



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

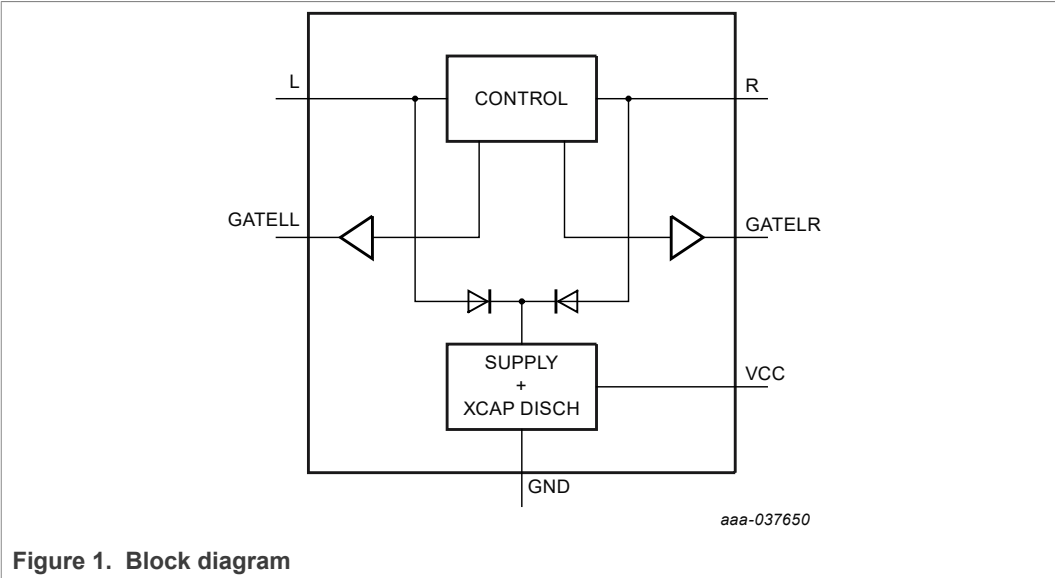
Type number	Package		Version
	Name	Description	
TEA2206T/1	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1

5 Marking

Table 2. Marking

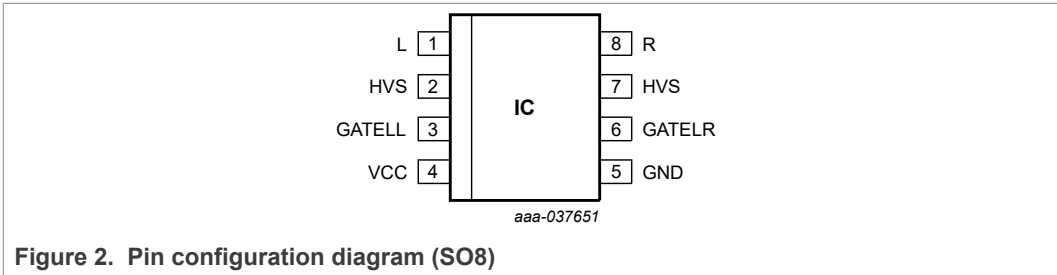
Type number	Marking code
TEA2206T/1	TEA2206

6 Block diagram



7 Pinning information

7.1 Pinning



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.

