

# TLVH431 family

## Low voltage adjustable precision shunt regulators

Rev. 1 — 27 April 2012

Product data sheet

### 1. General description

Low voltage three-terminal shunt regulator family with an output voltage range between  $V_{ref}$  (1.24 V) and 18 V, to be set by two external resistors.

Table 1. Product overview

| Reference voltage tolerance ( $V_{ref}$ ) | Package | Temperature range ( $T_{amb}$ ) |                 |                  | Pinning configuration (see <a href="#">Table 5</a> ) |
|-------------------------------------------|---------|---------------------------------|-----------------|------------------|------------------------------------------------------|
|                                           |         | 0 °C to 70 °C                   | –40 °C to 85 °C | –40 °C to 125 °C |                                                      |
| 1.5 %                                     | SOT23   | TLVH431CDBZR                    | TLVH431IDBZR    | TLVH431QDBZR     | normal pinning                                       |
|                                           |         | -                               | -               | TLVH431MQDBZR    | mirrored pinning                                     |
|                                           | SOT753  | -                               | -               | TLVH431QDBVR     | -                                                    |
| 1 %                                       | SOT23   | TLVH431ACDBZR                   | TLVH431AIDBZR   | TLVH431AQDBZR    | normal pinning                                       |
|                                           |         | -                               | -               | TLVH431AMQDBZR   | mirrored pinning                                     |
|                                           | SOT753  | -                               | -               | TLVH431AQDBVR    | -                                                    |
| 0.75 %                                    | SOT23   | -                               | -               | TLVH431DQDBZR    | normal pinning                                       |
|                                           |         | -                               | -               | TLVH431DMQDBZR   | mirrored pinning                                     |
|                                           | SOT753  | -                               | -               | TLVH431DQDBVR    | -                                                    |

### 2. Features and benefits

- Programmable output voltage up to 18 V
- Three different reference voltage tolerances:
  - ◆ Standard grade: 1.5 %
  - ◆ A-Grade: 1 %
  - ◆ D-Grade: 0.75 %
- Typical temperature drift: 4 mV (in a range of –40 °C up to 125 °C)
- Low output noise
- Typical output impedance: 0.1  $\Omega$
- Sink current capability: 0.08 mA to 70 mA
- AEC-Q100 qualified (grade 1)

### 3. Applications

- Shunt regulator
- Precision current limiter
- Precision constant current sink
- Isolated feedback loop for Switch Mode Power Supply (SMPS)



## 4. Quick reference data

Table 2. Quick reference data

| Symbol    | Parameter              | Conditions                                                              | Min       | Typ  | Max  | Unit |
|-----------|------------------------|-------------------------------------------------------------------------|-----------|------|------|------|
| $V_{KA}$  | cathode-anode voltage  |                                                                         | $V_{ref}$ | -    | 18   | V    |
| $I_K$     | cathode current        |                                                                         | 0.08      | -    | 70   | mA   |
| $V_{ref}$ | reference voltage      | $V_{KA} = V_{ref}$ ; $I_K = 10\text{ mA}$ ;<br>$T_{amb} = 25\text{ °C}$ |           |      |      |      |
|           | Standard-Grade (1.5 %) |                                                                         | 1222      | 1240 | 1258 | mV   |
|           | A-Grade (1 %)          |                                                                         | 1228      | 1240 | 1252 | mV   |
|           | D-Grade (0.75 %)       |                                                                         | 1231      | 1240 | 1249 | mV   |

## 5. Ordering information

Table 3. Ordering information

| Type number    | Package  |                                          |         |
|----------------|----------|------------------------------------------|---------|
|                | Name     | Description                              | Version |
| TLVH431CDBZR   | TO-236AB | plastic surface-mounted package; 3 leads | SOT23   |
| TLVH431IDBZR   |          |                                          |         |
| TLVH431QDBZR   |          |                                          |         |
| TLVH431MQDBZR  |          |                                          |         |
| TLVH431ACDBZR  |          |                                          |         |
| TLVH431AIDBZR  |          |                                          |         |
| TLVH431AQDBZR  |          |                                          |         |
| TLVH431AMQDBZR |          |                                          |         |
| TLVH431DQDBZR  |          |                                          |         |
| TLVH431DMQDBZR |          |                                          |         |
| TLVH431QDBVR   | SC-74A   | plastic surface-mounted package; 5 leads | SOT753  |
| TLVH431AQDBVR  |          |                                          |         |
| TLVH431DQDBVR  |          |                                          |         |

## 6. Marking

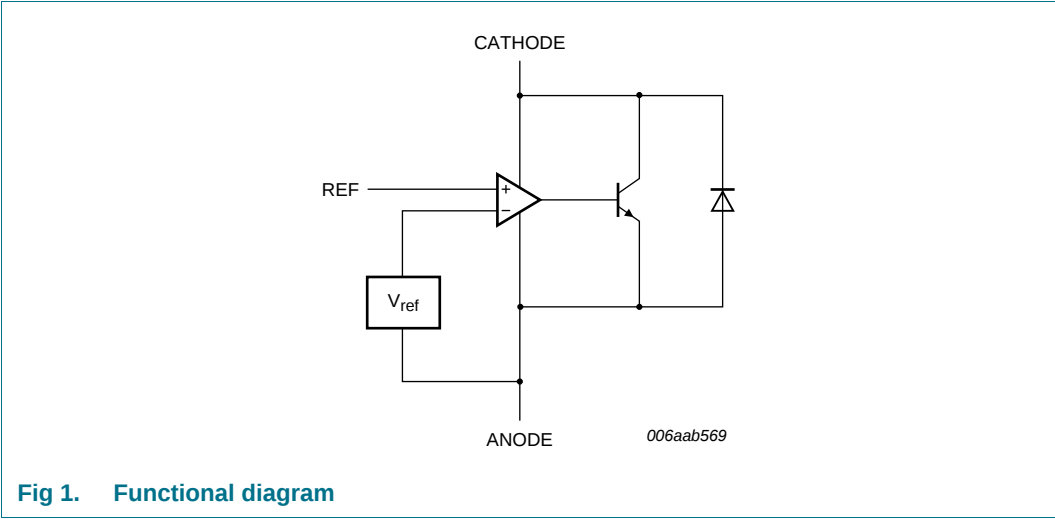
Table 4. Marking codes

| Type number   | Marking code <sup>[1]</sup> | Type number    | Marking code <sup>[1]</sup> |
|---------------|-----------------------------|----------------|-----------------------------|
| TLVH431CDBZR  | NM*                         | TLVH431AMQDBZR | NX*                         |
| TLVH431IDBZR  | NN*                         | TLVH431DQDBZR  | *SE                         |
| TLVH431QDBZR  | NP*                         | TLVH431DMQDBZR | *SF                         |
| TLVH431MQDBZR | NW*                         | TLVH431QDBVR   | AB3                         |
| TLVH431ACDBZR | NQ*                         | TLVH431AQDBVR  | AB6                         |
| TLVH431AIDBZR | NR*                         | TLVH431DQDBVR  | AC1                         |
| TLVH431AQDBZR | NS*                         | -              | -                           |

[1] \* = placeholder for manufacturing site code.

7. Functional diagram

The TLVH431 family comprises a range of 3-terminal adjustable shunt regulators, with specified thermal stability over applicable automotive and commercial temperature ranges. The output voltage can be set to any value between  $V_{ref}$  (approximately 1.24 V) and 18 V with two external resistors (see [Figure 10](#)). These devices have a typical output impedance of 0.1  $\Omega$ . Active output circuitry provides a very sharp turn-on characteristic, making these devices excellent replacements for Zener diodes in many applications like on-board regulation, adjustable power supplies and switching power supplies.



8. Pinning information

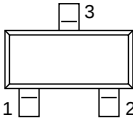
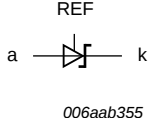
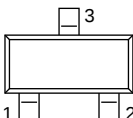
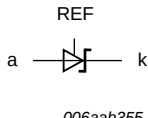
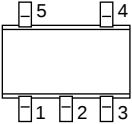
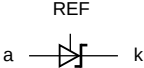
| Table 5. Pinning                                       |        |             |                                                                                       |                                                                                       |
|--------------------------------------------------------|--------|-------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Pin                                                    | Symbol | Description | Simplified outline                                                                    | Graphic symbol                                                                        |
| SOT23; normal pinning: All types without MQDBZR ending |        |             |                                                                                       |                                                                                       |
| 1                                                      | REF    | reference   |  |  |
| 2                                                      | k      | cathode     |                                                                                       |                                                                                       |
| 3                                                      | a      | anode       |                                                                                       |                                                                                       |
| SOT23; mirrored pinning: All types with MQDBZR ending  |        |             |                                                                                       |                                                                                       |
| 1                                                      | k      | cathode     |  |  |
| 2                                                      | REF    | reference   |                                                                                       |                                                                                       |
| 3                                                      | a      | anode       |                                                                                       |                                                                                       |

Table 5. Pinning ...continued

| Pin           | Symbol | Description   | Simplified outline                                                                  | Graphic symbol                                                                      |
|---------------|--------|---------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>SOT753</b> |        |               |                                                                                     |                                                                                     |
| 1             | n.c.   | not connected |  |  |
| 2             | n.c.   | not connected |                                                                                     |                                                                                     |
| 3             | k      | cathode       |                                                                                     |                                                                                     |
| 4             | REF    | reference     |                                                                                     |                                                                                     |
| 5             | a      | anode         |                                                                                     |                                                                                     |

[1] Pin 1 and 2 can be connected to anode for better thermal performance.

