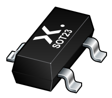


TLVH431N family

Adjustable precision shunt regulators

Rev. 1 — 25 June 2020 Product data sheet

1. Product profile

1.1. General description

Three-terminal shunt regulator family with an output voltage range between V_{ref} = 1.24 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

1.2. 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)

1.3. Applications

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

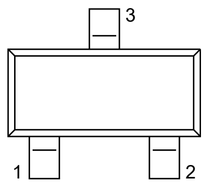
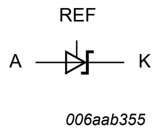
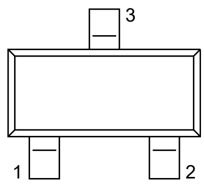
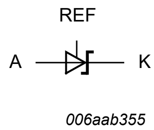
2. Quick reference data

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

3. Pinning information

Table 3. Pinning

Pin	Symbol	Description		Simplified outline	Graphic symbol
SOT23; normal pinning: All types without MFDT ending					
1	K	cathode			
2	REF	reference			
3	A	anode			
SOT23; mirrored pinning: All types with MFDT ending					
1	REF	reference			
2	K	cathode			
3	A	anode			

4. Ordering information

Table 4. Ordering information

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

5. 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.

6. 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.

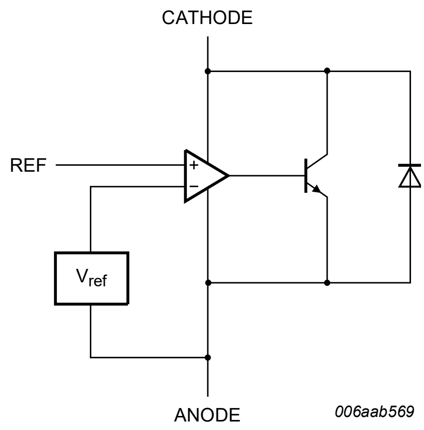


Fig. 1. Functional diagram

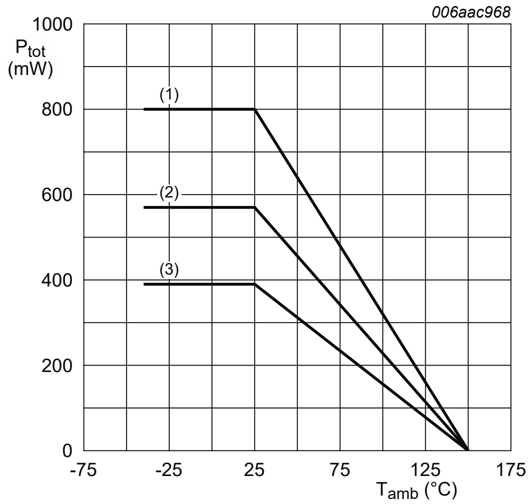
7. Limiting values

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	$T_{amb} \leq 25$ °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^2.
[3] Device mounted on a ceramic PCB, Al_2O_3, standard footprint.



1. Ceramic PCB, Al_2O_3, standard footprint
2. FR4 PCB, mounting pad for anode 1 cm^2
3. FR4 PCB, standard footprint

Fig. 2. Power derating curves

Table 7. ESD maximum ratings

T_{amb} = 25 °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

8. 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

9. 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

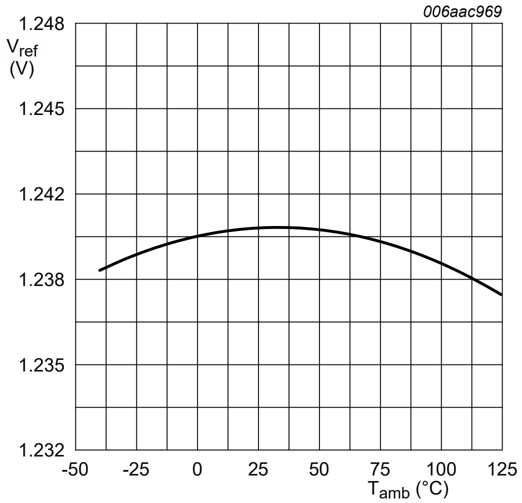
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.
[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for anode 1 cm^2.
[3] Device mounted on a ceramic PCB, Al_2O_3, standard footprint.
[4] Soldering point of anode.

