Important notice

Dear Customer,

On 7 February 2017 the former NXP Standard Product business became a new company with the tradename **Nexperia**. Nexperia is an industry leading supplier of Discrete, Logic and PowerMOS semiconductors with its focus on the automotive, industrial, computing, consumer and wearable application markets

In data sheets and application notes which still contain NXP or Philips Semiconductors references, use the references to Nexperia, as shown below.

Instead of http://www.nxp.com, http://www.philips.com/ or http://www.semiconductors.philips.com/, use **http://www.nexperia.com**

Instead of sales.addresses@www.nxp.com or sales.addresses@www.semiconductors.philips.com, use **salesaddresses@nexperia.com** (email)

Replace the copyright notice at the bottom of each page or elsewhere in the document, depending on the version, as shown below:
- © NXP N.V. (year). All rights reserved or © Koninklijke Philips Electronics N.V. (year). All rights reserved
Should be replaced with:
- **© Nexperia B.V. (year). All rights reserved**.

If you have any questions related to the data sheet, please contact our nearest sales office via e-mail or telephone (details via **salesaddresses@nexperia.com**). Thank you for your cooperation and understanding,

Kind regards,

Team Nexperia

TL431 family
Adjustable precision shunt regulator

Rev. 5 — 01 September 2015

Product data sheet

1. Product profile

1.1 General description

Three-terminal shunt regulator family with an output voltage range between V_{ref} and 36 V, to be set by two external resistors.

- The TL431xDBZR types feature an enhanced stability area with a very low load capacity requirement.
- The TL431xFDT types offer an enhanced stability area and a higher ElectroMagnetic Interference (EMI) ruggedness, for example, for Switch Mode Power Supply (SMPS) applications.
- The TL431xSDT types are designed for standard requirements and linear applications.

Table 1.   Product overview

Reference voltage tolerance (V_{ref})	Temperature range (T_{amb})			Pinning configuration (see Table 3)
	0 °C to 70 °C	−40 °C to 85 °C	−40 °C to 125 °C	
2 %	TL431CDBZR	TL431IDBZR	TL431QDBZR	normal pinning
			TL431FDT	normal pinning
			TL431MFDT	mirrored pinning
			TL431SDT	normal pinning
			TL431MSDT	mirrored pinning
1 %	TL431ACDBZR	TL431AIDBZR	TL431AQDBZR	normal pinning
			TL431AFDT	normal pinning
			TL431AMFDT	mirrored pinning
			TL431ASDT	normal pinning
			TL431AMSDT	mirrored pinning
0.5 %	TL431BCDBZR	TL431BIDBZR	TL431BQDBZR	normal pinning
			TL431BFDT	normal pinning
			TL431BMFDT	mirrored pinning
			TL431BSDT	normal pinning
			TL431BMSDT	mirrored pinning

1.2 Features and benefits

- Programmable output voltage up to 36 V
- Three different reference voltage tolerances:
  - ◆ Standard grade: 2 %
  - ◆ A-Grade: 1 %
  - ◆ B-Grade: 0.5 %
- Typical temperature drift: 6 mV (in a range of 0 °C up to 70 °C)
- Low output noise
- Typical output impedance: 0.2 Ω
- Sink current capability: 1 mA to 100 mA
- AEC-Q100 qualified (grade 1)

1.3 Applications

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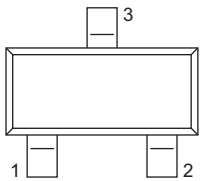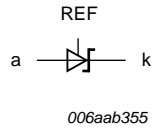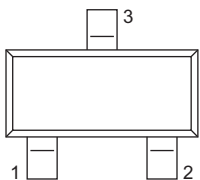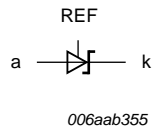- Isolated feedback loop for Switch Mode Power Supply (SMPS)

1.4 Quick reference data

Table 2. **Quick reference data**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{KA}	cathode-anode voltage		V_{ref}	-	36	V
I_K	cathode current		1	-	100	mA
V_{ref}	reference voltage	$V_{KA} = V_{ref}$; $I_K = 10$ mA; $T_{amb} = 25$ °C				
	Standard-Grade (2 %)		2440	2495	2550	mV
	A-Grade (1 %)		2470	2495	2520	mV
	B-Grade (0.5 %)		2483	2495	2507	mV

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

2 of 27

2. Pinning information

Table 3. **Pinning**

Pin	Symbol	Description	Simplified outline	Graphic symbol
Normal pinning: All types without MFDT and MSDT ending				
1	k	cathode		
2	REF	reference		
3	a	anode		006aab355
Mirrored pinning: All types with MFDT and MSDT ending				
1	REF	reference		
2	k	cathode		
3	a	anode		006aab355

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

3 of 27

3. Ordering information

Table 4. Ordering information

Type number	Package			
	Name	**Description**		**Version**
TL431CDBZR	-	plastic surface-mounted package; 3 leads		SOT23
TL431IDBZR				
TL431QDBZR				
TL431FDT				
TL431MFDT				
TL431SDT				
TL431MSDT				
TL431ACDBZR				
TL431AIDBZR				
TL431AQDBZR				
TL431AFDT				
TL431AMFDT				
TL431ASDT				
TL431AMSDT				
TL431BCDBZR				
TL431BIDBZR				
TL431BQDBZR				
TL431BFDT				
TL431BMFDT				
TL431BSDT				
TL431BMSDT				

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

4 of 27

4. Marking

Table 5.   Marking codes

Type number	Marking code[1]	Type number	Marking code[1]
TL431CDBZR	CA*	TL431ASDT	RL*
TL431IDBZR	CB*	TL431AMSDT	LQ*
TL431QDBZR	CC*	TL431BCDBZR	CG*
TL431FDT	AR*	TL431BIDBZR	CH*
TL431MFDT	AU*	TL431BQDBZR	CJ*
TL431SDT	RM*	TL431BFDT	AT*
TL431MSDT	LR*	TL431BMFDT	AW*
TL431ACDBZR	CD*	TL431BSDT	MA*
TL431AIDBZR	CE*	TL431BMSDT	MB*
TL431AQDBZR	CF*	-	-
TL431AFDT	AS*	-	-
TL431AMFDT	AV*	-	-

[1]   * = placeholder for manufacturing site code.

5. Functional diagram

The TL431 family comprises a range of 3-terminal adjustable shunt regulators, with specified thermal stability over applicable automotive and commercial temperature ranges. The output voltage may be set to any value between V_{ref} (approximately 2.5 V) and 36 V with two external resistors (see Figure 8). These devices have a typical output impedance of 0.2 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.
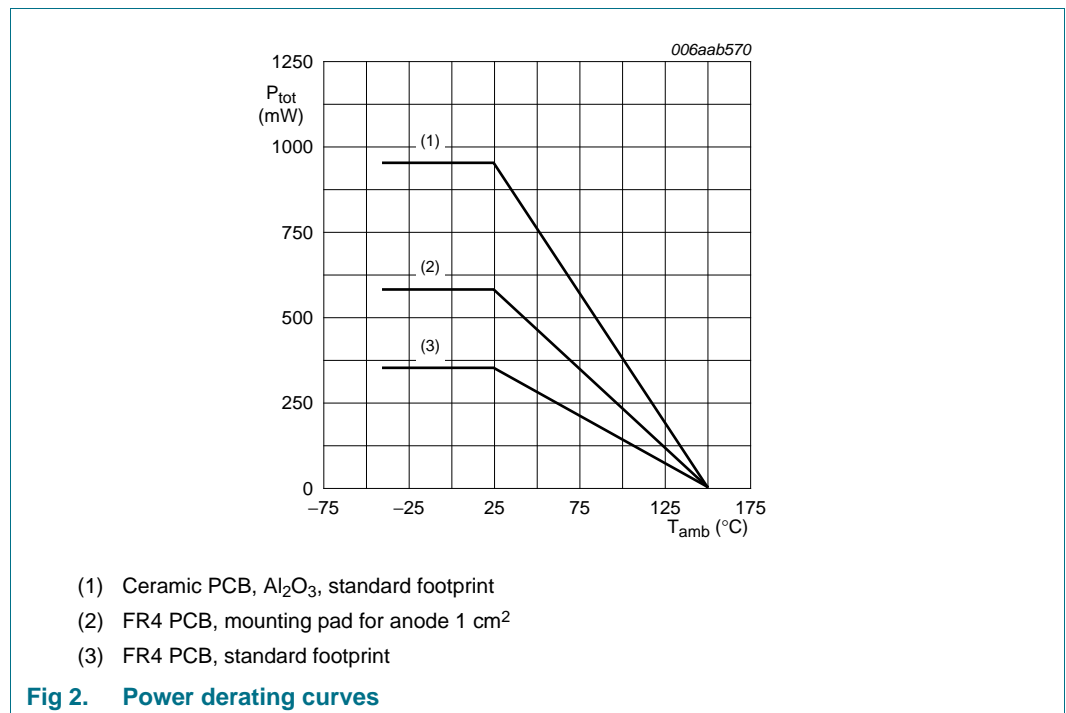