## 9. Limiting values

Table 6. Limiting values

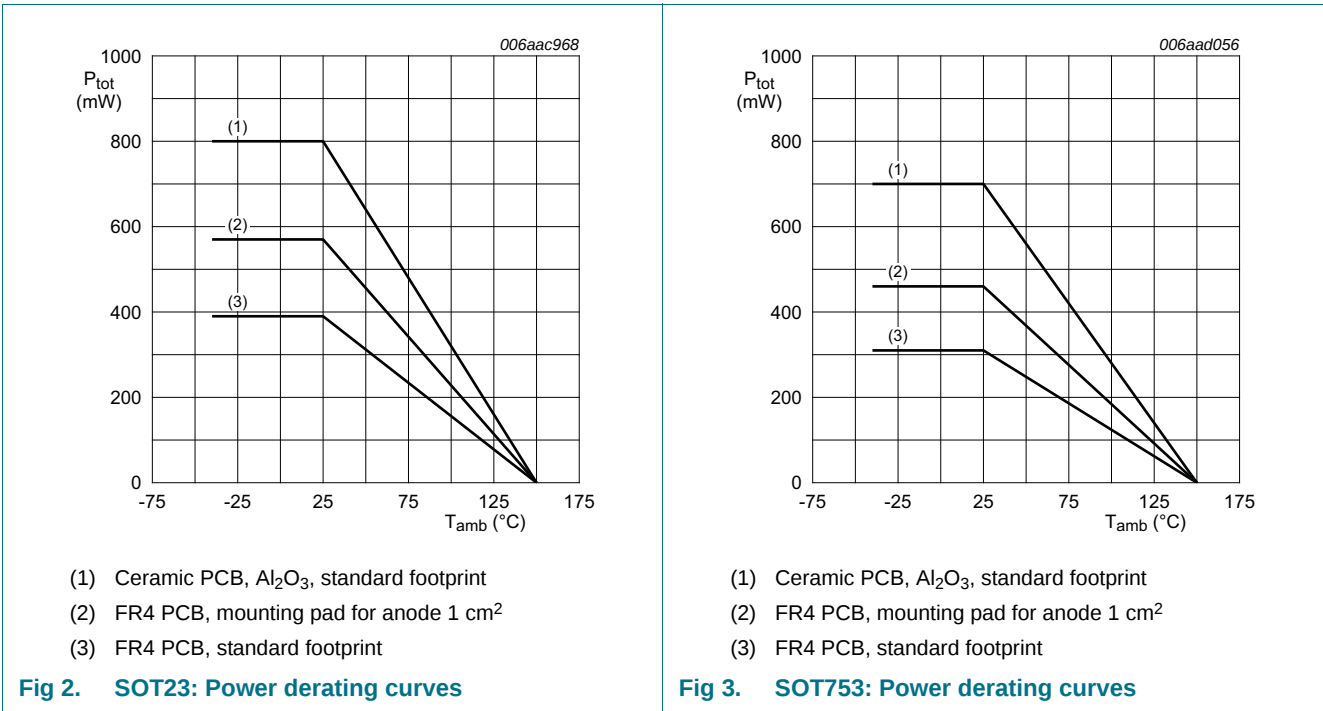
In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol           | Parameter               | Conditions               | Min   | Max  | Unit |
|------------------|-------------------------|--------------------------|-------|------|------|
| V <sub>KA</sub>  | cathode-anode voltage   |                          | -     | 20   | V    |
| I <sub>K</sub>   | cathode current         |                          | −25   | 80   | mA   |
| I <sub>ref</sub> | reference current       |                          | −0.05 | 3    | mA   |
| P <sub>tot</sub> | total power dissipation | T <sub>amb</sub> ≤ 25 °C |       |      |      |
|                  | SOT23                   |                          | [1] - | 390  | mW   |
|                  |                         |                          | [2] - | 570  | mW   |
|                  |                         |                          | [3] - | 800  | mW   |
|                  | SOT753                  |                          | [1] - | 310  | mW   |
|                  |                         |                          | [2] - | 460  | mW   |
|                  |                         |                          | [3] - | 700  | mW   |
|                  |                         |                          |       |      |      |
| T <sub>j</sub>   | junction temperature    | -                        | 150   | °C   |      |
| T <sub>amb</sub> | ambient temperature     |                          |       |      |      |
|                  | TLVH431XCDBZR           |                          | 0     | +70  | °C   |
|                  | TLVH431XIDBZR           |                          | −40   | +85  | °C   |
|                  | TLVH431XQDBZR           |                          | −40   | +125 | °C   |
|                  | TLVH431XQDBVR           |                          |       |      |      |
| T <sub>stg</sub> | storage temperature     |                          | −65   | +150 | °C   |

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for anode 1 cm<sup>2</sup>.

[3] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.



**Table 7. ESD maximum ratings**  
*T<sub>amb</sub> = 25 °C unless otherwise specified.*

| Symbol           | Parameter                       | Conditions                     | Min | Max | Unit |
|------------------|---------------------------------|--------------------------------|-----|-----|------|
| V <sub>ESD</sub> | electrostatic discharge voltage | MIL-STD-883 (human body model) | -   | 4   | kV   |
|                  |                                 | machine model                  | -   | 400 | V    |

10. Recommended operating conditions

**Table 8. Operating conditions**

| Symbol          | Parameter             | Conditions | Min              | Max | Unit |
|-----------------|-----------------------|------------|------------------|-----|------|
| V <sub>KA</sub> | cathode-anode voltage |            | V <sub>ref</sub> | 18  | V    |
| I <sub>K</sub>  | cathode current       |            | 0.08             | 70  | mA   |

## 11. Thermal characteristics

**Table 9. Thermal characteristics**

| Symbol         | Parameter                                        | Conditions  | Min | Typ | Max | Unit |
|----------------|--------------------------------------------------|-------------|-----|-----|-----|------|
| $R_{th(j-a)}$  | thermal resistance from junction to ambient      | in free air |     |     |     |      |
|                |                                                  |             |     |     |     |      |
|                |                                                  |             |     |     |     |      |
|                |                                                  |             |     |     |     |      |
|                |                                                  |             |     |     |     |      |
|                |                                                  |             |     |     |     |      |
|                |                                                  |             |     |     |     |      |
|                |                                                  |             |     |     |     |      |
|                |                                                  |             |     |     |     |      |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point |             |     |     |     |      |
|                |                                                  |             |     |     |     |      |
|                |                                                  |             |     |     |     |      |
|                |                                                  |             |     |     |     |      |
|                |                                                  |             |     |     |     |      |
|                |                                                  |             |     |     |     |      |

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for anode 1 cm<sup>2</sup>.

[3] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.

[4] Soldering point of anode.

