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 Table 5)
		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 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}	-	18	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 %)		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[1]	Type number	Marking code[1]
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 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.

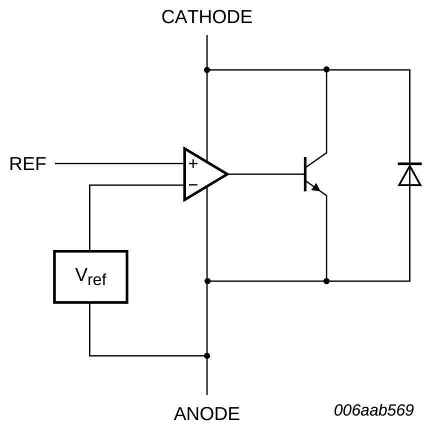


Fig 1. Functional diagram

8. Pinning information

Table 5. Pinning

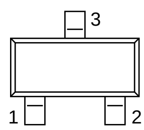
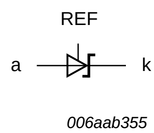
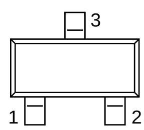
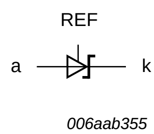
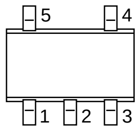
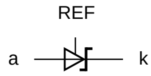
Pin	Symbol	Description	Simplified outline	Graphic symbol
SOT23; normal pinning: All types without MQDBZR ending				
1	REF	reference		
2	k	cathode		
3	a	anode		
SOT23; mirrored pinning: All types with MQDBZR ending				
1	k	cathode		
2	REF	reference		
3	a	anode		

Table 5. Pinning *...continued*

Pin	Symbol	Description	Simplified outline	Graphic symbol
SOT753				
1	n.c.	not connected [1]		 006aab355
2	n.c.	not connected [1]		
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

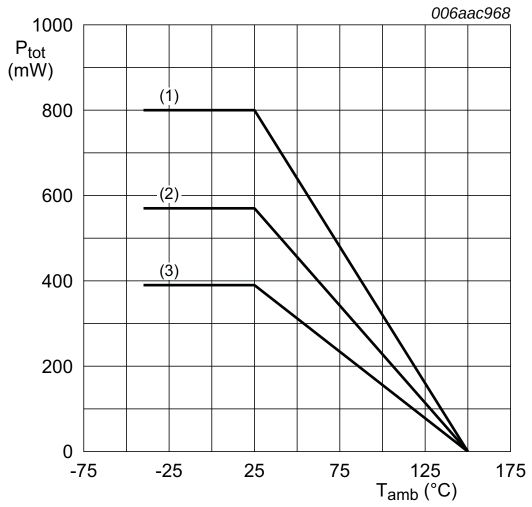
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{KA}	cathode-anode voltage		-	20	V
I_K	cathode current		–25	80	mA
I_{ref}	reference current		–0.05	3	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C			
	SOT23	[1]	-	390	mW
		[2]	-	570	mW
		[3]	-	800	mW
	SOT753	[1]	-	310	mW
		[2]	-	460	mW
		[3]	-	700	mW
T_j	junction temperature		-	150	°C
T_{amb}	ambient temperature				
	TLVH431XCDBZR		0	+70	°C
	TLVH431XIDBZR		–40	+85	°C
	TLVH431XQDBZR TLVH431XQDBVR		–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.

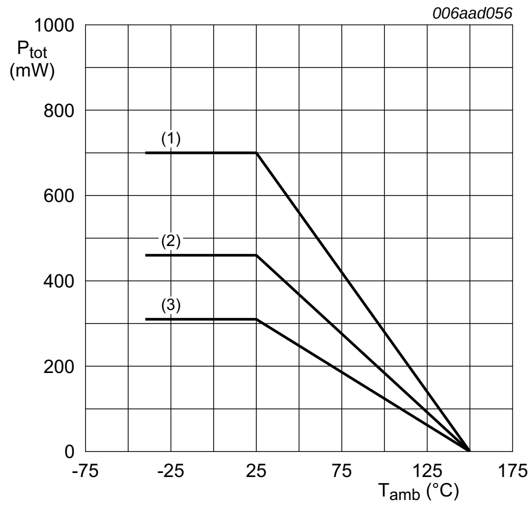


(1) Ceramic PCB, Al_2O_3, standard footprint

(2) FR4 PCB, mounting pad for anode 1 cm^2

(3) FR4 PCB, standard footprint

Fig 2. SOT23: Power derating curves



(1) Ceramic PCB, Al_2O_3, standard footprint

(2) FR4 PCB, mounting pad for anode 1 cm^2

(3) FR4 PCB, standard footprint

Fig 3. SOT753: 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	-	400	V

10. Recommended operating conditions

Table 8. Operating conditions

Symbol	Parameter	Conditions	Min	Max	Unit
V_{KA}	cathode-anode voltage		V_{ref}	18	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					
	SOT23		[1]	-	-	320	K/W
			[2]	-	-	220	K/W
			[3]	-	-	155	K/W
	SOT753		[1]	-	-	400	K/W
			[2]	-	-	270	K/W
			[3]	-	-	180	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		[4]				
	SOT23			-	-	35	K/W
	SOT753			-	-	40	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.

