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# TEA1762T

## GreenChip synchronous rectifier controller

Rev. 02 — 25 April 2007

Product data sheet

## 1. General description

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The TEA1762T is a member of the new generation of Synchronous Rectifier (SR) 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.

The TEA1762T is a controller IC dedicated for synchronous rectification on the secondary side of discontinuous conduction mode and quasi resonant flyback converters. Besides electronics for synchronous rectification, it also has integrated circuitry for output voltage and output current regulation.

The TEA1762T is fabricated in a Silicon On Insulator (SOI) process. This NXP SOI process makes possible a wide range of operation.

## 2. Features

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### 2.1 Distinctive features

- Combined synchronous rectification and primary feedback control functionality
- Wide supply voltage range (8.6 V to 38 V)
- High level of integration, resulting in a very low external component count
- Wide opto output voltage range (3.5 V to 38 V)
- Accurate internal voltage reference for voltage control (within 1 %)
- Separate sense ground for accurate voltage sensing
- High driver output voltage of 10 V to drive all MOSFET brands to the lowest  $R_{DSon}$
- Reference voltage output pin

### 2.2 Green features

- Low current consumption
- High system efficiency from no load to full load

### 2.3 Protection features

- Undervoltage protection
- Internal over-temperature protection
- General purpose protection input pin

### 3. Applications

- The TEA1762T is intended for adapters. The device can also be used in all other discontinuous conduction mode and quasi resonant flyback systems that demand a highly efficient and cost-effective solution.

### 4. Ordering information

Table 1. Ordering information

| Type number | Package |  | Version  |
|-------------|---------|--|----------|
|             | Name    | Description  |          |
| TEA1762T    | SO14    | plastic small outline package; 14 leads; body width 3.9 mm | SOT108-1 |

