



**MOTOROLA**

## Advance Information

# Micropower Voltage Regulator

The MC78BC00 voltage regulators are specifically designed to be used with an external power transistor to deliver high current with high voltage accuracy and low quiescent current.

The MC78BC00 series are devices suitable for constructing regulators with ultra-low dropout voltage and output current in the range of several tens of mA to hundreds of mA. These devices have a chip enable function, which minimizes the standby mode current drain. Each of these devices contains a voltage reference unit, an error amplifier, a driver transistor and feedback resistors. These devices are available in the SOT-23, 5 pin surface mount packages.

These devices are ideally suited for battery powered equipment, and power sources for hand-held audio instruments, communication equipment and domestic appliances.

### MC78BC00 Series Features:

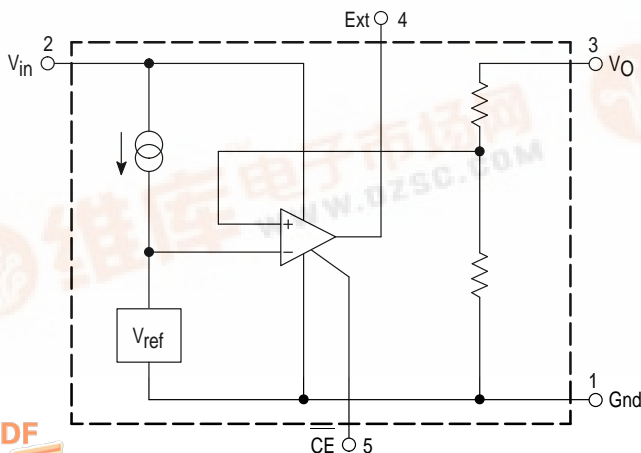
- Ultra-Low Supply Current (50  $\mu$ A)
- Standby Mode (0.2  $\mu$ A)
- Ultra-Low Dropout Voltage (0.1 V with External Transistor and  $I_O = 100$  mA)
- Excellent Line Regulation (Typically 0.1%/V)
- High Accuracy Output Voltage ( $\pm 2.5\%$ )

### ORDERING INFORMATION

Device	Output Voltage	Operating Temperature Range	Package
MC78BC30NTR	3.0	$T_A = -30^\circ$ to $+80^\circ\text{C}$	SOT-23
MC78BC33NTR	3.3		
MC78BC40NTR	4.0		
MC78BC50NTR	5.0		

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

### Representative Block Diagram



This device contains 13 active transistors.

## MC78BC00 Series

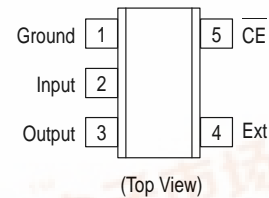
### VOLTAGE REGULATOR WITH EXTERNAL POWER TRANSISTOR

#### SEMICONDUCTOR TECHNICAL DATA



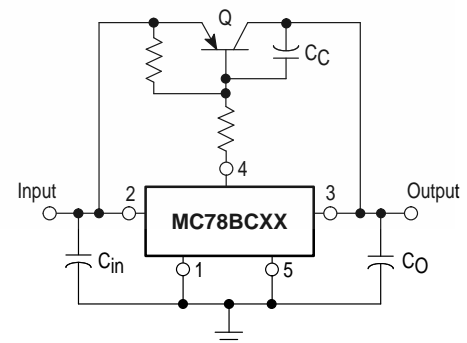
**N SUFFIX**  
PLASTIC PACKAGE  
CASE 1212  
(SOT-23)

### PIN CONNECTIONS



(Top View)

