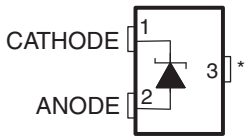
FEATURES

- **1.225-V Fixed and Adjustable (1.225-V to 10-V) Outputs**
- **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…20 μV_{RMS} (Typ)**
- **Wide Operating Current Range… 60 μA (Typ) to 12 mA**
- **Stable With All Capacitive Loads; No Output Capacitor Required**
- **Available in**
  - **Industrial Temperature: –40°C to 85°C**
  - **Extended Temperature: –40°C to 125°C**

APPLICATIONS

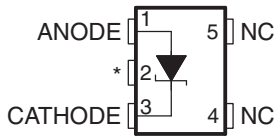
- **Data-Acquisition Systems**
- **Power Supplies and Power-Supply Monitors**
- **Instrumentation and Test Equipment**
- **Process Control**
- **Precision Audio**
- **Automotive Electronics**
- **Energy Management/Metering**
- **Battery-Powered Equipment**

1.2 V...DBZ (SOT-23-3) PACKAGE
(TOP VIEW)



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

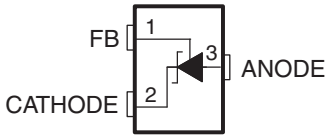
1.2 V...DCK (SC-70) PACKAGE
(TOP VIEW)



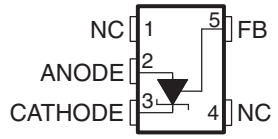
NC – No internal connection

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

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



Adjustable...DCK (SC-70) PACKAGE
(TOP VIEW)



NC – No internal connection

DESCRIPTION/ORDERING INFORMATION

The TL4051 series of shunt voltage references are versatile easy-to-use references suitable for a wide array of applications. The device is available in a fixed 1.225-V output or an adjustable output whose voltage is determined by an external resistor divider. The 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 TL4051 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 TL4051 also is ideal for portable applications.

The TL4051xI is characterized for operation over an ambient temperature range of –40°C to 85°C. The TL4051xQ is characterized for operation over an ambient temperature range of –40°C to 125°C.

ORDERING INFORMATION(1)

T_A	DEVICE GRADE	V_Z	PACKAGE(2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING(3)
–40°C to 85°C	A grade: 0.1% initial accuracy and 50 ppm/°C temperature coefficient	ADJ	SOT-23-3 – DBZ	Reel of 3000	TL4051AIDBZR	TN2_
				Reel of 250	TL4051AIDBZT	
			SC-70 – DCK	Reel of 3000	TL4051AIDCKR	97_
				Reel of 250	TL4051AIDCKT	
		1.2 V	SOT-23-3 – DBZ	Reel of 3000	TL4051A12IDBZR	TN8_
				Reel of 250	TL4051A12IDBZT	
			SC-70 – DCK	Reel of 3000	TL4051A12IDCKR	9D_
				Reel of 250	TL4051A12IDCKT	
	B grade: 0.2% initial accuracy and 50 ppm/°C temperature coefficient	ADJ	SOT-23-3 – DBZ	Reel of 3000	TL4051BIDBZR	TN3_
				Reel of 250	TL4051BIDBZT	
			SC-70 – DCK	Reel of 3000	TL4051BIDCKR	98_
				Reel of 250	TL4051BIDCKT	
		1.2 V	SOT-23-3 – DBZ	Reel of 3000	TL4051B12IDBZR	TN9_
				Reel of 250	TL4051B12IDBZT	
			SC-70 – DCK	Reel of 3000	TL4051B12IDCKR	9E_
				Reel of 250	TL4051B12IDCKT	
	C grade: 0.5% initial accuracy and 50 ppm/°C temperature coefficient	ADJ	SOT-23-3 – DBZ	Reel of 3000	TL4051CIDBZR	TN4_
				Reel of 250	TL4051CIDBZT	
			SC-70 – DCK	Reel of 3000	TL4051CIDCKR	99_
				Reel of 250	TL4051CIDCKT	
		1.2 V	SOT-23-3 – DBZ	Reel of 3000	TL4051C12IDBZR	TNU_
				Reel of 250	TL4051C12IDBZT	
			SC-70 – DCK	Reel of 3000	TL4051C12IDCKR	9F_
				Reel of 250	TL4051C12IDCKT	

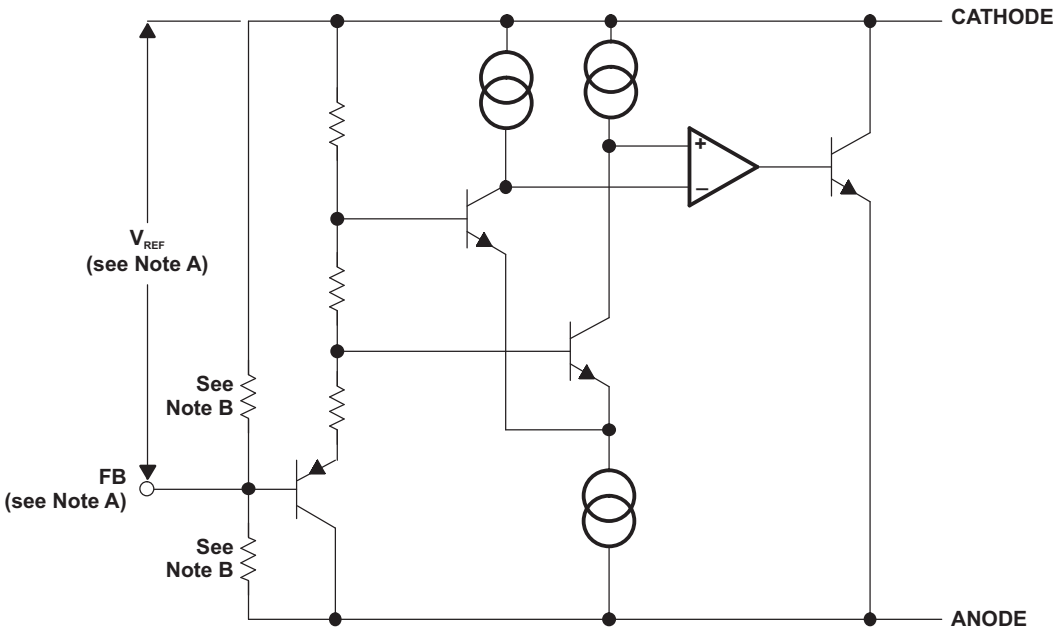
(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.
(3) The actual top-side marking has one additional character that designates the assembly/test site.

ORDERING INFORMATION(1)

T_A	DEVICE GRADE	V_Z	PACKAGE(2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING(3)
–40°C to 125°C	A grade: 0.1% initial accuracy and 50 ppm/°C temperature coefficient	ADJ	SOT-23-3 – DBZ	Reel of 3000	TL4051AQDBZR	TN5_
				Reel of 250	TL4051AQDBZT	
			SC-70 – DCK	Reel of 3000	TL4051AQDCKR	9A_
				Reel of 250	TL4051AQDCKT	
		1.2 V	SOT-23-3 – DBZ	Reel of 3000	TL4051A12QDBZR	TNV_
				Reel of 250	TL4051A12QDBZT	
			SC-70 – DCK	Reel of 3000	TL4051A12QDCKR	9G_
				Reel of 250	TL4051A12QDCKT	
	B grade: 0.2% initial accuracy and 50 ppm/°C temperature coefficient	ADJ	SOT-23-3 – DBZ	Reel of 3000	TL4051BQDBZR	TN6_
				Reel of 250	TL4051BQDBZT	
			SC-70 – DCK	Reel of 3000	TL4051BQDCKR	9B_
				Reel of 250	TL4051BQDCKT	
		1.2 V	SOT-23-3 – DBZ	Reel of 3000	TL4051B12QDBZR	TNW_
				Reel of 250	TL4051B12QDBZT	
			SC-70 – DCK	Reel of 3000	TL4051B12QDCKR	9H_
				Reel of 250	TL4051B12QDCKT	
	C grade: 0.5% initial accuracy and 50 ppm/°C temperature coefficient	ADJ	SOT-23-3 – DBZ	Reel of 3000	TL4051CQDBZR	TN7_
				Reel of 250	TL4051CQDBZT	
			SC-70 – DCK	Reel of 3000	TL4051CQDCKR	9C_
				Reel of 250	TL4051CQDCKT	
		1.2 V	SOT-23-3 – DBZ	Reel of 3000	TL4051C12QDBZR	TNY_
				Reel of 250	TL4051C12QDBZT	
			SC-70 – DCK	Reel of 3000	TL4051C12QDCKR	9J_
				Reel of 250	TL4051C12QDCKT	

(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.
(3) The actual top-side marking has one additional character that designates the assembly/test site.

