TES 2N Series

DC/DC CONVERTER 2W, SMD-Package

Features

- Small Footprint:
  24.0 x 18.1 mm (0.94 x 0.71 inches)
- Wide 2:1 Input Range
- Fully regulated Output
- Operating Temp. Range –40°C to +85°C
- Short Circuit Protection
- I/O-isolation 1500 VDC
- Input Filter meets EN55022,class A and FCC, level A
- Qualified for lead-free reflow solder process according IPC/JEDEC J-STD-020D
- 3 Years Product Warranty

Applications

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

General Description

The TRACO TES 2N series is a range of isolated 2W DC/DC converter modules featuring fully regulated output voltages and wide 2:1 input voltage ranges. The products come in a compact SMD package with a small footprint and low package height of just 8.0 mm (0.31 inch). All models are qualified for lead free reflow solder processes according IPC J-STD-020D standard.
An excellent efficiency allows an operating temperature range of–40°C to +85°C. The compact dimensions of these DC/DC converters make them an ideal solution for many space critical applications in battery-powered equipment and instrumentation.

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Absolute Maximum Rating				
Parameter	**Model**	**Min**	**Max**	**Unit**
Input Voltage Input Surge Voltage (1 sec.)	5VDC Input Models 12VDC Input Models 24VDC Input Models 48VDC Input Models	-0.7 -0.7 -0.7 -0.7	11 25 50 100	VDC
Operating Ambient Temperature Without Derating With Derating	All	 -40 -40	 +70 +85	℃
Operating Case Temperature	All	---	+90	℃
Storage Temperature	All	-50	+125	℃

Output Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Output Voltage (V_{in}=$V_{in\ nom}$; Full Load; T_A=25℃)	TES 2-xx10N	3.234	3.3	3.366	VDC
	TES 2-xx11N	4.9	5	5.1	
	TES 2-xx12N	11.76	12	12.24	
	TES 2-xx13N	14.7	15	15.3	
	TES 2-xx21N	±4.9	±5	±5.1	
	TES 2-xx22N	±11.76	±12	±12.24	
	TES 2-xx23N	±14.7	±15	±15.3	
Output Regulation Line ($V_{in\ min}$ to $V_{in\ max}$ at Full Load)		---	±0.3	±0.5	%
Output Regulation Load (25% to 100% of Full Load)		---	±0.5	±0.75	%
Output Ripple & Noise Peak-to-Peak (20MHz bandwidth)		---	30	50	mV pk-pk
Temperature Coefficient	All	---	±0.01	±0.02	%/℃
Dynamic Load Response (V_{in} = $V_{in\ nom}$; TA=25℃ Load step change form 75% to 100% or 100% to 75% of full Load)	All				
Peak Deviation		---	±3	±5	%
Recovery Time (V_{out} < 10% peak deviation)		---	100	300	µS
Output Current	TES 2-xx10N	125	---	500	mA
	TES 2-xx11N	100	---	400	
	TES 2-xx12N	42	---	167	
	TES 2-xx13N	33	---	134	
	TES 2-xx21N	±50	---	±200	
	TES 2-xx22N	±21	---	±83	
	TES 2-xx23N	±17	---	±67	
Output Short Circuit Protection	All	Continuous			

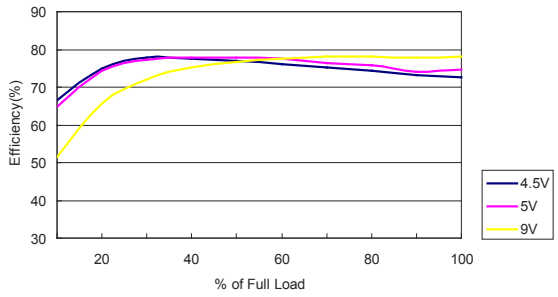
Input Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Operating Input Voltage	5V Input Models	4.5	5	9	VDC
	12V Input Models	9	12	18	
	24V Input Models	18	24	36	
	48V Input Models	36	48	75	
Under Voltage Lockout Turn-on Threshold	5V Input Models	3.5	4	4.5	VDC
	12V Input Models	4.5	7	9	
	24V Input Models	8	12	18	
	48V Input Models	16	24	36	
Under Voltage Lockout Turn-off Threshold	5V Input Models	---	3.5	4	VDC
	12V Input Models	---	6.5	8.5	
	24V Input Models	---	11	17	
	48V Input Models	---	22	34	
Input reflected ripple current (20MHz bandwidth) (Measured with a inductor 4.7µH and Capacitance 220uF,ESR<1.0 ohm at 100KHz to simulated source) impedance	5V Input Models	---	100	---	mA pk-pk
	12V Input Models	---	25	---	
	24V Input Models	---	15	---	
	48V Input Models	---	10	---	
Input Current (V_{in}= $V_{in\ nom}$;Full Load)	TES 2-0510N	---	471	---	mA
	TES 2-0511N	---	548	---	
	TES 2-0512N	---	534	---	
	TES 2-0513N	---	582	---	
	TES 2-0521N	---	667	---	
	TES 2-0522N	---	615	---	
	TES 2-0523N	---	598	---	
	TES 2-1210N	---	184	---	
	TES 2-1211N	---	217	---	
	TES 2-1212N	---	209	---	
	TES 2-1213N	---	220	---	
	TES 2-1221N	---	242	---	
	TES 2-1222N	---	224	---	
	TES 2-1223N	---	226	---	
	TES 2-2410N	---	96	---	
	TES 2-2411N	---	109	---	
	TES 2-2412N	---	109	---	
	TES 2-2413N	---	108	---	
	TES 2-2421N	---	119	---	
	TES 2-2422N	---	112	---	
	TES 2-2423N	---	110	---	
	TES 2-4810N	---	49	---	
	TES 2-4811N	---	57	---	
	TES 2-4812N	---	53	---	
	TES 2-4813N	---	55	---	
	TES 2-4821N	---	62	---	
	TES 2-4822N	---	57	---	
	TES 2-4823N	---	57	---	

Input Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Input Standby Current (Typical value at V_{in} = $V_{in\ nom}$; No Load)	TES 2-0510N	---	40	---	mA
	TES 2-0511N	---		---	
	TES 2-0512N	---		---	
	TES 2-0513N	---		---	
	TES 2-0521N	---		---	
	TES 2-0522N	---		---	
	TES 2-0523N	---		---	
	TES 2-1210N	---	20	---	
	TES 2-1211N	---		---	
	TES 2-1212N	---		---	
	TES 2-1213N	---		---	
	TES 2-1221N	---		---	
	TES 2-1222N	---		---	
	TES 2-1223N	---		---	
	TES 2-2410N	---	10	---	
	TES 2-2411N	---		---	
	TES 2-2412N	---		---	
	TES 2-2413N	---		---	
	TES 2-2421N	---		---	
	TES 2-2422N	---		---	
	TES 2-2423N	---		---	
	TES 2-4810N	---	8	---	
	TES 2-4811N	---		---	
	TES 2-4812N	---		---	
	TES 2-4813N	---		---	
	TES 2-4821N	---		---	
	TES 2-4822N	---		---	
	TES 2-4823N	---		---	

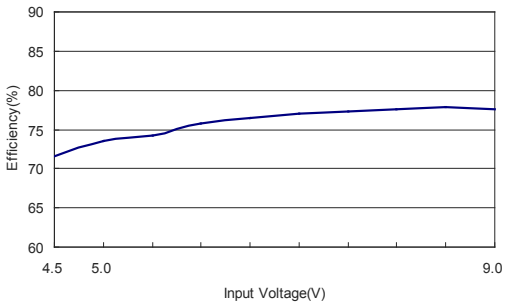
General Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Efficiency (V_{in} =$V_{in\ nom}$; Full Load; T_A =25°C)	TES 2-0510N	---	70	---	%
	TES 2-0511N	---	73	---	
	TES 2-0512N	---	75	---	
	TES 2-0513N	---	73	---	
	TES 2-0521N	---	64	---	
	TES 2-0522N	---	69	---	
	TES 2-0523N	---	71	---	
	TES 2-1210N	---	73	---	
	TES 2-1211N	---	77	---	
	TES 2-1212N	---	80	---	
	TES 2-1213N	---	80	---	
	TES 2-1221N	---	73	---	
	TES 2-1222N	---	78	---	
	TES 2-1223N	---	78	---	
	TES 2-2410N	---	72	---	
	TES 2-2411N	---	77	---	
	TES 2-2412N	---	80	---	
	TES 2-2413N	---	81	---	
	TES 2-2421N	---	74	---	
	TES 2-2422N	---	78	---	
	TES 2-2423N	---	80	---	
	TES 2-4810N	---	71	---	
	TES 2-4811N	---	73	---	
	TES 2-4812N	---	79	---	
	TES 2-4813N	---	79	---	
	TES 2-4821N	---	71	---	
	TES 2-4822N	---	77	---	
	TES 2-4823N	---	77	---	
Isolation Voltage Input to Output (for 60 seconds)		1500	---	---	VDC
Isolation Resistance	All	1000	---	---	MΩ
Isolation Capacitance		---	250	420	pF
Switching Frequency		---	300	---	KHz
MTBF MIL-STD-217F, TC=25°C		1,000,000	---	---	Hours

Characteristic Curves

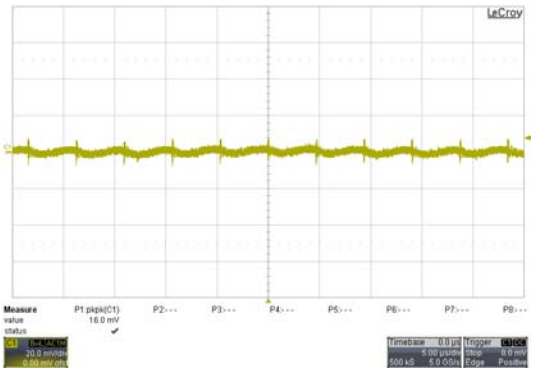
All test conditions are at 25°C The figures are identical for TES 2-0510N



Efficiency Versus Output Current

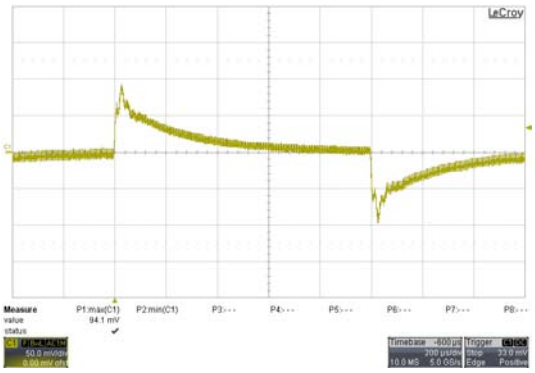


Efficiency Versus Input Voltage. Full Load

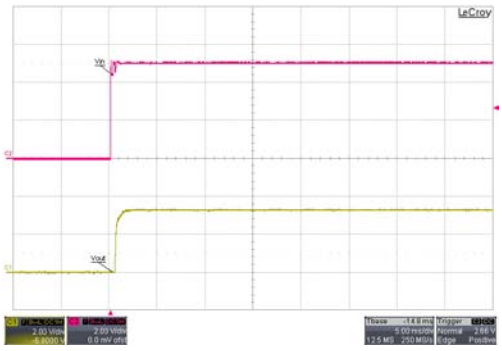


Typical Output Ripple and Noise.

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

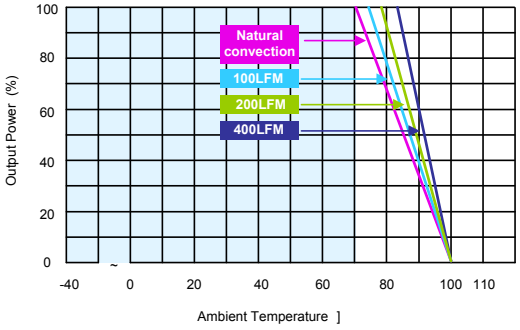


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



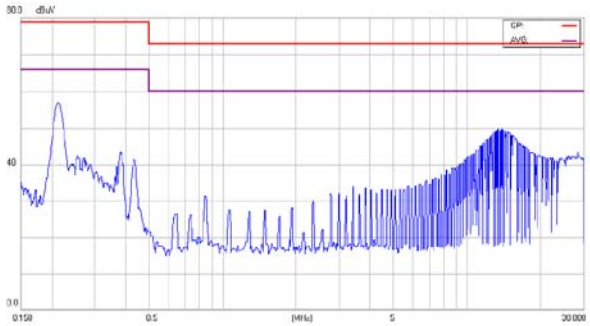
Typical Input Start-Up and Output Rise Characteristic

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



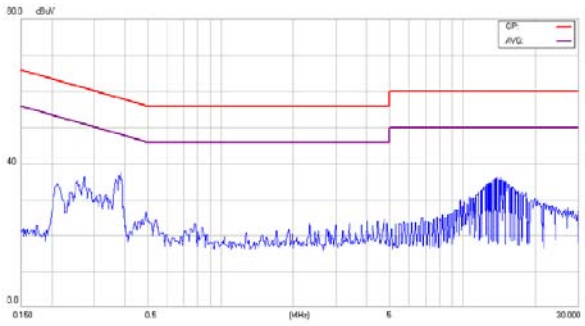
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

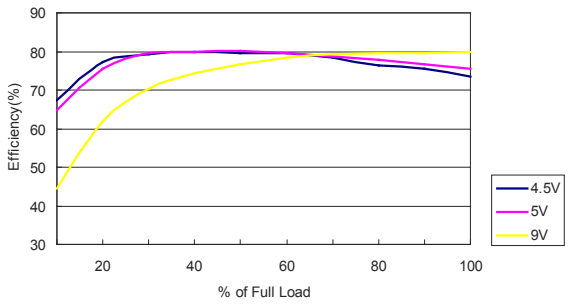


Conduction Emission of EN55022 Class B

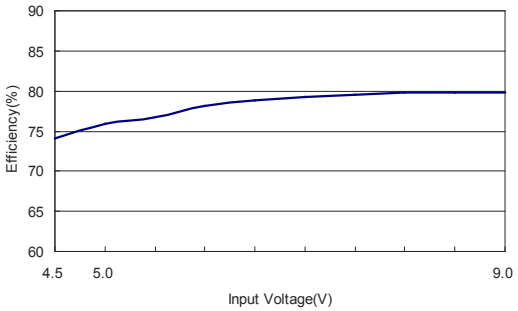
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

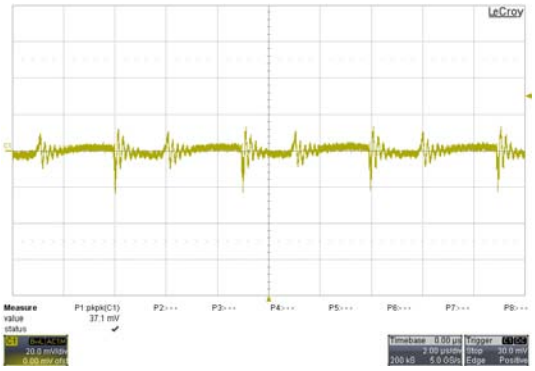
All test conditions are at 25°C The figures are identical for TES 2-0511N



Efficiency Versus Output Current

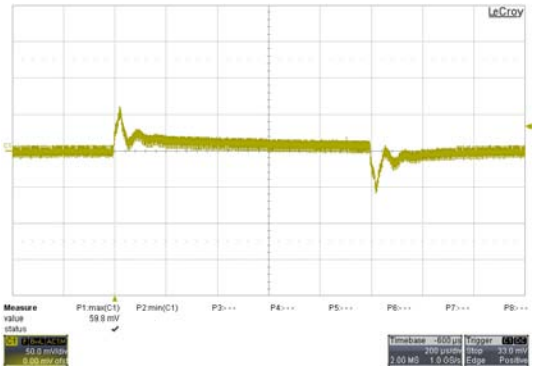


Efficiency Versus Input Voltage. Full Load



Typical Output Ripple and Noise.

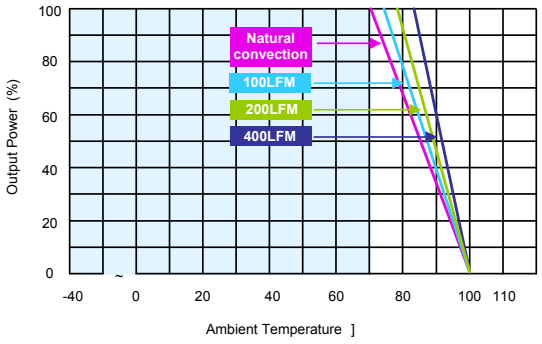
V_{in} =$V_{in\ nom}$; Full Load; T_A



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

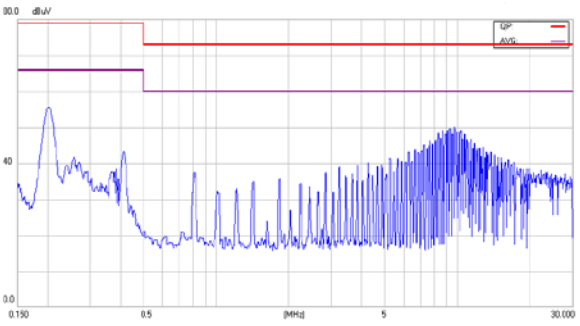
Typical Input Start-Up and Output Rise Characteristic

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



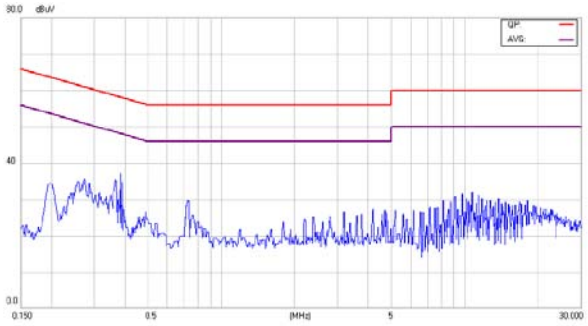
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

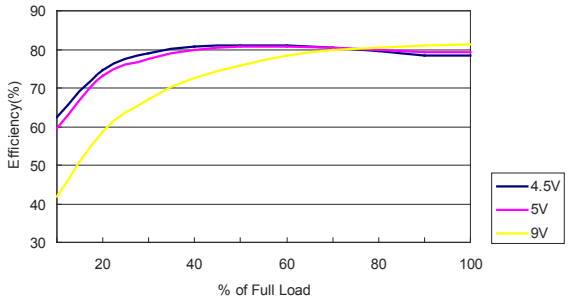


Conduction Emission of EN55022 Class B

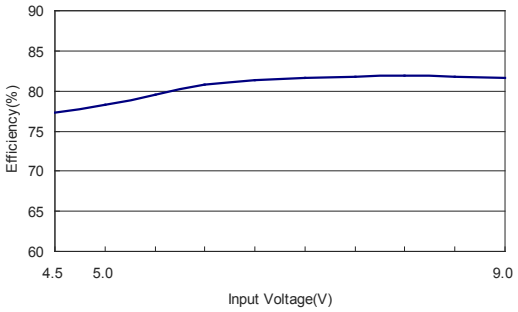
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

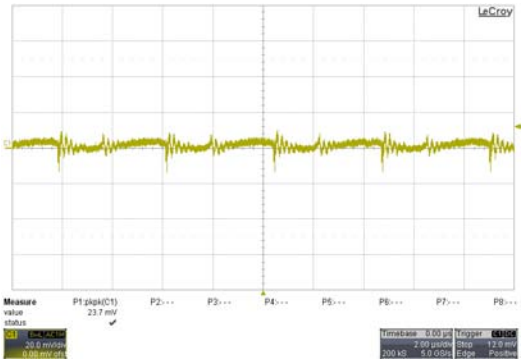
All test conditions are at 25°C The figures are identical for TES 2-0512N



Efficiency Versus Output Current

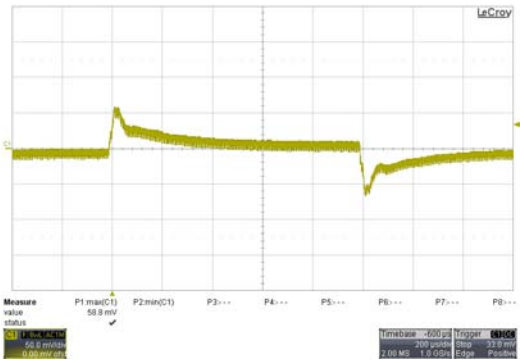


Efficiency Versus Input Voltage. Full Load



Typical Output Ripple and Noise.

