

TEST DATA OF TUNS500F28

Regulated DC Power Supply
October 1, 2014

Approved by : Takayuki Fukuda Design Manager

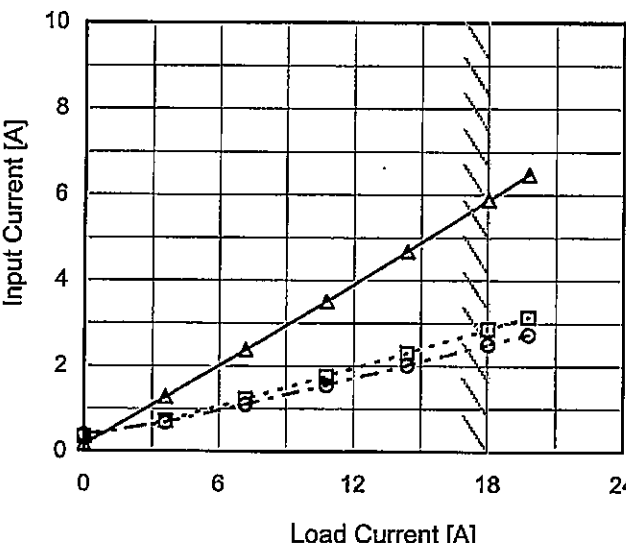
Prepared by : Kosuke Takarada Design Engineer

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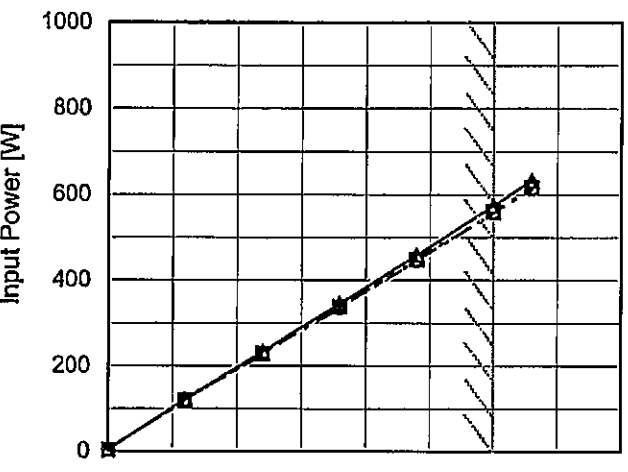
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Model		TUNS500F28																																																				
Item		Input Current (by Load Current)																																																				
Object																																																						
1.Graph		2.Values																																																				
<div><div><div>—△—</div><div>Input Volt. 100V</div></div><div><div>---□---</div><div>Input Volt. 200V</div></div><div><div>-·-○-·-</div><div>Input Volt. 230V</div></div></div> 		<table><tr><th rowspan="2">Load Current [A]</th><th colspan="3">Input Current [A]</th></tr><tr><th>Input Volt. 100[V]</th><th>Input Volt. 200[V]</th><th>Input Volt. 230[V]</th></tr><tr><td>0.0</td><td>0.163</td><td>0.339</td><td>0.390</td></tr><tr><td>3.6</td><td>1.268</td><td>0.708</td><td>0.670</td></tr><tr><td>7.2</td><td>2.381</td><td>1.224</td><td>1.100</td></tr><tr><td>10.8</td><td>3.513</td><td>1.757</td><td>1.554</td></tr><tr><td>14.4</td><td>4.682</td><td>2.303</td><td>2.021</td></tr><tr><td>18.0</td><td>5.874</td><td>2.857</td><td>2.499</td></tr><tr><td>19.8</td><td>6.471</td><td>3.137</td><td>2.740</td></tr><tr><td>--</td><td>-</td><td>-</td><td>-</td></tr><tr><td>--</td><td>-</td><td>-</td><td>-</td></tr><tr><td>--</td><td>-</td><td>-</td><td>-</td></tr><tr><td>--</td><td>-</td><td>-</td><td>-</td></tr></table>		Load Current [A]	Input Current [A]			Input Volt. 100[V]	Input Volt. 200[V]	Input Volt. 230[V]	0.0	0.163	0.339	0.390	3.6	1.268	0.708	0.670	7.2	2.381	1.224	1.100	10.8	3.513	1.757	1.554	14.4	4.682	2.303	2.021	18.0	5.874	2.857	2.499	19.8	6.471	3.137	2.740	--	-	-	-	--	-	-	-	--	-	-	-	--	-	-	-
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Note: Slanted line shows the range of the rated load current.																																																						

