LM4041

PRECISION MICROPOWER SHUNT VOLTAGE REFERENCES

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 surface mount packages which are ideal for applications where space saving is important.

Both packages are available to 0.2% B 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

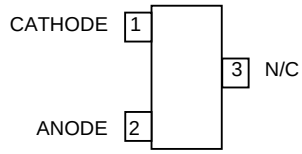
- Small packages: SOT23 and SC70-5
- No Output capacitor required
- Output voltage tolerance
- LM4041B ±0.2% at 25°C
- LM4041C ±0.5% at 25°C
- LM4041D ±1% at 25°C
- Low output noise
- (10 Hz to 10kHz) 20µVrms
- Wide operating current range 60µA to 12mA
- Extended temperature range -40°C to +125°C
- Low temperature coefficient 100ppm/°C (max)

Applications

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

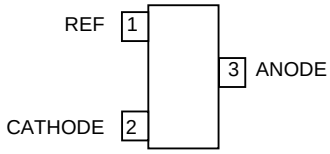
Pin Connections

LM4041_F (SOT23)

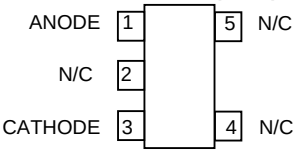


Pin 3 must left floating or connected to pin 2.

LM4041_ADJF….(SOT23)

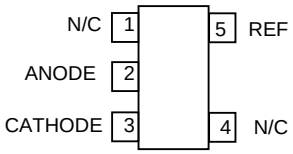


LM4041_H5 (SC70)



Pin 2 must be left floating or connected to pin 1

LM4041_ADJH5 (SC70)



Order Information

25°C Tol	Voltage (V)	ORDER CODE	PACK	PART MARK	STATUS	REEL SIZE	TAPE WIDTH	QUANTITY PER REEL
0.2%	1.225	**LM4041BFTA**	**SOT23**	**R1B**	Advance	**7", 180mm**	**8mm**	**3000**
		LM4041BH5TA	SC70-5	R1B	Advance	7", 180mm	8mm	3000
0.5%	1.225	**LM4041CFTA**	**SOT23**	**R1C**	**Active**	**7", 180mm**	**8mm**	**3000**
		LM4041CH5TA	SC70-5	R1C	Advance	7", 180mm	8mm	3000
	Adj	LM4041CADJFTA	SOT23	RAC	Advance	7", 180mm	8mm	3000
		LM4041CADJH5TA	SC70-5	RAC	Advance	7", 180mm	8mm	3000
1%	1.225	**LM4041DFTA**	**SOT23**	**R1D**	**Active**	**7", 180mm**	**8mm**	**3000**
		LM4041DH5TA	SC70-5	R1D	Active	7", 180mm	8mm	3000
	Adj	LM4041DADJFTA	SOT23	RAD	Active	7", 180mm	8mm	3000
		LM4041DADJH5TA	SC70-5	RAD	Active	7", 180mm	8mm	3000

ABSOLUTE MAXIMUM RATINGS

Continuous Reverse Current (I_R) 20mA
Continuous Forward current (I_F) 10mA
Maximum Output voltage (LM4041_ADJ) 15V
Operating Junction Temperature ..... -40 to 150°C
Storage Temperature ..... -55 to 150°C

Operation above the absolute maximum rating may cause device failure. Operation at the absolute maximum ratings, 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.

ESD susceptibility

Human body model	4000 V
Machine model	200 V

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 = 150°C
SOT23	380°C/W	330 mW
SC70-5	420°C/W	300 mW

Recommended Operating Conditions

	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°C, unless otherwise stated, $I_{RMIN} \leq I_R \leq 12mA$, $V_{REF} \leq V_{OUT} \leq 10V$. LM4041B, LM4041C and LM4041D have initial tolerances of 0.2%, 0.5% and 1% respectively.