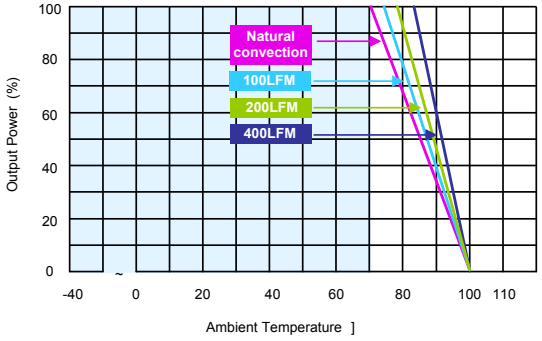
V_{in} =$V_{in\ nom}$; Full Load; T_A



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

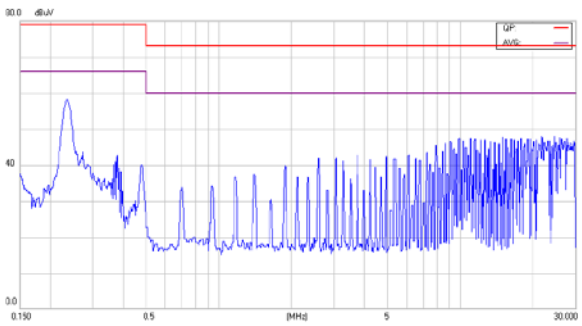
Typical Input Start-Up and Output Rise Characteristic

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



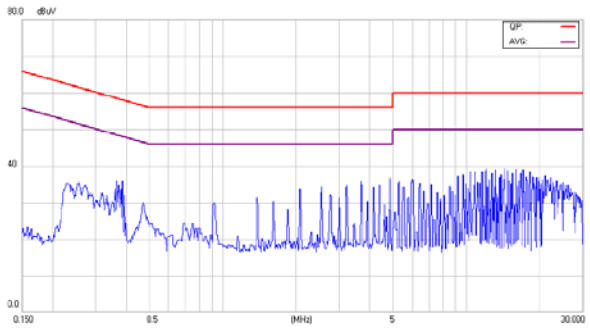
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

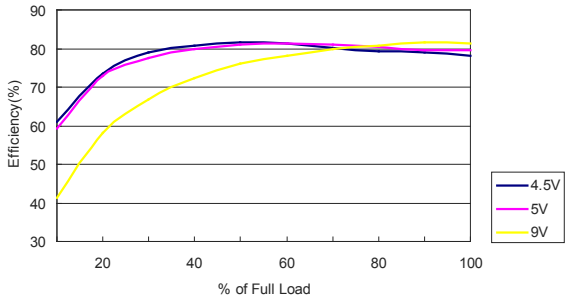


Conduction Emission of EN55022 Class B

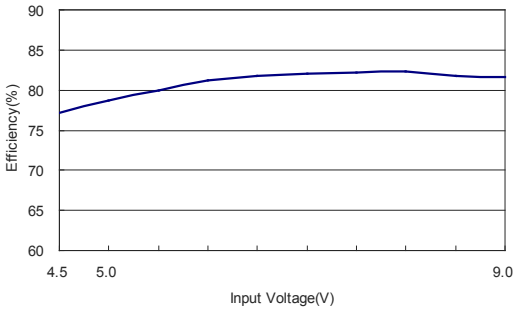
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

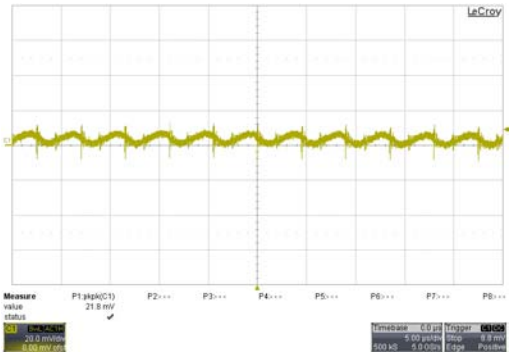
All test conditions are at 25°C The figures are identical for TES 2-0513N



Efficiency Versus Output Current

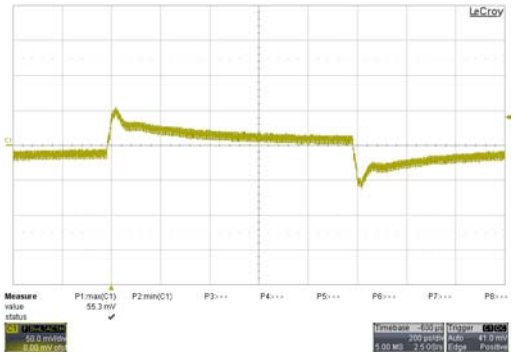


Efficiency Versus Input Voltage. Full Load

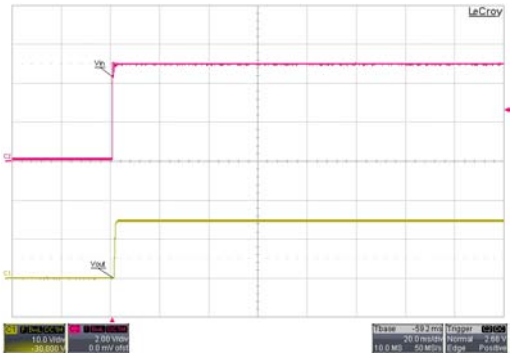


Typical Output Ripple and Noise.

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

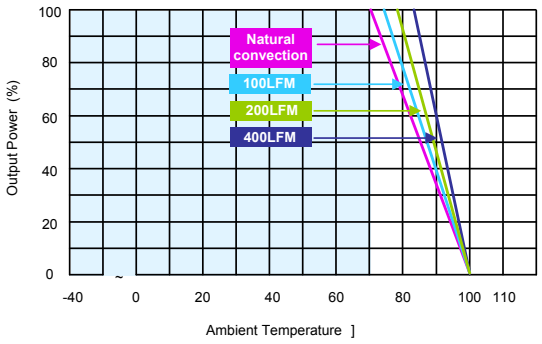


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



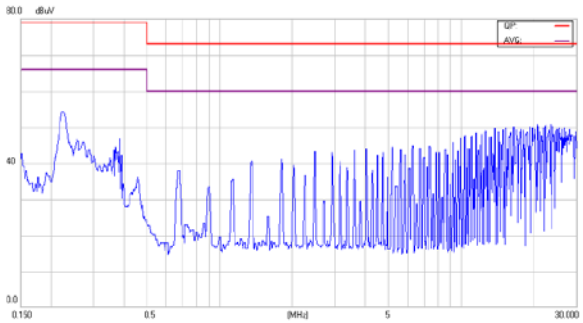
Typical Input Start-Up and Output Rise Characteristic

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



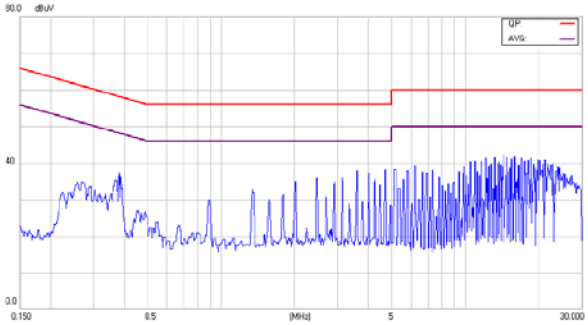
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

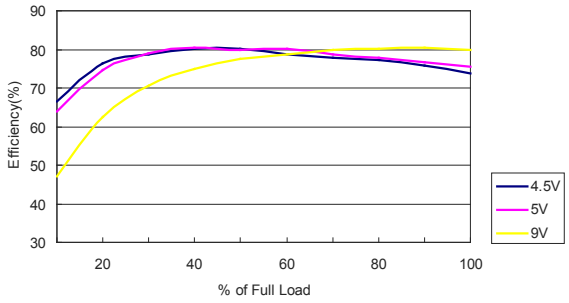


Conduction Emission of EN55022 Class B

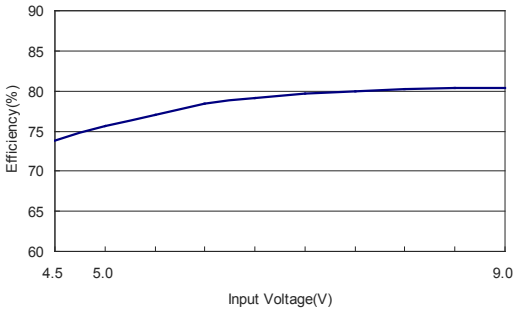
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

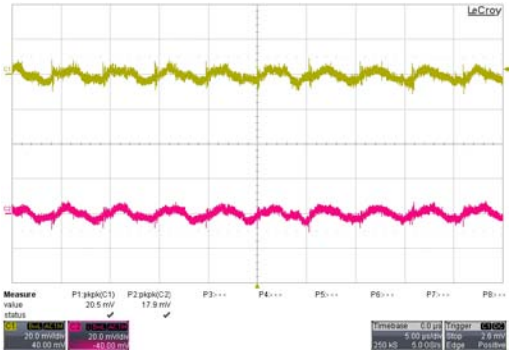
All test conditions are at 25°C The figures are identical for TES 2-0521N



Efficiency Versus Output Current

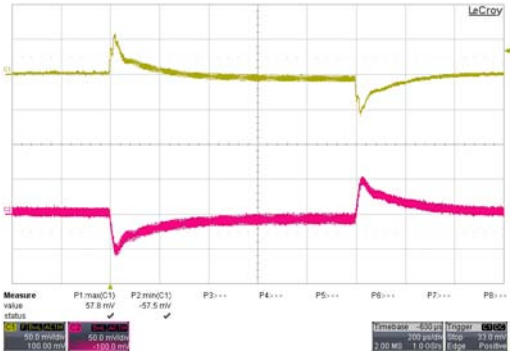


Efficiency Versus Input Voltage. Full Load

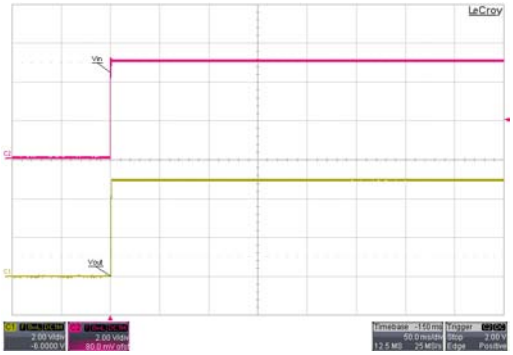


Typical Output Ripple and Noise.

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

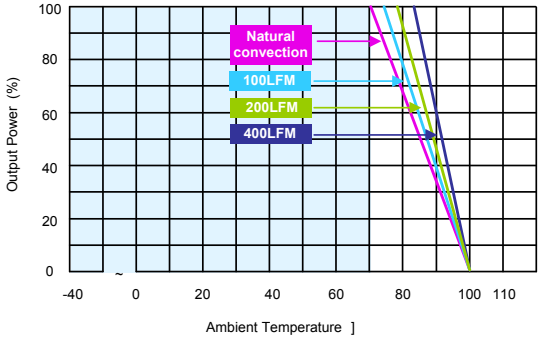


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



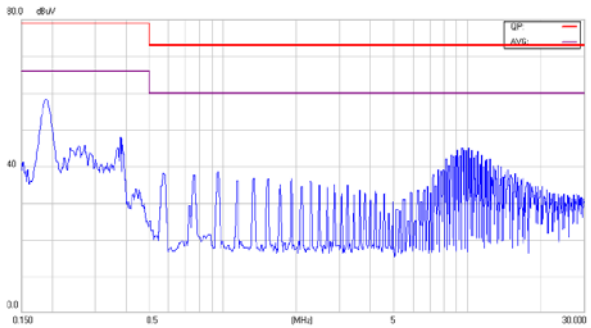
Typical Input Start-Up and Output Rise Characteristic

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



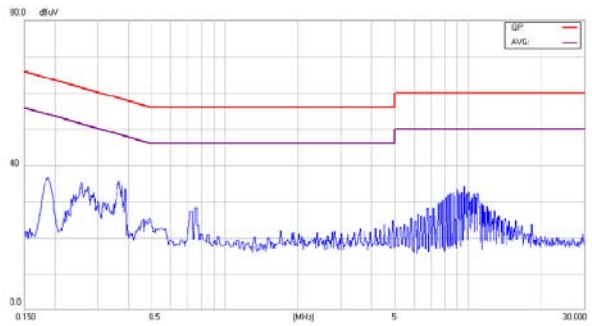
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

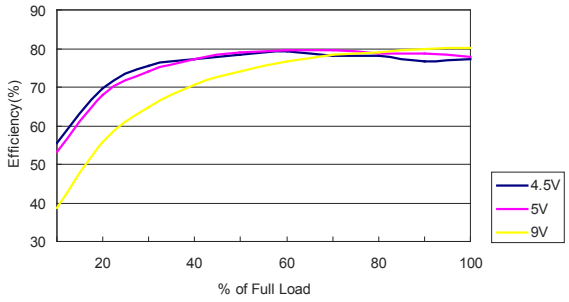


Conduction Emission of EN55022 Class B

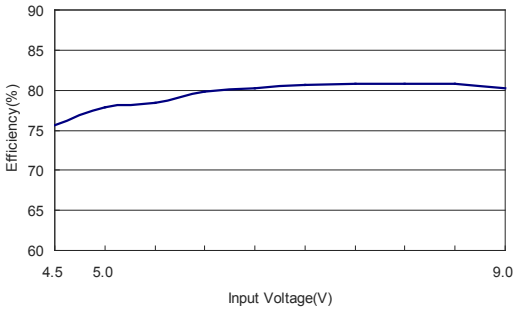
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

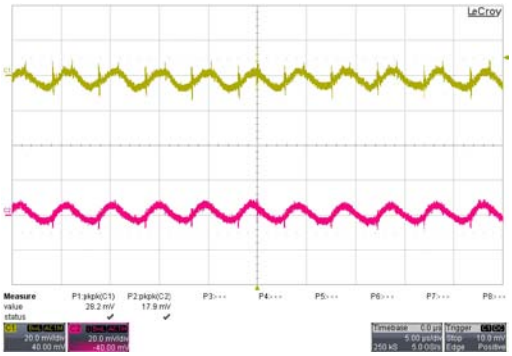
All test conditions are at 25°C The figures are identical for TES 2-0522N



Efficiency Versus Output Current

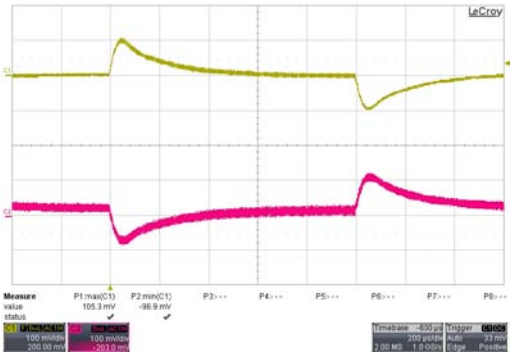


Efficiency Versus Input Voltage. Full Load



Typical Output Ripple and Noise.

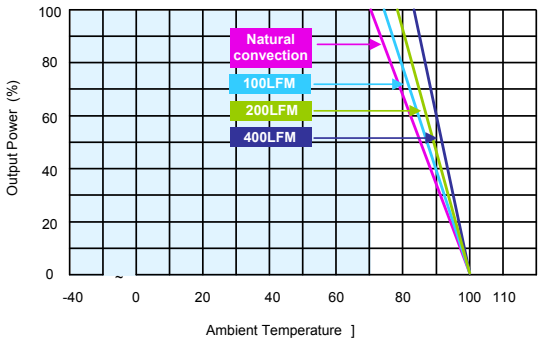
V_{in} =$V_{in\ nom}$; Full Load; T_A



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

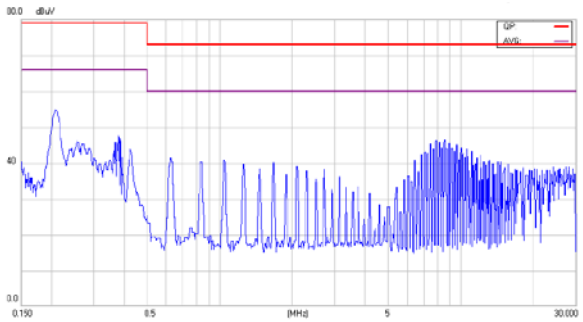
Typical Input Start-Up and Output Rise Characteristic

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



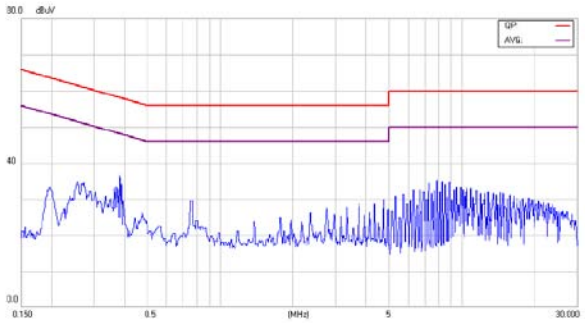
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

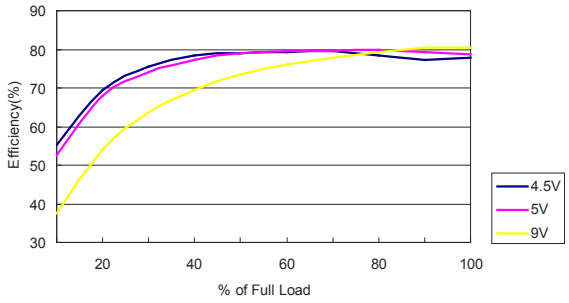


Conduction Emission of EN55022 Class B

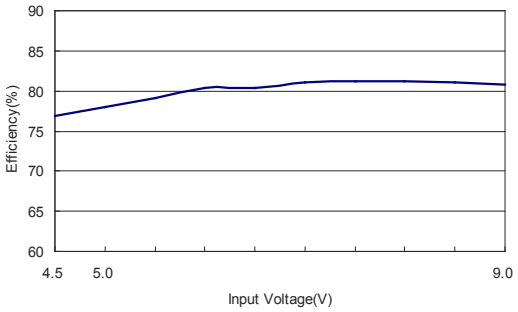
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

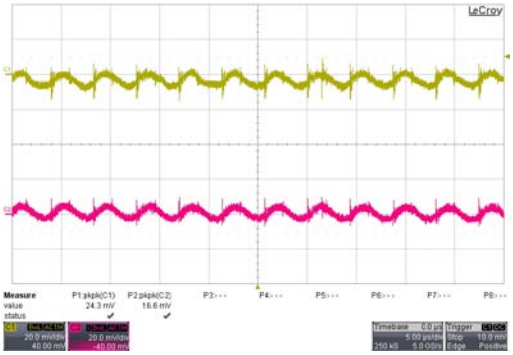
All test conditions are at 25°C The figures are identical for TES 2-0523N



Efficiency Versus Output Current

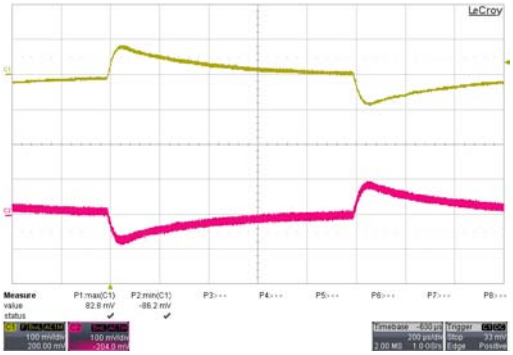


Efficiency Versus Input Voltage. Full Load

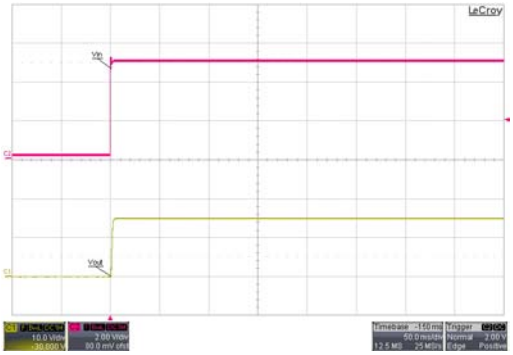


Typical Output Ripple and Noise.