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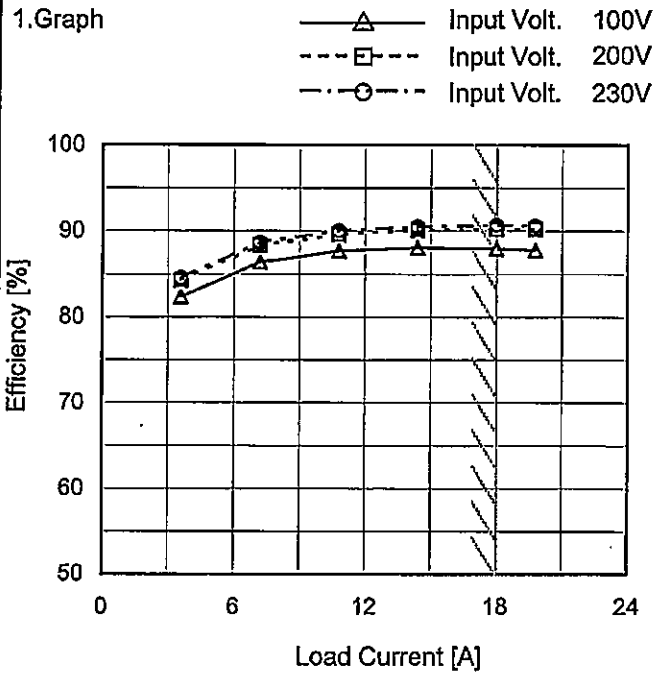
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<div><div><div><div>—△—</div><div>Input Volt.</div><div>100V</div></div><div><div>---□---</div><div>Input Volt.</div><div>200V</div></div><div><div>---○---</div><div>Input Volt.</div><div>230V</div></div></div></div>		<table><tr><th rowspan="2">Load Current [A]</th><th colspan="3">Input Power [W]</th></tr><tr><th>Input Volt. 100[V]</th><th>Input Volt. 200[V]</th><th>Input Volt. 230[V]</th></tr><tr><td>0.0</td><td>3.0</td><td>2.8</td><td>2.9</td></tr><tr><td>3.6</td><td>122.3</td><td>119.5</td><td>119.2</td></tr><tr><td>7.2</td><td>233.7</td><td>228.5</td><td>227.7</td></tr><tr><td>10.8</td><td>345.4</td><td>337.9</td><td>336.5</td></tr><tr><td>14.4</td><td>458.8</td><td>448.2</td><td>446.4</td></tr><tr><td>18.0</td><td>574.2</td><td>559.7</td><td>557.4</td></tr><tr><td>19.8</td><td>632.7</td><td>616.0</td><td>613.3</td></tr><tr><td>--</td><td>-</td><td>-</td><td>-</td></tr><tr><td>--</td><td>-</td><td>-</td><td>-</td></tr><tr><td>--</td><td>-</td><td>-</td><td>-</td></tr><tr><td>--</td><td>-</td><td>-</td><td>-</td></tr></table>		Load Current [A]	Input Power [W]			Input Volt. 100[V]	Input Volt. 200[V]	Input Volt. 230[V]	0.0	3.0	2.8	2.9	3.6	122.3	119.5	119.2	7.2	233.7	228.5	227.7	10.8	345.4	337.9	336.5	14.4	458.8	448.2	446.4	18.0	574.2	559.7	557.4	19.8	632.7	616.0	613.3	--	-	-	-	--	-	-	-	--	-	-	-	--	-	-	-
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Model		TUNS500F28																																	
Item		Efficiency (by Input Voltage)																																	
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<div><div><div><div><div></div><div></div></div><div></div></div><div><div><div></div><div></div></div><div></div></div></div><div>Load 50%</div><div>Load 100%</div></div> <table><thead><tr><th rowspan="2">Input Voltage [V]</th><th colspan="2">Efficiency [%]</th></tr><tr><th>Load 50%</th><th>Load 100%</th></tr></thead><tbody><tr><td>80</td><td>86.5</td><td>86.6</td></tr><tr><td>85</td><td>86.7</td><td>87.0</td></tr><tr><td>100</td><td>87.2</td><td>88.0</td></tr><tr><td>120</td><td>87.8</td><td>88.8</td></tr><tr><td>200</td><td>89.1</td><td>90.2</td></tr><tr><td>230</td><td>89.5</td><td>90.7</td></tr><tr><td>264</td><td>89.9</td><td>91.0</td></tr><tr><td>280</td><td>90.6</td><td>91.6</td></tr><tr><td>--</td><td>-</td><td>-</td></tr></tbody></table> <p>Note: Slanted line shows the range of the rated input voltage.</p>		Input Voltage [V]	Efficiency [%]		Load 50%	Load 100%	80	86.5	86.6	85	86.7	87.0	100	87.2	88.0	120	87.8	88.8	200	89.1	90.2	230	89.5	90.7	264	89.9	91.0	280	90.6	91.6	--	-	-		
Input Voltage [V]	Efficiency [%]																																		
	Load 50%	Load 100%																																	
80	86.5	86.6																																	
85	86.7	87.0																																	
100	87.2	88.0																																	
120	87.8	88.8																																	
200	89.1	90.2																																	
230	89.5	90.7																																	
264	89.9	91.0																																	
280	90.6	91.6																																	
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		BC-10852																																	

Model	TUNS500F28
Item	Efficiency (by Load Current)
Object	

Temperature 25°C
Testing Circuitry Figure A



2.Values

Load Current [A]	Efficiency [%]		
	Input Volt. 100[V]	Input Volt. 200[V]	Input Volt. 230[V]
0.0	-	-	-
3.6	82.4	84.3	84.6
7.2	86.4	88.3	88.7
10.8	87.7	89.6	90.1
14.4	88.1	90.1	90.5
18.0	88.0	90.2	90.7
19.8	87.8	90.2	90.6
--	-	-	-
--	-	-	-
--	-	-	-
--	-	-	-

Model

TUNS500F28

Item

Power Factor (by Input Voltage)

Object

1.Graph

□

Load 50%

△

Load 100%

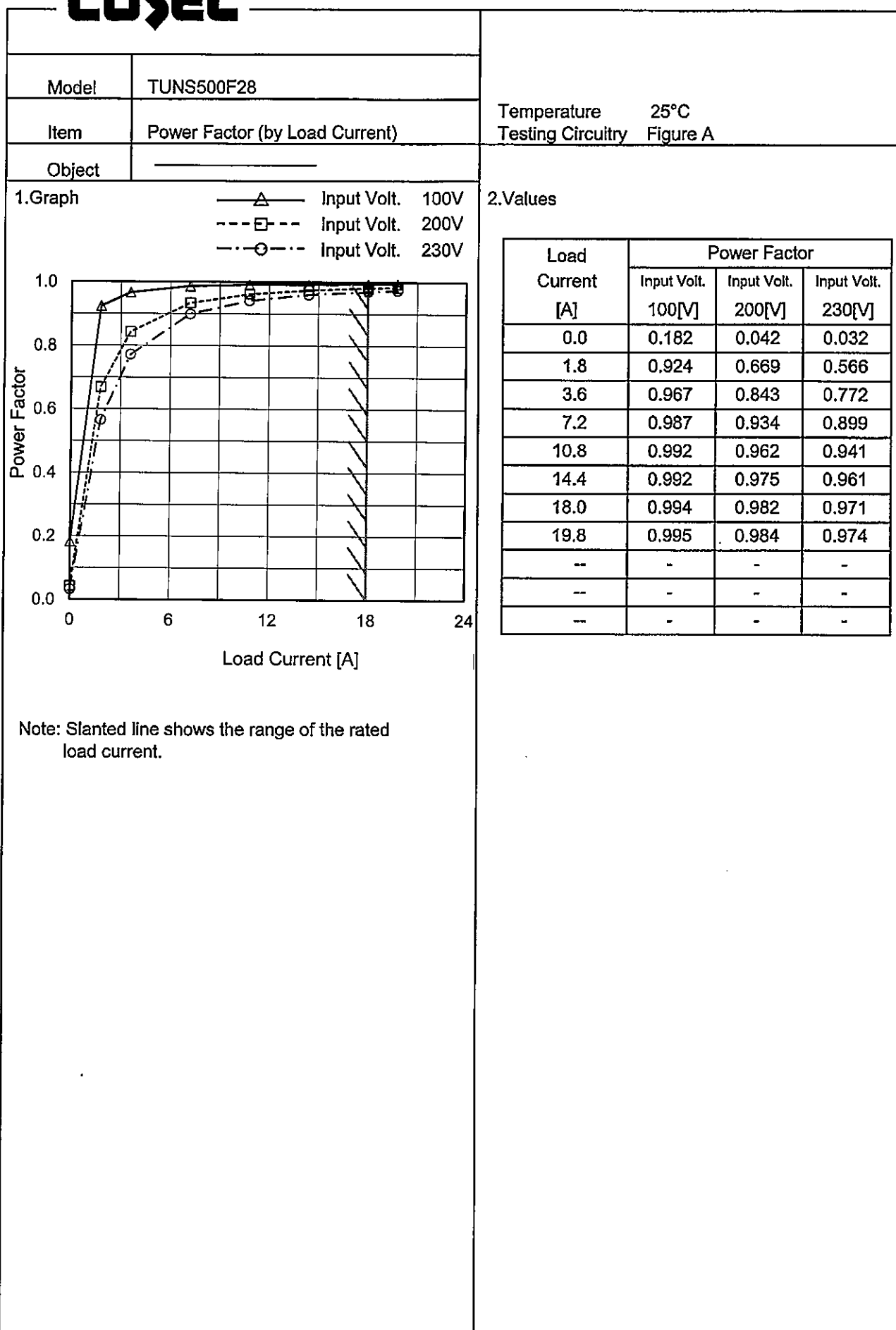
Note: Slanted line shows the range of the rated input voltage.

