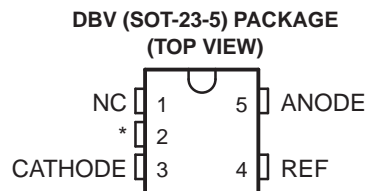


LOW-VOLTAGE ADJUSTABLE PRECISION SHUNT REGULATORS

Check for Samples: [TLVH431A-Q1](#), [TLVH431B-Q1](#)

FEATURES

- Qualified for Automotive Applications
- Low-Voltage Operation: Down to 1.24 V
- Reference Voltage Tolerances at 25°C
 - 0.5% for B Grade
 - 1% for A Grade
- Adjustable Output Voltage, $V_O = V_{REF}$ to 18 V
- Wide Operating Cathode Current Range:
100 μ A to 70 mA
- 0.25- Ω Typical Output Impedance
- –40°C to 125°C Specifications



NC – No internal connection

* Pin 2 is attached to Substrate and must be connected to ANODE or left open.

DESCRIPTION/ORDERING INFORMATION

The TLVH431 devices are low-voltage 3-terminal adjustable voltage references, with thermal stability specified over the automotive temperature range. Output voltage can be set to any value between V_{REF} (1.24 V) and 18 V with two external resistors (see [Figure 2](#)). These devices operate from a lower voltage (1.24 V) than the widely used TL431 and TL1431 shunt-regulator references.

When used with an optocoupler, the TLVH431 devices are ideal voltage reference in isolated feedback circuits for 3-V to 3.3-V switching-mode power supplies. They have a typical output impedance of 0.25 Ω . Active output circuitry provides a very sharp turn-on characteristic, making the TLVH431 an excellent replacement for low-voltage Zener diodes in many applications, including on-board regulation and adjustable power supplies.

ORDERING INFORMATION⁽¹⁾

T_A	V_{REF} TOLERANCE	PACKAGE ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	0.5%	SOT-23-5 – DBV	Reel of 3000	TLVH431BQDBVRQ1	VOPQ
	1%	SOT-23-5 – DBV	Reel of 3000	TLVH431AQDBVRQ1	VOOQ

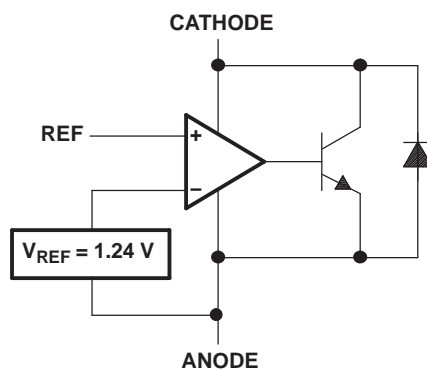
(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

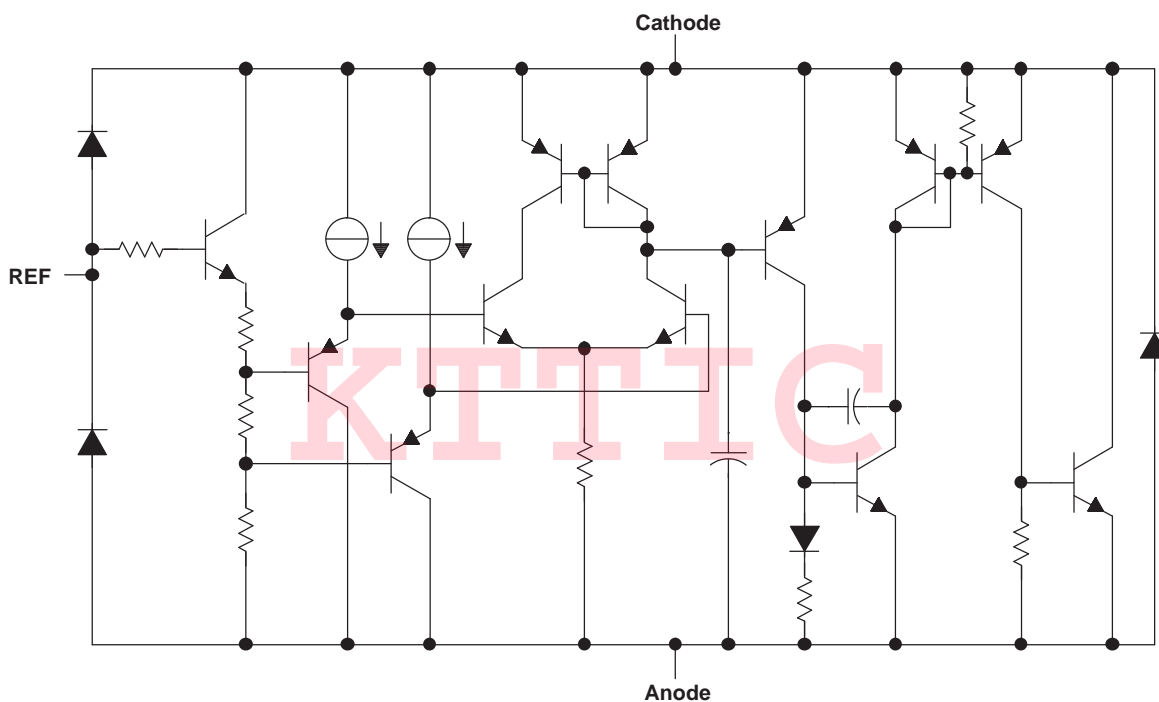


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

LOGIC BLOCK DIAGRAM



EQUIVALENT SCHEMATIC



ABSOLUTE MAXIMUM RATINGS⁽¹⁾

over operating free-air temperature range (unless otherwise noted)

V_{KA}	Cathode voltage ⁽²⁾	20 V
I_K	Cathode current range	–25 mA to 80 mA
I_{ref}	Reference current range	–0.05 mA to 3 mA
θ_{JA}	Package thermal impedance ⁽³⁾ ⁽⁴⁾	206°C/W
T_J	Operating virtual junction temperature	150°C
T_{stg}	Storage temperature range	–65°C to 150°C

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) Voltage values are with respect to the anode terminal, unless otherwise noted.
- (3) Maximum power dissipation is a function of $T_J(\text{max})$, θ_{JA} , and T_A . The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
V_{KA}	Cathode voltage	V_{REF}	18	V
I_K	Cathode current (continuous)	0.1	70	mA
T_A	Operating free-air temperature	–40	125	°C

