TEN 20 Series

20W, Wide Input Range, Single & Dual Output DC/DC Converters

Features

- ▶2”x 1”x 0.4” Metal Package
- ▶Wide 2:1 Input Range
- ▶Very high Efficiency up to 89%
- ▶Operating Temp. Range –40°C to +80°C
- ▶Short Circuit Protection
- ▶I/O-isolation 1500VDC
- ▶Input Filter meets EN 55022,class A and FCC, level A
- ▶Remote On/Off (Option)
- ▶3 Years Product Warranty

Applications

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

General Description

The TRACO TEN 20 series is a range of isolated 20W DC/DC converter modules featuring fully regulated output voltages and wide 2:1 input voltage ranges. The product comes in a 2”x 1”x 0.4” metal package with industry standard pinout. An excellent efficiency allows an operating temperature range of –40°C to +80°C. They feature an input filter to meet EN 55022, class A, and optional remote On/Off input.
Typical applications for these converters are battery operated equipment and instrumentation, distributed power systems, data communication and general industrial electronics.

Table of contents

Absolute Maximum Rating	P2	Remote ON/OFF Control	P43
Output Specification	P2	Mechanical Data	P44
Input Specification	P3	Recommended Pad Layout Single & Dual	P44
General Specification	P4	Packaging Information	P45
Characteristic Curves	P5	Soldering and Reflow Consideration	P45
Testing Configurations	P43	Part Number Structure	P46
EMC Considerations	P42	Safety and Installation Instruction	P47
Input Source Impedance	P42	MTBF and Reliability	P47
Output Over Current Protection	P42		

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 20-xx10 TEN 20-xx11 TEN 20-xx12 TEN 20-xx13 TEN 20-xx22 TEN 20-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) Load (10% to 100% of Full Load)	TEN 20-xx10 Other Models	--- ---	±0.5 ±0.1	±1.0 ±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} = $V_{in\ nom}$; TA=25℃ Load step change form 25% Load Step Change Peak Deviation Setting Time	All	 --- ---	 ±2%Vo 150	 ±4%Vo 300	 mV μS
Output Current	TEN 20-xx10 TEN 20-xx11 TEN 20-xx12 TEN 20-xx13 TEN 20-xx22 TEN 20-xx23	240 240 100 80 ±50 ±40	--- --- --- --- --- ---	4000 4000 1670 1340 ±835 ±670	mA
Output Over Current Protection	All	120	---	---	%FL
Output Short Circuit Protection	All	Continuous			

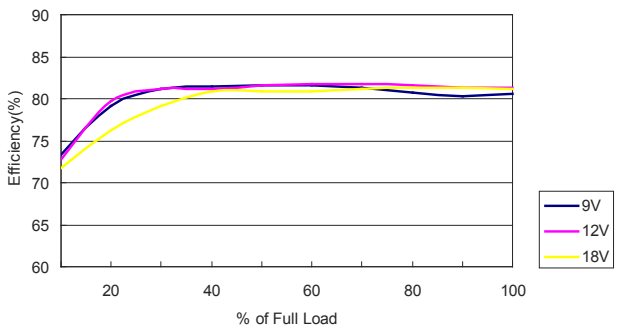
Input Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Operating Input Voltage	12V Input Models	9	12	18	VDC
	24V Input Models	18	24	36	
	48V Input Models	36	48	75	
Under Voltage Lockout Turn-on Threshold	12V Input Models	8.6	8.8	9	VDC
	24V Input Models	17	17.5	18	
	48V Input 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	---	50	---	mA pk-pk
	24V Input Models	---	30	---	
	48V Input Models	---	20	---	
Input Current (Maximum value at V_{in}= $V_{in\ nom}$;Full Load)	TEN 20-1210	---	1358	---	mA
	TEN 20-1211	---	1984	---	
	TEN 20-1212	---	1898	---	
	TEN 20-1213	---	1903	---	
	TEN 20-1222	---	1898	---	
	TEN 20-1223	---	1903	---	
	TEN 20-2410	---	671	---	
	TEN 20-2411	---	980	---	
	TEN 20-2412	---	938	---	
	TEN 20-2413	---	941	---	
	TEN 20-2422	---	938	---	
	TEN 20-2423	---	941	---	
	TEN 20-4810	---	335	---	
	TEN 20-4811	---	490	---	
	TEN 20-4812	---	469	---	
	TEN 20-4813	---	471	---	
	TEN 20-4822	---	469	---	
	TEN 20-4823	---	471	---	
Input Standby Current (Typical value at V_{in} = $V_{in\ nom}$; No Load)	TEN 20-1210 TEN 20-1211 TEN 20-1212 TEN 20-1213 TEN 20-1222 TEN 20-1223	---	30	---	mA
	TEN 20-2410 TEN 20-2411 TEN 20-2412 TEN 20-2413 TEN 20-2422 TEN 20-2423	---	17	---	
	TEN 20-4810 TEN 20-4811 TEN 20-4812 TEN 20-4813 TEN 20-4822 TEN 20-4823	---	10	---	

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	2.5	---	100	VDC
On/Off pin Low Voltage (Remote OFF)		0	---	1	VDC
Remote Off Stand by Input Current		---	2	5	mA
Control Pin Input Current (Remote ON)		---	---	5	µA
Control Pin Input Current (Remote OFF)		---	---	-100	µA

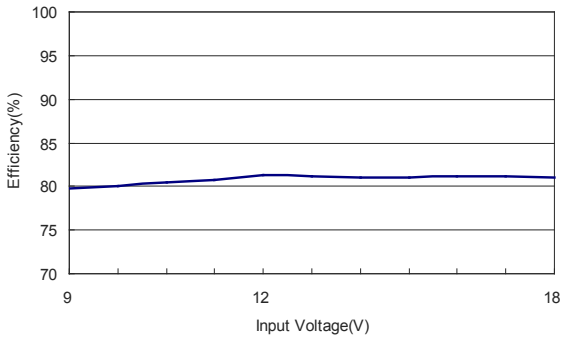
General Specification					
Parameter	**Model**	**Min**	**Nominal**	**Max**	**Unit**
Efficiency (V_{in} =$V_{in\ nom}$; Full Load; T_A =25°C)	TEN 20-1210	---	81	---	%
	TEN 20-1211	---	84	---	
	TEN 20-1212	---	88	---	
	TEN 20-1213	---	88	---	
	TEN 20-1222	---	88	---	
	TEN 20-1223	---	88	---	
	TEN 20-2410	---	82	---	
	TEN 20-2411	---	85	---	
	TEN 20-2412	---	89	---	
	TEN 20-2413	---	89	---	
	TEN 20-2422	---	89	---	
	TEN 20-2423	---	89	---	
	TEN 20-4810	---	82	---	
	TEN 20-4811	---	85	---	
	TEN 20-4812	---	89	---	
	TEN 20-4813	---	89	---	
	TEN 20-4822	---	89	---	
	TEN 20-4823	---	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		600,000	---	---	Hours

Characteristic Curves

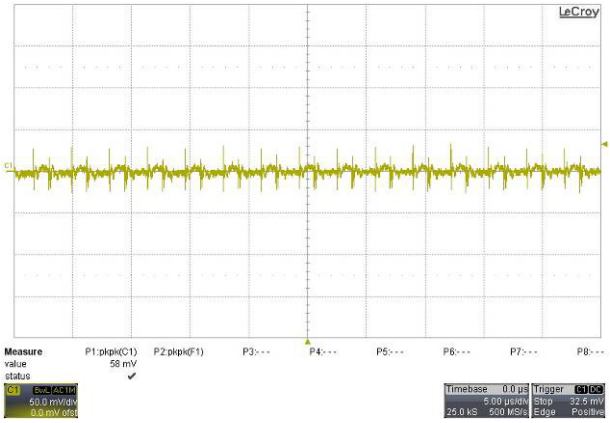
All test conditions are at 25°C The figures are identical for TEN 20-1210



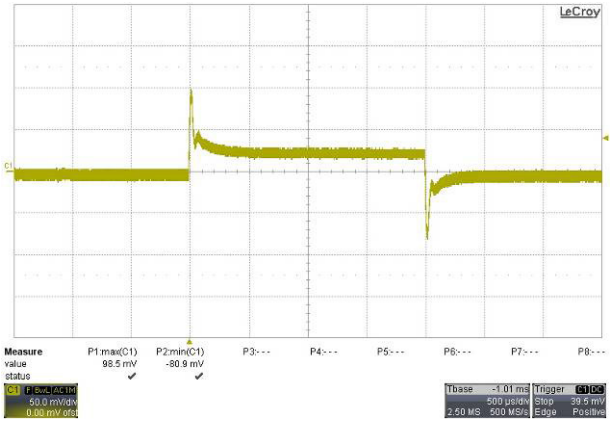
Efficiency Versus Output Current



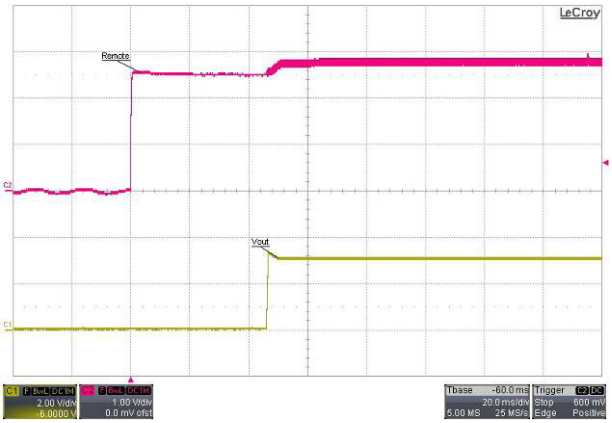
Efficiency Versus Input Voltage
Full Load



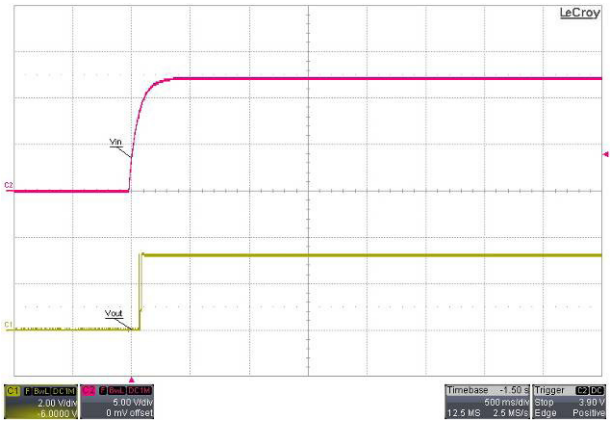
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A



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



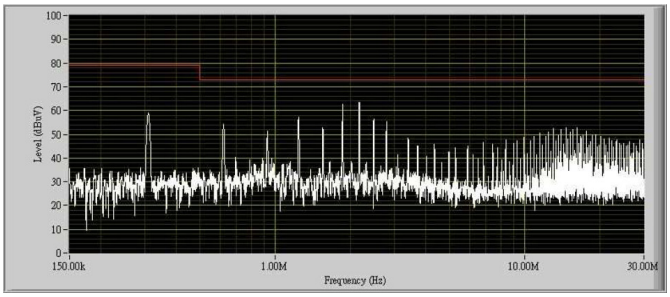
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



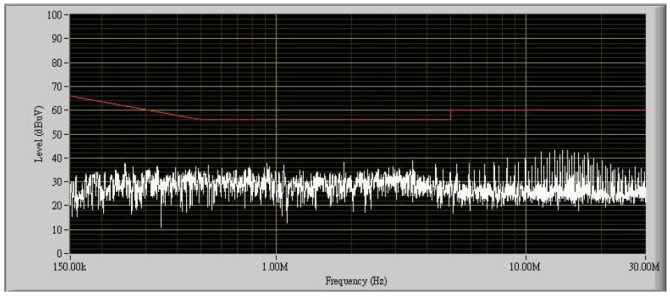
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

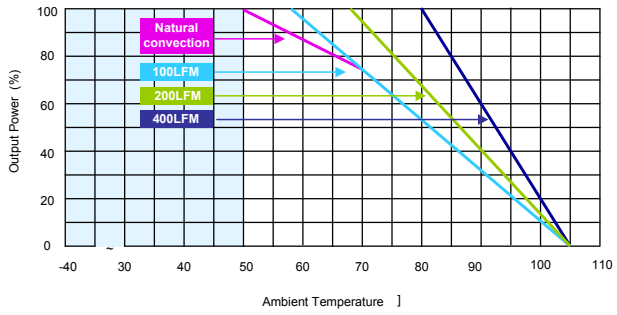
All test conditions are at 25°C The figures are identical for TEN 20-1210 (Continued)



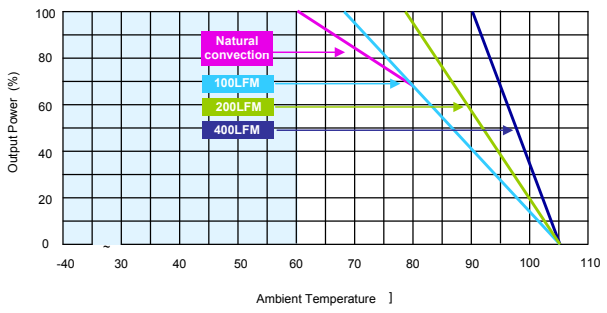
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



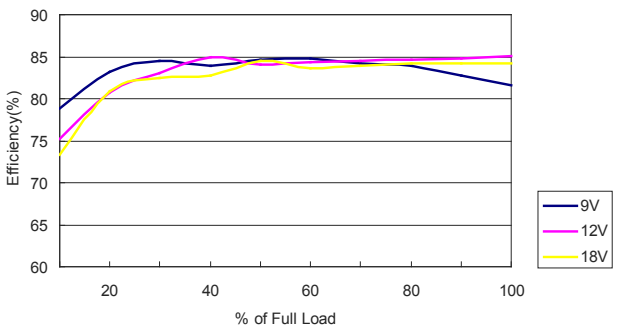
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



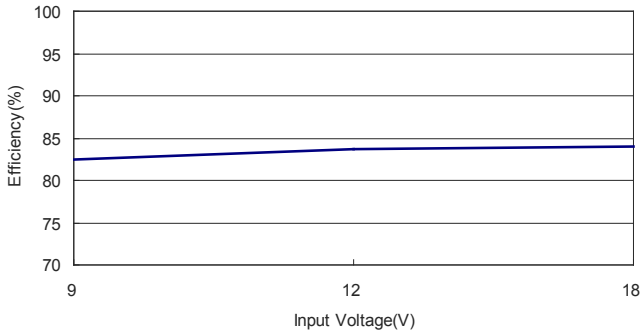
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

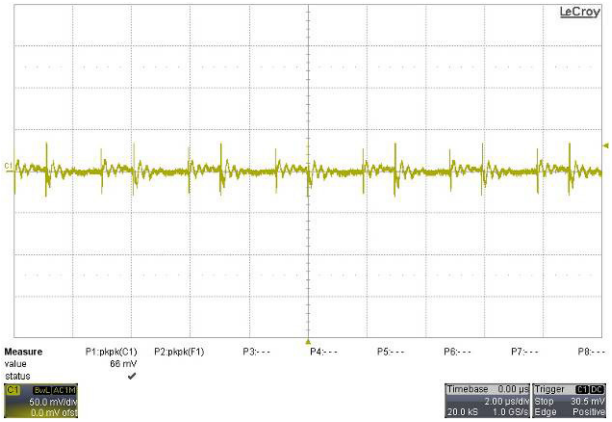
All test conditions are at 25°C The figures are identical for TEN 20-1211



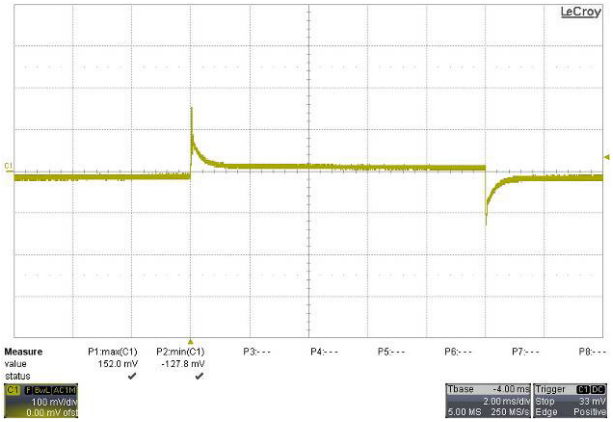
Efficiency Versus Output Current



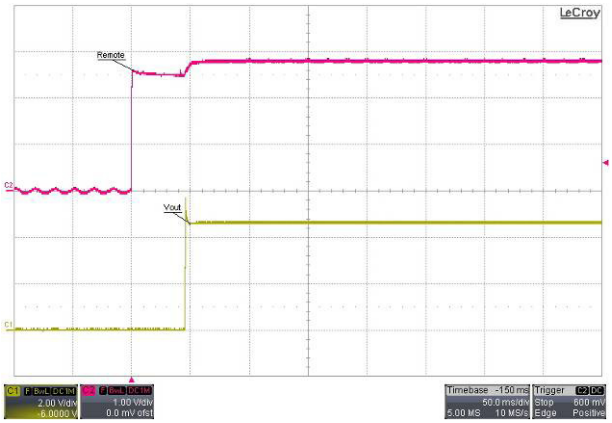
Efficiency Versus Input Voltage
Full Load



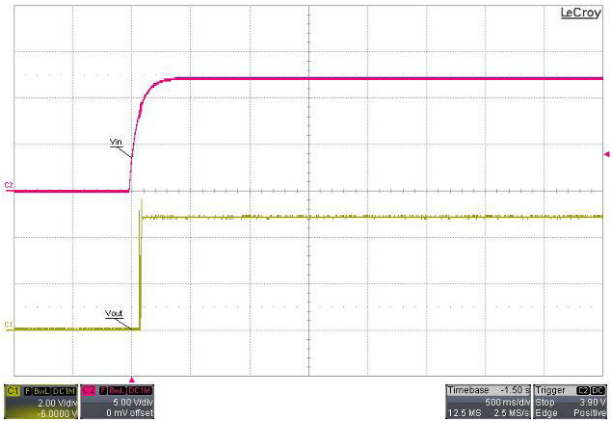
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load;



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



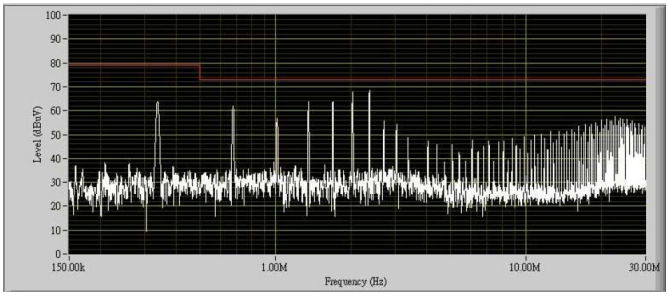
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



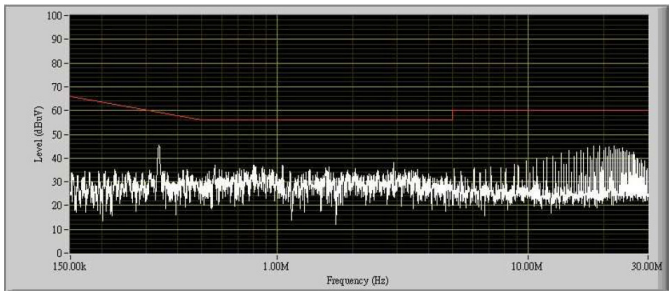
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

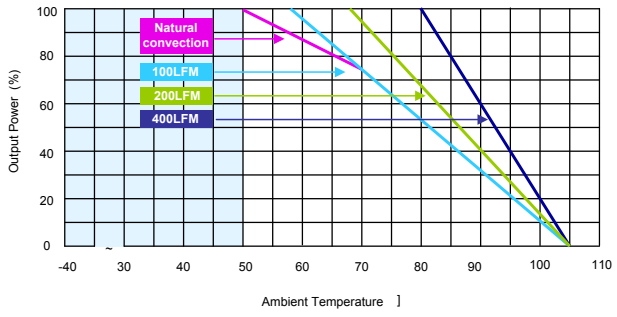
All test conditions are at 25°C The figures are identical for TEN 20-1211 (Continued)



