



TLVH431N family

Adjustable precision shunt regulators

Rev. 2 — 9 December 2020

Product data sheet

1. General description

Three-terminal shunt regulator family with an output voltage range between $V_{ref} = 1.24\text{ V}$ and 14 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 Table 5) |
|---|---------|---------------------------------|-----------------|------------------|-------------------------------------|
| | | 0 °C to 70 °C | -40 °C to 85 °C | -40 °C to 125 °C | |
| 1.5 % | SOT23 | TLVH431NCDBZR | TLVH431NIDBZR | TLVH431NQDBZR | normal pinning |
| | | | | TLVH431NMQDBZR | mirrored pinning |
| 1.0 % | | TLVH431NACDBZR | TLVH431NAIDBZR | TLVH431NAQDBZR | normal pinning |
| | | | | TLVH431NAMQDBZR | mirrored pinning |

2. Features and benefits

- Programmable output voltage up to 14 V
- Two different reference voltage tolerances:
 - Standard grade: 1.5 %
 - A-Grade: 1 %
- Low output noise
- Typical output impedance: 0.1 Ω
- 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} | - | 14 | V |
| I_K | cathode current | | 0.08 | - | 70 | mA |
| V_{ref} | reference voltage | $V_{KA} = V_{ref}$; $I_K = 10 \text{ mA}$; $T_{amb} = 25 \text{ }^\circ\text{C}$ | | | | |
| | • Standard-Grade (1.5 %) | | 1222 | 1240 | 1258 | mV |
| | • A-Grade (1.0 %) | | 1228 | 1240 | 1252 | mV |

5. Pinning information

Table 3. 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 | | |

6. Ordering information

Table 4. Ordering information

| Type number | Package | | Version |
|-----------------|----------|--|---------|
| | Name | Description | |
| TLVH431NCDBZR | TO-236AB | plastic surface-mounted package; 3 leads | SOT23 |
| TLVH431NIDBZR | | | |
| TLVH431NQDBZR | | | |
| TLVH431NMQDBZR | | | |
| TLVH431NACDBZR | | | |
| TLVH431NAIDBZR | | | |
| TLVH431NAQDBZR | | | |
| TLVH431NAMQDBZR | | | |

7. Marking

Table 5. Marking codes

| Type number | Marking code [1] | Type number | Marking code [1] |
|----------------|------------------|-----------------|------------------|
| TLVH431NCDBZR | 8M% | TLVH431NACDBZR | 8R% |
| TLVH431NIDBZR | 8N% | TLVH431NAIDBZR | 8S% |
| TLVH431NQDBZR | 8P% | TLVH431NAQDBZR | 8T% |
| TLVH431NMQDBZR | 8Q% | TLVH431NAMQDBZR | 8U% |

[1] % = placeholder for manufacturing site code.

8. Functional diagram

The TLVH431N 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 14 V with two external resistors (see Figure 10). These devices have a typical output impedance of 0.1 Ω . 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.

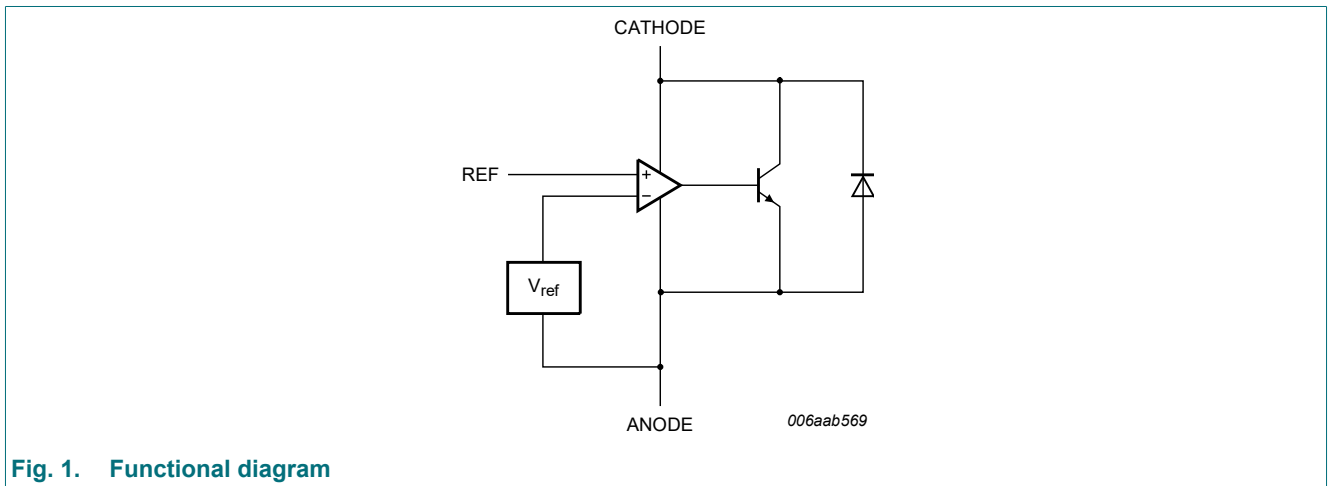


Fig. 1. Functional diagram

9. Limiting values

Table 6. Limiting values

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

| Symbol | Parameter | Conditions | Min | Max | Unit | |
|-----------|-------------------------|-----------------------------|-----|------|------|----|
| V_{KA} | cathode-anode voltage | | - | 14 | V | |
| I_K | cathode current | | -25 | 80 | mA | |
| I_{ref} | reference current | | - | 3 | mA | |
| P_{tot} | total power dissipation | $T_{amb} \leq 25\text{ °C}$ | [1] | - | 350 | mW |
| | | | [2] | - | 580 | mW |
| | | | [3] | - | 950 | mW |
| T_j | junction temperature | | - | 150 | °C | |
| T_{amb} | ambient temperature | | | | | |
| | TLVH431NXCDBZR | | 0 | +70 | °C | |
| | TLVH431NXIDBZR | | -40 | +85 | °C | |
| | TLVH431NXQDBZR | | -40 | +125 | °C | |
| T_{stg} | 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 cm².
- [3] Device mounted on a ceramic PCB, Al₂O₃, standard footprint.

