

To all our customers

---

## **Regarding the change of names mentioned in the document, such as Mitsubishi Electric and Mitsubishi XX, to Renesas Technology Corp.**

---

The semiconductor operations of Hitachi and Mitsubishi Electric were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.) Accordingly, although Mitsubishi Electric, Mitsubishi Electric Corporation, Mitsubishi Semiconductors, and other Mitsubishi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Note : Mitsubishi Electric will continue the business operations of high frequency & optical devices and power devices.

Renesas Technology Corp.  
Customer Support Dept.  
April 1, 2003

# M5278LXX, M5278LXXM

**(5V, 5.6V, 8V, 9V, 10V, 12V, 15V) 3-TERMINAL FIXED POSITIVE OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)**

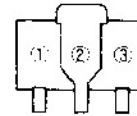
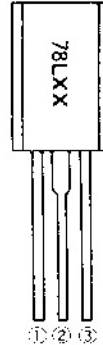
## DESCRIPTION

The M5278L series consists of monolithic integrated circuits, each a three-terminal regulator with maximum load capabilities of 100mA and featuring output voltages of 5, 5.6, 8, 9, 10, 12, or 15V. The high-performance, fixed-positive output power supply ICs are packaged in 3-pin packages featuring fold-back protective circuits for limiting current when load short. They are especially appropriate for use in personal computers and general power supplies of electrical appliances.

## FEATURES

- Interchangeable with other brand 78L series  
.....  $I_{Lmax}=100mA$
- Internal fold-back protection circuit limits current due to shorted loads.  
M5278L05 ..... 16.5mA (typ.) (1/10 that of other brands)
- High ripple division factor  
M5278L05 ..... 73dB (typ.)
- Low output voltage tolerance .....  $\pm 5\%$  (max.)
- High level of permissible internal heat dissipation  
..... 900mW (max.) 3P5  
..... 500mW (max.) 3P2

## PIN CONFIGURATION



Outline EIAJ: TO-92L

Outline SOT-89

ELECTRODE CONNECTION

ELECTRODE CONNECTION

- ① : OUTPUT
- ② : GND
- ③ : INPUT

- ① : INPUT
- ② : GND
- ③ : OUTPUT

## APPLICATION

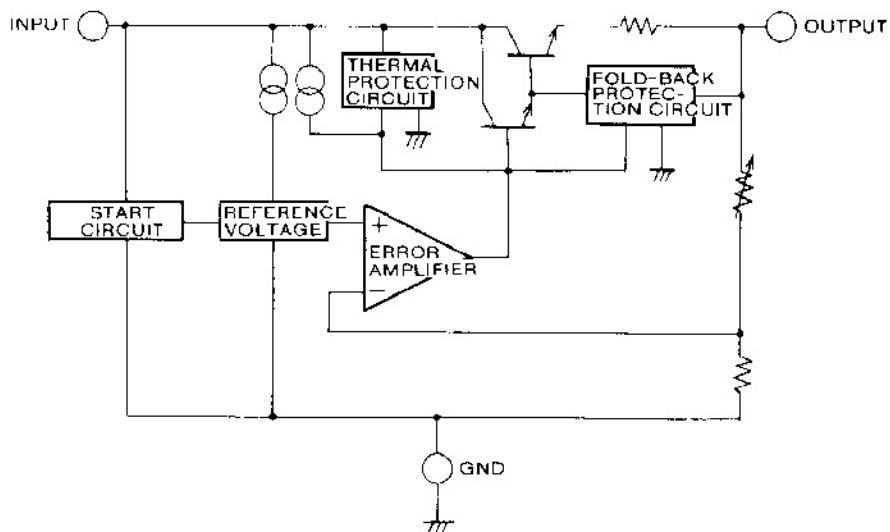
Power supply for microcomputer in VTR equipment, general power supply for electronic equipment of tape decks, car stereo equipment and radio cassette recorder.

