65 W USB-PD dual C power adapter solution

EZ-PD™ PAG1 and EZ-PD™ CCG7D-C

Engineering report

About this document

Scope and purpose

This test report contains test results of EZ-PD™ PAG1 and EZ-PD™ CCG7D-C based 65 W dual C power adapter solution board. The tests were performed on this board, which is equipped with Infineon CYPAP111A3-10SXQ on primary, CYPAS111/2A3-24LQXQ on secondary section and EZ-PD™ CCG7D-C of the converter.

Intended audience

This document is intended for all technical experts using Infineon secondary-controlled flyback converter in various applications.

Table of contents

About this document . . . 1

Table of contents . . . 1

1 Introduction . . . 3

2 Test setup . . . 4

2.1 DUT (Device under test) . . . 4

2.2 DUT setup . . . 5

2.3 Test equipment . . . 6

3 Power management test results . . . 7

3.1 Efficiency 4-point average . . . 7

3.1.1 Single port 65 W . . . 7

3.1.1.1 Detailed data . . . 7

3.1.1.2 Graphs . . . 8

3.1.2 Dual port 65 W (port1+port2) . . . 9

3.1.2.1 Detailed data . . . 9

3.1.2.2 Graphs . . . 10

3.2 Standby power consumption . . . 11

3.2.1 Detailed data . . . 11

3.2.2 Graph . . . 11

3.2.3 Details . . . 12

3.3 Output voltage ripple and noise peak-peak . . . 13

3.4 Output voltage ripple dynamic response . . . 16

3.5 Output current dynamic response . . . 17

3.6 Start-up turn-on delay . . . 18

3.7 Start-up turn-on rise time . . . 19

3.8 Shut-down hold-up and fall time . . . 20

Table of contents

3.9 Switch voltage stress . . . 21
3.10 Overcurrent protection . . . 22
3.11 Short circuit protection . . . 23
3.12 Overvoltage protection . . . 24
3.13 Overtemperature protection . . . 25
3.14 Thermal captures . . . 26
3.15 Conducted emission . . . 30
3.16 USB-PD source test results (using QuadraMax) . . . 34

4 Appendix . . . 35
4.1 Schematics . . . 35
4.2 Bill of materials . . . 38
4.3 PCB layout . . . 45
4.4 Transformer specifications (T1) . . . 48
4.5 Inductor specifications (L1 900 uH) . . . 50
4.6 Common mode choke specifications (LF1 600 uH, LF2 15 mH) . . . 51
4.7 Pulse transformer (T2) . . . 52
4.8 EZ-PD™ configuration utility . . . 54
4.9 Glossary . . . 58

References . . . 59

Revision history . . . 59

Disclaimer . . . 60

1 Introduction

Infineon CYPAP111/2 part of EZ-PD™ 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. CYPAP111/2 is responsible for providing the start-up function, driving the primary-side FET as well as responding to fault conditions.

Infineon CYPAS111 part of EZ-PD™ PAG1S family is an integrated secondary-side synchronous flyback controller, synchronous rectifier (SR) controller, and charging port controller. CYPAS111 is designed to fit a secondary-controlled flyback system with a primary start-up controller (CYPAP111/2) with secondary-side sensing and regulation. CYPAS111 is targeted towards mobile power adapters, it fits well into a high-efficiency AC-DC flyback designs for USB power delivery, Qualcomm® Quick Charge™, and other standard charging protocols. CYPAS111 also supports USB power delivery (USB-PD 3.0) programmable power supply (PPS) mode.

The interface between CYPAP111/2 and CYPAS111 is through a pulse-edged transformer and its associated circuitry.

The EZ-PD™ CCG7D is highly integrated with 2 PD controllers + 2 DC-DC controllers + 1 MCU, all integrated in one single chip thereby enabling the customers to build high power density charger designs. EZ-PD™ CCG7D is integrated with ARM® Cortex®-M0 and 128 KB Flash that allows the user to implement custom features and build competitive end products, as well as upgrade the firmware on the field for events, such as PD specification update or post-production issue fixes. EZ-PD™ CCG7D makes the customer end product competitive and secure by supporting features, such as dynamic load sharing, signed field firmware upgrade, and variable buck input voltage.

This document contains test results of EZ-PD™ PAG1 and EZ-PD™ CCG7D-C based 65 W dual C power adapter solution board. The tests were performed on this board, which is equipped with Infineon CYPAP111A3-10SXQ on primary, CYPAS111/2A3-24LQXQ on secondary section and EZ-PD™ CCG7D-C of the converter.

Table 1 Test specification

Parameter	Value
Rated input voltage	100~240 Vac
Input frequency	47–63 Hz
Total output power	65 W
Single port1 or port2	PDO-fixed: 65 W 5 V/3 A, 9 V/3 A, 12 V/3 A, 15 V/3 A, 20 V/3.25 A PPS: 3.3 V–21 V/3.25 A
Dual output: port1+port2	20 W: 5 V/3 A, 9 V/2.22 A, 3.3 V–5.9 V/3 A, 3.3 V–11 V/2.2 A 32.5 W: 5 V/3 A, 9 V/3 A, 12 V/2.7 A, 3.3 V–11 V/3 A, 3.3 V–16 V/2.15 A 45 W: 5 V/3 A, 9 V/3 A, 12 V/3 A, 15 V/3 A, 20 V/2.25 A, 3.3 V–16 V/3 A
Efficiency	DoE level-6
Standby power	DoE level-6
Protection	OVP, UVP, OCP, SCP, OTP

2 Test setup

2.1 DUT (Device under test)

65 W dual C EZ-PD™ PAG1P/PAG1S and EZ-PD™ CCG7D-C solution kit: (CYPAP111A3/CYPAS111A1+CYPD7271).

Table 2 EZ-PD™ PAG1P/PAG1S and EZ-PD™ CCG7D-C solution kit details

DUT contents	Description
CYPAP111A3+CYPAS111A1	Primary and secondary controller
CYPD7271	DC-DC and PD controller
Firmware version	CYPAS111-24LQXQ_pa_65w_1014.hex CYPD7291-68LDXS_rsc_0709_test1.hex

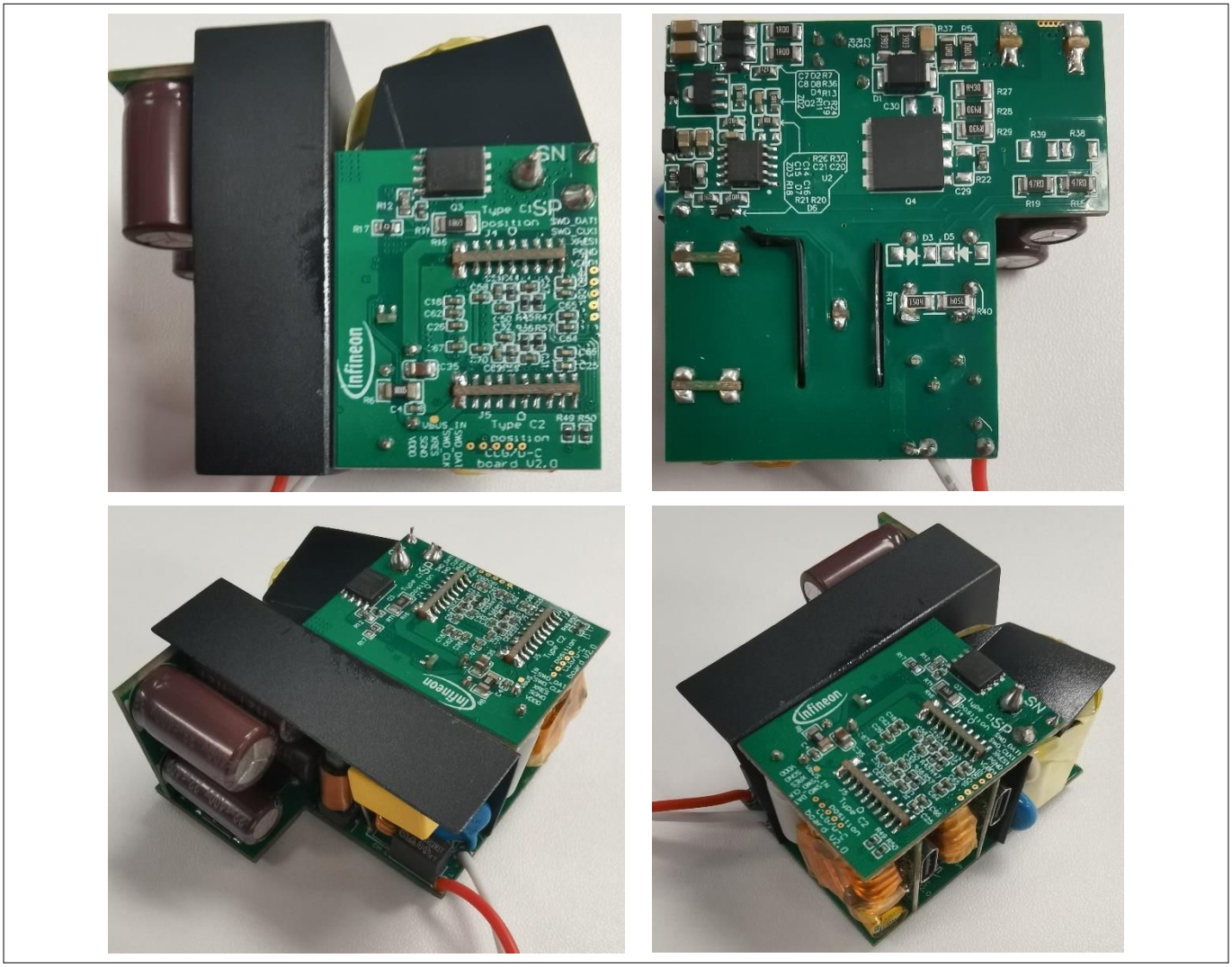


Figure 1 EZ-PD™ PAG1P/PAG1S and EZ-PD™ CCG7D-C Non-X-Cap Mode solution demo kit

PCBA dimensions (in mm): 51 (L) × 51 (W) × 29 (H)

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

2.2 DUT setup



Figure 2 Test setup

The DUT is connected to the PAT 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 this test setup, the solution kit is pre-configured with 4 PDOs for single port1 or single port2:

- PDO 1: 5 V, 3 A fixed
- PDO 2: 9 V,3 A fixed
- PDO 3: 12 V, 3 A fixed
- PDO 4: 15 V, 3 A fixed
- PDO 5: 20 V, 3.25 A fixed
- PDO 6: 3.3 V–21 V, 0–3.25 A PPS

Dual output: port1+port2:

- 20 W: 5 V/3 A, 9 V/2.22 A, 3.3 V–5.9 V/3 A, 3.3 V–11 V/2.2 A
- 32.5 W: 5 V/3 A, 9 V/3 A, 12 V/2.7 A, 3.3 V–11 V/3 A, 3.3 V–16 V/2.15 A
- 45 W: 5 V/3 A, 9 V/3 A, 12 V/3 A, 15 V/3 A, 20 V/2.25 A, 3.3 V–16 V/3 A

The user can either choose the suitable pre-configured PDO or configure a new one using the Infineon 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 (1 m long) in use: The type C-C cable being used for all the tests mentioned in this report is 3027003-01M. Datasheet is available at: https://www.qualtekusa.com/images/Cable%20Assemblies/PDF_2/3027003-01M.pdf.

2.3 Test equipment

Table 3 Test equipment list

Test setup	Description
Oscilloscope name	Tektronix MDO3024
Power meter	Yokogawa WT310E
Digital multimeter (V_o and I_o)	FLUKE 17B
Programmable AC source	JingCe DAL15P
Electronic load	Chroma 63600-1
Thermal camera	Fluke Ti200
Automation software	Chroma 8000
EMI test receiver 9 K–3.6 GHz	Rohde & Schwarz
QuadraMax	QuadraMax 103 1.4.4

3 Power management test results

The results documented here are based on the test reports of EZ-PD™ PAG1P/PAG1S and EZ-PD™ CCG7D-C dual C 65 W **Non-X-Cap Mode** solution demo kit.

3.1 Efficiency 4-point average

3.1.1 Single port 65 W

3.1.1.1 Detailed data

Table 4 Efficiency results

Parameter	Test condition	Minimum criteria	Unit	Test result	
		DoE level 6		115 Vac 60 Hz	230 Vac 50 Hz
4-point average efficiency (average of 25%, 50%, 75%, 100% load)[1) 2)]	V_o = 3.3 Vdc, I_o = 3 A	78.63	%	84.97	82.13
	V_o = 5 Vdc, I_o = 3 A	81.39	%	88.46	85.82
	V_o = 9 Vdc, I_o = 3 A	86.62	%	89.39	88.15
	V_o = 12 Vdc, I_o = 3 A	87.40	%	89.21	88.92
	V_o = 15 Vdc, I_o = 3 A	87.73	%	89.19	89.11
	V_o = 20 Vdc, I_o = 3.25 A	88.00	%	89.57	89.81
No load consumption	No USB sink attached	300 max	mW	33	48
10% load efficiency	V_o = 3.3 Vdc, I_o = 0.3 A		%	69.42	64.43
	V_o = 5 Vdc, I_o = 0.3 A		%	79.23	72.37
	V_o = 9 Vdc, I_o = 0.3 A		%	81.06	76.55
	V_o = 12 Vdc, I_o = 0.3 A		%	80.97	77.74
	V_o = 15 Vdc, I_o = 0.3 A		%	81.06	78.27
	V_o = 20 Vdc, I_o = 0.325 A		%	81.99	80.2

1) V_{out} for efficiency calculations is measured across V_{bus_c} at board end.
2) Variation of ±0.3% in 4-point average efficiency and ±1% in 10% efficiency can be observed.

Peak efficiency: **91.01 percent** (at 230 Vac–50 Hz, 20 V–3.25 A).

3.1.1.2 Graphs

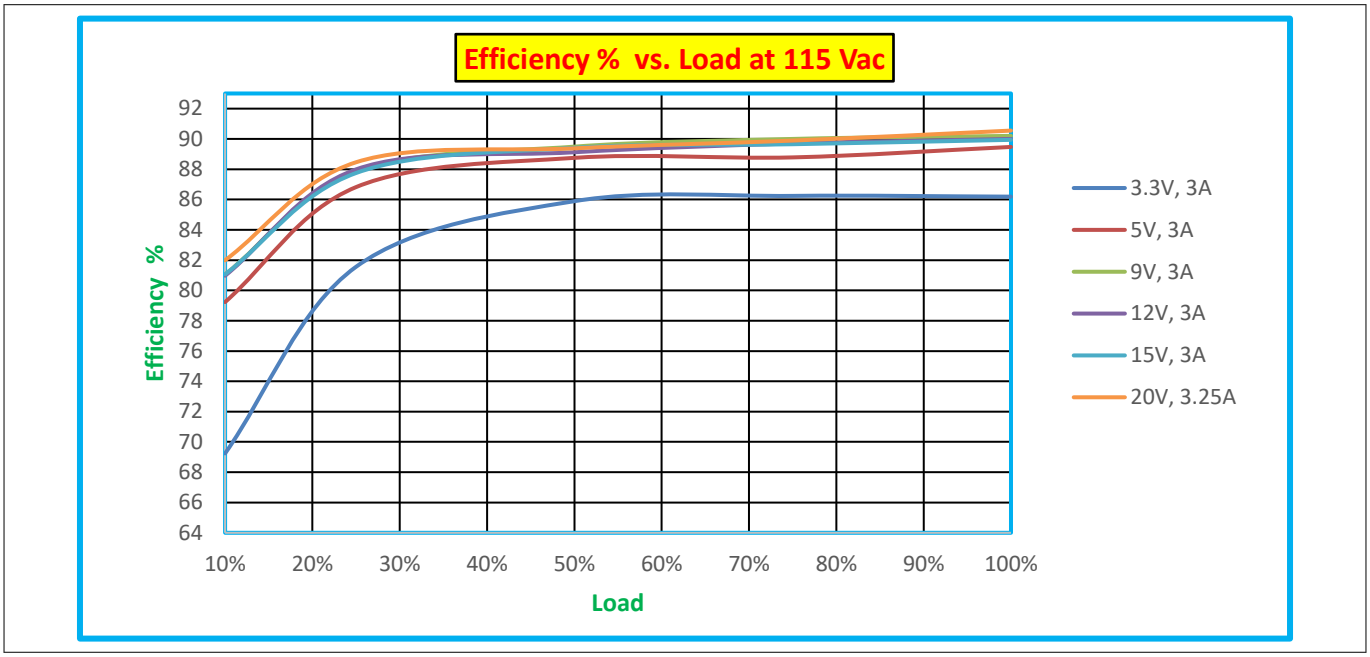


Figure 3 Efficiency at 115 Vac, 60 Hz

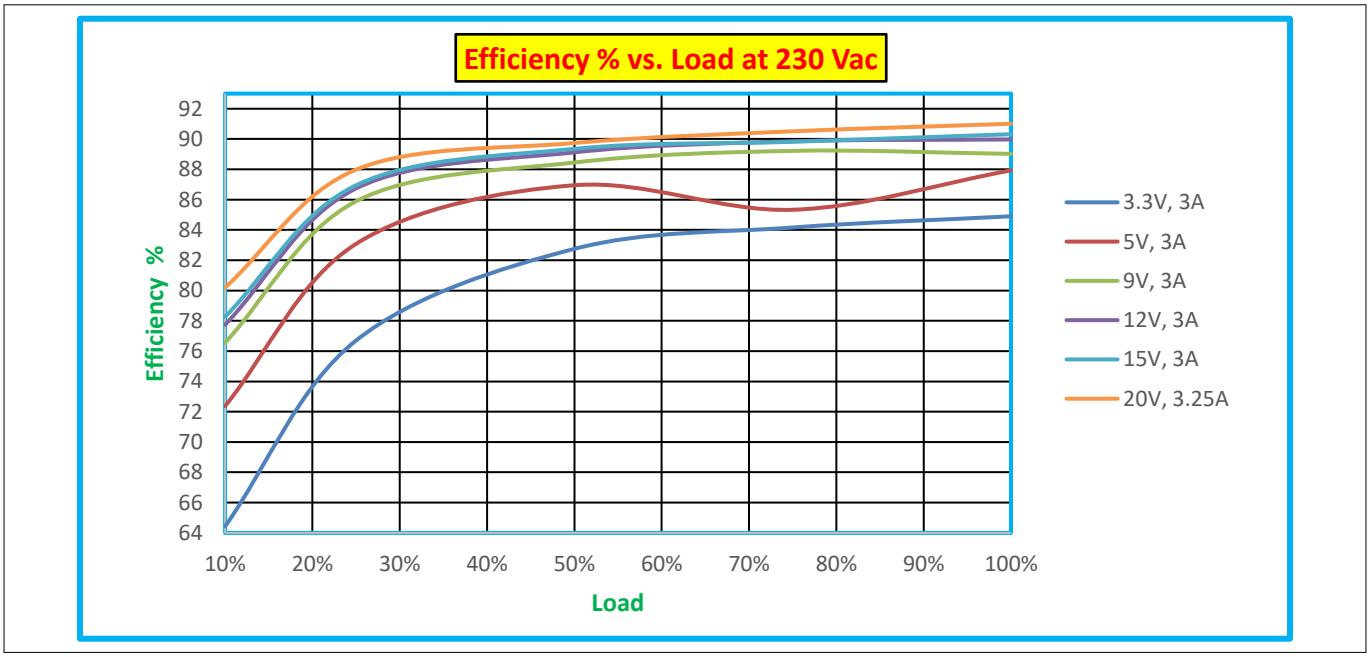


Figure 4 Efficiency at 230 Vac, 50 Hz

3.1.2 Dual port 65 W (port1+port2)

3.1.2.1 Detailed data

Table 5 Efficiency results

Parameter	Test condition	Minimum criteria	Unit	Test result	
		DoE level 6		115 Vac 60 Hz	230 Vac 50 Hz
4-point average efficiency (average of 25%, 50%, 75%, 100% load)[1) 2)]	Port1 5 V 3 A Port2 5 V 3 A	81.609	%	87.85	86.36
	Port1 5 V 3 A Port2 9 V 3 A	84.1325	%	88.17	87.33
	Port1 5 V 3 A Port2 12 V 3 A	86	%	87.72	87.44
	Port1 9 V 3 A Port2 9 V 3 A	86	%	88.51	88.10
	Port1 5 V 3 A Port2 15 V 3 A	86	%	87.70	87.86
	Port1 5 V 3 A Port2 20 V 2.25 A	86	%	88.07	88.06
	Port1 9 V 3 A Port2 12 V 3 A	86	%	88.43	88.09
	Port1 12 V 2.7 A Port2 12 V 2.7 A	86	%	88.38	88.38
	Port1 9 V 2.22 A Port2 15 V 3 A	86	%	88.17	87.07
	Port1 9 V 2.22 A Port2 20 V 2.25 A	86	%	88.26	88.32

1) V_{out} for efficiency calculations is measured across V_{bus_c} at board end.
2) Variation of ±0.3% in 4-point average efficiency and ±1% in 10% efficiency can be observed.

Peak efficiency: **89.94 percent** (at 230 Vac–50 Hz, port1 9 V 2.22 A+port2 20 V 2.25 A).