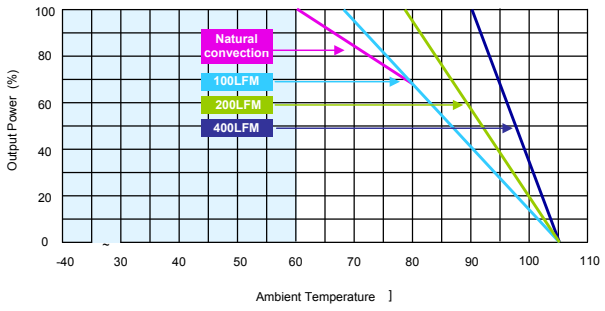
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



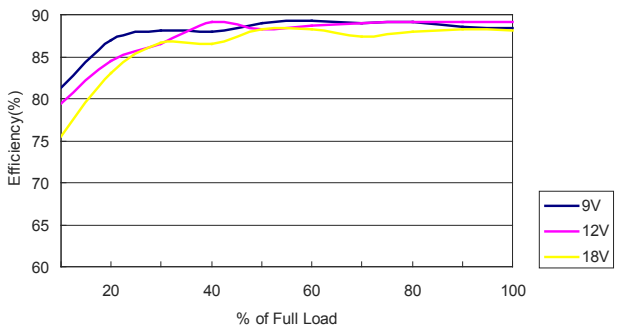
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



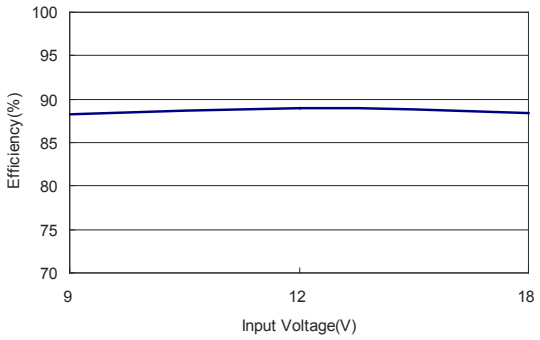
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

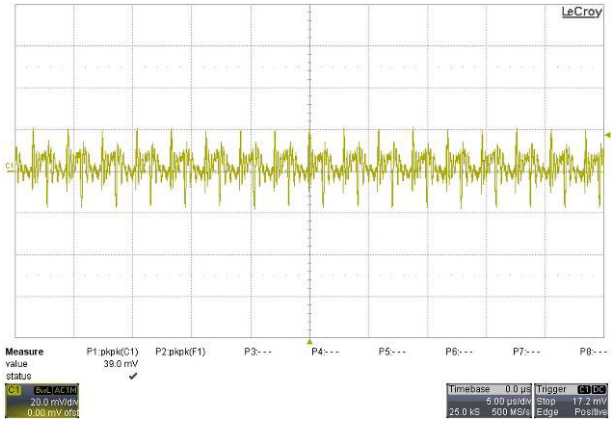
All test conditions are at 25°C The figures are identical for TEN 20-1212



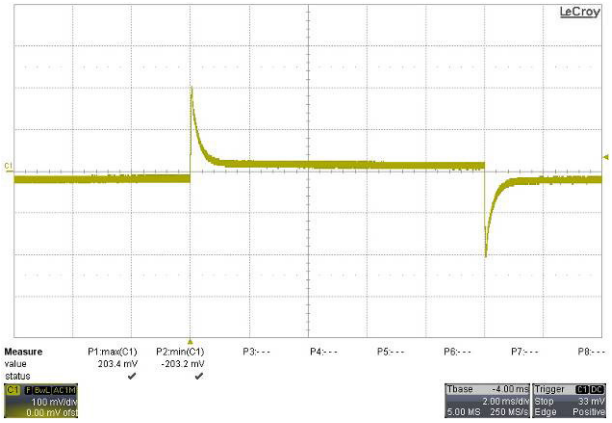
Efficiency Versus Output Current



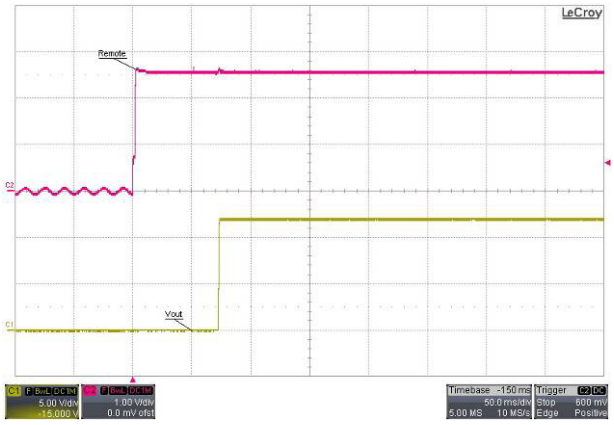
Efficiency Versus Input Voltage
Full Load



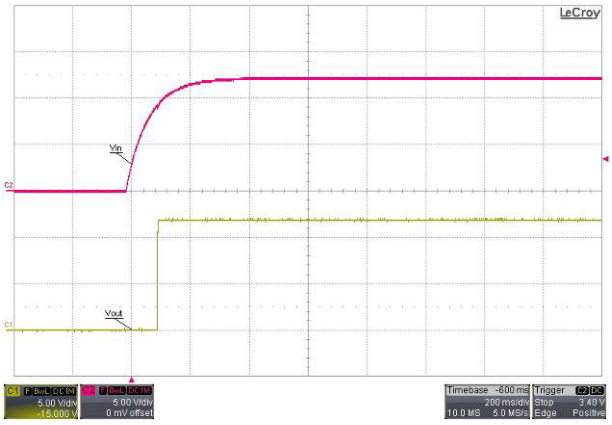
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



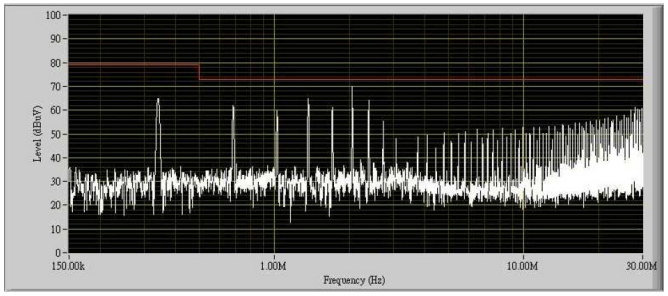
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



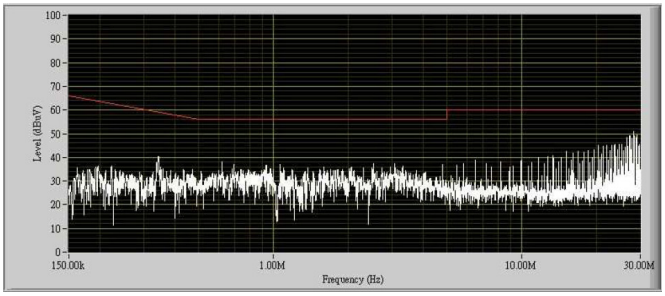
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

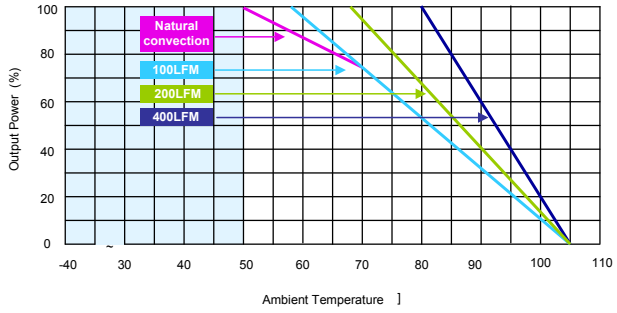
All test conditions are at 25°C The figures are identical for TEN 20-1212 (Continued)



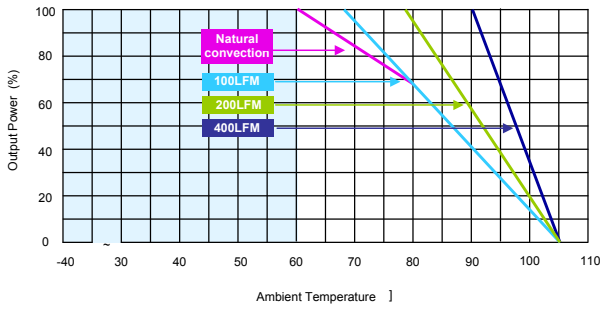
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



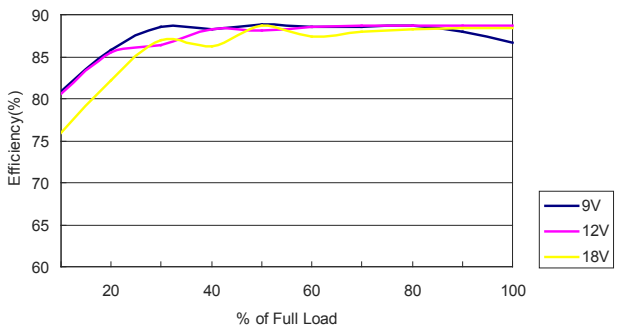
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



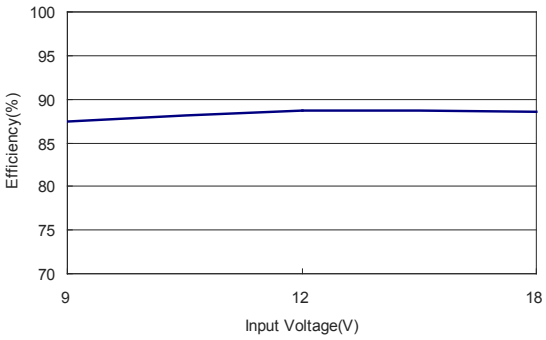
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

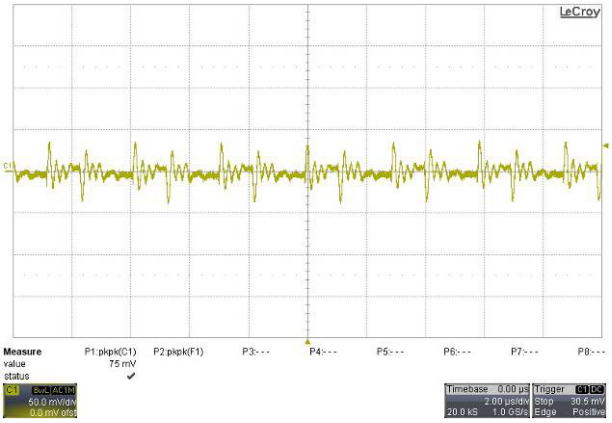
All test conditions are at 25°C The figures are identical for TEN 20-1213



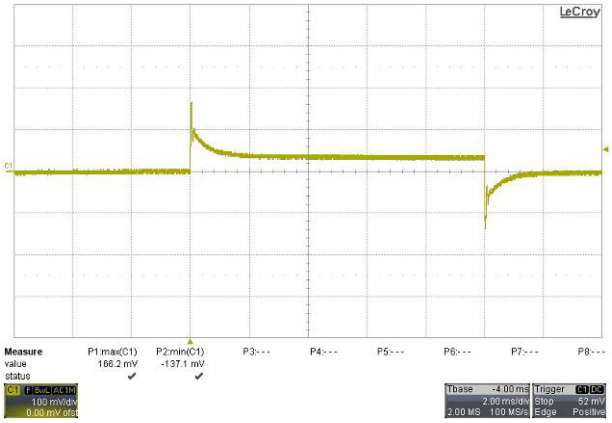
Efficiency Versus Output Current



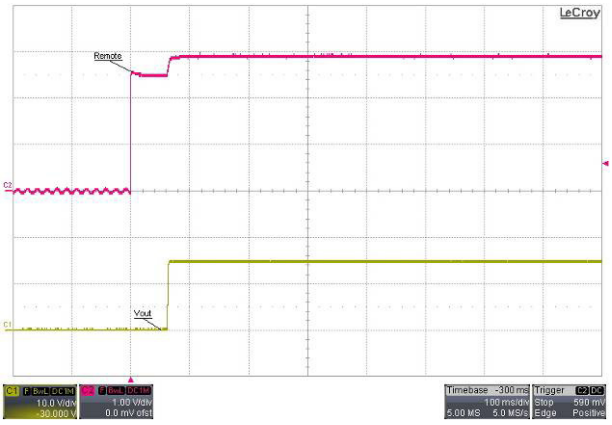
Efficiency Versus Input Voltage
Full Load



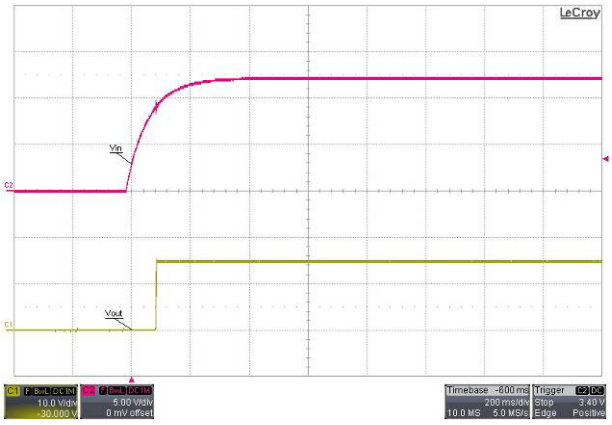
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A



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



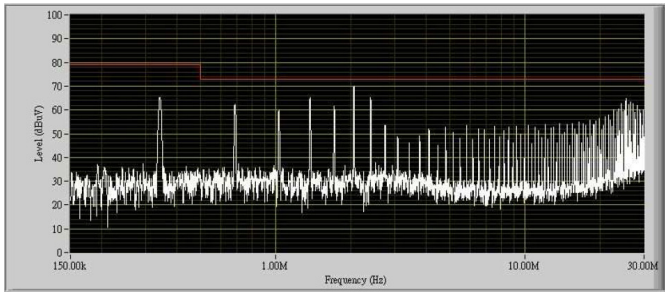
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



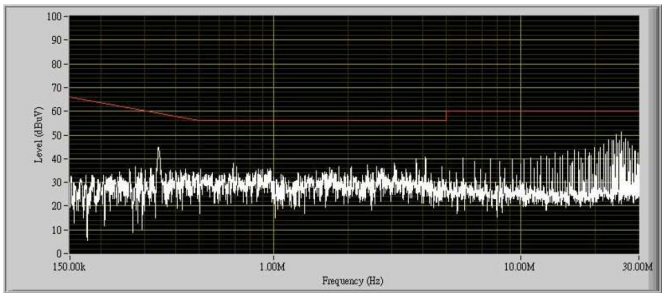
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

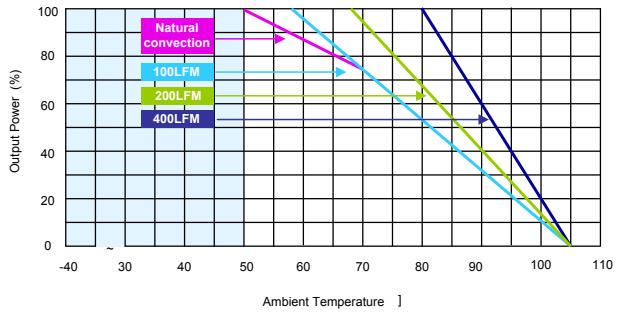
All test conditions are at 25°C The figures are identical for TEN 20-1213 (Continued)



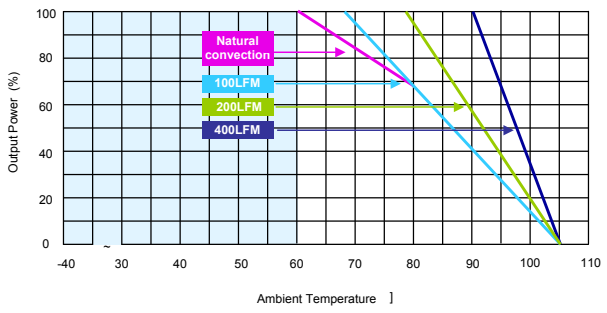
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



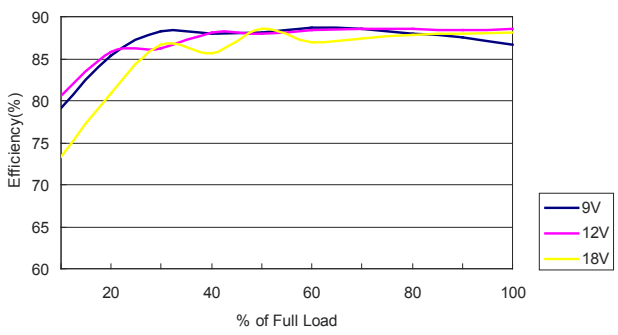
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



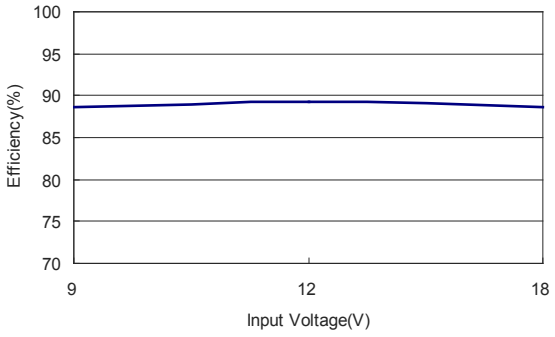
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

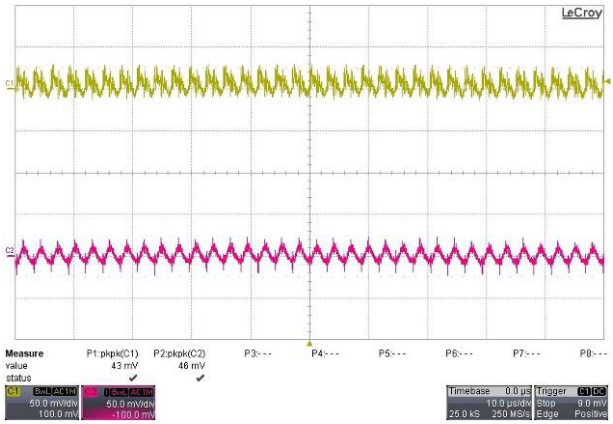
All test conditions are at 25°C The figures are identical for TEN 20-1222



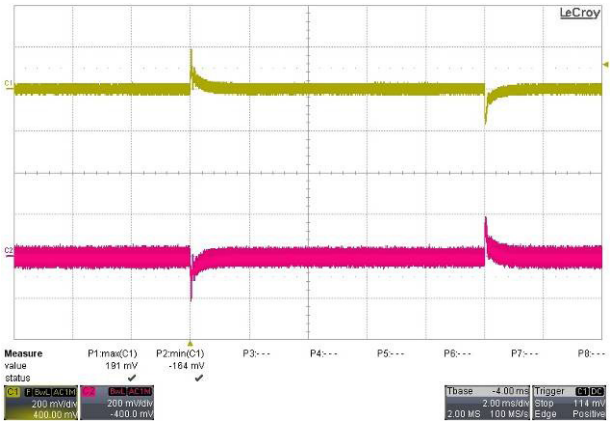
Efficiency Versus Output Current



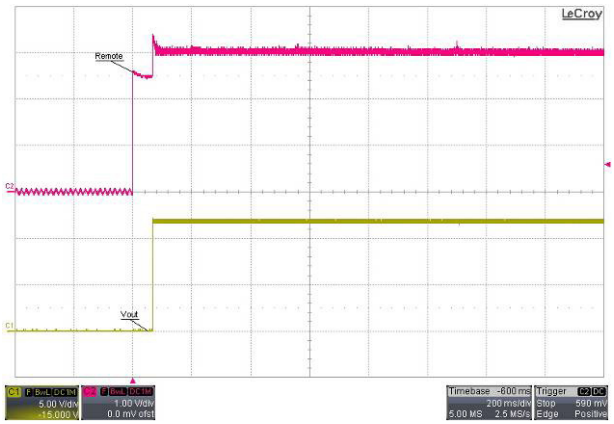
Efficiency Versus Input Voltage
Full Load