M5278LXX blank ..... 3P5 pkg.  
M ..... 3P2 pkg.  
OUTPUT VOLTAGE VALUE

Type	Marking		Output voltage
	3P5	3P2	
M5278L05	78L05	MA	5V
M5278L56	78L56	MB	5.6V
M5278L10	78L10	MF	10V
M5278L12	78L12	MG	12V

Type	Marking		Output voltage
	3P5	3P2	
M5278L08	78L08	MD	8V
M5278L09	78L09	ME	9V
M5278L15	78L15	MH	15V

## BLOCK DIAGRAM



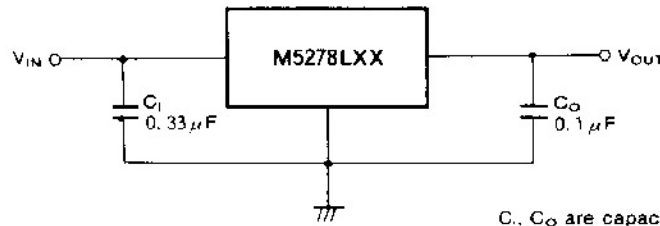
# M5278LXX, M5278LXXM

## (5V, 5.6V, 8V, 9V, 10V, 12V, 15V) 3-TERMINAL FIXED POSITIVE OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)

### ABSOLUTE MAXIMUM RATINGS (T<sub>a</sub>=25°C)

Symbol	Parameter	Ratings	Unit
V <sub>i</sub>	Input voltage	36	V
I <sub>L</sub>	Load current	100	mA
P <sub>d</sub>	Power dissipation	900(3P5)/500(3P2)	mW
T <sub>opr</sub>	Operating temperature	-20~+75	°C
T <sub>stg</sub>	Storage temperature	-55~+150	°C

### STANDARD CONNECTION



C<sub>1</sub>, C<sub>0</sub> are capacitors to prevent oscillation. Make connections as close to the IC as possible.

### ELECTRICAL CHARACTERISTICS

**M5278L05** (V<sub>i</sub>=10V, I<sub>L</sub>=40mA, T<sub>a</sub>=25°C, C<sub>1</sub>=0.33 μF, C<sub>0</sub>=0.1 μF, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V <sub>O</sub>	Output voltage		4.75	5.0	5.25	V
R <sub>reg-in</sub>	Input regulation	7.5V ≤ V <sub>i</sub> ≤ 20V		50	200	mV
		8V ≤ V <sub>i</sub> ≤ 20V		30	150	
R <sub>reg-L</sub>	Load regulation	1mA ≤ I <sub>L</sub> ≤ 100mA		10	60	mV
		1mA ≤ I <sub>L</sub> ≤ 40mA		5	30	
V <sub>O</sub>	Output voltage	7.5V ≤ V <sub>i</sub> ≤ 20V, 1mA ≤ I <sub>L</sub> ≤ 40mA	4.7	5.0	5.3	V
		V <sub>i</sub> =10V, 1mA ≤ I <sub>L</sub> ≤ 70mA	4.7	5.0	5.3	
I <sub>B</sub>	Bias current	I <sub>L</sub> =0		4.8	6.7	mA
ΔI <sub>B</sub>	Bias current variability	8V ≤ V <sub>i</sub> ≤ 20V, I <sub>L</sub> =40mA		0.1	1.5	mA
		V <sub>i</sub> =10V, 1mA ≤ I <sub>L</sub> ≤ 40mA			0.2	
V <sub>NO</sub>	Output noise voltage	BW: 10Hz~100kHz		49		μVrms
RR	Ripple rejection ratio	f=120Hz, V <sub>in</sub> =0dBm	63	73		dB
V <sub>i</sub> -V <sub>O</sub>	Minimum input-output voltage difference			2.0		V
I <sub>LP</sub>	Peak load current			130		mA
I <sub>OS</sub>	Output short holding current			16.5		mA
TC <sub>V<sub>O</sub></sub>	Temperature coefficient of output voltage	I <sub>L</sub> =5mA		-0.6		mV/°C

MITSUBISHI <LINEAR ICs>  
**M5278LXX, M5278LXXM**

**(5V, 5.6V, 8V, 9V, 10V, 12V, 15V) 3-TERMINAL FIXED POSITIVE  
OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)**

