TDK·Lambda

LZSa5003

EVALUATION DATA

INDEX

TEST EQUIPMENT USED:

Digital Multi Meter (DMM) – Model –HP 34401A , Serial # -3146A22113 ,
POWER Source – Model –KIKUSUI DCR4000L, Serial # -13010090 ,
Electronic Load – Model –KIKUSUI PLC1003W, Serial # -14030789 ,
Digital Power Meter-Yokogawa, Serial# 28AW7013
Oscilloscope – Model –Tektronix TDS524A, Serial # -B010488 ,
OVP Source - HP6655A DC Power Supply Asset#3639A-01304
Electronic Load - HP6050A DC Load Asset#US37142000
Electronic Load - HP6050A DC Load Asset#US7141950
Oscilloscope - HP54503A Digitizing Scope Asset#US34510441
DMM - HP34401A Asset#US36012637
AC Source - California Instruments Model 6000L Asset#3803
Power Meter - Yokogawa WT1030 Asset#1345

Terminology used:

Vout = Output Voltage
Iout = Output Current
Vin = Input Voltage
Iin = Input Current
Ta = Ambient Temperature
OVP = Over-voltage protection
OCP = Over-current protection

EVALUATION DATA

1.- Load/Line Regulation

Vout = 24Vdc , 100% load = 21 amps , Ta =25C

Vout measured across output bussbars using local sense connections.

Local Sense

Iout\Vin	85VAC	115VAC	230VAC	265VAC	Line Regulation	
0% Load	24.0385	24.0386	24.0387	24.0387	0.2mV	0.0008%
25% Load	24.0311	24.0312	24.0312	24.0313	0.2mV	0.0008%
50% Load	24.0294	24.0294	24.0294	24.0294	0mV	0.0000%
75% Load	24.0284	24.0284	24.0284	24.0284	0mV	0.0000%
100% Load	24.0276	24.0276	24.0276	24.0276	0mV	0.0000%
Load Regulation	10.9mV	11mV	11.1mV	11.1mV		
	0.0454%	0.0458%	0.0463%	0.0463%		

Vout measured on load using remote sense connections.

Remote Sense

Iout\Vin	85VAC	115VAC	230VAC	265VAC	Line Regulation	
0% Load	24.0347	24.0347	24.0347	24.0347	0mV	0.0000%
25% Load	24.0322	24.0322	24.0322	24.0322	0mV	0.0000%
50% Load	24.0320	24.0320	24.0320	24.0320	0mV	0.0000%
75% Load	24.0318	24.0318	24.0318	24.0318	0mV	0.0000%
100% Load	24.0314	24.0314	24.0314	24.0314	0mV	0.0000%
Load Regulation	3.3mV	3.3mV	3.3mV	3.3mV		
	0.0138%	0.0138%	0.0138%	0.0138%		

2.- Temperature Drift

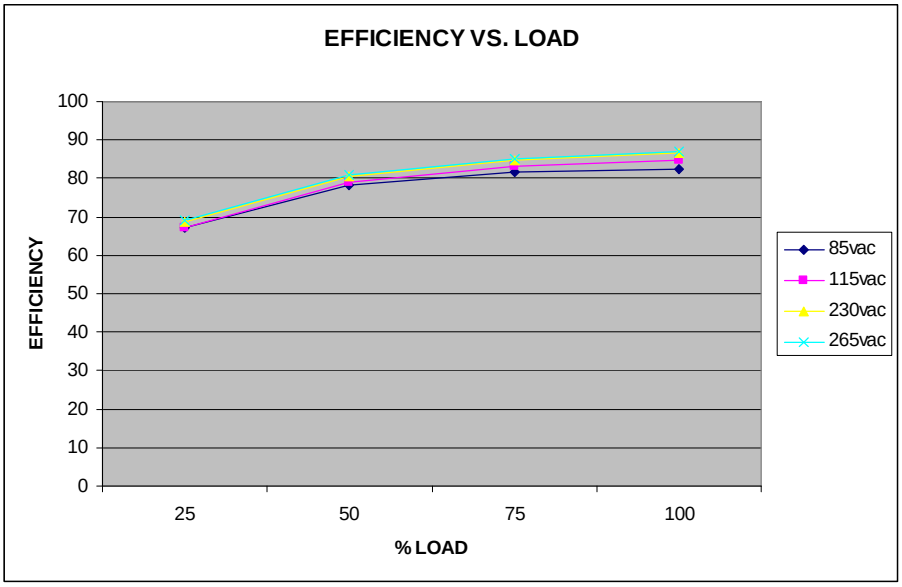
Vin = 115Vac , Vout = 24Vdc , Iout = 21 amps

				Temperature	Stability	
Ta	-30C	25C	60C	Vout Delta	V/C	%/C
Vout	24.0508	24.0455	24.0341	0.0167V	0.000186	0.000775

3.- Efficiency vs Output Current

Vout = 24vdc , 100% Load = 21Amps. , Ta = 25C

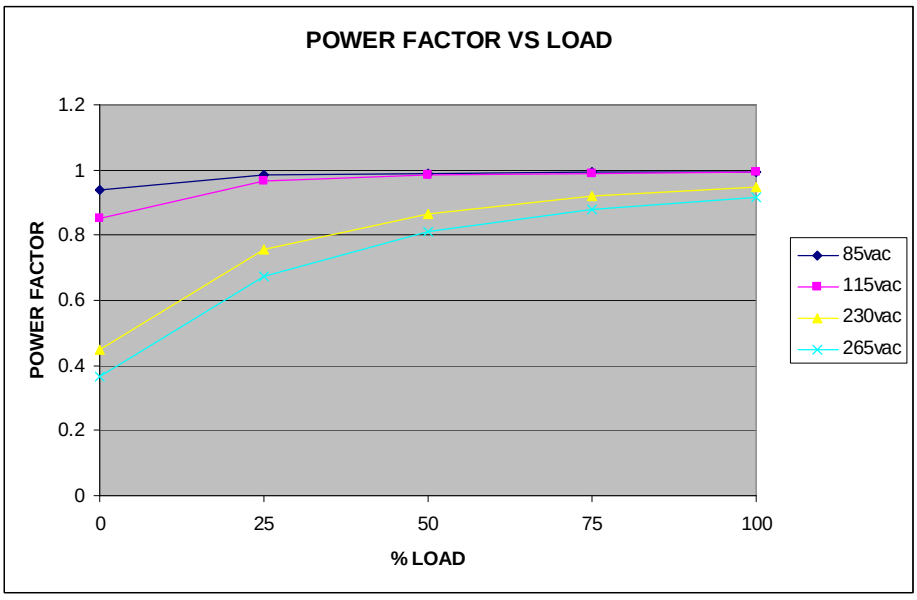
Iout(%)/Vin	85VAC	115VAC	230VAC	265VAC
25	67.05	67.3	68.85	69.23
50	78.23	79.14	80.51	81.02
75	81.6	83.02	84.75	85.13
100	82.52	84.56	86.6	87.04



4.- Power Factor vs Output Current

Vout = 24vdc , 100% Load = 21Amps. , Ta = 25C

Iout(%)/Vin	85VAC	115VAC	230VAC	265VAC
0	0.9393	0.8509	0.4509	0.3646
25	0.9855	0.9655	0.7569	0.6732
50	0.9914	0.9838	0.8655	0.8085
75	0.9924	0.9894	0.9197	0.8772
100	0.9922	0.9917	0.9459	0.9164



5.- Standby Input Current under inhibit condition & Input Current vs Output Current

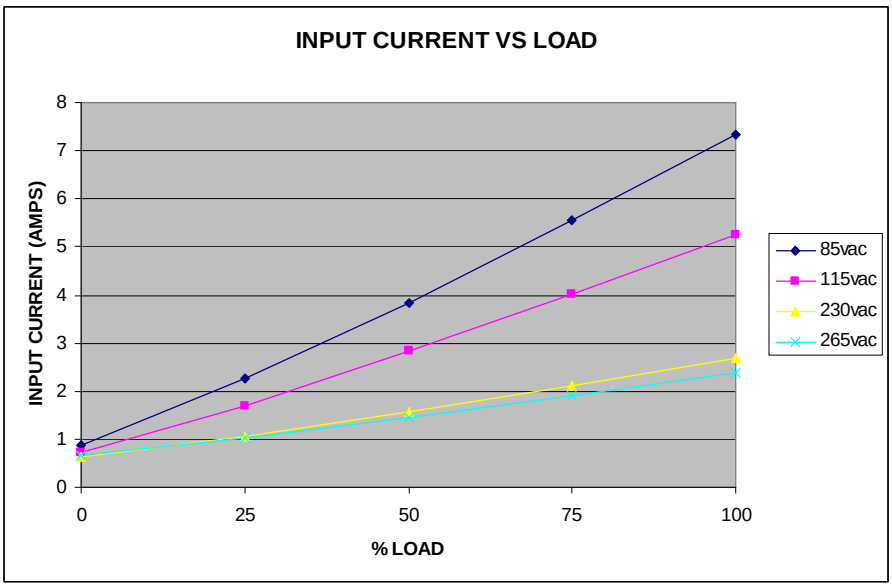
5.1 Standby Input Current under inhibit condition.

Vin(AC)	Iinput(AC)
85	0.368
110	0.368
132	0.368
170	0.405
220	0.476
265	0.543

5.2 Input Current vs output Current

Vout = 24vdc , 100% Load = 21Amps. , Ta = 25C

Iout(%)/Vin	85VAC	115VAC	230VAC	265VAC
0	0.889	0.723	0.639	0.67
25	2.256	1.691	1.052	1.02
50	3.849	2.827	1.574	1.451
75	5.543	4.023	2.113	1.912
100	7.322	5.259	2.679	2.387

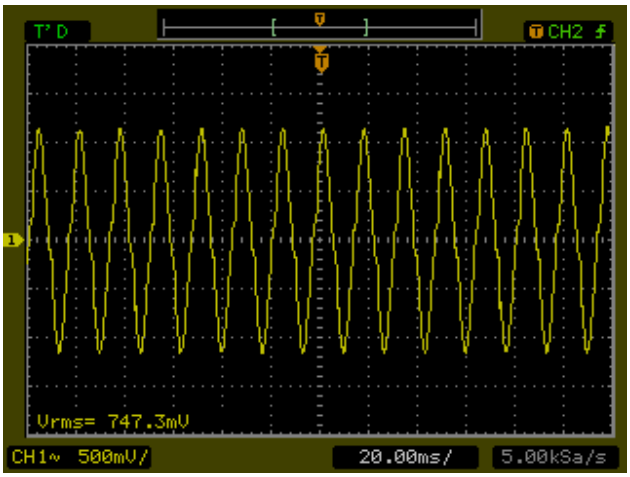


6.- Input Current Waveforms at Full Output Power

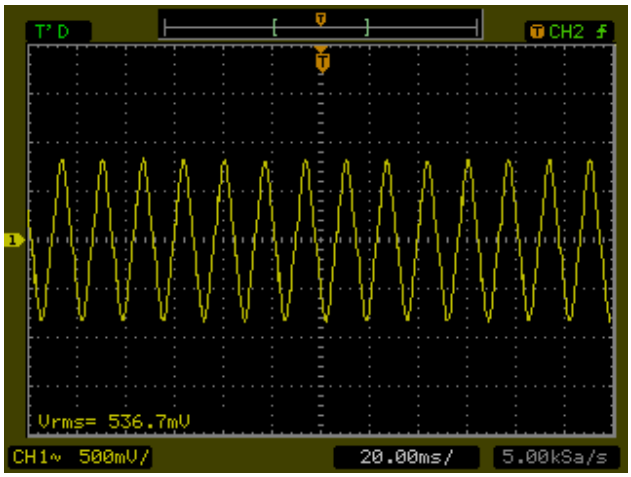
Vout = 24vdc , Iout = 21Amps. , Ta = 25C

