

# MC78LC00 Series

## Micropower Voltage Regulator

The MC78LC00 series voltage regulators are specifically designed for use as a power source for video instruments, handheld communication equipment, and battery powered equipment.

The MC78LC00 series features an ultra-low quiescent current of 1.1  $\mu\text{A}$  and a high accuracy output voltage. Each device contains a voltage reference, an error amplifier, a driver transistor and resistors for setting the output voltage. These devices are available in either SOT-89, 3 pin, or SOT-23, 5 pin, surface mount packages.

### MC78LC00 Series Features:

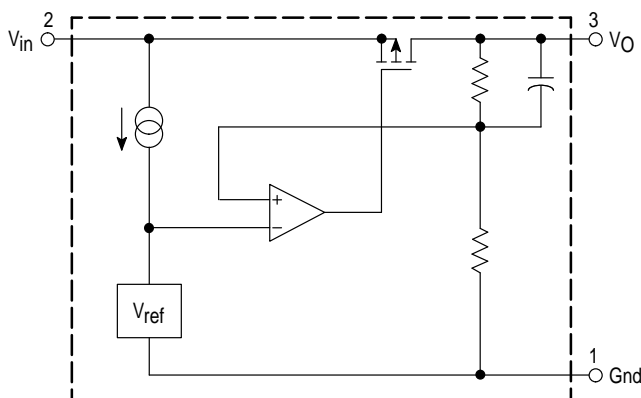
- Low Quiescent Current of 1.1  $\mu\text{A}$  Typical
- Low Dropout Voltage (220 mV at 10 mA)
- Excellent Line Regulation (0.1%)
- High Accuracy Output Voltage ( $\pm 2.5\%$ )
- Wide Output Voltage Range (2.0 V to 6.0 V)
- Output Current for Low Power (up to 80 mA)
- Two Surface Mount Packages (SOT-89, 3 Pin, or SOT-23, 5 Pin)

### ORDERING INFORMATION

Device	Output Voltage	Operating Temperature Range	Package
MC78LC30HT1	3.0	$T_A = -30^\circ \text{ to } +80^\circ \text{C}$	SOT-89
MC78LC33HT1	3.3		
MC78LC40HT1	4.0		
MC78LC50HT1	5.0		
MC78LC30NTR	3.0		SOT-23
MC78LC33NTR	3.3		
MC78LC40NTR	4.0		
MC78LC50NTR	5.0		

Other voltages from 2.0 to 6.0 V, in 0.1 V increments, are available upon request. Consult factory for information.

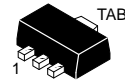
### Representative Block Diagram



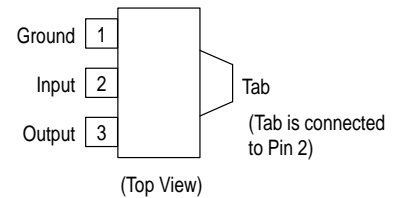
This device contains 8 active transistors.

## MICROPOWER ULTRA-LOW QUIESCENT CURRENT VOLTAGE REGULATORS

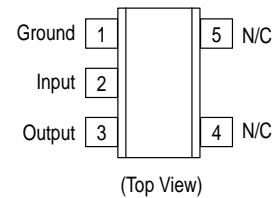
### SEMICONDUCTOR TECHNICAL DATA



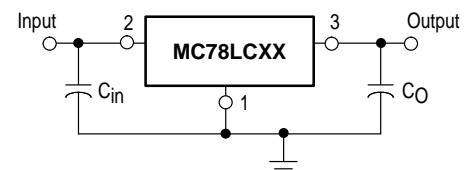
**H SUFFIX**  
PLASTIC PACKAGE  
CASE 1213  
(SOT-89)



