

## 2.5V micropower shunt voltage reference

### Features

- 2.5V output voltage
- Ultra low current consumption: 40µA typ.
- High precision @ 25°C:  $\pm 2\%$  and  $\pm 1\%$
- High stability when used with capacitive loads
- Industrial temperature range: -40°C to +85°C
- 150ppm/°C maximum temperature coefficient

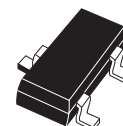
### Applications

- Computers
- Instrumentation
- Battery chargers
- Switch mode power supply
- Battery operated equipments

### Description

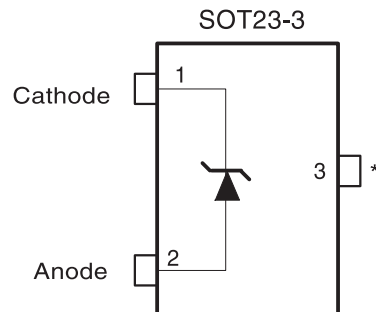
The TS4040 is a low power shunt voltage reference providing a stable 2.5V output voltage over the industrial temperature range (-40°C to +85°C). Available in SOT23-3 surface mount package, it can be designed in applications where space saving is critical.

The low operating current is a key advantage for power restricted designs. In addition, the TS4040 is very stable and can be used in a broad range of application conditions.



**L**  
**SOT23-3L**  
(Plastic micropackage)

### Pin connections (Top view)



\* This pin must be left floating or connected to pin 2

# 1 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings (AMR)**

Symbol	Parameter	Value	Unit
$I_k$	Reverse breakdown current	20	mA
$I_f$	Forward current	10	mA
$P_d$	Power dissipation <sup>(1)</sup> SOT23-3	360	mW
$T_{stg}$	Storage temperature	-65 to +150	°C
ESD	Human body model (HBM) <sup>(2)</sup>	2	kV
	Machine model (MM) <sup>(3)</sup>	200	V
$T_{lead}$	Lead temperature (soldering, 10 seconds)	260	°C

1.  $P_d$  is calculated with  $T_{amb} = 25^\circ\text{C}$ ,  $T_{junction} = 150^\circ\text{C}$  and  $R_{thja} = 340^\circ\text{C/W}$  for the SOT23-3 package.
2. Human body model: 100pF discharged through a 1.5k $\Omega$  resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
3. Machine model: a 200pF cap is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 $\Omega$ ), done for all couples of pin combinations with other pins floating.

**Table 2. Operating conditions**

Symbol	Parameter	Value	Unit
$I_{k-min}$	Minimum operating current	65	$\mu\text{A}$
$I_{k-max}$	Maximum operating current	15	mA
$T_{oper}$	Operating free air temperature range	-40 to +85	°C

## 2 Electrical characteristics

**Table 3. TS4040E (2% precision)  $T_{amb} = 25^{\circ}\text{C}$  <sup>(1)</sup> (unless otherwise specified)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_k$	Reverse breakdown voltage	$I_k = 100\mu\text{A}$	2.45	2.5	2.55	V
	Reverse breakdown voltage tolerance	$I_k = 100\mu\text{A}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$	-50 -74		50 74	mV
$I_{k-min}$	Minimum operating current	$T = 25^{\circ}\text{C}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		40	65 70	$\mu\text{A}$
$\Delta V_{ref}/\Delta T$	Average temperature coefficient	$I_k = 100\mu\text{A}$		30	150	ppm/ $^{\circ}\text{C}$
$\Delta V_k/\Delta I_k$	Reverse breakdown voltage change with operating current range	$I_{k-min} < I_k < 1\text{mA}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		0.4	1 1.2	mV
		$1\text{mA} < I_k < 15\text{mA}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		2.5	8 10	
$R_{ka}$	Reverse static impedance	$I_k = I_{k-min}$ to $1\text{mA}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		0.4	1 1.2	$\Omega$
		$I_k = 1$ to $15\text{mA}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		0.2	0.6 0.7	
$K_{vh}$	Long term stability	$I_k = 100\mu\text{A}$ , $t = 1000\text{hrs}$		120		ppm
$E_n$	Wide band noise	$I_k = 100\mu\text{A}$ $10\text{Hz} < f < 10\text{kHz}$		35		nV/ $\sqrt{\text{Hz}}$

1. Limits are 100% production tested at  $25^{\circ}\text{C}$ . Behavior at the temperature range limits is guaranteed through correlation and by design.

