TEA2206T

Active bridge rectifier controller

Rev. 1.1 — 14 April 2021 Product data sheet

1 General description

The TEA2206T is an active bridge rectifier controller for replacing the two low-side diodes in the traditional diode bridge with MOSFETs.

Using the TEA2206T with low-ohmic high-voltage external MOSFETs significantly improves the efficiency of the power converter as the typical rectifier-diode forward-conduction losses are reduced by 50 %. Efficiency can improve up to about 0.7 % at 90 V (AC) mains voltage.

The TEA2206T is fabricated in a silicon-on-insulator (SOI) process.

2 Features and benefits

2.1 Efficiency features

- Forward conduction losses of the diode rectifier bridge are reduced
- Very low IC power consumption (2 mW)

2.2 Application features

- Directly drives two rectifier MOSFETs
- Very low external part count
- Integrated X-capacitor discharge (2 mA)
- Self-supplying
- SO8 package

2.3 Control features

- Undervoltage lockout
- Drain-source overvoltage protection for all external power MOSFETs
- Gate pull-down currents at startup for all external power MOSFETs

3 Applications

The TEA2206T is intended for power supplies with a boost-type power-factor controller as a first stage. The second stage can be a resonant controller, a flyback controller, or any other controller topology. It can be used in all power supplies requiring high efficiency:

- Adapters
- Power supplies for desktop PC and all-in-one PC
- Power supplies for television
- Power supplies for servers

4 Ordering information

Table 1. Ordering information

Type number	Package		
	Name	Description	Version
TEA2206T/1	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1

5 Marking

Table 2. Marking

Type number	Marking code
TEA2206T/1	TEA2206

6 Block diagram

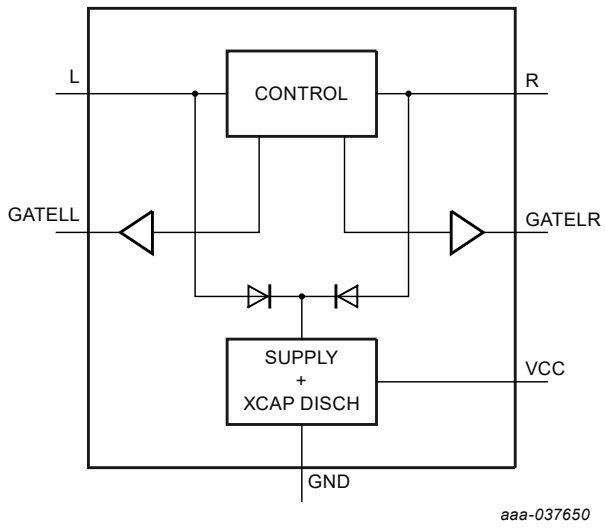


Figure 1. Block diagram

7 Pinning information

7.1 Pinning

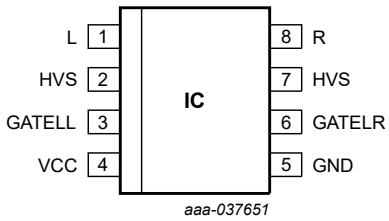


Figure 2. Pin configuration diagram (SO8)

7.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
L	1	left input
HVS	2	high-voltage spacer; not to be connected
GATELL	3	gate driver left low side
VCC	4	supply voltage
GND	5	ground
GATELR	6	gate driver right low side
HVS	7	high-voltage spacer; not to be connected
R	8	Right input

8 Functional description

8.1 Introduction

The TEA2206T is a controller IC for an active bridge rectifier consisting of two diodes and two MOSFETs. It can directly drive the two MOSFETs. Figure 1 shows a typical configuration. It is intended for applications followed by a boost type power factor circuit.

