



# 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
TLVH431NACDBZR		TLVH431NAIDBZR	TLVH431NAQDBZR	normal pinning	
			TLVH431NAMQDBZR	mirrored pinning	
1.0 %					

## 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  $\Omega$
- 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)

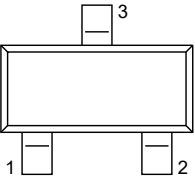
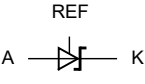

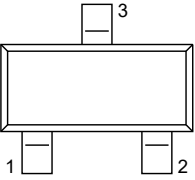
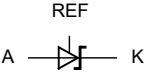

## 4. Quick reference data

Table 2. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{KA}$	cathode-anode voltage		$V_{ref}$	-	14	V
$I_K$	cathode current		0.08	-	70	mA
$V_{ref}$	reference voltage	$V_{KA} = V_{ref}$ ; $I_K = 10$ mA; $T_{amb} = 25$ °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
<b>SOT23; normal pinning: All types without MQDBZR ending</b>				
1	REF	reference		 REF A —  — K 006aab355
2	K	cathode		
3	A	anode		
<b>SOT23; mirrored pinning: All types with MQDBZR ending</b>				
1	K	cathode		 REF A —  — K 006aab355
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  $\Omega$ . 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.

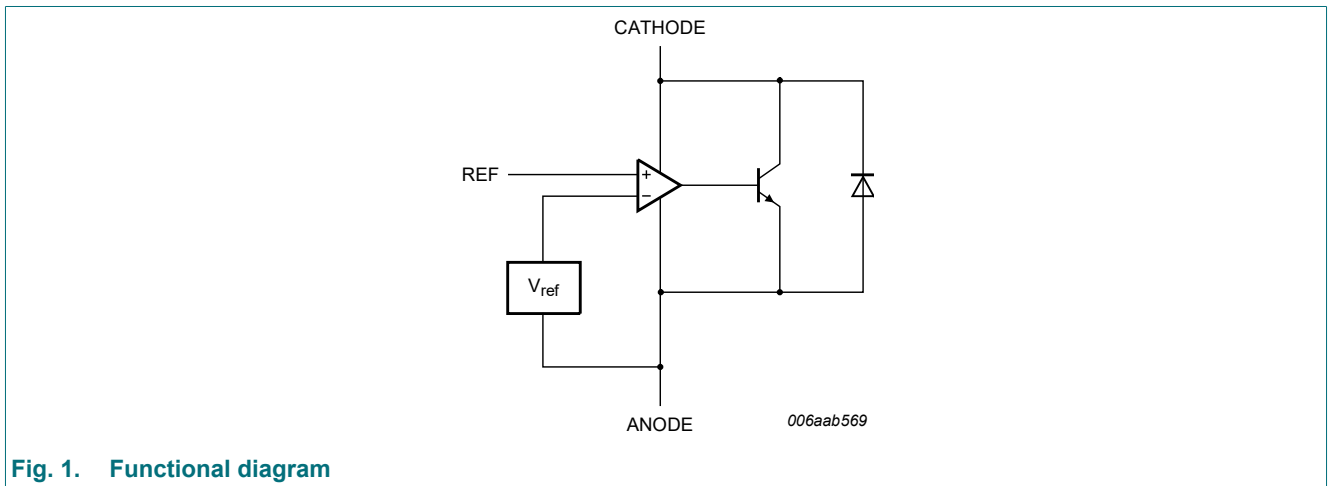


Fig. 1. Functional diagram

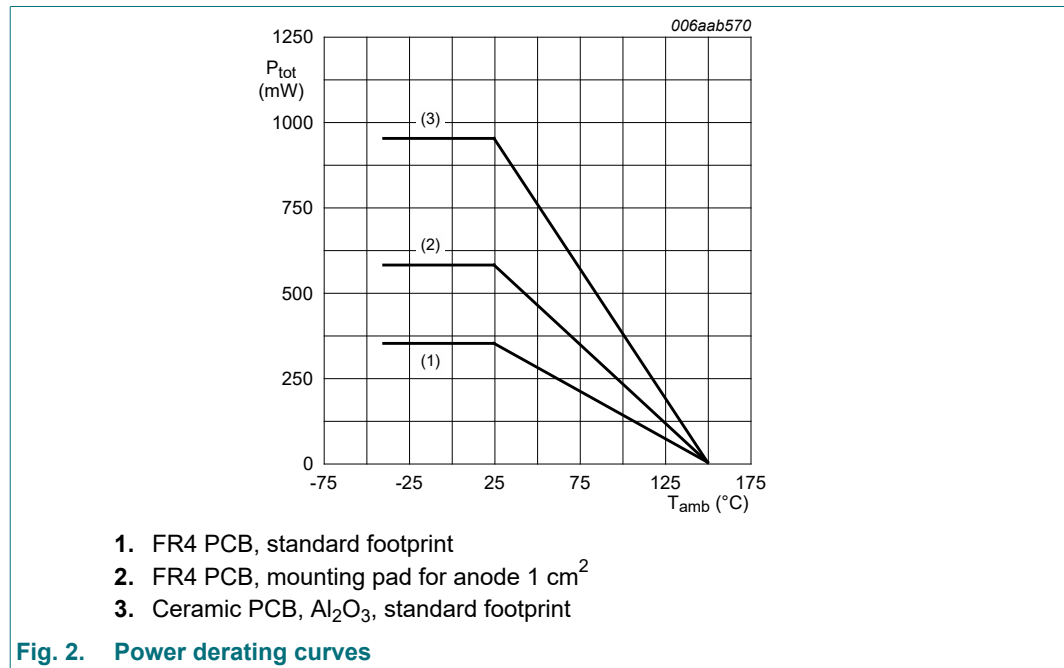
## 9. Limiting values

**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 cm<sup>2</sup>.
- [3] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, 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 cm<sup>2</sup>.

