



LM4041

LINEAR INTEGRATED CIRCUIT

PRECISION MICROPOWER SHUNT VOLTAGE REFERENCE

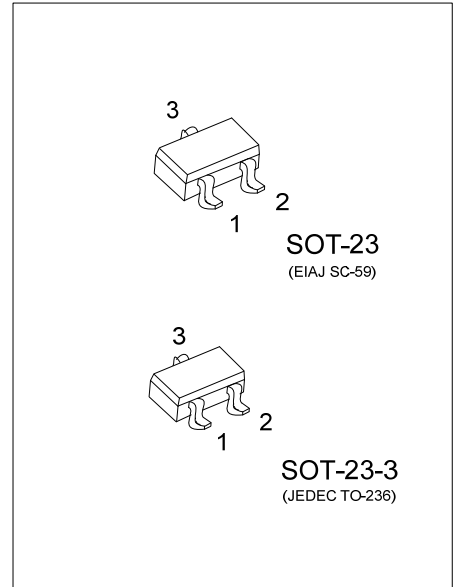
DESCRIPTION

As a shunt voltage reference integrated circuit, UTC **LM4041** can be used for widespread applications with enhancement of the competitive advantage by saving use of external capacitors..

In order to ensure a stable output voltage, the reference not only offers low dynamic impedance, low noise and a low temperature coefficient, but also provides tight output tolerance.

There are Five versions of fixed output and adjustable reverse breakdown voltage. The minimum operating current is 45 μ A for the **LM4041-XX** and the **LM4041-ADJ**.

However, for those applications which the output voltage needs to be adjusted between 1.233V and 10V, an external resistor divider is necessary.



FEATURES

* Low Output Noise : 20 μ V_{RMS} (Typ.)

* Operating Current range : 45 μ A ~ 12mA

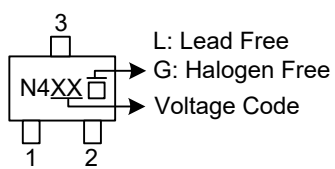
ORDERING INFORMATION

Ordering Number		Package	Packing
Lead Free	Halogen Free		
LM4041L-xx-AE2-R	LM4041G-xx-AE2-R	SOT-23-3	Tape Reel
LM4041L-xx-AE3-R	LM4041G-xx-AE3-R	SOT-23	Tape Reel

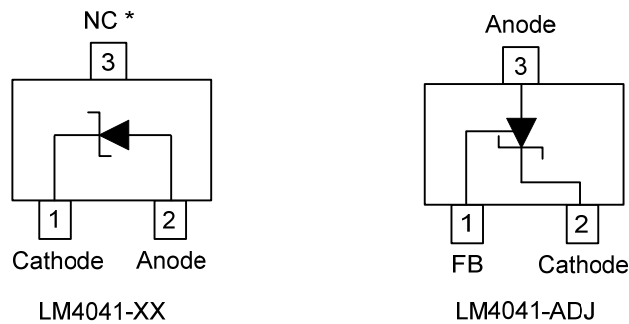
Note: xx: Output Voltage, refer to Marking Information.

LM4041G-xx-AE2-R	(1)Packing Type	(1) R: Tape Reel
	(2)Package Type	(2) AE2: SOT-23-3, AE3: SOT-23
	(3)Output Voltage Code	(3) xx: Refer to Marking Information
	(4)Green Package	(4) G: Halogen Free and Lead Free, L: Lead Free

MARKING INFORMATION

PACKAGE	VOLTAGE CODE	MARKING
SOT-23 SOT-23-3	12: 1.2V 30: 3.0V 25: 2.5V 50: 5.0V 10: 10V AD: ADJ	

PIN CONFIGURATION



* This pin must be left floating or connected to pin 2.