**M5278L56** ( $V_I=11V, I_L=40mA, T_a=25^\circ C, C_I=0.33\mu F, C_O=0.1\mu F$ , unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$V_O$	Output voltage		5.32	5.6	5.88	V
$Reg_{in}$	Input regulation	$8.5V \leq V_I \leq 21V$		50	200	mV
		$9V \leq V_I \leq 21V$		30	150	
$Reg_L$	Load regulation	$1mA \leq I_L \leq 100mA$		10	60	mV
		$1mA \leq I_L \leq 40mA$		5	30	
$V_O$	Output voltage	$8.5V \leq V \leq 21V, 1mA \leq I_L \leq 40mA$	5.27	5.6	5.93	V
		$V_I=11V, 1mA \leq I_L \leq 70mA$	5.27	5.6	5.93	
$I_B$	Bias current	$I_L=0$		4.8	6.7	mA
$\Delta I_B$	Bias current differential	$9V \leq V_I \leq 21V, I_L=40mA$		0.1	1.5	mA
		$V_I=11V, 1mA \leq I_L \leq 40mA$			0.2	
$V_{NO}$	Output noise voltage	BW: 10Hz~100kHz		55		$\mu V_{rms}$
RR	Ripple rejection ratio	$f=120Hz, V_{in}=0dBm$	63	73		dB
$V_I-V_O$	Minimum input-output voltage difference			2.0		V
$I_{LP}$	Peak load current			150		mA
$I_{OS}$	Output short circuit sustain current			16.5		mA
$TC_{VO}$	Temperature coefficient of output voltage	$I_L=5mA$		-0.65		mV/°C

**M5278L08** ( $V_I=14V, I_L=40mA, T_a=25^\circ C, C_I=0.33\mu F, C_O=0.1\mu F$ , unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$V_O$	Output voltage		7.6	8.0	8.4	V
$Reg_{in}$	Input regulation	$10.5V \leq V_I \leq 23V$		60	200	mV
		$11V \leq V_I \leq 23V$		40	150	
$Reg_L$	Load regulation	$1mA \leq I_L \leq 100mA$		10	30	mV
		$1mA \leq I_L \leq 40mA$		5	40	
$V_O$	Output voltage	$10.5V \leq V_I \leq 23V, 1mA \leq I_L \leq 40mA$	7.52	8.0	8.48	V
		$V_I=14V, 1mA \leq I_L \leq 70mA$	7.52	8.0	8.48	
$I_B$	Bias current	$I_L=0$		4.8	6.7	mA
$\Delta I_B$	Bias current differential	$10.5V \leq V_I \leq 23V, I_L=40mA$		0.1	1.5	mA
		$V_I=14V, 1mA \leq I_L \leq 40mA$			0.2	
$V_{NO}$	Output noise voltage	BW: 10Hz~100kHz		80		$\mu V_{rms}$
RR	Ripple rejection ratio	$f=120Hz, V_{in}=0dBm$		56		dB
$V_I-V_O$	Minimum input-output voltage difference			2.0		V
$I_{LP}$	Peak load current			150		mA
$I_{OS}$	Output short circuit sustain current			12.5		mA
$TC_{VO}$	Temperature coefficient of output voltage	$I_L=5mA$		-0.9		mV/°C

# M5278LXX, M5278LXXM

## (5V, 5.6V, 8V, 9V, 10V, 12V, 15V) 3-TERMINAL FIXED POSITIVE OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)

**M5278L09** ( $V_i=16V, I_L=40mA, T_a=25^\circ C, C_i=0.33\mu F, C_o=0.1\mu F$ , unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$V_O$	Output voltage		8.55	9.0	9.45	V
$R_{reg-in}$	Input regulation	$12V \leq V_i \leq 24V$		60	225	mV
		$13V \leq V_i \leq 24V$		40	170	
$R_{reg-L}$	Load regulation	$1mA \leq I_L \leq 100mA$		10	90	mV
		$1mA \leq I_L \leq 40mA$		5	40	
$V_O$	Output voltage	$12V \leq V_i \leq 24V, 1mA \leq I_L \leq 40mA$	8.46	9.0	9.54	V
		$V_i=16V, 1mA \leq I_L \leq 70mA$	8.46	9.0	8.54	
$I_B$	Bias current	$I_L=0$		4.8	6.7	mA
$\Delta I_B$	Bias current differential	$13V \leq V_i \leq 24V, I_L=40mA$		0.1	1.5	mA
		$V_i=16V, 1mA \leq I_L \leq 40mA$			0.2	
$V_{NO}$	Output noise voltage	BW: 10Hz~100kHz		90		$\mu V_{rms}$
RR	Ripple rejection ratio	$f=120Hz, V_{in}=0dBm$		60		dB
$V_i-V_O$	Minimum input-output voltage difference			2.0		V
$I_{LP}$	Peak load current			150		mA
$I_{OS}$	Output short circuit sustain current			12.5		mA
$TC_{V_O}$	Temperature coefficient of output voltage	$I_L=5mA$		-0.65		mV/°C

