Description

The LM4040 is a family of bandgap circuits designed to achieve precision micro-power voltage references of 2.5V, 3.0V and 5.0V. The devices are available in 0.2% B-grade, 0.5% C-grade and 1% D-grade initial tolerances.

They are available in small outline SOT23 surface mount packages which are ideal for applications where space is at a premium.

Excellent performance is maintained over the 60µA to 15mA operating current range with a typical temperature coefficient of only 20ppm/°C. The device has been designed to be highly tolerant of capacitive loads so maintaining excellent stability.

This device offers a pin for pin compatible alternative to the LM4040 voltage reference.

Features

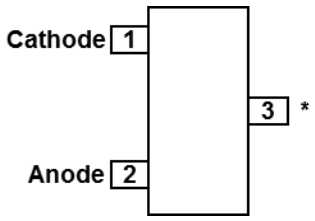
- Small Package: SOT23
  - SC70-5 Variants Are End of Life (EOL)
- No Output Capacitor Required
- Output Voltage Tolerance
  - LM4040B ±0.2% at +25°C
  - LM4040C ±0.5% at +25°C
  - LM4040D ±1% at +25°C
- Low Output Noise
- (10Hz to 10kHz) ..... 45µV_{RMS}
- Wide Operating Current Range 60µA to 15mA
- Extended Temperature Range -40°C to +125°C
- Low Temperature Coefficient 100 ppm/°C (max)
- Green Molding in Small Package SOT23
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **An Automotive-Compliant Part is Available Under Separate Datasheet (LM4040Q)**

Applications

- Battery Powered Equipment
- Precision Power Supplies
- Portable Instrumentation
- Portable Communications Devices
- Notebook and Palmtop Computers
- Data Acquisition Systems

Pin Assignments

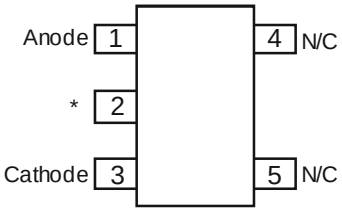
(Top View)



* Pin 3 must be left floating or connected to pin 2

SOT23

(Top View)



SC70-5**

* Pin 2 must be left floating or connected to pin 1.

** SC70-5 variants are End of Life (EOL).

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Absolute Maximum Ratings (Voltages to Anode Unless Otherwise Stated)

Parameter	Rating	Unit
Continuous Reverse Current	20	mA
Continuous Forward Current	10	mA
Operating Junction Temperature	-40 to +150	°C
Storage Temperature	-55 to +150	°C

Caution: Stresses greater than the 'Absolute Maximum Ratings' specified above, may cause permanent damage to the device. These are stress ratings only; functional operation of the device at conditions between maximum recommended operating conditions and absolute maximum ratings is not implied. Device reliability may be affected by exposure to absolute maximum rating conditions for extended periods of time.

(Semiconductor devices are ESD sensitive and may be damaged by exposure to ESD events. Suitable ESD precautions should be taken when handling and transporting these devices.)

Unless otherwise stated voltages specified are relative to the Anode pin.

Package Thermal Data

Package	θ_{JA}	P_{DIS} T_A = +25°C, T_J = +125°C
SOT23	380°C/W	330mW

Recommended Operating Conditions

Parameter	Min	Max	Unit
Reverse Current	0.06	15	mA
Operating Ambient Temperature Range	-40	+125	°C

Electrical Characteristics (Test conditions: T_A = +25°C, unless otherwise specified.)

LM4040-2.5

Symbol	Parameter	Conditions		Typ	LM4040 B Limits	LM4040 C Limits	LM4040 D Limits	Unit
		—	T_A					
V_{REF}	Reverse Breakdown Voltage	I_R = 100µA	+25°C	2.5	—	—	—	V
	Reverse Breakdown Voltage Tolerance	I_R = 100µA	+25°C	—	±5	±12	±25	mV
			-40 to +85°C		±21	±29	±49	
			-40 to +125°C		±30	±38	±63	
I_{RMIN}	Minimum Operating Current	—	+25°C	45	60	60	65	µA
			-40 to +85°C	—	65	65	70	
			-40 to +125°C		68	68	73	
$\Delta V_R/\Delta T$	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 10mA	-40 to +125°C	±20	—	—	—	ppm/°C
		I_R = 1mA		±15	±100	±100	±150	
		I_R = 100µA		±15	—	—	—	
$\Delta V_R/\Delta I_R$	Reverse Breakdown Change with Current	$I_{RMIN} \le I_R \le$ 1mA	+25°C	—	0.3	0.8	0.8	1.0	mV
			-40 to +85°C		1.0	1.0	1.2	
			-40 to +125°C		1.0	1.0	1.2	
		1mA ≤ I_R ≤ 15mA	+25°C	2.5	6.0	6.0	8.0	
			-40 to +85°C	—	8.0	8.0	10.0	
			-40 to +125°C		8.0	8.0	10.0	
Z_R	Dynamic Output Impedance	I_R = 1mA, f = 120Hz $I_{AC} = 0.1I_R$		0.3	0.8	0.9	1.1	Ω
e_n	Noise Voltage	I_R = 100µA 10Hz < f < 10kHz		35	—	—	—	μV_{RMS}
V_R	Long Term Stability (Non Cumulative)	t = 1000Hrs, I_R = 100µA		120	—	—	—	ppm
V_{HYST}	Thermal Hysteresis	ΔT = -40°C to +125°C		0.08	—	—	—	%

Electrical Characteristics (Cont.) (Test conditions: T_A = +25°C, unless otherwise specified.)