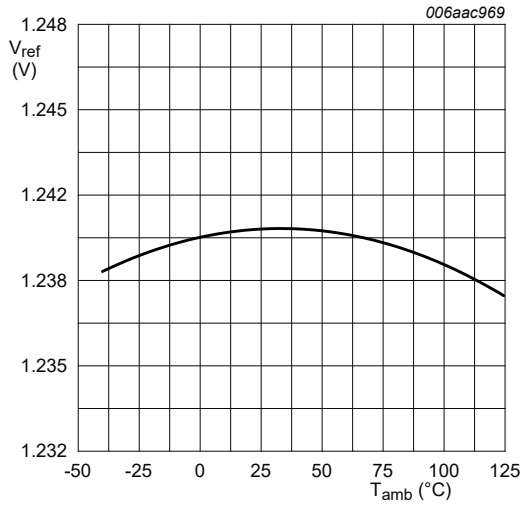
[3] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.

[4] Soldering point of anode.

## 12. Characteristics

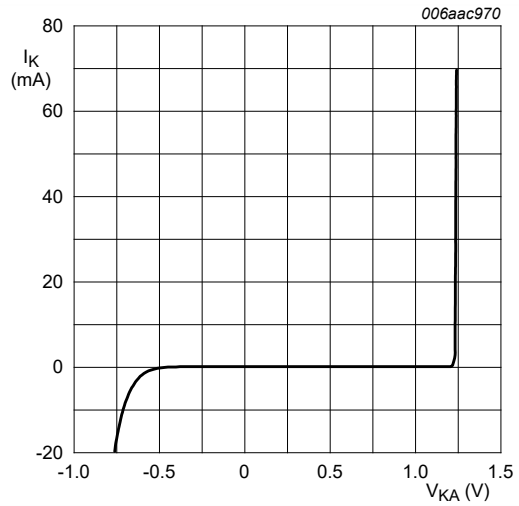
**Table 10. Characteristics**
 $T_{amb} = 25\text{ °C}$  unless otherwise specified.

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
$\Delta V_{ref}$	reference voltage variation	$V_{KA} = V_{ref}$ ; $I_K = 10\text{ mA}$				
	TLVH431NCDBZR	$T_{amb} = 0\text{ °C}$ to $70\text{ °C}$	-	2	10	mV
	TLVH431NIDBZR	$T_{amb} = -40\text{ °C}$ to $85\text{ °C}$	-	3	10	mV
	TLVH431NQDBZR	$T_{amb} = -40\text{ °C}$ to $125\text{ °C}$	-	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 $14\text{ V}$	-	-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	$\mu\text{A}$
$\Delta I_{ref}$	reference current variation	$I_K = 10\text{ mA}$ ; $R1 = 10\text{ k}\Omega$ ; $R2 = \text{open}$				
	TLVH431NCDBZR	$T_{amb} = 0\text{ °C}$ to $70\text{ °C}$	-	0.03	1.0	$\mu\text{A}$
	TLVH431NIDBZR	$T_{amb} = -40\text{ °C}$ to $85\text{ °C}$	-	0.06	0.16	$\mu\text{A}$
	TLVH431NQDBZR	$T_{amb} = -40\text{ °C}$ to $125\text{ °C}$	-	0.07	0.24	$\mu\text{A}$
	TLVH431NMQDBZR					
$I_{K(min)}$	minimum cathode current	$V_{KA} = V_{ref}$	-	55	80	$\mu\text{A}$
$I_{off}$	off-state current	$V_{KA} = 14\text{ V}$ ; $V_{ref} = 0$	-	0.01	0.05	$\mu\text{A}$
$Z_{KA}$	dynamic cathode-anode impedance	$I_K = 0.1\text{ mA}$ to $70\text{ mA}$ ; $V_{KA} = V_{ref}$ ; $f < 1\text{ kHz}$	-	0.10	0.15	$\Omega$
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
$\Delta V_{ref}$	reference voltage variation	$V_{KA} = V_{ref}$ ; $I_K = 10\text{ mA}$				
	TLVH431NACDBZR	$T_{amb} = 0\text{ °C}$ to $70\text{ °C}$	-	0.3	10	mV
	TLVH431NAIDBZR	$T_{amb} = -40\text{ °C}$ to $85\text{ °C}$	-	1.3	10	mV
	TLVH431NAQDBZR	$T_{amb} = -40\text{ °C}$ to $125\text{ °C}$	-	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 $14\text{ V}$	-	-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	$\mu\text{A}$
$\Delta I_{ref}$	reference current variation	$I_K = 10\text{ mA}$ ; $R1 = 10\text{ k}\Omega$ ; $R2 = \text{open}$				
	TLVH431NACDBZR	$T_{amb} = 0\text{ °C}$ to $70\text{ °C}$	-	0.03	0.10	$\mu\text{A}$
	TLVH431NAIDBZR	$T_{amb} = -40\text{ °C}$ to $85\text{ °C}$	-	0.06	0.16	$\mu\text{A}$
	TLVH431NAQDBZR	$T_{amb} = -40\text{ °C}$ to $125\text{ °C}$	-	0.07	0.24	$\mu\text{A}$
	TLVH431NAMQDBZR					
$I_{K(min)}$	minimum cathode current	$V_{KA} = V_{ref}$	-	55	80	$\mu\text{A}$
$I_{off}$	off-state current	$V_{KA} = 14\text{ V}$ ; $V_{ref} = 0$	-	0.01	0.05	$\mu\text{A}$
$Z_{KA}$	dynamic cathode-anode impedance	$I_K = 0.1\text{ mA}$ to $70\text{ mA}$ ; $V_{KA} = V_{ref}$ ; $f < 1\text{ kHz}$	-	0.10	0.15	$\Omega$