2.Values

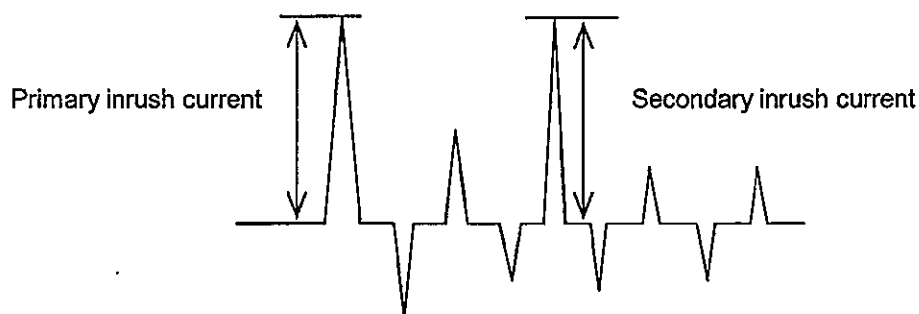
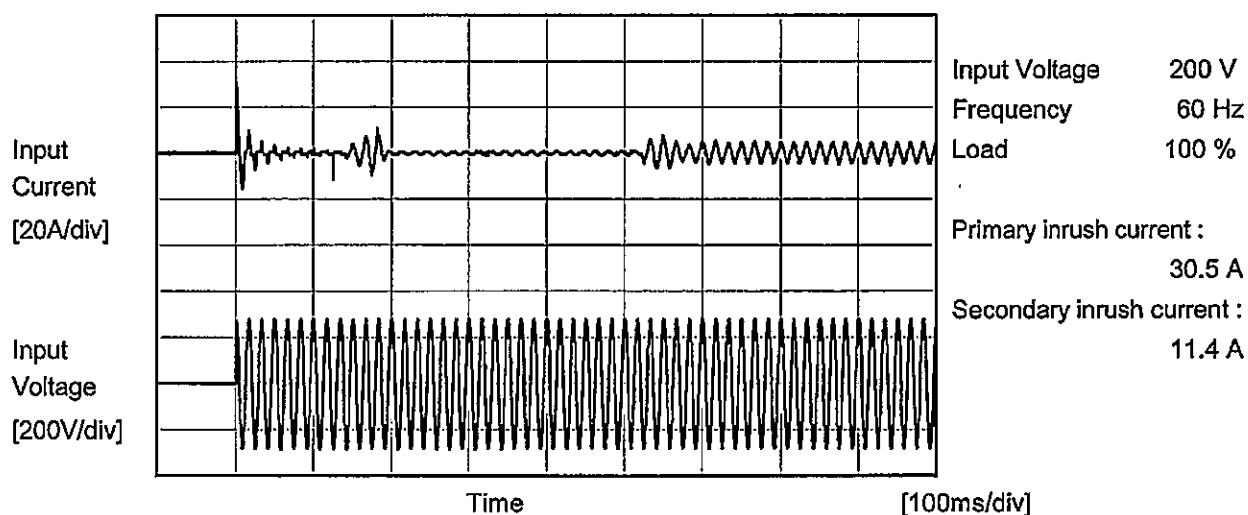
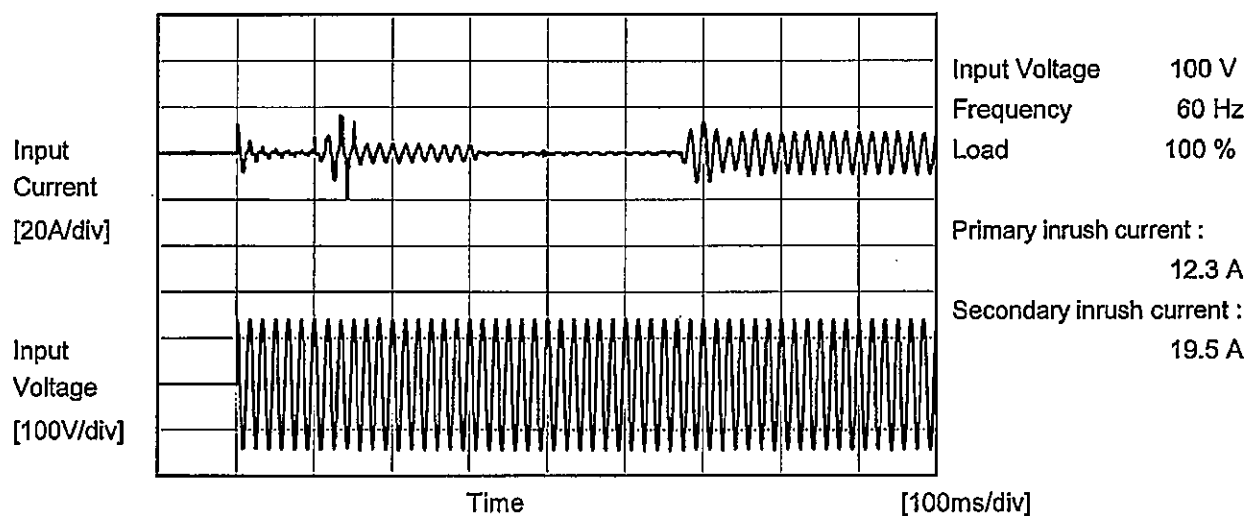
Input Voltage [V]	Power Factor	
	Load 50%	Load 100%
80	0.990	0.995
85	0.990	0.995
100	0.990	0.994
120	0.986	0.993
200	0.952	0.982
230	0.926	0.971
264	0.885	0.955
270	0.877	0.951
280	0.396	0.440

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Model	TUNS500F28	Temperature 25°C Testing Circuitry Figure A	
Item	Inrush Current		
Object			



		Temperature 25°C Testing Circuitry Figure B
Model	TUNS500F28	
Item	Leakage Current	
Object		

1.Results

[mA]

Standards		Input Volt.			Note
		100 [V]	200 [V]	240[V]	
IEC60950-1	Both phases	0.16	0.33	0.40	Operation
	One of phase	0.30	0.63	0.77	stand by

The value for "One phase" is the reference value only.

