



# UM10557

## TEA1716DB1255 90 W notebook adapter demo board

Rev. 1.1 — 7 January 2015

User manual

### Document information

| Info            | Content   |
|-----------------|---|
| <b>Keywords</b> | TEA1716DB1255, TEA1716T, 90 W notebook adapter, LLC, resonant, half-bridge, PFC, controller, converter, burst mode, power supply, demo board  |
| <b>Abstract</b> | <p>This user manual describes the application of the TEA1716DB1255 demo board. The TEA1716T includes a PFC controller as well as a controller for a half-bridge resonant converter.</p> <p>This document describes a 90 W resonant switching mode power supply for a typical notebook adapter design with the TEA1716T controller IC. The TEA1716DB1255 demo board provides an output of 19.5 V/4.65 A. It operates in normal mode for medium and high-power levels and in burst mode for low-power levels. Burst mode operation provides a reduction of power losses to increase performance.</p> <p>The efficiency at high power is well above 90 % and the no-load power consumption is well below 200 mW. At 250 mW output power the input power is lower than 450 mW (EUP lot6 compliant).</p> |



## Revision history

| Rev   | Date     | Description   |
|-------|----------|---------------|
| v.1.1 | 20150107 | updated issue |
| v.1   | 20121210 | first issue   |

## Contact information

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

## 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 document describes the TEA1716DB1255 90 W notebook adapter demo board using the TEA1716T. A functional description is given, including a set of measurements to show the main characteristics.

### 1.2 TEA1716T

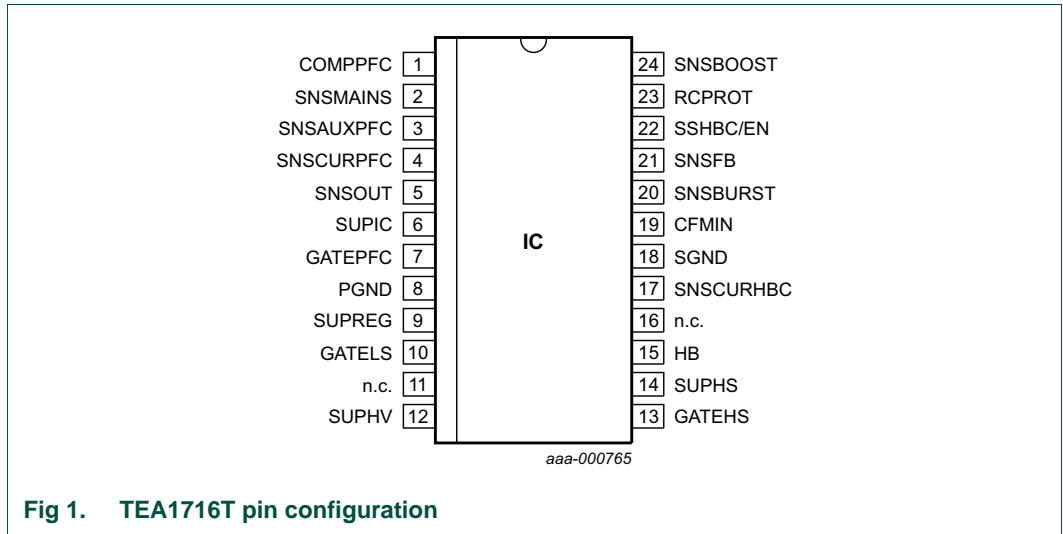
The TEA1716T integrates a controller for Power Factor Correction (PFC) and a controller for a half-bridge resonant converter (HBC). It provides the drive function for the discrete MOSFET for the upconverter and for the two discrete power MOSFETs in a resonant half-bridge configuration.

The resonant controller part is a high-voltage controller for a zero voltage switching LLC resonant converter. The resonant controller part of the IC includes a high-voltage level shift circuit. It also includes several protection features such as OverCurrent Protection (OCP), Open-Loop Protection (OLP), capacitive mode protection and a general purpose latched protection input.

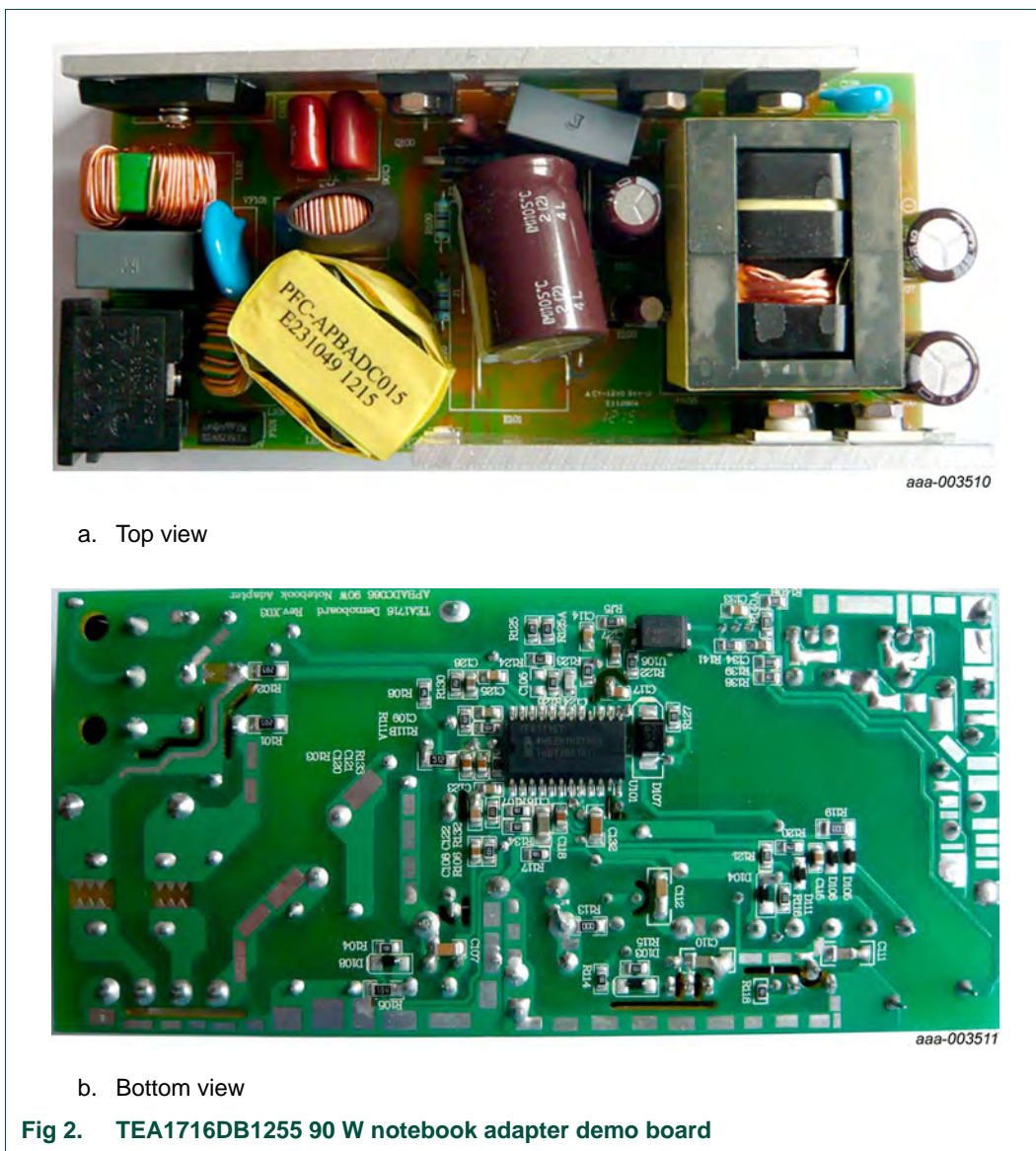
In addition to the resonant controller, the TEA1716T contains a Power Factor Correction (PFC) controller. Functions such as quasi-resonant operation at high-power levels and quasi-resonant operation with valley skipping at lower power levels obtain the PFC's efficient operation. OCP, OverVoltage Protection (OVP) and demagnetization sensing, ensure safe operation under all conditions.

The proprietary high-voltage BCD Power logic process enables direct start-up from the rectified universal mains voltage in an efficient way. A second low-voltage Silicon-On-Insulator (SOI) IC is used for accurate, high-speed protection functions and control.

The combination of PFC and a resonant controller in one IC makes the TEA1716T very suitable for notebook adapter power supplies, desktop PCs and all-in-one PC applications.



### 1.3 Setup of the 90 W notebook adapter



The TEA1716DB1255 demo board can operate at a mains input voltage between 90 V and 264 V (universal mains).

The demo board contains two subcircuits:

- A Power Factor Converter (PFC): BCM type
- A Half-Bridge Converter (HBC): resonant LLC-type

The TEA1716T control both converters.

At low power, the converters operate in burst mode to reduce power losses.

The purpose of the demo board is to show the operation of the TEA1716T in a single output supply including burst mode operation. The performance is in alignment with current general standards, including the EuP lot6 requirements, and can be used as a starting point for further development.

