

Description

The LM4041 is a bandgap circuit designed to achieve a precision micro-power voltage reference of 1.225 V. The device is available in the small outline SOT23 and SC70-5 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

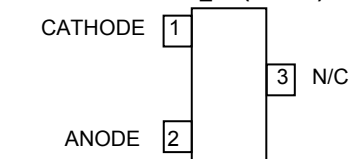
- Small packages: SOT23, SC70-5
- No output capacitor required
- Output voltage tolerance
- LM4041C: ±0.5% at 25°C
- LM4041D: ±1% at 25°C
- Low output noise: 20µVrms (10Hz to 10kHz)
- Wide operating current range: 60µA to 12mA
- Extended temperature range: -40°C to +125°C
- Low temperature coefficient : 100ppm/°C (max)
- All parts AEC-Q100 Grade1 qualified

Applications

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

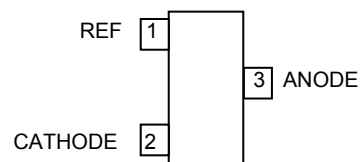
Pin Assignments

LM4041_F (SOT23)

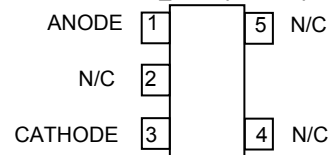


Pin 3 must left floating or connected to pin 2.

LM4041_ADJF....(SOT23)

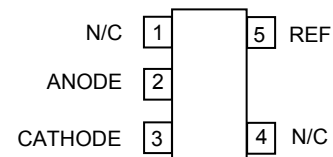


LM4041_H5 (SC70-5)



Pin 2 must be left floating or connected to pin 1

LM4041_ADJH5 (SC70-5)



Absolute Maximum Ratings

Description	Rating	Unit
Continuous Reverse Current (I_R)	20	mA
Continuous Forward Current (I_F)	10	mA
Maximum Output Voltage (LM4041_ADJ)	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

These are stress ratings only. Operation outside the absolute maximum ratings may cause device failure. Operation at the absolute maximum rating, for extended periods may reduce device reliability. 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.

Package Thermal Data

Package	θ_{JA}	P_{DIS} $T_A = 25^\circ\text{C}, T_J = 150^\circ\text{C}$
SOT23	380°C/W	330mW
SC70-5	420°C/W	300mW

Recommended Operating Conditions

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

Electrical Characteristics

LM4041-1.2

Electrical characteristics over recommended operating conditions, $T_A = 25^\circ\text{C}$, unless otherwise stated, $I_{RMIN} \leq I_R \leq 12\text{mA}$, $V_{REF} \leq V_{OUT} \leq 10\text{V}$. LM4041C and LM4041D have initial tolerances of 0.5% and 1% respectively.

