# TPS3000-24

# Evaluation Data

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# TEST EQUIPMENT USED

| | | |
|---|---|---|
| • 20 Channel Multiplexer | Agilent 34901A | Asset# 3594 |
| • 20 Channel Actuator | Agilent 34903A | Asset# 3593 |
| • Data Acquisition Unit | Agilent 34970A | Asset# 3586 |
| • AC Source | California Instruments 6000L-3PT-EHV Master | Asset# 3803 |
| • AC Source | California Instruments 6000L-3PT-EHV Slave | Asset# 3626 |
| • Isolation Probe | CalTest / Probe Master CT3687 / 4234 | Asset# 3611 |
| • DC Load | Chroma 125201 | Asset# 3466 |
| • DC Load | Chroma 125201 | Asset# 3465 |
| • Power Analyzer | Chroma 66203 | Asset# 3592 |
| • 4x8 Matrix Switch | Keysight 34904A | Asset# 3595 |
| • Current Monitor | Pearson 110 | Asset# 3623 |
| • Oscilloscope | Tektronix DPO2014B | Asset# 3591 |
| • Oscilloscope | Tektronix DPO2024B | Asset# 3560 |

## TERMINOLOGY USED

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

## Load/Line Regulation

Vout = 24Vdc, 100% load = 125A, Ta = 25°C
Vout measured across output bus bars. Remote sense connected to bus bars.

| Iout\Vin | 350VAC | 400VAC | 480VAC | 528VAC | Line Regulation | |
|---|---|---|---|---|---|---|
| 0% Load | 24.021 | 24.020 | 24.021 | 24.020 | 0.001 | 0.004% |
| 50% Load | 24.016 | 24.015 | 24.014 | 24.014 | 0.002 | 0.008% |
| 100% Load | 24.010 | 24.010 | 24.008 | 24.009 | 0.002 | 0.008% |
| Load Regulation | 0.011 | 0.01 | 0.013 | 0.011 | | |
| | 0.045% | 0.042% | 0.054% | 0.045% | | |

## Temperature Drift

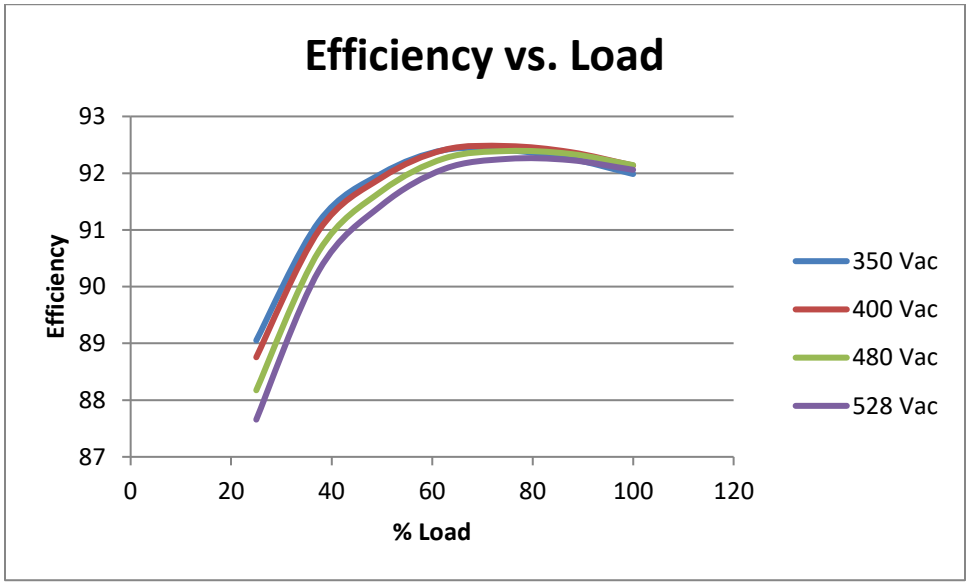
Vout =24Vdc, 100% load = 125A

| Vin | Iout | Vout @ -10°C | Vout @ 25°C | Vout @ 50°C | Vout Delta | Overall Temperature Coefficient (ppm) |
|---|---|---|---|---|---|---|
| 400 | 0% | 23.983 | 24.015 | 24.015 | 0.032 | 22.22222 |
| 400 | 100% | 23.982 | 24.013 | 24.013 | 0.031 | 21.52778 |
| 480 | 0% | 23.989 | 24.014 | 24.014 | 0.025 | 17.36111 |
| 480 | 100% | 23.986 | 24.014 | 24.014 | 0.028 | 19.44444 |

## Efficiency vs Output Current

Vout = 24Vdc, 100% Load = 125A, Ta = 25°C

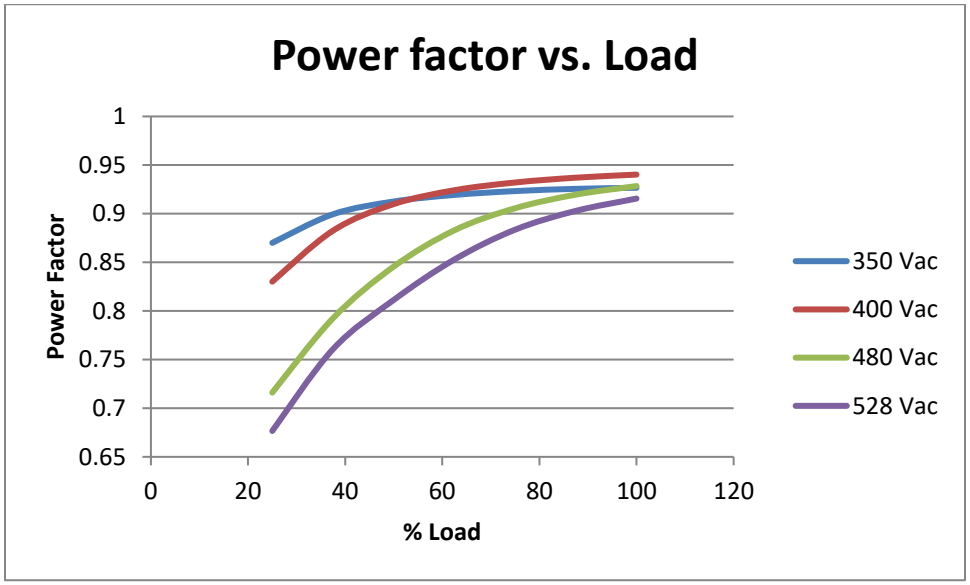
| Iout(%)/Vin | 350 Vac | 400 Vac | 480 Vac | 528 Vac |
|---|---|---|---|---|
| 25 | 89 | 89 | 88 | 88 |
| 50 | 92 | 92 | 92 | 91 |
| 75 | 92 | 92 | 92 | 92 |
| 100 | 92 | 92 | 92 | 92 |



## Power Factor vs Output Current

Vout = 24Vdc, 100% Load = 125A, Ta = 25°C

| Iout(%)/Vin | 350 Vac | 400 Vac | 480 Vac | 528 Vac |
|---|---|---|---|---|
| 25 | 0.870 | 0.830 | 0.716 | 0.677 |
| 50 | 0.913 | 0.910 | 0.846 | 0.811 |
| 75 | 0.923 | 0.932 | 0.906 | 0.884 |
| 100 | 0.927 | 0.940 | 0.928 | 0.916 |



## Inrush Characteristics

Inrush Current <15A peak per phase @ 400-480VAC input (excluding initial spike charging capacitors lasting < 2ms)

Vout =24Vdc, Ta=25°C, %100 Load = 125A

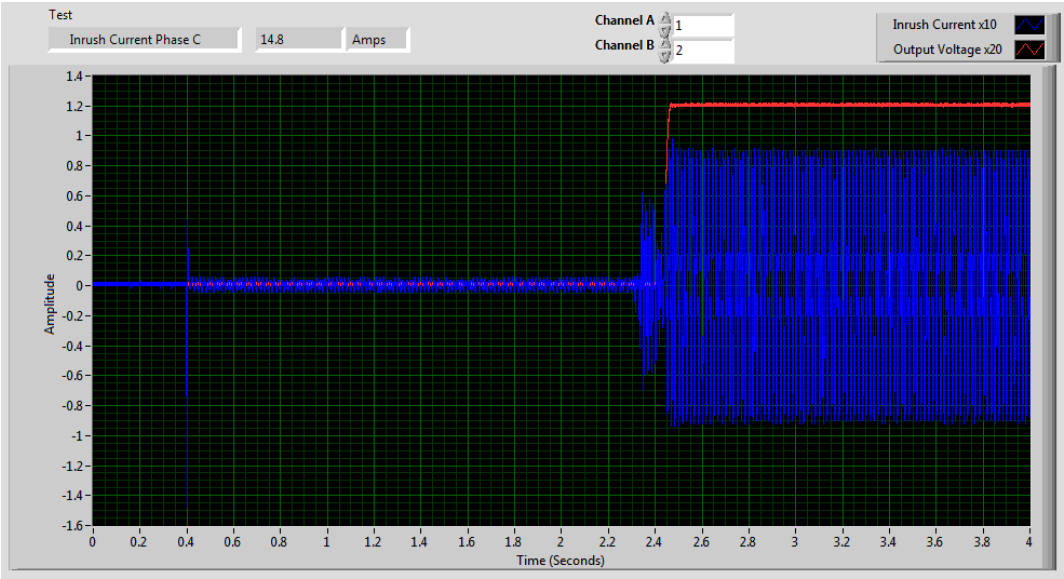



Figure 1: Inrush @ 400VAC, 100% Load

CH1 (Blue) – Inrush Current, 2A/DIV CH2 (Red) – Vout, 4V/DIV

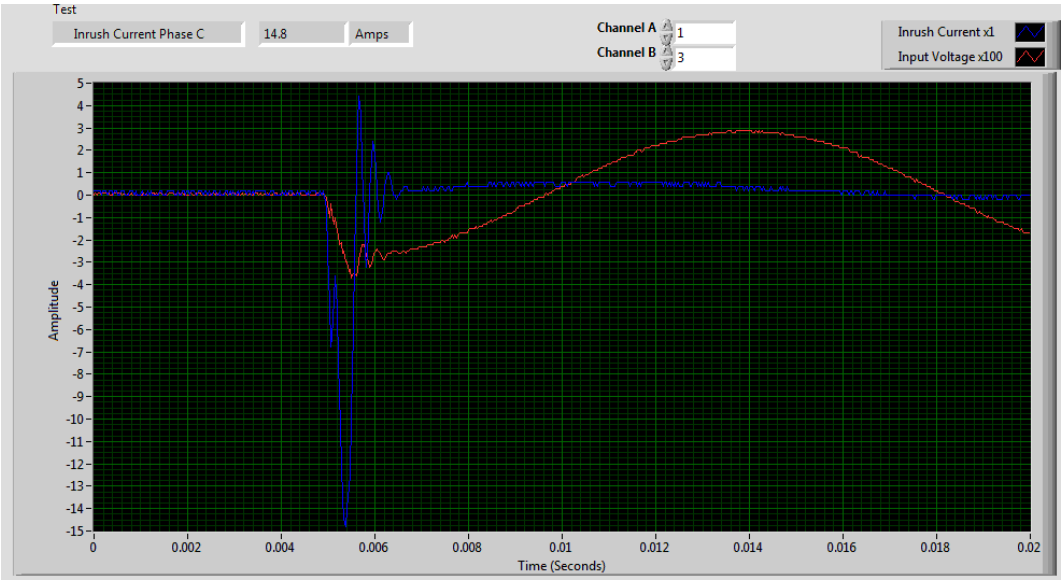



Figure 2: Inrush @ 400VAC, 100% Load. Initial spike charging capacitors

CH1 (Blue) – Inrush Current, 1A/DIV CH2 (Red) – Vin, 100V/DIV

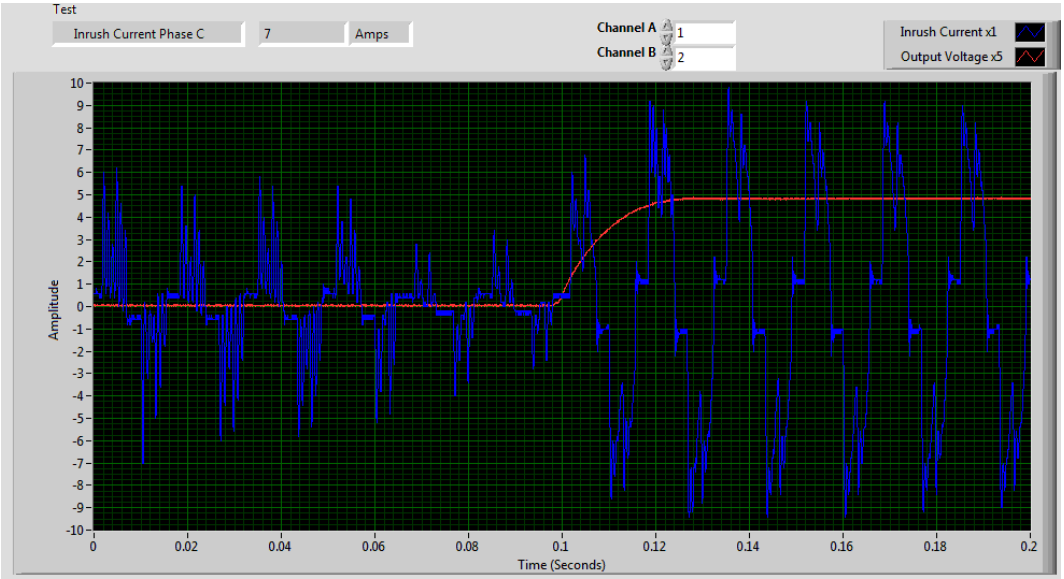



Figure 3: Inrush @ 400VAC, 100% Load.