FUNCTIONAL BLOCK DIAGRAM



A. TL4051x (Adjustable) only

B. TL4051x12 only

Absolute Maximum Ratings(1)

over free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V_Z	Continuous cathode voltage			15	V
I_Z	Continuous cathode current		–10	20	mA
θ_{JA}	Package thermal impedance(2)(3)	DBZ package		206	°C/W
		DCK package		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 $T_J(max)$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. 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)	12	mA
V_Z	Reverse breakdown voltage (adjustable version)			10	V
T_A	Free-air temperature	I temperature	–40	85	°C
		Q temperature	–40	125	

(1) See parametric tables

TL4051x12I Electrical Characteristics

full range T_A = –40°C to 85°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	TL4051A12I			TL4051B12I			TL4051C12I			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_Z	Reverse breakdown voltage	I_Z = 100 µA	25°C		1.225			1.225			1.225		V
	Reverse breakdown voltage tolerance	I_Z = 100 µA	25°C	–1.2		1.2	–2.4		2.4	–6		6	mV
			Full range	–5.2		5.2	–6.4		6.4	–10.1		10.1	
$I_{Z,min}$	Minimum cathode current		25°C		39	60		39	60		39	60	µA
			Full range			65			65			65	
α_{VZ}	Average temperature coefficient of reverse breakdown voltage	I_Z = 10 mA	25°C		±20			±20			±20		ppm/°C
		I_Z = 1 mA	25°C		±15			±15			±15		
		I_Z = 100 µA	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	$I_{Z,min} < I_Z < 1$ mA	25°C		0.3	1.1		0.3	1.1		0.3	1.1	mV
			Full range			1.5			1.5			1.5	
		1 mA < I_Z < 12 mA	25°C		1.8	6		1.8	6		1.8	6	
			Full range			8			8			8	
Z_Z	Reverse dynamic impedance	I_Z = 1 mA, f = 120 Hz, I_{AC} = 0.1 I_Z	25°C		0.5			0.5			0.5		Ω
e_N	Wideband noise	I_Z = 100 µA, 10 Hz ≤ f ≤ 10 kHz	25°C		20			20			20		μV_{RMS}
	Long-term stability of reverse breakdown voltage	t = 1000 h, T_A = 25°C ± 0.1°C, I_Z = 100 µA	25°C		120			120			120		ppm
V_{HYST}	Thermal hysteresis(1)	ΔT_A = –40°C to 125°C			0.36			0.36			0.36		mV/V

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

TL4051x12Q Electrical Characteristics

full range T_A = –40°C to 125°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	TL4051A12Q			TL4051B12Q			TL4051C12Q			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_Z	Reverse breakdown voltage	I_Z = 100 µA	25°C		1.225			1.225			1.225		V
	Reverse breakdown voltage tolerance	I_Z = 100 µA	25°C	–1.2		1.2	–2.4		2.4	–6		6	mV
			Full range	–7.4		7.4	–8.6		8.6	–12.2		12.2	
$I_{Z,min}$	Minimum cathode current		25°C		39	60		39	60		39	60	µA
			Full range			65			65			65	
α_{VZ}	Average temperature coefficient of reverse breakdown voltage	I_Z = 10 mA	25°C		±20			±20			±20		ppm/°C
		I_Z = 1 mA	25°C		±15			±15			±15		
		I_Z = 100 µA	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	$I_{Z,min} < I_Z < 1$ mA	25°C		0.3	1.1		0.3	1.1		0.3	1.1	mV
			Full range			1.5			1.5			1.5	
		1 mA < I_Z < 12 mA	25°C		1.8	6		1.8	6		1.8	6	
			Full range			8			8			8	
Z_Z	Reverse dynamic impedance	I_Z = 1 mA, f = 120 Hz, I_{AC} = 0.1 I_Z	25°C		0.5			0.5			0.5		Ω
e_N	Wideband noise	I_Z = 100 µA, 10 Hz ≤ f ≤ 10 kHz	25°C		20			20			20		μV_{RMS}
	Long-term stability of reverse breakdown voltage	t = 1000 h, T_A = 25°C ± 0.1°C, I_Z = 100 µA	25°C		120			120			120		ppm
V_{HYST}	Thermal hysteresis(1)	ΔT_A = –40°C to 125°C			0.36			0.36			0.36		mV/V

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

TL4051xI (Adjustable Version) Electrical Characteristics

full range T_A = –40°C to 85°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	TL4051AI			TL4051BI			TL4051CI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{REF}	Reference voltage	I_Z = 100 µA, V_Z = 5 V	25°C		1.212			1.212			1.212		V
	Reference voltage tolerance(1)	I_Z = 100 µA, V_Z = 5 V	25°C	–1.2		1.2	–2.4		2.4	–6		6	mV
			Full range	–5.2		5.2	–6.4		6.4	–10.1		10.1	
$I_{Z,min}$	Minimum cathode current		25°C		36	60		36	60		36	65	µA
			Full range			65			65			70	
$\frac{\Delta V_{REF}}{\Delta I_Z}$	Reference voltage change with cathode current change	$I_{Z,min} < I_Z < 1$ mA	25°C		0.3	1.1		0.3	1.1		0.3	1.1	mV
			Full range			1.5			1.5			1.5	
		1 mA < I_Z < 12 mA	25°C		0.6	6		0.6	6		0.6	6	
			Full range			8			8			8	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Reference voltage change with output voltage change	I_Z = 1 mA	25°C		–1.69	–2.8		–1.69	–2.8		–1.69	–2.8	mV/V
			Full range			–3.5			–3.5			–3.5	
I_{FB}	Feedback current		25°C		70	130		70	130		70	130	nA
			Full range			150			150			150	
αV_{REF}	Average temperature coefficient of reference voltage(1)	I_Z = 10 mA, V_Z = 2.5 V	25°C		±20			±20			±20		ppm/°C
		I_Z = 1 mA, V_Z = 2.5 V	25°C		±15			±15			±15		
		I_Z = 100 µA, V_Z = 2.5 V	25°C		±15			±15			±15		
			Full range			±50			±50			±50	
Z_Z	Reverse dynamic impedance	I_Z = 1 mA, f = 120 Hz, I_{AC} = 0.1 I_Z, V_Z = V_{REF}	25°C		0.3			0.3			0.3		Ω
		I_Z = 1 mA, f = 120 Hz, I_{AC} = 0.1 I_Z, V_Z = 10 V	25°C		2			2			2		
e_N	Wideband noise	I_Z = 100 µA, V_Z = V_{REF}, 10 Hz ≤ f ≤ 10 kHz	25°C		20			20			20		μV_{RMS}
	Long-term stability of reverse breakdown voltage	t = 1000 h, T_A = 25°C ± 0.1°C, I_Z = 100 µA	25°C		120			120			120		ppm
V_{HYST}	Thermal hysteresis(2)	ΔT_A = –40°C to 125°C			0.3			0.3			0.3		mV/V

(1) Reference voltage tolerance and average temperature coefficient change with output voltage (V_Z). See *Typical Characteristics*.
(2) Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to –40°C) – $V_{Z,25°C}$ (after cycling to 125°C).