### 5. Block diagram

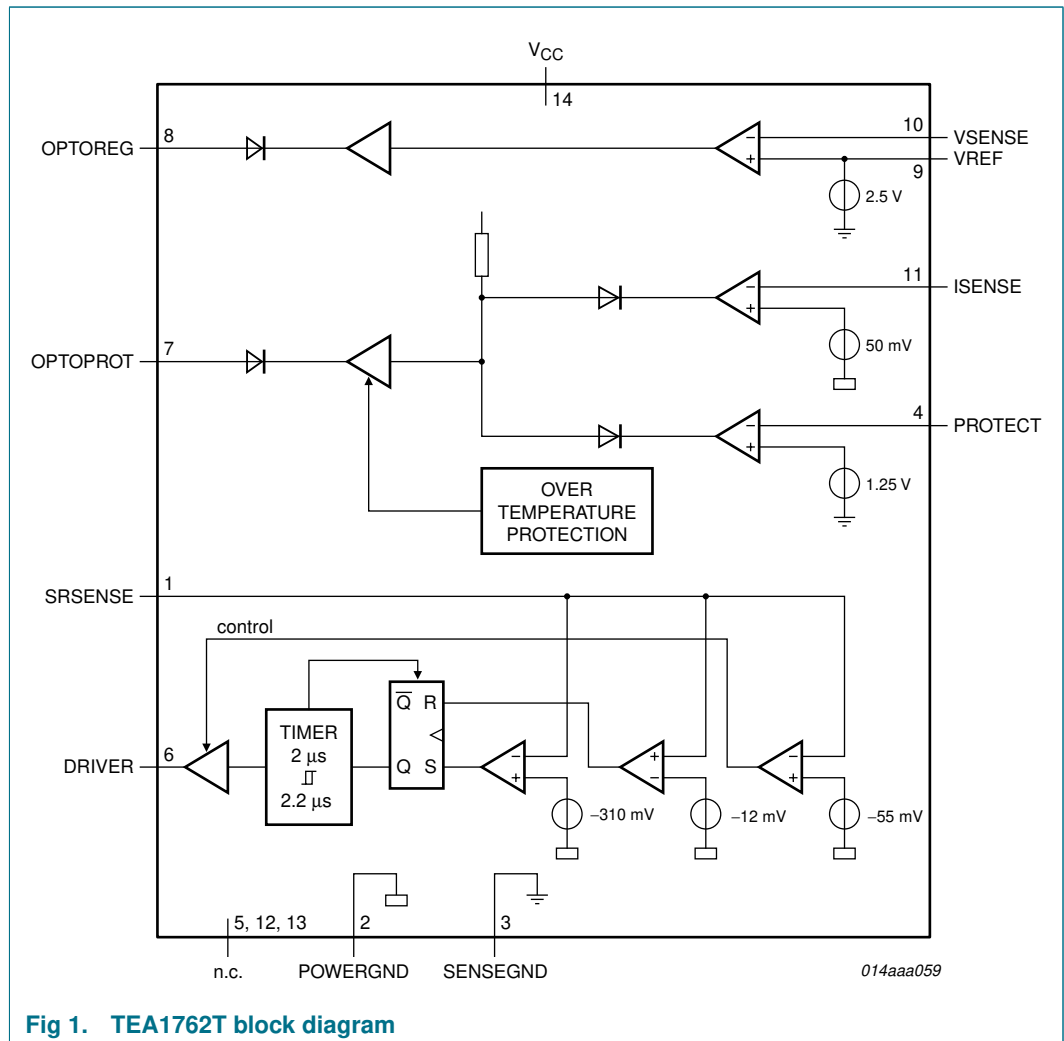


Fig 1. TEA1762T block diagram

## 6. Pinning information

### 6.1 Pinning

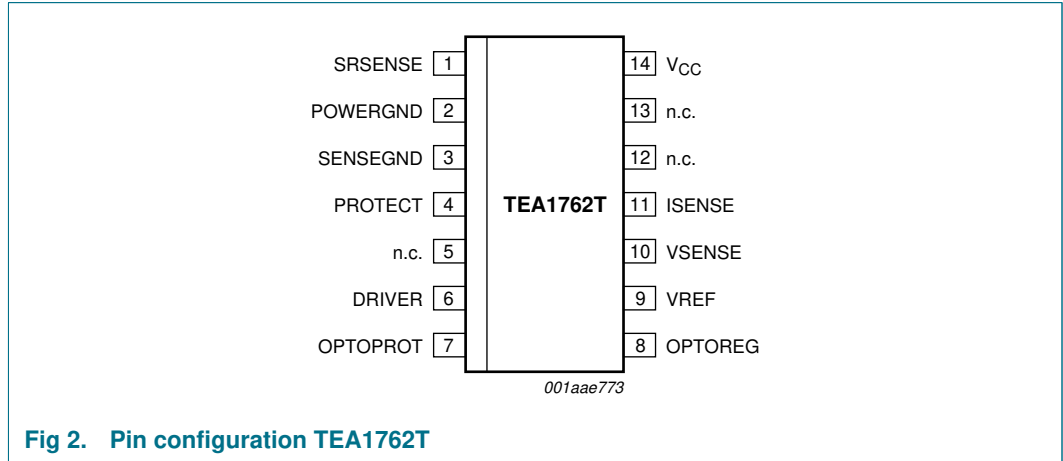


Fig 2. Pin configuration TEA1762T

### 6.2 Pin description

Table 2. Pin description for SO14

| Symbol          | Pin | Description                                       |
|-----------------|-----|---|
| SRSENSE         | 1   | synchronous timing input                          |
| POWERGND        | 2   | power ground                                      |
| SENSEGND        | 3   | sense ground                                      |
| PROTECT         | 4   | general purpose protection input                  |
| n.c.            | 5   | not connected                                     |
| DRIVER          | 6   | driver output for SR MOSFET                       |
| OPTOPROT        | 7   | opto coupler driver output for current protection |
| OPTOREG         | 8   | opto coupler driver output for voltage regulation |
| VREF            | 9   | reference voltage output                          |
| VSENSE          | 10  | sense input for voltage control                   |
| ISENSE          | 11  | sense input for current control                   |
| n.c.            | 12  | not connected                                     |
| n.c.            | 13  | not connected                                     |
| V <sub>CC</sub> | 14  | supply voltage                                    |

## 7. Functional description

The TEA1762T is the controller for synchronous rectification to be used in discontinuous conduction mode and quasi resonant flyback converters. Besides controlling the SR MOSFET, the TEA1762T contains the voltage reference and amplifiers to regulate and control the output voltage and output current of the power supply.

### 7.1 Start-up and undervoltage lock-out

The IC leaves the under-voltage lock-out state and activates the synchronous rectifier circuitry and also the voltage/current sense circuitry as soon as the voltage on the  $V_{CC}$  pin is above 8.6 V (typical). As soon as the voltage drops below 8.1 V (typical), the under-voltage lock-out state is re-entered and the SR driver output is actively kept low and also the opto driver outputs are disabled.

### 7.2 Synchronous rectification

After a negative voltage ( $-310$  mV typical) is sensed on the SRSENSE pin, the driver output voltage is made high and the external MOSFET is switched on. As soon as the SRSENSE voltage rises to  $-55$  mV, the driver output voltage is regulated to maintain the  $-55$  mV on the SRSENSE pin. As soon as the SRSENSE voltage is above  $-12$  mV, the driver output is pulled to ground. After switch-on of the SR MOSFET, the input signal on the SRSENSE pin is blanked for  $2 \mu\text{s}$  (typical). This will eliminate false switch-off due to high frequency ringing at the start of the secondary stroke.

Because the driver output voltage is reduced as soon as the voltage on the SRSENSE pin is  $-55$  mV, the external power switch can be switched off fast when the current through the switch reaches zero. With this zero-current switch off, no separate standby mode is needed to maintain high efficiency during no-load operation. The zero current is detected by sensing a  $-12$  mV level on the SRSENSE pin. See [Figure 3](#).