LM4040-3.0

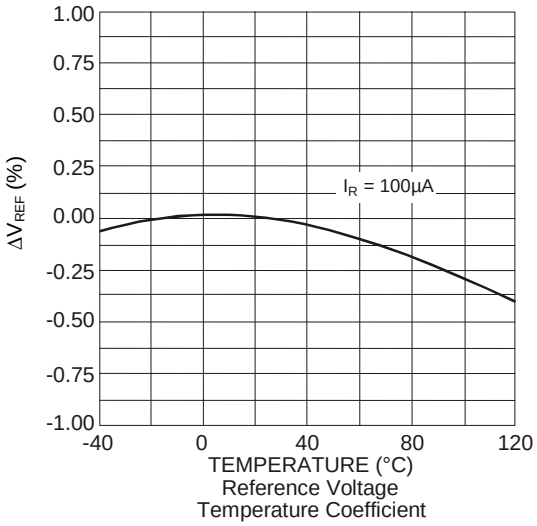
Symbol	Parameter	Conditions		Typ	LM4040 B Limits	LM4040 C Limits	LM4040 D Limits	Unit
		—	T_A					
V_{REF}	Reverse Breakdown Voltage	I_R = 100µA	+25°C	3.0	—	—	—	V
	Reverse Breakdown Voltage Tolerance	I_R = 100µA	+25°C	—	±6	±15	±30	mV
			-40 to +85°C		±26	±34	±59	
			-40 to +125°C		TBD	±45	±75	
I_{RMIN}	Minimum Operating Current	—	+25°C	47	62	62	67	µA
			-40 to +85°C	—	67	67	72	
			-40 to +125°C		70	70	75	
$\Delta V_R/\Delta T$	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 10mA	-40 to +125°C	±20	—	—	—	ppm/°C
		I_R = 1mA		±15	±100	±100	±150	
		I_R = 100µA		±15	—	—	—	
$\Delta V_R/\Delta I_R$	Reverse Breakdown Change with Current	$I_{RMIN} \le I_R \le$ 1mA	+25°C	0.4	0.8	0.8	1.0	mV
			-40 to +85°C	—	1.1	1.1	1.3	
			-40 to +125°C		1.1	1.1	1.3	
		1mA $\le I_R \le$ 15mA	+25°C	2.7	6.0	6.0	8.0	
			-40 to +85°C	—	9.0	9.0	11.0	
			-40 to +125°C		9.0	9.0	11.0	
Z_R	Dynamic Output Impedance	I_R = 1mA, f = 120Hz $I_{AC} = 0.1I_R$		0.4	0.9	0.9	1.2	Ω
e_n	Noise Voltage	I_R = 100µA 10Hz < f < 10kHz		35	—	—	—	μV_{RMS}
V_R	Long Term Stability (Non Cumulative)	t = 1000Hrs, I_R = 100µA		120	—	—	—	ppm
V_{HYST}	Thermal Hysteresis	ΔT = -40°C to +125°C		0.08	—	—	—	%

Electrical Characteristics (Cont.) (Test conditions: T_A = +25°C, unless otherwise specified.)

