

귀중

# Evaluation Data

품 목	SMPS
품 명	CSF1500-S
Rev. No.	A

2011년 5 월 17일

작 성 : 책 임 이 동 찬 

검 토 :

승 인 : 상 무 장 재 하 

**ORIENT**  
ELECTRONICS

경기도 성남시 중원구 상대원동 143-1번지

TEL : (031) 737-0200

FAX : (031) 737-0279

# Evaluation data

---

## 1. CSF1500-05

- 1-1. Input characteristics
  - . Inrush Current Characteristics
  - . Input Line Harmonics Characteris
  - . Input Current & Efficiency Characteristics
  - . Power Factor Characteristics
  - . Leakage Current Characteristics
- 1-2. Output characterist
  - . Line & Load Regulation Characteristics
  - . Dynamic Load Response Characteristics
  - . Ripple & Noise Characteristics
  - . Turn on Time Characteristics
  - . Hold up Time Characteristics
  - . Over Current Protection Characteristics
  - . Over Voltage Protection Characteristics

## 2. CSF1500-09

- 1-1. Input characteristics
- 1-2. Output characterist

## 3. CSF1500-12

- 1-1. Input characteristics
- 1-2. Output characterist

## 4. CSF1500-15

- 1-1. Input characteristics
- 1-2. Output characterist

## 5. CSF1500-24

- 1-1. Input characteristics
- 1-2. Output characterist

## 6. CSF1500-28

- 1-1. Input characteristics
- 1-2. Output characterist

## 7. CSF1500-48

- 1-1. Input characteristics
- 1-2. Output characterist

### 1-1. CSF1500-05 Input characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)
  - ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
  - ◇ CH2 : AC INPUT CURRENT - CP500 (Current Probe)
- (2) Power Analyzer WT500 (YOKOGAWA)

입력	출력	측정값	파형	비고
<b>Inrush Current Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (240A)	Irush 1차 = 23.4[A]  Irush 2차 = 29[A]		CH1(전압) 200V/div 200ms/div  CH2(전류) 20A/div 200ms/div
<b>Inrush Current Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (240A)	Irush 1차 = 59.0[A]  Irush 2차 = 16.2[A]		CH2(전압) 200V/div 100ms/div  CH3(전류) 20A/div 100ms/div
<b>Input Line Harmonics Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (240A)	IEC61000-3-2		
<b>Input Line Harmonics Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (240A)	IEC61000-3-2		

### 1-1. CSF1500-05 Input characteristics

- (1) Power Analyzer WT500 (YOKOGAWA)  
 (2) Digital multi meter 2000 (KEITHLEY)

#### Input Current & Efficiency Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		Load (min) 0A	0.517A	0.466A	0.482A	0.479A	0.537A
	Efficiency	-	-	-	-	-	-
Load (50%) 120A	Input Current	8.710A	6.676A	5.565A	4.262A	3.339A	2.895A
	Efficiency	80.10%	81.74%	82.07%	83.10%	83.56%	84.15%
Load (100%) 240A	Input Current	18.268A	13.730A	11.208A	8.763A	6.720A	5.690A
	Efficiency	77.07%	79.10%	80.05%	81.02%	81.68%	82.24%

#### Power Factor Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		Load (min) 0A	0.838	0.701	0.570	0.445	0.297
Load (50%) 120A		0.998	0.995	0.993	.0985	0.967	0.919
Load (100%) 240A		0.998	0.999	0.998	0.996	0.989	0.968

#### Leakage Current Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	220V	264V		
		Line L (mA)	0.46	0.53	0.77	0.88	
Line N (mA)		0.40	0.42	0.70	0.87		

## 1-2. CSF1500-05 Output characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)  
 ◇ CH1 : BNC Cable 1.5m, 50Ω, Band Width : 200Mhz  
 ◇ CH1 : OUTPUT CURRENT – CP500 (Current Probe)  
 ◇ CH2 : OUTPUT VOLTAGE – PP006 (Passive Voltage Probe)  
 (2) Digital multi meter 2000 (KEITHLEY)

### Line & Load Regulation Characteristics

Condition Ta : 25°C

$I_o$ \ $V_{in}$	90V	110V	132V	170V	220V	264V	Line Regulation
Load (0A)	5.019V	5.019V	5.019V	5.019V	5.019V	5.019V	0mV
Load (50%)	5.016V	5.015V	5.015V	5.016V	5.015V	5.016V	1mV
Load (100%)	5.013V	5.013V	5.013V	5.013V	5.013V	5.013V	0mV
Load Regulation	6mV	6mV	6mV	6mV	6mV	6mV	

입력

출력

측정값

파형

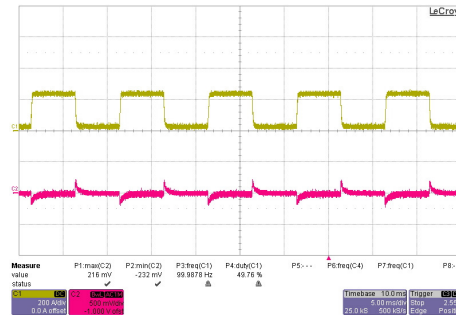
비고

### Dynamic Load Response Characteristics (100Hz)

AC220V

$I_o=10 \leftrightarrow 100\%$   
 $f_s=100\text{Hz}$   
 Duty=50%  
 Slew rate  
 50uS

+VPK = 216mV  
 (4.3%)  
  
 -VPK = 232mV  
 (4.6%)



CH1(전류)  
 200A/div  
 5ms/div

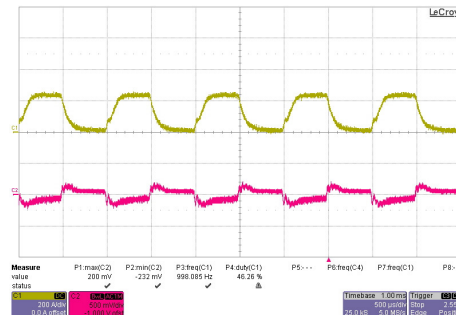
CH2(전압)  
 500mV/div  
 5ms/div

### Dynamic Load Response Characteristics (1KHz)

AC220V

$I_o=0 \leftrightarrow 100\%$   
 $f_s=1\text{Kz}$   
 Duty=50%  
 Slew rate  
 50uS

+VPK = 200mV  
 (4.0%)  
  
 -VPK = 232mV  
 (4.6%)



CH1(전류)  
 200A/div  
 500us/div

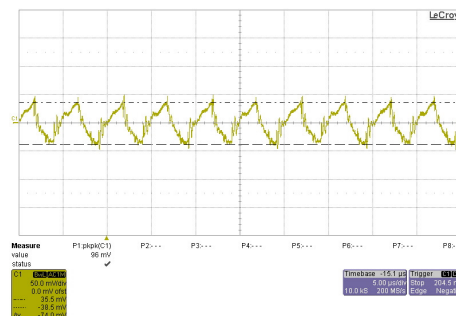
CH2(전압)  
 500mV/div  
 500us/div

### Ripple & Noise characteristics

AC220V

$I_o=100\%$   
 240A

Ripple  
 74mV  
  
 Ripple & Noise  
 96mV<sub>p-p</sub>



CH1(전압)  
 50mV/div  
 5us/div

Terminal 단자에  
 Elec-cap: 100uF  
 Film-cap: 0.47uF  
 접속 후 측정

## 1-2. CSF1500-05 Output characteristics

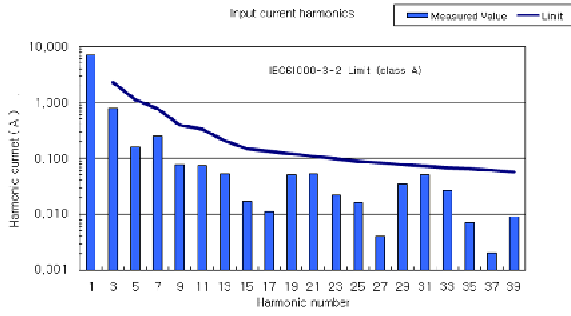
(1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)

- ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH2 : PFC OUTPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH3 : OUTPUT VOLTAGE - PP009 (Passive Voltage Probe)

입력	출력	측정값	파형	비고
<b>Turn on time characteristics</b>				
AC220V	$I_o=100\%$ 240A	$T_{on} = 1.13s$  Rise = 97.9ms		CH1(전압) 350V/div 200ms/div  CH3(전압) 200V/div 200ms/div  CH4(전압) 5V/div 200ms/div
<b>Hold up characteristics</b>				
AC220V	$I_o=100\%$ 240A	$T_{off} = 23.17ms$		CH1(전압) 350V/div 20ms/div  CH3(전압) 200V/div 20ms/div  CH4(전압) 5V/div 20ms/div
<b>Over Current protection characteristics</b>				
AC220V		OCP=285[A] (118%)		CH1(전류) 50A/div 1us/div  CH2(전압) 1V/div 1us/div
<b>Over Voltage protection characteristics</b>				
AC220V	$I_o=10\%$ 24A	OVP = 6.54[V] (130%)		CH1(전압) 2V/div 100ms/div

## 2-1. CSF1500-09 Input characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)  
 ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)  
 ◇ CH2 : AC INPUT CURRENT - CP500 (Current Probe)  
 (2) Power Analyzer WT500 (YOKOGAWA)

입력	출력	측정값	파형	비고
<b>Inrush Current Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (150A)	Inrush 1차 = 25.8[A]  Inrush 2차 = 27[A]		CH1(전압) 200V/div 200ms/div  CH2(전류) 20A/div 200ms/div
<b>Inrush Current Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (150A)	Inrush 1차 = 56.4[A]  Inrush 2차 = 11.8[A]		CH2(전압) 200V/div 100ms/div  CH3(전류) 20A/div 100ms/div
<b>Input Line Harmonics Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (150A)	IEC61000-3-2		
<b>Input Line Harmonics Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (150A)	IEC61000-3-2		

## 2-1. CSF1500-09 Input characteristics

- (1) Power Analyzer WT500 (YOKOGAWA)  
 (2) Digital multi meter 2000 (KEITHLEY)

### Input Current & Efficiency Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		Load (min) 0A	Input Current	0.536A	0.471A	0.454A	0.455A
	Efficiency	-	-	-	-	-	-
Load (50%) 75A	Input Current	8.928A	7.102A	6.022A	4.582A	3.624A	3.054A
	Efficiency	84.15%	85.17%	85.69%	86.60%	87.10%	87.68%
Load (100%) 150A	Input Current	18.515A	14.751A	12.310A	9.425A	7.268A	6.080A
	Efficiency	80.95%	82.53%	83.47%	84.46%	85.25%	85.71%

### Power Factor Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		Load (min) 0A	0.870	0.788	0.683	0.530	0.366
Load (50%) 75A		0.995	0.993	0.990	0.985	0.970	0.944
Load (100%) 150A		0.999	0.998	0.997	0.995	0.989	0.976

### Leakage Current Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	220V	264V		
		Line L (mA)	0.60	0.62	0.80	0.84	
Line N (mA)		0.62	0.65	0.88	1.00		



## 2-2. CSF1500-09 Output characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)  
 ◇ CH1 : BNC Cable 1.5m, 50Ω, Band Width : 200Mhz  
 ◇ CH1 : OUTPUT CURRENT – CP500 (Current Probe)  
 ◇ CH2 : OUTPUT VOLTAGE – PP006 (Passive Voltage Probe)  
 (2) Digital multi meter 2000 (KEITHLEY)

### Line & Load Regulation Characteristics

Condition Ta : 25°C

$I_o$ \ $V_{in}$	90V	110V	132V	170V	220V	264V	Line Regulation
Load (0A)	9.008V	9.008V	9.008V	9.008V	9.008V	9.008V	0mV
Load (50%)	9.008V	9.008V	9.008V	9.008V	9.008V	9.008V	0mV
Load (100%)	9.014V	9.014V	9.014V	9.014V	9.013V	9.013V	1mV
Load Regulation	6mV	6mV	6mV	6mV	5mV	5mV	

입력

출력

측정값

파형

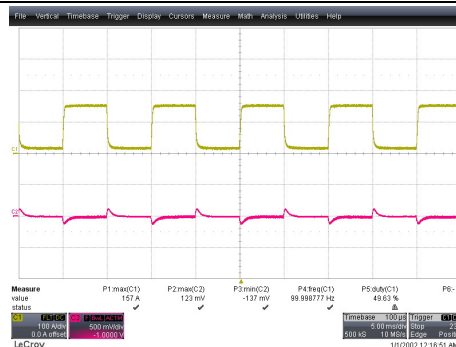
비고

### Dynamic Load Response Characteristics (100Hz)

AC220V

$I_o=10 \leftrightarrow 100\%$   
 $f_s=100\text{Hz}$   
 Duty=50%  
 Slew rate  
 10uS

+VPK = 123mV  
 (1.36%)  
  
 -VPK = 137mV  
 (1.52%)



CH1(전류)  
 100A/div  
 5ms/div

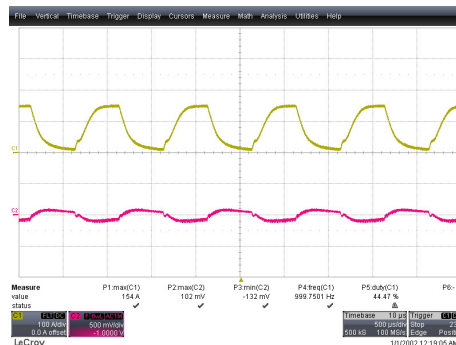
CH2(전압)  
 500mV/div  
 5ms/div

### Dynamic Load Response Characteristics (1KHz)

AC220V

$I_o=0 \leftrightarrow 100\%$   
 $f_s=1\text{Kz}$   
 Duty=50%  
 Slew rate  
 50uS

+VPK = 102mV  
 (1.13%)  
  
 -VPK = 132mV  
 (1.46%)



