TEA2093TS

GreenChip 同步整流控制器

第 1 版——2022 年 6 月 7 日 产品数据手册

1 简介

TEA2093TS 是针对开关电源的新一代同步整流器(SR)控制器 IC 系列中的一员。它包含自适应栅极驱动器，以便在任意负载下达到最高效率。

TEA2093TS 是一款专门用于非对称半桥反激式和标准反激式转换器次级侧同步整流的控制器 IC。它内置用于驱动 SR MOSFET 的检测级和驱动器级，对次级变压器绕组的输出进行整流。

TEA2093TS 可以为具有低输出电压的电池充电应用或具有高侧整流的应用生成自己的供电电压。

TEA2093TS 采用绝缘硅片(SOI)工艺制成。

2 特性和优势

2.1 能效特性

- 自适应栅极驱动器，在任意负载下达到最高效率
- 空载运行时的典型电源电流低于 200 μA

2.2 应用特性

- 在低至 0 V 的宽输出电压范围内工作
- 能够处理高达 120 V 输入电压的漏检测引脚
- 对低输出电压工作自供电
- 对不使用辅助绕组的高侧整流自供电
- 使用标准和逻辑电平 SR MOSFET
- 支持 USB BC、USB PD 和快充应用
- TSOP6 封装

2.3 控制特性

- 自适应栅极驱动器，实现导通终止时的快速关闭
- 带有源栅极下拉的欠压锁定(UVLO)

3 应用

TEA2093TS 适用于反激式电源。在此类应用中，它可以驱动外部同步整流器 MOSFET，这些 MOSFET 取代用于对变压器次级绕组上的电压进行整流的二极管。