CH1 (Blue) – Inrush Current, 1A/DIV CH2 (Red) – Vout, 5V/DIV

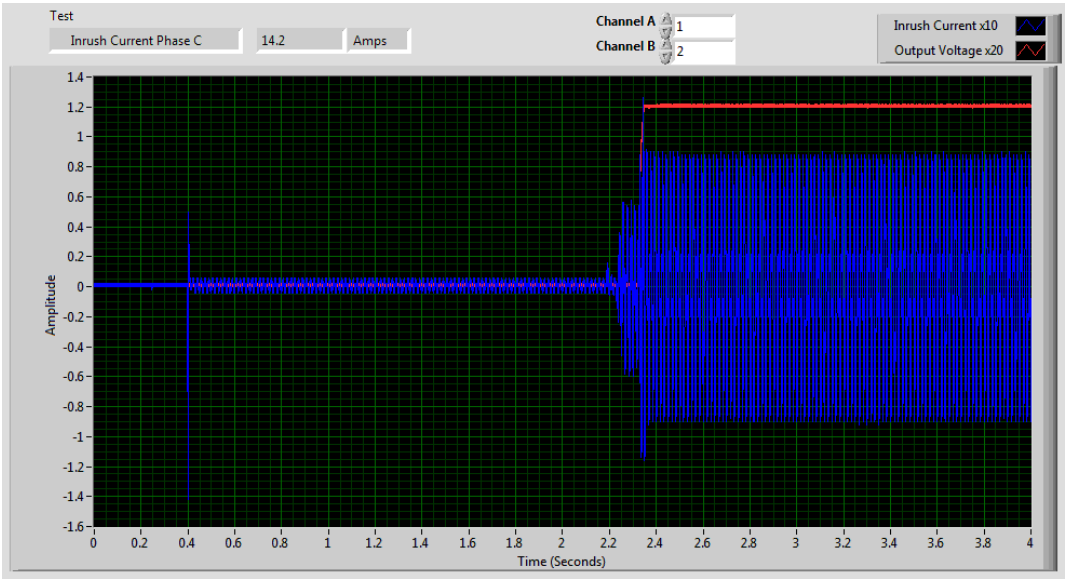



Figure 4: Inrush @ 480VAC, 100% Load

CH1 (Blue) – Inrush Current, 2A/DIV CH2 (Red) – Vout, 4V/DIV

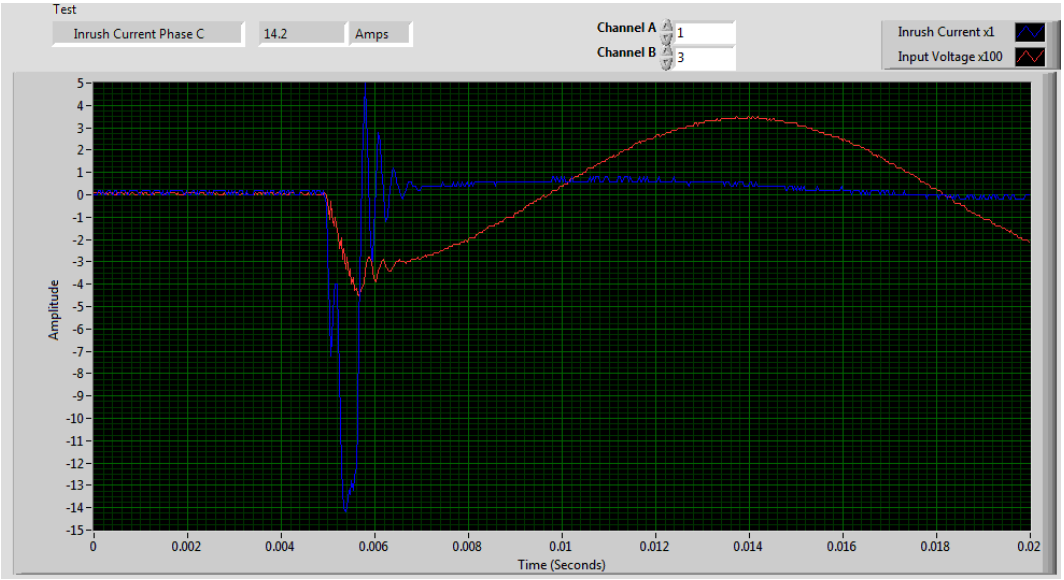



Figure 5: Inrush @ 480VAC, 100% Load. Initial spike charging capacitors

CH1 (Blue) – Inrush Current, 1A/DIV CH2 (Red) – Vin, 100V/DIV

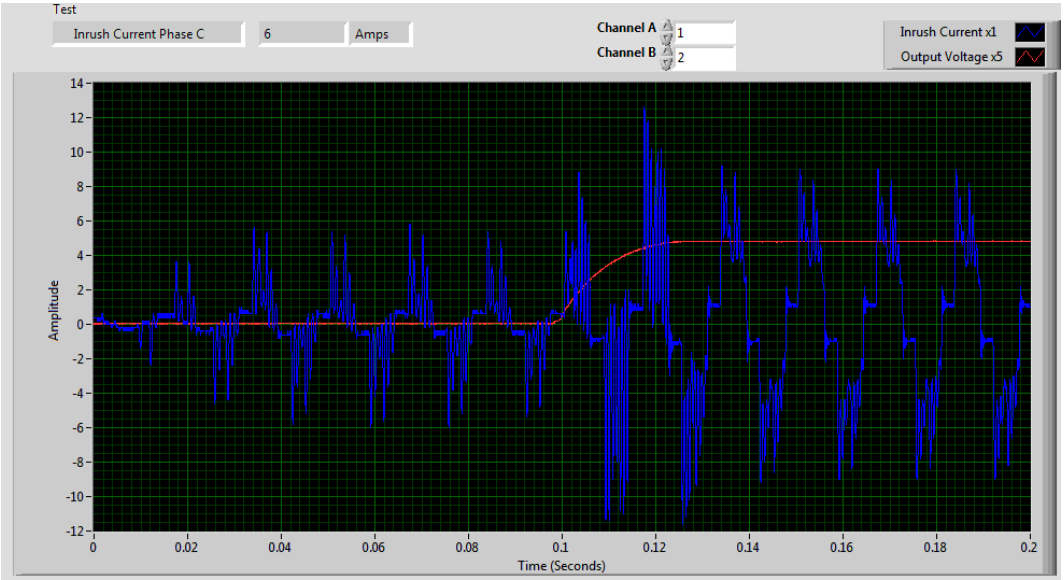



Figure 6: Inrush @ 480VAC, 100% Load.