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

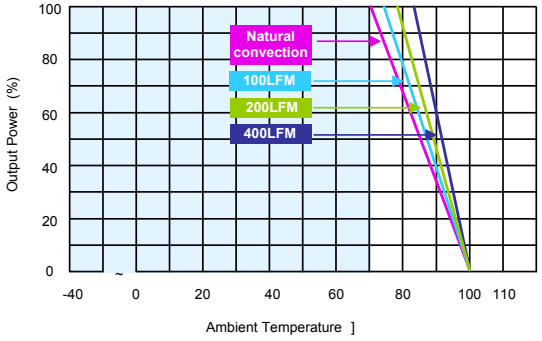


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



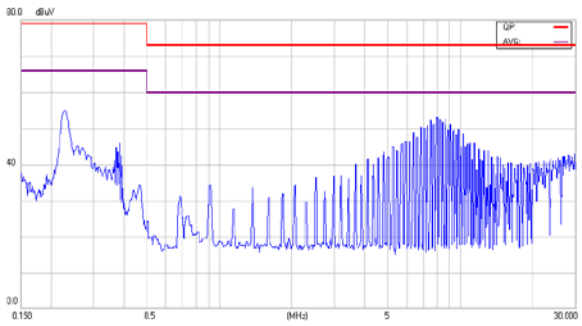
Typical Input Start-Up and Output Rise Characteristic

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



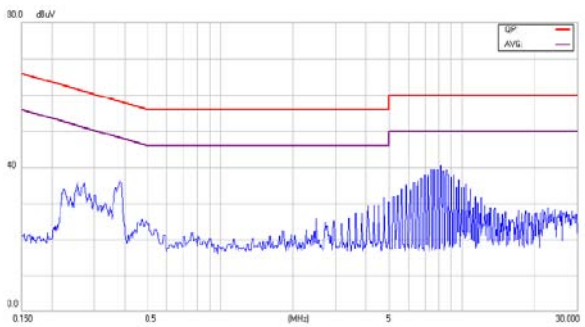
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

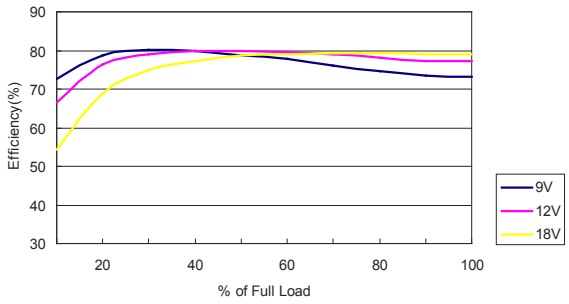


Conduction Emission of EN55022 Class B

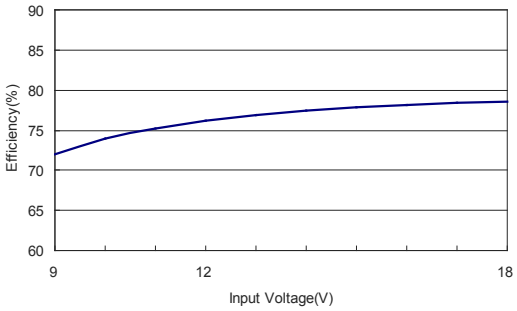
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

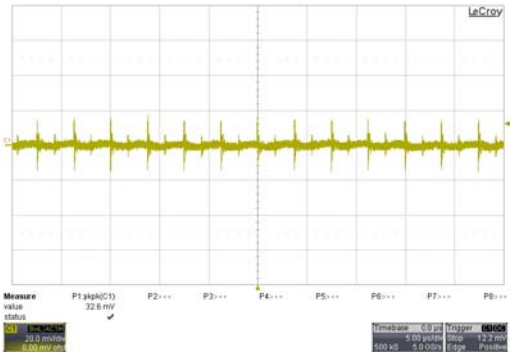
All test conditions are at 25°C The figures are identical for TES 2-1210N



Efficiency Versus Output Current

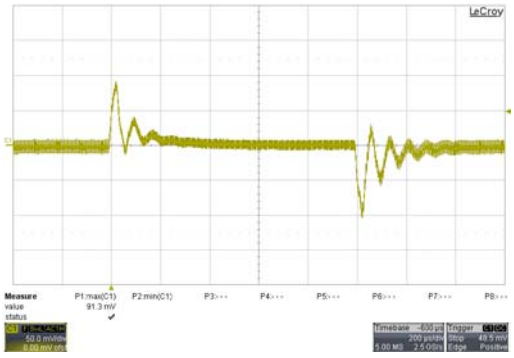


Efficiency Versus Input Voltage. Full Load

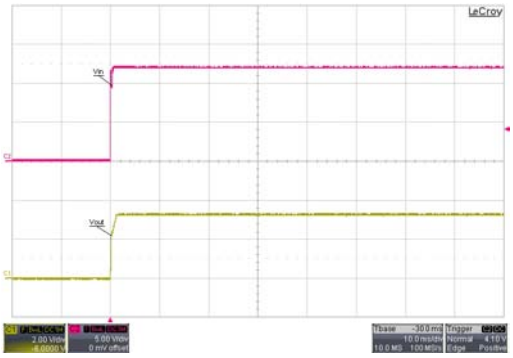


Typical Output Ripple and Noise.

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

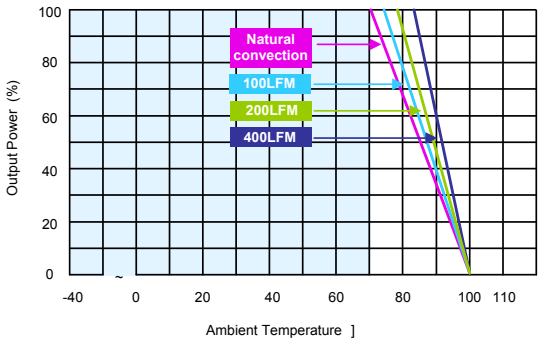


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



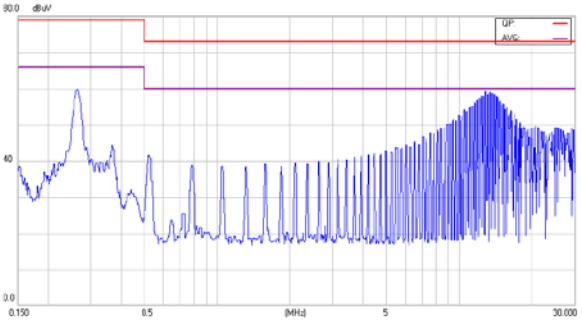
Typical Input Start-Up and Output Rise Characteristic

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



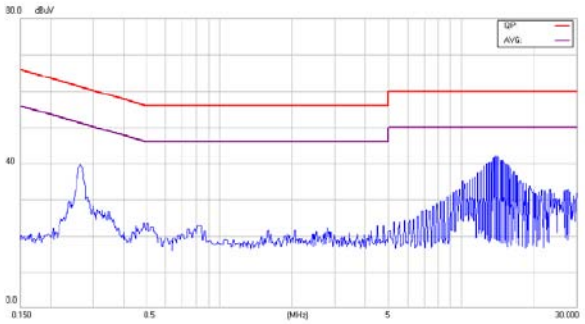
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

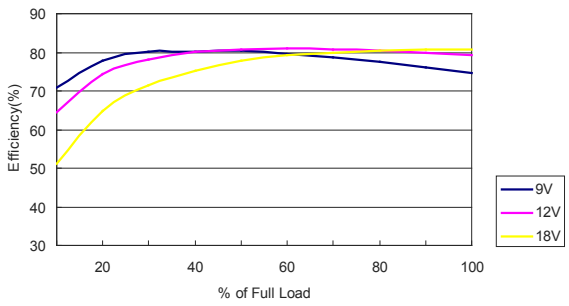


Conduction Emission of EN55022 Class B

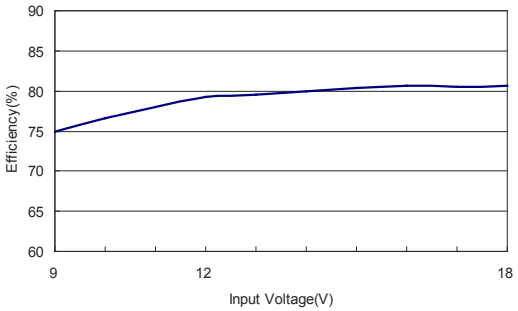
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

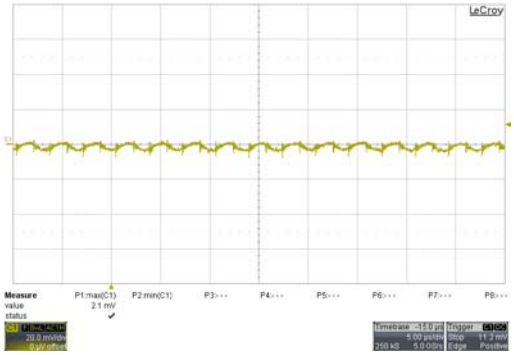
All test conditions are at 25°C The figures are identical for TWS 2-1211N



Efficiency Versus Output Current

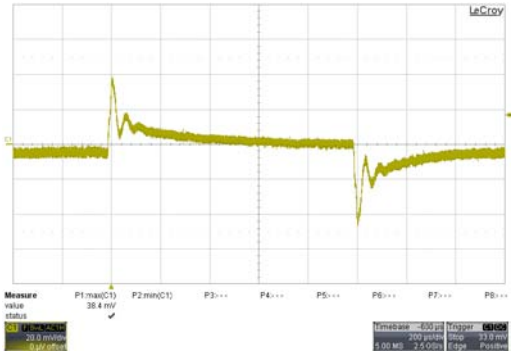


Efficiency Versus Input Voltage. Full Load

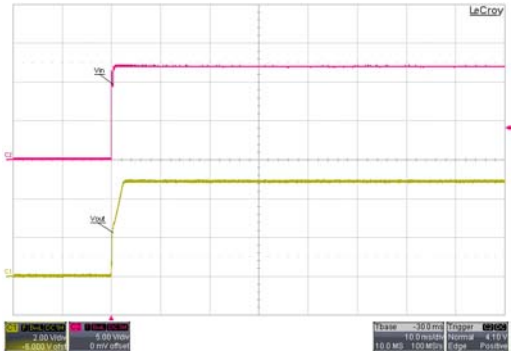


Typical Output Ripple and Noise.

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

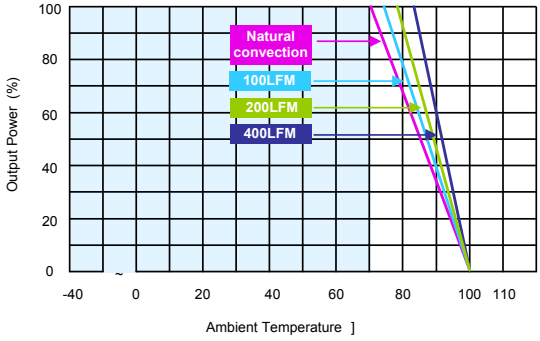


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



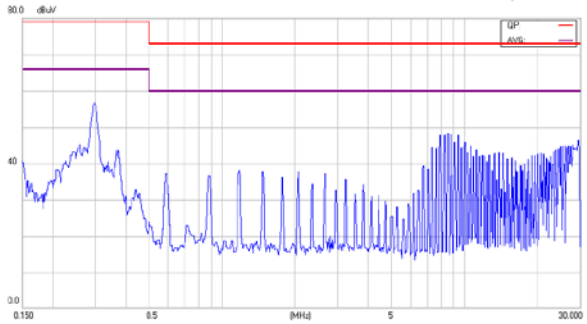
Typical Input Start-Up and Output Rise Characteristic

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



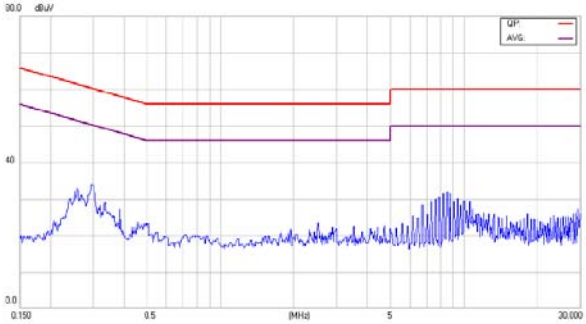
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

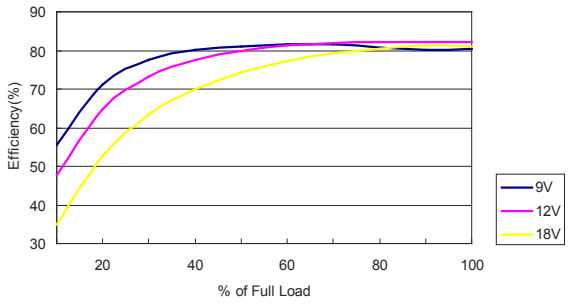


Conduction Emission of EN55022 Class B

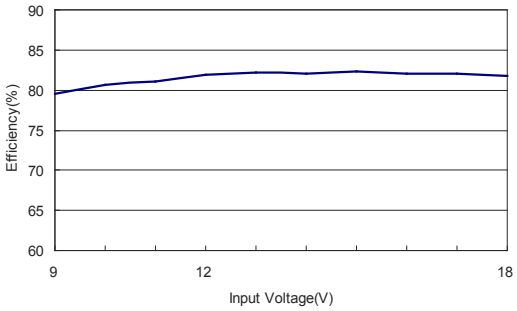
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

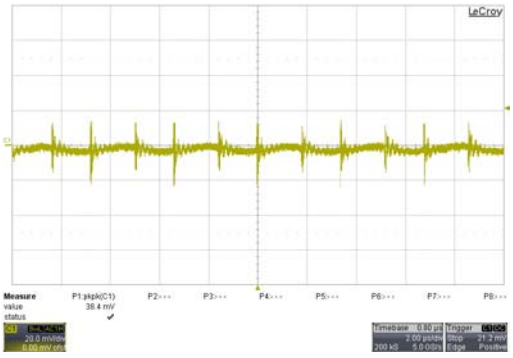
All test conditions are at 25°C The figures are identical for TES 2-1212N



Efficiency Versus Output Current

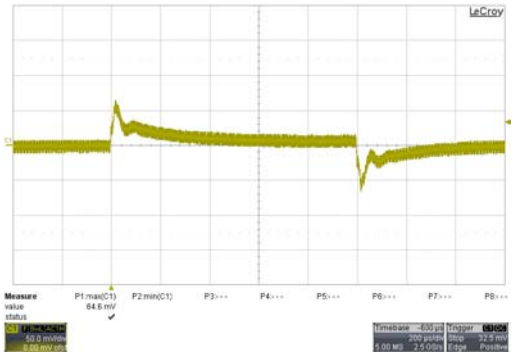


Efficiency Versus Input Voltage. Full Load

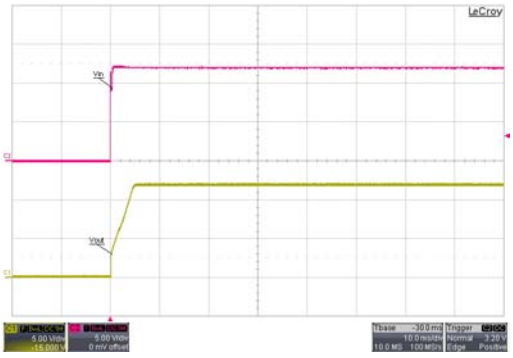


Typical Output Ripple and Noise.

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

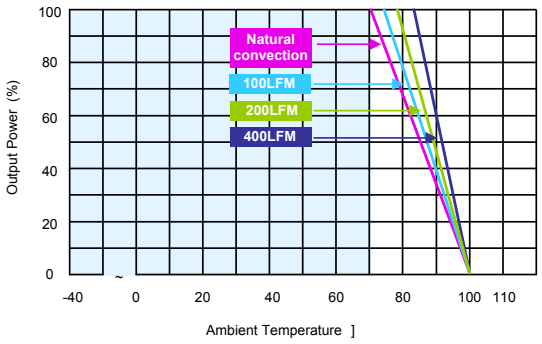


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



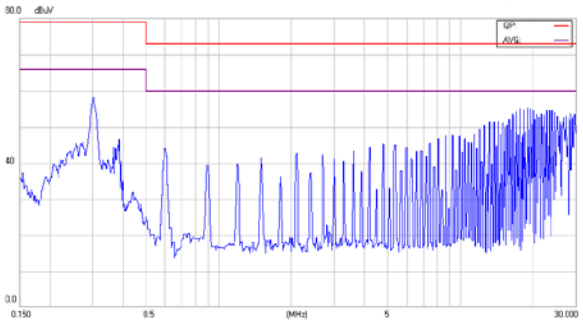
Typical Input Start-Up and Output Rise Characteristic

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



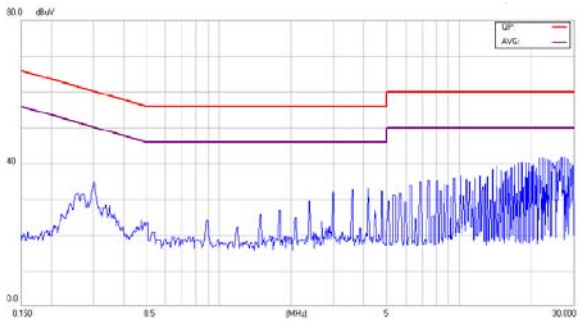
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

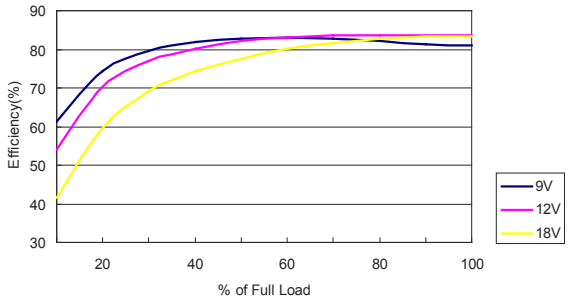


Conduction Emission of EN55022 Class B

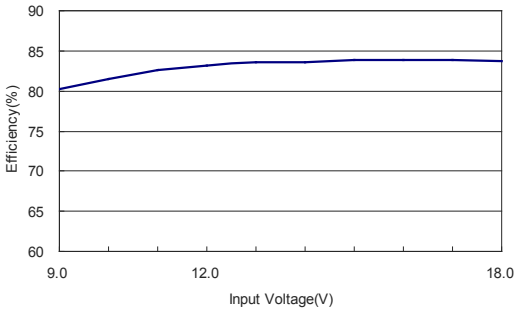
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

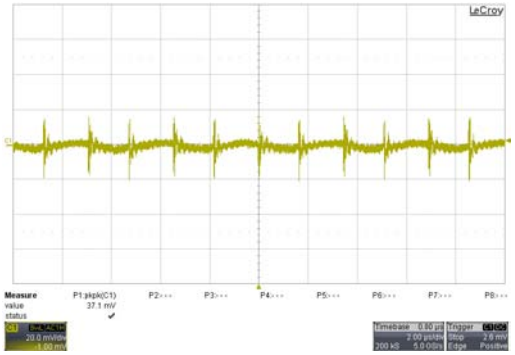
All test conditions are at 25°C The figures are identical for TES 2-1213N



Efficiency Versus Output Current

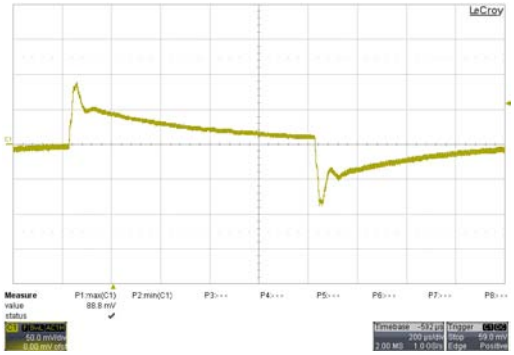


Efficiency Versus Input Voltage. Full Load

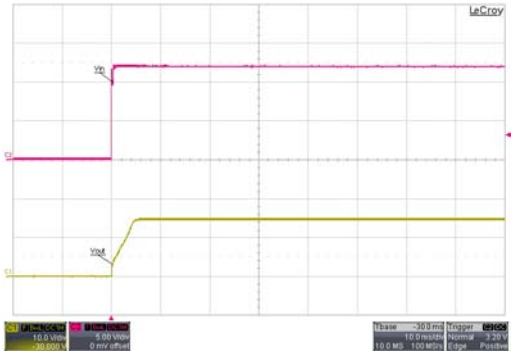


Typical Output Ripple and Noise.

