# CY-SD1124A
# 45W USB-C PD Power Adapter Solution
# (PAG1P-A3 and PAG1S-A1)
# CoolGaN Test Report
# Version 1.0

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# Contents

# 1. Introduction

Cypress CYPAP111 part of PAG1P family is designed for a secondary controlled AC/DC flyback converter topology. In this topology, the voltage and current regulation is performed by the secondary controller. CYPAP111 is responsible for providing the start-up function, driving the primary side FET as well as responding to fault conditions

Cypress CYPAS131 part of PAG1S family is an integrated secondary-side synchronous flyback controller, synchronous rectifier (SR) controller, and charging port controller. CYPAS131 is designed to fit a secondary-controlled flyback system with a primary startup controller (CYPAP111) with secondary-side sensing and regulation. CYPAS131 is targeted towards mobile power adapters, it fits well into high-efficiency AC-DC flyback designs for USB Power Delivery, Qualcomm Quick Charge, and other standard charging protocols. CYPAS131 also supports USB Power Delivery (USB PD 3.0) Programmable Power Supply (PPS) mode.

The interface between CYPAP111 and CYPAS131 is through a Pulse Edged Transformer and its associated circuitry.

This document contains test results of PAG1P + PAG1S based 45W Power Adapter solution board. The tests were performed on this board which is equipped with Cypress CYPAP111A3-10SXQ on primary and CYPAS131A1-24LQXQ on secondary section of the converter.

Table 1-1 Test Specification

| **Parameter** | **Value** |
|---|---|
| Input Voltage | 90 – 265Vac |
| Rated Input Voltage for CY-SD1124 | 100 – 240Vac |
| Input Frequency | 47 – 63Hz |
| Max Output Power | 45W |
| Main Output Vo / Io | PDO-Fixed: 5V/3A;<br>PDO-Fixed: 9V/3A;<br>PDO-Fixed: 15V/3A;<br>PDO-Fixed: 20V/2.25A;<br>PDO-PPS: 3.3V – 16V / 3A;<br>PDO-PPS: 3.3V – 21V / 2.25A |
| Efficiency | CoC Tier-2, DoE Level-6 |
| Standby Power | CoC Tier-2, DoE Level-6 |
| Protection | OVP, UVP, OCP, SCP, OTP |

# 2. Test Setup

## 2.1 DUT (Device Under Test)

CY-SD1124A 45W CoolGaN PAG1P+PAG1S Solution Kit:

Table 2-1 PAG1P-PAG1S Solution Kit Details

| DUT contents | Description |
| --- | --- |
| CYPAP111A3-10SXQ and CYPAS131A1-24LQXQ | Primary and Secondary Devices |
| Firmware Version | #2648 |

Dimensions (in mm): 39(L) x 35.4(W) x 30(H)

Figure 2.1-1 Side view of 45W Solution Demo Kit showing Pulse Transformer Board

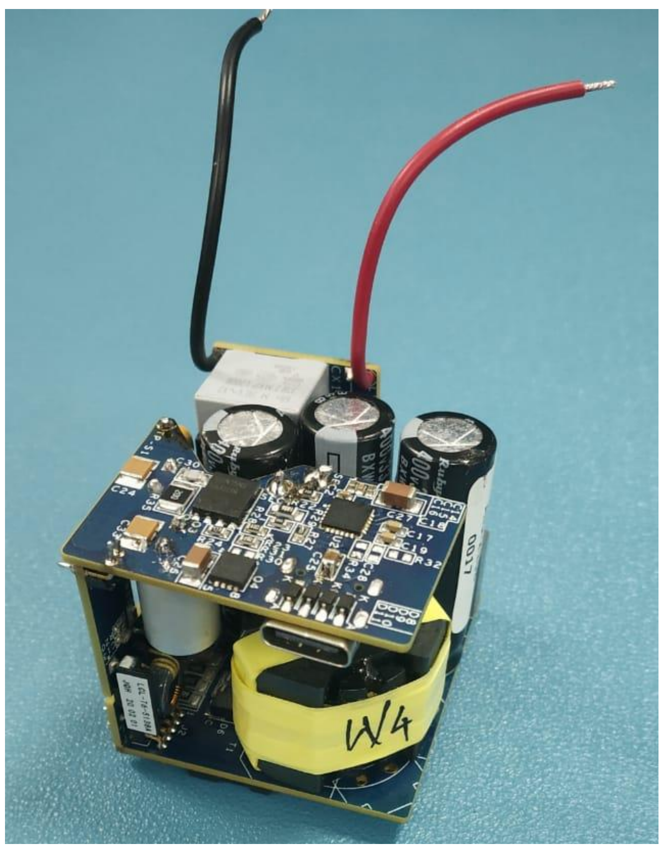


Figure 2.1-2 Bottom view showing Primary side board

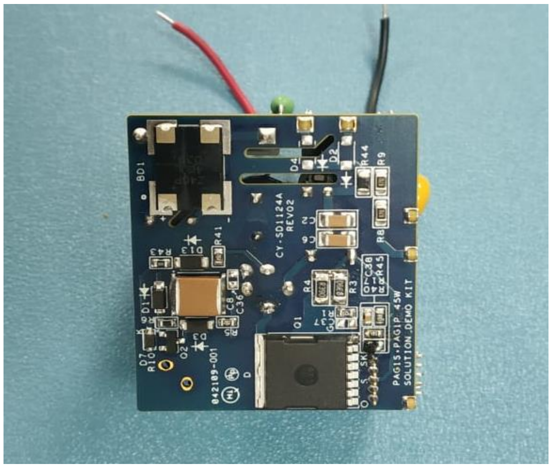
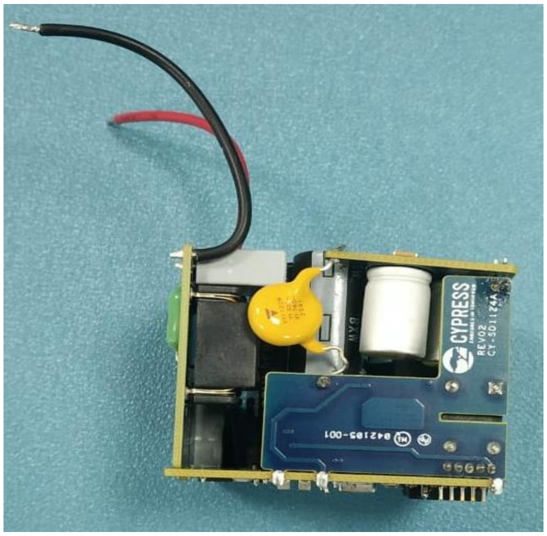


Figure 2.1-3 Top View showing Secondary side board

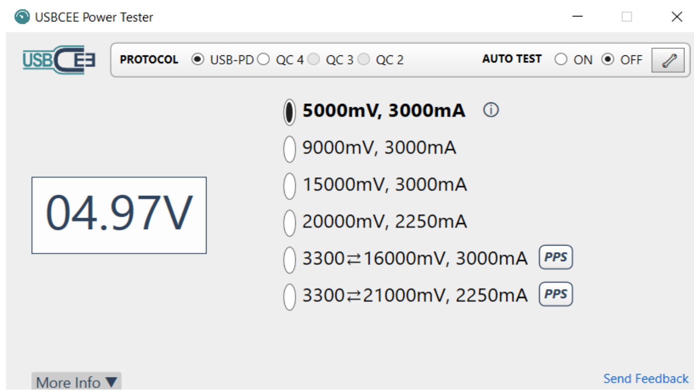
Figure 2.1-4 Side view showing EMI input filter board



## 2.2 DUT Setup

Figure 2.1-1 Physical CCGPROG PAT and Power Tester UI

CCPROG PAT : USB-C POWER ADAPTER TESTER




The DUT is connected to PAT i.e., Power Adapter Tester (CCPROG PAT) using a USB Type-C cable. Once a successful connection is established PAT UI does a PDO discovery and displays the same on the UI. In our case, the solution kit is pre-configured with 6 PDOs:

PDO 1: 5V, 3A FIXED
PDO 2: 9V, 3A FIXED
PDO 3: 15V, 3A FIXED
PDO 4: 20V, 2.25A FIXED
PDO 5: 3.3V-16V, 0-3A PPS
PDO 6: 3.3V-21V, 0-2.25A PPS

One can either choose the suitable pre-configured PDO or configure a new one using Cypress EZ-PD Configuration Utility. For the Tests in the following sections, we use the pre-configured PDOs.

To know more about PAT Tester and UI, visit: USBCEE: https://www.usbcee.com/product-details/3

**Type C-C cable (1meter long) used:** Type C-C cable being used for all the tests mentioned in this report is 3027003-01M. Datasheet is available at: http://www.qualtekusa.com/images/Cable%20Assemblies/PDF_2/3027003-01M.pdf

## 2.3 Test Equipment

Table 2-2 Test Equipment List

| Test setup | Description |
|---|---|
| Oscilloscope Name | Tektronix DPO 4104 |
| Power Meter | Yokogawa WT310E |
| Digital Multimeter (Vo & Io) | Agilent 34411A |
| Programmable AC Source | Chroma 61501 |
| Electronic Load | Chroma 63102A |
| Thermal Camera | Flir E75 |
| Automation Software | LabView |

# 3. Power Management Test Results

**Note: All the tests mentioned in this report are carried-out under open-frame condition.**

The results documented here are based on the test reports of PAG1P-PAG1S 45W CoolGaN Solution Demo Kit

## 3.1 Efficiency 4-pt average

### 3.1.1 Detailed Data

Table 3-1 Efficiency* Results

| Parameter | Standard (Minimum value) | | | Unit | Test Condition | Test Result | |
|---|---|---|---|---|---|---|---|
| | DoE Level-6 | | CoCv5 Tier 2 | | | 115Vac 60Hz | 230Vac 50Hz |
| Four-point Average Efficiency (Average of 25%, 50%, 75%, 100% load) | 78.63 | | 78.93 | % | Vo = 3.3Vdc, Io = 3A | 87.63 | 83.18 |
| | 81.39 | | 81.84 | % | Vo = 5Vdc, Io = 3A | 89.53 | 85.95 |
| | 86.62 | | 87.30 | % | Vo = 9Vdc, Io = 3A | 90.64 | 88.79 |
| | 87.73 | | 88.85 | % | Vo = 15Vdc, Io = 3A | 90.85 | 90.01 |
| | 87.73 | | 88.85 | % | Vo = 20Vdc, Io = 2.25A | 91.26 | 90.33 |
| | | | | | | | |
| CoCv5 Tier2 10% load Efficiency | | | 69.66 | % | Vo = 3.3Vdc, Io = 0.3A | 81.77 | 74.28 |
| | | | 72.48 | % | Vo = 5Vdc, Io = 0.3A | 83.73 | 76.86 |
| | | | 77.30 | % | Vo = 9Vdc, Io = 0.3A | 86.13 | 79.12 |
| | | | 78.85 | % | Vo = 15Vdc, Io = 0.3A | 86.62 | 82.57 |
| | | | 78.85 | % | Vo = 20Vdc, Io = 0.225A | 85.92 | 81.60 |
| | | | | | | | |
| | **Standard (Maximum value)** | | | | | **Test Result** | |
| **Parameter** | **DoE Level-6** | | **CoCv5 Tier 2** | | **Test Condition** | **115Vac 60Hz** | **230Vac 50Hz** |
| No load consumption | 100 | | 75 | mW | No USB sink attached | 25 | 28 |

- Peak Efficiency: **91.85%** (At 115Vac-60Hz, 20V-2.25A)

** For Vout = 3.3V, 100% load is considered as 2.95A due to CC limit for that condition.*

*** Vout for efficiency calculations is measured across Vbus_C at board end with 30 minutes' warmup**

*** Variation of ±1% in efficiency can be observed across units**

### 3.1.2 Graphs

Figure 3.1-1 Efficiency at 90Vac, 47Hz

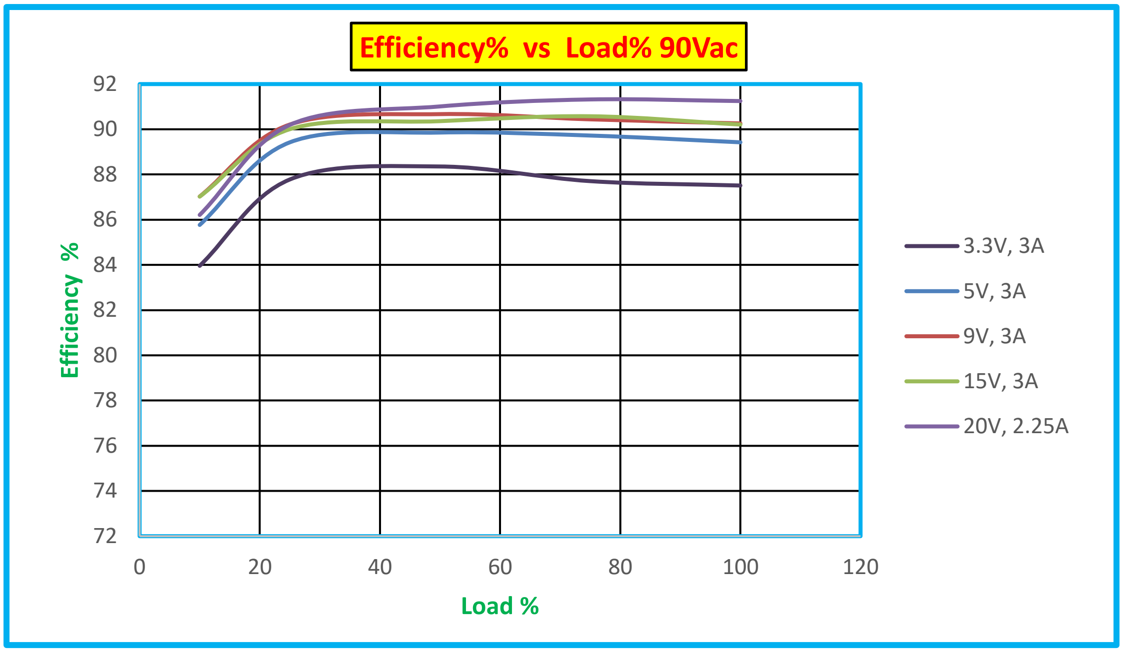



Figure 3.1-2 Efficiency at 115Vac, 60Hz

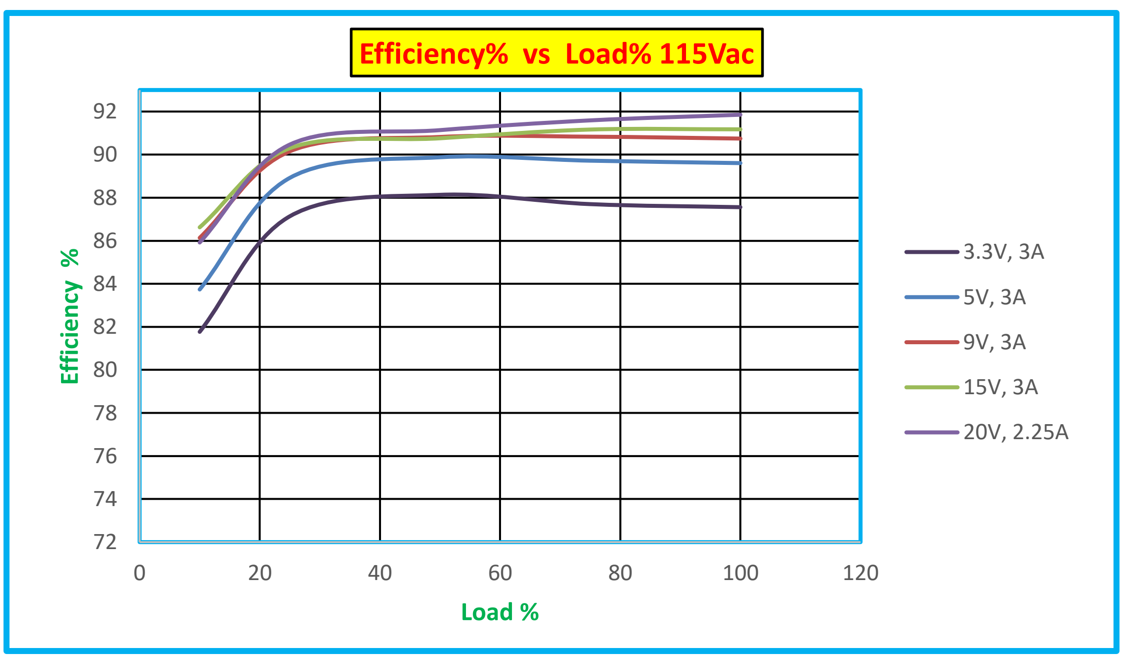


Figure 3.1-3 Efficiency at 230Vac, 50Hz

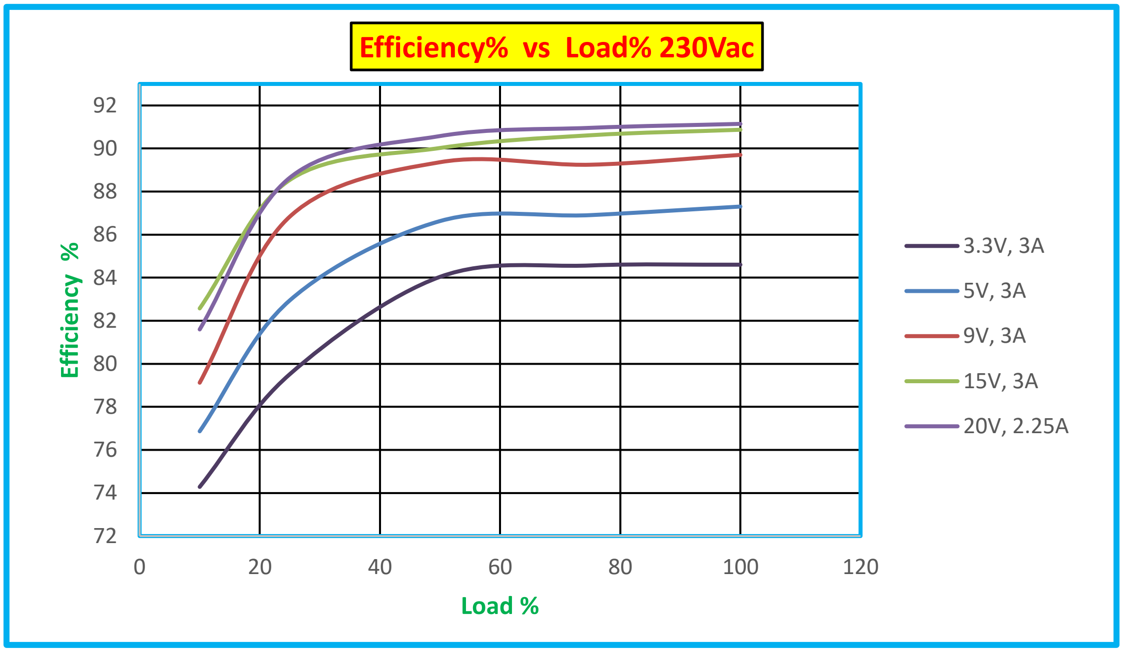



Figure 3.1-4 Efficiency at 265Vac, 63Hz

## 3.2 Standby Power Consumption

### 3.2.1 Detailed Data

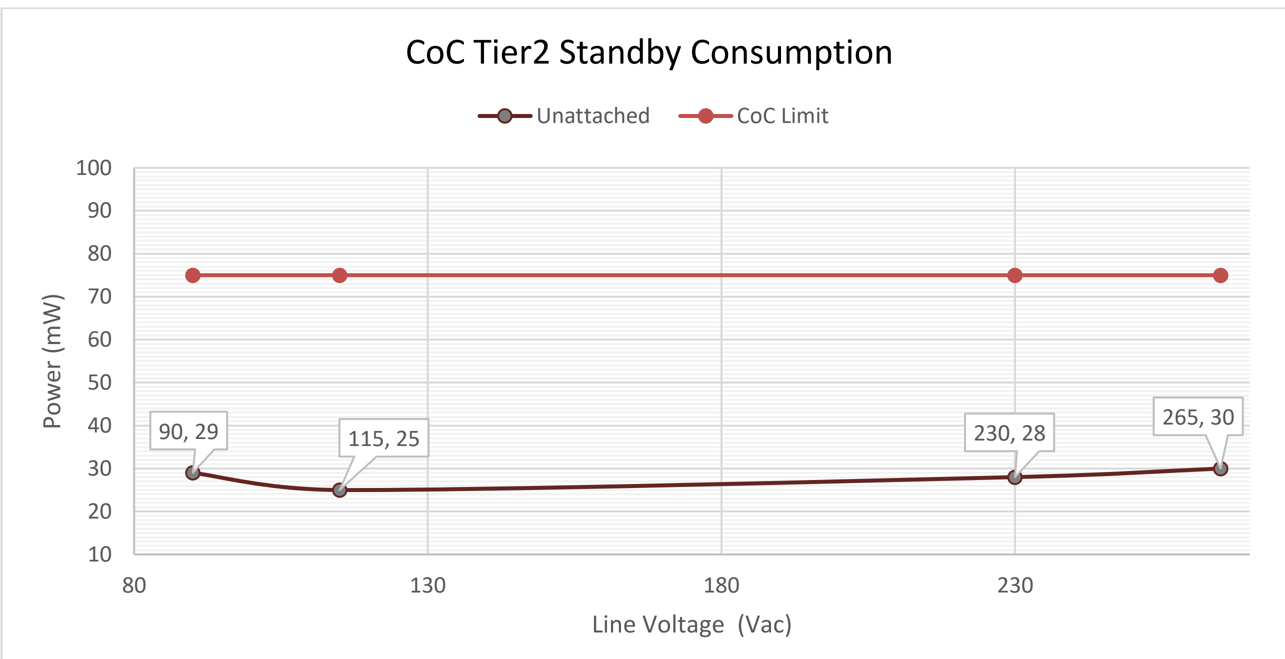
Table 3-2 Standby Power Results

| Vin (Vac) | 90Vac, 47Hz | 115Vac, 60Hz | 230Vac, 50Hz | 265Vac, 63Hz |
|---|---|---|---|---|
| Input Power (mW) | 29mW | 25mW | 28mW | 30mW |

**NOTE: There should be 15 minutes of warmup-up time before starting to measure standby power**

### 3.2.2 Graph

Figure 3.2-1 Standby Power vs CoC Tier2 criteria



### 3.2.3 Details

Figure 3.2-2 Detailed Power Measurement Results at 115Vac, 60Hz


Figure 3.2-3 Detailed Power Measurement Results at 230Vac, 50Hz

## 3.3 Output Voltage and Current Regulation

Figure 3.3-1 CV-CC regulation curve at 115Vac 60Hz

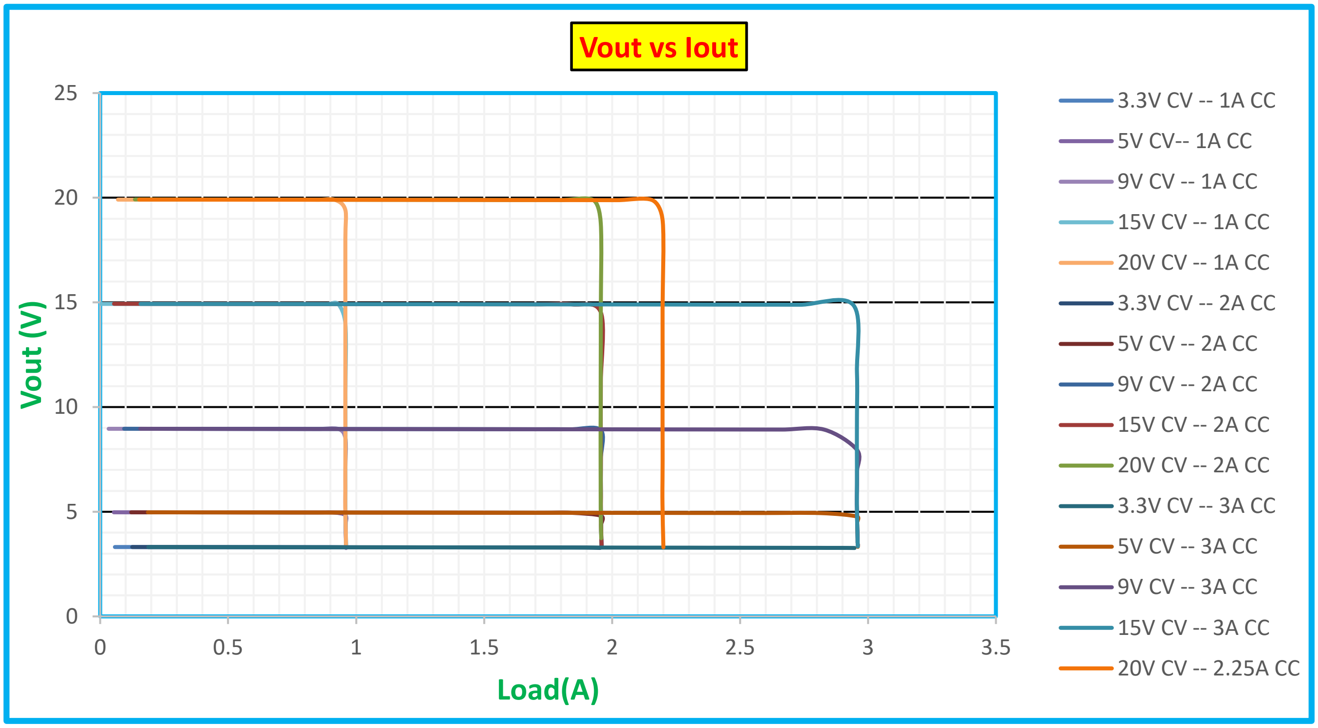
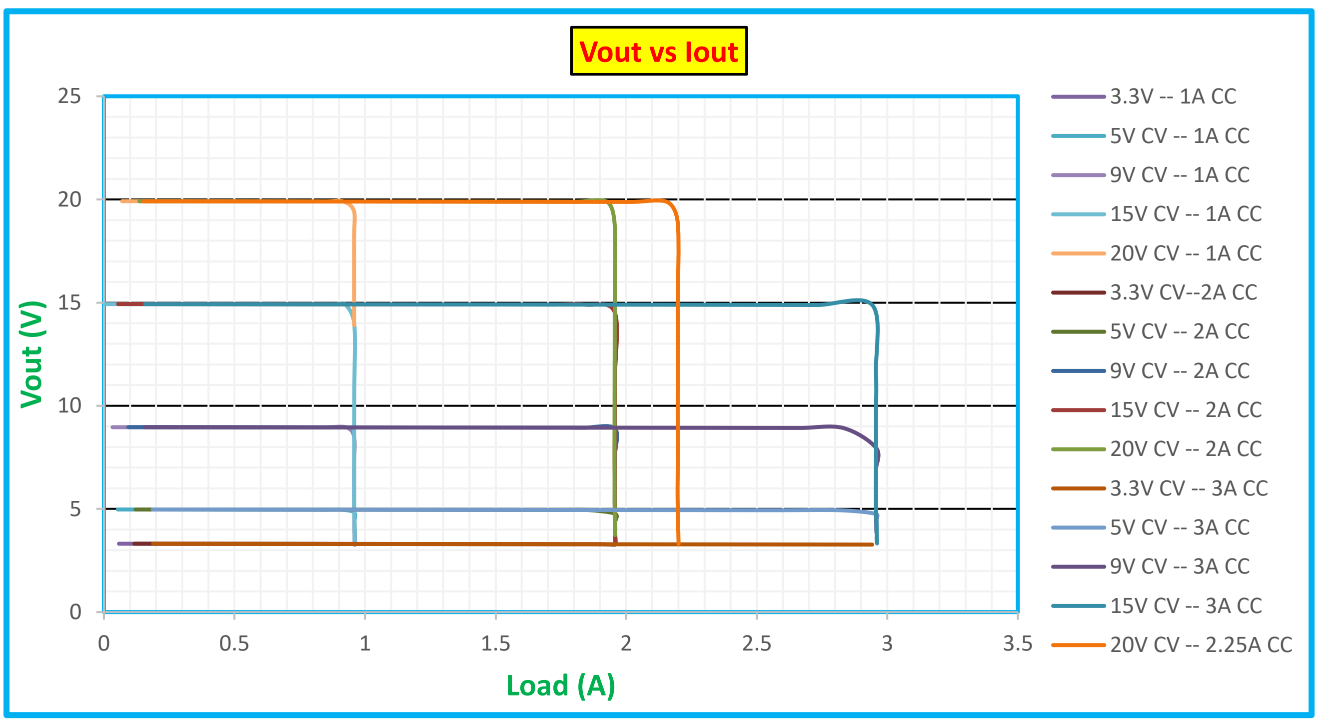



Figure 3.3-2 CV-CC regulation curve at 230Vac 50Hz

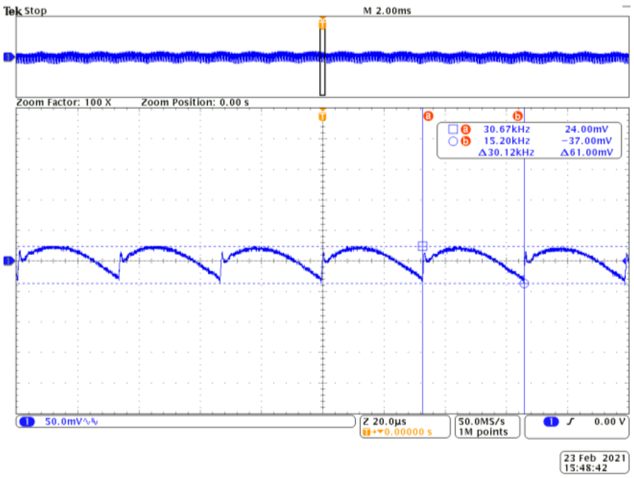


## 3.4 Output Voltage Ripple Peak-Peak

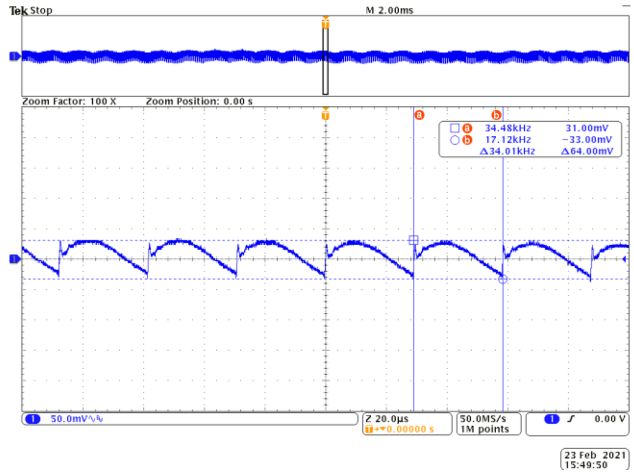
Figure 3-4-1. Ripple* at 90Vac 47Hz (**CH1:** Vbus_c)

**NOTE: RIPPLE MEASUREMENT IS DONE AT BOARD END USING LECROY PROBE ADAPTER PK6-5MM-105**

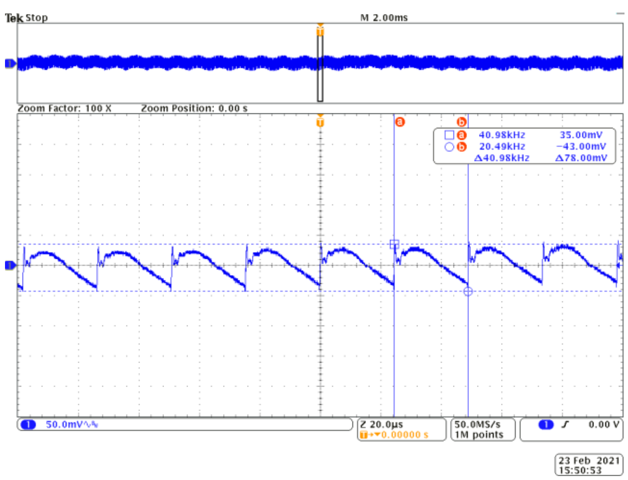
3.3V, 2.95A**, Ripple (p-p) = 61mV



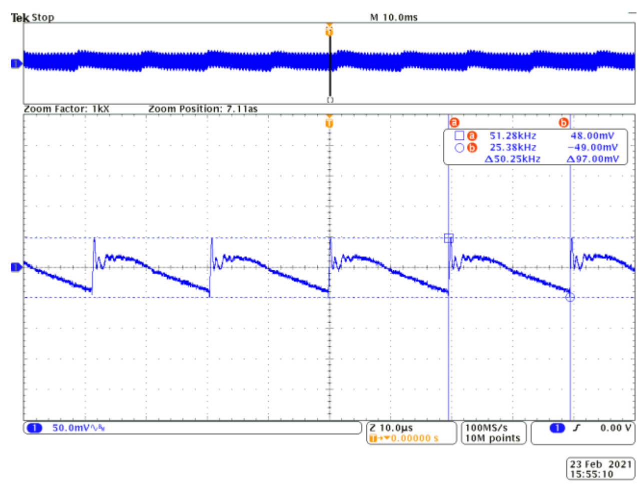

5V, 3A, Ripple (p-p) = 64mV




9V, 3A, Ripple (p-p) = 78mV




15V, 3A, Ripple (p-p) = 97mV




20V, 2.25A, Ripple (p-p) = 127mV

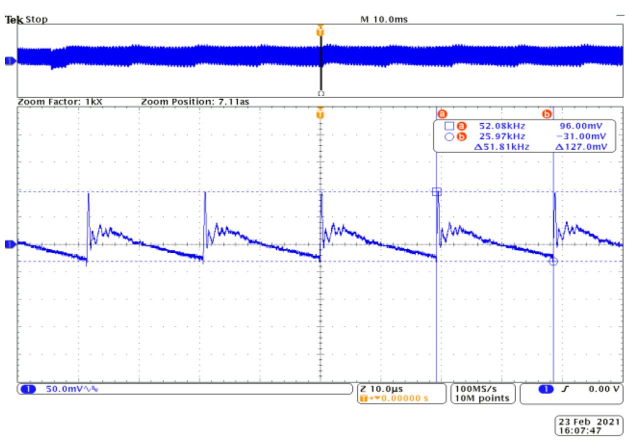
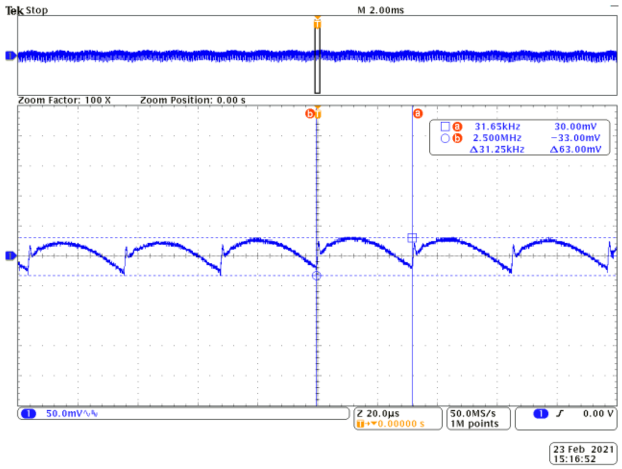
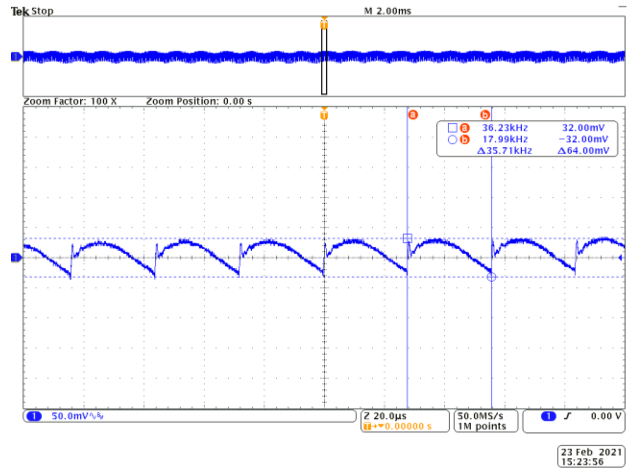


Figure 3-4-2. Ripple* at 115Vac 60Hz (**CH1:** Vbus_c)

