**FAIRCHILD**
A Schlumberger Company

# μA78G • μA79G 4-Terminal Adjustable Voltage Regulators

Linear Division Voltage Regulators

## Description

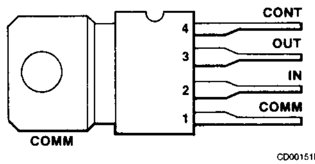
The μA78G and μA79G are 4-terminal adjustable voltage regulators. They are designed to deliver continuous load currents of up to 1.0 A with a maximum input voltage of +40 V for the positive regulator μA78G and -40 V for the negative regulator μA79G. Output current capability can be increased to greater than 1.0 A through use of one or more external transistors. The output voltage range of the μA78G positive voltage regulator is +5 V to +30 V and the output voltage range of the negative μA79G is -30 V to -2.2 V. For systems requiring both a positive and negative, the μA78G and μA79G are excellent for use as a dual tracking regulator with appropriate external circuitry. These 4-terminal voltage regulators are constructed using the Fairchild Planar process.

- **Output Current In Excess Of 1 A**
- **μA78G Positive Output +5 To +30 V**
- **μA79G Negative Output -30 To -2.2 V**
- **Internal Thermal Overload Protection**
- **Internal Short Circuit Protection**
- **Output Transistor Safe-Area Protection**

## Absolute Maximum Ratings

| | |
|---|---|
| Storage Temperature Range | -65°C to +150°C |
| Operating Junction Temperature Range | 0°C to 150°C |
| Lead Temperature (soldering, 10 s) | 265°C |
| Power Dissipation | Internally Limited |
| Input Voltage | |
| μA78G | +40 V |
| μA79G | -40 V |
| Control Lead Voltage | |
| μA78G | $0\ V \leq V+ \leq V_O$ |
| μA79G | $V_O- \leq V- \leq 0\ V$ |

## Connection Diagram 4-Lead TO-202 Package (Top View)

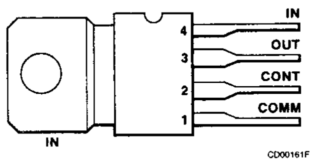



Heat sink tabs connected to common through device substrate.

## Order Information

| Device Code | Package Code | Package Description |
|---|---|---|
| μA78GU1C | 8Z | Power Watt |

## Connection Diagram 4-Lead TO-202 Package (Top View)

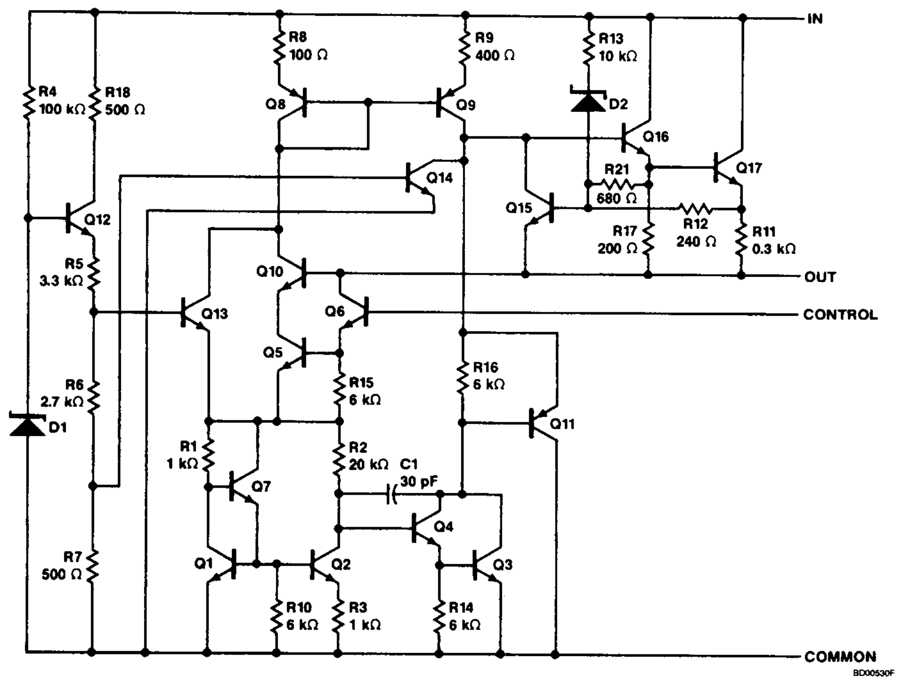



Heat sink tabs connected to input through device substrate. Not recommended for direct electrical connection.