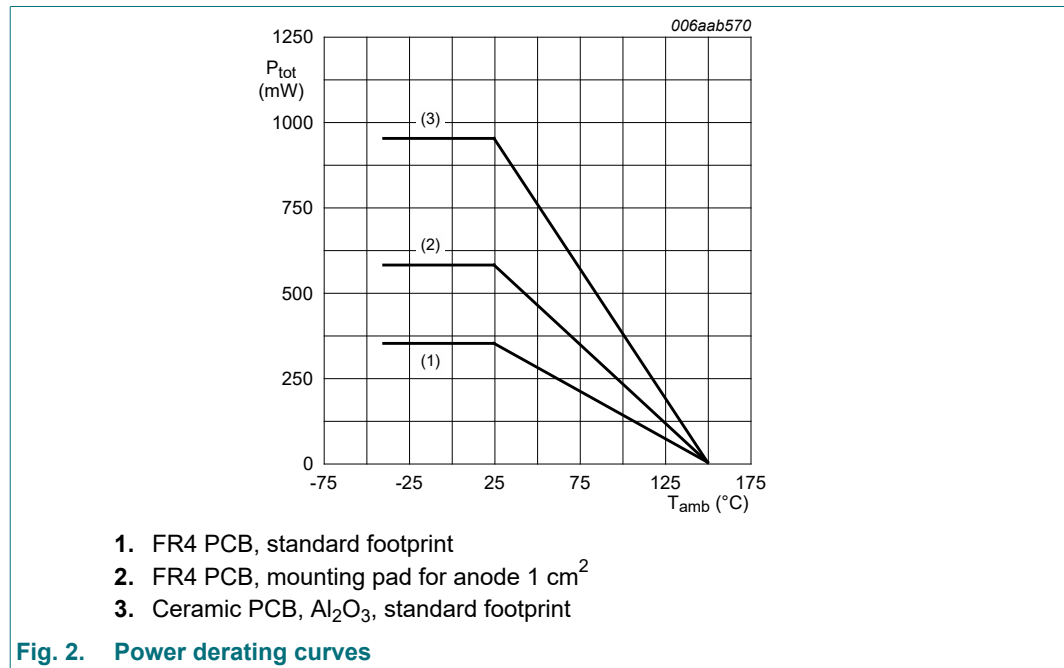


Fig. 2. Power derating curves

Table 7. ESD maximum ratings

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

| Symbol | Parameter | Conditions | Min | Max | Unit |
|-----------|---------------------------------|--------------------------------|-----|-----|------|
| V_{ESD} | electrostatic discharge voltage | MIL-STD-883 (human body model) | - | 4 | kV |
| | | machine model | - | 200 | V |

10. Recommended operating conditions

Table 8. Operating conditions

| Symbol | Parameter | Conditions | Min | Max | Unit |
|----------|-----------------------|------------|-----------|-----|------|
| V_{KA} | cathode-anode voltage | | V_{ref} | 14 | V |
| I_K | cathode current | | 0.08 | 70 | mA |

11. Thermal characteristics

Table 9. Thermal characteristics

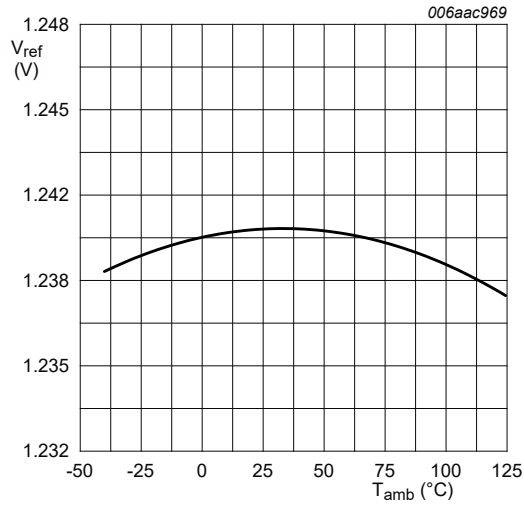
| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|----------------|--|-------------|-----|-----|-----|-----|------|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | [1] | - | - | 360 | K/W |
| | | | [2] | - | - | 216 | K/W |
| | | | [3] | - | - | 132 | K/W |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | [4] | - | - | 50 | K/W |

- [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 cm².
 [3] Device mounted on a ceramic PCB, Al₂O₃, standard footprint.
 [4] Soldering point of anode.