**Table 4. TS4040D (1% precision)  $T_{amb} = 25^{\circ}\text{C}$  <sup>(1)</sup> (unless otherwise specified)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_k$	Reverse breakdown voltage	$I_k = 100\mu\text{A}$	2.475	2.5	2.525	V
	Reverse breakdown voltage tolerance	$I_k = 100\mu\text{A}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$	-25 -49		25 49	mV
$I_{k-min}$	Minimum operating current	$T = 25^{\circ}\text{C}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		40	65 70	$\mu\text{A}$
$\Delta V_{ref}/\Delta T$	Average temperature coefficient	$I_k = 100\mu\text{A}$		30	150	ppm/ $^{\circ}\text{C}$
$\Delta V_k/\Delta I_k$	Reverse breakdown voltage change with operating current range	$I_{k-min} < I_k < 1\text{mA}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		0.4	1 1.2	mV
		$1\text{mA} < I_k < 15\text{mA}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		2.5	8 10	
$R_{ka}$	Reverse static impedance	$I_k = I_{k-min}$ to $1\text{mA}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		0.4	1 1.2	$\Omega$
		$I_k = 1\text{mA}$ to $15\text{mA}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		0.2	0.6 0.7	
$K_{vh}$	Long term stability	$I_k = 100\mu\text{A}$ , $t = 1000\text{hrs}$		120		ppm
$E_n$	Wide band noise	$I_k = 100\mu\text{A}$ $10\text{Hz} < f < 10\text{kHz}$		35		nV/ $\sqrt{\text{Hz}}$

1. Limits are 100% production tested at  $25^{\circ}\text{C}$ . Behavior at the temperature range limits is guaranteed through correlation and by design.