**M5278L10** ( $V_i=17V, I_L=40mA, T_a=25^\circ C, C_i=0.33\mu F, C_o=0.1\mu F$ , unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$V_O$	Output voltage		9.5	10.0	10.5	V
$R_{reg-in}$	Input regulation	$12.5V \leq V_i \leq 25V$		70	230	mV
		$13V \leq V_i \leq 25V$		50	170	
$R_{reg-L}$	Load regulation	$1mA \leq I_L \leq 100mA$		10	90	mV
		$1mA \leq I_L \leq 40mA$		5	45	
$V_O$	Output voltage	$12.5V \leq V_i \leq 25V, 1mA \leq I_L \leq 40mA$	9.4	10.0	10.6	V
		$V_i=17V, 1mA \leq I_L \leq 70mA$	9.4	10.0	10.6	
$I_B$	Bias current	$I_L=0$		4.8	6.7	mA
$\Delta I_B$	Bias current differential	$13V \leq V_i \leq 25V, I_L=40mA$		0.1	1.5	mA
		$V_i=17V, 1mA \leq I_L \leq 40mA$			0.2	
$V_{NO}$	Output noise voltage	BW: 10Hz~100kHz		100		$\mu V_{rms}$
RR	Ripple rejection ratio	$f=120Hz, V_{in}=0dBm$	52	59		dB
$V_i-V_O$	Minimum input-output voltage difference			2.0		V
$I_{LP}$	Peak load current			130		mA
$I_{OS}$	Output short circuit sustain current			2.5		mA
$TC_{V_O}$	Temperature coefficient of output voltage	$I_L=5mA$		-0.9		mV/°C

MITSUBISHI <LINEAR ICs>  
**M5278LXX, M5278LXXM**

**(5V, 5.6V, 8V, 9V, 10V, 12V, 15V) 3-TERMINAL FIXED POSITIVE  
OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)**

**M5278L12** ( $V_i=19V$ ,  $I_L=40mA$ ,  $T_a=25^\circ C$ ,  $C_1=0.33\mu F$ ,  $C_O=0.1\mu F$ , unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$V_O$	Output voltage		11.4	12.0	12.6	V
$R_{reg-in}$	Input regulation	$14.5V \leq V_i \leq 27V$		70	250	mV
		$16V \leq V_i \leq 27V$		50	200	
$R_{reg-L}$	Load regulation	$1mA \leq I_L \leq 100mA$		10	100	mV
		$1mA \leq I_L \leq 40mA$		5	50	
$V_O$	Output voltage	$14.5V \leq V_i \leq 27V$ , $1mA \leq I_L \leq 40mA$	11.3	12.0	12.7	V
		$V_i=9V$ , $1mA \leq I_L \leq 70mA$	11.3	12.0	12.7	
$I_B$	Bias current	$I_L=0$		4.8	6.7	mA
$\Delta I_B$	Bias current differential	$16V \leq V_i \leq 27V$ , $I_L=40mA$		0.1	1.5	mA
		$V_i=19V$ , $1mA \leq I_L \leq 40mA$			0.2	
$V_{NO}$	Output noise voltage	BW: 10Hz~100kHz		110		$\mu V_{rms}$
RR	Ripple rejection ratio	$f=120Hz$ , $V_{in}=0dBm$	50	56		dB
$V_i-V_O$	Minimum input-output voltage difference			2.0		V
$I_{LP}$	Peak load current			150		mA
$I_{OS}$	Output short circuit sustain current			12.5		mA
$TC_{VO}$	Temperature coefficient of output voltage	$I_L=5mA$		-1.0		mV/°C