10. Characteristics

Table 10. Characteristics

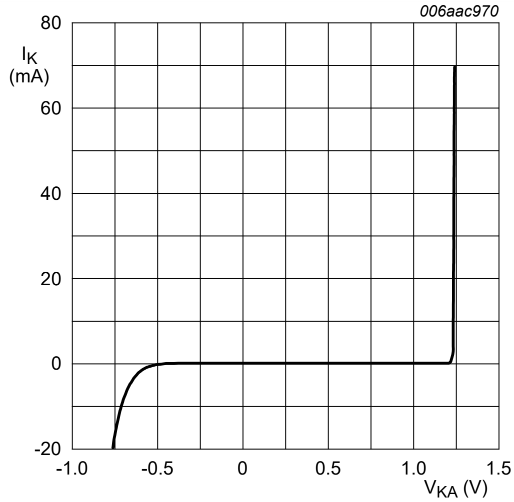
T_{amb} = 25 °C unless otherwise specified.

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



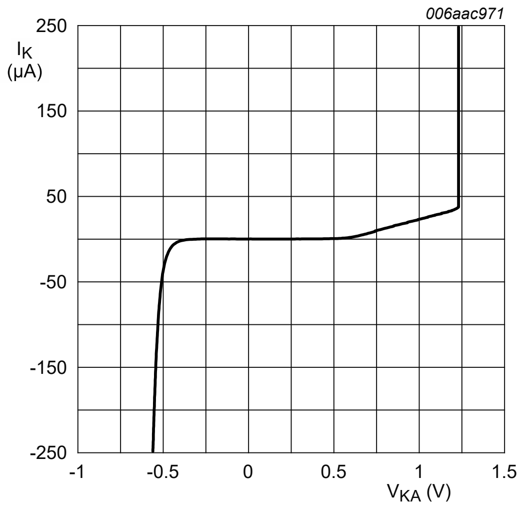
I_K = 10 mA; V_{KA} = V_{ref}

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



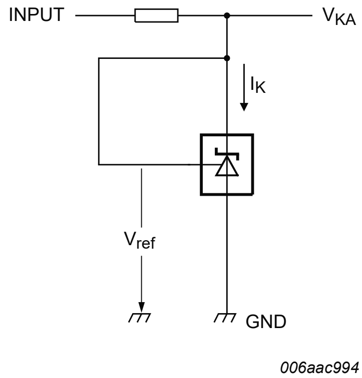
V_{KA} = V_{ref}; T_{amb} = 25 °C

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



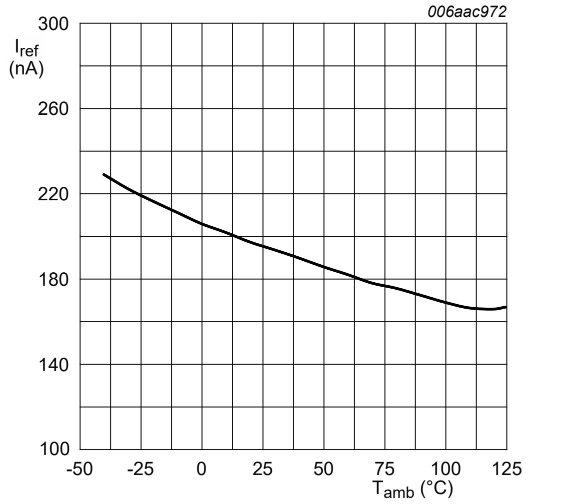
V_{KA} = V_{ref}; T_{amb} = 25 °C