它可用于所有需要高效率的电源，如：

- 充电器
- 电源适配器
- 非对称半桥反激式电源
- 具有极低和/或可变输出电压的反激式电源

4 订购信息

表 1.订购信息

型号	封装		
	名称	说明	版本
TEA2093TS/1	TSOP6	塑料小型封装；6 引脚	SOT457

5 标示

表 2.标记代码

型号	标记代码
TEA2093TS/1	TEA2093

6 功能框图

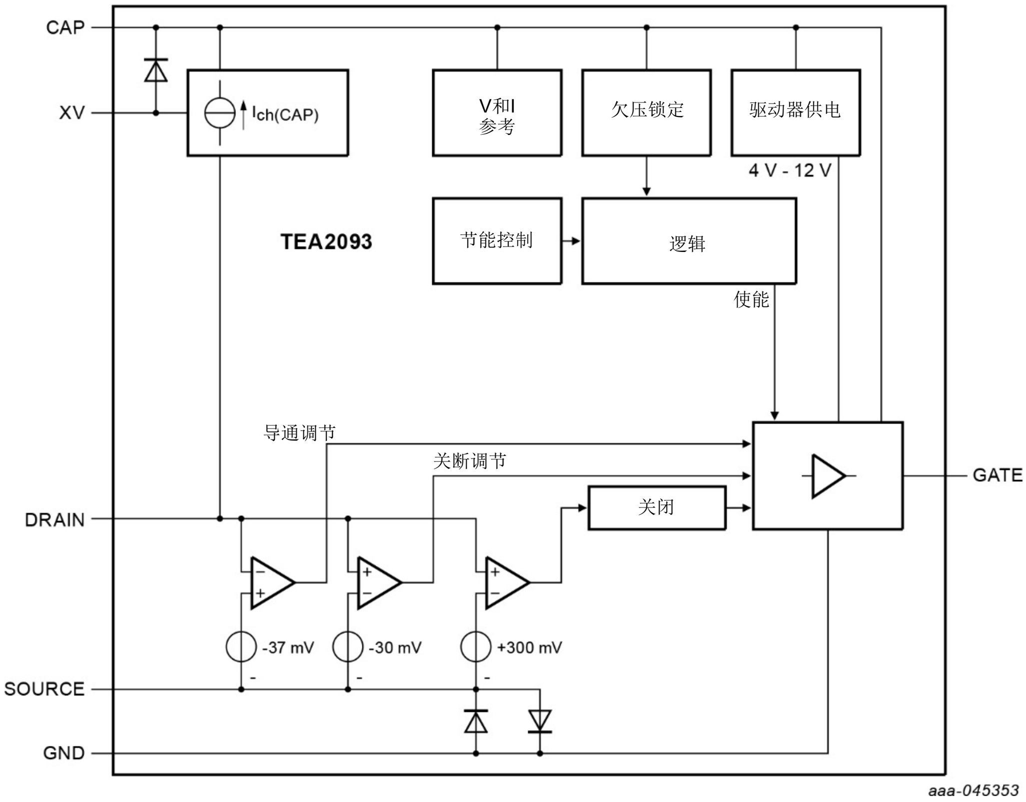


图 1. **TEA2093TS** 功能框图

7 引脚分布信息

7.1 引脚分布

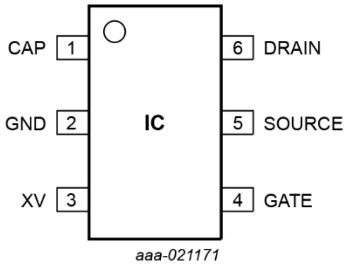


图 **2.TEA2093TS** 引脚分布**(SOT457)**

7.2 引脚说明

表 **3.**引脚说明

符号	引脚	说明
CAP	1	内部供电电压的电容输入
GND	2	接地
XV	3	外部电源输入
GATE	4	SR MOSFET 的栅极驱动器输出
SOURCE	5	SR MOSFET 的源极检测输入
DRAIN	6	SR MOSFET 的漏极检测输入

8 功能说明

8.1 简介

TEA2093TS 是一款用于非对称半桥反激式和标准反激式应用中的同步整流(SR)的控制器 IC。它可以驱动外部同步整流器 MOSFET，用于对变压器次级绕组上的电压进行整流。图 3 显示了典型的应用。

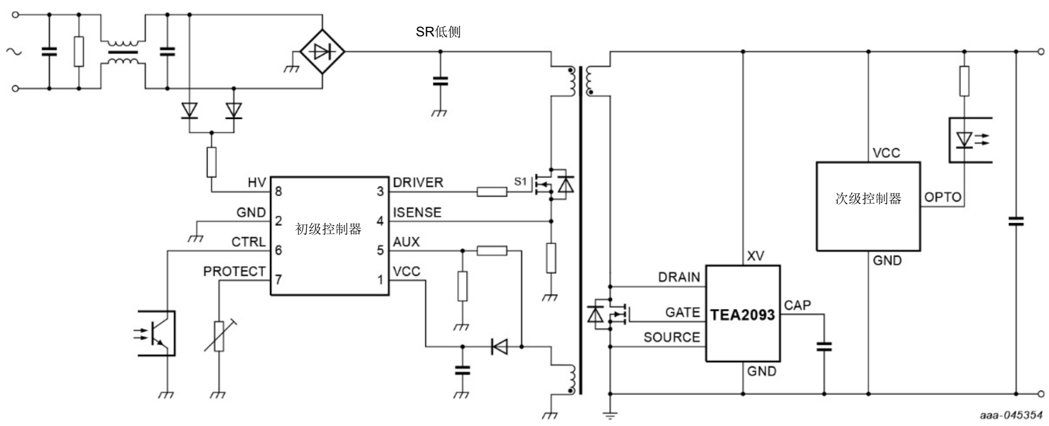


图 3.带低侧整流的 TEA2093TS 配置

8.2 启动与欠压锁定（UVLO；CAP 和 XV 引脚）

CAP 引脚上的电容为 TEA2093TS 供电。当 XV 电压 < 4.7 V 时，它通过 DRAIN 引脚充电。充电电流($I_{ch(CAP)}$)将电容充电至 4 V。当达到该电压时，它停止充电。如果外部电压超过 4.7 V，XV 引脚通过集成二极管增加电容电压。电容电压的增加提供了更高的栅极驱动器电压($V_{G(max)}$)。

当 CAP 引脚上的电压超过 $V_{start(CAP)}$（典型值为 3.7 V）时，IC 离开欠压锁定状态并激活同步整流器电路。当电压降至 3.6 V（典型值）以下时，将重新进入欠压锁定状态并主动使 SR MOSFET 栅极驱动器输出保持于低电平。

8.3 漏极检测（DRAIN 引脚）

漏极检测引脚是一个输入引脚，能够处理高达 120 V 的输入电压。在漏极检测电压为正时，栅极驱动器处于关闭模式，栅极驱动器下拉（引脚 GATE）。在漏极检测电压为负时，IC 通过检测漏源差分电压来启用同步整流(SR)。

8.4 同步整流（DRAIN 和 SOURCE 引脚）

IC 检测漏极检测（DRAIN 引脚）和源极检测（SOURCE 引脚）连接之间的压差。这个 SR MOSFET 的漏源差分电压用于驱动 SR MOSFET 的栅极。