## 1.4 Input and output properties

**Table 1. Input data**

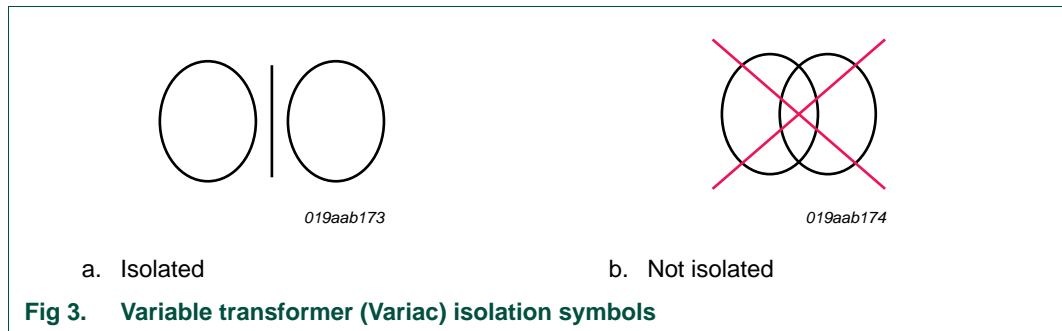
| Symbol                            | Description               | Conditions      | Specification | Unit    |
|-----------------------------------|---------------------------|-----------------|---------------|---------|
| $V_i$                             | input voltage             | AC              | 90 to 264     | V (RMS) |
| $f_i$                             | input frequency           |                 | 47 to 60      | Hz      |
| $P_{i(\text{no-load})}$           | No-load input power       | at 230 V; 50 Hz | < 300         | mW      |
| $P_{i(\text{load}=250\text{mW})}$ | standby power consumption | at 230 V; 50 Hz | < 450         | mW      |

**Table 2. Output data**

| Symbol                             | Description                        | Conditions          | Specification | Unit |
|------------------------------------|------------------------------------|---------------------|---------------|------|
| $V_o$                              | output voltage                     |                     | 19.5          | V    |
| $V_{o(\text{ripple})(\text{p-p})}$ | peak-to-peak output ripple voltage | bandwidth = 20 M Hz | < 150         | mV   |
| $I_o$                              | output current                     | continuous          | 0 to 4.65     | A    |

## 2. Safety warning

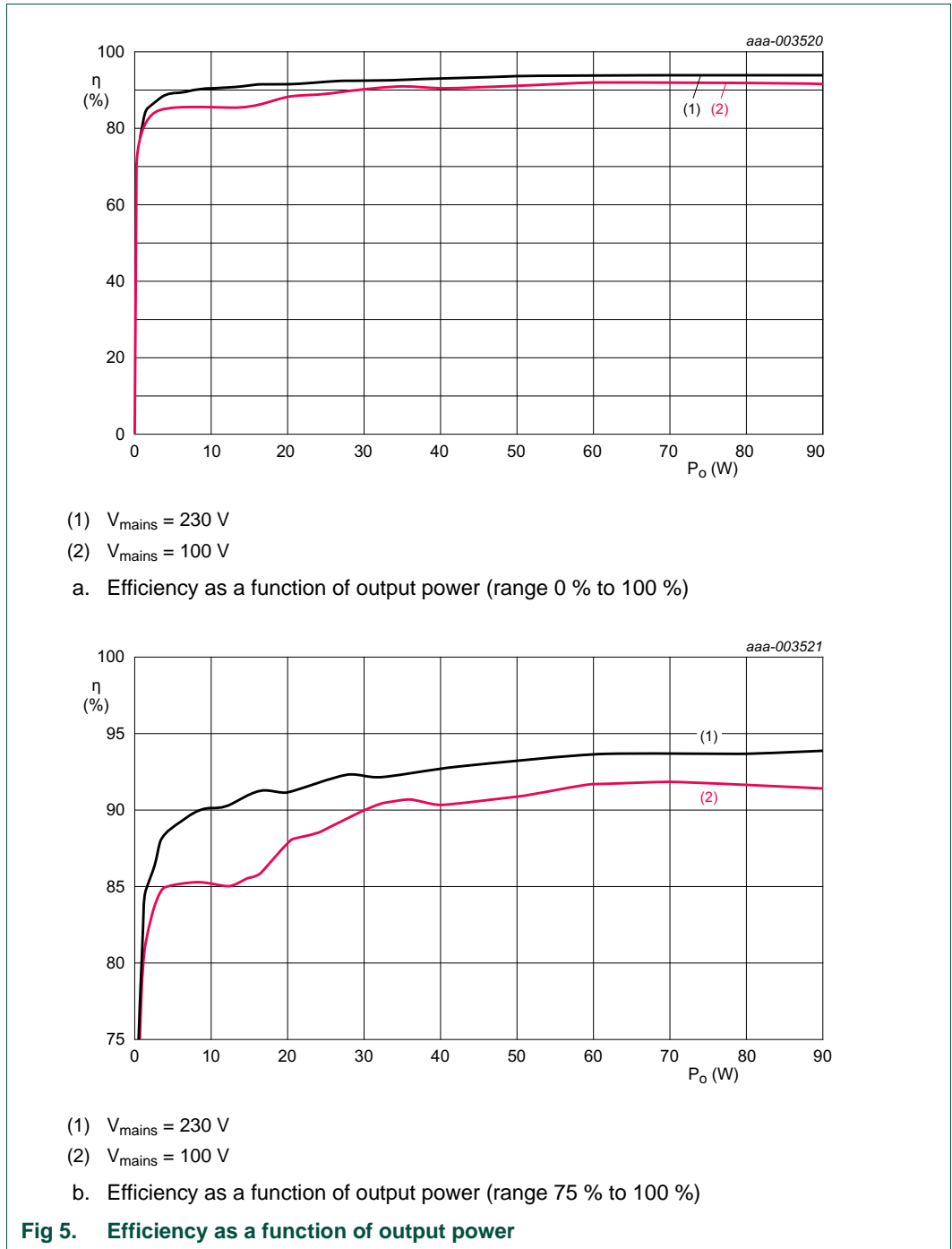
Connect the board to the mains voltage. Avoid touching the board while it is connected to the mains voltage. An isolated housing is obligatory when used in uncontrolled, non-laboratory environments. Galvanic isolation of the mains phase using a variable transformer is always recommended.



**Fig 3. Variable transformer (Variac) isolation symbols**







### 3.3.2 Power Factor Correction (PFC)

Table 4. Power factor correction

| Condition    | Energy Star 2.0 requirement | Output power (W) | Power factor |
|--------------|-----------------------------|------------------|--------------|
| 90 V; 60 Hz  | -                           | 90               | 0.99         |
| 100 V; 60 Hz | -                           | 90               | 0.99         |
| 115 V; 60 Hz | $\geq 0.9$                  | 90               | 0.98         |
| 230 V; 50 Hz | -                           | 90               | 0.91         |
| 264 V; 50 Hz | -                           | 90               | 0.88         |

### 3.3.3 No-load power consumption

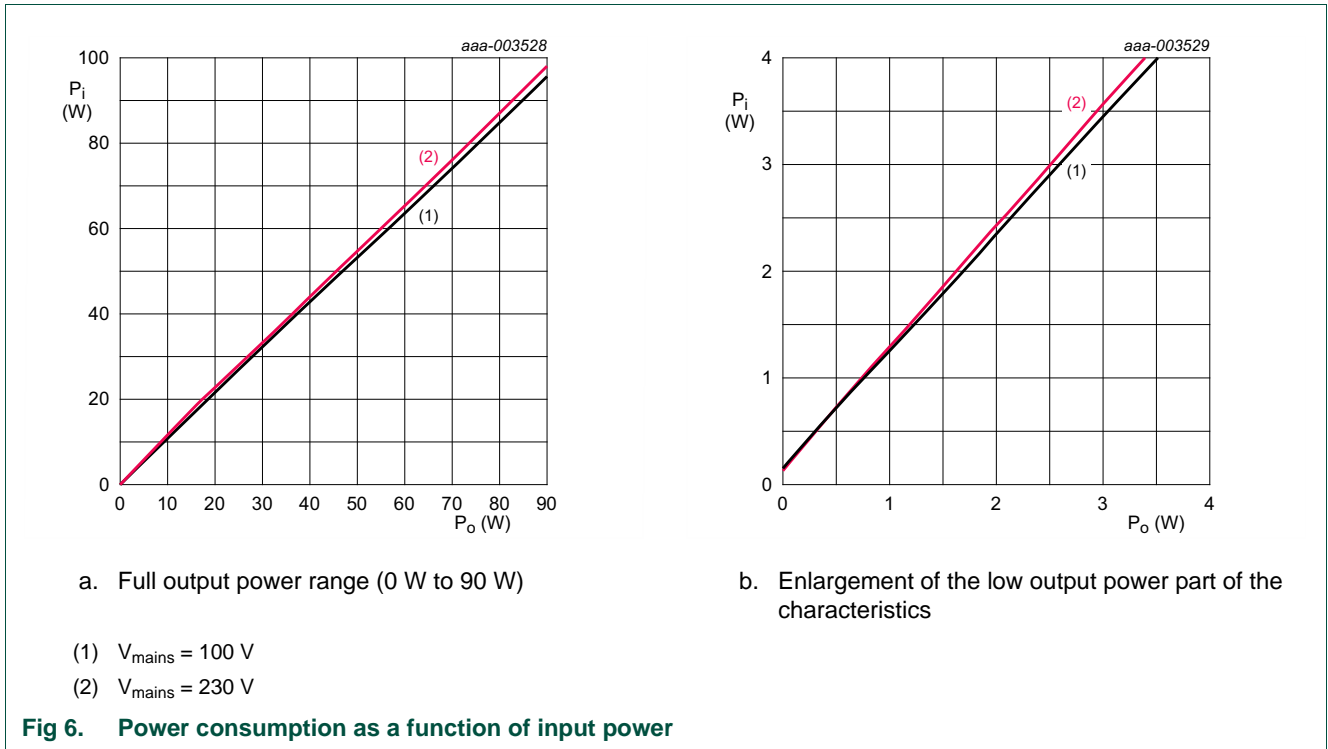
Table 5. Output voltage and power consumption at no-load

| Condition    | Energy Star 2.0 requirement (mW) | Output voltage (V) | No load power consumption (mW) |
|--------------|----------------------------------|--------------------|--------------------------------|
| 90 V; 60 Hz  | $\leq 500$                       | 19.5               | 140                            |
| 100 V; 60 Hz | $\leq 500$                       | 19.5               | 140                            |
| 115 V; 60 Hz | $\leq 500$                       | 19.5               | 140                            |
| 230 V; 50 Hz | $\leq 500$                       | 19.5               | 170                            |
| 264 V; 50 Hz | $\leq 500$                       | 19.5               | 170                            |

