



**THE DATASHEET OF
TEA1708T/1J**





TEA1708T

GreenChip X capacitor discharge IC

Rev. 1.1 — 6 April 2020

Product data sheet

1 General description

The TEA1708 is an automatic discharge IC for X capacitors with a low power consumption (typically 1 mW at 230 V (AC)).

A 500 V clamping circuit is integrated, protecting the IC during mains surges. In a typical application with only two 200 k Ω resistors, the maximum differential mode mains surge voltage allowed exceeds 6 kV. A metal-oxide varistor is not required to protect the IC.

The X-capacitor discharge current is internally limited to 2.3 mA. The discharge delay timer is set externally using a low-voltage capacitor.

To reduce EMI while retaining the low standby power, the very low power consumption with a high discharge current enables the use of a high value X-capacitor.

2 Features and benefits

- 1 mW power consumption at 230 V (AC)
- Integrated 500 V clamp; no metal oxide varistor required to protect the IC
- Self-Supplied, no external bias required
- Discharge current internally limited
- Adjustable discharge delay
- Very high differential surge: 6 kV with two 200 k Ω resistors
- Easier application design, resolving EMI issues while retaining the efficiency level

3 Applications

- All AC-connected power supplies with X-capacitors > 100 nF requiring a low load standby power.

4 Ordering information

Table 1. Ordering information

| Type number | Package | | |
|-------------|---------|---|---------|
| | Name | Description | Version |
| TEA1708T/1 | SO8 | plastic small outline package; 8 leads; body width 3.9 mm | SOT96-1 |

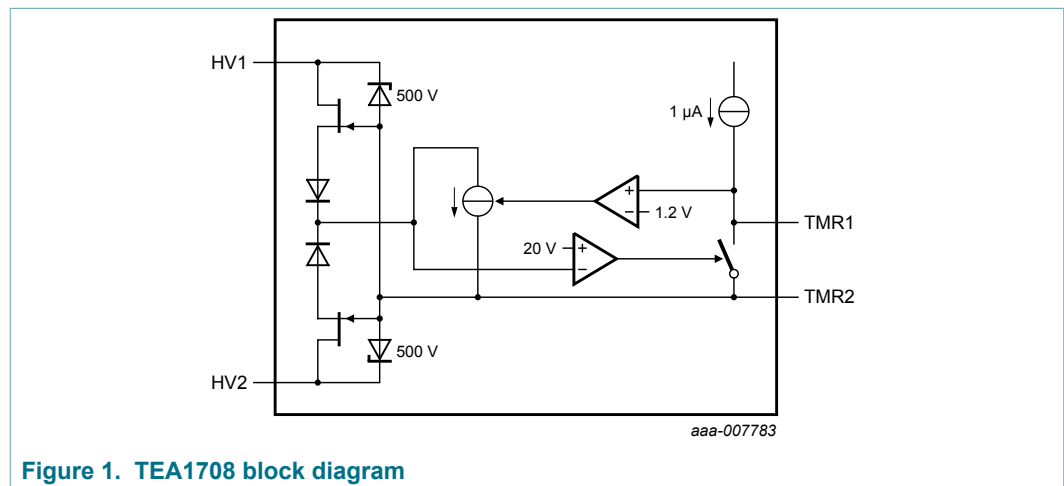


5 Marking

Table 2. Marking codes

| Type number | Marking code |
|-------------|--------------|
| TEA1708T/1 | TEA1708 |

6 Block diagram



7 Pinning information

7.1 Pinning

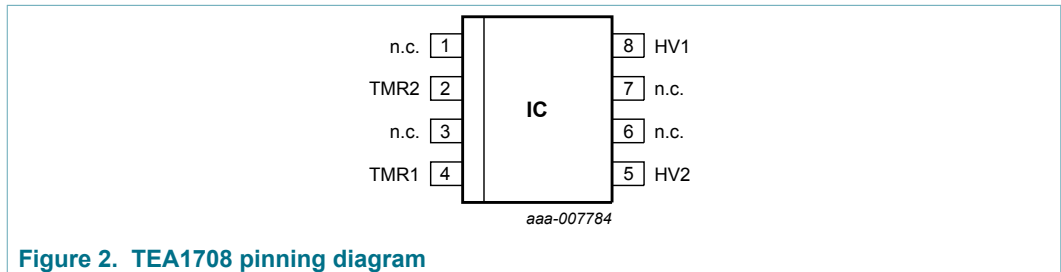


Figure 2. TEA1708 pinning diagram

7.2 Pin description

Table 3. Pin description

| Symbol | Pin | Description |
|--------|-----|---------------------------------|
| n.c. | 1 | not connected |
| TMR2 | 2 | timer pin 2 |
| n.c. | 3 | not connected |
| TMR1 | 4 | timer pin 1 |
| HV2 | 5 | high-voltage mains connection 2 |
| n.c. | 6 | not connected |
| n.c. | 7 | not connected |
| HV1 | 8 | high-voltage mains connection 1 |