2.Condition

Leakage current value is concluded after measuring both phases of AC input and by choosing the larger one.

Model

TUNS500F28

Item

Line Regulation

Object

+28V18A

1.Graph

□

Load 50%

△

Load 100%

Output Voltage [V]

28.30

28.20

28.10

28.00

27.90

27.80

27.70

50

100

150

200

250

300

Input Voltage [V]

Note: Slanted line shows the range of the rated input voltage.

2.Values

Input Voltage [V]	Output Voltage [V]	
	Load 50%	Load 100%
80	28.048	28.047
85	28.048	28.048
100	28.048	28.048
120	28.048	28.049
200	28.047	28.048
230	28.048	28.048
264	28.048	28.049
280	28.048	28.049
--	-	-

Model

TUNS500F28

Item

Load Regulation

Object

+28V18A

1.Graph

—△—

Input Volt.

100V

---□---

Input Volt.

200V

-·-○-·-

Input Volt.

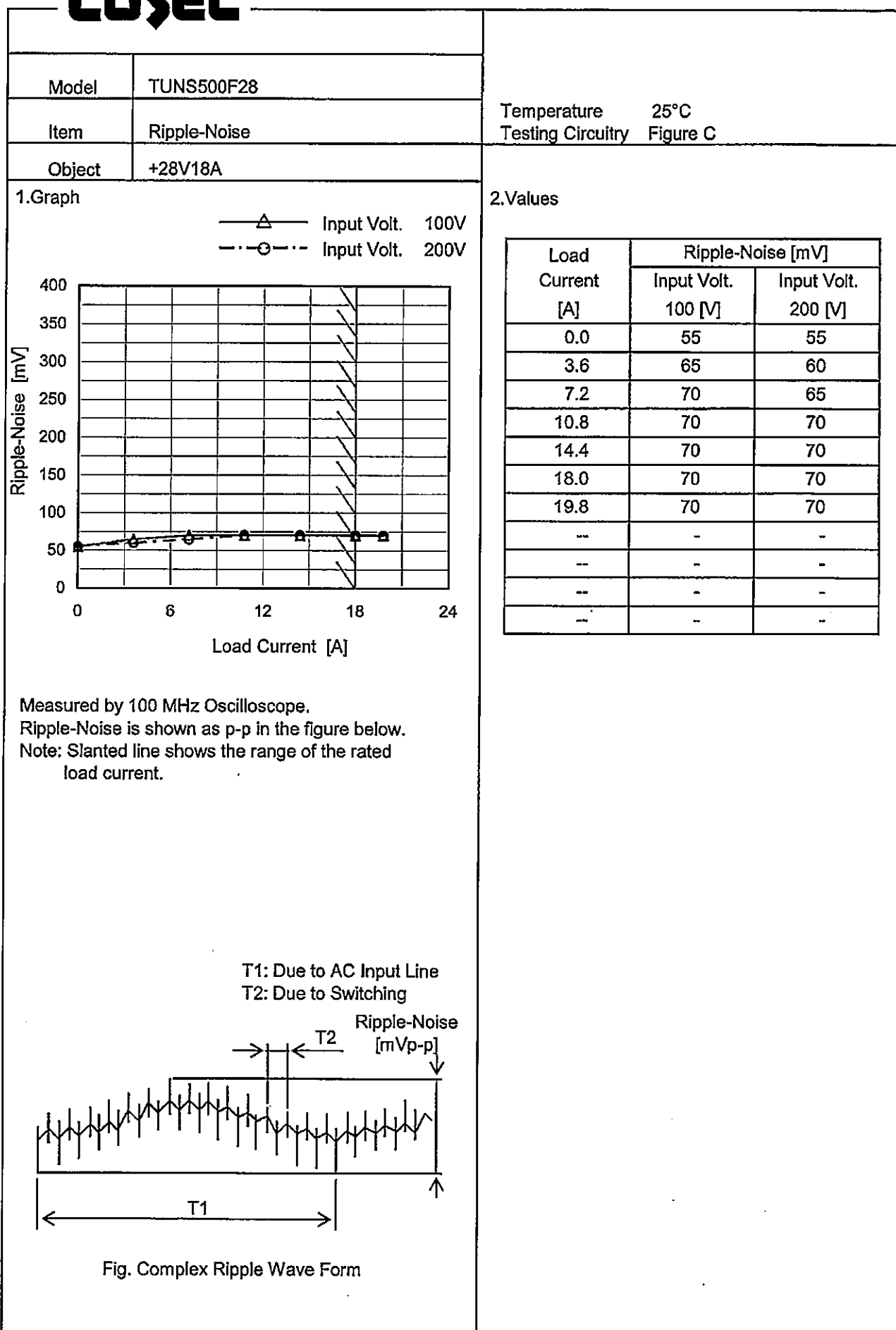
230V

Note: Slanted line shows the range of the rated load current.

2.Values

Load Current [A]	Output Voltage [V]		
	Input Volt. 100[V]	Input Volt. 200[V]	Input Volt. 230[V]
0.0	28.054	28.054	28.054
3.6	28.050	28.050	28.050
7.2	28.049	28.049	28.050
10.8	28.049	28.049	28.049
14.4	28.049	28.049	28.049
18.0	28.048	28.048	28.048
19.8	28.049	28.049	28.049
--	-	-	-
--	-	-	-
--	-	-	-
--	-	-	-