**N SUFFIX**  
PLASTIC PACKAGE  
CASE 1212  
(SOT-23)



### Standard Application



## MC78LC00 Series

### MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input Voltage	$V_{CC}$	10	Vdc
Power Dissipation and Thermal Characteristics			
Maximum Power Dissipation			
Case 1213 (SOT-89) H Suffix	$P_D$	300	mW
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	333	°C/W
Case 1212 (SOT-23) N Suffix	$P_D$	150	mW
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	667	°C/W
Operating Junction Temperature	$T_J$	125	°C
Operating Ambient Temperature	$T_A$	-30 to +80	°C
Storage Temperature Range	$T_{stg}$	-40 to +125	°C

**NOTE:** ESD data available upon request.

### ELECTRICAL CHARACTERISTICS ( $V_{in} = V_O + 1.0$ V, $I_O = 10$ mA, $T_J = 25^\circ\text{C}$ [Note 1], unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Output Voltage	$V_O$				V
30HT1 and 30NTR Suffixes ( $V_{in} = 5.0$ V)		2.950	3.0	3.075	
33HT1 and 33NTR Suffixes ( $V_{in} = 5.0$ V)		3.218	3.3	3.382	
40HT1 and 40NTR Suffixes ( $V_{in} = 6.0$ V)		3.900	4.0	4.100	
50HT1 and 50NTR Suffixes ( $V_{in} = 7.0$ V)		4.875	5.0	5.125	
Line Regulation	Reg <sub>line</sub>	–	0.05	0.2	mV
$V_{in} = [V_O + 1.0]$ V to 10 V, $I_O = 1.0$ mA					
Load Regulation ( $I_O = 1.0$ to 10 mA)	Reg <sub>load</sub>				mV
30HT1 and 30NTR Suffixes ( $V_{in} = 5.0$ V)		–	40	60	
33HT1 and 33NTR Suffixes ( $V_{in} = 6.0$ V)		–	40	60	
40HT1 and 40NTR Suffixes ( $V_{in} = 7.0$ V)		–	50	70	
50HT1 and 50NTR Suffixes ( $V_{in} = 8.0$ V)		–	60	90	
Output Current	$I_O$				mA
30HT1 and 30NTR Suffixes ( $V_{in} = 5.0$ V)		35	50	–	
33HT1 and 33NTR Suffixes ( $V_{in} = 6.0$ V)		35	50	–	
40HT1 and 40NTR Suffixes ( $V_{in} = 7.0$ V)		45	65	–	
50HT1 and 50NTR Suffixes ( $V_{in} = 8.0$ V)		55	80	–	
Dropout Voltage	$V_{in} - V_O$				V
30HT1 and 30NTR Suffixes ( $I_O = 1.0$ mA)		–	40	60	
33HT1 and 33NTR Suffixes ( $I_O = 1.0$ mA)		–	35	53	
40HT1 and 40NTR Suffixes ( $I_O = 1.0$ mA)		–	25	38	
50HT1 and 50NTR Suffixes ( $I_O = 1.0$ mA)		–	25	38	
Quiescent Current	$I_{CC}$				μA
30HT1 and 30NTR Suffixes ( $V_{in} = 5.0$ V)		–	1.1	3.3	
33HT1 and 33NTR Suffixes ( $V_{in} = 5.0$ V)		–	1.1	3.3	
40HT1 and 40NTR Suffixes ( $V_{in} = 6.0$ V)		–	1.2	3.6	
50HT1 and 50NTR Suffixes ( $V_{in} = 7.0$ V)		–	1.3	3.9	
Output Voltage Temperature Coefficient	$T_C$	–	±100	–	ppm/°C

**NOTE:** 1. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.

# MC78LC00 Series

## DEFINITIONS

**Dropout Voltage** – The input/output voltage differential at which the regulator output no longer maintains regulation against further reductions in input voltage. Measured when the output drops 100 mV below its nominal value (which is measured at 1.0 V differential), dropout voltage is affected by junction temperature, load current and minimum input supply requirements.

