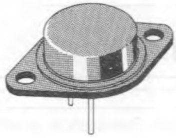
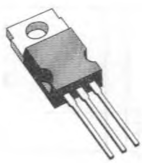
L78S00 SERIES

2A POSITIVE VOLTAGE REGULATORS

- OUTPUT CURRENT TO 2A
- OUTPUT VOLTAGES OF 5 ; 7.5 ; 9 ; 10 ; 12 ; 15 ; 18 ; 24V
- THERMAL OVERLOAD PROTECTION
- SHORT CIRCUIT PROTECTION
- OUTPUT TRANSISTOR SOA PROTECTION



TO-3

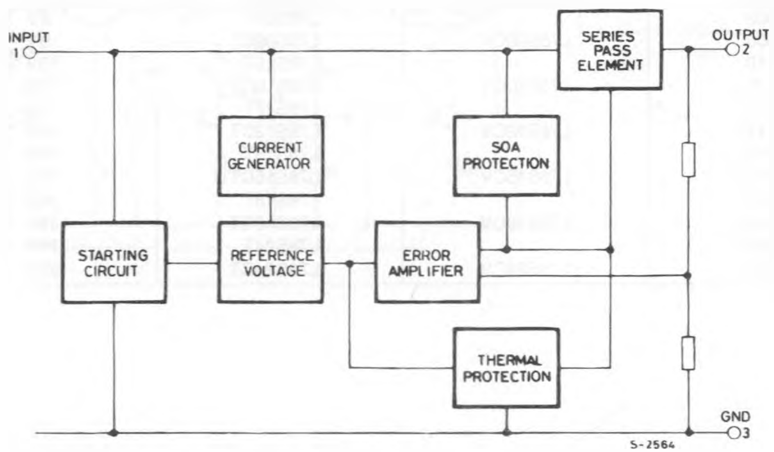


TO-220

DESCRIPTION

The L78S00 series of three-terminal positive regulators is available in TO-220 and TO-3 packages 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 2A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

BLOCK DIAGRAM



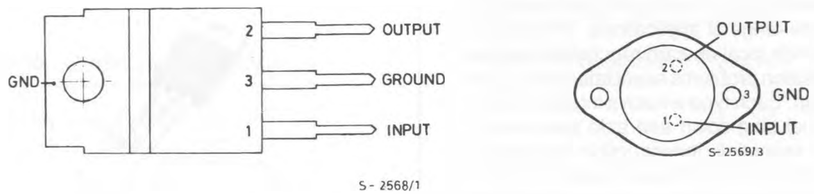
ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_i	DC Input Voltage (for V_o = 5 to 18V) (for V_o = 24V)	35 40	V 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 (for **L78S00**) (for **L78S00C**)	– 55 to + 150 0 to + 150	°C °C

THERMAL DATA

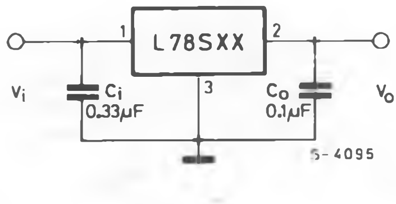
		TO-220	TO-3	
$R_{th\ j\text{-}case}$	Thermal Resistance Junction-case Max	3	4	°C/W
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient Max	50	35	°C/W

CONNECTION DIAGRAMS AND ORDERING NUMBERS (top views)