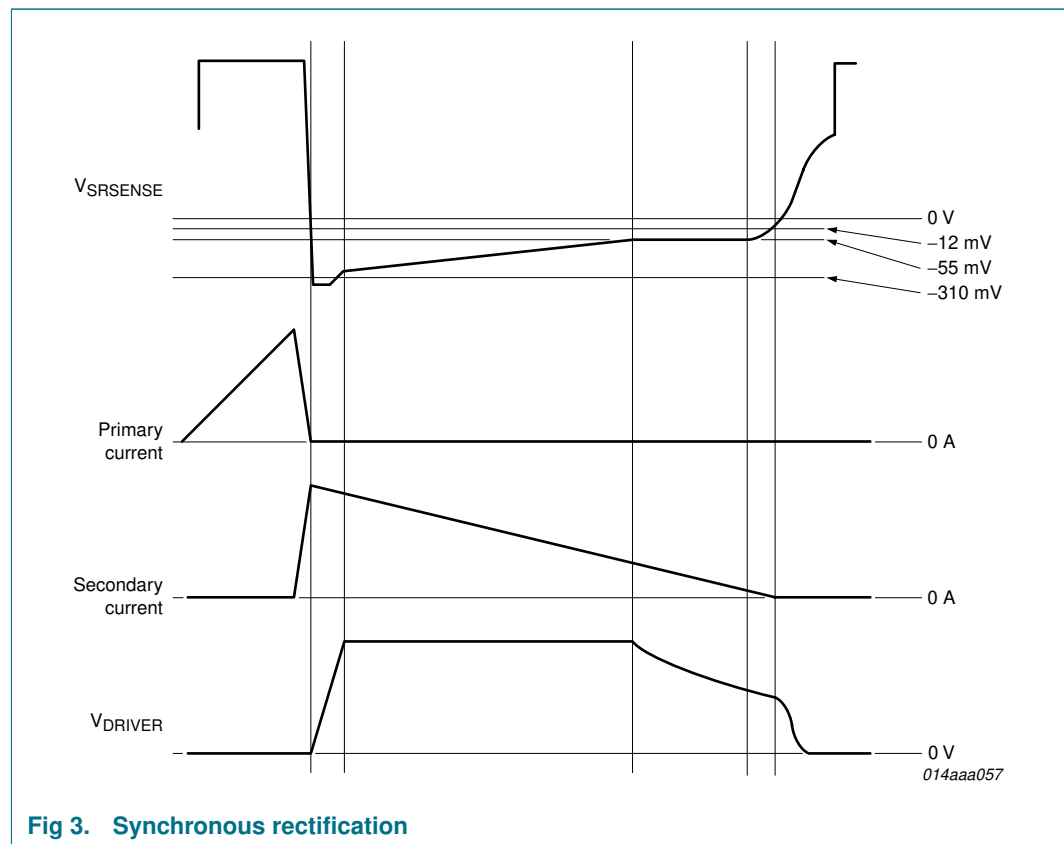


Fig 3. Synchronous rectification

If the secondary stroke of the flyback converter is shorter than  $2 \mu\text{s}$  (typical), the driver output is disabled. This will guarantee stable operation for very low duty cycles. When the secondary stroke increases above  $2.2 \mu\text{s}$  (typical), the driver output is again enabled.

### 7.3 SMPS output voltage and current regulation

The output voltage of the flyback Switched Mode Power Supply (SMPS) can be controlled by sensing the output voltage via the VSENSE pin. The feedback loop via the primary controller can regulate the output voltage of the switched mode power supply by regulating the voltage on the VSENSE pin to 2.5 V above the voltage on pin SENSEGND.

Also the output current of the flyback SMPS can be controlled or limited. The voltage on the ISENSE pin is regulated or limited to 50 mV above the voltage on pin POWERGND.

### 7.4 Opto outputs

The opto output is intended to drive an opto coupler (see [Figure 5](#)). The opto outputs have an open drain output configuration. The maximum sink current is internally limited to 5 mA (typical). The outputs are linearly controlled via the VSENSE and ISENSE input pins. An over-temperature situation will switch the protection opto output (OPTOPROT) to its maximum sink current.

During start-up ( $V_{CC} < V_{startup}$ ) and undervoltage lock-out the outputs are disabled.

### 7.5 Protection input

The PROTECT pin is a general purpose input pin which can be used for additional protection of the switched mode power supply. With a Negative Temperature Coefficient (NTC) thermistor external temperature protection can be provided, e.g. the external power switches and transformer can be protected against high temperatures. With a Zener diode a secondary overvoltage protection can be made.

### 7.6 Reference voltage output

The reference voltage output pin can be used for supplying external circuitry. The maximum output current must be limited to 1 mA.