### 3.3.4 Standby load power consumption

Table 6. Output voltage and power consumption in standby

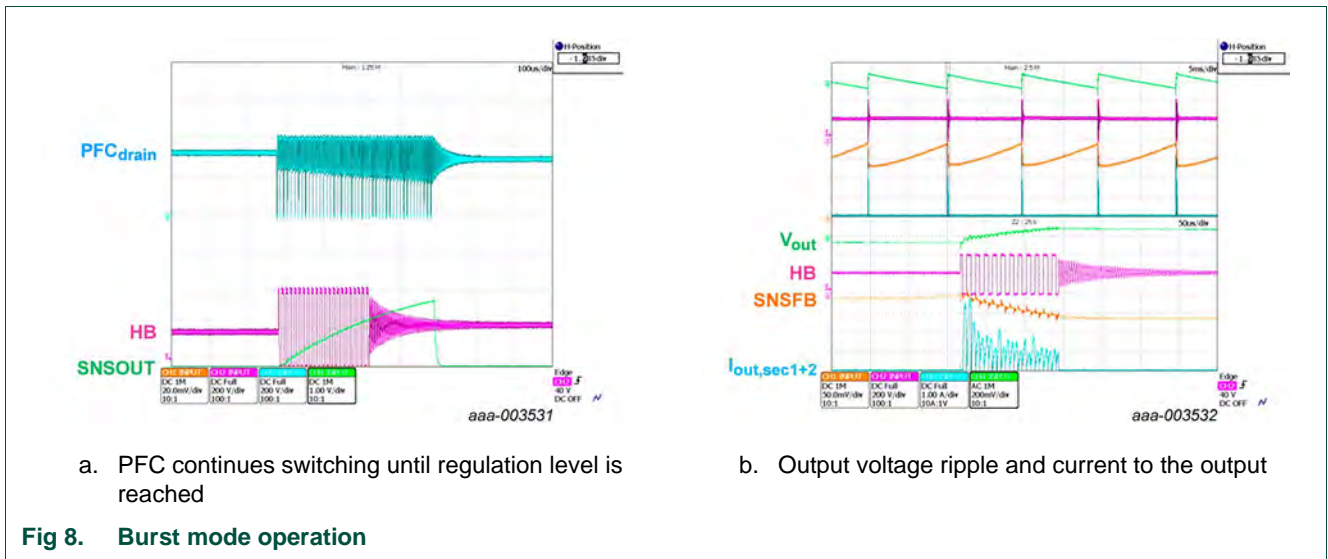
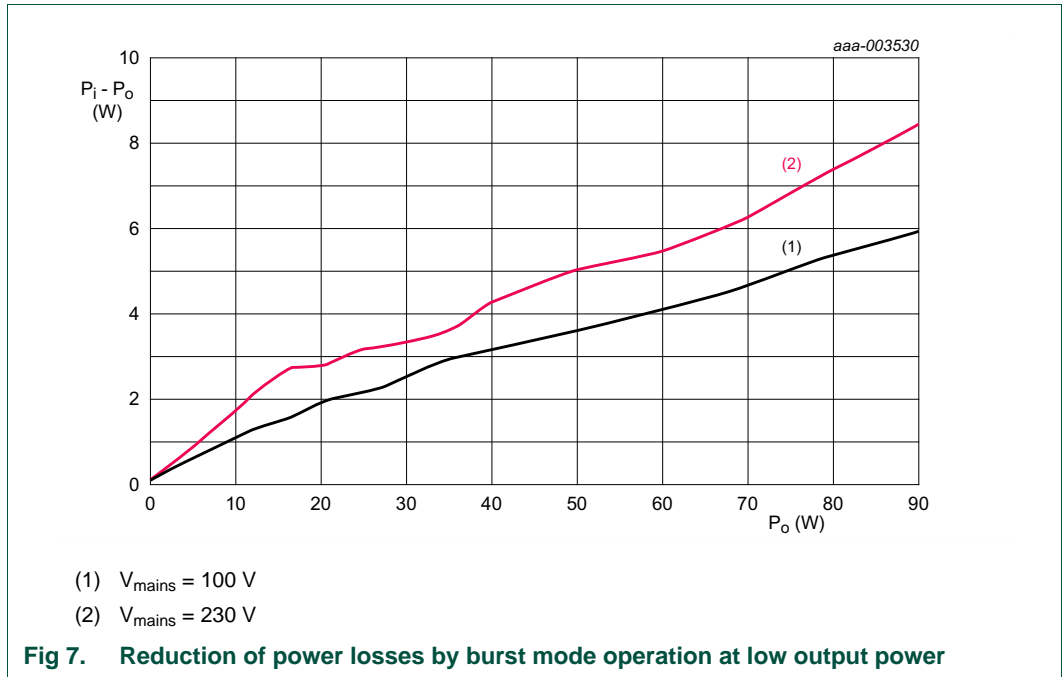
| Condition                    | Output voltage (V) | Power consumption (mW) |
|------------------------------|--------------------|------------------------|
| <b>Output power = 250 mW</b> |                    |                        |
| 90 V; 60 Hz                  | 19.5               | 430                    |
| 100 V; 60 Hz                 | 19.5               | 430                    |
| 115 V; 60 Hz                 | 19.5               | 430                    |
| 230 V; 50 Hz                 | 19.5               | 445                    |
| 264 V; 50 Hz                 | 19.5               | 445                    |



### 3.4 Burst mode operation

Burst mode operation is implemented. It improves the performance at low output load, so no-load and standby power consumption requirements (see [Section 3.3.3](#) and [Section 3.3.4](#)) can be achieved. The converter operates at less than approximately 30 W output power in burst mode. Between 30 W and 50 W output power the burst mode is triggered temporarily because of the ripple on the PFC output voltage.

Without burst mode operation, the power supply consumes approximately 2 W at no-load output.

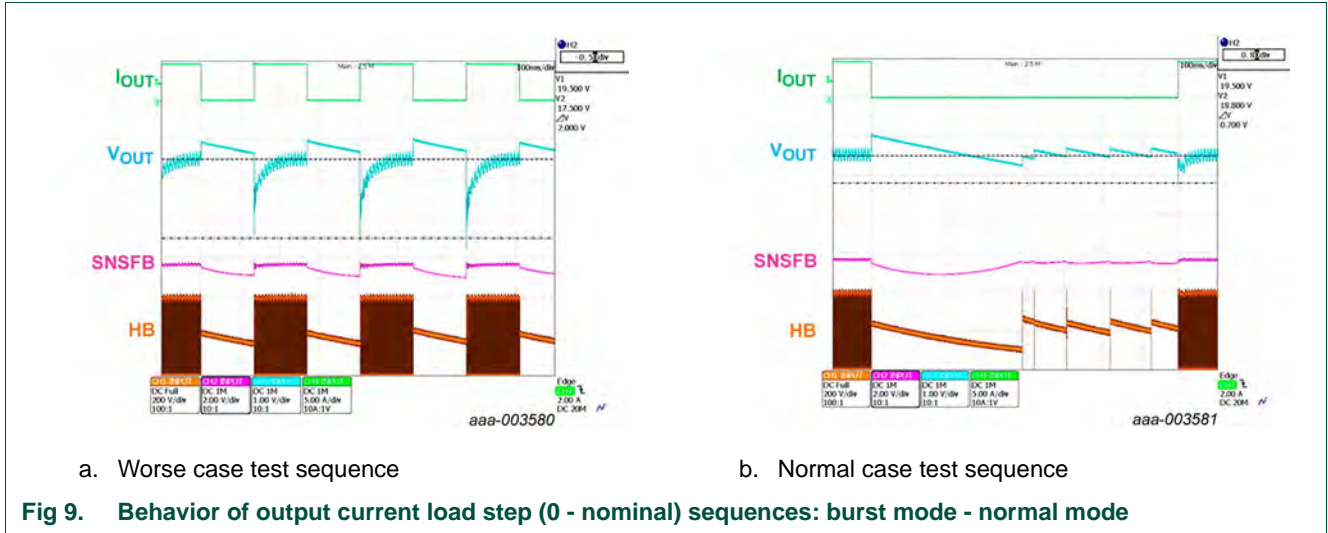


The interruptive character of burst mode can lead to the generation of unwanted audible noise. Because the system only operates in burst mode at low-power levels, audible noise levels are low.

