UM10521

TEA1721 isolated universal mains flyback converter demo board

Rev. 1 — 8 March 2012 **User manual**

Document information

Info	Content
Keywords	TEA1721AT, isolated, universal mains, AC/DC conversion, flyback converter, Switched Mode Power Supply (SMPS)
Abstract	This user manual describes the application of the TEA1721ADB1061 demo board. The demo board is designed as an isolated 12 V, and 3.3 V AC/DC SMPS for supplying up to 5 W into a load.

Revision history

Rev	Date	Description
v.1	20120308	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 application of the TEA1721ADB1061 demo board. The demo board is designed as an isolated 12 V and 3.3 V AC/DC SMPS for supplying up to 5 W to a load.

The switch-mode converter operates in flyback mode at a maximum frequency of around 51 kHz. Overcurrent and short-circuit protection are built in. The power consumption is between 10 mW and 20 mW under no-load conditions.

EMI filtering for compliance with EN55022 has been implemented in this circuit.

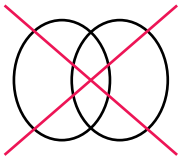
1.1 Features and benefits

- Compatible with Universal Mains
- Inrush current limitation
- EMI filtering to meet EMC requirements of EN55022

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.

019aab173



019aab174

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)	universal mains; supplied to the J1.1 and J1.2 terminals
Output voltage	12 V (DC) and 3.3 V (DC)	supplied from connectors:
		J2.1 = 0 V, GND
		J2.2 = 3.3 V
		J2.3 = 12 V
Maximum output current	12 V = 400 mA	-
	3.3 V = 400 mA	-
Maximum output power	5 W	-
Output voltage stability	±5 %	strongly depends on the magnetic coupling of the secondary and auxiliary winding of transformer T1
Efficiency	79.3 % at 115 V (AC)/60 Hz	-
	80 % at 230 V (AC)/50 Hz	-
Operating temperature	−40 °C to 85 °C	-
EMC Compliance	EN55022	-
Board dimensions	41 mm × 51 mm × 25 mm	L × B × H

Fig 2. TEA1721AT demo board front view

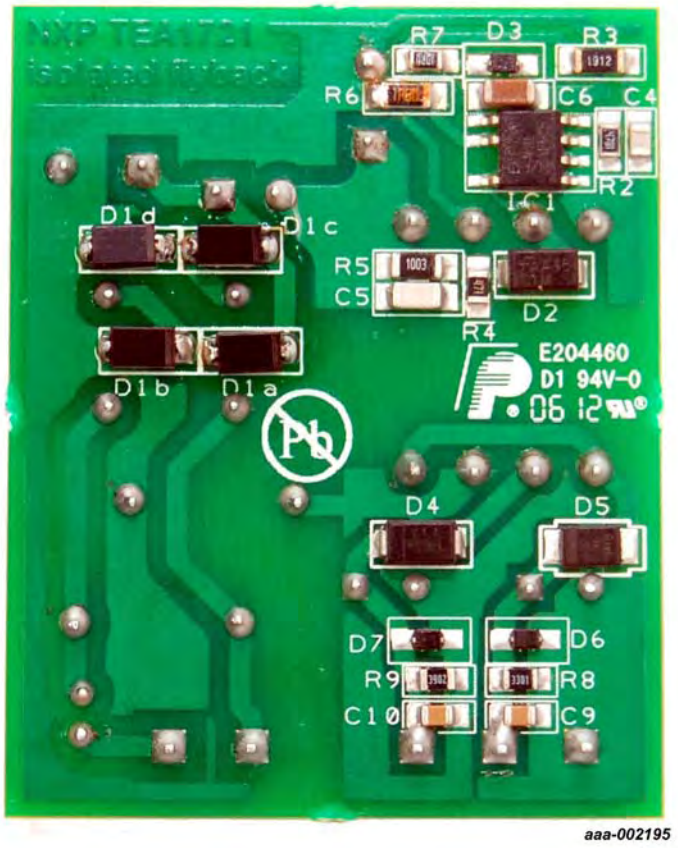


Fig 3. TEA1721AT demo board rear view

4. Demo board connections

The isolated universal mains flyback demo board has an input and an output terminal block.

The input terminal block (right on the picture) is connected to the mains voltage. Live and Neutral wires can be connected randomly to this terminal block.

The output terminal block (left on the picture) provides the 12 V and 3.3 V output voltages, both referenced to a common ground (GND).