### Standard Application



## MC78BC00 Series

**MAXIMUM RATINGS** ( $T_C = 25^\circ\text{C}$ , unless otherwise noted.)

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

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

**ELECTRICAL CHARACTERISTICS** ( $V_{in} = V_O + 1.0\text{ V}$ ,  $I_O = 50\text{ mA}$ ,  $T_J = 25^\circ\text{C}$  [Note 1], unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Output Voltage	$V_O$				V
MC78BC30NTR		2.925	3.0	3.075	
MC78BC33NTR		3.218	3.3	3.382	
MC78BC40NTR		3.900	4.0	4.100	
MC78BC50NTR		4.875	5.0	5.125	
Line Regulation $V_O + 0.5\text{ V} \leq V_{in} \leq 8.0\text{ V}$	Regline	0	0.1	0.3	mV
Load Regulation $V_{in} - V_O = 1.0\text{ V}$ $1.0\text{ mA} \leq I_O \leq 100\text{ mA}$	Regload	—	40	60	mV
Output Current (Note 2) $V_{in} - V_O = 1.0\text{ V}$	$I_O$	—	1000	—	mA
Dropout Voltage $I_O = 100\text{ mA}$	$V_{in} - V_O$	—	100	200	mV
Supply Current $V_{in} = 8.0\text{ V}$ $V_{in} - V_O = 1.0\text{ V}$ $I_O = 0$ (at no load)	$I_{ss}$	—	50	80	$\mu\text{A}$
Supply Current (Standby) $V_{in} = 8.0\text{ V}$	$I_{standby}$	0.1	0.2	1.0	$\mu\text{A}$
Ext Leakage Current	$I_{LK}$	—	—	0.5	$\mu\text{A}$
Chip Enable Input Logic Voltage	$V_{CE}$				V
Logic "0" (Regulator "On")		0	—	0.25	
Logic "1" (Regulator "Off")		1.5	—	8.0	
Chip Enable Input Current	$I_{CEL}$				$\mu\text{A}$
$V_{CE} = 0.25\text{ V}$		-5.0	-3.0	-0.1	
$V_{CE} = 1.5\text{ V}$		—	—	0.1	
Output Voltage Temperature Coefficient	$T_C$	—	$\pm 100$	—	ppm/ $^\circ\text{C}$

**NOTES:** 1. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.  
2. The output current depends upon the performance of External PNP Transistor. Use External PNP Transistor of a low saturation type, with an  $H_{FE}$  of 100 or more.