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

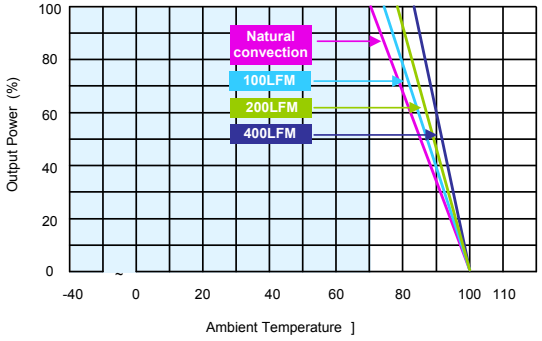


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



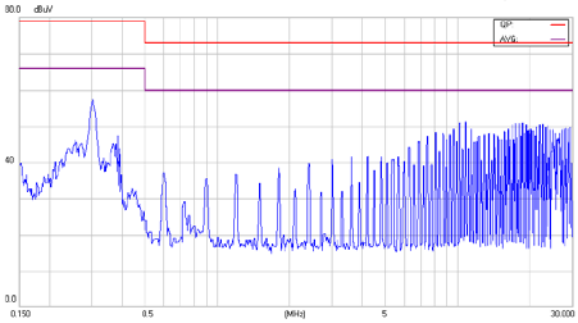
Typical Input Start-Up and Output Rise Characteristic

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



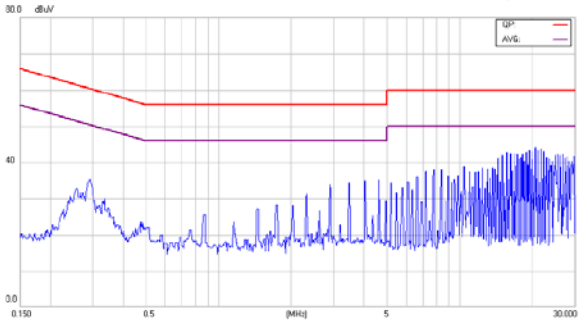
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

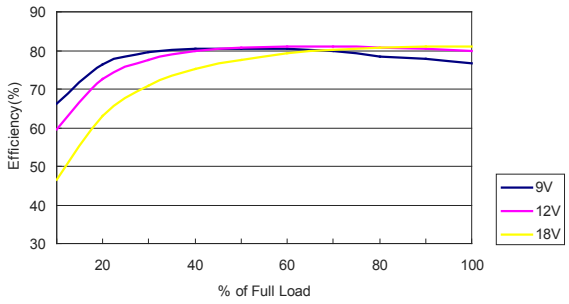


Conduction Emission of EN55022 Class B

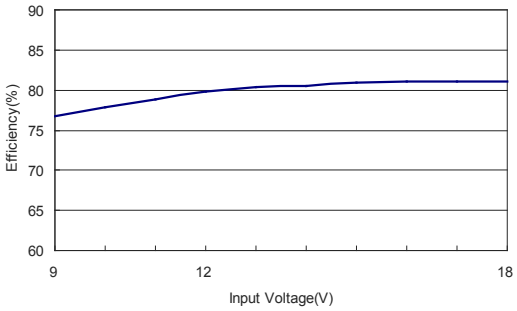
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

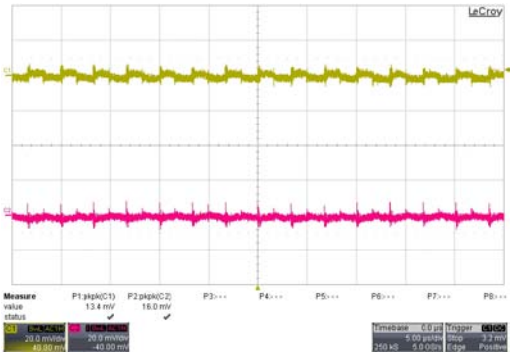
All test conditions are at 25°C The figures are identical for TES 2-1221N



Efficiency Versus Output Current

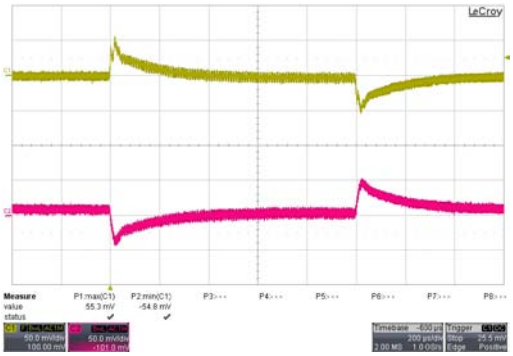


Efficiency Versus Input Voltage. Full Load

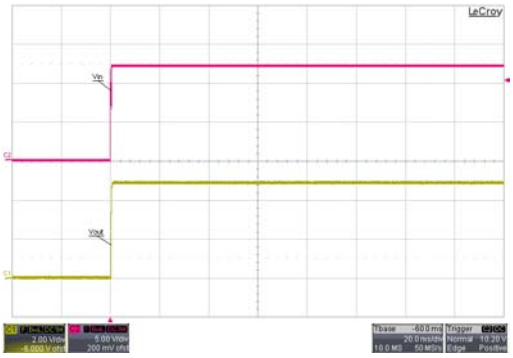


Typical Output Ripple and Noise.

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

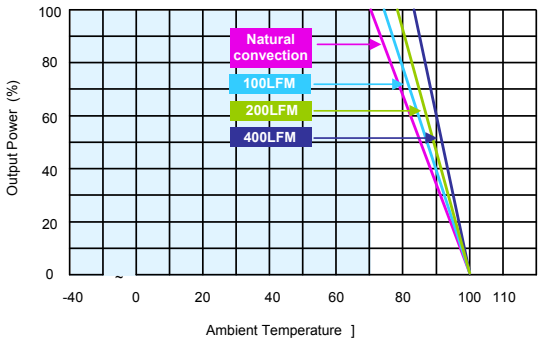


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



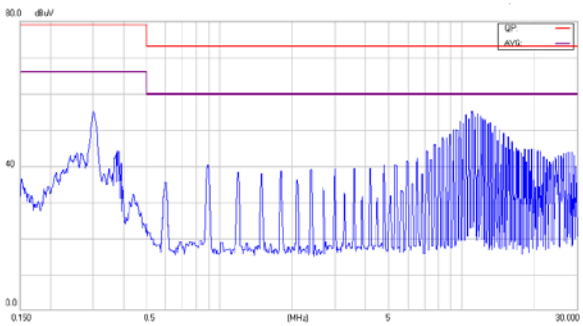
Typical Input Start-Up and Output Rise Characteristic

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



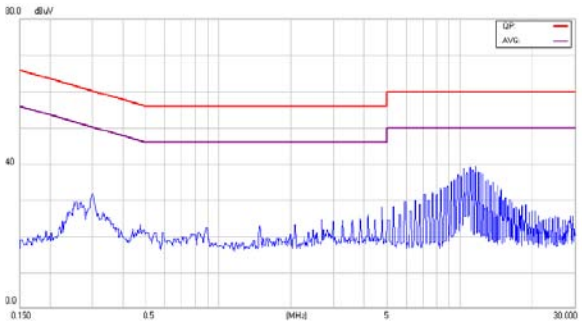
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

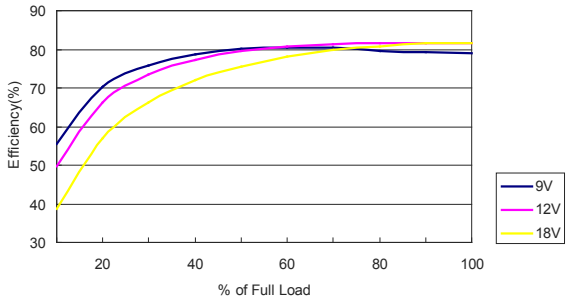


Conduction Emission of EN55022 Class B

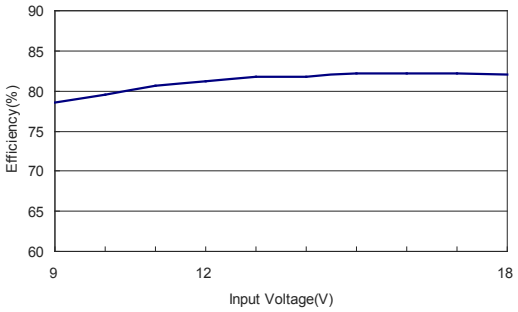
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

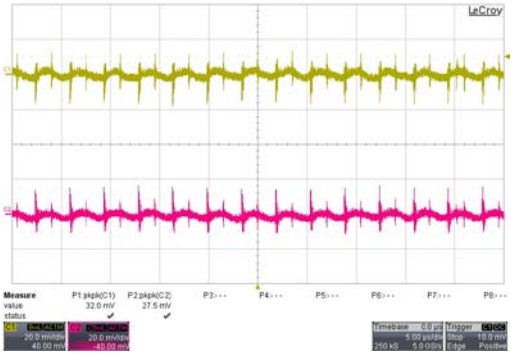
All test conditions are at 25°C The figures are identical for TES 2-1222N



Efficiency Versus Output Current

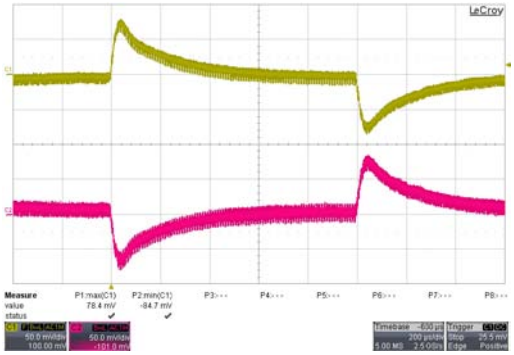


Efficiency Versus Input Voltage. Full Load

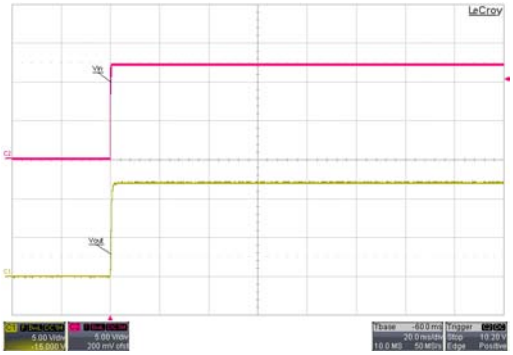


Typical Output Ripple and Noise.

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

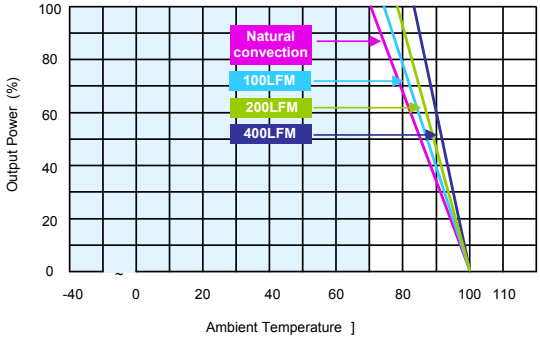


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



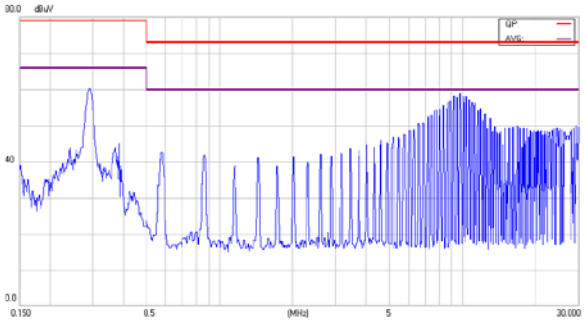
Typical Input Start-Up and Output Rise Characteristic

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



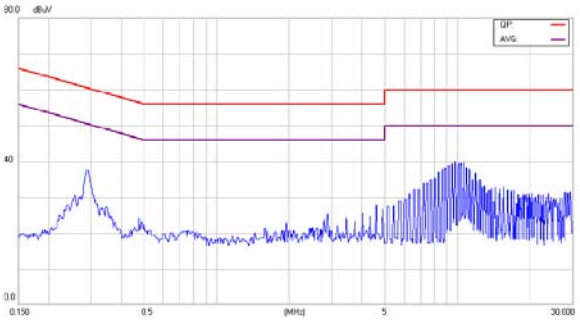
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

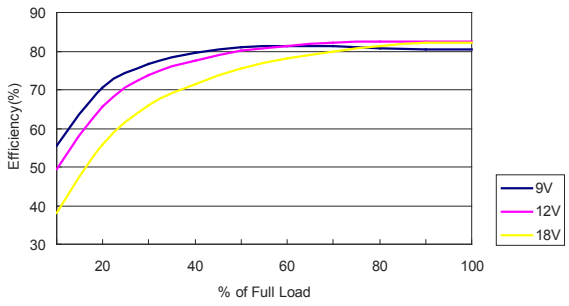


Conduction Emission of EN55022 Class B

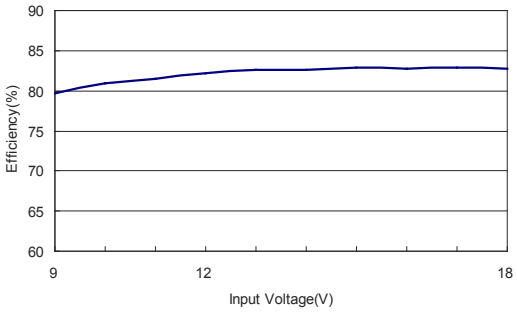
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

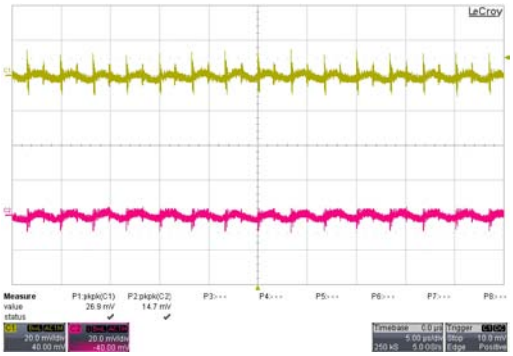
All test conditions are at 25°C The figures are identical for TES 2-1223N



Efficiency Versus Output Current



Efficiency Versus Input Voltage. Full Load



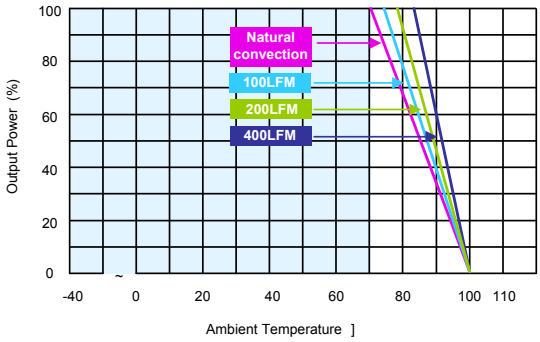
Typical Output Ripple and Noise.

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

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

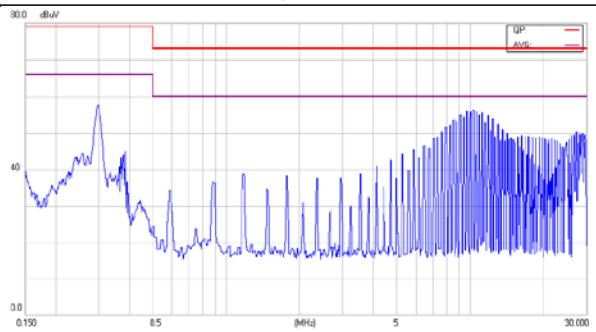
Typical Input Start-Up and Output Rise Characteristic

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



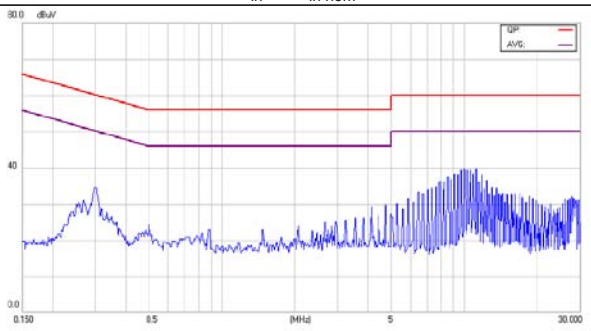
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

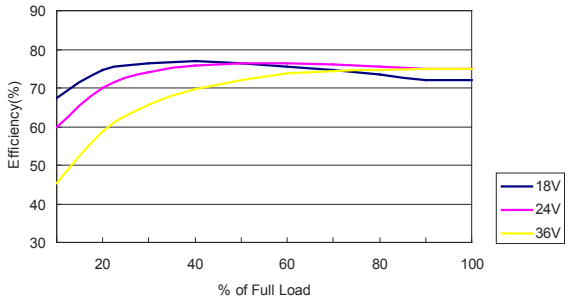


Conduction Emission of EN55022 Class B

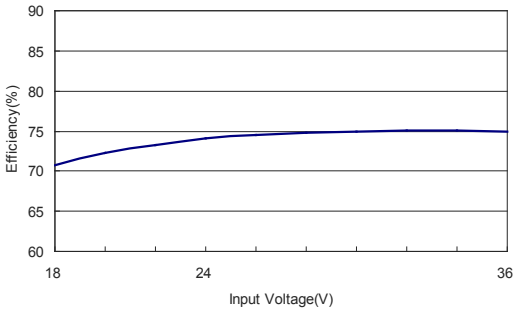
$V_{in=}$ =$V_{in\ nom}$; Full Load

Characteristic Curves

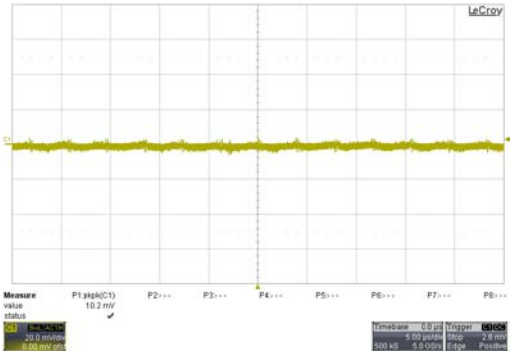
All test conditions are at 25°C The figures are identical for TES 2-2410N



Efficiency Versus Output Current

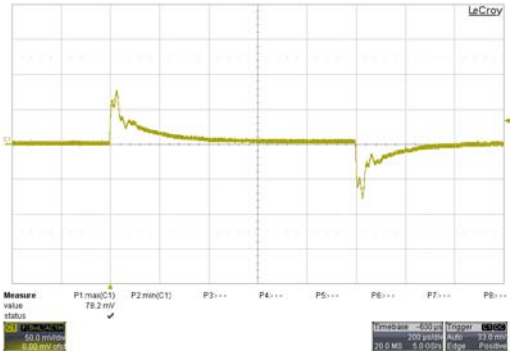


Efficiency Versus Input Voltage. Full Load

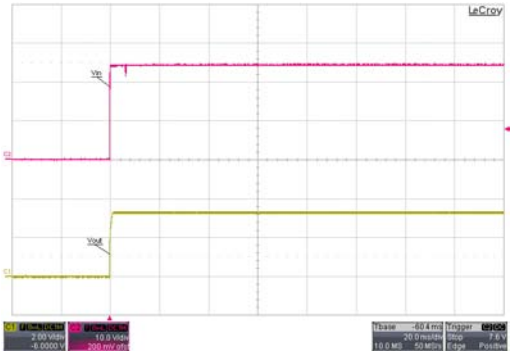


Typical Output Ripple and Noise.

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

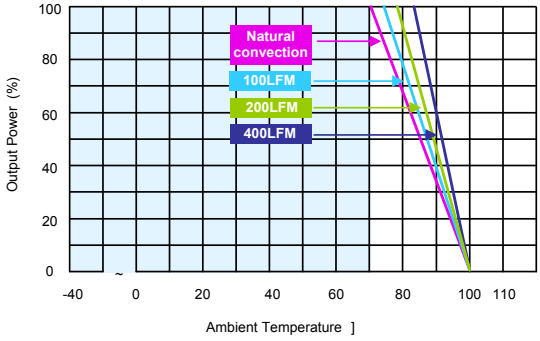


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



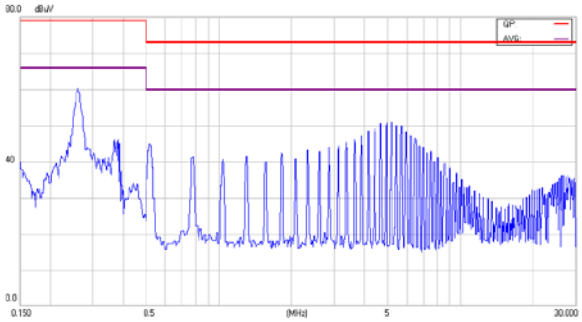
Typical Input Start-Up and Output Rise Characteristic

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



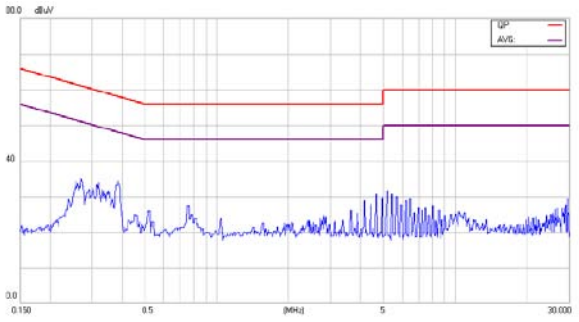
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

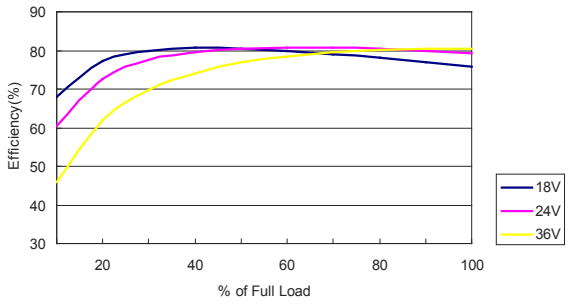


Conduction Emission of EN55022 Class B

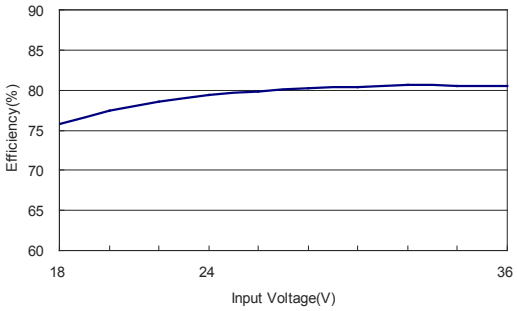
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

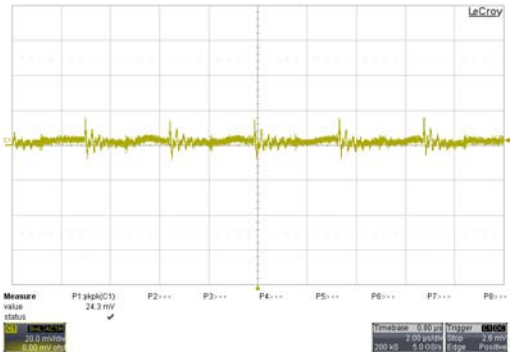
All test conditions are at 25°C The figures are identical for TES 2-2411N



Efficiency Versus Output Current

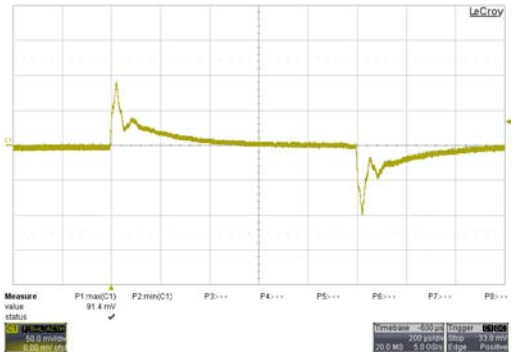


Efficiency Versus Input Voltage. Full Load

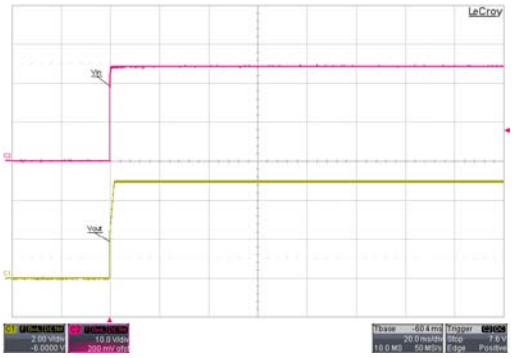


Typical Output Ripple and Noise.