## 12. Characteristics

**Table 10. Characteristics**

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| Symbol                                                                                               | Parameter                                                            | Conditions                                                                      | Min  | Typ  | Max  | Unit          |
|------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------|------|------|------|---------------|
| <b>Standard-Grade (1.5 %): TLVH431CDBZR; TLVH431IDBZR; TLVH431QDBZR; TLVH431MQDBRZ; TLVH431QDBVR</b> |                                                                      |                                                                                 |      |      |      |               |
| $V_{ref}$                                                                                            | reference voltage                                                    | $V_{KA} = V_{ref}; I_K = 10\text{ mA}$                                          |      |      |      |               |
|                                                                                                      |                                                                      | $T_{amb} = 25\text{ }^{\circ}\text{C}$                                          | 1222 | 1240 | 1258 | mV            |
|                                                                                                      | TLVH431CDBZR                                                         | $T_{amb} = 0\text{ }^{\circ}\text{C to } 70\text{ }^{\circ}\text{C}$            | 1210 | -    | 1270 | mV            |
|                                                                                                      | TLVH431IDBZR                                                         | $T_{amb} = -40\text{ }^{\circ}\text{C to } 85\text{ }^{\circ}\text{C}$          | 1202 | -    | 1278 | mV            |
|                                                                                                      | TLVH431QDBZR<br>TLVH431MQDBRZ<br>TLVH431QDBVR                        | $T_{amb} = -40\text{ }^{\circ}\text{C to } 125\text{ }^{\circ}\text{C}$         | 1194 | -    | 1286 | mV            |
| $\Delta V_{ref}$                                                                                     | reference voltage variation                                          | $V_{KA} = V_{ref}; I_K = 10\text{ mA}$                                          |      |      |      |               |
|                                                                                                      | TLVH431CDBZR                                                         | $T_{amb} = 0\text{ }^{\circ}\text{C to } 70\text{ }^{\circ}\text{C}$            | -    | 2    | 10   | mV            |
|                                                                                                      | TLVH431IDBZR                                                         | $T_{amb} = -40\text{ }^{\circ}\text{C to } 85\text{ }^{\circ}\text{C}$          | -    | 3    | 10   | mV            |
|                                                                                                      | TLVH431QDBZR<br>TLVH431MQDBRZ<br>TLVH431QDBVR                        | $T_{amb} = -40\text{ }^{\circ}\text{C to } 125\text{ }^{\circ}\text{C}$         | -    | 4    | 10   | mV            |
| $\Delta V_{ref}/\Delta V_{KA}$                                                                       | reference voltage variation to cathode-anode voltage variation ratio | $I_K = 10\text{ mA};$<br>$\Delta V_{KA} = V_{ref}\text{ to } 18\text{ V}$       | -    | -0.5 | -1.5 | mV/V          |
| $I_{ref}$                                                                                            | reference current                                                    | $I_K = 10\text{ mA};$<br>$R1 = 10\text{ k}\Omega; R2 = \text{open}$             | -    | 0.19 | 0.30 | $\mu\text{A}$ |
| $\Delta I_{ref}$                                                                                     | reference current variation                                          | $I_K = 10\text{ mA};$<br>$R1 = 10\text{ k}\Omega; R2 = \text{open}$             |      |      |      |               |
|                                                                                                      | TLVH431CDBZR                                                         | $T_{amb} = 0\text{ }^{\circ}\text{C to } 70\text{ }^{\circ}\text{C}$            | -    | 0.03 | 0.10 | $\mu\text{A}$ |
|                                                                                                      | TLVH431IDBZR                                                         | $T_{amb} = -40\text{ }^{\circ}\text{C to } 85\text{ }^{\circ}\text{C}$          | -    | 0.06 | 0.16 | $\mu\text{A}$ |
|                                                                                                      | TLVH431QDBZR<br>TLVH431MQDBRZ<br>TLVH431QDBVR                        | $T_{amb} = -40\text{ }^{\circ}\text{C to } 125\text{ }^{\circ}\text{C}$         | -    | 0.07 | 0.24 | $\mu\text{A}$ |
| $I_{K(min)}$                                                                                         | minimum cathode current                                              | $V_{KA} = V_{ref}$                                                              | -    | 55   | 80   | $\mu\text{A}$ |
| $I_{off}$                                                                                            | off-state current                                                    | $V_{KA} = 18\text{ V}; V_{ref} = 0$                                             | -    | 0.01 | 0.05 | $\mu\text{A}$ |
| $Z_{KA}$                                                                                             | dynamic cathode-anode impedance                                      | $I_K = 0.1\text{ mA to } 70\text{ mA};$<br>$V_{KA} = V_{ref}; f < 1\text{ kHz}$ |      |      |      |               |
|                                                                                                      | SOT23                                                                |                                                                                 | -    | 0.10 | 0.15 | $\Omega$      |
|                                                                                                      | SOT753                                                               |                                                                                 | -    | 0.15 | 0.20 | $\Omega$      |

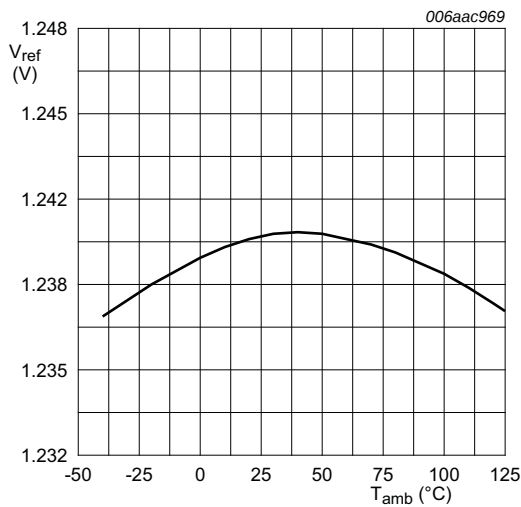
**Table 10. Characteristics ...continued**

$T_{amb} = 25\text{ °C}$  unless otherwise specified.

| Symbol                                                                                           | Parameter                                                            | Conditions                                                                     | Min  | Typ  | Max  | Unit          |
|--------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------|------|------|------|---------------|
| <b>A-Grade (1 %): TLVH431ACDBZR; TLVH431AIDBZR; TLVH431AQDBZR; TLVH431AMQDBZR; TLVH431AQDBVR</b> |                                                                      |                                                                                |      |      |      |               |
| $V_{ref}$                                                                                        | reference voltage                                                    | $V_{KA} = V_{ref}; I_K = 10\text{ mA}$                                         |      |      |      |               |
|                                                                                                  |                                                                      | $T_{amb} = 25\text{ °C}$                                                       | 1228 | 1240 | 1252 | mV            |
|                                                                                                  | TLVH431ACDBZR                                                        | $T_{amb} = 0\text{ °C to }70\text{ °C}$                                        | 1221 | -    | 1259 | mV            |
|                                                                                                  | TLVH431AIDBZR                                                        | $T_{amb} = -40\text{ °C to }85\text{ °C}$                                      | 1215 | -    | 1265 | mV            |
|                                                                                                  | TLVH431AQDBZR<br>TLVH431AMQDBZR<br>TLVH431AQDBVR                     | $T_{amb} = -40\text{ °C to }125\text{ °C}$                                     | 1209 | -    | 1271 | mV            |
| $\Delta V_{ref}$                                                                                 | reference voltage variation                                          | $V_{KA} = V_{ref}; I_K = 10\text{ mA}$                                         |      |      |      |               |
|                                                                                                  | TLVH431ACDBZR                                                        | $T_{amb} = 0\text{ °C to }70\text{ °C}$                                        | -    | 2    | 10   | mV            |
|                                                                                                  | TLVH431AIDBZR                                                        | $T_{amb} = -40\text{ °C to }85\text{ °C}$                                      | -    | 3    | 10   | mV            |
|                                                                                                  | TLVH431AQDBZR<br>TLVH431AMQDBZR<br>TLVH431AQDBVR                     | $T_{amb} = -40\text{ °C to }125\text{ °C}$                                     | -    | 4    | 10   | mV            |
|                                                                                                  |                                                                      |                                                                                |      |      |      |               |
| $\Delta V_{ref}/\Delta V_{KA}$                                                                   | reference voltage variation to cathode-anode voltage variation ratio | $I_K = 10\text{ mA};$<br>$\Delta V_{KA} = V_{ref}\text{ to }18\text{ V}$       | -    | -0.5 | -1.5 | mV/V          |
| $I_{ref}$                                                                                        | reference current                                                    | $I_K = 10\text{ mA};$<br>$R1 = 10\text{ k}\Omega; R2 = \text{open}$            | -    | 0.19 | 0.30 | $\mu\text{A}$ |
| $\Delta I_{ref}$                                                                                 | reference current variation                                          | $I_K = 10\text{ mA};$<br>$R1 = 10\text{ k}\Omega; R2 = \text{open}$            |      |      |      |               |
|                                                                                                  | TLVH431ACDBZR                                                        | $T_{amb} = 0\text{ °C to }70\text{ °C}$                                        | -    | 0.03 | 0.10 | $\mu\text{A}$ |
|                                                                                                  | TLVH431AIDBZR                                                        | $T_{amb} = -40\text{ °C to }85\text{ °C}$                                      | -    | 0.06 | 0.16 | $\mu\text{A}$ |
|                                                                                                  | TLVH431AQDBZR<br>TLVH431AMQDBZR<br>TLVH431AQDBVR                     | $T_{amb} = -40\text{ °C to }125\text{ °C}$                                     | -    | 0.07 | 0.24 | $\mu\text{A}$ |
|                                                                                                  |                                                                      |                                                                                |      |      |      |               |
| $I_{K(min)}$                                                                                     | minimum cathode current                                              | $V_{KA} = V_{ref}$                                                             | -    | 55   | 80   | $\mu\text{A}$ |
| $I_{off}$                                                                                        | off-state current                                                    | $V_{KA} = 18\text{ V}; V_{ref} = 0$                                            | -    | 0.01 | 0.05 | $\mu\text{A}$ |
| $Z_{KA}$                                                                                         | dynamic cathode-anode impedance                                      | $I_K = 0.1\text{ mA to }70\text{ mA};$<br>$V_{KA} = V_{ref}; f < 1\text{ kHz}$ |      |      |      |               |
|                                                                                                  | SOT23                                                                |                                                                                | -    | 0.10 | 0.15 | $\Omega$      |
|                                                                                                  | SOT753                                                               |                                                                                | -    | 0.15 | 0.20 | $\Omega$      |