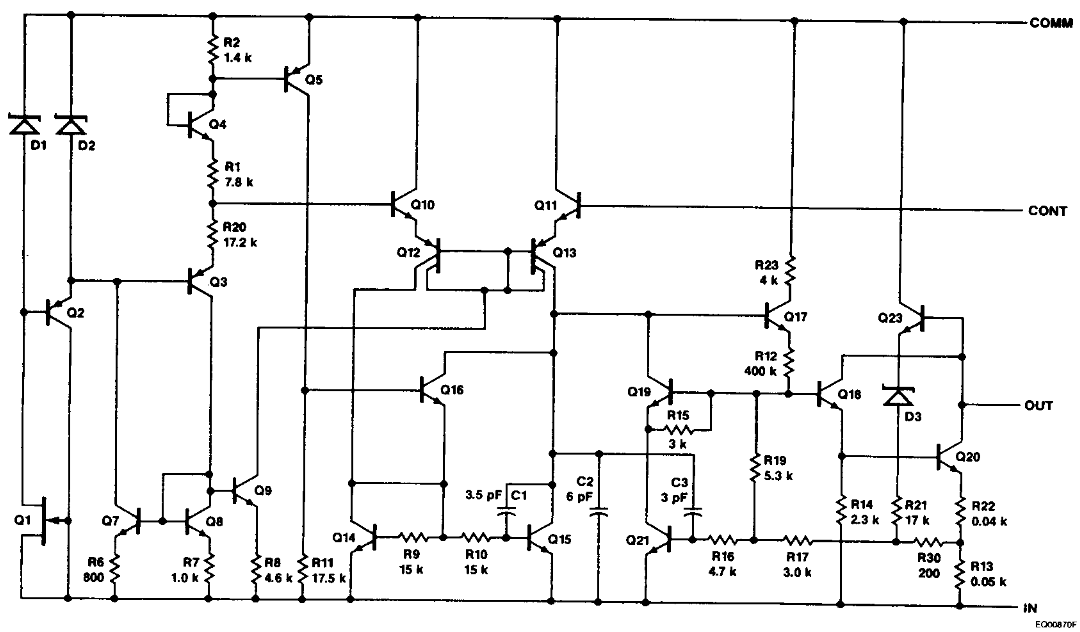
## Order Information

| Device Code | Package Code | Package Description |
|---|---|---|
| μA79GU1C | 8Z | Power Watt |

## μA78G Equivalent Circuit




## μA79G Equivalent Circuit (Note 1)




**Note**

1. All Resistor values in ohms

## µA78G

**Electrical Characteristics** $0°C \leqslant T_A \leqslant 125°C$, $C_I = 0.33\ \mu F$, $C_O = 0.1\ \mu F$, $V_I = 10\ V$, $I_O = 500\ mA$, Test Circuit 1, unless otherwise specified.