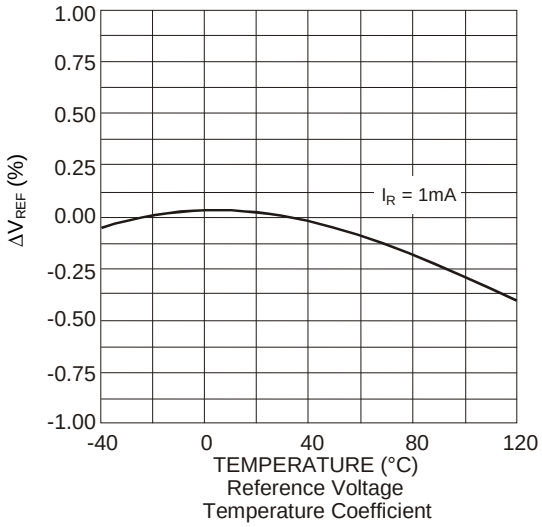
LM4040-5.0

Symbol	Parameter	Conditions		Typ	LM4040 B Limits	LM4040 C Limits	LM4040 D Limits	Units
		—	T_A					
V_{REF}	Reverse Breakdown Voltage	I_R = 100µA	+25°C	5.0	—	—	—	V
	Reverse Breakdown Voltage Tolerance	I_R = 100µA	+25°C	—	±10	±25	±50	mV
			-40 to +85°C		±43	±58	±99	
			-40 to +125°C		±60	±75	±125	
I_{RMIN}	Minimum Operating Current	—	+25°C	54	74	74	79	µA
			-40 to +85°C	—	80	80	85	
			-40 to +125°C		83	83	88	
$\Delta V_R/\Delta T$	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 10mA	-40 to +125°C	±30	—	—	—	ppm/°C
		I_R = 1mA		±20	±100	±100	±150	
		I_R = 100µA		±20	—	—	—	
$\Delta V_R/\Delta I_R$	Reverse Breakdown Change with Current	$I_{RMIN} \le I_R \le$ 1mA	+25°C	0.5	1.0	1.0	1.3	mV
			-40 to +85°C	—	1.4	1.4	1.8	
			-40 to +125°C		1.4	1.4	1.8	
		1mA $\le I_R \le$ 15mA	+25°C	3.5	8.0	8.0	10.0	
			-40 to +85°C	—	12.0	12.0	15.0	
			-40 to +125°C		12.0	12.0	15.0	
Z_R	Dynamic Output Impedance	I_R = 1mA, f = 120Hz $I_{AC} = 0.1I_R$		0.5	1.1	1.1	1.5	Ω
e_n	Noise Voltage	I_R = 100µA 10Hz < f < 10kHz		80	—	—	—	μV_{RMS}
V_R	Long Term Stability (Non Cumulative)	t = 1000Hrs, I_R = 100µA		120	—	—	—	ppm
V_{HYST}	Thermal Hysteresis	ΔT = -40°C to +125°C		0.08	—	—	—	%

Typical Characteristics LM4040-2.5



Reference Voltage Temperature Coefficient



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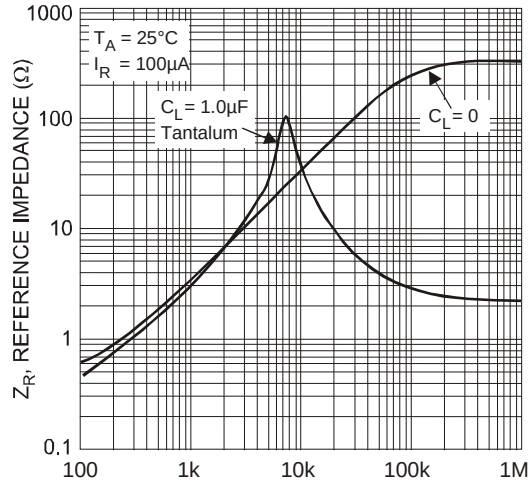
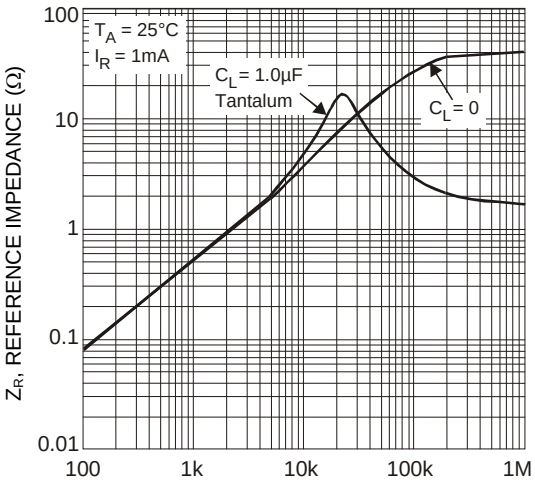


Reference Impedance vs. Frequency



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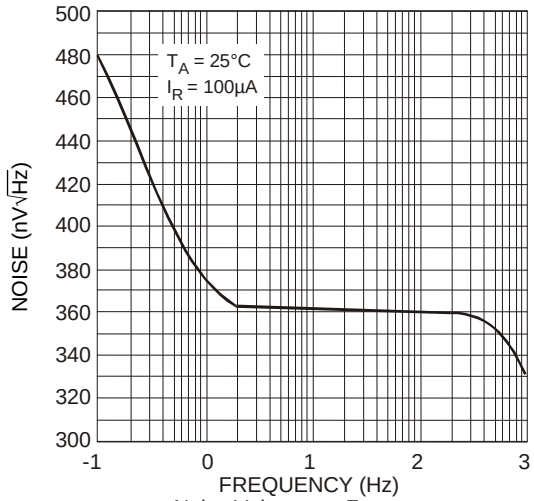
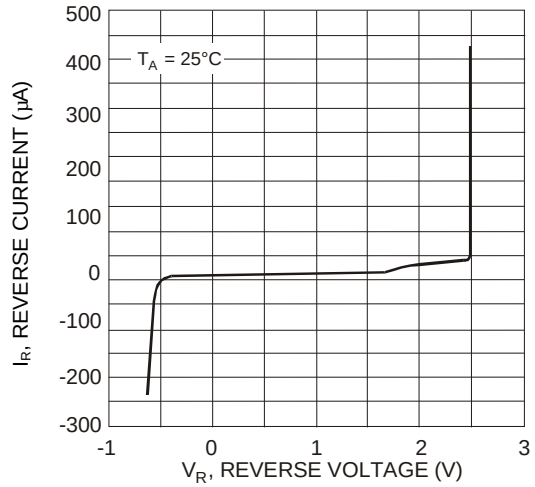
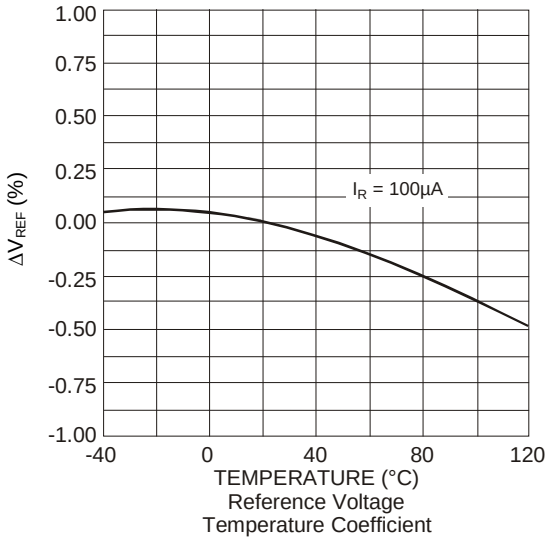