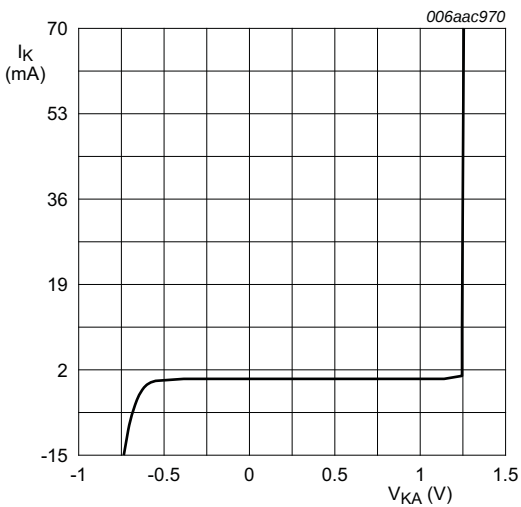
**Table 10. Characteristics ...continued** $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| Symbol                                                                | Parameter                                                            | Conditions                                                                                                                                      | Min  | Typ  | Max  | Unit          |
|-----------------------------------------------------------------------|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| <b>D-Grade (0.75 %): TLVH431DQDBZR; TLVH431DMQDBZR; TLVH431DQDBVR</b> |                                                                      |                                                                                                                                                 |      |      |      |               |
| $V_{ref}$                                                             | reference voltage                                                    | $V_{KA} = V_{ref}; I_K = 10\text{ mA}$                                                                                                          |      |      |      |               |
|                                                                       |                                                                      | $T_{amb} = 25\text{ }^{\circ}\text{C}$                                                                                                          | 1231 | 1240 | 1249 | mV            |
|                                                                       |                                                                      | $T_{amb} = -40\text{ }^{\circ}\text{C to } 125\text{ }^{\circ}\text{C}$                                                                         | 1215 | -    | 1265 | mV            |
| $\Delta V_{ref}$                                                      | reference voltage variation                                          | $V_{KA} = V_{ref}; I_K = 10\text{ mA}$                                                                                                          |      |      |      |               |
|                                                                       |                                                                      | $T_{amb} = 0\text{ }^{\circ}\text{C to } 70\text{ }^{\circ}\text{C}$                                                                            | -    | 2    | 10   | mV            |
|                                                                       |                                                                      | $T_{amb} = -40\text{ }^{\circ}\text{C to } 85\text{ }^{\circ}\text{C}$                                                                          | -    | 3    | 10   | mV            |
|                                                                       |                                                                      | $T_{amb} = -40\text{ }^{\circ}\text{C to } 125\text{ }^{\circ}\text{C}$                                                                         | -    | 4    | 10   | mV            |
| $\Delta V_{ref}/\Delta V_{KA}$                                        | reference voltage variation to cathode-anode voltage variation ratio | $I_K = 10\text{ mA};$<br>$\Delta V_{KA} = V_{ref}\text{ to } 18\text{ V}$                                                                       | -    | -0.5 | -1.5 | mV/V          |
| $I_{ref}$                                                             | reference current                                                    | $I_K = 10\text{ mA};$<br>$R1 = 10\text{ k}\Omega; R2 = \text{open}$                                                                             | -    | 0.19 | 0.30 | $\mu\text{A}$ |
| $\Delta I_{ref}$                                                      | reference current variation                                          | $I_K = 10\text{ mA};$<br>$R1 = 10\text{ k}\Omega; R2 = \text{open};$<br>$T_{amb} = -40\text{ }^{\circ}\text{C to } 125\text{ }^{\circ}\text{C}$ | -    | 0.07 | 0.24 | $\mu\text{A}$ |
| $I_{K(min)}$                                                          | minimum cathode current                                              | $V_{KA} = V_{ref}$                                                                                                                              | -    | 55   | 80   | $\mu\text{A}$ |
| $I_{off}$                                                             | off-state current                                                    | $V_{KA} = 18\text{ V}; V_{ref} = 0$                                                                                                             | -    | 0.01 | 0.05 | $\mu\text{A}$ |
| $Z_{KA}$                                                              | dynamic cathode-anode impedance                                      | $I_K = 0.1\text{ mA to } 70\text{ mA};$<br>$V_{KA} = V_{ref}; f < 1\text{ kHz}$                                                                 |      |      |      |               |
|                                                                       |                                                                      | SOT23                                                                                                                                           | -    | 0.10 | 0.15 | $\Omega$      |
|                                                                       |                                                                      | SOT753                                                                                                                                          | -    | 0.15 | 0.20 | $\Omega$      |



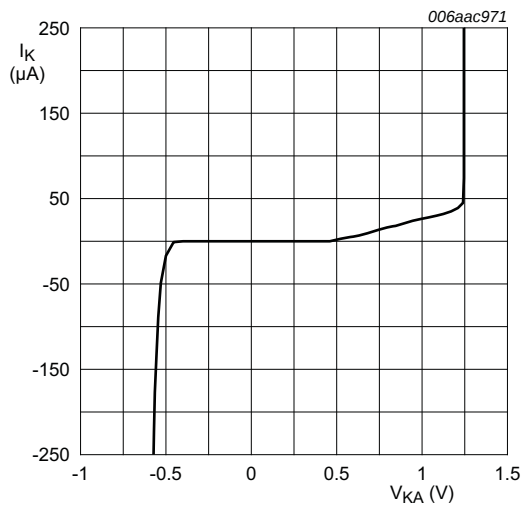
$I_K = 10\text{ mA}$ ;  $V_{KA} = V_{ref}$

Fig 4. Reference voltage as a function of ambient temperature; typical values



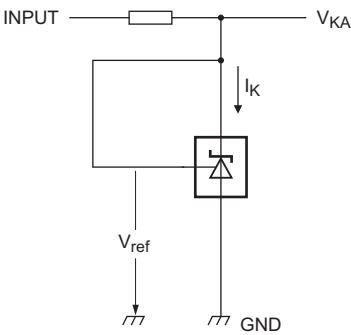
$V_{KA} = V_{ref}$ ;  $T_{amb} = 25\text{ °C}$

Fig 5. Cathode current as a function of cathode-anode voltage; typical values



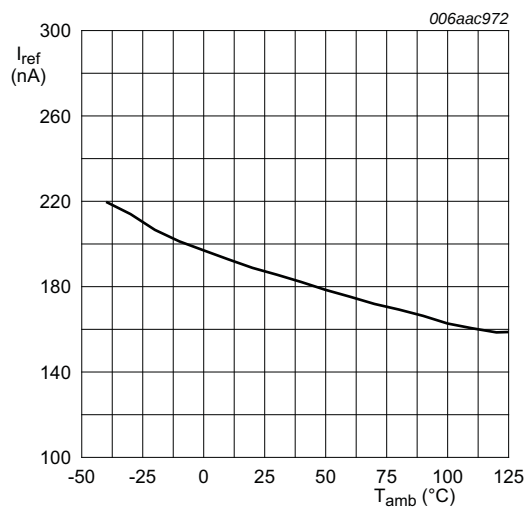
$V_{KA} = V_{ref}$ ;  $T_{amb} = 25\text{ °C}$

Fig 6. Cathode current as a function of cathode-anode voltage; typical values



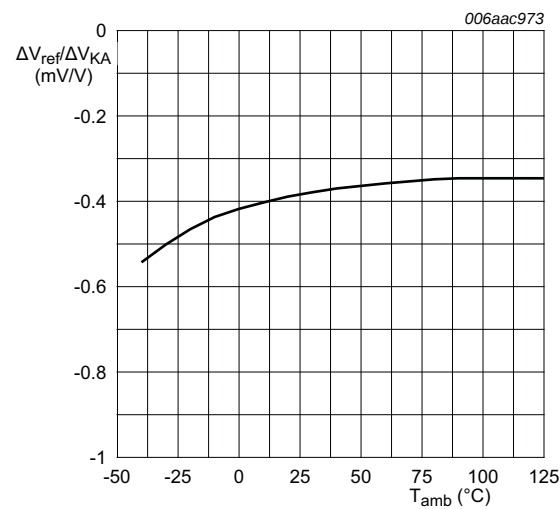
$I_K = 10\text{ mA}$ ;  $V_{KA} = V_{ref}$

Fig 7. Test circuit to [Figure 4](#), [5](#) and [6](#)



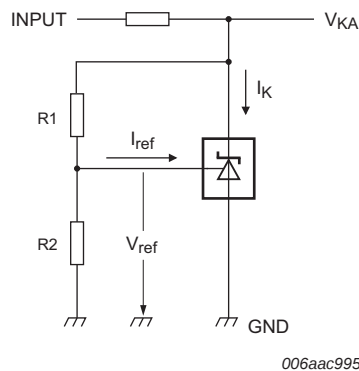
V<sub>KA</sub> = 1.24 V; I<sub>K</sub> = 10 mA; R1 = 10 kΩ; R2 = open