3.1.2.2 Graphs

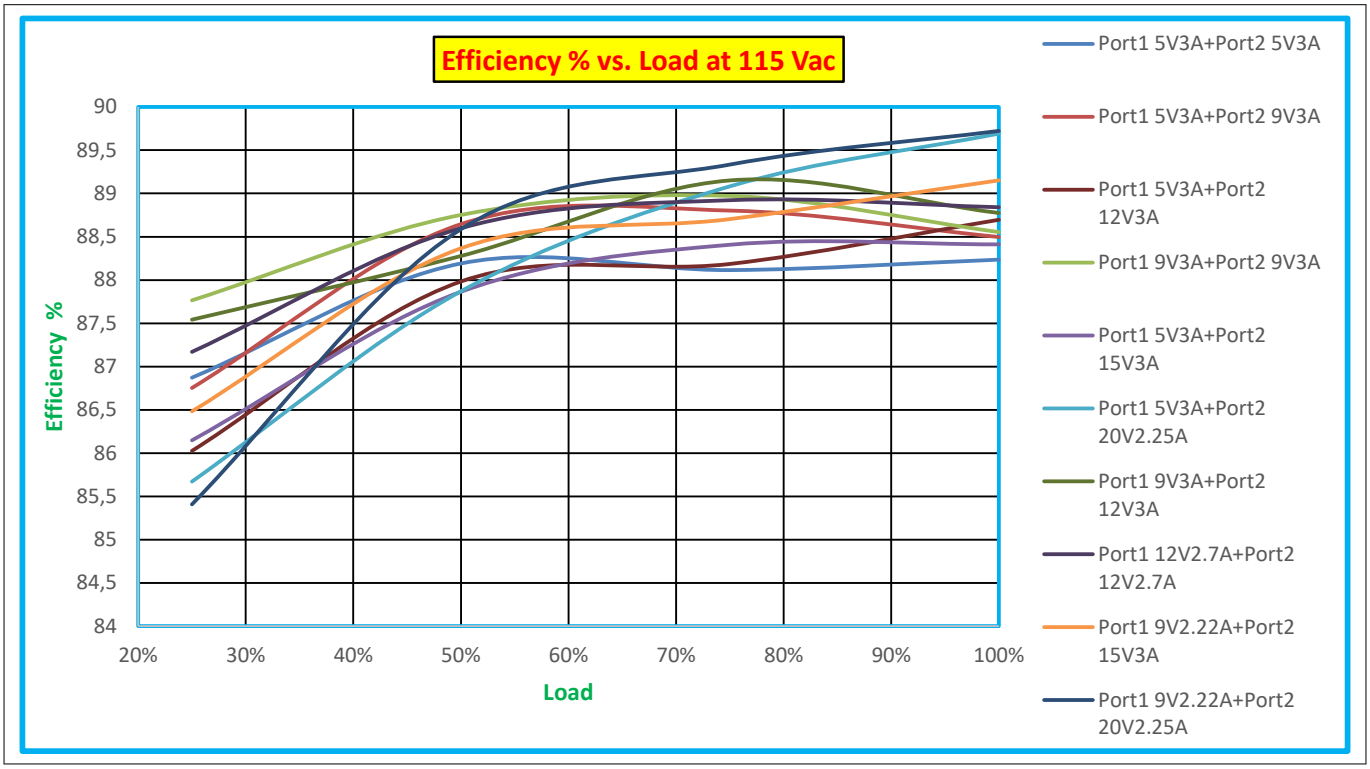


Figure 5 Efficiency at 115 Vac, 60 Hz

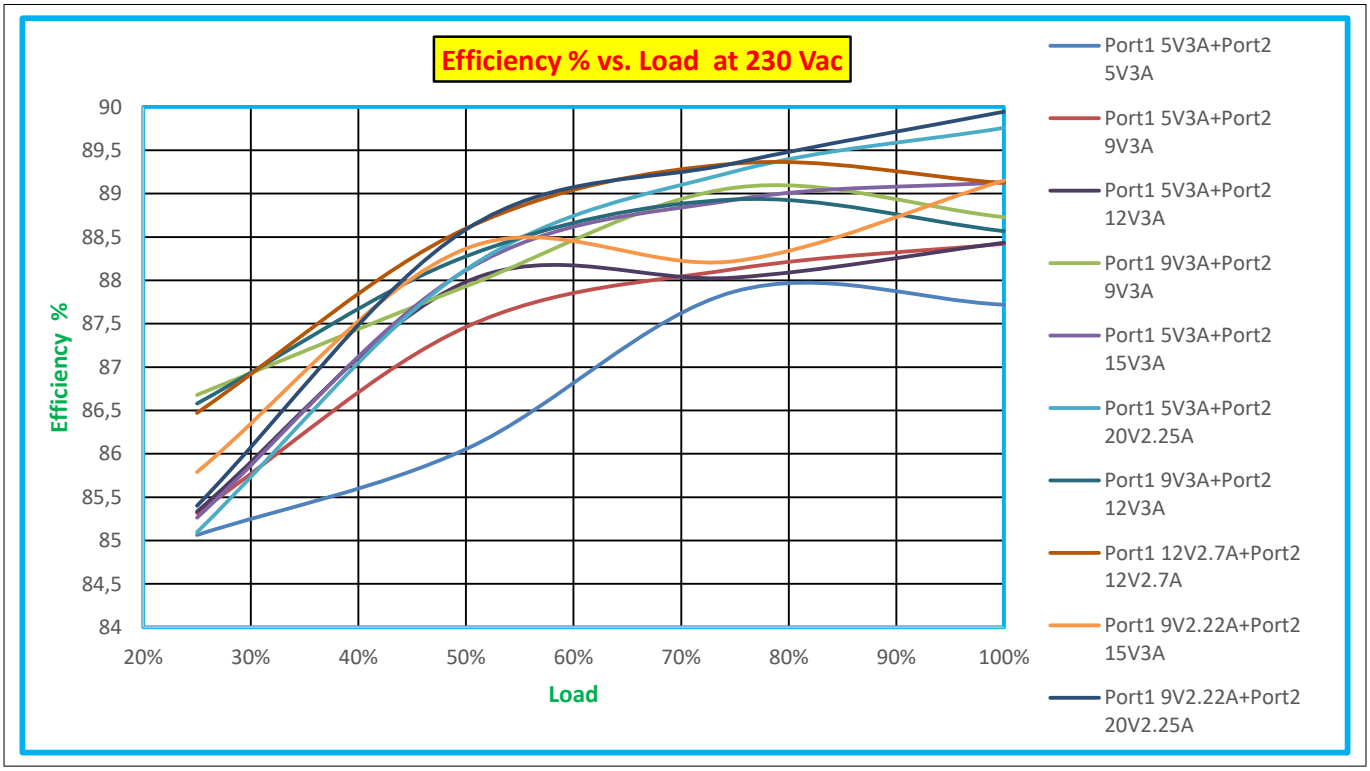


Figure 6 Efficiency at 230 Vac, 50 Hz

3.2 Standby power consumption

3.2.1 Detailed data

Table 6 Standby power results

V_{in} (Vac)	90 Vac, 60 Hz	115 Vac, 60 Hz	230 Vac, 50 Hz	264 Vac, 50 Hz
Input power (mW)[1)]	32	33	48	55

1) There should be 5 minutes of warm-up time before starting to measure standby power.

3.2.2 Graph

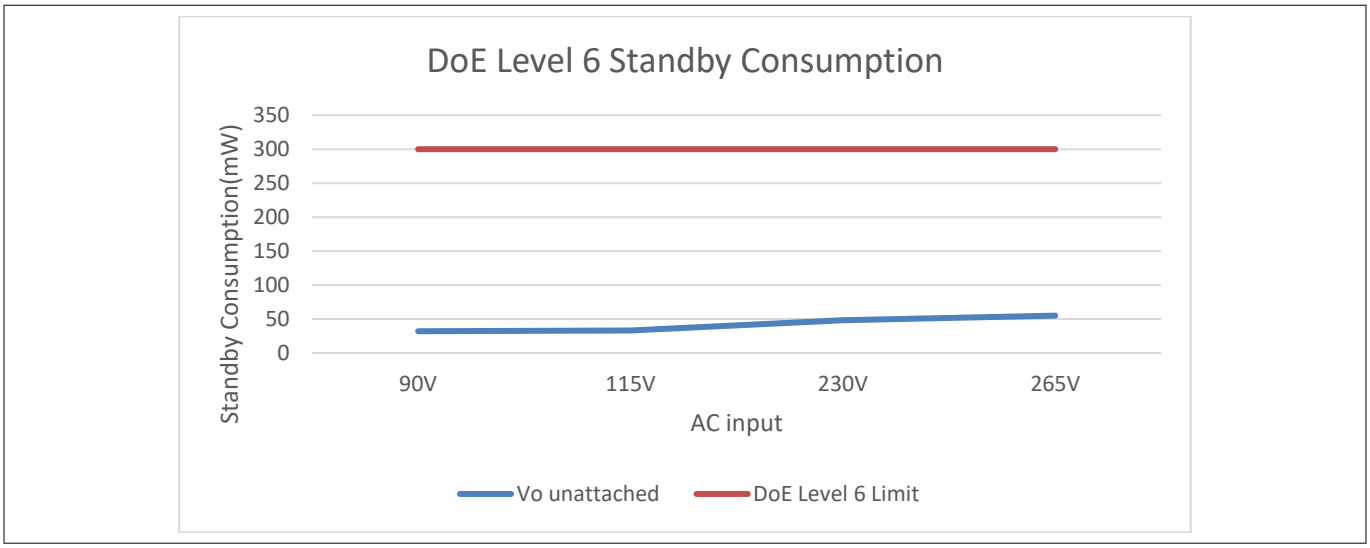


Figure 7 Standby power versus DoE level 6 criteria

3.2.3 Details



Figure 8 Detailed power measurement results at 115 Vac, 60 Hz

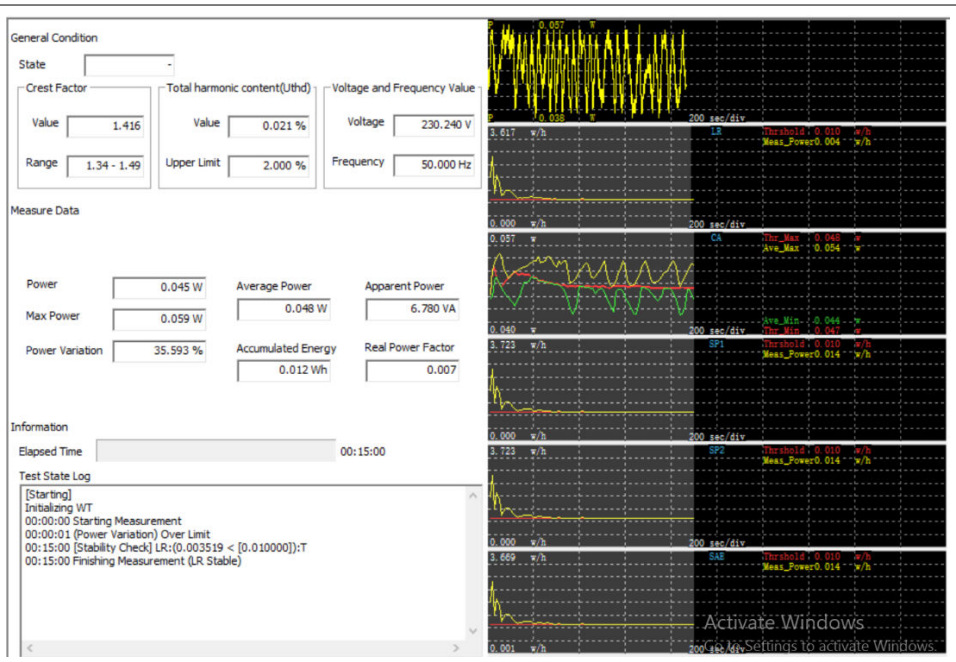


Figure 9 Detailed power measurement results at 230 Vac, 50 Hz

3.3 Output voltage ripple and noise peak-peak

The ripple and noise are measured with 10 uF E-cap and 104 K ceramic capacitor at V_{bus}, and the oscilloscope bandwidth is set at 20 MHz. The probe is needed to remove the outside plastic protector and GND wire, instead a spring PIN is necessary for directly grounding. Refer to Figure 10 for the ripple probe connection.

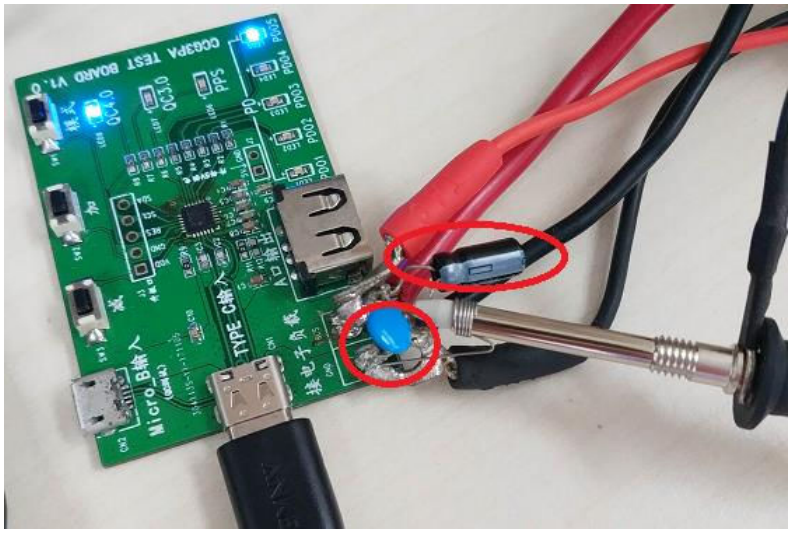


Figure 10 Ripple probe used (connected at board end)

3 Power management test results

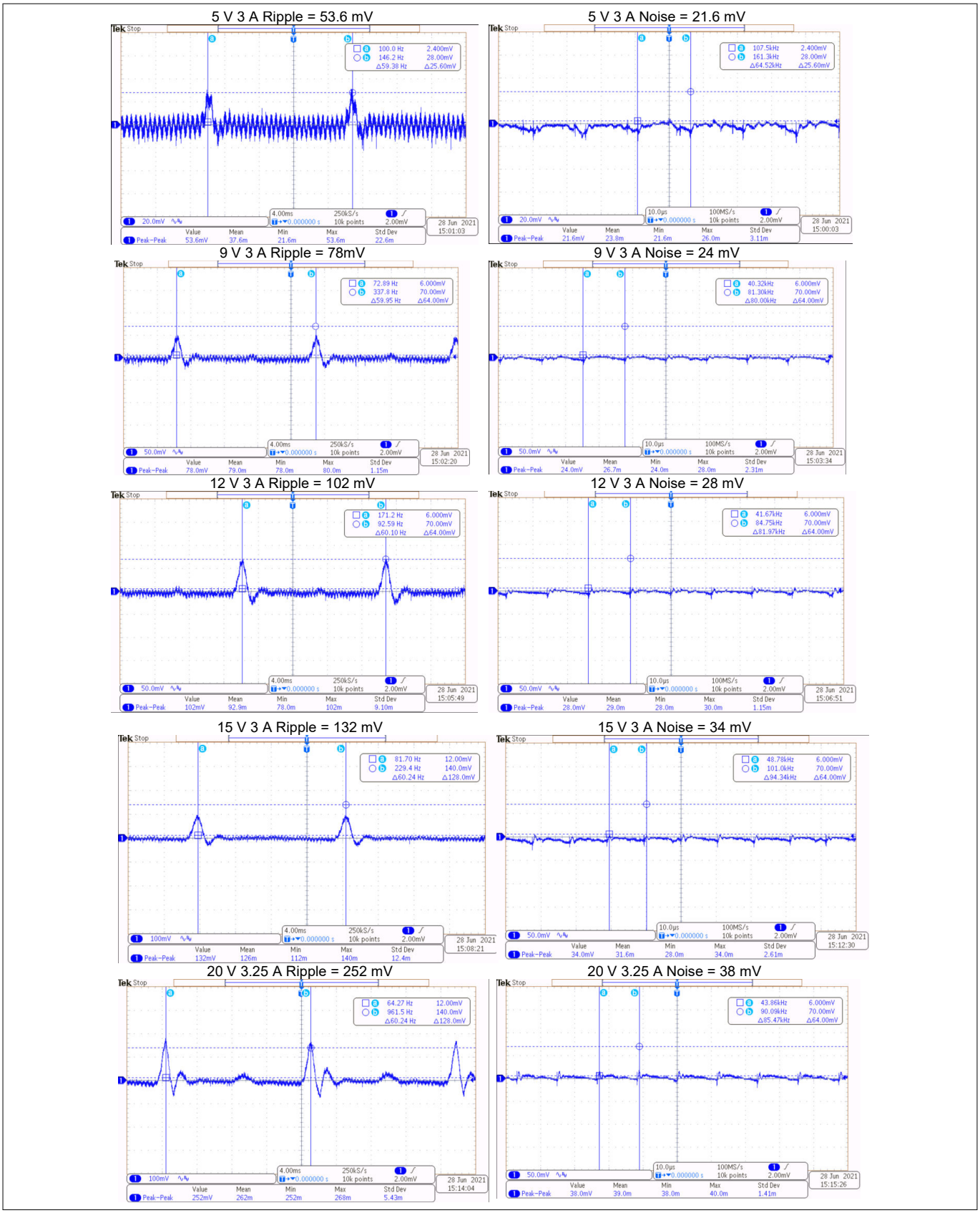


Figure 11 Ripple and noise at 100 Vac, 60 Hz (CH1: V_{bus_c})

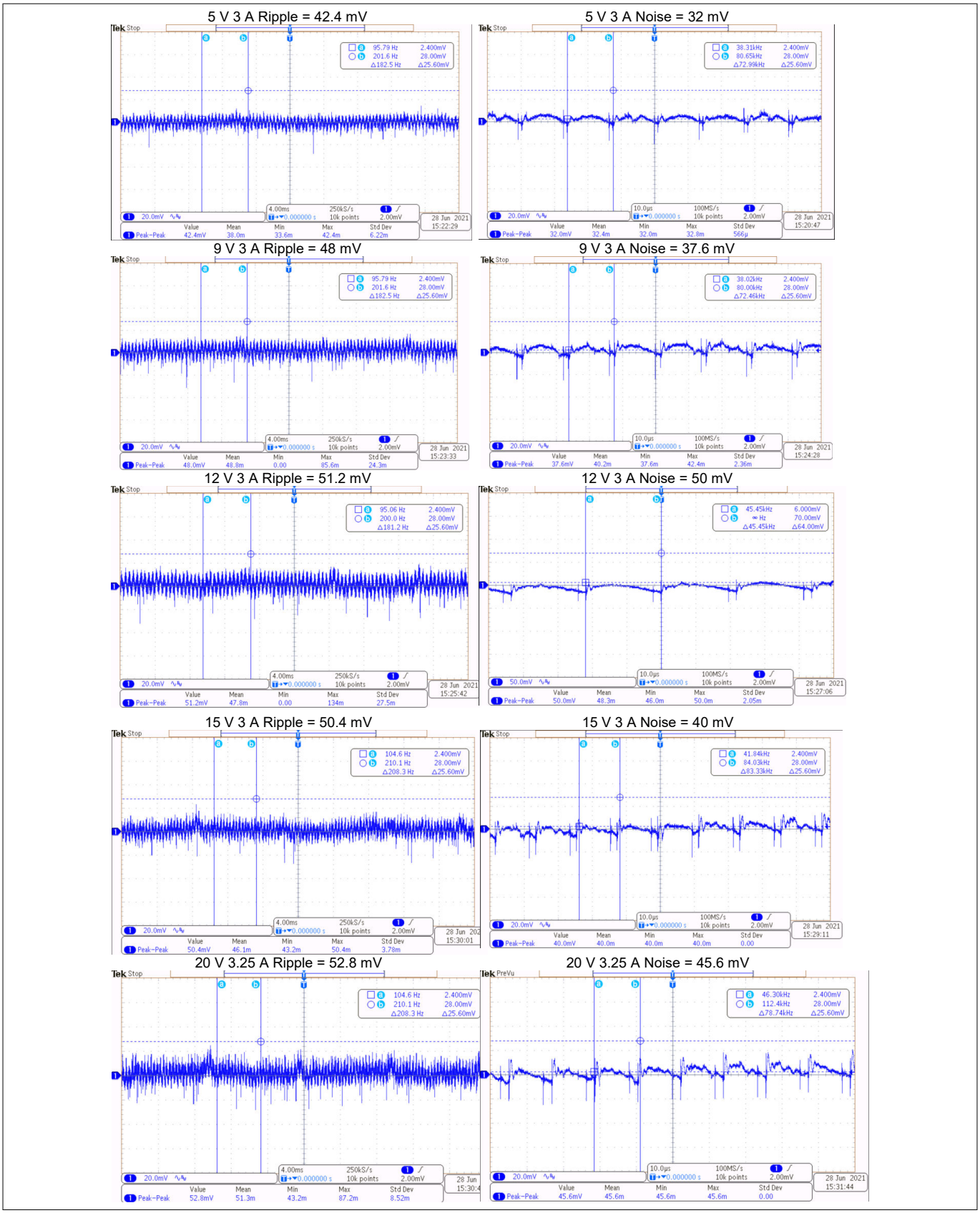


Figure 12 Ripple and noise at 240 Vac, 50 Hz (CH1: V_{bus_c})

3.4 Output voltage ripple dynamic response

Test condition: Load = 100–10 percent, T_1 = 20 ms, T_2 = 20 ms, slew = 0.5 A/uS, 115 Vac, 60 Hz (**CH1:** V_{bus_c}, **CH4:** I_{out})

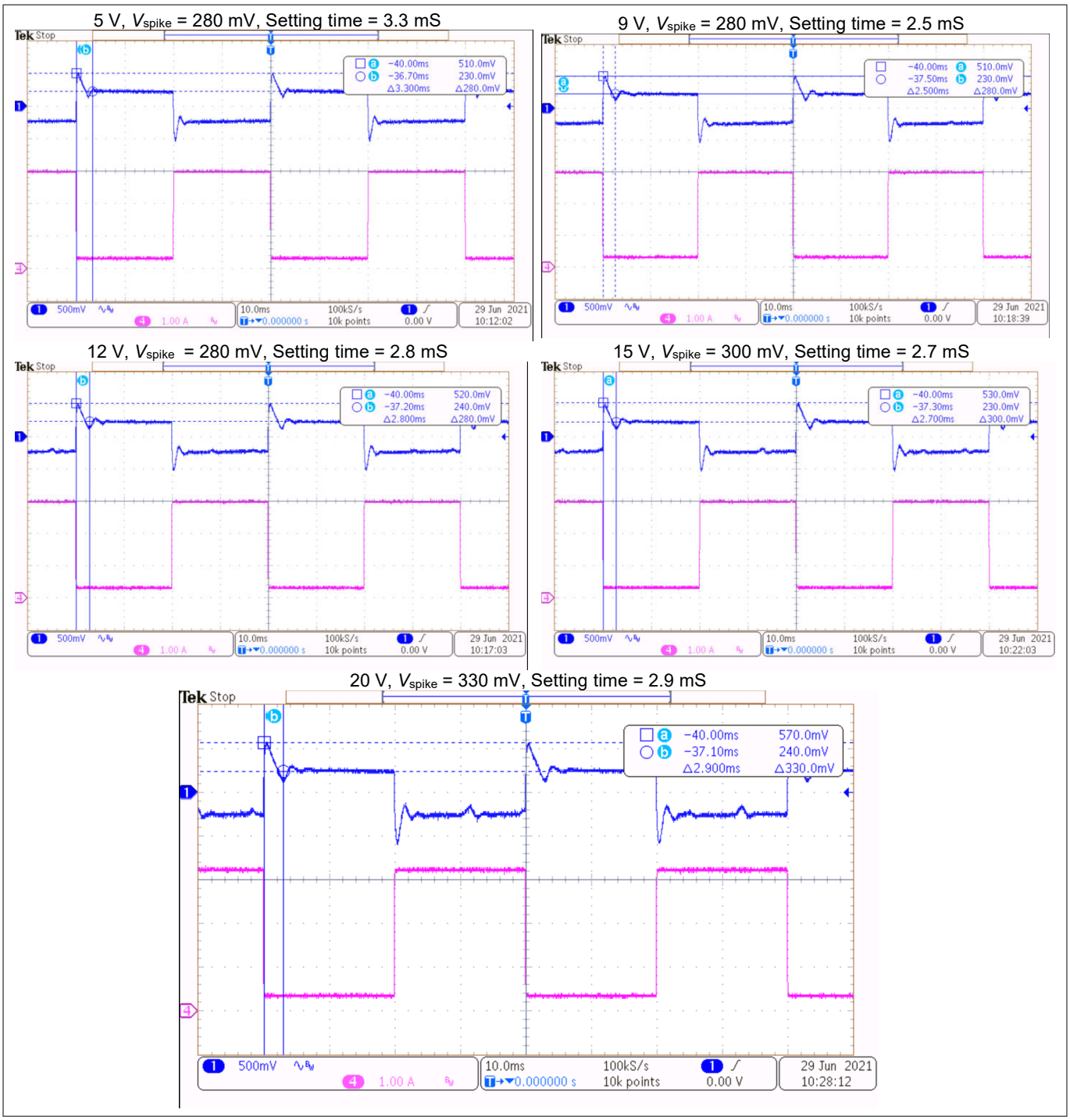
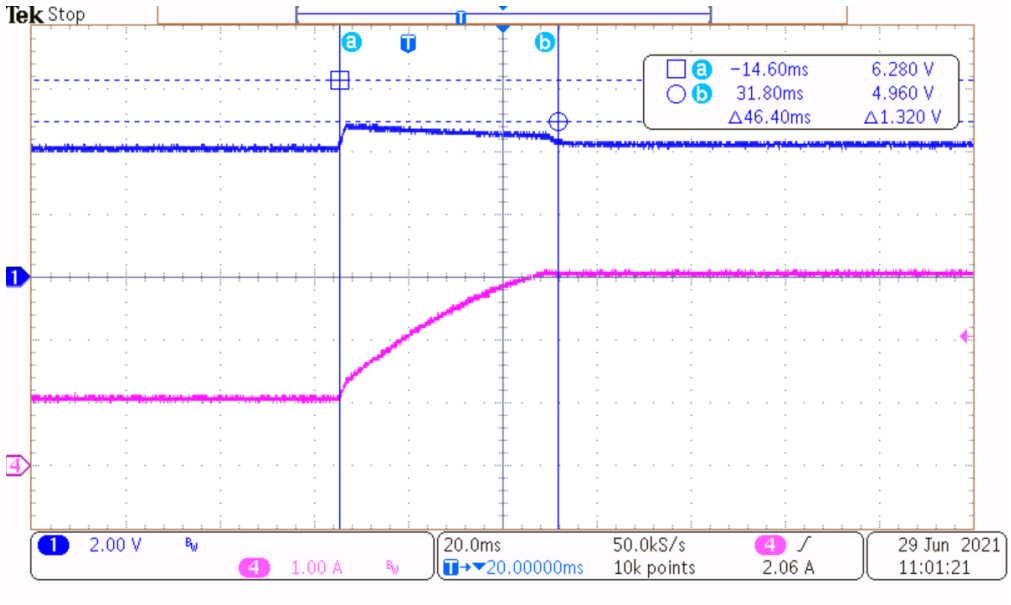


Figure 13 Voltage ripple dynamic response at 115 Vac, 60 Hz (CH1: V_{bus_c}, CH4: I_{out})

3.5 Output current dynamic response

Test condition: 115 Vac, 60 Hz, PPS CV mode at E-load (**CH1:** V_{bus_c}, **CH4:** I_{out}).

