PFE1800FB-48-xxx-R

Evaluation Report

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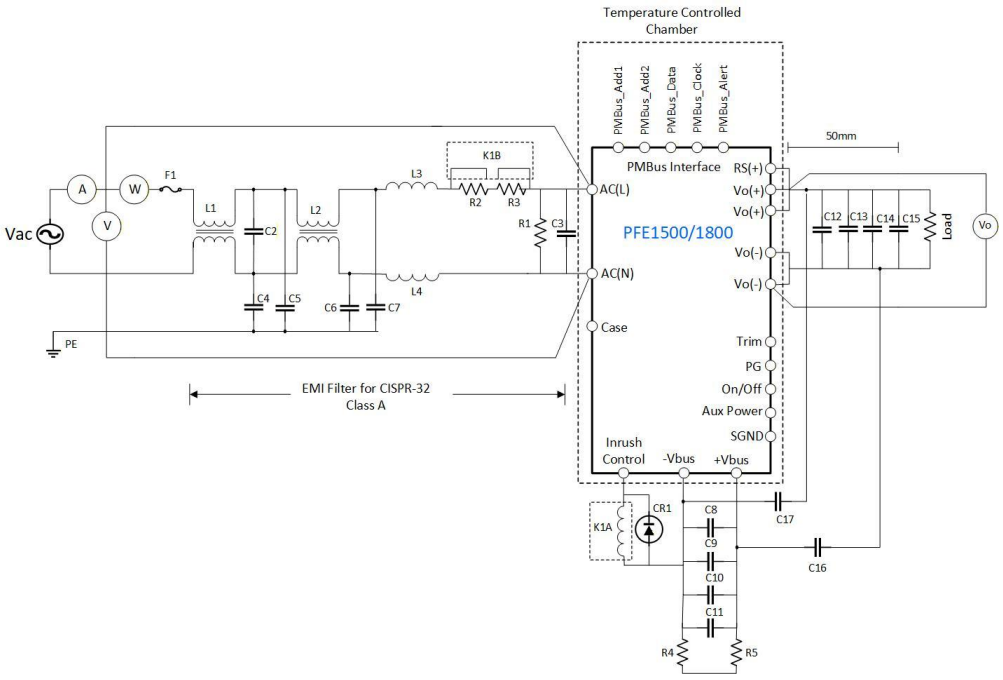
1. EVALUATION METHOD

1.1. Test / Measurement Circuits

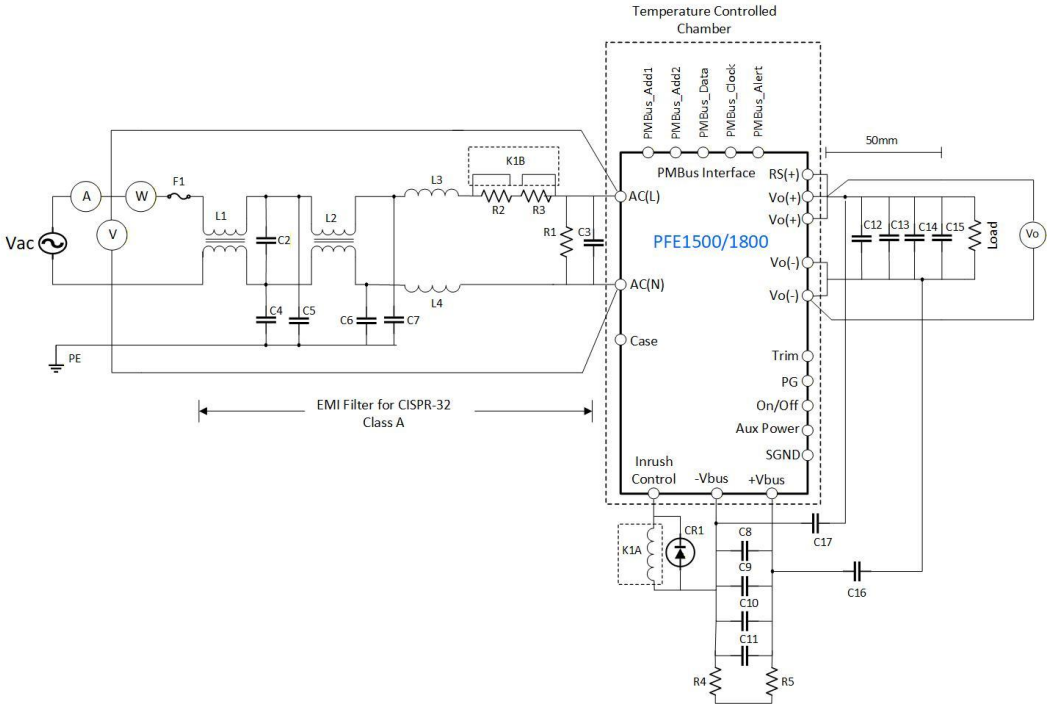
1.1.1. Components

Reference Designator	Description	Reference Designator	Description
C2	0.47 µF Film Capacitor	C3	2 x 2.2 µF Film Capacitor
C4, C5, C6, C7	4700 pF Ceramic Capacitor	C15	0.1 µF Ceramic Capacitor
C16, C17	7500 pF Ceramic Capacitor	CR1	CRH01, 200 V, 1 A Diode
L1	1 mH	R2, R3	10 Ω 5 W
L2	1.3 mH	C12, C13	560 µF Electrolytic Capacitor
L3, L4	27 µH	C14	8 x 4.7 µF Ceramic Capacitor
R1, R4, R5	470 kΩ, 2 W	C8, C9, C10, C11	470 µF Electrolytic Capacitor
K1	1 Form A Relay Contact Rating: 16 A, 277 VAC Coil Rating: 12 VDC, 16.7 mA, 200 mW	F1	20 A, 280 V, Fast Blow

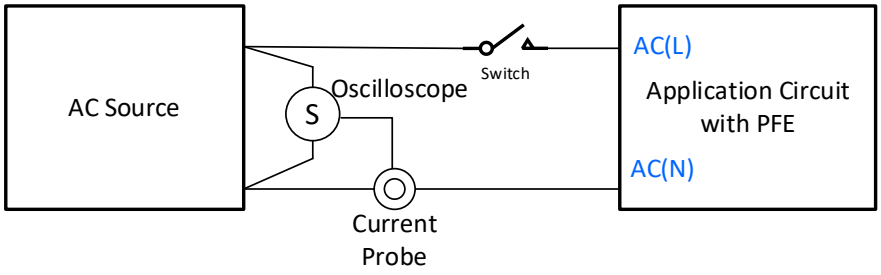
1.1.2. Steady State Test Measurement Circuit



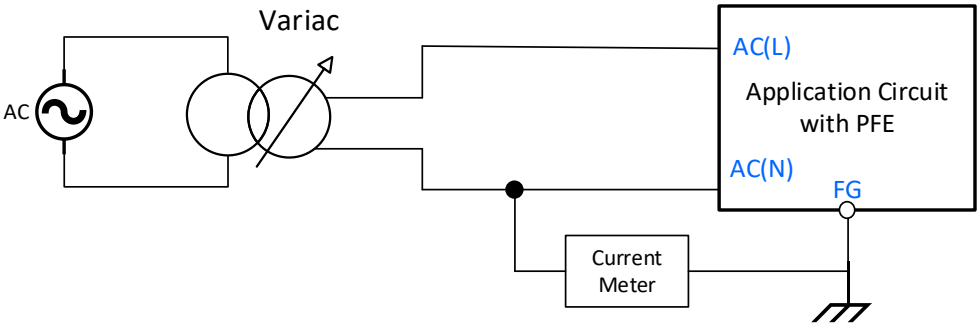
1.1.3. Dynamic, Protection, Output Ripple, and Noise Measurement Circuit



1.1.4. Inrush Current Measurement Circuit



1.1.5. Leakage Current Measurement Circuit

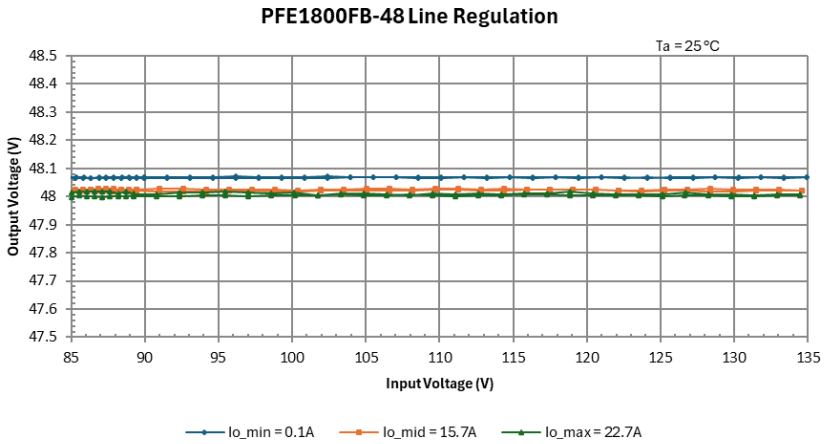


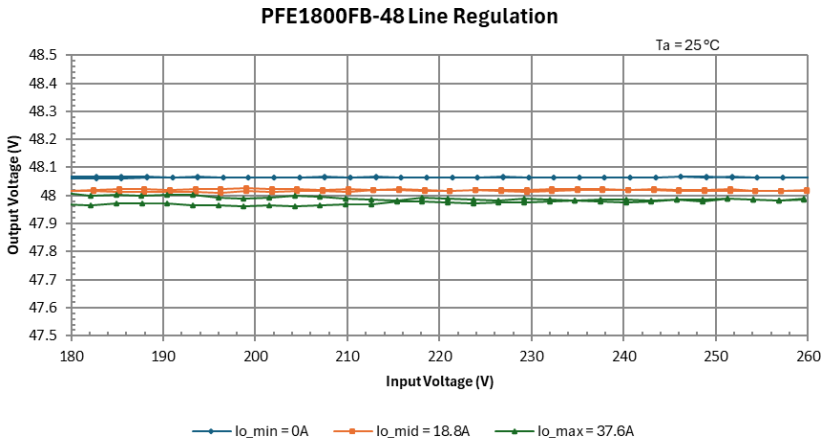
2. CHARACTERISTICS

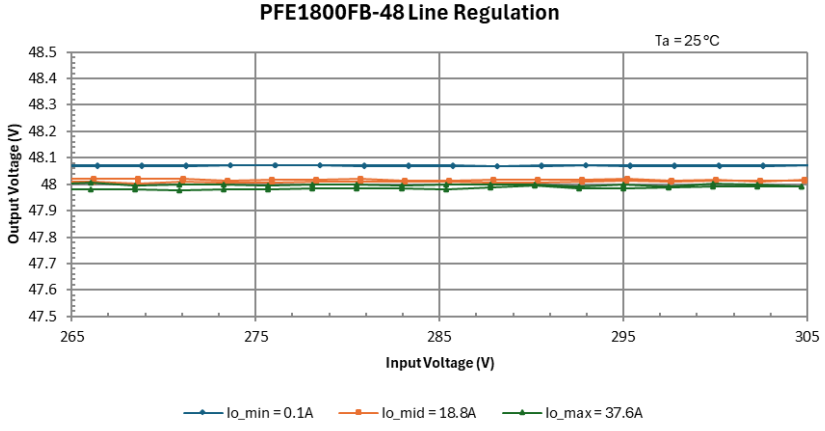
2.1. Steady State Data

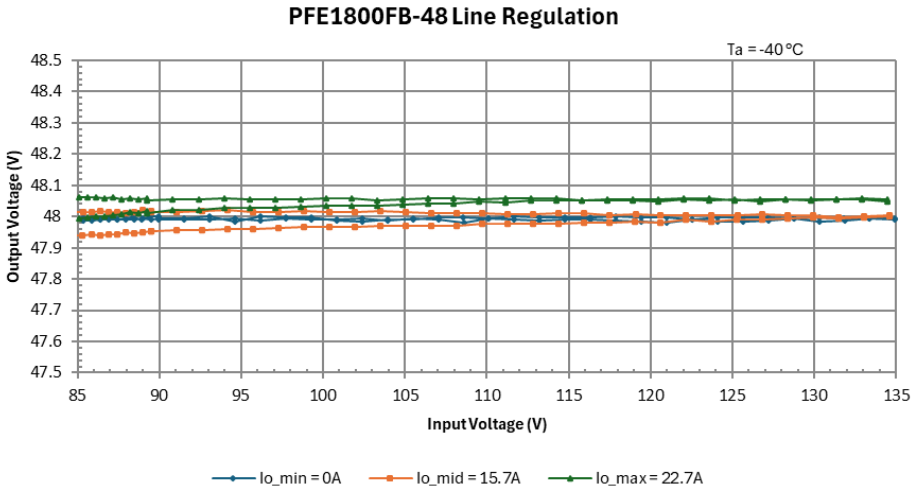
2.1.1. Regulation – Line, Load (60 Hz)

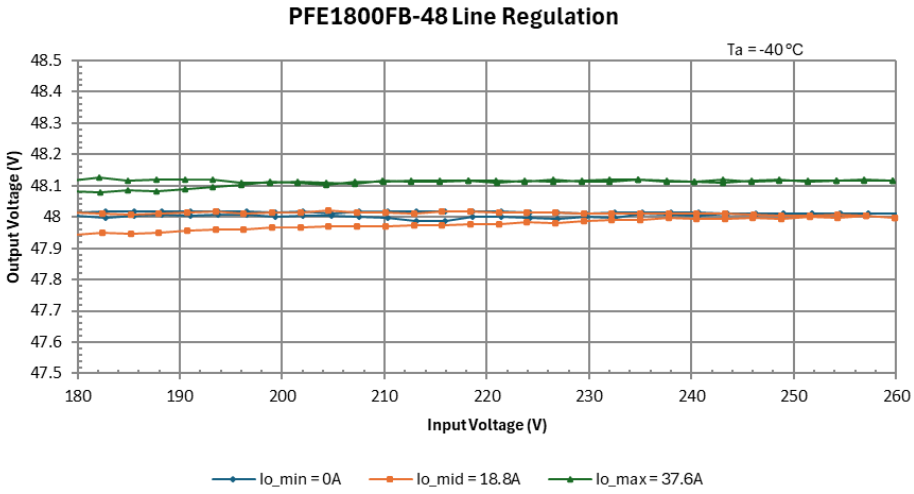
2.1.1.1. Line Regulation

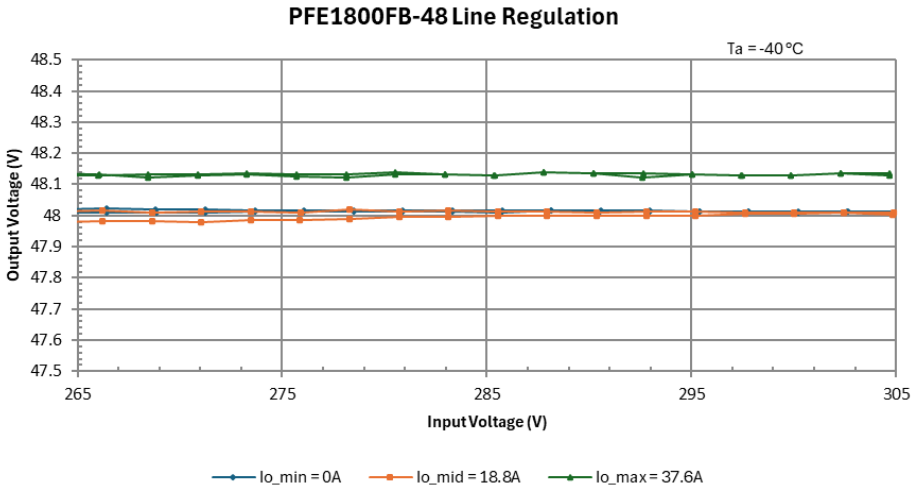


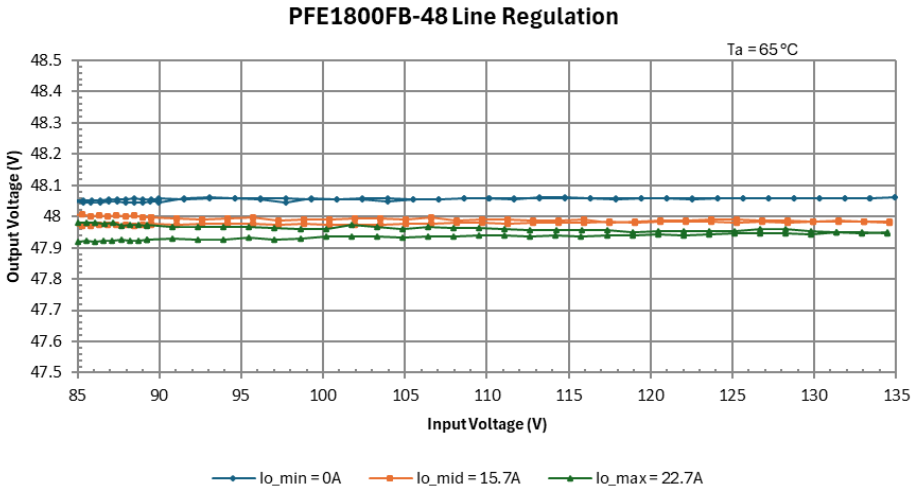


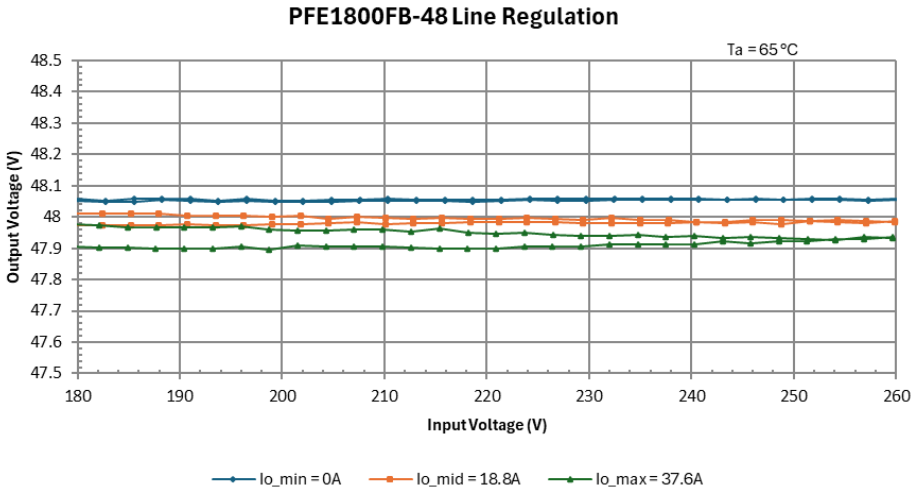


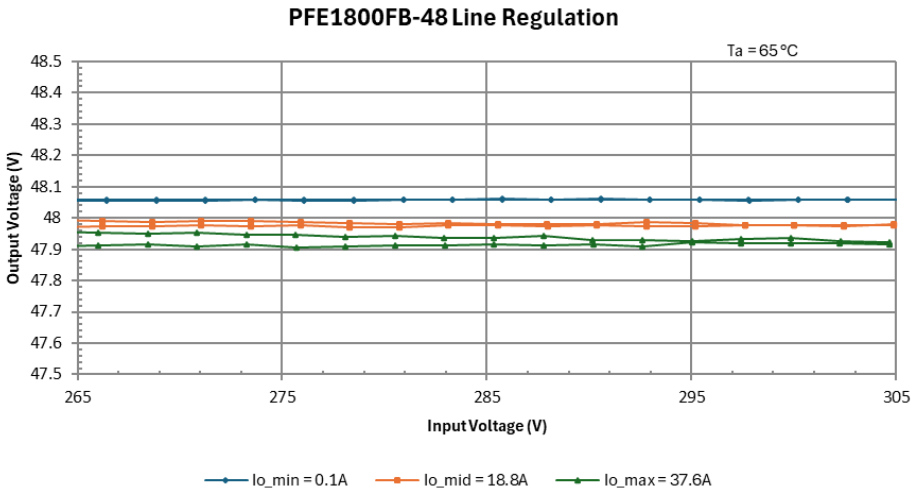

PFE1800FB-48 Line Regulation
Ta = -40 °C
Output Voltage (V)
48.5
48.4
48.3
48.2
48.1
48
47.9
47.8
47.7
47.6
47.5
85
90
95
100
105
110
115
120
125
130
135
Input Voltage (V)
Io_min = 0A
Io_mid = 15.7A
Io_max = 22.7A