Fig 8. Reference current as a function of ambient temperature; typical values



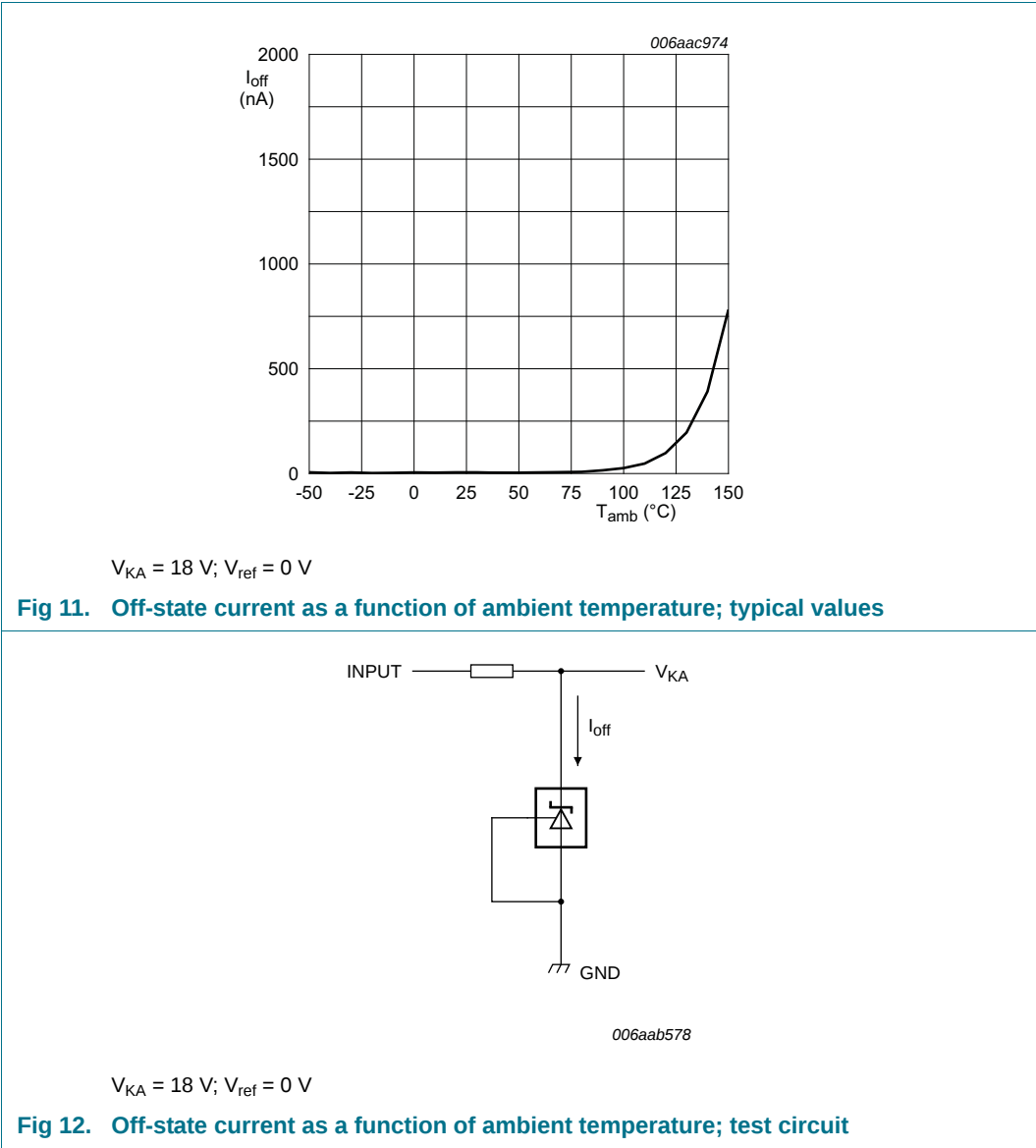
I<sub>K</sub> = 10 mA; T<sub>amb</sub> = 25 °C

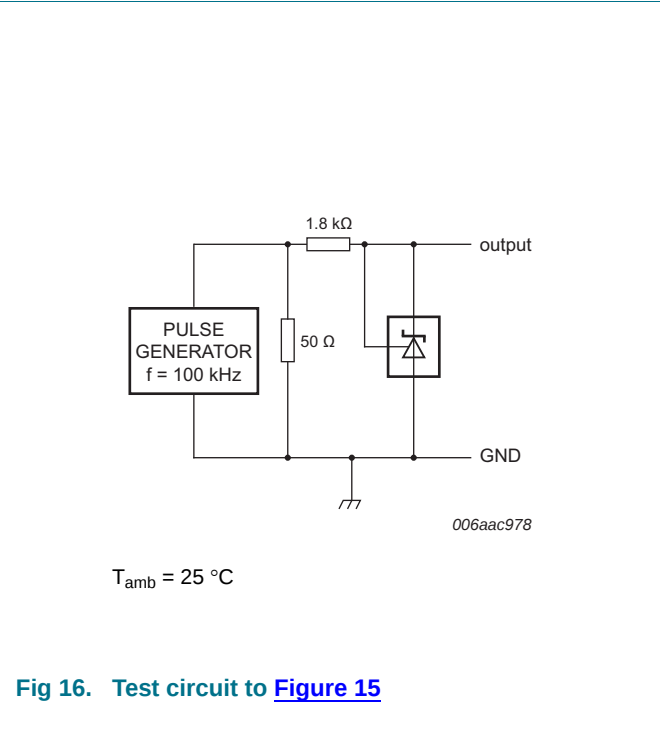
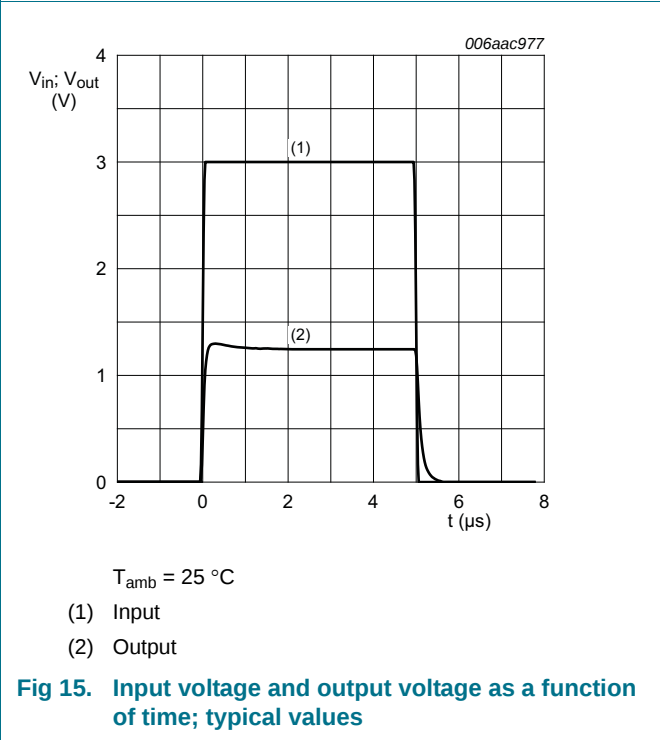
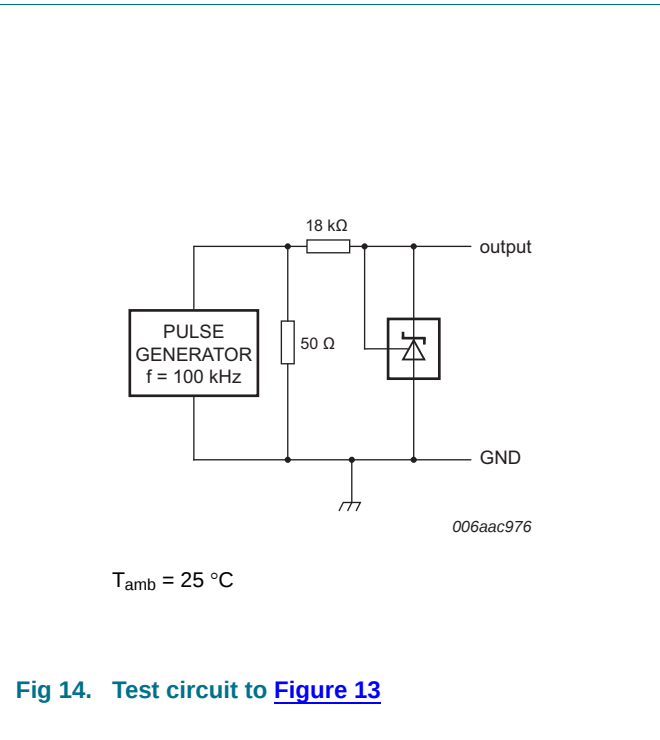
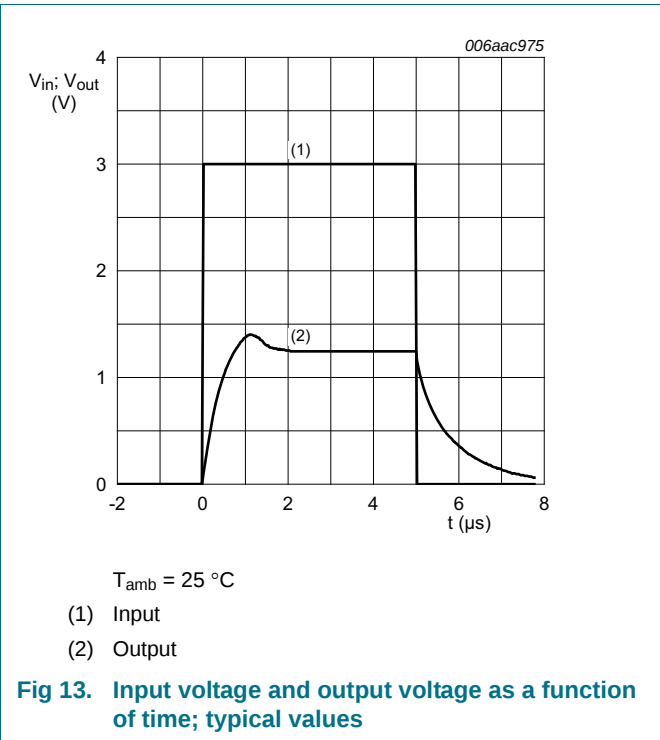
Fig 9. Reference voltage variation to cathode-anode voltage variation ratio as a function of ambient temperature; typical values