The reference voltage is activated as soon as the start-up voltage is reached on the  $V_{CC}$  pin and switched off again after the  $V_{CC}$  pin voltage drops below the  $V_{CC}$  stop level.

### 7.7 Supply management

All (internal) reference voltages are derived from a temperature compensated, on-chip band gap circuit. The reference voltage is trimmed to an accuracy within 1 %.

### 7.8 OverTemperature Protection (OTP)

The IC provides an accurate internal overtemperature protection of 150 °C (typical). The IC will maximize the current of pin OPTOPROT as soon as the internal temperature limit is reached. The opto signal can be used on the primary side of the flyback controller to activate the SMPS protection or limit the output power. As soon as the overtemperature condition is solved, normal operation will resume.

### 7.9 Driver

The driver circuit to the gate of the external power MOSFET has a source capability of typically 250 mA and a sink capability of typically 2.7 A. This permits fast turn-on and turn-off of the power MOSFET for efficient operation. The output voltage of the driver is limited to 10 V (typical). This high output voltage will drive all MOSFET brands to the minimum on-state resistance.

During start-up conditions ( $V_{CC} < V_{startup}$ ) and undervoltage lock-out the driver output voltage is actively pulled low.

### 7.10 Power ground and sense ground

The TEA1762T has two ground connections. The sense ground ensures an increased accuracy of the output voltage of the switched mode power supply and can also be used to compensate for cable losses on the output of the converter. The grounds are internally connected via two anti-parallel diodes.

## 8. Limiting values

**Table 3. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134). All voltages are measured with respect to power ground (pin 2); positive currents flow into the chip. The voltage ratings are valid provided other ratings are not violated; current ratings are valid provided the maximum power rating is not violated.

| Symbol          | Parameter               | Conditions               | Min  | Max  | Unit |
|-----------------|-------------------------|--------------------------|------|------|------|
| <b>Voltages</b> |                         |                          |      |      |      |
| $V_{CC}$        | supply voltage          | continuous               | -0.4 | +38  | V    |
| $V_{OPTOREG}$   | voltage on pin OPTOREG  | continuous               | -0.4 | +38  | V    |
| $V_{OPTOPROT}$  | voltage on pin OPTOPROT | continuous               | -0.4 | +38  | V    |
| $V_{SRSENSE}$   | voltage on pin SRSENSE  | continuous               | -    | +120 | V    |
| $V_{VSENSE}$    | voltage on pin VSENSE   | continuous               | -0.4 | +5   | V    |
| $V_{ISENSE}$    | voltage on pin ISENSE   |                          | -0.4 | +5   | V    |
| $V_{PROTECT}$   | voltage on pin PROTECT  |                          | -0.4 | +5   | V    |
| $V_{SENSEGND}$  | voltage on pin SENSEGND |                          | [1]  | +0.4 | V    |
| <b>Currents</b> |                         |                          |      |      |      |
| $I_{OPTOREG}$   | current on pin OPTOREG  |                          | -    | +6   | mA   |
| $I_{OPTOPROT}$  | current on pin OPTOPROT |                          | -    | +6   | mA   |
| $I_{DRIVER}$    | current on pin DRIVER   | duty cycle < 10 %        | -0.8 | +3   | A    |
| $I_{VREF}$      | current on pin VREF     |                          | -2   | -    | mA   |
| $I_{SRSENSE}$   | current on pin SRSENSE  |                          | -3   | -    | mA   |
| <b>General</b>  |                         |                          |      |      |      |
| $P_{tot}$       | total power dissipation | $T_{amb} < 80\text{ °C}$ | -    | 0.65 | W    |
| $T_{stg}$       | storage temperature     |                          | -55  | +150 | °C   |
| $T_j$           | junction temperature    |                          | -20  | +150 | °C   |

**Table 3. Limiting values ...continued**

In accordance with the Absolute Maximum Rating System (IEC 60134). All voltages are measured with respect to power ground (pin 2); positive currents flow into the chip. The voltage ratings are valid provided other ratings are not violated; current ratings are valid provided the maximum power rating is not violated.

| Symbol           | Parameter                       | Conditions           | Min | Max | Unit |   |
|------------------|---------------------------------|----------------------|-----|-----|------|---|
| <b>ESD</b>       |                                 |                      |     |     |      |   |
| V <sub>ESD</sub> | electrostatic discharge voltage | class 2              |     |     |      |   |
|                  |                                 | human body model     | [2] | -   | 2000 | V |
|                  |                                 | machine model        | [3] | -   | 200  | V |
|                  |                                 | charged device model |     | -   | 500  | V |

[1] Voltages on pin SENSEGND less than +1.0 V will not damage the IC when the duration is limited to 100 μs, but voltages on pin SENSEGND larger than +0.4 V may lead to disturbed IC operation.

