TRACO POWER®

TEP 100 Series — Application Note

DC/DC Converter 9 to 18Vdc, 18 to 36Vdc or 36 to 75Vdc Input and 100 Watt Output Power

3.3Vdc to 48 Vdc Single Output

Standard

Terminal Block

Terminal Block with EMC Filter

E188913

Complete TEP 100 datasheet can be downloaded at:
http://www.tracopower.com/products/tep100.pdf

Features

- Industry standard half-brick footprint 61.0×57.9×12.7 mm (2.40×2.28×0.50 inch)
- RoHS compliant
- Six-sided continuous shield
- Soft-start
- High power density
- 2:1 input voltage range
- High efficiency up to 93%
- Input to output basic Insulation
- Input reverse protection
- Output current up to 25A
- Adjustable output voltage
- No minimum load
- Bus terminal block option

Options

- Heat sinks available for extended operation
- Remote on/off logic configuration
- Terminal block with or without EMI Filter
- Pin length

Applications

- Wireless Network
- Telecom/ Datacom
- Industry Control System
- Distributed Power Architectures
- Semiconductor Equipment

General Description

TEP 100-Series DC/DC converters provide up to 100 watts of output power in an industry standard half-brick package and footprint. All models feature a wide input range, adjustable output voltage.

Table of contents

Absolute Maximum Rating				
Parameter	**Device**	**Min**	**Max**	**Unit**
Input Voltage				
Continuous	TEP 100-12xx		20	Vdc
	TEP 100-24xx		40	Vdc
	TEP 100-48xx		80	Vdc
Transient (100mS)	TEP 100-12xx		36	Vdc
	TEP 100-24xx		50	Vdc
	TEP 100-48xx		100	Vdc
Operating Ambient Temperature	All	-40	85	°C
Storage Temperature	All	-55	125	°C
I/O Isolation Voltage (Basic Insulation)	All	2250		Vdc

Output Specification					
Parameter	**Device**	**Min**	**Typ**	**Max**	**Unit**
Output Voltage					
($V_{in} = V_{in\,nom}$, $I_{out} = I_{out\,max.}$, T_A = 25°C)	TEP 100-xx10	3.267	3.3	3.333	Vdc
	TEP 100-xx11	4.95	5	5.05	Vdc
	TEP 100-xx12	11.88	12	12.12	Vdc
	TEP 100-xx13	14.85	15	15.15	Vdc
	TEP 100-xx15	23.76	24	24.24	Vdc
	TEP 100-xx16	27.72	28	28.28	Vdc
	TEP 100-xx18	47.52	48	48.48	Vdc
Voltage Adjustability (see page 52 & 53)	All	-20		+10	% V_{out}
Output Regulation					
Line ($V_{in\,min}$ to $V_{in\,max}$ at Full Load)	TEP 100-xx10			7	mV
	TEP 100-xx11			10	mV
	TEP 100-xx12			24	mV
	TEP 100-xx13			30	mV
	TEP 100-xx15			48	mV
	TEP 100-xx16			56	mV
	TEP 100-xx18			96	mV
Load (0% to 100% of Full Load)	TEP 100-xx10			10	mV
	TEP 100-xx11			15	mV
	TEP 100-xx12			30	mV
	TEP 100-xx13			38	mV
	TEP 100-xx15			48	mV
	TEP 100-xx16			56	mV
	TEP 100-xx18			72	mV
Output Ripple & Noise					
($V_{in} = V_{in\,nom}$, $I_{out} = I_{out\,max.}$, T_A = 25°C).	TEP 100-xx10			75	mV pk-pk
Peak-to-Peak (5Hz to 20MHz bandwidth)	TEP 100-xx11			75	mV pk-pk
$C_{OUT,\,ext.}$ = 4.7µF 50V X7R Ceramic	TEP 100-xx12			100	mV pk-pk
	TEP 100-xx13			100	mV pk-pk
	TEP 100-xx15			200	mV pk-pk
	TEP 100-xx16			200	mV pk-pk
$C_{OUT,\,ext.}$ = 2.2µF 100V X7R Ceramic	TEP 100-xx18			300	mV pk-pk
Temperature Coefficient	All	-0.02		+0.02	%/°C
Output Voltage Overshoot ($V_{in} = V_{in\,min.}$ to $V_{in\,max.}$, $I_{out} = I_{out\,max.}$, T_A = 25°C).	All		0	5	% V_{out}

Output Specification (continued)					
Parameter	**Device**	**Min**	**Typ**	**Max**	**Unit**
Dynamic Load Response					
(ΔI_O / Δt = 1A/10µS ; $V_{in} = V_{in\,nom}$, T_A = 25°C)					
Load step change between 75% to 100% of $I_{out\,max.}$	TEP 100-xx10		210		mV
Peak Deviation	TEP 100-xx11		210		mV
	TEP 100-xx12		350		mV
	TEP 100-xx13		470		mV
	TEP 100-xx15		1110		mV
	TEP 100-xx16		1110		mV
	TEP 100-xx18		1600		mV
Setting Time (V_{out} < 10% peak deviation)	All		200		µS
Output Current	TEP 100-xx10	0		25.0	A
	TEP 100-xx11	0		20.0	A
	TEP 100-xx12	0		8.4	A
	TEP 100-xx13	0		6.7	A
	TEP 100-xx15	0		4.2	A
	TEP 100-xx16	0		3.6	A
	TEP 100-xx18	0		2.1	A
Output Over Voltage Protection	TEP 100-xx10	3.795		4.29	Vdc
(Non-latch Hiccup)	TEP 100-xx11	5.75		6.50	Vdc
	TEP 100-xx12	13.80		15.60	Vdc
	TEP 100-xx13	17.25		19.50	Vdc
	TEP 100-xx15	27.60		31.20	Vdc
	TEP 100-xx16	32.20		36.40	Vdc
	TEP 100-xx18	55.20		62.40	Vdc
Output Over Current Protection (Hiccup Mode)	All	110		140	% I_{out}

Input Specification					
Parameter	**Device**	**Min**	**Typ**	**Max**	**Unit**
Operating Input Voltage	TEP 100-12xx	9	12	18	Vdc
	TEP 100-24xx	18	24	36	Vdc
	TEP 100-48xx	36	48	75	Vdc
Input Current	TEP 100-1210			7.768	A
(Maximum value at $V_{in} = V_{in\,nom}$, $I_{out} = I_{out\,max.}$)	TEP 100-1211			9.311	A
	TEP 100-1212			9.385	A
	TEP 100-1213			9.358	A
	TEP 100-1215			9.492	A
	TEP 100-1216			9.492	A
	TEP 100-1218			9.492	A
	TEP 100-2410			3.841	A
	TEP 100-2411			4.554	A
	TEP 100-2412			4.590	A
	TEP 100-2413			4.577	A
	TEP 100-2415			4.641	A
	TEP 100-2416			4.641	A
	TEP 100-2418			4.641	A
	TEP 100-4810			1.920	A
	TEP 100-4811			2.277	A
	TEP 100-4812			2.295	A
	TEP 100-4813			2.288	A
	TEP 100-4815			2.320	A
	TEP 100-4816			2.320	A
	TEP 100-4818			2.320	A
Input reflected ripple current (see page 49) (5 to 20MHz, 12µH source impedance)	All		20		mA pk-pk
Start Up Time	All				
(Vin = Vin(nom) and constant resistive load)					
Power up			25		mS
Remote ON/OFF			25		mS
Remote ON/OFF (see page 57)	All				
(The On/Off pin voltage is referenced to $-V_{IN}$)					
Positive logic (Standard): Device code without Suffix					
DC-DC ON (Open)		3		12.0	Vdc
DC-DC OFF (Short)		0		1.2	Vdc
Negative logic (Option): Device code with Suffix "-N"					
DC-DC ON (Short)		0		1.2	Vdc
DC-DC OFF (Open)		3		12.0	Vdc
Remote Off Input Current			3		mA
Input Current of Remote Control Pin		-0.5		1	mA
Under Voltage Lockout Turn-on Threshold	TEP 100-12xx		8.5		Vdc
	TEP 100-24xx		17.5		Vdc
	TEP 100-48xx		35.5		Vdc
Under Voltage Lockout Turn-off Threshold	TEP 100-12xx		7.5		Vdc
	TEP 100-24xx		16		Vdc
	TEP 100-48xx		34		Vdc

General Specification					
Parameter	**Device**	**Min**	**Typ**	**Max**	**Unit**
Efficiency	TEP 100-1210		90		%
($V_{in} = V_{in\,nom}$, $I_{out} = I_{out\,max.}$, $T_A = 25°C$)	TEP 100-1211		91		%
	TEP 100-1212		91		%
	TEP 100-1213		91		%
	TEP 100-1215		90		%
	TEP 100-1216		90		%
	TEP 100-1218		90		%
	TEP 100-2410		91		%
	TEP 100-2411		93		%
	TEP 100-2412		93		%
	TEP 100-2413		93		%
	TEP 100-2415		92		%
	TEP 100-2416		92		%
	TEP 100-2418		92		%
	TEP 100-4810		91		%
	TEP 100-4811		93		%
	TEP 100-4812		93		%
	TEP 100-4813		93		%
	TEP 100-4815		92		%
	TEP 100-4816		92		%
	TEP 100-4818		92		%
Isolation voltage (Basic Insulation)	All				
Input to Output		2250			Vdc
Input to Case		1600			Vdc
Output to Case		1600			Vdc
Isolation resistance	All	1			GΩ
Isolation capacitance	All			2500	pF
Switching Frequency	All		300		KHz
Weight	All		97		g
MTBF	All				
Bellcore TR-NWT-000332, $T_C = 40°C$,			1’010’000		hours
MIL-HDBK-217F			74’160		hours
Over Temperature Protection (see page 55)	All		115		°C

Environmental Specification					
Parameter	**Model**	**Min**	**Typ**	**Max**	**Unit**
Operating ambient temperature (with derating) *	All	-40		+85	°C
Maximum case temperature	All			+105	°C
Storage temperature range	All	-55		+125	°C
Thermal impedance without Heat-sink	All		6.7		°C/Watt
With TEP-HS1 Heat-sink			4.7		°C/Watt
Relative humidity	All	5		95	% RH
Thermal shock	MIL-STD-810F				
Vibration	MIL-STD-810F				

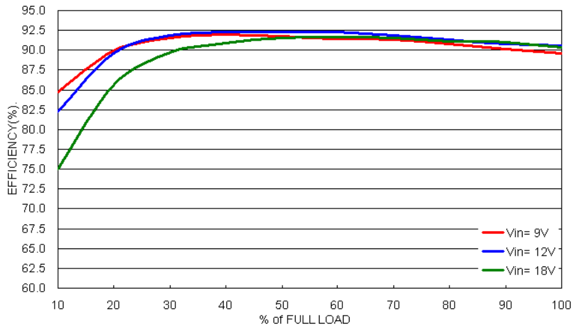
* Test condition with vertical direction by natural convection 20FLM)

EMC characteristic			
EMI	EN55022		Class A
ESD	EN61000-4-2	Air ±8KV Contact ±6KV	Performance Criteria A
Radiated immunity	EN61000-4-3	10V/m	Performance Criteria A
Fast transient **	EN61000-4-4	±2KV	Performance Criteria A
Surge **	EN61000-4-5	±1KV	Performance Criteria A
Conducted immunity	EN61000-4-6	10Vr.m.s	Performance Criteria A

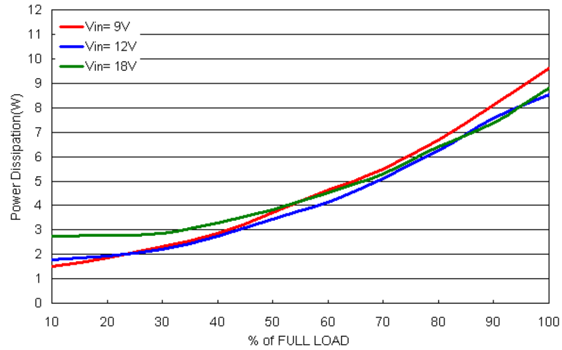
** The TEP 100 series meets EMC characteristics only with external components connected before the input pin to the converter.
If customer only need to meet EN 61000-4-4, EN 61000-4-5, an external input filter capacitor is required. The filter capacitor Tracopower suggest: Nippon Chemi-con KY series, 220µF/100V, ESR 48mΩ.

Characteristic Curves

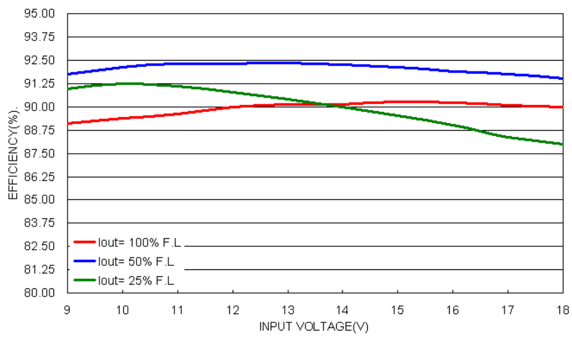
All test conditions are at 25°C. The figures are identical for TEP 100-1210



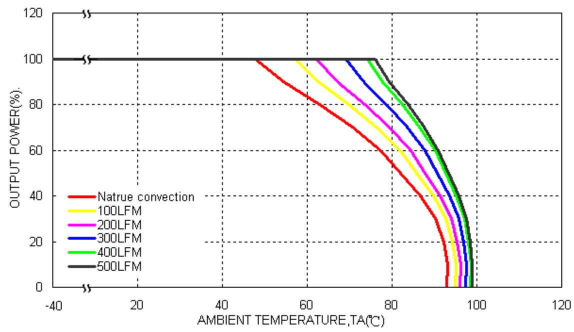
Efficiency versus Output Current



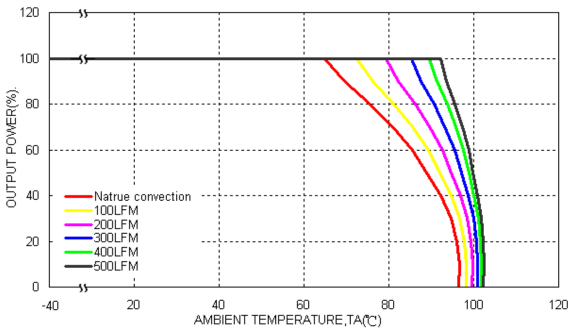
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



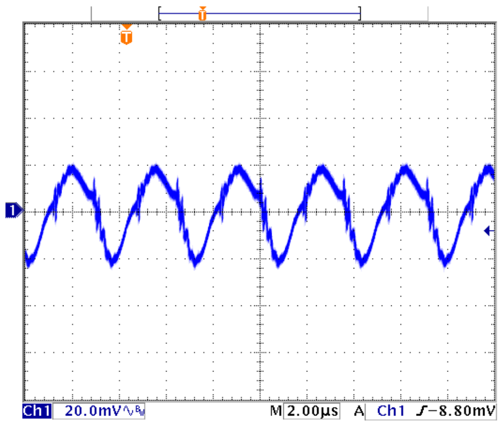
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\ nom}$



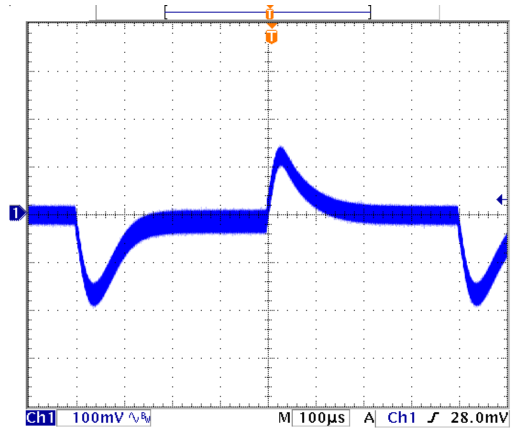
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\ nom}$

Characteristic Curves (Continued)

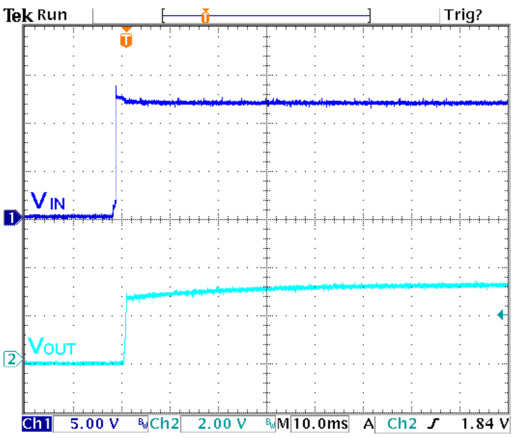
All test conditions are at 25°C. The figures are identical for TEP 100-1210



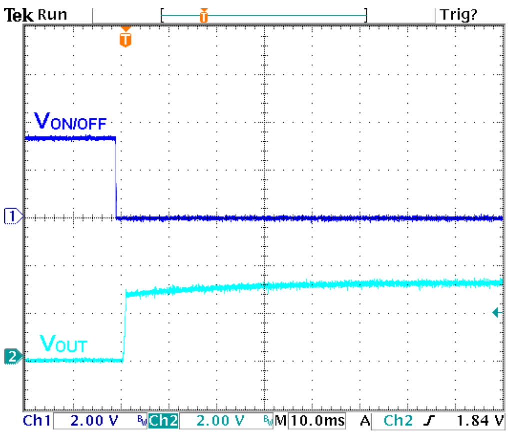
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



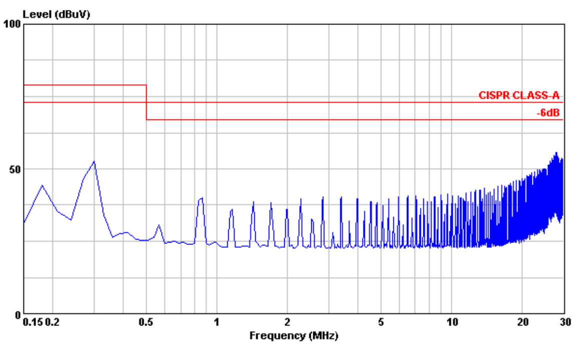
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\ nom}$



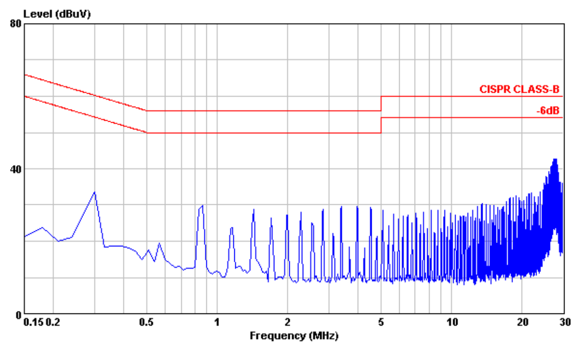
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



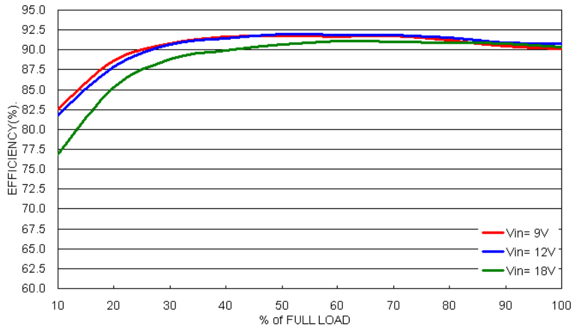
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



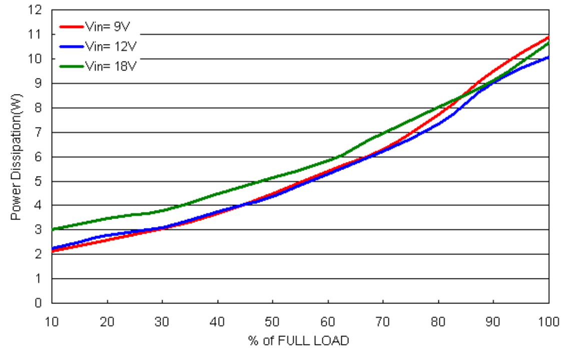
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves

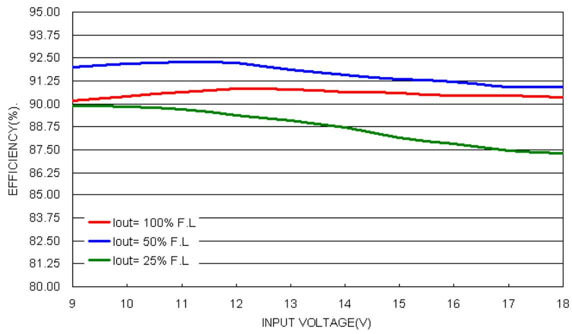
All test conditions are at 25°C. The figures are identical for TEP 100-1211



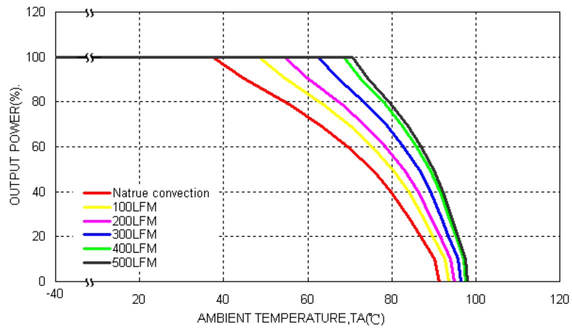
Efficiency versus Output Current



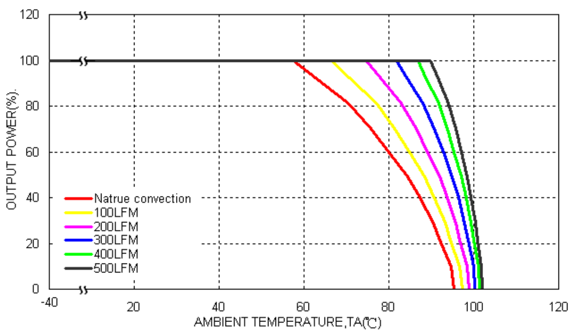
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



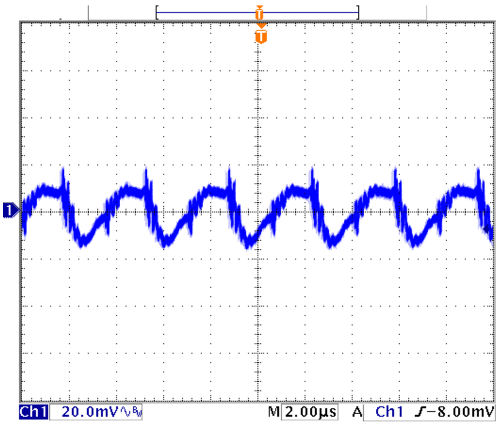
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\ nom}$



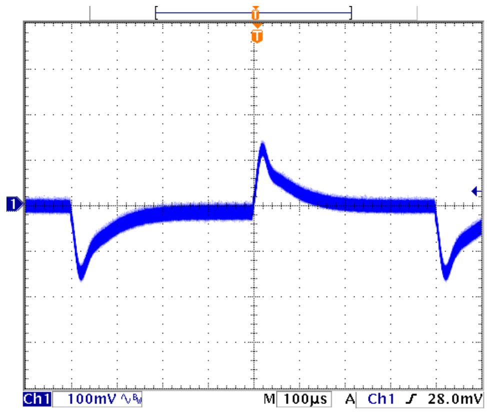
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\ nom}$

Characteristic Curves (Continued)

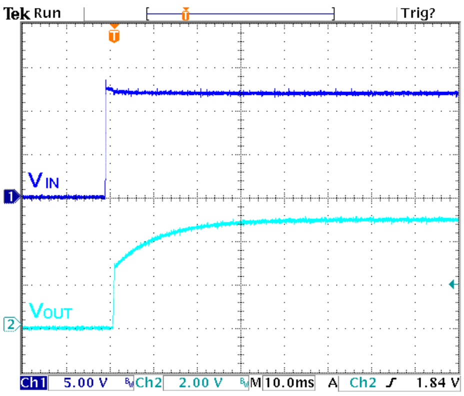
All test conditions are at 25°C. The figures are identical for TEP 100-1211



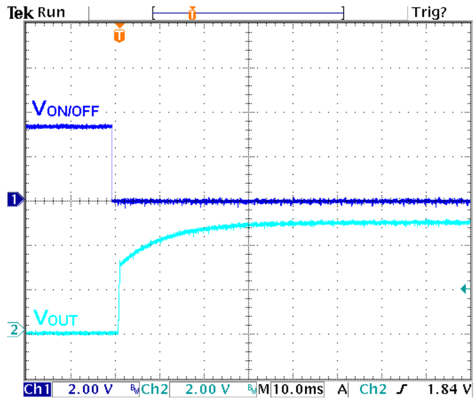
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$, Full Load



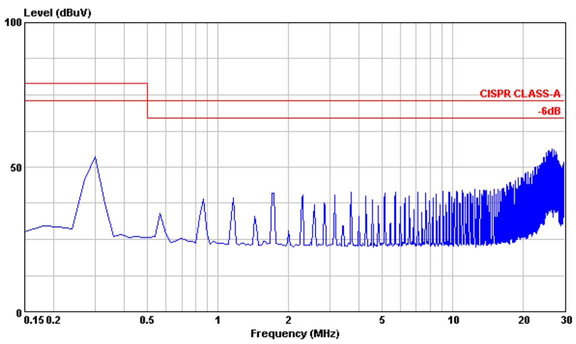
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; V_{in} = $V_{in\ nom}$



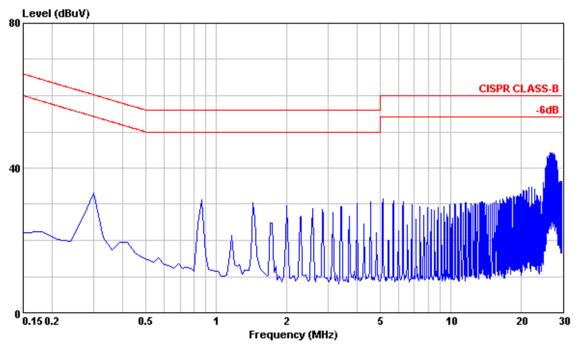
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
V_{in} = $V_{in\ nom}$, Full Load