| Symbol | Characteristic | Condition[1,3] | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{IR}$ | Input Voltage Range | $T_J = 25°C$ | | 7.5 | | 40 | V |
| $V_{OR}$ | Output Voltage Range | $V_I = V_O + 5.0\ V$ | | 5.0 | | 30 | V |
| $V_O$ | Output Voltage Tolerance | $V_O + 3.0\ V \leqslant V_I \leqslant V_O + 15\ V$, $5.0\ mA \leqslant I_O \leqslant 1.0\ A$ $P_D \leqslant 15\ W$, $V_{I\ max} = 38\ V$ | $T_J = 25°C$ | | | 4.0 | % $V_O$ |
| | | | | | | 5.0 | |
| $V_{O\ LINE}$ | Line Regulation | $T_J = 25°C$, $V_O \leqslant 10\ V$ $(V_O + 2.5\ V) \leqslant V_I \leqslant (V_O + 20\ V)$ | | | | 1.0 | % $V_O$ |
| $V_{O\ LOAD}$ | Load Regulation | $T_J = 25°C$, $V_I = V_O + 5.0\ V$ | $250\ mA \leqslant I_O \leqslant 750\ mA$ | | | 1.0 | % $V_O$ |
| | | | $5.0\ mA \leqslant I_O \leqslant 1.5\ A$ | | | 2.0 | |
| $I_C$ | Control Lead Current | $T_J = 25°C$ | | | 1.0 | 5.0 | µA |
| | | | | | | 8.0 | |
| $I_Q$ | Quiescent Current | $T_J = 25°C$ | | | 3.2 | 6.0 | mA |
| | | | | | | 7.0 | |
| $\Delta V_I/\Delta V_O$ | Ripple Rejection | $8.0\ V \leqslant V_I \leqslant 18\ V$, $f = 2400\ Hz$ $V_O = 5.0\ V$, $I_C = 350\ mA$ | | 68 | 78 | | dB |
| $N_O$ | Noise | $T_J = 25°C$, $10\ Hz < f < 100\ kHz$, $V_O = 5.0\ V$, $I_O = 5.0\ mA$ | | | 8.0 | 40 | µV/$V_O$ |
| $V_{DO}$ | Dropout Voltage[2] | | | | 2.0 | 2.5 | V |
| $I_{OS}$ | Output Short Circuit Current | $T_J = 25°C$, $V_I = 30\ V$ | | | .750 | 1.2 | A |
| $I_{pk}$ | Peak Output Current | $T_J = 25°C$ | | 1.3 | 2.2 | 3.3 | A |
| $\Delta V_O/\Delta T$ | Average Temperature Coefficient of Output Voltage | $V_O = 5.0\ V$, $I_O = 5.0\ mA$ | $T_A = -55°C$ to $+25°C$ | | | 0.4 | mV/°C/ $V_O$ |
| | | | $T_A = 25°C$ to $125°C$ | | | 0.3 | |
| $V_C$ | Control Lead Voltage (Reference) | $T_J = 25°C$ | | 4.8 | 5.0 | 5.2 | V |
| | | | | 4.75 | | 5.25 | |

**Notes**

1. $V_O$ is defined for the µA78G as $V_O = \frac{R1 + R2}{R2}(5.0)$; the µA79G as $V_O = \frac{R1 + R2}{R2}(-2.23)$.
2. Dropout Voltage is defined as that input/output voltage differential which causes the output voltage to decrease by 5% of its initial value.
3. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques ($t_w \leqslant 10$ ms, duty cycle $\leqslant 5\%$). Output voltage changes due to changes in internal temperature must be taken into account separately.

**$\mu$A79G**

**Electrical Characteristics** $0°C \leqslant T_A \leqslant 125°C$ for $\mu$A79G, $V_I = -10$ V, $I_O = 500$ mA, $C_I = 2.0$ $\mu$F, $C_O = 1.0$ $\mu$F, Test Circuit 2 and Note 3, unless otherwise specified.