TL4051xQ (Adjustable Version) Electrical Characteristics

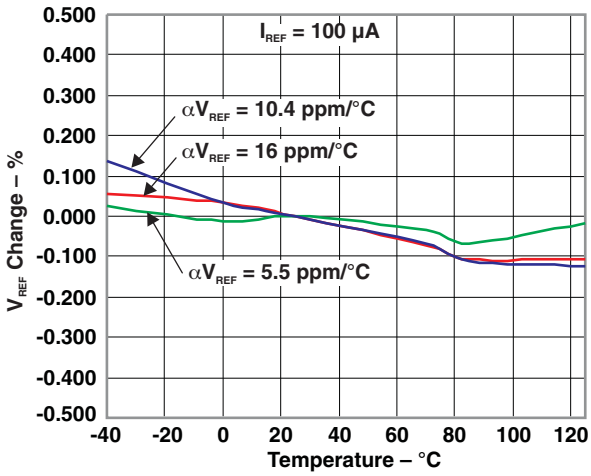
full range T_A = –40°C to 125°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	TL4051AQ			TL4051BQ			TL4051CQ			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{REF}	Reference voltage	I_Z = 100 µA, V_Z = 5 V	25°C		1.212			1.212			1.212		V
	Reference voltage tolerance(1)	I_Z = 100 µA, V_Z = 5 V	25°C	–1.2		1.2	–2.4		2.4	–6		6	mV
			Full range	–7.4		7.4	–8.6		8.6	–12.2		12.2	
$I_{Z,min}$	Minimum cathode current		25°C		36	60		36	60		36	65	µA
			Full range			70			70			75	
$\frac{\Delta V_{REF}}{\Delta I_Z}$	Reference voltage change with cathode current change	$I_{Z,min} < I_Z < 1$ mA	25°C		0.3	1.1		0.3	1.1		0.3	1.1	mV
			Full range			1.5			1.5			1.5	
		1 mA < I_Z < 12 mA	25°C		0.6	6		0.6	6		0.6	6	
			Full range			8			8			8	
$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	Reference voltage change with output voltage change	I_Z = 1 mA	25°C		–1.69	–2.8		–1.69	–2.8		–1.69	–2.8	mV/V
			Full range			–3.5			–3.5			–3.5	
I_{FB}	Feedback current		25°C		70	130		70	130		70	130	nA
			Full range			150			150			150	
αV_{REF}	Average temperature coefficient of reference voltage(1)	I_Z = 10 mA, V_Z = 2.5 V	25°C		±20			±20			±20		ppm/°C
		I_Z = 1 mA, V_Z = 2.5 V	25°C		±15			±15			±15		
		I_Z = 100 µA, V_Z = 2.5 V	25°C		±15			±15			±15		
			Full range			±50			±50			±50	
Z_Z	Reverse dynamic impedance	I_Z = 1 mA, f = 120 Hz, I_{AC} = 0.1 I_Z, V_Z = V_{REF}	25°C		0.3			0.3			0.3		Ω
		I_Z = 1 mA, f = 120 Hz, I_{AC} = 0.1 I_Z, V_Z = 10 V	25°C		2			2			2		
e_N	Wideband noise	I_Z = 100 µA, V_Z = V_{REF}, 10 Hz ≤ f ≤ 10 kHz	25°C		20			20			20		μV_{RMS}
	Long-term stability of reverse breakdown voltage	t = 1000 h, T_A = 25°C ± 0.1°C, I_Z = 100 µA	25°C		120			120			120		ppm
V_{HYST}	Thermal hysteresis(2)	ΔT_A = –40°C to 125°C			0.3			0.3			0.3		mV/V

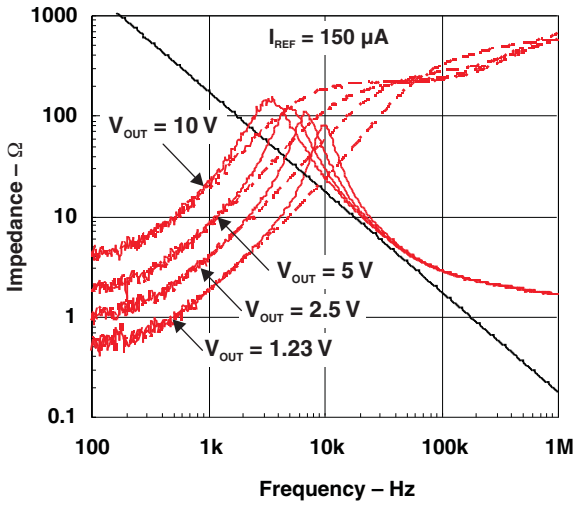
(1) Reference voltage tolerance and average temperature coefficient change with output voltage (V_Z). See *Typical Characteristics*.
(2) Thermal hysteresis is defined as $V_{Z,25°C}$ (after cycling to –40°C) – $V_{Z,25°C}$ (after cycling to 125°C).