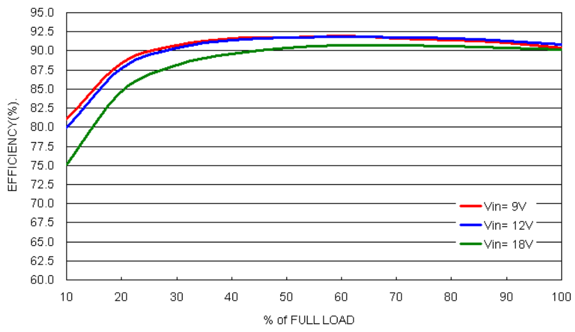
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\ nom}$, Full Load



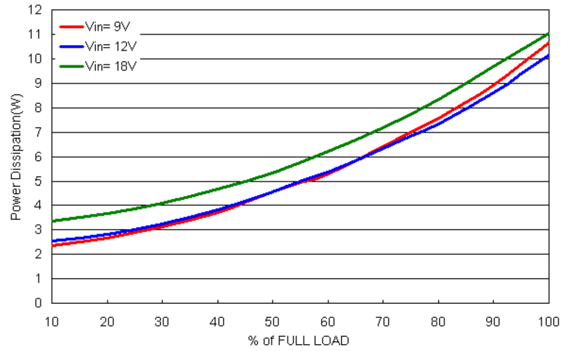
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\ nom}$, Full Load

Characteristic Curves

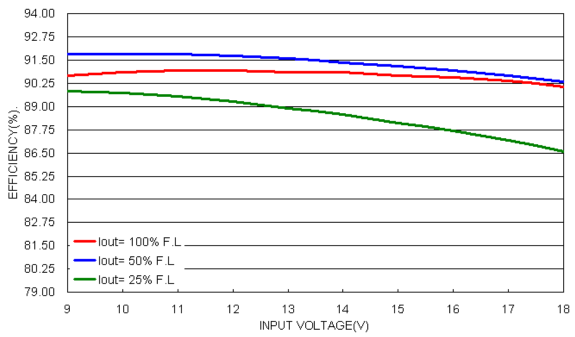
All test conditions are at 25°C. The figures are identical for TEP 100-1212



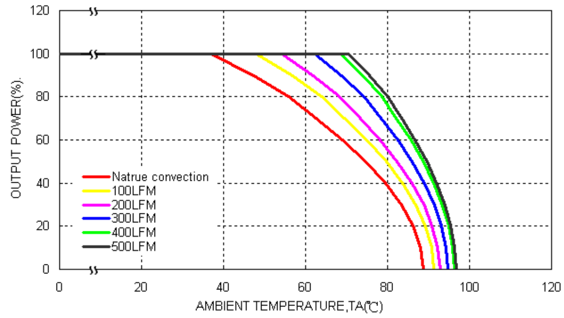
Efficiency versus Output Current



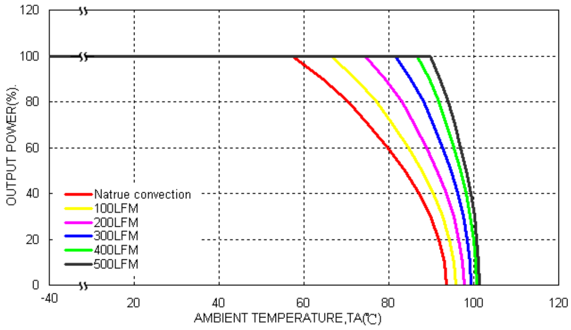
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



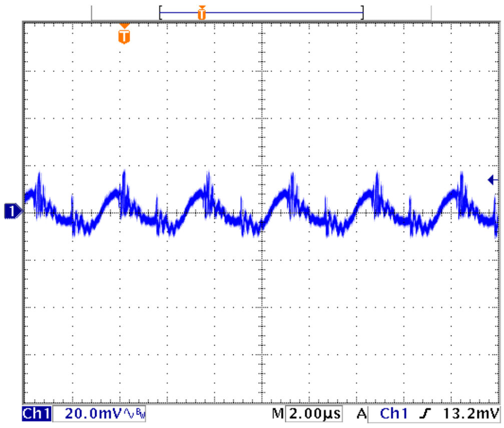
Derating Output Current versus Ambient Temperature with Airflow, V_{in} = $V_{in\ nom}$



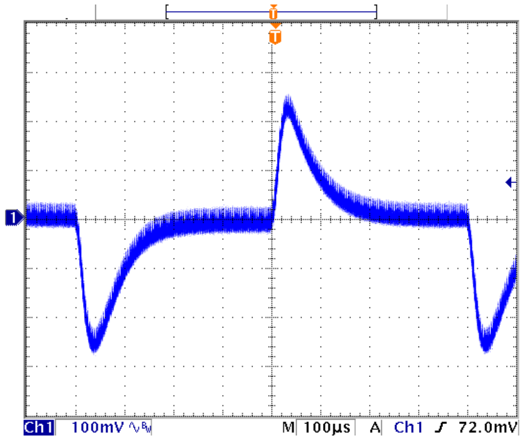
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, V_{in} = $V_{in\ nom}$

Characteristic Curves (Continued)

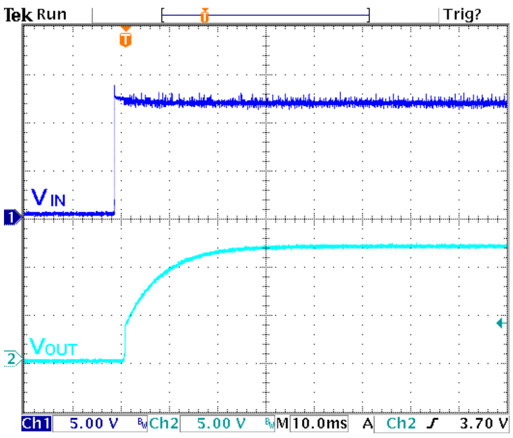
All test conditions are at 25°C. The figures are identical for TEP 100-1212



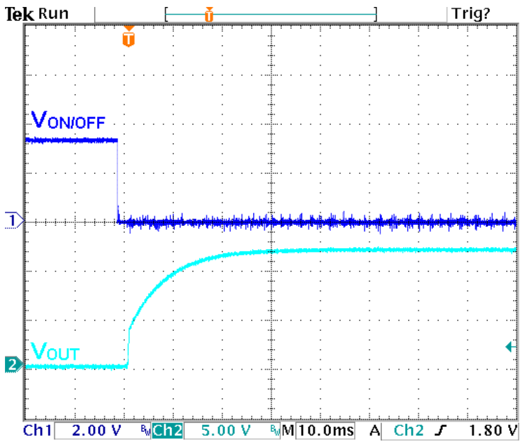
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



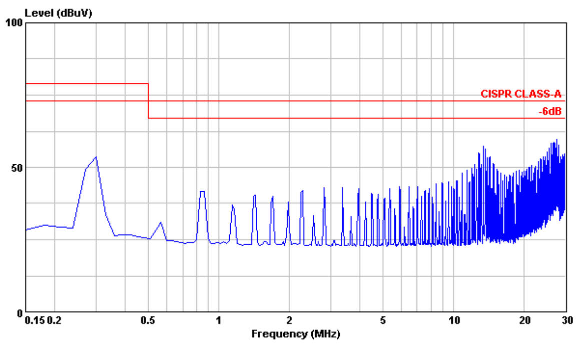
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\,nom}$



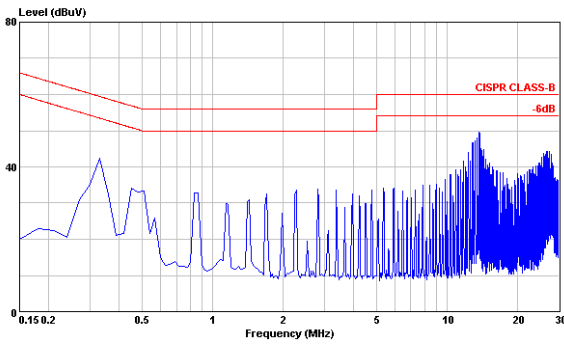
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



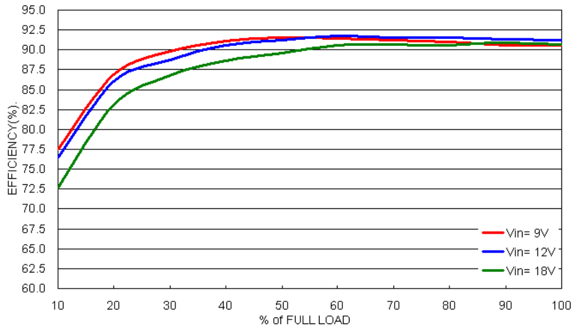
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



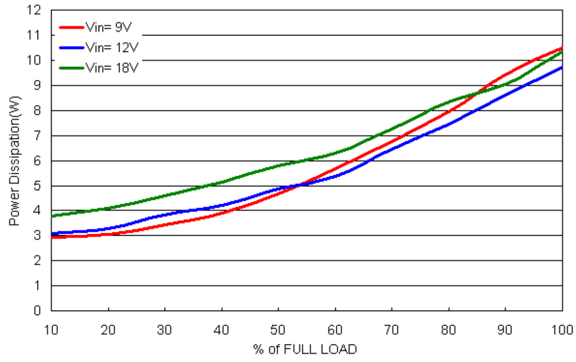
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

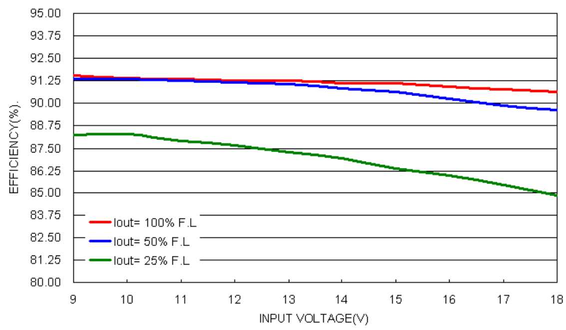
All test conditions are at 25°C. The figures are identical for TEP 100-1213



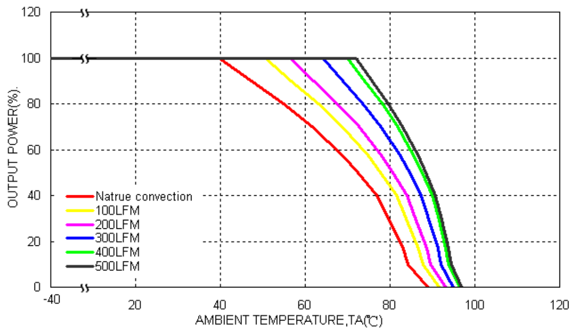
Efficiency versus Output Current



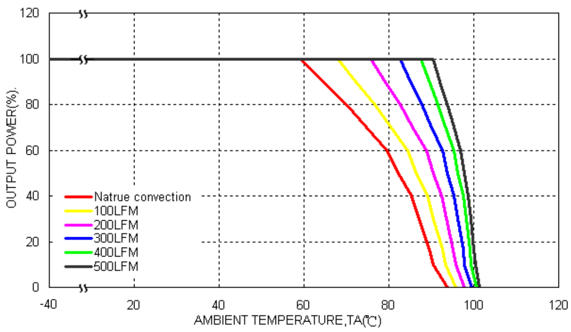
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



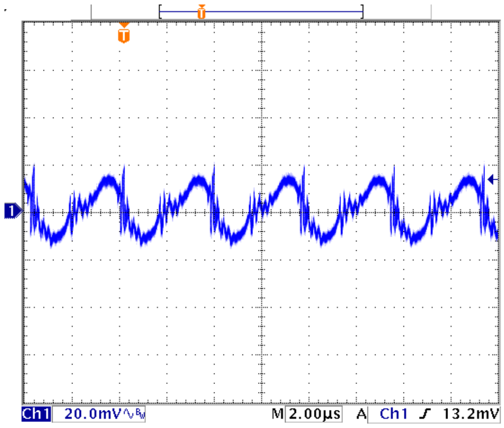
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\ nom}$



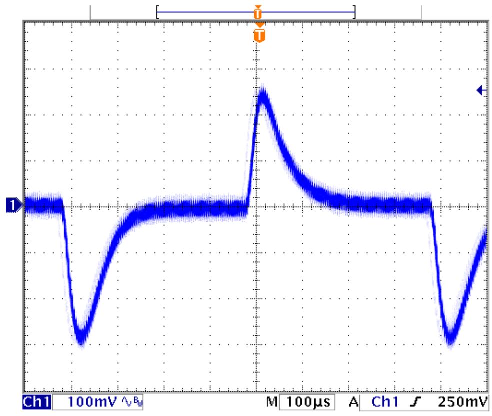
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\ nom}$

Characteristic Curves (Continued)

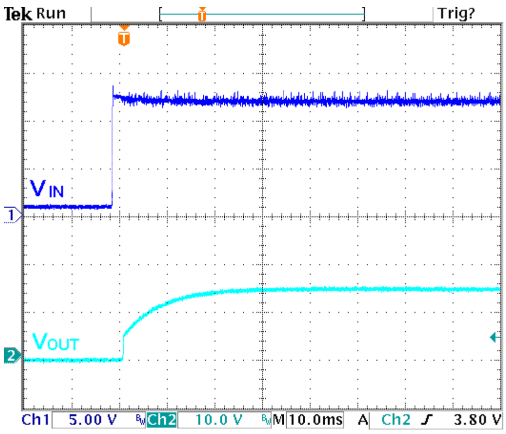
All test conditions are at 25°C. The figures are identical for TEP 100-1213



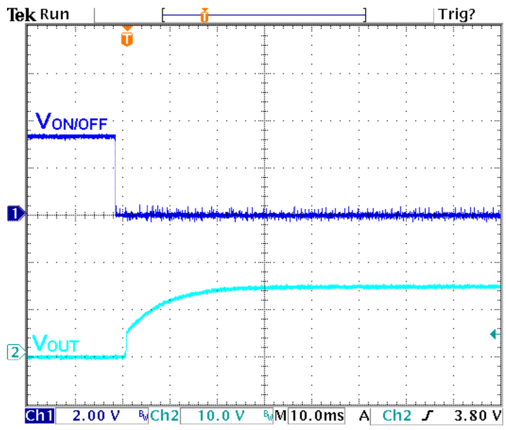
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



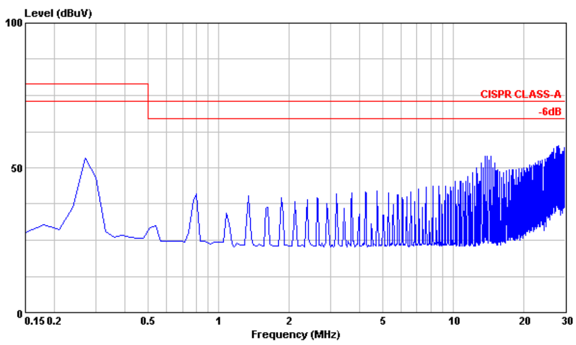
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\ nom}$



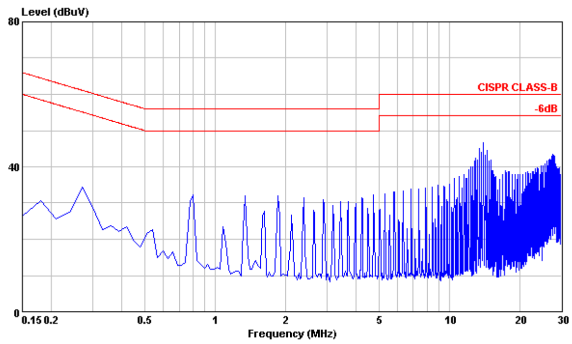
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



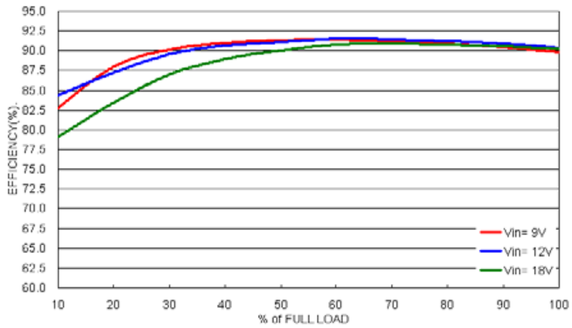
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



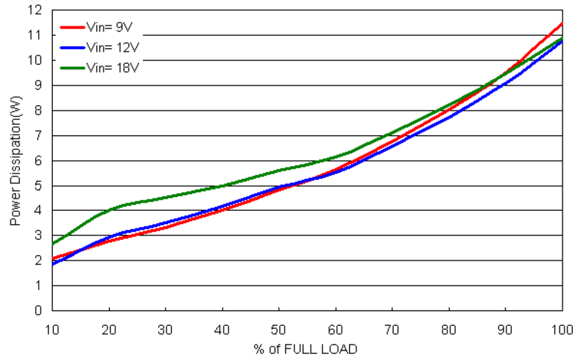
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves

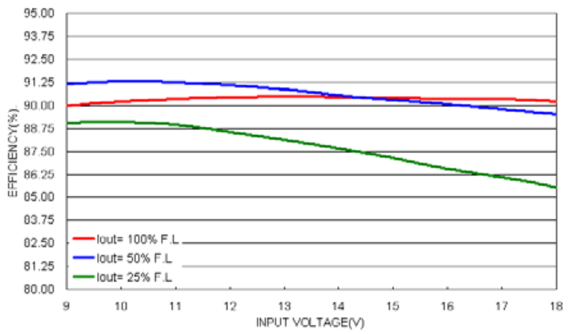
All test conditions are at 25°C. The figures are identical for TEP 100-1215



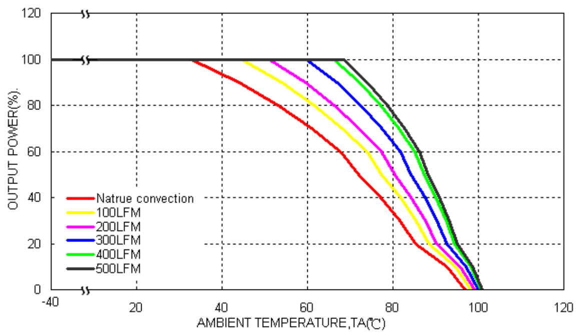
Efficiency versus Output Current



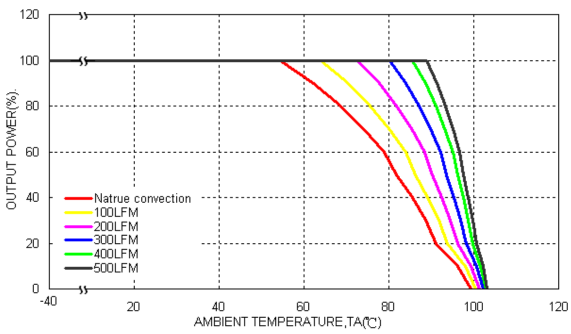
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



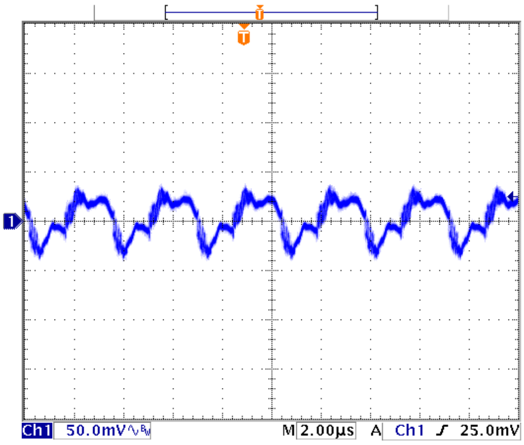
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\,nom}$



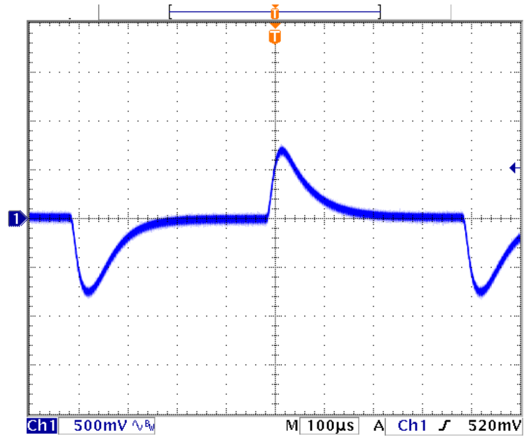
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

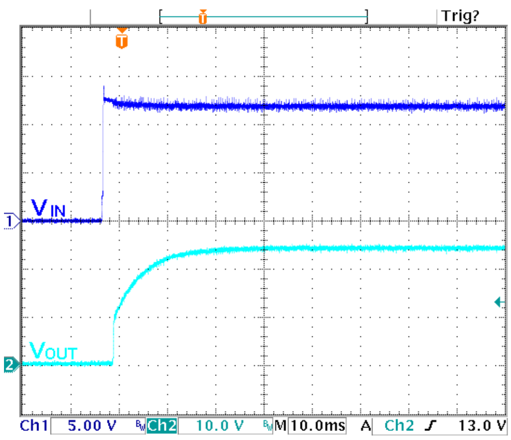
All test conditions are at 25°C. The figures are identical for TEP 100-1215



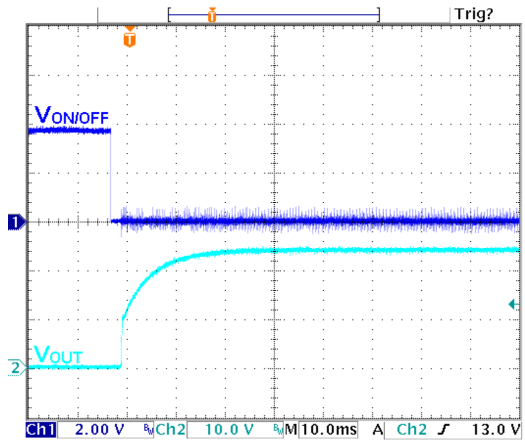
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



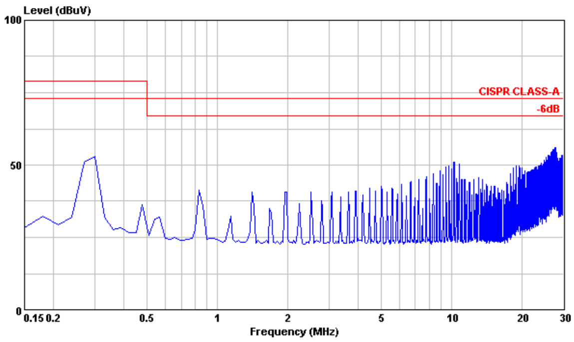
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\,nom}$



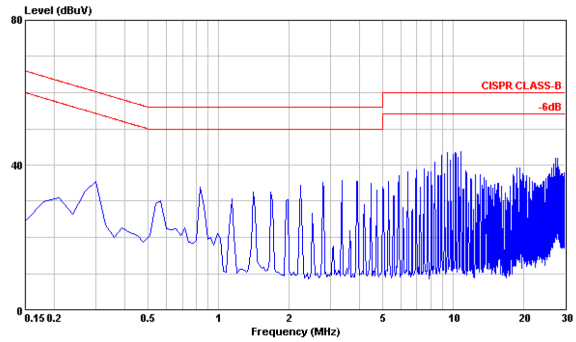
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



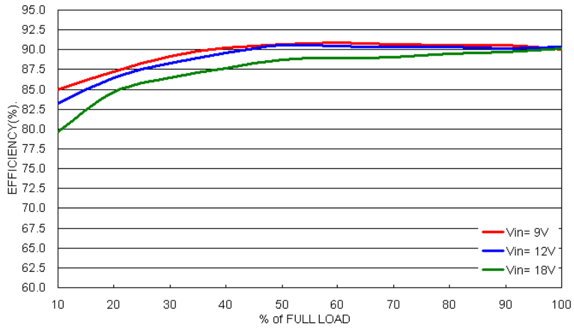
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



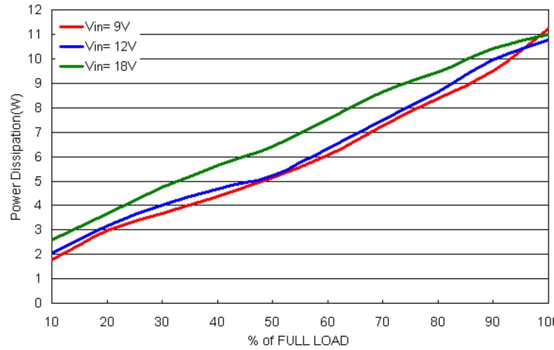
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

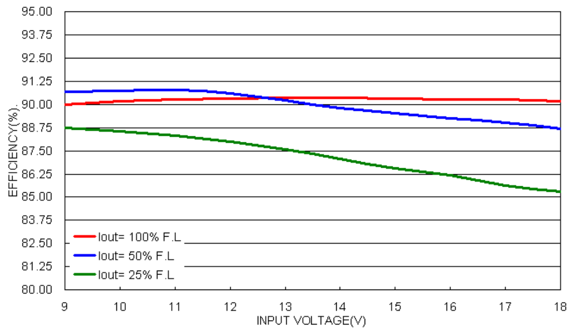
All test conditions are at 25°C. The figures are identical for TEP 100-1216



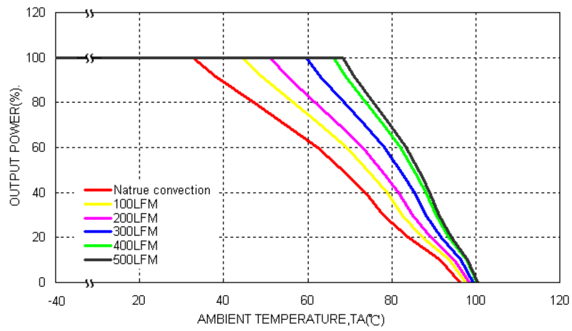
Efficiency versus Output Current



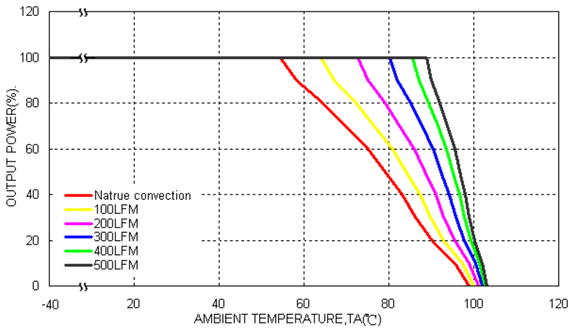
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



