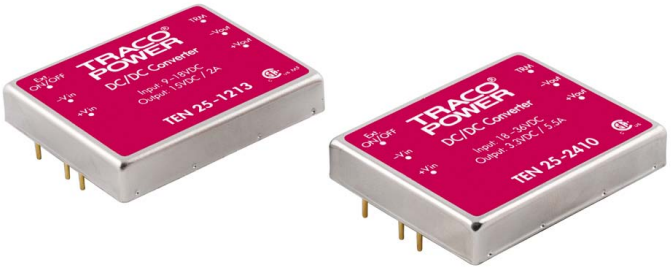
TEN 25 Series

Application Note

30W, Wide Input Range, Single & Dual Output DC/DC Converters

Features

- ►2”x 1.6”x 0.37” Metal Package
- ►Wide 2:1 Input Range
- ►Operating Temp. Range –40°C to +80°C
- ►Short Circuit Protection
- ►I/O-isolation 1500 VDC
- ►Input Filter meets EN 55022,class A and FCC, level A
- ►3 Years Product Warranty



Applications

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

General Description

The TRACOPOWER TEN 25 series is a range of isolated 30W DC/DC converter modules featuring fully regulated output voltages and wide 2:1 input voltage ranges. The product comes in a 2”x 1.6”x 0.37” metal package with industry standard pinout. An excellent efficiency allows an operating temperature range of –40° to +80°C (with derating). Typical applications for these converters are battery operated equipment and instrumentation, distributed power systems, data communication and general industrial electronics.

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Absolute Maximum Rating				
Parameter	**Model**	**Min**	**Max**	**Unit**
Input Voltage Input Surge Voltage (1 sec.)	12VDC Input Models 24VDC Input Models 48VDC Input Models	-0.7 -0.7 -0.7	25 50 100	VDC
Operating Ambient Temperature Without Derating With Derating	All	-40 -40	+50 +80	℃
Operating Case Temperature	All	---	+100	℃
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 ℃)	TEN 25-xx10 TEN 25-xx11 TEN 25-xx12 TEN 25-xx13 TEN 25-xx22 TEN 25-xx23	3.267 4.95 11.88 14.85 ±11.88 ±14.85	3.3 5 12 15 ±12 ±15	3.333 5.05 12.12 15.15 ±12.12 ±15.15	VDC
Output Regulation Line ($V_{in\ min}$ to $V_{in\ max}$ at Full Load)		---	±0.1	±0.3	%
Output Regulation Load (10% to 100% of Full Load)		---	±0.1	±0.5	%
Output Ripple & Noise Peak-to-Peak (5Hz to 20MHz bandwidth)		---	55	80	mV pk-pk
Temperature Coefficient	All	---	±0.01	±0.02	%/℃
Dynamic Load Response (V_{in} = $V_{in\ nom}$; T_A = 25℃ Load step change form 25% Load Step Change Peak Deviation Setting Time	All	 --- ---	 ±2%Vo 150	 ±4%Vo 300	 mV µsec
Output Current	TEN 25-xx10 TEN 25-xx11 TEN 25-xx12 TEN 25-xx13 TEN 25-xx22 TEN 25-xx23	400 350 166 133 ±83 ±65	--- --- --- --- --- ---	5500 5000 2500 2000 ±1250 ±1100	mA
Output Over Current Protection	All	110	---	---	%FL
Output Short Circuit Protection	All	Continuous			

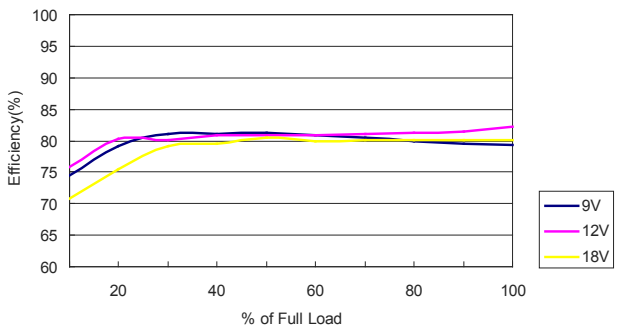
Input Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Operating Input Voltage	12V Input Models	9	12	18	VDC
	24V Input Models	18	24	36	
	48V Input Models	36	48	75	
Under Voltage Lockout Turn-on Threshold	12V Input Models	8.6	8.8	9	VDC
	24V Input Models	17	17.5	18	
	48V Input Models	34	35	36	
Under Voltage Lockout Turn-off Threshold	12V Input Models	8.1	8.3	8.5	VDC
	24V Input Models	16	16.5	17	
	48V Input Models	32	33	34	
Input Reflected Ripple Current (0 to 500KHz, 4.7µH source impedance)	12V Input Models	---	100	---	mA pk-pk
	24V Input Models	---	50	---	
	48V Input Models	---	25	---	
Input Current (Maximum value at V_{in}= $V_{in\ nom}$; Full Load)	TEN 25-1210	---	1867	---	mA
	TEN 25-1211	---	2480	---	
	TEN 25-1212	---	2841	---	
	TEN 25-1213	---	2841	---	
	TEN 25-1222	---	2841	---	
	TEN 25-1223	---	2841	---	
	TEN 25-2410	---	922	---	
	TEN 25-2411	---	1225	---	
	TEN 25-2412	---	1404	---	
	TEN 25-2413	---	1404	---	
	TEN 25-2422	---	1404	---	
	TEN 25-1423	---	1404	---	
	TEN 25-4810	---	461	---	
	TEN 25-4811	---	613	---	
	TEN 25-4812	---	702	---	
	TEN 25-4813	---	702	---	
	TEN 25-4822	---	702	---	
	TEN 25-4823	---	702	---	
Input Standby Current (Typical value at V_{in} = $V_{in\ nom}$; No Load)	TEN 25-1210	---	40	---	mA
	TEN 25-1211				
	TEN 25-1212				
	TEN 25-1213				
	TEN 25-1222				
	TEN 25-1223				
	TEN 25-2410	---	20	---	
	TEN 25-2411				
	TEN 25-2412				
	TEN 25-2413				
	TEN 25-2422				
	TEN 25-1423				
	TEN 25-4810	---	10	---	
	TEN 25-4811				
	TEN 25-4812				
	TEN 25-4813				
	TEN 25-4822				
	TEN 25-4823				

Input Specification					
Remote ON/OFF Control					
(The On/Off pin voltage is referenced to-V_{in})					
Positive logic					
On/Off pin High Voltage (Remote ON)	All	3.5	---	12	VDC
On/Off pin Low Voltage (Remote OFF)		0	---	1.2	VDC
Remote Off Stand by Input Current		---	2.5	---	mA
Control Pin Input Current (Remote ON)		---	0.5	---	µA
Control Pin Input Current (Remote OFF)		---	-0.5	---	µA

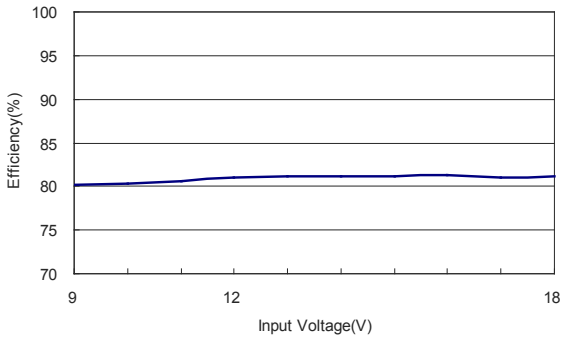
General Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Efficiency (V_{in} = $V_{in\ nom}$; Full Load; T_A = 25 °C)	TEN 25-1210	---	81	---	%
	TEN 25-1211	---	84	---	
	TEN 25-1212	---	88	---	
	TEN 25-1213	---	88	---	
	TEN 25-1222	---	88	---	
	TEN 25-1223	---	88	---	
	TEN 25-2410	---	82	---	
	TEN 25-2411	---	85	---	
	TEN 25-2412	---	89	---	
	TEN 25-2413	---	89	---	
	TEN 25-2422	---	89	---	
	TEN 25-1423	---	89	---	
	TEN 25-4810	---	82	---	
	TEN 25-4811	---	85	---	
	TEN 25-4812	---	89	---	
	TEN 25-4813	---	89	---	
	TEN 25-4822	---	89	---	
	TEN 25-4823	---	89	---	
Isolation Voltage					
Input to Output (for 60 seconds)		1500	---	---	VDC
Isolation Resistance	All	1000	---	---	MΩ
Isolation Capacitance		---	1200	1500	pF
Switching Frequency		290	330	360	KHz
MTBF					
MIL-STD-217F, TC=25°C		500,000	---	---	Hours

Characteristic Curves

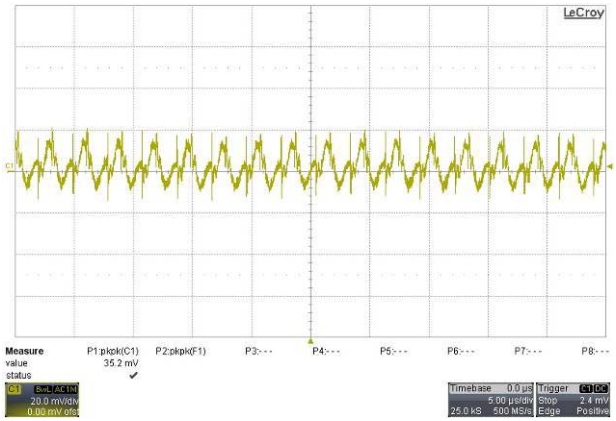
All test conditions are at 25°C The figures are identical for TEN 25-1210



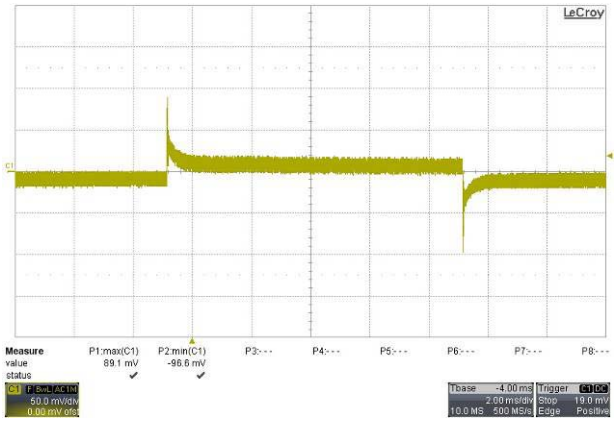
Efficiency Versus Output Current



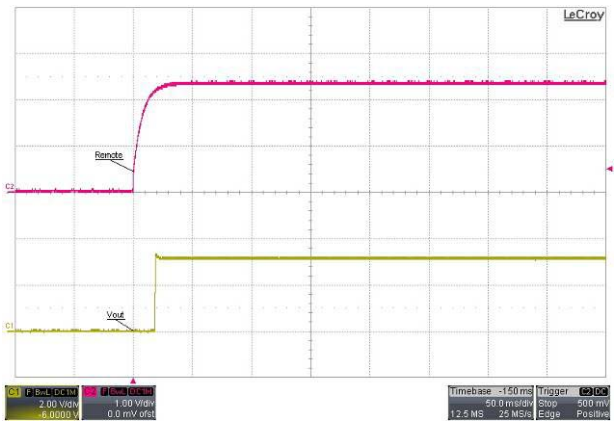
Efficiency Versus Input Voltage Full Load



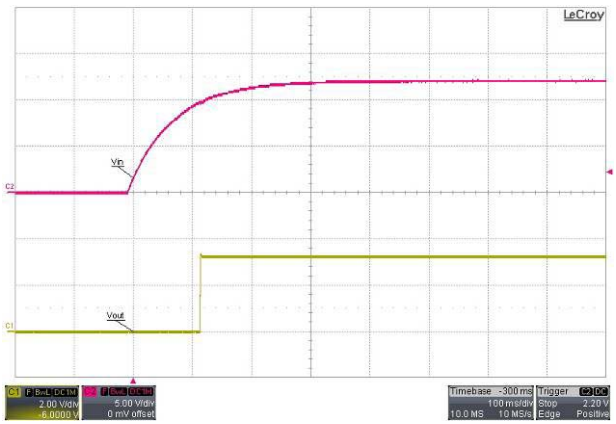
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A



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



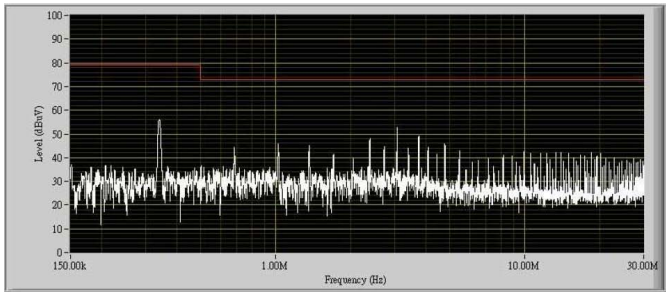
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



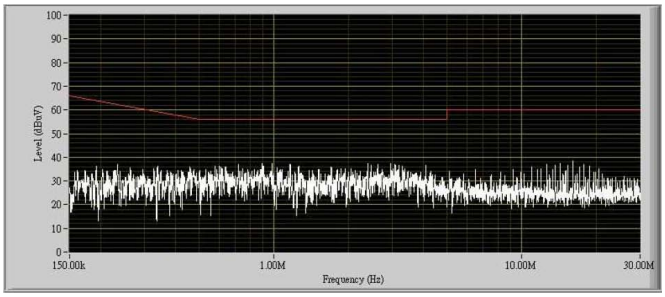
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

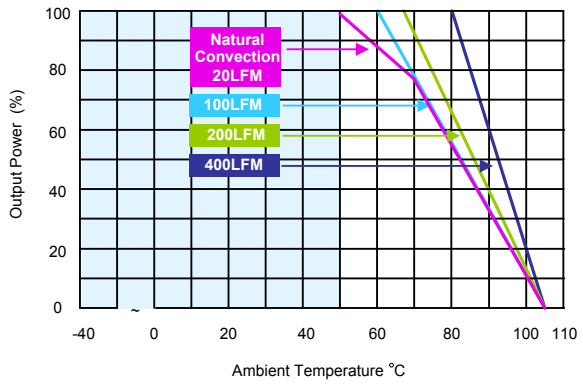
All test conditions are at 25°C The figures are identical for TEN 25-1210 (Continued)



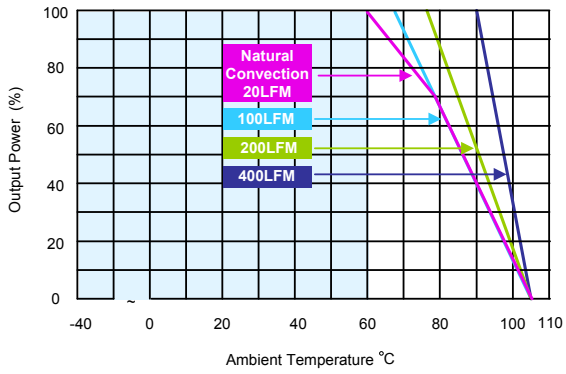
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



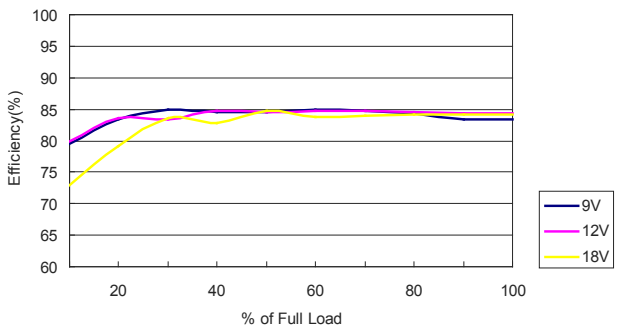
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



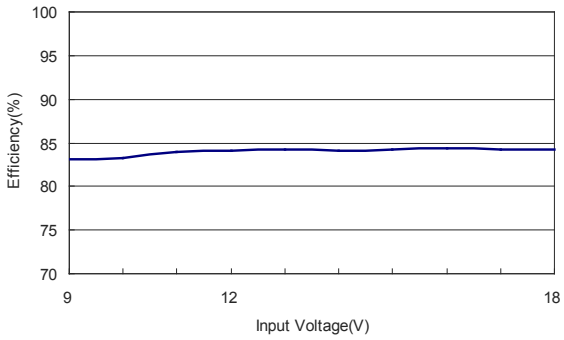
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

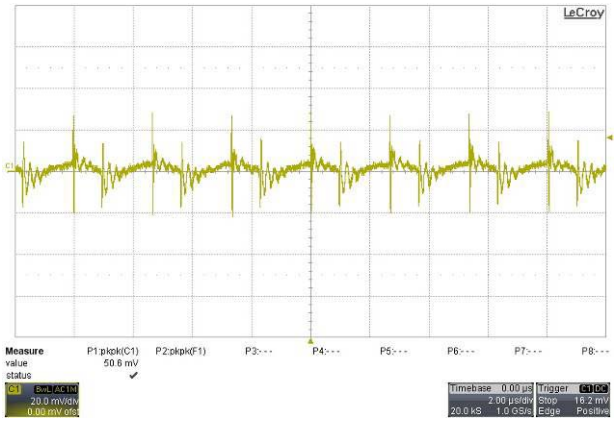
All test conditions are at 25°C The figures are identical for TEN 25-1211



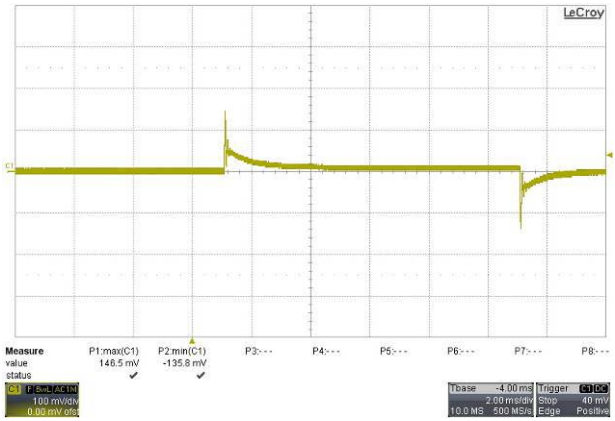
Efficiency Versus Output Current



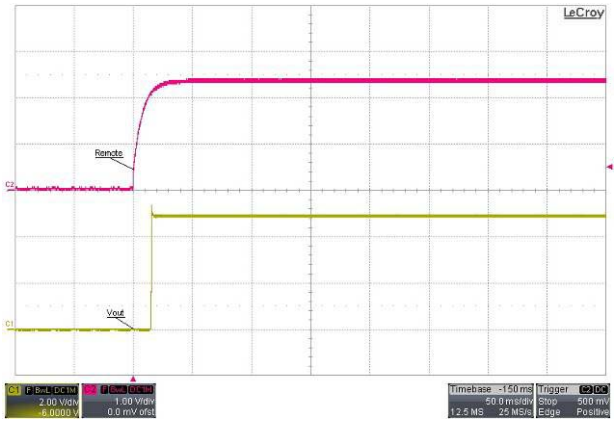
Efficiency Versus Input Voltage Full Load



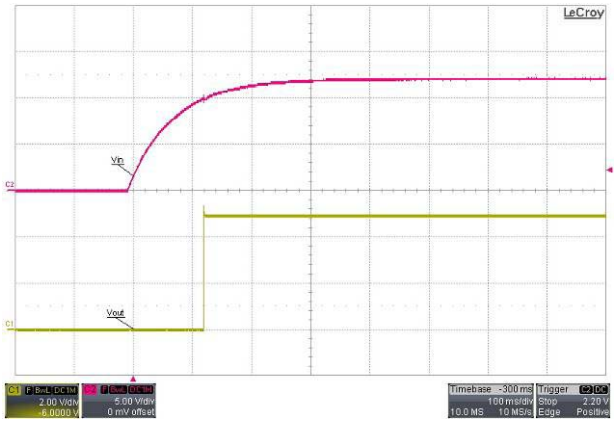
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load;



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



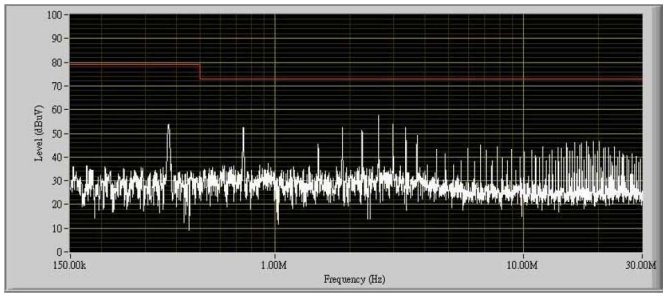
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



