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μA78MG • μA79MG

4-TERMINAL POSITIVE AND NEGATIVE ADJUSTABLE VOLTAGE REGULATORS

FAIRCHILD LINEAR INTEGRATED CIRCUITS

GENERAL DESCRIPTION — The μA78MG and μA79MG are 4-Terminal Adjustable Voltage Regulators. They are designed to deliver continuous load currents of up to 500 mA with a maximum input voltage of 40 V for the positive regulator 78MG and -40 V for the negative regulator 79MG. Output current capability can be increased to greater than 10 A through use of one or more external transistors. The output voltage range of the 78MG positive voltage regulator is 5 V to 30 V and the output voltage range of the negative 79MG is -30 V to -2.2 V. For systems requiring both a positive and negative, the 78MG and 79MG are excellent for use as a dual tracking regulator. These 4-terminal voltage regulators are constructed using the Fairchild Planar* process.

- OUTPUT CURRENT IN EXCESS OF 0.5 A
- μA78MG POSITIVE OUTPUT VOLTAGE 5 TO 30 V
- μA79MG NEGATIVE OUTPUT VOLTAGE -30 V TO -2.2 V
- INTERNAL THERMAL OVERLOAD PROTECTION
- INTERNAL SHORT CIRCUIT CURRENT PROTECTION
- OUTPUT TRANSISTOR SAFE AREA PROTECTION
- POWER MINI DUAL IN-LINE PACKAGE

ABSOLUTE MAXIMUM RATINGS

Input Voltage

μA78MG, μA79MGC 40V
 μA79MG, μA79MGC -40V

Control Pin Voltage

μA78MG, μA78MGC 0 < V < V_{OUT}
 μA79MG, μA79MGC -V_{OUT} < -V < 0

Power Dissipation

Operating Junction Temperature Range (Note 1)

Military (μA78MG, μA79MG) Internally Limited
 Commercial (μA78MGC, μA79MGC) Internally Limited

Storage Temperature Range

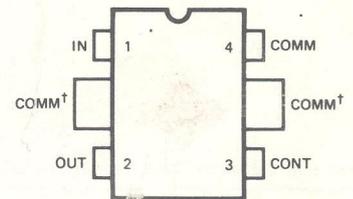
4-Pin TO-39 -65°C to +150°C
 Power Mini DIP and Power TAB -55°C to +150°C

Lead Temperature

Power TAB and Power Mini DIP (Soldering, 10 s) 230°C
 4-Pin TO-39(Soldering, 60 s) 300°C

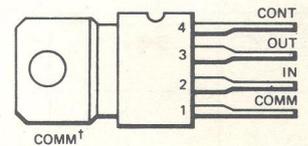
**μA78MG
CONNECTION DIAGRAMS
(TOP VIEWS)**

**POWER MINI DIP
PACKAGE OUTLINE 9V
PACKAGE CODE T2**



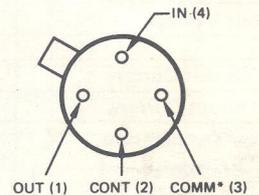
ORDER INFORMATION
 TYPE PART NO.
 μA78MGC μA78MGT2C

**POWER TAB
PACKAGE OUTLINE 8Z
PACKAGE CODE U1**



ORDER INFORMATION
 TYPE PART NO.
 μA78MGC μA78MGU1C

**4-PIN TO-39
PACKAGE OUTLINE 5K
PACKAGE CODE H**

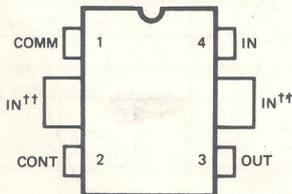


ORDER INFORMATION
 TYPE PART NO.
 μA78MG μA78MGHM
 μA78MG μA78MGHC

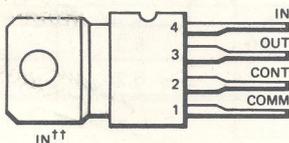
†NOTE:
Heat sink tabs connected to common through device substrate.