▼ 5 V 1 A~3 A load, Settling time = **46.4 mS**



▼ 20 V 1 A~3 A load, Settling time = **40.8 mS**

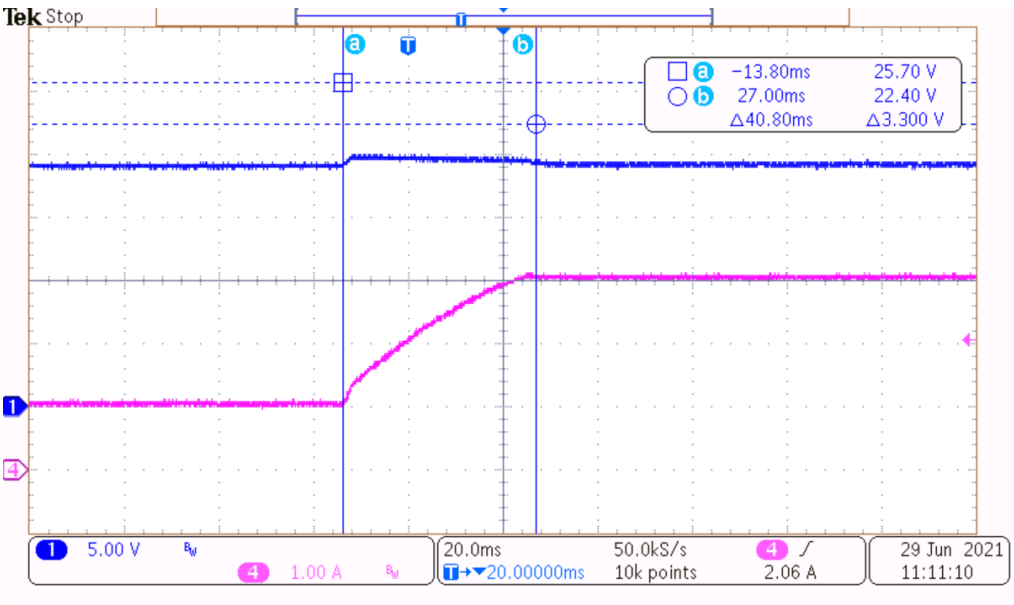


Figure 14 Current dynamic response at 115 Vac, 60 Hz (CH1: V_{bus_c}, CH4: I_{out})

3.6 Start-up turn-on delay

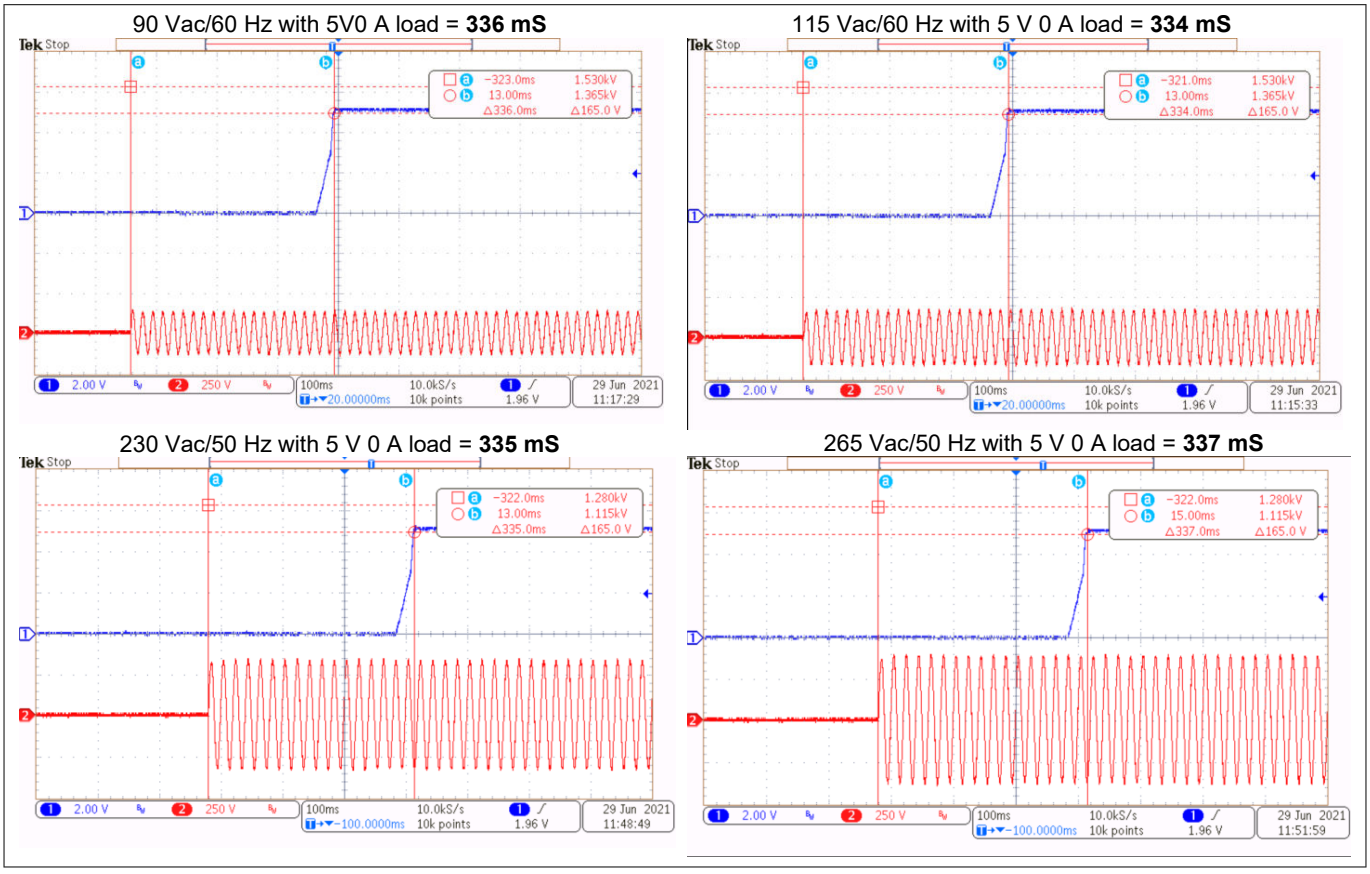
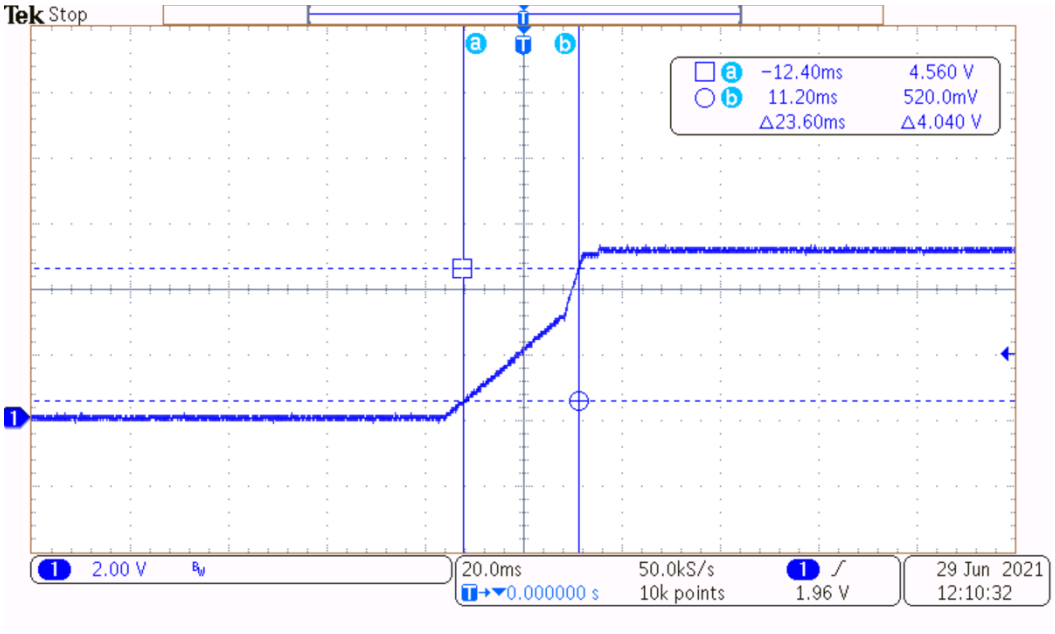


Figure 15 Start-up turn-on delay at various AC input (CH1: V_{bus_c}, CH2: AC input)

3.7 Start-up turn-on rise time

▼ Start-up rise time at 90 Vac/60 Hz with 5 V 0 A load = **23.6 mS** (**CH1:** V_{bus_c})



▼ Start-up rise time at 265 Vac/50 Hz with 5 V 0 A load = **22.8 mS** (**CH1:** V_{bus_c})

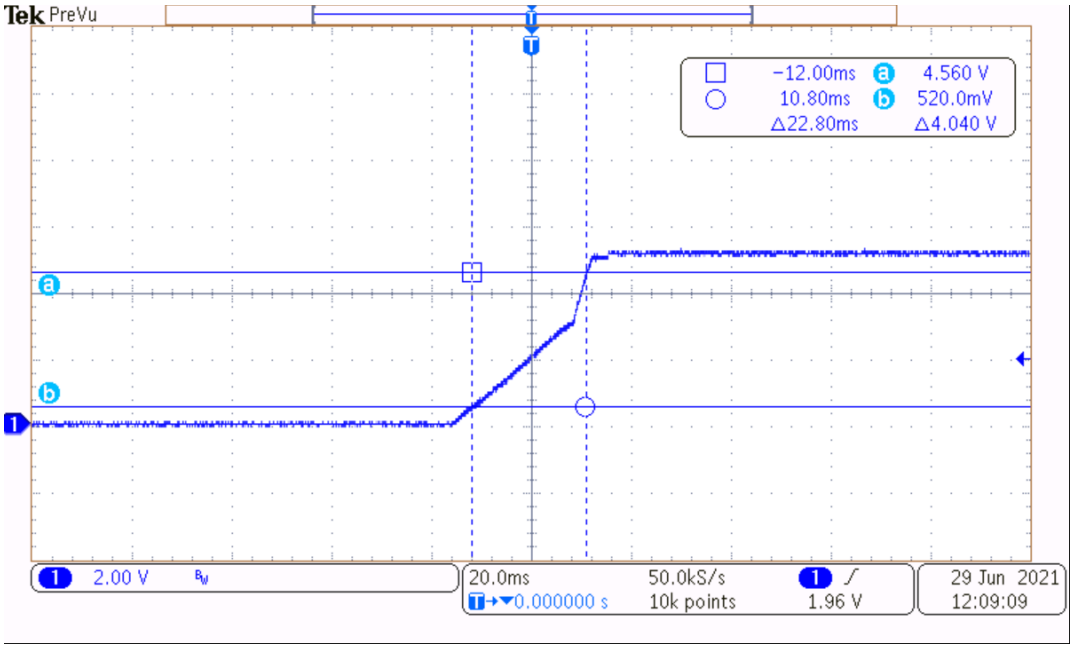
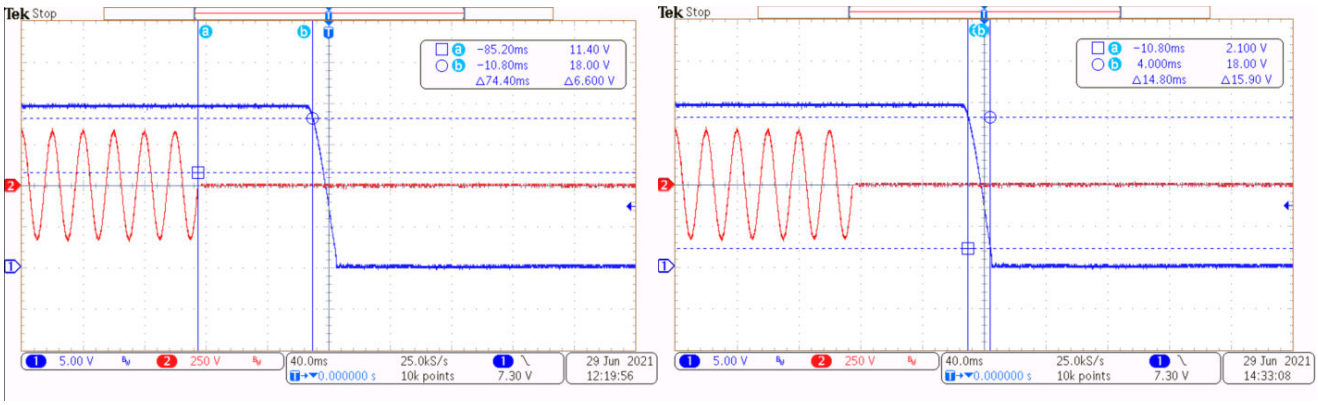


Figure 16 Start-up turn-on rise time at various AC input (CH1: V_{bus_c})

3.8 Shut-down hold-up and fall time

▼ 230 Vac/50 Hz with 20 V 3.25 A load, Thold-up = **74.4 mS**, T_{fall} = **14.8 mS** (**CH1:** V_{bus_c}, **CH2:** AC input)



▼ 115 Vac/60 Hz with 20 V 3.25 A load, Thold-up = **15.9 mS**, T_{fall} = **14 mS** (**CH1:** V_{bus_c},, **CH2:** AC input)

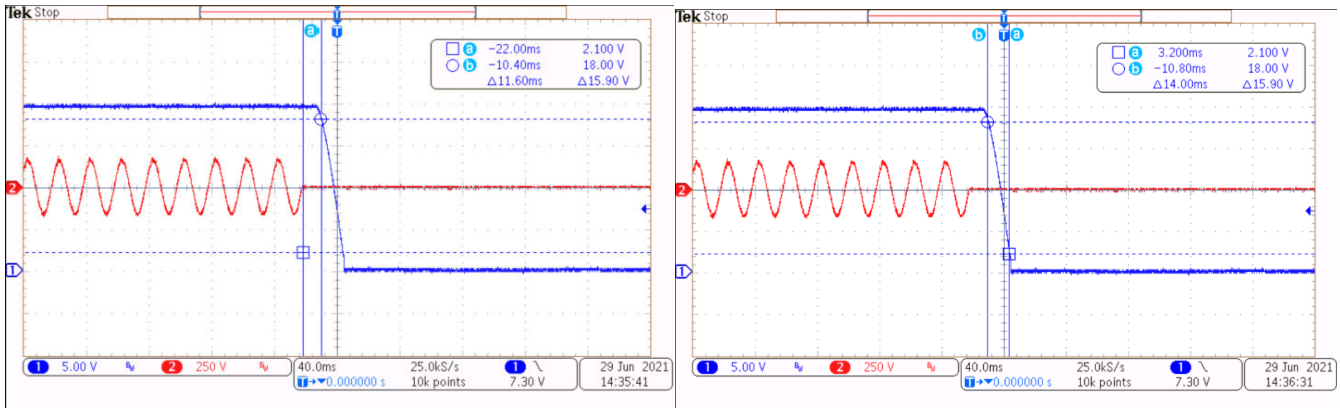


Figure 17 Shut-down hold-up and fall time at various AC input (CH1: V_{bus_c}, CH2: AC input)

3.9 Switch voltage stress

Test condition: V_{in} = 265 Vac, 50 Hz with 20 V/3.25 A full load.

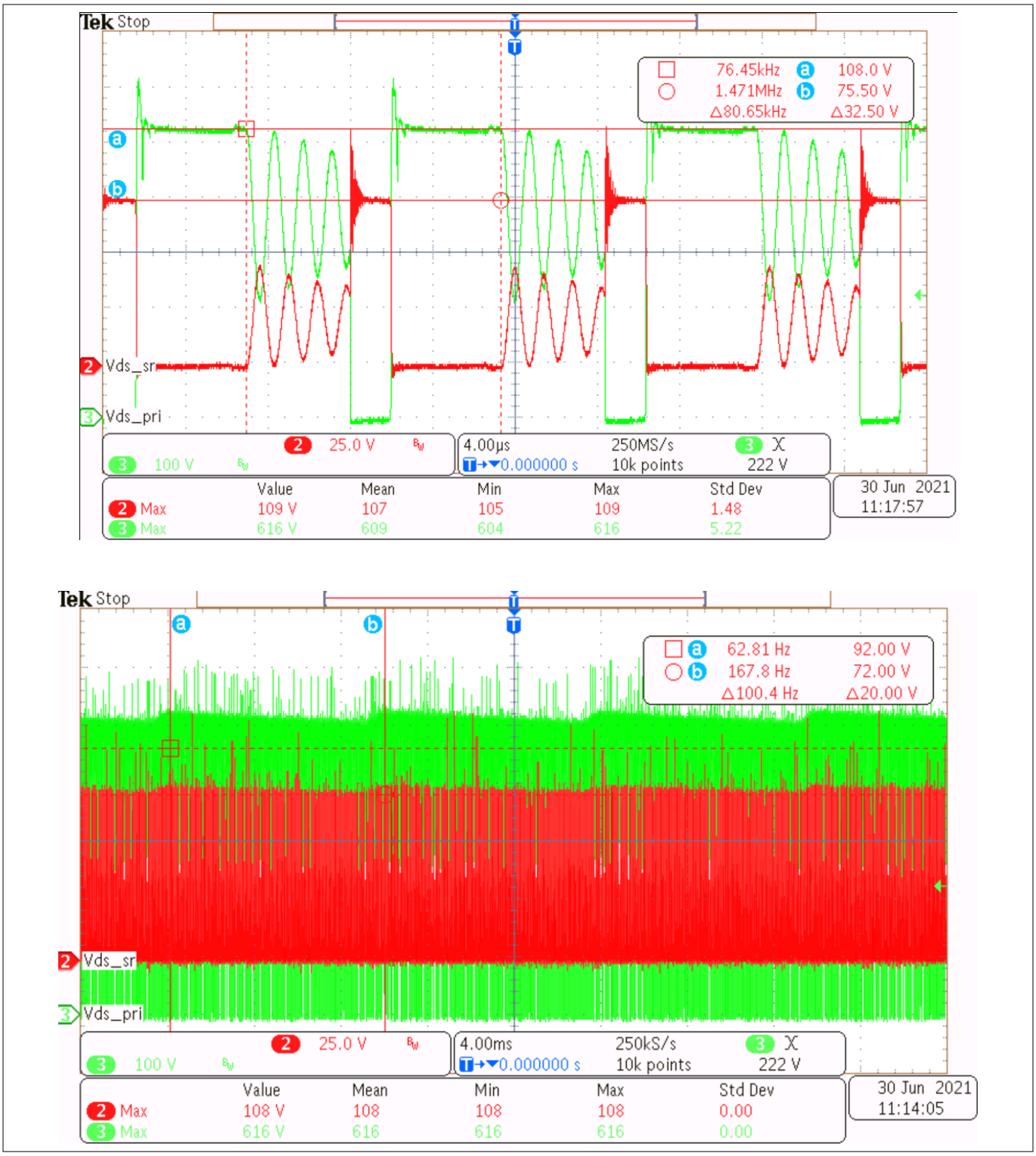


Figure 18 Voltage stress on primary FET and SR FET (CH2: V_{ds_sr}, CH3: V_{ds_pri})

V_{ds_pri} = 616 V < 700 V, V_{ds_sr} = 109 V < 150 V.