## MC78BC00 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.

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

Figure 1. Output Voltage versus Input Voltage

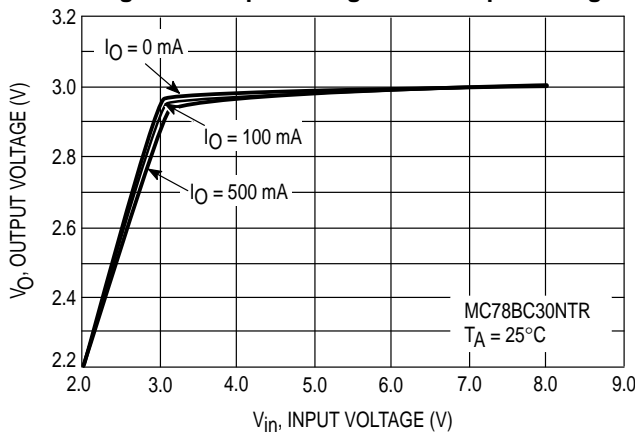


Figure 2. Output Voltage versus Output Current

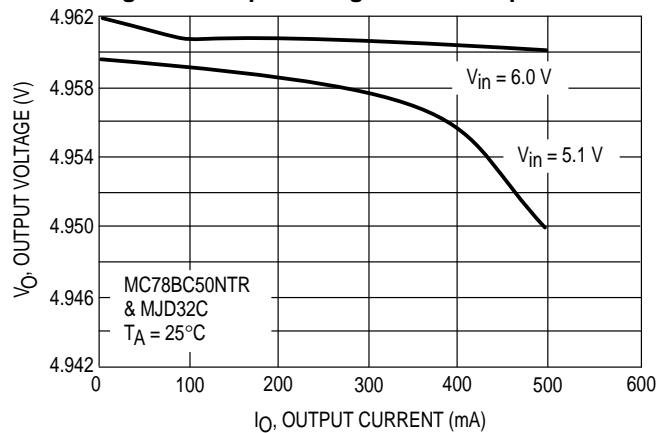


Figure 3. Dropout Voltage versus Output Current

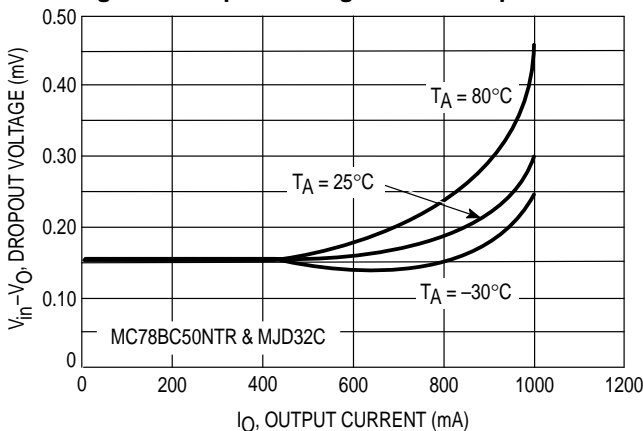
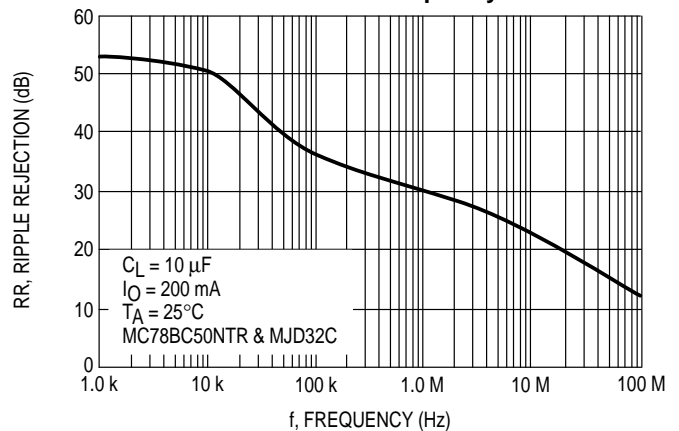
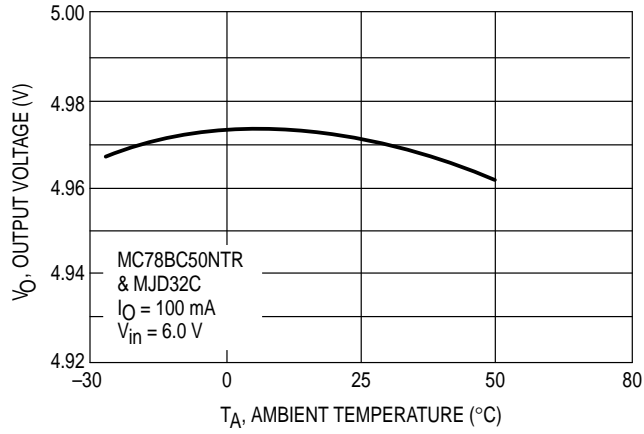


Figure 4. Ripple Rejection as a Function of Frequency

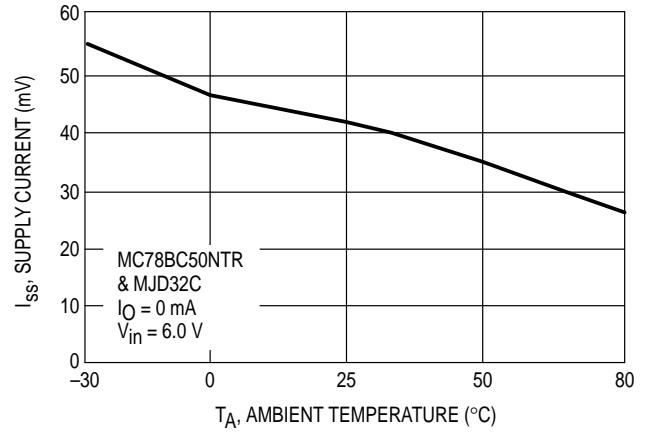


## MC78BC00 Series

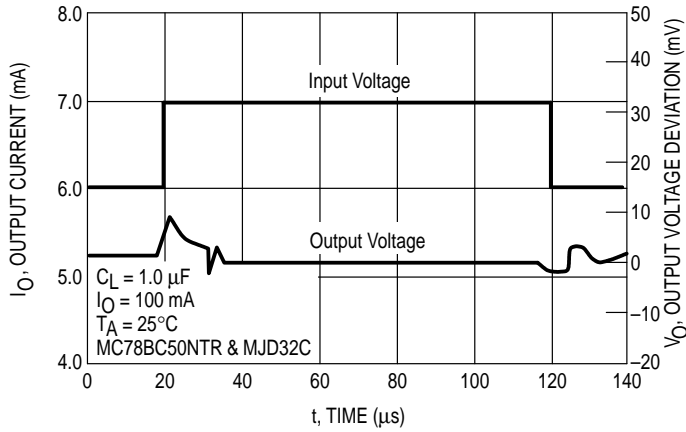
**Figure 5. Output Voltage versus Temperature**