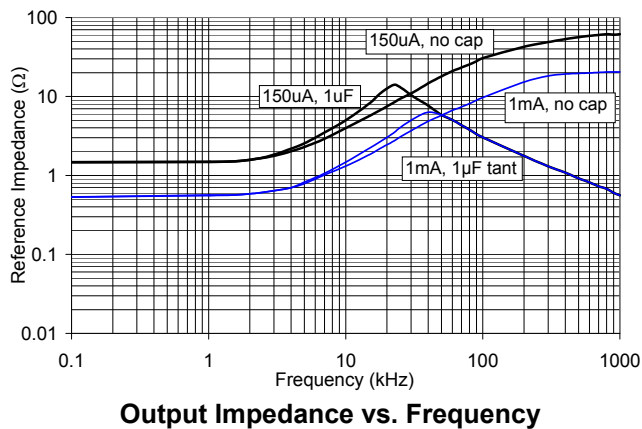
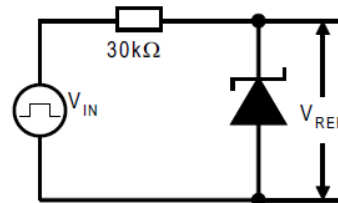
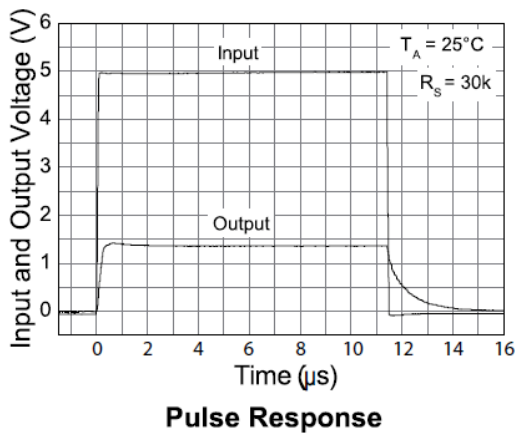
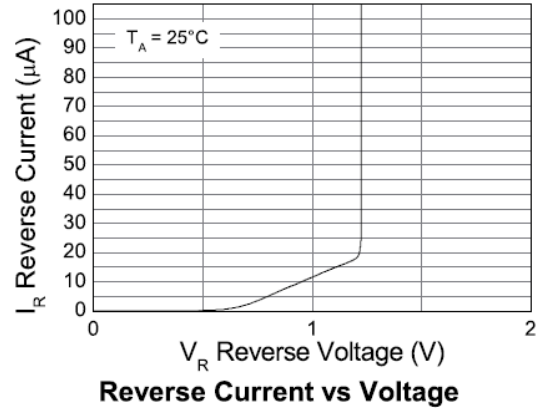
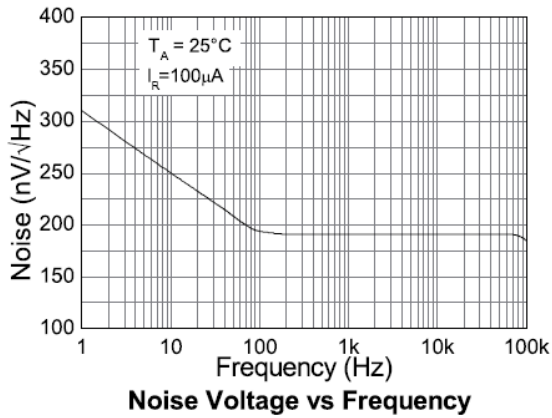
Symbol	Parameter	Conditions		Typ	LM4041C Limits	LM4041D Limits	Units
			T_A				
V_{REF}	Reverse Breakdown Voltage	$I_R = 100 \mu\text{A}$	25°C	1.225			V
	Reverse Breakdown Voltage Tolerance		25°C		± 6	± 12	mV
			-40 to 85°C		± 14	± 24	
			-40 to 125°C		± 18.4	± 31	
I_{RMIN}	Minimum Operating Current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

LM4041-Adj

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

Symbol	Parameter	Conditions		Typ	LM4041D Limits	Units
			T_A			
V_{REF}	Reverse Breakdown Voltage	$I_R = 100 \mu\text{A}$, $V_{KA} = 5\text{V}$	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	$I_R = 10 \text{ mA}$ $I_R = 1 \text{ mA}$, $I_R = 100 \mu\text{A}$	-40 to 125°C	± 20	± 150	ppm/ $^\circ\text{C}$
				± 15		
				± 15		
$\Delta V_R/\Delta V_K$	Reference voltage change with cathode voltage change	$I_R = 1 \text{ mA}$	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	$I_{RMIN} < I_R < 1 \text{ mA}$ $V_{OUT} > 1.6\text{V}$	25°C	0.7	2.0	mV
			-40 to 85°C		2.5	
			-40 to 125°C		2.5	
		$1 \text{ mA} < I_R < 12 \text{ mA}$ $V_{OUT} > 1.6\text{V}$	25°C	2	6.0	
			-40 to 85°C		8.0	
			-40 to 125°C		10.0	
Z_R	Dynamic Output Impedance	$I_R = 1 \text{ mA}$, $f = 120\text{Hz}$ $I_{AC} = 0.1 I_R$	$V_{KA} = V_{REF}$ $V_{KA} = 10\text{V}$	0.5		Ω
e_n	Noise Voltage	$I_R = 100 \mu\text{A}$ $10\text{Hz} < f < 10\text{kHz}$		20		μV_{RMS}
ΔV_R	Long Term Stability (Non cumulative)	$t = 1000\text{Hrs}$ $I_R = 100 \mu\text{A}$		120		ppm

Typical Characteristics LM4041 1.225



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.

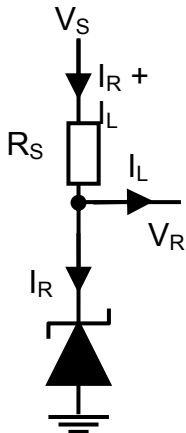


Figure 1

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 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 12 mA.

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

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

The LM4041 comes in two variants:

- LM4041 with fixed 1.225V output
- LM4041_ADJ with variable output voltage.