Noise Voltage vs. Frequency

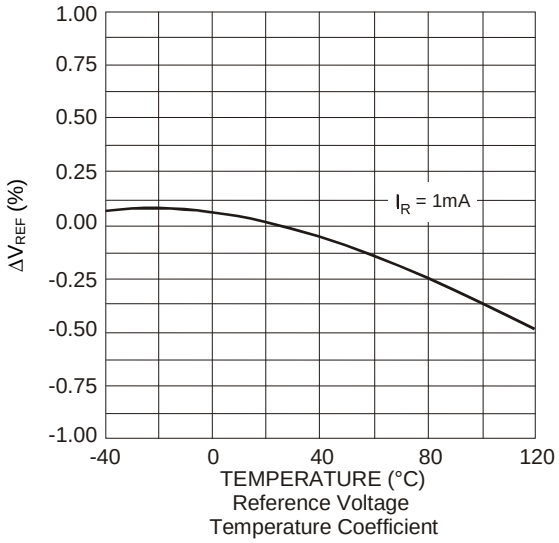


Reference Current vs. Voltage

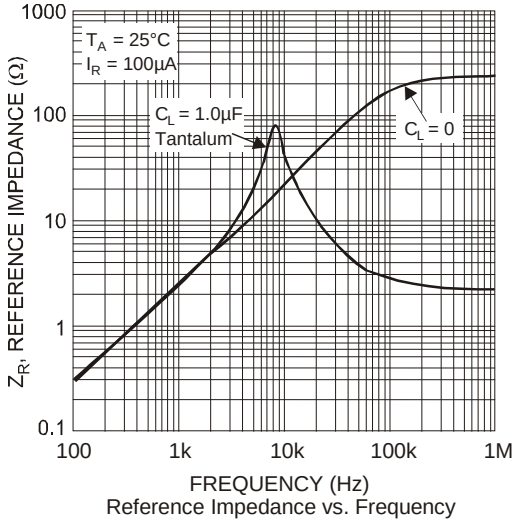
Typical Characteristics LM4040-3.0



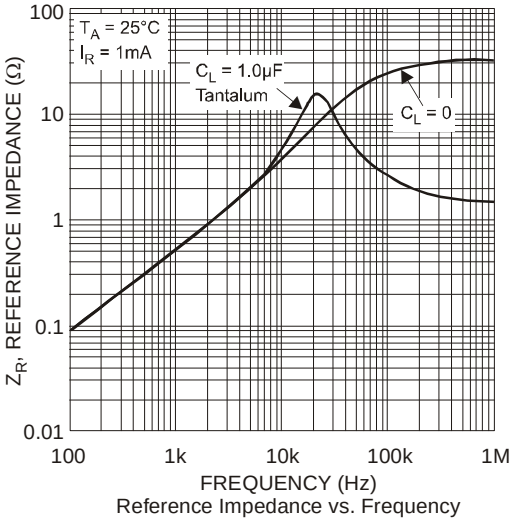
Reference Voltage Temperature Coefficient



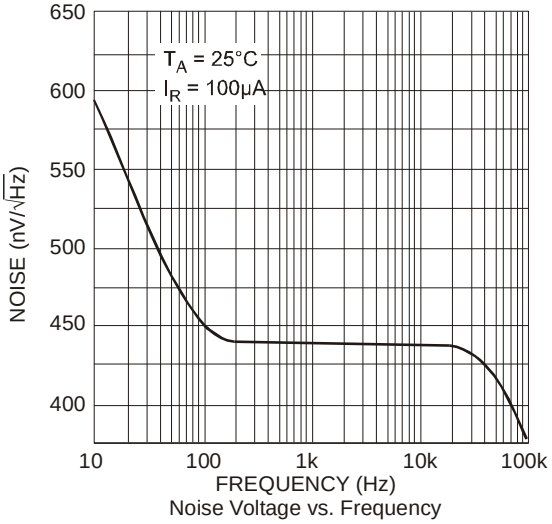
Reference Voltage Temperature Coefficient