TYPICAL CHARACTERISTICS

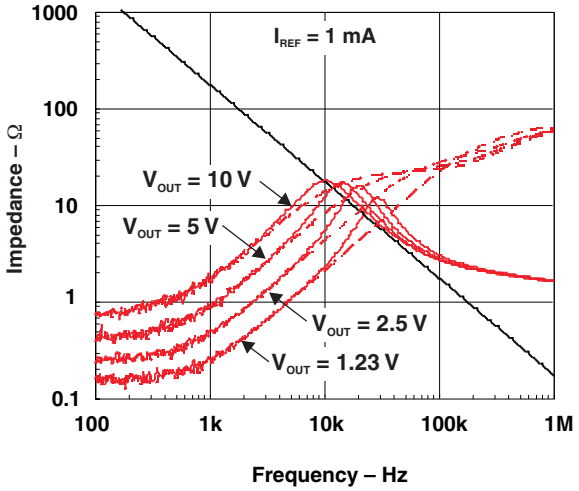
TEMPERATURE DRIFT FOR DIFFERENT AVERAGE TEMPERATURE COEFFICIENTS



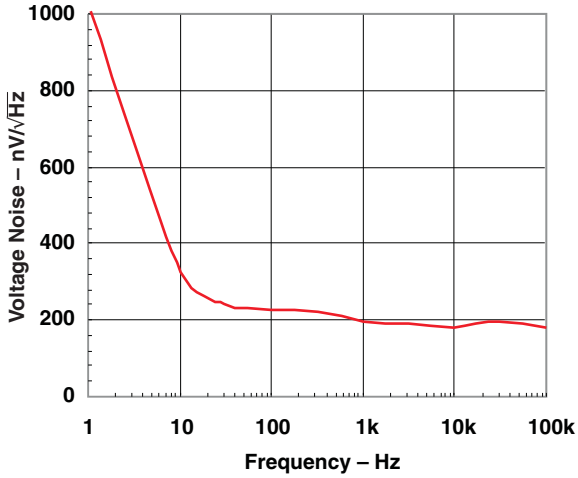
OUTPUT IMPEDANCE vs FREQUENCY



OUTPUT IMPEDANCE vs FREQUENCY

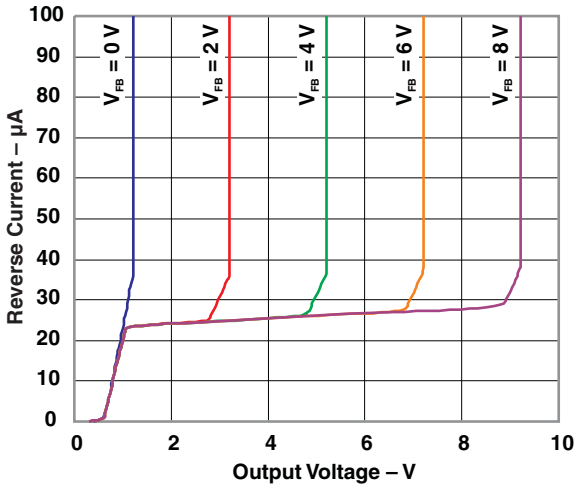


NOISE VOLTAGE vs FREQUENCY

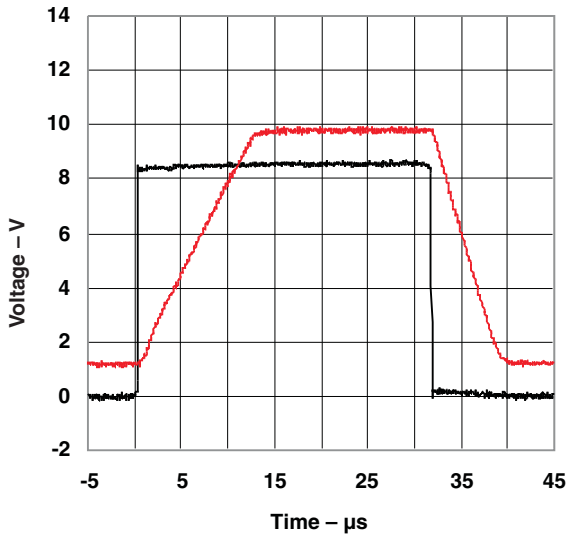


TYPICAL CHARACTERISTICS (continued)

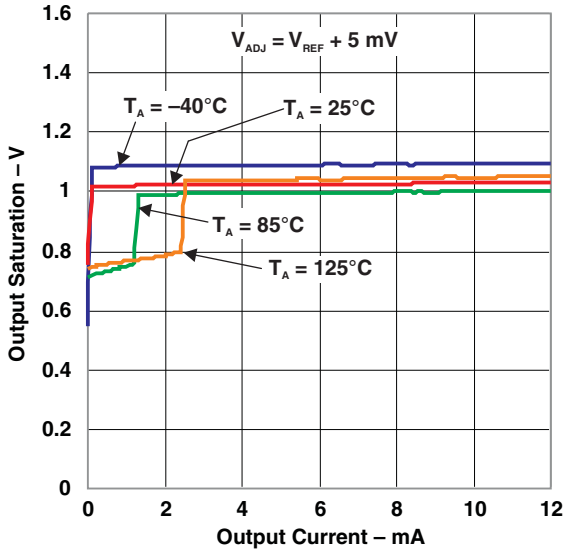
REVERSE CHARACTERISTICS



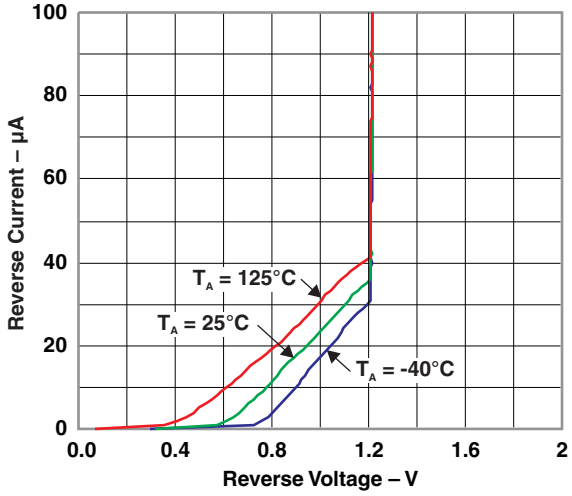
LARGE SIGNAL PULSE RESPONSE



OUTPUT SATURATION vs OUTPUT CURRENT

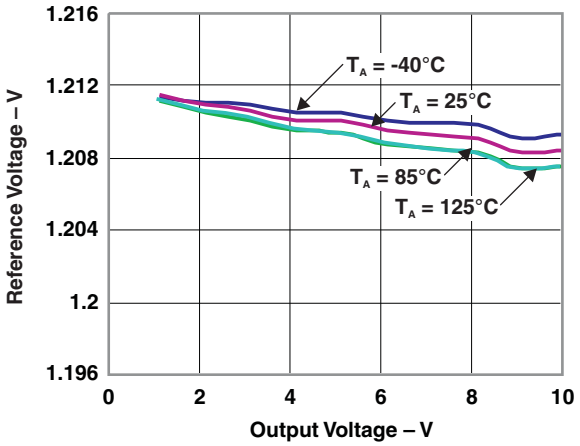


REVERSE CURRENT vs REVERSE VOLTAGE

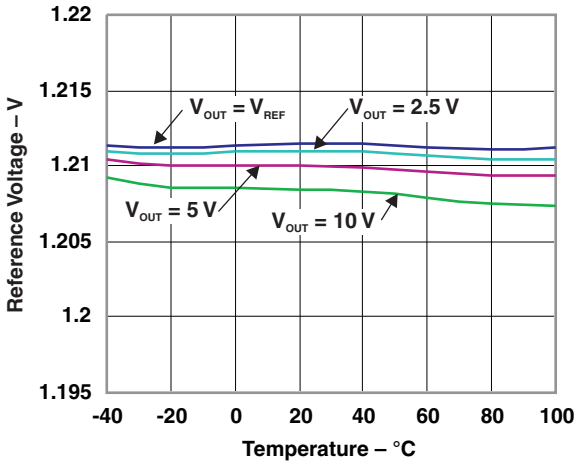


TYPICAL CHARACTERISTICS (continued)