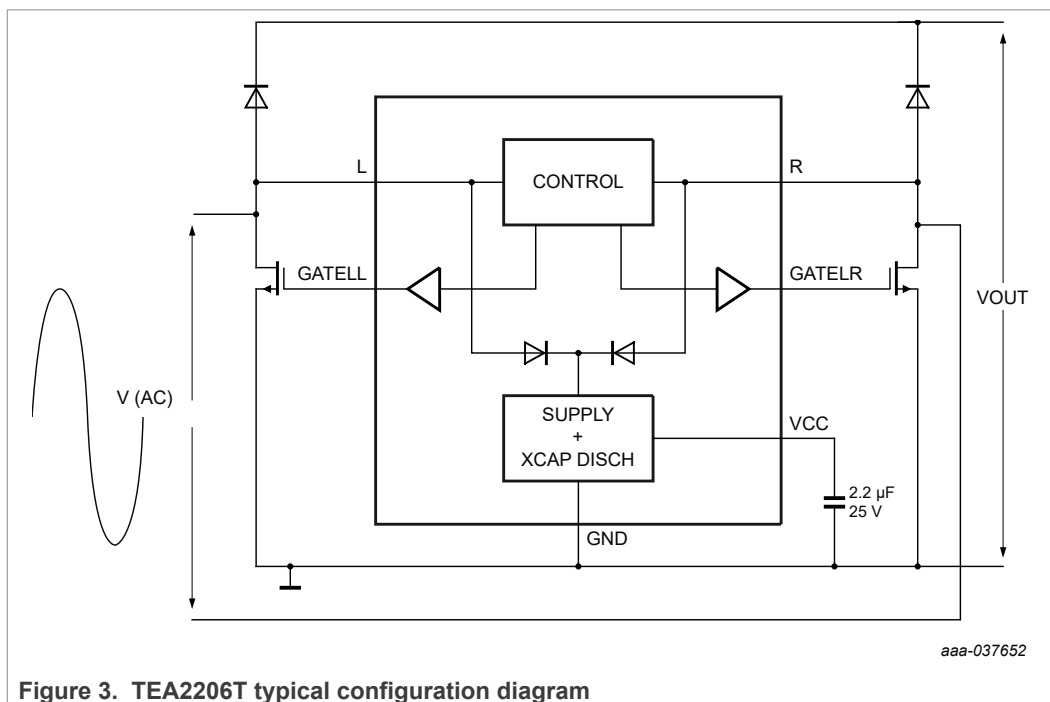


Figure 3. TEA2206T typical configuration diagram

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:

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

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.

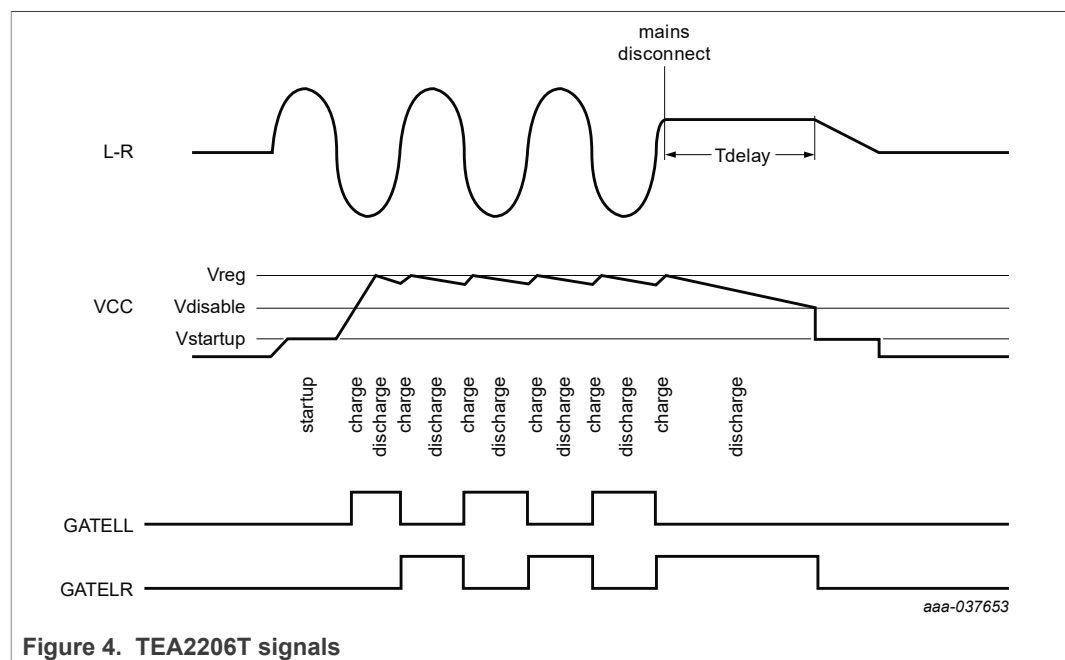


Figure 4. TEA2206T signals

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 $V_{VCC} - 2\text{ V}$, 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

$T_{amb} = 25\text{ }^{\circ}\text{C}$; 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	$V_{VCC} = 12\text{ V}$; $V_{gate} = 6\text{ V}$ ^[1]	125	200	400	mA
I_{sink}	sink current	$V_{VCC} = 12\text{ V}$; $V_{gate} = 6\text{ V}$ ^[1]	150	200	500	mA
I_{pd}	pull-down current	$V_{VCC} = 2\text{ V}$; $V_{gate} = 2\text{ V}$	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	$dV/dt = 0.1\text{ V}/\mu\text{s}$ ^[2]	1200	1500	2500	ns
		$dV/dt = 10\text{ V}/\mu\text{s}$ ^[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.