### 3.5 Transient response

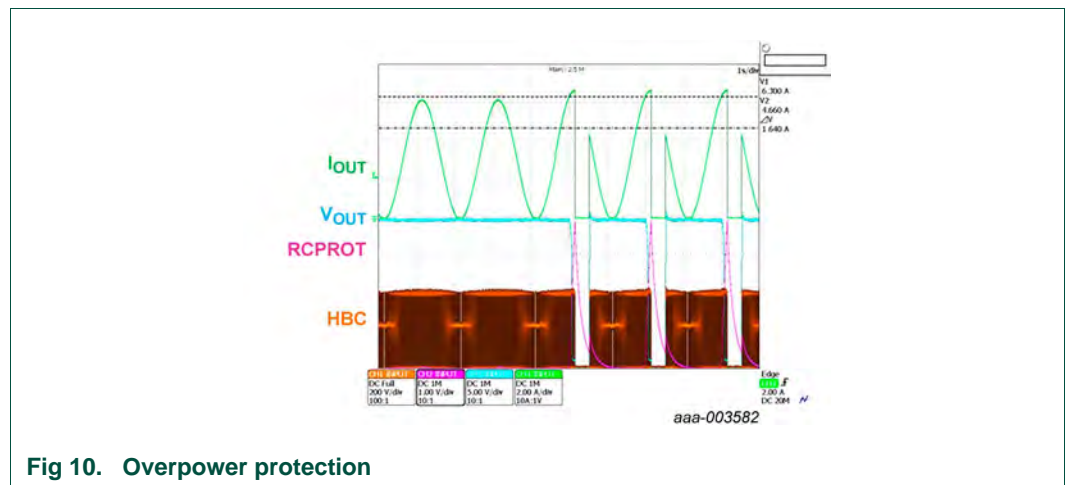
Normal load transients lead to a ripple on the output voltage  $\leq 750$  mV.

When a worse case timing sequence is applied, the voltage drop can be 2 V (–10 %).



### 3.6 OverPower Protection (OPP)

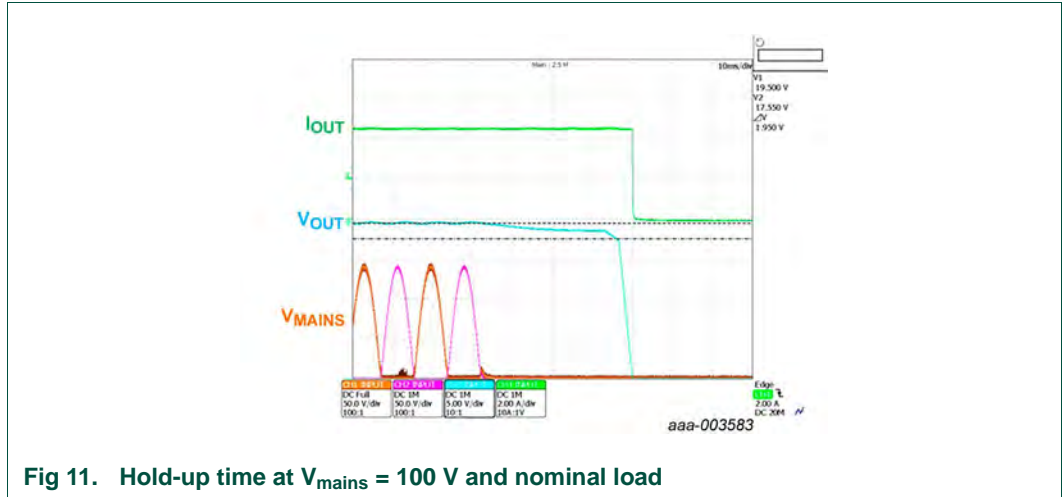
Tested with a higher current (dynamic overload) on the output voltage, the OPP is activated when the current exceeds 6.3 A (123 W). This corresponds with a load condition that is 35 % higher than the rated power for continuous use. The SNSCURHBC function of the TEA1716T which monitors the primary resonant current detects the OPP. When the voltage on the SNSCURHBC pin exceeds 0.5 V (or –0.5 V), the protection timer is started.



In some test conditions, another protection function can be triggered to initiate a restart (for example the SUPIC\_UVP, see [Section 3.8](#)).

### 3.7 Hold-up time

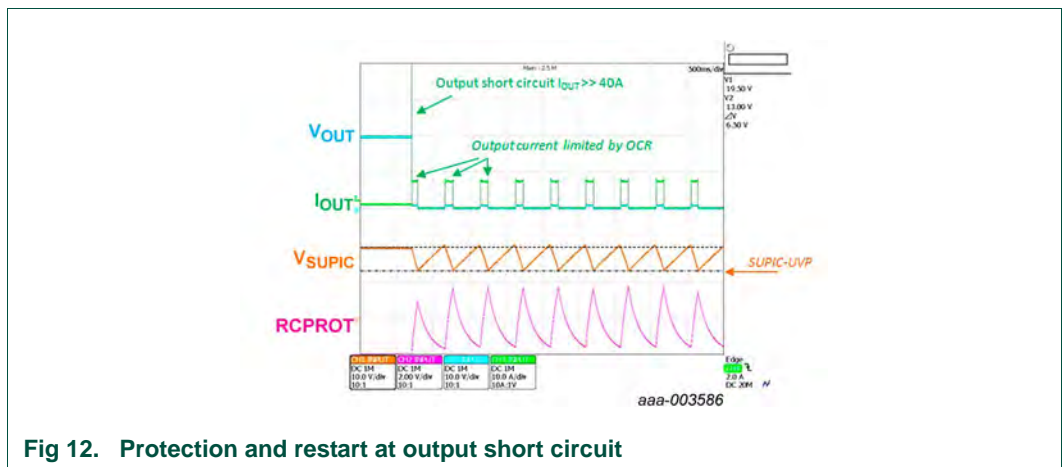
The output is set to full load and the mains supply voltage of 100 V disconnected. The time that passes before the output voltage falls below 90 % of its initial value, is measured. The hold-up time is 32 ms.



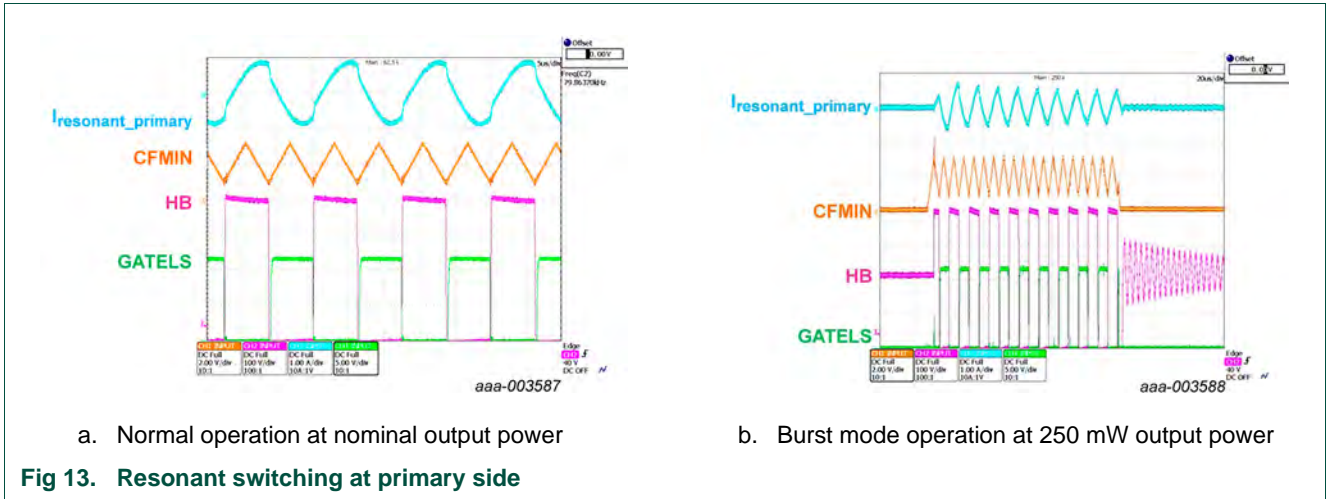
### 3.8 Short circuit protection

A short circuit on the output of the resonant converter causes the primary current to increase. The SNSCURHBC function detects the increase. It leads to running on a higher frequency (OCR) until the protection timer RCPROT reaches its protection level (4 V). The RCPROT function performs its restart timer function and restarts when the voltage has dropped to 0.5 V. When the short circuit situation is resolved, the converter starts up and runs normally again.

While SNSCURHBC is running in OCR, it reduces the amount of primary current. This reduction leads to a limited output current and voltage. It also affects the auxiliary supply that provides the supply voltage for the TEA1716T. In this demo board, the voltage drop on SUPIC reaches the UVP level (13 V) before the protection timer RCPROT has reached 4 V. The SUPIC-UVP function initiates the restart.