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

Fig 4. TEA1721AT Demo board connections

5. Demo board schematic

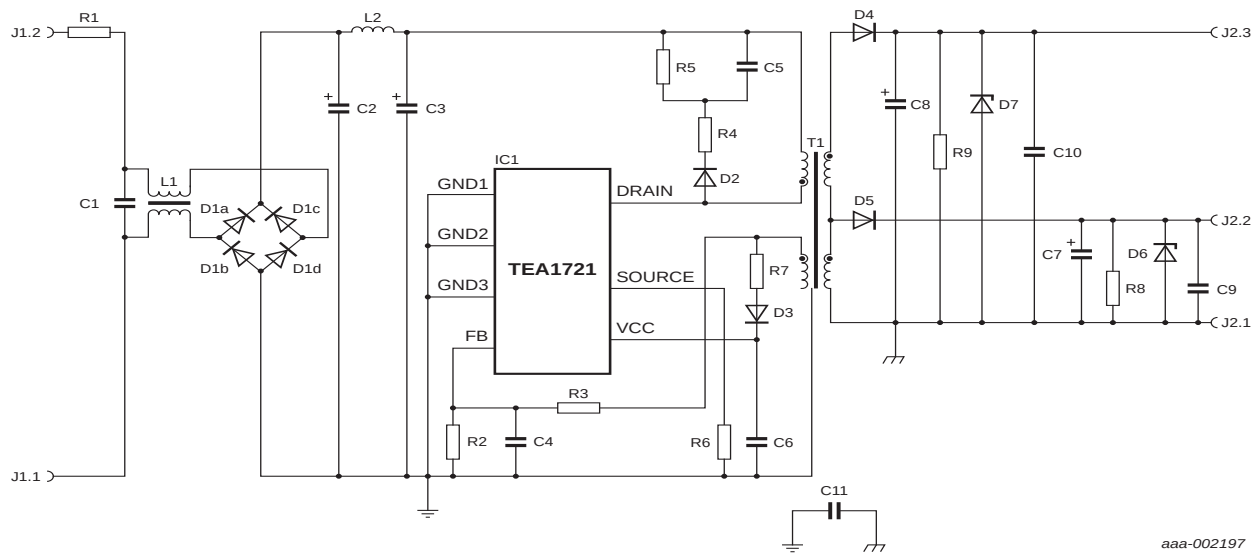


Fig 5. TEA1721AT flyback converter SMPS circuit diagram

6. PCB components

Table 2. Demo board components

Reference	Description and value	Part number	Manufacturer
C1	100 nF; 275 V (AC); 4E pitch	-	-
C2	electrolytic capacitor; ∅10 mm maximum; 4.7 μF; 400 V; 2E pitch	-	-
C3	electrolytic capacitor; ∅10 mm maximum; 4.7 μF; 400 V; 2E pitch	-	-
C4	10 pF; 25 V; 0805	-	-
C5	220 pF; 500 V; 1206	-	-
C6	2.2 μF; 50 V; 1206	-	-
C7	electrolytic capacitor; ∅10 mm maximum; 1 mF; 6.3 V; 1.5E pitch	-	-
C8	electrolytic capacitor; ∅10 mm maximum; 470 μF; 16 V; 1.5E pitch	-	-
C9	100 nF; 25 V; 0805	-	-
C10	100 nF; 25 V; 0805	-	-
C11	Y-capacitor; 2.2 nF; 1 kV; 4E pitch	-	-
D1a	S1M; SMA	-	Fairchild
D1b	S1M; SMA	-	Fairchild
D1c	S1M; SMA	-	Fairchild
D1d	S1M; SMA	-	Fairchild
D2	S1M; SMA	-	Fairchild
D3	BAS316; SOD323	-	NXP Semiconductors
D4	Schottky; 100 V; 1 A; 10MQ100NTRPBF; SMA	-	Vishay
D5	PMEG4050EP; SOD128	-	NXP Semiconductors
D6	BZX384-C3V6; SOD323	-	NXP Semiconductors
D7	BZX384-B12; SOD323	-	NXP Semiconductors
IC1	TEA1721AT; 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
L1	2 × 25 mH; 80 mA; 250 V (AC)	744862250	Würth Elektronik
L2	1 mH; 80 mA; 1.5E pitch	22R105	Murata
R1	carbon resistor; mounted upright; 33 Ω; 1E pitch	-	-
R2	4.7 kΩ; 1 %; 0805	-	-
R3	19.1 kΩ; 1 %; 1206[2]		-
R4	470 Ω; 0805	-	-
R5	100 kΩ; 0.5 W; 1206	-	-
R6	1.8 Ω; 0.25 W; 1206	-	-
R7	10 Ω; 0805	-	-

Table 2. Demo board components *…continued*

Reference	Description and value	Part number	Manufacturer
R8	3.3 kΩ; 0805	-	-
R9	39 kΩ; 0805	-	-
T1	Custom-made transformer[1]	750311993	Würth Elektronik

[1] Custom 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.