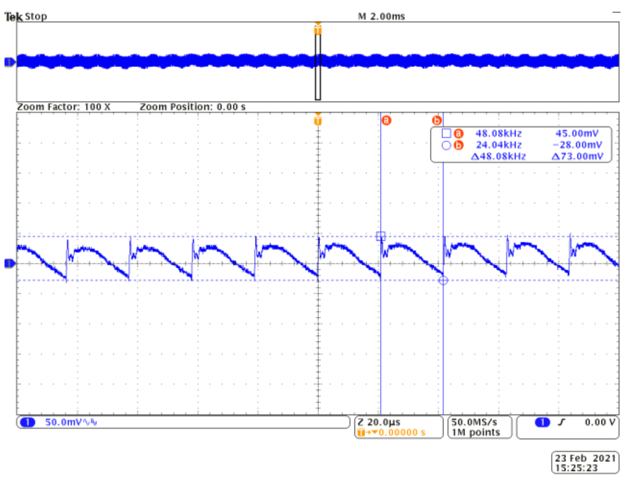
3.3V, 2.95A**, Ripple (p-p) = 63mV



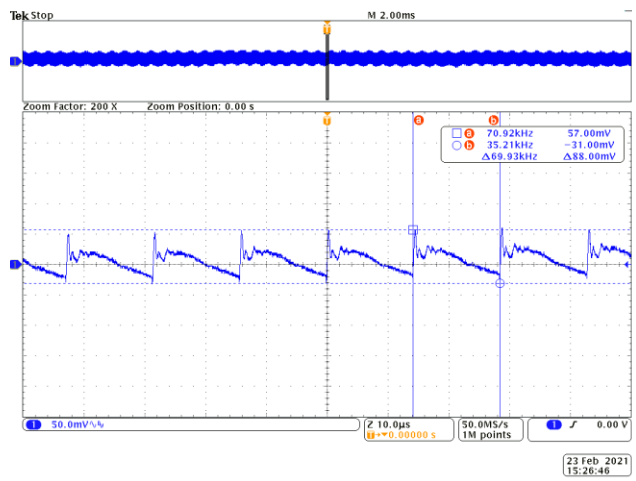

5V, 3A, Ripple (p-p) = 64mV



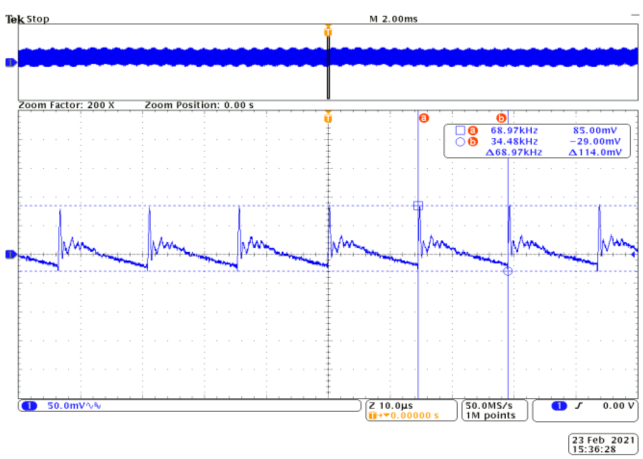

9V, 3A, Ripple (p-p) = 73mV




15V, 3A, Ripple (p-p) = 88mV




20V, 2.25A, Ripple (p-p) = 114mV

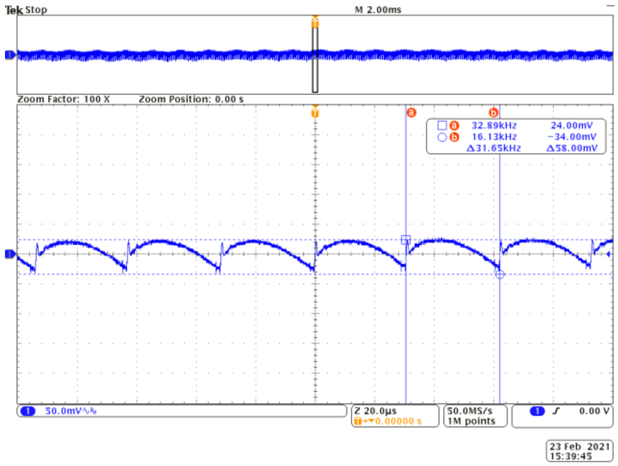



***Waveforms have been taken by keeping the oscilloscope in 20MHz Bandwidth limitation**

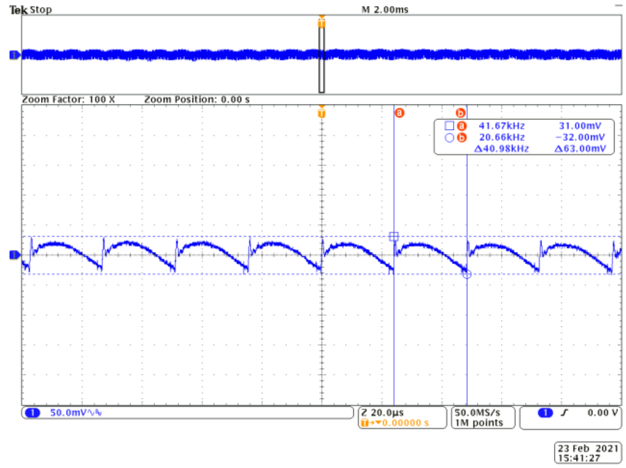
****For 3.3V PPS-PDO, 100% load is taken as 2.95A since the CC limit for 3A is lesser than 3A (~2.96A)**

Figure 3-4-3. Ripple* at 230Vac 50Hz (**CH1:** Vbus_c)

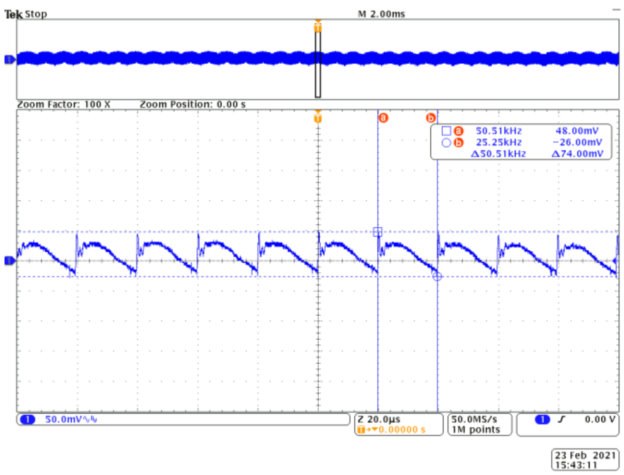
3.3V, 2.95A**, Ripple (p-p) = 58mV



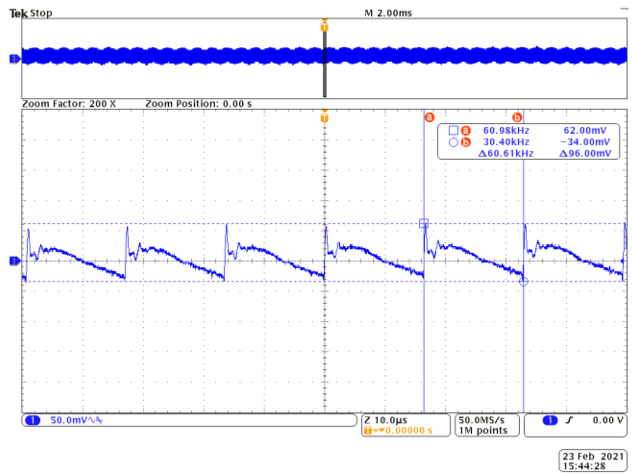
5V, 3A, Ripple (p-p) = 63mV



9V, 3A, Ripple (p-p) = 74mV



15V, 3A, Ripple (p-p) = 96mV



20V, 2.25A, Ripple (p-p) = 104mV

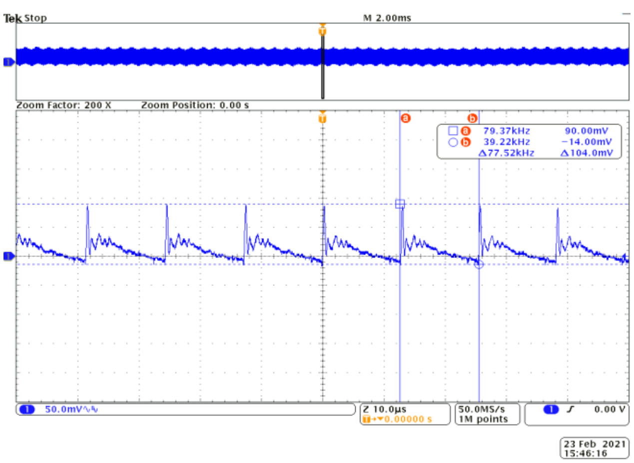
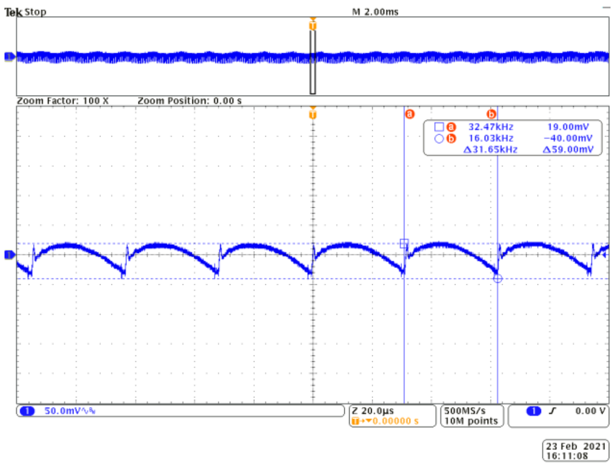
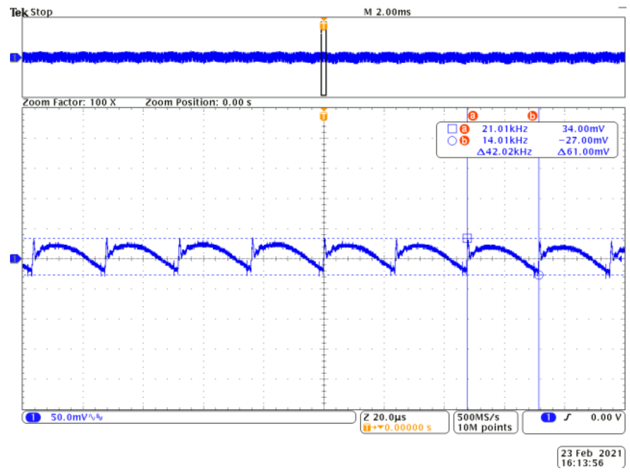


Figure 3-4-4. Ripple* at 265Vac 63Hz (**CH1:** Vbus_c)

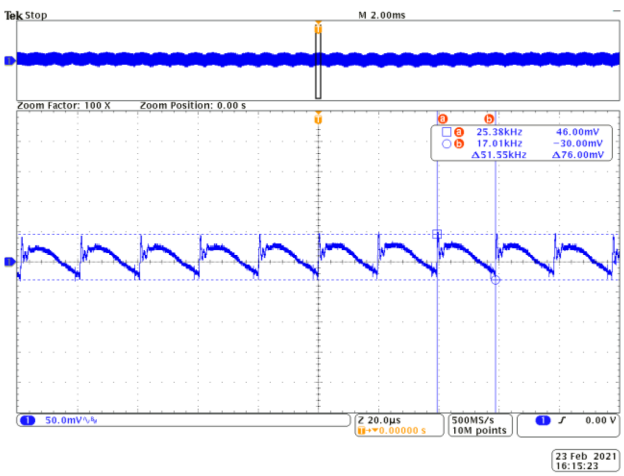
3.3V, 2.95A**, Ripple (p-p) = 59mV



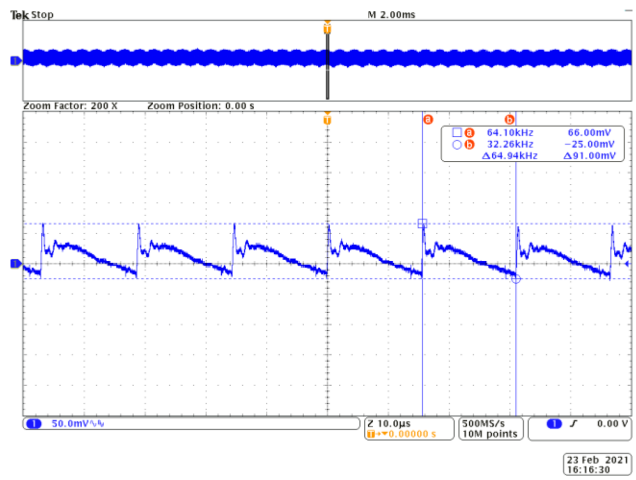

5V, 3A, Ripple (p-p) = 61mV



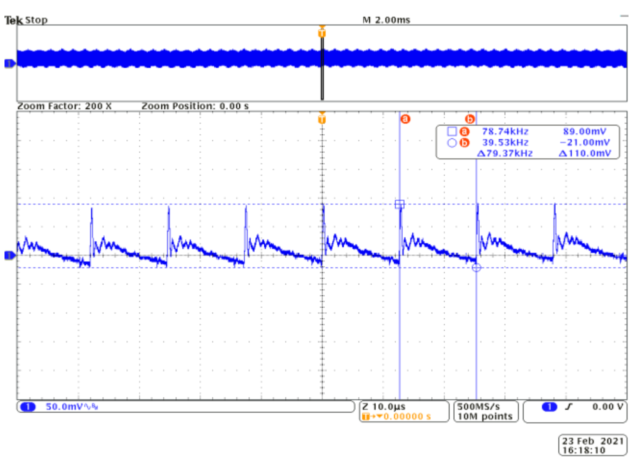

9V, 3A, Ripple (p-p) = 76mV




15V, 3A, Ripple (p-p) = 91mV




20V, 2.25A, Ripple (p-p) = 110mV



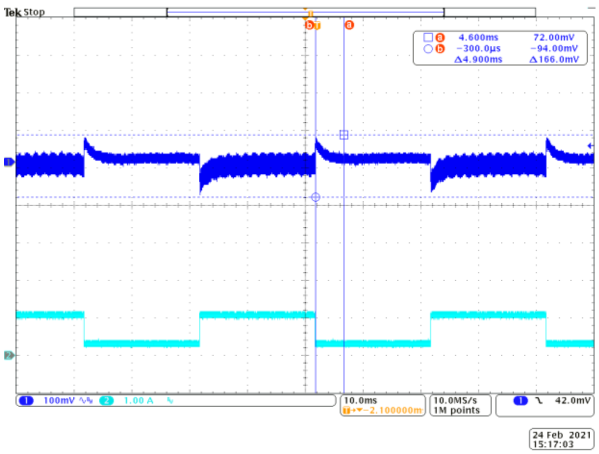

***Waveforms have been taken by keeping the oscilloscope in 20MHz Bandwidth limitation**

****For 3.3V PPS-PDO, 100% load is taken as 2.95A since the CC limit for 3A is lesser than 3A (~2.96A)**

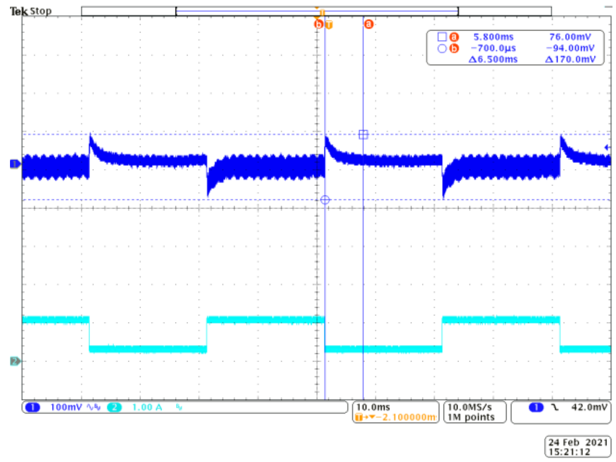
## 3.5 Output Dynamic Response Settling Time

Figure 3-5-1. Settling time for 115Vac, 60Hz Load Transition 10% to 35% load (**CH1:** Vbus_c, **CH2:** Iout)

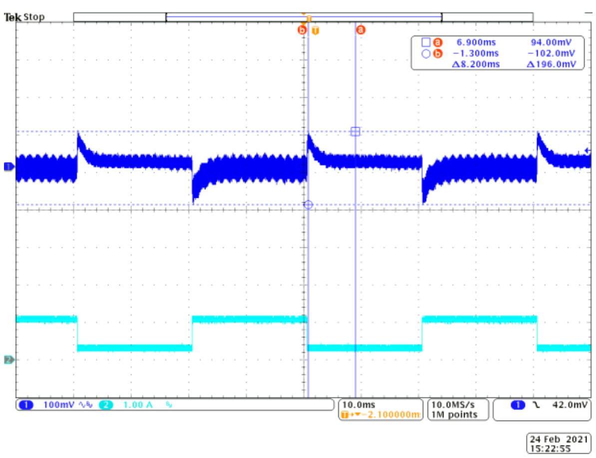
**3.3V – 0.3A to 1.05A,** Settling time = 4.9ms



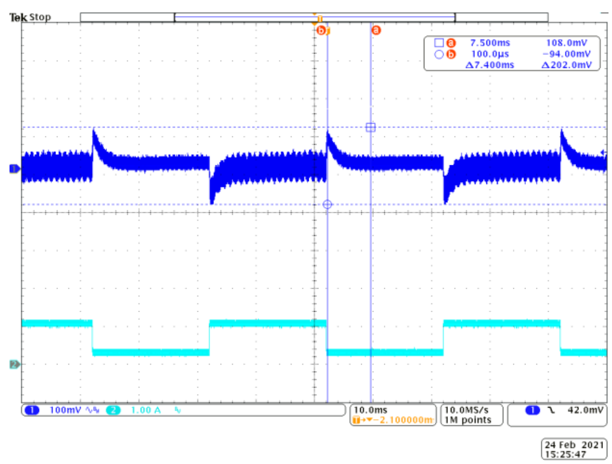
**5V – 0.3A to 1.05A,** Settling time = 6.5ms



**9V – 0.3A to 1.05A,** Settling time = 8.2ms



**15V – 0.3A to 1.05A,** Settling time = 7.4ms



**20V – 0.225A to 0.7875A,** Settling time = 12ms

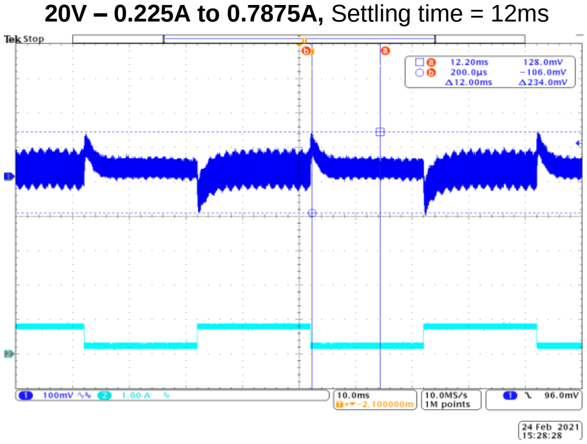
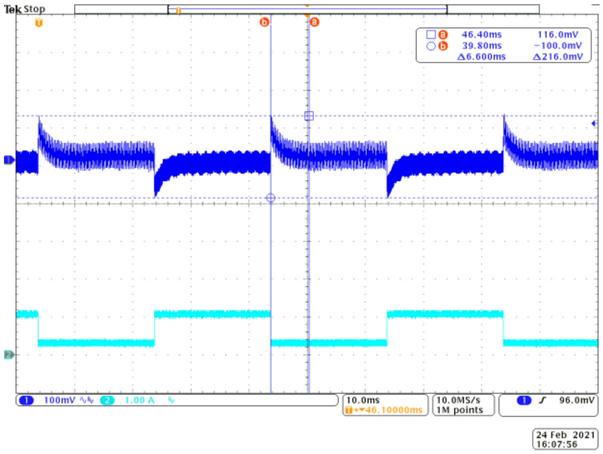
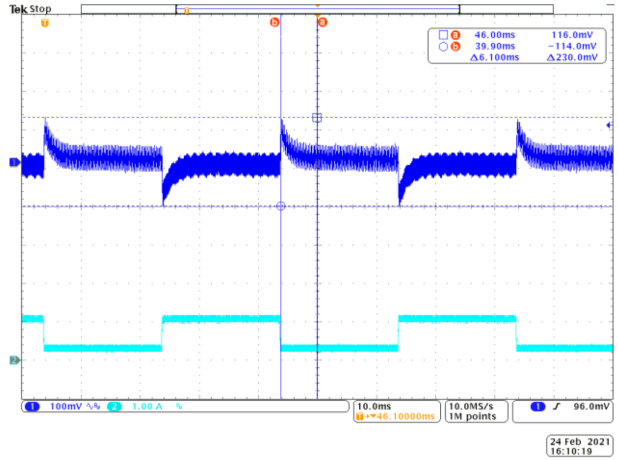


Figure 3-5.2. Settling time for 230Vac, 50Hz; Load Transition 10% to 35% load (**CH1:** Vbus_c, **CH2:** Iout)

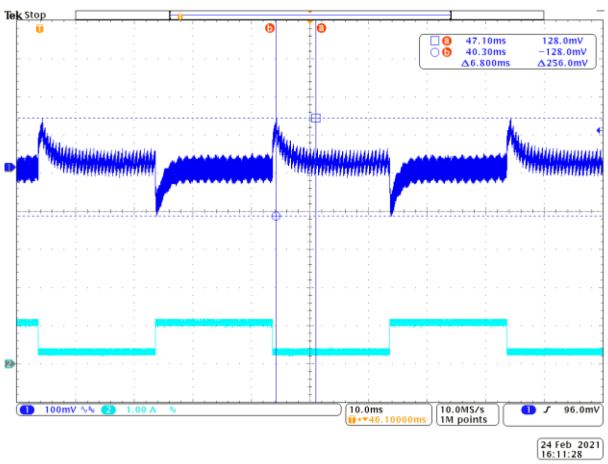
**3.3V – 0.3A to 1.05A,** Settling time = 6.6ms



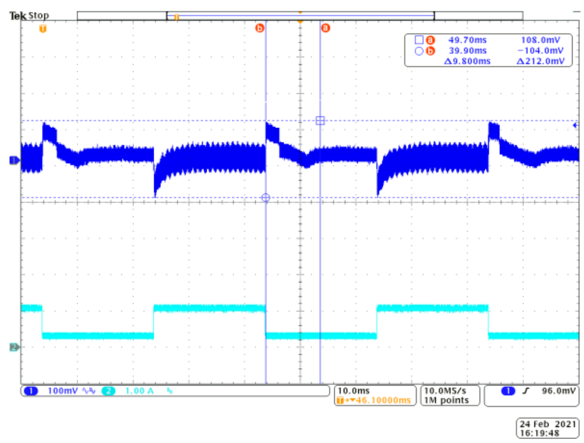
**5V – 0.3A to 1.05A,** Settling time = 6.1ms



**9V – 0.3A to 1.05A,** Settling time = 6.8ms



**15V – 0.3A to 1.05A,** Settling time = 9.8ms



**20V – 0.225A to 0.7875A,** Settling time = 8.5ms

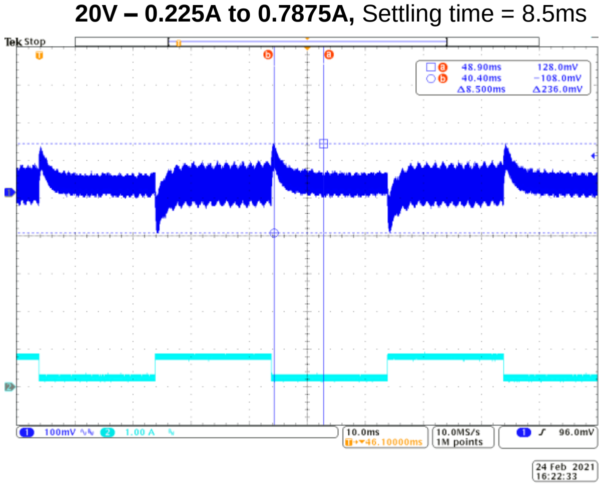
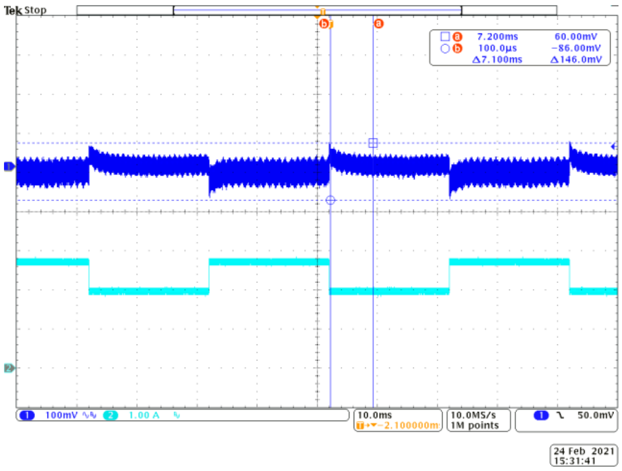
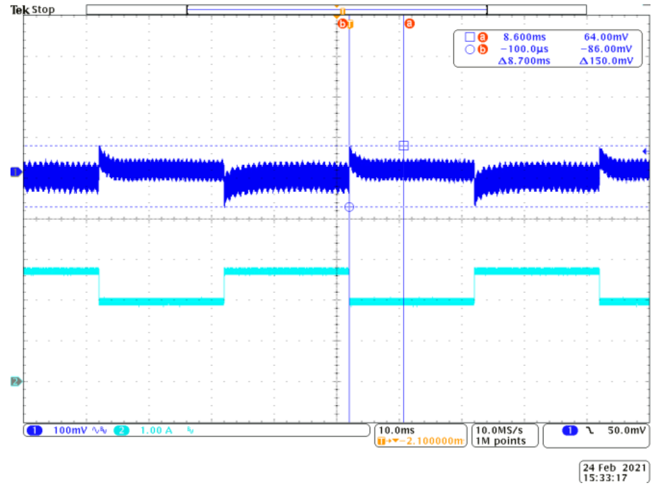


Figure 3-5-3. Settling time for 115Vac, 60Hz Load Transition 65% to 90% load (**CH1:** Vbus_c, **CH2:** Iout)

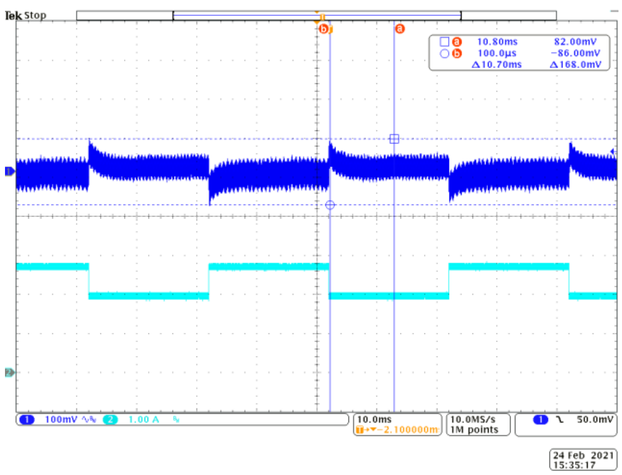
**3.3V – 1.95A to 2.7A,** Settling time = 7.1ms



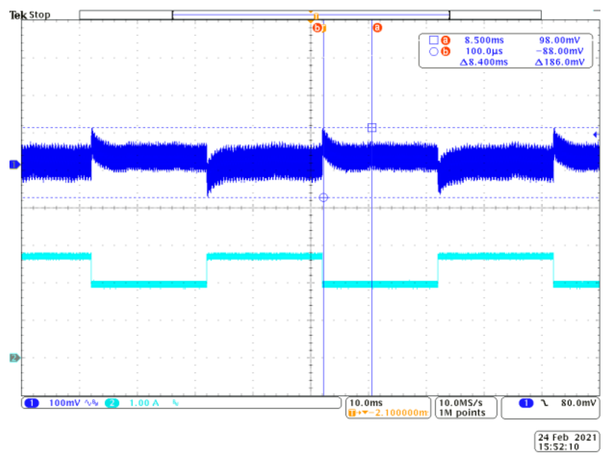

**5V – 1.95A to 2.7A,** Settling time = 8.7ms




**9V – 1.95A to 2.7A,** Settling time = 10.7ms




**15V – 1.95A to 2.7A,** Settling time = 8.4ms




**20V – 1.4625A to 2.025A,** Settling time = 10.1ms

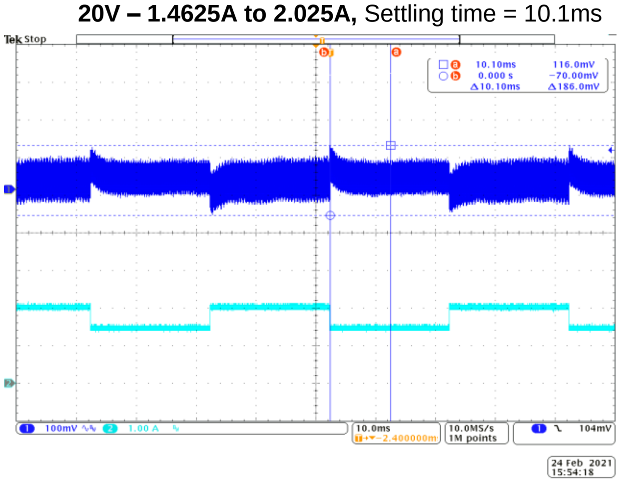
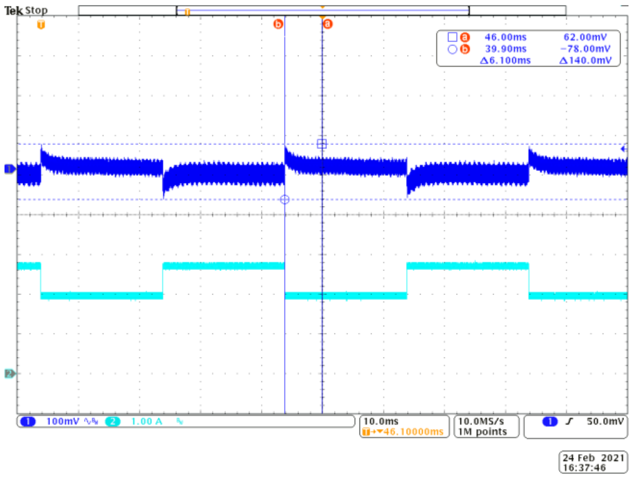
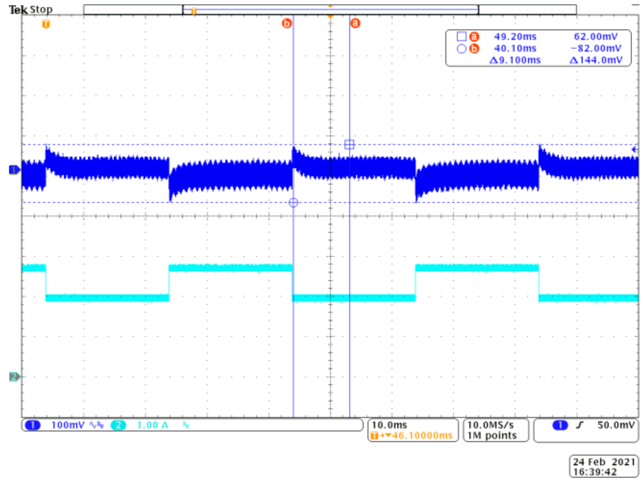


Figure 3-5.4. Settling time for 230Vac, 50Hz; Load Transition 65% to 90% load (**CH1:** Vbus_c, **CH2:** Iout)

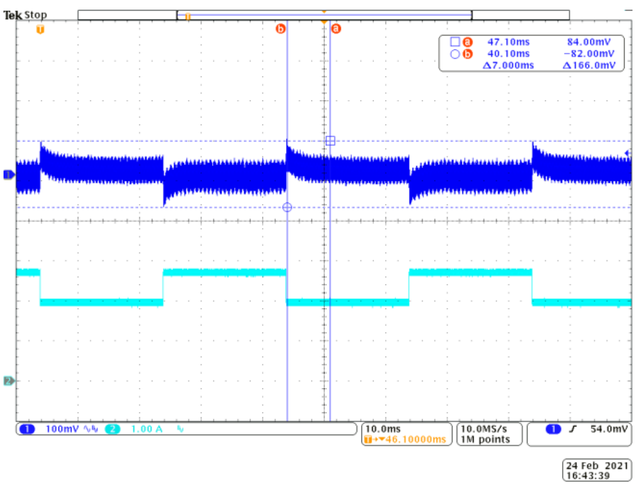
**3.3V – 1.95A to 2.7A,** Settling time = 6.1ms



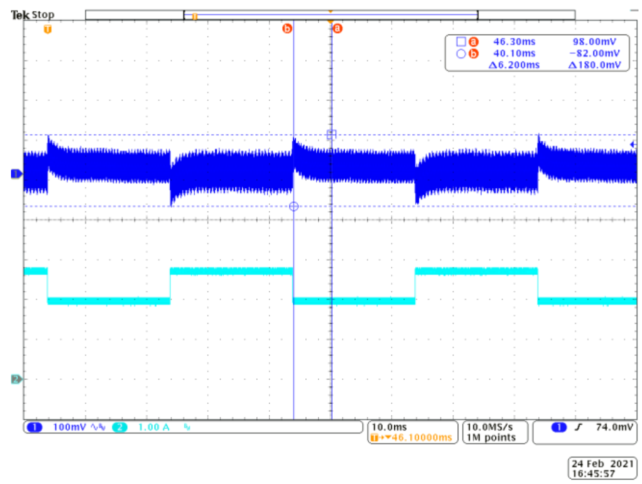

**5V – 1.95A to 2.7A,** Settling time = 9.1ms



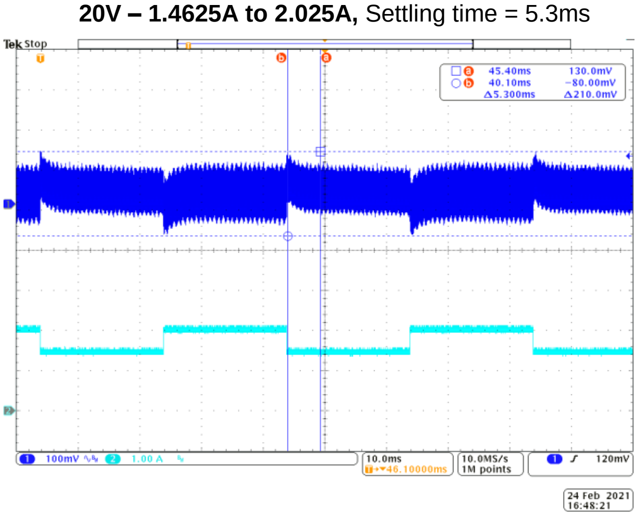

**9V – 1.95A to 2.7A,** Settling time = 7ms




**15V – 1.95A to 2.7A,** Settling time = 6.2ms




**20V – 1.4625A to 2.025A,** Settling time = 5.3ms



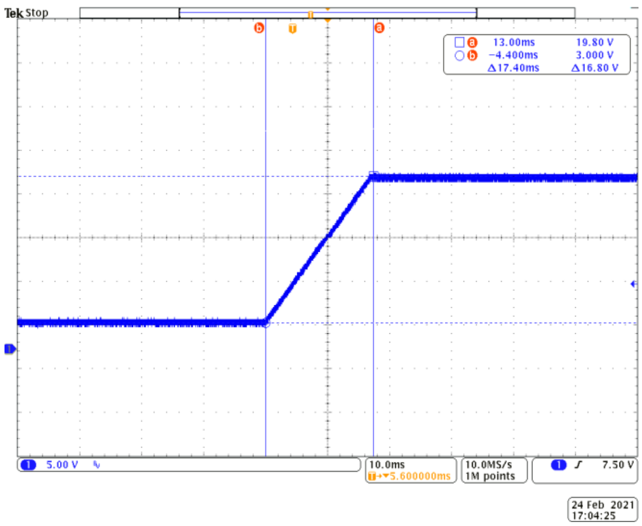
## 3.6 Output Voltage Transfer Transition

Figure 3.6-1 Output voltage transition for 115Vac, 60Hz; (**CH1:** Vbus_c)

**Vout = 3.3V to 20V, Iout = 0A**

**Transition time: 17.4ms**

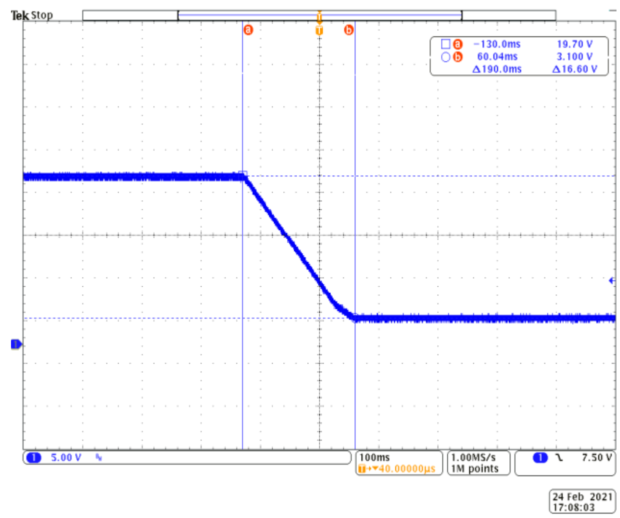
**Slew Rate: 0.966 V/ms**




**Vout = 20V to 3.3V, Iout = 0A**

**Transition time: 190ms**

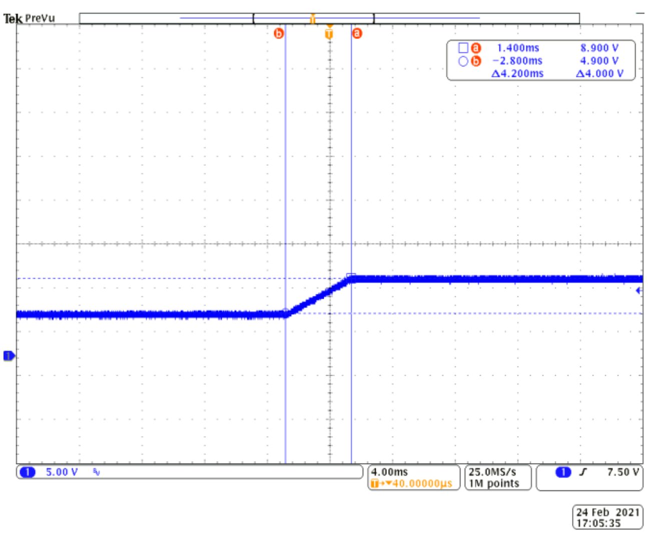
**Slew Rate: -0.097 V/ms**




**Vout = 5V to 9V, Iout = 0A**

**Transition time: 4.2ms**

**Slew Rate: 0.952 V/ms**




**Vout = 9V to 5V, Iout = 0A**

**Transition time: 39.6ms**

**Slew Rate: -0.104 V/ms**

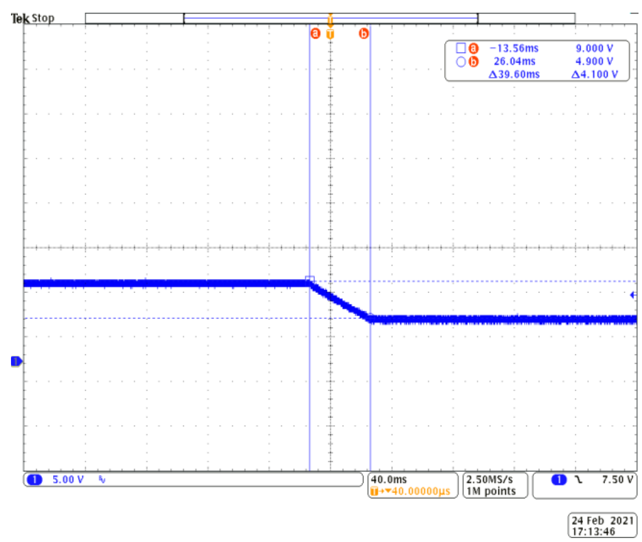
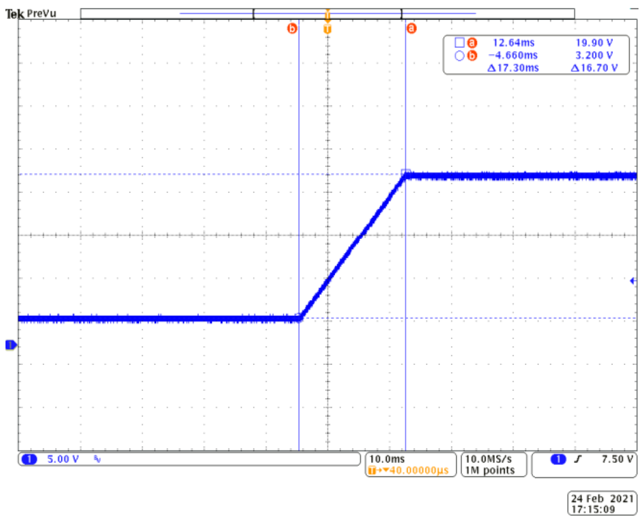