3.10 Overcurrent protection

Test condition: At 115 V, 60 Hz with full load of each PDO (**CH1:** V_{bus_c}, **CH4:** I_{out})

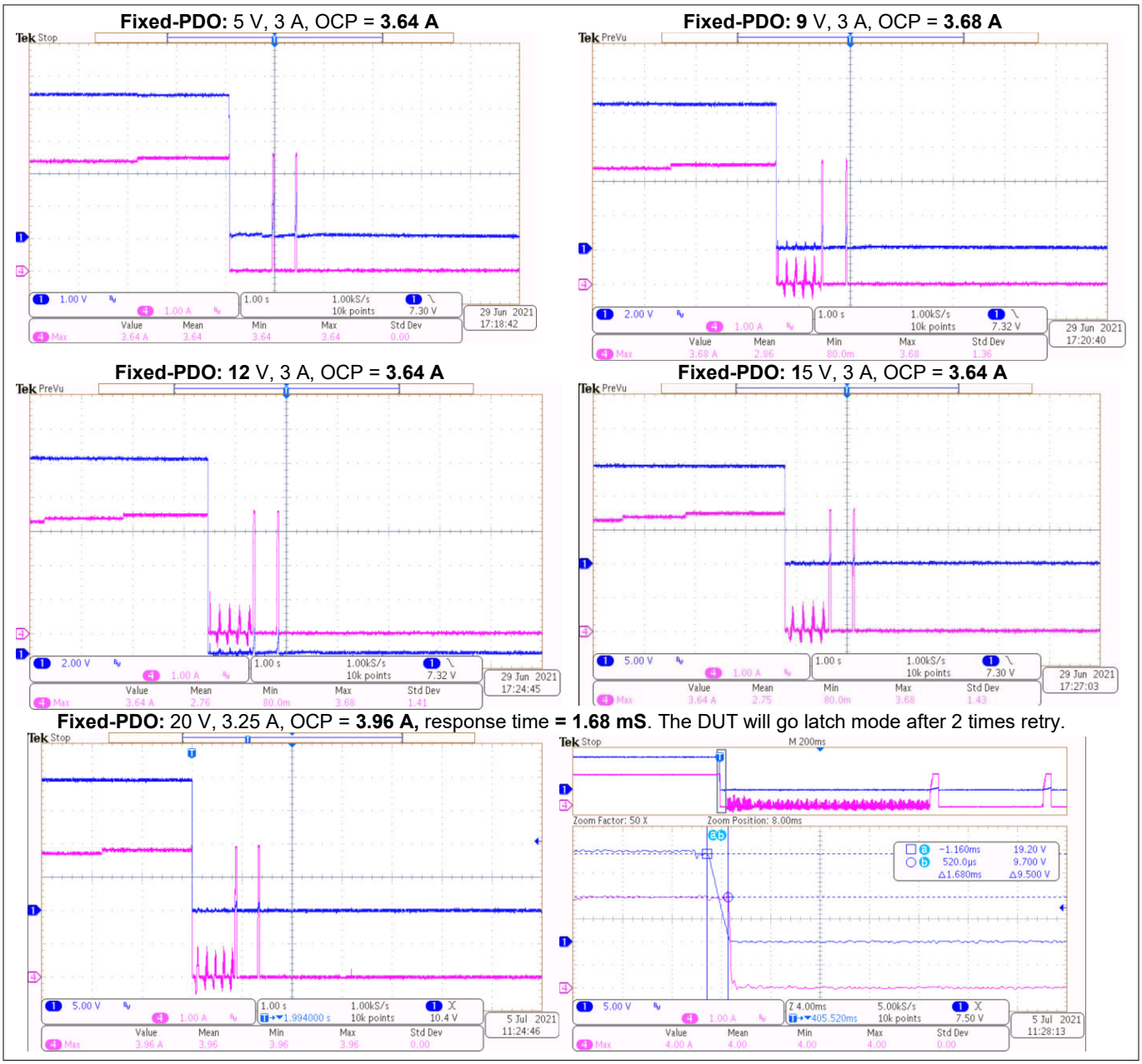


Figure 19 Overcurrent protection at 115 V, 60 Hz (CH1: V_{bus_c}, CH4: I_{out})

3.11 Short circuit protection

Test condition: At 115 Vac, 5 V 0.3 A load. Short E-load output.

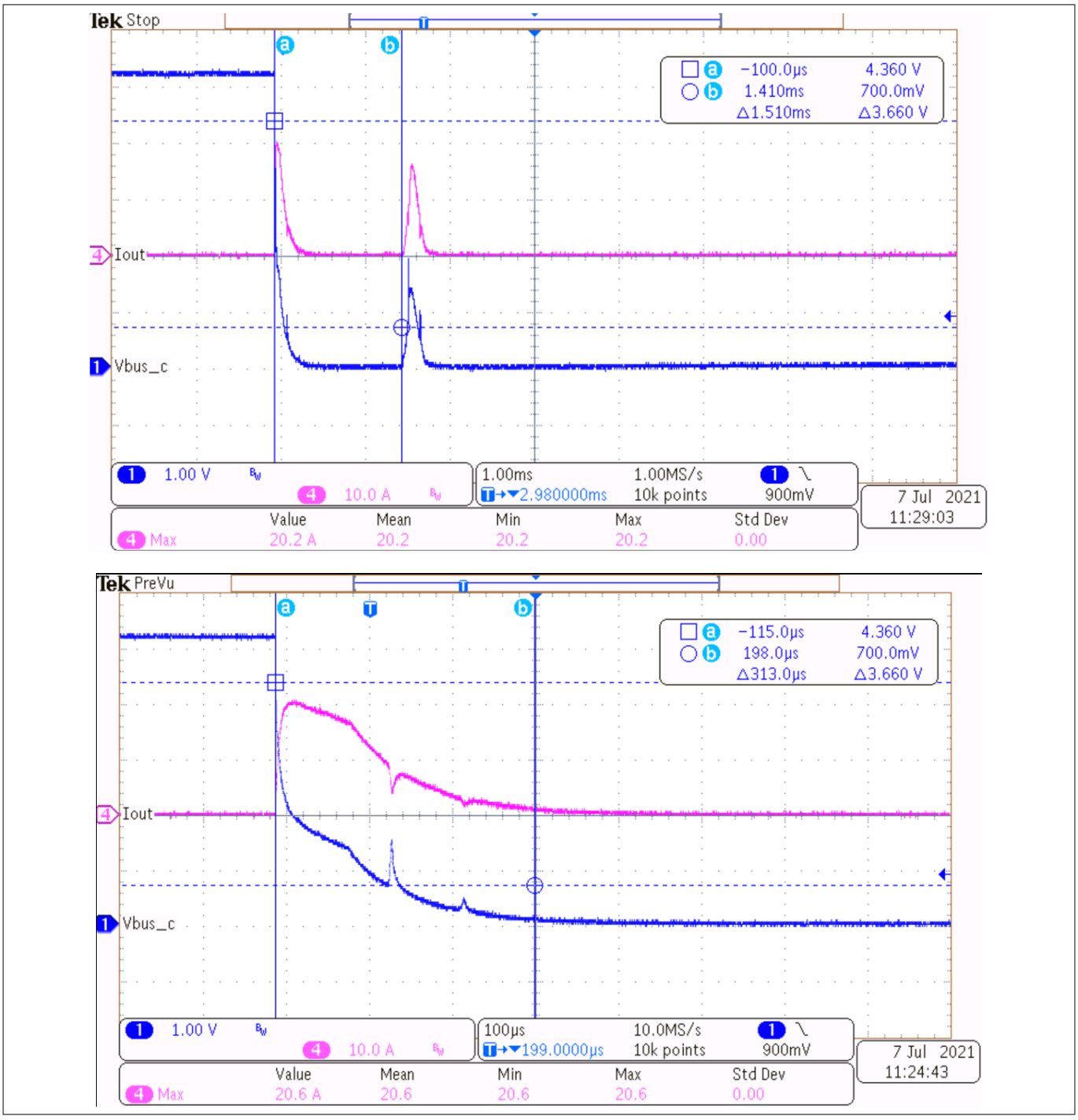
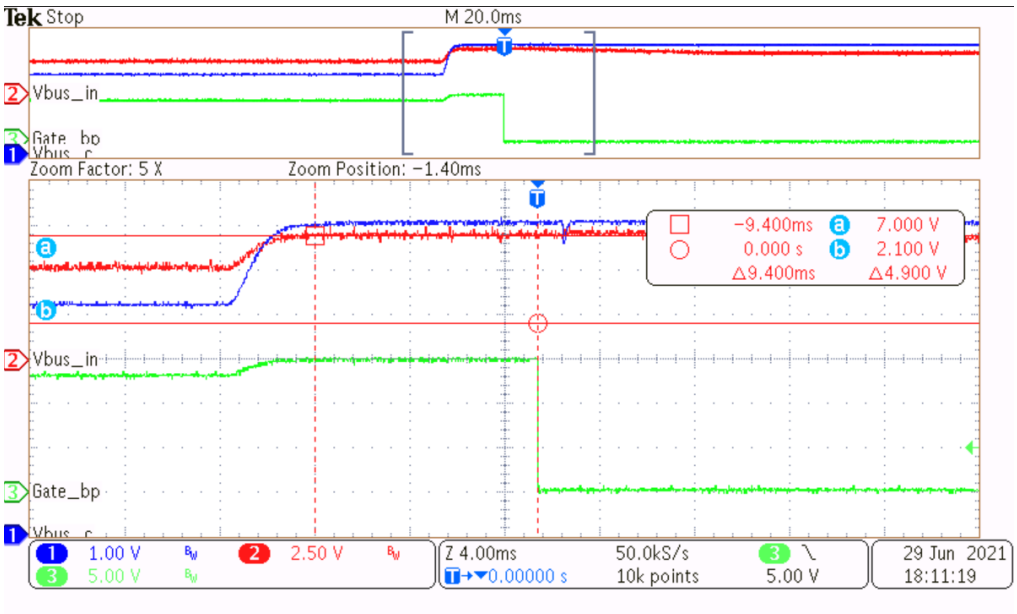


Figure 20 Short circuit protection at 115 Vac

3.12 Overvoltage protection

Test condition: 115 Vac, 0 A load.

PDO 5 V, apply 7 V DC source to V_{bus_c} and GND. Vovp = **7 V** on V_{bus_in}



PDO 12 V, apply 15 V DC source to V_{bus_c} and GND, V_{ovp} = 1**5 V** on V_{bus_in}

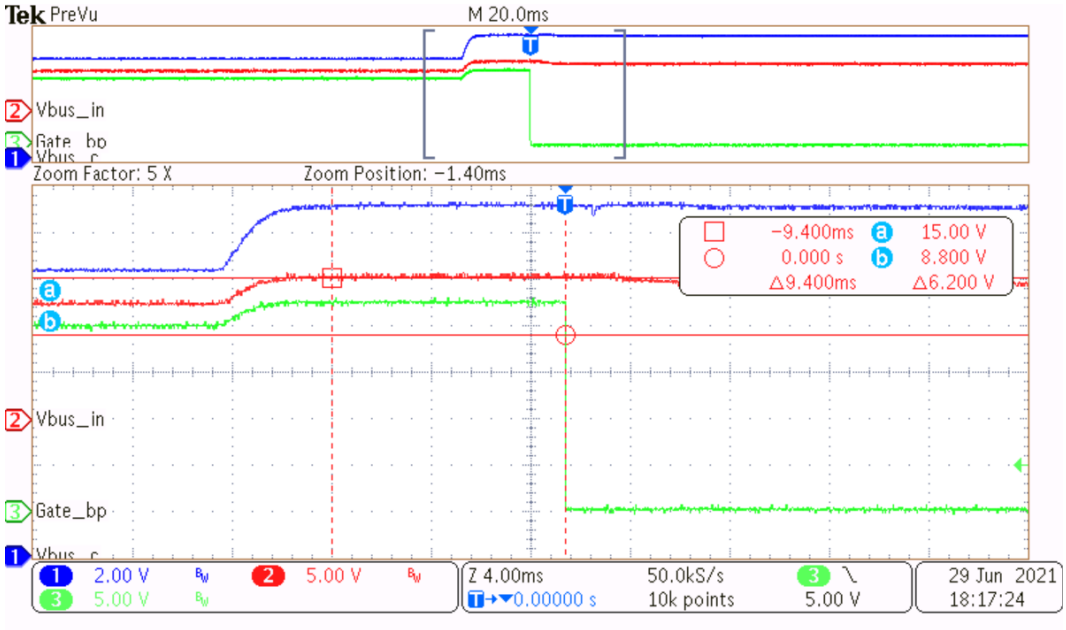


Figure 21 Overvoltage protection at 115 Vac

3.13 Overtemperature protection

Single port C1 (20 V 3.25 A)

- OTP trigger point = 100°C, bypass MOSFET close and V_{bus_c} drops to 0 V
- OTP resume point = 90°C, bypass MOSFET turn on again and V_{bus_c} resumes to 20 V

Dual port C1 (12 V 3 A)+port C2(5 V 3 A)

- OTP trigger point = 100°C, buck MOSFET close, V_{bus_c1} and V_{bus_c2} drops to 0 V
- OTP resume point = 90°C, buck MOSFET turn on again, V_{bus_c1} resumes to 12 V and V_{bus_c2} resumes to 5 V

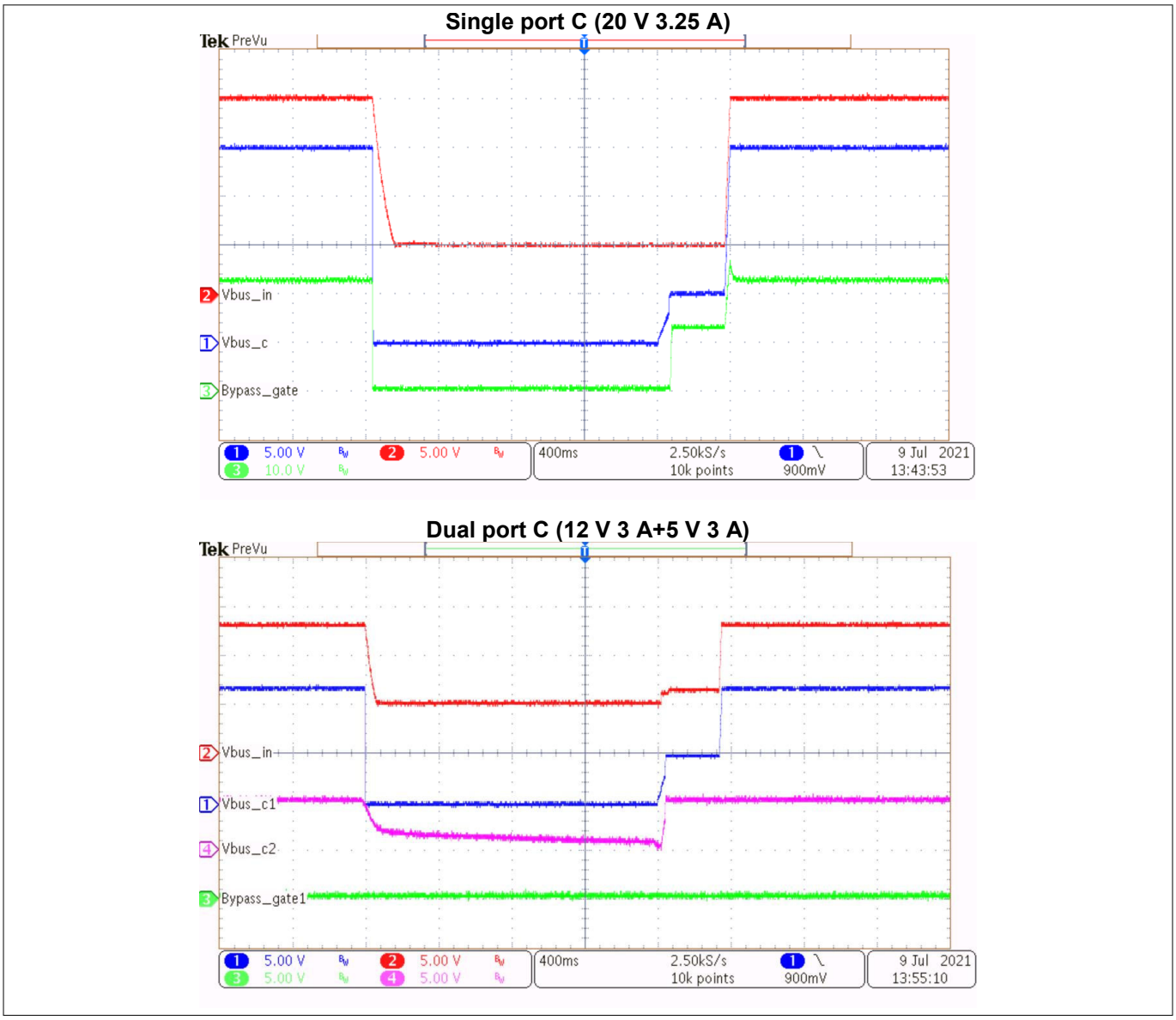


Figure 22 Overtemperature protection at single port and dual port

The sense point of temperature is from NTC 100 K resistor on the type C1 and type C2 boards.

3.14 Thermal captures

1. Test condition: Single port V_{out} = 20 V, I_{out} = 3.25 A full load.
Ambient condition: 25°C and in open-frame with free air-flow for running 60 minutes.

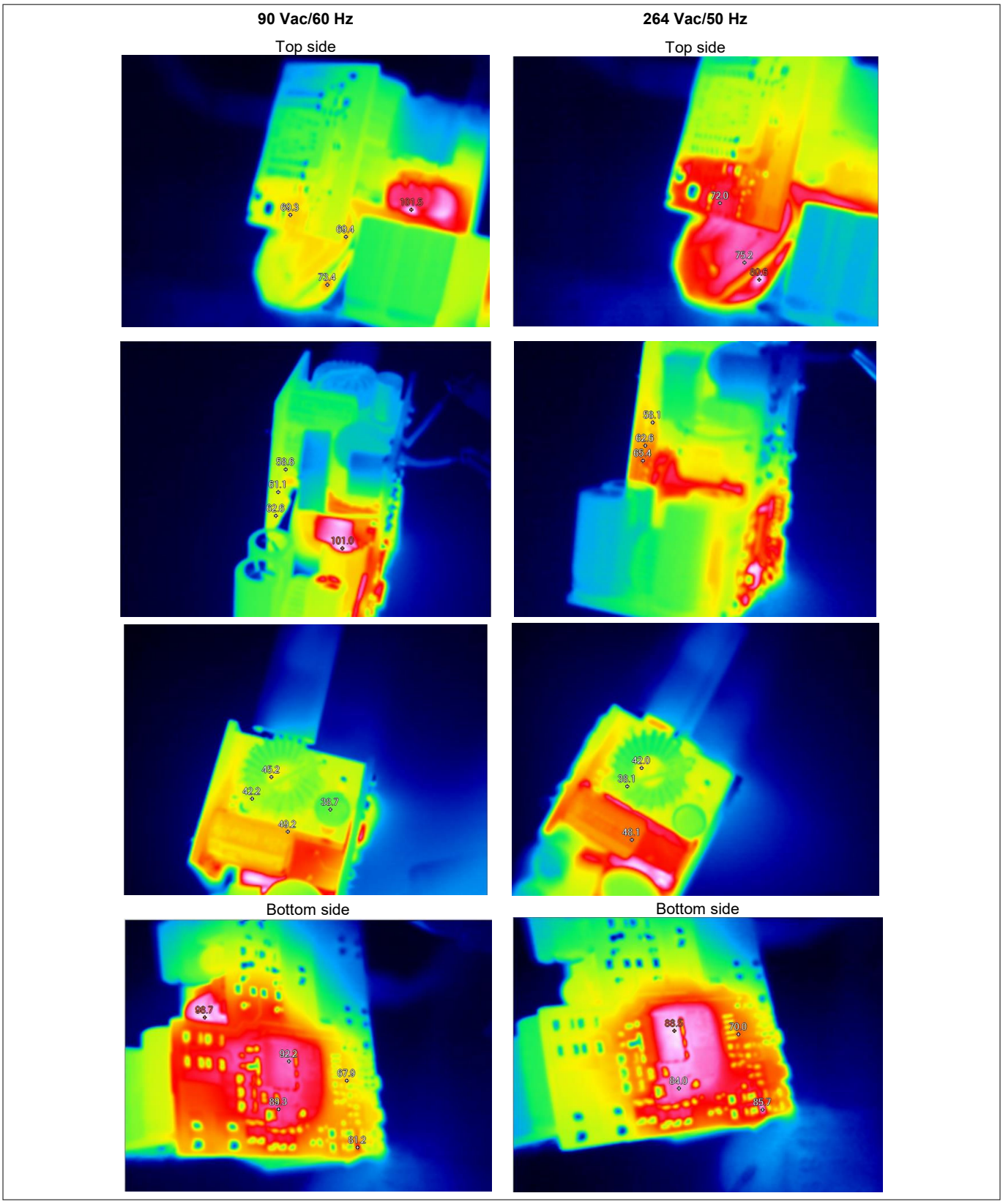


Figure 23 Thermal capture for single port at 90 Vac, 60 Hz and 264 Vac, 50 Hz

Table 7 Test results

Measured key component	Temperature (°C)	
	90 Vac/60 Hz	264 Vac/50 Hz
Transformer RM10 core (T1)	80	75.2
Transformer RM10 wire (T1)	83	80.6
Pulse transformer (T2)	71	52.5
Primary-MOSFET: IPL65R195C7 (Q4)	92.2	88.5
SR MOSFET: BSC0402NS(Q3)	69.3	72
Primary snubber diode (D1)	89.3	84
SR snubber (C3+R1)	62.6	65.4
Bridge diode: MSB407 (BD1//BD2)	94.9	60.8
EZ-PD™ PAG1P (U2)	67.9	70
EZ-PD™ PAG1S (U1)	61.1	62.6
Primary AUX LDO (Q2+D2)	81.2	85.7
CMC (LF2)	101.5	56.5
EZ-PD™ CCG7D-C (U3)	58.6	58.1
Bypass MOSFET (Q7)	45.2	42
Power inductor (L3)	42.2	38.1

2. Test condition: Port1 V_{out} = 15 V, I_{out} = 3 A and port2 V_{out} = 9 V, I_{out} = 2.22 A.
Ambient condition: 25°C and in open-frame with free air-flow for running 60 minutes.