8 Functional description

The TEA1708 incorporates a timer and a zero-crossing mains voltage detector. If a positive or negative voltage exceeding the threshold zero-crossing mains voltage (20 V) is applied between the high-voltage pins, the timer charges the external capacitor on the TMR1 and TMR2 pins. If the voltage between the TMR1 and TMR2 pins reaches 1.2 V, a discharge current is activated. If the voltage applied between the high-voltage pins, is below the threshold zero-crossing mains voltage, the external capacitor is discharged and the discharging stops. The discharge current is internally limited.

When an AC mains voltage is applied, the timer capacitor is charged between the mains zero crossings and discharged during the mains zero crossings. When the AC mains is disconnected and a high voltage remains on the X-capacitor, the timer charges the external capacitor above its discharge activation threshold voltage point (1.2 V), switching on the internally limited discharge current of the external X-capacitor.

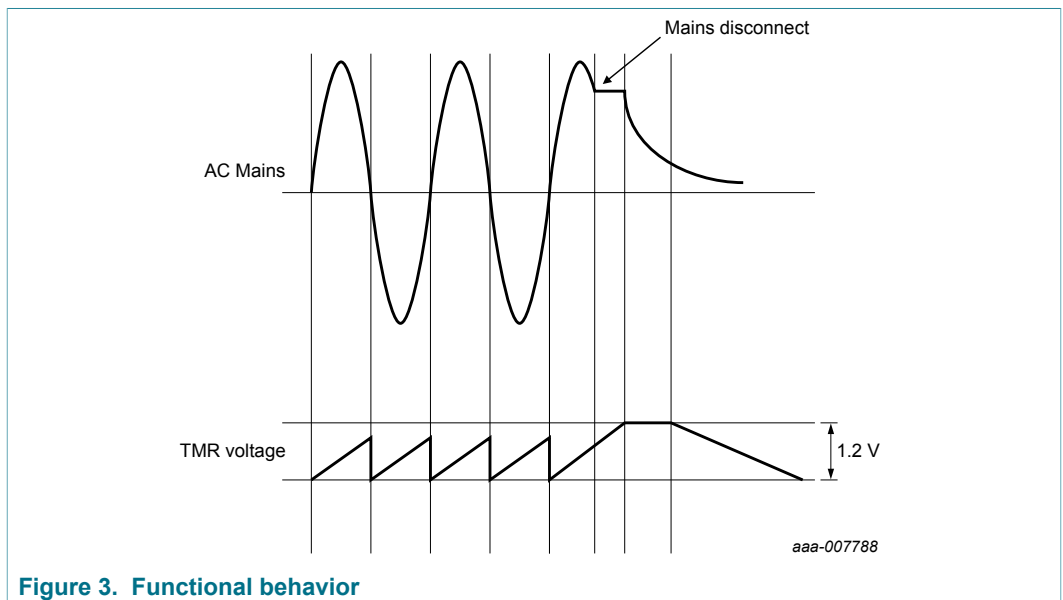


Figure 3. Functional behavior

To protect the IC during mains surges, a high-voltage clamping circuit is integrated. The clamping circuit is activated for positive and negative voltages > 500 V. The high-voltage pins HV1 and HV2 are fully symmetrical.

9 Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol | Parameter | Conditions | Min | Max | Unit |
|-----------------|---------------------------------------|--|------------------|------|------|
| Voltages | | | | | |
| $V_{TMR1-TMR2}$ | voltage between pin TMR1 and pin TMR2 | $0 \mu A > I_{dch(tmr)} < 10 \mu A$ | -0.4 | +3.5 | V |
| $V_{HV1-HV2}$ | voltage between pin HV1 and pin HV2 | normal operation, so no mains surge | -410 | +410 | V |
| Currents | | | | | |
| I_{HV} | current on pin HV | both HV pins; $t < 2$ ms, during mains surge | -15 | +15 | mA |
| General | | | | | |
| P_{tot} | total power dissipation | $T_{amb} < 75$ °C | - | 0.5 | W |
| T_{stg} | storage temperature | | -55 | +150 | °C |
| T_j | junction temperature | | -40 | +150 | °C |
| ESD | | | | | |
| V_{ESD} | electrostatic discharge voltage | class 1 | | | |
| | | human body model (HBM); pins HV1 and HV2 | ^[1] - | 1000 | V |
| | | human body model(HBM); all other pins | - | 4000 | V |
| | charged device model (CDM); all pins | ^[2] - | 750 | V | |