**μA79MG
CONNECTION DIAGRAMS
(TOP VIEWS)**

**POWER MINI DIP
PACKAGE OUTLINE 9V
PACKAGE CODE T2**

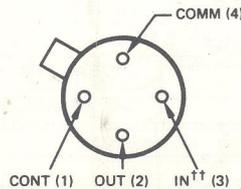


**POWER TAB
PACKAGE OUTLINE 8Z
PACKAGE CODE U1**



ORDER INFORMATION
 TYPE PART NO.
 μA79MG μA79MGU1C

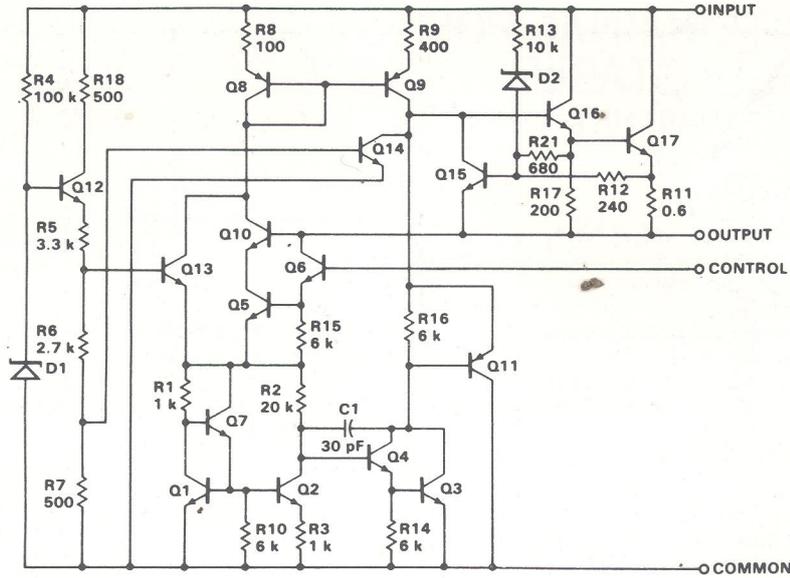
**4-LEAD TO-39
PACKAGE OUTLINE 5K
PACKAGE CODE H**



ORDER INFORMATION
 TYPE PART NO.
 μA79MG μA79MGHM
 μA79MGC μA79MGHC

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

78MG EQUIVALENT CIRCUIT



Resistor values in Ω unless otherwise noted.

$\mu A78MG$ (C, HC, HM)

ELECTRICAL CHARACTERISTICS Unless otherwise specified, the following specifications apply: $0^\circ C \leq T_J \leq 125^\circ C$ for $\mu A78MGHC$ and $\mu A78MGC$, $-55^\circ C \leq T_J \leq 150^\circ C$ for $\mu A78MGHM$, $V_{IN} = 10 V$, $I_{OUT} = 350 mA$, Test Circuit 1.

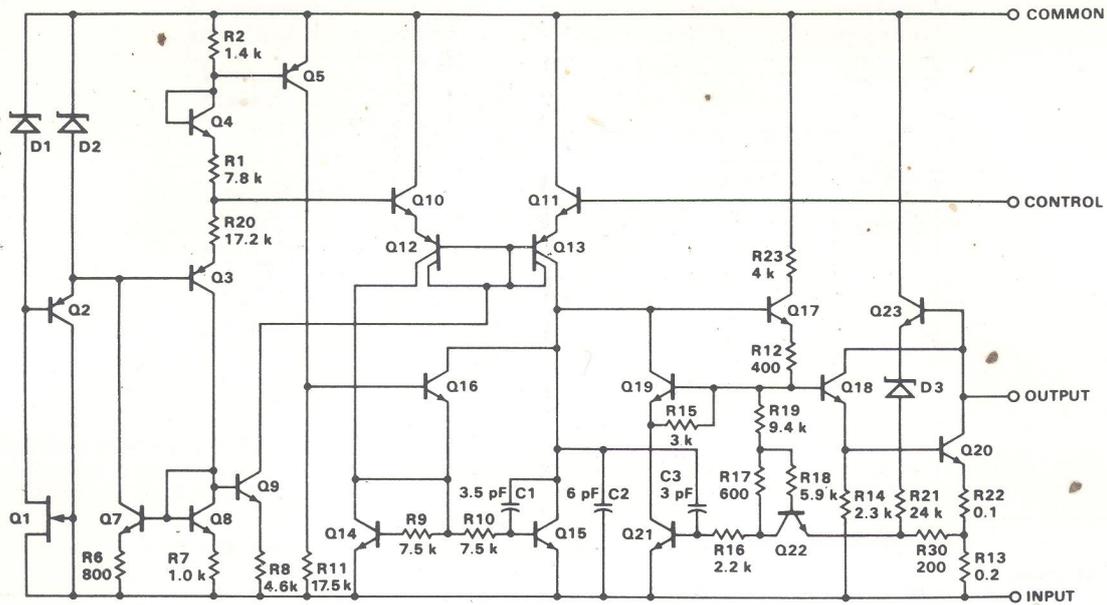
PARAMETER	CONDITION (Note 1)	MIN	TYP	MAX	UNITS	
Input Voltage Range	$T_J = 25^\circ C$	7.5		40	V V	
Output Voltage Range	$V_{IN} = V_{OUT} + 5 V$	5.0		30	V	
Output Voltage Tolerance	$V_{OUT} + 3 V \leq V_{IN} \leq V_{OUT} + 15 V$, $5 mA \leq I_{OUT} \leq 350 mA$ $P_D \leq 5 W, V_{INMAX} = 38 V$	$T_J = 25^\circ C$		4.0	$\%(V_{OUT})$	
				5.0	$\%(V_{OUT})$	
Line Regulation	$T_J = 25^\circ C, I_{OUT} = 200 mA, V_{OUT} \leq 10 V$ $(V_{OUT} + 2.5 V) \leq V_{IN} \leq (V_{OUT} + 20 V)$ $T_J = 25^\circ C, I_{OUT} = 200 mA, V_{OUT} \geq 10 V$ $(V_{OUT} + 3 V) \leq V_{IN} \leq (V_{OUT} + 15 V)$ $(V_{OUT} + 3 V) \leq V_{IN} \leq (V_{OUT} + 7 V)$			1.0	$\%(V_{OUT})$	
				0.75 0.67	$\%(V_{OUT})$ $\%(V_{OUT})$	
Load Regulation	$T_J = 25^\circ C$ $5 mA \leq I_{OUT} \leq 500 mA, V_{IN} = V_{OUT} + 7 V$			1.0	$\%(V_{OUT})$	
Control Pin Current	$T_J = 25^\circ C$		1.0	5.0	μA	
				8.0	μA	
Quiescent Current	$T_J = 25^\circ C$		2.8	4.0	mA	
				5.0	mA	
Ripple Rejection	$8 V \leq V_{IN} \leq 18 V$ $V_{OUT} = 5 V, f = 120 Hz$	$I_{OUT} = 300 mA, T_J = 25^\circ C$	62	80	dB	
		$I_{OUT} = 100 mA$	62		dB	
Output Noise Voltage	$10 Hz \leq f \leq 100 kHz, V_{OUT} = 5 V$		25		μV	
Dropout Voltage	(Note 2)	$\mu A78MGHM$		3.0	V	
		$\mu A78MG(HC \text{ and } C)$		2.5	V	
Short Circuit Current	$V_{IN} = 35 V, T_J = 25^\circ C$		300		mA	
Peak Output Current	$T_J = 25^\circ C$		800		mA	
Average Temperature Coefficient of Output Voltage	$V_{OUT} = 5 V$ $I_{OUT} = 5 mA$		-0.5		$mV/^\circ C$	
Control Pin Voltage (Reference)	$T_J = 25^\circ C$		4.8	5.0	5.2	V
			4.75		5.25	V