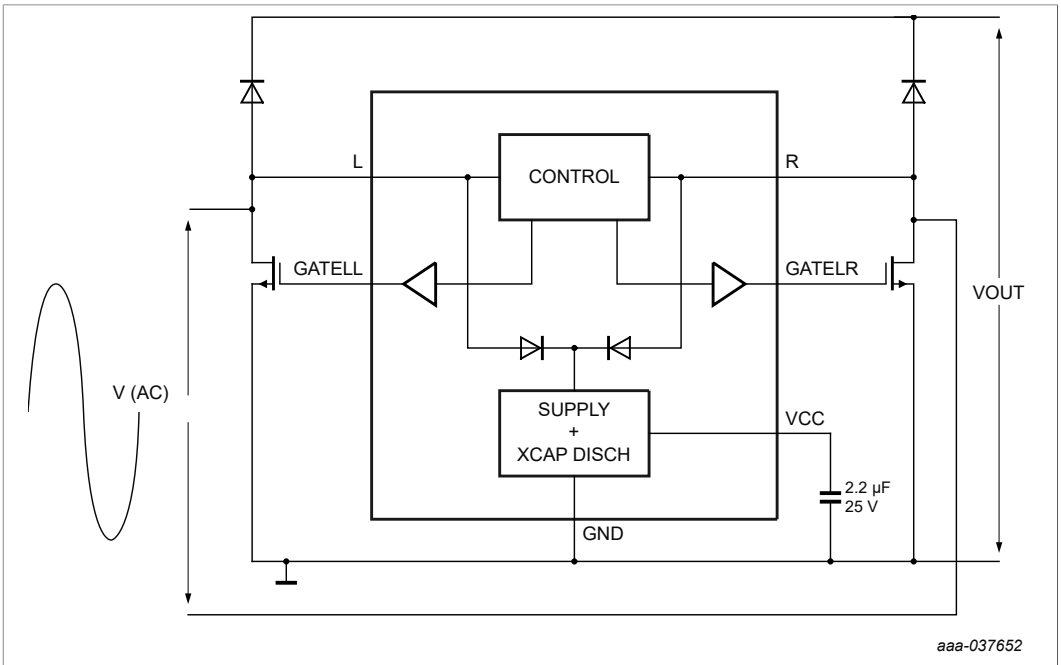


Figure 3. TEA2206T typical configuration diagram

8.2 Operation

The control circuit of the TEA2206T senses the polarity of the mains voltage between pins L and R. Depending on the polarity, either GATELL or GATELR is switched on. The comparator in the control circuit, which compares the L and R voltages, has thresholds of 250 mV and −250 mV depending on the slope polarity. If the difference voltage between L and R is less than 250 mV both GATELL and GATELR are low.

The gate drivers are high-current rail-to-rail MOS output drivers. An on-chip supply circuit which draws current from either L or R generated the gate driver voltage. After a zero-crossing of the mains voltage, the supply capacitor C_{VCC} is charged to the regulation level V_{reg}. Then the discharge state is entered. The resulting power dissipation from the mains voltage is about 1 mW excluding gate charge losses of the external power MOSFETs. These gate charge losses typically add 1 mW of dissipation.

At start-up, the supply capacitor is first charged to the V_{start} voltage and enters the start-up state. After a next zero-crossing of the mains voltage, the supply capacitor is charged to V_{reg} in the charging state. When the voltage at the supply capacitor exceeds V_{dis}, the gate driver outputs are enabled. When all drivers are active, the MOSFETs take over the role of the diodes which, compared to a passive diode rectifier bridge, results in lower power loss.

When the mains voltage is disconnected, the internal bias current in the discharge state discharges the supply capacitor. When the voltage at pin VCC drops to below V_{dis} the X-capacitor discharge state is entered, which draws 2 mA of current from pin L or pin R to discharge the X-capacitor. The waiting time t_d until X-capacitor discharge starts is:

$$t_d = C_{VCC} * \left(V_{reg} - V_{dis}\right) / 20\ \mu A = 0.2E6 * C \quad (1)$$

Using a typical value of 2.2 µF for C_{VCC} yields about 0.45 s. While the L or R pin discharges the X-capacitor, the mains can be reconnected. In that case, the charge mode is entered again.