12. Characteristics

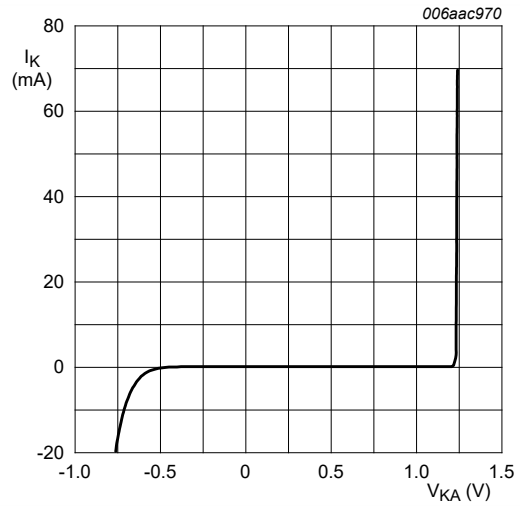
Table 10. Characteristics
 $T_{amb} = 25\text{ °C}$ unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|--|--|------|------|------|---------------|
| Standard-Grade (1.5 %): TLVH431NCDBZR; TLVH431NIDBZR; TLVH431NQDBZR; TLVH431NMQDBZR | | | | | | |
| V_{ref} | reference voltage | $V_{KA} = V_{ref}$; $I_K = 10\text{ mA}$; $T_{amb} = 25\text{ °C}$ | 1222 | 1240 | 1258 | mV |
| ΔV_{ref} | reference voltage variation | $V_{KA} = V_{ref}$; $I_K = 10\text{ mA}$ | | | | |
| | TLVH431NCDBZR | $T_{amb} = 0\text{ °C}$ to 70 °C | - | 2 | 10 | mV |
| | TLVH431NIDBZR | $T_{amb} = -40\text{ °C}$ to 85 °C | - | 3 | 10 | mV |
| | TLVH431NQDBZR | $T_{amb} = -40\text{ °C}$ to 125 °C | - | 5 | 10 | mV |
| | TLVH431NMQDBZR | | | | | |
| $\Delta V_{ref}/\Delta V_{KA}$ | reference voltage variation to cathode-anode voltage variation ratio | $I_K = 10\text{ mA}$; $\Delta V_{KA} = V_{ref}$ to 14 V | - | -0.8 | -2.7 | mV/V |
| I_{ref} | reference current | $I_K = 10\text{ mA}$; $R1 = 10\text{ k}\Omega$; $R2 = \text{open}$ | - | 0.19 | 0.30 | μA |
| ΔI_{ref} | reference current variation | $I_K = 10\text{ mA}$; $R1 = 10\text{ k}\Omega$; $R2 = \text{open}$ | | | | |
| | TLVH431NCDBZR | $T_{amb} = 0\text{ °C}$ to 70 °C | - | 0.03 | 1.0 | μA |
| | TLVH431NIDBZR | $T_{amb} = -40\text{ °C}$ to 85 °C | - | 0.06 | 0.16 | μA |
| | TLVH431NQDBZR | $T_{amb} = -40\text{ °C}$ to 125 °C | - | 0.07 | 0.24 | μA |
| | TLVH431NMQDBZR | | | | | |
| $I_{K(\min)}$ | minimum cathode current | $V_{KA} = V_{ref}$ | - | 55 | 80 | μA |
| I_{off} | off-state current | $V_{KA} = 14\text{ V}$; $V_{ref} = 0$ | - | 0.01 | 0.05 | μA |
| Z_{KA} | dynamic cathode-anode impedance | $I_K = 0.1\text{ mA}$ to 70 mA ; $V_{KA} = V_{ref}$; $f < 1\text{ kHz}$ | - | 0.10 | 0.15 | Ω |
| A-Grade (1 %): TLVH431NACDBZR; TLVH431NAIDBZR; TLVH431NAQDBZR; TLVH431NAMQDBZR | | | | | | |
| V_{ref} | reference voltage | $V_{KA} = V_{ref}$; $I_K = 10\text{ mA}$; $T_{amb} = 25\text{ °C}$ | 1228 | 1240 | 1252 | mV |
| ΔV_{ref} | reference voltage variation | $V_{KA} = V_{ref}$; $I_K = 10\text{ mA}$ | | | | |
| | TLVH431NACDBZR | $T_{amb} = 0\text{ °C}$ to 70 °C | - | 0.3 | 10 | mV |
| | TLVH431NAIDBZR | $T_{amb} = -40\text{ °C}$ to 85 °C | - | 1.3 | 10 | mV |
| | TLVH431NAQDBZR | $T_{amb} = -40\text{ °C}$ to 125 °C | - | 2.2 | 10 | mV |
| | TLVH431NAMQDBZR | | | | | |
| $\Delta V_{ref}/\Delta V_{KA}$ | reference voltage variation to cathode-anode voltage variation ratio | $I_K = 10\text{ mA}$; $\Delta V_{KA} = V_{ref}$ to 14 V | - | -0.5 | -2.7 | mV/V |
| I_{ref} | reference current | $I_K = 10\text{ mA}$; $R1 = 10\text{ k}\Omega$; $R2 = \text{open}$ | - | 0.19 | 0.30 | μA |
| ΔI_{ref} | reference current variation | $I_K = 10\text{ mA}$; $R1 = 10\text{ k}\Omega$; $R2 = \text{open}$ | | | | |
| | TLVH431NACDBZR | $T_{amb} = 0\text{ °C}$ to 70 °C | - | 0.03 | 0.10 | μA |
| | TLVH431NAIDBZR | $T_{amb} = -40\text{ °C}$ to 85 °C | - | 0.06 | 0.16 | μA |
| | TLVH431NAQDBZR | $T_{amb} = -40\text{ °C}$ to 125 °C | - | 0.07 | 0.24 | μA |
| | TLVH431NAMQDBZR | | | | | |
| $I_{K(\min)}$ | minimum cathode current | $V_{KA} = V_{ref}$ | - | 55 | 80 | μA |
| I_{off} | off-state current | $V_{KA} = 14\text{ V}$; $V_{ref} = 0$ | - | 0.01 | 0.05 | μA |
| Z_{KA} | dynamic cathode-anode impedance | $I_K = 0.1\text{ mA}$ to 70 mA ; $V_{KA} = V_{ref}$; $f < 1\text{ kHz}$ | - | 0.10 | 0.15 | Ω |



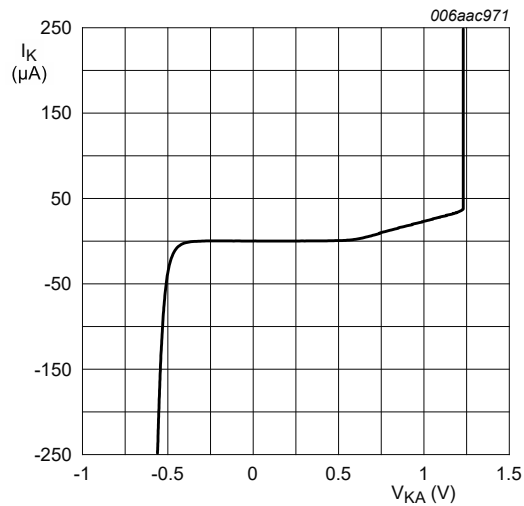
$I_K = 10 \text{ mA}; V_{KA} = V_{ref}$

Fig. 3. Reference voltage as a function of ambient temperature; typical values



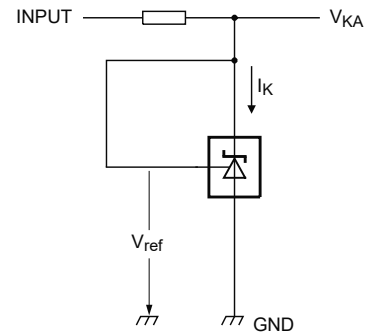
$V_{KA} = V_{ref}; T_{amb} = 25 \text{ °C}$

Fig. 4. Cathode current as a function of cathode-anode voltage; typical values



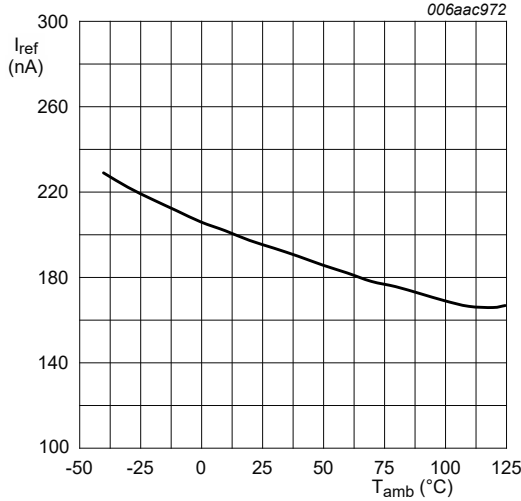
$V_{KA} = V_{ref}; T_{amb} = 25 \text{ °C}$