PFE1800FB-48 Line Regulation
Ta = -40 °C
Output Voltage (V)
48.5
48.4
48.3
48.2
48.1
48
47.9
47.8
47.7
47.6
47.5
180
190
200
210
220
230
240
250
260
Input Voltage (V)
Io_min = 0A
Io_mid = 18.8A
Io_max = 37.6A

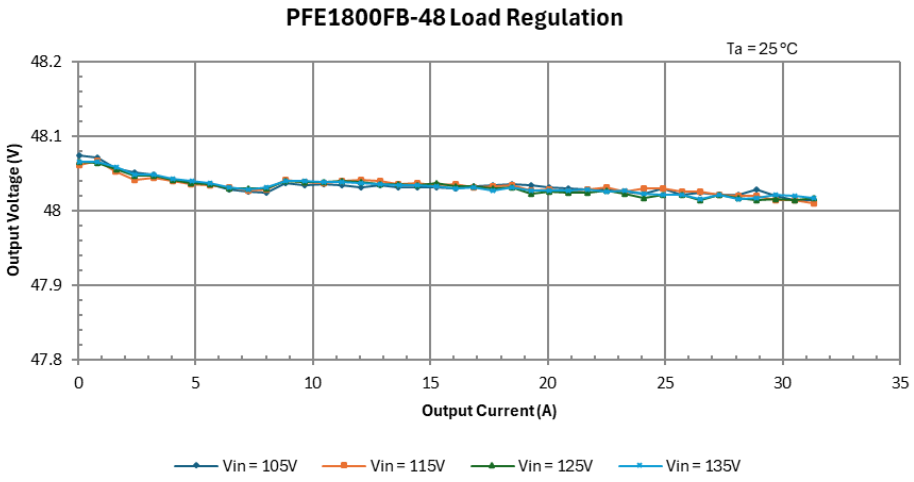

PFE1800FB-48 Line Regulation
Ta = -40 °C
Output Voltage (V)
48.5
48.4
48.3
48.2
48.1
48
47.9
47.8
47.7
47.6
47.5
265
275
285
295
305
Input Voltage (V)
Io_min = 0A
Io_mid = 18.8A
Io_max = 37.6A

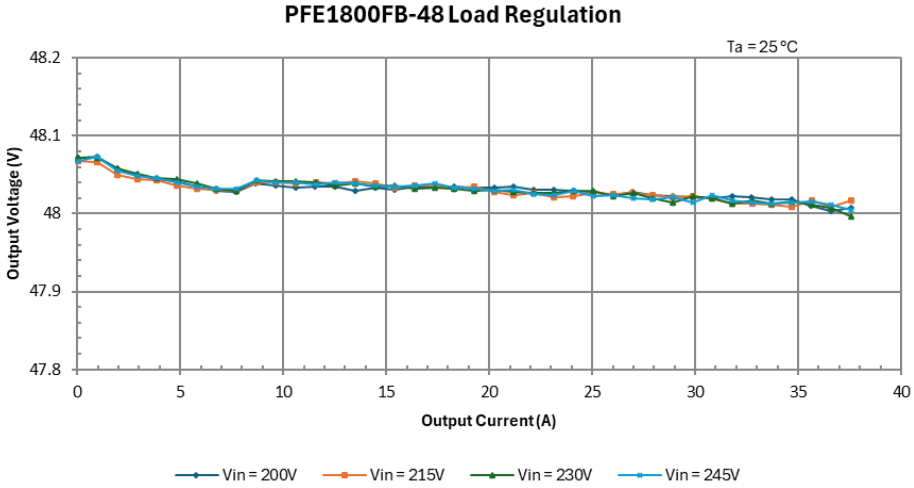

PFE1800FB-48 Line Regulation
Ta = 65 °C
Output Voltage (V)
48.5
48.4
48.3
48.2
48.1
48
47.9
47.8
47.7
47.6
47.5
85
90
95
100
105
110
115
120
125
130
135
Input Voltage (V)
Io_min = 0A
Io_mid = 15.7A
Io_max = 22.7A

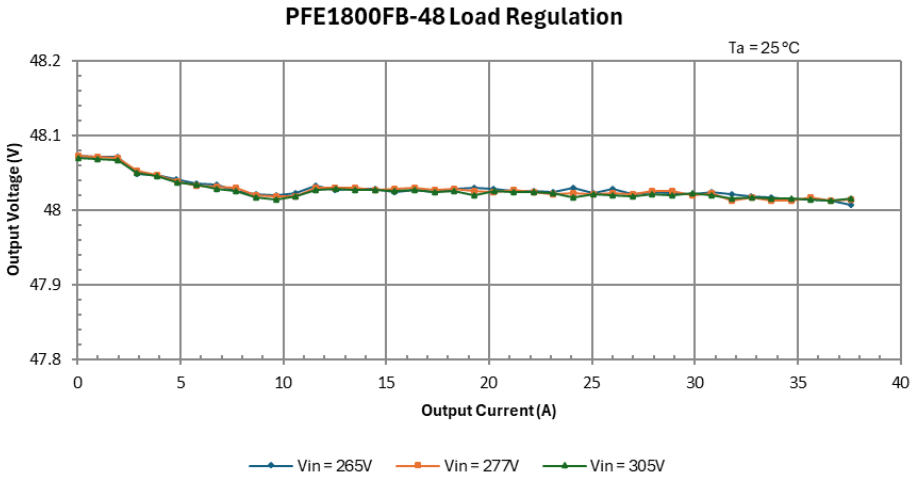

PFE1800FB-48 Line Regulation
Ta = 65 °C
Output Voltage (V)
48.5
48.4
48.3
48.2
48.1
48
47.9
47.8
47.7
47.6
47.5
180
190
200
210
220
230
240
250
260
Input Voltage (V)
Io_min = 0A
Io_mid = 18.8A
Io_max = 37.6A

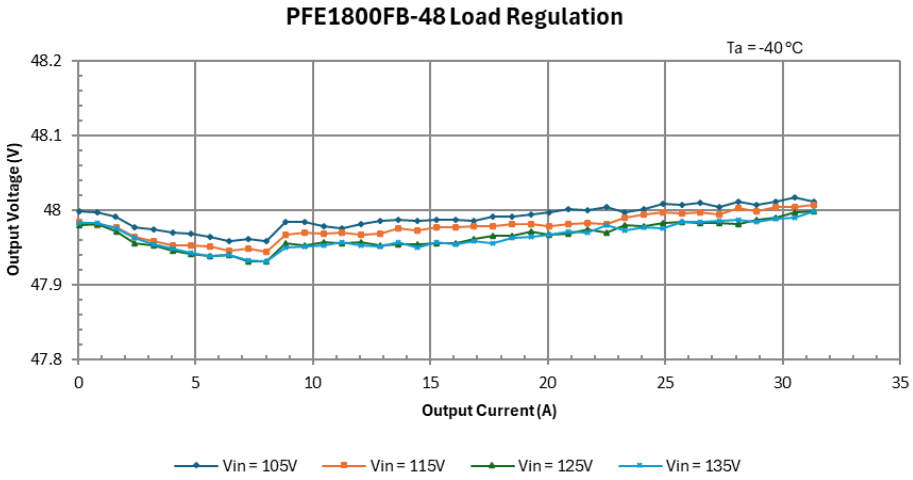

PFE1800FB-48 Line Regulation
Ta = 65 °C
Output Voltage (V)
48.5
48.4
48.3
48.2
48.1
48
47.9
47.8
47.7
47.6
47.5
265
275
285
295
305
Input Voltage (V)
Io_min = 0.1A
Io_mid = 18.8A
Io_max = 37.6A

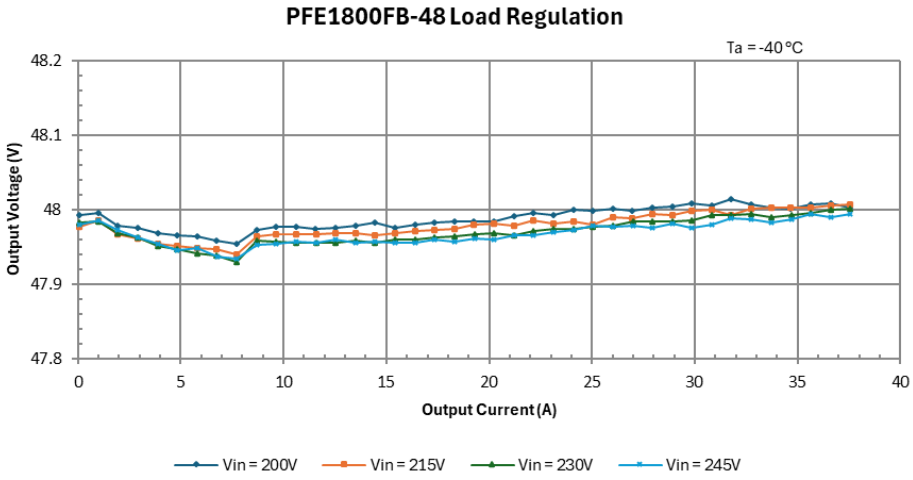
2.1.1.2. Load Regulation

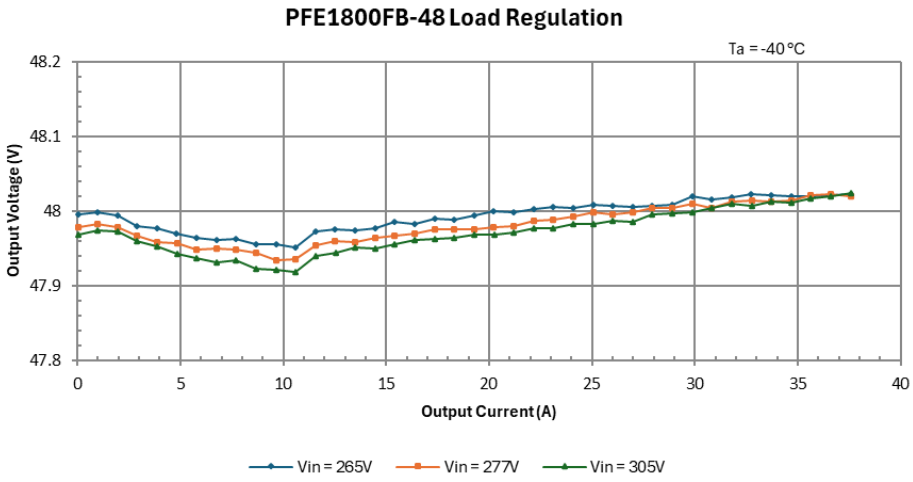


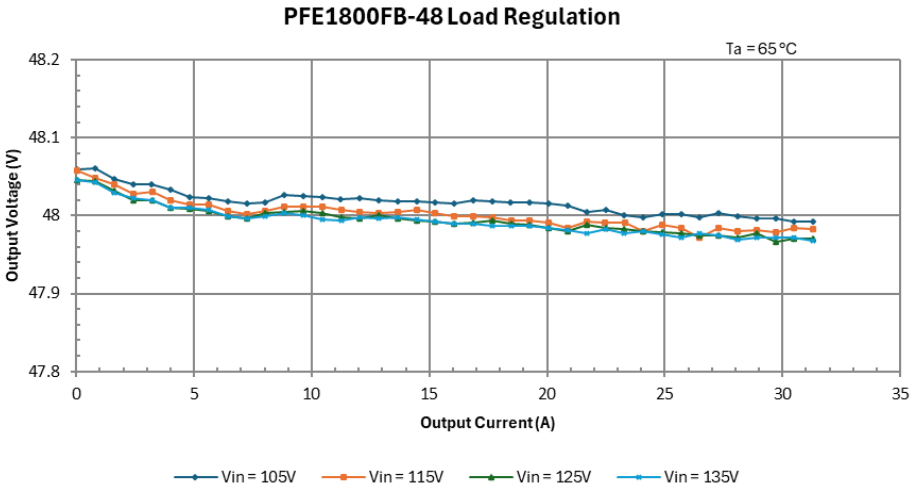


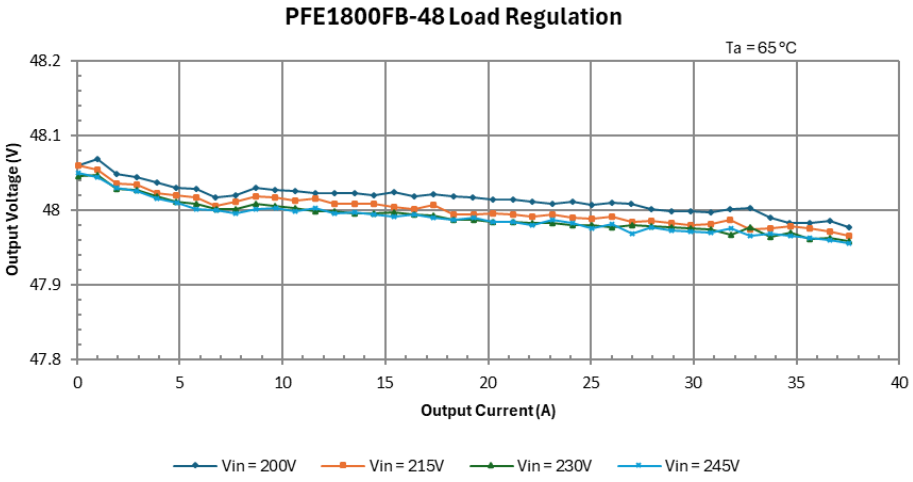


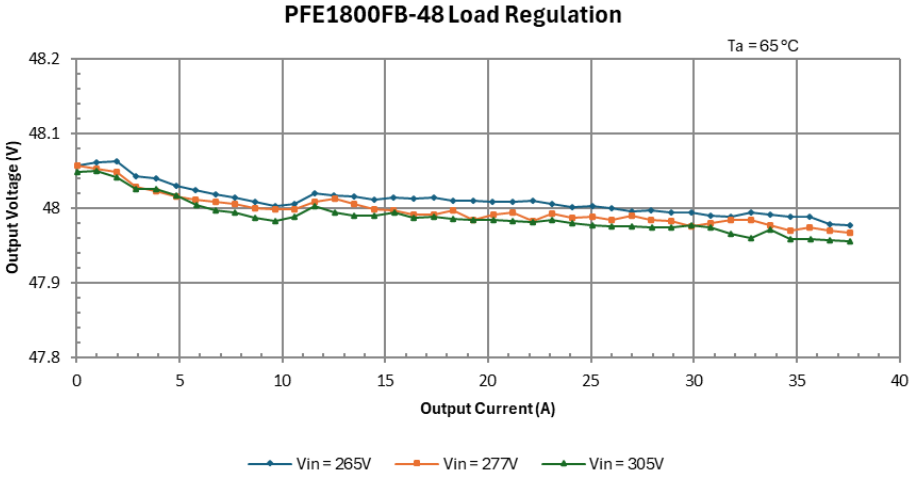

PFE1800FB-48 Load Regulation
Ta = -40 °C
Output Voltage (V)
48.2
48.1
48
47.9
47.8
0
5
10
15
20
25
30
35
Output Current (A)
Vin = 105V
Vin = 115V
Vin = 125V
Vin = 135V


PFE1800FB-48 Load Regulation
Ta = -40 °C
Output Voltage (V)
48.2
48.1
48
47.9
47.8
0
5
10
15
20
25
30
35
40
Output Current (A)
Vin = 200V
Vin = 215V
Vin = 230V
Vin = 245V

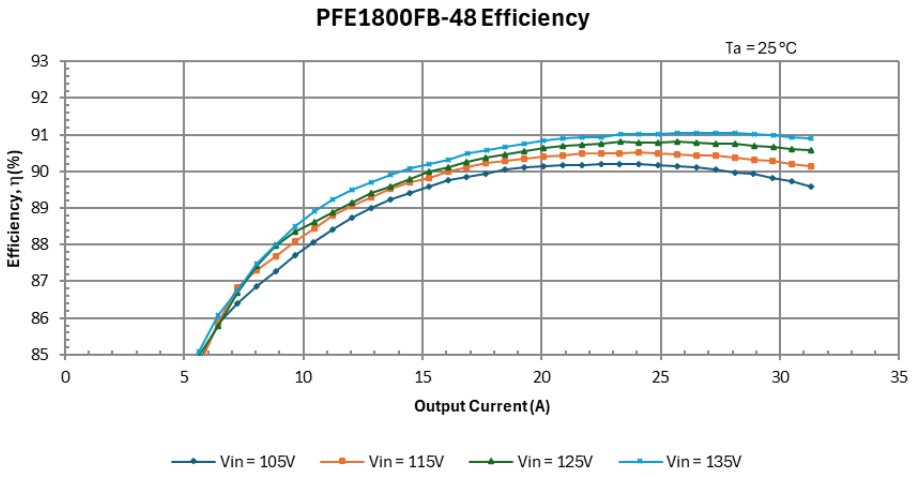

PFE1800FB-48 Load Regulation
Ta = -40 °C
Output Voltage (V)
48.2
48.1
48
47.9
47.8
0
5
10
15
20
25
30
35
40
Output Current (A)
Vin = 265V
Vin = 277V
Vin = 305V