NOTES:

1. V_{OUT} is defined for the 78MGC as $V_{OUT} = \frac{R1 + R2}{R2} (5.0)$; The 79MGC as $V_{OUT} = \frac{R1 + R2}{R2} (-2.23)$.

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

79MG EQUIVALENT CIRCUIT



Resistor values in Ω unless otherwise noted.

μ A79MG (C, HC, HM)

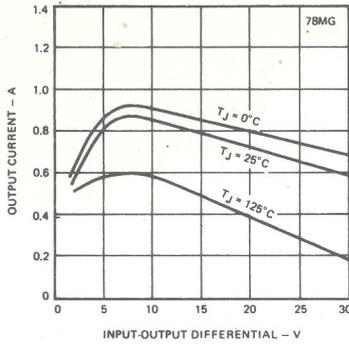
ELECTRICAL CHARACTERISTICS Unless otherwise specified, the following specifications apply: $0^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$ for μ A79MGHC and μ A79MGC, $-55^\circ\text{C} \leq T_J \leq 150^\circ\text{C}$ for μ A79MGHM, $V_{IN} = -10\text{ V}$, $I_{OUT} = 350\text{ mA}$, Test Circuit 2.

PARAMETER	CONDITION (Note 1)	MIN	TYP	MAX	UNITS	
Input Voltage Range	$T_J = 25^\circ\text{C}$	-40		-7.0	V	
Output Voltage Range	$V_{IN} = V_{OUT} - 5\text{ V}$	-30		-2.23	V	
Output Voltage Tolerance	$V_{OUT} - 15\text{ V} < V_{IN} < V_{OUT} - 3\text{ V}$, $5\text{ mA} < I_{OUT} < 350\text{ mA}$ $P_D < 5\text{ W}$, $V_{INMAX} = -38\text{ V}$	$T_J = 25^\circ\text{C}$		4.0	%(V_{OUT})	
				5.0	%(V_{OUT})	
Line Regulation	$T_J = 25^\circ\text{C}$, $I_{OUT} = 200\text{ mA}$, $V_{OUT} > -10\text{ V}$ $(V_{OUT} - 20\text{ V}) < V_{IN} < (V_{OUT} - 2.5\text{ V})$			1.0	%(V_{OUT})	
	$T_J = 25^\circ\text{C}$, $I_{OUT} = 200\text{ mA}$, $V_{OUT} < -10\text{ V}$ $(V_{OUT} - 15\text{ V}) < V_{IN} < (V_{OUT} - 3\text{ V})$			0.75	%(V_{OUT})	
	$(V_{OUT} - 7\text{ V}) < V_{IN} < (V_{OUT} - 3\text{ V})$			0.67	%(V_{OUT})	
Load Regulation	$V_{IN} = V_{OUT} - 7\text{ V}$, $5\text{ mA} < I_{OUT} < 500\text{ mA}$ $T_J = 25^\circ\text{C}$			1.0	%(V_{OUT})	
Control Pin Current	$T_J = 25^\circ\text{C}$			3.0	μA	
				2.0	μA	
Quiescent Current	$T_J = 25^\circ\text{C}$		0.5	1.5	mA	
				2.5	mA	
Ripple Rejection	$-18\text{ V} < V_{IN} < -8\text{ V}$	$T_J = 25^\circ\text{C}$, $I_{OUT} = 300\text{ mA}$ $I_{OUT} = 100\text{ mA}$	54	65	dB	
	$V_{OUT} = -5\text{ V}$, $f = 120\text{ Hz}$		50		dB	
Output Noise Voltage	$10\text{ Hz} < f < 100\text{ kHz}$, $V_{OUT} = -5\text{ V}$		125		μV	
Dropout Voltage	(Note 2)	μ A79MGHM		2.5	V	
		μ A79MG (HC and C)		2.3	V	
Short Circuit Current	$V_{IN} = -35\text{ V}$		100		mA	
Peak Output Current			650		mA	
Average Temperature Coefficient of Output Voltage	$V_{OUT} = -5\text{ V}$ $I_{OUT} = 5\text{ mA}$		-0.4		mV/ $^\circ\text{C}$	
Control Pin Voltage (Reference)	$T_J = 25^\circ\text{C}$		-2.32	-2.23	-2.14	V
			-2.35		-2.11	V

