# UM10833

## TEA1836DB1200 TEA18362LT + TEA1892TS 45 W cool cube charger

Rev. 1 — 3 February 2015 User manual

### Document information

| Info | Content |
|---|---|
| **Keywords** | TEA1836DB1200, TEA18362LT, TEA1892TS, very low standby power consumption, active X-cap discharge, burst mode operation, flyback converter, 45 W, charger, converter, power supply, demo board |
| **Abstract** | This user manual describes the 45 W cool cube demo board with the TEA18362LT and TEA1892TS. The TEA1836DB1200 demo board provides an output of 19.5 V/2.31 A. It has very small dimensions (31 mm × 52 mm). It fits in the cool cube casing (outer dimensions). |

### Revision history

| Rev | Date | Description |
|---|---|---|
| v.1 | 20150203 | first issue |

## Contact information

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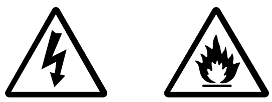
# 1. Introduction

**WARNING**

**Lethal voltage and fire ignition hazard**



The non-insulated high voltages that are present when operating this product, constitute a risk of electric shock, personal injury, death and/or ignition of fire.

This product is intended for evaluation purposes only. It shall be operated in a designated test area by personnel qualified according to local requirements and labor laws to work with non-insulated mains voltages and high-voltage circuits. This product shall never be operated unattended.

## 1.1 Scope of this document

This user manual describes the 45 W notebook adapter TEA1836DB1200 demo board using the TEA18362LT and TEA1892TS. It contains a set of measurements that shows the main characteristics.

## 1.2 TEA18362LT

The TEA18362LT is a controller IC for low-cost Switched Mode Power Supplies (SMPS) intended for flyback topologies. The built-in green functions provide high efficiency at all power levels.

At high power levels, the flyback operates in QR mode. When lowering the power levels, the controller switches to DCM or Frequency Reduction (FR) mode. The peak current is reduced to 25 % of the maximum peak current.

At low power levels, when the flyback switching frequency reaches 25 kHz, the flyback converter switches to burst mode. To ensure high efficiency at low power and excellent no-load power performance, a burst mode has been integrated that reduces the opto current to a minimum level. As the switching frequency in this mode has a minimum value of 25 kHz while the burst frequency is always below 800 Hz, the frequencies are outside the audible range.

During the non-switching phase of the burst mode, the internal IC supply current is reduced to optimize efficiency further.

Valley switching is used in all operating modes.

The TEA18362LT includes an OverPower Protection (OPP). The OPP enables the controller to deliver 150 % peak power for a limited amount of time (200 ms) in case of overpower situations. If the output is shorted, the output power is limited to 100 % to keep the average power consumption lower than 5 W.

The TEA18362LT is realized in a high-voltage Silicon-On-Insulator (SOI) process. This process combines the advantages of a low-voltage process, like accuracy, high-speed protection functions, and control, while maintaining the high-voltage capabilities like high-voltage start-up and integrated X-cap discharge.

The TEA18362LT enables low-cost, highly efficient and reliable supplies for power requirements up to 75 W to be designed easily and with a minimum number of external components.

### 1.3 TEA1892TS

The TEA1892TS is a member of the generation of Synchronous Rectifier (SR) controller ICs for switched mode power supplies. Its high level of integration enables the design of a cost-effective power supply with a very low number of external components.

The TEA1892TS is a controller IC dedicated to synchronous rectification on the secondary side of discontinuous conduction mode and quasi-resonant flyback converters.

### 1.4 Setup of the 45 W notebook adapter

The board is designed for universal mains (90 V (AC) to 265 V (AC)). When a DC input voltage is applied, the power consumption is higher due to continuous activation of the X-capacitor discharge function.

The TEA1836DB1200 demo board incorporates two subcircuits:

- A DCM/QR type flyback converter
- A Synchronous Rectifier (SR)

The purpose of the demo board is to show the operation of the TEA18362LT and TEA1892TS in a small-size board. The performance is according to the current general standards including the DoE + CoC efficiency requirements. It can be used as a starting point for further product development.

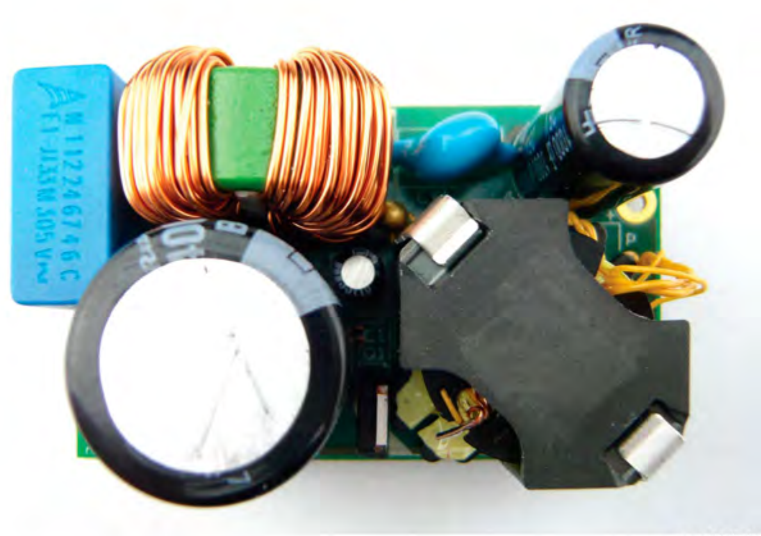
## 2. Safety warning

The board must be connected to the mains voltage. Touching the board during operation must always be avoided. An isolated housing is obligatory when used in uncontrolled, non-laboratory environments. Galvanic isolation of the mains phase using a variable transformer is always recommended. Figure 1 shows the symbols by which these devices can be recognized.


a. Isolated    b. Not isolated

**Fig 1. Variable transformer (Variac) isolation symbols**

## 3. Board photographs



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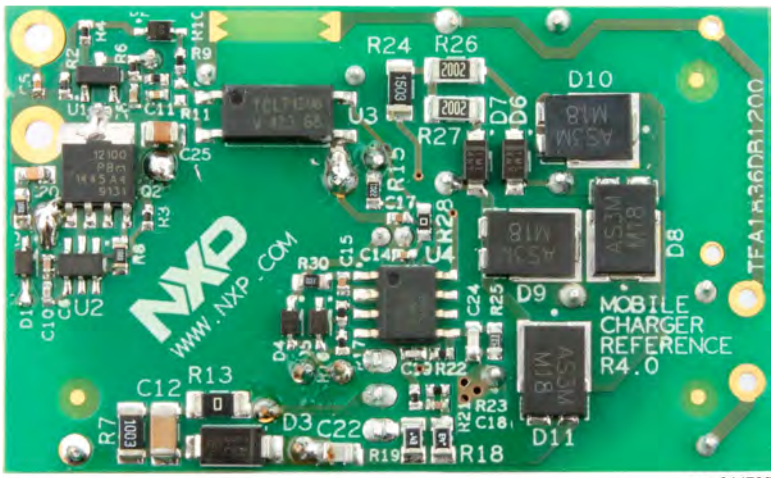
a. Top

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b. Bottom

**Fig 2. TEA1836DB1200 demo board photographs**

# 4. Specifications

Table 1. TEA1836DB1200 specifications

| Symbol | Description | Conditions | Value |
|---|---|---|---|
| **Input specifications** | | | |
| $V_{in}$ | input voltage | | 90 V to 265 V |
| $f_i$ | input frequency | | 47 Hz to 64 Hz |
| $P_{i(noload)}$ | no-load input power | at 230 V/50 Hz | < 25 mW |
| **Output specifications** | | | |
| $V_{out}$ | output voltage | | 19.5 V |
| $I_{out}$ | output current | | 0 A to 2.31 A |
| $I_{o(peak)}$ | peak output current | for 200 ms at $V_i$ = 90 V at 60 Hz | 3 A |
| $t_{hold}$ | hold time | at 115 V/60 Hz; full load | > 10 ms |
| - | line regulation | | ±1 % |
| - | load regulation | | ±1 % |
| $t_{startup}$ | start-up time | at 115 V/60 Hz | ≤ 1 s |
| η | efficiency | DoE: > 88.5 % at cable end (including 0.5 % margin); CoC: > 89.5 % at cable end (including 0.5 % margin) | ≥ 92 % |
| - | ElectroMagnetic Interference (EMI) | CISPR22 compliant | pass |

# 5. Measurements

## 5.1 Test facilities

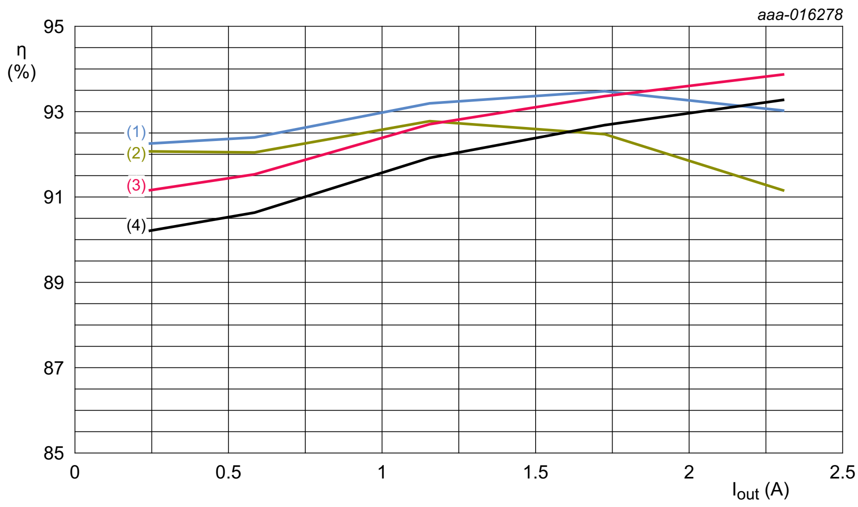
- Oscilloscope: Yokogawa DL9140L
- AC Power Source: Agilent 6812B
- Electronic load: Agilent 6063B
- Digital power meter: Yokogawa WT210

## 5.2 Efficiency

Efficiency measurements are performed at stabilized conditions. The output voltage and output current is measured directly at the PCB connector. Measurements are done for 90 V/60 Hz, 115 V/60 Hz, 230 V/50 Hz, and 265 V/50 Hz. Table 2 shows the average value of 10 boards.