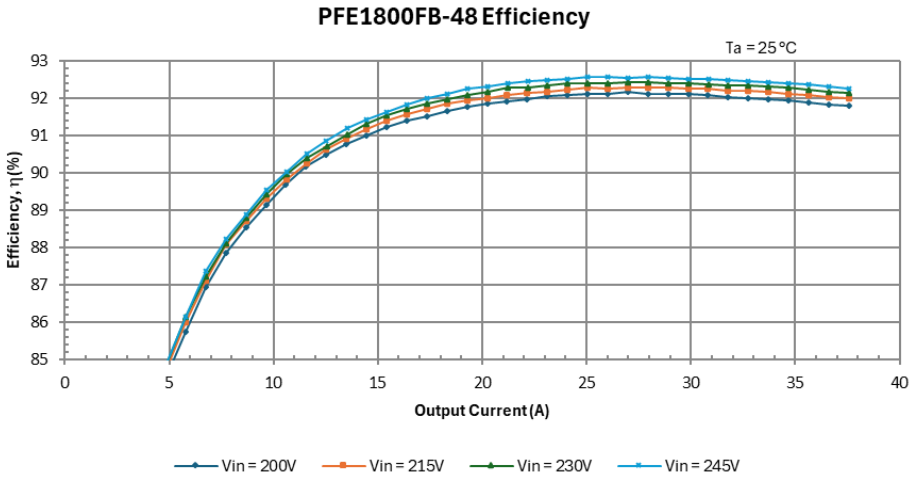

PFE1800FB-48 Load Regulation
Ta = 65 °C
48.2
48.1
48
47.9
47.8
Output Voltage (V)
0
5
10
15
20
25
30
35
Output Current (A)
Vin = 105V
Vin = 115V
Vin = 125V
Vin = 135V

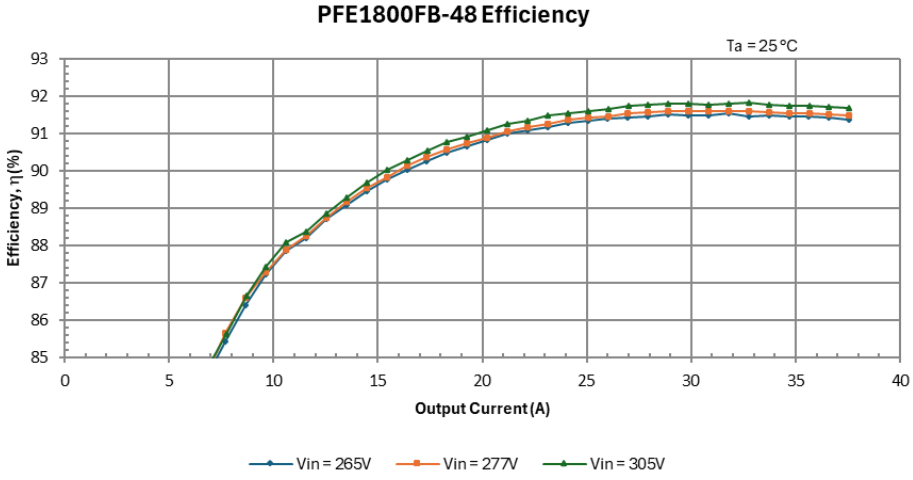

PFE1800FB-48 Load Regulation
Ta = 65 °C
48.2
48.1
48
47.9
47.8
Output Voltage (V)
0
5
10
15
20
25
30
35
40
Output Current (A)
Vin = 200V
Vin = 215V
Vin = 230V
Vin = 245V

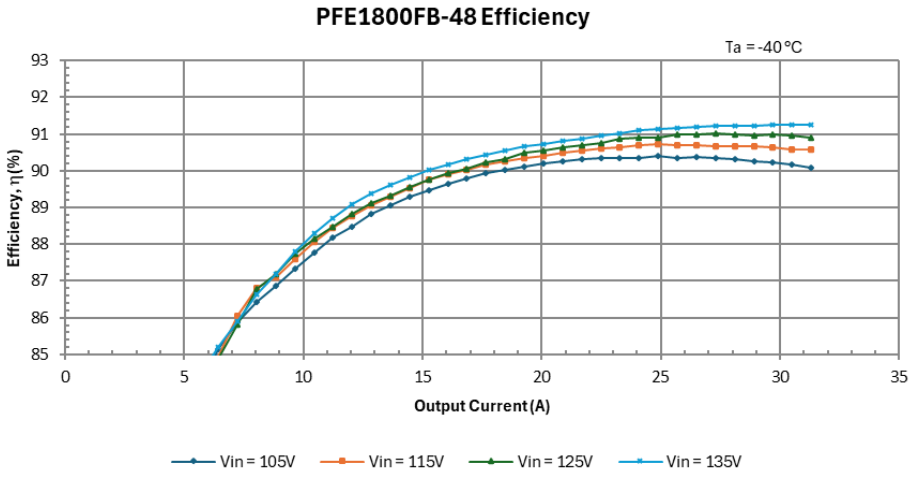

PFE1800FB-48 Load Regulation
Ta = 65 °C
48.2
48.1
48
47.9
47.8
Output Voltage (V)
0
5
10
15
20
25
30
35
40
Output Current (A)
Vin = 265V
Vin = 277V
Vin = 305V

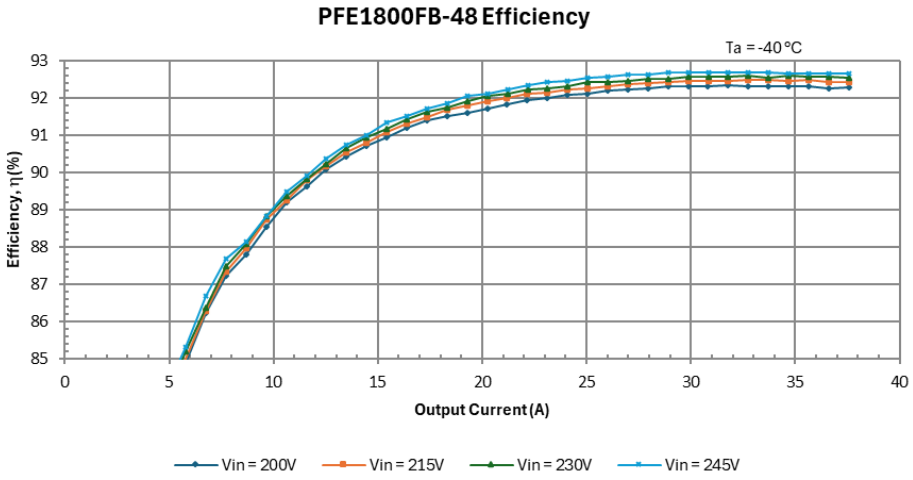
2.1.2. Efficiency vs. Output Current (60 Hz)

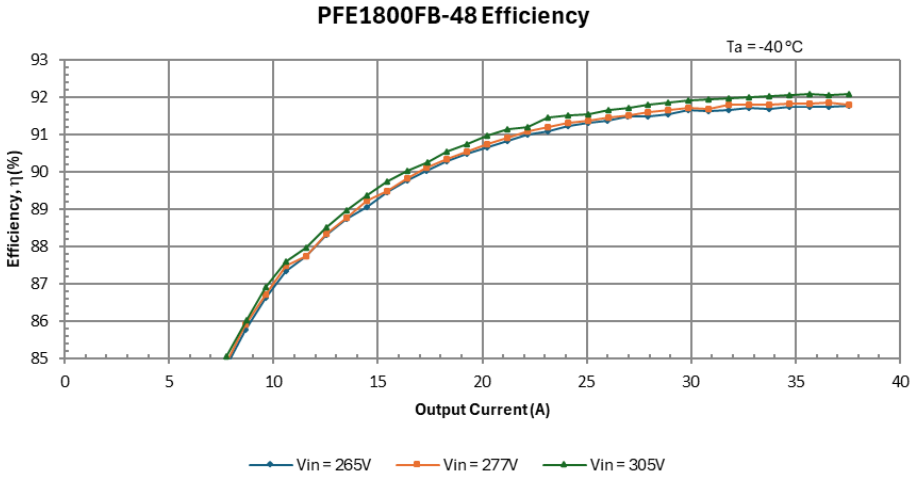


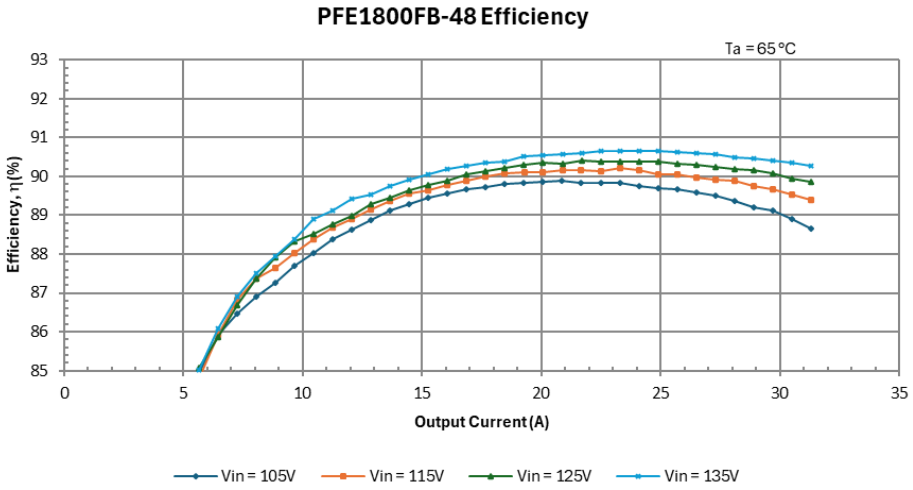


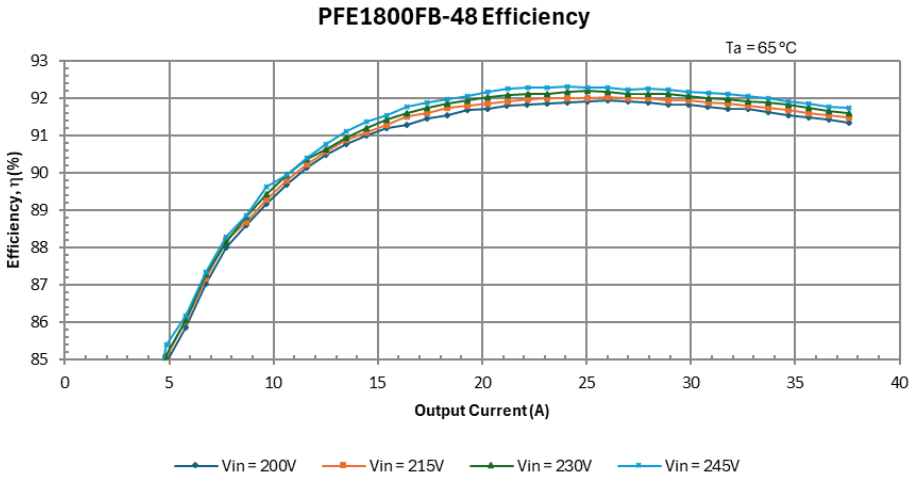


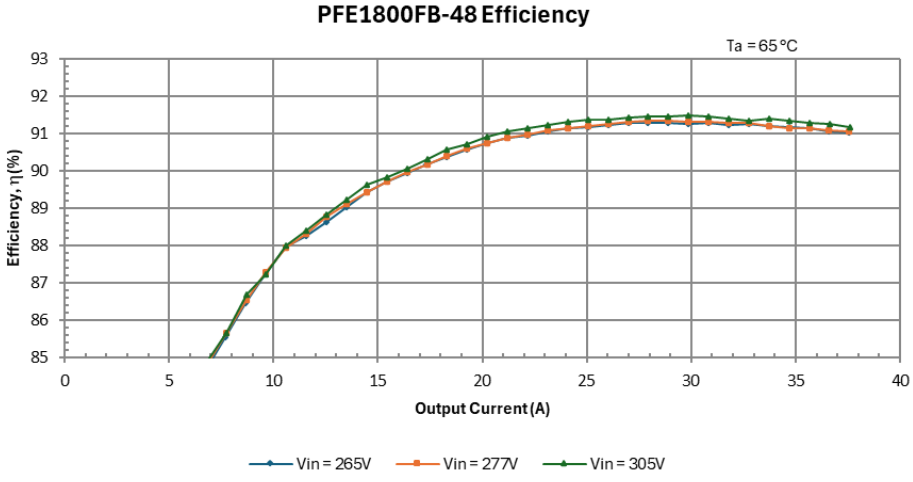

PFE1800FB-48 Efficiency
Ta = -40 °C
Efficiency, η(%)
Output Current (A)
Vin = 105V
Vin = 115V
Vin = 125V
Vin = 135V


PFE1800FB-48 Efficiency
Ta = -40 °C
Efficiency, η(%)
Output Current (A)
Vin = 200V
Vin = 215V
Vin = 230V
Vin = 245V

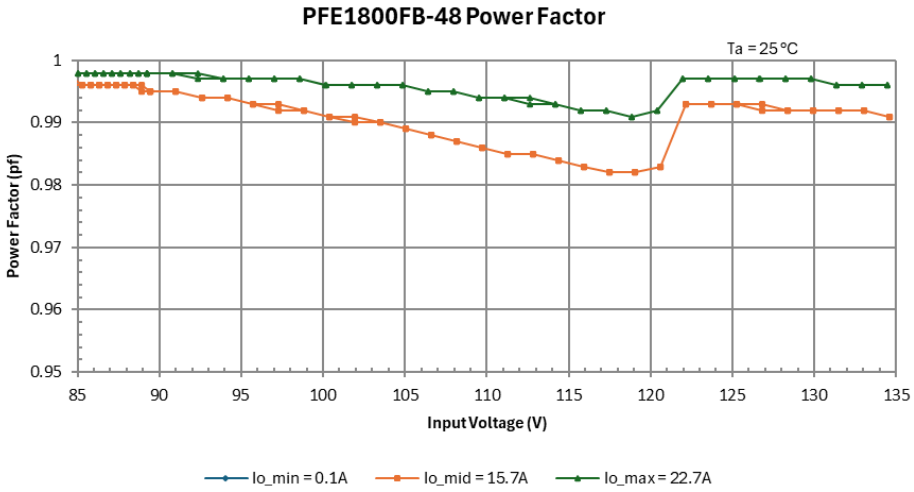

PFE1800FB-48 Efficiency
Ta = -40 °C
Efficiency, η(%)
Output Current (A)
Vin = 265V
Vin = 277V
Vin = 305V

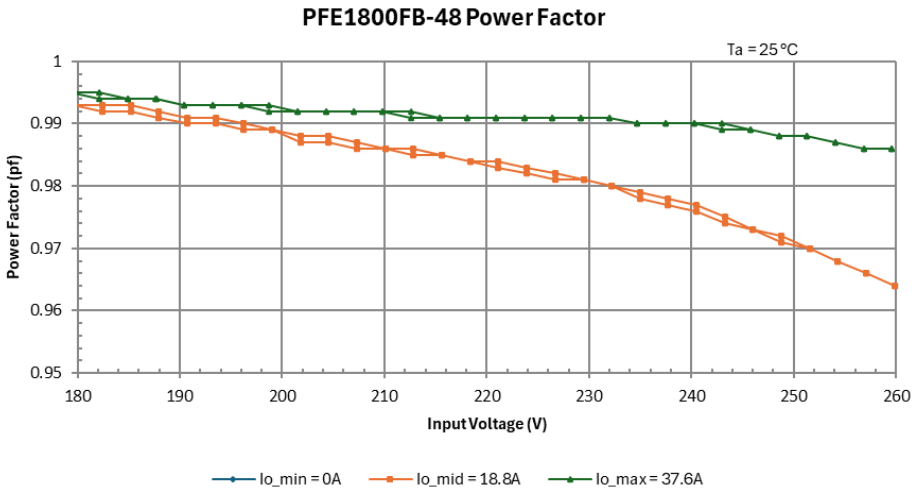

PFE1800FB-48 Efficiency
Ta = 65 °C
Efficiency, η(%)
Output Current (A)
Vin = 105V
Vin = 115V
Vin = 125V
Vin = 135V

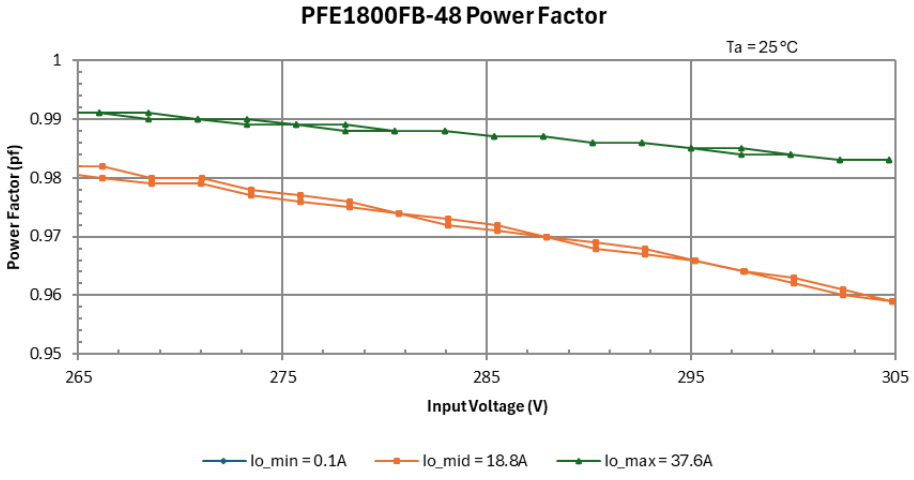

PFE1800FB-48 Efficiency
Ta = 65 °C
Efficiency, η(%)
Output Current (A)
Vin = 200V
Vin = 215V
Vin = 230V
Vin = 245V

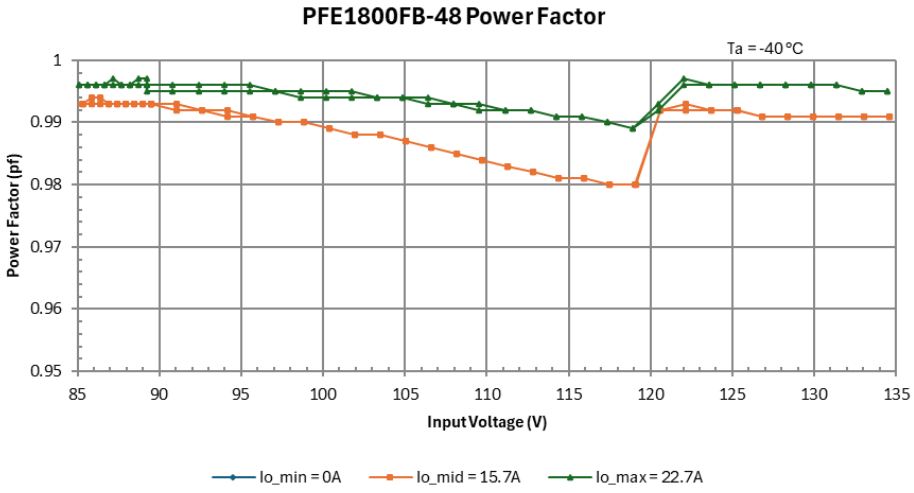

PFE1800FB-48 Efficiency
Ta = 65 °C
Efficiency, η(%)
Output Current (A)
Vin = 265V
Vin = 277V
Vin = 305V