PIN DESCRIPTION

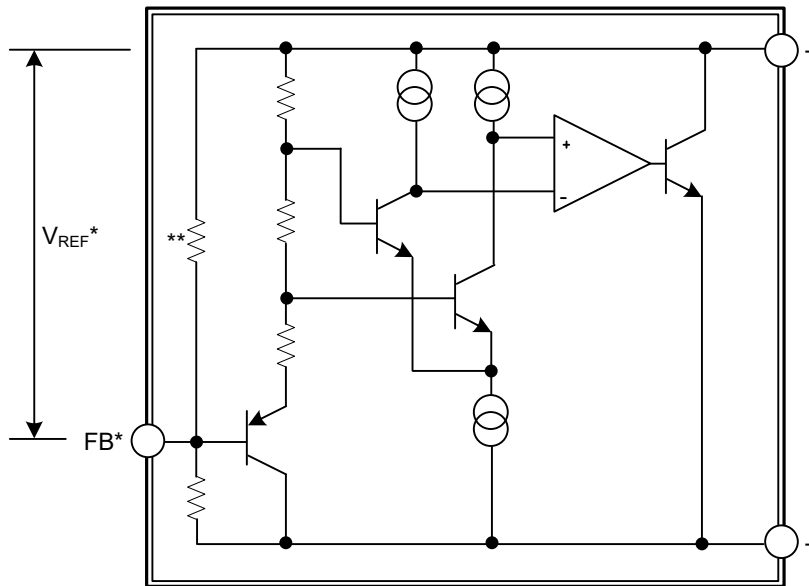
UTC LM4041-1.2

PIN NO.	PIN NAME	DESCRIPTION
1	Cathode	Output reference voltage, cathode terminal
2	Anode	Output reference voltage, anode terminal
3	NC	No Connection

UTC LM4041-ADJ

PIN NO.	PIN NAME	DESCRIPTION
1	FB	Feedback terminal (for)
2	Cathode	Output reference voltage, cathode terminal
3	Anode	Output reference voltage, anode terminal

■ BLOCK DIAGRAM



- * UTC LM4041-ADJ Output only
- ** UTC LM4041-Fixed Output only

■ ABSOLUTE MAXIMUM RATING ($T_A = 25^\circ\text{C}$, unless otherwise specified.)

PARAMETER	SYMBOL	RATINGS	UNIT
Continuous Cathode Voltage	V_Z	15	V
Continuous Cathode Current	I_Z	-10 ~ +25	mA
Power Dissipation (Note 3)	P_D	300	mW
Junction Temperature	T_J	+150	$^\circ\text{C}$
Storage Temperature	T_{STG}	-65 ~ +150	$^\circ\text{C}$

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

■ RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	RATINGS	UNIT
Cathode Current (max)	I_Z	12	mA
Reverse Breakdown Voltage	V_Z	10	V
Operating Temperature	T_A	-40 ~ +85	$^\circ\text{C}$

■ ELECTRICAL CHARACTERISTICS ($T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$, unless otherwise specified.)

FOR UTC LM4041-1.2

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Reverse Breakdown Voltage	V_{REF}	$I_Z = 100\mu\text{A}$, $T_A = 25^\circ\text{C}$		1.225		V
Reverse Breakdown Voltage Tolerance		$I_Z = 100\mu\text{A}$	$T_A = 25^\circ\text{C}$	-12	12	mV
			$T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$	-24	24	mV
Reverse Breakdown Voltage Change With Operating Current Change	$\frac{\Delta V_{REF}}{\Delta I_Z}$	$I_{Z(MIN)} < I_Z < 1\text{mA}$	$T_A = 25^\circ\text{C}$	0.7	2.0	mV
			$T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$		2.5	mV
		$1\text{mA} < I_Z < 12\text{mA}$	$T_A = 25^\circ\text{C}$	2.5	8	mV
			$T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$		10	mV
Minimum Operating Current	$I_{Z(MIN)}$	$T_A = 25^\circ\text{C}$		45	65	μA
		$T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$			70	μA
Temperature Coefficient of Output Voltage (Note)	T_{CVO}	$V_Z = 5\text{V}$, $I_Z = 100\mu\text{A}$, $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$		± 70		ppm/ $^\circ\text{C}$
Reverse Dynamic Impedance	Z_Z	$I_Z = 1\text{mA}$, $I_{AC} = 0.1I_Z$, $f = 120\text{Hz}$, $T_A = 25^\circ\text{C}$		0.5	2.0	Ω
Output Voltage Noise	e_N	$I_Z = 100\mu\text{A}$, $10\text{Hz} \leq f \leq 10\text{kHz}$, $T_A = 25^\circ\text{C}$		20		μV_{rms}
Long-term Stability of Reverse Breakdown Voltage		$t = 1000\text{h}$, $I_Z = 100\mu\text{A}$, $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$,		120		ppm

■ ELECTRICAL CHARACTERISTICS (Cont.)