### 3.9 Resonant switching



4. Circuit diagram

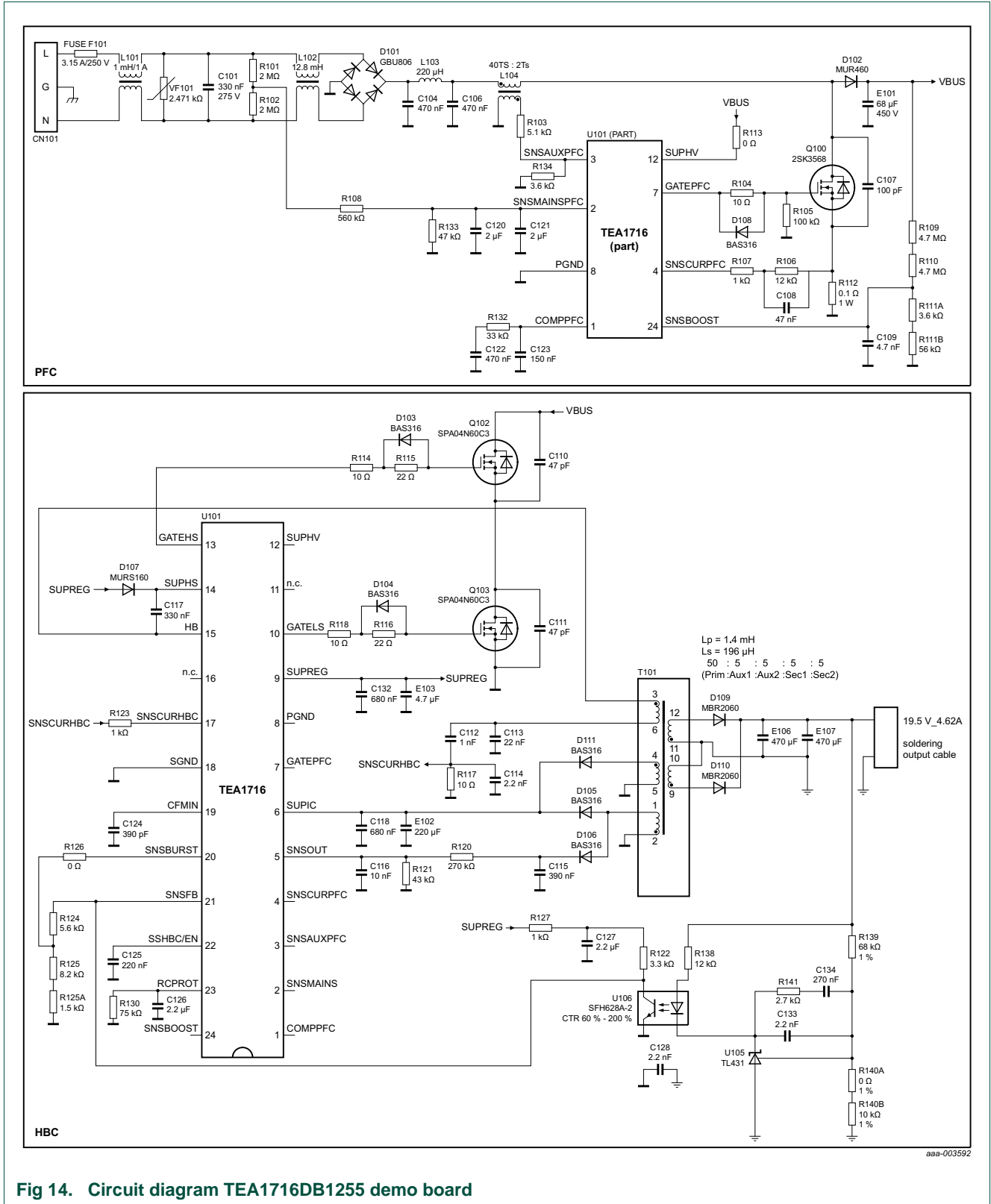


Fig 14. Circuit diagram TEA1716DB1255 demo board



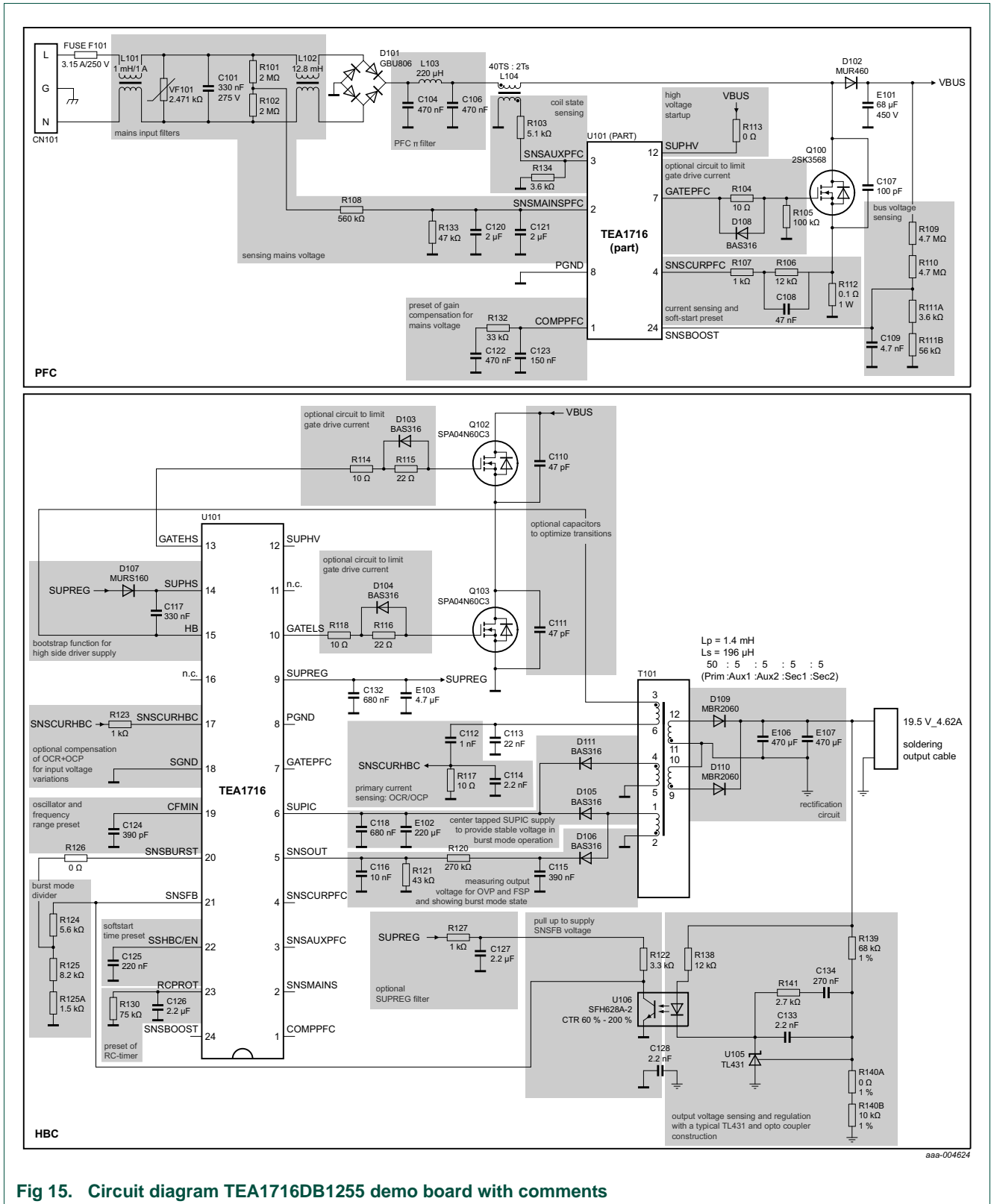
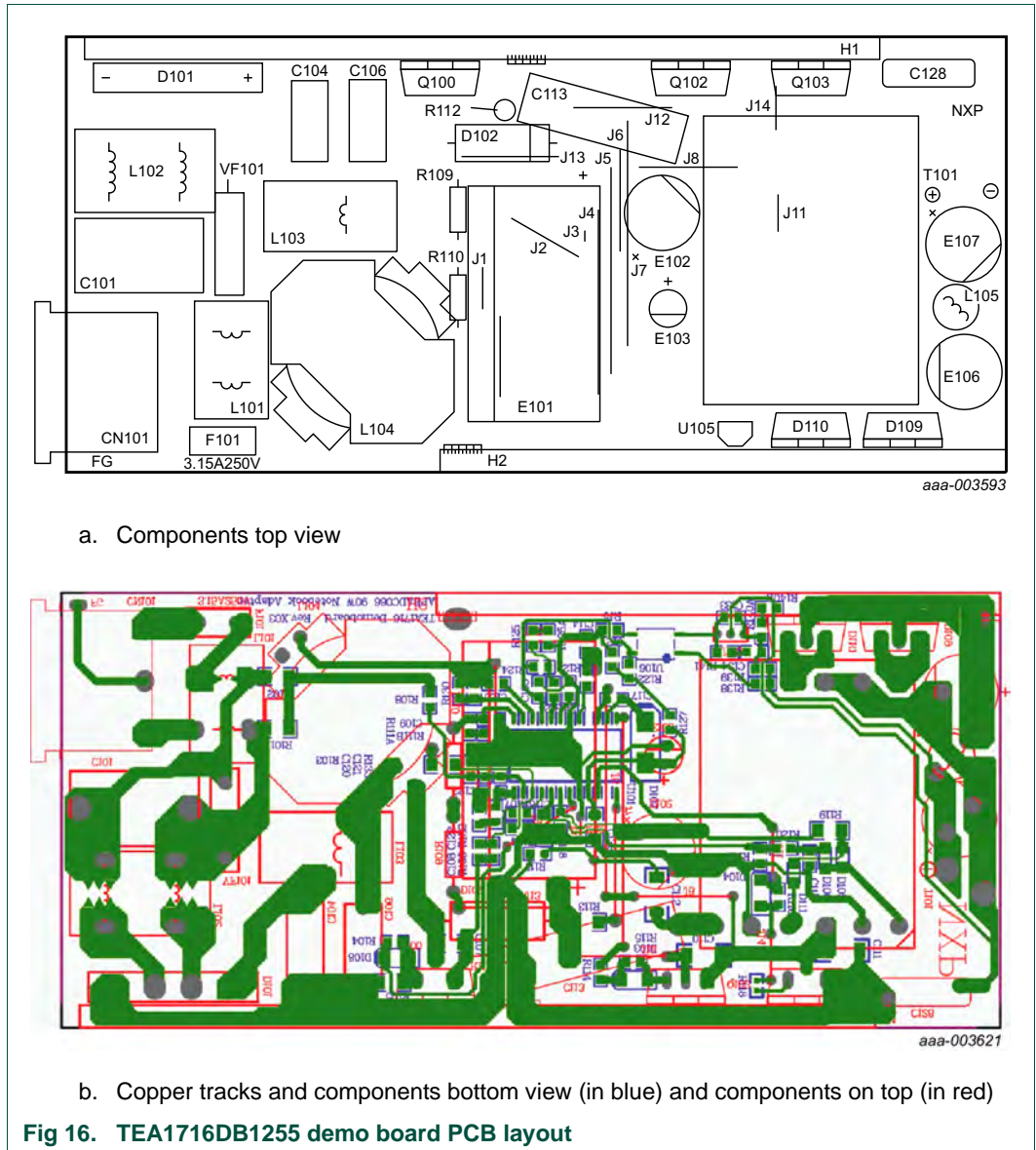


