

PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

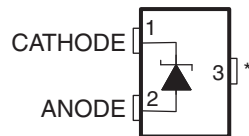
FEATURES

- Qualified for Automotive Applications
- Fixed Output Voltages of 2.048 V, 2.5 V, 4.096 V, 5 V, 8.192 V, and 10 V
- Tight Output Tolerances and Low Temperature Coefficient
 - Max 0.1%, 50 ppm/°C – A Grade
 - Max 0.2%, 50 ppm/°C – B Grade
 - Max 0.5%, 50 ppm/°C – C Grade
- Low Output Noise...41 μV_{RMS} Typ
- Wide Operating Current Range...
60 μA Typ to 15 mA
- Stable With All Capacitive Loads; No Output Capacitor Required
- Available in Extended Temperature Range...–40°C to 125°C

APPLICATIONS

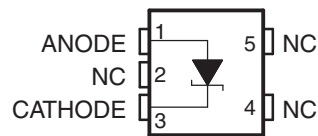
- Data-Acquisition Systems
- Power Supplies and Power-Supply Monitors
- Instrumentation and Test Equipment
- Process Controls
- Precision Audio
- Automotive Electronics
- Energy Management
- Battery-Powered Equipment

DBZ (SOT-23-3) PACKAGE
(TOP VIEW)



*Pin 3 is attached to Substrate and must be connected to ANODE or left open.

DCK (SC-70) PACKAGE
(TOP VIEW)



NC – No internal connection

DESCRIPTION/ORDERING INFORMATION

The TL4050 series of shunt voltage references are versatile easy-to-use references suitable for a wide array of applications. The two-terminal fixed-output device requires no external capacitors for operation and is stable with all capacitive loads. Additionally, the reference offers low dynamic impedance, low noise, and low temperature coefficient to ensure a stable output voltage over a wide range of operating currents and temperatures.

The TL4050 is offered in three initial tolerances, ranging from 0.1% (max) for the A grade to 0.5% (max) for the C grade. Thus, a great deal of flexibility is offered to designers in choosing the best cost-to-performance ratio for their applications. Packaged in the space-saving SOT-23-3 and SC-70 packages and requiring a minimum current of 45 μA (typ), the TL4050 also is ideal for portable applications.

The TL4050xl is characterized for operation over an ambient temperature range of –40°C to 85°C. The TL4050xQ is characterized for operation over an ambient temperature range of –40°C to 125°C.



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.

ORDERING INFORMATION⁽¹⁾

T _A	DEVICE GRADE	V _{KA}	PACKAGE ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	A grade: 0.1% initial accuracy and 50 ppm/°C temperature coefficient	2.048 V	SOT-23-3 – DBZ	Reel of 3000	TL4050A20IDBZRQ1	PREVIEW
				Reel of 250	TL4050A20IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050A20IDCKRQ1	PREVIEW
				Reel of 250	TL4050A20IDCKTQ1	
		2.5 V	SOT-23-3 – DBZ	Reel of 3000	TL4050A25IDBZRQ1	PREVIEW
				Reel of 250	TL4050A25IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050A25IDCKRQ1	PREVIEW
				Reel of 250	TL4050A25IDCKTQ1	
		4.096 V	SOT-23-3 – DBZ	Reel of 3000	TL4050A41IDBZRQ1	PREVIEW
				Reel of 250	TL4050A41IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050A41IDCKRQ1	PREVIEW
				Reel of 250	TL4050A41IDCKTQ1	
		5 V	SOT-23-3 – DBZ	Reel of 3000	TL4050A50IDBZRQ1	PREVIEW
				Reel of 250	TL4050A50IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050A50IDCKRQ1	PREVIEW
				Reel of 250	TL4050A50IDCKTQ1	
		8.192 V	SOT-23-3 – DBZ	Reel of 3000	TL4050A82IDBZRQ1	PREVIEW
				Reel of 250	TL4050A82IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050A82IDCKRQ1	PREVIEW
				Reel of 250	TL4050A82IDCKTQ1	
		10 V	SOT-23-3 – DBZ	Reel of 3000	TL4050A10IDBZRQ1	PREVIEW
				Reel of 250	TL4050B10IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050A10IDCKRQ1	PREVIEW
				Reel of 250	TL4050B10IDCKTQ1	

- (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, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

ORDERING INFORMATION (continued)

T _A	DEVICE GRADE	V _{KA}	PACKAGE ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	B grade: 0.2% initial accuracy and 50 ppm/°C temperature coefficient	2.048 V	SOT-23-3 – DBZ	Reel of 3000	TL4050B20IDBZRQ1	PREVIEW
				Reel of 250	TL4050B20IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050B20IDCKRQ1	PREVIEW
				Reel of 250	TL4050B20IDCKTQ1	
		2.5 V	SOT-23-3 – DBZ	Reel of 3000	TL4050B25IDBZRQ1	PREVIEW
				Reel of 250	TL4050B25IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050B25IDCKRQ1	PREVIEW
				Reel of 250	TL4050B25IDCKTQ1	
		4.096 V	SOT-23-3 – DBZ	Reel of 3000	TL4050B41IDBZRQ1	PREVIEW
				Reel of 250	TL4050B41IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050B41IDCKRQ1	PREVIEW
				Reel of 250	TL4050B41IDCKTQ1	
		5 V	SOT-23-3 – DBZ	Reel of 3000	TL4050B50IDBZRQ1	PREVIEW
				Reel of 250	TL4050B50IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050B50IDCKRQ1	PREVIEW
				Reel of 250	TL4050B50IDCKTQ1	
		8.192 V	SOT-23-3 – DBZ	Reel of 3000	TL4050B82IDBZRQ1	PREVIEW
				Reel of 250	TL4050B82IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050B82IDCKRQ1	PREVIEW
				Reel of 250	TL4050B82IDCKTQ1	
		10 V	SOT-23-3 – DBZ	Reel of 3000	TL4050B10IDBZRQ1	PREVIEW
				Reel of 250	TL4050B10IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050B10IDCKRQ1	PREVIEW
				Reel of 250	TL4050B10IDCKTQ1	

ORDERING INFORMATION (continued)