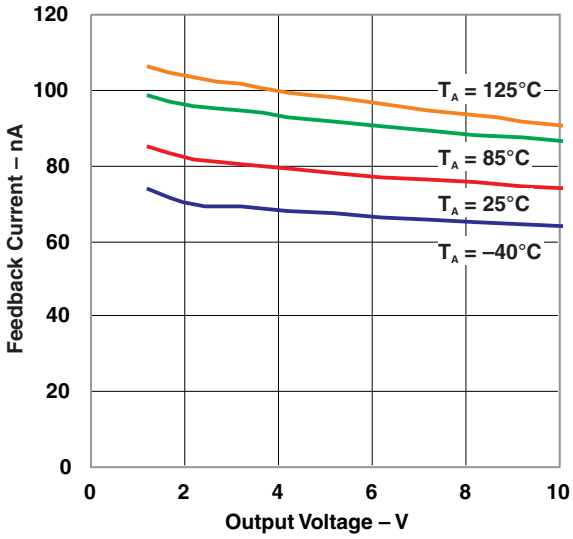
REFERENCE VOLTAGE
vs
OUTPUT VOLTAGE



REFERENCE VOLTAGE
vs
TEMPERATURE



FEEDBACK CURRENT
vs
OUTPUT VOLTAGE



APPLICATION INFORMATION

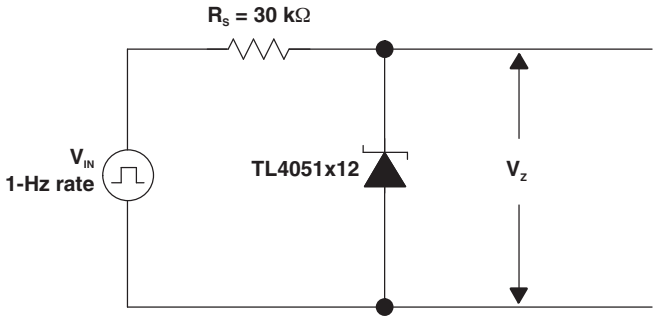


Figure 1. Start-Up Characteristics Test Circuit

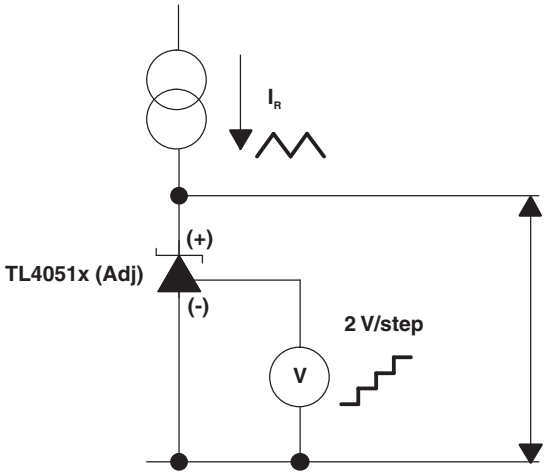


Figure 2. Reverse Characteristics Test Circuit

Output Capacitor

The TL4051 does not require an output capacitor across CATHODE and ANODE for stability. However, if an output bypass capacitor is desired, the TL4051 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.

APPLICATION INFORMATION (continued)

Adjustable Version

The adjustable version allows V_Z to be set by a user-defined resistor divider. The output voltage, V_Z, is set according to the equation shown in Figure 3.

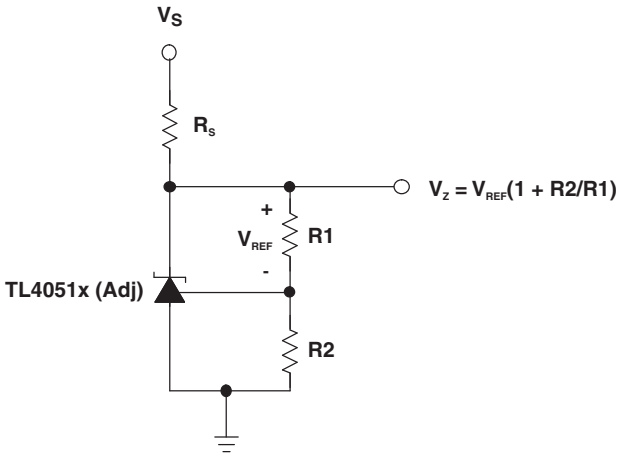


Figure 3. Adjustable Shunt Regulator

Cathode and Load Currents

In a typical shunt regulator configuration (see Figure 4), an external resistor, R_S, is connected between the supply and the cathode of the TL4051. R_S must be set properly, as it sets the total current available to supply the load (I_L) and bias the TL4051 (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 recommended rating of 12 mA.

R_S is calculated as shown in Equation 1.

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

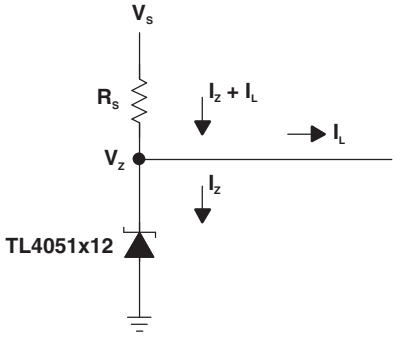


Figure 4. Shunt Regulator

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TL4051A12IDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TN8U	Samples
TL4051A12IDBZRG4	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TN8U	Samples
TL4051A12IDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TN8U	Samples
TL4051A12IDBZTG4	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TN8U	Samples
TL4051A12QDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	TNVU	Samples
TL4051A12QDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	TNVU	Samples
TL4051A12QDBZTG4	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	TNVU	Samples
TL4051A12QDCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	9GU	Samples
TL4051AIDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TN2U	Samples
TL4051AIDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TN2U	Samples
TL4051AIDBZTG4	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TN2U	Samples
TL4051AIDCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	97U	Samples
TL4051AQDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	TN5U	Samples
TL4051AQDCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	9AU	Samples
TL4051B12IDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	(TN93, TN9U)	Samples
TL4051B12IDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	(TN93, TN9U)	Samples
TL4051B12QDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	(TNW3, TNWU)	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TL4051B12QDCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	9HU	Samples
TL4051BIDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TN3U	Samples
TL4051BIDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TN3U	Samples
TL4051BIDCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	98U	Samples
TL4051BQDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	TN6U	Samples
TL4051BQDCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	9BU	Samples
TL4051C12IDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TNUU	Samples
TL4051C12IDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TNUU	Samples
TL4051C12IDCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	9FU	Samples
TL4051C12QDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	TNYU	Samples
TL4051C12QDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	TNYU	Samples
TL4051C12QDCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	9JU	Samples
TL4051CIDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TN4U	Samples
TL4051CIDBZT	ACTIVE	SOT-23	DBZ	3	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TN4U	Samples
TL4051CIDCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	99U	Samples
TL4051CQDBZR	ACTIVE	SOT-23	DBZ	3	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	TN7U	Samples
TL4051CQDCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	9CU	Samples

(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) RoHS: TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

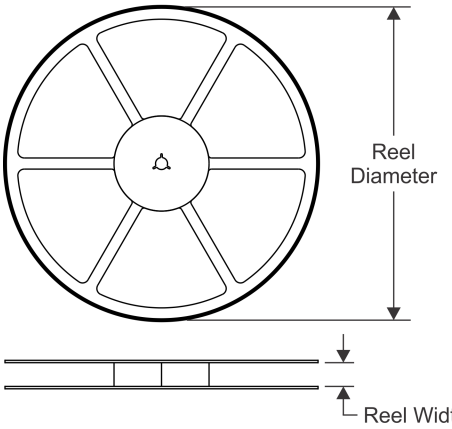
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

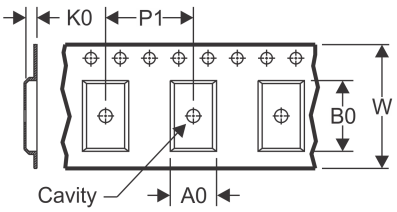
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