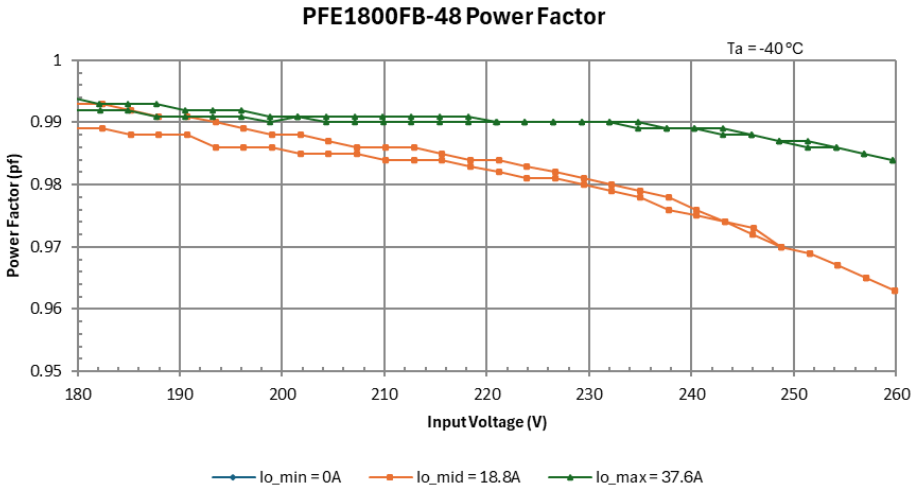
2.1.3. Power Factor (PF) vs. Input Voltage (60 Hz)

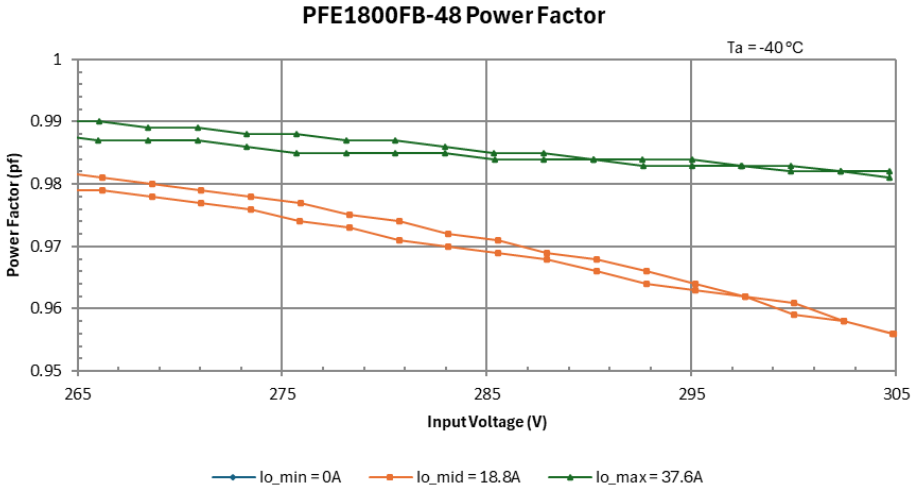


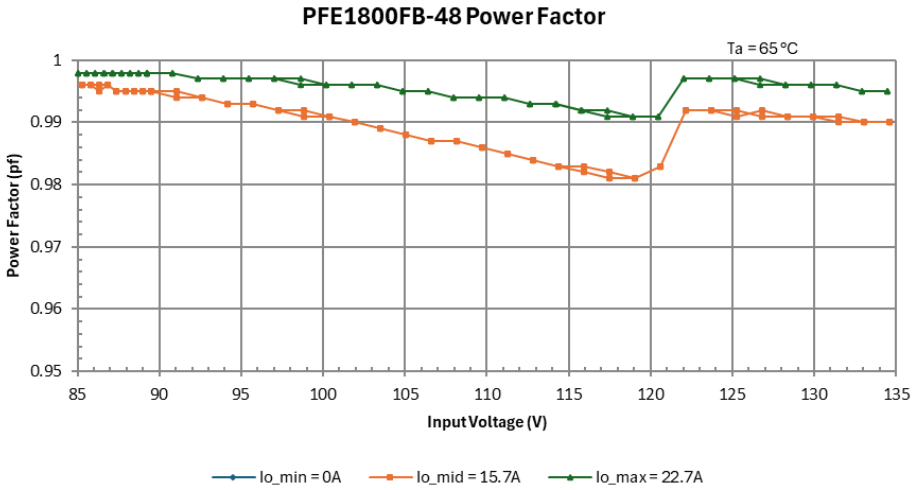


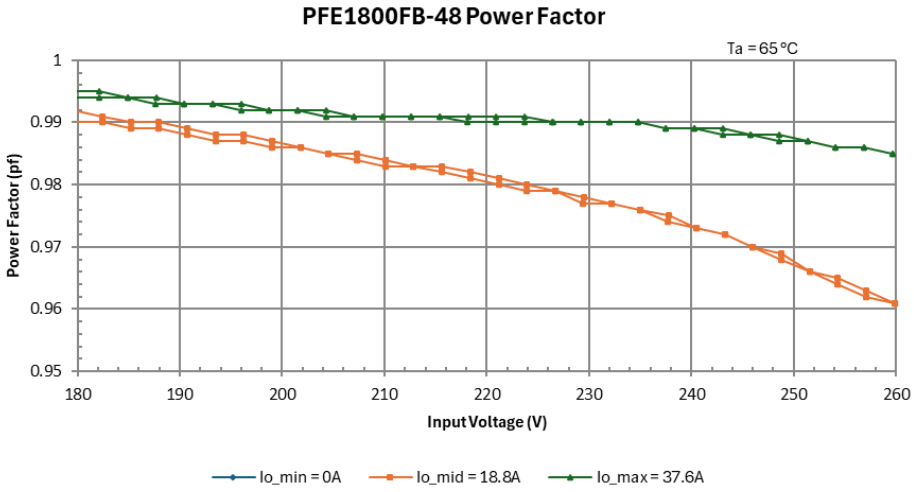


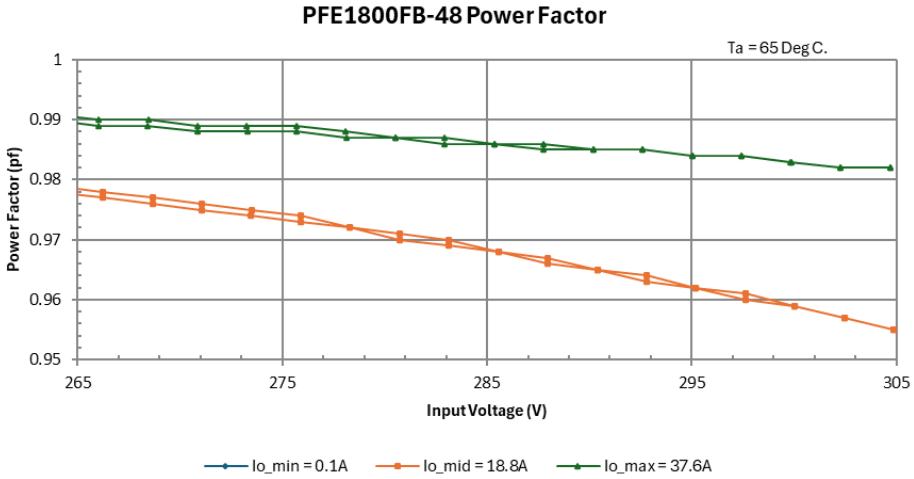

PFE1800FB-48 Power Factor
Ta = -40 °C
Power Factor (pf)
1
0.99
0.98
0.97
0.96
0.95
85
90
95
100
105
110
115
120
125
130
135
Input Voltage (V)
Io_min = 0A
Io_mid = 15.7A
Io_max = 22.7A


PFE1800FB-48 Power Factor
Ta = -40 °C
Power Factor (pf)
1
0.99
0.98
0.97
0.96
0.95
180
190
200
210
220
230
240
250
260
Input Voltage (V)
Io_min = 0A
Io_mid = 18.8A
Io_max = 37.6A

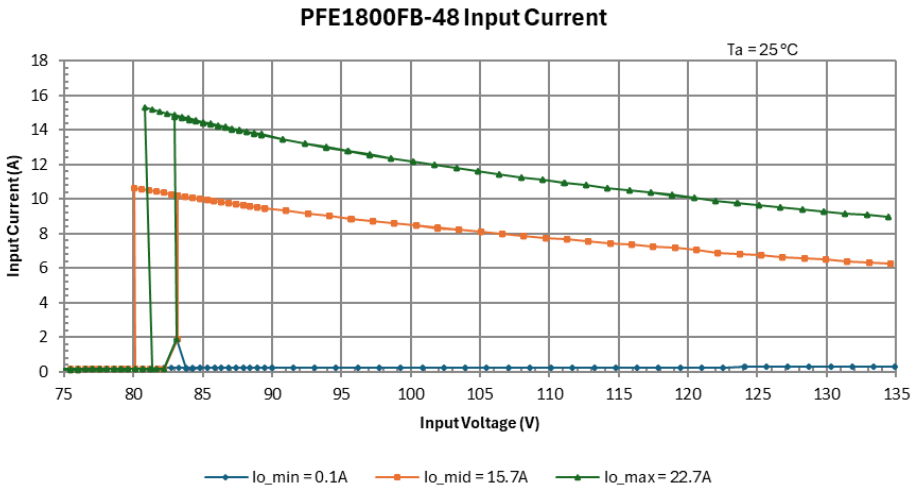

PFE1800FB-48 Power Factor
Ta = -40 °C
Power Factor (pf)
1
0.99
0.98
0.97
0.96
0.95
265
275
285
295
305
Input Voltage (V)
Io_min = 0A
Io_mid = 18.8A
Io_max = 37.6A

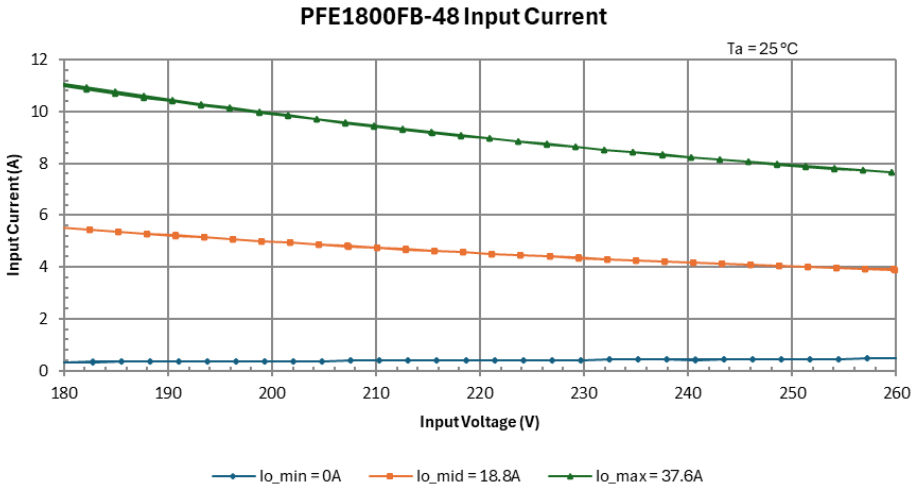

PFE1800FB-48 Power Factor
Ta = 65 °C
Power Factor (pf)
1
0.99
0.98
0.97
0.96
0.95
85
90
95
100
105
110
115
120
125
130
135
Input Voltage (V)
Io_min = 0A
Io_mid = 15.7A
Io_max = 22.7A

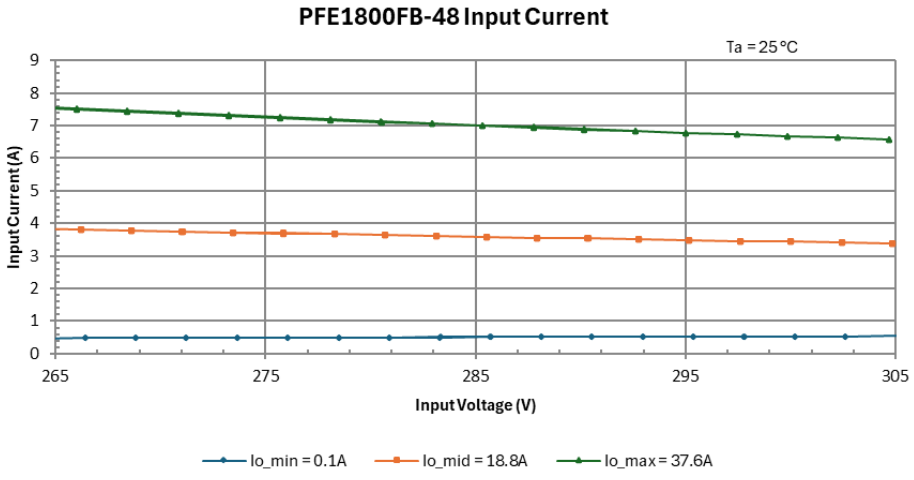

PFE1800FB-48 Power Factor
Ta = 65 °C
Power Factor (pf)
1
0.99
0.98
0.97
0.96
0.95
180
190
200
210
220
230
240
250
260
Input Voltage (V)
Io_min = 0A
Io_mid = 18.8A
Io_max = 37.6A

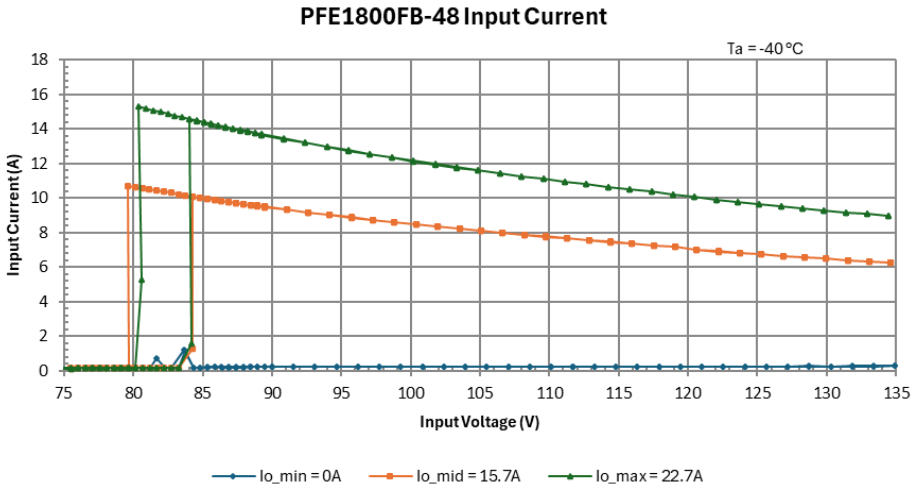

PFE1800FB-48 Power Factor
Ta = 65 Deg C.
Power Factor (pf)
1
0.99
0.98
0.97
0.96
0.95
265
275
285
295
305
Input Voltage (V)
Io_min = 0.1A
Io_mid = 18.8A
Io_max = 37.6A

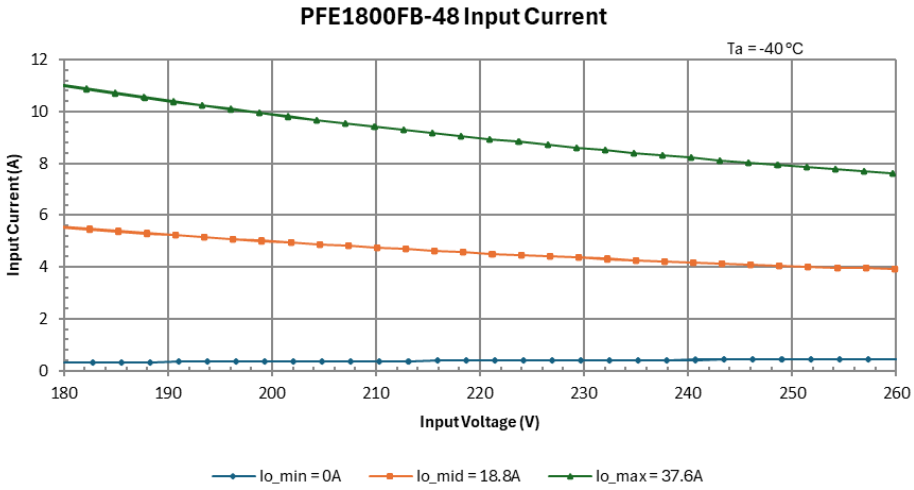
2.1.4. Input Line Current vs. Input Voltage (60 Hz)

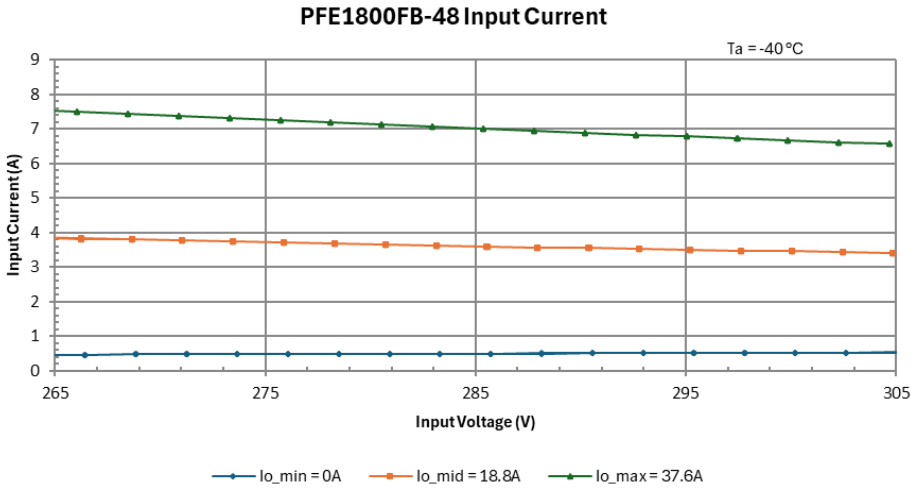


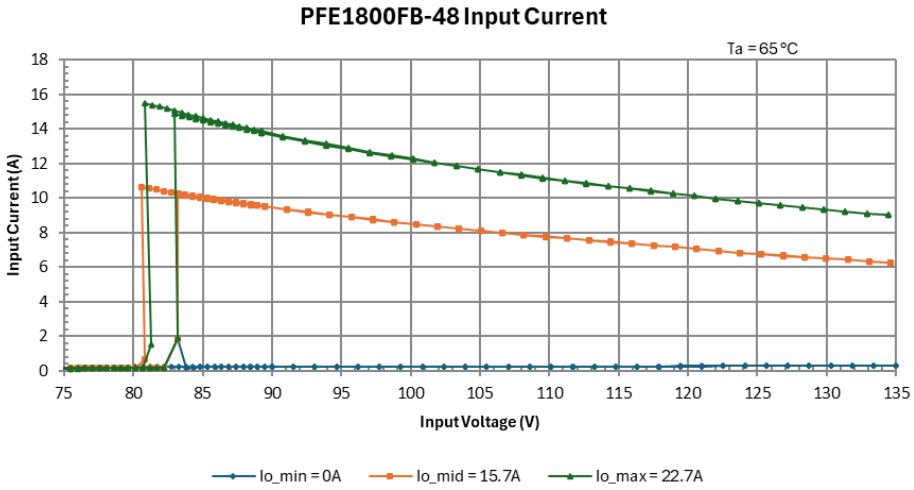


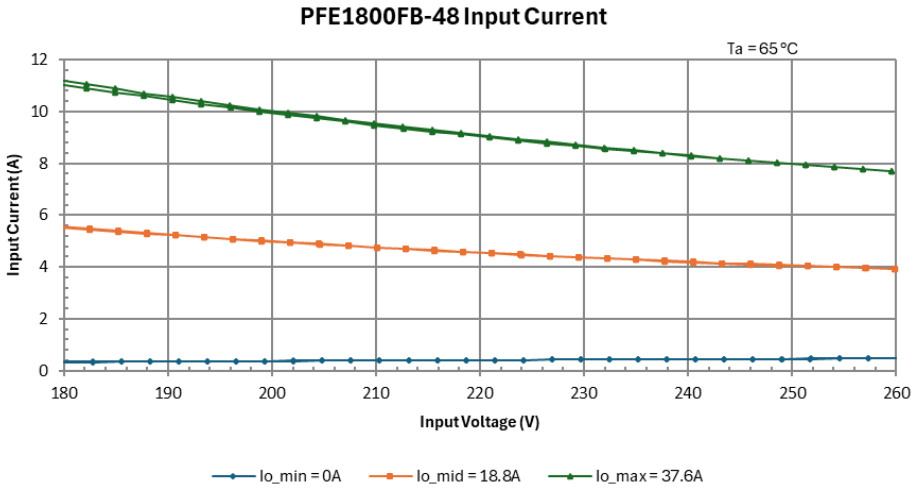


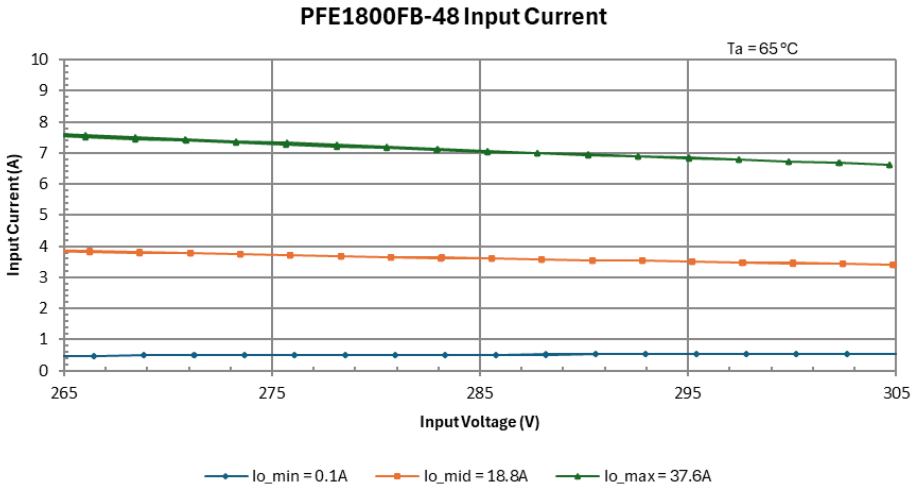

PFE1800FB-48 Input Current
Ta = -40 °C
Input Current (A)
Input Voltage (V)
Io_min = 0A
Io_mid = 15.7A
Io_max = 22.7A