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

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

10 Thermal characteristics

Table 5. Thermal characteristics

| Symbol | Parameter | Conditions | Typ | Unit |
|---------------|---|-------------------------------|-----|------|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air; JEDEC test board | 160 | K/W |
| $R_{th(j-c)}$ | thermal resistance from junction to case | in free air; JEDEC test board | 72 | K/W |

11 Characteristics

Table 6. Characteristics

$T_{amb} = 25\text{ }^{\circ}\text{C}$; currents are positive when flowing into the IC; unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--|--|---|-------|-------|-------|---------------|
| High voltage (pins HV1 and HV2) | | | | | | |
| I_{HV} | current on pin HV | both HV pins; $V_{HV1} > 50\text{ V}$; $V_{HV2} > 50\text{ V}$ | | | | |
| | | $V_{TMR} < 1.2\text{ V}$ | 2.5 | 3.5 | 4.5 | μA |
| | | current limited; $V_{TMR} > 1.2\text{ V}$ | 1.8 | 2.3 | 2.8 | mA |
| V_{clamp} | clamp voltage | | 475 | 500 | 525 | V |
| $V_{th(ch)}$ | charge threshold voltage | threshold zero-crossing mains voltage | 19 | 21 | 23 | V |
| Timer (pins TMR1 and TMR2) | | | | | | |
| $V_{th(act)dch}$ | discharge activation threshold voltage | to discharge the X-capacitor | 1.1 | 1.2 | 1.3 | V |
| $I_{dch(tmr)}$ | timer discharge current | | -1.20 | -0.95 | -0.70 | μA |

12 Application information

The TEA1708 is typically connected across the X-capacitor. A metal-oxide varistor is not required to protect the IC because the device incorporates a high-voltage clamping circuit. The IC is sufficiently protected for differential mode surge voltages up to 4 kV with only two 200 k Ω resistors (see [Figure 4](#)).

The discharge delay time is set externally using a low-voltage capacitor connected between the TMR1 and TMR2 pins. Select a value between 10 nF and 22 nF for a mains frequency of 50 Hz or 60 Hz. The minimum value is 10 nF which gives the smallest delay time. Do not use values < 10 nF. They can lead to unwanted discharge of the X-capacitor.

The delay time (t_d) for discharge can be calculated with [Equation 1](#):

$$t_d = C_{tmr} \times \frac{V_{th(act)dch}}{I_{dch(tmr)}} \tag{1}$$

If the low-voltage capacitor value is 22 nF the delay time is:

$$22\text{ nF} \times \frac{1.2\text{ V}}{1\mu\text{ A}} = 26\text{ ms}$$

When the voltage across the device exceeds the threshold zero-crossing mains voltage, the discharge current is activated. The current is limited to $\approx 2.3\text{ mA}$. When the current < the current limit, I_{HV} is calculated with [Equation 2](#):

$$I_{HV1} = I_{HV2} \approx \frac{V_{xcap(t)} - (V_{th(ch)} + 4\text{ V})}{(R1 + R2)} \tag{2}$$

When the X-capacitor value is 330 nF and $R1 = R2 = 200\text{ k}\Omega$, the capacitor is discharged to a voltage $< 60\text{ V}$ at a mains of 230 V (AC) in 300 ms.