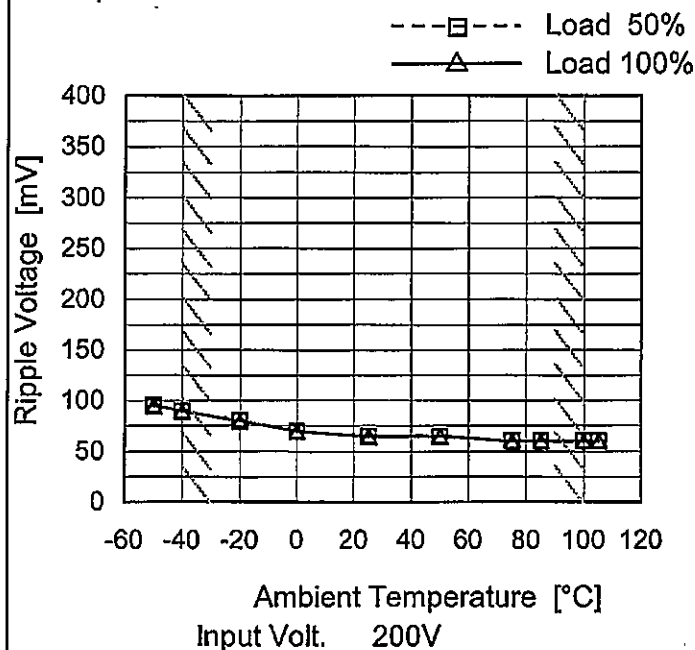
Model	TUNS500F28																																								
Item	Ripple Voltage (by Load Current)	Temperature	25°C																																						
Object	+28V18A	Testing Circuitry	Figure C																																						
1.Graph		2.Values																																							
<div><div><div>—△— Input Volt. 100V</div><div>- -○- - Input Volt. 200V</div></div><p>Ripple Voltage [mV]</p><p>Load Current [A]</p></div>		<table><tr><th rowspan="2">Load Current [A]</th><th colspan="2">Ripple Voltage [mV]</th></tr><tr><th>Input Volt. 100 [V]</th><th>Input Volt. 200 [V]</th></tr><tr><td>0.0</td><td>50</td><td>60</td></tr><tr><td>3.6</td><td>60</td><td>66</td></tr><tr><td>7.2</td><td>60</td><td>60</td></tr><tr><td>10.8</td><td>60</td><td>60</td></tr><tr><td>14.4</td><td>60</td><td>60</td></tr><tr><td>18.0</td><td>60</td><td>60</td></tr><tr><td>19.8</td><td>65</td><td>60</td></tr><tr><td>--</td><td>-</td><td>-</td></tr><tr><td>--</td><td>-</td><td>-</td></tr><tr><td>--</td><td>-</td><td>-</td></tr><tr><td>--</td><td>-</td><td>-</td></tr></table>		Load Current [A]	Ripple Voltage [mV]		Input Volt. 100 [V]	Input Volt. 200 [V]	0.0	50	60	3.6	60	66	7.2	60	60	10.8	60	60	14.4	60	60	18.0	60	60	19.8	65	60	--	-	-	--	-	-	--	-	-	--	-	-
Load Current [A]	Ripple Voltage [mV]																																								
	Input Volt. 100 [V]	Input Volt. 200 [V]																																							
0.0	50	60																																							
3.6	60	66																																							
7.2	60	60																																							
10.8	60	60																																							
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19.8	65	60																																							
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<p>Measured by 100 MHz Oscilloscope. Ripple Voltage is shown as p-p in the figure below. Note: Slanted line shows the range of the rated load current.</p>																																									
<div><div>T1: Due to AC Input Line</div><div>T2: Due to Switching</div><p>Ripple [mVp-p]</p><p>T1</p><p>T2</p></div>																																									
Fig. Complex Ripple Wave Form																																									



Model	TUNS500F28
Item	Ripple Voltage (by Ambient Temp.)
Object	+28V18A

Testing Circuitry Figure C

1. Graph



Measured by 100 MHz Oscilloscope.

Note: Slanted line shows the range of the rated ambient temperature.

2. Values

Ambient Temperature [°C]	Ripple Voltage [mV]	
	Load 50%	Load 100%
-50	95	95
-40	90	90
-20	80	80
0	70	70
25	65	65
50	65	65
75	60	60
85	60	60
100	60	60
105	60	60
--	-	-

Model

TUNS500F28

Item

Ambient Temperature Drift

Object

+28V18A

1.Graph

—△—

Input Volt.

100V

---□---

Input Volt.

200V

-·-○-·-

Input Volt.

230V

Output Voltage [V]

Ambient Temperature [°C]

Load 100%

Note: Slanted line shows the range of the rated ambient temperature.

Testing Circuitry

Figure A

2.Values

Ambient Temperature [°C]	Output Voltage [V]		
	Input Volt. 100[V]	Input Volt. 200[V]	Input Volt. 230[V]
-50	27.884	27.885	27.886
-40	27.916	27.917	27.917
-20	27.970	27.970	27.971
0	28.012	28.013	28.013
25	28.048	28.048	28.048
50	28.069	28.069	28.069
75	28.079	28.079	28.079
85	28.082	28.082	28.082
100	28.091	28.091	28.091
105	28.097	28.098	28.098
--	-	-	-



Model		TUNS500F28	Testing Circuitry Figure A
Item		Output Voltage Accuracy	
Object		+28V18A	

1. Output Voltage Accuracy

This is defined as the value of the output voltage, regulation load, ambient temperature and input voltage varied at random in the range as specified below.

Temperature : -40 - 100°C

Input Voltage : 85 - 264V

Load Current : 0 - 18A

* Output Voltage Accuracy = $\pm(\text{Maximum of Output Voltage} - \text{Minimum of Output Voltage}) / 2$

* Output Voltage Accuracy (Ratio) = $\frac{\text{Output Voltage Accuracy}}{\text{Rated Output Voltage}} \times 100$

2. Values

Item	Temperature [°C]	Input Voltage[V]	Output		Output Voltage Accuracy	
			Current[A]	Voltage[V]	Value [mV]	Ratio [%]
Maximum Voltage	100	85	0	28.098	±92	±0.3
Minimum Voltage	-40	85	18	27.914		

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Model	TUNS500F28
Item	Time Lapse Drift
Object	+28V18A

Temperature
25°C

Testing Circuitry
Figure A

1.Graph

The graph displays a constant output voltage of 28.051V over a 10-hour period. The y-axis represents Output Voltage [V] from 27.70 to 28.30, and the x-axis represents Time [H] from 0 to 10. A horizontal line at 28.051V indicates no drift. Test conditions: Input Volt. 100V, Load 100%.

Time [H]	Output Voltage [V]
0.0	28.045
0.5	28.051
1.0	28.051
2.0	28.051
3.0	28.051
4.0	28.051
5.0	28.051
6.0	28.051
7.0	28.051
8.0	28.051

2.Values

Time since start [H]	Output Voltage [V]
0.0	28.045
0.5	28.051
1.0	28.051
2.0	28.051
3.0	28.051
4.0	28.051
5.0	28.051
6.0	28.051
7.0	28.051
8.0	28.051

* The characteristic of AC200V is equal.