T _A	DEVICE GRADE	V _{KA}	PACKAGE ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	C grade: 0.5% initial accuracy and 50 ppm/°C temperature coefficient	2.048 V	SOT-23-3 – DBZ	Reel of 3000	TL4050C20IDBZRQ1	TMWU
				Reel of 250	TL4050C20IDBZTQ1	PREVIEW
			SC-70 – DCK	Reel of 3000	TL4050C20IDCKRQ1	PREVIEW
				Reel of 250	TL4050C20IDCKTQ1	
		2.5 V	SOT-23-3 – DBZ	Reel of 3000	TL4050C25IDBZRQ1	PREVIEW
				Reel of 250	TL4050C25IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050C25IDCKRQ1	PREVIEW
				Reel of 250	TL4050C25IDCKTQ1	
		4.096 V	SOT-23-3 – DBZ	Reel of 3000	TL4050C41IDBZRQ1	PREVIEW
				Reel of 250	TL4050C41IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050C41IDCKRQ1	PREVIEW
				Reel of 250	TL4050C41IDCKTQ1	
		5 V	SOT-23-3 – DBZ	Reel of 3000	TL4050C50IDBZRQ1	PREVIEW
				Reel of 250	TL4050C50IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050C50IDCKRQ1	PREVIEW
				Reel of 250	TL4050C50IDCKTQ1	
		8.192 V	SOT-23-3 – DBZ	Reel of 3000	TL4050C82IDBZRQ1	PREVIEW
				Reel of 250	TL4050C82IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050C82IDCKRQ1	PREVIEW
				Reel of 250	TL4050C82IDCKTQ1	
		10 V	SOT-23-3 – DBZ	Reel of 3000	TL4050C10IDBZRQ1	PREVIEW
				Reel of 250	TL4050C10IDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050C10IDCKRQ1	PREVIEW
				Reel of 250	TL4050C10IDCKTQ1	

ORDERING INFORMATION⁽¹⁾

T _A	DEVICE GRADE	V _{KA}	PACKAGE ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	A grade: 0.1% initial accuracy and 50 ppm/°C temperature coefficient	2.048 V	SOT-23-3 – DBZ	Reel of 3000	TL4050A20QDBZRQ1	PREVIEW
				Reel of 250	TL4050A20QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050A20QDCKRQ1	PREVIEW
				Reel of 250	TL4050A20QDCKTQ1	
		2.5 V	SOT-23-3 – DBZ	Reel of 3000	TL4050A25QDBZRQ1	PREVIEW
				Reel of 250	TL4050A25QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050A25QDCKRQ1	PREVIEW
				Reel of 250	TL4050A25QDCKTQ1	
		4.096 V	SOT-23-3 – DBZ	Reel of 3000	TL4050A41QDBZRQ1	PREVIEW
				Reel of 250	TL4050A41QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050A41QDCKRQ1	PREVIEW
				Reel of 250	TL4050A41QDCKTQ1	
		5 V	SOT-23-3 – DBZ	Reel of 3000	TL4050A50QDBZRQ1	PREVIEW
				Reel of 250	TL4050A50QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050A50QDCKRQ1	PREVIEW
				Reel of 250	TL4050A50QDCKTQ1	
		8.192 V	SOT-23-3 – DBZ	Reel of 3000	TL4050A82QDBZRQ1	PREVIEW
				Reel of 250	TL4050A82QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050A82QDCKRQ1	PREVIEW
				Reel of 250	TL4050A82QDCKTQ1	
		10 V	SOT-23-3 – DBZ	Reel of 3000	TL4050A10QDBZRQ1	PREVIEW
				Reel of 250	TL4050B10QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050A10QDCKRQ1	PREVIEW
				Reel of 250	TL4050A10QDCKTQ1	

- (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, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

ORDERING INFORMATION (continued)

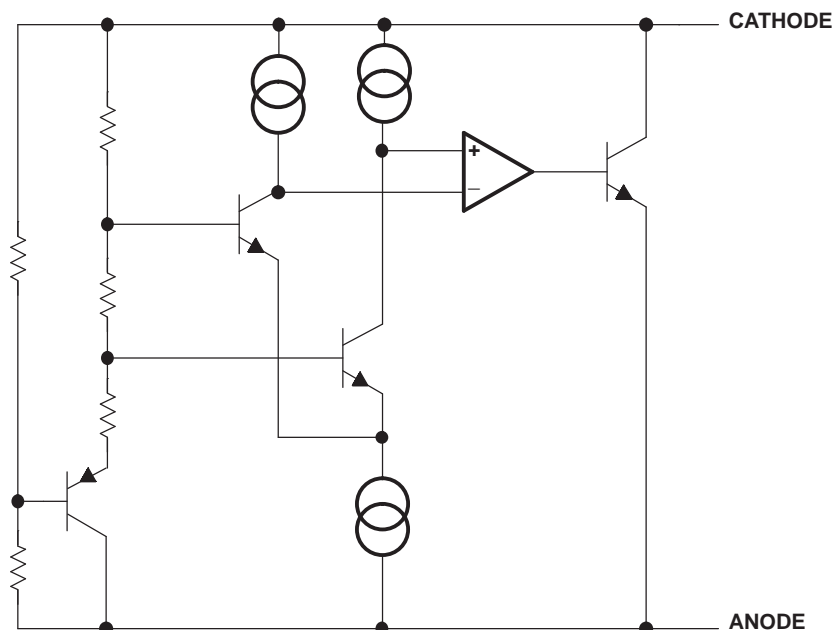
T _A	DEVICE GRADE	V _{KA}	PACKAGE ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	B grade: 0.2% initial accuracy and 50 ppm/°C temperature coefficient	2.048 V	SOT-23-3 – DBZ	Reel of 3000	TL4050B20QDBZRQ1	PREVIEW
				Reel of 250	TL4050B20QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050B20QDCKRQ1	PREVIEW
				Reel of 250	TL4050B20QDCKTQ1	
		2.5 V	SOT-23-3 – DBZ	Reel of 3000	TL4050B25QDBZRQ1	PREVIEW
				Reel of 250	TL4050B25QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050B25QDCKRQ1	PREVIEW
				Reel of 250	TL4050B25QDCKTQ1	
		4.096 V	SOT-23-3 – DBZ	Reel of 3000	TL4050B41QDBZRQ1	TMXU
				Reel of 250	TL4050B41QDBZTQ1	PREVIEW
			SC-70 – DCK	Reel of 3000	TL4050B41QDCKRQ1	PREVIEW
				Reel of 250	TL4050B41QDCKTQ1	
		5 V	SOT-23-3 – DBZ	Reel of 3000	TL4050B50QDBZRQ1	PREVIEW
				Reel of 250	TL4050B50QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050B50QDCKRQ1	PREVIEW
				Reel of 250	TL4050B50QDCKTQ1	
		8.192 V	SOT-23-3 – DBZ	Reel of 3000	TL4050B82QDBZRQ1	PREVIEW
				Reel of 250	TL4050B82QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050B82QDCKRQ1	PREVIEW
				Reel of 250	TL4050B82QDCKTQ1	
		10 V	SOT-23-3 – DBZ	Reel of 3000	TL4050B10QDBZRQ1	PREVIEW
				Reel of 250	TL4050B10QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050B10QDCKRQ1	PREVIEW
				Reel of 250	TL4050B10QDCKTQ1	

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ORDERING INFORMATION (continued)

