UM10523

TEA1721 universal mains white goods flyback SMPS demo board

Rev. 1 — 27 January 2012 **User manual**

Document information

Info	Content
Keywords	TEA1721XT, flyback, non-isolated, dual output, white goods, SMPS, very low no-load power, primary-side feedback
Abstract	This user manual describes the TEA1721 based −12 V and −3.3 V AC/DC SMPS demo board which provides 5 W into a load.

Revision history

Rev	Date	Description
v.1	20120127	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.

This user manual describes the TEA1721 based −12 V and −3.3 V AC/DC SMPS demo board which provides 5 W into a load.

The switch-mode converter operates in flyback mode at a maximum frequency of around 50 kHz. Over-current and short circuit protection are built in.

Under no-load conditions, the power consumption of the flyback converter is around 20 mW. This application is typically suited for White Goods appliances and industrial applications.

1.1 Features and benefits

- Compatible with Universal Mains 85 V (AC) to 265 V (AC)
- Dual output voltage −12 V (DC) and −3.3 V (DC)
- Primary side voltage regulation removes the need for an optocoupler
- Total maximum power is 5 W
- No-load power consumption of 20 mW

2. Safety Warning

The demo board is powered by AC mains voltage. Avoid touching the board when power is applied. An isolated housing is obligatory when used in uncontrolled, non-laboratory environments. Always provide galvanic isolation of the mains phase using a variable transformer. The following symbols identify isolated and non-isolated devices.

a. Isolated b. Non-isolated

Fig 1. Isolated and non-isolated symbols

3. Specification

Table 1. Demo board specification

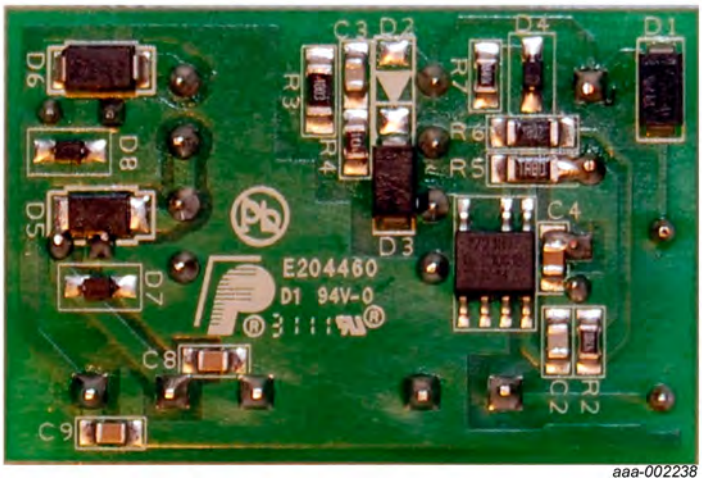
Parameter	Value	Comment
AC line input voltage	85 V (AC) to 265 V (AC)	supplied to J1 (Live) and J2 (Neutral) terminals
Output voltage	−12 V (DC) and −3.3 V (DC) with respect to neutral	supplied from connectors:
		J2.1 = 0 V, GND[1][2]
		J2.2 = −3.3 V
		J2.3 = −12 V
Maximum output current	−12 V = −400 mA −3.3 V = −400 mA	-
		requires a concurrent minimum load on the −12 V output of approximately 50 mA
Maximum output power	5 W	-
Output voltage accuracy	−12 V = +5 % to −5 %	adjustable using resistor R3.
Output voltage regulation and stability	−12 V = ± 1 %	in load range 5 % to 100 %[3]
Maximum output ripple current	100 mV peak to peak	under full load on the −12 V (DC) output
No-load power consumption	20 mW	-
Efficiency	±80 %	-
Operating temperature	−40 °C to 85 °C	-
EMC filtering	not applicable	It is assumed that EMI filtering is performed using an external Mains filter in the (white goods) appliance. If compliance with regulations is required for the standalone SMPS, the appropriate filtering stage(s) must be separately implemented.
Board dimensions	34.3 mm × 34.3 mm × 21 mm	L × B × H

[1] J2.1 is at the same potential as J1.2.