Fig 15. Circuit diagram TEA1716DB1255 demo board with comments

5. PCB layout



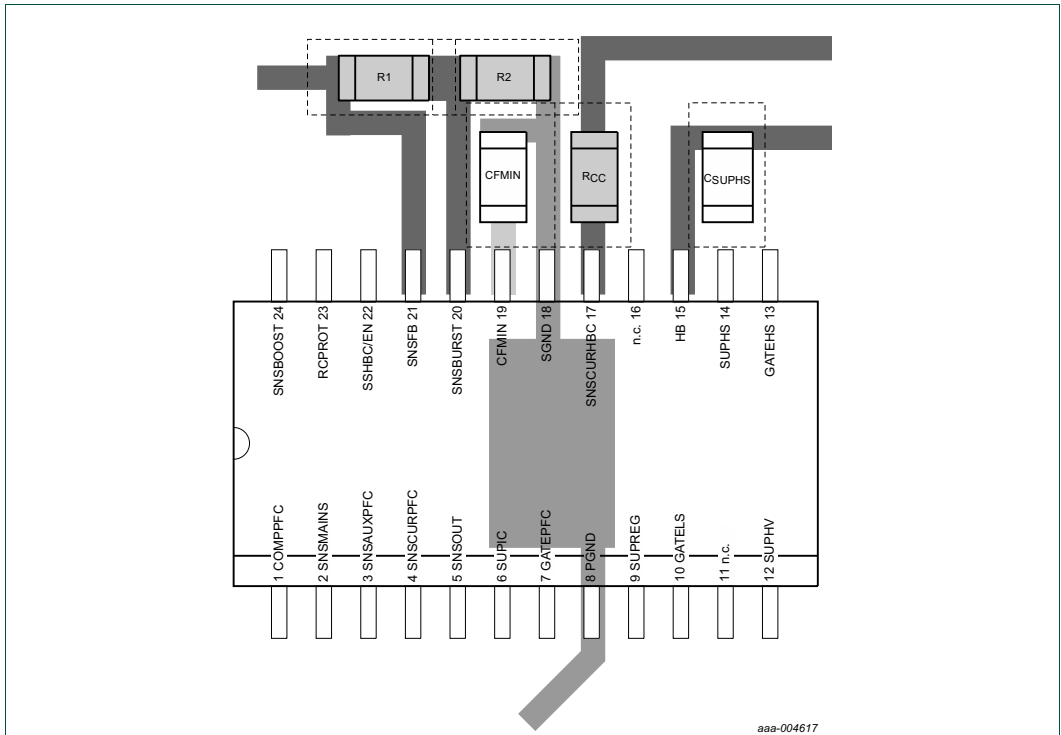


Fig 17. Layout area near CFMIN pin: Advice from AN11179, “TEA1716 resonant power supply control IC with PFC”

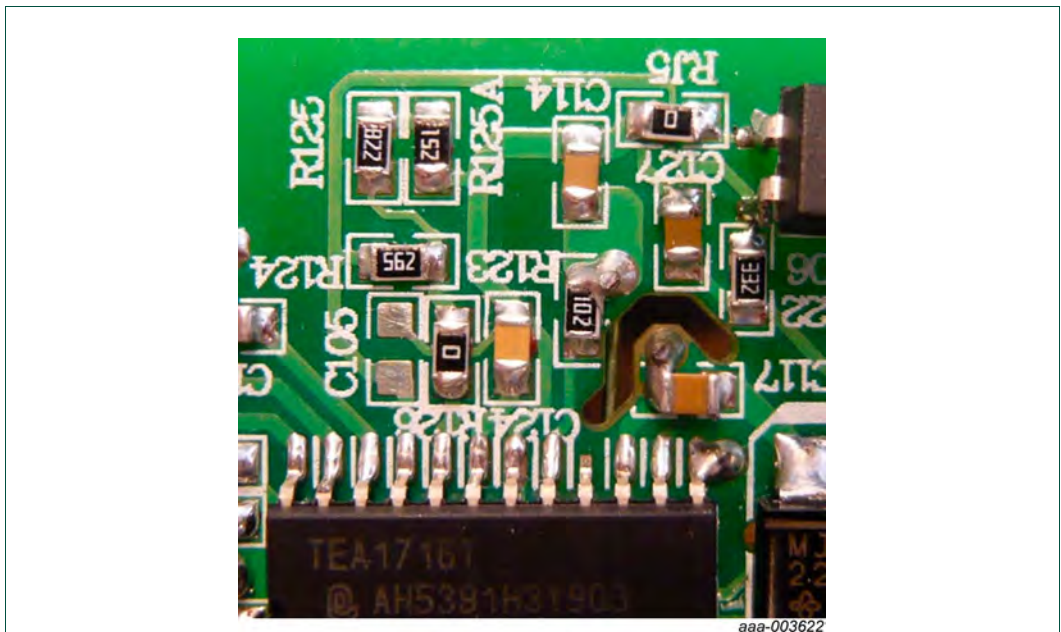


Fig 18. Layout area near CFMIN pin: Practical implementation in the TEA1716DB1255 demo board

## 6. Bill Of Materials (BOM)

Table 7. TEA1716DB1255 demo board bill of materials

| Reference | Description and values                              | Part number     | Manufacturer      |
|-----------|---|-----------------|-------------------|
| C101      | x-capacitor; 330 nF; 275 V; RAD0.6H                 | -               | -                 |
| C104      | thin film capacitor; 0.47 $\mu$ F; 450 V; rad0.4V   | -               | -                 |
| C105      | ceramic capacitor; 805                              | -               | -                 |
| C106      | thin film capacitor; 0.47 $\mu$ F; 450 V; rad0.4V   | -               | -                 |
| C107      | ceramic capacitor; 100 pF; 1 kV; 1206               | -               | -                 |
| C108      | ceramic capacitor; 47 nF; 50 V; 805                 | -               | -                 |
| C109      | ceramic capacitor; 4.7 nF; 50 V; 805                | -               | -                 |
| C110      | ceramic capacitor; 47 pF; 1 kV; 1206                | -               | -                 |
| C111      | ceramic capacitor; 47 pF; 1 kV; 1206                | -               | -                 |
| C112      | ceramic capacitor; 1 nF; 1 kV; 1206                 | -               | -                 |
| C113      | thin film capacitor; 22 nF; 1 kV;<br>RAD0.6(0.8)-3P | -               | -                 |
| C114      | ceramic capacitor; 2.2 nF; 16 V; 805                | -               | -                 |
| C115      | ceramic capacitor; 390 nF; 50 V; 805                | -               | -                 |
| C116      | ceramic capacitor; 10 nF; 16 V; 1206                | -               | -                 |
| C117      | ceramic capacitor; 330 nF; 50 V; 805                | -               | -                 |
| C118      | ceramic capacitor; 680 nF; 50 V; 805                | -               | -                 |
| C120      | ceramic capacitor; 2 $\mu$ F; 50 V; 805             | -               | -                 |
| C121      | ceramic capacitor; 2 $\mu$ F; 50 V; 805             | -               | -                 |
| C122      | ceramic capacitor; 470 nF; 16 V; 805                | -               | -                 |
| C123      | ceramic capacitor; 150 nF; 16 V; 805                | -               | -                 |
| C124      | ceramic capacitor; 390 pF; 16 V; 805                | -               | -                 |
| C125      | ceramic capacitor; 220 nF; 16 V; 805                | -               | -                 |
| C126      | ceramic capacitor; 2.2 $\mu$ F; 16 V; 805           | -               | -                 |
| C127      | ceramic capacitor; 2.2 $\mu$ F; 16 V; 805           | -               | -                 |
| C128      | Y1-capacitor; 2.2 nF; C10(0.6)-1F                   | -               | -                 |
| C132      | ceramic capacitor; 680 nF; 16 V; 1206               | -               | -                 |
| C133      | ceramic capacitor; 2.2 nF; 16 V; 805                | -               | -                 |
| C134      | ceramic capacitor; 270 nF; 16 V; 805                | -               | -                 |
| CN101     | connector; 3.96X5                                   | ST-A04-001JT6T4 | -                 |
| D101      | diode bridge  | GBU806          | Diodes            |
| D102      | diode; diode0.7                                     | MUR460          | Vishay            |
| D103      | diode; sc-76  | BAS316          | -                 |
| D104      | diode; sc-76  | BAS316          | -                 |
| D105      | diode; sc-76  | BAS316          | -                 |
| D106      | diode; sc-76  | BAS316          | -                 |
| D107      | diode; SMB  | MURS160         | Vishay            |
| D108      | diode; sc-76  | BAS316          | -                 |
| D109      | diode; TO-220                                       | MBR2060         | ON Semiconductors |