CH1(전류)  
 100A/div  
 500us/div

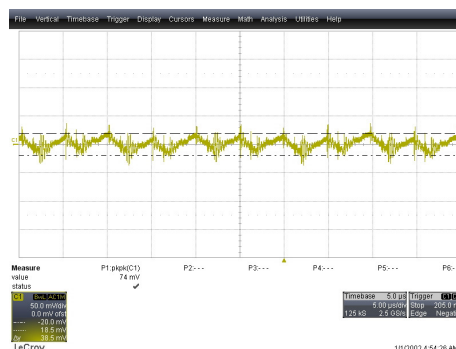
CH2(전압)  
 500mV/div  
 500us/div

### Ripple & Noise characteristics

AC220V

$I_o=100\%$   
 150A

Ripple  
 38mV  
  
 Ripple & Noise  
 74mV<sub>p-p</sub>



CH1(전압)  
 50mV/div  
 5us/div

Terminal 단자에  
 Elec-cap:100uF  
 Film-cap:0.47uF  
 접속 후 측정

## 2-2. CSF1500-09 Output characteristics

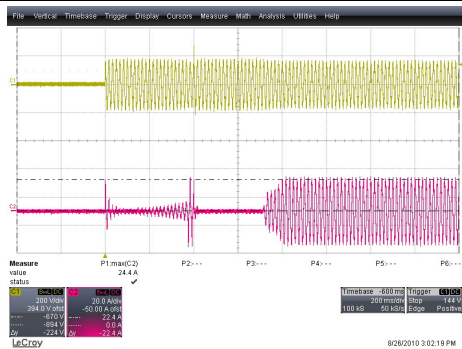
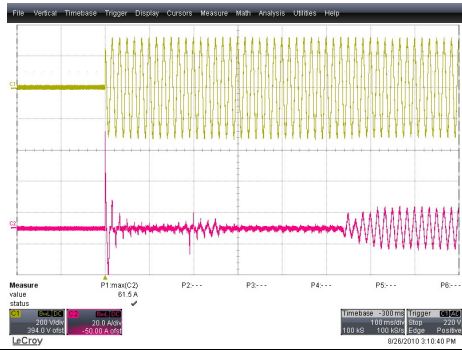
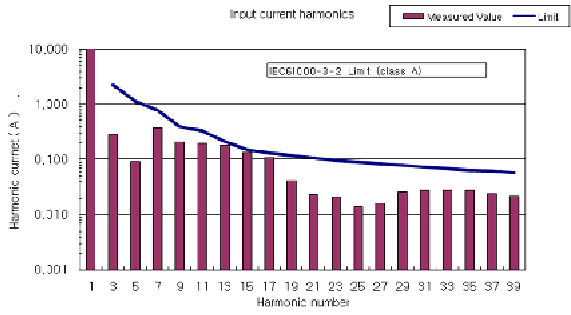
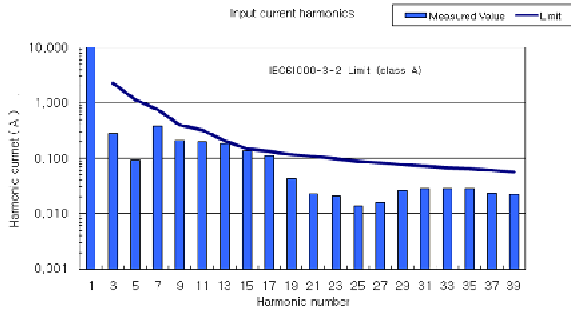
(1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)

- ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH2 : PFC OUTPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH3 : OUTPUT VOLTAGE - PP009 (Passive Voltage Probe)

입력	출력	측정값	파형	비고
<b>Turn on time characteristics</b>				
AC220V	$I_o=100\%$ 150A	$T_{on} = 1.18s$ $Rise = 73.5ms$		CH1(전압) 350V/div 200ms/div  CH3(전압) 200V/div 200ms/div  CH4(전압) 5V/div 200ms/div
<b>Hold up characteristics</b>				
AC220V	$I_o=100\%$ 150A	$T_{off} = 15.5ms$		CH1(전압) 350V/div 20ms/div  CH3(전압) 200V/div 20ms/div  CH4(전압) 5V/div 20ms/div
<b>Over Current protection characteristics</b>				
AC220V		OCP=181.1[A] (120%)		CH1(전류) 50A/div 5ms/div  CH2(전압) 2V/div 5ms/div
<b>Over Voltage protection characteristics</b>				
AC220V	$I_o=10\%$ 15A	OVP =12.56[V] (139.5%)		CH1(전압) 5V/div 100ms/div

### 3-1. CSF1500-12 Input characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)  
 ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)  
 ◇ CH2 : AC INPUT CURRENT - CP500 (Current Probe)  
 (2) Power Analyzer WT500 (YOKOGAWA)

입력	출력	측정값	파형	비고
<b>Inrush Current Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (125A)	Inrush 1차 = 22.4[A]  Inrush 2차 = 24.4[A]		CH1(전압) 200V/div 200ms/div  CH2(전류) 20A/div 200ms/div
<b>Inrush Current Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (125A)	Inrush 1차 = 61.5[A]  Inrush 2차 = 16.6[A]		CH2(전압) 200V/div 100ms/div  CH3(전류) 20A/div 100ms/div
<b>Input Line Harmonics Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (125A)	IEC61000-3-2		
<b>Input Line Harmonics Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (125A)	IEC61000-3-2		

### 3-1. CSF1500-12 Input characteristics

- (1) Power Analyzer WT500 (YOKOGAWA)  
 (2) Digital multi meter 2000 (KEITHLEY)

#### Input Current & Efficiency Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		Load (min) 0A	0.540A	0.499A	0.485A	0.480A	0.527A
	Efficiency	-	-	-	-	-	-
Load (50%) 62.5A	Input Current	9.800A	7.987A	6.681A	5.048A	3.988A	3.384A
	Efficiency	84.66%	85.78%	86.61%	87.52%	88.17%	88.67%
Load (100%) 125A	Input Current	20.328A	16.418A	13.467A	10.257A	7.899A	6.654A
	Efficiency	81.30%	83.19%	84.55%	85.91%	86.80%	87.31%

#### Power Factor Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		Load (min) 0A	0.849	0.738	0.640	0.485	0.339
Load (50%) 62.5A		0.997	0.995	0.993	0.987	0.970	0.944
Load (100%) 125A		0.998	0.999	0.998	0.996	0.990	0.977

#### Leakage Current Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	220V	264V		
		Line L (mA)	0.61	0.66	0.80	0.85	
Line N (mA)		0.60	0.62	0.84	0.87		

### 3-2. CSF1500-12 Output characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)  
 ◇ CH1 : BNC Cable 1.5m, 50Ω, Band Width : 200Mhz  
 ◇ CH1 : OUTPUT CURRENT – CP500 (Current Probe)  
 ◇ CH2 : OUTPUT VOLTAGE – PP006 (Passive Voltage Probe)  
 (2) Digital multi meter 2000 (KEITHLEY)

#### Line & Load Regulation Characteristics

Condition Ta : 25°C

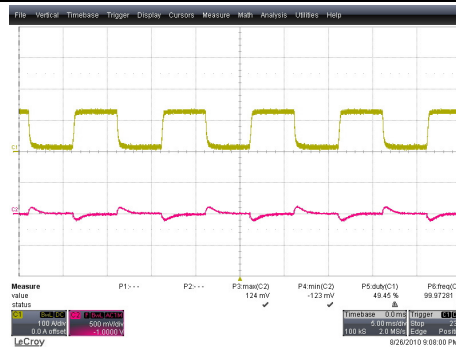
$I_o$ \ $V_{in}$	90V	110V	132V	170V	220V	264V	Line Regulation
Load (0A)	12.014V	12.014V	12.014V	12.014V	12.014V	12.014V	0mV
Load (50%)	12.017V	12.016V	12.016V	12.016V	12.016V	12.016V	1mV
Load (100%)	12.023V	12.022V	12.021V	12.021V	12.021V	12.021V	2mV
Load Regulation	9mV	8mV	7mV	7mV	7mV	7mV	

입력	출력	측정값	파형	비고
----	----	-----	----	----

#### Dynamic Load Response Characteristics (100Hz)

AC220V  
 $I_o=10 \leftrightarrow 100\%$   
 $f_s=100\text{Hz}$   
 Duty=50%  
 Slew rate  
 10uS

+VPK = 124mV  
 (0.82%)  
 -VPK = 123mV  
 (0.82%)

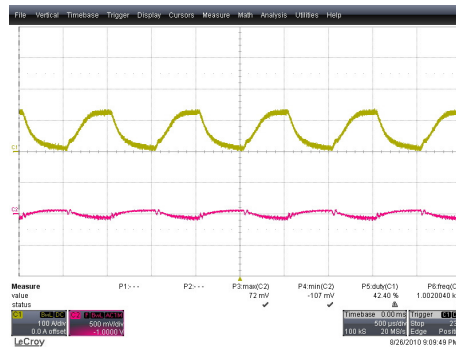


CH1(전류)  
 100A/div  
 5ms/div  
 CH2(전압)  
 500mV/div  
 5ms/div

#### Dynamic Load Response Characteristics (1KHz)

AC220V  
 $I_o=0 \leftrightarrow 100\%$   
 $f_s=1\text{Kz}$   
 Duty=50%  
 Slew rate  
 50uS

+VPK = 72mV  
 (0.48%)  
 -VPK = 107mV  
 (0.71%)