[2] Equivalent to discharging a 100 pF capacitor through a 1.5 kΩ series resistor.

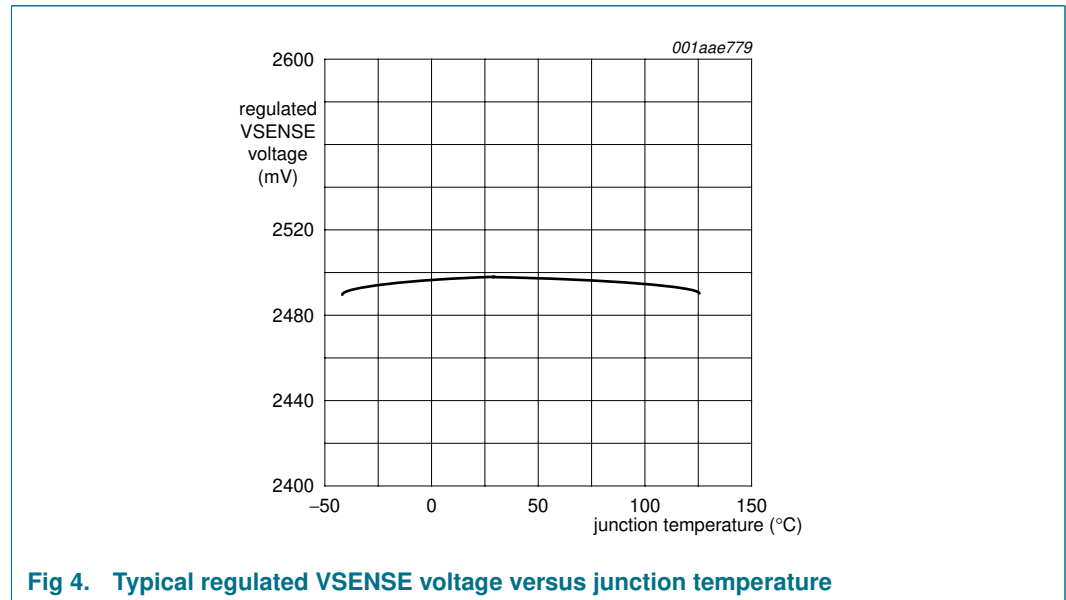
[3] Equivalent to discharging a 200 pF capacitor through a 0.75 μH coil and a 10 Ω resistor.

## 9. Thermal characteristics

**Table 4. Thermal characteristics**

| Symbol               | Parameter                                   | Conditions  | Typ | Unit |
|----------------------|---|-------------|-----|------|
| R <sub>th(j-a)</sub> | thermal resistance from junction to ambient | in free air | 100 | K/W  |

The graph in [Figure 4](#) shows the relationship between junction temperature and VSENSE voltage.



**Fig 4. Typical regulated VSENSE voltage versus junction temperature**



## 10. Characteristics

**Table 5. Characteristics**

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 20\text{ V}$ ; all voltages are measured with respect to sense ground (pin 3); currents are positive when flowing into the IC; unless otherwise specified.