CH1 (Blue) – Inrush Current, 2A/DIV CH2 (Red) – Vout, 10V/DIV

## Output Rise Characteristics

Vout = 24Vdc, Ta = 25°C, Iout = 125A

***AC ON Control*** - Output Rise time from application of input voltage

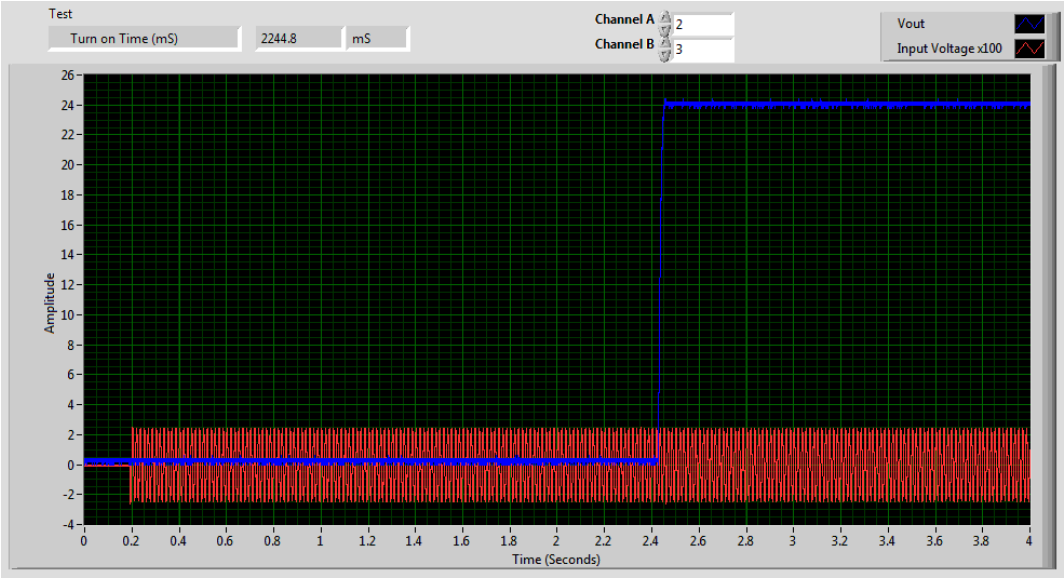



**Figure 7: Turn ON Time from Vin = 346VAC**

CH1 (Blue) – Vout, 2V/DIV CH2 (Red) – Vin, 200V/DIV

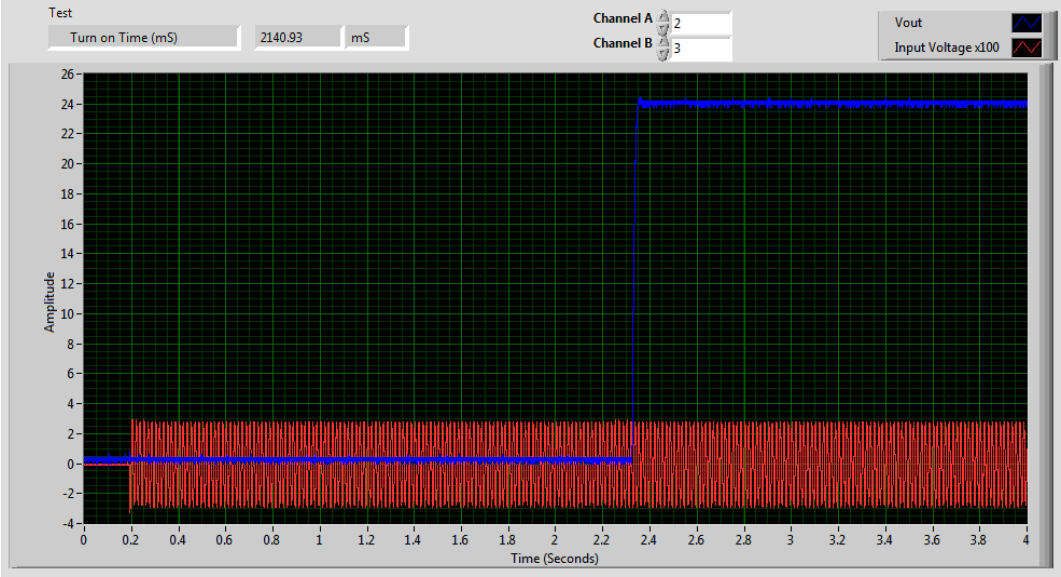



**Figure 8: Turn ON Time from Vin = 400VAC**

CH1 (Blue) – Vout, 2V/DIV CH2 (Red) – Vin, 200V/DIV

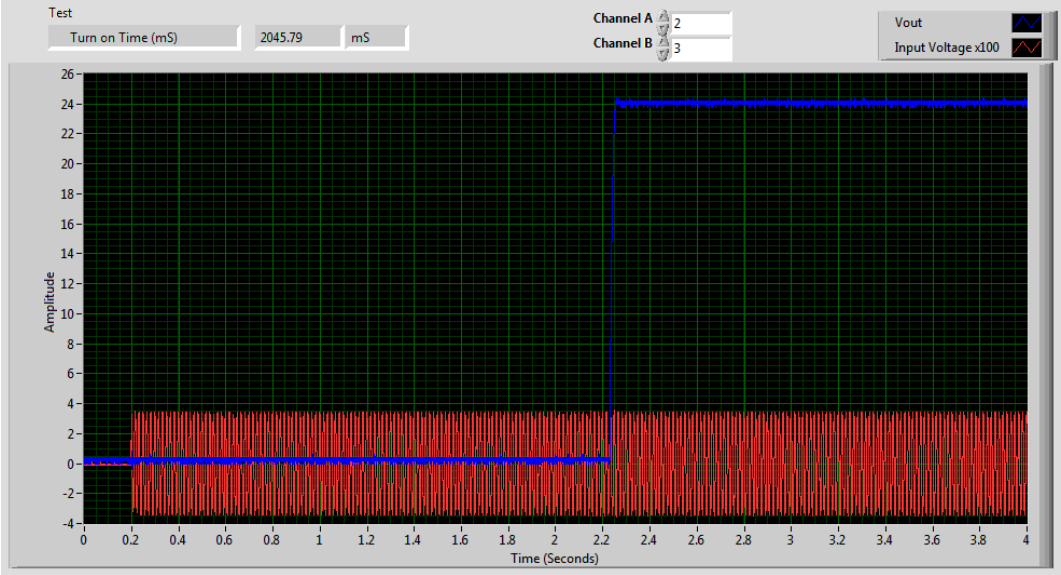



**Figure 9: Turn ON Time from Vin = 480VAC**

CH1 (Blue) – Vout, 2V/DIV CH2 (Red) – Vin, 200V/DIV

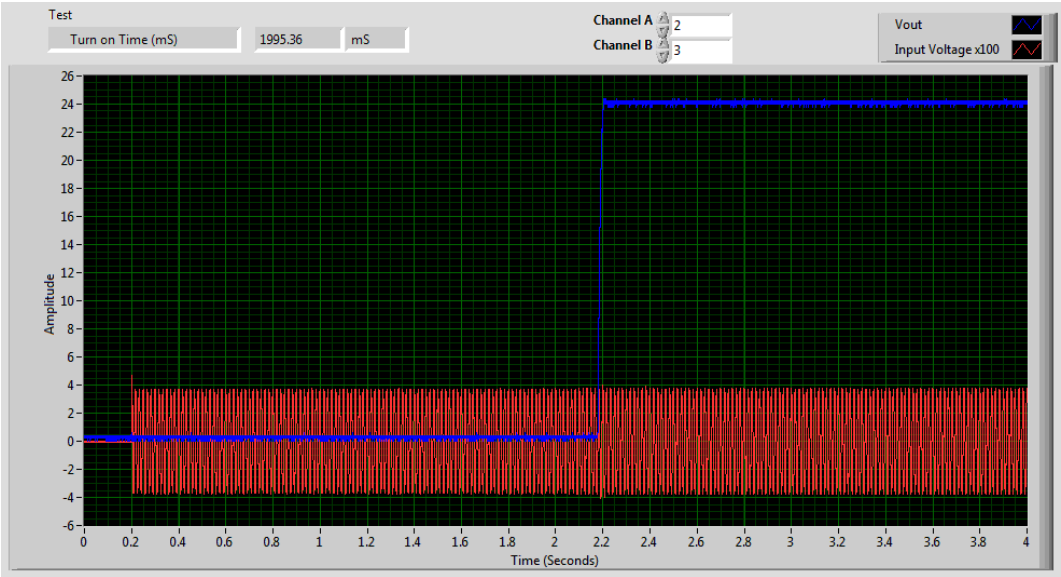



**Figure 10: Turn ON Time from Vin = 528VAC**

CH1 (Blue) – Vout, 2V/DIV CH2 (Red) – Vin, 200V/DIV

***Remote On/Off Control*** – TTL voltage level compatible signal connected between pins 14 and 18 of the Signal Connector. With the Output Enable switch in the ON position, a Logic High or Open will enable the output. A Logic Low or Short will disable the output.

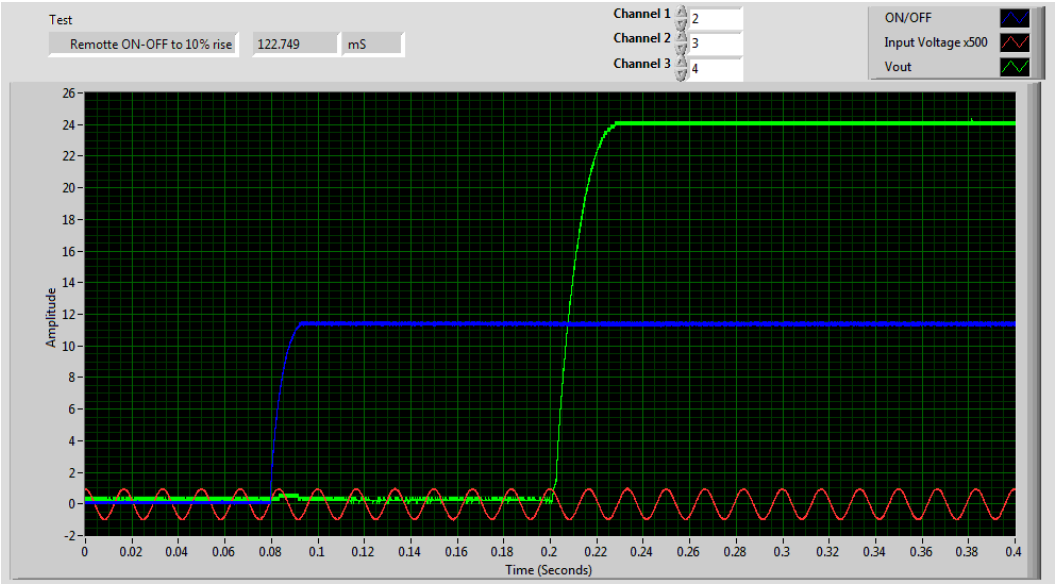



**Figure 11: Rise Time from Remote On-Off 346VAC 100% load**

CH1 (Blue) – Enable Signal, 2V/DIV CH2 (Red) – Vin, 1000V/DIV CH3 (Green) – Vout, 2V/DIV

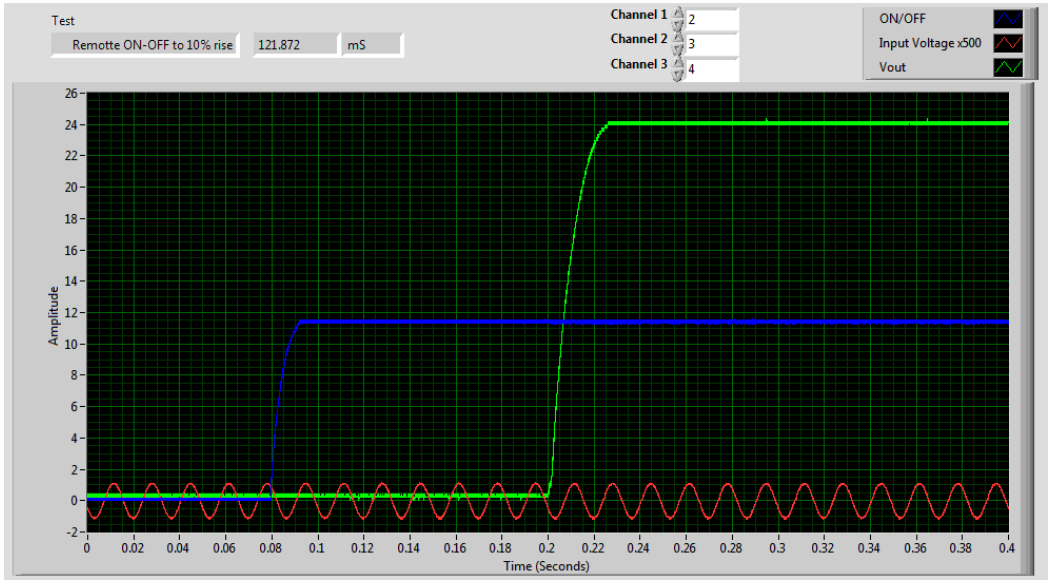



**Figure 12: Rise Time from Remote On-Off 400VAC 100% load**

CH1 (Blue) – Enable Signal, 2V/DIV CH2 (Red) – Vin, 1000V/DIV CH3 (Green) – Vout, 2V/DIV

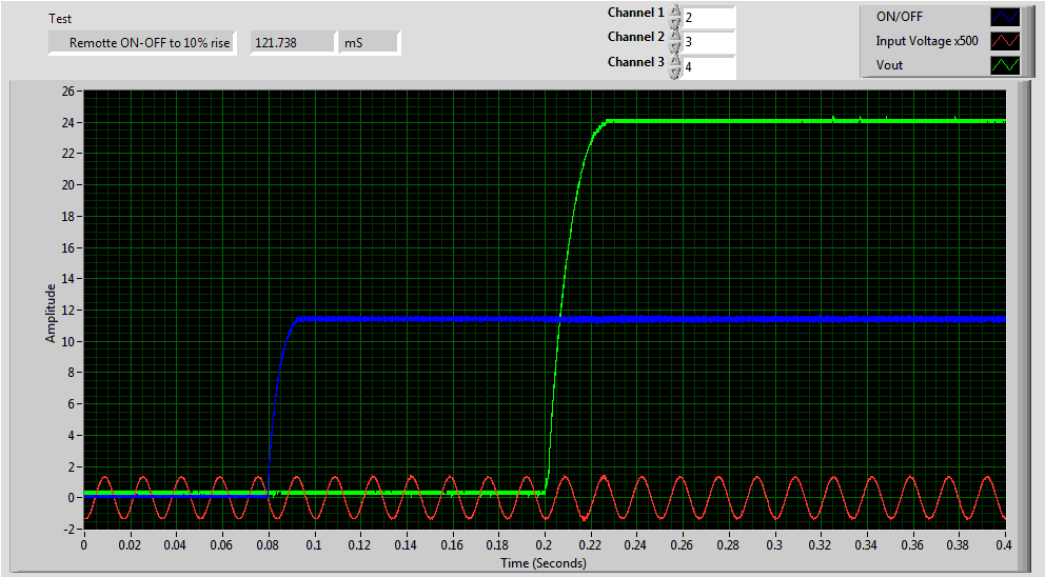



**Figure 13: Rise Time from Remote On-Off 480VAC 100% load**

CH1 (Blue) – Enable Signal, 2V/DIV CH2 (Red) – Vin, 1000V/DIV CH3 (Green) – Vout, 2V/DIV

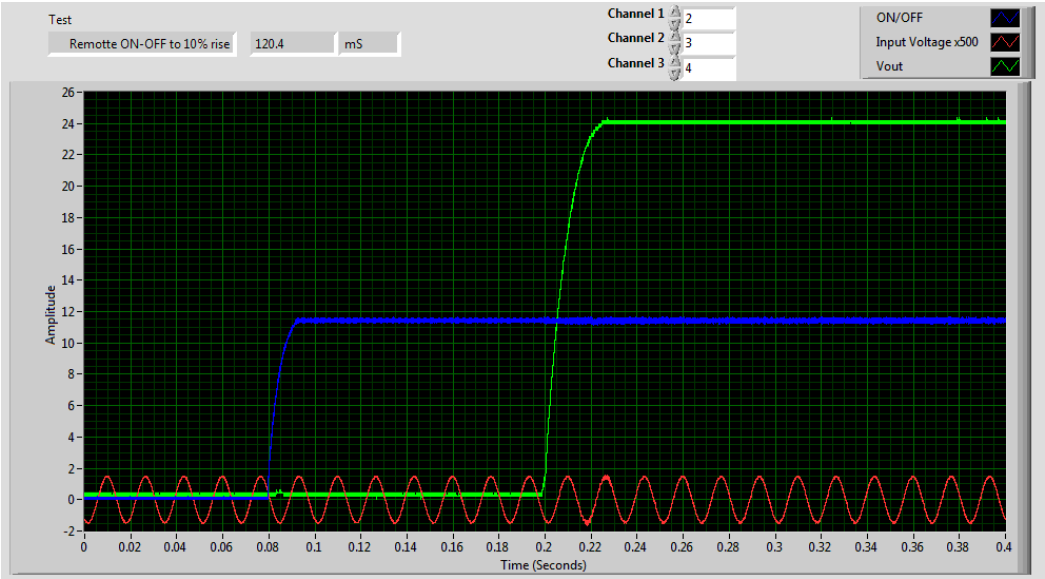



**Figure 14: Rise Time from Remote On-Off 528VAC 100% load**

CH1 (Blue) – Enable Signal, 2V/DIV CH2 (Red) – Vin, 1000V/DIV CH3 (Green) – Vout, 2V/DIV