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

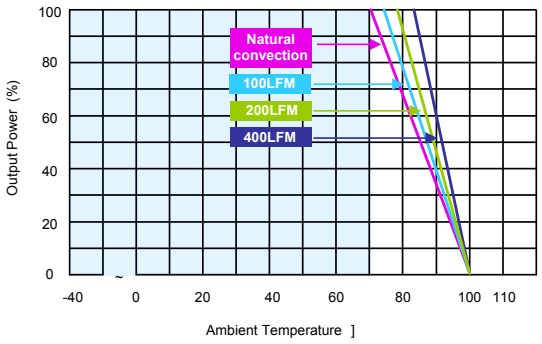


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



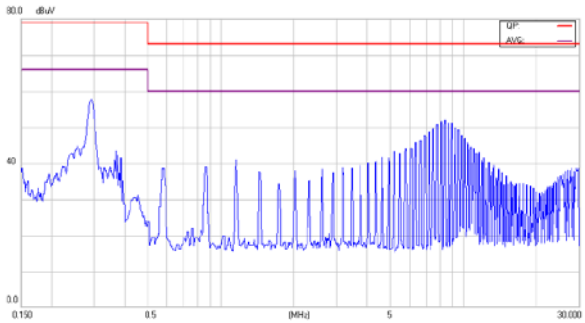
Typical Input Start-Up and Output Rise Characteristic

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



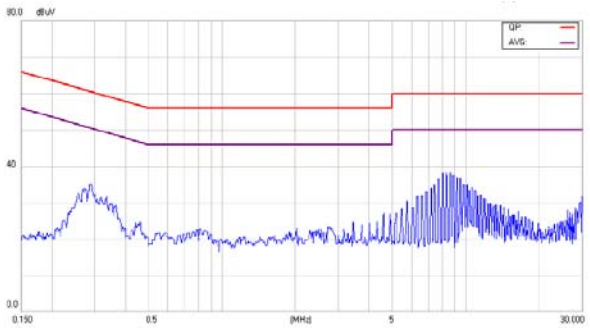
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

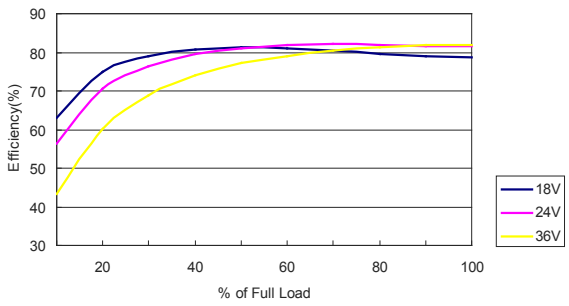


Conduction Emission of EN55022 Class B

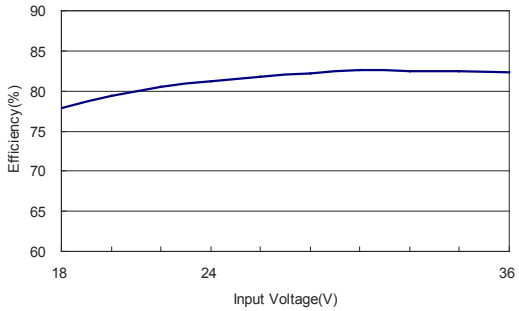
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

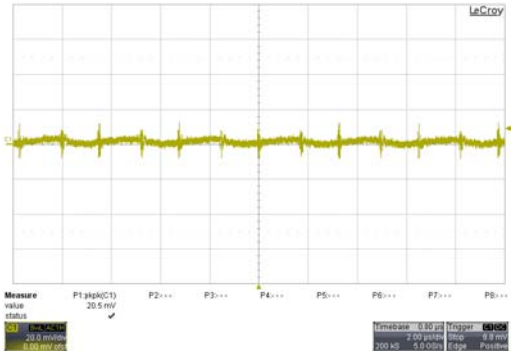
All test conditions are at 25°C The figures are identical for TES 2-2412N



Efficiency Versus Output Current

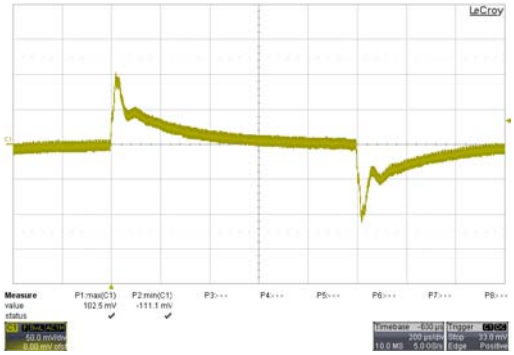


Efficiency Versus Input Voltage. Full Load

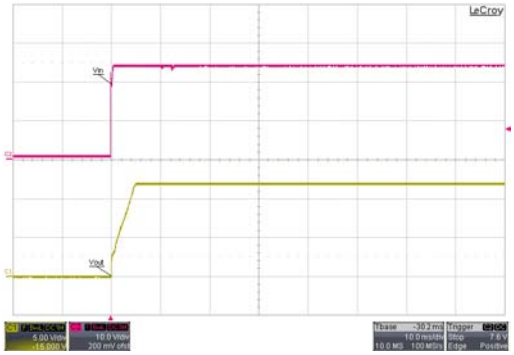


Typical Output Ripple and Noise.

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

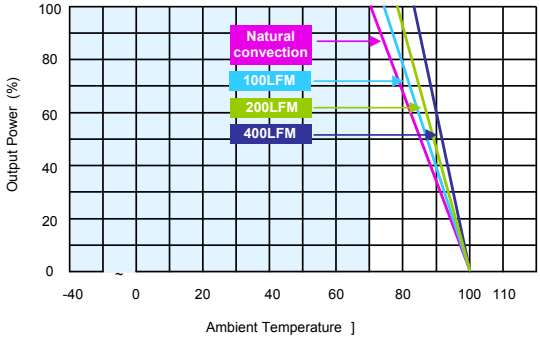


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



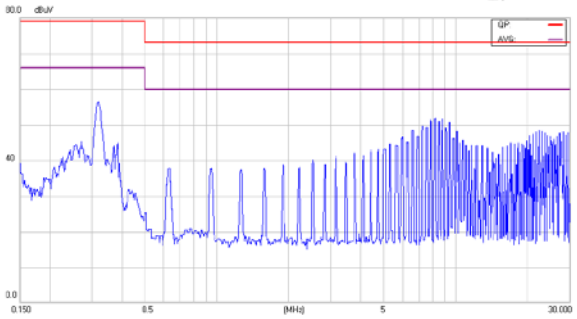
Typical Input Start-Up and Output Rise Characteristic

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



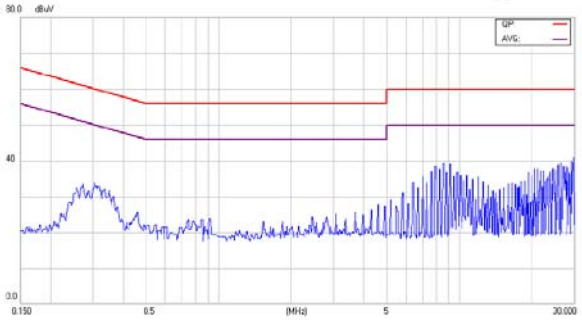
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

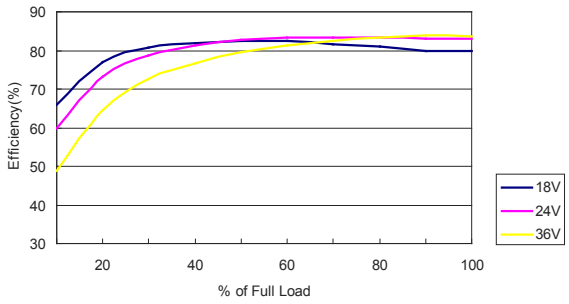


Conduction Emission of EN55022 Class B

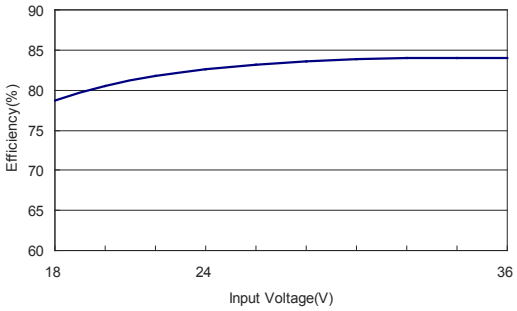
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

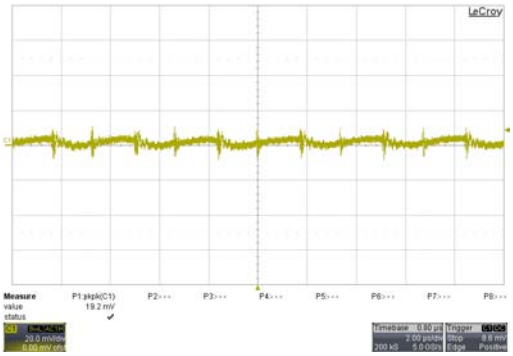
All test conditions are at 25°C The figures are identical for TES 2-2413N



Efficiency Versus Output Current

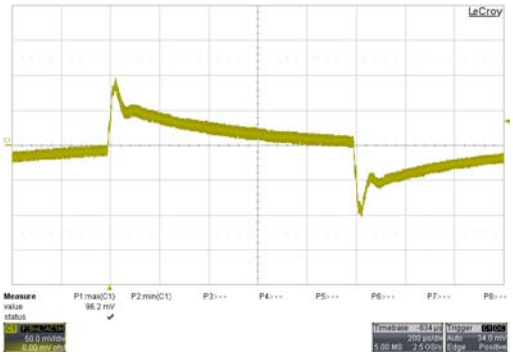


Efficiency Versus Input Voltage. Full Load

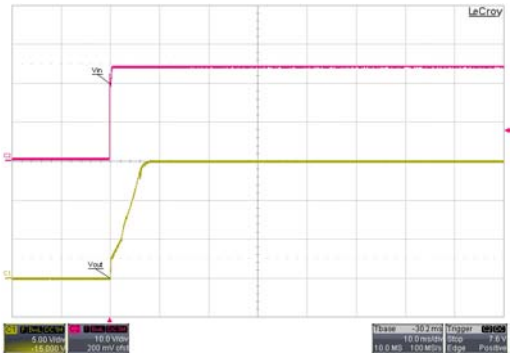


Typical Output Ripple and Noise.

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

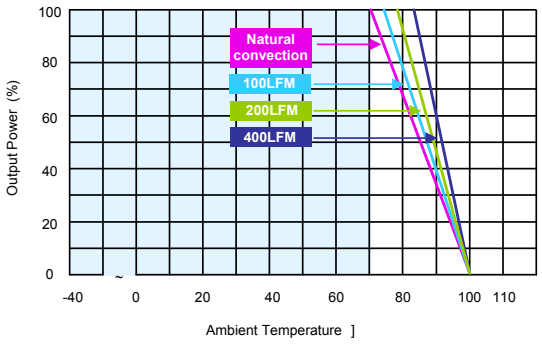


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



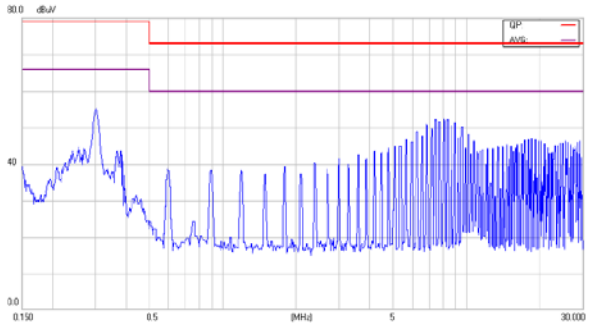
Typical Input Start-Up and Output Rise Characteristic

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



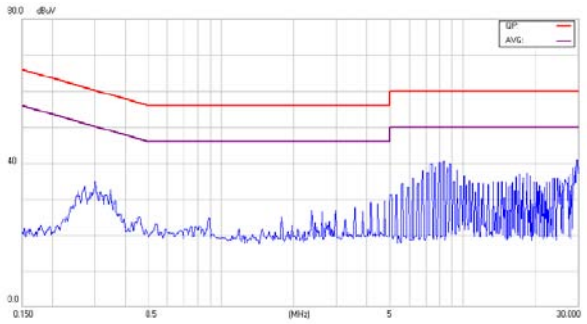
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

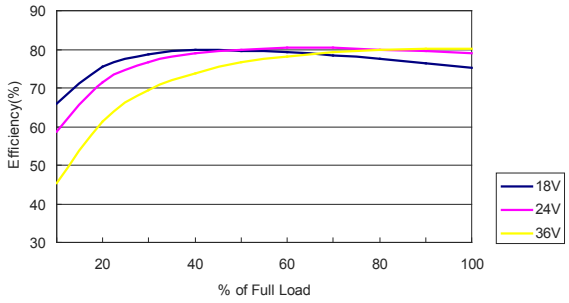


Conduction Emission of EN55022 Class B

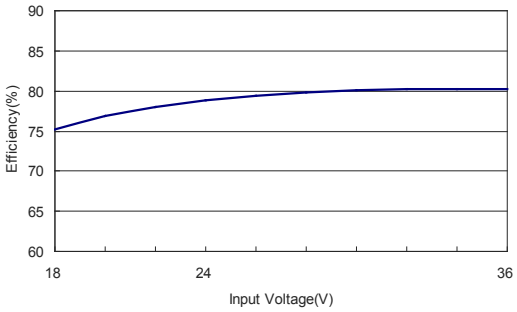
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

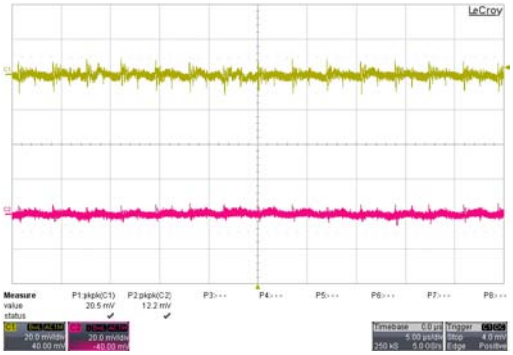
All test conditions are at 25°C The figures are identical for TES 2-2421N



Efficiency Versus Output Current

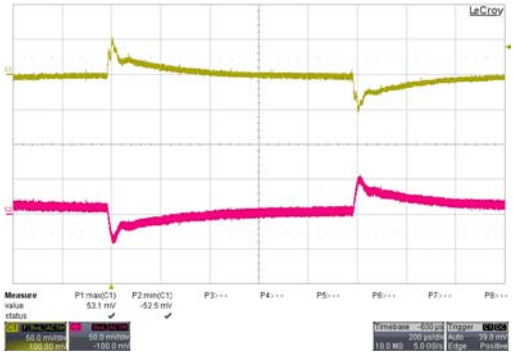


Efficiency Versus Input Voltage. Full Load

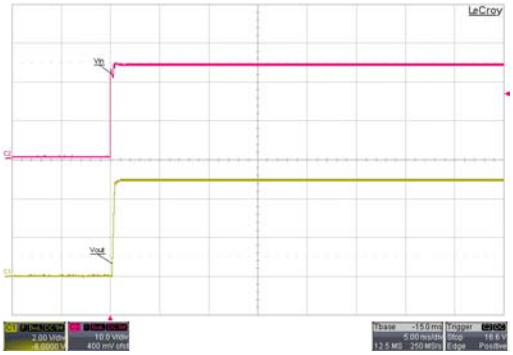


Typical Output Ripple and Noise.

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

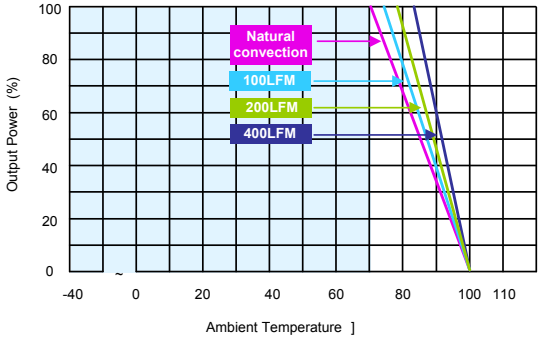


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



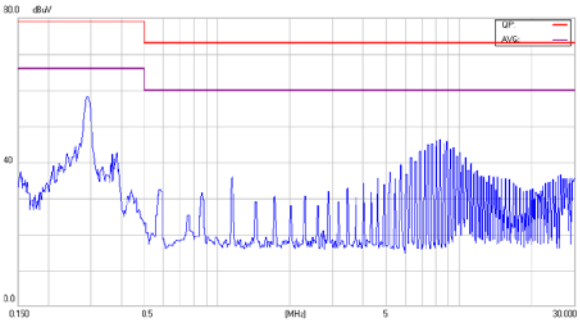
Typical Input Start-Up and Output Rise Characteristic

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



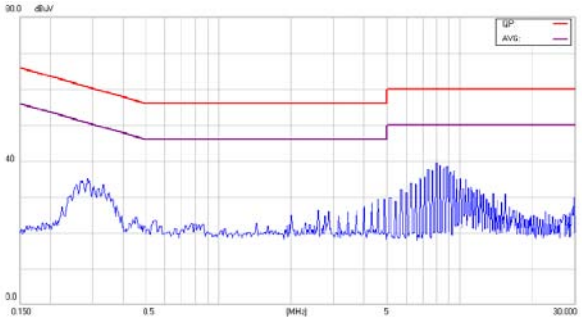
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

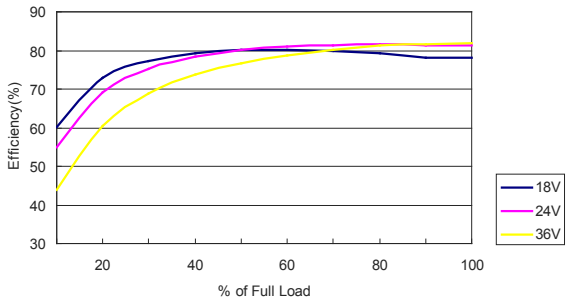


Conduction Emission of EN55022 Class B

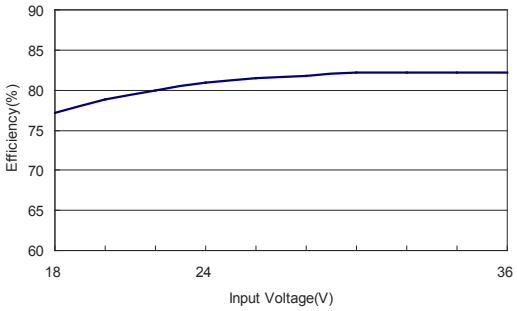
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

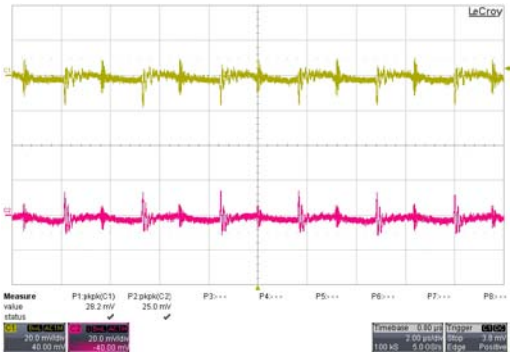
All test conditions are at 25°C The figures are identical for TES 2-2422N



Efficiency Versus Output Current

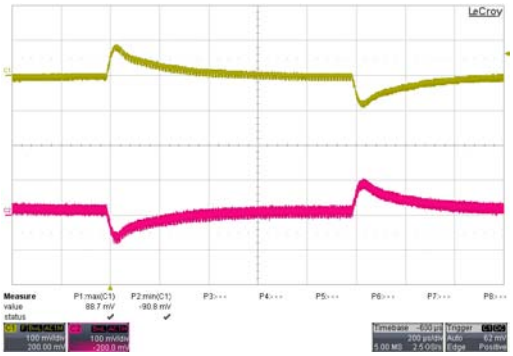


Efficiency Versus Input Voltage. Full Load

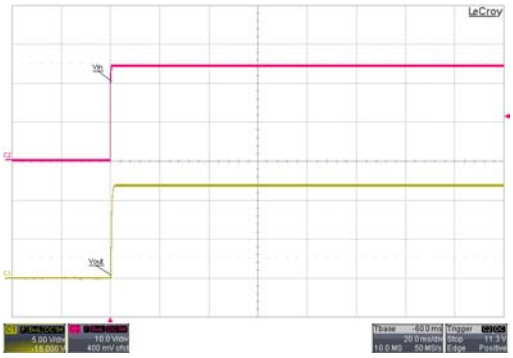


Typical Output Ripple and Noise.