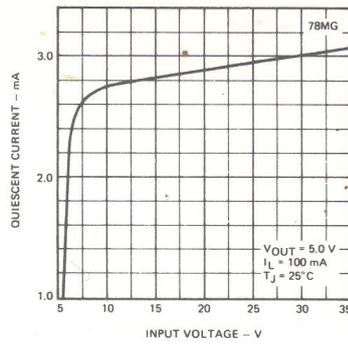
NOTE: The convention for Negative Regulators is the Algebraic value, thus -15 is less than -10 V.

TYPICAL PERFORMANCE CURVES FOR μ A78MG

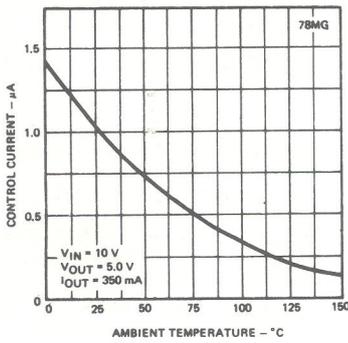
PEAK OUTPUT CURRENT AS A FUNCTION OF INPUT-OUTPUT DIFFERENTIAL VOLTAGE



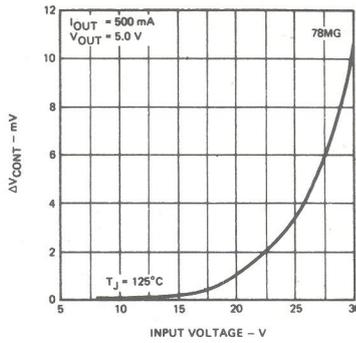
QUIESCENT CURRENT AS A FUNCTION OF INPUT VOLTAGE



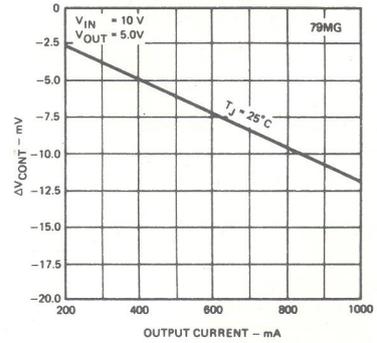
CONTROL CURRENT AS A FUNCTION OF TEMPERATURE



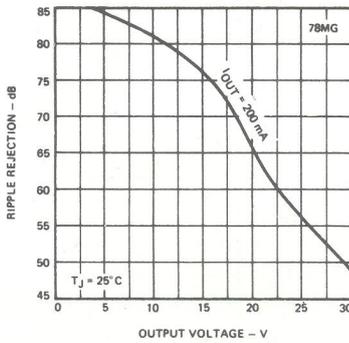
DIFFERENTIAL CONTROL VOLTAGE AS A FUNCTION OF INPUT VOLTAGE



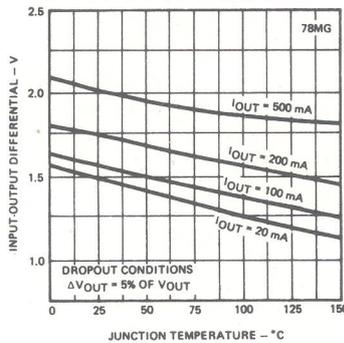
DIFFERENTIAL CONTROL VOLTAGE AS A FUNCTION OF OUTPUT CURRENT



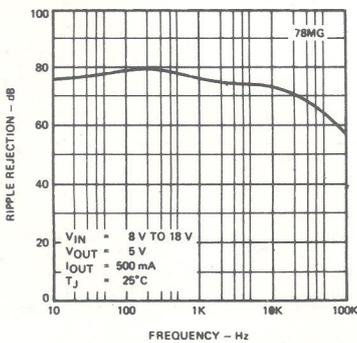
RIPLLE REJECTION AS A FUNCTION OF OUTPUT VOLTAGE



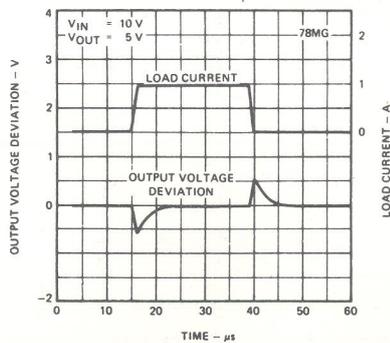
DROPOUT VOLTAGE AS A FUNCTION OF JUNCTION TEMPERATURE



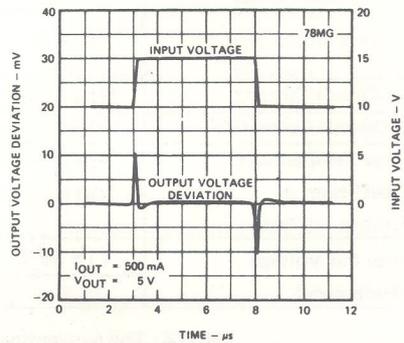
RIPLLE REJECTION AS A FUNCTION OF FREQUENCY