KTTIC

TLVH431A ELECTRICAL CHARACTERISTICS

at 25°C free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT	
V _{REF}	Reference voltage	V _{KA} = V _{REF} , I _K = 10 mA	T _A = 25°C	1.228	1.24	1.252	V
			T _A = full range ⁽¹⁾ (see Figure 1)	1.209		1.271	
V _{REF(dev)}	V _{REF} deviation over full temperature range ^{(1) (2)}	V _{KA} = V _{REF} , I _K = 10 mA (see Figure 1)		11	31	mV	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of V _{REF} change to cathode voltage change	V _K = V _{REF} to 18 V, I _K = 10 mA (see Figure 2)		-1.5	-2.7	mV/V	
I _{ref}	Reference terminal current	I _K = 10 mA, R1 = 10 kΩ, R2 = open (see Figure 2)		0.1	0.5	μA	
I _{ref(dev)}	I _{ref} deviation over full temperature range ^{(1) (2)}	I _K = 10 mA, R1 = 10 kΩ, R2 = open (see Figure 2)		0.15	0.5	μA	
I _{K(min)}	Minimum cathode current for regulation	V _{KA} = V _{REF} (see Figure 1)		60	100	μA	
I _{K(off)}	Off-state cathode current	V _{REF} = 0, V _{KA} = 18 V (see Figure 3)		0.02	0.1	μA	
z _{KA}	Dynamic impedance ⁽³⁾	V _{KA} = V _{REF} , f ≤ 1 kHz, I _K = 0.1 mA to 70 mA (see Figure 1)		0.25	0.4	Ω	

(1) Full temperature range is -40°C to 125°C.

(2) The deviation parameters V_{REF(dev)} and I_{ref(dev)} are defined as the differences between the maximum and minimum values obtained over the rated temperature range. The average full-range temperature coefficient of the reference input voltage, αV_{REF}, is defined as:

$$|\alpha V_{REF}| \left(\frac{\text{ppm}}{\text{°C}} \right) = \frac{\left(\frac{V_{REF(dev)}}{V_{REF}(T_A = 25\text{°C})} \right) \times 10^6}{\Delta T_A}$$

where ΔT_A is the rated operating free-air temperature range of the device.

αV_{REF} can be positive or negative, depending on whether minimum V_{REF} or maximum V_{REF}, respectively, occurs at the lower temperature.

(3) The dynamic impedance is defined as:

$$|z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$$

When the device is operating with two external resistors (see Figure 2), the total dynamic impedance of the circuit is defined as:

$$|z_{KA}| = \frac{\Delta V}{\Delta I} \approx |z_{KA}| \times \left(1 + \frac{R1}{R2} \right)$$

TLVH431B ELECTRICAL CHARACTERISTICS

at 25°C free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT	
V _{REF}	Reference voltage	V _{KA} = V _{REF} , I _K = 10 mA	T _A = 25°C	1.234	1.24	1.246	V
			T _A = full range ⁽¹⁾ (see Figure 1)	1.221		1.265	
V _{REF(dev)}	V _{REF} deviation over full temperature range ^{(1) (2)}	V _{KA} = V _{REF} , I _K = 10 mA (see Figure 1)		11	31	mV	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Ratio of V _{REF} change to cathode voltage change	I _K = 10 mA, V _K = V _{REF} to 18 V (see Figure 2)		-1.5	-2.7	mV/V	
I _{ref}	Reference terminal current	I _K = 10 mA, R1 = 10 kΩ, R2 = open (see Figure 2)		0.1	0.5	μA	
I _{ref(dev)}	I _{ref} deviation over full temperature range ^{(1) (2)}	I _K = 10 mA, R1 = 10 kΩ, R2 = open (see Figure 2)		0.15	0.5	μA	
I _{K(min)}	Minimum cathode current for regulation	V _{KA} = V _{REF} (see Figure 1)		60	100	μA	
I _{K(off)}	Off-state cathode current	V _{REF} = 0, V _{KA} = 18 V (see Figure 3)		0.02	0.1	μA	
z _{KA}	Dynamic impedance ⁽³⁾	V _{KA} = V _{REF} , f ≤ 1 kHz, I _K = 0.1 mA to 70 mA (see Figure 1)		0.25	0.4	Ω	

(1) Full temperature range is -40°C to 125°C.

(2) The deviation parameters V_{REF(dev)} and I_{ref(dev)} are defined as the differences between the maximum and minimum values obtained over the rated temperature range. The average full-range temperature coefficient of the reference input voltage, αV_{REF}, is defined as:

$$|\alpha V_{REF}| \left(\frac{\text{ppm}}{\text{°C}} \right) = \frac{\left(\frac{V_{REF(dev)}}{V_{REF}(T_A = 25\text{°C})} \right) \times 10^6}{\Delta T_A}$$

where ΔT_A is the rated operating free-air temperature range of the device.

αV_{REF} can be positive or negative, depending on whether minimum V_{REF} or maximum V_{REF}, respectively, occurs at the lower temperature.

(3) The dynamic impedance is defined as:

$$|z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$$

When the device is operating with two external resistors (see Figure 2), the total dynamic impedance of the circuit is defined as:

$$|z_{KA}| = \frac{\Delta V}{\Delta I} \approx |z_{KA}| \times \left(1 + \frac{R1}{R2} \right)$$

PARAMETER MEASUREMENT INFORMATION

Operation of the device at any conditions beyond those indicated under *recommended operating conditions* is not implied.

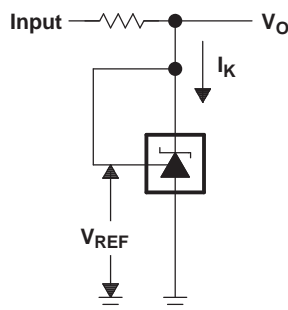


Figure 1. Test Circuit for $V_{KA} = V_{REF}$, $V_O = V_{KA} = V_{REF}$

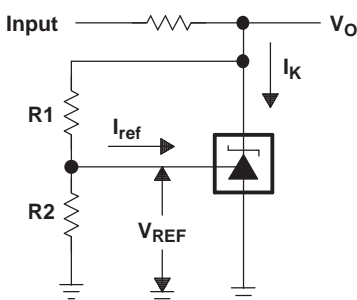


Figure 2. Test Circuit for $V_{KA} > V_{REF}$, $V_O = V_{KA} = V_{REF} \times (1 + R1/R2) + I_{ref} \times R1$

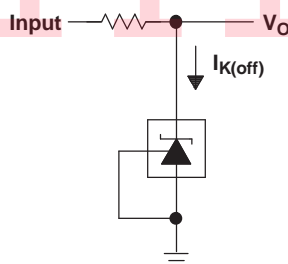


Figure 3. Test Circuit for $I_{K(off)}$

PARAMETER MEASUREMENT INFORMATION (continued)

