

# **65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report**

**CYPAP212A1-14SXI and CYPAS212A1-32LQXQ**

## **About this document**

### **Scope and purpose**

This document provides power management test results of the 65 W PAG2P-2S ACF REV2B Solution Demo Board. The tests were performed on the REV2B ACF board, which is equipped with Infineon CYPAP212A1-14SXI on the primary, and CYPAS212A1-32LQXQ on the secondary section of the converter.

### **Intended audience**

This document is intended for customers and FAEs using the EZ-PD™ PAG2P/PAG2S Active Clamp Flyback REF\_65W\_ACF\_PAG2 hardware.

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Test setup

2 Test setup

2.1 Device under test (DUT)

65 W PAG2P-2S HFACF charger solution board.

Table 1 DUT hardware and software configurations

| DUT contents                                      | Description  |
|---------------------------------------------------|--------------|
| <b>Hardware – configuration</b>                   |              |
| PAG2P+PAG2S HFACF 65 W solution board V2B         | Rev 2B       |
| <b>Firmware</b>                                   |              |
| Firmware repo: <a href="#">REF_65W_HFACF_PAG2</a> | acf_hf_ver42 |

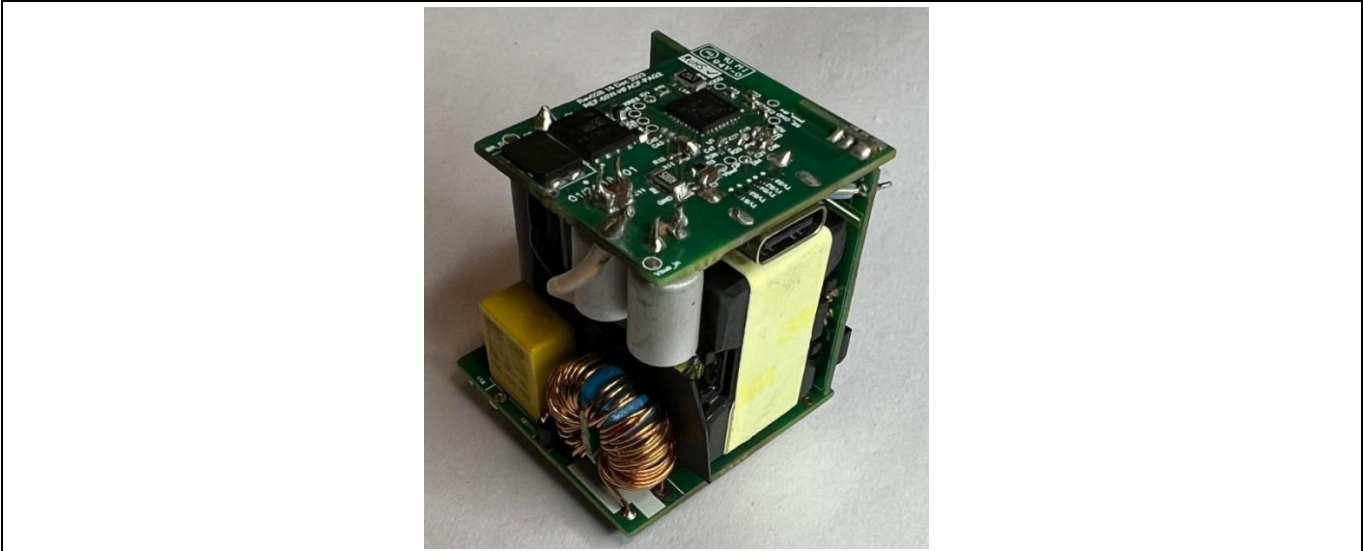


Figure 2 Isometric view of 65 W HFACF solution board

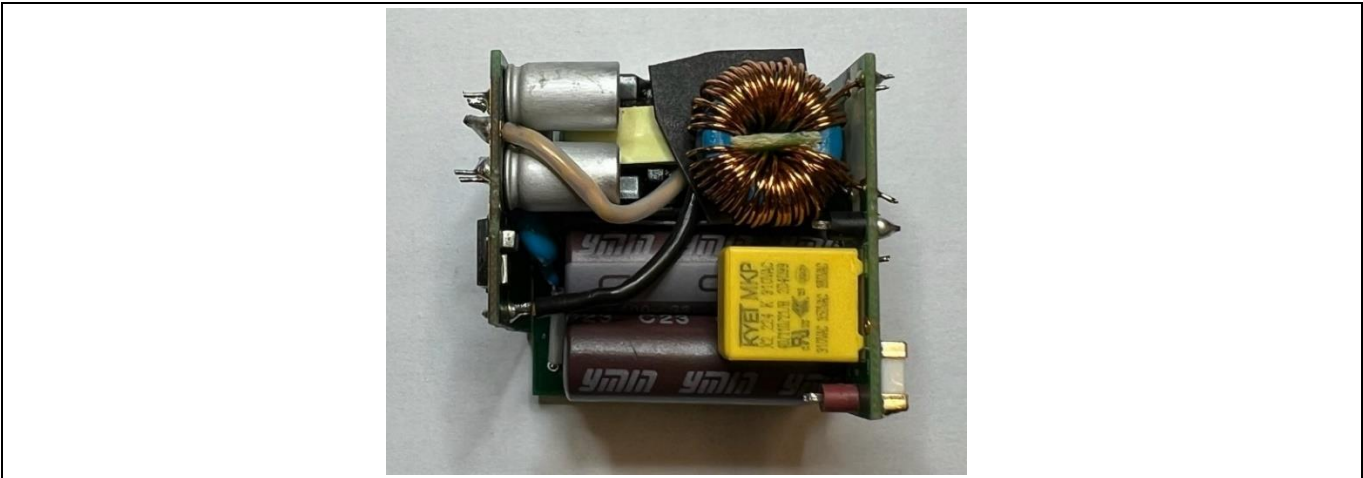


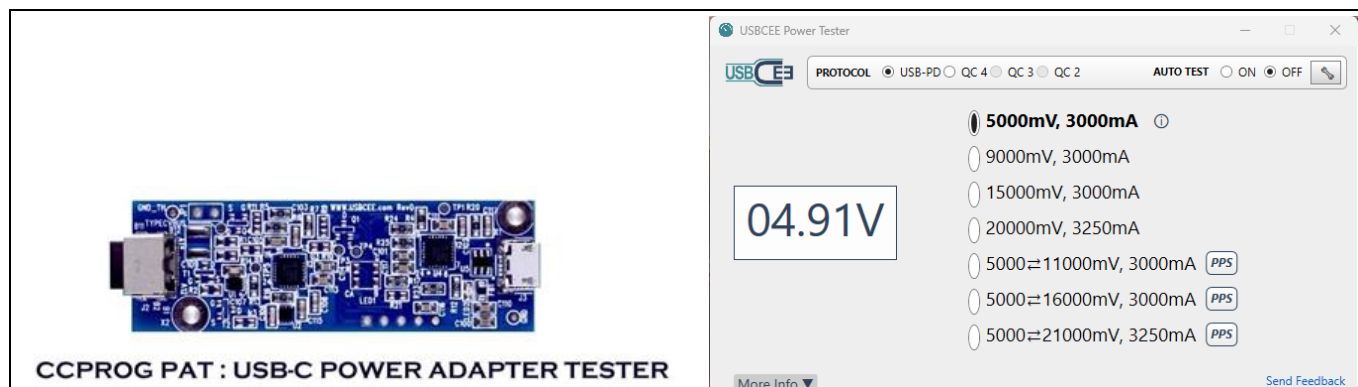
Figure 3 Top view of the 65 W HFACF solution board

Dimensions (in mm): 34.29 x 31.97 x 30.46 (LxWxH)

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## Test setup

### 2.2 DUT setup



**Figure 4** Physical CCGPROG PAT and Power Tester UI

Connect the DUT to a power adapter tester (PAT) (CCPROG PAT) using a USB Type-C cable. After the connection is established, the PAT UI does a PDO discovery and displays the same on the UI. The solution kit is pre-configured with 7 PDOs:

- PDO 1: 5 V, 3 A FIXED
- PDO 2: 9 V, 3 A FIXED
- PDO 3: 15 V, 3 A FIXED
- PDO 4: 20 V, 3.25 A FIXED
- PDO 5: 5 V-11 V, 0-3 A PPS
- PDO 6: 5 V-16 V, 0-3 A PPS
- PDO 7: 5 V-21 V, 0-3.25 A PPS

Choose the suitable pre-configured PDO or configure a new one using Infineon's [USB EZ-PD™ Configuration Utility](#). Tests in the following sections use the pre-configured PDOs.

To know more about PAT tester, see [USBCEE](#).

### 2.3 Test equipment

[Table 2](#) shows the test equipment to measure the efficiency, ripple, regulation, and transient response.

**Table 2** Test equipment details

| Test setup                   | Description                  |
|------------------------------|------------------------------|
| Oscilloscope Name            | Tektronix MDO 034            |
| Power Meter                  | Yokogawa WT310E/Chroma 66205 |
| Digital Multimeter (Vo & Io) | Keysight 34465A              |
| Programmable AC Source       | Chroma 61501                 |
| Electronic Load              | Chroma 63113A                |
| Thermal Camera               | Flir E75                     |
| Automation Software          | LabView                      |

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## Power management test results

### 3 Power management test results

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

#### 3.1 Efficiency & no-load consumption

**Table 3** Efficiency and no-load consumption results

| Parameter                                                           | Standard (minimum value)           |              | Unit | Test condition                                                 | Test result               |                           |
|---------------------------------------------------------------------|------------------------------------|--------------|------|----------------------------------------------------------------|---------------------------|---------------------------|
|                                                                     | DoE Level-6                        | CoCv5 Tier 2 |      |                                                                | 115 V <sub>ac</sub> 60 Hz | 230 V <sub>ac</sub> 50 Hz |
| Four-point average efficiency (average of 25%, 50%, 75%, 100% load) | 81.39                              | 81.84        | %    | V <sub>o</sub> = 5 V <sub>dc</sub> , I <sub>o</sub> = 3 A      | 92.243                    | 90.881                    |
|                                                                     | 86.62                              | 87.30        | %    | V <sub>o</sub> = 9 V <sub>dc</sub> , I <sub>o</sub> = 3 A      | 93.223                    | 92.969                    |
|                                                                     | 87.73                              | 88.85        | %    | V <sub>o</sub> = 15V <sub>dc</sub> , I <sub>o</sub> = 3 A      | 93.431                    | 93.817                    |
|                                                                     | 88                                 | 89           | %    | V <sub>o</sub> = 20V <sub>dc</sub> , I <sub>o</sub> = 3.25 A   | 93.374                    | 93.947                    |
| CoCv5 Tier 2 10% load efficiency                                    | -                                  | 72.48        | %    | V <sub>o</sub> = 5 V <sub>dc</sub> , I <sub>o</sub> = 0.3 A    | 81.84                     | 81.84                     |
|                                                                     | -                                  | 77.30        | %    | V <sub>o</sub> = 9 V <sub>dc</sub> , I <sub>o</sub> = 0.3 A    | 87.3                      | 87.3                      |
|                                                                     | -                                  | 78.85        | %    | V <sub>o</sub> = 15 V <sub>dc</sub> , I <sub>o</sub> = 0.3 A   | 88.85                     | 88.85                     |
|                                                                     | -                                  | 79           | %    | V <sub>o</sub> = 20 V <sub>dc</sub> , I <sub>o</sub> = 0.325 A | 89                        | 89                        |
|                                                                     | <b>Standard</b><br>(maximum value) |              |      |                                                                |                           |                           |
| No load consumption                                                 | 100                                | 75           | mW   | No USB sink attached                                           | 24                        | 29                        |

Notes:

Peak Efficiency: 94.488% (at 230 V<sub>ac</sub>-50 Hz, 20 V-3.25 A)

V<sub>out</sub> for efficiency calculations is measured across V<sub>bus\_C</sub> at board end with 15 minutes warmup

Variation of ±0.5% in efficiency can be observed across units

Instruments used to capture efficiency data:

**Table 4** Equipment used for measurement

| Instruments                                                                                | Model number           |
|--------------------------------------------------------------------------------------------|------------------------|
| AC source                                                                                  | GWinstek ASR2100       |
| Power meter                                                                                | Hioki PW3335           |
| Input current (I <sub>IN</sub> and I <sub>OUT</sub> ) measurement shunt                    | Vishay Y14730R00500B0R |
| Electronic load                                                                            | GwINSTEK PEL-3021      |
| Data logger (I <sub>IN</sub> , V <sub>IN</sub> , V <sub>BUS</sub> , and I <sub>OUT</sub> ) | Keysight 34970 A       |

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Power management test results

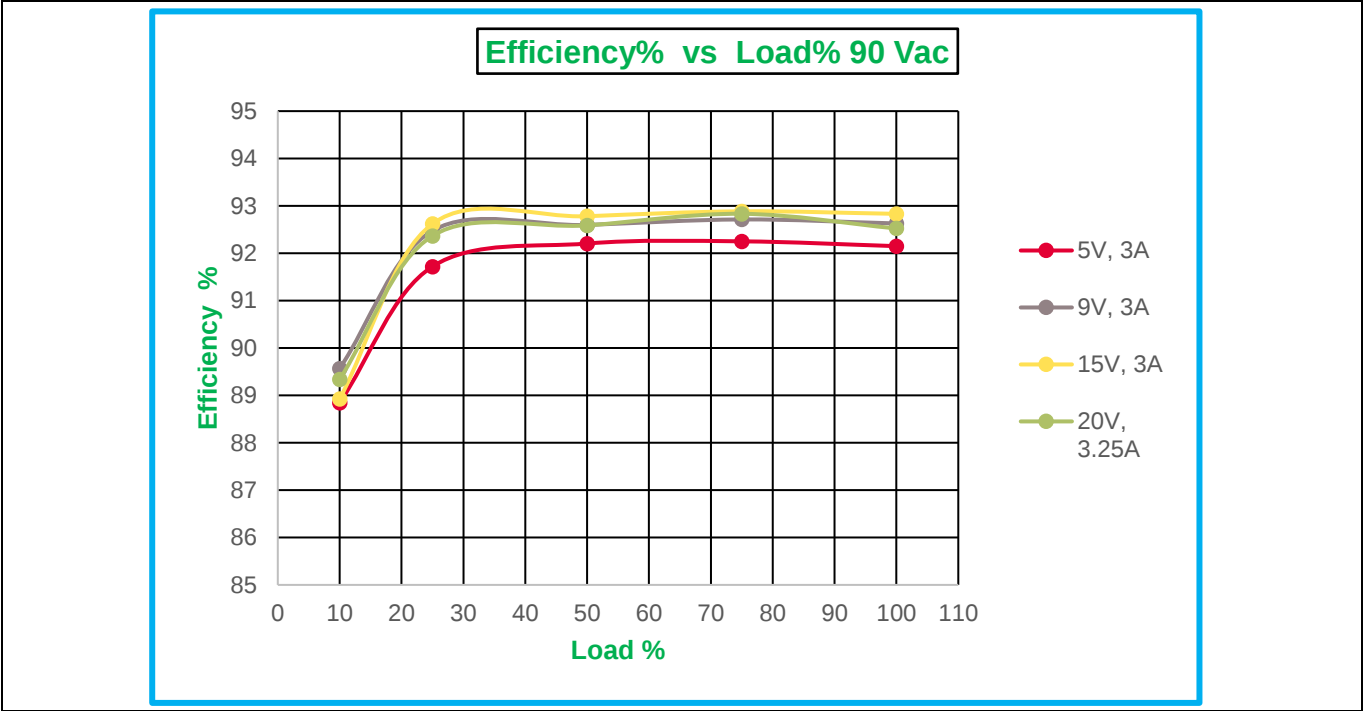


Figure 5 Efficiency at 90 V<sub>ac</sub>, 47 Hz

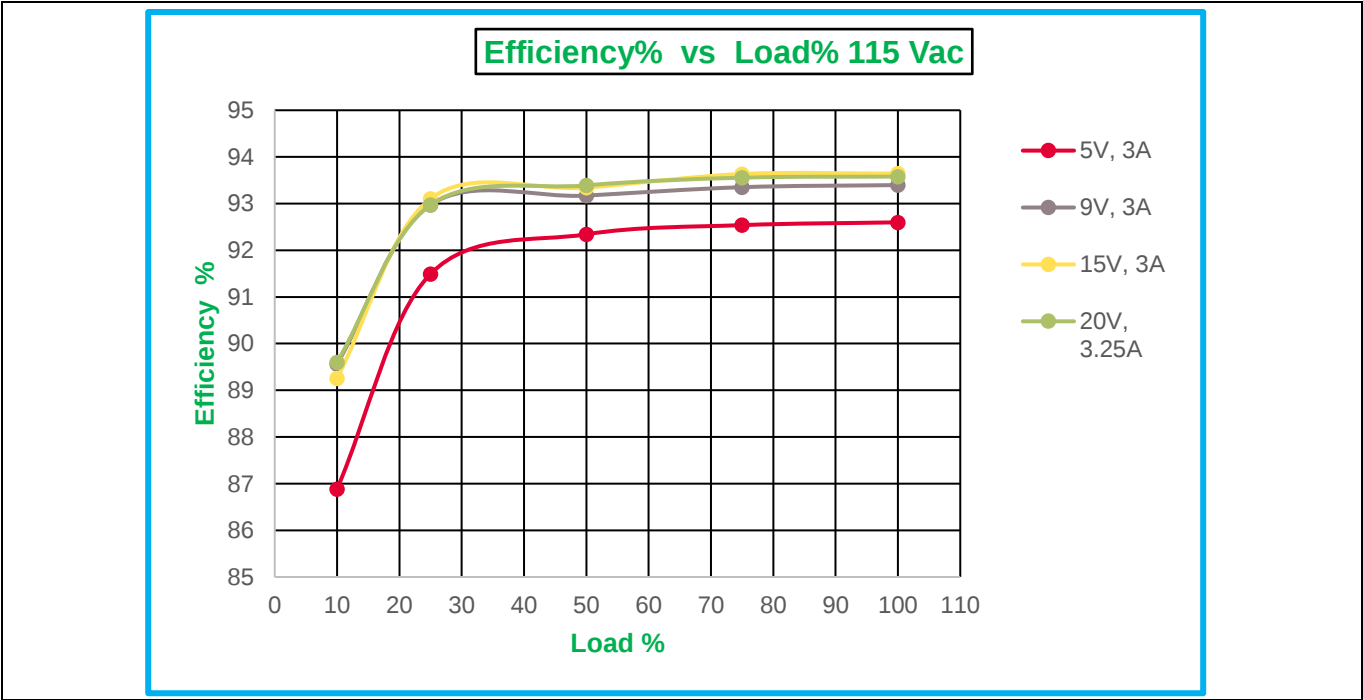


Figure 6 Efficiency at 115 V<sub>ac</sub>, 60 Hz

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## Power management test results

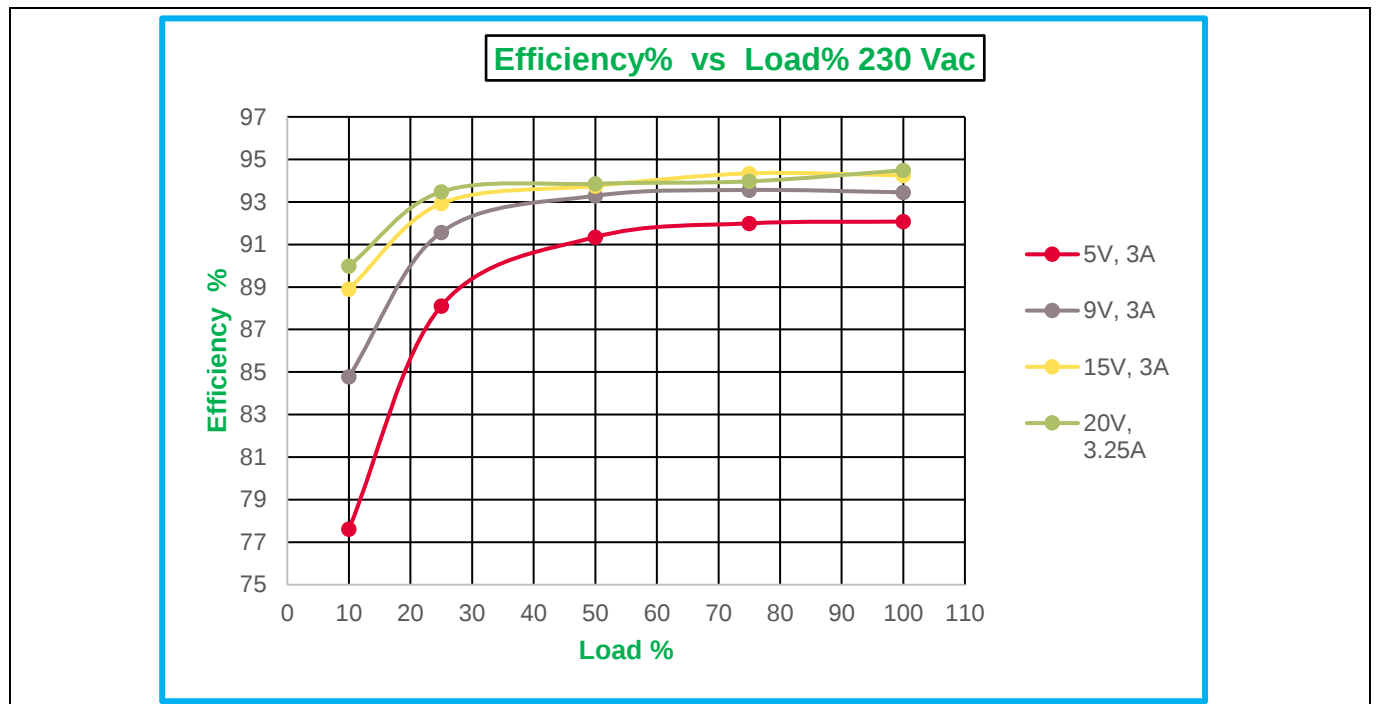


Figure 7 Efficiency at 230 V<sub>ac</sub>, 50 Hz

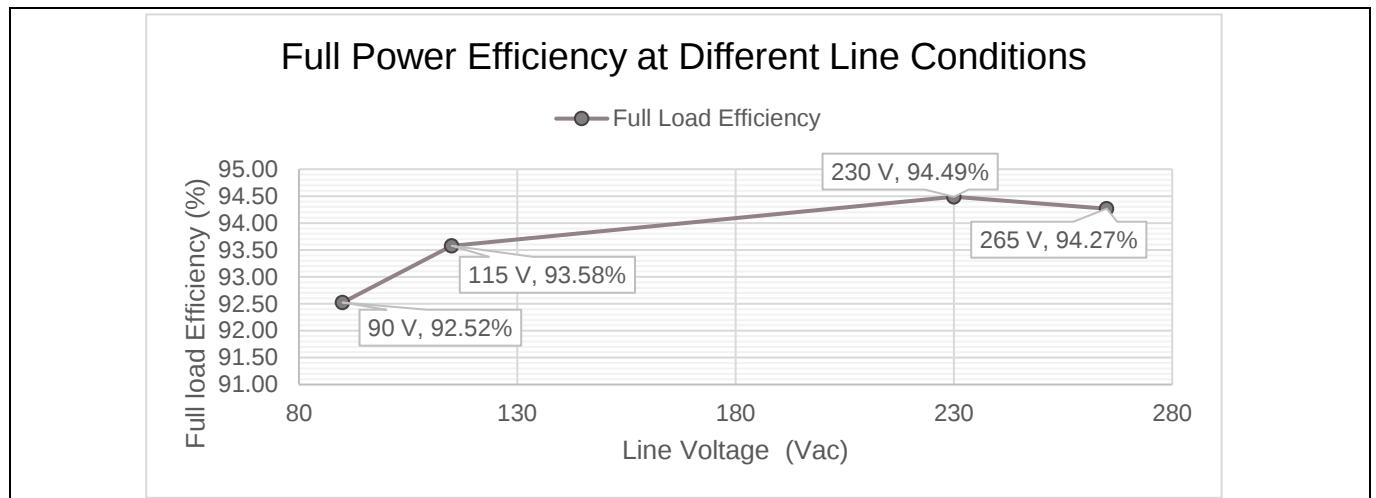
Table 5 Full load efficiency at different line condition

| S.no | Vac (V) | Freq (Hz) | Pin    | Vout (V) | Iout (A) | Po     | Efficiency (%) | 4-pt average efficieny(%) | CoC T2 | DOE 6 | Full load switching frequency (kHz) |
|------|---------|-----------|--------|----------|----------|--------|----------------|---------------------------|--------|-------|-------------------------------------|
| 1    | 90      | 47        | 7.260  | 19.977   | 0.325    | 6.486  | 89.34          | -                         | 79     | -     | 101                                 |
| 2    | 90      | 47        | 17.580 | 19.962   | 0.813    | 16.238 | 92.37          | 92.578                    | 89     | 88    |                                     |
| 3    | 90      | 47        | 35.090 | 19.953   | 1.628    | 32.489 | 92.59          |                           |        |       |                                     |
| 4    | 90      | 47        | 52.460 | 19.944   | 2.442    | 48.700 | 92.83          |                           |        |       |                                     |
| 5    | 90      | 47        | 70.160 | 19.937   | 3.256    | 64.915 | 92.52          |                           |        |       |                                     |
| 6    | 115     | 60        | 7.24   | 19.975   | 0.325    | 6.487  | 89.602         | -                         | 79     | -     | 145.56                              |
| 7    | 115     | 60        | 17.467 | 19.960   | 0.814    | 16.240 | 92.973         | 93.375                    | 89     | 88    |                                     |
| 8    | 115     | 60        | 34.79  | 19.953   | 1.628    | 32.491 | 93.390         |                           |        |       |                                     |
| 9    | 115     | 60        | 52.05  | 19.942   | 2.442    | 48.696 | 93.556         |                           |        |       |                                     |
| 10   | 115     | 60        | 69.36  | 19.935   | 3.256    | 64.907 | 93.579         |                           |        |       |                                     |
| 11   | 230     | 50        | 7.21   | 19.975   | 0.325    | 6.488  | 89.990         | -                         | 79     | -     | 119.44                              |
| 12   | 230     | 50        | 17.37  | 19.959   | 0.814    | 16.237 | 93.476         | 93.947                    | 89     | 88    |                                     |
| 13   | 230     | 50        | 34.61  | 19.951   | 1.628    | 32.483 | 93.855         |                           |        |       |                                     |
| 14   | 230     | 50        | 51.82  | 19.941   | 2.442    | 48.695 | 93.969         |                           |        |       |                                     |
| 15   | 230     | 50        | 68.69  | 19.934   | 3.256    | 64.904 | 94.488         |                           |        |       |                                     |
| 16   | 264     | 63        | 7.22   | 19.971   | 0.325    | 6.490  | 89.892         | -                         | 79     | -     | 124.3                               |
| 17   | 264     | 63        | 17.41  | 19.959   | 0.813    | 16.236 | 93.258         | 93.709                    | 89     | 88    |                                     |
| 18   | 264     | 63        | 34.66  | 19.951   | 1.628    | 32.485 | 93.725         |                           |        |       |                                     |
| 19   | 264     | 63        | 52.03  | 19.941   | 2.442    | 48.692 | 93.584         |                           |        |       |                                     |
| 20   | 264     | 63        | 68.85  | 19.933   | 3.256    | 64.903 | 94.267         |                           |        |       |                                     |

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## Power management test results



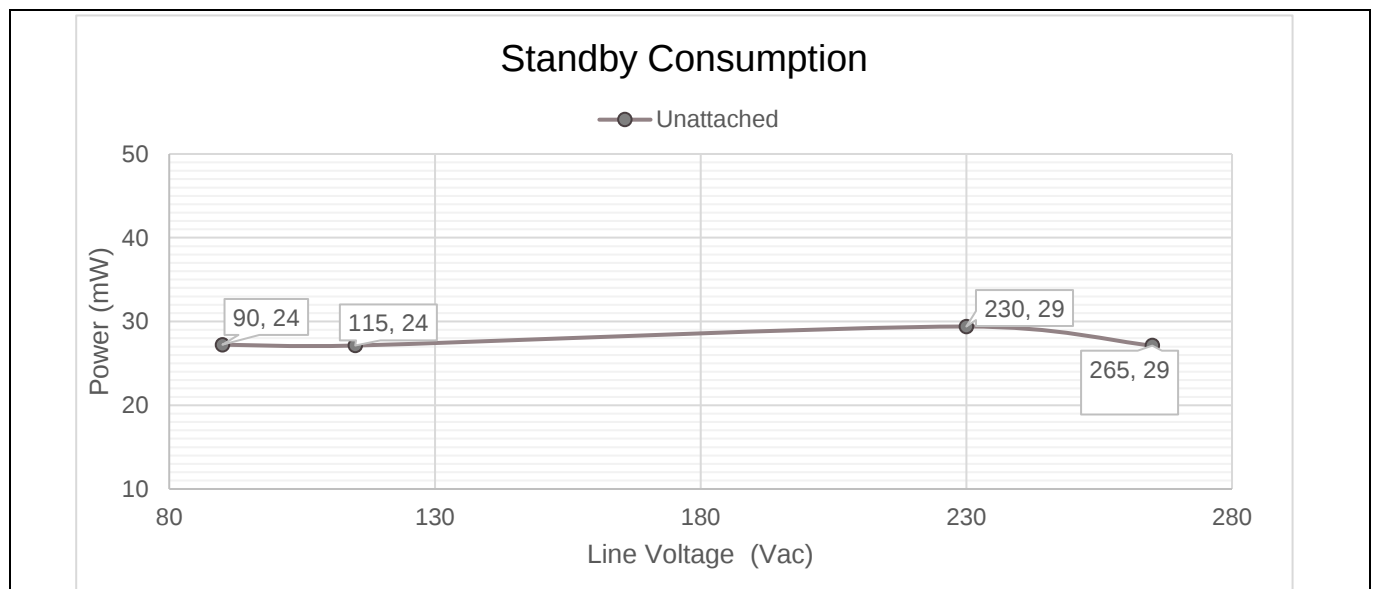
**Figure 8** Full power efficiency at different line conditions

## 3.2 Standby power consumption

**Table 6** Standby power consumption across line conditions

| Vin (Vac)        | 90 Vac, 47 Hz | 115 Vac, 60 Hz | 230 Vac, 50 Hz | 265 Vac, 63 Hz |
|------------------|---------------|----------------|----------------|----------------|
| Input power (mW) | 24mW          | 24mW           | 29mW           | 29mW           |

*Note:* There should be 15 minutes of warmup time before starting to measure standby power.



**Figure 9** Standby power consumption

*Note:* The measurement was taken using WTVIEWERfree software with line filter ON.