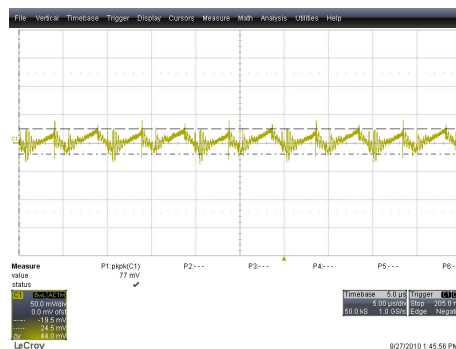


CH1(전류)  
 100A/div  
 500us/div  
 CH2(전압)  
 500mV/div  
 500us/div

#### Ripple & Noise characteristics

AC220V  
 $I_o=100\%$   
 125A

Ripple  
 44mV  
 Ripple & Noise  
 77mV<sub>P-P</sub>

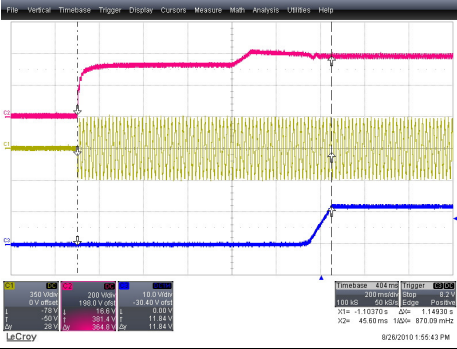
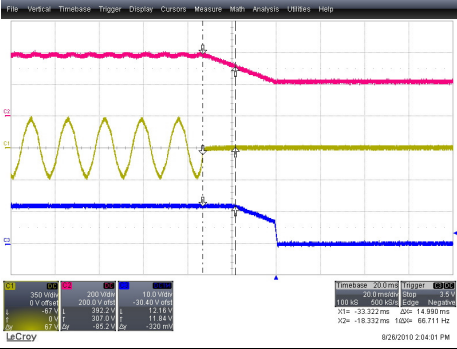
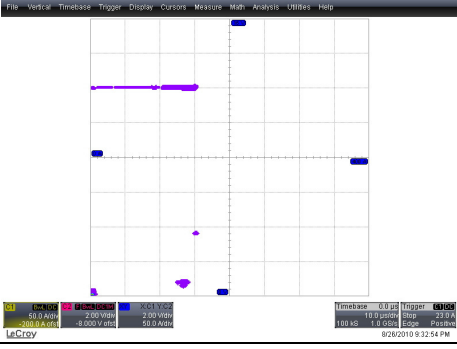
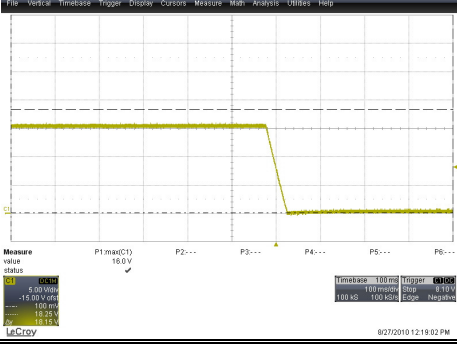


CH1(전압)  
 50mV/div  
 5us/div  
 Terminal 단자에  
 Elec-cap:100uF  
 Film-cap:0.47uF  
 접속 후 측정

### 3-2. CSF1500-12 Output characteristics

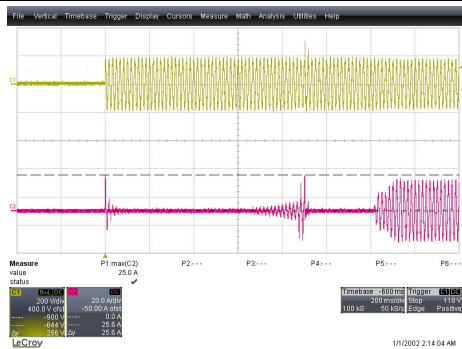
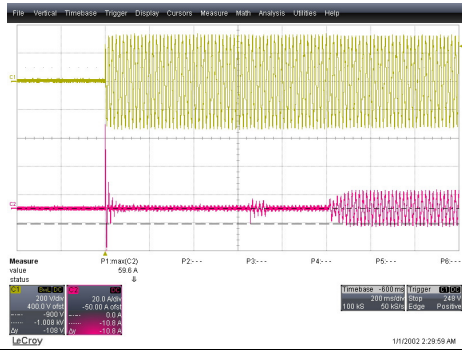
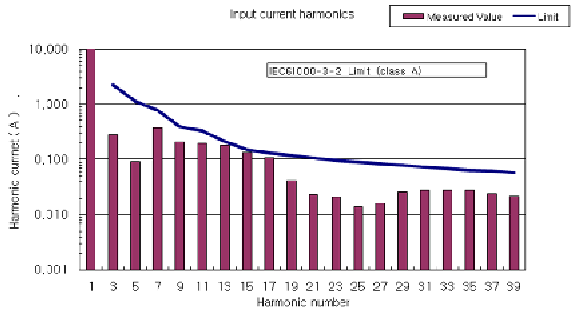
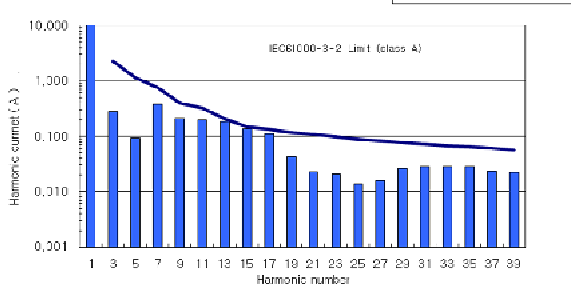
(1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)

- ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH2 : PFC OUTPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH3 : OUTPUT VOLTAGE - PP009 (Passive Voltage Probe)

입력	출력	측정값	파형	비고
<b>Turn on time characteristics</b>				
AC220V	$I_o=100\%$ 125A	$T_{on} = 1.14s$ $Rise = 111.3ms$		CH1(전압) 350V/div 200ms/div  CH3(전압) 200V/div 200ms/div  CH4(전압) 10V/div 200ms/div
<b>Hold up characteristics</b>				
AC220V	$I_o=100\%$ 125A	$T_{off} = 14.99ms$		CH1(전압) 350V/div 20ms/div  CH3(전압) 200V/div 20ms/div  CH4(전압) 10V/div 20ms/div
<b>Over Current protection characteristics</b>				
AC220V		OCP=151[A] (120%)		CH1(전류) 50A/div 10us/div  CH2(전압) 2V/div 10us/div
<b>Over Voltage protection characteristics</b>				
AC220V	$I_o=10\%$ 12.5A	OVP = 16.0[V] (133%)		CH1(전압) 5V/div 100ms/div

#### 4-1. CSF1500-15 Input characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)  
 ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)  
 ◇ CH2 : AC INPUT CURRENT - CP500 (Current Probe)  
 (2) Power Analyzer WT500 (YOKOGAWA)

입력	출력	측정값	파형	비고
<b>Inrush Current Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (100A)	Inrush 1차 = 25[A]  Inrush 2차 = 25.2[A]		CH1(전압) 200V/div 200ms/div  CH2(전류) 20A/div 200ms/div
<b>Inrush Current Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (100A)	Inrush 1차 = 59.6[A]  Inrush 2차 = 10.8[A]		CH2(전압) 200V/div 100ms/div  CH3(전류) 20A/div 100ms/div
<b>Input Line Harmonics Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (100A)	IEC61000-3-2		
<b>Input Line Harmonics Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (100A)	IEC61000-3-2		

#### 4-1. CSF1500-15 Input characteristics

- (1) Power Analyzer WT500 (YOKOGAWA)  
 (2) Digital multi meter 2000 (KEITHLEY)

##### Input Current & Efficiency Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		Load (min) 0A	Input Current	0.536A	0.477A	0.460A	0.460A
	Efficiency	-	-	-	-	-	-
Load (50%) 50A	Input Current	9.792A	7.842A	6.513A	5.082A	3.929A	3.351A
	Efficiency	85.67%	86.66%	87.35%	88.02%	88.76%	89.14%
Load (100%) 100A	Input Current	19.825A	16.022A	13.110A	10.018A	7.740A	6.488A
	Efficiency	84.02%	85.77%	86.92%	88.02%	88.82%	89.31%