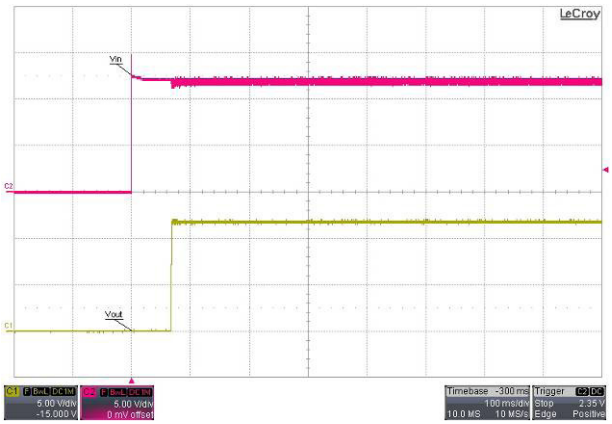
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



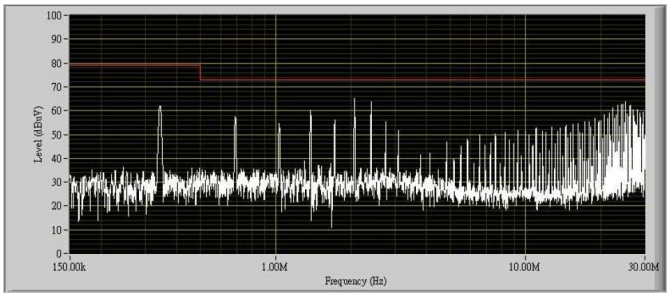
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



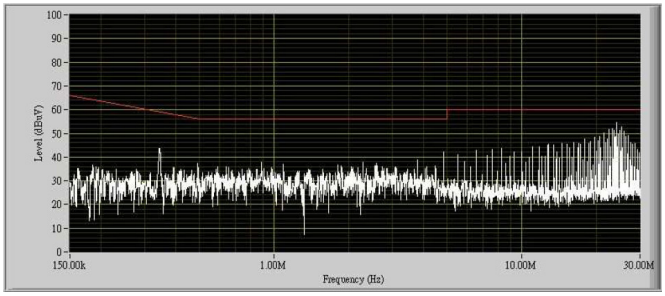
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

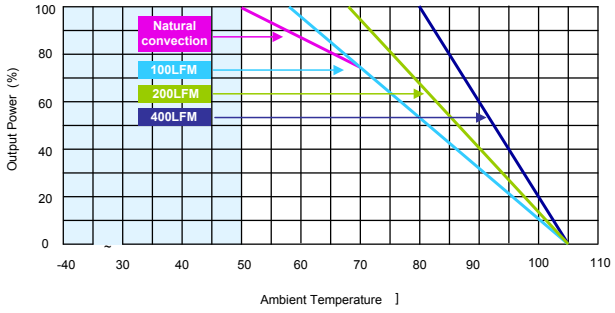
All test conditions are at 25°C The figures are identical for TEN 20-1222 (Continued)



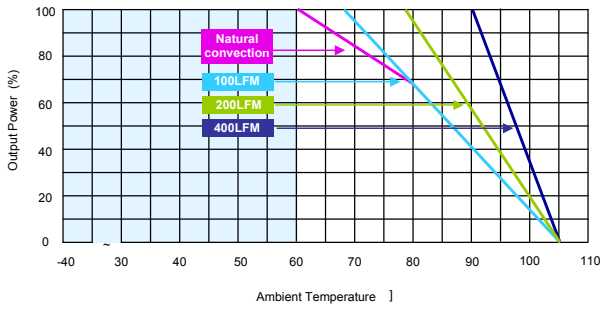
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



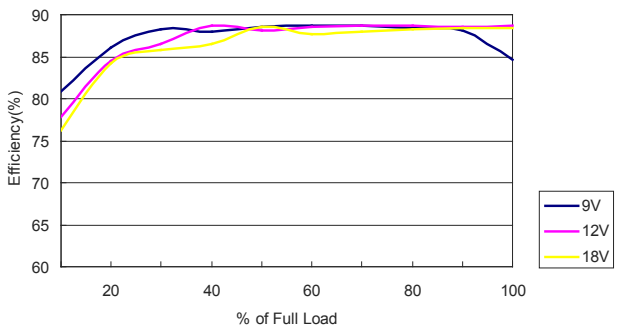
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



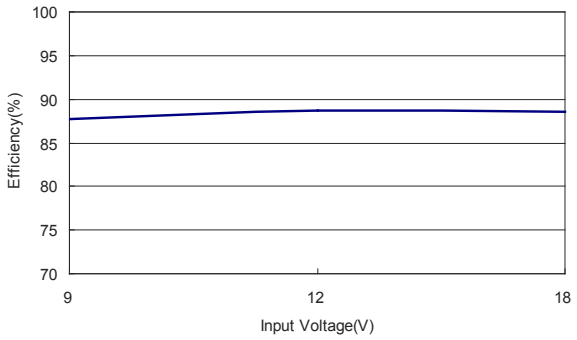
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

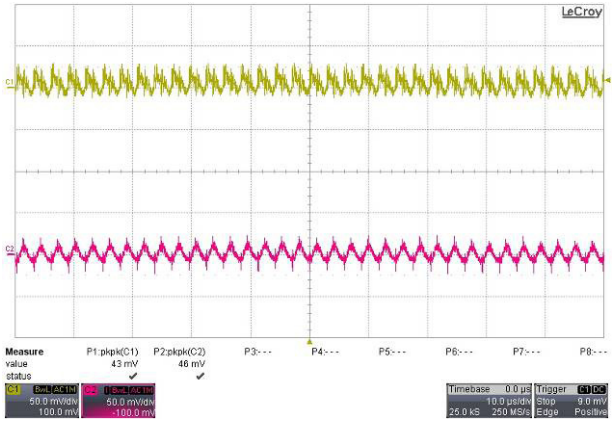
All test conditions are at 25°C The figures are identical for TEN 20-1223



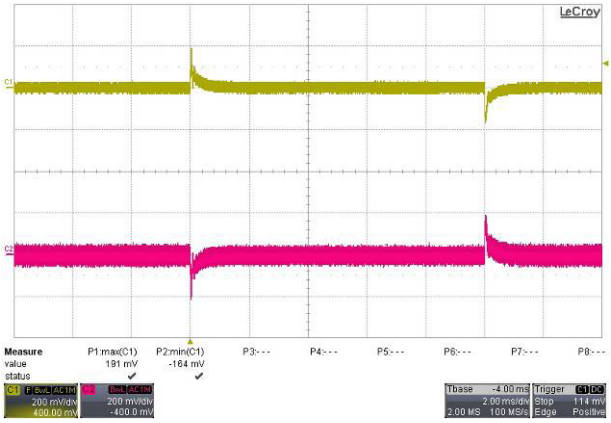
Efficiency Versus Output Current



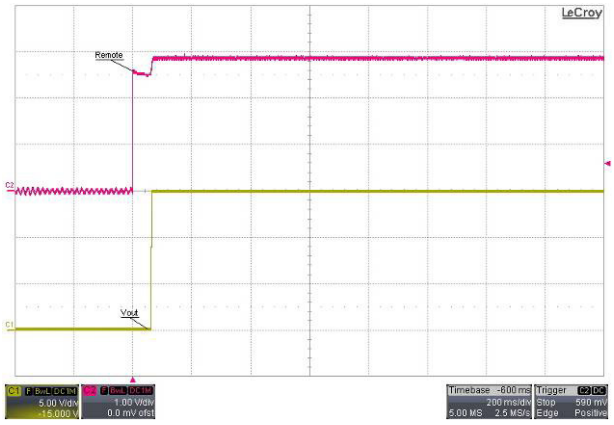
Efficiency Versus Input Voltage
Full Load



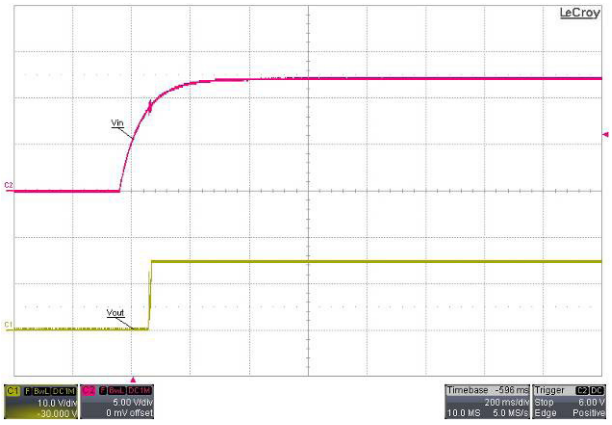
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



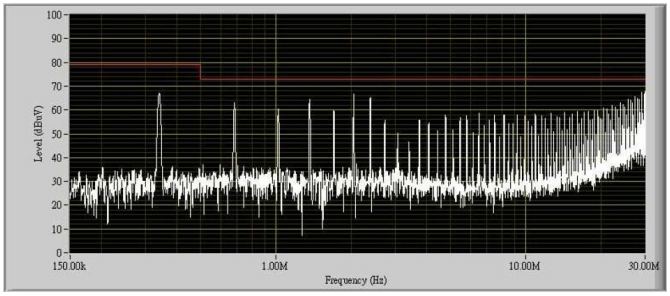
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



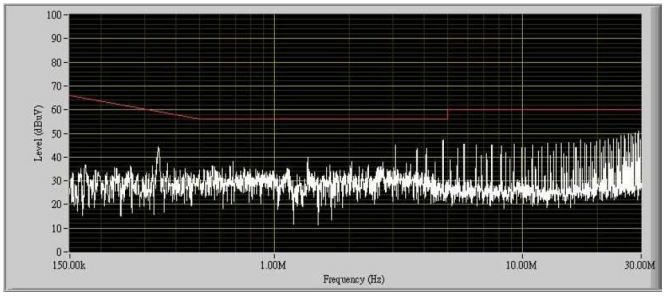
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

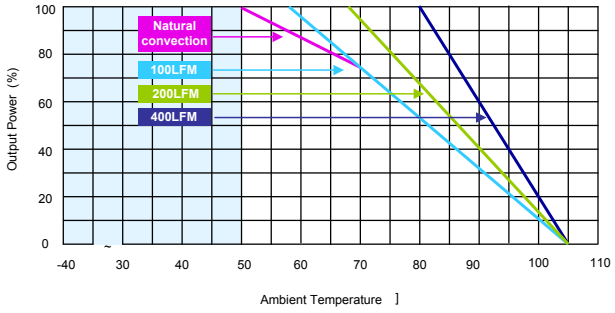
All test conditions are at 25°C The figures are identical for TEN 20-1223 (Continued)



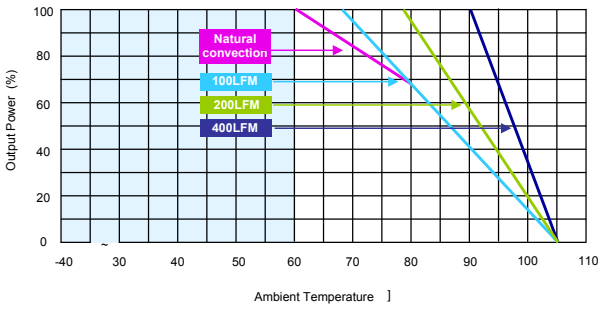
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



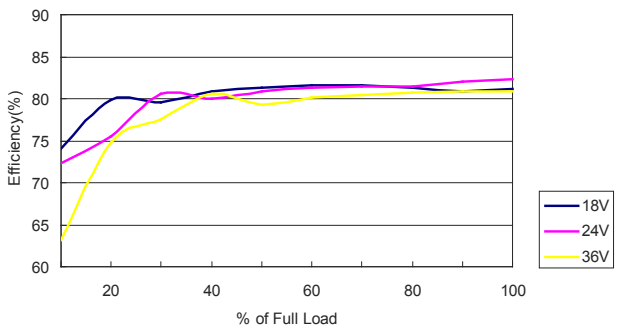
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



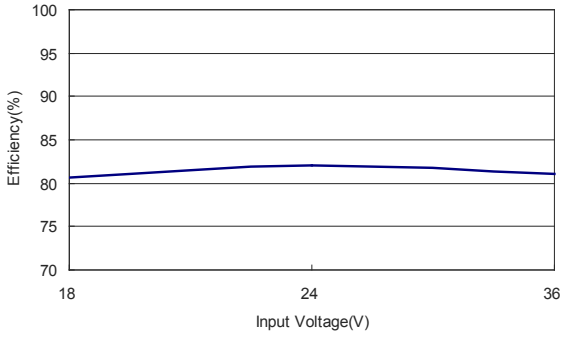
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

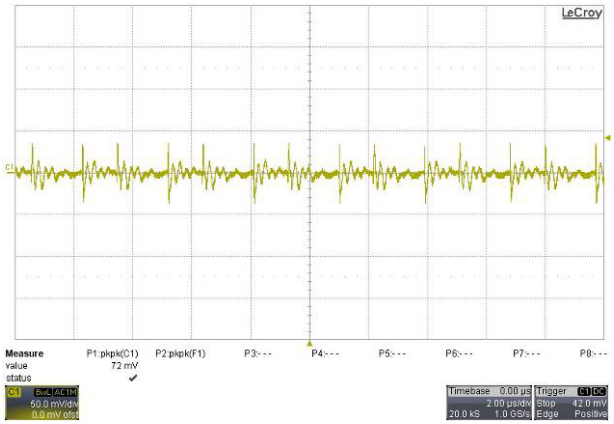
All test conditions are at 25°C The figures are identical for TEN 20-2410



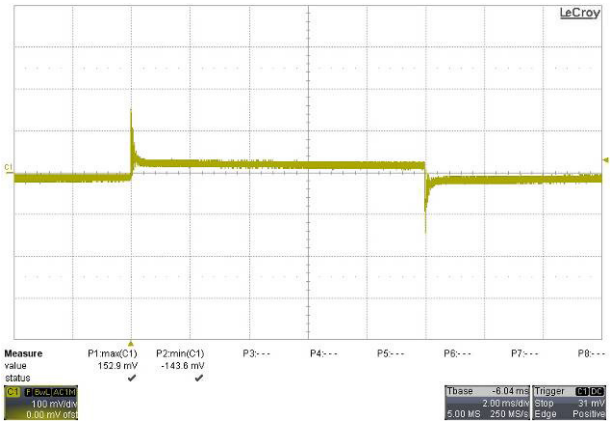
Efficiency Versus Output Current



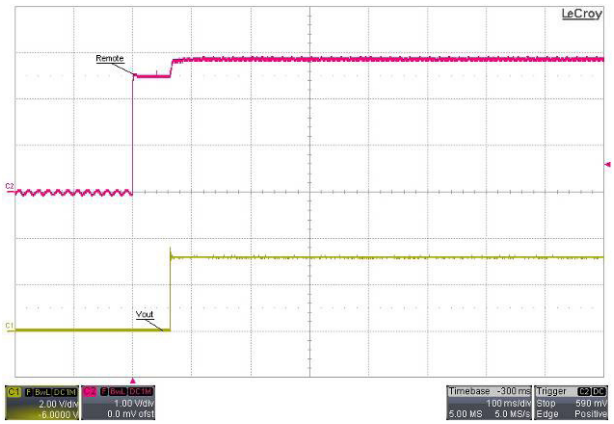
Efficiency Versus Input Voltage
Full Load



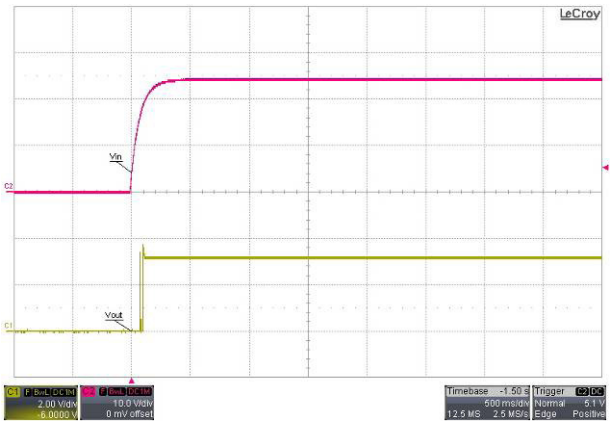
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



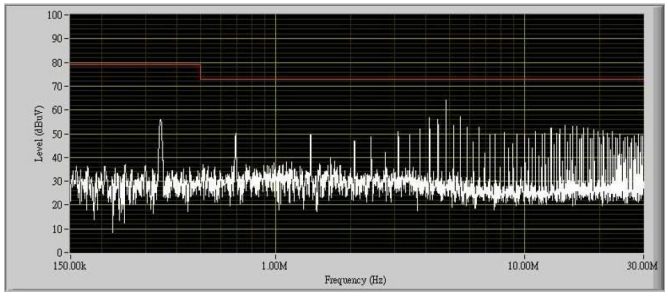
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



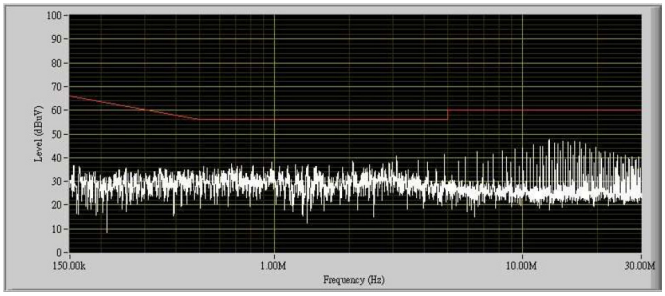
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

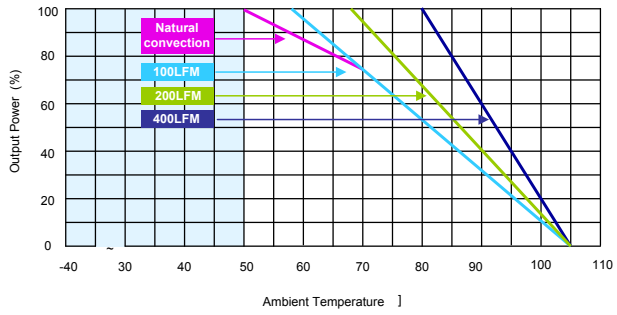
All test conditions are at 25°C The figures are identical for TEN 20-2410 (Continued)



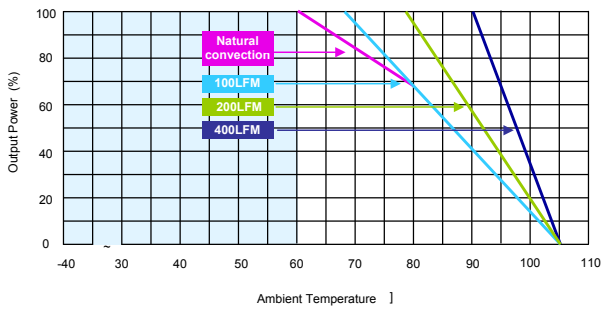
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



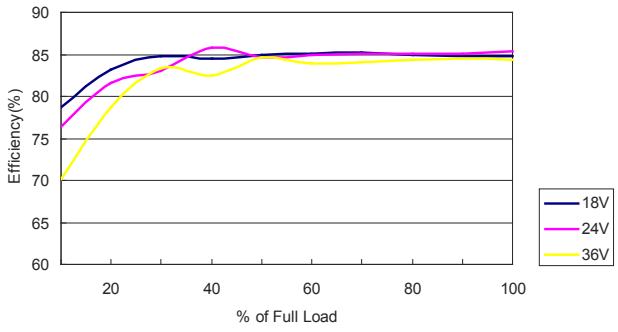
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