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



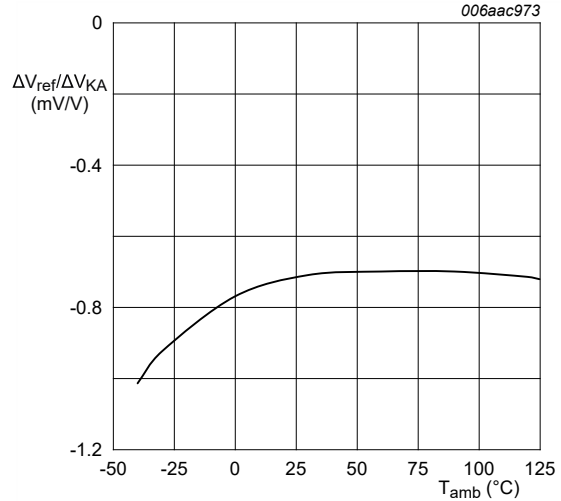
$I_K = 10 \text{ mA}; V_{KA} = V_{ref}$

Fig. 6. Test circuit to Figures 3, 4 and 5



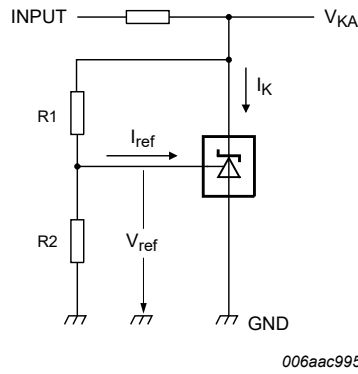
V_{KA} = 1.24 V; I_K = 10 mA; R1 = 10 kΩ; R2 = open

Fig. 7. Reference current as a function of ambient temperature; typical values



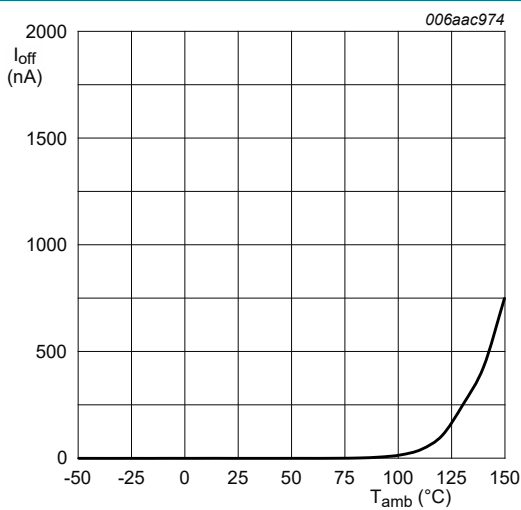
I_K = 10 mA; T_{amb} = 25 °C

Fig. 8. Reference voltage variation to cathode-anode voltage variation ratio as a function of ambient temperature; typical values



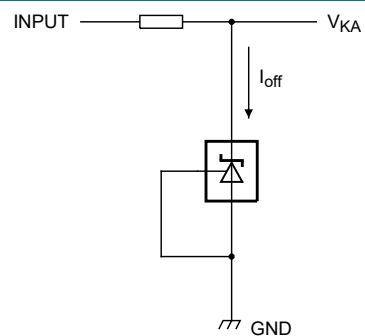
$$V_{KA} = V_{ref} \times (1 + R1/R2) + I_{ref} \times R1$$

Fig. 9. Test circuit to Figures 7 and 8



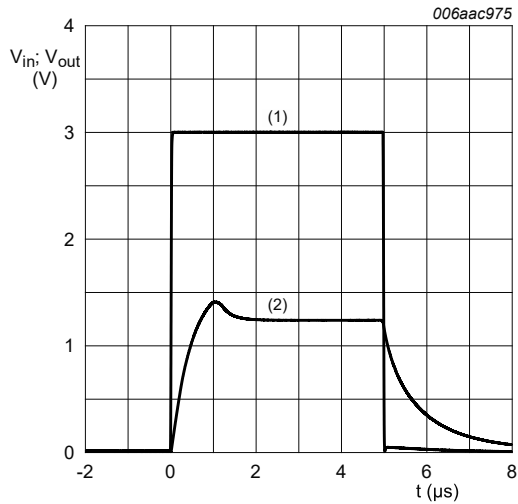
V_{KA} = 14 V; V_{ref} = 0

Fig. 10. Off-state current as a function of ambient temperature; typical values



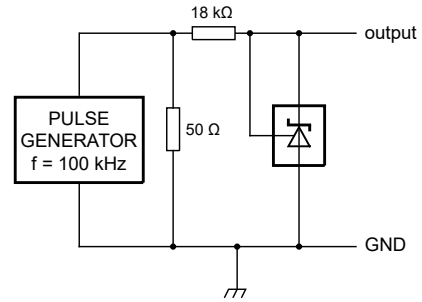
V_{KA} = 14 V; V_{ref} = 0

Fig. 11. Test circuit to Figure 10



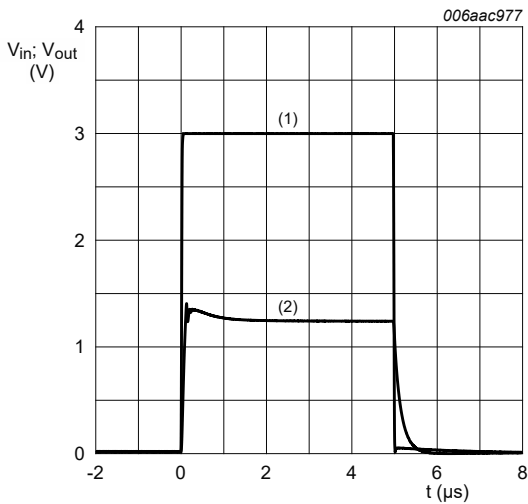
$T_{amb} = 25\text{ }^\circ\text{C}$
 (1) Input
 (2) Output

Fig. 12. Input voltage and output voltage as a function of time; typical values



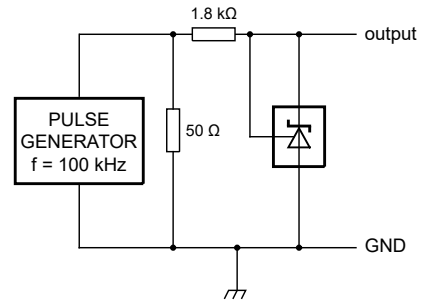
$T_{amb} = 25\text{ }^\circ\text{C}$

Fig. 13. Test circuit to Figure 12



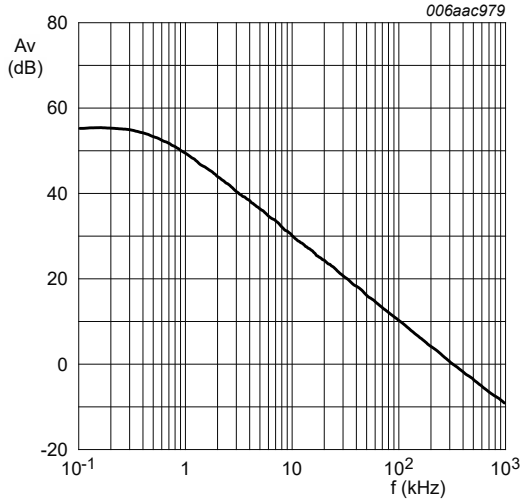
$T_{amb} = 25\text{ }^\circ\text{C}$
 (1) Input
 (2) Output

