

μ A78G • μ A79G 4-Terminal Adjustable Voltage Regulators

Linear Division Voltage Regulators

Description

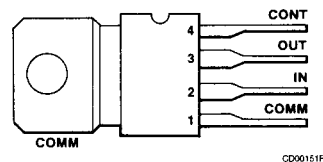
The μ A78G and μ A79G are 4-terminal adjustable voltage regulators. They are designed to deliver continuous load currents of up to 1.0 A with a maximum input voltage of +40 V for the positive regulator μ A78G and -40 V for the negative regulator μ A79G. Output current capability can be increased to greater than 1.0 A through use of one or more external transistors. The output voltage range of the μ A78G positive voltage regulator is +5 V to +30 V and the output voltage range of the negative μ A79G is -30 V to -2.2 V. For systems requiring both a positive and negative, the μ A78G and μ 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
- μ A78G Positive Output +5 To +30 V
- μ 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°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	
μ A78G	+40 V
μ A79G	-40 V
Control Lead Voltage	
μ A78G	$0 \text{ V} \leq V+ \leq V_O$
μ A79G	$V_{O-} \leq V- \leq 0 \text{ V}$

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

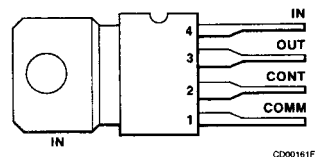


Heat sink tabs connected to common through device substrate.

Order Information

Device Code	Package Code	Package Description
μ A78GU1C	8Z	Power Watt

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

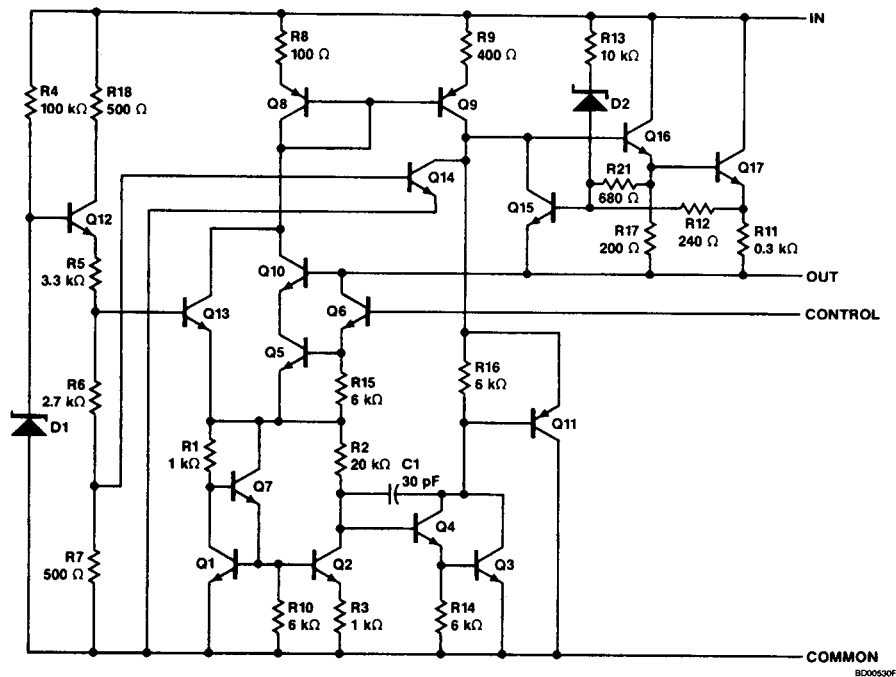


Heat sink tabs connected to input through device substrate. Not recommended for direct electrical connection.