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

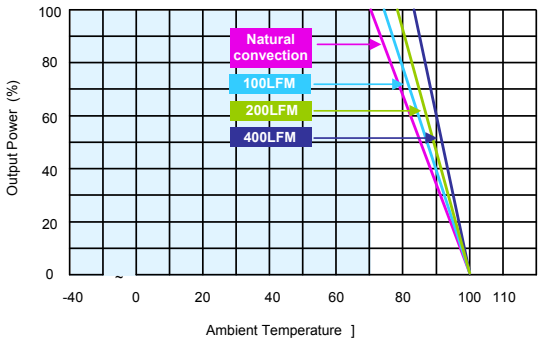


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



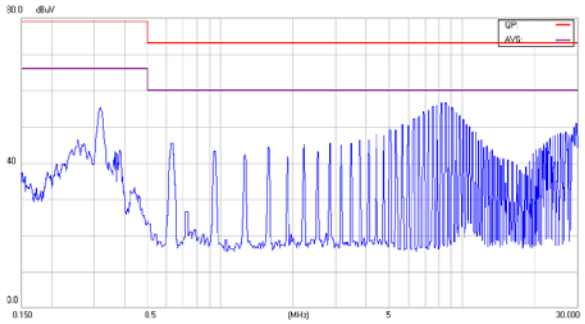
Typical Input Start-Up and Output Rise Characteristic

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



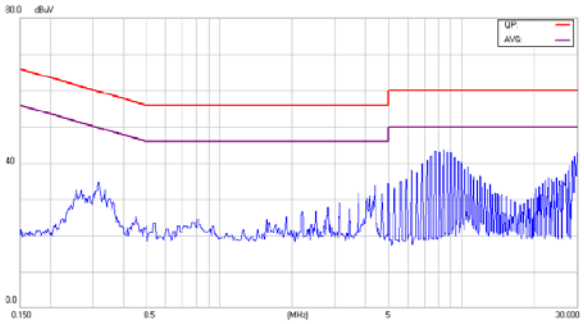
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

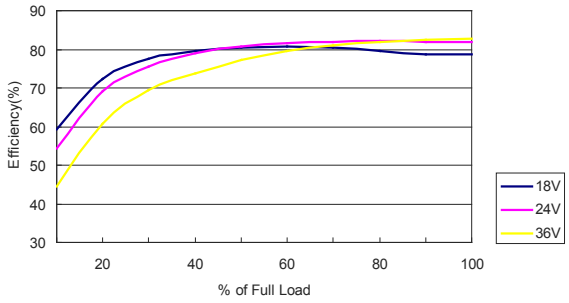


Conduction Emission of EN55022 Class B

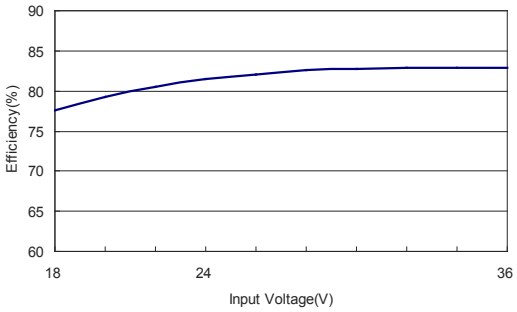
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

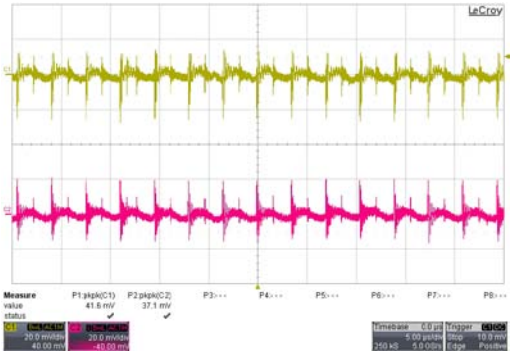
All test conditions are at 25°C The figures are identical for TES 2-2423N



Efficiency Versus Output Current

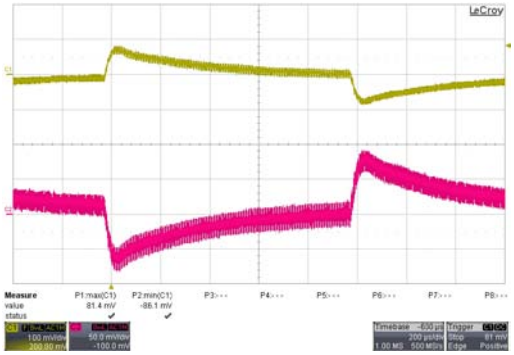


Efficiency Versus Input Voltage. Full Load

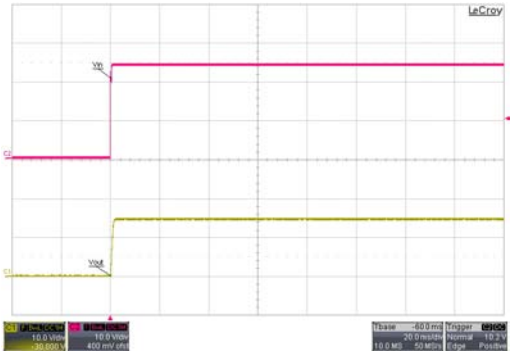


Typical Output Ripple and Noise.

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

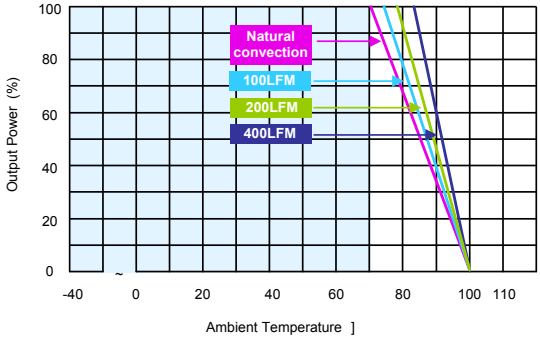


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



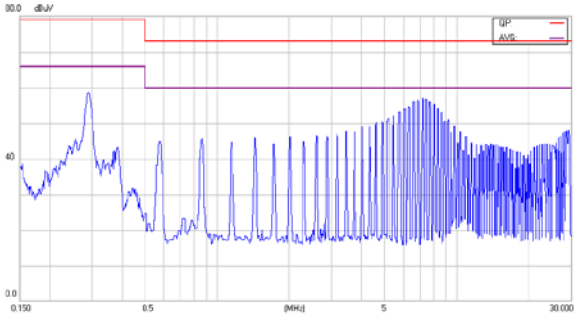
Typical Input Start-Up and Output Rise Characteristic

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



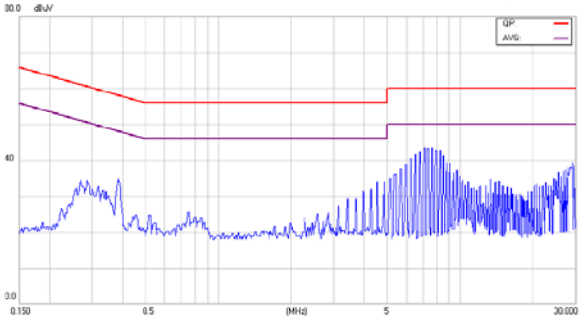
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

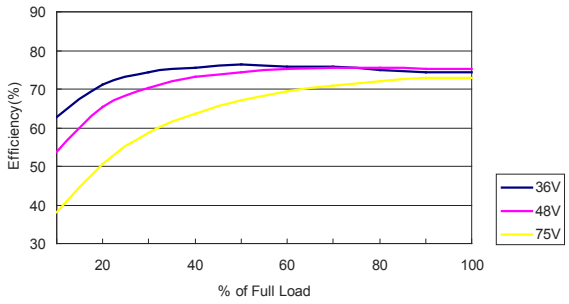


Conduction Emission of EN55022 Class B

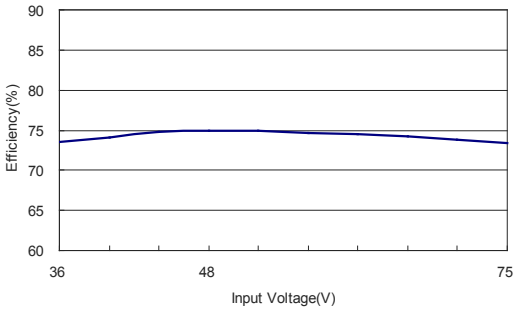
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

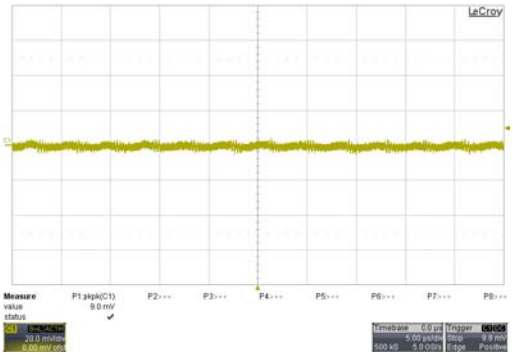
All test conditions are at 25°C The figures are identical for TES 2-4810N



Efficiency Versus Output Current

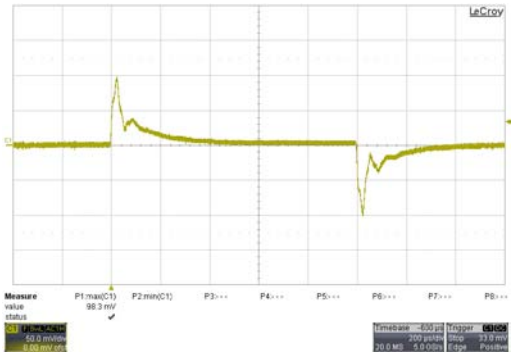


Efficiency Versus Input Voltage. Full Load

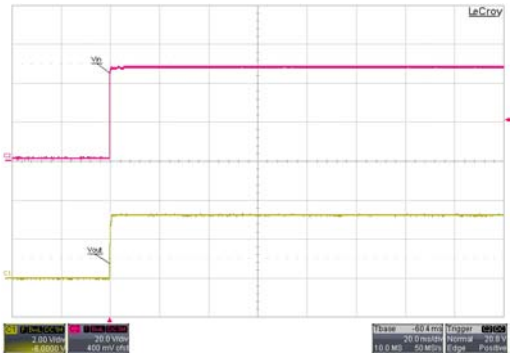


Typical Output Ripple and Noise.

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

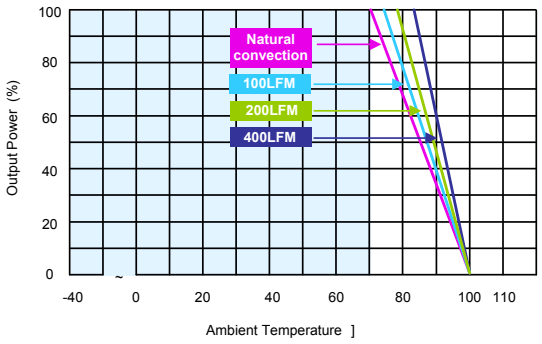


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



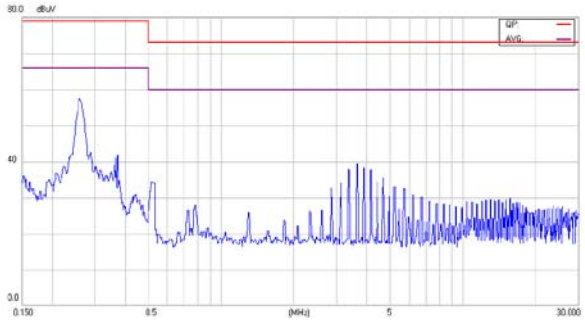
Typical Input Start-Up and Output Rise Characteristic

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



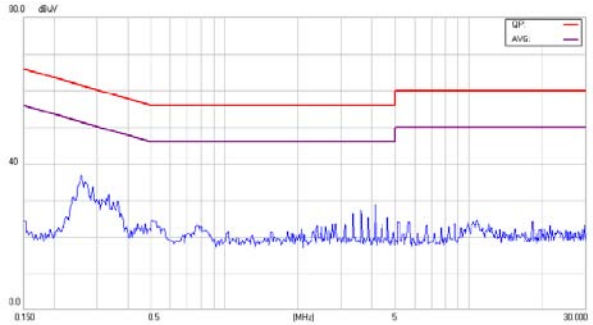
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

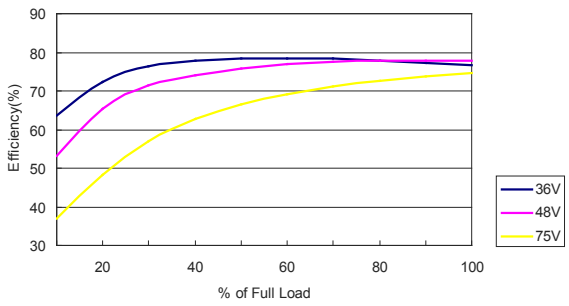


Conduction Emission of EN55022 Class B

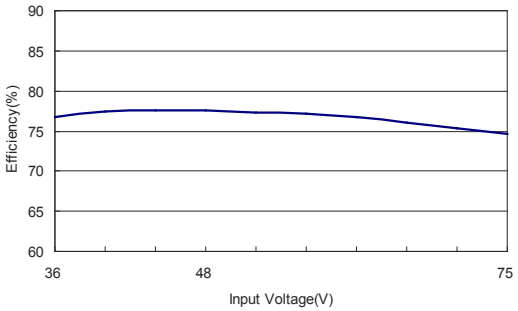
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

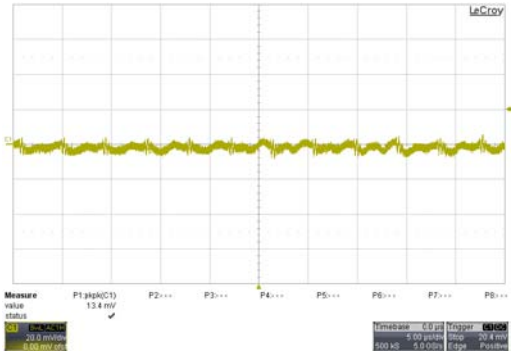
All test conditions are at 25°C The figures are identical for TES 2-4811N



Efficiency Versus Output Current

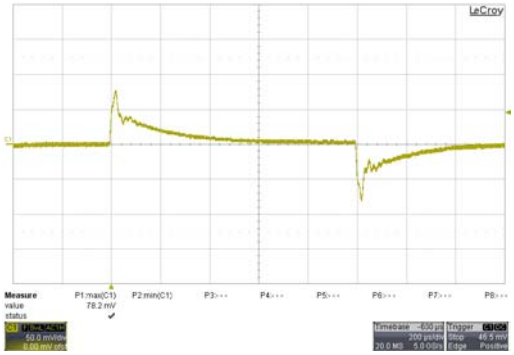


Efficiency Versus Input Voltage. Full Load

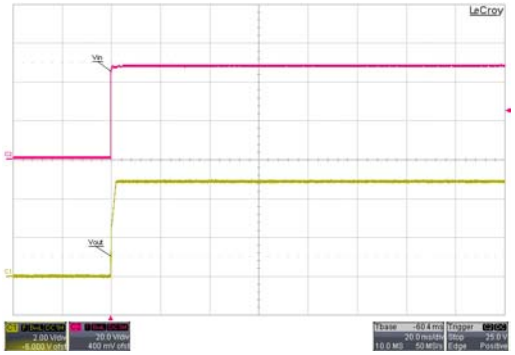


Typical Output Ripple and Noise.

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

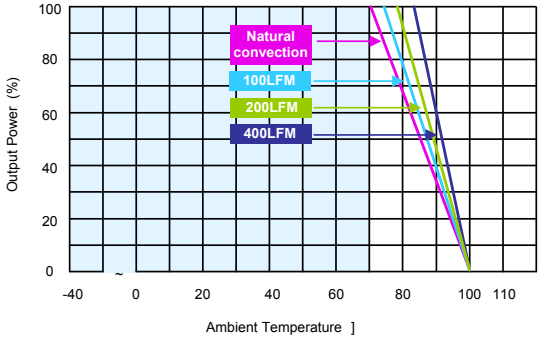


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



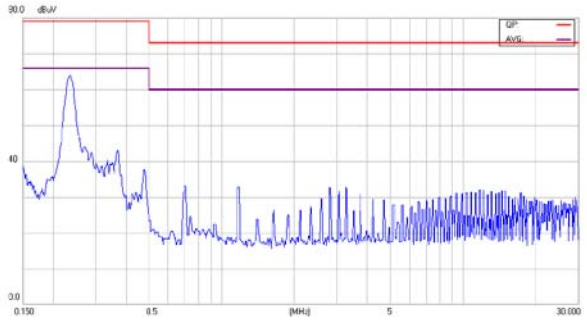
Typical Input Start-Up and Output Rise Characteristic

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



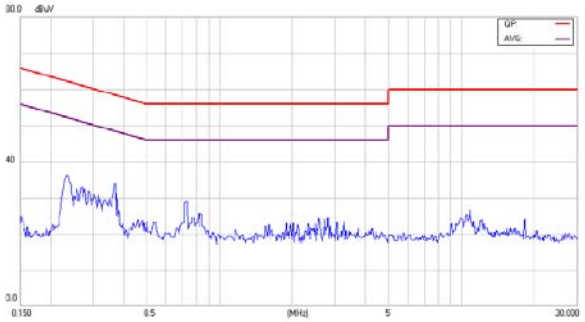
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

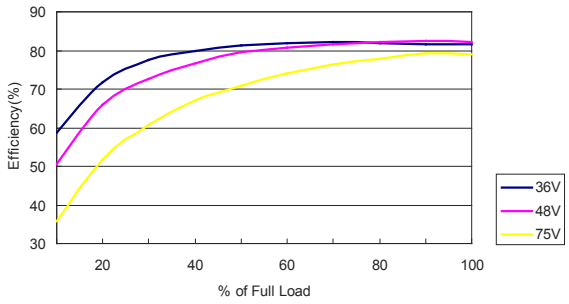


Conduction Emission of EN55022 Class B

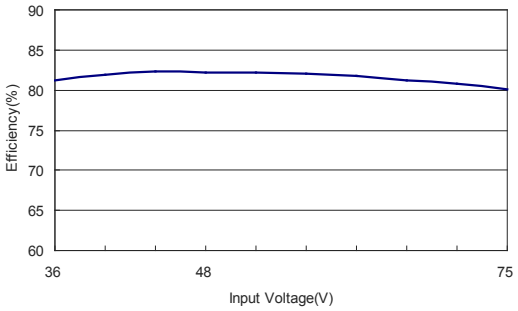
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

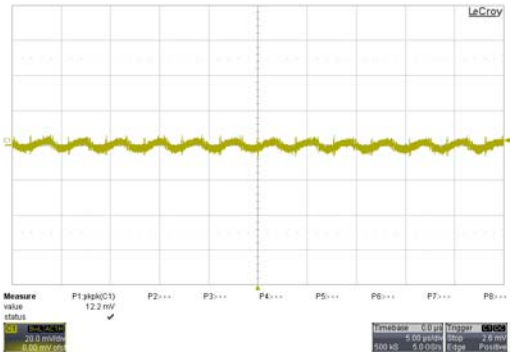
All test conditions are at 25°C The figures are identical for TES 2-4812N



Efficiency Versus Output Current

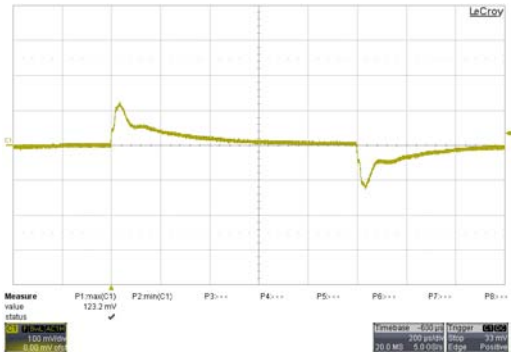


Efficiency Versus Input Voltage. Full Load

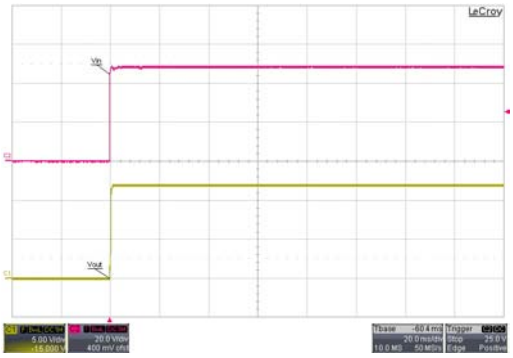


Typical Output Ripple and Noise.