12. Characteristics

Table 10. Characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Standard-Grade (1.5 %): TLVH431CDBZR; TLVH431IDBZR; TLVH431QDBZR; TLVH431MQDBRZ; TLVH431QDBVR						
V_{ref}	reference voltage	$V_{KA} = V_{ref}$; I_K = 10 mA				
		T_{amb} = 25 °C	1222	1240	1258	mV
	TLVH431CDBZR	T_{amb} = 0 °C to 70 °C	1210	-	1270	mV
	TLVH431IDBZR	T_{amb} = −40 °C to 85 °C	1202	-	1278	mV
	TLVH431QDBZR TLVH431MQDBRZ TLVH431QDBVR	T_{amb} = −40 °C to 125 °C	1194	-	1286	mV
ΔV_{ref}	reference voltage variation	$V_{KA} = V_{ref}$; I_K = 10 mA				
	TLVH431CDBZR	T_{amb} = 0 °C to 70 °C	-	2	10	mV
	TLVH431IDBZR	T_{amb} = −40 °C to 85 °C	-	3	10	mV
	TLVH431QDBZR TLVH431MQDBRZ TLVH431QDBVR	T_{amb} = −40 °C to 125 °C	-	4	10	mV
$\Delta V_{ref}/\Delta V_{KA}$	reference voltage variation to cathode-anode voltage variation ratio	I_K = 10 mA; $\Delta V_{KA} = V_{ref}$ to 18 V	-	−0.5	−1.5	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				
	TLVH431CDBZR	T_{amb} = 0 °C to 70 °C	-	0.03	0.10	μA
	TLVH431IDBZR	T_{amb} = −40 °C to 85 °C	-	0.06	0.16	μA
	TLVH431QDBZR TLVH431MQDBRZ TLVH431QDBVR	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} = 18 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				
	SOT23		-	0.10	0.15	Ω
	SOT753		-	0.15	0.20	Ω

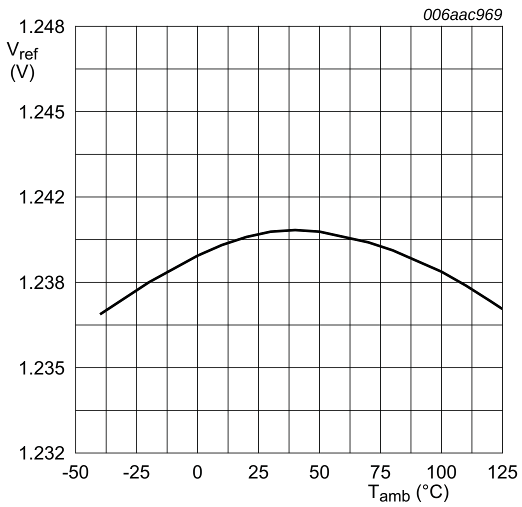
Table 10. Characteristics *…continued*

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
A-Grade (1 %): TLVH431ACDBZR; TLVH431AIDBZR; TLVH431AQDBZR; TLVH431AMQDBZR; TLVH431AQDBVR						
V_{ref}	reference voltage	$V_{KA} = V_{ref}$; I_K = 10 mA				
		T_{amb} = 25 °C	1228	1240	1252	mV
	TLVH431ACDBZR	T_{amb} = 0 °C to 70 °C	1221	-	1259	mV
	TLVH431AIDBZR	T_{amb} = −40 °C to 85 °C	1215	-	1265	mV
	TLVH431AQDBZR TLVH431AMQDBRZ TLVH431AQDBVR	T_{amb} = −40 °C to 125 °C	1209	-	1271	mV
ΔV_{ref}	reference voltage variation	$V_{KA} = V_{ref}$; I_K = 10 mA				
	TLVH431ACDBZR	T_{amb} = 0 °C to 70 °C	-	2	10	mV
	TLVH431AIDBZR	T_{amb} = −40 °C to 85 °C	-	3	10	mV
	TLVH431AQDBZR TLVH431AMQDBRZ TLVH431AQDBVR	T_{amb} = −40 °C to 125 °C	-	4	10	mV
$\Delta V_{ref}/\Delta V_{KA}$	reference voltage variation to cathode-anode voltage variation ratio	I_K = 10 mA; $\Delta V_{KA} = V_{ref}$ to 18 V	-	−0.5	−1.5	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				
	TLVH431ACDBZR	T_{amb} = 0 °C to 70 °C	-	0.03	0.10	μA
	TLVH431AIDBZR	T_{amb} = −40 °C to 85 °C	-	0.06	0.16	μA
	TLVH431AQDBZR TLVH431AMQDBRZ TLVH431AQDBVR	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} = 18 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				
	SOT23		-	0.10	0.15	Ω
	SOT753		-	0.15	0.20	Ω