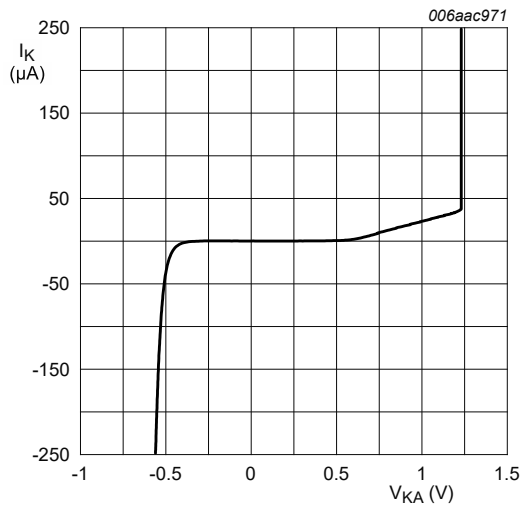
$I_K = 10 \text{ mA}; V_{KA} = V_{ref}$

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



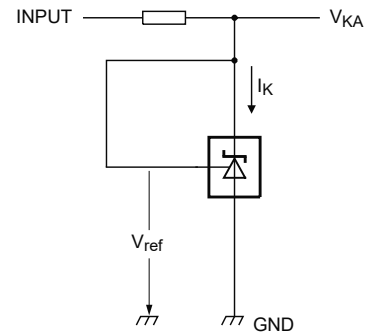
$V_{KA} = V_{ref}; T_{amb} = 25 \text{ °C}$

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



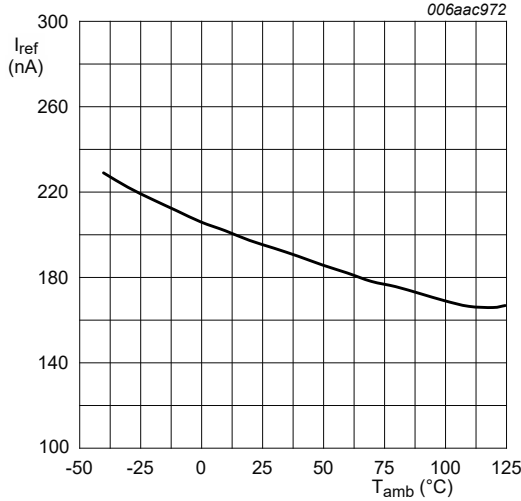
$V_{KA} = V_{ref}; T_{amb} = 25 \text{ °C}$

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



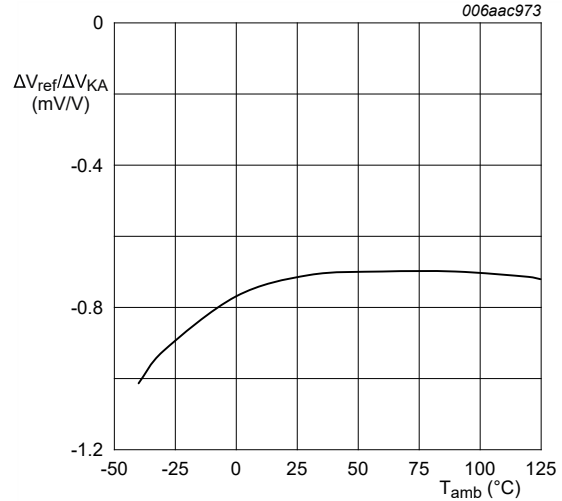
$I_K = 10 \text{ mA}; V_{KA} = V_{ref}$

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



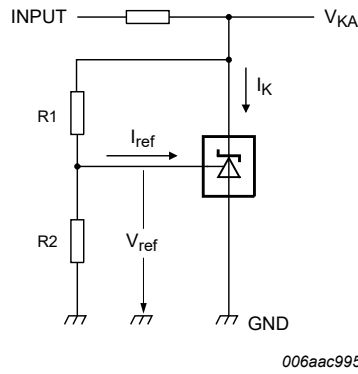
V<sub>KA</sub> = 1.24 V; I<sub>K</sub> = 10 mA; R<sub>1</sub> = 10 kΩ; R<sub>2</sub> = open

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



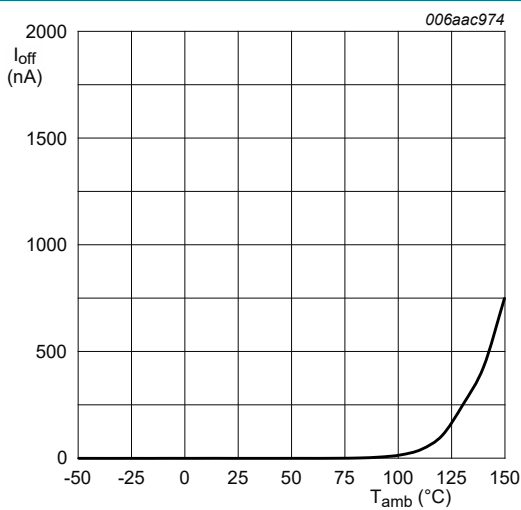
I<sub>K</sub> = 10 mA; T<sub>amb</sub> = 25 °C

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



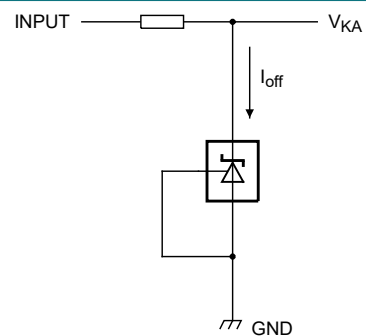
$$V_{KA} = V_{ref} \times (1 + R1/R2) + I_{ref} \times R1$$