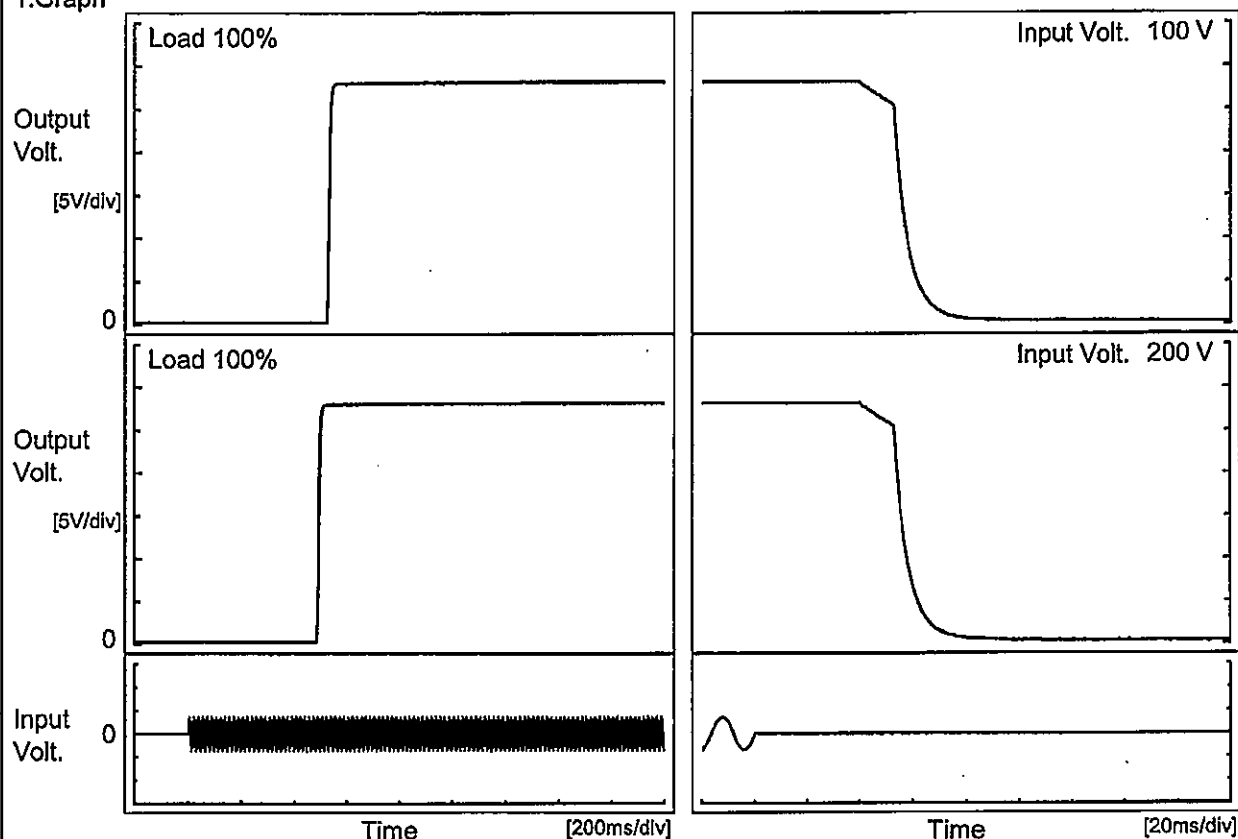
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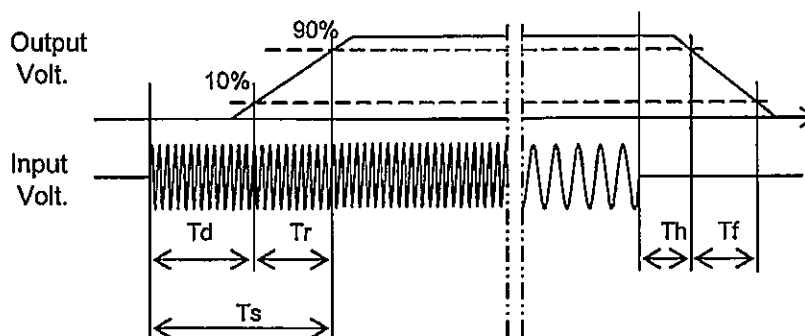
Model	TUNS500F28	Temperature	25°C
Item	Rise and Fall Time	Testing Circuitry	Figure A
Object	+28V18A		

1.Graph



2.Values

Input Volt.	Time	Td	Tr	Ts	Th	Tf
100 V		528.0	13.0	541.0	52.6	12.3
200 V		488.0	13.0	501.0	52.9	12.1



LOREL

Model TUNS500F28

Item Hold-Up Time

Object +28V18A

Temperature 25°C
Testing Circuitry Figure A

1.Graph

---□--- Load 50%
---△--- Load 100%

The graph plots Hold-Up Time [ms] on a logarithmic y-axis (1 to 1000) against Input Voltage [V] on a linear x-axis (50 to 300). Two data series are shown: Load 50% (dashed line with square markers) and Load 100% (solid line with triangle markers). Both series show a constant hold-up time of approximately 88 ms for input voltages from 80V to 280V. For input voltages above 280V, the hold-up time decreases sharply, as indicated by the slanted lines. The Load 100% series shows a slightly lower hold-up time of approximately 41 ms for input voltages from 80V to 280V.

Input Voltage [V]	Hold-Up Time [ms] (Load 50%)	Hold-Up Time [ms] (Load 100%)
80	88	41
85	88	41
100	88	41
120	88	41
200	88	42
230	88	41
264	88	41
280	88	41
--	-	-

2.Values

Input Voltage [V]	Hold-Up Time [ms]	
	Load 50%	Load 100%
80	88	41
85	88	41
100	88	41
120	88	41
200	88	42
230	88	41
264	88	41
280	88	41
--	-	-

This duration covers from Shut-off of input voltage to the moment when output voltage descends to the rated range of voltage accuracy.
Note: Slanted line shows the range of the rated input voltage.