***Rise Time & Overshoot***

Vout = 24Vdc, 100% Load = 125A, Ta = 25°C

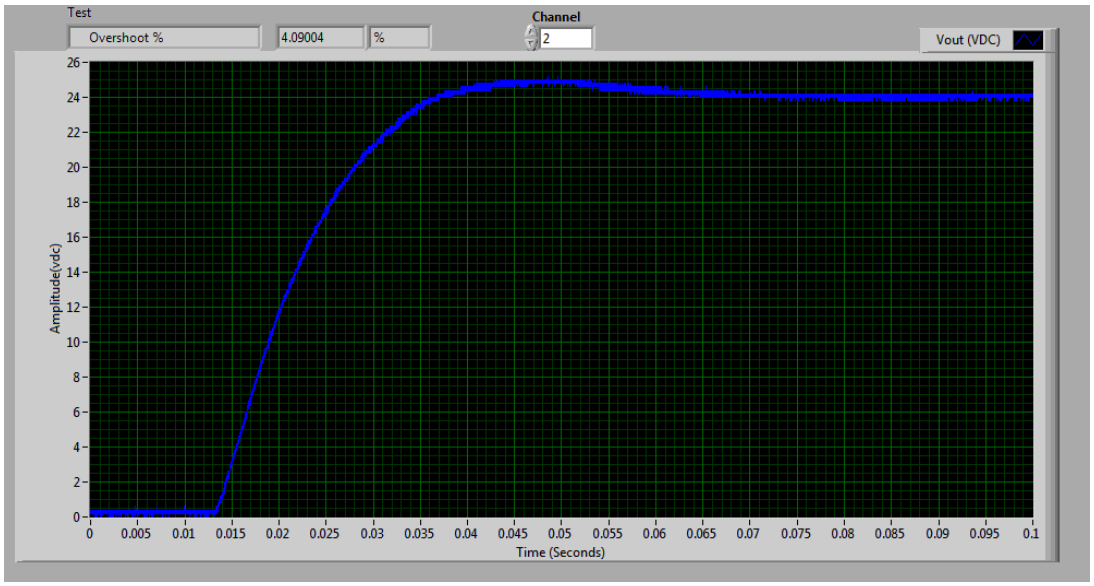



Figure 15: Rise Characteristics at Turn On 400VAC 0% load

CH1 (Blue) – Vout, 2V/DIV

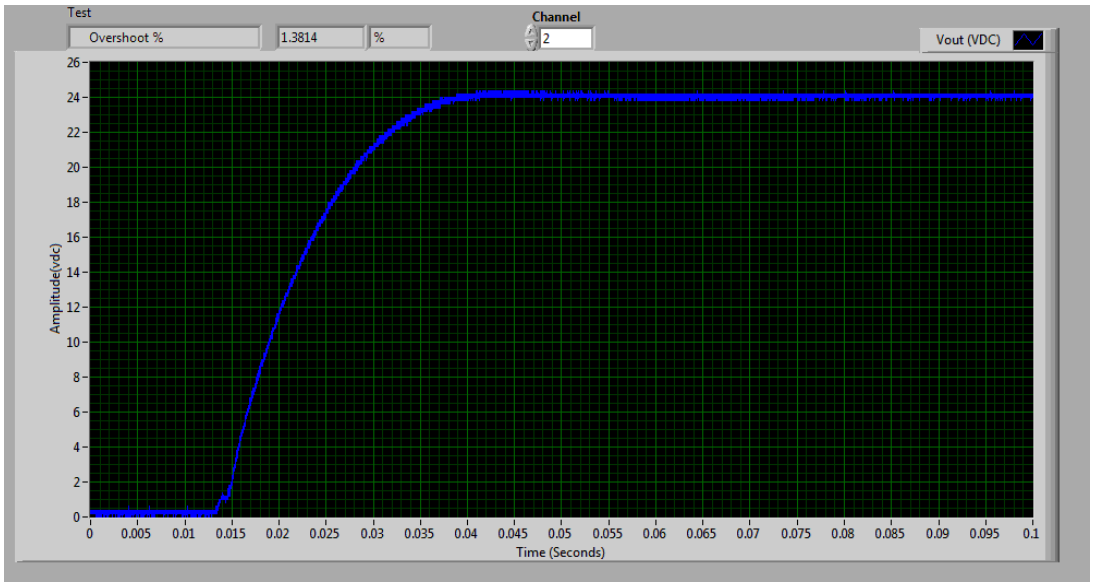



Figure 16: Rise Characteristics at Turn On 400VAC 100% load

CH1 (Blue) – Vout, 2V/DIV

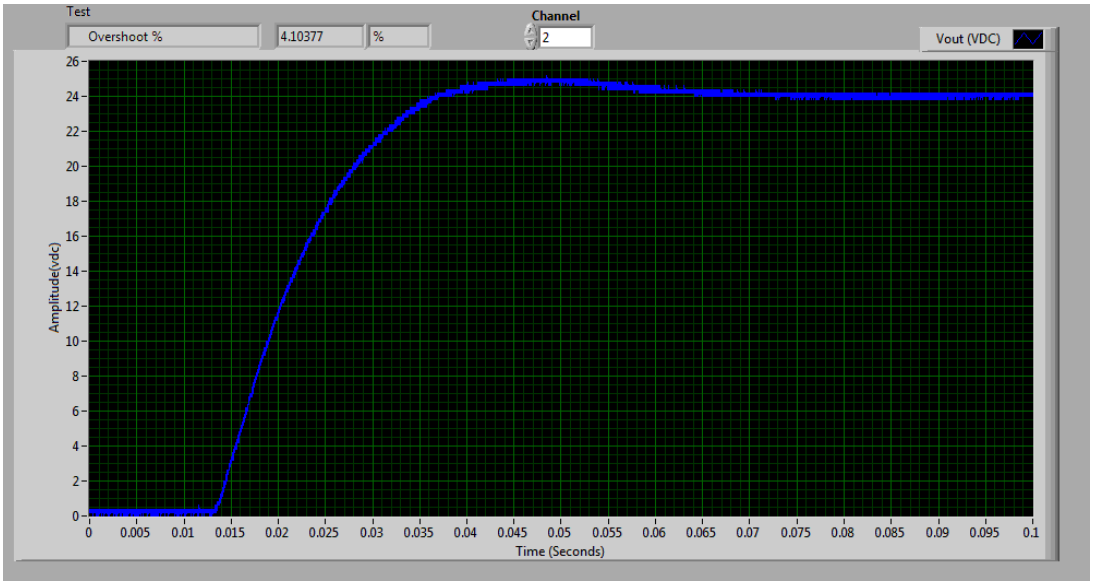



Figure 17: Rise Characteristics at Turn On 480VAC 0% load

CH1 (Blue) – Vout, 2V/DIV

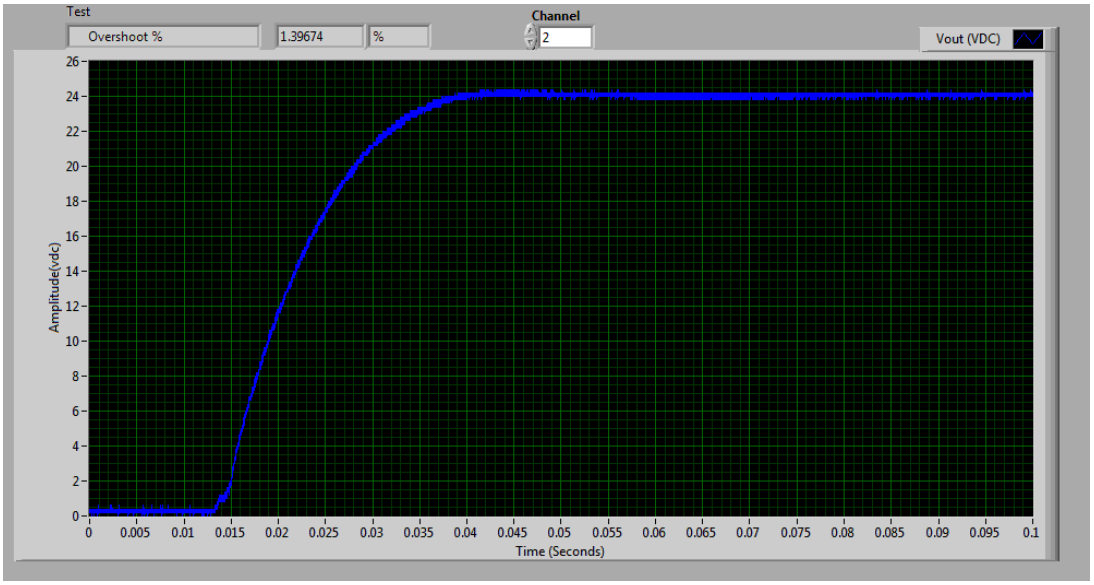



Figure 18: Rise Characteristics at Turn On 480VAC 100% load

CH1 (Blue) – Vout, 2V/DIV

## Hold-Up Time Characteristics

Vout =24Vdc, Ta=25°C, 80% Load = 100A

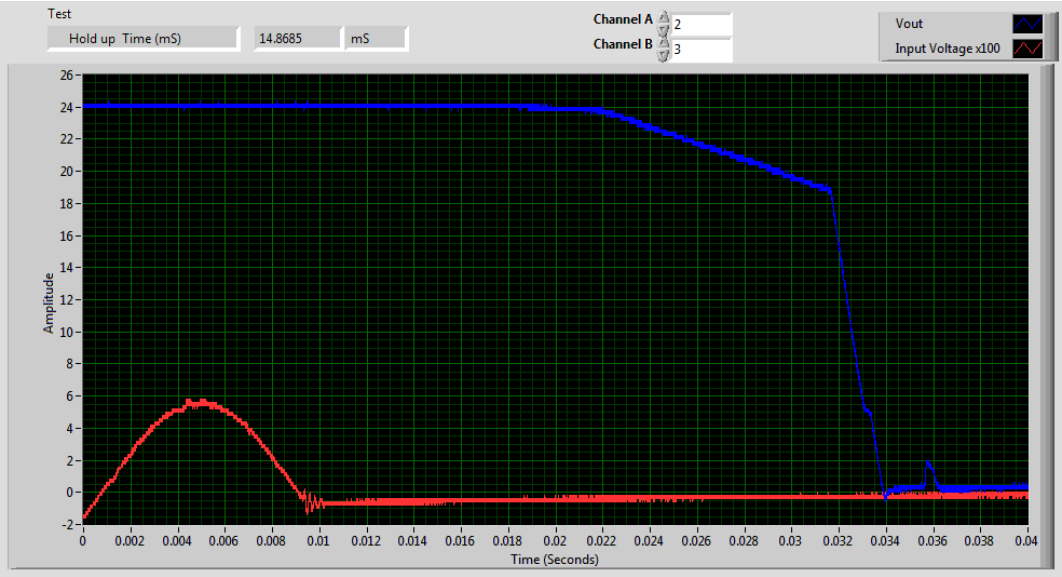



**Figure 19: HOLD-UP TIME 400VAC 80% Load**

CH1 (Blue) – Vout, 5V/DIV CH2 (Red) – Vin, 100V/DIV

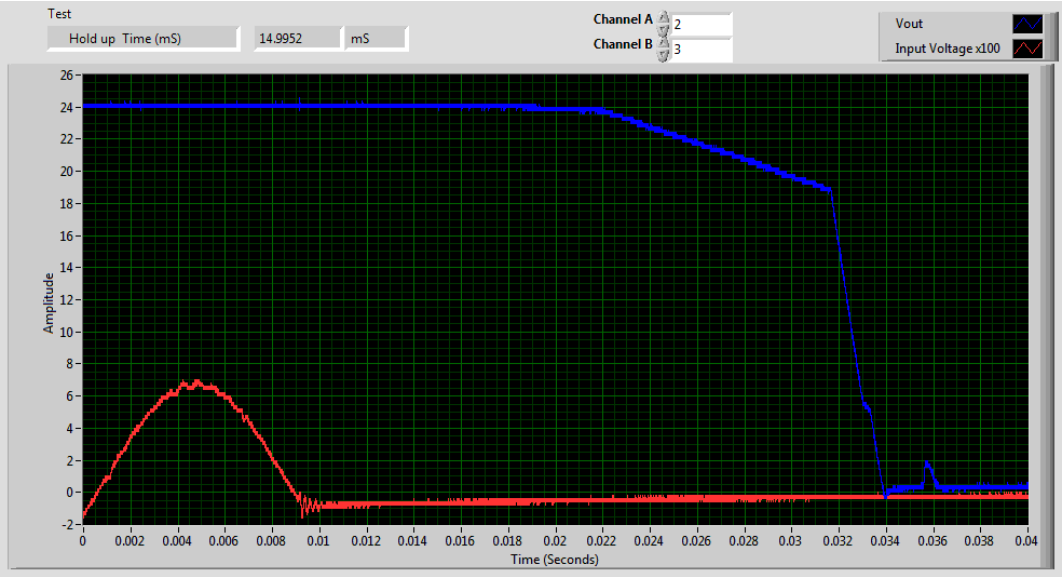



**Figure 20: HOLD-UP TIME 480VAC 80% Load**

CH1 (Blue) – Vout, 5V/DIV CH2 (Red) – Vin, 100V/DIV

## Ripple Characteristics

Ripple and Noise: 240mV pk-pk max, 100MHz bandwidth. Jeita RC-9131C Procedure.
Vout =24Vdc, Ta=25°C, 100% Load = 125A

