

CPFE1000Fi-12

EVALUATION DATA

| | |
|---|-------------------|
| Tested By: Miguel Valdez / <i>M. Valdez</i> | Date : 11/11/2015 |
|---|-------------------|

Name/Signature

| | |
|---|-------------------|
| Checked By: Kenneth Rose / <i>KC Rose</i> | Date : 11/11/2015 |
|---|-------------------|

Name/Signature

| | |
|---|------------------|
| Approved By: Greg Laufman / <i>Greg Laufman</i> | Date: 11/12/2015 |
|---|------------------|

Name/Signature

INDEX

1. Test Set-ups

2. Characteristics

- 2.1 Line and Load regulation
- 2.2 Input turn ON/OFF voltage characteristics.
- 2.3 Efficiency and Power factor vs. Output power and Input Voltage, Standby Input Power
- 2.4 Over current protection (OCP) characteristics.
- 2.5 Over voltage protection (OVP) characteristics.
- 2.6 Output rise and fall characteristics
- 2.7 Output rise and fall characteristics with ON/OFF control.
- 2.8 Hold up time characteristics
- 2.9 Dynamic line response characteristics
- 2.10 Dynamic load response characteristics
- 2.11 Response to brownout characteristics
- 2.12 Inrush current characteristics
- 2.13 Input current waveforms
- 2.14 Input current harmonics
- 2.15 Leakage current characteristics
- 2.16 Output ripple and noise waveforms

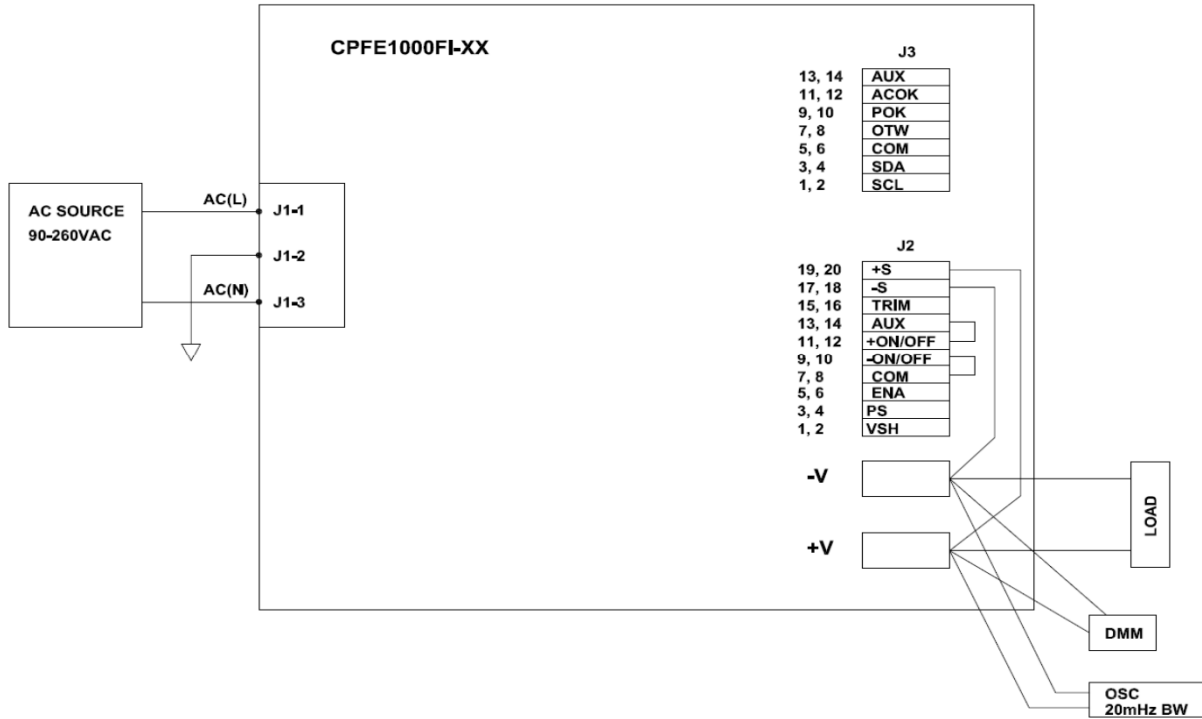
Test Equipment used:

Digital Multi-Meter (DMM) - Model: Fluke 45
Power Source - Model: Kikusui DCR4000L
Electronic Load - Model: Chroma 63201
Digital Power Meter - Model: Yokogawa WT2010
Digital Power Meter - Model: Chroma 66202
Oscilloscope - Model: Tektronix DPO2024
Leakage Tester - Associate Research Model no. 620L

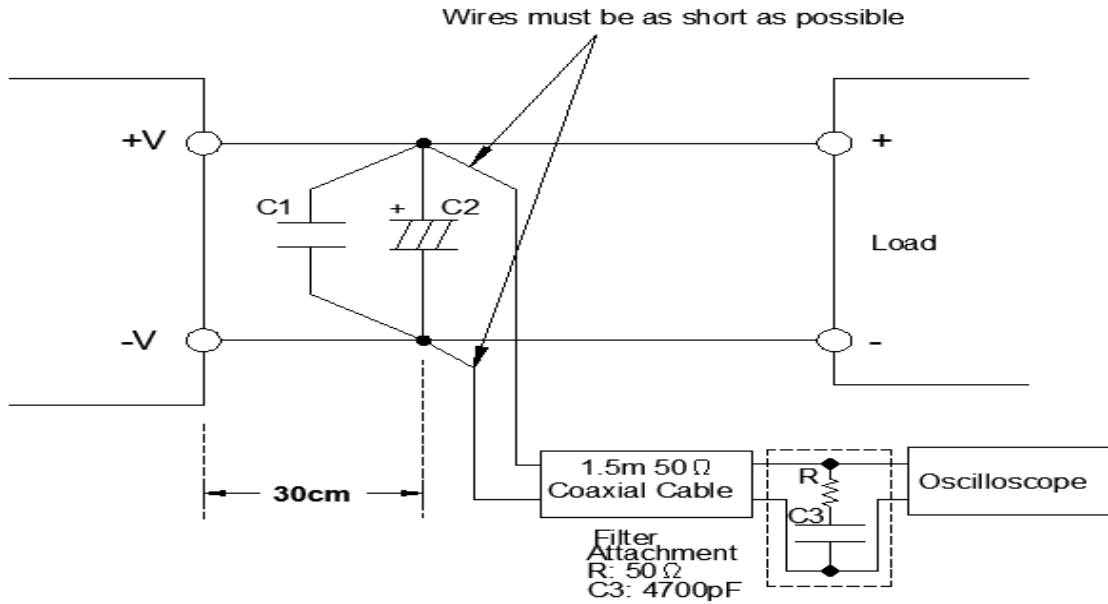
Terminology used

| | | | |
|-------------|-----------------|----------|------------------------|
| Vin | Input Voltage | Io..... | Output Current |
| Vout..... | Output Voltage | Tbp..... | Base Plate Temperature |
| On/Off..... | Control Voltage | Ta..... | Ambient Temperature |
| Iin..... | Input Current | f..... | Frequency |
| Pin..... | Input Power | Eff..... | Efficiency |
| Po..... | Ouptut Power | PF..... | Power factor |

1. Test set-ups



General Test Setup



C1 - 0.1 μ F Ceramic Capacitor

C2 - 47 μ F Aluminum Electrolytic Capacitor

Setup for Ripple Measurement

2. Characteristics

2.1 Line and Load Regulation:

Condition Tbp = 25°C

Vout measured across output studs using local sense connections.

| Io \ Vin | 90 VAC | 110 VAC | 220 VAC | 265 VAC | Line Regulation | |
|-----------------|---------|---------|---------|---------|-----------------|--------|
| 0% Load | 12.0350 | 12.0360 | 12.0370 | 12.0380 | 0.003 | 0.006% |
| 25% Load | 12.0440 | 12.0430 | 12.0420 | 12.0410 | 0.003 | 0.006% |
| 50% Load | 12.0320 | 12.0340 | 12.0340 | 12.0350 | 0.003 | 0.006% |
| 75% Load | 12.0250 | 12.0240 | 12.0240 | 12.0240 | 0.001 | 0.002% |
| 100% Load | 12.0130 | 12.0130 | 12.0130 | 12.0130 | 0 | 0.000% |
| Load Regulation | 0.031 | 0.03 | 0.029 | 0.028 | | |
| | 0.065% | 0.062% | 0.060% | 0.058% | | |

Vout measured across output studs using remote sense connections.

| Io \ Vin | 90 VAC | 110 VAC | 220 VAC | 265 VAC | Line Regulation | |
|-----------------|--------|---------|---------|---------|-----------------|--------|
| 0% Load | 11.974 | 11.972 | 11.97 | 11.968 | 0.006 | 0.013% |
| 25% Load | 12.027 | 12.028 | 12.028 | 12.03 | 0.003 | 0.006% |
| 50% Load | 12.083 | 12.083 | 12.083 | 12.082 | 0.001 | 0.002% |
| 75% Load | 12.141 | 12.14 | 12.14 | 12.14 | 0.001 | 0.002% |
| 100% Load | 12.199 | 12.2 | 12.202 | 12.203 | 0.004 | 0.008% |
| Load Regulation | 0.225 | 0.228 | 0.232 | 0.235 | | |
| | 0.469% | 0.475% | 0.483% | 0.490% | | |

2.2 Input turn ON/OFF voltage characteristics.

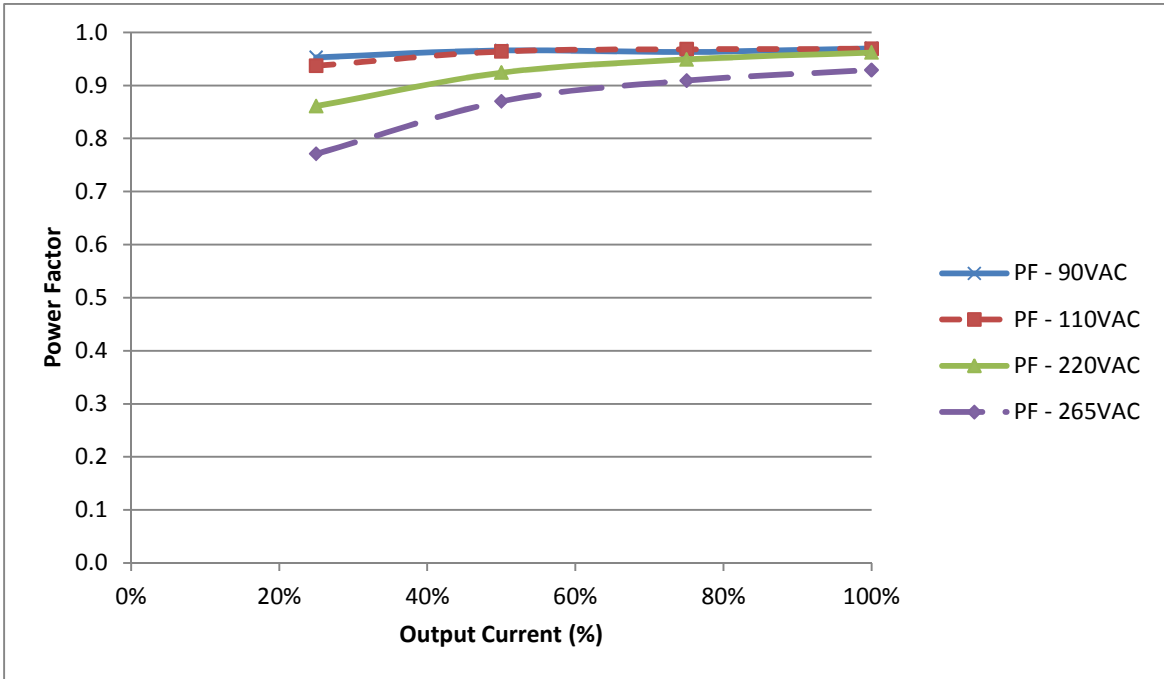
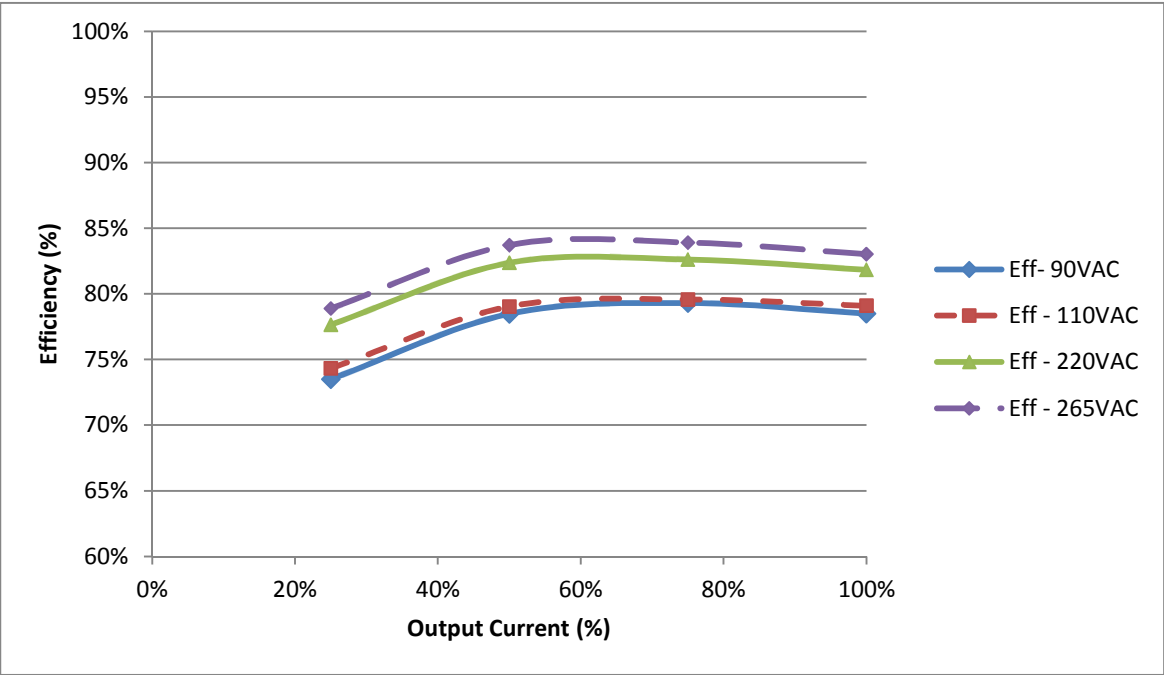
Condition Tbp = 25°C

| | 0% Load | 100%Load |
|------------------|---------|----------|
| Turn ON Voltage | 75 | 73 |
| Turn OFF Voltage | 68 | 70 |

