



# TS824-2.5

## HIGH THERMAL STABILITY MICROPOWER SHUNT VOLTAGE REFERENCE

- LOW Tc: 50 ppm/°C MAXIMUM
- 2.5V OUTPUT VOLTAGE
- LOW OPERATING CURRENT: 60µA max @ 25°C
- HIGH PRECISION AT 25°C: ±0.5% AND ±1%
- STABLE WHEN USED WITH CAPACITIVE LOADS
- INDUSTRIAL TEMPERATURE RANGE: -40 to +85°C

### DESCRIPTION

The TS824-2.5 is a low power shunt voltage reference featuring a very low temperature coefficient of 50ppm/°C as a maximum value. Providing a 2.5V output voltage, the TS824-2.5 operates over the industrial temperature range (-40 to +85°C). Ideal for battery-powered equipments where power conservation is critical, the TS824 is housed in a tiny SOT23-3 package allowing space saving.

The TS824 is typically stable with any capacitive loads within the entire temperature range. The product is thus easy to use and the design simplified.

### APPLICATION

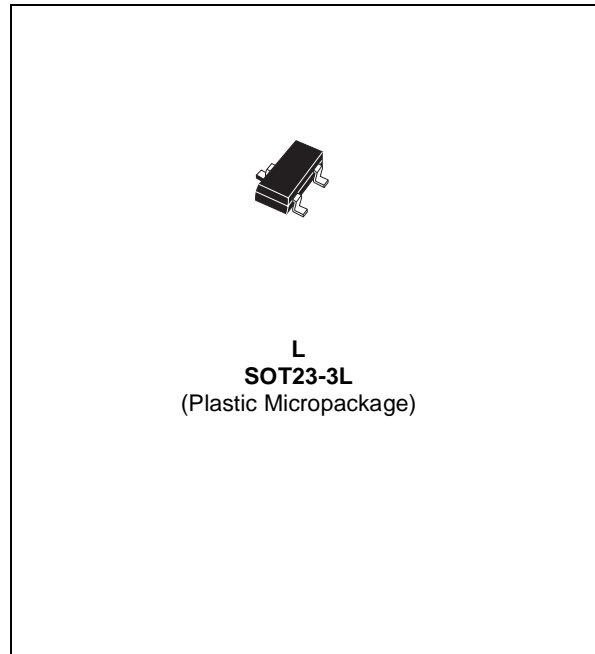
- Instrumentation,
- Data acquisition systems,
- Portable, Battery powered equipments
- Power management

### ORDER CODE

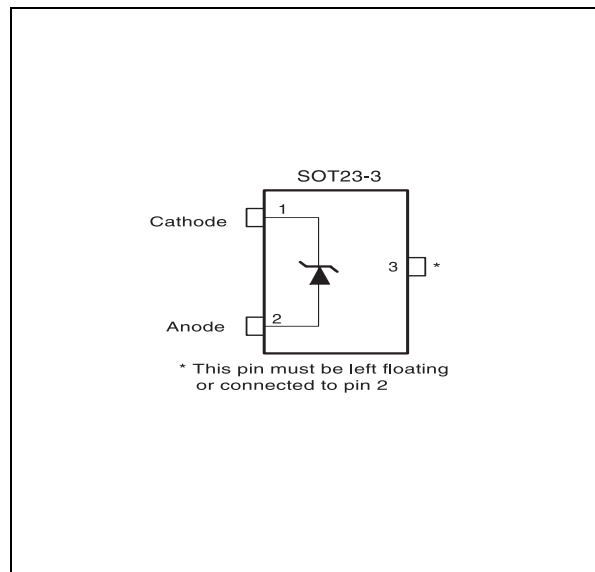
Voltage	Precision	SOT23-3	SOT23 Marking
2.5V	±1%	TS824ILT-2.5	L252
	±0.5%	TS824AILT-2.5	L253

Single temperature range: -40 to +85°C

LT = Tiny Package (SOT23-3) - only available in Tape & Reel (LT)