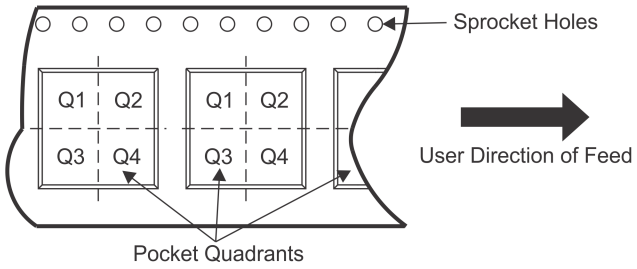


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

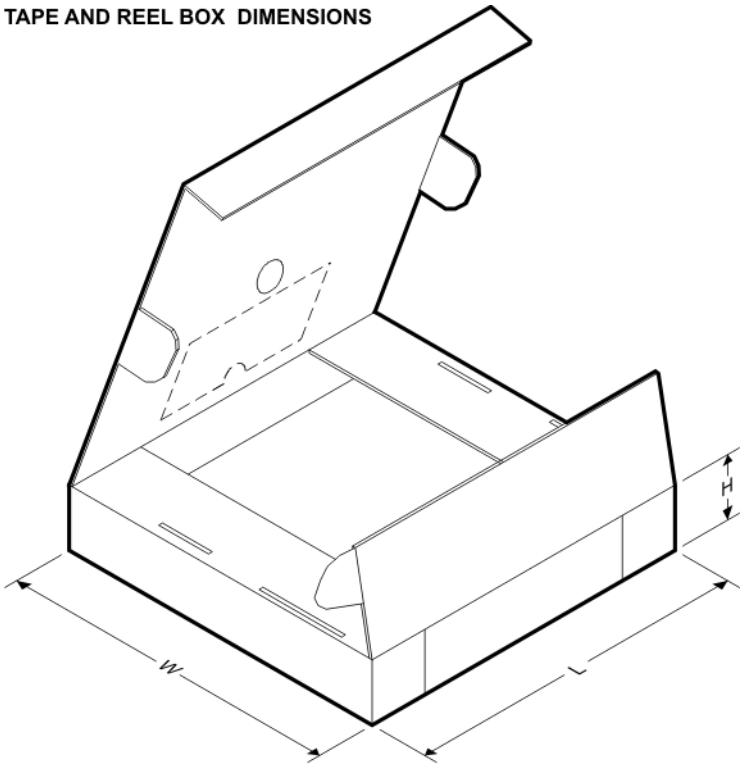


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TL4051A12IDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051A12IDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051A12QDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051A12QDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051A12QDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TL4051AIDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051AIDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051AIDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TL4051AQDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051AQDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TL4051B12IDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
TL4051B12IDBZT	SOT-23	DBZ	3	250	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
TL4051B12QDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051B12QDBZR	SOT-23	DBZ	3	3000	178.0	9.2	3.15	2.77	1.22	4.0	8.0	Q3
TL4051B12QDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TL4051BIDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051BIDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051BIDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TL4051BQDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051BQDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TL4051C12IDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051C12IDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051C12IDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TL4051C12QDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051C12QDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051C12QDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TL4051CIDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051CIDBZT	SOT-23	DBZ	3	250	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051CIDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TL4051CQDBZR	SOT-23	DBZ	3	3000	179.0	8.4	3.15	2.95	1.22	4.0	8.0	Q3
TL4051CQDCKR	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS

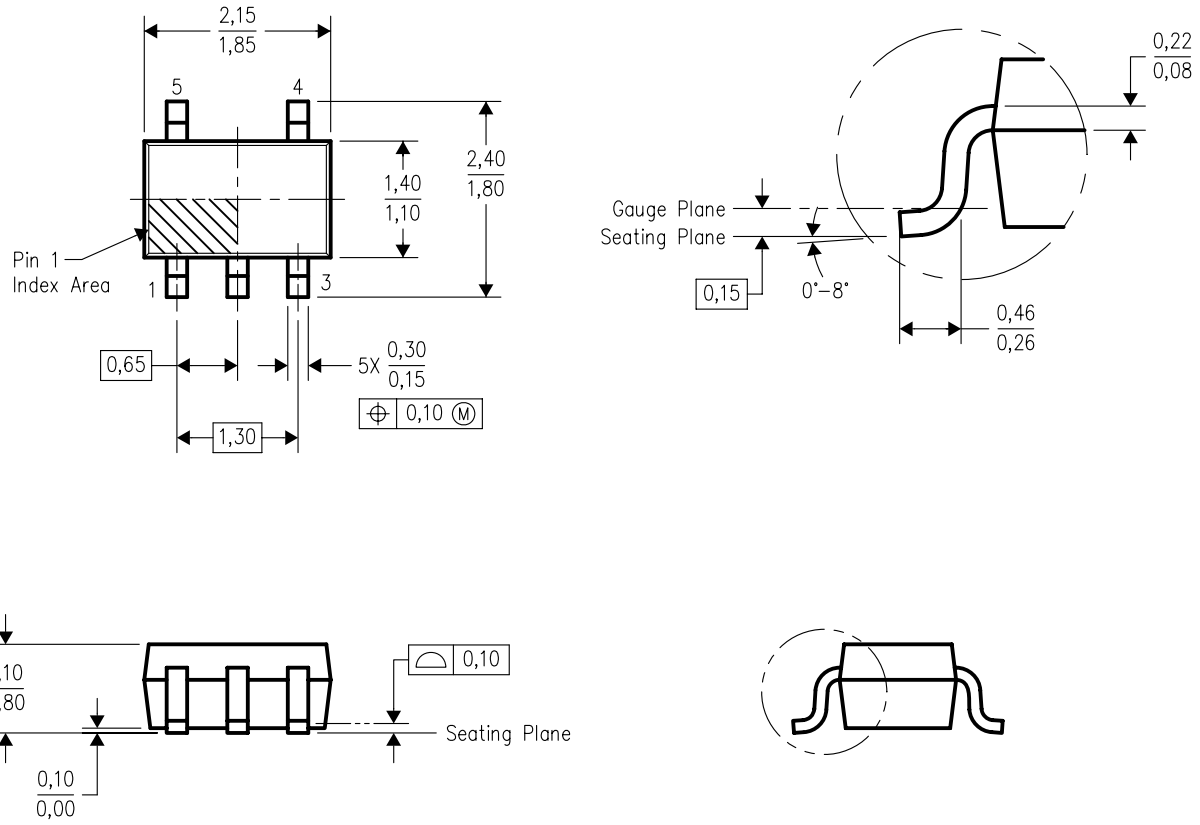


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL4051A12IDBZR	SOT-23	DBZ	3	3000	203.0	203.0	35.0
TL4051A12IDBZT	SOT-23	DBZ	3	250	203.0	203.0	35.0
TL4051A12QDBZR	SOT-23	DBZ	3	3000	203.0	203.0	35.0
TL4051A12QDBZT	SOT-23	DBZ	3	250	203.0	203.0	35.0

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL4051A12QDCKR	SC70	DCK	5	3000	203.0	203.0	35.0
TL4051AIDBZR	SOT-23	DBZ	3	3000	203.0	203.0	35.0
TL4051AIDBZT	SOT-23	DBZ	3	250	203.0	203.0	35.0
TL4051AIDCKR	SC70	DCK	5	3000	203.0	203.0	35.0
TL4051AQDBZR	SOT-23	DBZ	3	3000	203.0	203.0	35.0
TL4051AQDCKR	SC70	DCK	5	3000	203.0	203.0	35.0
TL4051B12IDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
TL4051B12IDBZT	SOT-23	DBZ	3	250	180.0	180.0	18.0
TL4051B12QDBZR	SOT-23	DBZ	3	3000	203.0	203.0	35.0
TL4051B12QDBZR	SOT-23	DBZ	3	3000	180.0	180.0	18.0
TL4051B12QDCKR	SC70	DCK	5	3000	203.0	203.0	35.0
TL4051BIDBZR	SOT-23	DBZ	3	3000	203.0	203.0	35.0
TL4051BIDBZT	SOT-23	DBZ	3	250	203.0	203.0	35.0
TL4051BIDCKR	SC70	DCK	5	3000	203.0	203.0	35.0
TL4051BQDBZR	SOT-23	DBZ	3	3000	203.0	203.0	35.0
TL4051BQDCKR	SC70	DCK	5	3000	203.0	203.0	35.0
TL4051C12IDBZR	SOT-23	DBZ	3	3000	203.0	203.0	35.0
TL4051C12IDBZT	SOT-23	DBZ	3	250	203.0	203.0	35.0
TL4051C12IDCKR	SC70	DCK	5	3000	203.0	203.0	35.0
TL4051C12QDBZR	SOT-23	DBZ	3	3000	203.0	203.0	35.0
TL4051C12QDBZT	SOT-23	DBZ	3	250	203.0	203.0	35.0
TL4051C12QDCKR	SC70	DCK	5	3000	203.0	203.0	35.0
TL4051CIDBZR	SOT-23	DBZ	3	3000	203.0	203.0	35.0
TL4051CIDBZT	SOT-23	DBZ	3	250	203.0	203.0	35.0
TL4051CIDCKR	SC70	DCK	5	3000	203.0	203.0	35.0
TL4051CQDBZR	SOT-23	DBZ	3	3000	203.0	203.0	35.0
TL4051CQDCKR	SC70	DCK	5	3000	203.0	203.0	35.0