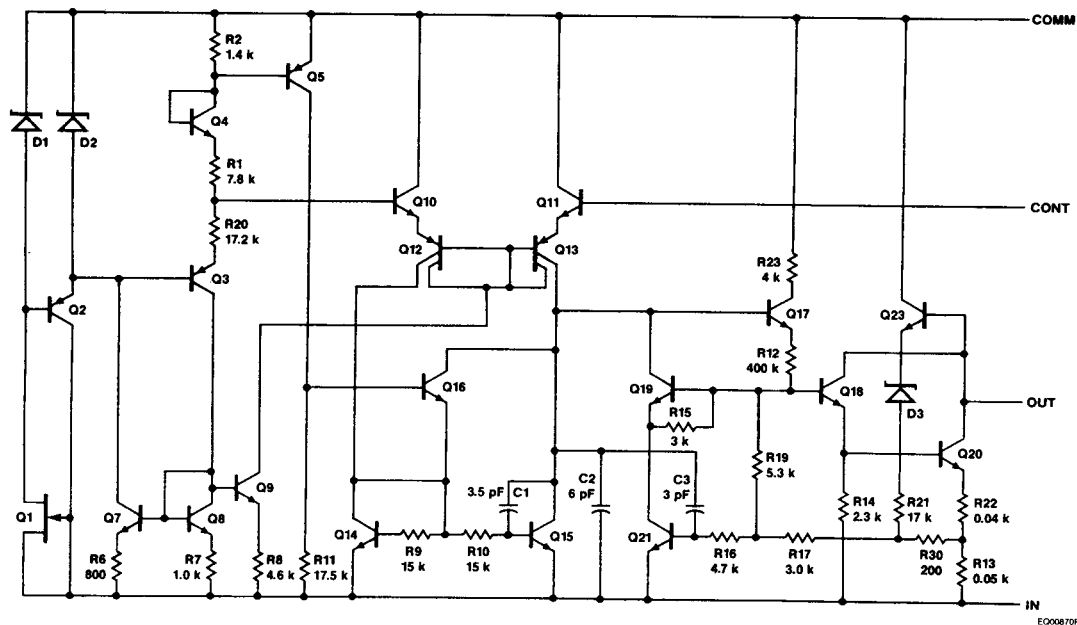
Order Information

Device Code	Package Code	Package Description
μ A79GU1C	8Z	Power Watt

μA78G Equivalent Circuit



μA79G Equivalent Circuit (Note 1)



Note

1. All Resistor values in ohms

μA78G

Electrical Characteristics $0^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$, $C_I = 0.33 \mu\text{F}$, $C_O = 0.1 \mu\text{F}$, $V_I = 10 \text{ V}$, $I_O = 500 \text{ mA}$,
Test Circuit 1, unless otherwise specified.

Symbol	Characteristic	Condition ^{1,3}	Min	Typ	Max	Unit
V_{IR}	Input Voltage Range	$T_J = 25^{\circ}\text{C}$	7.5		40	V
V_{OR}	Output Voltage Range	$V_I = V_O + 5.0 \text{ V}$	5.0		30	V
V_O	Output Voltage Tolerance	$V_O + 3.0 \text{ V} \leq V_I \leq V_O + 15 \text{ V}$, $5.0 \text{ mA} \leq I_O \leq 1.0 \text{ A}$ $P_D \leq 15 \text{ W}$, $V_{I \text{ max}} = 38 \text{ V}$	$T_J = 25^{\circ}\text{C}$		4.0	% V_O
					5.0	
$V_{O \text{ LINE}}$	Line Regulation	$T_J = 25^{\circ}\text{C}$, $V_O \leq 10 \text{ V}$ $(V_O + 2.5 \text{ V}) \leq V_I \leq (V_O + 20 \text{ V})$			1.0	% V_O
$V_{O \text{ LOAD}}$	Load Regulation	$T_J = 25^{\circ}\text{C}$, $V_I = V_O + 5.0 \text{ V}$	$250 \text{ mA} \leq I_O \leq 750 \text{ mA}$		1.0	% V_O
			$5.0 \text{ mA} \leq I_O \leq 1.5 \text{ A}$		2.0	
I_C	Control Lead Current	$T_J = 25^{\circ}\text{C}$		1.0	5.0	μA
					8.0	
I_Q	Quiescent Current	$T_J = 25^{\circ}\text{C}$		3.2	6.0	mA
					7.0	
$\Delta V_I / \Delta V_O$	Ripple Rejection	$8.0 \text{ V} \leq V_I \leq 18 \text{ V}$, $f = 2400 \text{ Hz}$ $V_O = 5.0 \text{ V}$, $I_C = 350 \text{ mA}$	68	78		dB
N_O	Noise	$T_J = 25^{\circ}\text{C}$, $10 \text{ Hz} < f < 100 \text{ kHz}$, $V_O = 5.0 \text{ V}$, $I_O = 5.0 \text{ mA}$		8.0	40	μV/ V_O
V_{DO}	Dropout Voltage ²			2.0	2.5	V
I_{OS}	Output Short Circuit Current	$T_J = 25^{\circ}\text{C}$, $V_I = 30 \text{ V}$.750	1.2	A
I_{pk}	Peak Output Current	$T_J = 25^{\circ}\text{C}$	1.3	2.2	3.3	A
$\Delta V_O / \Delta T$	Average Temperature Coefficient of Output Voltage	$V_O = 5.0 \text{ V}$, $I_O = 5.0 \text{ mA}$	$T_A = -55^{\circ}\text{C} \text{ to } +25^{\circ}\text{C}$		0.4	mV/ $^{\circ}\text{C}$ / V_O
			$T_A = 25^{\circ}\text{C} \text{ to } 125^{\circ}\text{C}$		0.3	
V_C	Control Lead Voltage (Reference)	$T_J = 25^{\circ}\text{C}$	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 ($t_w \leq 10 \text{ ms}$, duty cycle $\leq 5\%$). Output voltage changes due to changes in internal temperature must be taken into account separately.