T _A	DEVICE GRADE	V _{KA}	PACKAGE ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	C grade: 0.5% initial accuracy and 50 ppm/°C temperature coefficient	2.048 V	SOT-23-3 – DBZ	Reel of 3000	TL4050C20QDBZRQ1	TMYU
				Reel of 250	TL4050C20QDBZTQ1	PREVIEW
			SC-70 – DCK	Reel of 3000	TL4050C20QDCKRQ1	PREVIEW
				Reel of 250	TL4050C20QDCKTQ1	
		2.5 V	SOT-23-3 – DBZ	Reel of 3000	TL4050C25QDBZRQ1	PREVIEW
				Reel of 250	TL4050C25QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050C25QDCKRQ1	PREVIEW
				Reel of 250	TL4050C25QDCKTQ1	
		4.096 V	SOT-23-3 – DBZ	Reel of 3000	TL4050C41QDBZRQ1	PREVIEW
				Reel of 250	TL4050C41QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050C41QDCKRQ1	PREVIEW
				Reel of 250	TL4050C41QDCKTQ1	
		5 V	SOT-23-3 – DBZ	Reel of 3000	TL4050C50QDBZRQ1	PREVIEW
				Reel of 250	TL4050C50QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050C50QDCKRQ1	PREVIEW
				Reel of 250	TL4050C50QDCKTQ1	
		8.192 V	SOT-23-3 – DBZ	Reel of 3000	TL4050C82QDBZRQ1	PREVIEW
				Reel of 250	TL4050C82QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050C82QDCKRQ1	PREVIEW
				Reel of 250	TL4050C82QDCKTQ1	
		10 V	SOT-23-3 – DBZ	Reel of 3000	TL4050C10QDBZRQ1	PREVIEW
				Reel of 250	TL4050C10QDBZTQ1	
			SC-70 – DCK	Reel of 3000	TL4050C10QDCKRQ1	PREVIEW
				Reel of 250	TL4050C10QDCKTQ1	

FUNCTIONAL BLOCK DIAGRAM



Absolute Maximum Ratings⁽¹⁾

over free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
I_Z	Continuous cathode current	-10	20	mA
θ_{JA}	Package thermal impedance ⁽²⁾⁽³⁾		206	°C/W
			252	
T_J	Operating virtual junction temperature		150	°C
T_{stg}	Storage temperature range	-65	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) 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.
- (3) The package thermal impedance is calculated in accordance with JESD 51-7.

Recommended Operating Conditions

		MIN	MAX	UNIT	
I_Z	Cathode current	(1)	15	mA	
T_A	Free-air temperature	I temperature	-40	85	°C
		Q temperature	-40	125	

- (1) See parametric tables

TL4050x20I Electrical Characteristics

 at industrial temperature range, full range $T_A = -40^{\circ}\text{C}$ to 85°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	TL4050A20I			TL4050B20I			TL4050C20I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_Z	Reverse breakdown voltage $I_Z = 100 \mu\text{A}$	25°C	2.048			2.048			2.048			V
ΔV_Z	Reverse breakdown voltage tolerance $I_Z = 100 \mu\text{A}$	25°C	-2.048	2.048		-4.096	4.096		-10.24	10.24		mV
		Full range	-9.0112	9.0112		-11.4688	11.4688		-14.7456	14.7456		
$I_{Z,\text{min}}$	Minimum cathode current	25°C	41		60		41		60		μA	
		Full range			65				65			
α_{VZ}	Average temperature coefficient of reverse breakdown voltage $I_Z = 10 \text{ mA}$	25°C	± 20			± 20			± 20			ppm/°C
		25°C	± 15			± 15			± 15			
		25°C	± 15			± 15			± 15			
		Full range	± 50			± 50			± 50			
$\frac{\Delta V_Z}{\Delta I_Z}$	Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1 \text{ mA}$	25°C	0.3		0.8		0.3		0.8		mV
			Full range			1.2				1.2		
		$1 \text{ mA} < I_Z < 15 \text{ mA}$	25°C	2.3		6		2.3		6		
			Full range			8				8		
Z_Z	Reverse dynamic impedance $I_Z = 1 \text{ mA}$, $f = 120 \text{ Hz}$, $I_{AC} = 0.1 I_Z$	25°C	0.3			0.3			0.3			Ω
e_N	Wideband noise $I_Z = 100 \mu\text{A}$, $10 \text{ Hz} \leq f \leq 10 \text{ kHz}$	25°C	34			34			34			μV_{RMS}
	Long-term stability of reverse breakdown voltage $t = 1000 \text{ h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100 \mu\text{A}$		120			120			120			ppm
V_{HYST}	Thermal hysteresis ⁽¹⁾ $\Delta T_A = -40^{\circ}\text{C}$ to 125°C		0.7			0.7			0.7			mV

 (1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) $- V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

TL4050x20Q Electrical Characteristics

at extended temperature range, full range $T_A = -40^{\circ}\text{C}$ to 125°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	TL4050A20Q			TL4050B20Q			TL4050C20Q			UNIT		
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX			
V_Z	Reverse breakdown voltage $I_Z = 100 \mu\text{A}$	25°C	2.048			2.048			2.048			V		
ΔV_Z	Reverse breakdown voltage tolerance $I_Z = 100 \mu\text{A}$	25°C	-2.048	2.048		-4.096	4.096		-10.24	10.24		mV		
		Full range	-12.288	12.288		-14.7456	14.7456		-17.2032	17.2032				
$I_{Z,\text{min}}$	Minimum cathode current	25°C	41	60		41	60		41	60		μA		
		Full range		65			65			65				
α_{VZ}	Average temperature coefficient of reverse breakdown voltage $I_Z = 10 \text{ mA}$	25°C	± 20			± 20			± 20			ppm/°C		
		25°C	± 15			± 15			± 15					
		25°C	± 15			± 15			± 15					
		Full range	± 50			± 50			± 50					
$\frac{\Delta V_Z}{\Delta I_Z}$	Reverse breakdown voltage change with cathode current change $I_{Z,\text{min}} < I_Z < 1 \text{ mA}$	25°C	0.3	0.8		0.3	0.8		0.3	0.8		mV		
		Full range		1.2			1.2			1.2				
	25°C	2.3			6	2.3			6	2.3			6	
		Full range				8				8				8
Z_Z	Reverse dynamic impedance $I_Z = 1 \text{ mA}$, $f = 120 \text{ Hz}$, $I_{AC} = 0.1 I_Z$	25°C	0.3			0.3			0.3			Ω		
e_N	Wideband noise $I_Z = 100 \mu\text{A}$, $10 \text{ Hz} \leq f \leq 10 \text{ kHz}$	25°C	34			34			34			μV_{RMS}		
	Long-term stability of reverse breakdown voltage $t = 1000 \text{ h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100 \mu\text{A}$		120			120			120			ppm		
V_{HYST}	Thermal hysteresis ⁽¹⁾ $\Delta T_A = -40^{\circ}\text{C}$ to 125°C		0.7			0.7			0.7			mV		

(1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) $- V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