**Table 2. Efficiency PCB end**

| $I_{out}$ (A) | $V_{out}$ (V) | $P_{in}$ (W) | Efficiency (%) | Average 0.585 A to 2.31 A |
|---|---|---|---|---|
| **90 V (AC)/60 Hz** | | | | |
| 0.24 | 19.392 | 5.055 | 92.07 | 92.11 |
| 0.585 | 19.4 | 12.33 | 92.04 | |
| 1.155 | 19.406 | 24.159 | 92.78 | |
| 1.725 | 19.411 | 36.21 | 92.47 | |
| 2.31 | 19.421 | 49.22 | 91.15 | |
| **115 V (AC)/60 Hz** | | | | |
| 0.24 | 19.392 | 5.045 | 92.25 | 93.02 |
| 0.585 | 19.4 | 12.283 | 92.40 | |
| 1.155 | 19.407 | 24.052 | 93.19 | |
| 1.725 | 19.411 | 35.82 | 93.48 | |
| 2.31 | 19.418 | 48.22 | 93.02 | |
| **230 V (AC)/50 Hz** | | | | |
| 0.24 | 19.393 | 5.106 | 91.15 | 92.87 |
| 0.585 | 19.403 | 12.401 | 91.53 | |
| 1.155 | 19.408 | 24.18 | 92.71 | |
| 1.725 | 19.414 | 35.87 | 93.36 | |
| 2.31 | 19.421 | 47.79 | 93.87 | |
| **265 V (AC)/50 Hz** | | | | |
| 0.24 | 19.394 | 5.16 | 90.20 | 92.13 |
| 0.585 | 19.405 | 12.525 | 90.63 | |
| 1.155 | 19.41 | 24.39 | 91.92 | |
| 1.725 | 19.418 | 36.14 | 92.68 | |
| 2.31 | 19.423 | 48.1 | 93.28 | |




(1) $V_{in}$ = 115 V (AC)

(2) $V_{in}$ = 90 V (AC)

(3) $V_{in}$ = 230 V (AC)

(4) $V_{in}$ = 265 V (AC)

**Fig 3. Efficiency as a function of $I_{out}$**

## 5.3 Standby power consumption

Power consumption performance of the total application board without load connected was measured with a Yokogawa WT210 digital power meter. The standby power consumption has been measured 20 minutes after switch-on.

Measurements were performed for 90 V/60 Hz, 115 V/60 Hz, 230 V/50 Hz, and 265 V/50 Hz. Table 3 shows the average value of 10 boards.

**Table 3. Standby power consumption**

| $V_{in}$ V (AC) | $P_{noload}$ (mW) | $V_{out}$ (V) |
|---|---|---|
| 90 V/60 Hz | 18.5 | 19.4 |
| 115 V/60 Hz | 19.1 | 19.4 |
| 230 V/50 Hz | 22.9 | 19.4 |
| 265 V/50 Hz | 24.8 | 19.4 |

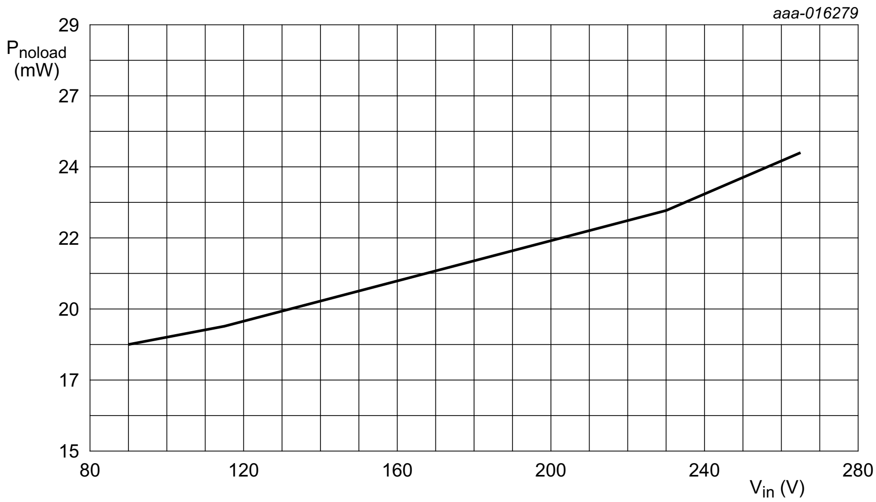



**Fig 4. Standby power consumption at no-load**

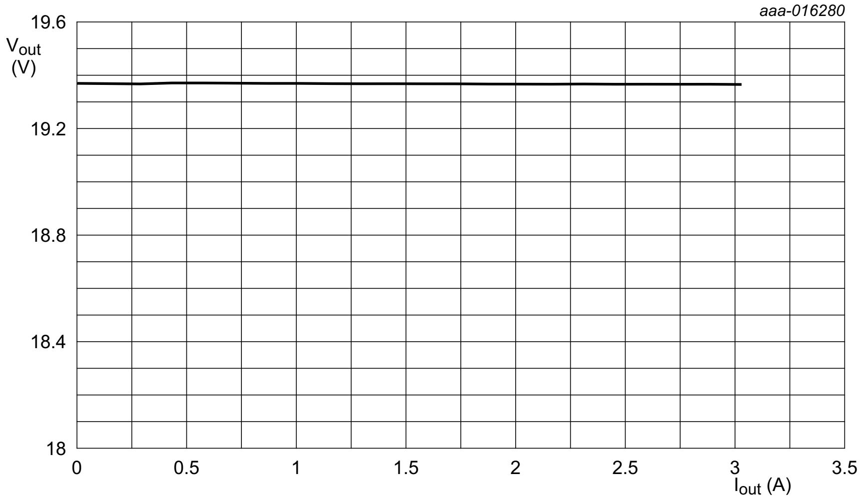
## 5.4 Current for changing between normal and burst mode operation

**Table 4. Current for changing between normal and burst mode operation**

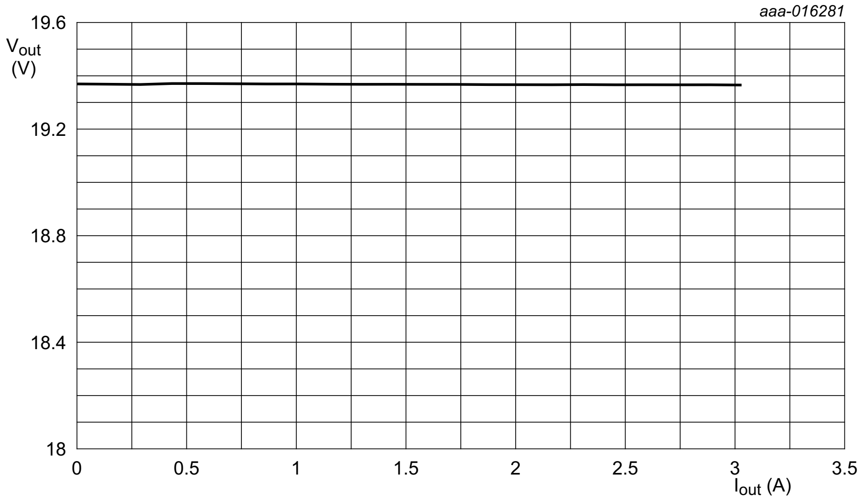
| Condition | 115 V/60 Hz | 230 V/50 Hz |
|---|---|---|
| **From normal mode to burst mode operation** | | |
| current (A) | 0.40 | 0.50 |
| power (W) | 7.75 | 9.7 |
| **From burst mode to normal mode operation** | | |
| current (A) | 0.25 | 0.33 |
| power (W) | 4.85 | 6.4 |

## 5.5 Load regulation

The output voltage versus load current was measured at the PCB connector.




a. $V_{in}$ = 115 V/60 Hz




b. $V_{in}$ = 230 V/50 Hz

**Fig 5. Output voltage as a function of output current**

## 5.6 Line regulation

The output voltage versus mains input voltage was measured directly at the output connector for nominal load condition (2.31 A).

The values remain within the target of 19.5 V ±1 %.

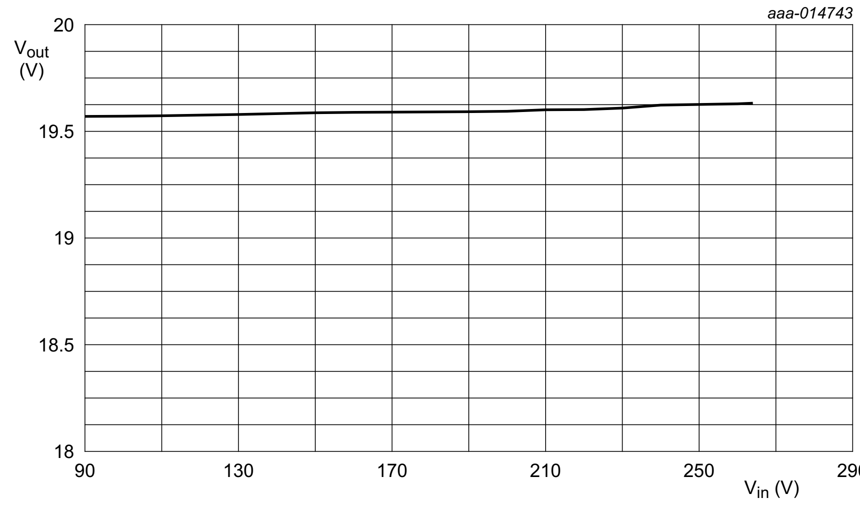
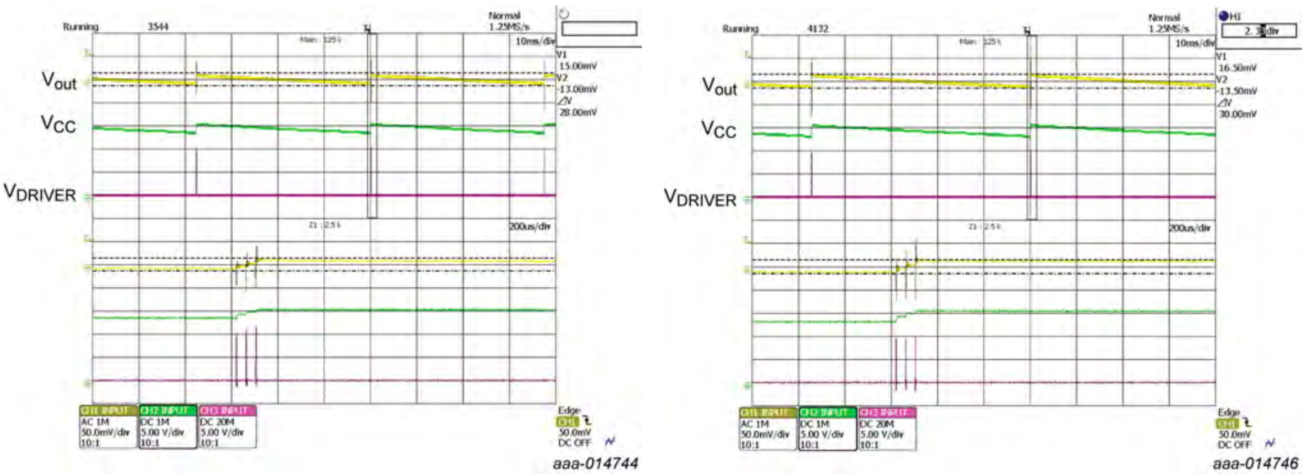