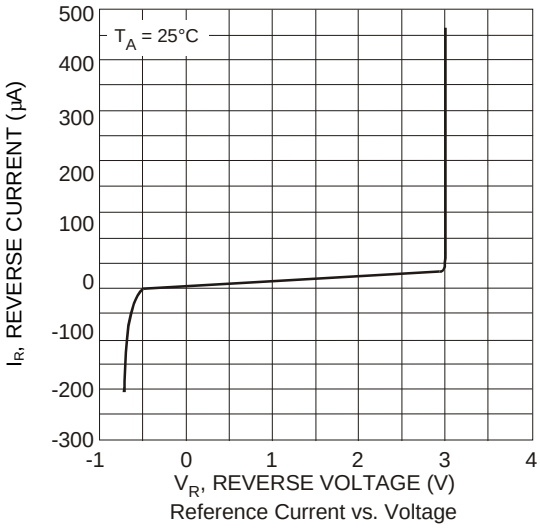
Reference Impedance vs. Frequency



Reference Impedance vs. Frequency

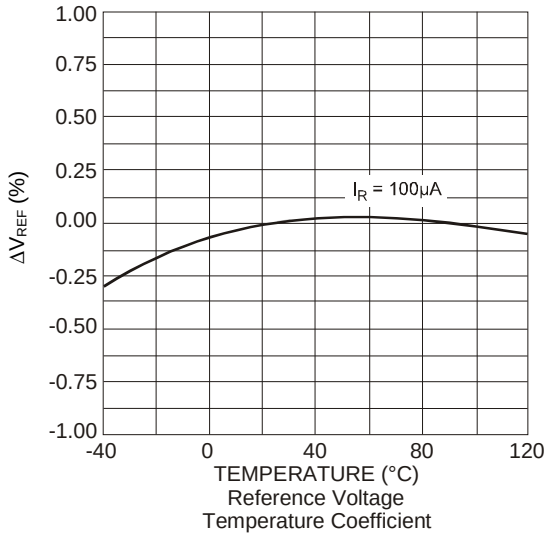


Noise Voltage vs. Frequency

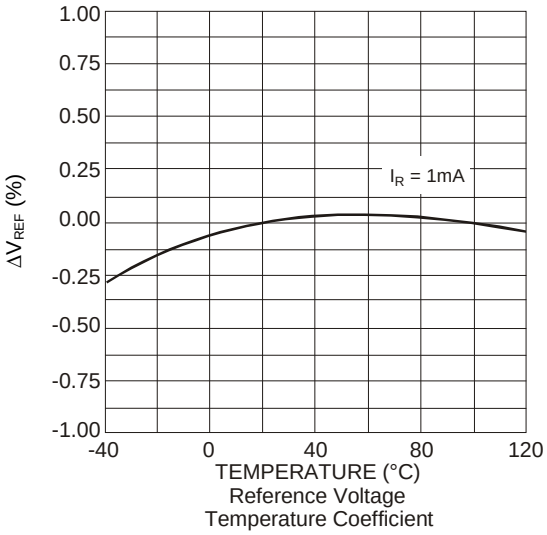


Reference Current vs. Voltage

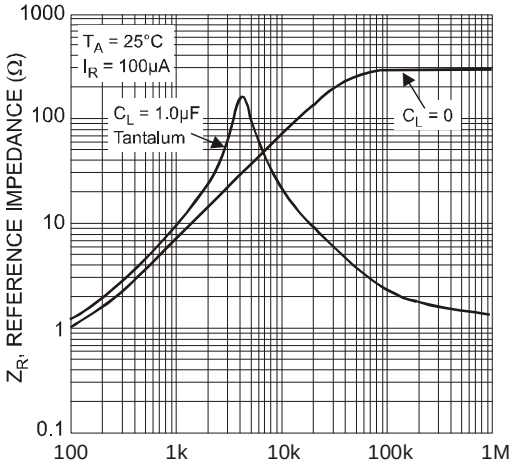
Typical Characteristics LM4040-5.0



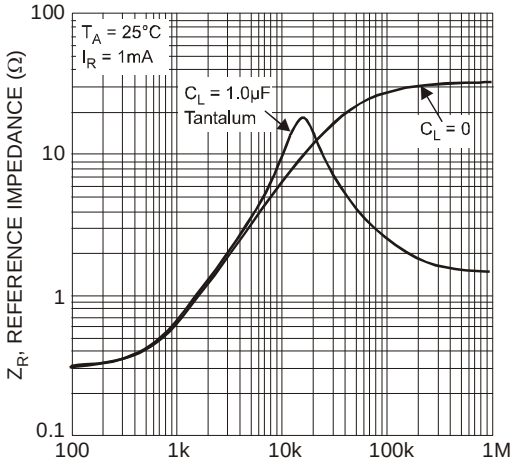
Reference Voltage Temperature Coefficient



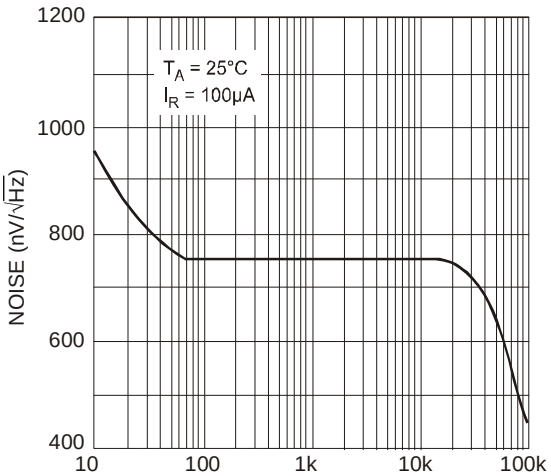
Reference Voltage Temperature Coefficient