LOAD TRANSIENT RESPONSE

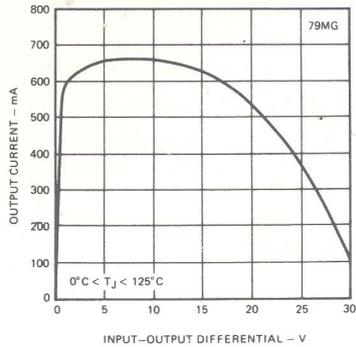


LINE TRANSIENT RESPONSE

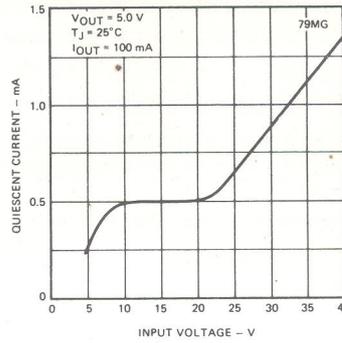


TYPICAL PERFORMANCE CURVES FOR μ A79MG

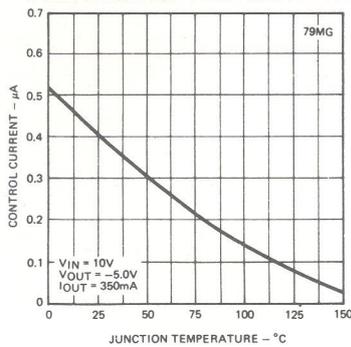
PEAK OUTPUT CURRENT AS A FUNCTION OF INPUT-OUTPUT DIFFERENTIAL VOLTAGE



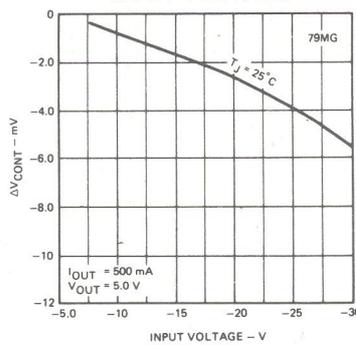
QUIESCENT CURRENT AS A FUNCTION OF INPUT VOLTAGE



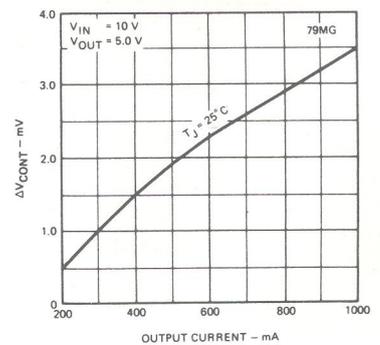
CONTROL CURRENT AS A FUNCTION OF TEMPERATURE



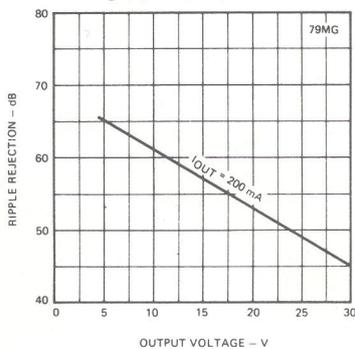
DIFFERENTIAL CONTROL VOLTAGE AS A FUNCTION OF INPUT VOLTAGE



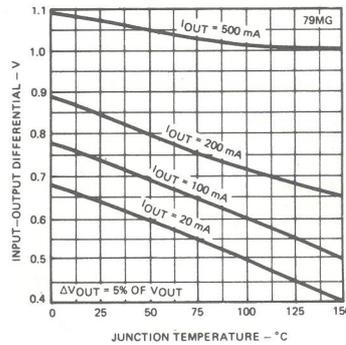
DIFFERENTIAL CONTROL VOLTAGE AS A FUNCTION OF OUTPUT CURRENT



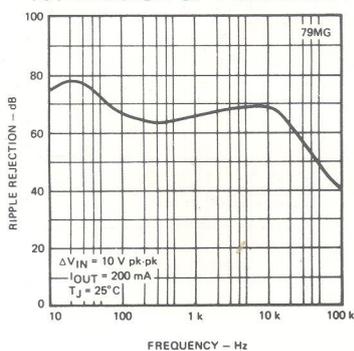
RIPPLE REJECTION AS A FUNCTION OF OUTPUT VOLTAGE



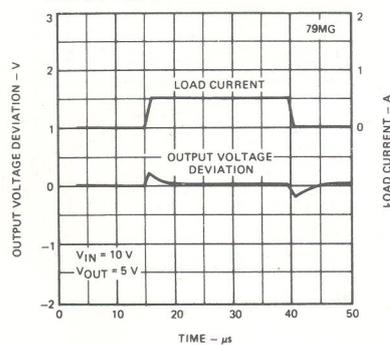
DROPOUT VOLTAGE AS A FUNCTION OF JUNCTION TEMPERATURE



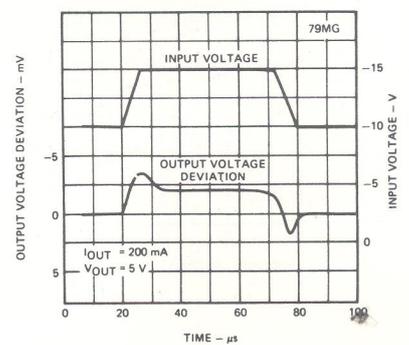
RIPPLE REJECTION AS A FUNCTION OF FREQUENCY