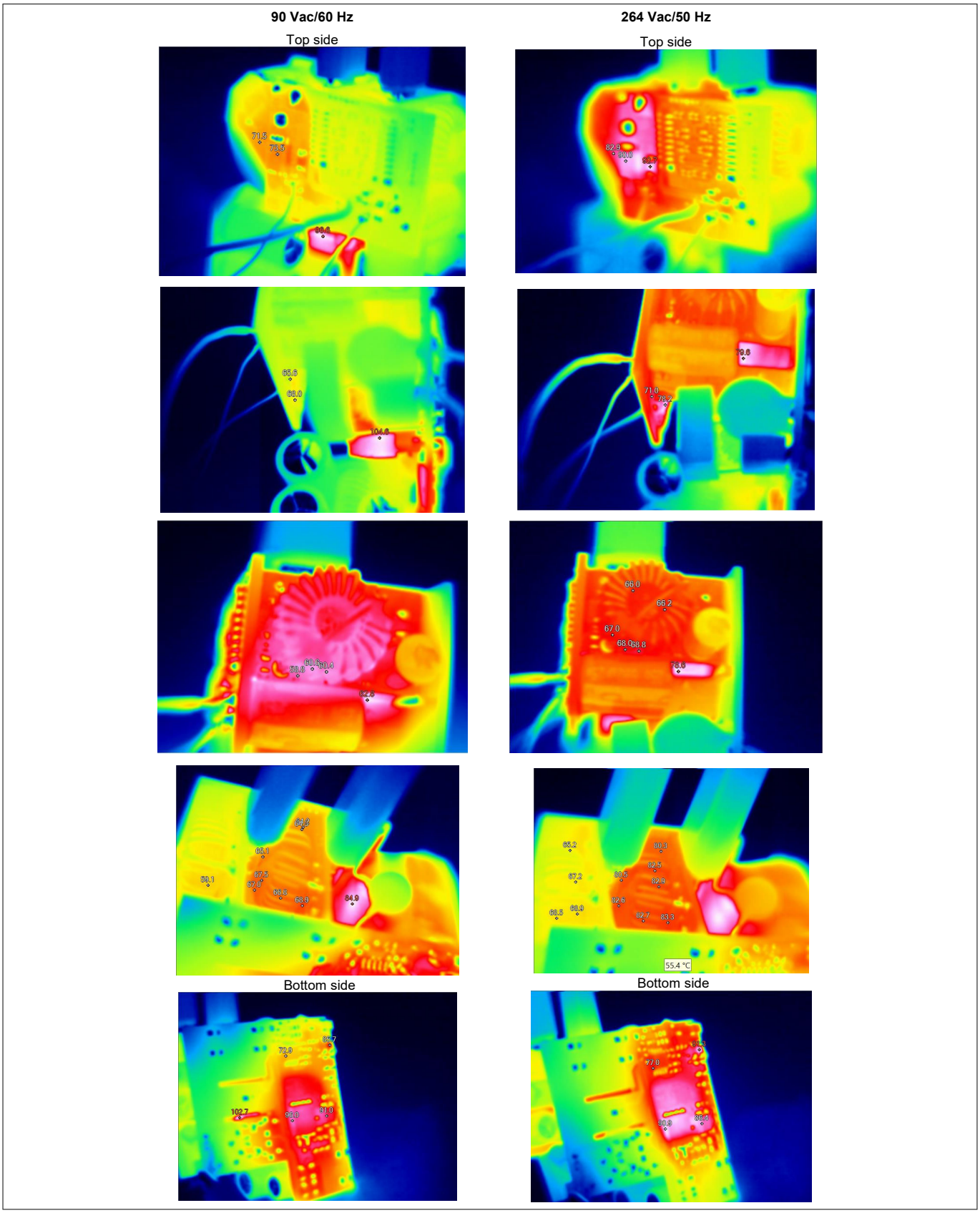


Figure 24 Thermal capture for dual port at 90 Vac, 60 Hz and 264 Vac, 50 Hz

Table 8 Test results

Measured key component	Temperature (°C)	
	90 Vac/60 Hz	264 Vac/50 Hz
Transformer RM10 core (T1)	84.9	87
Transformer RM10 wire (T1)	88	89
Pulse transformer (T2)	70.3	67.3
Primary-MOSFET: IPL65R195C7 (Q4)	96	90.9
SR MOSFET: BSC0402NS(Q3)	73.5	90
Primary snubber diode (D1)	91	86.4
SR snubber (C3+R1)	68	78.2
Bridge diode: MSB407 (BD1//BD2)	99.1	70.4
EZ-PD™ PAG1P (U2)	72.9	77
EZ-PD™ PAG1S (U1)	65.6	71
Primary AUX LDO (Q2+D2)	85.7	91.3
CMC (LF2)	104.6	55.5
EZ-PD™ CCG7D-C (U3)	64.3	80.3
Buck MOSFET1 (Q1+Q9)	68.9	83.3
Buck MOSFET1 (Q6+Q5)	58.8	68
Power inductor 1 (L2)	67.5	82.7
Power inductor 2 (L3)	60.6	68.8

3.15 Conducted emission

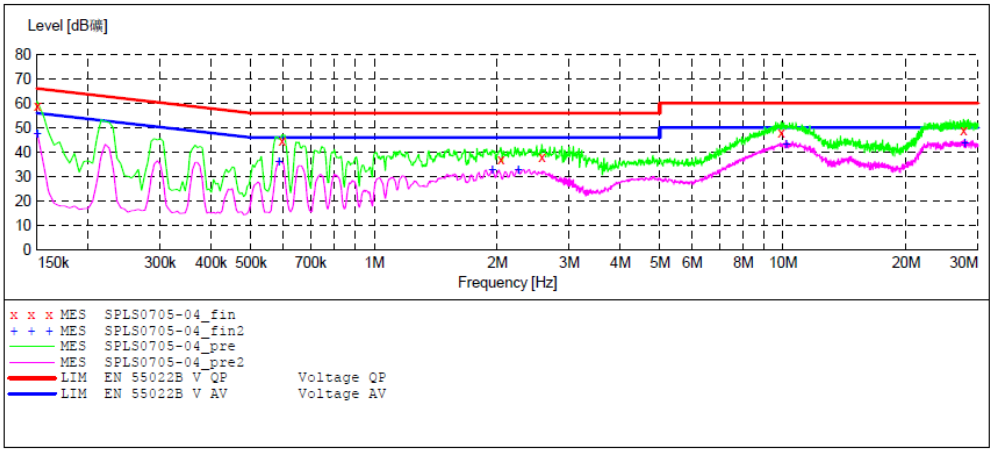
ACCURATE TECHNOLOGY CO.,LTD

CONDUCTED EMISSION STANDARD EN 55032B

```
EUT:                    M/N:PAG1+CCG7D 2C 65W
Manufacturer:           SPLS
Operating Condition:    Working
Test Site:              2#Shielding Room
Operator:               BIN
Test Specification:     N  230V/50Hz
Comment:
Start of Test:          2021-7-8 / 03:23:35下午
```

SCAN TABLE: "V 150K-30MHz fin"

```
  Short Description:                SUB STD VTERM2 1.70
  Start      Stop       Step        Detector  Meas.     IF       Transducer
  Frequency  Frequency  Width                 Time      Bandw.
  150.0 kHz  30.0 MHz   4.5 kHz     QuasiPeak 1.0 s     9 kHz    NLV216
                                    Average
```



MEASUREMENT RESULT: "SPLS0705-04_fin"

2021-7-8 03:24下午

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.150000	58.90	10.8	66	7.1	QP	N	GND
0.595000	44.80	11.0	56	11.2	QP	N	GND
2.040000	36.90	11.3	56	19.1	QP	N	GND
2.570000	38.20	11.3	56	17.8	QP	N	GND
9.900000	48.00	11.6	60	12.0	QP	N	GND
27.625000	48.80	11.8	60	11.2	QP	N	GND

MEASUREMENT RESULT: "SPLS0705-04_fin2"

2021-7-8 03:24下午

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.150000	47.40	10.8	56	8.6	AV	N	GND
0.585000	36.20	11.0	46	9.8	AV	N	GND
1.945000	32.80	11.3	46	13.2	AV	N	GND
2.250000	33.00	11.3	46	13.0	AV	N	GND
10.175000	43.50	11.6	50	6.5	AV	N	GND
27.800000	43.60	11.8	50	6.4	AV	N	GND

Figure 25 CE at 230 V, 50 Hz: N line (QP and AV margin ≥6.4 dB)

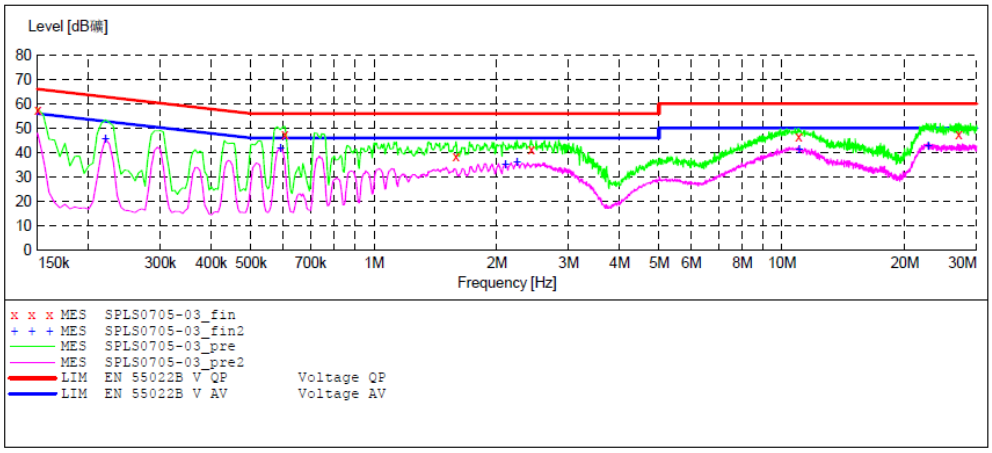
ACCURATE TECHNOLOGY CO.,LTD

CONDUCTED EMISSION STANDARD EN 55032B

```
EUT:                  M/N:PAG1+CCG7D 2C 65W
Manufacturer:         SPLS
Operating Condition:  Working
Test Site:            2#Shielding Room
Operator:             BIN
Test Specification:   L  230V/50Hz
Comment:
Start of Test:        2021-7-8 / 03:21:41下午
```

SCAN TABLE: "V 150K-30MHz fin"

```
  Short Description:                SUB STD VTERM2 1.70
  Start      Stop       Step        Detector  Meas.     IF       Transducer
  Frequency  Frequency  Width                 Time      Bandw.
  150.0 kHz  30.0 MHz   4.5 kHz     QuasiPeak 1.0 s     9 kHz    NLV216
                                    Average
```



MEASUREMENT RESULT: "SPLS0705-03_fin"

2021-7-8 03:22下午

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.150000	57.60	10.8	66	8.4	QP	L1	GND
0.605000	47.70	11.0	56	8.3	QP	L1	GND
1.590000	38.50	11.2	56	17.5	QP	L1	GND
2.430000	41.40	11.3	56	14.6	QP	L1	GND
11.000000	46.50	11.6	60	13.5	QP	L1	GND
27.100000	47.30	11.8	60	12.7	QP	L1	GND

MEASUREMENT RESULT: "SPLS0705-03_fin2"

2021-7-8 03:22下午

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.220000	45.50	10.8	53	7.3	AV	L1	GND
0.590000	41.70	11.0	46	4.3	AV	L1	GND
2.100000	35.20	11.3	46	10.8	AV	L1	GND
2.240000	36.30	11.3	46	9.7	AV	L1	GND
11.000000	41.50	11.6	50	8.5	AV	L1	GND
22.800000	43.00	11.7	50	7.0	AV	L1	GND

Figure 26 CE at 230 V, 50 Hz: L line (QP and AV margin ≥4.3 dB)

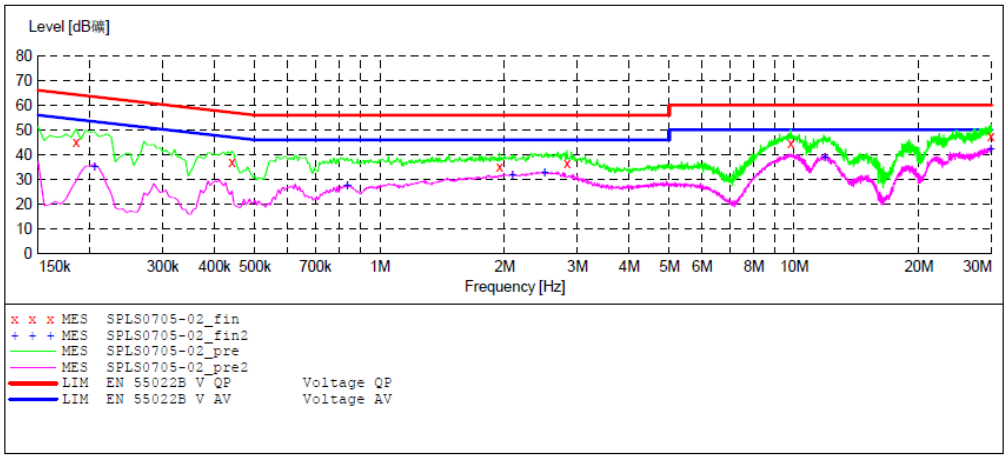
ACCURATE TECHNOLOGY CO.,LTD

CONDUCTED EMISSION STANDARD EN 55032B

```
EUT:                  M/N:PAG1+CCG7D 2C 65W
Manufacturer:         SPLS
Operating Condition:  Working
Test Site:            2#Shielding Room
Operator:             BIN
Test Specification:   N  120V/60Hz
Comment:
Start of Test:        2021-7-8 / 03:19:39下午
```

SCAN TABLE: "V 150K-30MHz fin"

```
  Short Description:                SUB STD VTERM2 1.70
  Start      Stop       Step        Detector  Meas.     IF       Transducer
  Frequency  Frequency  Width                 Time      Bandw.
  150.0 kHz  30.0 MHz   4.5 kHz     QuasiPeak 1.0 s     9 kHz    NLV216
                                    Average
```



MEASUREMENT RESULT: "SPLS0705-02_fin"

2021-7-8 03:20下午

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.185000	45.10	10.8	64	19.2	QP	N	GND
0.440000	37.10	11.0	57	20.0	QP	N	GND
1.945000	35.10	11.3	56	20.9	QP	N	GND
2.830000	36.50	11.3	56	19.5	QP	N	GND
9.810000	44.70	11.6	60	15.3	QP	N	GND
29.850000	47.70	11.8	60	12.3	QP	N	GND

MEASUREMENT RESULT: "SPLS0705-02_fin2"

2021-7-8 03:20下午

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.205000	35.20	10.8	53	18.2	AV	N	GND
0.835000	27.50	11.1	46	18.5	AV	N	GND
2.090000	31.90	11.3	46	14.1	AV	N	GND
2.500000	32.70	11.3	46	13.3	AV	N	GND
11.850000	38.90	11.6	50	11.1	AV	N	GND
29.825000	42.20	11.8	50	7.8	AV	N	GND

Figure 27 CE at 120 V, 60 Hz: N line (QP and AV margin ≥7.8 dB)

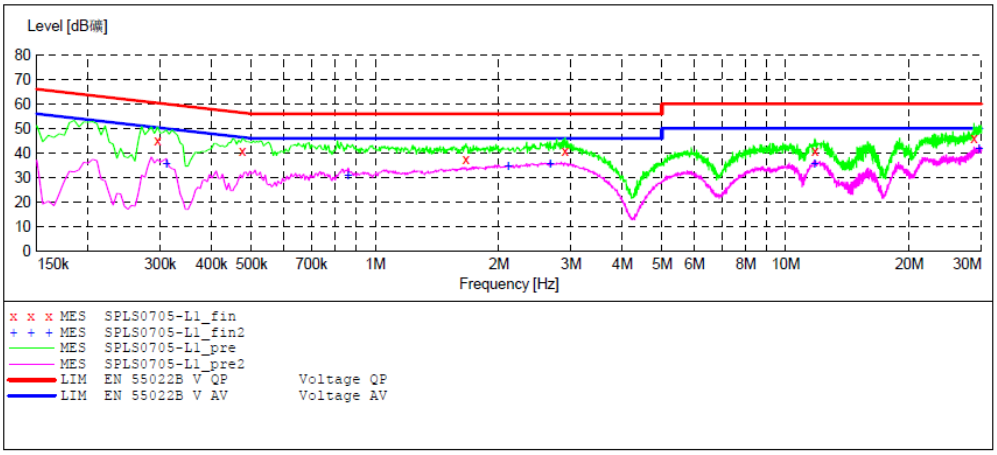
ACCURATE TECHNOLOGY CO.,LTD

CONDUCTED EMISSION STANDARD EN 55032B

```
EUT:                  M/N:PAG1+CCG7D 2C 65W
Manufacturer:         SPLS
Operating Condition:  Working
Test Site:            2#Shielding Room
Operator:             BIN
Test Specification:   L  120V/60Hz
Comment:
Start of Test:        2021-7-8 / 03:17:17下午
```

SCAN TABLE: "V 150K-30MHz fin"

```
  Short Description:              SUB STD VTERM2 1.70
  Start      Stop       Step      Detector  Meas.     IF       Transducer
  Frequency  Frequency  Width               Time      Bandw.
  150.0 kHz  30.0 MHz   4.5 kHz   QuasiPeak 1.0 s     9 kHz    NLV216
                                  Average
```



MEASUREMENT RESULT: "SPLS0705-L1_fin"

2021-7-8 03:18下午

Frequency MHz	Level dBµ	Transd dB	Limit dBµ	Margin dB	Detector	Line	PE
0.295000	44.90	10.9	60	15.5	QP	L1	GND
0.475000	40.80	11.0	56	15.6	QP	L1	GND
1.665000	37.60	11.2	56	18.4	QP	L1	GND
2.900000	40.70	11.3	56	15.3	QP	L1	GND
11.775000	41.10	11.6	60	18.9	QP	L1	GND
28.750000	46.10	11.8	60	13.9	QP	L1	GND

MEASUREMENT RESULT: "SPLS0705-L1_fin2"

2021-7-8 03:18下午

Frequency MHz	Level dBµ	Transd dB	Limit dBµ	Margin dB	Detector	Line	PE
0.310000	35.70	10.9	50	14.3	AV	L1	GND
0.860000	30.90	11.1	46	15.1	AV	L1	GND
2.110000	34.60	11.3	46	11.4	AV	L1	GND
2.670000	35.60	11.3	46	10.4	AV	L1	GND
11.750000	35.90	11.6	50	14.1	AV	L1	GND
29.575000	41.60	11.8	50	8.4	AV	L1	GND

Figure 28 CE at 120 V, 60 Hz: L line (QP and AV margin ≥8.4 dB)

3.16 USB-PD source test results (using QuadraMax)



Figure 29 Test setup for QuadraMax

Table 9 Test result

Testing initialized: 2021/6/25 17:12:32
QuadDraw version: 0.8.7285
QM#103 HWRev:1.4.4 FWST:0.0.1376 FWCCG1:0.10

Test	Description	Result
TD SPT.1	Load test	Pass
TD SPT.2	Capabilities test	Pass
TD SPT.3	Hard reset test	Pass
TD SPT.5	Overcurrent test	Pass
TD SPT.6	PPS voltage step test	Pass
TD SPT.7	PPS current limit test	Pass