TL4050x25I Electrical Characteristics

 at industrial temperature range, full range $T_A = -40^{\circ}\text{C}$ to 85°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	TL4050A25I			TL4050B25I			TL4050C25I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_Z Reverse breakdown voltage	$I_Z = 100\ \mu\text{A}$	25°C	2.5			2.5			2.5			V
ΔV_Z Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$	25°C	-2.5	2.5		-5	5		-13	13		mV
		Full range	-11		11	-14		14	-21		21	
$I_{Z,\text{min}}$ Minimum cathode current		25°C	41		60		41		60		μA	
		Full range			65				65			
α_{V_Z} Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C	± 20			± 20			± 20			ppm/ $^{\circ}\text{C}$
	$I_Z = 1\ \text{mA}$	25°C	± 15			± 15			± 15			
	$I_Z = 100\ \mu\text{A}$	25°C	± 15			± 15			± 15			
		Full range	± 50			± 50			± 50			
$\frac{\Delta V_Z}{\Delta I_Z}$ Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	25°C	0.3	0.8		0.3	0.8		0.3	0.8		mV
		Full range			1.2				1.2			
	$1\ \text{mA} < I_Z < 15\ \text{mA}$	25°C	2.3		6		2.3		6			
		Full range			8				8			
Z_Z Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{\text{AC}} = 0.1 I_Z$	25°C	0.3			0.3			0.3			Ω
e_N Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	25°C	41			41			41			μV_{RMS}
Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100\ \mu\text{A}$		120			120			120			ppm
V_{HYST} Thermal hysteresis ⁽¹⁾	$\Delta T_A = -40^{\circ}\text{C}$ to 125°C		0.7			0.7			0.7			mV

 (1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) – $V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

TL4050x25Q Electrical Characteristics

at extended temperature range, full range $T_A = -40^{\circ}\text{C}$ to 125°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	TL4050A25Q			TL4050B25Q			TL4050C25Q			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_Z Reverse breakdown voltage	$I_Z = 100\ \mu\text{A}$	25°C	2.5			2.5			2.5			V
ΔV_Z Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$	25°C	-2.5	2.5		-5	5		-13	13		mV
		Full range	-15		15	-18		18	-25		25	
$I_{Z,\text{min}}$ Minimum cathode current		25°C	41		60	41		60	41		60	μA
		Full range			65			65			65	
α_{VZ} Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C	± 20			± 20			± 20			ppm/ $^{\circ}\text{C}$
	$I_Z = 1\ \text{mA}$	25°C	± 15			± 15			± 15			
	$I_Z = 100\ \mu\text{A}$	25°C	± 15			± 15			± 15			
		Full range	± 50			± 50			± 50			
$\frac{\Delta V_Z}{\Delta I_Z}$ Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	25°C	0.3	0.8		0.3	0.8		0.3	0.8		mV
		Full range			1.2			1.2			1.2	
	$1\ \text{mA} < I_Z < 15\ \text{mA}$	25°C	2.3		6	2.3		6	2.3		6	
		Full range			8			8			8	
Z_Z Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1 I_Z$	25°C	0.3			0.3			0.3			Ω
e_N Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	25°C	41			41			41			μV_{RMS}
Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100\ \mu\text{A}$		120			120			120			ppm
V_{HYST} Thermal hysteresis ⁽¹⁾	$\Delta T_A = -40^{\circ}\text{C}$ to 125°C		0.7			0.7			0.7			mV

(1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) – $V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

TL4050x41I Electrical Characteristics

 at industrial temperature range, full range $T_A = -40^{\circ}\text{C}$ to 85°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	TL4050A41I			TL4050B41I			TL4050C41I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_Z Reverse breakdown voltage	$I_Z = 100\ \mu\text{A}$	25°C	4.096			4.096			4.096			V
ΔV_Z Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$	25°C	-4.1	4.1		-8.2	8.2		-21	21		mV
		Full range	-18		18		-22		22		-34	
$I_{Z,\text{min}}$ Minimum cathode current		25°C	52		68		52		68		μA	
		Full range	73			73						
α_{V_Z} Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C	± 30			± 30			± 30			ppm/ $^{\circ}\text{C}$
	$I_Z = 1\ \text{mA}$	25°C	± 20			± 20			± 20			
	$I_Z = 100\ \mu\text{A}$	25°C	± 20			± 20			± 20			
		Full range	± 50			± 50			± 50			
$\frac{\Delta V_Z}{\Delta I_Z}$ Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	25°C	0.2	0.9		0.2	0.9		0.2	0.9		mV
		Full range	1.2			1.2			1.2			
	$1\ \text{mA} < I_Z < 15\ \text{mA}$	25°C	2		7		2		7			
		Full range	10			10			10			
Z_Z Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{\text{AC}} = 0.1 I_Z$	25°C	0.5			0.5			0.5			Ω
e_N Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	25°C	93			93			93			μV_{RMS}
Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100\ \mu\text{A}$		120			120			120			ppm
V_{HYST} Thermal hysteresis ⁽¹⁾	$\Delta T_A = -40^{\circ}\text{C}$ to 125°C		1.148			1.148			1.148			mV

 (1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) $- V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

TL4050x41Q Electrical Characteristics

at extended temperature range, full range $T_A = -40^{\circ}\text{C}$ to 125°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	TL4050A41Q			TL4050B41Q			TL4050C41Q			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_Z Reverse breakdown voltage	$I_Z = 100\ \mu\text{A}$	25°C	4.096			4.096			4.096			V
ΔV_Z Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$	25°C	-4.1	4.1		-8.2	8.2		-21	21		mV
		Full range	-25		25	-29		29	-41		41	
$I_{Z,\text{min}}$ Minimum cathode current		25°C	52		68	52		68	52		68	μA
		Full range	78			78			78			
α_{VZ} Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C	± 30			± 30			± 30			ppm/ $^{\circ}\text{C}$
	$I_Z = 1\ \text{mA}$	25°C	± 20			± 20			± 20			
	$I_Z = 100\ \mu\text{A}$	25°C	± 20			± 20			± 20			
		Full range	± 50			± 50			± 50			
$\frac{\Delta V_Z}{\Delta I_Z}$ Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	25°C	0.2	0.9		0.2	0.9		0.2	0.9		mV
		Full range	1.2			1.2			1.2			
	$1\ \text{mA} < I_Z < 15\ \text{mA}$	25°C	2		7	2		7	2		7	
		Full range	10			10			10			
Z_Z Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1 I_Z$	25°C	0.5			0.5			0.5			Ω
e_N Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	25°C	93			93			93			μV_{RMS}
Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100\ \mu\text{A}$		120			120			120			ppm
V_{HYST} Thermal hysteresis ⁽¹⁾	$\Delta T_A = -40^{\circ}\text{C}$ to 125°C		1.148			1.148			1.148			mV

(1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) $- V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

