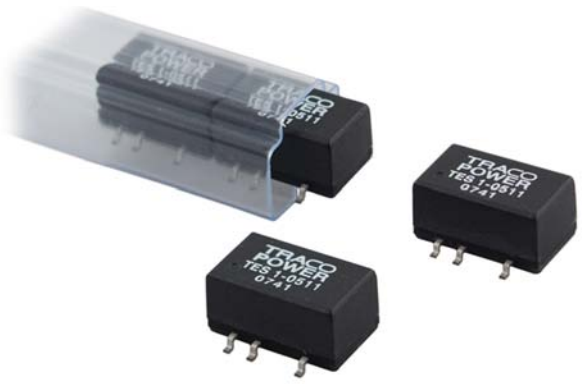
TES 1 Series

1W, Miniature SMD, Single & Dual Output DC/DC Converters

Features

- SMD Package with Industry Standard Pinout
- Small Footprint:
  11.0 x 13.7 mm (0.43”x 0.54”) Single Output Models
  11.0 x 16.3 mm (0.43”x 0.64”) Dual Output Models
- I/O-Isolation 1500 VDC
- Single and Dual Output Models
- Operating Temp. Range –40°C to +85°C
- High Accuracy of Pin Planarity
- Qualified for lead-free reflow solder process according IPC/ JEDEC J-STD-020D
- Tape & Reel Package available
- 3 Year Product Warranty



Applications

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

General Description

The Traco TES 1 series is a range of 1W DC/DC converters in a SMD- Package featuring I/O-isolation of 1500VDC.The very small footprint makes this product the ideal solution for many applications where a voltage has to be isolated i.e for noise reduction, ground loop elimination, in digital interfaces or where a converted voltage is required.
An excellent efficiency allows an operating temperature range of –40°C to +85°C. With a new package design these converters are fully qualified for the higher temperature profile used in lead-free reflow solder processes. For automated SMD production lines the product can be supplied in tape& reel package.

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Absolute Maximum Rating				
Parameter	**Model**	**Min**	**Max**	**Unit**
Input Voltage				
Input Surge Voltage (1 sec.)	5VDC Input Models	-0.7	9	
	12VDC Input Models	-0.7	18	VDC
	15VDC Input Models	-0.7	20	
	24VDC Input Models	-0.7	30	
Operating Ambient Temperature				
Without Derating	All	-40	+75	℃
With Derating		-40	+85	
Operating Case Temperature	All	---	+90	℃
Storage Temperature	All	-50	+125	℃

Output Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Output Regulation					
Line ($V_{in\ min}$ to $V_{in\ max}$ at Full Load)		---	±1.2	±1.5	%
Output Regulation	TES 1-0510	---	---	10	
Load (20% to 100% of Full Load)	TES 1-0511	---	---	10	
	TES 1-0519	---	---	10	
	TES 1-0512	---	---	8	
	TES 1-0513	---	---	7	
	TES 1-0521	---	---	10	
	TES 1-0522	---	---	8	
	TES 1-0523	---	---	7	
	TES 1-1210	---	---	8	
	TES 1-1211	---	---	8	
	TES 1-1219	---	---	8	
	TES 1-1212	---	---	5	
	TES 1-1213	---	---	5	%
	TES 1-1221	---	---	8	
	TES 1-1222	---	---	5	
	TES 1-1223	---	---	5	
	TES 1-2410	---	---	8	
	TES 1-2411	---	---	8	
	TES 1-2419	---	---	8	
	TES 1-2412	---	---	5	
	TES 1-2413	---	---	5	
	TES 1-2421	---	---	8	
	TES 1-2422	---	---	5	
	TES 1-2423	---	---	5	
Output Ripple & Noise					
Peak-to-Peak (5Hz to 20MHz bandwidth)		---	60	120	mV pk-pk

Output Specification (Continued)					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Temperature Coefficient	All	---	±0.01	±0.02	%/°C
Output Current	TES 1-xx10	6	---	300	mA
	TES 1-xx11	4	---	200	
	TES 1-xx19	2	---	110	
	TES 1-xx12	1.5	---	84	
	TES 1-xx13	1	---	67	
	TES 1-xx21	±2	---	±100	
	TES 1-xx22	±0.8	---	±42	
	TES 1-xx23	±0.7	---	±33	
Output Short Circuit Protection	All	0.5 Second Max.			

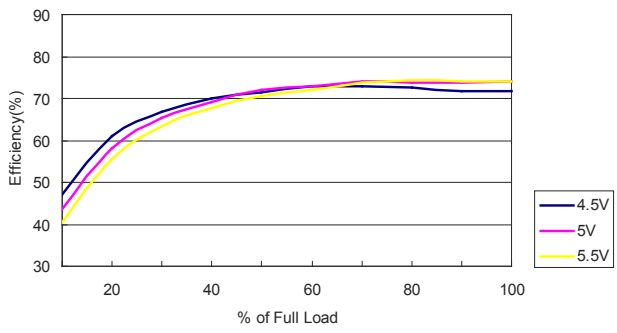
Input Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Operating Input Voltage	5V Input Models	4.5	5	5.5	VDC
	12V Input Models	10.8	12	13.2	
	15V Input Models	13.5	15	16.5	
	24V Input Models	21.6	24	26.4	
Input Current (Maximum value at V_{in}= $V_{in\ nom}$;Full Load)	TES 1-0510	---	271	---	mA
	TES 1-0511	---	256	---	
	TES 1-0519	---	254	---	
	TES 1-0512	---	259	---	
	TES 1-0513	---	254	---	
	TES 1-0521	---	270	---	
	TES 1-0522	---	259	---	
	TES 1-0523	---	254	---	
	TES 1-1210	---	112	---	
	TES 1-1211	---	109	---	
	TES 1-1219	---	106	---	
	TES 1-1212	---	106	---	
	TES 1-1213	---	105	---	
	TES 1-1221	---	113	---	
	TES 1-1222	---	108	---	
	TES 1-1223	---	104	---	
	TES 1-2410	---	58	---	
	TES 1-2411	---	54	---	
	TES 1-2419	---	54	---	
	TES 1-2412	---	55	---	
	TES 1-2413	---	53	---	
	TES 1-2421	---	57	---	
	TES 1-2422	---	54	---	
	TES 1-2423	---	53	---	

Input Specification (Continued)					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Input Standby current (Typical value at $V_{in} = V_{in\ nom}$; No Load)	TES 1-0510 TES 1-0511 TES 1-0519 TES 1-0512 TES 1-0513 TES 1-0521 TES 1-0522 TES 1-0523	---	30	---	mA
	TES 1-1210 TES 1-1211 TES 1-1219 TES 1-1212 TES 1-1213 TES 1-1221 TES 1-1222 TES 1-1223	---	15	---	
	TES 1-2410 TES 1-2411 TES 1-2419 TES 1-2412 TES 1-2413	---	8	---	
	TES 1-2421 TES 1-2422 TES 1-2423	---	9	---	

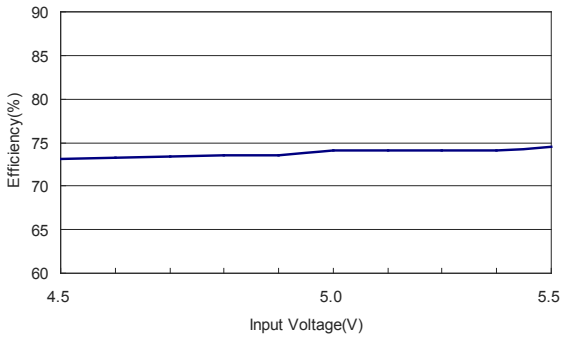
General Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Efficiency (V_{in} =$V_{in\ nom}$; Full Load; T_A =25°C)	TES 1-0510	---	73	---	%
	TES 1-0511	---	78	---	
	TES 1-0519	---	78	---	
	TES 1-0512	---	78	---	
	TES 1-0513	---	79	---	
	TES 1-0521	---	74	---	
	TES 1-0522	---	78	---	
	TES 1-0523	---	78	---	
	TES 1-1210	---	74	---	
	TES 1-1211	---	76	---	
	TES 1-1219	---	78	---	
	TES 1-1212	---	79	---	
	TES 1-1213	---	80	---	
	TES 1-1221	---	74	---	
	TES 1-1222	---	78	---	
	TES 1-1223	---	79	---	
	TES 1-2410	---	72	---	
	TES 1-2411	---	78	---	
	TES 1-2419	---	77	---	
	TES 1-2412	---	77	---	
	TES 1-2413	---	79	---	
	TES 1-2421	---	73	---	
	TES 1-2422	---	78	---	
	TES 1-2423	---	78	---	
Isolation voltage Input to Output (for 60 seconds)		1500	---	---	VDC
Isolation resistance	All	1000	---	---	MΩ
Isolation capacitance		---	40	100	pF
Switching Frequency		50	100	140	KHz
MTBF MIL-STD-217F, TC=25°C		2000	---	---	K Hours

Characteristic Curves

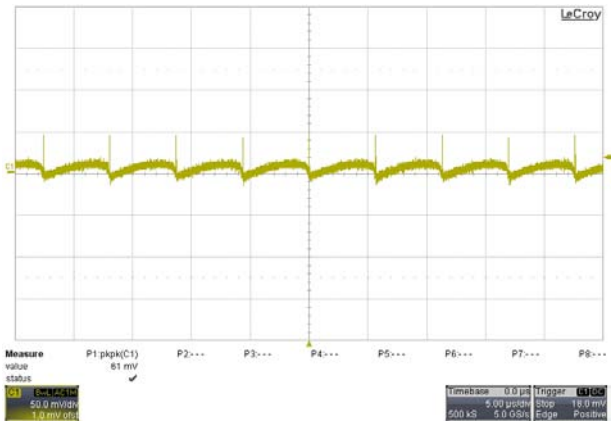
All test conditions are at 25°C The figures are identical for TES 1-0510



Efficiency Versus Output Current

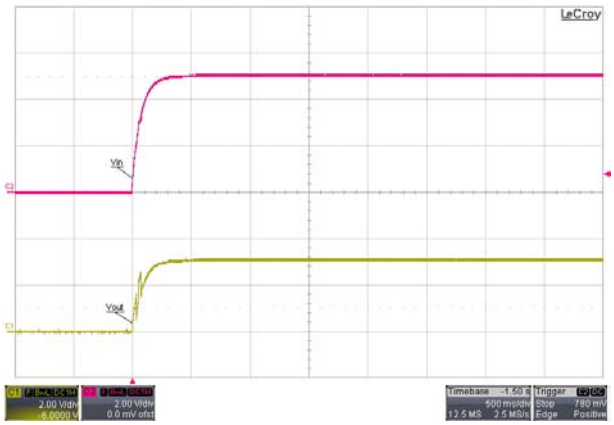


Efficiency Versus Input Voltage. Full Load



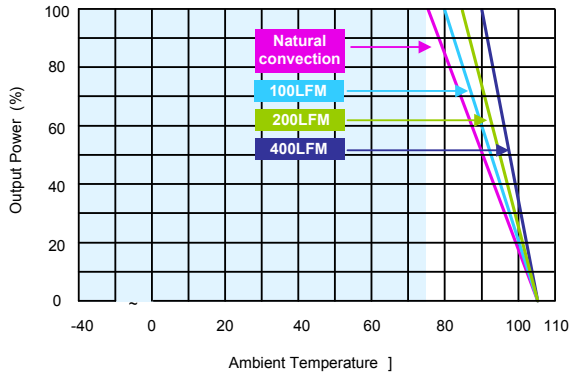
Typical Output Ripple and Noise.

V_{in} =$V_{in\ nom}$; Full Load; T_A



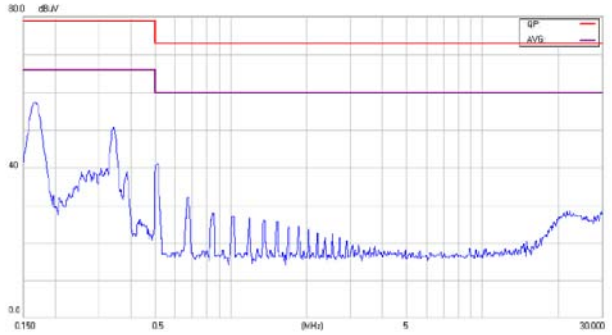
Typical Input Start-Up and Output Rise Characteristic

V_{in} =$V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow

V_{in} =$V_{in\ nom}$

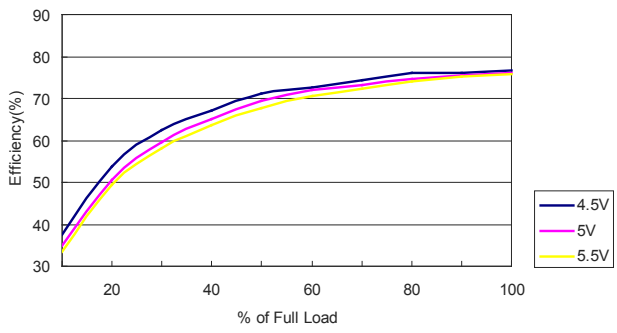


Conduction Emission of EN55022 Class A

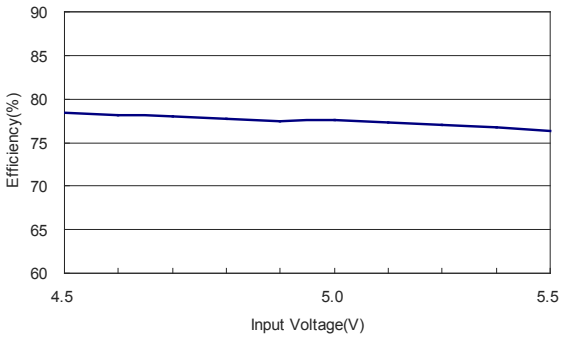
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

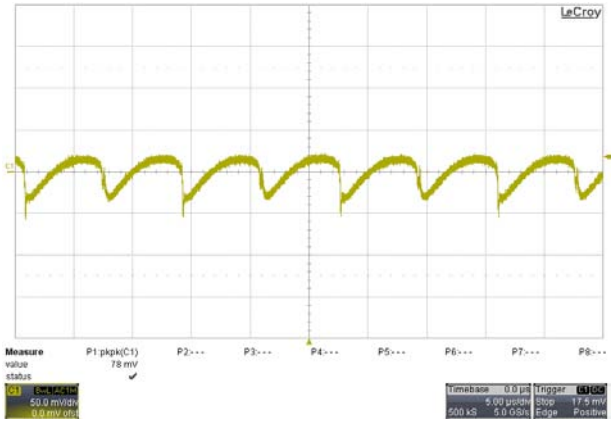
All test conditions are at 25°C The figures are identical for TES 1-0511



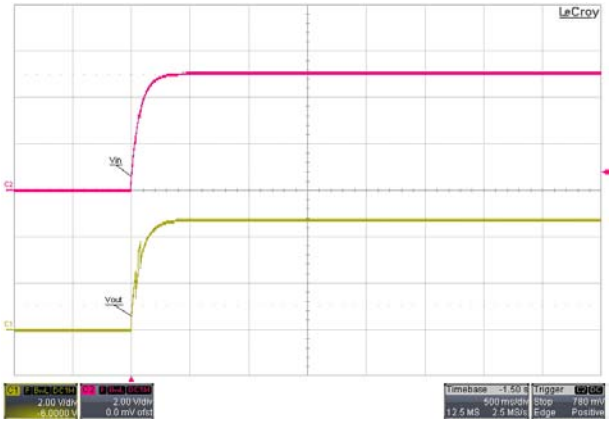
Efficiency Versus Output Current



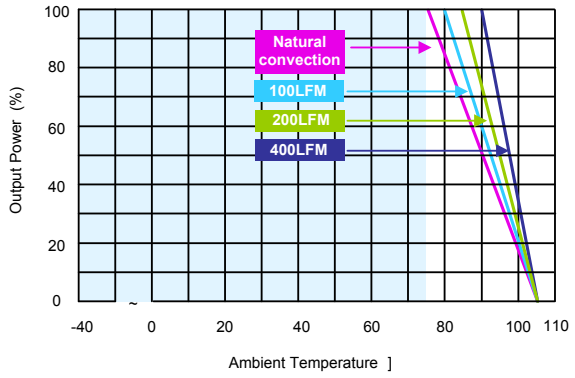
Efficiency Versus Input Voltage. Full Load



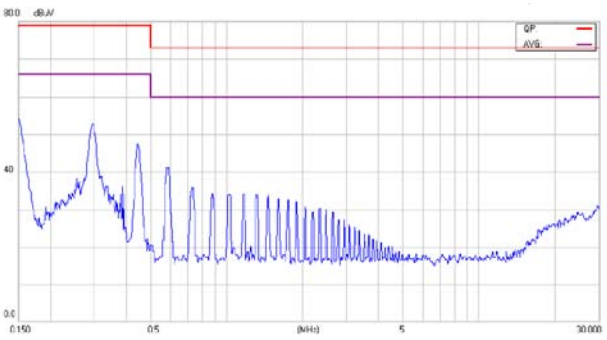
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



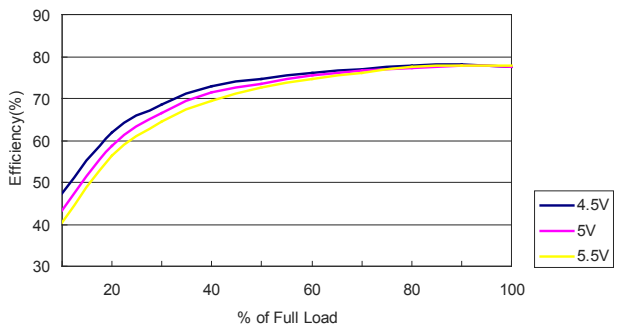
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



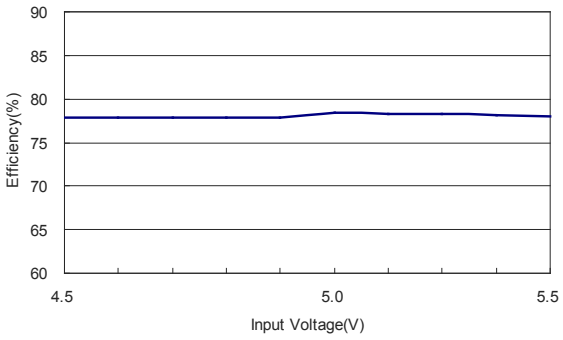
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

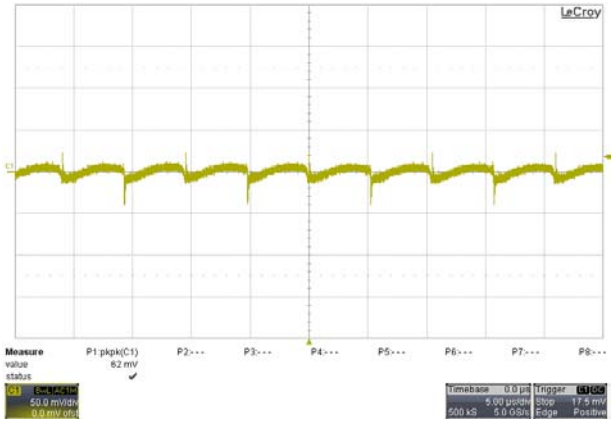
All test conditions are at 25°C The figures are identical for TES 1-0519



Efficiency Versus Output Current

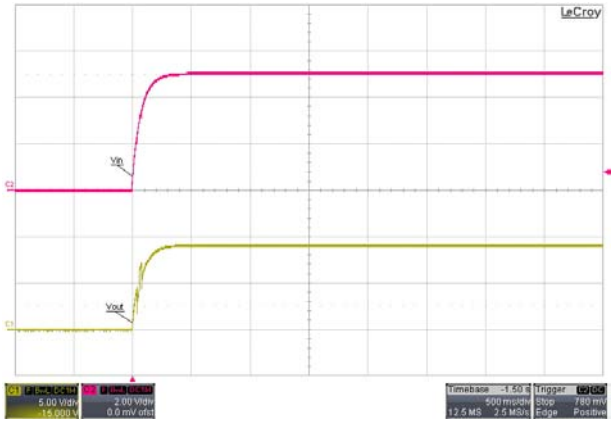


Efficiency Versus Input Voltage. Full Load



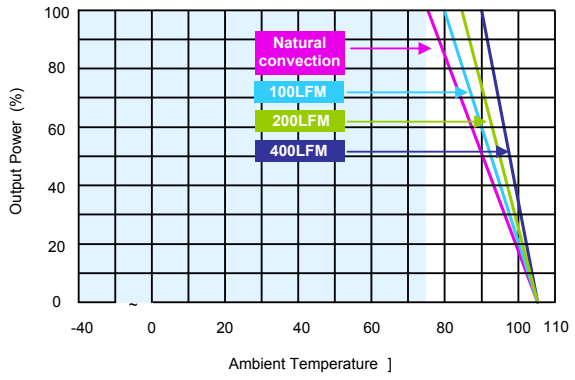
Typical Output Ripple and Noise.