**Fig 6. Output voltage as function of the mains voltage**

## 5.7 Output voltage regulation in standby mode

The output voltage regulation during no load operation was measured for 90 V/60 Hz and 265 V/50 Hz.




a. $V_{in}$ = 90 V at 60 Hz

b. $V_{in}$ = 265 V at 50 Hz

**Fig 7. Output voltage regulation at no-load**

**Table 5. Output voltage ripple at no-load condition**

| Symbol | 90 V/60 Hz | 230 V/50 Hz |
|---|---|---|
| $V_{ripple}$ (mV) | 79 | 96 |

## 5.8 OverPower Protection (OPP)

The continuous maximum peak output power was measured directly at the output connector for various mains input voltages. When this level is exceeded, the protection is activated after the internal overpower counter-passes 200 ms.

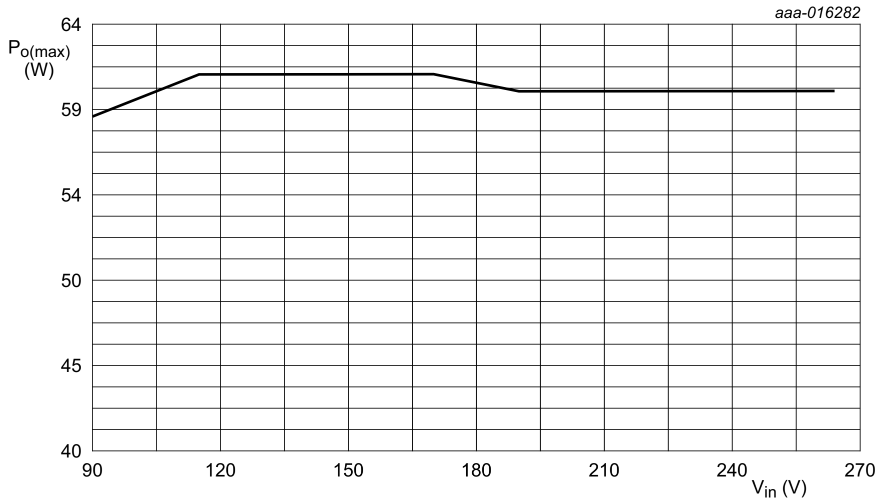



**Fig 8. Overpower protection level**

## 5.9 Voltage on pin VCC

**Table 6. VCC voltage**

| Condition | 115 V/60 Hz | 230 V/50 Hz |
|---|---|---|
| no-load | 12 | 12 |
| nominal load | 22.9 | 20.1 |

## 5.10 Brownout and start-up level

**Table 7. VCC voltage**

| Condition | Brownout (V) | Start level (V) |
|---|---|---|
| no-load | 70 | 79 |
| nominal load | 70 | 79 |

## 5.11 Short circuit protection

Output short circuit directly at the PCB connectors before switching on the mains voltage or during operation. The system protects and latches during the short circuit condition. With a TEA18362T, the system protects and restarts continuously during the short circuit condition.

**Table 8. Behavior during output short circuit condition**

| Condition | Behavior |
|---|---|
| output short before applying AC mains voltage | latch |
| output short circuit during operation at full load and no-load | latch |

**Table 9. Input power at output short circuit condition**

| Condition | 90 V/60 Hz | 230 V/50 Hz | 265 V/50 Hz |
|---|---|---|---|
| input power | 0.33 W | 0.31 W | 0.35 W |

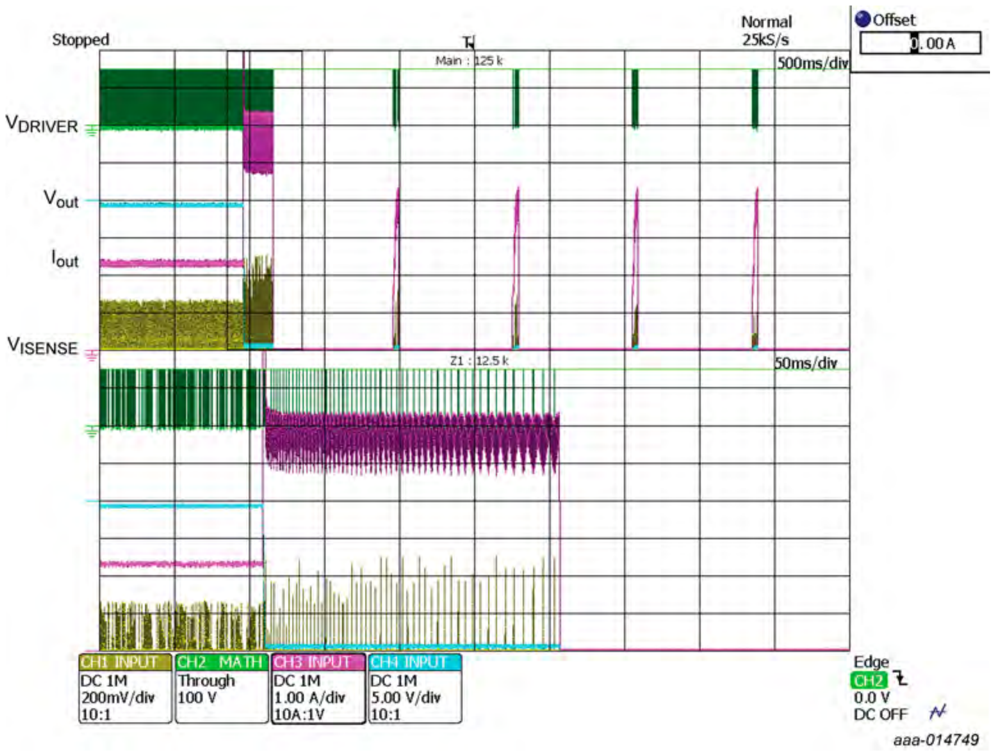


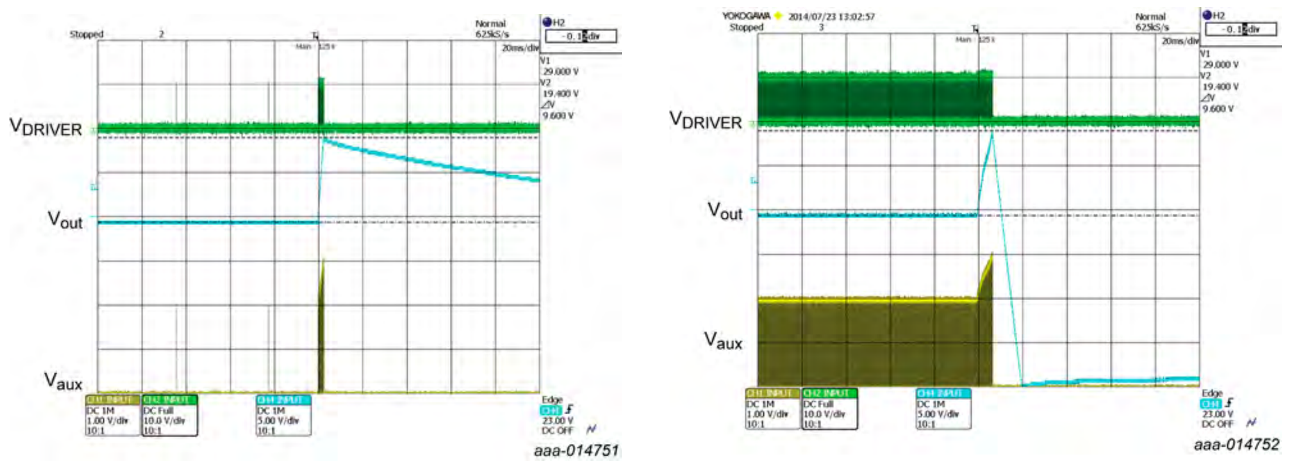

**Fig 9. Short circuit during operation at $V_{in}$ = 230 V (AC)**

### 5.12 Overvoltage protection

Applying a short circuit across the optoLED of the optocoupler (OPTO1; see Figure 22) creates an output overvoltage condition. The overvoltage protection is triggered when the AUX pin voltage increases to 3 V during the OVP detection interval. The output voltage was measured directly at the output connector for both a nominal load (2.31 A) and a no-load condition.

