LINEAR INTEGRATED CIRCUITS

SGS

L78M00 Series

PRELIMINARY DATA

3-TERMINAL POSITIVE VOLTAGE REGULATORS

- OUTPUT CURRENT UP TO 0.5A
- OUTPUT VOLTAGES OF 5; 6; 8; 12, 15; 18; 20; 24V
- THERMAL OVERLOAD PROTECTION
- SHORT CIRCUIT PROTECTION
- OUTPUT TRANSISTOR SOA PROTECTION

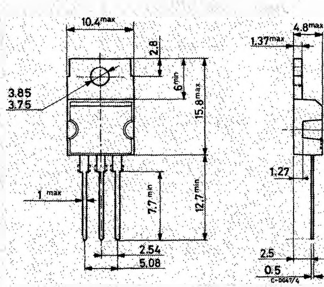
The L78M00 series of three-terminal positive regulators is available in TO-220 package and with several fixed output voltages, making it useful in a wide range of applications. These regulators can provide local on-card regulation, eliminating the distribution problems associated with single point regulation. Each type employs internal current limiting, thermal shut-down and safe area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 0.5A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

ABSOLUTE MAXIMUM RATINGS

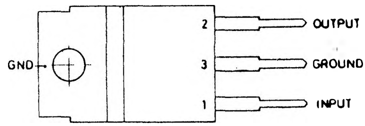
V_i	DC input voltage (for V_o = 5 to 18V)	35	V
	(for V_o = 20, 24V)	40	V
I_o	Output current	Internally limited	
P_{tot}	Power dissipation	Internally limited	
T_{stg}	Storage temperature	-65 to +150	°C
T_{op}	Operating junction temperature	0 to +150	°C

MECHANICAL DATA

Dimensions in mm



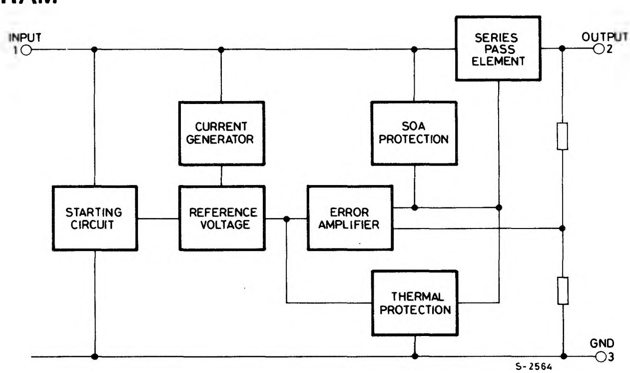
CONNECTION DIAGRAM AND ORDERING NUMBERS
(top view)



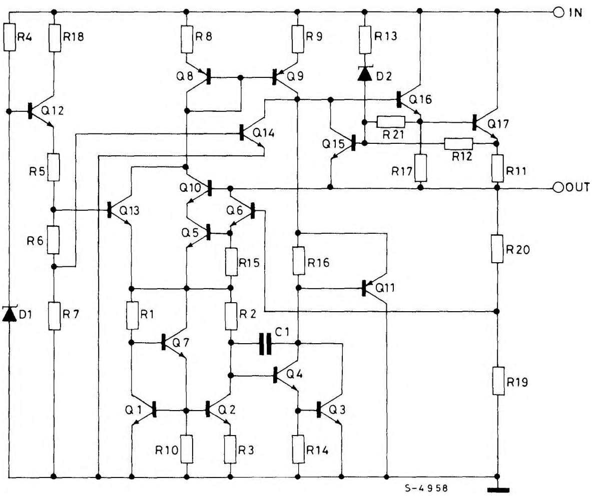
S-2568/1

Ordering Numbers	Output Voltage
L78M05CV	5V
L78M06CV	6V
L78M08CV	8V
L78M12CV	12V
L78M15CV	15V
L78M18CV	18V
L78M20CV	20V
L78M24CV	24V

BLOCK DIAGRAM



SCHEMATIC DIAGRAM



TEST CIRCUITS

Fig. 1 - DC parameters

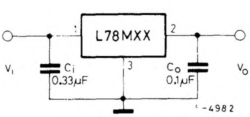


Fig. 2 - Load regulation

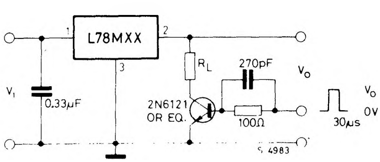
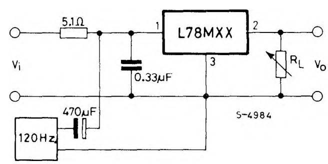