FOR UTC LM4041-2.5

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Reverse Breakdown Voltage	V_{REF}	$I_Z = 100\mu A, T_A = 25^\circ C$		2.5		V
Reverse Breakdown Voltage Tolerance		$I_Z = 100\mu A$	$T_A = 25^\circ C$	-13	13	mV
			$T_A = -40^\circ C \sim +85^\circ C$	-38	38	mV
Reverse Breakdown Voltage Change With Operating Current Change	$\frac{\Delta V_{REF}}{\Delta I_Z}$	$I_{Z(MIN)} < I_Z < 1mA$	$T_A = 25^\circ C$	0.7	2.0	mV
			$T_A = -40^\circ C \sim +85^\circ C$		2.5	mV
		$1mA < I_Z < 12mA$	$T_A = 25^\circ C$	2.5	9	mV
			$T_A = -40^\circ C \sim +85^\circ C$		11	mV
Minimum Operating Current	$I_{Z(MIN)}$	$T_A = 25^\circ C$		45	65	μA
		$T_A = -40^\circ C \sim +85^\circ C$			70	μA
Temperature Coefficient of Output Voltage (Note)	$T_C V_O$	$I_Z = 100\mu A, T_A = -40^\circ C \sim +85^\circ C$		± 550		ppm/ $^\circ C$
Reverse Dynamic Impedance	Z_Z	$I_Z = 1mA, I_{AC} = 0.1I_Z, f = 120Hz, T_A = 25^\circ C$		0.5	2.0	Ω
Output Voltage Noise	e_N	$I_Z = 100\mu A, 10Hz \leq f \leq 10kHz, T_A = 25^\circ C$		20		μV_{rms}
Long-term Stability of Reverse Breakdown Voltage		$t = 1000h, I_Z = 100\mu A, T_A = 25^\circ C \pm 0.1^\circ C,$		120		ppm

FOR UTC LM4041-3.0

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Reverse Breakdown Voltage	V_{REF}	$I_Z = 100\mu A, T_A = 25^\circ C$		3.0		V
Reverse Breakdown Voltage Tolerance		$I_Z = 100\mu A$	$T_A = 25^\circ C$	-15	15	mV
			$T_A = -40^\circ C \sim +85^\circ C$	-45	45	mV
Reverse Breakdown Voltage Change With Operating Current Change	$\frac{\Delta V_{REF}}{\Delta I_Z}$	$I_{Z(MIN)} < I_Z < 1mA$	$T_A = 25^\circ C$	0.7	2.0	mV
			$T_A = -40^\circ C \sim +85^\circ C$		2.5	mV
		$1mA < I_Z < 12mA$	$T_A = 25^\circ C$	2.5	10	mV
			$T_A = -40^\circ C \sim +85^\circ C$		12	mV
Minimum Operating Current	$I_{Z(MIN)}$	$T_A = 25^\circ C$		45	65	μA
		$T_A = -40^\circ C \sim +85^\circ C$			70	μA
Temperature Coefficient of Output Voltage (Note)	$T_C V_O$	$I_Z = 100\mu A, T_A = -40^\circ C \sim +85^\circ C$		± 550		ppm/ $^\circ C$
Reverse Dynamic Impedance	Z_Z	$I_Z = 1mA, I_{AC} = 0.1I_Z, f = 120Hz, T_A = 25^\circ C$		0.5	2.0	Ω
Output Voltage Noise	e_N	$I_Z = 100\mu A, 10Hz \leq f \leq 10kHz, T_A = 25^\circ C$		20		μV_{rms}
Long-term Stability of Reverse Breakdown Voltage		$t = 1000h, I_Z = 100\mu A, T_A = 25^\circ C \pm 0.1^\circ C,$		120		ppm

■ ELECTRICAL CHARACTERISTICS (Cont.)