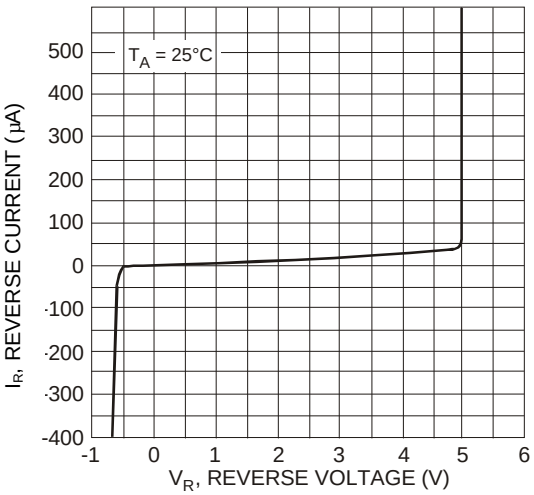
Reference Impedance vs. Frequency



Reference Impedance vs. Frequency



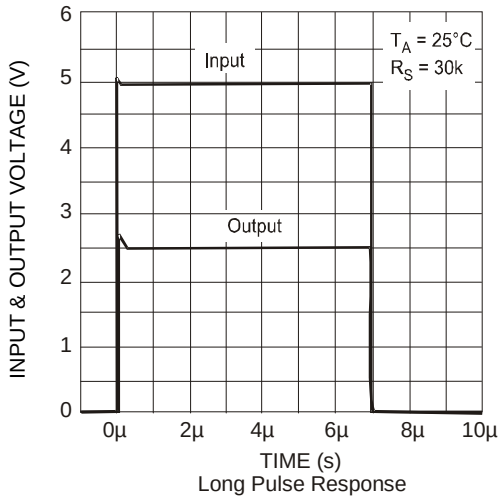
Noise Voltage vs. Frequency



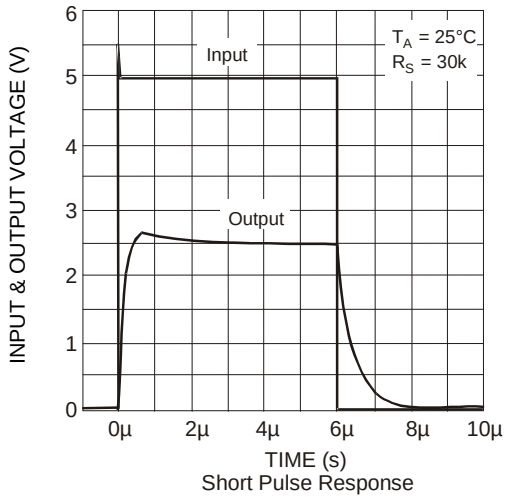
Reference Current vs. Voltage

Start Up Characteristics LM4040-2.5, 3.0 and 5.0

LM4040-2.5

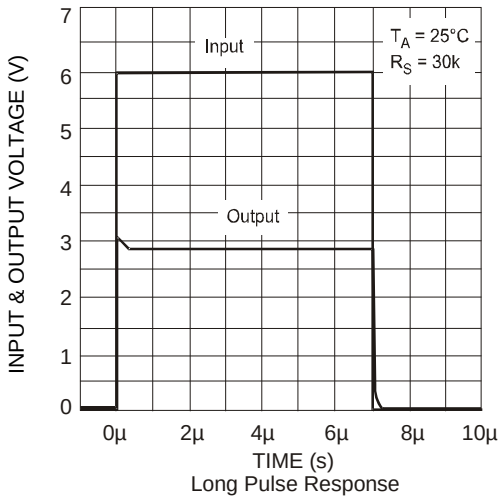


Long Pulse Response

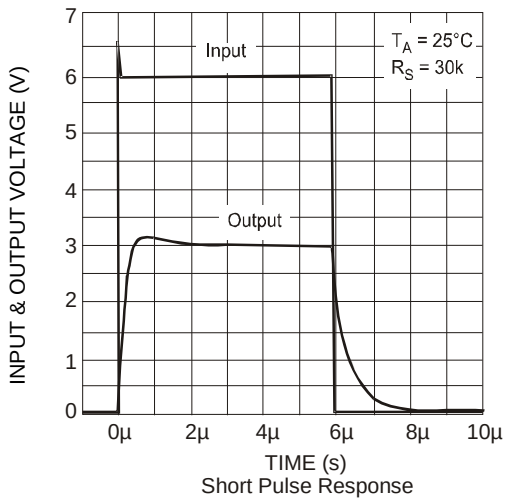


Short Pulse Response

LM4040-3.0

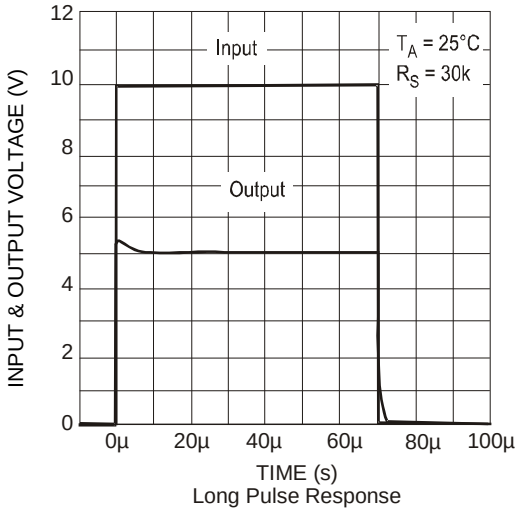


Long Pulse Response

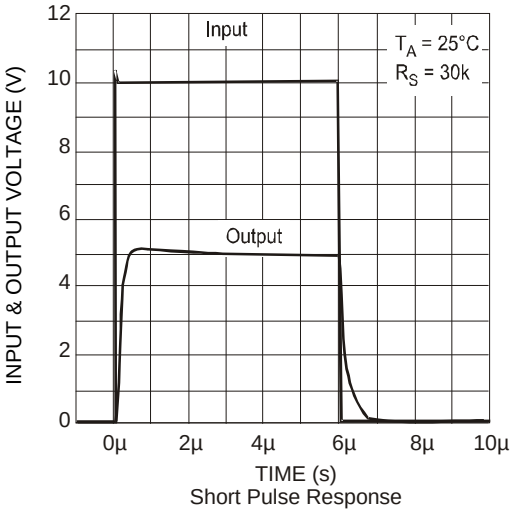


Short Pulse Response

LM4040-5.0



Long Pulse Response



Short Pulse Response

Application Information

In a conventional shunt regulator application (Figure 1), an external series resistor (R_S) is connected between the supply voltage, V_S, and the LM4040.

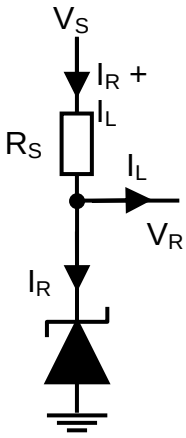


Figure 1

R_S determines the current that flows through the load (I_L) and the LM4040 (I_R). Since load current and supply voltage may vary, R_S should be small enough to supply at least the minimum acceptable I_R to the LM4040 even when the supply voltage is at its minimum and the load current is at its maximum value. When the supply voltage is at its maximum and I_L is at its minimum, R_S should be large enough so that the current flowing through the LM4040 is less than 15mA.

R_S is determined by the supply voltage, (V_S), the load and operating current, (I_L and I_R), and the LM4040's reverse breakdown voltage, V_R.

$$R_S = \frac{V_S - V_R}{I_L + I_R}$$

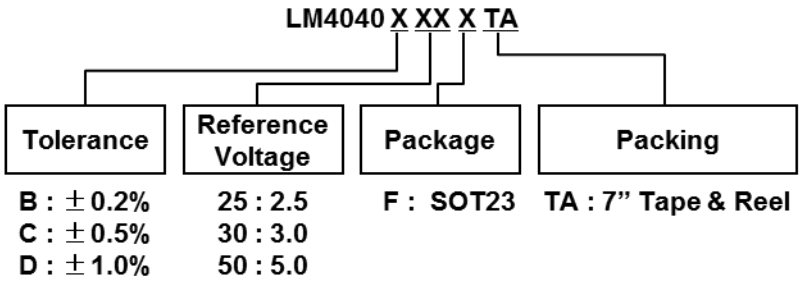
Printed Circuit Board Layout Considerations

LM4040s in the SOT23 package have the die attached to pin 1, which results in an electrical contact between pin 2 and pin 3. Therefore, pin 1 of the SOT23 package must be left floating or connected to pin 2.