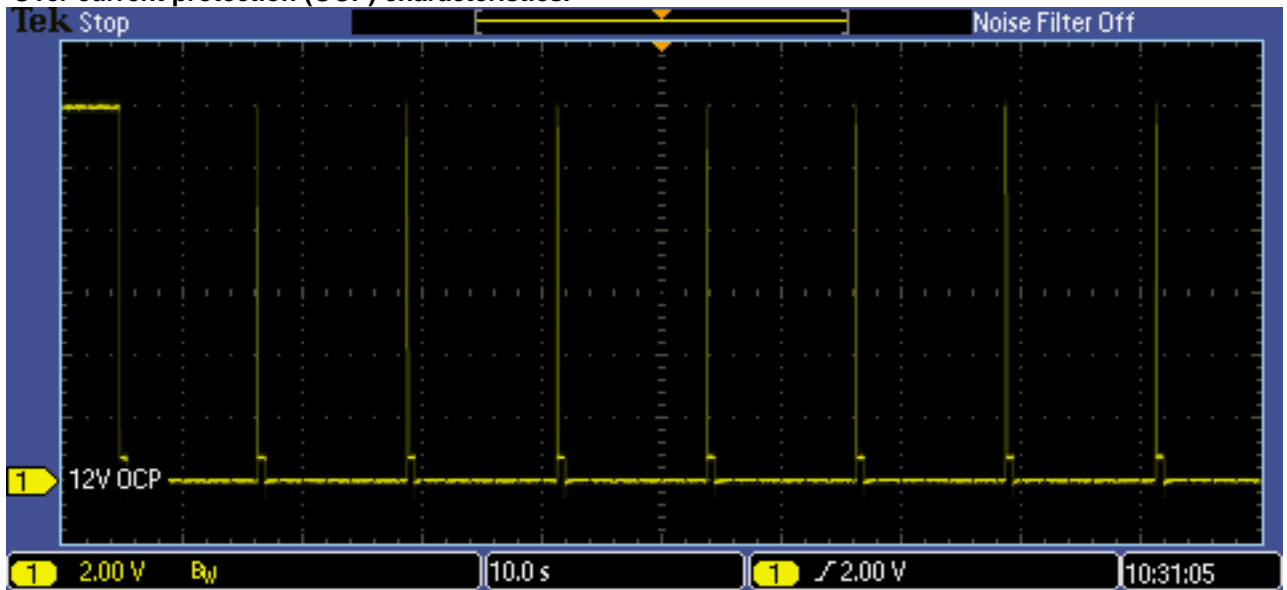
2.3 Efficiency and Power factor vs. Output power and Input Voltage, Standby Input Power

Condition Tbp = 25°C

| Vin | Iin | Pin | PF | Vout | Io | Po | Eff | Load |
|---------|-------|-------|-------|--------|----|---------|--------|------|
| 90 VAC | 0.65 | 51.6 | 0.863 | 12.035 | 0 | 0 | N/A | 0% |
| 110 VAC | 0.55 | 50.8 | 0.837 | 12.040 | 0 | 0 | N/A | |
| 220 VAC | 0.50 | 48.6 | 0.439 | 12.032 | 0 | 0 | N/A | |
| 265 VAC | 0.66 | 47.4 | 0.271 | 12.043 | 0 | 0 | N/A | |
| 90 VAC | 2.81 | 245.5 | 0.953 | 12.030 | 15 | 180.45 | 73.50% | 25% |
| 110 VAC | 2.34 | 243.1 | 0.937 | 12.045 | 15 | 180.675 | 74.32% | |
| 220 VAC | 1.22 | 232.4 | 0.861 | 12.031 | 15 | 180.465 | 77.65% | |
| 265 VAC | 1.13 | 229.1 | 0.771 | 12.049 | 15 | 180.735 | 78.89% | |
| 90 VAC | 5.20 | 459.4 | 0.966 | 12.017 | 30 | 360.51 | 78.47% | 50% |
| 110 VAC | 4.28 | 456.8 | 0.964 | 12.034 | 30 | 361.02 | 79.03% | |
| 220 VAC | 2.15 | 437.9 | 0.924 | 12.022 | 30 | 360.66 | 82.36% | |
| 265 VAC | 1.87 | 431.4 | 0.870 | 12.038 | 30 | 361.14 | 83.71% | |
| 90 VAC | 7.76 | 681.4 | 0.963 | 12.007 | 45 | 540.315 | 79.29% | 75% |
| 110 VAC | 6.36 | 679.9 | 0.968 | 12.022 | 45 | 540.99 | 79.57% | |
| 220 VAC | 3.13 | 654.3 | 0.949 | 12.011 | 45 | 540.495 | 82.61% | |
| 265 VAC | 2.67 | 645.1 | 0.909 | 12.029 | 45 | 541.305 | 83.91% | |
| 90 VAC | 10.40 | 917.2 | 0.970 | 11.999 | 60 | 719.94 | 78.49% | 100% |
| 110 VAC | 8.53 | 910.9 | 0.969 | 12.008 | 60 | 720.48 | 79.10% | |
| 220 VAC | 4.15 | 879.9 | 0.962 | 12.001 | 60 | 720.06 | 81.83% | |
| 265 VAC | 3.49 | 868.6 | 0.929 | 12.018 | 60 | 721.08 | 83.02% | |

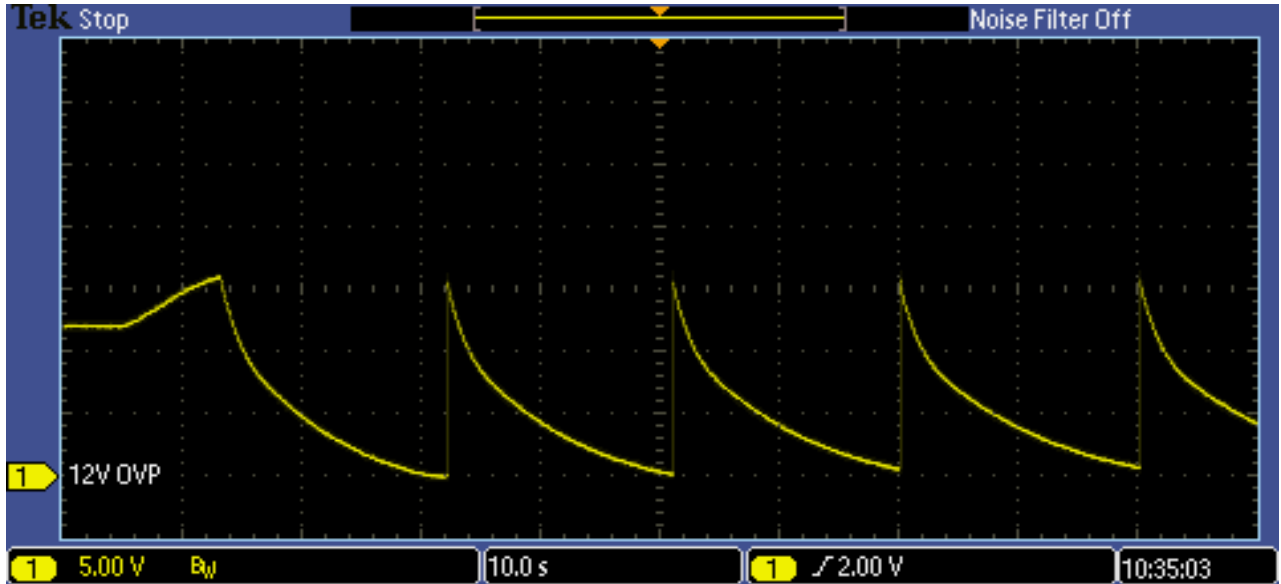


2.4 Over current protection (OCP) characteristics.

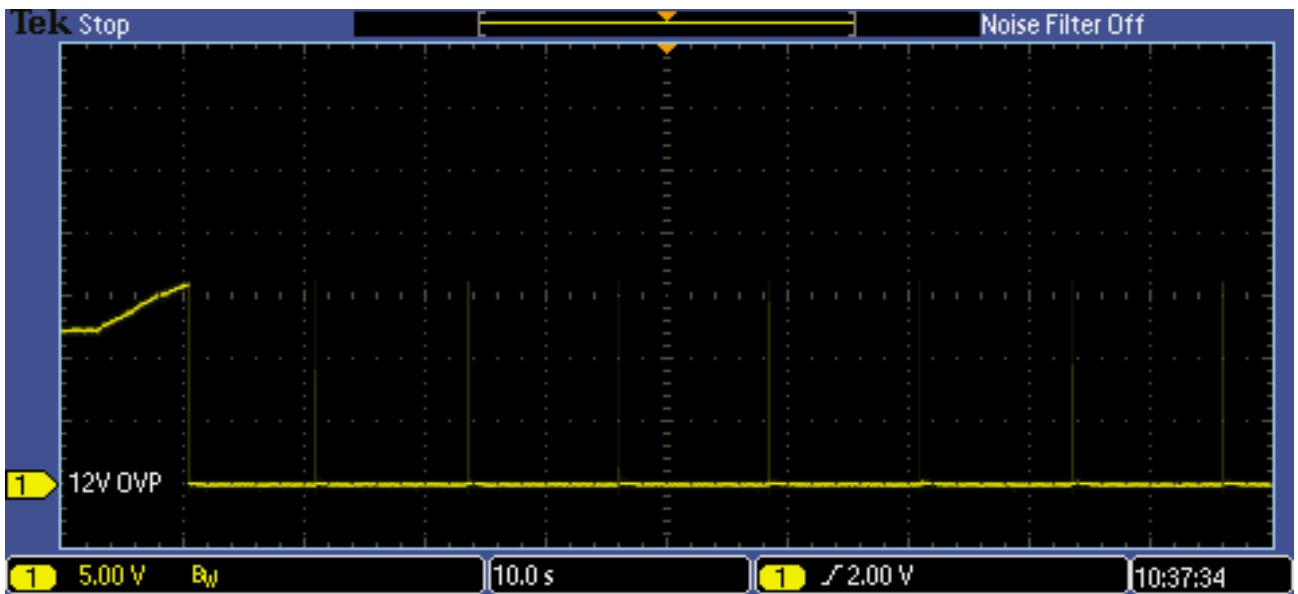


Vout: 2V/div 10s/div
Output Voltage during OCP mode.

2.5 Over voltage protection (OVP) characteristics.

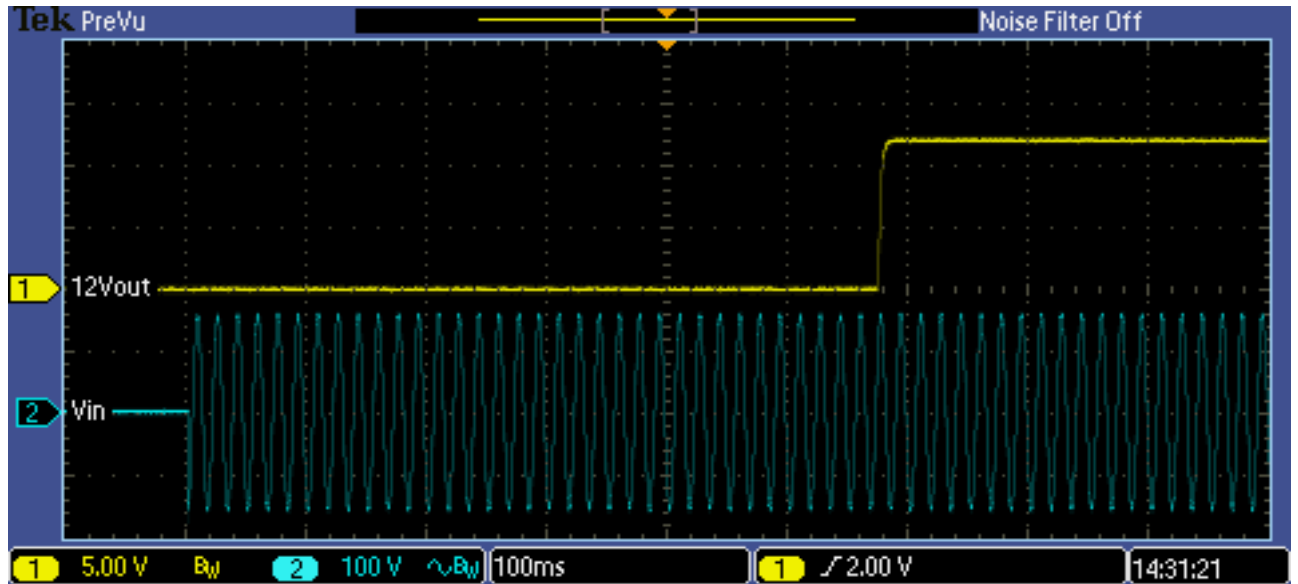


Vout: 5V/div 10s/div
Output Voltage during OVP mode (0% Load)

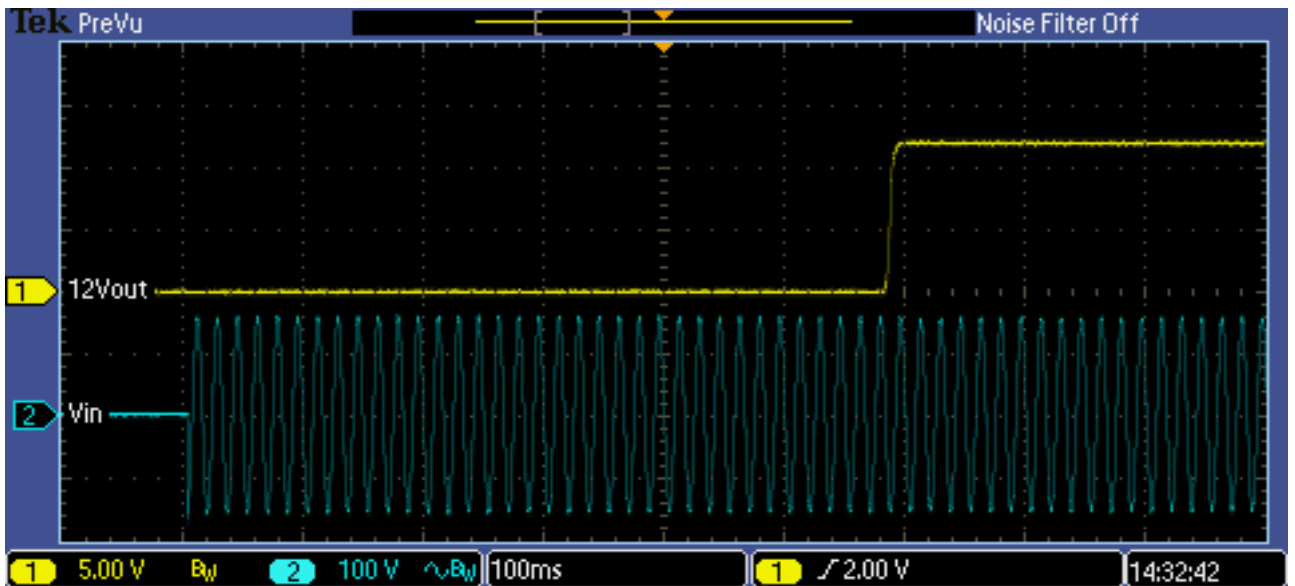


Vout: 5V/div 10s/div
Output Voltage during OVP mode (100% Load)