PFE1800FB-48 Input Current
Ta = -40 °C
Input Current (A)
Input Voltage (V)
Io_min = 0A
Io_mid = 18.8A
Io_max = 37.6A

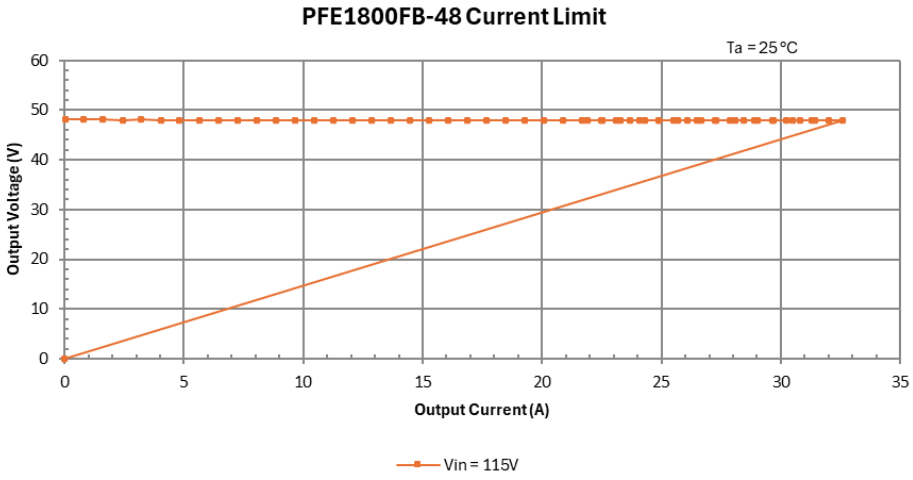

PFE1800FB-48 Input Current
Ta = -40 °C
Input Current (A)
Input Voltage (V)
Io_min = 0A
Io_mid = 18.8A
Io_max = 37.6A

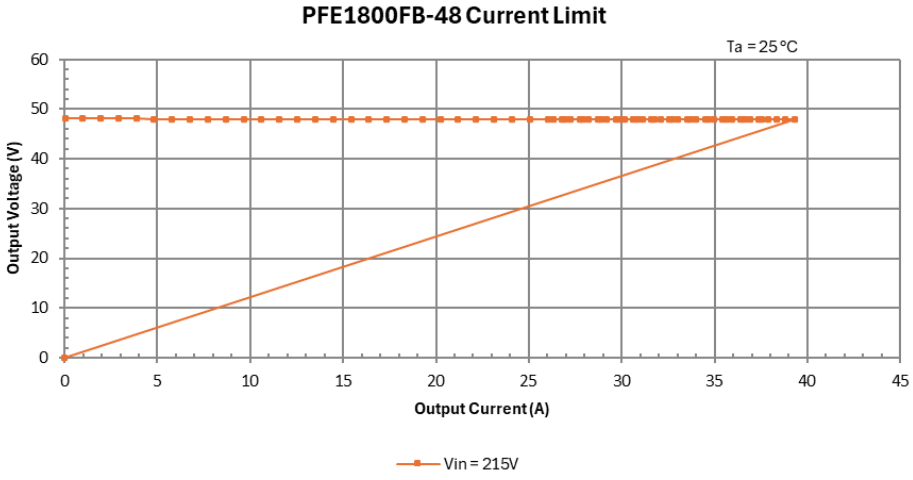

PFE1800FB-48 Input Current
Ta = 65 °C
Input Current (A)
Input Voltage (V)
Io_min = 0A
Io_mid = 15.7A
Io_max = 22.7A

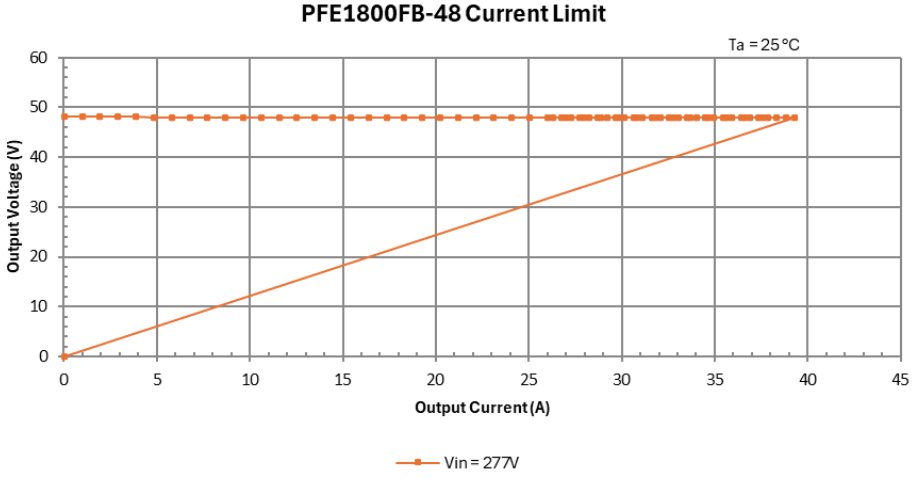

PFE1800FB-48 Input Current
Ta = 65 °C
Input Current (A)
Input Voltage (V)
Io_min = 0A
Io_mid = 18.8A
Io_max = 37.6A

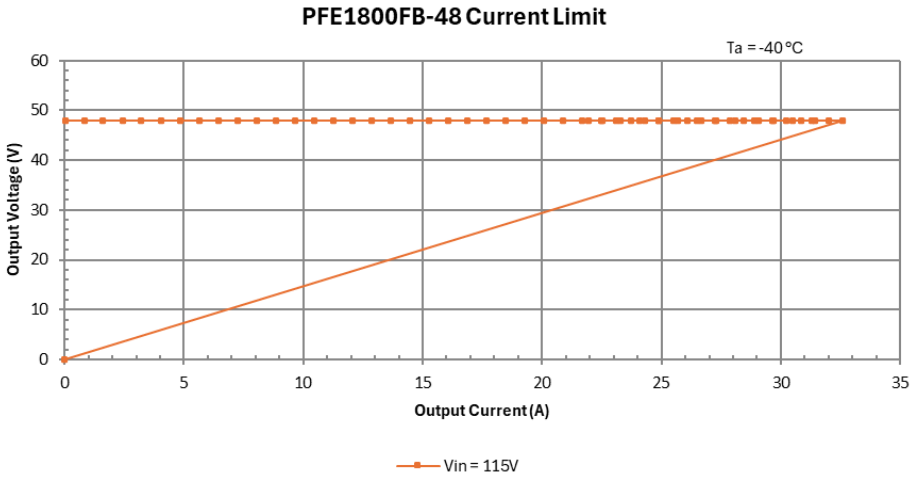

PFE1800FB-48 Input Current
Ta = 65 °C
Input Current (A)
Input Voltage (V)
Io_min = 0.1A
Io_mid = 18.8A
Io_max = 37.6A

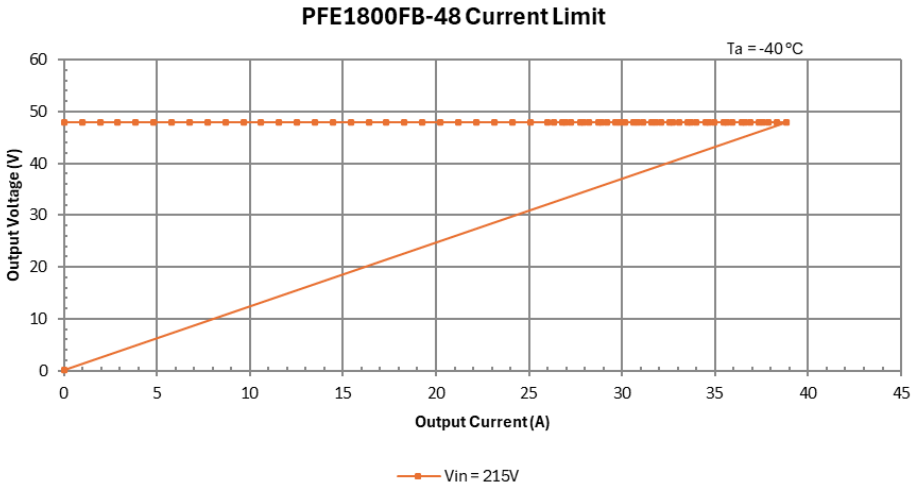
2.1.5. Over Current Protection (OCP) Characteristics (60 Hz)

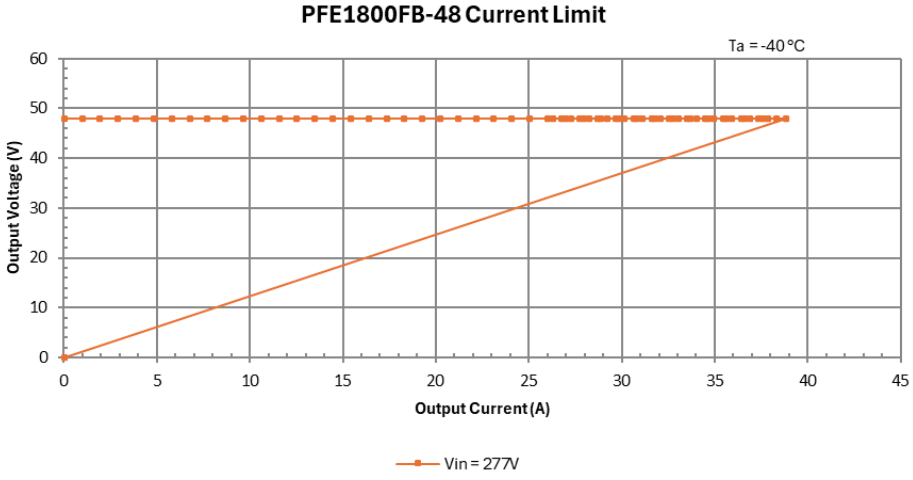


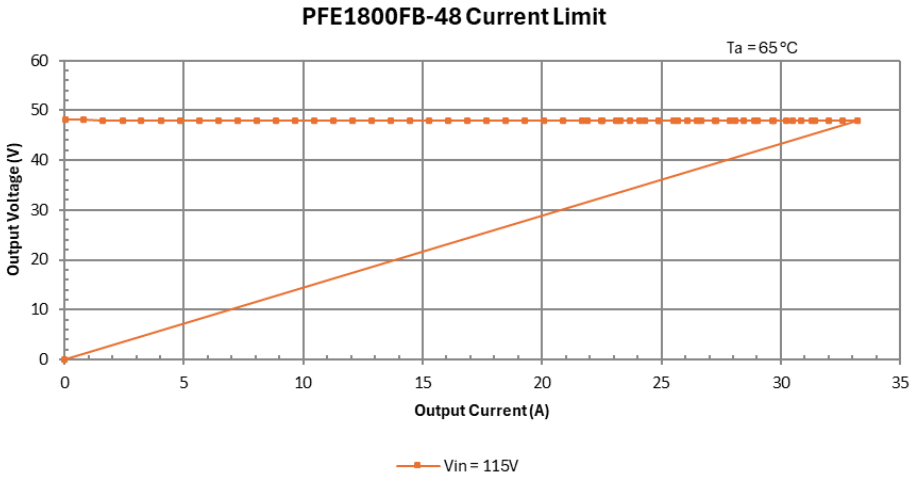


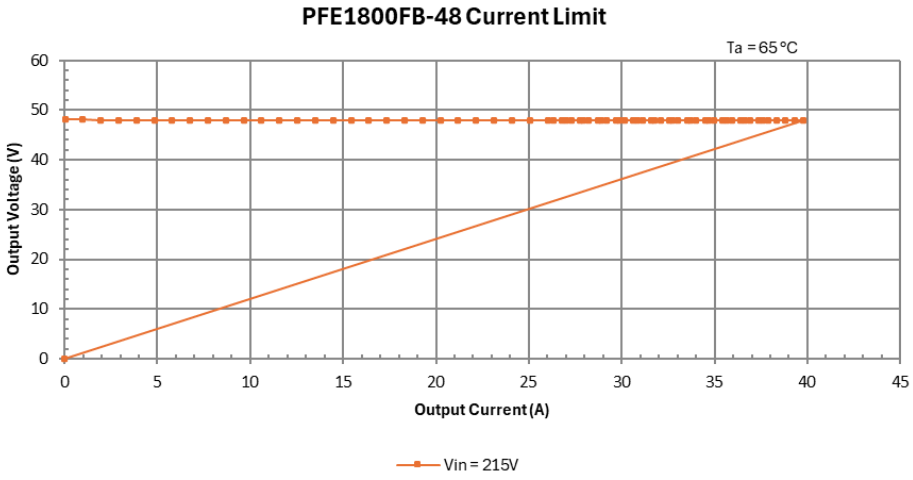


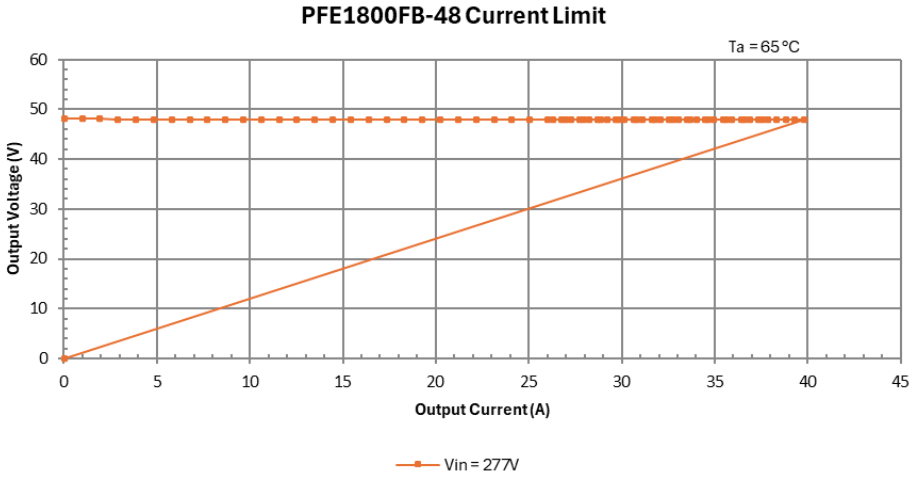

PFE1800FB-48 Current Limit
Ta = -40 °C
Output Voltage (V)
Output Current (A)
Vin = 115V


PFE1800FB-48 Current Limit
Ta = -40 °C
Output Voltage (V)
Output Current (A)
Vin = 215V


PFE1800FB-48 Current Limit
Ta = -40 °C
Output Voltage (V)
Output Current (A)
Vin = 277V


PFE1800FB-48 Current Limit
Ta = 65 °C
Output Voltage (V)
Output Current (A)
Vin = 115V

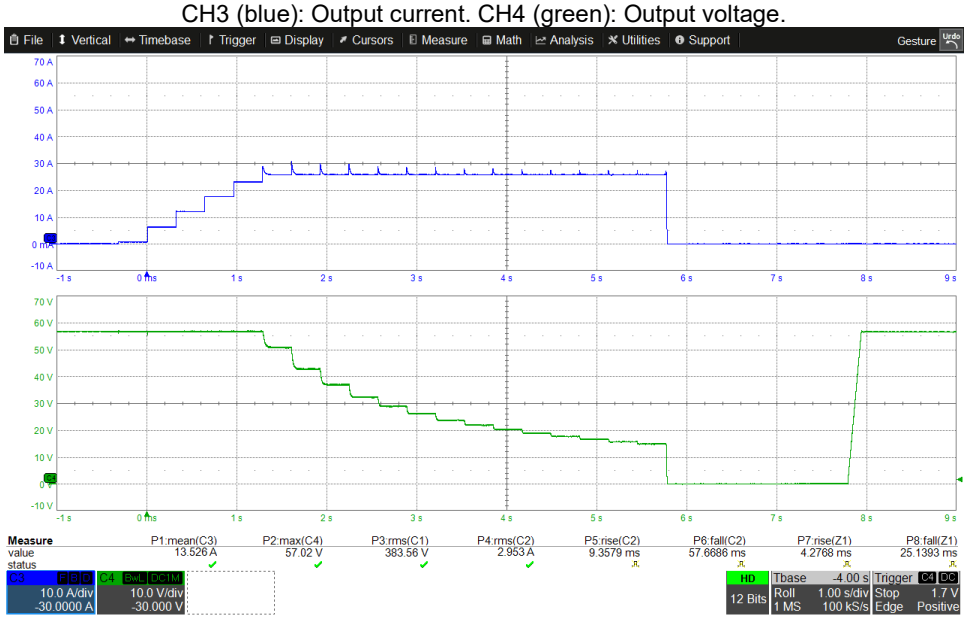

PFE1800FB-48 Current Limit
Ta = 65 °C
Output Voltage (V)
Output Current (A)
Vin = 215V


PFE1800FB-48 Current Limit
Ta = 65 °C
Output Voltage (V)
Output Current (A)
Vin = 277V

2.1.5.1. Voltage Foldback

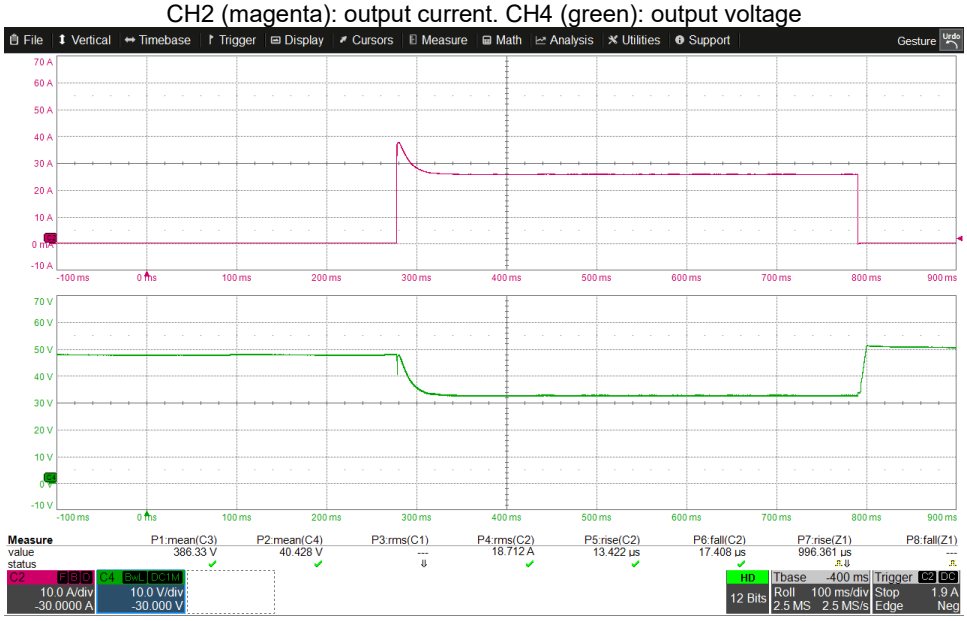
Current Limit is 26 A. Resistive load value is decreased step by step every ~300 ms. Once the load current exceeds the 26 A limit, the output voltage folds back keeping the output current at about 26 A. This continues until the output voltage trips output Under Voltage Protection (UVP) hiccup. The resistive load is removed after UVP, and the output voltage recovers after 2 seconds.