4 Appendix

4.1 Schematics

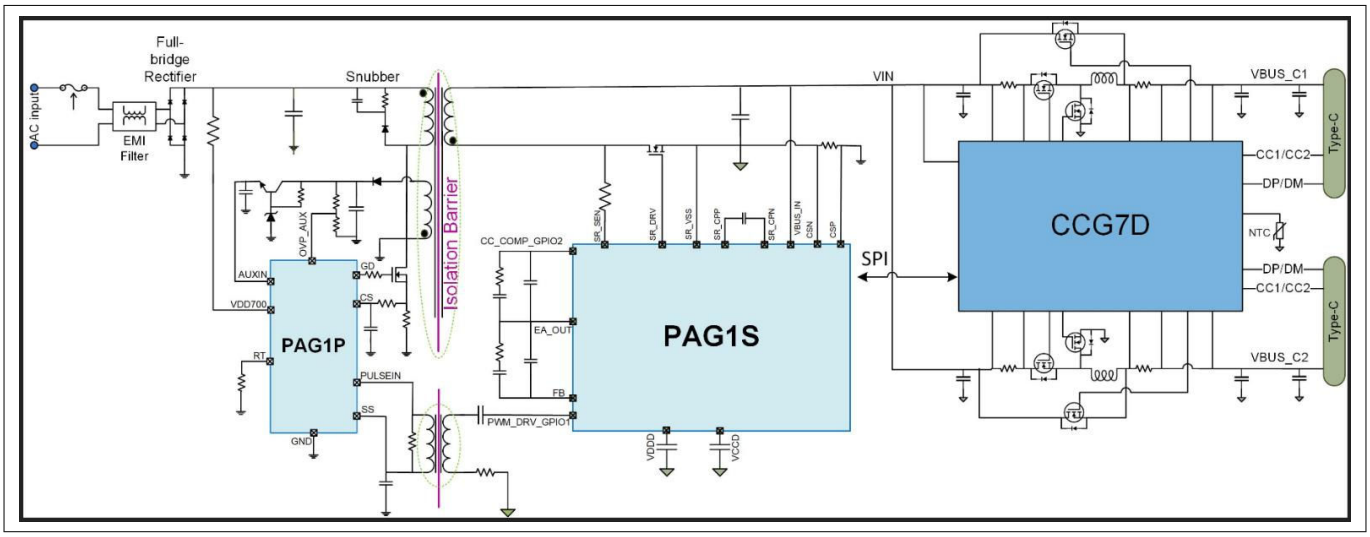


Figure 30 Diagram of total solution

4 Appendix

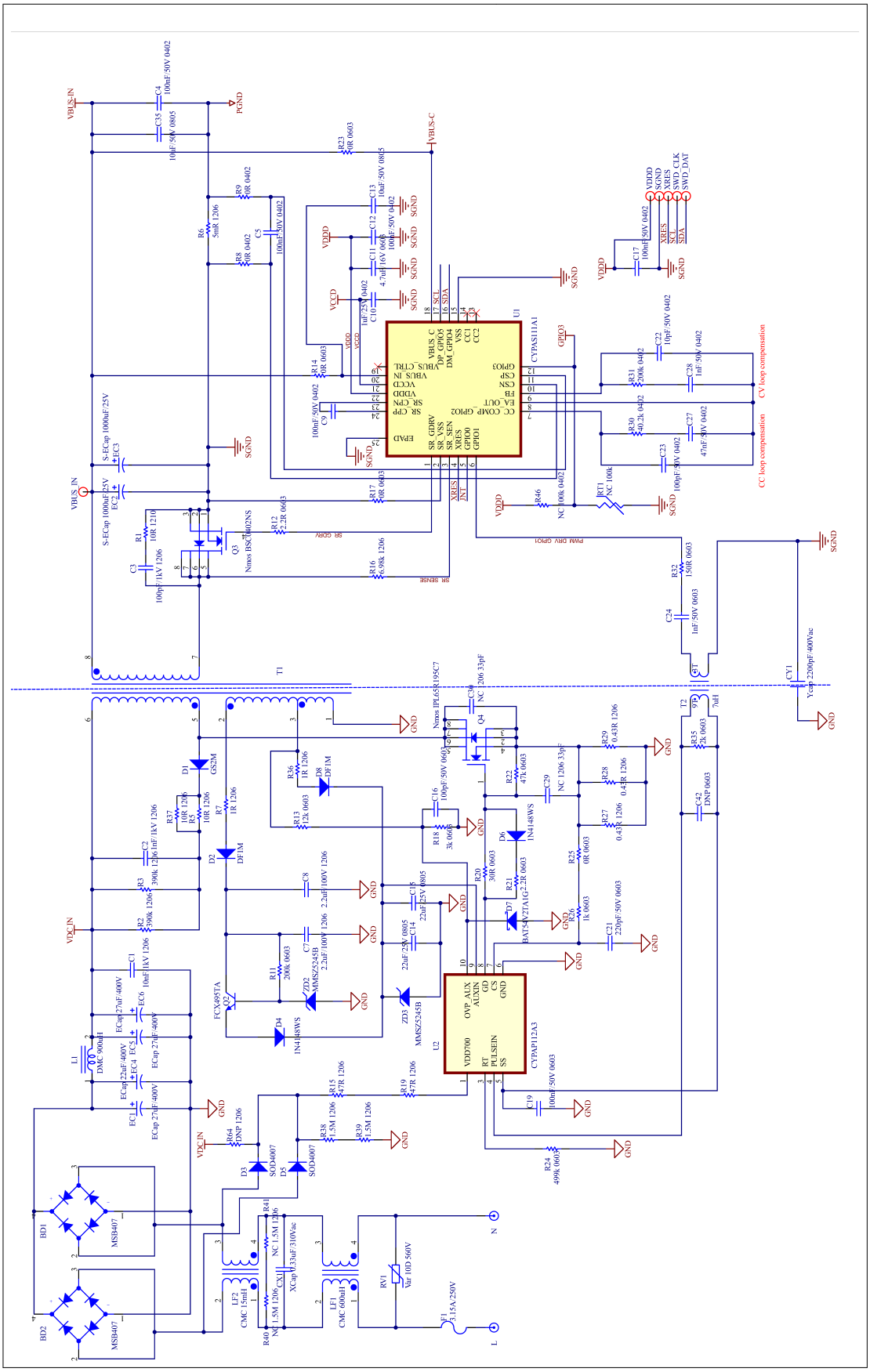


Figure 31 EZ-PD™ PAG1P + EZ-PD™ PAG1S AC-DC schematic

4 Appendix

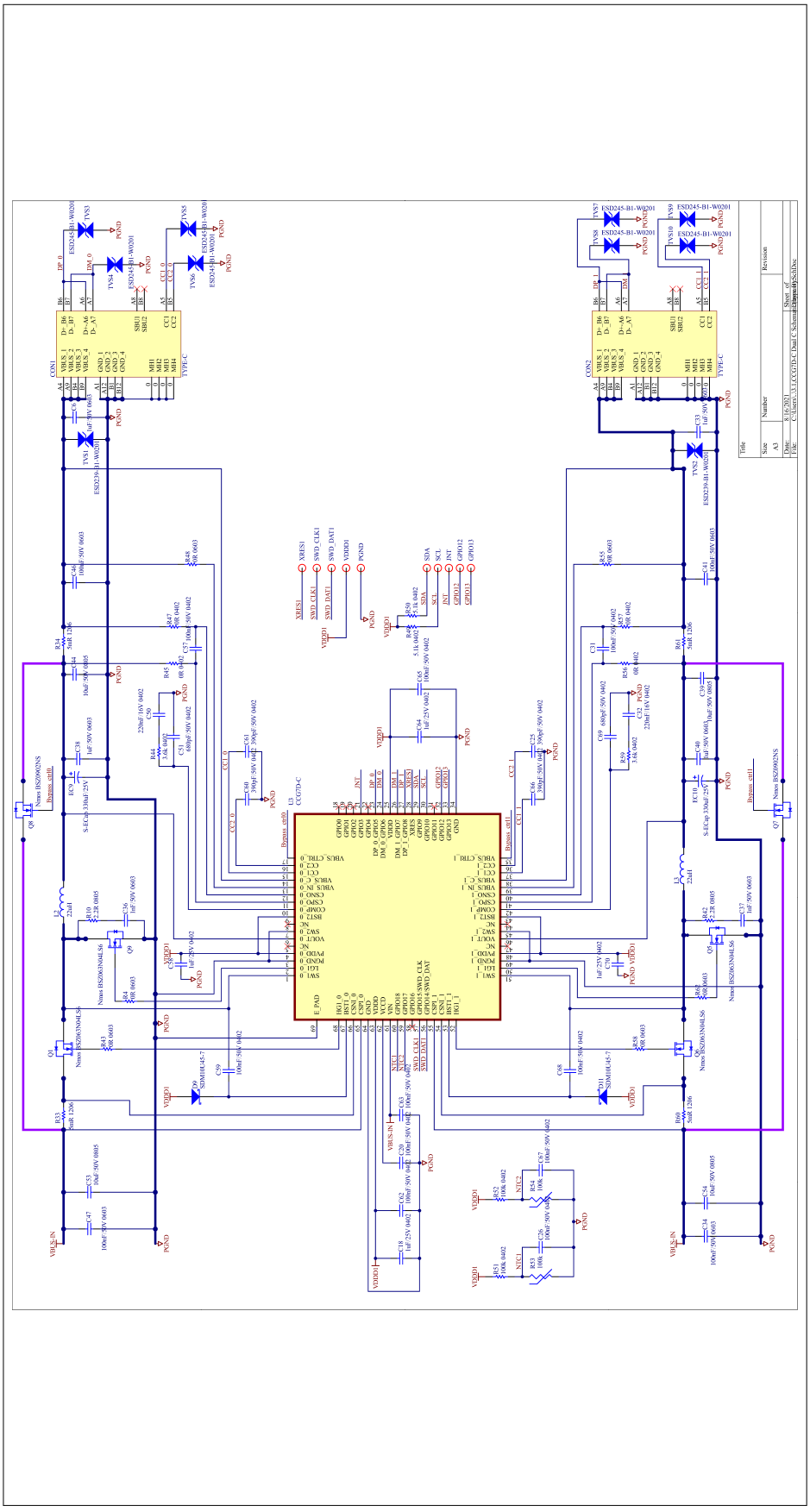


Figure 32 EZ-PD™ CCG7D-C DC-DC dual C schematic

4.2 Bill of materials

Table 10 Main board BOM

Footprint	Comment	LibRef	Designator	Description	Quantity
BD(DB106)	MSB407	BD MSB407	BD1, BD2	Bridge Rectifier MSB407 4 A 1000 V	2
1206_C	MLCC 1206 1 nF	MLCC 1206 1 nF	C2	MLCC 1 nF/1000 V X7R 1206 ±10%	1
1206_C	MLCC 1206 2.2 uF	MLCC 1206 2.2 uF	C7, C8	MLCC 2.2 uF/100 V X7R 1206 ±10%	2
0805_C	MLCC 0805 22 uF	MLCC 0805 22 uF	C14, C15	MLCC 22 uF/25 V X7R 0805 ±10%	2
0603_C	MLCC 0603 100 pF	MLCC 0603 100 pF	C16	MLCC 100 pF/50 V X7R 0603 ±10%	1
0603_C	MLCC 0603 100 nF	MLCC 0603 100 nF	C19	MLCC 100 nF/50 V X7R 0603 ±10%	1
0603_C	MLCC 0603 220 pF	MLCC 0603 220 pF	C21	MLCC 220 pF/50 V X7R 0603 ±10%	1
1206_C	DNP	MLCC 1206 DNP	C29, C30	MLCC DNP X7R 1206 ±10%	2
CX12.5	XCap 0.33 uF/310 Vac	XCap 0.33 uF/310 Vac	CX1	XCap 0.33 uF/310 Vac 334K310VAC Yixingjie	1
CAP10Y1	Ycap 2200 pF/400 Vac	Ycap 2200 pF/400 Vac	CY1	YCap 400 V 2200 PF Z5U Or Y5P	1
SMA	GS2M	GS2M	D1	Diode GS2M 2 A/1000 V SMA	1
1206	SRGC10MH	SRGC10MH	D2, D8	Diode SRGC10MH 1 A 1000 V 1206	2
WSOD123	DNP	SOD4007	D3, DS	Diode SOD4007 SOD-123	2
SOD-323	1N4148WS	Diode 1N4148WS	D6	Diode 1N4148WS SOD-323	1
SOD-123	BAT54W	Diode BAT54W	D7	Schottky Diode BAT54W SOD-123	1
fuse1	Fuse 3.15 A/250 V	Fuse 3.15 A/250 V	F1	FUSE BRD MNT 3.15 A 250 VAC RADIAL	1
Bivet Big Hole	DNP	TEST_POINT	L, N		2
9*5*3	CMC 600 uH	CMC 600 uH	LF1	CMC 600 uH T9*3*3	1
CMC 15 mH 13*8*12	CMC 15 mH	CMC 15 mH	LF2	CMC 立式 15 mH 2.8 A	1

(table continues...)

Table 10 (continued) Main board BOM

Footprint	Comment	LibRef	Designator	Description	Quantity
SOT89	FCX495TA	FCX495TA	Q2	NPN Transistor FCX495TA 150 V SOT-89-3	1
DFN8*8	Nmos IPL65R195C7	Nmos IPL65R195C7	Q4	Nmos IPL65R195C7 700 V 195 mΩ 12 A ThinPAK8x8	1
1206_R	R1206 390 kΩ	R1206 390 kΩ	R2, R3	Resistor 390 kΩ 1206 1% 1/4 W	2
1206_R	R1206 10 Ω	R1206 10 Ω	R5, R37	Resistor 10 Ω 1206 1% 1/4 W	2
1206_R	R1206 2.2 Ω	R1206 2.2 Ω	R7, R36	Resistor 2.2 Ω 1206 1% 1/4 W	2
0603_R	R0603 200 kΩ	R0603 200 kΩ	R11	Resistor 200 kΩ 0603 1% 1/10 W	1
0603_R	R0603 12 kΩ	R0603 12 kΩ	R13	Resistor 12 kΩ 0603 1% 1/10 W	1
1206_R	R1206 47 Ω	R1206 47 Ω	R15, R19	Resistor 47 Ω 1206 1% 1/4 W	2
0603_R	R0603 3 kΩ	R0603 3 kΩ	R18	Resistor 3 kΩ 0603 1% 1/10 W	1
0603_R	R0603 30 Ω	R0603 30 Ω	R20	Resistor 30 Ω 0603 1% 1/10 W	1
0603_R	R0603 2.2 Ω	R0603 2.2 Ω	R21	Resistor 2.2 Ω 0603 1% 1/10 W	1
0603_R	R0603 47 kΩ	R0603 47 kΩ	R22	Resistor 47 k 0603 1% 1/10 W	1
0603_R	R0603 499 kΩ	R0603 499 kΩ	R24	Resistor 499 kΩ 0603 1% 1/10 W	1
0603_R	R0603 0 Ω	R0603 0 Ω	R25	Resistor 0 Ω 0603 1% 1/10 W	1
0603_R	R0603 1 kΩ	R0603 1 kΩ	R26	Resistor 1 kΩ 0603 1% 1/10 W	1
1206_R	R1206 0.43 Ω	R1206 0.43 Ω	R27, R28, R29	Resistor 0.43 Ω 1206 1% 1/4 W	3
0603_R	R0603 2 kΩ	R0603 2 kΩ	R35	Resistor 2 kΩ 0603 1% 1/10 W	1
1206_R	DNP	R1206 1.5 MΩ	R38, R39	Resistor 1.5 MΩ 1206 1% 1/4 W	2
1206_R	R1206 1.5 MΩ	R1206 1.5 MΩ	R40, R41	Resistor 1.5 MΩ 1206 1% 1/4 W	2

(table continues...)

Table 10 (continued) Main board BOM

Footprint	Comment	LibRef	Designator	Description	Quantity
1206_R	R1206 0 Ω	R1206 0 Ω	R64	Resistor 0 Ω 1206 1% 1/4 W	1
MOV10D471	Var 10D 560 V	Var 10D561	RV1	Varistor 10 D 560 V	1
RM10-3	PA5222NL_24	PA5222NL_24	T1		1
SOP-10	CYPAP11243	CYPAP112A3	U2	EZ-PD™ PAG1P PWM Controller SOIC-10	1
SOD-123	Zener 15 V BZT52C15	Zener 15 V BZT52C15	ZD2, ZD3	Zener Diode BZT52C15 15 V SOD123	2
SOD-123	1N4148WS	1N4148WS	D4	Diode 1N4148WS SOD-323	2
PCB			PCB	FR4 2 layer 1.6 T 2OZ	1

Table 11 Primary cap board BOM

Footprint	Comment	LibRef	Designator	Description	Quantity
1206_C	MLCC 1206 10 nF	MLCC 1206 10 nF	C1	MLCC 10 nF/1000 V X7R 1206 ±10%	1
EC10	ECap 33 uF/400 V	ECap 33 uF/400 V	EC1, EC5, EC6	Electrolytic Capacitor 33 uF/400 V 10*20 RK Series AISHI	3
EC8-5	ECap 22 uF/400 V	ECap 22 uF/400 V	EC4	Electrolytic Capacitor 22 uF/400 V AISHI 8*20 2000H	1
T11	DMC 900 uH	DMC 900 uH	L1	DMC T10 10*5*6 900 uH	1
PCB			PCB	FR4 2 layer 1.6T 2OZ	1

Table 12 Pulse transformer board BOM

Footprint	Comment	LibRef	Designator	Description	Quantity
0603_C	MLCC 0603 1 nF	MLCC 0603 1 nF	C24	MLCC 1 nF/50 V NPO 0603 ±10%	1
0603_R	R0603 150 Ω	R0603 150 Ω	R32	Resistor 150 Ω 0603 1% 1/10 W	1
Pulse Transformer-DIP	Pulse Transformer	Pulse Transformer	T2	JQH LCL00T5138A1 3:9, 8 mm	1
PCB			PCB	FR4 2 layer 1.0 T 1OZ	1

Table 13 EZ-PD™ PAG1S + EZ-PD™ CCG7D-C board BOM

Footprint	Comment	LibRef	Designator	Description	Quantity
1206_C	MLCC 1206 100 pF	MLCC 1206 100 pF	C3	MLCC 100 pF/1000 V X7R 1206 ±10%	1
0402_C	MLCC 0402 100 nF	MLCC 0402 100 nF_1, MLCC 0402 100 nF	C4, C5, C9, C12, C17, C20, C26, C31, C57, C59, C62, C63, C65, C67, C68	MLCC 100 nF/50 V X7R 0402 ±10%	15
0402_C	MLCC 0402 1 uF	MLCC 0402 1 uF	C10, C18, C58, C64, C70	MLCC 1 uF/25 V X5R 0402 ±10%	5
0603_C	MLCC 0603 4.7 uF	MLCC 0603 4.7 uF	C11	MLCC 4.7 uF/16 V X7R 0603 ±10%	1
0805_C	MLCC 0805 10 uF	MLCC 0805 10 uF_1	C13, C35	MLCC 10 uF/50 V X5R 0805 ±10%	2
0402_C	MLCC 0402 10 pF	MLCC 0402 10 pF	C22	MLCC 10 pF/50 V 0402 NPO ±5%	1
0402_C	MLCC 0402 100 pF	MLCC 0402 100 pF	C23	MLCC 100 pF/50 V NPO 0402 ±5%	1
0402_C	MLCC 0402 390 pF	MLCC 0402 390 pF	C25, C60, C61, C66	MLCC 390 pF/50 V X7R 0402 ±10%	4
0402_C	MLCC 0402 47 nF	MLCC 0402 47 nF_1	C27	MLCC 47 nF/50 V X7R 0402 ±10%	1
0402_C	MLCC 0402 220 nF	MLCC 0402 220 nF	C32, C50	MLCC 220 nF/16 V X7R 0402 ±10%	2
0402_C	MLCC 0402 1 nF	MLCC 0402 1 nF_1	C28	MLCC 1 nF/50 V 0402 NPO ±5%	1
0402_C	MLCC 0402 680 pF	MLCC 0402 680 pF	C51, C69	MLCC 680 pF/50 V X7R 0402 ±10%	2
SOD-323	SDM10U45-7	SDM10U45-7	D9, D11	Schottky Diode SDM10U45-7 SOD323	2
EC8-5	S-ECap 680 uF/25 V	S-ECap 680 uF/25 V_2, S-ECap	EC2, EC3	Solid Electrolytic Capacitor 680 uF/25 V	2
Test point	DNP	TEST POINT	GPIO12, GPIO13, JNT, PGND, SCL, SDA, SGND, SWD_CLK, SWD_CLK1, SWD_DAT, SWD_DAT1, VBUS IN, VDDD, VDDD1, XRES, XRES1	Test point	0

(table continues...)

Table 13 (continued) EZ-PD™ PAG1S + EZ-PD™ CCG7D-C board BOM

Footprint	Comment	LibRef	Designator	Description	Quantity
DFN5X6	Nmos BSC0402NS	Nmos BSC0402NS	Q3	Nmos BSC0402NS 150 V 9.3 mR PG-	1
1210-R	R1210 10 Ω	R1210 10 Ω	R1	Resistor 10 Ω 1210 1% 1/3 W	1
1206_R	R1206 0.005 Ω	R1206 0.005 Ω	R6	Resistor 0.005 Ω 1206 1% 1/4 W	1
0402_R	R0402 0 Ω	R0402 0 Ω	R8, R9, R45, R47, R56, R57	Resistor 0 Ω 0402 1% 1/16 W	6
0603_R	R0603 2.2 Ω	R0603 2.2 Ω	R12	Resistor 2.2 Ω 0603 1% 1/10 W	1
0603_R	R0603 0 Ω	R0603 0Ω	R14, R17, R23, R48	Resistor 0 Ω 0603 1% 1/10 W	4
1206_R	R1206 6.98 kΩ	R1206 6.98 kΩ	R16	Resistor 6.98 kΩ 1206 1% 1/4 W	1
0402_R	R0402 40.2 kΩ	R0402 40.2 kΩ	R30	Resistor 40.2 kΩ 0402 1% 1/16 W	1
0402_R	R0402 200 kΩ	R0402 200 kΩ	R31	Resistor 200 kΩ 0402 1% 1/16 W	1
0402_R	R0402 3.6 kΩ	R0402 3.6 kΩ	R44, R59	Resistor 3.6 kΩ 0402 1% 1/16 W	2
0402_R	R0402 100 kΩ	R0402 100 kΩ	R46, R51, R52	Resistor 100 kΩ 0402 1% 1/16 W	3
0402_R	R0402 5.1 kΩ	R0402 5.1 kΩ	R49, R50	Resistor 5.1 kΩ 0402 1% 1/16 W	2
0402_R	Ntc 100 k	Ntc 100 k	RT1	100 k Thermistor 0402	1
QFN-24 4x4x05P	CYPAS111A1	CYPAS111A1	U1	EZ-PD™ PAG1S PWM+PD+SR Controller QFN-24	1
QFN-68_8*8	EZ-PD™ CCG7D-C	EZ-PD™ CCG7D-C	U3	EZ-PD™ CCG7D-C Dual-C PD and Buck-Boost Controller QFN68-8*8	1
PCB			PCB	FR4 4 layer 1.6 T 1OZ	1

Table 14 Type C1 board BOM

Footprint	Comment	LibRef	Designator	Description	Quantity
0603_C	MLCC 0603 1 uF	MLCC 0603 1 uF	C6	MLCC 1 uF/50 V X7R 0603 ±10%	1
0603_C	MLCC 0603 1 nF	MLCC 0603 1 nF	C36	MLCC 1 nF/50 V NPO 0603 ±10%	1

(table continues...)

Table 14 (continued) Type C1 board BOM

Footprint	Comment	LibRef	Designator	Description	Quantity
0805_C	MLCC 0805 10 uF	MLCC 0805 10 uF_1	C44, C53	MLCC 10 uF/50 V X5R 0805 ±10%	2
0603_C	MLCC 0603 100 nF	MLCC 0603 100 nF	C46, C47	MLCC 100 nF/50 V X7R 0603 ±10%	2
TYPE-C-16P	TYPE-C	TYPE-C connector_1	CON1	TYPE-C connector 16-pin	1
CE6.3/11	S-ECap 330 uF/25 V	S-ECap 330 uF/25 V	EC9	Solid Electrolytic Capacitor 330 uF/25 V	1
INDUCTOR-H-15 MM	10 uH	10 uH	L2	Power inductor 10 uH	1
PG-TSDSON-8_3.3*3.3	Nmos BSZ063N04LS6	Nmos BSZ063N04LS6	Q1, Q9	Nmos BSZ063N04LS6 40 V 6.3 mΩ 40 A PG-TSDSON-8_3.3*3.3	2
PG-TSDSON-8_3.3*3.3	Nmos BSZ0902NS	Nmos BSZ0902NS	Q8	Nmos BSZ0902NS 30 V 3.5 mΩ 58 A PG-TSDSON-8_3.3*3.3	1
0603_R	R0603 0 Ω	R0603 0 Ω	R4, R43	Resistor 0 Ω 0603 1% 1/10 W	2
0805_R	R0805 2.2 Ω	R0805 2.2 Ω	R10	Resistor 2.2 Ω 0805 1% 1/16 W	1
1206_R	R1206 0.005 Ω	R1206 0.005 Ω	R33, R34	Resistor 0.005 Ω 1206 1% 1/4 W	2
0402_R	Ntc 100 k	Ntc 100 k	R53	100 k Thermistor 0402	1
WLL-2-3	TVS ESD239-B1-W0201	TVS ESD239-B1-W0201	TVS1	ESD protection ESD239-B1-W0201 Vc=27 V 0201	1
WLL-2-3	TVS ESD245-B1-W0201	TVS ESD245-B1-W0201	TVS3, TVS4, TVS5, TVS6	ESD protection ESD245-B1-W0201 Vc=7.5 V ±18 kV (air), ±15 kV (contact discharge) 0201	4
PCB			PCB	FR4 4 layer 1.2 T 1OZ	1

Table 15 Type C2 board BOM

Footprint	Comment	LibRef	Designator	Description	Quantity
0603_C	MLCC 0603 1 uF	MLCC 0603 1 uF	C33	MLCC 1 uF/50 V X7R 0603 ±10%	1
0603_C	MLCC 0603 100 nF	MLCC 0603 100 nF	C34, C41	MLCC 100 nF/50 V X7R 0603 ±10%	2
0603_C	MLCC 0603 1 nF	MLCC 0603 1 nF	C37	MLCC 1 nF/50 V NPO 0603 ±10%	1

(table continues...)