在调节阶段，IC 将漏极检测和源极检测输入之间的差值调节到绝对水平 37 mV。当绝对差超过 37 mV($V_{reg(drv)}$)时，栅极驱动器输出会增加外部 SR MOSFET 的栅极电压，直到达到 37 mV 电压。SR MOSFET 在低电流时不会关闭。

当绝对差 < 30 mV 时，栅极驱动器输出会降低外部 SR MOSFET 的栅极电压。SR MOSFET 栅极上的电压波形跟随通过 SR MOSFET 的电流波形。当通过 SR MOSFET 的电流达到零时，SR MOSFET 会迅速关断。

在 SR MOSFET 关断后，漏极电压增加。当漏极电压超过 300 mV 时，7 Ω 的低欧姆栅极下拉保持 SR MOSFET 的栅极关断。

8.5 栅极驱动器（GATE 引脚）

栅极驱动器电路在电流的上升部分期间为外部 SR MOSFET 的栅极充电。在电流下降部分期间，驱动器电路将栅极放电。栅极驱动器的灌电流能力通常为 0.50 A，抽电流能力通常为 0.65 A，允许快速开启和关闭外部 SR MOSFET。

驱动器的最大输出电压限制为 12 V。这个高输出电压将所有 MOSFET 品牌驱动到最小导通电阻。在为 IC 提供 5 V 电源的应用中，驱动器的最大输出电压限制为 4.2 V，并且可以使用逻辑电平 SR MOSFET（参见图 3）。

该 IC 在高侧整流应用或输出电压低于 4.7 V 的电池充电应用中自供电。当 XV 引脚接地以驱动标准 SR MOSFET 时，驱动器调节至 9 V。当 XV 引脚连接到用于驱动逻辑电平 SR MOSFET 的转换器输出，如果输出电压低于 4.7 V，则驱动器调节至 4 V。

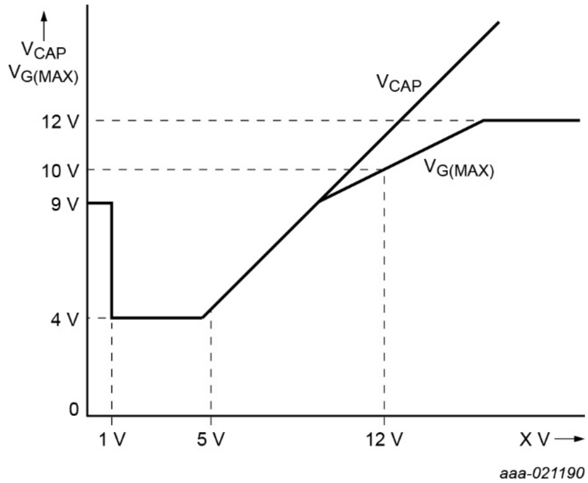


图 4.最大栅极电压 $V_{g(max)}$

启动条件($V_{CAP} < V_{start(CAP)}$)和欠压锁定期间，驱动器输出电压被主动拉低。

8.6 源极检测（SOURCE 引脚）

IC 另外配有源极检测引脚(SOURCE)。该引脚用于测量外部 SR MOSFET 的漏源电压。源极检测输入的连接位置必须尽可能靠近外部 SR MOSFET 的 SOURCE 引脚。这样可将由于寄生电感与大 dI/dt 值结合而导致 PCB 走线上电压差所引起的误差降至最低。

9 限值

表 4.限值

依据绝对最大额定值系统(IEC 60134)。所有电压均基于接地（引脚2）测量；正电流流入芯片。只要不违反其他额定值，则电压额定值有效；只要不违反其他额定值，则电流额定值有效。

符号	参数名称	条件	最小值	最大值	单位
电压					
V_{XV}	引脚 XV 上的电压		-0.4	+38	V
$V_{sense(DRAIN)}$	漏极检测电压		-0.8	+120	V
$V_{sense(SOURCE)}$	源极检测电压		-0.4	+0.4	V
电流					
I_{XV}	引脚 XV 上的电流	峰值电流	-	0.5	A
概览					
P_{tot}	总功耗	T_{amb} = 90 °C	-	300	mW
T_{stg}	存储温度		-55	+150	℃
T_j	芯片结温		-40	+150	℃
静电放电(ESD)					
V_{ESD}	静电放电电压	Class 2			
		人体模型 [1]	-	2000	V
		充电设备模型	-	500	V