##### Power Factor Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		Load (min) 0A	0.869	0.802	0.685	0.539	0.377
Load (50%) 50A		0.995	0.994	0.992	0.987	0.973	0.951
Load (100%) 100A		0.999	0.998	0.998	0.996	0.990	0.979

##### Leakage Current Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	220V	264V		
		Line L (mA)	0.62	0.65	0.82	0.87	
Line N (mA)		0.60	0.62	0.85	1.0		



## 4-2. CSF1500-15 Output characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)
  - ◇ CH1 : BNC Cable 1.5m, 50Ω, Band Width : 200Mhz
  - ◇ CH1 : OUTPUT CURRENT – CP500 (Current Probe)
  - ◇ CH2 : OUTPUT VOLTAGE – PP006 (Passive Voltage Probe)
- (2) Digital multi meter 2000 (KEITHLEY)

### Line & Load Regulation Characteristics

Condition Ta : 25°C

$I_o$ \ $V_{in}$	90V	110V	132V	170V	220V	264V	Line Regulation
Load (0A)	15.018V	15.018V	15.018V	15.018V	15.018V	15.018V	0mV
Load (50%)	15.021V	15.020V	15.020V	12.019V	12.019V	12.019V	2mV
Load (100%)	15.028V	15.026V	15.025V	15.025V	15.025V	15.024V	4mV
Load Regulation	10mV	8mV	7mV	7mV	7mV	6mV	

입력

출력

측정값

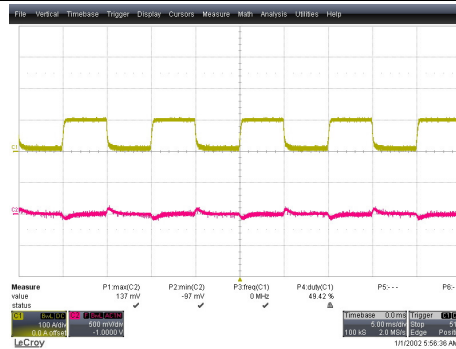
파형

비고

### Dynamic Load Response Characteristics (100Hz)

AC220V  
 $I_o=10 \leftrightarrow 100\%$   
 $f_s=100\text{Hz}$   
 Duty=50%  
 Slew rate  
 10uS

+VPK = 137mV  
 (0.91%)  
  
 -VPK = 97mV  
 (0.64%)

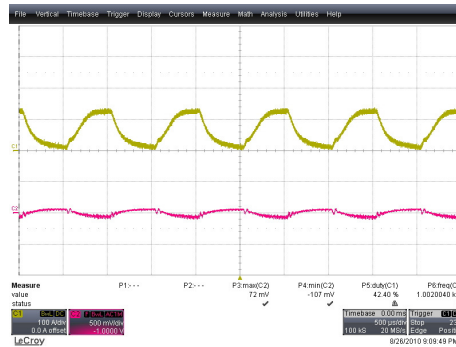


CH1(전류)  
 100A/div  
 5ms/div  
  
 CH2(전압)  
 500mV/div  
 5ms/div

### Dynamic Load Response Characteristics (1KHz)

AC220V  
 $I_o=0 \leftrightarrow 100\%$   
 $f_s=1\text{Kz}$   
 Duty=50%  
 Slew rate  
 50uS

+VPK = 72mV  
 (0.48%)  
  
 -VPK = 107mV  
 (0.71%)

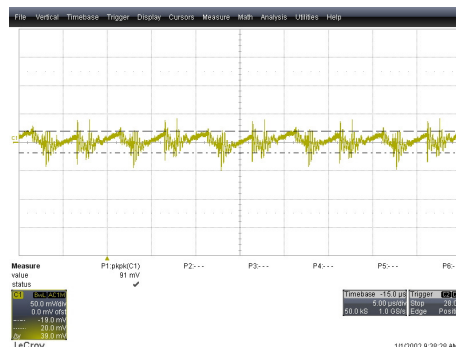


CH1(전류)  
 100A/div  
 500us/div  
  
 CH2(전압)  
 500mV/div  
 500us/div

### Ripple & Noise characteristics

AC220V  
 $I_o=100\%$   
 100A

Ripple  
 39mV  
  
 Ripple & Noise  
 91mV<sub>P-P</sub>



CH1(전압)  
 50mV/div  
 5us/div  
  
 Terminal 단자에  
 Elec-cap: 100uF  
 Film-cap: 0.47uF  
 접속 후 측정

## 4-2. CSF1500-15 Output characteristics

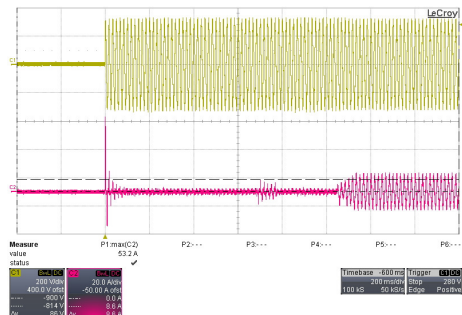
(1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)

- ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH2 : PFC OUTPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH3 : OUTPUT VOLTAGE - PP009 (Passive Voltage Probe)

입력	출력	측정값	파형	비고
<b>Turn on time characteristics</b>				
AC220V	$I_o=100\%$ 100A	$T_{on} = 1.13s$ $Rise = 90.78ms$		CH1(전압) 350V/div 200ms/div  CH3(전압) 200V/div 200ms/div  CH4(전압) 10V/div 200ms/div
<b>Hold up characteristics</b>				
AC220V	$I_o=100\%$ 100A	$T_{off} = 10.90ms$		CH1(전압) 350V/div 20ms/div  CH3(전압) 200V/div 20ms/div  CH4(전압) 10V/div 20ms/div
<b>Over Current protection characteristics</b>				
AC220V		OCP=126.2[A] (126.2%)		CH1(전류) 50A/div 10us/div  CH2(전압) 2V/div 10us/div
<b>Over Voltage protection characteristics</b>				
AC220V	$I_o=10\%$ 10A	OVP =18.89[V] (125.9%)		CH1(전압) 5V/div 100ms/div

## 5-1. CSF1500-24 Input characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)  
 ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)  
 ◇ CH2 : AC INPUT CURRENT - CP500 (Current Probe)  
 (2) Power Analyzer WT500 (YOKOGAWA)

입력	출력	측정값	파형	비고
<b>Inrush Current Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (63A)	Inrush 1차 = 19.2[A]  Inrush 2차 = 25.0[A]		CH1(전압) 200V/div 200ms/div  CH2(전류) 20A/div 200ms/div
<b>Inrush Current Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (63A)	Inrush 1차 = 53.2[A]  Inrush 2차 = 8.6[A]		CH2(전압) 200V/div 100ms/div  CH3(전류) 20A/div 100ms/div
<b>Input Line Harmonics Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (63A)	IEC61000-3-2		
<b>Input Line Harmonics Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (63A)	IEC61000-3-2		

### 5-1. CSF1500-24 Input characteristics

- (1) Power Analyzer WT500 (YOKOGAWA)  
 (2) Digital multi meter 2000 (KEITHLEY)

#### Input Current & Efficiency Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		90V	110V	132V	170V	220V	264V
Load (min) 0A	Input Current	0.578A	0.508A	0.500A	0.500A	0.533A	0.584A
	Efficiency	-	-	-	-	-	-
Load (50%) 31.5A	Input Current	9.865A	7.984A	6.609A	5.249A	3.963A	3.403A
	Efficiency	85.05%	86.31%	87.20%	88.01%	88.74%	89.15%
Load (100%) 63A	Input Current	20.290A	16.009A	13.203A	10.079A	7.763A	6.555A
	Efficiency	83.32%	85.67%	86.95%	88.31%	89.24%	89.72%

#### Power Factor Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		90V	110V	132V	170V	220V	264V
Load (min) 0A		0.850	0.774	0.675	0.517	0.369	0.272
Load (50%) 31.5A		0.997	0.995	0.993	0.987	0.972	0.946
Load (100%) 63A		0.998	0.999	0.998	0.996	0.990	0.976