**Table 10. Maximum output voltage at OVP**

| Condition | 115 V/60 Hz | 230 V/50 Hz |
|---|---|---|
| no-load | 29 V | 29 V |
| nominal load (3.37 A) | 29 V | 29 V |




a. $I_o = 0$ A

b. $I_o = 2.31$ A

**Fig 10. Maximum output voltage when OVP is triggered**

### 5.13 Start-up time

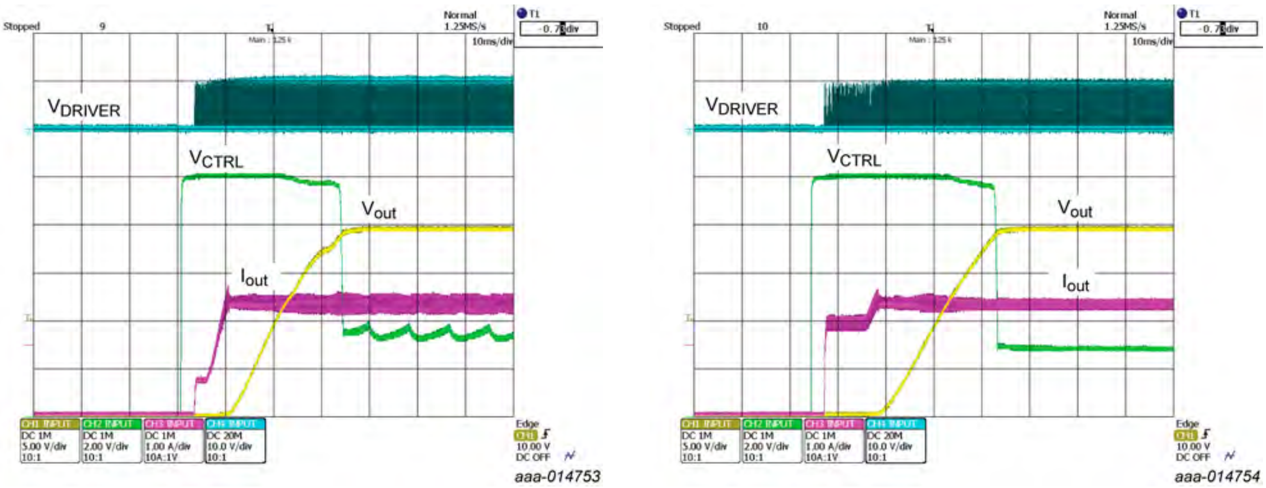
The start-up time is the time between the mains voltage switching on and the nominal output power available at the output.

**Table 11. Start-up time**

| Condition | Start-up time |
|---|---|
| 90 V/60 Hz | 370 ms |
| 115 V/60 Hz | 210 ms |
| 230 V/50 Hz | 150 ms |

## 5.14 Start-up profile

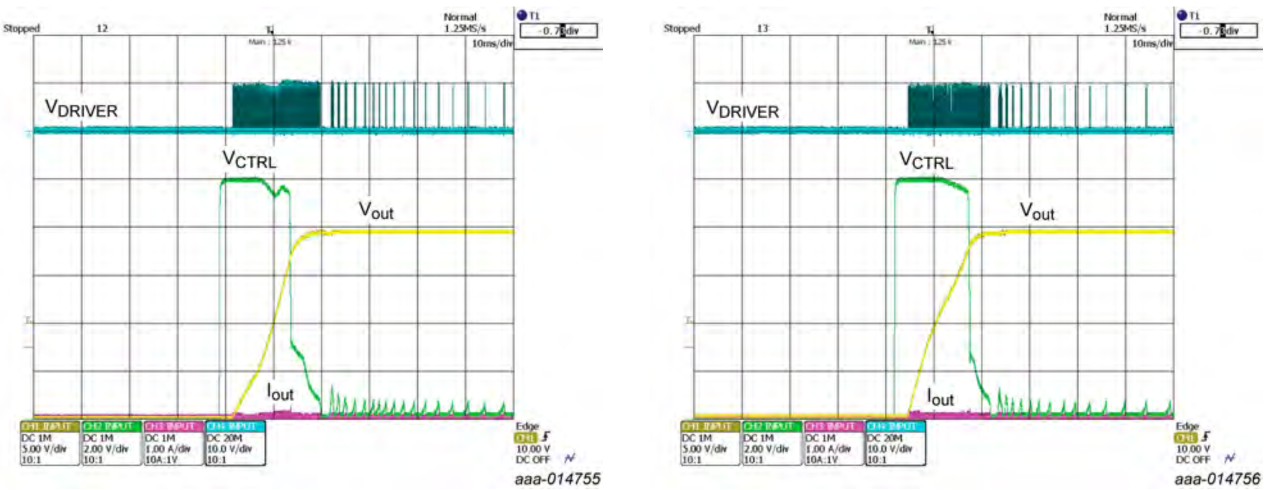
The shape of the output voltage during start-up was measured for 90 V/60 Hz and 265 V/50 Hz. It was measured directly at the output connector for a no-load and a nominal load (2.31 A) condition.




a. $V_{in}$ = 90 V (AC)

b. $V_{in}$ = 265 V (AC)

**Fig 11. Start-up at nominal output load**




a. $V_{in}$ = 90 V (AC)

b. $V_{in}$ = 265 V (AC)

**Fig 12. Start-up at no output load**

## 5.15 Hold-up time

The hold-up time is defined as the time between the following moments:

- After mains switch-off: The moment that the lowest bulk capacitor voltage during a mains cycle is crossed.
- The moment that the output voltage starts to decrease.

The hold-up time is measured for 115 V/60 Hz for a full load (2.31 A) condition. The output voltage was measured directly at the output connector.

**Table 12. Hold-up time**

| Condition | Hold-up time |
|---|---|
| 115 V/60 Hz | 10 ms |

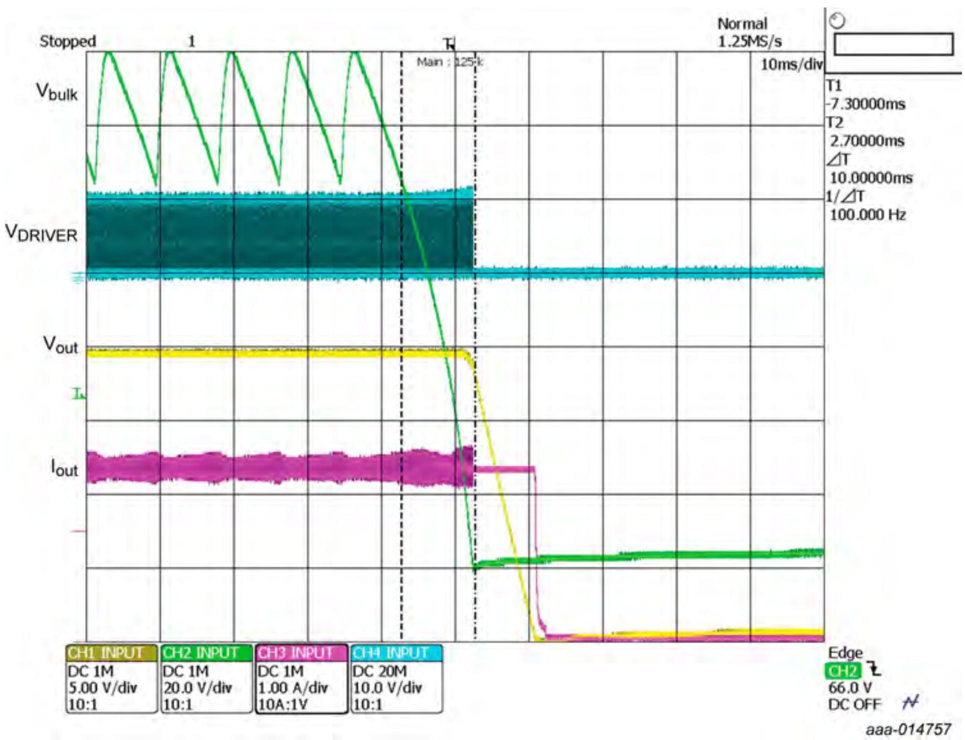



**Fig 13. Hold-up time at $V_{in}$ = 115 V (AC) and full load condition (2.31 A)**

## 5.16 Fast latch reset

The fast latch reset time was measured. The fast latch reset time is the time that the voltage on pin VCC requires to drop to the reset level (8.65 V typical) when the mains voltage is disconnected. It is 730 ms.

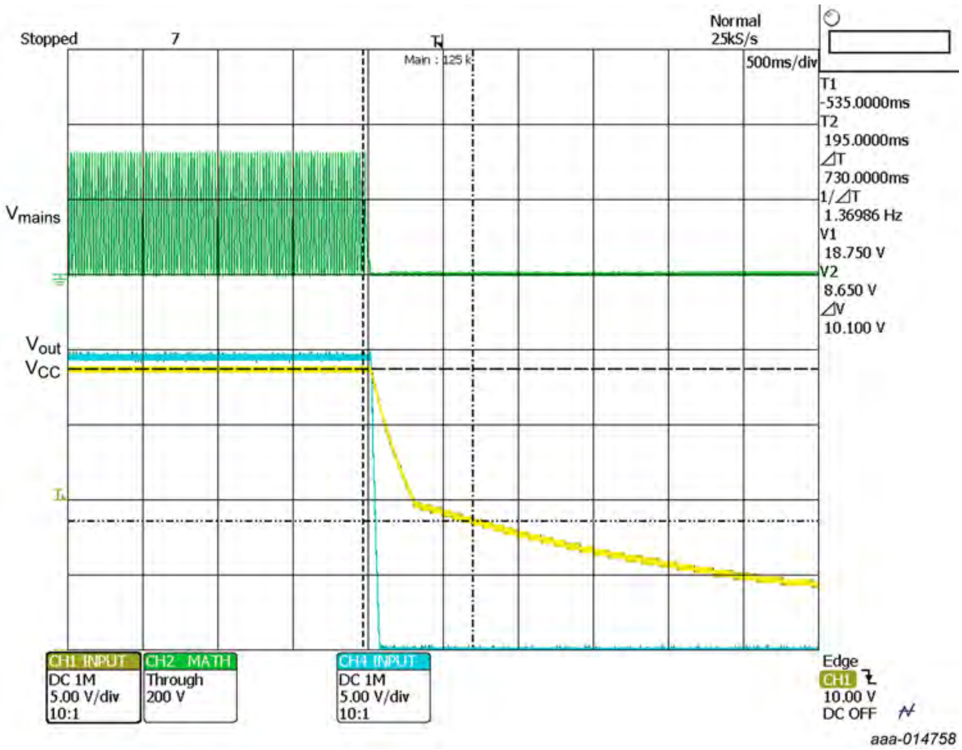



**Fig 14. Latch reset when disconnecting mains voltage**

## 5.17 X-capacitor discharge time

Unplug the power line at no-load condition and measure the discharge time at the X-capacitor (330 nF).

