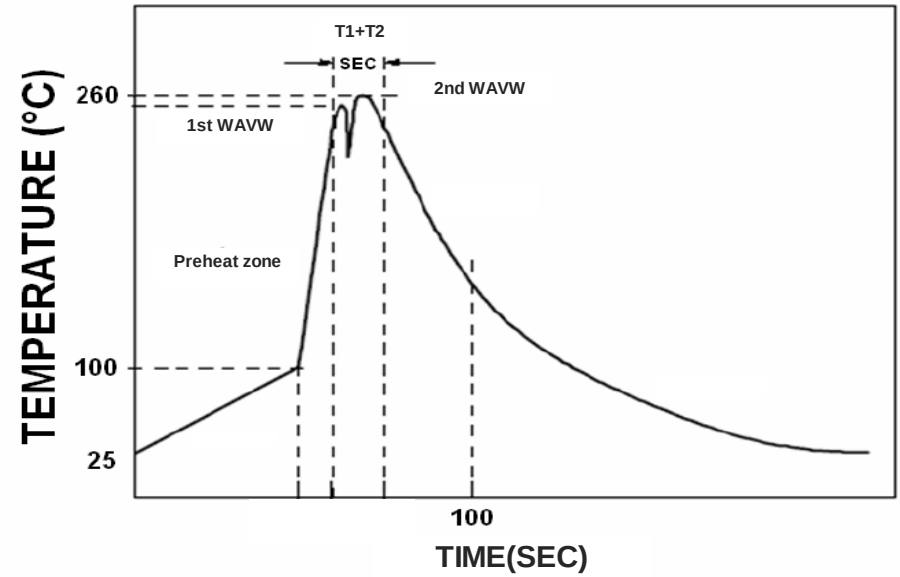
TUBE



10 PCS per TUBE

Soldering and Reflow Considerations

Lead free wave solder profile for THP 3 Series



Part Number Structure

Model Number	Input Range [Vdc]	Output Voltage [Vdc]	Max. Output Current [mA]	Input Current at Full Load (1) [mA]	Efficiency (2) [%]
THP 3-2411	9 – 40	5	600	160	78
THP 3-2412	9 – 40	12	250	151	83
THP 3-2422	9 – 40	±12	±125	151	83
THP 3-2423	9 – 40	±15	±100	151	83
THP 3-4811	18 – 80	5	600	80	78
THP 3-4812	18 – 80	12	250	75	83
THP 3-4822	18 – 80	±12	±125	75	83
THP 3-4823	18 – 80	±15	±100	75	83
THP 3-7211	36 – 160	5	600	35	78
THP 3-7212	36 – 160	12	250	33	83
THP 3-7222	36 – 160	±12	±125	33	83
THP 3-7223	36 – 160	±15	±100	33	83

Note 1. Maximum value at nominal input voltage and full load.

Note 2. Typical value at nominal input voltage and full load.

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 safety agencies require a normal-blow fuse in 24Vin, 48Vin, 110Vin with maximum rating of 1000mA, 500mA, 300mA. Based on the information provided in this data sheet on Inrush energy and maximum dc input current; the same type of fuse with lower rating can be used. Refer to the fuse manufacturer's data for further information.

MTBF and Reliability

The MTBF of THP 3 series of DC/DC converters has been calculated using MIL-HDBK 217F

Operating Temperature 25°C, Ground Benign.

Model	MTBF	Unit
THP 3-2411	1,055,632	Hours
THP 3-2412	1,105,583	Hours
THP 3-2422	1,085,776	Hours
THP 3-2423	1,091,465	Hours
THP 3-4811	1,044,168	Hours
THP 3-4812	1,093,016	Hours
THP 3-4822	1,072,386	Hours
THP 3-4823	1,073,653	Hours
THP 3-7211	1,023,541	Hours
THP 3-7212	1,070,435	Hours
THP 3-7222	1,051,746	Hours
THP 3-7223	1,053,630	Hours