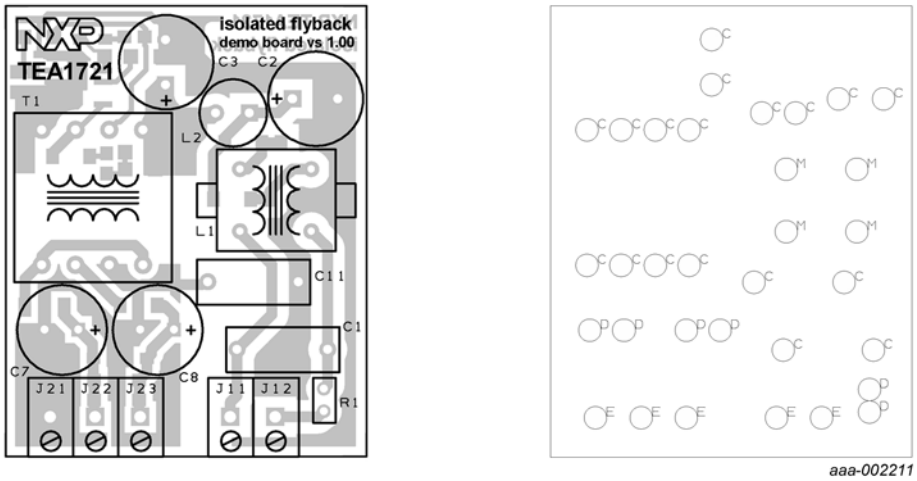
[2] To set the output voltage with greater accuracy, fine-tuning is required.

7. Optional modifications implementation guidelines

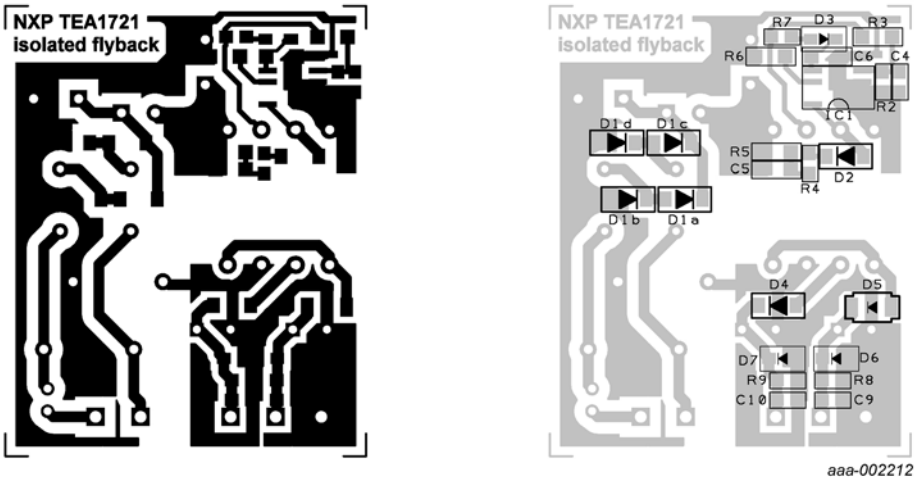
- The output voltages are adjusted using resistors R2 and R3. The secondary winding on transformer T1 turns ratio defines the ratio between the two output voltages. Using a different transformer makes other output voltages and/or other output voltage ratios available.
- The maximum output power and output current levels are adjusted using resistor R6. The maximum current allowed in the TEA1721 IC switching MOSFET is 700 mA. Take care that under no circumstances, the peak current in the primary winding of the T1 transformer exceeds 700 mA. Changing the value of R6 also needs a change to the primary inductance value.
- 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 inrush current limiting is required, the resistor can be replaced with a short-circuit.
- EMI-filtering is implemented using separate stages for common mode (L1) and differential mode (L2). Depending on the requirements, the filtering stage can be adapted. For example, inductor L1 can be chosen to ensure that its leakage inductance takes care of differential filtering. As a consequence L2 can be omitted.
- Resistors R8 and R9 form small pre-loads for the converter. When the output voltages are adjusted, also adjust the pre-load resistors to ensure that they consume roughly the same amount of power. Depending on the connected load, eliminate the resistors.
- Zener diodes D6 and D7 implement the elementary output OverVoltage Protection (OVP). When OVP is not needed, eliminate these diodes.
- Capacitors C9 and C10 are used to obtain additional (HF) voltage stability and noise suppression. Eliminate the capacitors when the feature is not needed.
- Capacitor C11 is a Y-capacitor. If theT1 transformer construction provides the required EMI performance without the use of capacitor C11, omit the capacitor.

8. Board layout

A 41 mm × 51 mm sized evaluation PCB was created that accommodates an implementation of the TEA1721 isolated universal mains flyback converter.



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



b. Bottom copper and bottom silk screen plus component placement

Fig 6. 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 2 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
M	0.8 mm

Gerber files are available from your local NXP Semiconductor sales representative, on request.

9. Abbreviations

Table 4. Abbreviations

Acronym	Description
EMC	ElectroMagnetic Compatibility
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
PFC	Power Factor Correction
SMPS	Switched Mode Power Supply
ZVS	Zero Voltage Switching

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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