### 3.3 Output voltage and current regulation

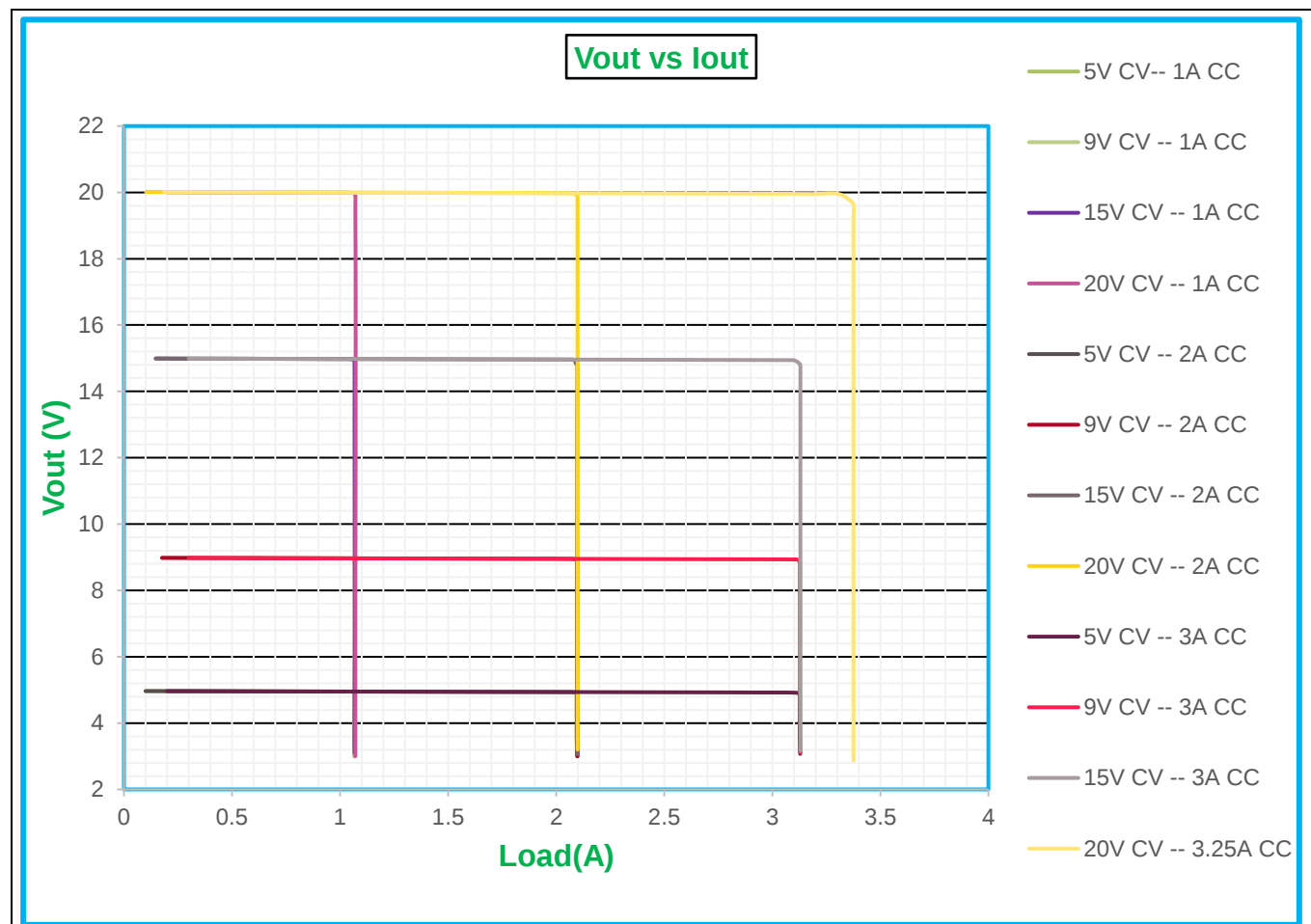


Figure 10 CV-CC regulation curve at 115 V<sub>ac</sub> 60 Hz

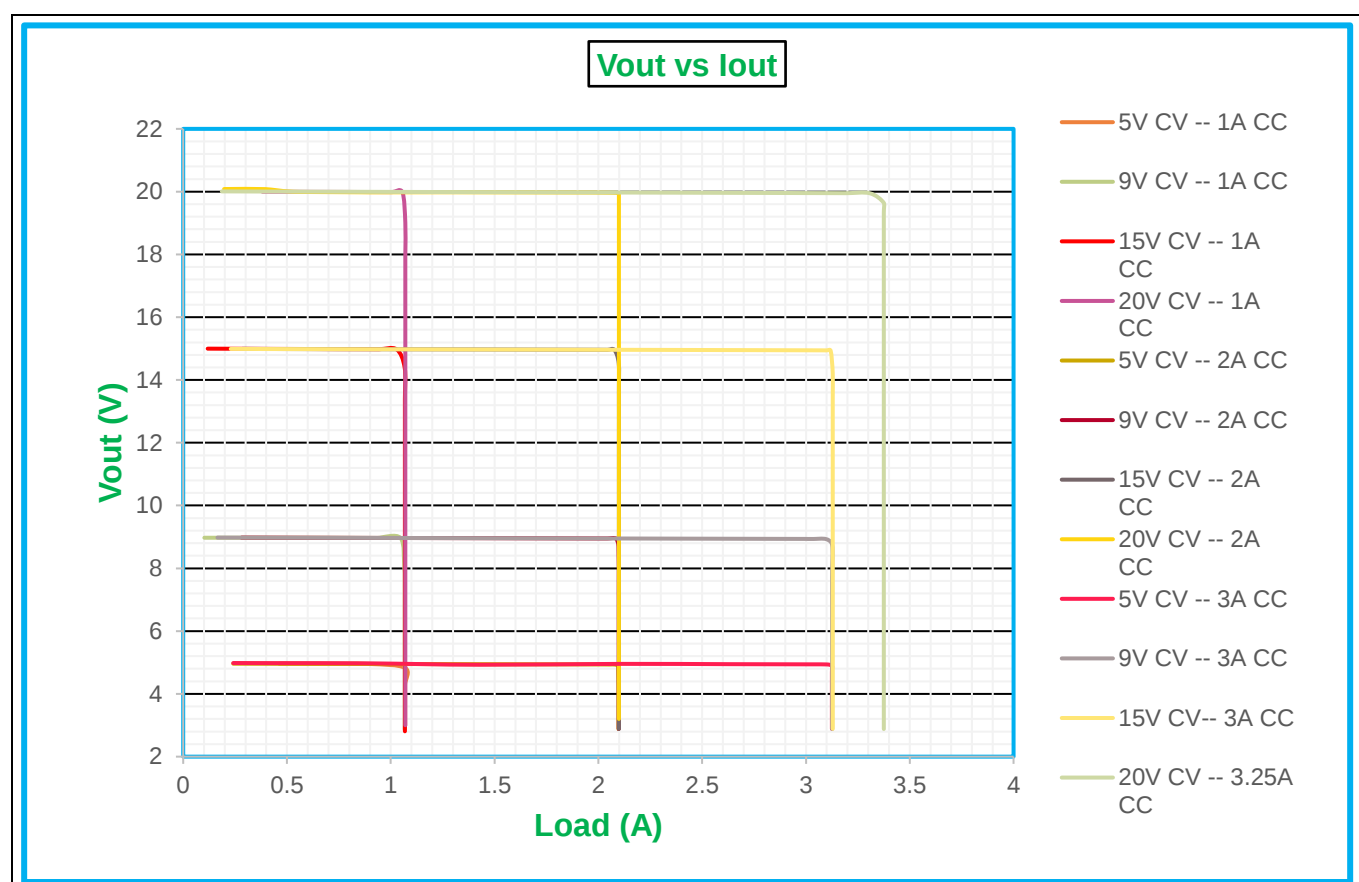
Table 7 CC limits 115 V<sub>ac</sub> 60 Hz

|      | 1 A    | 2 A   | 3 A    | 3.25 A |
|------|--------|-------|--------|--------|
| 5 V  | 1.004  | 1.967 | 2.9904 | NA     |
| 9 V  | 1.002  | 1.966 | 2.99   | NA     |
| 15 V | 1.0029 | 1.968 | 2.99   | NA     |
| 20 V | 1.0045 | 1.968 | 2.991  | 3.214  |

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## Power management test results



**Figure 11** CV-CC regulation curve at 230 V<sub>ac</sub> 50 Hz

**Table 8** CC limits 230 V<sub>ac</sub> 50 Hz

|      | 1 A    | 2 A   | 3 A    | 3.25 A |
|------|--------|-------|--------|--------|
| 5 V  | 1.004  | 1.967 | 2.9904 | NA     |
| 9 V  | 1.0032 | 1.968 | 2.992  | NA     |
| 15 V | 1.004  | 1.97  | 2.9923 | NA     |
| 20 V | 1.0037 | 1.967 | 2.9927 | 3.217  |

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## Power management test results

### 3.4 Output voltage ripple peak-peak

Note: Ripple measurement is done at board end using lecroly probe. Refer [PK6-5MM-105](#).

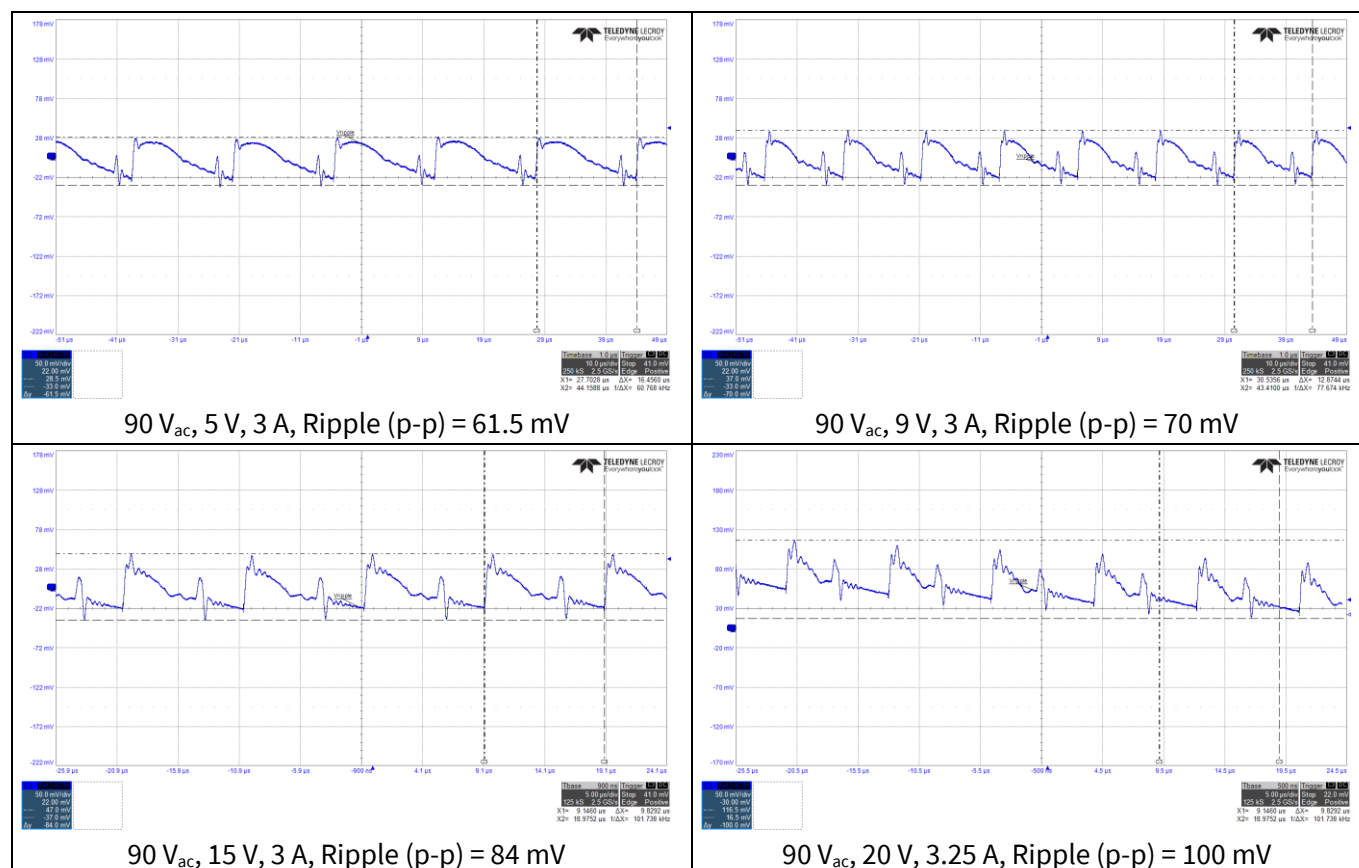


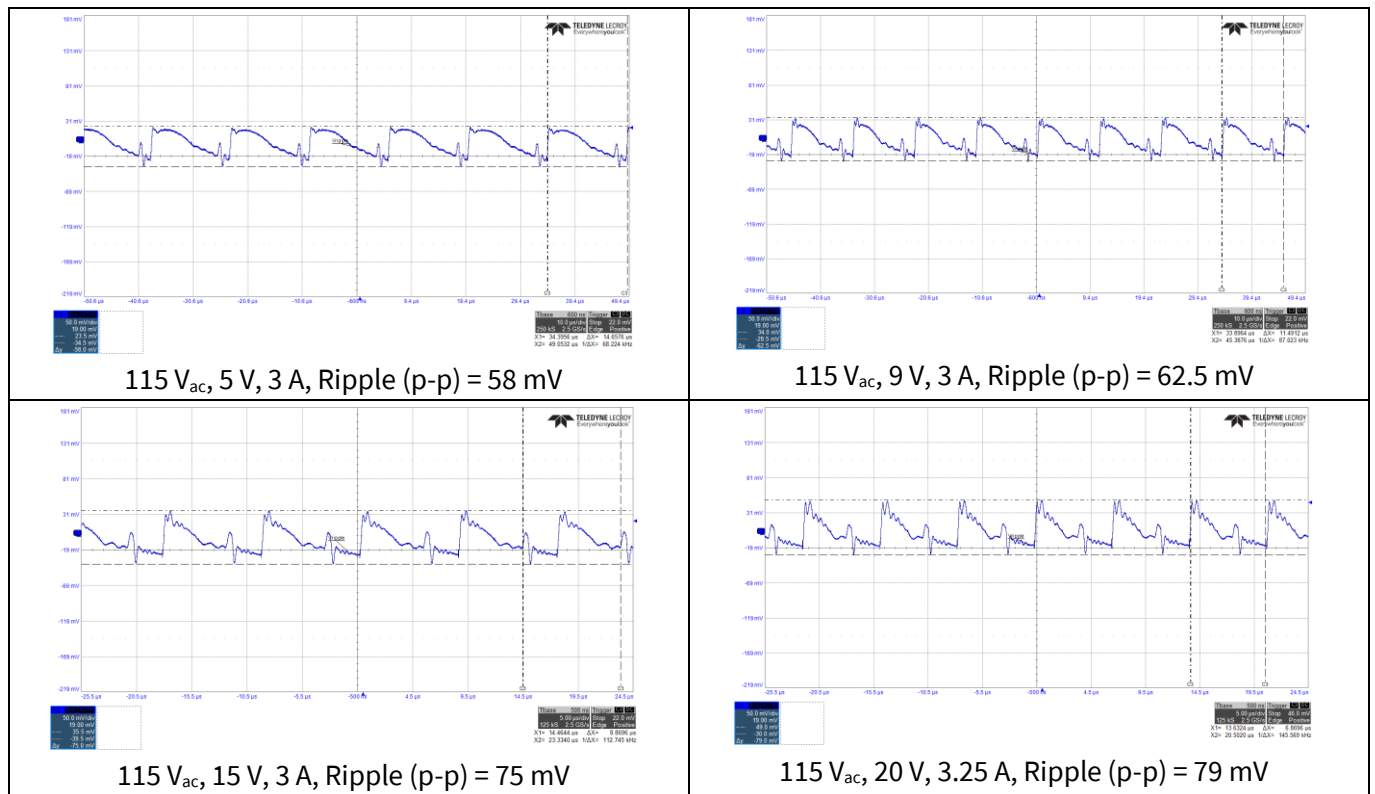
Figure 12 Ripple<sup>1</sup> at 90 V<sub>ac</sub> 47 Hz (CH3: V<sub>bus\_c</sub>)

<sup>1</sup> Waveforms have been taken by keeping the oscilloscope in 20 MHz bandwidth limitation.

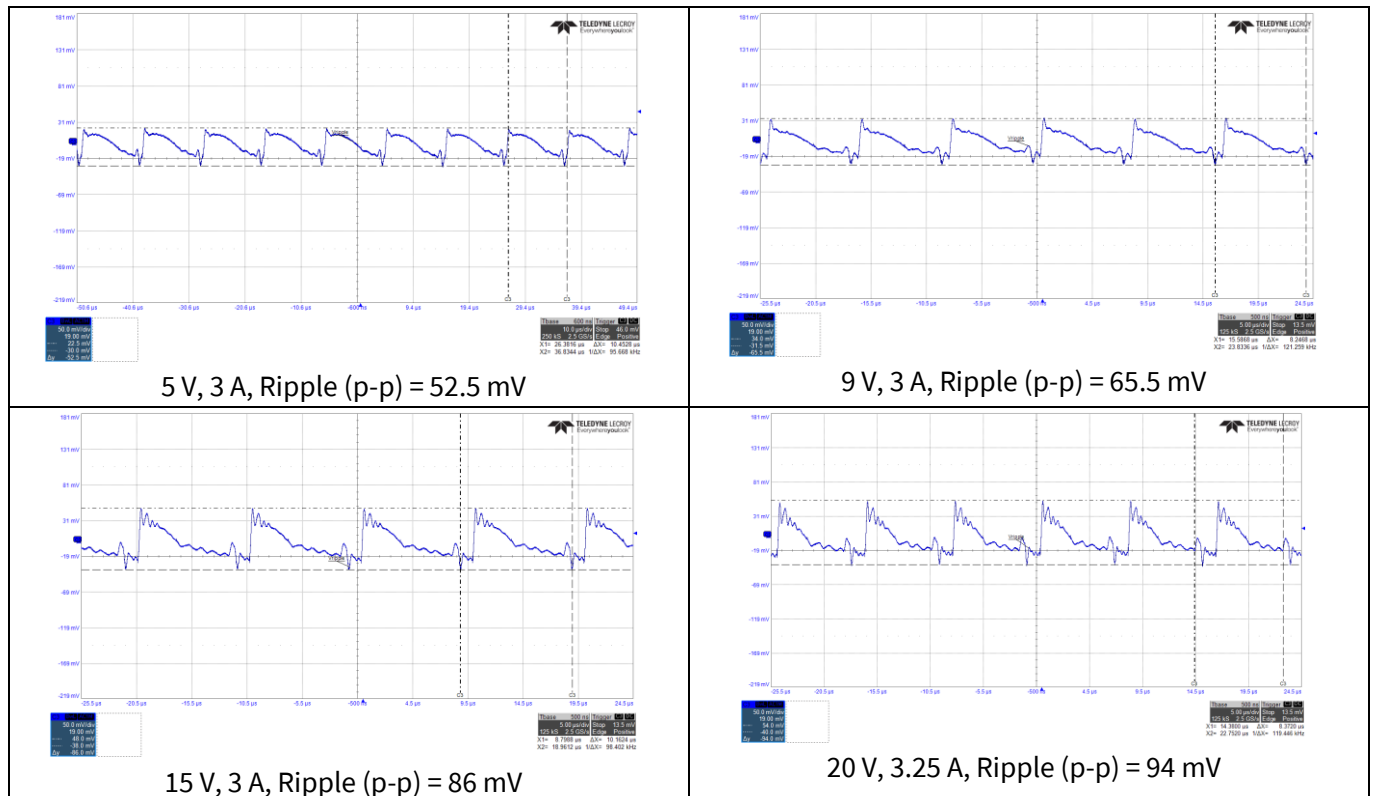
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## Power management test results



**Figure 13** Ripple<sup>2</sup> at 115 V<sub>ac</sub> 60 Hz (CH3: V<sub>bus\_c</sub>)

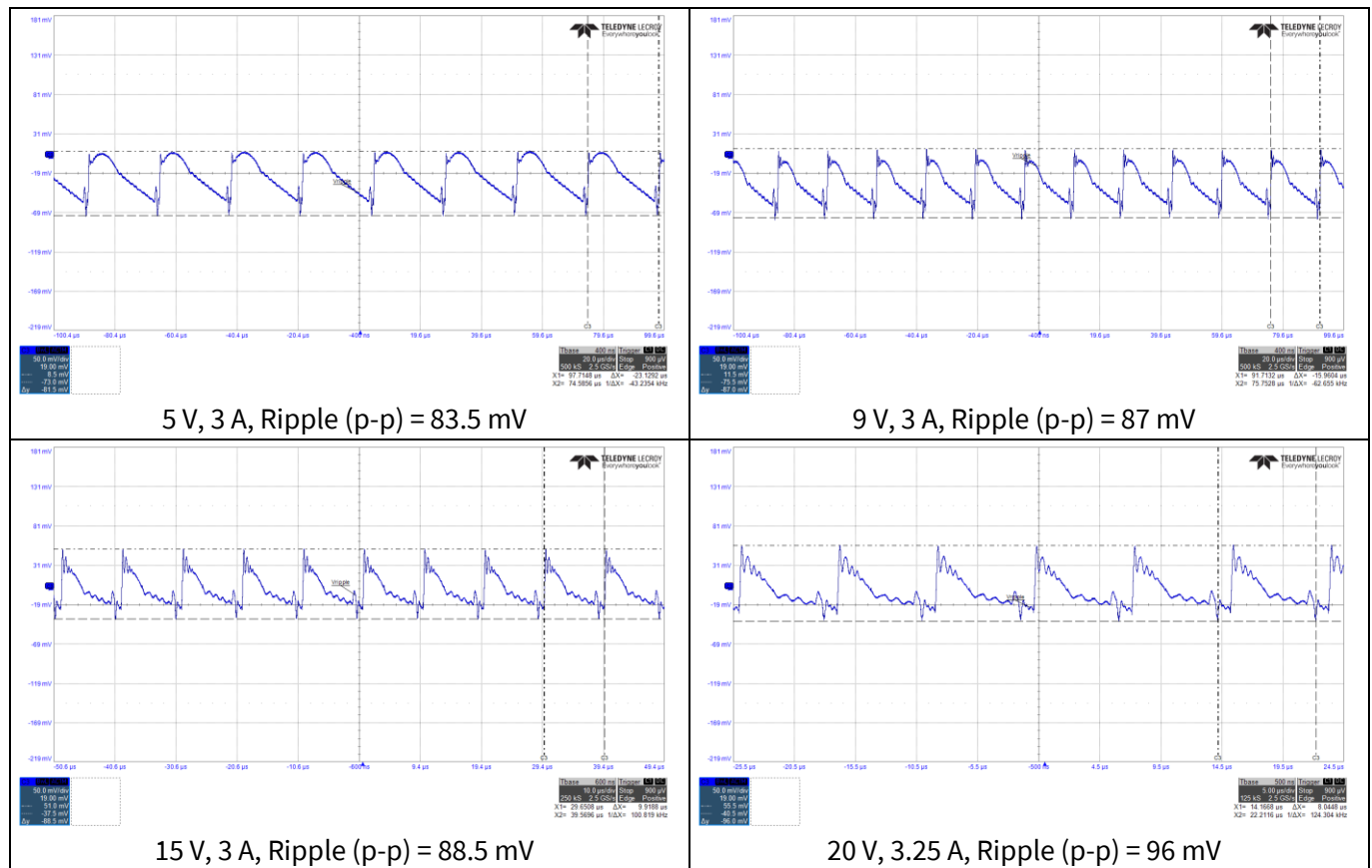


**Figure 14** Ripple<sup>2</sup> at 230 V<sub>ac</sub> 50 Hz (CH3: V<sub>bus\_c</sub>)

<sup>2</sup> Waveforms have been taken by keeping the oscilloscope in 20 MHz bandwidth limitation.

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**Figure 15** Ripple<sup>3</sup> at 265 V<sub>ac</sub> 63 Hz (CH3: V<sub>bus\_c</sub>)

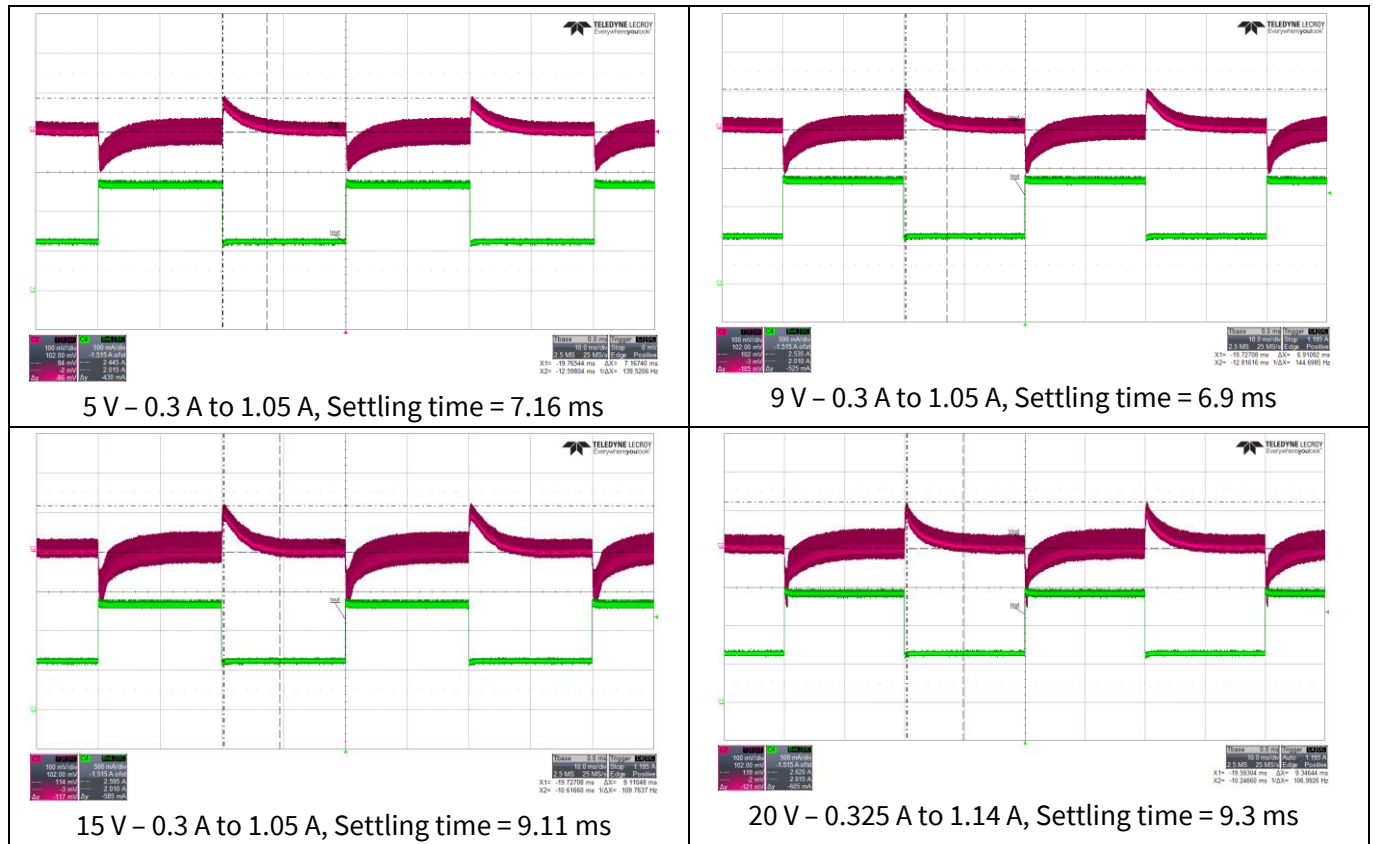
<sup>3</sup> Waveforms have been taken by keeping the oscilloscope in 20 MHz bandwidth limitation.

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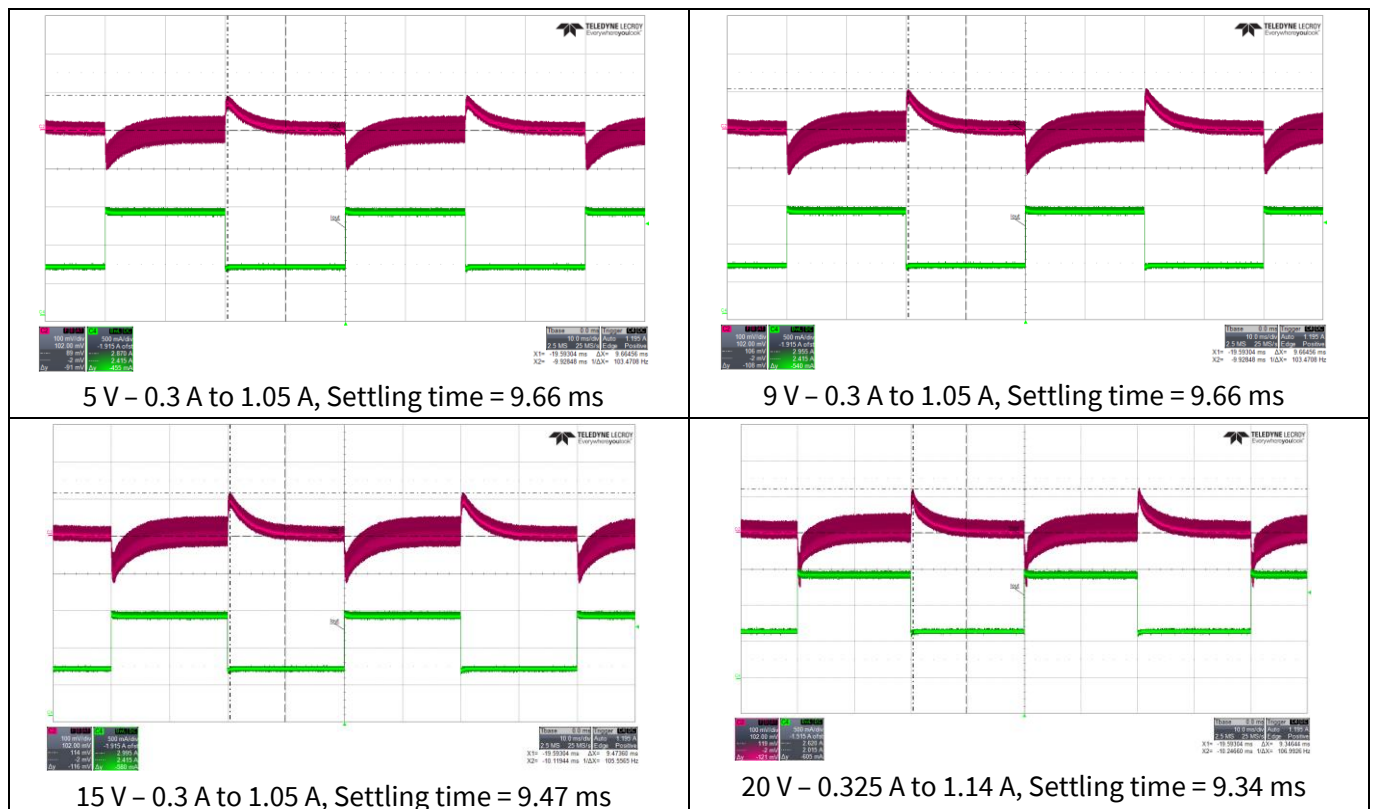


## Power management test results

### 3.5 Output dynamic response settling time



**Figure 16** Settling time for 115 Vac, 60 Hz load transition 10% to 35% load (CH3: V<sub>bus\_c</sub>, CH4: I<sub>out</sub>)

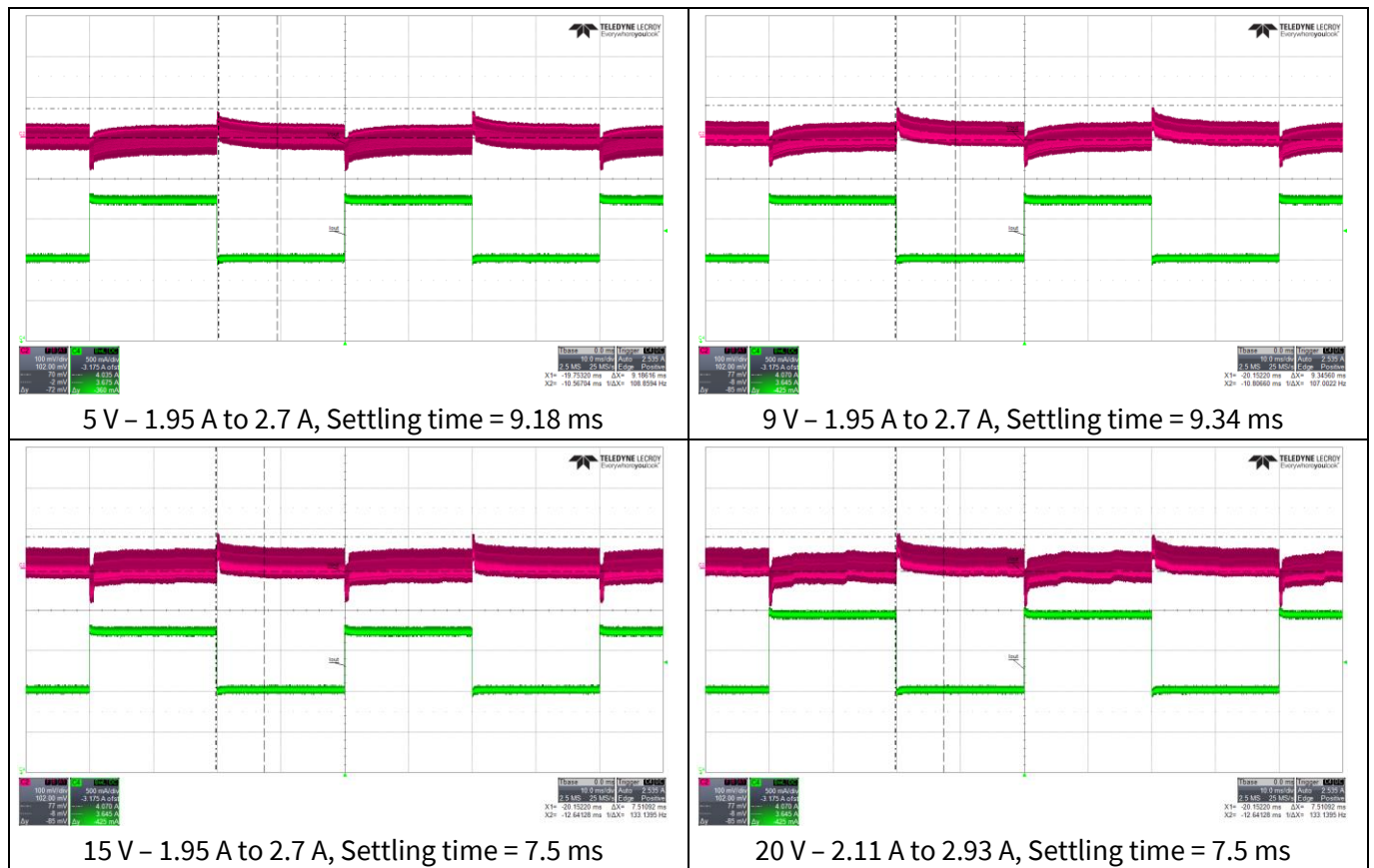


**Figure 17** Settling time for 230 V<sub>ac</sub>, 50 Hz load transition 10% to 35% load (CH3: V<sub>bus\_c</sub>, CH4: I<sub>out</sub>)