**Line Regulation** – The change in output voltage for a change in input voltage. The measurement is made under conditions

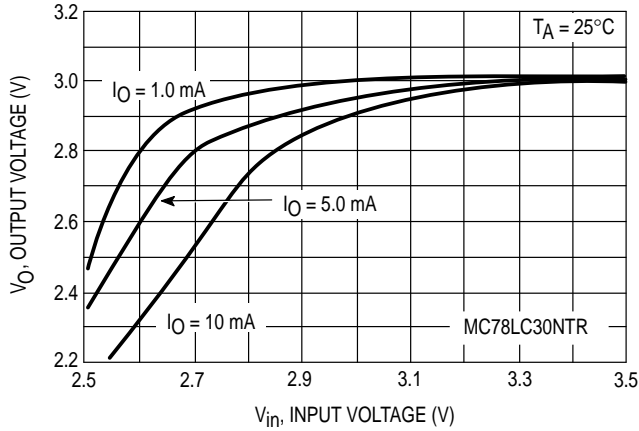
of low dissipation or by using pulse techniques such that average chip temperature is not significantly affected.

**Load Regulation** – The change in output voltage for a change in load current at constant chip temperature.

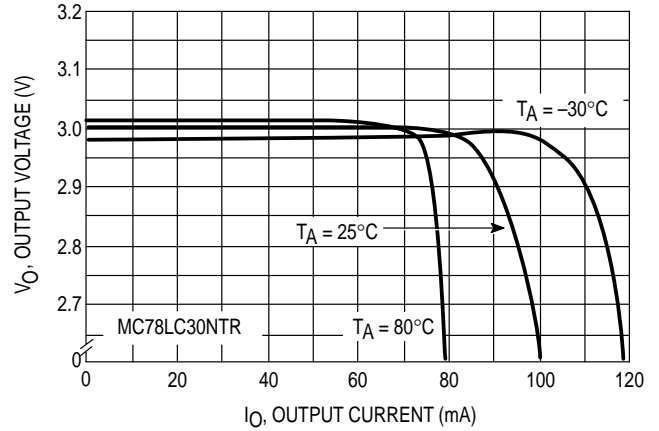
**Maximum Power Dissipation** – The maximum total device dissipation for which the regulator will operate within specifications.

**Quiescent Bias Current** – Current which is used to operate the regulator chip and is not delivered to the load.

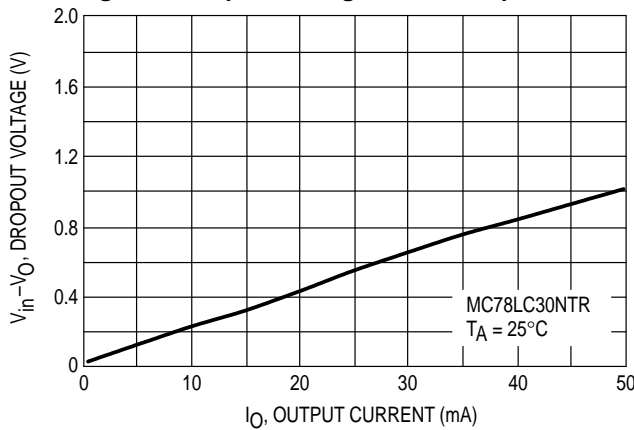
**Figure 1. Output Voltage versus Input Voltage**



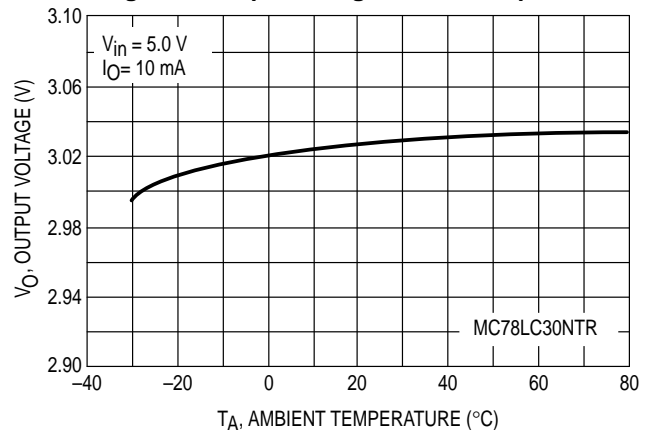
**Figure 2. Output Voltage versus Output Current**