Table 15 (continued) Type C2 board BOM

Footprint	Comment	LibRef	Designator	Description	Quantity
0805_C	MLCC 0805 10 uF	MLCC 0805 10 uF_1	C39, C54	MLCC 10 uF/50 V X5R 0805 ±10%	2
TYPE-C-16P	TYPE-C	TYPE-C connector_1	CON2	TYPE-C connector 16-pin	1
CE6.3/11	S-ECap 330 uF/25 V	S-ECap 330 uF/25 V	EC10	Solid Electrolytic Capacitor 330 uF/25 V	1
INDUCTOR-H-15 MM	10 uH	10 uH	L3	Power inductor 10 uH	1
PG-TSDSON-8_3.3*3.3	Nmos BSZ063N04LS6	Nmos BSZ063N04LS6	Q5, Q6	Nmos BSZ063N04LS6 40 V 6.3 mΩ 40 A PG-TSDSON-8_3.3*3.3	2
PG-TSDSON-8_3.3*3.3	Nmos BSZ0902NS	Nmos BSZ0902NS	Q7	Nmos BSZ0902NS 30 V 3.5 mΩ 58 A PG-TSDSON-8_3.3*3.3	1
0805_R	R0805 2.2 Ω	R0805 2.2 Ω	R42	Resistor 2.2 Ω 0805 1% 1/16 W	1
0402_R	Ntc 100 k	Ntc 100 k	R54	100 k Thermistor 0402	1
0603_R	R0603 0 Ω	R0603 0 Ω	R55, R58, R62	Resistor 0 Ω 0603 1% 1/10 W	3
1206_R	R1206 0.005 Ω	R1206 0.005 Ω	R60, R61	Resistor 0.005 Ω 1206 1% 1/4 W	2
WLL-2-3	TVS ESD239-B1-W0201	TVS ESD239-B1-W0201	TVS2	ESD protection ESD239-B1-W0201 Vc=27 V 0201	1
WLL-2-3	TVS ESD245-B1-W0201	TVS ESD245-B1-W0201	TVS7, TVS8, TVS9, TVS10	ESD protection ESD245-B1-W0201 Vc=7.5 V ±18 kV (air), ±15 kV (contact discharge) 0201	4
PCB			PCB	FR4 4 layer 1.2 T 1OZ	1

Total components: 182 pcs.

4.3 PCB layout

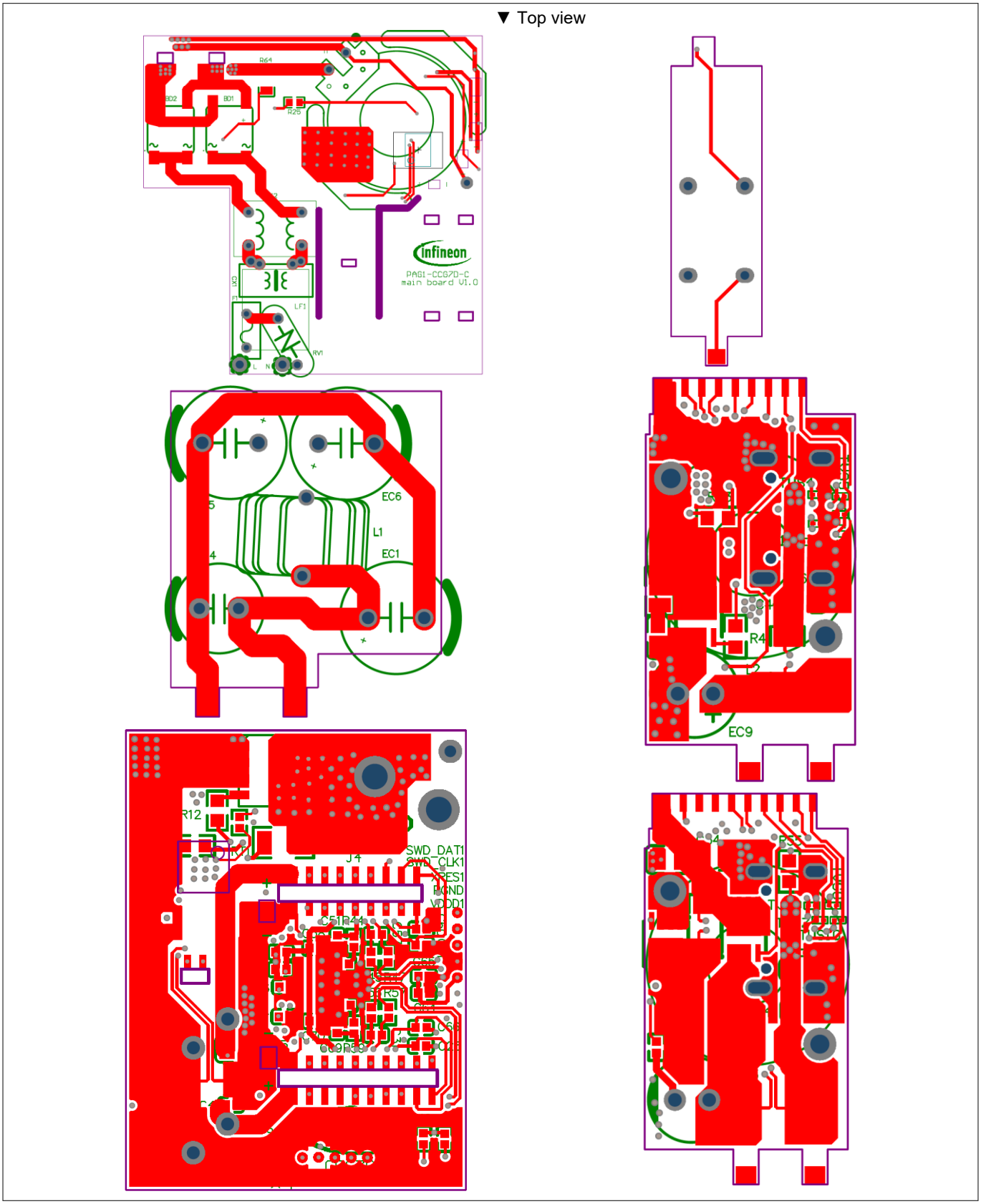


Figure 33 Top view

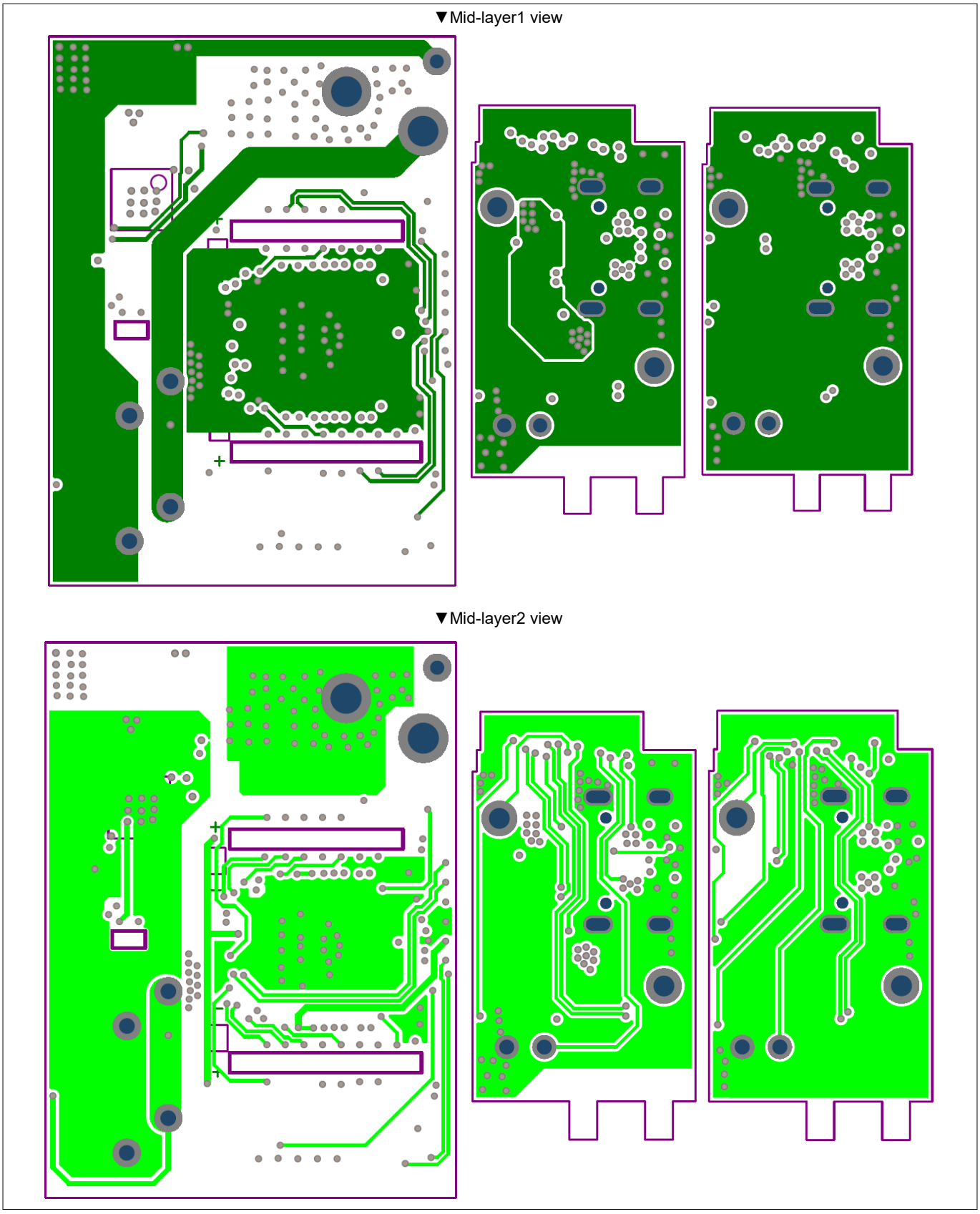


Figure 34 Mid-layer view

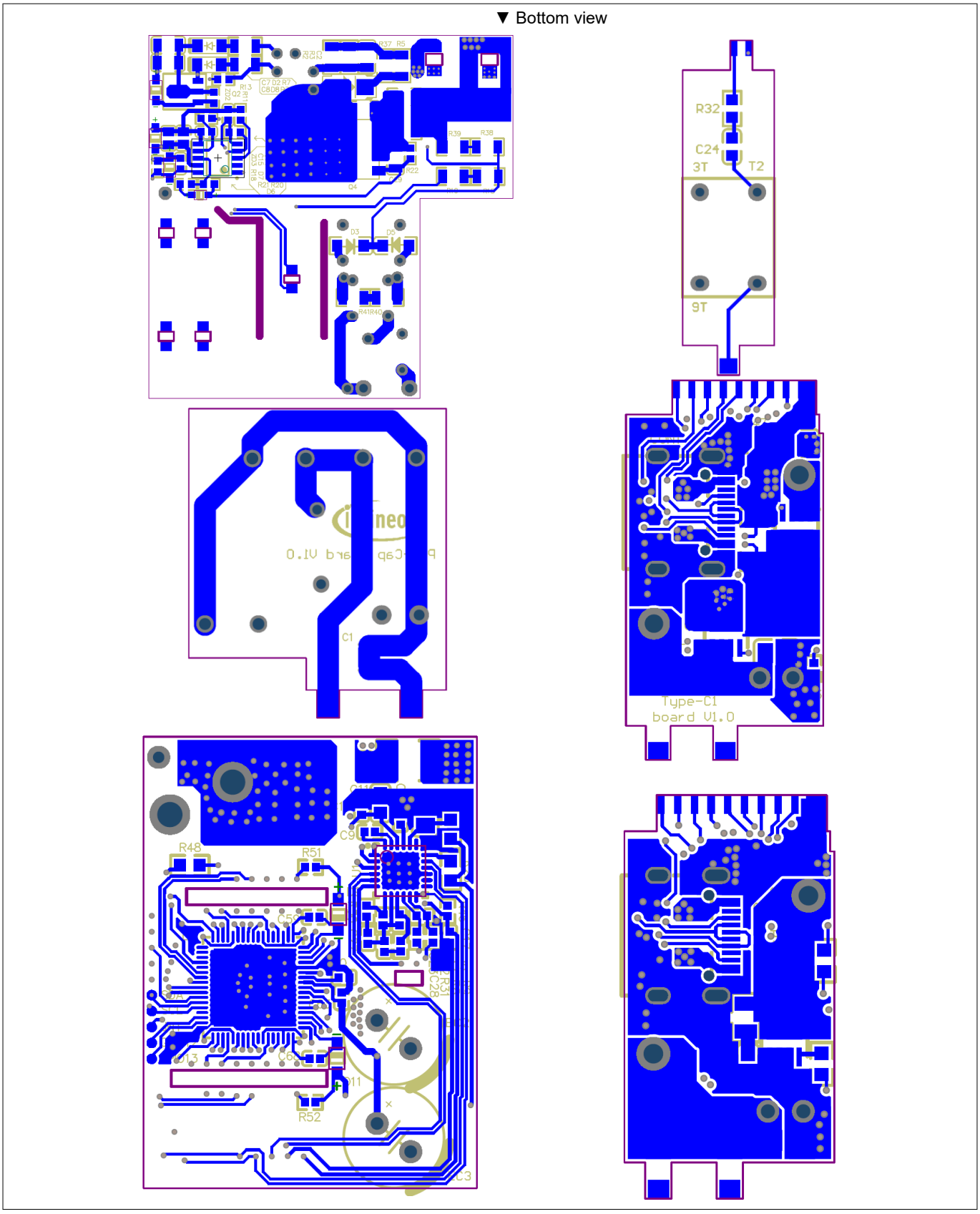
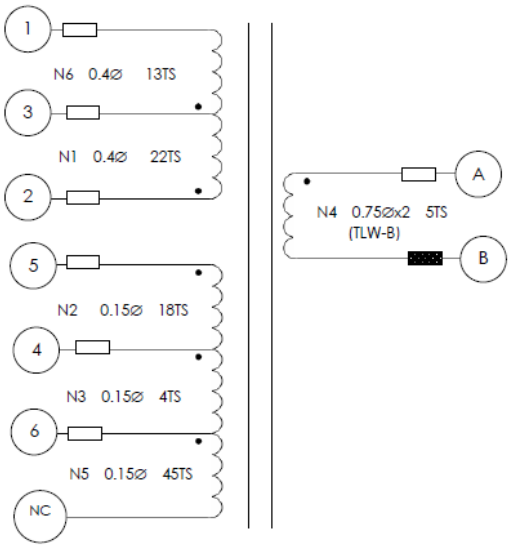


Figure 35 Bottom view

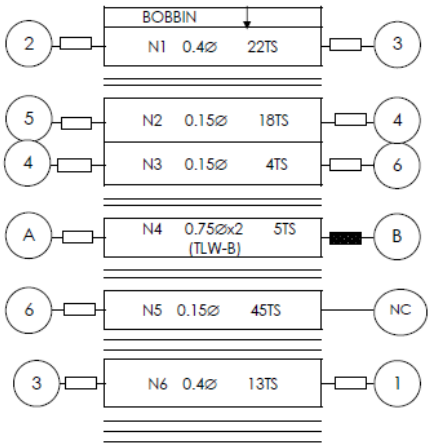
4.4 Transformer specifications (T1)

1. SCHEMATICS.



2. WINDING SEQUENCE.

*N2 & N3 並繞
*N4 出線在無 PIN 側頂部，A 加白色 B 加黑色套管，出線長 25MM 含 5MM 鍍錫



3. MATERIAL LIST.

NO/ITEM	MATERIAL	MAKER
3-1. CORE	RM-10 FERRITE CORE. 3C95,V095	FERROXCUBE.,VAKOS
3-2. BOBBIN	RM-10V.TYPE W / 6PINS PHENOLIC / T375HF SW-RM10-5	CHANG CHUN PLASTICS CO.,LTD. UL NO.E59481
3-3. WIRE	UEW-2 / 130℃	JUNG SHING WIRE CO.,LTD. UL NO.E174837
	TLW-B	DAH JIN TECHNOLOGY CO.,LTD UL NO. E236542
3-4. TAPE	POLYESTER TAPE. #1350F-1.	3M COMPANY. UL NO.E17385.
3-5. VARNISH	V-1630FS	ELANTAS PDG,INC/VIKING UL NO.E87039
3-6. TUBING	PTFE / TFL / 150V.	GREAT HOLDING IND CO.,LTD. UL NO.E156256.
3-7. EPOXY	9001A/B	WELLS ELECTRONIC MATERIAL(GUANGZHOU)CO LTD. UL NO.E229633

4. ELECTRICAL SPECIFICATION.

4-1.INDUCTANCE. P(2-1) 340 uH±5% @ 40KHz 0.3V HP-4284A
4-2.LEAKAGE INDUCTANCE. P(2-1) 5.5uH MAX @ 40KHz 0.3V
4-3.D.C.RESISTANCE. P(2-1) 0.32Ω MAX.
4-4.HI-POT. PRI TO SEC 3.75KVAC @5mA 3SEC.

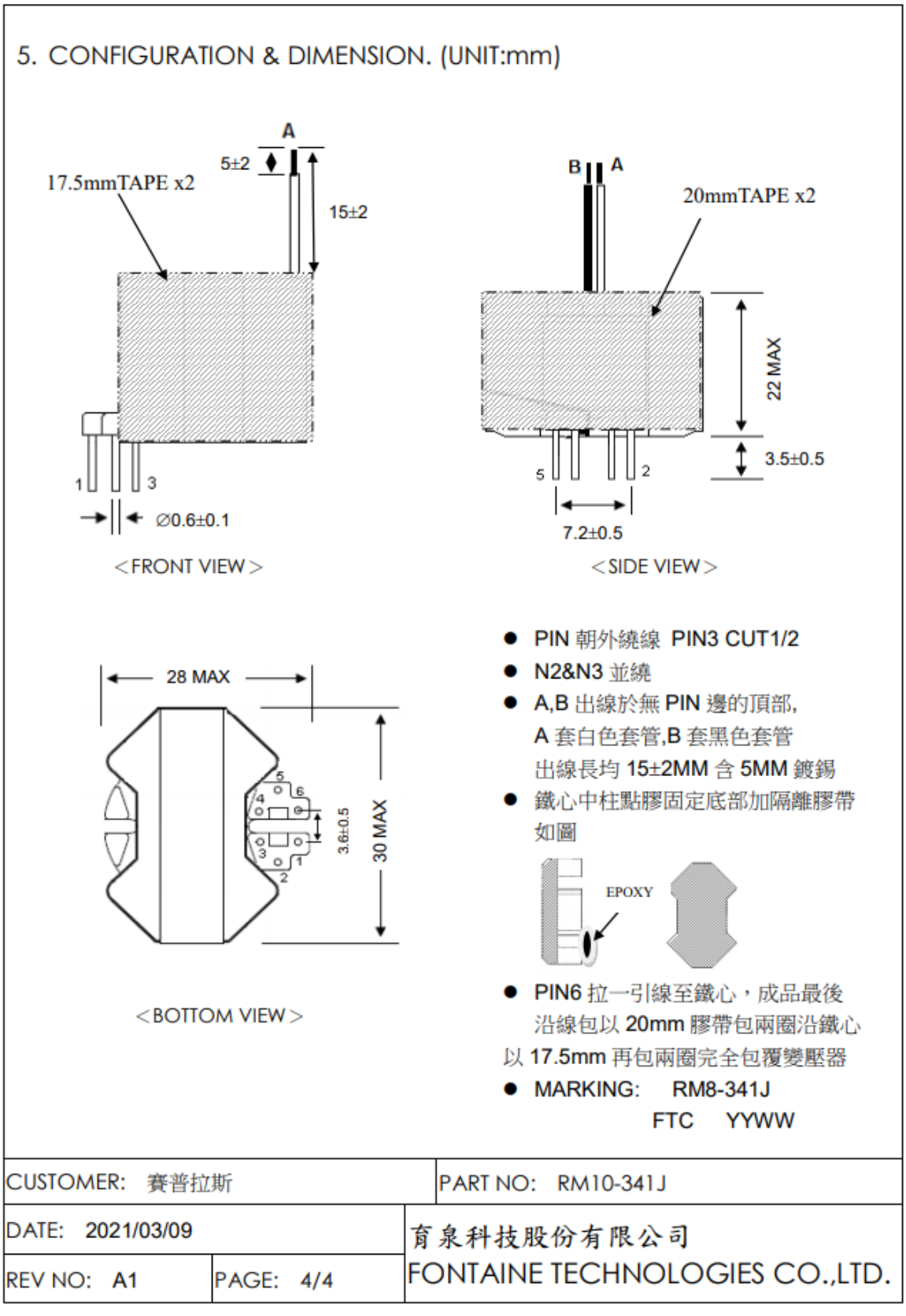
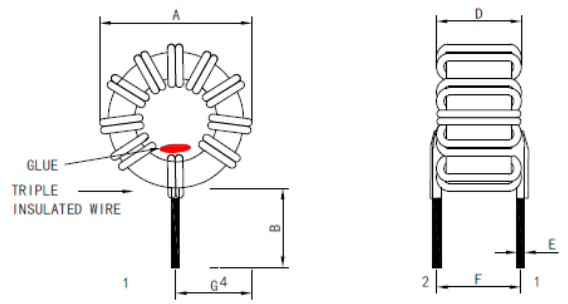


Figure 36 RM10 transformer design specification

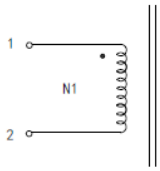
4.5 Inductor specifications (L1 900 uH)

1. 外观图示(单位：mm)/DIMENSION(UNIT:mm)



A	B	C	D	E	F	
12 MAX	3.5 ±0.5	1.5 MAX	6.5 MAX	φ0.60 ±0.1	5.5 ±0.5	

2. 电气原理/CIRCUIT DIAGRAM



" • ": POLARITY/极性

3. 绕组/WINDING

绕组 WINDING	漆包线 WIRE(mm)	起末端 S-F	圈数 TURNS(Ts)	绕组方式 WINDING CONDITION
N1	φ0.70(2UEW)	1-2	19	BIFILAR/并绕

4. 特性/CHARACTERISTIC

序号 NO.	项目 ITEM	测试点 MEASURED POINT	技术要求 TECHNICAL DATA	测试条件及仪器 TESTING CONDITION & INSTRUMENT
4.1	电感量 INDUCTANCE	L(1-2)	900uH MIN	HP-4284A 1KHz/0.25V, AT 25°C
4.2	平衡性 INDUCTANCE BALANCE			
4.3	耐压 HI-POT TEST	COIL-COIL	AC 1.0KV	CS9929 5mA 60Hz 3S
		COIL-CORE	AC 0.5KV	
4.4	Operating temperature range: -20°C ~+40°C, 45% ~95%RH			
4.5	Storage temperature range: -20°C ~+70°C, 45% ~95%RH			
4.6	Storage time: 3 months			