CH3 (blue): Output current. CH4 (green): Output voltage.



Current limit is 26 A. Resistive load is stepped from 1000 Ω to 1.25 Ω. Output voltage folds back to about 32.5 V limiting the output current to about 26 A. Then, the resistive load is stepped back to 1000 Ω and the output voltage returns to 48 V regulation.

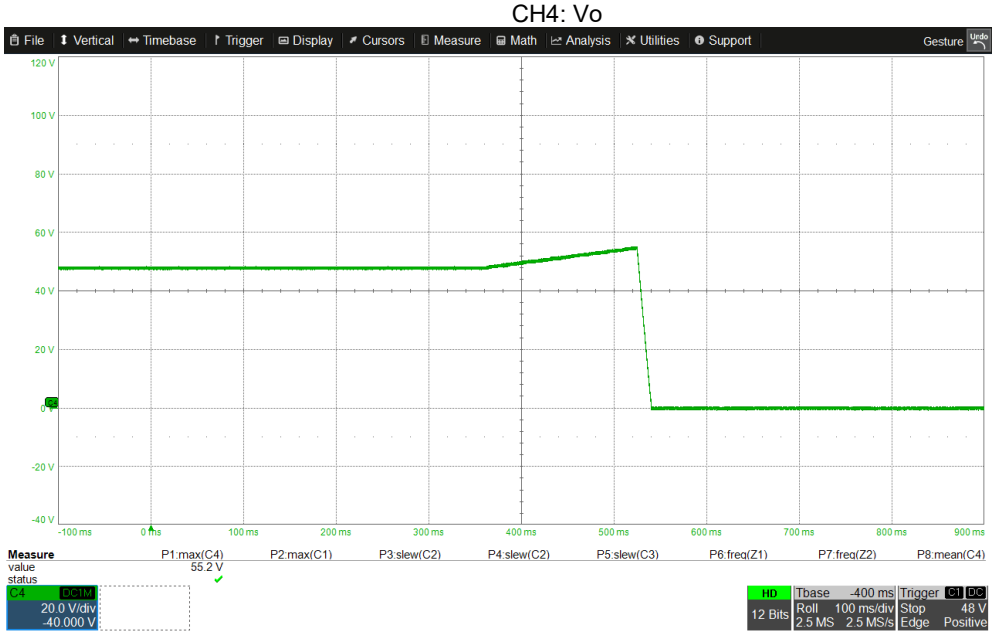
CH2 (magenta): output current. CH4 (green): output voltage



2.2. Over Voltage Protection (OVP) Characteristics

Conditions: **OVP Setpoint = 55 V**	I_O = 4 A
	T_a = 25 °C
	V_{IN} = 115 VAC

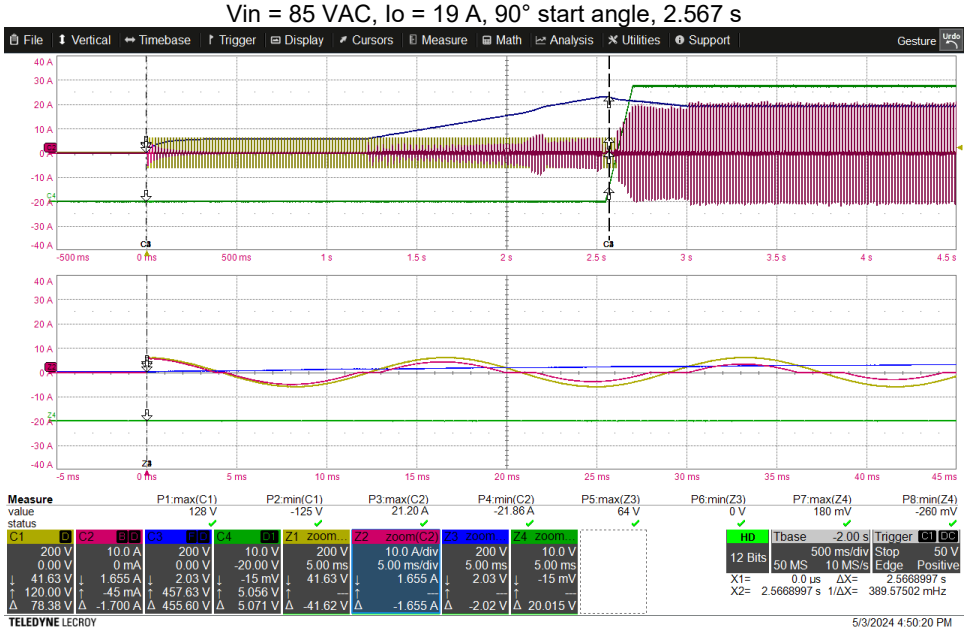
CH4: Vo



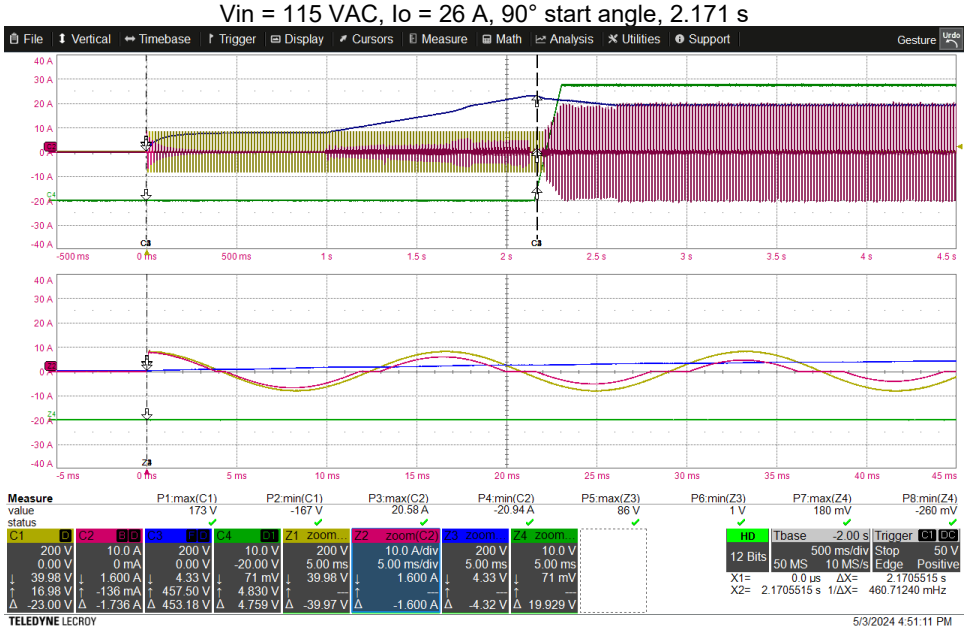
2.3. Turn-On Characteristics from AC Applied

CH1: Vin at fixture input, CH2: Iin at fixture input, CH3: Vbus, CH4: Vo
Top: full waveform. Bottom: zoom of AC applied

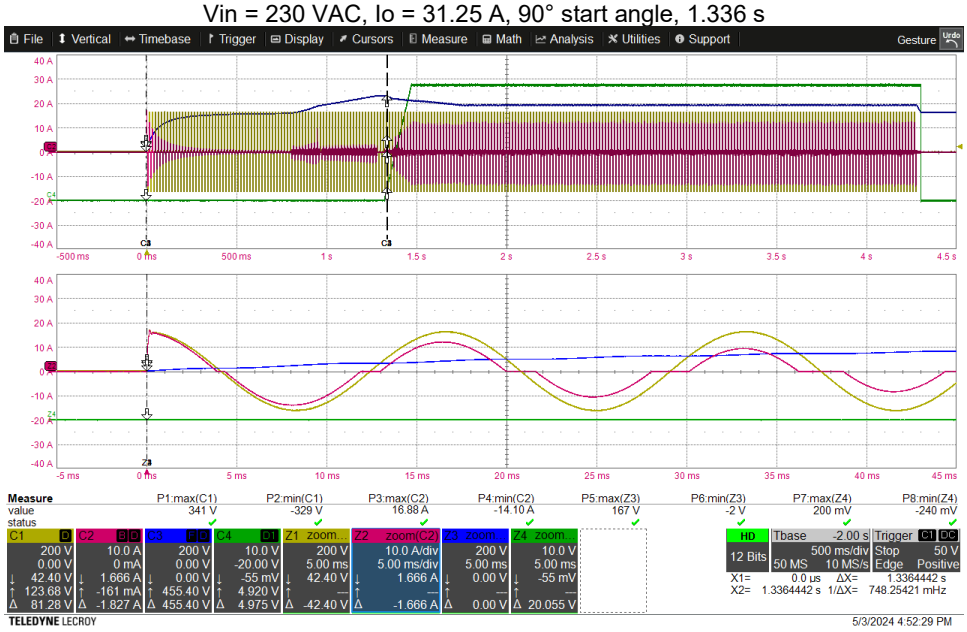
Vin = 85 VAC, Io = 19 A, 90° start angle, 2.567 s



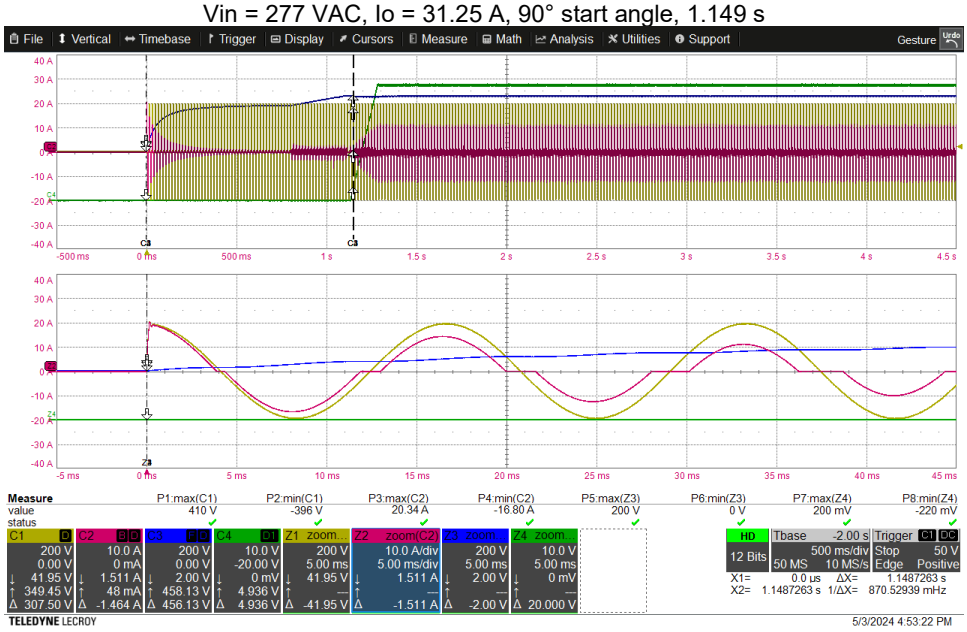
Vin = 115 VAC, Io = 26 A, 90° start angle, 2.171 s



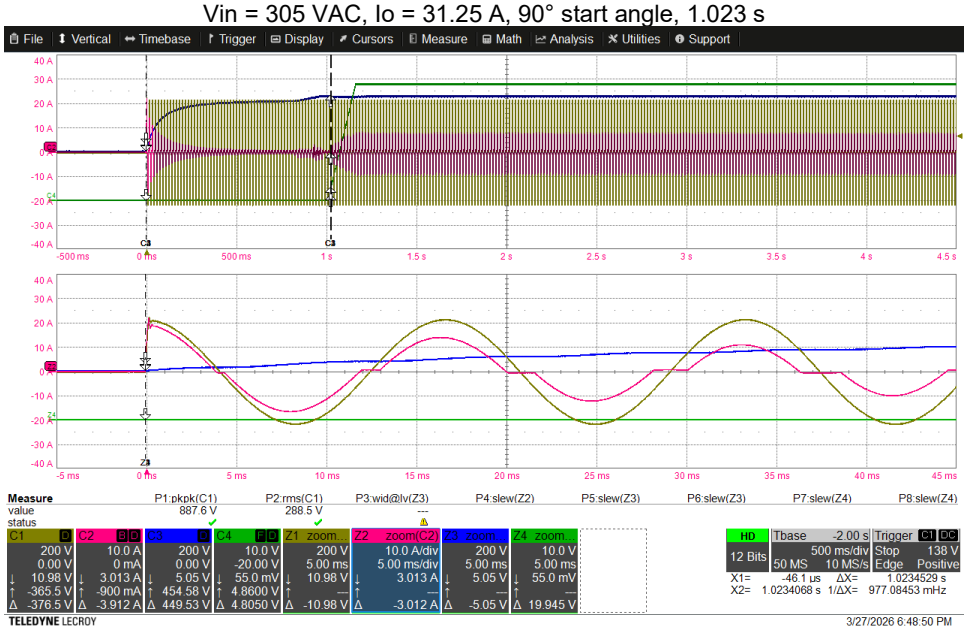
Vin = 230 VAC, Io = 31.25 A, 90° start angle, 1.336 s



Vin = 277 VAC, Io = 31.25 A, 90° start angle, 1.149 s

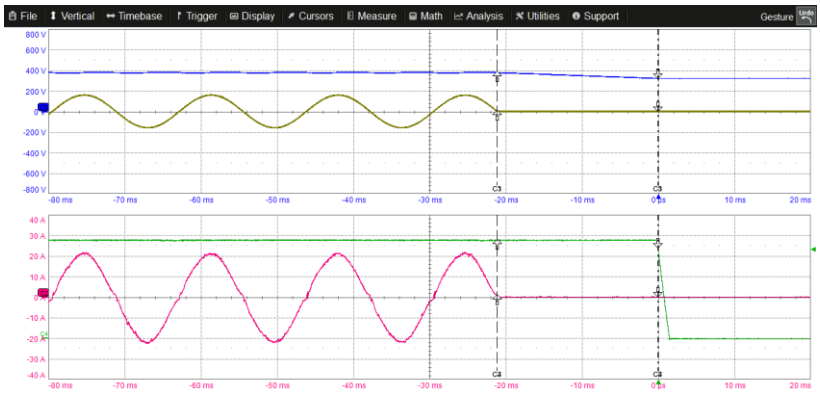


Vin = 305 VAC, Io = 31.25 A, 90° start angle, 1.023 s



2.4. Hold-Up Time Characteristic

Hold-up time is defined as the time from the loss of AC voltage to Vo violating its regulation accuracy specification at 100% load.

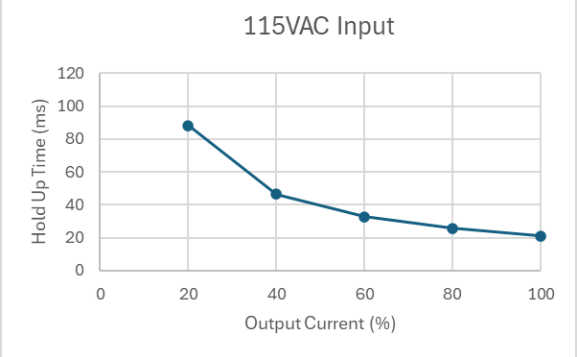


Vin = 115 VAC
Io = 31.25 A

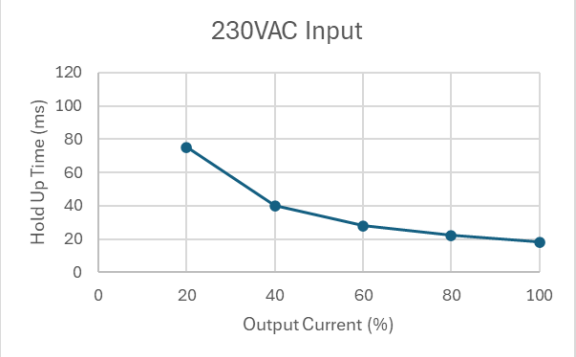
21.1 ms

Ch1: Vin (pre-filter)
Ch2: Iin (pre-filter)
Ch3: Vbus
Ch4: Vout

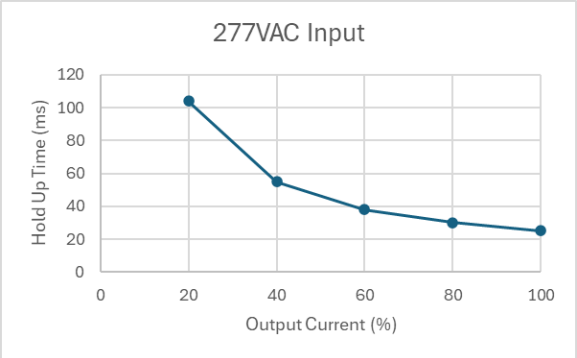
Vin = 115 VAC, Vo = 48 VDC
100% Io = 31.25 A



Vin = 230 VAC, Vo = 48 VDC
100% Io = 37.5 A



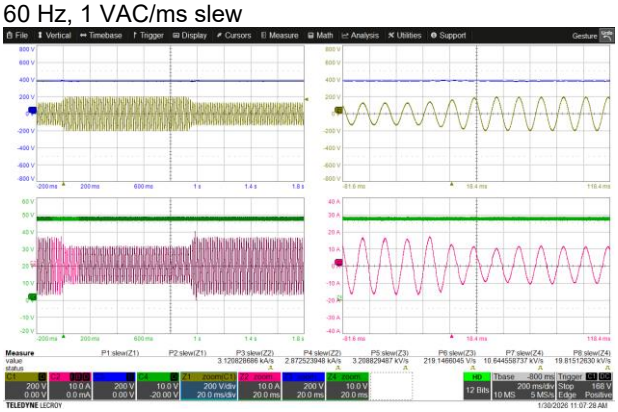
Vin = 277 VAC, Vo = 48 VDC
100% Io = 37.5 A



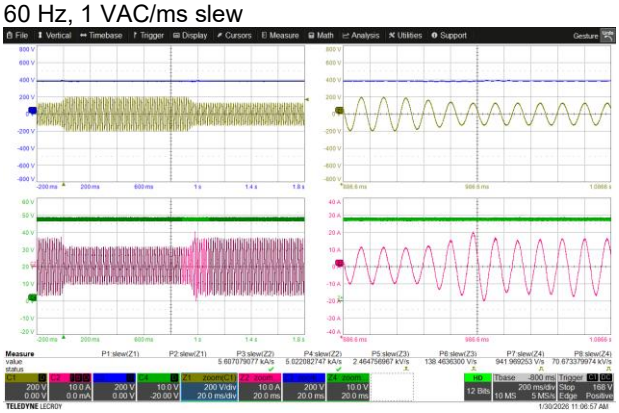
2.5. Dynamic Line Response (60 Hz)

CH1: AC line (pre-filter), CH2: AC input current, CH3: Vbus, CH4: Vout
Left: full waveform. Right: zoom of a transient.