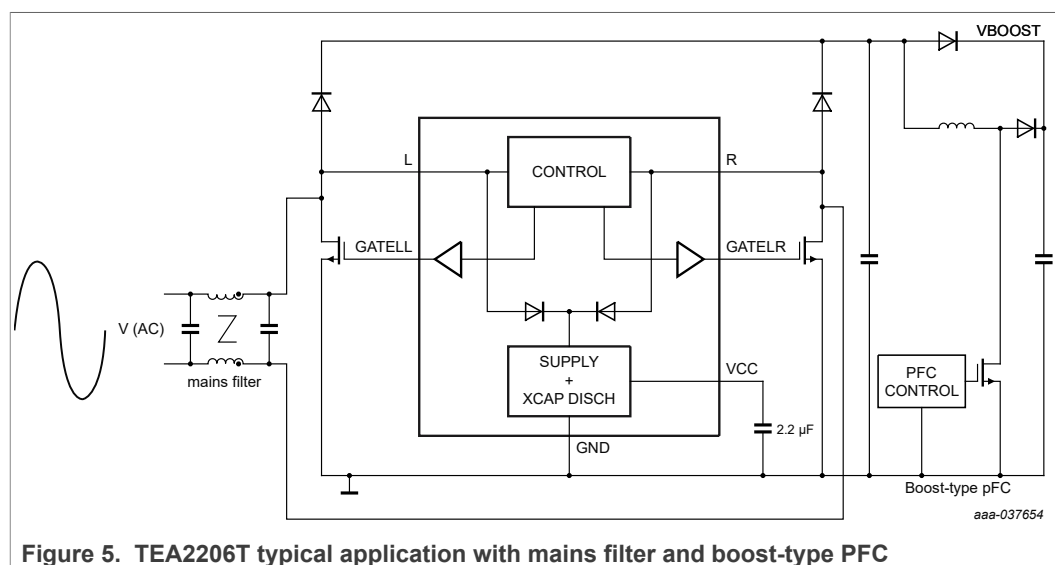


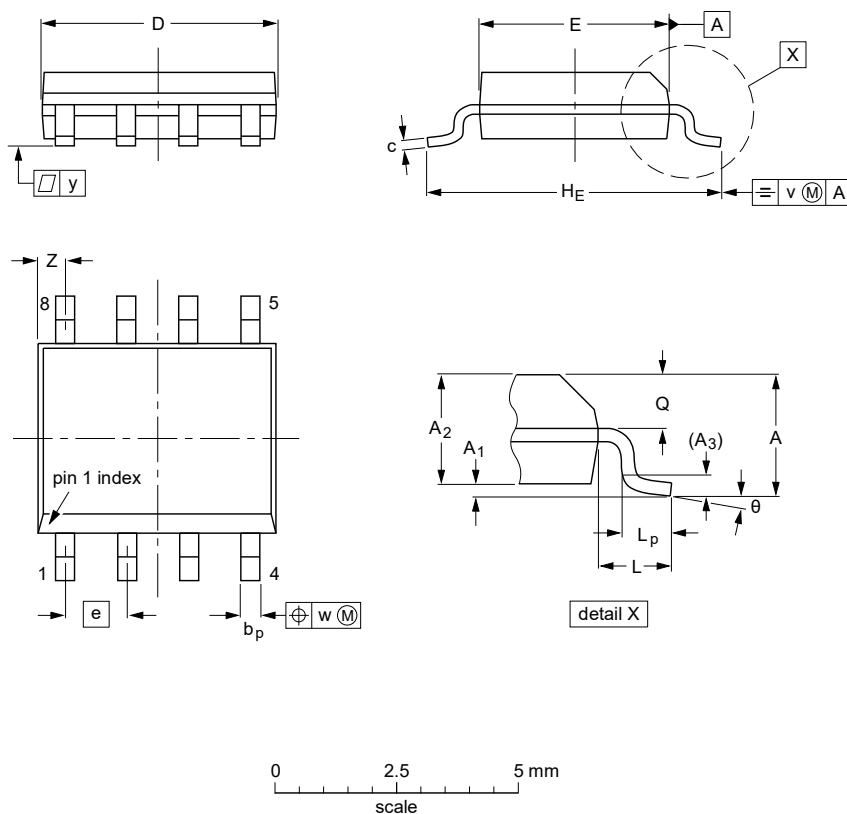
Figure 5. TEA2206T typical application with mains filter and boost-type PFC