FOR UTC LM4041-5.0

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Reverse Breakdown Voltage	V_{REF}	$I_Z = 100\mu A, T_A = 25^\circ C$		5.0		V
Reverse Breakdown Voltage Tolerance		$I_Z = 100\mu A$	$T_A = 25^\circ C$	-25	25	mV
			$T_A = -40^\circ C \sim +85^\circ C$	-75	75	mV
Reverse Breakdown Voltage Change With Operating Current Change	$\frac{\Delta V_{REF}}{\Delta I_Z}$	$I_{Z(MIN)} < I_Z < 1mA$	$T_A = 25^\circ C$	0.7	2.0	mV
			$T_A = -40^\circ C \sim +85^\circ C$		2.5	mV
		$1mA < I_Z < 12mA$	$T_A = 25^\circ C$	2.5	12	mV
			$T_A = -40^\circ C \sim +85^\circ C$		15	mV
Minimum Operating Current	$I_{Z(MIN)}$	$T_A = 25^\circ C$		45	65	μA
		$T_A = -40^\circ C \sim +85^\circ C$			70	μA
Temperature Coefficient of Output Voltage (Note)	T_{CV_O}	$I_Z = 100\mu A, T_A = -40^\circ C \sim +85^\circ C$		± 550		ppm/ $^\circ C$
Reverse Dynamic Impedance	Z_Z	$I_Z = 1mA, I_{AC} = 0.1I_Z, f = 120Hz, T_A = 25^\circ C$		0.5	2.0	Ω
Output Voltage Noise	e_N	$I_Z = 100\mu A, 10Hz \leq f \leq 10kHz, T_A = 25^\circ C$		20		μV_{rms}
Long-term Stability of Reverse Breakdown Voltage		$t = 1000h, I_Z = 100\mu A, T_A = 25^\circ C \pm 0.1^\circ C,$		120		ppm

FOR UTC LM4041-10

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Reverse Breakdown Voltage	V_{REF}	$I_Z = 100\mu A, T_A = 25^\circ C$		10		V
Reverse Breakdown Voltage Tolerance		$I_Z = 100\mu A$	$T_A = 25^\circ C$	-50	50	mV
			$T_A = -40^\circ C \sim +85^\circ C$	-115	115	mV
Reverse Breakdown Voltage Change With Operating Current Change	$\frac{\Delta V_{REF}}{\Delta I_Z}$	$I_{Z(MIN)} < I_Z < 1mA$	$T_A = 25^\circ C$	0.7	2.0	mV
			$T_A = -40^\circ C \sim +85^\circ C$		4.0	mV
		$1mA < I_Z < 12mA$	$T_A = 25^\circ C$	2.5	15	mV
			$T_A = -40^\circ C \sim +85^\circ C$		25	mV
Minimum Operating Current	$I_{Z(MIN)}$	$T_A = 25^\circ C$		45	65	μA
		$T_A = -40^\circ C \sim +85^\circ C$			70	μA
Temperature Coefficient of Output Voltage (Note)	T_{CV_O}	$I_Z = 100\mu A, T_A = -40^\circ C \sim +85^\circ C$		± 550		ppm/ $^\circ C$
Reverse Dynamic Impedance	Z_Z	$I_Z = 1mA, I_{AC} = 0.1I_Z, f = 120Hz, T_A = 25^\circ C$		0.5	2.0	Ω
Output Voltage Noise	e_N	$I_Z = 100\mu A, 10Hz \leq f \leq 10kHz, T_A = 25^\circ C$		20		μV_{rms}
Long-term Stability of Reverse Breakdown Voltage		$t = 1000h, I_Z = 100\mu A, T_A = 25^\circ C \pm 0.1^\circ C,$		120		ppm

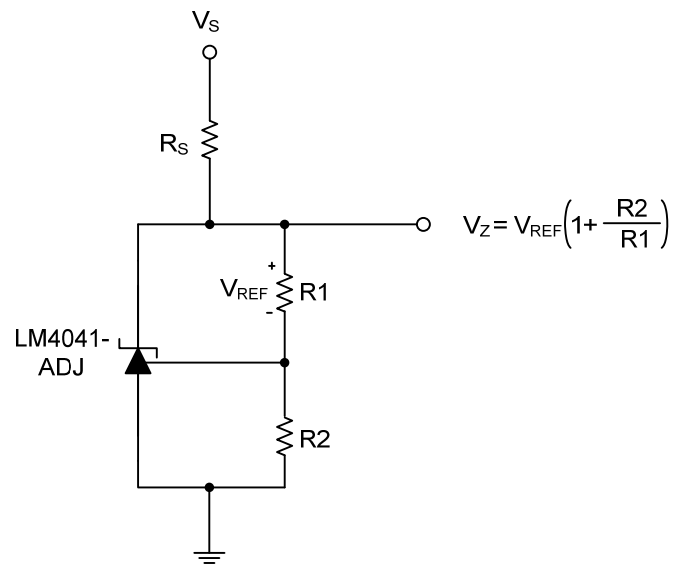
■ ELECTRICAL CHARACTERISTICS (Cont.)