[2] The output voltage can be adjusted with resistor R3. The turns ratio of the secondary windings on transformer T1 defines the ratio between the two output voltages.

[3] Output voltage regulation can deviate by up to +8 % under the no load condition. The variation can be reduced by changing the Zener voltage of the D7 and/or D8 Zener diodes. Reducing the D7 and D8 Zener diode voltage can have marginal consequences for the no-load power consumption.

a. Front view.



b. Back view.

Fig 2. Photographs of the board

4. Demo board connections

Remark: Mount the board in a shielded or isolated box for demonstration purposes.

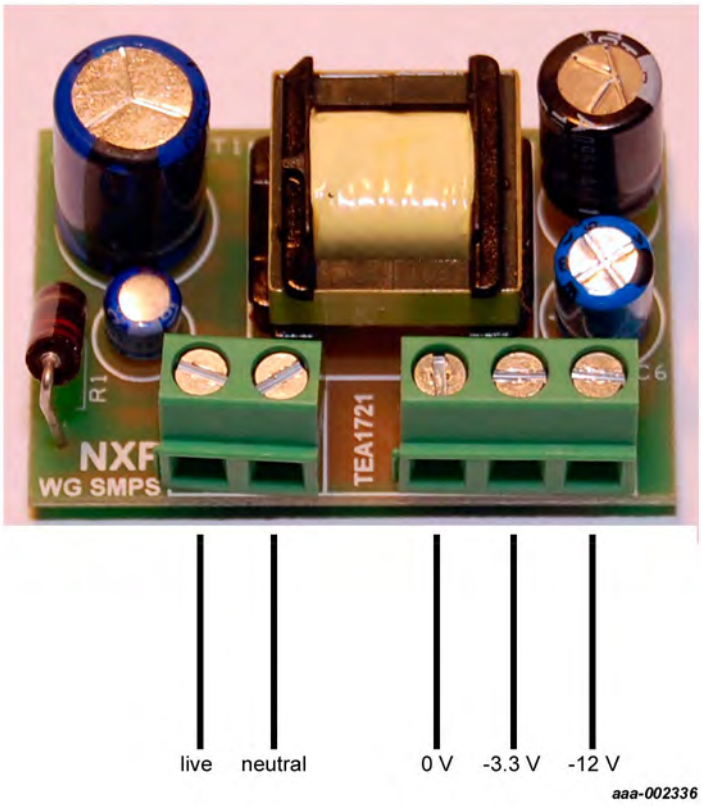
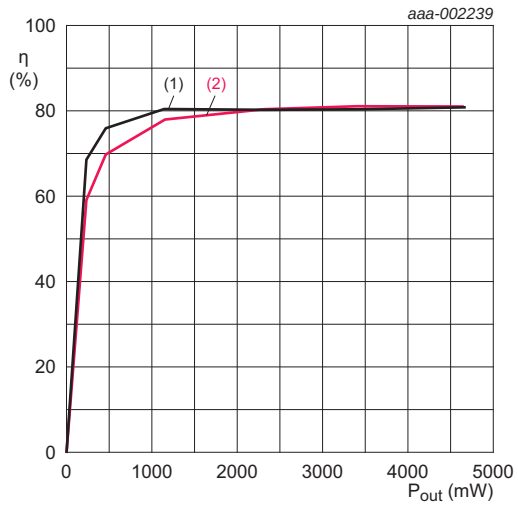


Fig 3. TEA1721XT Demo board connections

5. Operation and performance

Basic operation of the IC is described in the NXP Semiconductors *TEA1721XT data sheets*.

5.1 Efficiency

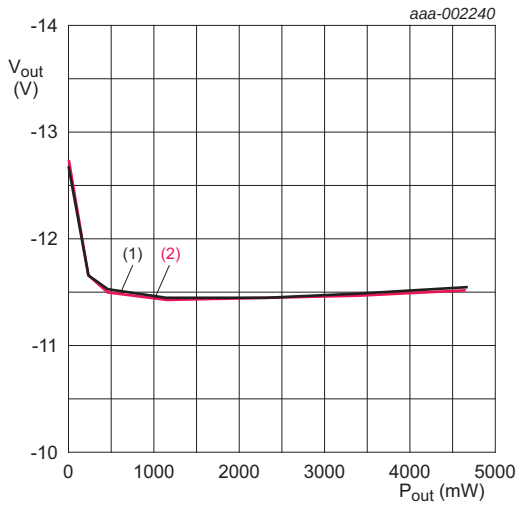


(1) 115 V (AC) input.