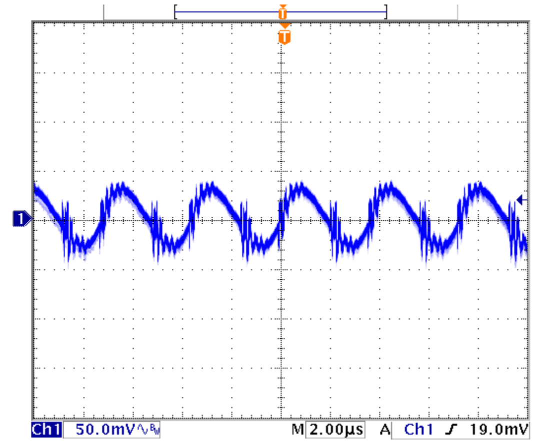
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\,nom}$



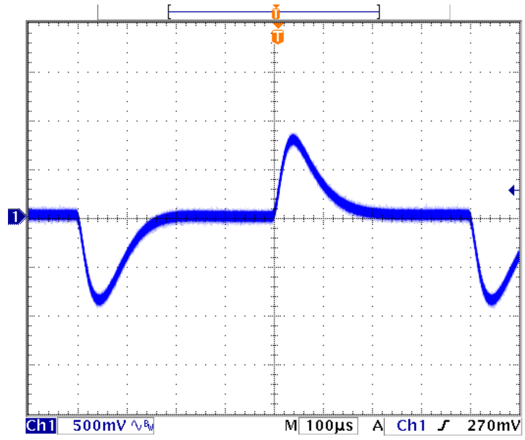
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

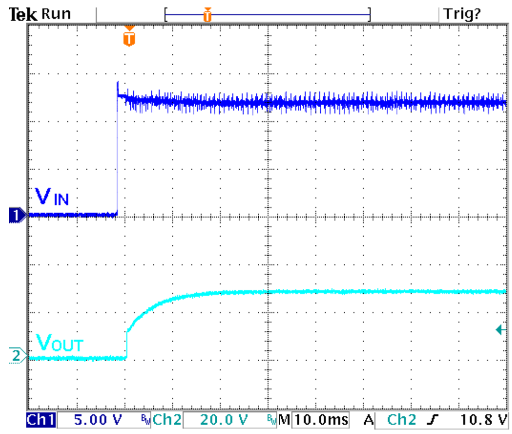
All test conditions are at 25°C. The figures are identical for TEP 100-1216



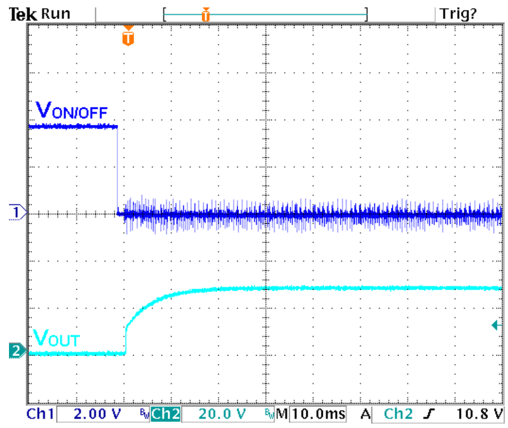
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



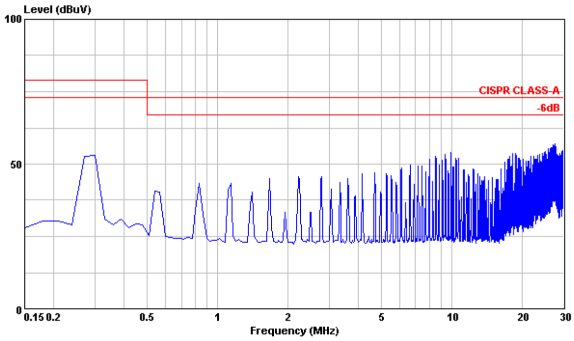
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\,nom}$



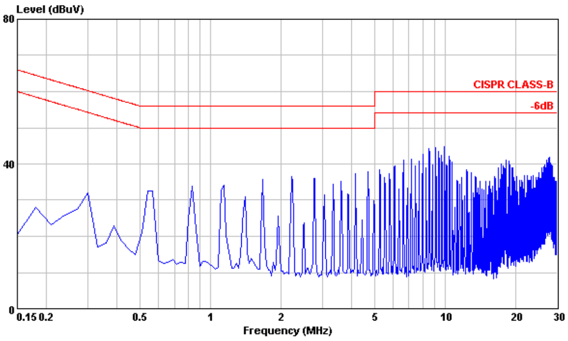
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



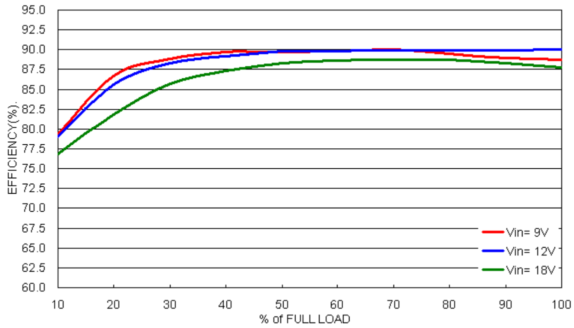
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



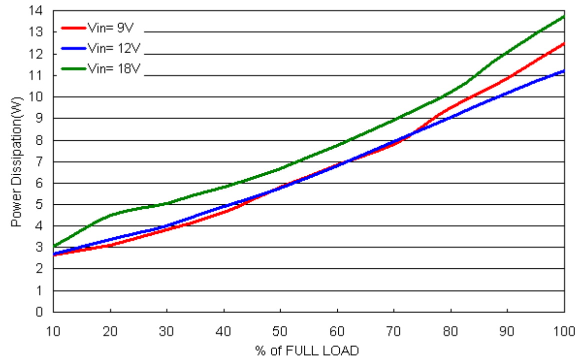
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

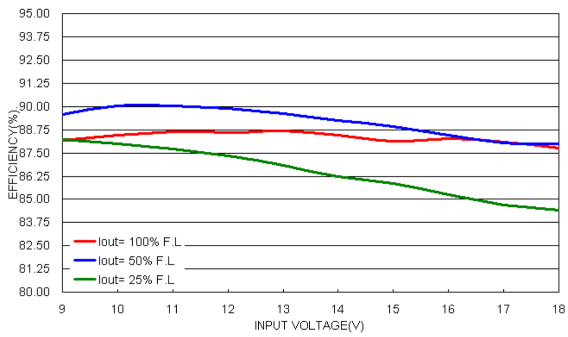
All test conditions are at 25°C. The figures are identical for TEP 100-1218



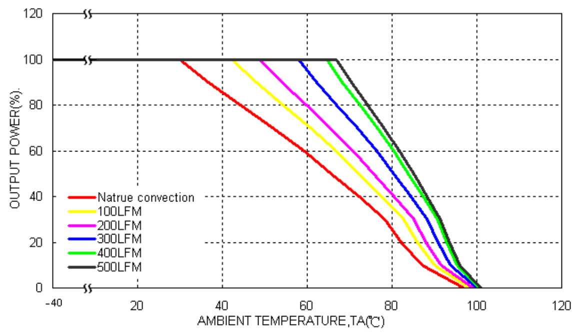
Efficiency versus Output Current



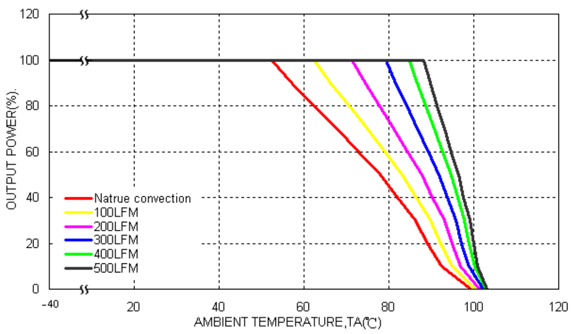
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



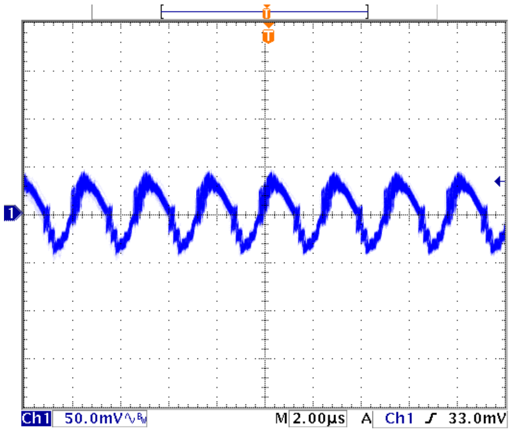
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\,nom}$



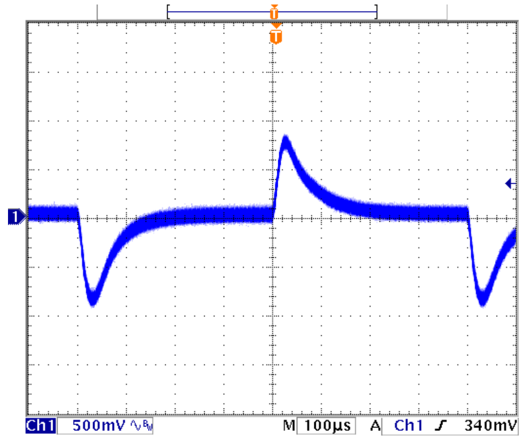
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

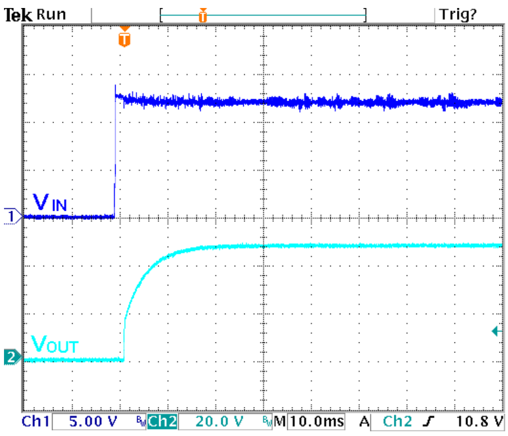
All test conditions are at 25°C. The figures are identical for TEP 100-1218



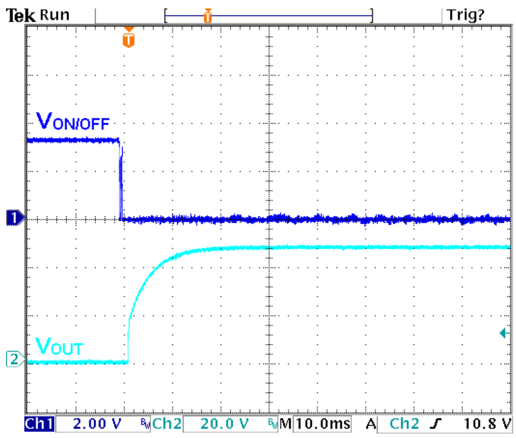
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



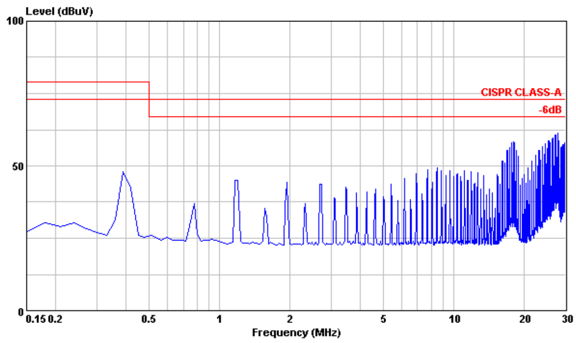
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\,nom}$



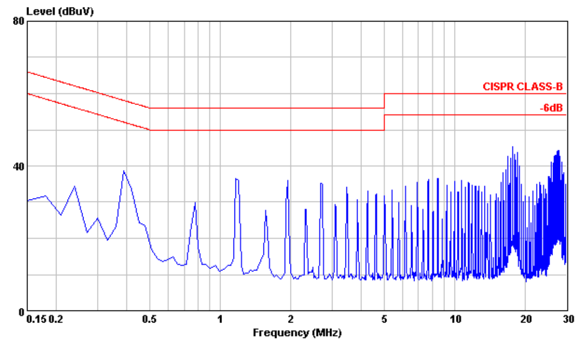
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



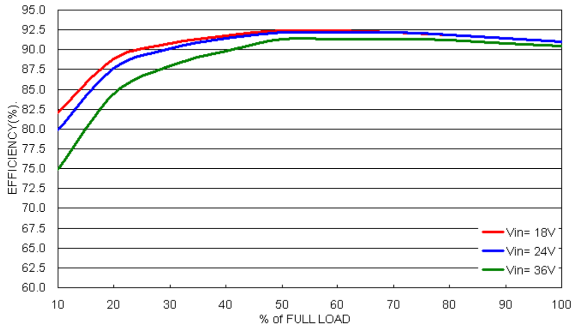
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



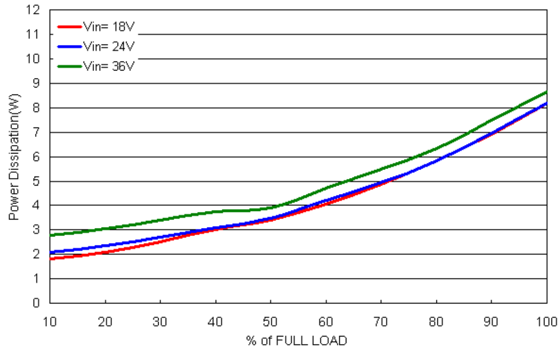
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

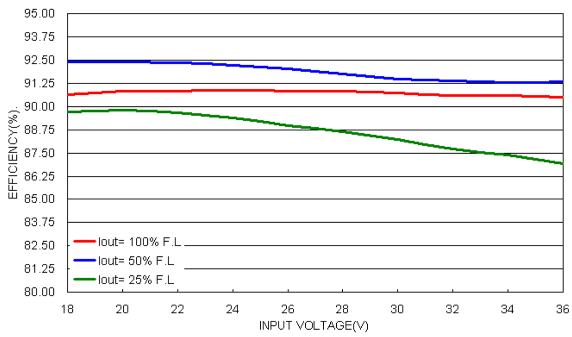
All test conditions are at 25°C. The figures are identical for TEP 100-2410



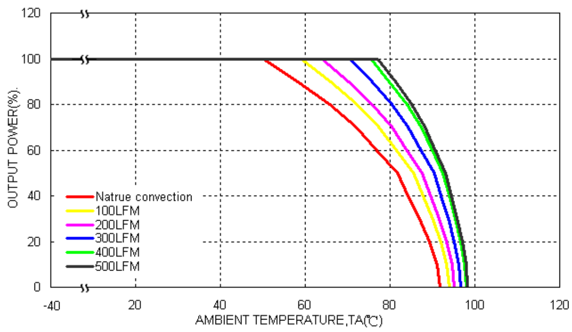
Efficiency versus Output Current



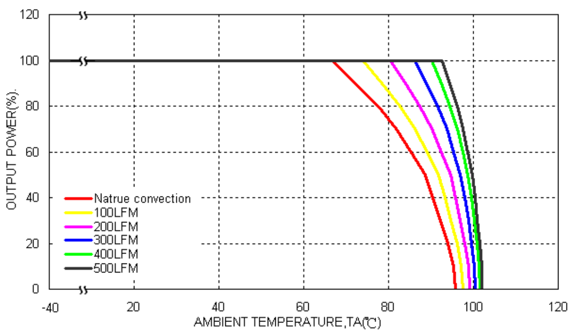
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



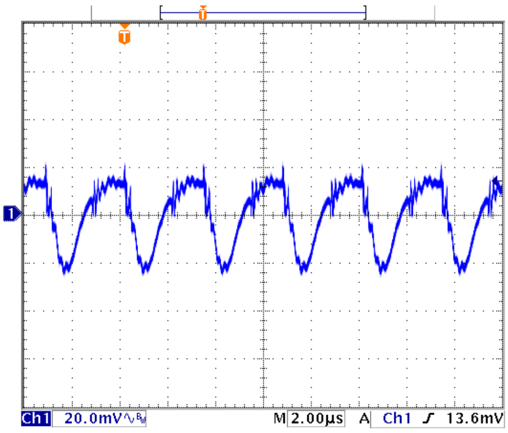
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\ nom}$



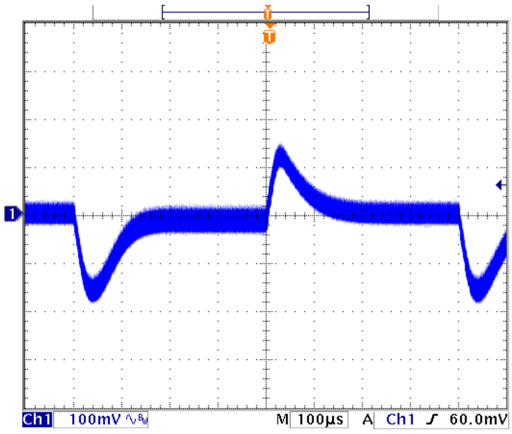
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\ nom}$

Characteristic Curves (Continued)

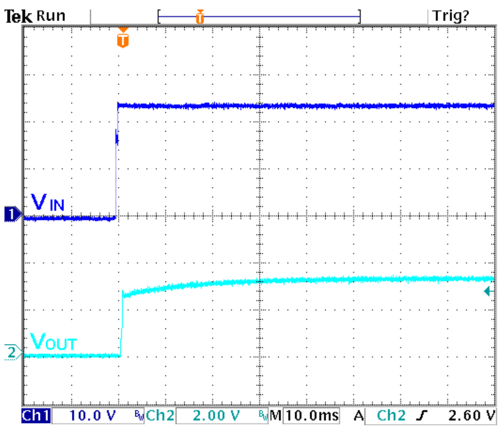
All test conditions are at 25°C. The figures are identical for TEP 100-2410



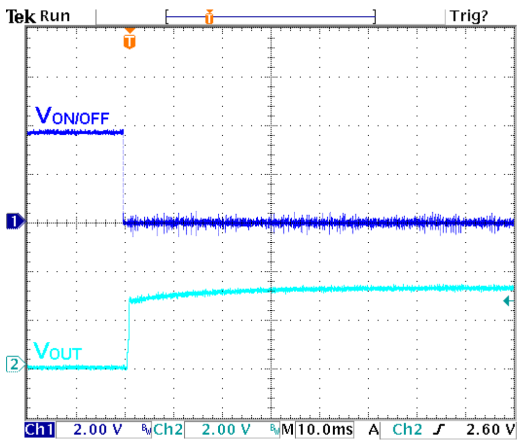
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



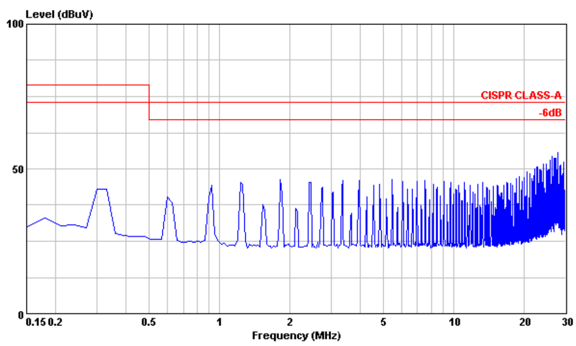
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\,nom}$



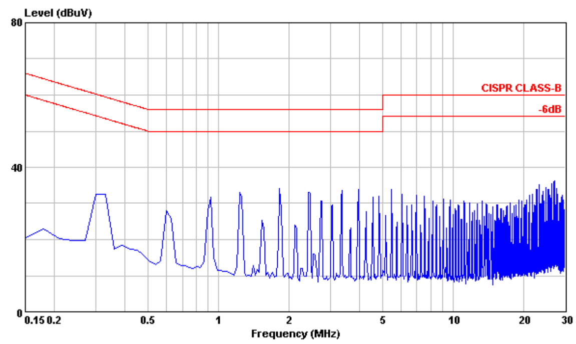
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



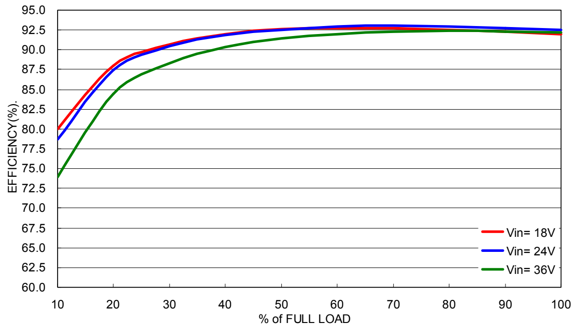
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



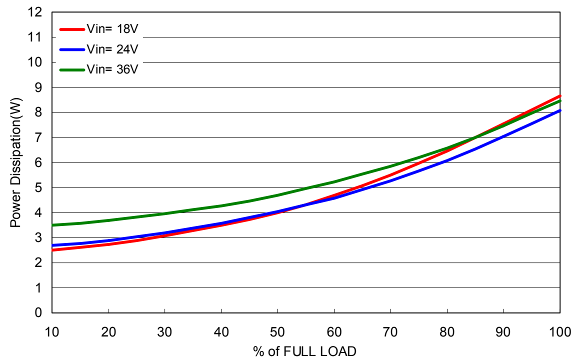
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

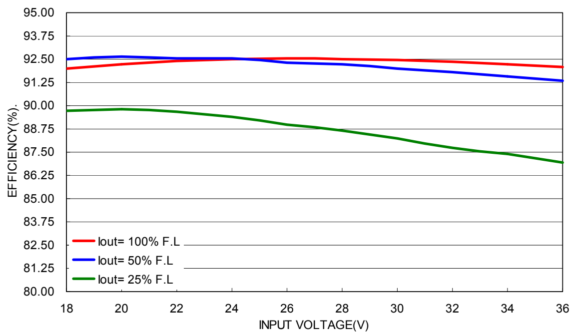
All test conditions are at 25°C. The figures are identical for TEP 100-2411



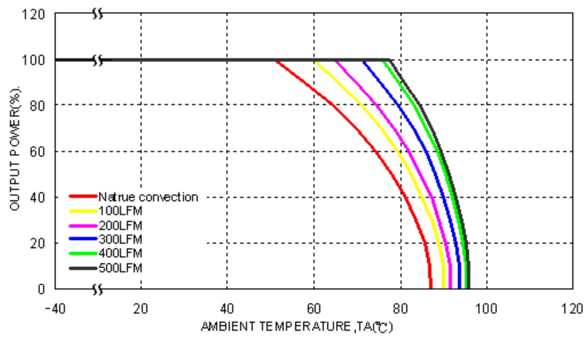
Efficiency versus Output Current



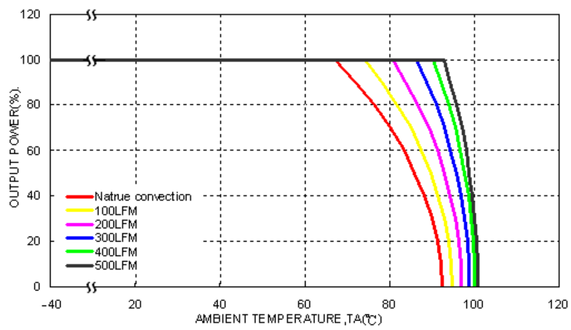
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



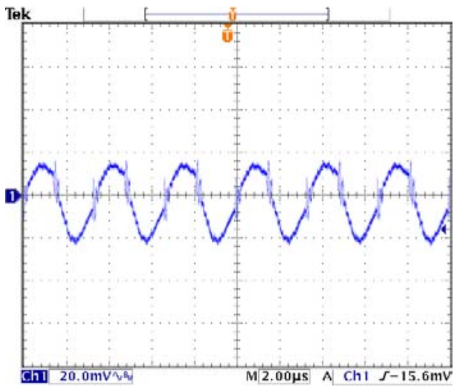
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\,nom}$



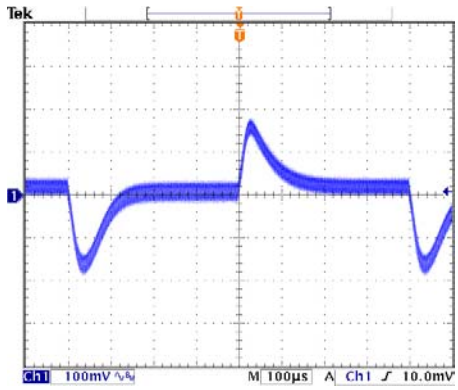
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

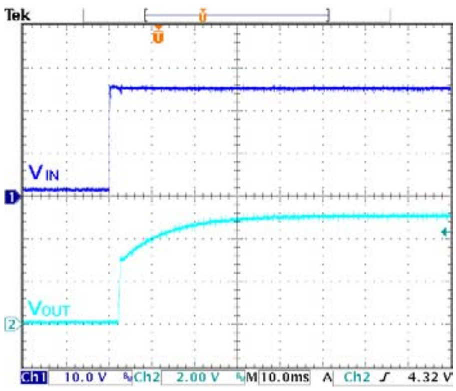
All test conditions are at 25°C. The figures are identical for TEP 100-2411



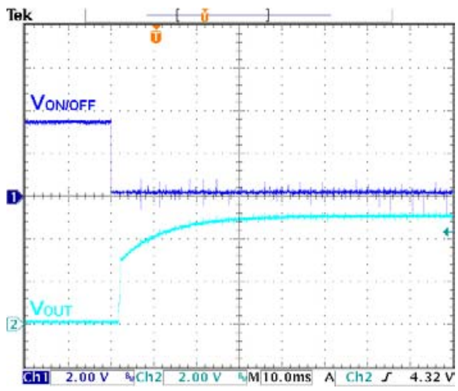
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