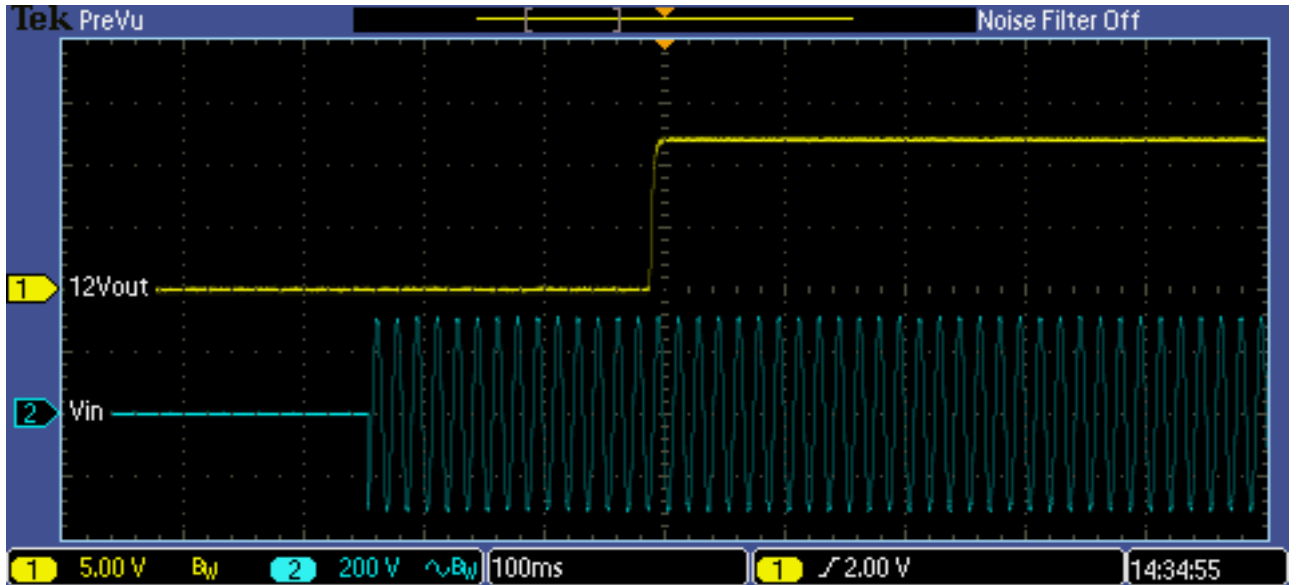
2.6 Output rise and fall characteristics



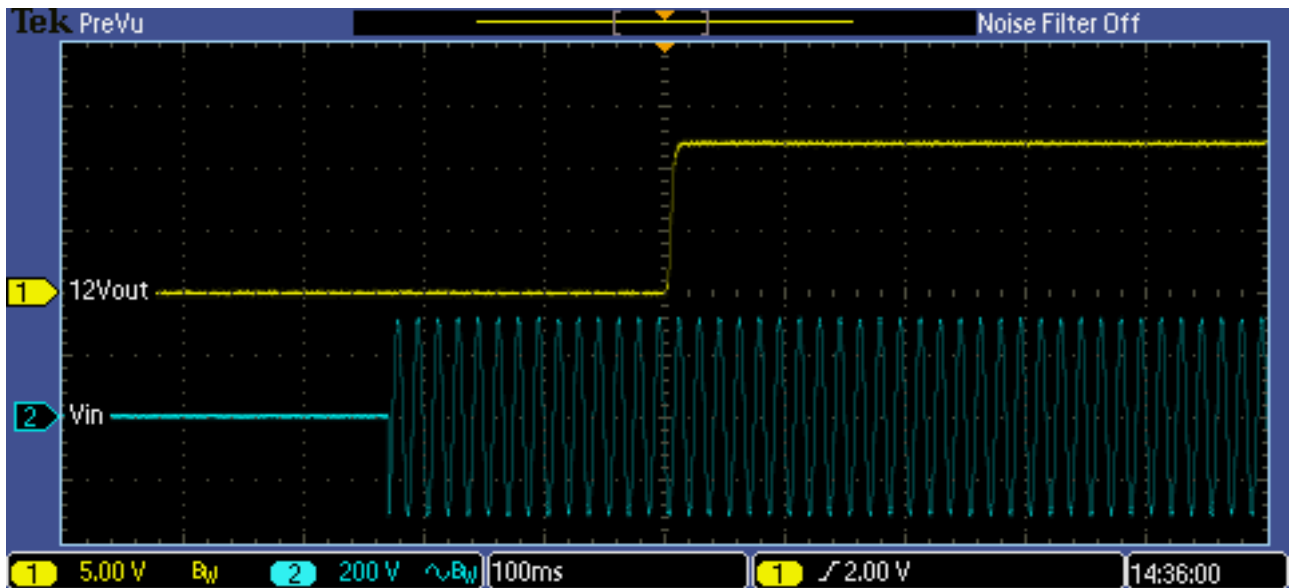
Vin: 100V/div Vout: 5V/div 100ms/div
Output rise (0% Load, 110Vac input)



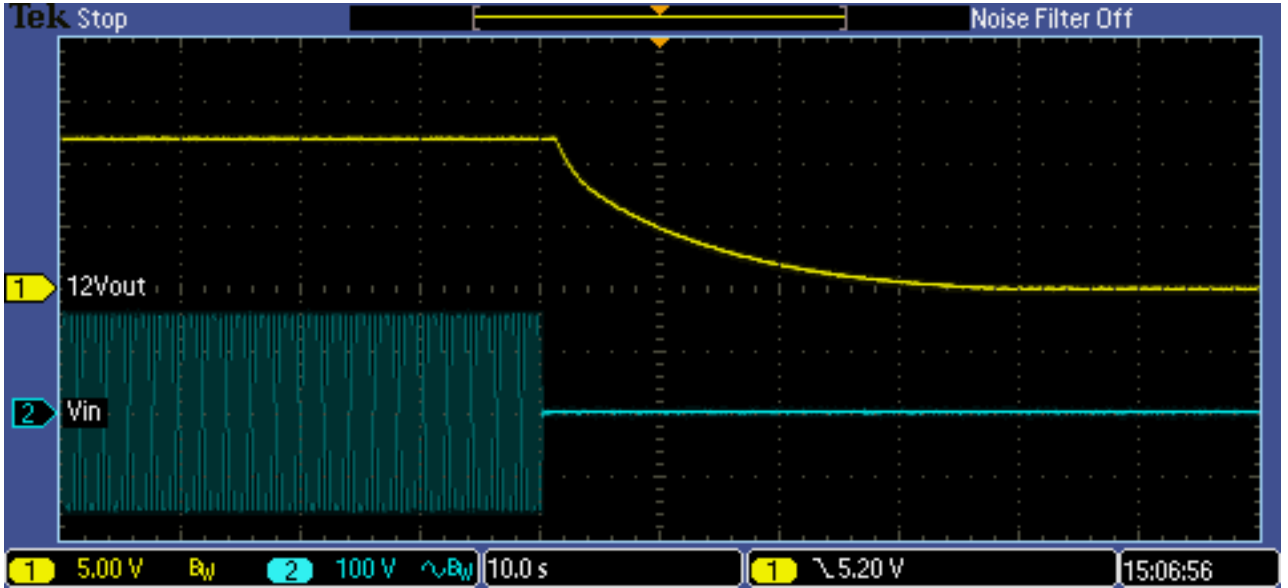
Vin: 100V/div Vout: 5V/div 100ms/div
Output rise (100% Load, 110Vac input)



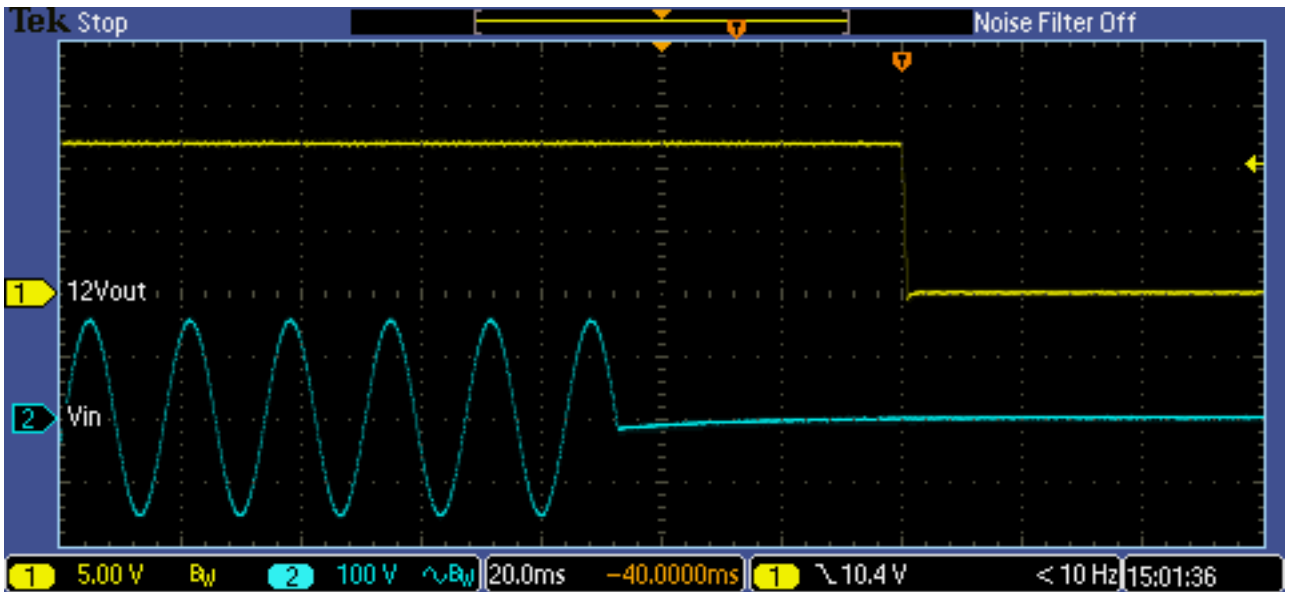
Vin: 200V/div Vout: 5V/div 100ms/div
Output rise (0% Load, 220Vac input)



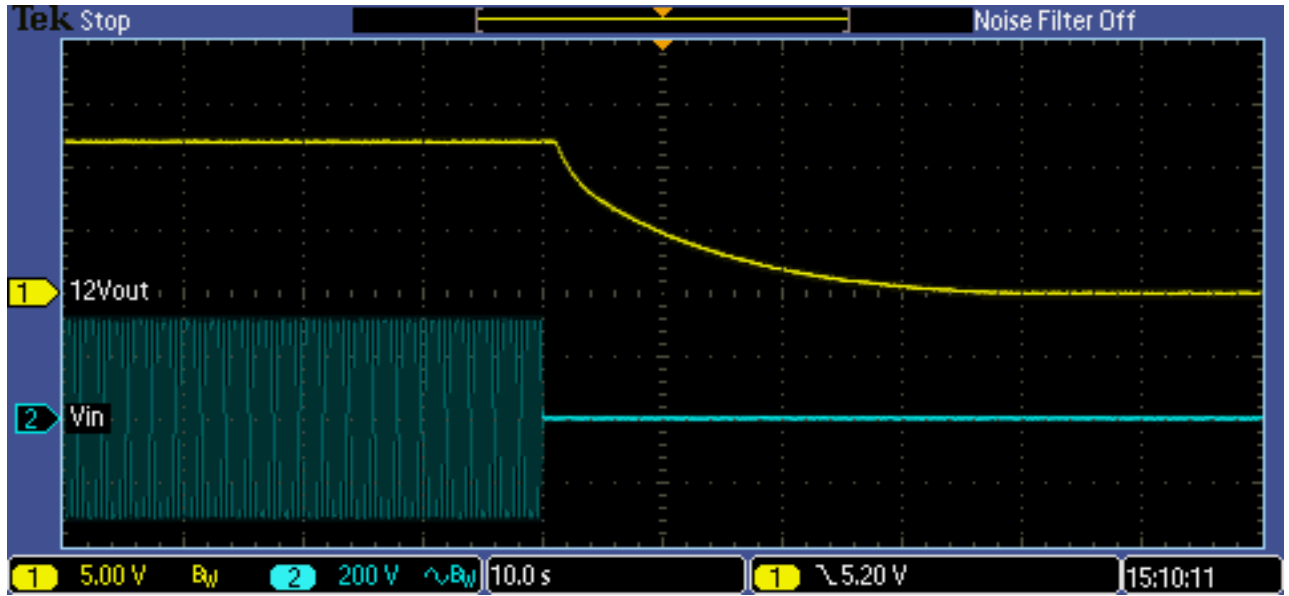
Vin: 200V/div Vout: 5V/div 100ms/div
Output rise (0% Load, 220Vac input)



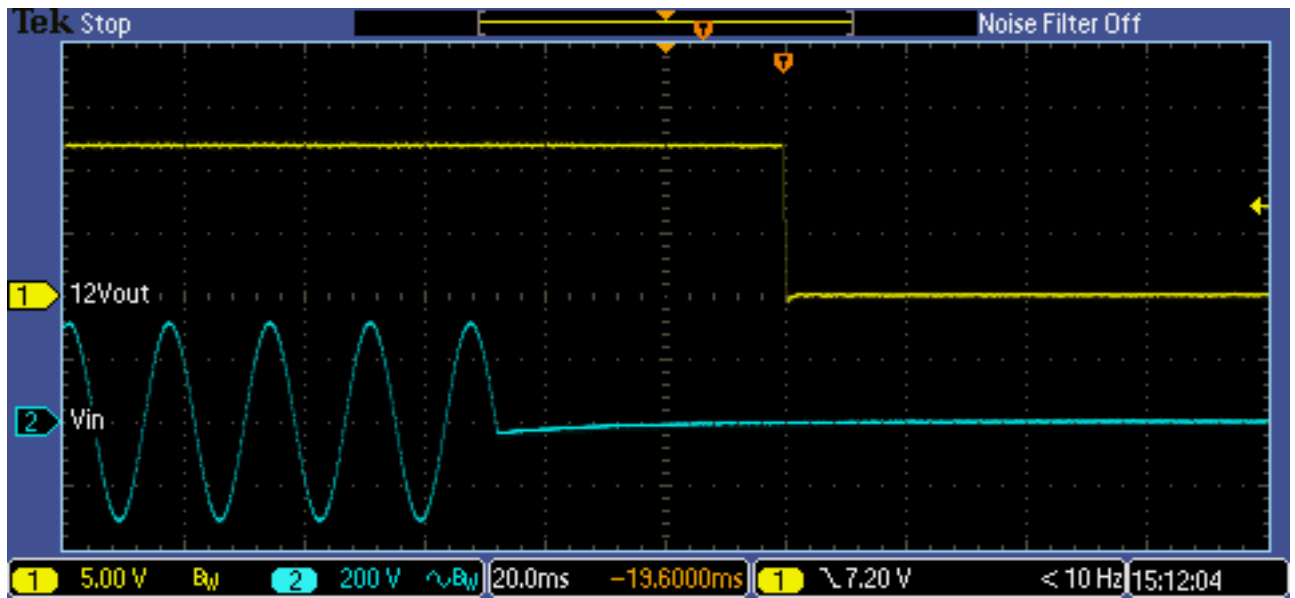
Vin: 100V/div Vout: 5V/div 10s/div
Output fall (0% Load, 110Vac input)