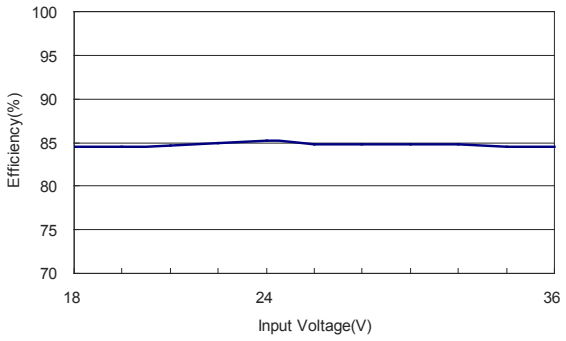
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

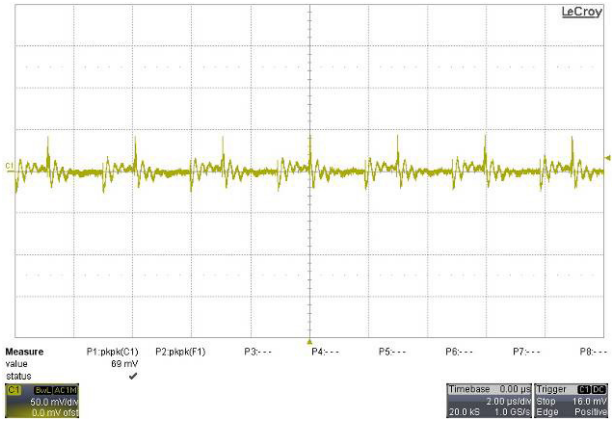
All test conditions are at 25°C The figures are identical for TEN 20-2411



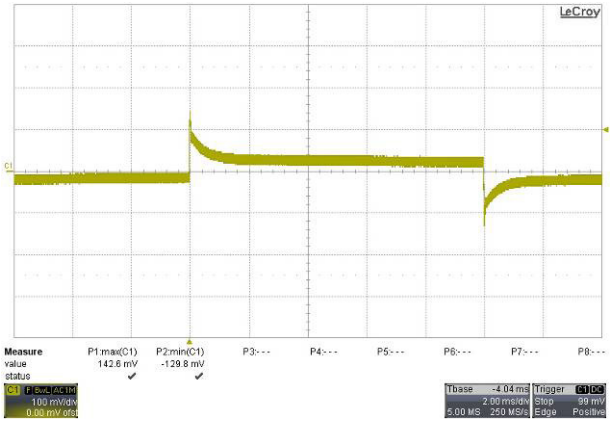
Efficiency Versus Output Current



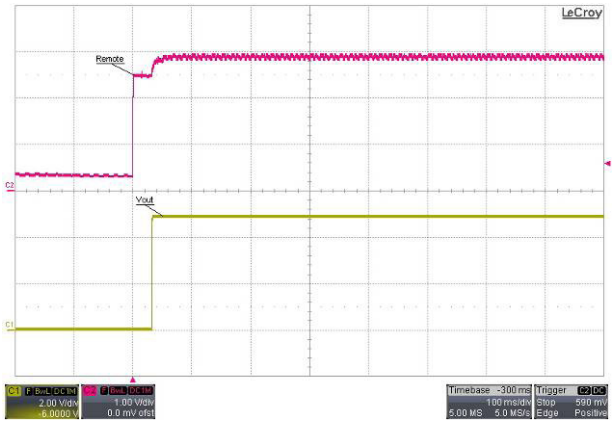
Efficiency Versus Input Voltage
Full Load



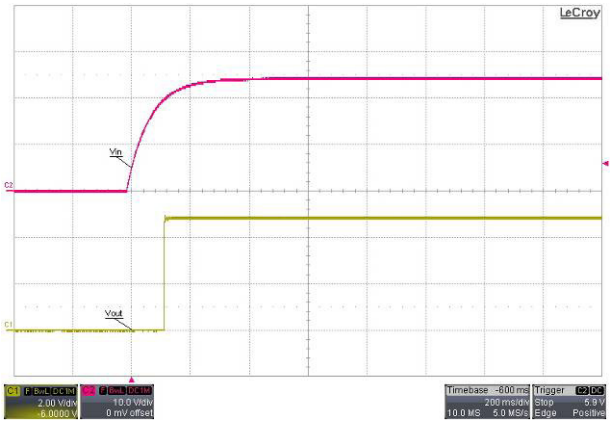
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



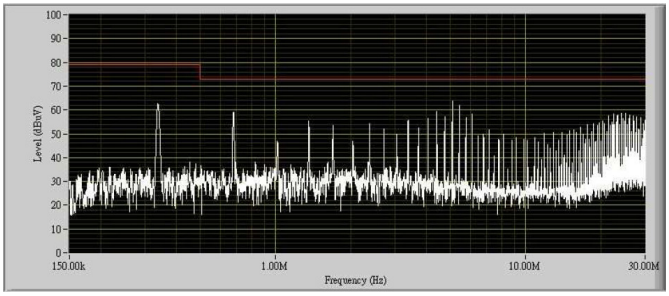
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



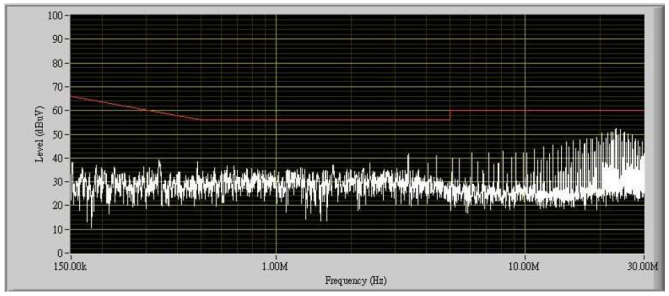
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

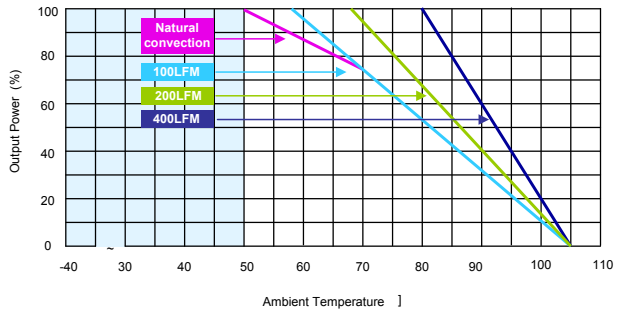
All test conditions are at 25°C The figures are identical for TEN 20-2411 (Continued)



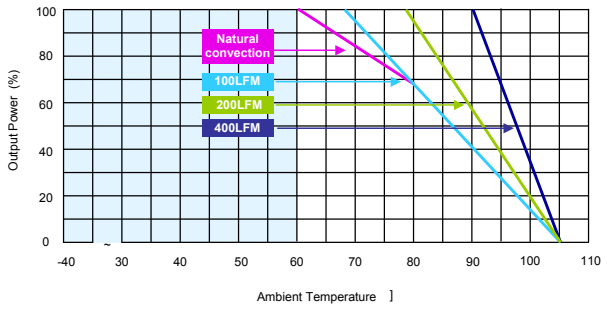
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



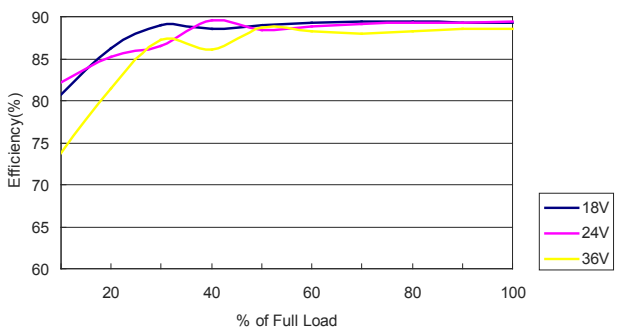
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



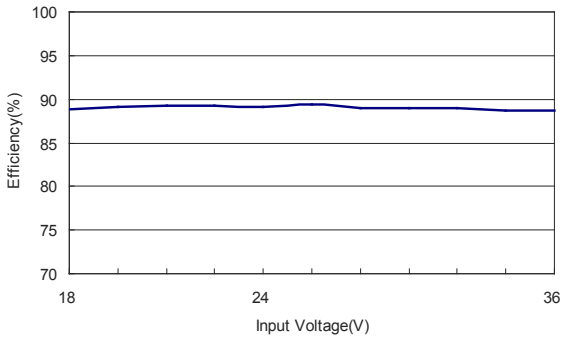
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

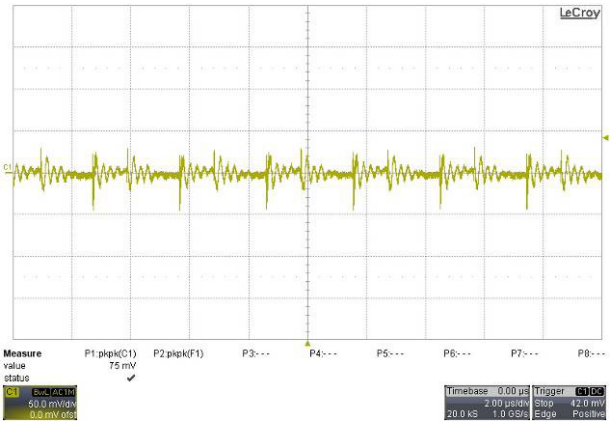
All test conditions are at 25°C The figures are identical for TEN 20-2412



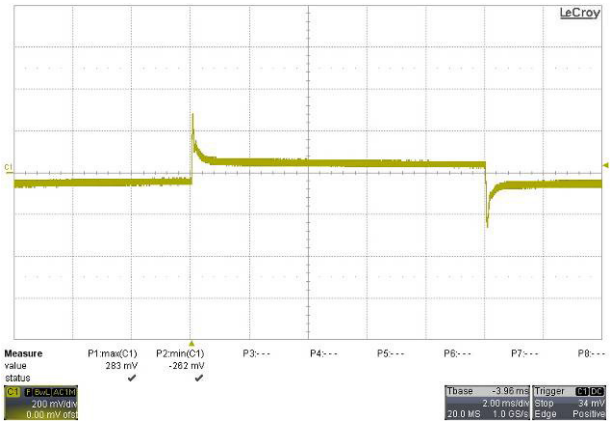
Efficiency Versus Output Current



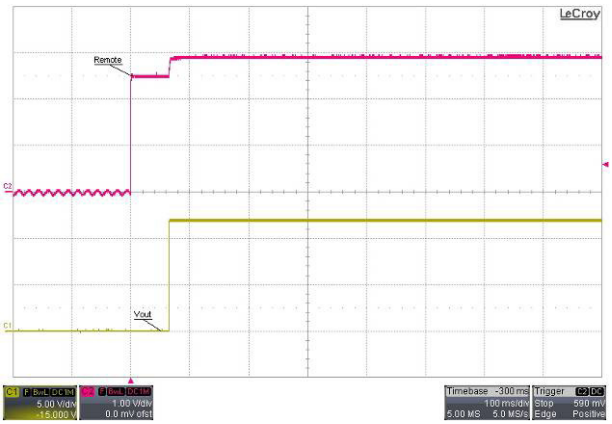
Efficiency Versus Input Voltage
Full Load



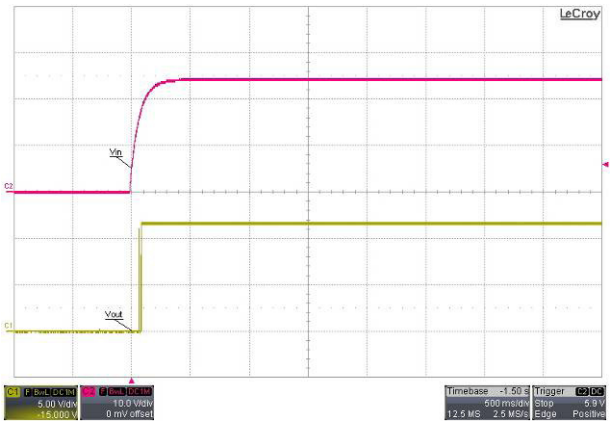
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



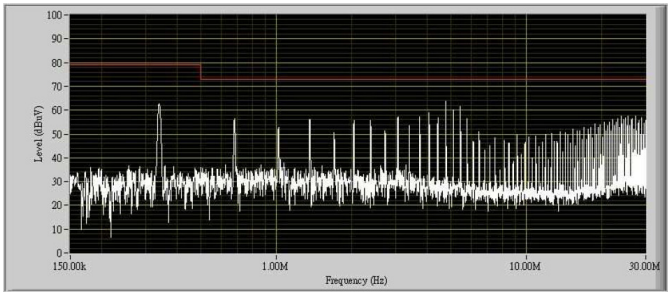
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



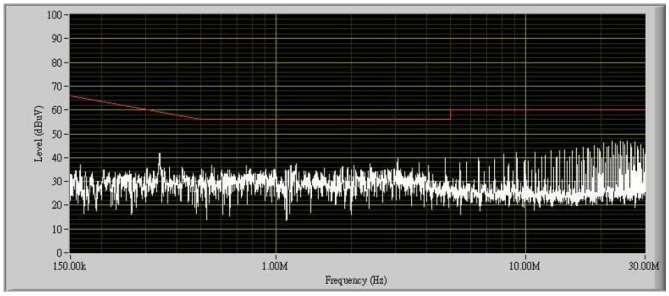
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

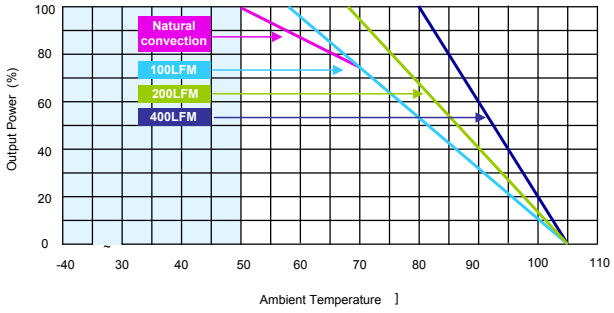
All test conditions are at 25°C The figures are identical for TEN 20-2412(Continued)



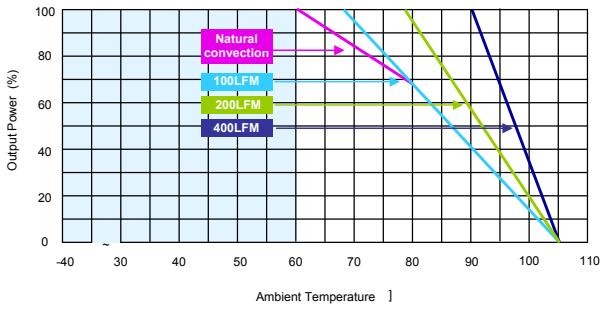
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



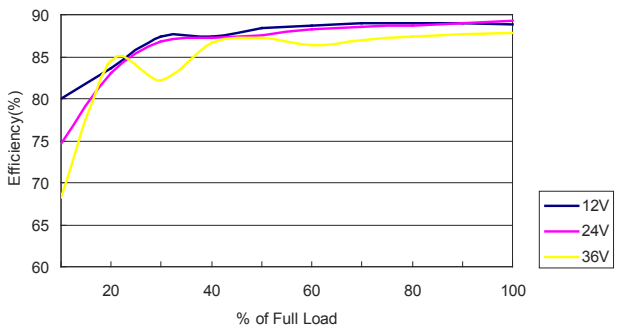
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



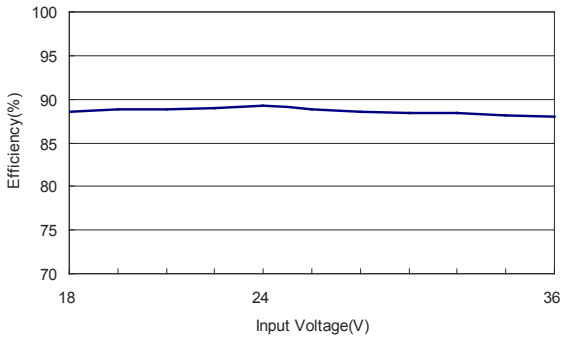
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

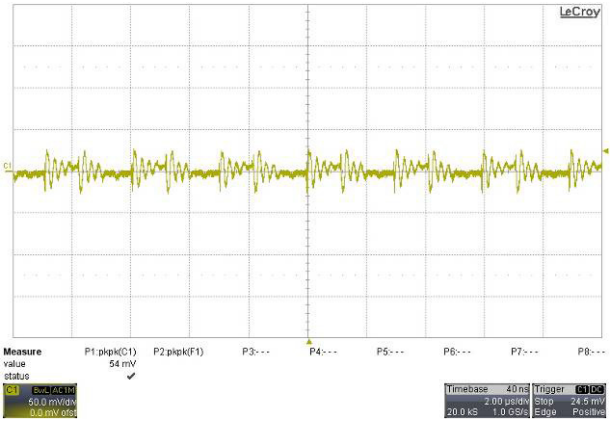
All test conditions are at 25°C The figures are identical for TEN 20-2413



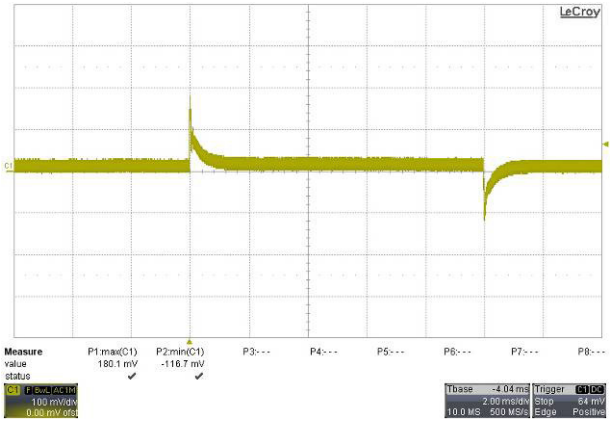
Efficiency Versus Output Current



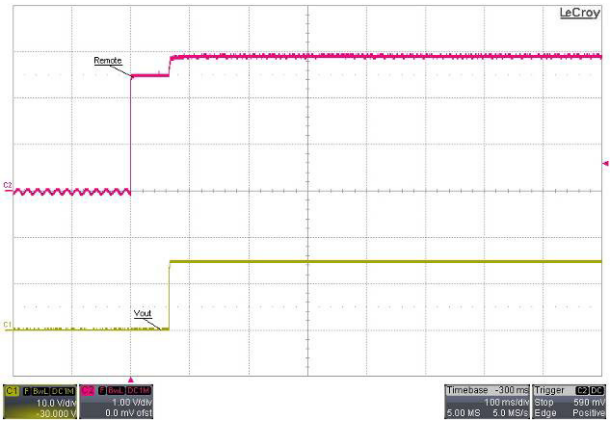
Efficiency Versus Input Voltage
Full Load



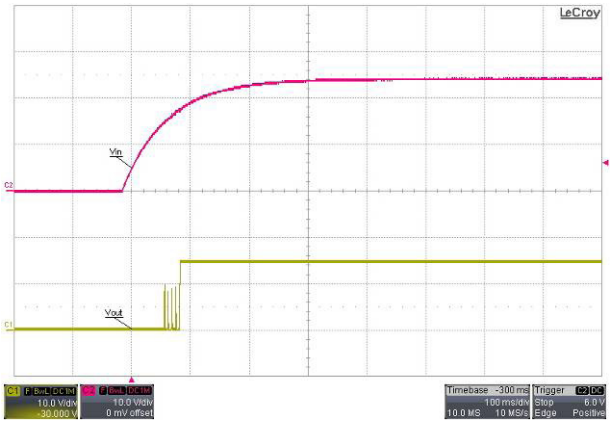
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



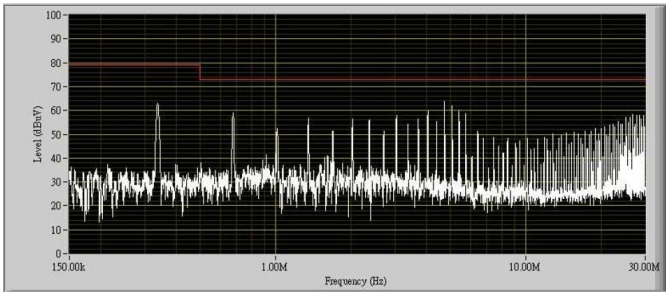
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