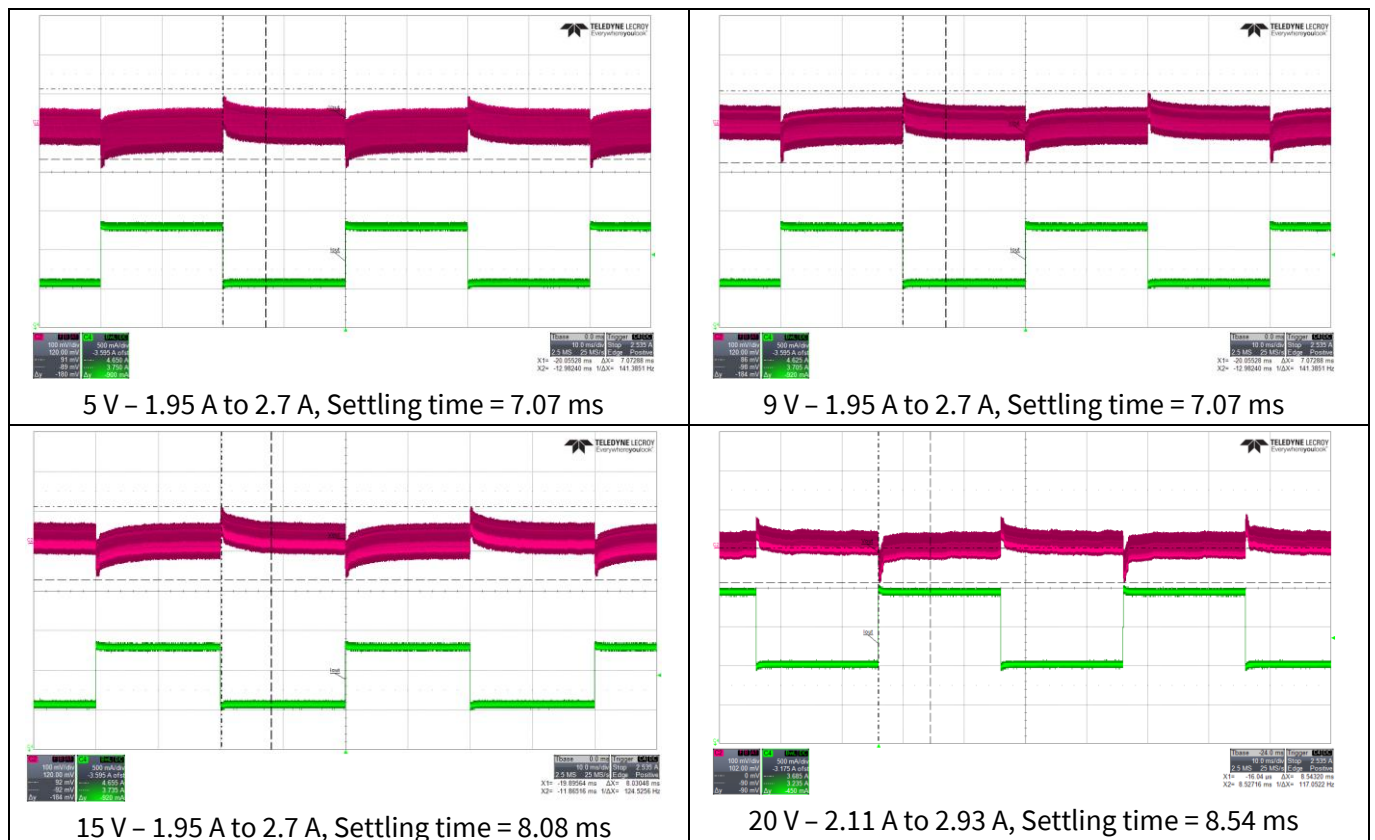
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## Power management test results



**Figure 18 Settling time for 115 V<sub>ac</sub>, 60 Hz load transition 65% to 90% load (CH3: V<sub>bus\_c</sub>, CH4: I<sub>out</sub>)**



**Figure 19 Settling time for 230 V<sub>ac</sub>, 50 Hz Load Transition 65% to 90% load (CH2: V<sub>bus\_c</sub>, CH4: I<sub>out</sub>)**

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## Power management test results

### 3.6 Output voltage transfer transition

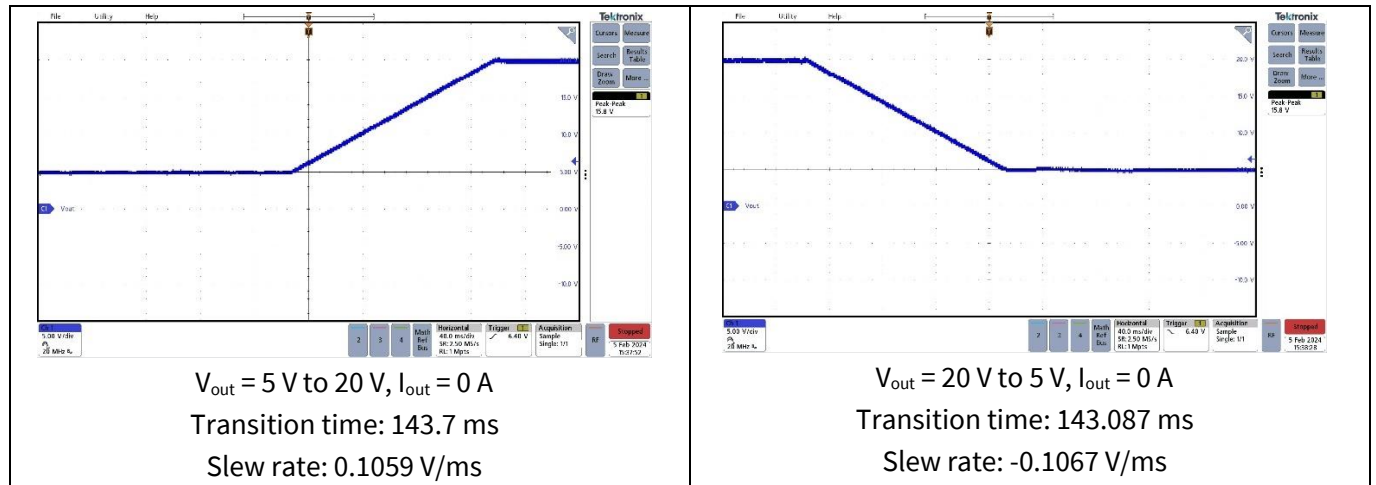


Figure 20 Output voltage transition for 115 V<sub>AC</sub>, 60 Hz; (CH1: V<sub>bus\_c</sub>)

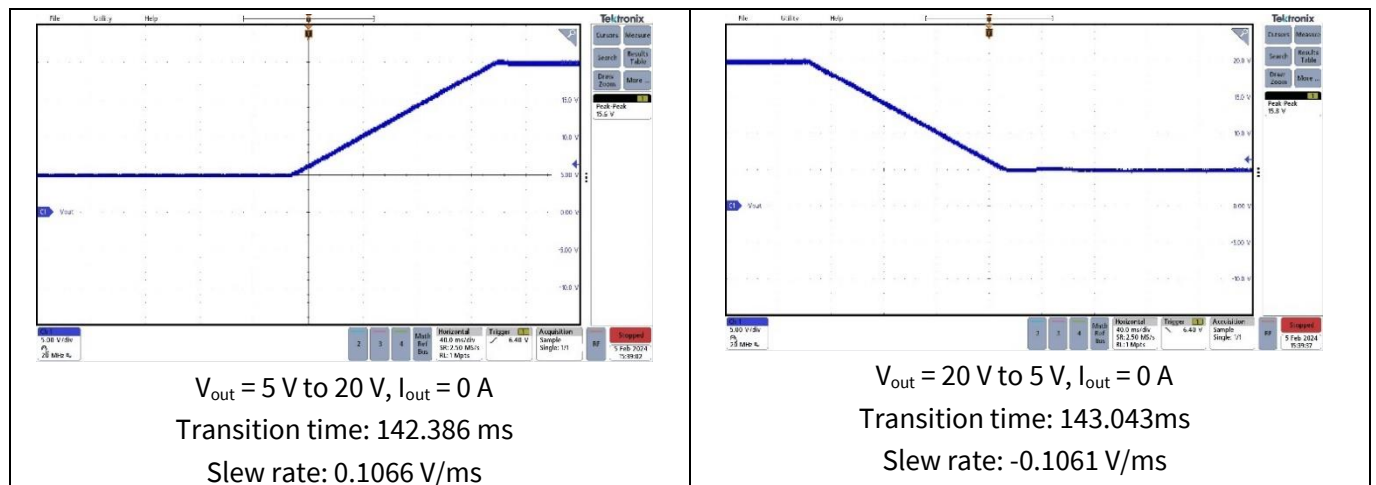


Figure 21 Output voltage transition for 230 V<sub>AC</sub>, 50 Hz; (CH1: V<sub>bus\_c</sub>)

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## Power management test results

### 3.7 Start-up turn-on delay and start-up rise time

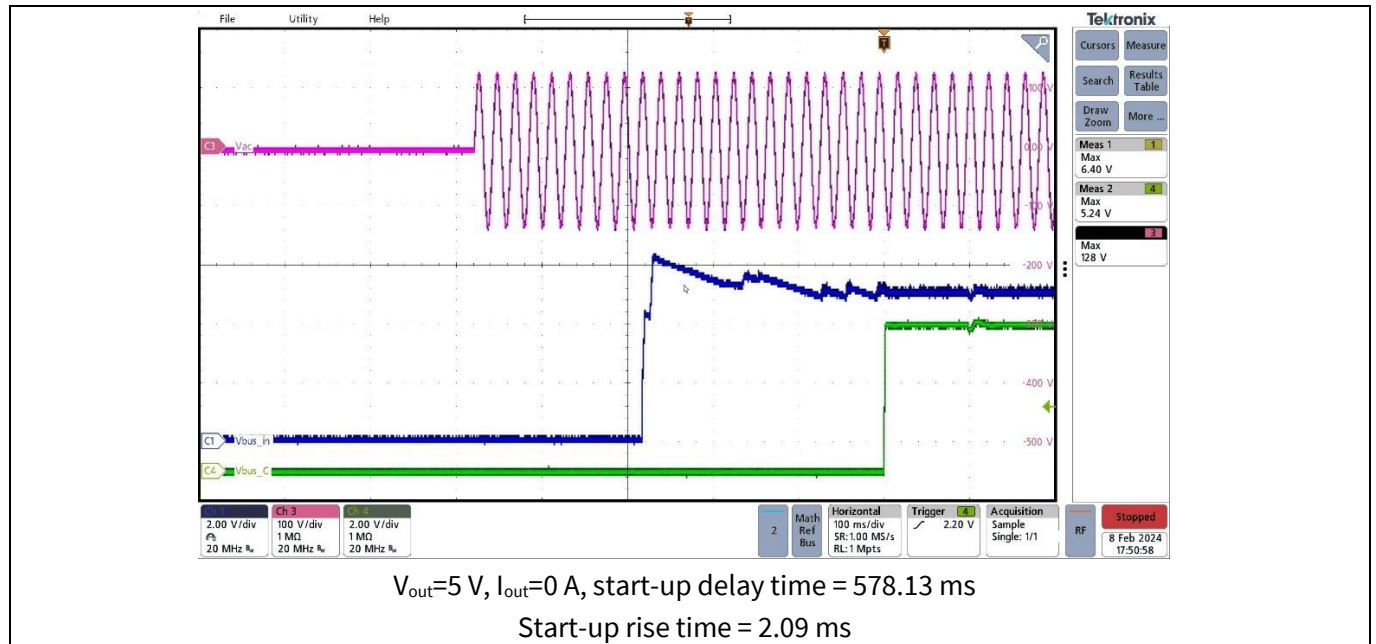


Figure 22 Start-up turn-on delay at 90 V<sub>ac</sub>, 47 Hz (CH4: V<sub>bus\_c</sub>, CH3: V<sub>in\_ac</sub>)

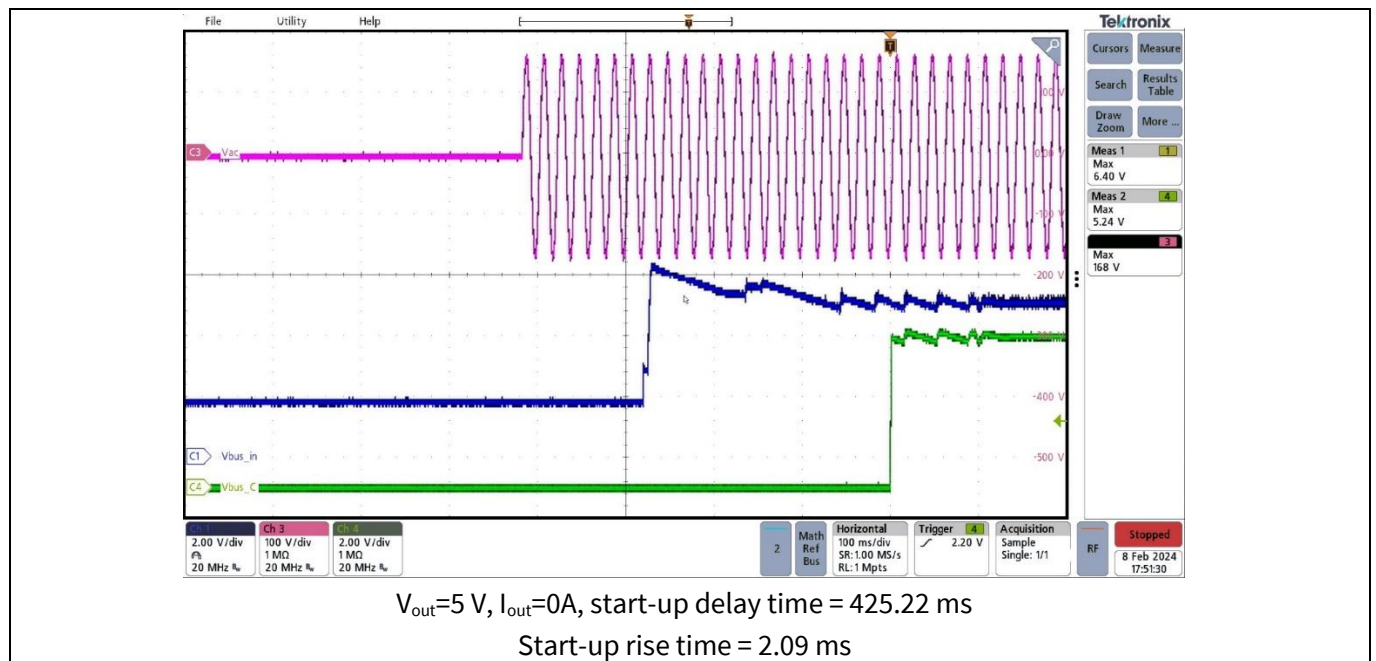


Figure 23 Start-up turn-on delay at 115 V<sub>ac</sub>, 60 Hz (CH4: V<sub>bus\_c</sub>, CH3: V<sub>in\_ac</sub>)

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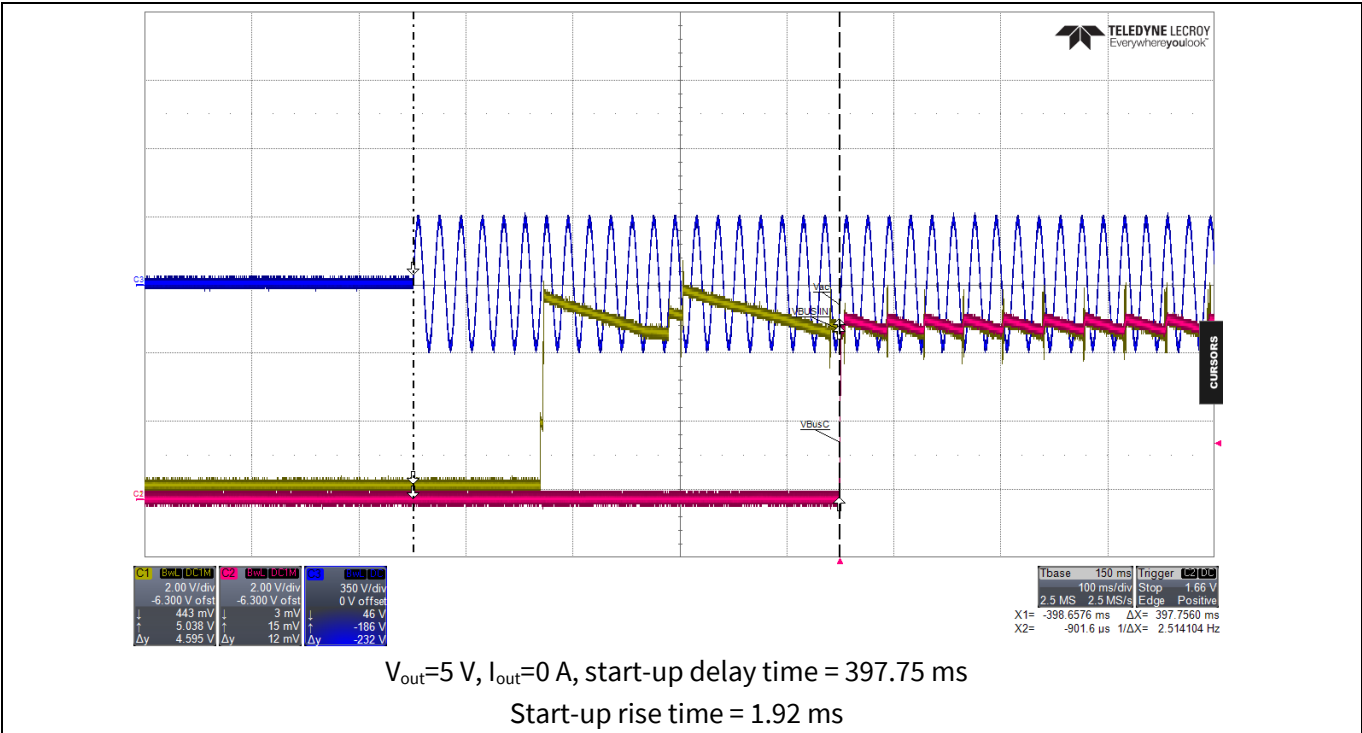


Figure 24 Start-up turn-on delay at 230 V<sub>ac</sub>, 50 Hz (CH2: V<sub>bus\_c</sub>, CH3: V<sub>in\_ac</sub>)

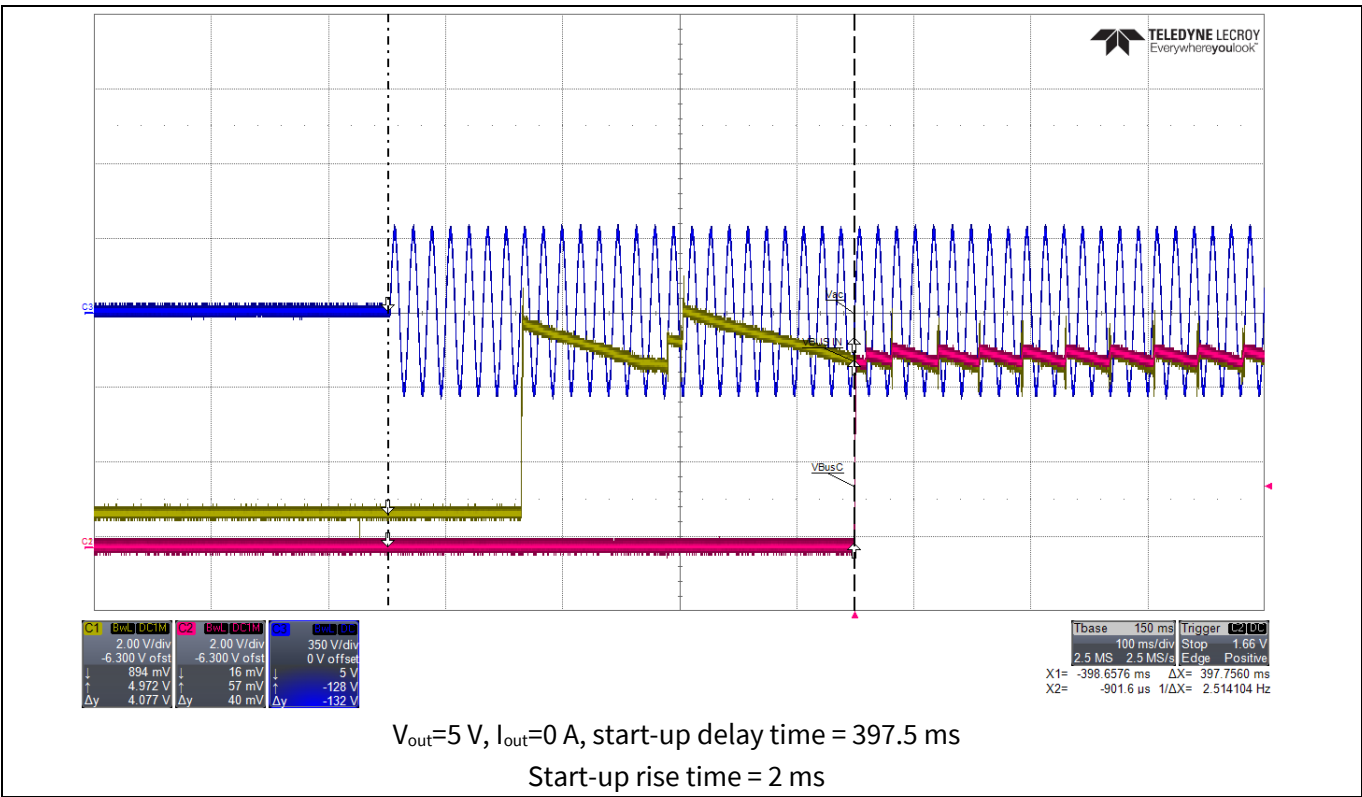


Figure 25 Start-up turn-on delay at 265 V<sub>ac</sub>, 63 Hz (CH4: V<sub>bus\_c</sub>, CH3: V<sub>in\_ac</sub>)

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## Power management test results

### 3.8 Hold-up time

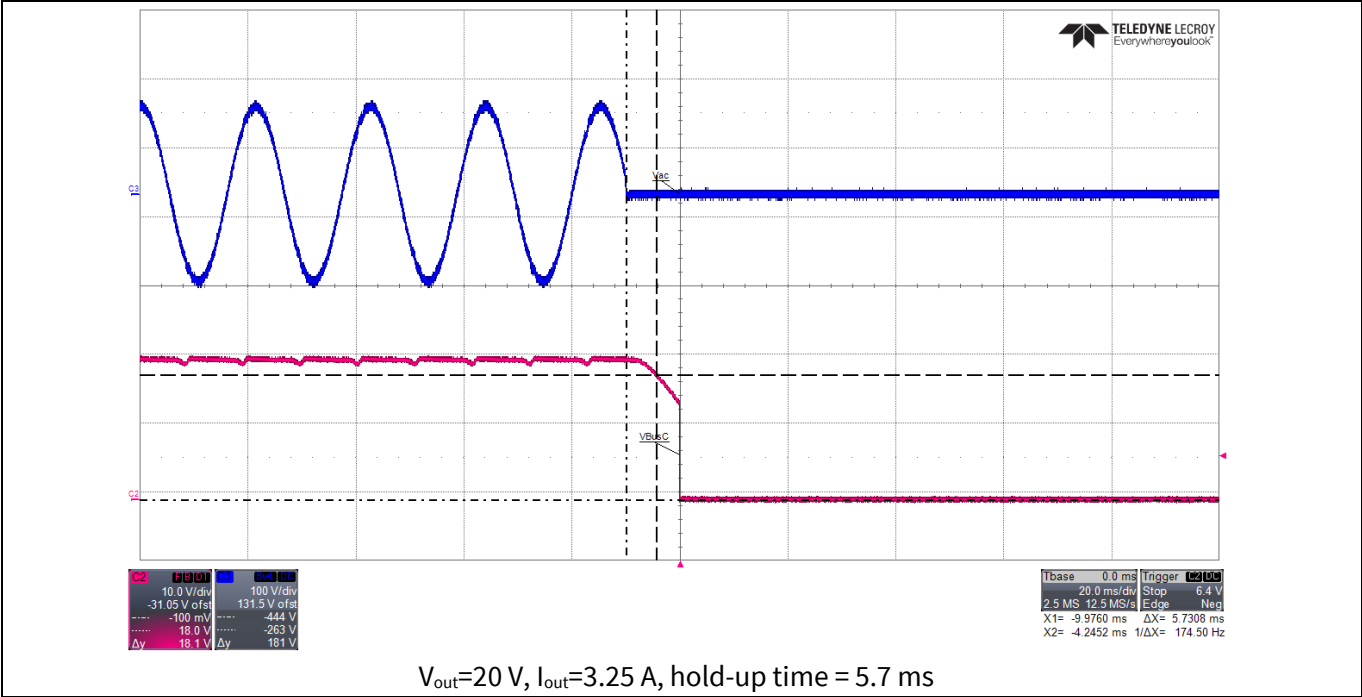
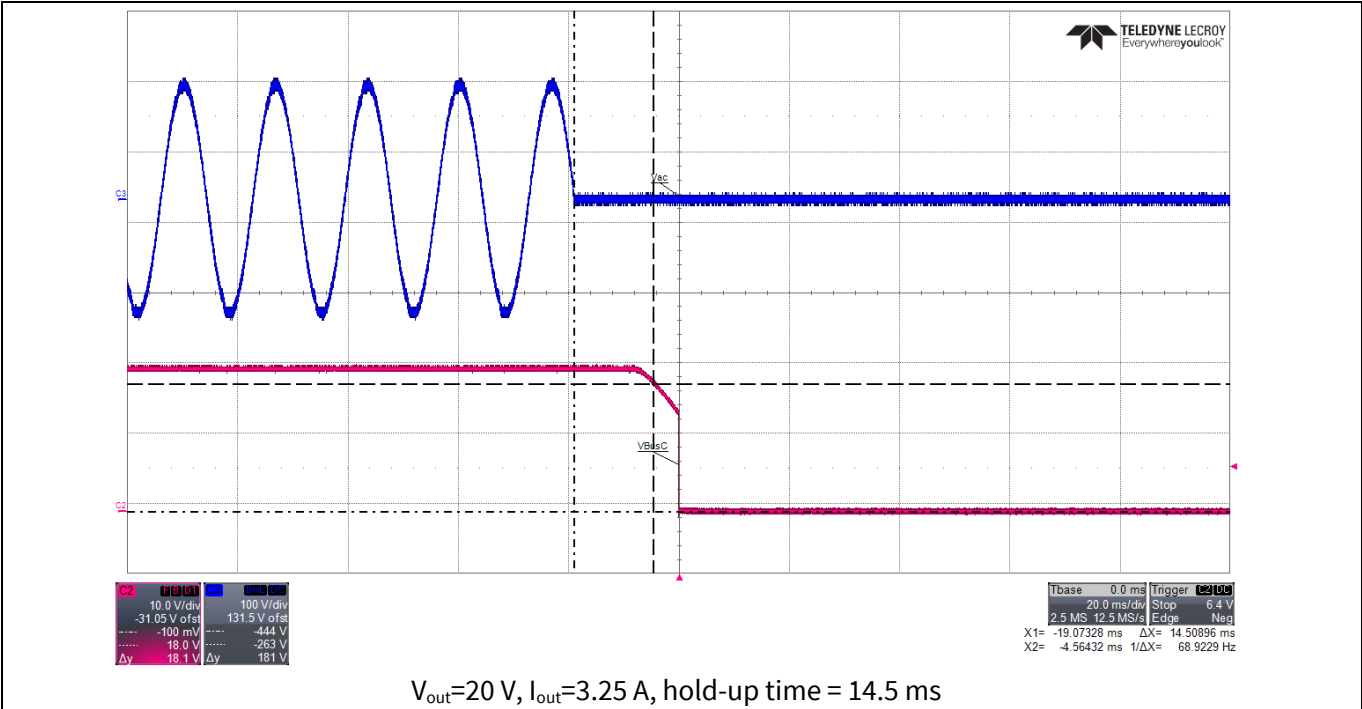


Figure 26 Hold-up time at 90  $V_{ac}$ , 47 Hz (CH2:  $V_{bus\_c}$ , CH3:  $V_{in\_ac}$ )



Hold-up time at 115  $V_{ac}$ , 60 Hz (CH2:  $V_{bus\_c}$ , CH3:  $V_{in\_ac}$ )

65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board  
test report

Power management test results

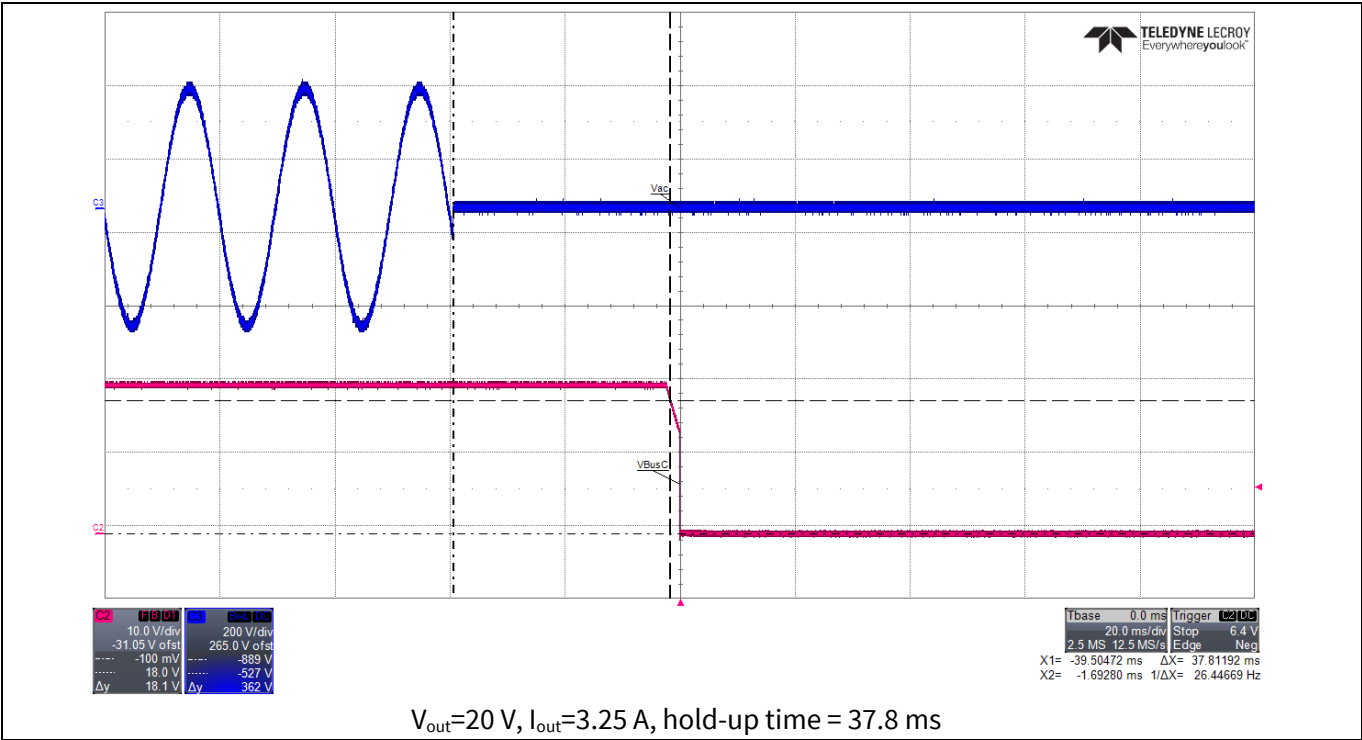


Figure 27 Hold-up time at 230 V<sub>ac</sub>, 50 Hz (CH2: V<sub>bus\_c</sub>, CH3: V<sub>in\_ac</sub>)