### PIN CONNECTIONS (top view)



**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
$I_K$	Reverse Breakdown Current	20	mA
$I_F$	Forward Current	10	mA
$P_D$	Power Dissipation (note1) SOT23-3	360	mW
$T_{Std}$	Storage Temperature	-65 to +150	°C
ESD	Human Body Model (HBM) (note2)	2	kV
	Machine Model (MM) (note 2)	200	V
$T_{Lead}$	Lead Temperature (soldering, 10 seconds)	260	°C

**Note 1:** The maximum power dissipation must be derated at high temperature. It can be calculated using  $T_{JMAX}$  (maximum junction temperature),  $R_{THJA}$  (Thermal resistance junction to ambient) and  $T_A$  (Ambient temperature). The maximum power dissipation formula at any temperature is  $P_{DMAX} = (T_{JMAX} - T_A) / R_{THJA}$ .  $R_{THJA}$  is 340°C/W for the SOT23-3 package.

**Note 2:** The Human Body Model (HBM) is defined as a 100pF capacitor discharge through a 1.5kΩ resistor into each pin.  
The Machine Mode (MM) is defined as a 200pF capacitor discharge directly into each pins.

**OPERATING CONDITIONS**

Symbol	Parameter	Value	Unit
$I_{min}$	Minimum Operating Current	60	μA
$I_{max}$	Maximum Operating Current	15	mA
$T_{oper}$	Operating Free Air Temperature Range	-40 to +85	°C

**ELECTRICAL CHARACTERISTICS (note 3)**

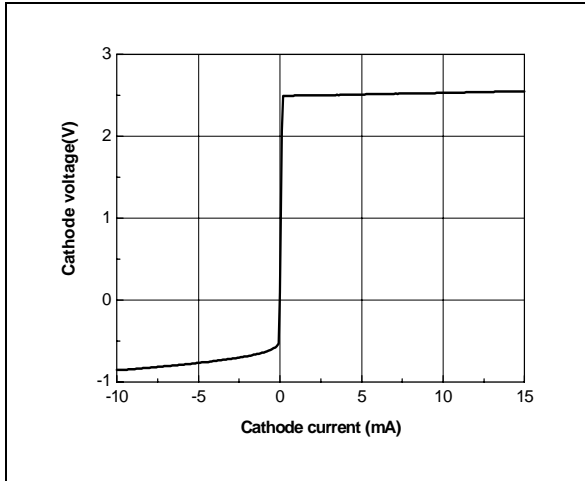
$T_{amb} = 25^\circ\text{C}$  (unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$V_K$	Reverse Breakdown Voltage	$I_K = 100\mu\text{A}, \pm 0.5\%$	2.4875	2.500	2.5125	V
		$I_K = 100\mu\text{A}, \pm 1\%$	2.475	2.500	2.525	
$V_K$	Reverse Breakdown Voltage Tolerance	$I_K = 100\mu\text{A}, \pm 0.5\%$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$	-12.5 -20		+12.5 +20	mV
		$I_K = 100\mu\text{A}, \pm 1\%$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$	-25 -33		+25 +33	
$I_{KMIN}$	Minimum Operating Current	$T_{amb} = 25^\circ\text{C}$		50	60	μA
		$-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$			65	
$\Delta V_K / \Delta T$	Average Temperature Coefficient (note 5)	$I_K = 100\mu\text{A}$			50	ppm/°C
$\Delta V_K / \Delta I_K$	Reverse Breakdown Voltage Change with Operating Current Range	$I_{KMIN} < I_K < 1\text{mA}$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$		0.4	1 1.2	mV
		$1\text{mA} < I_K < 15\text{mA}$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$		4.5	8 10	
$R_{KA}$	Static Impedance	$\Delta I_K = I_{KMIN}$ to 1mA $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$		0.4	1 1.2	Ω
		$\Delta I_K = 1\text{mA}$ to 15mA $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$		0.3	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	$I_K = 100\mu\text{A}$ $100\text{Hz} < f < 10\text{kHz}$		350		nV/√Hz