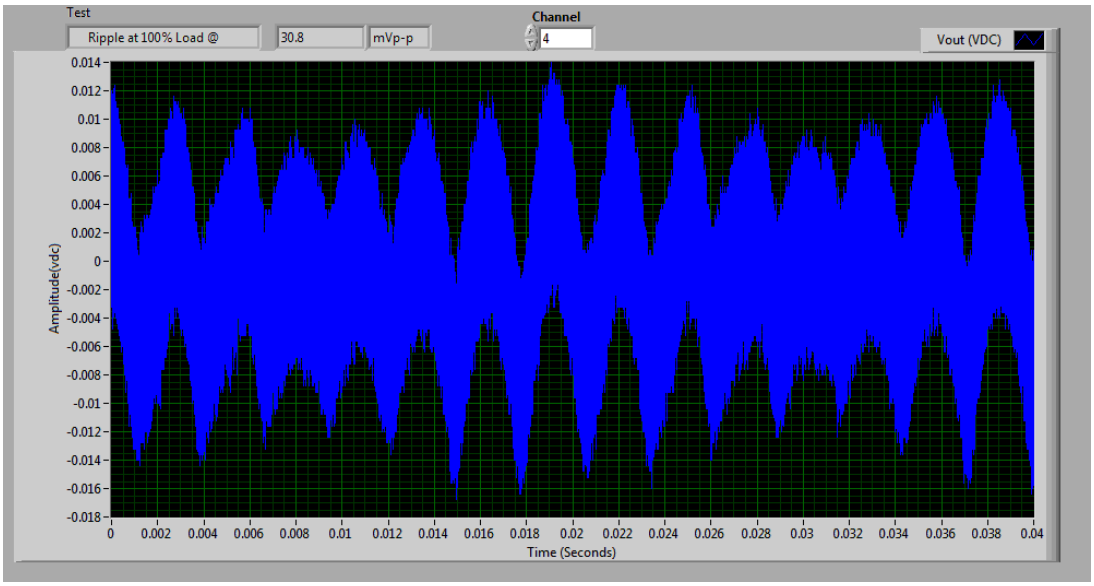



Figure 21: Ripple at 100% Load @ 346VAC. Timebase = 2mS/Div

CH1 (Blue) – Vout Ripple, 2mV/DIV

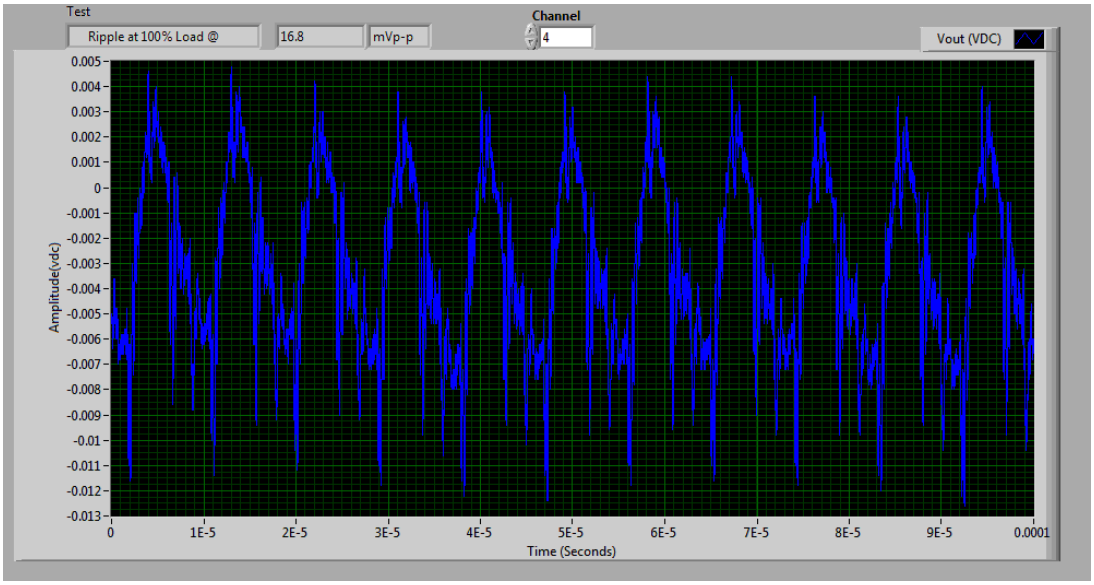



Figure 22: Ripple at 100% Load @ 346VAC. Timebase = 10uS/Div

CH1 (Blue) – Vout Ripple, 1mV/DIV

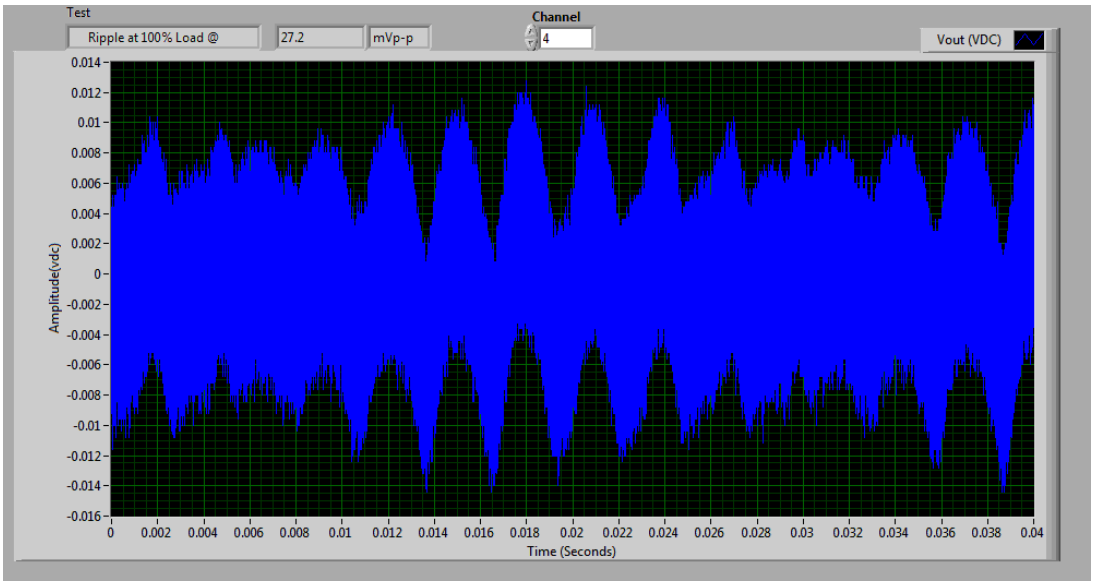



**Figure 23: Ripple at 100% Load @ 400VAC. Timebase = 2mS/Div**

CH1 (Blue) – Vout Ripple, 2mV/DIV

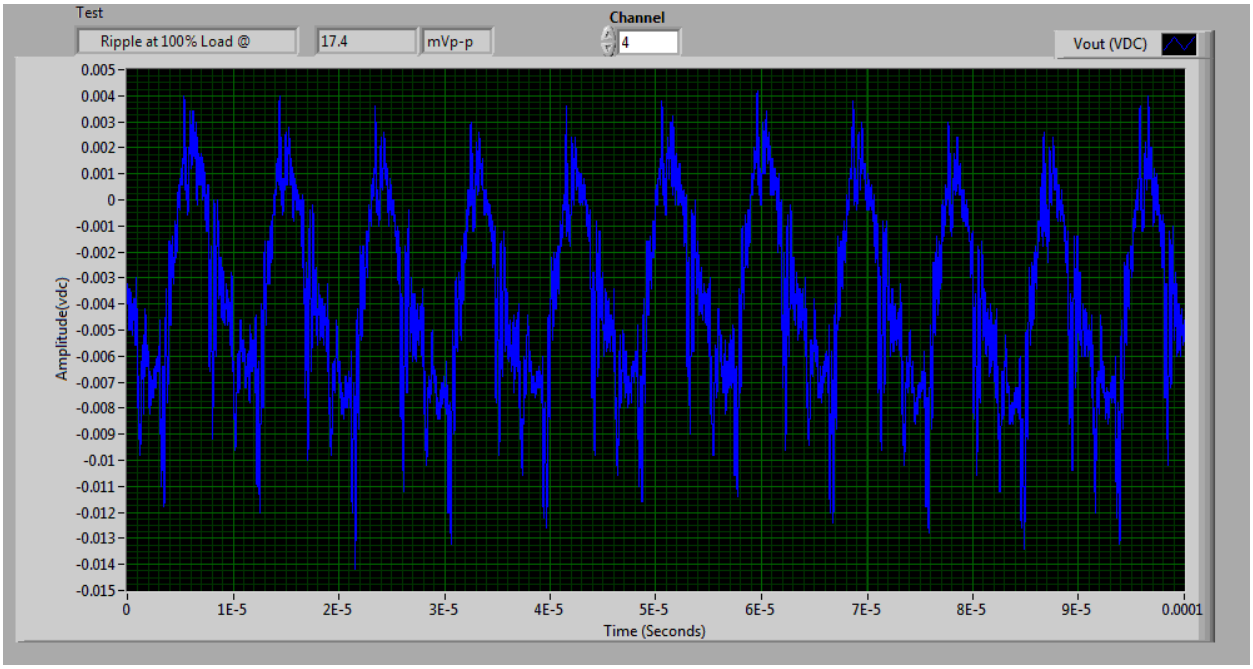



**Figure 24: Ripple at 100% Load @ 400VAC. Timebase = 10uS/Div**

CH1 (Blue) – Vout Ripple, 1mV/DIV

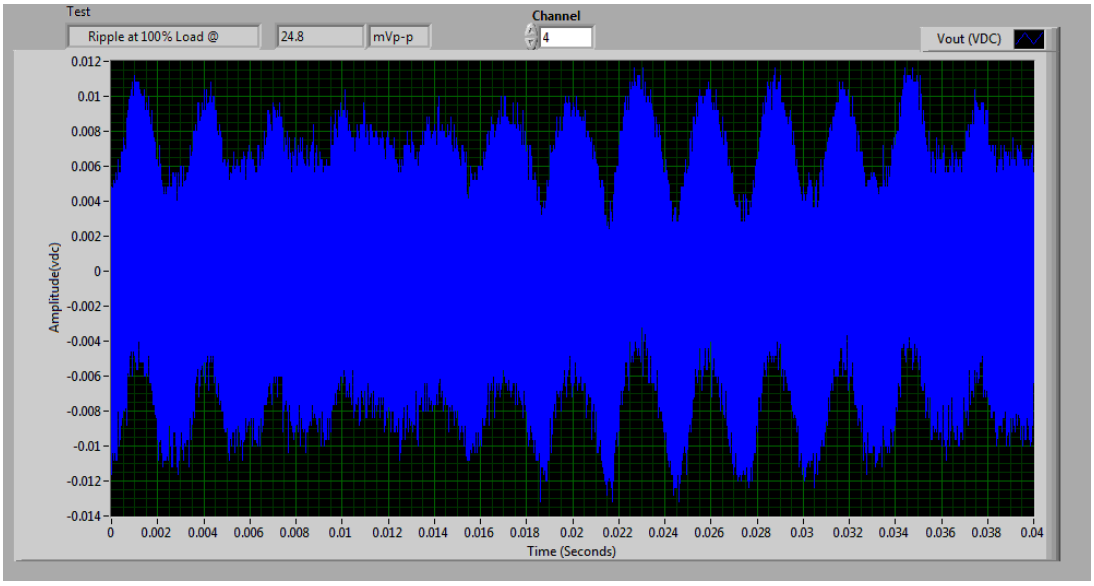



**Figure 25: Ripple at 100% Load @ 480VAC. Timebase = 2mS/Div**

CH1 (Blue) – Vout Ripple, 2mV/DIV

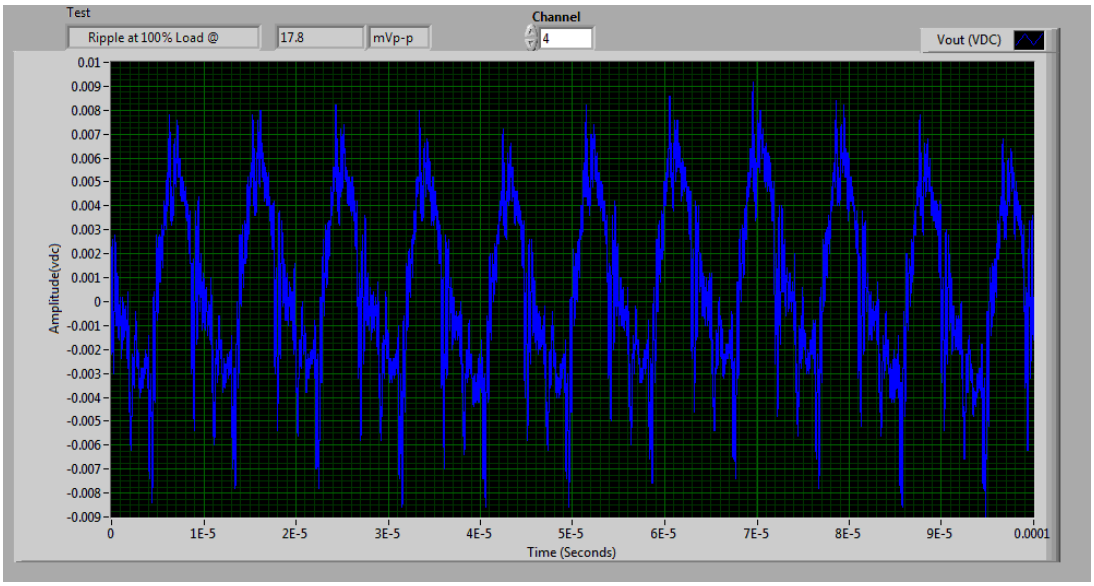



**Figure 26: Ripple at 100% Load @ 480VAC. Timebase = 1uS/Div**

CH1 (Blue) – Vout Ripple, 1mV/DIV

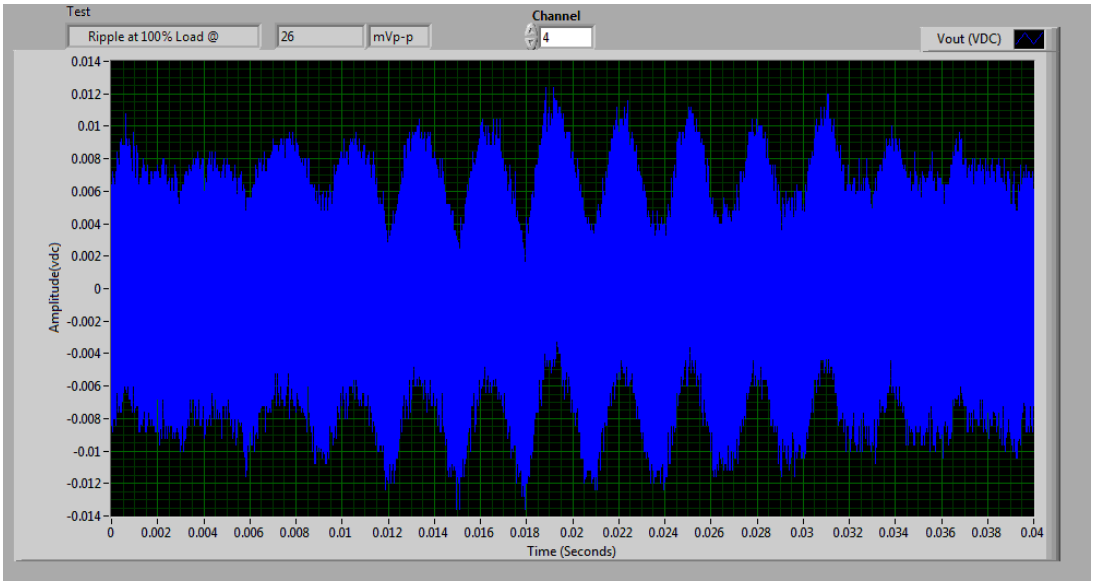