| Symbol   | Parameter                                     | Conditions  | Min   | Typ   | Max   | Unit |
|--|---|---|-------|-------|-------|------|
| <b>Supply voltage management (pin V<sub>CC</sub>)</b>      |   |   |       |       |       |      |
| V <sub>startup</sub>                                       | start-up voltage                              |   | 8.35  | 8.6   | 8.85  | V    |
| V <sub>hys</sub>   | hysteresis voltage                            |   | [1] - | 0.5   | -     | V    |
| I <sub>CC(oper)</sub>                                      | operating supply current                      | V <sub>CC</sub> = 8 V; V <sub>CC</sub> < V <sub>startup</sub><br>under normal operation;<br>no load on pin DRIVER | -     | 1     | -     | mA   |
|  |   |   | -     | 1.4   | -     | mA   |
| <b>Synchronous rectification sense input (pin SRSENSE)</b> |   |   |       |       |       |      |
| V <sub>act(drv)</sub>                                      | driver activation voltage                     | w.r.t. power ground   | -340  | -310  | -280  | mV   |
| V <sub>reg(drv)</sub>                                      | driver regulation voltage                     | w.r.t. power ground   | -65   | -55   | -45   | mV   |
| V <sub>deact(drv)</sub>                                    | driver deactivation voltage                   | w.r.t. power ground   |       | -12   |       | mV   |
| t <sub>d(act)(drv)</sub>                                   | driver activation delay time                  |   |       | 125   |       | ns   |
| t <sub>act(sr)(min)</sub>                                  | minimum synchronous rectification active time | Short time  | 1.5   | 2     | 2.5   | μs   |
|  |   | Long time   | 1.7   | 2.2   | 2.7   | μs   |
| <b>Driver (pin DRIVER)</b>                                 |   |   |       |       |       |      |
| I <sub>source</sub>  | source current                                | V <sub>CC</sub> = 15 V; voltage on pin DRIVER = 2 V   | -0.3  | -0.25 | -0.2  | A    |
| I <sub>sink</sub>  | sink current                                  | V <sub>CC</sub> = 15 V  |       |       |       |      |
|  |   | voltage on pin DRIVER = 2 V   | 1     | 1.4   | -     | A    |
|  |   | voltage on pin DRIVER = 9.5 V   | 2.2   | 2.7   | -     | A    |
| V <sub>o(max)</sub>  | maximum output voltage                        | V <sub>CC</sub> = 15 V  | -     | 10    | 12    | V    |
| <b>Opto output (pin OPTOREG and OPTOPROT)</b>              |   |   |       |       |       |      |
| I <sub>O(max)</sub>  | maximum output current                        | V <sub>OPTO</sub> > 5 V   | 4     | 5     | 6     | mA   |
| V <sub>O(min)</sub>  | minimum output voltage                        | I <sub>OPTO</sub> = 4 mA  |       |       | 3.5   | V    |
| <b>Voltage sense (pin VSENSE)</b>                          |   |   |       |       |       |      |
| V <sub>reg(VSENSE)</sub>                                   | regulation voltage on pin VSENSE              | See <a href="#">Figure 4</a>  | 2.475 | 2.5   | 2.525 | V    |
| I <sub>I(VSENSE)</sub>                                     | input current on pin VSENSE                   | V <sub>VSENSE</sub> = V <sub>reg(VSENSE)</sub>  | -100  | 0     | +100  | nA   |
| g <sub>m</sub>   | transconductance                              | V <sub>VSENSE</sub> to I <sub>OPTOREG</sub>   |       | 40    |       | A/V  |
| GB   | gain bandwidth product                        | R <sub>L</sub> = 1 kΩ   | 1     |       |       | MHz  |
| <b>Reference voltage (pin VREF)</b>                        |   |   |       |       |       |      |
| V <sub>VREF</sub>  | voltage on pin VREF                           |   | 2.465 | 2.5   | 2.535 | V    |
| I <sub>VREF</sub>  | current on pin VREF                           |   | -1    |       |       | mA   |
| C <sub>VREF(max)</sub>                                     | maximum capacitance on pin VREF               |   |       |       | 40    | pF   |
| <b>Current sense (pin ISENSE)</b>                          |   |   |       |       |       |      |
| V <sub>reg(ISENSE)</sub>                                   | regulation voltage on pin ISENSE              | w.r.t. power ground;<br>V <sub>POWERGND</sub> > -0.4 V  | 46    | 50    | 54    | mV   |
| I <sub>I(reg)(ISENSE)</sub>                                | regulation input current on pin ISENSE        | V <sub>ISENSE</sub> = V <sub>reg(ISENSE)</sub>  | -200  | -100  | 0     | nA   |
| g <sub>m</sub>   | transconductance                              | V <sub>ISENSE</sub> to I <sub>OPTOPROT</sub>  |       | 8     |       | A/V  |

**Table 5. Characteristics ...continued**

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{CC} = 20\text{ V}$ ; all voltages are measured with respect to sense ground (pin 3); currents are positive when flowing into the IC; unless otherwise specified.

| Symbol                                | Parameter                               | Conditions                                    | Min  | Typ  | Max  | Unit               |
|---------------------------------------|---|---|------|------|------|--------------------|
| GB                                    | gain bandwidth product                  | $R_L = 1\text{ k}\Omega$                      | 1    |      |      | MHz                |
| <b>Protection input (pin PROTECT)</b> |   |   |      |      |      |                    |
| $V_{th(\text{PROTECT})}$              | threshold voltage on pin PROTECT        |   | 1.15 | 1.25 | 1.35 | V                  |
| $V_{hys}$                             | hysteresis voltage                      |   | 15   | 30   | 45   | mV                 |
| $I_{I(\text{PROTECT})}$               | input current on pin PROTECT            | $V_{\text{PROTECT}} = V_{th(\text{PROTECT})}$ | -100 | -50  | -5   | nA                 |
| <b>Temperature protection</b>         |   |   |      |      |      |                    |
| $T_{pl(\text{max})}$                  | maximum protection level temperature    |   | 140  | 150  | -    | $^{\circ}\text{C}$ |
| $T_{pl(\text{hys})}$                  | protection level hysteresis temperature |   | -    | 12   | -    | $^{\circ}\text{C}$ |

[1] The  $V_{CC}$  stop voltage is  $V_{\text{startup}} - V_{\text{hys}}$ .

### 11. Application information

A switched mode power supply with the TEA1762T consists of a primary side discontinuous conduction mode flyback controller, a transformer, and an output stage with a feedback circuit. In the output stage a MOSFET ( $Q_{sec}$ ) is used for low conduction losses. The MOSFET is controlled by the TEA1762T. The output voltage and/or current is also controlled by the TEA1762T via the opto coupler connection to the primary side. See [Figure 5](#).