The discharge time is the time between the moment of disconnecting the mains source and the moment when the voltage reaches a defined voltage value.

**Table 13. X-capacitor discharge time test results**

| Condition | from 265 V * √2 to 135 V | from 265 V * √2 to 60 V |
|---|---|---|
| X-capacitor discharge time | 55 ms | 145 ms |

**Remark:** The discharge can start 100 ms later (worse case) than measured and shown because in burst mode operation the mains measurement interval is approximately 100 ms ($t_{wait(burst)HV}$).

The TEA1836 complies with Nemko Certification: NO081101 and with the DK-40437-UL certification (see for documentation on the certificates http://www.nxp.com/demoboard/TEA1836DB1200.html#documentation).

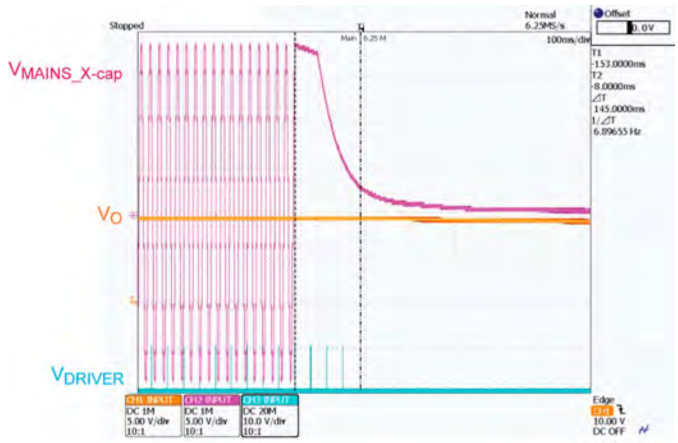


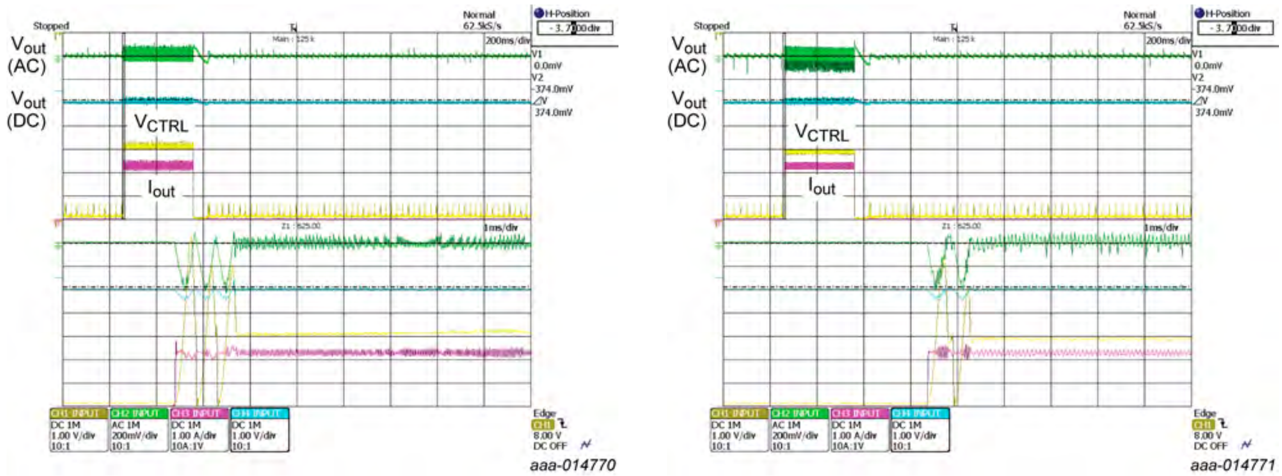

**Fig 15. X-capacitor discharge at 265 V (AC)/50 Hz and no-load**

## 5.18 Dynamic load

The output voltage was measured at the end of the board.

**Table 14. Maximum output voltage ripple in case of OVP**

| Condition | Load | Output voltage ripple (mV) |
|---|---|---|
| 115 V/60 Hz | $I_o$: 0 % to 100 % | 374 |
| 230 V/50 Hz | $I_o$: 0 % to 100 % | 374 |




a. $V_{in}$ = 115 V (AC)

b. $V_{in}$ = 230 V (AC)

**Fig 16. Output voltage during dynamic load**

### 5.19 Output ripple

Output ripple was measured at the end of a 16AWG cable with 1.2 m length using a standard filter of 10 μF + 100 nF on the probing position. Output ripple and noise were measured at nominal output current (2.31 A) and at no-load condition (0 A).

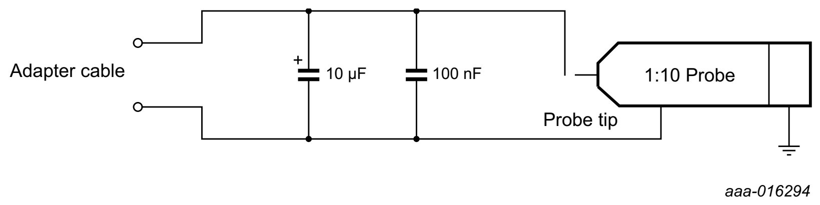
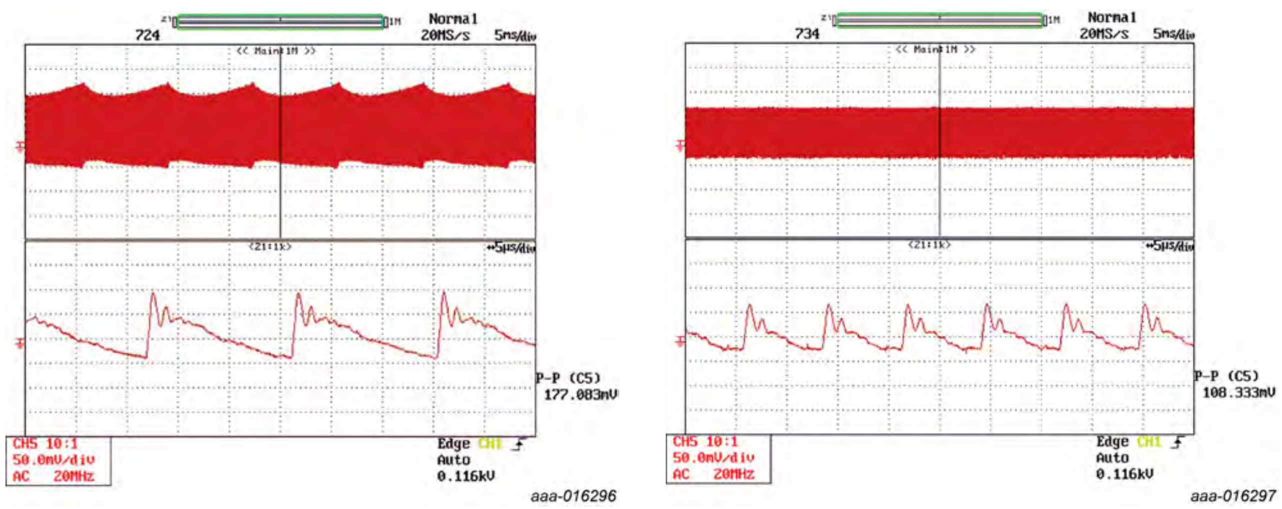



**Fig 17. Measurement setup**



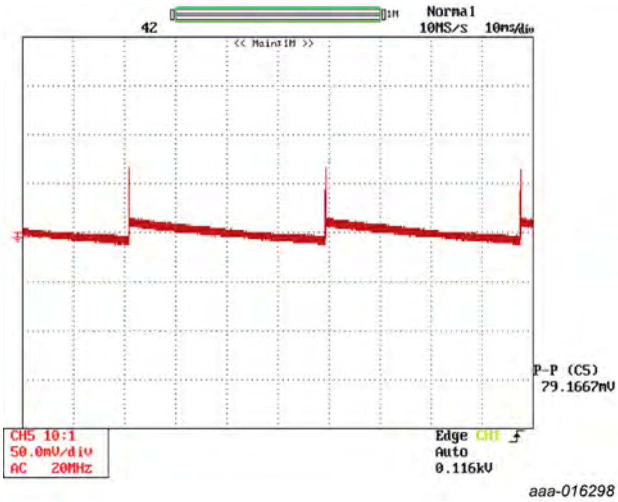

a. $V_{in}$ = 90 V (AC)

b. $V_{in}$ = 265 V (AC)

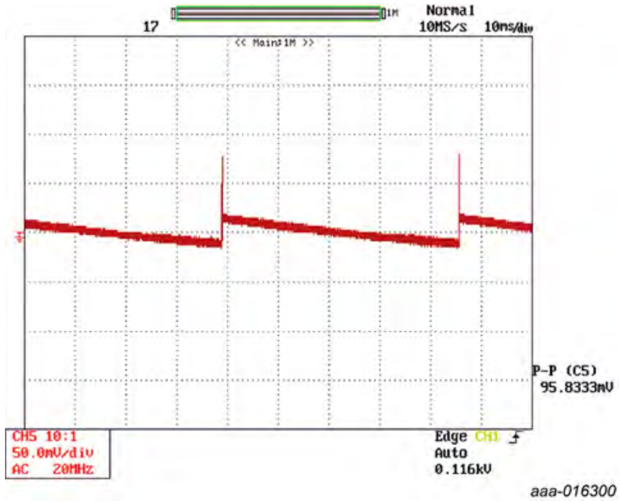
**Fig 18. Output voltage ripple nominal load**

**Table 15. Output voltage ripple at nominal load**

| Condition | peak-to-peak output voltage ripple and noise |
|---|---|
| 90 V/60 Hz | 177 mV |
| 265 V/50 Hz | 108 mV |




a. $V_{in}$ = 90 V (AC)




b. $V_{in}$ = 265 V (AC)

**Fig 19. Output voltage ripple at burst mode operation (no-load)**

**Table 16. Output voltage ripple at no-load**

| Condition | peak-to-peak output voltage ripple and noise |
|---|---|
| 90 V/60 Hz | 70 mV |
| 265 V/50 Hz | 96 mV |