Figure 1. Reference voltage versus cathode current

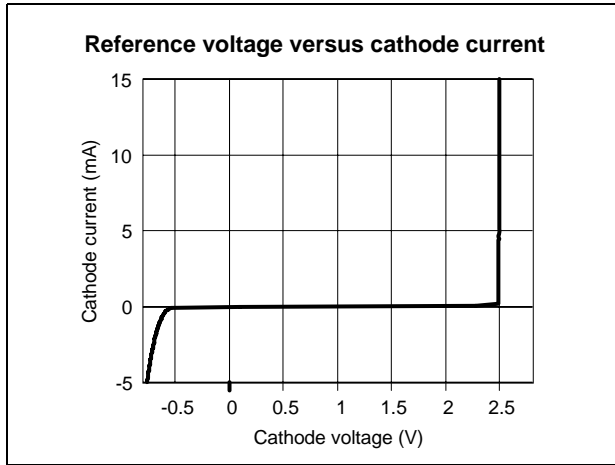


Figure 2. Minimum operating current

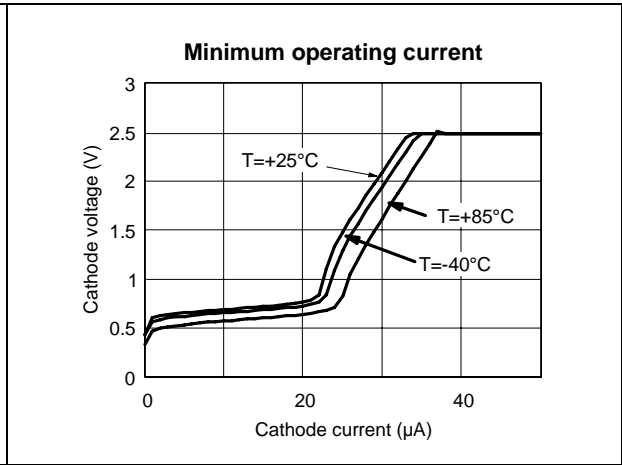


Figure 3. Test circuit

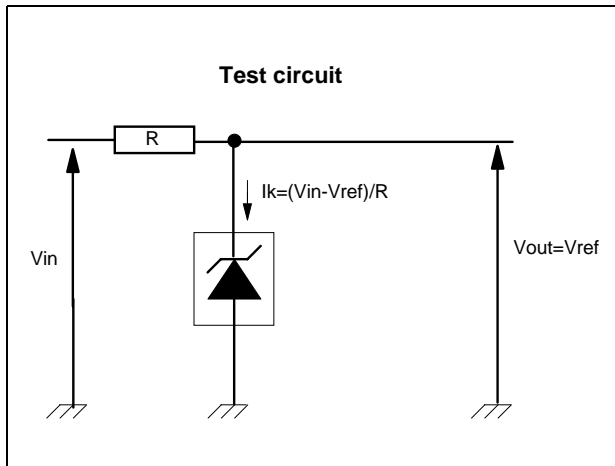


Figure 4. Reference voltage versus temperature

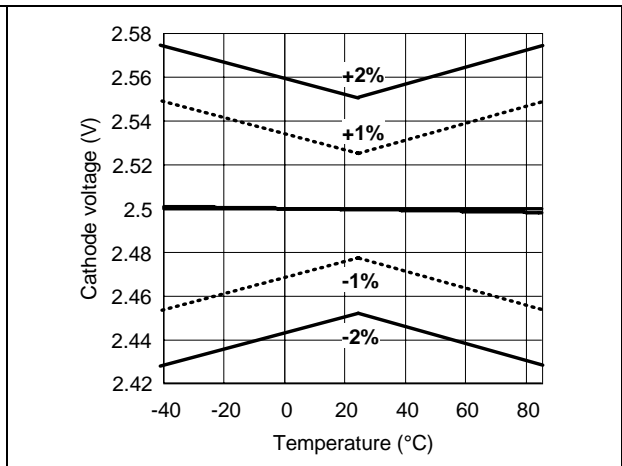


Figure 5. Static impedance  $R_{ka}$  versus temperature

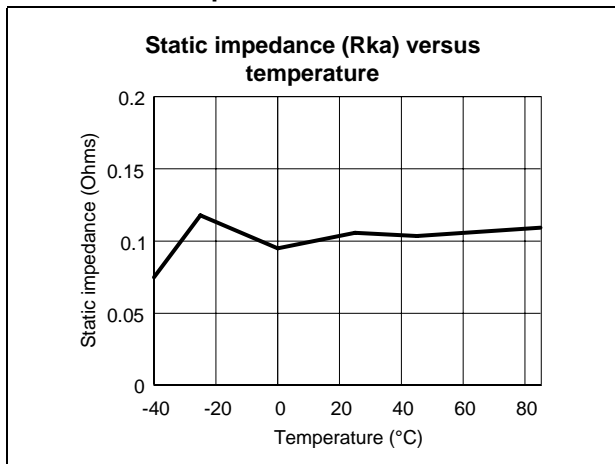