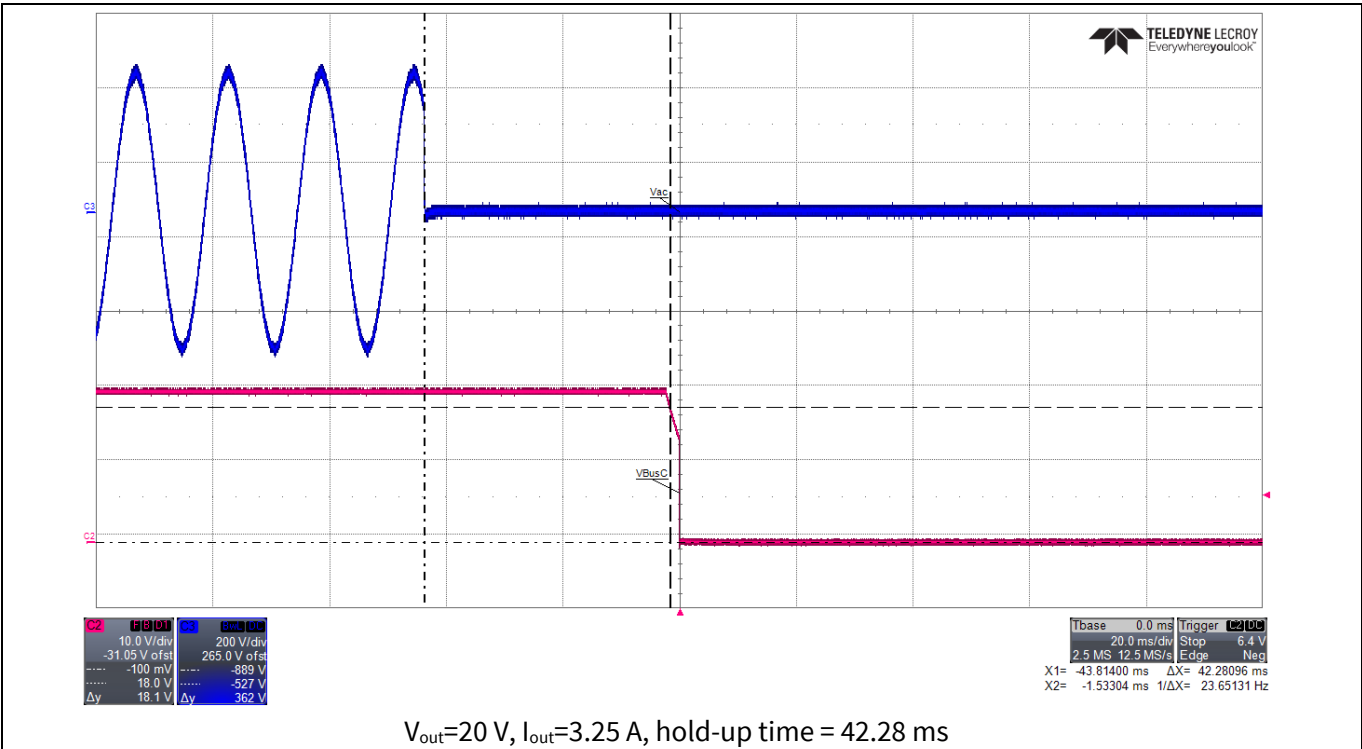


Figure 28 Hold-up time at 265 V<sub>ac</sub>, 63 Hz (CH2: V<sub>bus\_c</sub>, CH3: V<sub>in\_ac</sub>)

65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board  
test report

Power management test results

3.9 Shut-down fall time

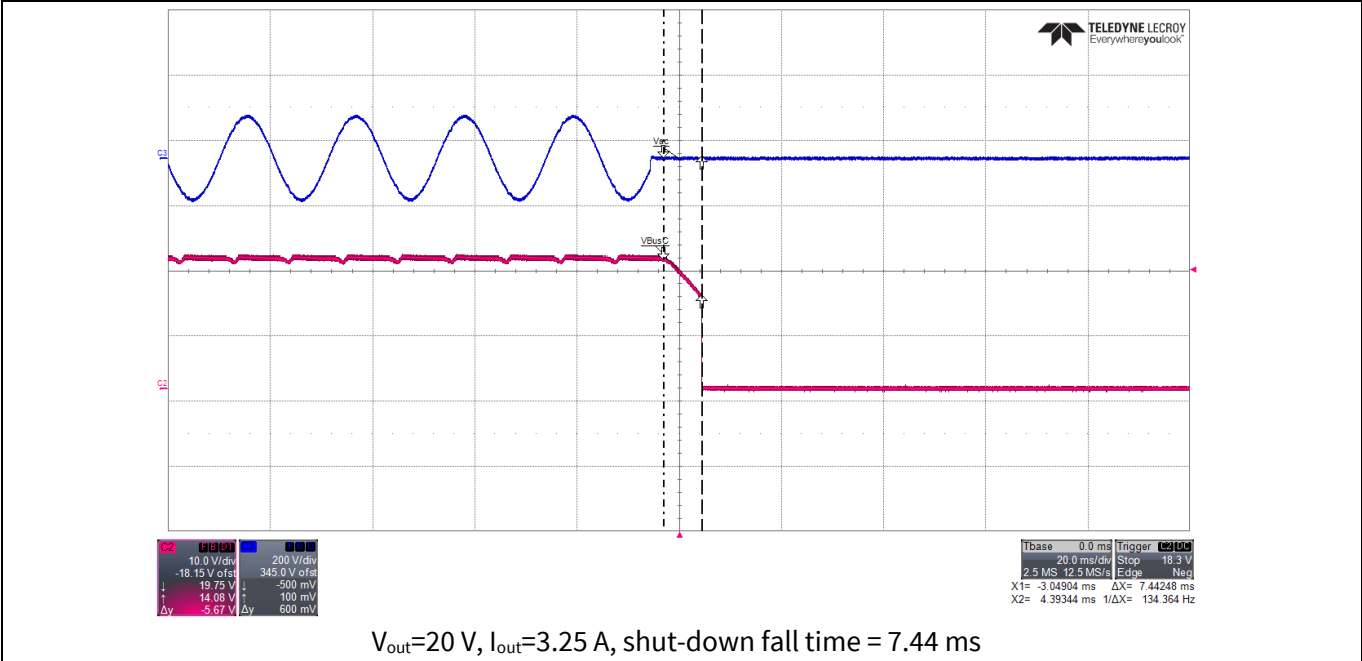


Figure 29 Shut-down fall time at 90  $V_{ac}$ , 47 Hz (CH2:  $V_{bus\_c}$ , CH3:  $V_{in\_ac}$ )

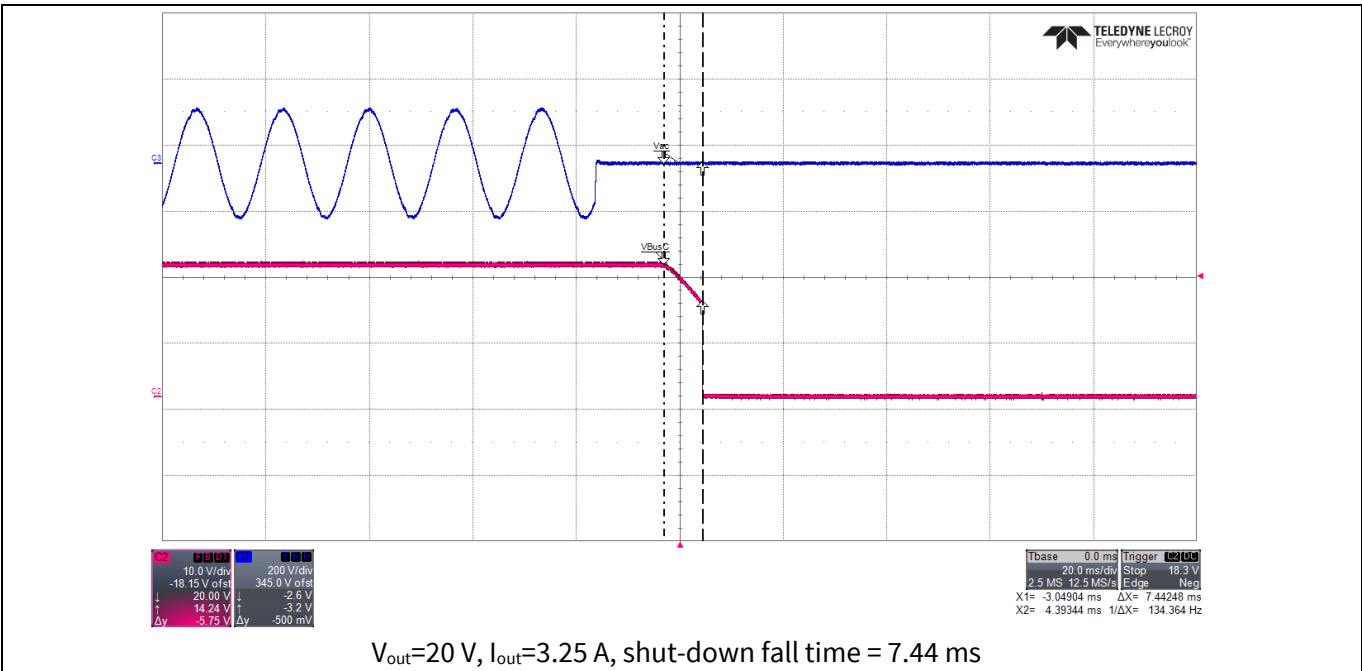


Figure 30 Shut-down fall time at 115  $V_{ac}$ , 60 Hz (CH2:  $V_{bus\_c}$ , CH3:  $V_{in\_ac}$ )

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report

## Power management test results

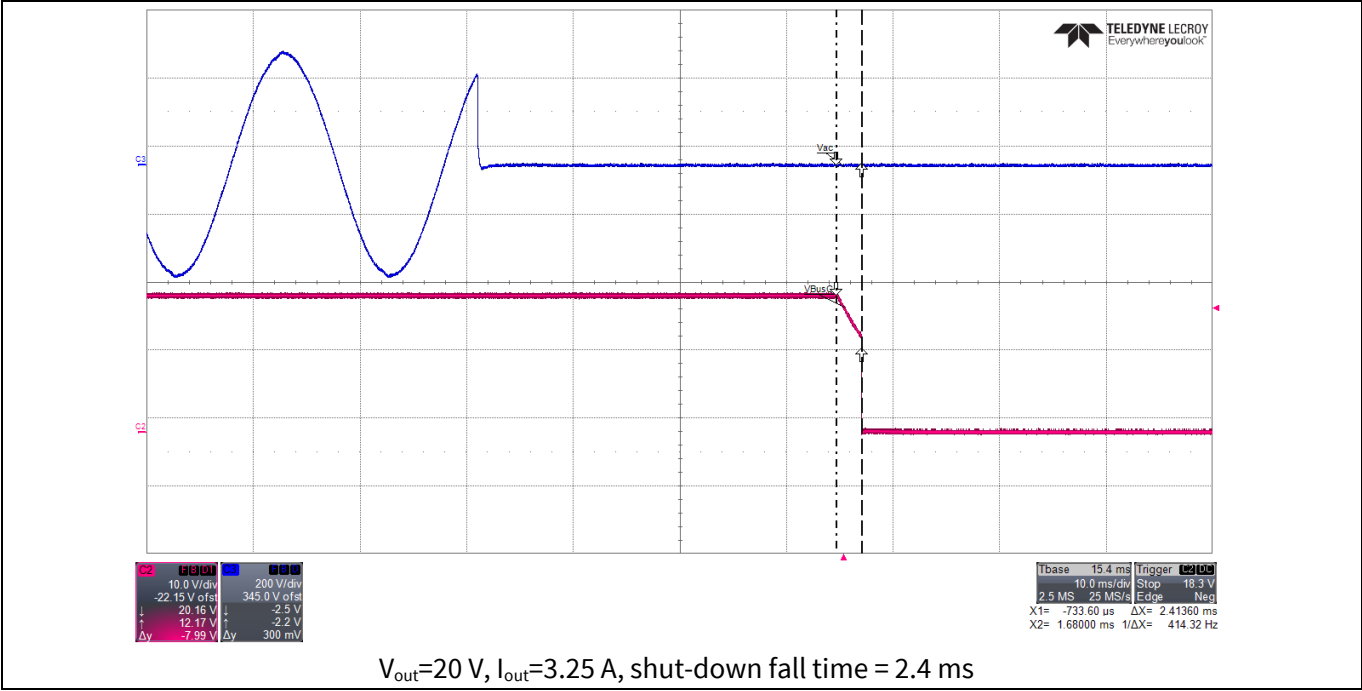


Figure 31 Shut-down fall time at 230  $V_{ac}$ , 50 Hz (CH:  $V_{bus\_c}$ , CH3:  $V_{in\_ac}$ )

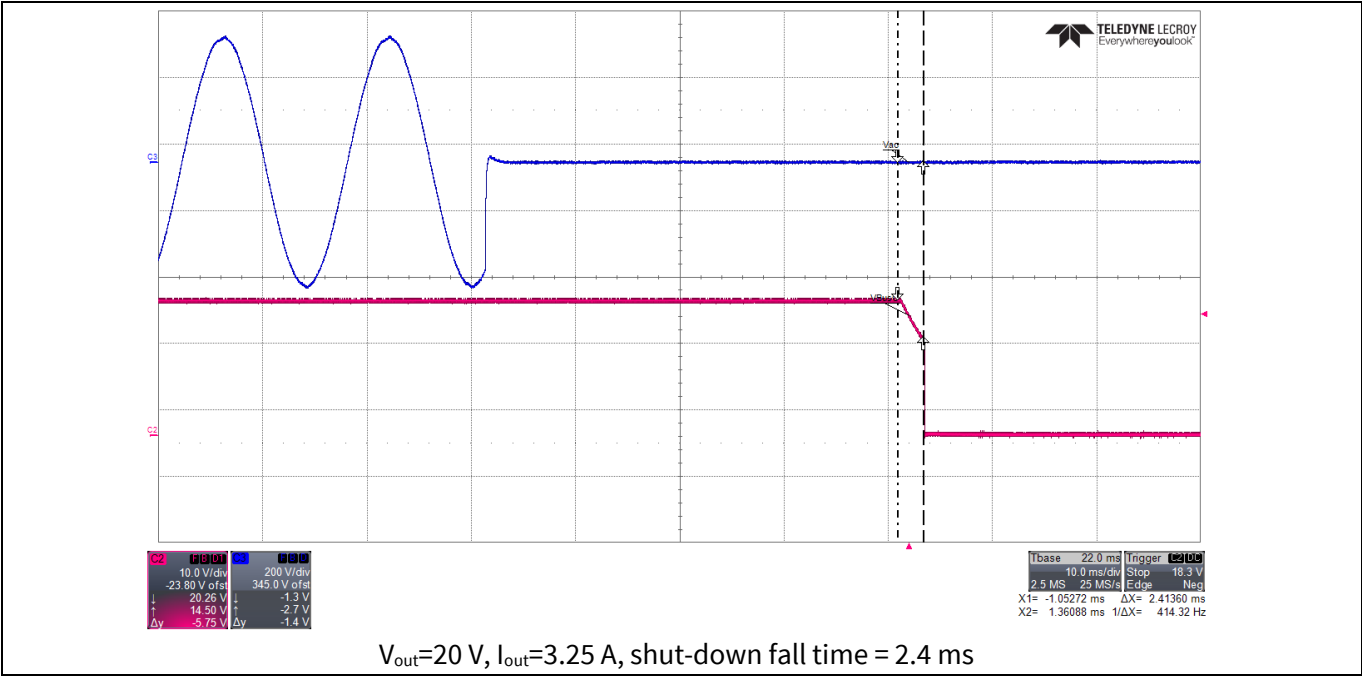


Figure 32 Shut-down fall time at 265  $V_{ac}$ , 63 Hz (CH2:  $V_{bus\_c}$ , CH3:  $V_{in\_ac}$ )

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report

## Power management test results

### 3.10 Switch voltage stress

Test Condition:  $V_{in} = 265\text{ V}_{ac}$ , 63 Hz,  $V_{out} = 20\text{ V}$ ,  $I_{out} = 3.25\text{ A}$

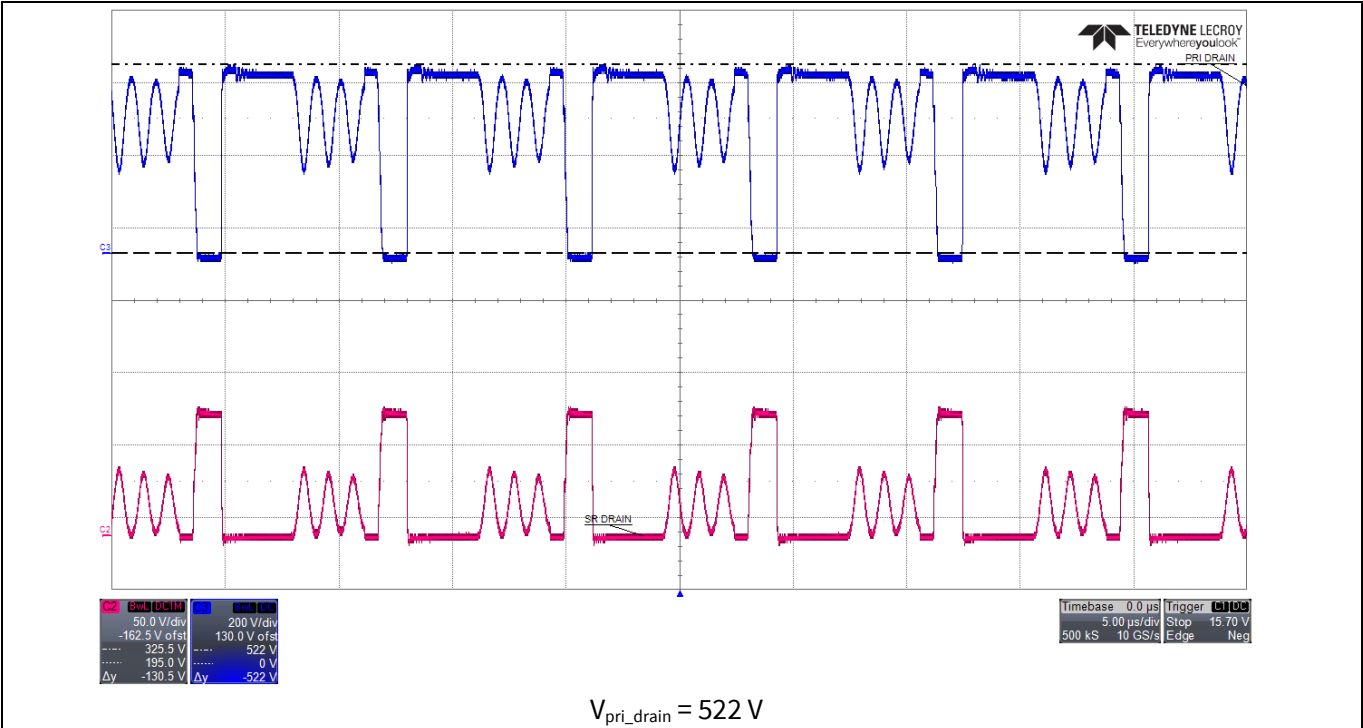


Figure 33 Switch voltage stress on primary FET (CH3:  $V_{pri\_drain}$ )

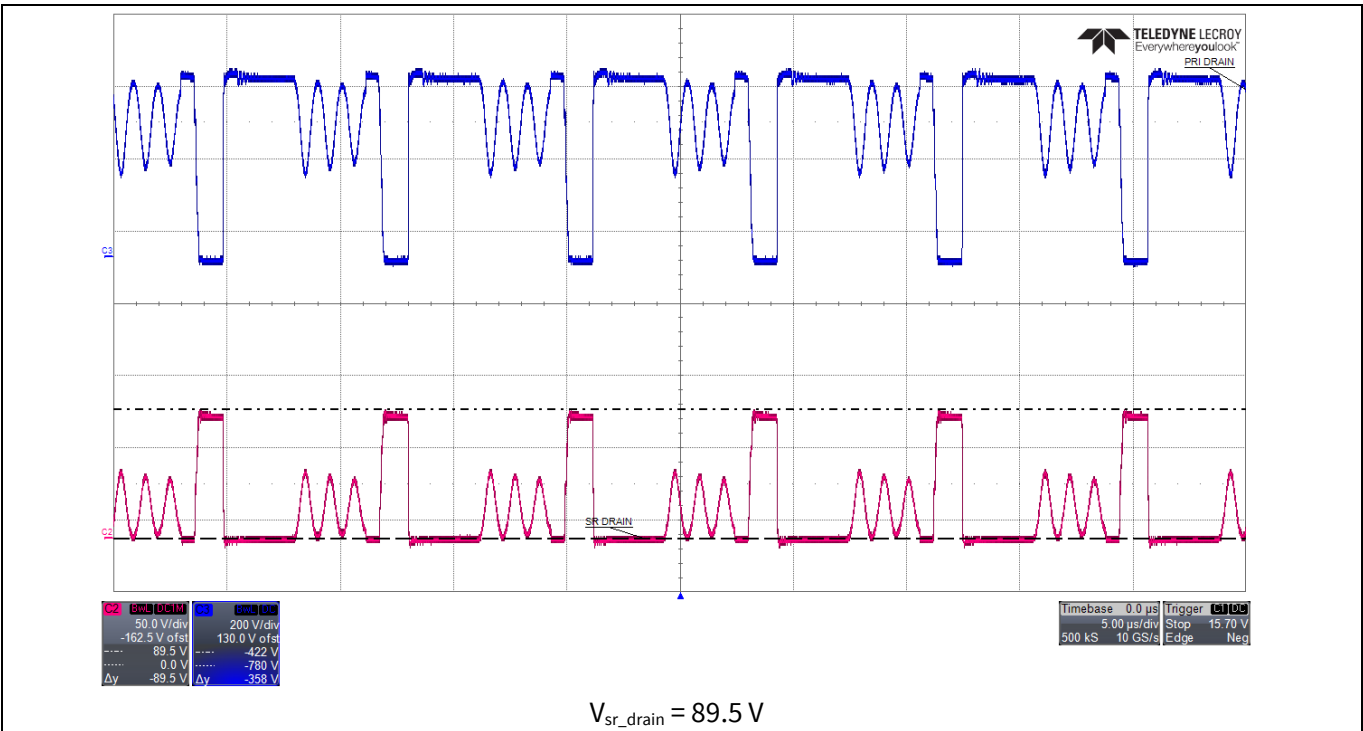


Figure 34 Switch voltage stress on secondary FET (CH2:  $V_{sr\_drain}$ )

65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board  
test report

Power management test results

Test Condition:  $V_{in} = 265\text{ V}_{ac}$ , 63 Hz,  $V_{out} = 20\text{ V}$ , no-load

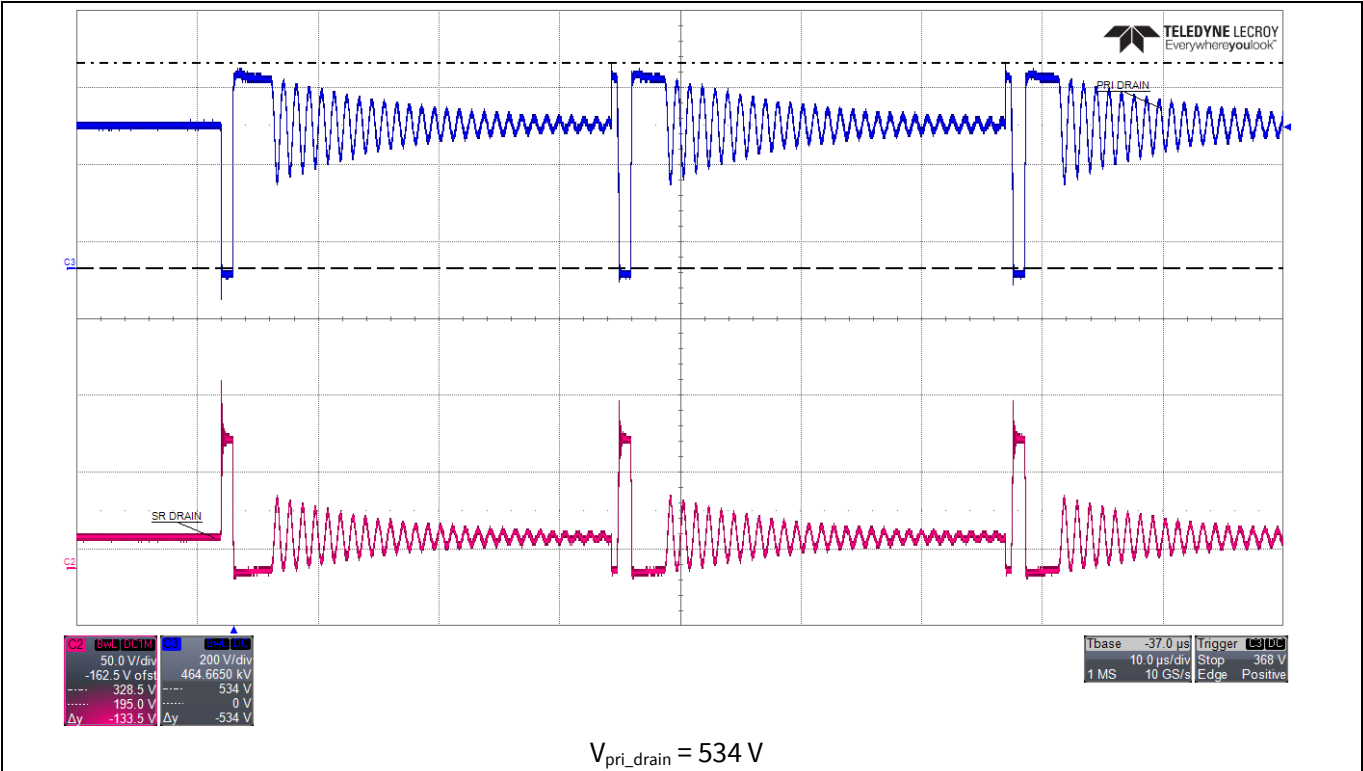


Figure 35 Switch voltage stress on primary FET (CH3:  $V_{pri\_drain}$ )

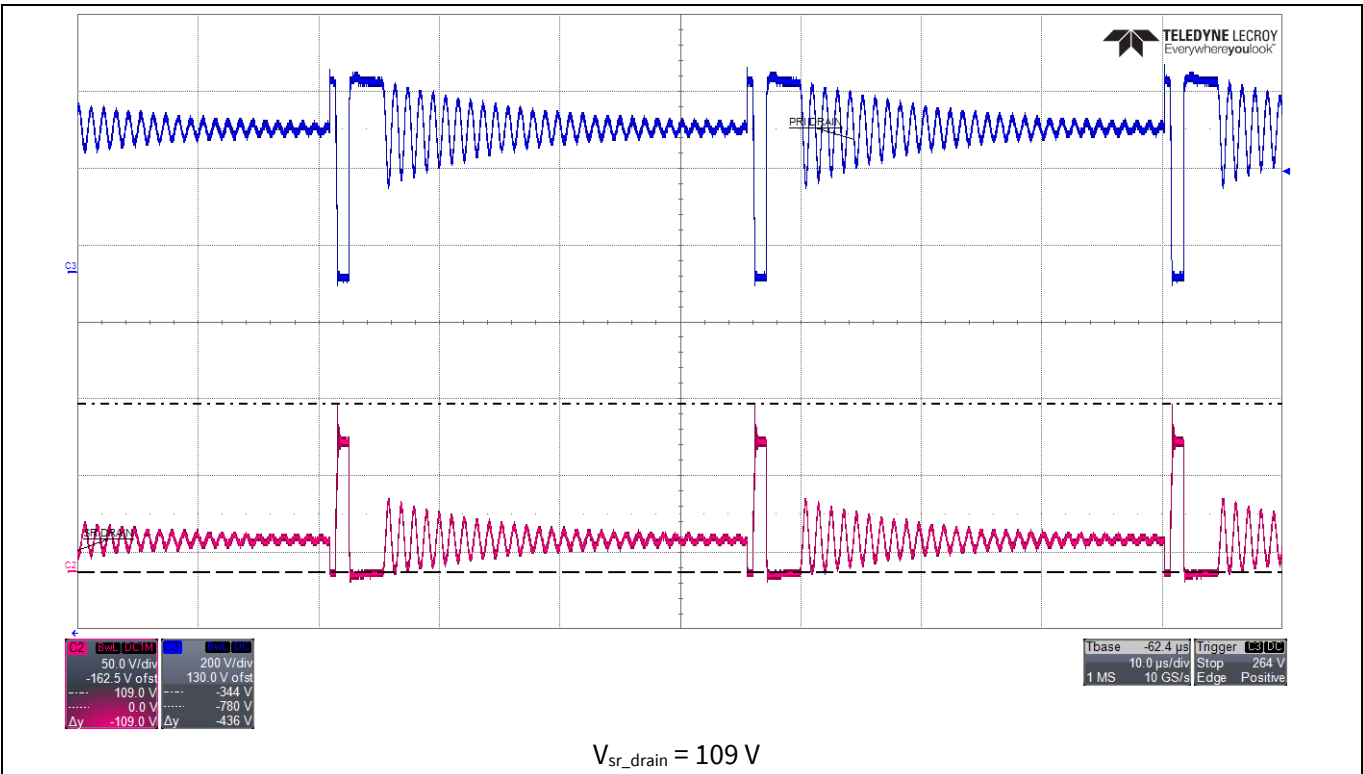


Figure 36 Switch voltage stress on secondary FET (CH2:  $V_{sr\_drain}$ )

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results

### 3.11 Over voltage protection (OVP)

OVP tested at 115 V<sub>ac</sub> 60 Hz

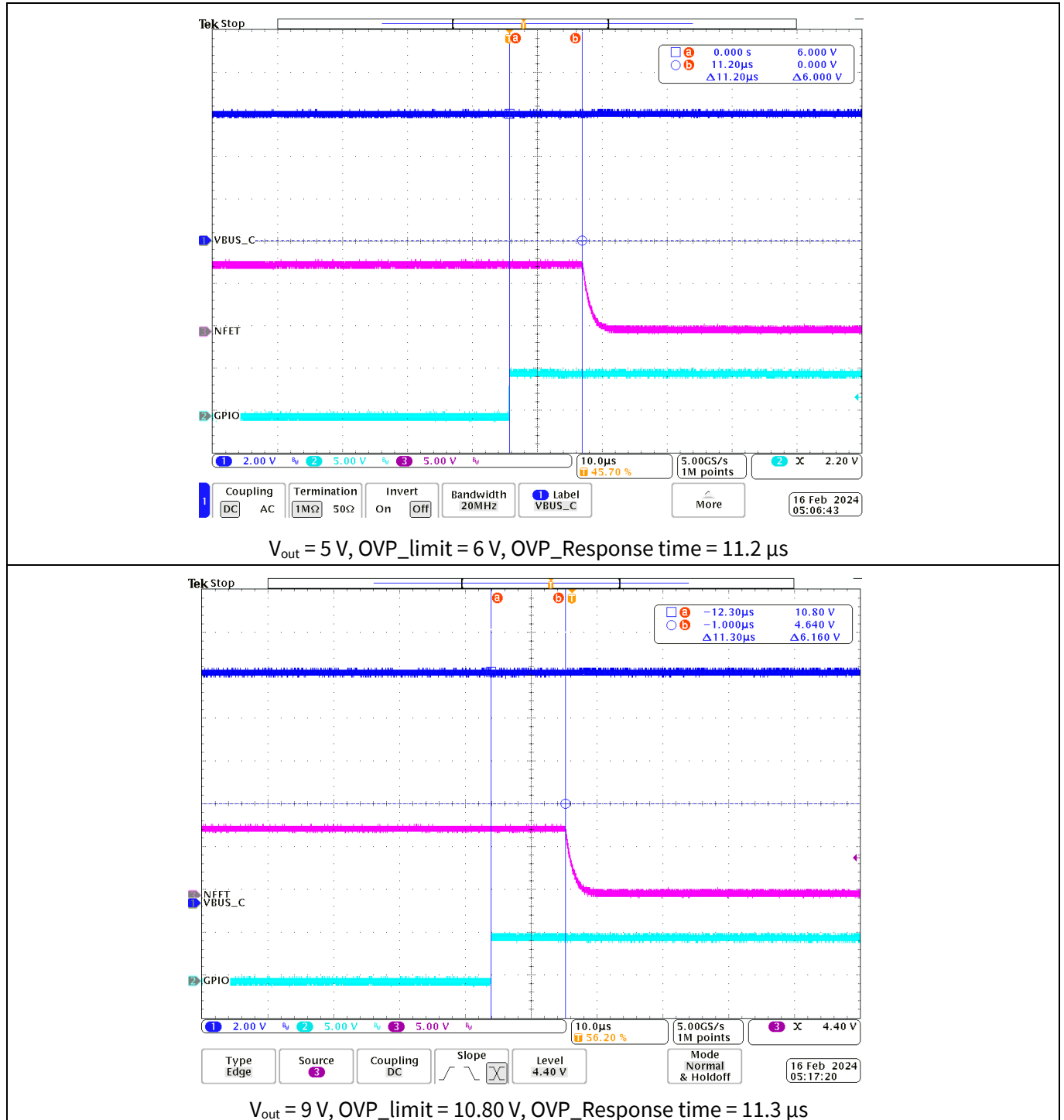


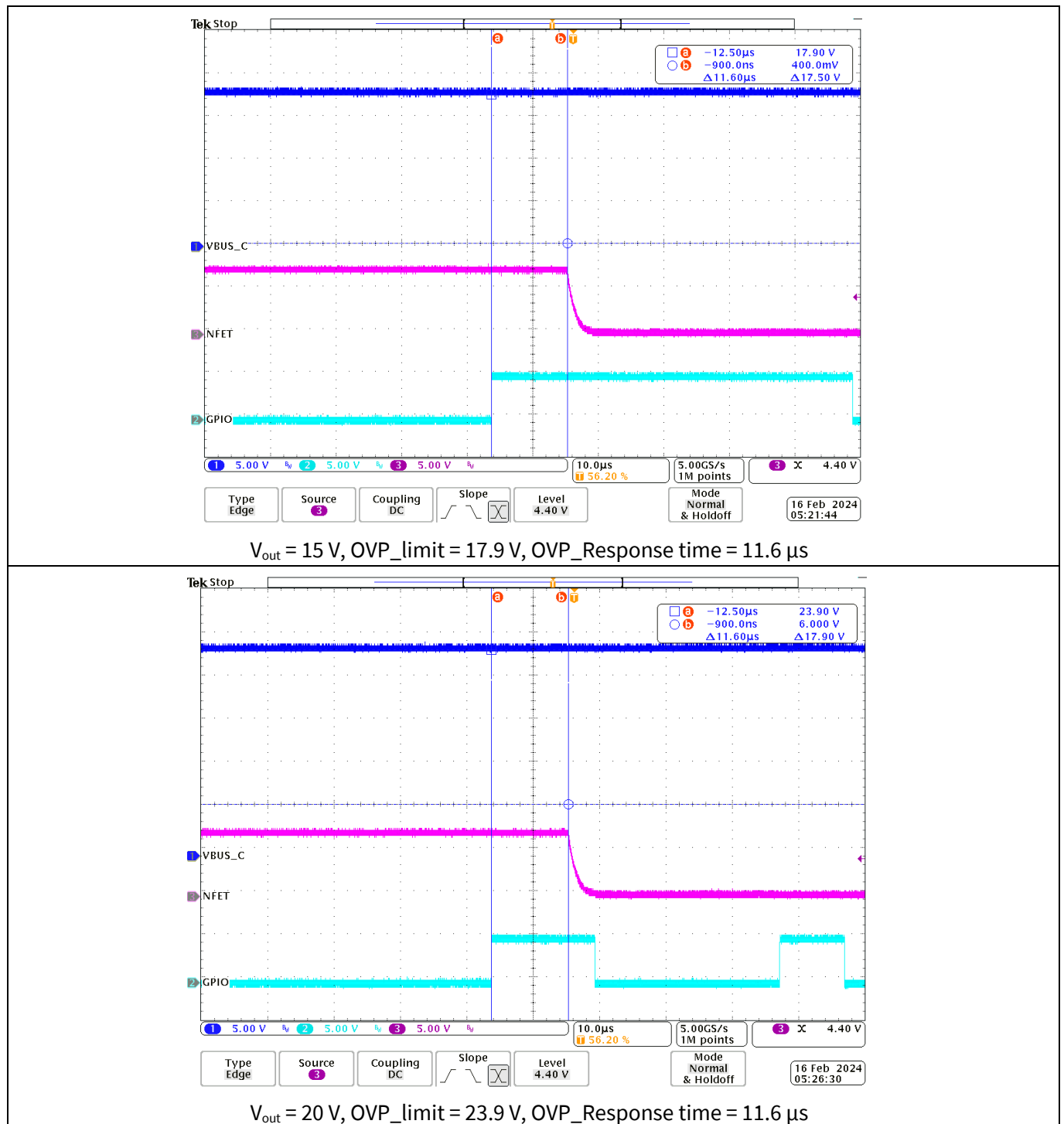
Figure 37 OVP at 115 V<sub>ac</sub>, 60 Hz (CH3: NFET<sup>4</sup>; CH2: GPIO9; CH1: V<sub>bus\_c</sub>) (1 of 2)

<sup>4</sup> NFET - Provider FET(Q2) Gate to source waveform.