Vin: 100V/div Vout: 5V/div 20ms/div
Output fall (100% Load, 110Vac input)

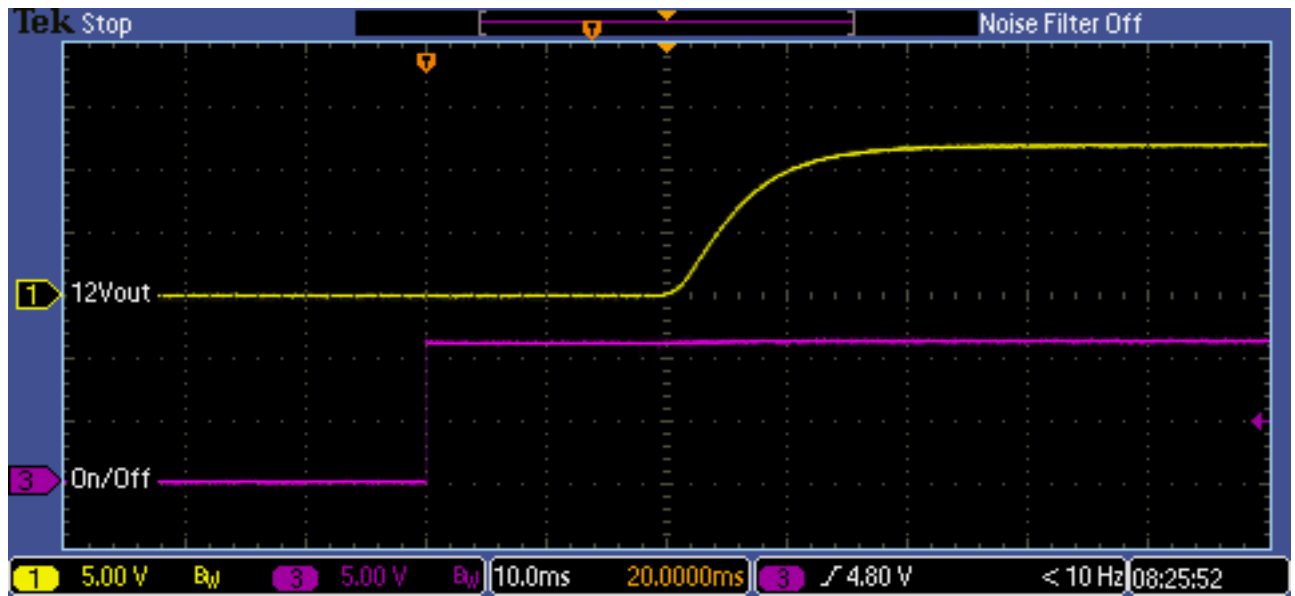


Vin: 200V/div Vout: 5V/div 10s/div
 Output fall (0% Load, 220Vac input)

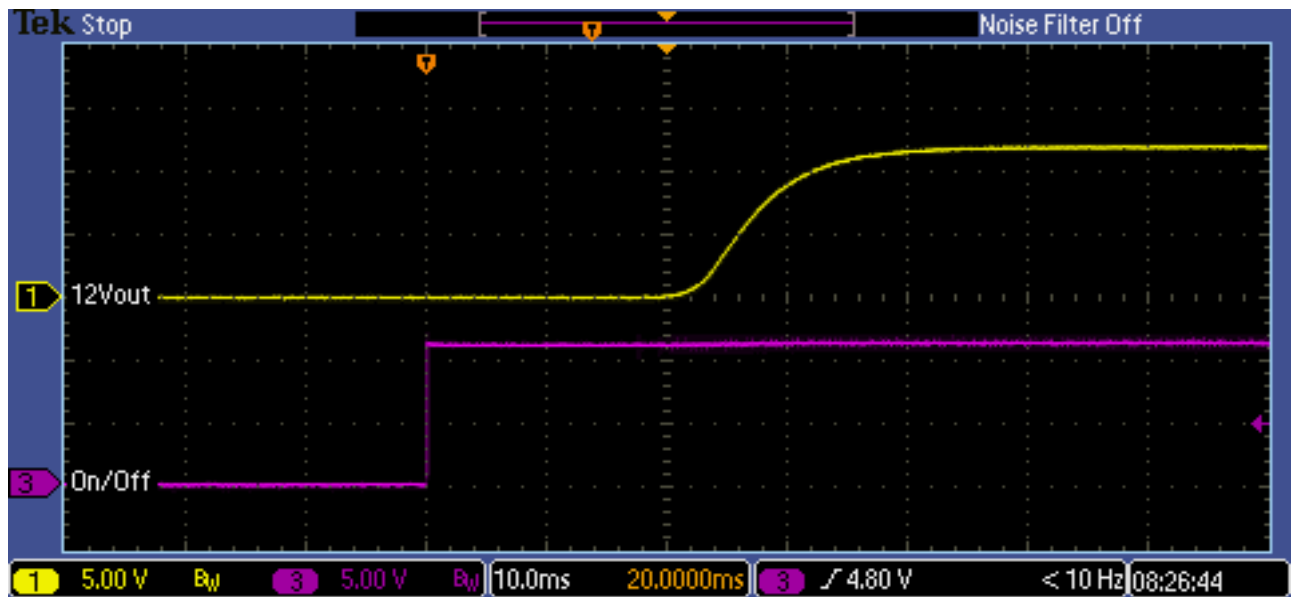


Vin: 200V/div Vout: 5V/div 20ms/div
 Output fall (100% Load, 220Vac input)

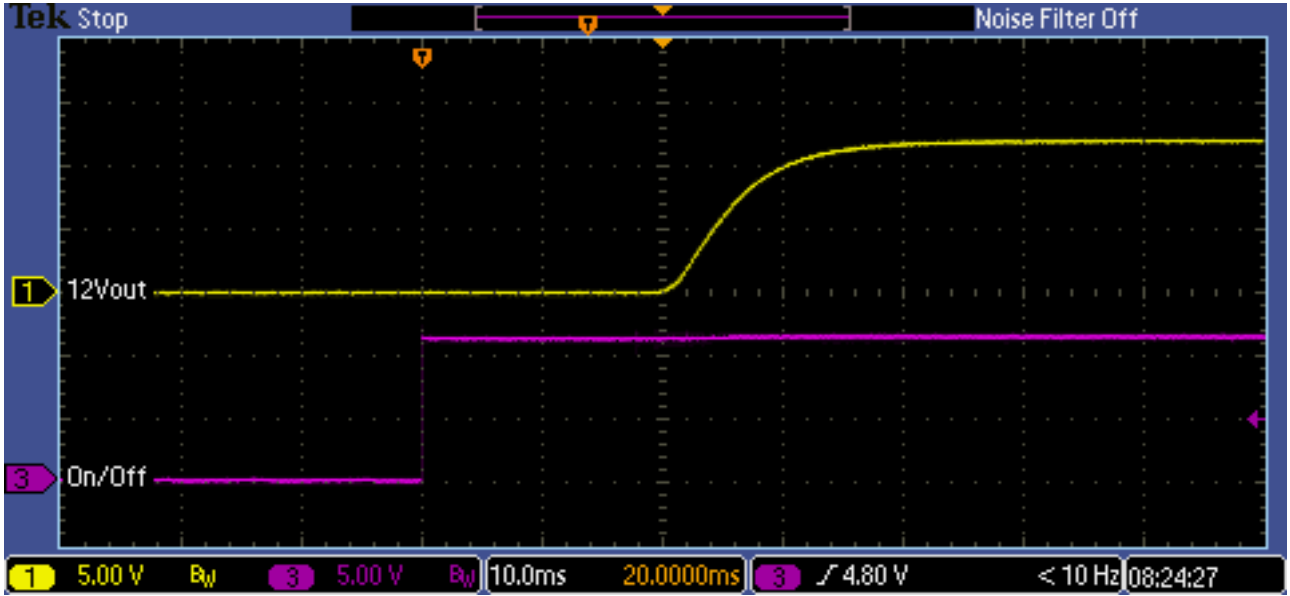
2.7 Output rise and fall characteristics with ON/OFF control.



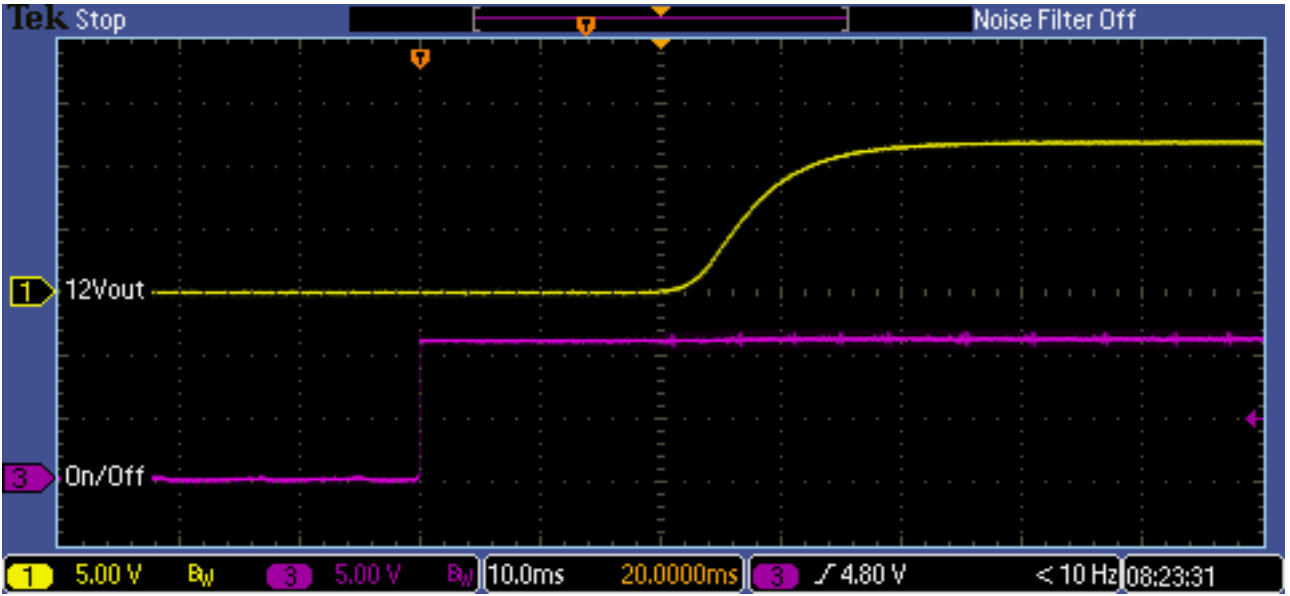
On/Off: 5V/div Vout: 5V/div 10ms/div
Output rise with ON/OFF control(0% Load, 110Vac input)



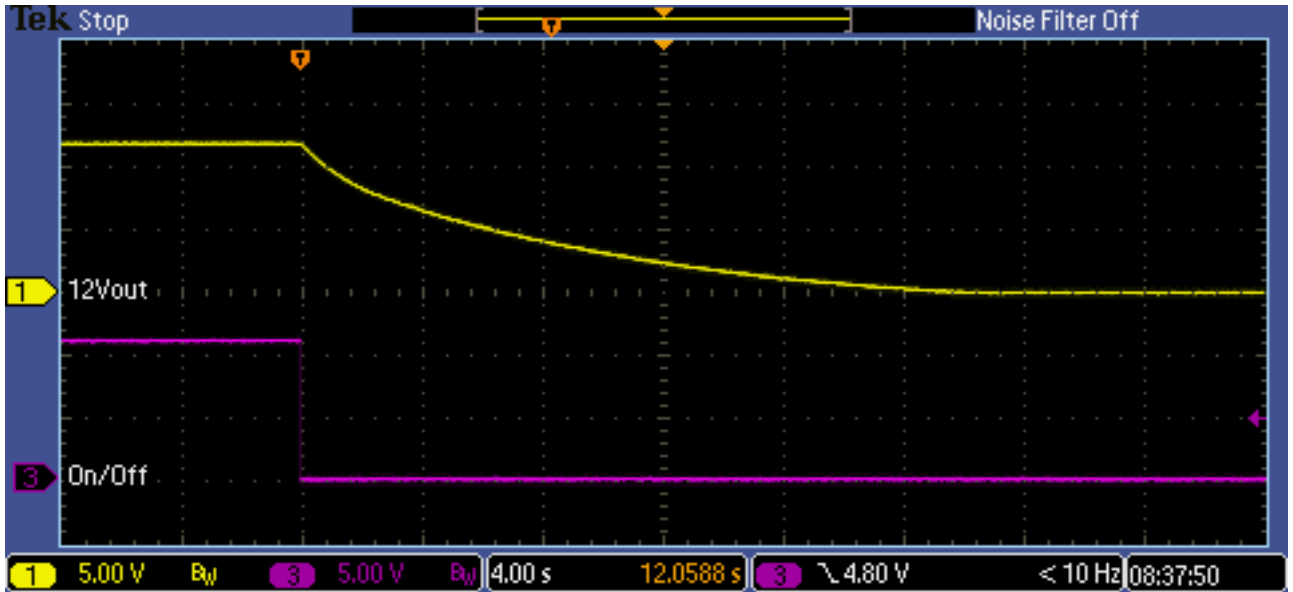
On/Off: 5V/div Vout: 5V/div 10ms/div
Output rise with ON/OFF control(100% Load, 110Vac input)