V_{in} =$V_{in\ nom}$; Full Load; T_A



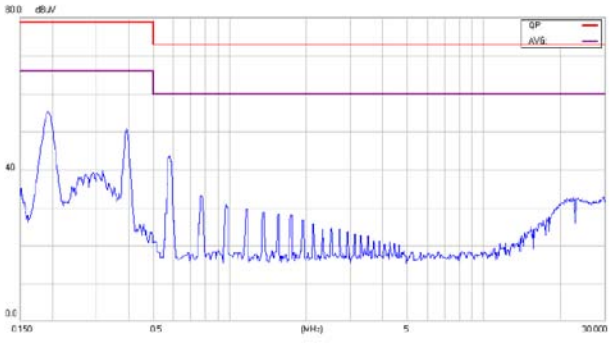
Typical Input Start-Up and Output Rise Characteristic

V_{in} =$V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow

V_{in} =$V_{in\ nom}$

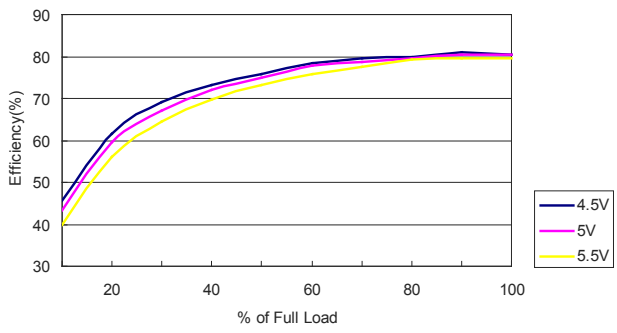


Conduction Emission of EN55022 Class A

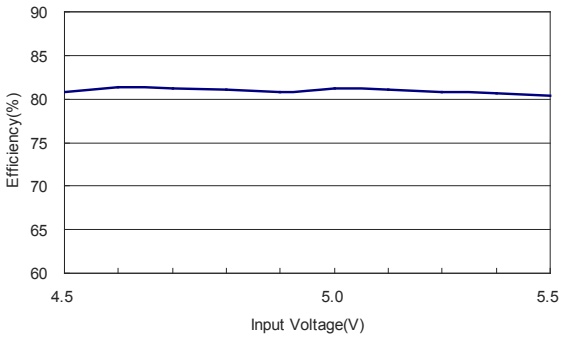
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

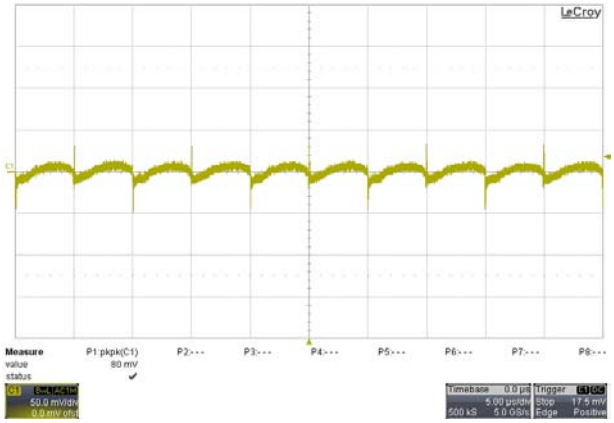
All test conditions are at 25°C The figures are identical for TES 1-0512



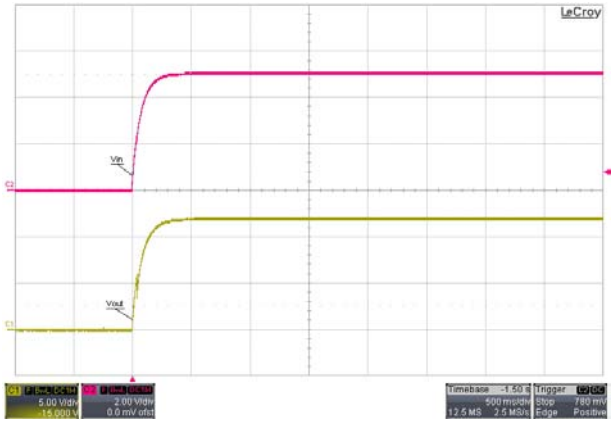
Efficiency Versus Output Current



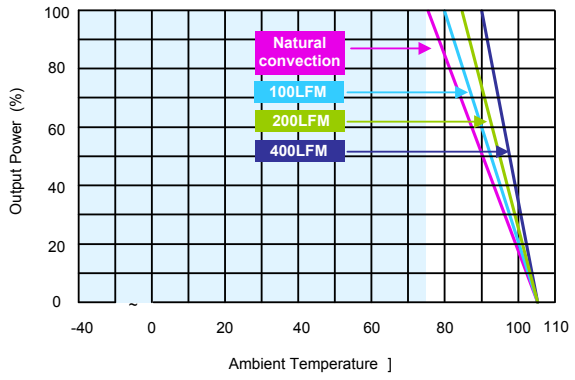
Efficiency Versus Input Voltage. Full Load



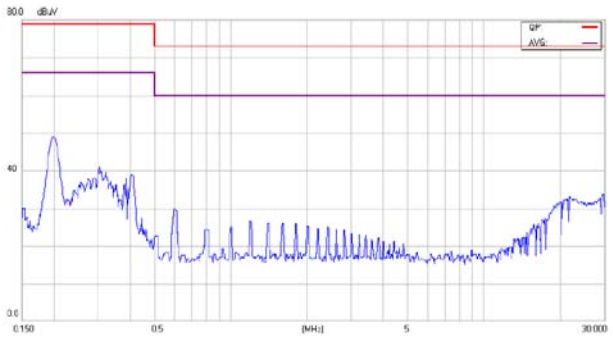
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



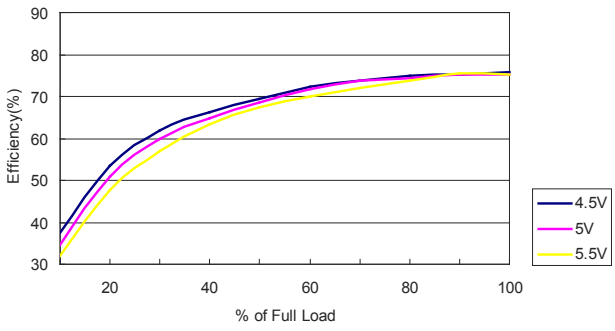
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



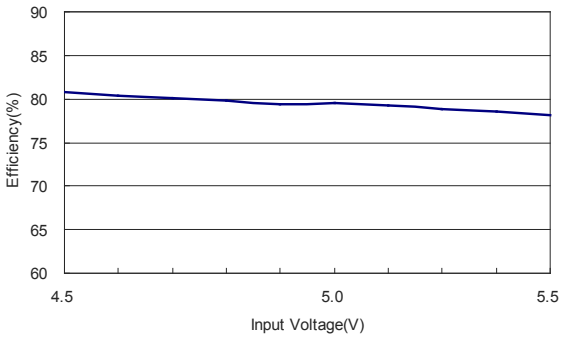
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

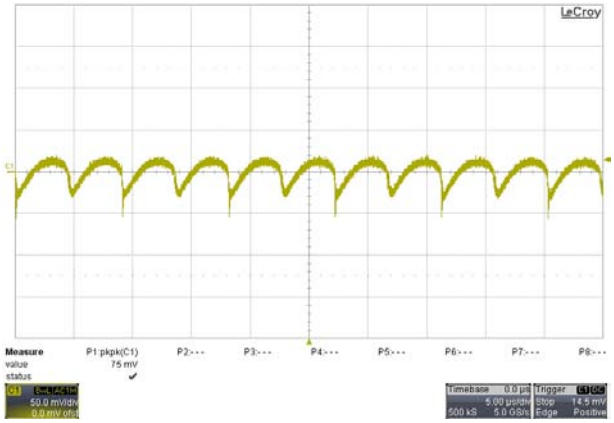
All test conditions are at 25°C The figures are identical for TES 1-0513



Efficiency Versus Output Current

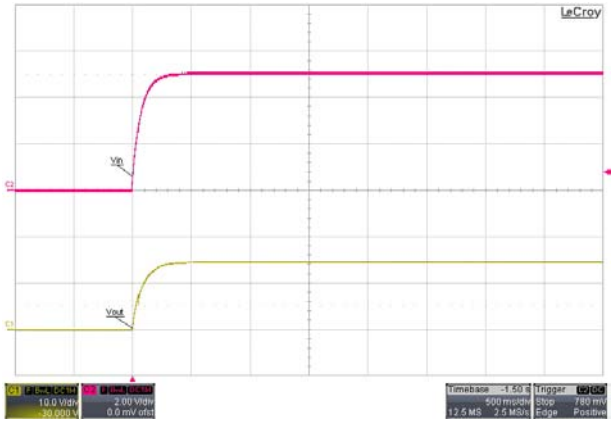


Efficiency Versus Input Voltage. Full Load



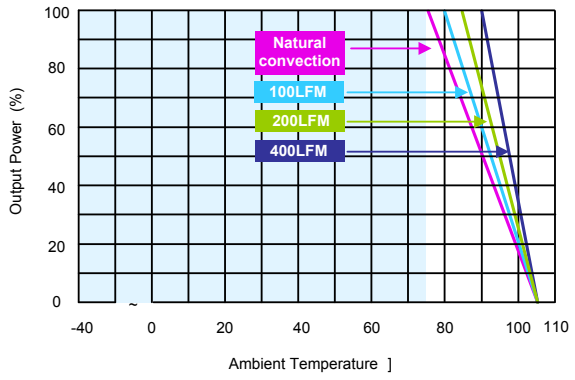
Typical Output Ripple and Noise.

V_{in} =$V_{in\ nom}$; Full Load; T_A



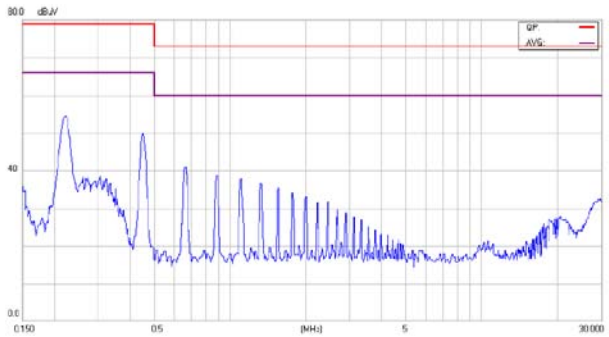
Typical Input Start-Up and Output Rise Characteristic

V_{in} =$V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow

V_{in} =$V_{in\ nom}$

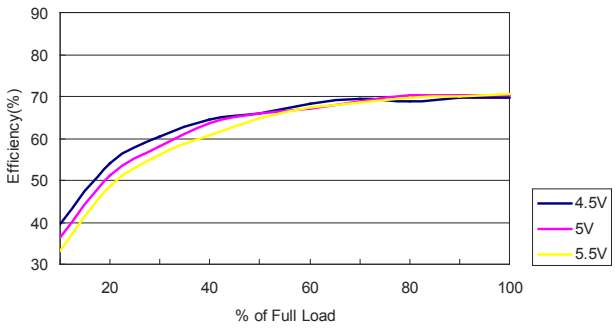


Conduction Emission of EN55022 Class A

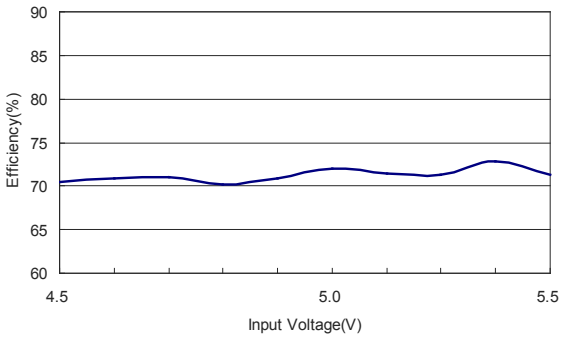
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

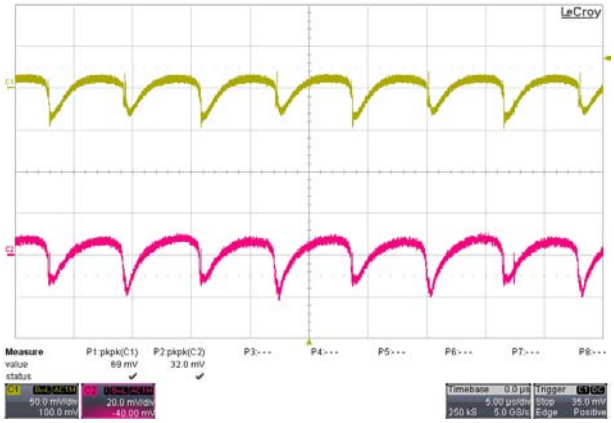
All test conditions are at 25°C The figures are identical for TES 1-0521



Efficiency Versus Output Current

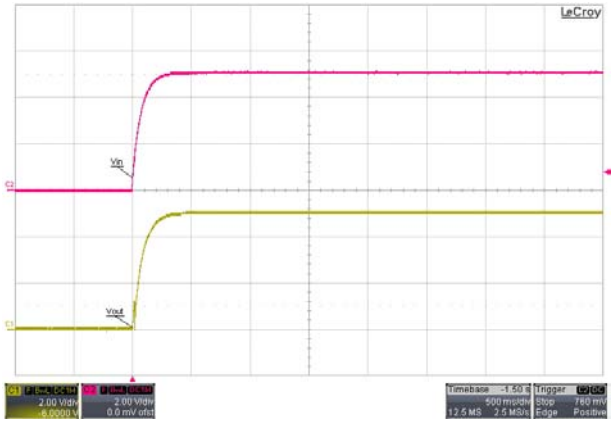


Efficiency Versus Input Voltage. Full Load



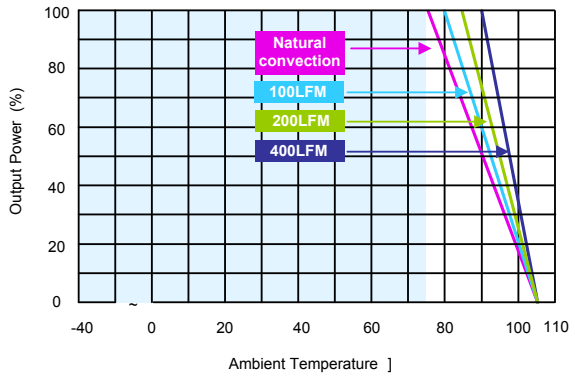
Typical Output Ripple and Noise.