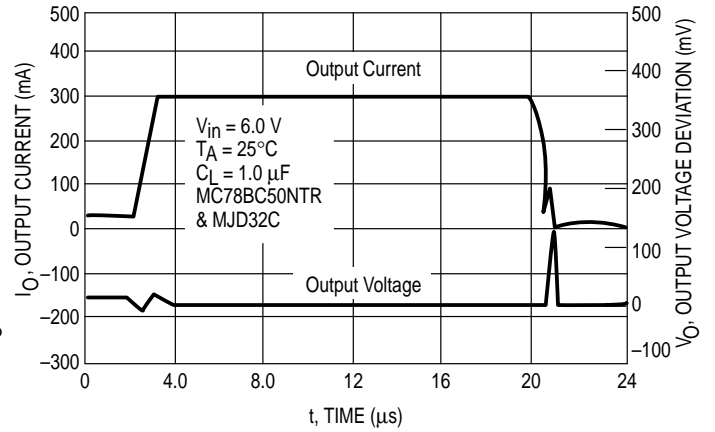
**Figure 6. Supply Current versus Temperature**



**Figure 7. Line Transient Response**



**Figure 8. Load Transient Response**



## MC78BC00 Series

### APPLICATIONS INFORMATION

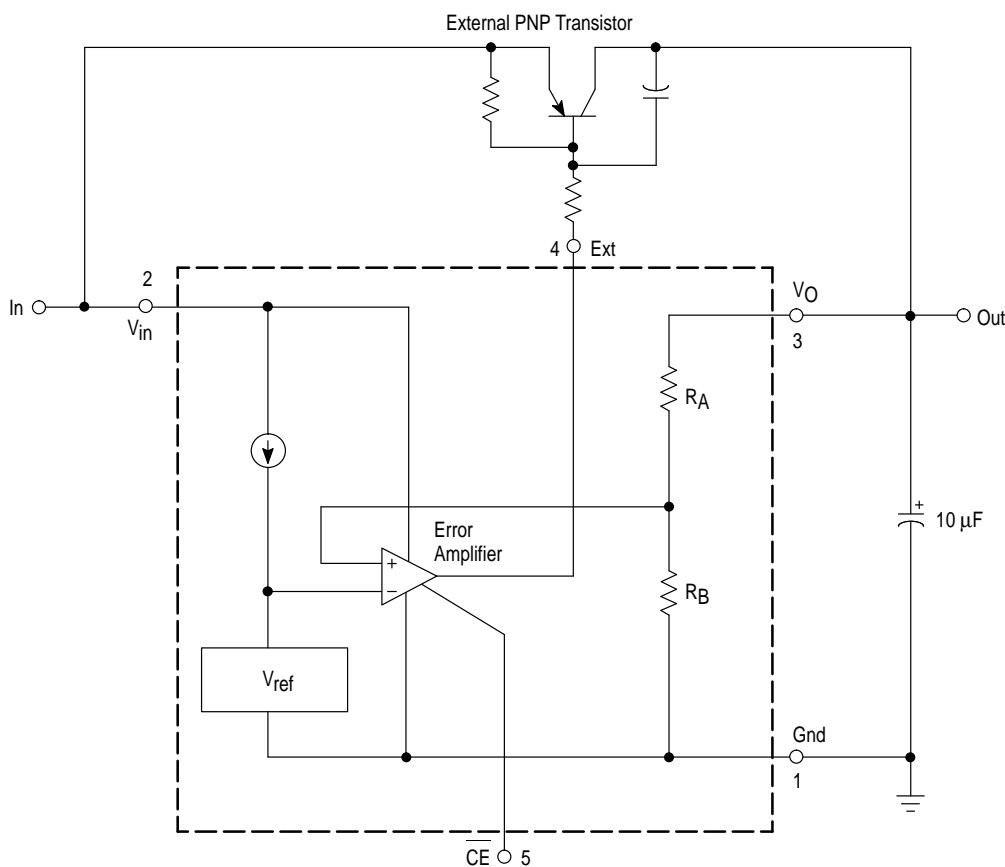
#### Introduction

The MC78BC00 series of micropower voltage regulators are specifically designed for ultra-low dropout voltage and an output current which ranges from several tens of mA to several hundreds of mA making them ideal for battery-powered equipment. These regulators also have a chip enable function which minimizes supply current in stand-by mode. 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 a  $10\text{ }\mu\text{F}$  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  $3.0\text{ }\Omega$  must be observed over temperature to maintain stability.