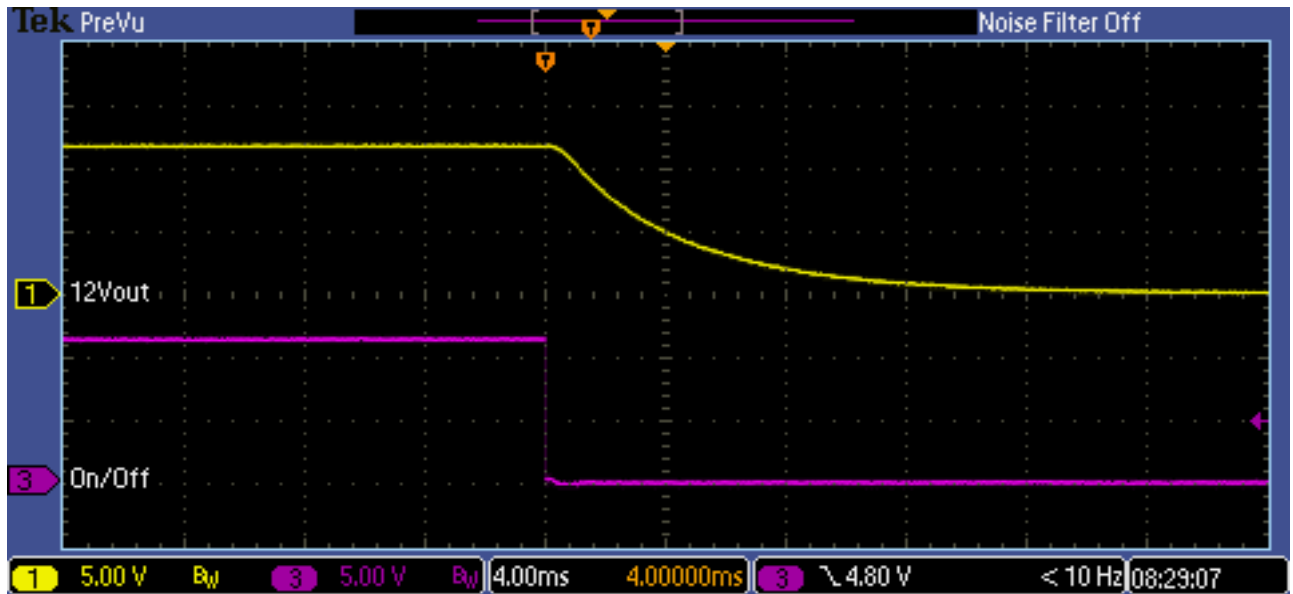
On/Off: 5V/div Vout: 5V/div 10ms/div
 Output rise with ON/OFF control(0% Load, 220Vac input)



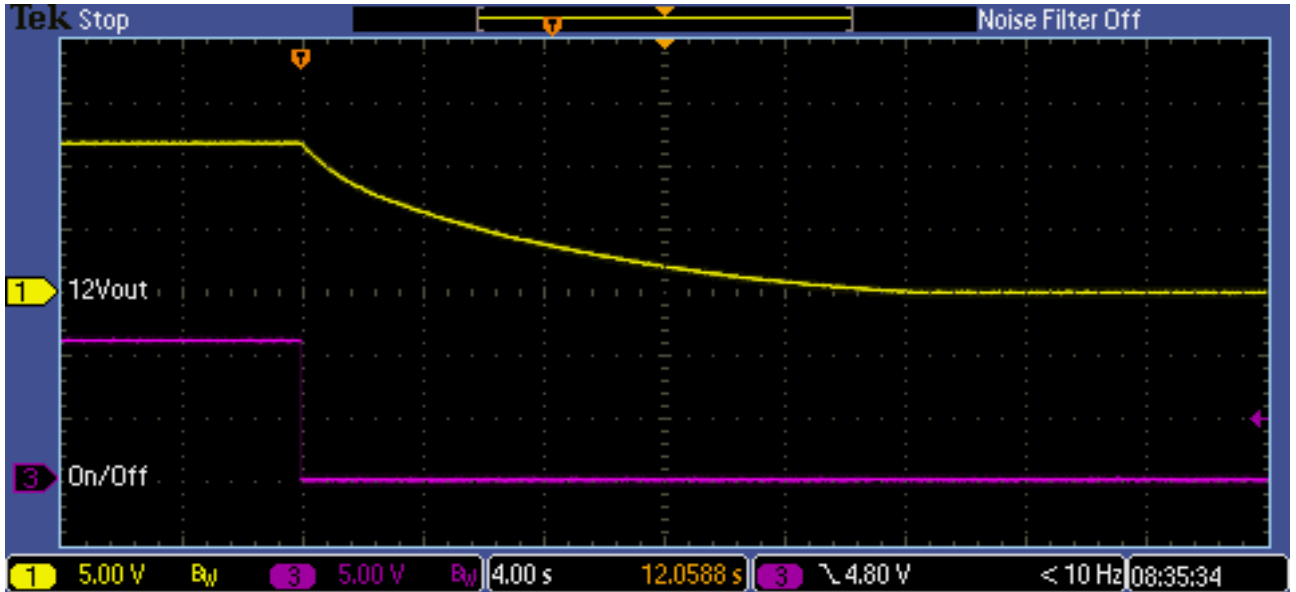
On/Off: 5V/div Vout: 5V/div 10ms/div
 Output rise with ON/OFF control(100% Load, 220Vac input)



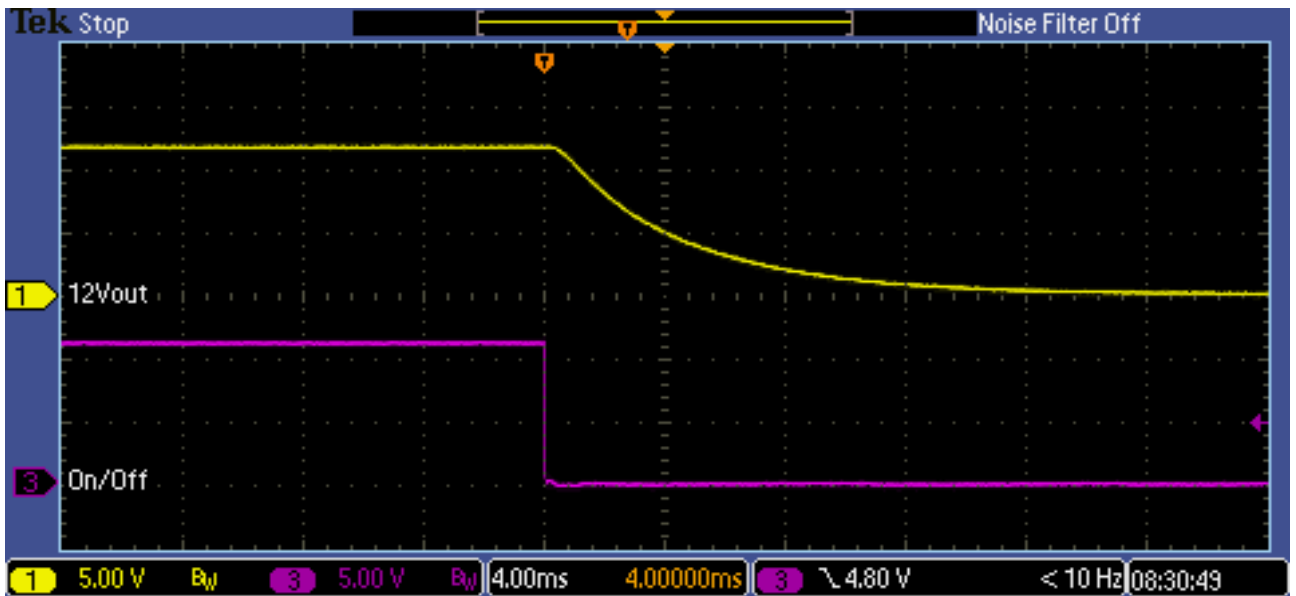
On/Off: 5V/div Vout: 5V/div 4s/div
 Output fall with ON/OFF control(0% Load, 110Vac input)



On/Off: 5V/div Vout: 5V/div 4ms/div
 Output fall with ON/OFF control(100% Load, 110Vac input)

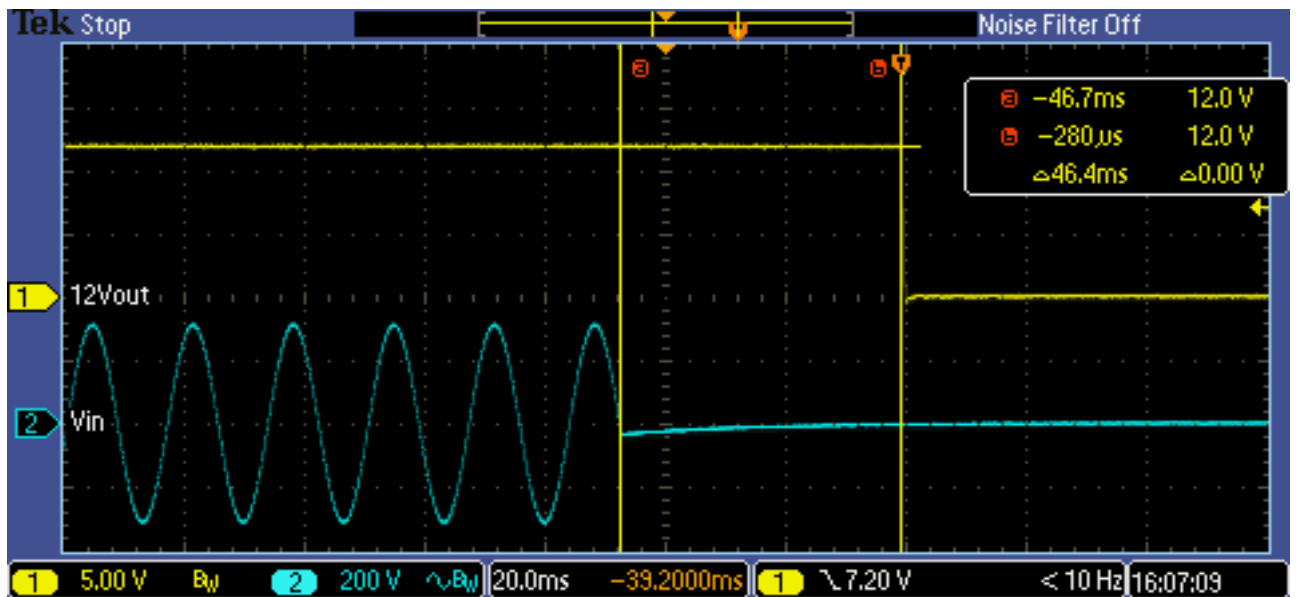


On/Off: 5V/div Vout: 5V/div 4s/div
 Output fall with ON/OFF control(0% Load, 220Vac input)



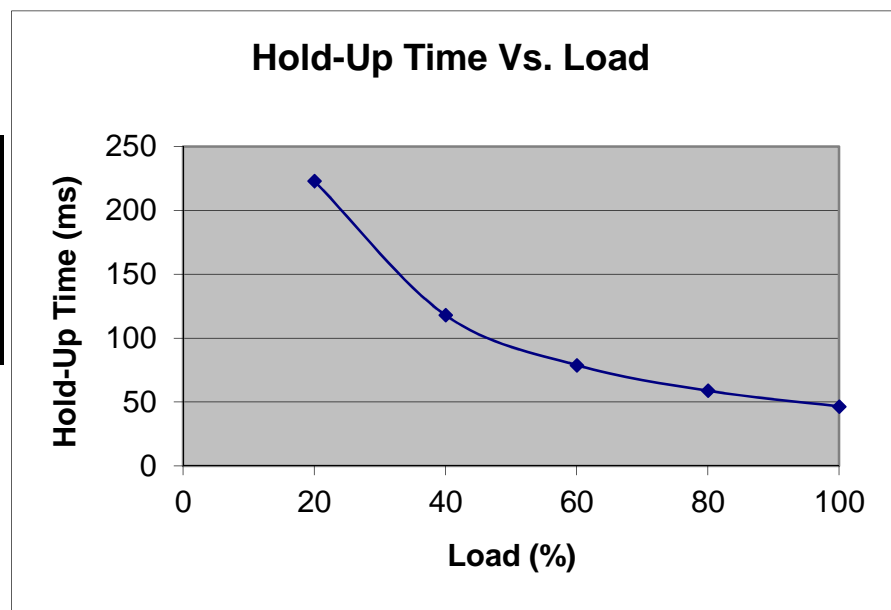
On/Off: 5V/div Vout: 5V/div 4ms/div
 Output fall with ON/OFF control(100% Load, 220Vac input)

2.8 Hold up time characteristics

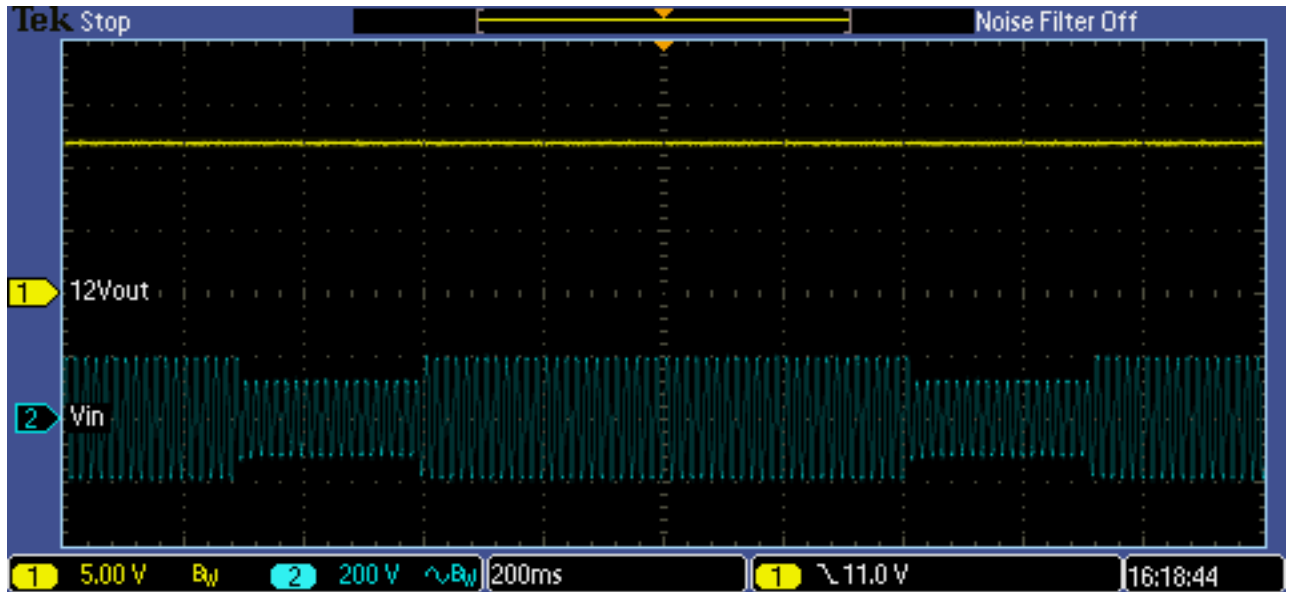


Vin: 200V/div Vout: 5V/div 20ms/div
 Output fall with ON/OFF control(100% Load, 220Vac input)