CH1 Iinput 100mV/1Amp

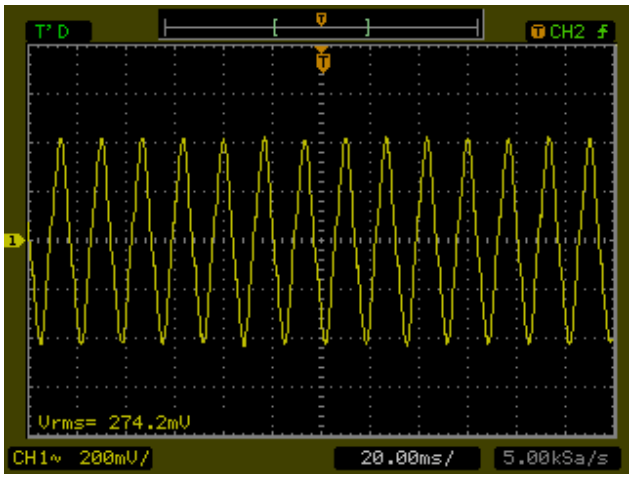
Frequency = 60Hz



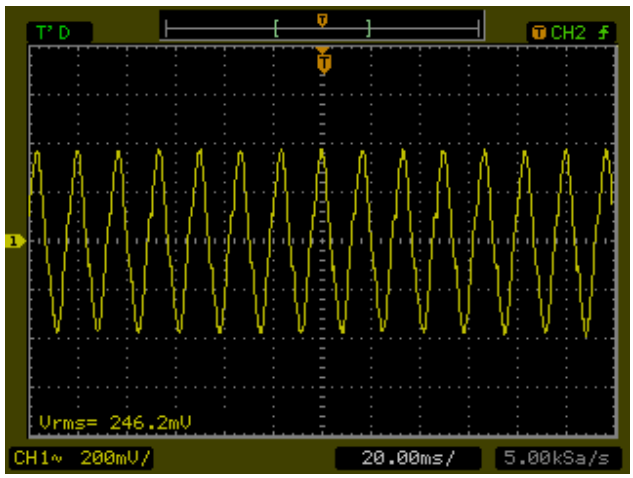
Vin = 85VAC , Iin = 7.47 Amps



Vin = 115 VAC , Iin = 5.36 Amps



Vin = 230VAC , Iin = 2.74 Amps



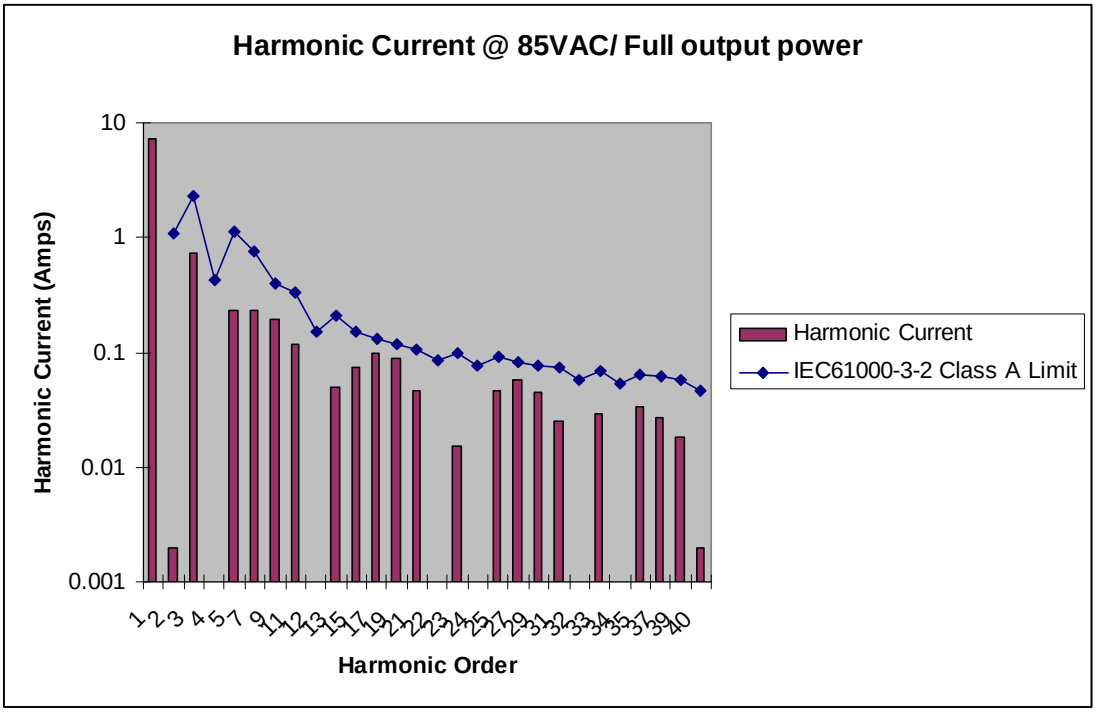
Vin = 265 VAC , Iin = 2.46 Amps

7.- Input Current harmonics and THD

Vout = 24vdc , Iout = 21Amps. , Ta = 25C
Frequency = 60Hz

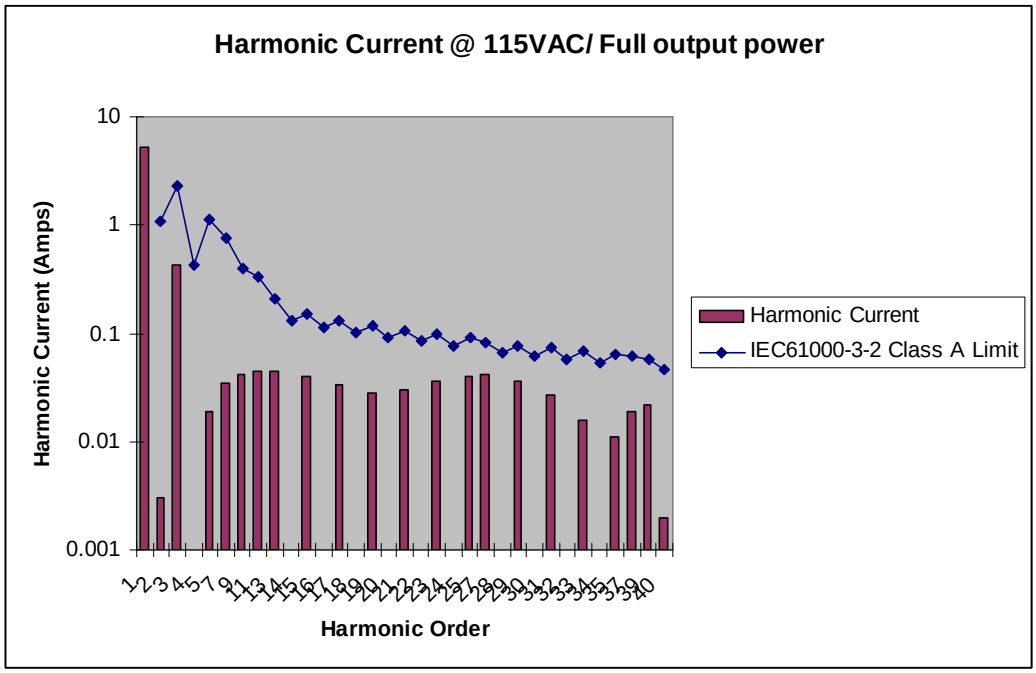
Harmonic Order	Current (A)
1	7.247
2	0.002
3	0.739
4	0.001
5	0.231
6	0
7	0.233
8	0
9	0.192
10	0
11	0.116
12	0.001
13	0.049
14	0
15	0.073
16	0
17	0.1
18	0
19	0.089
20	0
21	0.046
22	0.001
23	0.015
24	0.001
25	0.047
26	0
27	0.057
28	0
29	0.045
30	0
31	0.025
32	0.001
33	0.029
34	0.001
35	0.034
36	0
37	0.027
38	0
39	0.018
40	0.002

Vin = 85Vac
Iin = 7.299 Amps
THD = 11.92 %



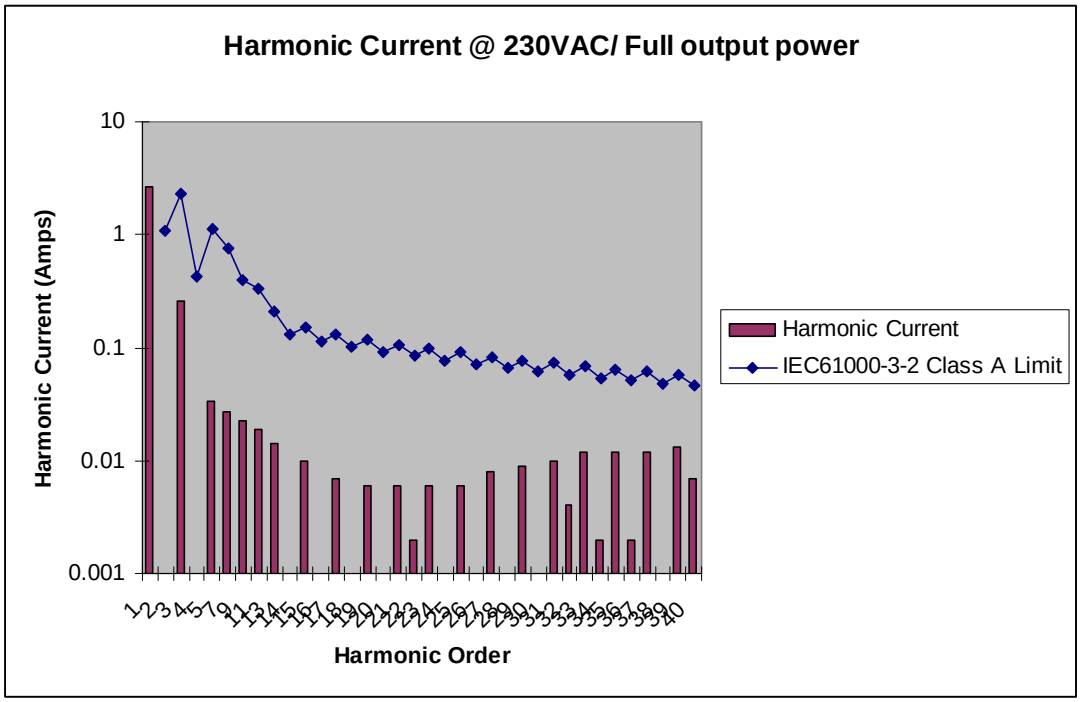
Harmonic Order	Current (A)
1	5.235
2	0.003
3	0.426
4	0.001
5	0.019
6	0
7	0.035
8	0
9	0.041
10	0
11	0.044
12	0
13	0.044
14	0.001
15	0.04
16	0.001
17	0.034
18	0.001
19	0.028
20	0.001
21	0.03
22	0.001
23	0.036
24	0.001
25	0.04
26	0
27	0.041
28	0.001
29	0.036
30	0.001
31	0.027
32	0.001
33	0.016
34	0.001
35	0.011
36	0
37	0.019
38	0
39	0.022
40	0.002

Vin = 115Vac
Iin = 5.255 Amps
THD = 8.61 %



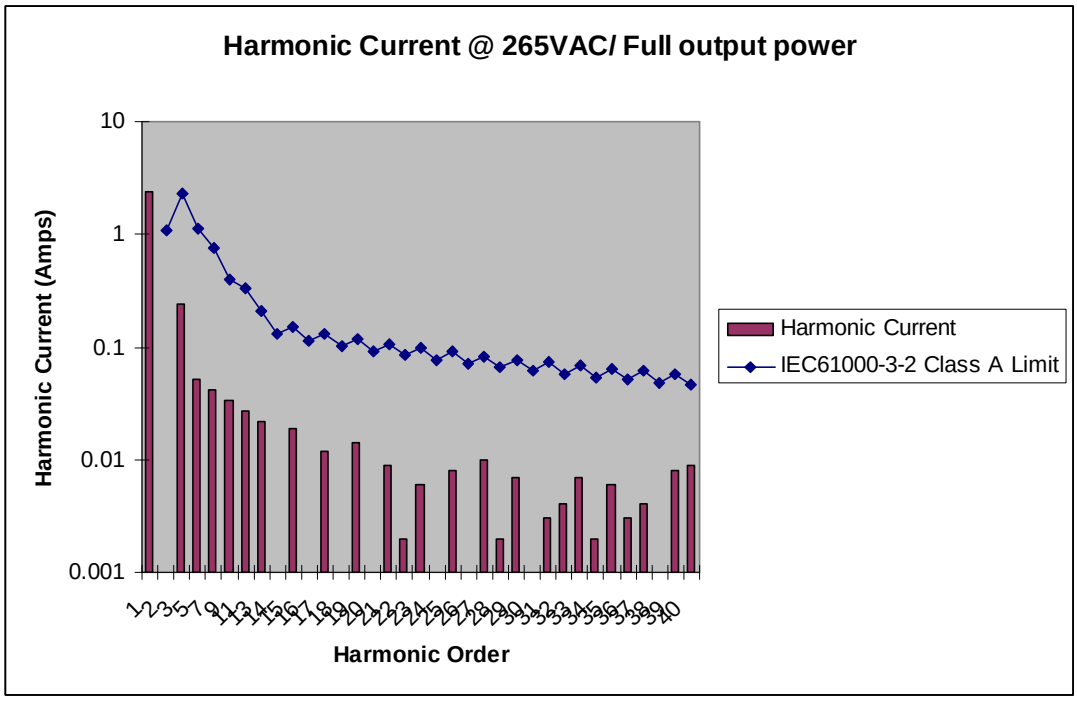
Harmonic Order	Current (A)
1	2.668
2	0.001
3	0.259
4	0.001
5	0.033
6	0
7	0.027
8	0
9	0.023
10	0
11	0.019
12	0
13	0.014
14	0.001
15	0.01
16	0.001
17	0.007
18	0.001
19	0.006
20	0.001
21	0.006
22	0.002
23	0.006
24	0.001
25	0.006
26	0.001
27	0.008
28	0.001
29	0.009
30	0.001
31	0.01
32	0.004
33	0.012
34	0.002
35	0.012
36	0.002
37	0.012
38	0.001
39	0.013
40	0.007

Vin = 230Vac
Iin = 2.682 Amps
THD = 10.05 %



Harmonic Order	Current (A)
1	2.377
2	0.001
3	0.243
4	0
5	0.051
6	0
7	0.041
8	0
9	0.034
10	0
11	0.027
12	0
13	0.022
14	0.001
15	0.019
16	0.001
17	0.012
18	0.001
19	0.014
20	0.001
21	0.009
22	0.002
23	0.006
24	0.001
25	0.008
26	0.001
27	0.01
28	0.002
29	0.007
30	0.001
31	0.003
32	0.004
33	0.007
34	0.002
35	0.006
36	0.003
37	0.004
38	0.001
39	0.008
40	0.009

Vin = 265Vac
Iin = 2.391 Amps
THD = 10.96 %

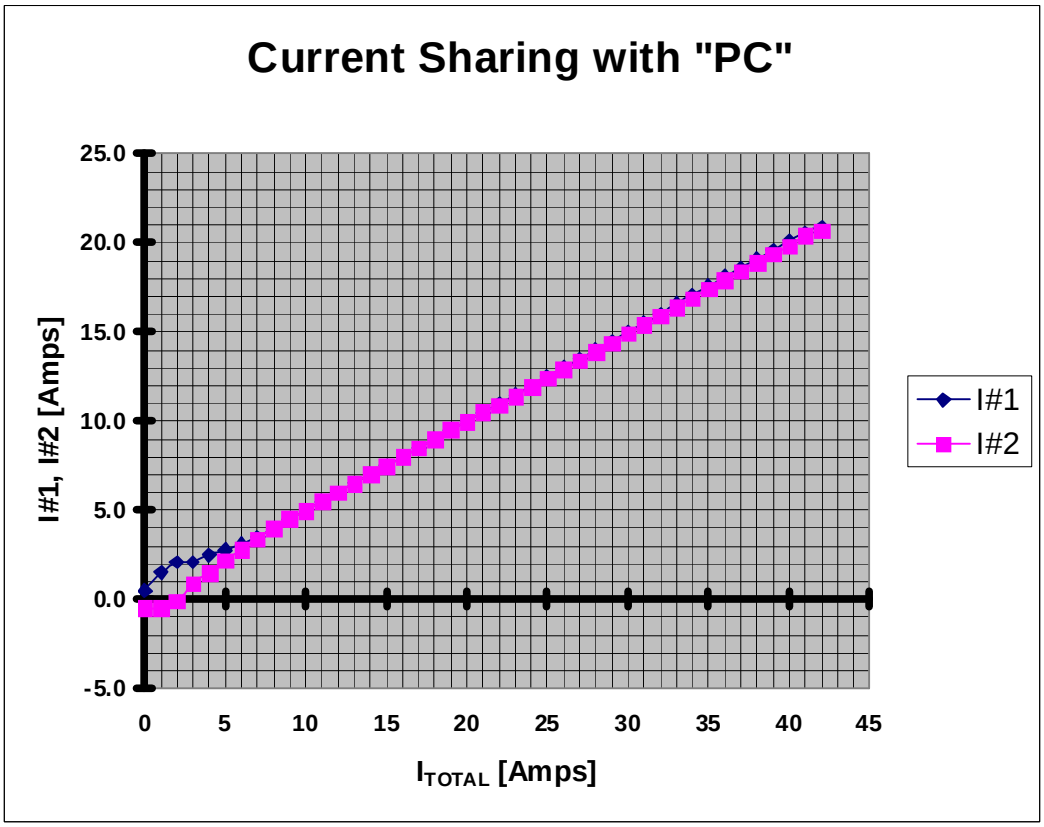


8.- Current Share Test

Vin = 110VAC , Unit 1 Vout = 24.509Vdc, Unit 2 Vout = 24.023vdc with local sense. Ta = 25C

Current Sharing Data with Current Share pin used:

I_{TOTAL}	$I_{\#1}$	$I_{\#2}$
0	0.5	-0.5
1	1.5	-0.5
2	2.1	-0.1
3	2.1	0.9
4	2.5	1.5
5	2.8	2.2
6	3.1	2.8
7	3.5	3.4
8	4.0	4.0
9	4.5	4.5
10	5.0	5.0
11	5.5	5.5
12	6.0	6.0
13	6.5	6.5
14	7.0	7.0
15	7.5	7.5
16	8.0	8.0
17	8.5	8.5
18	9.0	9.0
19	9.5	9.5
20	10.0	10.0
21	10.5	10.5
22	11.0	10.9
23	11.5	11.4
24	12.0	11.9
25	12.5	12.4
26	13.0	12.9
27	13.5	13.4
28	14.0	13.9
29	14.5	14.4
30	15.0	14.9
31	15.5	15.4
32	16.0	15.9
33	16.6	16.4
34	17.1	16.9
35	17.6	17.4
36	18.1	17.9
37	18.6	18.4
38	19.1	18.9
39	19.6	19.4
40	20.1	19.8
41	20.6	20.4
42	20.9	20.7



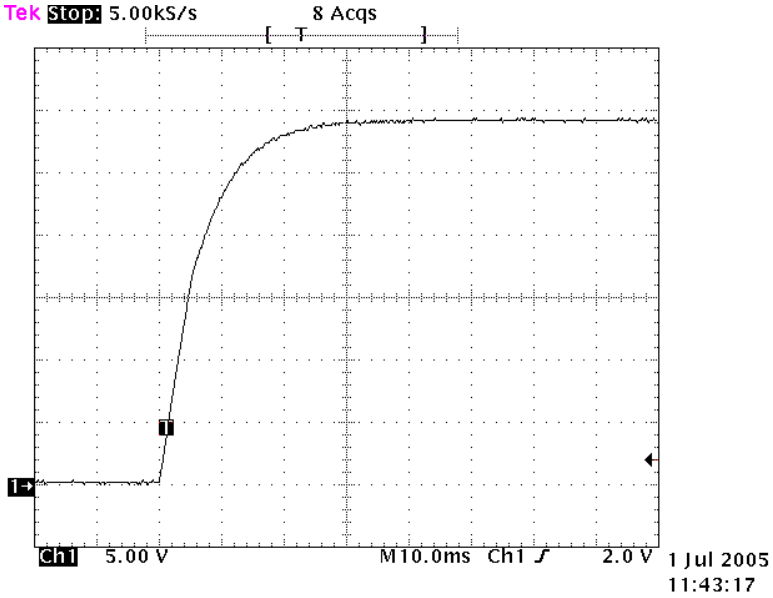
***This plot shows the sharing between two units with the PC connection in place (Excellent tracking between 2 units all the way down to 4A (<10% full system load).

9.- Enable Switch Test and OVP Reaction time Test

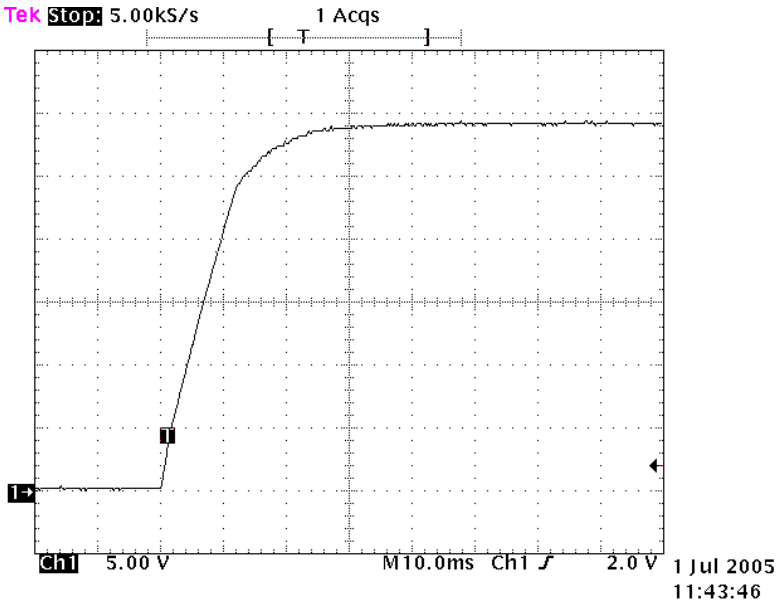
9.1 Output enable switch test
Vin = 110Vac , Vout = 29.5Vdc , Ta =25C

SWITCH ENABLE TEST

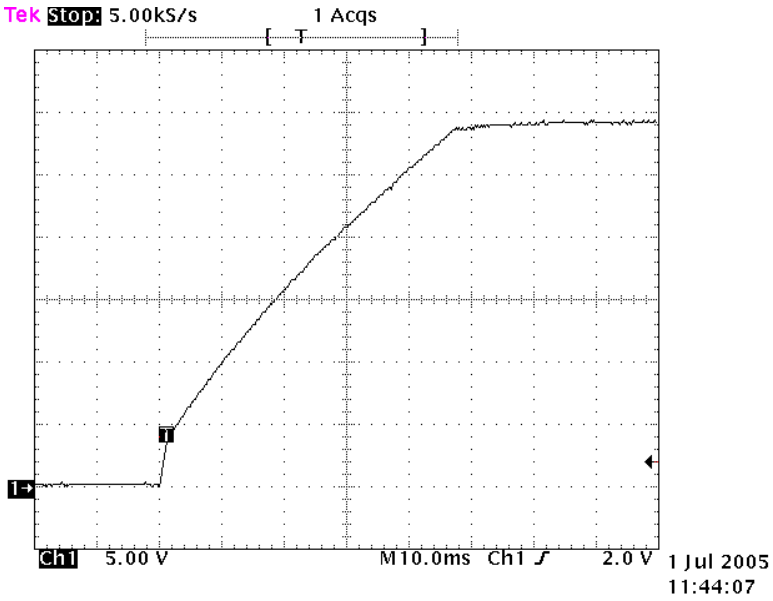
Channel 1: Vout set to 29.5 V with Enable switch turned "ON" with 2A load:



Channel 1: Vout set to 29.5 V with Enable switch turned "ON" with 11A load:



Channel 1: Vout set to 29.5 V with Enable switch turned "ON" with 21A load:

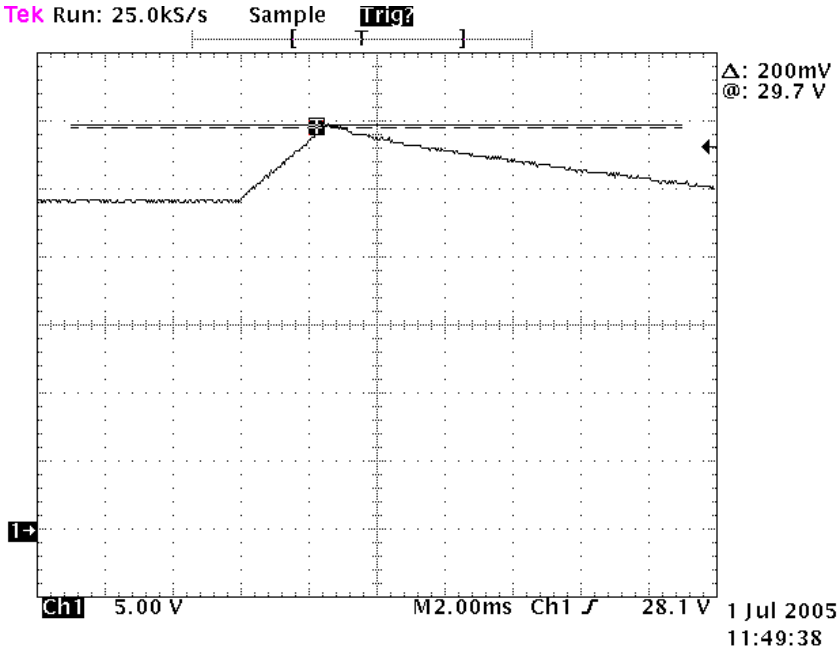


9.2- OVP REACTION TIME TEST

Channel 1: Vout set to 24V with sense lines shorted with 2A load:

- **OVP SET-POINT = 29.5V**
- **OVP TRIP-POINT=29.7V**

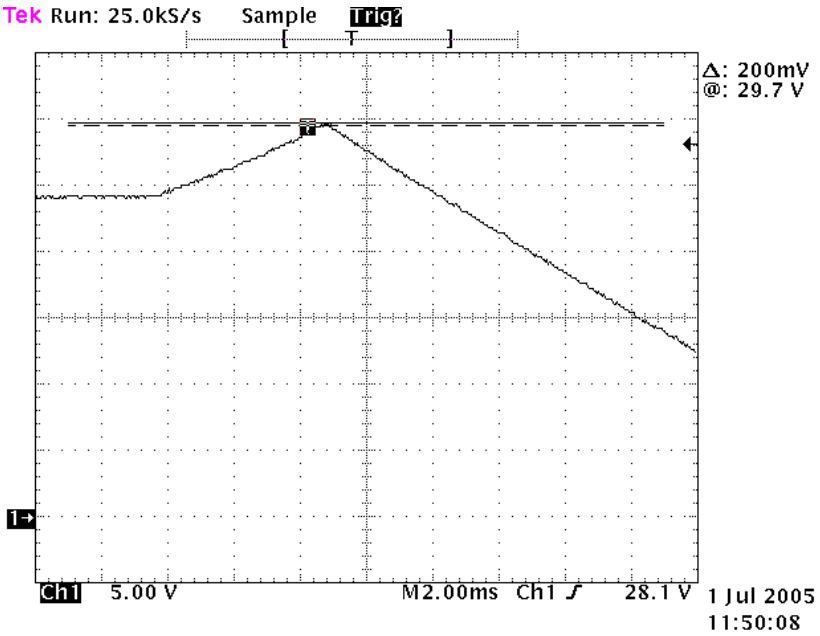
Reaction time <1mS.



Channel 1: Vout set to 24 V with sense lines shorted with 11A load:

- **OVP SET-POINT = 29.5V**
- **OVP TRIP-POINT=29.7V**

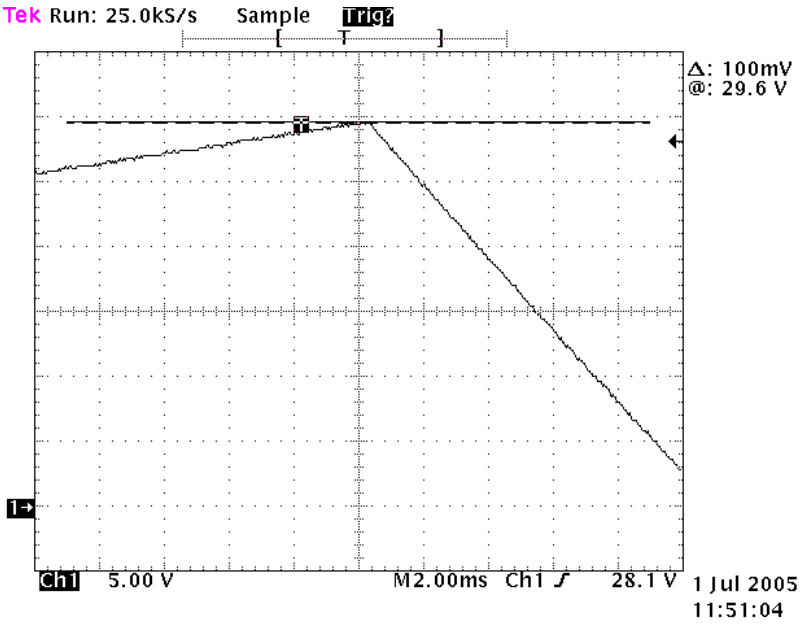
Reaction time <1mS.



Channel 1: Vout set to 24 V with sense lines shorted with 21A load:

- **OVP SET-POINT = 29.5V**
- **OVP TRIP-POINT=29.7V**

Reaction time <1mS.

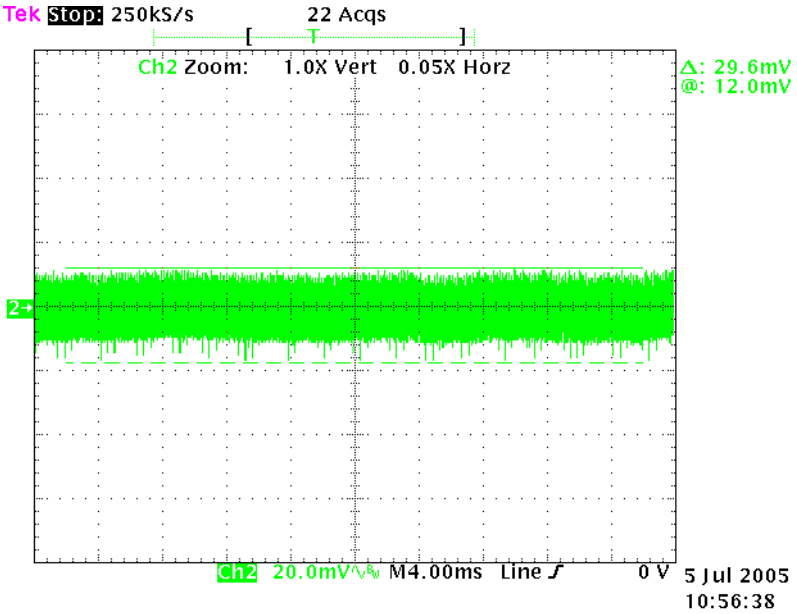


10.- Ripple noise test.

Vout = 24Vdc, Vin = 85Vac , Ta = 25C

To measure ripple, we are using a X1 scope probe connected to channel 2 of the above listed oscilloscope and placed directly across the buss bars of the supply without the use of a ground strap (ground case of probe directly touching bus bar (shunt method-see picture).

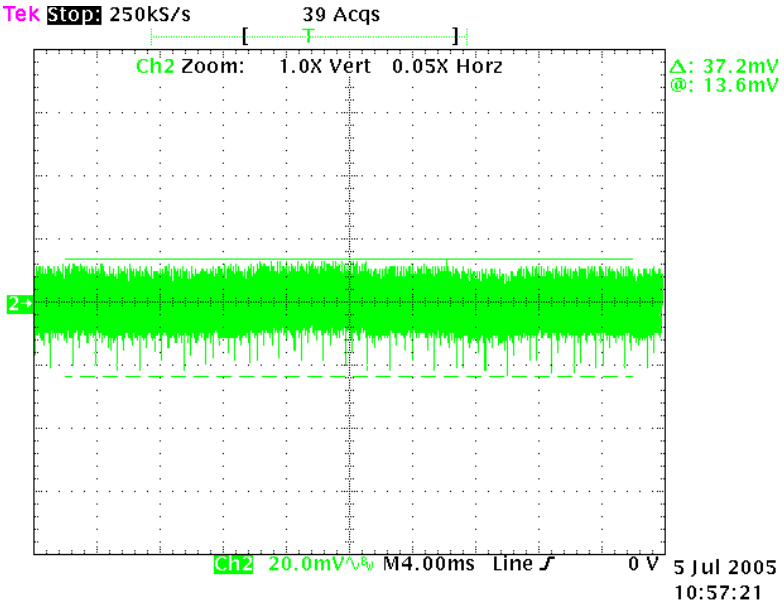
Ripple test at 2Amp load.