Symbol	Parameter	Conditions		Typ	LM4041B Limits	LM4041C Limits	LM4041D Limits	Units
			T_A					
V_{REF}	Reverse Breakdown Voltage	I_R = 100 µA	25°C	1.225				V
	Reverse Breakdown Voltage Tolerance		25°C		±2.4	±6	±12	mV
			-40 to 85°C		±10.4	±14	±24	
			-40 to 125°C		±14.8	±18.4	±31	
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 = 10 mA	-40 to 125°C	±20				ppm/°C
		I_R = 1 mA,		±15	±100	±100	±150	
		I_R = 100 µA		±15				
$\Delta V_R/\Delta I_R$	Reverse Breakdown Change With Current	$I_{RMIN} < I_R < 1mA$	25°C	0.7	1.5	1.5	2.0	mV
			-40 to 85°C		2.0	2.0	2.5	
			-40 to 125°C		2.0	2.0	2.5	
		1mA < I_R < 12 mA	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 $I_{AC} = 0.1I_R$		0.5	1.5	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

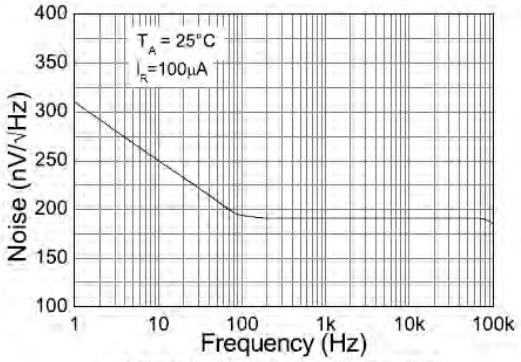
ELECTRICAL CHARACTERISTICS

LM4041-Adj

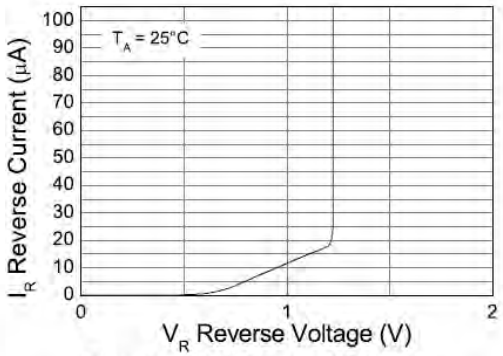
Electrical characteristics over recommended operating conditions, T_A = 25°C, I_{RMIN} . I_R . 12 mA, V_{REF} . V_{OUT} . 10V unless otherwise stated. The grades C and D designate initial Reference Voltage Tolerances of ±0.5% and ±1% and are measured at an output/cathode voltage of 5V.

Symbol	Parameter	Conditions		Typ	LM4041C Limits	LM4041D Limits	Units
			T_A				
V_{REF}	Reverse Breakdown Voltage	I_R = 100 µA, V_{KA} = 5V	25°C	1.233			V
	Reverse Breakdown Voltage Tolerance		25°C		±6.2	±12	mV
			-40 to 85°C		±14	±24	
			-40 to 125°C		±18	±30	
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 mA	-40 to 125°C	±20			ppm/°C
		I_R = 1 mA,		±15	±100	±150	
		I_R = 100 µA		±15			
$\Delta V_R/\Delta V_K$	Reference voltage change with cathode voltage change	I_R = 1mA	25°C	-1.55	-2.0	-2.5	mV/V
			-40 to 85°C		-2.5	-3.0	
			-40 to 125°C		-3.0	-4.0	
I_{REF}	Reference input current		25°C	60	100	150	nA
			-40 to 85°C		120	200	
			-40 to 125°C		120	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	1.5	2.0	mV
			-40 to 85°C		2.0	2.5	
			-40 to 125°C		2.0	2.5	
		1mA < I_R < 12 mA V_{OUT} > 1.6V	25°C	2	4.0	6.0	
			-40 to 85°C		6.0	8.0	
			-40 to 125°C		8.0	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