Figure 3.6-2 Output voltage transition for 230Vac, 50Hz; (**CH1:** Vbus_c)

**Vout = 3.3V to 20V, Iout = 0A**

**Transition time: 17.3ms**

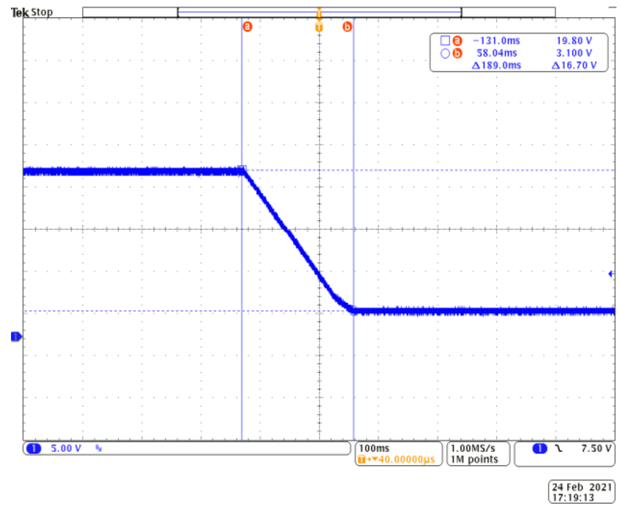
**Slew Rate: 0.965 V/ms**




**Vout = 20V to 3.3V, Iout = 0A**

**Transition time: 189ms**

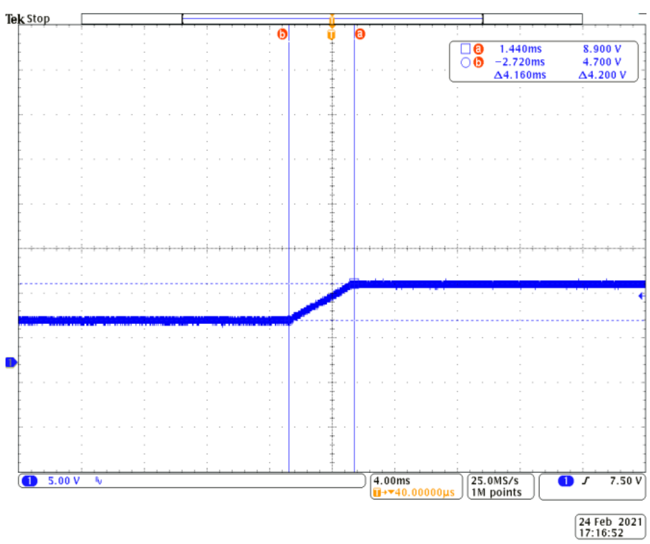
**Slew Rate: -0.096 V/ms**




**Vout = 5V to 9V, Iout = 0A**

**Transition time: 4.16ms**

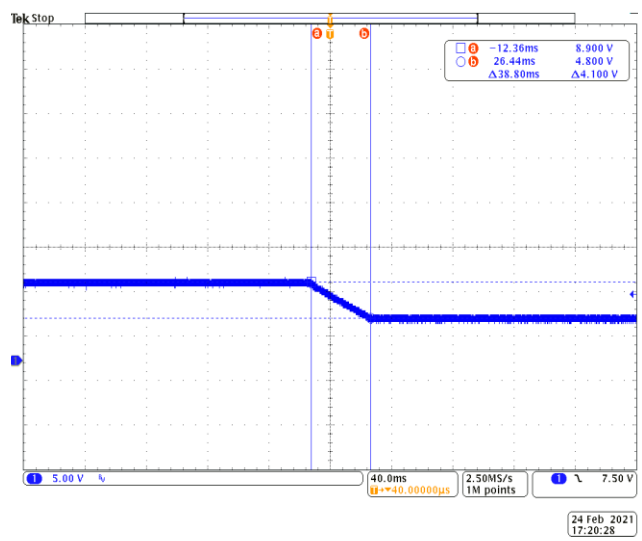
**Slew Rate: 1.01 V/ms**




**Vout = 9V to 5V, Iout = 0A**

**Transition time: 38.8ms**

**Slew Rate: -0.106 V/ms**



## 3.7 Start-up Turn-on Delay

Figure 3.7-1 Start-up Turn-on Delay at 90Vac, 47Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)

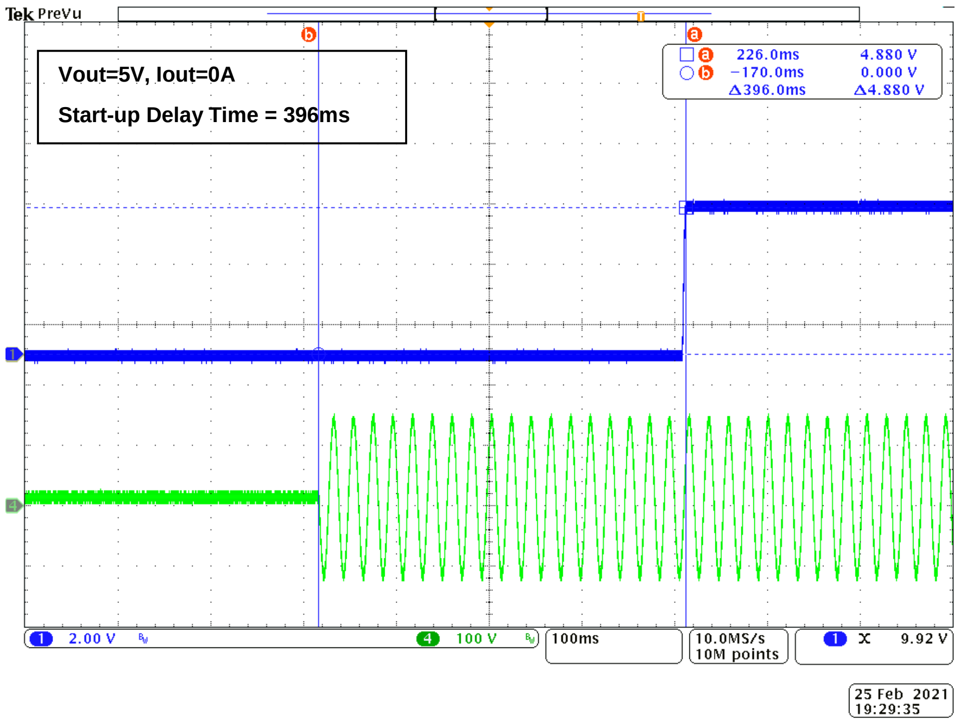



Figure 3.7-2 Start-up Turn-on Delay at 115Vac, 60Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)

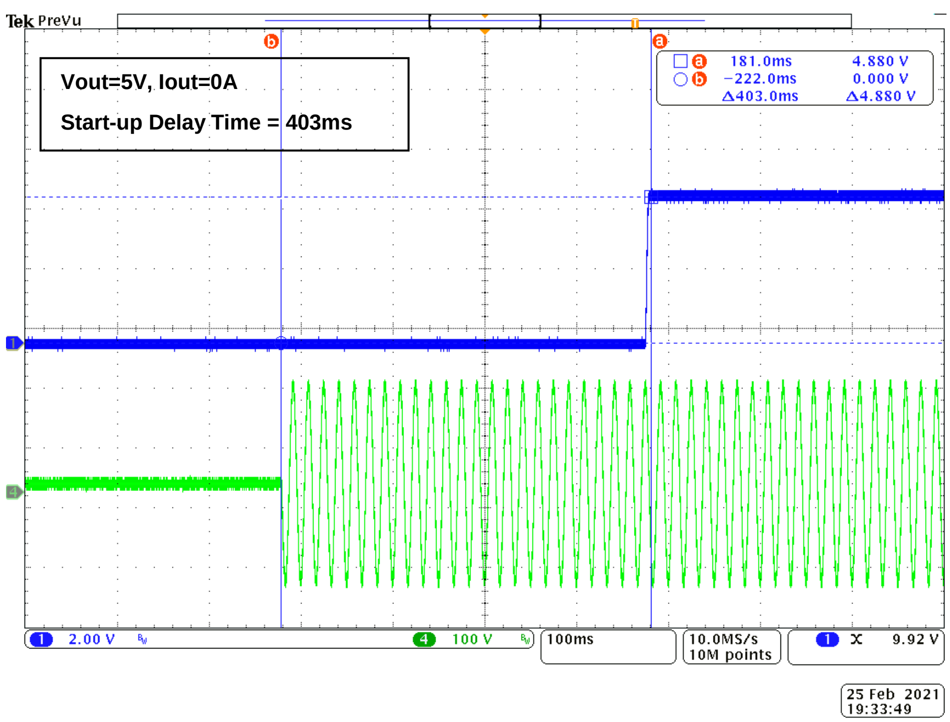


Figure 3.7-3 Start-up Turn-on Delay at 230Vac, 50Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)

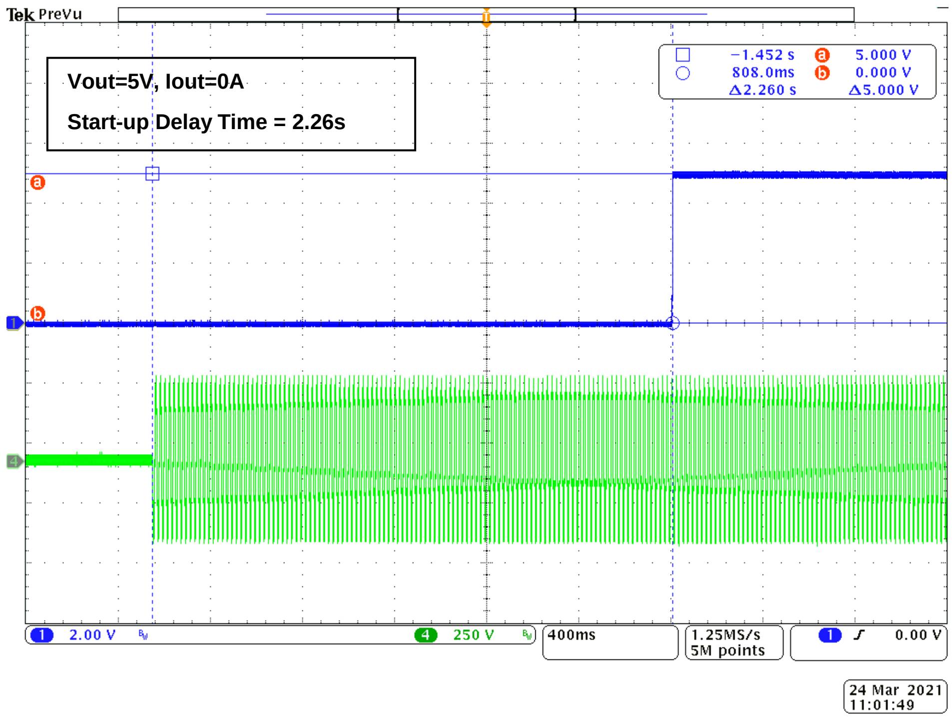
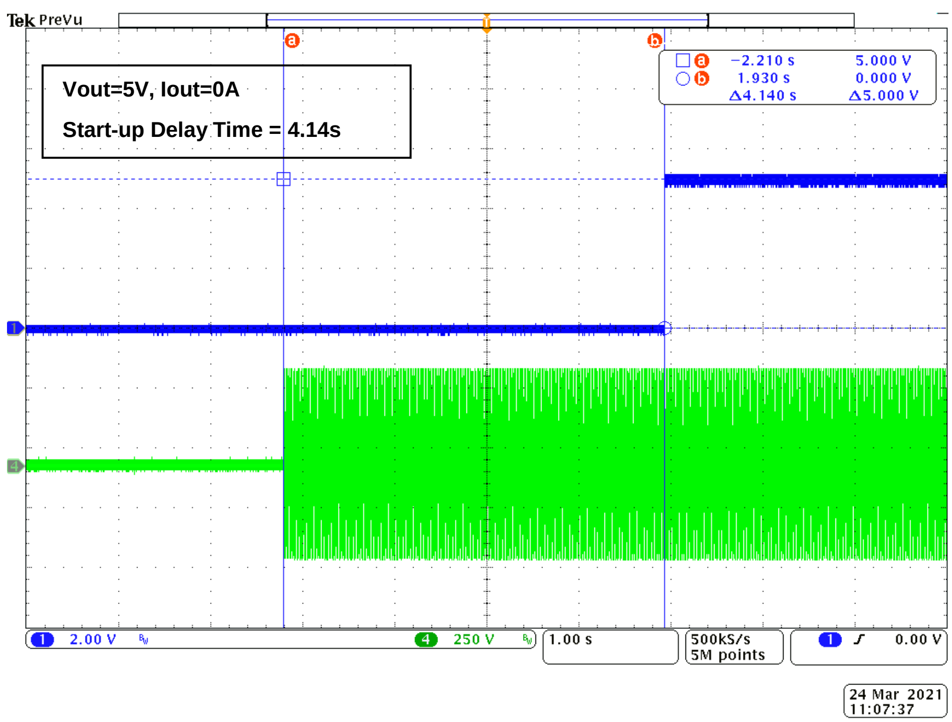



Figure 3.7-4 Start-up Turn-on Delay at 265Vac, 63Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)



## 3.8 Start-up Rise Time

Figure 3.7-1 Start-up Rise time at 90Vac, 47Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)

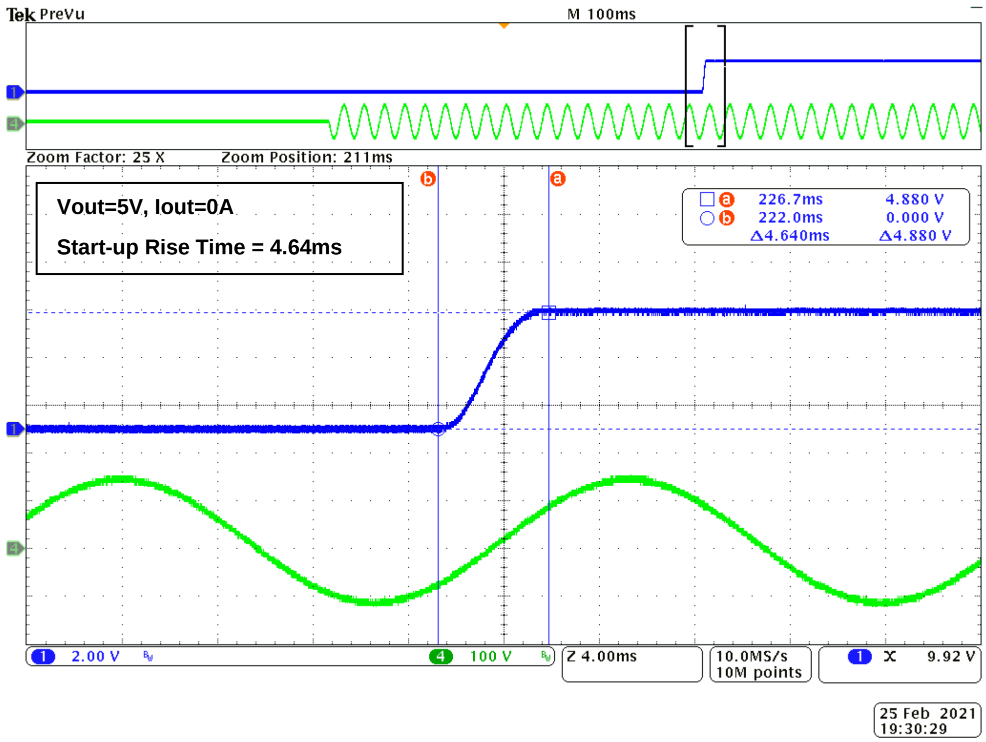



Figure 3.8-2 Start-up Rise time at 115Vac, 60Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)

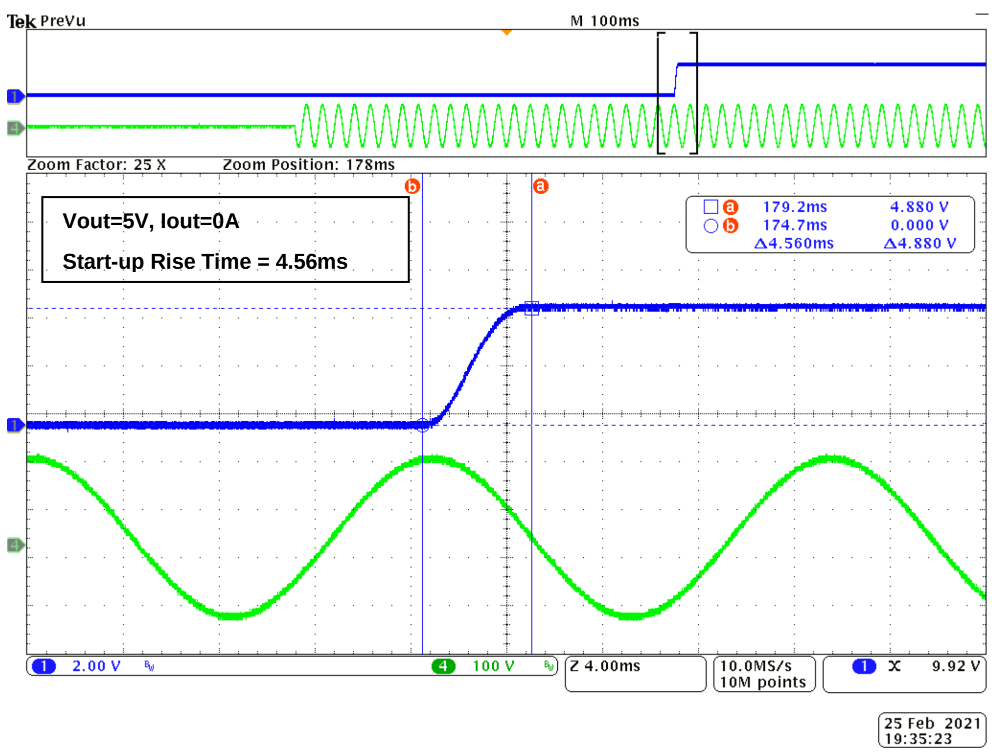


Figure 3.8-3 Start-up Rise time at 230Vac, 50Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)

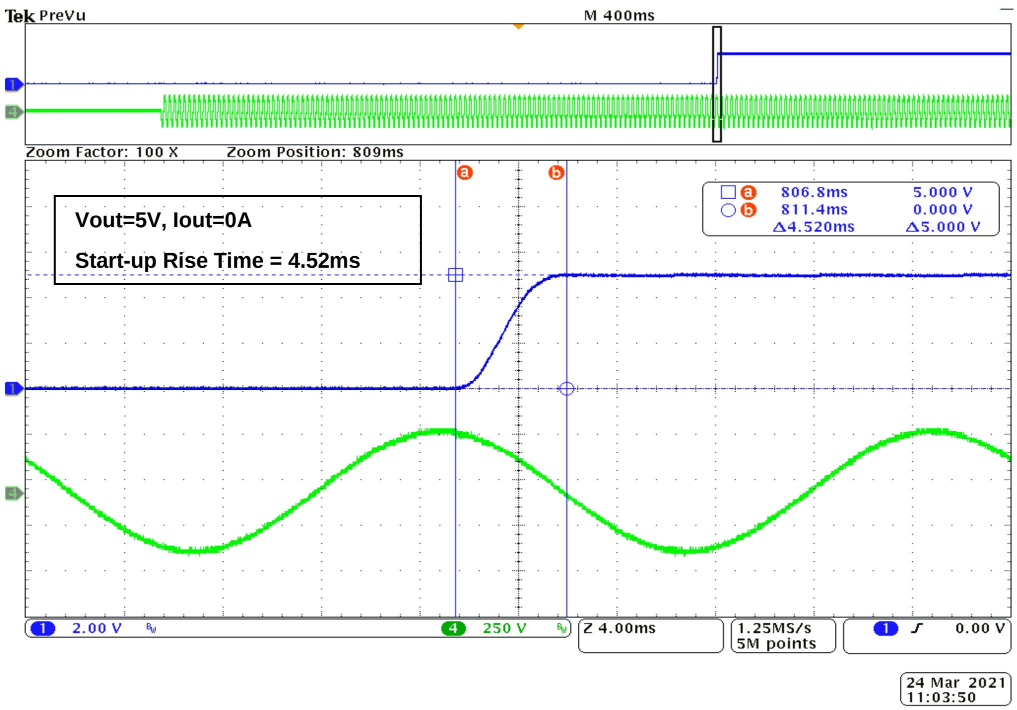
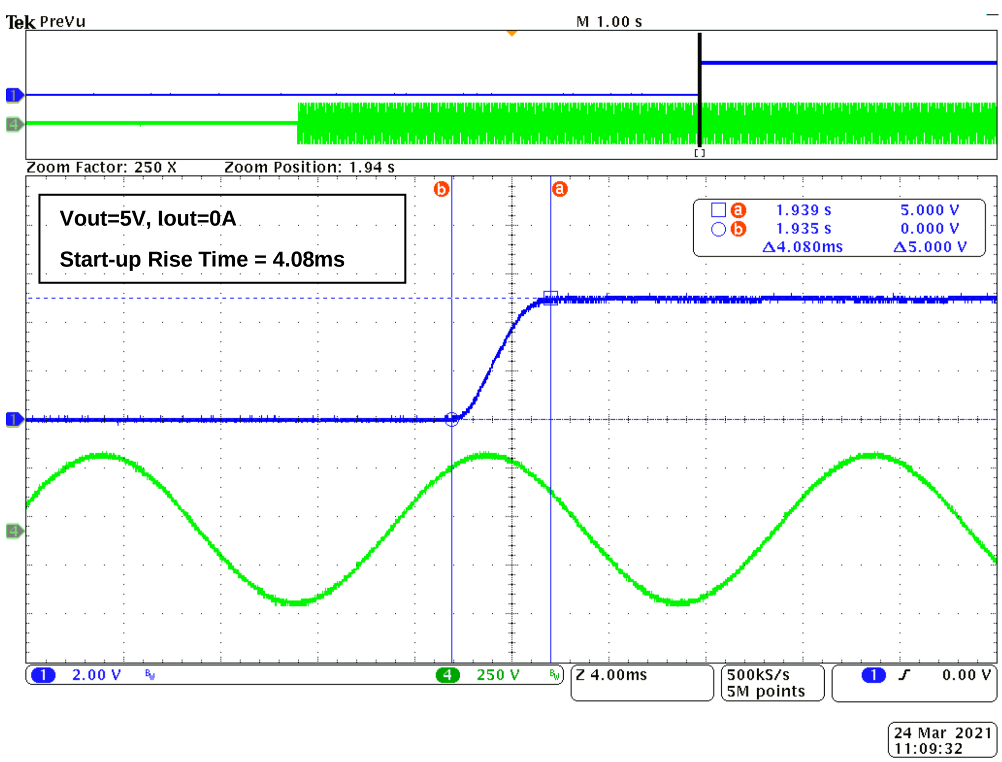



Figure 3.8-4 Start-up Rise time at 265Vac, 60Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)



## 3.9 Hold-up Time

Figure 3.8-1 Hold-up time at 90Vac, 47Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)

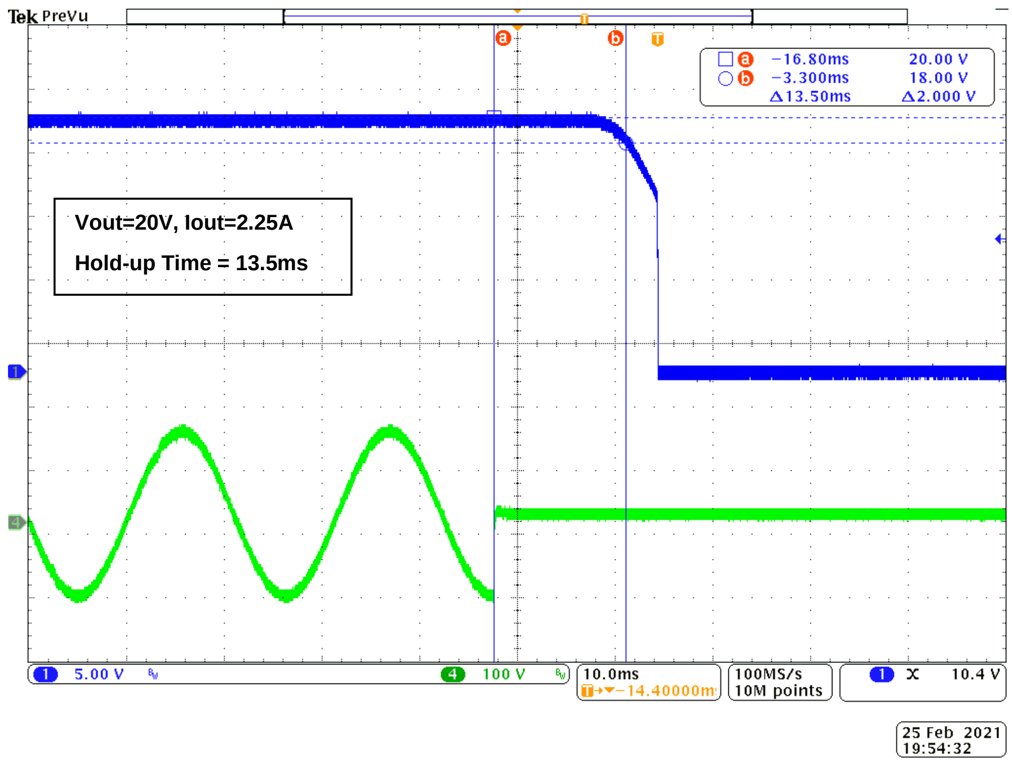



Figure 3.9-2 Hold-up time at 115Vac, 60Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)

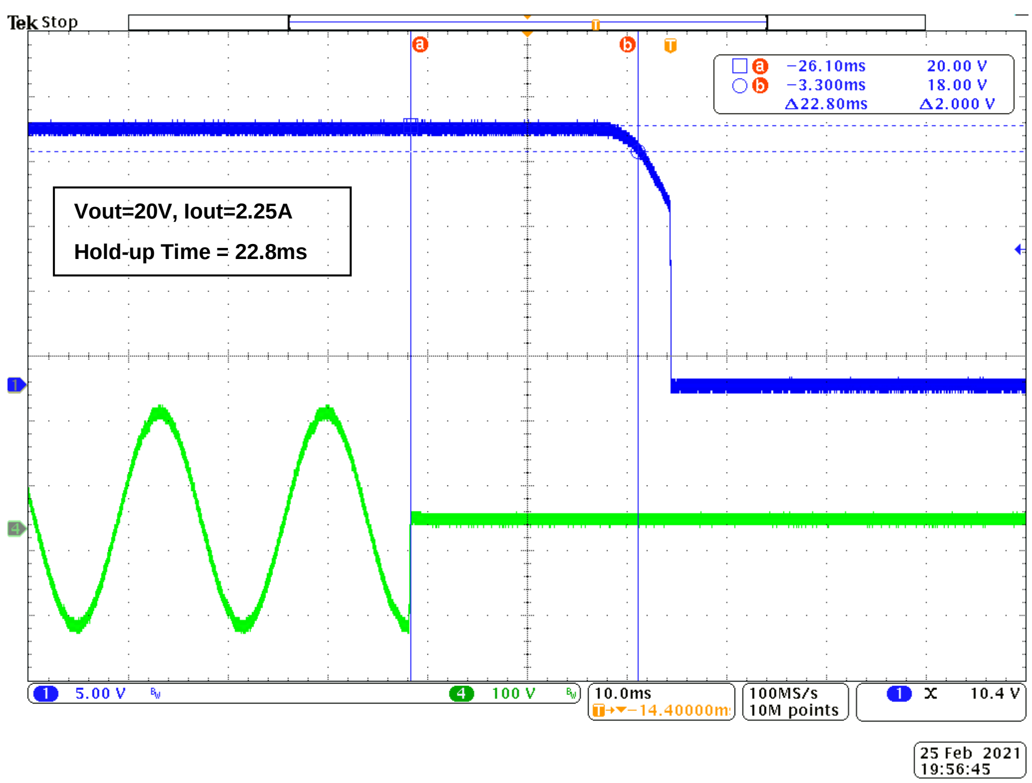


Figure 3.9-3 Hold-up time at 230Vac, 60Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)

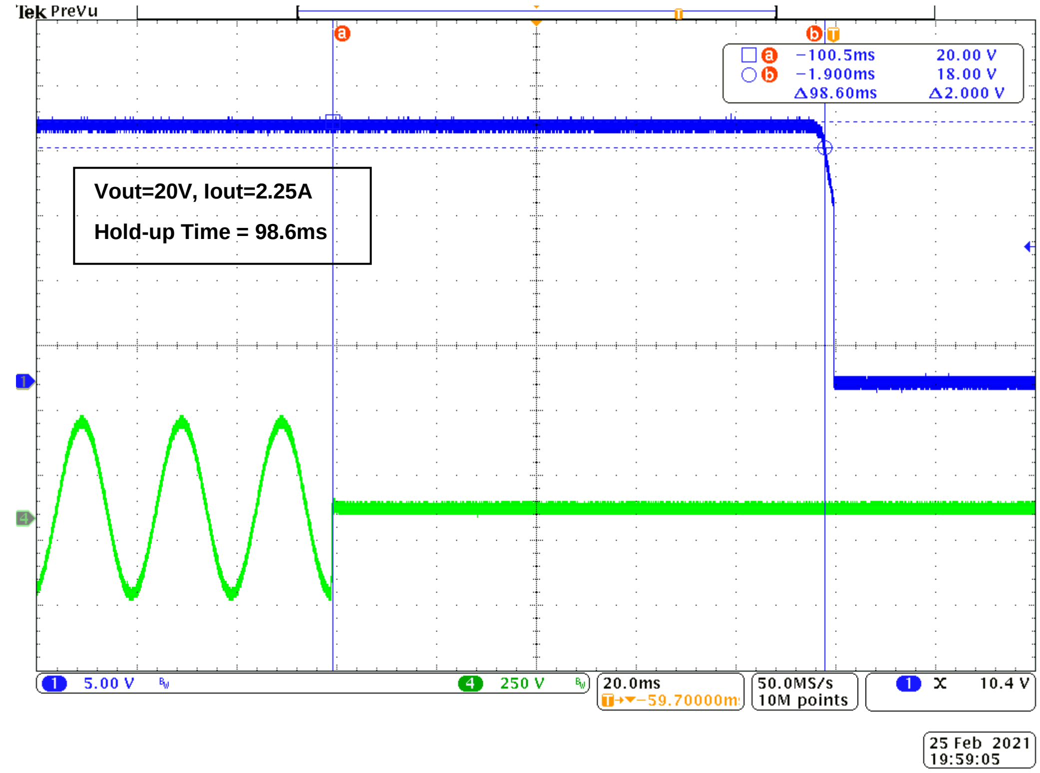
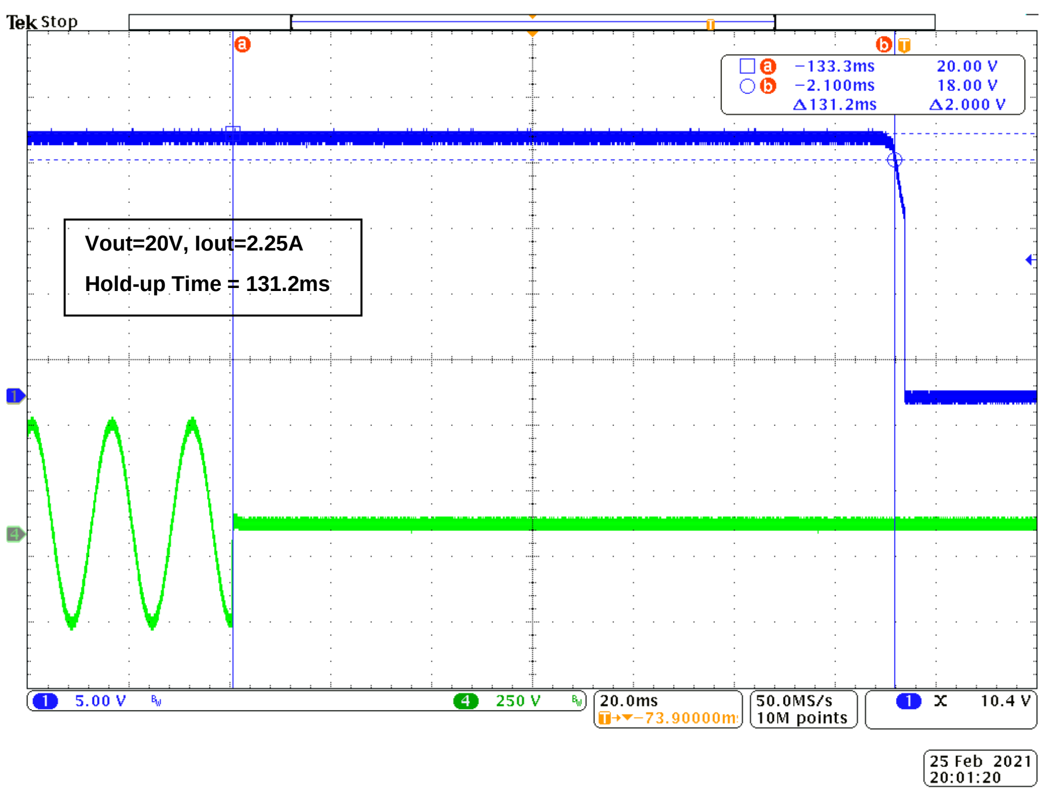



Figure 3.9-4 Hold-up time at 265Vac, 63Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)



## 3.10 Shut-down Fall Time

Figure 3.9-1 Shut-down Fall time at 90Vac, 47Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)

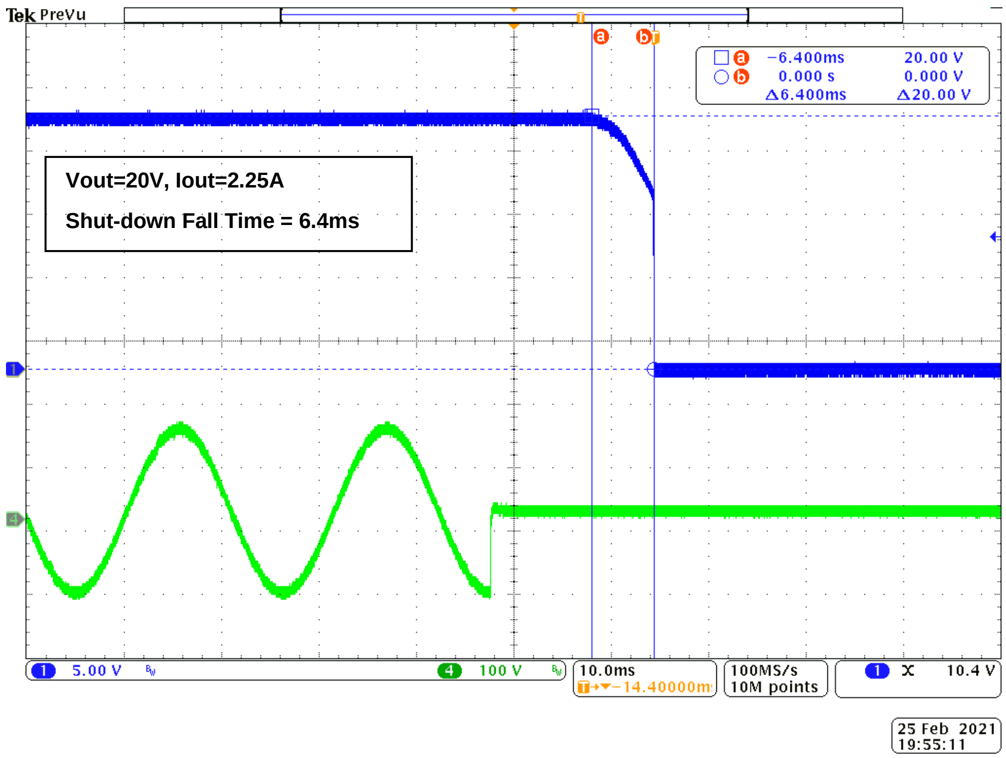



Figure 3.10-2 Shut-down Fall time at 115Vac, 60Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)