SPEC: **75mV p-p, 20MHZ Bandwidth**

ACTUAL: **29.6 mVp-p** **PASS**

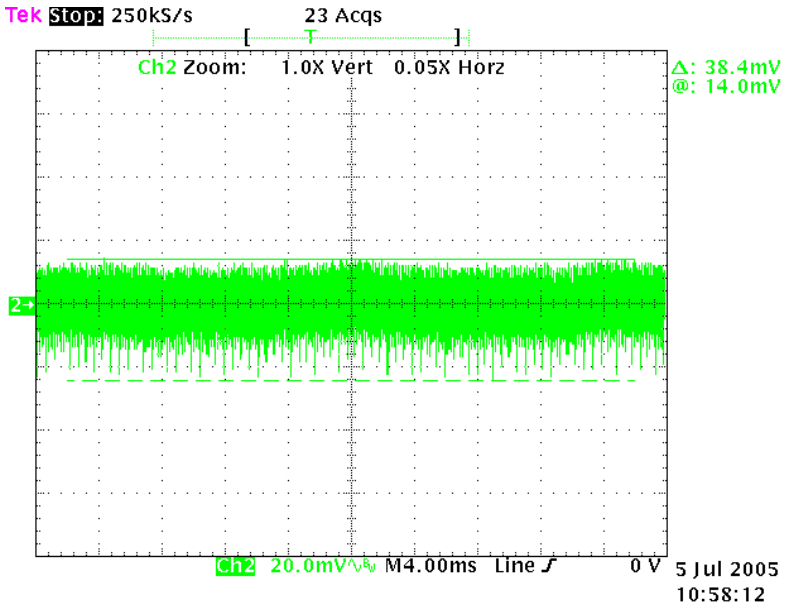
Ripple test at 5.25Amp (25%) load.



SPEC: **75mV p-p, 20MHZ Bandwidth**

ACTUAL: **37.2 mVp-p** **PASS**

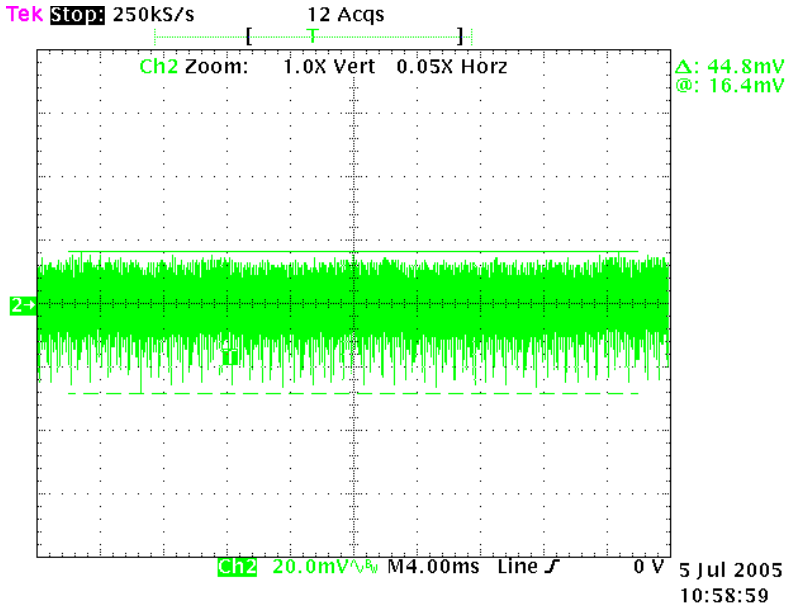
Ripple test at 10.5Amp (50%) load.



SPEC: **75mV p-p, 20MHZ Bandwidth**

ACTUAL: **38.4 mVp-p** **PASS**

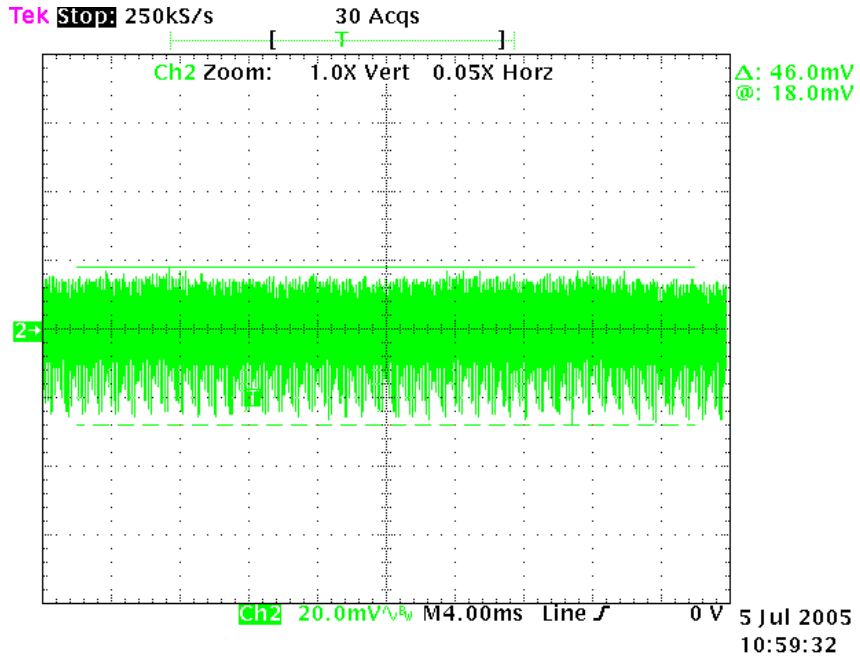
Ripple test at 15.75Amp (75%) load.



SPEC: **75mV p-p, 20MHZ Bandwidth**

ACTUAL: **44.8 mVp-p** **PASS**

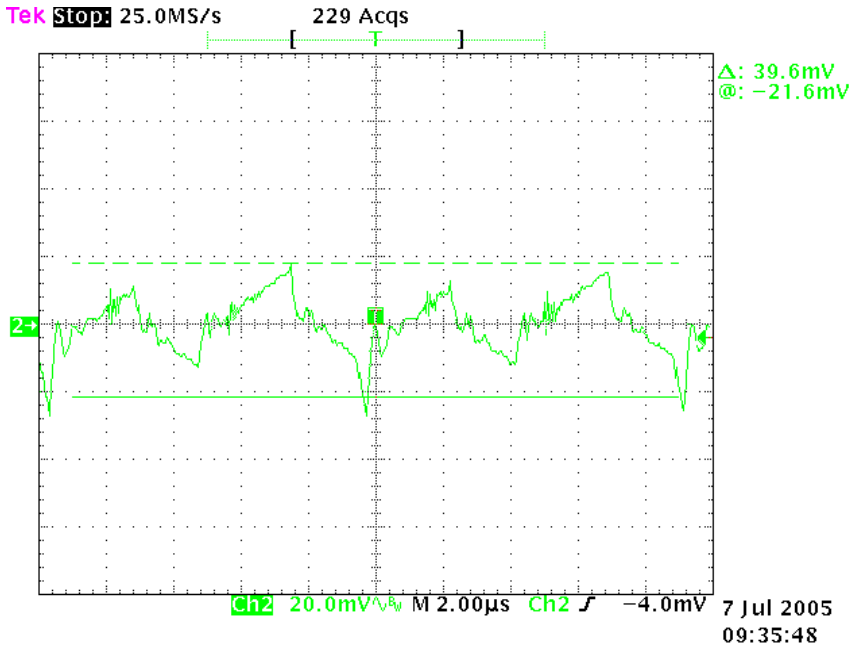
Ripple test at 21Amp (100%) load.



SPEC: **75mV p-p, 20MHZ Bandwidth**

ACTUAL: **46.0 mVp-p** **PASS**

Ripple test at 21Amp (100%) load with expanded time base:



SPEC: **75mV p-p, 20MHZ Bandwidth**

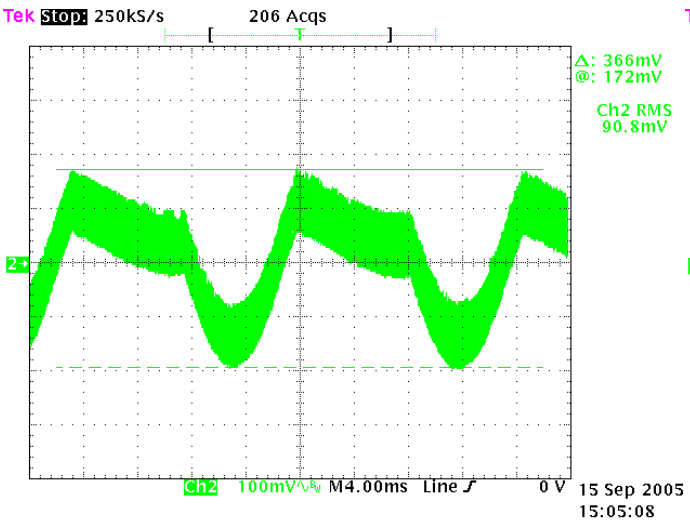
ACTUAL: **46.0 mVp-p** **PASS**

11.- Common noise test.

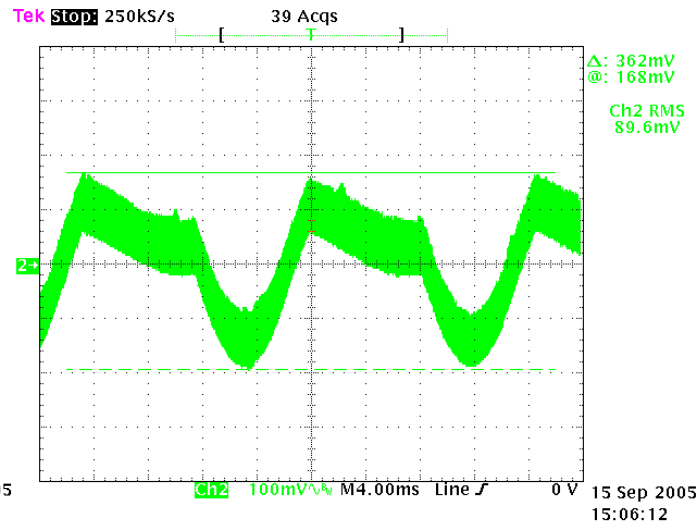
Vout = 24Vdc, Vin = 220Vac , Ta = 25C

To measure ripple, we are using a X1 scope probe connected connected to channel 2 of the above listed oscilloscope and placed directly across the ground and buss bars of the supply without the use of a ground strap (ground case of probe directly touching bus bar (shunt method).

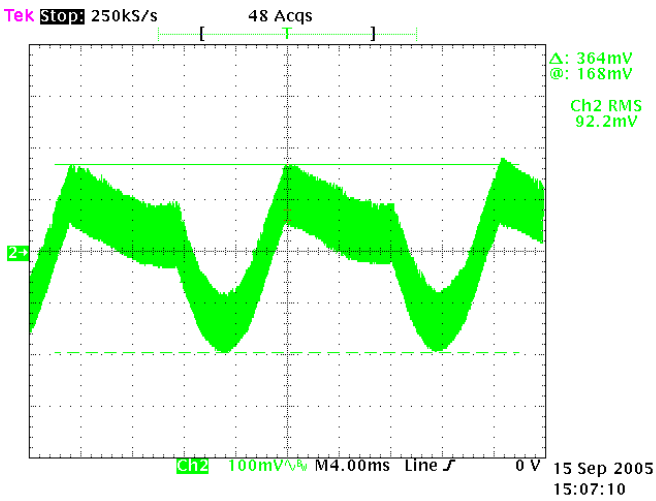
Common Noise test at 10Amp load (+) bar.



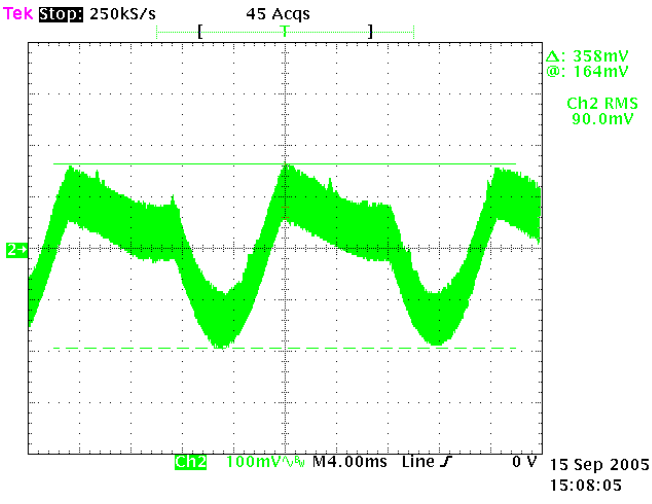
Common Noise test at 10Amp load (-) bar.



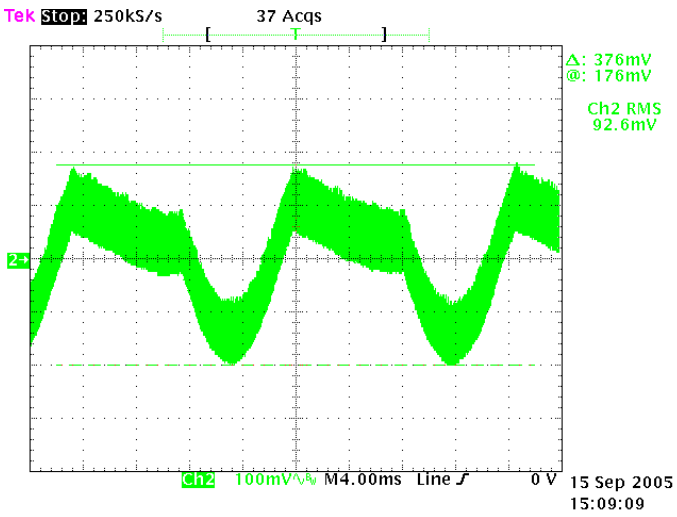
Common Noise test at 15Amp load (+) bar.



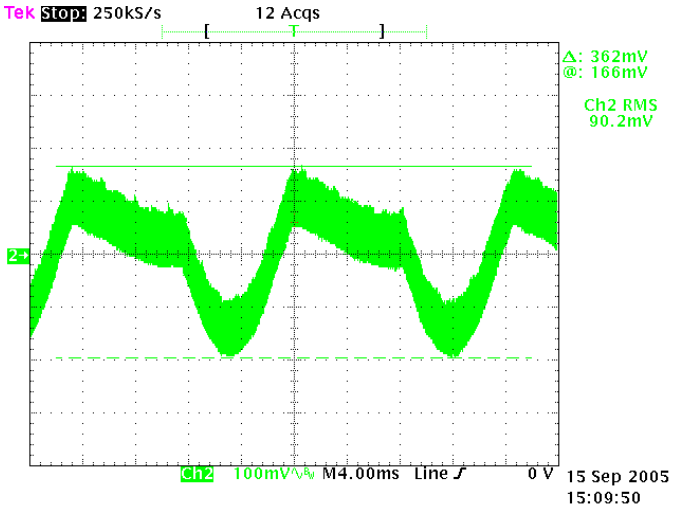
Common Noise test at 15Amp load (-) bar.



Common Noise test at 20Amp load (+) bar.



Common Noise test at 20Amp load (-) bar.



12.- Dynamic Load Response.