[1] 相当于 100 pF 电容通过 1.5 kΩ 串联电阻放电。

10 热特性

表 5. 热特性

符号	参数名称	条件	典型值	单位
$R_{th(j-a)}$	从结点到环境的热阻值	JEDEC 测试板	200	K/W
$R_{th(j-c)}$	从结点到机壳的热阻值	JEDEC 测试板	115	K/W

11 特性

表 6.特性

−25 ℃ < T_j < +125 ℃；V_{xv} = 12 V；C_{CAP} = 1 μF；C_{GATE} = 10 nF（GATE 和 GND 引脚之间的电容）；所有电压均基于接地（引脚 2）测量；流入 IC 的电流为正电流；除非另做说明。限值在 25 ℃下进行生产测试。温度工作范围内的统计特性可确保这些限值。

符号	参数名称	条件	最小值	典型值	最大值	单位
供电电压管理（**XV** 和 **CAP** 引脚）						
$V_{start(CAP)}$	引脚 CAP 上的启动电压	V_{XV} = 0 V	3.55	3.70	3.90	V
$V_{stop(CAP)}$	引脚 CAP 上的停止电压	V_{XV} = 0 V	3.45	3.60	3.80	V
$I_{ch(CAP)}$	引脚 CAP 上的充电电流	V_{XV} = 0 V；V_{CAP} = 7 V； V_{DRAIN} = 12 V；T_j = 25 ℃	-95	-70	-50	mA
		V_{XV} = 2 V；V_{CAP} = 3.65 V； V_{DRAIN} = 12 V；T_j = 25 ℃	-95	-70	-50	mA
$V_{I(CAP)}$	引脚 CAP 上的输入电压	V_{XV} = 0 V；V_{DRAIN} = 12 V	8.70	9.20	9.60	V
		V_{XV} = 2 V；V_{DRAIN} = 12 V	3.80	4.00	4.15	V
		V_{XV} = 5 V	4.15	4.30	4.75	V
		V_{XV} = 12 V	11.0	11.3	11.7	V
$I_{I(XV)}$	引脚 XV 上的输入电流	节能模式； V_{XV} = 5 V	90	160	300	μA
		正常工作； 无栅极充电；V_{XV} = 5 V； T_j = 25 ℃	1.35	1.60	1.85	mA
同步整流检测输入（**DRAIN** 和 **SOURCE** 引脚）						
$V_{reg(drv)}$	栅极驱动调节电压	V_{SOURCE} = 0 V；T_j = 25 ℃	-40	-37	-35	mV
V_{swoff}	关断电压	V_{SOURCE} = 0 V；T_j = 25 ℃	200	300	400	mV
$t_{d(act)(drv)}$	驱动激活延迟时间	V_{SOURCE} = 0 V； 正常工作； 从达到 V_{DRAIN}（2 V 至−0.5 V）上升到 V_{GATE}（10 %最终值时）的时间	-	65	-	ns
$t_{d(deact)(drv)}$	驱动关闭延迟时间	V_{SOURCE} = 0 V； 正常工作； 从达到 V_{DRAIN}（−0.5 V 至 2 V）降低到 V_{GATE}（10 %开始值时）的时间	-	40	-	ns

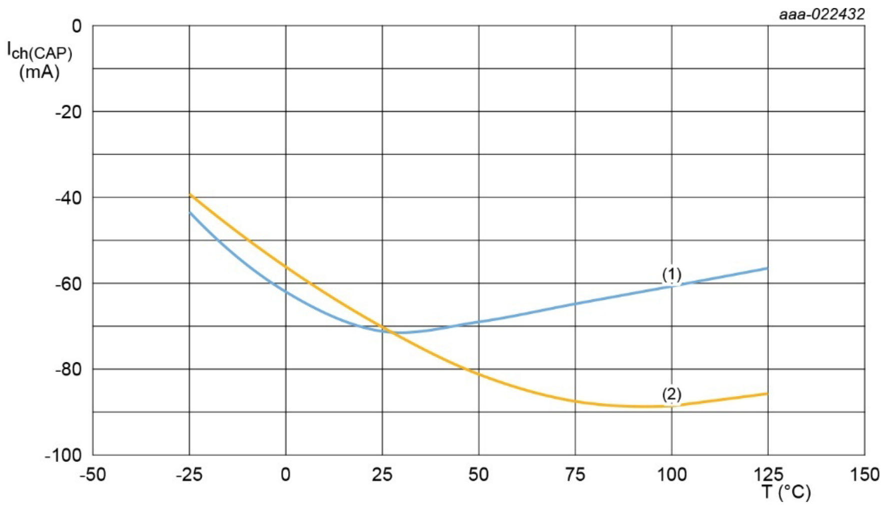
表 6.特性……*续*

−25 ℃ < T_j < +125 ℃；V_{xv} = 12 V；C_{CAP} = 1 μF；C_{GATE} = 10 nF（GATE 和 GND 引脚之间的电容）；所有电压均基于接地（引脚 2）测量；流入 IC 的电流为正电流；除非另做说明。限值在 25 ℃下进行生产测试。温度工作范围内的统计特性可确保这些限值。