## 5.20 EMI performance

Conditions:

- Type: Conducted EMI measurement
- Frequency range: 150 kHz to 30 MHz
- Output power: Full load condition
- Input voltage: 115 V and 230 V
- Secondary GND connected to PE GND

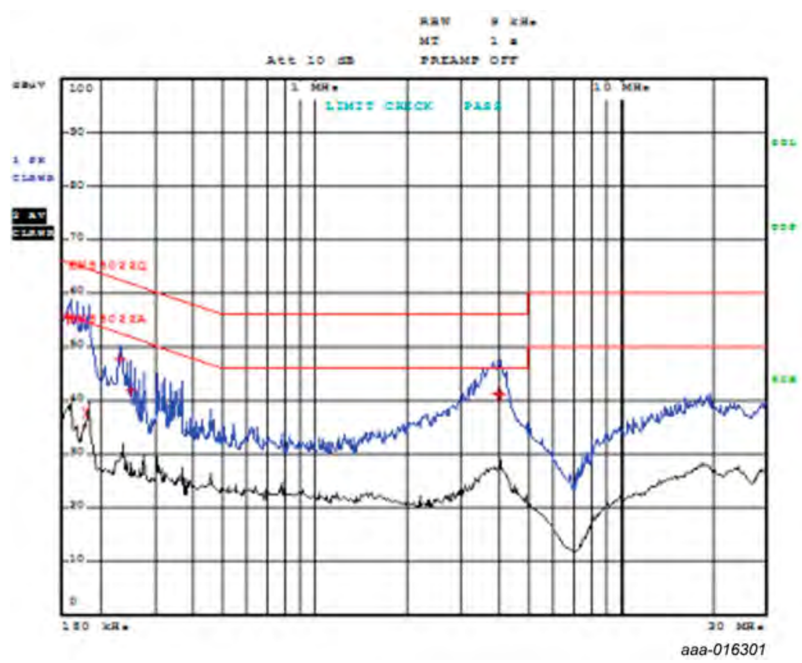



**Fig 20. Conducted EMI: $V_{in}$ = 115 V (AC) - curves**

**Table 17. Conducted EMI: $V_{mains}$ = 115 V (AC) - sheet**

| **Trace 1: EN55022Q**<br>**Trace 2: EN55022A**<br>**Trace 3: ---** | | | |
|---|---|---|---|
| **Trace** | **Frequency** | **Level dBμV** | **Delta limit dB** |
| 1 quasi peak | 158 kHz | 55.25 N | –10.31 |
| 1 quasi peak | 3.97 MHz | 41.43 N | –14.56 |
| 1 quasi peak | 230 kHz | 47.80 N | –14.64 |
| 1 quasi peak | 4.046 MHz | 41.01 N | –14.99 |
| 2 average | 182 kHz | 37.77 N | –16.62 |
| 1 quasi peak | 250 kHz | 41.94 N | –19.80 |

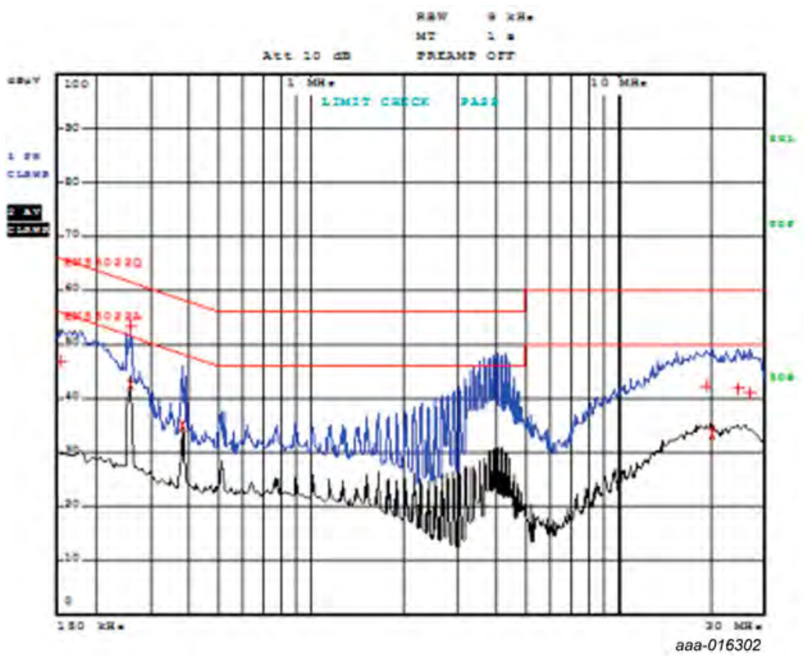



**Fig 21. Conducted EMI: $V_{in}$ = 230 V (AC) - curves**

**Table 18. Conducted EMI: $V_{in}$ = 230 V (AC) - sheet**

| Trace 1: EN55022Q<br>Trace 2: EN55022A<br>Trace 3: --- | | | |
|---|---|---|---|
| **Trace** | **Frequency** | **Level dBμV** | **Delta limit dB** |
| 1 quasi peak | 258 kHz | 53.49 N | –8.00 |
| 2 average | 258 kHz | 42.63 N | –8.86 |
| 2 average | 382 kHz | 35.00 N | –13.23 |
| 2 average | 20.166 MHz | 33.80 N | –16.19 |
| 1 quasi peak | 19.37 MHz | 42.46 N | –17.53 |
| 1 quasi peak | 24.706 MHz | 41.82 L1 | –18.17 |
| 1 quasi peak | 154 kHz | 47.03 N | –18.74 |
| 1 quasi peak | 26.958 MHz | 41.08 L1 | –18.91 |

## 5.21 Thermal measurements

The component temperatures were measured with open frame. The open PCB was placed on the table. After 1 hour of warming up time at full load (2.31 A), the component temperatures were measured using an infrared thermal camera. $T_{amb}$ = 25 °C. The MOSFET switch uses thermal compound for cooling.

**Table 19. Thermal measurements**

| Component | Part reference | Temperature (°C) |
|---|---|---|
| **$V_{in}$ = 115 V (AC)** | | |
| TEA1836 | U4 | 76.8 |
| Transformer core | T1 | 84.1 |
| Transformer winding | T1 | 88.5 |
| MOSFET switch SPU07N60C3 | Q1 | 92.5 |
| Clamp diode SA2M | D3 | 83.1 |
| Discharge resistor in peak clamp | R7 | 84.3 |
| SR MOSFFET PSMN012-100YS | Q2 | 63.2 |
| **$V_{in}$ = 230 V (AC)** | | |
| TEA1836 | U4 | 73.5 |
| Transformer core | T1 | 84 |
| Transformer winding | T1 | 86.5 |
| MOSFET switch SPU07N60C3 | Q1 | 88.8 |
| Clamp diode SA2M | D3 | 82.7 |
| Discharge resistor in peak clamp | R7 | 84.7 |
| SR MOSFFET PSMN012-100YS | Q2 | 68.7 |