V_{in} =$V_{in\ nom}$; Full Load; T_A



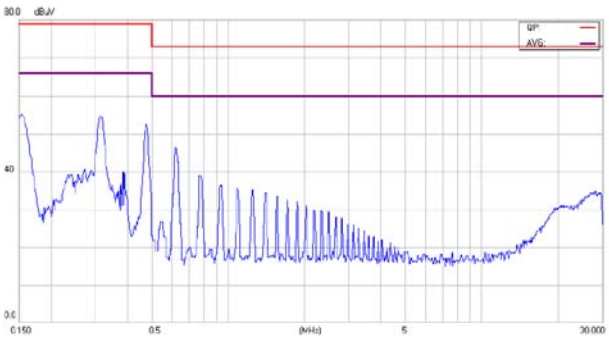
Typical Input Start-Up and Output Rise Characteristic

V_{in} =$V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow

V_{in} =$V_{in\ nom}$

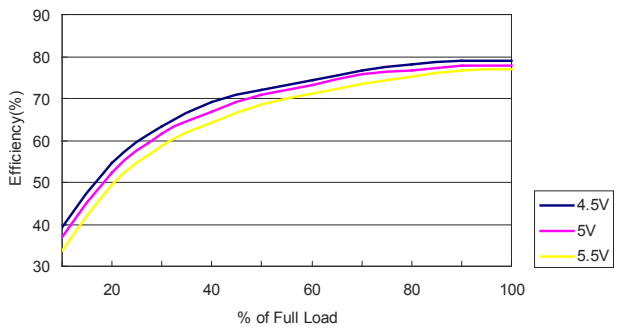


Conduction Emission of EN55022 Class A

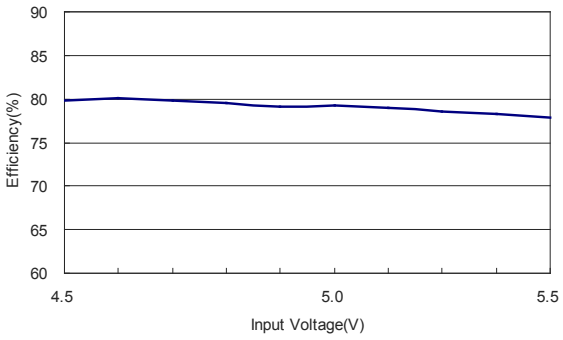
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

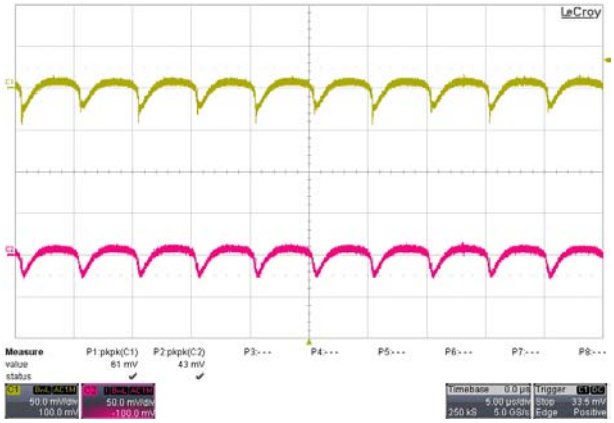
All test conditions are at 25°C The figures are identical for TES 1-0522



Efficiency Versus Output Current

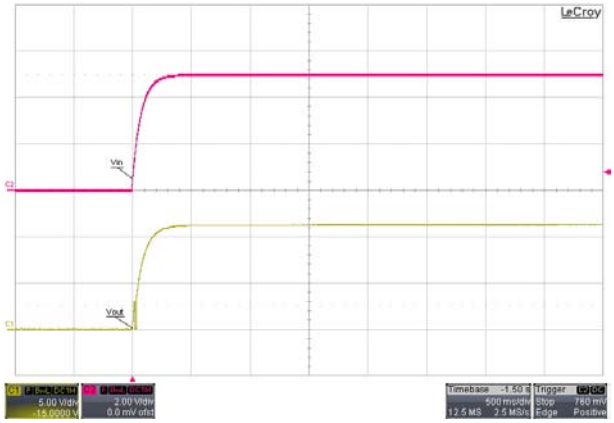


Efficiency Versus Input Voltage. Full Load



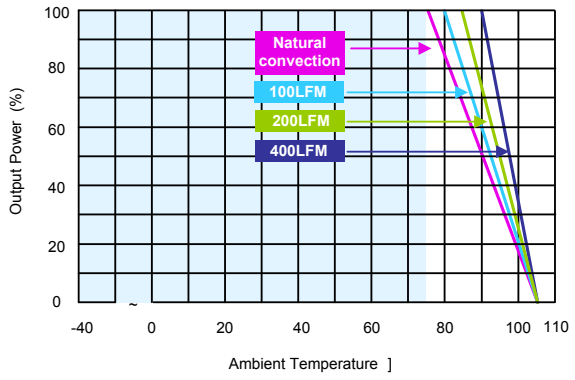
Typical Output Ripple and Noise.

V_{in} =$V_{in\ nom}$; Full Load; T_A



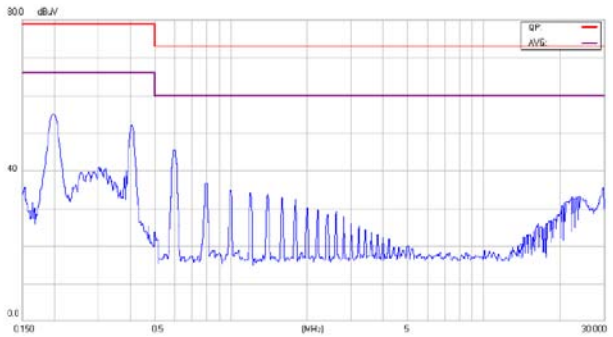
Typical Input Start-Up and Output Rise Characteristic

V_{in} =$V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow

V_{in} =$V_{in\ nom}$

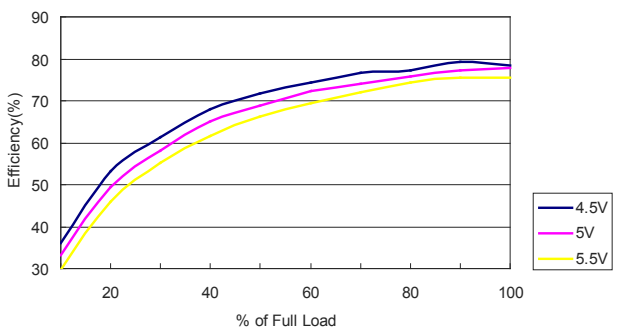


Conduction Emission of EN55022 Class A

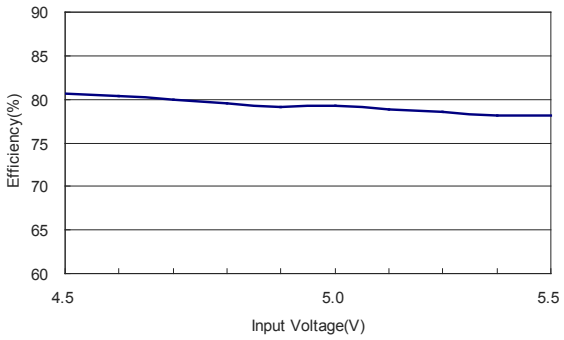
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

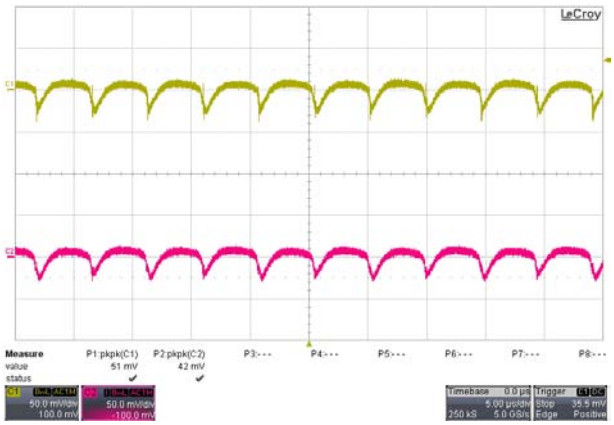
All test conditions are at 25°C The figures are identical for TES 1-0523



Efficiency Versus Output Current

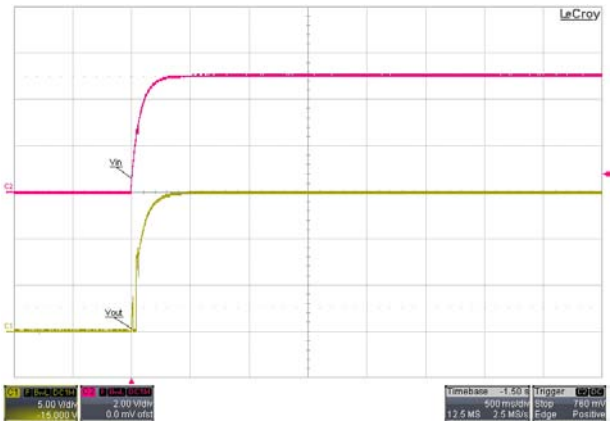


Efficiency Versus Input Voltage. Full Load



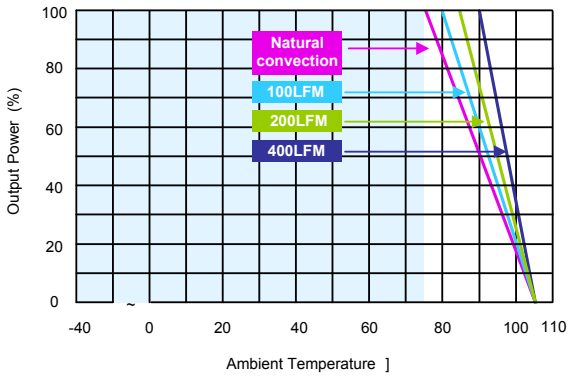
Typical Output Ripple and Noise.

V_{in} =$V_{in\ nom}$; Full Load; T_A



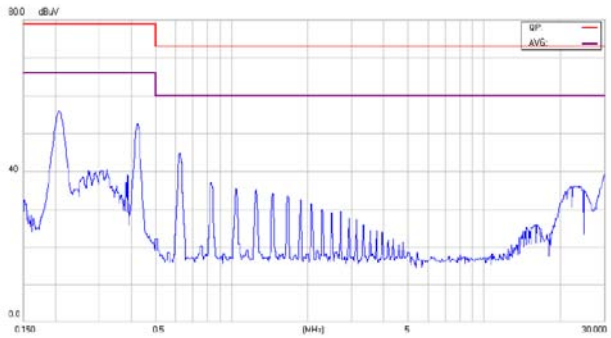
Typical Input Start-Up and Output Rise Characteristic

V_{in} =$V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow

V_{in} =$V_{in\ nom}$

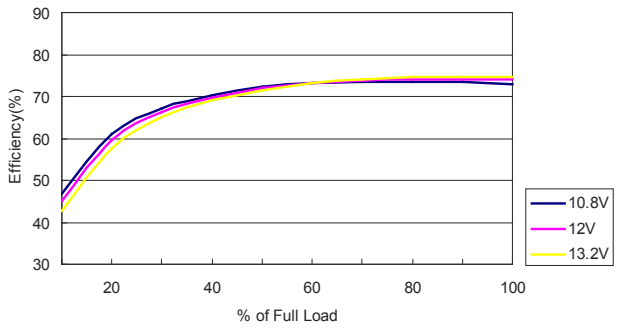


Conduction Emission of EN55022 Class A

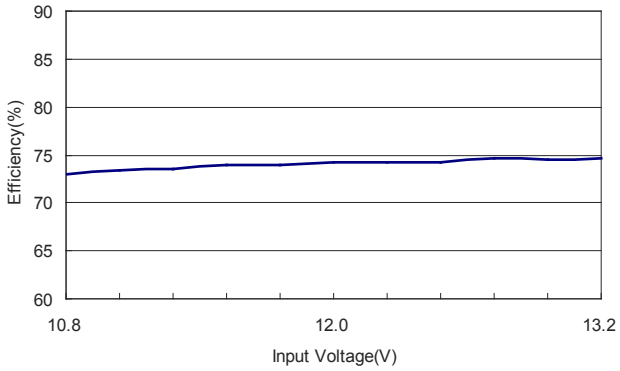
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

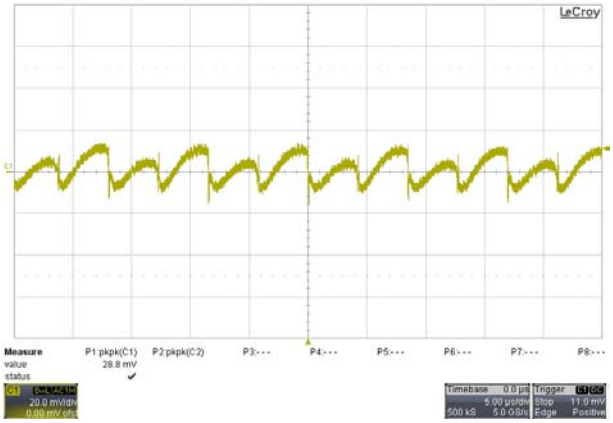
All test conditions are at 25°C The figures are identical for TES 1-1210



Efficiency Versus Output Current

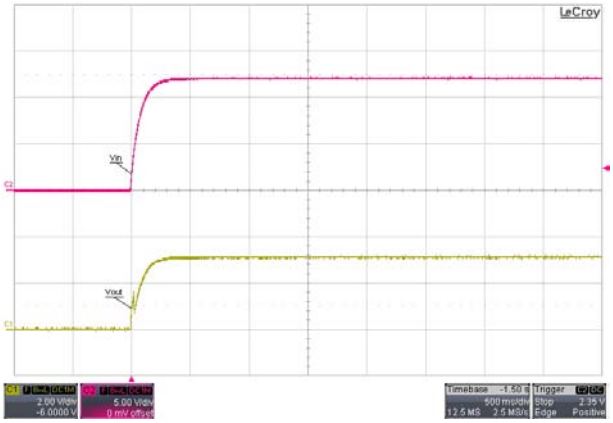


Efficiency Versus Input Voltage. Full Load



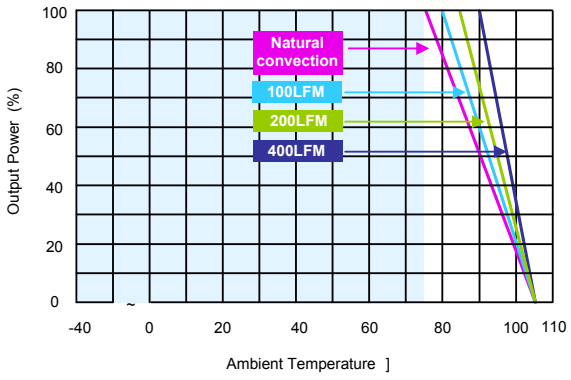
Typical Output Ripple and Noise.

V_{in} =$V_{in\ nom}$; Full Load; T_A



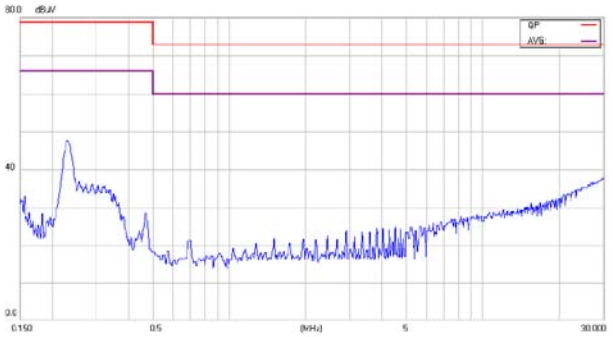
Typical Input Start-Up and Output Rise Characteristic

V_{in} =$V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow

V_{in} =$V_{in\ nom}$

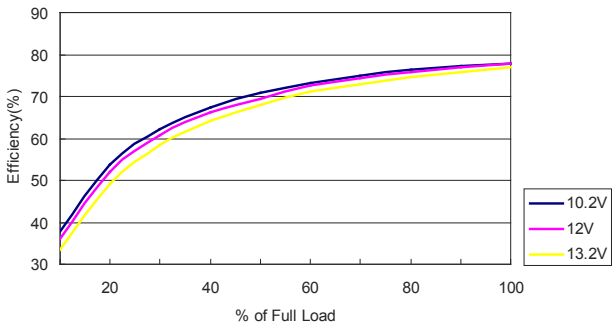


Conduction Emission of EN55022 Class A

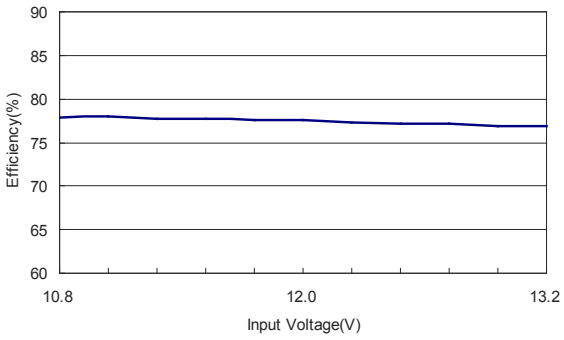
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

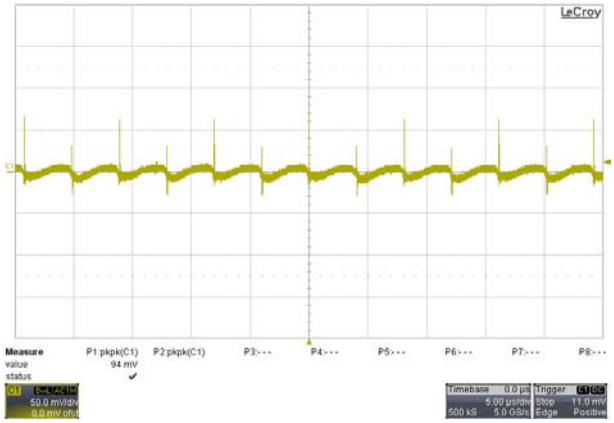
All test conditions are at 25°C The figures are identical for TES 1-1211



Efficiency Versus Output Current

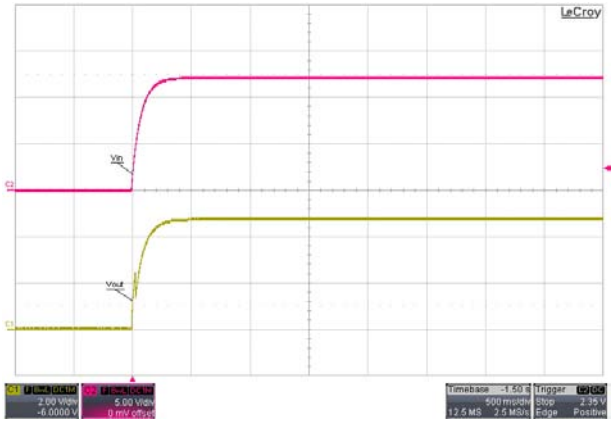


Efficiency Versus Input Voltage. Full Load



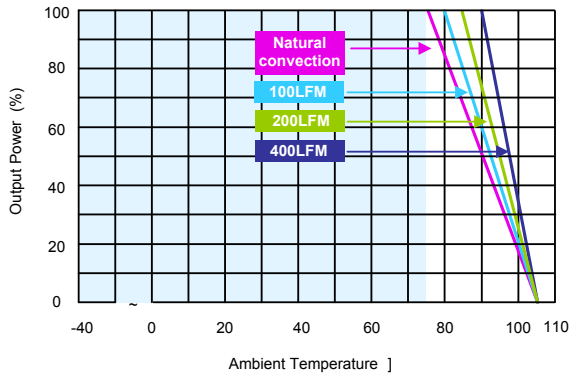
Typical Output Ripple and Noise.