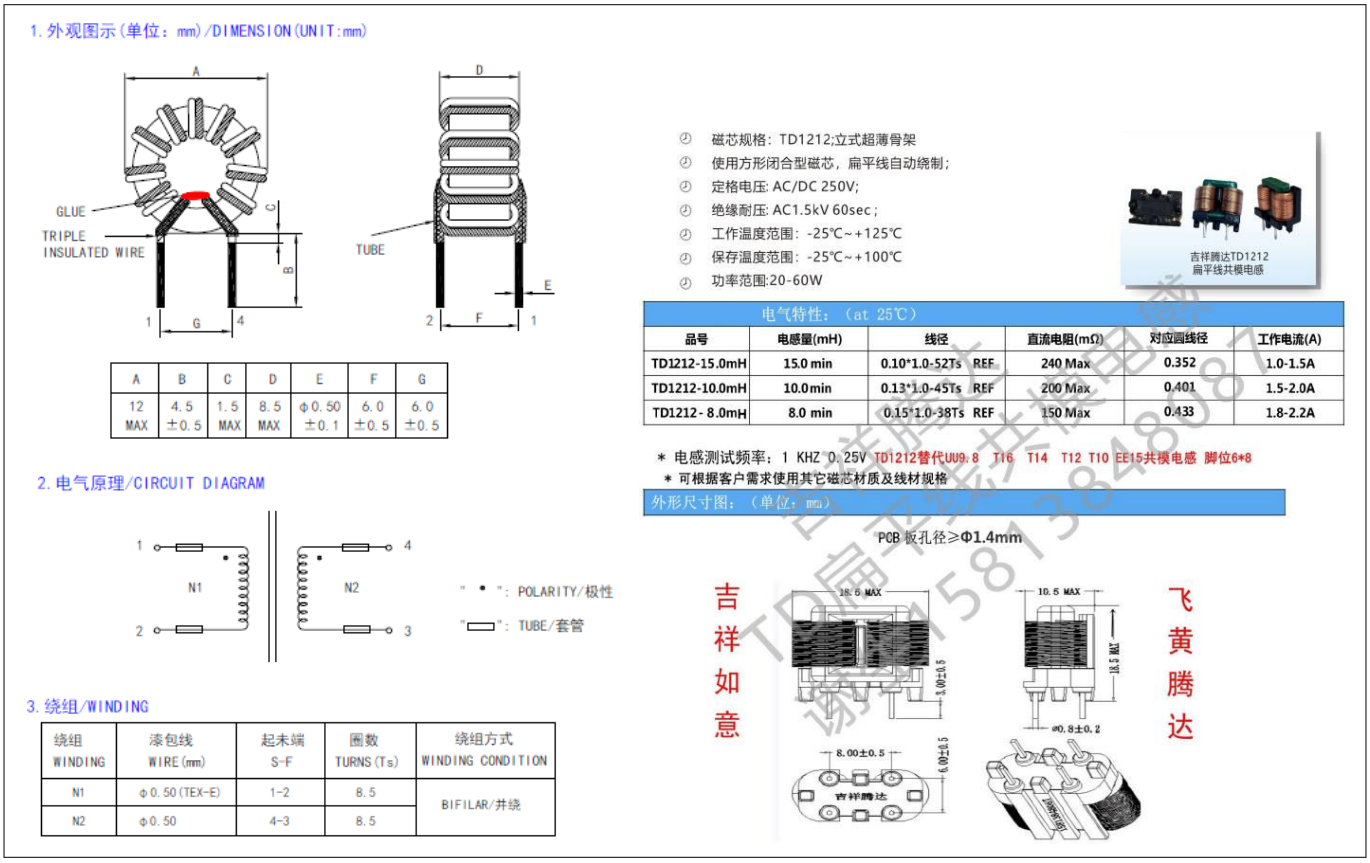
5. 材料清单/MATERIAL LIST

序号 NO.	项目 ITEM	规格&材质 TYPE & MATERIAL	供应商 SUPPLIERS	认证号 UL NO.
1	磁芯 CORE	TYPE:T10×6×5 MATERIAL:FH4 A121	SHENZHEN SHI LI CI ELECTRICAL CO.,LTD. ACME ELECTRONIC CORPORATION OR EQUAL	
2	漆包线 WIRE	POLYURETHANE ENAMELED MTLDSG:UEW ANSI TYPE:MW75C THERMAL RATING:130°C	TAI-I ELECTRIC WIRE & CABLE CO LTD	E85640
		POLYURETHANE ENAMELED MTLDSG:UEW% ANSI TYPE:MW75 THERMAL RATING:130°C	XIN LONG MAGNET WIRE CO LTD	E171082
3	三层绝缘线 TRIPLE INSULATED WIRE	THERMAL RATING:130 C°	FURUKAWA ELECTRIC CO.,LTD OR EQUAL	E206440
4	胶 GLUE	TYPE:2008A/B-X	DONGGUAN EATTO ELECTRONIC MATERIAL CO.,LTD OR EQUAL	E218090
5	套管 TUBE	TYPE:TFT THERMAL RATING:200°C	GREAT HOLDING INDUSTRIAL CO LTD	E156256
		TYPE:2T-TFT THERMAL RATING:200°C	P LEO & CO (B C) LTD	E176865
6	凡立水 VARNISH	TYPE:8562(a) THERMAL RATING:155°C	HANG CHEUNG PETROCHEMICAL LTD	E200154

The filter must be manufactured to comply with the ROHS directive ,use only Pb-free solder

Figure 37 Datasheet of pi filter inductor L1

4.6 Common mode choke specifications (LF1 600 uH, LF2 15 mH)



A	B	C	D	E	F	G
12 MAX	4.5 ±0.5	1.5 MAX	8.5 MAX	φ0.50 ±0.1	6.0 ±0.5	6.0 ±0.5

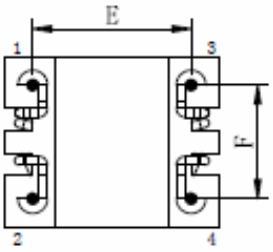
品号	电感量(mH)	线径	直流电阻(mΩ)	对应圆线径	工作电流(A)
TD1212-15.0mH	15.0 min	0.10*1.0-52Ts REF	240 Max	0.352	1.0-1.5A
TD1212-10.0mH	10.0min	0.13*1.0-45Ts REF	200 Max	0.401	1.5-2.0A
TD1212- 8.0mH	8.0 min	0.15*1.0-38Ts REF	150 Max	0.433	1.8-2.2A

绕组 WINDING	漆包线 WIRE(mm)	起末端 S-F	圈数 TURNS(Ts)	绕组方式 WINDING CONDITION
N1	φ0.50(TEX-E)	1-2	8.5	BIFILAR/并绕
N2	φ0.50	4-3	8.5	

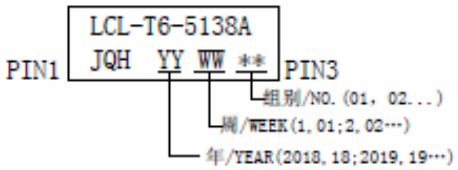
Figure 38 Datasheet of common mode choke

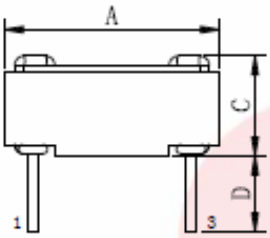
4.7 Pulse transformer (T2)

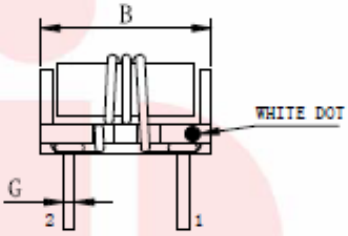
1. 外观图(单位:mm)/DIMENSION(UNIT:mm)

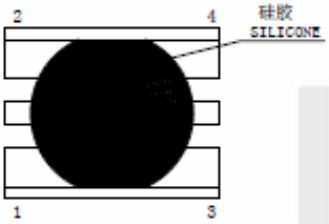


MARKING/LABEL:





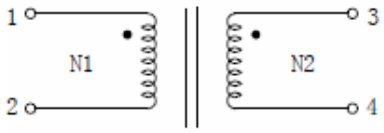




NOTE:
1. 线圈和磁环点胶将磁环全部封住。
2. PIN1打点标识。

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

2. 电原理图/CIRCUIT DIAGRAM



″ ● ″: POLARITY/极性

3. 绕组/WINDING

绕组 WINDING	漆包线 WIRE(mm)	起末端 S-F	圈数 TURNS(Ts)	绕制方式 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 NO.	项目 ITEM	测量点 MEASURED POINT	技术要求 TECHNICAL DATA	测试条件及仪器 TESTING CONDITION & INSTRUMENT
1	电感量 INDUCTANCE	L(1-2)	7.0uH MIN	Agilent 4284A 100KHz/0.3V, AT 25℃
2	耐压 HI-POT	N1-N2	3.0KV AC	CS9929 50Hz/60Hz 4mA 4S

5. 材料清单/MATERIAL LIST

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

Figure 39 Datasheet of pulse transformer LCL-T6-5138A

4.8 EZ-PD™ configuration utility

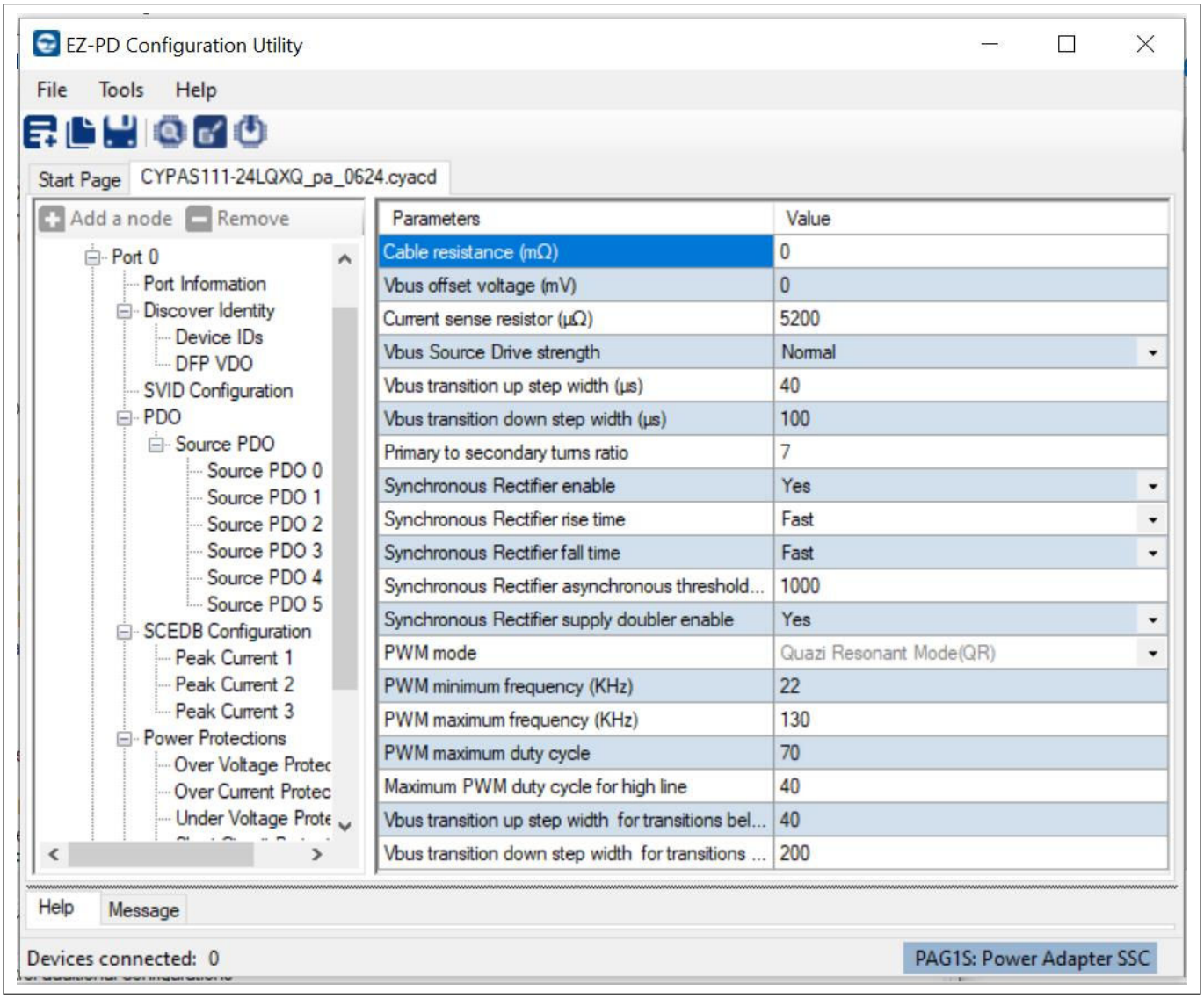


Figure 40 EZ-PD™ PAG1 utility screenshot

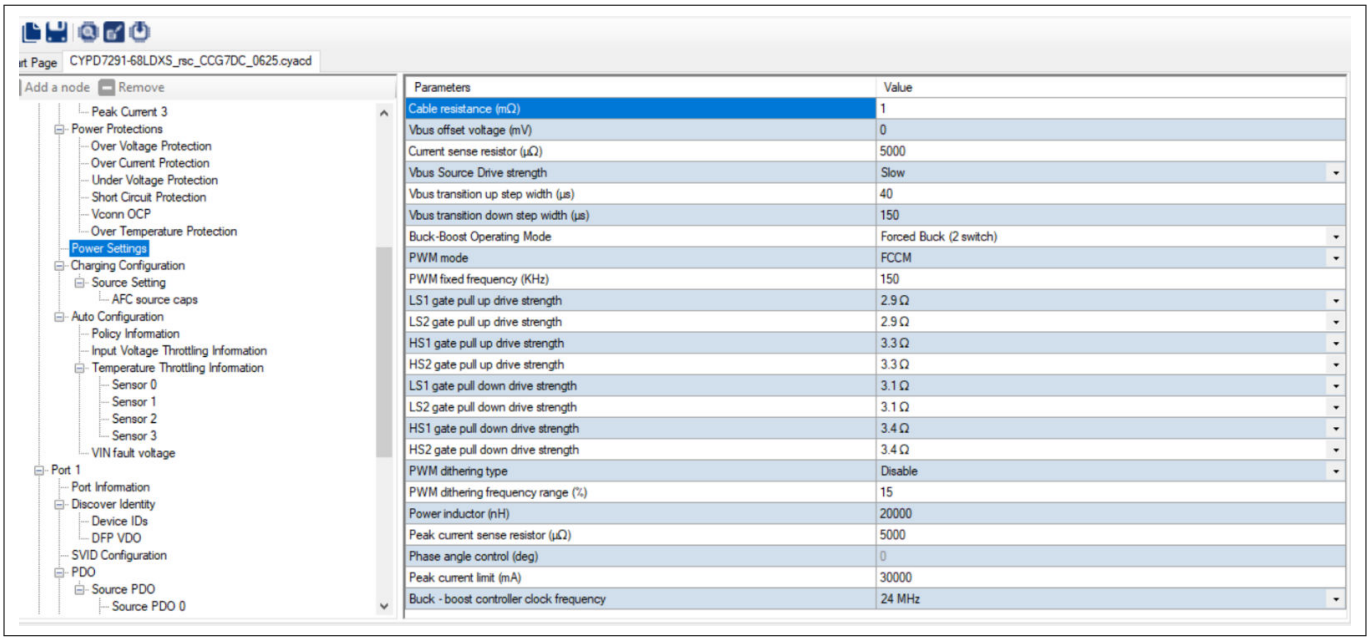


Figure 41 EZ-PD™ CCG7D-C port1 utility screenshot

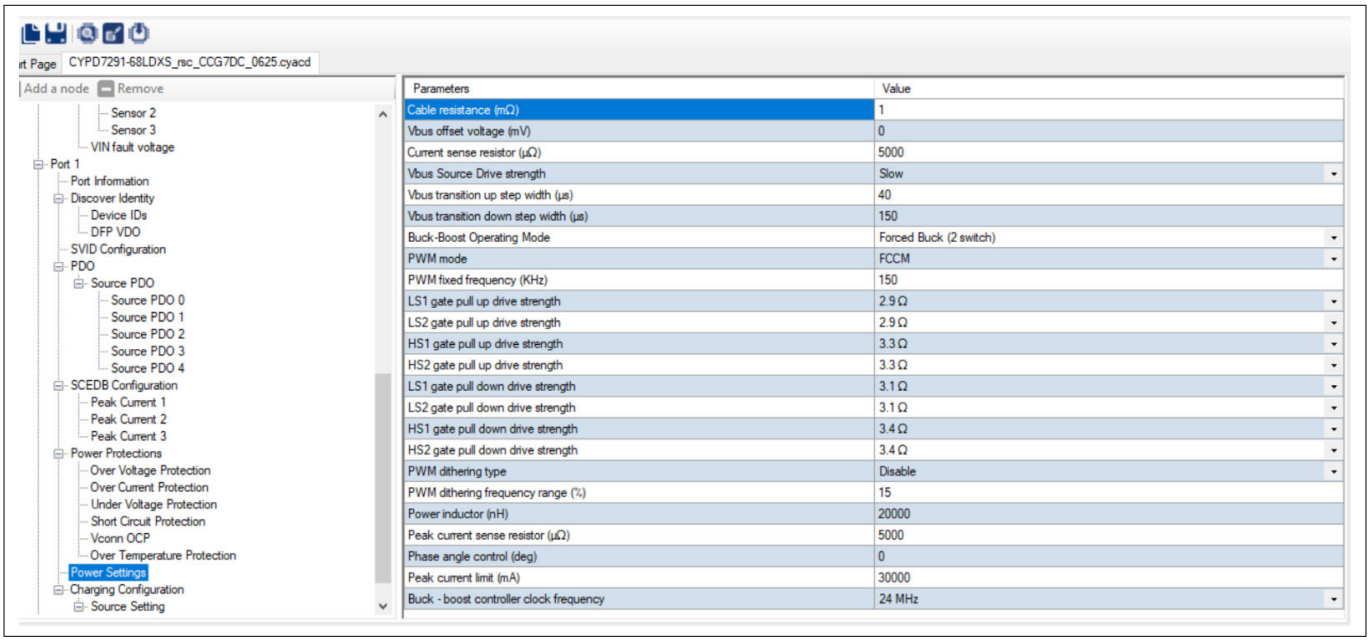


Figure 42 EZ-PD™ CCG7D-C port2 utility screenshot

The Infineon 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 the Infineon customers according to their use cases and requirements.

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

Table 16 provides the default configured values with respect to power settings and power protections.

Table 16 Default configuration values

Parameters	Values
Power settings	
Cable resistance (mΩ)	0
V_{bus} offset voltage (mV)	0
Current sense resistor (µΩ)	5100
V_{bus} source drive strength	**Normal**
V_{bus} transition up step width (µs)	**40**
V_{bus} transition down step width (µs)	**100**
Primary to secondary turns ratio	**7**
Synchronous rectifier enable	Yes
Synchronous rectifier rise time	Fast
Synchronous rectifier fall time	Fast
Synchronous rectifier asynchronous threshold (ns)	1000
Synchronous rectifier doubler enable	Yes
PWM mode	Quasi Resonant mode (QR)
PWM minimum frequency (KHz)	22
PWM maximum frequency (KHz)	**130**
PWM maximum duty cycle (%)	70
Power protections	
1. Overvoltage protection	
Enable	Yes
OVP threshold (%)	20
Debounce period (µs)	10
Retry count	2
2. Overcurrent protection	
Enable	Yes
OCP threshold (%)	20
Debounce period (ms)	10
Retry count	2
3. Undervoltage protection	
Enable	Yes
UVP threshold (%)	70
Debounce period (µs)	10
Retry count	2

(table continues...)

Table 16 (continued) Default configuration values

Parameters	Values
4. Short circuit protection	
Enable	No
Debounce period (µs)	4
Retry count	**2**
5. Overtemperature protection	
Enable	Yes
Thermistor type 1	NTC
Cutoff value 1	**4800**
Restart value 1	**4650**
Debounce period (ms)	10
Enable thermistor 2	No
Thermistor type 2	0
Cutoff value 2	0
Restart value 2	0

4.9 Glossary

Table 17 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	I_o/I_{out}	Output current of the DUT
9	NGDO	NFET gate driver output – Q4
10	OCP	Overcurrent protection
11	OVP	Overvoltage 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	V_{bus_c}	Bus voltage at type C, i.e., after provider/NGDO FET
18	V_{bus_in}	Bus voltage before provider/NGDO FET
19	V_{in}/V_{in_ac}	Input AC voltage to the DUT
20	V_o/V_{out}	Output voltage of the DUT

References

[1] Infineon Technologies AG: *Primary Side Startup Controller, PAG1P Datasheet (Rev. *E)*; 2020-06-18; Primary Side Startup Controller, PAG1P Datasheet (Rev. *E)

[2] Infineon Technologies AG: *USB-PD Power Adapter Secondary Side Controller, CYPAS111 Datasheet (Rev. *B)*; 2019-08-19; USB-PD Power Adapter Secondary Side Controller, CYPAS111 Datasheet (Rev. *B)

[3] Infineon Technologies AG: *EZ-PD™ CCG7D consumer Datasheet, Dual-port USB-C PD controller with integrated Buck-Boost controller, Datasheet (Rev. *B)*; 2022-02-14

[4] Infineon Technologies AG: *Power Adaptor System Design Guidelines Using CYPAP11x, Application Note (Rev. *A)*; 2021-03-22

[5] Infineon Technologies AG: *Design Calculator for PAG1 Designs, Knowledge Base Article (Rev. *A)*; 2021-12-16

[6] Infineon Technologies AG: *Hardware design guidelines for EZ-PD™ CCG7D consumer - Cigarette lighter adapter (CLA), User Guide (Rev. **)*; 2021-09-24

Revision history

Document version	Date of release	Description of changes
Rev. 1.0	2021-07-09	Initial with basic function data
Rev. 1.1	2022-02-17	Template adjusted and minor spelling corrections
Rev. 1.2	2022-03-08	Reference section added
Rev. 1.3	2022-03-15	Trademarks adapted

Trademarks

All referenced product or service names and trademarks are the property of their respective owners.

Edition 2022-03-15

Published by

Infineon Technologies AG

81726 Munich, Germany

© 2022 Infineon Technologies AG

All Rights Reserved.

Do you have a question about any aspect of this document?

Email: erratum@infineon.com

Document reference
IFX-jrv1643902872416

Important notice

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics ("Beschaffenheitsgarantie").

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer's compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer's products and any use of the product of Infineon Technologies in customer's applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

Warnings

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.