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



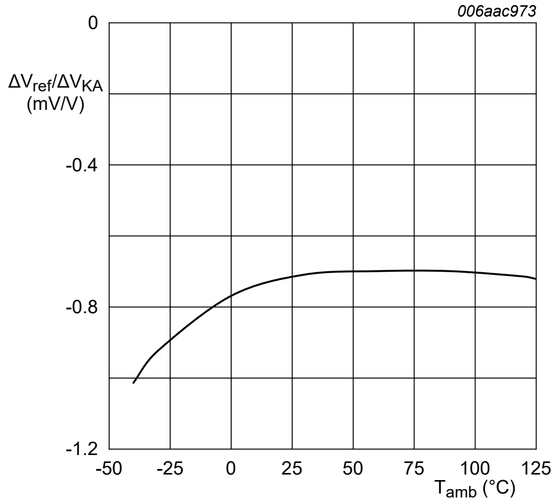
I_K = 10 mA;V_{KA} = V_{ref}

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



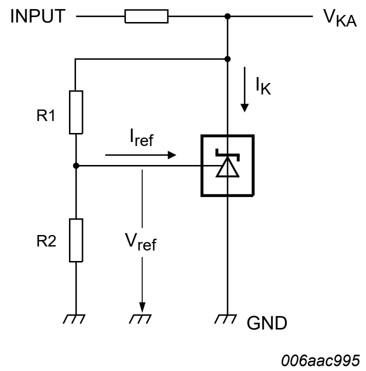
V_{KA} = 1.24 V; I_K = 10 mA; R1 = 10 kΩ; R2 = open

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



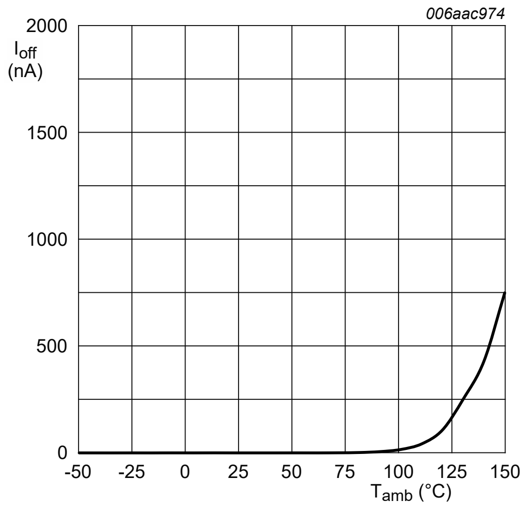
I_K = 10 mA; T_{amb} = 25 °C

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



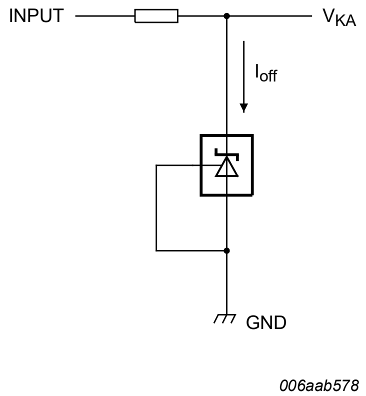
$V_{KA} = V_{ref} \times (1 + R1/R2) + I_{ref} \times R1$