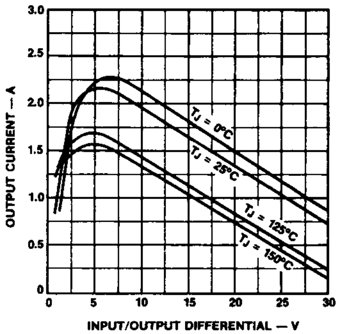
| Symbol | Charateristic | Condition[1] | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{IR}$ | Input Voltage Range | $T_J = 25°C$ | | −40 | | −7.0 | V |
| $V_{OR}$ | Nominal Output Voltage Range | $V_I = V_O - 5.0$ V | | −30 | | −2.23 | V |
| $V_O$ | Output Voltage Tolerance | $V_O - 15\ V \leqslant V_I \leqslant V_O - 3.0$ V, $5.0\ mA \leqslant I_O \leqslant 1.0$ A, $P_D \leqslant 15$ W, $V_{I\ Max} = -3.8$ V | $T_J = 25°C$ | | | 4.0 | $\%V_O$ |
| | | | | | | 5.0 | |
| $V_{O\ LINE}$ | Line Regulation | $T_J = 25°C$, $V_O \geqslant -10$ V, $(V_O - 20\ V) \leqslant V_I \leqslant (V_O - 2.5\ V)$ | | | | 1.0 | $\%V_O$ |
| $V_{O\ LOAD}$ | Load Regulation | $T_J = 25°C$, $V_I = V_O - 5.0$ V | $250\ mA \leqslant I_O \leqslant 750$ mA | | | 1.0 | $\%V_O$ |
| | | | $5.0\ mA \leqslant I_O \leqslant 1.5$ A | | | 2.0 | |
| $I_C$ | Control Lead Current | $T_J = 25°C$ | | | 0.4 | 2.0 | $\mu$A |
| | | | | | | 3.0 | |
| $I_Q$ | Quiescent Current | $T_J = 25°C$ | | | 0.5 | 2.5 | mA |
| | | | | | | 3.0 | |
| $\Delta V_I/\Delta V_O$ | Ripple Rejection | $V_O = -8.0$ V, $V_I = -13$ V, f = 2400 Hz, $I_C = 350$ mA | | 50 | 60 | | dB |
| $N_O$ | Noise | $T_J = 25°C$, $10\ Hz \leqslant f \leqslant 100$ kHz, $V_O = -8.0$ V, $I_O = 5.0$ mA | | | 25 | 80 | $\mu V/V_O$ |
| $V_{DO}$ | Dropout Voltage[2] | | | | 1.1 | 2.3 | V |
| $I_{OS}$ | Output Short Circuit Current | $T_J = 25°C$, $V_I = -30$ V | | | 0.25 | 1.2 | A |
| $I_{pk}$ | Peak Output Current | $T_J = 25°C$ | | 1.3 | 2.1 | 3.3 | A |
| $\Delta V_O/\Delta T$ | Average Temperature Coefficient of Output Voltage | $V_O = -5.0$ V, $I_O = 5.0$ mA | $T_A = -55°C$ to $+25°C$ | | | 0.3 | mV/°C/$V_O$ |
| | | | $T_A = 25°C$ to $125°C$ | | | 0.3 | |
| $V_C$ | Control Lead Voltage (Reference) | $T_J = 25°C$ | | −2.32 | −2.23 | −2.14 | V |
| | | | | −2.35 | | −2.11 | |

**Notes**

1. $V_O$ is defined for the $\mu$A78G as $V_O = \frac{R1 + R2}{R2}(5.0)$; the $\mu$A79G as $V_O = \frac{R1 + R2}{R2}(-2.23)$.
2. Dropout voltage is defined as that input/output voltage differential which causes the output voltage to decrease by 5% of its initial value.
3. The convention for negative regulators is the algebraic value, thus −15 V is less than −10 V.
4. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques ($t_W \leqslant 10$ ms, duty cycle $\leqslant 5\%$). Output voltage changes due to changes in internal temperature must be taken into account separately.