μA79G

Electrical Characteristics $0^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$ for μA79G, $V_I = -10\text{ V}$, $I_O = 500\text{ mA}$, $C_I = 2.0\text{ }\mu\text{F}$, $C_O = 1.0\text{ }\mu\text{F}$, Test Circuit 2 and Note 3, unless otherwise specified.

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

Notes

1. V_O is defined for the μA78G as $V_O = \frac{R1 + R2}{R2}(-5.0)$;
the μA79G as $V_O = \frac{R1 + R2}{R2}(-2.23)$.

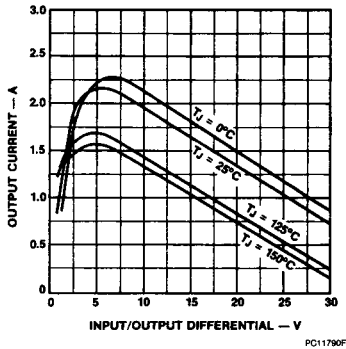
2. Dropout voltage is defined as that input/output voltage differential which causes the output voltage to decrease by 5% of its initial value.

3. The convention for negative regulators is the algebraic value, thus -15 V is less than -10 V.

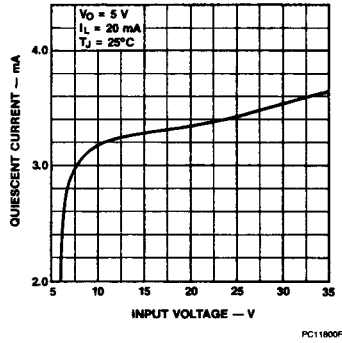
4. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques ($t_W \leq 10\text{ ms}$, duty cycle $\leq 5\%$). Output voltage changes due to changes in internal temperature must be taken into account separately.

Typical Performance Curves for $\mu A78G$

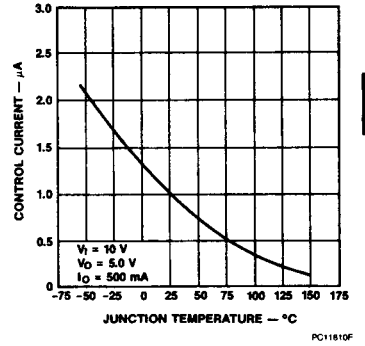
Peak Output Current vs Input/Output Differential Voltage