Fig 1.   Functional diagram

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

5 of 27
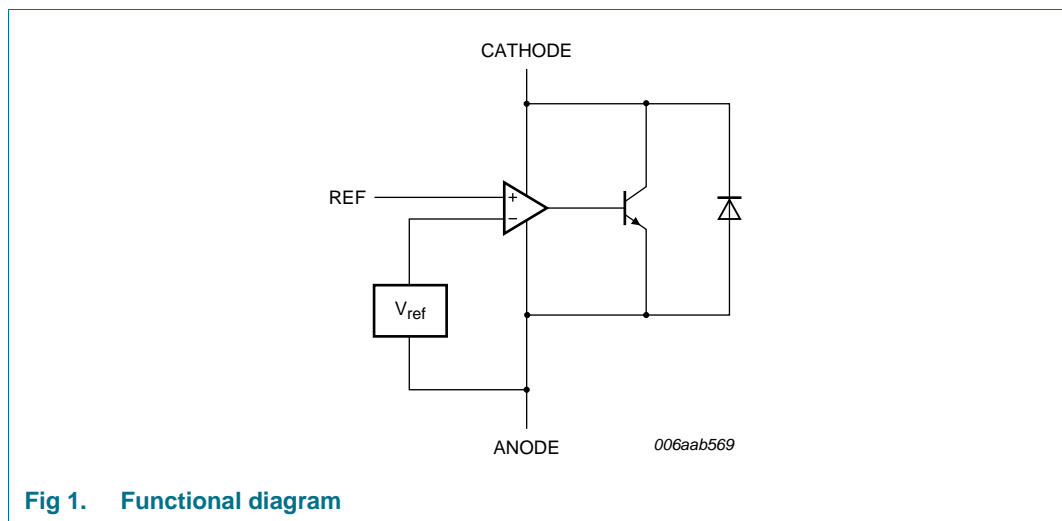
6. Limiting values

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			-	37	V
I_K	cathode current			−100	150	mA
I_{ref}	reference current			−0.05	10	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					
	TL431XCDBZR			0	+70	°C
	TL431XIDBZR			−40	+85	°C
	TL431XQDBZR TL431XFDT TL431XSDT			−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

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

6 of 27

Table 7.   ESD maximum ratings

T_{amb} = 25 ℃ unless otherwise specified.

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

7.   Recommended operating conditions

Table 8.   Operating conditions

Symbol	Parameter	Conditions	Min	Max	Unit
V_{KA}	cathode-anode voltage		V_{ref}	36	V
I_K	cathode current		1	100	mA

8.   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.

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

7 of 27

9. Characteristics

Table 10. Characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Standard-Grade (2 %): **TL431CDBZR; TL431IDBZR; TL431QDBZR; TL431FDT; TL431MFDT; TL431SDT; TL431MSDT**						
V_{ref}	reference voltage	$V_{KA} = V_{ref}$; $I_K = 10$ mA	2440	2495	2550	mV
ΔV_{ref}	reference voltage variation	$V_{KA} = V_{ref}$; $I_K = 10$ mA				
	TL431CDBZR	$T_{amb} = 0$ °C to 70 °C	-	6	16	mV
	TL431IDBZR	$T_{amb} = -40$ °C to 85 °C	-	14	34	mV
	TL431QDBZR TL431FDT TL431MFDT TL431SDT TL431MSDT	$T_{amb} = -40$ °C to 125 °C				
$\Delta V_{ref}/\Delta V_{KA}$	reference voltage variation to cathode-anode voltage variation ratio	$I_K = 10$ mA				
		$\Delta V_{KA} = 10$ V to V_{ref}	-	−1.4	−2.7	mV/V
		$\Delta V_{KA} = 36$ V to 10 V	-	−1	−2	mV/V
I_{ref}	reference current	$I_K = 10$ mA; R1 = 10 kΩ; R2 = open	-	2	4	μA
ΔI_{ref}	reference current variation	$I_K = 10$ mA; R1 = 10 kΩ; R2 = open				
	TL431CDBZR	$T_{amb} = 0$ °C to 70 °C	-	0.4	1.2	μA
	TL431IDBZR	$T_{amb} = -40$ °C to 85 °C	-	0.8	2.5	μA
	TL431QDBZR TL431FDT TL431MFDT TL431SDT TL431MSDT	$T_{amb} = -40$ °C to 125 °C				
$I_{K(min)}$	minimum cathode current	$V_{KA} = V_{ref}$	-	0.4	1	mA
I_{off}	off-state current	$V_{KA} = 36$ V; $V_{ref} = 0$	-	0.1	1	μA
Z_{KA}	dynamic cathode-anode impedance	$I_K = 1$ mA to 100 mA; $V_{KA} = V_{ref}$; f < 1 kHz	-	0.2	0.5	Ω
A-Grade (1 %): **TL431ACDBZR; TL431AIDBZR; TL431AQDBZR; TL431AFDT; TL431AMFDT; TL431ASDT; TL431AMSDT**						
V_{ref}	reference voltage	$V_{KA} = V_{ref}$; $I_K = 10$ mA	2470	2495	2520	mV
ΔV_{ref}	reference voltage variation	$V_{KA} = V_{ref}$; $I_K = 10$ mA				
	TL431ACDBZR	$T_{amb} = 0$ °C to 70 °C	-	6	16	mV
	TL431AIDBZR	$T_{amb} = -40$ °C to 85 °C	-	14	34	mV
	TL431AQDBZR TL431AFDT TL431AMFDT TL431ASDT TL431AMSDT	$T_{amb} = -40$ °C to 125 °C				
$\Delta V_{ref}/\Delta V_{KA}$	reference voltage variation to cathode-anode voltage variation ratio	$I_K = 10$ mA				
		$\Delta V_{KA} = 10$ V to V_{ref}	-	−1.4	−2.7	mV/V
		$\Delta V_{KA} = 36$ V to 10 V	-	−1	−2	mV/V

TL431 family

Product data sheet

Rev. 5 — 01 September 2015

8 of 27

Table 10.   Characteristics *…continued*

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{ref}	reference current	I_K = 10 mA; R1 = 10 kΩ; R2 = open	-	2	4	μA
ΔI_{ref}	reference current variation	I_K = 10 mA; R1 = 10 kΩ; R2 = open				
	TL431ACDBZR	T_{amb} = 0 °C to 70 °C	-	0.4	1.2	μA
	TL431AIDBZR	T_{amb} = −40 °C to 85 °C	-	0.8	2.5	μA
	TL431AQDBZR TL431AFDT TL431AMFDT TL431ASDT TL431AMSDT	T_{amb} = −40 °C to 125 °C				
$I_{K(min)}$	minimum cathode current	V_{KA} = V_{ref}				
	TL431ACDBZR	T_{amb} = 0 °C to 70 °C	-	0.4	0.6	mA
	TL431AIDBZR	T_{amb} = −40 °C to 85 °C				
	TL431AQDBZR TL431AFDT TL431AMFDT TL431ASDT TL431AMSDT	T_{amb} = −40 °C to 125 °C				
I_{off}	off-state current	V_{KA} = 36 V; V_{ref} = 0	-	0.1	0.5	μA
Z_{KA}	dynamic cathode-anode impedance	I_K = 1 mA to 100 mA; V_{KA} = V_{ref}; f < 1 kHz	-	0.2	0.5	Ω
B-Grade (0.5 %): **TL431BCDBZR; TL431BIDBZR; TL431BQDBZR; TL431BFDT; TL431BMFDT; TL431BSDT; TL431BMSDT**						
V_{ref}	reference voltage	V_{KA} = V_{ref}; I_K = 10 mA	2483	2495	2507	mV
ΔV_{ref}	reference voltage variation	V_{KA} = V_{ref}; I_K = 10 mA				
	TL431BCDBZR	T_{amb} = 0 °C to 70 °C	-	6	16	mV
	TL431BIDBZR	T_{amb} = −40 °C to 85 °C	-	14	34	mV
	TL431BQDBZR TL431BFDT TL431BMFDT TL431BSDT TL431BMSDT	T_{amb} = −40 °C to 125 °C				
$\Delta V_{ref}/\Delta V_{KA}$	reference voltage variation to cathode-anode voltage variation ratio	I_K = 10 mA				
		ΔV_{KA} = 10 V to V_{ref}	-	−1.4	−2.7	mV/V
		ΔV_{KA} = 36 V to 10 V	-	−1	−2	mV/V
I_{ref}	reference current	I_K = 10 mA; R1 = 10 kΩ; R2 = open	-	2	4	μA