TL4050x50I Electrical Characteristics

 at industrial temperature range, full range $T_A = -40^{\circ}\text{C}$ to 85°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	TL4050A50I			TL4050B50I			TL4050C50I			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		
V_Z Reverse breakdown voltage	$I_Z = 100\ \mu\text{A}$	25°C	5			5			5			V	
ΔV_Z Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$	25°C	-5		5	-10		10	-25		25	mV	
		Full range	-22		22	-27		27	-42		42		
$I_{Z,\text{min}}$ Minimum cathode current		25°C		56	74		56	74		56	74	μA	
		Full range			80			80			80		
α_{V_Z} Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C	± 30			± 30			± 30			ppm/ $^{\circ}\text{C}$	
	$I_Z = 1\ \text{mA}$	25°C	± 20			± 20			± 20				
	$I_Z = 100\ \mu\text{A}$	25°C	± 20			± 20			± 20				
		Full range	± 50			± 50			± 50				
$\frac{\Delta V_Z}{\Delta I_Z}$ Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	25°C	0.2		1	0.2		1	0.2		1	mV	
		Full range			1.4			1.4			1.4		
	$1\ \text{mA} < I_Z < 15\ \text{mA}$	25°C		2		8		2		8			8
		Full range			12			12			12		
Z_Z Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{\text{AC}} = 0.1 I_Z$	25°C	0.5			0.5			0.5			Ω	
e_N Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	25°C	93			93			93			μV_{RMS}	
Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100\ \mu\text{A}$		120			120			120			ppm	
V_{HYST} Thermal hysteresis ⁽¹⁾	$\Delta T_A = -40^{\circ}\text{C}$ to 125°C		1.4			1.4			1.4			mV	

 (1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) – $V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

TL4050x50Q Electrical Characteristics

at extended temperature range, full range $T_A = -40^{\circ}\text{C}$ to 125°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	TL4050A50Q			TL4050B50Q			TL4050C50Q			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_Z Reverse breakdown voltage	$I_Z = 100\ \mu\text{A}$	25°C	5			5			5			V
ΔV_Z Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$	25°C	-5		5	-10		10	-25		25	mV
		Full range	-30		30	-35		35	-50		50	
$I_{Z,\text{min}}$ Minimum cathode current		25°C		56	74		56	74		56	74	μA
		Full range			90			90			90	
α_{VZ} Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C	± 30			± 30			± 30			ppm/ $^{\circ}\text{C}$
	$I_Z = 1\ \text{mA}$	25°C	± 20			± 20			± 20			
	$I_Z = 100\ \mu\text{A}$	25°C	± 20			± 20			± 20			
		Full range			± 50			± 50			± 50	
$\frac{\Delta V_Z}{\Delta I_Z}$ Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	25°C		0.2	1		0.2	1		0.2	1	mV
		Full range			1.4			1.4			1.4	
	$1\ \text{mA} < I_Z < 15\ \text{mA}$	25°C		2	8		2	8		2	8	
		Full range			12			12			12	
Z_Z Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1 I_Z$	25°C	0.5			0.5			0.5			Ω
e_N Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	25°C	93			93			93			μV_{RMS}
Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100\ \mu\text{A}$		120			120			120			ppm
V_{HYST} Thermal hysteresis ⁽¹⁾	$\Delta T_A = -40^{\circ}\text{C}$ to 125°C		1.4			1.4			1.4			mV

(1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) $- V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

TL4050x82I Electrical Characteristics

 at industrial temperature range, full range $T_A = -40^{\circ}\text{C}$ to 85°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	TL4050A82I			TL4050B82I			TL4050C82I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_Z Reverse breakdown voltage	$I_Z = 100\ \mu\text{A}$	25°C	8.192			8.192			8.192			V
ΔV_Z Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$	25°C	-8.2	8.2		-16	16		-41	41		mV
		Full range	-35		35	-43		43	-68		68	
$I_{Z,\text{min}}$ Minimum cathode current		25°C	74		91		74		91		μA	
		Full range			95				95			
α_{V_Z} Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C	± 40			± 40			± 40			ppm/ $^{\circ}\text{C}$
	$I_Z = 1\ \text{mA}$	25°C	± 20			± 20			± 20			
	$I_Z = 100\ \mu\text{A}$	25°C	± 20			± 20			± 20			
		Full range	± 50			± 50			± 50			
$\frac{\Delta V_Z}{\Delta I_Z}$ Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	25°C	0.6	1.3		0.6	1.3		0.6	1.3		mV
		Full range			2.5				2.5			
	$1\ \text{mA} < I_Z < 15\ \text{mA}$	25°C	7		10		7		10			
		Full range			18				18			
Z_Z Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{\text{AC}} = 0.1 I_Z$	25°C	0.6			0.6			0.6			Ω
e_N Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	25°C	150			150			150			μV_{RMS}
Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100\ \mu\text{A}$		120			120			120			ppm
V_{HYST} Thermal hysteresis ⁽¹⁾	$\Delta T_A = -40^{\circ}\text{C}$ to 125°C		2.3			2.3			2.3			mV

 (1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) $- V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

TL4050x82Q Electrical Characteristics

at extended temperature range, full range $T_A = -40^{\circ}\text{C}$ to 125°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	TL4050A82Q			TL4050B82Q			TL4050C82Q			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_Z Reverse breakdown voltage	$I_Z = 100\ \mu\text{A}$	25°C	8.192			8.192			8.192			V
ΔV_Z Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$	25°C	-8.2	8.2		-16	16		-41	41		mV
		Full range	-49		49	-57		57	-82		82	
$I_{Z,\text{min}}$ Minimum cathode current		25°C	74		91	74		91	74		91	μA
		Full range	100			100			100			
α_{VZ} Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C	± 40			± 40			± 40			ppm/ $^{\circ}\text{C}$
	$I_Z = 1\ \text{mA}$	25°C	± 20			± 20			± 20			
	$I_Z = 100\ \mu\text{A}$	25°C	± 20			± 20			± 20			
		Full range	± 50			± 50			± 50			
$\frac{\Delta V_Z}{\Delta I_Z}$ Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	25°C	0.6	1.3		0.6	1.3		0.6	1.3		mV
		Full range	2.5			2.5			2.5			
	$1\ \text{mA} < I_Z < 15\ \text{mA}$	25°C	7		10	7		10	7		10	
		Full range	18			18			18			
Z_Z Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{AC} = 0.1 I_Z$	25°C	0.6			0.6			0.6			Ω
e_N Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	25°C	150			150			150			μV_{RMS}
Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100\ \mu\text{A}$		120			120			120			ppm
V_{HYST} Thermal hysteresis ⁽¹⁾	$\Delta T_A = -40^{\circ}\text{C}$ to 125°C		2.3			2.3			2.3			mV

(1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) $- V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

