Description

The LM4041 is a bandgap circuit designed to achieve a precision micro-power voltage reference of 1.225V. The device is available in the small outline SOT23 and SOT353 surface-mount packages which are ideal for applications where space saving is important.

Both packages are available to 0.5% C grade and 1% D grade for precision applications. Excellent performance is maintained over the 60µA to 12mA 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 LM4041 voltage reference in both adjustable and 1.225V output variants.

Features

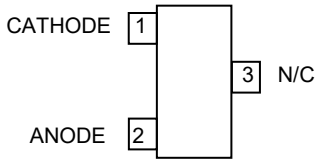
- Small Packages: SOT23, SOT353
- No Output Capacitor Required
- Output Voltage Tolerance
- LM4041C: ±0.5% at +25°C
- LM4041D: ±1% at +25°C
- Low Output Noise: 20µV_{RMS} (10Hz to 10kHz)
- Wide Operating Current Range: 60µA to 12mA
- Extended Temperature Range: -40°C to +125°C
- Low-Temperature Coefficient: 100ppm/°C (max)
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **This part is qualified to JEDEC standards (as references in AEC-Q) for High Reliability. https://www.diodes.com/quality/product-definitions/**
- **An automotive-compliant part is available under a separate datasheet (LM4041Q).**

Applications

- Battery powered equipment
- Precision power supplies
- Portable instrumentation
- Portable communications devices
- Notebook and palmtop computers
- Data acquisition systems

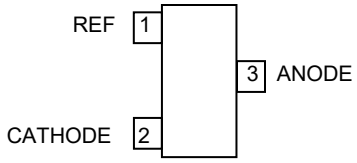
Pin Assignments

LM4041CF/LM4041DF (SOT23)

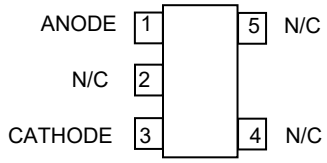


Pin 3 must be left floating or connected to pin 2.

LM4041DADJF (SOT23)

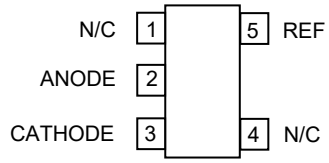


LM4041CH5/LM4041DH5 (SOT353)



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

LM4041DADJH5 (SOT353)



Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ 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.

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Absolute Maximum Ratings (Note 4)

Description	Rating	Unit
Continuous Reverse Current (I_R)	20	mA
Continuous Forward Current (I_F)	10	mA
Maximum Output Voltage (LM4041DADJ)	15	V
Junction Temperature	-40 to 155	°C
Storage Temperature	-55 to 150	°C
ESD Ratings		
Human Body Model	4000	V
Machine Model	200	V

Note: 4. These are stress ratings only. Operation outside the absolute maximum ratings can cause device failure. Operation at the absolute maximum rating, for extended periods can reduce device reliability. Semiconductor devices are ESD sensitive and can be damaged by exposure to ESD events. Suitable ESD precautions should be taken when handling and transporting these devices.

Package Thermal Data

Package	θ_{JA}	P_{DIS} T_A = 25°C, T_J = 150°C
SOT23	380°C/W	330mW
SOT353	420°C/W	300mW

Recommended Operating Conditions

Parameter	Min	Max	Unit
Reverse Current	0.06	12	mA
Output Voltage Range	1.24	10	V
Operating Ambient Temperature Range	-40	125	°C

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Electrical Characteristics

LM4041C/LM4041D

Electrical characteristics over recommended operating conditions, T_A = +25°C, unless otherwise stated, I_{RMIN} I_R ≤ 12mA, V_{REF} ≤ V_{OUT} ≤ 10V. The LM4041C and LM4041D have initial tolerances of 0.5% and 1% respectively.