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

9 of 27

Table 10.   Characteristics *…continued*

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
ΔI_{ref}	reference current variation	I_K = 10 mA; R1 = 10 kΩ; R2 = open				
	TL431BCDBZR	T_{amb} = 0 °C to 70 °C	-	0.4	1.2	μA
	TL431BIDBZR	T_{amb} = −40 °C to 85 °C	-	0.8	2.5	μA
	TL431BQDBZR TL431BFDT TL431BMFDT TL431BSDT TL431BMSDT	T_{amb} = −40 °C to 125 °C				
$I_{K(min)}$	minimum cathode current	$V_{KA} = V_{ref}$				
	TL431BCDBZR	T_{amb} = 0 °C to 70 °C	-	0.4	0.6	mA
	TL431BIDBZR	T_{amb} = −40 °C to 85 °C				
	TL431BQDBZR TL431BFDT TL431BMFDT TL431BSDT TL431BMSDT	T_{amb} = −40 °C to 125 °C				
I_{off}	off-state current	V_{KA} = 36 V; V_{ref} = 0	-	0.1	0.5	μA
Z_{KA}	dynamic cathode-anode impedance	I_K = 1 mA to 100 mA; $V_{KA} = V_{ref}$; f < 1 kHz	-	0.2	0.5	Ω

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

10 of 27

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

Fig 3. **Reference voltage as a function of ambient temperature; typical values**
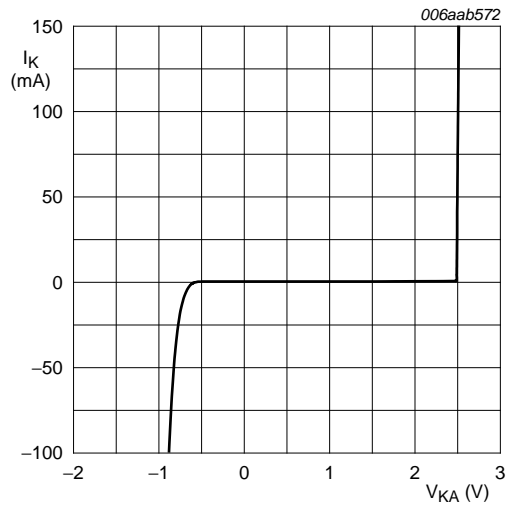
$V_{KA} = V_{ref}$; $T_{amb} = 25$ °C

Fig 4. **Cathode current as a function of cathode-anode voltage; typical values**
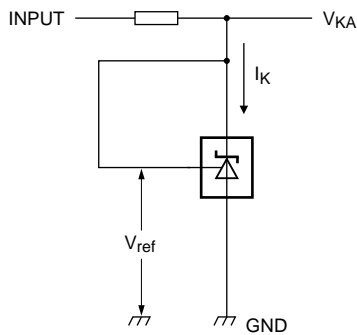
$I_K = 10$ mA; $V_{KA} = V_{ref}$

Fig 5. **Test circuit to Figure 3 and Figure 4**

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

11 of 27
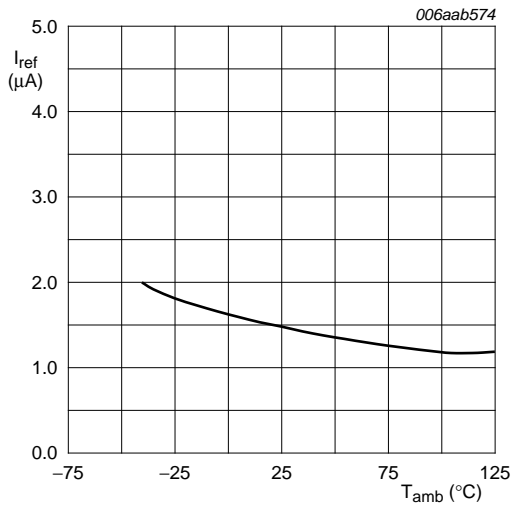
$I_K = 10$ mA; R1 = 10 kΩ; R2 = open

Fig 6. **Reference current as a function of ambient temperature; typical values**
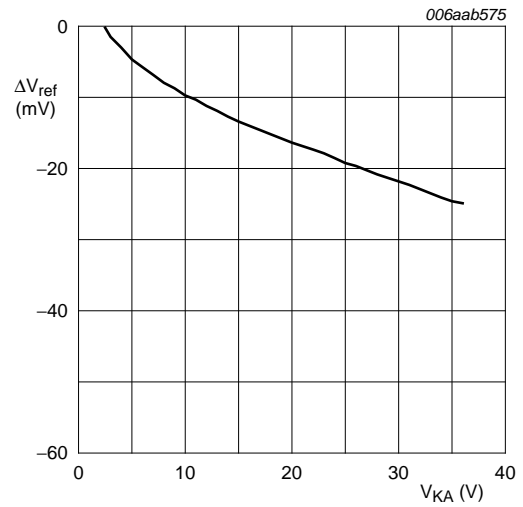
$I_K = 10$ mA; $T_{amb} = 25$ °C

Fig 7. **Reference voltage variation as a function of cathode-anode voltage; typical values**
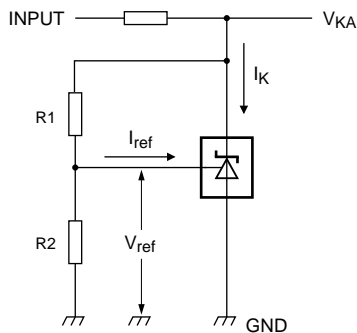
$$V_{KA} = V_{ref} \times \left(1 + \frac{R1}{R2} \right) + I_{ref} \times R1$$

Fig 8. **Test circuit to Figure 6 and Figure 7**

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

12 of 27
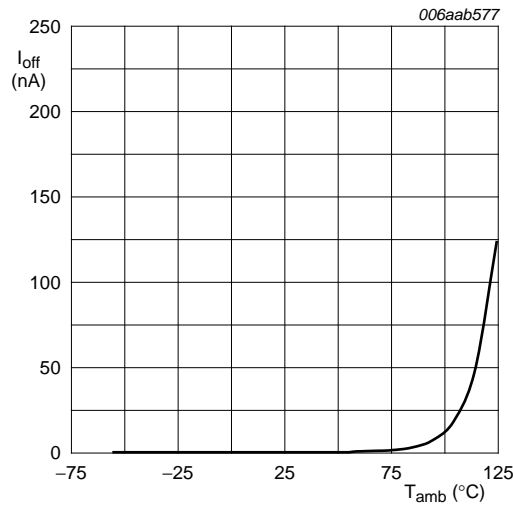
V_{KA} = 36 V; V_{ref} = 0 V

Fig 9. Off-state current as a function of ambient temperature; typical values
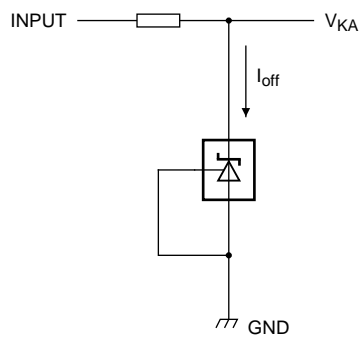
V_{KA} = 36 V; V_{ref} = 0 V

Fig 10. Off-state current as a function of ambient temperature; test circuit

TL431 family

Product data sheet

All information provided in this document is subject to legal disclaimers.

Rev. 5 — 01 September 2015

© NXP Semiconductors N.V. 2015. All rights reserved.