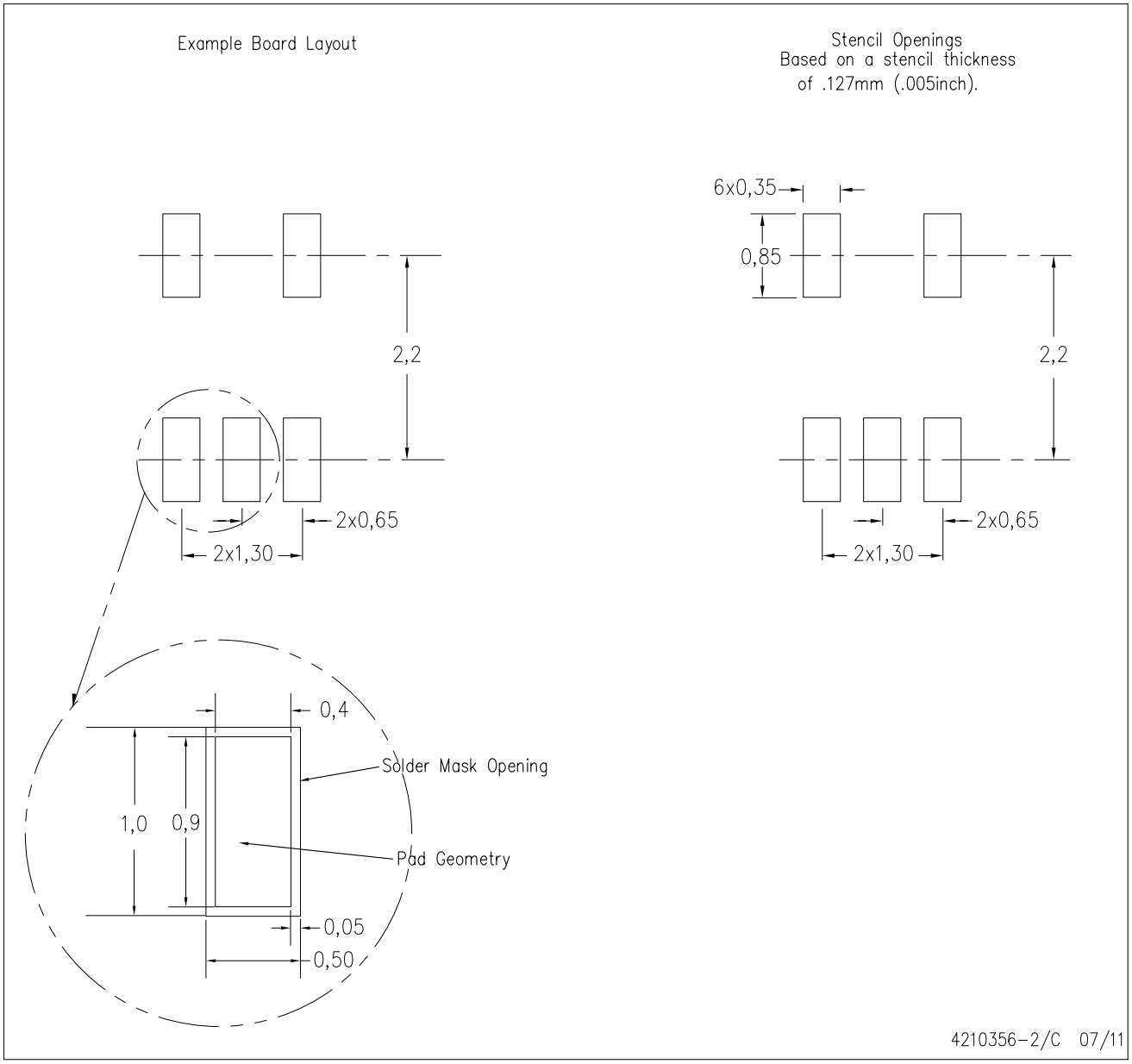
DCK (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE



4093553–3/G 01/2007

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO–203 variation AA.

DCK (R–PDSO–G5) PLASTIC SMALL OUTLINE

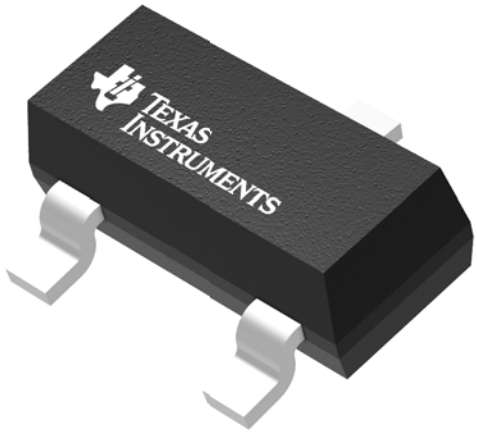


NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC–7351 is recommended for alternate designs.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC–7525 for other stencil recommendations.

GENERIC PACKAGE VIEW

DBZ 3 SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



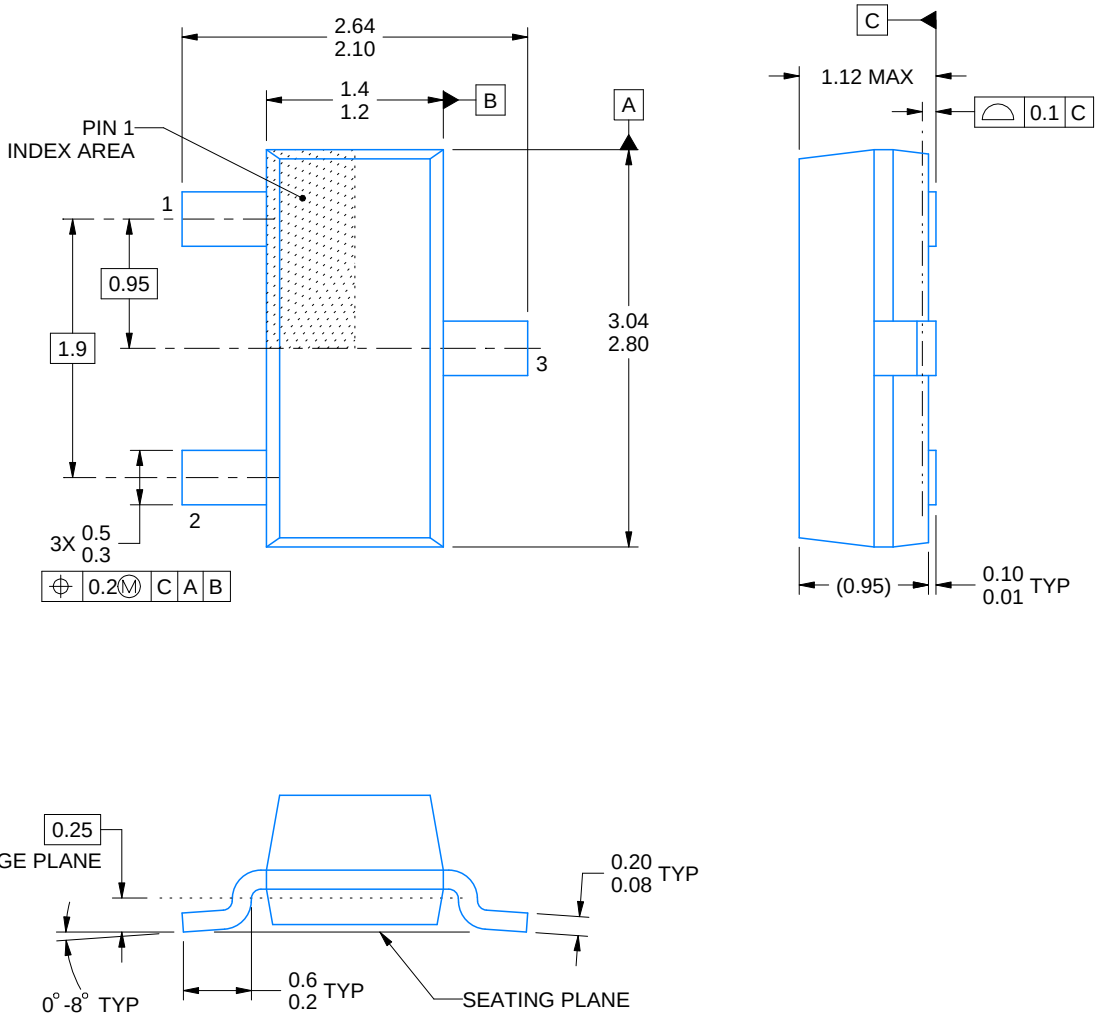
Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