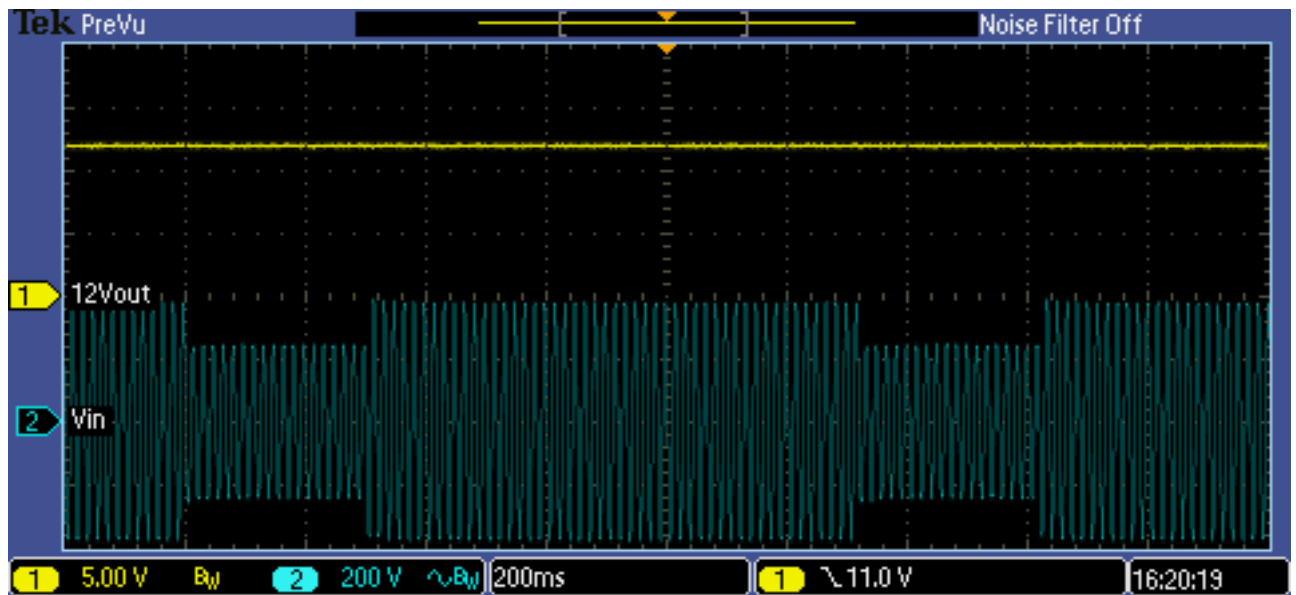
| Load (%) | Hold up time (ms) |
|----------|-------------------|
| 20 | 223 |
| 40 | 118 |
| 60 | 78.8 |
| 80 | 58.8 |
| 100 | 46.4 |



2.9 Dynamic line response characteristics

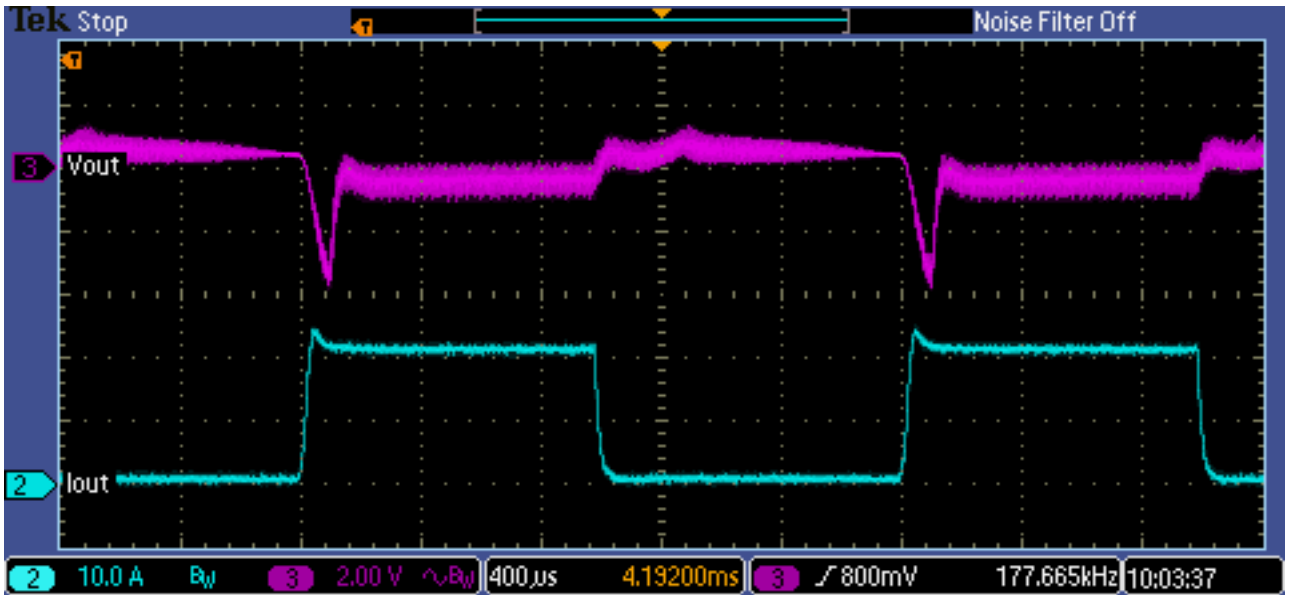


Vin: 200V/div Vout: 5V/div 200ms/div
Vin: 90VAC \Leftrightarrow 135VAC (100% Load)

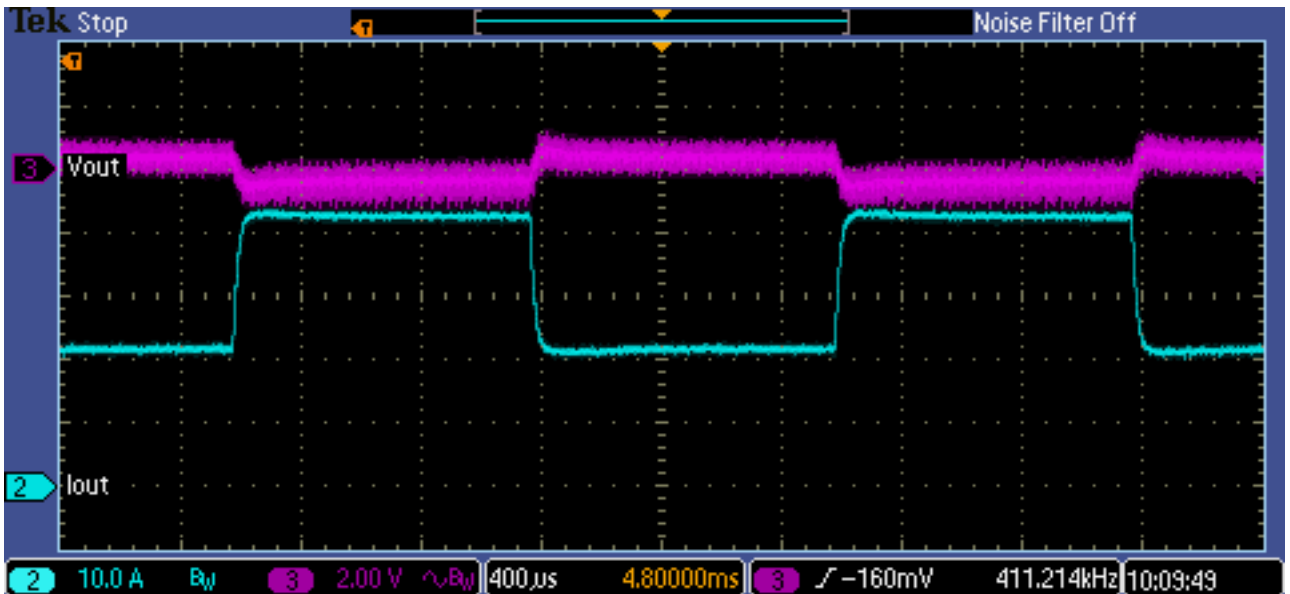


Vin: 200V/div Vout: 5V/div 200ms/div
Vin: 170VAC \Leftrightarrow 265VAC (100% Load)

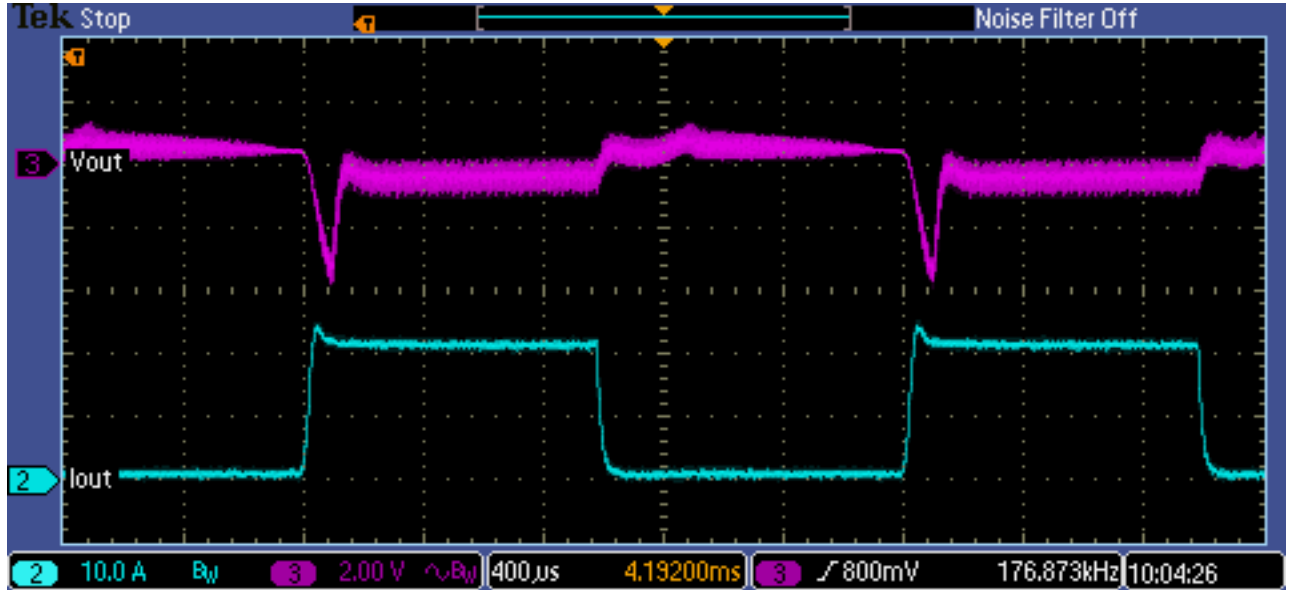
2.10 Dynamic load response characteristics



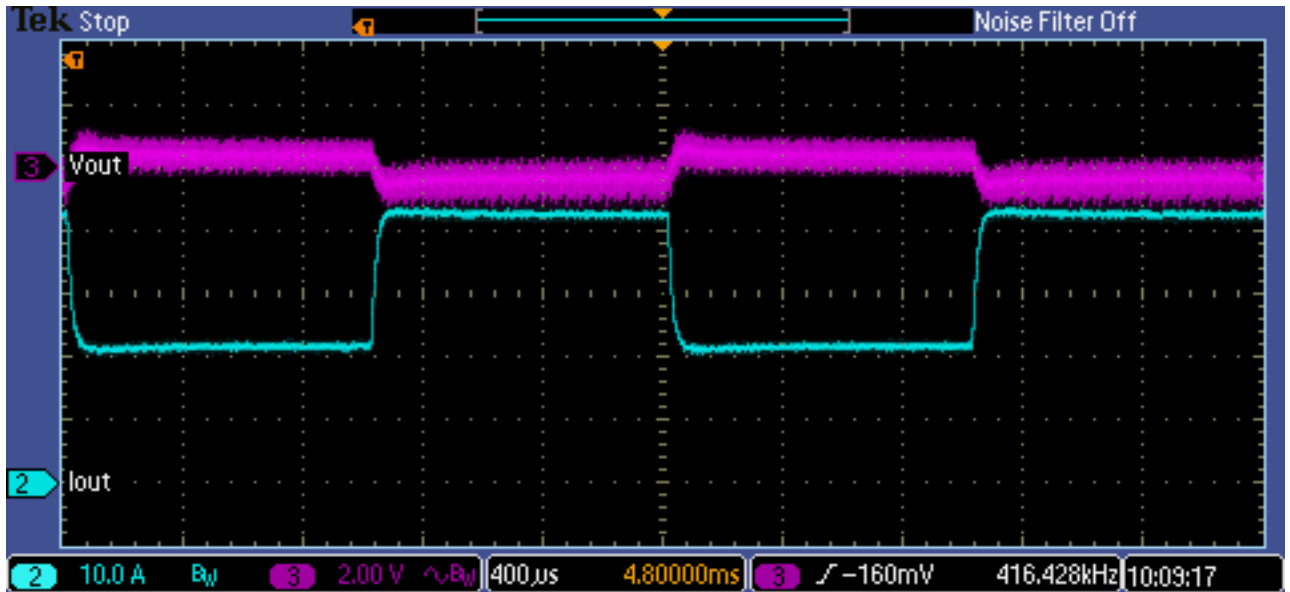
Iout: 10A/div Vout: 2V/div 400us/div
Dynamic Load Response (0% to 50% Load, 110Vac input)



Iout: 10A/div Vout: 2V/div 400us/div
Dynamic Load Response (50% to 100% Load, 110Vac input)

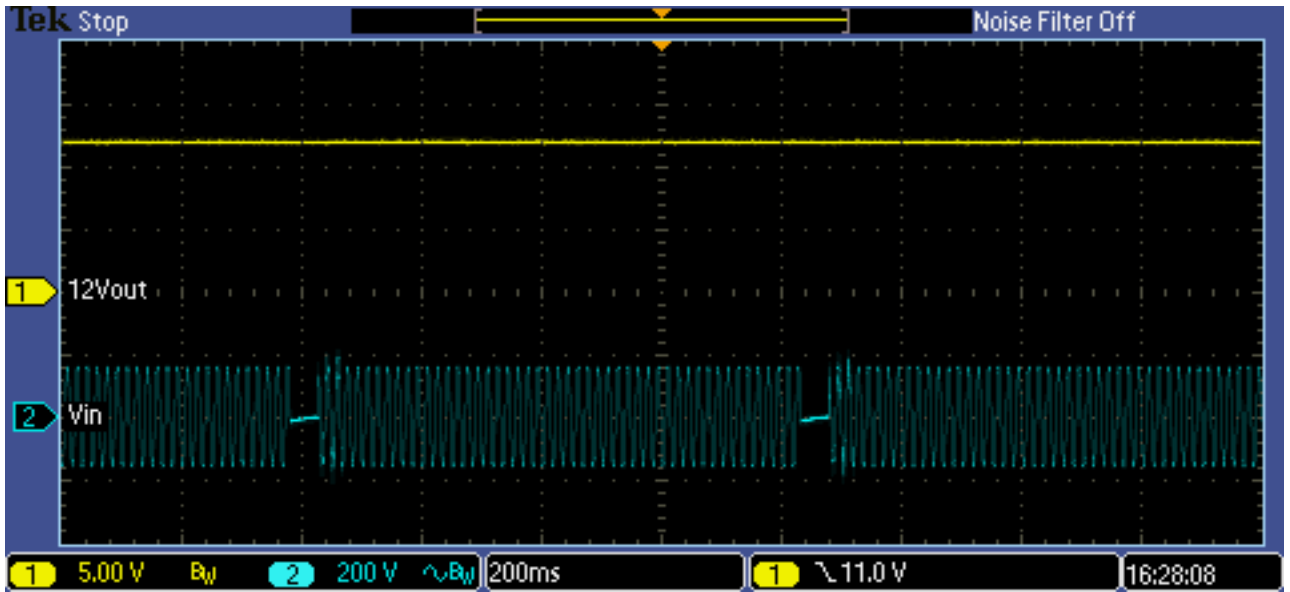


Iout: 10A/div Vout: 2V/div 400us/div
 Dynamic Load Response (0% to 50% Load, 220Vac input)