13 of 27
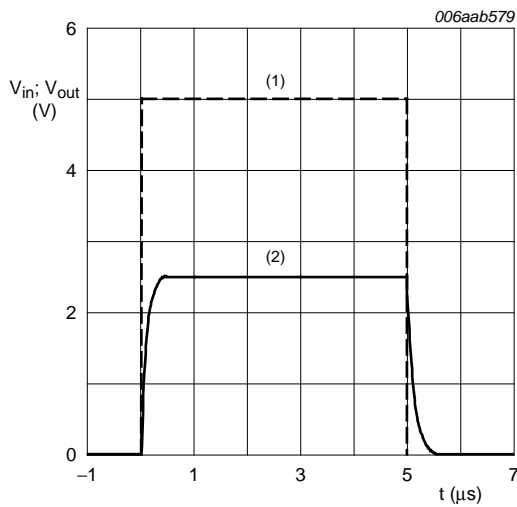
$T_{amb} = 25 \,^{\circ}\text{C}$

(1) Input

(2) Output

Fig 11. All types except TL431XFDT and TL431XSDT: Input voltage and output voltage as a function of time; typical values
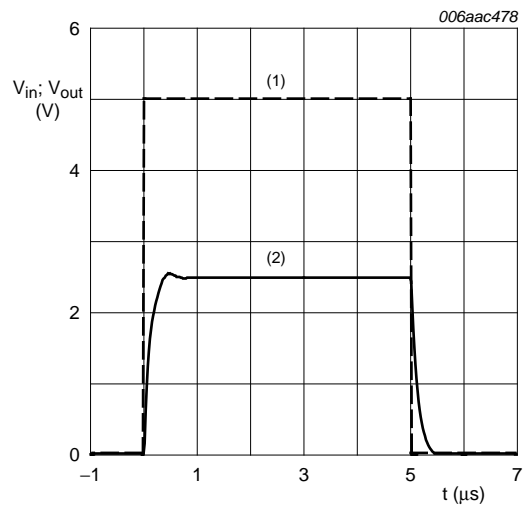
$T_{amb} = 25 \,^{\circ}\text{C}$

(1) Input

(2) Output

Fig 12. TL431XFDT: Input voltage and output voltage as a function of time; typical values
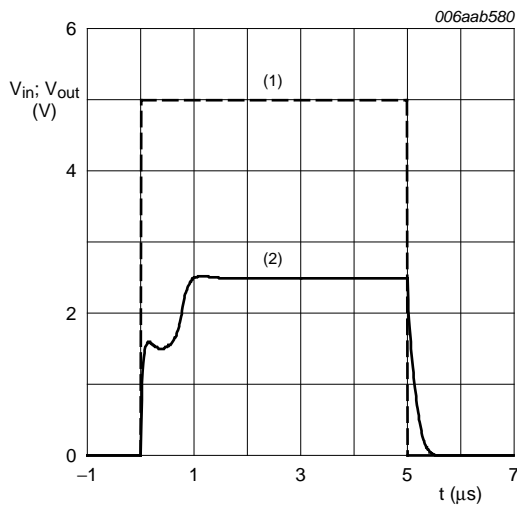
$T_{amb} = 25 \,^{\circ}\text{C}$

(1) Input

(2) Output

Fig 13. TL431XSDT: Input voltage and output voltage as a function of time; typical values
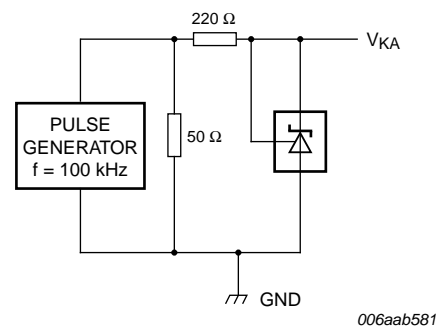
$T_{amb} = 25 \,^{\circ}\text{C}$

Fig 14. Test circuit to Figure 11, Figure 12 and Figure 13

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

14 of 27
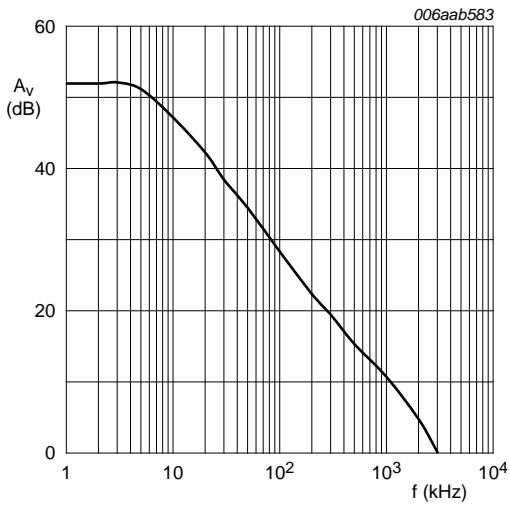
I_K = 10 mA; T_{amb} = 25 °C

Fig 15. All types except TL431XFDT and TL431XSDT: Voltage amplification as a function of frequency; typical values
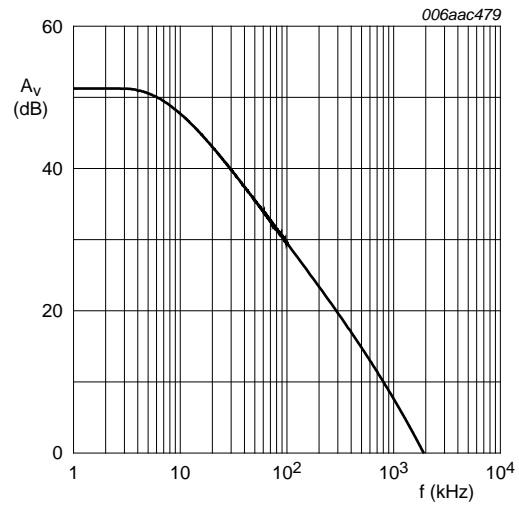
I_K = 10 mA; T_{amb} = 25 °C

Fig 16. TL431XFDT: Voltage amplification as a function of frequency; typical values
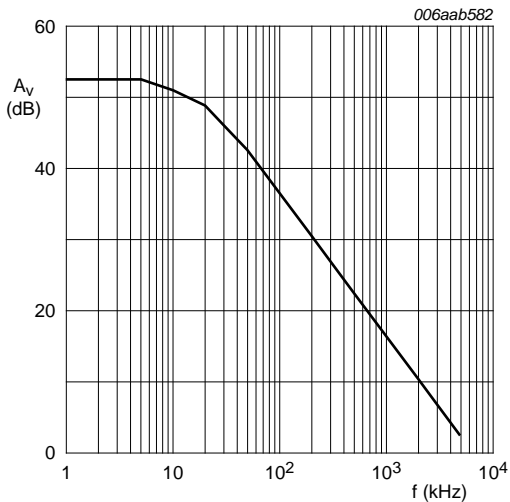
I_K = 10 mA; T_{amb} = 25 °C

Fig 17. TL431XSDT: Voltage amplification as a function of frequency; typical values
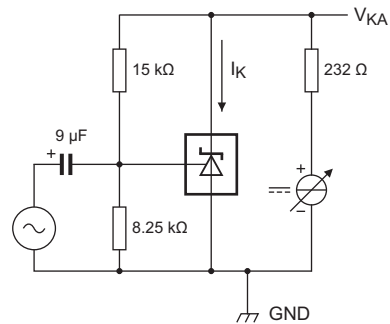
I_K = 10 mA; T_{amb} = 25 °C

Fig 18. Test circuit to Figure 15, Figure 16 and Figure 17

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

15 of 27
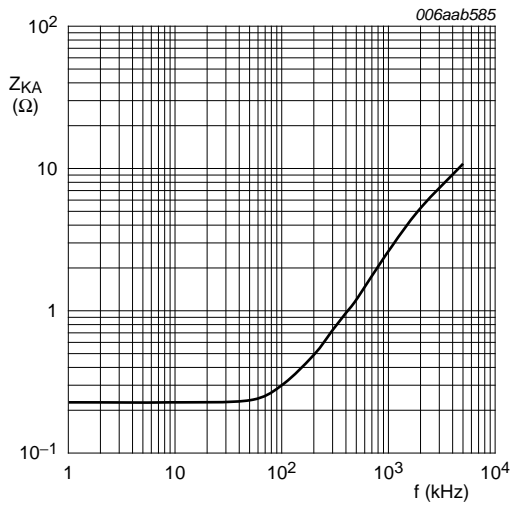
I_K = 10 mA; T_{amb} = 25 °C

Fig 19. **All types except TL431XFDT and TL431XSDT: Dynamic cathode-anode impedance as a function of frequency; typical values**
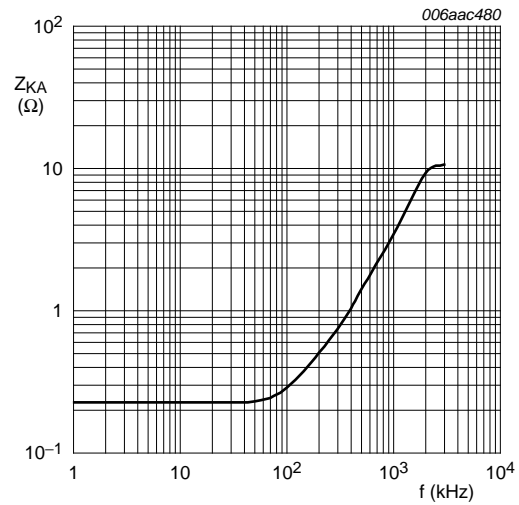
I_K = 10 mA; T_{amb} = 25 °C