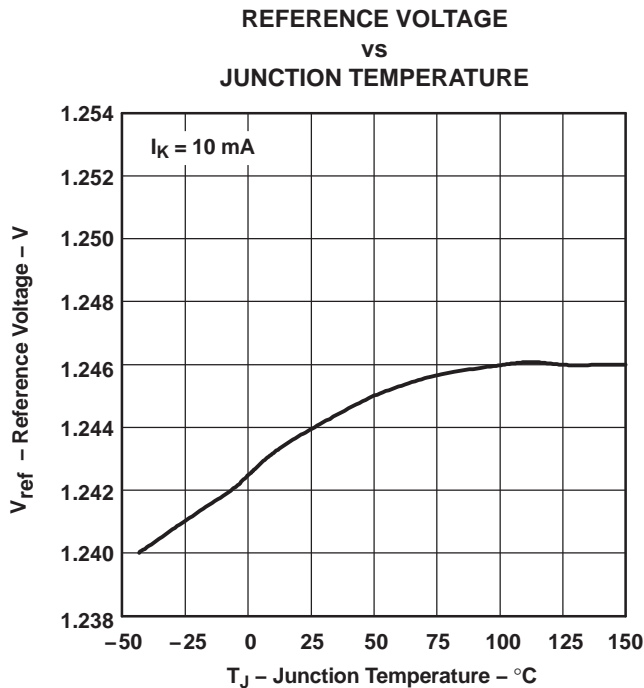


Figure 4.

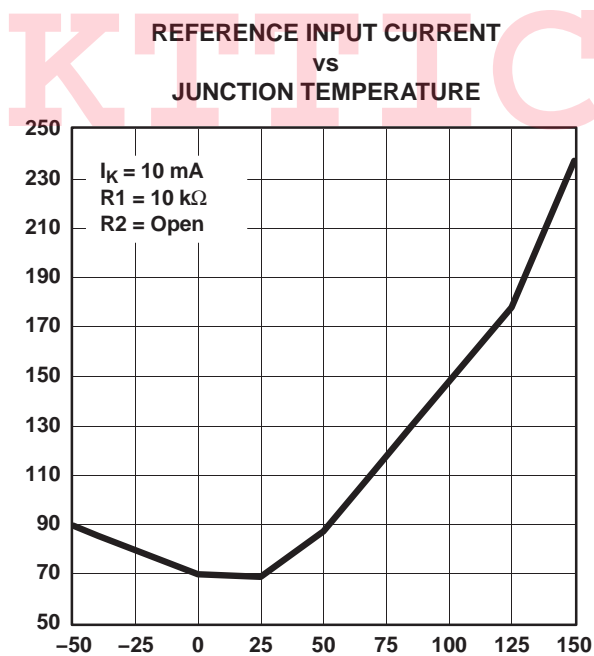


Figure 5.

PARAMETER MEASUREMENT INFORMATION (continued)

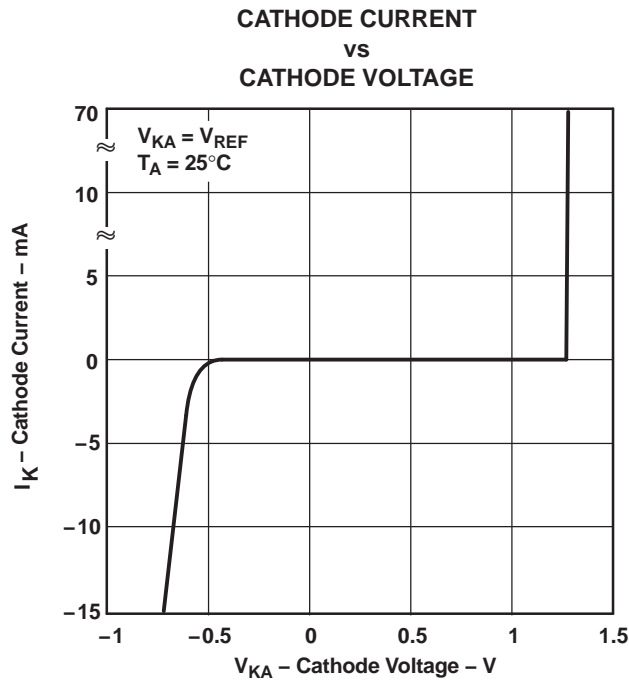


Figure 6.

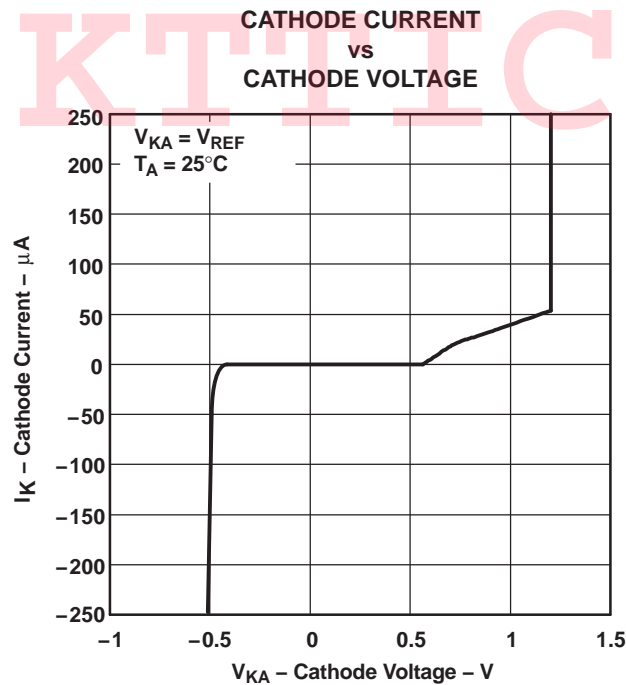


Figure 7.

PARAMETER MEASUREMENT INFORMATION (continued)

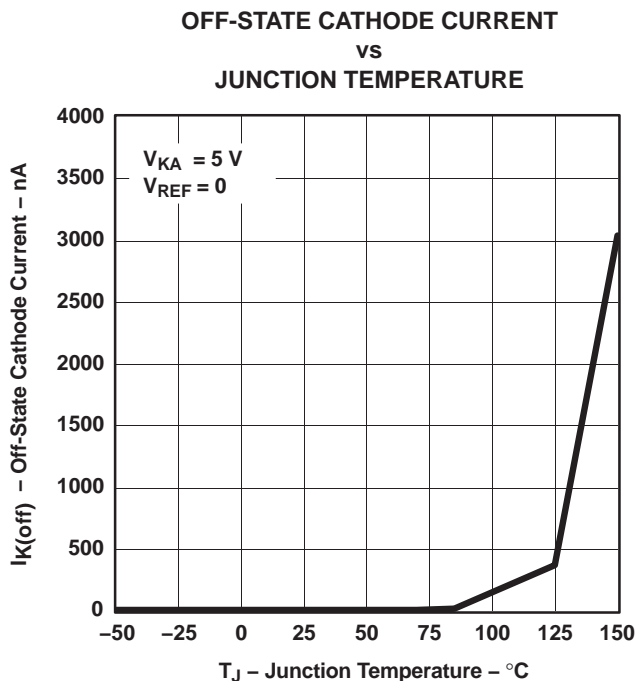


Figure 8.