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

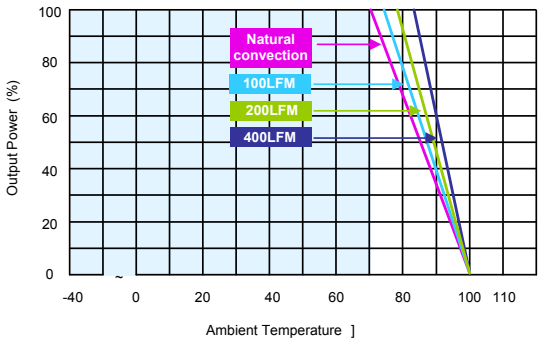


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



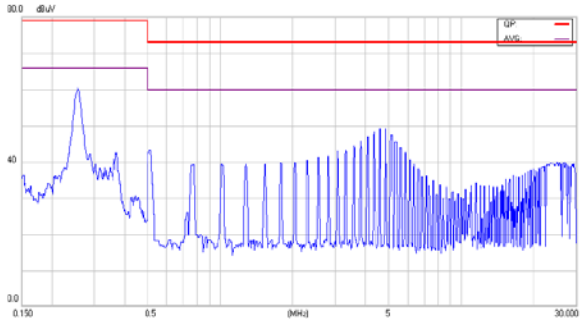
Typical Input Start-Up and Output Rise Characteristic

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



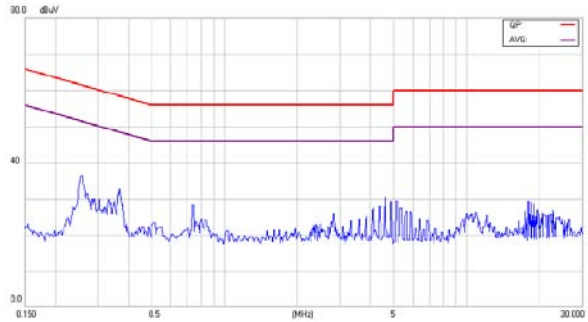
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

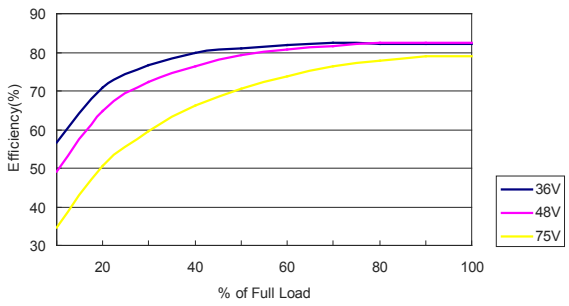


Conduction Emission of EN55022 Class B

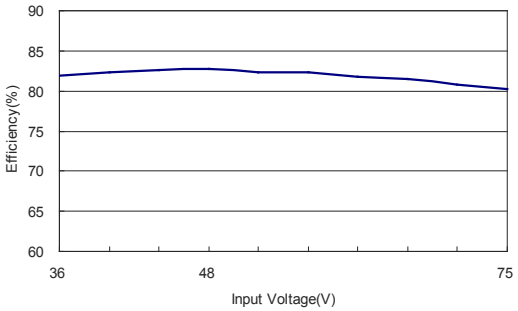
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

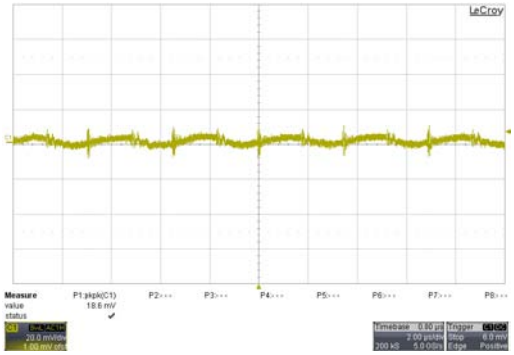
All test conditions are at 25°C The figures are identical for TES 2-4813N



Efficiency Versus Output Current

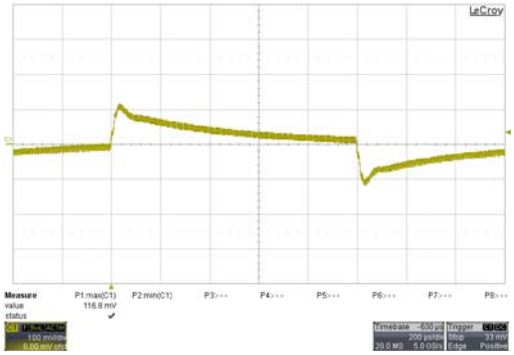


Efficiency Versus Input Voltage. Full Load

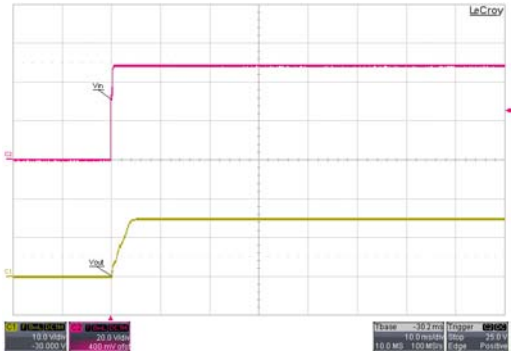


Typical Output Ripple and Noise.

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

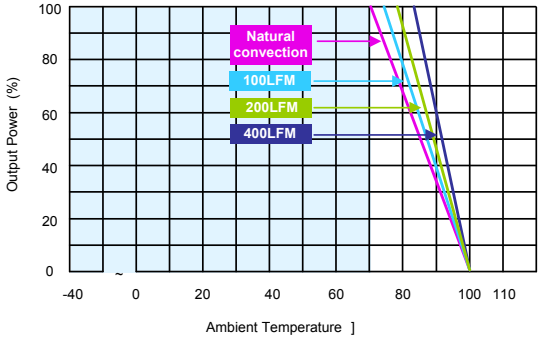


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



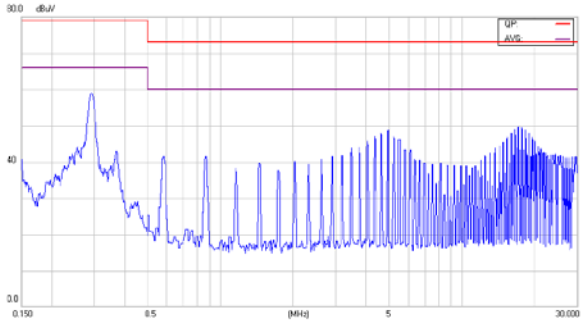
Typical Input Start-Up and Output Rise Characteristic

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



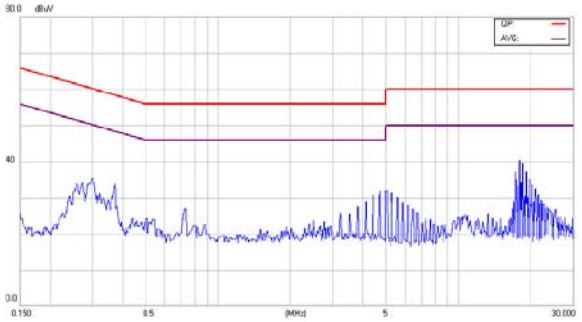
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

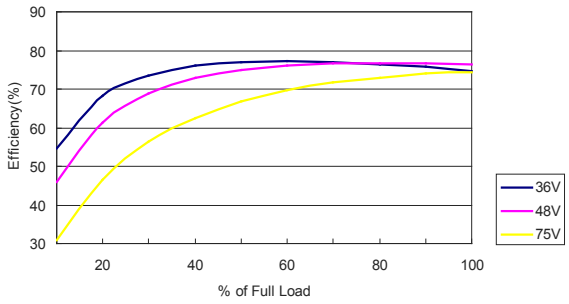


Conduction Emission of EN55022 Class B

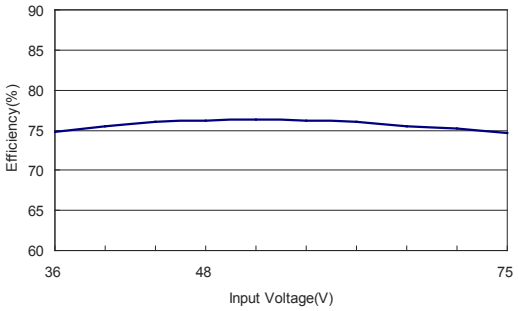
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

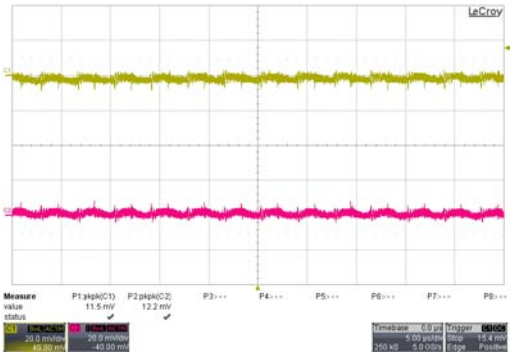
All test conditions are at 25°C The figures are identical for TES 2-4821N



Efficiency Versus Output Current

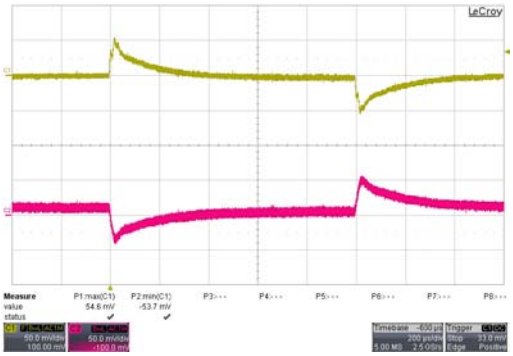


Efficiency Versus Input Voltage. Full Load

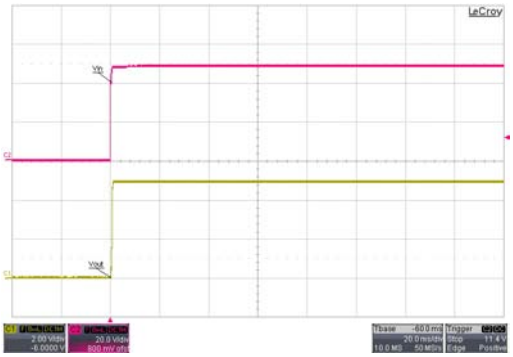


Typical Output Ripple and Noise.

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

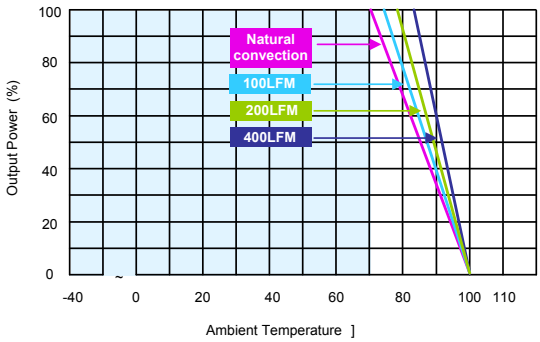


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



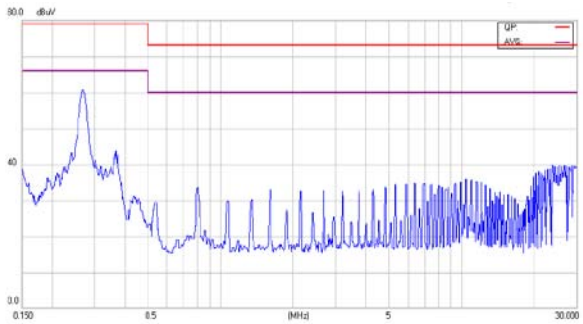
Typical Input Start-Up and Output Rise Characteristic

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



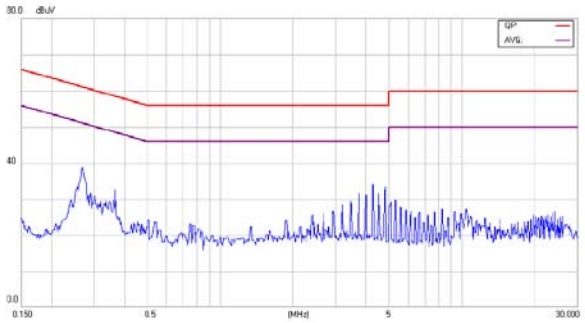
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

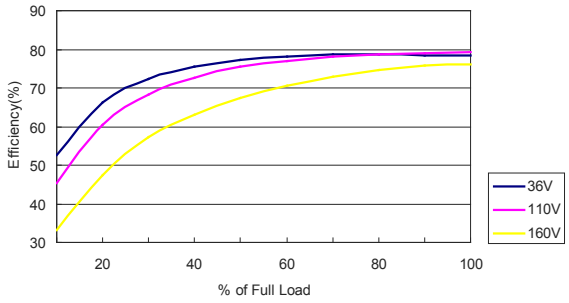


Conduction Emission of EN55022 Class B

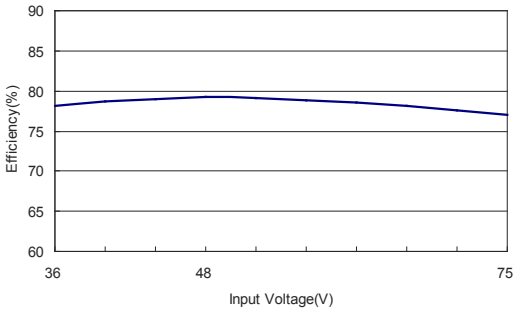
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

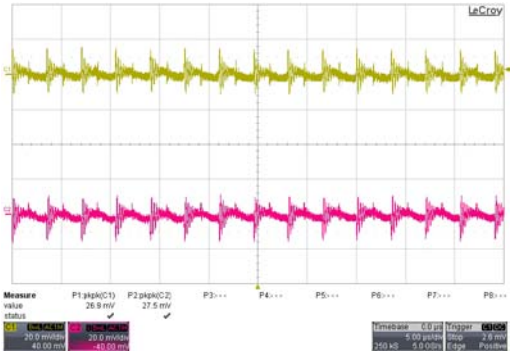
All test conditions are at 25°C The figures are identical for TES 2-4822N



Efficiency Versus Output Current

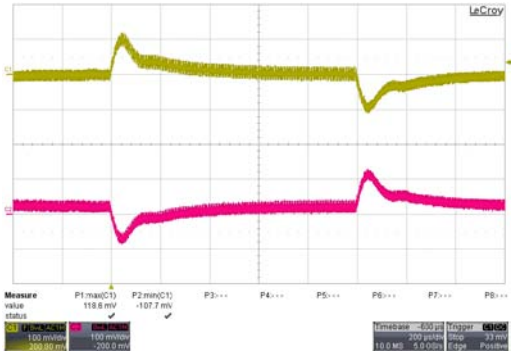


Efficiency Versus Input Voltage. Full Load

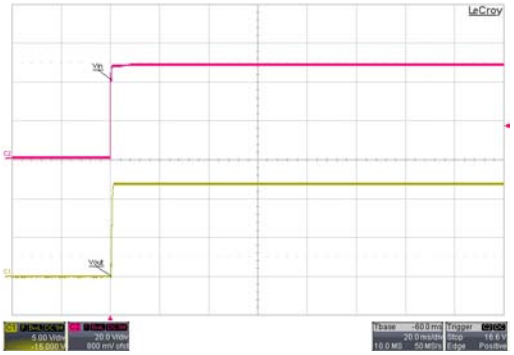


Typical Output Ripple and Noise.

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

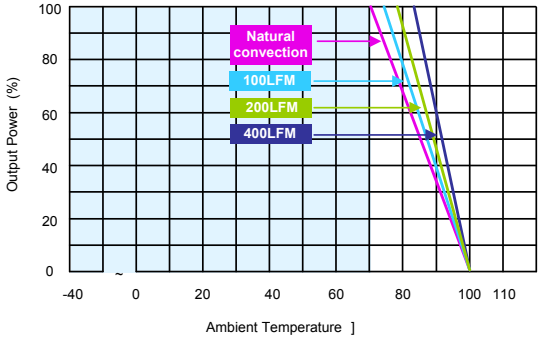


Transient Response to Dynamic Load Change from 100% to 75% of Full Load ; V_{in} =$V_{in\ nom}$



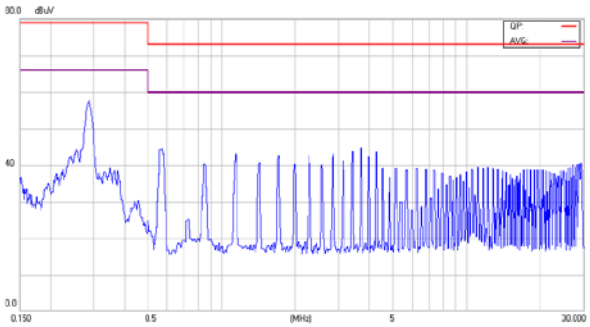
Typical Input Start-Up and Output Rise Characteristic

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



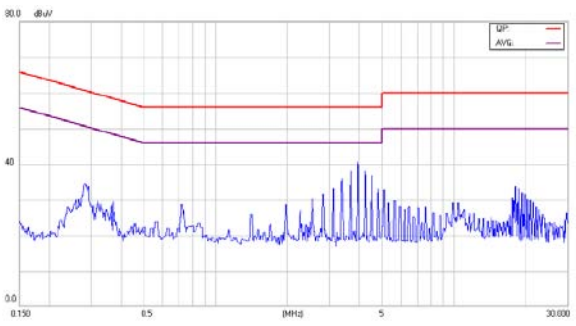
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

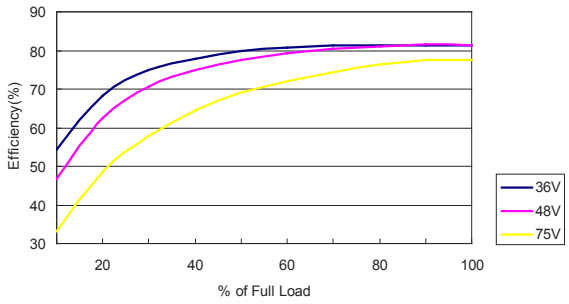


Conduction Emission of EN55022 Class B

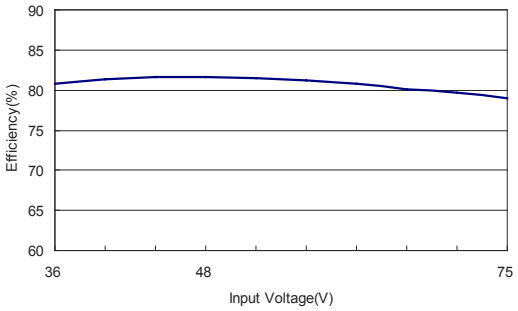
V_{in} =$V_{in\ nom}$; Full Load

Characteristic Curves

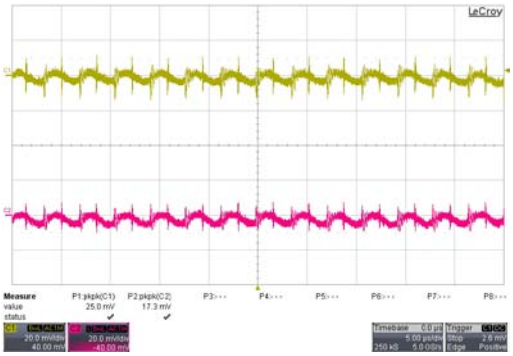
All test conditions are at 25°C The figures are identical for TES 2-4823N



Efficiency Versus Output Current



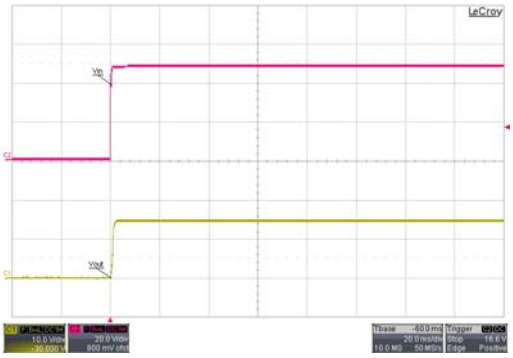
Efficiency Versus Input Voltage. Full Load



Typical Output Ripple and Noise.