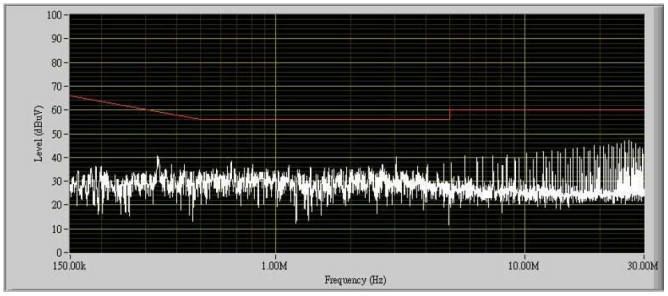
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

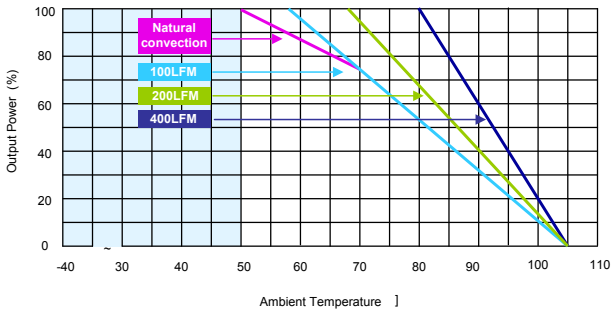
All test conditions are at 25°C The figures are identical for TEN 20-2413 (Continued)



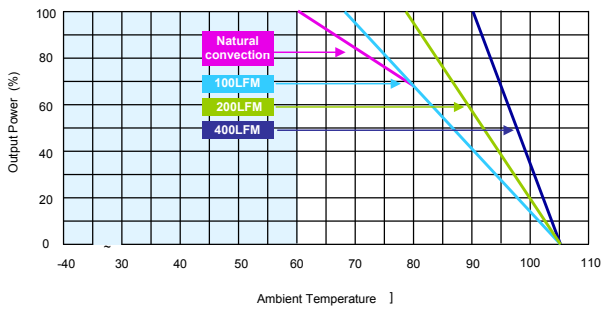
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



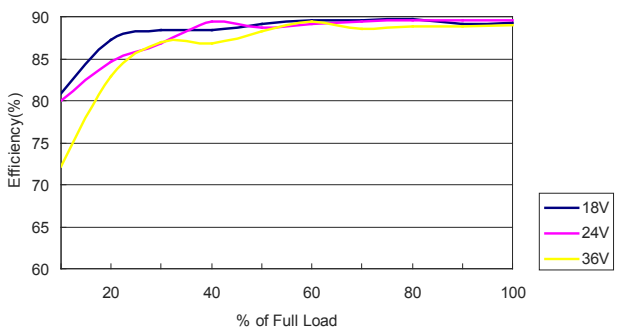
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



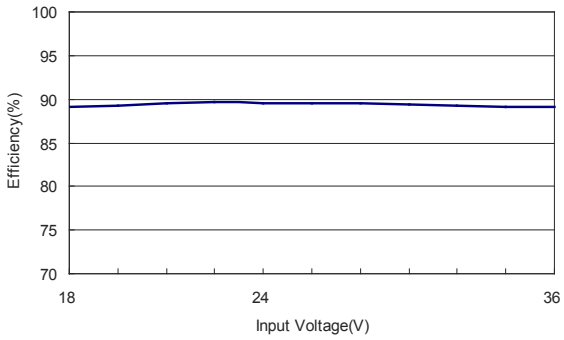
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

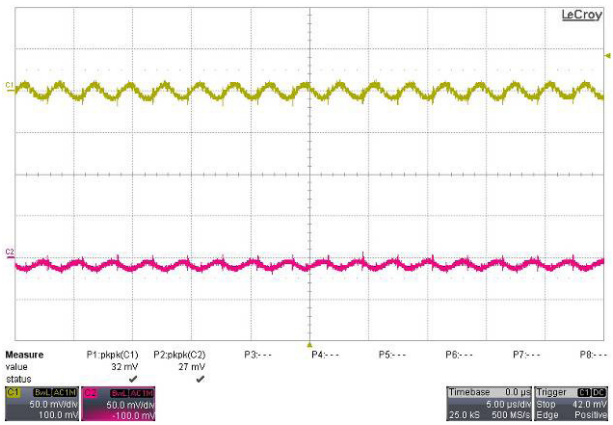
All test conditions are at 25°C The figures are identical for TEN 20-2422



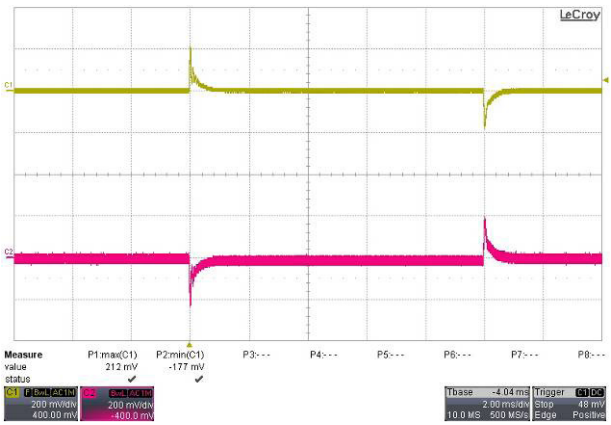
Efficiency Versus Output Current



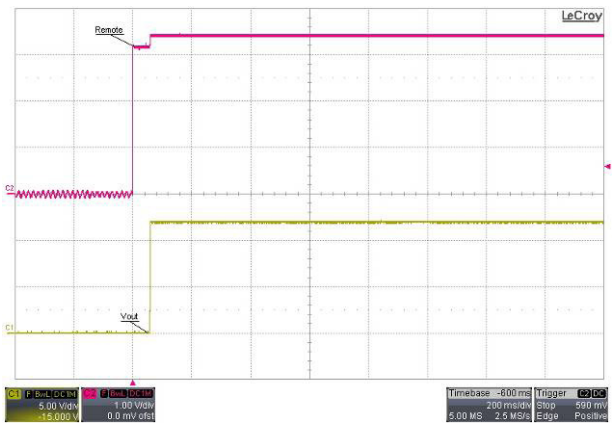
Efficiency Versus Input Voltage
Full Load



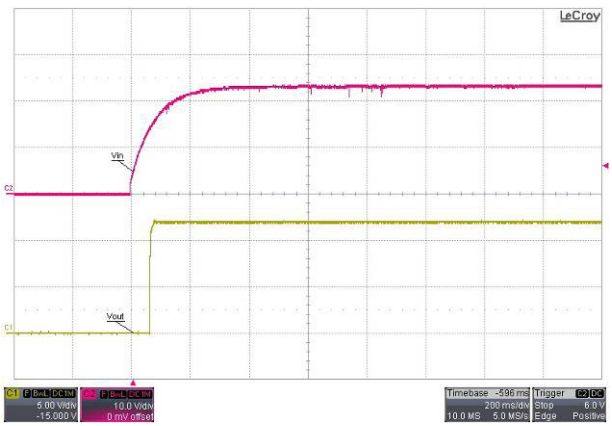
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



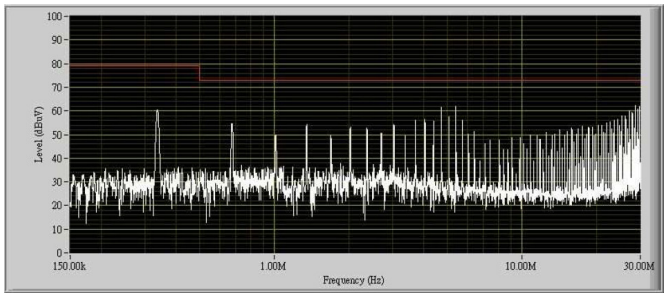
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



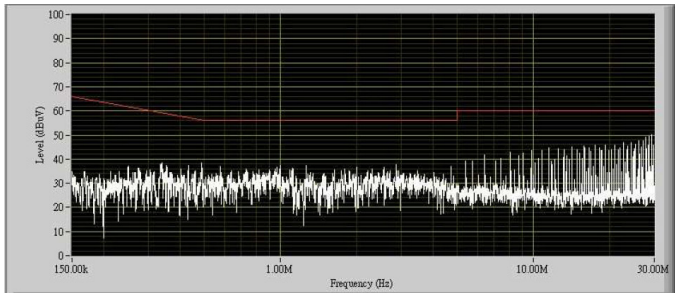
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

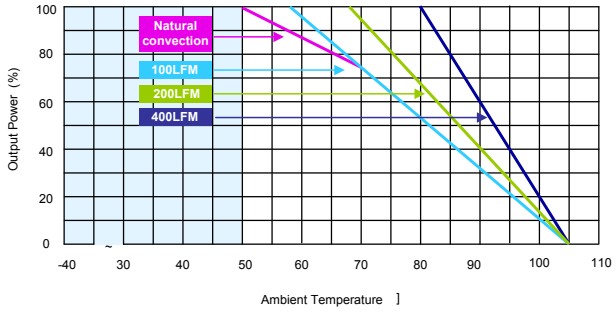
All test conditions are at 25°C The figures are identical for TEN 20-2422 (Continued)



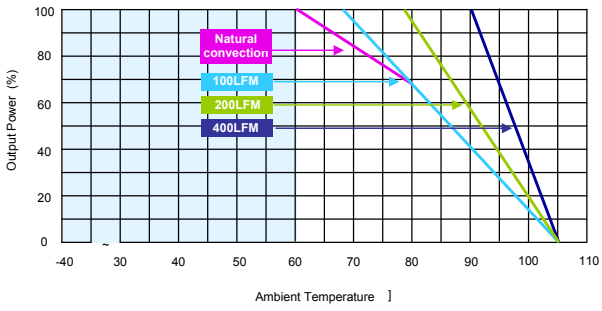
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



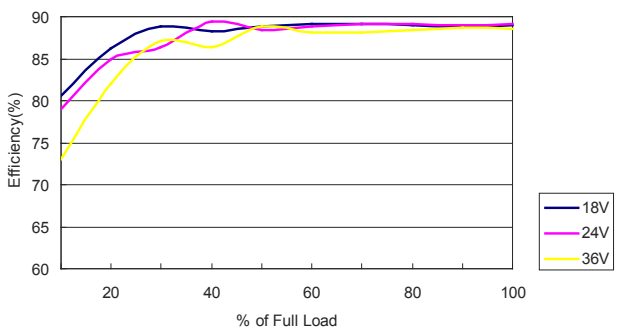
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



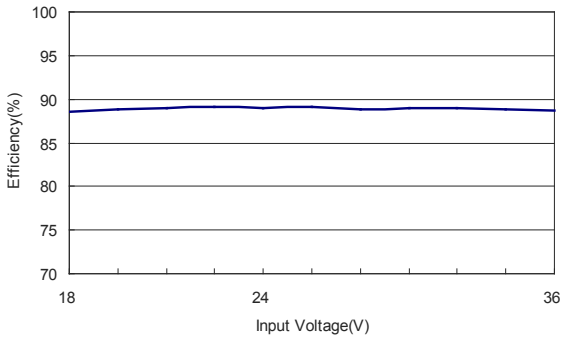
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

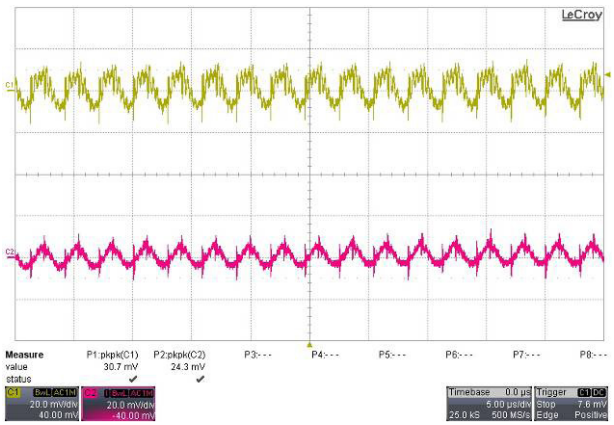
All test conditions are at 25°C The figures are identical for TEN 20-2423



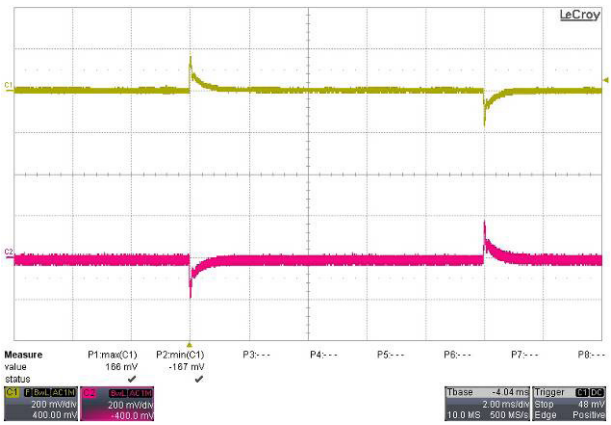
Efficiency Versus Output Current



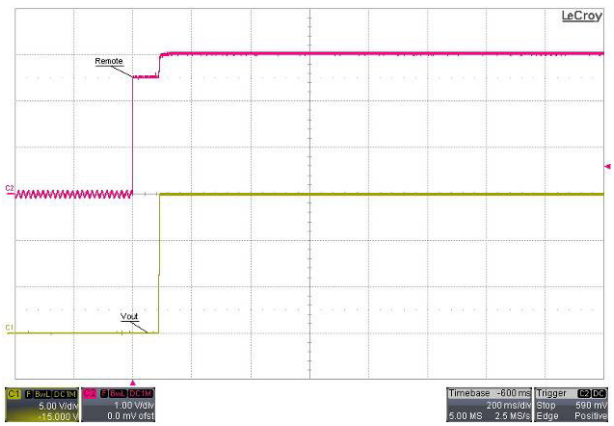
Efficiency Versus Input Voltage
Full Load



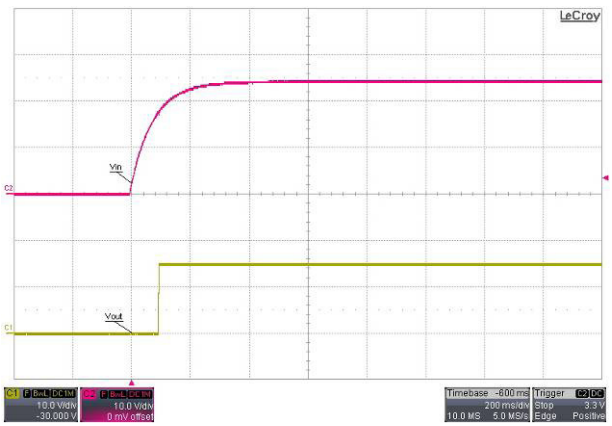
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



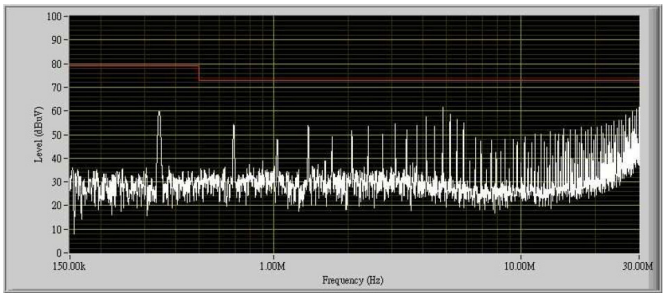
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



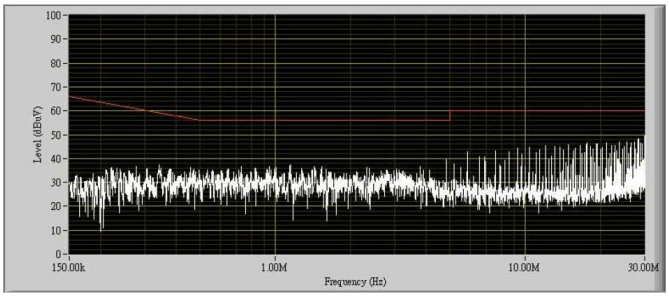
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

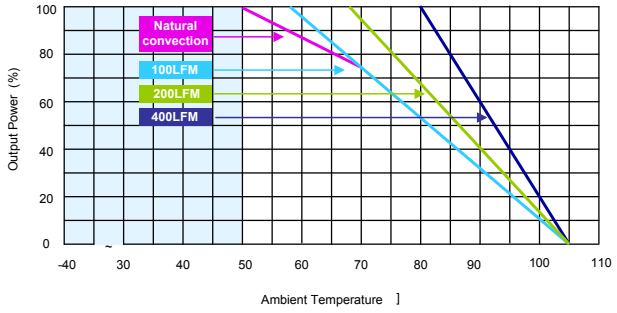
All test conditions are at 25°C The figures are identical for TEN 20-2423 (Continued)



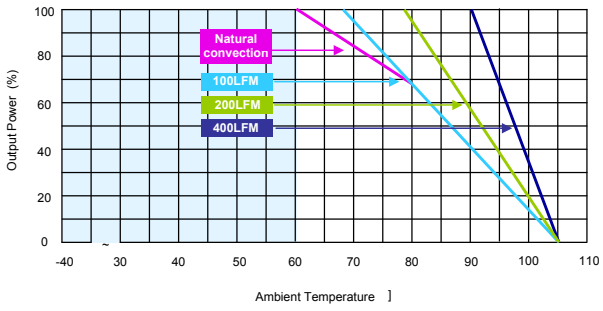
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



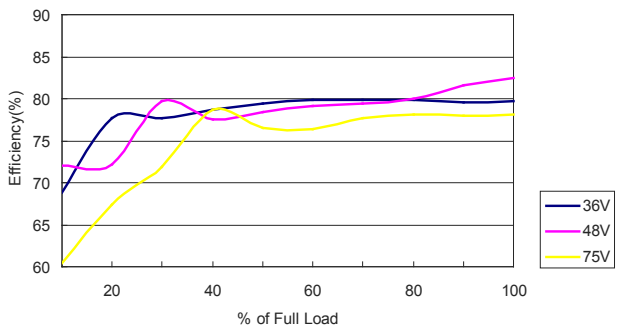
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



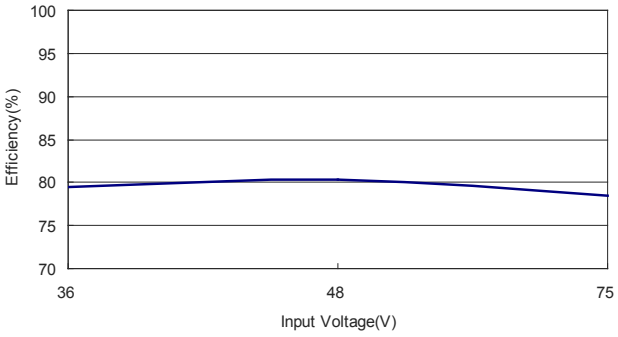
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

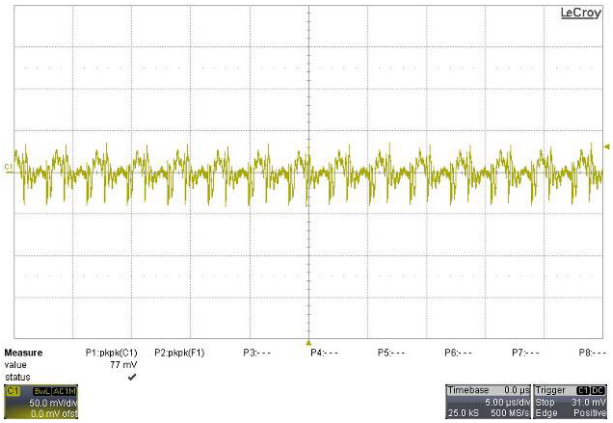
All test conditions are at 25°C The figures are identical for TEN 20-4810