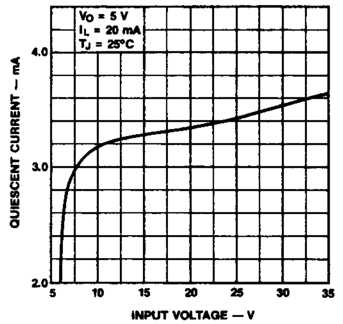
## Typical Performance Curves for μA78G

### Peak Output Current vs Input/Output Differential Voltage



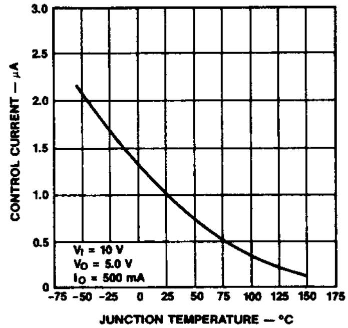

PC11790F

### Quiescent Current vs Input Voltage



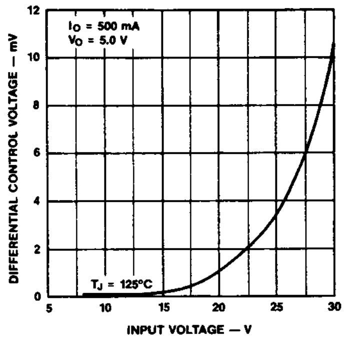

PC11800F

### Control Current vs Junction Temperature



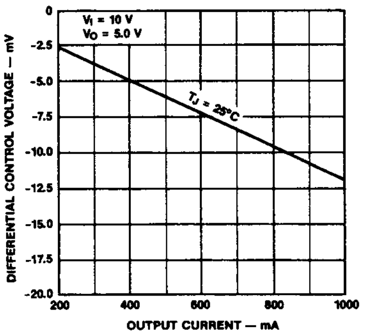

PC11810F

### Differential Control Voltage vs Input Voltage



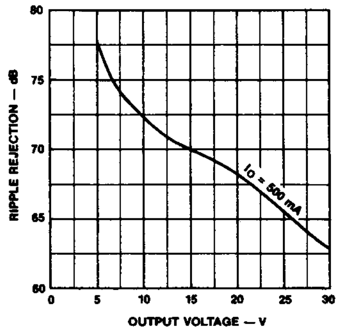

PC11820F

### Differential Control Voltage vs Output Current



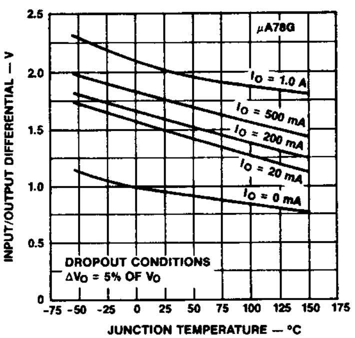

PC11830F

### Ripple Rejection vs Output Voltage



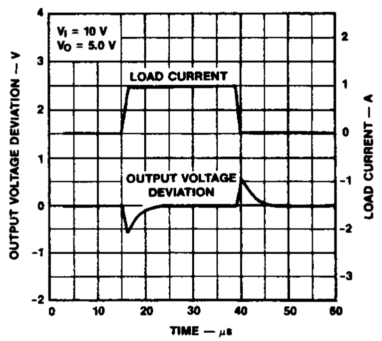

PC11840F

### Dropout Voltage vs Junction Temperature vs Frequency



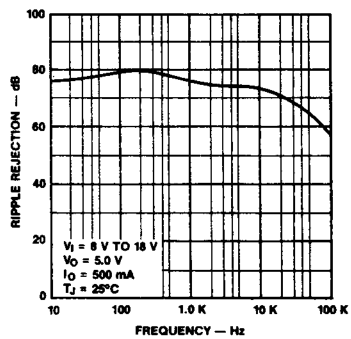

PC11851F

### Load Transient Response




PC11870F

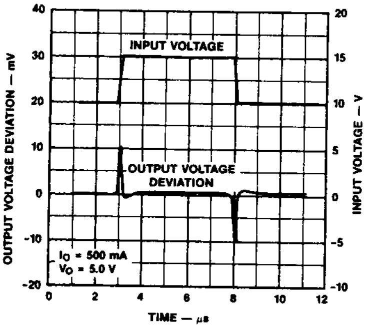
### Ripple Rejection vs Frequency




PC11860F

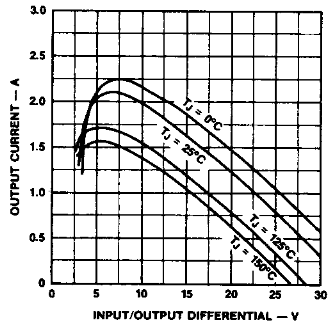
## Typical Performance Curves for μA79G

### Line Transient Response for μA78G



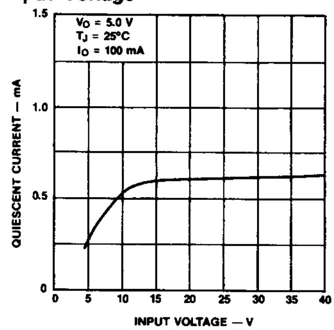

PC11680F

### Peak Output Current vs Input/Output Differential Voltage



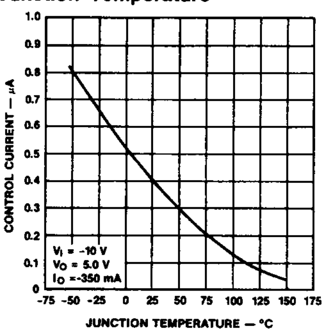

PC11690F

### Quiescent Current vs Input Voltage



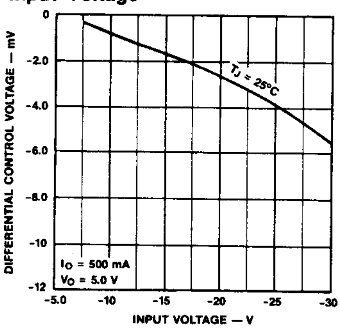