Figure 6. Noise voltage versus frequency

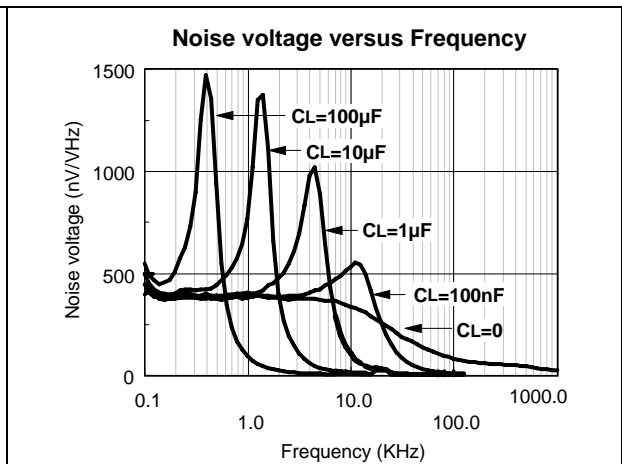


Figure 7. Test circuit for pulse response at  $I_k=100\mu A$

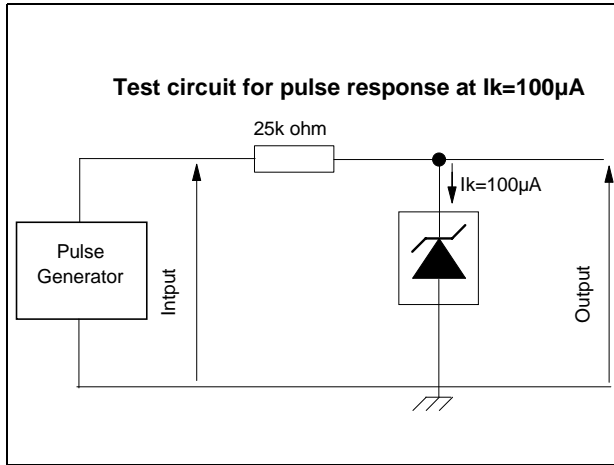


Figure 8. Pulse response for  $I_k=100\mu A$

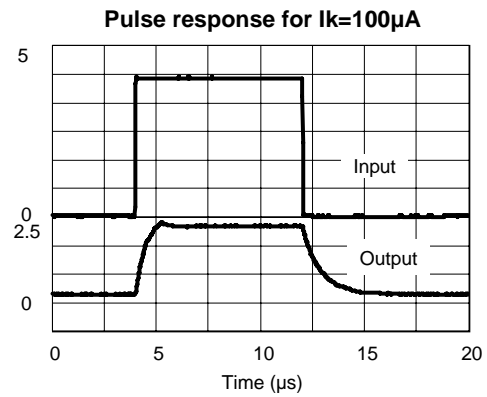


Figure 9. Test circuit for pulse response at  $I_k=100\mu A$  (detailed part)



Figure 10. Test circuit for pulse response at  $I_k=100\mu A$  (detailed part)