Fig 20. **TL431XFDT: Dynamic cathode-anode impedance as a function of frequency; typical values**
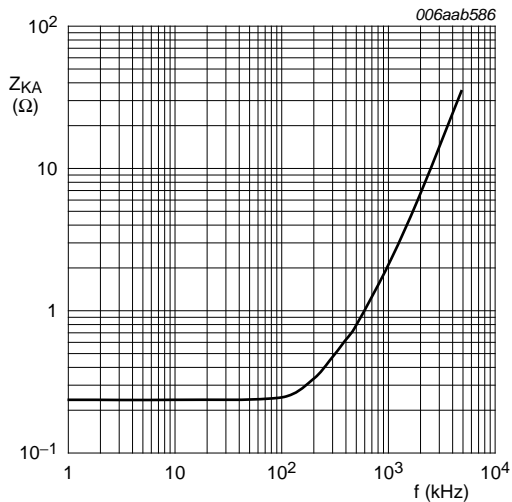
I_K = 10 mA; T_{amb} = 25 °C

Fig 21. **TL431XSDT: Dynamic cathode-anode impedance as a function of frequency; typical values**
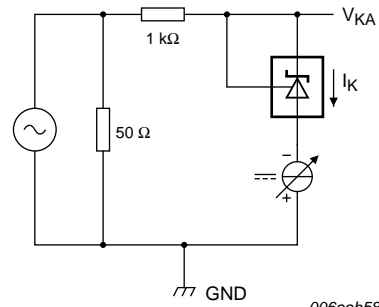
I_K = 10 mA; T_{amb} = 25 °C

Fig 22. **Test circuit to Figure 19, Figure 20 and Figure 21**
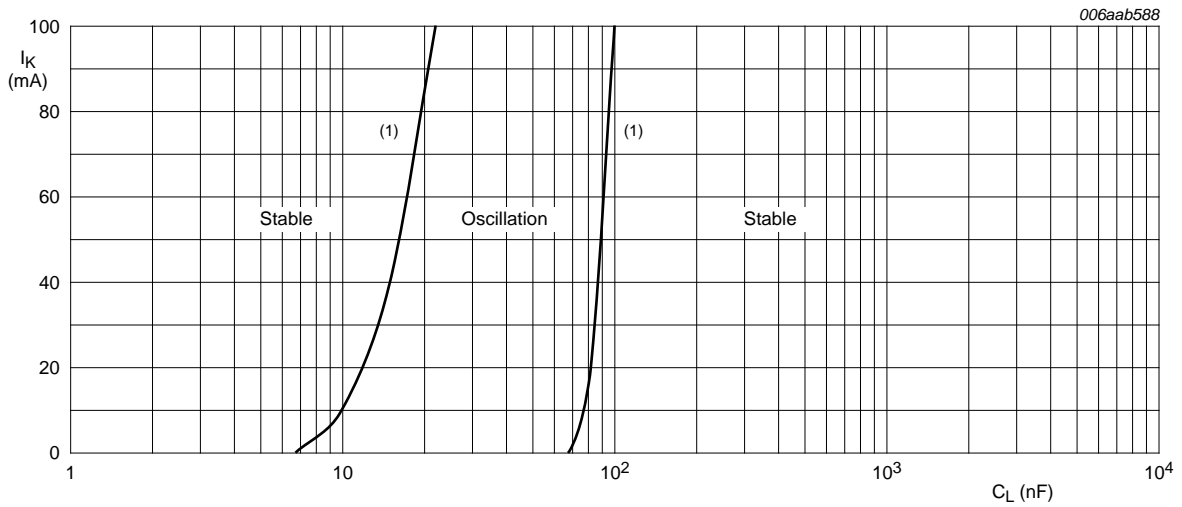
T_{amb} = 25 °C

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

V_{KA} = 5 V: no oscillation

V_{KA} = 10 V: no oscillation

V_{KA} = 15 V: no oscillation

Fig 23.   All types except TL431XFDT and TL431XSDT:
Cathode current as a function of load capacitance; typical values
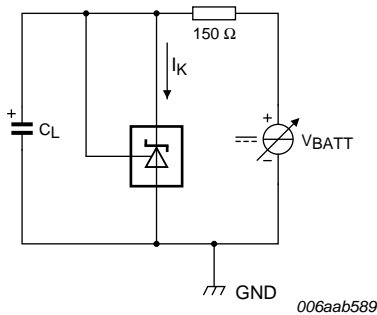
V_{KA} = V_{ref}

T_{amb} = 25 °C

Fig 24.   Test circuit (1) to Figure 23
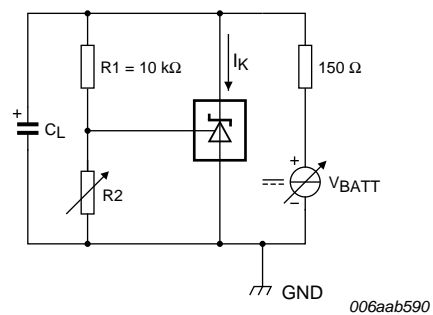
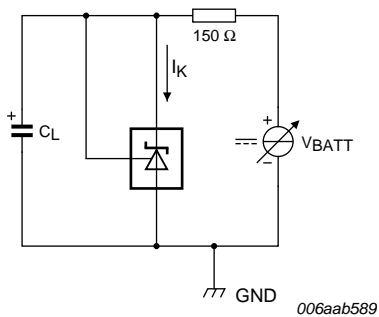V_{KA} > 5 V: stable operation

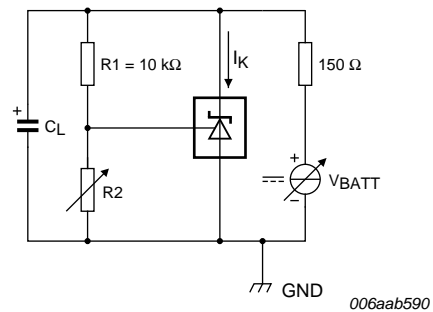T_{amb} = 25 °C

Fig 25.   Test circuit (2) to Figure 23
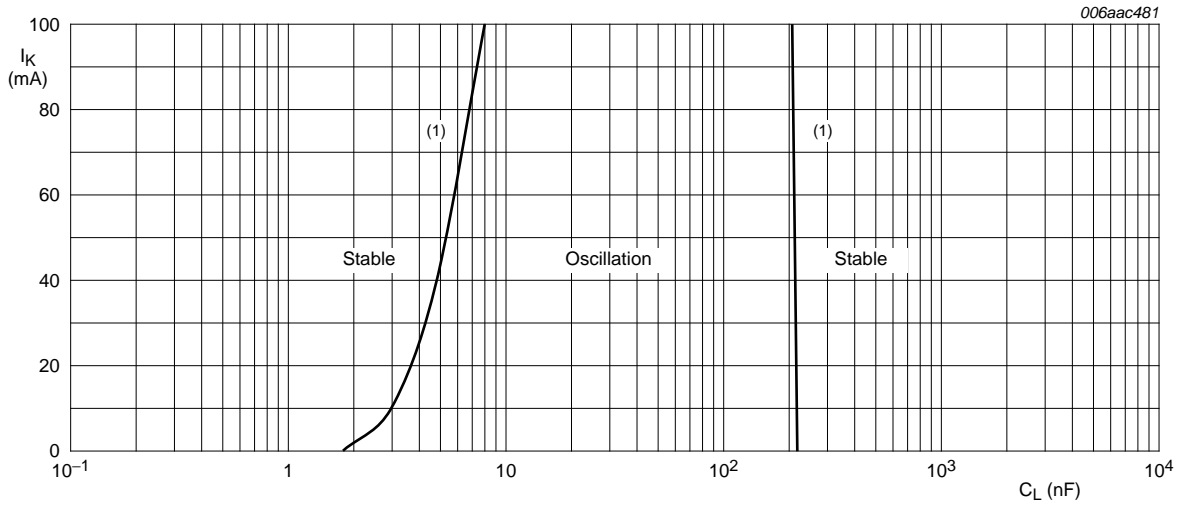
$T_{amb} = 25\ °C$