PC11700F

### Control Current vs Junction Temperature



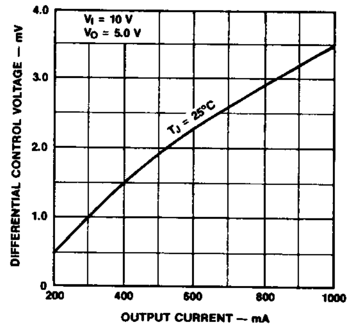

PC11710F

### Differential Control Voltage vs Input Voltage



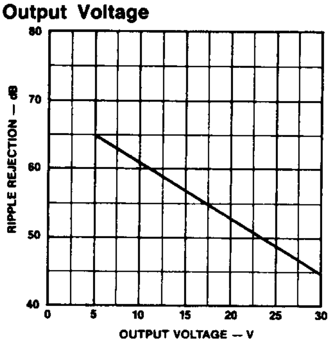

PC11720F

### Differential Control Voltage vs Output Current



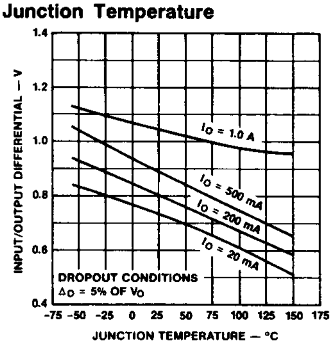

PC11730F

### Ripple Rejection vs Output Voltage



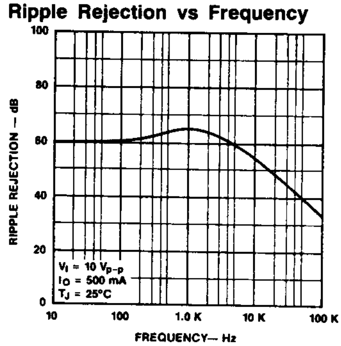

PC11740F

### Dropout Voltage vs Junction Temperature




PC11750F

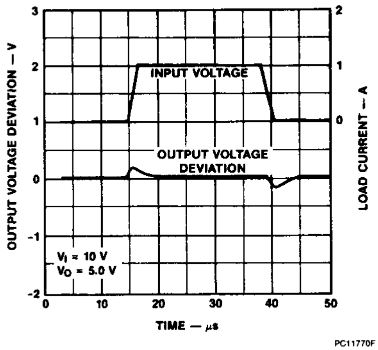
### Ripple Rejection vs Frequency



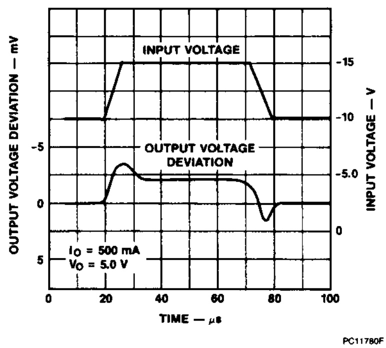

PC11760F

## Typical Performance Curves for μA79G (Cont.)

### Load Transient Response

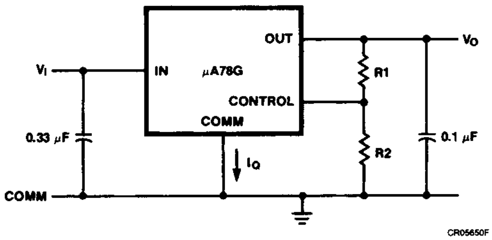



### Line Transient Response




## Test Circuits

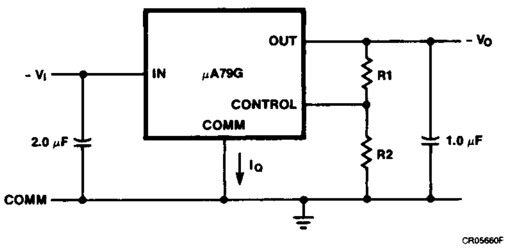
### μA78G Test Circuit 1




$$V_O = \left(\frac{R1 + R2}{R2}\right) V_{CONT}$$

$V_{CONT}$ Nominal = 5.0 V

### μA79G Test Circuit 2




$$V_O = \left(\frac{R1 + R2}{R2}\right) V_{CONT}$$

$V_{CONT}$ Nominal = −2.23 V
Recommended R2 current ≈ 1.0 mA
∴ R2 = 5.0 kΩ (μA78G)
R2 = 2.2 kΩ (μA79G)

## Design Considerations

The μA78G and μA79G Adjustable Voltage Regulators have an output voltage which varies from $V_{CONT}$ to typically

$$V_I - 2.0 \text{ V by } V_O = V_{CONT} \frac{R1 + R2}{R2}$$