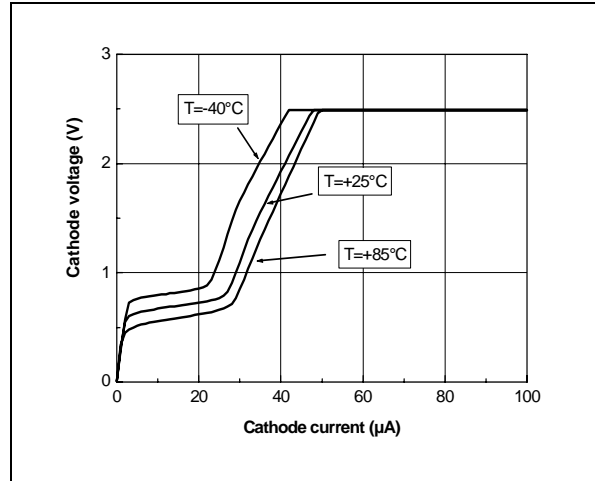
**Note 3:** Limits are 100% production tested at 25°C. Limits over temperature are guaranteed through correlation and by design.

**Note 4:** The total tolerance within the industrial range, where the maximum ΔT versus 25°C is 65°C, is explained hereafter:  
 $\pm 1\% + (\pm 50 \text{ ppm}/^\circ\text{C} \times 65^\circ\text{C}) = \pm 1.325\%$

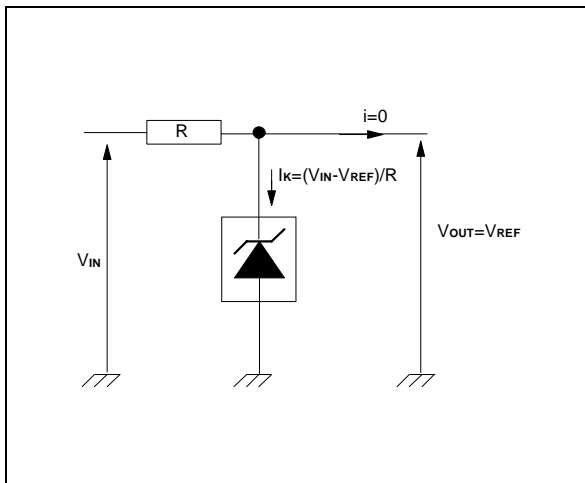
Reference voltage versus cathode current



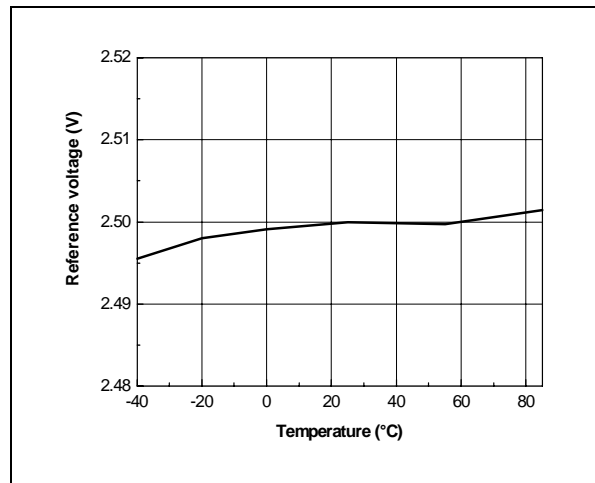
Reference voltage versus cathode current