LOAD TRANSIENT RESPONSE



LINE TRANSIENT RESPONSE



FAIRCHILD LINEAR INTEGRATED CIRCUITS • μ A78MG • μ A79MG

DESIGN CONSIDERATIONS — The 78MG and 79MG variable voltage regulators have an output voltage which varies from $V_{CONTROL}$ to typically $V_{IN} - 2V$ by $V_{OUT} = V_{CONTROL} \frac{(R1 + R2)}{R2}$. The nominal reference in the 78MG is 5.0 V and 79MG is -2.23 V. If we allow 1.0 mA to flow in the control string to eliminate bias current effects, we can make $R2 = 5 k\Omega$ in the 78MG. The output voltage is then: $V_{OUT} = (R1 + R2)$ Volts, where $R1$ and $R2$ are in $k\Omega$ s.

Example: If $R2 = 5 k\Omega$ and $R1 = 10 k\Omega$ then $V_{OUT} = 15 V$ nominal, for the 78MG;
 $R2 = 2.2 k\Omega$ and $R1 = 12.8 k\Omega$ then $V_{OUT} = -15.2 V$ nominal, for the 79MG.

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

Both 78MG and 79MG 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 ($125^{\circ}C$) 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:

PACKAGE	TYPICAL	MAX	TYPICAL	MAX
	θ_{JC}	θ_{JC}	θ_{JA}	θ_{JA}
Power Mini DIP (T2)	7.5	11.0	75	80
Power TAB	8.0	12.0	75	80
TO-39	18.0	25.0	120	190

$$P_D (\text{MAX}) = \frac{T_J (\text{MAX}) - T_A}{\theta_{JC} + \theta_{CA}} \quad \text{or} \quad \frac{T_J (\text{MAX}) - T_A}{\theta_{JA}} \quad (\text{Without a heat sink})$$

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

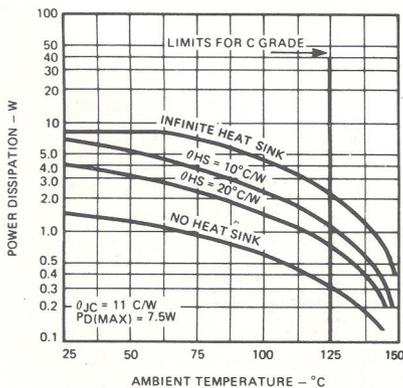
$$\text{Solving for } T_J: \quad T_J = T_A + P_D (\theta_{JC} + \theta_{CA}) \quad \text{or} \quad T_A + P_D \theta_{JA} \quad (\text{Without heat sink})$$

Where T_J = Junction Temperature
 T_A = Ambient Temperature
 P_D = Power Dissipation

θ_{JC} = Junction to case thermal resistance
 θ_{CA} = Case to ambient thermal resistance
 θ_{CS} = Case to ambient thermal resistance
 θ_{SA} = Heat sink to ambient thermal resistance
 θ_{JA} = Junction to ambient thermal resistance

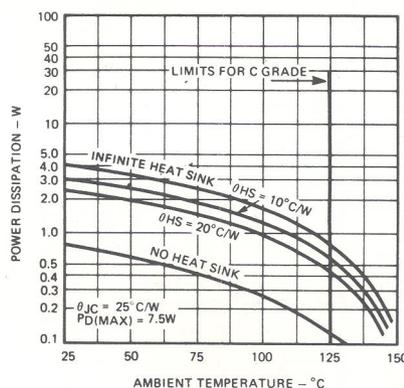
**μ A78MG AND μ A79MG
POWER MINI DIP (T2)**

**WORST CASE POWER
DISSIPATION VERSUS
AMBIENT TEMPERATURE**



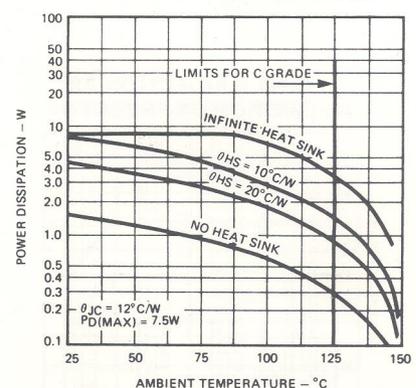
**μ A78MG AND μ A79MG
TO-39**

**WORST CASE POWER
DISSIPATION VERSUS
AMBIENT TEMPERATURE**



**μ A78MG AND μ A79MG
POWER TAB (U1)**

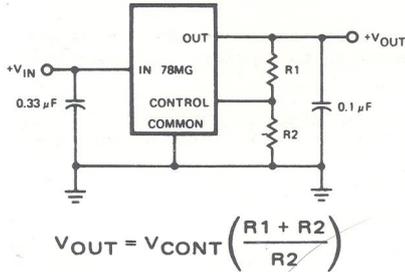
**WORST CASE POWER
DISSIPATION VERSUS
AMBIENT TEMPERATURE**



TYPICAL APPLICATIONS FOR μ A78MG

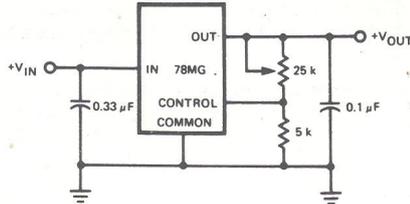
In many μ A78MG applications, compensation capacitors may not be required. However, for stable operation of the regulator over all input voltage and output current ranges, bypassing of the input and output (0.33 μ F and 0.1 μ F, respectively) is recommended. Input bypassing is necessary if the regulator is located far from the filter capacitor of the power supply. Bypassing the output will improve the transient response of the regulator.