PACKAGE OUTLINE

DBZ0003A

SOT-23 - 1.12 mm max height

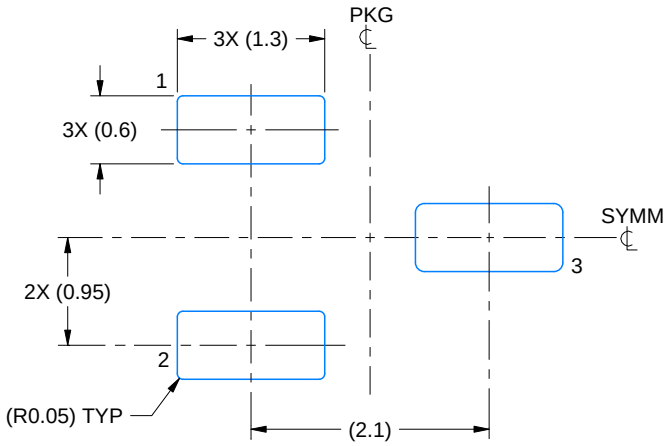
SMALL OUTLINE TRANSISTOR



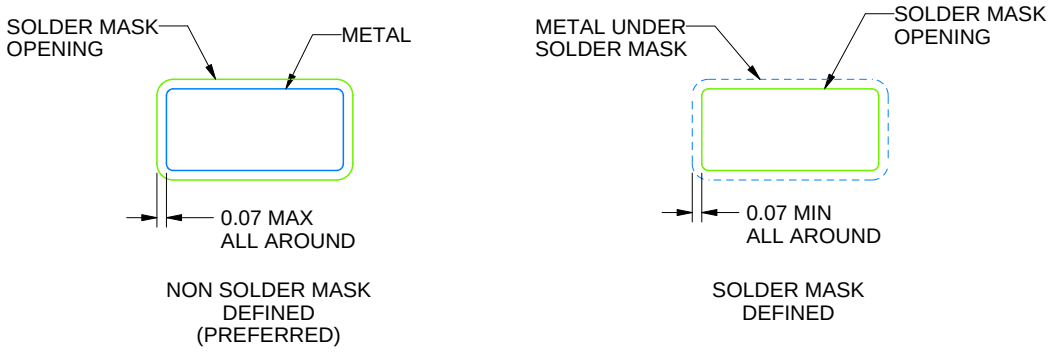
4214838/C 04/2017

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC registration TO-236, except minimum foot length.



LAND PATTERN EXAMPLE
SCALE:15X

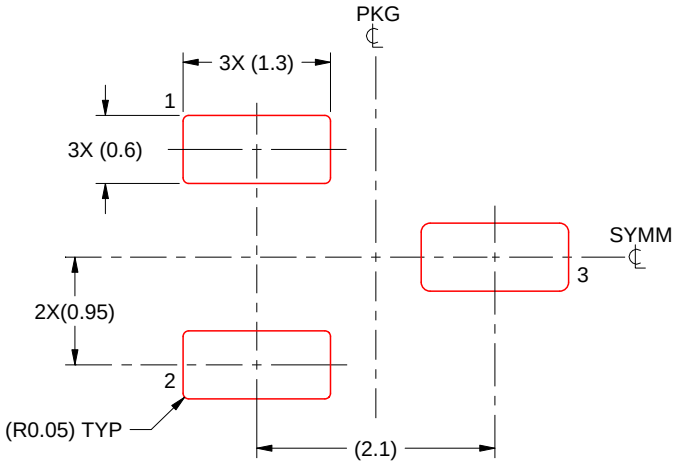


SOLDER MASK DETAILS

4214838/C 04/2017

NOTES: (continued)

4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE:15X

4214838/C 04/2017

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
7. Board assembly site may have different recommendations for stencil design.

IMPORTANT NOTICE

Texas Instruments Incorporated (TI) reserves the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

TI's published terms of sale for semiconductor products (http://www.ti.com/sc/docs/stdterms.htm) apply to the sale of packaged integrated circuit products that TI has qualified and released to market. Additional terms may apply to the use or sale of other types of TI products and services.

Reproduction of significant portions of TI information in TI data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such reproduced 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.

Buyers and others who are developing systems that incorporate TI products (collectively, "Designers") understand and agree that Designers remain responsible for using their independent analysis, evaluation and judgment in designing their applications and that Designers have full and exclusive responsibility to assure the safety of Designers' applications and compliance of their applications (and of all TI products used in or for Designers' applications) with all applicable regulations, laws and other applicable requirements. Designer represents that, with respect to their applications, Designer has all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. Designer agrees that prior to using or distributing any applications that include TI products, Designer will thoroughly test such applications and the functionality of such TI products as used in such applications.

TI's provision of technical, application or other design advice, quality characterization, reliability data or other services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using TI Resources in any way, Designer (individually or, if Designer is acting on behalf of a company, Designer's company) agrees to use any particular TI Resource solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

Designer is authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources 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.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS. TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY DESIGNER AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Unless TI has explicitly designated an individual product as meeting the requirements of a particular industry standard (e.g., ISO/TS 16949 and ISO 26262), TI is not responsible for any failure to meet such industry standard requirements.

Where TI specifically promotes products as facilitating functional safety or as compliant with industry functional safety standards, such products are intended to help enable customers to design and create their own applications that meet applicable functional safety standards and requirements. Using products in an application does not by itself establish any safety features in the application. Designers must ensure compliance with safety-related requirements and standards applicable to their applications. Designer may not use any TI products in life-critical medical equipment unless authorized officers of the parties have executed a special contract specifically governing such use. Life-critical medical equipment is medical equipment where failure of such equipment would cause serious bodily injury or death (e.g., life support, pacemakers, defibrillators, heart pumps, neurostimulators, and implantables). Such equipment includes, without limitation, all medical devices identified by the U.S. Food and Drug Administration as Class III devices and equivalent classifications outside the U.S.

TI may expressly designate certain products as completing a particular qualification (e.g., Q100, Military Grade, or Enhanced Product). Designers agree that it has the necessary expertise to select the product with the appropriate qualification designation for their applications and that proper product selection is at Designers' own risk. Designers are solely responsible for compliance with all legal and regulatory requirements in connection with such selection.

Designer will fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of Designer's non-compliance with the terms and provisions of this Notice.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265