V_{in} =$V_{in\ nom}$; Full Load; T_A



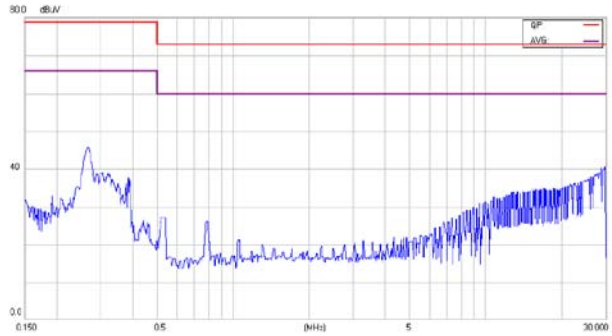
Typical Input Start-Up and Output Rise Characteristic

V_{in} =$V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow

V_{in} =$V_{in\ nom}$

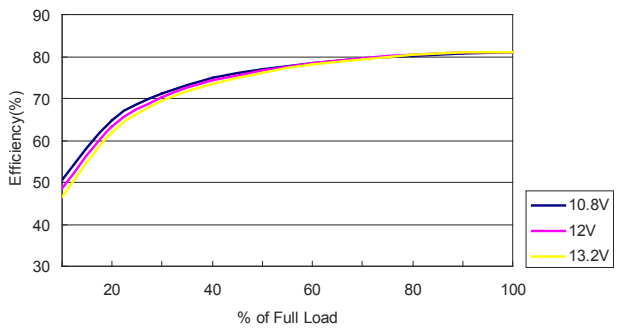


Conduction Emission of EN55022 Class A

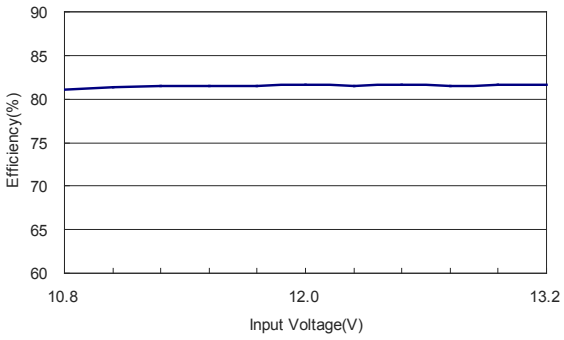
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

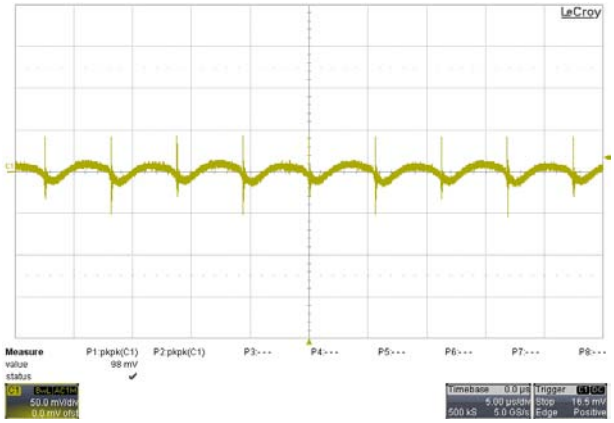
All test conditions are at 25°C The figures are identical for TES 1-1219



Efficiency Versus Output Current

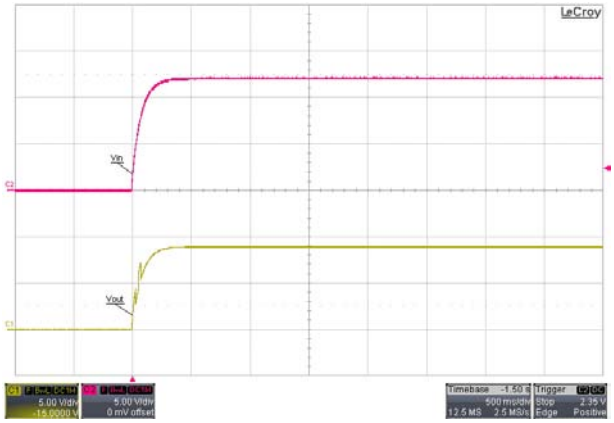


Efficiency Versus Input Voltage. Full Load



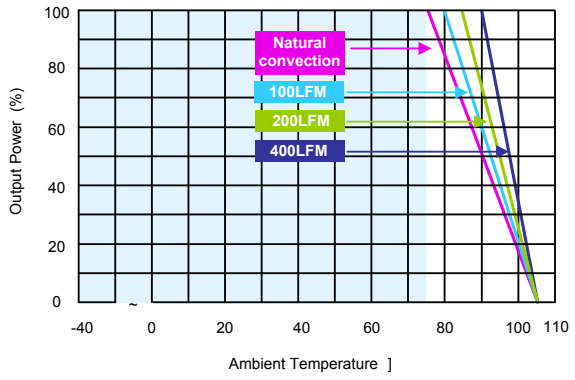
Typical Output Ripple and Noise.

V_{in} =$V_{in\ nom}$; Full Load; T_A



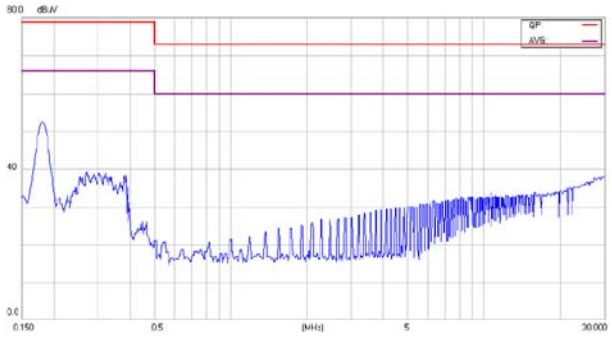
Typical Input Start-Up and Output Rise Characteristic

V_{in} =$V_{in\ nom}$; Full Load



Derating Output Current Versus Ambient Temperature and Airflow

V_{in} =$V_{in\ nom}$

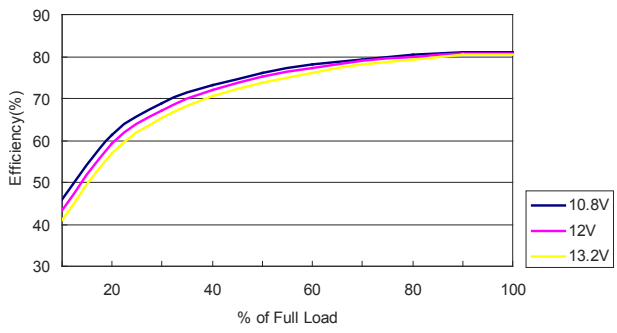


Conduction Emission of EN55022 Class A

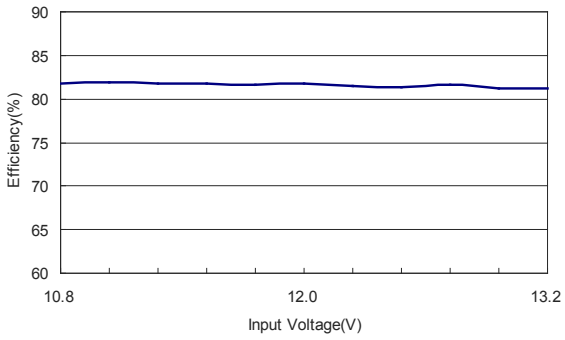
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

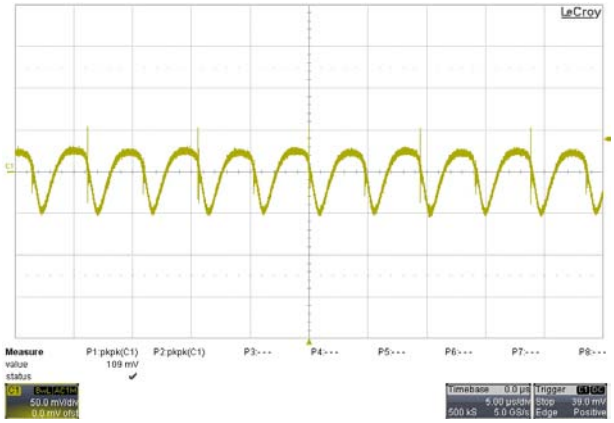
All test conditions are at 25°C The figures are identical for TES 1-1212



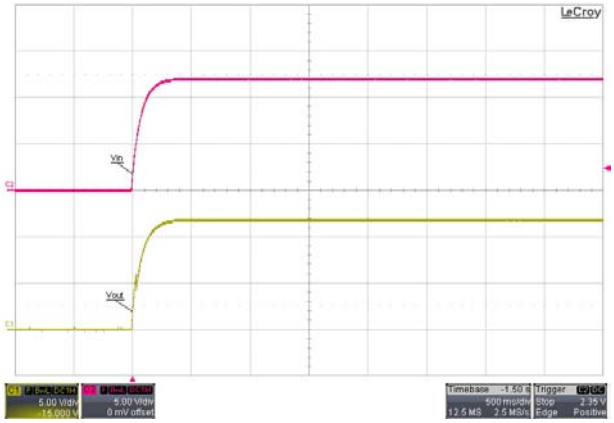
Efficiency Versus Output Current



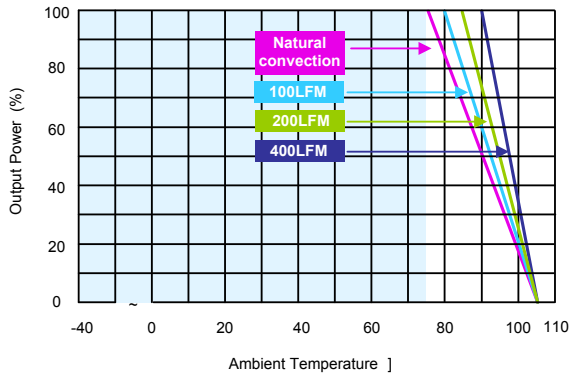
Efficiency Versus Input Voltage. Full Load



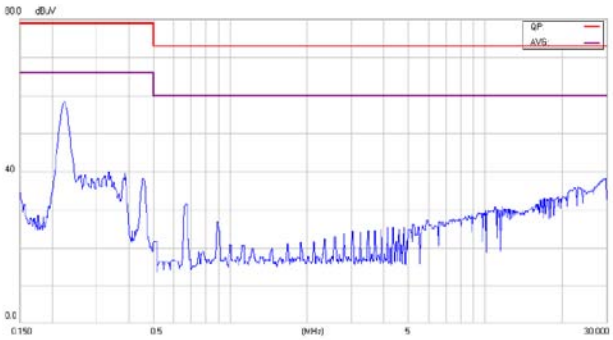
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



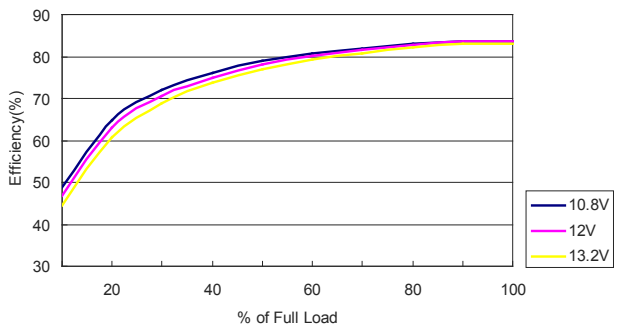
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



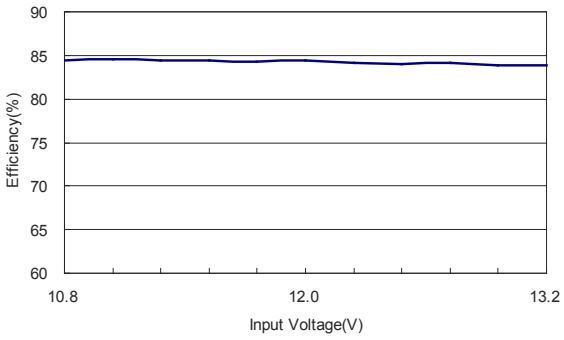
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

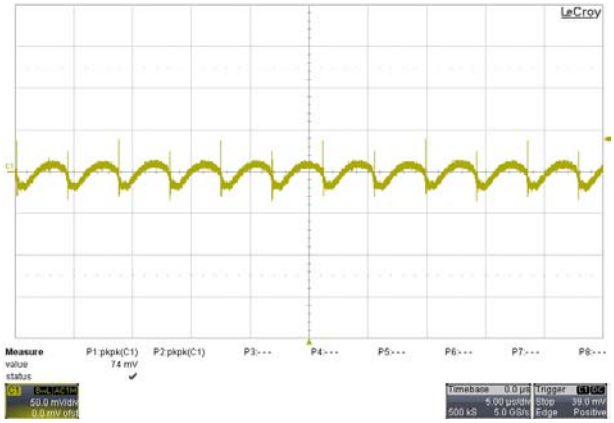
All test conditions are at 25°C The figures are identical for TES 1-1213



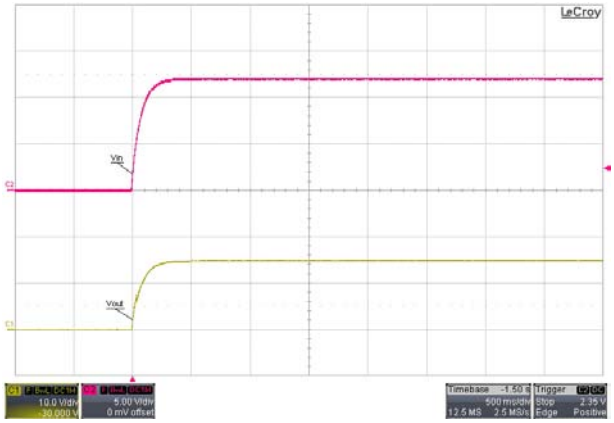
Efficiency Versus Output Current



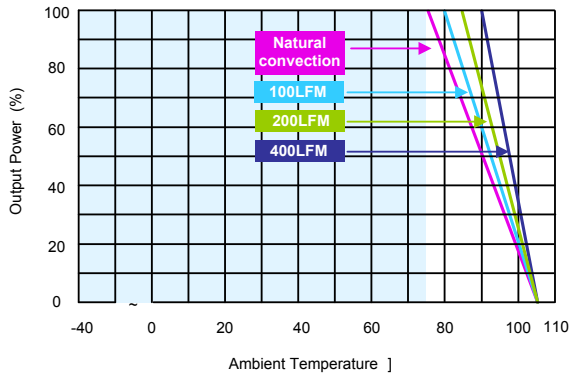
Efficiency Versus Input Voltage. Full Load



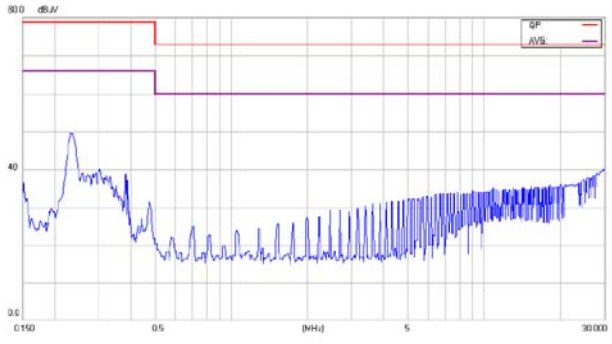
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



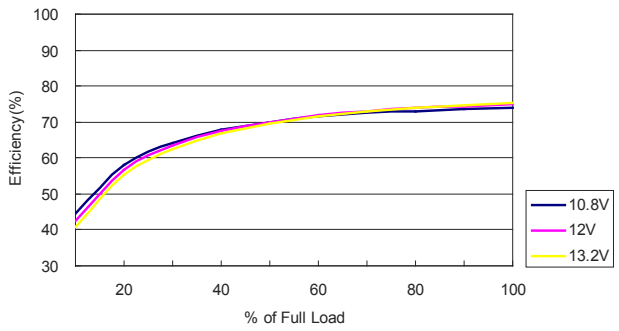
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



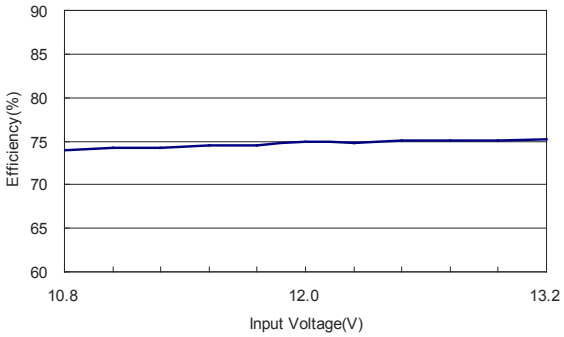
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

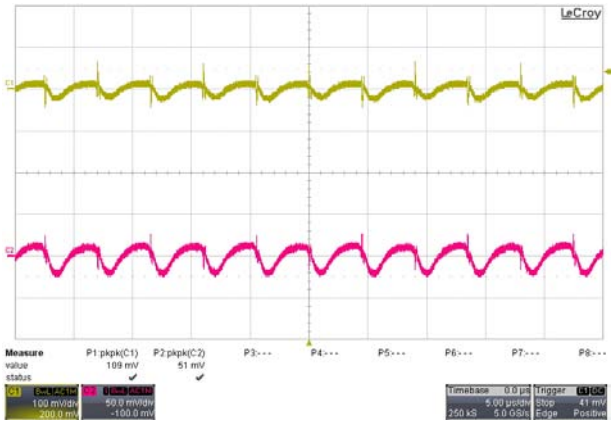
All test conditions are at 25°C The figures are identical for TES 1-1221