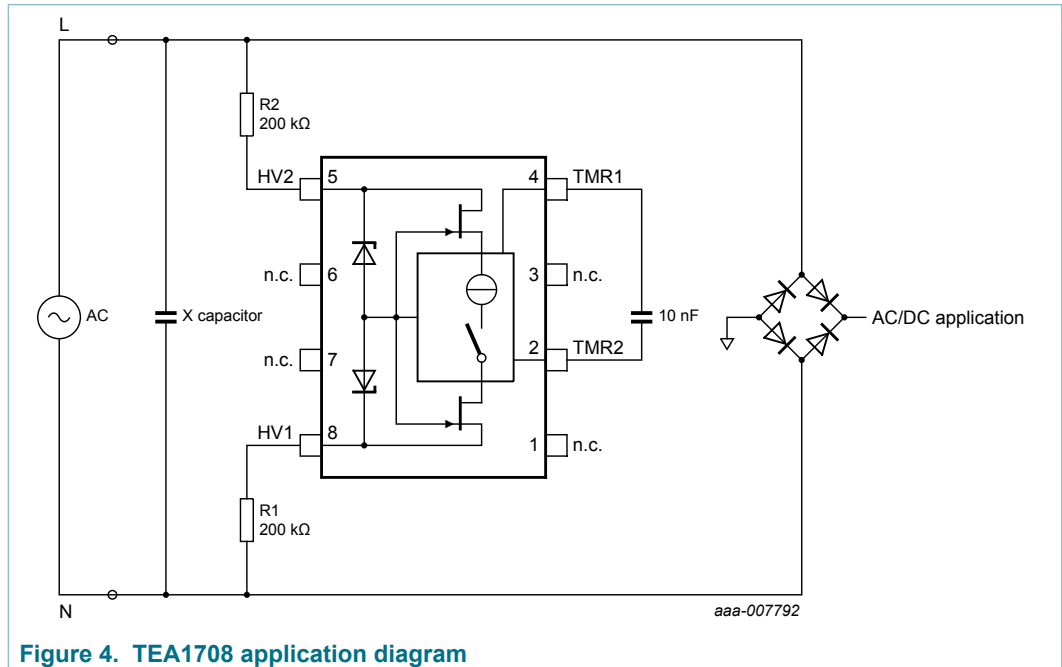


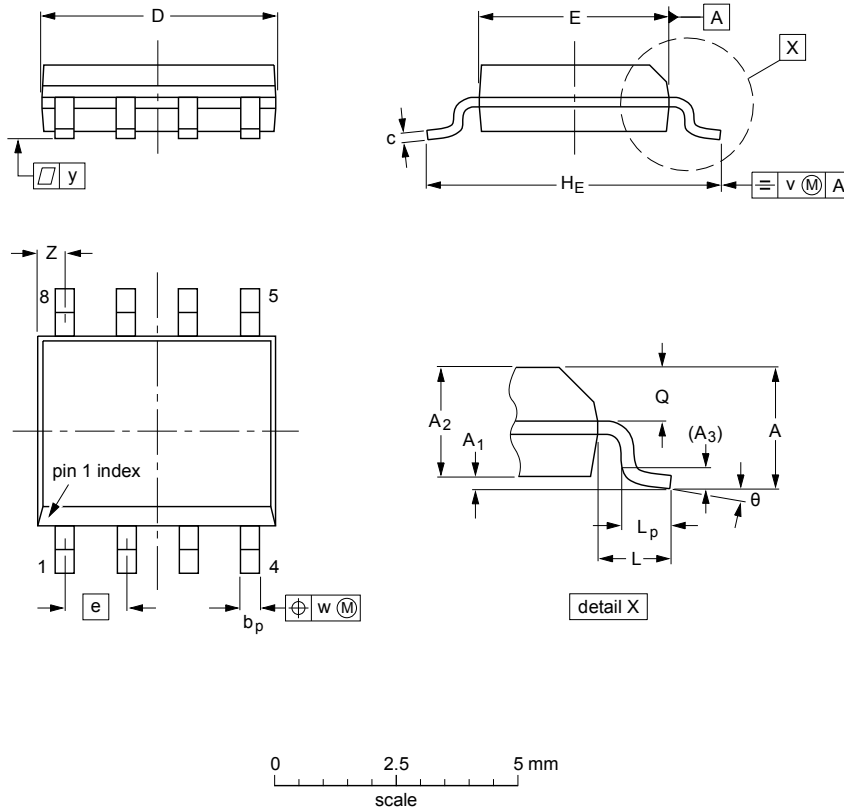
Figure 4. TEA1708 application diagram

To ensure that the capacitor is discharged to a voltage $< 60\text{ V}$ within 2 seconds, use $R1 = R2 = 200\text{ k}\Omega$ for X-capacitor values $< 1.8\text{ }\mu\text{F}$. Lowering $R1 + R2$, for faster discharge or when a higher value for the X-capacitor is required, is possible but it decreases the surge protection level.

13 Package outline

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 5. Package outline SOT96-1 (SO8)

14 Revision history

Table 7. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|------------------|--------------|--------------------|---------------|----------------|
| TEA1708T_1 v.1.1 | 20200406 | Product data sheet | - | TEA1708T_1 v.1 |
| TEA1708T_1 v.1 | 20130925 | 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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