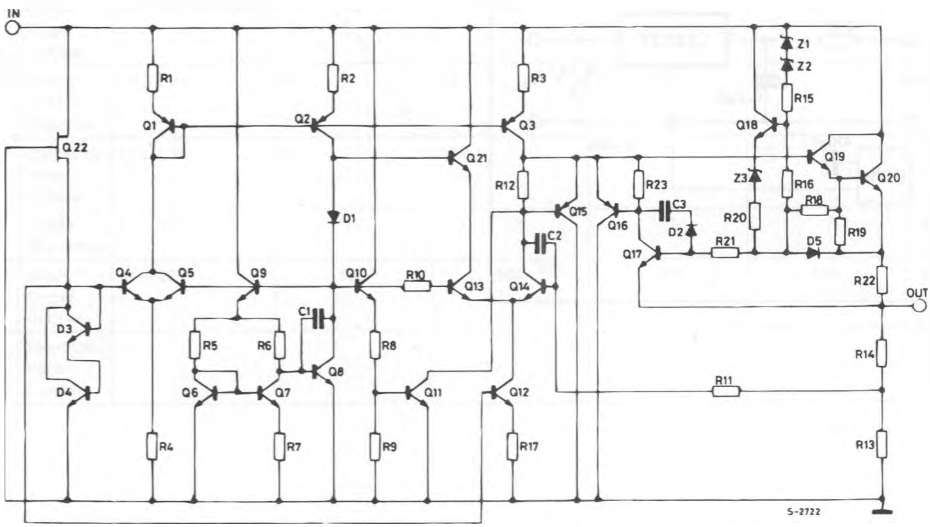


Type	TO-220	TO-3	Output Voltage
L78S05		L78S05T	5 V
L78S05C	L78S05CV	L78S05CT	5 V
L78S75		L78S75T	7.5V
L78S75C	L78S75CV	L78S75CT	7.5V
L78S09		L78S09T	9 V
L78S09C	L78S09CV	L78S09CT	9 V
L78S10		L78S10T	10V
L78S10C	L78S10CV	L78S10CT	10V
L78S12		L78S12T	12V
L78S12C	L78S12CV	L78S12CT	12V
L78S15		L78S15T	15V
L78S15C	L78S15CV	L78S15CT	15V
L78S18		L78S18T	18V
L78S18C	L78S18CV	L78S18CT	18V
L78S24		L78S24T	24V
L78S24C	L78S24CV	L78S24CT	24V

APPLICATION CIRCUIT



SCHEMATIC DIAGRAM



TEST CIRCUITS

Figure 1 : DC Parameters.

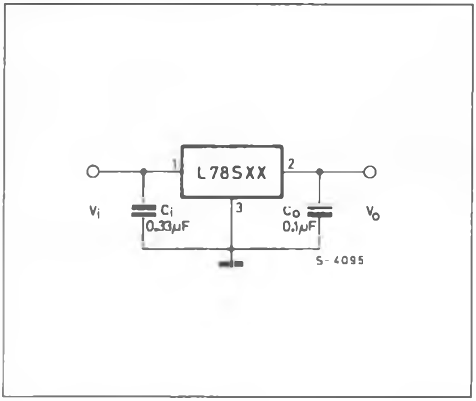


Figure 2 : Load Regulation.

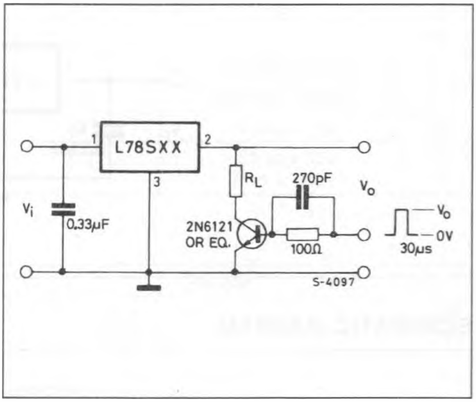
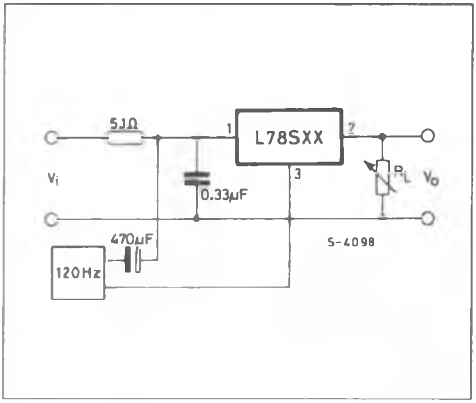


Figure 3 : Ripple Rejection.



ELECTRICAL CHARACTERISTICS L78S00

(Refer to the test circuits, T_j = 25°C, I_o = 500mA unless otherwise specified)