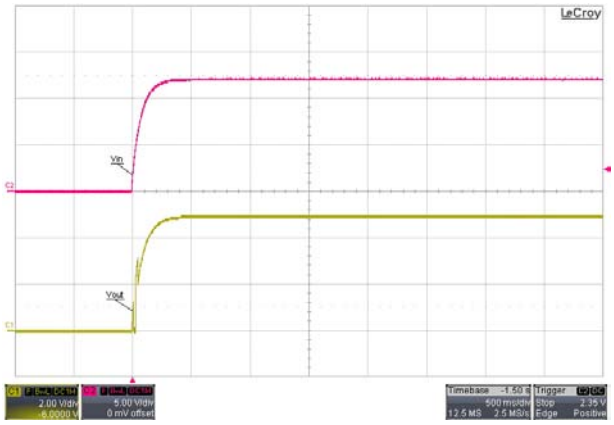
Efficiency Versus Output Current



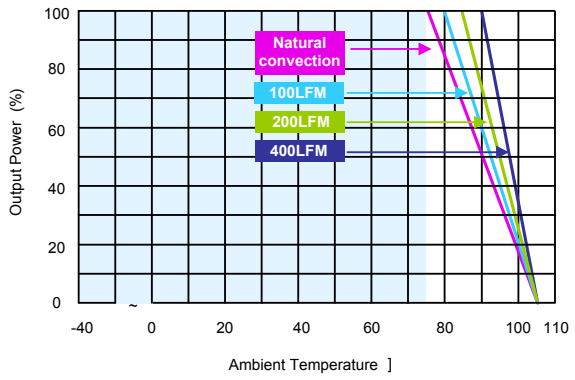
Efficiency Versus Input Voltage. Full Load



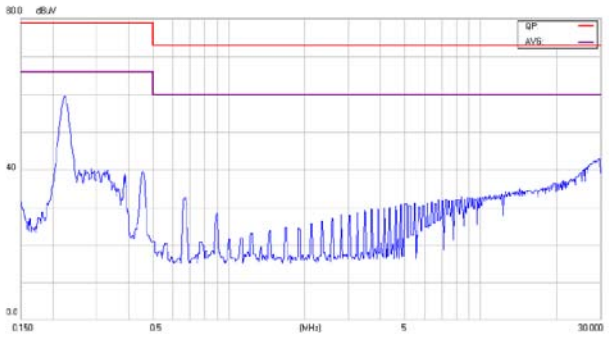
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



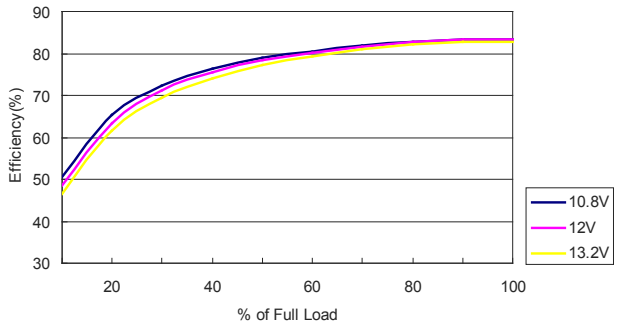
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



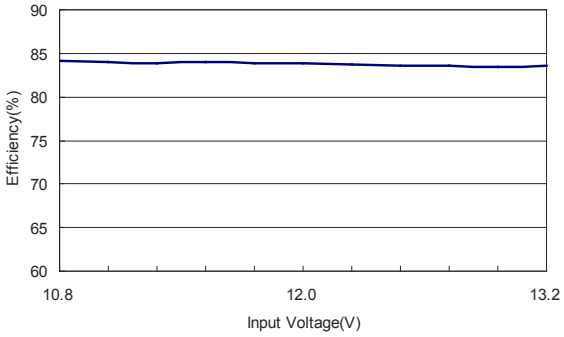
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

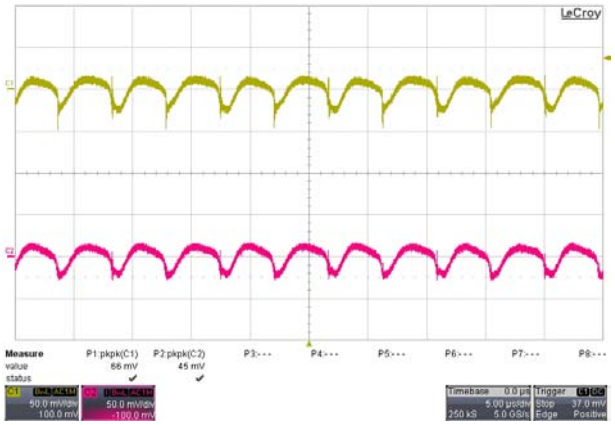
All test conditions are at 25°C The figures are identical for TES 1-1222



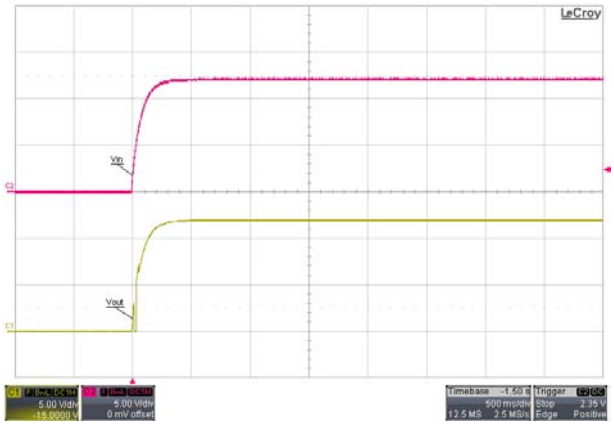
Efficiency Versus Output Current



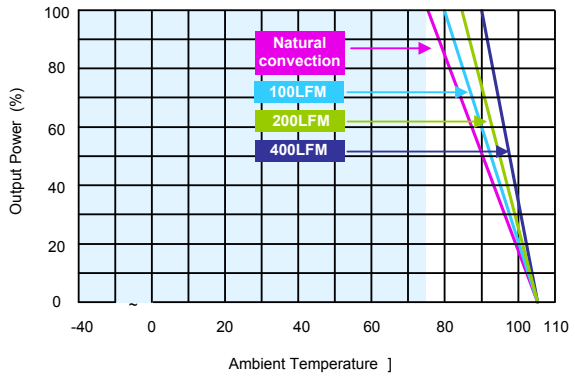
Efficiency Versus Input Voltage. Full Load



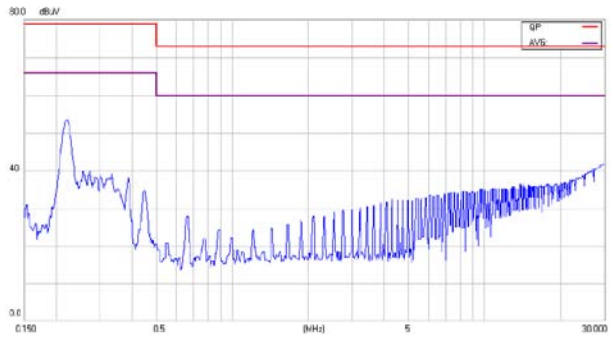
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



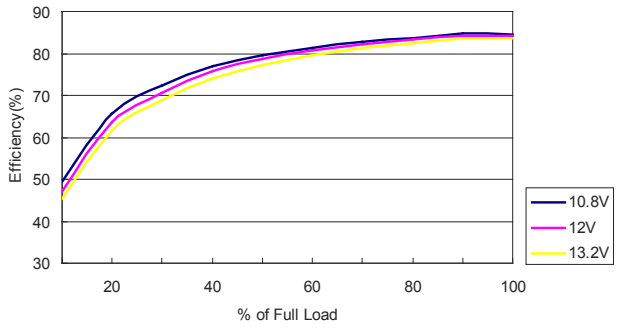
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



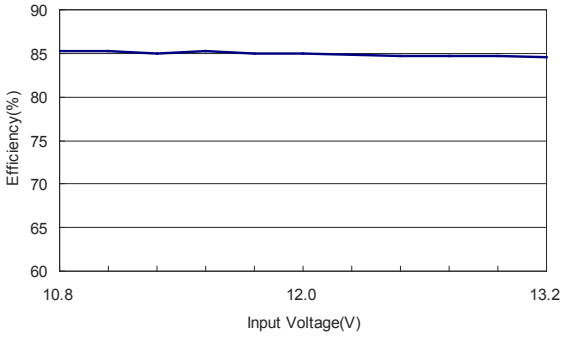
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

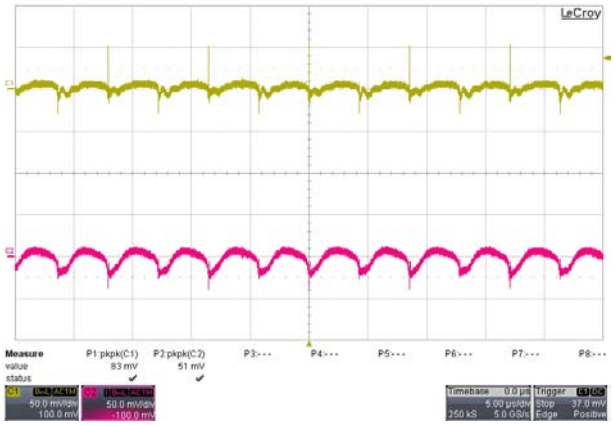
All test conditions are at 25°C The figures are identical for TES 1-1223



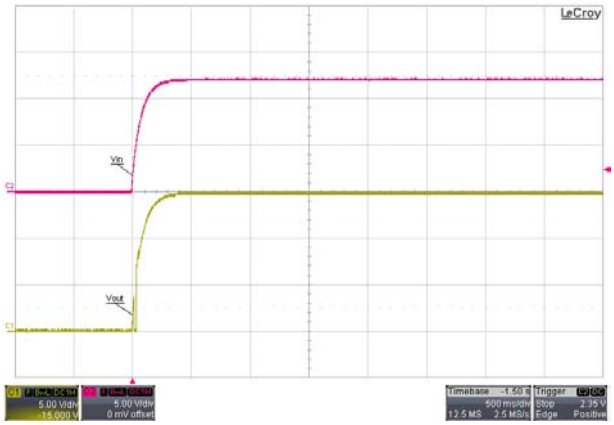
Efficiency Versus Output Current



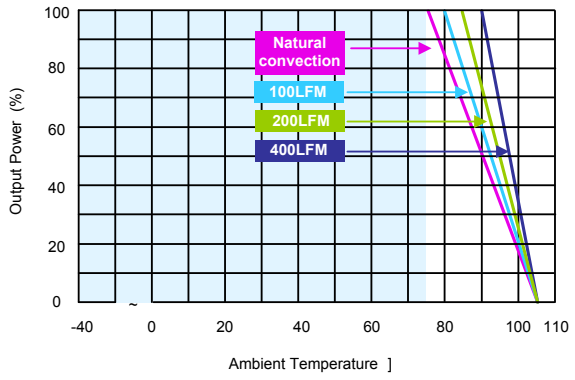
Efficiency Versus Input Voltage. Full Load



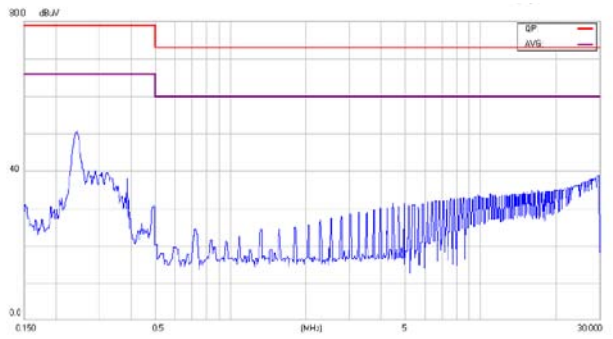
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



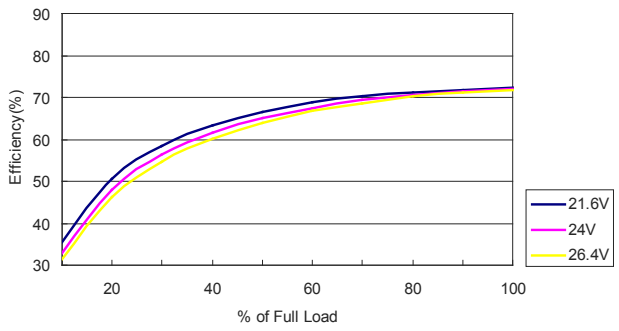
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



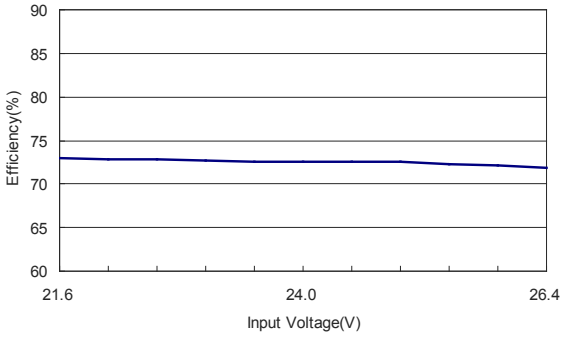
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

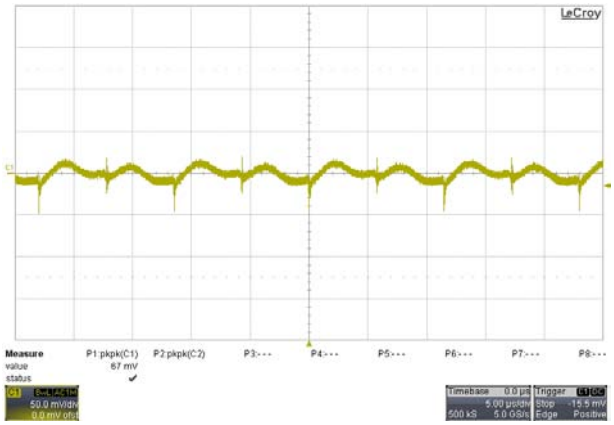
All test conditions are at 25°C The figures are identical for TES 1-2410



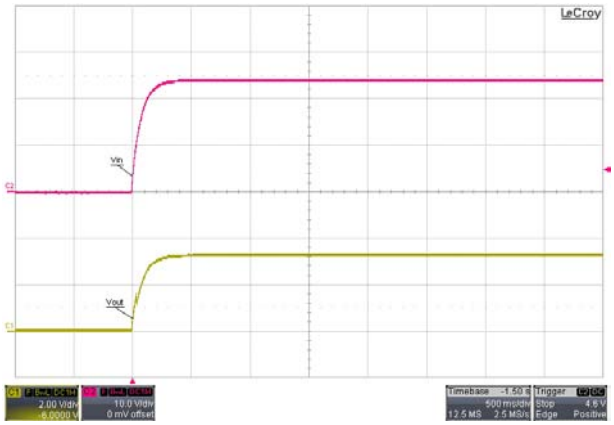
Efficiency Versus Output Current



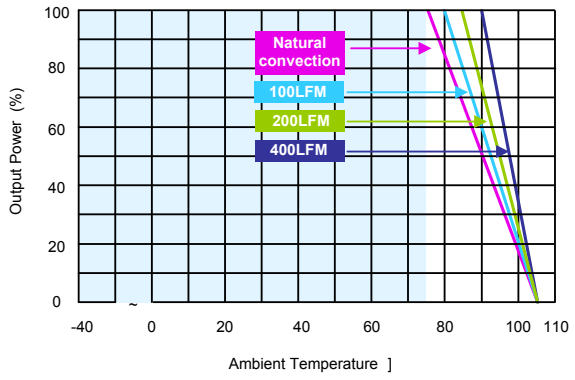
Efficiency Versus Input Voltage. Full Load



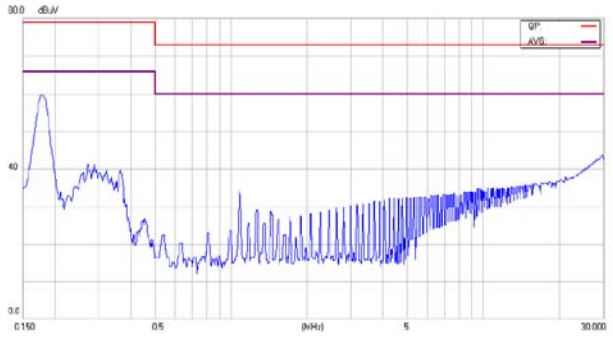
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



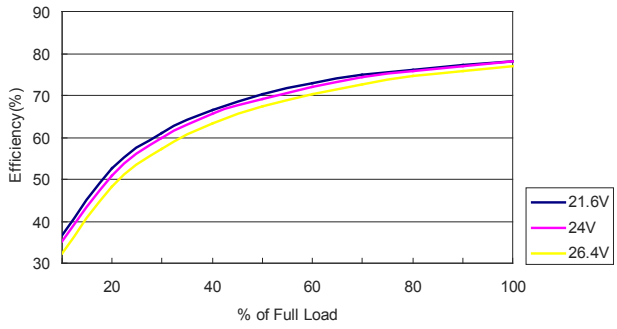
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



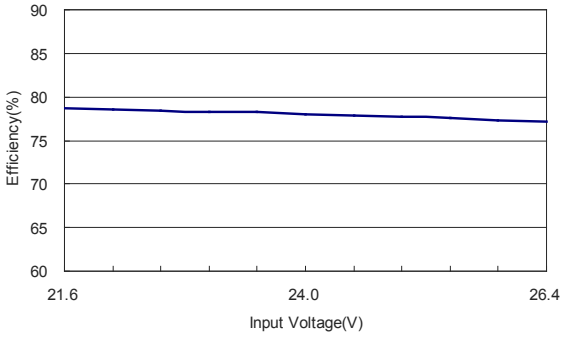
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

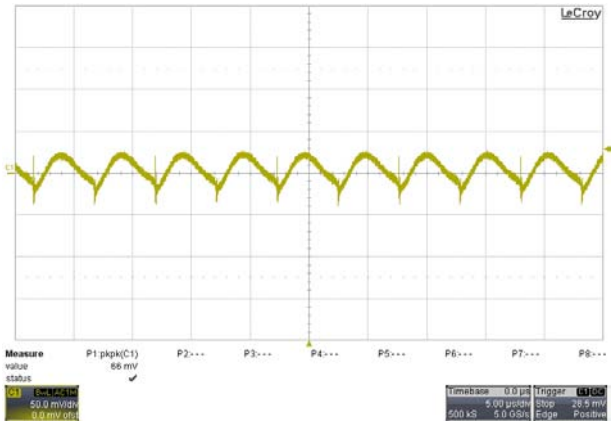
All test conditions are at 25°C The figures are identical for TES 1-2411