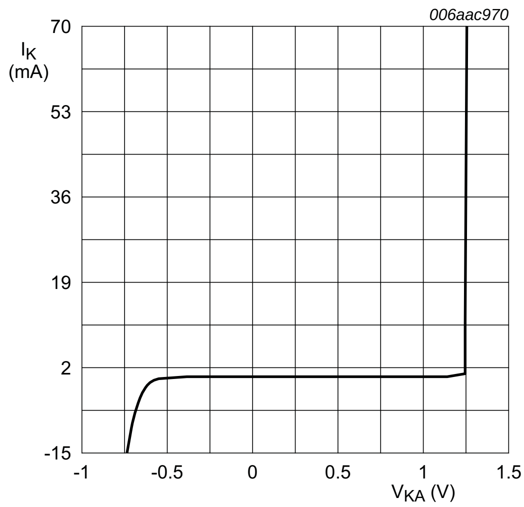
Table 10. Characteristics *…continued*
T_{amb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
D-Grade (0.75 %): TLVH431DQDBZR; TLVH431DMQDBZR; TLVH431DQDBVR						
V_{ref}	reference voltage	$V_{KA} = V_{ref}$; I_K = 10 mA				
		T_{amb} = 25 °C	1231	1240	1249	mV
		T_{amb} = −40 °C to 125 °C	1215	-	1265	mV
ΔV_{ref}	reference voltage variation	$V_{KA} = V_{ref}$; I_K = 10 mA				
		T_{amb} = 0 °C to 70 °C	-	2	10	mV
		T_{amb} = −40 °C to 85 °C	-	3	10	mV
		T_{amb} = −40 °C to 125 °C	-	4	10	mV
$\Delta V_{ref}/\Delta V_{KA}$	reference voltage variation to cathode-anode voltage variation ratio	I_K = 10 mA; $\Delta V_{KA} = V_{ref}$ to 18 V	-	−0.5	−1.5	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; 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} = 18 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				
	SOT23		-	0.10	0.15	Ω
	SOT753		-	0.15	0.20	Ω



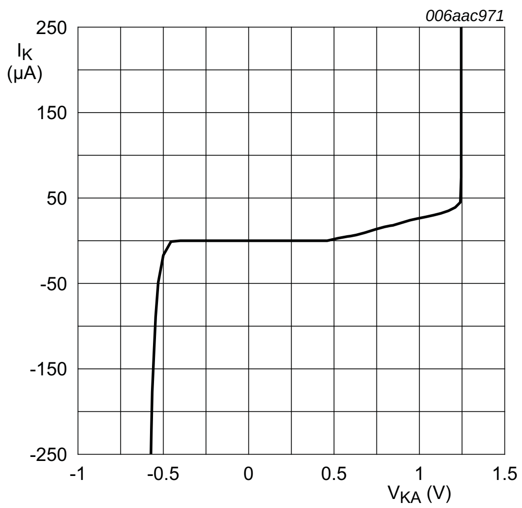
I_K = 10 mA; V_{KA} = V_{ref}

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



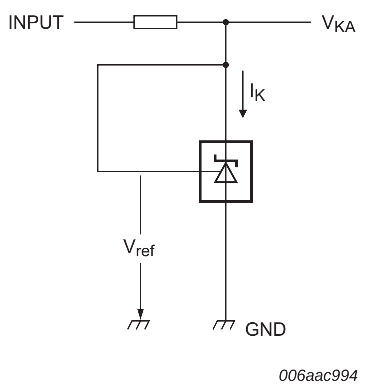
V_{KA} = V_{ref}; T_{amb} = 25 °C

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



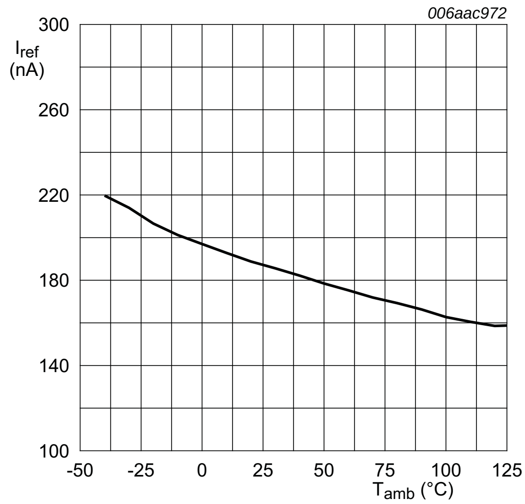
V_{KA} = V_{ref}; T_{amb} = 25 °C

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



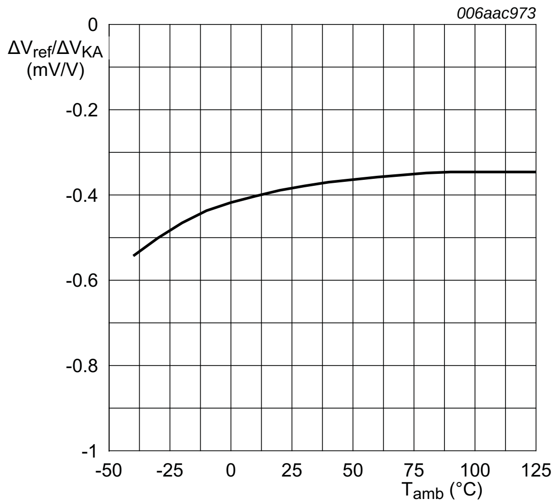
I_K = 10 mA; V_{KA} = V_{ref}

Fig 7. Test circuit to Figure 4, 5 and 6



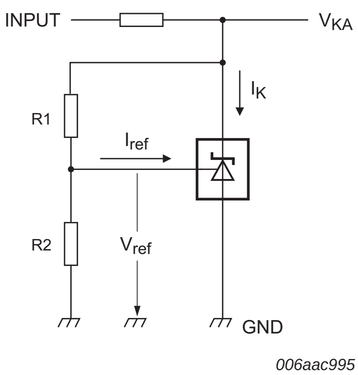
V_{KA} = 1.24 V; I_K = 10 mA; R1 = 10 kΩ; R2 = open