**Figure 3. Dropout Voltage versus Output Current**

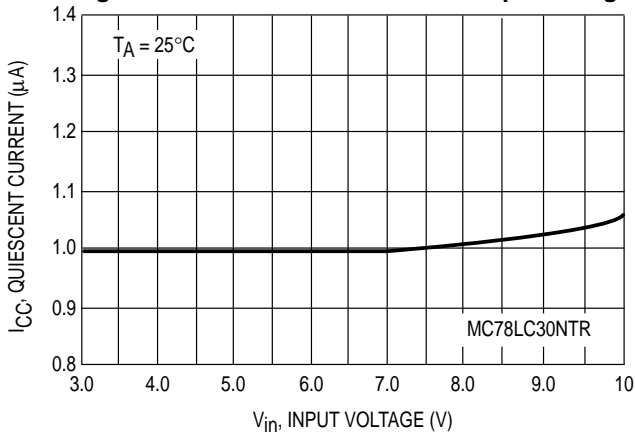


**Figure 4. Output Voltage versus Temperature**

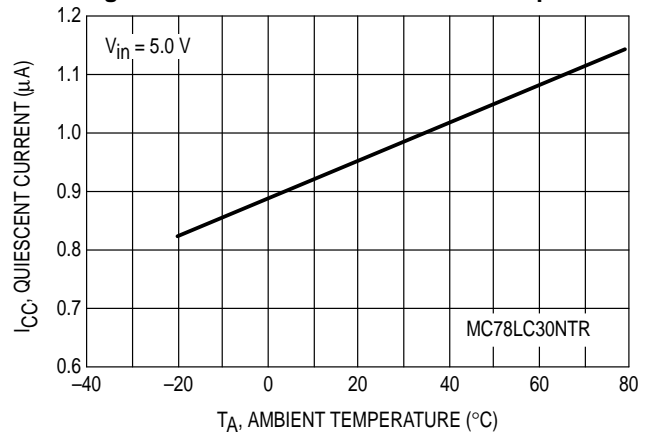


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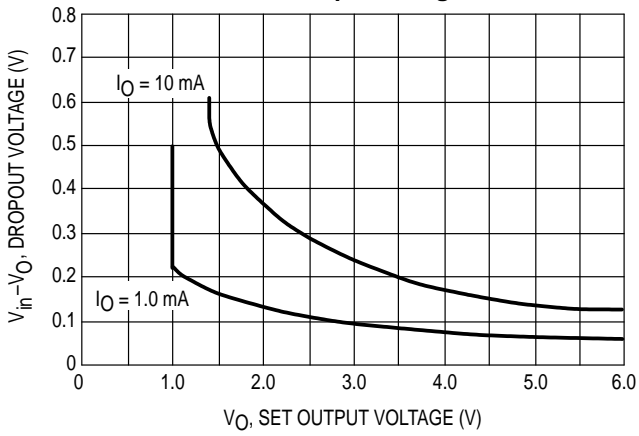
**Figure 5. Quiescent Current versus Input Voltage**



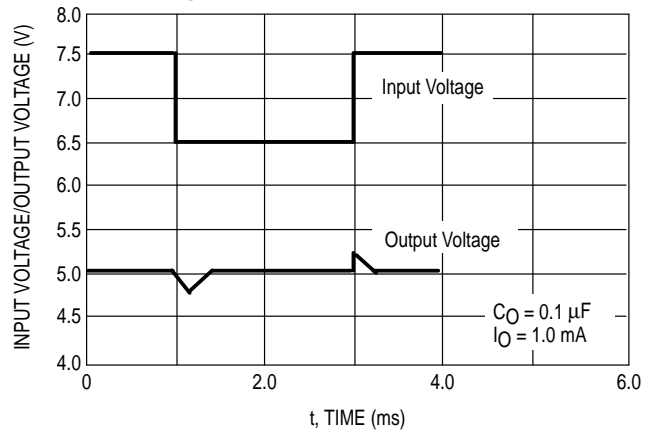
**Figure 6. Quiescent Current versus Temperature**