Fig. 3 - Ripple rejection



THERMAL DATA

$R_{th\ j\text{-}case}$	Thermal resistance junction-case	max	3	°C/W
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	50	°C/W

ELECTRICAL CHARACTERISTICS L78M00C (Refer to the test circuits, $T_j = 25°C$, $I_o = 350$ mA unless otherwise specified, $C_i = 0.33\ \mu F$, $C_o = 0.1\ \mu F$)

OUTPUT VOLTAGE		5			6			8			12			Unit
INPUT VOLTAGE (Unless otherwise specified)		10			11			14			19			
Parameter	Test conditions	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
V_o Output voltage		4.8	5	5.2	5.75	6	6.25	7.7	8	8.3	11.5	12	12.5	V
	I_o = 5 to 350 mA	4.75	5	5.25 (V_i = 7 to 20V)	5.7	6	6.3 (V_i = 8 to 21V)	7.6	8	8.4 (V_i = 10.5 to 23V)	11.4	12	12.6 (V_i = 14.5 to 27V)	V
ΔV_o Line regulation	I_o = 200 mA			100 (V_i = 7 to 25V)			100 (V_i = 8 to 25V)			100 (V_i = 10.5 to 25V)			100 (V_i = 14.5 to 30V)	mV
				50 (V_i = 8 to 25V)			50 (V_i = 9 to 25V)			50 (V_i = 11 to 25V)			50 (V_i = 16 to 30V)	mV
ΔV_o Load regulation	I_o = 5 mA to 0.5A			100			120			160			240	mV
	I_o = 5 mA to 200 mA			50			60			80			120	mV
I_d Quiescent current				6			6			6			6	mA
ΔI_d Quiescent current change	I_o = 5 mA to 350 mA			0.5			0.5			0.5			0.5	mA
	I_o = 200 mA			0.8 (V_i = 8 to 25V)			0.8 (V_i = 9 to 25V)			0.8 (V_i = 10.5 to 25)			0.8 (V_i = 14.5 to 30V)	mA
$\frac{\Delta V_o}{\Delta T}$ Output Voltage drift	I_o = 5 mA, T_j = 0 to 125°C		-0.5			-0.5			-0.5			-1.0		mV/°C
e_N Output noise voltage	B = 10Hz to 100KHz		40			45			52			75		μV
SVR Supply voltage rejection	f = 120 Hz, I_o = 300 mA	62 (V_i = 8 to 18V)			59 (V_i = 9 to 19V)			56 (V_i = 11.5 to 21.5V)			55 (V_i = 15 to 25V)			dB
V_d Dropout voltage			2			2			2			2		V
I_{sc} Short circuit current	V_i = 35V		300			270			250			240		mA
I_{scp} Short circ. peak current			700			700			700			700		mA

ELECTRICAL CHARACTERISTICS L78M00C (continued)