#### Leakage Current Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	220V	264V		
		90V	110V	220V	264V		
Line L (mA)		0.46	0.49	0.82	0.87		
Line N (mA)		0.40	0.42	0.83	0.87		

## 5-2. CSF1500-24 Output characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)  
 ◇ CH1 : BNC Cable 1.5m, 50Ω, Band Width : 200Mhz  
 ◇ CH1 : OUTPUT CURRENT – CP500 (Current Probe)  
 ◇ CH2 : OUTPUT VOLTAGE – PP006 (Passive Voltage Probe)  
 (2) Digital multi meter 2000 (KEITHLEY)

### Line & Load Regulation Characteristics

Condition Ta : 25°C

$I_o$ \ $V_{in}$	90V	110V	132V	170V	220V	264V	Line Regulation
Load (0A)	24.048V	24.048V	24.048V	24.049V	24.049V	24.049V	1mV
Load (50%)	24.052V	24.052V	24.052V	24.052V	24.052V	24.052V	0mV
Load (100%)	24.054V	24.055V	24.055V	24.056V	24.056V	24.056V	2mV
Load Regulation	6mV	7mV	7mV	7mV	7mV	7mV	

입력

출력

측정값

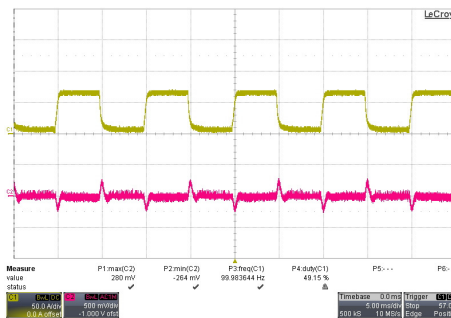
파형

비고

### Dynamic Load Response Characteristics (100Hz)

AC220V  
 $I_o=10 \leftrightarrow 100\%$   
 $f_s=100\text{Hz}$   
 Duty=50%  
 Slew rate  
 10uS

+VPK = 280mV  
 (1.16%)  
 -VPK = 264mV  
 (1.10%)



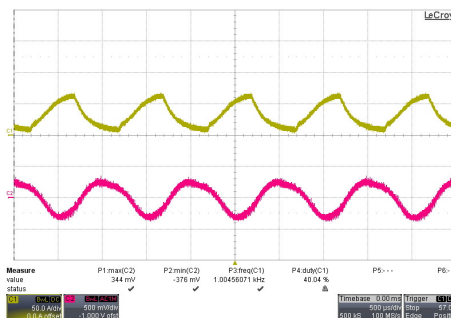
CH1(전류)  
 50A/div  
 5ms/div

CH2(전압)  
 500mV/div  
 5ms/div

### Dynamic Load Response Characteristics (1KHz)

AC220V  
 $I_o=0 \leftrightarrow 100\%$   
 $f_s=1\text{Kz}$   
 Duty=50%  
 Slew rate  
 50uS

+VPK = 344mV  
 (1.43%)  
 -VPK = 376mV  
 (1.56%)



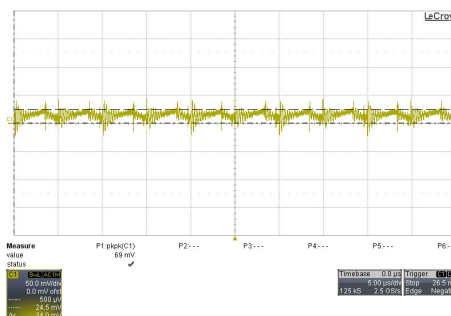
CH1(전류)  
 50A/div  
 500us/div

CH2(전압)  
 500mV/div  
 500us/div

### Ripple & Noise characteristics

AC220V  
 $I_o=100\%$   
 63A

Ripple  
 24mV  
 Ripple & Noise  
 69mV<sub>P-P</sub>



CH1(전압)  
 50mV/div  
 5us/div

Terminal 단자에  
 Elec-cap: 100uF  
 Film-cap: 0.47uF  
 접속 후 측정

## 5-2. CSF1500-24 Output characteristics

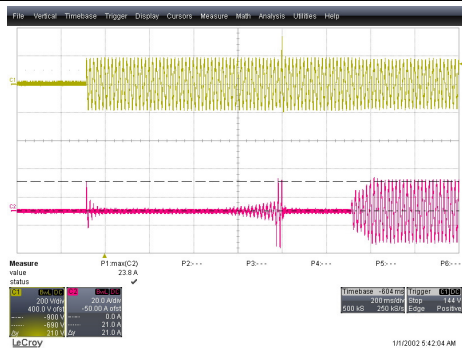
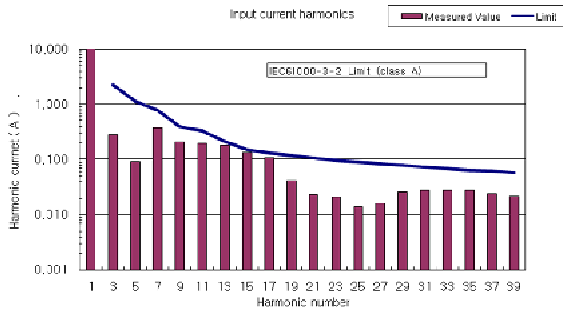
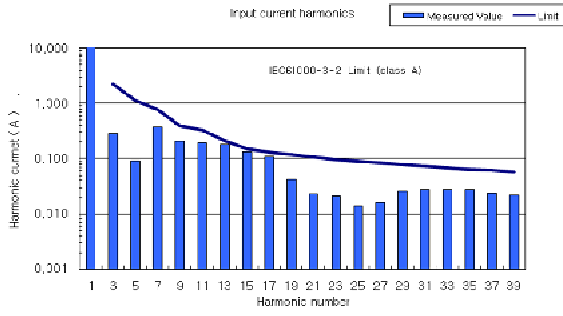
(1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)

- ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH2 : PFC OUTPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH3 : OUTPUT VOLTAGE - PP009 (Passive Voltage Probe)

입력	출력	측정값	파형	비고
<b>Turn on time characteristics</b>				
AC220V	$I_o=100\%$ 63A	Ton = 621.3ms Rise = 109.7ms		CH1(전압) 350V/div 200ms/div  CH3(전압) 200V/div 200ms/div  CH4(전압) 20V/div 200ms/div
<b>Hold up characteristics</b>				
AC220V	$I_o=100\%$ 63A	Toff = 17.0ms		CH1(전압) 350V/div 20ms/div  CH3(전압) 200V/div 20ms/div  CH4(전압) 20V/div 20ms/div
<b>Over Current protection characteristics</b>				
AC220V		OCP=80[A] (126%)		CH1(전류) 20A/div 2ms/div  CH2(전압) 5V/div 2ms/div
<b>Over Voltage protection characteristics</b>				
AC220V	$I_o=10\%$ 6.3A	OVP =29.4[V] (122%)		CH1(전압) 10V/div 100ms/div

## 6-1. CSF1500-28 Input characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)  
 ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)  
 ◇ CH2 : AC INPUT CURRENT - CP500 (Current Probe)  
 (2) Power Analyzer WT500 (YOKOGAWA)

입력	출력	측정값	파형	비고
<b>Inrush Current Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (54A)	Inrush 1차 = 21.0[A]  Inrush 2차 = 23.8[A]		CH1(전압) 200V/div 200ms/div  CH2(전류) 20A/div 200ms/div
<b>Inrush Current Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (54A)	Inrush 1차 = 67.9[A]  Inrush 2차 = 11.6[A]		CH2(전압) 200V/div 100ms/div  CH3(전류) 20A/div 100ms/div
<b>Input Line Harmonics Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (54A)	IEC61000-3-2		
<b>Input Line Harmonics Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (54A)	IEC61000-3-2		