Fig. 14. Input voltage and output voltage as a function of time; typical values



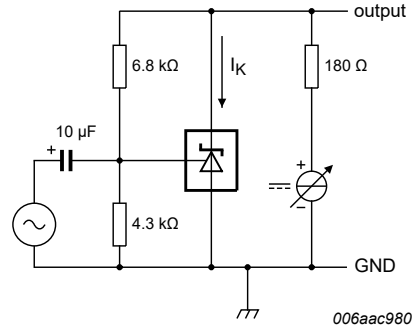
$T_{amb} = 25\text{ }^\circ\text{C}$

Fig. 15. Test circuit to Figure 14



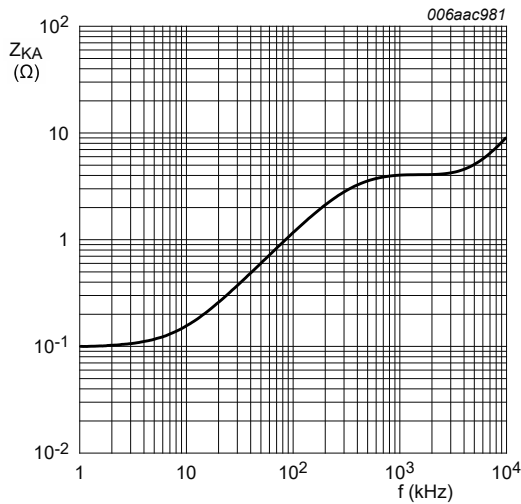
$I_K = 10 \text{ mA}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

Fig. 16. Voltage amplification as a function of frequency; typical values



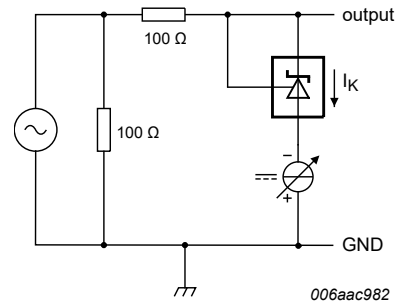
$I_K = 10 \text{ mA}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

Fig. 17. Test circuit to Figure 16



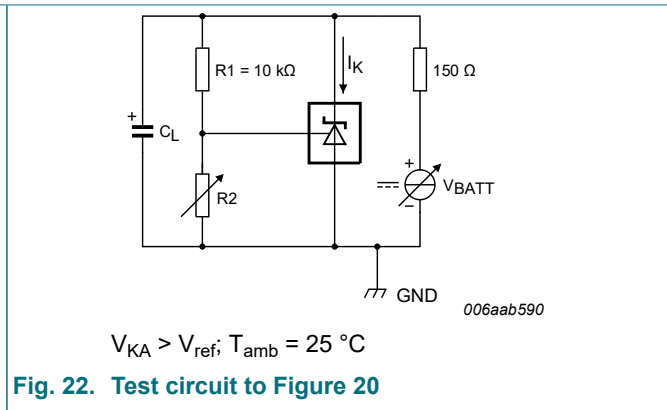
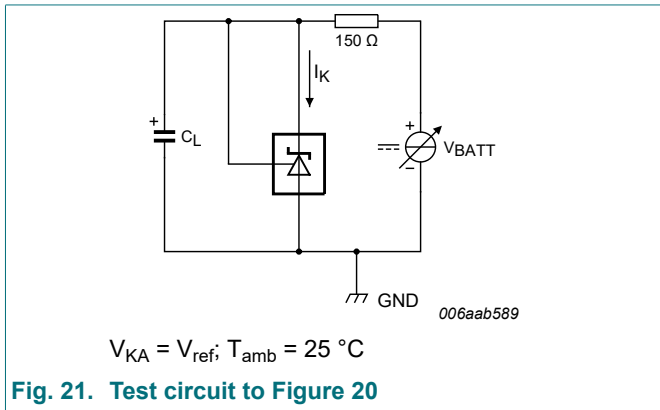
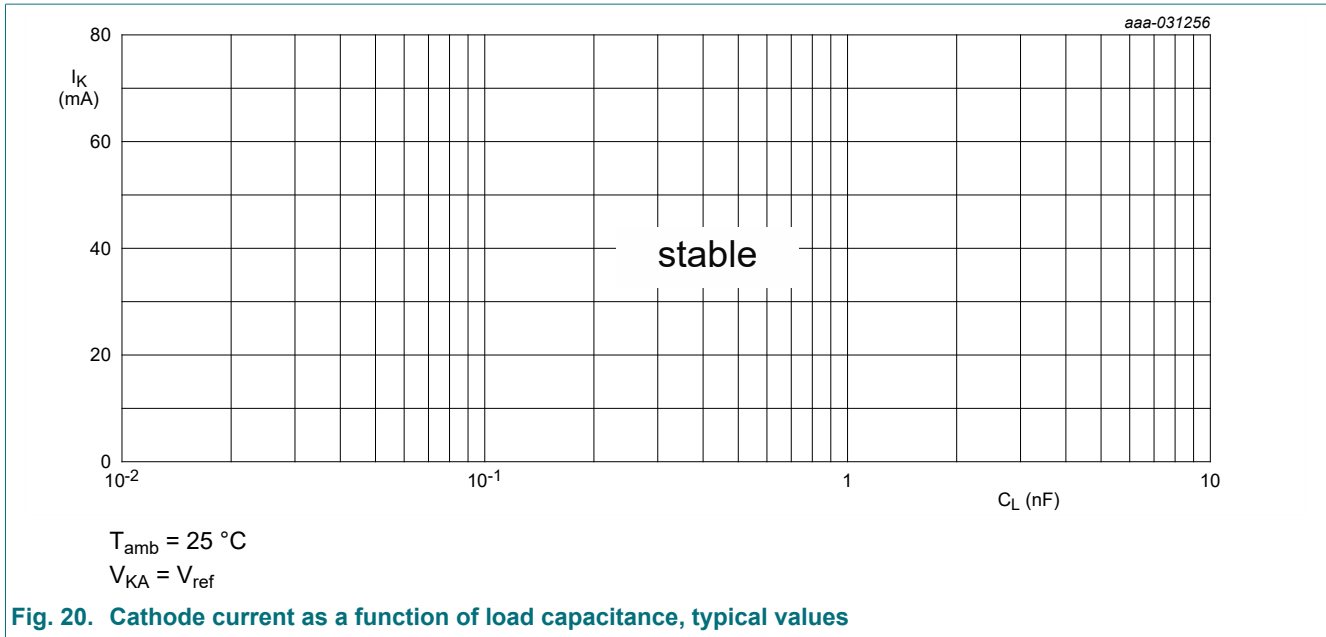
$I_K = 10 \text{ mA}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