符号	参数名称	条件	最小值	典型值	最大值	单位
栅极驱动器（GATE 引脚）						
I_{source}	灌电流	峰值电流				
		V_{XV} = 5 V；V_{ds} = −0.5 V；V_g = 0 V	-	-0.13	-	A
		V_{XV} = 12 V；V_{ds} = −0.5 V；V_g = 0 V	-	-0.50	-	A
I_{sink}	抽电流	调节电流				
		V_{XV} = 5 V；V_{ds} = 0 V；V_g = 4 V	-	150	-	mA
		V_{XV} = 12 V；V_{ds} = 0 V；V_g = 10 V	-	210	-	mA
		峰值电流				
		V_{XV} = 5 V；V_{ds} = 4 V；V_g = 4 V	-	0.35	-	A
		V_{XV} = 12 V；V_{ds} = 4 V；V_g = 4 V	-	0.65	-	A
$R_{pd(G)}$	栅极下拉阻抗	V_{DRAIN} = 4 V；I_{GATE} = 30 mA；V_{XV} = 12 V；T_j = 25 ℃	6.00	6.80	7.60	Ω
$V_{G(max)}$	最大栅极电压	V_{XV} = 0 V	7.80	8.90	9.60	V
		V_{XV} = 2 V	3.75	3.95	4.15	V
		V_{XV} = 5 V	4.00	4.20	4.40	V
		V_{XV} = V_{CAP} = 5 V	4.90	4.95	5.00	V
		V_{XV} = 12 V	9.40	9.80	10.70	V
		V_{XV} = 18 V 至 38 V	11.80	12.30	12.70	V