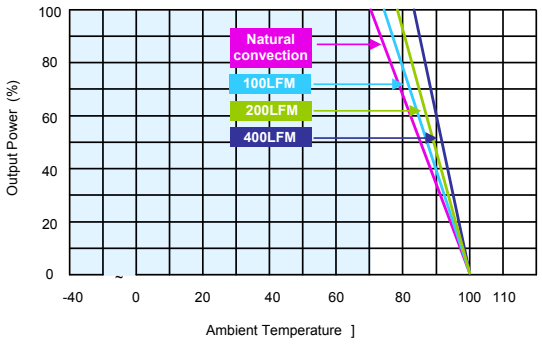
V_{in} =$V_{in\ nom}$; Full Load; T_A

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



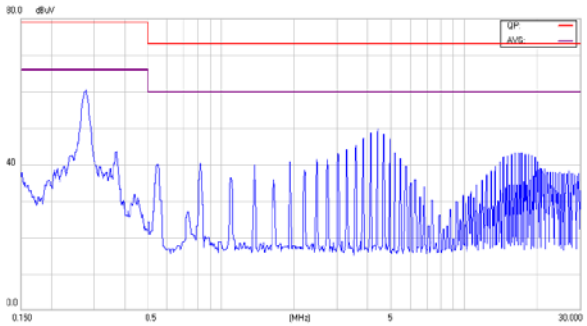
Typical Input Start-Up and Output Rise Characteristic

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



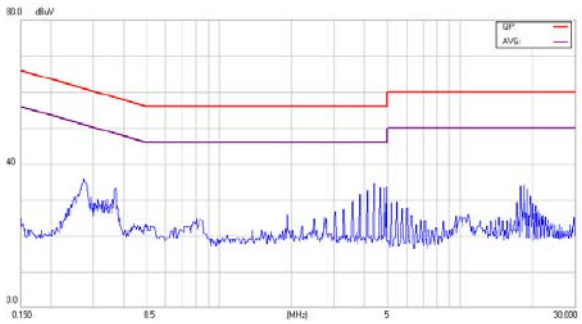
Derating Output Current Versus Ambient Temperature and Airflow

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



Conduction Emission of EN55022 Class A

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

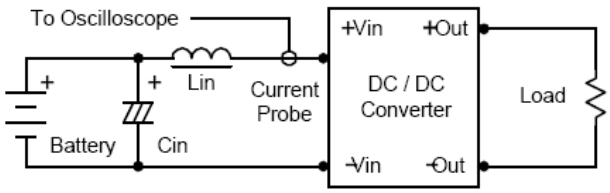


Conduction Emission of EN55022 Class B

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

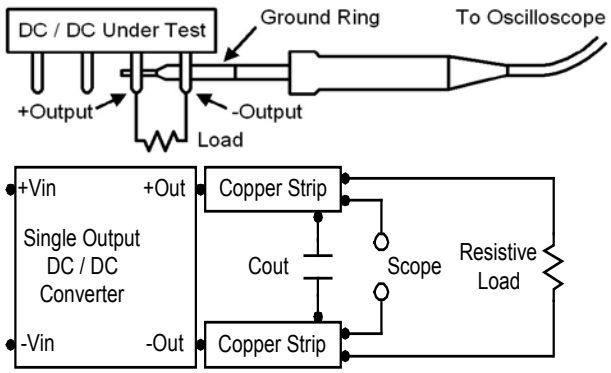
Testing Configurations

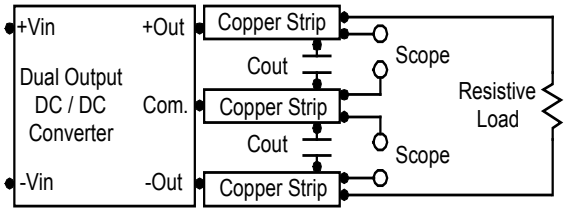
Input reflected-ripple current measurement test up



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

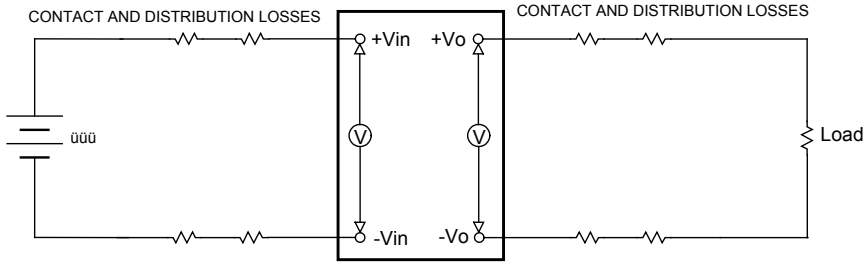
Peak-to-peak output ripple & noise measurement test up



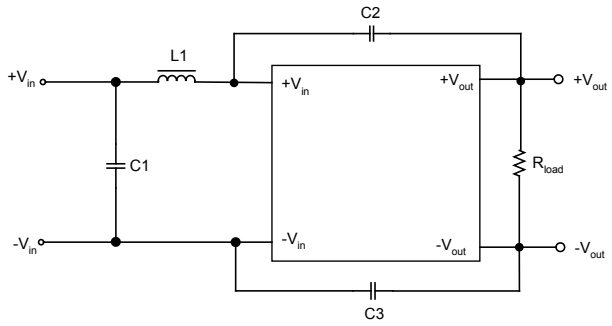


Output voltage and efficiency measurement test up

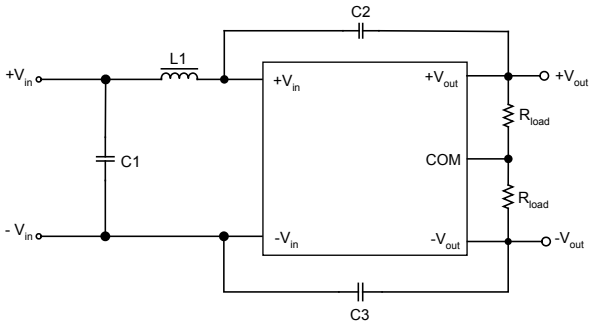
$$Efficiency = \left(\frac{V_{out} \times I_{out}}{V_{in} \times I_{in}} \right) \times 100\% = [\%]$$



EMC considerations

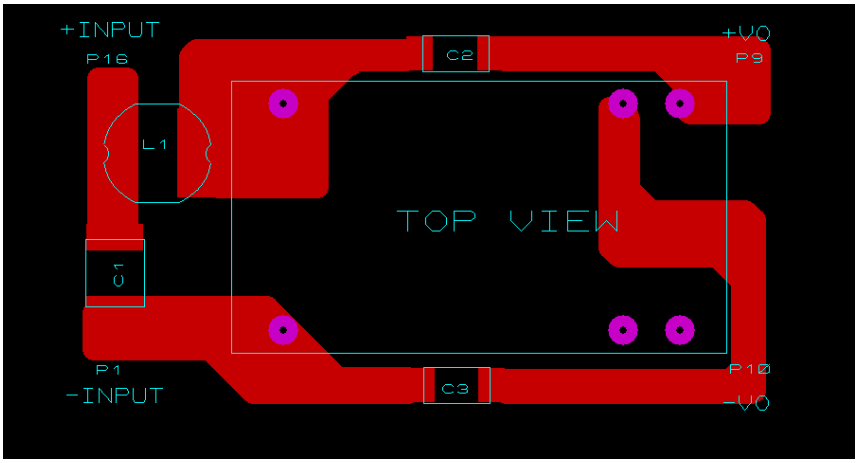


Single Output



Dual Output

Recommended circuit to comply EN55022 Class B Limits



Recommended PCB Layout with Input Filter

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

Model	Component	Value
TES 2-05xxN	C1	2.2µF/16V 1206 X7R
	C2	100pF/2KV 1808 X7R
	L1	4.7µH SR0302/1.2A
TES 2-12xxN	C1	1µF/25V 1206 X7R
	C2	100pF/2KV 1808 X7R
	C3	220pF/2KV 1808 X7R
	L1	6.8µH SR0302/1A
TES 2-24xxN	C1	1µF/50V 1206 X7R
	C2	100pF/2KV 1808 X7R
	C3	220pF/2KV 1808 X7R
	L1	47µH SR0302/0.36A
TES 2-48xxN	C1	0.47µF/100V 1206 X7R
	C2,C3	470pF/2KV 1808 X7R
	L1	47µH SR0302/0.36A

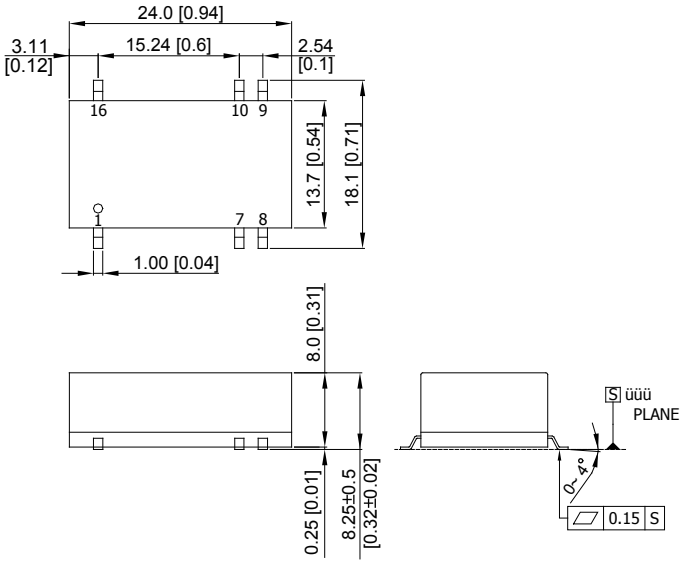
Input Source Impedance

The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module.
In applications where power is supplied over long lines and output loading is high, it may be necessary to use a capacitor on the input to insure startup.
By using a good quality low Equivalent Series Resistance (ESR < 1.0Ω at 100 kHz) capacitor of a 8.2µF for the 5V input devices, a 3.3µF for the 12V input devices and a 1.5µF for the 24V and 48V devices, capacitor mounted close to the power module helps ensure stability of the unit.

Output Over Current Protection

To provide protection in a fault (output overload) condition, the unit is equipped with internal current limiting circuitry and can endure current limiting for an unlimited duration. At the point of current-limit inception, the unit shifts from voltage control to current control. The unit operates normally once the output current is brought back into its specified range.

Mechanical Dimensions

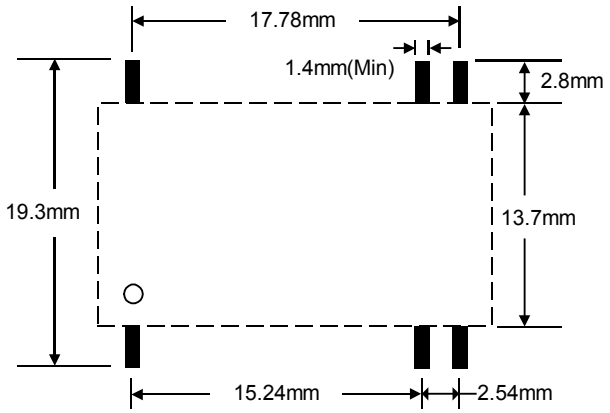


Weight:5.1g

Pin Connections		
Pin	Single Output	Dual Output
1	-Vin	-Vin
7	NC	NC
8	NC	Common
9	+Vout	+Vout
10	-Vout	-Vout
16	+Vin	+Vin

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

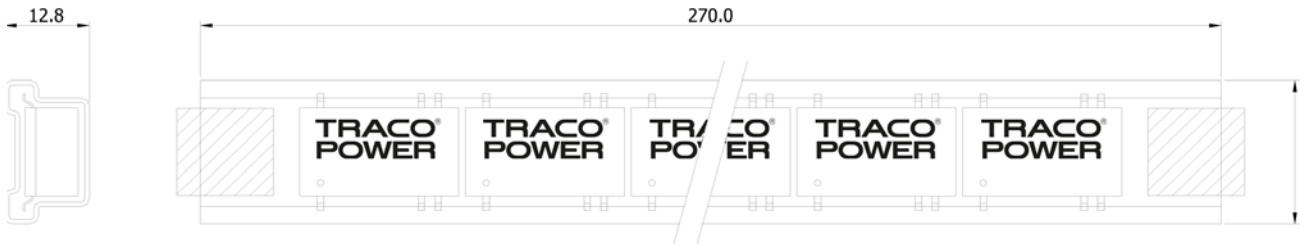
Recommended Pad Layout for Single & Dual Output Converter



1.All dimensions in mm (Inches)
Tolerance: x.x±0.25mm (x.xx ±0.01")
x.xx±0.13mm (x.xxx ±0.005")
2. Pins ±0.05 (±0.002")

Packaging Information

TUBE



unit : mm

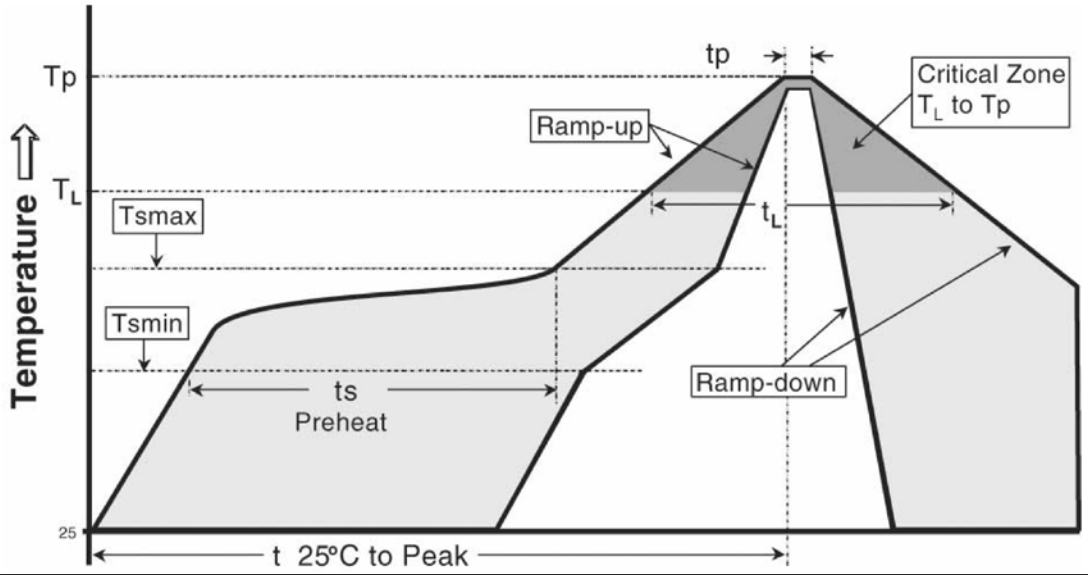
10 PCS per TUBE

Soldering and Reflow Considerations

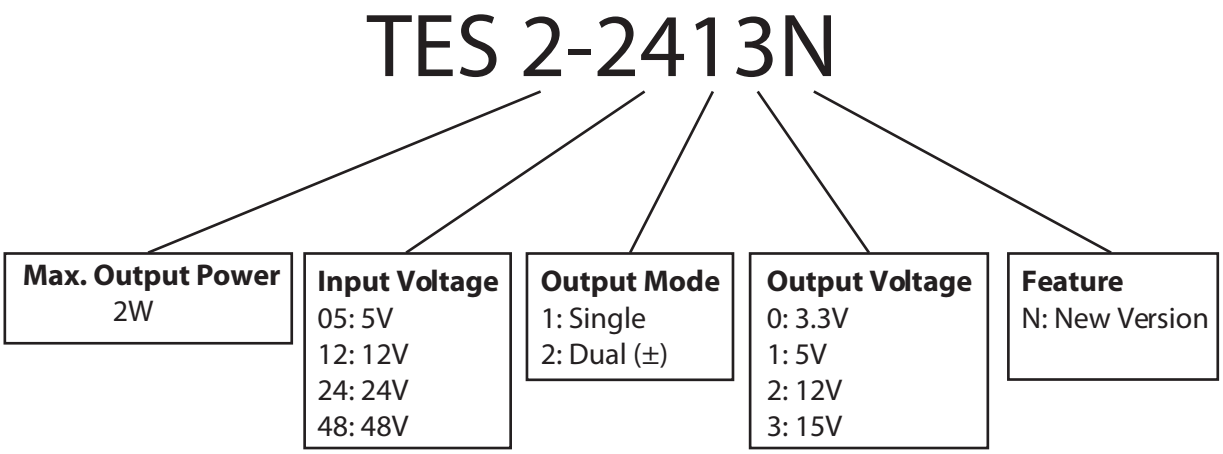
Lead free wave solder profile for TES 2N Series

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 2-0510N	4.5-9	3.3	500	471	70
TES 2-0511N	4.5-9	5	400	548	73
TES 2-0512N	4.5-9	12	167	534	75
TES 2-0513N	4.5-9	15	134	582	73
TES 2-0521N	4.5-9	±5	±200	667	64
TES 2-0522N	4.5-9	±12	±83	615	69
TES 2-0523N	4.5-9	±15	±67	598	71
TES 2-1210N	9-18	3.3	500	184	73
TES 2-1211N	9-18	5	400	217	77
TES 2-1212N	9-18	12	167	209	80
TES 2-1213N	9-18	15	134	220	80
TES 2-1221N	9-18	±5	±200	242	73
TES 2-1222N	9-18	±12	±83	224	78
TES 2-1223N	9-18	±15	±67	226	78
TES 2-2410N	18-36	3.3	500	96	72
TES 2-2411N	18-36	5	400	109	77
TES 2-2412N	18-36	12	167	109	80
TES 2-2413N	18-36	15	134	108	81
TES 2-2421N	18-36	±5	±200	119	74
TES 2-2422N	18-36	±12	±83	112	78
TES 2-2423N	18-36	±15	±67	110	80
TES 2-4810N	36-75	3.3	500	49	71
TES 2-4811N	36-75	5	400	57	73
TES 2-4812N	36-75	12	167	53	79
TES 2-4813N	36-75	15	134	55	79
TES 2-4821N	36-75	±5	±200	62	71
TES 2-4822N	36-75	±12	±83	57	77
TES 2-4823N	36-75	±15	±67	57	77

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 1A, in 12Vin with maximum rating of 500mA, in 24Vin with maximum rating of 250mA and in 48Vin with maximum rating of 120mA. 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 2N series of DC/DC converters has been calculated using MIL-HDBK 217F NOTICE2, Operating Temperature 25°C, Ground Benign.

Model	MTBF	Unit
TES 2-0510N	1,360,729	Hours
TES 2-0511N	1,699,813	
TES 2-0512N	1,389,082	
TES 2-0513N	1,389,082	
TES 2-0521N	1,340,123	
TES 2-0522N	1,366,867	
TES 2-0523N	1,366,867	
TES 2-1210N	1,370,238	
TES 2-1211N	1,370,238	
TES 2-1212N	1,403,115	
TES 2-1213N	1,403,115	
TES 2-1221N	1,353,363	
TES 2-1222N	1,380,643	
TES 2-1223N	1,380,643	
TES 2-2410N	1,365,934	
TES 2-2411N	1,365,934	
TES 2-2412N	1,407,856	
TES 2-2413N	1,407,856	
TES 2-2421N	1,347,709	
TES 2-2422N	1,374,759	
TES 2-2423N	1,374,759	
TES 2-4810N	1,367,428	
TES 2-4811N	1,367,428	
TES 2-4812N	1,394,895	
TES 2-4813N	1,394,895	
TES 2-4821N	1,331,381	
TES 2-4822N	1,357,773	
TES 2-4823N	1,357,773	

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