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results



**Figure 38 OVP at 115 Vac, 60 Hz (CH3: NFET<sup>5</sup>; CH2: GPIO9; CH1: Vbus\_C) (2 of 2)**

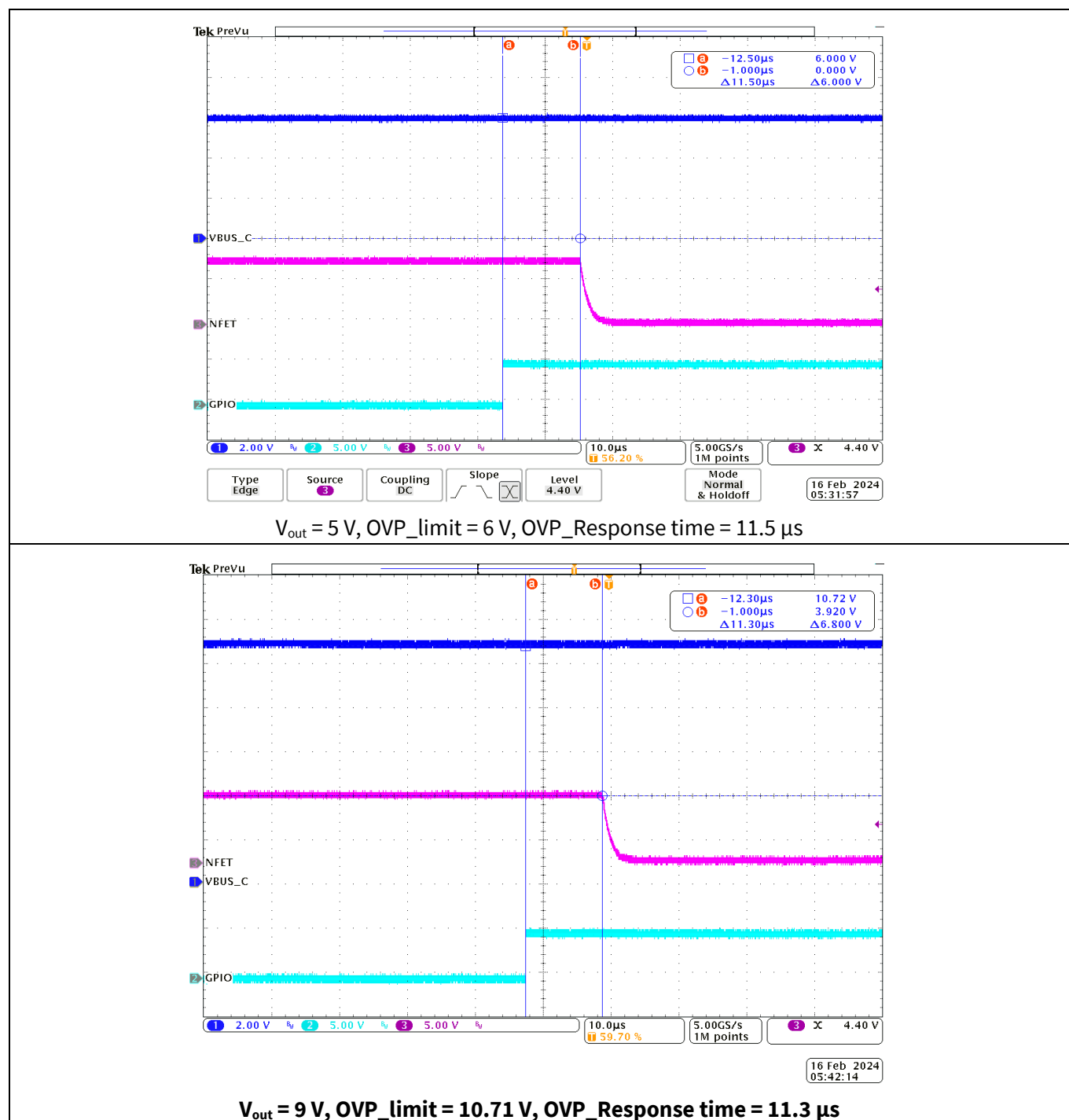
## OVP Tested at 230 Vac 50 Hz

<sup>5</sup> NFET - Provider FET(Q2) Gate to source waveform.

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results



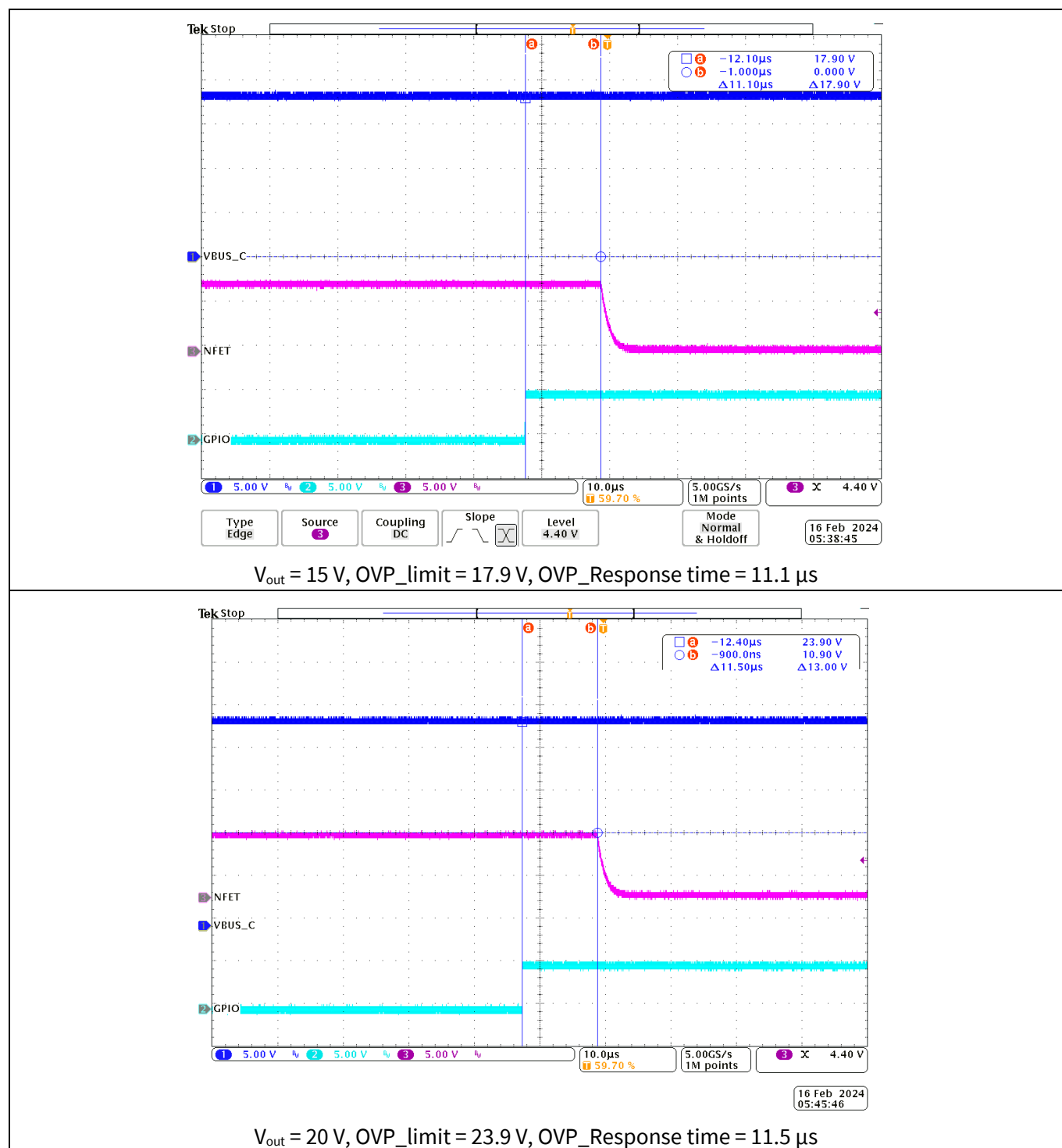
**Figure 39 OVP at 230 V<sub>ac</sub>, 50 Hz (CH3: NFET<sup>6</sup>; CH2: GPIO9; CH1: V<sub>bus\_c</sub>) (1 of 2)**

<sup>6</sup> NFET - Provider FET(Q2) Gate to source waveform.

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results



**Figure 40 OVP at 230 Vac, 50 Hz (CH3: NFET<sup>7</sup> ; CH2: GPIO9; CH1: Vbus\_C) (2 of 2)**

<sup>7</sup> NFET - Provider FET(Q2) Gate to source waveform.

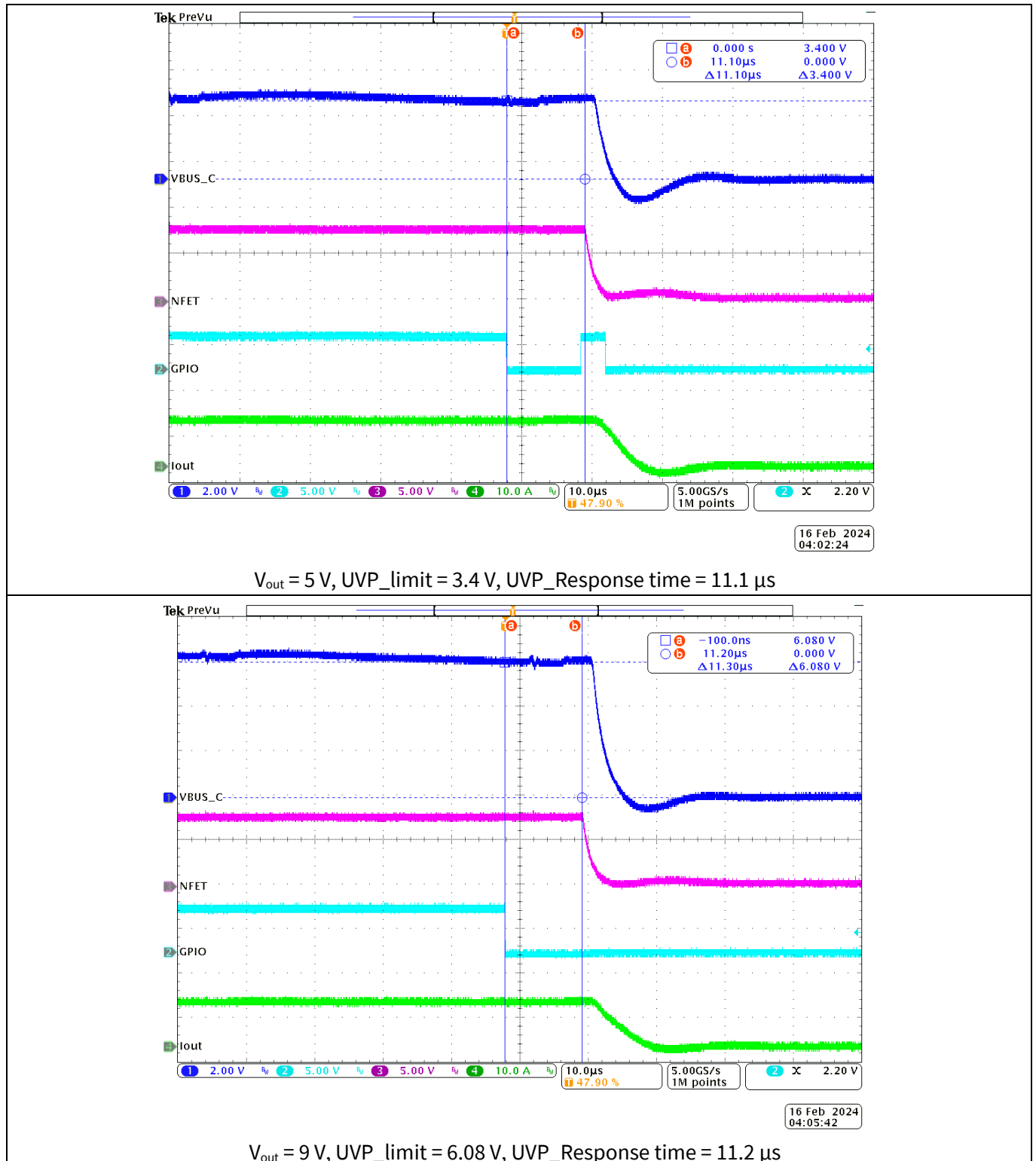
# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results

### 3.12 Under Voltage Protection (UVP)

UVP tested at 115 V<sub>ac</sub> 60 Hz



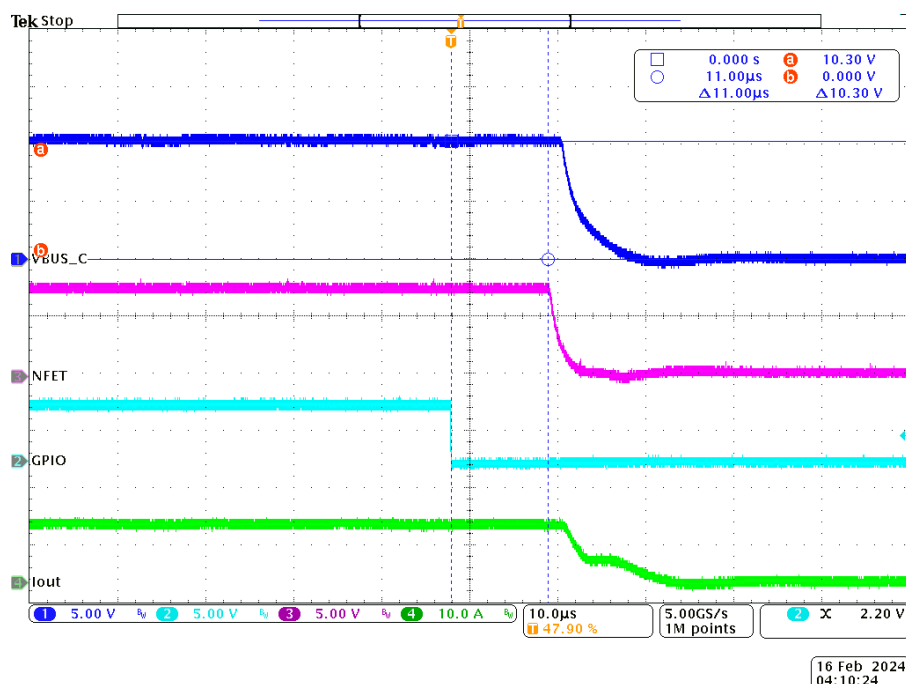
**Figure 41 UVP at 115 V<sub>ac</sub>, 60 Hz (CH3: NFET<sup>8</sup>; CH3: GPIO9; CH1: V<sub>bus\_c</sub>; CH4: I<sub>out</sub>) (1 of 2)**

<sup>8</sup> NFET - Provider FET(Q2) Gate to source waveform.

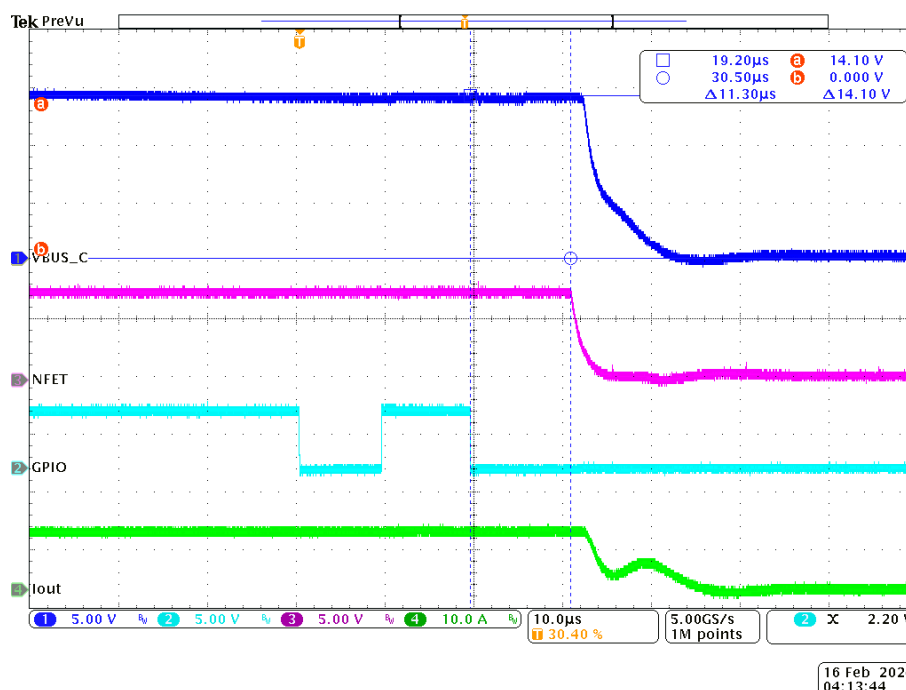
# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results



$V_{out} = 15 \text{ V}$ ,  $UVP\_limit = 10.3 \text{ V}$ ,  $UVP\_Response \text{ time} = 11 \mu\text{s}$



$V_{out} = 20 \text{ V}$ ,  $UVP\_limit = 14.1 \text{ V}$ ,  $UVP\_Response \text{ time} = 11.3 \mu\text{s}$

**Figure 42** UVP at 115 Vac, 60 Hz (CH3: NFET<sup>9</sup>; CH3: GPIO9; CH1: Vbus\_C; CH4: Iout) (2 of 2)

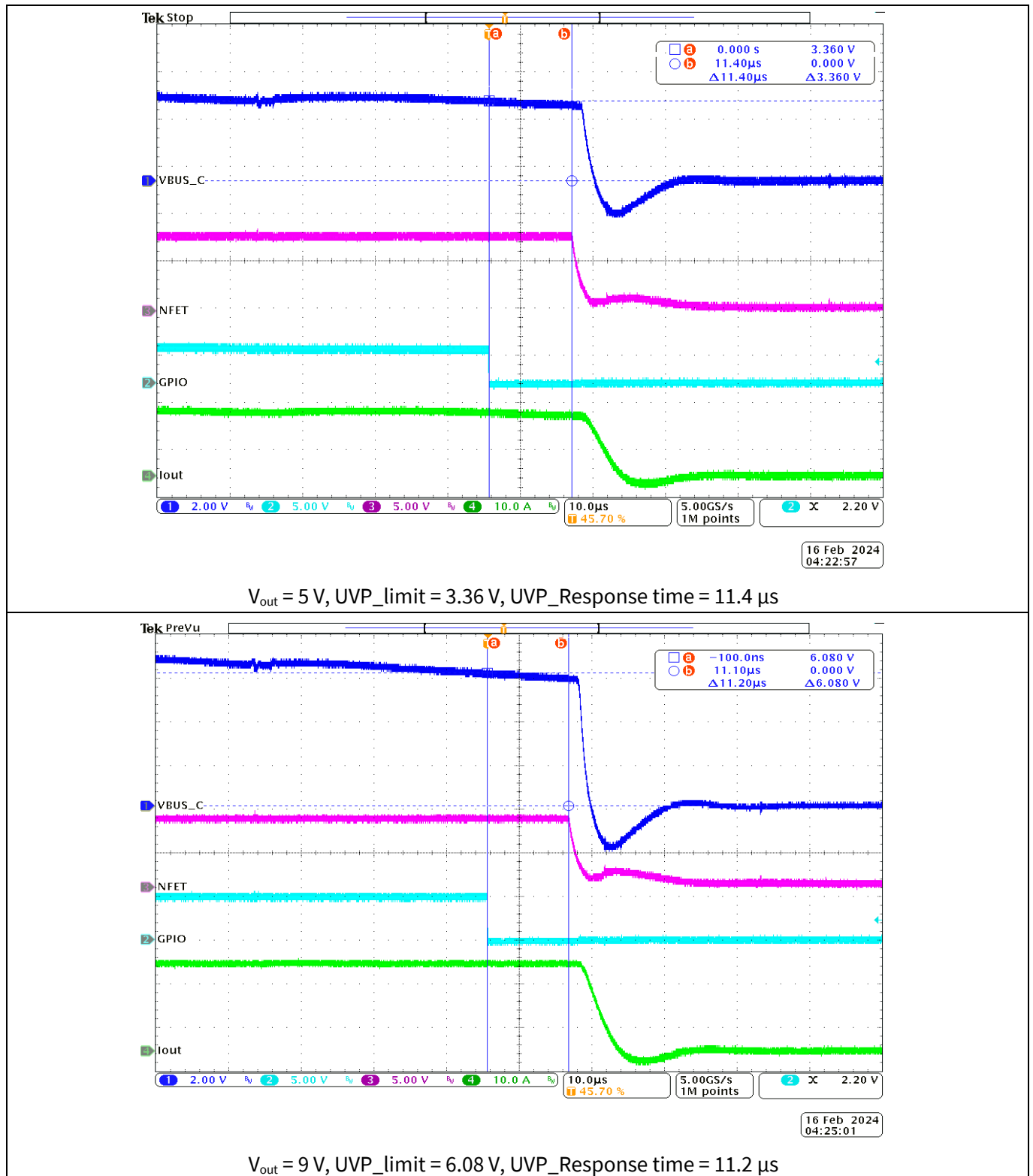
<sup>9</sup> NFET - Provider FET(Q2) Gate to source waveform.

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results

UVP Tested at 230 V<sub>ac</sub> 50 Hz

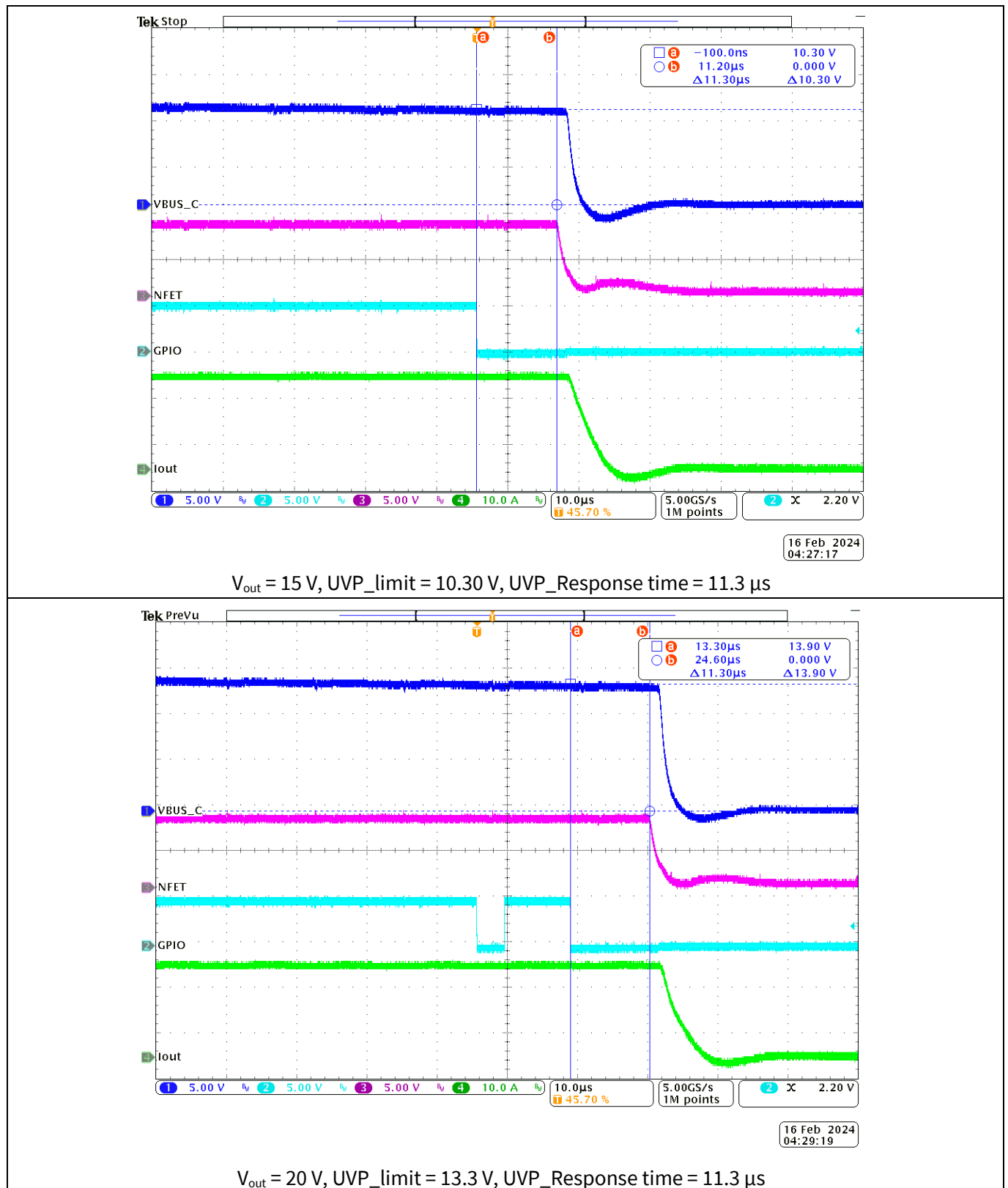


<sup>10</sup> NFET - Provider FET(Q2) Gate to source waveform.

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results



**Figure 44** UVP at 230 Vac, 50 Hz (CH3: NFET<sup>11</sup> ; CH3: GPIO9; CH1: Vbus\_C; CH4: Iout) (2 of 2)

<sup>11</sup> NFET - Provider FET(Q2) Gate to source waveform.