**Figure 27: Ripple at 100% Load @ 528VAC. Timebase = 2mS/Div**

CH1 (Blue) – Vout Ripple, 2mV/DIV

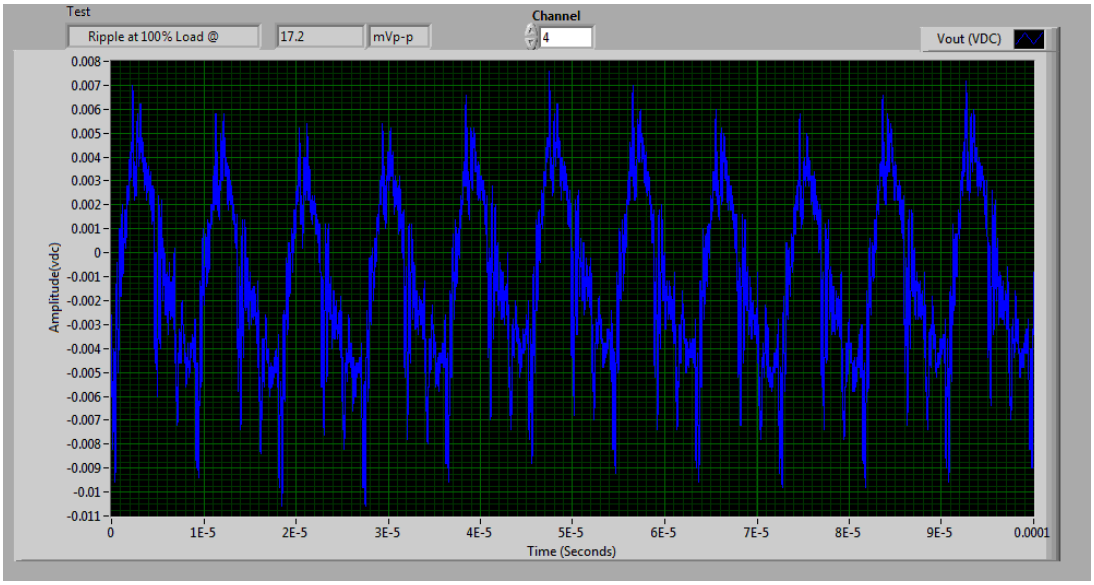



**Figure 28: Ripple at 100% Load @ 528VAC. Timebase = 1uS/Div**

CH1 (Blue) – Vout Ripple, 1mV/DIV

## OCP Characteristics

Vout =24Vdc, Ta=25°C

### *Local Mode*

In local mode, the current setpoint is adjustable via either the Ilimit Adjust trim pot or by applying a 0-5V signal to terminals 10 and 18 of the signal connector. See User manual for details.

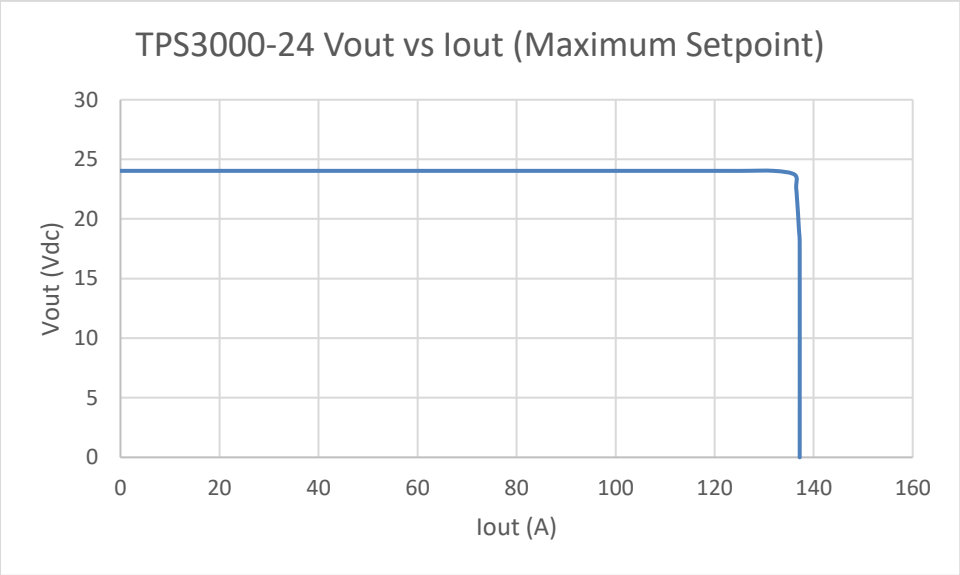



Figure 29: OCP Dropout Curve. Ilim setpoint= Maximum. Local Mode

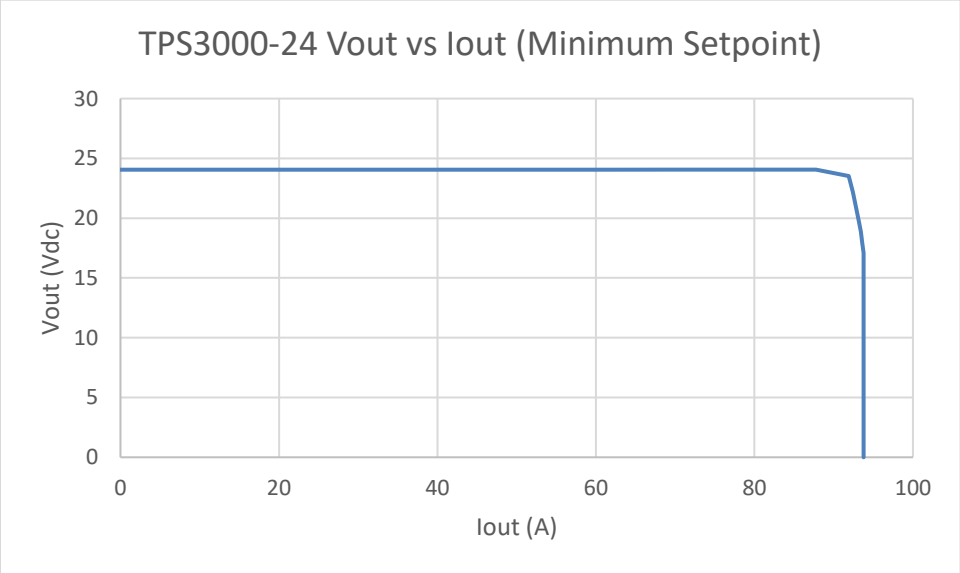



Figure 30: OCP Dropout Curve. Ilim setpoint= Minimum. Local Mode

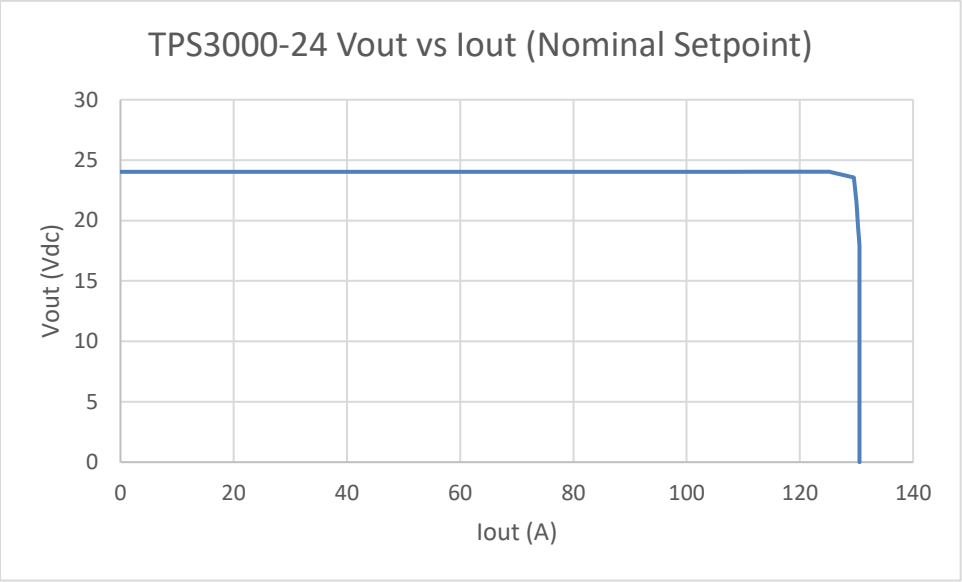



Figure 31: OCP Dropout Curve. Ilim setpoint= Nominal. Local Mode

***Remote Mode***

In remote mode, the current limit setpoint is programmable via the I2C Connector.