Fig. 9. Test circuit to Figures 7 and 8



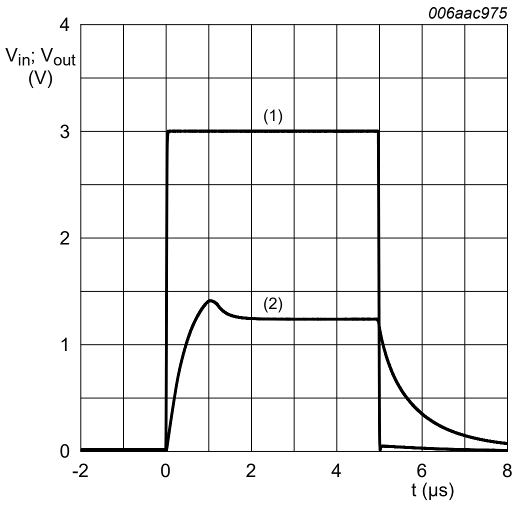
V_{KA} = 14 V; V_{ref} = 0

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

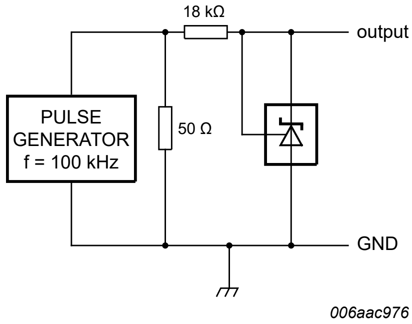


T_{amb} = 25 °C

(1) Input

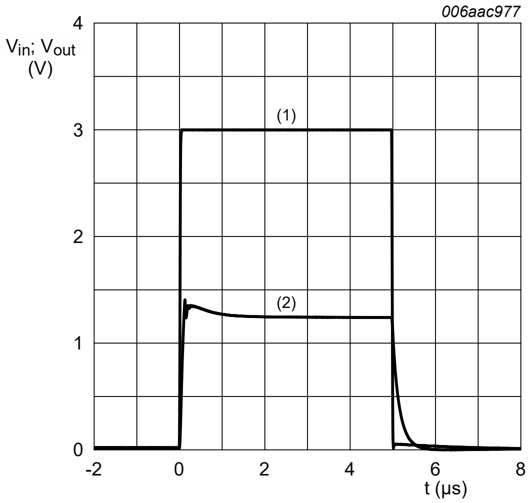
(2) Output

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



T_{amb} = 25 °C

Fig. 13. Test circuit to Figure 12

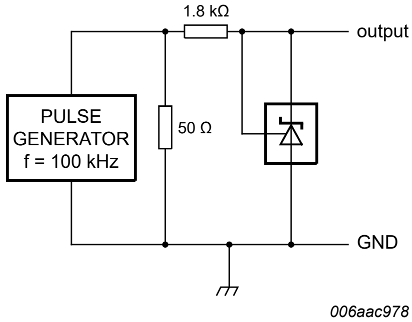


T_{amb} = 25 °C

(1) Input

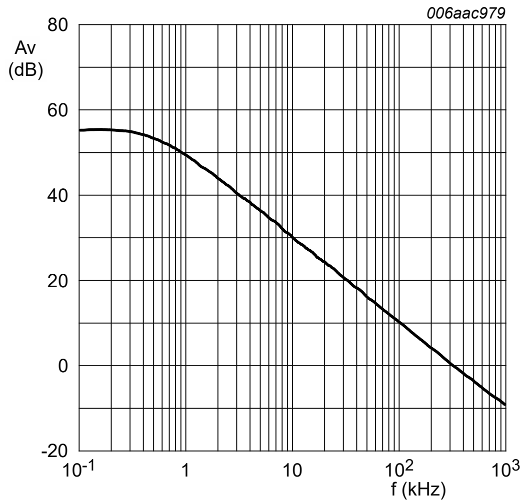
(2) Output

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



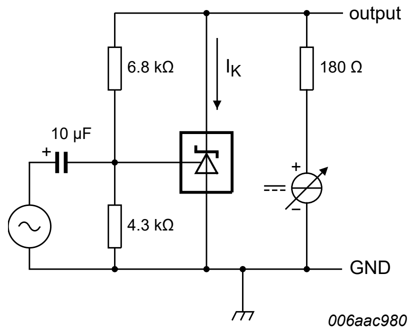
T_{amb} = 25 °C

Fig. 15. Test circuit to Figure 14



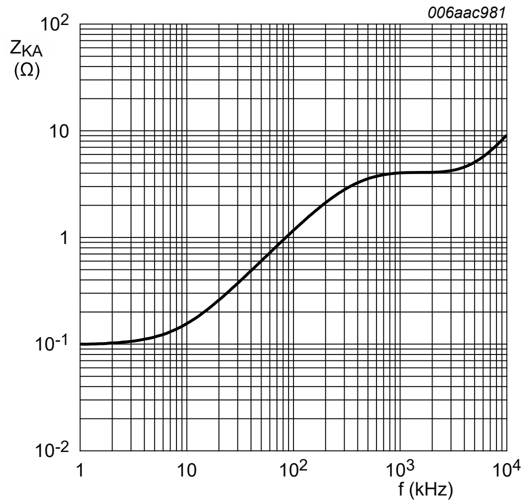
I_K = 10 mA; T_{amb} = 25 °C

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



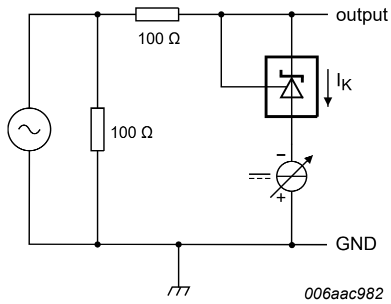
I_K = 10 mA; T_{amb} = 25 °C

Fig. 17. Test circuit to Figure 16



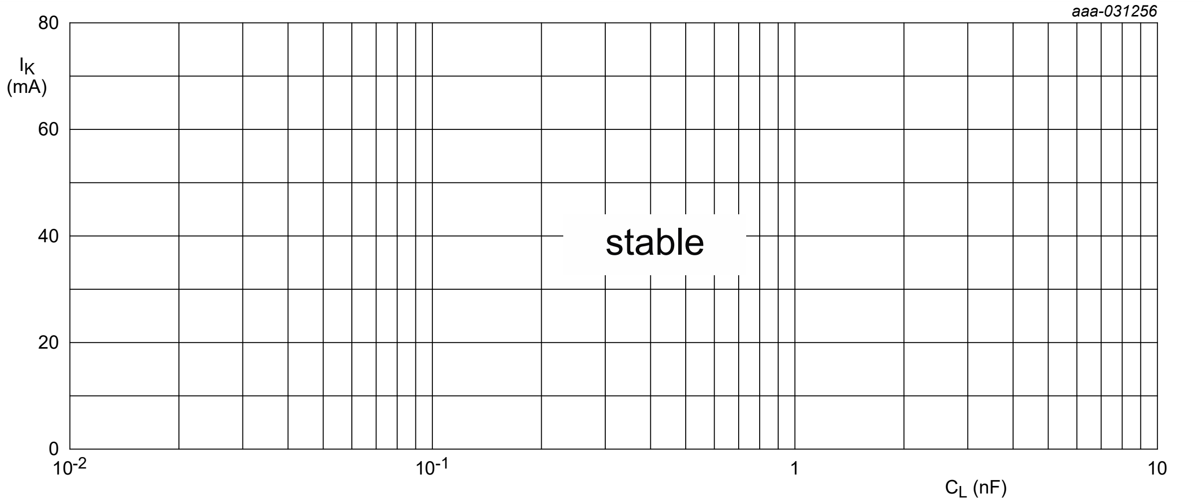
I_K = 10 mA; T_{amb} = 25 °C