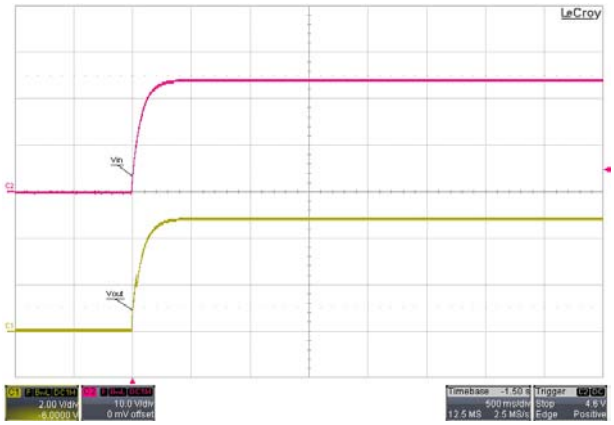
Efficiency Versus Output Current



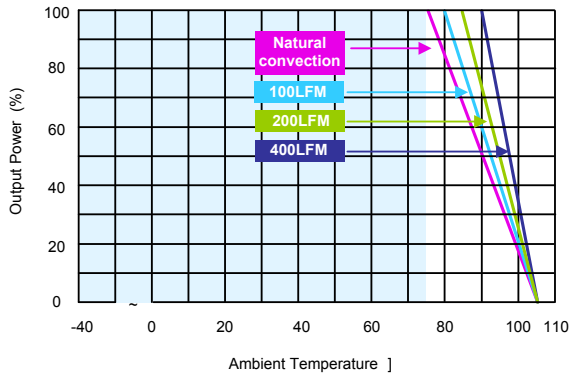
Efficiency Versus Input Voltage. Full Load



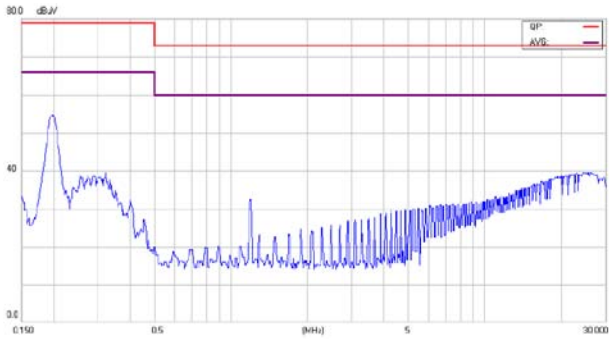
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



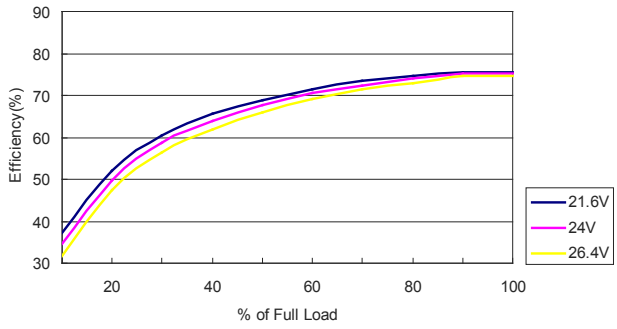
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



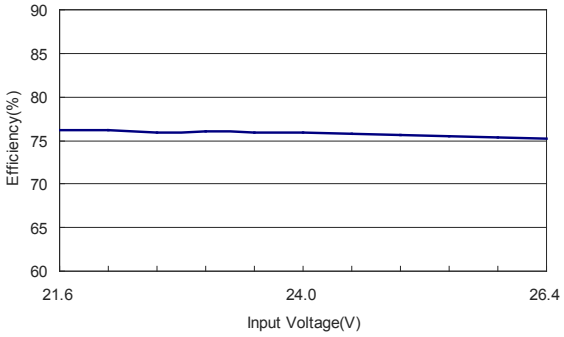
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

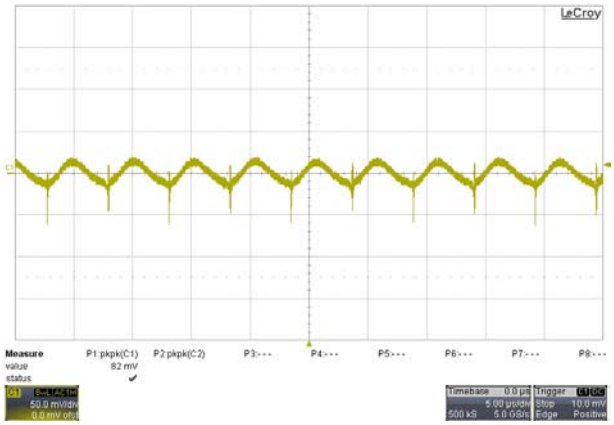
All test conditions are at 25°C The figures are identical for TES 1-2419



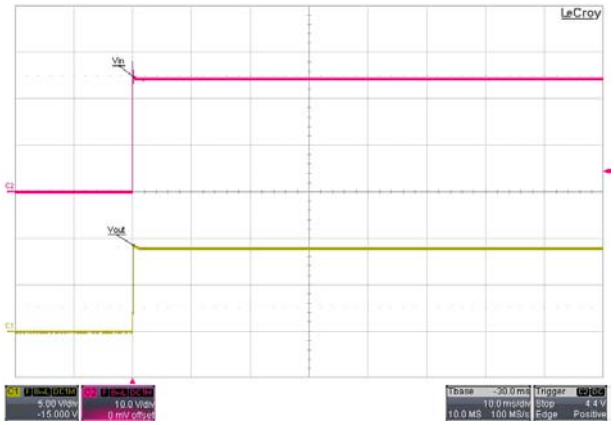
Efficiency Versus Output Current



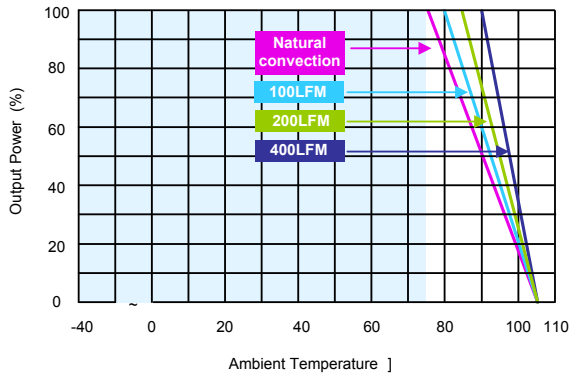
Efficiency Versus Input Voltage. Full Load



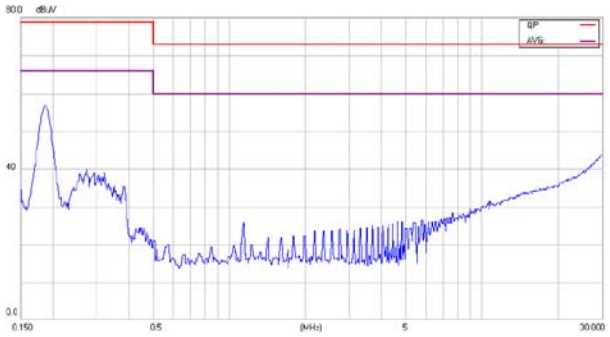
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



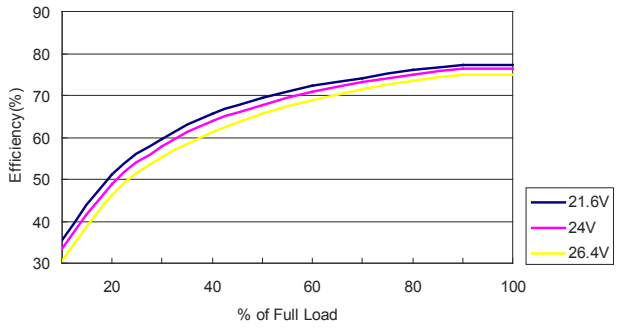
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



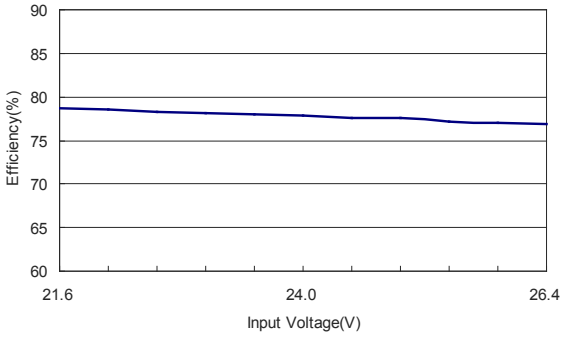
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

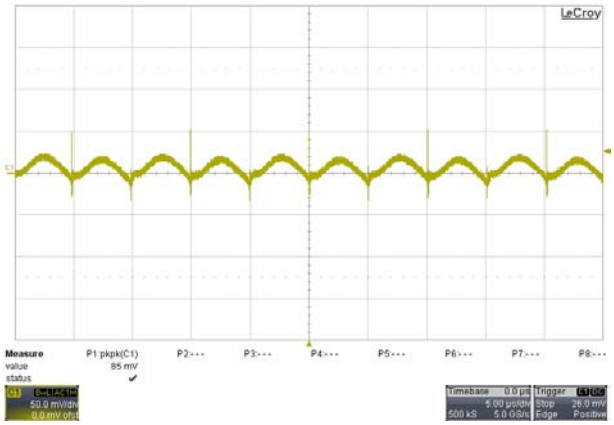
All test conditions are at 25°C The figures are identical for TES 1-2412



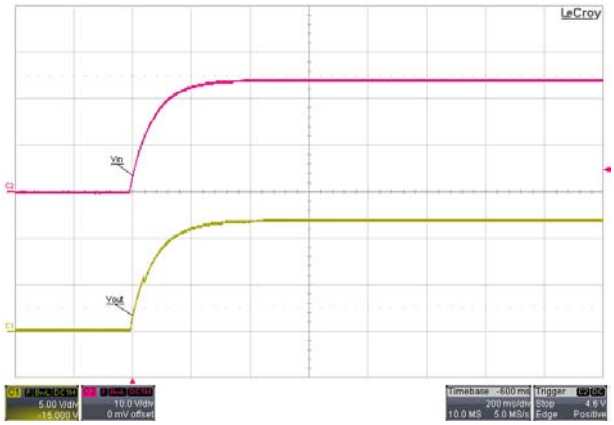
Efficiency Versus Output Current



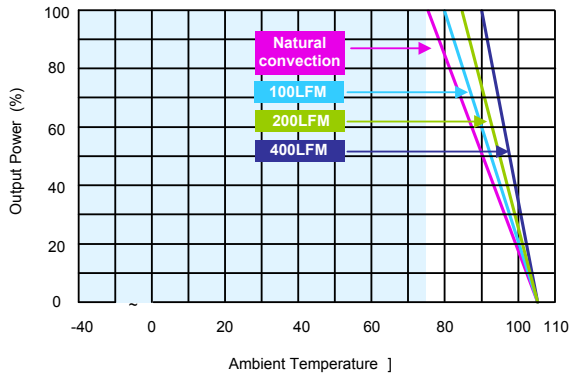
Efficiency Versus Input Voltage. Full Load



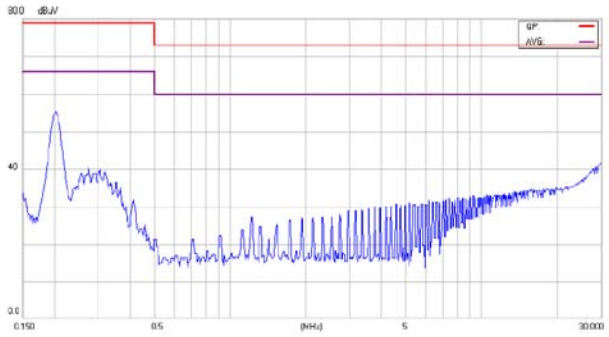
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



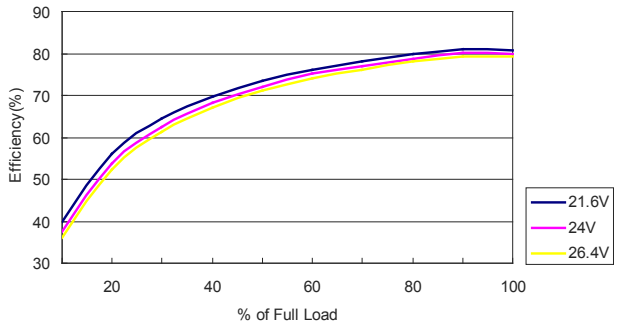
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



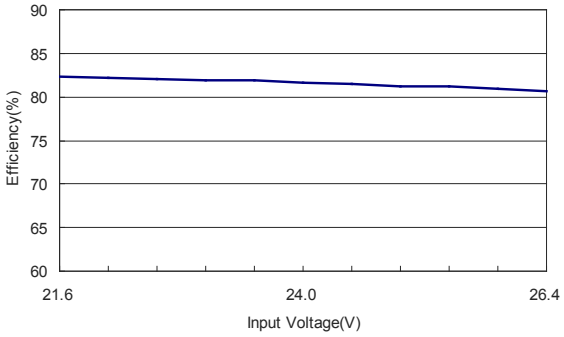
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

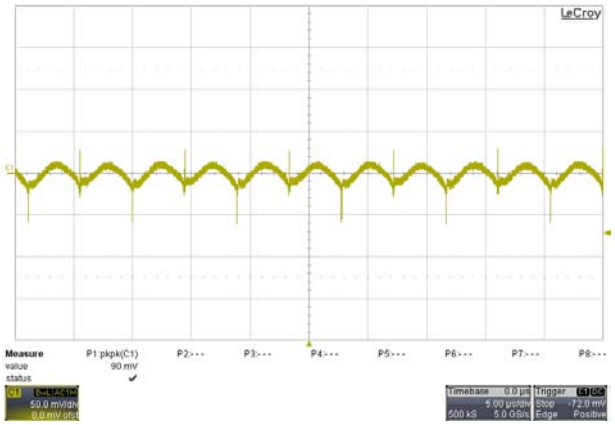
All test conditions are at 25°C The figures are identical for TES 1-2413



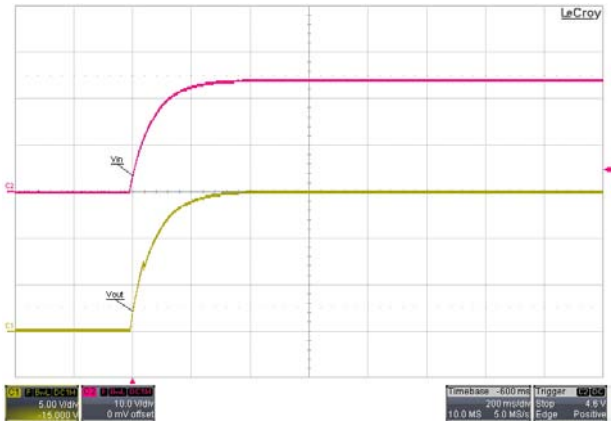
Efficiency Versus Output Current



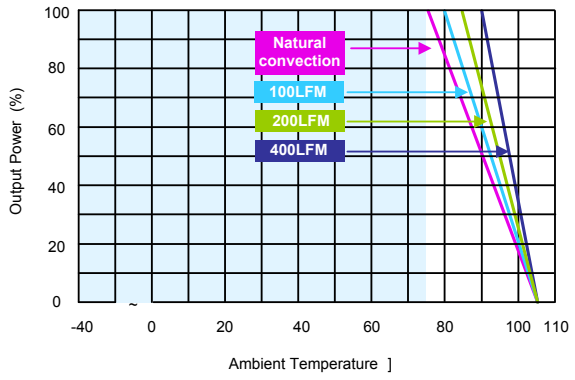
Efficiency Versus Input Voltage. Full Load



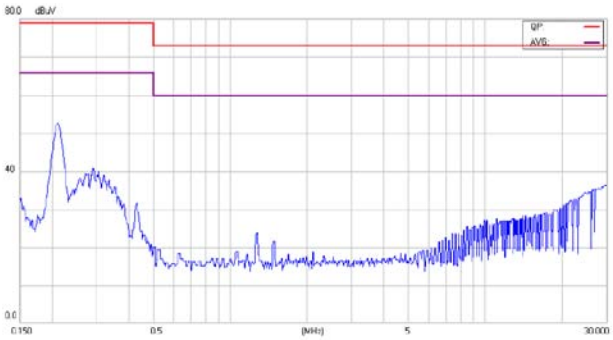
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



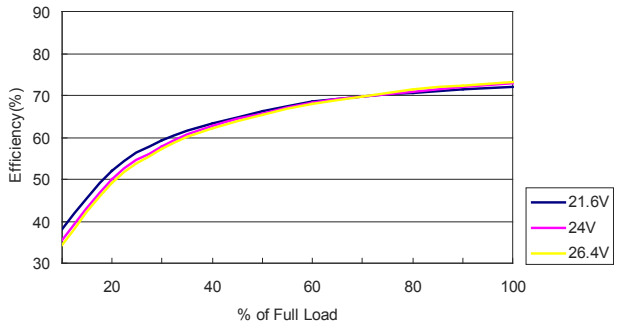
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



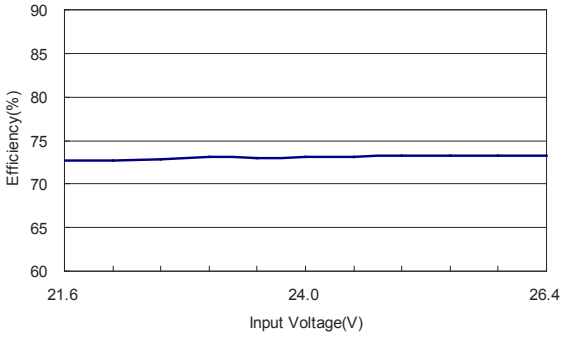
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

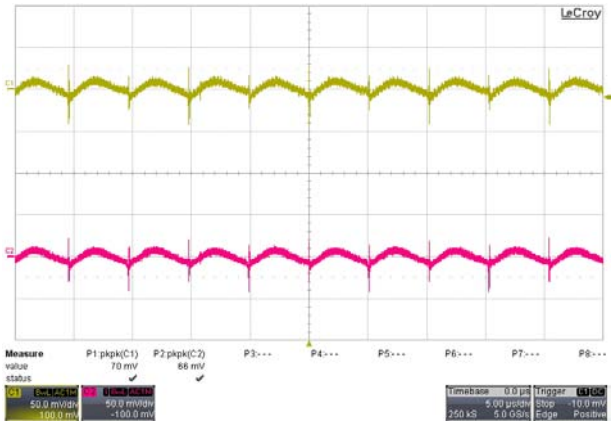
All test conditions are at 25°C The figures are identical for TES 1-2421