TL4050x10I Electrical Characteristics

 at industrial temperature range, full range $T_A = -40^{\circ}\text{C}$ to 85°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T_A	TL4050A10I			TL4050B10I			TL4050C10I			UNIT			
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX				
V_Z Reverse breakdown voltage	$I_Z = 100\ \mu\text{A}$	25°C	10			10			10			V			
ΔV_Z Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$	25°C	-10	10		-20	20		-50	50		mV			
		Full range	-43		43		-53		53		-83		83		
$I_{Z,\text{min}}$ Minimum cathode current		25°C	80		100		80		100		80		100		μA
		Full range			103				103				103		
α_{V_Z} Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C	± 40			± 40			± 40			ppm/ $^{\circ}\text{C}$			
	$I_Z = 1\ \text{mA}$	25°C	± 20			± 20			± 20						
	$I_Z = 100\ \mu\text{A}$	25°C	± 20			± 20			± 20						
		Full range	± 50			± 50			± 50						
$\frac{\Delta V_Z}{\Delta I_Z}$ Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	25°C	0.8	1.5		0.8	1.5		0.8	1.5		mV			
		Full range	3.5		3.5		3.5		3.5						
	$1\ \text{mA} < I_Z < 15\ \text{mA}$	25°C	8	12		8	12		8	12					
		Full range	23		23		23		23						
Z_Z Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{\text{AC}} = 0.1 I_Z$	25°C	0.7			0.7			0.7			Ω			
e_N Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	25°C	150			150			150			μV_{RMS}			
Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100\ \mu\text{A}$		120			120			120			ppm			
V_{HYST} Thermal hysteresis ⁽¹⁾	$\Delta T_A = -40^{\circ}\text{C}$ to 125°C		2.8			2.8			2.8			mV			

 (1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) $- V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

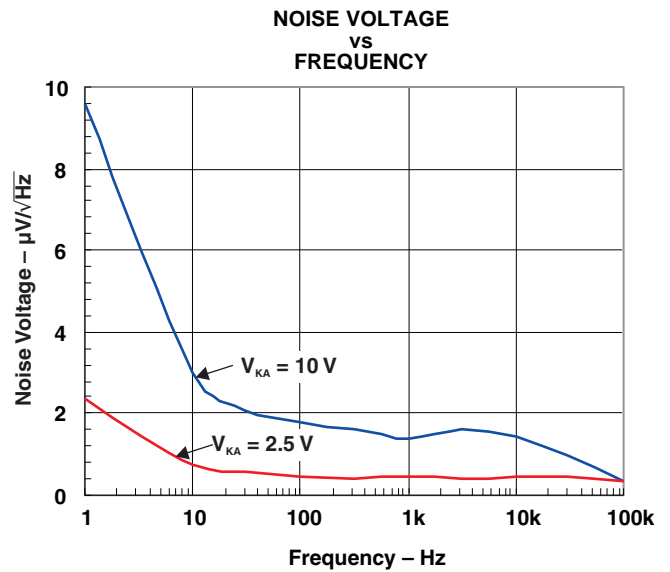
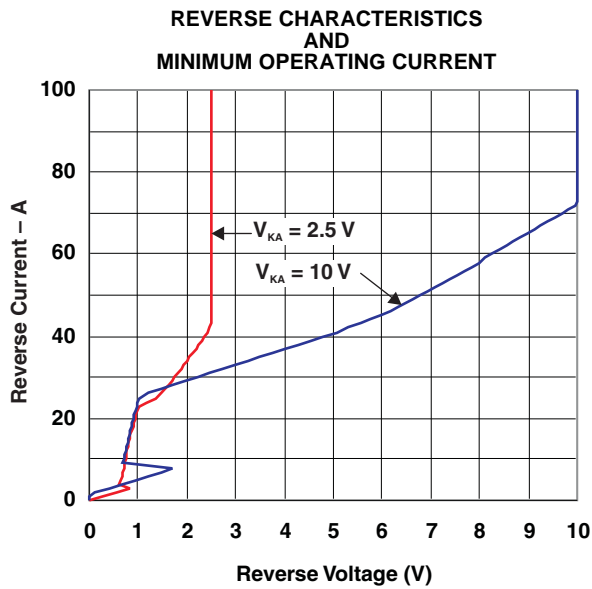
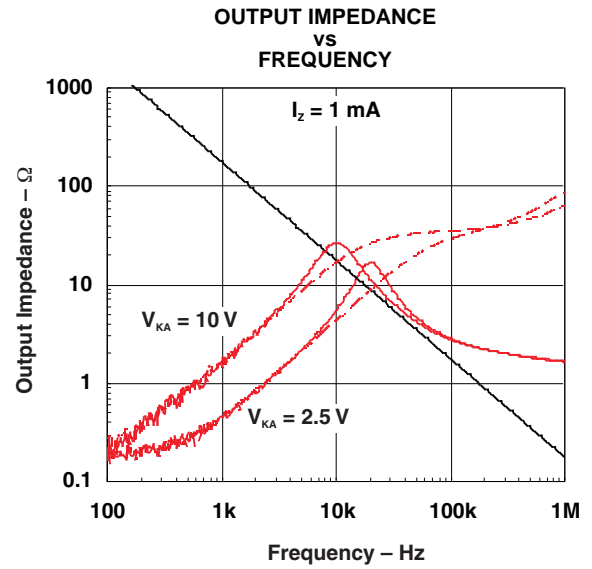
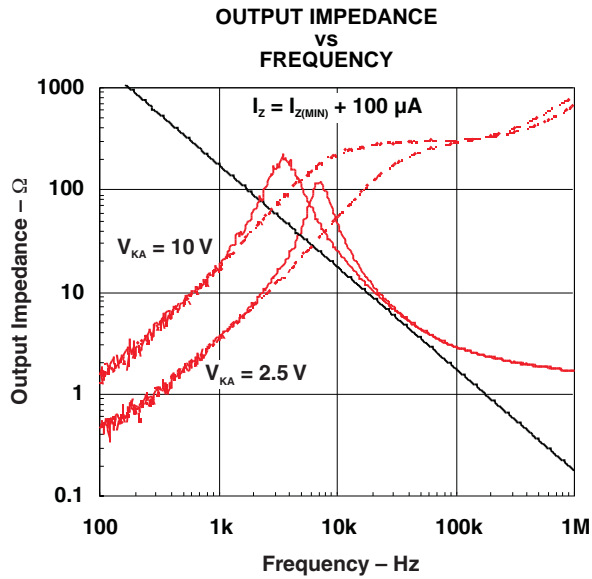
TL4050x10Q Electrical Characteristics

at extended temperature range, full range $T_A = -40^{\circ}\text{C}$ to 125°C (unless otherwise noted)