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

   $V_{KA} = 5\ V$: no oscillation

   $V_{KA} = 10\ V$: no oscillation

   $V_{KA} = 15\ V$: no oscillation

Fig 26. TL431XFDT: Cathode current as a function of load capacitance; typical values

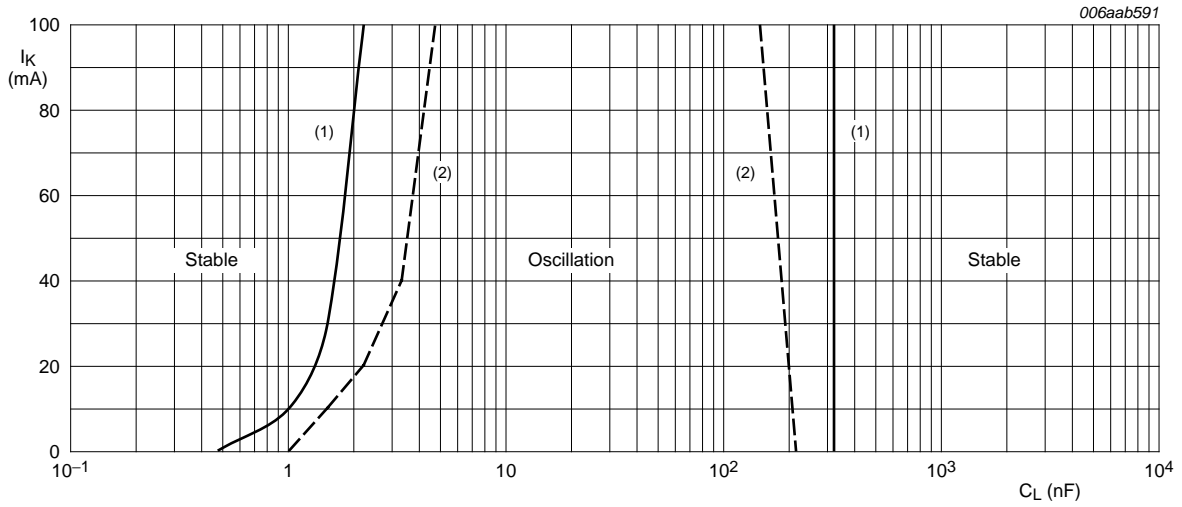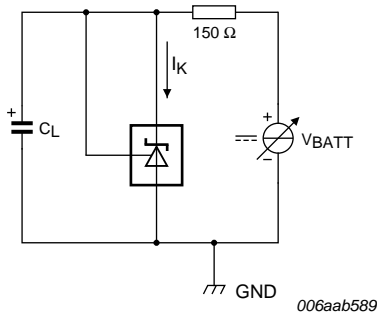
$V_{KA} = V_{ref}$

$T_{amb} = 25\ °C$

Fig 27. Test circuit (1) to Figure 26

$V_{KA} > 5\ V$: stable operation

$T_{amb} = 25\ °C$

Fig 28. Test circuit (2) to Figure 26

T_{amb} = 25 °C
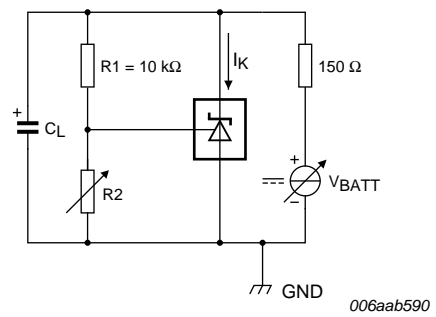
(1) V_{KA} = V_{ref}

(2) V_{KA} = 5 V

V_{KA} = 10 V: no oscillation

V_{KA} = 15 V: no oscillation

Fig 29. TL431XSDT: Cathode current as a function of load capacitance; typical values
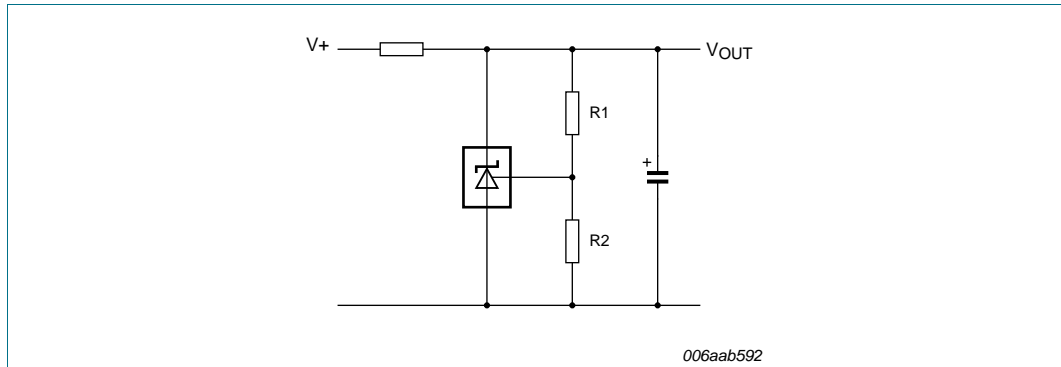

V_{KA} = V_{ref}

T_{amb} = 25 °C

Fig 30. Test circuit (1) to Figure 29

V_{KA} = 5 V

V_{KA} > 10 V: stable operation

T_{amb} = 25 °C

Fig 31. Test circuit (2) to Figure 29

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

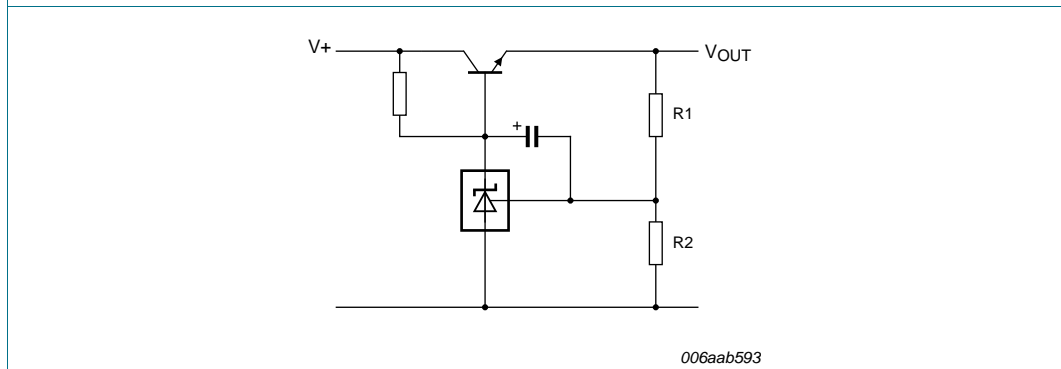**19 of 27**

10. Application information

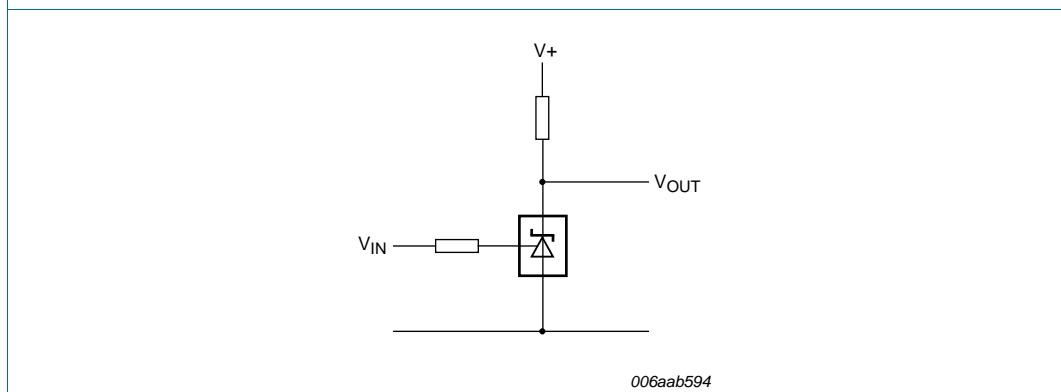$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) \times V_{ref}$$

