**Description**
The $\mu$A78G and $\mu$A79G 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 $\mu$A78G and -40 V for the negative regulator $\mu$A79G. 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 $\mu$A78G positive voltage regulator is +5 V to +30 V and the output voltage range of the negative $\mu$A79G is -30 V to -2.2 V. For systems requiring both a positive and negative, the $\mu$A78G and $\mu$A79G 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
- $\mu$A78G Positive Output +5 To +30 V
- $\mu$A79G 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: $-65^\circ$C to $+150^\circ$C
- Operating Junction Temperature Range: 0°C to 150°C
- Lead Temperature (soldering, 10 s): 265°C
- Power Dissipation: Internally Limited

**Input Voltage**
- $\mu$A78G: +40 V
- $\mu$A79G: -40 V

**Control Load Voltage**
- $\mu$A78G: $0 \leq V_+ \leq V_O$
- $\mu$A79G: $V_O \leq V_- \leq 0$ V

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

Heat sink tabs connected to common through device substrate.

**Order Information**

<table>
<thead>
<tr>
<th>Device Code</th>
<th>Package Code</th>
<th>Package Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu$A78GU1C</td>
<td>8Z</td>
<td>Power Watt</td>
</tr>
</tbody>
</table>

**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**

<table>
<thead>
<tr>
<th>Device Code</th>
<th>Package Code</th>
<th>Package Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu$A79GU1C</td>
<td>8Z</td>
<td>Power Watt</td>
</tr>
</tbody>
</table>
\( \mu A78G \) Equivalent Circuit

\( \mu A79G \) Equivalent Circuit (Note 1)

**Note**

1. All Resistor values in ohms.
### μA78G

#### Electrical Characteristics

$0^\circ C \leq T_A \leq 125^\circ C$, $C_i = 0.33 \mu F$, $C_o = 0.1 \mu F$, $V_i = 10$ V, $I_o = 500$ mA,

Test Circuit 1, unless otherwise specified.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Characteristic</th>
<th>Condition$^{1,3}$</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IR}$</td>
<td>Input Voltage Range</td>
<td>$T_j = 25^\circ C$</td>
<td>7.5</td>
<td>40</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$V_{OR}$</td>
<td>Output Voltage Range</td>
<td>$V_i = V_o + 5.0$ V</td>
<td>5.0</td>
<td>30</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>$V_o$</td>
<td>Output Voltage Tolerance</td>
<td>$V_o + 3.0$ V $\leq V_i \leq V_o + 15$ V, $5.0$ mA $\leq I_o \leq 1.0$ A, $P_o \leq 15$ W, $V_i_{max} = 38$ V</td>
<td>$T_j = 25^\circ C$</td>
<td>4.0</td>
<td>$% V_o$</td>
<td>5.0</td>
</tr>
<tr>
<td>$V_{O LINE}$</td>
<td>Line Regulation</td>
<td>$T_j = 25^\circ C$, $V_o \leq 10$ V($V_o + 2.5$ V) $\leq V_i \leq (V_o + 20$ V)</td>
<td>1.0</td>
<td>$% V_o$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{O LOAD}$</td>
<td>Load Regulation</td>
<td>$T_j = 25^\circ C$, $V_i = V_o + 5.0$ V</td>
<td>250 mA $\leq I_o \leq 750$ mA</td>
<td>1.0</td>
<td>$% V_o$</td>
<td>2.0</td>
</tr>
<tr>
<td>$I_C$</td>
<td>Control Lead Current</td>
<td>$T_j = 25^\circ C$</td>
<td>1.0</td>
<td>5.0</td>
<td>5.0</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>$I_Q$</td>
<td>Quiescent Current</td>
<td>$T_j = 25^\circ C$</td>
<td>3.2</td>
<td>6.0</td>
<td>6.0</td>
<td>mA</td>
</tr>
<tr>
<td>$\Delta V_i / \Delta V_o$</td>
<td>Ripple Rejection</td>
<td>$8.0$ V $\leq V_i \leq 18$ V, $f = 2400$ Hz</td>
<td>68</td>
<td>78</td>
<td>78</td>
<td>dB</td>
</tr>
<tr>
<td>$N_o$</td>
<td>Noise</td>
<td>$T_j = 25^\circ C$, 10 Hz $&lt; f &lt; 100$ kHz, $V_o = 5.0$ V, $I_o = 5.0$ mA</td>
<td>8.0</td>
<td>40</td>
<td>$\mu V/V_o$</td>
<td></td>
</tr>
<tr>
<td>$V_{DO}$</td>
<td>Dropout Voltage$^2$</td>
<td></td>
<td>2.0</td>
<td>2.5</td>
<td>2.5</td>
<td>V</td>
</tr>
<tr>
<td>$I_{OS}$</td>
<td>Output Short Circuit Current</td>
<td>$T_j = 25^\circ C$, $V_i = 30$ V</td>
<td>.750</td>
<td>1.2</td>
<td>1.2</td>
<td>A</td>
</tr>
<tr>
<td>$I_{pk}$</td>
<td>Peak Output Current</td>
<td>$T_j = 25^\circ C$</td>
<td>1.3</td>
<td>2.2</td>
<td>2.2</td>
<td>A</td>
</tr>
<tr>
<td>$\Delta V_o / \Delta T$</td>
<td>Average Temperature Coefficient of Output Voltage</td>
<td>$V_o = 5.0$ V, $I_o = 5.0$ mA</td>
<td>$T_A = -55^\circ C$ to $+25^\circ C$</td>
<td>.3</td>
<td>$\mu V/^\circ C/V_o$</td>
<td></td>
</tr>
<tr>
<td>$V_C$</td>
<td>Control Lead Voltage (Reference)</td>
<td>$T_j = 25^\circ C$</td>
<td>4.8</td>
<td>5.0</td>
<td>5.2</td>
<td>V</td>
</tr>
</tbody>
</table>