Model

TUNS500F28

Item

Instantaneous Interruption Compensation

Object

+28V18A

1.Graph

—△—

Input Volt. 100V

---□---

Input Volt. 200V

---○---

Input Volt. 230V

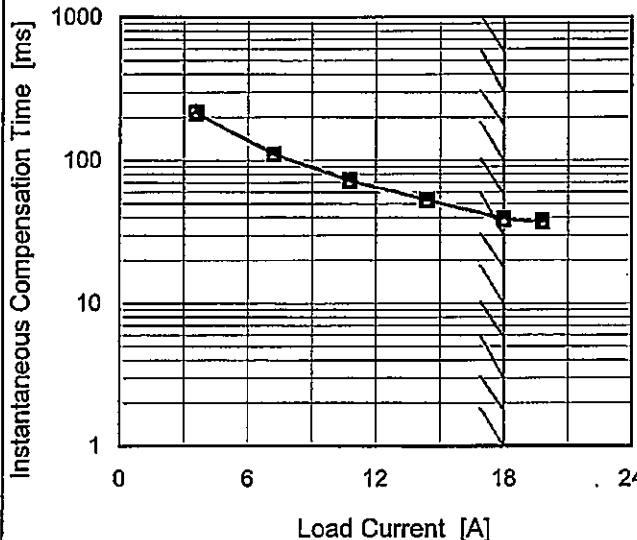
Instantaneous Compensation Time [ms]

1000

100

10

1



0

6

12

18

24

Load Current [A]

Note: Slanted line shows the range of the rated load current.

Temperature 25°C

Testing Circuitry Figure A

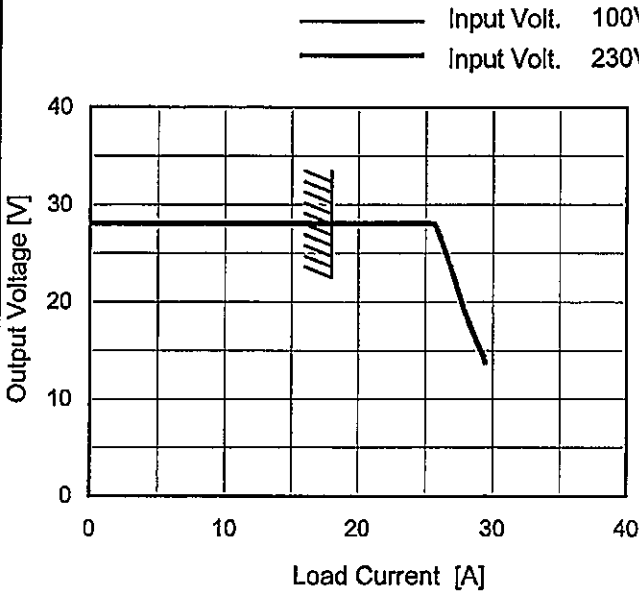
2.Values

Load Current [A]	Time [ms]		
	Input Volt. 100[V]	Input Volt. 200[V]	Input Volt. 230[V]
0.0	-	-	-
3.6	214	215	218
7.2	111	111	111
10.8	72	73	73
14.4	53	53	53
18.0	39	39	39
19.8	37	38	38
--	-	-	-
--	-	-	-
--	-	-	-
--	-	-	-

Model	TUNS500F28
Item	Overcurrent Protection
Object	+28V18A

Temperature 25°C
Testing Circuitry Figure A

1.Graph



Note: Slanted line shows the range of the rated load current.

Intermittent operation occurs when the output voltage is from 14V to 0V.

2.Values

Output Voltage [V]	Load Current [A]	
	Input Volt. 100[V]	Input Volt. 230[V]
28.0	18.06	18.06
26.6	26.08	26.09
25.2	26.42	26.44
22.4	27.12	27.13
19.6	27.79	27.81
16.8	28.38	28.40
14.0	29.42	29.44
--	-	-
--	-	-
--	-	-
--	-	-
--	-	-

Model

TUNS500F28

Item

Overvoltage Protection

Object

+28V18A

1.Graph

—△—

Input Volt. 100V

---□---

Input Volt. 200V

Operating Point [V]

Ambient Temperature [°C]

Load 0%

Note: Slanted line shows the range of the rated ambient temperature.

2.Values

Ambient Temperature [°C]	Operating Point [V]	
	Input Volt. 100[V]	Input Volt. 200[V]
-50	36.74	36.74
-40	36.86	36.86
-20	36.86	36.86
0	36.98	36.98
25	36.98	36.98
50	37.09	37.09
75	37.09	37.09
85	37.09	37.09
100	37.09	37.09
105	37.09	37.09
---	-	-

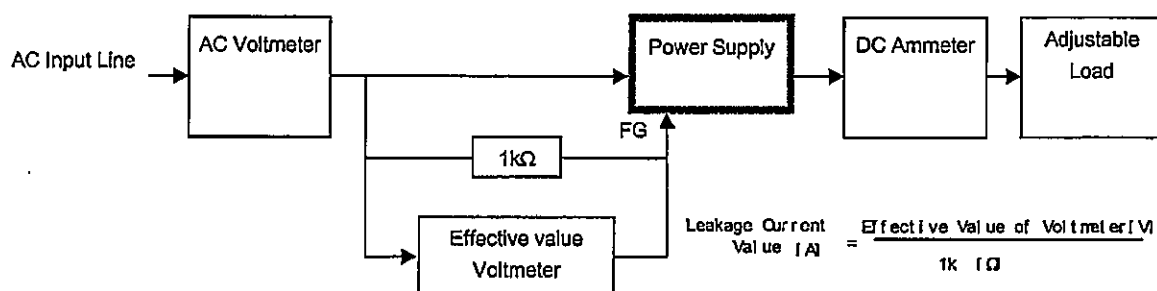
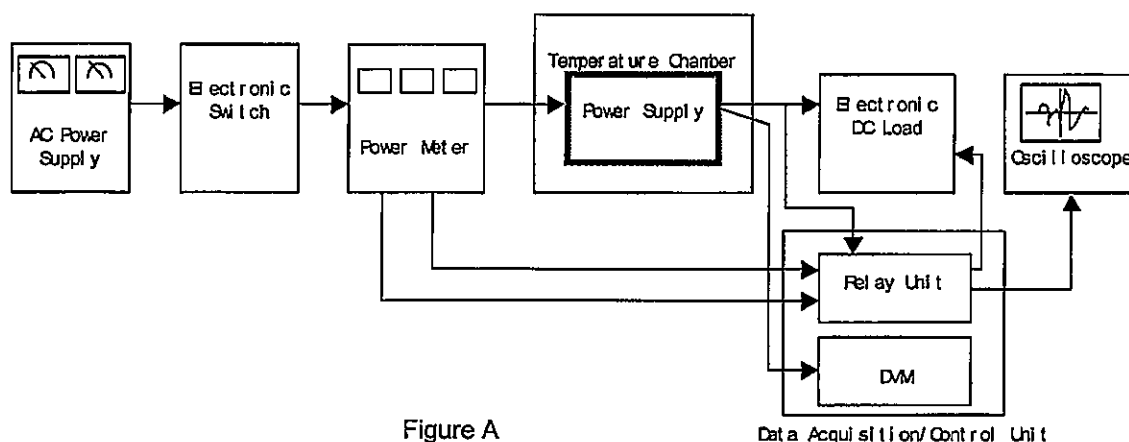