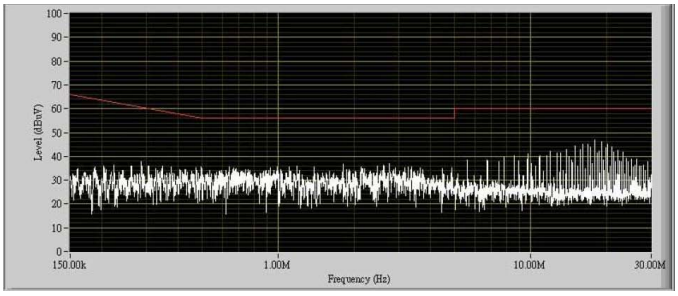
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

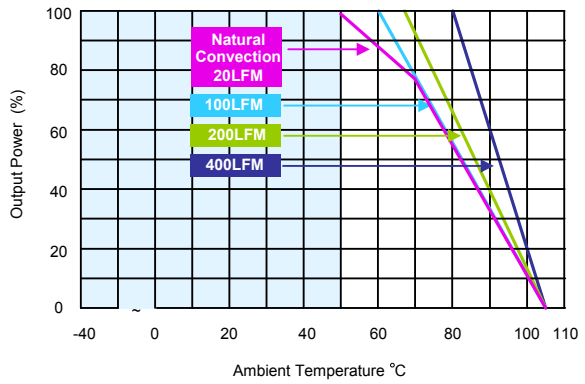
All test conditions are at 25°C The figures are identical for TEN 25-1211 (Continued)



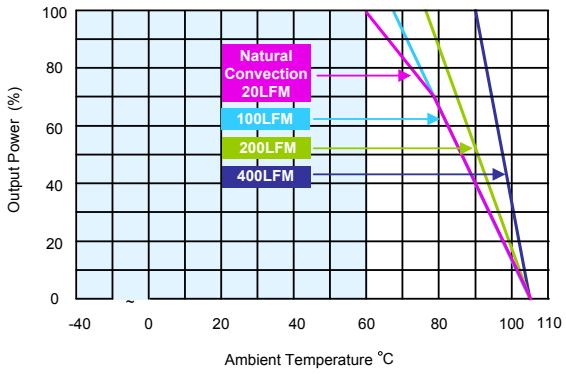
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



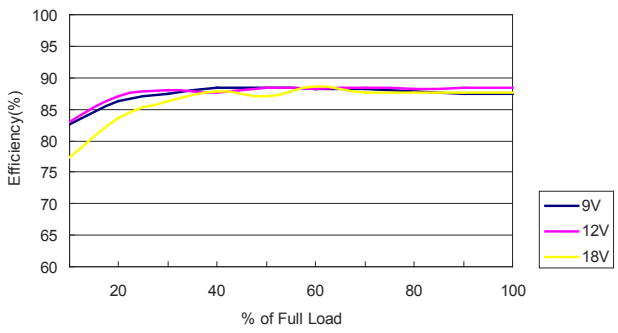
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



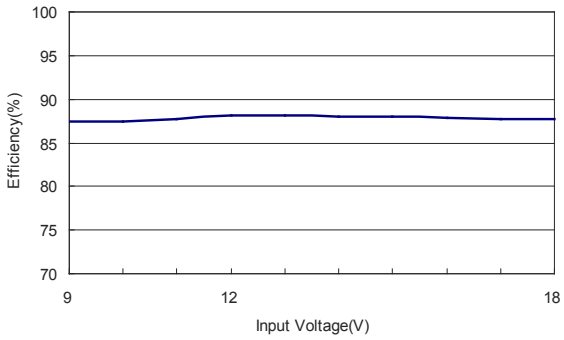
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

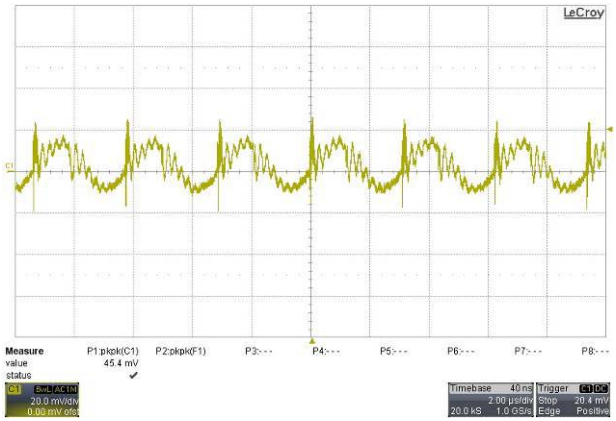
All test conditions are at 25°C The figures are identical for TEN 25-1212



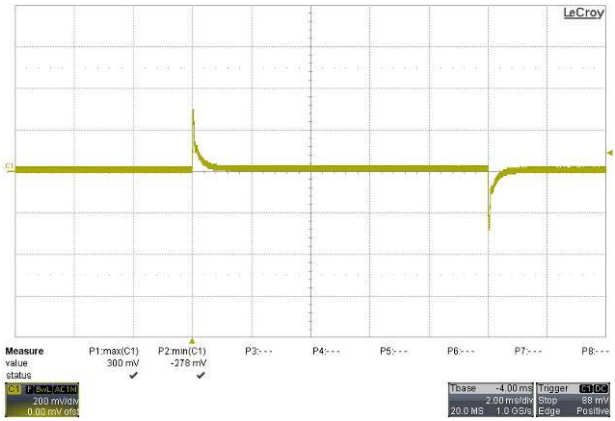
Efficiency Versus Output Current



Efficiency Versus Input Voltage Full Load

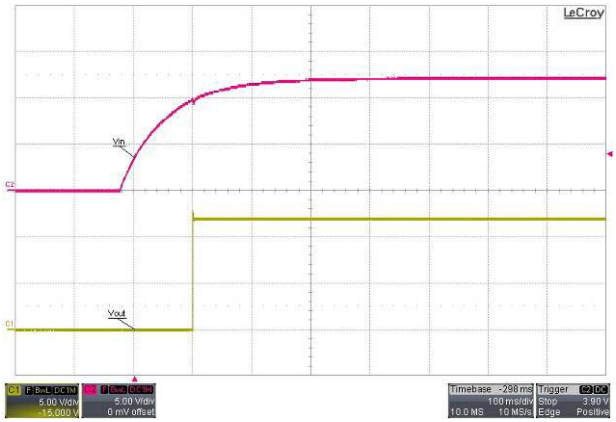


Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A



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

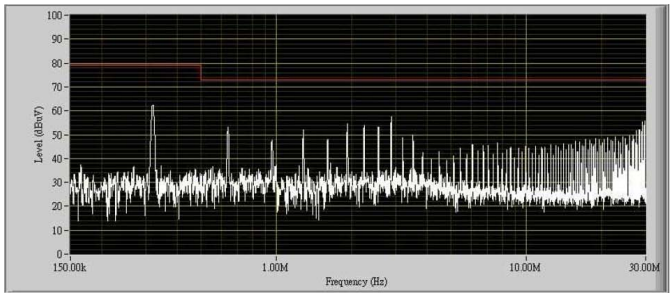
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



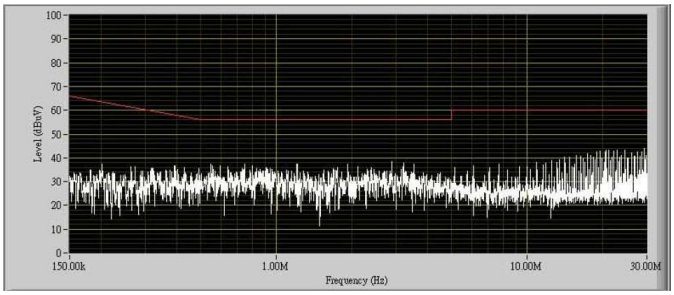
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

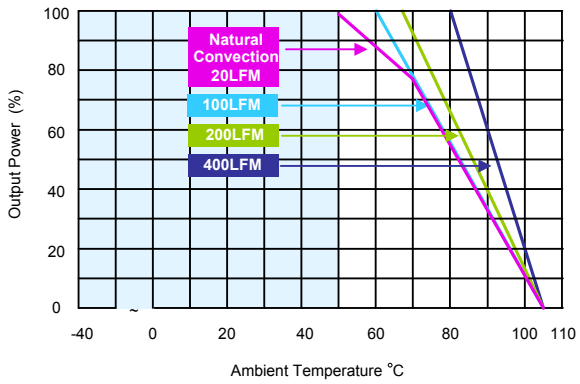
All test conditions are at 25°C The figures are identical for TEN 25-1212 (Continued)



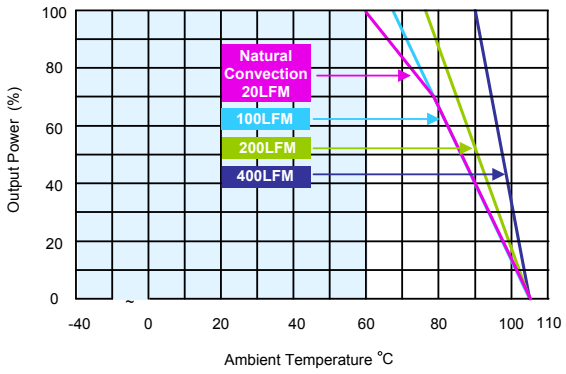
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



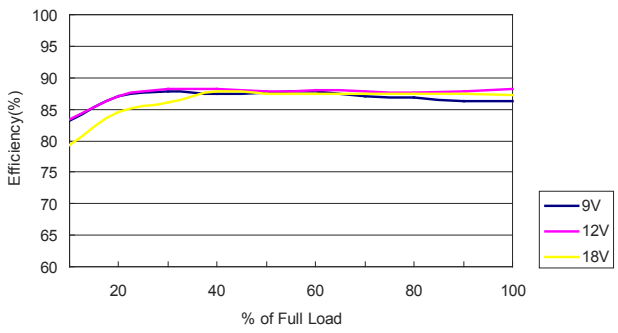
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



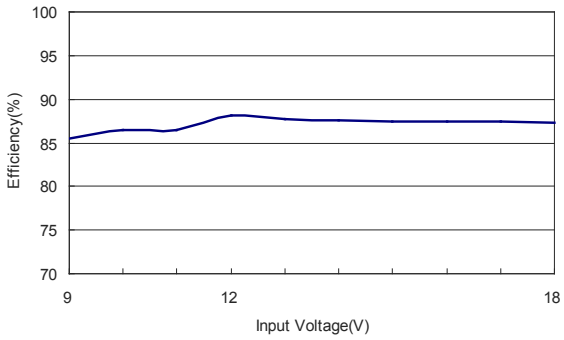
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

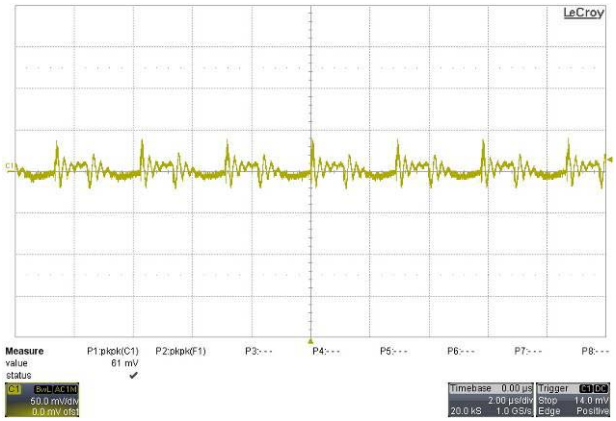
All test conditions are at 25°C The figures are identical for TEN 25-1213



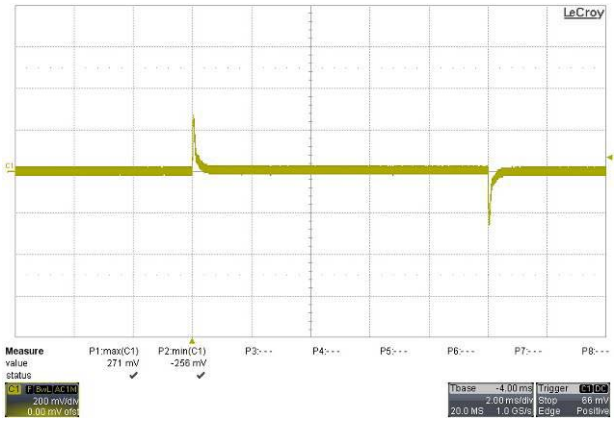
Efficiency Versus Output Current



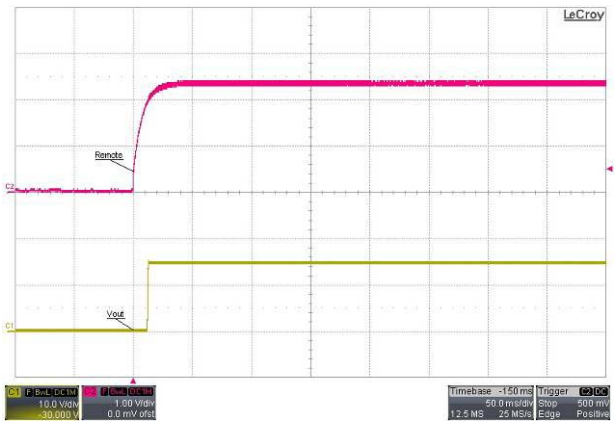
Efficiency Versus Input Voltage Full Load



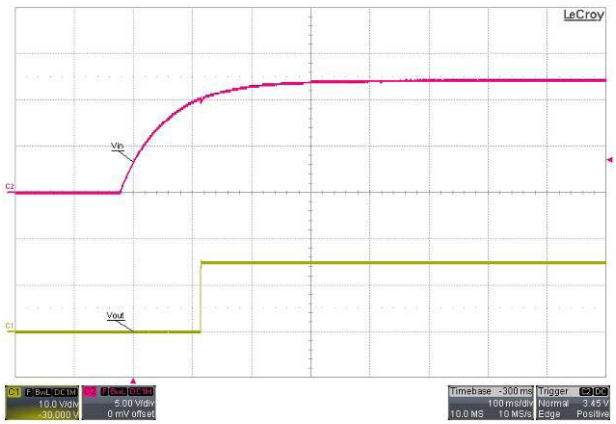
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A



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



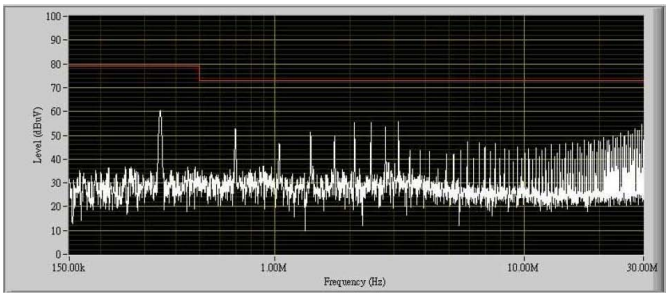
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



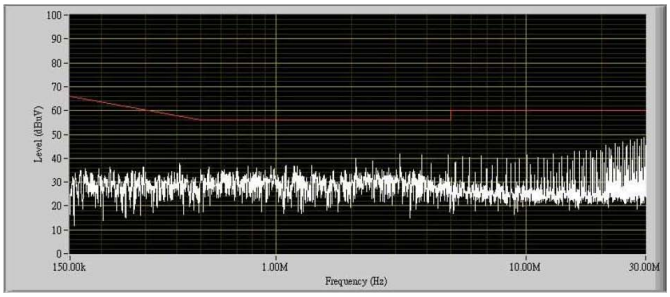
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

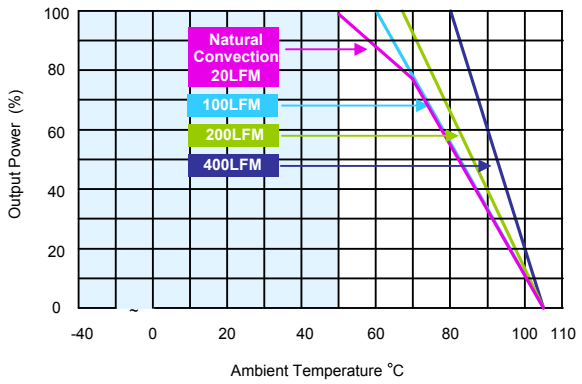
All test conditions are at 25°C The figures are identical for TEN 25-1213 (Continued)



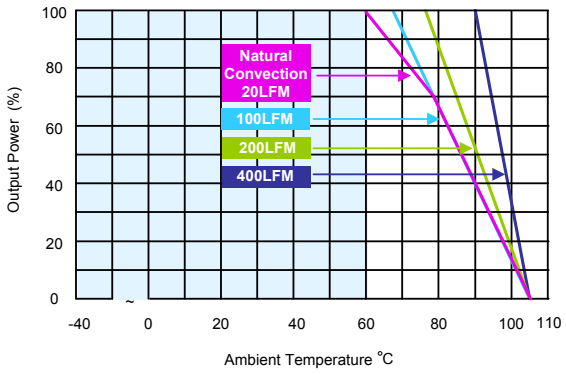
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



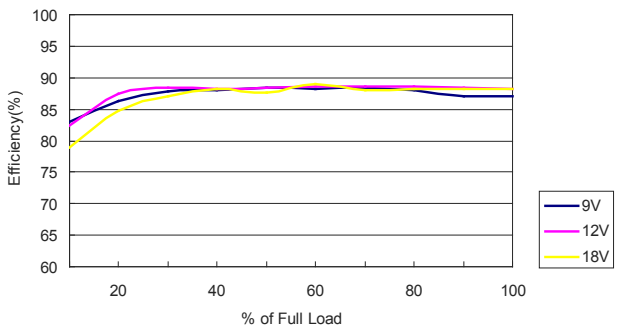
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



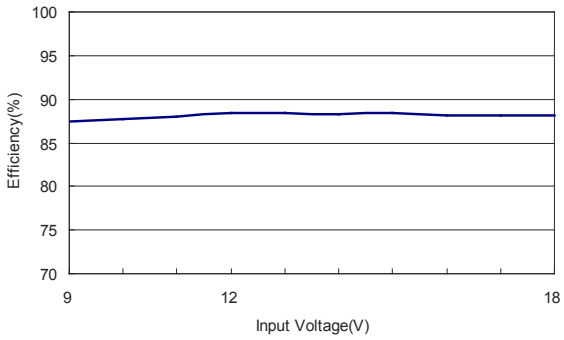
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

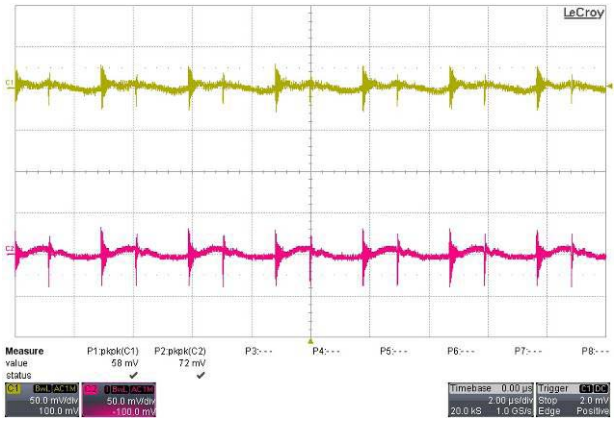
All test conditions are at 25°C The figures are identical for TEN 25-1222