Fig. 9. Test circuit to Figures 7 and 8



V<sub>KA</sub> = 14 V; V<sub>ref</sub> = 0

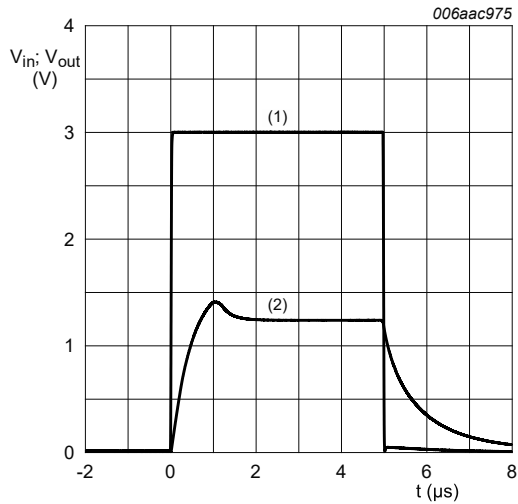
Fig. 10. Off-state current as a function of ambient temperature; typical values



V<sub>KA</sub> = 14 V; V<sub>ref</sub> = 0

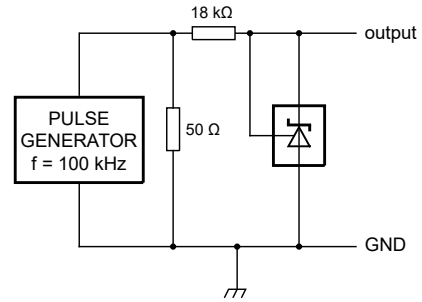
Fig. 11. Test circuit to Figure 10





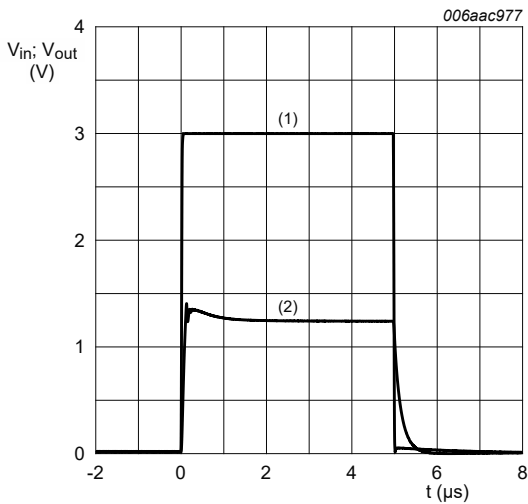
$T_{amb} = 25\text{ }^{\circ}\text{C}$   
 (1) Input  
 (2) Output

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



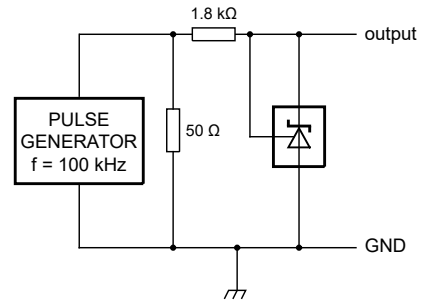
$T_{amb} = 25\text{ }^{\circ}\text{C}$

**Fig. 13. Test circuit to Figure 12**



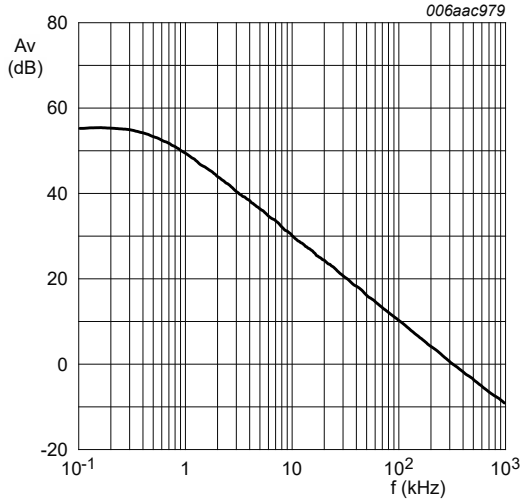
$T_{amb} = 25\text{ }^{\circ}\text{C}$   
 (1) Input  
 (2) Output

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



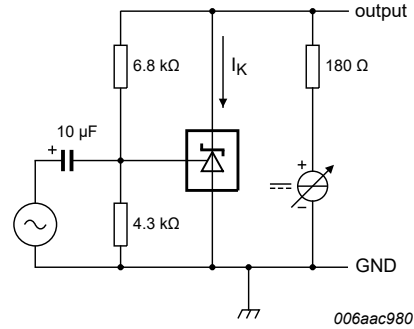
$T_{amb} = 25\text{ }^{\circ}\text{C}$

**Fig. 15. Test circuit to Figure 14**



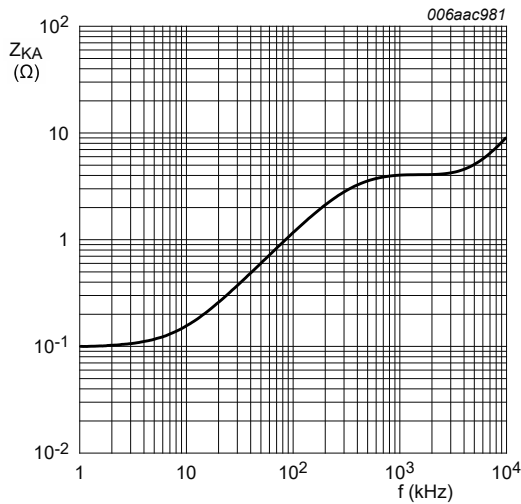
$I_K = 10 \text{ mA}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

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



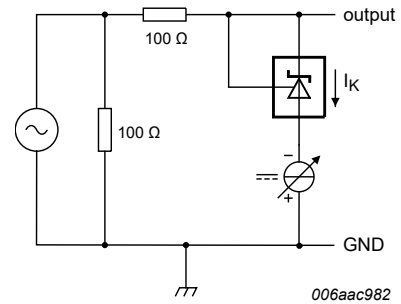
$I_K = 10 \text{ mA}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