OUTPUT VOLTAGE			15			18			20			24			Unit
INPUT VOLTAGE (Unless otherwise specified)			23			26			29			33			
Parameter		Test conditions	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
V_o	Output Voltage		14.4	15	15.6	17.3	18	18.7	19.2	20	20.8	23	24	25	V
		I_o = 5 to 350 mA	14.25	15 (V$_i$= 17.5 to 30V)	15.75	17.1	18 (V$_i$= 20.5 to 33V)	18.9	19	20 (V$_i$= 23 to 35V)	21	22.8	24 (V$_i$= 27 to 38V)	25.2	V
ΔV_o	Line regulation	I_o = 200 mA			100 (V$_i$= 17.5 to 30V)			100 (V$_i$= 21 to 33V)			100 (V$_i$= 23 to 35V)			100 (V$_i$= 27 to 38V)	mV
					50 (V$_i$= 20 to 30V)			50 (V$_i$= 24 to 33V)			50 (V$_i$= 24 to 35V)			50 (V$_i$= 28 to 38V)	mV
ΔV_o	Load regulation	I_o = 5 mA to 0.5A			300			360			400			480	mV
		I_o = 5 mA to 200 mA			150			180			200			240	mV
I_d	Quiescent current				6			6			6			6	mA
ΔI_d	Quiescent current change	I_o = 5 mA to 350 mA			0.5			0.5			0.5			0.5	mA
		I_o = 200 mA			0.8 (V$_i$= 17.5 to 30V)			0.8 (V$_i$= 21 to 33V)			0.8 (V$_i$= 23 to 35V)			0.8 (V$_i$= 27 to 38V)	mA
$\frac{\Delta V_o}{\Delta T}$	Output voltage drift	I_o = 5 mA, T_{amb} = 0 to 125°C		-1			-1.1			-1.1			-1.2		mV/°C
e_N	Output noise voltage	B = 10Hz to 100KHz		90			100			110			170		µV
SVR	Supply voltage rejection	f = 120 Hz, I_o = 300 mA	54 (V$_i$= 18.5 to 28.5V)			53 (V$_i$= 22 to 32V)			53 (V$_i$= 24 to 34V)			50 (V$_i$= 28 to 38V)			dB
V_d	Dropout Voltage			2			2			2			2		V
I_{sc}	Short circuit current	V_i = 35V		240			240			240			240		mA
I_{scp}	Short circ. peak current			700			700			700			700		mA