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



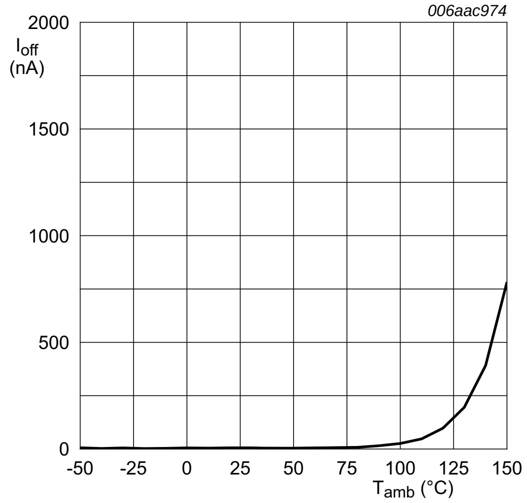
I_K = 10 mA; T_{amb} = 25 °C

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



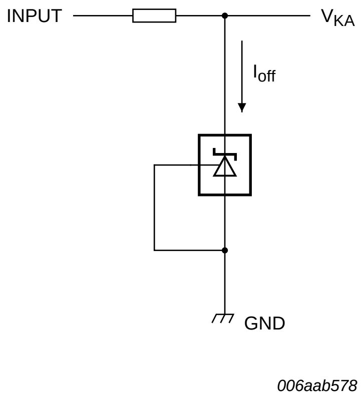
$$V_{KA} = V_{ref} \times \left(1 + \frac{R1}{R2}\right) + I_{ref} \times R1$$