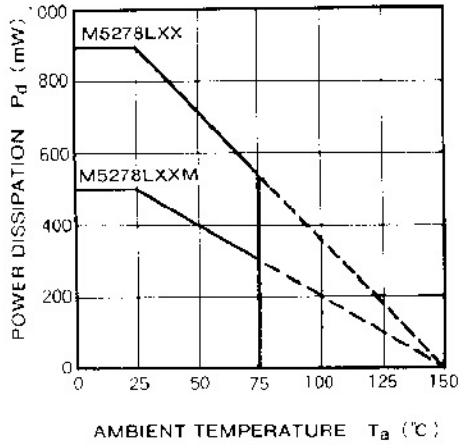
**M5278L15** ( $V_i=23V$ ,  $I_L=40mA$ ,  $T_a=25^\circ C$ ,  $C_1=0.33\mu F$ ,  $C_O=0.1\mu F$ , unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$V_O$	Output voltage		14.25	15.0	15.75	V
$R_{reg-in}$	Input regulation	$17.5V \leq V_i \leq 30V$		80	300	mV
		$20V \leq V_i \leq 30V$		60	250	
$R_{reg-L}$	Load regulation	$1mA \leq I_L \leq 100mA$		10	150	mV
		$1mA \leq I_L \leq 40mA$		5	75	
$V_O$	Output voltage	$17.5V \leq V_i \leq 30V$ , $1mA \leq I_L \leq 40mA$	14.1	15.0	15.9	V
		$V_i=23V$ , $1mA \leq I_L \leq 70mA$	14.1	15.0	15.9	
$I_B$	Bias current	$I_L=0$		4.8	6.7	mA
$\Delta I_B$	Bias current differential	$23V \leq V_i \leq 30V$ , $I_L=40mA$		0.1	1.5	mA
		$V_i=23V$ , $1mA \leq I_L \leq 40mA$			0.2	
$V_{NO}$	Output noise voltage	BW: 10Hz~100kHz		140		$\mu V_{rms}$
RR	Ripple rejection ratio	$f=120Hz$ , $V_{in}=0dBm$	40	45		dB
$V_i-V_O$	Minimum input-output voltage difference			2.0		V
$I_{LP}$	Peak load current			150		mA
$I_{OS}$	Output short circuit sustain current			12.5		mA
$TC_{VO}$	Temperature coefficient of output voltage	$I_L=5mA$		-0.9		mV/°C

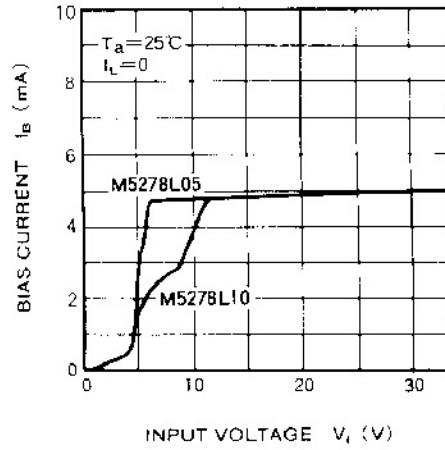
**(5V, 5.6V, 8V, 9V, 10V, 12V, 15V) 3-TERMINAL FIXED POSITIVE  
 OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)**