Fig. 18. Dynamic cathode-anode impedance as a function of frequency; typical values



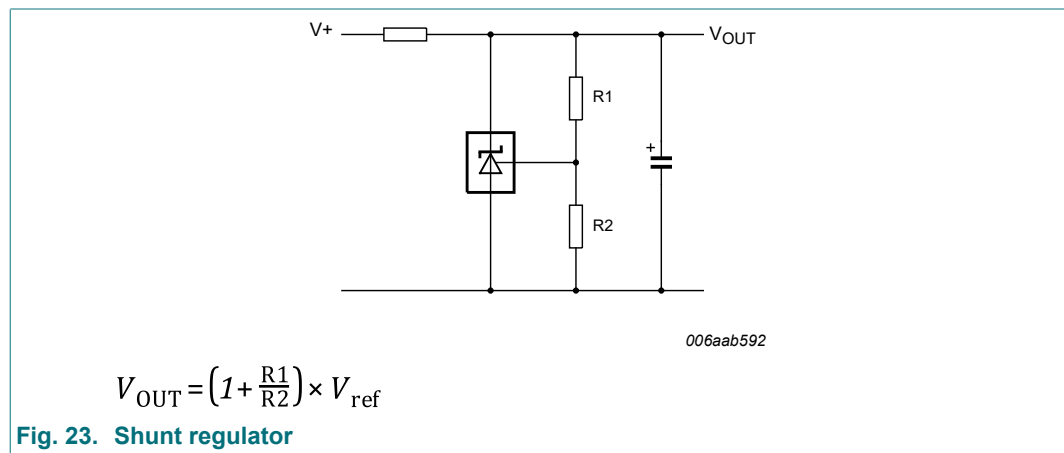
$I_K = 10 \text{ mA}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