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



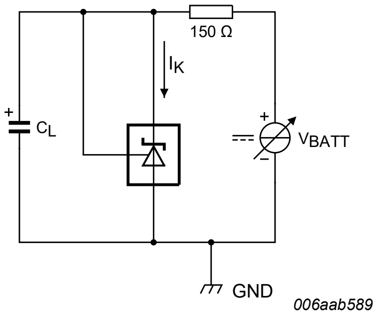
I_K = 10 mA; T_{amb} = 25 °C

Fig. 19. Test circuit to Figure 18



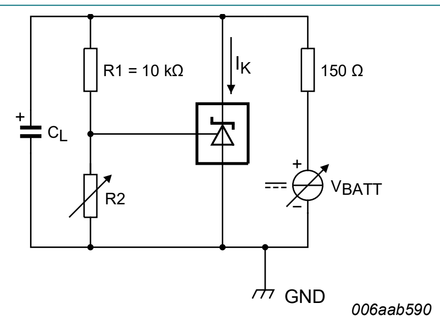
T_{amb} = 25 °C
$V_{KA} = V_{ref}$

Fig. 20. Cathode current as a function of load capacitance, typical values



$V_{KA} = V_{ref}$; T_{amb} = 25 °C

Fig. 21. Test circuit to Figure 20

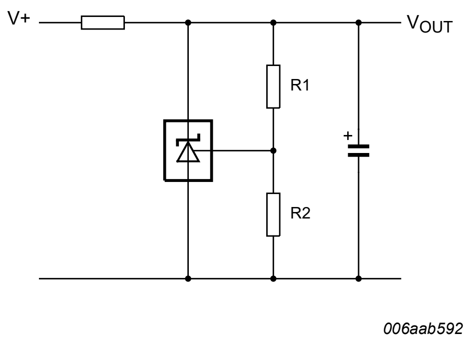


$V_{KA} > V_{ref}$; T_{amb} = 25 °C

Fig. 22. Test circuit to Figure 20

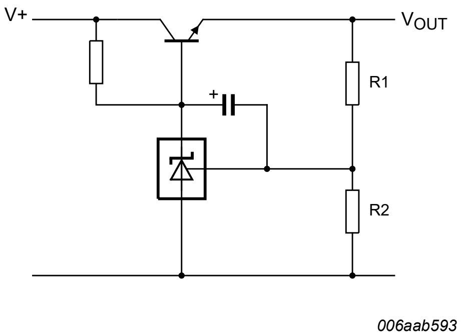
Figures 20, 21 and 22 show the stability boundaries and test circuits for the worst case conditions with a load capacitance mounted as close as possible to the device. The required load capacitance for stable operation varies depending on the operating temperature and capacitor Equivalent Series Resistance (ESR). Verify that the application circuit is stable over the anticipated operating current and temperature ranges.