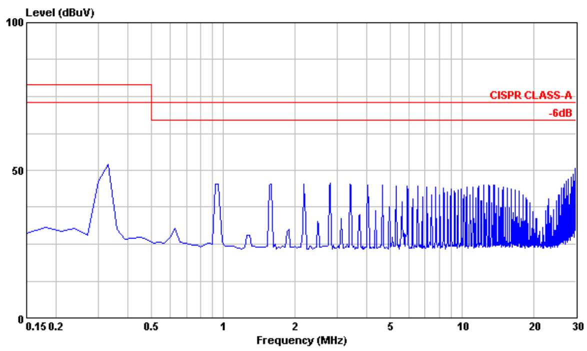
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\ nom}$



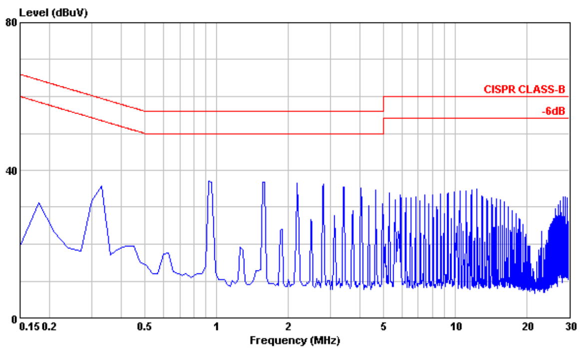
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



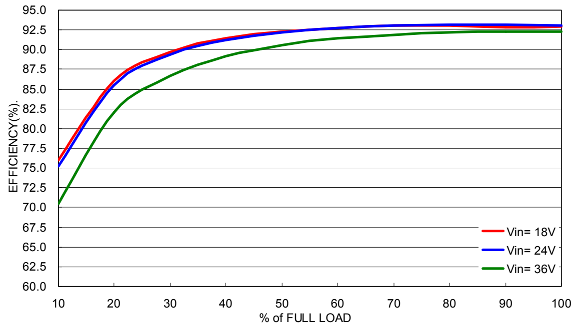
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



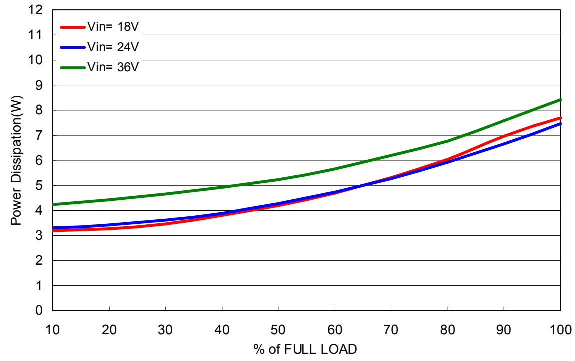
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves (Continued)

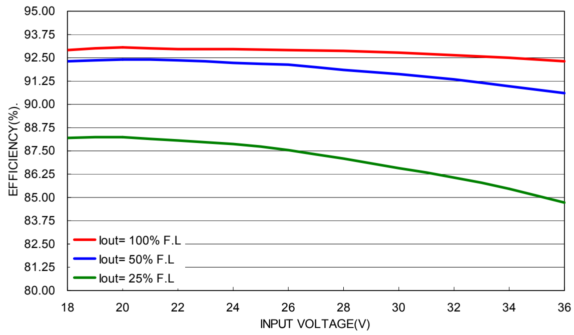
All test conditions are at 25°C. The figures are identical for TEP 100-2412



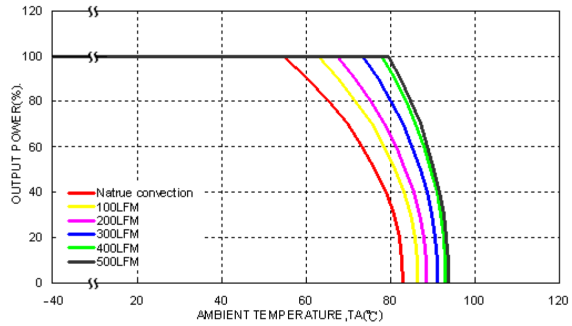
Efficiency versus Output Current



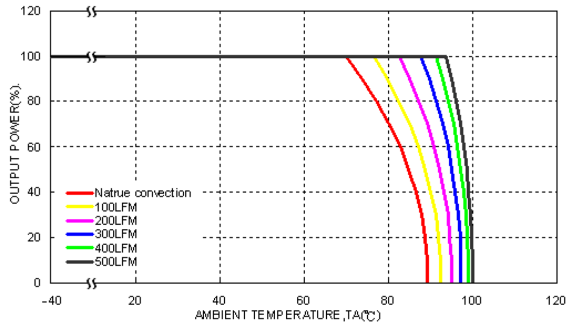
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



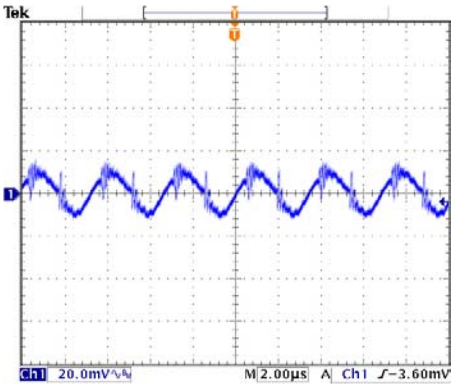
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\ nom}$



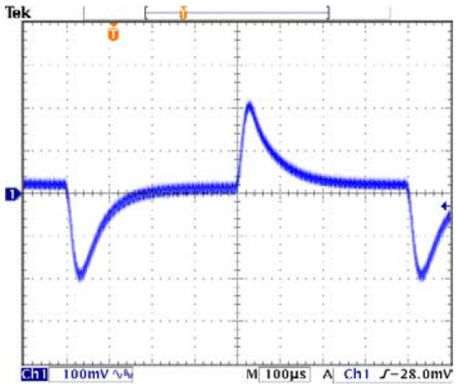
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\ nom}$

Characteristic Curves (Continued)

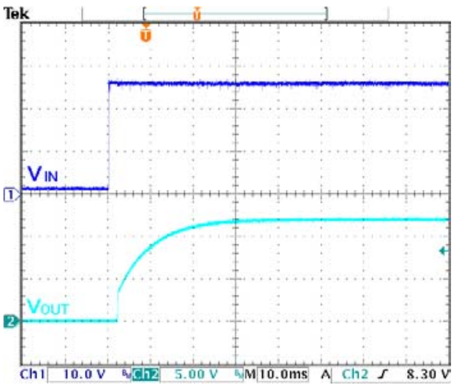
All test conditions are at 25°C. The figures are identical for TEP 100-2412



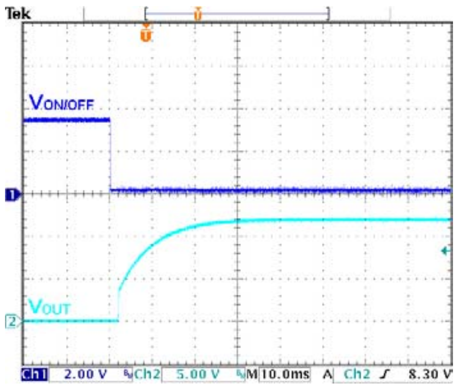
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



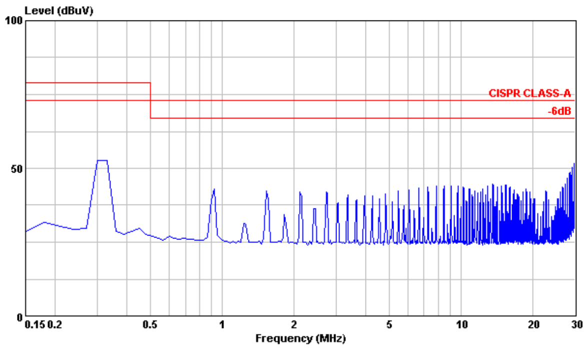
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\,nom}$



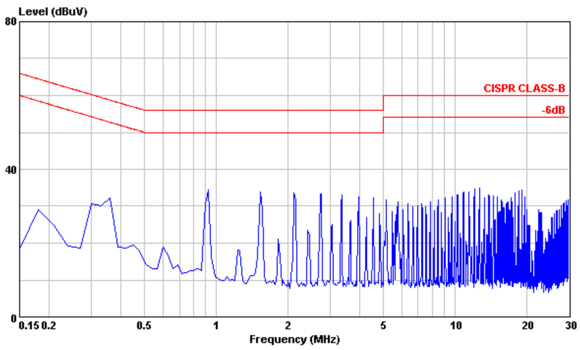
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



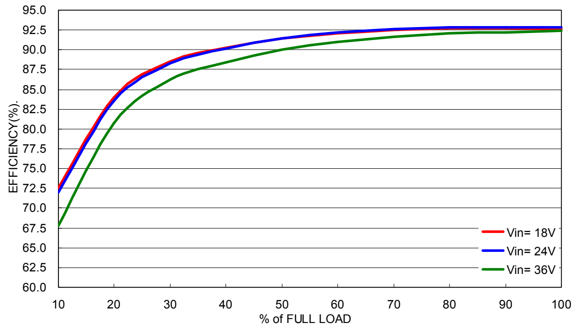
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



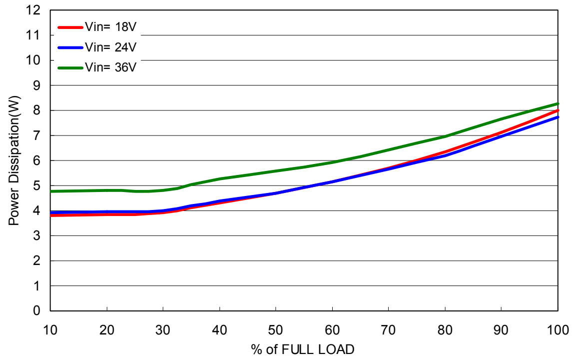
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves (Continued)

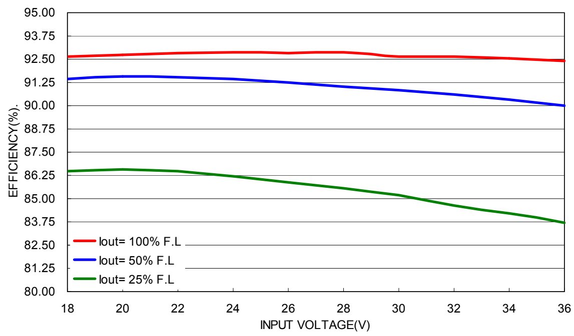
All test conditions are at 25°C. The figures are identical for TEP 100-2413



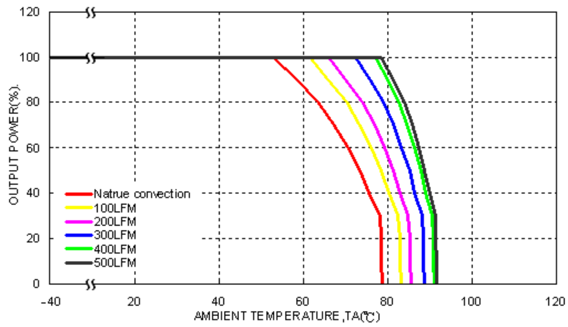
Efficiency versus Output Current



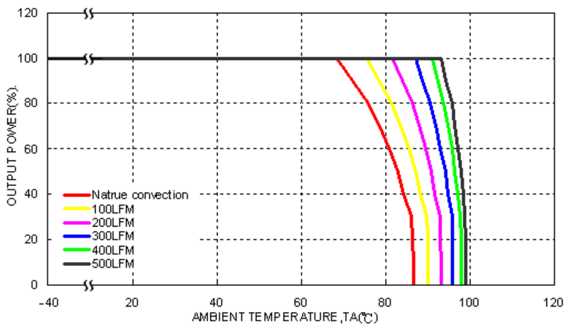
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



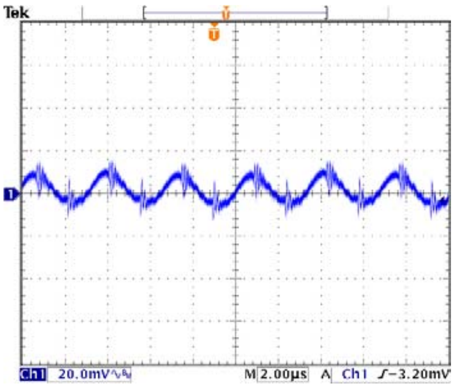
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\,nom}$



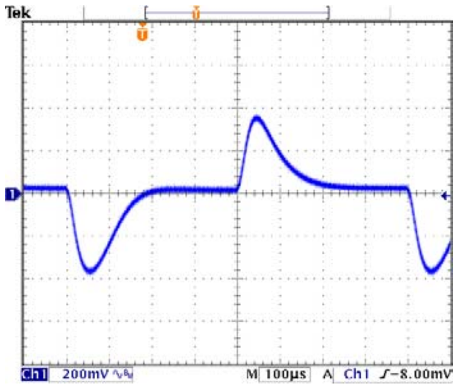
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

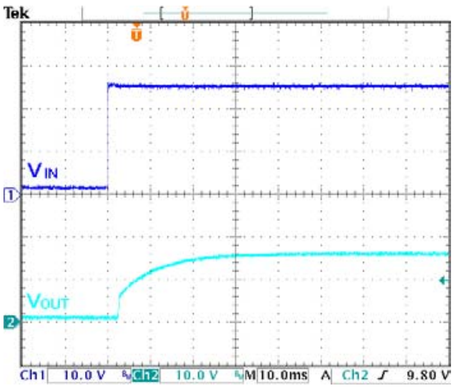
All test conditions are at 25°C. The figures are identical for TEP 100-2413



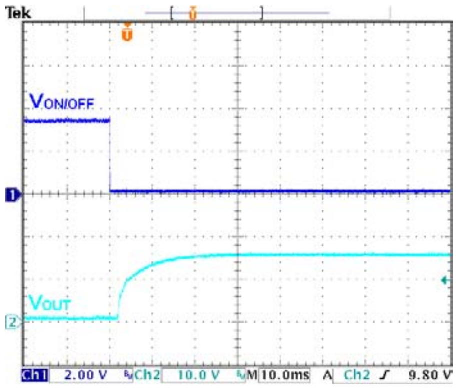
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



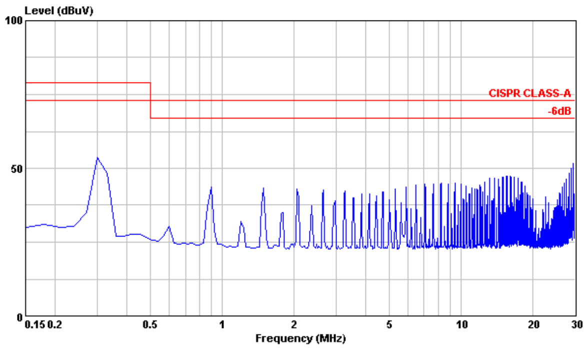
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\,nom}$



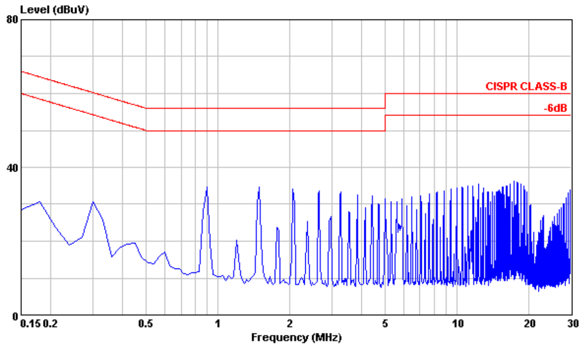
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



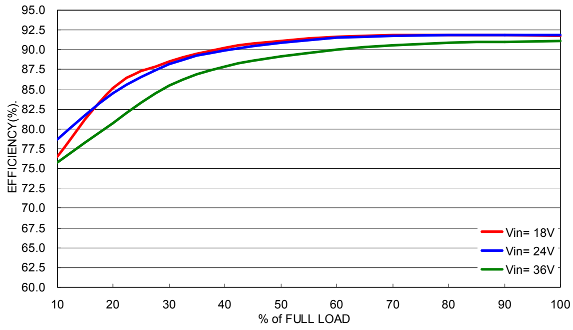
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



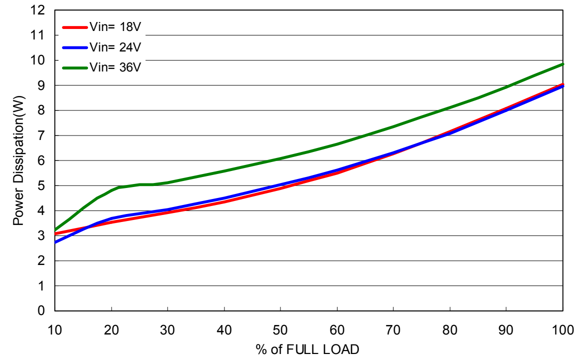
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves (Continued)

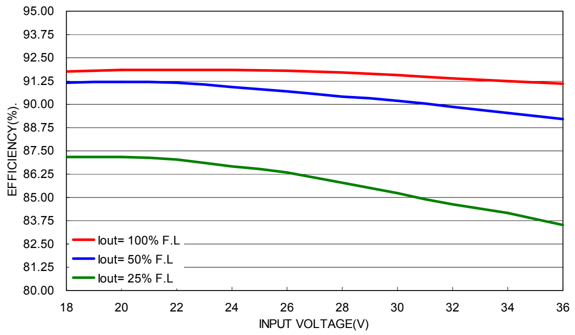
All test conditions are at 25°C. The figures are identical for TEP 100-2415



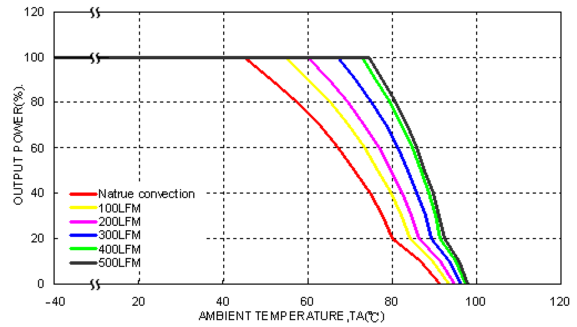
Efficiency versus Output Current



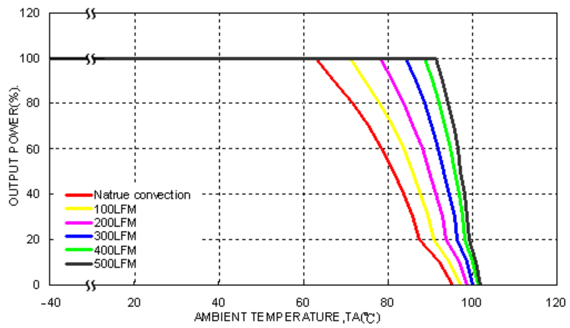
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



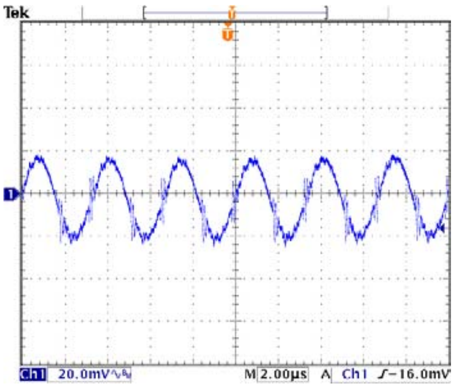
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\,nom}$



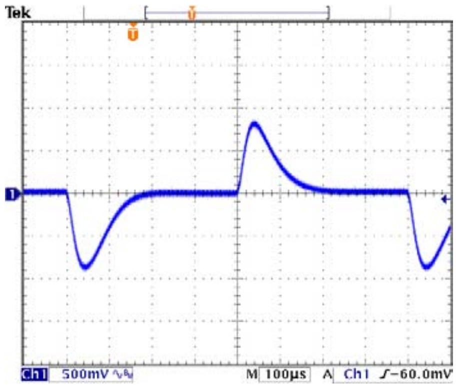
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

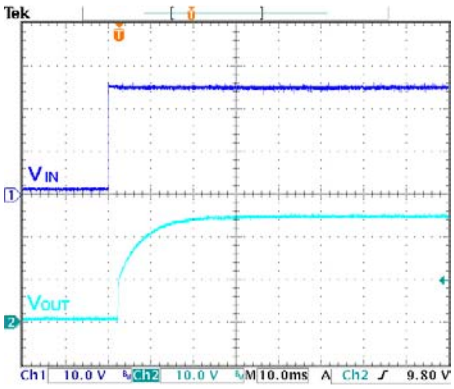
All test conditions are at 25°C. The figures are identical for TEP 100-2415



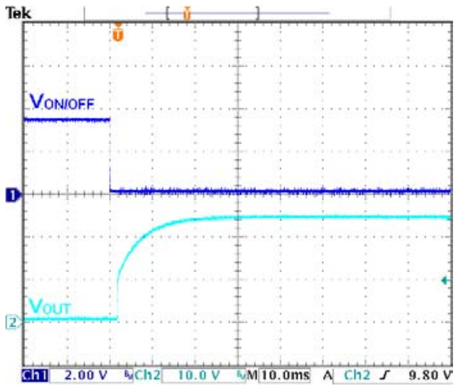
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



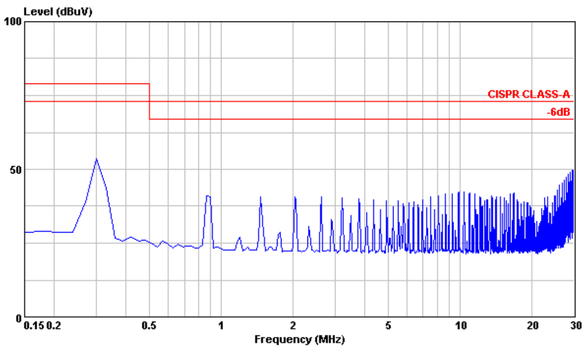
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; $V_{in} = V_{in\,nom}$



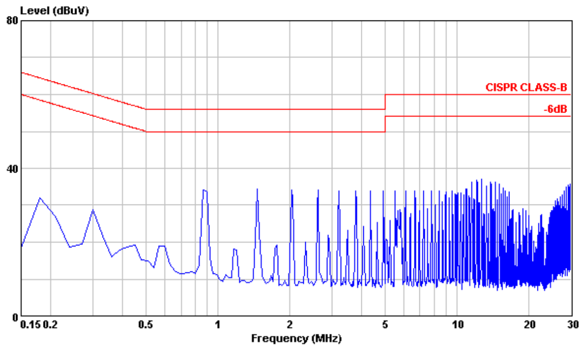
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



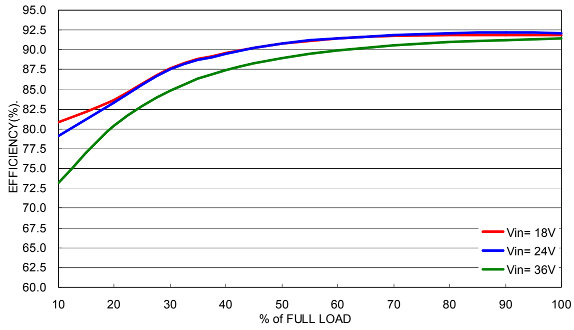
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



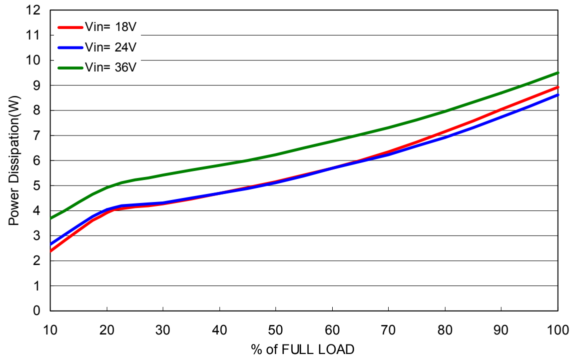
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves (Continued)

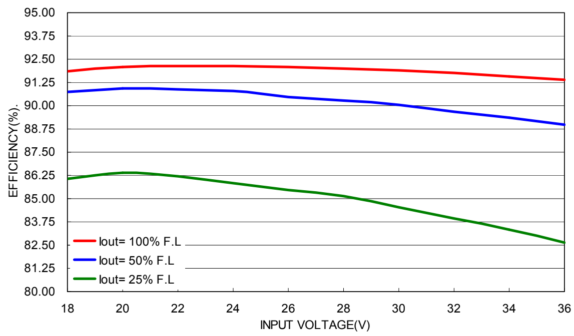
All test conditions are at 25°C. The figures are identical for TEP 100-2416



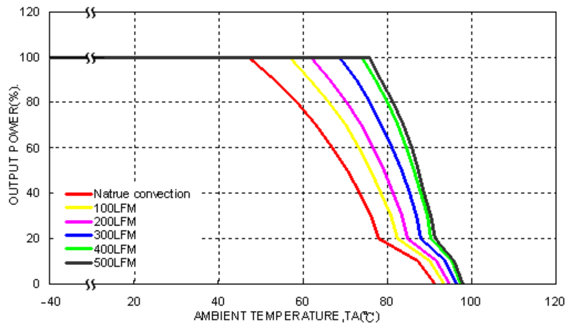
Efficiency versus Output Current



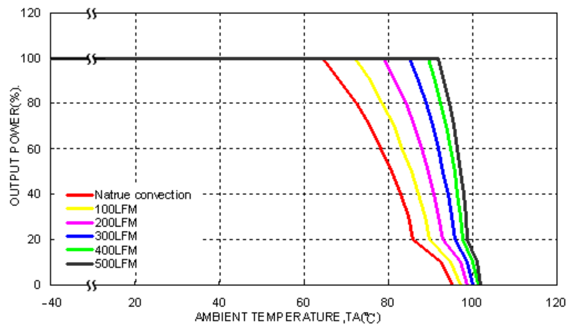
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



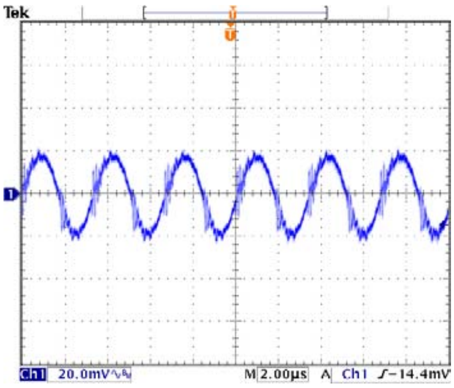
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\,nom}$