The nominal reference in the μA78G is 5.0 V and μA79G is −2.23 V. If we allow 1.0 mA to flow in the control string to eliminate bias current effects, we can make R2 = 5.0 kΩ in the μA78G. Then, the output voltage is; $V_O$ = (R1 + R2) V, where R1 and R2 are in kΩs.

Example: If R2 = 5.0 kΩ and R1 = 10 kΩ then
$V_O$ = 15 V nominal, for the μA78G
R2 = 2.2 kΩ and R1 = 12.8 kΩ then
$V_O$ = −15.2 nominal, for the μA79G

By proper wiring of the feedback resistors, load regulation of the device can be improved significantly.

Both μA78G and μA79G regulators have thermal overload protection from excessive power, internal short circuit protection which limits each circuit's maximum current, and output transistor safe-area protection for reducing the output current as the voltage across each pass transistor is increased.

Although the internal power dissipation is limited, the junction temperature must be kept below the maximum specified temperature in order to meet data sheet specifications. To calculate the maximum junction temperature or heat sink required, the following thermal resistance values should be used:

| | Typ °C/W | Max °C/W | Typ °C/W | Max °C/W |
|---|---|---|---|---|
| Package | $\theta_{JC}$ | $\theta_{JC}$ | $\theta_{JA}$ | $\theta_{JA}$ |
| Power Watt | 7.5 | 11 | 75 | 80 |