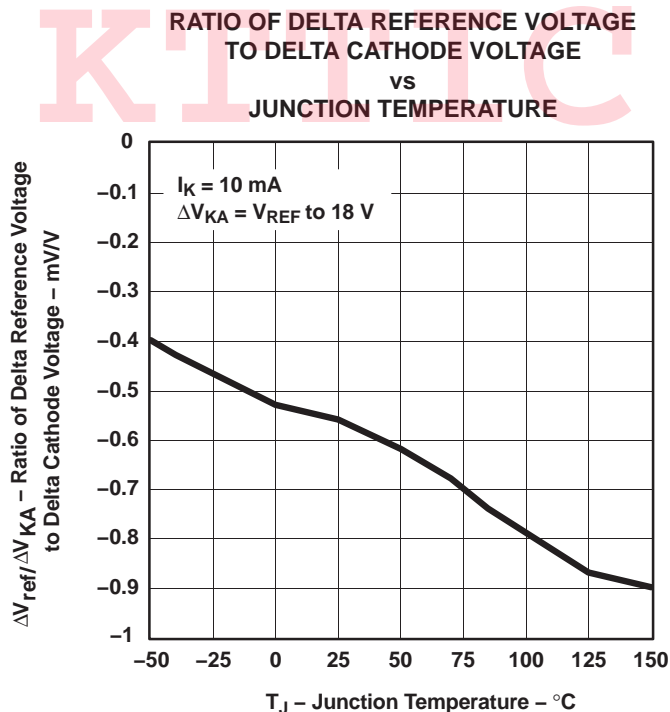
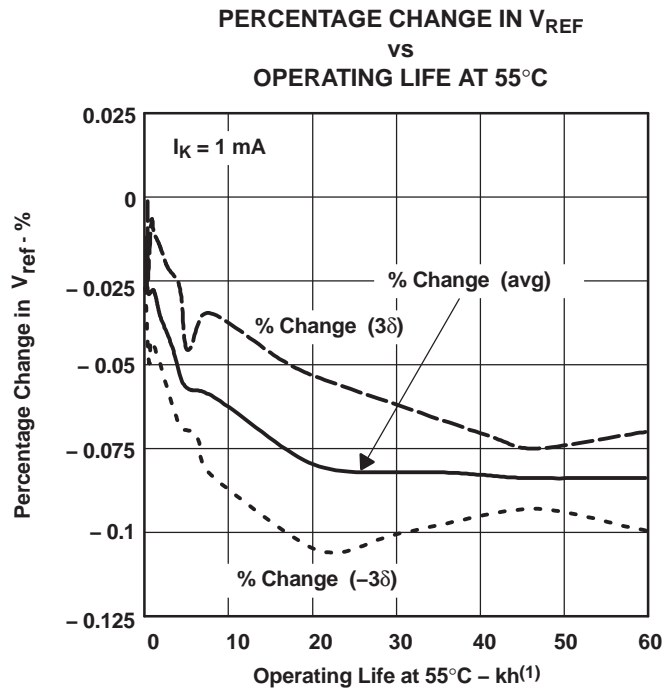


Figure 9.

PARAMETER MEASUREMENT INFORMATION (continued)



(1) Extrapolated from life-test data taken at 125°C; the activation energy assumed is 0.7 eV.

Figure 10.

EQUIVALENT INPUT NOISE VOLTAGE
vs
FREQUENCY

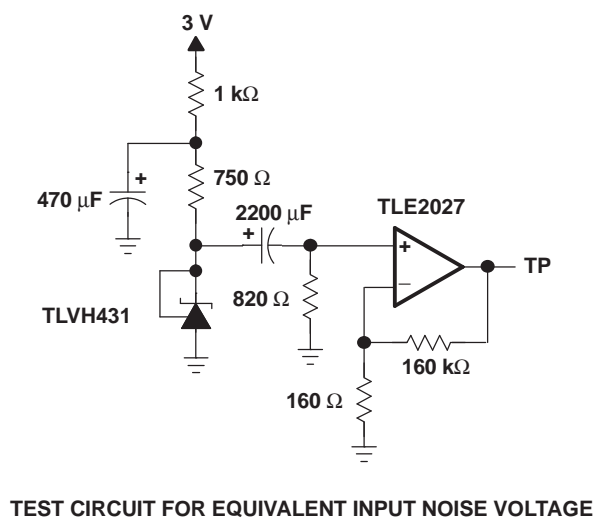
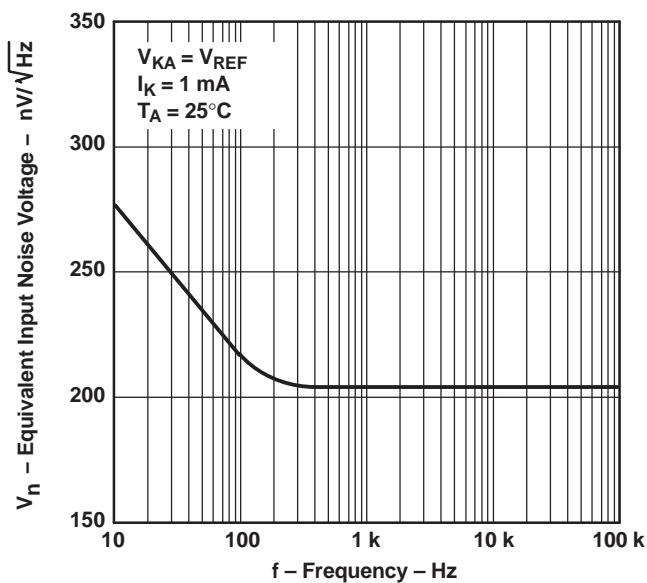
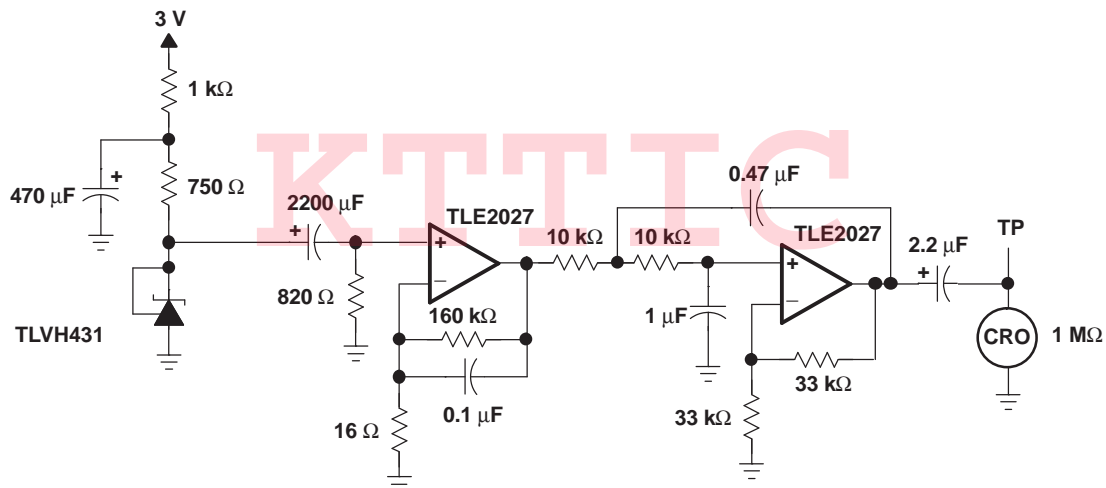
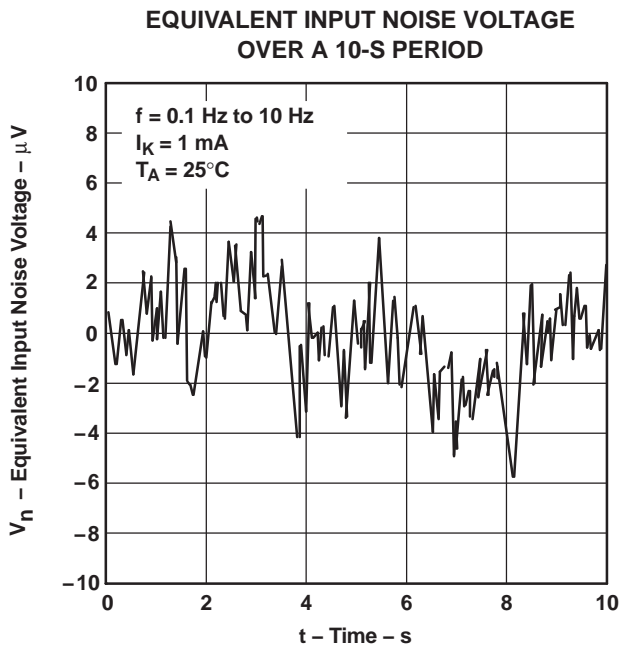