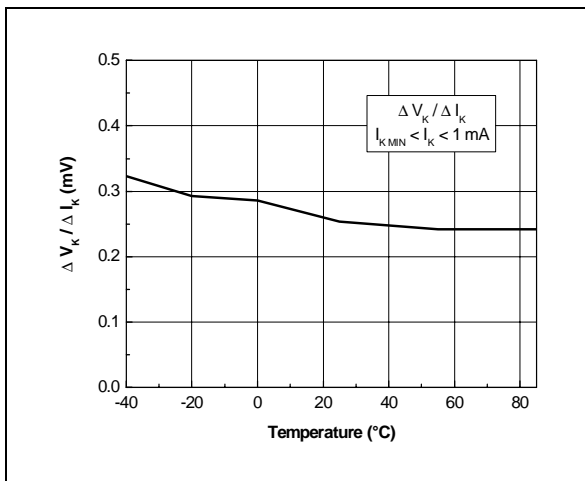
Test circuit



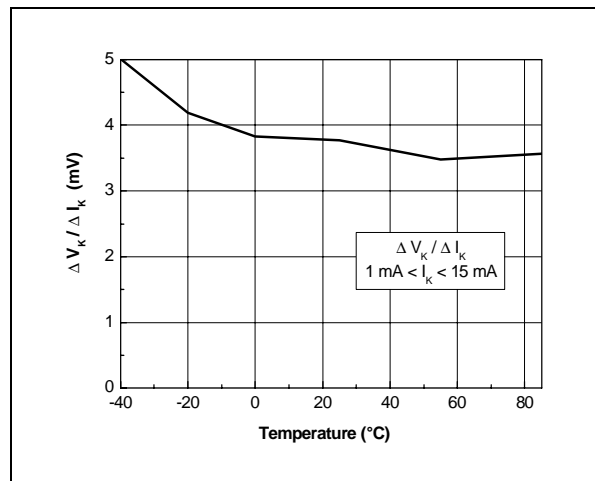
Reference voltage versus Temperature



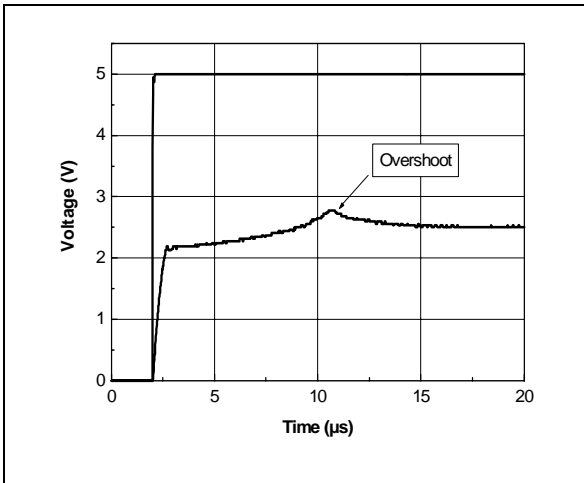
$\Delta V_K / \Delta I_K$  for  $I_K < 1 \text{ mA}$  versus temperature



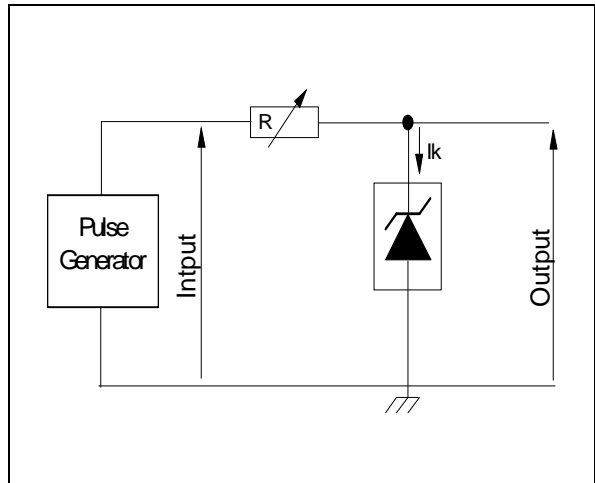
$\Delta V_K / \Delta I_K$  for  $I_K > 1 \text{ mA}$  versus temperature



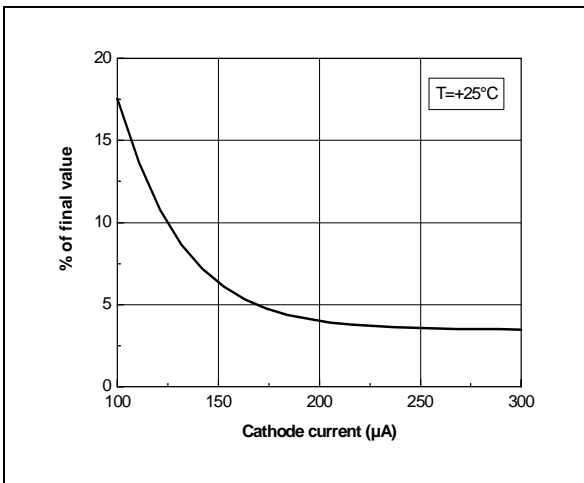
Start-up response with low cathode current