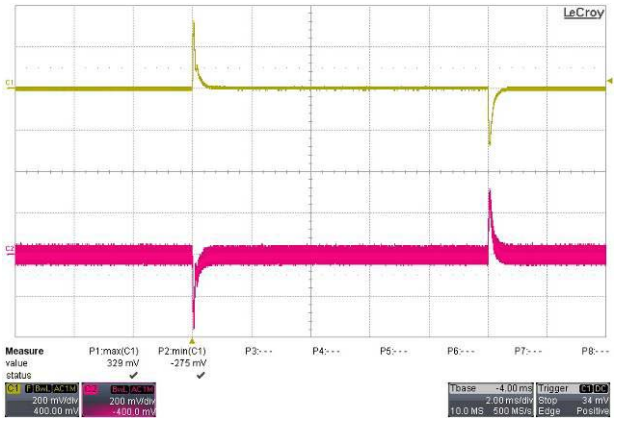
Efficiency Versus Output Current



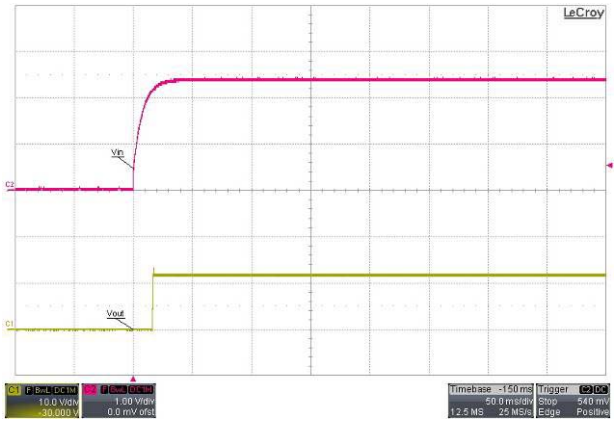
Efficiency Versus Input Voltage Full Load



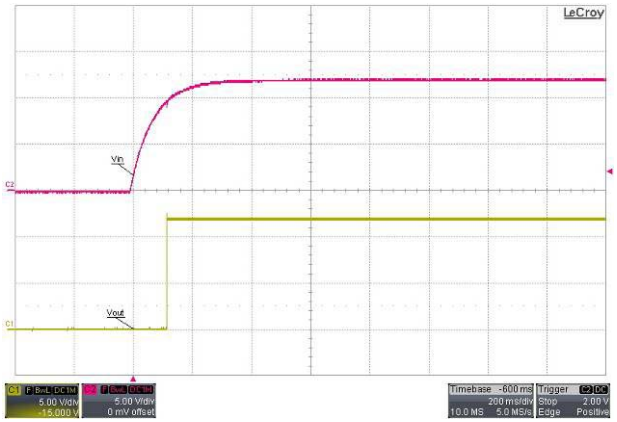
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A



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



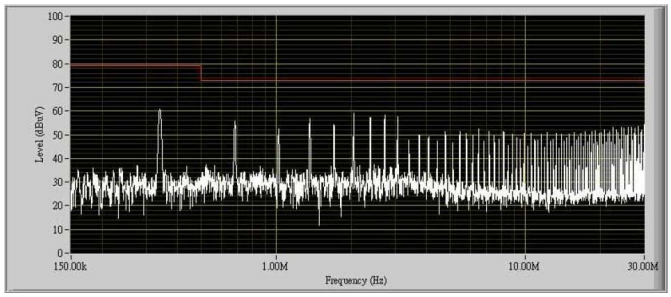
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



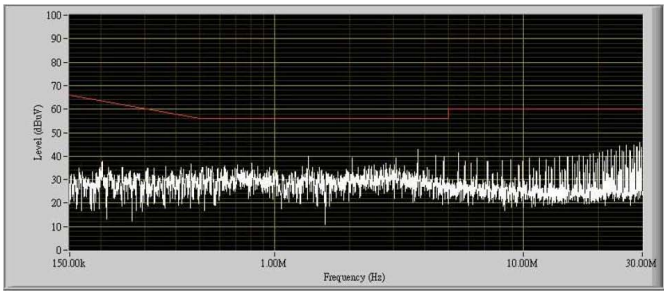
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

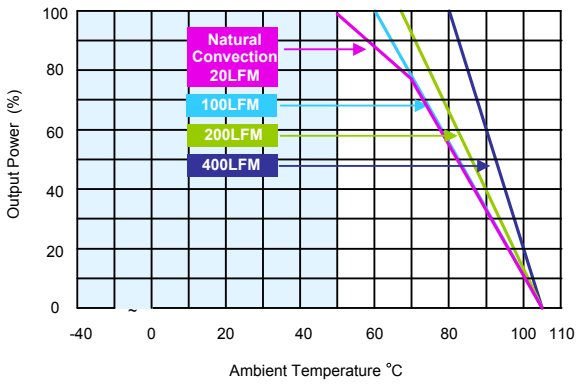
All test conditions are at 25°C The figures are identical for TEN 25-1222 (Continued)



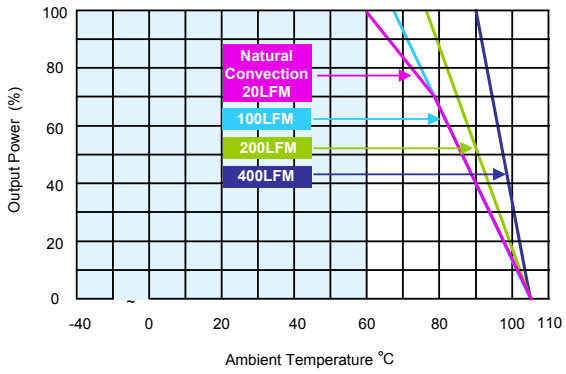
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



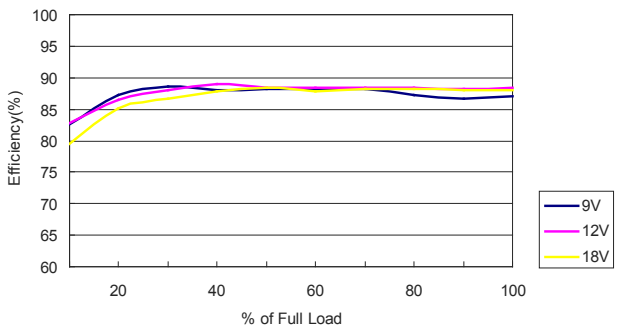
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



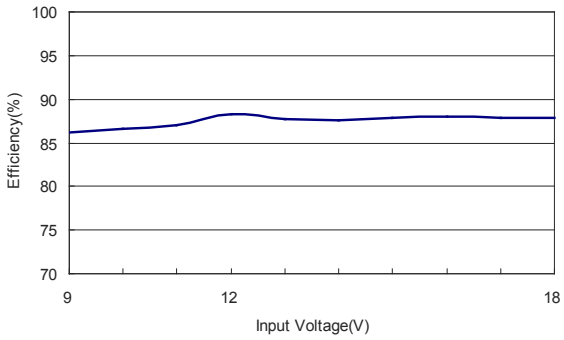
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

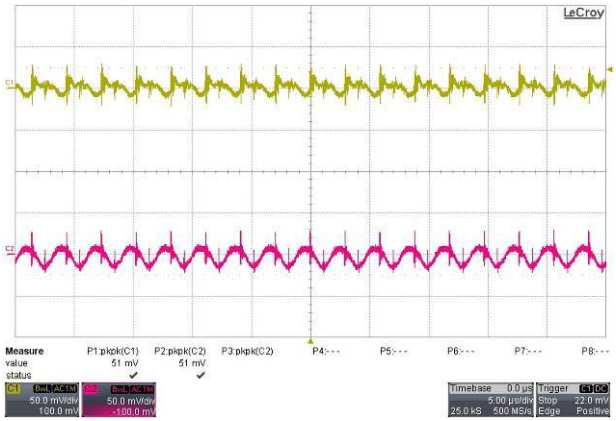
All test conditions are at 25°C The figures are identical for TEN 25-1223



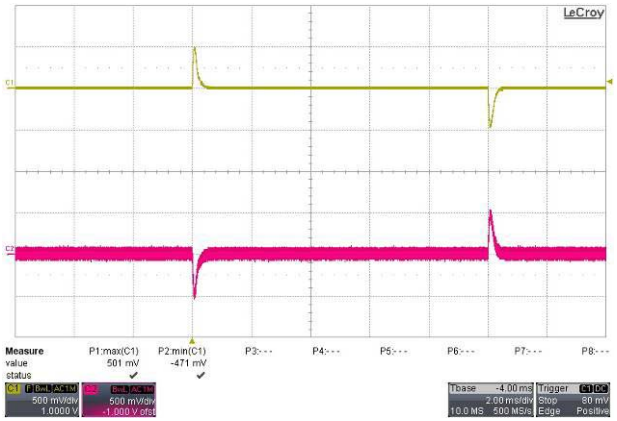
Efficiency Versus Output Current



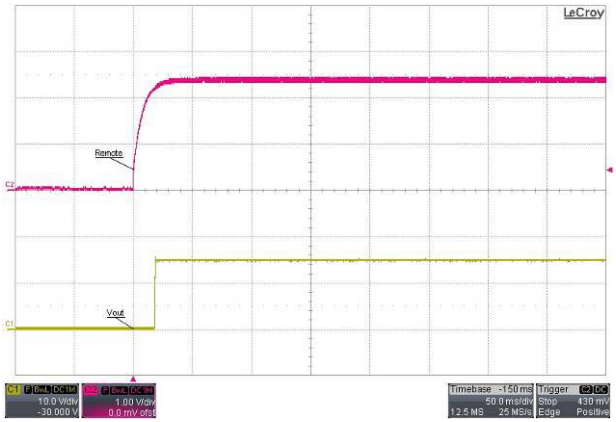
Efficiency Versus Input Voltage Full Load



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



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

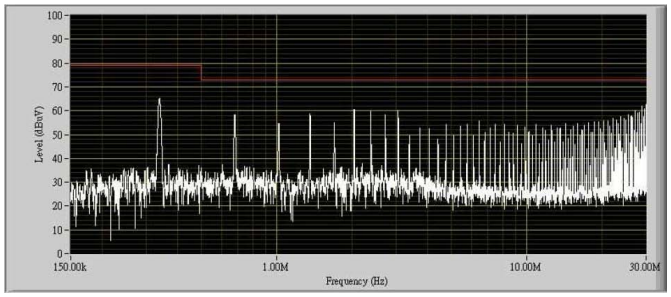


ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

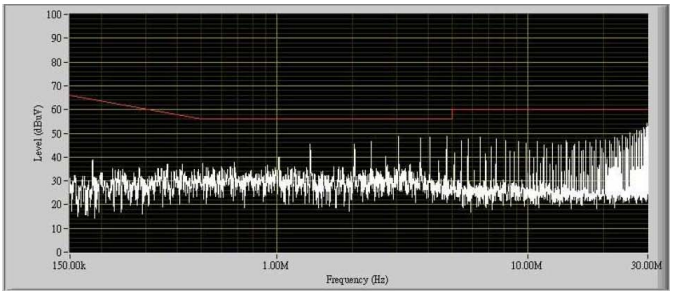
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

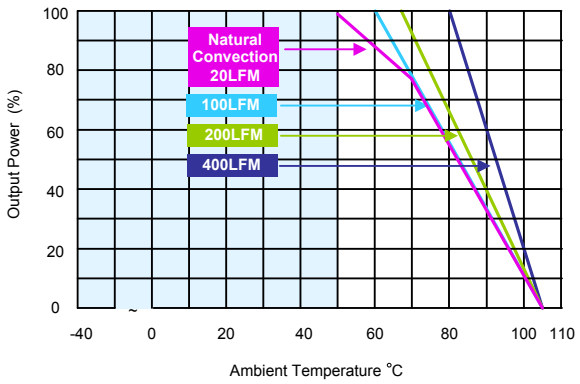
All test conditions are at 25°C The figures are identical for TEN 25-1223 (Continued)



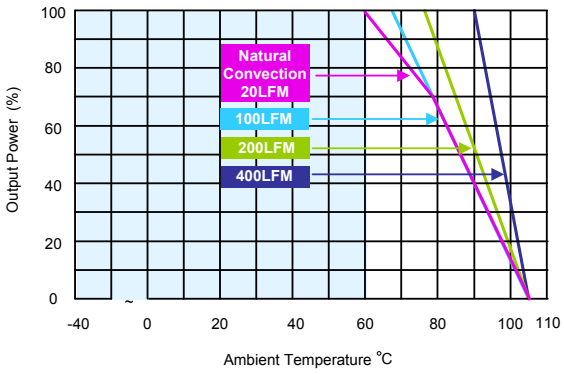
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



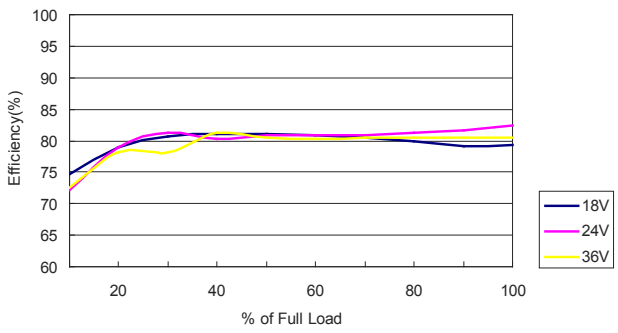
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



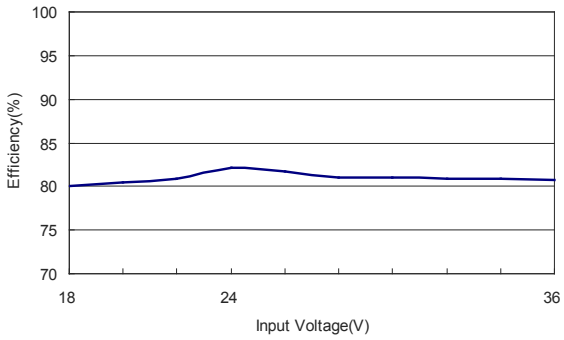
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

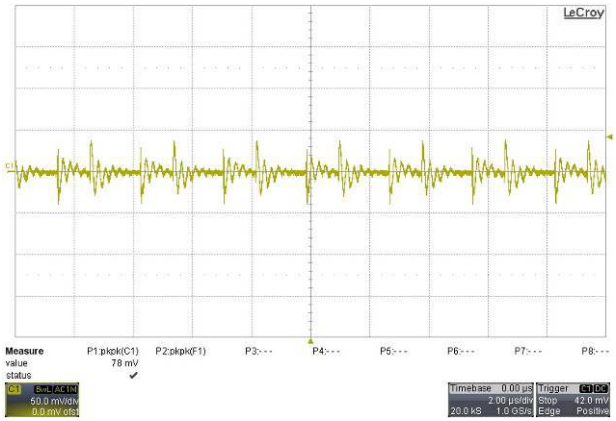
All test conditions are at 25°C The figures are identical for TEN 25-2410



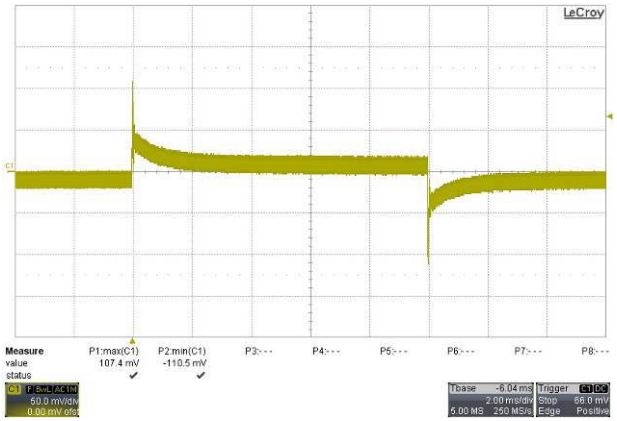
Efficiency Versus Output Current



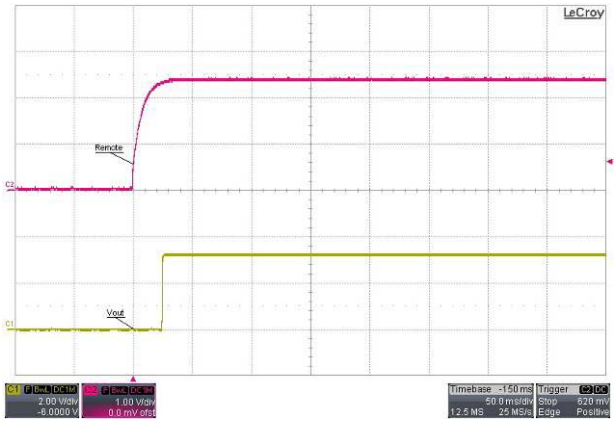
Efficiency Versus Input Voltage Full Load



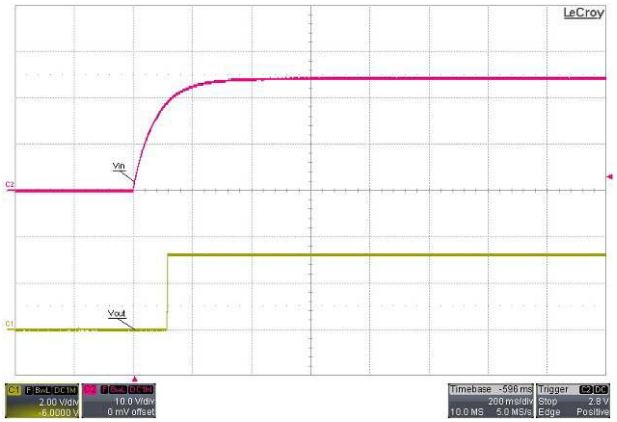
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A



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



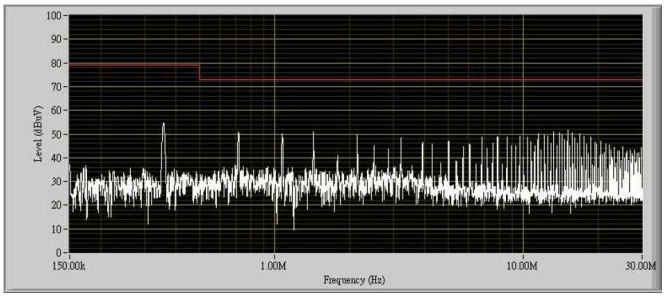
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



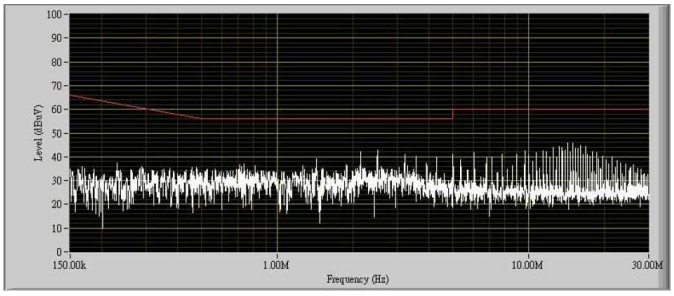
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

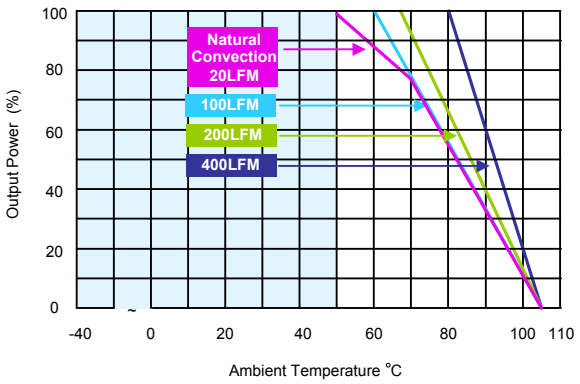
All test conditions are at 25°C The figures are identical for TEN 25-2410 (Continued)



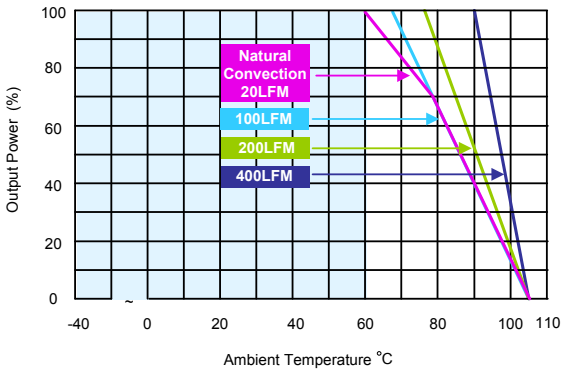
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



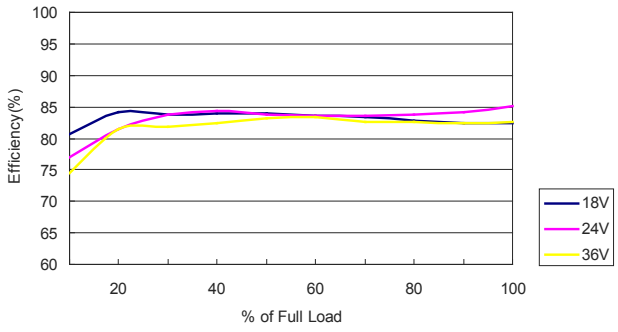
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