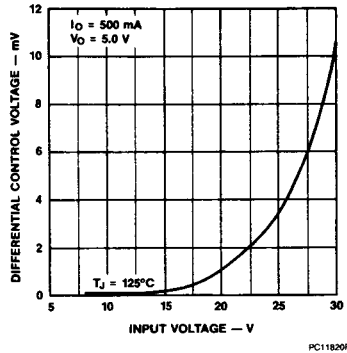
Quiescent Current vs Input Voltage



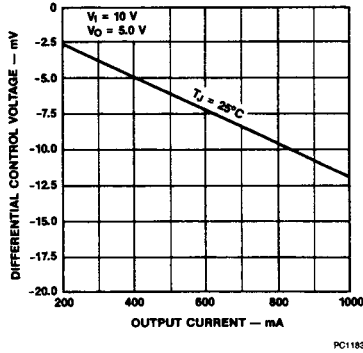
Control Current vs Junction Temperature



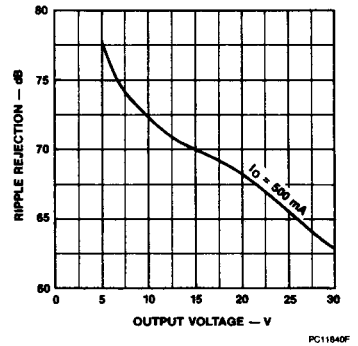
Differential Control Voltage vs Input Voltage



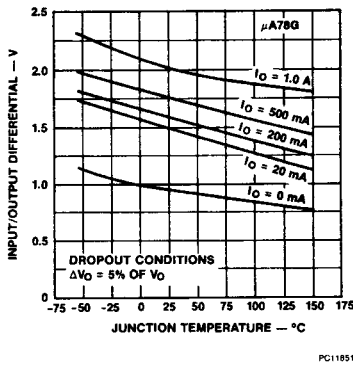
Differential Control Voltage vs Output Current



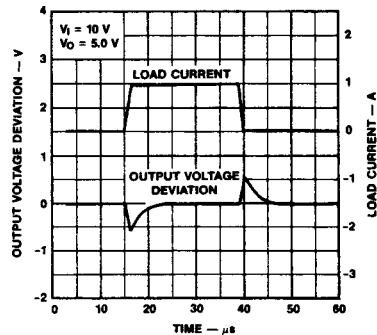
Ripple Rejection vs Output Voltage



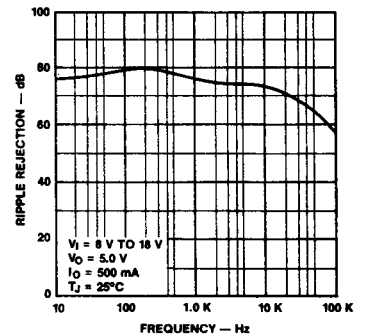
Dropout Voltage vs Junction Temperature vs Frequency



Load Transient Response

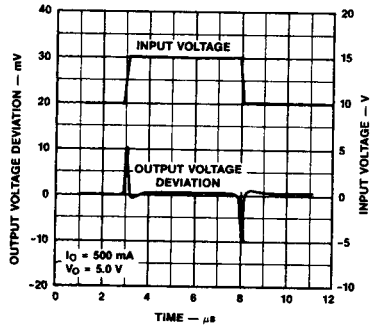


Ripple Rejection vs Frequency



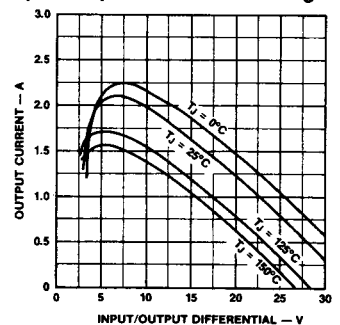
Typical Performance Curves for $\mu A79G$