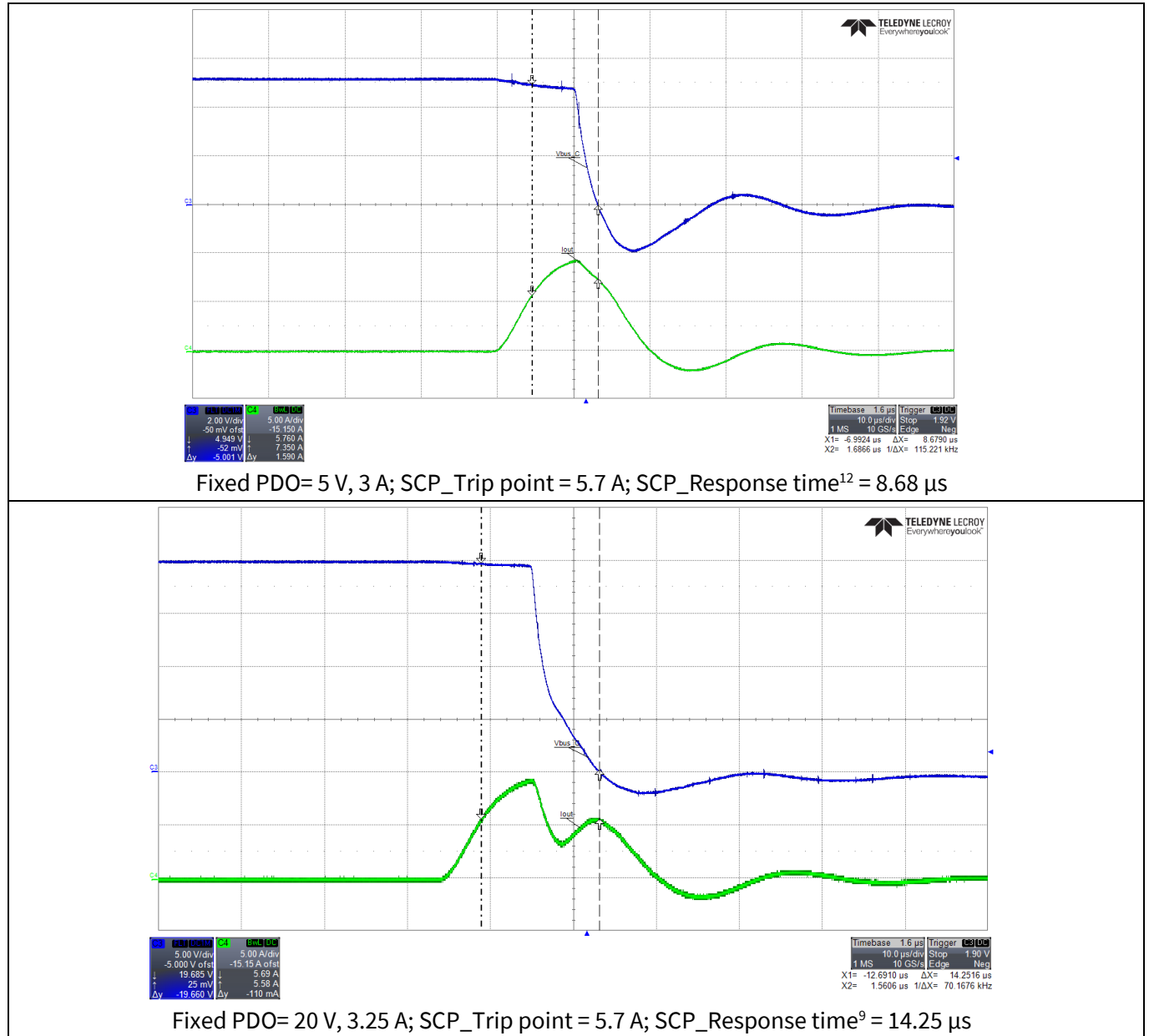
# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results

### 3.13 Short-circuit protection (SCP)

SCP tested at 115 V<sub>ac</sub> 60 Hz



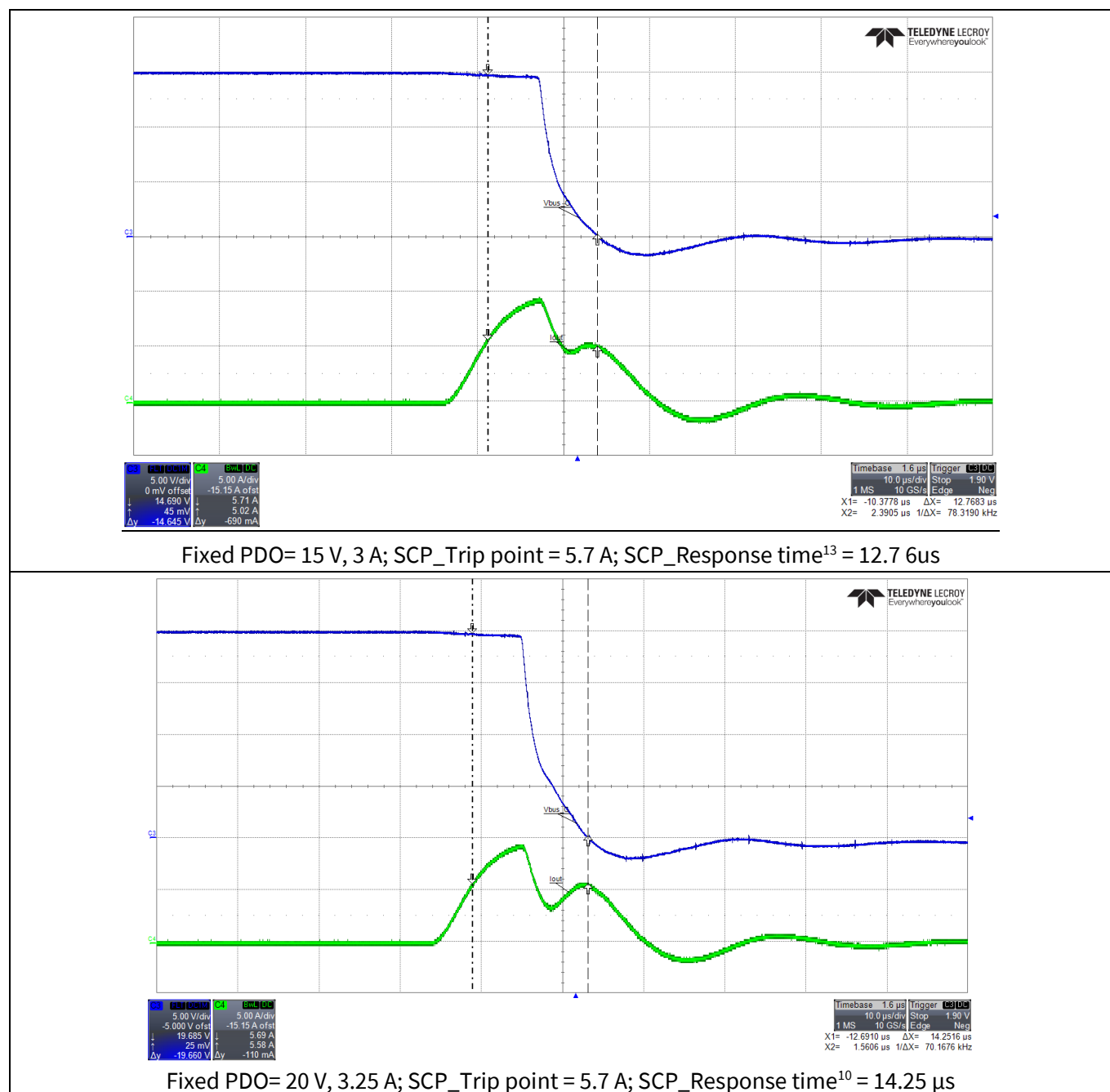
**Figure 45** SCP at 115 V<sub>ac</sub>, 60 Hz (CH3: V<sub>bus\_c</sub>; CH4: I<sub>out</sub>) (1 of 2)

<sup>12</sup> Due to the RC filter at the current sense resistor, the SCP response time is more.

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results



**Figure 46** SCP at 115 V<sub>ac</sub>, 60 Hz (CH3: V<sub>bus\_c</sub>; CH4: I<sub>out</sub>) (2 of 2)

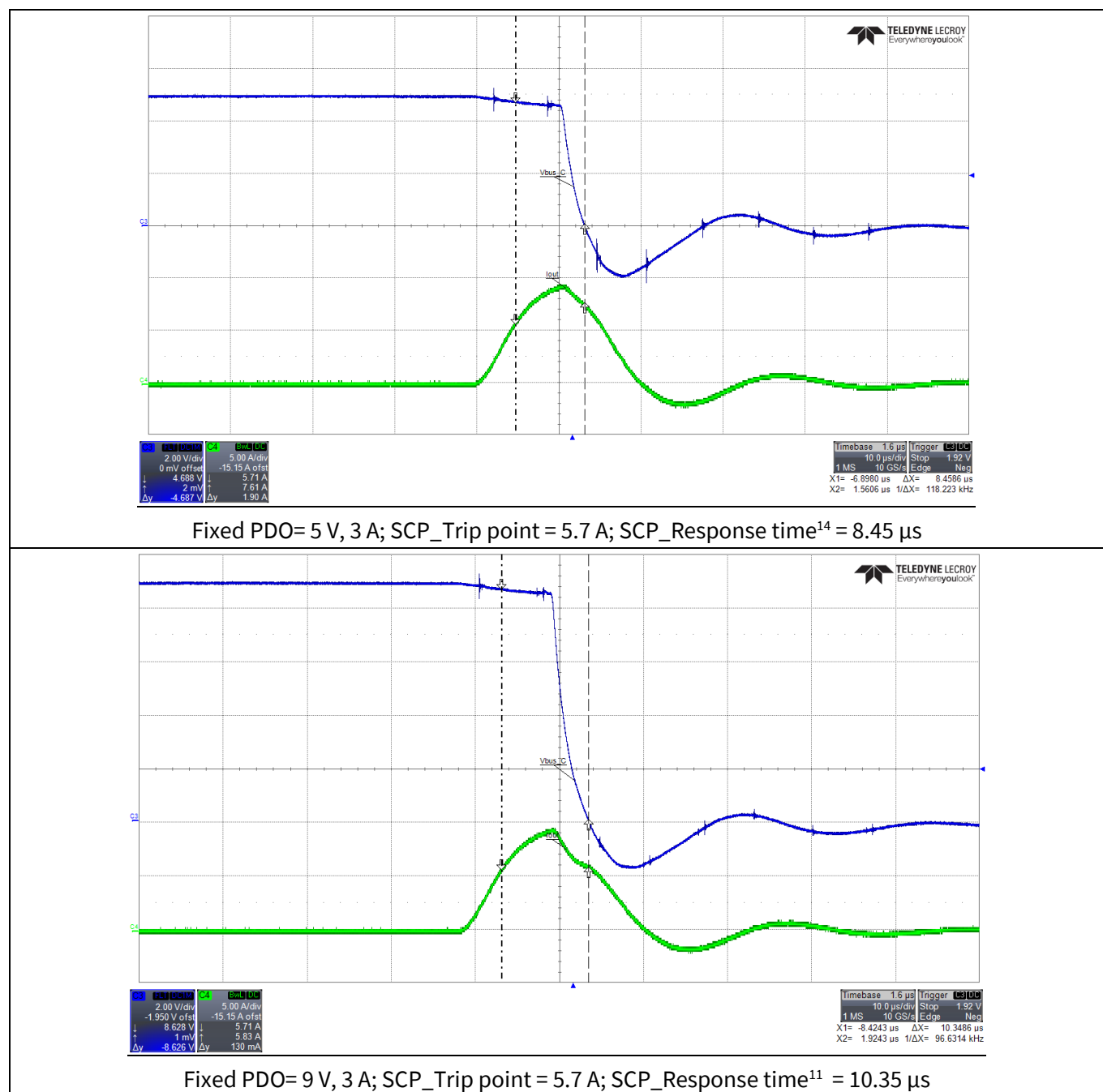
<sup>13</sup> Due to the RC filter at the current sense resistor, the SCP response time is more.

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results

SCP Tested at 230 V<sub>ac</sub> 50 Hz



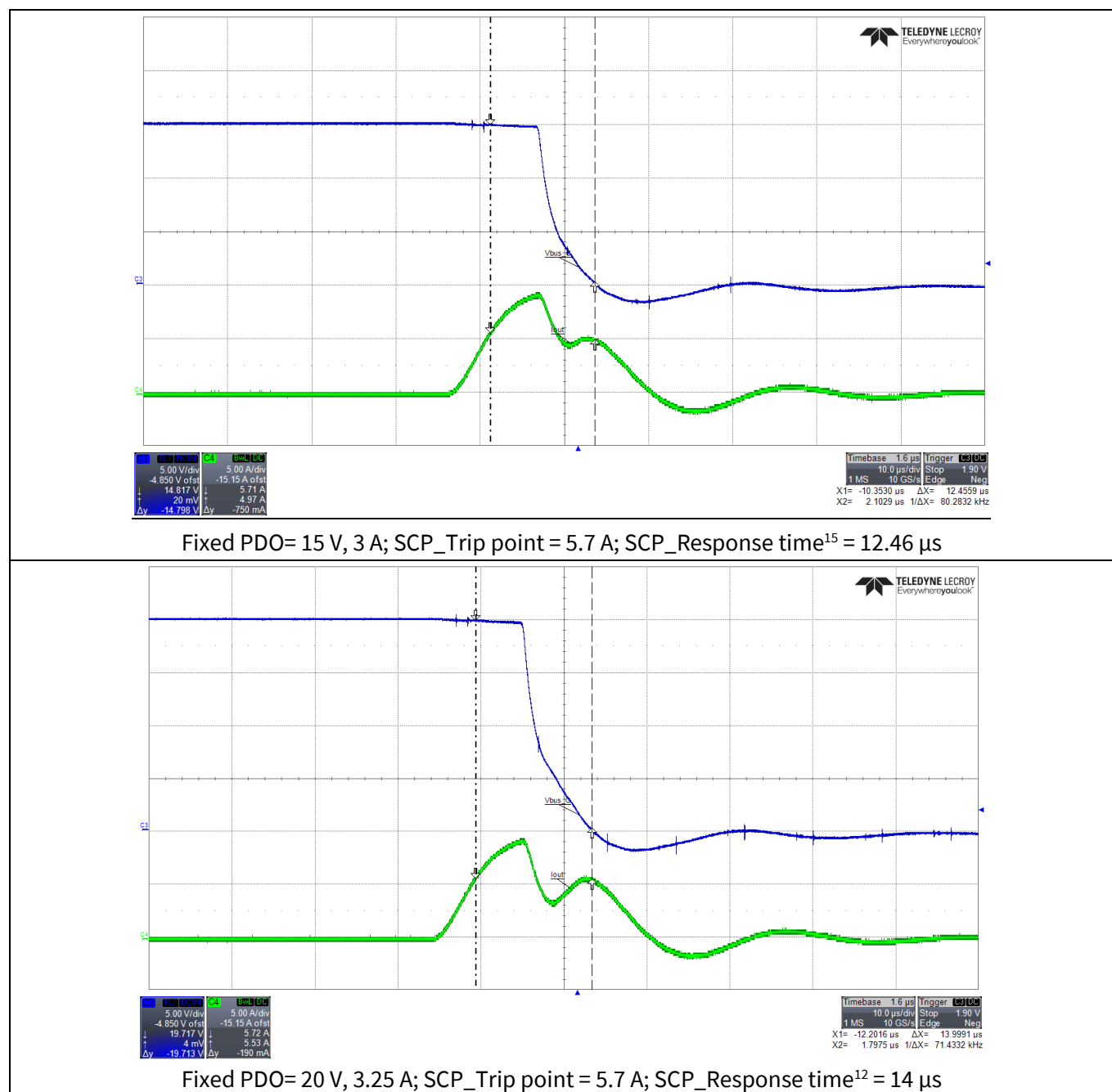
**Figure 47** SCP at 230 V<sub>ac</sub>, 50 Hz (CH3: V<sub>bus\_c</sub>; CH4: I<sub>out</sub>) (1 of 2)

<sup>14</sup> Due to the RC filter at the current sense resistor, the SCP response time is more.

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results



**Figure 48** SCP at 230 V<sub>ac</sub>, 50 Hz (CH3: Vbus\_c; CH4: Iout) (2 of 2)

<sup>15</sup> Due to the RC filter at the current sense resistor, the SCP response time is more.

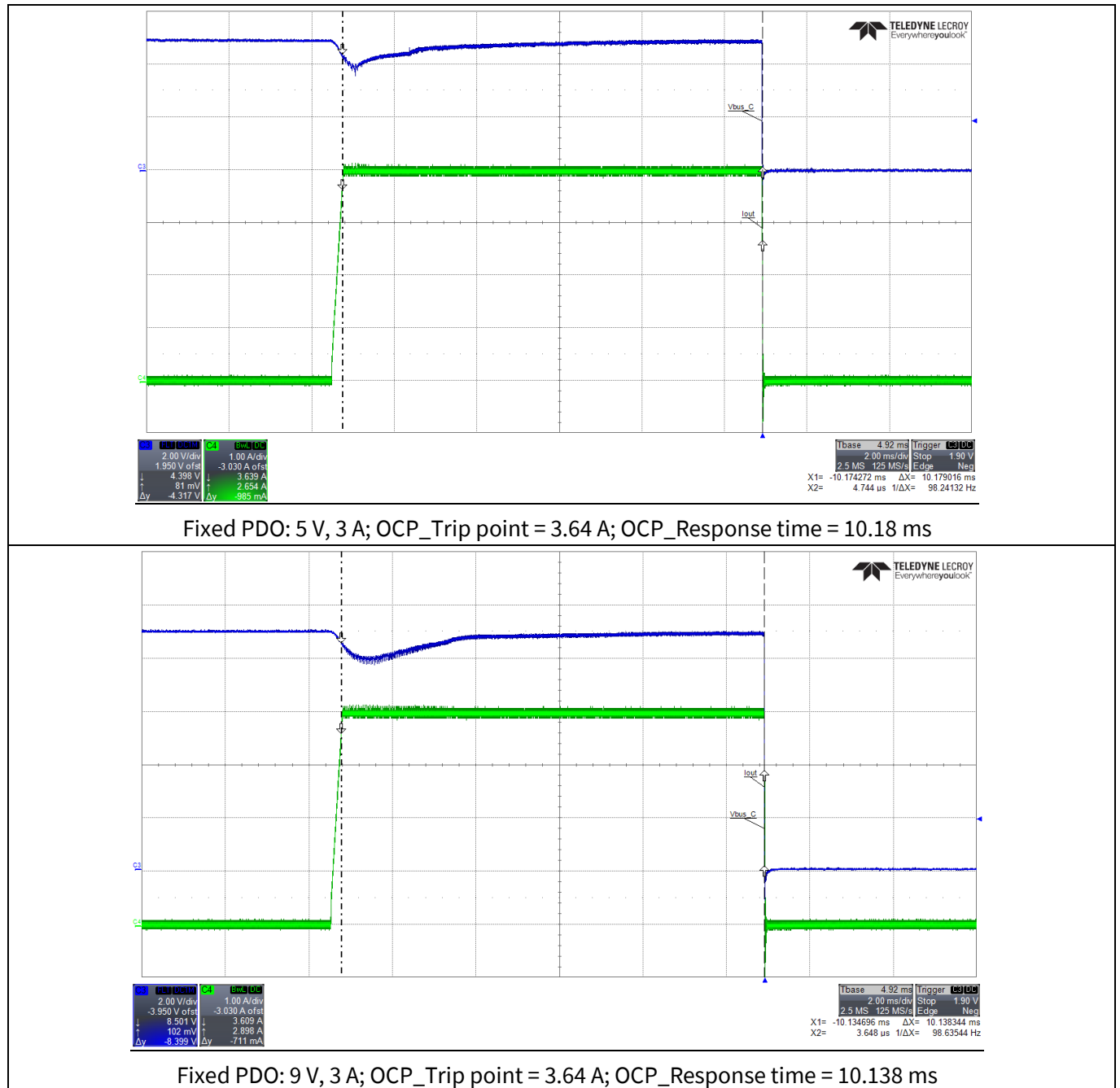
# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results

### 3.14 Over current protection (OCP)

OCP tested at 115 V<sub>ac</sub> 60 Hz

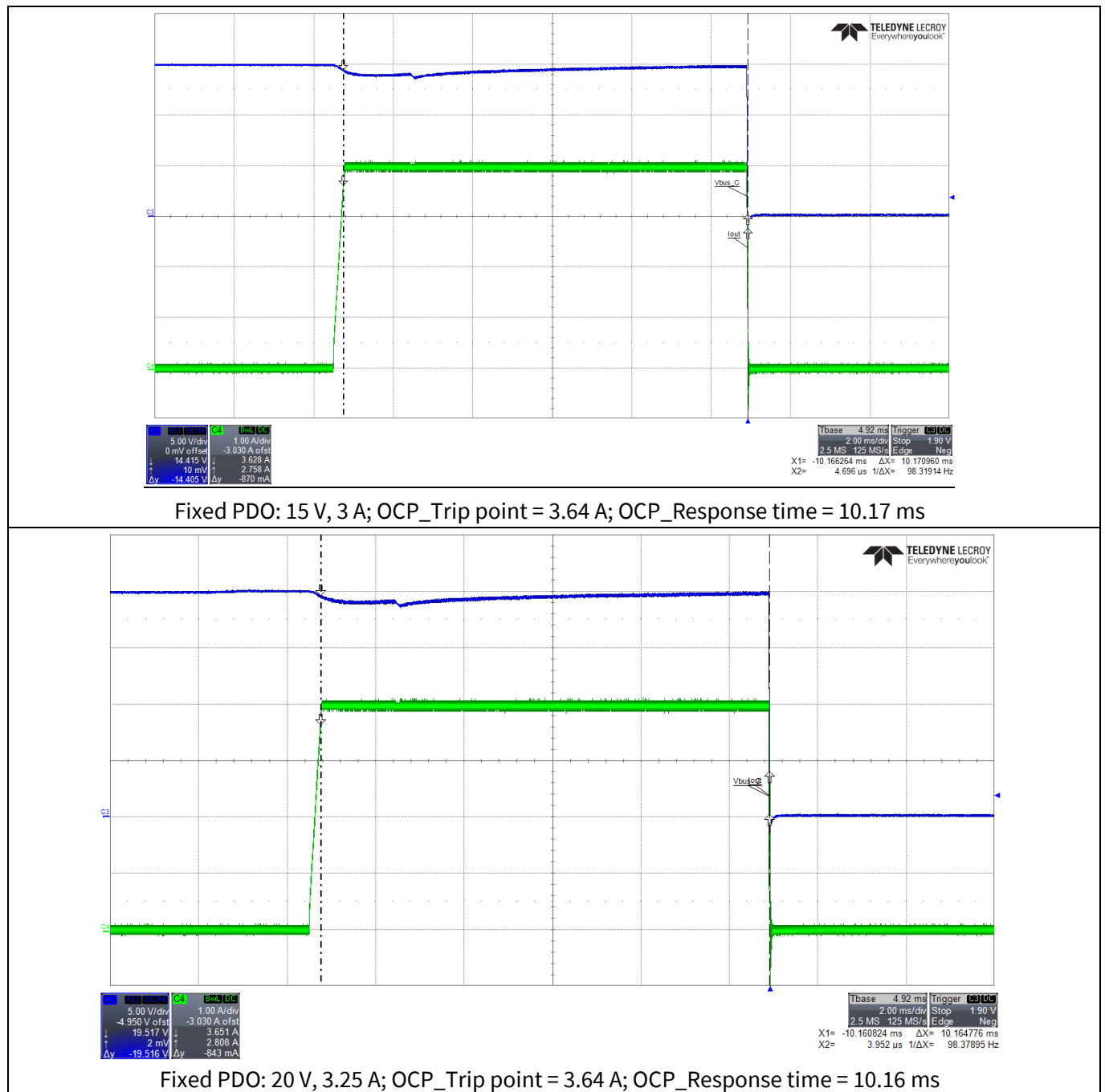


**Figure 49** OCP at 115 V<sub>ac</sub>, 60 Hz (CH3: V<sub>bus\_c</sub>; CH4: I<sub>out</sub>) (1 of 2)

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results

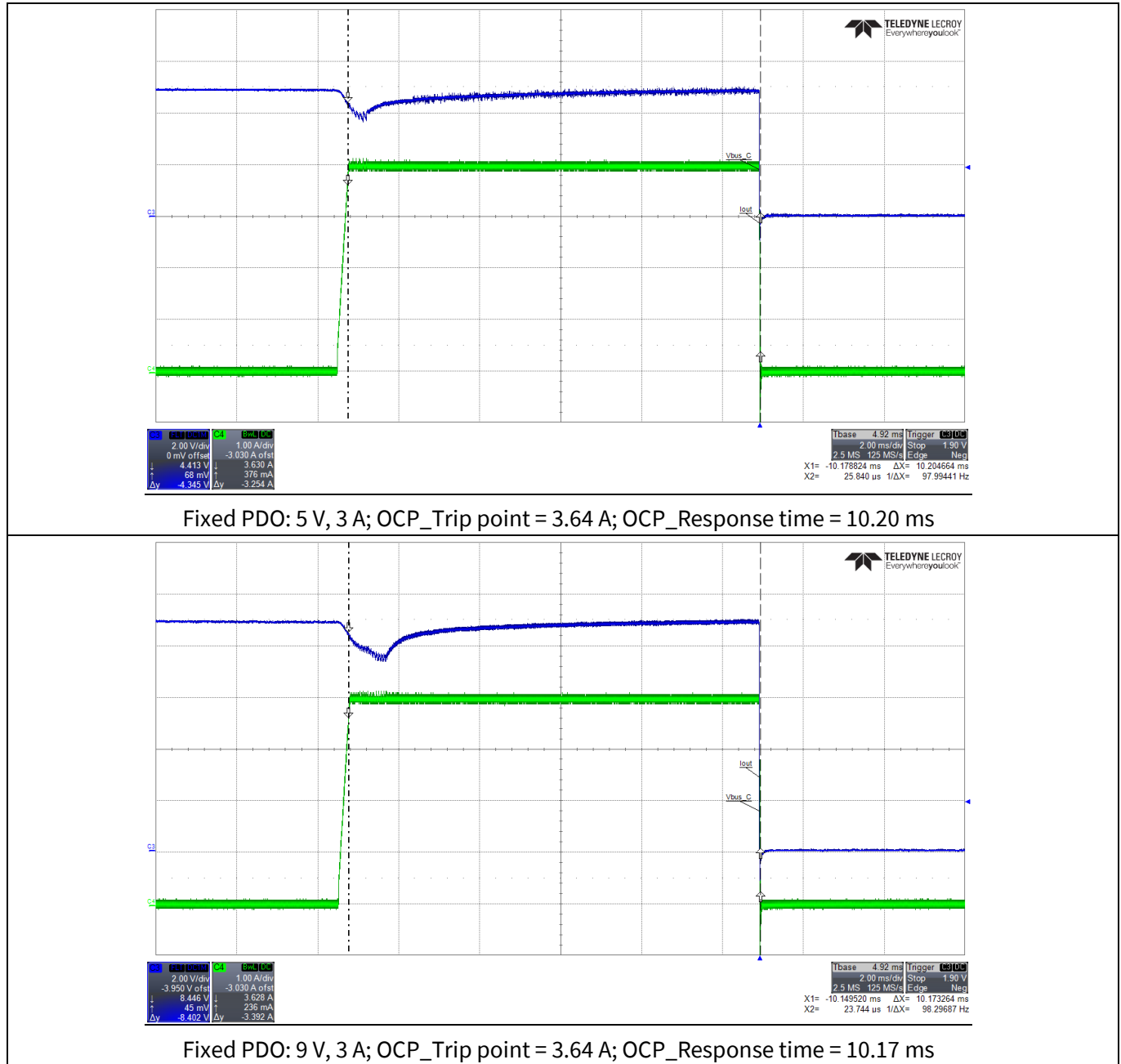


**Figure 50** OCP at 115 V<sub>ac</sub>, 60 Hz (CH3: Vbus\_c; CH4: Iout) (2 of 2)

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report

## Power management test results

OCP tested at 230 V<sub>ac</sub> 50 Hz

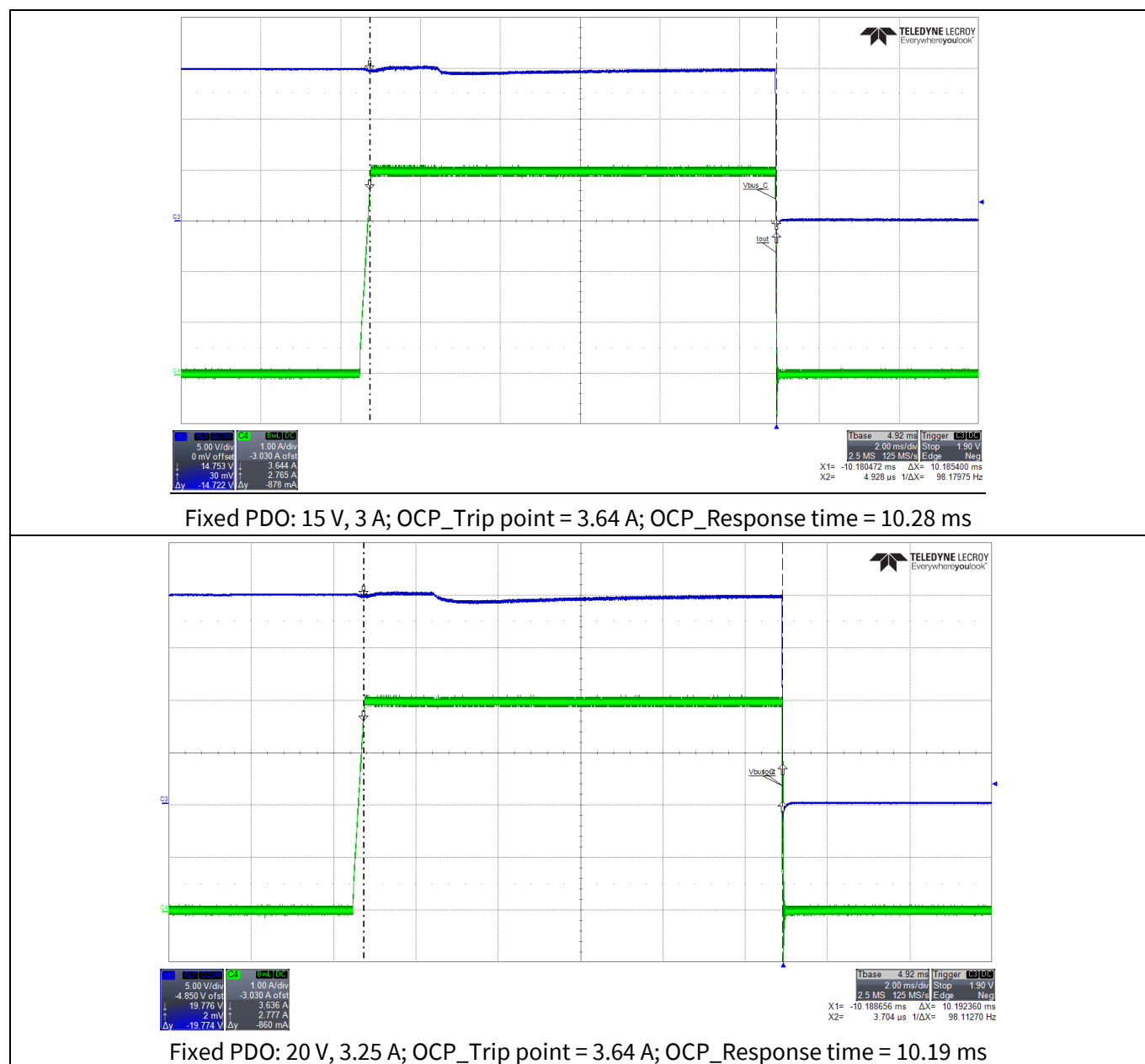


**Figure 51** OCP at 230 V<sub>ac</sub>, 50 Hz (CH2: V<sub>bus\_C</sub>; CH3: I<sub>out</sub>) (1 of 2)

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results



**Figure 52 OCP at 230 V<sub>ac</sub>, 50 Hz (CH2: V<sub>bus\_c</sub>; CH3: I<sub>out</sub>) (2 of 2)**

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results

### 3.15 Thermal stress

- **Test condition:**  $V_{in\_ac} = 90\text{ V}_{ac}$ -47 Hz,  $V_{out} = 20\text{ V}$ ,  $I_{out} = 3.25\text{ A}$
- **Lab ambient temperature:** 23°C and in open frame
- **Run time:** 60 minutes

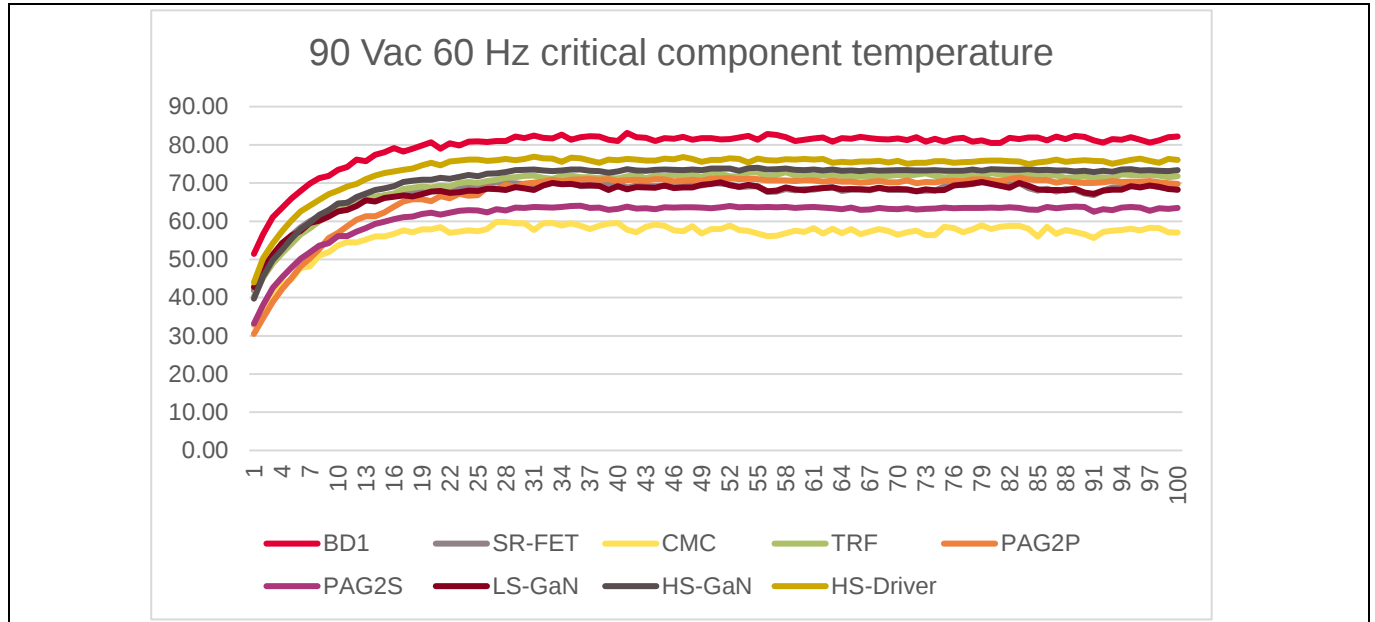


Figure 53 Thermal data logging of various components with time at 90 V<sub>ac</sub>-47 Hz, 20 V, 3.25 A

Table 9 Thermal data logging of various components at the end of 60 mins at 90 V<sub>ac</sub>-47 Hz, 20 V, 3.25 A

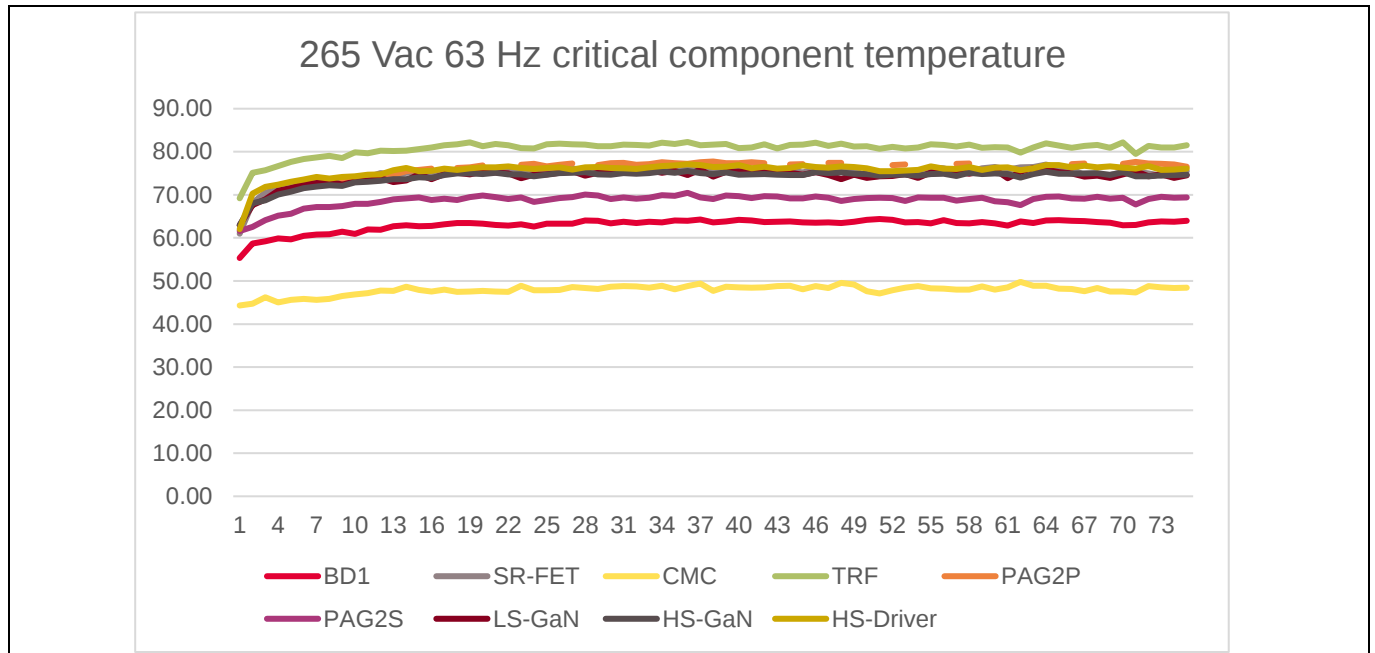
| Sl. No. | Component            | Max Temp in °C at the end of 60mins |
|---------|----------------------|-------------------------------------|
| 1       | Bridge rectifier     | 82.14                               |
| 2       | SR FET               | 68.24                               |
| 3       | CMC                  | 57.03                               |
| 4       | Transformer          | 71.78                               |
| 5       | PAG2P (primary IC)   | 69.81                               |
| 6       | PAG2S (secondary IC) | 63.52                               |
| 7       | Low side switch      | 68.30                               |
| 8       | High side switch     | 73.40                               |
| 9       | High side driver     | 76.05                               |

- **Test condition:**  $V_{in\_ac} = 265\text{ V}_{ac}$ -63 Hz,  $V_{out} = 20\text{ V}$ ,  $I_{out} = 3.25\text{ A}$
- **Lab ambient temperature:** 23°C and in open frame
- **Run time:** 60 minutes

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Power management test results



**Figure 54 Thermal data logging of various components with time at 265 V<sub>ac</sub>-63 Hz, 20 V, 3.25 A**

**Table 10 Thermal data logging of various components at the end of 60 mins at 265 V<sub>ac</sub>-63 Hz, 20 V, 3.25 A**

| Sl. No. | Component            | Max Temp in °C at the end of 60mins |
|---------|----------------------|-------------------------------------|
| 1       | Bridge rectifier     | 63.97                               |
| 2       | SR FET               | 75.48                               |
| 3       | CMC                  | 48.46                               |
| 4       | Transformer          | 81.54                               |
| 5       | PAG2P (primary IC)   | 76.53                               |
| 6       | PAG2S (secondary IC) | 69.36                               |
| 7       | Low side switch      | 74.49                               |
| 8       | High side switch     | 74.70                               |
| 9       | High side driver     | 76.12                               |

## Power management test results

### 3.16 EMI/EMC

#### 3.16.1 Conducted emission

Conducted emission on 115 V<sub>ac</sub> and 230 V<sub>ac</sub> mains port, spectral diagram, 0.15 – 30 MHz.