Fig. 4 - Dropout voltage vs. junction temperature

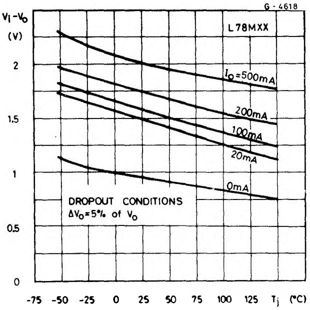


Fig. 5 - Dropout characteristics

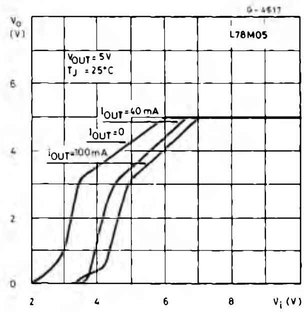


Fig. 6 - Peak output current vs. input-output differential voltage

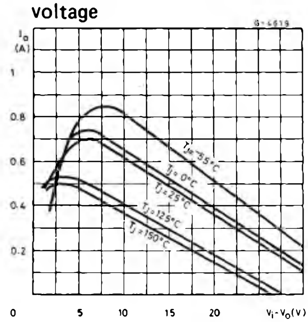


Fig. 7 - Output voltage vs. junction temperature

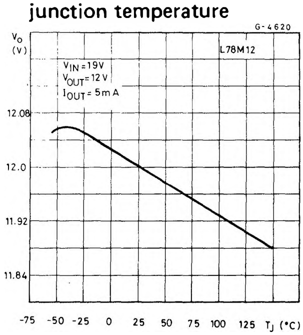


Fig. 8 - Supply voltage rejection vs. frequency

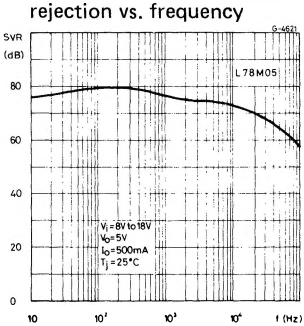


Fig. 9 - Quiescent current vs. junction temperature

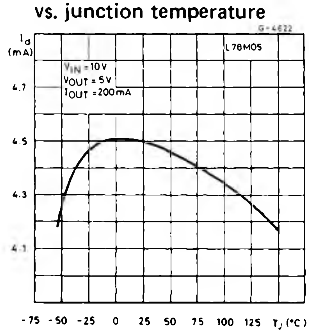


Fig. 10 - Load transient response

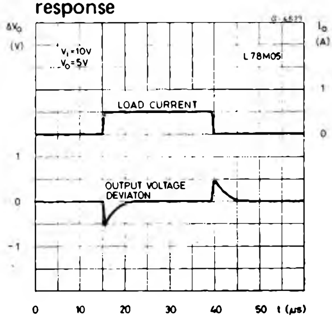


Fig. 11 - Line transient response

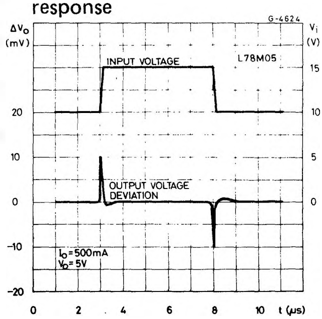
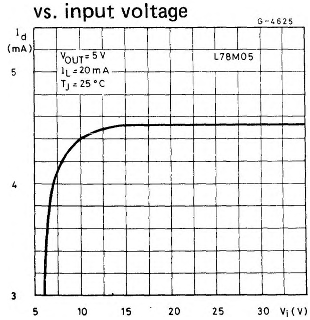
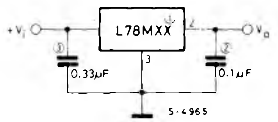


Fig. 12 - Quiescent current vs. input voltage



APPLICATION INFORMATION (continued)

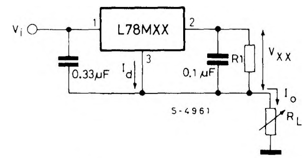
Fig. 13 - Fixed output regulator



Notes:

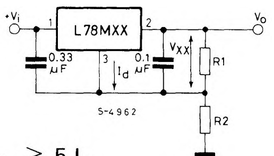
(1) To specify an output voltage, substitute voltage value for "XX".
(2) Although no output capacitor is needed for stability, it does improve transient response.
(3) Required if regulator is located an appreciable distance from power supply filter.

Fig. 14 - Costant current regulator



$$I_o = \frac{V_{XX}}{R_1} + I_d$$

Fig. 15 - Circuit for increasing output voltage



$$I_{R_1} \geqslant 5\, I_d$$

$$V_o = V_{XX} \left(1 + \frac{R_2}{R_1}\right) + I_d\, R_2$$

Fig. 16 - Adjustable output regulator (7 to 30V)

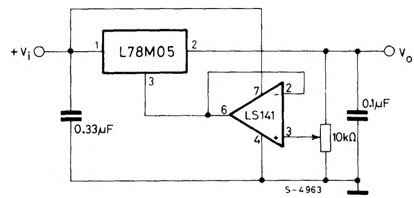
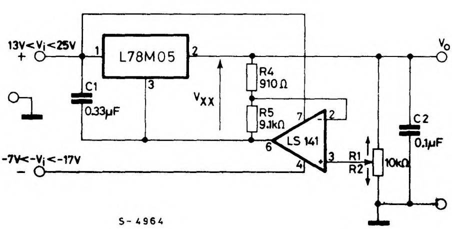
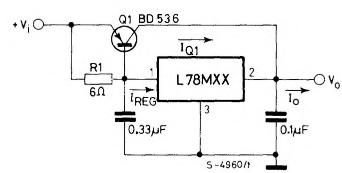


Fig. 17 - 0.5 to 10V regulator



$$V_o = V_{XX}\, \frac{R_4}{R_1}$$

Fig. 18 - High current voltage regulator

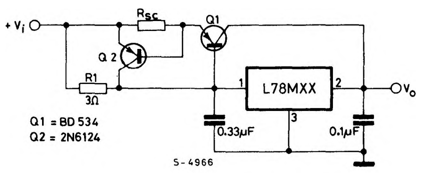


$$R_1 = \frac{V_{BEQ_1}}{I_{REG} - \frac{I_{Q_1}}{\beta_{Q_1}}}$$

$$I_o = I_{REG} + \beta_{Q_1} \left[I_{REG} - \frac{V_{BEQ_1}}{R_1} \right]$$

APPLICATION INFORMATION (continued)

Fig. 19 - High output current with short circuit protection



$$R_{SC} = \frac{V_{BEQ_2}}{I_{SC}}$$

Fig. 20 - Tracking voltage regulator

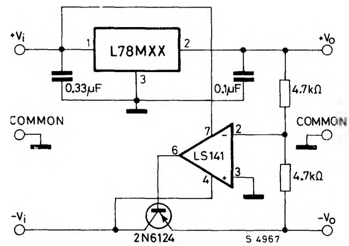
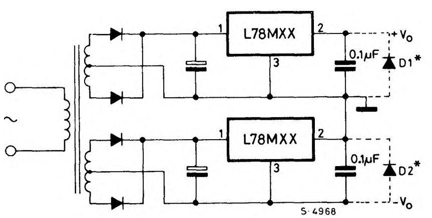