## 6. Schematic

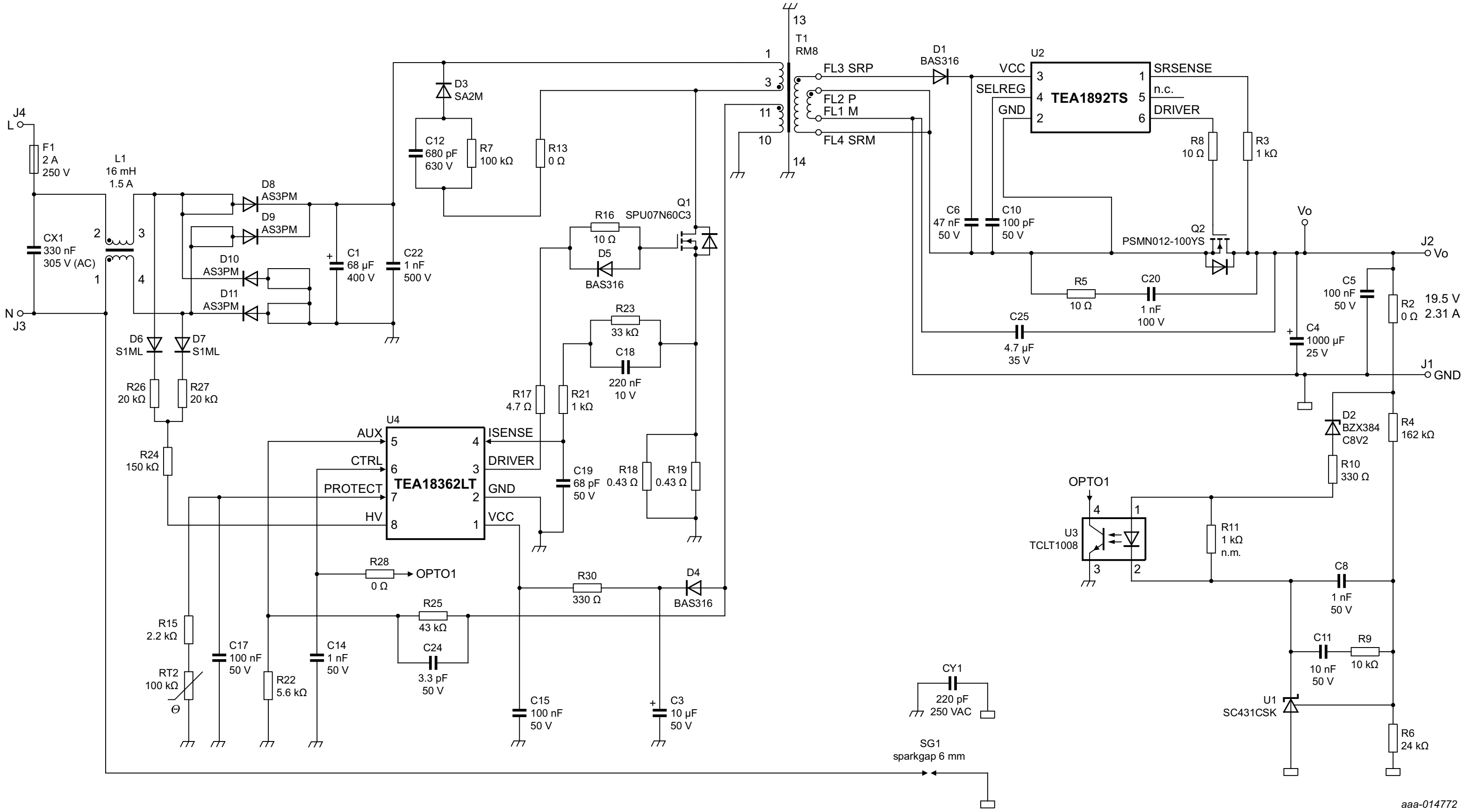



**Fig 22. TEA1836DB1200 schematic diagram TEA18362LT and TEA1892TS 45 W charger demo board**

# 7. Bill Of Materials (BOM)

**Table 20. TEA1836DB1200 bill of material**

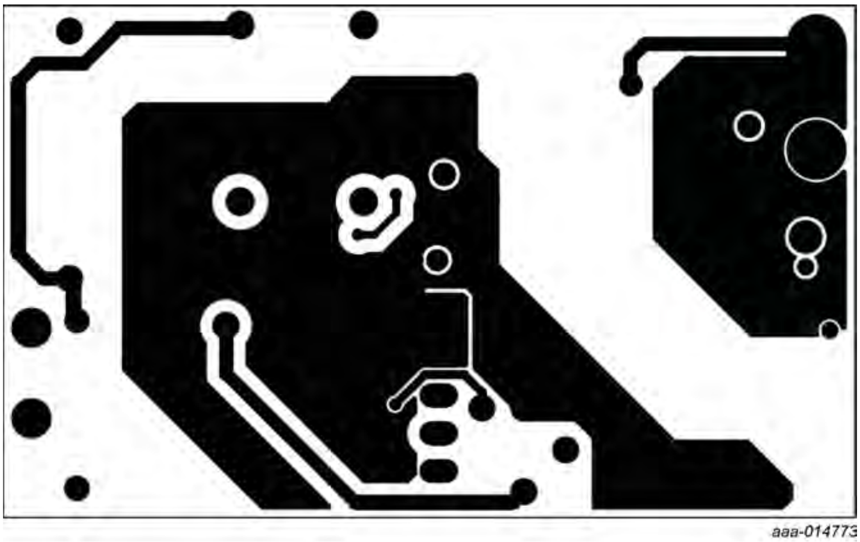
| Reference | Description and values | Part number | Manufacturer |
|---|---|---|---|
| C1 | capacitor; 68 μF; 20 %; 400 V; aluminum; THT | 400BXW68MEFC18X20 | Rubycon |
| C3 | capacitor; 10 μF; 20 %; 35 V; aluminum; THT | 35ML10MEFC4X7 | Rubycon |
| C4 | capacitor; 1000 μF; 20 %; 25 V; aluminum; 10 mm × 20 mm | EEUFR1E102 | Panasonic |
| C5; C15; C17 | capacitor; 100 nF; 10 %; 50 V; X7R; 0402 | C1005X7R1H104K050BB | TDK |
| C6 | capacitor; 47 nF; 10 %; 50 V; X7R; 0402 | CGA2B3X7R1H473K050BB | TDK |
| C8; C14 | capacitor; 1 nF; 10 %; 50 V; X7R; 0402 | C0402C102K5RACTU | KEMET |
| C10 | capacitor; 100 pF; 5 %; 50 V; C0G; 0402 | C0402C101J5GACTU | KEMET |
| C11 | capacitor; 10 nF; 10 %; 50 V; X7R; 0402 | C0402C103K5RACTU | KEMET |
| C12 | capacitor; 680 pF; 10 %; 630 V; X7R; 1206 | C1206C681KBRACTU | KEMET |
| C18 | capacitor; 220 nF; 10 %; 10 V; X5R; 0402 | GRM155R61A224KE19D | Murata |
| C19 | capacitor; 68 pF; 5 %; 50 V; C0G; 0402 | C0402C680J5GACTU | KEMET |
| C20 | capacitor; 1 nF; 10 %; 100 V; X7R; 0603 | C1608X7R2A102K080AA | TDK |
| C22 | capacitor; 1 nF; 5 %; 500 V; X7R; 0805 | 501R15W102KV4E | Johanson Dielectrics |
| C24 | capacitor; 3.3 pF; 0.25 pF; 50 V; C0G; 0402 | 06035A3R3CAT2A | AVX |
| C25 | capacitor; 4.7 μF; 10 %; 35 V; X7R; 0805 | C2012X7R1V475K125AC | TDK |
| CX1 | capacitor; X2; 330 nF; 20 %; 630 V; MKP | B32922C3334M189 | EPCOS |
| CY1 | capacitor; X1/Y1; 220 pF; 10 %; 250 V (AC); DE1 | DE1B3KX221KA5B | Murata |
| D1; D4; D5 | diode; 100 V; 250 mA | BAS316 | NXP Semiconductors |
| D2 | diode; Zener; 8.2 V; 200 mA | BZX384-C8V2 | NXP Semiconductors |
| D3 | diode; 1000 V; 2 A | SA2M-E3/61T | Vishay |
| D6; D7 | diode; 1000 V; 1 A | S1ML | Taiwan Semiconductor |
| D8; D9; D10; D11 | diode; 1 kV; 3 A | AS3PM-M3/86A | Vishay |
| F1 | fuse; 250 V; 2 A; slow blow | MCPMP 2A 250V | Multicomp |
| L1 | CM-choke: T16 × 12 × 8 (16.5 mH); 0.6 ϕ 60T:60T | AC10300301 | Axis Power |
| Q1 | MOSFET-N; 650 V; 7.3 A | SPU07N60C3 | Infineon |
| Q2 | MOSFET-N; 100 V; 15 A; LFPAK | PSMN012-100YS,115 | NXP Semiconductors |
| R2 | resistor; 0 Ω; 63 mW; 0402 | CRCW04020000Z0ED | Vishay |
| R3; R21 | resistor; 1 kΩ; 1 %; 63 mW; 0402 | CRCW04021K00FKED | Vishay |
| R4 | resistor; 162 kΩ; 1 %; 63 mW; 0402 | CRCW0402162KFKED | Vishay |
| R5; R8 | resistor; 10 Ω; 1 %; 63 mW; 0603 | - | - |
| R6 | resistor; 24 kΩ; 1 %; 63 mW; 0402 | CRCW040224K0FKED | Vishay |
| R7 | resistor; 100 kΩ; 1 %; 500 mW; 1206 | CRCW1206100KFKEAHP | Vishay |
| R9 | resistor; 10 kΩ; 1 %; 63 mW; 0402 | CRCW040210K0FKED | Vishay |
| R10 | resistor; 330 Ω; 1 %; 63 mW; 0402 | CRCW0402330RFKED | Vishay |
| R13 | resistor; jumper; 0 Ω; 2 A; 250 mW; 1206 | - | - |

**Table 20. TEA1836DB1200 bill of material** *...continued*

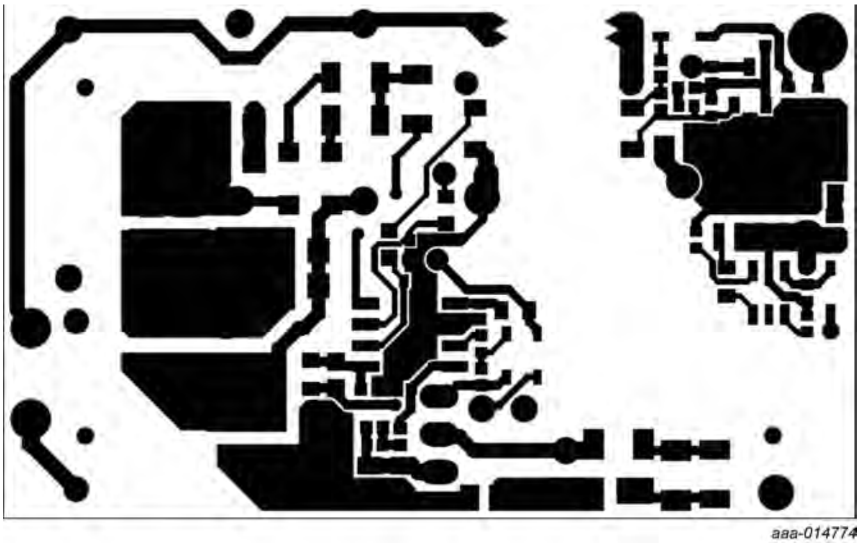
| Reference | Description and values | Part number | Manufacturer |
|---|---|---|---|
| R15 | resistor; 2.2 kΩ; 1 %; 100 mW; 0603 | RC0603FR-072K2L | Yageo |
| R16 | resistor; 10 Ω; 1 %; 63 mW; 0402 | CRCW040210R0FKED | Vishay |
| R17 | resistor; 4.7 Ω; 5 %; 63 mW; 0402 | CRCW04024R70JNEAIF | Vishay |
| R18; R19 | resistor; 0.43 Ω; 1 %; 250 mW; 0805 | ERJ6BQFR43V | Panasonic |
| R22 | resistor; 5.6 kΩ; 1 %; 63 mW; 0402 | CRCW04025K60FKED | Vishay |
| R23 | resistor; 33 kΩ; 1 %; 63 mW; 0402 | CRCW040233K0FKED | Vishay |
| R24 | resistor; 150 kΩ; 1 %; 250 mW; 1206 | - | - |
| R25 | resistor; 43 kΩ; 1 %; 63 mW; 0402 | - | - |
| R26; R27 | resistor; 20 kΩ; 1 %; 250 mW; 1206 | - | - |
| R28 | resistor; jumper; 0 Ω; 63 mW; 0603 | - | - |
| R30 | resistor; 330 Ω; 5 %; 63 mW; 0603 | - | - |
| RT2 | resistor; NTC; 100 kΩ; 5 %; 100 mW; 4190K; mount high against transformer T1 (top) | NTCLE100E3104JB0 | Vishay |
| T1 | transformer; RM8; 12P | TEA1836DB1200_T1 | NXP Semiconductors |
| U1 | voltage regulator; 2.495 V to 30 V; 1 %; 150 mA | SC431CSK-1TRT | Semtech Corporation |
| U2 | synchronization rectifier controller; TEA1892TS | TEA1892TS-1 | NXP Semiconductors |
| U3 | optocoupler; 70 V; 50 mA; controller 130 % to 260 % | TCLT1008 | Vishay |
| U4 | SMTP controller; TEA18362LT | TEA18362LT | NXP Semiconductors |