11.1 温度曲线

11.1.1 充电电流（CAP 引脚）

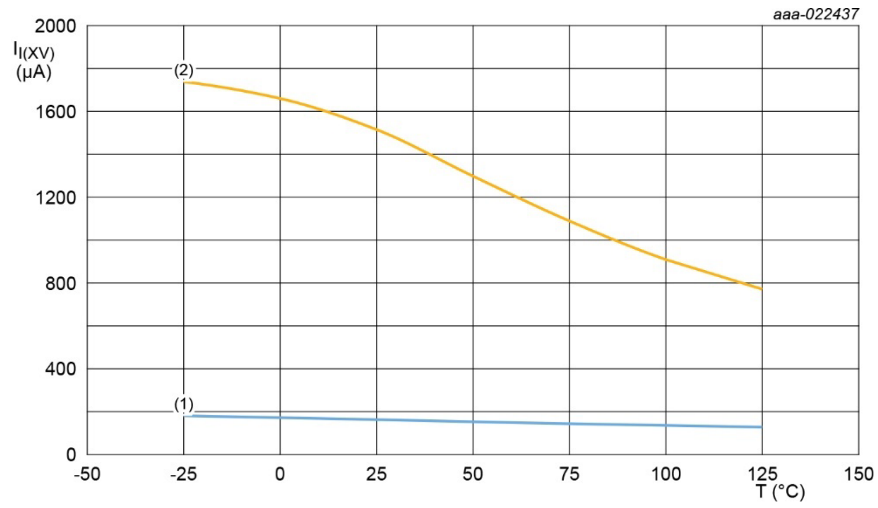


(1) V_{CAP} = 7 V 时的 $I_{ch(CAP)}$； V_{XV} = 0 V

(2) V_{CAP} = 3.65 V 时的 $I_{ch(CAP)}$； V_{XV} = 2 V

图 5.$I_{ch(CAP)}$与温度变化关系图

11.1.2 工作电流（XV 引脚）



(1) $I_{I(XV)}$ - 节能模式

(2) $I_{I(XV)}$ - 正常工作

图 6.$I_{I(XV)}$与温度变化关系图

11.1.3 驱动器调节电压

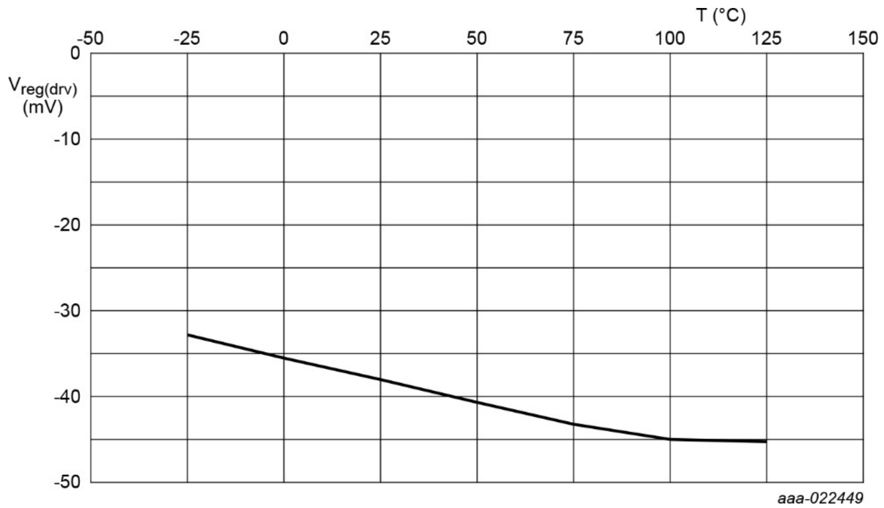


图 7.$V_{reg(drv)}$与温度变化关系图

11.1.4 栅极下拉阻抗

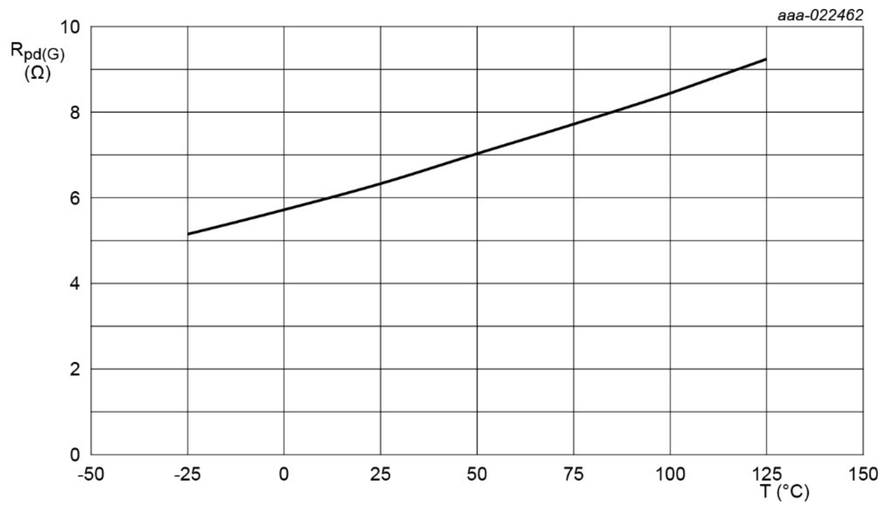


图 8.$R_{pd(G)}$与温度变化关系图

11.1.5 关断电压

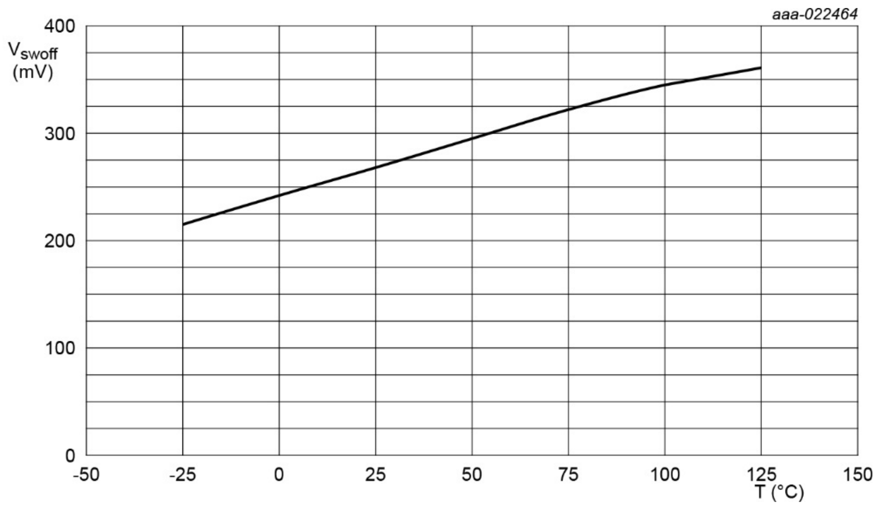


图 9. V_{swoff} 与温度变化关系图

12 应用信息

带 TEA2093TS 的反激式开关电源包含带初级开关的初级侧控制器、变压器和输出级。为了获得低传导损耗整流，在输出级使用了 SR MOSFET。SR MOSFET 可以放置在低侧（参见图 3），也可以放置在高侧（参见图 10）。在高侧应用中，TEA2093TS 自供电。CAP 引脚上的电容为 TEA2093TS 供电。当漏极电压为正时，它通过 DRAIN 引脚充电。