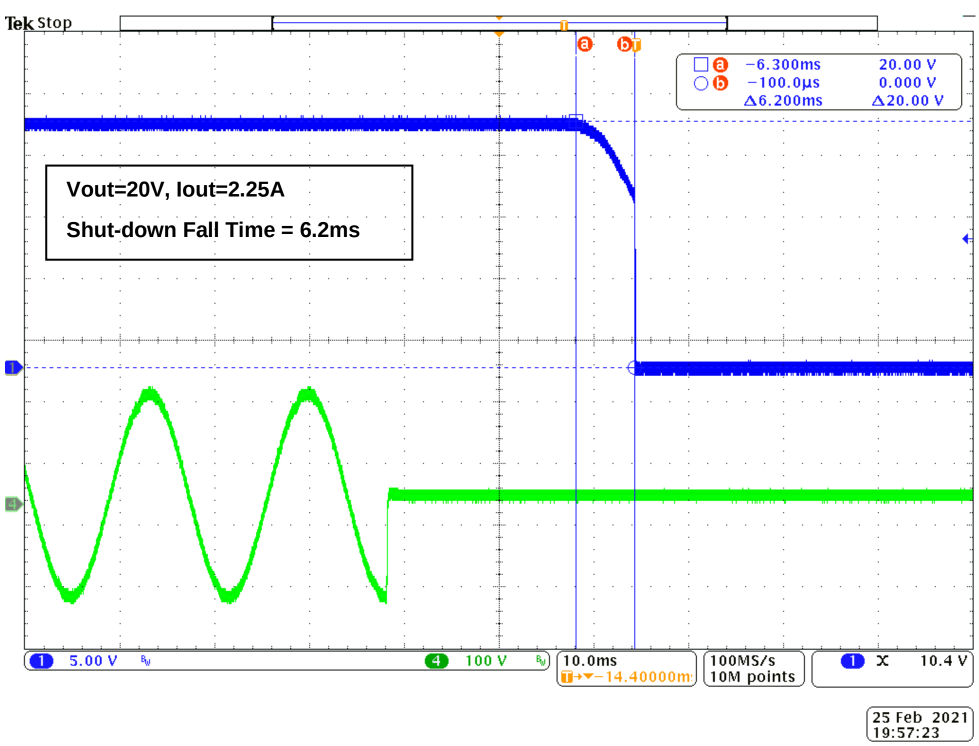


Figure 3.10-3 Shut-down Fall time at 230Vac, 50Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)

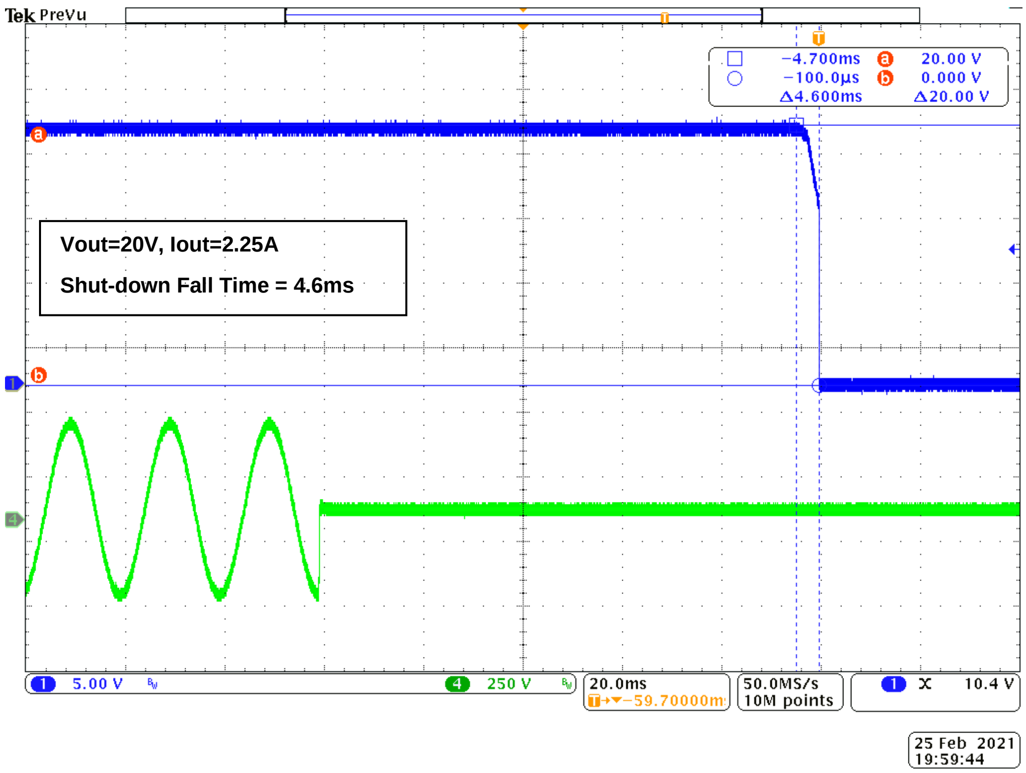
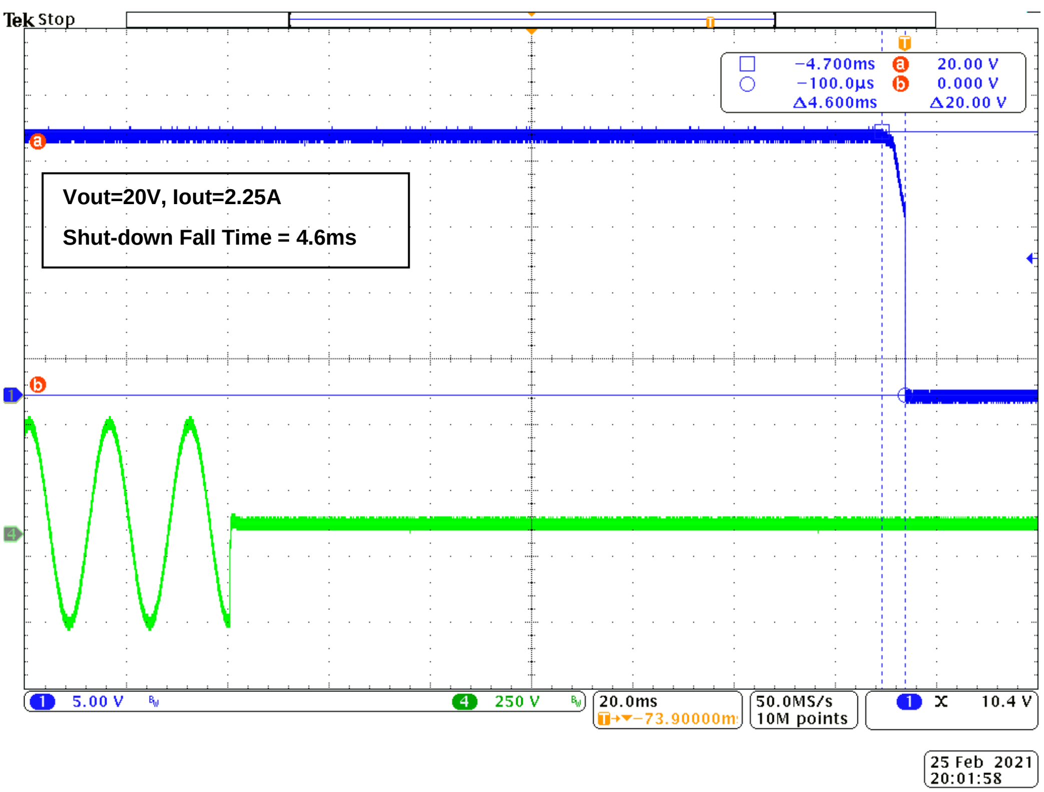


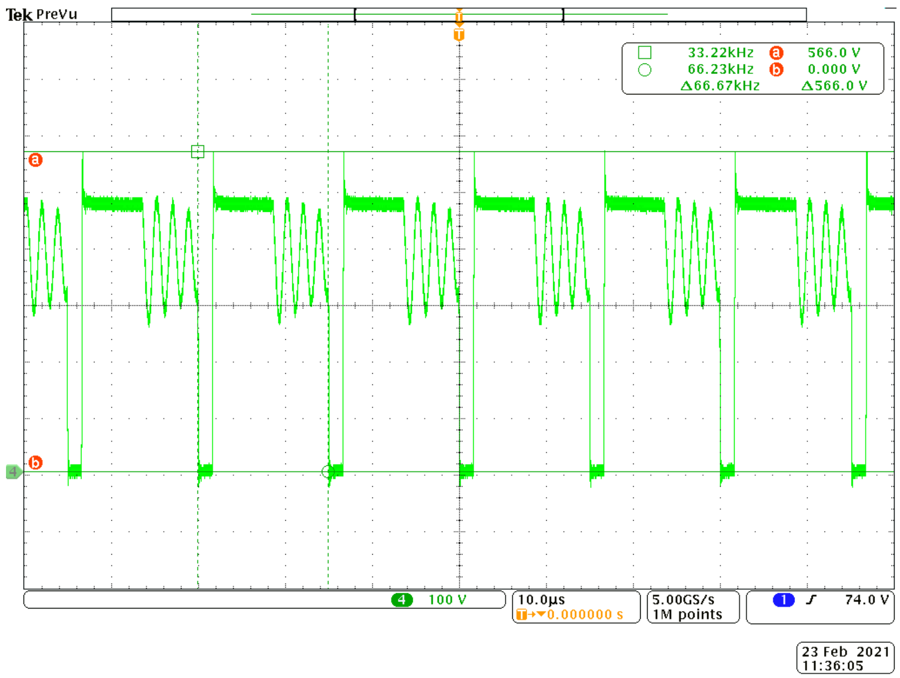

Figure 3.10-4 Shut-down Fall time at 265Vac, 63Hz (**CH1**: Vbus_c, **CH4**: Vin_ac)



## 3.11 Switch Voltage Stress

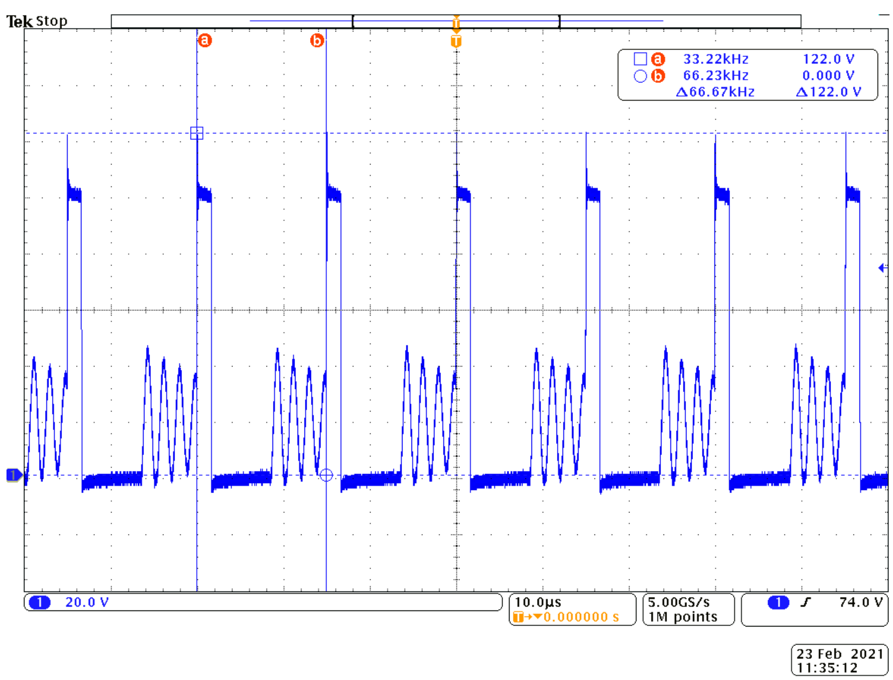
**Condition:** Vin = 265Vac, 63Hz, Vout=20V & Iout=2.25A

Figure 3.11-1 Voltage Stress on Primary FET (**CH4**: Vds_primary)




**Vds_primary = 566V**

Figure 3.11-2 Voltage Stress on Secondary FET (**CH1**: Vds_secondary)

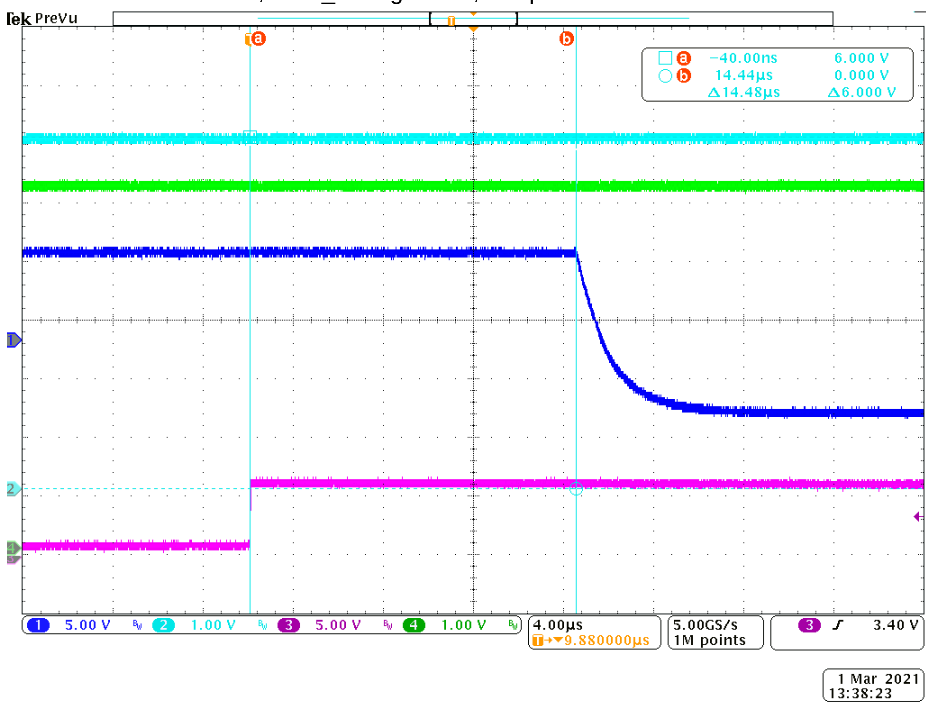



**Vds_secondary = 122V**

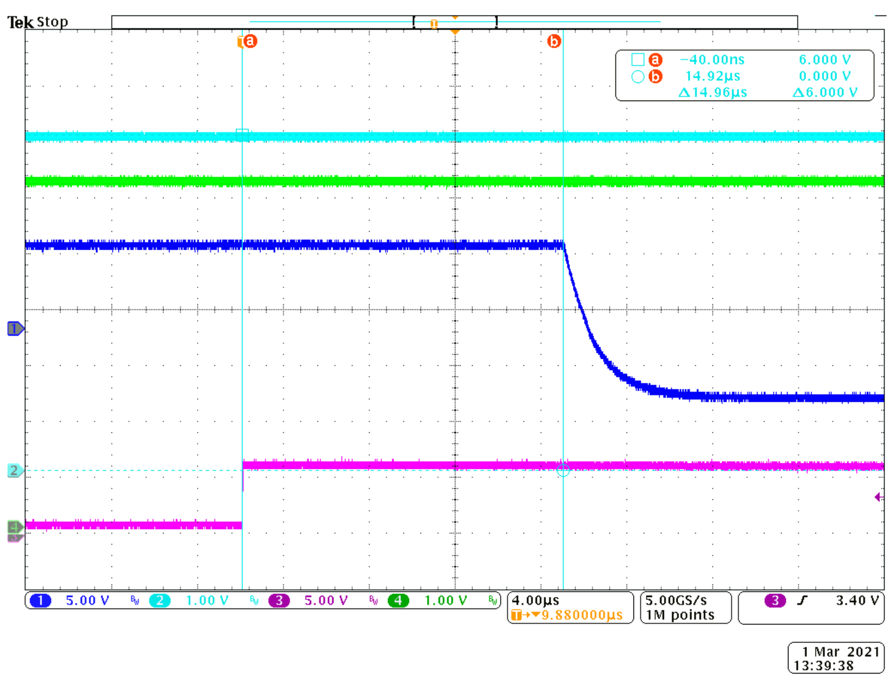
## 3.12 Over Voltage Protection (OVP)

Figure 3.12-1 OVP at 115Vac, 60Hz (**CH1**: NGDO1; **CH2**: Vbus_C; **CH3**: GPIO; **CH4**: Vbus_in)

Vout = 3.3V, OVP_Voltage = 6V, Response Time = 14.48us

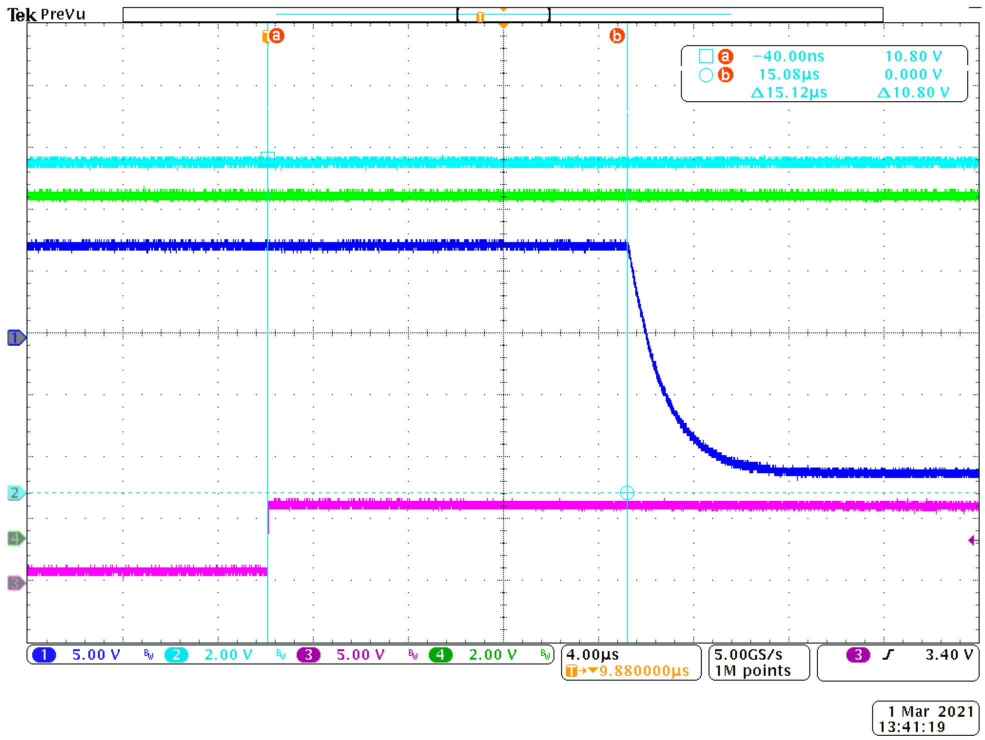



Vout = 5V, OVP_Voltage = 6V, Response Time = 14.96us

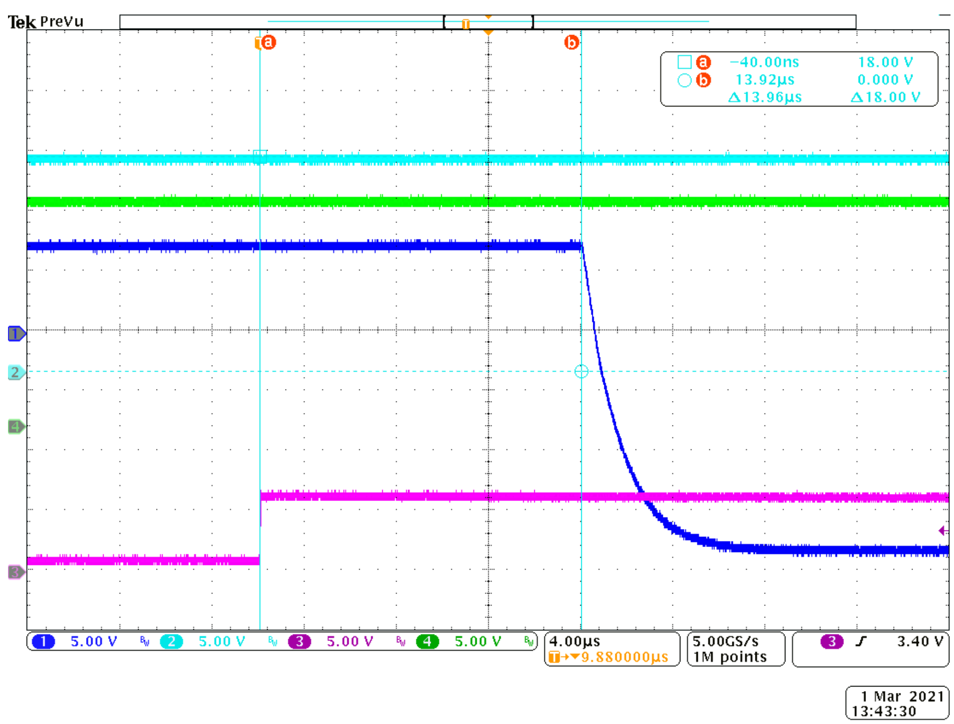



1. NGDO: NFET Gate driver output (Provider/Output MOSFET)

Vout = 9V, OVP_Voltage = 10.8V, Response Time = 15.12us




Vout = 15V, OVP_Voltage = 18V, Response Time = 13.96us



Vout = 20V, OVP_Voltage = 22.9V, Response Time = 14.88us

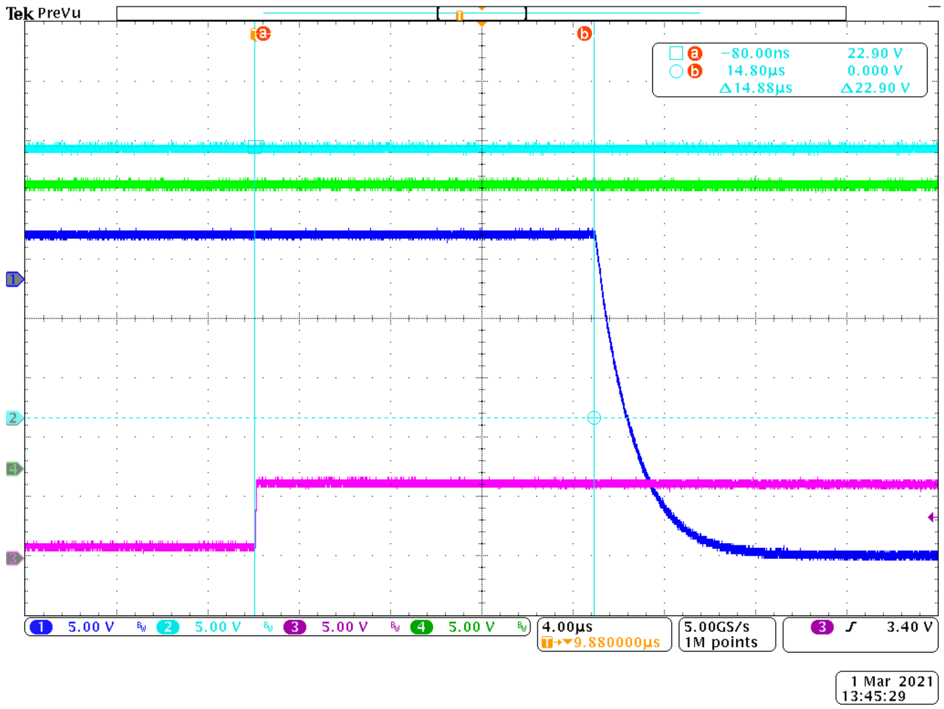
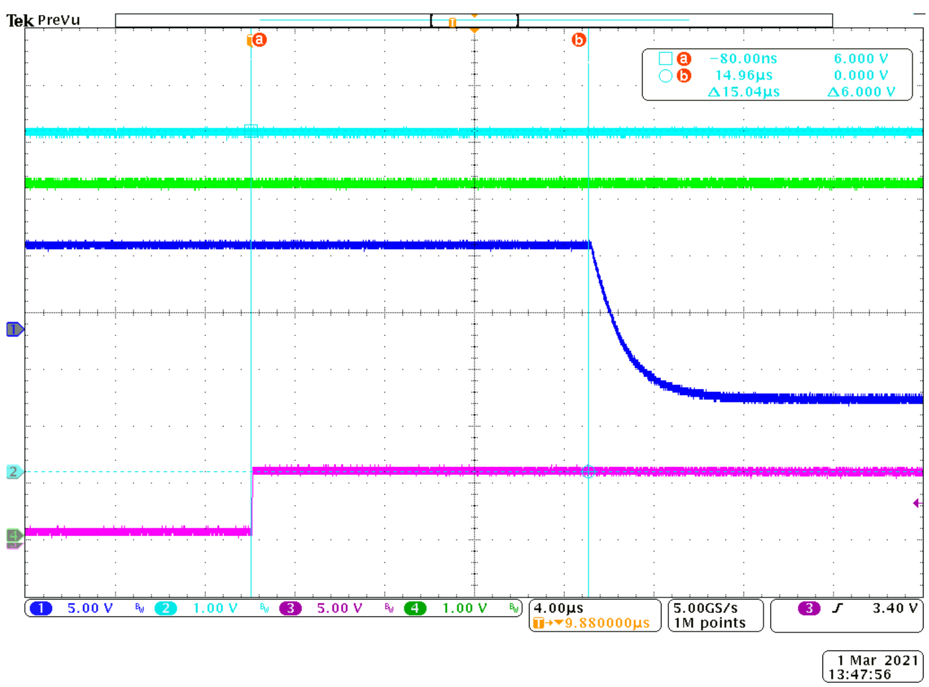
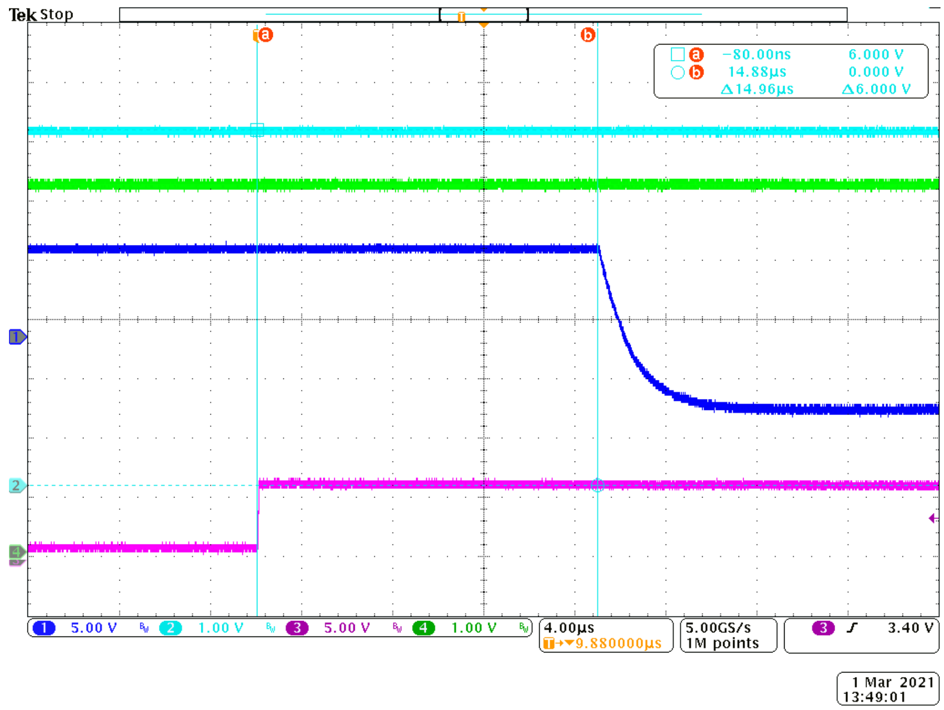



Figure 3.12-2 OVP at 230Vac, 50Hz (**CH1**: NGDO1; **CH2**: Vbus_C; **CH3**: GPIO; **CH4**: Vbus_in)

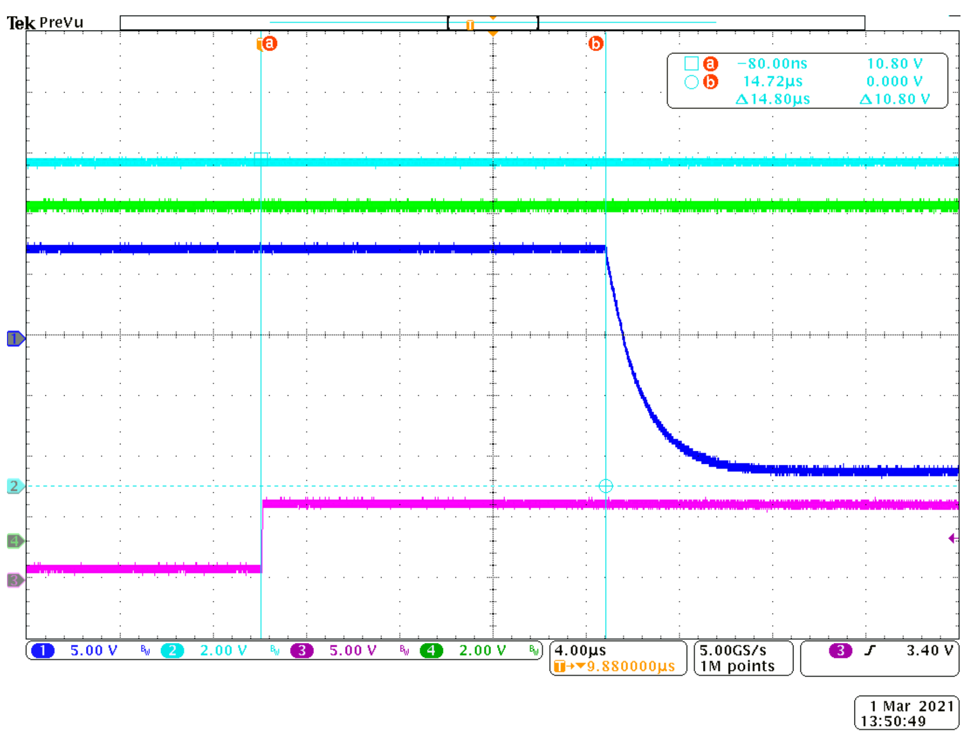
Vout = 3.3V, OVP_Voltage = 6V, Response Time = 15.04us



Vout = 5V, OVP_Voltage = 6V, Response Time = 14.96us

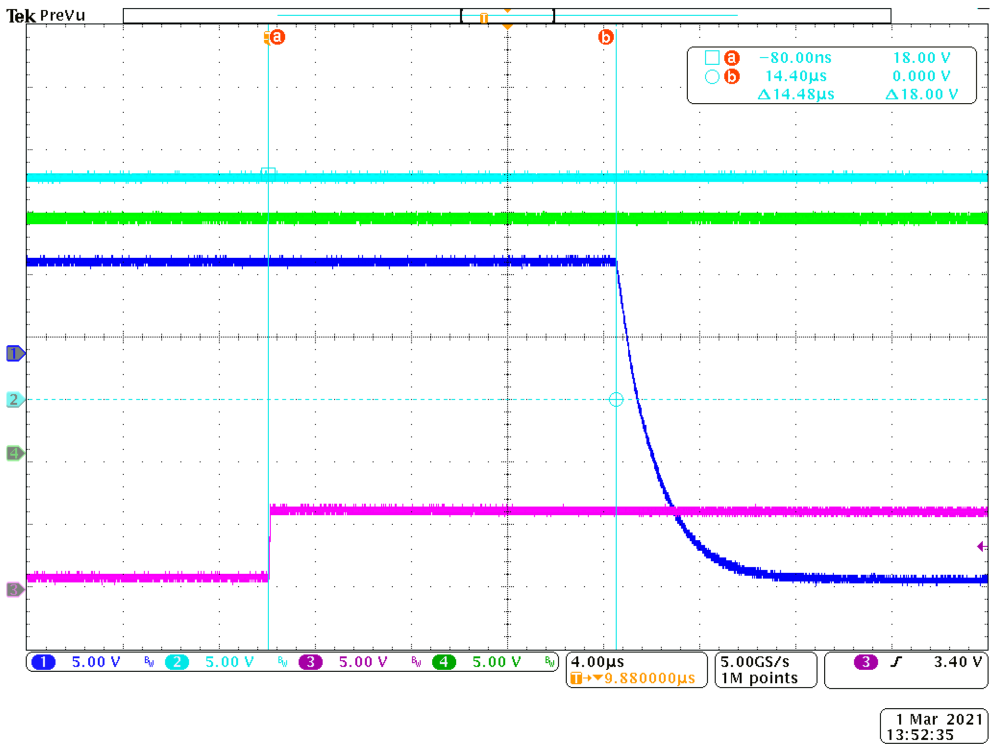



Vout = 9V, OVP_Voltage = 10.8V, Response Time = 14.8us

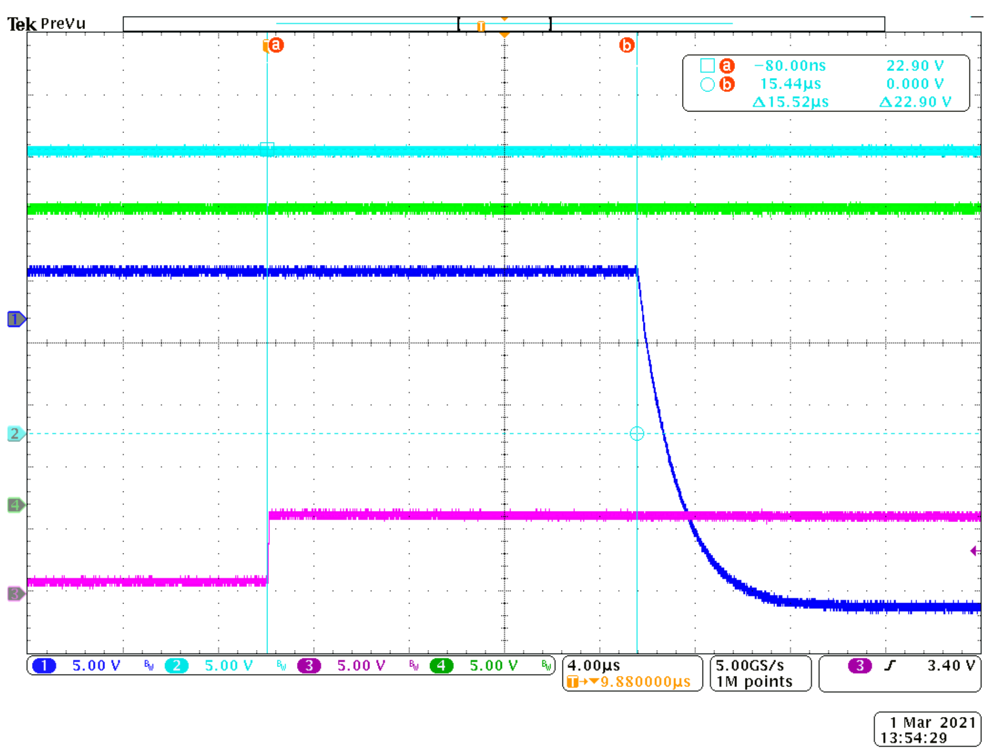



1. NGDO: NFET Gate driver output (Provider/Output MOSFET)

Vout = 15V, OVP_Voltage = 18V, Response Time = 14.48us



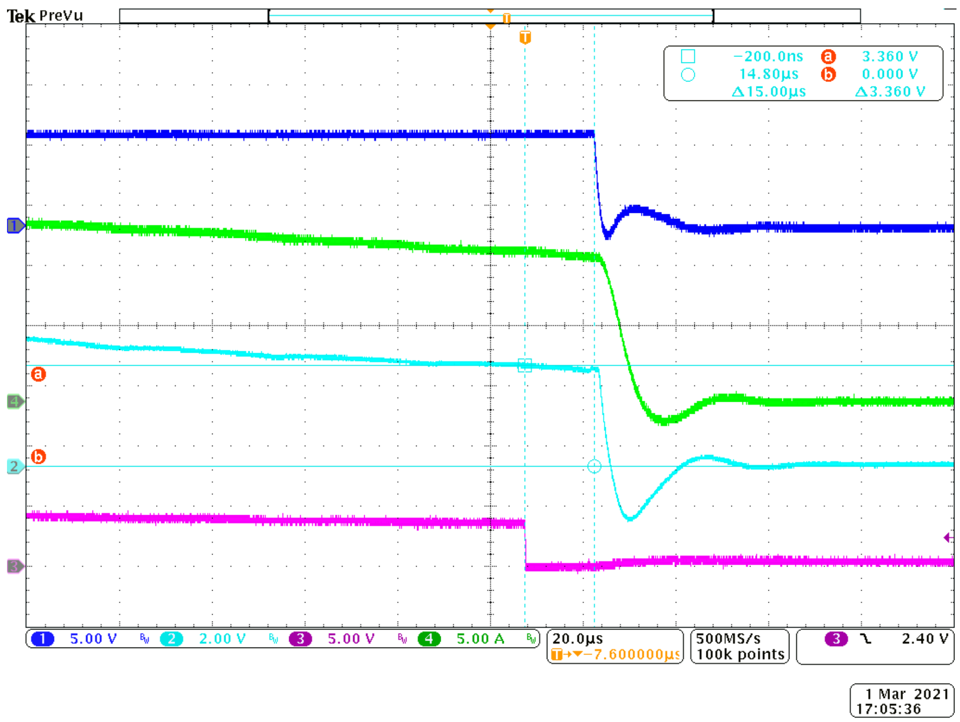

Vout = 20V, OVP_Voltage = 22.9V, Response Time = 15.52us



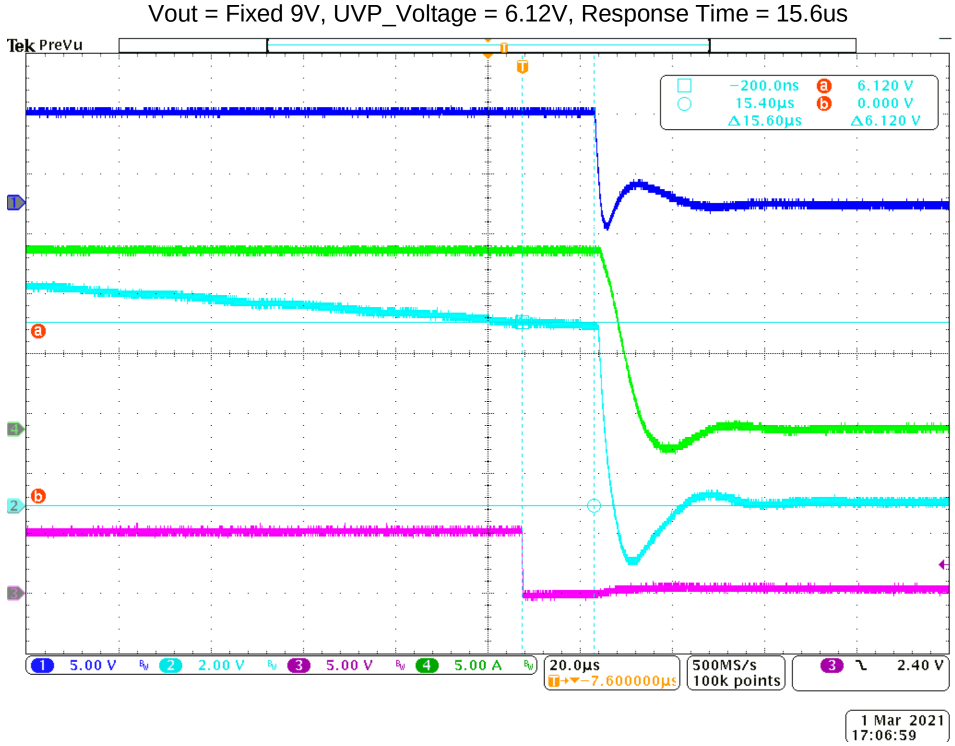
## 3.13 Under Voltage Protection (UVP)