With the scope listed above connected to the 24V output, we do a load step from 2A-25%, 25%-50%, 50%-75% and finally 75%-100% of full load (21A). Freq = 200 Hz, 50% Duty Cycle and dI/dT=1A/uS.

Transient Response 10% - 25%:

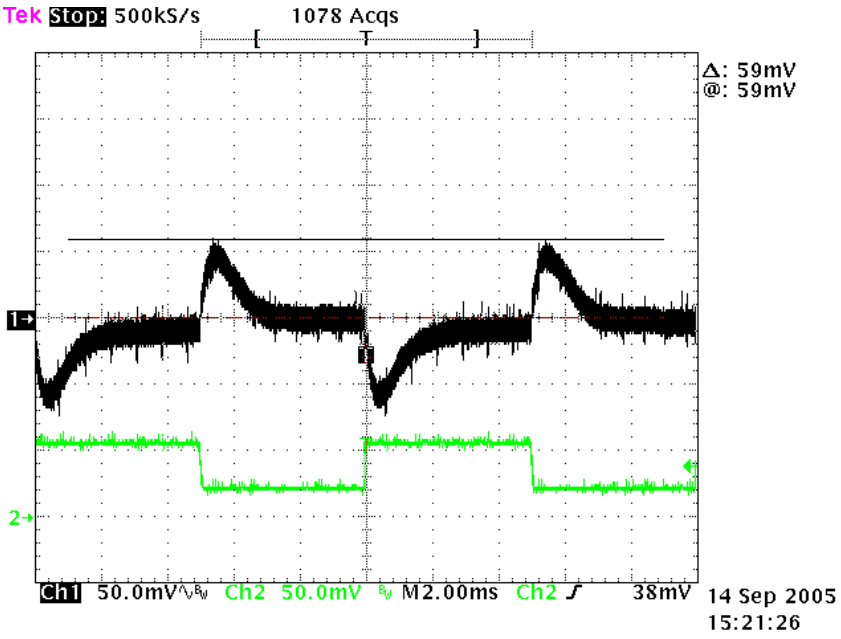
Conditions: 115V AC Input Line. Room temperature.

Load Step; 2 Amps to 5.25 Amps (25%):

CH1: Vout (24V)

CH2: Iout 100mV /10A shunt.

Peak overshoot = 59mV
Peak undershoot = 98mV



Transient Response 25% - 50%:

Conditions: 115V AC Input Line. Room temperature.

Load Step; 5.25 Amps to 10.5 Amps (50%):

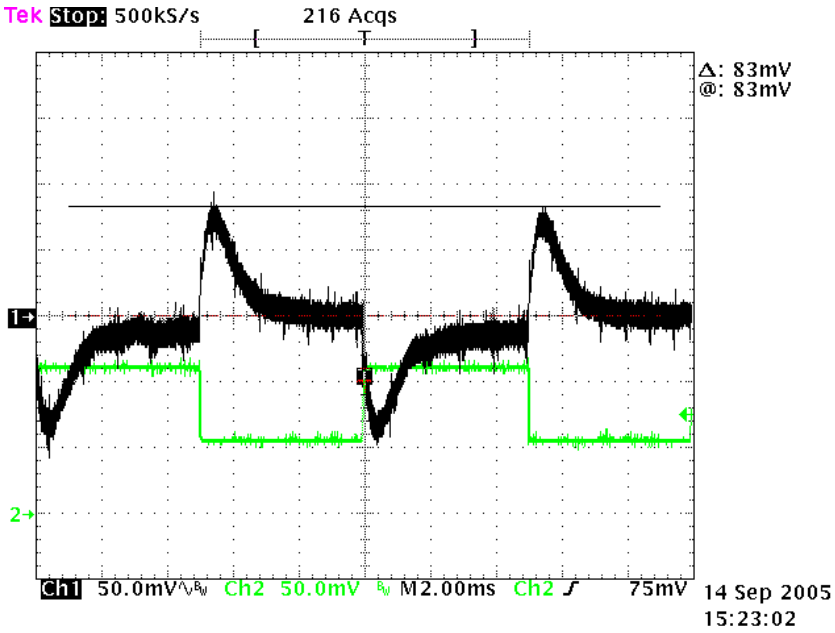
CH1: Vout (24V)

CH2: Iout 100mV /10A shunt.

Peak overshoot = 83mV

Peak undershoot = 98mV

Transient Response: 5.25Amp to 10.5Amp(50%).



Transient Response 50% - 75%:

Conditions: 115V AC Input Line. Room temperature.

Load Step; 10.5 Amps to 15.75 Amps (75%):

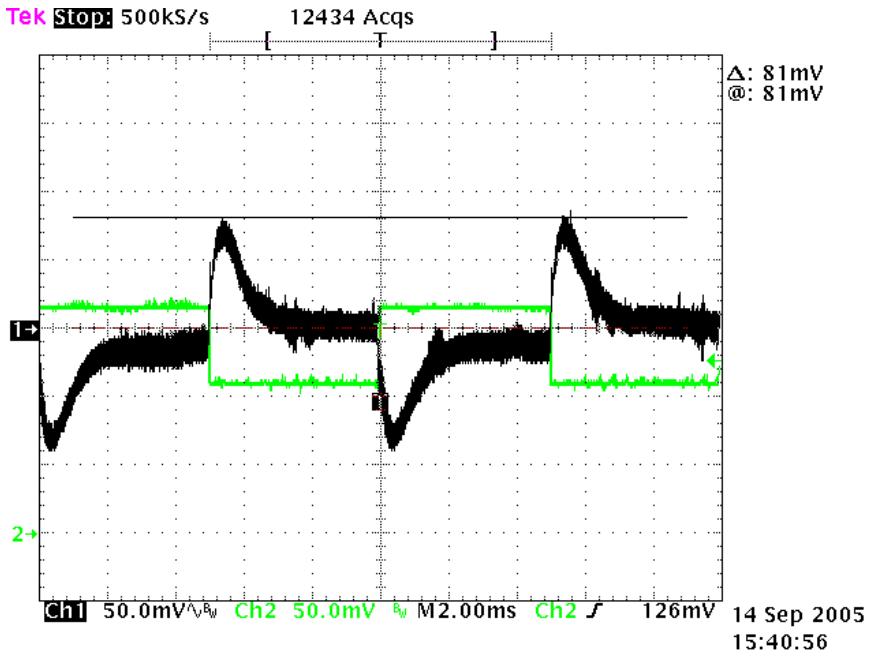
CH1: Vout (24V)

CH2: Iout 100mV /10A shunt.

Peak overshoot = 81mV

Peak undershoot = 91mV

Transient Response: 10.5Amp to 15.75Amp(75%).



Transient Response 75% - 100%:

Conditions: 115V AC Input Line. Room temperature.

Load Step; 15.75 Amps to 21 Amps (100%):

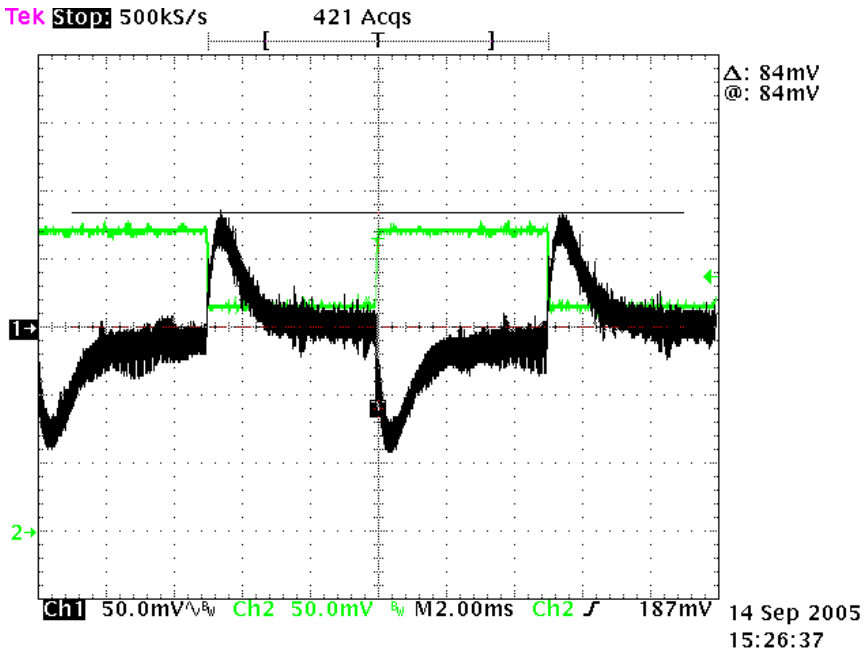
CH1: Vout (24V)

CH2: Iout100mV /10A shunt.

Peak overshoot = 84mV

Peak undershoot = 93mV

Transient Response: 15.75Amp to 21Amp(100%).



Overshoot Response 100% to 0%:

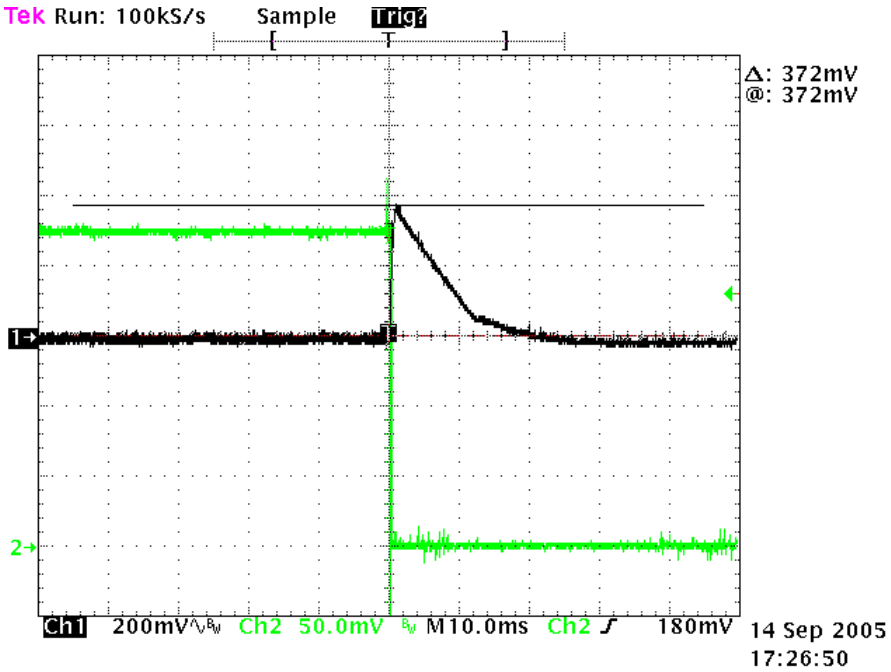
Conditions: 115V AC Input Line. Room temperature.

OVP set point=26.4V DC

Output setpoint=24.0V DC

Load Step; 21 Amps to 0 Amps using knife switch.

Peak overshoot = 372mV



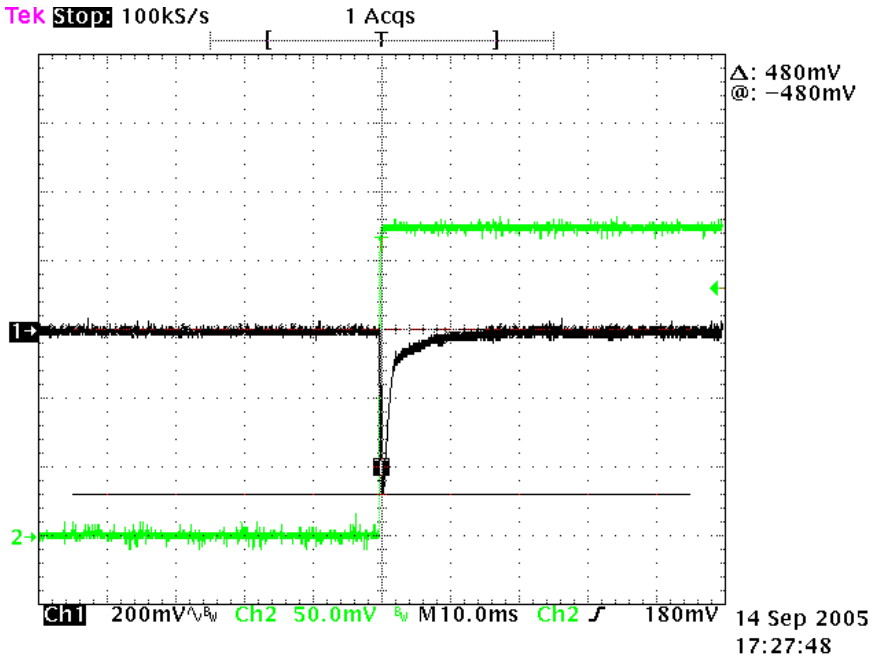
Transient Response 0% - 100%:

Conditions: 115V AC Input Line. Room temperature.

Load Step; 0 Amps to 100 Amps (100%):

Peak undershoot = 480mV

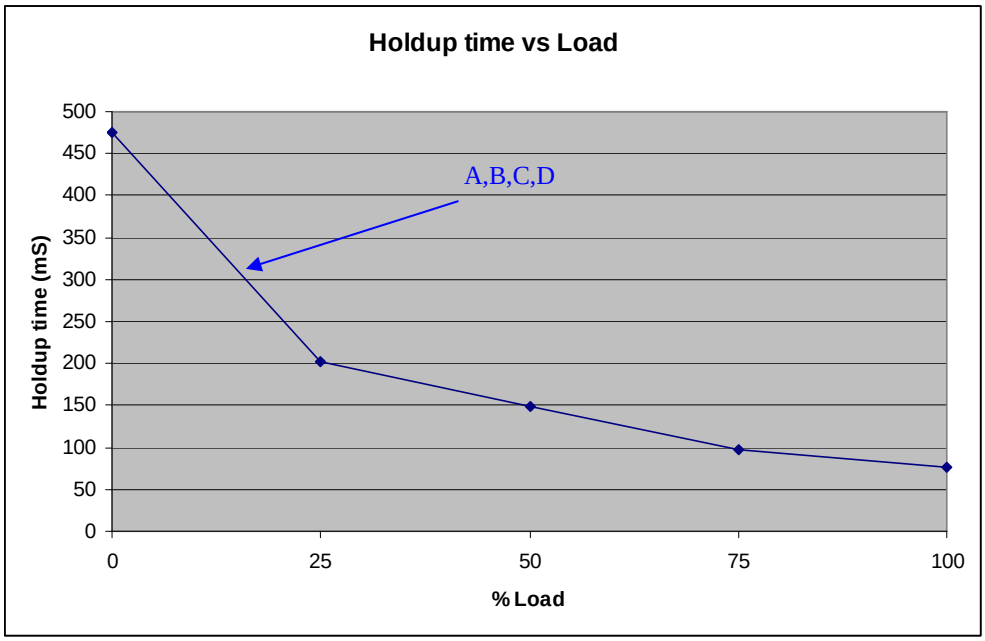
Transient Response: 0Amp to 100Amp(100%).