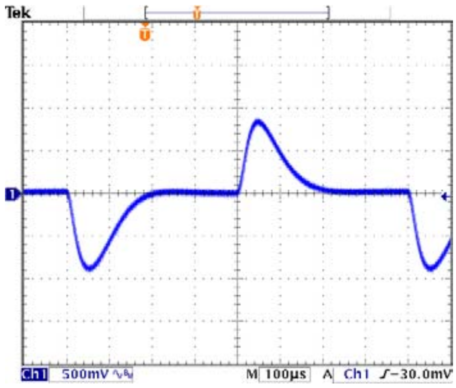
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

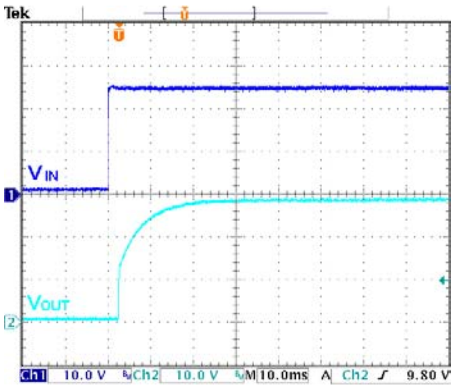
All test conditions are at 25°C. The figures are identical for TEP 100-2416



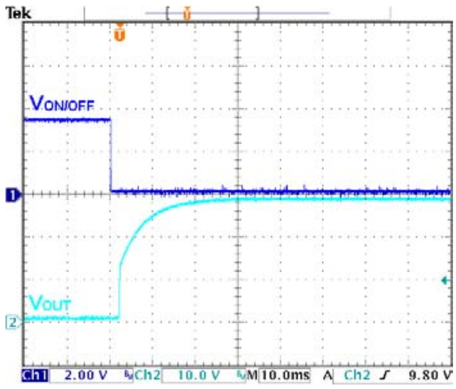
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



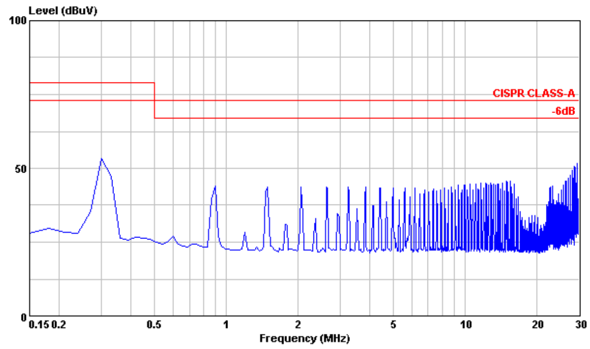
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\ nom}$



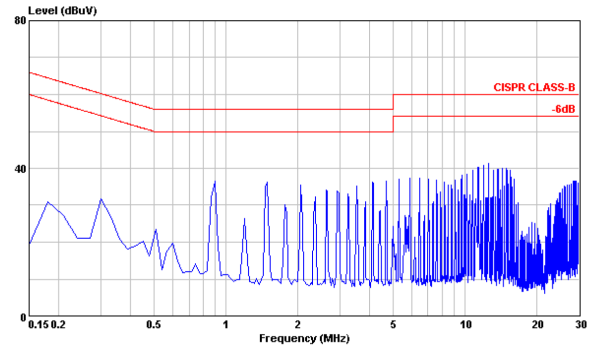
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



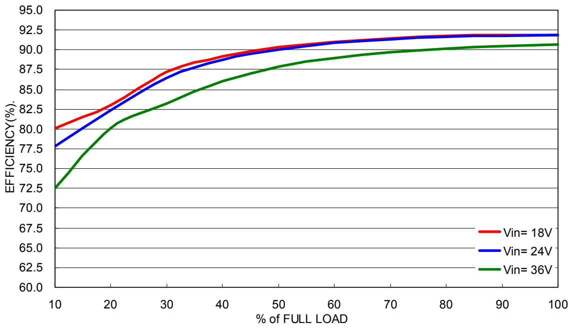
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



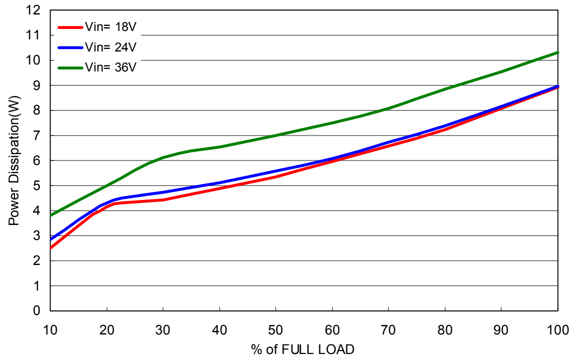
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves (Continued)

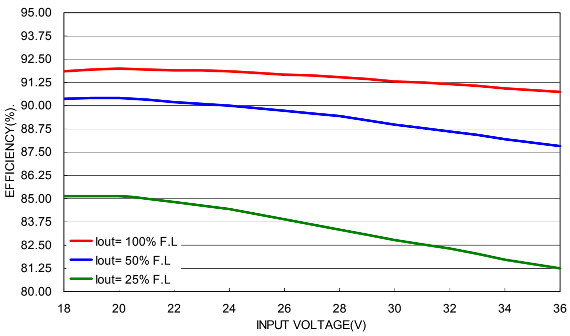
All test conditions are at 25°C. The figures are identical for TEP 100-2418



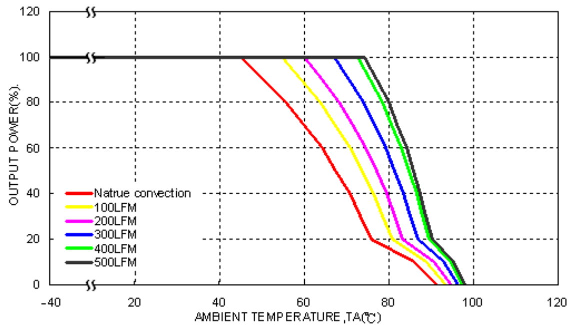
Efficiency versus Output Current



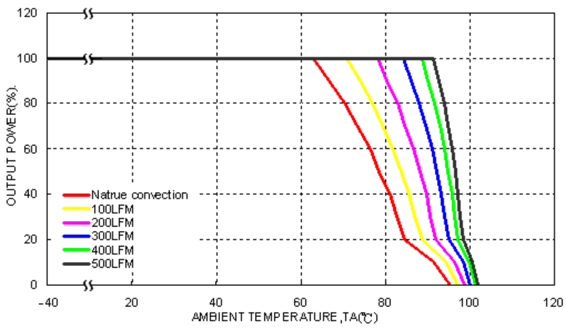
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



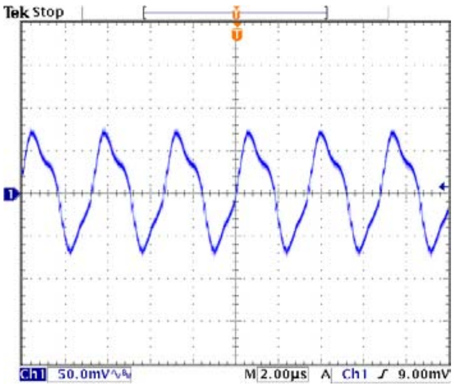
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\,nom}$



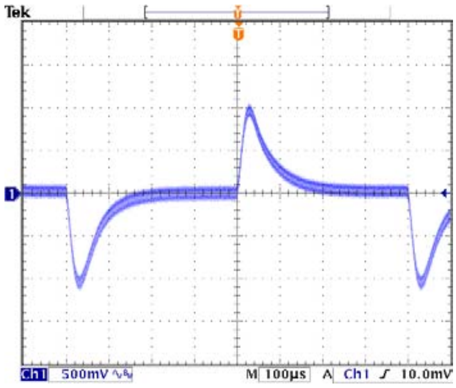
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

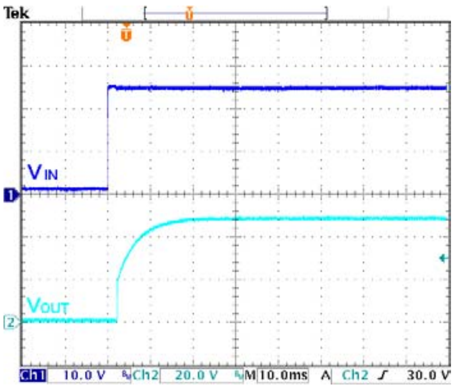
All test conditions are at 25°C. The figures are identical for TEP 100-2418



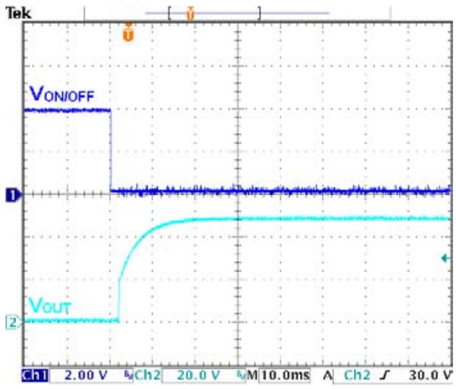
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



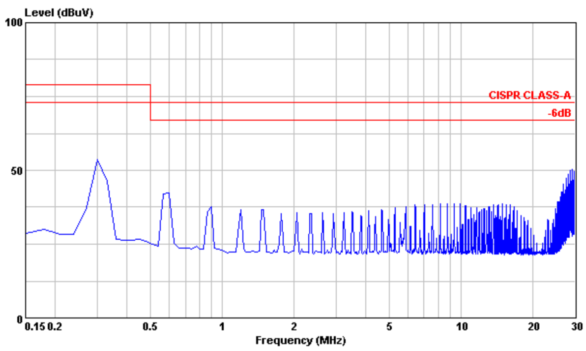
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\ nom}$



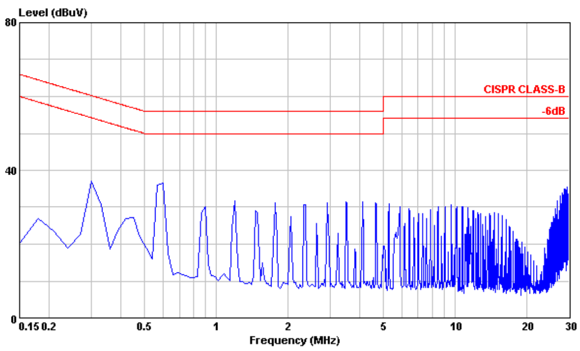
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



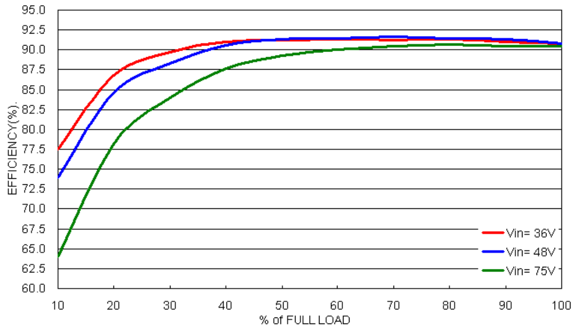
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



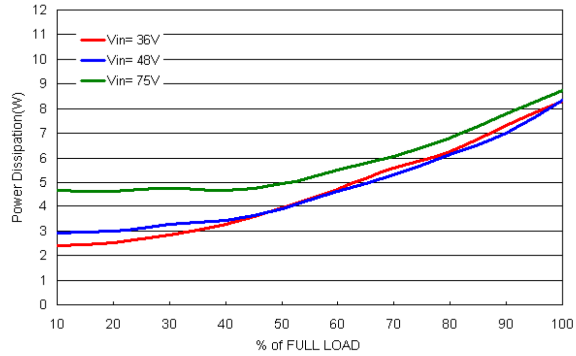
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves

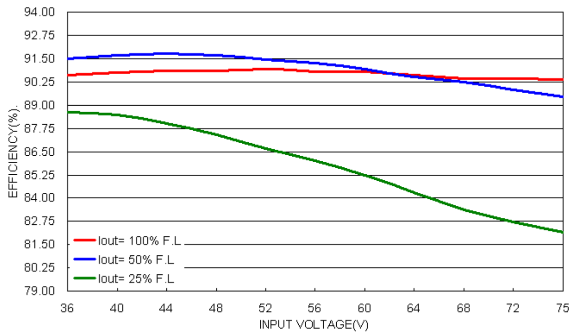
All test conditions are at 25°C. The figures are identical for TEP 100-4810



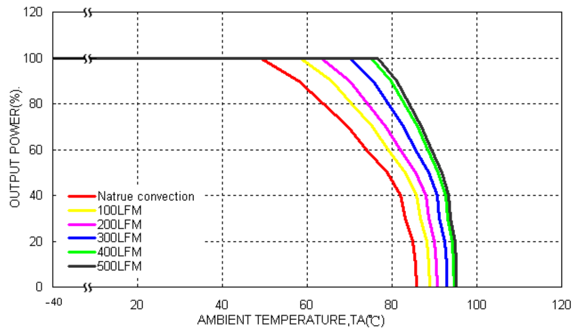
Efficiency versus Output Current



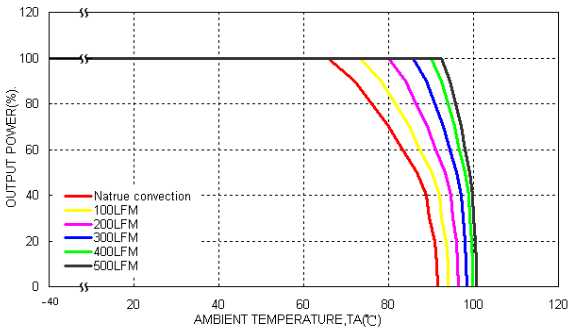
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



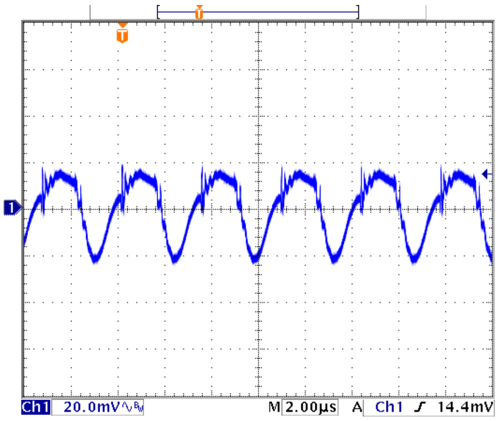
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\ nom}$



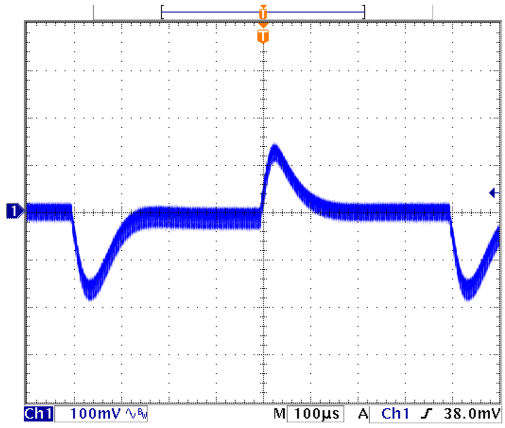
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\ nom}$

Characteristic Curves (Continued)

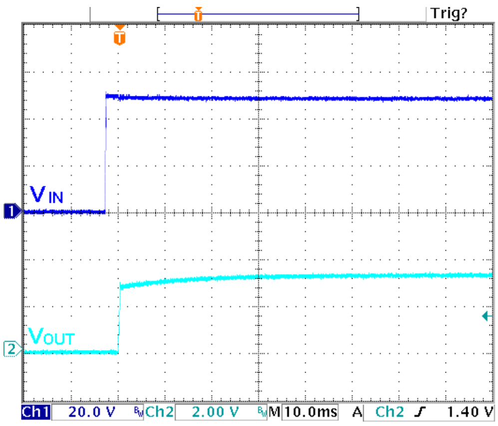
All test conditions are at 25°C. The figures are identical for TEP 100-4810



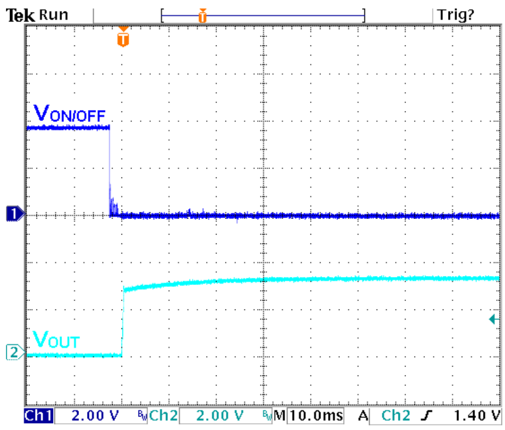
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



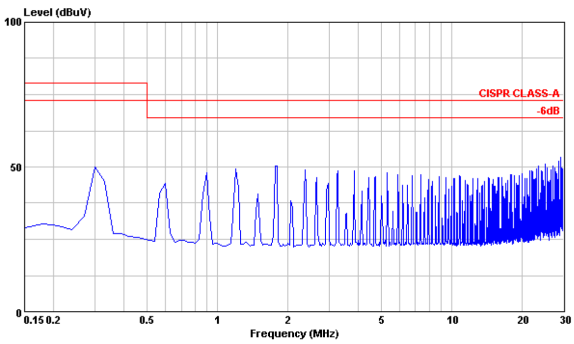
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\,nom}$



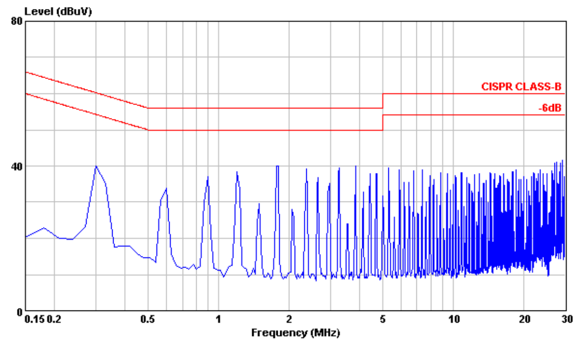
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



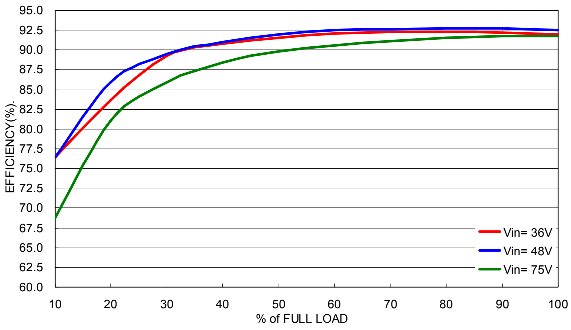
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



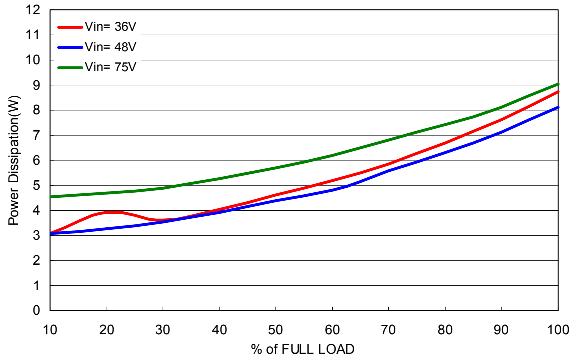
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves (Continued)

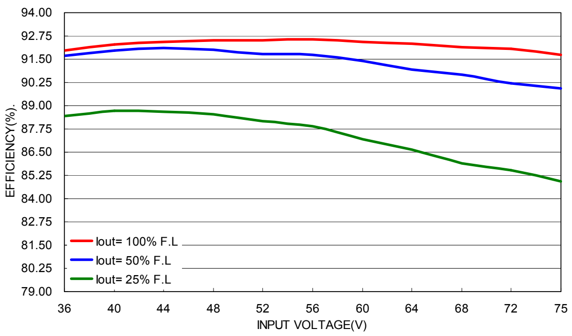
All test conditions are at 25°C. The figures are identical for TEP 100-4811



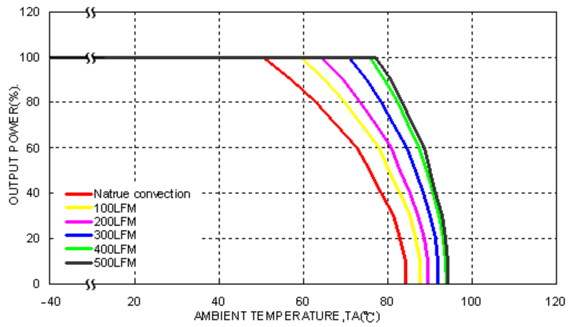
Efficiency versus Output Current



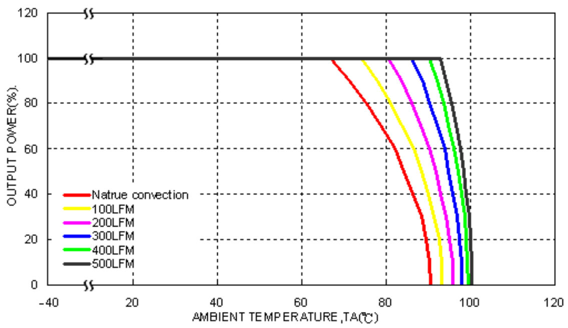
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



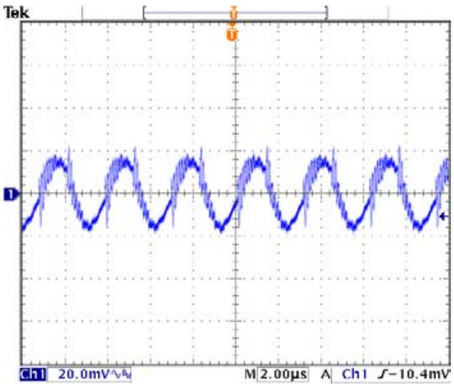
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\,nom}$



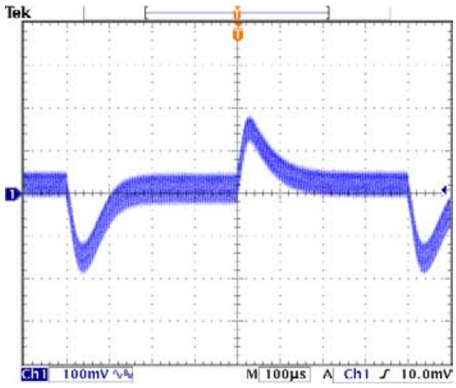
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

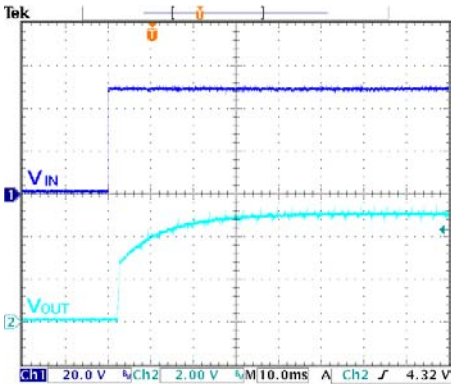
All test conditions are at 25°C. The figures are identical for TEP 100-4811



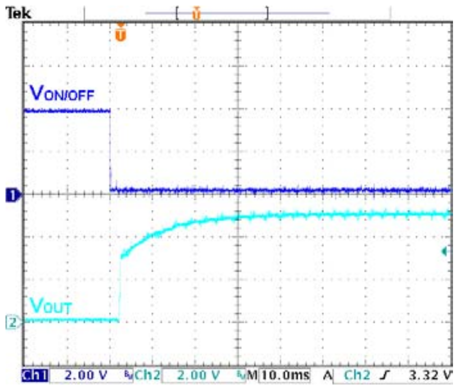
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



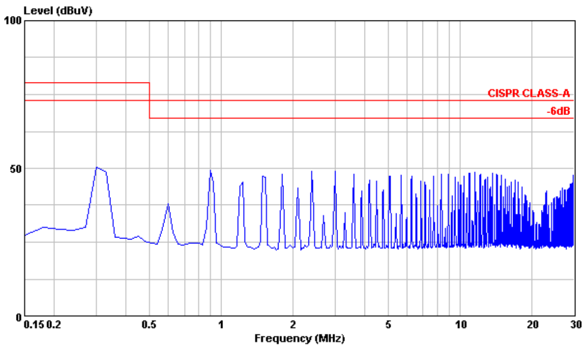
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\ nom}$



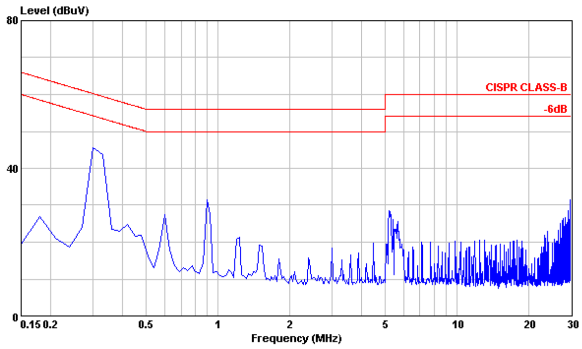
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



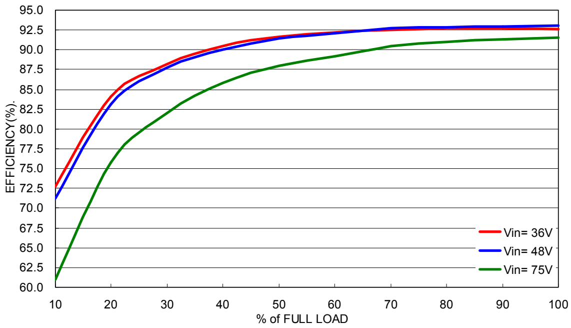
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



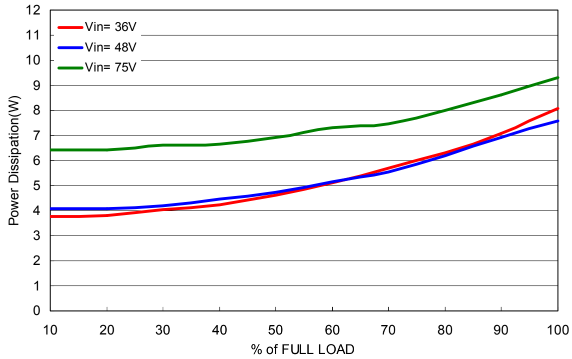
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves (Continued)