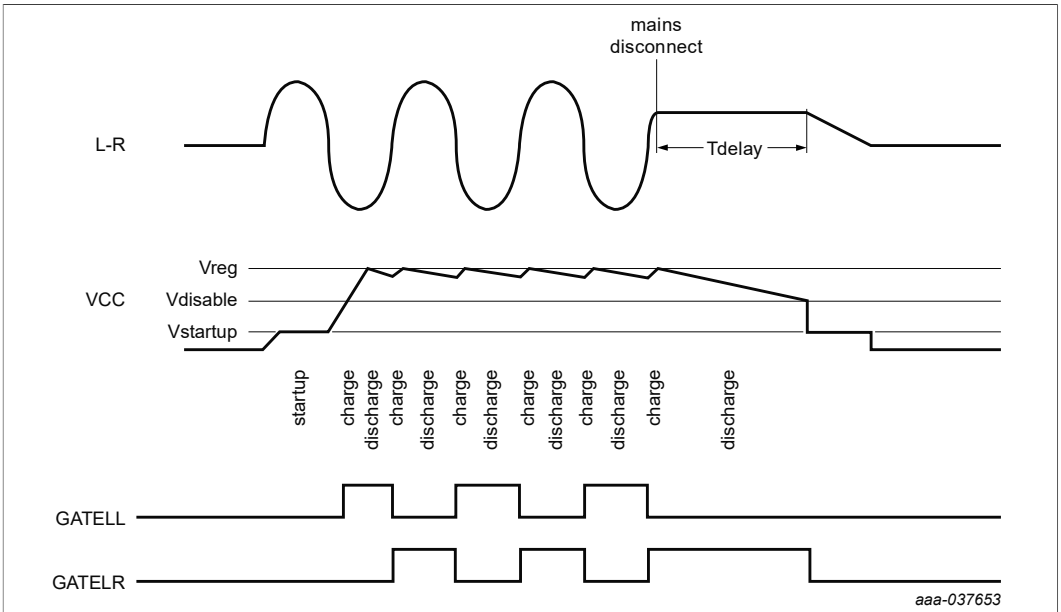


Figure 4. TEA2206T signals

Table 4. TEA2206T states

States	Description	I (L) or I (R)	I (VCC)
start-up	supply capacitor kept stable at 4.8 V	2 mA	0
charge	supply capacitor is being charged with 2 mA from pin L or R	2 mA	−2 mA
discharge	internal bias currents and gate charge losses discharge the supply capacitor	1 µA	20 µA
x-capacitor discharge	supply capacitor and x-capacitor are being discharged by 2 mA	2 mA	−2 mA

8.3 Protections

8.3.1 Gate pull-down

All gate driver outputs have a pull-down circuit. This circuit ensures that, if a driver supply voltage is below the undervoltage lockout level, the gate driver output is discharged to less than 2 V.

8.3.2 Power MOSFET drain-source protection

If the drain-source voltage of the external power MOSFET exceeds V_{VCC} − 2 V, all gate driver outputs are disabled. It avoids high dissipation and high current peaks in the power MOSFETs during start-up.

8.3.3 Minimum mains voltage

Only when the voltage at either node L or R exceeds 22 V, the charge state is entered.

9 Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). All voltages are measured with respect to ground (pin 7); positive currents flow into the chip. Voltage ratings are valid provided other ratings are not violated; current ratings are valid provided the other ratings are not violated.

Symbol	Parameter	Conditions	Min	Max	Unit
Voltages					
V_L	voltage on pin L	operating	−5	+440	V
		mains transient: maximum 10 minutes over lifetime	−5	+700	V
V_R	voltage on pin R	operating	−5	+440	V
		mains transient: maximum 10 minutes over lifetime	−5	+700	V
SR_{max}	maximum slew rate	pins L and R	-	50	V/ns
V_{VCC}	voltage on pin VCC		−0.4	14	V
V_{GATELL}	voltage on pin GATELL		−0.4	14	V
V_{GATELR}	voltage on pin GATELR		−0.4	14	V
General					
T_j	junction temperature		−40	+125	°C
T_{stg}	storage temperature		−55	+150	°C
Electrostatic discharge					
V_{ESD}	electrostatic discharge voltage	human body model (HBM)			
		pins L and R	−1000	+1000	V
		other pins	−2000	+2000	V
		charge device model (CDM)	−500	+500	V

10 Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions		Typ	Unit
$R_{th(j-c)}$	thermal resistance from junction to case	in free air	[1]	46	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air; 1-layer PCB	[1]	177	K/W
		in free air; 4-layer PCB; JEDEC test board	[1]	126	K/W

[1] Given thermal resistance values are based on simulation results.