Line Transient Response for $\mu A78G$



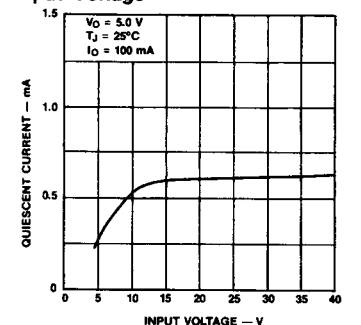
PC11680F

Peak Output Current vs Input/Output Differential Voltage



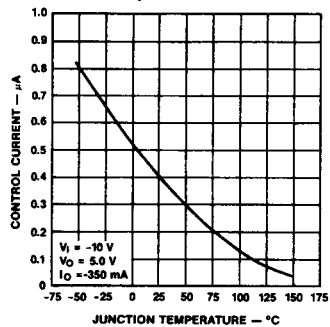
PC11690F

Quiescent Current vs Input Voltage



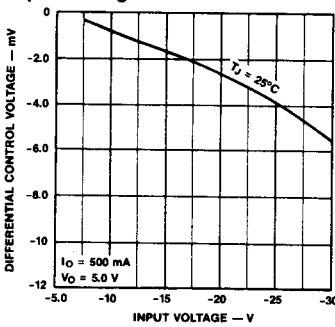
PC11700F

Control Current vs Junction Temperature



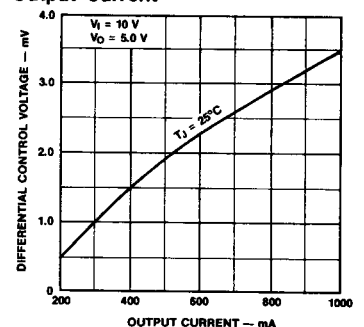
PC11710F

Differential Control Voltage vs Input Voltage



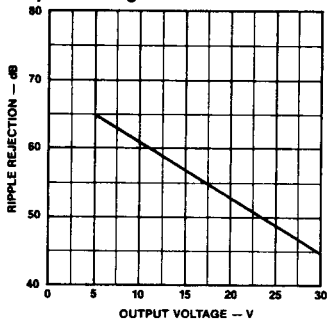
PC11720F

Differential Control Voltage vs Output Current



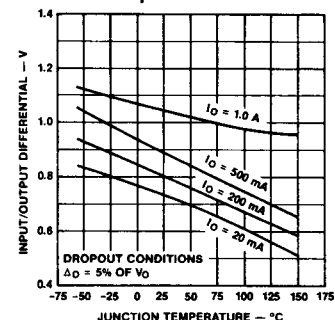
PC11730F

Ripple Rejection vs Output Voltage



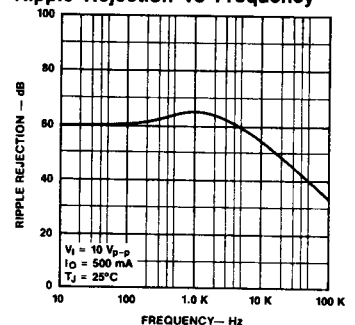
PC11740F

Dropout Voltage vs Junction Temperature



PC11750F

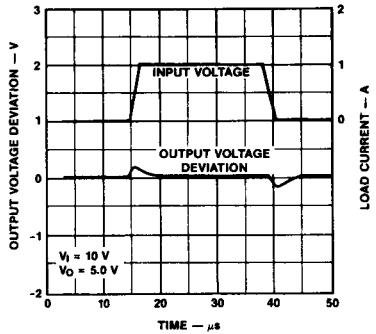
Ripple Rejection vs Frequency



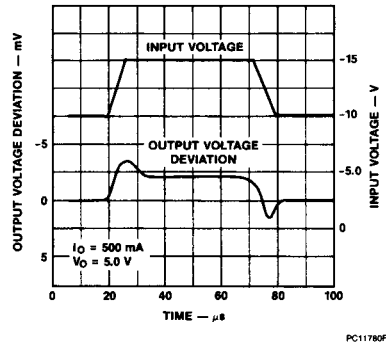
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Typical Performance Curves for μA79G (Cont.)

Load Transient Response

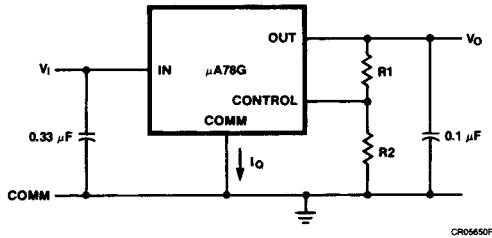


Line Transient Response



Test Circuits

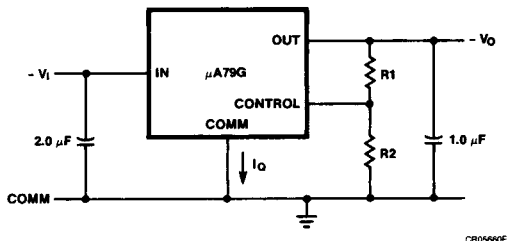
μA78G Test Circuit 1



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

V_{CONT} Nominal = 5.0 V

μA79G Test Circuit 2



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

V_{CONT} Nominal = -2.23 V
 Recommended R_2 current ≈ 1.0 mA
 $\therefore R_2 = 5.0$ kΩ (μA78G)
 $R_2 = 2.2$ kΩ (μA79G)

Design Considerations

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

$$V_I - 2.0 \text{ V by } V_O = V_{\text{CONT}} \frac{R_1 + R_2}{R_2}$$

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 $R_2 = 5.0$ kΩ in the μA78G. Then, the output voltage is; $V_O = (R_1 + R_2) V$, where R_1 and R_2 are in kΩs.