同步整流器开关的栅极驱动器电压由相应的漏极检测引脚和源极检测引脚之间的电压差得出。

需要特别注意漏极检测和源极检测引脚连接。这些引脚上测得的电压用于栅极驱动器电压。错误的测量结果会导致栅极驱动器效率降低，因为这时栅极电压要么太低要么太高。到这些引脚的连接不得干扰电源线。

电源线传导高值 dI/dt 的电流。结果很可能因寄生电感产生的感生电压导致测量误差。独立的源极检测引脚可以直接检测外部 MOSFET 的源电压。因此，不需要载流电源接地线路。

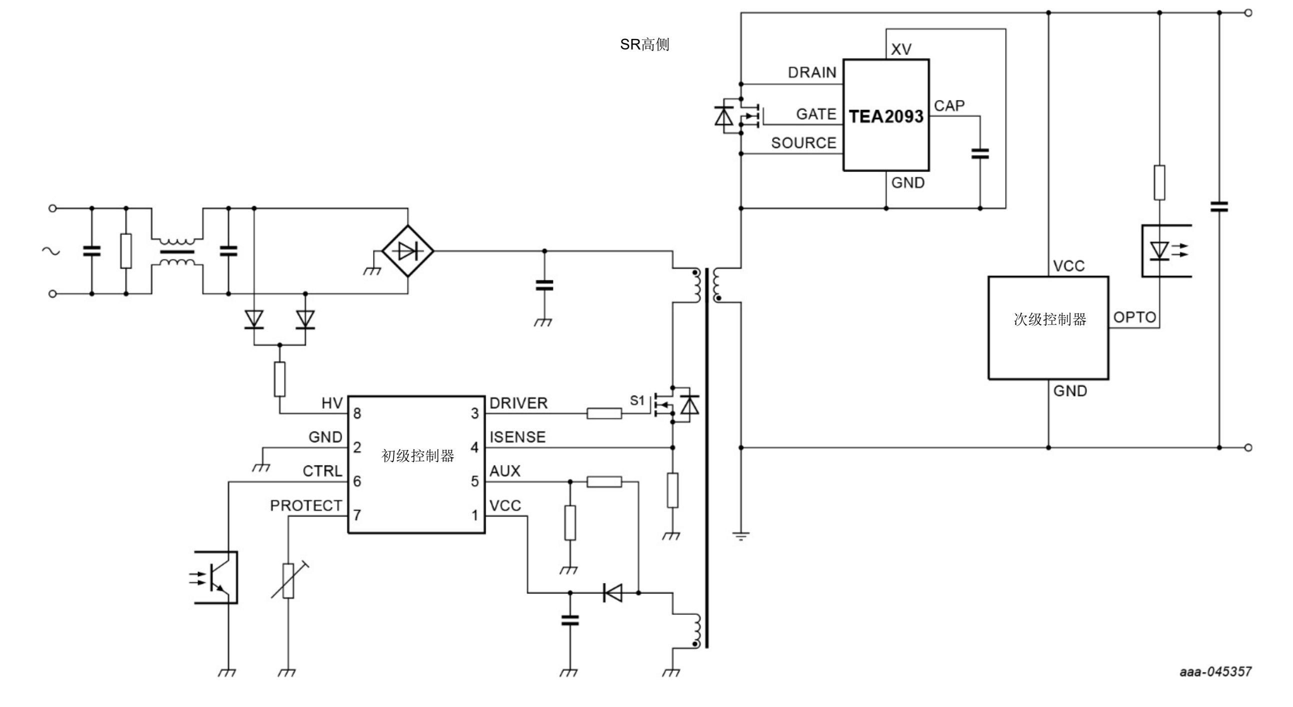
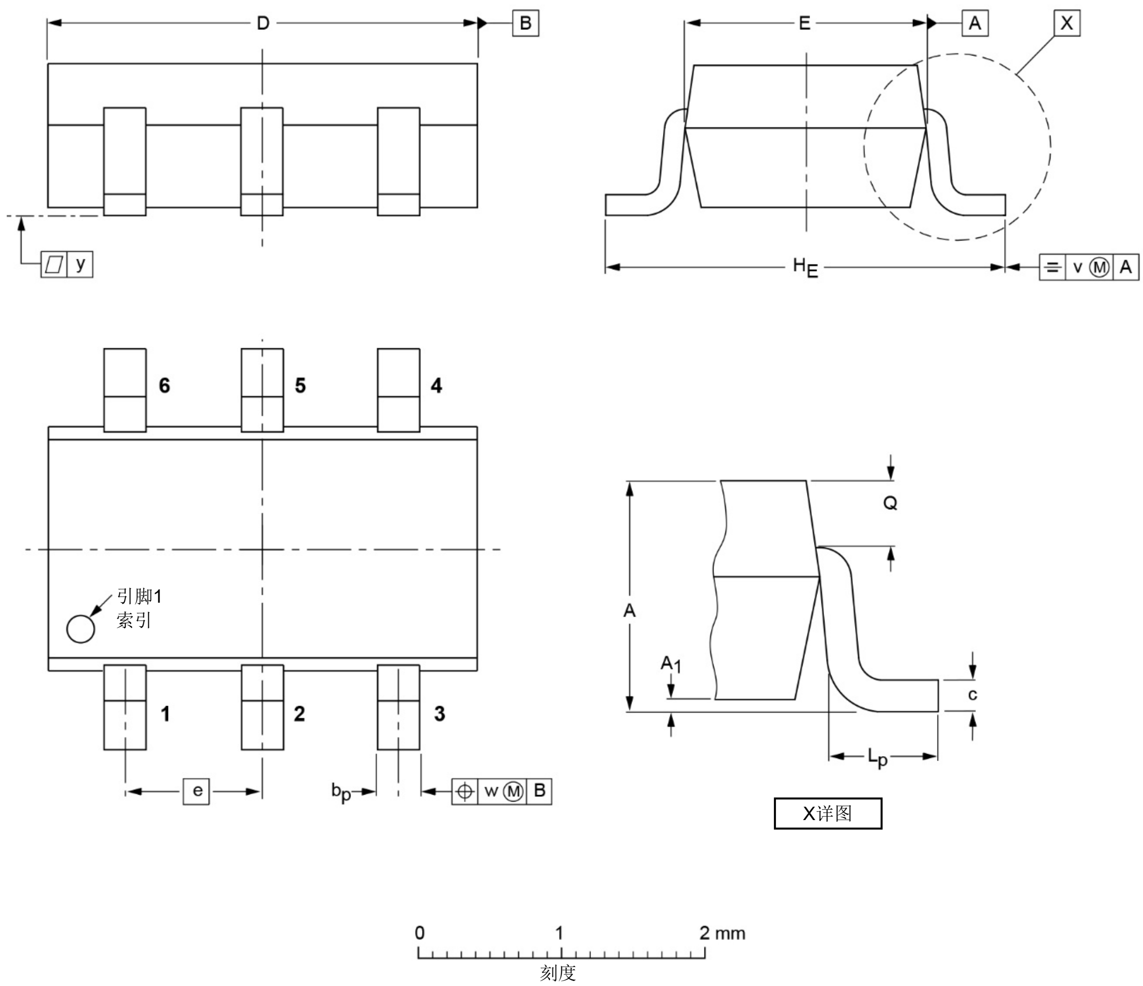


图 10.带高侧整流的 TEA2093TS 配置

13 封装尺寸

表 7.

塑料表面贴装封装(TSOP6)；6 引脚 **SOT457**



尺寸（mm是原始尺寸）

单位	A	A_1	b_p	c	D	E	e	H_E	L_p	Q	v	w	y
mm	1.1 0.9	0.1 0.013	0.40 0.25	0.26 0.10	3.1 2.7	1.7 1.3	0.95	3.0 2.5	0.6 0.2	0.33 0.23	0.2	0.2	0.1

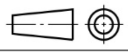
尺寸版本	参考文献				第一角投影	发行日期
	IEC	JEDEC	JEITA			
SOT457			SC-74			~~05-11-07~~ 06-03-16

图 11.封装尺寸：SOT457(TSOP6)

14 修订记录

表 8.修订记录

文档 ID	发布日期	数据手册状态	更改说明	取代版本
TEA2093TS v.1	20220607	产品数据手册	-	-

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.

Suitability for use in 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, including the legal information in that 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 vulnerabilities or may support established security standards or specifications with known limitations. 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.

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

GreenChip — is a trademark of NXP B.V.

目录

发布日期：2022年6月7日
文档编号：TEA2093TS