Table 7. TEA1716DB1255 demo board bill of materials ...continued

| Reference | Description and values                             | Part number | Manufacturer      |
|-----------|--|-------------|-------------------|
| D110      | diode; TO-221                                      | MBR2060     | ON Semiconductors |
| D111      | diode; sc-76                                       | BAS316      | -                 |
| E101      | electrolytic capacitor; 68 $\mu$ F; 450 V; EC16/8H | -           | -                 |
| E102      | electrolytic capacitor; 220 $\mu$ F; 35 V; RB.1/.2 | -           | -                 |
| E103      | electrolytic capacitor; 4.7 $\mu$ F; 16 V; RB.1/.2 | -           | -                 |
| E106      | electrolytic capacitor; 470 $\mu$ F; 35 V; EC5/10H | -           | -                 |
| E107      | electrolytic capacitor; 470 $\mu$ F; 35 V; EC5/10H | -           | -                 |
| F101      | fuse; 3.15 A; 250 V; FUSH_1                        | -           | -                 |
| H1        | 108 $\times$ 23 $\times$ 3                         | -           | -                 |
| H2        | 80 $\times$ 23 $\times$ 3                          | -           | -                 |
| J1        | jumper; 6.8 mm                                     | -           | -                 |
| J2        | jumper; 9.2 mm                                     | -           | -                 |
| J3        | jumper; 2.9 mm                                     | -           | -                 |
| J4        | jumper; 31 mm                                      | -           | -                 |
| J5        | jumper; 28 mm                                      | -           | -                 |
| J6        | jumper; 31 mm                                      | -           | -                 |
| J7        | jumper; 31 mm                                      | -           | -                 |
| J8        | jumper; 15 mm                                      | -           | -                 |
| J9        | jumper; 17.5 mm                                    | -           | -                 |
| J10       | jumper; 20.9 mm                                    | -           | -                 |
| J11       | jumper; 6.6 mm                                     | -           | -                 |
| J12       | jumper; 13.9 mm                                    | -           | -                 |
| J13       | jumper; 13.2 mm                                    | -           | -                 |
| J14       | jumper; 6.6 mm                                     | -           | -                 |
| L101      | common choke; 1 mH; 1 A; L0.2H                     | -           | -                 |
| L102      | common choke; 12.8 mH; L0.4                        | -           | -                 |
| L103      | inductor; 220 $\mu$ H; EM1H                        | -           | -                 |
| L104      | PFC choke; RM8;                                    | PFC_PQ2620  | -                 |
| L105      | jumper; 6.6 mm                                     | -           | -                 |
| Q100      | MOSFET; TO-220H                                    | 2SK3568     | Toshiba           |
| Q102      | MOSFET; TO-220H                                    | SPA04N60C3  | Infineon          |
| Q103      | MOSFET; TO-220H                                    | SPA04N60C3  | Infineon          |
| R101      | resistor; 2 M $\Omega$ ; $\pm$ 5 %; 1206           | -           | -                 |
| R102      | resistor; 2 M $\Omega$ ; $\pm$ 5 %; 1206           | -           | -                 |
| R103      | resistor; 5.1 k $\Omega$ ; $\pm$ 5 %; 1206         | -           | -                 |
| R104      | resistor; 10 $\Omega$ ; $\pm$ 5 %; 805             | -           | -                 |
| R105      | resistor; 100 k $\Omega$ ; $\pm$ 5 %; 1206         | -           | -                 |
| R106      | resistor; 12 k $\Omega$ ; $\pm$ 5 %; 805           | -           | -                 |
| R107      | resistor; 1 k $\Omega$ ; $\pm$ 5 %; 805            | -           | -                 |

Table 7. TEA1716DB1255 demo board bill of materials ...continued

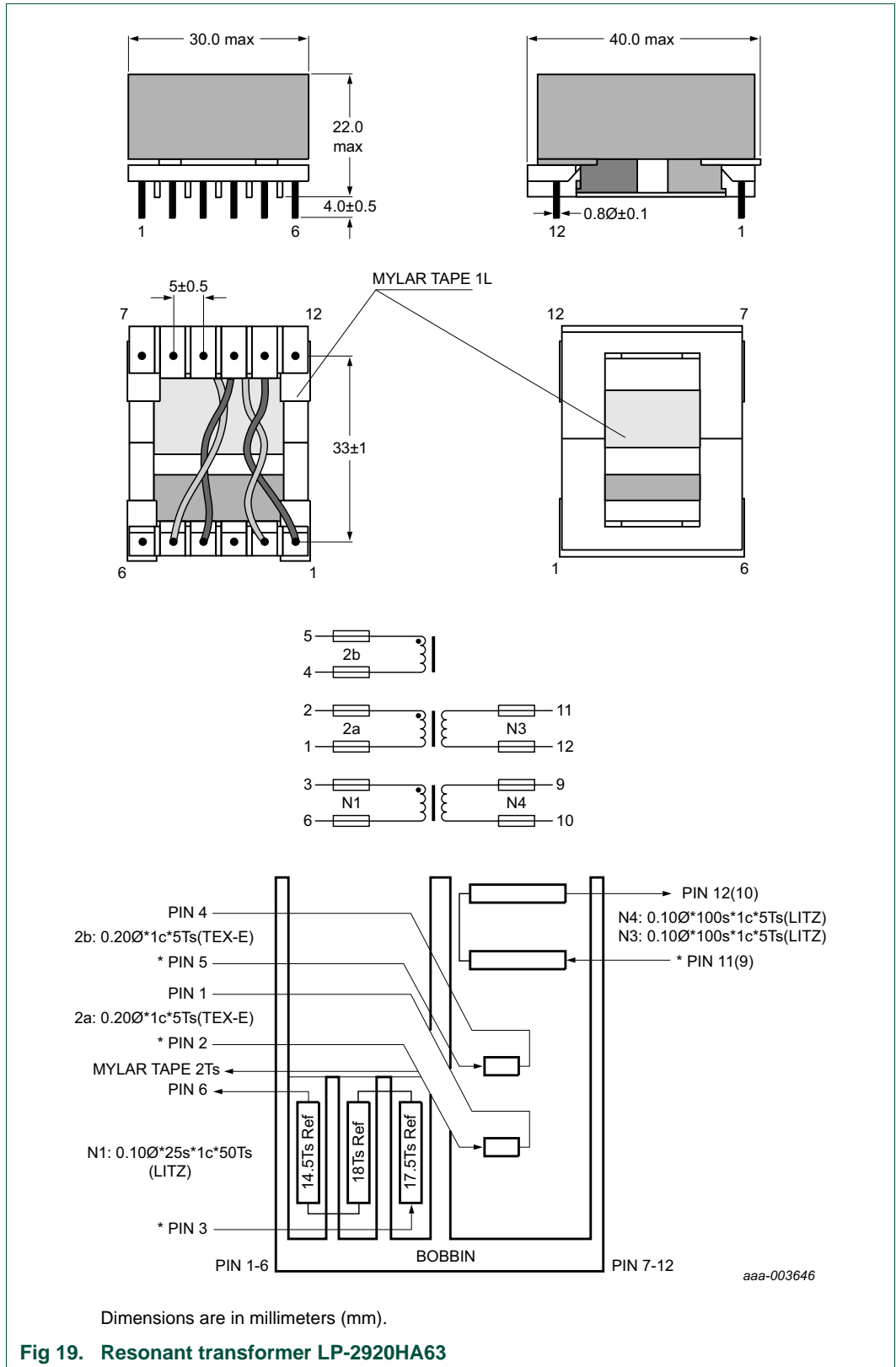
| Reference | Description and values                                   | Part number | Manufacturer |
|-----------|--|-------------|--------------|
| R108      | resistor; 560 k $\Omega$ ; $\pm 5$ %; 805                | -           | -            |
| R109      | resistor; 4.7 M $\Omega$ ; $\pm 1$ %; axial0.4           | -           | -            |
| R110      | resistor; 4.7 M $\Omega$ ; $\pm 1$ %; axial0.4           | -           | -            |
| R111A     | resistor; 3.6 k $\Omega$ ; $\pm 1$ %; 805 <sup>[1]</sup> | -           | -            |
| R111B     | resistor; 56 k $\Omega$ ; $\pm 1$ %; 805                 | -           | -            |
| R112      | resistor; 100 m $\Omega$ ; $\pm 1$ %; resV               | -           | -            |
| R113      | resistor; 0 $\Omega$ ; 1206                              | -           | -            |
| R114      | resistor; 10 $\Omega$ ; $\pm 5$ %; 805                   | -           | -            |
| R115      | resistor; 22 $\Omega$ ; $\pm 5$ %; 805                   | -           | -            |
| R116      | resistor; 22 $\Omega$ ; $\pm 5$ %; 805                   | -           | -            |
| R117      | resistor; 10 $\Omega$ ; $\pm 5$ %; 805                   | -           | -            |
| R118      | resistor; 10 $\Omega$ ; $\pm 5$ %; 402                   | -           | -            |
| R119      | resistor; 0 $\Omega$ ; 1206                              | -           | -            |
| R120      | resistor; 270 k $\Omega$ ; 805                           | -           | -            |
| R121      | resistor; 43 k $\Omega$ ; 805                            | -           | -            |
| R122      | resistor; 3.3 k $\Omega$ ; 805                           | -           | -            |
| R123      | resistor; 1 k $\Omega$ ; 805                             | -           | -            |
| R124      | resistor; 5.6 k $\Omega$ ; 805                           | -           | -            |
| R125      | resistor; 8.2 k $\Omega$ ; 805                           | -           | -            |
| R125A     | resistor; 1.5 k $\Omega$ ; 805 <sup>[1]</sup>            | -           | -            |
| R126      | resistor; 0 $\Omega$ ; 805                               | -           | -            |
| R127      | resistor; 1 k $\Omega$ ; 805                             | -           | -            |
| R130      | resistor; 75 k $\Omega$ ; 805                            | -           | -            |
| R132      | resistor; 33 k $\Omega$ ; 805                            | -           | -            |
| R133      | resistor; 47 k $\Omega$ ; 805                            | -           | -            |
| R134      | resistor; 3.6 k $\Omega$ ; 805                           | -           | -            |
| R138      | resistor; 12 k $\Omega$ ; 805                            | -           | -            |
| R139      | resistor; 68 k $\Omega$ ; $\pm 1$ %; 805                 | -           | -            |
| R140A     | resistor; 0 $\Omega$ ; 805 <sup>[1]</sup>                | -           | -            |
| R140B     | resistor; 10 k $\Omega$ ; $\pm 1$ %; 805                 | -           | -            |
| R141      | resistor; 2.7 k $\Omega$ ; 805                           | -           | -            |
| RJ1       | resistor; 0 $\Omega$ ; 805                               | -           | -            |
| RJ2       | resistor; 0 $\Omega$ ; 805                               | -           | -            |
| RJ3       | resistor; 0 $\Omega$ ; 805                               | -           | -            |
| RJ4       | resistor; 0 $\Omega$ ; 805                               | -           | -            |
| RJ5       | resistor; 0 $\Omega$ ; 805                               | -           | -            |