Symbol	Parameter	Conditions		Typ	LM4041C Limits	LM4041D Limits	Unit
		—	T_A				
V_{REF}	Reverse Breakdown Voltage	I_R = 100µA	25°C	1.225	—	—	V
	Reverse Breakdown Voltage Tolerance		25°C	—	±6	±12	mV
			-40°C to 85°C		±14	±24	
			-40°C to 125°C		±18.4	±31	
I_{RMIN}	Minimum Operating Current	—	25°C	45	60	65	µA
			-40°C to 85°C		65	70	
			-40°C to 125°C		68	73	
$\Delta V_R/\Delta T$	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 10mA	-40°C to 125°C	±20	—	—	ppm/°C
		I_R = 1mA		±15	±100	±150	
		I_R = 100µA		±15	—	—	
$\Delta V_R/\Delta I_R$	Reverse Breakdown Change with Current	I_{RMIN} < I_R < 1mA	25°C	0.7	1.5	2.0	mV
			-40°C to 85°C		2.0	2.5	
			-40°C to 125°C		2.0	2.5	
		1mA < I_R < 12mA	25°C	2.5	6.0	8.0	
			-40°C to 85°C		8.0	10.0	
			-40°C to 125°C		8.0	10.0	
Z_R	Dynamic Output Impedance	I_R = 1mA, f = 120Hz, I_{AC} = 0.1I_R		0.5	1.5	2.0	Ω
e_n	Noise Voltage	I_R = 100µA, 10Hz < f < 10kHz		20	—	—	μV_{RMS}
ΔV_R	Long Term Stability (Non Cumulative)	t = 1000Hrs, I_R = 100µA		120	—	—	ppm

LM4041DADJ

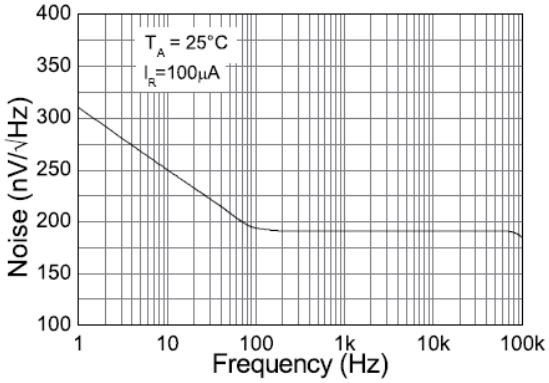
Electrical characteristics over recommended operating conditions, T_A = +25°C, I_{RMIN} ≤ I_R ≤ 12mA, V_{REF} ≤ V_{OUT} ≤ 10V unless otherwise stated. The grade D designates initial reference voltage tolerance of ±1% and is measured at an output/cathode voltage of 5V.

Symbol	Parameter	Conditions		Typ	LM4041D Limits	Unit
		—	T_A			
V_{REF}	Reverse Breakdown Voltage	I_R = 100µA, V_{KA} = 5V	25°C	1.233	—	V
	Reverse Breakdown Voltage Tolerance		25°C	—	±12	mV
			-40 to 85°C	—	±24	
			-40 to 125°C	—	±30	
I_{RMIN}	Minimum Operating Current	—	25°C	45	65	µA
			-40 to 85°C		70	
			-40 to 125°C		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	±150	
		I_R = 100µA		±15	—	
$\Delta V_R/\Delta V_K$	Reference Voltage Change with Cathode Voltage Change	I_R = 1mA	25°C	-1.55	-2.5	mV/V
			-40 to 85°C		-3.0	
			-40 to 125°C		-4.0	
I_{REF}	Reference Input Current	—	25°C	60	150	nA
			-40 to 85°C		200	
			-40 to 125°C		200	
$\Delta V_R/\Delta I_R$	Reverse Breakdown Change with Current	I_{RMIN} < I_R < 1mA, V_{OUT} > 1.6V	25°C	0.7	2.0	mV
			-40 to 85°C		2.5	
			-40 to 125°C		2.5	
		1mA < I_R < 12mA, V_{OUT} > 1.6V	25°C	2	6.0	
			-40 to 85°C		8.0	
			-40 to 125°C		10.0	
Z_R	Dynamic Output Impedance	I_R = 1mA, f = 120Hz, I_{AC} = 0.1I_R	V_{KA} = V_{REF}	0.5	—	Ω
			V_{KA} = 10V	2	—	—
e_n	Noise Voltage	I_R = 100µA, 10Hz < f < 10kHz		20	—	μV_{RMS}
ΔV_R	Long Term Stability (Non Cumulative)	t = 1000Hrs I_R = 100µA		120	—	ppm