11 Characteristics

Table 7. Characteristics

T_{amb} = 25 °C; all voltages are measured with respect to GND; currents are positive when flowing into the IC; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
High-voltage supply (pins L and R)						
I_{on}	on-state current	charging state; X-capacitor discharge state; start-up state	1.5	2	2.75	mA
I_{off}	off-state current	discharge state	0.9	1.3	1.8	µA
V_{start}	start voltage	high-voltage start-up	9	-	-	V
Low-voltage supply (pin VCC)						
I_{dch}	discharge current	X-capacitor discharge	3	4	5.5	mA
I_{bias}	bias current	discharge state	15	20	30	µA
I_{ch}	charge current	charge state	1.5	2	2.75	mA
V_{UVLO}	undervoltage lockout voltage		3.6	4.2	4.9	V
$V_{startup}$	start-up voltage	start-up state	4.3	4.8	5.3	V
V_{dis}	disable voltage	high level	9.2	9.7	10.2	V
		hysteresis	1.1	1.5	1.8	V
V_{regd}	regulated output voltage		11.4	12	12.8	V
Gate driver output pins (GATELL, GATELR)						
I_{source}	source current	V_{VCC} = 12 V; V_{gate} = 6 V [1]	125	200	400	mA
I_{sink}	sink current	V_{VCC} = 12 V; V_{gate} = 6 V [1]	150	200	500	mA
I_{pd}	pull-down current	V_{VCC} = 2 V; V_{gate} = 2 V	100	200	250	µA
R_{on}	on-state resistance		11	15	20	Ω
R_{off}	off-state resistance		7	10	14	Ω
$V_{prot(G)}$	gate driver protection voltage	L-VCC; R-VCC	−3	−2.3	−1	V
Control circuit (pins L and R)						
V_{th}	threshold voltage	peak detector threshold voltage	15	22	32	V
V_{offset}	offset voltage	Zero crossing comparator offset voltage	150	250	350	mV
t_d	delay time	dV/dt = 0.1 V/µs [2]	1200	1500	2500	ns
		dV/dt = 10 V/µs [2]	550	700	1200	ns

[1] Covered by correlating measurement.
[2] Guaranteed by design and validation.

12 Application information

A switched mode power supply with the TEA2206T typically consists of a mains filter in front of the TEA2206T followed by a boost-type power-factor controller. A resonant controller, flyback controller, or any other topology can follow this boost-type PFC.

Special attention must be paid to the connection of the L and R pins of the TEA2206T. Mains transients or surges must be limited to voltages below 700 V.

Typical value for the supply capacitor is 1 µF to 2.2 µF. Supply capacitors with higher values increase the delay time (t_d) for the X-capacitor discharge. They may also increase the dissipation because the supply capacitor C_{VCC} may not be charged every half-mains cycle.