$$P_{D\,Max} = \frac{T_{J\,Max} - T_A}{\theta_{JC} + \theta_{CA}} \text{ or}$$

$$= \frac{T_{J\,Max} - T_A}{\theta_{JA}} \text{ (without a heat sink)}$$

$$\theta_{CA} = \theta_{CS} + \theta_{SA}$$

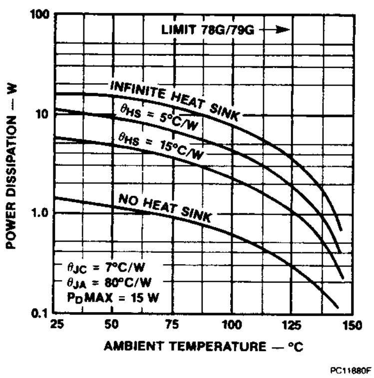
Solving for $T_J$:

$$T_J = T_A + P_D(\theta_{JC} + \theta_{CA}) \text{ or}$$
$$= T_A + P_D\theta_{JA} \text{ (without heat sink)}$$

Where:

$T_J$ = Junction Temperature
$T_A$ = Ambient Temperature
$P_D$ = Power Dissipation
$\theta_{JA}$ = Junction to ambient thermal resistance
$\theta_{JC}$ = Junction to case thermal resistance
$\theta_{CA}$ = Case to ambient thermal resistance
$\theta_{CS}$ = Case to heat sink resistance
$\theta_{SA}$ = Heat sink to ambient thermal resistance

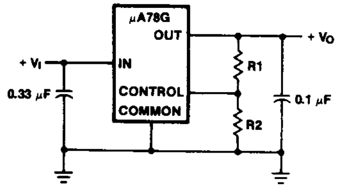
### µA78G and µA79G Power Tab (U1) Package Worst Case Power Dissipation vs Ambient Temperature




### Typical Applications For µA78G (Note 1)

Bypassing of the input and output (0.33 µF and 0.1 µF, respectively) is necessary.

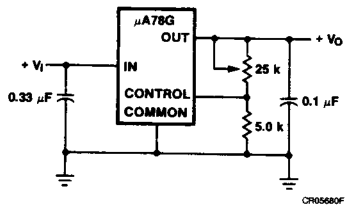
**Basic Positive Regulator**




$V_O = V_{CONT}\left(\frac{R1 + R2}{R2}\right)$

CR05670F

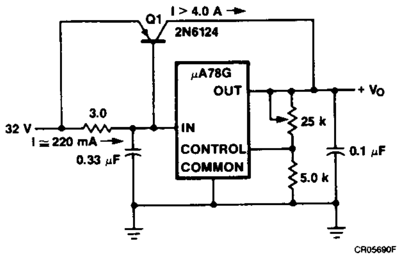
**Positive 5.0 V to 30 V Adjustable Regulator**



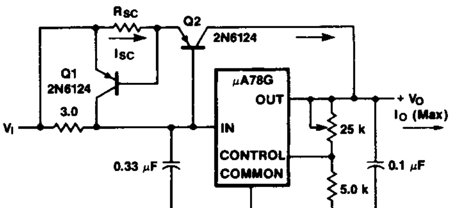

**Note**
1. All resistor values in ohms.

## Typical Applications For μA78G (Note 1) (Cont.)

### Positive 5.0 V to 30 V Adjustable Regulator
($I_O$ > 5.0 A) (Note 2)

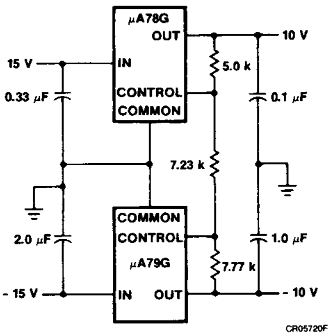



### Positive High Current Short Circuit, Protected Regulator




$$R_{SC} = \frac{V_{BE}\,(Q1)}{I_{SC}}$$

### ± 10 V, 1.0 A
### Dual Tracking Regulator (Note 3)




**Notes**
1. All resistor values in ohms.
2. External series pass device is not short circuit protected.
3. If load is not ground referenced, connect reverse biased diodes from outputs to ground.

### Positive High Current, Short Circuit Protected Regulator