Fig 32. Shunt regulator

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

$$V_{OUT(min)} = V_{ref} + V_{be}$$

Fig 33. Series pass regulator

$$V_{th} = V_{ref}$$
$$V_{IN} < V_{ref} \Rightarrow V_{OUT} > 0$$
$$V_{IN} > V_{ref} \Rightarrow V_{OUT} \cong 2V$$

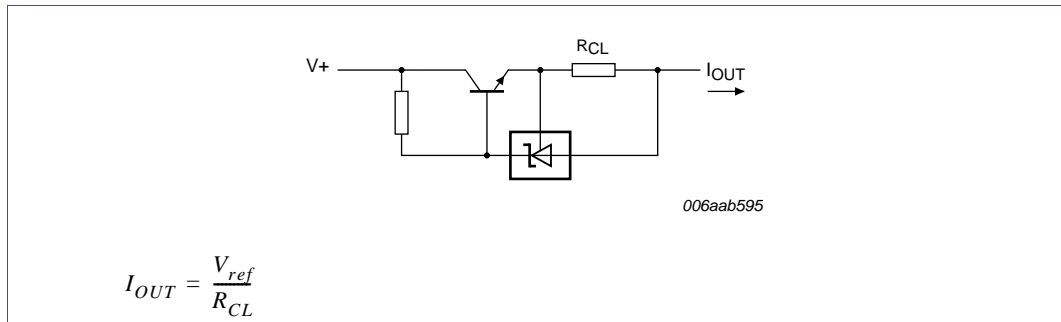**Fig 34. Single-supply comparator with temperature-compensated threshold**
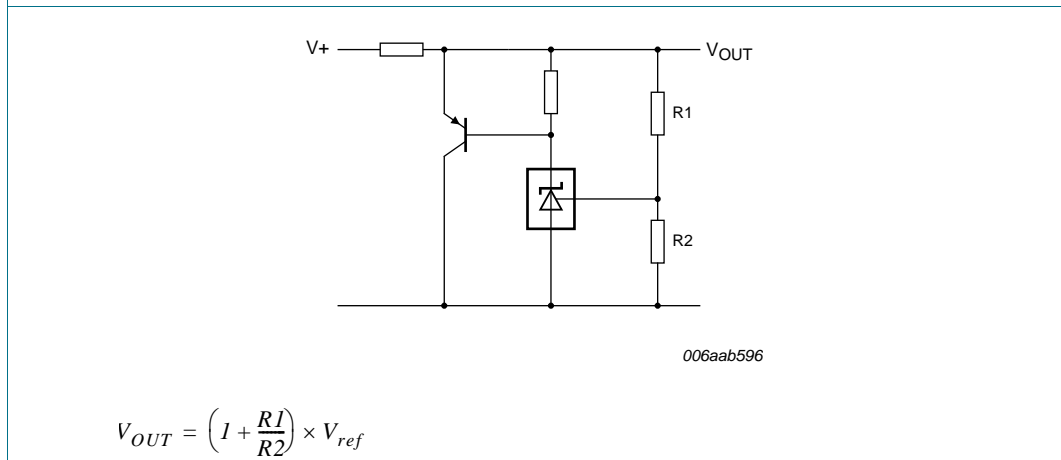
TL431 family

Product data sheet

All information provided in this document is subject to legal disclaimers.

Rev. 5 — 01 September 2015

© NXP Semiconductors N.V. 2015. All rights reserved.

20 of 27

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

Fig 35. Constant current source

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

Fig 36. High-current shunt regulator

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

Fig 37. Constant current sink

TL431 family

Product data sheet

All information provided in this document is subject to legal disclaimers.

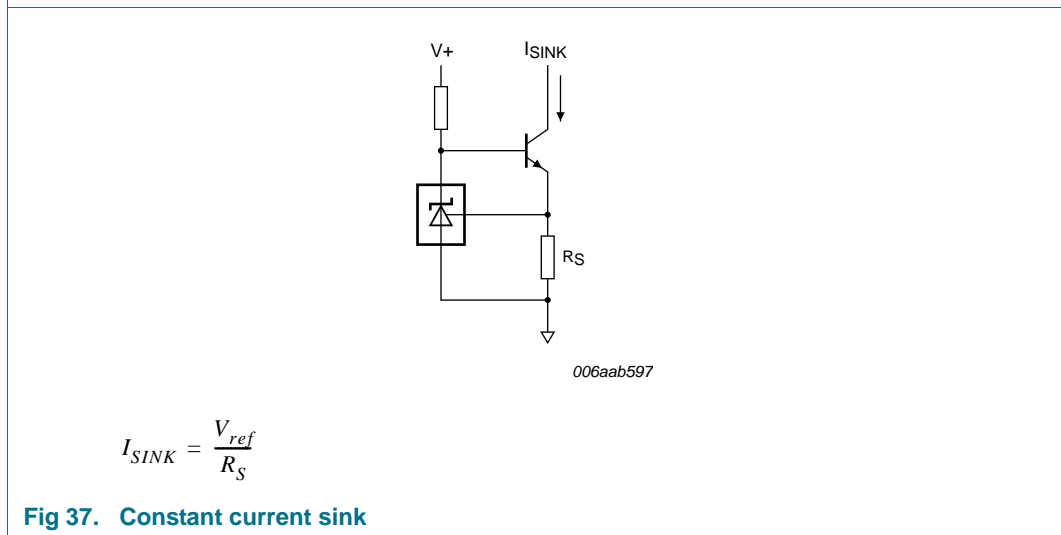Rev. 5 — 01 September 2015

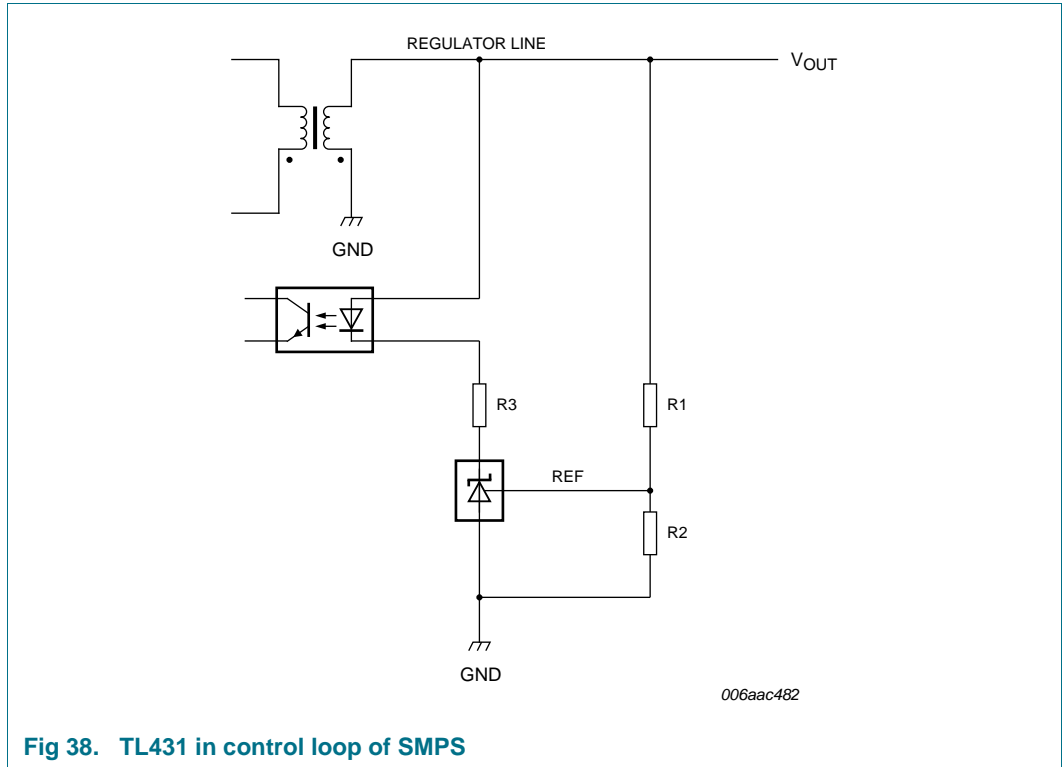© NXP Semiconductors N.V. 2015. All rights reserved.