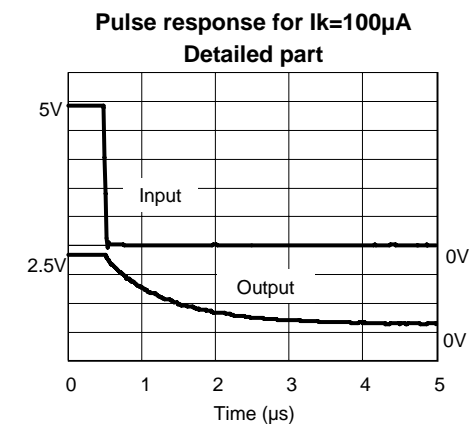


Figure 11. Test circuit for pulse response at  $I_k=1mA$

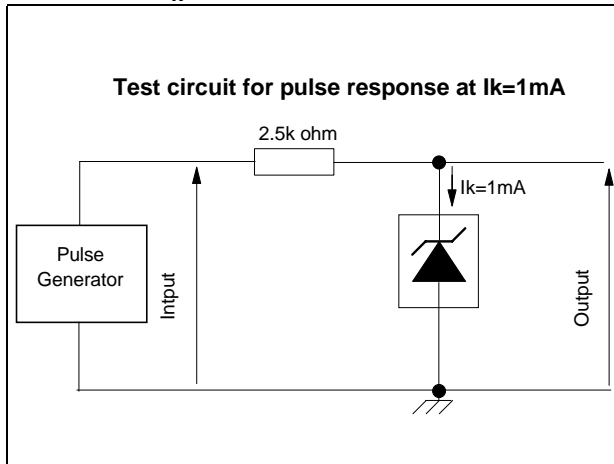


Figure 12. Pulse response at  $I_k=1mA$

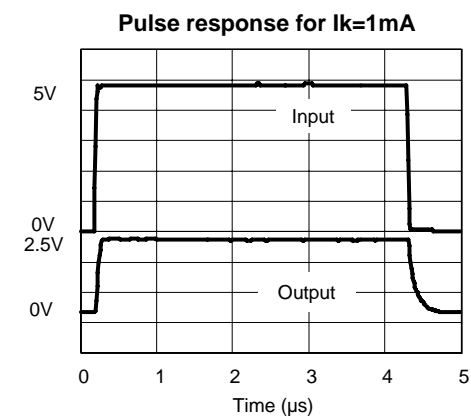


Figure 13. Test circuit for pulse response at  $I_k=1\text{mA}$  (detailed part)

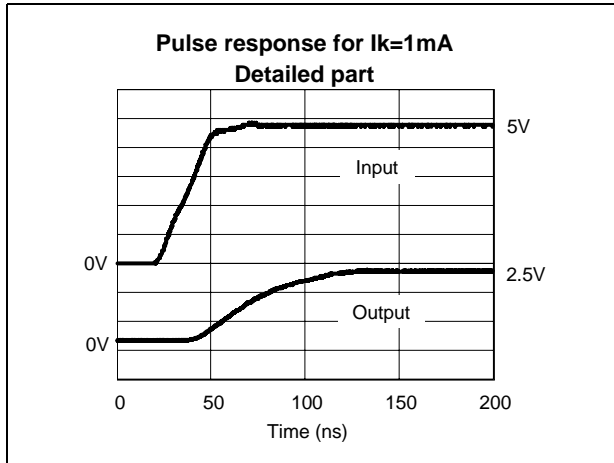
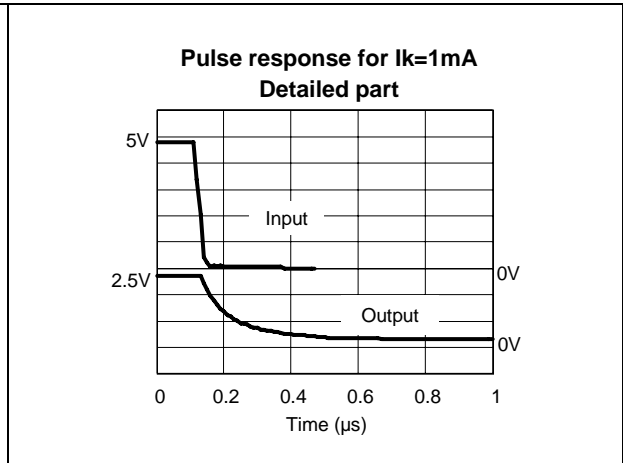


Figure 14. Test circuit for pulse response at  $I_k=1\text{mA}$  (detailed part)



### 3 Package information

In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK<sup>®</sup> packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

Figure 15. SOT23-3 package mechanical data

Ref.	Dimensions					
	Millimeters			Mils		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.890		1.120	35.05		44.12
A1	0.010		0.100	0.39		3.94
A2	0.880	0.950	1.020	34.65	37.41	40.17
b	0.300		0.500	11.81		19.69
C	0.080		0.200	3.15		7.88
D	2.800	2.900	3.040	110.26	114.17	119.72
E	2.100		2.64	82.70		103.96
E1	1.200	1.300	1.400	47.26	51.19	55.13
e		0.950			37.41	
e1		1.900			74.82	
L	0.400		0.600	15.75		23.63
L1		0.540			21.27	
k	0°		8°	0°		8°



## 4 Ordering information

**Table 5. Order codes**

Part number	Precision	Temperature range	Package	Packing	Marking
TS4040EILT-2.5	2%	-40°C to +85°C	SOT23-3	Tape & reel	L243
TS4040DILT-2.5	1%				L242

## 5 Revision history

**Table 6. Document revision history**

Date	Revision	Changes
14-Mar-2002	1	Initial release.
20-Aug-2007	2	Removed TO-92 package information. Format update.



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