**Notes**

1. $V_o$ is defined for the μA78G as $V_o = \frac{R_1 + R_2}{R_2}(5.0)$; the μA79G as $V_o = \frac{R_1 + R_2}{R_2}(-2.23)$.
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 ($t_o < 10$ ms, duty cycle $< 5\%)$. Output voltage changes due to changes in internal temperature must be taken into account separately.
\(\mu A78G \cdot \mu A79G\)

**Electrical Characteristics** \(0^\circ C \leq T_A \leq 125^\circ C\) 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.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Characteristic</th>
<th>Condition (^1)</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_I)</td>
<td>Input Voltage Range</td>
<td>(T_J = 25^\circ C)</td>
<td>-40</td>
<td>-7.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>(V_O)</td>
<td>Nominal Output Voltage Range</td>
<td>(V_I = V_O - 5.0) V</td>
<td>-30</td>
<td>-2.23</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>(V_O)</td>
<td>Output Voltage Tolerance</td>
<td>(V_O - 15) V (\leq V_I \leq V_O - 3.0) V (5.0) mA (\leq I_O \leq 1.0) A (P_D \leq 15) W, (V_I_{\text{Max}} = -3.8) V (T_J = 25^\circ C)</td>
<td>4.0</td>
<td>%(V_O)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_O)</td>
<td>Line Regulation</td>
<td>(T_J = 25^\circ C, V_O &gt; -10) V ((V_O - 20) V (\leq V_I \leq (V_O - 2.5) V)</td>
<td>1.0</td>
<td>%(V_O)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_O)</td>
<td>Load Regulation</td>
<td>(T_J = 25^\circ C, V_I = V_O - 5.0) V (250) mA (\leq I_O \leq 750) mA (5.0) mA (\leq I_O \leq 1.5) A</td>
<td>1.0</td>
<td>%(V_O)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(I_C)</td>
<td>Control Lead Current</td>
<td>(T_J = 25^\circ C)</td>
<td>0.4</td>
<td>2.0</td>
<td>(\mu A)</td>
<td></td>
</tr>
<tr>
<td>(I_O)</td>
<td>Quiescent Current</td>
<td>(T_J = 25^\circ C)</td>
<td>0.5</td>
<td>2.5</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>(\Delta V_I/\Delta V_O)</td>
<td>Ripple Rejection</td>
<td>(V_O = -8.0) V, (V_I = -13) V, (f = 2400) Hz, (I_C = 350) mA</td>
<td>50</td>
<td>60</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>(N_O)</td>
<td>Noise</td>
<td>(T_J = 25^\circ C, 10) Hz (\leq f \leq 100) kHz, (V_O = -8.0) V, (I_O = 5.0) mA</td>
<td>25</td>
<td>80</td>
<td>(\mu V/V_O)</td>
<td></td>
</tr>
<tr>
<td>(V_{DO})</td>
<td>Dropout Voltage (^2)</td>
<td></td>
<td>1.1</td>
<td>2.3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>(I_{OS})</td>
<td>Output Short Circuit Current</td>
<td>(T_J = 25^\circ C, V_I = -30) V</td>
<td>0.25</td>
<td>1.2</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>(I_{pk})</td>
<td>Peak Output Current</td>
<td>(T_J = 25^\circ C)</td>
<td>1.3</td>
<td>2.1</td>
<td>3.3</td>
<td>A</td>
</tr>
<tr>
<td>(\Delta V_O/\Delta T)</td>
<td>Average Temperature Coefficient of Output Voltage</td>
<td>(V_O = -5.0) V, (I_O = 5.0) mA (T_A = -55^\circ C) to +25(^\circ C)</td>
<td>0.3</td>
<td>m(V/\circ C)/V_O</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_C)</td>
<td>Control Lead Voltage (Reference)</td>
<td>(T_J = 25^\circ C)</td>
<td>-2.32</td>
<td>-2.23</td>
<td>-2.14</td>
<td>V</td>
</tr>
</tbody>
</table>

**Notes**

1. \(V_O\) is defined for the \(\mu A78G\) as \(V_O = R_1 + \frac{R_2}{R_1 + R_2}(5.0)\);
   the \(\mu A79G\) as \(V_O = \frac{R_1}{R_2}(-2.23)\).
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 (\(I_W \leq 10\) ms, duty cycle \(\leq 5\%\)).