Fig. 21 - Positive and negative regulator



(*) D_1 and D_2 are necessary if the load is connected between $+V_o$ and $-V_o$

Fig. 22 - Negative output voltage circuit

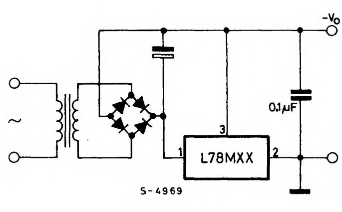
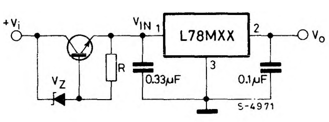
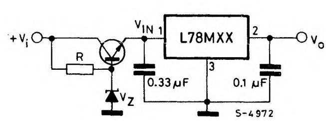


Fig. 23 - High input voltage circuit



$$V_{IN} = V_i - (V_Z + V_{BE})$$

Fig. 24 - High input voltage circuit



$$V_{IN} = V_Z - V_{BE}$$

APPLICATION INFORMATION (continued)

Fig. 25 - High output voltage regulator

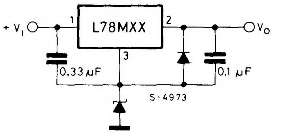
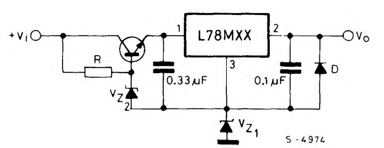
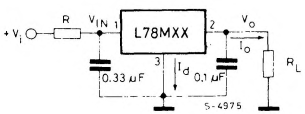


Fig. 26 - High input and output voltage



$$V_O = V_{XX} + V_{Z1}$$

Fig. 27 - Reducing power dissipation with dropping resistor



$$R = \frac{V_{i(min)} - V_{XX} - V_{DROP(max)}}{I_{o(max)} + I_{d(max)}}$$

Fig. 28 - Remote shuntdown

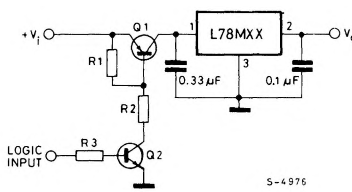
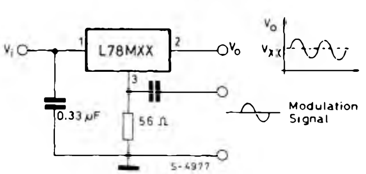
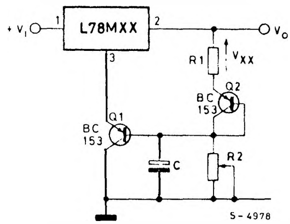


Fig. 29 - Power AM modulator (unity voltage gain, $I_o \leqslant 0.5$)



Note: The circuit performs well up to 100 KHz.

Fig. 30 - Adjustable output voltage with temperature compensation



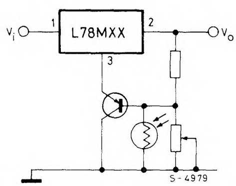
Note: Q_2 is connected as a diode in order to compensate the variation of the Q_1 V_{BE} with the temperature. C allows a slow rise-time of the V_o

$$V_o = V_{XX} \left(1 + \frac{R_2}{R_1}\right) + V_{BE}$$

APPLICATION INFORMATION (continued)

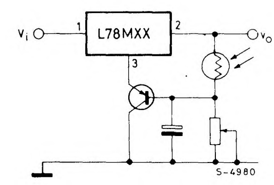
Fig. 31 - Light controllers ($V_{o\ min} = V_{XX} + V_{BE}$)

(a)



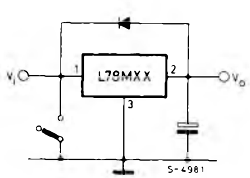
V_o falls when the light goes up

(b)



V_o rises when the light goes up

Fig. 32 - Protection against input short-circuit with high capacitance loads



Applications with high capacitance loads and an output voltage greater than 6 volts need an external diode (see fig. 32) to protect the device against input short circuit. In this case the input voltage falls rapidly while the output voltage decreases showly. The capacitance discharges by means of the Base-Emitter junction of the series pass transistor in the regulator. If the energy is sufficiently high, the transistor may be destroyed. The external diode by-passes the current from the IC to ground.