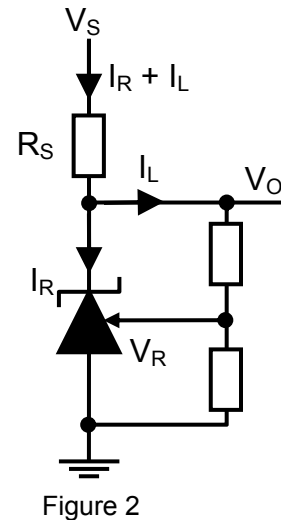


Figure 2

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

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.

LM4041 with fixed output voltage in the SC70-5 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.

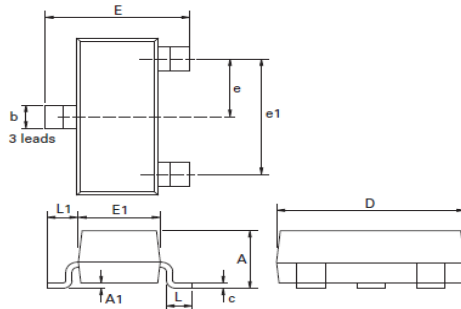
Ordering Information

25°C Tol	Voltage (V)	ORDER CODE	QUALIFICATION†	PACK	PART MARK	REEL SIZE	TAPE WIDTH	QUANTITY PER REEL
0.5%	1.225	LM4041CFTA	Commercial	SOT23	R1C	7", 180mm	8mm	3000
		LM4041CQFTA	Automotive	SOT23	R1C	7", 180mm	8mm	3000
		LM4041CH5TA	Commercial	SC70-5	R1C	7", 180mm	8mm	3000
1%	1.225	LM4041DFTA	Commercial	SOT23	R1D	7", 180mm	8mm	3000
		LM4041DQFTA	Automotive	SOT23	R1D	7", 180mm	8mm	3000
		LM4041DH5TA	Commercial	SC70-5	R1D	7", 180mm	8mm	3000
	Adj	LM4041DADJFTA	Commercial	SOT23	RAD	7", 180mm	8mm	3000
		LM4041DADJH5TA	Commercial	SC70-5	RAD	7", 180mm	8mm	3000

† All parts AEC-Q100 grade 1 qualified

Package Outline Information

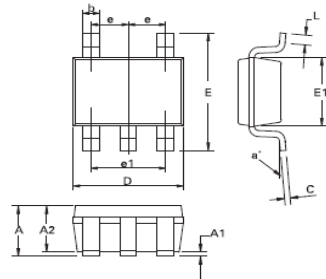
Package outline - SOT23



Dim.	Millimeters		Inches		Dim.	Millimeters		Inches	
	Min.	Max.	Min.	Max.		Min.	Max.	Max.	Max.
A	-	1.12	-	0.044	e1	1.90 NOM		0.075 NOM	
A1	0.01	0.10	0.0004	0.004	E	2.10	2.64	0.083	0.104
b	0.30	0.50	0.012	0.020	E1	1.20	1.40	0.047	0.055
C	0.085	0.120	0.003	0.008	L	0.25	0.62	0.018	0.024
D	2.80	3.04	0.110	0.120	L1	0.45	0.62	0.018	0.024
e	0.95 NOM		0.0375 NOM		-	-	-	-	-

Note: Controlling dimensions are in millimeters. Approximate dimensions are provided in inches

Package outline SC-70-5



Dim.	Millimeters		Inches		Dim.	Millimeters		Inches	
	Min.	Max.	Min.	Max.		Min.	Max.	Max.	Max.
A	0.80	1.10	0.0315	0.0433	E	2.10 BSC		0.0826 BSC	
A1	-	0.10	-	0.0039	E1	1.25 BSC		0.0492 BSC	
A2	0.80	1.00	0.0315	0.0394	e	0.65 BSC		0.0255 BSC	
b	0.15	0.30	0.006	0.0118	e1	1.30 BSC		0.0511 BSC	
C	0.08	0.25	0.0031	0.0098	L	0.26	0.46	0.0102	0.0181
D	2.00 BSC		0.0787 BSC		a°	0	8	0	8

IMPORTANT NOTICE

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

LIFE SUPPORT

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

- A. Life support devices or systems are devices or systems which:
1. are intended to implant into the body, or
 2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.
- B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

Copyright © 2011, Diodes Incorporated

www.diodes.com