Fig. 19. Test circuit to Figure 18



Figures 20, 21 and 22 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



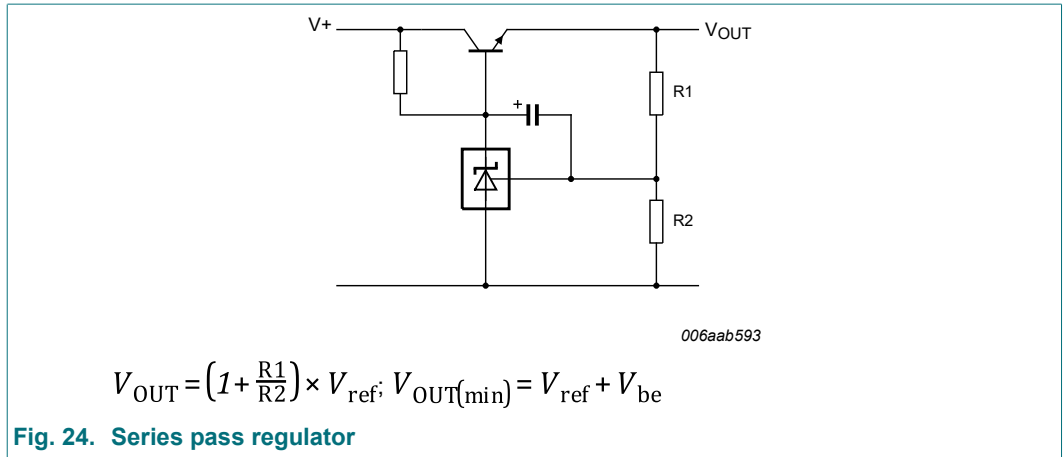


Fig. 24. Series pass regulator

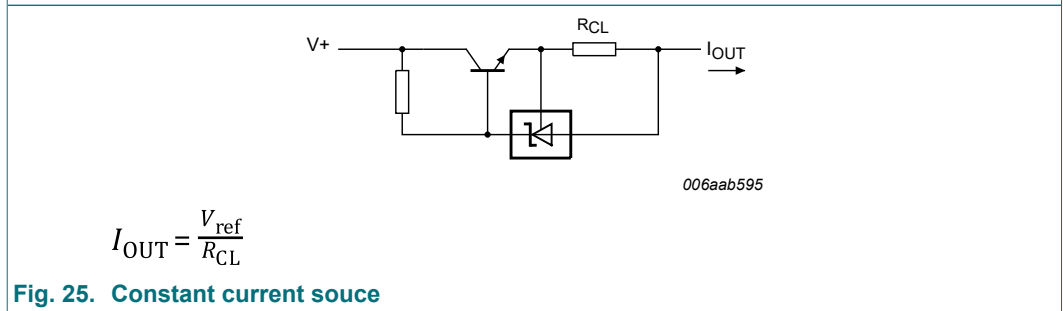


Fig. 25. Constant current source

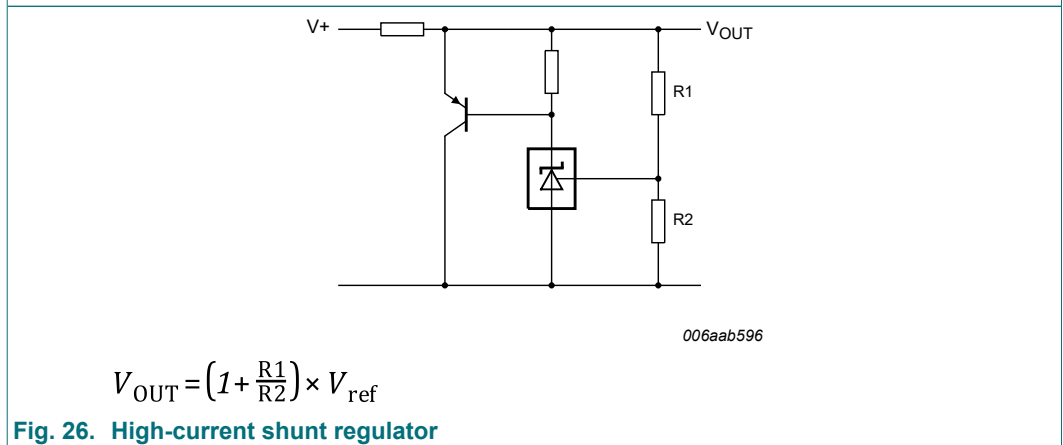


Fig. 26. High-current shunt regulator

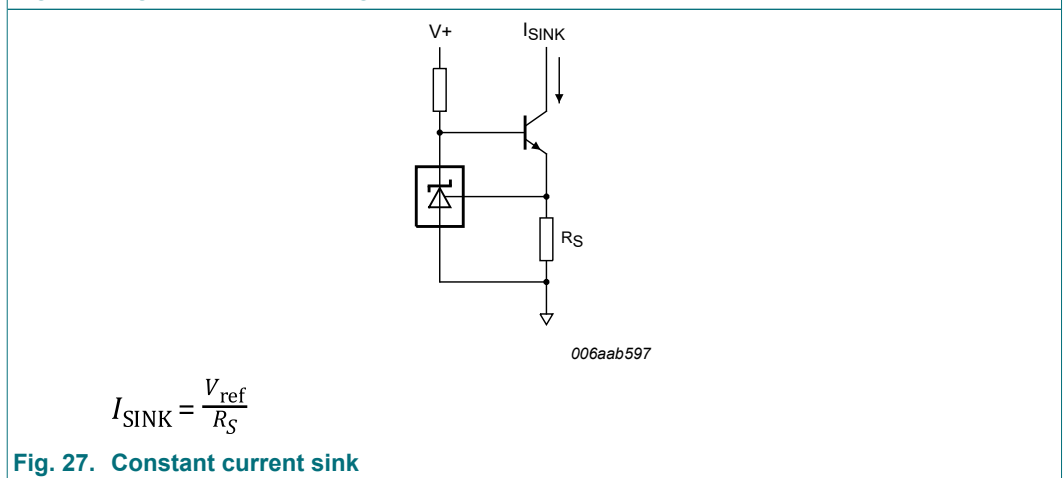


Fig. 27. Constant current sink

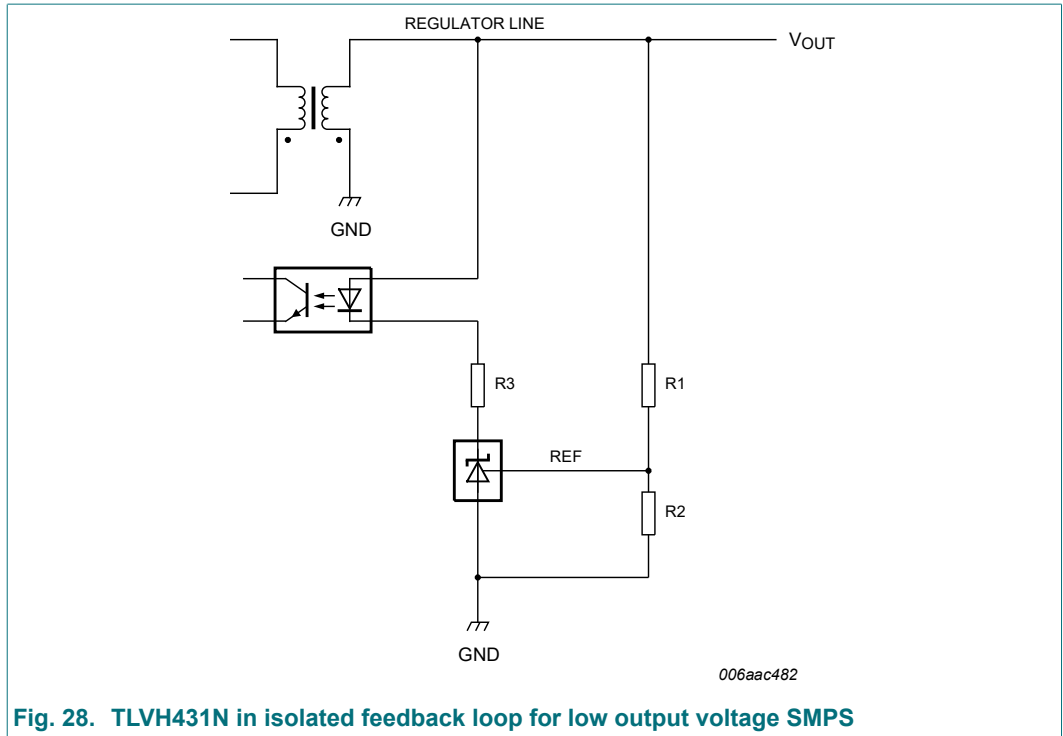


Fig. 28. TLVH431N in isolated feedback loop for low output voltage SMPS

14. Test information

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

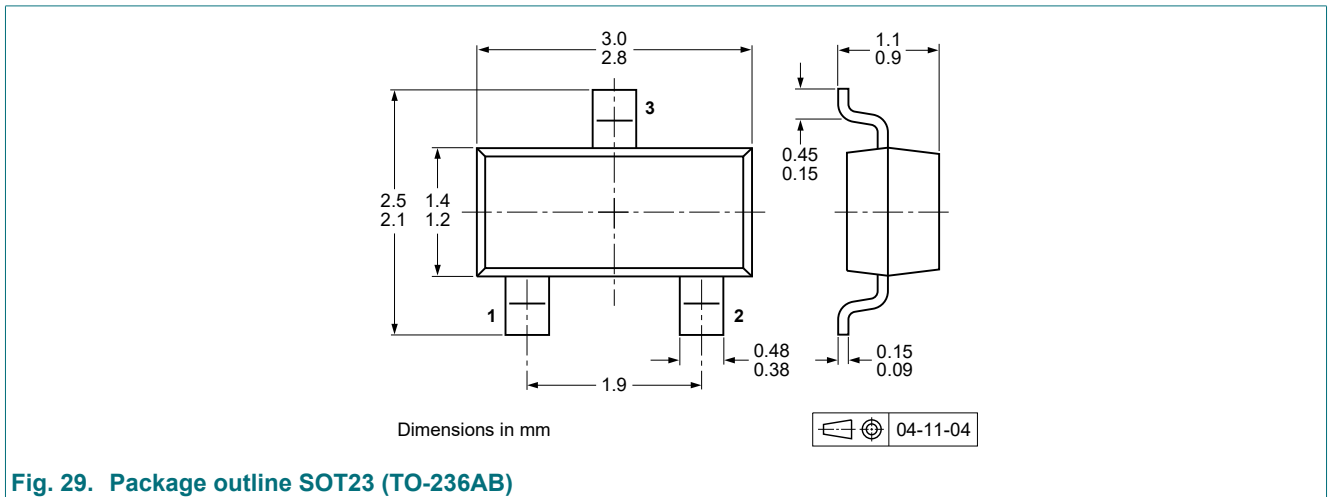


Fig. 29. Package outline SOT23 (TO-236AB)