Remarks: The CE results are captured with X-cap and transformer shielded to primary GND.

#### Conducted smission at 230 V<sub>ac</sub> 50 Hz

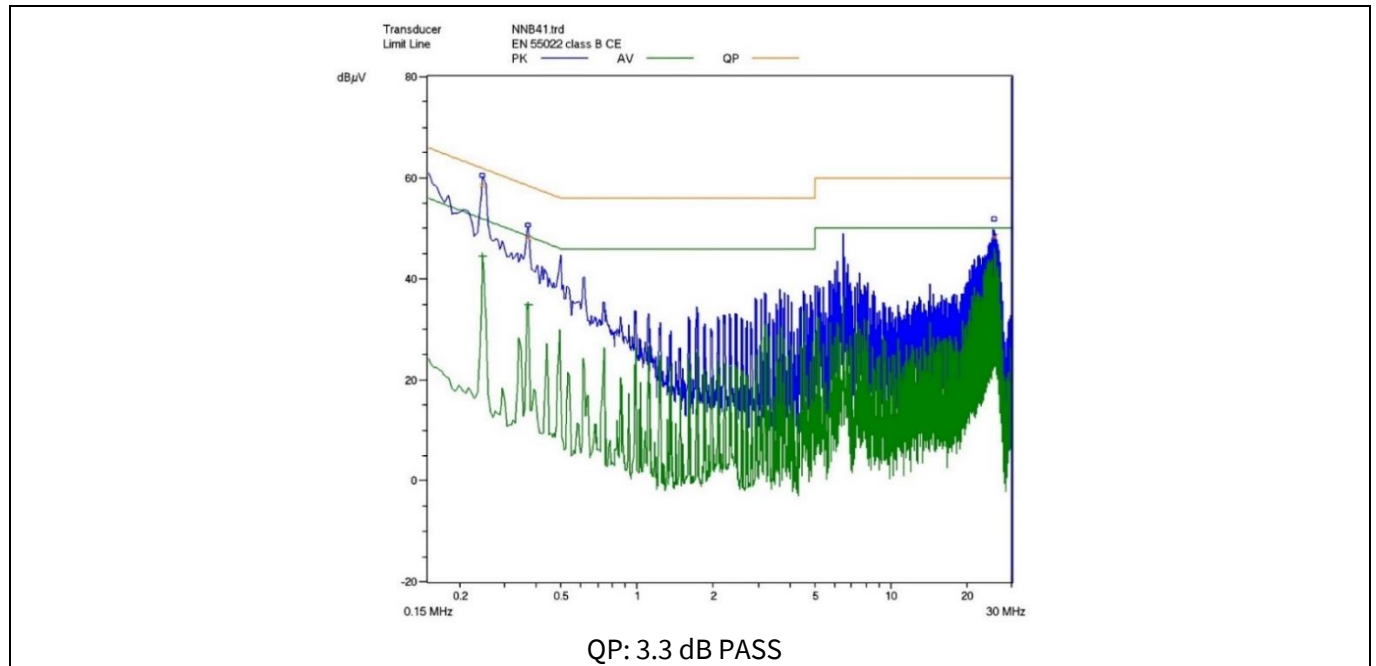


Figure 55 CE at 230 V<sub>ac</sub> 20 V full load with trace L1

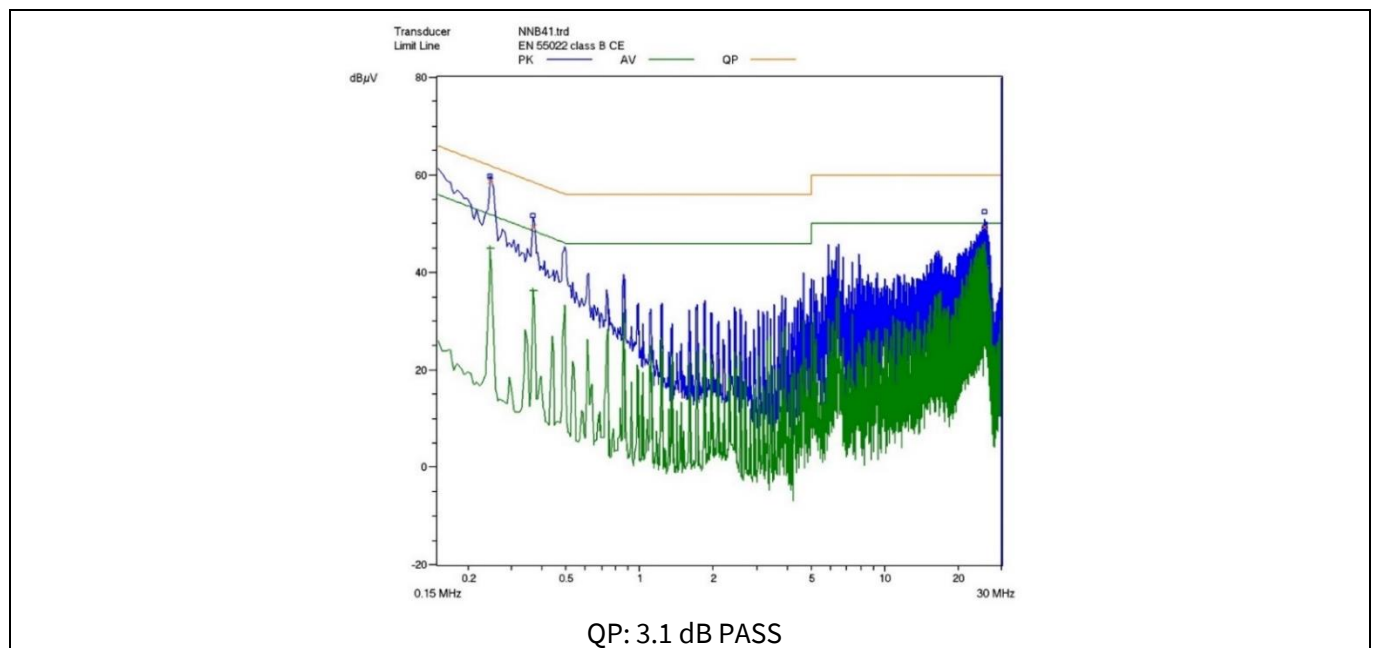
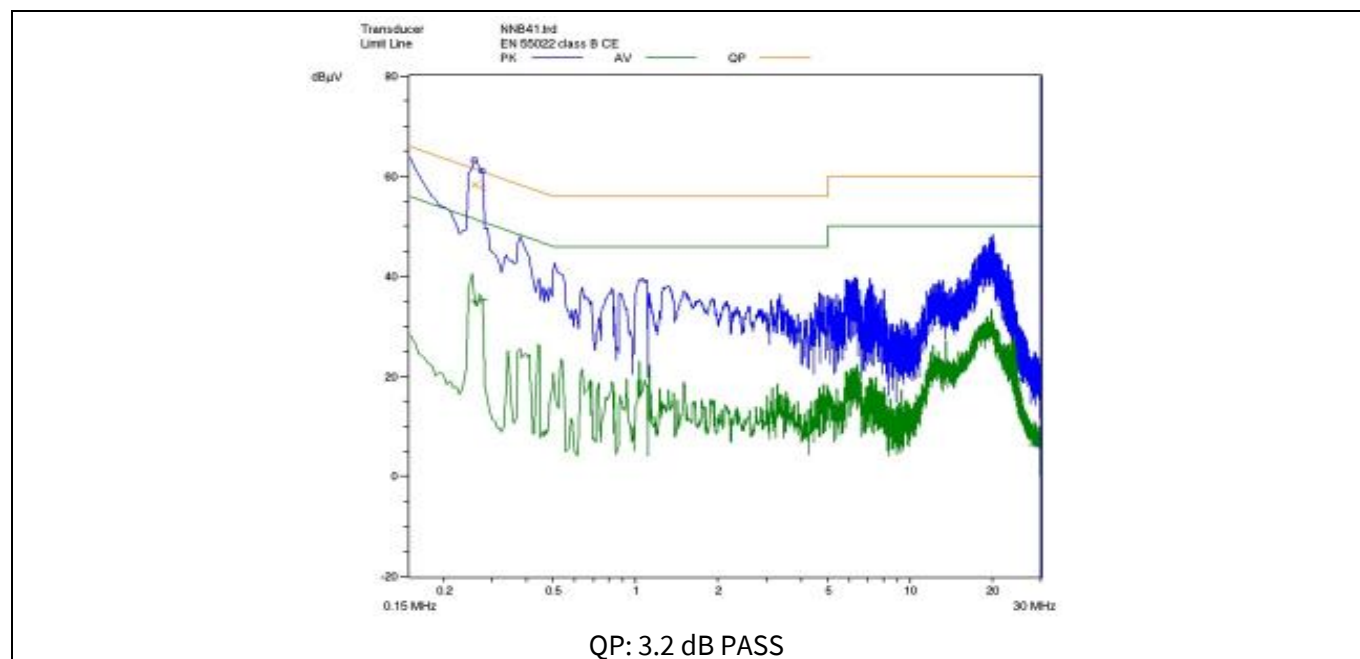


Figure 56 CE at 230 V<sub>ac</sub> 20 v full load with trace L2

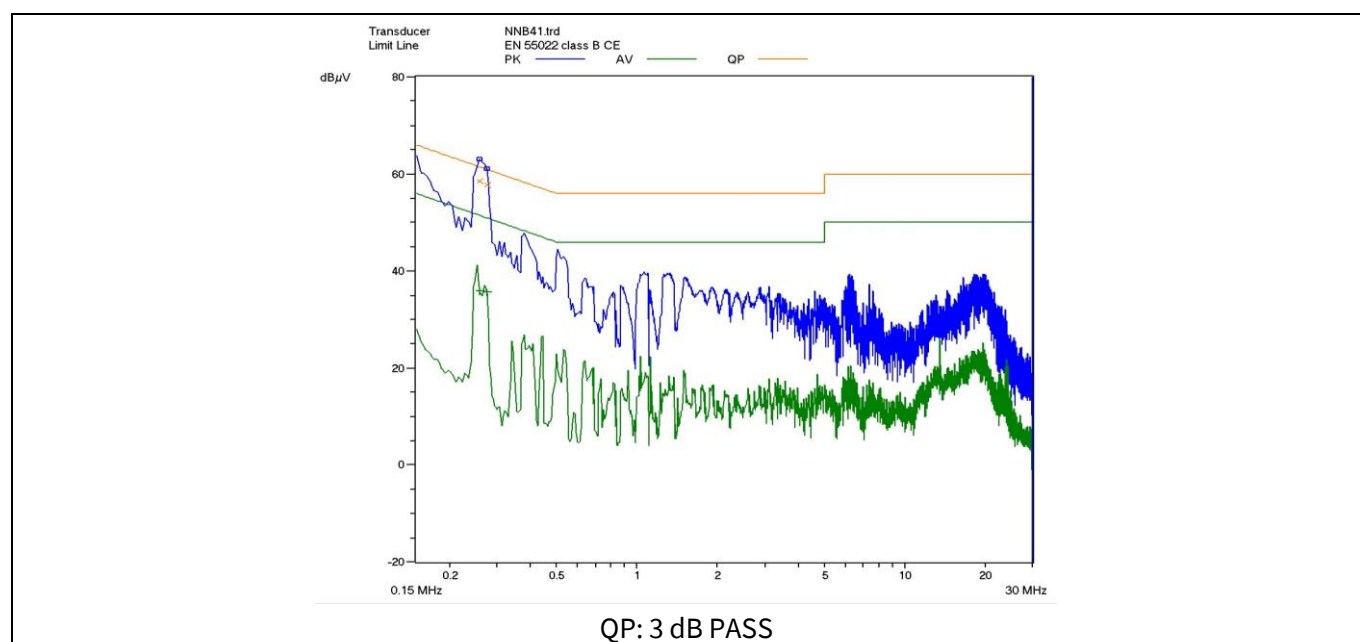
# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report

## Power management test results

### Conducted emission at 115 V<sub>ac</sub> 60 Hz



**Figure 57** CE at 115 V<sub>ac</sub> 20 V full load with trace L1



**Figure 58** CE at 115 V<sub>ac</sub> 20 V full load with trace L2

- Surge

IEC61000-4-5, ±2 kV DM, Criteria A (auto-recovery)

- ESD

IEC61000-4-2 level 4; ±8 kV contact, ±16 kV air, Criteria A

65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board  
test report

USB PD source test results (using Quadramax)

4 USB PD source test results (using Quadramax)

4.1 Test setup



Figure 59 Quadramax tester

- QuadDraw Version: 0.9.8594
- QM#108 HWRev:1.4.4 FWST:0.0.1376 FWCCG1:0.10

4.2 Test result

Test input voltage conditions: 115 V<sub>ac</sub>, 60 Hz and 230 V<sub>ac</sub>, 50 Hz

Table 11 Test result

| 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   |

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Appendix

### 5 Appendix

#### 5.1 Schematics

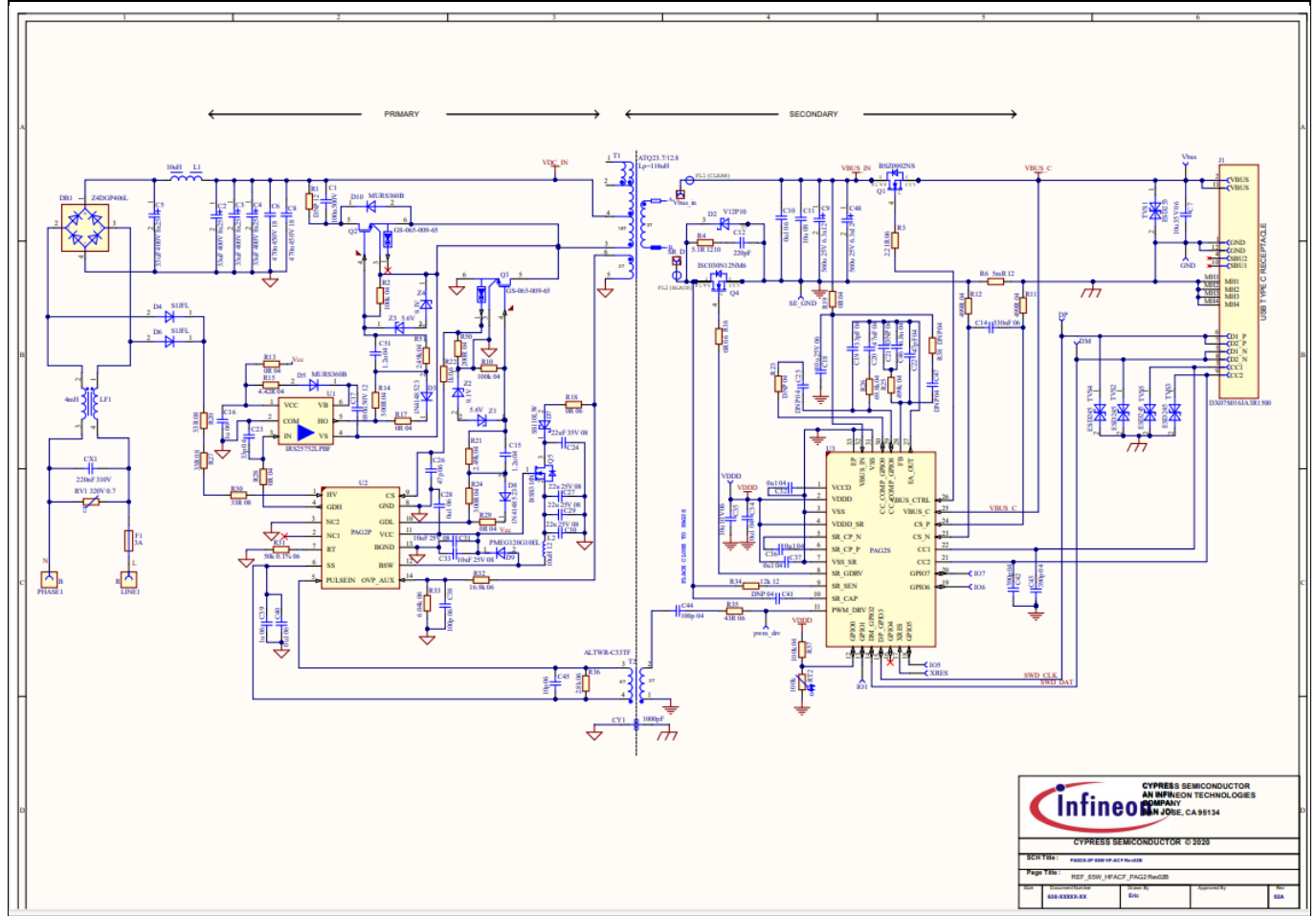


Figure 60 Schematic diagram of 65 W PAG2P\_PAG2S\_HF ACF\_Rev2B\_GaN system\_SCH

#### 5.2 Bill of material (BOM)

Table 12 Bill of material (BOM)

| Designator     | Comment         | Value           | Manufacturer order number | Manufacturer    |
|----------------|-----------------|-----------------|---------------------------|-----------------|
| C1             | 100n 500V       | 100n 500V       | C1210C104KCRCTU           | Kemet           |
| C2, C3, C4, C5 | 33uF 400V 8x25  | 33uF 400V 8x25  | KCX 33u1F 400V 8X25       | Rubycon         |
| C6, C8         | 470n 450V 18    | 470n 450V 18    | CGA8N4X7T2W474M230KA      | TDK Corporation |
| C7             | 10u 35V 06      | 10u 35V 06      | GRM188R6YA106MA73D        | MuRata          |
| C9, C48        | 560u 25V 6.3x12 | 560u 25V 6.3x12 | NPX 470uF 25V 6.3 x 12    | Sh-ymin         |
| C10            | 0u1 06          | 0u1 06          | CGA3E2X8R1E104K080AA      | TDK Corporation |
| C11            | 10u 08          | 10u 08          | GRM21BR61H106KE43K        | MuRata          |

# 65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board test report



## Appendix

| Designator         | Comment     | Value       | Manufacturer order number                                                           | Manufacturer        |
|--------------------|-------------|-------------|-------------------------------------------------------------------------------------|---------------------|
| C12                | 220pF       | 220pF       | 1206B221K201CT                                                                      | Walsin Technology   |
| C14                | 330nF 06    | 330nF 06    | GRM188R71A334KA61                                                                   | MuRata              |
| C15, C51           | 1.2n 04     | 1.2n 04     | GRM155R71H122JA01                                                                   | MuRata              |
| C16                | 1u 06       | 1u 06       | CGA3E3X5R1H105K080AB                                                                | TDK Corporation     |
| C17                | 680n 50V 12 | 680n 50V 12 | GCM31MR71H684JA55                                                                   | MuRata              |
| C18                | 10u 25V 06  | 10u 25V 06  | 885012106031                                                                        | Würth Elektronik    |
| C19                | 33pF 04     | 33pF 04     | GRM1555C1E330GA01                                                                   | MuRata              |
| C20                | 47nF 04     | 47nF 04     | GRM155R61C473JA01                                                                   | MuRata              |
| C21, C25, C41, C47 | DNP 04      | DNP 04      | GRM155R61C333KA01,<br>GRM1555C1E101JA01,<br>GRM1555C1E100JA01,<br>GRM1555C1H102GA01 | MuRata              |
| C22                | 4.7pF 04    | 4.7pF 04    | GCM1555C1H470GA16                                                                   | MuRata              |
| C23                | 33p 04      | 33p 04      | CGA2B2NP01H330J050BA                                                                | TDK Corporation     |
| C24                | 22uF 35V 08 | 22uF 35V 08 | C2012X5R1V226M125AC                                                                 | TDK                 |
| C26                | 47p 06      | 47p 06      | GRM1885C1H470GA01                                                                   | MuRata              |
| C27, C29, C30      | 22u 25V 08  | 22u 25V 08  | GRM21BR61E226ME44                                                                   | MuRata              |
| C28                | 0u1 06      | 0u1 06      | 06035C104JAT2A                                                                      | AVX                 |
| C31, C33           | 10uF 25V 08 | 10uF 25V 08 | GRM21BR61E106KA73                                                                   | MuRata              |
| C32, C34           | 0u1 04      | 0u1 04      | GRM152R61A104KE19                                                                   | MuRata              |
| C35                | 10u 10V 06  | 10u 10V 06  | ZRB18AD71A106KE01L                                                                  | MuRata              |
| C36, C37           | 0u1 04      | 0u1 04      | GCM155R71C104KA55                                                                   | MuRata              |
| C38                | 100p 06     | 100p 06     | 06033A101JAT2A                                                                      | AVX                 |
| C39                | 1u 06       | 1u 06       | GRM185R61A105KE26                                                                   | MuRata              |
| C40                | 0u1 06      | 0u1 06      | C0603C104J8RAC                                                                      | Kemet               |
| C42, C43           | 390p 04     | 390p 04     | GRM1555C1E391JA01                                                                   | MuRata              |
| C44                | 100p 04     | 100p 04     | GRM1555C1E101JA01                                                                   | MuRata              |
| C45                | 10p 06      | 10p 06      | C0603C100K5GACAUTO                                                                  | Kemet               |
| C46                | 6.8n 04     | 6.8n 04     | GRM155R71E682JA01                                                                   | MuRata              |
| CX1                | 220nF 310V  | 220nF 310V  | PX224K2C0702T                                                                       | KYET                |
| CY1                | 1000pF      | 1000pF      | DE1E3RA102MA4BP01F                                                                  | MuRata              |
| D2                 | V12P10      | V12P10      | V12P10-M3/86A                                                                       | Vishay              |
| D3, D8             | 1N4148 523  | 1N4148 523  | 1N4148WT-7                                                                          | Diodes Incorporated |
| D4, D6             | S1JFL       | S1JFL       | S1JFL                                                                               | ON Semiconductor    |

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## Appendix

| Designator                                                         | Comment          | Value            | Manufacturer order number     | Manufacturer               |
|--------------------------------------------------------------------|------------------|------------------|-------------------------------|----------------------------|
| D5, D10                                                            | MURS360B         | MURS360B         | MURS360BT3G                   | ON Semiconductor           |
| D7                                                                 | SS110LW          | SS110LW          | SS110LW                       | Taiwan Semiconductor       |
| D9                                                                 | PMEG120G10EL     | PMEG120G10EL     | PMEG120G10ELRX                | Nexperia                   |
| DB1                                                                | Z4DGP406L        | Z4DGP406L        | Z4DGP406L-HF                  | Comchiptech                |
| DM, DP, GND, IO1, IO5, IO6, IO7, pwm_drv, SE_GND, Vbus, VDDD, XRES | 1:2              | 1:2              | test pad                      |                            |
| F1                                                                 | 3A               | 3A               | 2410T03-R                     | Bussmann                   |
| J1                                                                 | DX07S016JA3R1500 | DX07S016JA3R1500 | DX07S016JA3R1500              | JAE                        |
| L1                                                                 | 10uH             | 10uH             | 74437346100                   | Würth Elektronik           |
| L2                                                                 | 10uH 12          | 10uH 12          | LSQCA322525T100KR             | Taiyo Yuden                |
| LF1                                                                | 4mH              | 4mH              | T38 core, 2 x 30T<br>Φ0.544mm | EPCOS                      |
| LINE1                                                              | R                | R                | 5000                          | Keystone Electronics Corp. |
| PHASE1                                                             | B                | B                | 5001                          | Keystone Electronics Corp. |
| Q1                                                                 | BSZ0902NS        | BSZ0902NS        | BSZ0902NS                     | Infineon Technologies      |
| Q2, Q3                                                             | GS-065-009-65    | GS-065-009-65    | GS-065-009-65                 |                            |
| Q4                                                                 | ISC030N12NM6     | ISC030N12NM6     | ISC030N12NM6                  | Infineon Technologies      |
| Q5                                                                 | BSS316N          | BSS316N          | BSS316N H6327                 | Infineon Technologies      |
| R1                                                                 | DNP 12           | DNP 12           | CRCW12061M00FK                | Vishay                     |
| R2, R10                                                            | 100k 04          | 100k 04          | RC0402FR-07100KL              | Yageo                      |
| R3                                                                 | 2.21R 06         | 2.21R 06         | CRCW06032R21FK                | Vishay                     |
| R4                                                                 | 5.1R 1210        | 5.1R 1210        | ERJ-14YJ5R1U                  | Panasonic                  |
| R6                                                                 | 5mR 12           | 5mR 12           | CSRF1206FT5L00                | Stackpole Electronics      |
| R11, R12                                                           | 499R 04          | 499R 04          | CRCW0402499RFK                | Vishay                     |
| R13, R28                                                           | 0R 04            | 0R 04            | CRCW04020000Z0                | Vishay                     |
| R14, R24                                                           | 300R 04          | 300R 04          | CRCW0402300RFK                | Vishay                     |
| R15                                                                | 4.42R 04         | 4.42R 04         | CRCW04024R42FK                | Vishay                     |

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## Appendix

| Designator             | Comment      | Value        | Manufacturer order number | Manufacturer          |
|------------------------|--------------|--------------|---------------------------|-----------------------|
| R16, R18               | 0R 06        | 0R 06        | CRCW06030000Z0EA          | Vishay                |
| R17, R29               | 0R 04        | 0R 04        | RC0402JR-070RL            | Yageo                 |
| R19                    | 0R 04        | 0R 04        | RC0402FR-070RL            | Yageo                 |
| R20, R27, R30          | 33R 08       | 33R 08       | CRCW080533R0FKEAHP        | Vishay                |
| R21, R51               | 2.49k 04     | 2.49k 04     | CRCW04022K49FK            | Vishay                |
| R22                    | 1k 06        | 1k 06        | AC0603JR-071KL            | Yageo                 |
| R23                    | DNP 04       | DNP 04       | CPF0402B49K9E1            | TE Connectivity       |
| R25                    | 499k 04      | 499k 04      | CRCW0402499KFK            | Vishay                |
| R26                    | 69.8k 04     | 69.8k 04     | CRCW040269K8FK            | Vishay                |
| R31                    | 50k 0.1% 06  | 50k 0.1% 06  | RT0603BRD0750KL           | Yageo                 |
| R32                    | 16.9k 06     | 16.9k 06     | CRCW060316K9FK            | Vishay                |
| R33                    | 6.04k 06     | 6.04k 06     | CRCW06036K04FK            | Vishay                |
| R34                    | 12k 12       | 12k 12       | CRCW120612K0FK            | Vishay                |
| R35                    | 43R 06       | 43R 06       | CRCW060343R0FK            | Vishay                |
| R36                    | 2.8k 06      | 2.8k 06      | MCR03EZPFX2801            | ROHM Semiconductors   |
| R37                    | 100k 04      | 100k 04      | CRCW0402100KFK            | Vishay                |
| R38                    | DNP 04       | DNP 04       | CRCW040210K0FK            | Vishay                |
| R50                    | 200R 04      | 200R 04      | CRCW0402200RFK            | Vishay                |
| RT2                    | 100k         | 100k         | NCU18WF104J60RB           | MuRata                |
| RV1                    | 320V 0.7     | 320V 0.7     | B72207S2321K101           | Epcos                 |
| SR_D, Vbus_in          | -            | -            | -                         | -                     |
| T1                     | ATQ23.7/12.8 | ATQ23.7/12.8 | ATQ23.7/12.8              | -                     |
| T2                     | ALTWR-C33TF  | ALTWR-C33TF  | ALTWR-C33TF               | Sunlord               |
| TVS1                   | ESD253       | ESD253       | ESD253-B1-W0201           | Infineon Technologies |
| TVS2, TVS3, TVS4, TVS5 | ESD245       | ESD245       | ESD245-B1-W0201           | Infineon Technologies |
| U1                     | IRS25752LPBF | IRS25752LPBF | IRS25752LPBF              | Infineon Technologies |
| U2                     | PAG2P        | PAG2P        | CYPAP212A1-14SXI          | Infineon Technologies |
| U3                     | PAG2S        | PAG2S        | CYPAS212A1-32LQXQ         | Infineon Technologies |
| Z1, Z3                 | 5.6V         | 5.6V         | DZ9F5V6S92                | Diodes Incorporated   |
| Z2, Z4                 | 9.1V         | 9.1V         | DZ9F9V1S92-7              | Diodes Incorporated   |