Figure 3.12-1 UVP at 115Vac, 60Hz: Fixed-PDO (**CH1**: NGDO1; **CH2**: Vbus_C; **CH3**: GPIO; **CH4**: Iout)

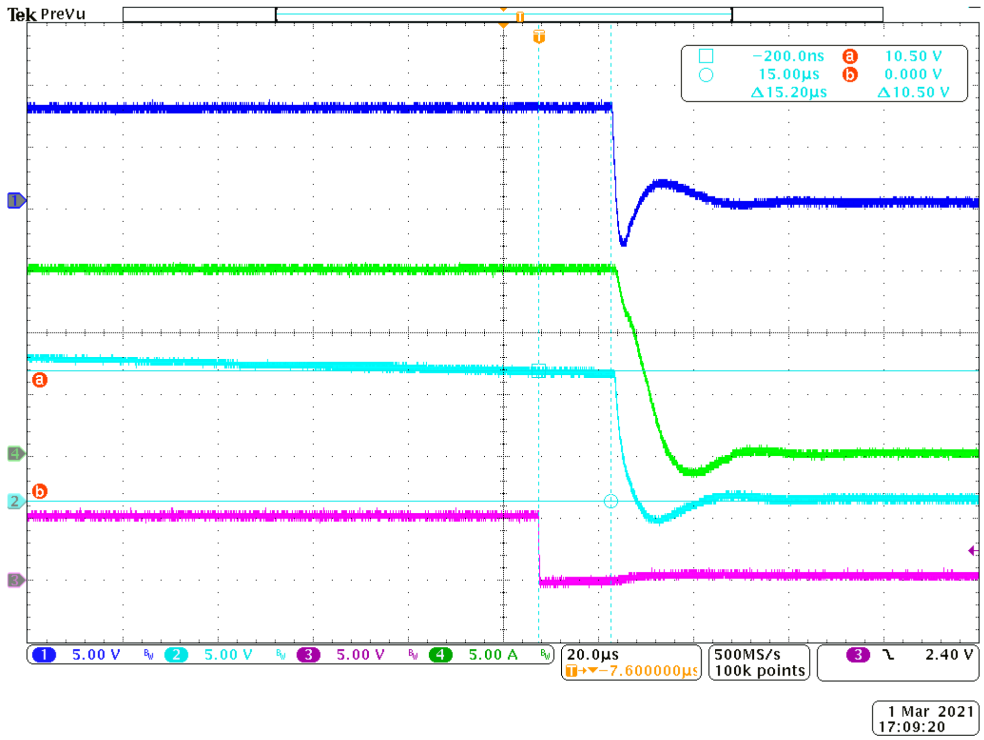
Vout = Fixed 5V, UVP_Voltage = 3.36V, Response Time = 15us




Vout = Fixed 9V, UVP_Voltage = 6.12V, Response Time = 15.6us



Vout = Fixed 15V, UVP_Voltage = 10.5V, Response Time = 15.2us




Vout = Fixed 20V, UVP_Voltage = 13.8V, Response Time = 14.4us

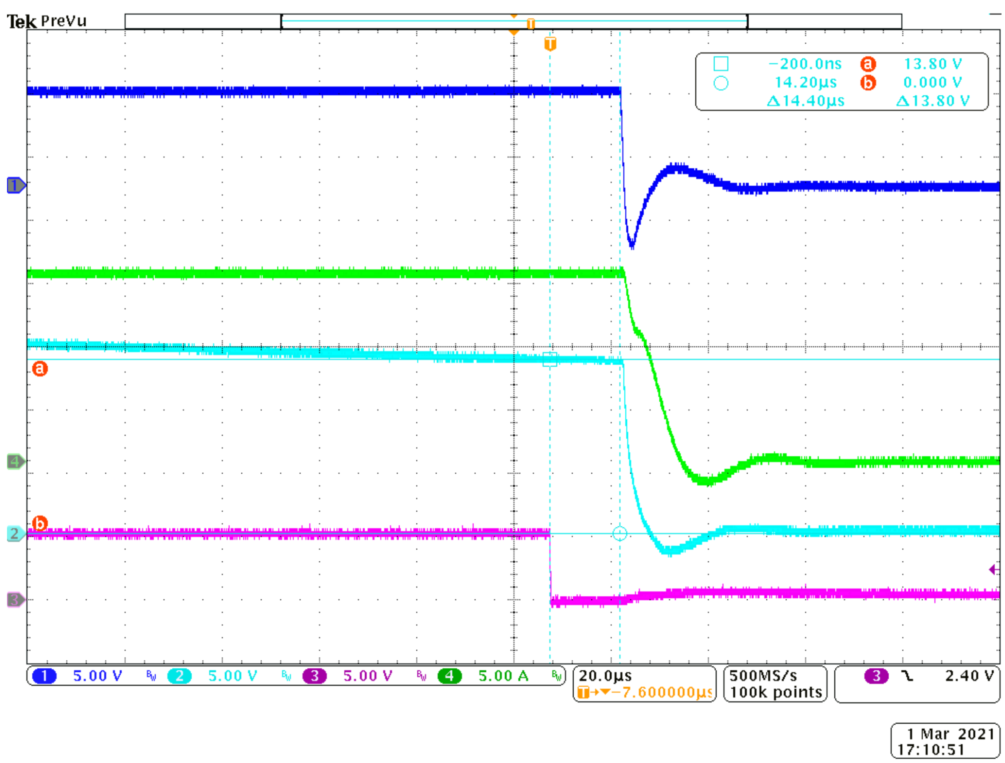
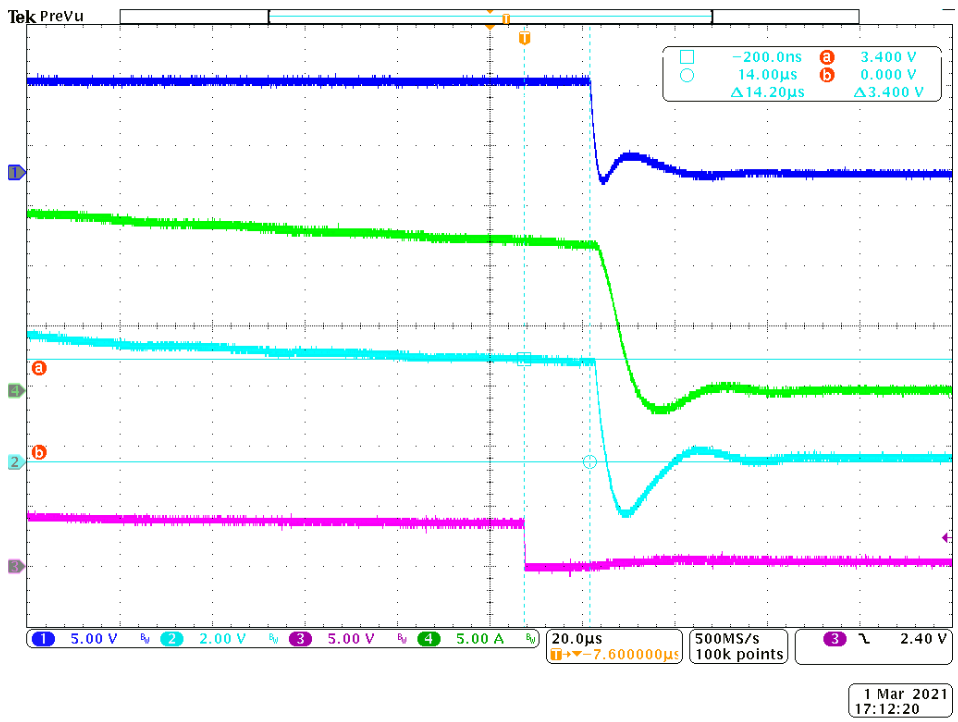
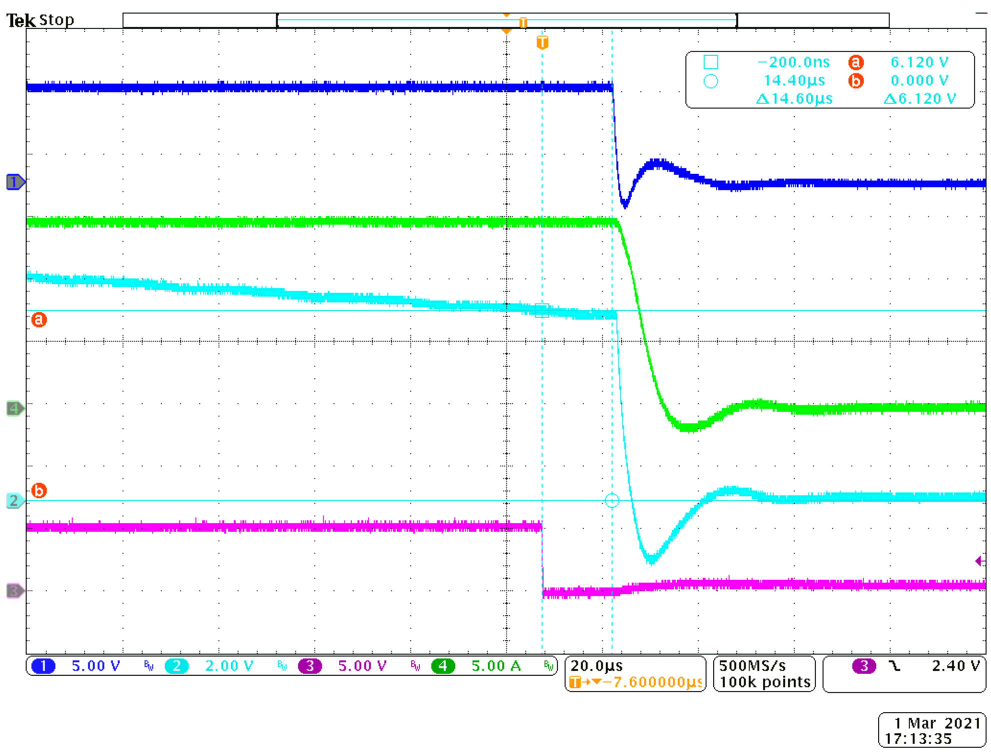


Figure 3.13-2 UVP at 230Vac, 50Hz: Fixed-PDO (**CH1**: NGDO1; **CH2**: Vbus_C; **CH3**: GPIO; **CH4**: Iout)

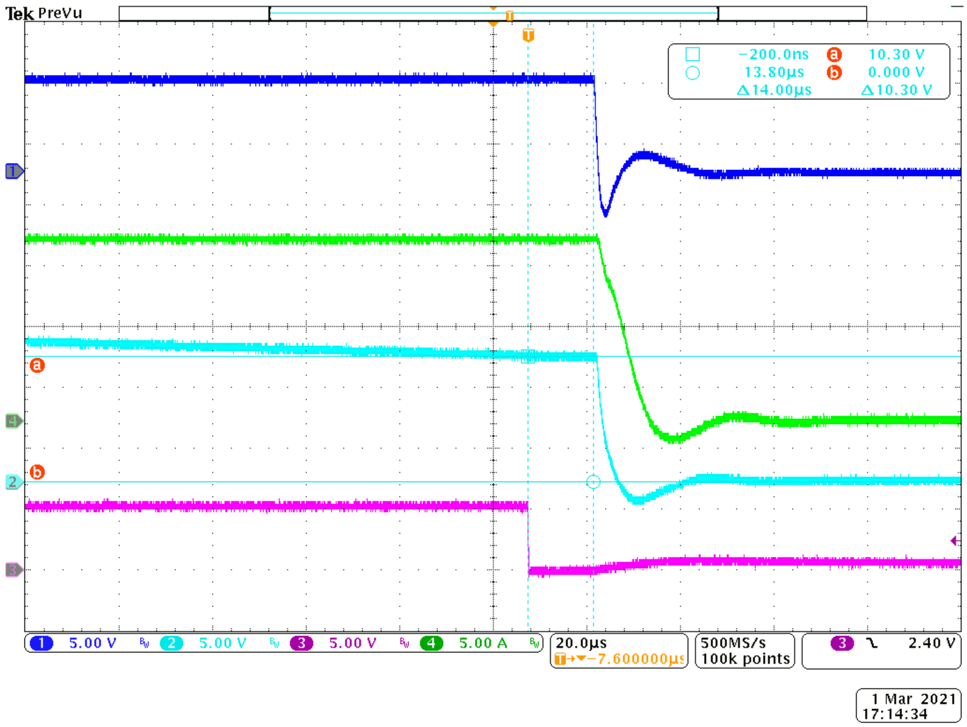
Vout = Fixed 5V, UVP_Voltage = 3.4V, Response Time = 14.2us



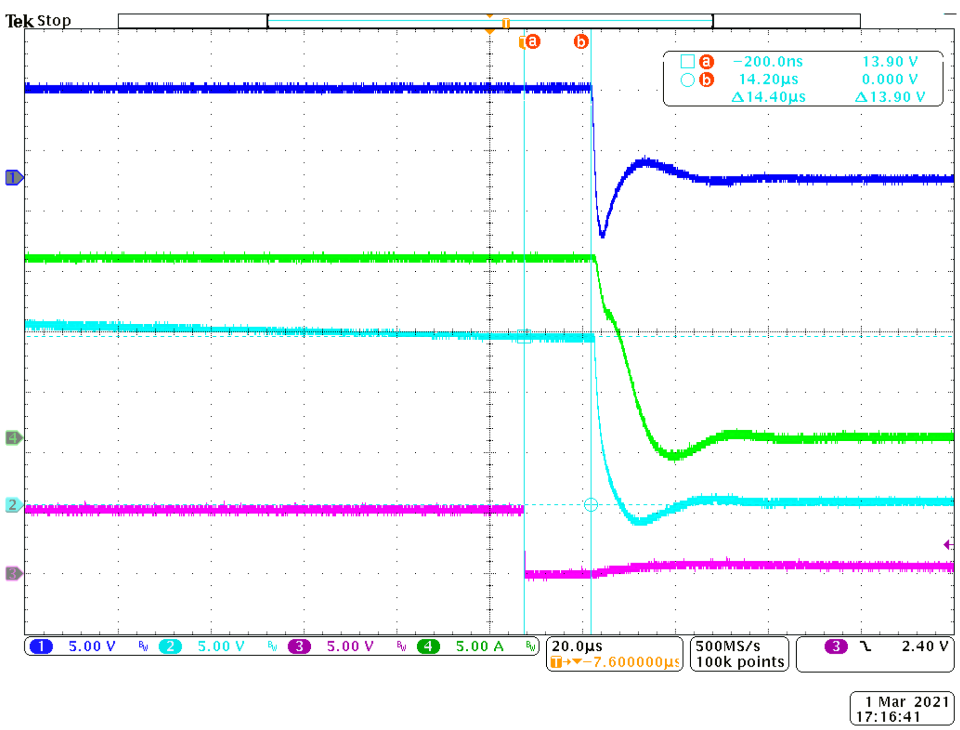

Vout = Fixed 9V, UVP_Voltage = 6.12V, Response Time = 14.6us



Vout = Fixed 15V, UVP_Voltage = 10.3V, Response Time = 14us




Vout = Fixed 20V, UVP_Voltage = 13.9V, Response Time = 14.4us

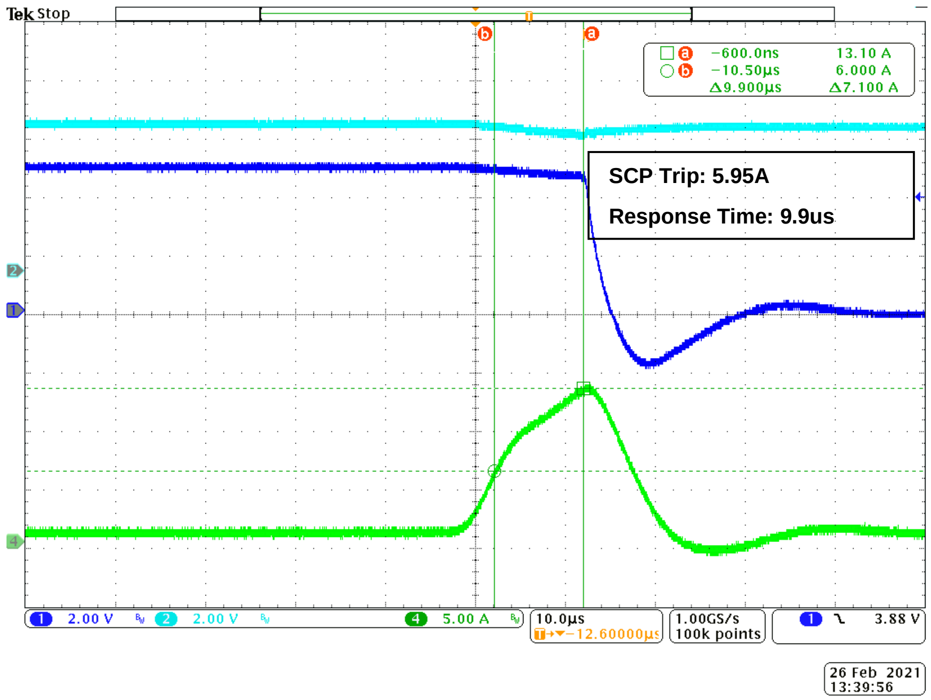



1. NGDO: NFET Gate driver output (Provider/Output MOSFET)

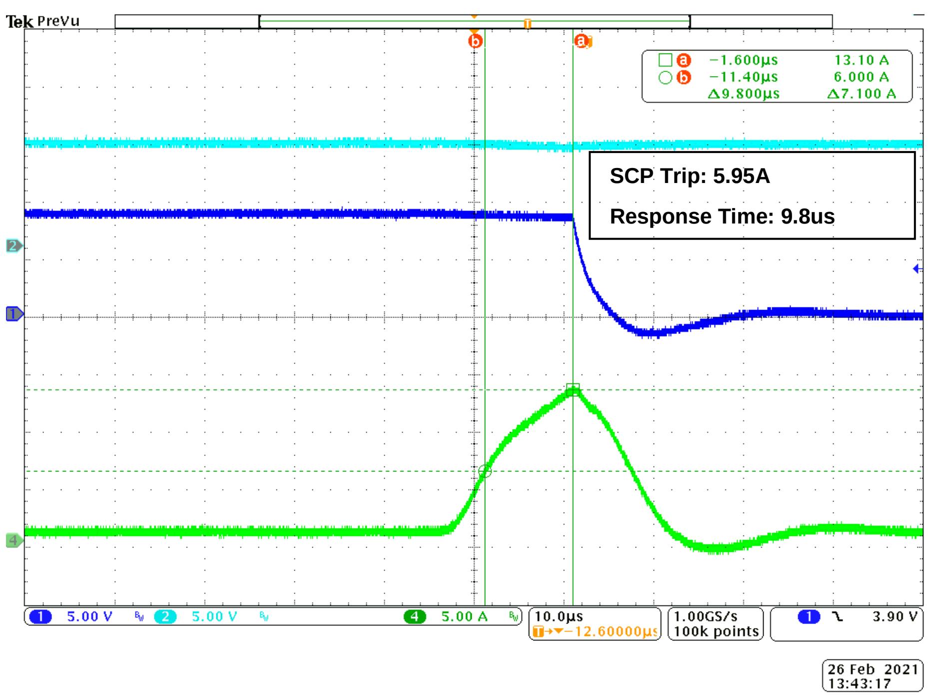
## 3.14 Short-Circuit Protection (SCP)

Figure 3.13-1 SCP at 115Vac, 60Hz (**CH2**: Vbus_in; **CH1**: Vbus_C; **CH4**: Iout)

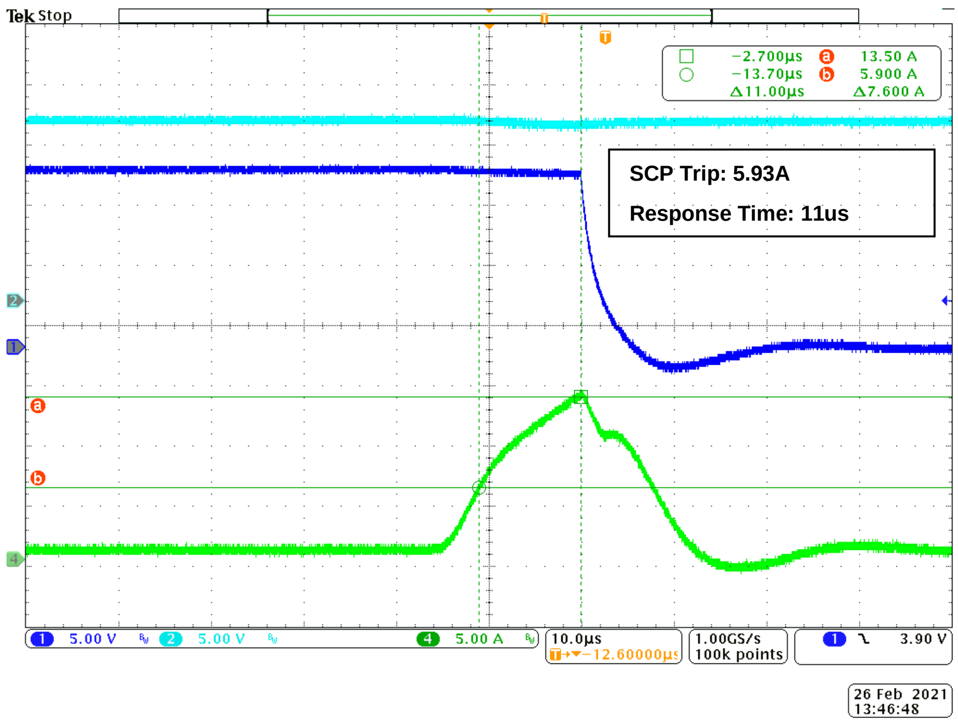
**Fixed-PDO:** 5V, 3A




**Fixed-PDO:** 9V, 3A




**Fixed-PDO:** 15V, 3A




**Fixed-PDO:** 20V, 2.25A

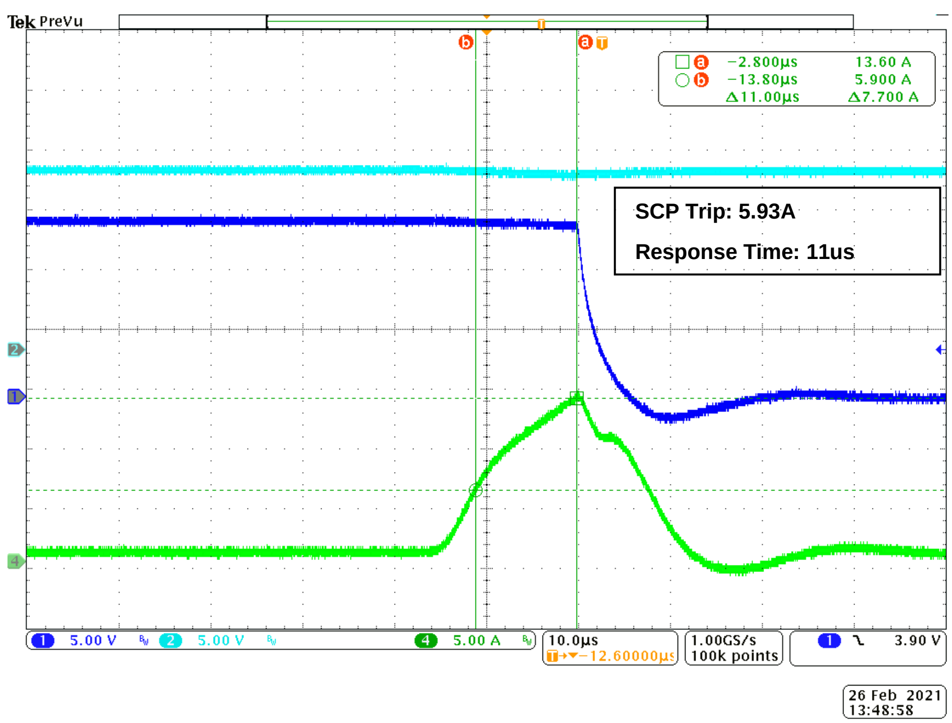
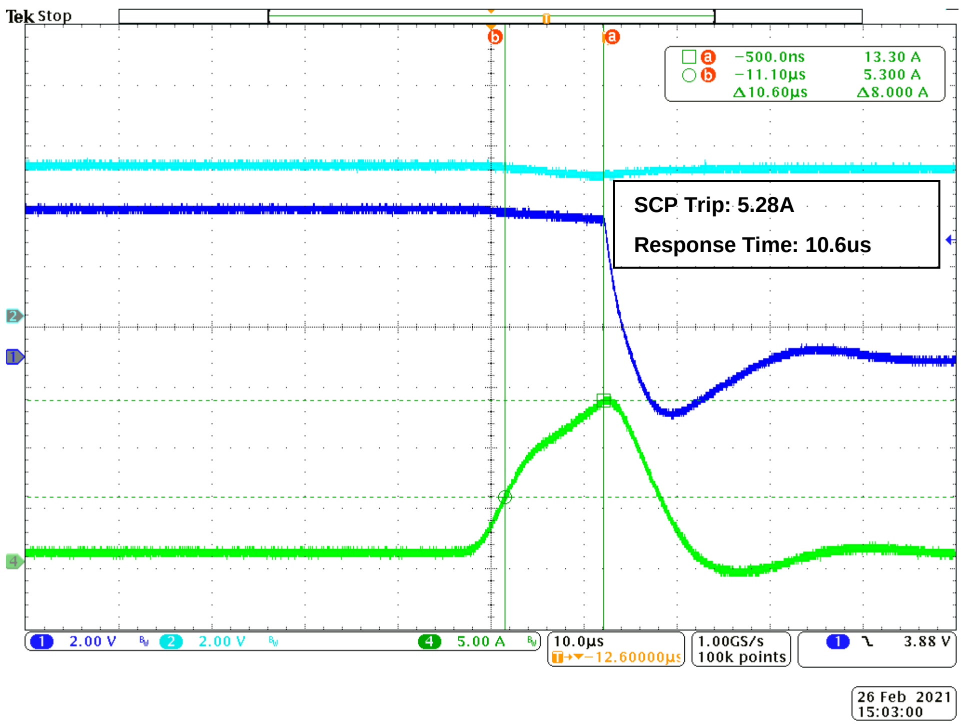
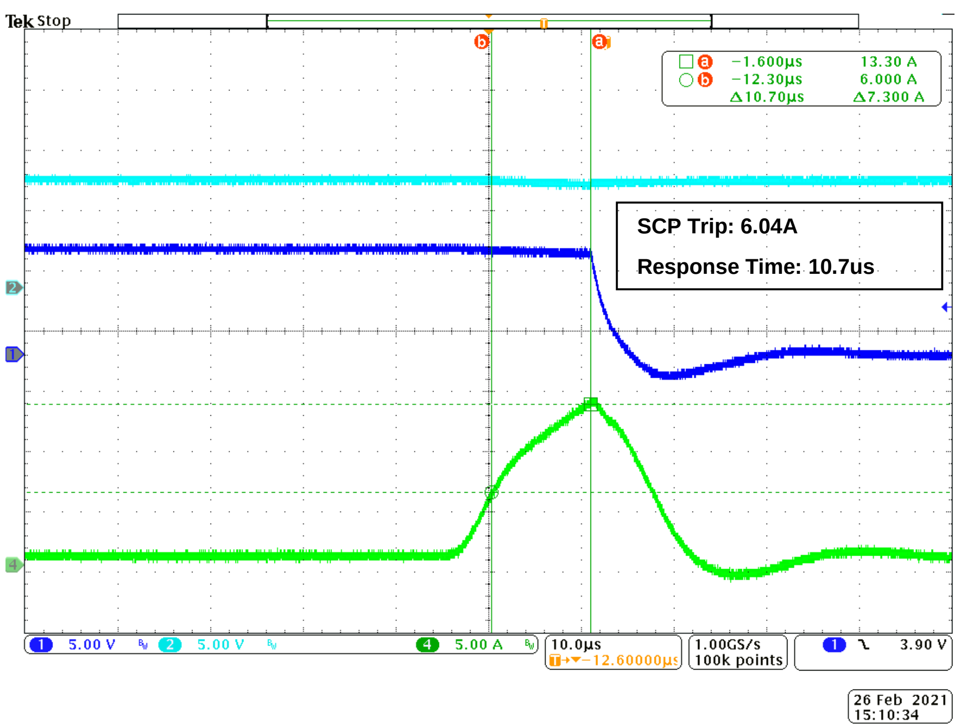


Figure 3.14-2 SCP at 230Vac, 50Hz (**CH2**: Vbus_in; **CH1**: Vbus_C; **CH4**: Iout)

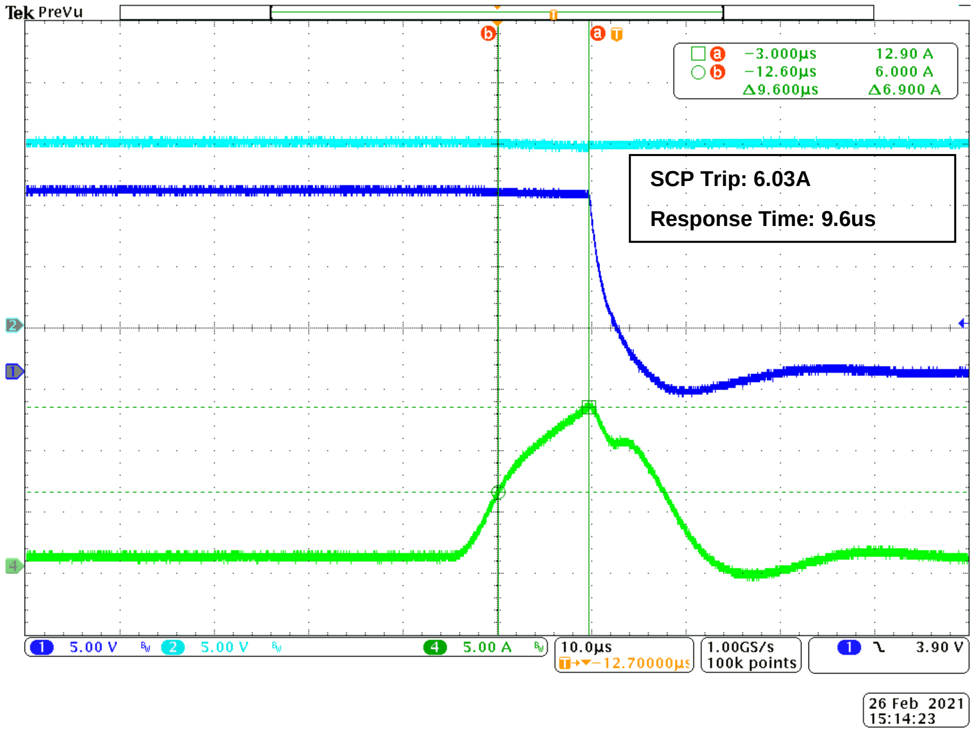
**Fixed-PDO:** 5V, 3A



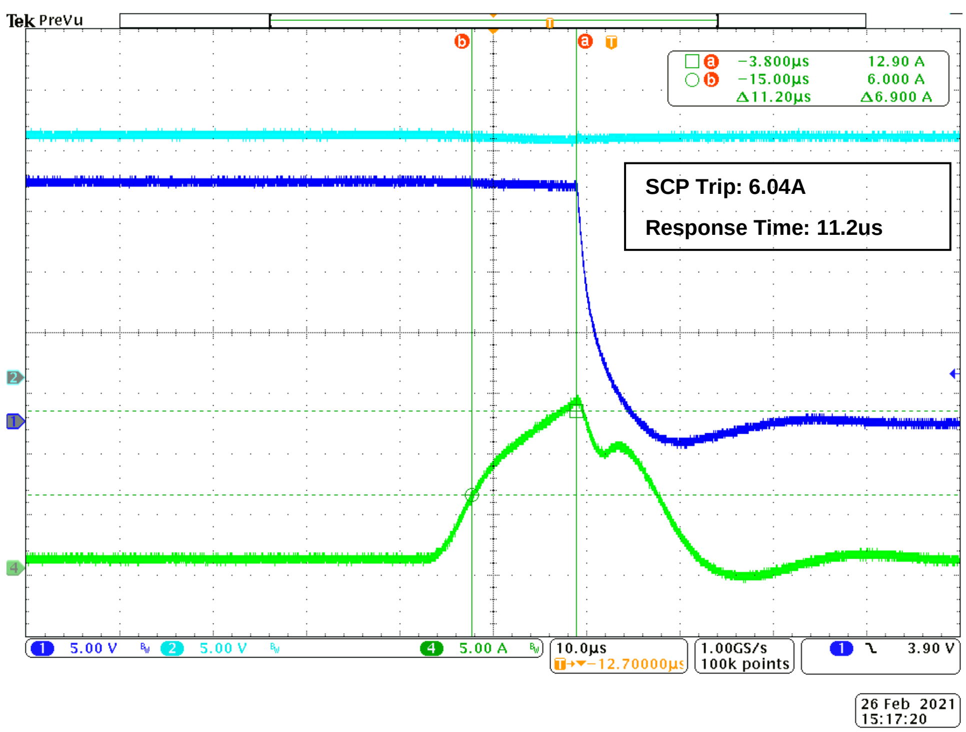

**Fixed-PDO:** 9V, 3A



**Fixed-PDO:** 15V, 3A



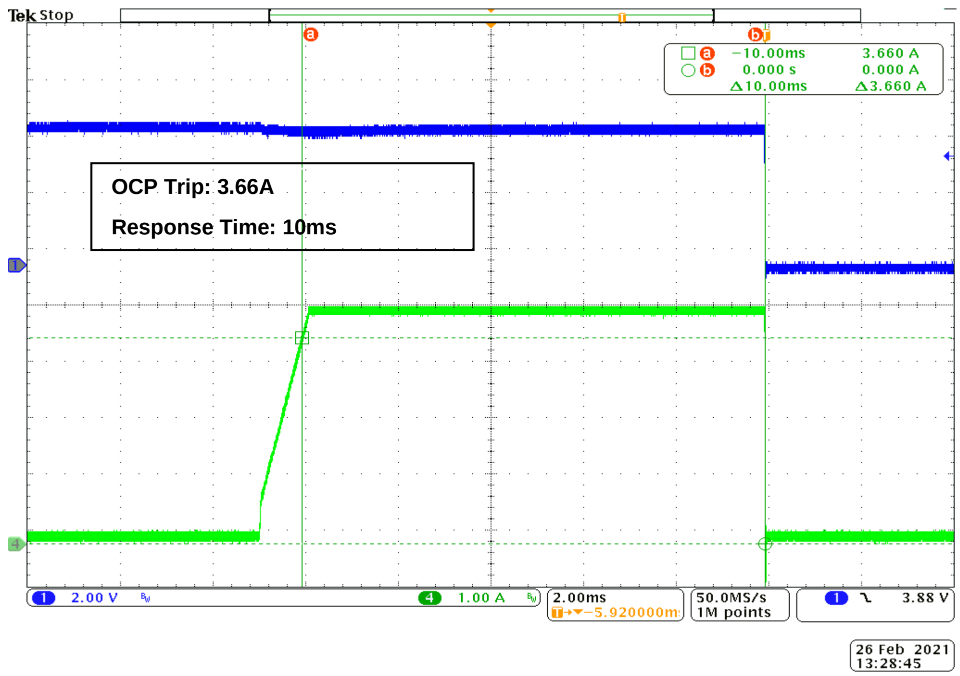

**Fixed-PDO:** 20V, 2.25A



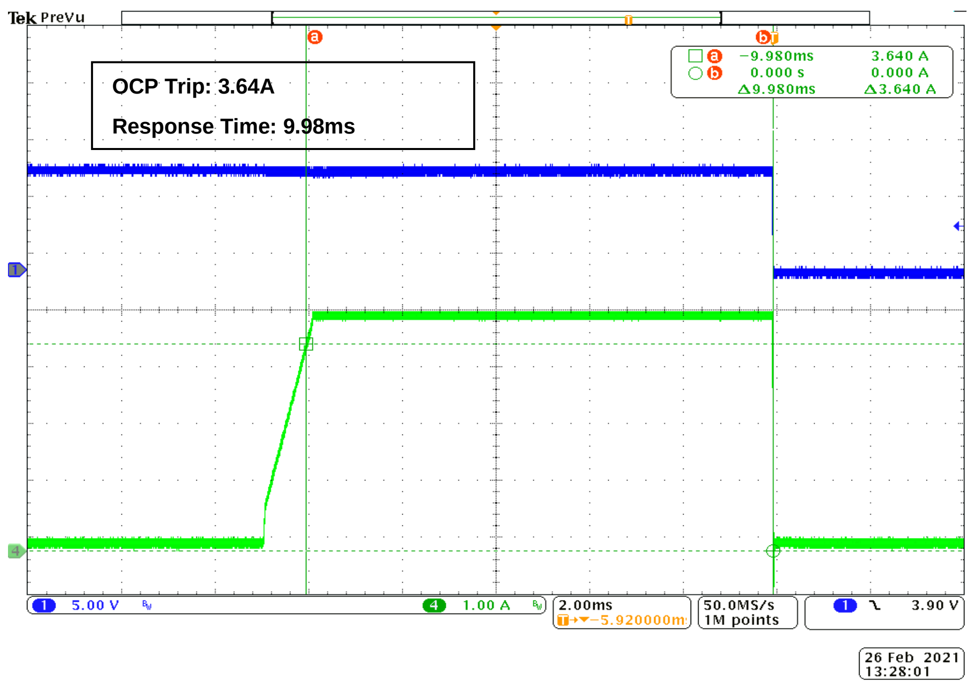
## 3.15 Over Current Protection (OCP)