**Fig. 17. Test circuit to Figure 16**



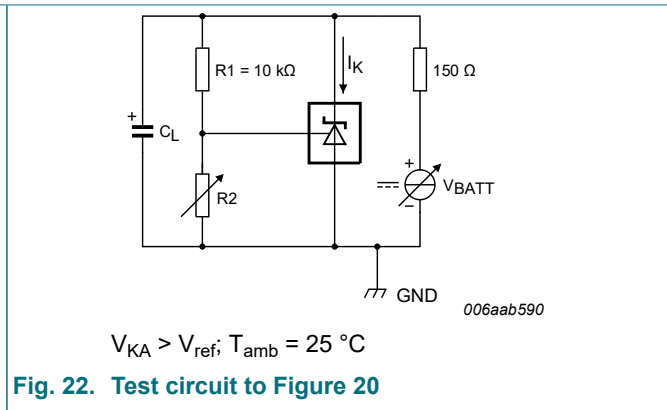
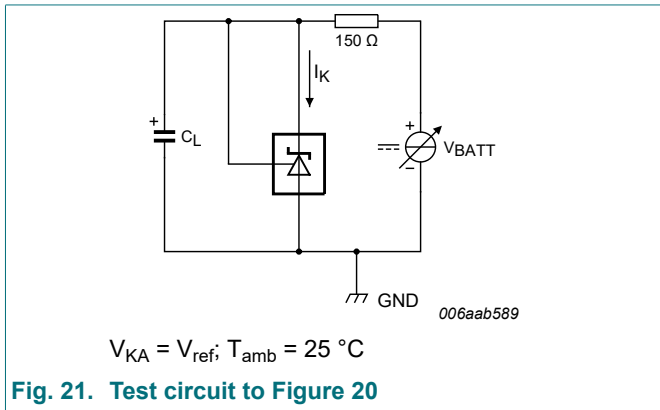
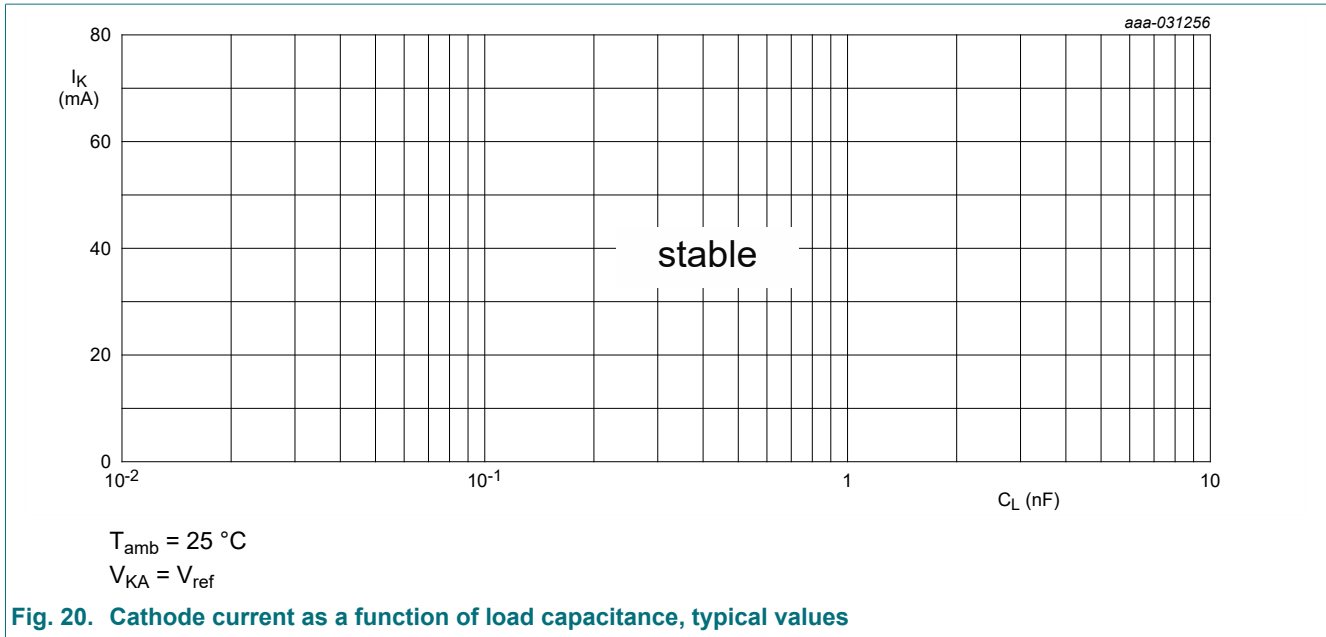
$I_K = 10 \text{ mA}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

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



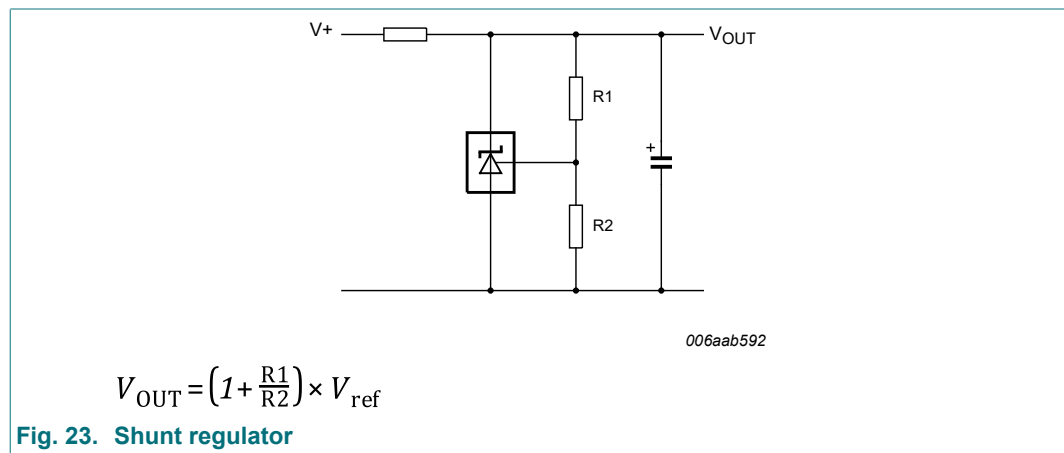
$I_K = 10 \text{ mA}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