Figure B (DEN-AN)

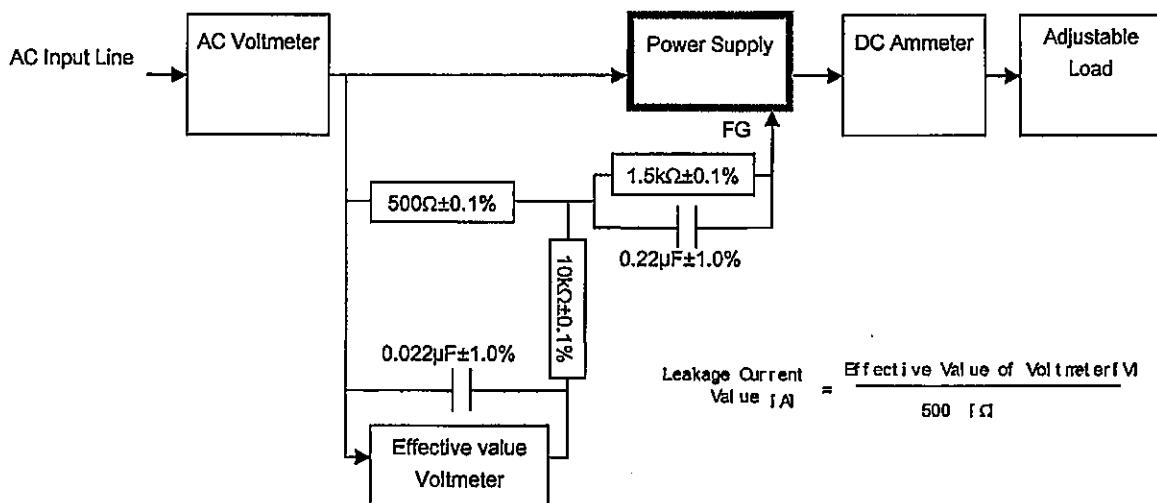
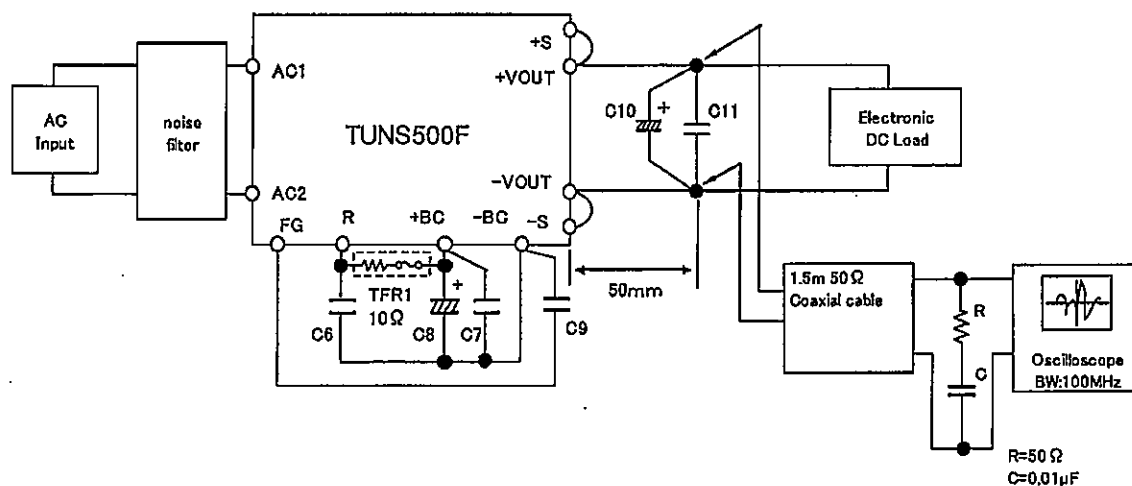


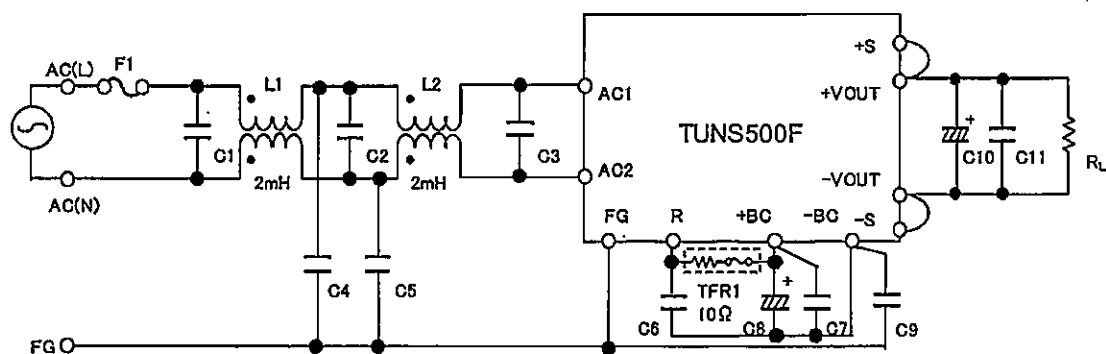
Figure B (IEC60950-1)



C10	: TUNS500F12	2200 μ F	($0 \leq T_c \leq 100$)	C11	: TUNS500F12	10 μ F
		2200 μ F \times 3	($-40 \leq T_c < 0$)		TUNS500F28	4.7 μ F
	TUNS500F28	1000 μ F	($0 \leq T_c \leq 100$)		TUNS500F48	2.2 μ F
		1000 μ F \times 3	($-40 \leq T_c < 0$)			
	TUNS500F48	470 μ F	($0 \leq T_c \leq 100$)			
		470 μ F \times 3	($-40 \leq T_c < 0$)			

Tc: Base Plate Temp.

Figure C



L1, L2	: SC-15-200(NEC TOKIN)	C11	: TUNS500F12	10 μ F Ceramic Capacitor
C1, C2	: 0.68 μ F 310V Film Capacitor \times 2		TUNS500F28	4.7 μ F Ceramic Capacitor
C3	: 1.0 μ F 310V Film Capacitor \times 2		TUNS500F48	2.2 μ F Ceramic Capacitor
C4, C5, C9	: 2200pF Ceramic Capacitor			
C6, C7	: 0.68 μ F 450V Film Capacitor \times 2			
C8	: 390 μ F 450V Electrolytic Capacitor \times 2			
C10	: TUNS500F12	2200 μ F	25V Electrolytic Capacitor	
	TUNS500F28	1000 μ F	50V Electrolytic Capacitor	
	TUNS500F48	470 μ F	63V Electrolytic Capacitor	

Figure D