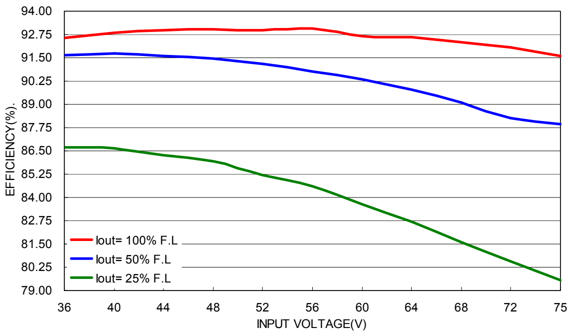
All test conditions are at 25°C. The figures are identical for TEP 100-4812



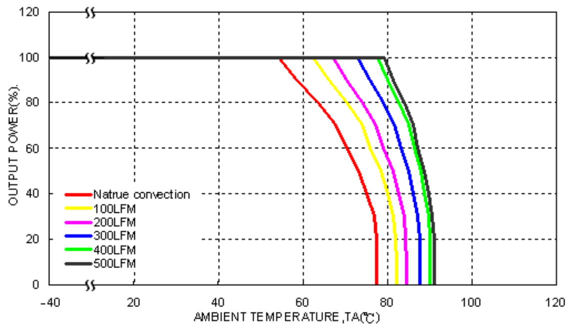
Efficiency versus Output Current



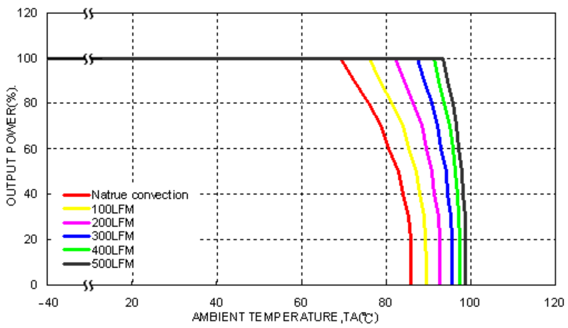
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



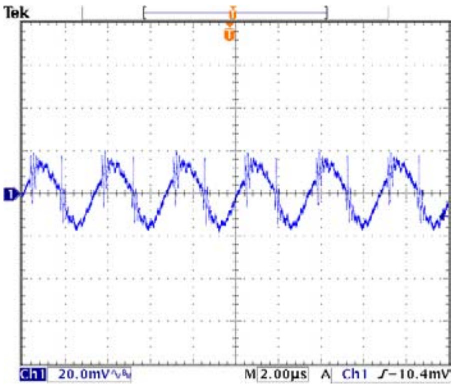
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\ nom}$



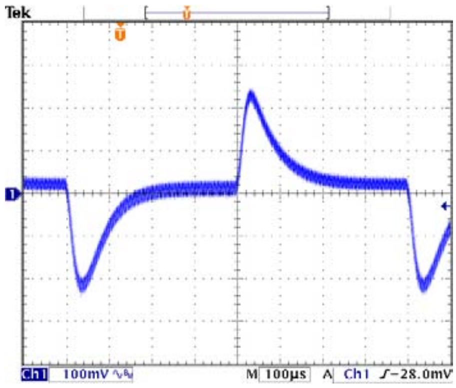
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\ nom}$

Characteristic Curves (Continued)

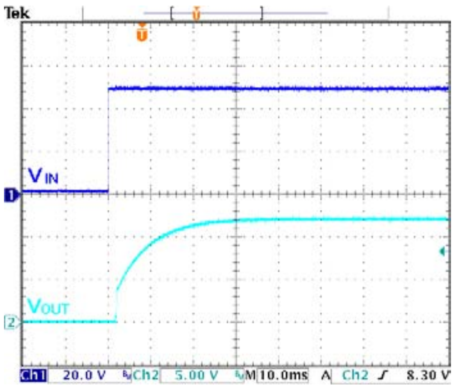
All test conditions are at 25°C. The figures are identical for TEP 100-4812



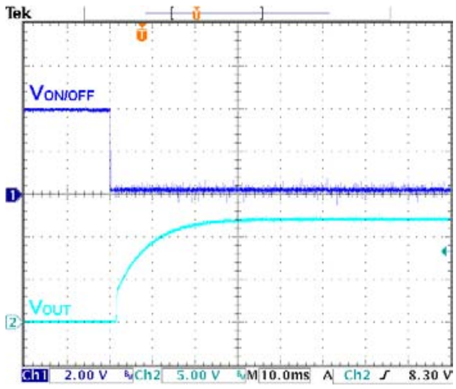
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



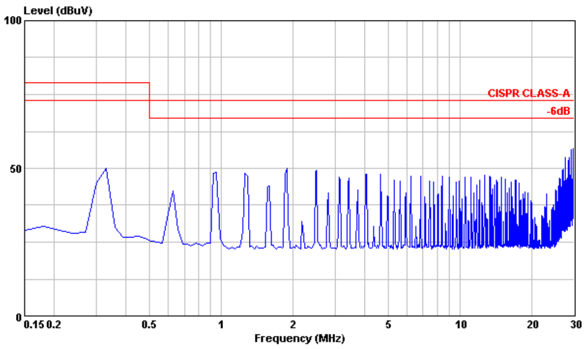
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\,nom}$



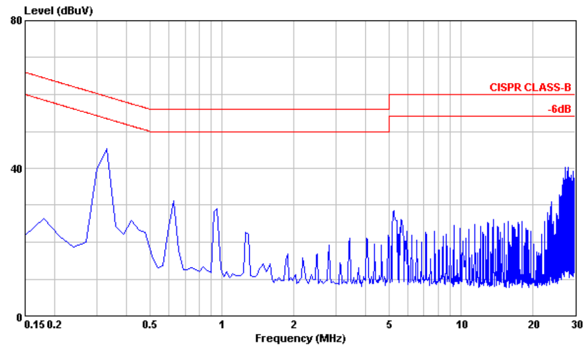
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



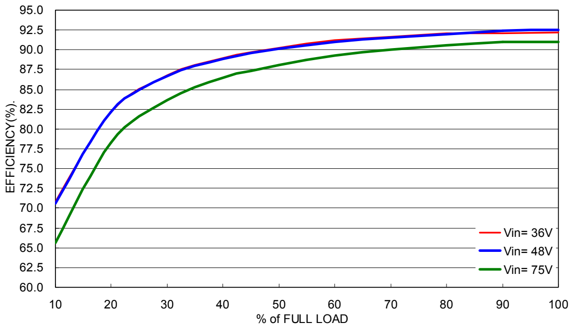
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



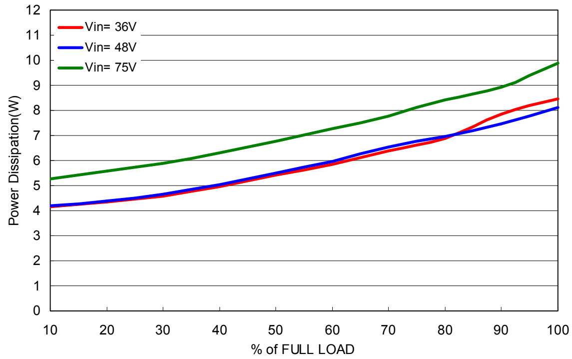
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves (Continued)

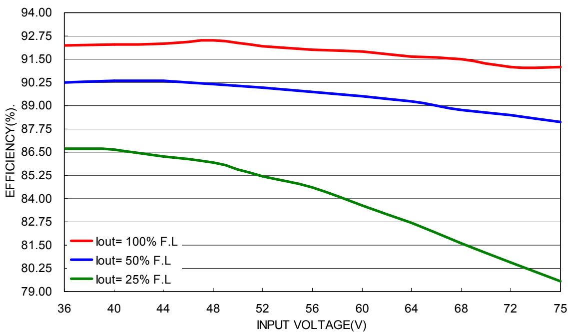
All test conditions are at 25°C. The figures are identical for TEP 100-4813



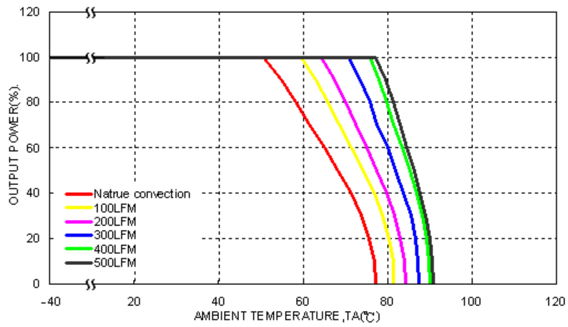
Efficiency versus Output Current



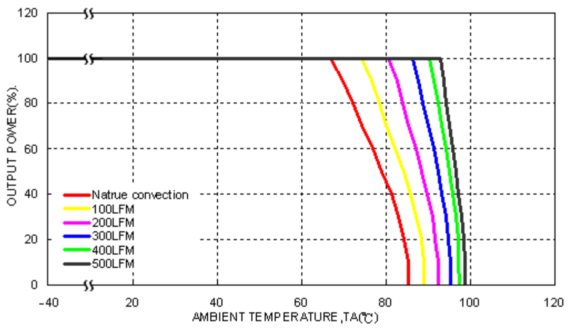
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



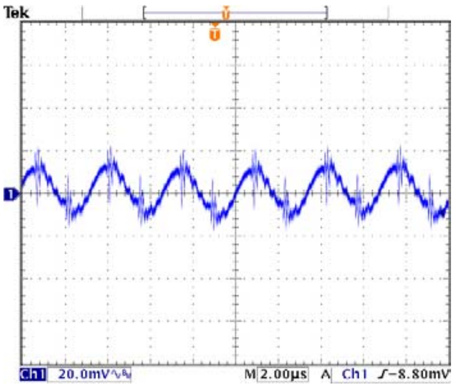
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\,nom}$



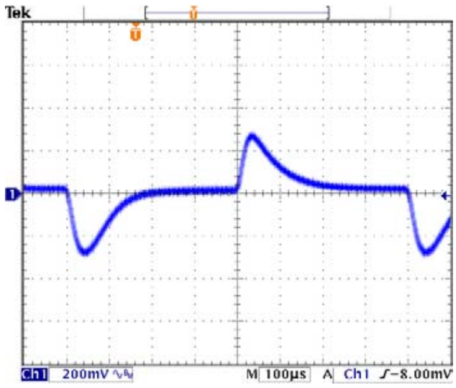
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

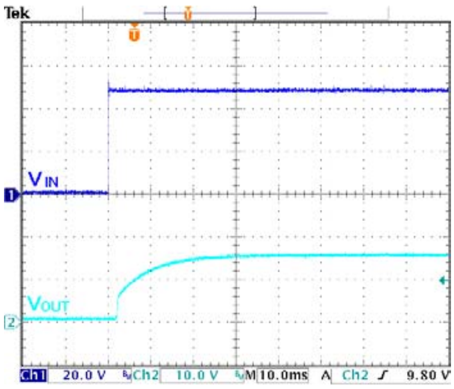
All test conditions are at 25°C. The figures are identical for TEP 100-4813



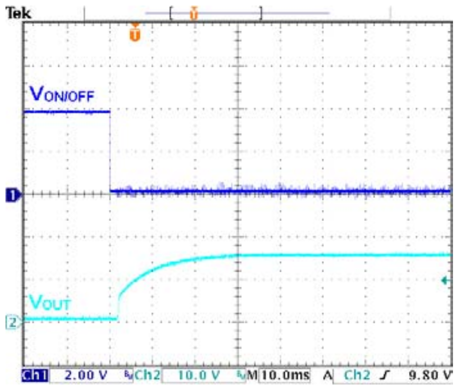
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



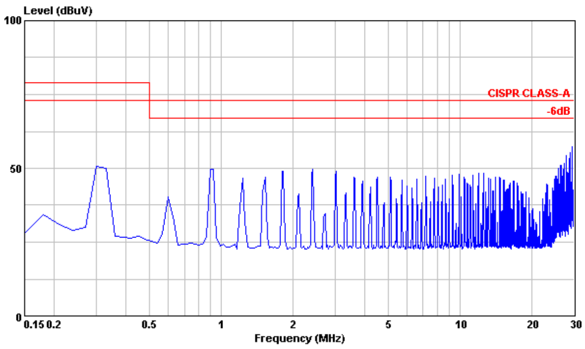
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; $V_{in} = V_{in\,nom}$



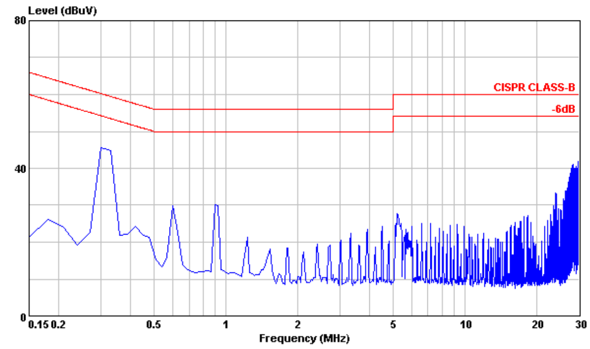
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



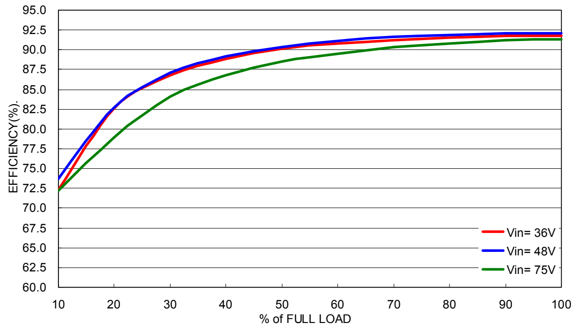
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



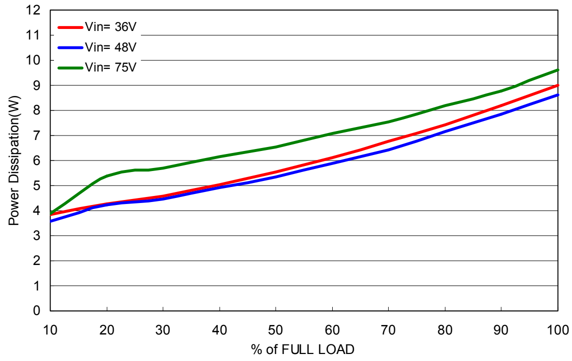
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves (Continued)

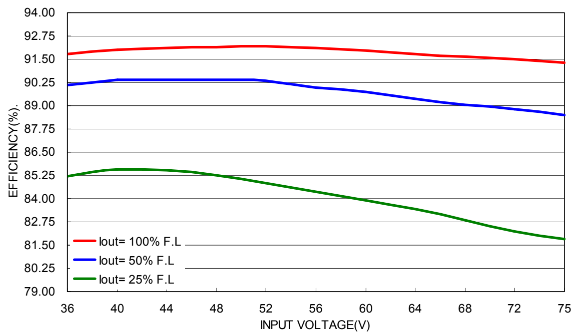
All test conditions are at 25°C. The figures are identical for TEP 100-4815



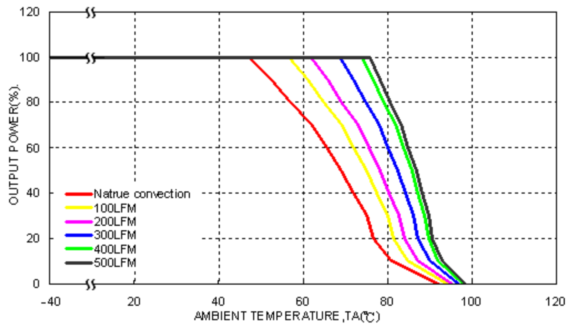
Efficiency versus Output Current



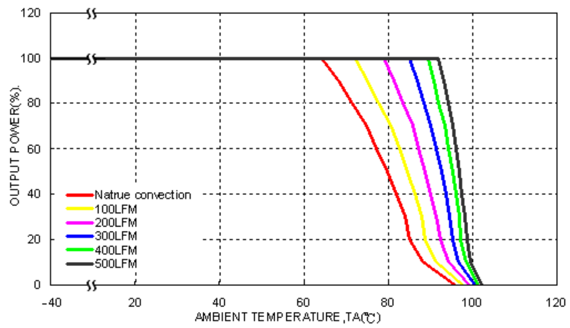
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



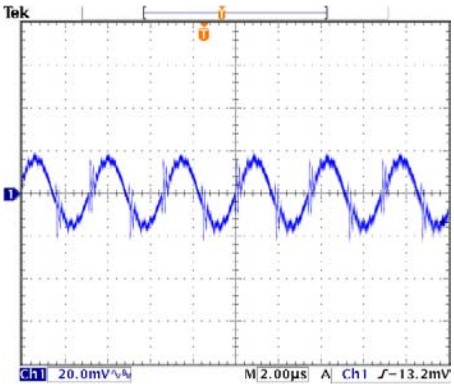
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\,nom}$



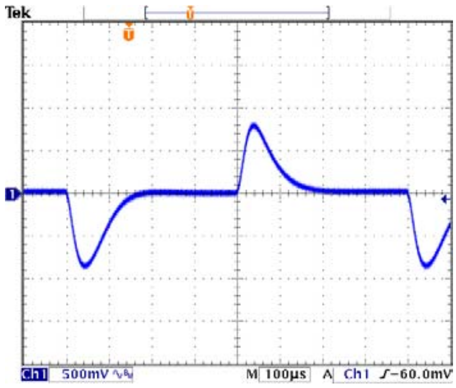
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

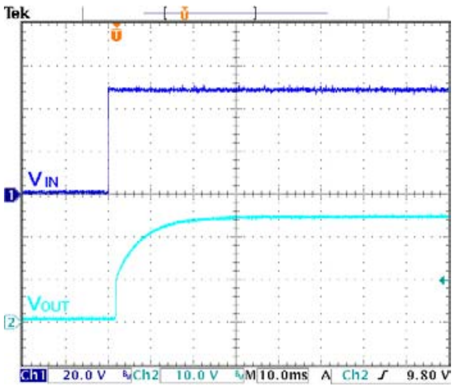
All test conditions are at 25°C. The figures are identical for TEP 100-4815



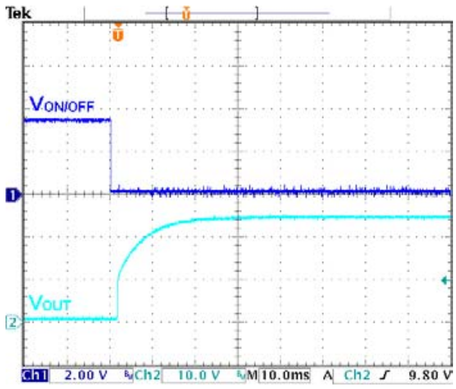
Typical Output Ripple and Noise.
V_{in} = $V_{in\,nom}$, Full Load



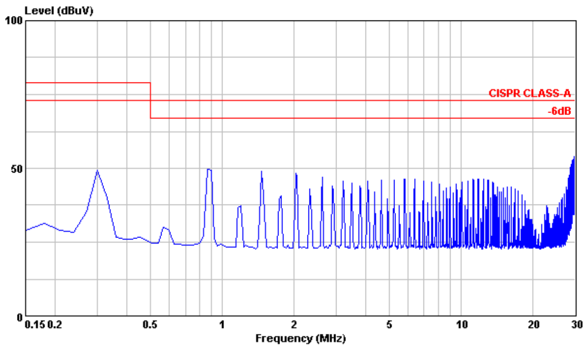
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; V_{in} = $V_{in\,nom}$



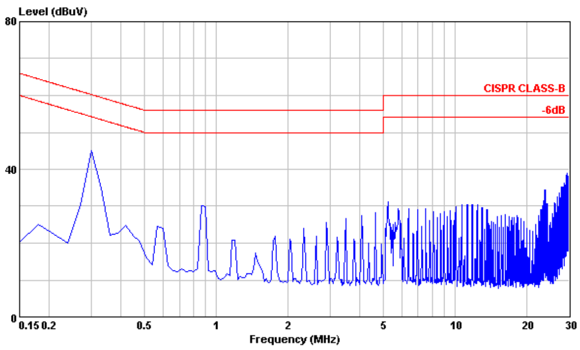
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\,nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
V_{in} = $V_{in\,nom}$, Full Load



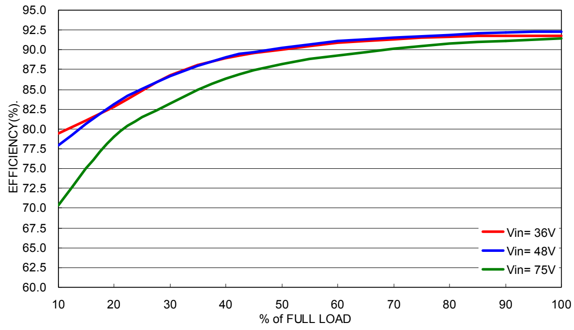
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\,nom}$, Full Load



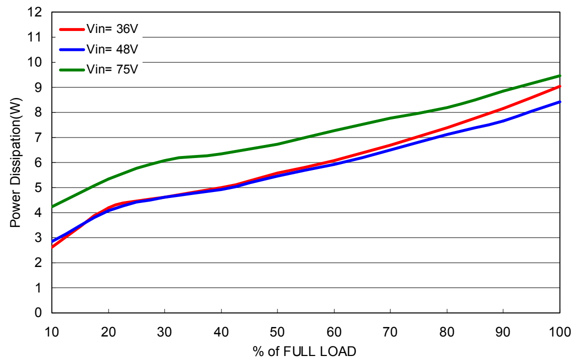
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\,nom}$, Full Load

Characteristic Curves (Continued)

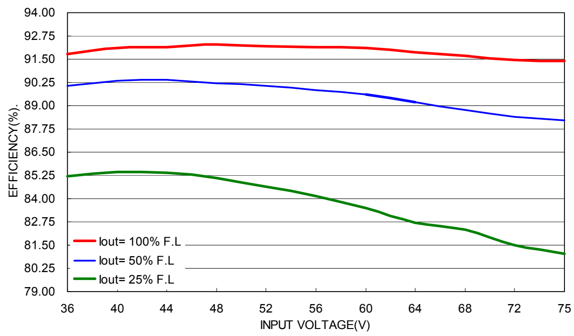
All test conditions are at 25°C. The figures are identical for TEP 100-4816



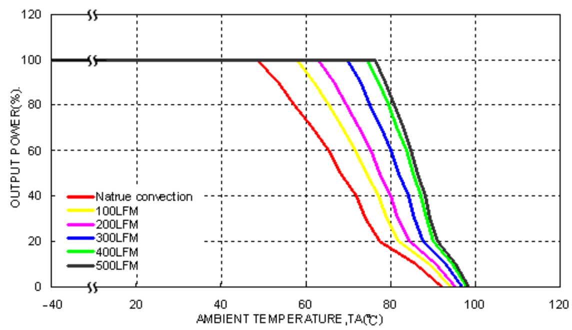
Efficiency versus Output Current



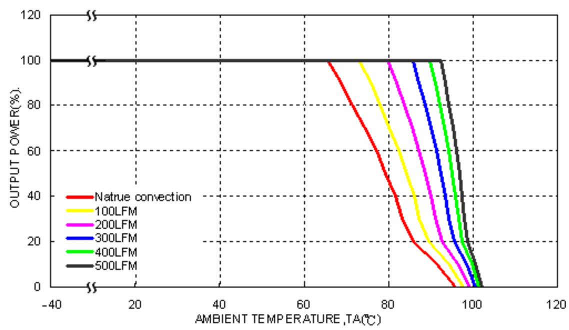
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



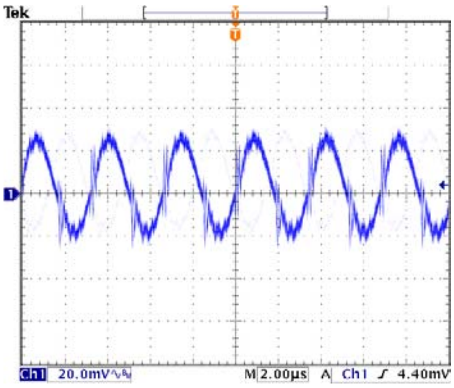
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\ nom}$



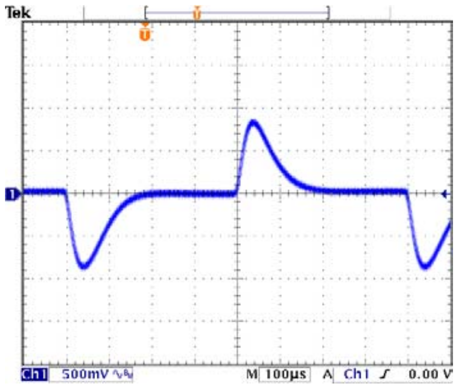
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\ nom}$

Characteristic Curves (Continued)

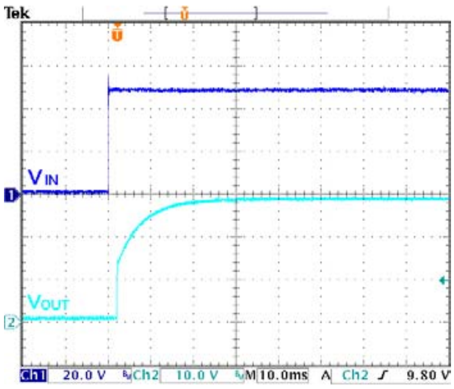
All test conditions are at 25°C. The figures are identical for TEP 100-4816



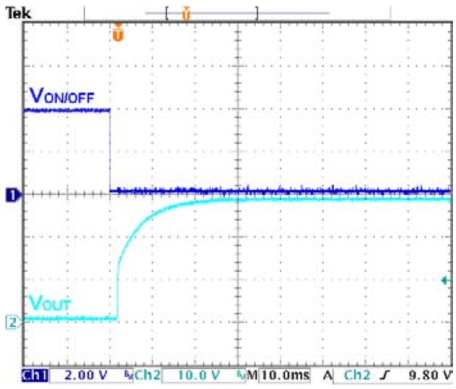
Typical Output Ripple and Noise.
V_{in} = $V_{in\,nom}$, Full Load