Figure 3.15-1 OCP at 115Vac, 60Hz (**CH1**: Vbus_C, **CH4**: Iout)

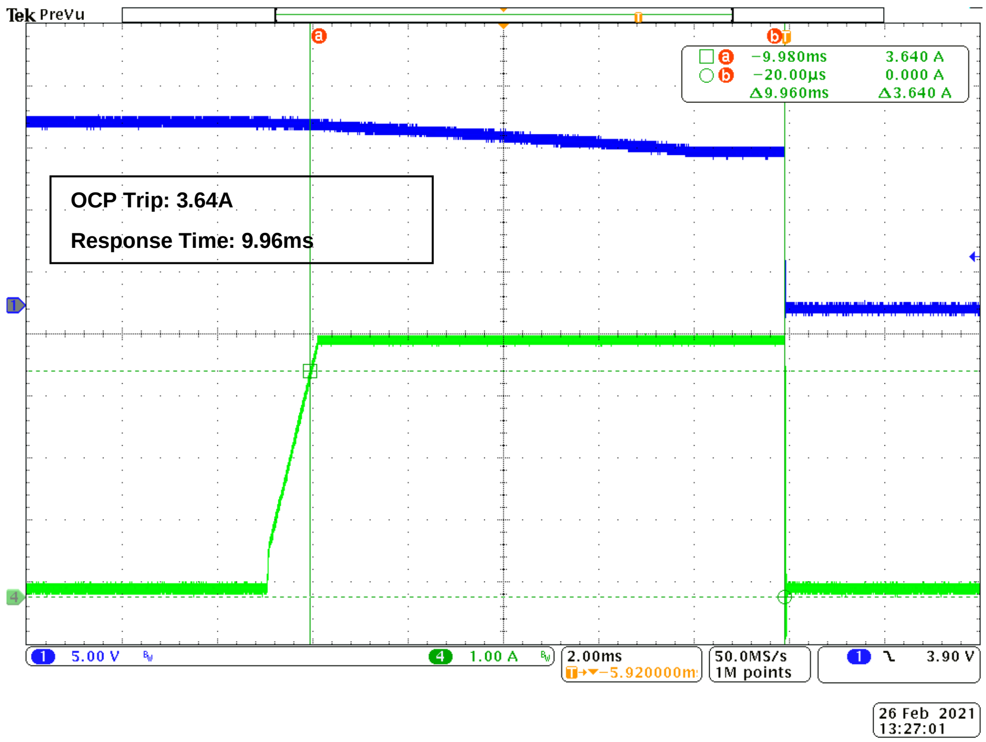
**Fixed-PDO:** 5V, 3A




**Fixed-PDO:** 9V, 3A



**Fixed-PDO:** 15V, 3A




**Fixed-PDO:** 20V, 2.25A

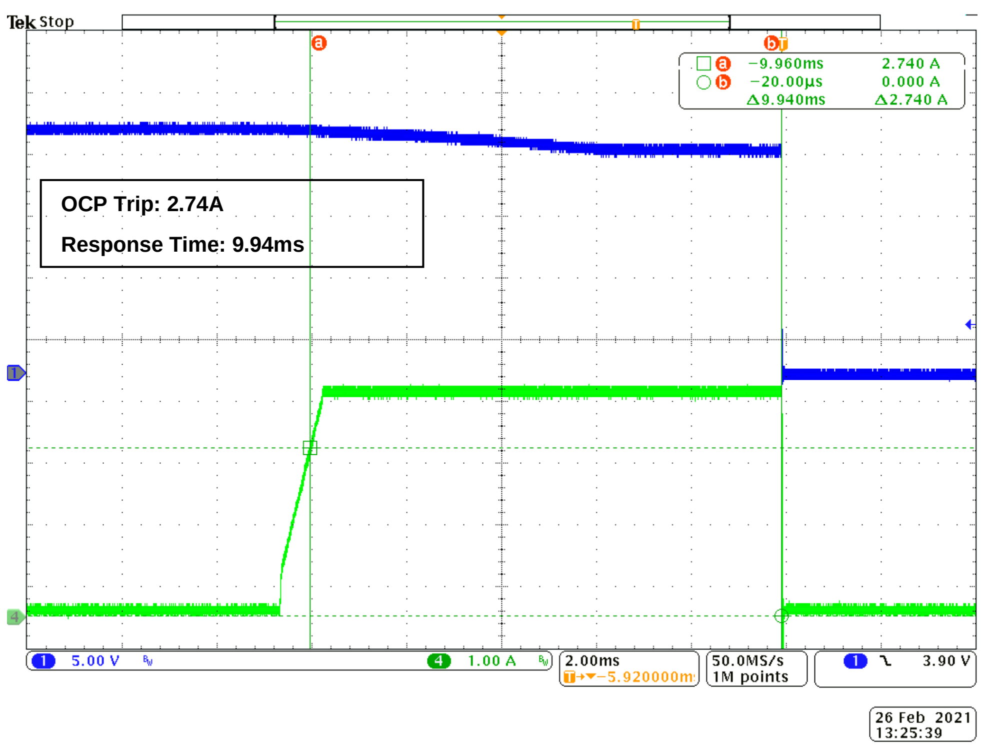
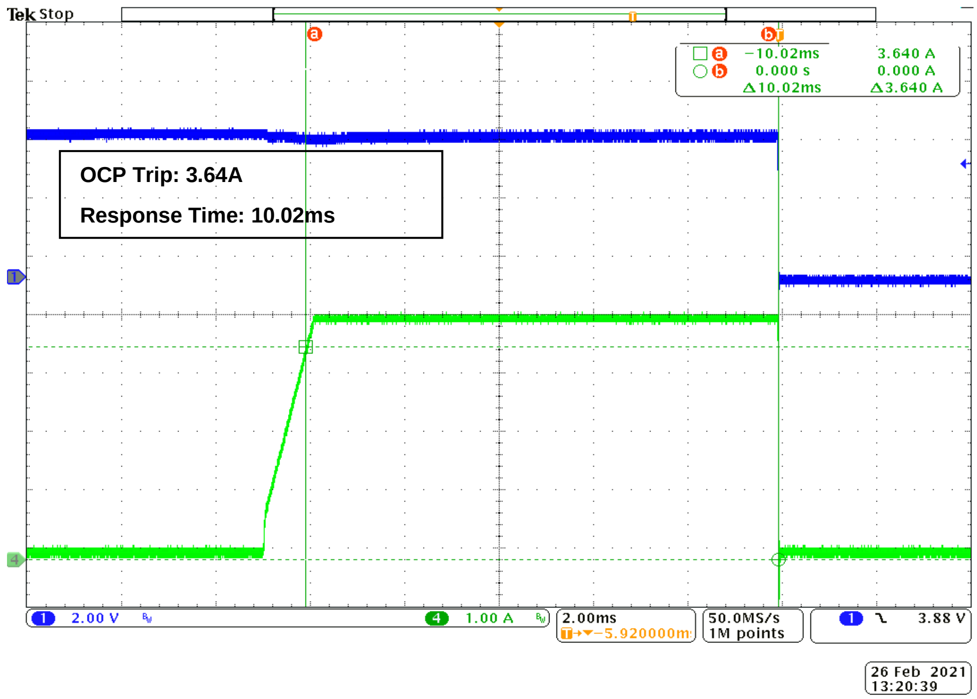
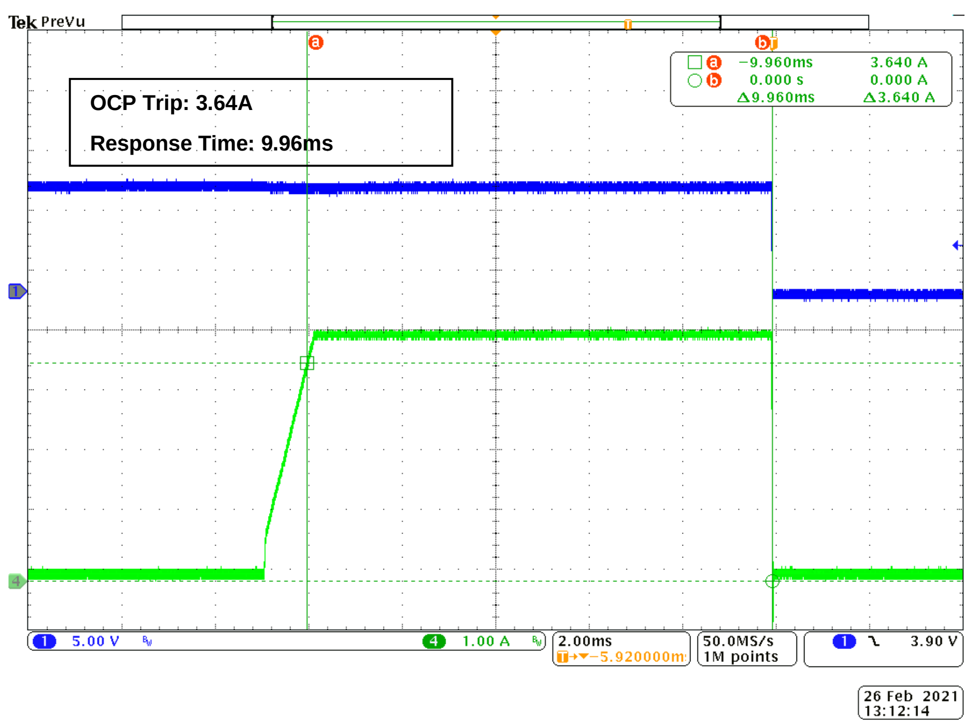


Figure 3.15-2 OCP at 230Vac, 50Hz (**CH1**: Vbus_C, **CH4**: Iout)

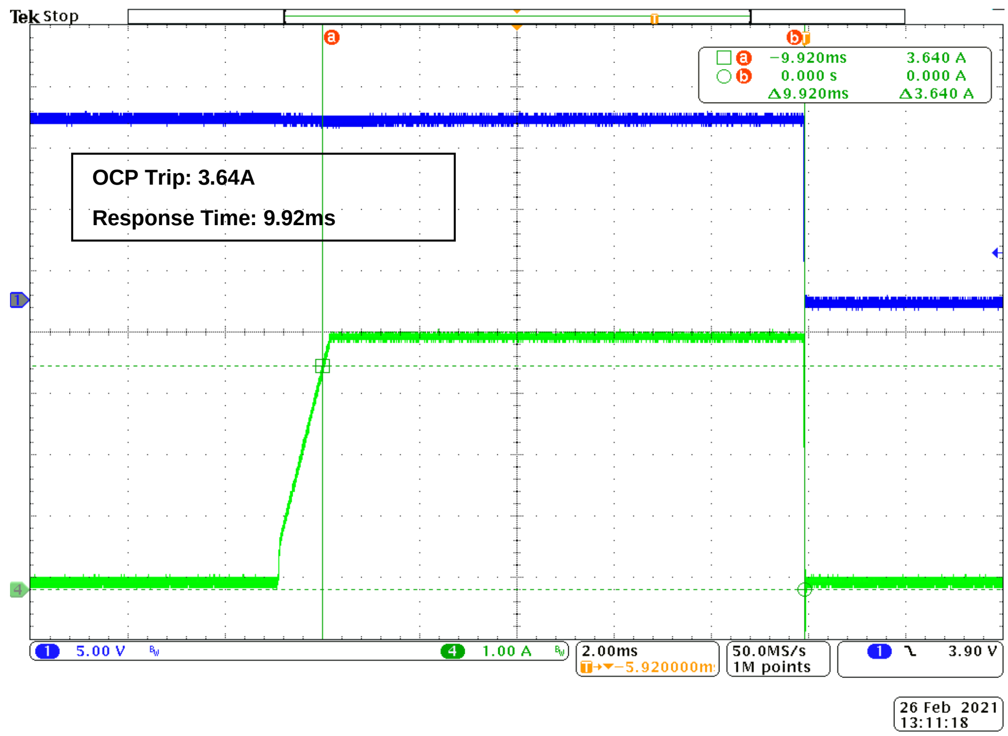
**Fixed-PDO:** 5V, 3A



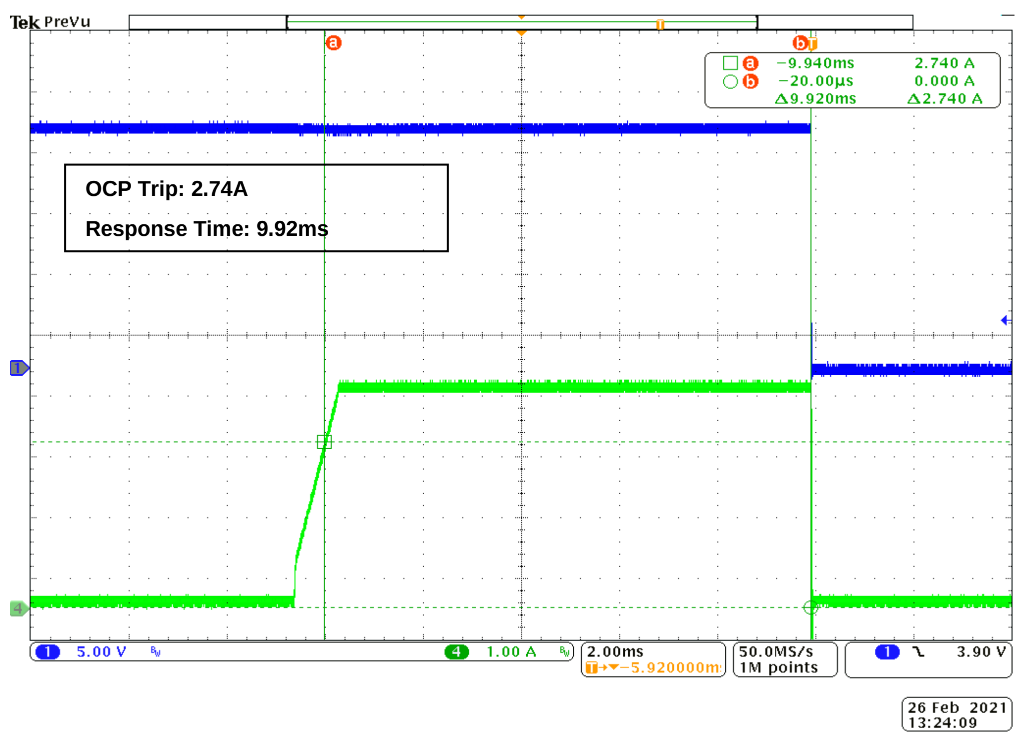

**Fixed-PDO:** 9V, 3A



**Fixed-PDO:** 15V, 3A




**Fixed-PDO:** 20V, 2.25A



## 3.16 Conducted Emission (CE)

Conducted Emission on AC Mains Port, Spectral Diagram, 0.15-30MHz

Figure 3.16-1 CE at 230Vac: NEUTRAL(N)

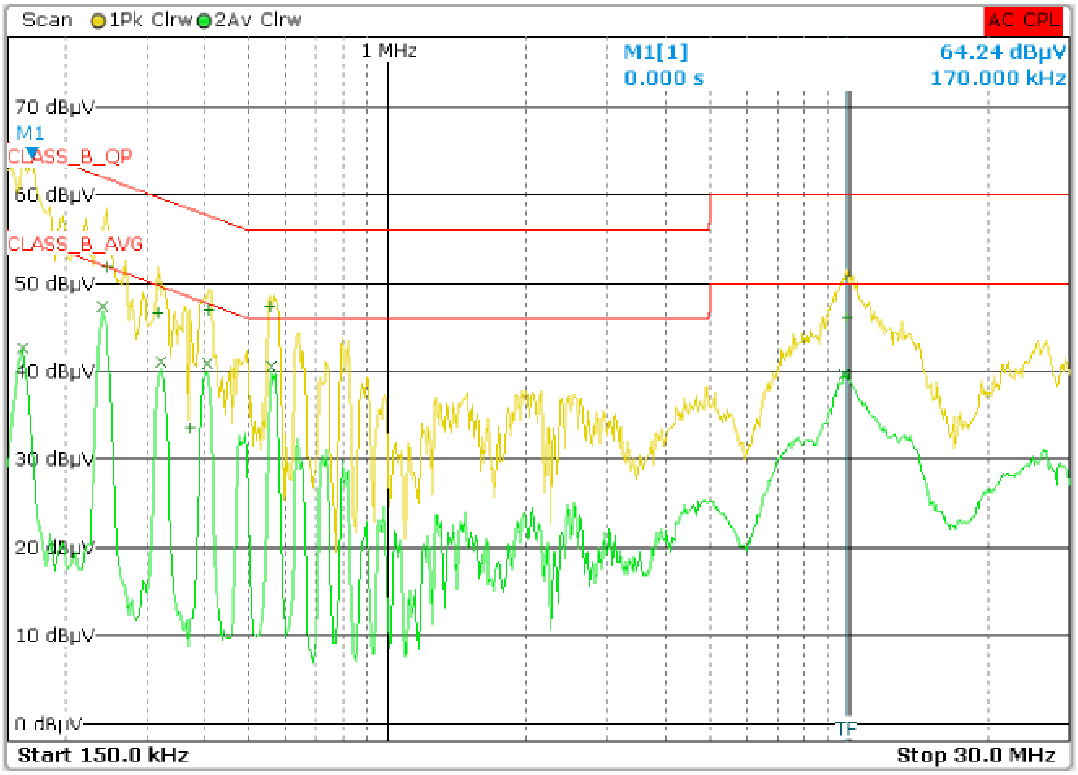



Table 3.3 CE at 230Vac, 150kHz-30MHz, Quasi Peak and Average Data, Neutral (N)

Meas Time 1.0 s
Margin 6.0 dB
Peaks 25

| Trace | Frequency | Level (dBµV) | Phase | Detector | Delta Limit/dB |
|---|---|---|---|---|---|
| 2 | 242.000000000 kHz | 47.30 | | Average | -4.73 |
| 2 | 558.000000000 kHz | 40.58 | | Average | -5.42 |
| 2 | 406.000000000 kHz | 40.83 | | Average | -6.90 |
| 2 | 322.000000000 kHz | 41.11 | | Average | -8.55 |
| 1 | 554.000000000 kHz | 47.36 | | Quasi Peak | -8.64 |
| 1 | 246.000000000 kHz | 51.90 | | Quasi Peak | -9.99 |
| 2 | 9.726000000 MHz | 39.74 | | Average | -10.26 |
| 1 | 410.000000000 kHz | 47.04 | | Quasi Peak | -10.61 |
| 1 | 170.000000000 kHz | 54.28 | | Quasi Peak | -10.68 |
| 2 | 162.000000000 kHz | 42.64 | | Average | -12.72 |
| 1 | 318.000000000 kHz | 46.68 | | Quasi Peak | -13.08 |
| 1 | 9.890000000 MHz | 46.07 | | Quasi Peak | -13.93 |
| 1 | 374.000000000 kHz | 33.63 | | Quasi Peak | -24.78 |

Figure 3.16-2 CE at 230Vac: LINE(L)

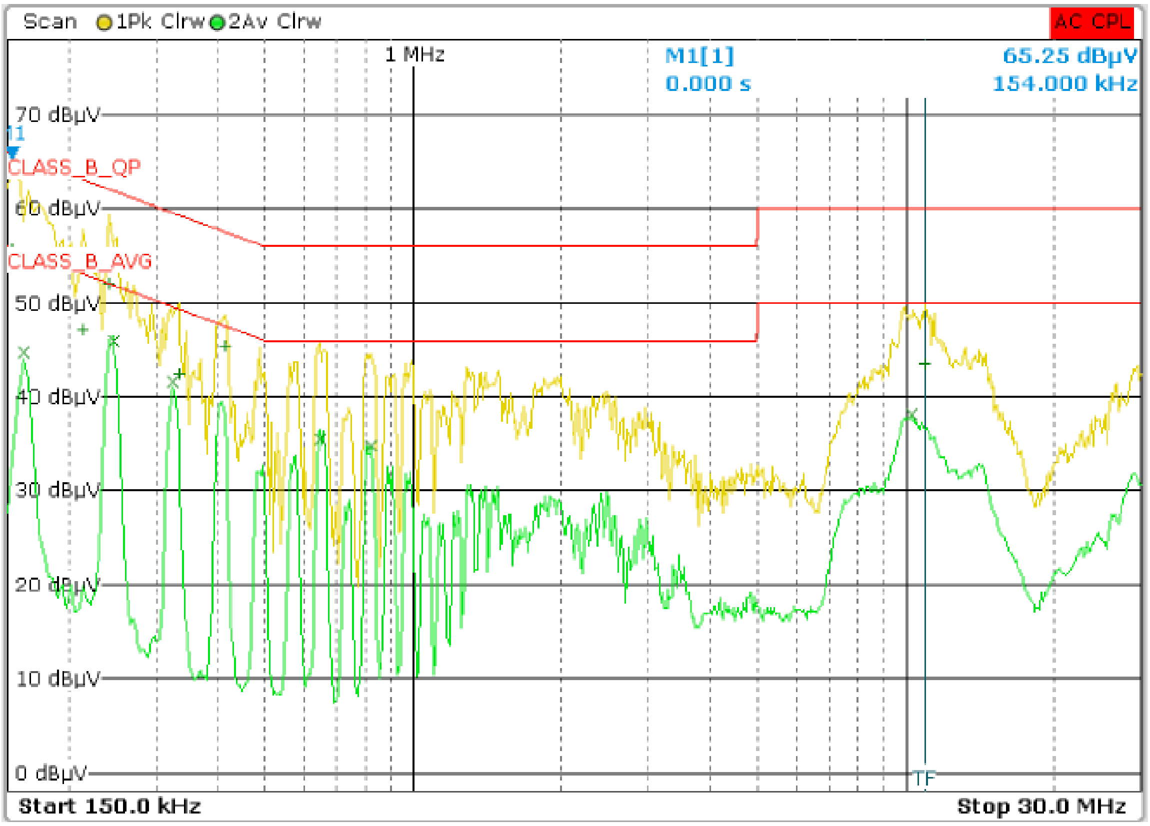



Table 3.4 CE at 230Vac, 150kHz-30MHz, Quasi Peak and Average Data, Line (L)

| | |
|---|---|
| Meas Time | 1.0 s |
| Margin | 6.0 dB |
| Peaks | 25 |

| Trace | Frequency | Level (dBµV) | Phase | Detector | Delta Limit/dB |
|---|---|---|---|---|---|
| 2 | 246.000000000 kHz | 45.86 | | Average | -6.03 |
| 2 | 326.000000000 kHz | 41.51 | | Average | -8.04 |
| 1 | 242.000000000 kHz | 51.99 | | Quasi Peak | -10.04 |
| 1 | 154.000000000 kHz | 55.70 | | Quasi Peak | -10.08 |
| 2 | 646.000000000 kHz | 35.52 | | Average | -10.48 |
| 2 | 162.000000000 kHz | 44.64 | | Average | -10.72 |
| 2 | 822.000000000 kHz | 34.72 | | Average | -11.28 |
| 2 | 10.286000000 MHz | 38.13 | | Average | -11.87 |
| 1 | 414.000000000 kHz | 45.40 | | Quasi Peak | -12.17 |
| 1 | 214.000000000 kHz | 47.20 | | Quasi Peak | -15.85 |
| 1 | 10.890000000 MHz | 43.46 | | Quasi Peak | -16.54 |
| 1 | 334.000000000 kHz | 42.40 | | Quasi Peak | -16.95 |

## 3.17 Thermal Stress

**Test Condition:** Vin_ac = 90Vac-47Hz, Vout = 20V, Iout = 2.25A

**Lab Ambient Temperature:** 25°C and in Open-frame

**Run time:** 60 minutes

Figure 3.17-1 Thermal data logging of various components with time at 90Vac, 45W

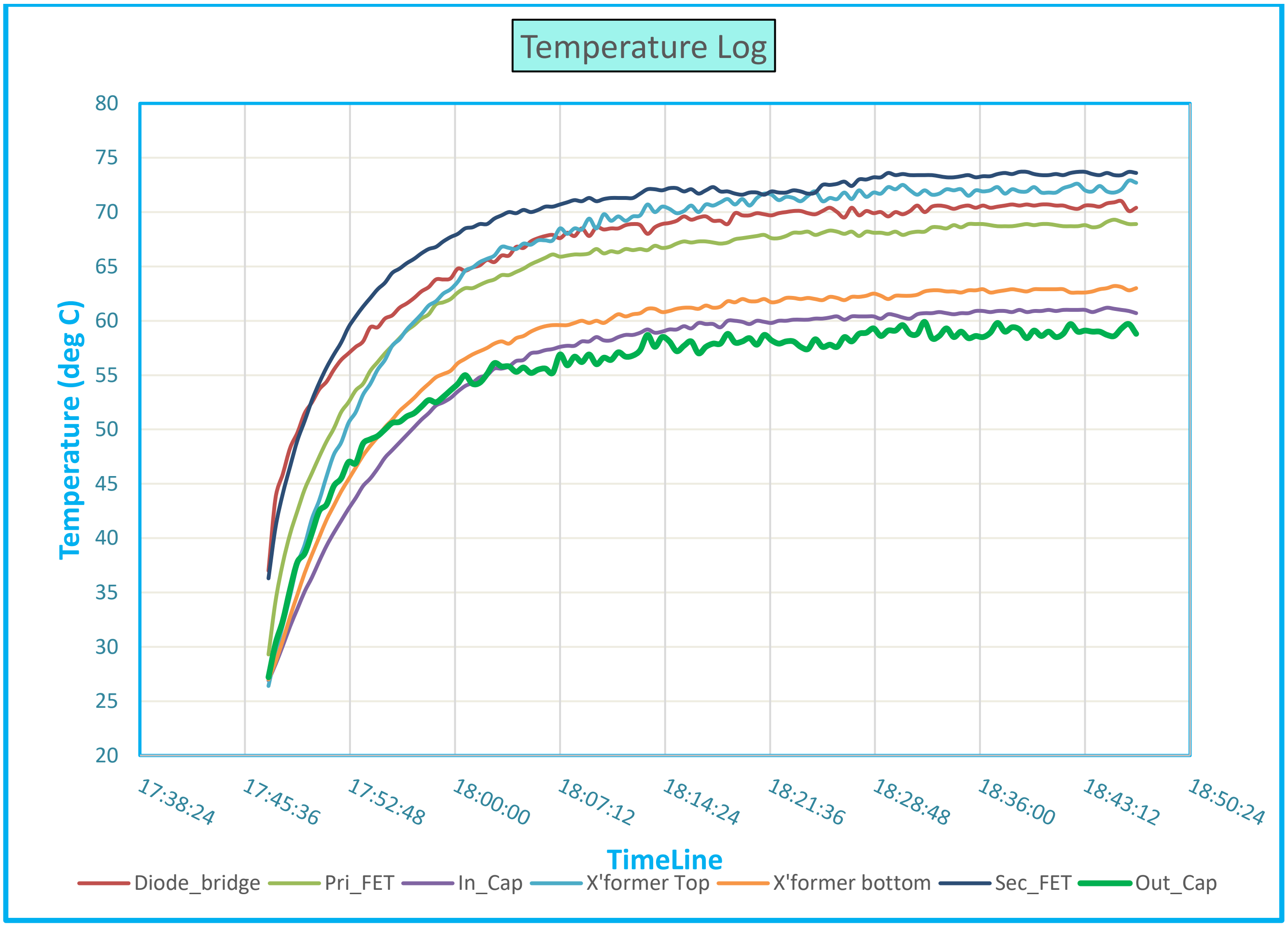



Table 3.5 Data showing Max temperatures and efficiency after 60 minutes

| S.No. | Parameter | Line (Vac) | Freq(Hz) | Pin (W) | Vout (V) | Iout (A) | Efficiency (%) | Max. Temp |
|---|---|---|---|---|---|---|---|---|
| 1 | Diode_bridge | 90 | 46.975 | 48.92 | 19.826 | 2.2511 | 91.2301 | 71 |
| 2 | Pri_FET | 90 | 46.975 | 48.92 | 19.826 | 2.2511 | 91.2301 | 69.3 |
| 3 | In_Cap | 90 | 46.975 | 48.92 | 19.826 | 2.2511 | 91.2301 | 61.2 |
| 4 | X'former Top | 90 | 46.975 | 48.92 | 19.826 | 2.2511 | 91.2301 | 72.9 |
| 5 | X'former bottom | 90 | 46.975 | 48.92 | 19.826 | 2.2511 | 91.2301 | 63.2 |
| 6 | Sec_FET | 90 | 46.975 | 48.92 | 19.826 | 2.2511 | 91.2301 | 73.7 |
| 7 | Out_Cap | 90 | 46.975 | 48.92 | 19.826 | 2.2511 | 91.2301 | 59.9 |

**Test Condition:** Vin_ac = 265Vac-63Hz, Vout = 20V, Iout = 2.25A

**Lab Ambient Temperature:** 25°C and in Open-frame

**Run time:** 50 minutes

Figure 3.17-2 Thermal data logging of various components with time at 265Vac, 45W

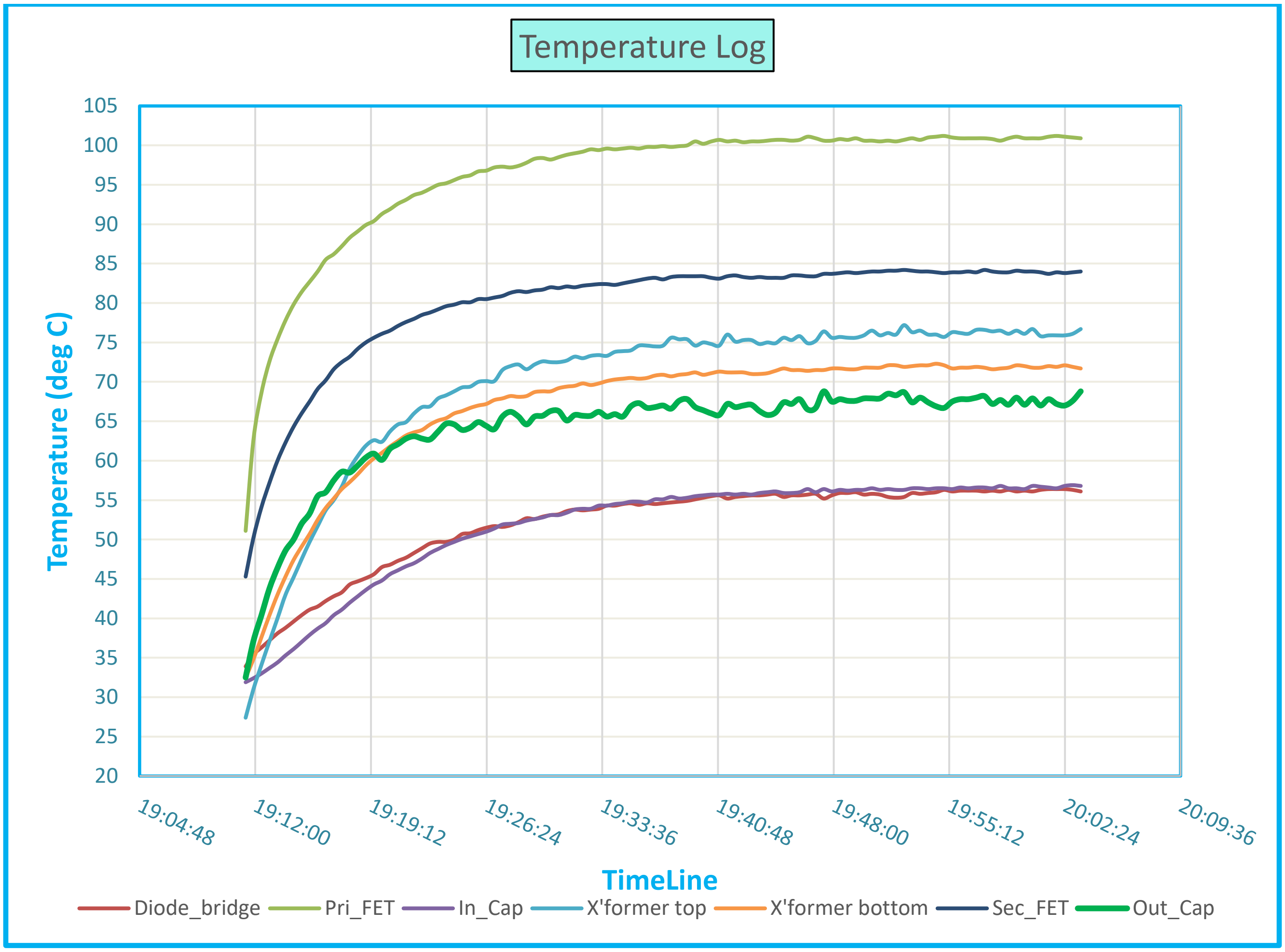



Table 3.6 Data showing Max temperatures and efficiency after 50 minutes

| S.No. | Parameter | Line (Vac) | Freq(Hz) | Pin (W) | Vout (V) | Iout (A) | Efficiency (%) | Max. Temp |
|---|---|---|---|---|---|---|---|---|
| 1 | Diode_bridge | 265.45 | 62.965 | 49.1 | 19.8161 | 2.2511 | 90.8492 | 56.4 |
| 2 | Pri_FET | 265.45 | 62.965 | 49.1 | 19.8161 | 2.2511 | 90.8492 | 101.2 |
| 3 | In_Cap | 265.45 | 62.965 | 49.1 | 19.8161 | 2.2511 | 90.8492 | 56.9 |
| 4 | X'former Top | 265.45 | 62.965 | 49.1 | 19.8161 | 2.2511 | 90.8492 | 77.2 |
| 5 | X'former bottom | 265.45 | 62.965 | 49.1 | 19.8161 | 2.2511 | 90.8492 | 72.3 |
| 6 | Sec_FET | 265.45 | 62.965 | 49.1 | 19.8161 | 2.2511 | 90.8492 | 84.2 |
| 7 | Out_Cap | 265.45 | 62.965 | 49.1 | 19.8161 | 2.2511 | 90.8492 | 68.8 |

# 4. USB PD Source Test Results (using QuadraMAX)

## 4.1 Test Setup

Figure 4.1-1. Quadramax Test Setup


- QuadDraw Version: 0.8.7523
- QM#156 HWRev:1.4.4 FWST:0.0.1376 FWCCG1:0.10

## 4.2 Test Results

**R25 = 1.6Mohm**

Test Input Voltage Conditions: 100Vac,60Hz and 240Vac,50Hz

Table 4-1 USB PD Source Test Results

| Test | Description | Result |
|---|---|---|
| TD SPT.1 | Load Test | PASS |
| TD SPT.2 | Capabilities Test | PASS |
| TD SPT.3 | Hard Reset Test | PASS |
| TD SPT.6 | PPS Voltage Step Test | PASS |
| TD SPT.7 | PPS Current Limit Test | PASS |