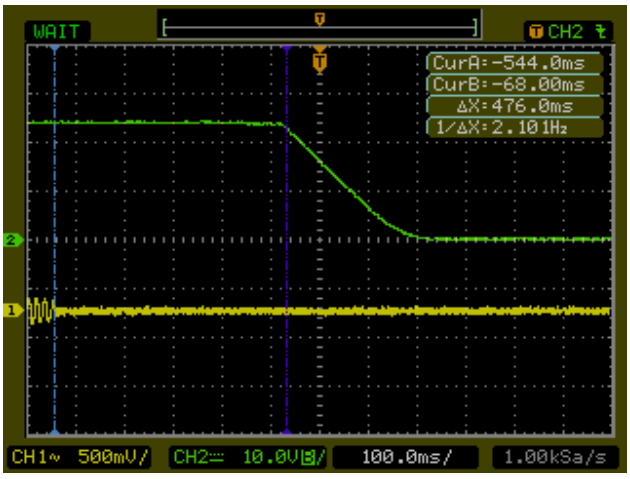
13.- Hold up time characteristics.

Vout = 24vdc , 100%Iout = 21Amps. , Ta = 25C

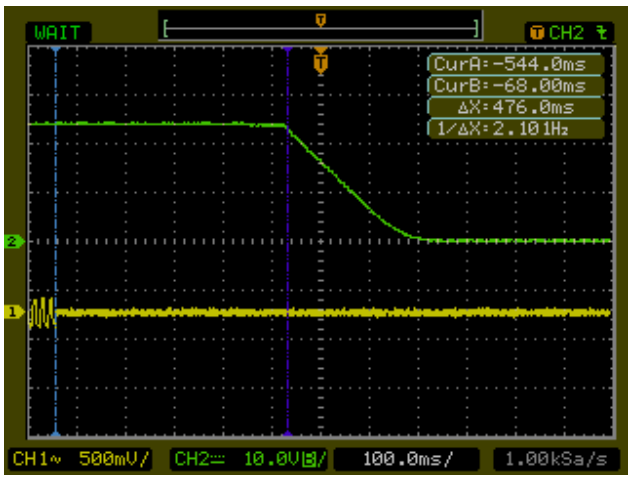
A – 85Vac
B – 115Vac
C – 230Vac
D – 265Vac



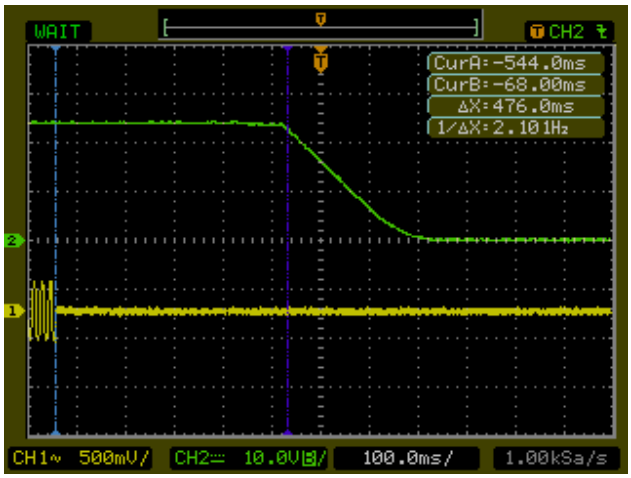
Vout = 24vdc
Iout = 0% Load
CH1 – Input Line Differential Amplifier 100V/DIV
CH2 – Output Voltage 10V/DIV



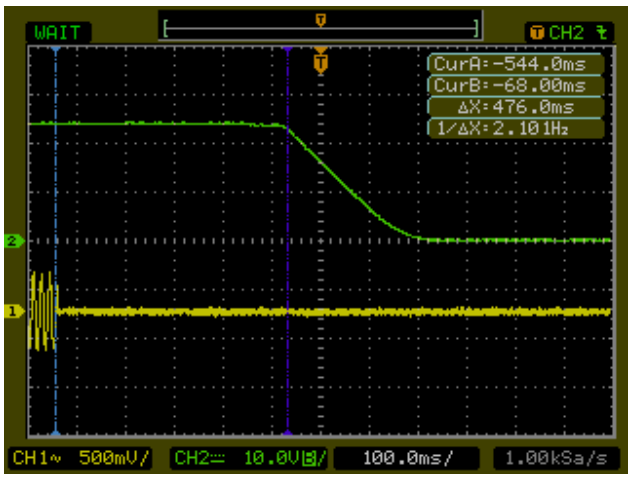
Vin = 85Vac



Vin = 115Vac



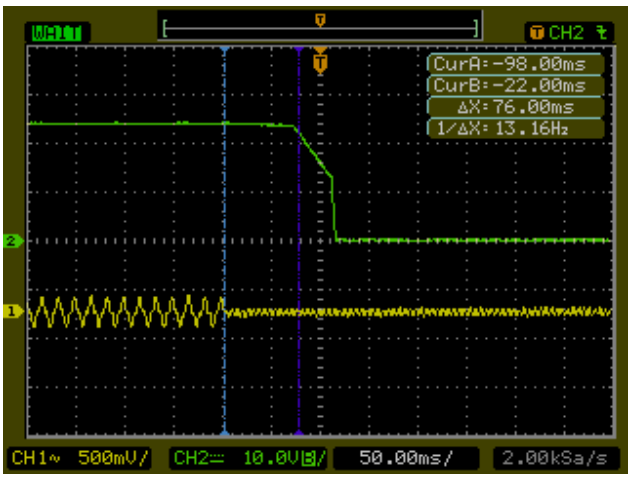
Vin = 230Vac



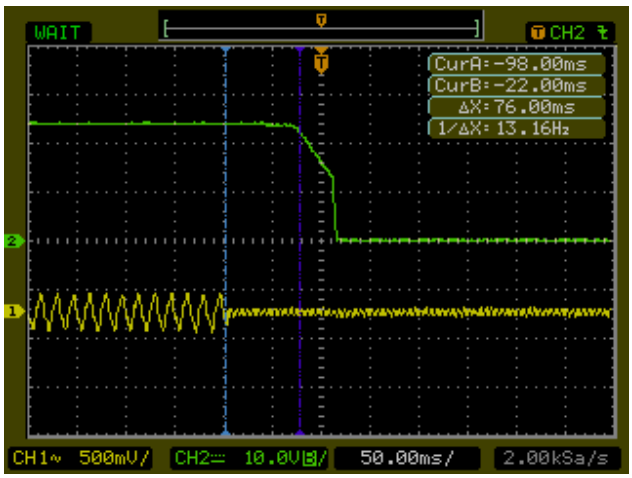
Vin = 265Vac

Vout = 24vdc
Iout = 100% Load

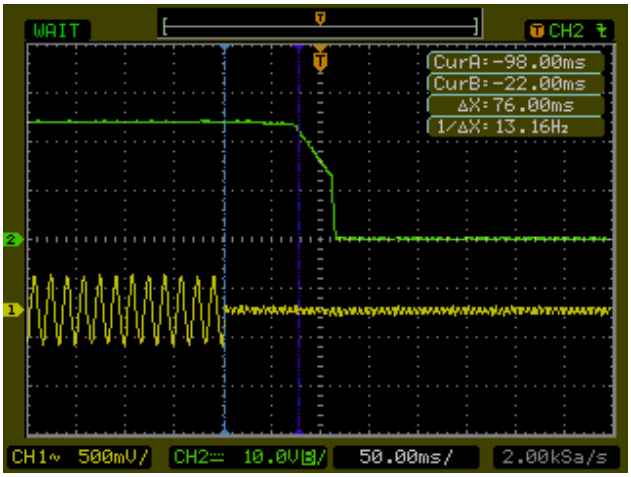
CH1 – Input Line Differential Amplifier 100V/DIV
CH2 – Output Voltage 10V/DIV



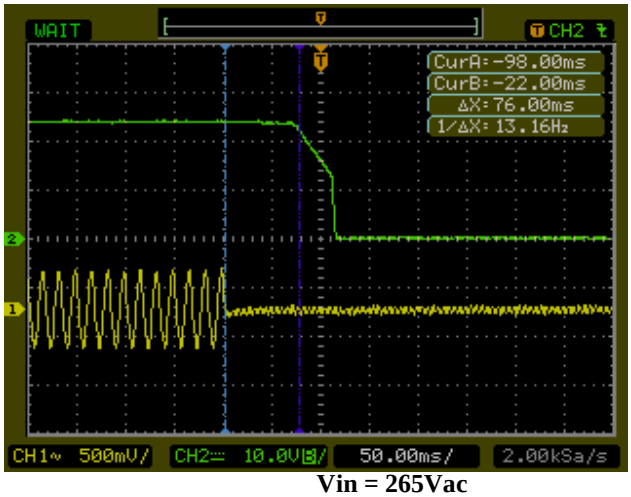
Vin = 85Vac



Vin = 115Vac



Vin = 230Vac

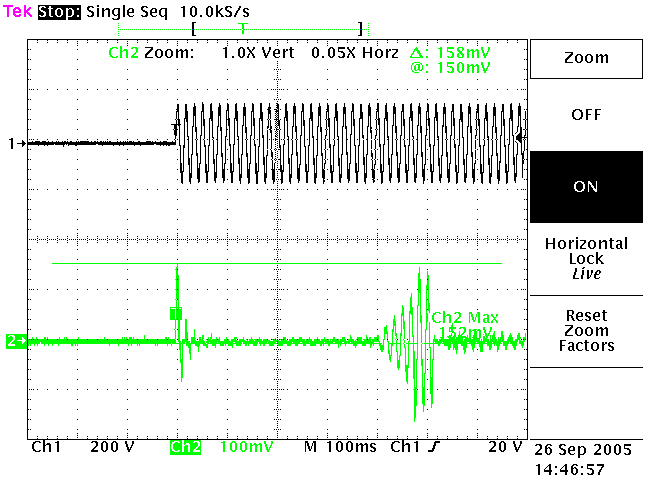


Vin = 265Vac

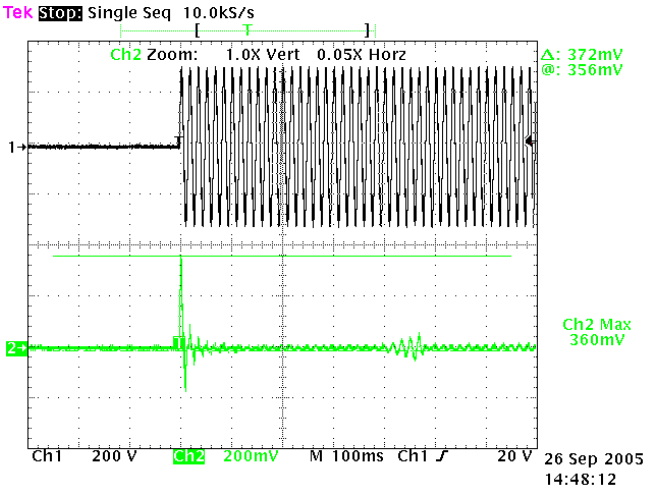
14.- Peak Inrush Current characteristics.

With a 100mV/10A shunt we measure the inrush with the output at full load and lines of 110VAC & 220VAC. We use a X1 scope for the shunt measurement and a X100 probe for the line measurement.
Spec: maximum 20 Amps at 110VAC Input / 40 Amps at 220VAC input

CH1: Input current 10A/100mV shunt =15.8 A pk.
CH2: Input Line X100 scope proble = 110 VAC



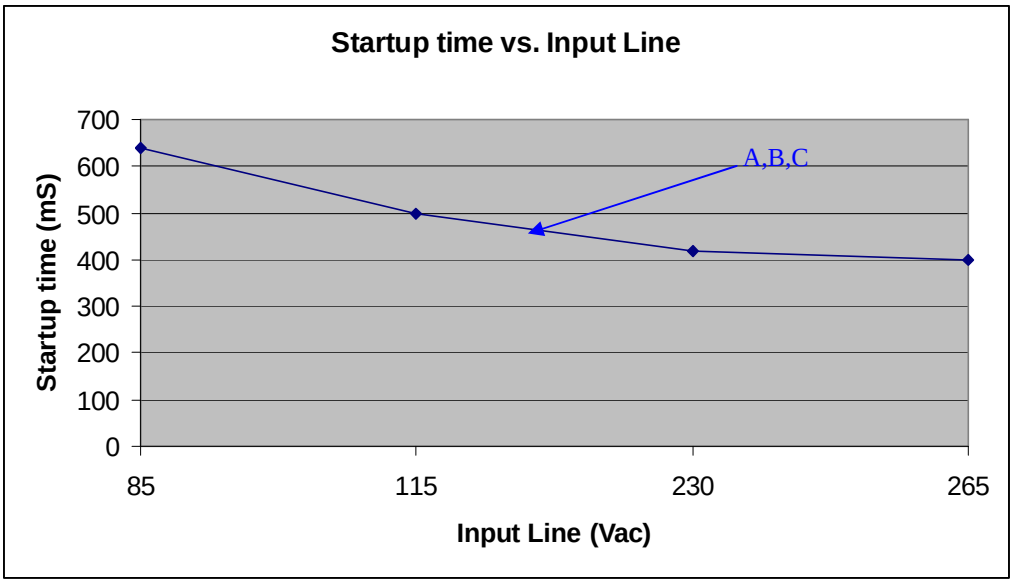
CH1: Input current 10A/100mV shunt =37.2A pk.
CH2: Input Line = 220 VAC



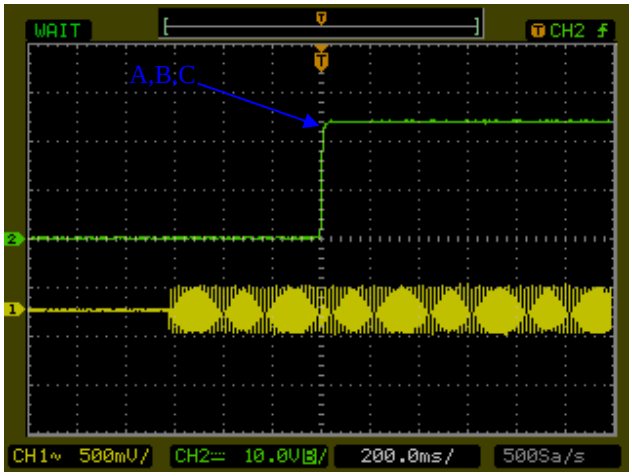
15.- Start up time characteristics

Vout = 24Vdc , 100% Iout = 21 Amps , Ta = 25C

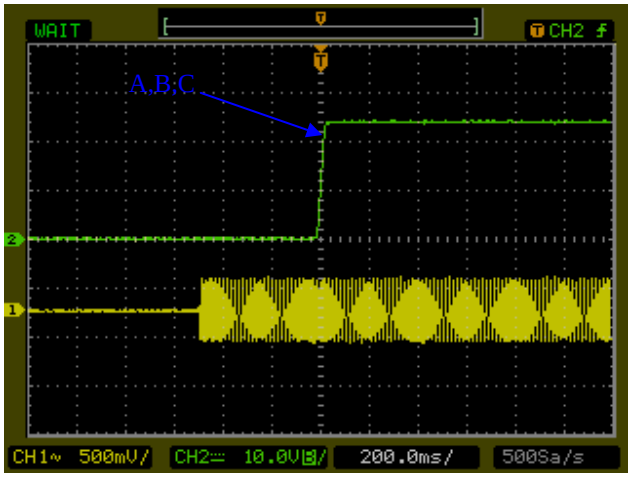
A - Iout = 0%
B - Iout = 50%
C - Iout = 100%