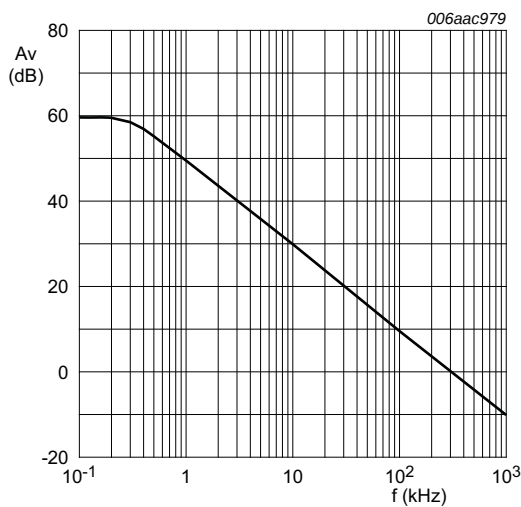


$$V_{KA} = V_{ref} \times \left(1 + \frac{R1}{R2}\right) + I_{ref} \times R1$$

Fig 10. Test circuit to [Figure 8](#) and [9](#)

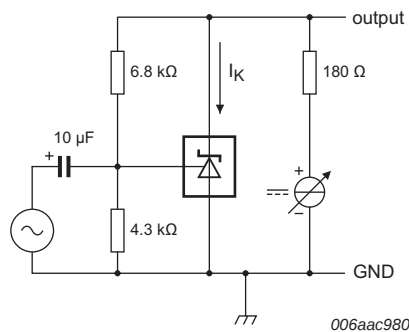






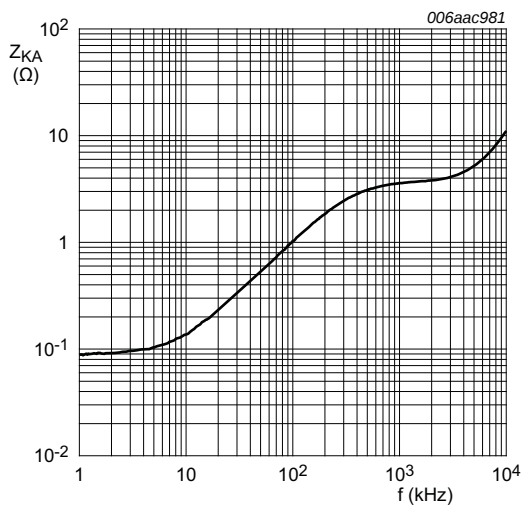
$I_K = 10\text{ mA}$ ;  $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$

Fig 17. Voltage amplification as a function of frequency; typical values



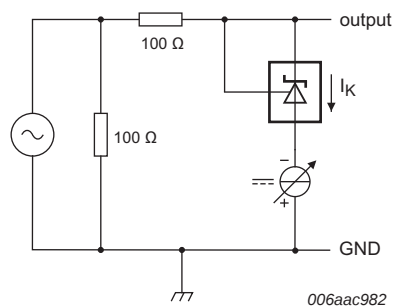
$I_K = 10\text{ mA}$ ;  $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$

Fig 18. Test circuit to [Figure 17](#)



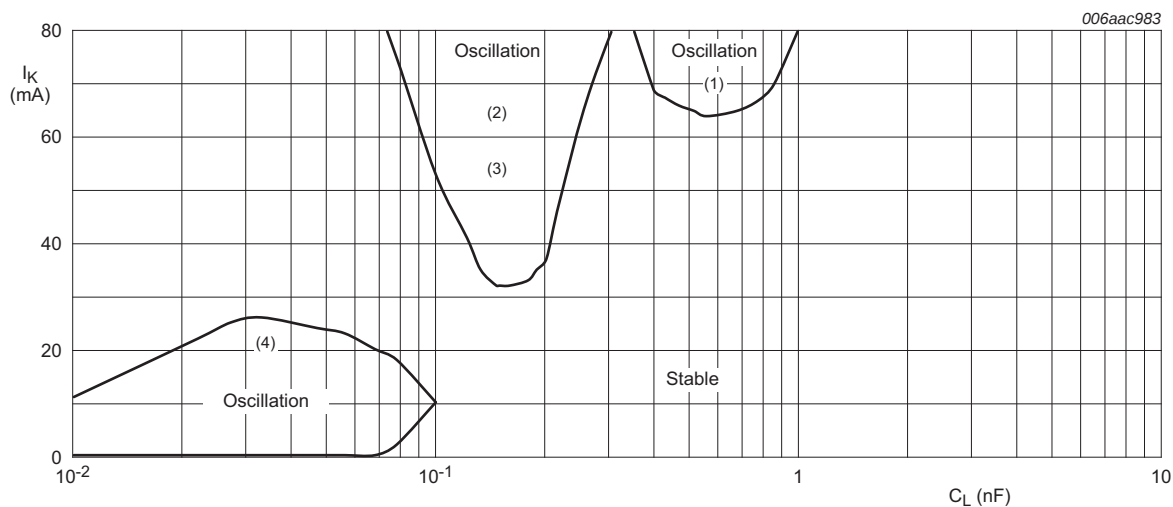
$I_K = 10\text{ mA}$ ;  $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$

Fig 19. Dynamic cathode-anode impedance as a function of frequency; typical values



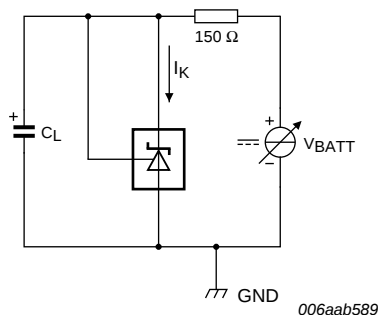
$I_K = 10\text{ mA}$ ;  $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$

Fig 20. Test circuit to [Figure 19](#)



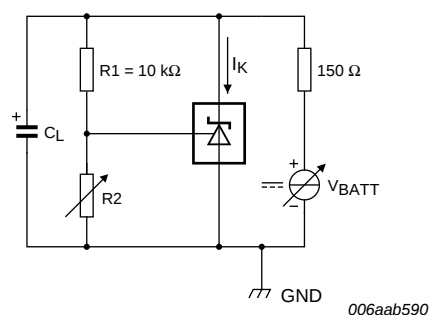
- $T_{amb} = 25\text{ }^{\circ}\text{C}$
- (1)  $V_{KA} = V_{ref}$
  - (2)  $V_{KA} = 2\text{ V}$
  - (3)  $V_{KA} = 3\text{ V}$
  - (4)  $V_{KA} = 18\text{ V}$

**Fig 21. Cathode current as a function of load capacitance; typical values**



$V_{KA} = V_{ref}$   
 $T_{amb} = 25\text{ }^{\circ}\text{C}$

**Fig 22. Test circuit to Figure 21**

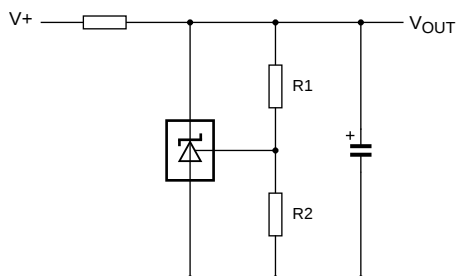


$V_{KA} > V_{ref}$   
 $T_{amb} = 25\text{ }^{\circ}\text{C}$

**Fig 23. Test circuit to Figure 21**

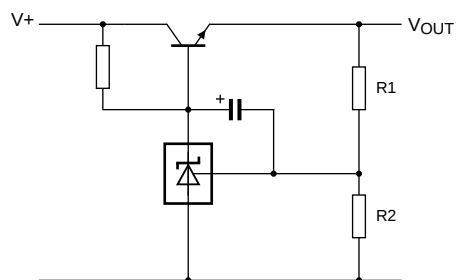
Figure 21, 22 and 23 show the stability boundaries and test circuits for the worst case conditions with a load capacitance mounted as close as possible to the device. The required load capacitance for stable operation varies depending on the operating temperature and capacitor Equivalent Series Resistance (ESR). Verify that the application circuit is stable over the anticipated operating current and temperature ranges.