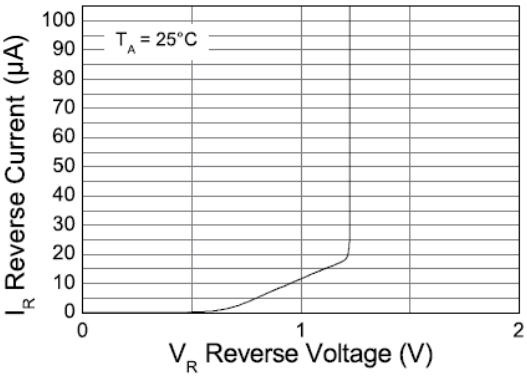
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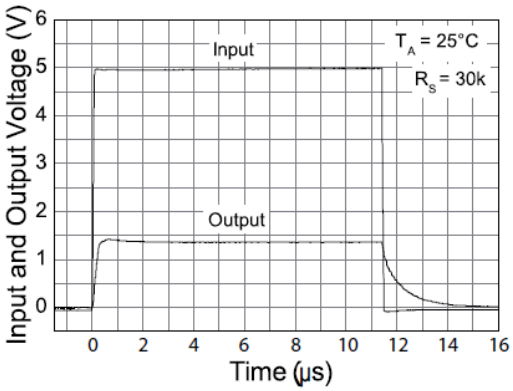
Typical Characteristics LM4041 1.225



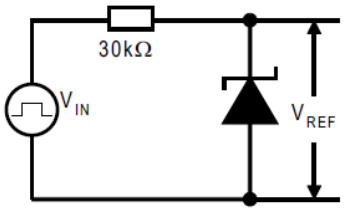
Noise Voltage vs Frequency

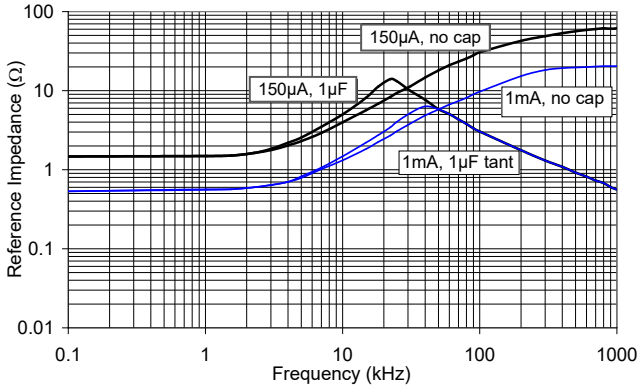


Reverse Current vs Voltage



Pulse Response





Output Impedance vs. Frequency

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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 LM4041.

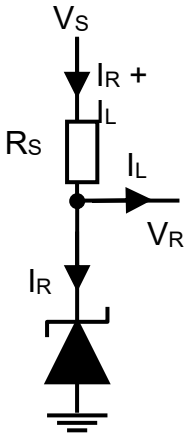


Figure 1

R_S determines the current that flows through the load (I_L) and the LM4041 (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 LM4041 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 LM4041 is less than 12mA.

R_S is determined by the supply voltage, (V_S), the load and operating current, (I_L and I_Q), and the LM4041's reverse breakdown voltage, V_R.