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## Appendix

### 5.3 Transformer specification (T1)

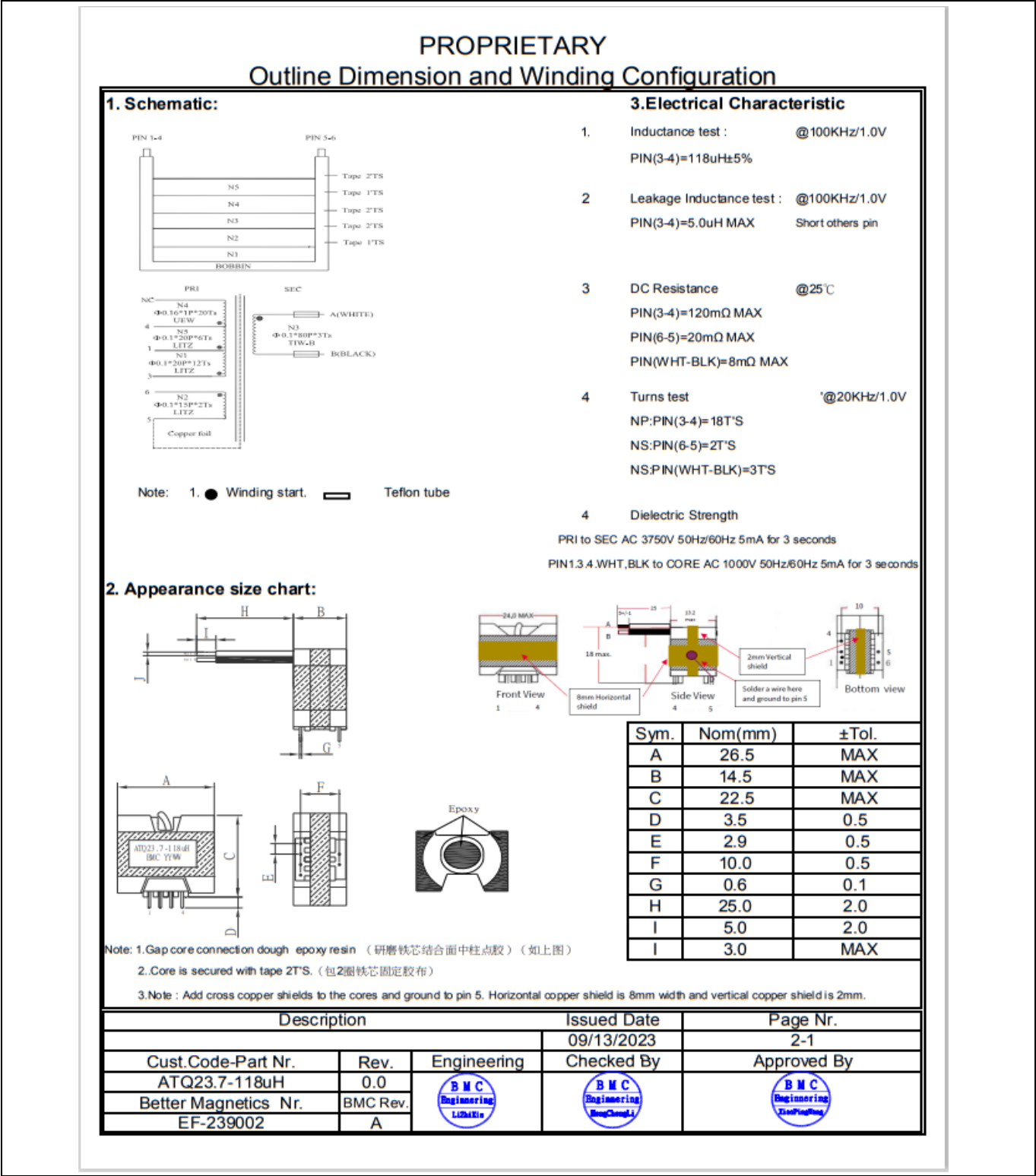
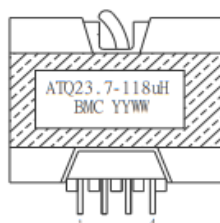


Figure 61 Transformer specification (T1)

## PROPRIETARY Material List



All materials listed are in compliance with RoHS requirements

| No.                                            | Name        | Description                                                                                                                                 | Rating                  | Approval                      | Maker                                   |
|------------------------------------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-------------------------------|-----------------------------------------|
| 1                                              | Core        | Ferrite core<br>ATQ23.7/12.8/17.8 NH97<br>or equivalent                                                                                     |                         |                               | LIANFENG                                |
| 2                                              | Bobbin      | Phenolic PM-9630 UL 94V-0                                                                                                                   | 150°C                   | E41429                        | SUMITOMO ✓                              |
| 3                                              | Wire        | Polyurethane enamelled copper<br>Wire UEW MW75-C<br>Ø0.1*20P, Ø0.1*15P<br>Ø0.16<br>Triple insulated wire<br>TIW-B Ø0.1X80P<br>or equivalent | 130°C<br>130°C<br>130°C | E339217<br>E201757<br>E357240 | WEIHAN ✓<br>PACIFIC ✓<br>KAIZHONGHEDONG |
| 4                                              | Tape        | Polyester tape<br>#1350F-1<br>or #CT280                                                                                                     | 130°C<br>130°C          | E17385<br>E165111             | 3M<br>YA HUA ✓                          |
| 5                                              | Tube        | CB-HFT<br>ND-LL                                                                                                                             | 125°C<br>200°C          | E180908<br>E350651            | CHANGYUAN<br>NANDIAN ✓                  |
| 6                                              | Copper foil | 0.05(T)*8mm<br>0.05(T)*3mm                                                                                                                  |                         |                               | HAIYU ✓<br>DETAI                        |
| 7                                              | Epoxy       | 2050<br>2041                                                                                                                                |                         |                               | CHENGGE ✓<br>CHENGGE ✓                  |
| 8                                              | Varnish     | BC-359<br>WP-2952F-2G(Y)                                                                                                                    | 180°C<br>130°C          | E317427<br>E72979             | DOLPH ✓<br>HITACHI                      |
| Description                                    |             |                                                                                                                                             | Issued Date             |                               | Page Nr.                                |
| Note: denotes the material used for the sample |             |                                                                                                                                             | 09/13/2023              |                               | 2-2                                     |
| Cust.Code-Part Nr.                             |             | Rev.                                                                                                                                        | Engineering             |                               | Checked By                              |
| ATQ23.7-118uH                                  |             | 0.0                                                                                                                                         |                         |                               | Approved By                             |
| Better Magnetics Nr.                           |             | BMC Rev.                                                                                                                                    |                         |                               |                                         |
| EF-239002                                      |             | A                                                                                                                                           |                         |                               |                                         |

Figure 62 ATQ23.7-118  $\mu$ H (NH97)

65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board  
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Appendix

5.4 Inductor specification (L1)

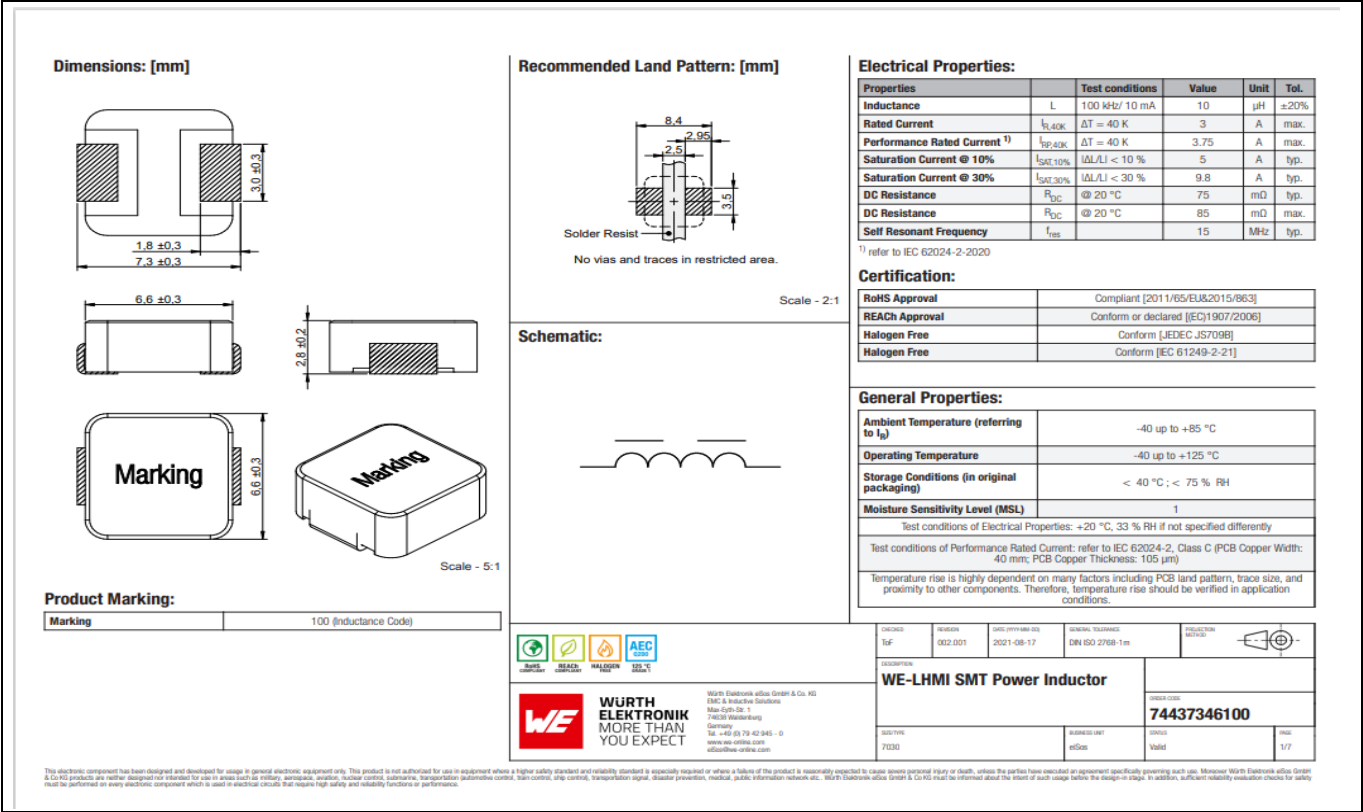


Figure 63 Fixed IND 10 μH 3 A 85 MΩ SMD Wurth Elektronik

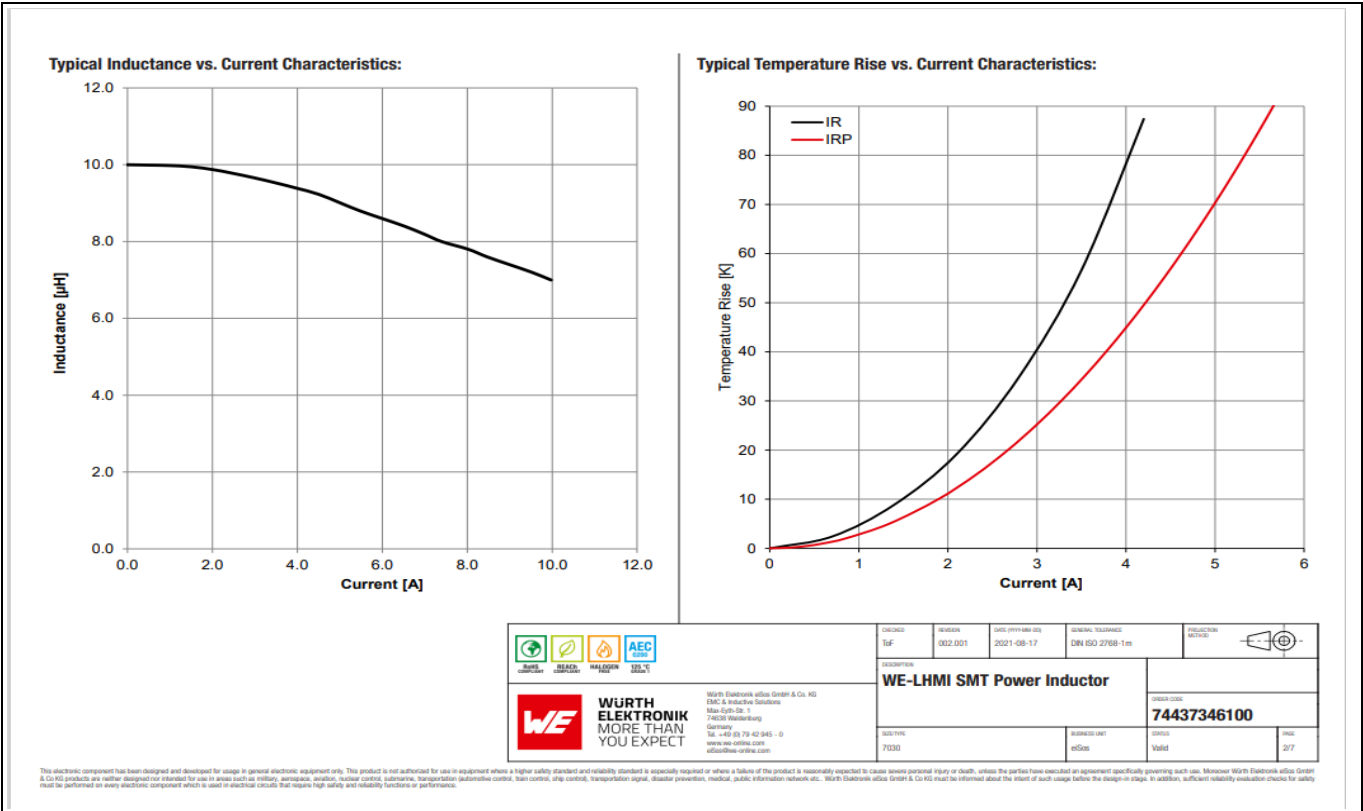
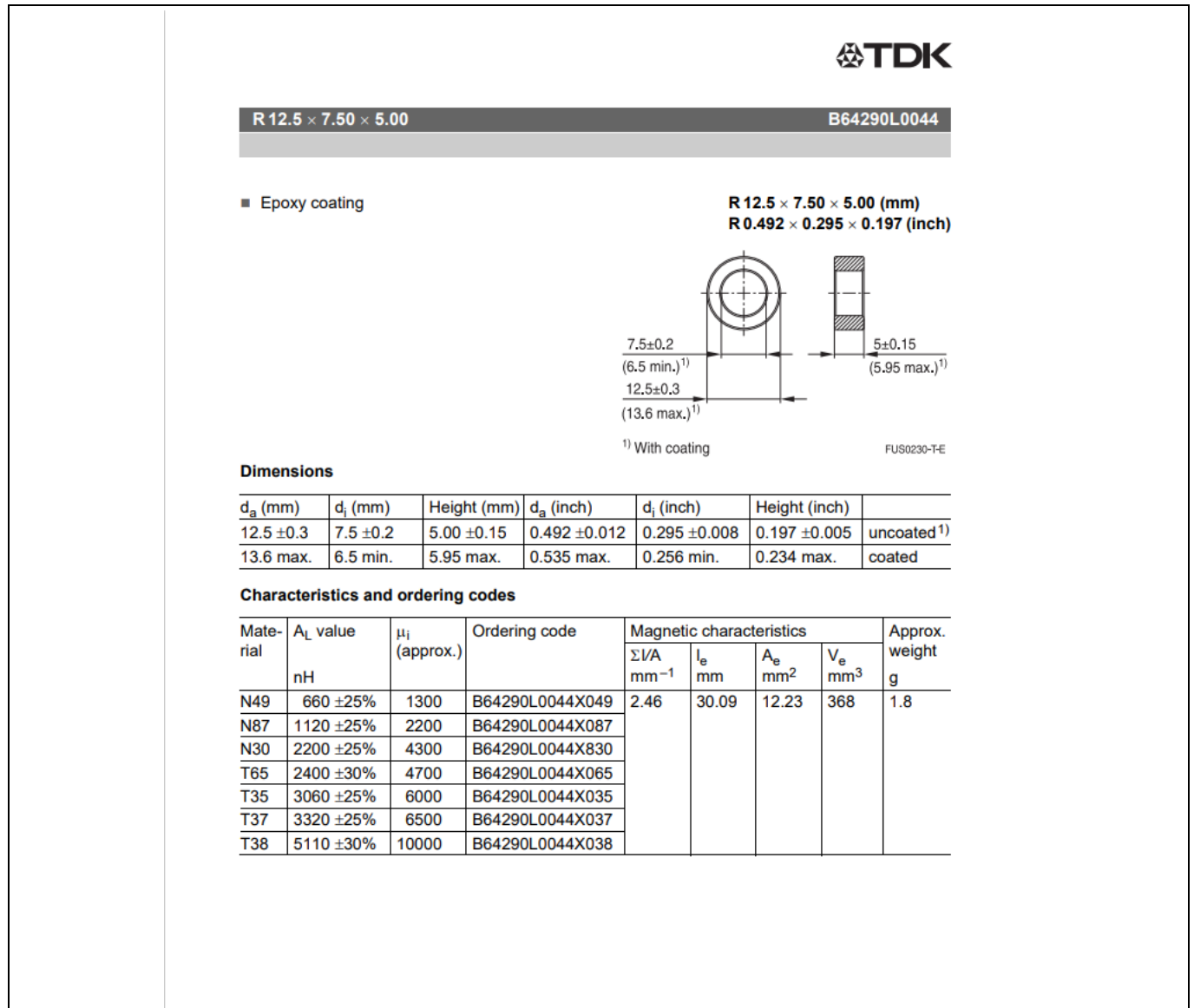


Figure 64 L1 Fixed IND 10 μH 3 A 85 MΩ SMD Wurth Elektronik Inductor specifications

## 5.5 Common Mode Choke specification (LF2)



**Figure 65 Common Mode Chock specification**

Remarks: Turns:30, L=6.6 mH, Rdc=66 mOhm

65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board  
test report

Appendix

5.6 Pulse transformer specification (T2)

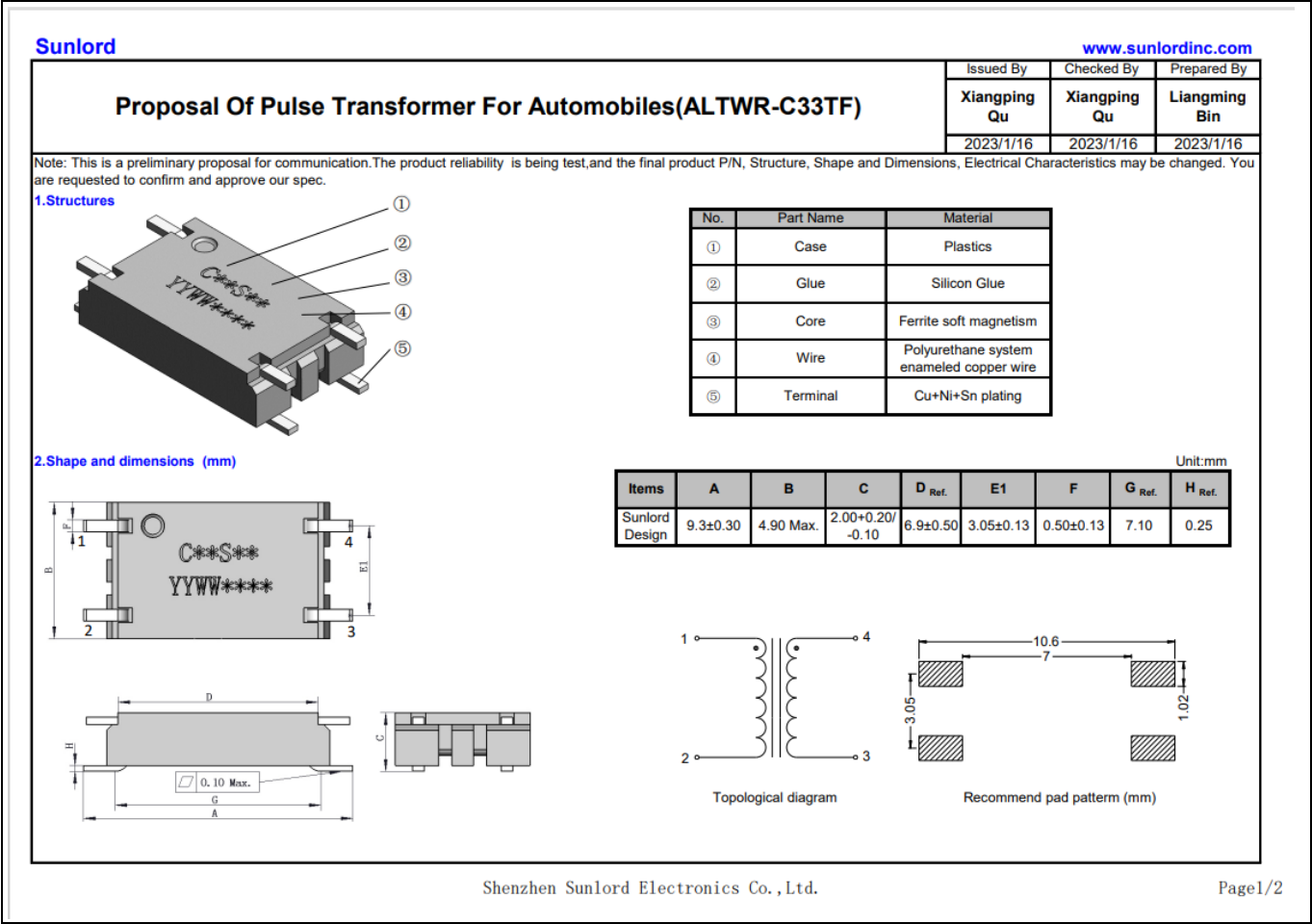


Figure 66 Pulse transformer specification

65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board  
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Appendix

5.7 PCB layout

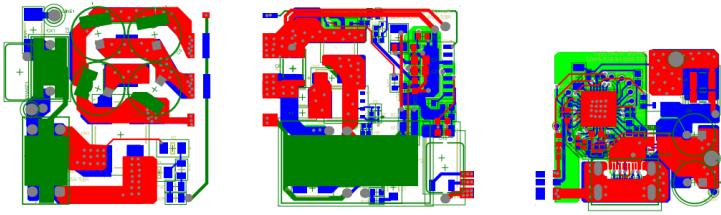
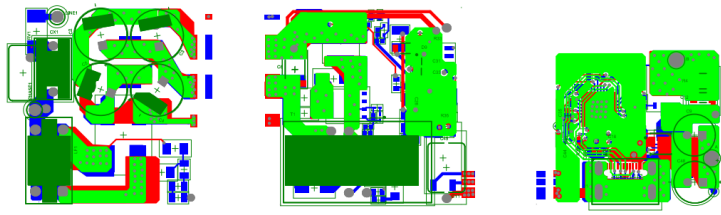
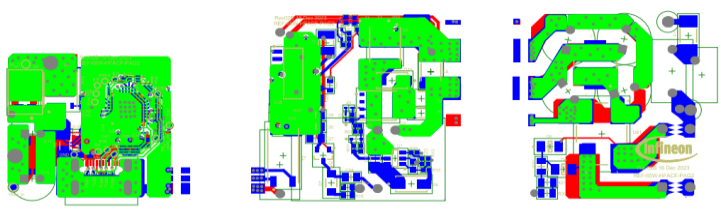
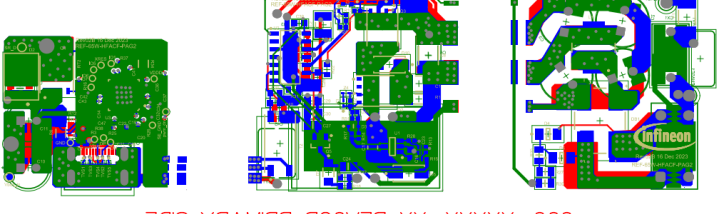
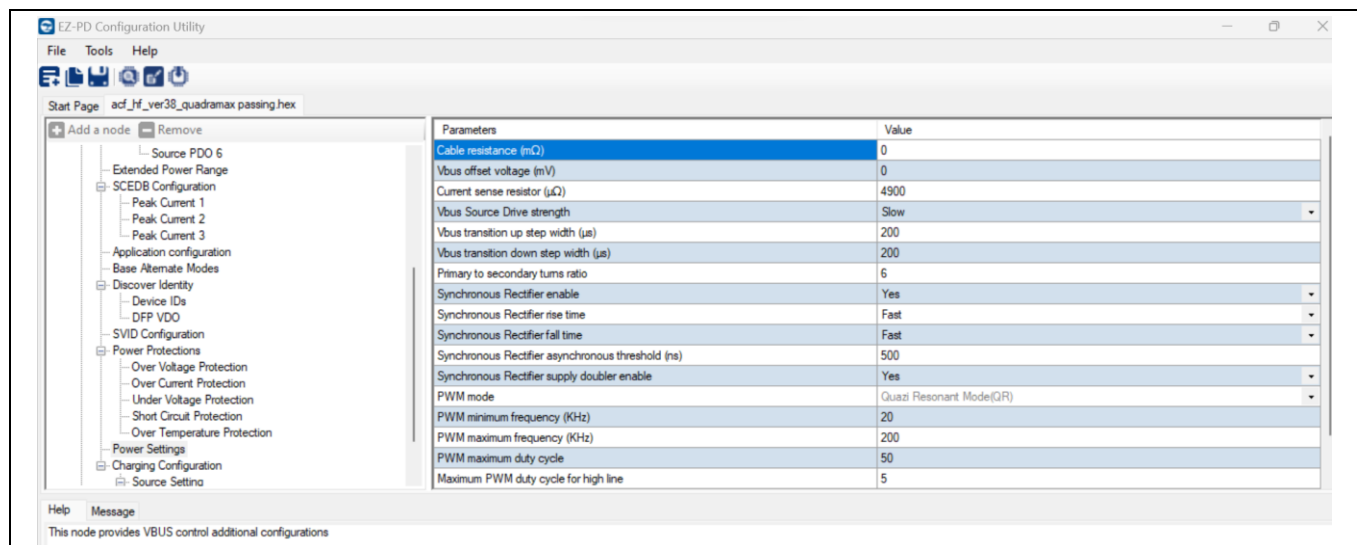
|  |                                                                                                                                                                                                                                               |  |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|  |  <p>600-XXXXX-XX REV02B PRIMARY SIDE<br/>600-XXXXX-XX REV02B GROUND1 PLANE<br/>600-XXXXX-XX REV02B GROUND2 PLANE<br/>600-XXXXX-XX REV02B SECONDARY SIDE</p> |  |
|  |  <p>600-XXXXX-XX REV02B PRIMARY SIDE<br/>600-XXXXX-XX REV02B GROUND2 PLANE<br/>600-XXXXX-XX REV02B SECONDARY SIDE</p>                                       |  |
|  |  <p>600-XXXXX-XX REV02B PRIMARY SIDE<br/>600-XXXXX-XX REV02B GROUND2 PLANE<br/>600-XXXXX-XX REV02B SECONDARY SIDE</p>                                     |  |
|  |  <p>600-XXXXX-XX REV02B PRIMARY SIDE<br/>600-XXXXX-XX REV02B GROUND1 PLANE<br/>600-XXXXX-XX REV02B SECONDARY SIDE</p>                                     |  |
|  |  <p>600-XXXXX-XX REV02B PRIMARY SIDE<br/>600-XXXXX-XX REV02B GROUND2 PLANE<br/>600-XXXXX-XX REV02B SECONDARY SIDE</p>                                     |  |

Figure 67 PCB layout

### 5.8 EZ-PD™ Configuration Utility



**Figure 68 EZ-PD™ Configuration Utility**

The Infineon's EZ-PD™ PAG2S 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 Infineon 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 13 Default configuration values**

| Parameters                                 | Values                   |
|--------------------------------------------|--------------------------|
| <b>Power Settings</b>                      |                          |
| Cable resistance (mΩ)                      | 0                        |
| Vbus offset voltage (mV)                   | 0                        |
| Current Sense resistor (μΩ)                | 4900                     |
| Vbus Source Drive strength                 | Slow                     |
| Vbus transition up step width (μs)         | 200                      |
| Vbus transition down step width (μs)       | 200                      |
| Primary to secondary turns ratio           | 6                        |
| Synchronous Rectifier enable               | Yes                      |
| Synchronous Rectifier rise time            | Fast                     |
| Synchronous Rectifier fall time            | Fast                     |
| Synchronous Rectifier async threshold (ns) | 500                      |
| Synchronous Rectifier doubler enable       | Yes                      |
| PWM mode                                   | Quasi Resonant Mode (QR) |
| PWM minimum frequency (kHz)                | 20                       |
| PWM maximum frequency (kHz)                | 200                      |

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## Appendix

| Parameters                                                     | Values |
|----------------------------------------------------------------|--------|
| PWM maximum duty cycle (%)                                     | 50     |
| Maximum PWM Duty Cycle for high line                           | 5      |
| Vbus transition up step width for transitions below 5 V (μs)   | 1      |
| Vbus transition down step width for transitions below 5 V (μs) | 1      |
| <b>Power Protections</b>                                       |        |
| <b>Over Voltage Protection</b>                                 |        |
| Enable                                                         | Yes    |
| OVP Threshold (%)                                              | 20     |
| Debounce period (μs)                                           | 10     |
| Retry count                                                    | 2      |
| <b>Over Current Protection</b>                                 |        |
| Enable                                                         | Yes    |
| OCP Threshold (%)                                              | 20     |
| Debounce period (ms)                                           | 10     |
| Retry count                                                    | 2      |
| <b>Under Voltage Protection</b>                                |        |
| Enable                                                         | Yes    |
| UVP Threshold (%)                                              | 70     |
| Debounce period (μs)                                           | 10     |
| Retry count                                                    | 2      |
| <b>Short Circuit Protection</b>                                |        |
| Enable                                                         | Yes    |
| SCP Threshold (%)                                              | 40     |
| Debounce period (μs)                                           | 2      |
| Retry count                                                    | 2      |
| <b>Over Temperature Protection</b>                             |        |
| Enable                                                         | Yes    |
| Thermistor type 1                                              | NTC    |
| Cut-off value 1                                                | 255    |
| Restart value 1                                                | 909    |
| Debounce period(ms)                                            | 10     |
| Enable Thermistor 2                                            | Yes    |
| Thermistor type 2                                              | NTC    |
| Cut-off value 2                                                | 255    |
| Restart value 2                                                | 909    |

## References

- [1] USB Implementers Forum, Inc.: [Document library](#)
- [2] USB Implementers Forum, Inc.: USB Type-C and connector specification ([release 2.3](#))
- [3] Infineon Technologies AG: [USB EZ-PD™ Configuration Utility](#)
- [4] Infineon Technologies AG: [EZ-PD™ PAG2P primary-side startup controller](#)
- [5] Infineon Technologies AG: [EZ-PD™ PAG2S-AC integrated USB PD and secondary-side ACF controller](#)

## Acronyms

## Acronyms

**Table 14 Abbreviations**

| Abbreviation         | Definition                                                 |
|----------------------|------------------------------------------------------------|
| ACF                  | Active Clamp Flyback                                       |
| HF                   | High Frequency                                             |
| CC-CV                | Constant current - constant voltage                        |
| CE                   | Conducted emission                                         |
| CH'x'                | Oscilloscope channel numbers                               |
| CR Mode              | Constant Resistance mode in Electronic Load                |
| DCM                  | Discontinuous current mode                                 |
| DP/DM                | USB data positive / data negative lines                    |
| DUT / EUT            | Device under test / equipment under test                   |
| FET                  | MOSFET (metal oxide semiconductor field effect transistor) |
| GUI                  | Graphical User Interface                                   |
| Io/IOUT              | Output current of the DUT                                  |
| NGDO                 | NFET gate driver output                                    |
| OCP                  | Overcurrent protection                                     |
| OVP                  | Overvoltage protection                                     |
| P-P                  | Peak-to-peak                                               |
| PAT                  | Power adaptor tester                                       |
| PDO                  | Power delivery output                                      |
| PPS                  | Programmable power supply                                  |
| SCP                  | Short-circuit protection                                   |
| USB PD               | Universal Serial Bus Power Delivery                        |
| $V_{BUS\_C}/V_{OUT}$ | Output voltage of the DUT                                  |
| $V_{AC}/V_{IN\_AC}$  | Input DC voltage to the DUT                                |

**65 W PAG2P-2S HF-ACF (REF\_65W\_ACF\_PAG2) charger board  
test report**

**Revision history**

**Revision history**

| Document revision | Date       | Description of changes                                         |
|-------------------|------------|----------------------------------------------------------------|
| **                | 2024-03-27 | Initial release                                                |
| *A                | 2024-04-29 | Added the link “REF_65W_HFACF_PAG2” in <a href="#">Table 1</a> |

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