## 6-1. CSF1500-28 Input characteristics

- (1) Power Analyzer WT500 (YOKOGAWA)  
 (2) Digital multi meter 2000 (KEITHLEY)

### Input Current & Efficiency Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		Load (min) 0A	Input Current	0.581A	0.501A	0.479A	0.474A
	Efficiency	-	-	-	-	-	-
Load (50%) 27A	Input Current	9.700A	7.810A	6.559A	5.147A	3.984A	3.371A
	Efficiency	85.90%	86.89%	87.44%	88.21%	88.76%	89.35%
Load (100%) 54A	Input Current	19.481A	15.738A	13.055A	10.045A	7.707A	6.452A
	Efficiency	85.51%	87.17%	88.21%	89.34%	90.11%	90.69%

### Power Factor Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		Load (min) 0A	0.885	0.813	0.719	0.554	0.394
Load (50%) 27A	0.995	0.994	0.992	0.987	0.974	0.950	
Load (100%) 54A	0.999	0.998	0.998	0.996	0.990	0.978	

### Leakage Current Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	220V	264V		
		Line L (mA)	0.60	0.64	0.78	0.85	
Line N (mA)	0.60	0.62	0.80	0.97			



## 6-2. CSF1500-28 Output characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)  
 ◇ CH1 : BNC Cable 1.5m, 50Ω, Band Width : 200Mhz  
 ◇ CH1 : OUTPUT CURRENT – CP500 (Current Probe)  
 ◇ CH2 : OUTPUT VOLTAGE – PP006 (Passive Voltage Probe)  
 (2) Digital multi meter 2000 (KEITHLEY)

### Line & Load Regulation Characteristics

Condition Ta : 25°C

$I_o$ \ $V_{in}$	90V	110V	132V	170V	220V	264V	Line Regulation
Load (0A)	28.034V	28.033V	28.033V	28.032V	28.032V	28.032V	2mV
Load (50%)	28.038V	28.038V	28.038V	28.038V	28.037V	28.036V	2mV
Load (100%)	28.041V	28.041V	28.041V	28.041V	28.041V	28.041V	0mV
Load Regulation	7mV	8mV	8mV	9mV	9mV	9mV	

입력

출력

측정값

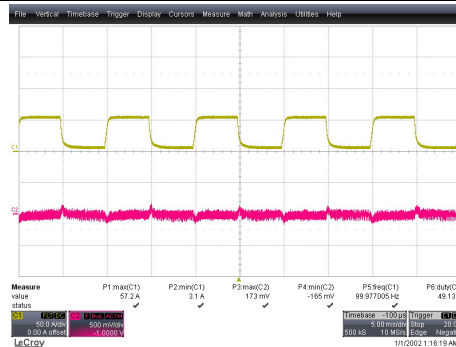
파형

비고

### Dynamic Load Response Characteristics (100Hz)

AC220V  
 $I_o=10 \leftrightarrow 100\%$   
 $f_s=100\text{Hz}$   
 Duty=50%  
 Slew rate  
 10uS

+VPK = 173mV  
 (0.61%)  
 -VPK = 165mV  
 (0.59%)



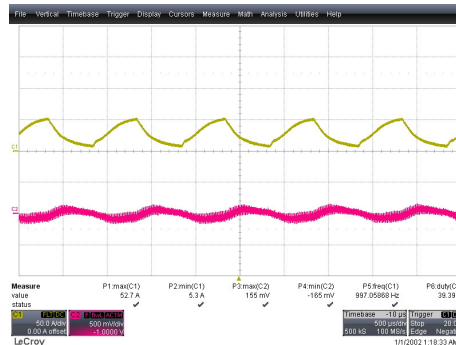
CH1(전류)  
 50A/div  
 5ms/div

CH2(전압)  
 500mV/div  
 5ms/div

### Dynamic Load Response Characteristics (1KHz)

AC220V  
 $I_o=0 \leftrightarrow 100\%$   
 $f_s=1\text{Kz}$   
 Duty=50%  
 Slew rate  
 50uS

+VPK = 155mV  
 (0.55%)  
 -VPK = 165mV  
 (0.59%)



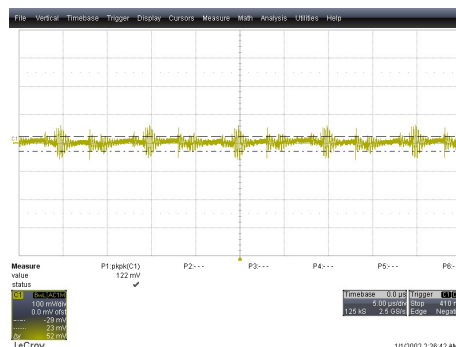
CH1(전류)  
 50A/div  
 500us/div

CH2(전압)  
 500mV/div  
 500us/div

### Ripple & Noise characteristics

AC220V  
 $I_o=100\%$   
 54A

Ripple  
 52mV  
 Ripple & Noise  
 122mV<sub>P-P</sub>



CH1(전압)  
 50mV/div  
 5us/div

Terminal 단자에  
 Elec-cap:100uF  
 Film-cap:0.47uF  
 접속 후 측정

## 6-2. CSF1500-28 Output characteristics

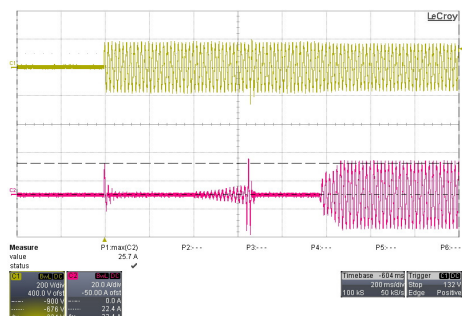
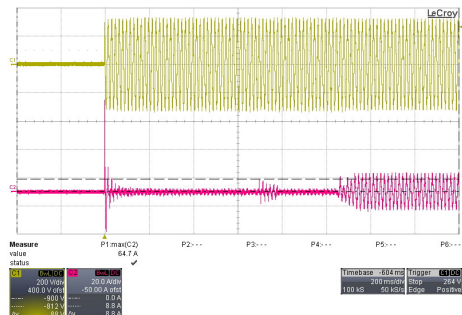
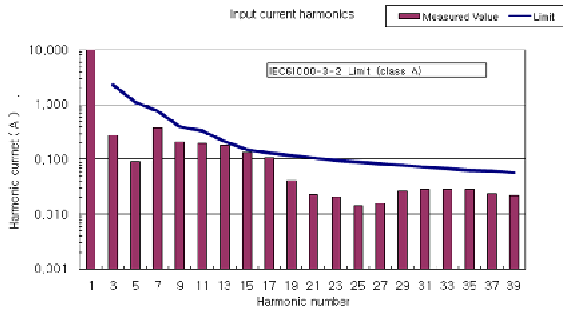
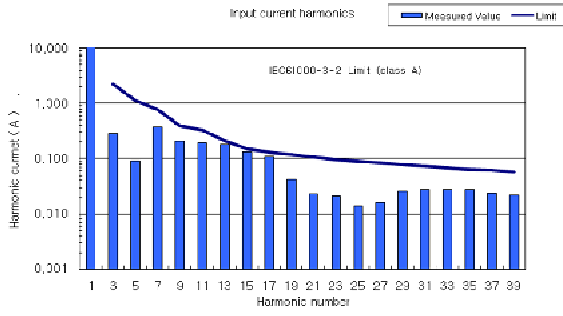
(1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)

- ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH2 : PFC OUTPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH3 : OUTPUT VOLTAGE - PP009 (Passive Voltage Probe)