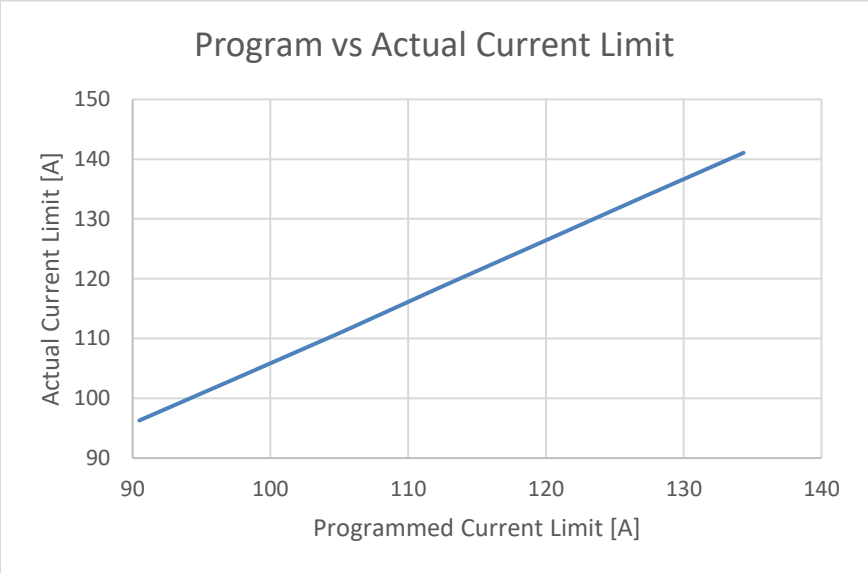



Figure 32: Programmed vs Actual Current Limit

## Conducted Emissions

EN 55022:2010 + AC:2011 Class A

Vout =24Vdc, Ta=25°C, %100 Load = 125A

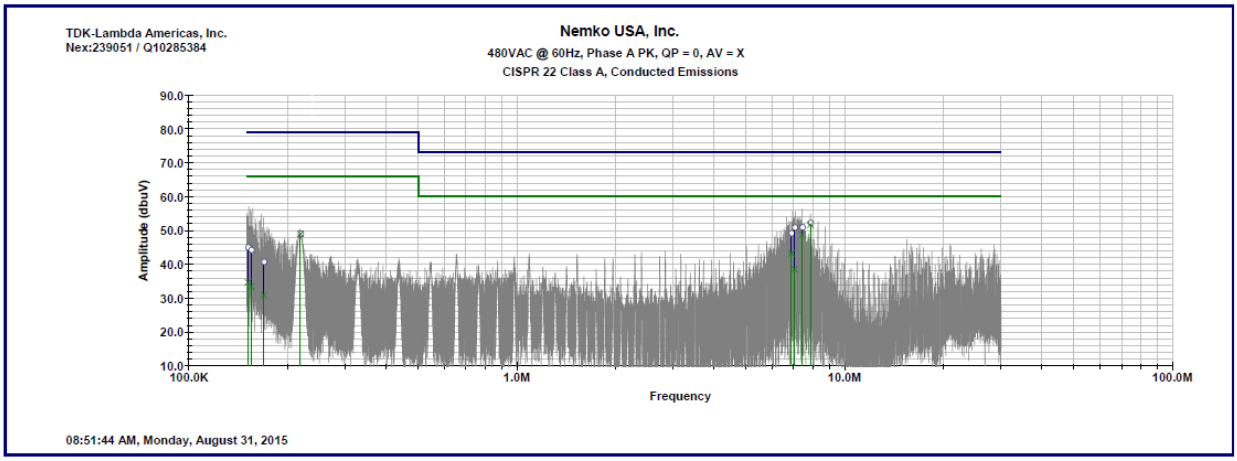



Figure 33: Phase A Conducted Emissions. Vin = 477Vac

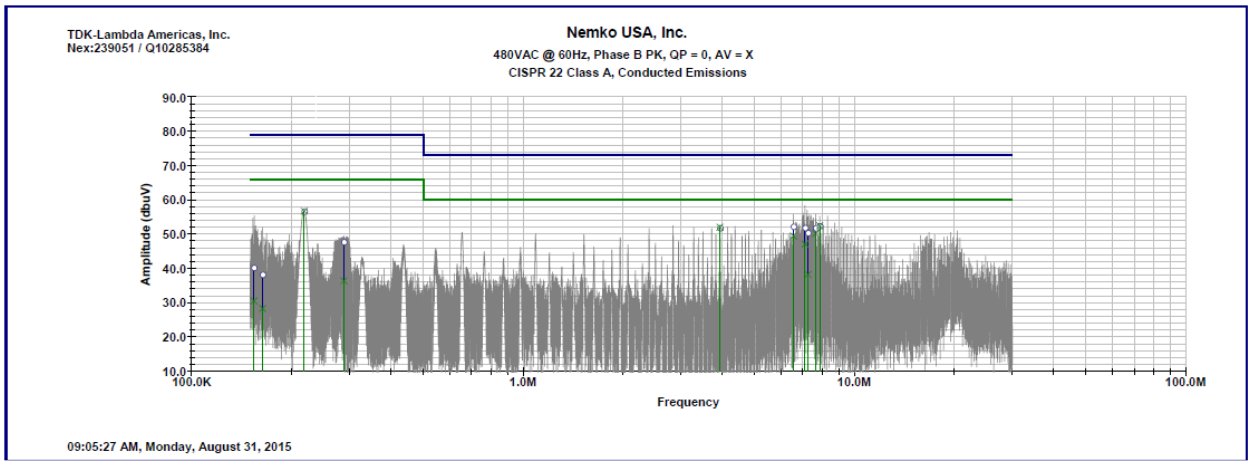



Figure 34: Phase B Conducted Emissions. Vin = 477Vac

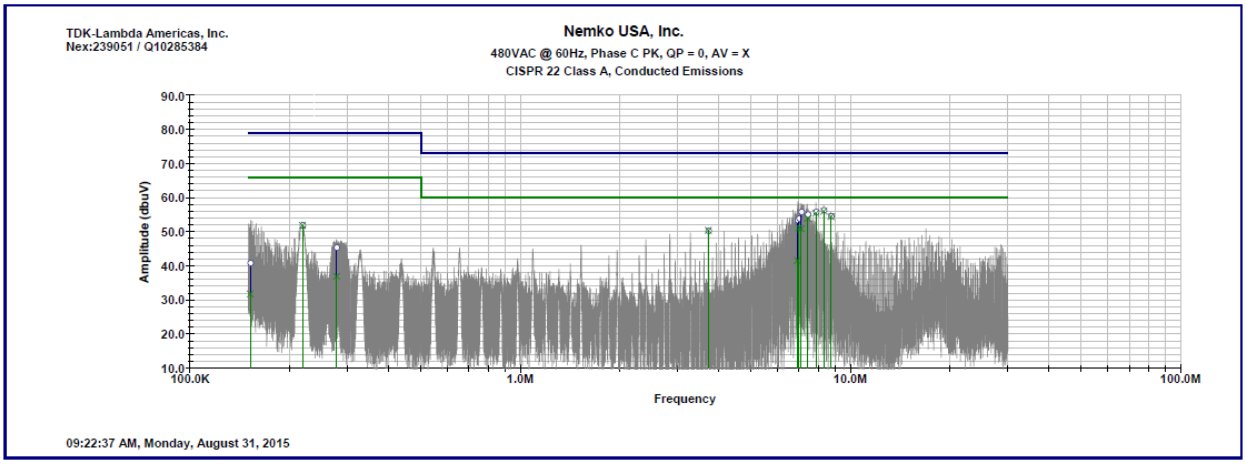



Figure 35: Phase C Conducted Emissions. Vin = 477Vac

## Radiated Emissions

FCC Part 15 B/ EN55032 Class A/ EN55022 Class A

Vout =24Vdc, Ta=25°C, %100 Load = 125A

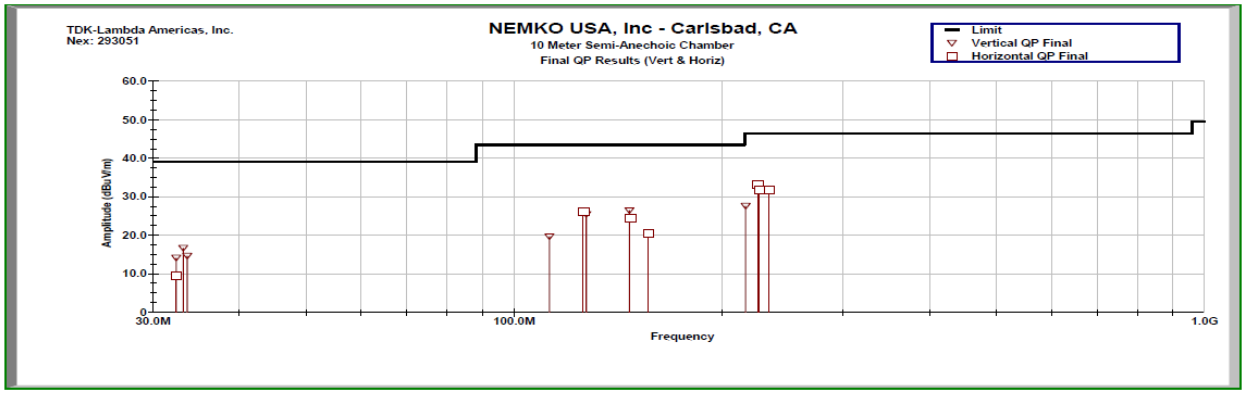



Figure 36: FCC Part 15 B Radiated Emissions

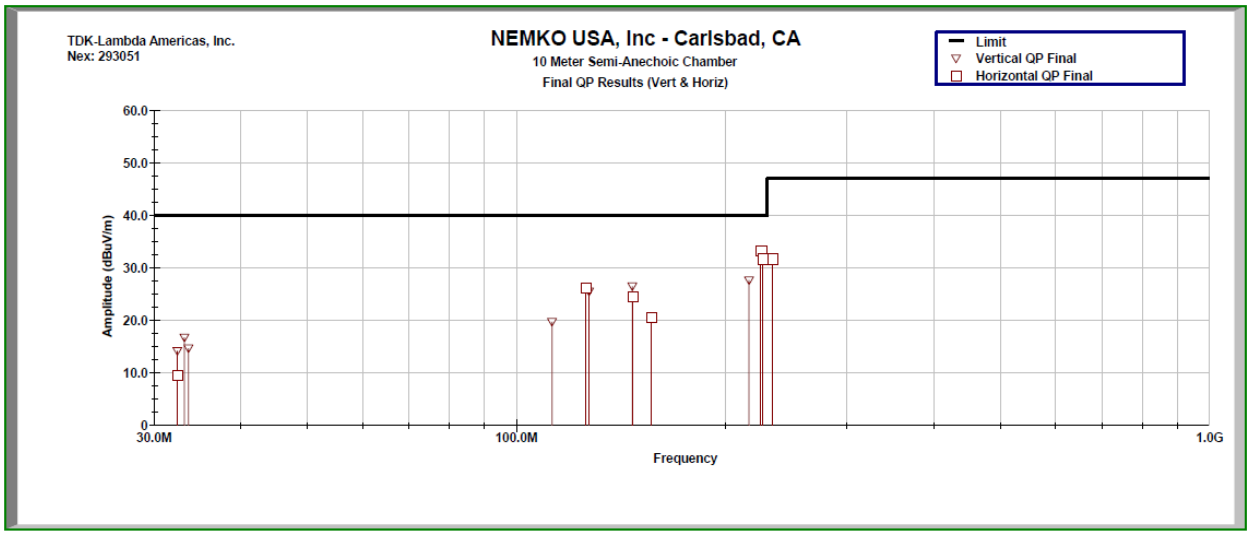



Figure 37: EN55022/EN55032 Class A Radiated Emissions

## Current Share

Vin = 480Vac, Vout = 24Vdc, Ta = 25°C

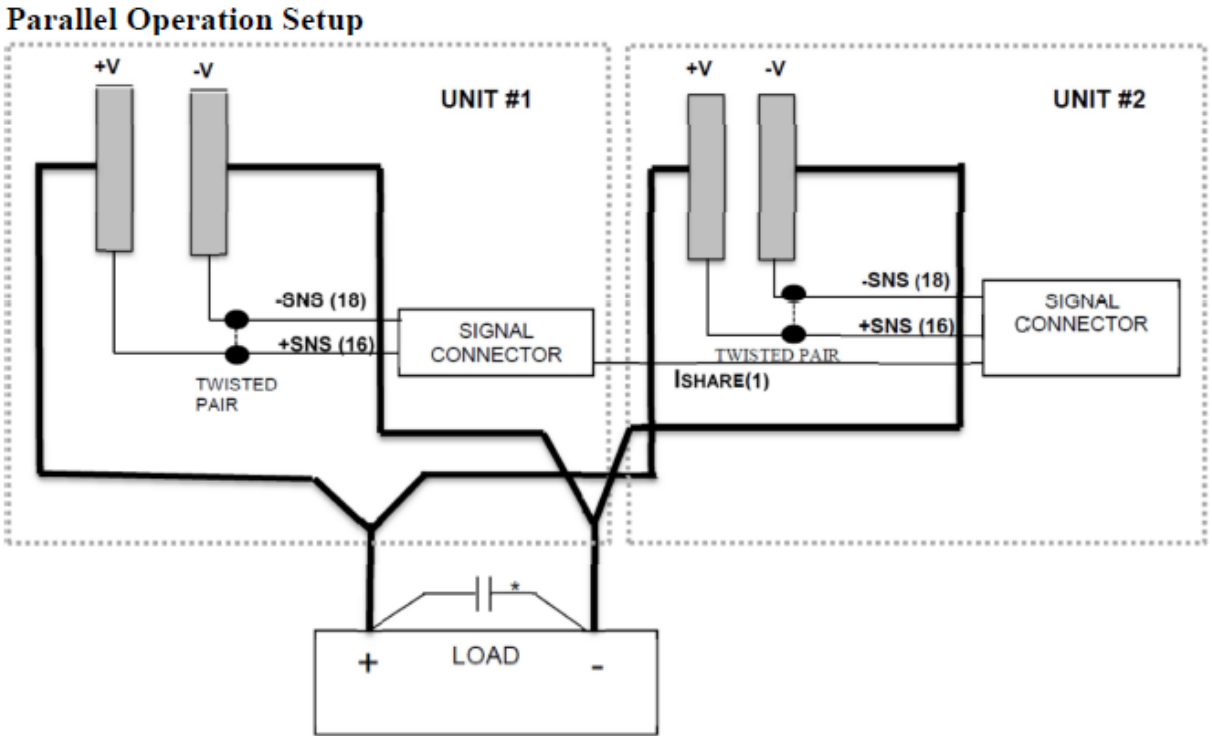
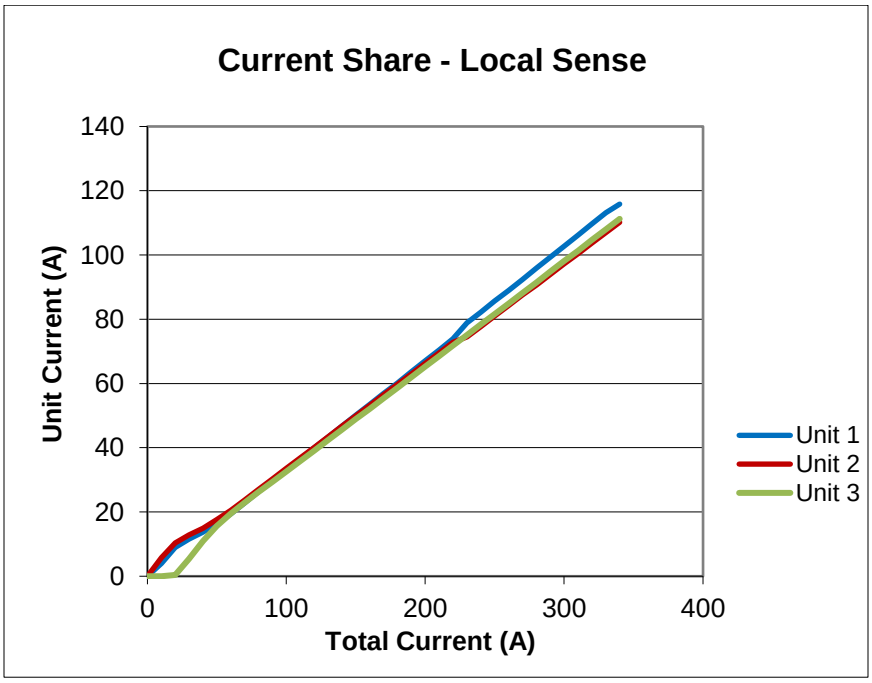