# 5. Appendix

## 5.1 Schematics

Figure 5.1-1 Schematic of Primary Board

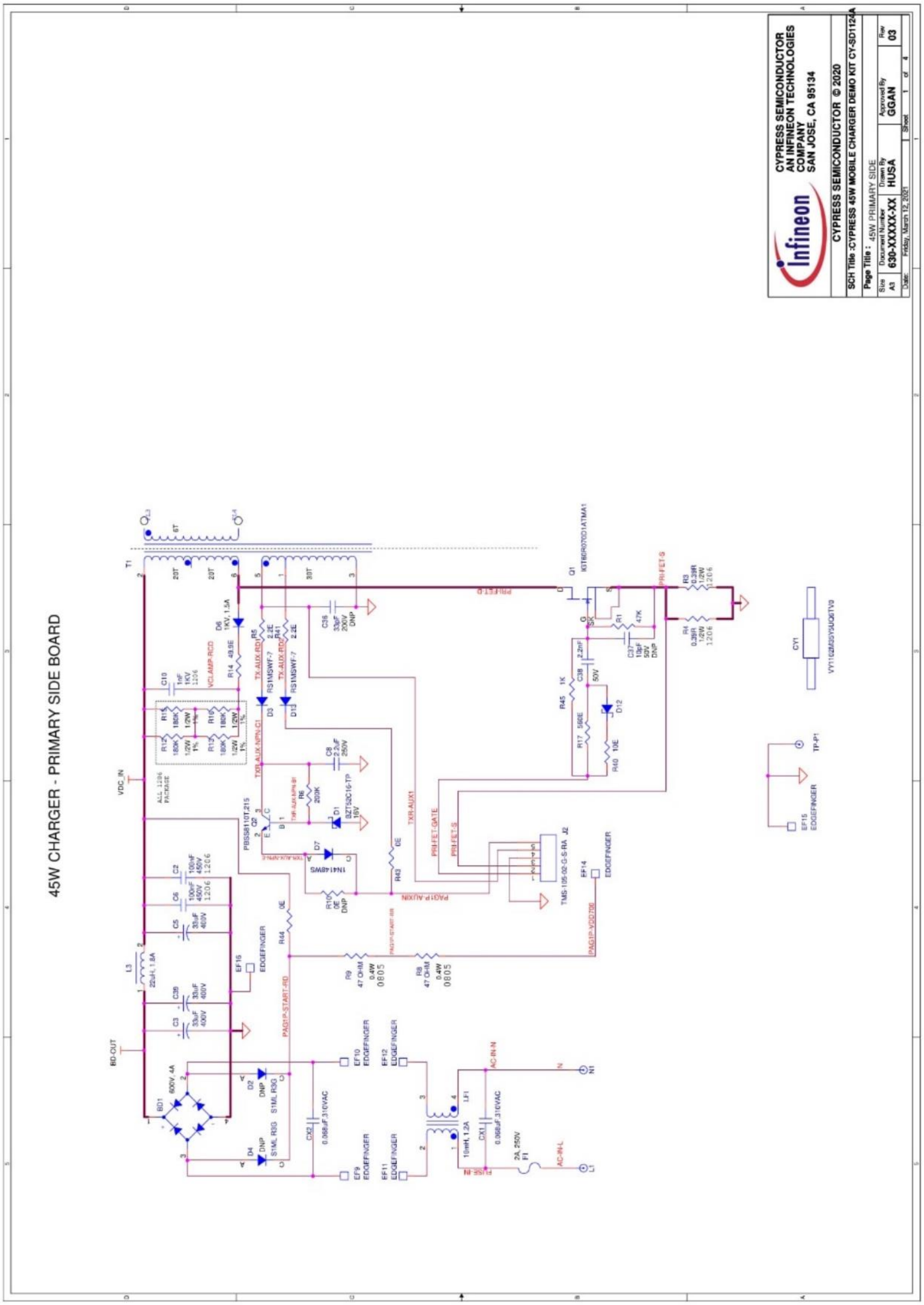


Figure 5.1-2 Schematic of Pulse Transformer Board

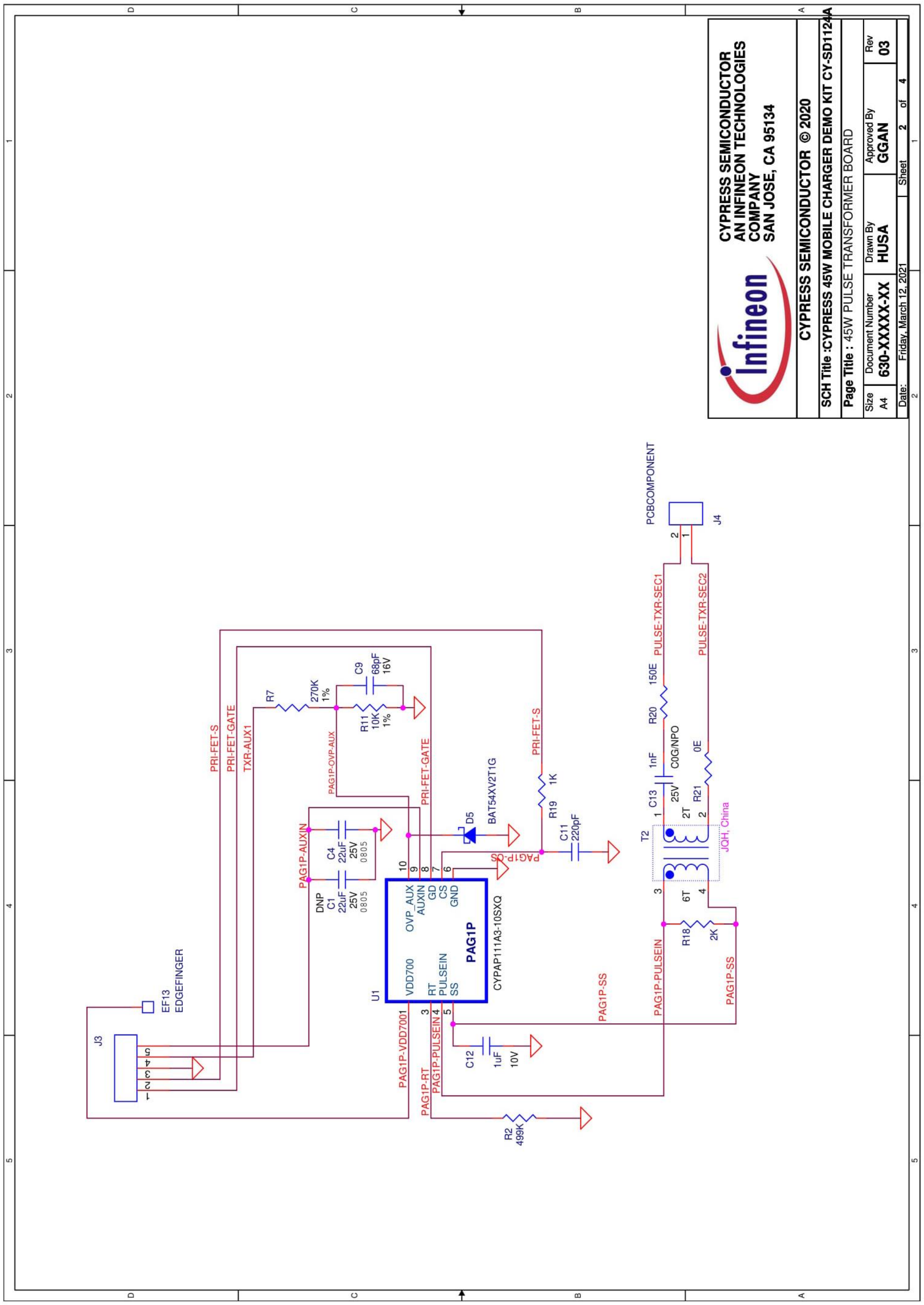
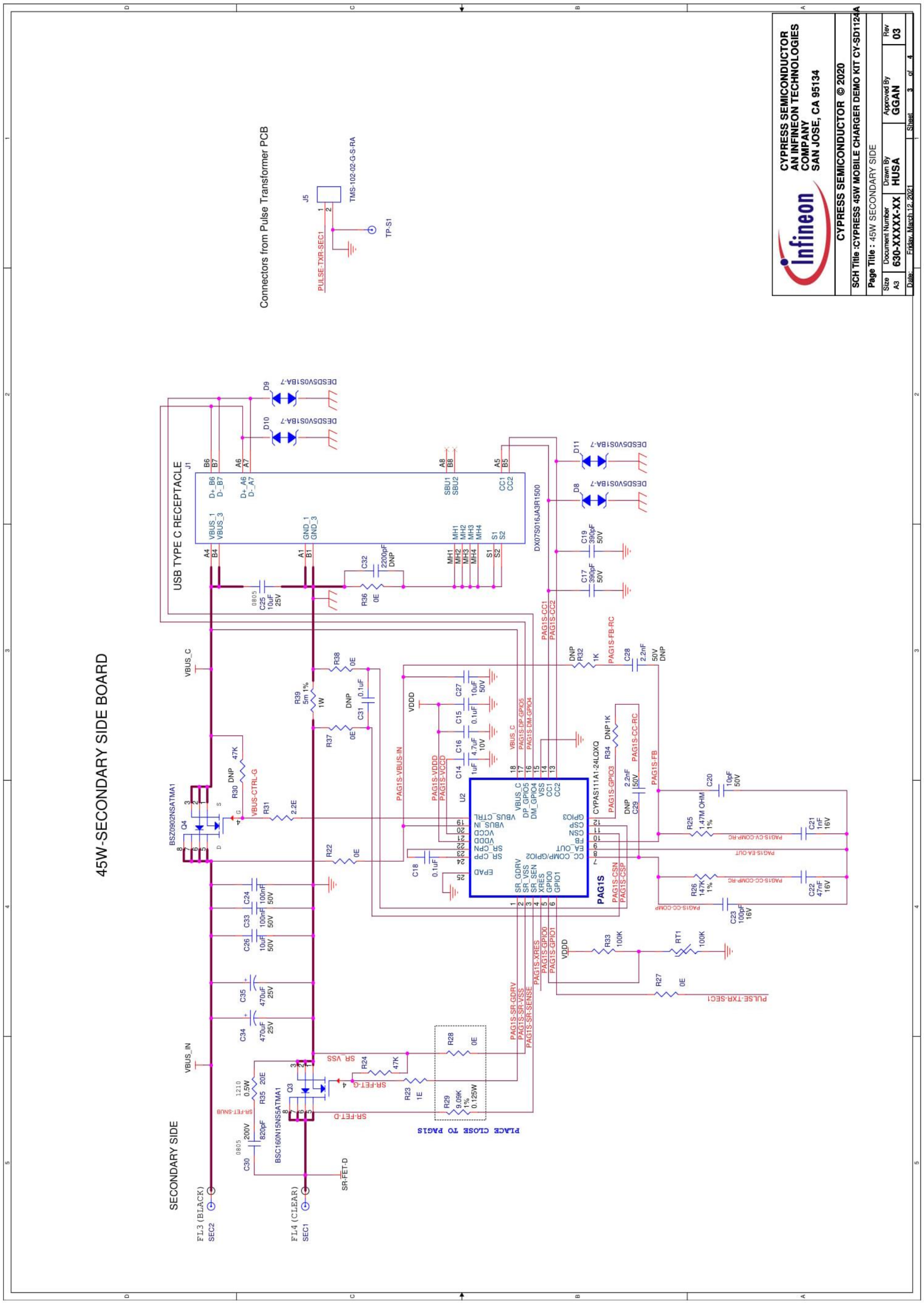


Figure 5.1-3 Schematic of Secondary Board



## 5.2 Bill of Materials (BOM)

Table 5-1 Bill of Materials

| S.No. | Qty | Reference | Value | Description | Manufacturer | MFG Part Number |
|---|---|---|---|---|---|---|
| 1 | 1 | BD1 | Z4DGP406L-HF | BRIDGE RECT 1PHASE 600V 4A Z4-D | Comchip Technology | Z4DGP406L-HF |
| 2 | 1 | C10 | 1nF | CAP CER 1206 1NF 1000V X7R 10% | KEMET | C1206C102KDRACAUTO |
| 3 | 2 | C2,C6 | 100nF | CAP CER 100nF 450V X7T 1206 | TDK Corporation | C3216X7T2W104K160AA |
| 4 | 3 | C3,C5,C39 | 33uF | CAP ALUM 33UF 20% 400V RADIAL | United Chemi-Con | EKXL401ELL330MJ30S |
| 5 | 1 | C38 | 2.2nF | CAP CER SMD 0603 2200PF 10% X7R 50V | KEMET | C0603C222K5RAC7411 |
| 6 | 1 | C8 | 2.2uF | CAP CER 2.2UF 250V X7T 2220 | TDK Corporation | C5750X7T2E225K250KA |
| 7 | 1 | CX2 | 0.068uF,310VAC | CAP FILM 0.068UF 20% 630VDC RAD | KEMET | R463I26804001M |
| 8 | 1 | D1 | BZT52C16-TP | DIODE ZENER 16V 200MW SOD123 | Micro Commercial Co | BZT52C16-TP |
| 9 | 2 | D3,D13 | RS1MSWF-7 | DIODE GEN PURP 1KV 1A SOD123F | Diodes Incorporated | RS1MSWF-7 |
| 10 | 1 | D6 | RS2MA-13-F | DIODE GEN PURP 1KV 1.5A SMA | Diodes Incorporated | RS2MA-13-F |
| 11 | 1 | D7 | 1N4148WS | DIODE GEN PURP 75V 150MA SOD323F | ON Semiconductor | 1N4148WS |
| 12 | 1 | D12 | BAT54J,115 | DIODE SCHOTTKY 30V 200MA SOD323F | Nexperia USA Inc. | BAT54J,115 |
| 13 | 1 | J2 | TMS-105-02-G-S-RA | 1.27mm pich Through Hole Right Angle Connector | Samtec Inc. | TMS-105-02-G-S-RA |
| 14 | 1 | L3 | 22uH, 1.8A | FIXED IND 22UH 1.8A 130 MOHM TH | Wurth Electronics Inc. | 7447462220 |
| 15 | 1 | Q1 | IGT60R070D1ATMA1 | N-Channel 600V 31A (Tc) 125W (Tc) Surface Mount PG-HSOF-8-3 | Infineon Technologies | IGT60R070D1ATMA1 |
| 16 | 1 | Q2 | PBSS8110T,215 | TRANS NPN 100V 1A SOT23 | Nexperia USA Inc. | PBSS8110T,215 |
| 17 | 1 | R1 | 47K | RES SMD 47K OHM 1% 1/10W 0603 | Yageo | RC0603FR-0747KL |
| 18 | 4 | R12,R13,R15,R16 | 180K | CRGP 1206 180K 1% 1/2W | TE Connectivity Passive Product | CRGP1206F180K |
| 19 | 1 | R14 | 49.9E | RES SMD 49.9 OHM 1% 1/4W 1206 | Yageo | RC1206FR-0749R9L |
| 20 | 2 | R17 | 560E | RES SMD 560 OHM 1% 1/10W 0603 | Panasonic Electronic Components | ERJ-3EKF5600V |
| 21 | 2 | R3,R4 | 0.39R | RES 0.39 OHM 1% 1/2W 1206 | Vishay Dale | RCWE1206R390FKEA |
| 22 | 2 | R40 | 10E | RES 10 OHM 5% 1/10W 0603 SMD | Panasonic Electronic Components | ERJ-U03J100V |
| 23 | 1 | R45 | 1K | RES SMD 1K OHM 1% 1/10W 0603 | Yageo | RC0603FR-071KL |
| 24 | 2 | R5,R41 | 2.2E | RES SMD 2.2 OHM 1% 1/10W 0603 | Yageo | RC0603FR-072R2L |
| 25 | 1 | R6 | 200K | RES SMD 200K OHM 1% 1/10W 0603 | Panasonic Electronic Components | ERJ-3EKF2003V |
| 26 | 2 | R8,R9 | 47 OHM | RES SMD 47 OHM 5% 0.4W 0805 | Rohm Semiconductor | ESR10EZPJ470 |
| 27 | 1 | CX1 | 0.068uF,310VAC | CAP FILM 0.068UF 20% 630VDC RAD | Vishay BC Components | BFC233820683 |
| 28 | 1 | F1 | 2A Fuse | Fuses with Leads (Through Hole) 2A 250V Epoxy Coated | Coiltronics / Eaton | C310FH-2-RE-TR1 |
| 29 | 1 | LF1 | 10mH, 1.2A | CMC 10mH 1.2A 2LN SMD | coilcraft | CJ5094-CL |
| 30 | 1 | C4 | 22uF | CAP CER 22UF 25V X5R 0805 | Murata Electronics North America | GRM21BR61E226ME44K |
| 31 | 1 | C9 | 68pF | CAP CER 68PF 16V C0G/NP0 0603 | Wurth Electronics Inc. | 885012006022 |
| 32 | 1 | C11 | 220pF | CAP CER 220PF 10V C0G/NP0 0603 | KEMET | C0603C221J8GAC7867 |
| 33 | 1 | C12 | 1uF | CAP CER 0603 1UF 10V X7R 10% | KEMET | C0603C105K8RACAUTO |
| 34 | 1 | C13 | 1nF | CAP CER 1000PF 25V C0G/NP0 0603 | KEMET | C0603C102J3GACTU |
| 35 | 1 | D5 | BAT54XV2T1G | DIODE SCHOTTKY 30V 200MA SOD523 | ON Semiconductor | BAT54XV2T1G |
| 36 | 1 | R2 | 499K | RES SMD 499K OHM 1% 1/8W 0603 | Vishay Beyschlag | MCT06030C4993FP500 |
| 37 | 1 | R7 | 270K | RES 270K OHM 1% 1/10W 0603 | Stackpole Electronics Inc | RMCF0603FT270K |
| 38 | 1 | R11 | 10K | RES SMD 10K OHM 1% 1/10W 0603 | Yageo | RC0603FR-0710KL |
| 39 | 1 | R18 | 2K | RES SMD 2K OHM 1% 1/10W 0603 | Yageo | RC0603FR-072KL |

| | | | | | | |
|---|---|---|---|---|---|---|
| 40 | 1 | R19 | 1K | RES SMD 1K OHM 1% 1/16W 0402 | Yageo | RC0402FR-071KL |
| 41 | 1 | R20 | 150E | RES SMD 150 OHM 1% 1/10W 0603 | Yageo | RC0603FR-07150RL |
| 42 | 1 | C14 | 1uF | CAP CER 1UF 16V X5R 0402 | Samsung Electro-Mechanics | CL05A105MO5NNNC |
| 43 | 2 | C15,C18 | 0.1uF | CAP CER 0.1UF 25V X7R 0402 | KEMET | C0402C104K3RAC7867 |
| 44 | 1 | C16 | 4.7uF | CAP CER 4.7UF 10V X5R 0402 | Murata Electronics | GRM155R61A475MEAAD |
| 45 | 2 | C17,C19 | 390pF | CAP CER 390PF 50V X7R 0603 | Yageo | CC0603KRX7R9BB391 |
| 46 | 1 | C20 | 10pF | CAP CER 10PF 50V NP0 0603 | TDK Corporation | C1608NP01H100D080AA |
| 47 | 1 | C21 | 1nF | CAP CER SMD 0603 1000PF 10% X7R | KEMET | C0603C102K4RACAUTO |
| 48 | 1 | C22 | 47nF | CAP CER 0.047UF 16V X7R 0603 | Yageo | CC0603KRX7R7BB473 |
| 49 | 1 | C23 | 100pF | CAP CER 100PF 16V X7R 0603 | KEMET | C0603C101K4RAC7867 |
| 50 | 2 | C24,C33 | 100nF | CAP CER 0.1UF 50V X7R 1210 | KEMET | C1210C104K5RAC7210 |
| 51 | 1 | C25 | 10uF | CAP CER 10UF 25V X5R 0805 | TDK Corporation | C2012X5R1E106M125AB |
| 52 | 1 | C26 | 10uF | CAP CER 10UF 50V X7R 1206 | TDK Corporation | CGA5L1X7R1H106K160AE |
| 53 | 1 | C27 | 10uF | CAP CER 10UF 50V X7R 1206 | TDK Corporation | CGA5L1X7R1H106K160AC |
| 54 | 1 | C30 | 820pF | CAP CER 820PF 200V C0G 0805 | TDK Corporation | CGJ4C3C0G2D821J060AA |
| 55 | 3 | C34,C35 | 470UF | CAP ALUM POLY 470UF 20% 25V T/H | Illinois Capacitor | 477AVG025MFBJ |
| 56 | 4 | D8,D9,D10,D11 | DESD5V0S1BA-7 | TVS DIODE 5V 14V SOD323 | Diodes Incorporated | DESD5V0S1BA-7 |
| 57 | 1 | J1 | DX07S016JA3R1500 | CONN USB-C RCPT 16 POS R/A SMT | JAE Electronics | DX07S016JA3R1500 |
| 58 | 1 | J5 | TMS-102-02-G-S-RA | CONN HEADER R/A 2POS 1.27MM | Samtec Inc. | TMS-102-02-G-S-RA |
| 59 | 1 | Q3 | BSC160N15NS5ATMA1 | MOSFET N-CH 150V 56A 8TDSON | Infineon Technologies | BSC160N15NS5ATMA1 |
| 60 | 1 | Q4 | BSZ0902NSATMA1 | MOSFET N-CH 30V 40A TSDSON-8 | Infineon Technologies | BSZ0902NS |
| 61 | 1 | RT1 | 100K | THERM NTC 100KOHM 4250K 0805 | Murata Electronics North America | NCP21WF104J03RA |
| 62 | 1 | R23 | 1E | RES SMD 1 OHM 1% 1/10W 0603 | Yageo | RC0603FR-071RL |
| 63 | 1 | R24 | 47K | RES SMD 47K OHM 1% 1/10W 0603 | Yageo | RC0603FR-0747KL |
| 64 | 1 | R25 | 1.47M | RES SMD 1.47M OHM 1% 1/10W 0603 | Yageo | CRCW06031M47FKEA |
| 65 | 1 | R26 | 147K | RES SMD 147K OHM 1% 1/10W 0603 | Yageo | RC0603FR-07147KL |
| 66 | 1 | R29 | 9.09K | RES SMD 9.09K OHM 1% 1/8W 0805 | Yageo | RC0805FR-079K09L |
| 67 | 1 | R31 | 2.2E | RES SMD 2.2 OHM 1% 1/10W 0603 | Yageo | RC0603FR-072R2L |
| 68 | 1 | R33 | 100K | RES SMD 100K OHM 1% 1/10W 0603 | Panasonic Electronic Components | ERJ-3EKF1003V |
| 69 | 1 | R35 | 20E | RES SMD 20 OHM 5% 1/2W 1210 | Vishay Dale | CRCW121020R0JNEA |
| 70 | 1 | R39 | 5m | RES 0.005 OHM 1% 1W 1206 | Stackpole Electronics Inc. | CSRF1206FT5L00 |
| 71 | 1 | CY1 | VY1102M35Y5UQ6TV0 | CAP CER 1000PF 760VAC Y5U RADIAL | Vishay BC Components | VY1102M35Y5UQ6TV0 |
| 72 | 1 | T1 | RM8 CORE | POWER TRANSFORMER_RM8 CORE | <Manufacturer> | EL-TXR-19-01-005 |
| 73 | 1 | T2 | 1:3 | Pulse transformer, 1:3, 4.8uH, 3KV isolation voltage | JQH, China | LCL-T6-5138A |
| 74 | 1 | U1 | PAG1P | PRIMARY SIDE STARTUP CONTROLLER | CYPRESS SEMICONDUCTOR | CYPAP111A3-10SXQ |
| 75 | 1 | U2 | PAG1S | USB-PD Power Adapter Secondary Side Controller | CYPRESS SEMICONDUCTOR | CYPAS131A1-24LQXQ |
| **Total Components (BOM Count) = 95** | | | | | | |
| | | | | **For Test and Debug Purpose** | | |
| 76 | 1 | R43 | 0E | RES SMD 0 OHM JUMPER 1/4W 0603 | Vishay Dale | CRCW06030000Z0EAHP |
| 77 | 1 | R44 | 0E | RES SMD 0 OHM JUMPER 0.4W 0805 | Vishay Dale | RCS08050000Z0EA |
| 78 | 1 | R21 | 0E | RES SMD 0 OHM JUMPER 1/4W 0603 | Vishay Dale | CRCW06030000Z0EAHP |
| 79 | 6 | R22,R27,R28,R36,R37,R38 | 0E | RES SMD 0 OHM JUMPER 1/4W 0603 | Vishay Dale | CRCW06030000Z0EAHP |

| | | | | | | |
|---|---|---|---|---|---|---|
| **DNP** | | | | | | |
| 80 | 1 | C36 | 33pF | CAP CER 33PF 200V C0G/NP0 0603 | KEMET | C0603C330J2GACTU |
| 81 | 1 | C37 | 10pF | CAP CER 10PF 50V NPO 0603 | Yageo | CC0603KRNPO9BN100 |
| 82 | 2 | D2,D4 | S1ML R3G | DIODE GEN PURP 1KV 1A SUB SMA | Taiwan Semiconductor Corporation | S1ML R3G |
| 83 | 1 | R10 | 0E | RES SMD 0 OHM JUMPER 1/4W 0603 | Vishay Dale | CRCW06030000Z0EAHP |
| 84 | 1 | C1 | 22uF | CAP CER 22UF 25V X5R 0805 | Murata Electronics North America | GRM21BR61E226ME44K |
| 85 | 2 | C28,C29 | 2.2nF | CAP CER SMD 0603 2200PF 10% X7R 50V | KEMET | C0603C222K5RAC7411 |
| 86 | 1 | C31 | 0.1uF | CAP CER 0.1UF 35V X7R 0603 | Taiyo Yuden | GMK107B7104KAHT |
| 87 | 1 | C32 | 2200pF | CAP CER 2200PF 500V X7R 0603 | KEMET | C0603C222KCRAC7867 |
| 88 | 1 | R30 | 47K | RES SMD 47K OHM 1% 1/10W 0603 | Yageo | RC0603FR-0747KL |
| 89 | 2 | R32,R34 | 1K | RES SMD 1K OHM 1% 1/10W 0603 | Yageo | RC0603FR-071KL |

## 5.3 PCB Layout

Figure 5.3-1 Layout Top Layer

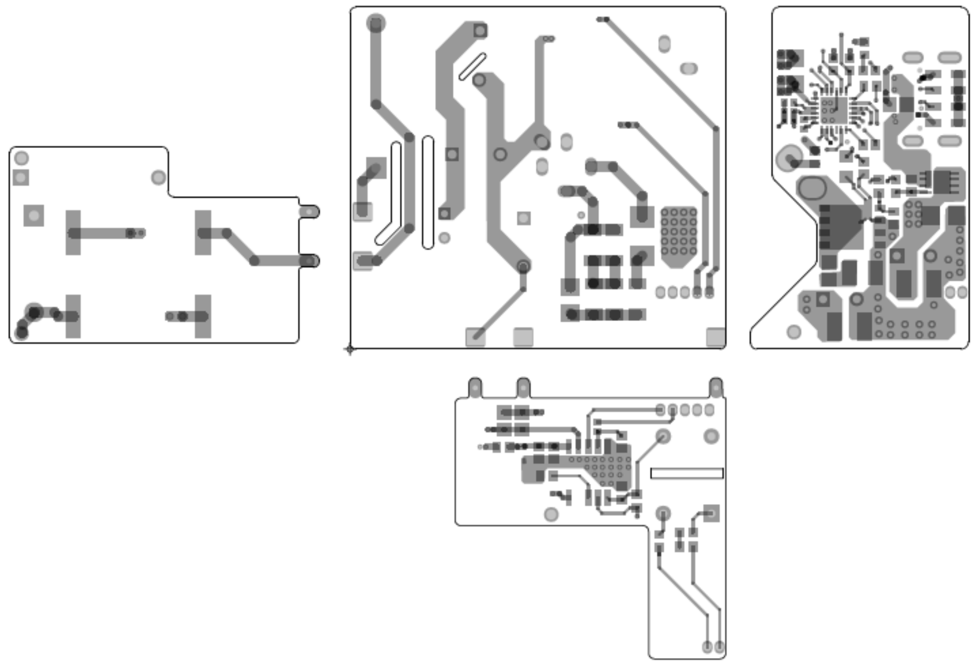


Figure 5.3-2 Layout Inner Layer 1

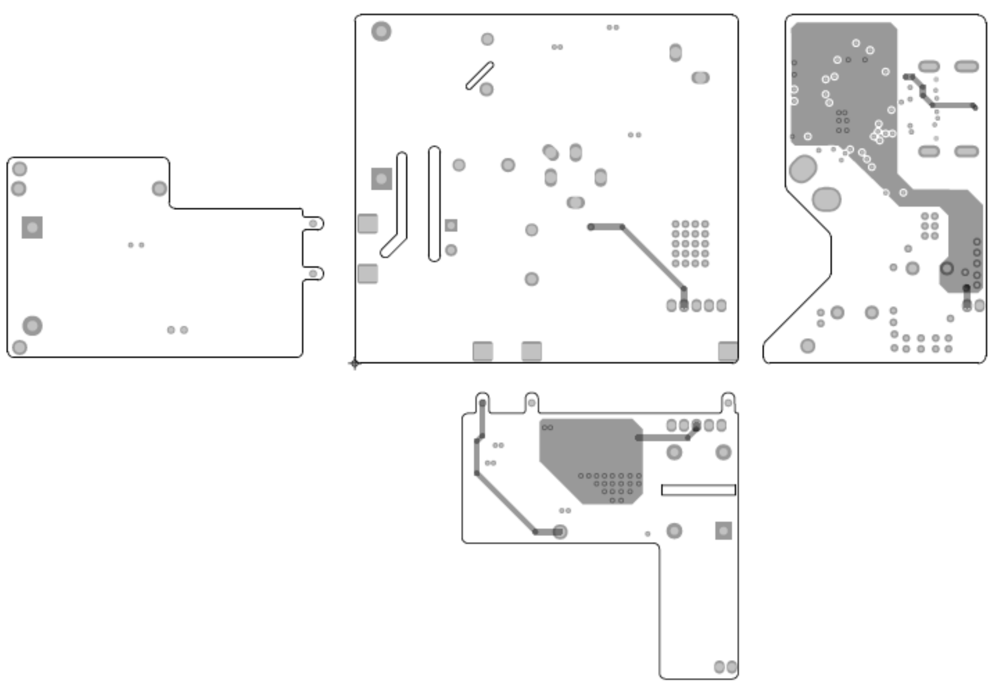


Figure 5.3-3 Layout Inner Layer 2

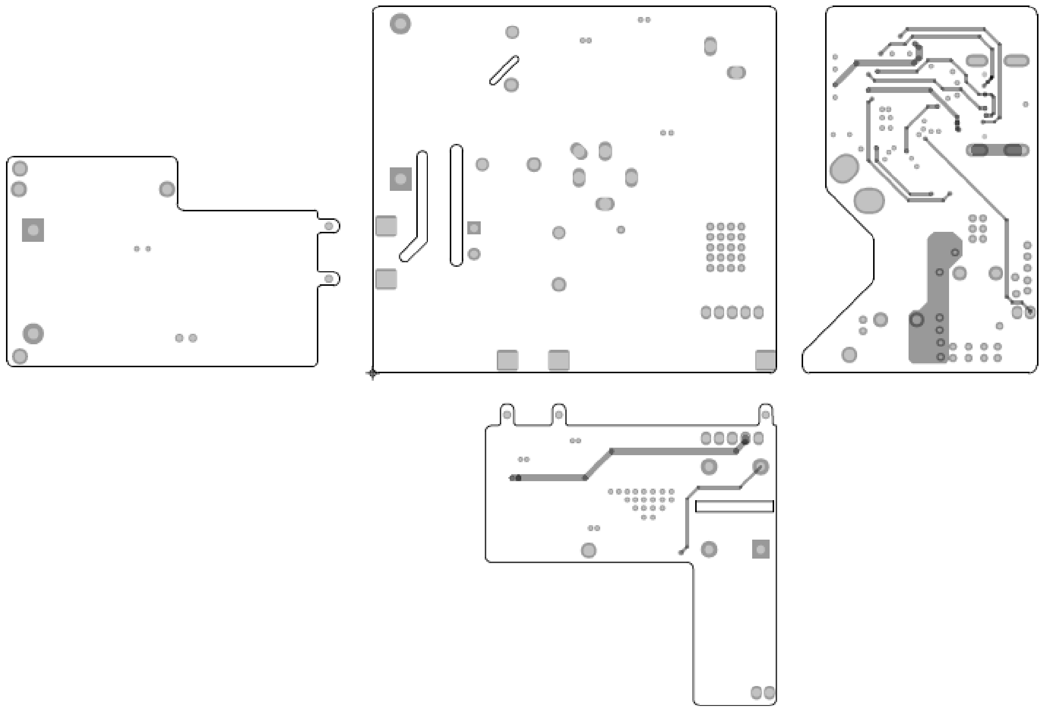


Figure 5.3-4 Layout Bottom Layer

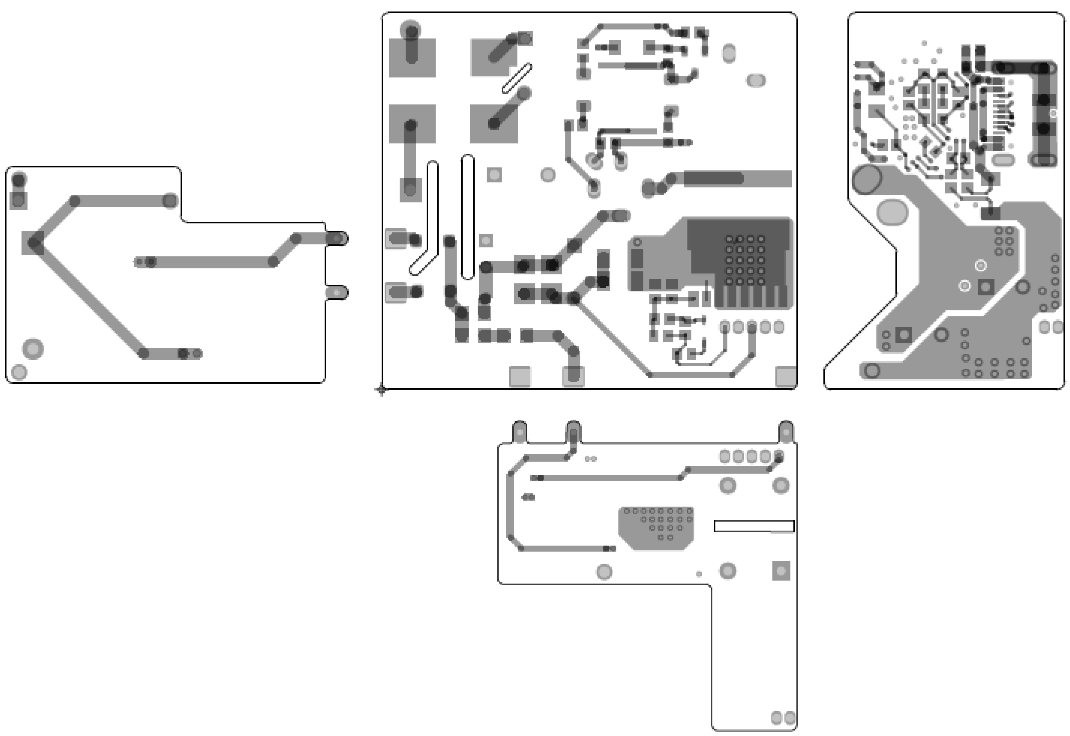


Figure 5.3-5 Silkscreen Top

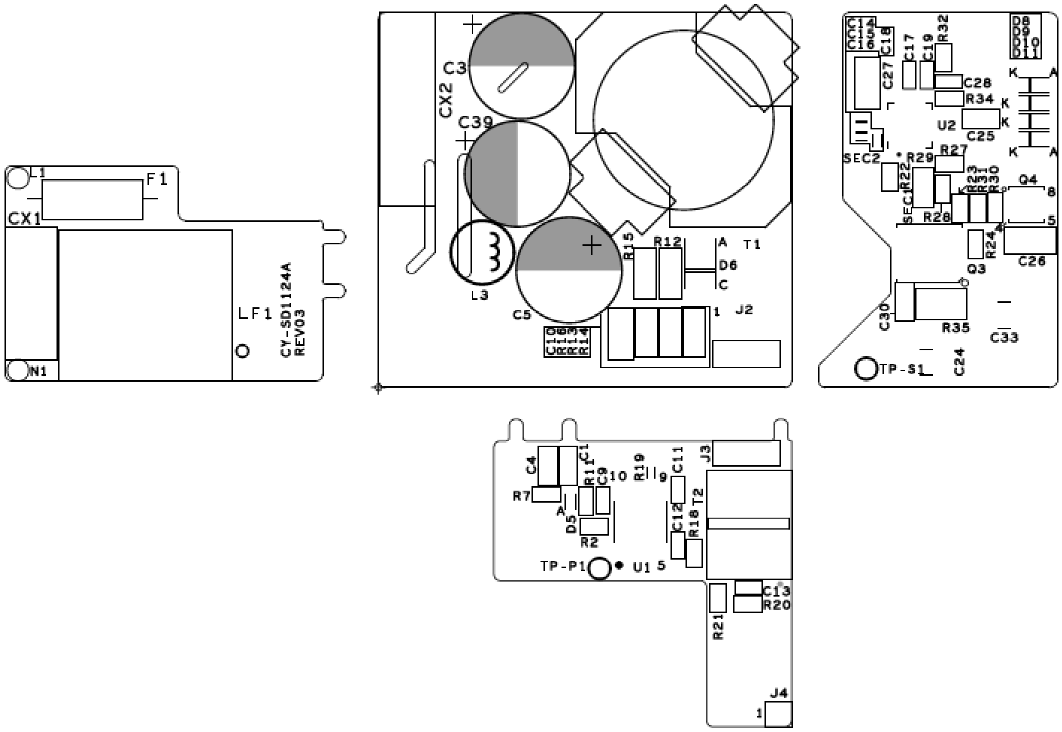
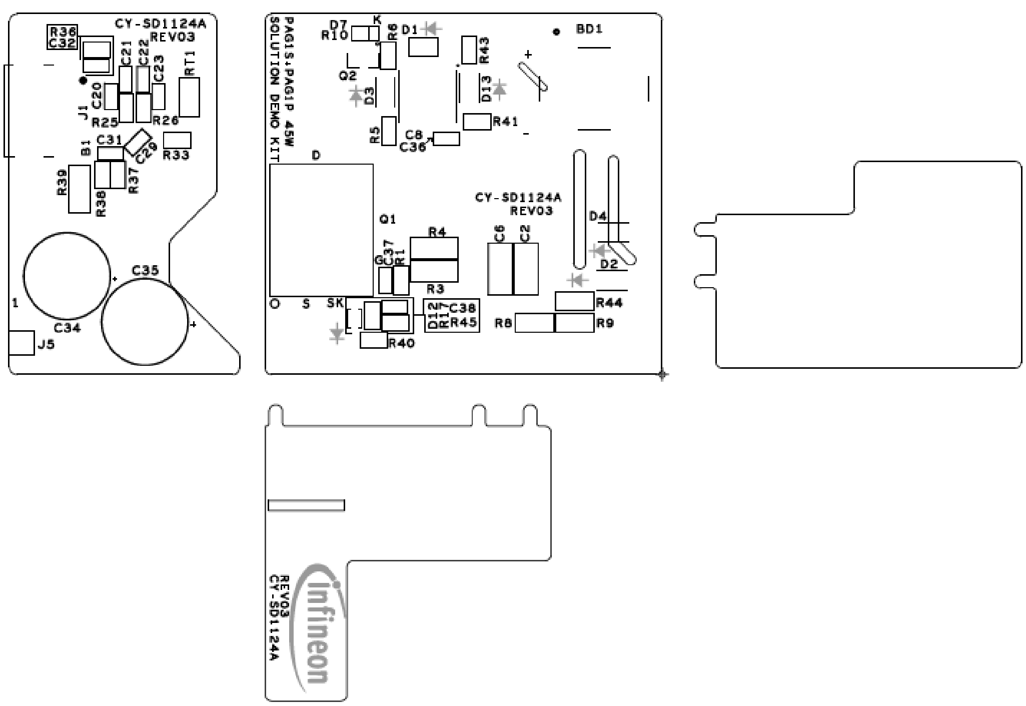