16. Soldering

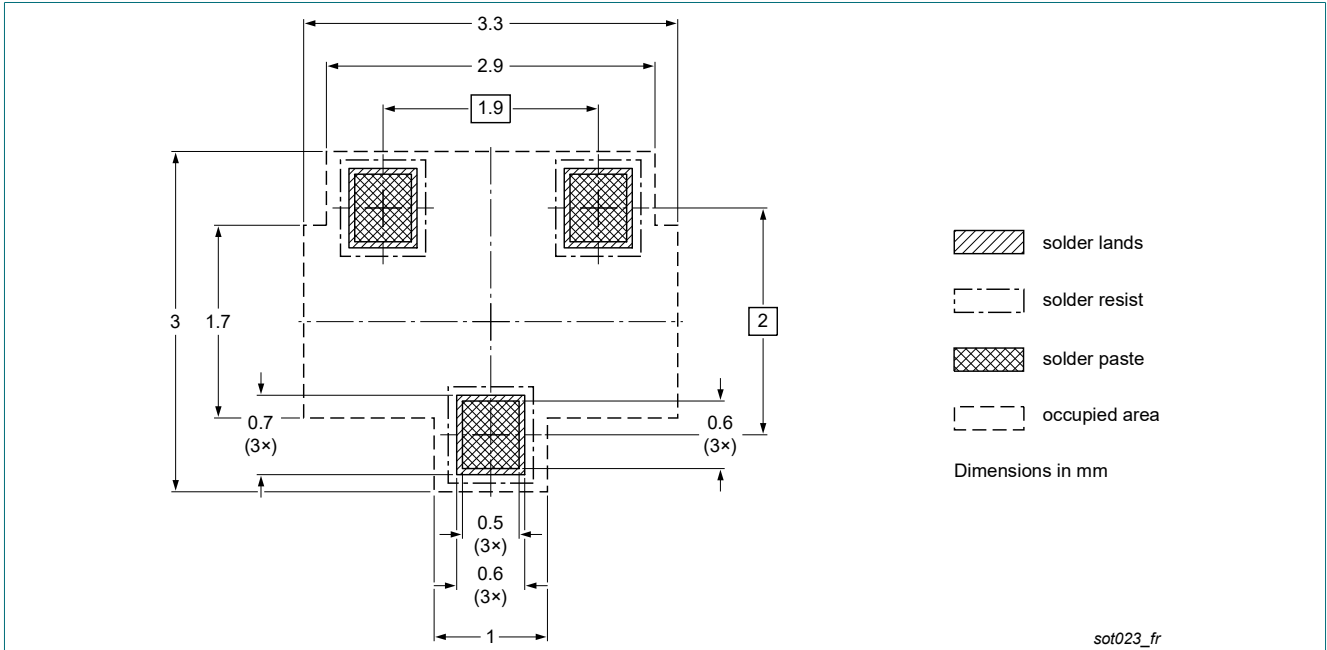


Fig. 30. Reflow soldering footprint SOT23 (TO-236AB)

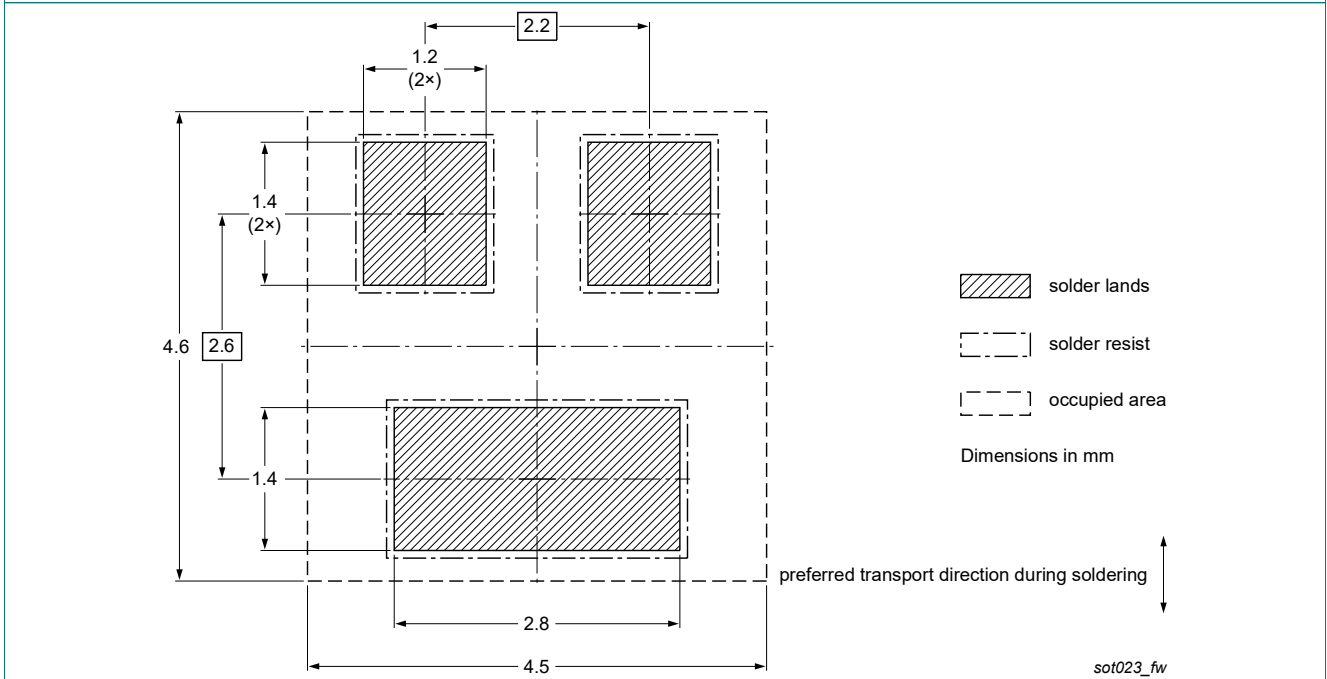


Fig. 31. Wave soldering footprint SOT23 (TO-236AB)

17. Revision history

Table 11. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|------------------|--|--------------------|---------------|------------|
| TLVH431N_FAM v.2 | 20201209 | Product data sheet | - | - |
| Modifications: | <ul style="list-style-type: none">• Pinning table changed• Figure 2 changed | | | |
| TLVH431N_FAM v.1 | 20200625 | Product data sheet | - | - |

18. Legal information

Data sheet status

| Document status [1][2] | Product status [3] | Definition |
|--------------------------------|--------------------|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at <https://www.nexperia.com>.

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