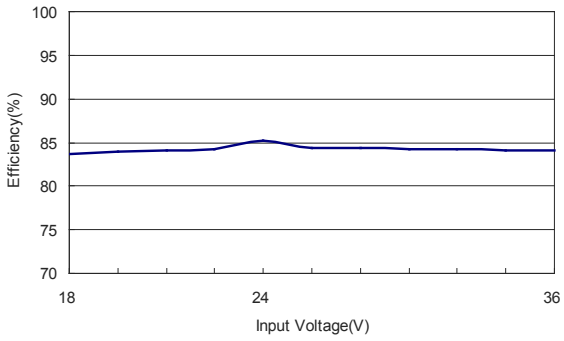
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

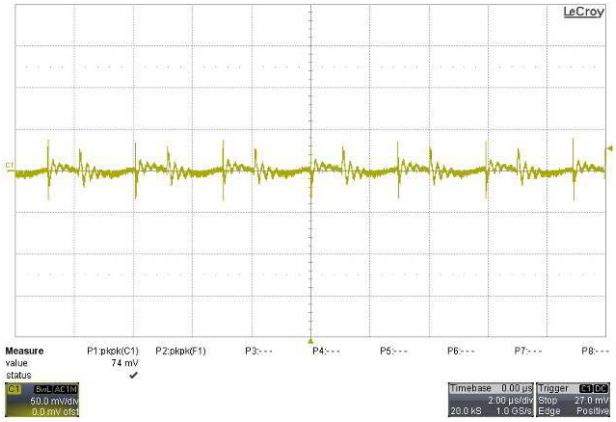
All test conditions are at 25°C The figures are identical for TEN 25-2411



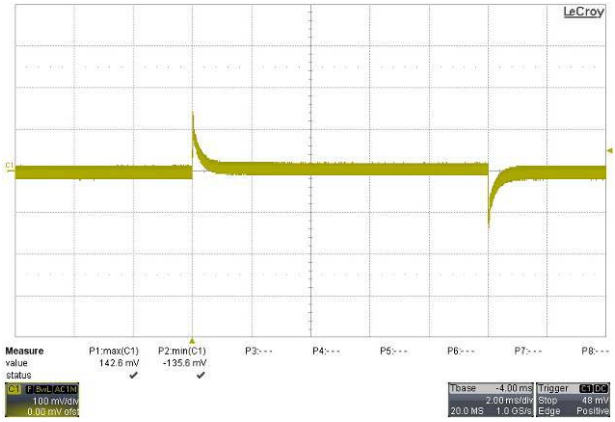
Efficiency Versus Output Current



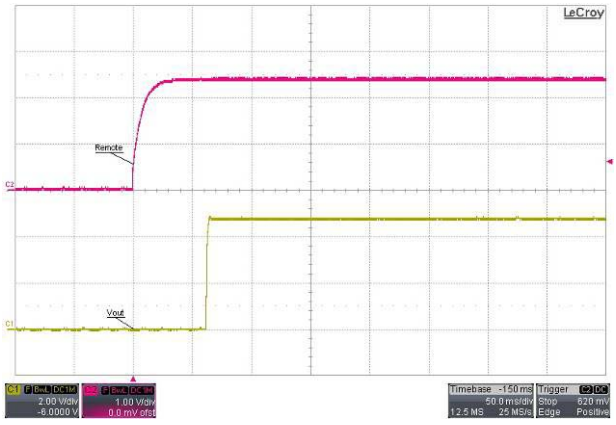
Efficiency Versus Input Voltage Full Load



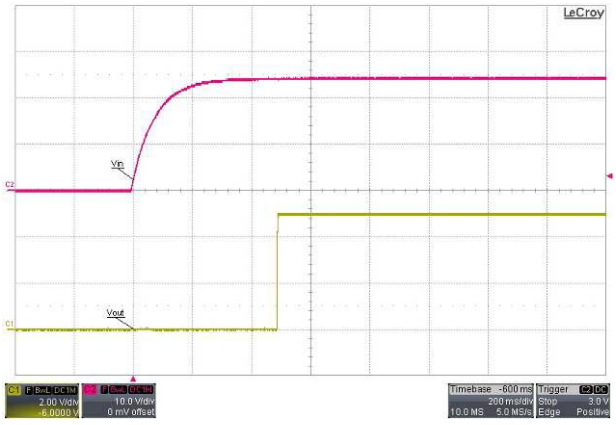
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



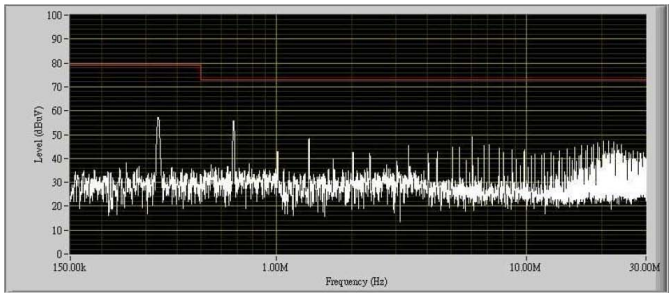
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



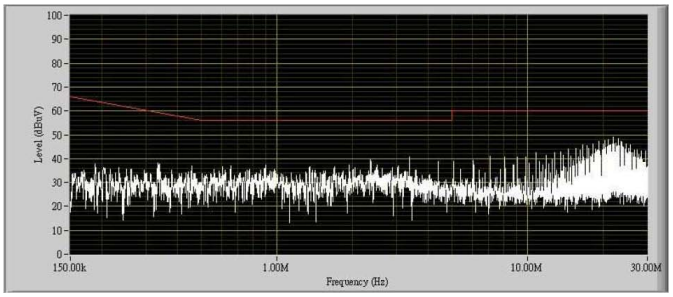
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

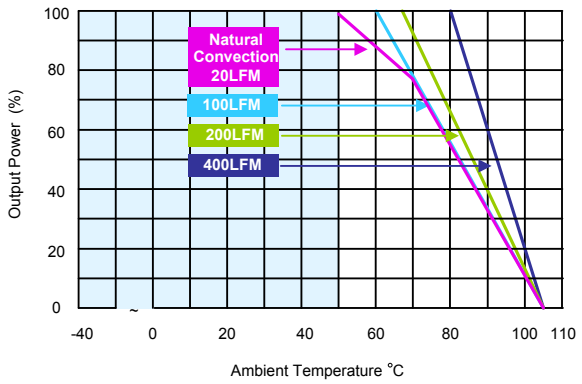
All test conditions are at 25°C The figures are identical for TEN 25-2411 (Continued)



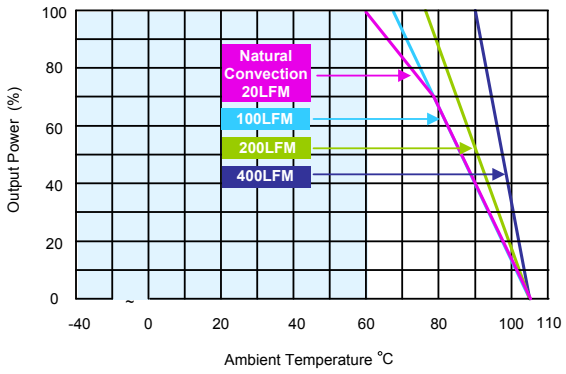
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



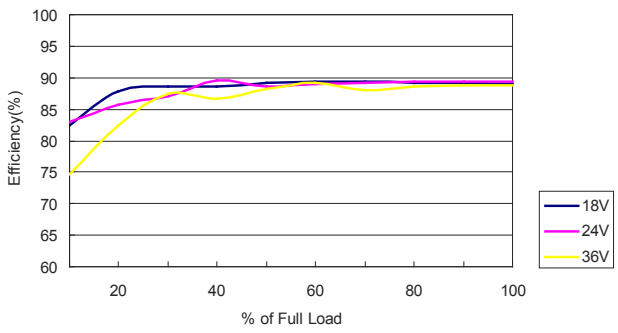
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



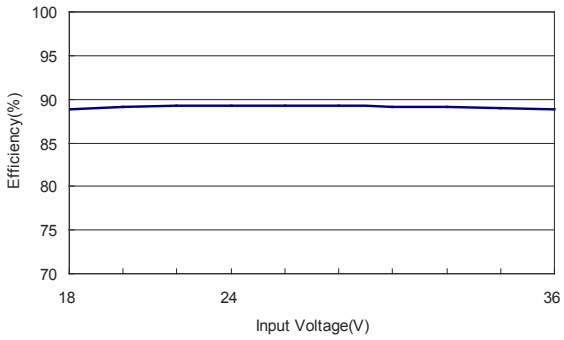
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

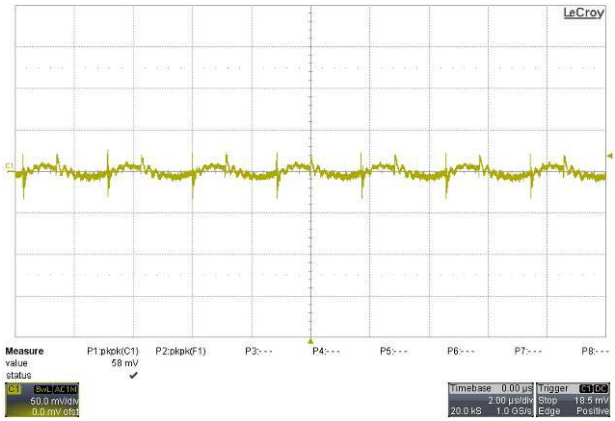
All test conditions are at 25°C The figures are identical for TEN 25-2412



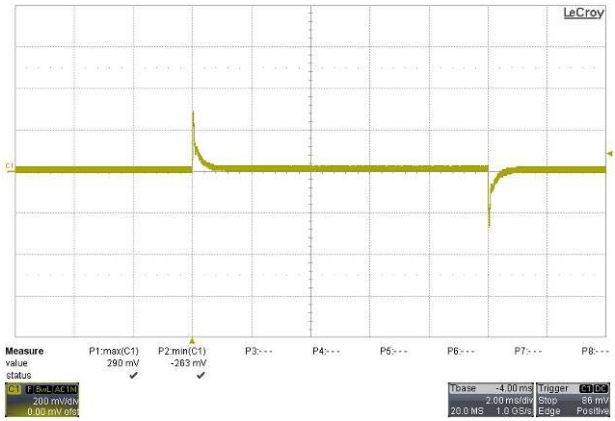
Efficiency Versus Output Current



Efficiency Versus Input Voltage Full Load

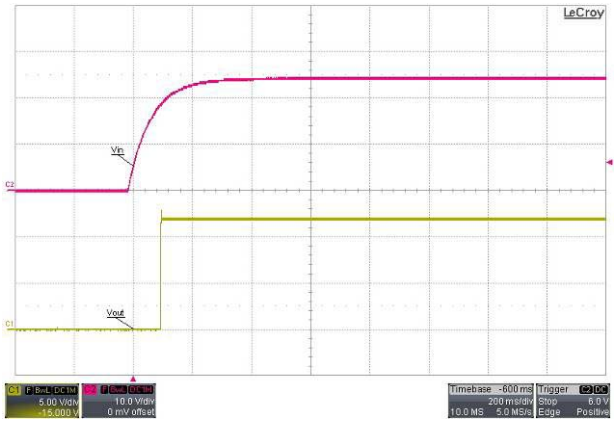


Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A



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

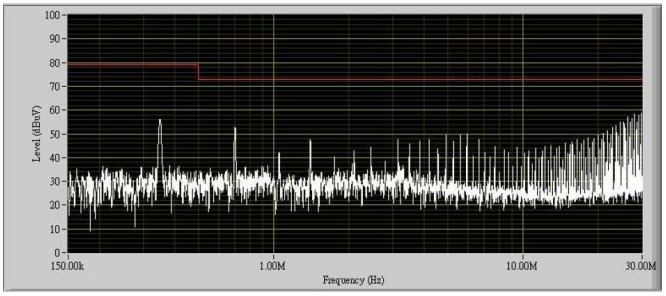
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



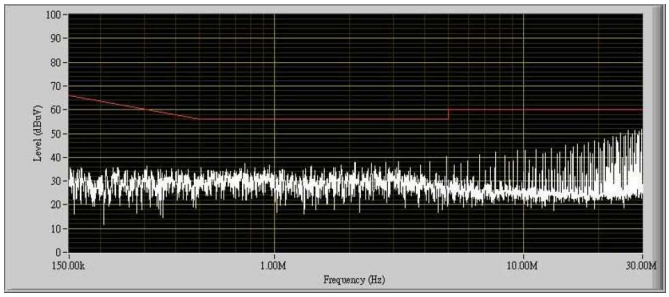
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

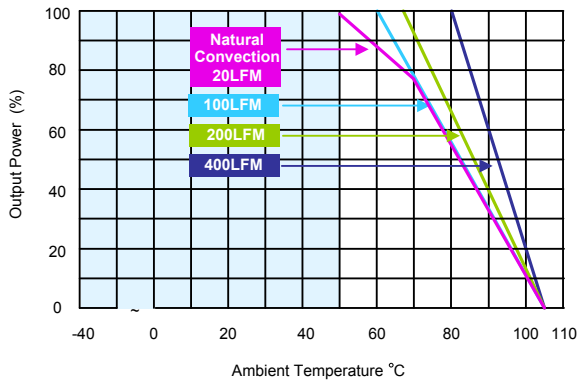
All test conditions are at 25°C The figures are identical for TEN 25-2412 (Continued)



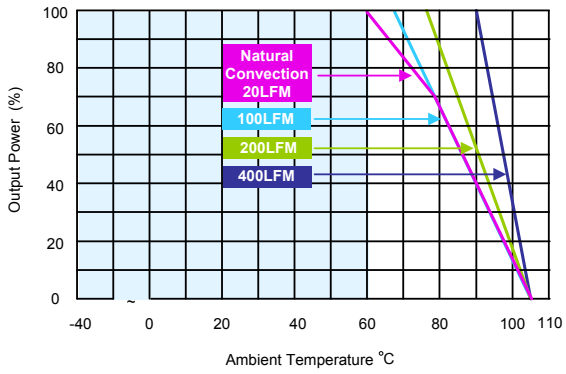
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



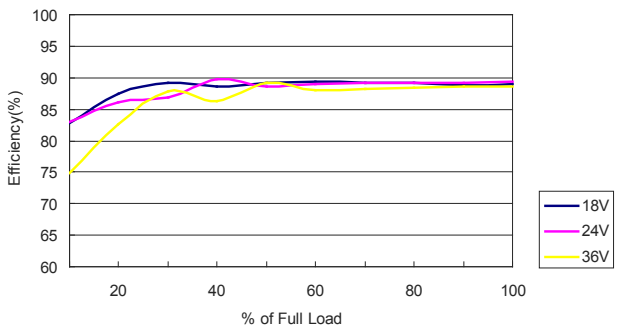
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



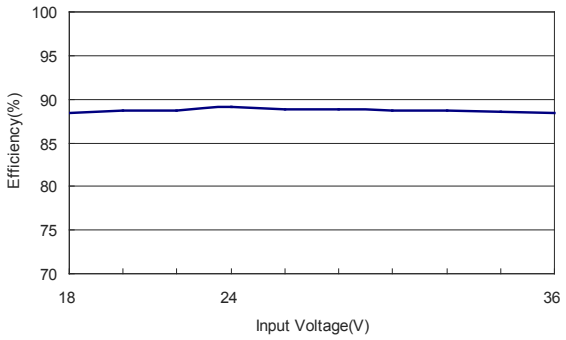
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

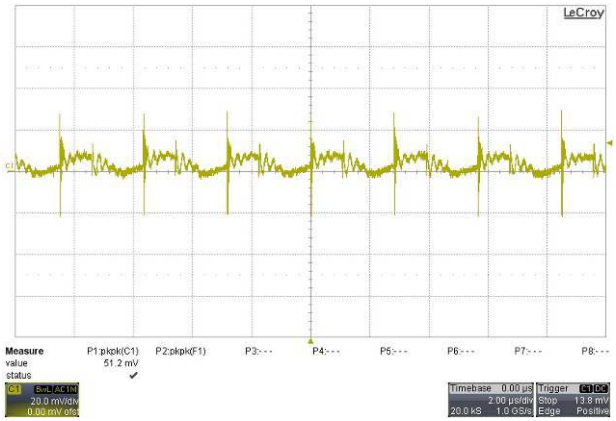
All test conditions are at 25°C The figures are identical for TEN 25-2413



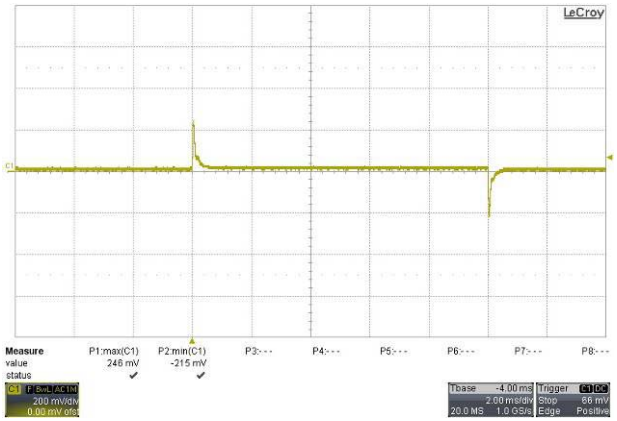
Efficiency Versus Output Current



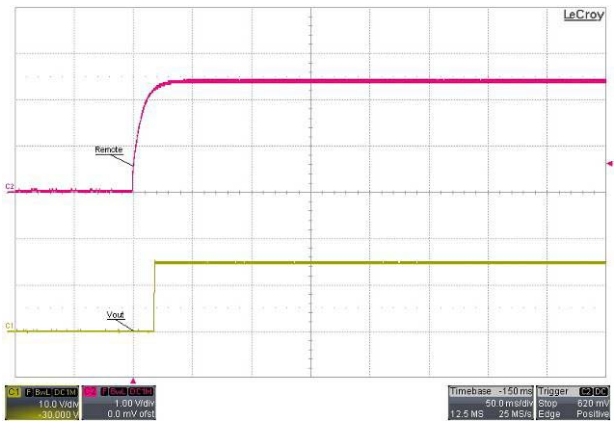
Efficiency Versus Input Voltage Full Load



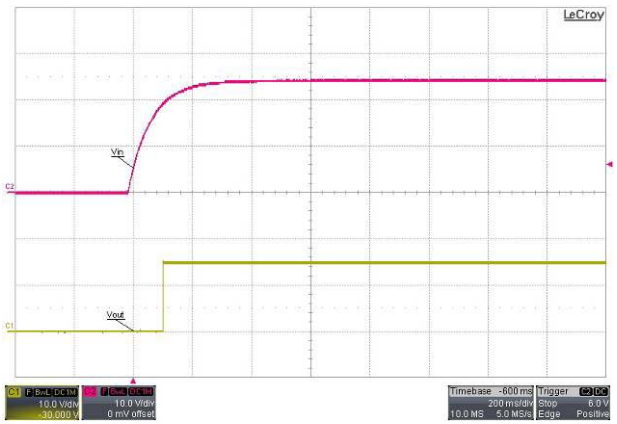
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A



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



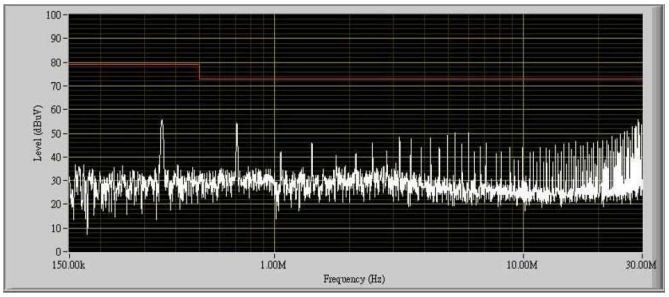
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



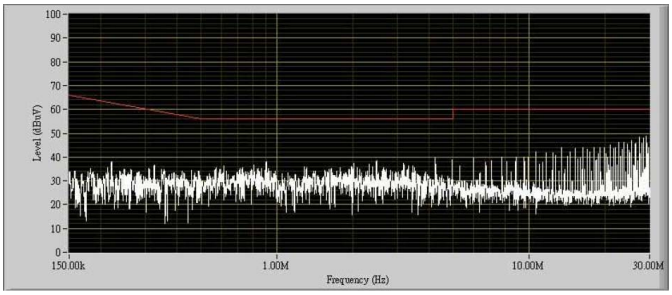
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