Figure 5.3-6 Silkscreen Bottom

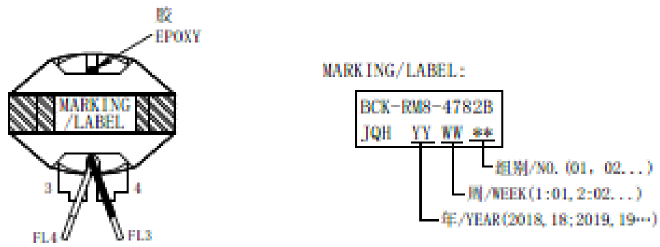


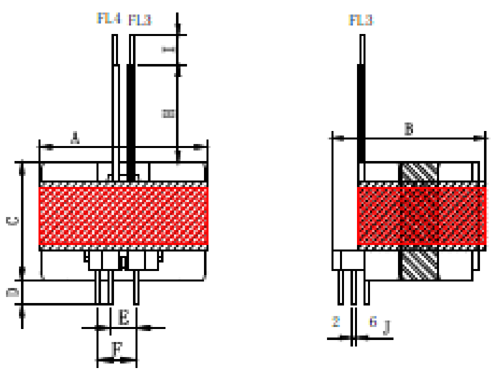
## 5.4 Transformer Specifications (T1)

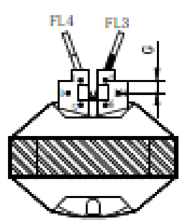
Figure 5.4-1 RM8 Transformer BCK-RM8-4782B datasheet

| 顾　　客<br>CUSTOMER | SA00169 | 产品名称<br>DESCRIPTION | RM8 TRANSFORMER | 01版 |
|---|---|---|---|---|
| 部　品　号<br>PART NO. | 45W RM8 | 型　　号<br>MODEL | BCK-RM8-4782B | 页修改号:<br>0 |

1. 外观图示(单位:mm)/DIMENSION(UNIT:mm)



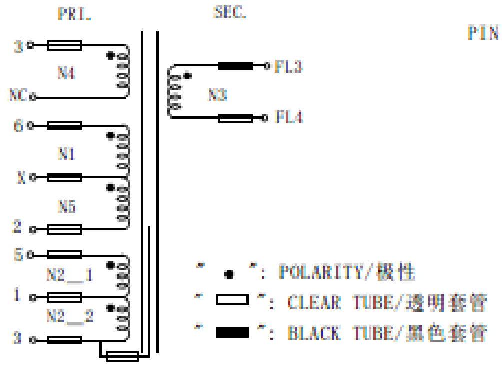

NOTE:
1. 骨架拔除PIN4 。
/removing PIN4 .
2. N3从顶部出线。
/ The wire of N3 is out from the BOBBIN top .
3. 磁芯开单气隙，装于PIN端，磁芯与骨架结合处点胶，磁芯外包3Ts胶带固定。
/The core has a single air gap and is installed at the PIN end. Magnetic core and bobbin junction glue fix, and the core is wrapped with 3Ts tape to fix.
4. 沿绕制方向在磁芯包2Ts胶带，再绕一圈0.05mm/t*8mm/W铜箔，将导线接PIN3。焊接铜箔后包2Ts胶带:
/Wrap 2Ts tape along the wrapping direction outside the magnetic core, and then wrap a circle of 0.05mm/t * 8mm / W spare copper foil, and connect the lead to Pin3. After welding the copper foil, wrap 2Ts tape.
5. 产品需真空含浸。
/The part must be vacuum varnished.

| A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|
| 25.0 MAX | 22.0 MAX | 18.0 MAX | 4.0 ±0.5 | 3.5 ±0.2 | 5.3 ±0.2 | 1.8 ±0.3 | 35.0 ±3.0 | 5.0 ±0.5 | Ø0.6 ±0.1 |

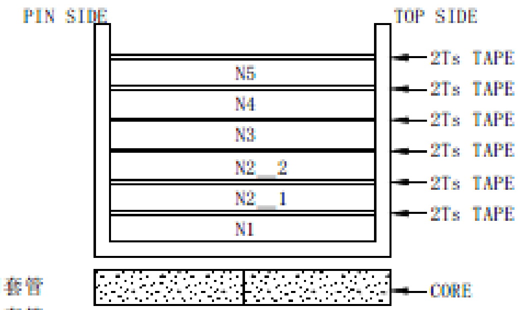
| 料　号<br>MATERIAL NO. | 制　图<br>DRAWING | 制　样<br>SAMPLE | 校　核<br>CHECKED | QC 审 核<br>QC CHECKED | RD 审 核<br>RD CHECKED | 批　准<br>APPROVED | 日　期<br>DATE |
|---|---|---|---|---|---|---|---|
| BCKORM4782B1 | 张 艳 | ---- | 张庆庭 | 唐天玲 | 袁志军 | 朱 勇 | 2020-10-23 |

| 顾 客<br>CUSTOMER | SA00169 | 产品名称<br>DESCRIPTION | RM8 TRANSFORMER | 01版 |
|---|---|---|---|---|
| 部 品 号<br>PART NO. | 45W RM8 | 型 号<br>MODEL | BCK-RM8-4782B | 页修改号:<br>0 |

2. 电原理图/CIRCUIT DIAGRAM




3. 解剖图/CONSTRUCTION DIAGRAM




4. 绕组/WINDING

| 绕组<br>WINDING | 漆包线<br>WIRE(mm) | 起末端<br>S-F | 圈数<br>TURNS(Ts) | 胶带圈数<br>TAPE TURNS(Ts) | 绕制方式<br>WINDING CONDITION |
|---|---|---|---|---|---|
| N1 | Φ0.36mm*1P 2UEW-B | 6-X | 16 | 2 | CLOSE/密绕 |
| N2__1 | Φ0.15mm*1P 2UEW-B | 5-1 | 28 | 2 | SPACE/散绕 |
| N2__2 | Φ0.15mm*1P 2UEW-B | 1-3 | 6 | 2 | SPACE/散绕 |
| N3 | Φ0.40mm*4P TEX-E | FL3-FL4 | 7 | 2 | CLOSE/密绕 |
| N4 | Φ0.15mm*1P 2UEW-B | 3-NC | 34 | 2 | CLOSE/密绕 |
| N5 | Φ0.36mm*1P 2UEW-B | X-2 | 17 | 2 | SPACE/散绕 |

5. 电气特性/ELECTRICAL CHARACTERISTIC

| 序号<br>NO. | 项目<br>ITEM | 测量点<br>MEASURED POINT | 技术要求<br>TECHNICAL DATA | 测试条件及仪器<br>TESTING CONDITION & INSTRUMENT |
|---|---|---|---|---|
| 1 | 电感量<br>INDUCTANCE | L(6-2) | 285uH±10% | Agilent 4284A<br>100KHz/1V, AT 25℃ |
| 2 | 漏感<br>LEAKAGE INDUCTACE | LK(6-2)<br>(SHORT OTHER/短路其他) | 3.0uH MAX | |
| 3 | 直流电阻<br>DC RESISTANCE | R(6-2) | TBDΩ MAX | TH2512B<br>AT 25℃ |
| | | R(5-3) | TBDΩ MAX | |
| | | R(FL3-FL4) | TBDmΩ MAX | |
| 4 | 抗电强度<br>HI-POT | PRI-SEC | AC 3.75KV | CS9929<br>50Hz 5mA 3SEC |
| | | COIL-CORE | AC 1.0KV | |
| 5 | 绝缘阻抗<br>INSULATION RESISTANCE | COIL-COIL | 100MΩ MIN | TH2681A<br>DC500V 60S |

| 料 号<br>MATERIAL NO. | 制 图<br>DRAWING | 制 样<br>SAMPLE | 校 核<br>CHECKED | QC 审 核<br>QC CHECKED | RD 审 核<br>RD CHECKED | 批 准<br>APPROVED | 日 期<br>DATE |
|---|---|---|---|---|---|---|---|
| BCKORM4782B1 | 张 艳 | ---- | 张庆庭 | 唐天玲 | 袁志军 | 朱 勇 | 2020-10-23 |

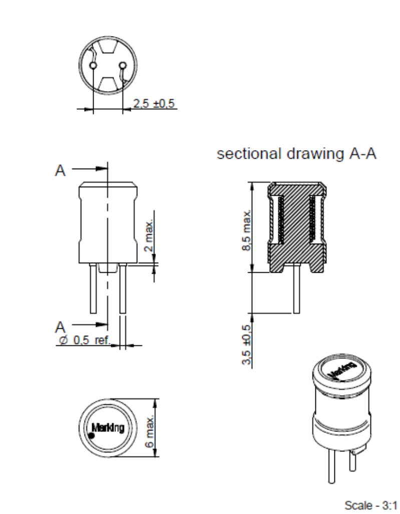
**<u>Note</u>: Transformer undergoes DIP and BAKE varnishing methodology.**

## 5.5 Inductor Specifications (L3)

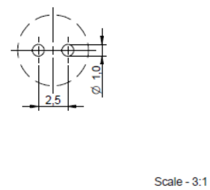
PRODUCT: Wurth Electronics Inc. Inductor 22uH 1.8A 130mohm; MPN: 7447462220

Figure 5.5-1 Inductor L3 datasheet

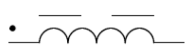
**Dimensions: [mm]**




**Recommended Hole Pattern: [mm]**




**Schematic:**



**Electrical Properties:**

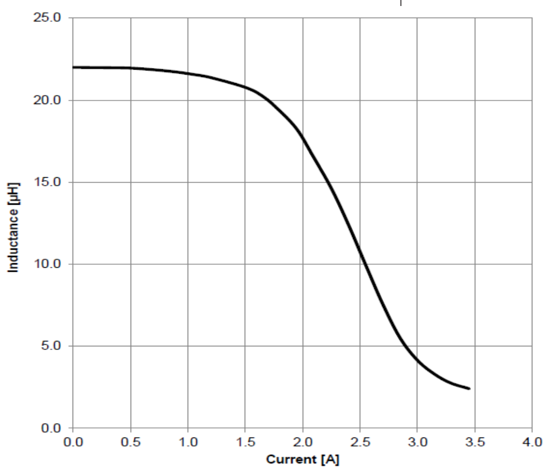
| Properties | | Test conditions | Value | Unit | Tol. |
|---|---|---|---|---|---|
| Inductance | $L$ | 100 kHz/ 5 mA | 22 | µH | ±20% |
| Rated Current | $I_R$ | ΔT = 40 K | 1.8 | A | max. |
| Saturation Current | $I_{SAT}$ | \|ΔL/L\| < 10 % | 1.7 | A | typ. |
| DC Resistance | $R_{DC}$ | @ 20 °C | 0.102 | Ω | typ. |
| DC Resistance | $R_{DC}$ | @ 20 °C | 0.13 | Ω | max. |
| Self Resonant Frequency | $f_{res}$ | | 15 | MHz | typ. |

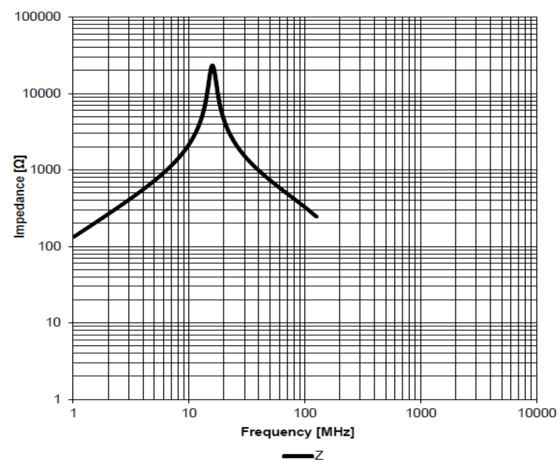
**Certification:**

| | |
|---|---|
| RoHS Approval | Compliant [ 2011/65/EU&2015/863 ] |
| REACh Approval | Conform or declared [ (EC)1907/2006 ] |
| Halogen Free | Conform [ JEDEC JS709B ] |
| Halogen Free | Conform [ IEC 61249-2-21 ] |

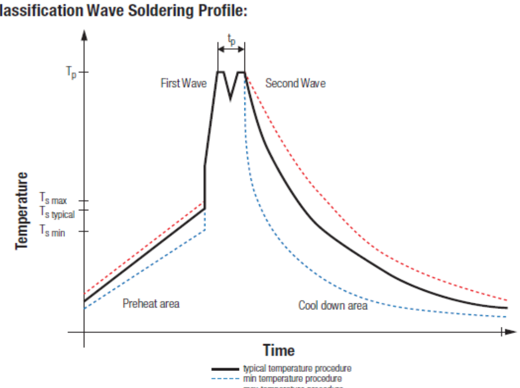
**General Properties:**

| | |
|---|---|
| It is recommended that the temperature of the component does not exceed +125 °C under worst case conditions | |
| Ambient Temperature (referring to $I_R$) | -40 up to +85 °C |
| Operating Temperature | -40 up to +125 °C |
| Storage Conditions (in original packaging) | < 40 °C ; < 75 % RH |
| Moisture Sensitivity Level (MSL) | 1 |
| Test conditions of Electrical Properties: +20 °C, 33 % RH if not specified differently | |




**Classification Wave Soldering Profile:**




**Classification Wave Soldering Profile:**

| Profile Feature | | Pb-Free Assembly | Sn-Pb Assembly |
|---|---|---|---|
| Preheat Temperature Min | $T_{s\ min}$ | 100 °C | 100 °C |
| Preheat Temperature Typical | $T_{s\ typical}$ | 120 °C | 120 °C |
| Preheat Temperature Max | $T_{s\ max}$ | 130 °C | 130 °C |
| Preheat Time $t_s$ from $T_{s\ min}$ to $T_{s\ max}$ | $t_s$ | 70 seconds | 70 seconds |
| Ramp-up Rate | Δ T | 150 °C max. | 150 °C max. |
| Peak Temperature | $T_p$ | 250 °C - 260 °C | 235 °C - 260 °C |
| Time of actual peak temperature | $t_p$ | max. 10 seconds<br>max. 5 seconds each wave | max. 10 seconds<br>max. 5 seconds each wave |
| Ramp-down Rate, Min | | ~ 2 K/ second | ~ 2 K/ second |
| Ramp-down Rate, Typical | | ~ 3.5 K/ second | ~ 3.5 K/ second |
| Ramp-down Rate, Max | | ~ 5 K/ second | ~ 5 K/ second |
| Time 25 °C to 25 °C | | 4 minutes | 4 minutes |

refer to EN61760-1:2006

## 5.6 Common Mode Choke Specifications (LF1)

PRODUCT: Coilcraft CMC 10mH 1.2A 2LN SMD

Figure 5.6-1 Common Mode Choke datasheet

| Part number[1] | Common mode impedance max (kOhms) | Inductance (mH)[2] nom | Inductance (mH)[2] min | Irms[3] (A) | DCR max[4] (mOhms) | Isolation[5] (Vrms) |
|---|---|---|---|---|---|---|
| CJ5094-CL_ | 28.28 @ 0.26 MHz | 10.0 | 6.5 | 1.2 | 180 | 1000 |

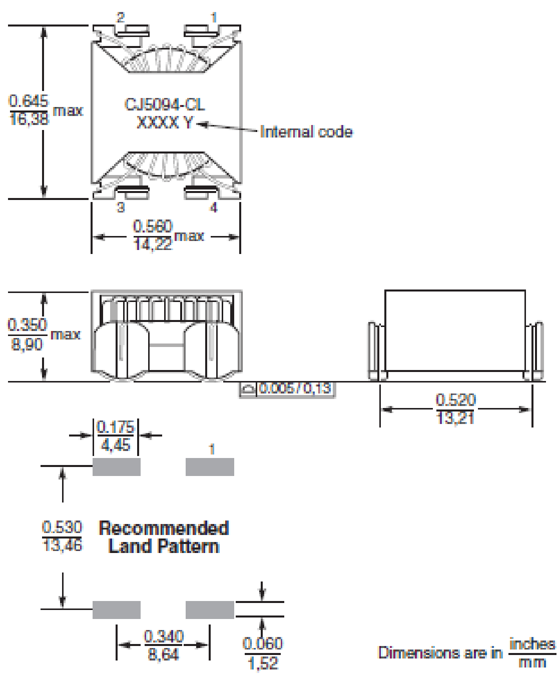
1. When ordering, please specify **packaging** code:

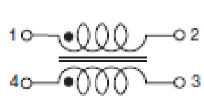
   **CJ5094-CLD**

   **Packaging:** D = 13″ machine-ready reel. EIA-481 embossed plastic tape (350 parts per full reel).

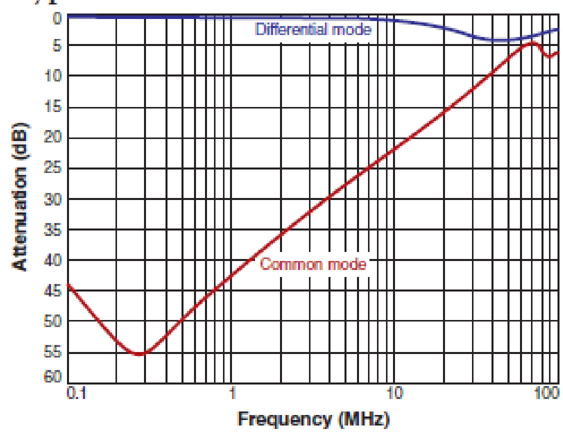
   B = Less than full reel. In tape, but not machine ready. To have a leader and trailer added ($25 charge), use code letter D instead.
2. Inductance shown for each winding, measured at 10 kHz, 0.1 Vrms, 0 Adc on an Agilent/HP 4263B LCR meter or equivalent.
3. Current per winding that causes a 40°C rise from 25°C ambient. This information is for reference only and does not represent absolute maximum ratings.
4. DCR is specified per winding.
5. Isolation (hipot) measured for two seconds.
6. Electrical specifications at 25°C.

Refer to Doc 362 "Soldering Surface Mount Components" before soldering.

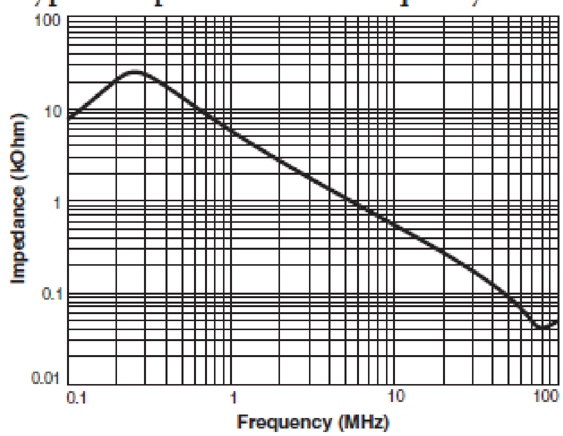


### Typical Attenuation




### Typical Impedance versus Frequency




**Core material** Ferrite
**Terminations** RoHS compliant tin-silver-copper over copper
**Weight** 2.9 g
**Ambient temperature** –40°C to +85°C with Irms current
**Maximum part temperature** +125°C (ambient + temp rise)
**Storage temperature** Component: –40°C to +125°C. Tape and reel packaging: –40°C to +80°C
**Resistance to soldering heat** Max three 40 second reflows at +260°C, parts cooled to room temperature between cycles
**Moisture Sensitivity Level (MSL)** 1 (unlimited floor life at <30°C / 85% relative humidity)
**Failures in Time (FIT) / Mean Time Between Failures (MTBF)** 38 per billion hours / 26,315,789 hours, calculated per Telcordia SR-332
**Packaging** 350/13″ reel Plastic tape: 24 mm wide, 0.4 mm thick, 24 mm pocket spacing, 8.6 mm pocket depth
**PCB washing** Tested to MIL-STD-202 Method 215 plus an additional aqueous wash. See Doc787_PCB_Washing.pdf.

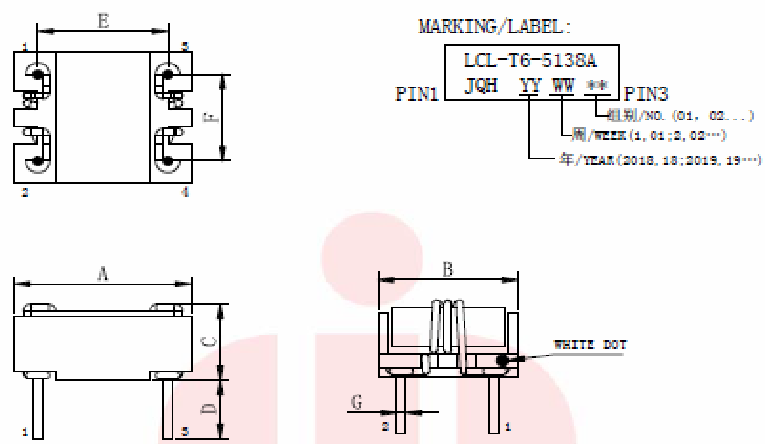
## 5.7 Pulse Transformer (T2)

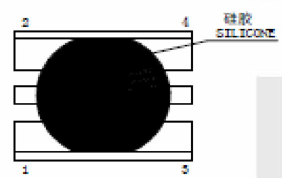
PRODUCT: JQH China, 1:3, 4.8uH, 3KV isolation voltage; MPN: LCL-T6-5138A

Figure 5.7-1 Pulse Transformer datasheet

| | | | | |
|---|---|---|---|---|
| 顾 客 CUSTOMER | SA00169 | 产品名称 DESCRIPTION | T6 FILTER | 00 版 |
| 部 品 号 PART NO. | | 型 号 MODEL | LCL-T6-5138A | 页修改号: 0 |

1. 外观图(单位:mm)/DIMENSION(UNIT:mm)



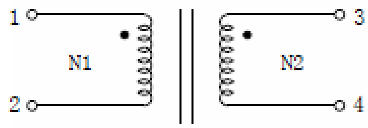

NOTE:
1. 线圈和磁环点胶将磁环全部封住。
2. PIN1打点标识。

| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| 10.4 MAX | 8.0 MAX | 6.0 MAX | 3.5 ±0.3 | 8.0 ±0.15 | 5.0 ±0.15 | Ø0.5 ±0.1 |

| 料 号 MATERIAL NO. | 制 图 DRAWING | 制 样 SAMPLE | 校 核 CHECKED | QC 审 核 QC CHECKED | RD 审 核 RD CHECKED | 批 准 APPROVED | 日 期 DATE |
|---|---|---|---|---|---|---|---|
| LCL00T5138A1 | 赖彩玲 | ---- | 徐科 | 朱金金 | 张庆庭 | 袁志军 | 2019-08-17 |

| 顾 客<br>CUSTOMER | SA00169 | 产品名称<br>DESCRIPTION | T6 FILTER | 00 版 |
|---|---|---|---|---|
| 部 品 号<br>PART NO. | | 型 号<br>MODEL | LCL-T6-5138A | 页修改号:<br>0 |

## 2. 电原理图/CIRCUIT DIAGRAM




" • ": POLARITY/极性

## 3. 绕组/WINDING

| 绕组<br>WINDING | 漆包线<br>WIRE(mm) | 起末端<br>S-F | 圈数<br>TURNS(Ts) | 绕制方式<br>WINDING CONDITION |
|---|---|---|---|---|
| N1 | Φ0.2mm*1P T.I.W | 1-2 | 3 | CLOSE/密绕 |
| N2 | Φ0.2mm*1P 2UEW-F | 3-4 | 9 | CLOSE/密绕 |

## 4. 电气特性/ELECTRICAL CHARACTERISTIC

| 序号<br>NO. | 项目<br>ITEM | 测量点<br>MEASURED POINT | 技术要求<br>TECHNICAL DATA | 测试条件及仪器<br>TESTING CONDITION & INSTRUMENT |
|---|---|---|---|---|
| 1 | 电感量<br>INDUCTANCE | L(1-2) | 7.0uH MIN | Agilent 4284A<br>100KHz/0.3V, AT 25℃ |
| 2 | 耐压<br>HI-POT | N1-N2 | 3.0KV AC | CS9929<br>50Hz/60Hz 4mA 4S |

## 5. 材料清单/MATERIAL LIST

| 序号<br>NO. | 材料名称<br>ITEM | 规格<br>TYPE | 供应商<br>SUPPLIERS | 认证号<br>UL NO. |
|---|---|---|---|---|
| 1 | 磁芯<br>CORE | TYPE:T6*4*2.15<br>R10K | HENGDIAN GROUP DMEGC MAGNETICS CO.,LTD<br>ACME | N/A |
| 2 | 底座<br>BASE | TYPE:Phenolic (PF)<br>MATERIAL:PM-9820/PM-9630<br>THERMAL RATING:150℃ | SUMITOMO BAKELITE CO LTD | E41429 |
| 3 | 三层绝缘线<br>TRIPLE INSULATED WIRE | TYPE: FIW<br>TYPE: FIW<br>THERMAL RATING:155℃ | HOI LUEN ELECTRICAL MFR CO LTD<br>TAI-I COPPER (GUANZHOU) CO LTD | E257525<br>E234896 |
| 4 | 漆包线<br>WIRE | MARK DSG:xUEW/155, QA-x/155<br>ANSI TYPE:MW 79-C<br>THERMAL RATING:155℃ | DONG GUAN YIDA INDUSTRIAL CO LTD | E344055 |
| 5 | 硅胶<br>SILICONE | TYPE:3140<br>THERMAL RATING:200℃ | DOW CORNING CORPORATION | |

注:产品符合RoHS要求.

Note: The products comply with RoHS requirements.

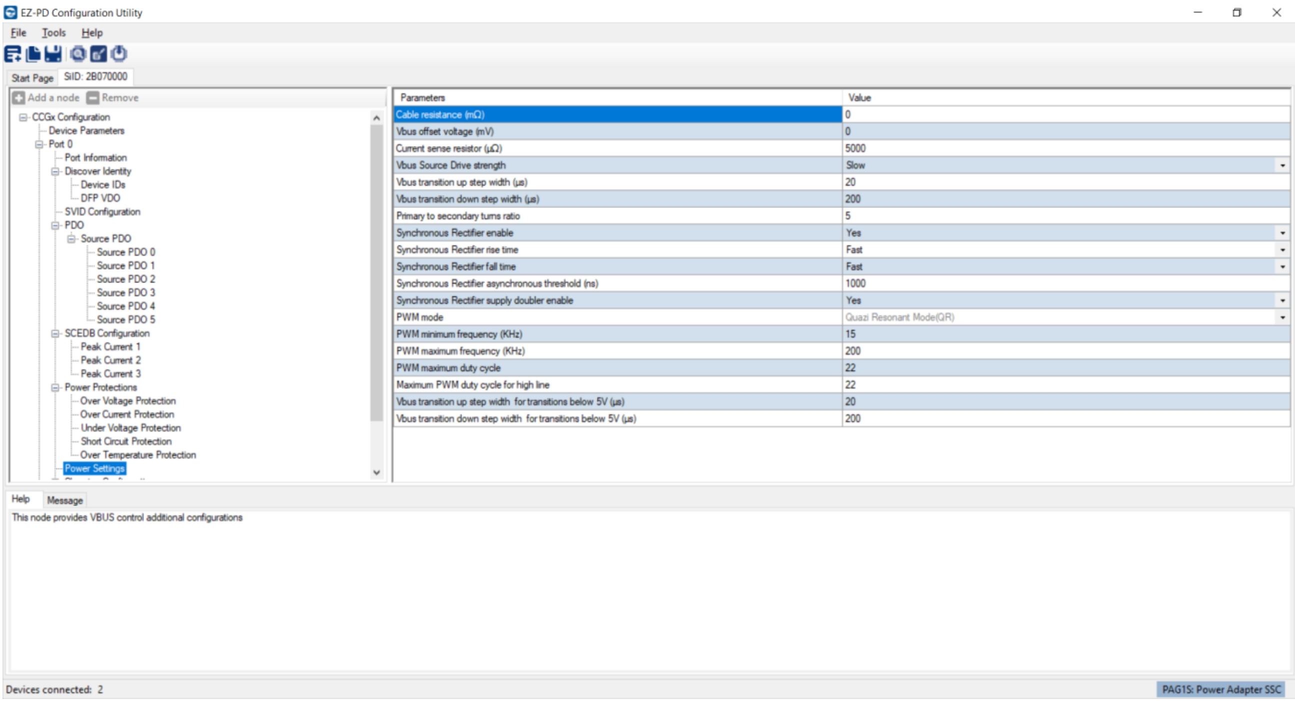
## 6. 产品单重/WEIGHT

Net Weight:***g/PC

| 料 号<br>MATERIAL NO. | 制 图<br>DRAWING | 制 样<br>SAMPLE | 校 核<br>CHECKED | QC 审 核<br>QC CHECKED | RD 审 核<br>RD CHECKED | 批 准<br>APPROVED | 日 期<br>DATE |
|---|---|---|---|---|---|---|---|
| LCL00T5138A1 | 赖彩玲 | ---- | 徐科 | 朱金金 | 张庆庭 | 袁志军 | 2019-08-17 |

## 5.8 EZ-PD Configuration Utility

Figure 5.8-1 Utility Screenshot




The Cypress EZ-PD PAG1S controller is a highly configurable and programmable solution. The chip can be configured using parameters stored in the internal flash memory. These parameters are to be chosen and programmed by Cypress customers according to their use cases and requirements.

The Graphical User Interface (GUI) of EZ-PD Configuration Utility allows users to intuitively select and configure the parameters for their application.

Here are the default configured values with respect to Power Settings and Power Protections.

Table 5-2 Default Configuration Values

| Parameters | Values |
|---|---|
| ***Power Settings*** | |
| Cable resistance (mΩ) | 0 |
| Vbus offset voltage (mV) | 0 |
| Current Sense resistor (µΩ) | 5000 |
| Vbus Source Drive strength | Slow |
| Vbus transition up step width (µs) | 20 |
| Vbus transition down step width (µs) | 200 |
| Primary to secondary turns ratio | 5 |
| Synchronous Rectifier enable | Yes |
| Synchronous Rectifier rise time | Fast |
| Synchronous Rectifier fall time | Fast |
| Synchronous Rectifier async threshold (ns) | 1000 |

| | |
|---|---|
| Synchronous Rectifier doubler enable | Yes |
| PWM mode | Quasi Resonant Mode (QR) |
| PWM minimum frequency (kHz) | 15 |
| PWM maximum frequency (kHz) | 200 |
| PWM maximum duty cycle (%) | 22 |
| Maximum PWM Duty Cycle for high line | 22 |
| Vbus transition up step width for transitions below 5V (us) | 20 |
| Vbus transition down step width for transitions below 5V (us) | 200 |
| ***Power Protections*** | |
| **1. Over Voltage Protection** | |
| Enable | Yes |
| OVP Threshold (%) | 20 |
| Debounce period (µs) | 10 |
| Retry count | 2 |
| **2. Over Current Protection** | |
| Enable | Yes |
| OCP Threshold (%) | 20 |
| Debounce period (ms) | 10 |
| Retry count | 2 |
| **3. Under Voltage Protection** | |
| Enable | Yes |
| UVP Threshold (%) | 70 |
| Debounce period (µs) | 10 |
| Retry count | 2 |
| **4. Short Circuit Protection** | |
| Enable | Yes |
| Debounce period (µs) | 4 |
| Retry count | 2 |
| **5. Over Temperature Protection** | |
| Enable | Yes |
| Thermistor type 1 | NTC |
| Cutoff value 1 | 477 |
| Restart value 1 | 909 |
| Debounce period (ms) | 10 |
| Enable Thermistor 2 | Yes |
| Thermistor type 2 | NTC |
| Cutoff value 2 | 0 |
| Restart value 2 | 0 |

## 5.9 DUT Burn-in Test

**Test Condition: Vac=0 to 230Vac, 50Hz; Vout = 20V and Iout = 0A to 2.25A**

**Run Duration: 8 hours**

The DUT undergoes an 8-hour burn-in test where the Programmable AC supply is programmed to toggle Voltage from 0Vac to 230Vac every 10sec each and 20V PPS-PDO with load pulsing from 0A to 2.25A every 10ms each with slew rate of 150mA/us.

Figure 5.9-1 Stress Test zoomed in (**CH1:** Vbus_in, **CH2:** Vin_ac, **CH3:** Vbus_C, **CH4**: Iout)

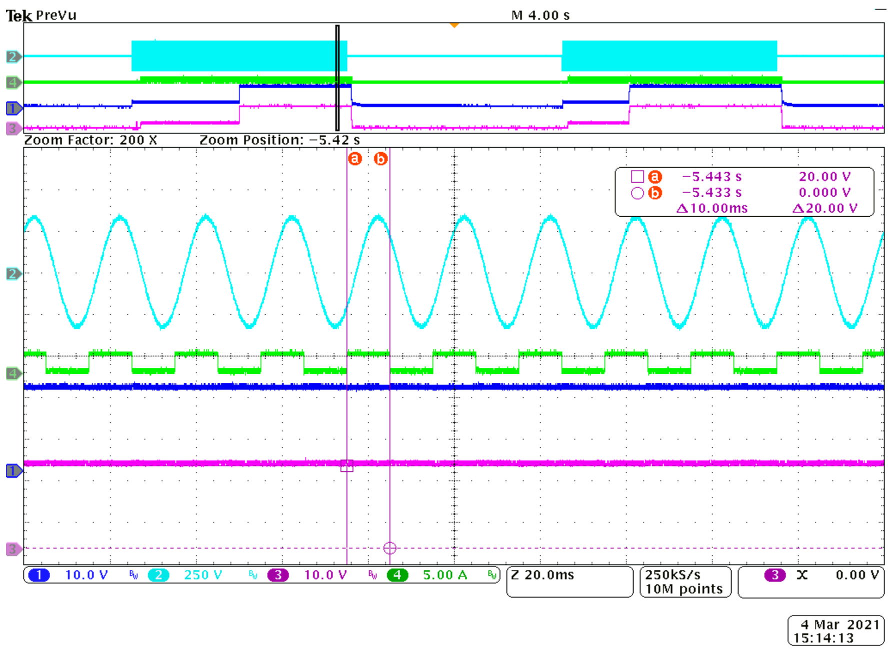
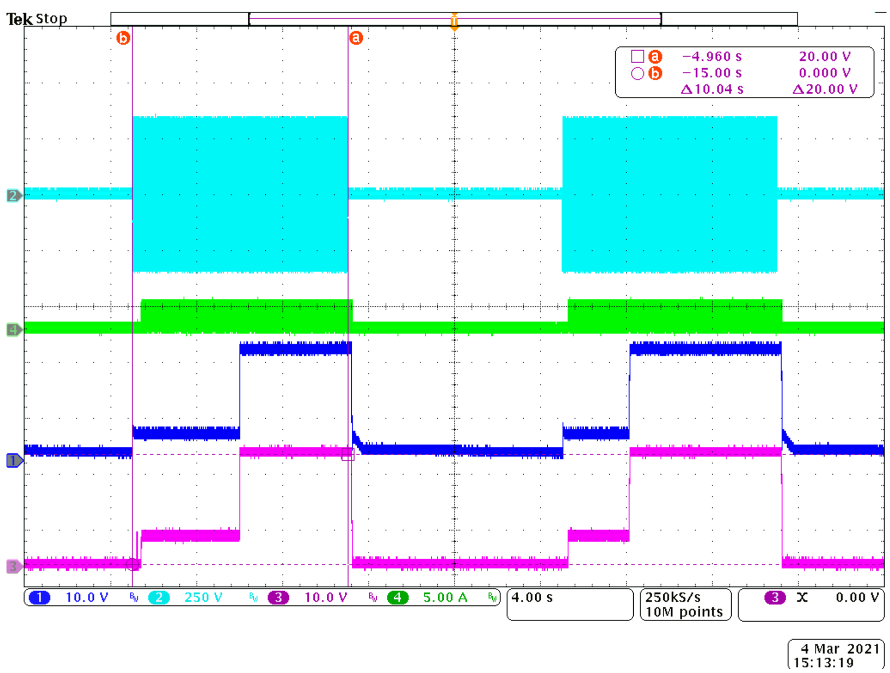



Figure 5.9-2 Stress Test zoomed out (**CH1:** Vbus_in, **CH2:** Vin_ac, **CH3:** Vbus_C, **CH4**: Iout)



## 5.10 Glossary

Table 5-3 Glossary Table

| Sr. No. | Acronyms | Full Names |
|---|---|---|
| 1 | CC Mode | Constant Current Mode in Electronic Load |
| 2 | CC-CV | Constant Current - Constant Voltage |
| 3 | CE | Conducted Emission |
| 4 | CH'x' | Oscilloscope Channel numbers |
| 5 | CR Mode | Constant Resistance Mode in Electronic Load |
| 6 | DUT | Device Under Test |
| 7 | FET | MOSFET (Metal Oxide Semiconductor Field Effect Transistor) |
| 8 | Io/Iout | Output Current of the DUT |
| 9 | NGDO | NFET Gate driver output – Q4 |
| 10 | OCP | Over current protection |
| 11 | OVP | Over voltage protection |
| 12 | P-P | Peak to Peak |
| 13 | PPS-PDO | Programmable Power Supply - Power Delivery Output |
| 14 | SR | Synchronous Rectifier |
| 15 | UI | User Interface |
| 16 | USB PD | Universal Serial Bus Power Delivery |
| 17 | Vbus_c | Bus voltage at Type-C i.e. after Provider/NGDO FET |
| 18 | Vbus_in | Bus voltage before Provider/NGDO FET |
| 19 | Vin/Vin_ac | Input AC Voltage to the DUT |
| 20 | Vo/Vout | Output Voltage of the DUT |

# Revision History

**Document Revision History**

| Document Title: CY-SD1124A 45W USB-C PD PAG1P-PAG1S CoolGaN Test Report | | | |
|---|---|---|---|
| **Revision** | **Issue Date** | **Origin of Change** | **Description of Change** |
| ** | 17 March 2021 | MGUP | Initial Version |
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