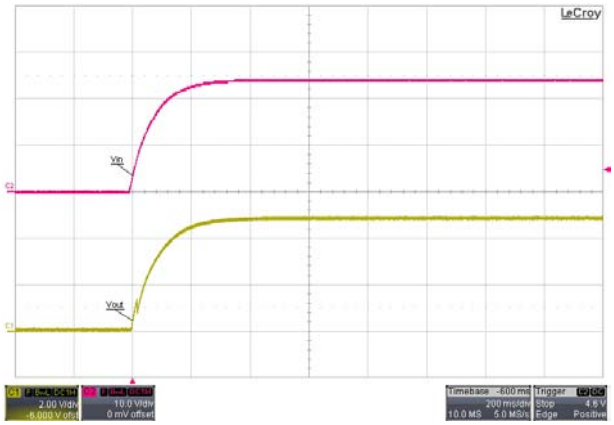
Efficiency Versus Output Current



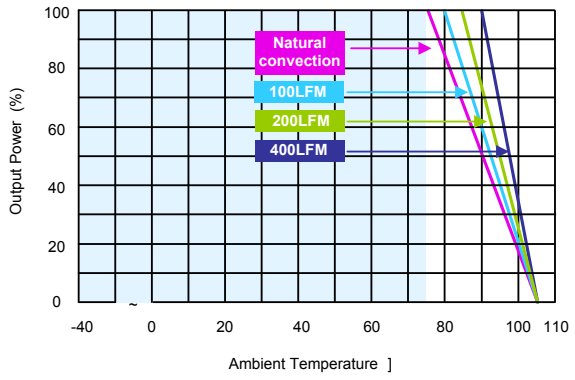
Efficiency Versus Input Voltage. Full Load



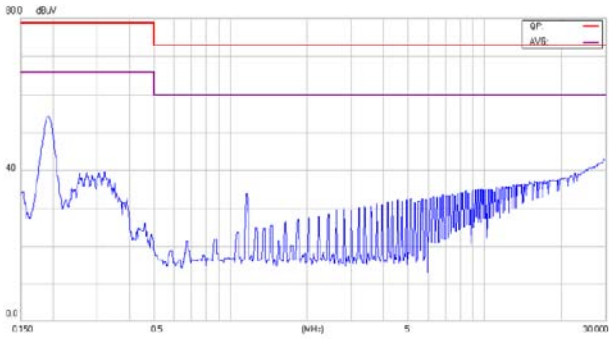
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



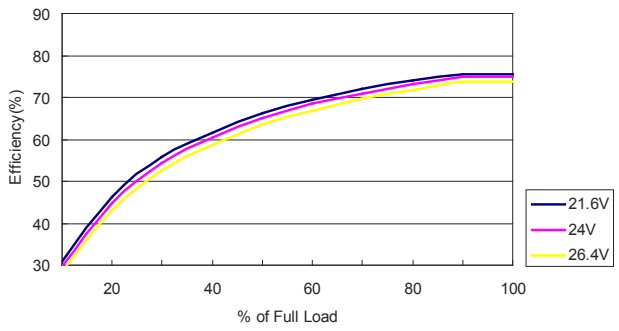
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



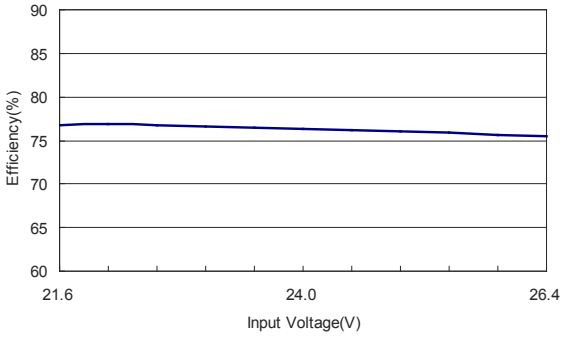
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

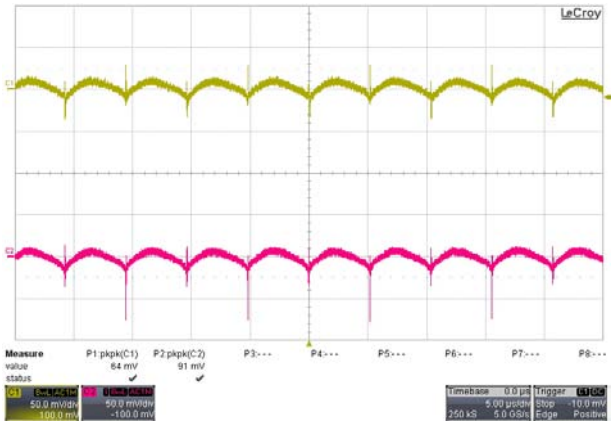
All test conditions are at 25°C The figures are identical for TES 1-2422



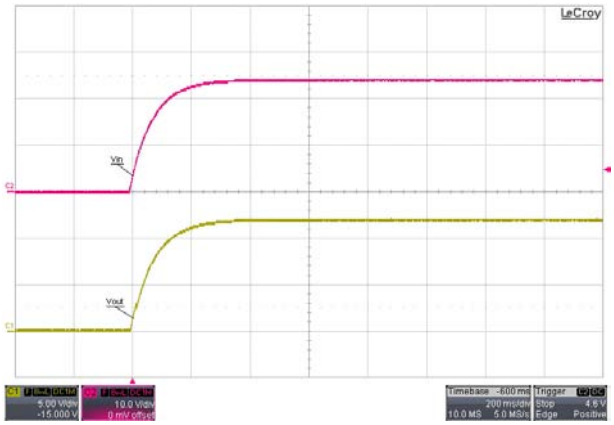
Efficiency Versus Output Current



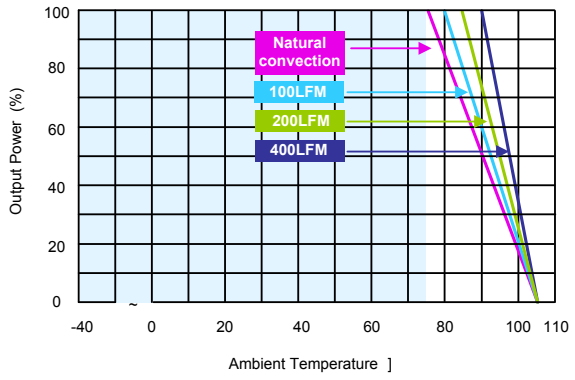
Efficiency Versus Input Voltage. Full Load



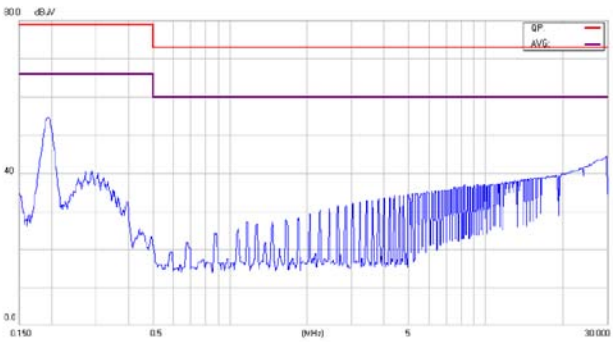
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



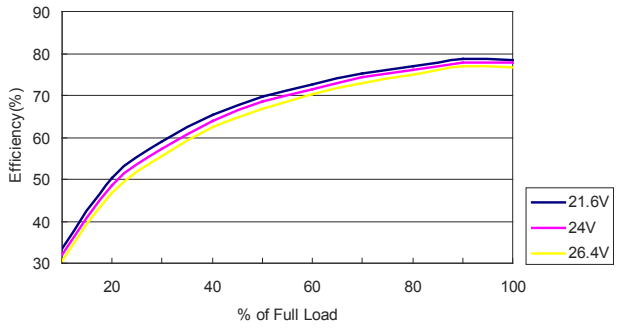
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



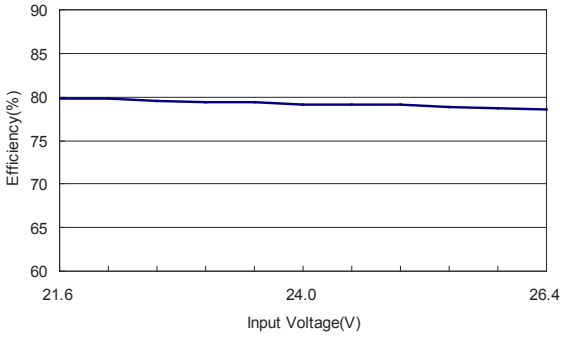
Conduction Emission of EN55022 Class A
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

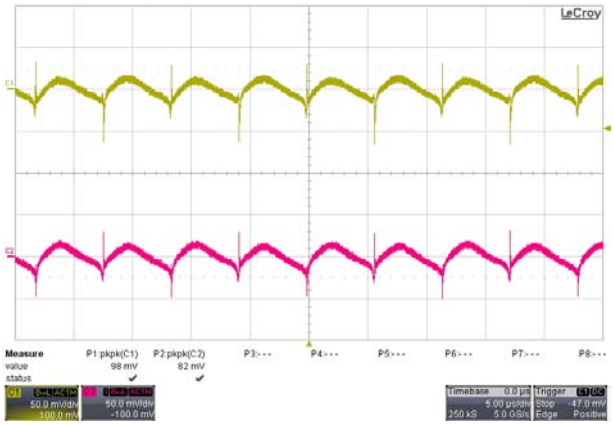
All test conditions are at 25°C The figures are identical for TES 1-2423



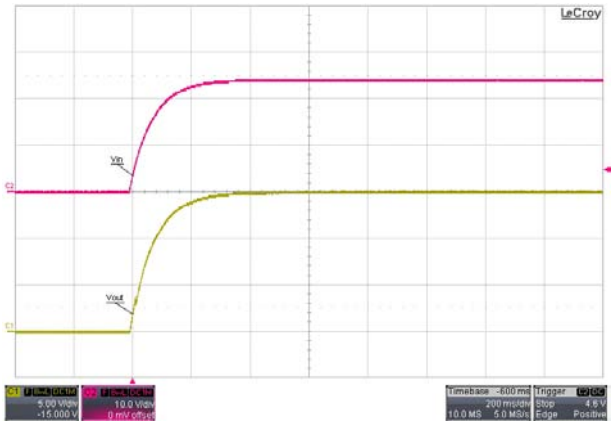
Efficiency Versus Output Current



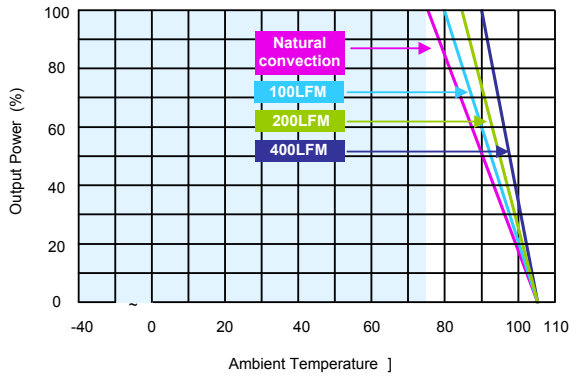
Efficiency Versus Input Voltage. Full Load



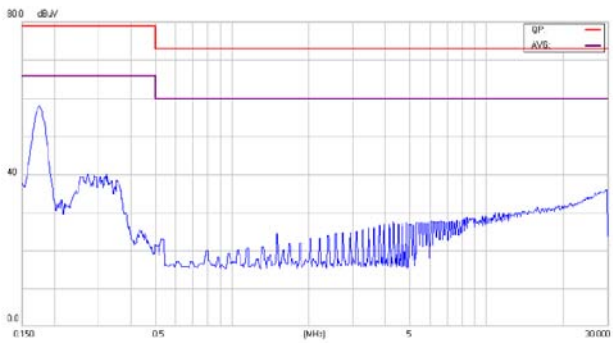
Typical Output Ripple and Noise.
V_{in} =$V_{in\ nom}$; Full Load; T_A



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



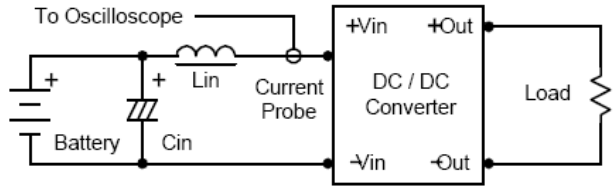
Derating Output Current Versus Ambient Temperature and Airflow
V_{in} =$V_{in\ nom}$



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

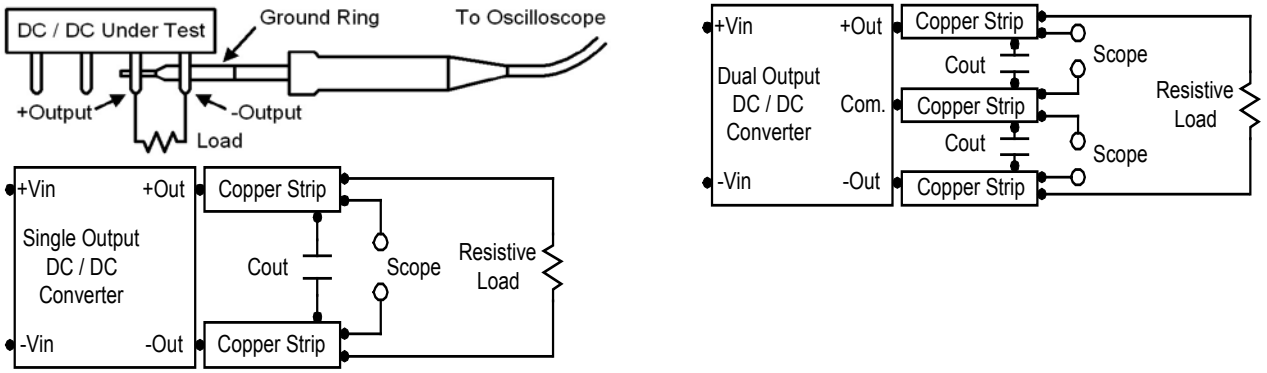
Testing Configurations

Input reflected-ripple current measurement test up



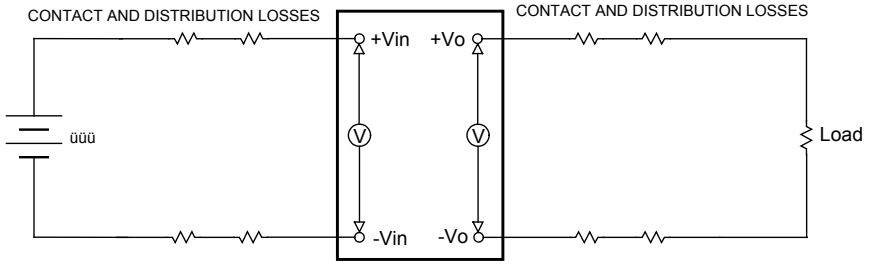
Component	Value	Reference
L	4.7µH	-----
C	220µF (ESR<1.0Ω at 100KHz)	Aluminum Electrolytic Capacitor

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

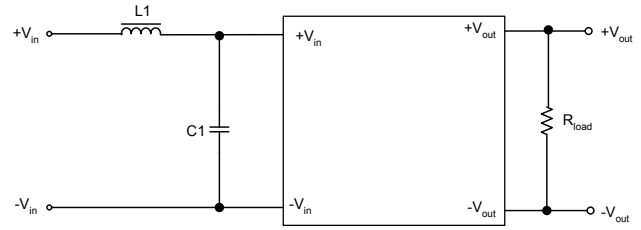


Output voltage and efficiency measurement test up

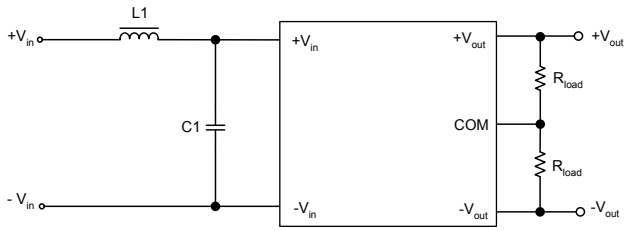
$$Efficiency = \left(\frac{V_{out} \times I_{out}}{V_{in} \times I_{in}} \right) \times 100\% = [\%]$$



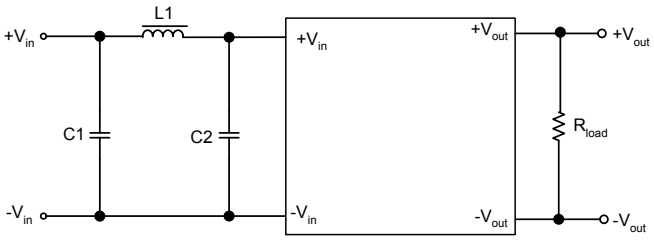
EMC considerations



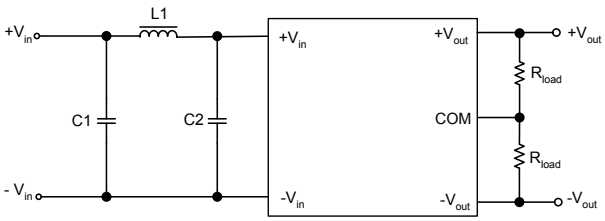
Single Output (TES 1-051x)



Dual Output (TES 1-052X)

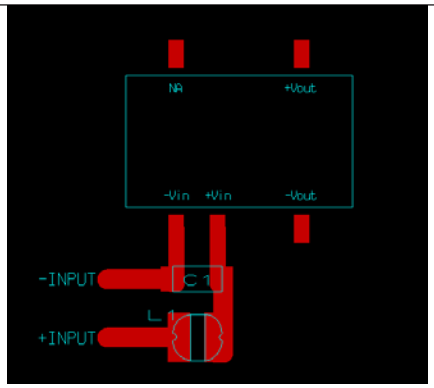


Single Output (TES 1-121x, TES 1-241x)

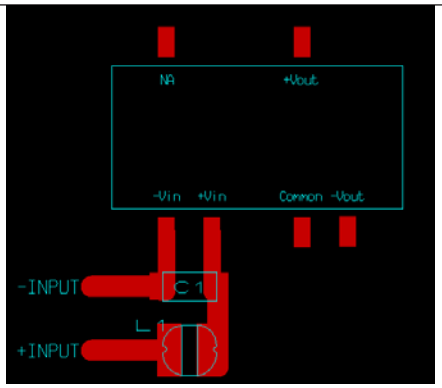


Dual Output (TES 1-122x, TES 1-242x)