## 13. Application information



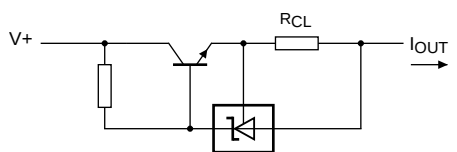
006aab592

$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) \times V_{ref}$$

**Fig 24. Shunt regulator**


006aab593

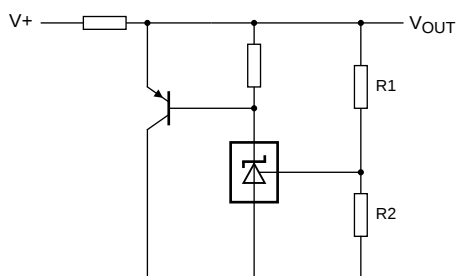
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) \times V_{ref}; V_{OUT(min)} = V_{ref} + V_{be}$$

**Fig 25. Series pass regulator**


006aab595

$$I_{OUT} = \frac{V_{ref}}{R_{CL}}$$

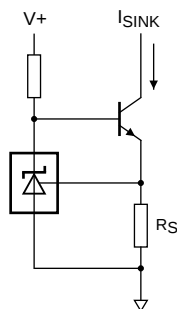
**Fig 26. Constant current source**



006aab596

$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) \times V_{ref}$$

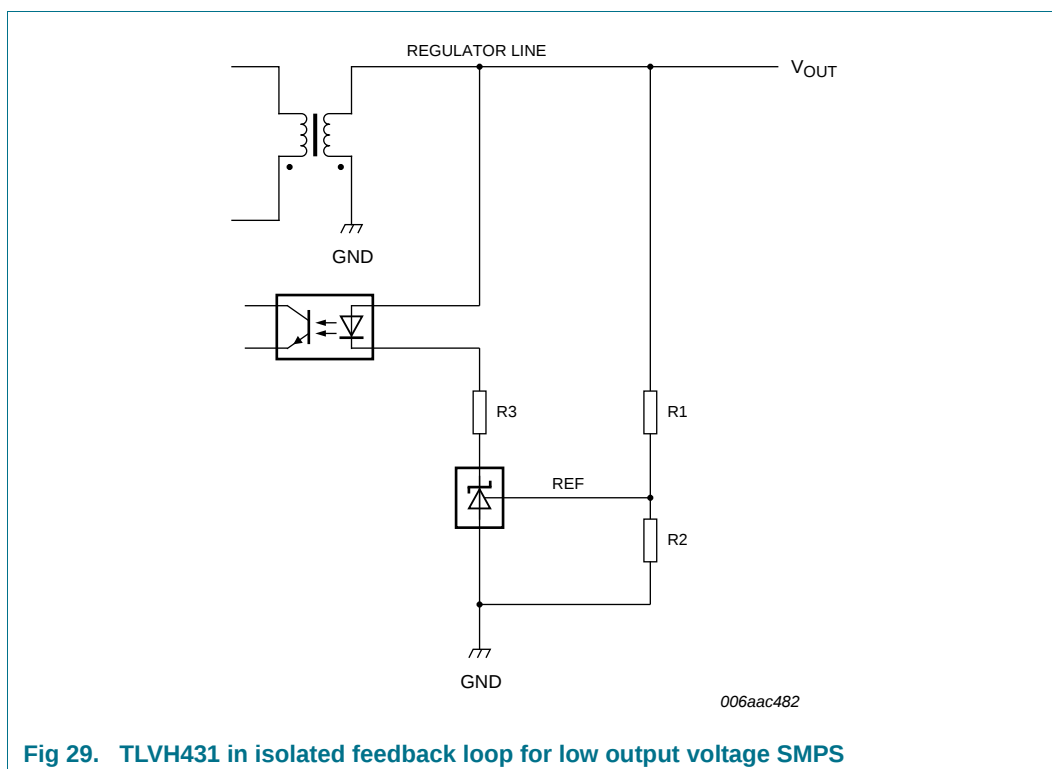
**Fig 27. High-current shunt regulator**



006aab597

$$I_{SINK} = \frac{V_{ref}}{R_S}$$

**Fig 28. Constant current sink**

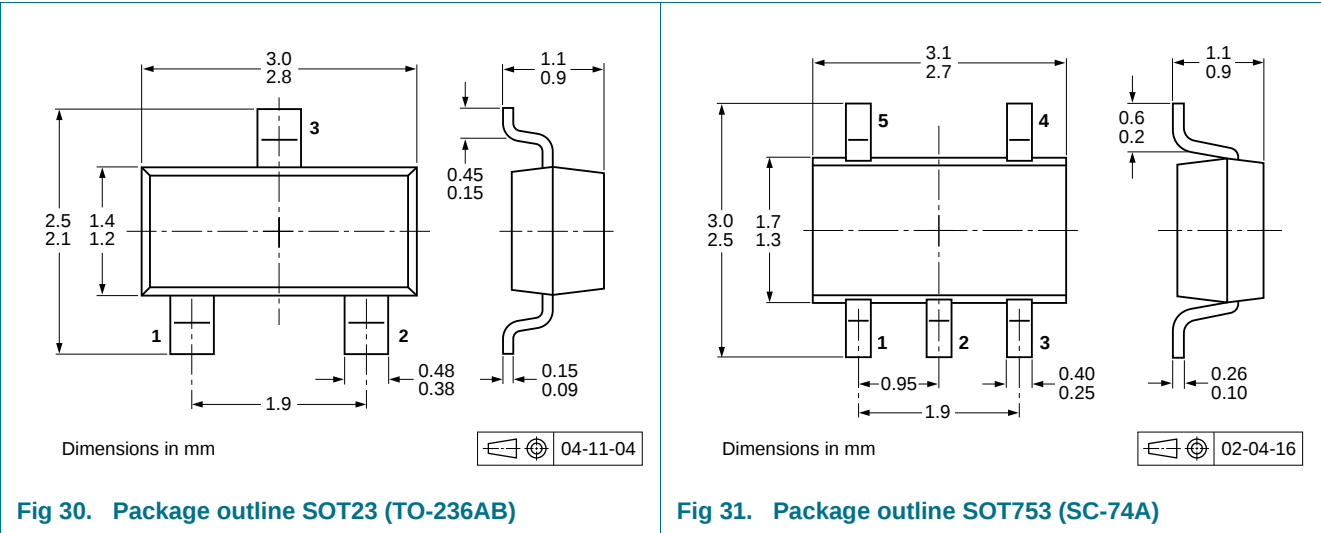


## 14. Test information

### 14.1 Quality information

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard *Q100 - Failure mechanism based stress test qualification for integrated circuits*, and is suitable for use in automotive applications.

15. Package outline



16. Packing information

**Table 11. Packing methods**  
*The indicated -xxx are the last three digits of the 12NC ordering code.*<sup>[1]</sup>

| Type number | Package | Description                    | Packing quantity |       |
|-------------|---------|--------------------------------|------------------|-------|
|             |         |                                | 3000             | 10000 |
| TLVH431XBZR | SOT23   | 4 mm pitch, 8 mm tape and reel | -215             | -235  |
| TLVH431XBVR | SOT753  | 4 mm pitch, 8 mm tape and reel | -115             | -     |

[1] For further information and the availability of packing methods, see [Section 20](#).

17. Soldering

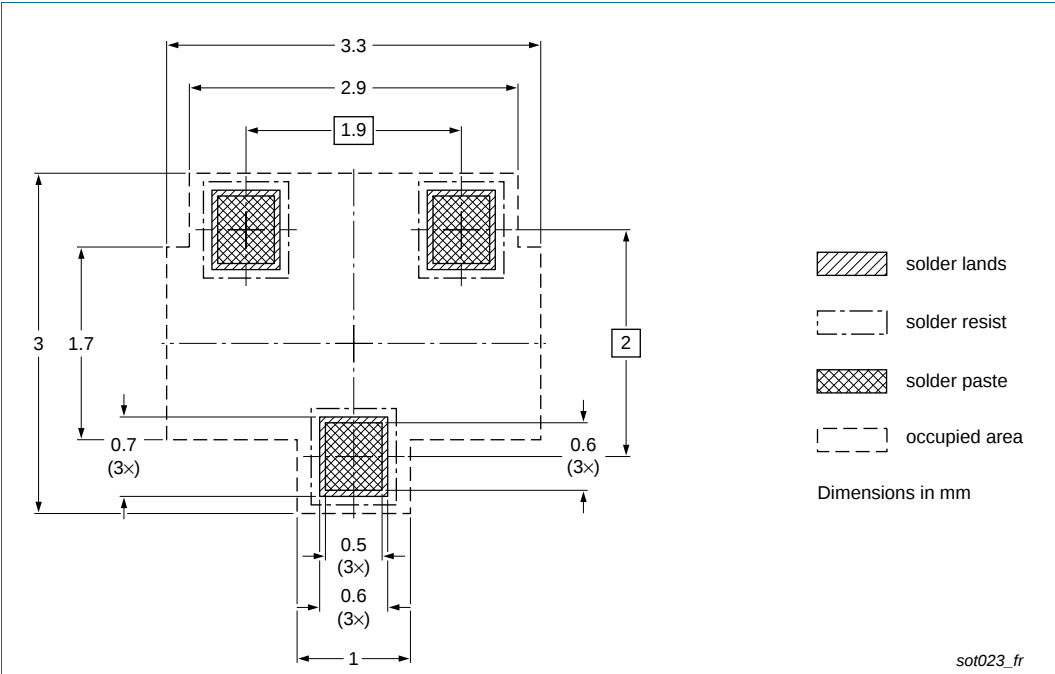


Fig 32. Reflow soldering footprint SOT23 (TO-236AB)