CH1 – Input Line Differential Amplifier 100V/DIV
CH2 – Output Voltage 10V/DIV

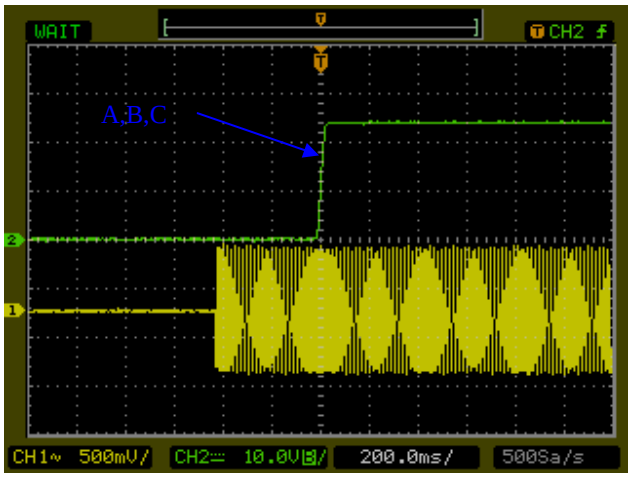


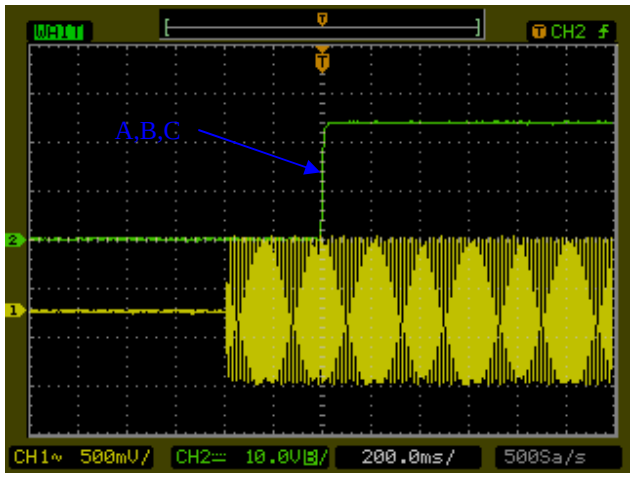
Vin = 85Vac



Vin = 115Vac

CH1 – Input Line Differential Amplifier 100V/DIV
CH2 – Output Voltage 10V/DIV





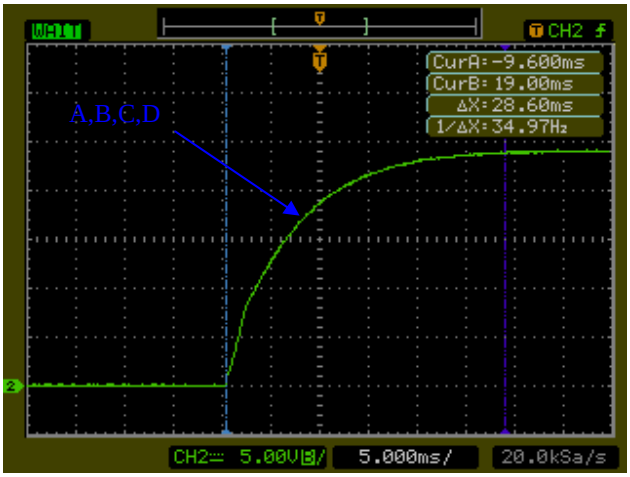
Vin = 230Vac

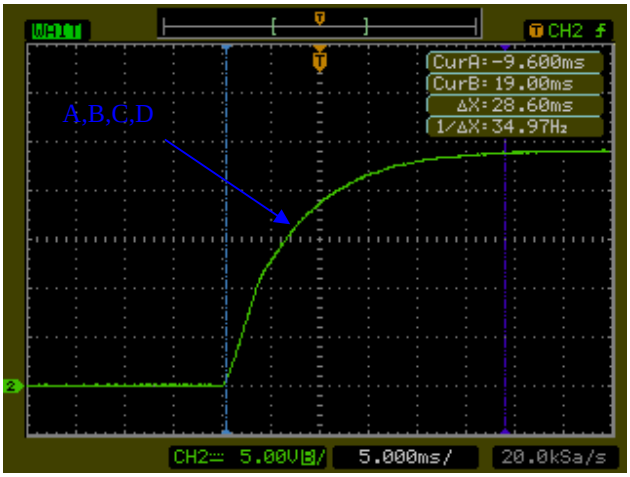
Vin = 265Vac

16.- Output Rise Time characteristics

Vout = 24Vdc , 100% Load = 21Amps , Ta = 25C

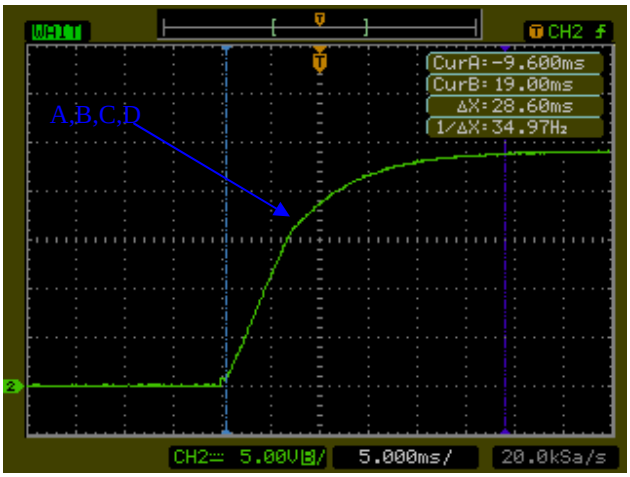
A – 85VAC
B – 115VAC
C – 230VAC
D – 265VAC



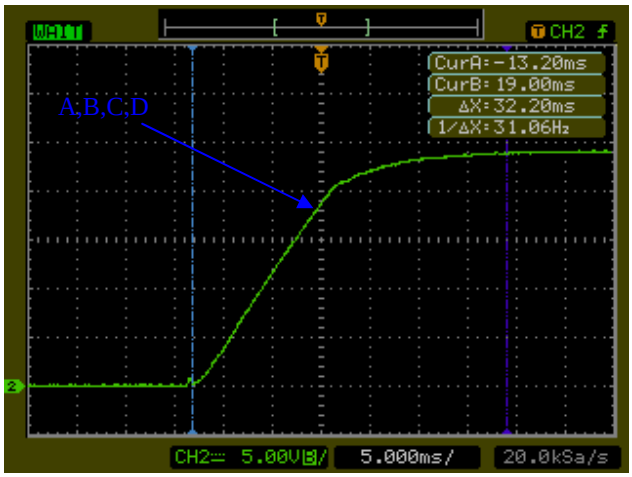


Iout = 0% Load

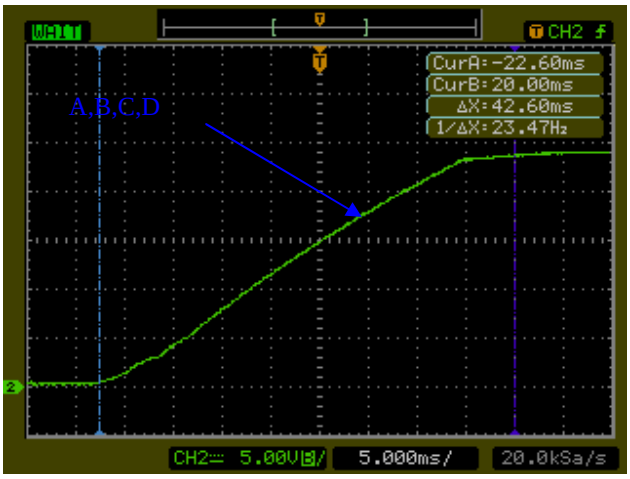
Iout = 25% Load



Iout = 50% Load



Iout = 75% Load

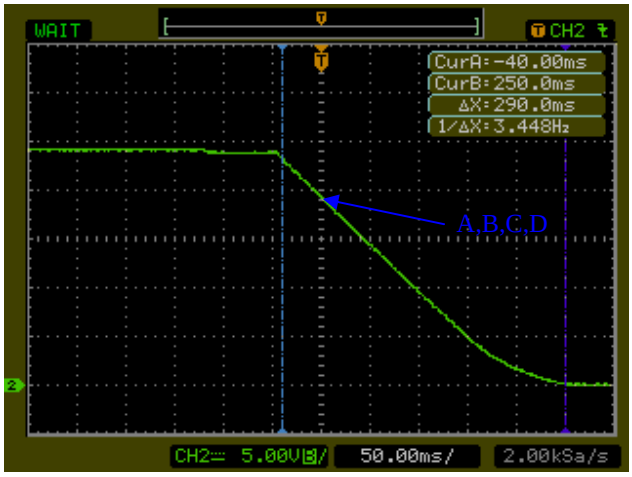


Iout = 100% Load

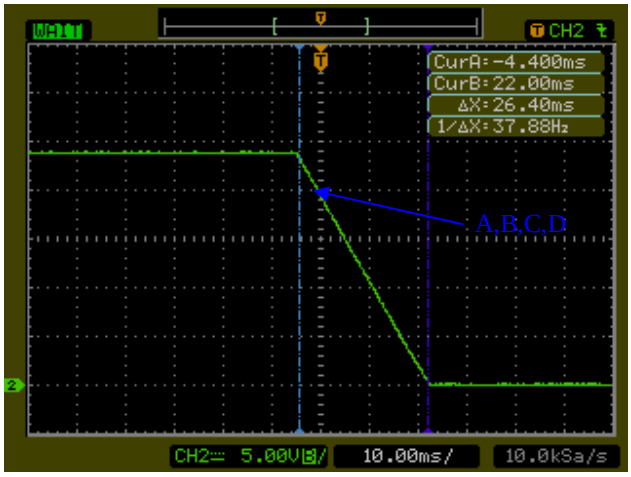
17.- Output Fall Time characteristics

Vout = 24Vdc , 100% Load = 21Amps , Ta = 25C

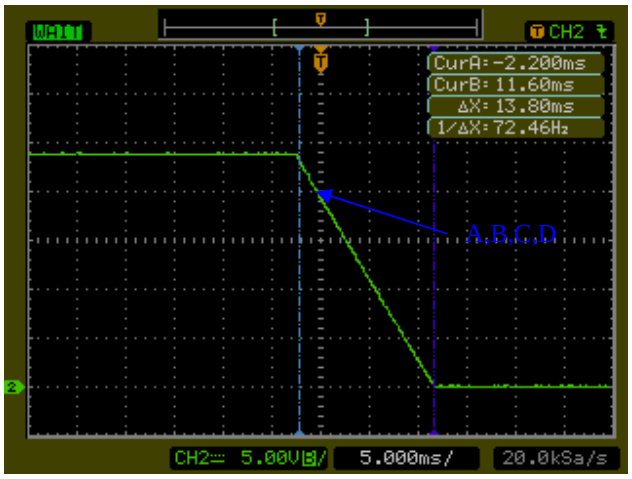
A – 85VAC
B – 115VAC
C – 230VAC
D – 265VAC



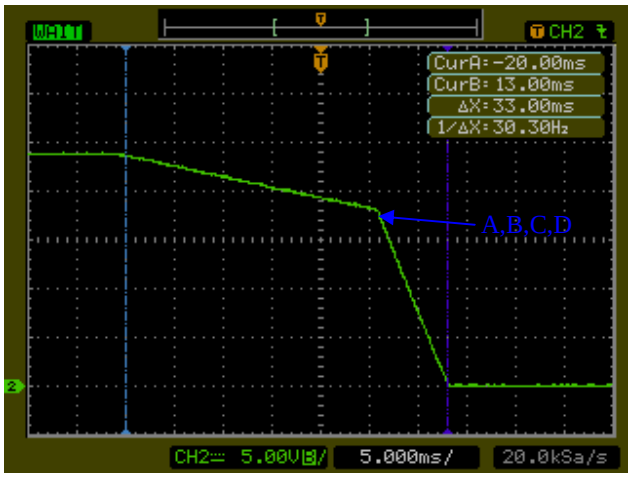
Iout = 0% Load



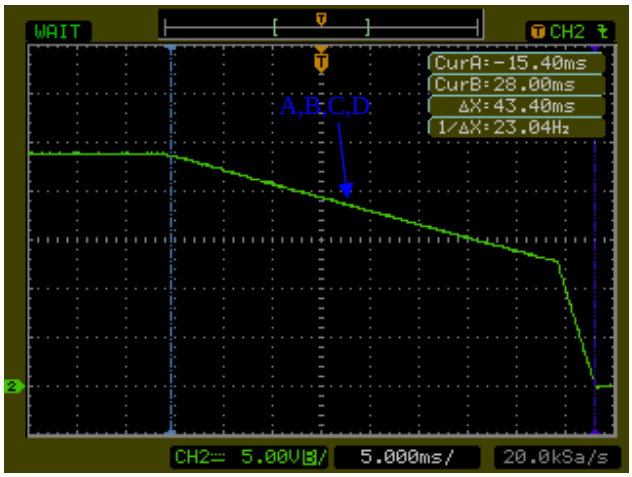
Iout = 25% Load



Iout = 50% Load



Iout = 75% Load



Iout = 100% Load

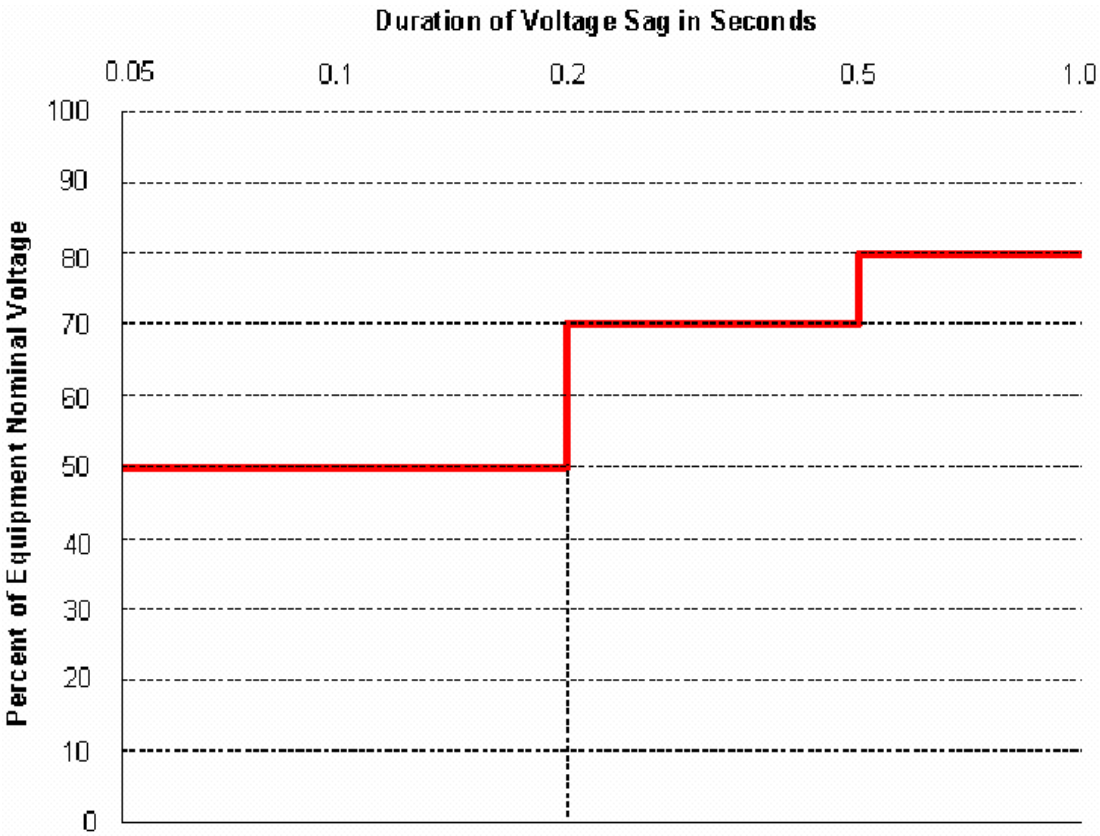
18.- Dynamic Line Response

SEMI F47 Compliant – Must tolerate voltage sags as follows:

a. **50% of nominal voltage for 200 msec (required)**
b. **70% for 500 msec (required)**
c. **80% for 1 second (required)**
d. **0 % for 1 cycle, 17 msec or 20 msec (recommended)**
e. **80% for 10 seconds (recommended)**
f. **90% for continuous, 15 second test (recommended)**

Vin = 100VAC , Iout = 20A , Vout = 25V DC (full load of 500W).