11. Application information



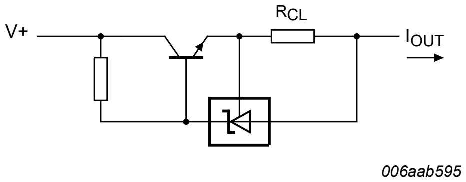
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) \times V_{ref}$$

Fig. 23. Shunt regulator



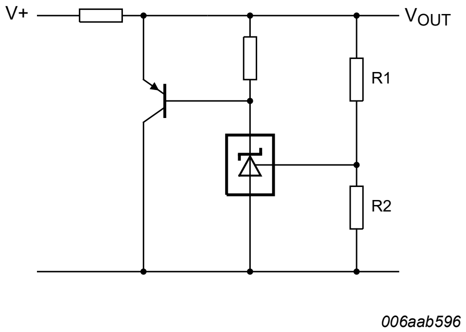
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) \times V_{ref};\ V_{OUT(min)} = V_{ref} + V_{be}$$

Fig. 24. Series pass regulator



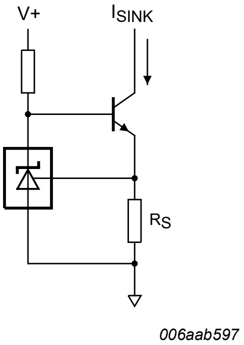
$$I_{OUT} = \frac{V_{ref}}{R_{CL}}$$

Fig. 25. Constant current souce



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

Fig. 26. High-current shunt regulator



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

Fig. 27. Constant current sink

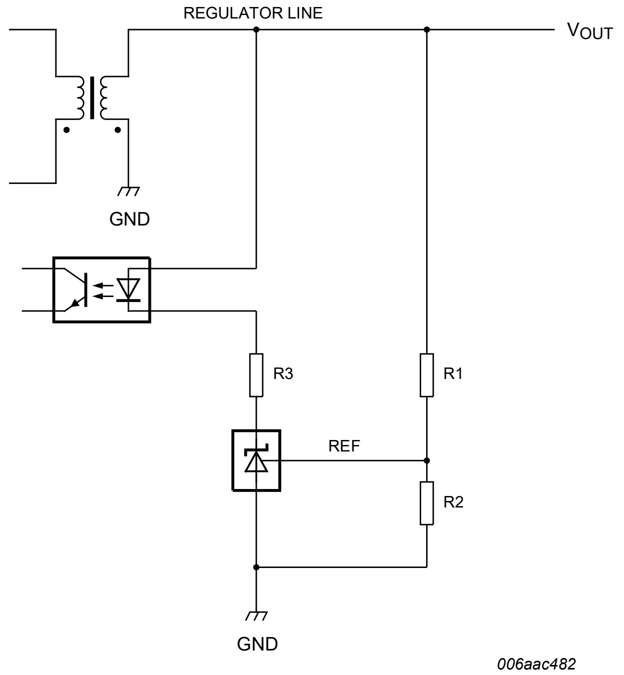


Fig. 28. TLVH431N in isolated feedback loop for low output voltage SMPS

12. 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.

13. Package outline

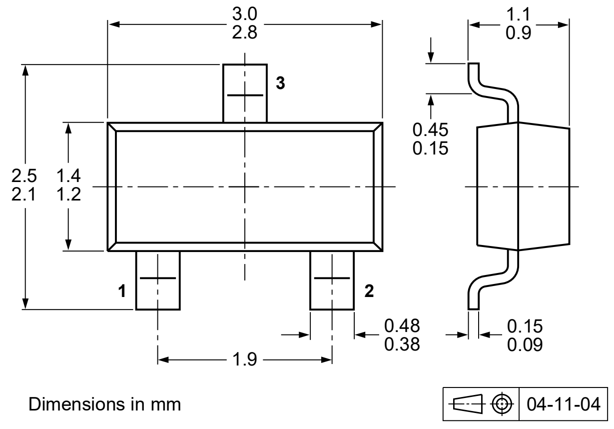


Fig. 29. Package outline SOT23 (TO-236AB)