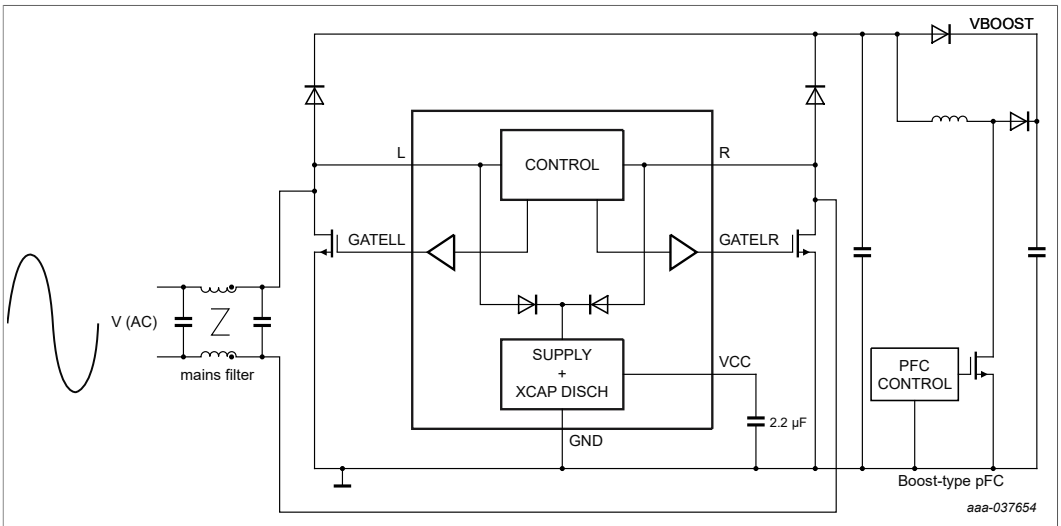
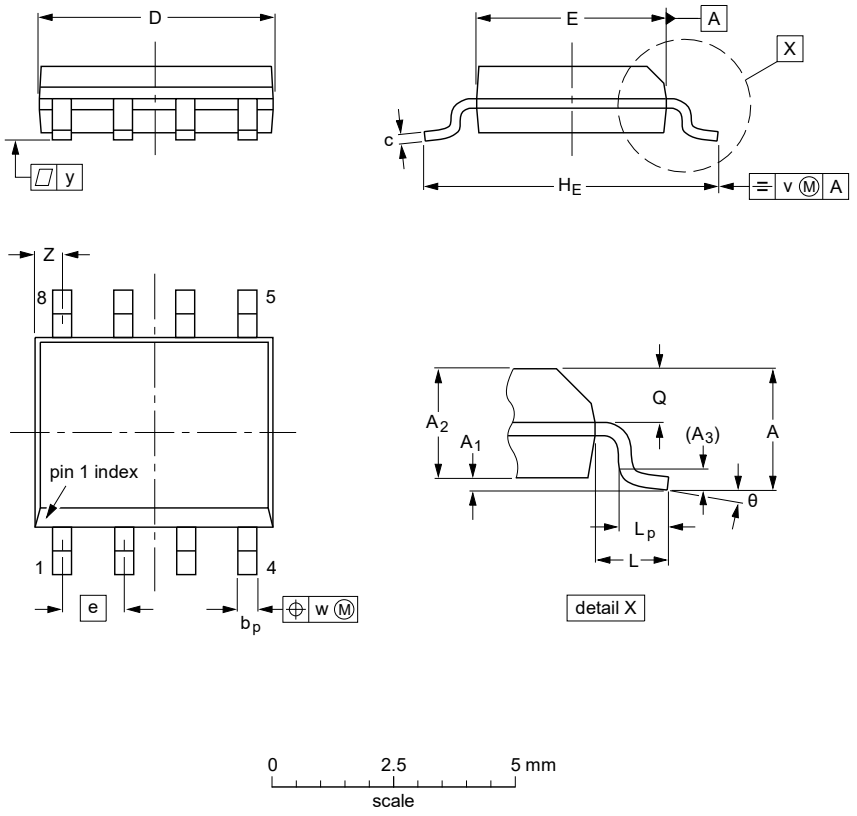


Figure 5. TEA2206T typical application with mains filter and boost-type PFC

13 Package outline

Table 8.

SO8: plastic small outline package; 8 leads; body width 3.9 mm **SOT96-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(2)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	5.0 4.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.20 0.19	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Notes

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm (0.01 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT96-1	076E03	MS-012				~~99-12-27~~ 03-02-18

Figure 6. Package outline SOT96-1 (SO8)

14 Revision history

Table 9. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
TEA2206T v.1.1	20210414	Product data sheet	-	TEA2206T v.1
Modifications:	• Characteristics "Characteristics" has been updated.			
TEA2206T v.1	20201202	Product data sheet	-	-

15 Legal information

15.1 Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.
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