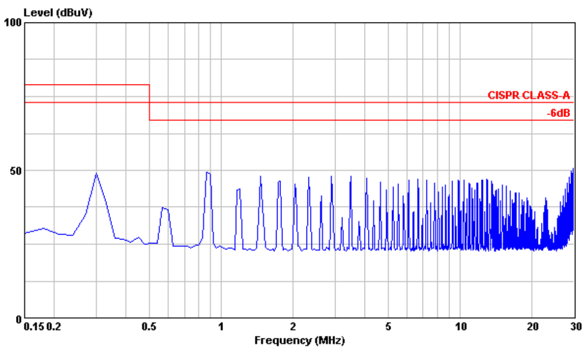
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; V_{in} = $V_{in\,nom}$



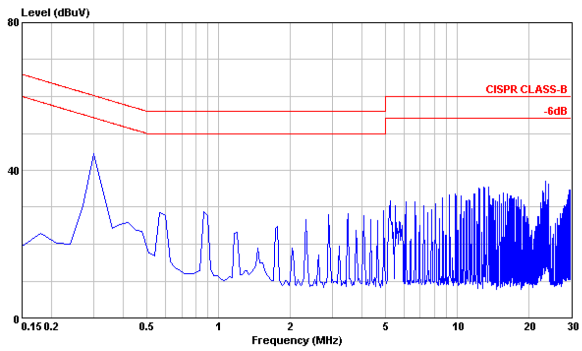
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\,nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
V_{in} = $V_{in\,nom}$, Full Load



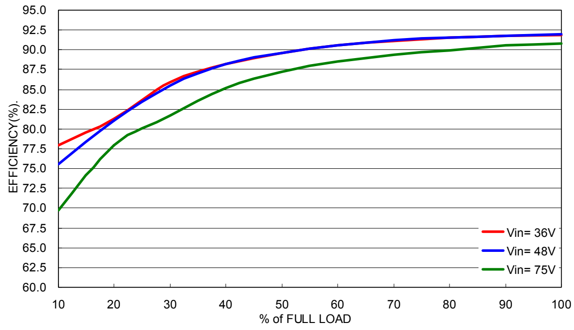
Conduction Emission of EN55022 Class A
V_{in} = $V_{in\,nom}$, Full Load



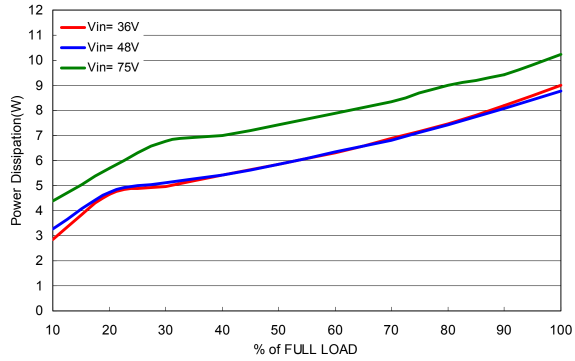
Conduction Emission of EN55022 Class B
V_{in} = $V_{in\,nom}$, Full Load

Characteristic Curves (Continued)

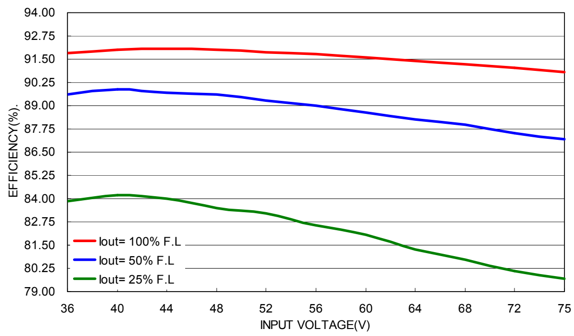
All test conditions are at 25°C. The figures are identical for TEP 100-4818



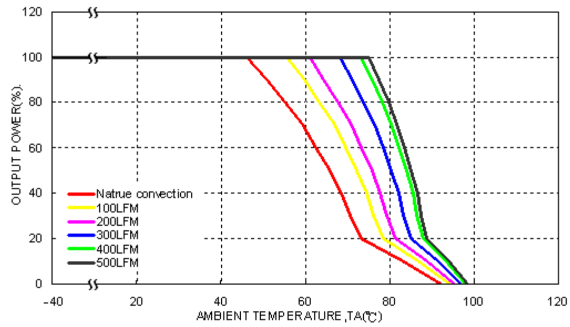
Efficiency versus Output Current



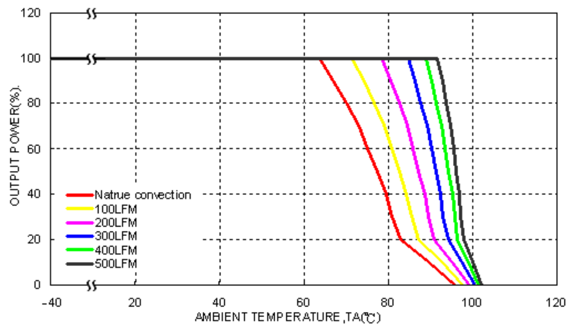
Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load



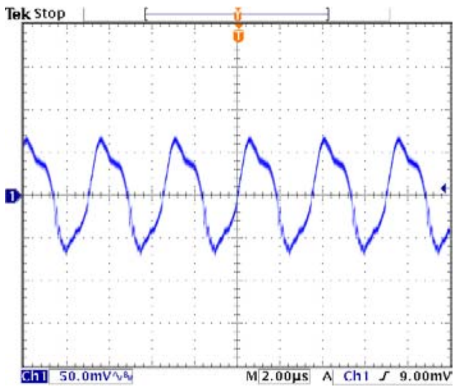
Derating Output Current versus Ambient Temperature with Airflow, $V_{in} = V_{in\ nom}$



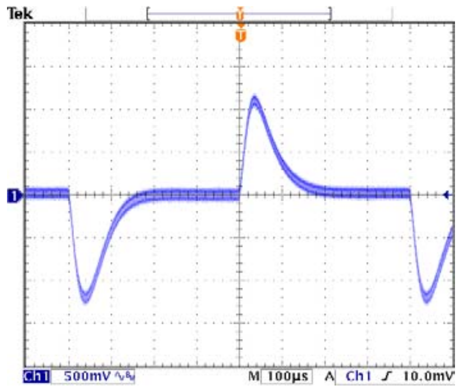
Derating Output Current Versus Ambient Temperature with TEP-HS1 Heat-Sink and Airflow, $V_{in} = V_{in\ nom}$

Characteristic Curves (Continued)

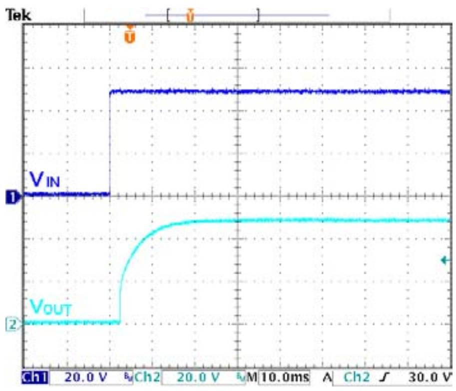
All test conditions are at 25°C. The figures are identical for TEP 100-4818



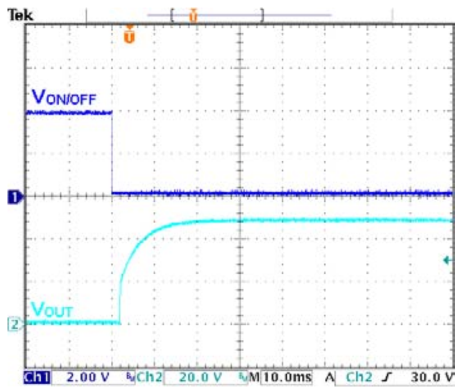
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



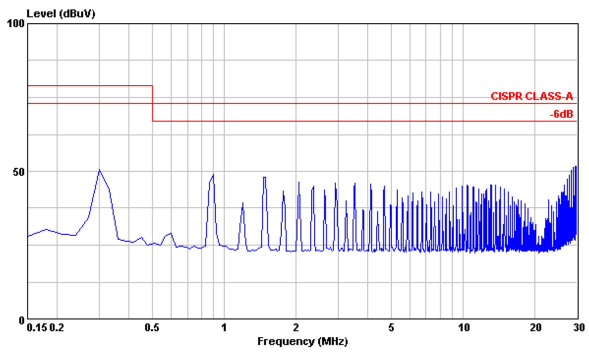
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\ nom}$



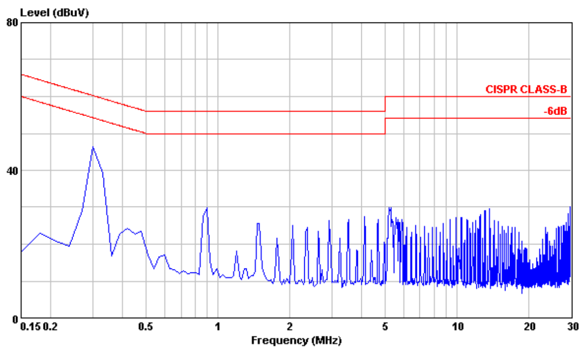
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



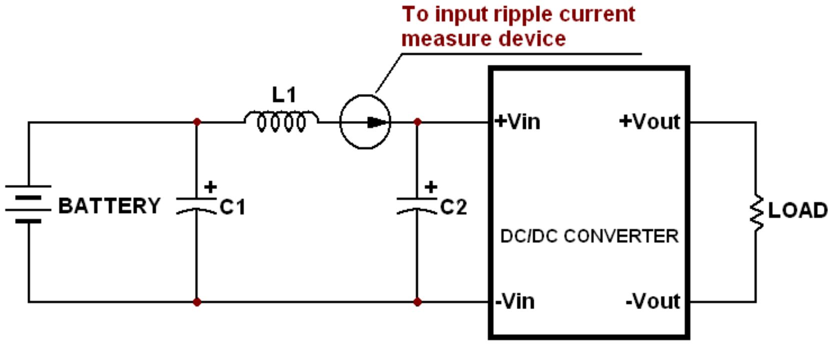
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



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

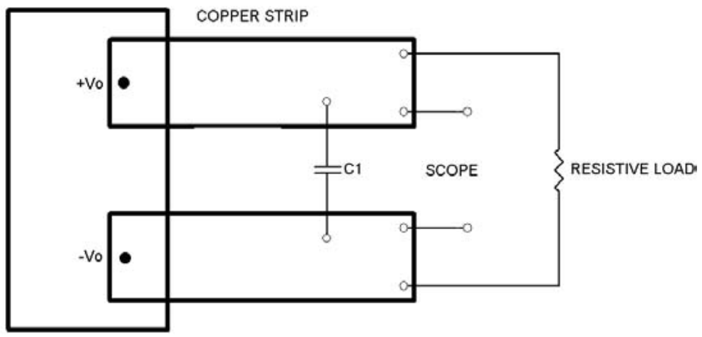
Testing Configurations

Input reflected-ripple current measurement test up



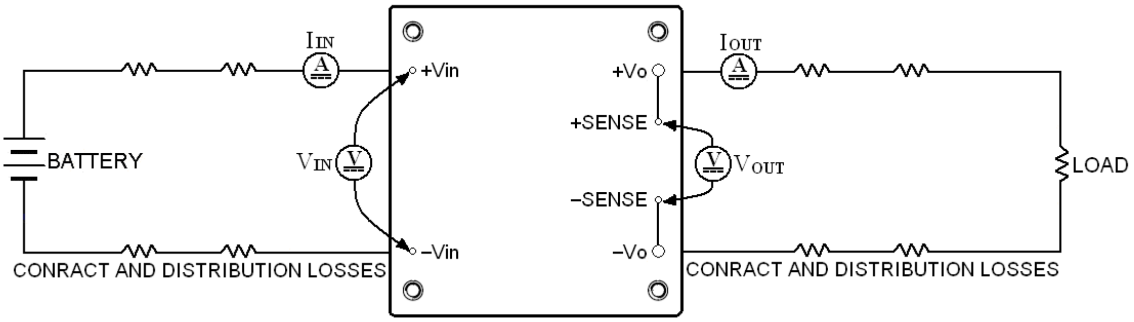
Component	Value	Voltage	Reference
L1	12μH	---	ARLITECH: ATPI0705120
C1 & C2	100μF	100V	NIPPON CHEMI-CON: KY series (EKY-101ELL101MK16S)

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



Device	Component	Value	Voltage	Reference
TEP 100-xx10 TEP 100-xx11 TEP 100-xx12 TEP 100-xx13 TEP 100-xx15 TEP 100-xx16	C1	4.7μF	50V	TDK: C4532X7R1H475M
TEP 100-xx18	C1	2.2μF	100V	TDK: C4532X7R2A225M

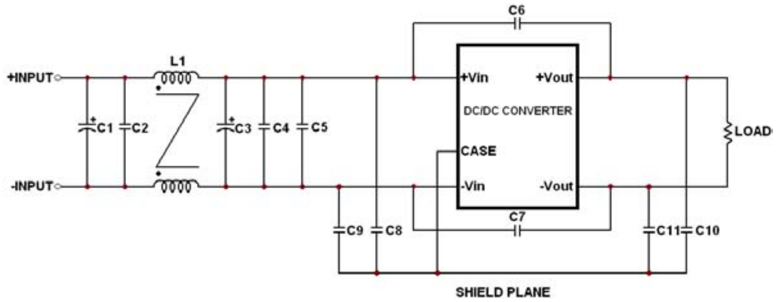
Output voltage and efficiency measurement test up



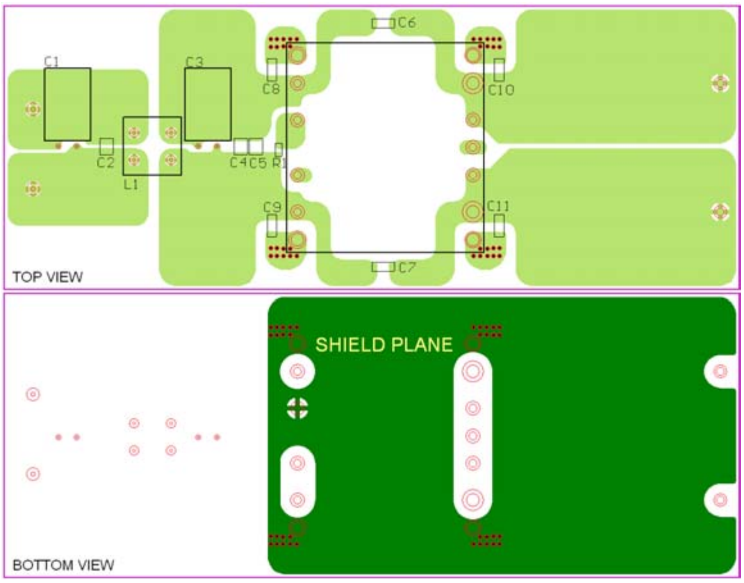
Note: All measurements are taken at the module terminals.

$$Efficiency = \left(\frac{V_{OUT} \times I_{OUT}}{V_{IN} \times I_{IN}} \right) \times 100\%$$

EMI considerations



Suggested schematic to comply with EN55022 conducted emission Class A



Recommended Layout with Input Filter

To comply with conducted noise according to EN 55022 Class A following components are recommended:

TEP 100-12xx

Component	Value	Voltage	Reference
C1, C3	470μF	35V	Nippon Chemi-con KY series
C2, C4, C5	22μF	25V	1812 MLCC
C6, C7, C8, C9, C10, C11	1000pF	3KV	1808 MLCC
L1	156μH ±35%	—	Common Choke, P/N: TCK-072

TEP 100-24xx

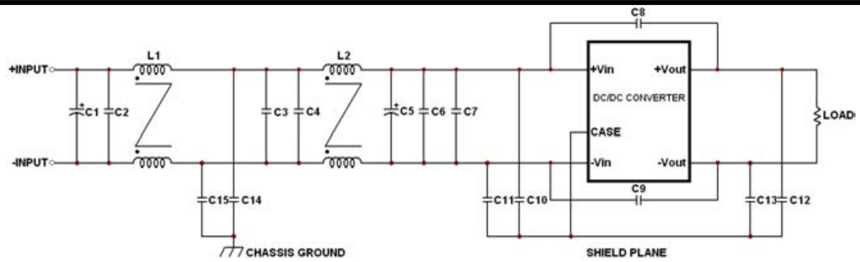
Component	Value	Voltage	Reference
C1, C3	100μF	50V	Nippon Chemi-con KY series
C2, C4, C5	4.7μF	50V	1812 MLCC
C6, C7, C8, C9, C10, C11	1000pF	3KV	1808 MLCC
L1	156μH ±35%	—	Common Choke, P/N: TCK-072

TEP 100-48xx

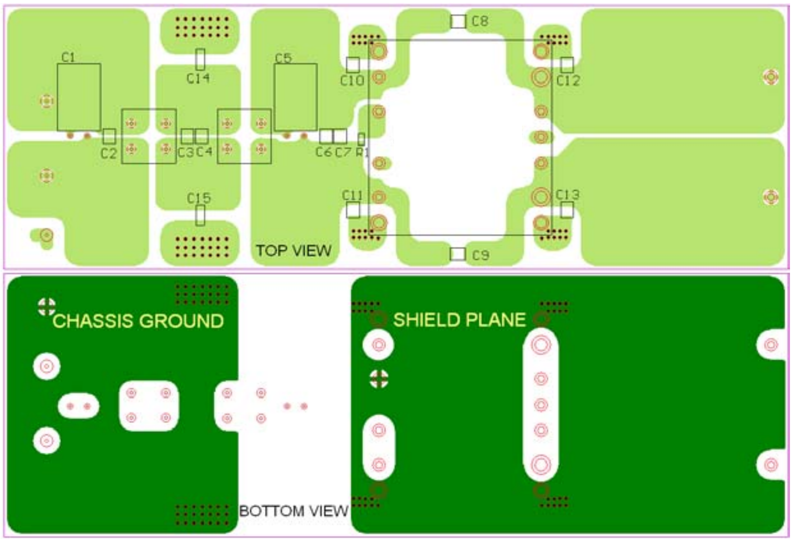
Component	Value	Voltage	Reference
C1, C3	100μF	100V	Nippon Chemi-con KY series
C2, C4, C5	2.2μF	100V	1812 MLCC
C6, C7, C8, C9, C10, C11	1000pF	3KV	1808 MLCC
L1	753μH ±35%	—	Common Choke, P/N: TCK-067

Note: 1. Common mode choke have been define and show in page 52.
2. While testing, connect the case pin and the four screw bolts to shield plane, the EMI could be better reduced.

EMI considerations (continued)



Suggested schematic to comply with EN55022 conducted emission Class B



Recommended Layout With Input Filter

To comply with conducted noise according to EN 55022 Class B following components are recommended:

TEP 100-12xx

Component	Value	Voltage	Reference
C1, C5	470µF	35V	Nippon chemi-con KY series
C2, C3, C4, C6, C7	22µF	25V	1812 MLCC
C8, C9, C14, C15	1000pF	3KV	1808 MLCC
C10, C11, C12, C13	10nF	2KV	1812 MLCC
L1, L2	305µH ±35%	—	Common Choke, P/N: TCK-073

TEP 100-24xx

Component	Value	Voltage	Reference
C1, C5	100µF	50V	Nippon chemi-con KY series
C2, C3, C4, C6, C7	4.7µF	50 V	1812 MLCC
C8, C9, C14, C15	1000pF	3KV	1808 MLCC
C10, C11, C12, C13	10 nF	2KV	1812 MLCC
L1, L2	305µH ± 35%	—	Common Choke, P/N: TCK-073

TEP 100-48xx

Component	Value	Voltage	Reference
C1, C5	100µF	100V	Nippon chemi-con KY series
C2, C3, C4, C6, C7	2.2µF	100V	1812 MLCC
C8, C14, C15	1000pF	3KV	1808 MLCC
C9	4700pF	3KV	1812 MLCC
C10, C11, C12, C13	10nF	2KV	1812 MLCC
L1	1400µH ±35%	—	Common Choke, P/N: TCK-064
L2	156µH ±35%	—	Common Choke, P/N: TCK-072

Note: 1. Common mode choke have been define and show in page 52.
2. While testing, connect the case pin and the four screw bolts to shield plane, the EMI could be better reduced.

EMI considerations (continued)

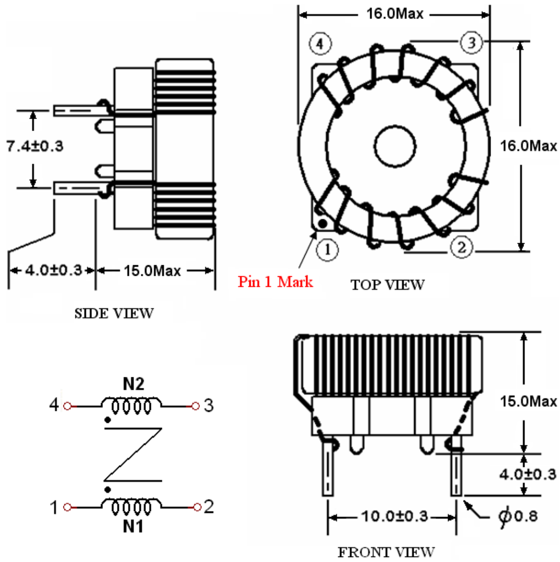
These common mode choke have been define as follow:

- **TCK-064:** Inductance: 1400µH ±35%
  Impedance: 21.56mΩ, max.
  Rated current: 5.8A, max.
- **TCK-067:** Inductance: 753µH ±35%
  Impedante: 25mΩ, max.
  Rated current: 7.5A, max.
- **TCK-072:** Inductance: 156µH ±35%
  Impedance: 15mΩ, max
  Rated current: 11.3A, max.
- **TCK-073:** Inductance: 305µH ±35%
  Impedante: 20mΩ, max.
  Rated current: 11.3A, max.

Measurement Instrument (Test condition):

- L: HP 4263B LCR Meter (100KHz / 100mV)
- DCR: HIOKI 3540 mΩ HITESTER
- IDC: Agilent 34401A Meter

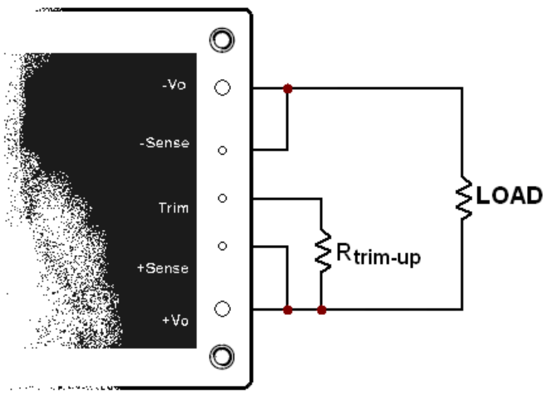
Recommended through hole: Φ1.0mm



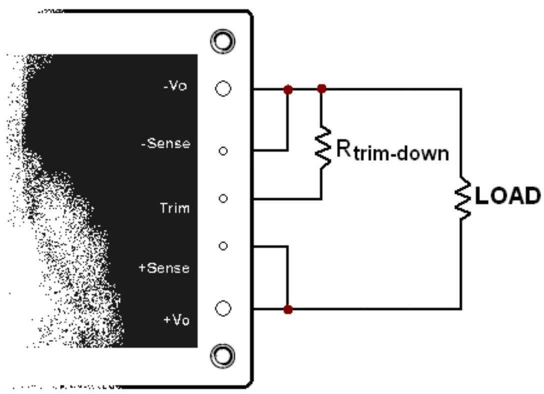
All dimensions in millimeters

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. (Please refer to page 54, remote sense) The value of external resistor can be obtained by equation or trim table shown in next page.



TRIM UP



TRIM DOWN

Output Voltage Adjustment (continued)

TRIM EQUATION

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

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

TRIM TABLE

TEP 100-xx10

Trim up (%)	1	2	3	4	5	6	7	8	9	10
V_{OUT} (Volts)=	3.333	3.366	3.399	3.432	3.465	3.498	3.531	3.564	3.597	3.630
R_U (KΩ)=	170.082	85.388	57.156	43.041	34.571	28.925	24.892	21.867	19.515	17.633

TEP 100-xx11

Trim up (%)	1	2	3	4	5	6	7	8	9	10
V_{OUT} (Volts)=	5.05	5.10	5.15	5.20	5.25	5.30	5.35	5.40	5.45	5.50
R_U (KΩ)=	310.245	156.163	104.803	79.122	63.714	53.442	46.105	40.602	36.322	32.898

TEP 100-xx12

Trim up (%)	1	2	3	4	5	6	7	8	9	10
V_{OUT} (Volts)=	12.12	12.24	12.36	12.48	12.60	12.72	12.84	12.96	13.08	13.20
R_U (KΩ)=	887.388	447.592	300.993	227.694	183.714	154.395	133.452	117.745	105.528	95.755

TEP 100-xx13

Trim up (%)	1	2	3	4	5	6	7	8	9	10
V_{OUT} (Volts)=	15.15	15.30	15.45	15.60	15.75	15.90	16.05	16.20	16.35	16.50
R_U (KΩ)=	1134.735	572.490	385.075	291.367	235.143	197.660	170.886	150.806	135.188	122.694

TEP 100-xx15

Trim up (%)	1	2	3	4	5	6	7	8	9	10
V_{OUT} (Volts)=	24.24	24.48	24.72	24.96	25.20	25.44	25.68	25.92	26.16	26.40
R_U (KΩ)=	1876.776	947.184	637.320	482.388	389.429	327.456	283.190	249.990	224.168	203.510

TEP 100-xx16

Trim up (%)	1	2	3	4	5	6	7	8	9	10
V_{OUT} (Volts)=	28.28	28.56	28.84	29.12	29.40	29.68	29.96	30.24	30.52	30.80
R_U (KΩ)=	2206.571	1113.714	749.429	567.286	458.000	385.143	333.102	294.071	263.714	239.429

TEP 100-xx18

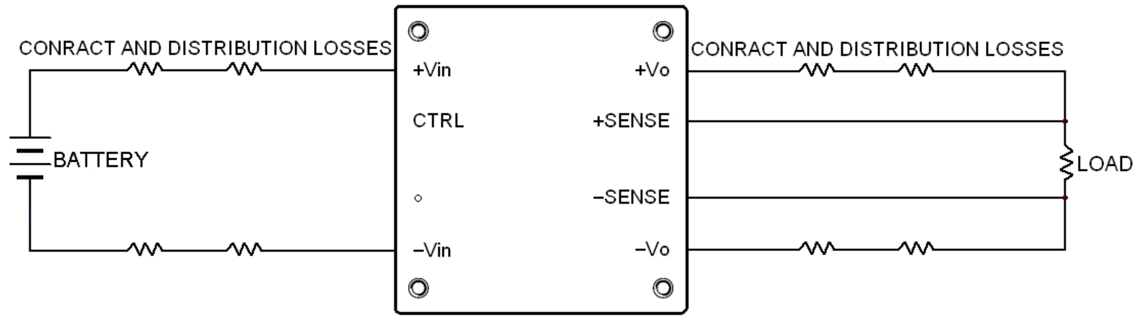
Trim up (%)	1	2	3	4	5	6	7	8	9	10
V_{OUT} (Volts)=	48.48	48.96	49.44	49.92	50.40	50.88	51.36	51.84	52.32	52.80
R_U (KΩ)=	3855.551	1946.367	1309.973	991.776	800.857	673.578	582.665	514.480	461.447	419.020

All

Trim down (%)	1	2	3	4	5	6	7	8	9	10
R_D (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
R_D (KΩ)=	7.091	6.333	5.692	5.143	4.667	4.250	3.882	3.556	3.263	3.000

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 V_{out} pin must not exceed 10% of V_{out}. i.e. [+V_{out} to –V_{out}] – [+Sense to –Sense] < 10% V_{out}
The voltage between +V_{out} and –V_{out} terminals must not exceed the minimum output over voltage 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}.