Fig 10. Test circuit to Figure 8 and 9



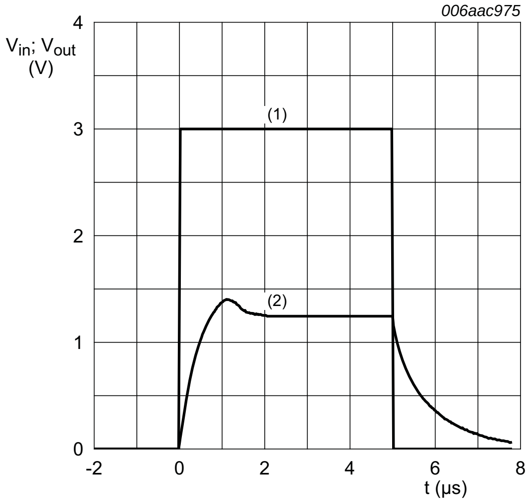
V_{KA} = 18 V; V_{ref} = 0 V

Fig 11. Off-state current as a function of ambient temperature; typical values



V_{KA} = 18 V; V_{ref} = 0 V

Fig 12. Off-state current as a function of ambient temperature; test circuit

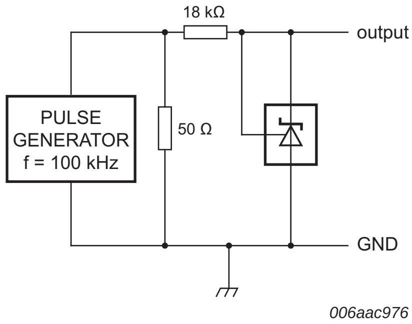


T_{amb} = 25 °C

(1) Input

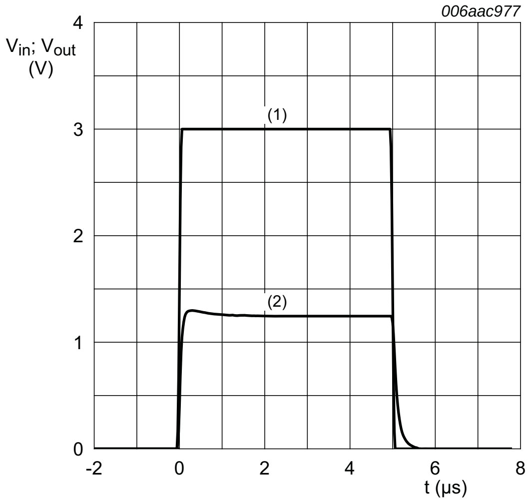
(2) Output

Fig 13. Input voltage and output voltage as a function of time; typical values



T_{amb} = 25 °C

Fig 14. Test circuit to Figure 13

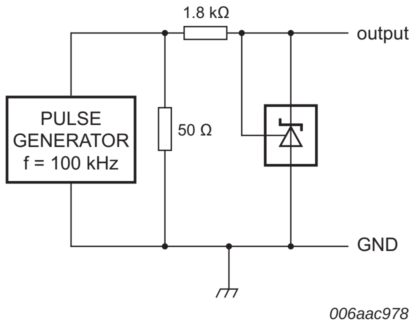


T_{amb} = 25 °C

(1) Input

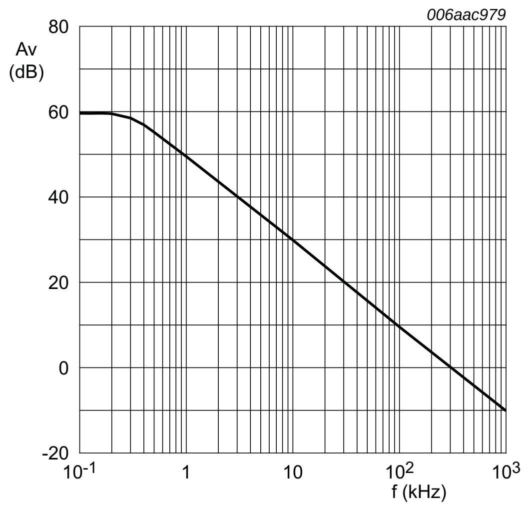
(2) Output

Fig 15. Input voltage and output voltage as a function of time; typical values



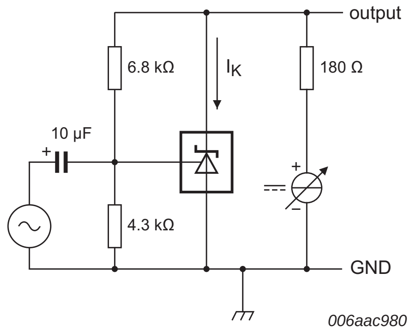
T_{amb} = 25 °C

Fig 16. Test circuit to Figure 15



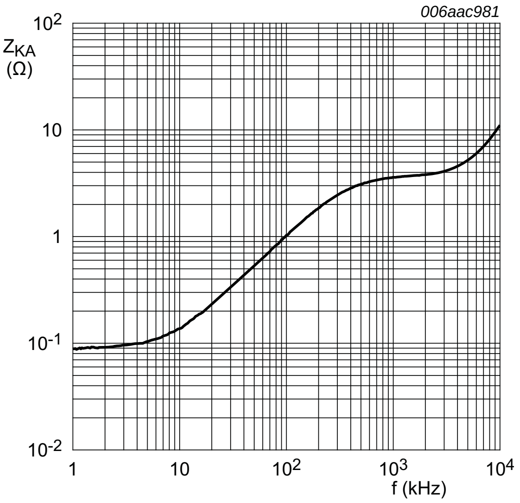
I_K = 10 mA; T_{amb} = 25 °C

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



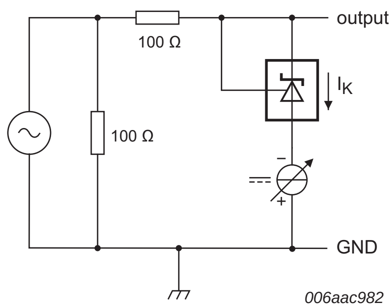
I_K = 10 mA; T_{amb} = 25 °C

Fig 18. Test circuit to Figure 17



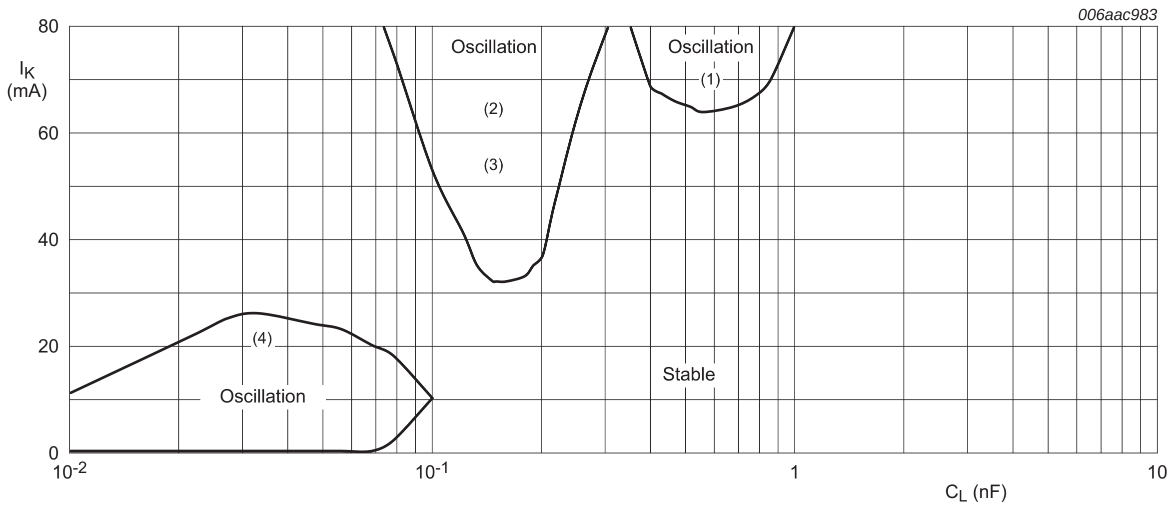
I_K = 10 mA; T_{amb} = 25 °C

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