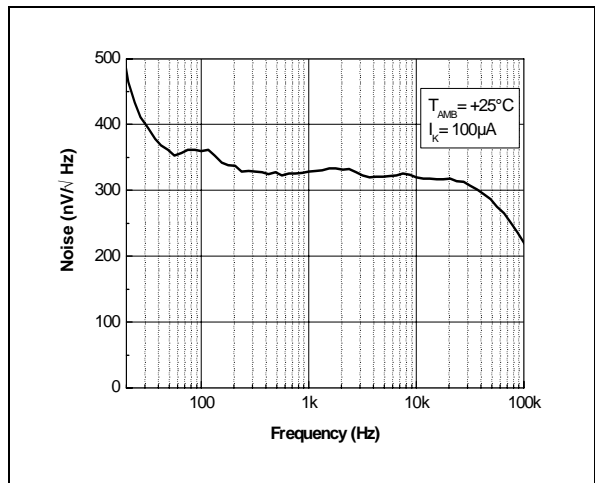
Start-up schematic with low cathode current



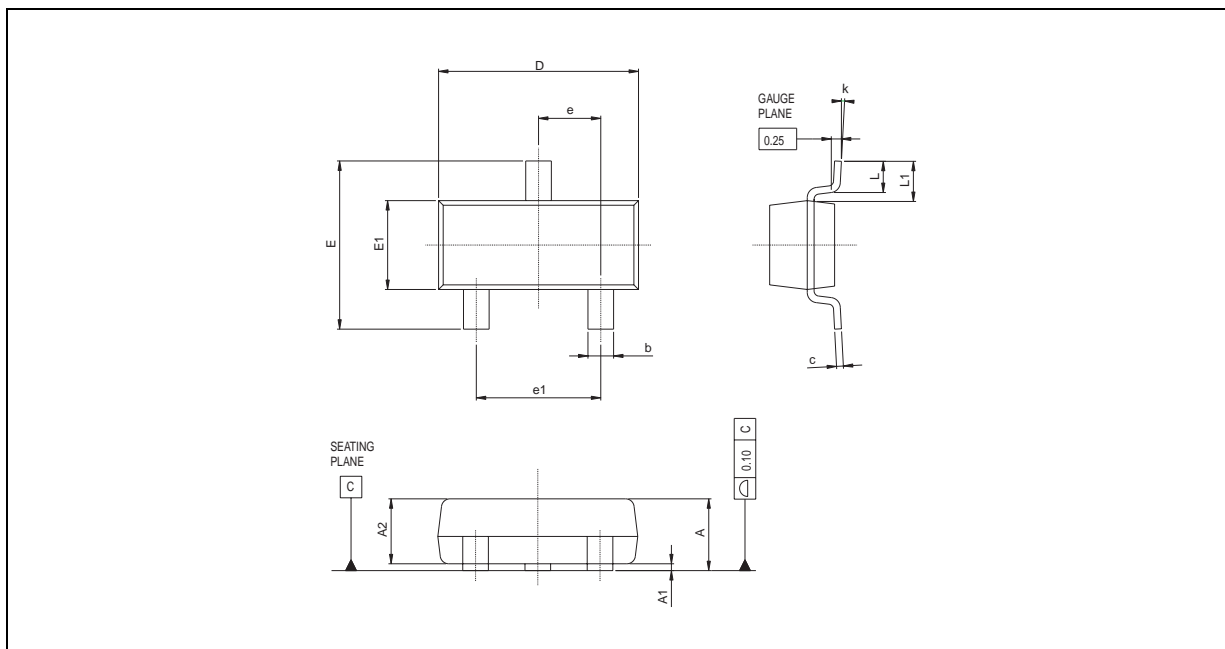
Overshoot versus cathode current



Noise versus frequency



**PACKAGE MECHANICAL DATA**  
3 PINS - TINY PACKAGE (SOT23-3)



Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.890		1.120	0.035		0.044
A1	0.010		0.100	0.0004		0.004
A2	0.880	0.950	1.020		0.037	0.040
b	0.300		0.500	0.012		0.020
c	0.080		0.200	0.003		0.008
D	2.800	2.900	3.040	0.110	0.114	0.120
E	2.100		2.640	0.083		0.104
E1	1.200	1.300	1.400	0.047	0.051	0.055
e		0.950			0.037	
e1		1.900			0.075	
L	0.400	0.500	0.600	0.016	0.020	0.024
L1		0.540			0.021	
k	0°		8°			

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