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 SC70-5 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/℃. 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

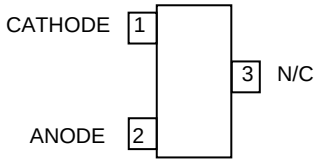
- Small packages: SOT23, SC70-5
- No output capacitor required
- Output voltage tolerance
- LM4041C: ±0.5% at 25℃
- LM4041D: ±1% at 25℃
- Low output noise: 20µVrms (10Hz to 10kHz)
- Wide operating current range: 60µA to 12mA
- Extended temperature range: -40℃ to +125℃
- Low temperature coefficient :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

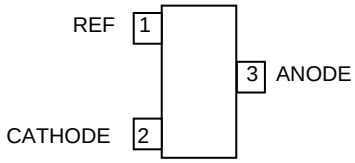
Pin Assignments

LM4041_F (SOT23)

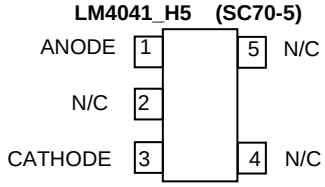


Pin 3 must left floating or connected to pin 2.

LM4041_ADJF….(SOT23)

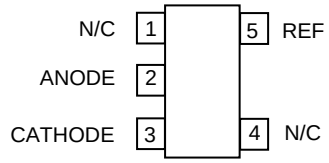


LM4041_H5 (SC70-5)



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	℃
Storage Temperature	-55 to 150	℃
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℃, T_J = 150℃
SOT23	380℃/W	330mW
SC70-5	420℃/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°C, unless otherwise stated, $I_{RMIN} \leq I_R \leq 12mA$, $V_{REF} \leq V_{OUT} \leq 10V$. LM4041C and LM4041D have initial tolerances of 0.5% and 1% respectively.

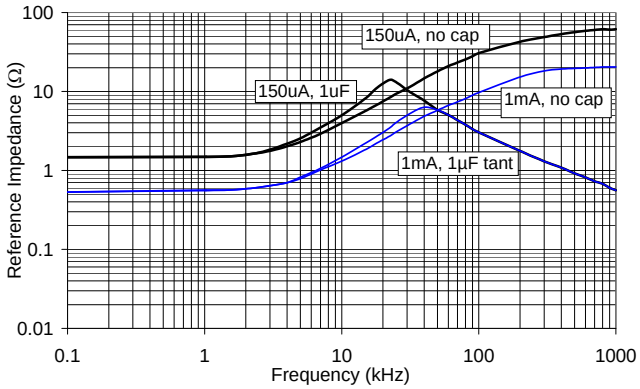
Symbol	Parameter	Conditions	T_A	Typ	LM4041C Limits	LM4041D Limits	Units
V_{REF}	Reverse Breakdown Voltage	I_R = 100 µA	25℃	1.225			V
	Reverse Breakdown Voltage Tolerance		25℃		±6	±12	mV
			-40 to 85℃		±14	±24	
			-40 to 125℃		±18.4	±31	
I_{RMIN}	Minimum Operating Current		25℃	45	60	65	µA
			-40 to 85℃		65	70	
			-40 to 125℃		68	73	
$\Delta V_R/\Delta T$	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 10 mA	-40 to 125℃	±20			ppm/℃
		I_R = 1 mA,		±15	±100	±150	
		I_R = 100 µA		±15			
$\Delta V_R/\Delta I_R$	Reverse Breakdown Change With Current	$I_{RMIN} < I_R < 1mA$	25℃	0.7	1.5	2.0	mV
			-40 to 85℃		2.0	2.5	
			-40 to 125℃		2.0	2.5	
		1mA < I_R < 12 mA	25℃	2.5	6.0	8.0	
			-40 to 85℃		8.0	10.0	
			-40 to 125℃		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

LM4041-Adj

Electrical characteristics over recommended operating conditions, T_A = 25°C, $I_{RMIN} \leq I_R \leq 12$ mA, $V_{REF} \leq V_{OUT} \leq 10V$ 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	T_A	Typ	LM4041D Limits	Units
V_{REF}	Reverse Breakdown Voltage	I_R = 100 µA, V_{KA} = 5V	25℃	1.233		V
	Reverse Breakdown Voltage Tolerance		25℃		±12	mV
			-40 to 85℃		±24	
			-40 to 125℃		±30	
I_{RMIN}	Minimum Operating Current		25℃	45	65	µA
			-40 to 85℃		70	
			-40 to 125℃		73	
$\Delta V_R/\Delta T$	Average Reverse Breakdown Voltage Temperature Coefficient	I_R = 10 mA	-40 to 125℃	±20		ppm/℃
		I_R = 1 mA,		±15	±150	
		I_R = 100 µA		±15		
$\Delta V_R/\Delta V_K$	Reference voltage change with cathode voltage change	I_R = 1mA	25℃	-1.55	-2.5	mV/V
			-40 to 85℃		-3.0	
			-40 to 125℃		-4.0	
I_{REF}	Reference input current		25℃	60	150	nA
			-40 to 85℃		200	
			-40 to 125℃		200	
$\Delta V_R/\Delta I_R$	Reverse Breakdown Change With Current	$I_{RMIN} < I_R < 1mA$ $V_{OUT} > 1.6V$	25℃	0.7	2.0	mV
			-40 to 85℃		2.5	
			-40 to 125℃		2.5	
		1mA < I_R < 12 mA $V_{OUT} > 1.6V$	25℃	2	6.0	
			-40 to 85℃		8.0	
			-40 to 125℃		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

Typical Characteristics LM4041 1.225



Output Impedance vs. Frequency

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.

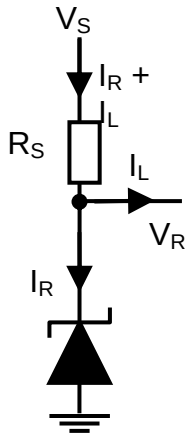


Figure 1

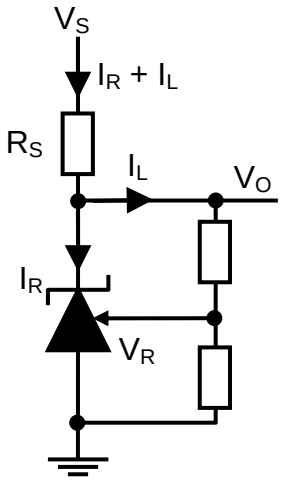


Figure 2

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 varients:

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

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.

Ordering Information

25℃ 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

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