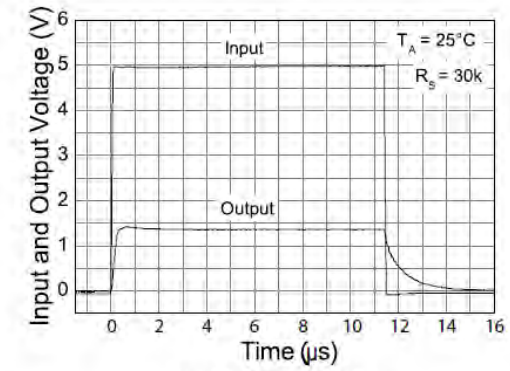
LM4041 1.225 Typical characteristics



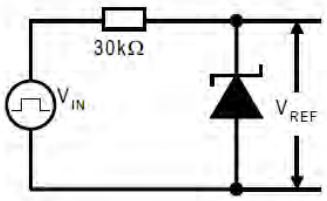
Noise Voltage vs Frequency

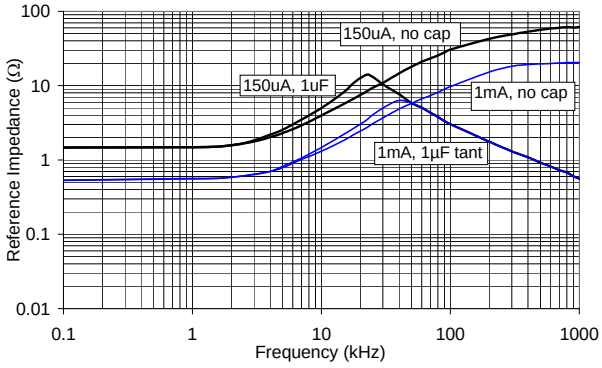


Reverse Current vs Voltage



Pulse Response





Output impedance Vs frequency

Application information

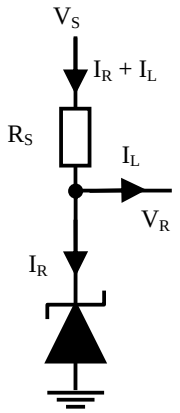


Figure 1

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.

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.

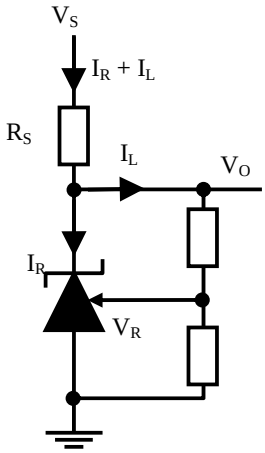


Figure 2

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:

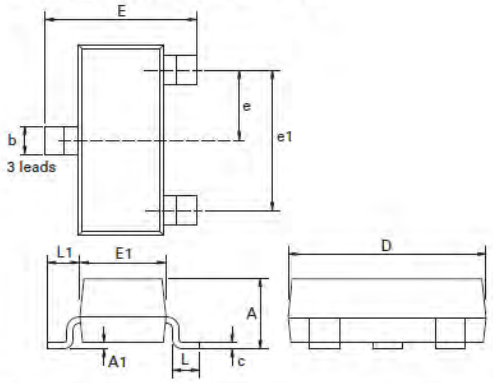
$$V_O = V_R \times \left(1 + \frac{R_2}{R_1}\right)$$

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 pin1.

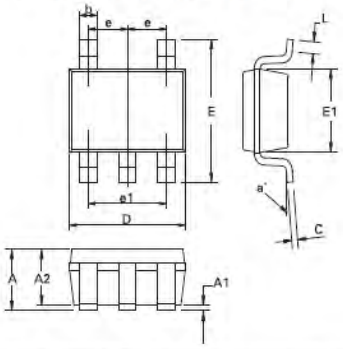
Package outline - SOT23



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

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