Figure 11.

PARAMETER MEASUREMENT INFORMATION (continued)



TEST CIRCUIT FOR 0.1-Hz TO 10-Hz EQUIVALENT NOISE VOLTAGE

Figure 12.

PARAMETER MEASUREMENT INFORMATION (continued)

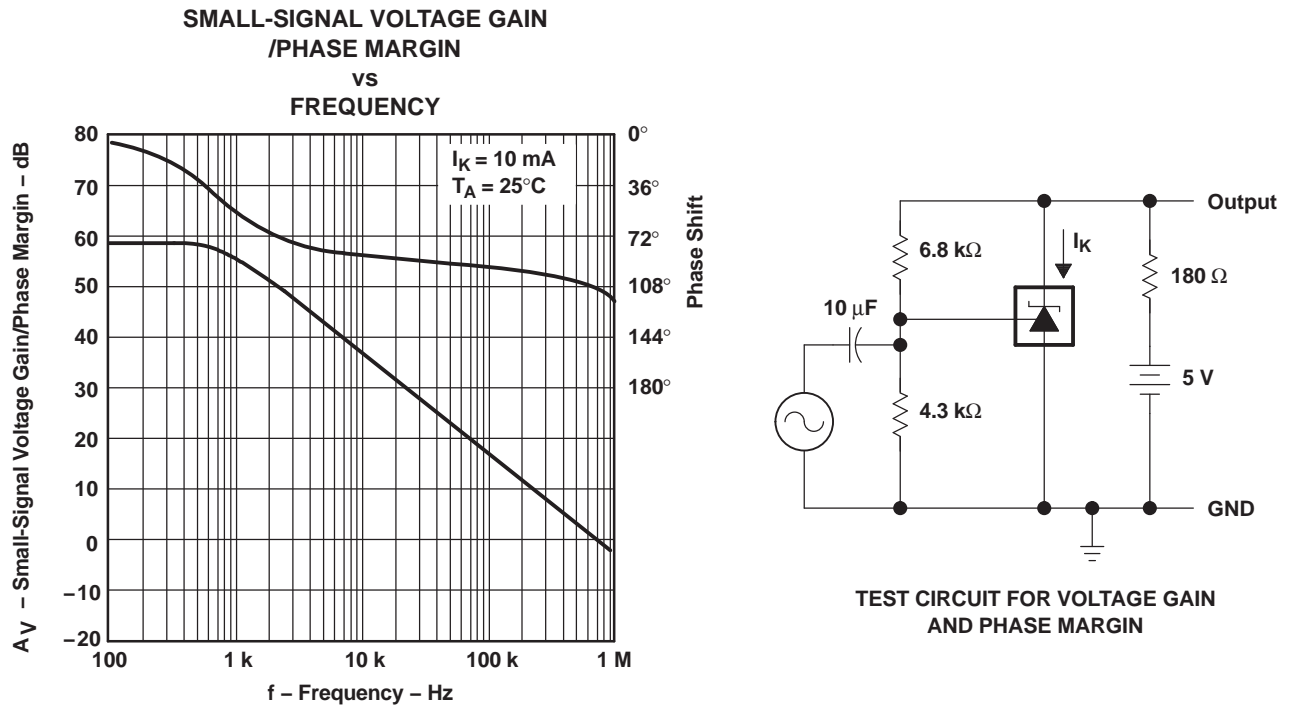


Figure 13.