BASIC POSITIVE REGULATOR

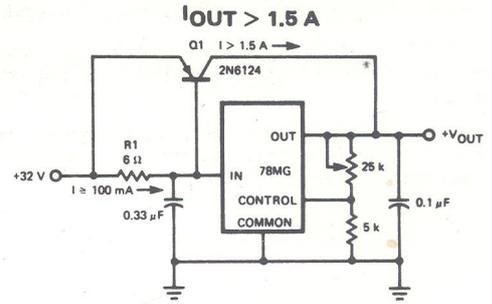


$$V_{OUT} = V_{CONT} \left(\frac{R1 + R2}{R2} \right)$$

POSITIVE 5 TO 30 V ADJUSTABLE REGULATOR



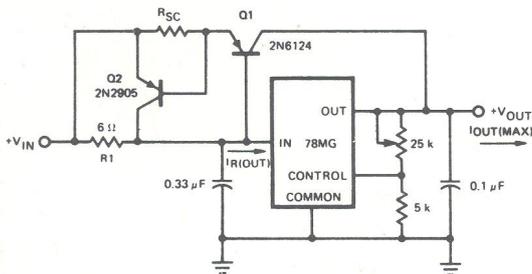
POSITIVE 5 TO 30 V ADJUSTABLE REGULATOR



$$R1 = \frac{\beta V_{BE}(Q1)}{V_{R(MAX)} (\beta + 1) - I_{OUT(MAX)}}$$

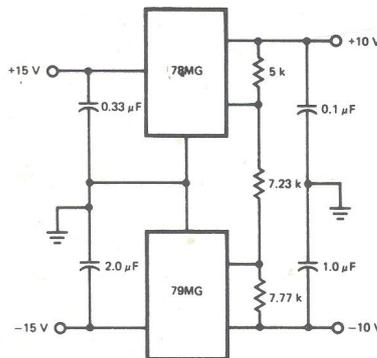
NOTE: External series pass device is not short circuit protected.

POSITIVE HIGH CURRENT SHORT CIRCUIT PROTECTED REGULATOR



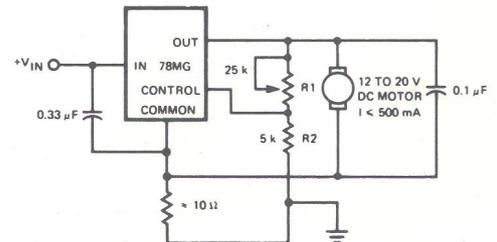
$$R1 = \frac{\beta V_{BE}(Q1)}{V_{R(MAX)} (\beta + 1) - I_{OUT(MAX)}}$$

± 10 V, 500 mA DUAL TRACKING REGULATOR



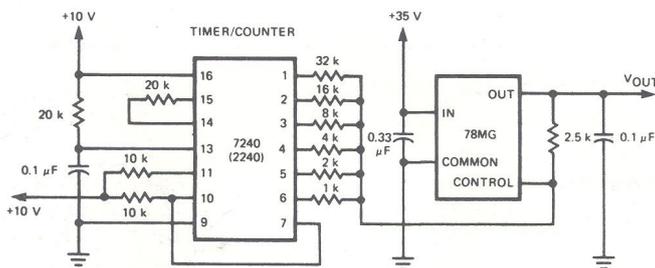
If load is not ground referenced, connect reverse biased diodes from outputs to ground.

MOTOR SPEED CONTROL

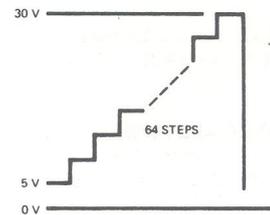


Use flyback diode across motor if necessary.

PROGRAMMABLE SUPPLY

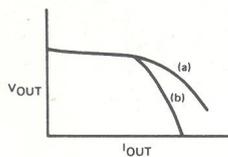
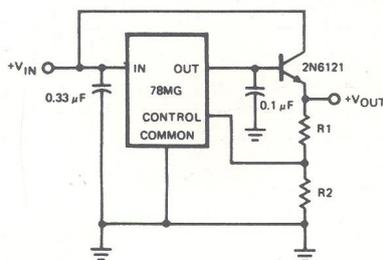