**Table 7.** TEA1716DB1255 demo board bill of materials ...continued

| Reference | Description and values | Part number | Manufacturer       |
|-----------|------------------------|-------------|--------------------|
| T101      | transformer; TR2       | LP-2920     | Yujingtech         |
| U101      | IC; TEA1716T           | SO-24       | NXP Semiconductors |
| U105      | IC; TL431BFDT          | TO92/SOT54  | NXP Semiconductors |
| U106      | optocoupler; SMD       | SFH628A-2   | -                  |
| VF101     | MOV; 2k471; rad0.4     | -           | -                  |

[1] This value can be different in a batch of boards.

7. Appendix 1: Resonant transformer data





**Table 8. Electrical specification***HP: 4284A ZENTECH: 3200B, 502A, F = 100 kHz, V = 1 V, at 25 °C*

| No  | Start | Finish | Wire  | Color | Turns        | Inductance                                | DCR (mΩ) |
|-----|-------|--------|---|-------|--------------|---|----------|
| L1  | 3     | 6      | 0.10 $\varnothing$ $\times$ 25 s $\times$ 1 $\varnothing$ (LITZ)  | Y     | 50 $\pm$ 0.5 | 1.4 mH $\pm$ 10 %                         | 334 max  |
| L2a | 2     | 1      | 0.20 $\varnothing$ $\times$ 1 $\varnothing$ (TEX-E)               | Y     | 5 $\pm$ 0.5  | 19.0 $\mu$ H REF                          | 250 max  |
| L2b | 5     | 4      | 0.20 $\varnothing$ $\times$ 1 $\varnothing$ (TEX-E)               | Y     | 5 $\pm$ 0.5  | 19.0 $\mu$ H REF                          | 250 max  |
| L3  | 11    | 12     | 0.10 $\varnothing$ $\times$ 100 s $\times$ 1 $\varnothing$ (LITZ) | Y     | 5 $\pm$ 0.5  | 12.0 $\mu$ H REF                          | 9 max    |
| L4  | 9     | 10     | 0.10 $\varnothing$ $\times$ 100 s $\times$ 1 $\varnothing$ (LITZ) | Y     | 5 $\pm$ 0.5  | 12.0 $\mu$ H REF                          | 9 max    |
| Lk  | 3     | 6      | 0.10 $\varnothing$ $\times$ 25 s $\times$ 1 $\varnothing$ (LITZ)  | Y     | 50 $\pm$ 0.5 | 225 $\mu$ H $\pm$ 10 % at secondary short |          |

## 8. Appendix 2: PFC coil data

### 8.1 Transformer schematic diagram

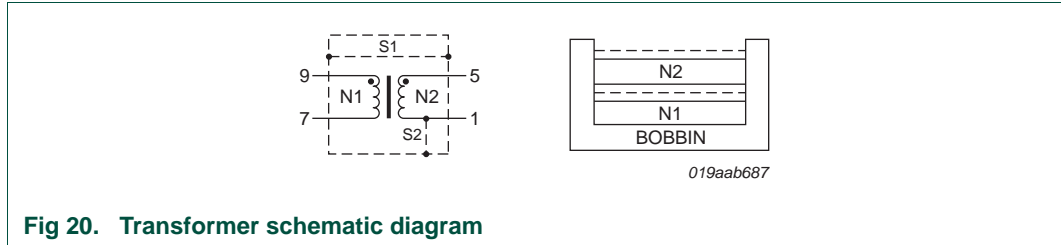


Fig 20. Transformer schematic diagram

### 8.2 Winding specification

Table 9. Winding specification

| No | Pin   |        | Wire                          | Turns | Winding method | Margin tape |           | Insulation |            |
|----|-------|--------|-------------------------------|-------|----------------|-------------|-----------|------------|------------|
|    | Start | Finish |                               |       |                | Primary     | Secondary | Turn       | Width      |
| N1 | 9     | 7      | 0.1 $\varnothing$ $\times$ 30 | 40    | center         | -           | -         | 1          | 10 mm      |
| N2 | 5     | 1      | 0.22 $\varnothing$ $\times$ 2 | 2     | center         | -           | -         | 1          | 10 mm      |
| S1 | -     | -      | 0.05<br>t $\times$ 14 mm      | 1     | center         | -           | -         | 1          | 14 mm (S2) |
| S2 | -     | 1      | 0.05<br>t $\times$ 14 mm      | 1     | center         | -           | -         | 1          | 14 mm (S1) |

### 8.3 Electrical characteristics

Table 10. Electrical characteristic

|                    | Pins   | Specification          | Remarks     |
|--------------------|--------|------------------------|-------------|
| Inductance         | 9 to 7 | 250 $\mu$ H $\pm$ 10 % | 60 kHz, 1 V |
| Leakage inductance | 9 to 7 | N/A                    | -           |

### 8.4 Core, bobbin and marking

#### Core and bobbin:

- Core: RM-10 (Ferroxcube RM/I or equivalent)
- Bobbin: RM-10 (12 pin, vertical type)
- Ae: 96.6 mm<sup>2</sup>

#### Marking:

- PFC-APBADC015

## 9. Abbreviations

Table 11. Abbreviations

| Acronym | Description                                       |
|---------|---|
| BCM     | Boundary conduction Mode                          |
| CMP     | Capacitive Mode Protection                        |
| EMC     | ElectroMagnetic Compatibility                     |
| EMI     | ElectroMagnetic Interference                      |
| FSP     | Failed Start Protection                           |
| HBC     | Half-Bridge resonant Converter                    |
| MOSFET  | Metal-Oxide Semiconductor Field-Effect Transistor |
| OCP     | OverCurrent Protection                            |
| OPP     | OverPower Protection                              |
| OVP     | OverVoltage Protection                            |
| OLP     | Open-Loop Protection                              |
| PCB     | Printed-Circuit Board                             |
| PFC     | Power Factor Correction                           |
| RMS     | Root Mean Square                                  |
| SOI     | Silicon-On-Insulator                              |
| ZVS     | Zero Voltage Switching                            |

## 10. References

- [1] **TEA1716T** — Data sheet: Resonant power supply control IC with PFC
- [2] **AN11179** — Application note: TEA1716 resonant power supply control IC with PFC
- [3] **Calculation sheet** — [http://www.nxp.com/technical\\_support/designportal/llc](http://www.nxp.com/technical_support/designportal/llc)

## 11. Legal information

### 11.1 Definitions

**Draft** — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

### 11.2 Disclaimers

**Limited warranty and liability** — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of NXP Semiconductors.

**Right to make changes** — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

**Suitability for use** — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

**Applications** — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

**Export control** — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

**Evaluation products** — This product is provided on an "as is" and "with all faults" basis for evaluation purposes only. NXP Semiconductors, its affiliates and their suppliers expressly disclaim all warranties, whether express, implied or statutory, including but not limited to the implied warranties of non-infringement, merchantability and fitness for a particular purpose. The entire risk as to the quality, or arising out of the use or performance, of this product remains with customer.

In no event shall NXP Semiconductors, its affiliates or their suppliers be liable to customer for any special, indirect, consequential, punitive or incidental damages (including without limitation damages for loss of business, business interruption, loss of use, loss of data or information, and the like) arising out of the use of or inability to use the product, whether or not based on tort (including negligence), strict liability, breach of contract, breach of warranty or any other theory, even if advised of the possibility of such damages.

Notwithstanding any damages that customer might incur for any reason whatsoever (including without limitation, all damages referenced above and all direct or general damages), the entire liability of NXP Semiconductors, its affiliates and their suppliers and customer's exclusive remedy for all of the foregoing shall be limited to actual damages incurred by customer based on reasonable reliance up to the greater of the amount actually paid by customer for the product or five dollars (US\$5.00). The foregoing limitations, exclusions and disclaimers shall apply to the maximum extent permitted by applicable law, even if any remedy fails of its essential purpose.

**Safety of high-voltage evaluation products** — 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 that is qualified according to local requirements and labor laws to work with non-insulated mains voltages and high-voltage circuits.

The product does not comply with IEC 60950 based national or regional safety standards. NXP Semiconductors does not accept any liability for damages incurred due to inappropriate use of this product or related to non-insulated high voltages. Any use of this product is at customer's own risk and liability. The customer shall fully indemnify and hold harmless NXP Semiconductors from any liability, damages and claims resulting from the use of the product.

**Translations** — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

### 11.3 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

**GreenChip** — is a trademark of NXP Semiconductors N.V.