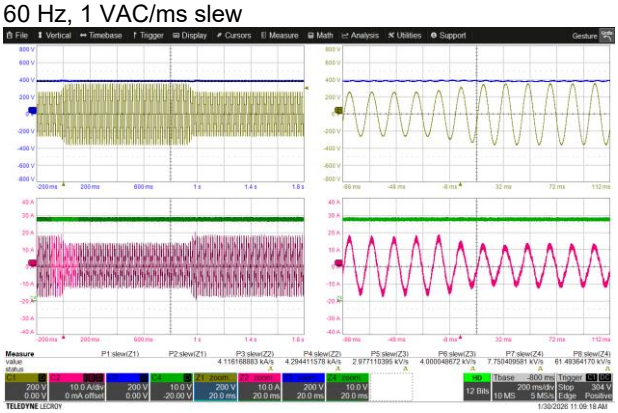
Vin = 92 VAC to 138 VAC, Io = 19 A
60 Hz, 1 VAC/ms slew



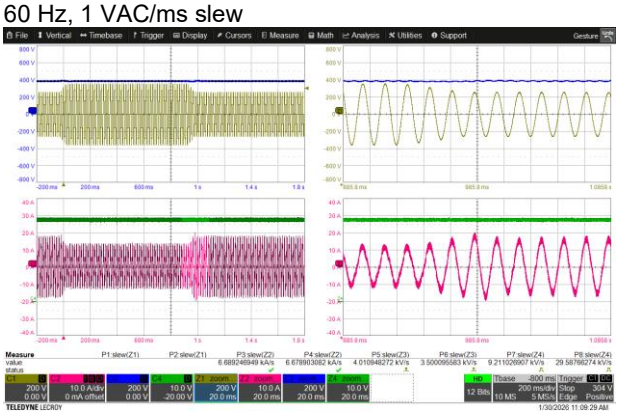
Vin = 92 VAC to 138 VAC, Io = 19 A
60 Hz, 1 VAC/ms slew



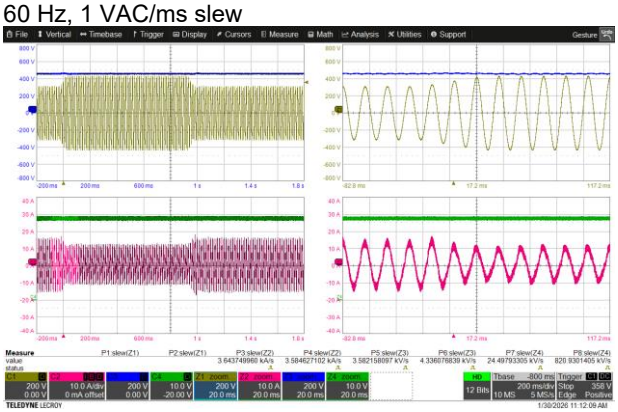
Vin = 184VAC to 253 VAC, Io = 37.5 A
60 Hz, 1 VAC/ms slew



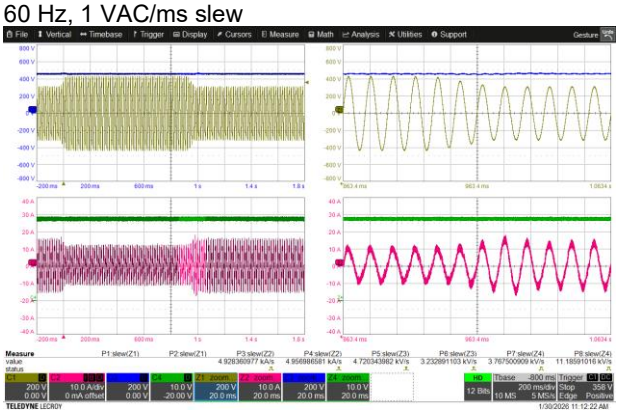
Vin = 184 VAC to 253 VAC, Io = 37.5 A
60 Hz, 1 VAC/ms slew



Vin = 221 VAC to 305 VAC, Io = 37.5 A
60 Hz, 1 VAC/ms slew



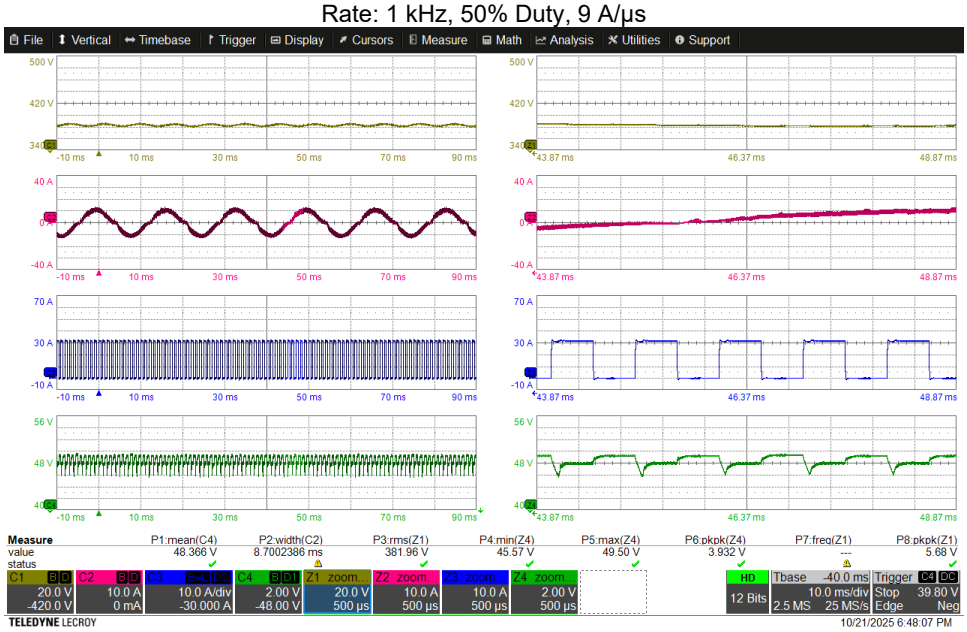
Vin = 221 VAC to 305 VAC, Io = 37.5 A
60 Hz, 1 VAC/ms slew



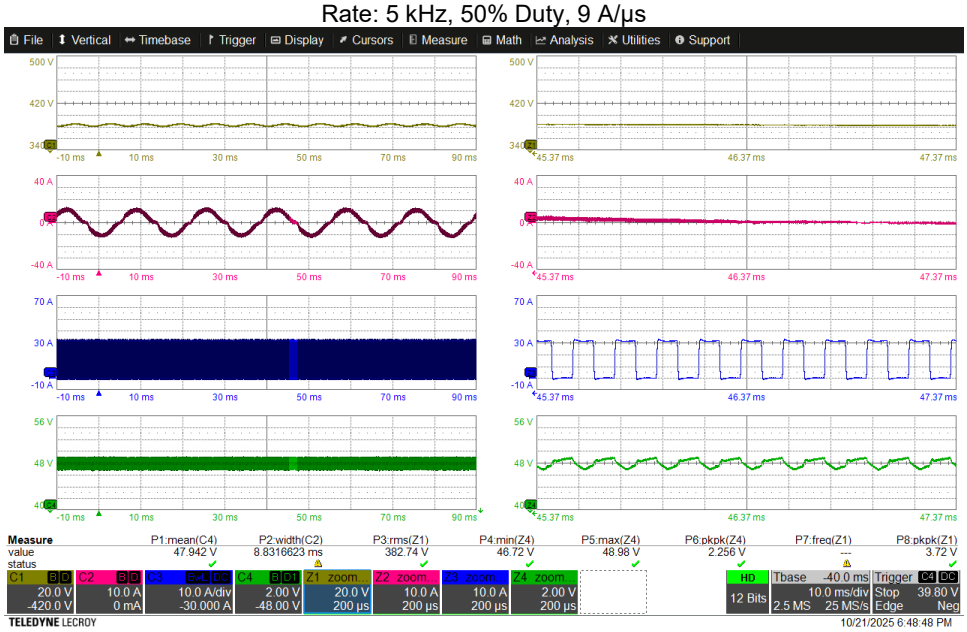
2.6. Dynamic Load Response

CH1: Vbus, CH2: Input current at module input, CH3: Io, CH4: Vo

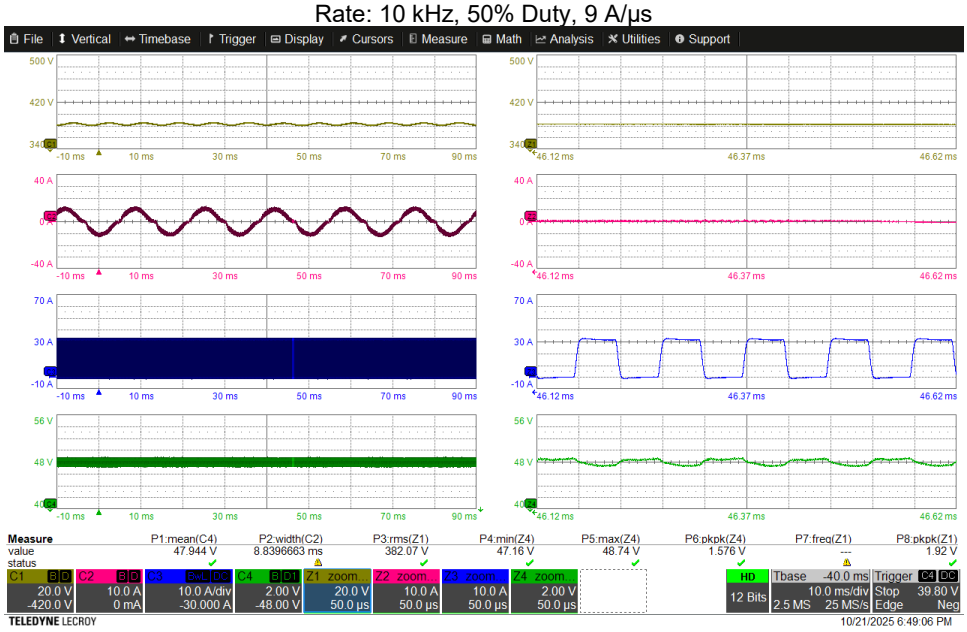
Vin = 115 VAC, Io = 0 A - 31.25 A, Vo = 48 V
Rate: 1 kHz, 50% Duty, 9 A/µs



Vin = 115 VAC, Io = 0 A - 31.25 A, Vo = 48 V
Rate: 5 kHz, 50% Duty, 9 A/µs

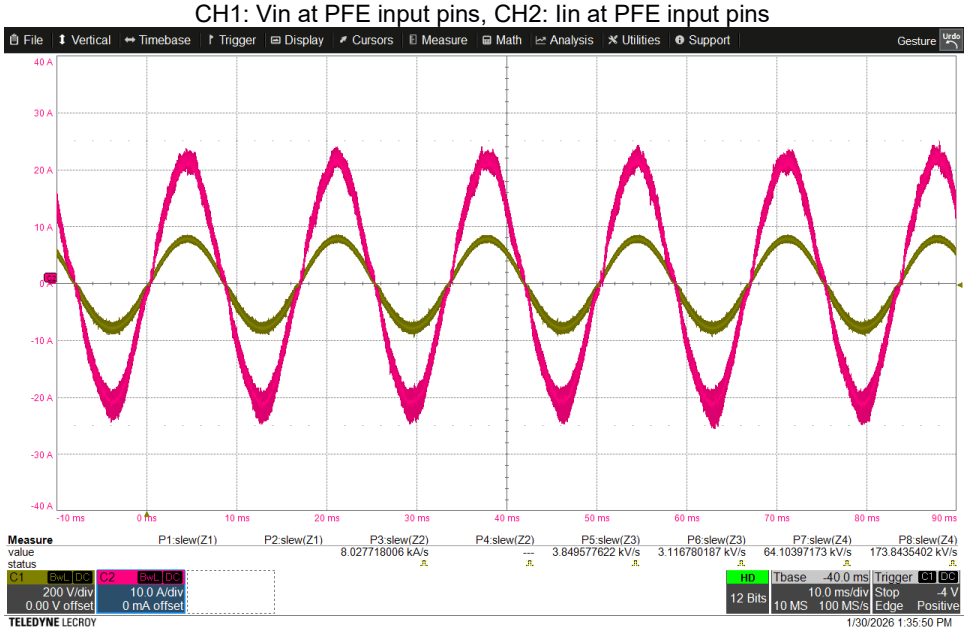


Vin = 115 VAC, Io = 0 A - 31.25 A, Vo = 48 V
Rate: 10 kHz, 50% Duty, 9 A/µs

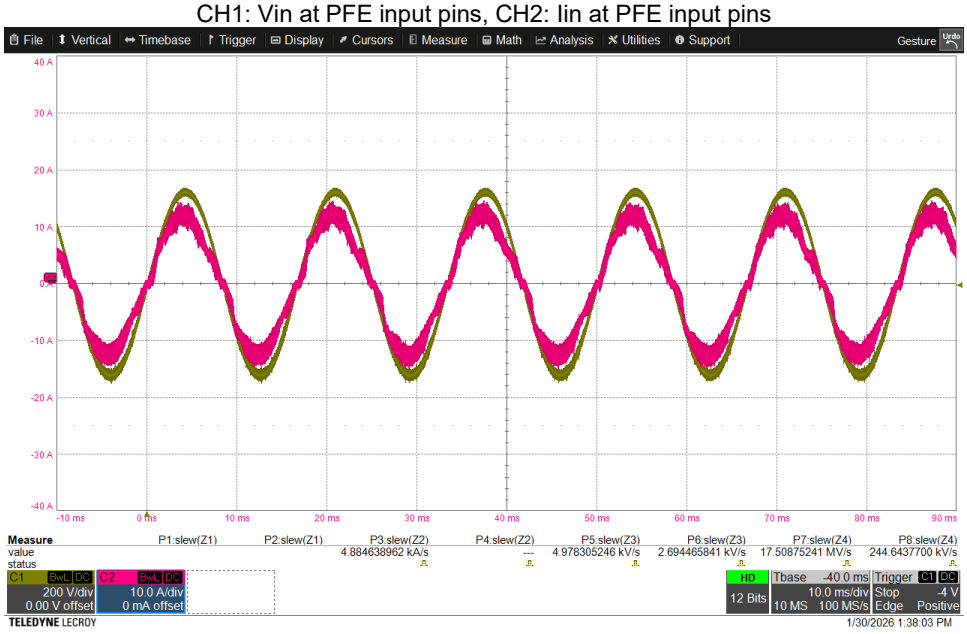


2.7. Input Current Waveform

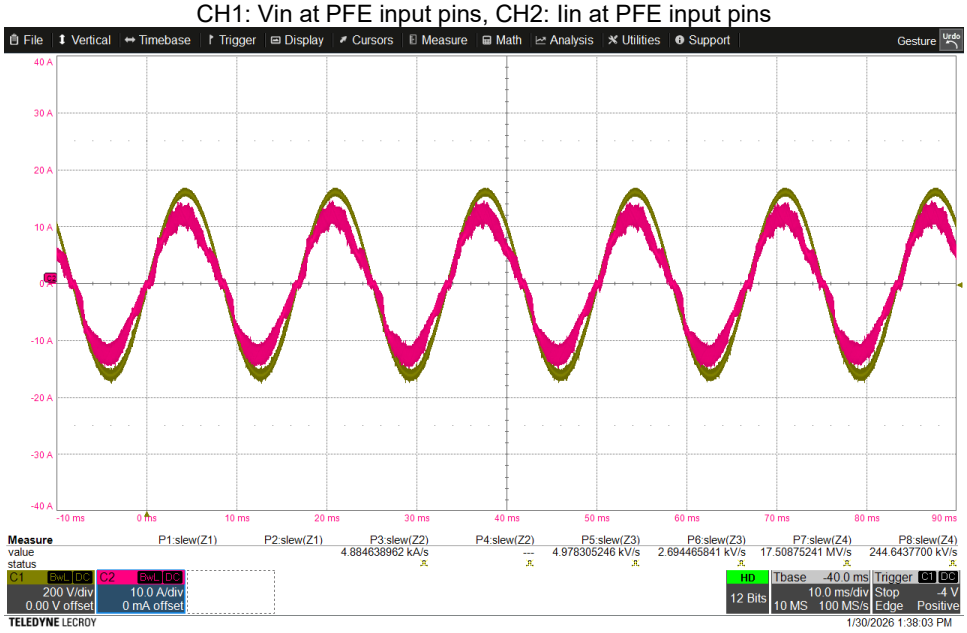
Vin = 115 VAC 60 Hz, Load = 31.25 A
CH1: Vin at PFE input pins, CH2: Iin at PFE input pins



Vin = 230 VAC 60 Hz, Load = 37.5 A
CH1: Vin at PFE input pins, CH2: Iin at PFE input pins