(2) 230 V (AC) input.

Fig 4. Typical efficiency of the TEA1721 universal mains white goods flyback controller as a function of load

5.2 Output voltage stability



(1) 115 V (AC) input.

(2) 230 V (AC) input.

Fig 5. Typical output voltage stability of the TEA1721 universal mains white goods flyback controllers a function of load

6. Demo board schematic

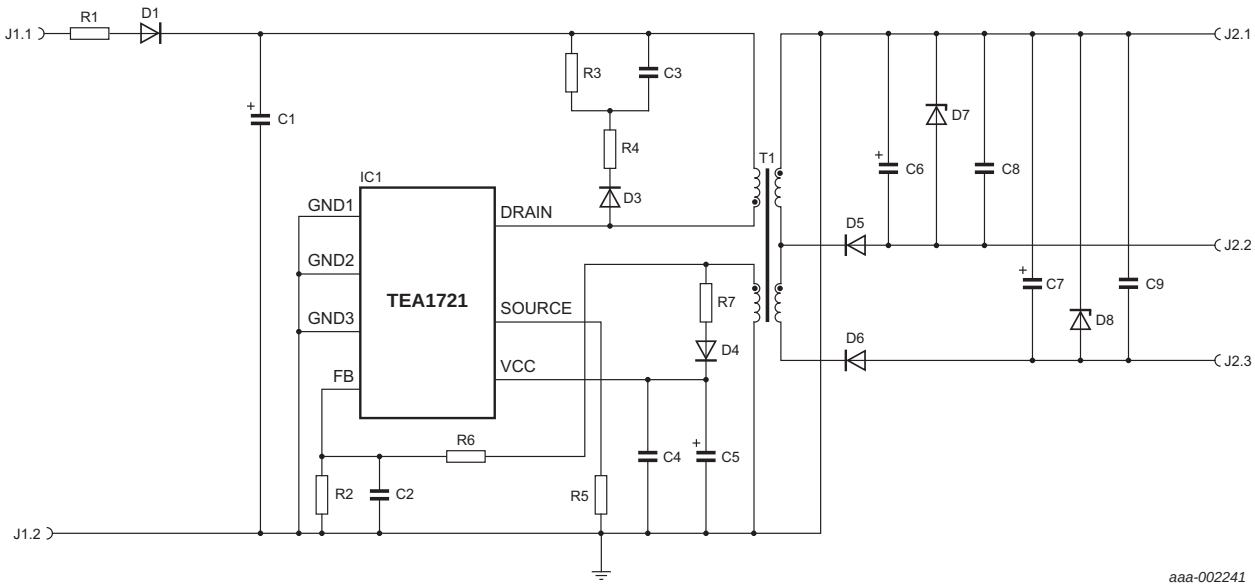


Fig 6. TEA1721 white goods SMPS circuit diagram

7. PCB components

Table 2. Demo board components

Reference	Description and value	Part number	Manufacturer
C1	electrolytic capacitor; 2E pitch; 4.7 μF; 400 V	-	-
C2	capacitor; 10 pF; 400 V; 0805	-	-
C3	capacitor; 220 pF; 500 V; 0805	-	-
C4	capacitor; 1 μF; 50 V; 0805	-	-
C5	electrolytic capacitor; 1E pitch; 10 μF; 35 V	-	-
C6	electrolytic capacitor; 1E pitch; 470 μF; 10 V	-	-
C7	electrolytic capacitor; 1E pitch; 470 μF; 16 V	-	-
C8	capacitor; 100 nF; 25 V; 0805	-	-
C9	capacitor; 100 nF; 25 V; 0805	-	-
D1	diode; S1M; SMA	-	Fairchild
D2	not mounted; diode; BZG03-C200; SMA	BZG03-C200	-
D3	diode; S1M; SMA	-	Fairchild
D4	diode; BAS316; SOD323	-	NXP Semiconductors
D5	diode; BYG20J; SMA	BYG20J	-
D6	diode; PMEG4050EP; SOD128	-	-
D7	diode; BZX384-C3V6; SOD323	BZX384-C3V6	NXP Semiconductors
D8	diode; BZX384-C13; SOD323	BZX384-C13	NXP Semiconductors
IC1	TEA1721; SO7	-	NXP Semiconductors
J1.1, J1.2	2-pole terminal block; 2E pitch	1729128	Phoenix
J2.1; J2.2; J2.3	3-pole terminal block; 2E pitch	1729131	Phoenix
T1	Würth Elektronik 750311993; EE16[1]	-	Würth Elektronik
R1	carbon resistor; 22 Ω; 4E pitch	-	
R2	resistor; 4.7 kΩ; 1 %; 0805	-	
R3	resistor; 100 kΩ; 0.5 W; 1206	-	
R4	resistor; 470 Ω; 0805	-	
R5	resistor; 1.8 Ω; 0.25 W; 1206	-	
R6	resistor; 18 kΩ; 1 %[2]	-	
R7	resistor; 10 Ω; 0805	-	