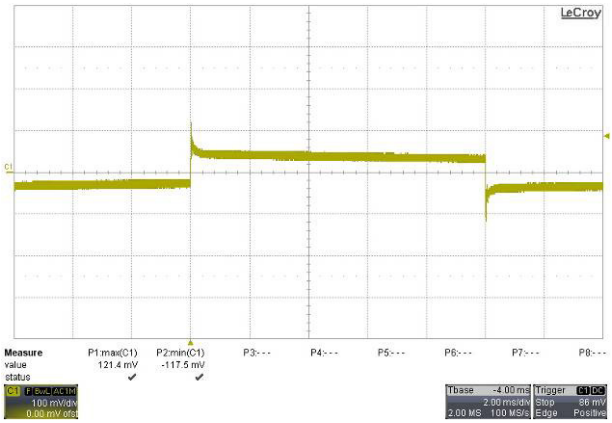
Efficiency Versus Output Current



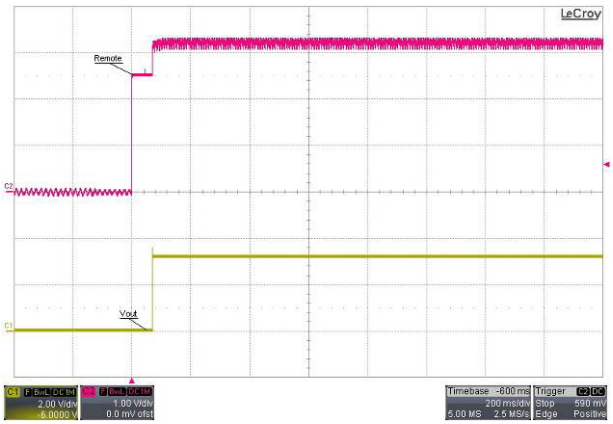
Efficiency Versus Input Voltage
Full Load



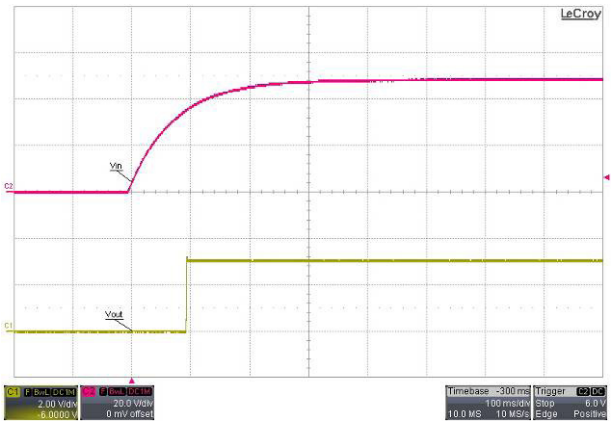
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



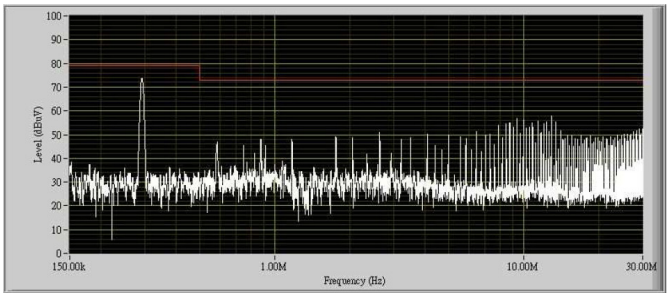
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



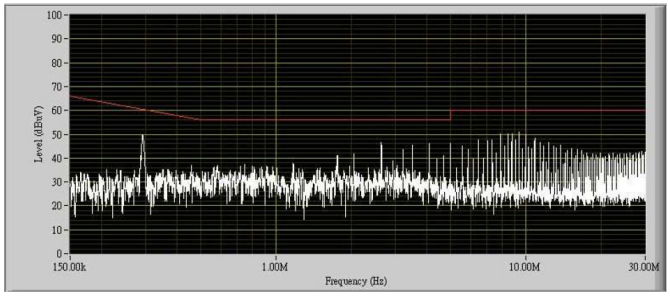
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

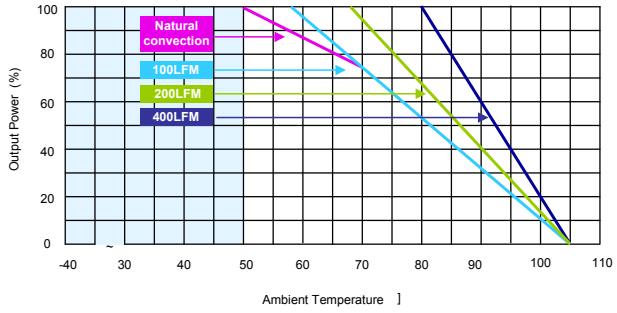
All test conditions are at 25°C The figures are identical for TEN 20-4810 (Continued)



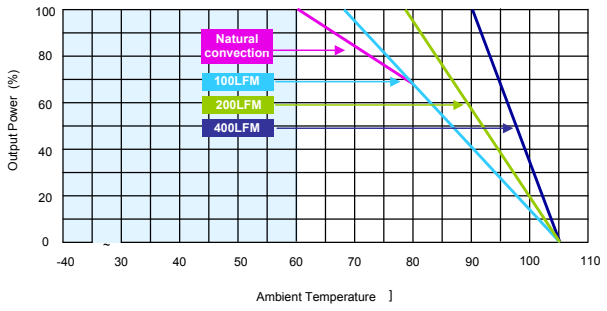
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



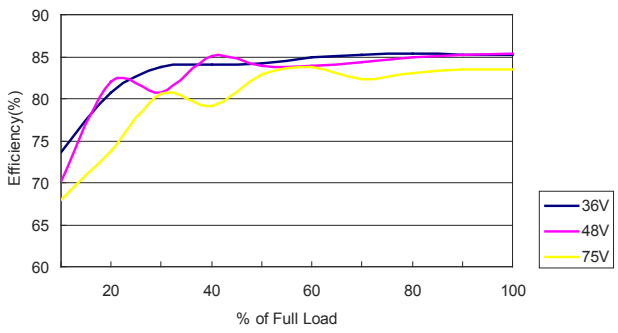
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



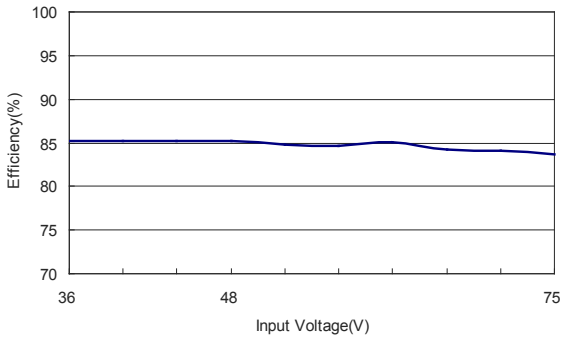
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

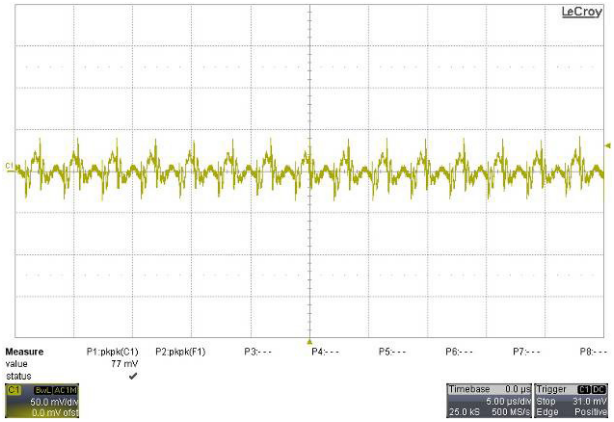
All test conditions are at 25°C The figures are identical for TEN 20-4811



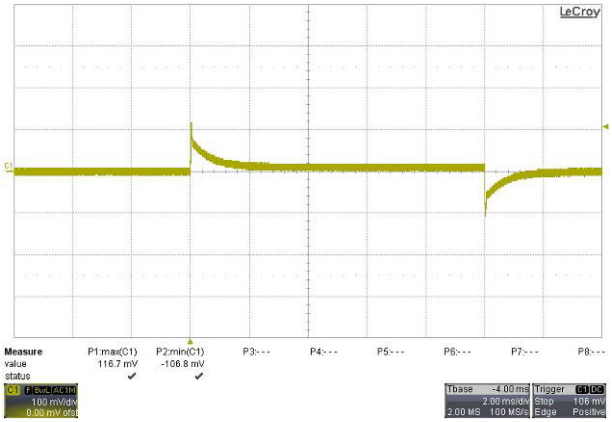
Efficiency Versus Output Current



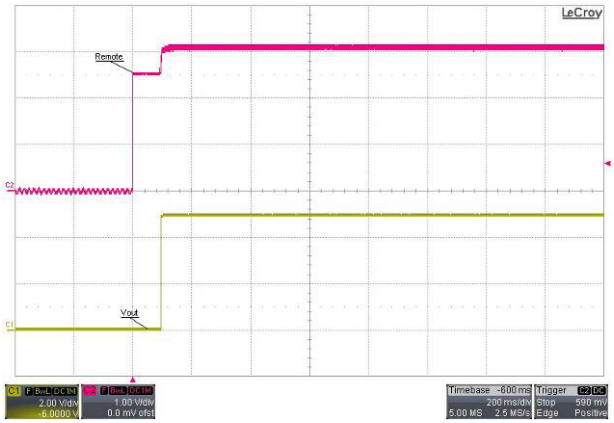
Efficiency Versus Input Voltage
Full Load



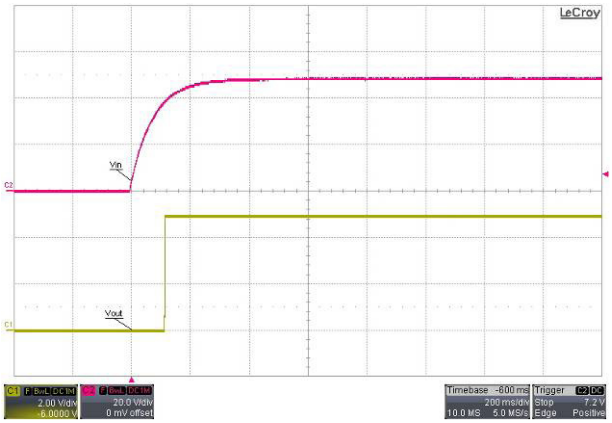
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



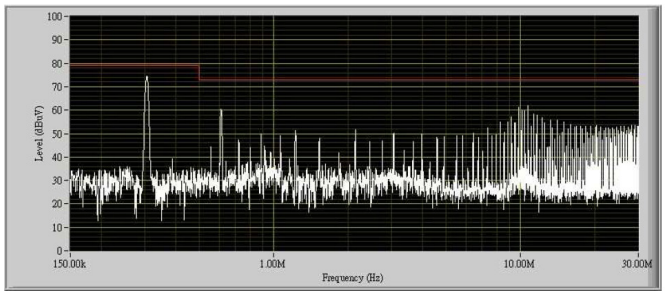
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



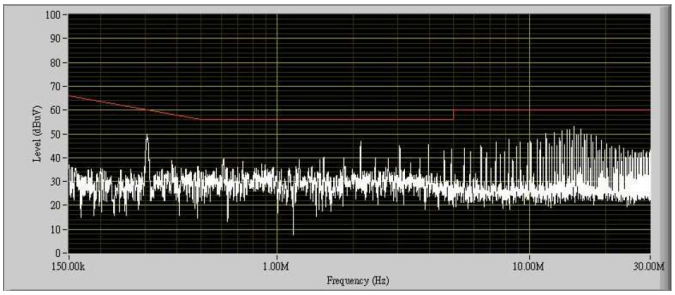
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

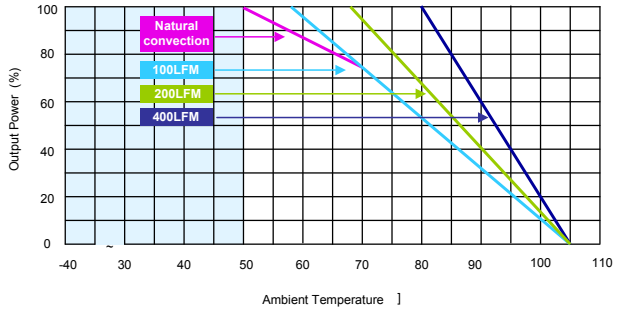
All test conditions are at 25°C The figures are identical for TEN 20-4811(Continued)



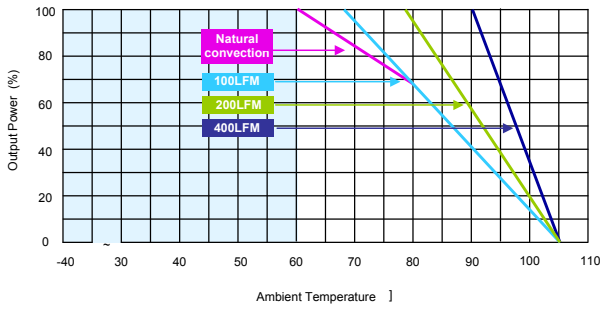
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



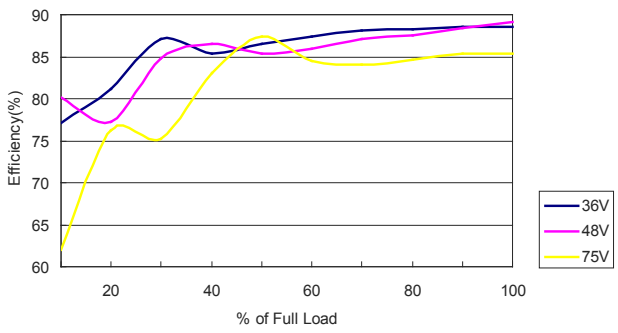
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



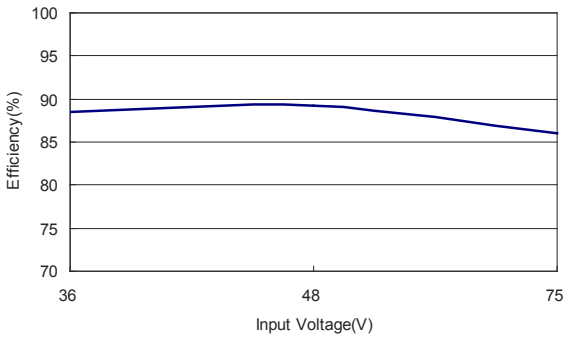
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

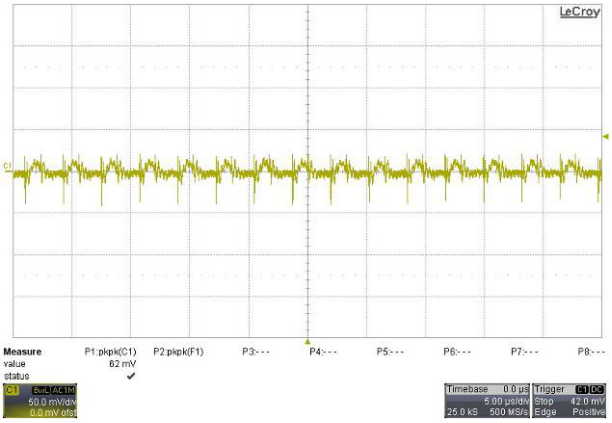
All test conditions are at 25°C The figures are identical for TEN 20-4812



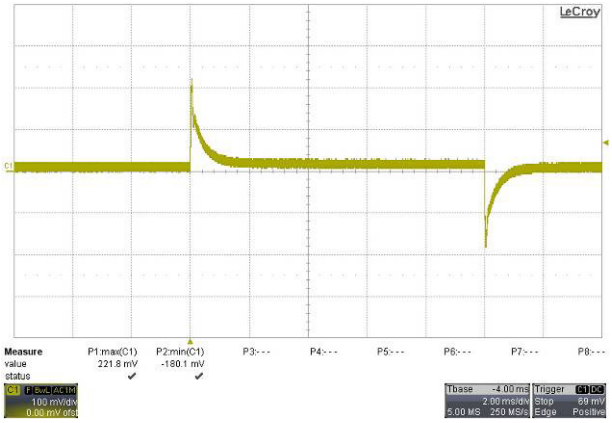
Efficiency Versus Output Current



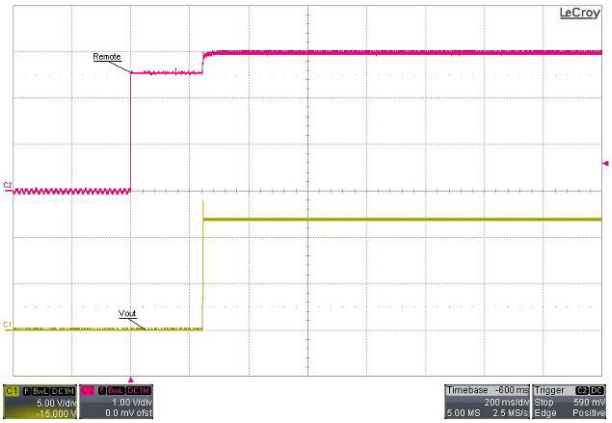
Efficiency Versus Input Voltage
Full Load



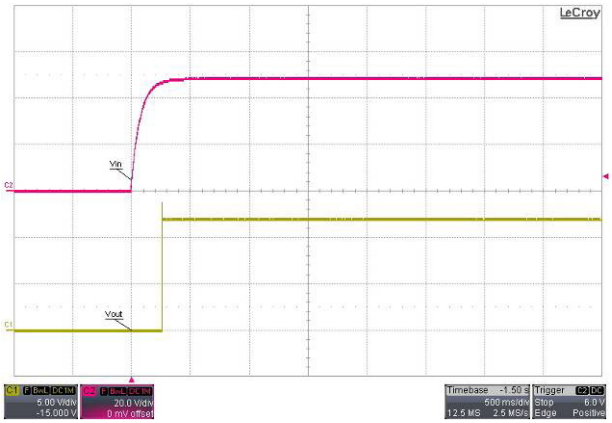
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



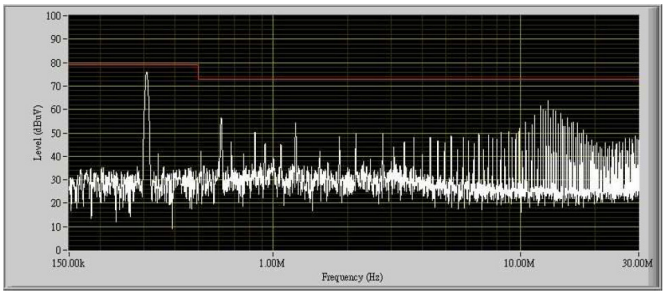
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



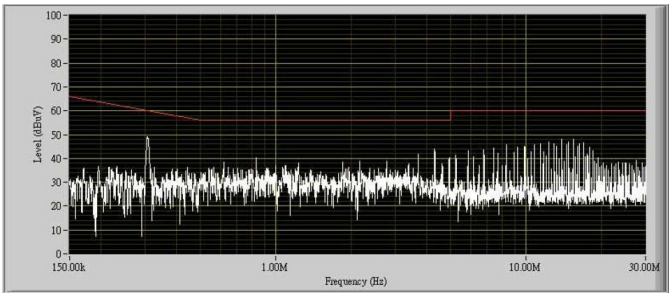
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

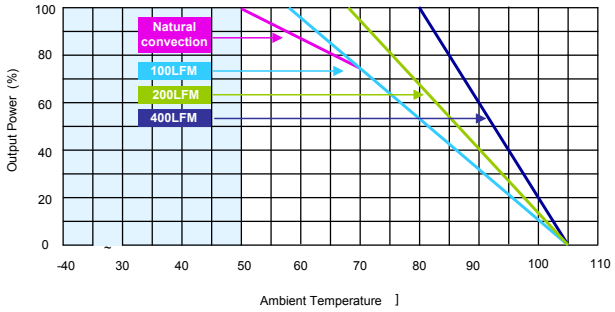
All test conditions are at 25°C The figures are identical for TEN 20-4812 (Continued)