The output voltage is set by resistors  $R_{fb1}$  and  $R_{fb2}$ . The output current is controlled by the resistor  $R_{isense}$ . The timing for the synchronous rectifier switch is derived from the voltage sensed on the SRSENSE pin. The resistor in the SRSENSE connection is needed to protect the TEA1762T from excessive voltages. The SRSENSE resistor should typically be 1 k $\Omega$ . Higher values might impair correct timing, lower values may not provide sufficient protection.

During output short circuit or load connection, the limiting values on pin SENSEGND must not be exceeded.

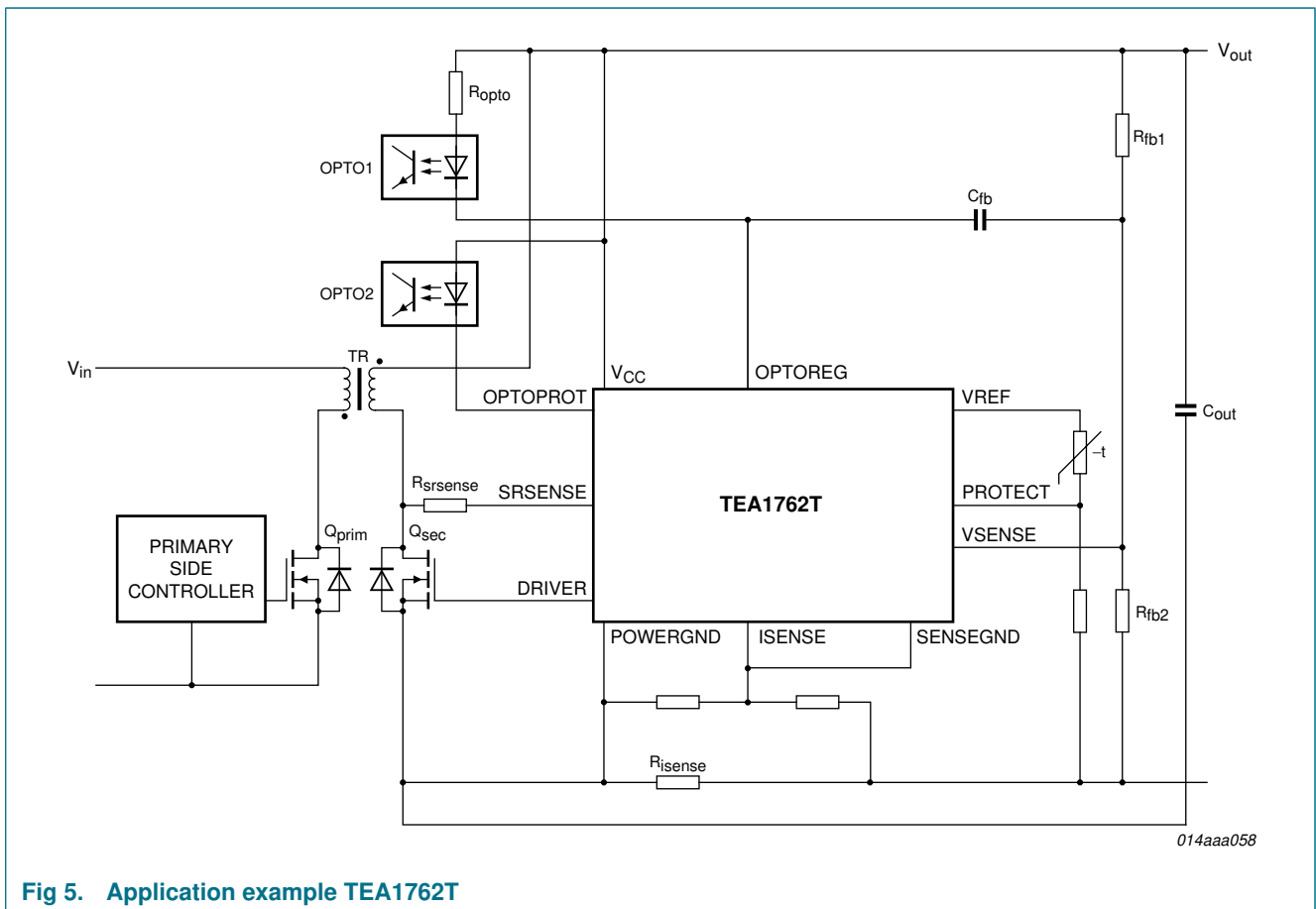


Fig 5. Application example TEA1762T

## 12. Test information

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### 12.1 Quality information

The *General Quality Specification for Integrated Circuits, SNW-FQ-611* is applicable.