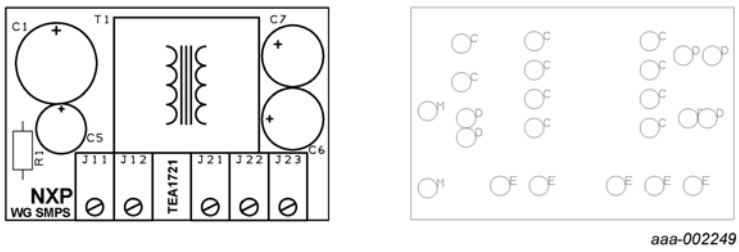
[1] Custom-made transformer. Primary winding inductance: 2.4 mH, turns ratio primary : secondary : auxiliary = 6.5 : 1 : 1. The secondary winding must have a tap for the −3.3 V output voltage.

[2] To tune the output voltage, change this value.

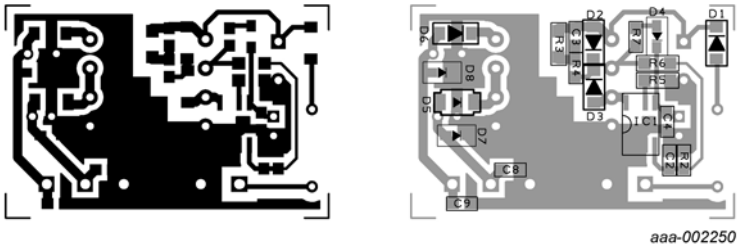
8. Implementation guidelines

- The maximum current allowed in for the TEA1721 internal switching MOSFET is 700 mA. When adapting this circuit, take care to ensure that this current value is not exceeded under any circumstances.
- Resistor R1 limits the inrush current. The resistor must be a carbon resistor because metal film resistors can act as a fuse in this position. If no current limiting is required, the resistor can be replaced with a short-circuit.
- Zener diodes D7 and D8 form a small pre-load and act as overvoltage spike suppressors. If no over-voltage suppression is necessary, the Zener diodes can be replaced with small resistors.
- Capacitors C7 and C8 are mounted for additional HF noise suppression. If it is not needed, these components can be omitted.

9. Board layout



a. Top silk screen plus top component placement and drill pattern



b. Bottom copper and bottom silk screen plus component placement

Fig 7. PCB layout

The bottom silk screen is normally not used in PCB production. Merged with the bottom copper, it is shown here as a component placement reference only. See Table 3 for a list of components.

Table 3. Drill tool table

Drill tool code	Drill diameter
C	1 mm
D	0.9 mm
E	1.3 mm

10. References

[1] **TEA1721XT -** Ultra-low standby SMPS controller with integrated power switch

[2] **AN11060 -** TEA172X 5 W to 11 W power supply/USB charger

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