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

The LM4041 comes in two varients:

- LM4041 with fixed 1.225V output
- LM4041DADJ with variable output voltage

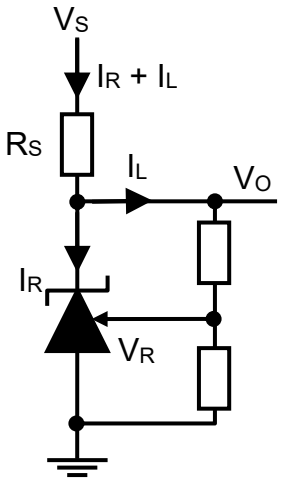


Figure 2

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Application Information (continued)

The LM4041-ADJ's output voltage can be adjusted to any value in the range of 1.24V through 10V. The output voltage is set by the ratio of two external feedback resistors as shown in Figure 2 and the internal reference voltage (V_R).

The output voltage is found using the equation:

$$V_O = V_R \times \left(1 + \frac{R_2}{R_1}\right)$$

Printed Circuit Board Layout Considerations

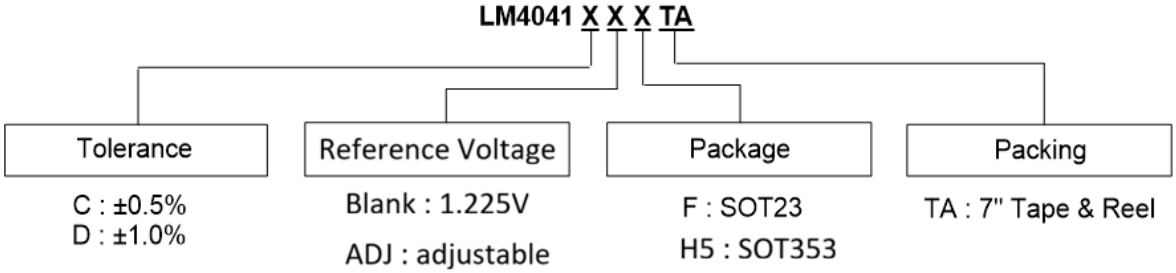
The LM4041 with fixed output voltage in the SOT23 package has the die attached to pin 1, which results in an electrical contact between pin 2 and pin 1. Therefore, pin 1 of the SOT23 package must be left floating or connected to pin 2.

The LM4041 with fixed output voltage in the SOT353 package has 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.

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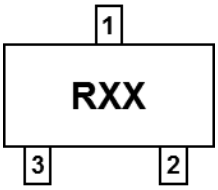
Ordering Information (Note 5)



Orderable Part Number	25°C Tol	Voltage (V)	Package	Identification Code	Reel Size	Tape Width	Packing	
							Qty.	Carrier
LM4041CFTA	0.5%	1.225	SOT23	R1C	7”, 180mm	8mm	3000	Reel
LM4041CH5TA	0.5%	1.225	SOT353	R1C	7”, 180mm	8mm	3000	Reel
LM4041DFTA	1%	1.225	SOT23	R1D	7”, 180mm	8mm	3000	Reel
LM4041DH5TA			SOT353	R1D	7”, 80mm	8mm	3000	Reel
LM4041DADJFTA		ADJ	SOT23	RAD	7”, 180mm	8mm	3000	Reel
LM4041DADJH5TA			SOT353	RAD	7”, 180mm	8mm	3000	Reel

Note: 5. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

Marking Information



RXX : Identification Code

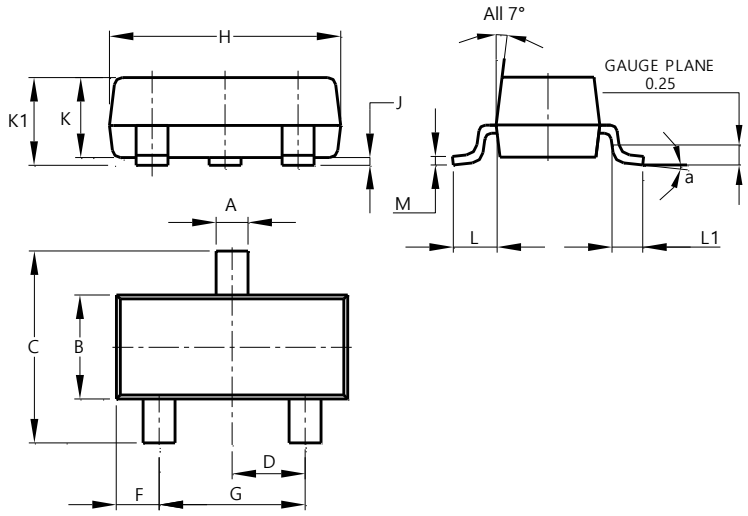
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Package Outline Dimensions