LM4040s in the SC70-5 (Note 4) package have the die attached to pin 2, which results in an electrical contact between pin 2 and pin 1. Therefore, pin 2 must be left floating or connected to pin 1.

Note: 4. SC70-5 variants are End of Life (EOL).

Ordering Information

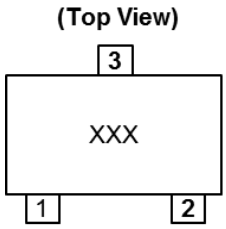


+25°C Tol	Voltage (V)	Part Number	Status (Note 4)	Package (Note 5)	Identification Code	Reel Size	Tape Width	Quantity per Reel
0.2%	2.5	LM4040B25FTA	Full Production	SOT23	R2B	7", 180mm	8mm	3000
		LM4040B25H5TA	End of Life	SC70-5	R2B	7", 180mm	8mm	3000
	3.0	LM4040B30FTA	Full Production	SOT23	R3B	7", 180mm	8mm	3000
		LM4040B30H5TA	End of Life	SC70-5	R3B	7", 180mm	8mm	3000
	5.0	LM4040B50FTA	Full Production	SOT23	R5B	7", 180mm	8mm	3000
		LM4040B50H5TA	End of Life	SC70-5	R5B	7", 180mm	8mm	3000
0.5%	2.5	LM4040C25FTA	Full Production	SOT23	R2C	7", 180mm	8mm	3000
		LM4040C25H5TA	End of Life	SC70-5	R2C	7", 180mm	8mm	3000
	3.0	LM4040C30FTA	Full Production	SOT23	R3C	7", 180mm	8mm	3000
		LM4040C30H5TA	End of Life	SC70-5	R3C	7", 180mm	8mm	3000
	5.0	LM4040C50FTA	Full Production	SOT23	R5C	7", 180mm	8mm	3000
		LM4040C50H5TA	End of Life	SC70-5	R5C	7", 180mm	8mm	3000
1%	2.5	LM4040D25FTA	Full Production	SOT23	R2D	7", 180mm	8mm	3000
		LM4040D25H5TA	End of Life	SC70-5	R2D	7", 180mm	8mm	3000
	3.0	LM4040D30FTA	Full Production	SOT23	R3D	7", 180mm	8mm	3000
		LM4040D30H5TA	End of Life	SC70-5	R3D	7", 180mm	8mm	3000
	5.0	LM4040D50FTA	Full Production	SOT23	R5D	7", 180mm	8mm	3000
		LM4040D50H5TA	End of Life	SC70-5	R5D	7", 180mm	8mm	3000

Notes: 4. SC70-5 variants are End of Life.
5. Package dimensions and pad layout can be found on our website at http://www.diodes.com/package-outlines.html.