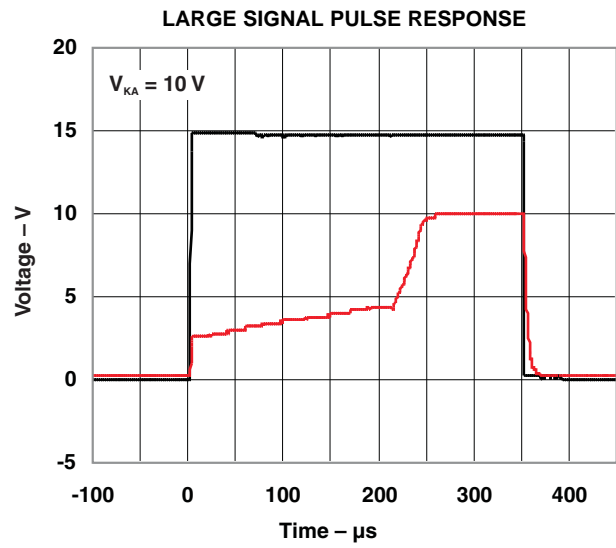
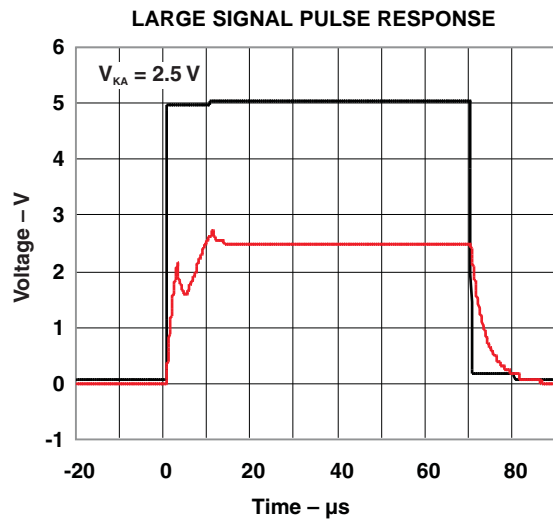
PARAMETER	TEST CONDITIONS	T_A	TL4050A10Q			TL4050B10Q			TL4050C10Q			UNIT		
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX			
V_Z Reverse breakdown voltage	$I_Z = 100\ \mu\text{A}$	25°C	10			10			10			V		
ΔV_Z Reverse breakdown voltage tolerance	$I_Z = 100\ \mu\text{A}$	25°C	-10	10		-20	20		-50	50		mV		
		Full range	-60		60		-70		70		-100		100	
$I_{Z,\text{min}}$ Minimum cathode current		25°C	80		100		80		100		80		100	
		Full range	110			110			110			110		
α_{V_Z} Average temperature coefficient of reverse breakdown voltage	$I_Z = 10\ \text{mA}$	25°C	± 40			± 40			± 40			ppm/ $^{\circ}\text{C}$		
	$I_Z = 1\ \text{mA}$	25°C	± 20			± 20			± 20					
	$I_Z = 100\ \mu\text{A}$	25°C	± 20			± 20			± 20					
		Full range	± 50			± 50			± 50					
$\frac{\Delta V_Z}{\Delta I_Z}$ Reverse breakdown voltage change with cathode current change	$I_{Z,\text{min}} < I_Z < 1\ \text{mA}$	25°C	0.8	1.5		0.8	1.5		0.8	1.5		mV		
		Full range	3.5			3.5			3.5					
	$1\ \text{mA} < I_Z < 15\ \text{mA}$	25°C	8	12		8	12		8	12				
		Full range	23			23			23					
Z_Z Reverse dynamic impedance	$I_Z = 1\ \text{mA}$, $f = 120\ \text{Hz}$, $I_{\text{AC}} = 0.1 I_Z$	25°C	0.7			0.7			0.7			Ω		
e_N Wideband noise	$I_Z = 100\ \mu\text{A}$, $10\ \text{Hz} \leq f \leq 10\ \text{kHz}$	25°C	150			150			150			μV_{RMS}		
Long-term stability of reverse breakdown voltage	$t = 1000\ \text{h}$, $T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, $I_Z = 100\ \mu\text{A}$		120			120			120			ppm		
V_{HYST} Thermal hysteresis ⁽¹⁾	$\Delta T_A = -40^{\circ}\text{C}$ to 125°C		2.8			2.8			2.8			mV		

(1) Thermal hysteresis is defined as $V_{Z,25^{\circ}\text{C}}$ (after cycling to -40°C) $- V_{Z,25^{\circ}\text{C}}$ (after cycling to 125°C).

TYPICAL CHARACTERISTICS



TYPICAL CHARACTERISTICS (continued)



APPLICATION INFORMATION

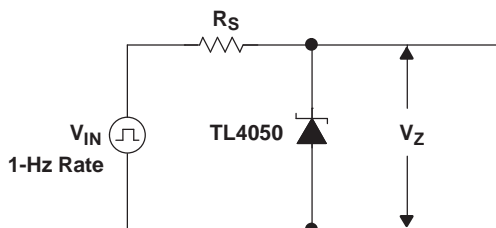


Figure 1. Start-Up Test Circuit

Output Capacitor

The TL4050 does not require an output capacitor across cathode and anode for stability. However, if an output bypass capacitor is desired, the TL4050 is designed to be stable with all capacitive loads.

SOT-23 Pin Connections

There is a parasitic Schottky diode connected between pins 2 and 3 of the SOT-23 packaged device. Thus, pin 3 of the SOT-23 package must be left floating or connected to pin 2.

Use With ADCs or DACs

The TL4050x-41 is designed to be a cost-effective voltage reference as required in 12-bit data-acquisition systems. For 12-bit systems operating from 5-V supplies, such as the ADS7842 (see Figure 2), the TL4050x-41 (4.096 V) permits operation with an LSB of 1 mV.