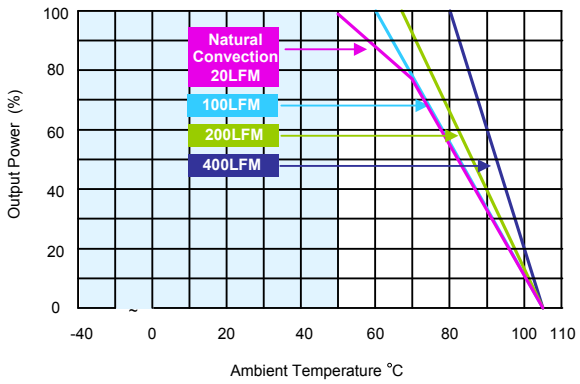
All test conditions are at 25°C The figures are identical for TEN 25-2413 (Continued)



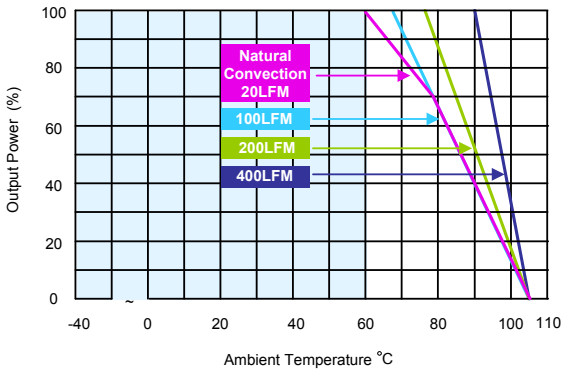
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



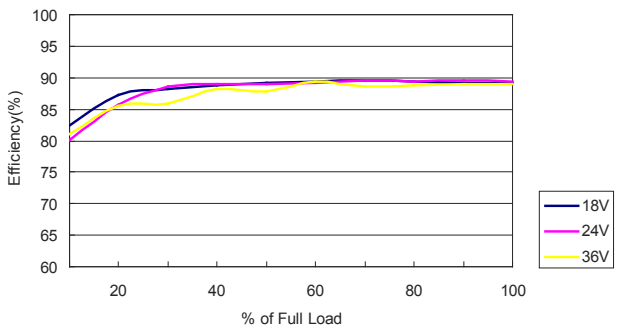
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



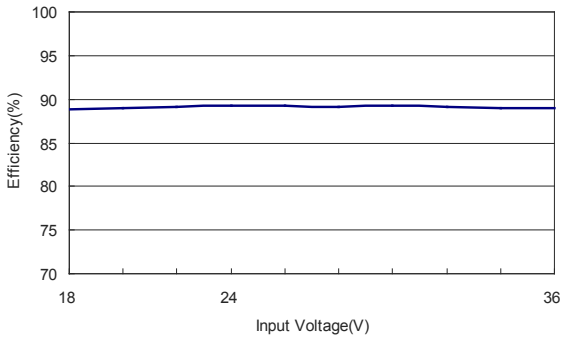
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

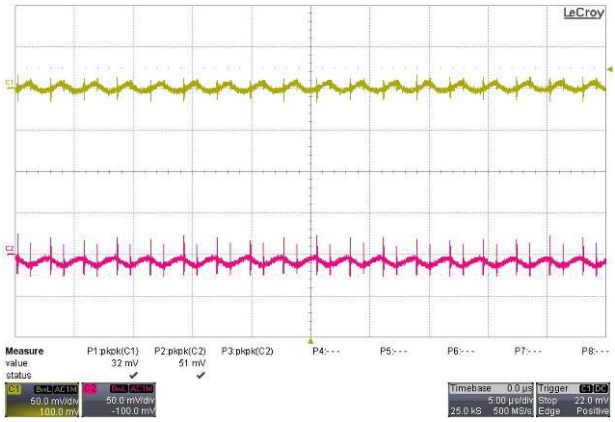
All test conditions are at 25°C The figures are identical for TEN 25-2422



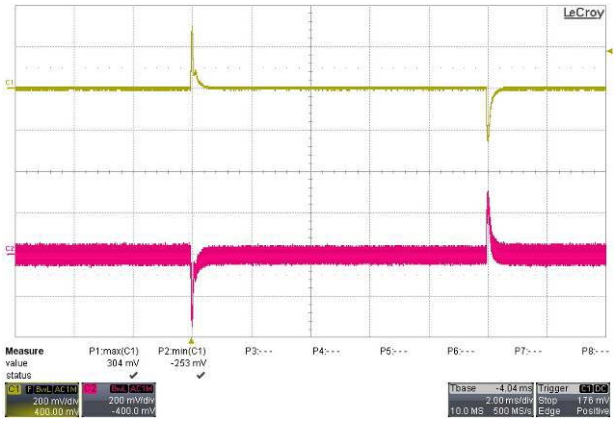
Efficiency Versus Output Current



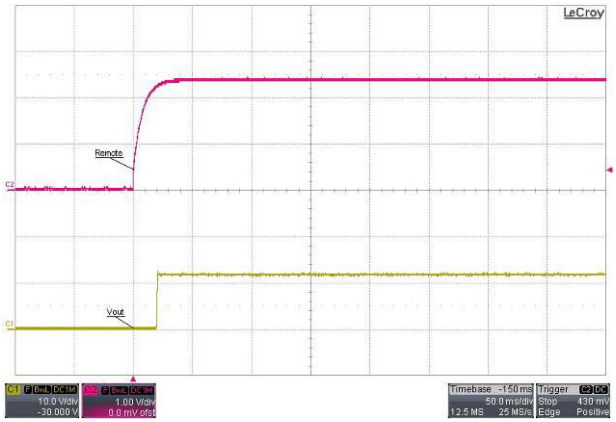
Efficiency Versus Input Voltage Full Load



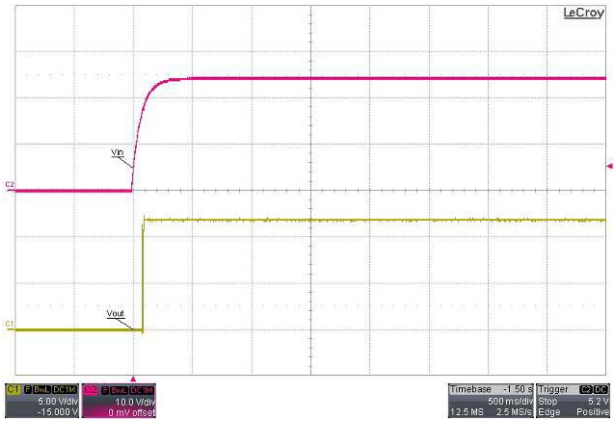
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



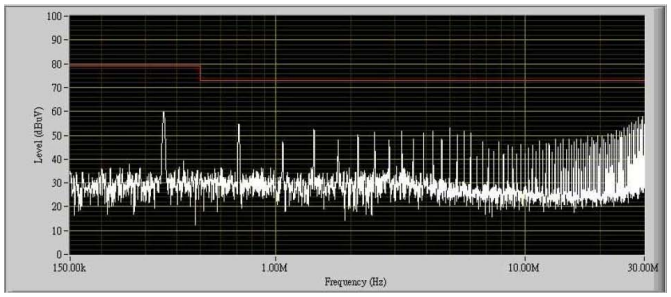
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



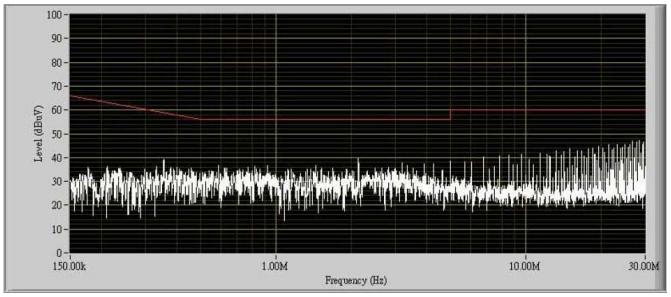
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

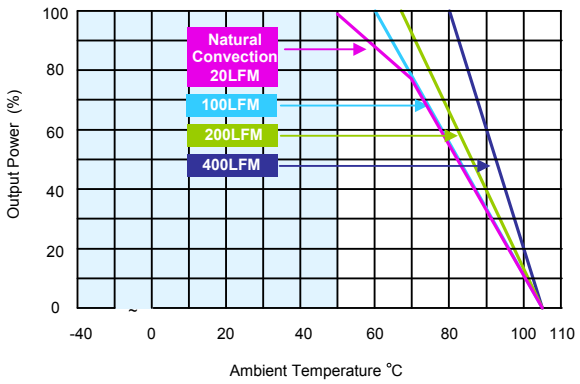
All test conditions are at 25°C The figures are identical for TEN 25-2422 (Continued)



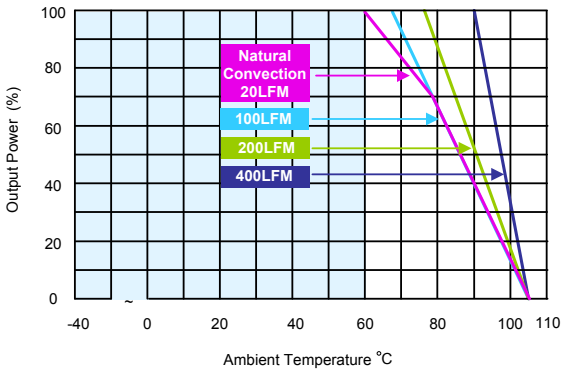
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



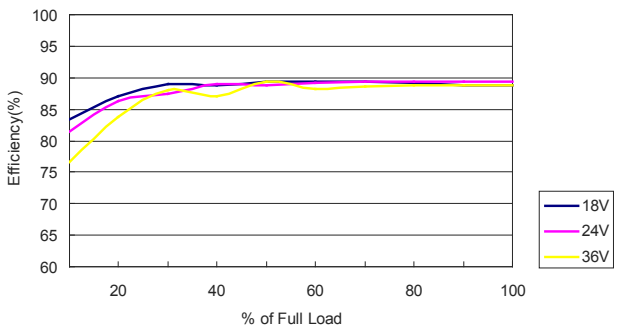
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



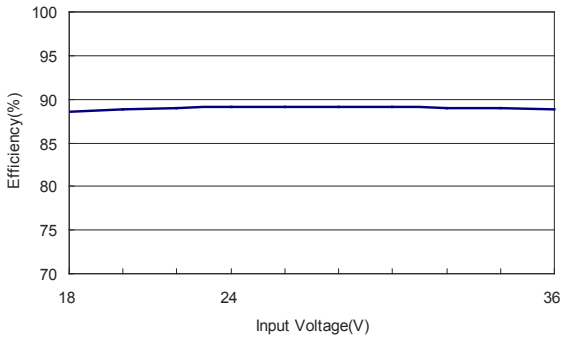
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

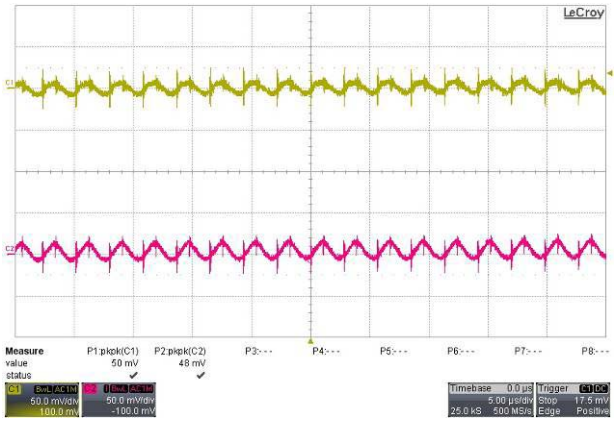
All test conditions are at 25°C The figures are identical for TEN 25-2423



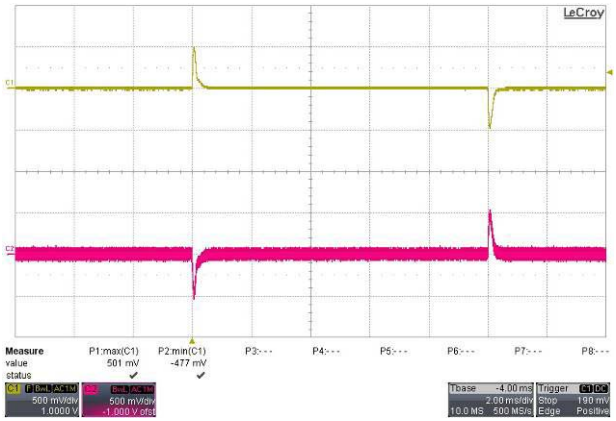
Efficiency Versus Output Current



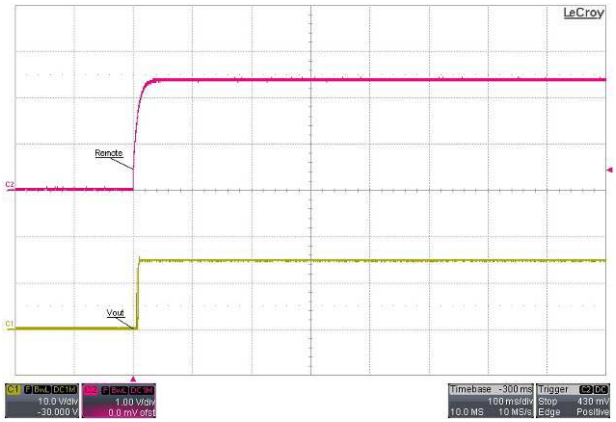
Efficiency Versus Input Voltage Full Load



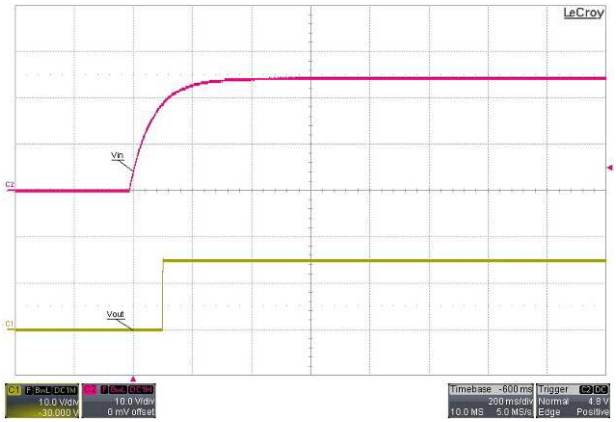
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



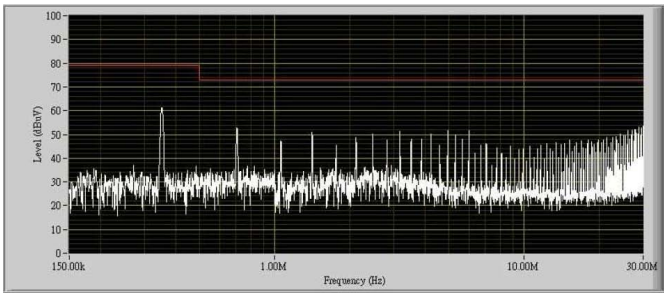
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



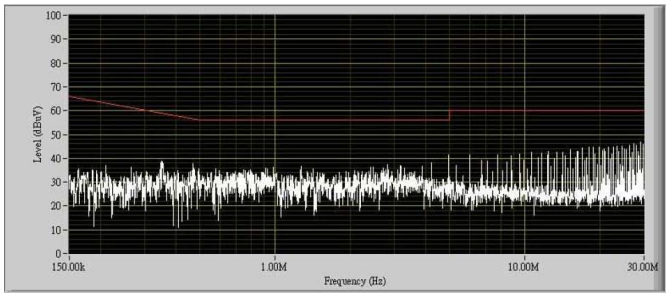
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

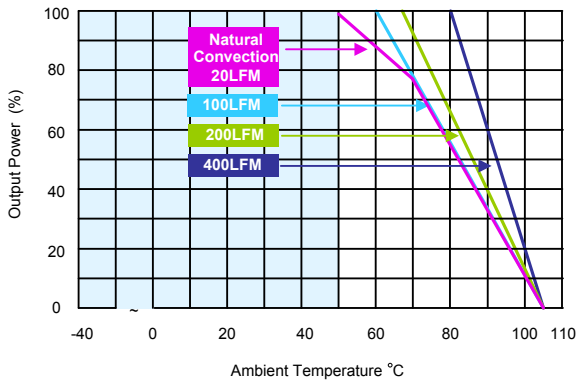
All test conditions are at 25°C The figures are identical for TEN 25-2423 (Continued)



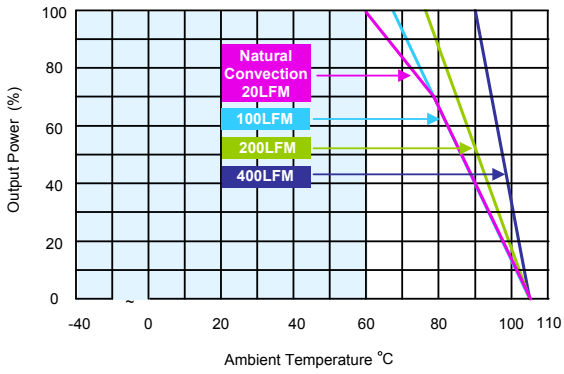
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



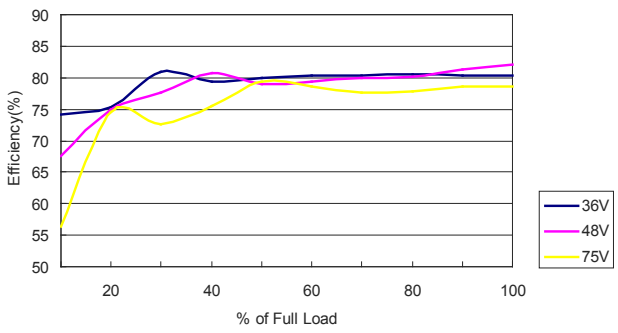
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



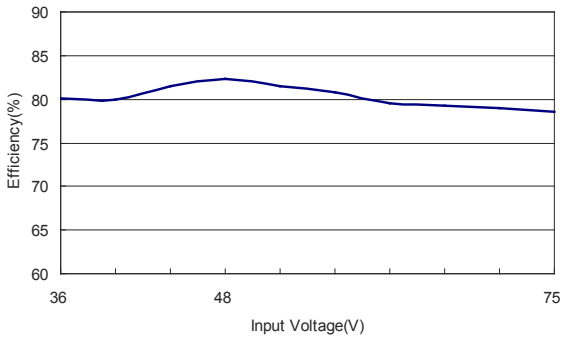
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

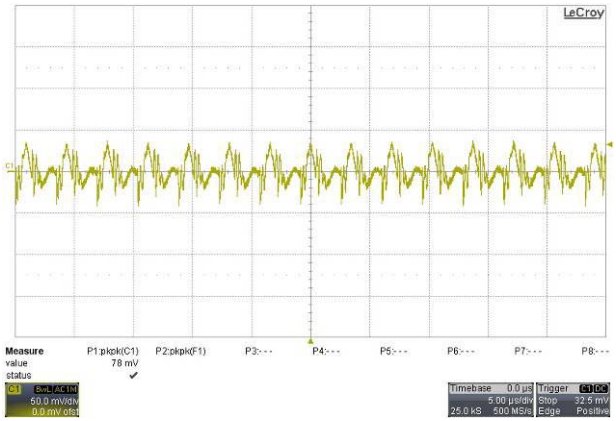
All test conditions are at 25°C The figures are identical for TEN 25-4810