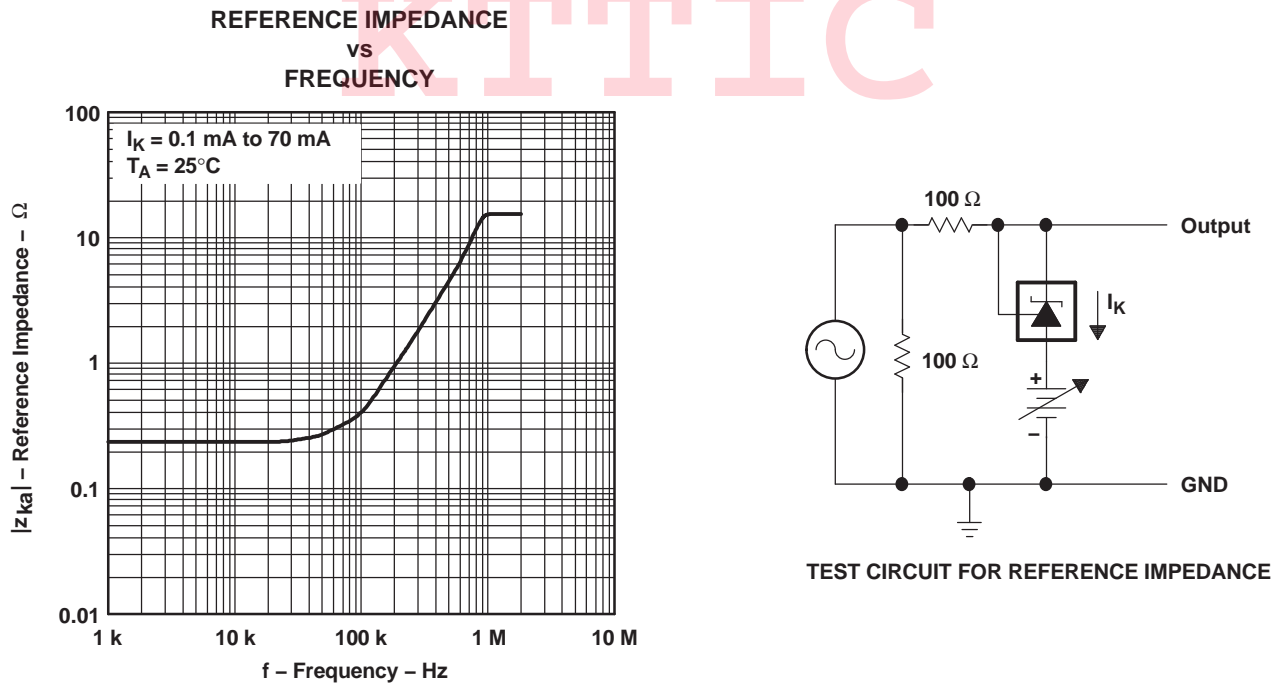


Figure 14.

PARAMETER MEASUREMENT INFORMATION (continued)

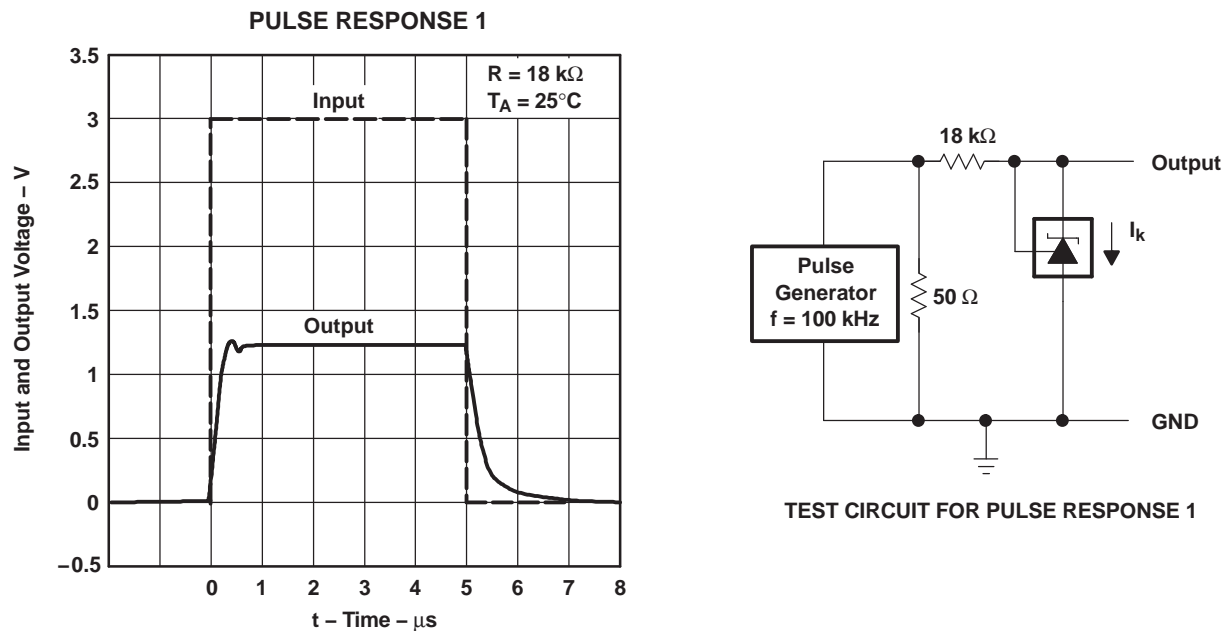


Figure 15.

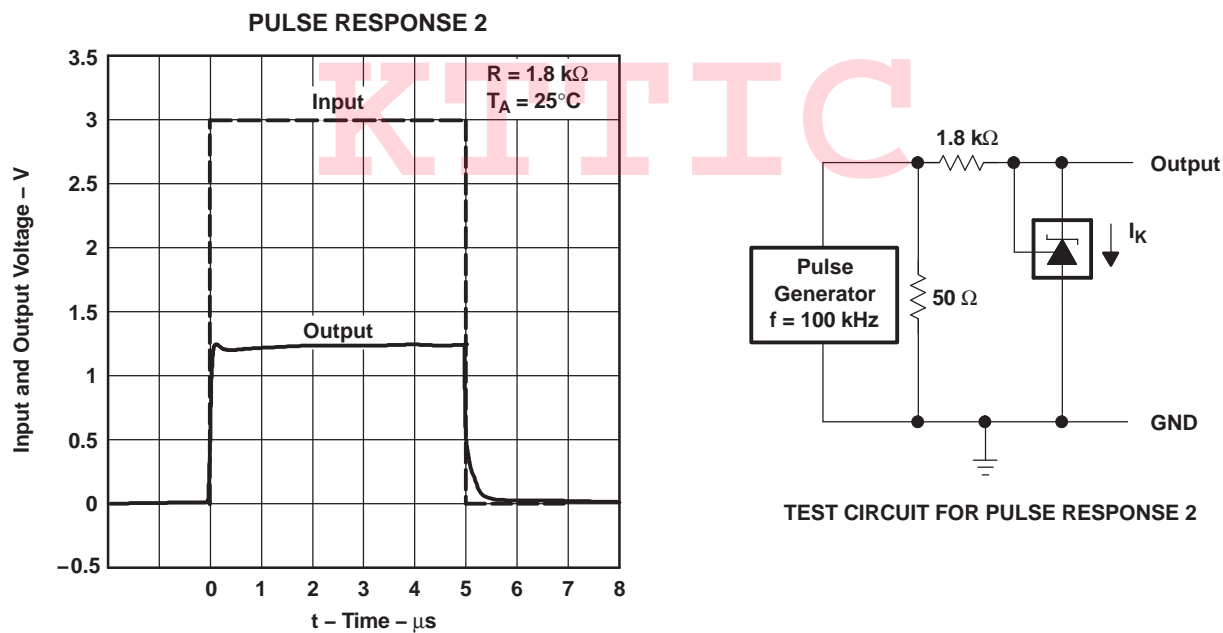


Figure 16.