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.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

15.2 Definitions

Draft — A draft status on a document indicates that 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 in a draft version of a document and shall have no liability for the consequences of use of such information.

Short data sheet — A short data sheet is an extract from a full data sheet with the same product type number(s) and title. A short data sheet is intended for quick reference only and should not be relied upon to contain detailed and full information. For detailed and full information see the relevant full data sheet, which is available on request via the local NXP Semiconductors sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

Product specification — The information and data provided in a Product data sheet shall define the specification of the product as agreed between NXP Semiconductors and its customer, unless NXP Semiconductors and customer have explicitly agreed otherwise in writing. In no event however, shall an agreement be valid in which the NXP Semiconductors product is deemed to offer functions and qualities beyond those described in the Product data sheet.

15.3 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.

Limiting values — Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and (proper) operation of the device at these or any other conditions above those given in the Recommended operating conditions section (if present) or the Characteristics sections of this document is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

Terms and conditions of commercial sale — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at <http://www.nxp.com/profile/terms>, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

No offer to sell or license — Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

Quick reference data — The Quick reference data is an extract of the product data given in the Limiting values and Characteristics sections of this document, and as such is not complete, exhaustive or legally binding.

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.

Non-automotive qualified products — Unless this data sheet expressly states that this specific NXP Semiconductors product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. NXP Semiconductors accepts no liability for inclusion and/or use of non-automotive qualified products in automotive equipment or applications. In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without NXP Semiconductors' warranty of the product for such automotive applications, use and specifications, and (b) whenever customer uses the product for automotive applications beyond NXP Semiconductors' specifications such use shall be solely at customer's own risk, and (c) customer fully indemnifies NXP Semiconductors for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond NXP Semiconductors' standard warranty and NXP Semiconductors' product specifications.

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.

Security — Customer understands that all NXP products may be subject to unidentified or documented vulnerabilities. Customer is responsible for the design and operation of its applications and products throughout their lifecycles to reduce the effect of these vulnerabilities on customer's applications and products. Customer's responsibility also extends to other open and/or proprietary technologies supported by NXP products for use in customer's applications. NXP accepts no liability for any vulnerability. Customer should regularly check security updates from NXP and follow up appropriately. Customer shall select products with security features that best meet rules, regulations, and standards of the intended application and make the ultimate design decisions regarding its products and is solely responsible for compliance with all legal, regulatory, and security related requirements concerning its products, regardless of any information or support that may be provided by NXP. NXP has a Product Security Incident Response Team (PSIRT) (reachable at PSIRT@nxp.com) that manages the investigation, reporting, and solution release to security vulnerabilities of NXP products.

15.4 Trademarks

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

GreenChip — is a trademark of NXP B.V.

NXP — wordmark and logo are trademarks of NXP B.V.

Contents

1	General description	1
2	Features and benefits	1
2.1	Efficiency features	1
2.2	Application features	1
2.3	Control features	1
3	Applications	1
4	Ordering information	2
5	Marking	2
6	Block diagram	2
7	Pinning information	3
7.1	Pinning	3
7.2	Pin description	3
8	Functional description	4
8.1	Introduction	4
8.2	Operation	4
8.3	Protections	6
8.3.1	Gate pull-down	6
8.3.2	Power MOSFET drain-source protection	6
8.3.3	Minimum mains voltage	6
9	Limiting values	7
10	Thermal characteristics	7
11	Characteristics	8
12	Application information	9
13	Package outline	10
14	Revision history	11
15	Legal information	12

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

© NXP B.V. 2021.

All rights reserved.

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

For sales office addresses, please send an email to: salesaddresses@nxp.com

Date of release: 14 April 2021
Document identifier: TEA2206T