**Figure 7. Dropout Voltage versus Set Output Voltage**



**Figure 8. Line Transient Response**



# MC78LC00 Series

## APPLICATIONS INFORMATION

### Introduction

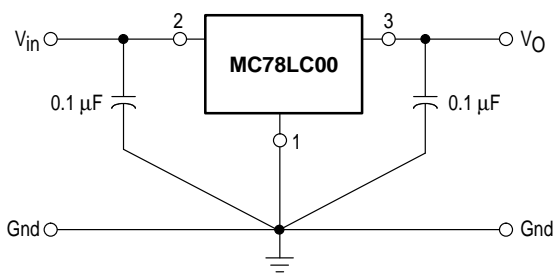
The MC78LC00 micropower voltage regulators are specifically designed with high accuracy output voltage and ultra low quiescent current by CMOS process making them ideal for battery powered applications and hand-held communication equipment. An input bypass capacitor is recommended if the regulator is located an appreciable distance ( $\geq 4$  inches) from the input voltage source. These regulators require  $\geq 0.1 \mu\text{F}$  capacitance between the output terminal and ground for stability. Most types of aluminum, tantalum or multilayer ceramic will perform adequately. Solid tantalums or other appropriate capacitors are recommended for operation below  $25^\circ\text{C}$ . The bypass capacitors should be mounted with the shortest possible leads or track lengths directly across the regulator input and output terminals.

With economical electrolytic capacitors, cold temperature operation can pose a serious stability problem. As the

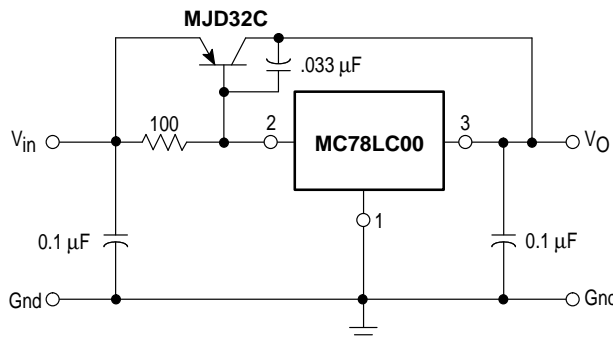
electrolyte freezes, around  $-30^\circ\text{C}$ , the capacitance will decrease and the equivalent series resistance (ESR) will increase drastically, causing the circuit to oscillate. Quality electrolytic capacitors with extended temperature ranges of  $-40^\circ$  to  $+85^\circ\text{C}$  are readily available. Solid tantalum capacitors may be the better choice if small size is a requirement. However, a maximum ESR limit of  $3.0 \Omega$  must be observed over temperature to maintain stability.

In the Current Boost Circuit, shown in Figures 10 and 12, an output current of up to 600 mA can be delivered by the circuit. The circuit of Figure 10 has no current limit. In each case, the external transistor must be rated for the expected power dissipation. Figure 11 shows how a fixed output may be programmed, using R1 and R2, to provide a higher output voltage.