**Figure 9. Typical Operation**



## MC78BC00 Series

### External PNP Transistor

The external pin of this IC is protected by a current limit circuit from the destruction caused by excess current. The R2 resistor shown in Figure 10 is used for the protection of the

external transistor, although this circuit can operate without the resistor. Resistor R2 should be determined via the input voltage, output voltage, output current, temperature and the  $H_{FE}$  of the external pass transistor.

Figure 10. External PNP

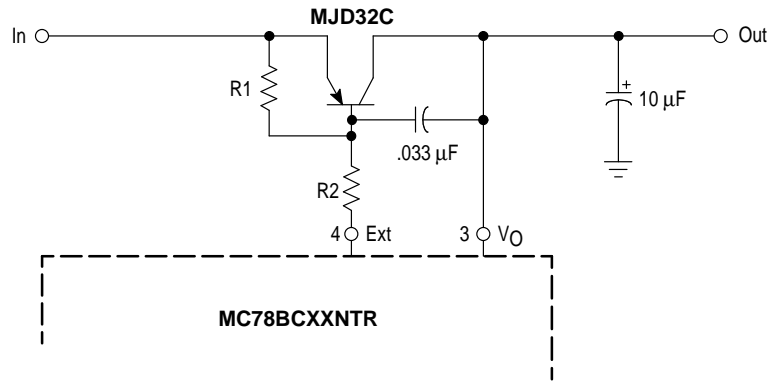
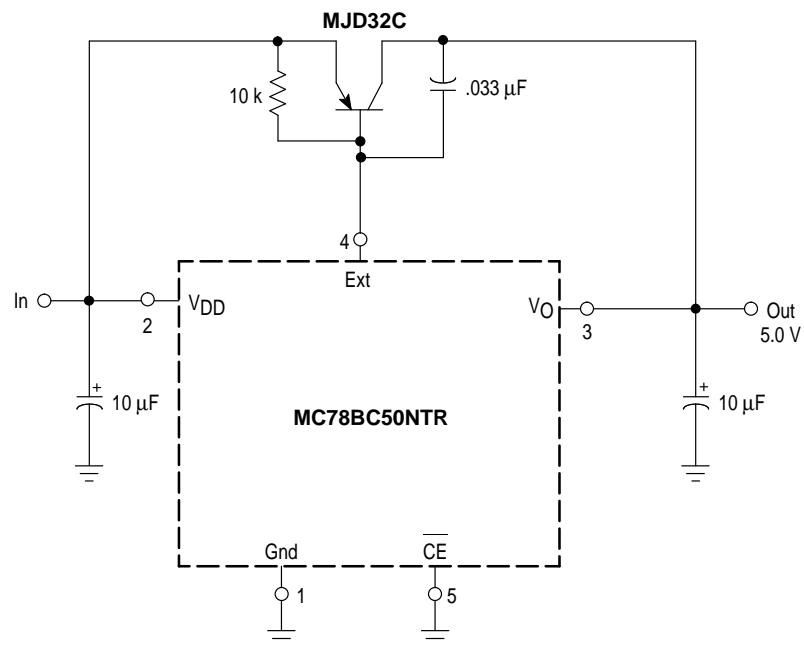


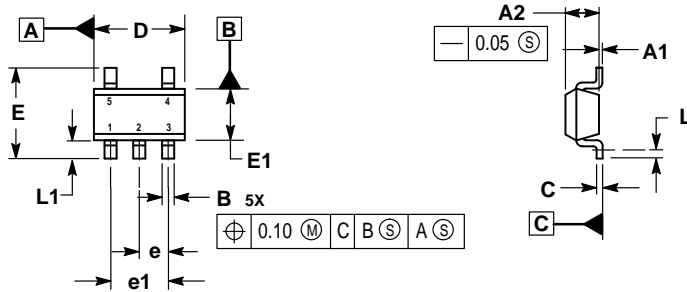
Figure 11. Typical Application



# MC78BC00 Series

## OUTLINE DIMENSIONS

N SUFFIX  
PLASTIC PACKAGE  
CASE 1212  
(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

## MC78BC00 Series

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