Example: If $R_2 = 5.0$ kΩ and $R_1 = 10$ kΩ then
 $V_O = 15$ V nominal, for the μA78G
 $R_2 = 2.2$ kΩ and $R_1 = 12.8$ 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	θ_{JC}	θ_{JC}	θ_{JA}	θ_{JA}
Power Watt	7.5	11	75	80

$$P_D \text{ Max} = \frac{T_J \text{ Max} - T_A}{\theta_{JC} + \theta_{CA}} \text{ or}$$

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

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

Solving for T_J :

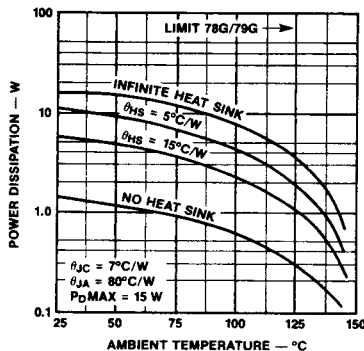
$$T_J = T_A + P_D(\theta_{JC} + \theta_{CA}) \text{ or}$$

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

Where:

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

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

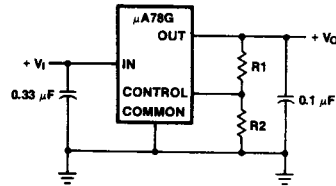


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Typical Applications For μA78G (Note 1)

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

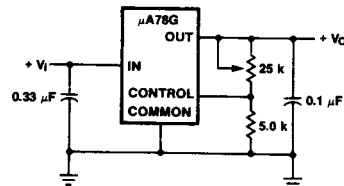
Basic Positive Regulator



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

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Positive 5.0 V to 30 V Adjustable Regulator



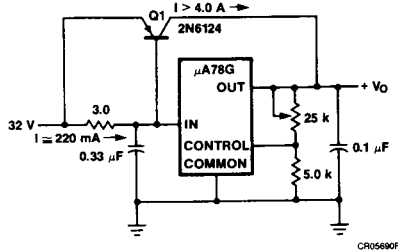
CR05680F

Note

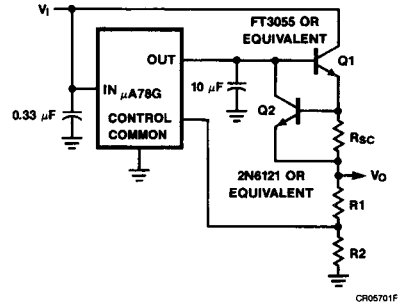
1. All resistor values in ohms.

Typical Applications For $\mu A78G$ (Note 1) (Cont.)

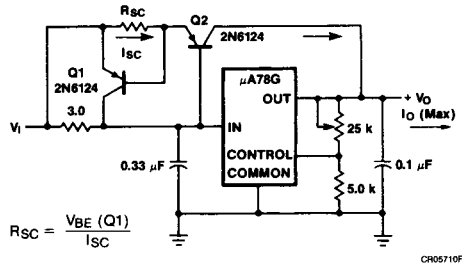
Positive 5.0 V to 30 V Adjustable Regulator ($I_O > 5.0$ A) (Note 2)



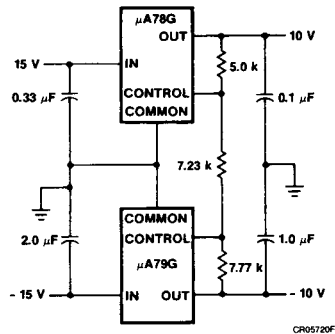
Positive High Current, Short Circuit Protected Regulator



Positive High Current Short Circuit, Protected Regulator



± 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.