**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



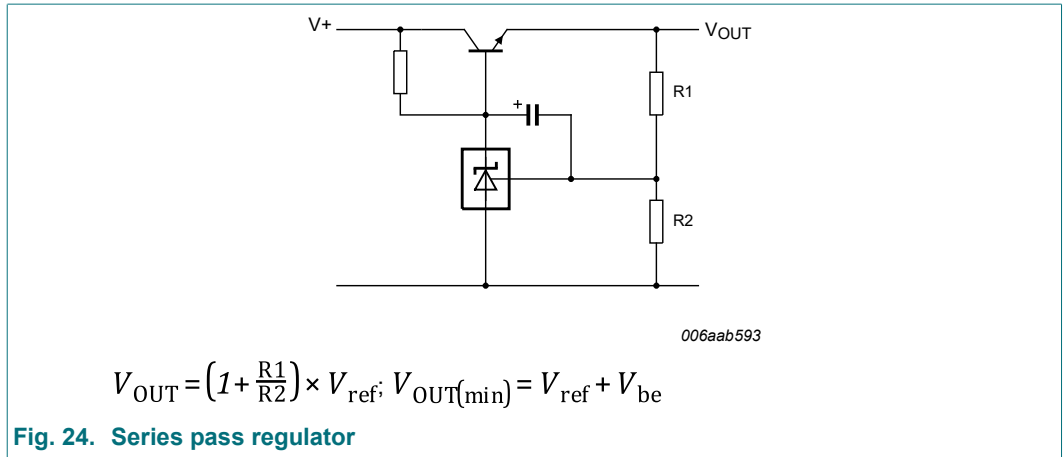


Fig. 24. Series pass regulator

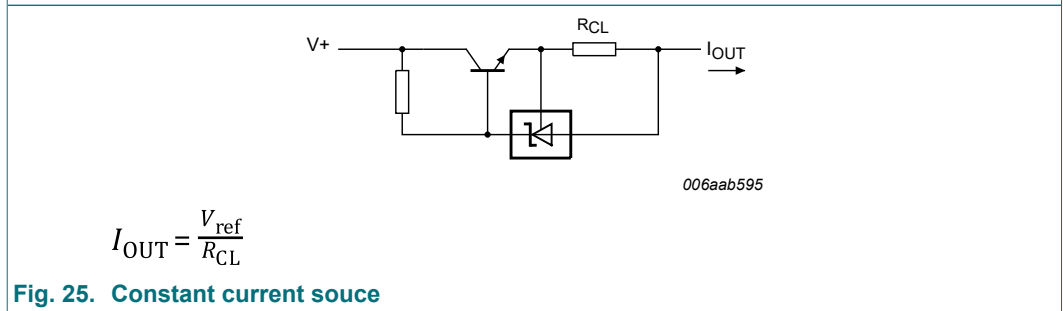


Fig. 25. Constant current source

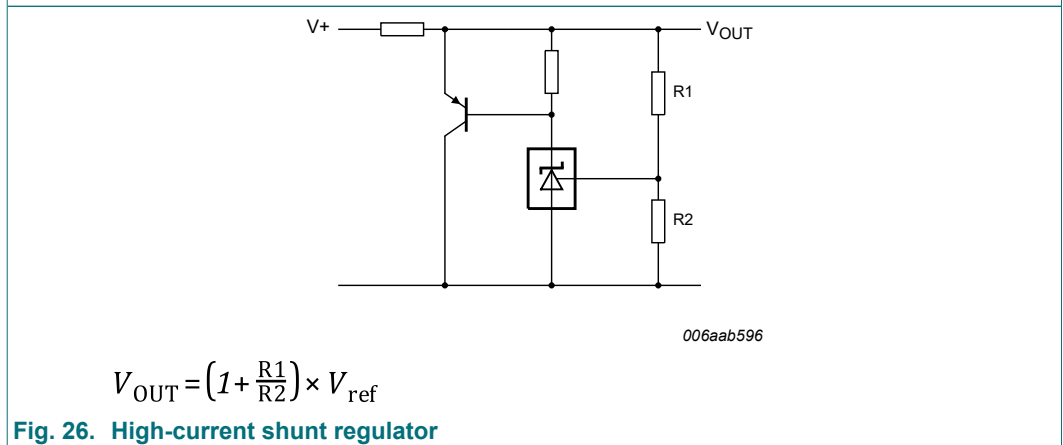


Fig. 26. High-current shunt regulator