OUTPUT WAVEFORM

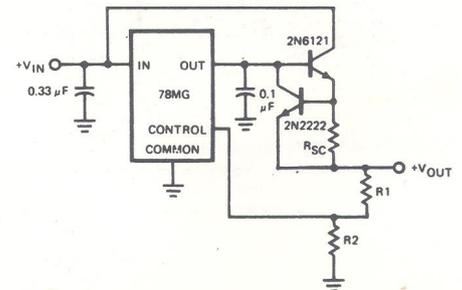


POSITIVE HIGH CURRENT VOLTAGE REGULATOR

EXTERNAL SERIES PASS (a)



SHORT CIRCUIT LIMIT (b)



Handwritten notes:

$$R1 = R2 \left(\frac{V_{out}}{V_{cont}} - 1 \right)$$

$$R1 = 4k7 \left(\frac{25}{5} - 1 \right)$$

Handwritten notes:

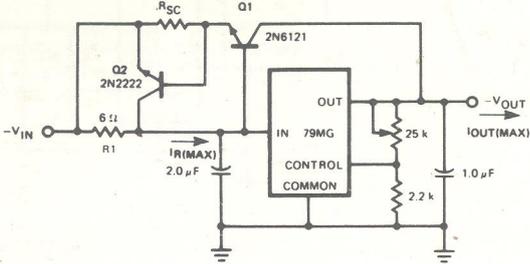
$$\frac{V_{out} \cdot R2}{V_{cont}} - R2 = R1$$

TYPICAL APPLICATIONS FOR 79MG

Bypass capacitors are recommended for stable operation of the $\mu A79MG$ over the input voltage and output current ranges. Output bypass capacitors will improve the transient response of the regulator.

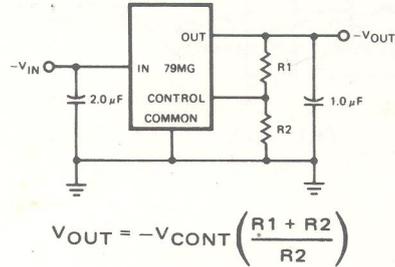
The bypass capacitors, ($2 \mu F$ on the input, $1 \mu F$ on the output) should be ceramic or solid tantalum which have good high frequency characteristics. If aluminum electrolytics are used, their values should be $10 \mu F$ or larger. The bypass capacitors should be mounted with the shortest leads, and if possible, directly across the regulator terminals.

NEGATIVE HIGH CURRENT SHORT CIRCUIT PROTECTED REGULATOR



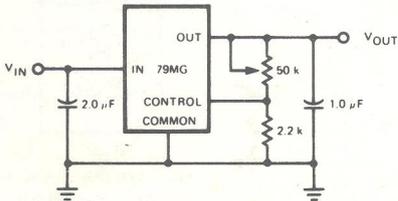
$$R1 = \frac{\beta V_{BE}(Q1)}{V_{R(MAX)}(\beta + 1) - I_{OUT(MAX)}}$$

BASIC NEGATIVE REGULATOR



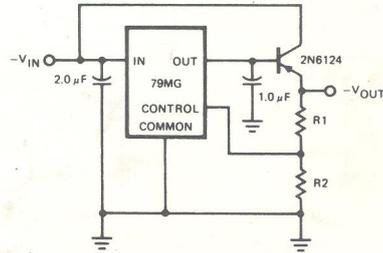
$$V_{OUT} = -V_{CONT} \left(\frac{R1 + R2}{R2} \right)$$

-30 V TO -2.2 V ADJUSTABLE REGULATOR



$$V_x = \left(\frac{R1 + 5K}{5K} \right) 5$$

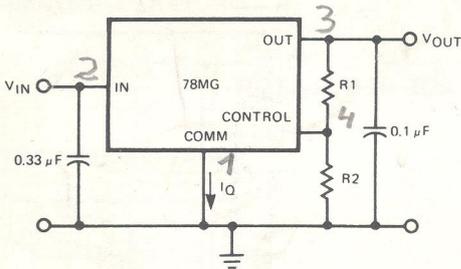
NEGATIVE HIGH CURRENT VOLTAGE REGULATOR EXTERNAL SERIES PASS



$$\frac{5 \cdot 12}{8} = R1 + 5 \quad R1 = 7$$

20.94

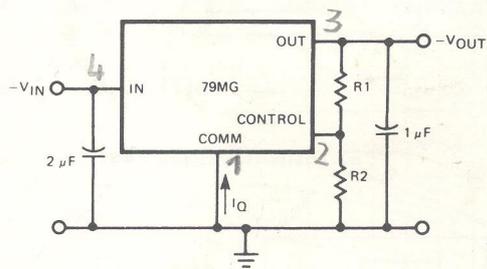
78MG TEST CIRCUIT 1



$$V_{OUT} = \left(\frac{R1 + R2}{R2} \right) V_{CONTROL}$$

$V_{CONTROL}$ Nominally = 5 V

79MG TEST CIRCUIT 2



$$V_{OUT} = \left(\frac{R1 + R2}{R2} \right) V_{CONTROL}$$

$V_{CONTROL}$ Nominally = -2.23 V

Recommended $R2$ current ≈ 1 mA
 $\therefore R2 = 5 \text{ k}\Omega$ (78MG)
 $R2 = 2.2 \text{ k}\Omega$ (79MG)

$$21 = \left(\frac{2430 + 19600}{2430} \right) - 2.29$$

$$R1 \times \frac{21}{2.29} = \frac{R1 + 19600}{R1}$$