PARAMETER MEASUREMENT INFORMATION (continued)

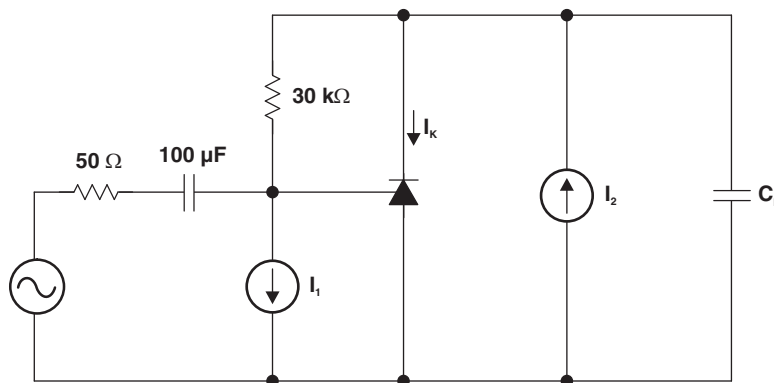


Figure 17. Phase Margin Test Circuit

PHASE MARGIN vs CAPACITIVE LOAD

$V_{ka} = V_{REF} (1.25 V)$, $T_A = 25^\circ C$

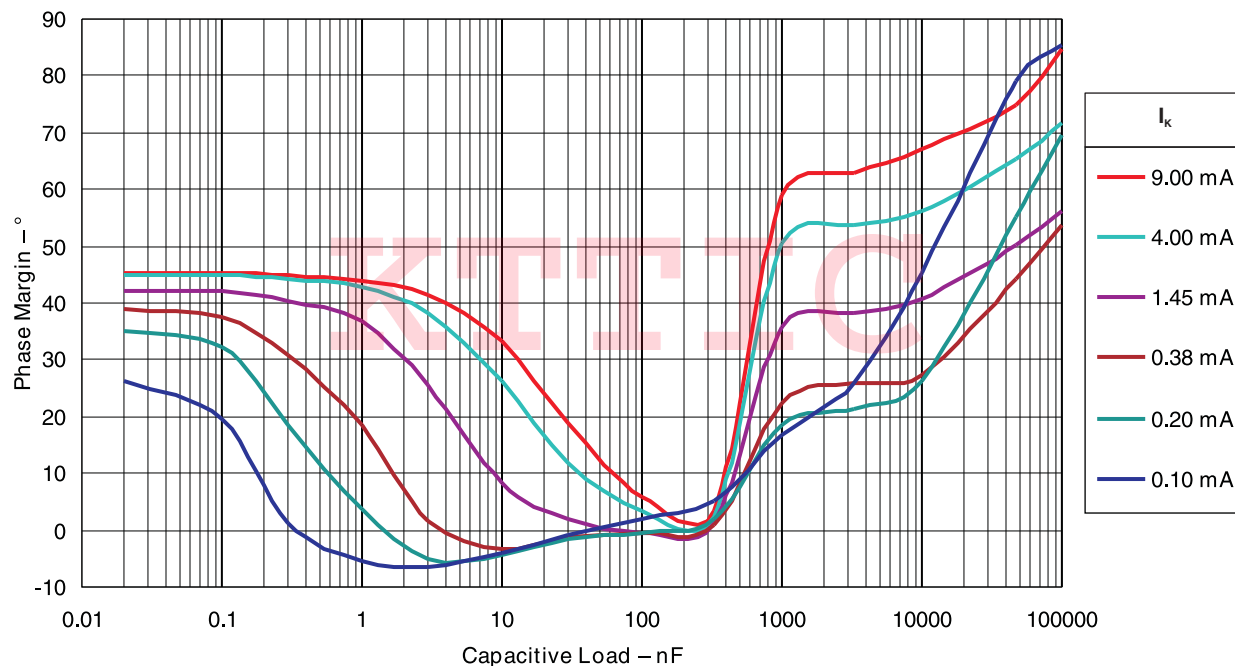


Figure 18.

PARAMETER MEASUREMENT INFORMATION (continued)

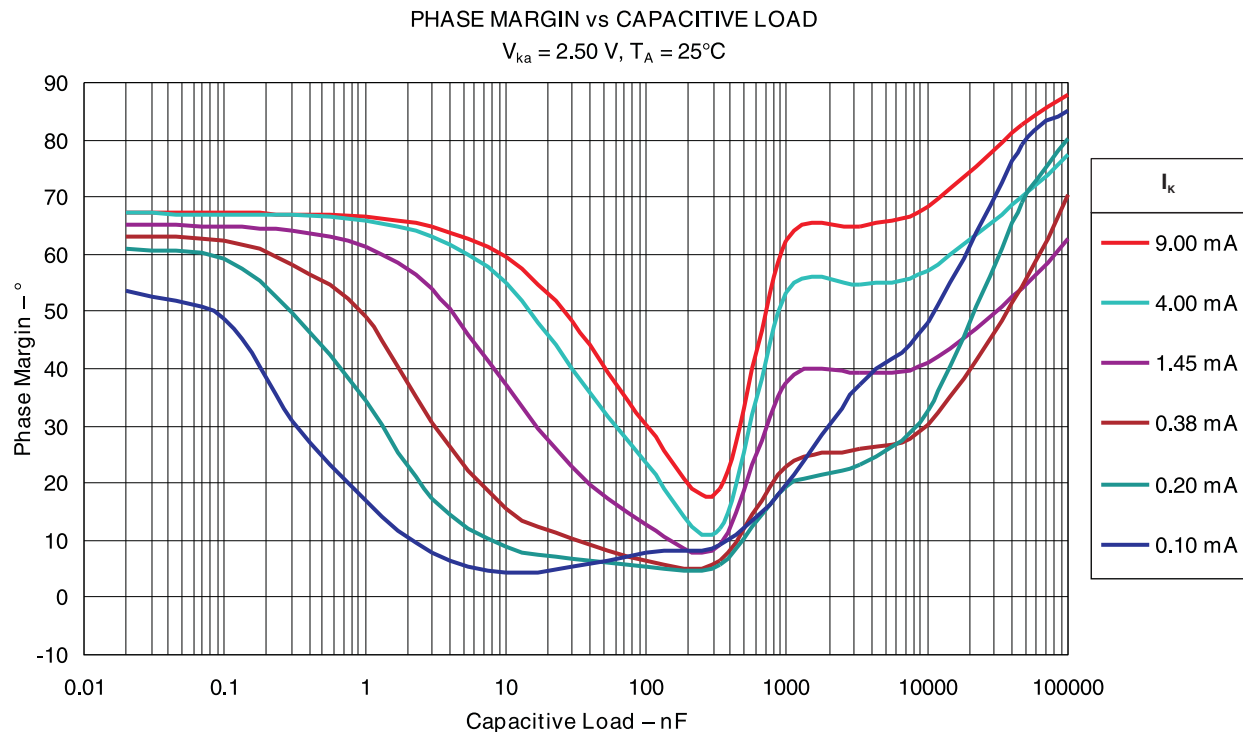


Figure 19.