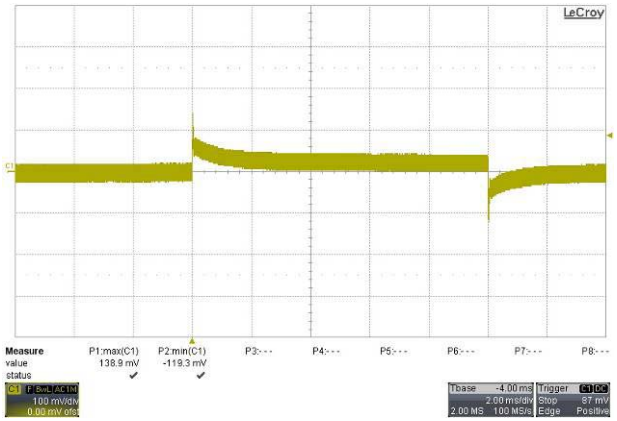
Efficiency Versus Output Current



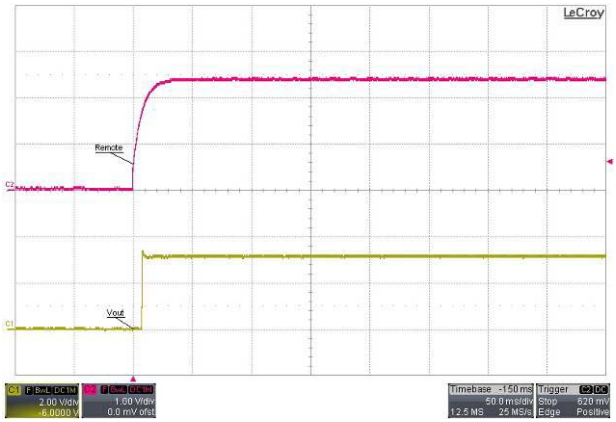
Efficiency Versus Input Voltage Full Load



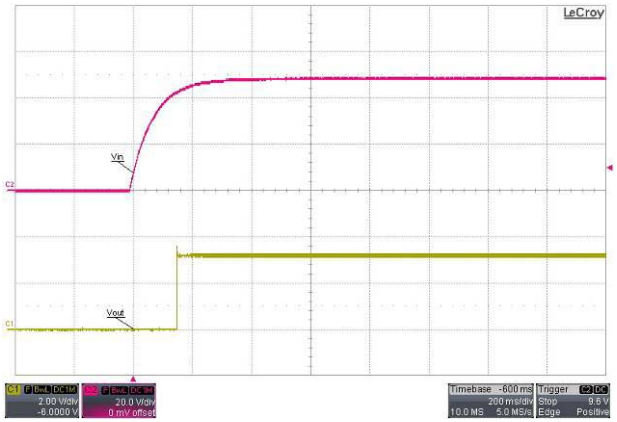
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A



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



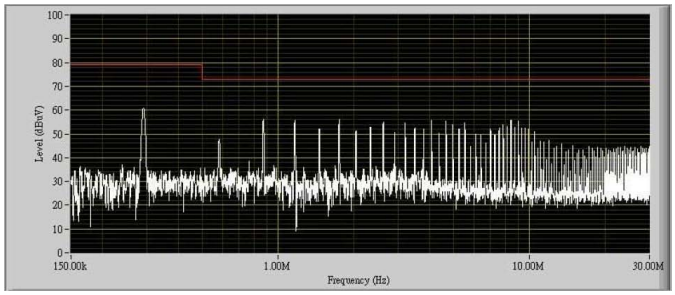
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



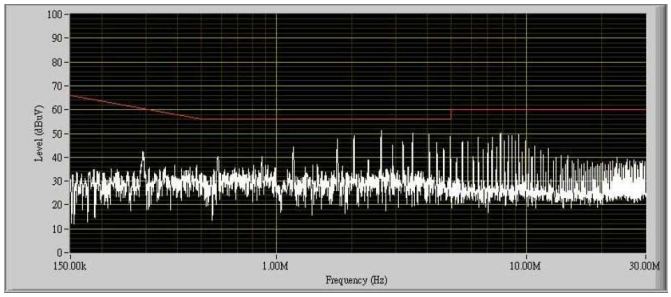
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

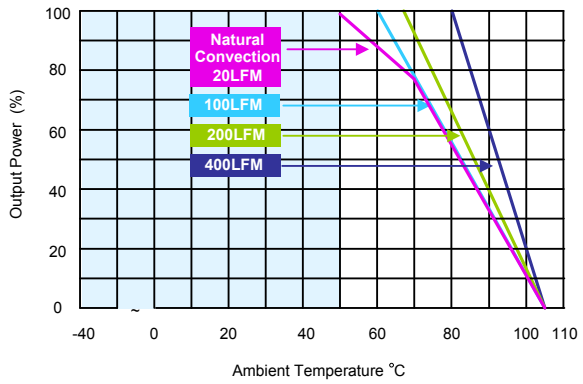
All test conditions are at 25°C The figures are identical for TEN 25-4810 (Continued)



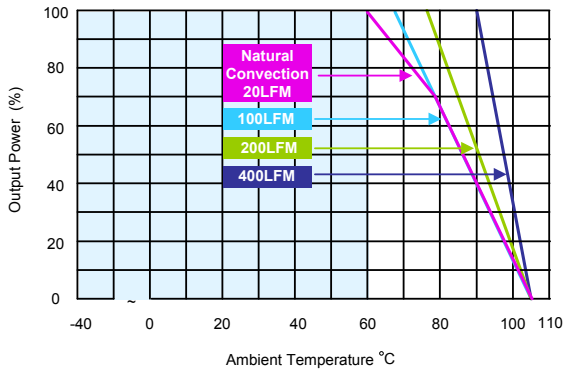
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



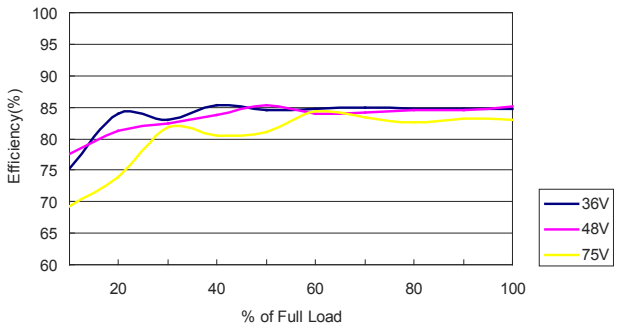
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



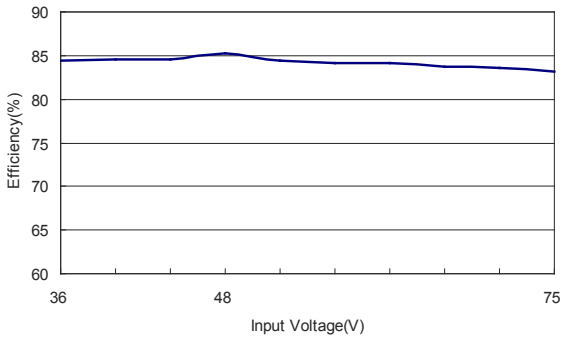
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

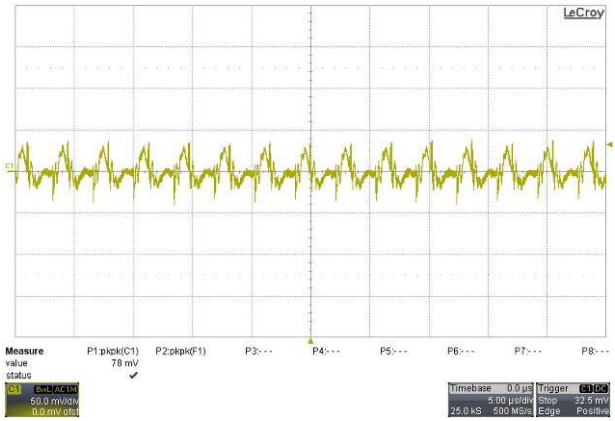
All test conditions are at 25°C The figures are identical for TEN 25-4811



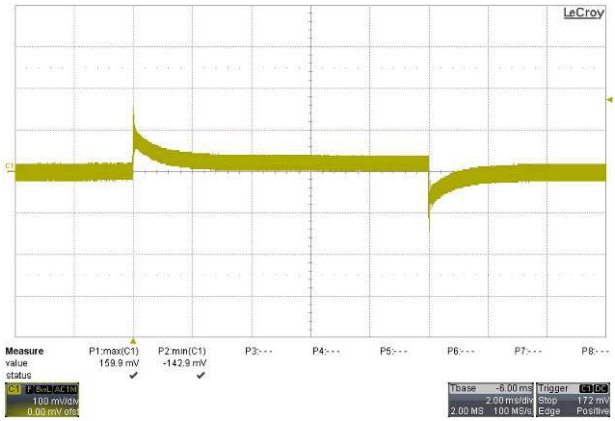
Efficiency Versus Output Current



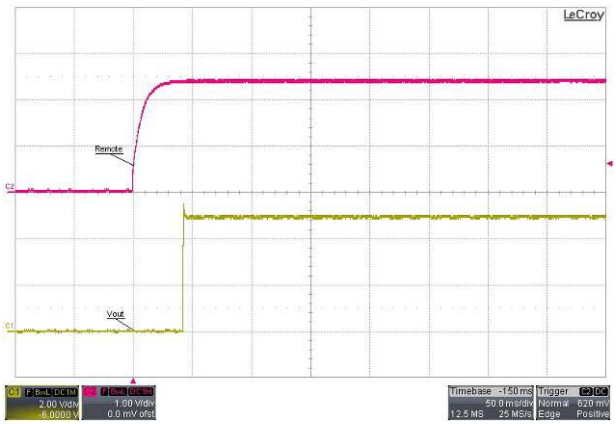
Efficiency Versus Input Voltage Full Load



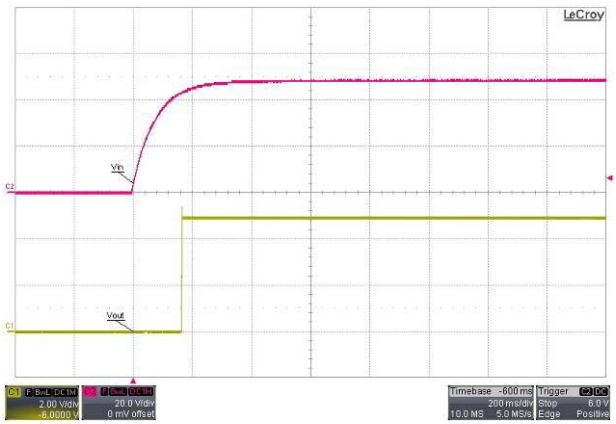
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



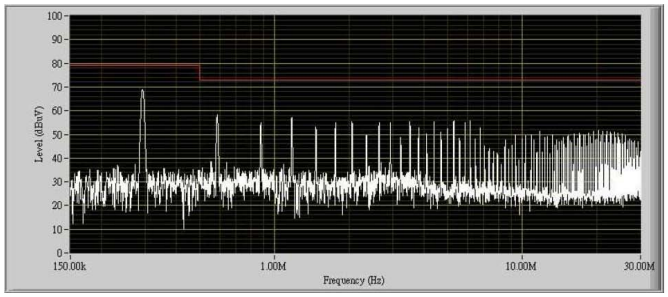
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



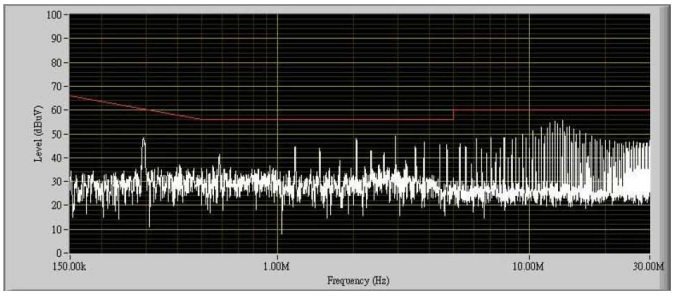
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

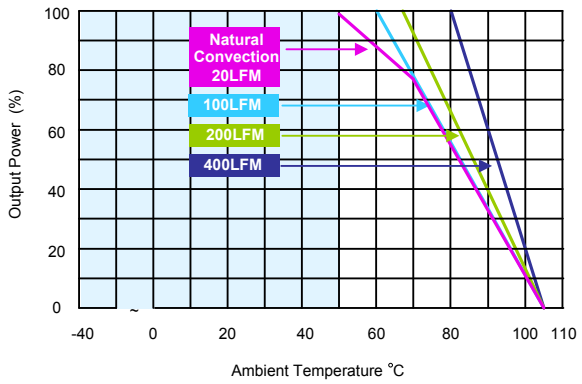
All test conditions are at 25°C The figures are identical for TEN 25-4811 (Continued)



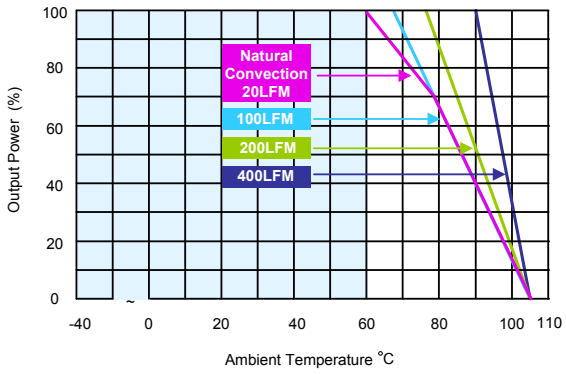
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



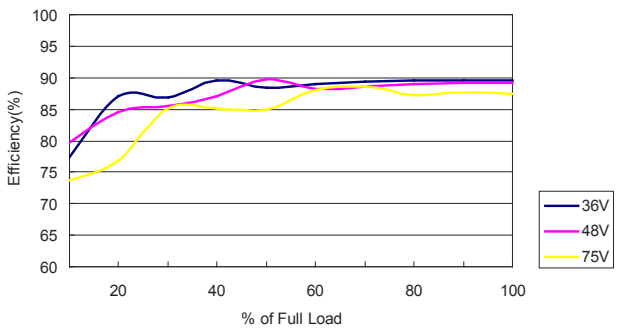
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



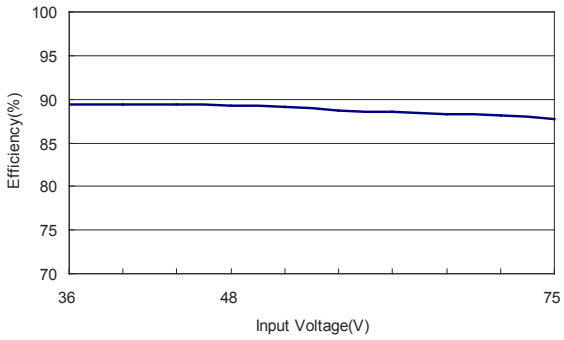
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

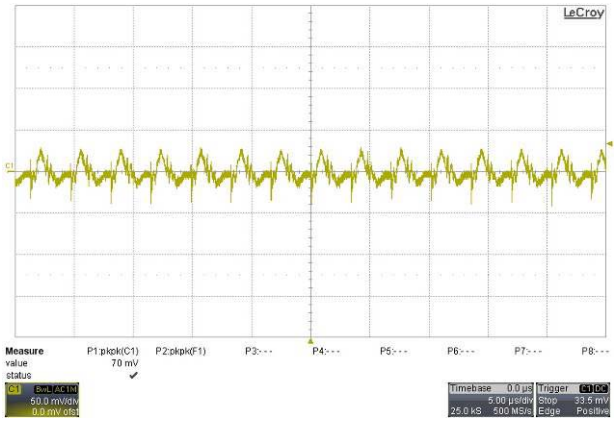
All test conditions are at 25°C The figures are identical for TEN 25-4812



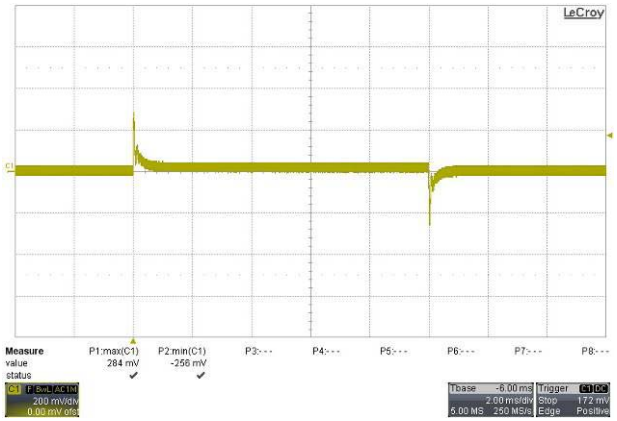
Efficiency Versus Output Current



Efficiency Versus Input Voltage Full Load

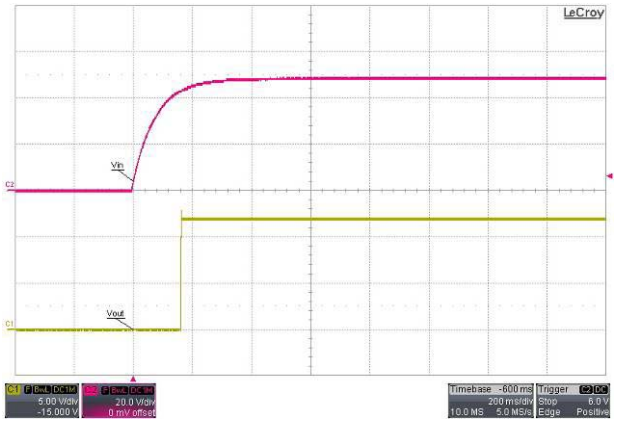


Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A



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

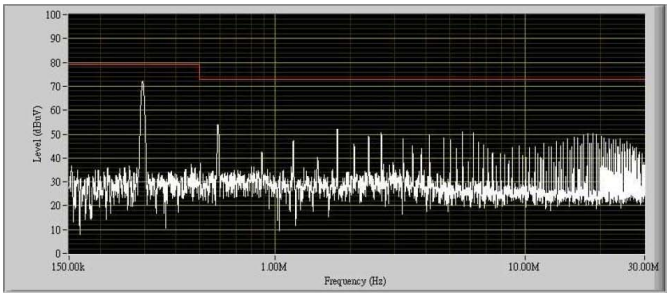
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



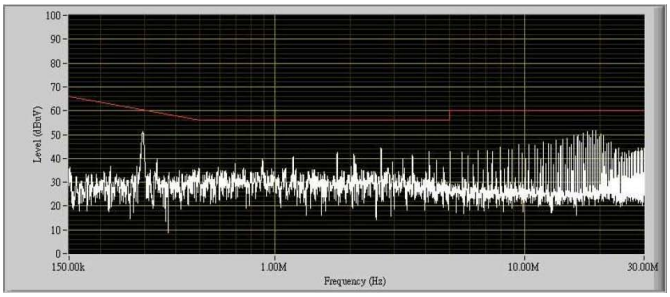
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

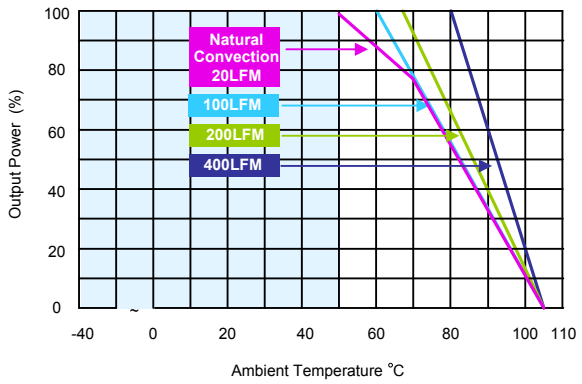
All test conditions are at 25°C The figures are identical for TEN 25-4812 (Continued)



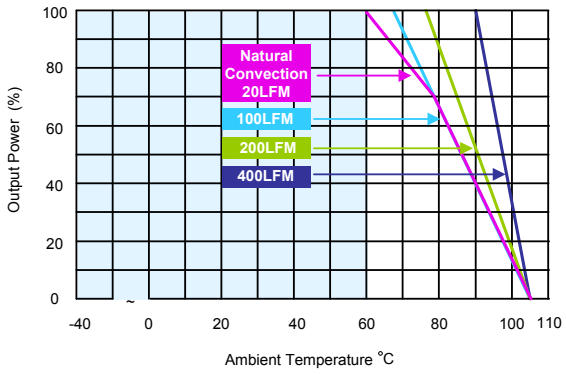
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



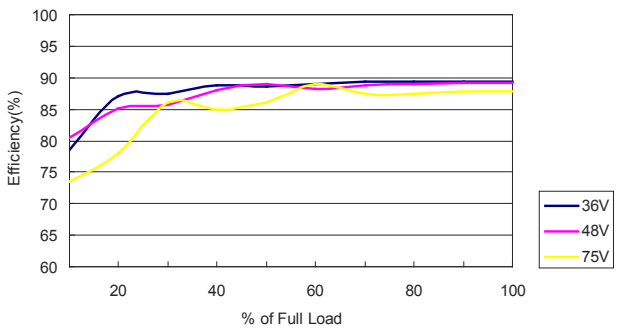
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