**TYPICAL CHARACTERISTICS**

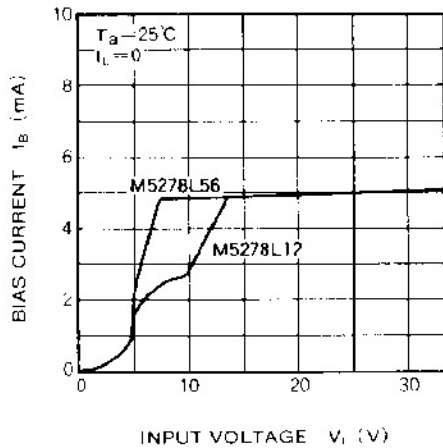
**THERMAL DERATING (MAXIMUM RATING)**



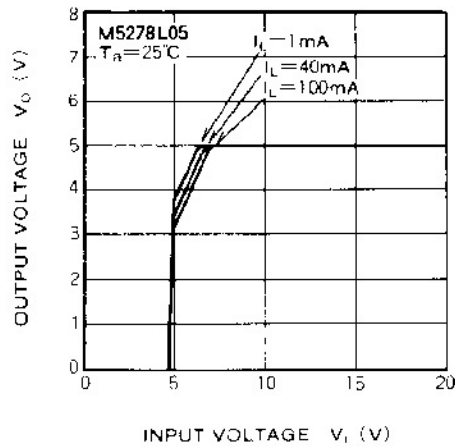
**BIAS CURRENT VS. INPUT VOLTAGE**



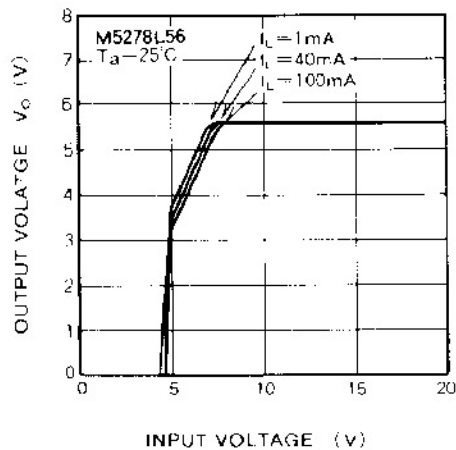
**BIAS CURRENT VS. INPUT VOLTAGE**



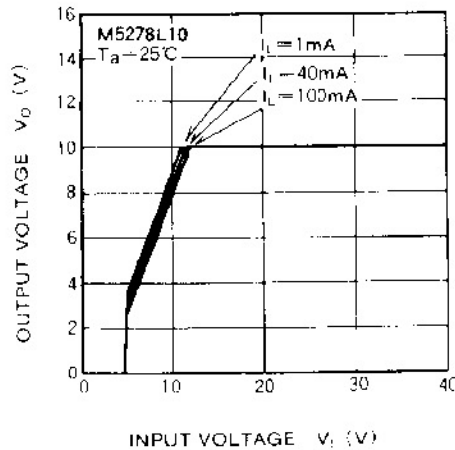
**OUTPUT VOLTAGE VS. INPUT VOLTAGE**



**OUTPUT VOLTAGE VS. INPUT VOLTAGE**



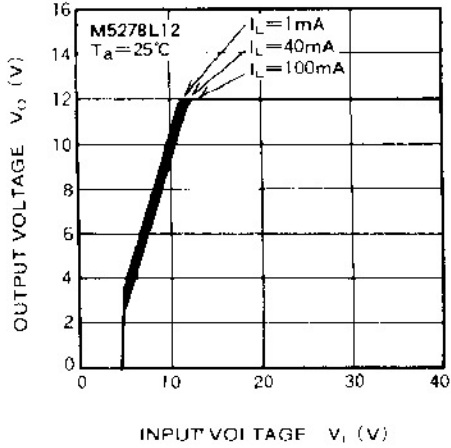
**OUTPUT VOLTAGE VS. INPUT VOLTAGE**



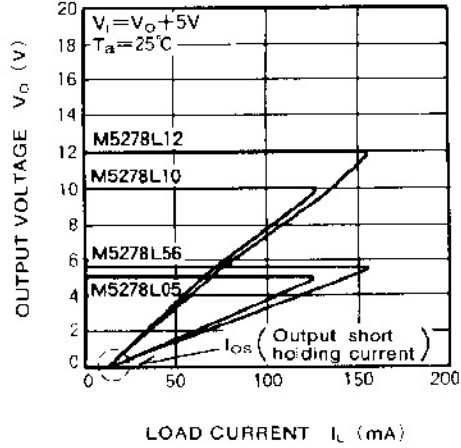
# M5278LXX, M5278LXXM

## (5V, 5.6V, 8V, 9V, 10V, 12V, 15V) 3-TERMINAL FIXED POSITIVE OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)

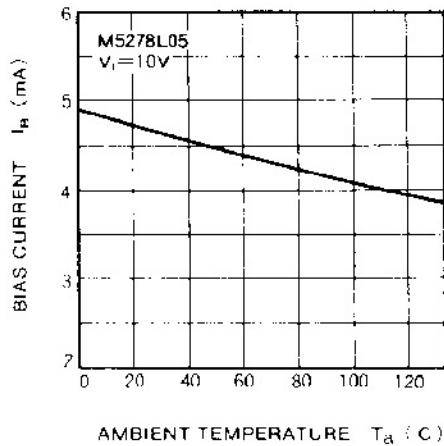
OUTPUT VOLTAGE VS. INPUT VOLTAGE



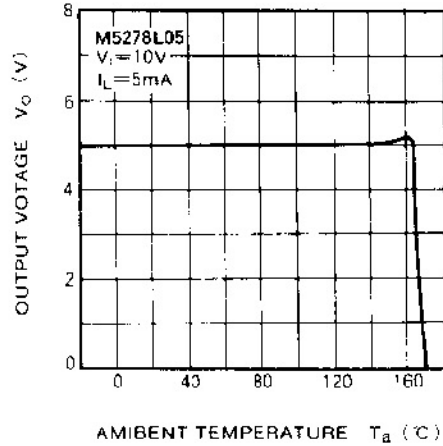
OUTPUT VOLTAGE VS. LOAD CURRENT



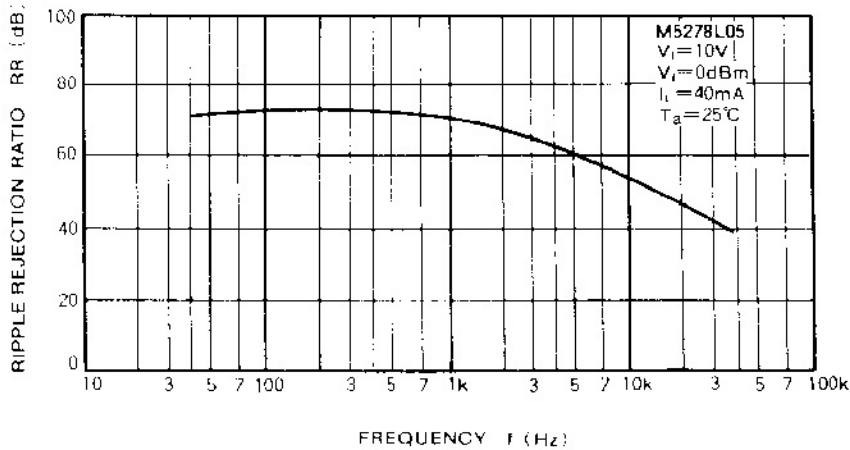
BIAS CURRENT VS. AMBIENT TEMPERATURE



OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE



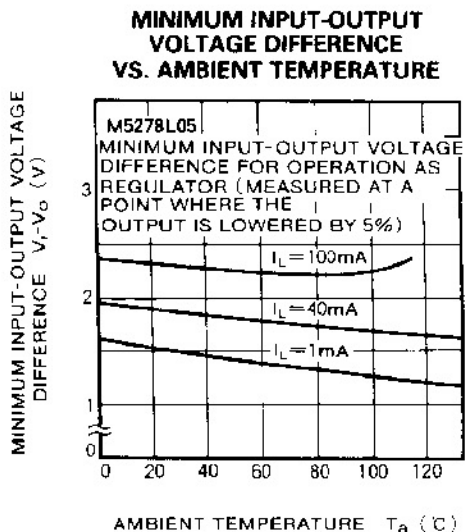
RIPPLE REJECTION VS. FREQUENCY





# M5278LXX, M5278LXXM

## (5V, 5.6V, 8V, 9V, 10V, 12V, 15V) 3-TERMINAL FIXED POSITIVE OUTPUT VOLTAGE REGULATOR (WITH FOLD-BACK PROTECTION CIRCUIT)



### FOLD-BACK PROTECTION CIRCUIT

The M5278L series has been designed to be complete with three-pin, 78L type regulators manufactured by other companies for applications with loading currents in the 100mA class. They additionally have an internalized fold-back protection circuit for protection against shorted loads.

Other 78L units do have an internalized protection circuit known as a drooping type circuit that are rather simple, merely limiting maximum loading current. When large current begins to flow in these units due to a short circuit, abnormal temperatures are generated leading to breakdown and effective setting reliability.

As shown in the diagram, the fold-back protection circuit employed in the M5278L decreases immediately excessive current caused by a short in the load. This not only improves set reliability but permits the elimination of such protection circuits as fuses in the protection circuit.

### PRECAUTIONS FOR USE

The current-control circuit requires that, as an IC power supply, this device be operated within the fold-back operating range shown in the accompanying chart.

### OUTPUT VOLTAGE VS. LOAD CURRENT