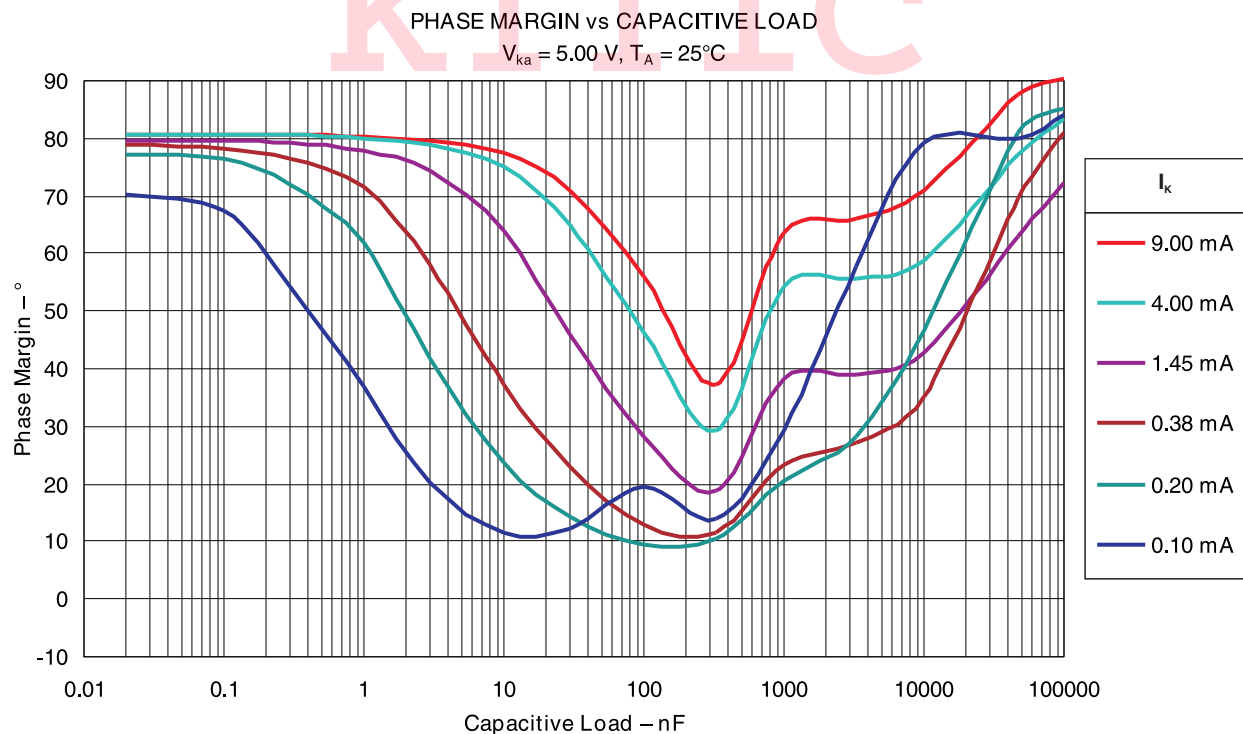


Figure 20.

APPLICATION INFORMATION

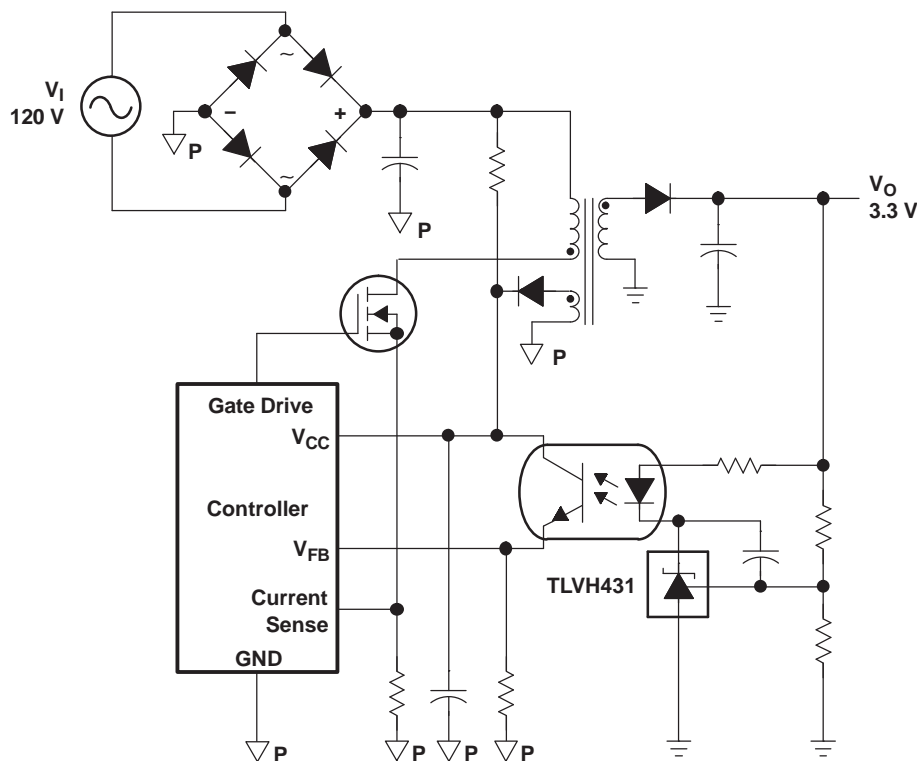


Figure 21. Flyback With Isolation Using TLVH431 as Voltage Reference and Error Amplifier

Figure 21 shows the TLVH431 used in a 3.3-V isolated flyback supply. Output voltage V_O can be as low as reference voltage V_{REF} (1.24 V). The output of the regulator plus the forward voltage drop of the optocoupler LED ($1.24 + 1.4 = 2.64$ V) determine the minimum voltage that can be regulated in an isolated supply configuration. Regulated voltage as low as 2.7 Vdc is possible in the topology shown in Figure 21.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DLP® Products	www.dlp.com	Communications and Telecom	www.ti.com/communications
DSP	dsp.ti.com	Computers and Peripherals	www.ti.com/computers
Clocks and Timers	www.ti.com/clocks	Consumer Electronics	www.ti.com/consumer-apps
Interface	interface.ti.com	Energy	www.ti.com/energy
Logic	logic.ti.com	Industrial	www.ti.com/industrial
Power Mgmt	power.ti.com	Medical	www.ti.com/medical
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Space, Avionics & Defense	www.ti.com/space-avionics-defense
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video and Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless-apps

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2010, Texas Instruments Incorporated