입력	출력	측정값	파형	비고
<b>Turn on time characteristics</b>				
AC220V	$I_o=100\%$ 54A	$T_{on} = 1.12s$ $Rise = 99.8ms$		CH1(전압) 350V/div 200ms/div  CH3(전압) 200V/div 200ms/div  CH4(전압) 20V/div 200ms/div
<b>Hold up characteristics</b>				
AC220V	$I_o=100\%$ 54A	$T_{off} = 16.1ms$		CH1(전압) 350V/div 20ms/div  CH3(전압) 200V/div 20ms/div  CH4(전압) 20V/div 20ms/div
<b>Over Current protection characteristics</b>				
AC220V		OCP=65.3[A] (120.9%)		CH1(전류) 10A/div 5us/div  CH2(전압) 5V/div 5us/div
<b>Over Voltage protection characteristics</b>				
AC220V	$I_o=10\%$ 5.4A	OVP =35.7[V] (127.5%)		CH1(전압) 10V/div 100ms/div

## 7-1. CSF1500-48 Input characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)  
 ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)  
 ◇ CH2 : AC INPUT CURRENT - CP500 (Current Probe)  
 (2) Power Analyzer WT500 (YOKOGAWA)

입력	출력	측정값	파형	비고
<b>Inrush Current Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (32A)	Inrush 1차 = 22.4[A]  Inrush 2차 = 25.7[A]		CH1(전압) 200V/div 200ms/div  CH2(전류) 20A/div 200ms/div
<b>Inrush Current Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (32A)	Inrush 1차 = 64.7[A]  Inrush 2차 = 8.8[A]		CH2(전압) 200V/div 100ms/div  CH3(전류) 20A/div 100ms/div
<b>Input Line Harmonics Characteristics (110V)</b>				
AC110V	$I_o=100\%$ (32A)	IEC61000-3-2		
<b>Input Line Harmonics Characteristics (220V)</b>				
AC220V	$I_o=100\%$ (32A)	IEC61000-3-2		

## 7-1. CSF1500-48 Input characteristics

- (1) Power Analyzer WT500 (YOKOGAWA)  
 (2) Digital multi meter 2000 (KEITHLEY)

### Input Current & Efficiency Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		Load (min) 0A	Input Current	0.612A	0.532A	0.492A	0.482A
	Efficiency	-	-	-	-	-	-
Load (50%) 16A	Input Current	10.182A	8.106A	6.730A	5.215A	4.037A	3.431A
	Efficiency	83.51%	85.97%	86.99%	87.49%	88.69%	88.81%
Load (100%) 32A	Input Current	19.975A	16.153A	13.122A	10.065A	7.767A	6.528A
	Efficiency	84.70%	86.68%	88.02%	89.20%	90.20%	90.67%

### Power Factor Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	132V	170V	220V	264V
		Load (min) 0A	0.880	0.813	0.729	0.581	0.416
Load (50%) 16A	0.999	0.998	0.996	0.990	0.977	0.955	
Load (100%) 32A	0.999	0.999	0.999	0.997	0.992	0.981	

### Leakage Current Characteristics

Condition Ta : 25°C

Io \ Vin		90V	110V	220V	264V		
		Line L (mA)	0.62	0.65	0.88	1.0	
Line N (mA)	0.60	0.65	0.85	0.96			

## 7-2. CSF1500-48 Output characteristics

- (1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)  
 ◇ CH1 : BNC Cable 1.5m, 50Ω, Band Width : 200Mhz  
 ◇ CH1 : OUTPUT CURRENT – CP500 (Current Probe)  
 ◇ CH2 : OUTPUT VOLTAGE – PP006 (Passive Voltage Probe)  
 (2) Digital multi meter 2000 (KEITHLEY)

### Line & Load Regulation Characteristics

Condition Ta : 25°C

$I_o$ \ $V_{in}$	90V	110V	132V	170V	220V	264V	Line Regulation
Load (0A)	48.039V	48.039V	48.039V	48.039V	48.039V	48.039V	0mV
Load (50%)	48.042V	48.043V	48.043V	48.043V	48.044V	48.044V	2mV
Load (100%)	48.041V	48.043V	48.044V	48.046V	48.046V	48.047V	6mV
Load Regulation	3mV	4mV	5mV	7mV	7mV	8mV	

입력

출력

측정값

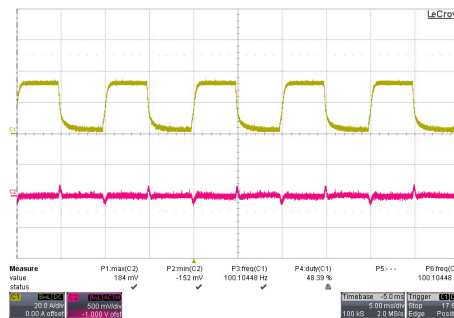
파형

비고

### Dynamic Load Response Characteristics (100Hz)

AC220V  
 $I_o=10 \leftrightarrow 100\%$   
 $f_s=100\text{Hz}$   
 Duty=50%  
 Slew rate  
 10uS

+VPK = 184mV  
 (0.38%)  
 -VPK = 152mV  
 (0.31%)



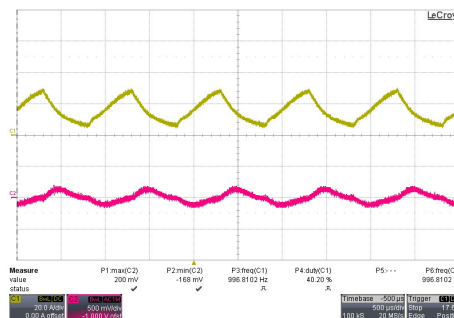
CH1(전류)  
 20A/div  
 5ms/div

CH2(전압)  
 500mV/div  
 5ms/div

### Dynamic Load Response Characteristics (1KHz)

AC220V  
 $I_o=0 \leftrightarrow 100\%$   
 $f_s=1\text{Kz}$   
 Duty=50%  
 Slew rate  
 50uS

+VPK = 200mV  
 (0.41%)  
 -VPK = 168mV  
 (0.35%)



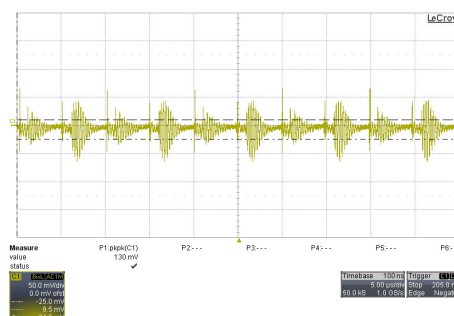
CH1(전류)  
 20A/div  
 500us/div

CH2(전압)  
 500mV/div  
 500us/div

### Ripple & Noise characteristics

AC220V  
 $I_o=100\%$   
 32A

Ripple  
 34.5mV  
 Ripple & Noise  
 130mV<sub>P-P</sub>



CH1(전압)  
 50mV/div  
 5us/div

Terminal 단자에  
 Elec-cap:100uF  
 Film-cap:0.47uF  
 접속 후 측정

## 7-2. CSF1500-48 Output characteristics

(1) Oscilloscope : WAVE Runner 104Mxi (LeCroy)

- ◇ CH1 : AC INPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH2 : PFC OUTPUT VOLTAGE - ADP305 (High Voltage Differential Probe)
- ◇ CH3 : OUTPUT VOLTAGE - PP009 (Passive Voltage Probe)

입력	출력	측정값	파형	비고
<b>Turn on time characteristics</b>				
AC220V	$I_o=100\%$ 32A	Ton = 907.8ms  Rise = 120ms		CH1(전압) 350V/div 200ms/div  CH3(전압) 200V/div 200ms/div  CH4(전압) 50V/div 200ms/div
<b>Hold up characteristics</b>				
AC220V	$I_o=100\%$ 32A	Toff = 15.41ms		CH1(전압) 350V/div 20ms/div  CH3(전압) 200V/div 20ms/div  CH4(전압) 50V/div 20ms/div
<b>Over Current protection characteristics</b>				
AC220V		OCP=41.9[A] (130%)		CH1(전류) 10A/div 10us/div  CH2(전압) 10V/div 10us/div
<b>Over Voltage protection characteristics</b>				
AC220V	$I_o=10\%$ 3.2A	OVP = 62.6[V] (130%)		CH1(전압) 20V/div 100ms/div