Remote Sense circuit configuration

Input Source Impedance

The power module should be connected to a low impedance input source. Highly inductive source impedance can affect the stability of the power module. Input external π filter is recommended to minimize input reflected ripple current. The inductor is simulated source impedance of 12μH and capacitor is Nippon Chemi-con KY series 100μF/100V. The capacitor must as close as possible to the input terminals of the power module for lower impedance.

Output Over Current Protection

When excessive output currents occur in the system, circuit protection is required on all power supplies. Normally, overload current is maintained at approximately 110~140 percent of rated current for TEP 100 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 foldback methods.
One of the problems resulting from over current is that excessive heat may be generated in power devices; especially MOSFET and Shottky diodes and the temperature of those devices may exceed their specified limits. A protection mechanism has to be used to prevent those power devices from being damaged.
The operation of hiccup is as follows. When the current sense circuit sees an over-current event, the controller shuts off the power supply for a given time and then tries to start up the power supply again. If the over-load condition has been removed, the power supply will start up and operate normally; otherwise, the controller will see another over-current event and shut off the power supply again, repeating the previous cycle. Hiccup operation has none of the drawbacks of the other two protection methods, although its circuit is more complicated because it requires a timing circuit. The excess heat due to overload lasts for only a short duration in the hiccup cycle, hence the junction temperature of the power devices is much lower.
The hiccup operation can be done in various ways. For example, one can start hiccup operation any time an over-current event is detected; or prohibit hiccup during a designated start-up is usually larger than during normal operation and it is easier for an over-current event is detected; or prohibit hiccup during a designated start-up interval (usually a few milliseconds). The reason for the latter operation is that during start-up, the power supply needs to provide extra current to charge up the output capacitor. Thus the current demand during start-up is usually larger than during normal operation and it is easier for an over-current event to occur. If the power supply starts to hiccup once there is an over-current, it might never start up successfully. Hiccup mode protection will give the best protection for a power supply against over current situations, since it will limit the average current to the load at a low level, so reducing power dissipation and case temperature in the power devices.

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.

Output Over Voltage Protection

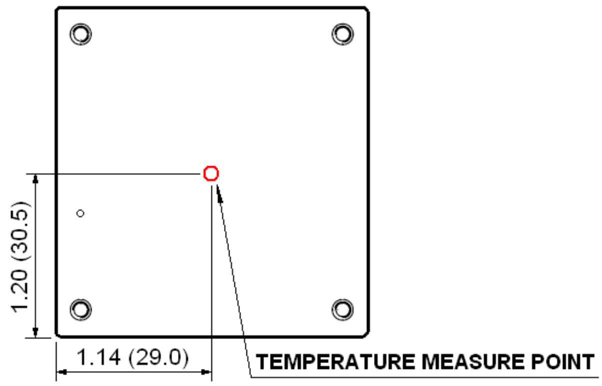
The output over-voltage protection consists of circuitry that monitors the voltage on the output terminals. If the voltage on the output terminals exceeds the over-voltage protection threshold, then the module enter the non-latch hiccup mode.

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 case is to the protection threshold, the unit enters "Hiccup" mode. And it will auto restart when the temperature is down.

Thermal Consideration

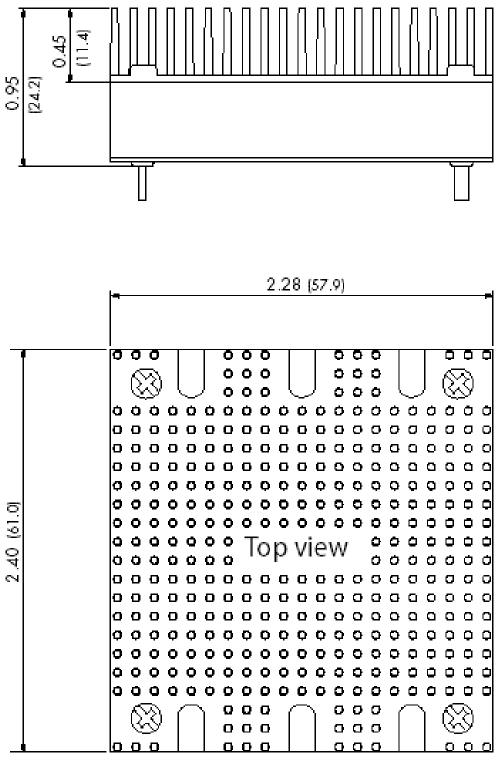
The power module operates in a variety of thermal environments. However, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convection, and radiation to the surrounding Environment. Proper cooling can be verified by measuring the point as the figure below. The temperature at this location should not exceed 105°C. When Operating, adequate cooling must be provided to maintain the test point temperature at or below 105°C. Although the maximum point Temperature of the power modules is 105°C, you can limit this Temperature to a lower value for extremely high reliability.



TOP VIEW
Measurement shown in inches (mm)

Heat Sink

Heat-sink for lower temperature and higher reliability of the module. Order Code: TEP-HS1

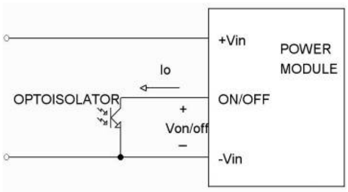


Order code: TEP-HS1
Includes heatsink with thermal pad and mounting screws.
To order modules with mounted heatsink, please ask factory.

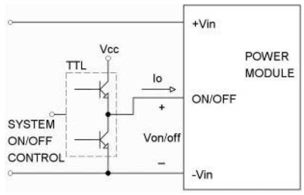
Remote ON/OFF Control

The Remote ON/OFF 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 -V_{in}. The switch can be open collector transistor, FET and Photo-Couple. The switch must be capable of sinking up to 1 mA at low-level logic Voltage. High-level logic of the ON/OFF signal maximum voltage is allowable leakage current of the switch at 12V is 0.5 mA.

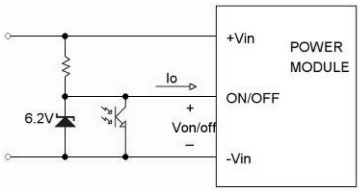
Remote ON/OFF Implementation Circuits



Isolated-Closure Remote ON/OFF



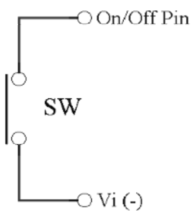
Level Control Using TTL Output

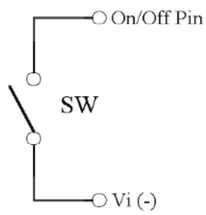


Level Control Using Line Voltage

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

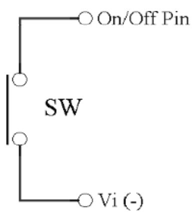
a. The Positive logic structure turned on of the DC/DC module when the ON/OFF pin is at high-level logic and low-level logic is turned off it.

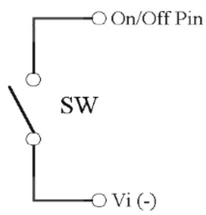




When TEP 100 module is turned off at Low-level logic   When TEP 100 module is turned on at High-level logic

b. The Negative logic structure turned on of the DC/DC module when the ON/OFF pin is at low-level logic and turned off when at high-level logic. To order TEP 75WI with negative remote on/off logic please add –N on the order code.

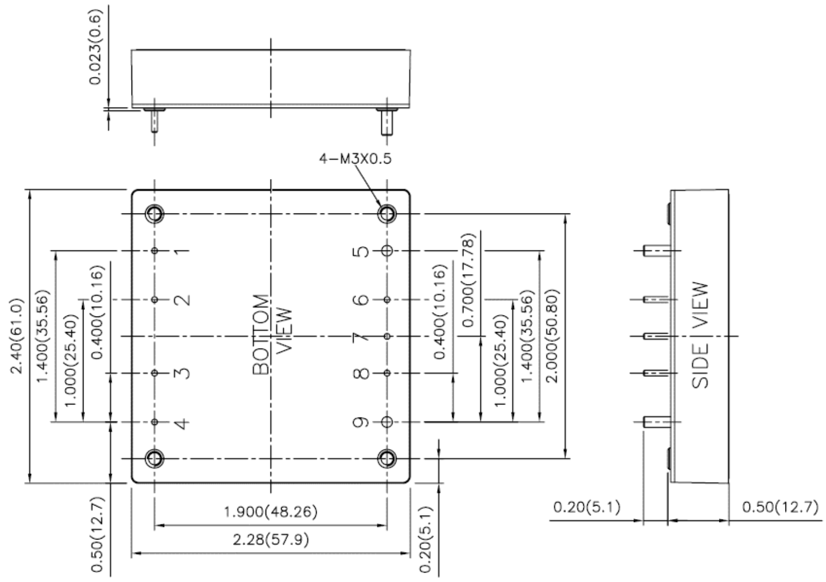




When TEP 100 module is turned on at Low-level logic   When TEP 100 module is turned off at High-level logic

Mechanical Data

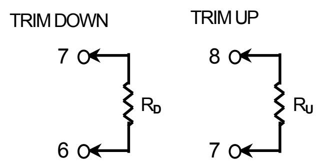
Standard



1. Pin 1,2,3,4,6,7,8: Diameter 0.040 (1.02mm)
   Pin 5,9: Diameter 0.080 (2.03mm)
2. All dimensions in inches (mm)
   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 dimensions tolerance: ± 0.004 (±0.1)

EXTERNAL OUTPUT TRIMMING

Output can be externally trimmed by using the method shown below.

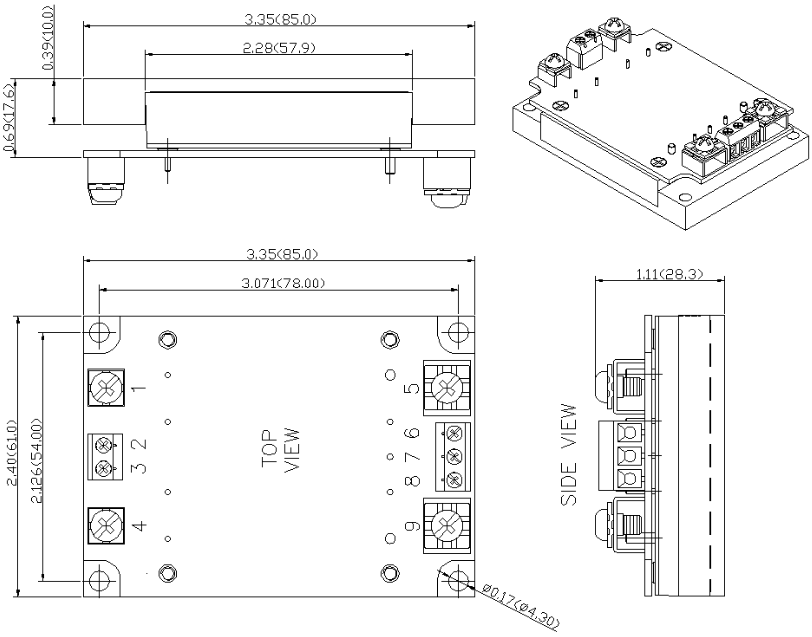


PIN CONNECTION

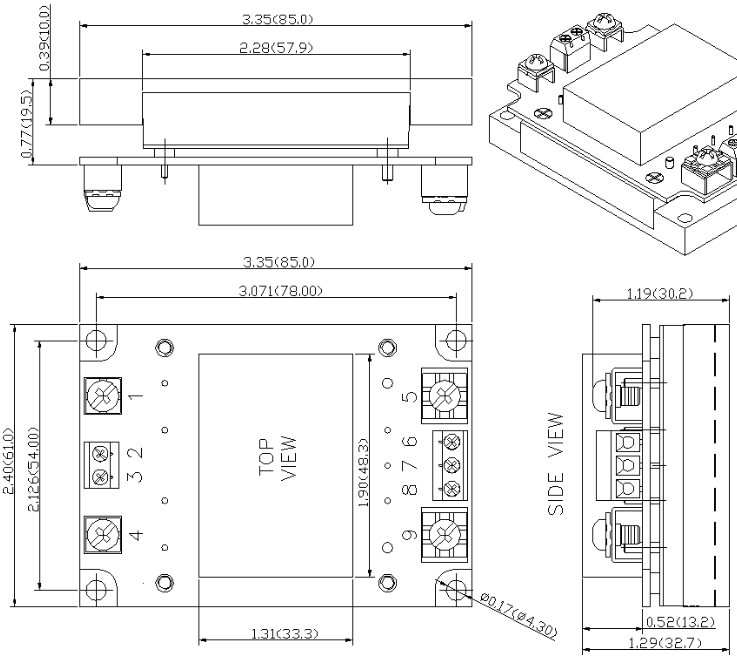
PIN	Define	Diameter
1	$-V_{in}$ (GND)	0.04 inches
2	Case	0.04 inches
3	Remote on/off	0.04 inches
4	$+V_{in}$ (Vcc)	0.04 inches
5	$-V_{out}$	0.08 inches
6	-Sense	0.04 inches
7	V_{adjust}	0.04 inches
8	+Sense	0.04 inches
9	$+V_{out}$	0.08 inches

Mechanical Data (continued)

Option: The terminal block type of TEP – CM



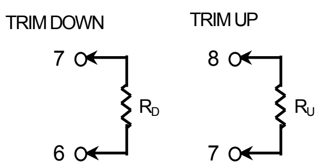
Option: The terminal block with an EMC filter type of TEP – CMF can meet the EMC characteristics.



All dimensions in inches (mm)
Tolerance: x.xx ±0.02 (x.x ±0.5)
x.xxx ±0.01 (x.xx ±0.25)

EXTERNAL OUTPUT TRIMMING

Output can be externally trimmed by using the method shown below.

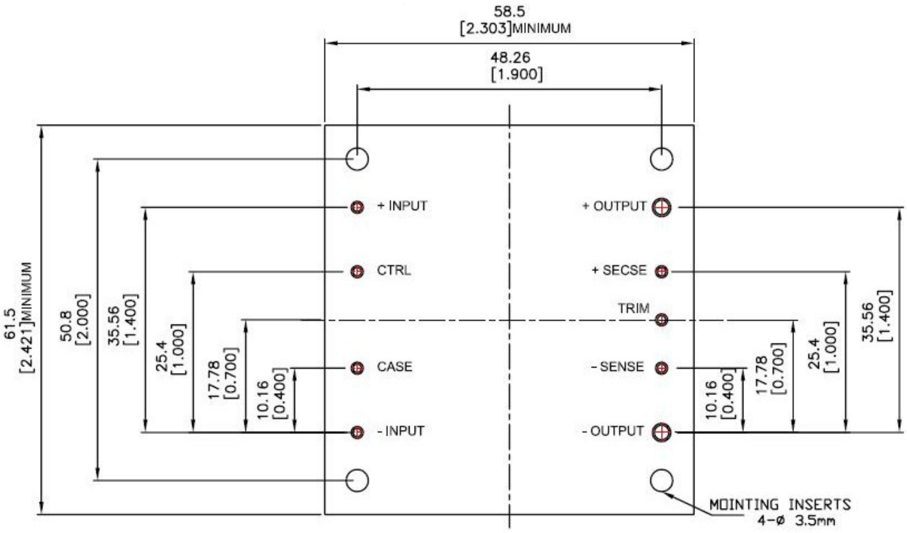


PIN CONNECTION

PIN	Define	Wire Range
1	$-V_{in}$ (GND)	14 AWG to 16 AWG
2	Case	14 AWG to 18 AWG
3	Remote on/off	14 AWG to 18 AWG
4	$+V_{in}$ (Vcc)	14 AWG to 16 AWG
5	$-V_{out}$	10 AWG to 12 AWG
6	-Sense	14 AWG to 18 AWG
7	V_{adjust}	14 AWG to 18 AWG
8	+Sense	14 AWG to 18 AWG
9	$+V_{out}$	10 AWG to 12 AWG

Recommended Pad Layout

All dimensions in millimeters (inches.)
Tolerances: x.xx mm ±0.25 mm (x.xxx in ±0.010 in)



PAD SIZE (LEAD FREE RECOMMENDED)

+/- OUTPUT :

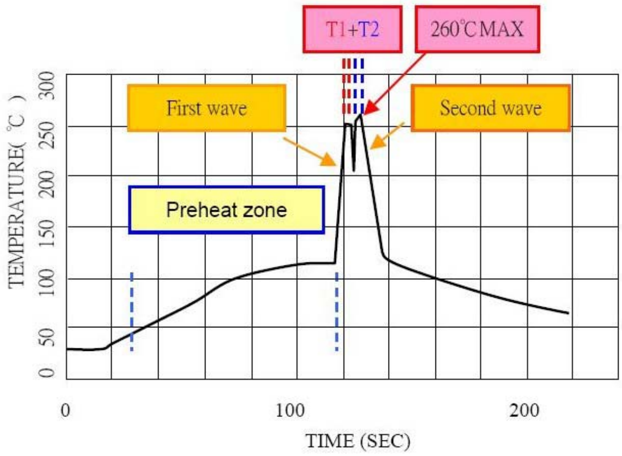
THROUGH HOLE:	Ø 2.3mm
TOP VIEW PAD:	Ø 2.9mm
BOTTOM VIEW PAD:	Ø 3.6mm

OTHERS :

THROUGH HOLE:	Ø 1.3mm
TOP VIEW PAD:	Ø 1.9mm
BOTTOM VIEW PAD:	Ø 2.6mm

Soldering Considerations

Lead free wave solder profile for TEP 100 Series

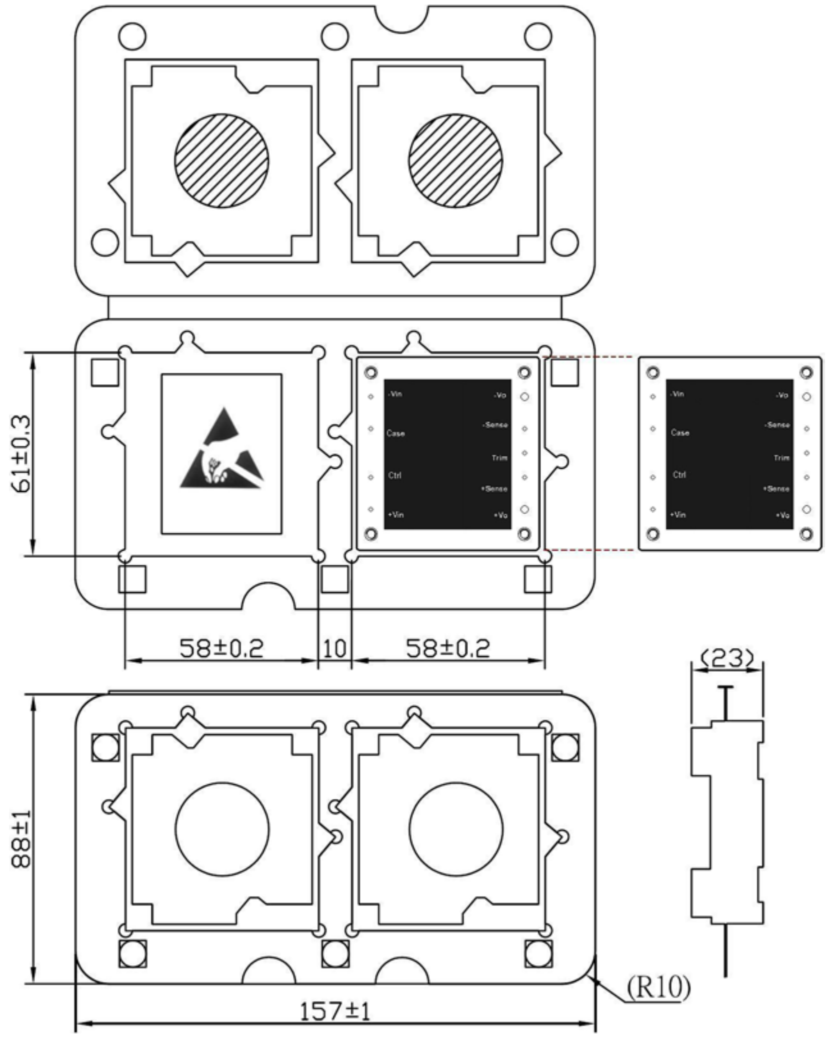


Zone	Reference Parameter
Preheat zone	Rise temperature speed: 3°C/sec max. Preheat temperature: 100~130°C
Actual heating	Peak temperature: 250~260°C Peak time (T1+T2 time): 4~6 sec

Reference Solder: Sn-Ag-Cu; Sn-Cu

Hand Welding:
- Soldering iron: Power 90W
- Welding Time: 2~4 sec
- Temperature: 380~400°C

Packaging Information



Dimensions shown in millimeters

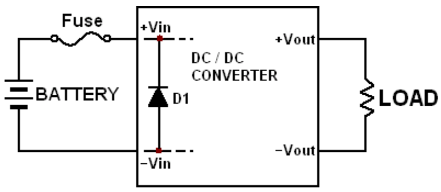
Order Code

Model Number	Input Range	Output Voltage	Output Current Max. Load	Input Current No Load[1]	Input Current Full Load [2]	Efficiency [3] (%)
TEP 100-1210	9 – 18Vdc	3.3Vdc	25.0A	200mA	7.768A	90
TEP 100-1211	9 – 18Vdc	5Vdc	20.0A	210mA	9.311A	91
TEP 100-1212	9 – 18Vdc	12Vdc	8.4A	210mA	9.385A	91
TEP 100-1213	9 – 18Vdc	15Vdc	6.7A	210mA	9.358A	91
TEP 100-1215	9 – 18Vdc	24Vdc	4.2A	100mA	9.492A	90
TEP 100-1216	9 –18Vdc	28Vdc	3.6A	100mA	9.492A	90
TEP 100-1218	9 – 18Vdc	48Vdc	2.1A	100mA	9.492A	90
TEP 100-2410	18 – 36Vdc	3.3Vdc	25.0A	90mA	3.841A	91
TEP 100-2411	18 – 36Vdc	5Vdc	20.0A	185mA	4.554 A	93
TEP 100-2412	18 – 36Vdc	12Vdc	8.4A	185mA	4.590A	93
TEP 100-2413	18 – 36Vdc	15Vdc	6.7A	185mA	4.577 A	93
TEP 100-2415	18 – 36Vdc	24Vdc	4.2A	85mA	4.641A	92
TEP 100-2416	18 – 36Vdc	28Vdc	3.6A	85mA	4.641A	92
TEP 100-2418	18 – 36Vdc	48Vdc	2.1A	85mA	4.641A	92
TEP 100-4810	36 – 75Vdc	3.3Vdc	25.0A	80mA	1.920A	91
TEP 100-4811	36 – 75Vdc	5Vdc	20.0 A	90mA	2.277 A	93
TEP 100-4812	36 – 75Vdc	12Vdc	8.4A	90mA	2.295A	93
TEP 100-4813	36 – 75Vdc	15Vdc	6.7A	90mA	2.288 A	93
TEP 100-4815	36 – 75Vdc	24Vdc	4.2A	40mA	2.320A	92
TEP 100-4816	36 – 75Vdc	28Vdc	3.6A	40mA	2.320A	92
TEP 100-4818	36 – 75Vdc	48Vdc	2.1A	40mA	2.320A	92

Note 1: Typical value at nominal input voltage and no load.
Note 2: Maximum value at nominal input voltage and full load of standard type.
Note 3: Typical value at nominal input voltage and full load.
Note 4: To order TEP 100 with negative remote on/off logic please add –N (e.g. TEP 100-2411-N)
Note 5: To order the TEP 100 with terminal block please add –CM (e.g. TEP 100-2411-CM)
Note 6: To order the TEP 100 with terminal block and EMI filter please add –CMF (e.g. TEP 100-2411-CMF)

Safety and Installation Instruction

The TEP 100 Series has built in the protection function of the polarity reverse as the following figure.



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 slow-blow fuse with maximum rating of 20A for TEP 100-12xx and 10A for TEP 100–24xx and 5A for TEP 100–48xx. 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 TEP 100 SERIES of DC/DC converters has been calculated according to:

Bellcore TR-NWT-000332 Case I: 50% stress, Operating Temperature at 40°C (Ground fixed and controlled environment). The resulting figure for MTBF is 1'010'000 hours.

MIL-HDBK 217F NOTICE2 FULL LOAD, Operating Temperature at 25°C. The resulting figure for MTBF is 74'160 hours.