FOR UTC LM4041-ADJ

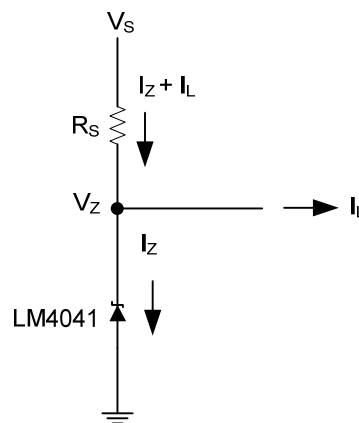
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT	
Reference Voltage	V_{REF}	$V_Z=5V, I_Z = 100\mu A, T_A=25^\circ C$		1.233		V	
Reference Voltage Tolerance		$V_Z=5V, I_Z = 100\mu A$	$T_A=25^\circ C$	-12	12	mV	
			$T_A=-40^\circ C \sim +85^\circ C$	-24	24	mV	
Reference Voltage Change With Cathode Current Change	$\frac{\Delta V_{REF}}{\Delta I_Z}$	$I_{Z(MIN)} < I_Z < 1mA$	$T_A=25^\circ C$		0.7	2	mV
			$T_A=-40^\circ C \sim +85^\circ C$			2.5	mV
		$1mA < I_Z < 12mA$	$T_A=25^\circ C$		2	6	mV
			$T_A=-40^\circ C \sim +85^\circ C$			8	mV
Reference Voltage Change With Output Voltage Change	$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	$I_Z=1mA$	$T_A=25^\circ C$	-1.55	-2	mV/V	
			$T_A=-40^\circ C \sim +85^\circ C$		-3	mV/V	
Minimum Cathode Current	$I_{Z(MIN)}$	$T_A=25^\circ C$		45	75	μA	
		$T_A=-40^\circ C \sim +85^\circ C$			80	μA	
Feedback Current	I_{FB}		$T_A=25^\circ C$		60	150	nA
			$T_A=-40^\circ C \sim +85^\circ C$			200	nA
Temperature Coefficient of Output Voltage (Note)	T_{CVo}	$V_Z=5V, I_Z=100\mu A, T_A=-40^\circ C \sim +85^\circ C$		± 70		ppm/ $^\circ C$	
Reverse Dynamic Impedance	Z_Z	$V_Z=V_{REF}, I_Z=1mA, I_{AC}=0.1I_Z$ $f=120Hz, T_A=25^\circ C$		0.3		Ω	
		$V_Z=10V, I_Z=1mA, I_{AC}=0.1I_Z$ $f=120Hz, T_A=25^\circ C$		2		Ω	
Output Voltage Noise	e_N	$V_Z=V_{REF}, I_Z = 100\mu A$ $10Hz \leq f \leq 10 kHz, T_A=25^\circ C$		20		μV_{rms}	
Long-term Stability of Reverse Breakdown Voltage		$t=1000h, I_Z=100\mu A, T_A= 25^\circ C \pm 0.1^\circ C,$		120		ppm	

Note: Reference voltage and average temperature coefficient change with output voltage (V_Z).

■ TYPICAL APPLICATION CIRCUIT



Adjustable Shunt Regulator



Shunt Regulator

■ APPLICATION INFORMATION

V_Z is set according to the equation shown as below which can be set by a user-defined resistor divider.

Cathode and Load Currents

The total current available to supply the load (I_L) and bias the UTC **LM4041** (I_Z) is set by R_S , so its value must be set properly. In all cases, I_Z must stay in a specified range for proper operation of the reference; R_S must be small enough to supply the minimum I_Z . At maximum V_S and minimum I_L , to limit I_Z to not exceed rating of 12 mA, R_S must be large enough.

$$R_S = \frac{(V_S - V_Z)}{(I_L + I_Z)}$$

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