I_K = 10 mA; T_{amb} = 25 °C

Fig 20. Test circuit to Figure 19



T_{amb} = 25 °C

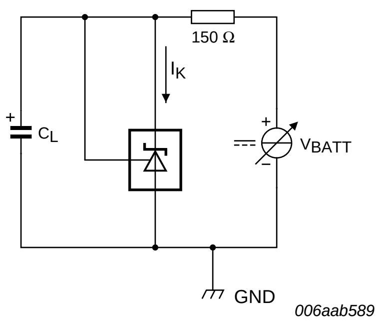
(1) $V_{KA} = V_{ref}$

(2) V_{KA} = 2 V

(3) V_{KA} = 3 V

(4) V_{KA} = 18 V

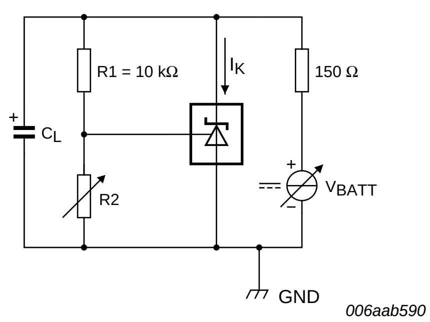
Fig 21. Cathode current as a function of load capacitance; typical values



$V_{KA} = V_{ref}$

T_{amb} = 25 °C

Fig 22. Test circuit to Figure 21



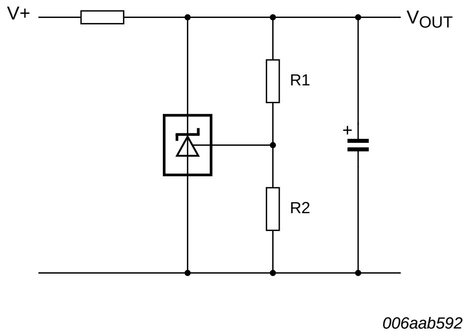
$V_{KA} > V_{ref}$

T_{amb} = 25 °C

Fig 23. Test circuit to Figure 21

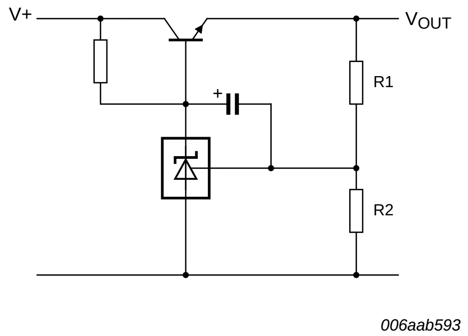
Figure 21, 22 and 23 show the stability boundaries and test circuits for the worst case conditions with a load capacitance mounted as close as possible to the device. The required load capacitance for stable operation varies depending on the operating temperature and capacitor Equivalent Series Resistance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

13. Application information



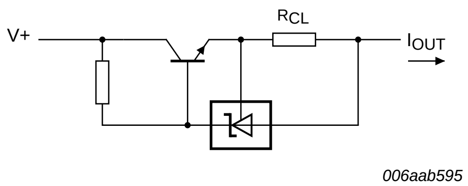
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) \times V_{ref}$$

Fig 24. Shunt regulator



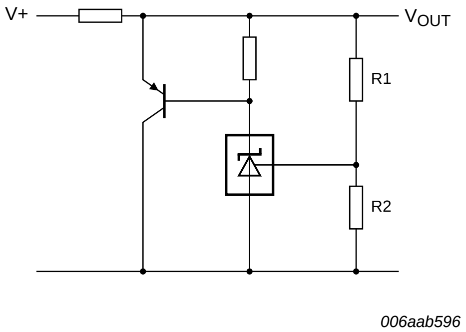
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) \times V_{ref};\ V_{OUT(min)} = V_{ref} + V_{be}$$