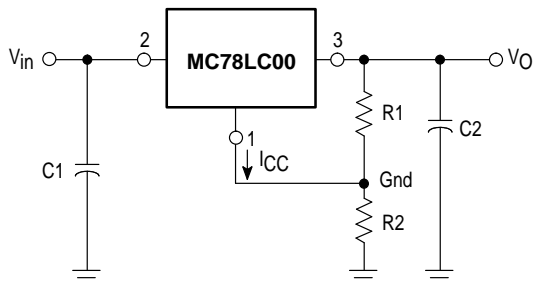
**Figure 9. Typical Application**



**Figure 10. Current Boost Circuit**

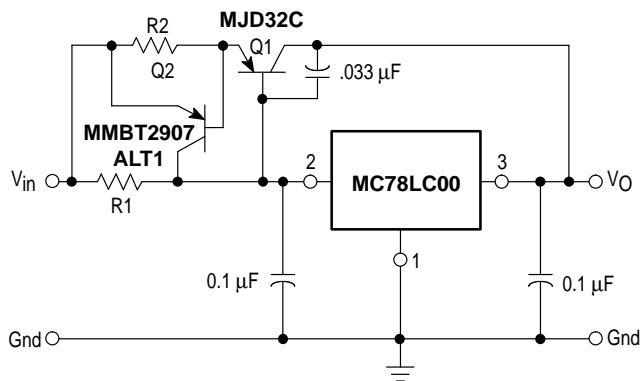


**Figure 11. Adjustable  $V_O$**



$$V_O = V_{O(\text{Reg})} \left( 1 + \frac{R_2}{R_1} \right) + I_{CC} R_2$$

**Figure 12. Current Boost Circuit with Overcurrent Limit Circuit**

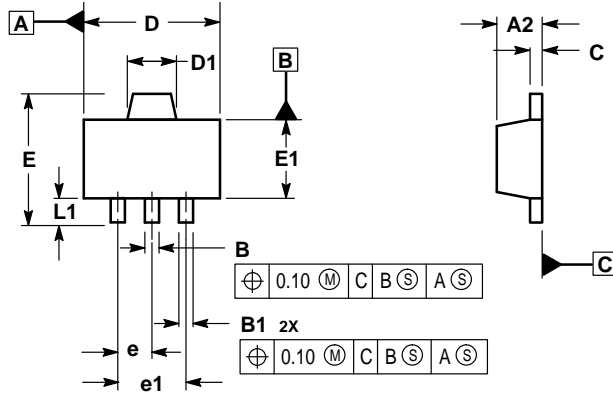


$$I_{O(\text{short circuit})} \approx \frac{V_{BE2}}{R_2} + \frac{V_{BE1} + V_{BE2}}{R_1}$$

# MC78LC00 Series

## OUTLINE DIMENSIONS

H SUFFIX  
 PLASTIC PACKAGE  
 CASE 1213-01  
 (SOT-89)  
 ISSUE O



NOTES:

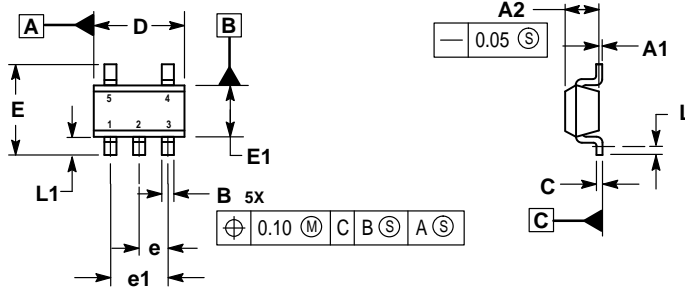
1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCING PER ASME Y14.5M, 1994.
3. DATUM C IS A SEATING PLANE.

DIM	MILLIMETERS	
	MIN	MAX
A2	1.40	1.60
B	0.37	0.57
B1	0.32	0.52
C	0.30	0.50
D	4.40	4.60
D1	1.50	1.70
E	—	4.25
E1	2.40	2.60
e	1.50 BSC	
e1	3.00 BSC	
L1	0.80	—

# MC78LC00 Series

## OUTLINE DIMENSIONS


N SUFFIX  
 PLASTIC PACKAGE  
 CASE 1212-01  
 (SOT-23)  
 ISSUE O



- NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.
  2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
  3. DATUM C IS A SEATING PLANE.

MILLIMETERS		
DIM	MIN	MAX
A1	0.00	0.10
A2	1.00	1.30
B	0.30	0.50
C	0.10	0.25
D	2.80	3.00
E	2.50	3.10
E1	1.50	1.80
e	0.95 BSC	
e1	1.90 BSC	
L	0.20	—
L1	0.45	0.75

# MC78LC00 Series

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