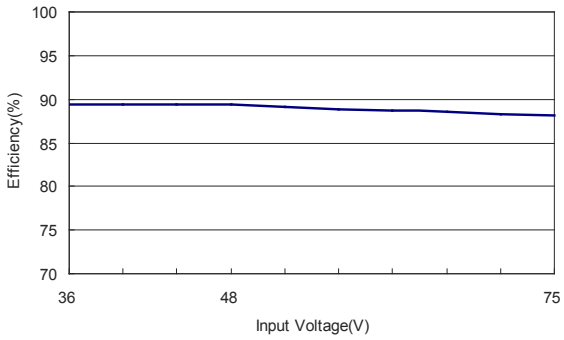
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

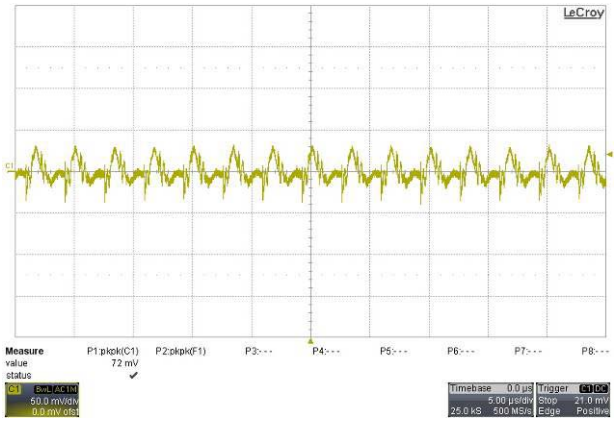
All test conditions are at 25°C The figures are identical for TEN 25-4813



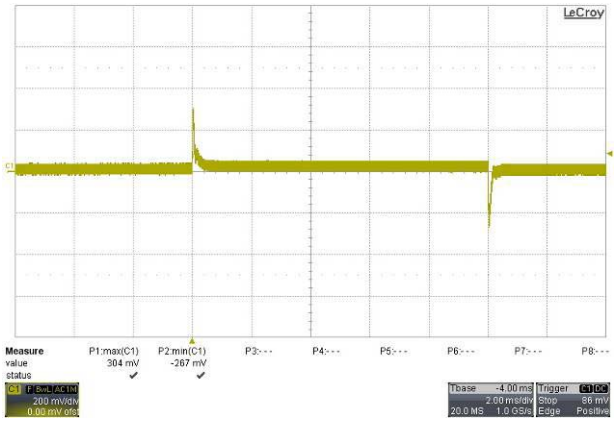
Efficiency Versus Output Current



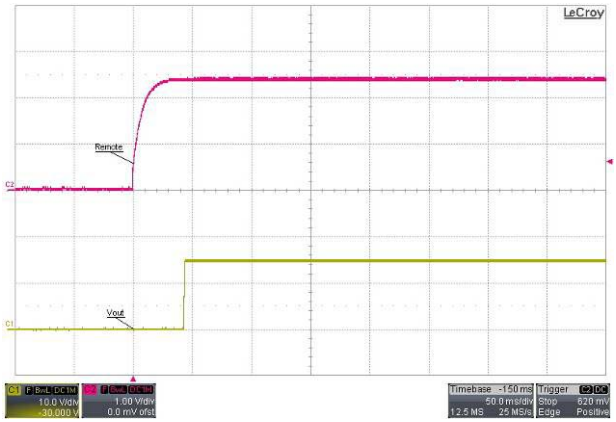
Efficiency Versus Input Voltage Full Load



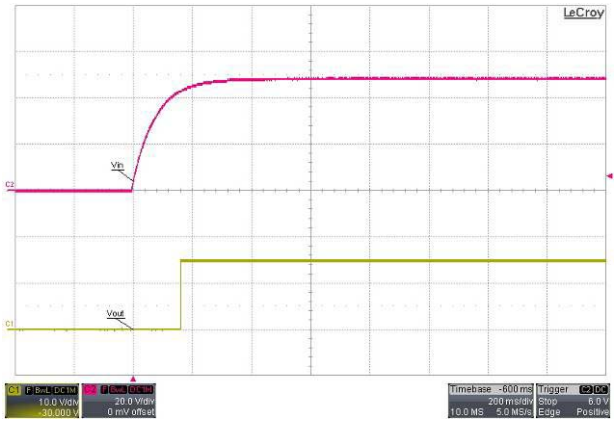
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A



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



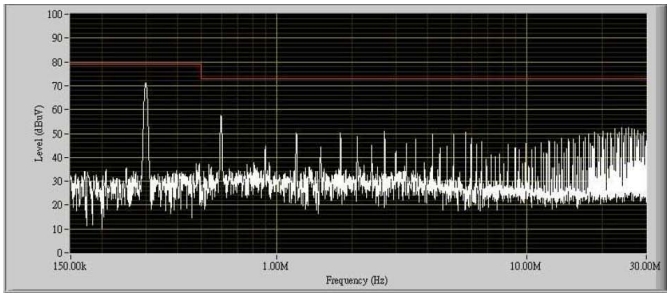
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



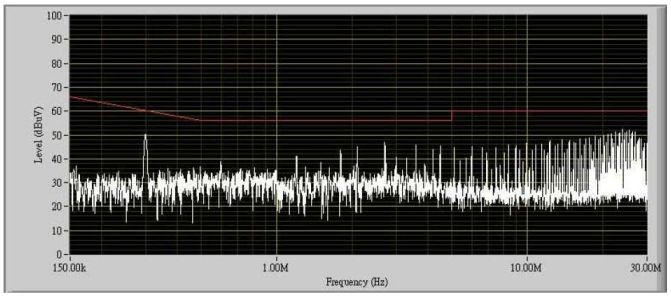
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

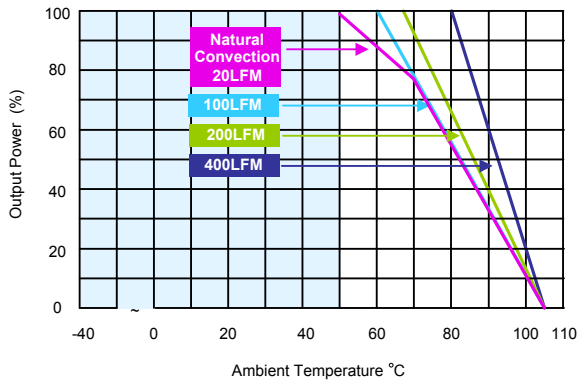
All test conditions are at 25°C The figures are identical for TEN 25-4813 (Continued)



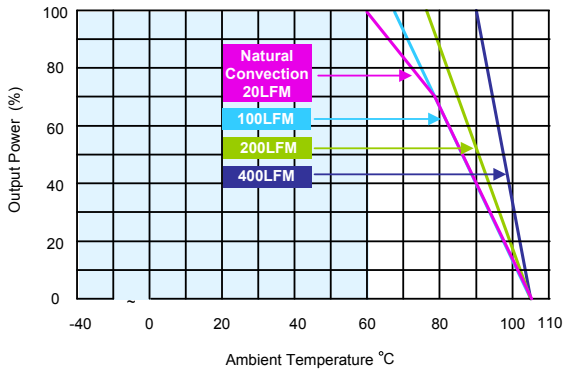
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



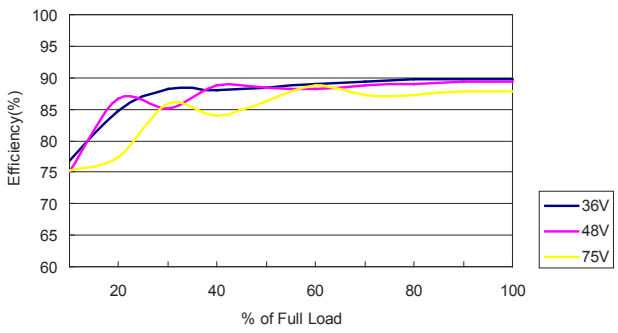
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



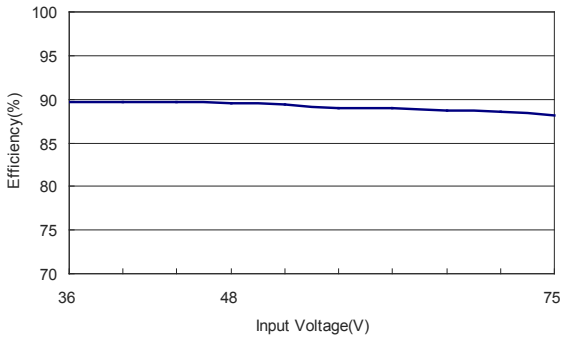
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

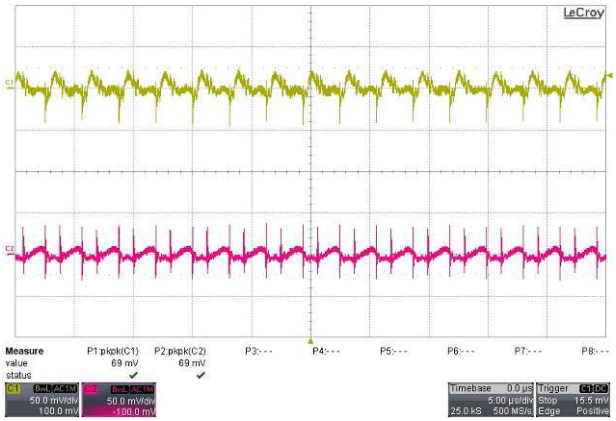
All test conditions are at 25°C The figures are identical for TEN 25-4822



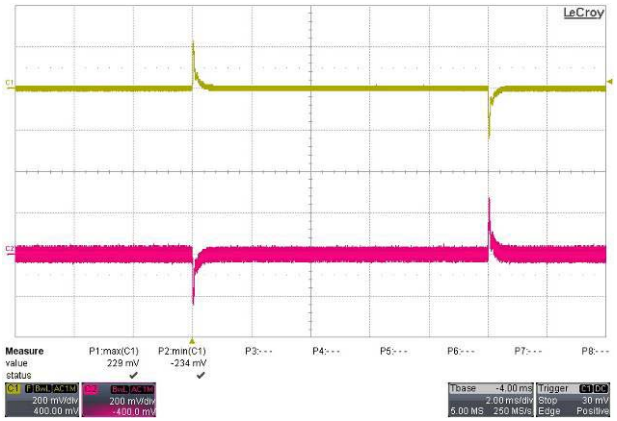
Efficiency Versus Output Current



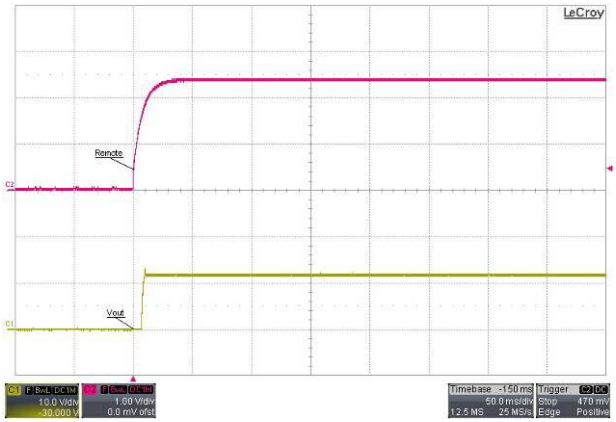
Efficiency Versus Input Voltage Full Load



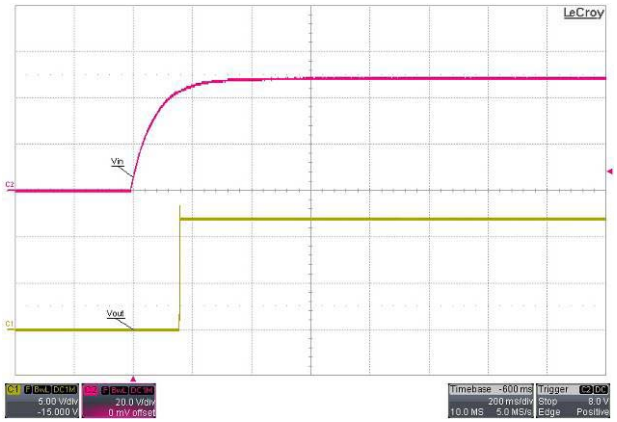
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



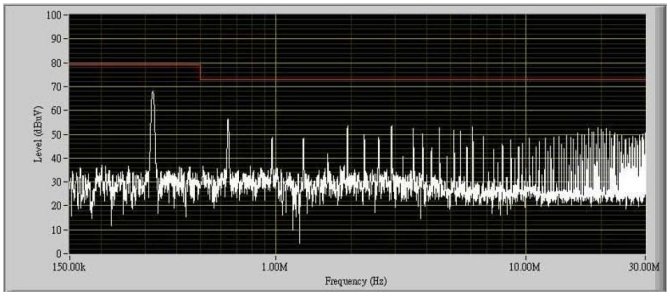
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



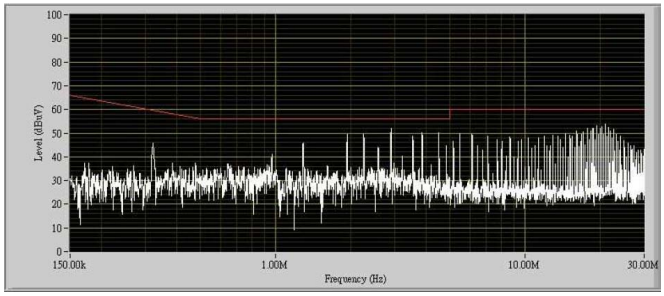
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

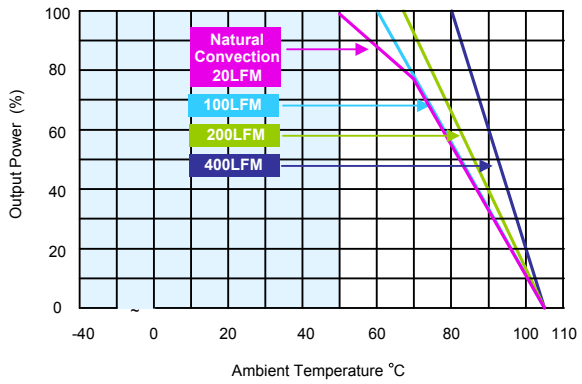
All test conditions are at 25°C The figures are identical for TEN 25-4822 (Continued)



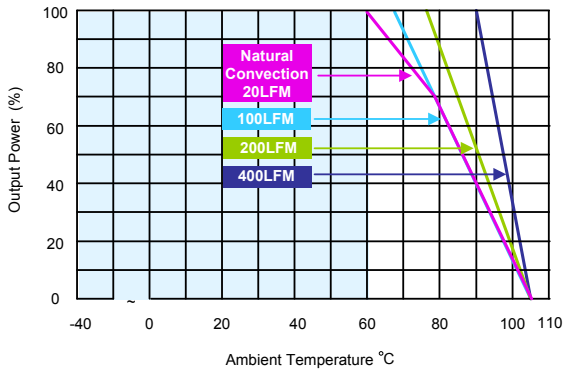
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



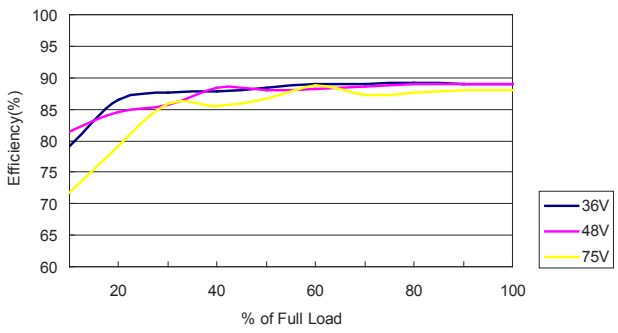
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



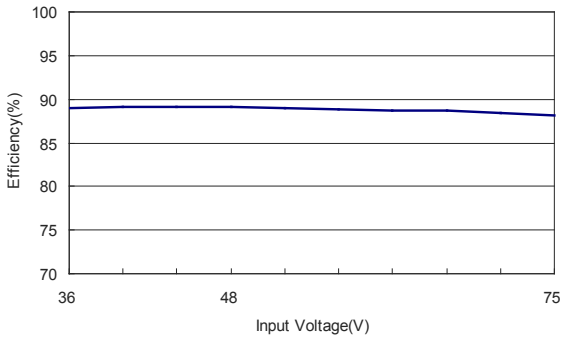
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

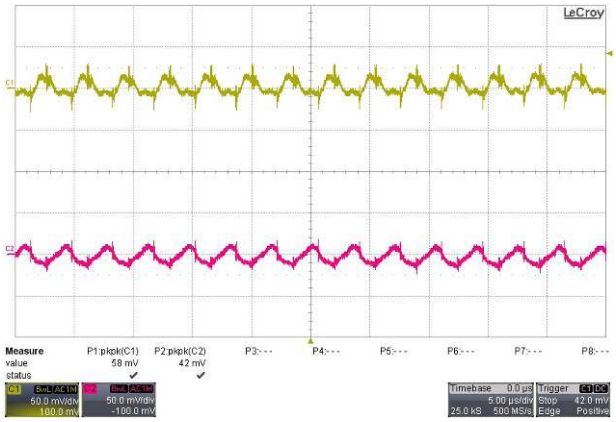
All test conditions are at 25°C The figures are identical for TEN 25-4823



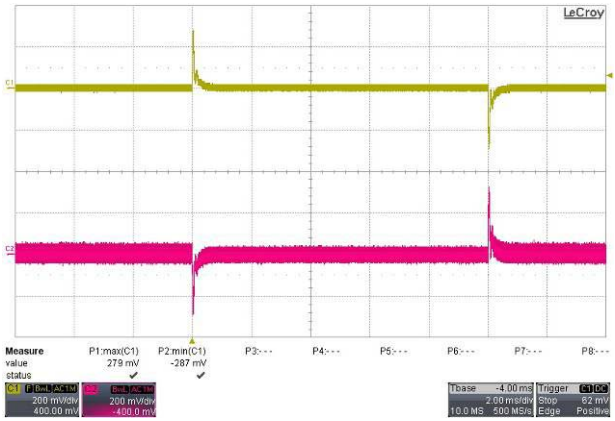
Efficiency Versus Output Current



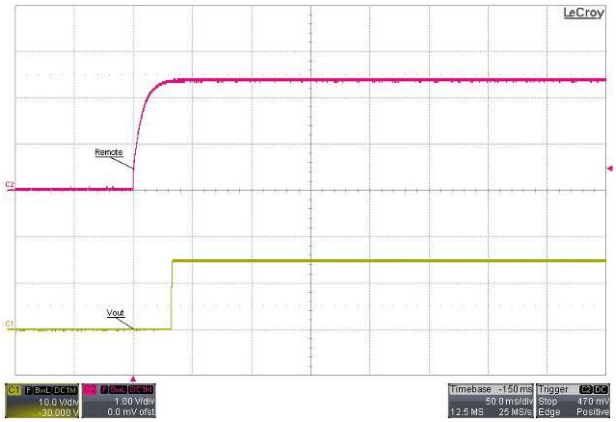
Efficiency Versus Input Voltage Full Load



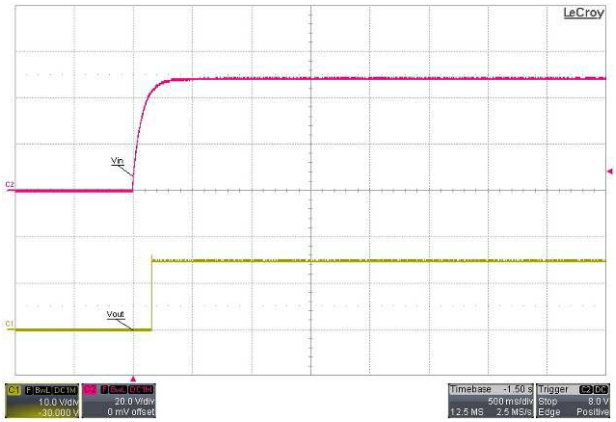
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



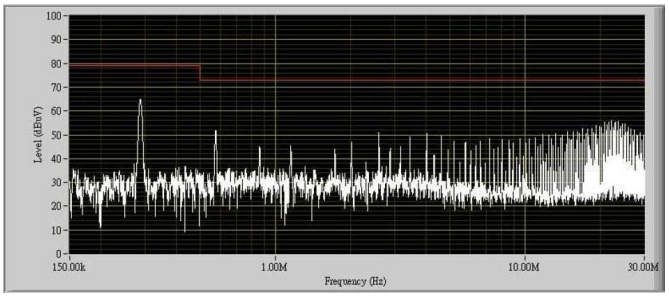
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