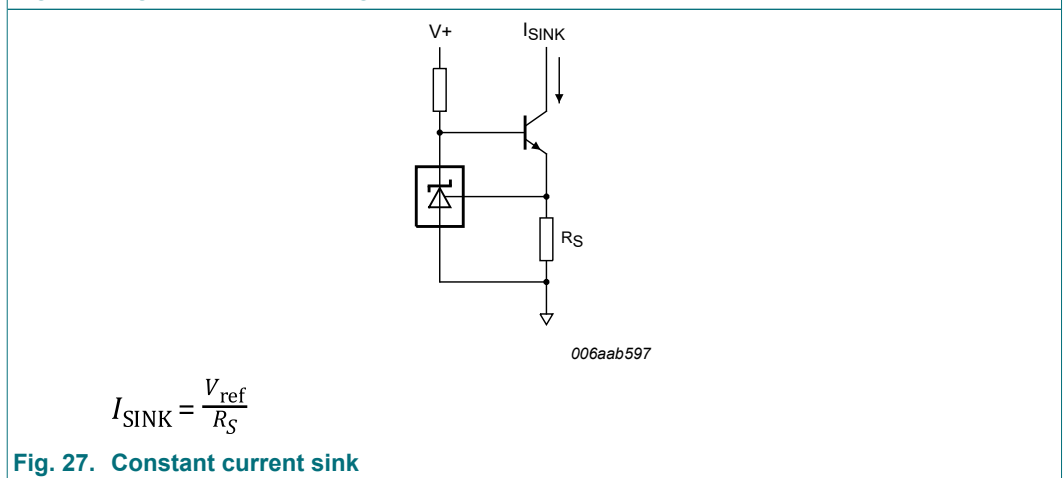


Fig. 27. Constant current sink

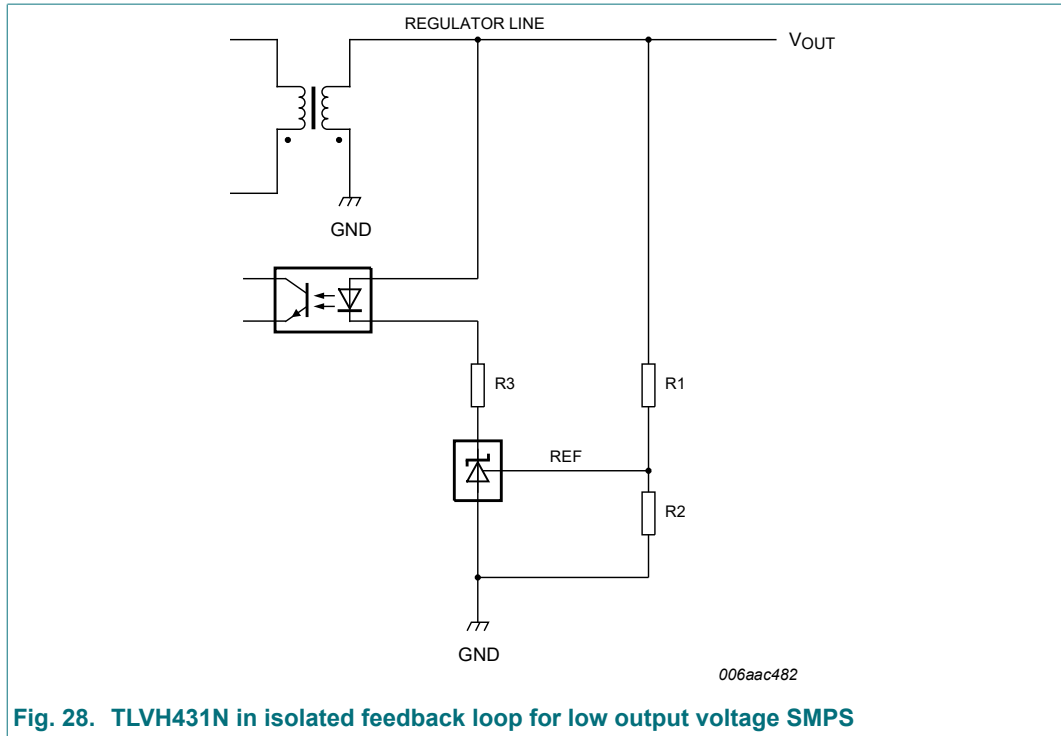


Fig. 28. TLVH431N in isolated feedback loop for low output voltage SMPS

## 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

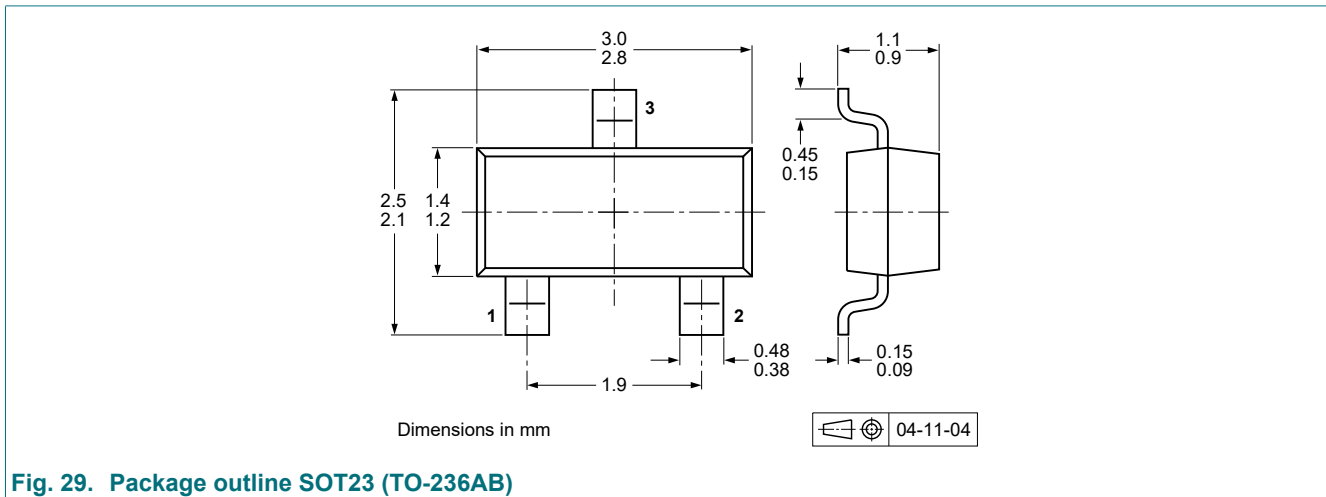


Fig. 29. Package outline SOT23 (TO-236AB)