21 of 27

Fig 38.   TL431 in control loop of SMPS

11. Test information

11.1 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.
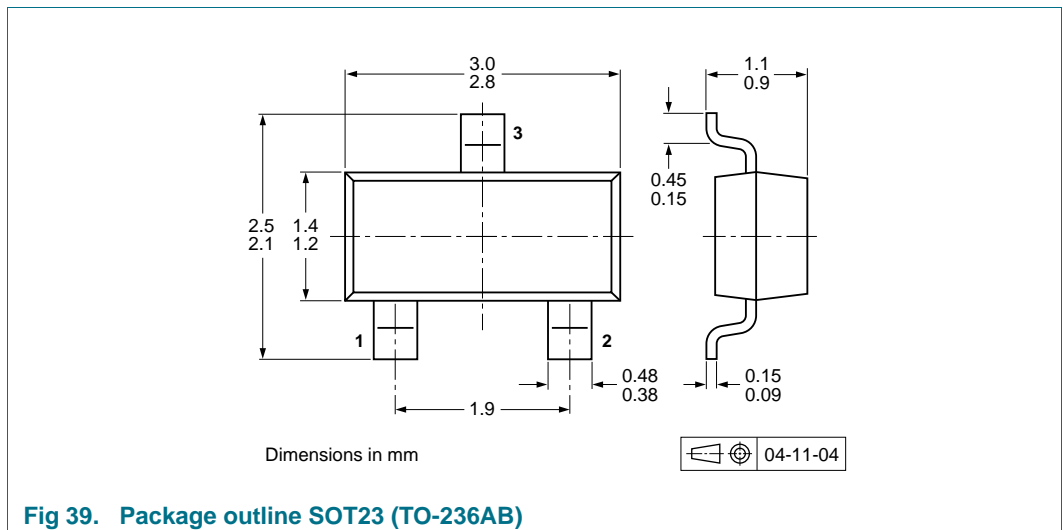
12. Package outline

Dimensions in mm

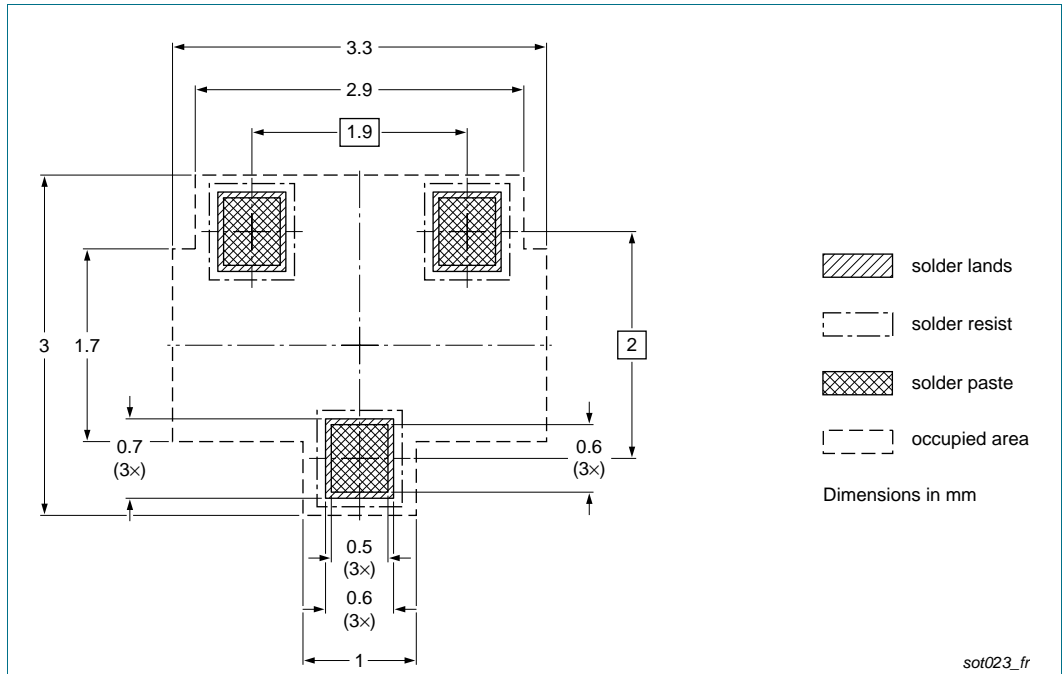**Fig 39.   Package outline SOT23 (TO-236AB)**

13. Soldering

Fig 40. Reflow soldering footprint SOT23 (TO-236AB)
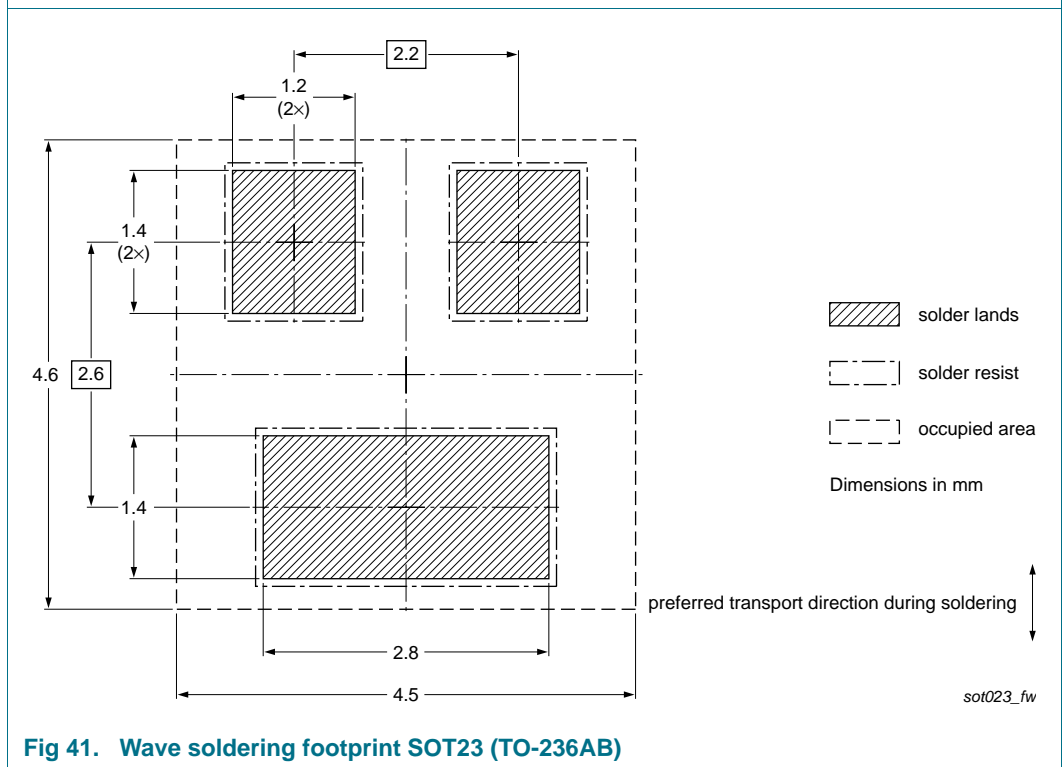
Fig 41. Wave soldering footprint SOT23 (TO-236AB)

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

23 of 27

14. Revision history

Table 11.   Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
TL431_FAM v.5	20150901	Product data sheet	-	TL431_FAM v.4
Modifications:	• Figure 18: Capacitor value corrected			
TL431_FAM v.4	20110630	Product data sheet	-	TL431_FAM v.3
TL431_FAM v.3	20101105	Product data sheet	-	TL431_FAM v.2
TL431_FAM v.2	20100120	Product data sheet	-	TL431_FAM v.1
TL431_FAM v.1	20090806	Product data sheet	-	-

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

24 of 27

15. Legal information

15.1 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.

15.2 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.

15.3 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 in automotive applications — This NXP Semiconductors product has been qualified for use in automotive applications. Unless otherwise agreed in writing, the product is 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.

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

25 of 27

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.

Translations — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

15.4 Trademarks

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

16. Contact information

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

For sales office addresses, please send an email to: **salesaddresses@nxp.com**

TL431 family

All information provided in this document is subject to legal disclaimers.

© NXP Semiconductors N.V. 2015. All rights reserved.

Product data sheet

Rev. 5 — 01 September 2015

26 of 27

17. Contents