# 8. PCB layout

## 8.1 Copper tracks and area



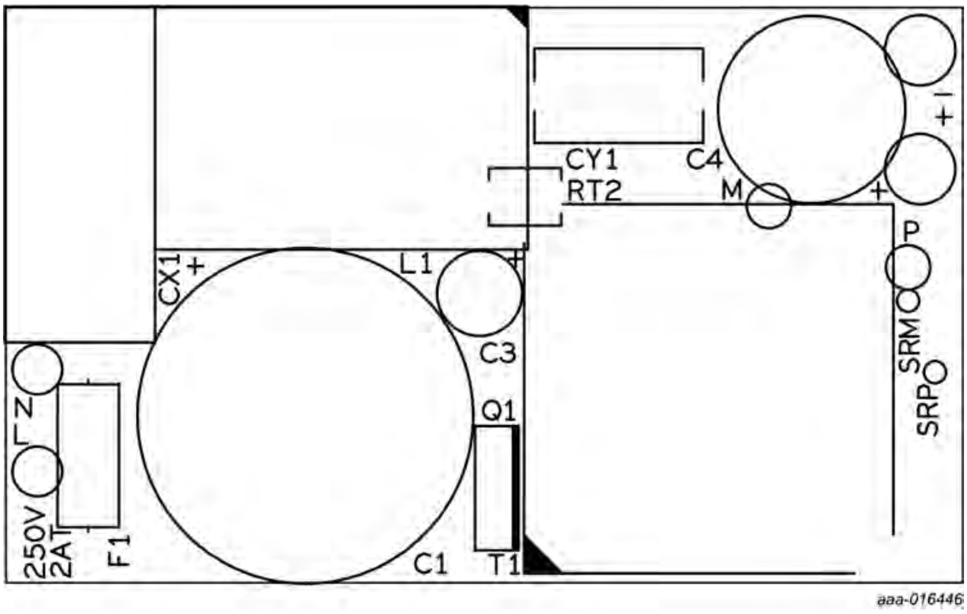

a. Top



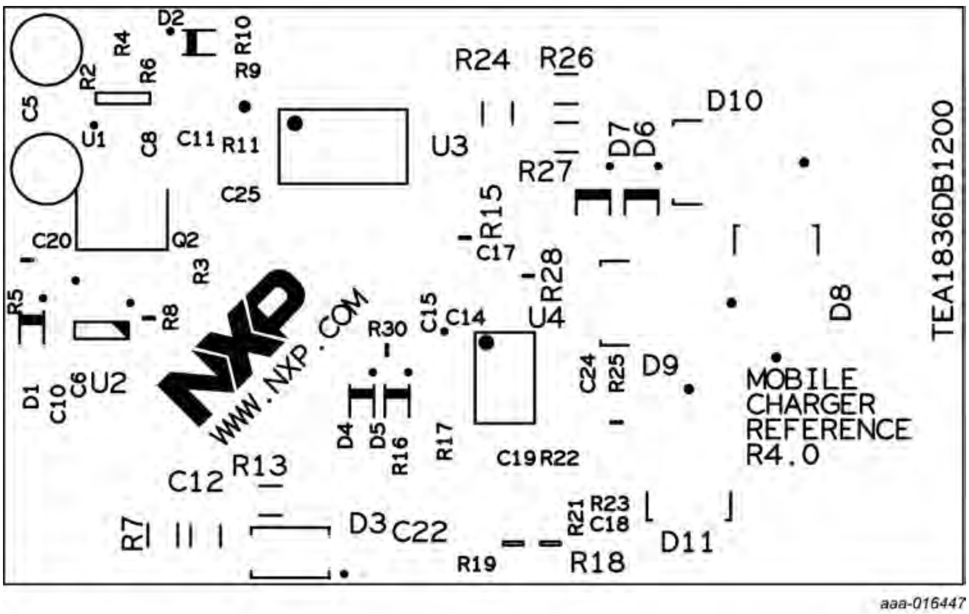

b. Bottom

**Fig 23. Demo board PCB layout (copper tracks and areas)**

## 8.2 Component placement




a. Top




b. Bottom

**Fig 24. Demo board PCB layout (component placement)**

# 9. Transformer data

## 9.1 Introduction

For this demo board, requirements were set to show high performance in a very small 45 W form factor board using a basic circuit configuration. To reach this goal, the transformer design requires extra attention to support the combination of high-efficiency performance while still being EMI-compliant using a 220 pF Y-capacitor. At the same time, the concept must deliver 45 W nominal output power and generate a peak output power that is 50 % higher.

An RM8 core was used in combination with a customized bobbin type to build the transformer.

## 9.2 Transformer data

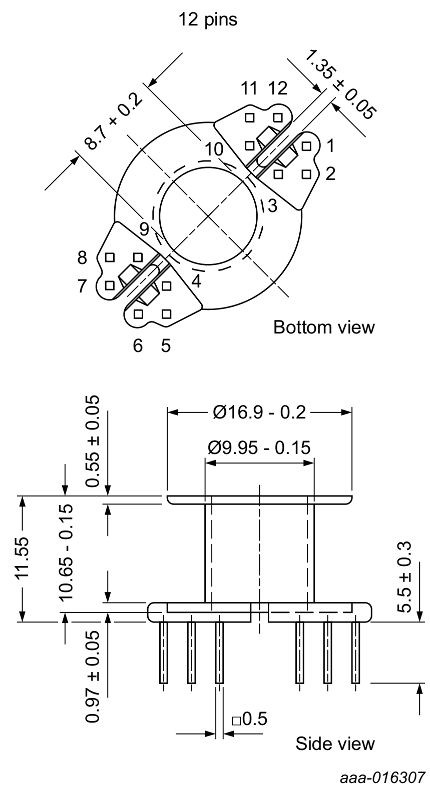



Fig 25. Transformer data

Table 21. Technical specifications transformer

| Description | Value/requirement |
|---|---|
| bobbin | RM8 |
| ferrite material | N87 (EPCOS) or equivalent |
| input voltage | 85 V to 265 V (AC) |
| output voltage | 19.5 V |

**Table 21. Technical specifications transformer** *…continued*

| Description | Value/requirement |
|---|---|
| output current | 2.36 A |
| maximum switching frequency | 130 kHz |
| inductance | 340 μH; ±3 % |

## 9.3 Transformer winding construction

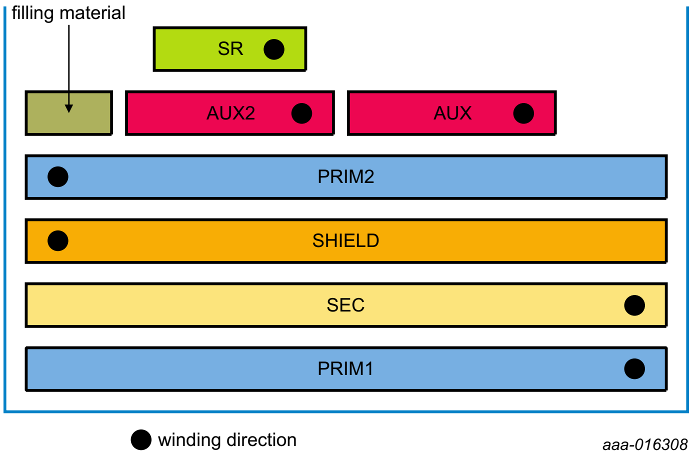



**Fig 26. Transformer winding construction**

**Table 22. Transformer winding construction**

| Layer | Name | Number of turns | Wires parallel | Wire type | Wire diameter (μm) | Pin (in) | Pin (out) |
|---|---|---|---|---|---|---|---|
| 1 | 1/2 PRIM | 18 | 2 | enameled | 212 | pin 1 | flying lead |
| 2 | SEC | 8 | 2 | TIW | 350 | flying lead | flying lead |
| 3 | SHIELD | –1 | 1 | foil (CuSn6) | 20 | pin 10 | - |
| 4 | 1/2 PRIM | 24 | 1 | enameled | 280 | flying lead | pin 3 |
| 5 | AUX | 7 | 1 | enameled | 150 | pin 10 | pin 11 |
| 6 | AUX2 | 7 | 1 | TIW | 200 | pin 11 | flying lead |
| 7 | SR | 4 | 1 | TIW | 200 | flying lead | flying lead |

## 10. Abbreviations

**Table 23. Abbreviations**

| Acronym | Description |
|---|---|
| BCM | Boundary Conduction Mode |
| DCM | Discontinuous Conduction Mode |
| EMI | ElectroMagnetic Interference |
| MOSFET | Metal-Oxide Semiconductor Field-Effect Transistor |
| OCP | OverCurrent Protection |
| OPP | OverPower Protection |
| OVP | OverVoltage Protection |
| OLP | Open-Loop Protection |
| PCB | Printed-Circuit Board |
| QR | Quasi Resonant |
| RMS | Root Mean Square |
| SOI | Silicon-On-Insulator |
| SR | Synchronous Rectification |

## 11. References

[1] **TEA18361LT data sheet —** GreenChip SMPS control IC

[2] **TEA18361T data sheet —** GreenChip SMPS control IC

[3] **TEA18362LT data sheet —** GreenChip SMPS control IC

[4] **TEA18362T data sheet —** GreenChip SMPS control IC

[5] **TEA18363LT data sheet —** GreenChip SMPS control IC

[6] **TEA18363T data sheet —** GreenChip SMPS control IC

[7] **TEA1892TS data sheet —** GreenChip synchronous rectifier controller

[8] **AN11403 application note —** TEA1836XT GreenChip SMPS control IC

[9] **AN11149 application note —** TEA1792 GreenChip synchronous rectifier controller

[10] **UM10758 user manual —** TEA1836DB1094 TEA1836 + TEA1792 65 W notebook adapter

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