16. Soldering

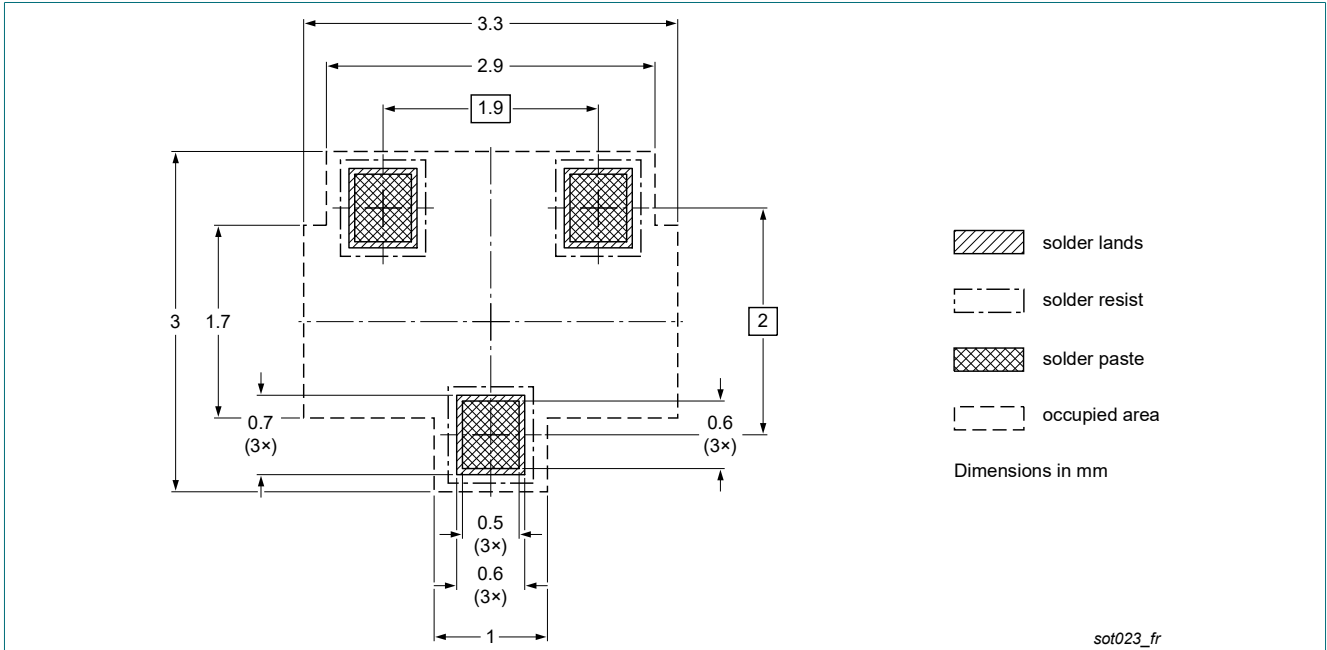


Fig. 30. Reflow soldering footprint SOT23 (TO-236AB)

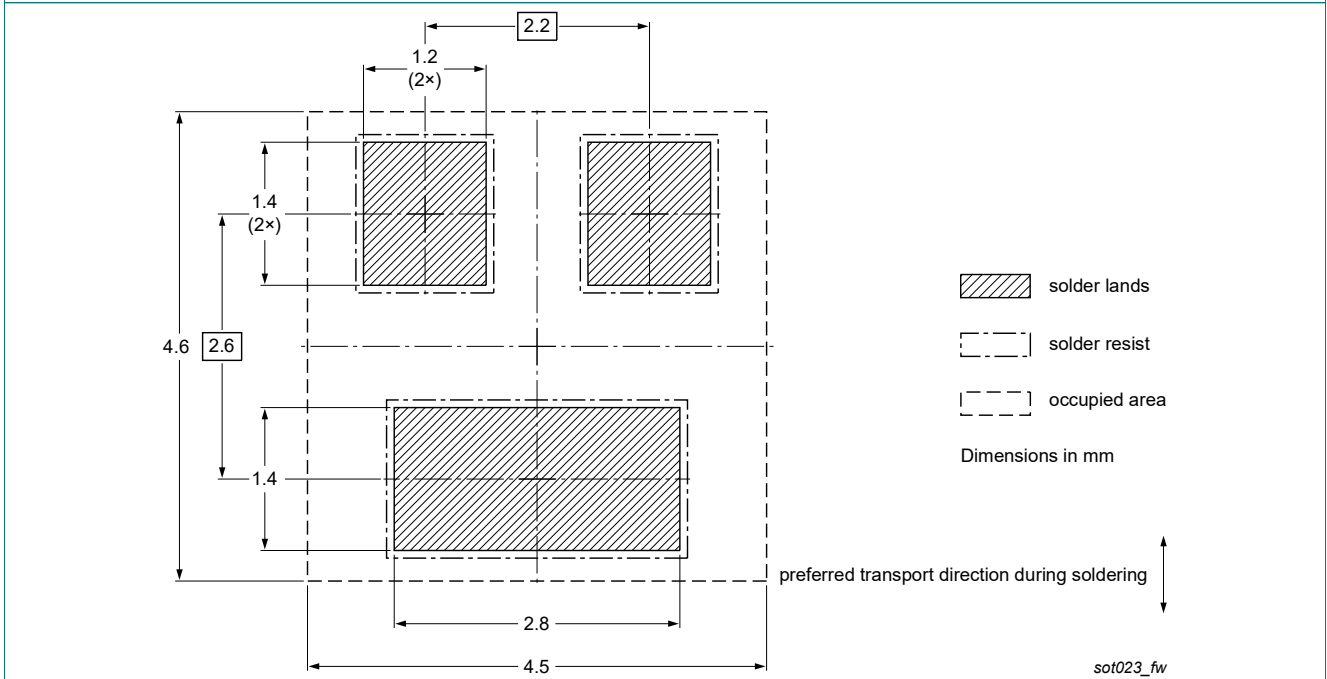


Fig. 31. Wave soldering footprint SOT23 (TO-236AB)

## 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"><li>• Pinning table changed</li><li>• Figure 2 changed</li></ul>			
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".
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