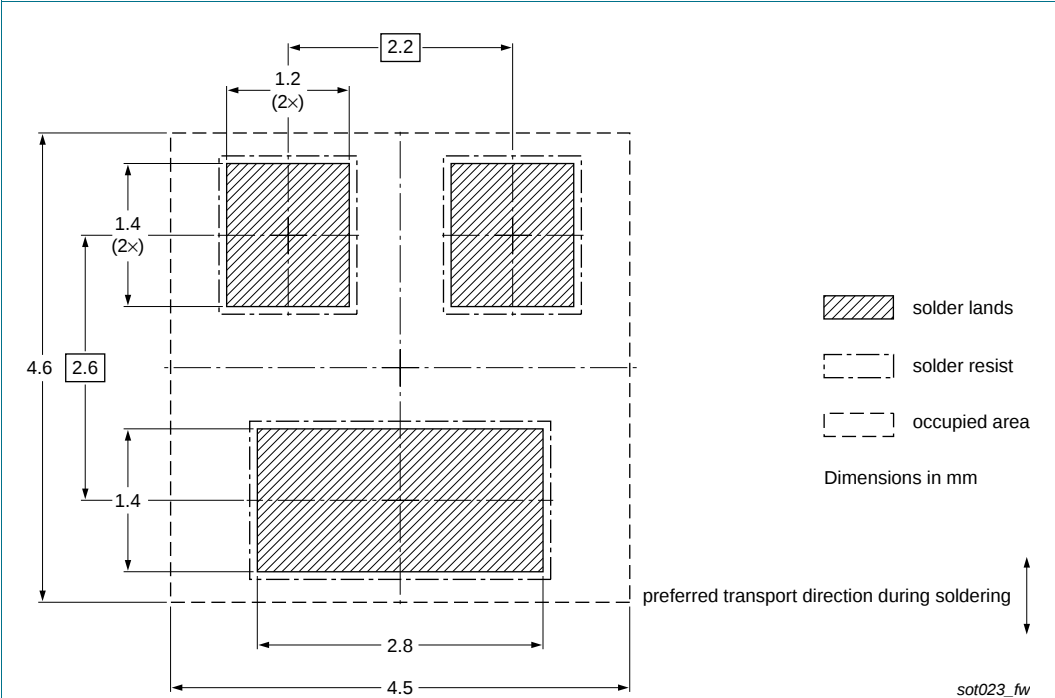


Fig 33. Wave soldering footprint SOT23 (TO-236AB)

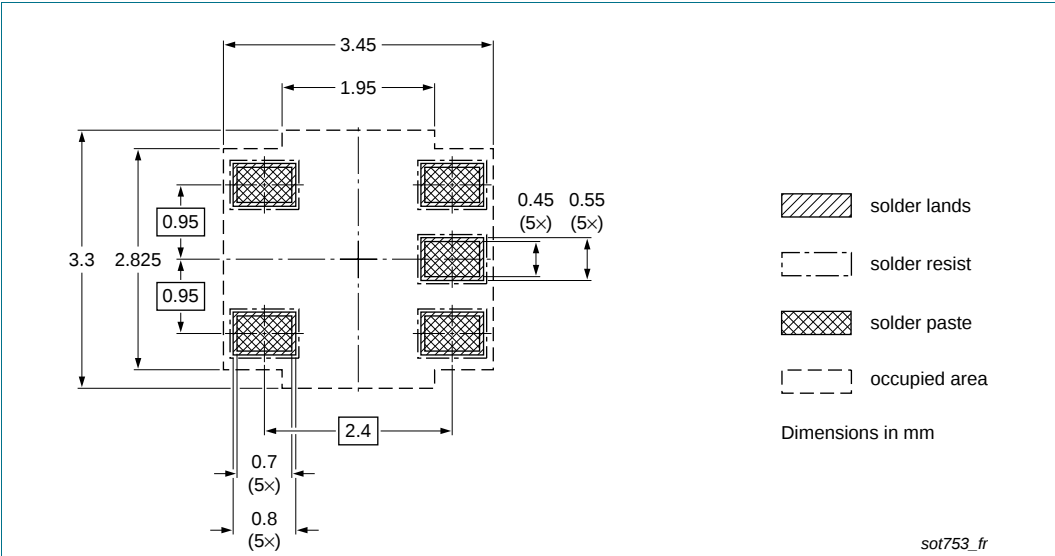


Fig 34. Reflow soldering footprint SOT753 (SC-74A)

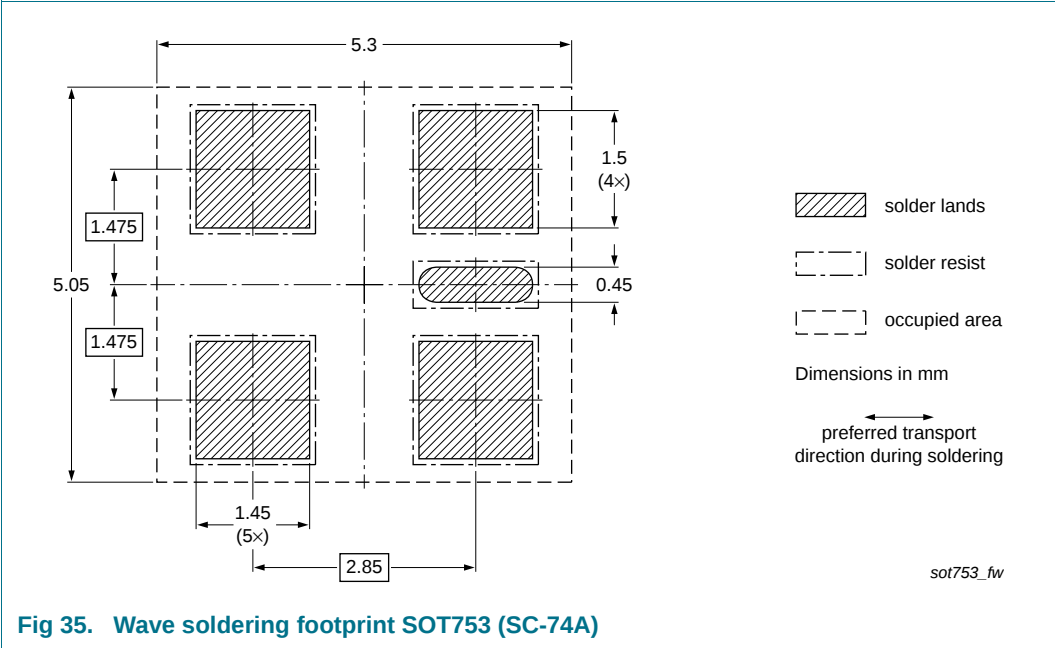


Fig 35. Wave soldering footprint SOT753 (SC-74A)

## 18. Revision history

Table 12. Revision history

| Document ID     | Release date | Data sheet status  | Change notice | Supersedes |
|-----------------|--------------|--------------------|---------------|------------|
| TLVH431_FAM v.1 | 20120427     | Product data sheet | -             | -          |

## 19. Legal information

### 19.1 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".

[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>.

### 19.2 Definitions

**Draft** — The document is a draft version only. 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 herein 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.

### 19.3 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.

**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.

**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.

## 19.4 Trademarks

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

## 20. Contact information

---

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

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

## 21. Contents

---

|           |                                               |           |
|-----------|-----------------------------------------------|-----------|
| <b>1</b>  | <b>General description</b> .....              | <b>1</b>  |
| <b>2</b>  | <b>Features and benefits</b> .....            | <b>1</b>  |
| <b>3</b>  | <b>Applications</b> .....                     | <b>1</b>  |
| <b>4</b>  | <b>Quick reference data</b> .....             | <b>2</b>  |
| <b>5</b>  | <b>Ordering information</b> .....             | <b>2</b>  |
| <b>6</b>  | <b>Marking</b> .....                          | <b>2</b>  |
| <b>7</b>  | <b>Functional diagram</b> .....               | <b>3</b>  |
| <b>8</b>  | <b>Pinning information</b> .....              | <b>3</b>  |
| <b>9</b>  | <b>Limiting values</b> .....                  | <b>4</b>  |
| <b>10</b> | <b>Recommended operating conditions</b> ..... | <b>5</b>  |
| <b>11</b> | <b>Thermal characteristics</b> .....          | <b>6</b>  |
| <b>12</b> | <b>Characteristics</b> .....                  | <b>7</b>  |
| <b>13</b> | <b>Application information</b> .....          | <b>16</b> |
| <b>14</b> | <b>Test information</b> .....                 | <b>18</b> |
| 14.1      | Quality information .....                     | 18        |
| <b>15</b> | <b>Package outline</b> .....                  | <b>19</b> |
| <b>16</b> | <b>Packing information</b> .....              | <b>19</b> |
| <b>17</b> | <b>Soldering</b> .....                        | <b>20</b> |
| <b>18</b> | <b>Revision history</b> .....                 | <b>22</b> |
| <b>19</b> | <b>Legal information</b> .....                | <b>23</b> |
| 19.1      | Data sheet status .....                       | 23        |
| 19.2      | Definitions .....                             | 23        |
| 19.3      | Disclaimers .....                             | 23        |
| 19.4      | Trademarks .....                              | 24        |
| <b>20</b> | <b>Contact information</b> .....              | <b>24</b> |
| <b>21</b> | <b>Contents</b> .....                         | <b>25</b> |

---

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. 2012.

All rights reserved.

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

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

Date of release: 27 April 2012

Document identifier: TLVH431\_FAM