13. Package outline

SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1

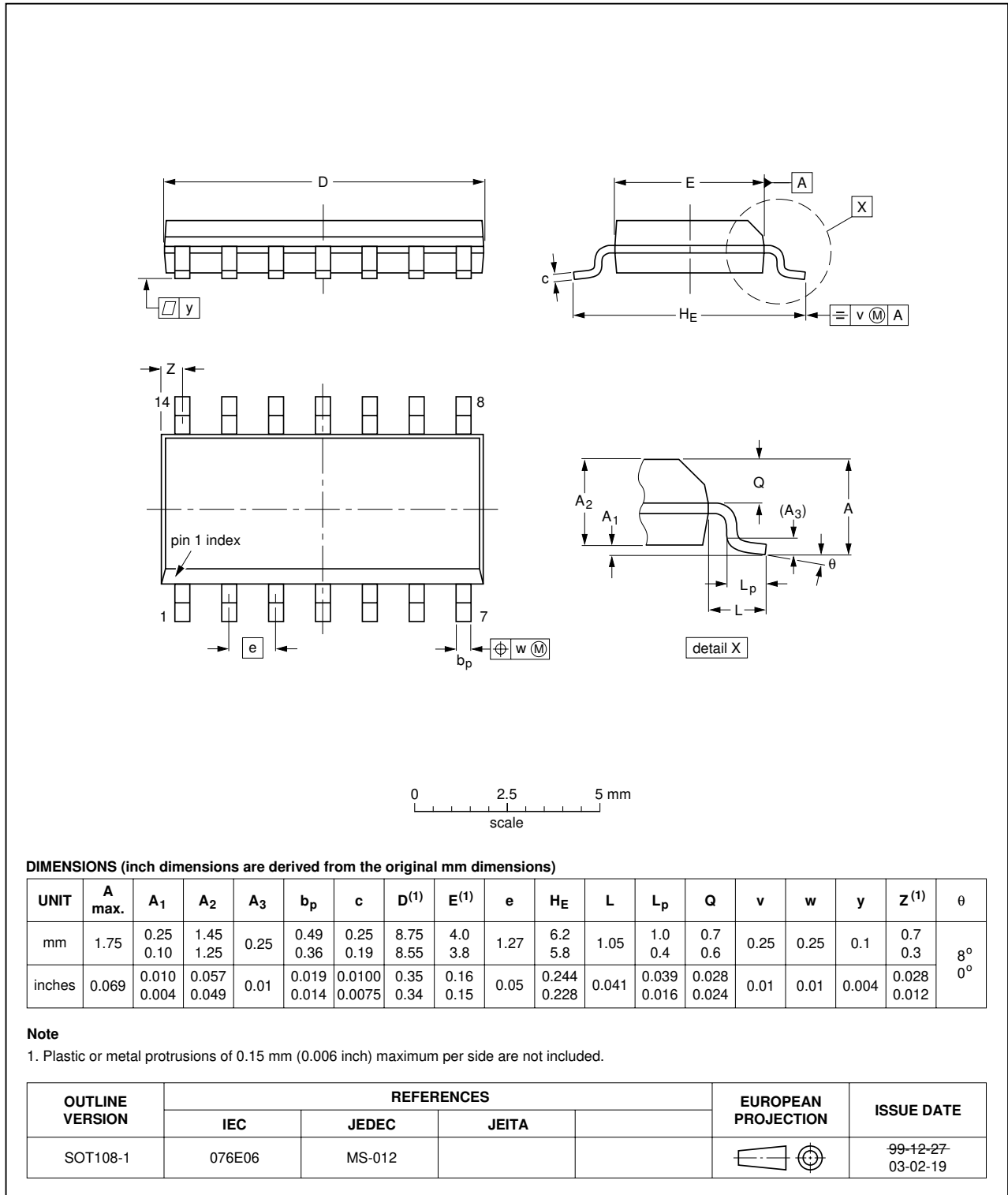


Fig 6. Package outline SOT108-1 (SO14)

## 14. Revision history

Table 6. Revision history

| Document ID    | Release date | Data sheet status  | Change notice | Supersedes |
|----------------|--------------|--|---------------|------------|
| TEA1762T_2     | 20070425     | Product data sheet   | -             | TEA1762T_1 |
| Modifications: |              | <ul style="list-style-type: none"><li>• Updated limiting values for <math>I_{SRSENSE}</math> in <a href="#">Table 3</a>.</li><li>• Updated characteristic values for <math>I_{source}</math>, <math>I_{sink}</math>, GB (voltage and current sense) and <math>T_{pl(max)}</math> in <a href="#">Table 5</a>.</li><li>• Soldering section removed.</li><li>• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li><li>• Legal texts have been adapted to the new company name where appropriate.</li></ul> |               |            |
| TEA1762T_1     | 20060331     | Objective data sheet   | -             | -          |

## 15. Legal information

### 15.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | 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".

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