Fig 25. Series pass regulator



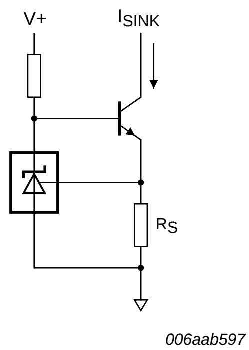
$$I_{OUT} = \frac{V_{ref}}{R_{CL}}$$

Fig 26. Constant current source



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

Fig 27. High-current shunt regulator



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

Fig 28. Constant current sink

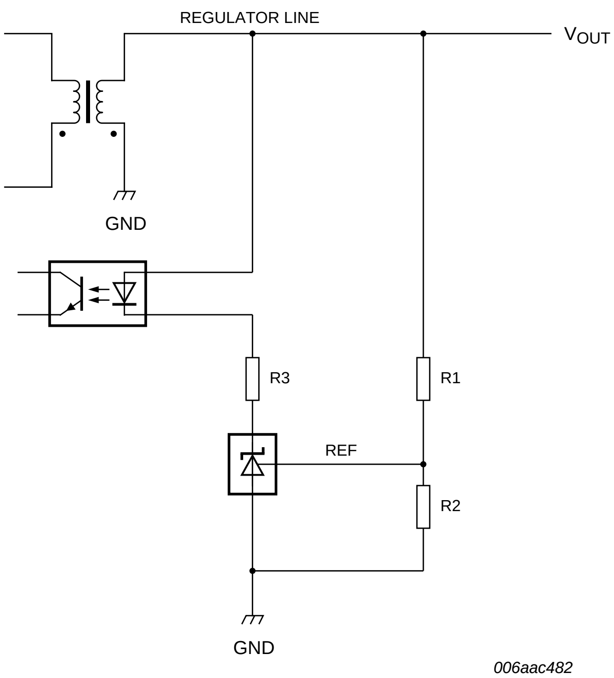


Fig 29. TLVH431 in isolated feedback loop for low output voltage SMPS

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

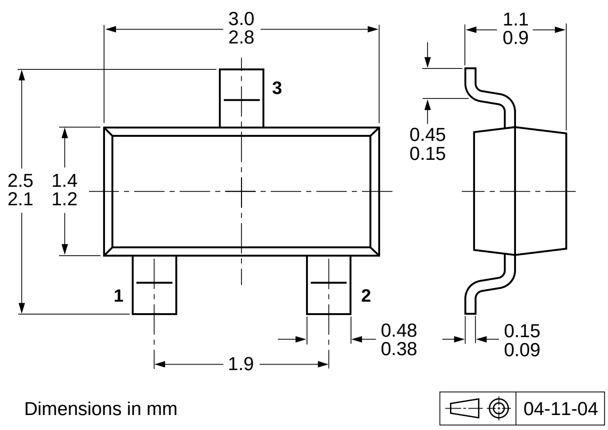


Fig 30. Package outline SOT23 (TO-236AB)

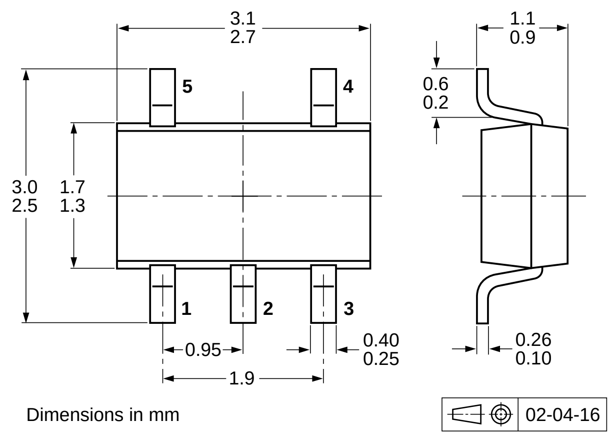


Fig 31. Package outline SOT753 (SC-74A)

16. Packing information

Table 11. Packing methods

The indicated -xxx are the last three digits of the 12NC ordering code.[1]

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

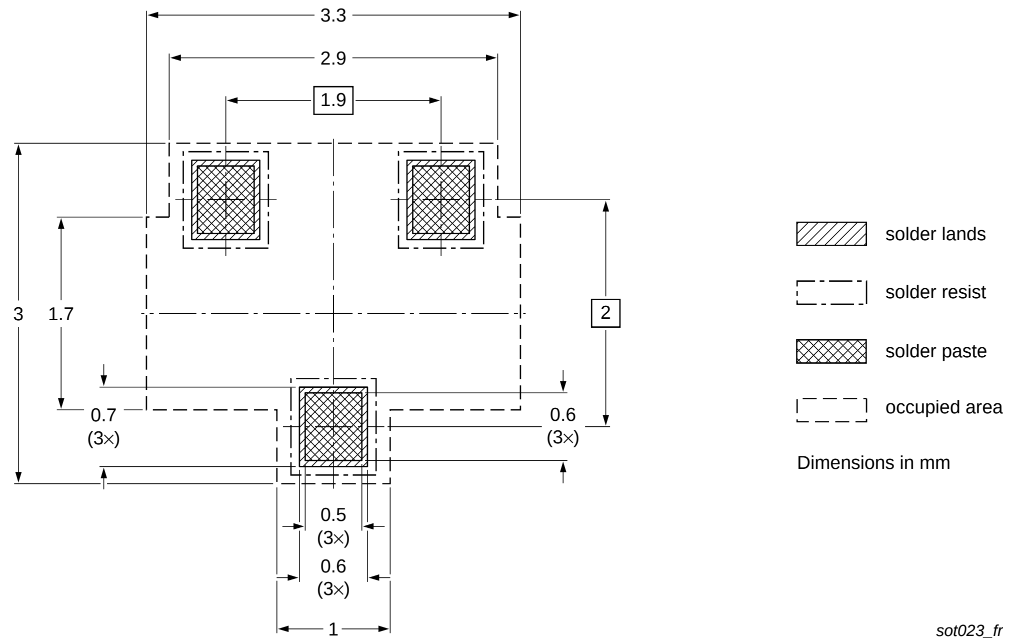


Fig 32. Reflow soldering footprint SOT23 (TO-236AB)