14. Soldering

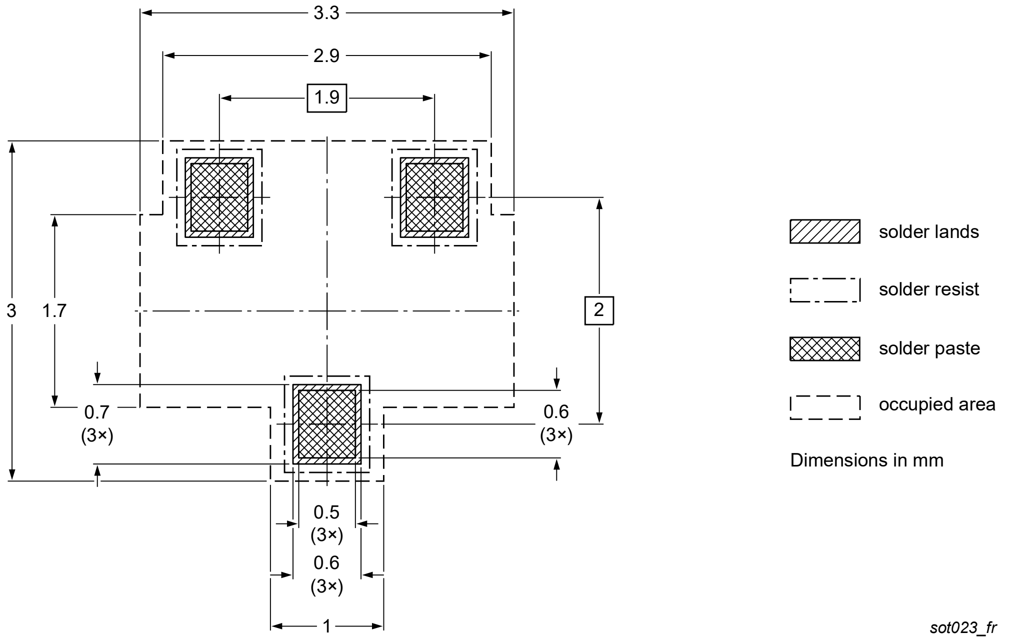


Fig. 30. Reflow soldering footprint SOT23 (TO-236AB)

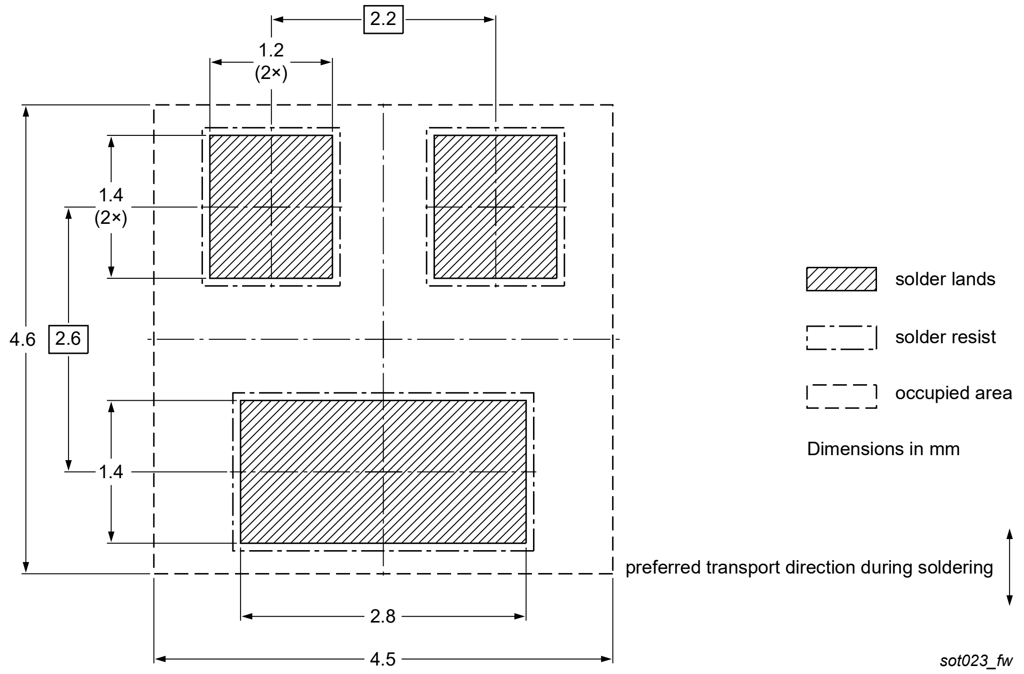


Fig. 31. Wave soldering footprint SOT23 (TO-236AB)

15. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
TLVH431N_FAM v.1	20200625	Product data sheet	-	-

16. 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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