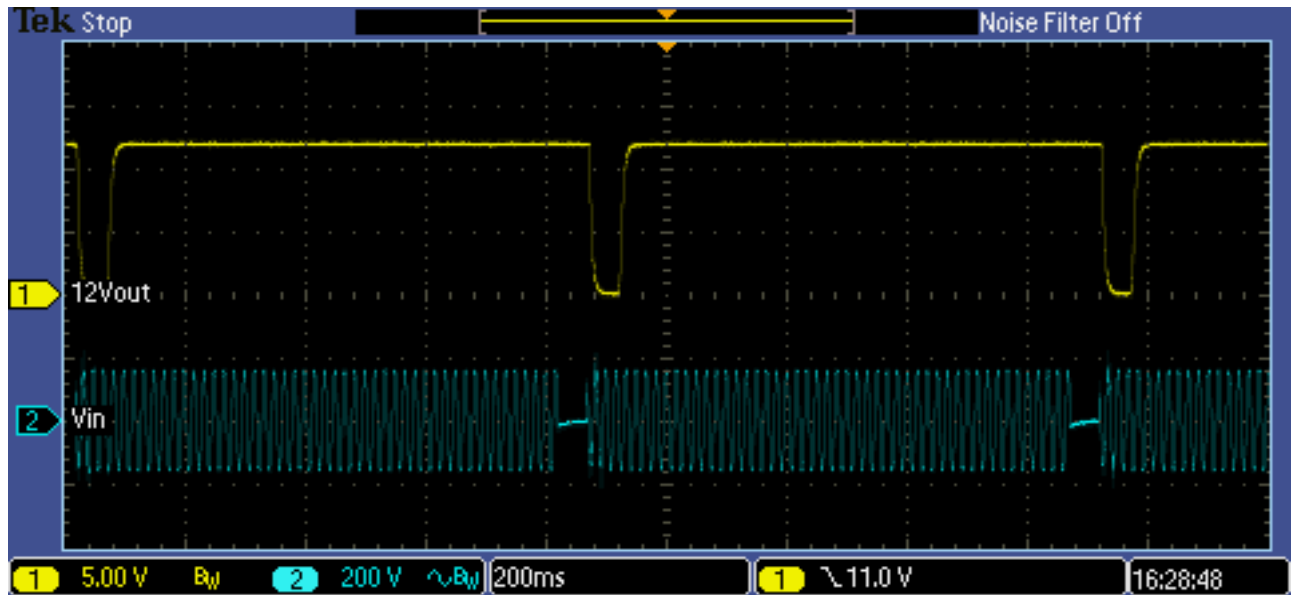


Iout: 10A/div Vout: 2V/div 400us/div
 Dynamic Load Response (50% to 100% Load, 220Vac input)

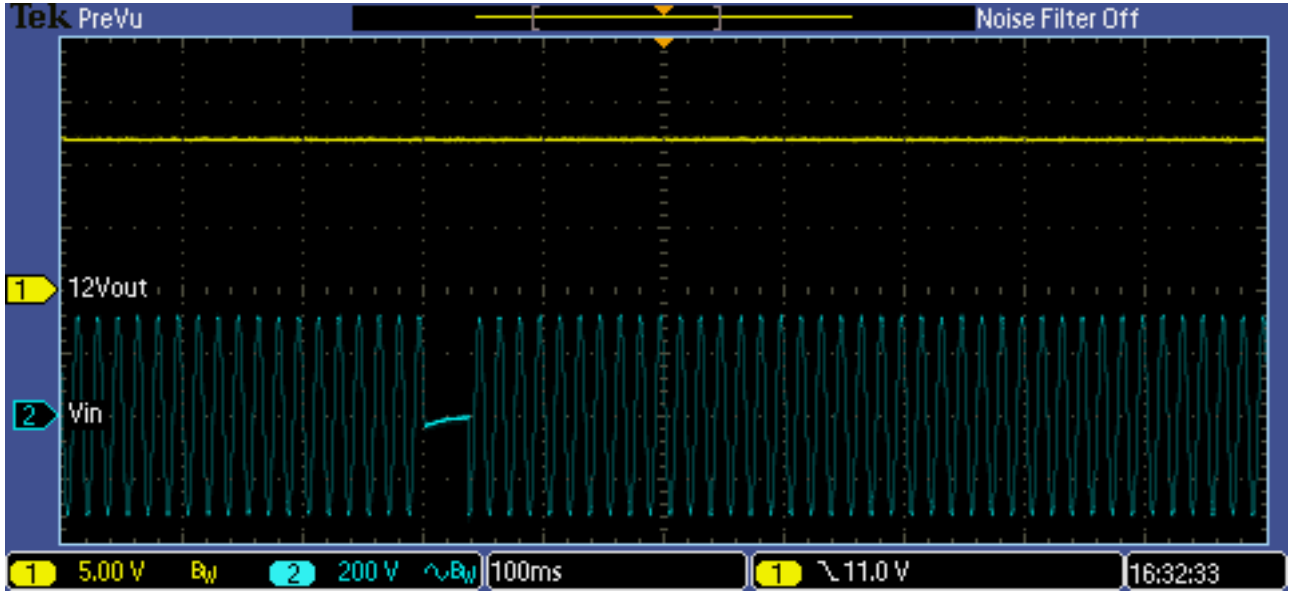
2.11 Response to brownout characteristics



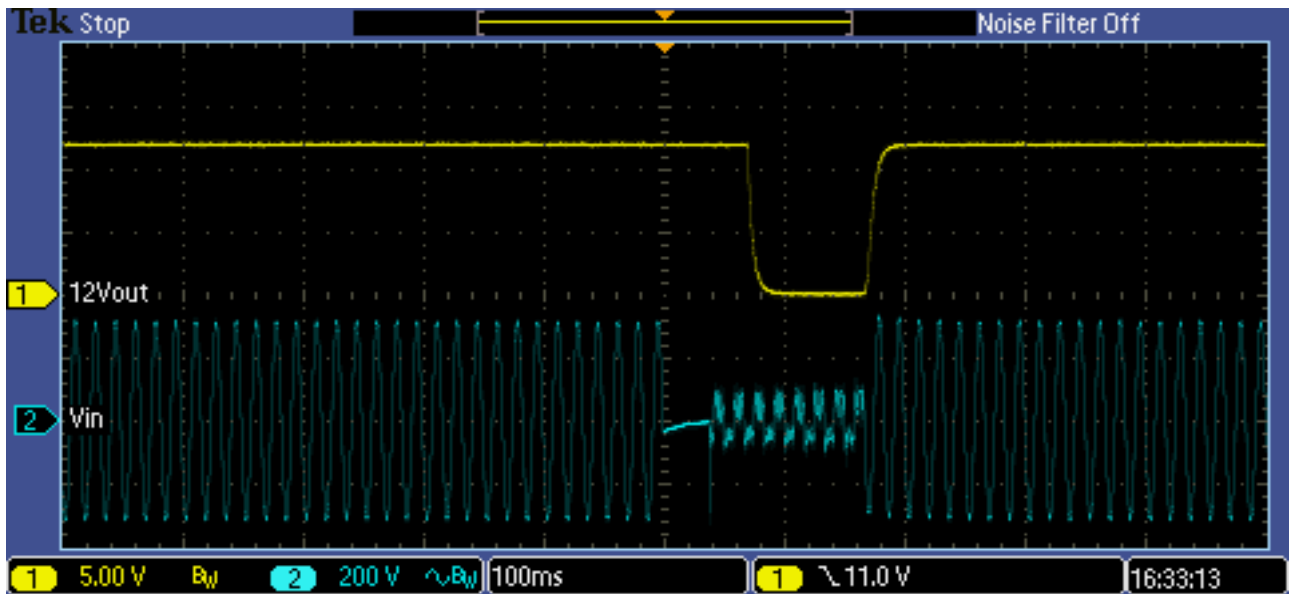
Vin: 200V/div Vout: 5V/div 200ms/div
Vin: 110VAC - 47mS Dropout (100% Load)



Vin: 200V/div Vout: 5V/div 200ms/div
Vin: 110VAC - 48mS Dropout (100% Load)

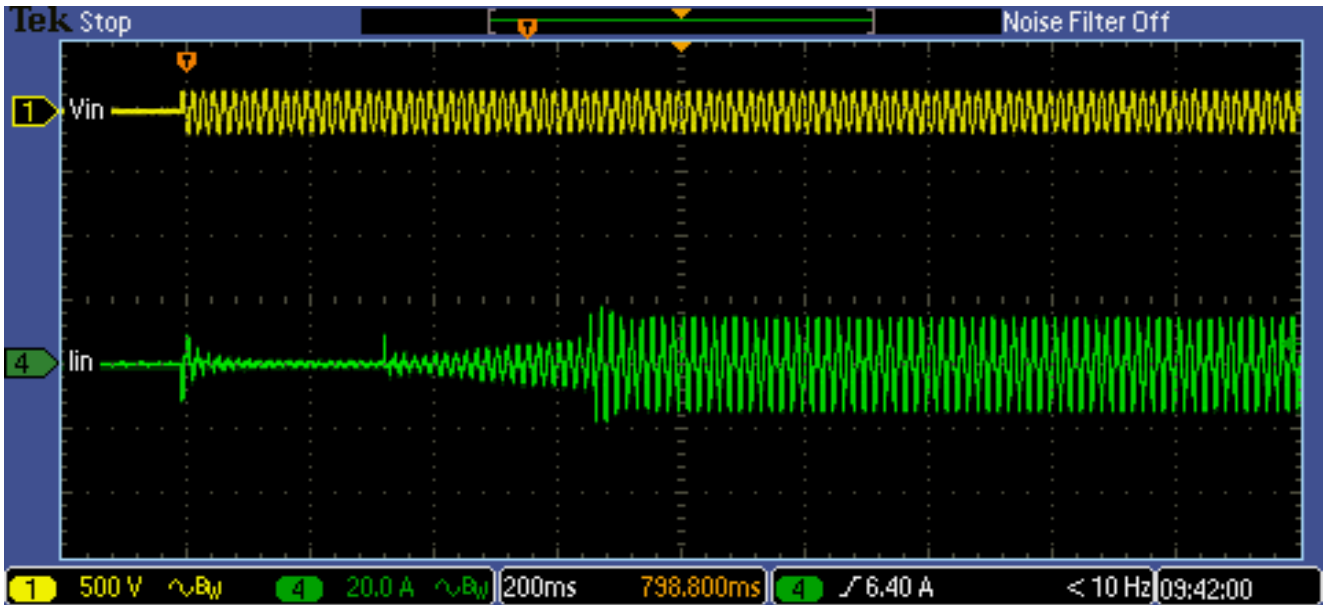


Vin: 200V/div Vout: 5V/div 100ms/div
 Vin: 220VAC - 37mS Dropout (100% Load)

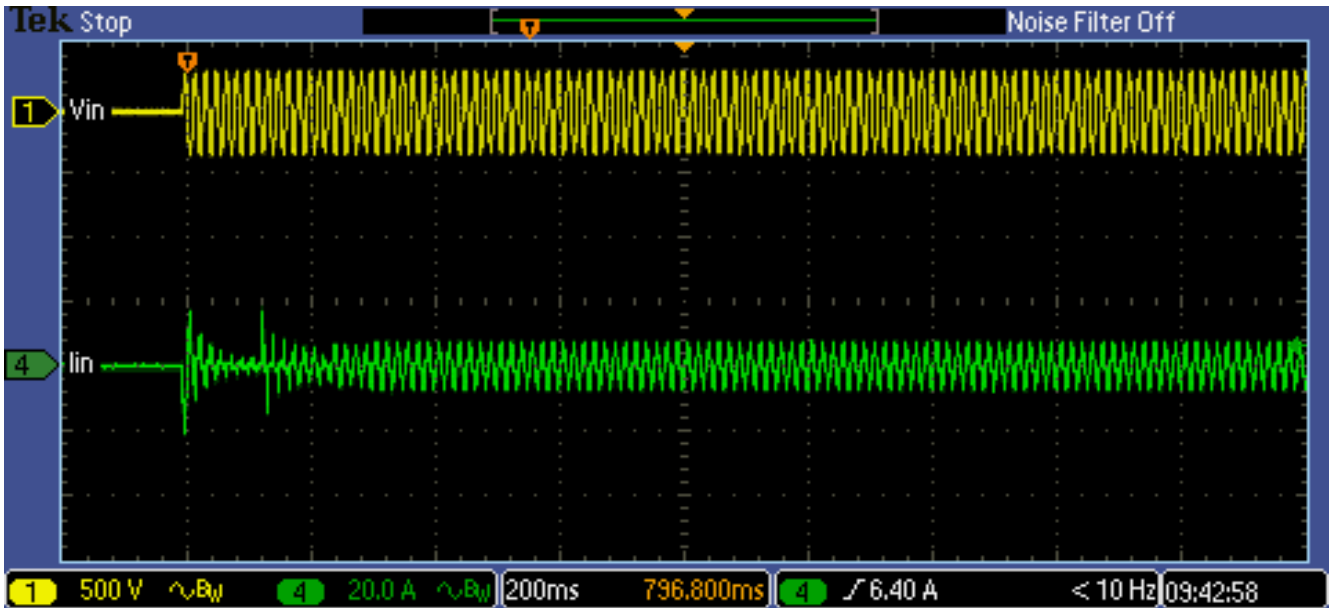


Vin: 200V/div Vout: 5V/div 100ms/div
 Vin: 220VAC - 38mS Dropout (100% Load)

