

AN10781

GreenChip SR TEA1791T integrated synchronous rectification controller

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Application note

Document information

Info	Content
Keywords	GreenChip SR, TEA1791T, Synchronous rectification, High efficiency, Flyback.
Abstract	<p>The TEA1791T is a member of the new generation of synchronous rectifier controller ICs for switched mode power supplies. Its high level of integration allows the design of a cost effective power supply with a very low number of external components.</p> <p>The TEA1791T is a controller IC dedicated for synchronous rectification on the secondary side of Discontinuous Conduction Mode (DCM) and quasi resonant flyback converters.</p> <p>The TEA1791T is fabricated in a Silicon On Insulator (SOI) process. This NXP SOI process makes a wide voltage range possible.</p>

Revision history

Rev	Date	Description
01	20090209	First release

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1. Introduction

The TEA1791T is the controller for synchronous rectification to be used in quasi resonant and discontinuous conduction mode flyback converters.

2. Application schematic TEA1791T

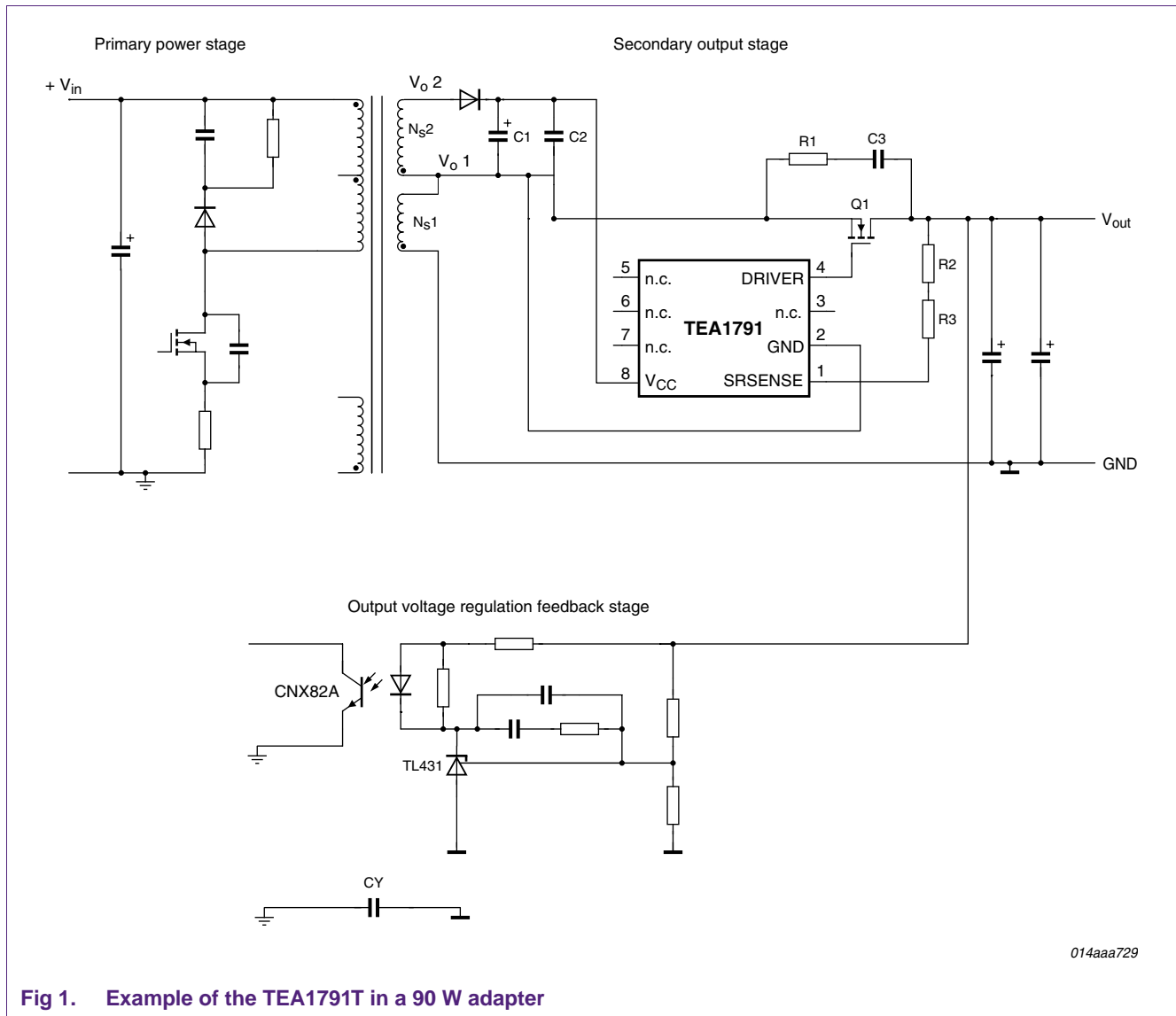


Fig 1. Example of the TEA1791T in a 90 W adapter

For the relevant component values see [Table 1 "Bill of materials"](#) in [Section 5.2](#).

3. Functional description and application

3.1 SR control

The TEA1791T uses the SRSENSE pin as an input sense in the control of the drain-source voltage (V_{DS}) of the MOSFETs. No adjustment is necessary in the SR-control.