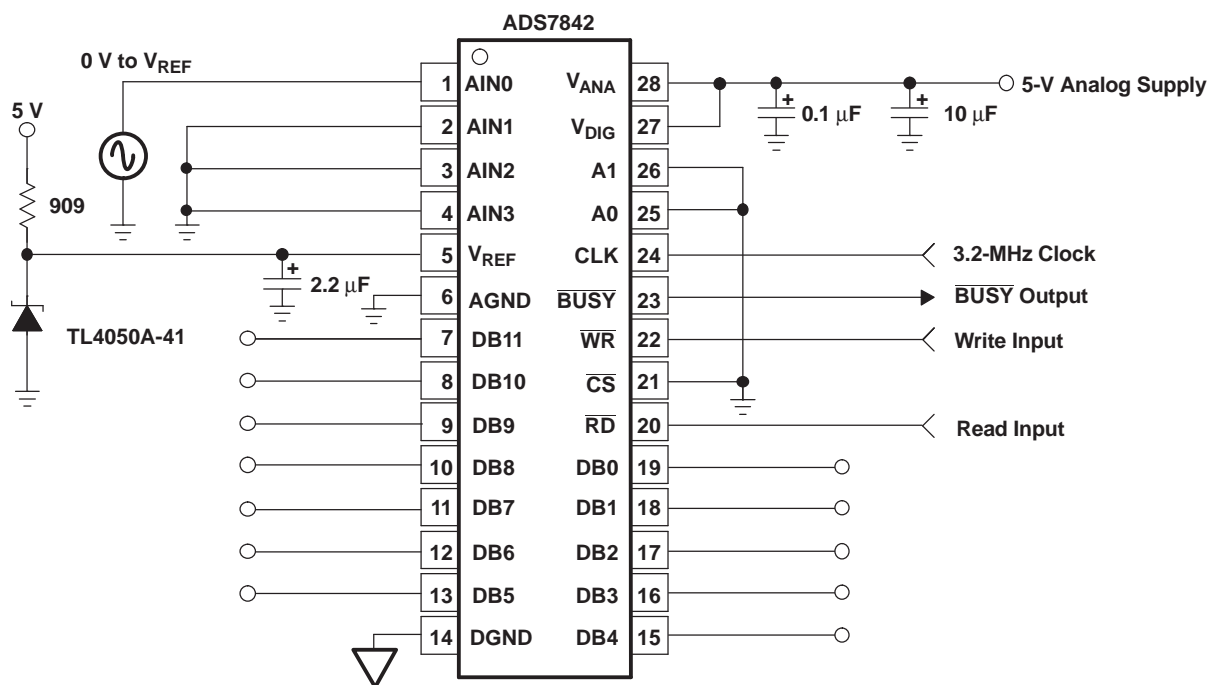


Figure 2. Data-Acquisition Circuit With TL4050x-41

Cathode and Load Currents

In a typical shunt-regulator configuration (see [Figure 3](#)), an external resistor, R_S , is connected between the supply and the cathode of the TL4050. R_S must be set properly, as it sets the total current available to supply the load (I_L) and bias the TL4050 (I_Z). In all cases, I_Z must stay within a specified range for proper operation of the reference. Taking into consideration one extreme in the variation of the load and supply voltage (maximum I_L and minimum V_S), R_S must be small enough to supply the minimum I_Z required for operation of the regulator, as given by data-sheet parameters. At the other extreme, maximum V_S and minimum I_L , R_S must be large enough to limit I_Z to less than its maximum-rated value of 15 mA.

R_S is calculated according to [Equation 1](#):

$$R_S = \frac{(V_S - V_Z)}{(I_L + I_Z)} \quad (1)$$

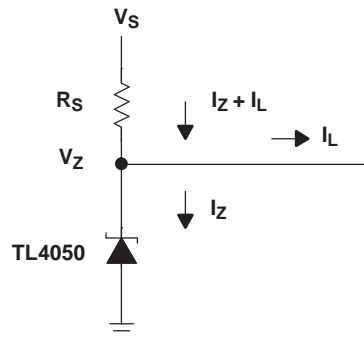


Figure 3. Shunt Regulator

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
TL4050B41QDBZRQ1	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL4050C20QDBZRQ1	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBsolete: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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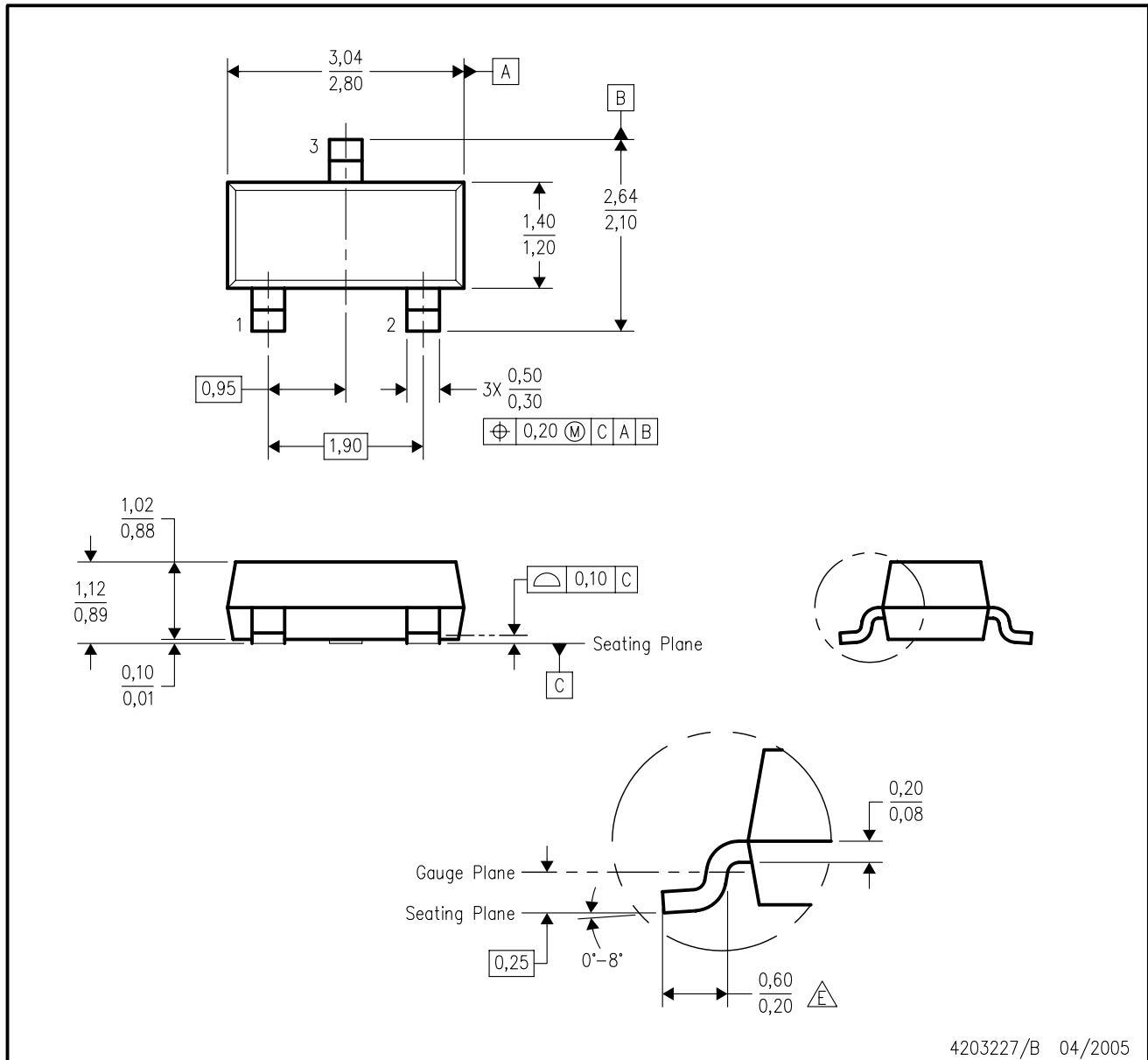
- Catalog: [TL4050B41](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

DBZ (R-PDSO-G3)

PLASTIC SMALL-OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Lead dimensions are inclusive of plating.
 - D. Body dimensions are exclusive of mold flash and protrusion. Mold flash and protrusion not to exceed 0.25 per side.
 - $\triangle E$ Falls within JEDEC TO-236 variation AB, except minimum foot length.

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