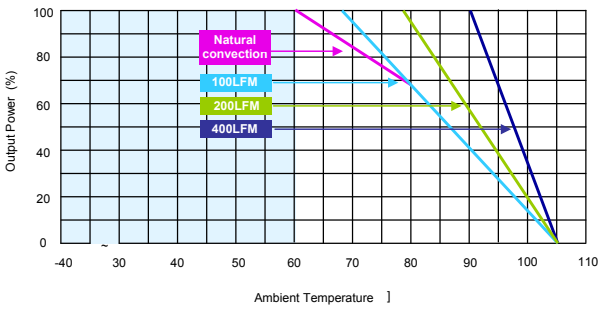
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



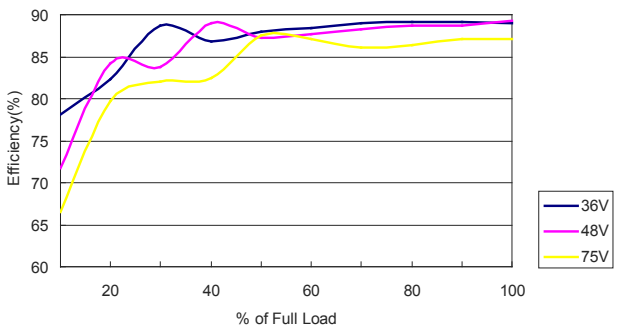
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



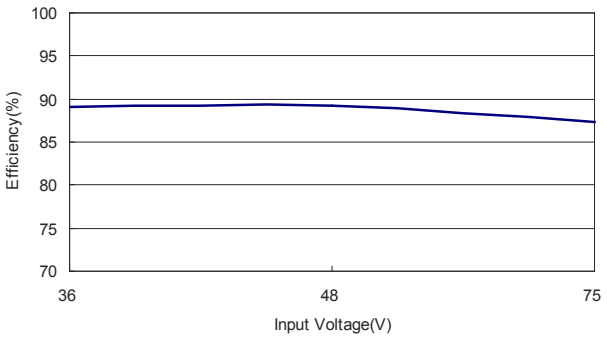
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

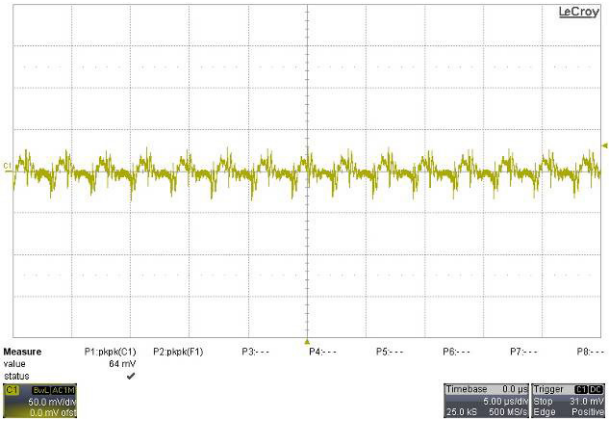
All test conditions are at 25°C The figures are identical for TEN 20-4813



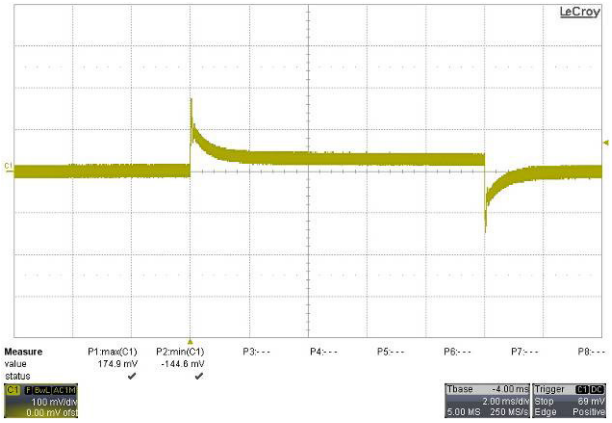
Efficiency Versus Output Current



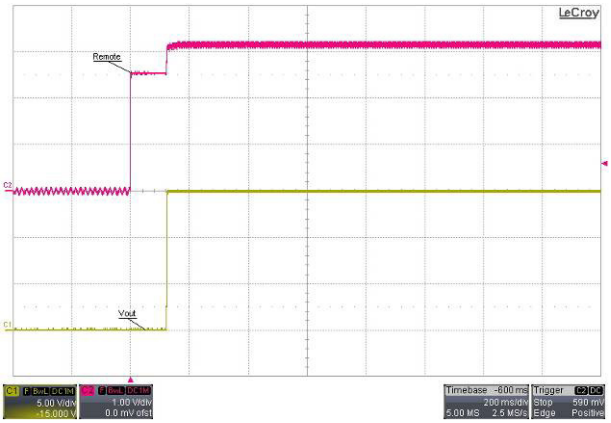
Efficiency Versus Input Voltage
Full Load



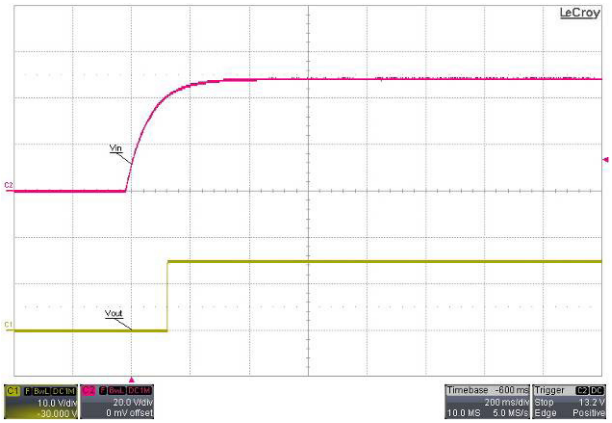
Typical Output Ripple and Noise.
V_{in} = $V_{in\ nom}$; Full Load; T_A



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



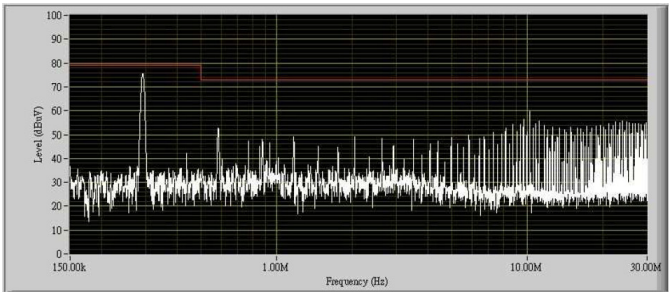
ON/OFF Voltage Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load



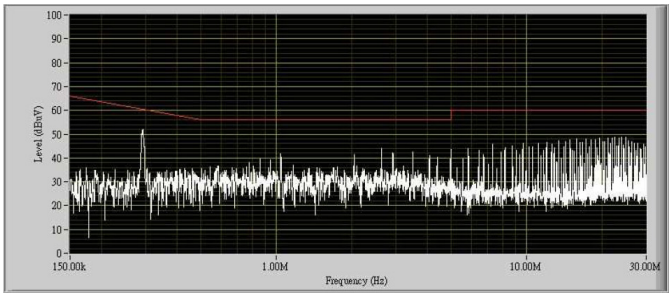
Typical Input Start-Up and Output Rise Characteristic
V_{in} = $V_{in\ nom}$; Full Load

Characteristic Curves

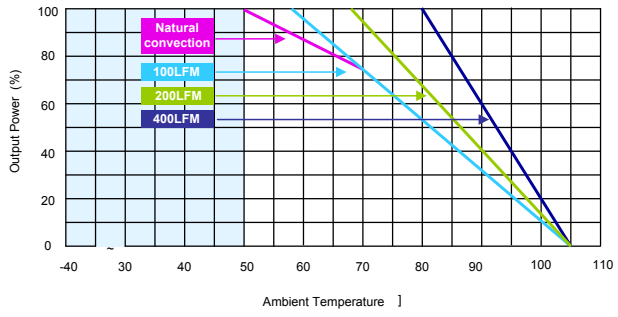
All test conditions are at 25°C The figures are identical for TEN 20-4813 (Continued)



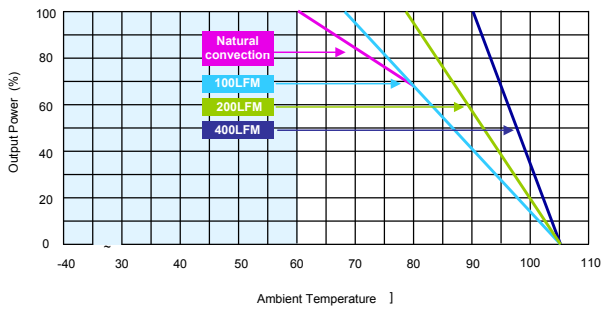
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



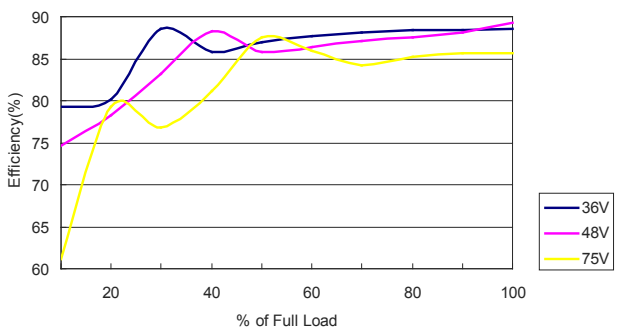
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



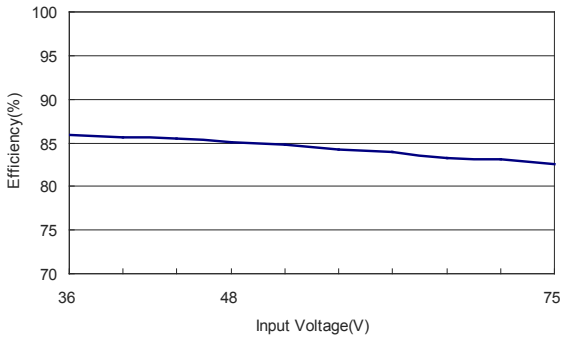
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

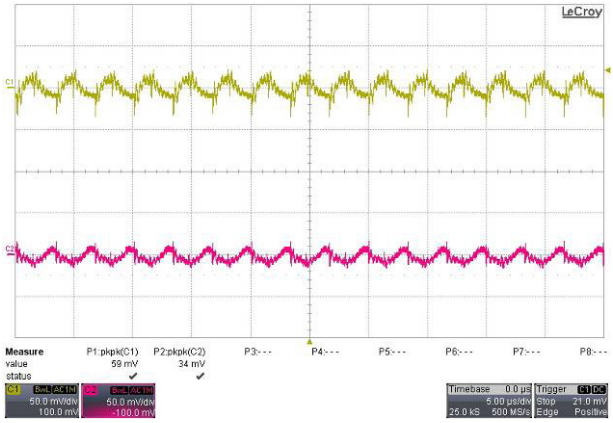
All test conditions are at 25°C The figures are identical for TEN 20-4822



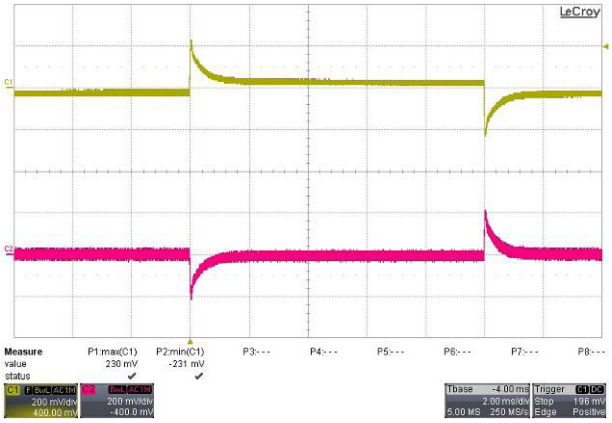
Efficiency Versus Output Current



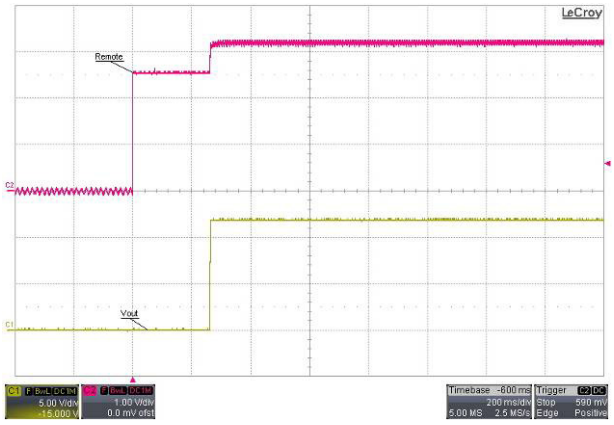
Efficiency Versus Input Voltage
Full Load



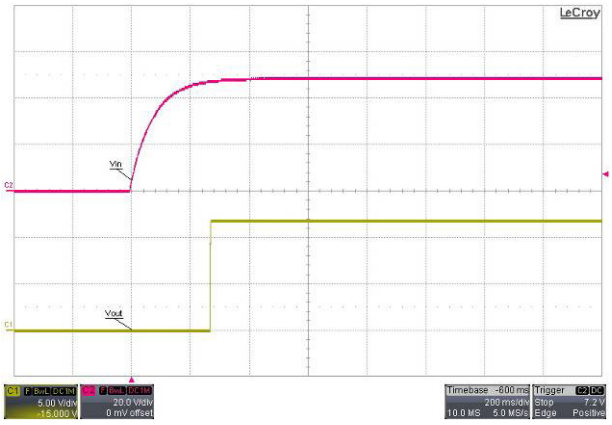
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



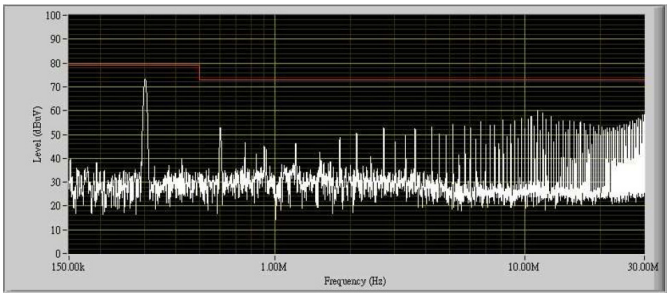
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



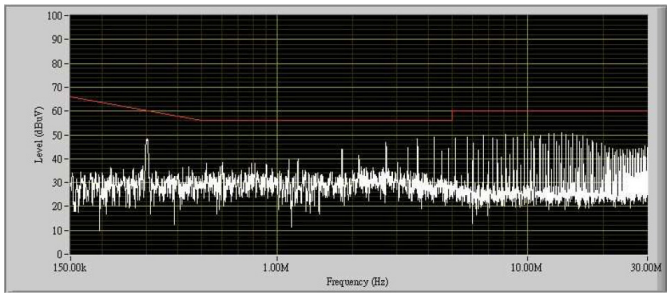
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

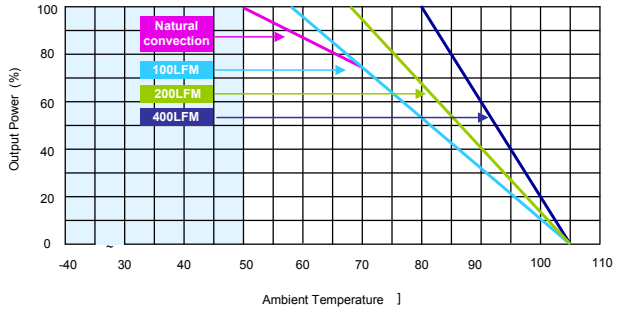
All test conditions are at 25°C The figures are identical for TEN 20-4822 (Continued)



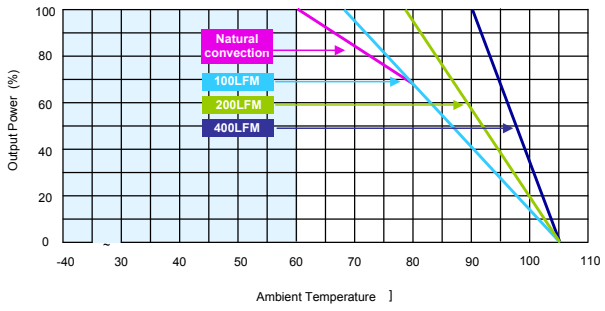
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



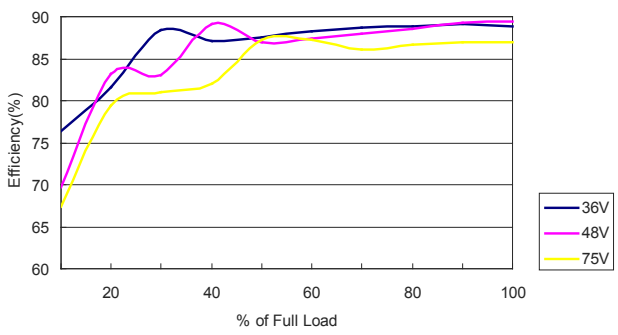
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



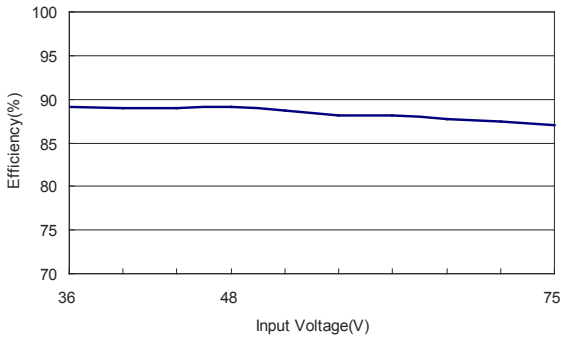
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (with heatsink)

Characteristic Curves

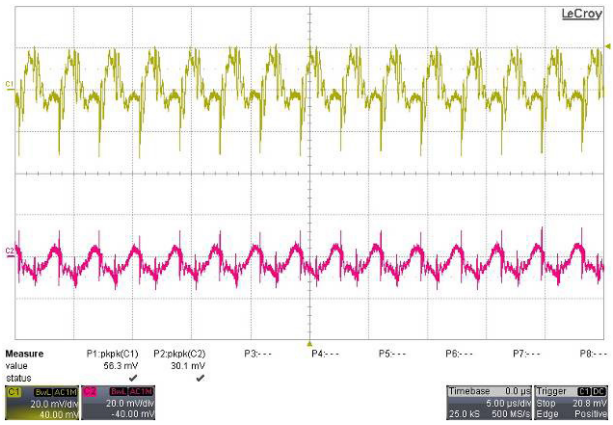
All test conditions are at 25°C The figures are identical for TEN 20-4823



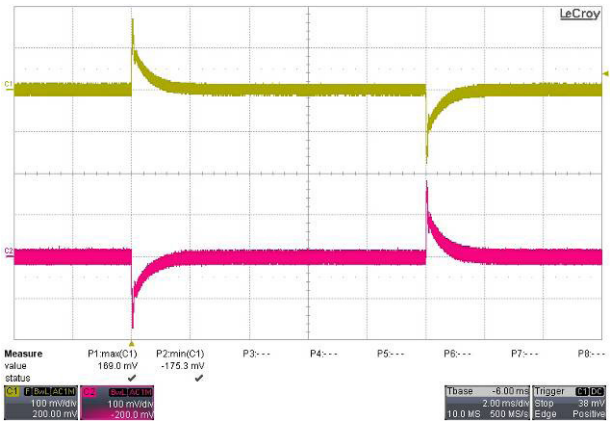
Efficiency Versus Output Current



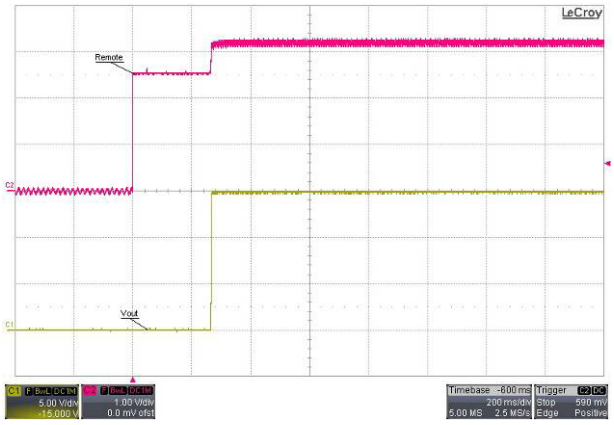
Efficiency Versus Input Voltage
Full Load