Output voltage changes due to changes in internal temperature must be taken into account separately.
Typical Performance Curves for μA79G

Line Transient Response for μA78G

Peak Output Current vs Input/Output Differential Voltage

Quiescent Current vs Input Voltage

Control Current vs Junction Temperature

Differential Control Voltage vs Input Voltage

Differential Control Voltage vs Output Current

Ripple Rejection vs Output Voltage

Dropout Voltage vs Junction Temperature

Ripple Rejection vs Frequency
Typical Performance Curves for \( \mu A79G \) (Cont.)

Load Transient Response

[Graph showing load transient response]

Line Transient Response

[Graph showing line transient response]

Test Circuits

\( \mu A78G \) Test Circuit 1

\[ V_0 = \left( \frac{R_1 + R_2}{R_2} \right) V_{\text{CONT}} \]

\( V_{\text{CONT}} \) Nominal = 5.0 V

\( \mu A79G \) Test Circuit 2

\[ V_0 = \left( \frac{R_1 + R_2}{R_2} \right) V_{\text{CONT}} \]

\( V_{\text{CONT}} \) Nominal = -2.23 V

Recommended \( R_2 \) current \( \approx 1.0 \) mA

\( R_2 = 5.0 \, \text{k} \Omega \) (\( \mu A78G \))

\( R_2 = 2.2 \, \text{k} \Omega \) (\( \mu A79G \))

Design Considerations

The \( \mu A78G \) and \( \mu A79G \) Adjustable Voltage Regulators have an output voltage which varies from \( V_{\text{CONT}} \) to typically

\[ V_I - 2.0 \, \text{V by } V_0 = V_{\text{CONT}} \frac{R_1 + R_2}{R_2} \]

The nominal reference in the \( \mu A78G \) is 5.0 V and \( \mu A79G \) is -2.23 V. If we allow 1.0 mA to flow in the control string to eliminate bias current effects, we can make \( R_2 = 5.0 \, \text{k} \Omega \) in the \( \mu A78G \). Then, the output voltage is:

\[ V_0 = \left( R_1 + R_2 \right) V_{\text{CONT}} \]

Example: If \( R_2 = 5.0 \, \text{k} \Omega \) and \( R_1 = 10 \, \text{k} \Omega \) then

\[ V_0 = 15 \, \text{V nominal, for the } \mu A78G \]

\[ R_2 = 2.2 \, \text{k} \Omega \) and \( R_1 = 12.8 \, \text{k} \Omega \) then

\[ V_0 = -15.2 \, \text{nominal, for the } \mu A79G \]

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

Both \( \mu A78G \) and \( \mu A79G \) 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:

<table>
<thead>
<tr>
<th>Package</th>
<th>$\theta_{JC}$</th>
<th>$\theta_{JA}$</th>
<th>$\theta_{JC}$</th>
<th>$\theta_{JA}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Watt</td>
<td>7.5</td>
<td>11</td>
<td>75</td>
<td>80</td>
</tr>
</tbody>
</table>

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

$$P_{D,\text{Max}} = \frac{T_J - T_A}{\theta_{JA}} \quad \text{(without a heat sink)}$$

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

Solving for $T_J$:

$$T_J = T_A + P_D(\theta_{JC} + \theta_{CA}) \quad \text{or}$$

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

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

**Typical Applications For \mu A78G (Note 1)**

Bypassing of the input and output (0.33 $\mu$F and 0.1 $\mu$F, respectively) is necessary.

**Basic Positive Regulator**

![Basic Positive Regulator Diagram]

$$V_O = V_{\text{CONT}} \left( \frac{R_1 + R_2}{R_2} \right)$$

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

![Positive 5.0 V to 30 V Adjustable Regulator Diagram]

Note

1. All resistor values in ohms.

**\mu A78G and \mu A79G**

**Power Tab (U1) Package**

**Worst Case Power Dissipation vs Ambient Temperature**

![Power Dissipation vs Ambient Temperature Graph]
Typical Applications For \( \mu A78G \) (Note 1) (Cont.)

Positive 5.0 V to 30 V Adjustable Regulator
\((I_O > 5.0 \text{ A})\) (Note 2)

Positive High Current Short Circuit, Protected Regulator

\( \pm 10 \text{ V, 1.0 A} \)
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.