2.12 Inrush current characteristics

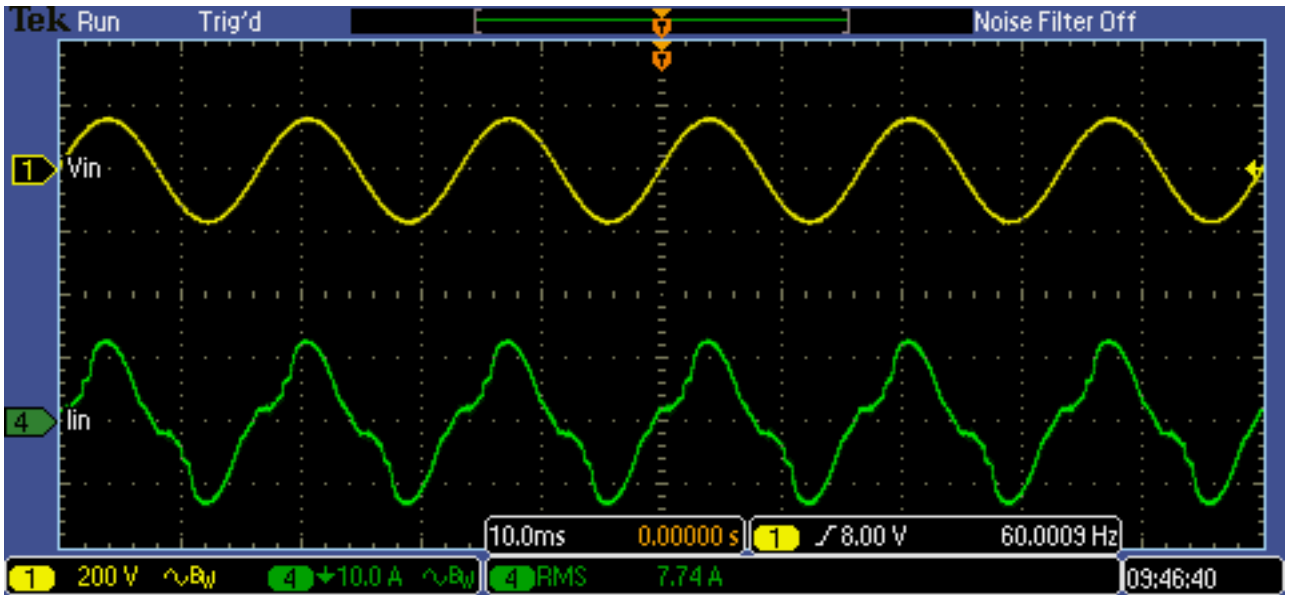


Inrush (100% Load, 110VAC input)

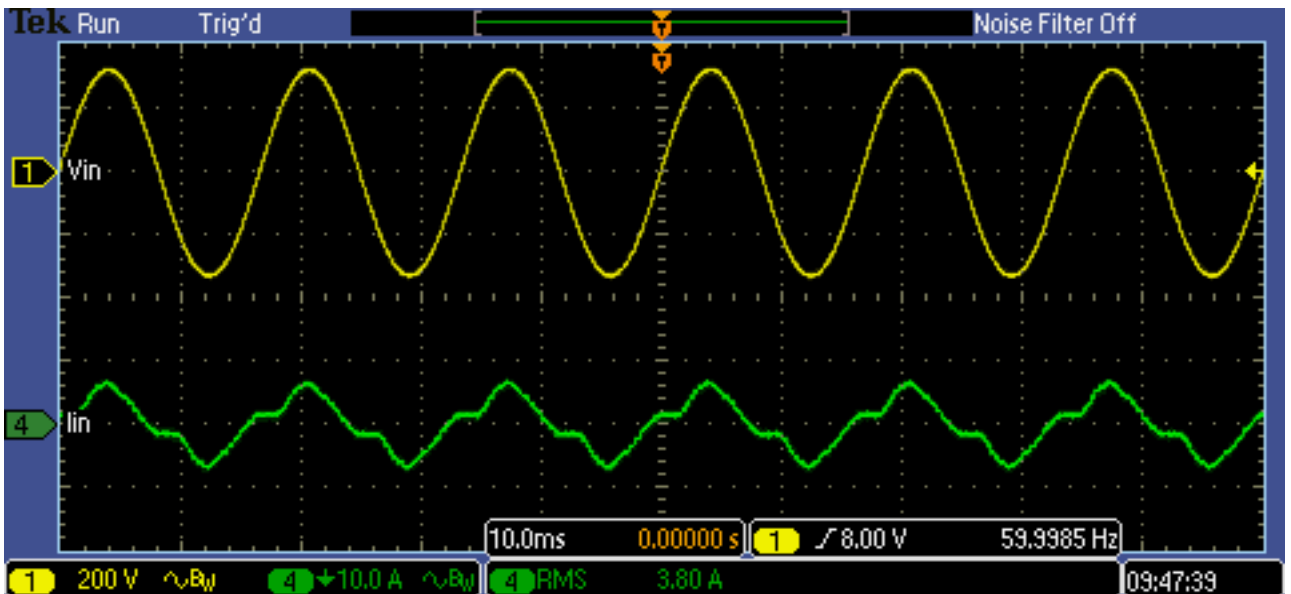


Inrush (100% Load, 220VAC input)

2.13 Input current waveforms



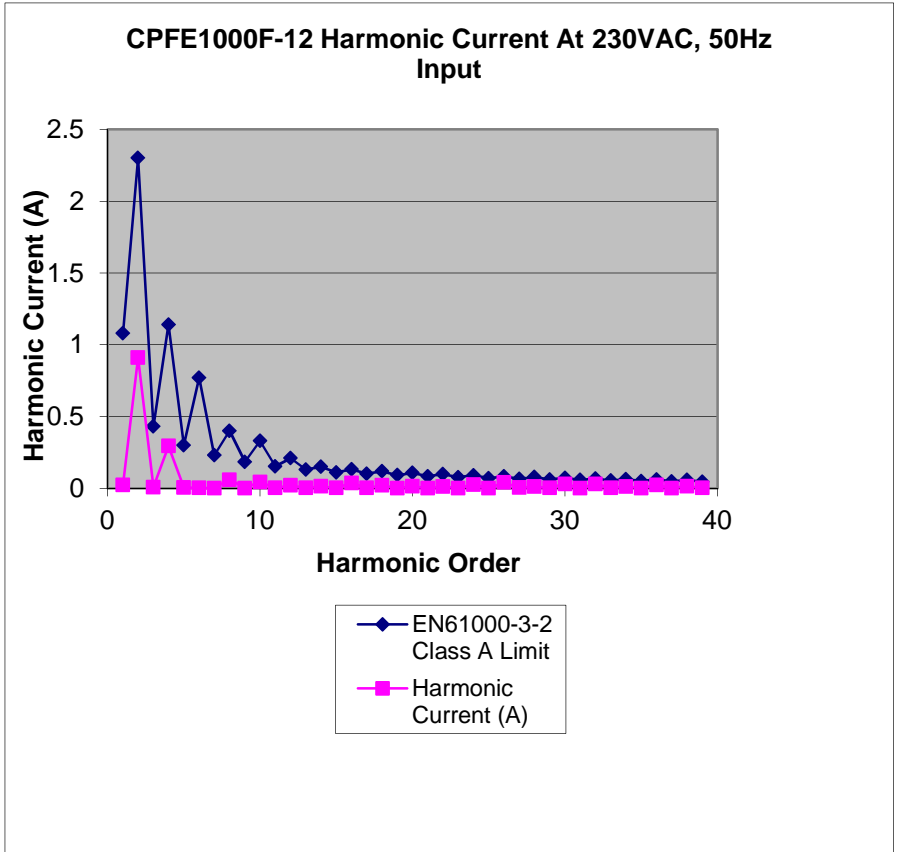
Iin: 10A/div Vin: 200V/div 10ms/div
Input Current (100% Load, 110VAC input)



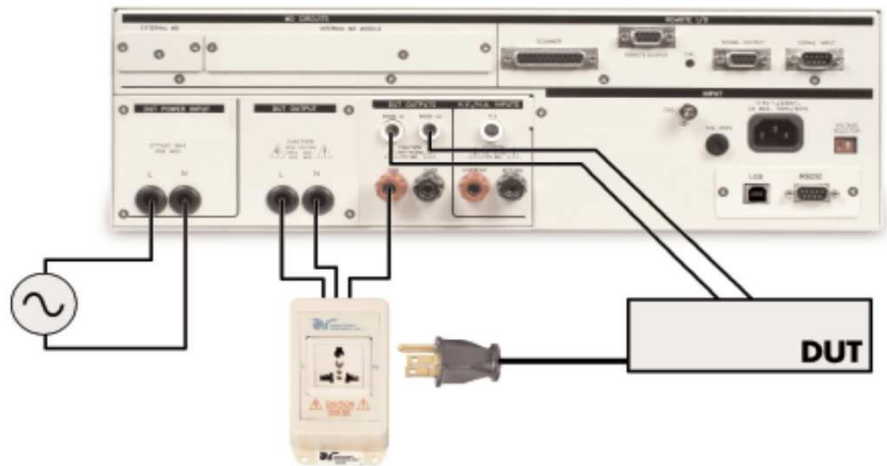
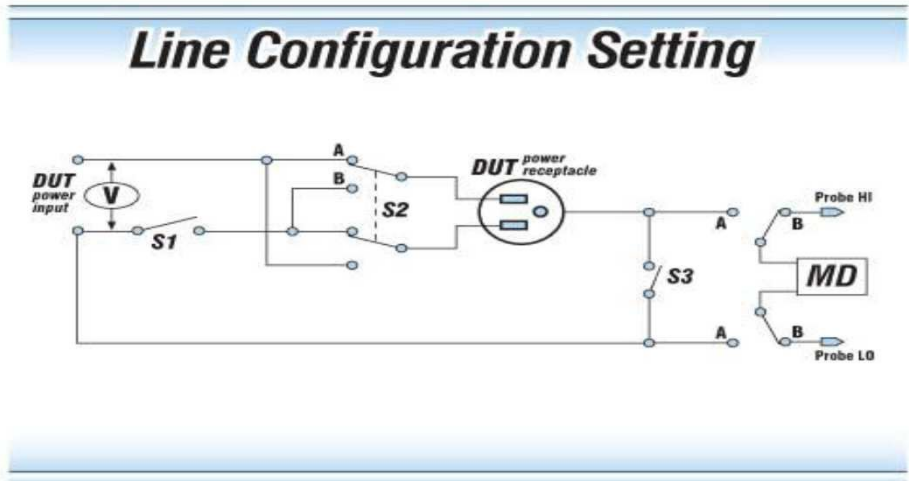
Iin: 10A/div Vin: 200V/div 10ms/div
Input Current (100% Load, 220VAC input)

2.14 Input current harmonics

| CPFE1000F-12 | | |
|--------------|-----------|--------|
| Vin | 230 VAC | |
| Freq | 50 HZ | |
| Io | 60 ADC | |
| Vo | 12VDC | |
| lin | 3.9763 | |
| Harmonics | Limit (A) | A |
| 2 | 1.08 | 0.0231 |
| 3 | 2.3 | 0.9092 |
| 4 | 0.43 | 0.0081 |
| 5 | 1.14 | 0.2944 |
| 6 | 0.3 | 0.0055 |
| 7 | 0.77 | 0.0027 |
| 8 | 0.23 | 0.0011 |
| 9 | 0.4 | 0.0597 |
| 10 | 0.184 | 0.0019 |
| 11 | 0.33 | 0.0438 |
| 12 | 0.153 | 0.0022 |
| 13 | 0.21 | 0.0201 |
| 14 | 0.131 | 0.0024 |
| 15 | 0.15 | 0.014 |
| 16 | 0.11 | 0.0023 |
| 17 | 0.132 | 0.0372 |
| 18 | 0.102 | 0.0024 |
| 19 | 0.118 | 0.0204 |
| 20 | 0.092 | 0.0018 |
| 21 | 0.107 | 0.0133 |
| 22 | 0.084 | 0.0019 |
| 23 | 0.098 | 0.0111 |
| 24 | 0.077 | 0.0015 |
| 25 | 0.09 | 0.0263 |
| 26 | 0.071 | 0.0012 |
| 27 | 0.083 | 0.0403 |
| 28 | 0.066 | 0.0043 |
| 29 | 0.078 | 0.0117 |
| 30 | 0.061 | 0.004 |
| 31 | 0.073 | 0.0298 |
| 32 | 0.058 | 0.002 |
| 33 | 0.068 | 0.0297 |
| 34 | 0.054 | 0.0038 |
| 35 | 0.064 | 0.0119 |
| 36 | 0.051 | 0.0017 |
| 37 | 0.061 | 0.0228 |
| 38 | 0.048 | 0.0015 |
| 39 | 0.058 | 0.0144 |
| 40 | 0.046 | 0.003 |

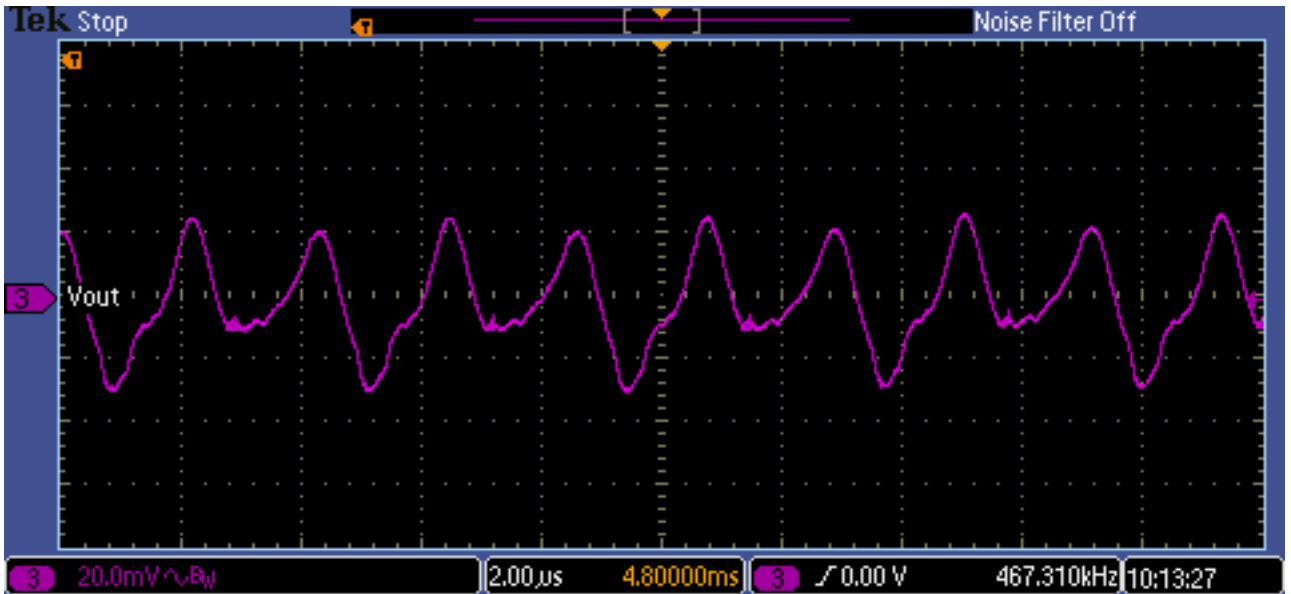


2.15 Leakage current characteristics



| PS Vout | Time (s) | Freq (Hz) | Nom.1 110VAC | Nom.2 220VAC | Non.2HI 265VAC | Configuration | | |
|---------|----------|-----------|-----------------|-----------------|-------------------|---------------|---------|------|
| | | | | | | Neutral | S2 | S3 |
| 12 | 10 | 60 | <1.5mA | <1.5mA | <1.5mA | Closed | Normal | Open |
| | 10 | 60 | 0.2580 | 0.5460 | 0.6670 | Closed | Reverse | Open |

2.16 Output ripple and noise waveforms



Vout: 20mV/div
2us/div
Output Ripple (100% Load, 110VAC input)



Vout: 20mV/div
2us/div
Output Ripple (100% Load, 220VAC input)