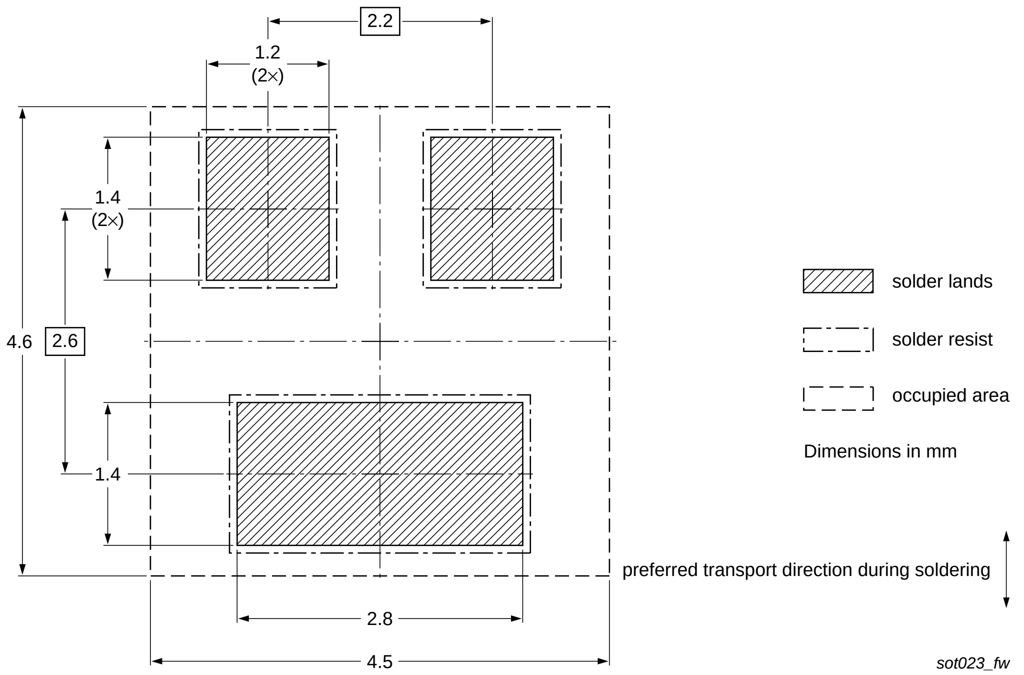


Fig 33. Wave soldering footprint SOT23 (TO-236AB)

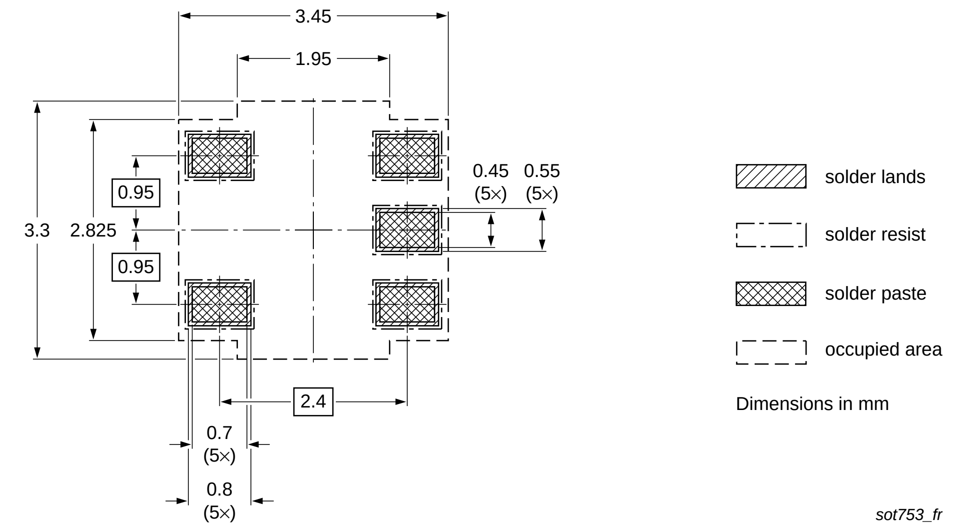


Fig 34. Reflow soldering footprint SOT753 (SC-74A)

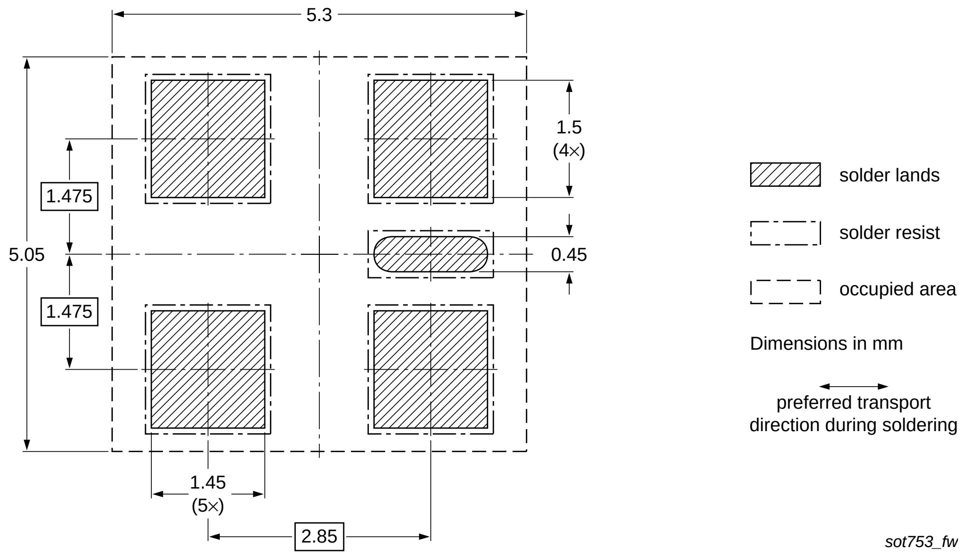


Fig 35. Wave soldering footprint SOT753 (SC-74A)

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[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 URL http://www.nxp.com.

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21. Contents

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