The SR MOSFET is switched on when the drain voltage sensed by pin SRSENSE is under -310 mV. When the sensed voltage has reached -55 mV, i.e. $I_D \times R_{DSon}$, the driver output will reduce the gate voltage to set the feedback level that regulates the -55 mV level.

When, at very low drain current, the voltage at the SRSENSE pin rises above -12 mV (typ), the SR MOSFET is switched off.

If the secondary stroke duration of the flyback converter is less than $2 \mu\text{s}$ (typ), the driver output is disabled. This will guarantee stable operation at very low duty cycles. The driver output is enabled when the secondary stroke time is greater than $2.2 \mu\text{s}$ (typ).

In Standby mode synchronous rectification remains active as long as the secondary stroke is less than $2 \mu\text{s}$ (typ).

For the best performance it is advised that SRSENSE senses the drain of the MOSFET Q1 directly via the external series resistors. See [Section 5.1](#).

It is not necessary to insert a MOSFET gate series resistor. However, if, because of switching noise reduction, a gate series resistor is required, the switch-off state of the SR MOSFET must be checked. Recheck at a high temperature of the MOSFET as well. When the power MOSFET on the primary side switches on, the drain-source voltage of the SR MOSFET rises with a high dV/dt . If dV/dt is steep, a capacitive current will flow from drain to gate through the capacitor C_{dg} of the MOSFET. This current together with a gate resistor lifts the gate voltage (V_{GS}). But the voltage rise should remain well below the threshold voltage (V_{th}) of the SR MOSFET to prevent switch-on. Therefore the gate series resistor value is limited and 10Ω is an indicative value.

3.2 Function of resistors in series with pin SRSENSE

All pins of TEA1791T are protected against ElectroStatic Discharge (ESD) to prevent IC damage when handled. While operating in the application, ESD protection could possibly be triggered by an ESD event taking place under testing for instance.

If the ESD protection on the SRSENSE pin is triggered, the pin will be pulled to ground by the internal ESD protection component. As SRSENSE senses the drain voltage of the MOSFET, this pin should be protected by a series resistor that limits a possible surge current initiated by a severe ESD event. Therefore the current limiting resistors R2 and R3 are applied. See [Figure 1](#). A total resistance value of $1 \text{ k}\Omega$ is sufficient to protect pin SRSENSE. Two SMD 1206 (see [Section 5.2](#)) resistors in series are used to obey the peak-power rating.

3.3 V_{CC}

$V_{start-up}$ is 8.5 V typical and the V_{CC} stop voltage is 8.0 V (typ). If necessary, a capacitor C2 can be placed between pin V_{CC} and pin GND to smooth the supply voltage.

3.4 V_{CC} auxiliary supply

The IC is supplied by an auxiliary secondary winding which is stacked on the main power output winding. The IC supply voltage should be greater than 12 V to get full driver output capability. A supply of circa 15 V can be targeted and is set by the turns ratio between the power output windings and the AUX windings.

$$V_{CC} = \frac{N_{s2}}{N_{s1}} \cdot V_{out} - 0.7 \text{ V}$$

The average IC supply current depends on the dynamic gate charge transfer characteristic of the applied MOSFET. The gate charge cycle will be under the conditions of a 10 V gate drive amplitude and a V_{DS} of less than 1 V. In the application example the MOSFET PSMN015-100P is used. Its total gate charge over 10 V is 75 nC. So at a switching frequency of 100 kHz, the supply current used for driving is 7.5 mA; $75 \text{ nC} \times 100 \text{ kHz}$. The IC itself uses only 0.95 mA.

3.5 Driver output

Between 0 V and the UnderVoltage LockOut (UVLO), an active current sink circuit keeps the external MOSFET in the off state.

4. Meeting EMC requirements

By this circuit outline in which the synchronous rectifier MOSFET is placed in the positive output voltage path, the ElectroMagnetic Compatibility (EMC) requirements can be met by using a single y-capacitor between the grounds of the primary and secondary buffer capacitors.

5. Appendix

5.1 Layout considerations

The IC ground copper track should be as wide and as low ohmic as possible. The IC ground is used as reference by the internal circuits, but it also shares the high driver output current pulses.

The IC ground is used in the control of the SR MOSFET. Direct the IC ground track close to the MOSFET source and position the IC near the MOSFET.

The SRSENSE pin should be directly connected to the drain pin of the SR MOSFET via the series resistors. Make the sense track a separate one. This is good practice in proper sensing and regulating the MOSFET drain-source voltage.

5.2 Bill of materials

Table 1. Bill of materials

Relevant component values for a 19.5 V / 4.62 A application with the TEA1791T.

Description	Position
Resistor SMD 0805: Thin Film Chip, 47 Ω , 5 %	R1
Resistor SMD 1206: Thin Film Chip, 560 Ω , 5 %	R2, R3
MLCC SMD 0805: 10 mF / 50 V, Y5V	C1
MLCC SMD 0805: 0.1 μ F / 50 V, X7R	C2
MLCC SMD 0805: 220 pF / 100 V, X7R	C3
Switching diode, SMD SOD-80: 0.2 A / 100 V, LL4148	D1
MOSFET, TO-220: 75 A / 100 V, 0.015/220p-typ, PSMN015-100P/NXP	Q1

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