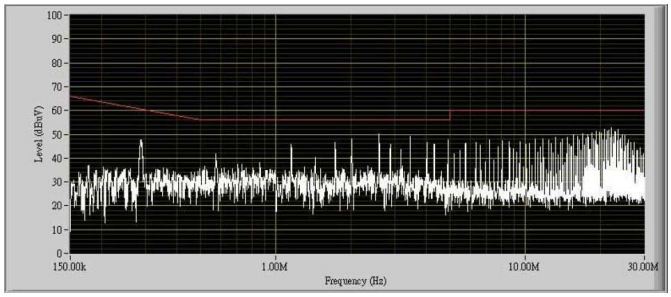
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

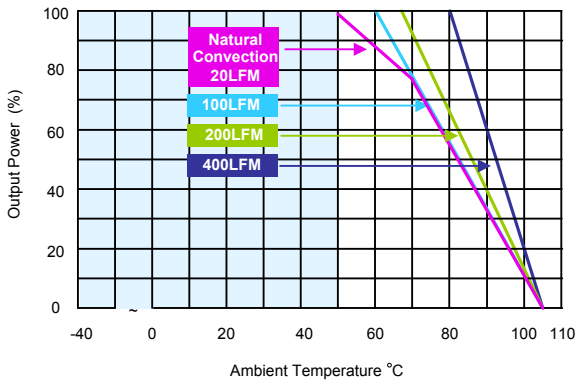
All test conditions are at 25°C The figures are identical for TEN 25-4823 (Continued)



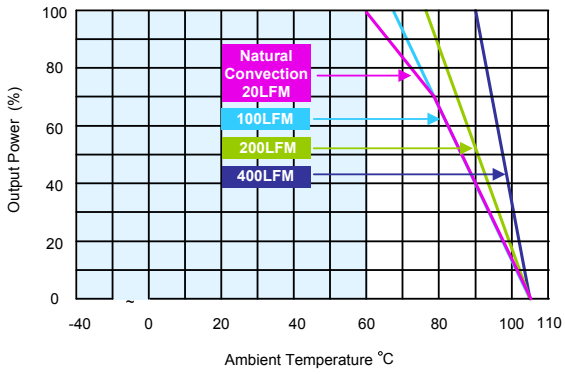
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$; Full Load (see page 42)



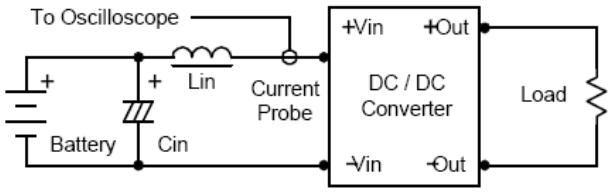
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



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

Testing Configurations

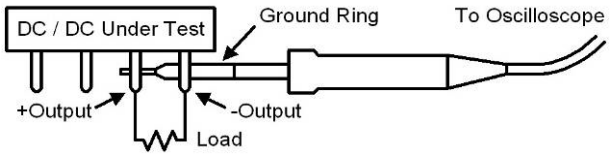
Input reflected-ripple current measurement test up



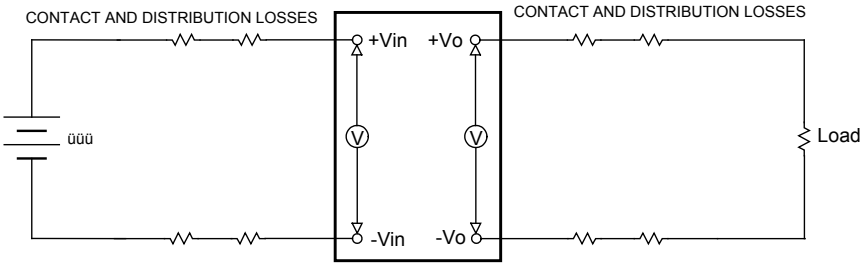
Component	Value	Reference
Lin	4.7µH	-----
Cin	220µF (ESR<1.0Ω at 100KHz)	Aluminum Electrolytic Capacitor

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

This noise pickup is eliminated as shown in Figure by using a scope probe with an external ground band or ring and pressing this band directly against the output common terminal of the power converter while the tip contacts the voltage output terminal. This makes the shortest possible connection across the output terminals.

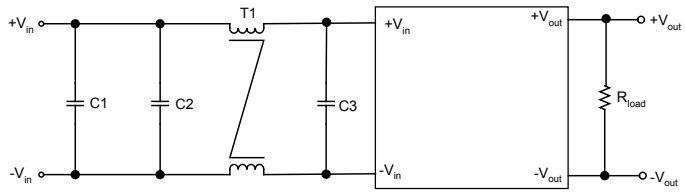


Output voltage and efficiency measurement test up

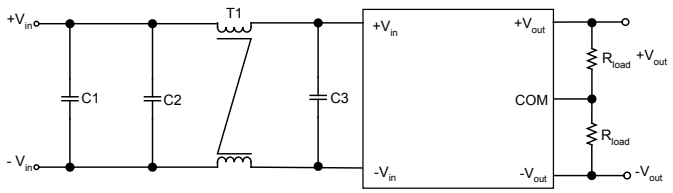


$$Efficiency = \left(\frac{V_{out} \times I_{out}}{V_{in} \times I_{in}} \right) \times 100\% = [\%]$$

EMC considerations

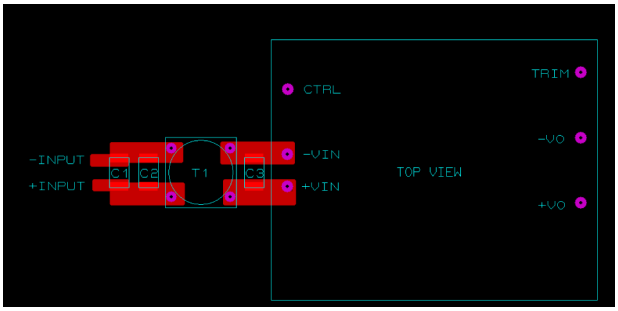


Single Output

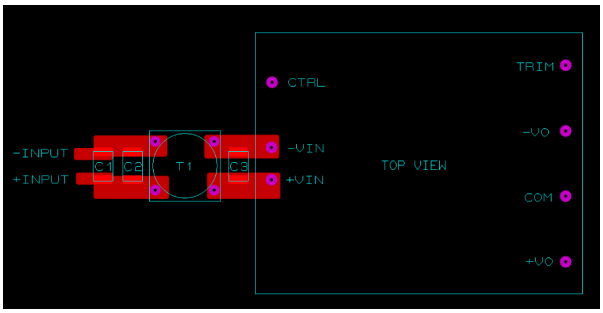


Dual Output

Recommended circuit to comply EN55022 Class B Limits



Single Output



Dual Output

Recommended PCB Layout with Input Filter

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

Model	Component	Value
TEN 25-12xx	C1	10µF/25V 1812 MLCC
	T1	0.55mH Common choke, core: T10X2.5X5 H5C3/HPN155 ϕ0.64X9T
TEN 25-24xx	C1	3.3µF/50V 1812 MLCC
	T1	0.55mH Common choke, core: T10X2.5X5 H5C3/HPN155 ϕ0.64X9T
TEN 25-48xx	C1,C2,C3	1.5µF/100V 1812 MLCC
	T1	0.55mH Common choke, core: T10X2.5X5 H5C3/HPN155 ϕ0.64X9T

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 33µF for the 12V input devices and a 10µF for the 24V and 48V devices.

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.

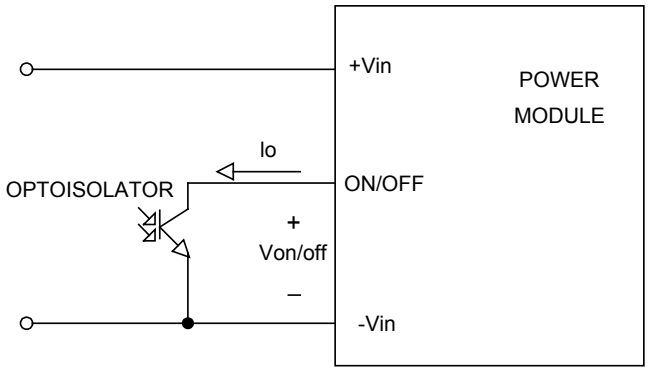
Output Over Voltage Protection

The output overvoltage clamp consists of control circuitry, which is independent of the primary regulation loop, that monitors the voltage on the output terminals.
The control loop of the clamp has a higher voltage set point than the primary loop. This provides a redundant voltage control that reduces the risk of output overvoltage. The OVP level can be found in the output data

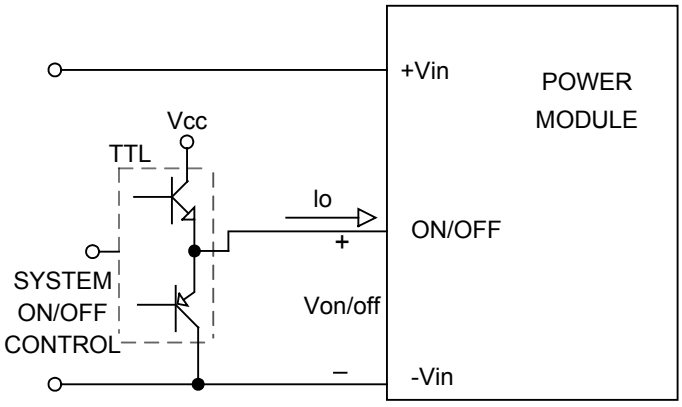
Remote ON/OFF Control

(With suffix-RC) The positive logic remote ON/OFF control circuits is included. The input refers to -Vin.

Remote ON/OFF implementation ON: 3.5...12 VDC or open circuit
OFF: 0.....1.2 VDC or short circuit

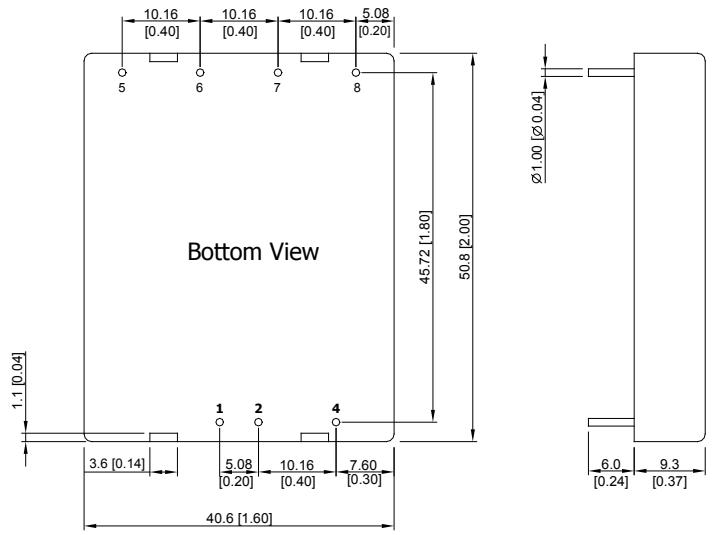


Isolated-Closure Remote ON/OFF



Level Control Using TTL Output

Mechanical Dimensions

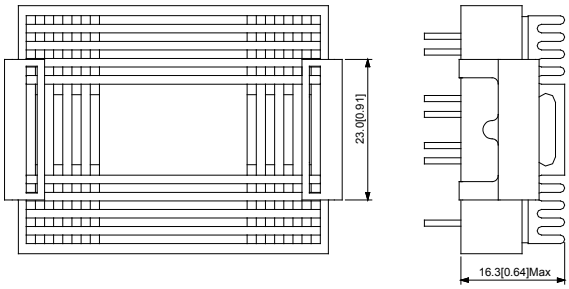


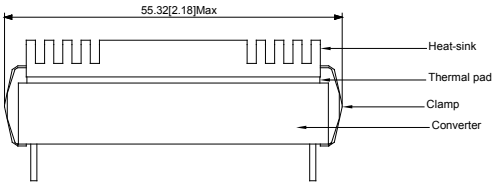
Pin Connections		
Pin	Single Output	Dual Output
1	+Vin	+Vin
2	-Vin	-Vin
4	Remote On/Off	Remote On/Off
5	No Pin	+Vout
6	+Vout	Common
7	-Vout	-Vout
8	Trim	Trim

1. All dimensions in mm (inches)
Tolerance: X.X±0.25 (X.XX±0.01”)
X.XX±0.13 (X.XXX±0.005”)
2.Pin pitch tolerance:±0.25 (±0.01”)
3.Pin dimension tolerance:±0.05 (±0.002”)

Heat Sink Consideration

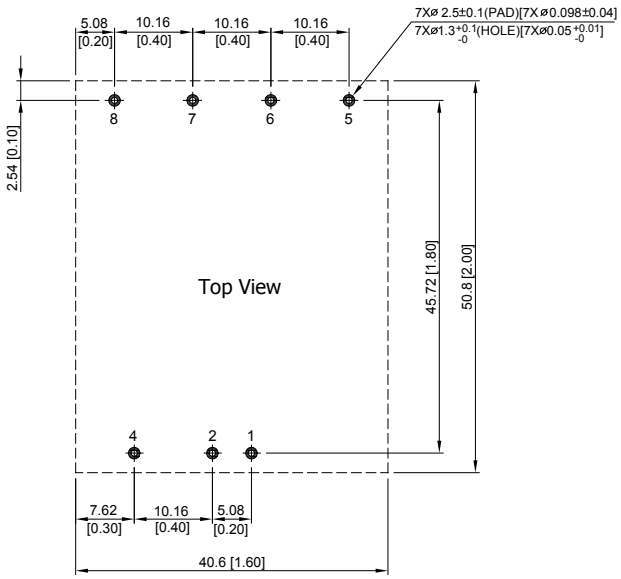
Equip heat-sink for lower temperature and higher reliability of the module.
Order Code: **TEN-HS5**



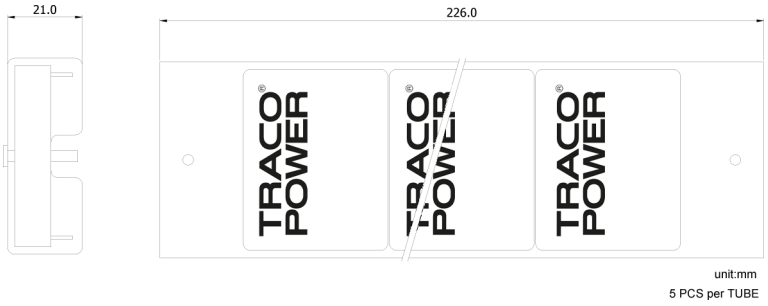


All dimensions in mm (inches)

Recommended Pad Layout for Single & Dual Output Converter

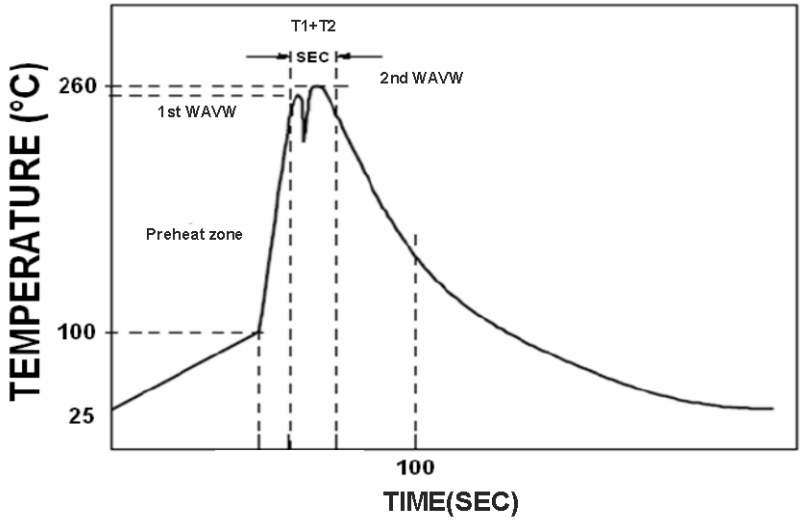


Packaging Information

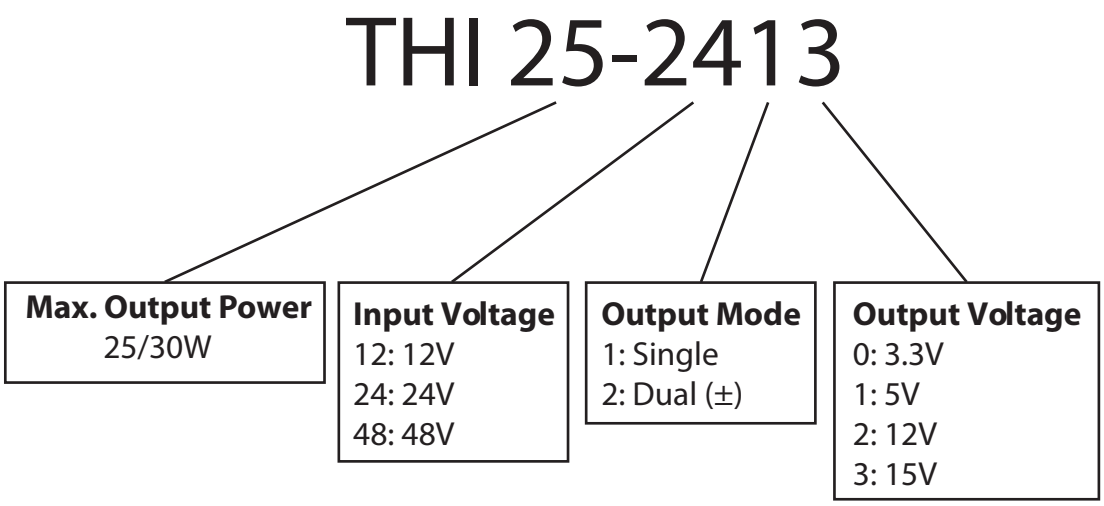


Soldering and Reflow Considerations

Lead free wave solder profile for TEN 25 Series



Part Number Structure



Model Number	Input Range (VDC)	Output Voltage (VDC)	Max. Output Current (mA)	Input Current at Full Load[1] (mA)	Efficiency[2] (%)
TEN 25-1210	9-18	3.3	5500	1867	81
TEN 25-1211	9-18	5	5000	2480	84
TEN 25-1212	9-18	12	2500	2841	88
TEN 25-1213	9-18	15	2000	2841	88
TEN 25-1222	9-18	±12	±1250	2841	88
TEN 25-1223	9-18	±15	±1100	2841	88
TEN 25-2410	18-36	3.3	5500	922	82
TEN 25-2411	18-36	5	5000	1225	85
TEN 25-2412	18-36	12	2500	1404	89
TEN 25-2413	18-36	15	2000	1404	89
TEN 25-2422	18-36	±12	±1250	1404	89
TEN 25-2423	18-36	±15	±1100	1404	89
TEN 25-4810	36-75	3.3	5500	461	82
TEN 25-4811	36-75	5	5000	613	85
TEN 25-4812	36-75	12	2500	702	89
TEN 25-4813	36-75	15	2000	702	89
TEN 25-4822	36-75	±12	±1250	702	89
TEN 25-4823	36-75	±15	±1100	702	89

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 slow-blow fuse in 12Vin with maximum rating of 6000mA, in 24Vin with maximum rating of 3000mA, in 48Vin with maximum rating of 1500mA. 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 TEN 25 series of DC/DC converters has been calculated using MIL-HDBK 217F NOTICE2, Operating Temperature 25°C, Ground Benign.

Model	MTBF	Unit
TEN 25-1210	603,828	Hour
TEN 25-1211	524,356	
TEN 25-1212	533,191	
TEN 25-1213	533,191	
TEN 25-1222	550,509	
TEN 25-1223	547,675	
TEN 25-2410	603,682	
TEN 25-2411	524,246	
TEN 25-2412	533,077	
TEN 25-2413	533,077	
TEN 25-2422	563,920	
TEN 25-2423	560,947	
TEN 25-4810	581,937	
TEN 25-4811	524,164	
TEN 25-4812	532,922	
TEN 25-4813	532,922	
TEN 25-4822	549,571	
TEN 25-4823	546,747	

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