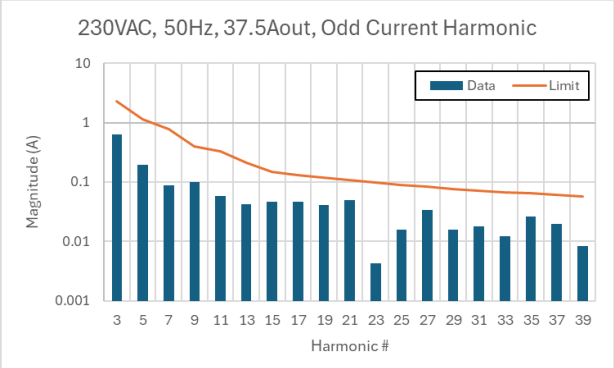


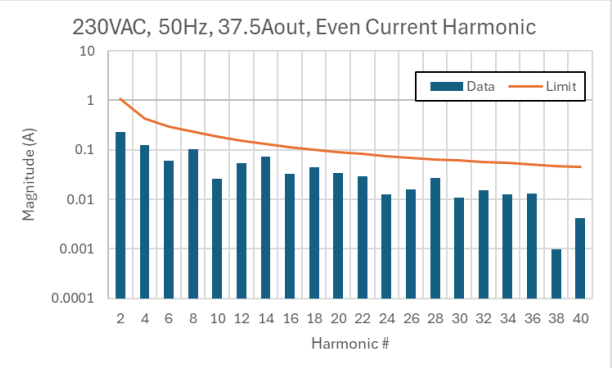
Vin = 230 VAC 60 Hz, Load = 37.5 A
CH1: Vin at PFE input pins, CH2: Iin at PFE input pins



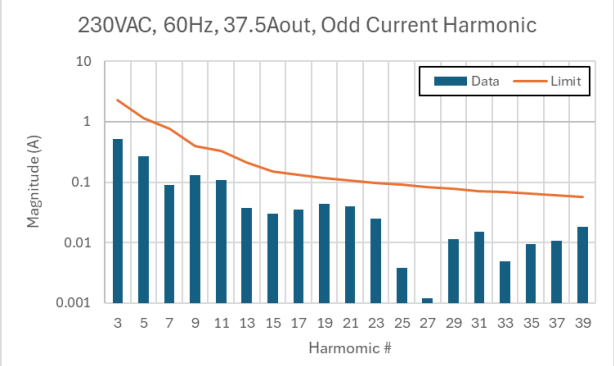
2.8. Input Current Harmonics

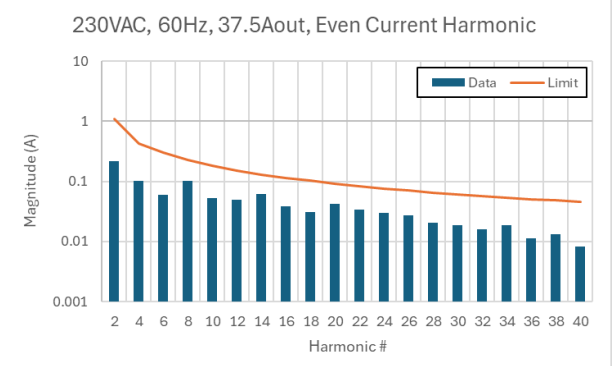
2.8.1. 230 VAC, 50 Hz, 37.5 A output





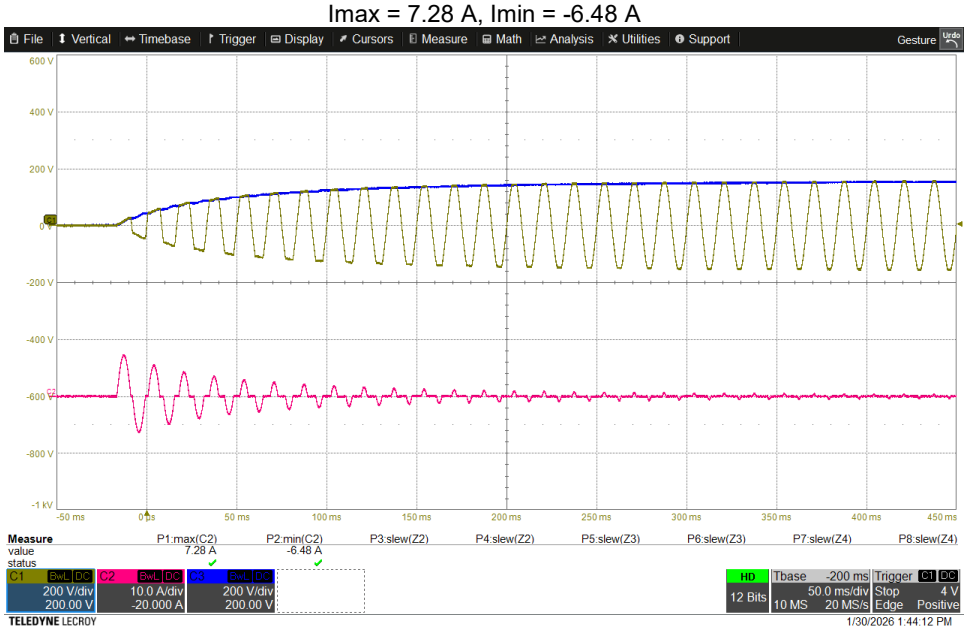
2.8.2. 230 VAC, 60 Hz, 37.5 A output



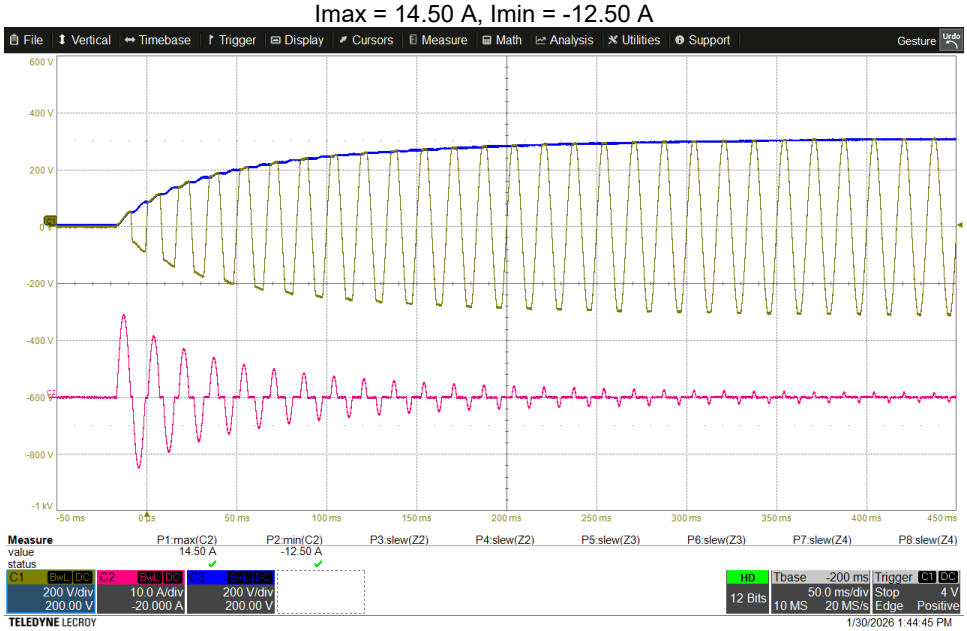


2.9. Input Inrush Current

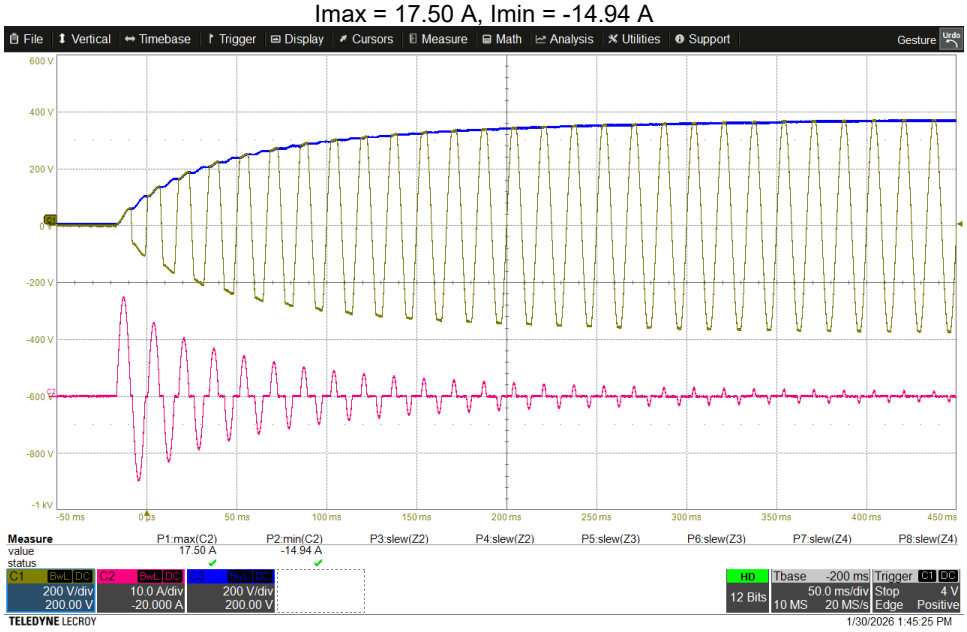
Vin = 115 VAC, Vo = 48 V
CH1: Vin, CH2: Iin, CH3: Vbus
Imax = 7.28 A, Imin = -6.48 A



Vin = 230 VAC, Vo = 48 V
CH1: Vin, CH2: Iin, CH3: Vbus
Imax = 14.50 A, Imin = -12.50 A



Vin = 230 VAC, Vo = 48 V
CH1: Vin, CH2: Iin, CH3: Vbus
Imax = 17.50 A, Imin = -14.94 A



2.10. Brownout Data

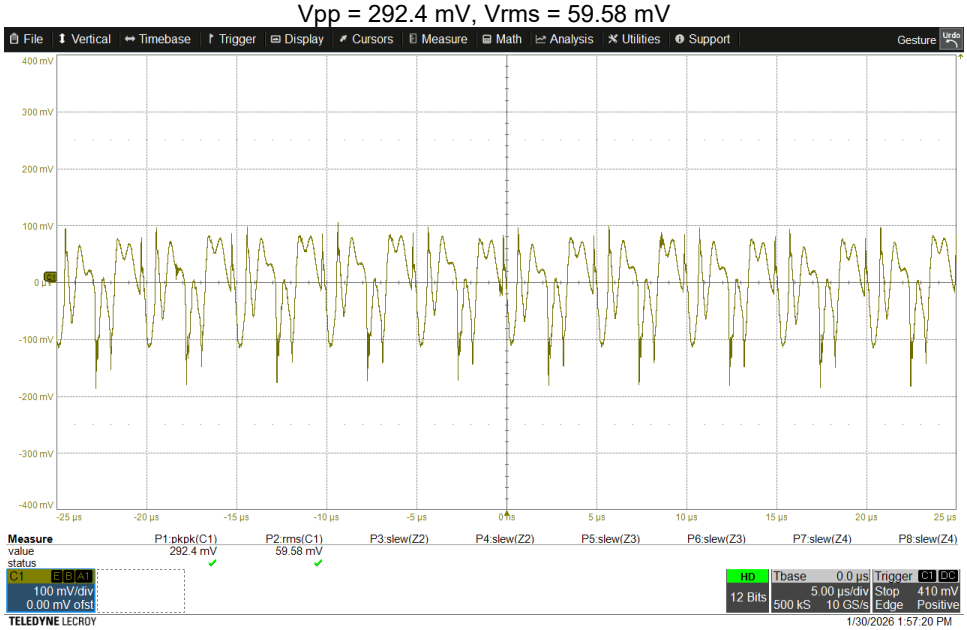
Vo = 48 V
Hardware: Vbus 4 x 470 µF (electrolytic cap), Output 2 x 470 µF (electrolytic cap), 8 x 4.7 µF ceramic cap.

Results table
A = criteria A - DUT operates within specification limits during and after test.
B = criteria B - DUT exhibits a change in performance when operating then self-recovered.
A/B = some are criteria A or criteria B based on start angle.

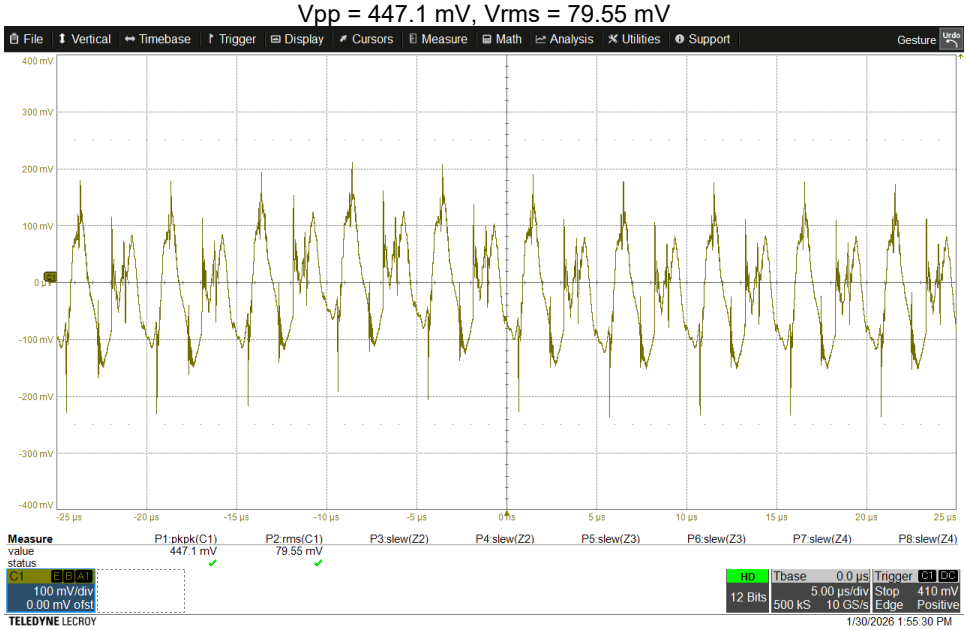
	50 Hz			60 Hz		
	115 VAC	**230 VAC**	**277 VAC**	**115 VAC**	**230 VAC**	**277 VAC**
70% VAC, 0.5 cycle	A	A/B	A	A	A/B	A
40% VAC, 25 cycle	B	B	B	B	B	B
0% VAC, 250/300 cycles	B	B	B	B	B	B
0% VAC, 0.5 cycle	A/B	A/B	A	A	A/B	A
0% VAC, 1 cycle	B	B	B	B	B	A/B
40% VAC, 10 cycles	B	B	B	B	B	B
70% VAC, 25 cycles	B	A	A	B	A	A
80% VAC, 250 cycles	B	A	A	B	A	A
0% VAC, 250 cycles	B	B	B	B	B	B

2.11. Output Ripple and Noise

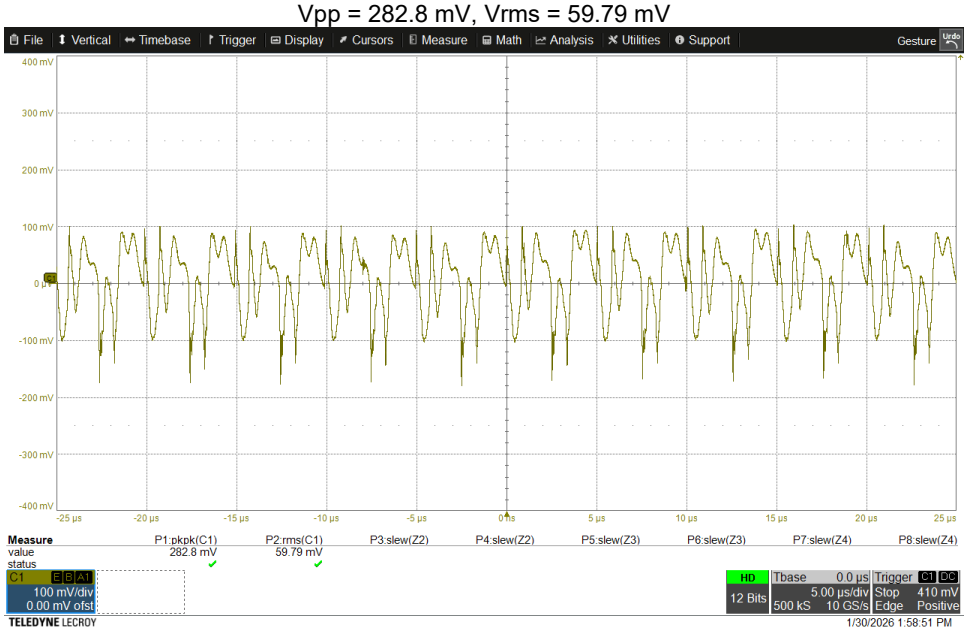
Vin = 115 VAC 60 Hz, Io = 3 A, Vo = 48 VDC, 20 MHz BW
Vpp = 292.4 mV, Vrms = 59.58 mV



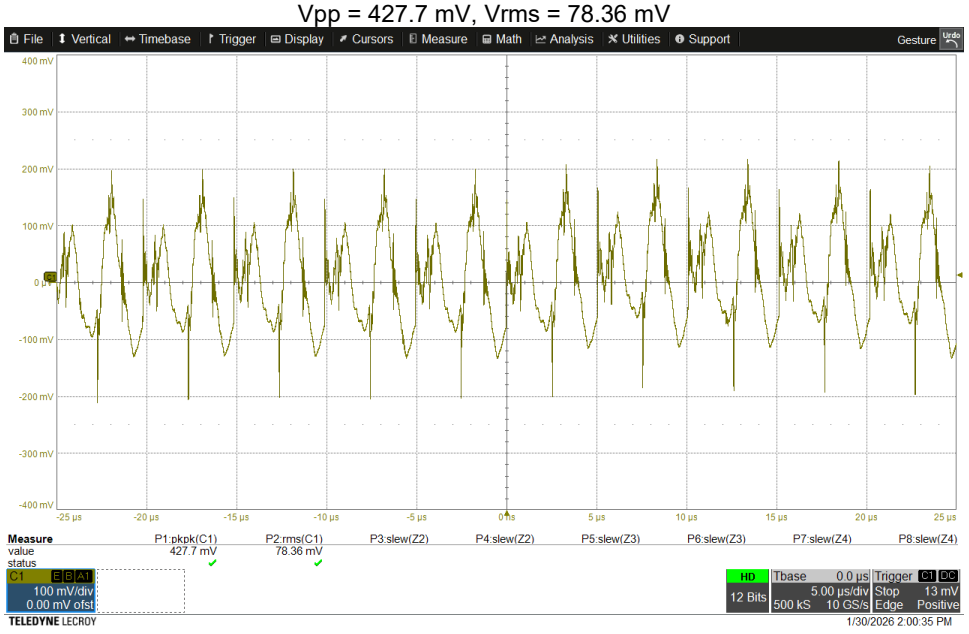
Vin = 115 VAC 60 Hz, Io = 31.2 A, Vo = 48 VDC, 20 MHz BW
Vpp = 447.1 mV, Vrms = 79.55 mV



Vin = 230 VAC 60 Hz, Io = 3 A, Vo = 48 VDC, 20 MHz BW
Vpp = 282.8 mV, Vrms = 59.79 mV



Vin = 230 VAC 60 Hz, Io = 37.5 A; Vo = 48 VDC, 20 MHz BW
Vpp = 427.7 mV, Vrms = 78.36 mV



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