We are using a line isolation transformer connected to the source for AC line measurements relative to the output. We probe the output and determine whether or not it's affected by the input disturbance. Our measurements include the brown out conditions mentioned above. SEE GRAPH # 1 BELOW FOR VISUAL SUMMARY OF POWER LINE CONDITIONS.



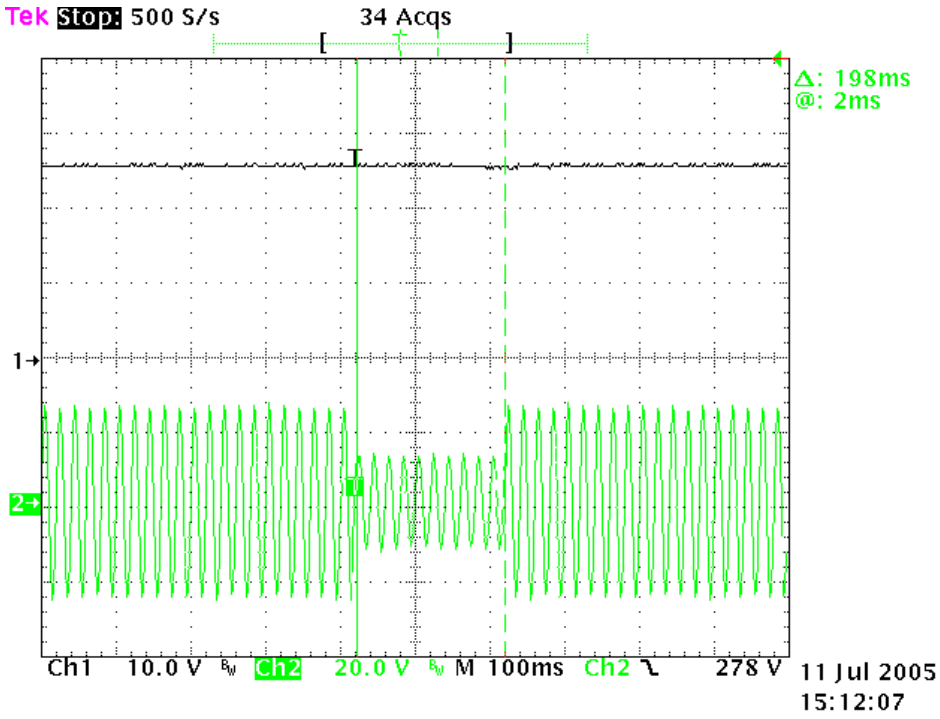
GRAPH #1 (SEMI F47 REQUIREMENTS)

100V-50V OR 50% for 200mS

Conditions: **Output set to 25V DC at full 500W output power. Input goes from 100 VAC to 50VAC for 200mS and then back to 100VAC.**

Channel 1: 25V Output at Full Load (20A).
Channel 2: Input Line

SPEC: NO OUTPUT VARIATION FOR DURATION OF SAG; PASS

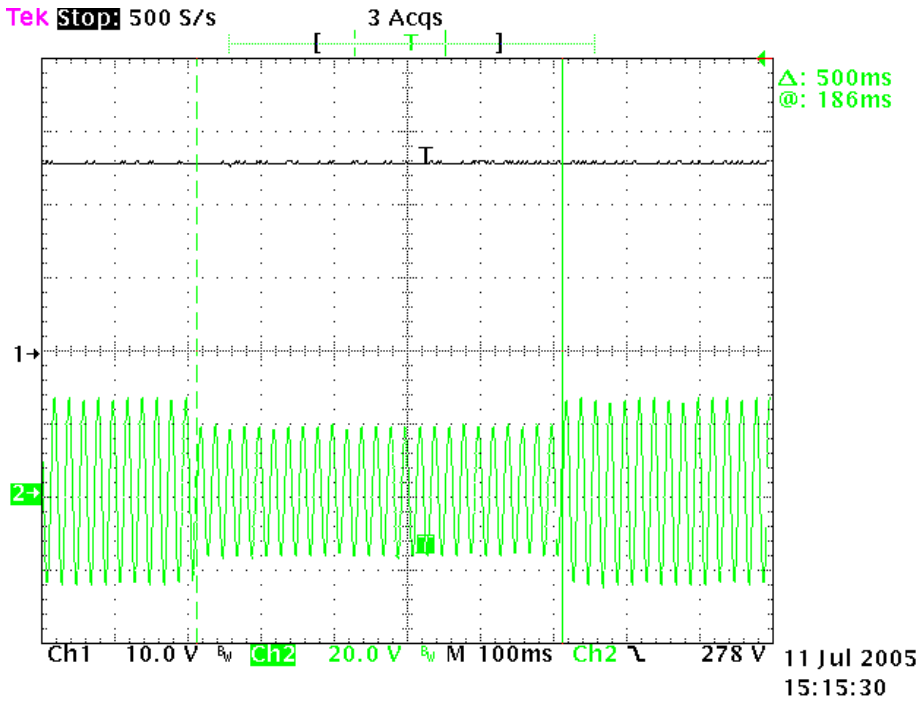


100V-70V OR 70% for 500mS

Conditions: **Output set to 25V DC at full 500W output power. Input goes from 100 VAC to 70VAC for 500mS and then back to 100VAC.**

Channel 1: 25V Output at Full Load (20A).
Channel 2: Input Line

SPEC: NO OUTPUT VARIATION FOR DURATION OF SAG; **PASS**

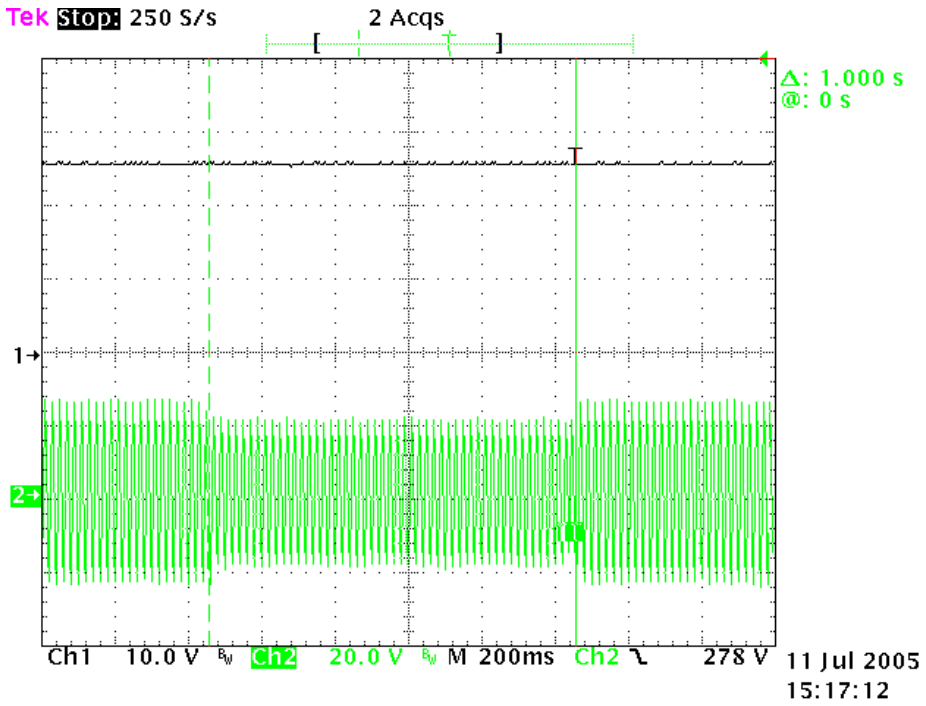


100V-80V OR 80% for 1 SEC

Conditions: **Output set to 25V DC at full 500W output power. Input goes from 100 VAC to 80VAC for 1 SEC and then back to 100VAC.**

Channel 1: 25V Output at Full Load (20A).
Channel 2: Input Line

SPEC: NO OUTPUT VARIATION FOR DURATION OF SAG; PASS

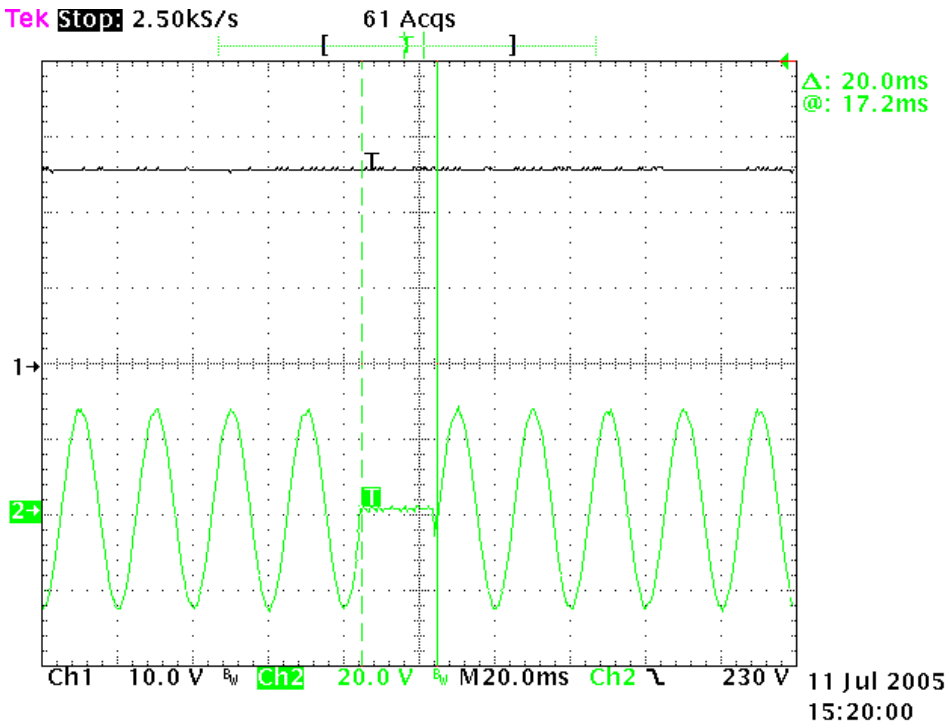


100V-0V OR 0% for 20mS

Conditions: **Output set to 25V DC at full 500W output power. Input goes from 100 VAC to 0VAC for 20mS and then back to 100VAC.**

Channel 1: 25V Output at Full Load (20A).
Channel 2: Input Line

SPEC: NO OUTPUT VARIATION FOR DURATION OF SAG; PASS



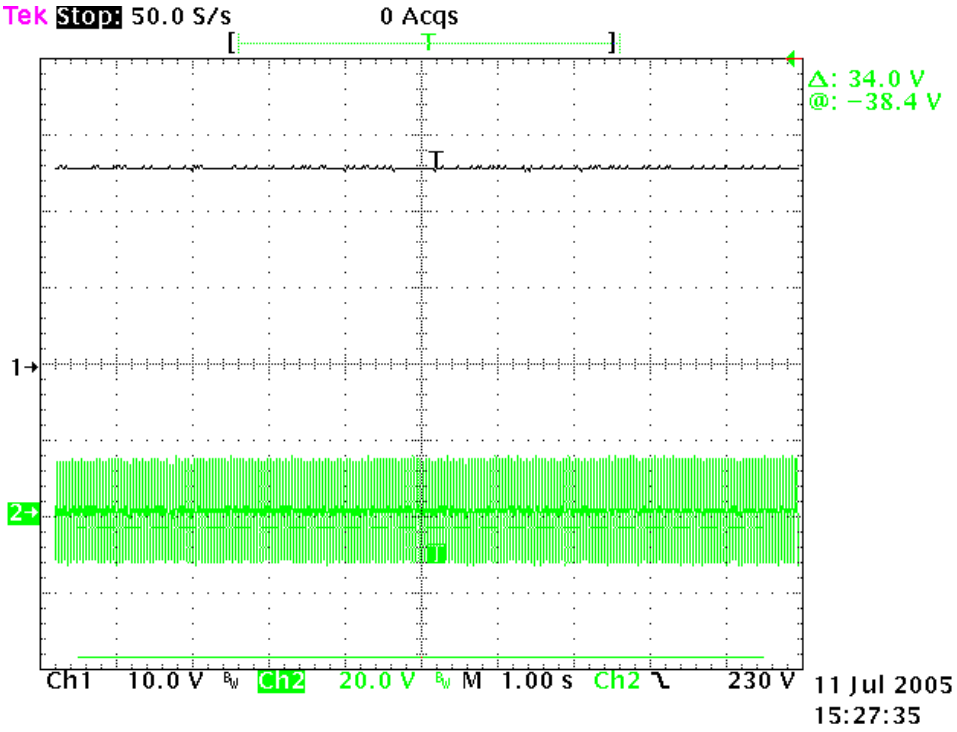
100V-80V OR 80% for 10 SEC

Conditions: **Output set to 25V DC at full 500W output power. Input goes from 100 VAC to 80VAC for 10 SEC and then back to 100VAC.**

Channel 1: 25V Output at Full Load (20A).

Channel 2: **Input Line (amplitude correlates to 80VAC). Verified with DMM Listed above.**

SPEC: NO OUTPUT VARIATION FOR DURATION OF SAG; **PASS**



19.- OCP Characteristics
Vin = 115VAC , Vout =24Vdc , Ta = 25C
CC = Constant Current Mode
CR = Constant Resistance Mode