Marking Information

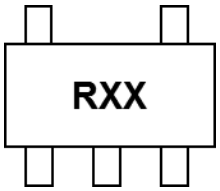
(1) SOT23



XXX : Identification Code

Part Number	Identification Code
LM4040B25FTA	R2B
LM4040B30FTA	R3B
LM4040B50FTA	R5B
LM4040C25FTA	R2C
LM4040C30FTA	R3C
LM4040C50FTA	R5C
LM4040D25FTA	R2D
LM4040D30FTA	R3D
LM4040D50FTA	R5D

(2) SC70-5 (Note 4)

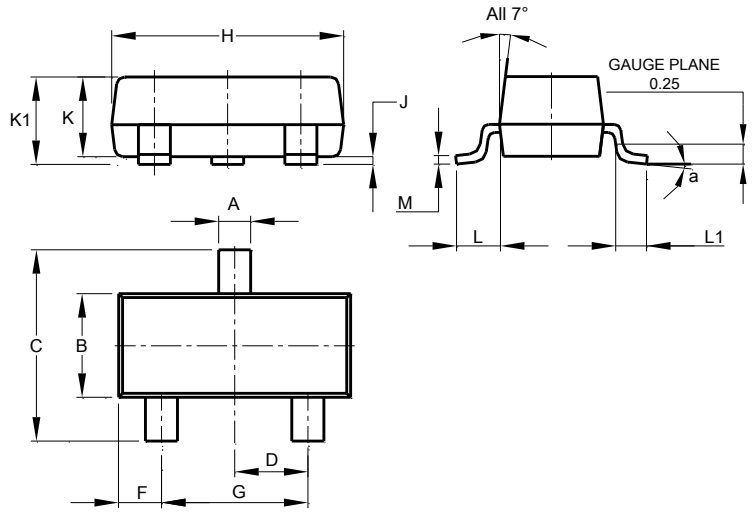


RXX : Identification code

Package Outline Dimensions

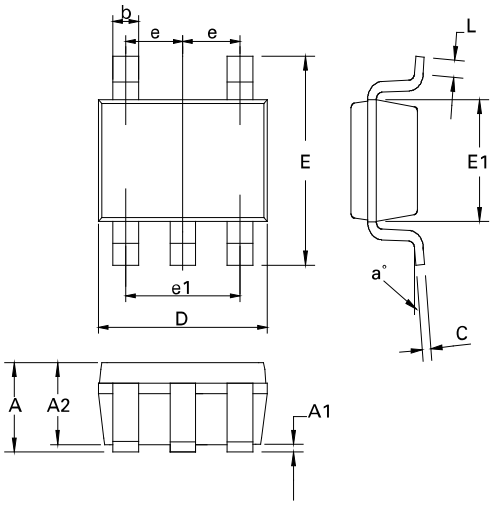
Please see http://www.diodes.com/package-outlines.html for the latest version.

(1) Package Type: SOT23



SOT23			
Dim	**Min**	**Max**	**Typ**
A	0.37	0.51	0.40
B	1.20	1.40	1.30
C	2.30	2.50	2.40
D	0.89	1.03	0.915
F	0.45	0.60	0.535
G	1.78	2.05	1.83
H	2.80	3.00	2.90
J	0.013	0.10	0.05
K	0.890	1.00	0.975
K1	0.903	1.10	1.025
L	0.45	0.61	0.55
L1	0.25	0.55	0.40
M	0.085	0.150	0.110
a	0°	8°	--
All Dimensions in mm			

(2) SC70-5 (Note 4)

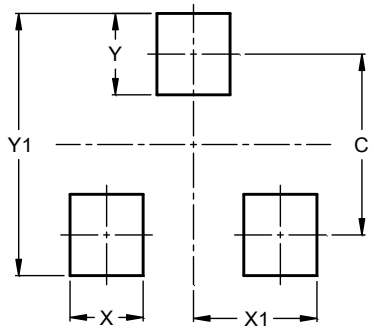


Dim.	Min.	Max.	Typ.
A	1.1	0.8	-
A1	0.1	-	-
A2	1	0.8	-
b	0.3	0.15	-
C	0.25	0.08	-
D	2.00 BSC		
E	2.10 BSC		
E1	1.25 BSC		
e	0.65 BSC		
e1	1.30 BSC		
L	0.46	0.26	-
a°	0	8	-

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

(1) Package Type: SOT23



Dimensions	Value (in mm)
C	2.0
X	0.8
X1	1.35
Y	0.9
Y1	2.9