Figure 38: Typical Local Sense Parallel Operation Setup



| Itotal | I1(A) | I2(A) | I3(A) | Delta I [% of I total] |
|---|---|---|---|---|
| 0 | 0.0 | 0.0 | 0.0 | N/A |
| 10 | 4.0 | 5.8 | 0.0 | 57.60% |
| 20 | 9.0 | 10.4 | 0.5 | 49.80% |
| 30 | 11.5 | 12.8 | 5.4 | 24.85% |
| 40 | 13.7 | 14.9 | 11.0 | 9.90% |
| 50 | 16.5 | 17.6 | 15.6 | 3.90% |
| 60 | 19.5 | 20.5 | 19.6 | 1.69% |
| 70 | 22.8 | 23.7 | 22.9 | 1.23% |
| 80 | 26.3 | 27.0 | 26.2 | 1.03% |
| 90 | 29.7 | 30.3 | 29.4 | 1.01% |
| 100 | 33.1 | 33.5 | 32.6 | 0.97% |
| 110 | 36.5 | 36.8 | 35.8 | 0.93% |
| 120 | 39.9 | 40.1 | 39.1 | 0.86% |
| 130 | 43.3 | 43.4 | 42.3 | 0.81% |
| 140 | 46.7 | 46.7 | 45.6 | 0.75% |
| 150 | 50.1 | 49.9 | 48.9 | 0.79% |
| 160 | 53.5 | 53.2 | 52.1 | 0.83% |
| 170 | 56.8 | 56.5 | 55.4 | 0.84% |
| 180 | 60.2 | 59.8 | 58.7 | 0.85% |
| 190 | 63.6 | 63.0 | 62.0 | 0.88% |
| 200 | 67.1 | 66.3 | 65.3 | 0.91% |
| 210 | 70.5 | 69.5 | 68.5 | 0.92% |
| 220 | 73.9 | 72.8 | 71.8 | 0.95% |
| 230 | 78.9 | 74.5 | 75.1 | 1.92% |
| 240 | 82.2 | 77.7 | 78.4 | 1.87% |
| 250 | 85.6 | 81.0 | 81.6 | 1.87% |
| 260 | 89.0 | 84.3 | 84.9 | 1.80% |
| 270 | 92.4 | 87.6 | 88.2 | 1.78% |
| 280 | 95.9 | 90.6 | 91.5 | 1.91% |
| 290 | 99.3 | 94.0 | 94.8 | 1.85% |
| 300 | 102.8 | 97.2 | 98.1 | 1.85% |
| 310 | 106.2 | 100.5 | 101.4 | 1.85% |
| 320 | 109.6 | 103.7 | 104.7 | 1.85% |
| 330 | 113.1 | 107.0 | 108.0 | 1.87% |
| 340 | 115.8 | 110.2 | 111.2 | 1.66% |

**Table 1: Current Share - Local Sense (Sense signals connected to bus bars)**

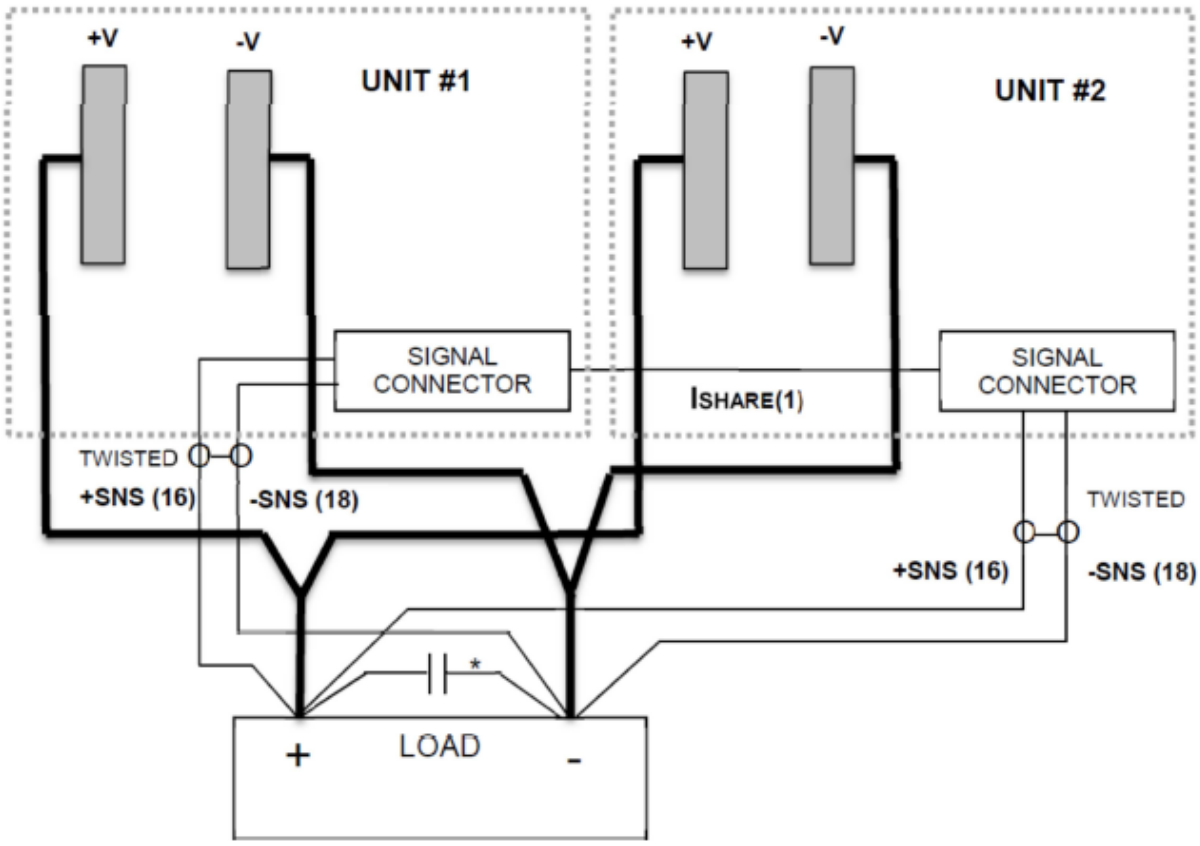
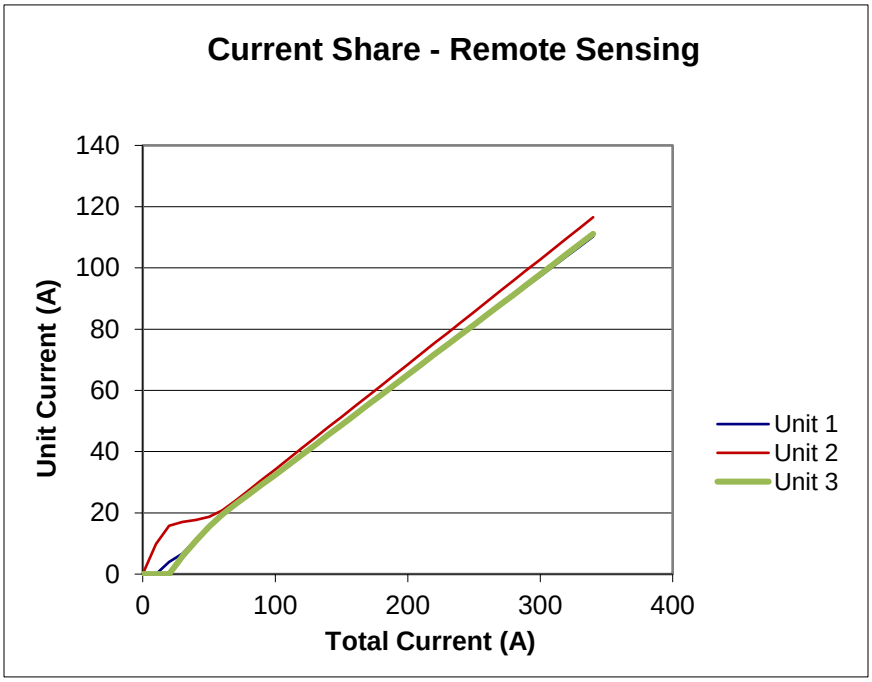



Figure 39: Typical Remote Sense Parallel Operation Setup



| Itotal | I1(A) | I2(A) | I3(A) | Delta I [% of I total] |
|---|---|---|---|---|
| 0 | 0.0 | 0.0 | 0.0 | N/A |
| 10 | 0.0 | 9.8 | 0.0 | 98.04% |
| 20 | 4.0 | 15.8 | 0.0 | 79.13% |
| 30 | 6.7 | 17.1 | 5.9 | 37.20% |
| 40 | 11.1 | 17.7 | 10.8 | 17.14% |
| 50 | 15.5 | 18.8 | 15.5 | 6.63% |
| 60 | 19.2 | 20.9 | 19.4 | 2.68% |
| 70 | 22.7 | 23.9 | 22.8 | 1.84% |
| 80 | 26.0 | 27.4 | 26.0 | 1.74% |
| 90 | 29.3 | 30.8 | 29.2 | 1.75% |
| 100 | 32.6 | 34.2 | 32.4 | 1.80% |
| 110 | 35.9 | 37.7 | 35.7 | 1.81% |
| 120 | 39.1 | 41.1 | 38.9 | 1.81% |
| 130 | 42.3 | 44.5 | 42.2 | 1.79% |
| 140 | 45.6 | 47.9 | 45.5 | 1.77% |
| 150 | 48.8 | 51.3 | 48.7 | 1.74% |
| 160 | 52.1 | 54.7 | 52.0 | 1.72% |
| 170 | 55.3 | 58.1 | 55.2 | 1.70% |
| 180 | 58.6 | 61.6 | 58.5 | 1.70% |
| 190 | 61.8 | 65.0 | 61.8 | 1.69% |
| 200 | 65.0 | 68.4 | 65.1 | 1.70% |
| 210 | 68.3 | 71.9 | 68.4 | 1.72% |
| 220 | 71.5 | 75.3 | 71.7 | 1.73% |
| 230 | 74.7 | 78.7 | 74.9 | 1.75% |
| 240 | 77.9 | 82.2 | 78.2 | 1.76% |
| 250 | 81.2 | 85.6 | 81.5 | 1.78% |
| 260 | 84.4 | 89.0 | 84.8 | 1.78% |
| 270 | 87.6 | 92.4 | 88.0 | 1.80% |
| 280 | 90.8 | 95.9 | 91.2 | 1.82% |
| 290 | 94.1 | 99.4 | 94.6 | 1.83% |
| 300 | 97.3 | 102.8 | 97.9 | 1.83% |
| 310 | 100.5 | 106.2 | 101.2 | 1.83% |
| 320 | 103.8 | 109.7 | 104.5 | 1.84% |
| 330 | 107.0 | 113.1 | 107.8 | 1.85% |
| 340 | 110.3 | 116.6 | 111.1 | 1.84% |

**Table 2: Current Share- Remote Sense (Sense signals connected at load)**