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

Package Type 1:

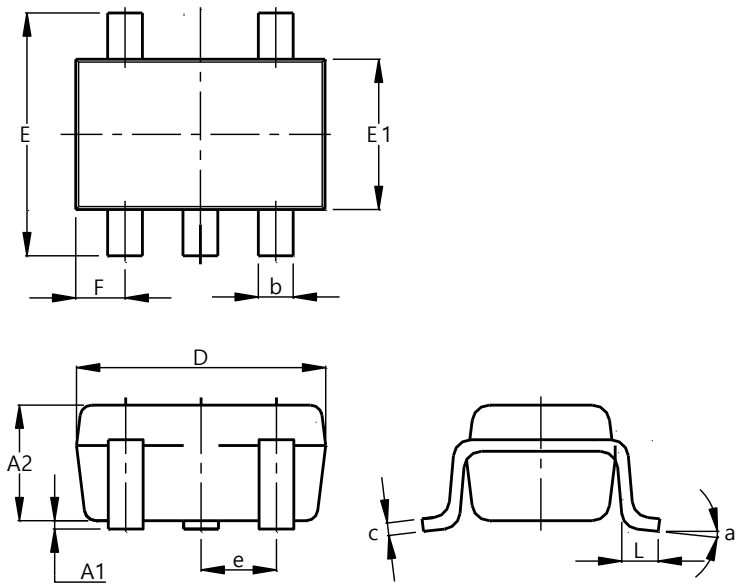
SOT23



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			

Package Type 2:

SOT353



SOT353			
Dim	**Min**	**Max**	**Typ**
A1	0.00	0.10	0.05
A2	0.90	1.00	0.95
b	0.10	0.30	0.25
c	0.10	0.22	0.11
D	1.80	2.20	2.15
E	2.00	2.20	2.10
E1	1.15	1.35	1.30
e	0.650 BSC		
F	0.40	0.45	0.425
L	0.25	0.40	0.30
a	0°	8°	--
All Dimensions in mm			

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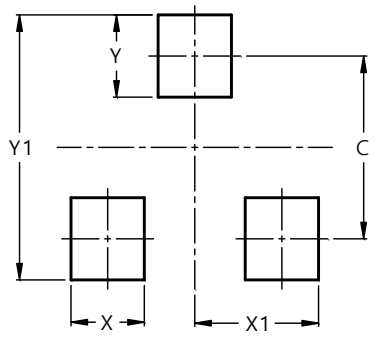
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Suggested Pad Layout

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

Package Type 1:

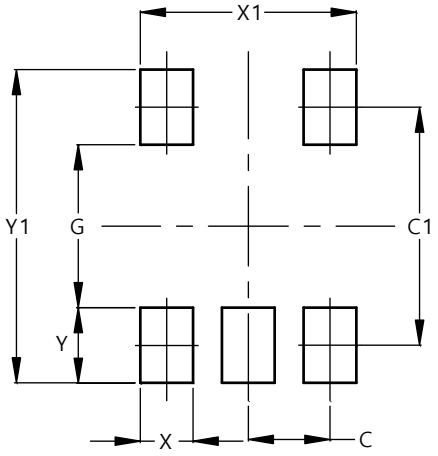
SOT23



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

Package Type 2:

SOT353



Dimensions	Value (in mm)
C	0.650
C1	1.900
G	1.300
X	0.420
X1	1.720
Y	0.600
Y1	2.500

Mechanical Data

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish — Matte Tin Plated Leads. Solderable per MIL-STD-202, Method 208 e3
- Weight:
  - SOT23: 0.009 grams (Approximate)
  - SOT353: 0.006 grams (Approximate)

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