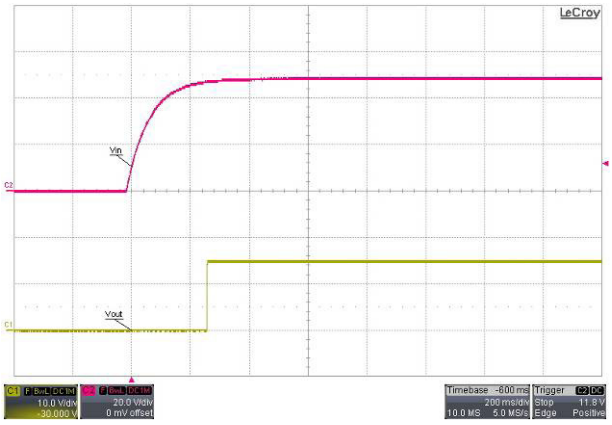
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$; Full Load; T_A



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



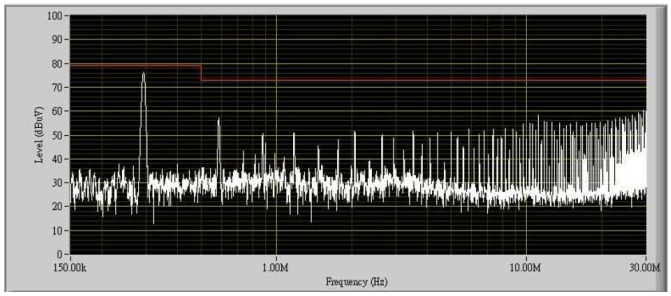
ON/OFF Voltage Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load



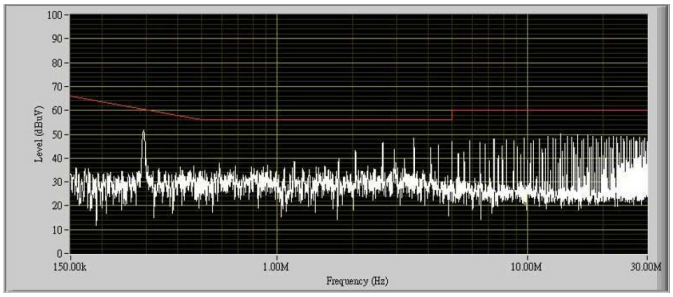
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$; Full Load

Characteristic Curves

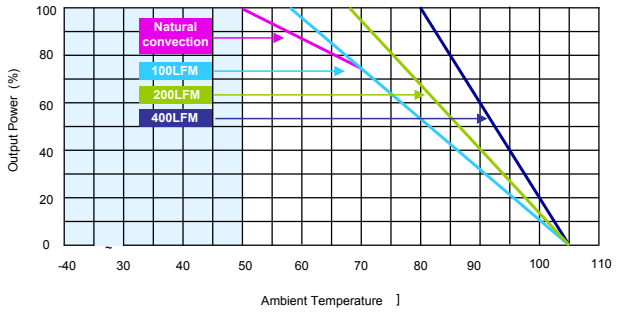
All test conditions are at 25°C The figures are identical for TEN 20-4823 (Continued)



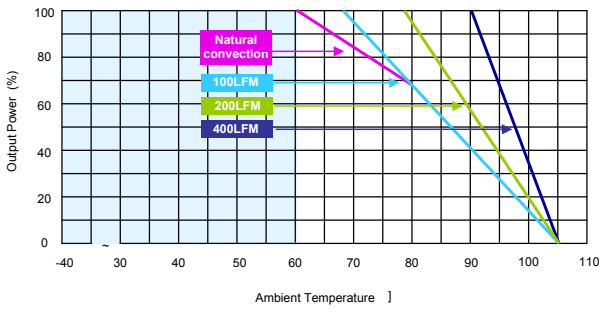
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$; Full Load



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



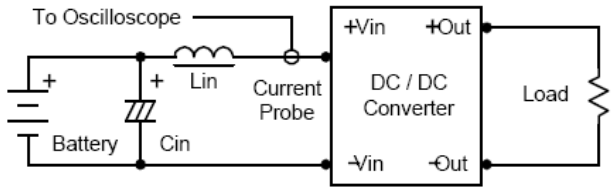
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$ (without heatsink)



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

Testing Configurations

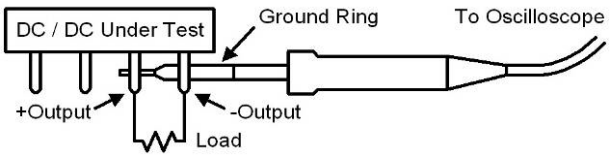
Input reflected-ripple current measurement test up



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

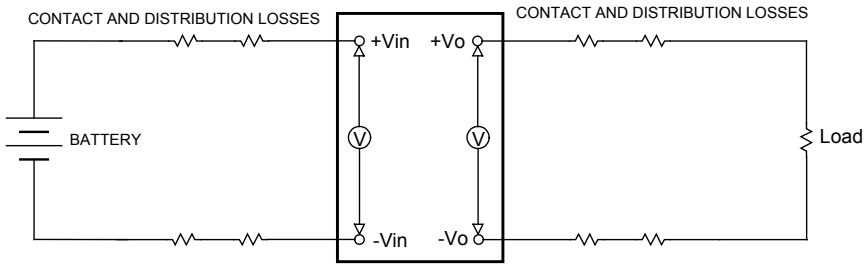
Peak-to-peak output ripple & noise measurement test up

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.

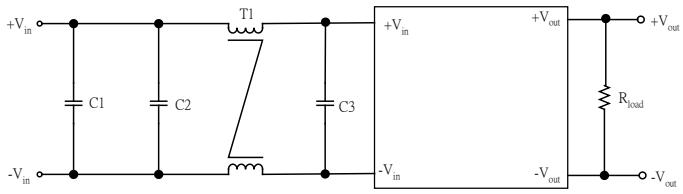


Output voltage and efficiency measurement test up

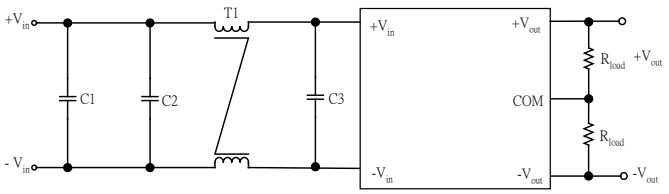
$$Efficiency = \left(\frac{V_{out} \times I_{out}}{V_{in} \times I_{in}} \right) \times 100\% = [\%]$$



EMC considerations

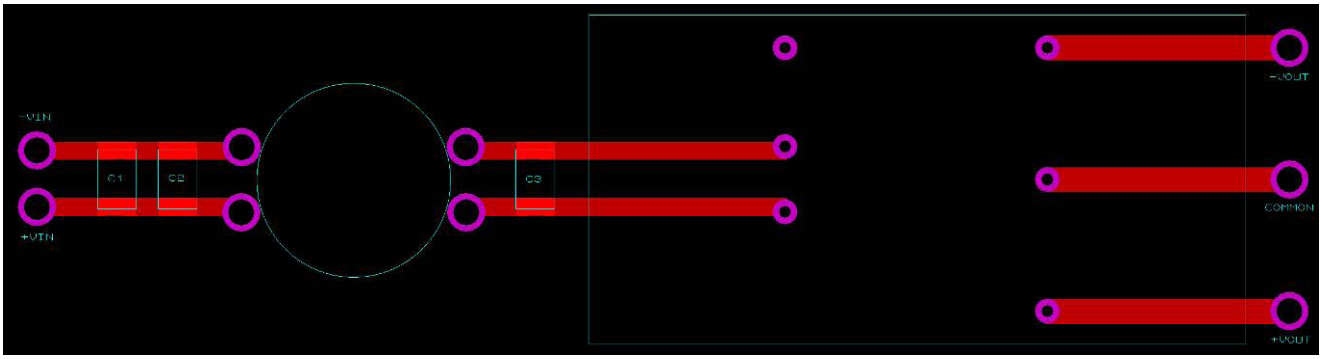


Single Output



Dual Output

Recommended circuit to comply EN55022 Class B Limits



Recommended PCB Layout with Input Filter

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

Model	Component	Value
TEN 20-12xx, TEN 20-24xx	C1,C2	4.7µF/50V 1210 MLCC
	T1	0.55mH Common choke, core: T10X2.5X5 H5C3/HPN155 ψ0.64X9T
TEN 20-48xx	C1,C2,C3	1.5µF/100V 1812 MLCC
	T1	0.55mH Common choke, core: T10X2.5X5 H5C3/HPN155 ψ0.64X9T

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 22µF for the 12V input devices and a 6.8µF for the 24V and 48V devices.

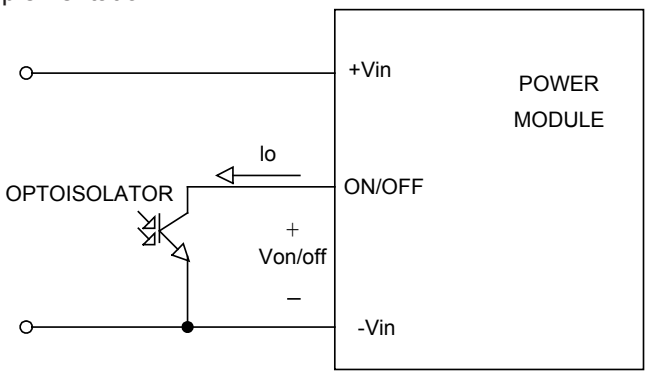
Output Over Current Protection

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.

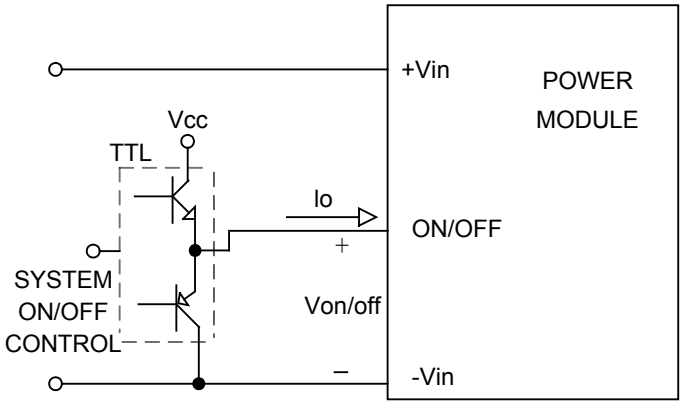
Remote ON/OFF Control

With suffix-RC, the positive logic remote ON/OFF control circuit is included. Turns the module ON during logic High on the ON/Off pin and turns OFF during logic Low. The ON/OFF input signal (Von/off) that referenced to GND. If not using the remote on/off feature, please open circuit between on/off pin and -Vin pin to turn the module on.

Remote ON/OFF implementation

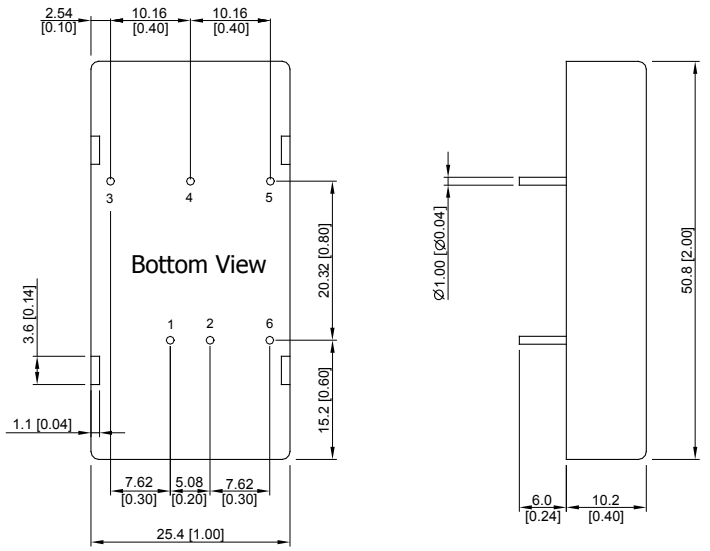


Isolated-Closure Remote ON/OFF



Level Control Using TTL Output

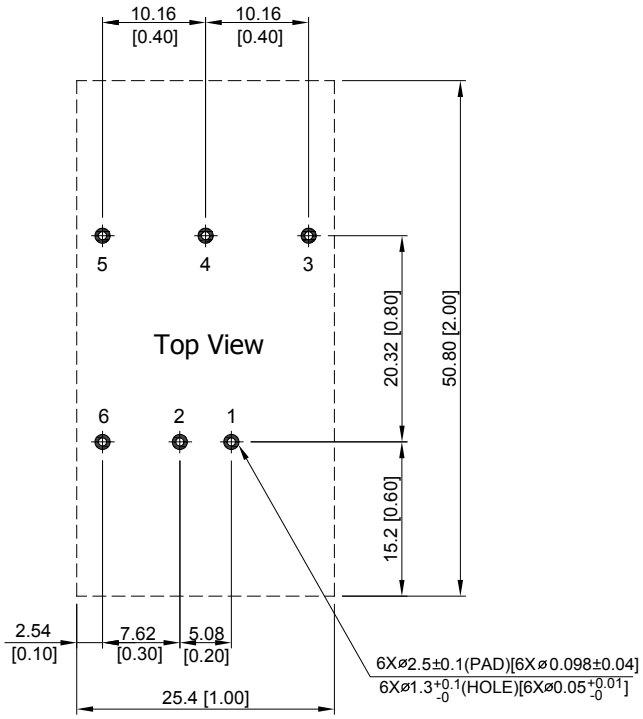
Mechanical Dimensions



Pin Connections		
Pin	Single Output	Dual Output
1	+Vin	+Vin
2	-Vin	-Vin
3	+Vout	+Vout
4	No Pin	Common
5	-Vout	-Vout
6	Remote On/Off (Optional)	

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")

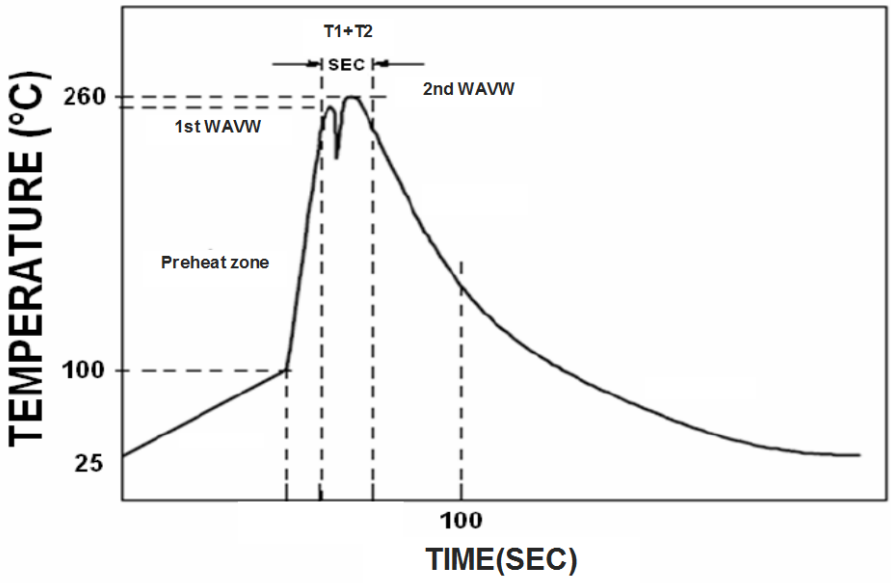
Recommended Pad Layout for Single & Dual Output Converter



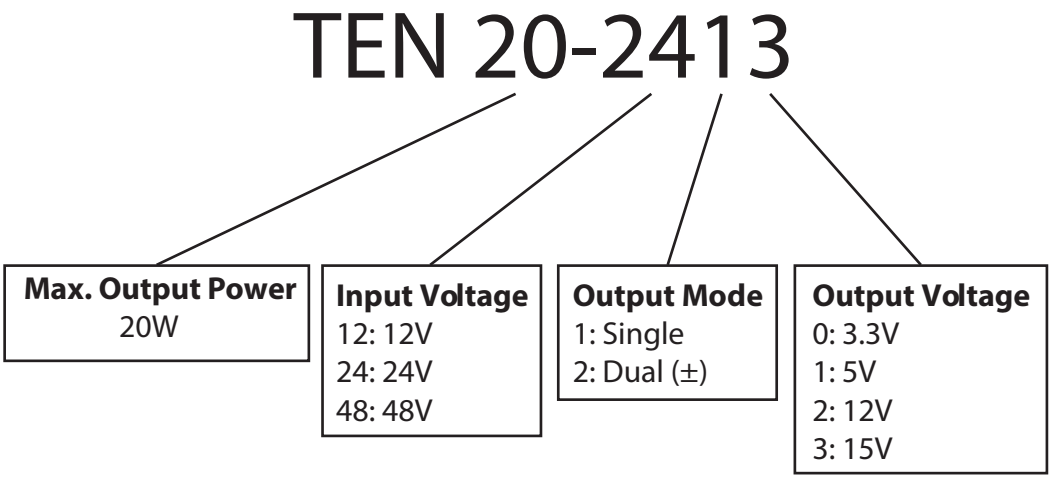
Packaging Information

Soldering and Reflow Considerations

Lead free wave solder profile for TEN 20 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 20-1210	9-18	3.3	4000	1358	81
TEN 20-1211	9-18	5	4000	1984	84
TEN 20-1212	9-18	12	1670	1898	88
TEN 20-1213	9-18	15	1340	1903	88
TEN 20-1222	9-18	±12	±835	1898	88
TEN 20-1223	9-18	±15	±670	1903	88
TEN 20-2410	18-36	3.3	4000	671	82
TEN 20-2411	18-36	5	4000	980	85
TEN 20-2412	18-36	12	1670	938	89
TEN 20-2413	18-36	15	1340	941	89
TEN 20-2422	18-36	±12	±835	938	89
TEN 20-2423	18-36	±15	±670	941	89
TEN 20-4810	36-75	3.3	4000	335	82
TEN 20-4811	36-75	5	4000	490	85
TEN 20-4812	36-75	12	1670	469	89
TEN 20-4813	36-75	15	1340	471	89
TEN 20-4822	36-75	±12	±835	469	89
TEN 20-4823	36-75	±15	±670	471	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 4000mA, in 24Vin with maximum rating of 2000mA, in 48Vin with maximum rating of 1000mA. 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 20 series of DC/DC converters has been calculated using MIL-HDBK 217F NOTICE2, Operating Temperature 25°C, Ground Benign.

Model	MTBF	Unit
TEN 20-1210	635,768	Hours
TEN 20-1211	579,139	
TEN 20-1212	556,731	
TEN 20-1213	556,731	
TEN 20-1222	572,443	
TEN 20-1223	570,353	
TEN 20-2410	640,328	
TEN 20-2411	567,601	
TEN 20-2412	556,514	
TEN 20-2413	556,514	
TEN 20-2422	567,634	
TEN 20-2423	567,408	
TEN 20-4810	617,551	
TEN 20-4811	568,440	
TEN 20-4812	563,761	
TEN 20-4813	535,647	
TEN 20-4822	581,159	
TEN 20-4823	607,755	