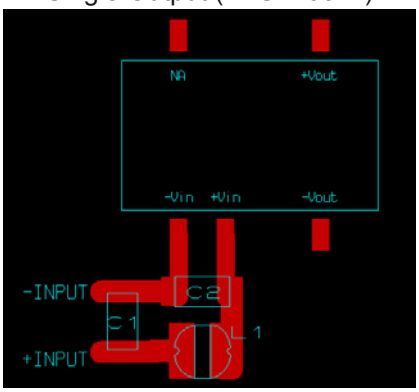
Recommended circuit to comply EN55022 Class A Limits



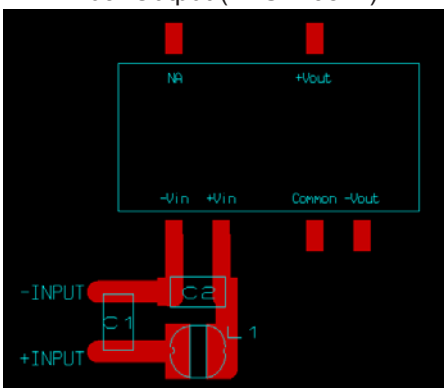
Single Output (TES 1-051x)



Dual Output (TES 1-051x)



Single Output (TES 1-121x, TES 1-241x)



Dual Output (TES 1-121x, TES 1-241x)

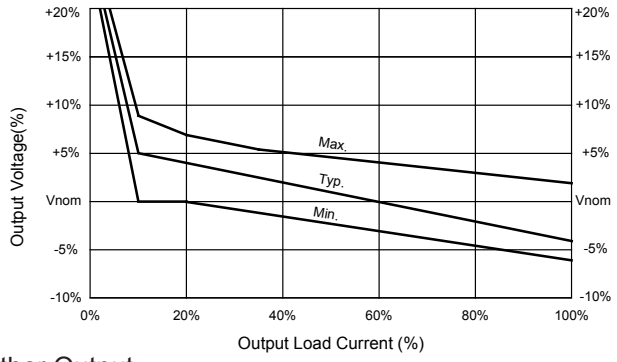
Recommended PCB Layout with Input Filter

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

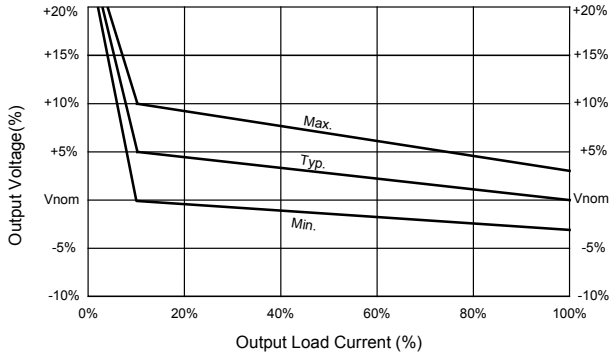
Model	Component	Value
TES 1-05xx	C1	4.7µF / 25V 1206 MLCC
	L1	4.7µH SR0302 / 1.2A
TES 1-12xx	C1,C2	2.2µF / 25V 1206 MLCC
	L1	2.2µH SR0302 / 1.65A
TES 1-24xx	C1	4.7µF / 50V 1206 MLCC
	C2	2.2µF / 50V 1206 MLCC
	L1	2.2µH SR0302 / 1.65A

Tolerance Envelopes Graph

3.3V & 5V Output



Other Output

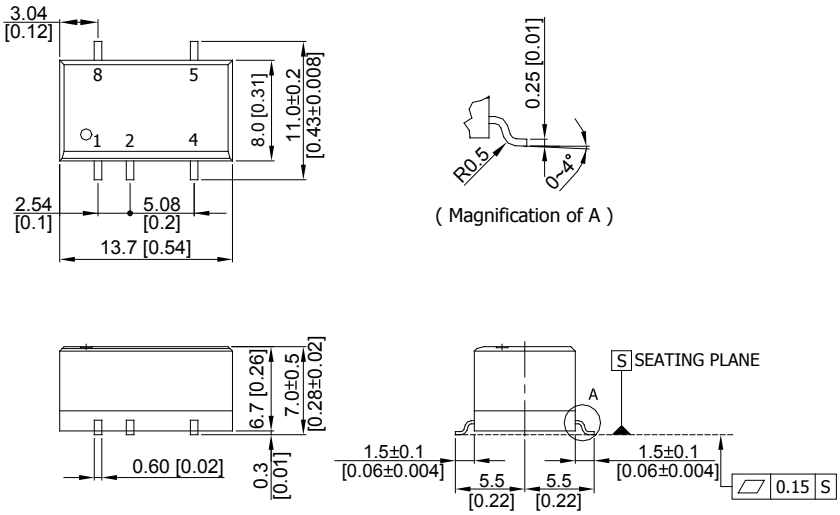


Input Source Impedance

The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module.
In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor at the input to ensure startup.
Capacitor mounted close to the power module helps ensure stability of the unit, it is recommended to use a good quality low Equivalent Series Resistance (ESR < 1.0Ω at 100 KHz) capacitor of a 2.2µF for the 5V input devices, a 1.0µF for the 12V input devices and a 0.47µF for the 24V input devices.

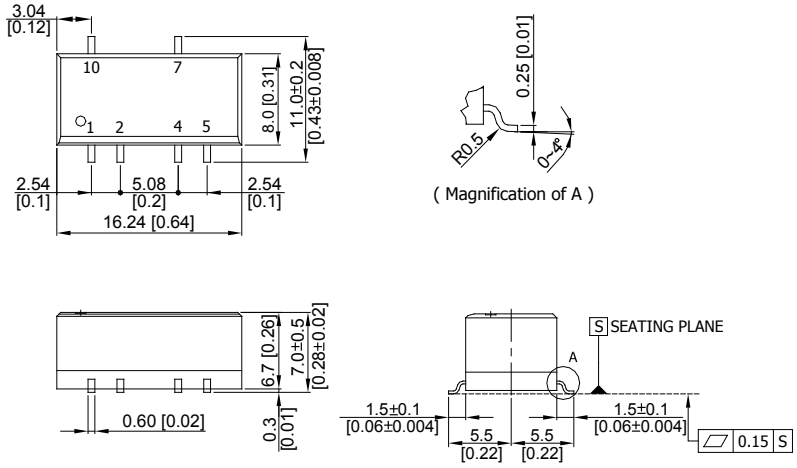
Mechanical Dimensions

Single Output



Weight:1.5g

Dual Output



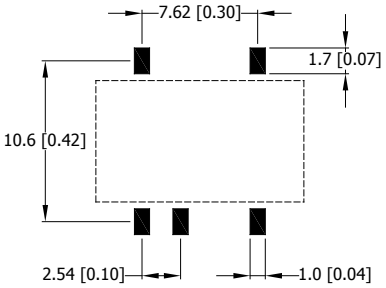
Weight:2.2g

Pin Connections		
Pin	Single Output	Dual Output
1	-Vin	-Vin
2	+Vin	+Vin
3	No Pin	No Pin
4	-Vout	Common
5	+Vout	-Vout
6	No Pin	No Pin
7	No Pin	+Vout
8	NA	No Pin
9	---	No Pin
10	---	NA

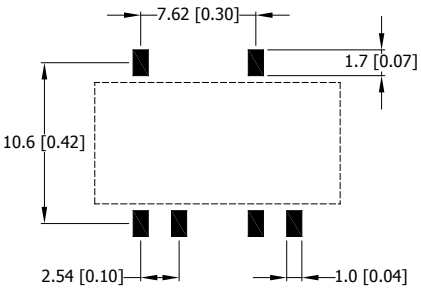
1. All dimensions in mm (inches)
Tolerance: X.X±0.25 (X.XX±0.01”)
X.XX±0.13 (X.XXX±0.005”)
2. Pins ±0.05 (±0.002)

Recommended Pad Layout for Single & Dual Output Converter

Single Output



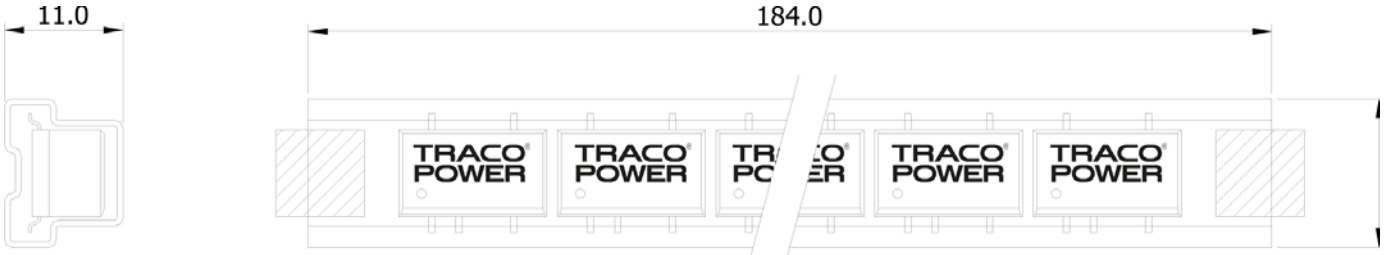
Dual Output



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

Packaging Information

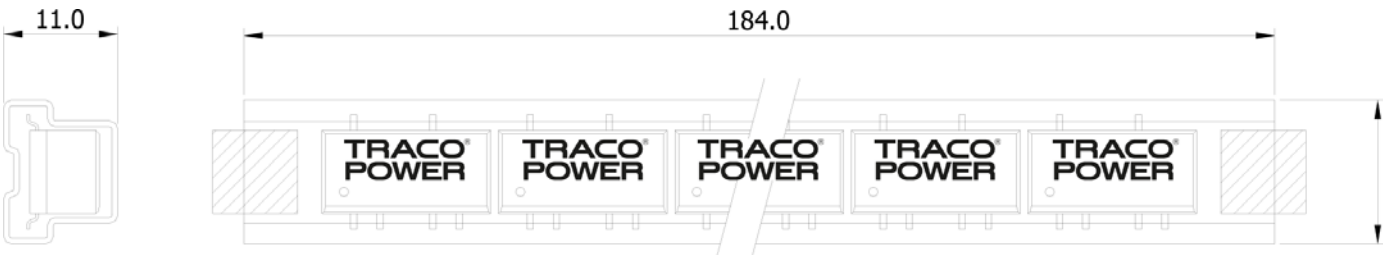
Single Output



unit : mm

10 PCS per TUBE

Dual Output



unit : mm

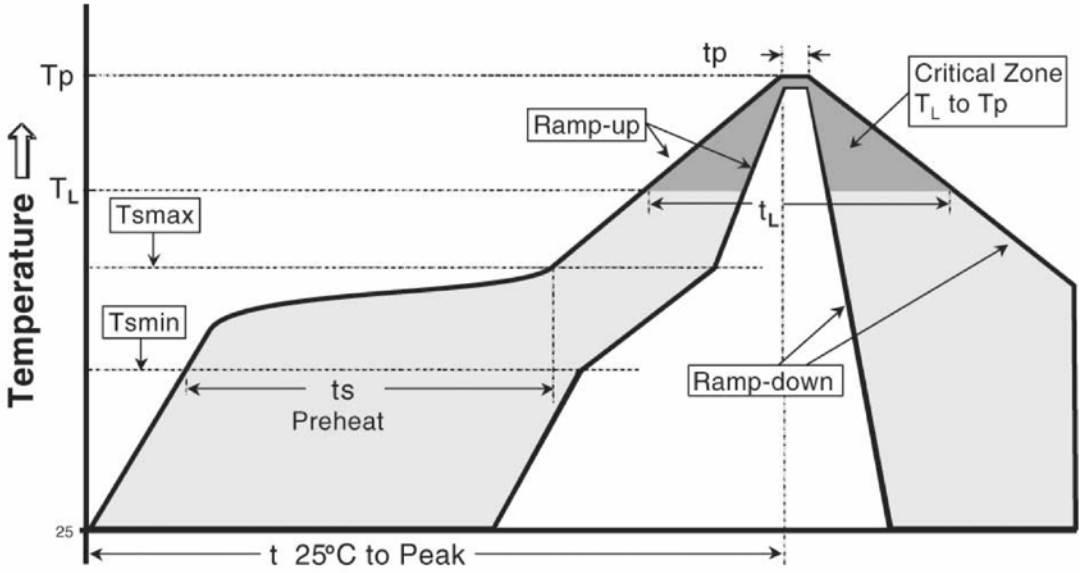
10 PCS per TUBE

Soldering and Reflow Considerations

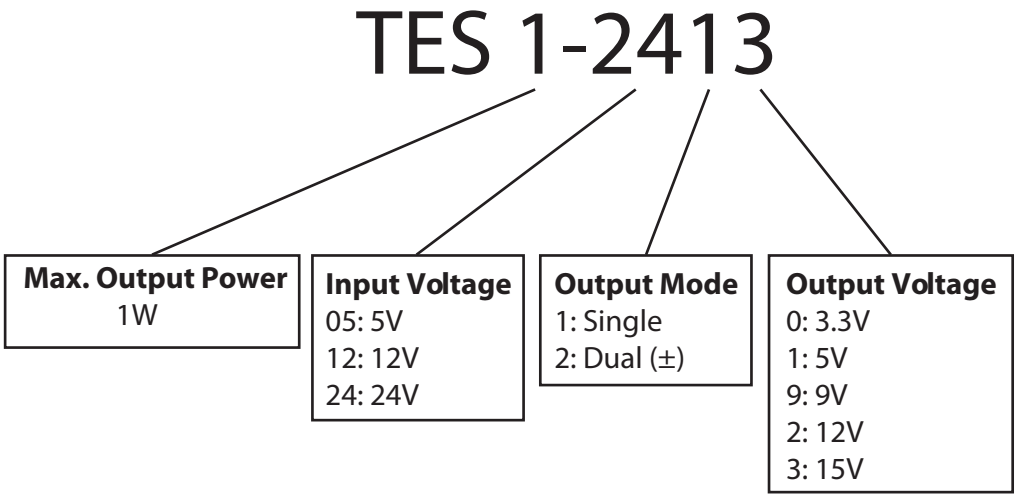
Lead free wave solder profile for TES 1 Series

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate (Tsmax to Tp)	3° C/second max.	3° C/second max.
Preheat - Temperature Min (Ts_{min}) - Temperature Max (Ts_{max}) - Time (Ts_{min} to Ts_{max}) (ts)	 100 °C 150 °C 60-120 seconds	 150 °C 200 °C 60-180 seconds
Time maintained above: - Temperature (T_L) - Time (t_L)	 183 °C 60-150 seconds	 217 °C 60-150 seconds
Peak Temperature (Tp)	See Table 4.1	See Table 4.2
Time within 5°C of actual Peak Temperature $(tp)^2$	10-30 seconds	20-40 seconds
Ramp-down Rate	6 °C/second max.	6 °C/second max.
Time 25°C to Peak Temperature	6 minutes max.	8 minutes max.

Note 1: All temperatures refer to topside of the package, measured on the package body surface.
Note 2: Time within 5 °C of actual peak temperature (tp) specified for the reflow profiles is a "supplier" minimum and "user" maximum.



Part Number Structure



Model Number	Input Range (VDC)	Output Voltage (VDC)	Max. Output Current (mA)	Input Current at Full Load[1] (mA)	Efficiency[2] (%)
TES 1-0510	4.5-5.5	3.3	300	271	73
TES 1-0511	4.5-5.5	5	200	256	78
TES 1-0519	4.5-5.5	9	110	254	78
TES 1-0512	4.5-5.5	12	84	259	78
TES 1-0513	4.5-5.5	15	67	254	79
TES 1-0521	4.5-5.5	±5	±100	270	74
TES 1-0522	4.5-5.5	±12	±42	259	78
TES 1-0523	4.5-5.5	±15	±33	254	78
TES 1-1210	10.8-13.2	3.3	300	112	74
TES 1-1211	10.8-13.2	5	200	109	76
TES 1-1219	10.8-13.2	9	110	106	78
TES 1-1212	10.8-13.2	12	84	106	79
TES 1-1213	10.8-13.2	15	67	105	80
TES 1-1221	10.8-13.2	±5	±100	113	74
TES 1-1222	10.8-13.2	±12	±42	108	78
TES 1-1223	10.8-13.2	±15	±33	104	79
TES 1-2410	21.6-26.4	3.3	300	58	72
TES 1-2411	21.6-26.4	5	200	54	78
TES 1-2419	21.6-26.4	9	110	54	77
TES 1-2412	21.6-26.4	12	84	55	77
TES 1-2413	21.6-26.4	15	67	53	79
TES 1-2421	21.6-26.4	±5	±100	57	73
TES 1-2422	21.6-26.4	±12	±42	54	78
TES 1-2423	21.6-26.4	±15	±33	53	78

Note 1. Maximum value at nominal input voltage and full load of standard type.
Note 2. Typical value at nominal input voltage and full load.

Safety and Installation Instruction

Fusing Consideration

Caution: This power module is not internally fused. An input line fuse must always be used.This encapsulated power module can be used in a wide variety of applications, ranging from simple stand-alone operation to an integrated part of sophisticated power architecture. To maximum flexibility, internal fusing is not included; however, to achieve maximum safety and system protection, always use an input line fuse. The safety agencies require a normal-blow fuse in 5Vin with maximum rating of 500mA, in 12Vin with maximum rating of 200mA, in 15Vin with maximum rating of 150mA , in 24Vin with maximum rating of 100mA. 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 TES 1 series of DC/DC converters has been calculated using MIL-HDBK 217F NOTICE2, Operating Temperature 25°C, Ground Benign.

Model	MTBF	Unit
TES 1-0510	5,116,959	
TES 1-0511	5,120,702	
TES 1-0519	5,143,277	
TES 1-0512	5,169,867	
TES 1-0513	5,169,867	
TES 1-0521	5,116,959	
TES 1-0522	5,120,702	
TES 1-0523	5,120,702	
TES 1-1210	5,162,242	
TES 1-1211	5,166,052	
TES 1-1219	5,200,595	
TES 1-1212	5,216,096	
TES 1-1213	5,166,052	Hours
TES 1-1221	5,162,242	
TES 1-1222	5,166,052	
TES 1-1223	5,166,052	
TES 1-2410	5,247,376	
TES 1-2411	5,251,313	
TES 1-2419	5,275,057	
TES 1-2412	5,303,031	
TES 1-2413	5,251,313	
TES 1-2421	5,247,376	
TES 1-2422	5,251,313	
TES 1-2423	5,251,313	

Jenatschstrasse 1 · CH-8002 Zurich · Switzerland
Tel. +41 43 311 45 11 · Fax +41 43 311 45 45 · info@traco.ch · www.tracopower.com