Output Voltage			5			7.5			9			10			Unit
Input Voltage (unless otherwise specified)			10			12.5			14			15			
Sym.	Parameter	Test Conditions	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
V_o	Output Voltage		4.8	5	5.2	7.15	7.5	7.9	8.65	9	9.35	9.5	10	10.5	V
		I_o = 1A	4.75	5 (V_i = 7V)	5.25	7.1	7.5 (V_i = 9.5V)	7.95	8.6	9 (V_i = 11V)	9.4	9.4	10 (V_i = 12.5V)	10.6	
ΔV_o	Line Regulation				100 (V_i = 7 to 25V)			120 (V_i = 9.5 to 25V)			130 (V_i = 11 to 25V)			200 (V_i = 12.5 to 30V)	mV
					50 (V_i = 8 to 12V)			60 (V_i = 10.5 to 20V)			65 (V_i = 11 to 20V)			100 (V_i = 14 to 22V)	
ΔV_o	Load Regulation	I_o = 20mA to 2A			100			120			130			150	mV
I_d	Quiescent Current				8			8			8			8	mA
ΔI_d	Quiescent Current Change	I_o = 20mA to 1A			0.5			0.5			0.5			0.5	mA
		I_o = 20mA			1.3 (Vi = 7 to 25V)			1.3 (V_i = 9.5 to 25V)			1.3 (V_i = 11 to 25V)			1 (V_i = 12.5 to 30V)	
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift	I_o = 5mA T_j = – 55 to 150°C		– 1.1			– 0.8			– 1			– 1		mV/°C
e_N	Output Noise Voltage	B = 10Hz to 100KHz		40			52			60			65		μV
SVR	Supply Voltage Rejection	f = 120Hz	60			54			53			53			dB
V_i	Operating Input Voltage	$I_o \leq$ 1.5A	8			10.5			12			13			V
R_o	Output Resistance	f = 1KHz		17			16			17			17		mΩ
I_{sc}	Short Circuit Current	V_i = 27V		500			500			500			500		mA
I_{scp}	Short Circ Peak Current				4			4			4			4	A

ELECTRICAL CHARACTERISTICS L78S00 (continued)

Output Voltage			12			15			18			24			Unit
Input Voltage (unless otherwise specified)			19			23			26			33			
Sym.	Parameter	Test Conditions	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
V_o	Output Voltage		11.5	12	12.5	14.4	15	15.6	17.1	18	18.9	23	24	25	V
		I_o = 1A	11.4	12	12.6	14.25	15	15.75	17	18	19	22.8	24	25.2	
				(V_i = 14.5V)			(V_i = 17.5V)			(V_i = 20.5V)			(V_i = 27V)		
ΔV_o	Line Regulation				240 (V_i = 14.5 to 30V)			300 (V_i = 17.5 to 30V)			360 (V_i = 20.5 to 30V)			480 (V_i = 27 to 38V)	mV
					120 (V_i = 16 to 22V)			150 (V_i = 20 to 26V)			180 (V_i = 22 to 28V)			240 (V_i = 30 to 36V)	
ΔV_o	Load Regulation	I_o = 20mA to 2A			160			180			200			250	mV
I_d	Quiescent Current				8			8			8			8	mA
ΔI_d	Quiescent Current Change	I_o = 20mA to 1A			0.5			0.5			0.5			0.5	mA
		I_o = 20mA			1 (V_i = 14.5 to 30V)			1 (V_i = 17.5 to 30V)			1 (V_i = 22 to 33V)			1 (V_i = 28 to 38V)	
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift	I_o = 5mA T_{amb} = 0 to 70°C		– 1			– 1			– 1			– 1.5		mV/°C
e_N	Output Noise Voltage	B = 10Hz to 100KHz		75			90			110			170		µV
SVR	Supply Voltage Rejection	f = 120Hz	53			52			49			48			dB
V_i	Operating Input Voltage	$I_o \leq$ 1.5A	15			18			21			27			V
R_o	Output Resistance	f = 1KHz		18			19			22			23		mΩ
I_{sc}	Short Circuit Current	V_i = 27V		500			500			500			500		mA
I_{scp}	Short Circ. Peak Current				4			4			4			4	A

ELECTRICAL CHARACTERISTICS L78S00C

(Refer to the test circuits, T_j = 25°C, I_o = 500mA unless otherwise specified)

Output Voltage			5			7.5			9			10			Unit
Input Voltage (unless otherwise specified)			10			12.5			14			15			
Sym.	Parameter	Test Conditions	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
V_o	Output Voltage		4.8	5	5.2	7.15	7.5	7.9	8.65	9	9.35	9.5	10	10.5	V
		I_o = 1A	4.75	5	5.25	7.1	7.5	7.95	8.6	9	9.4	9.4	10	10.6	
				(V_i = 7V)			(V_i = 9.5V)			(V_i = 11V)			(V_i = 12.5V)		
ΔV_o	Line Regulation				100 (V_i = 7 to 25V)			120 (V_i = 9.5 to 25V)			130 (V_i = 11 to 25V)			200 (V_i = 12.5 to 30V)	mV
					50 (V_i = 8 to 12V)			60 (V_i = 10.5 to 20V)			65 (V_i = 11 to 20V)			100 (V_i = 14 to 22V)	
ΔV_o	Load Regulation	I_o = 20mA to 1.5A			100			140			170			240	mV
		I_o = 2A		80			100			100			150		
I_d	Quiescent Current				8			8			8			8	mA
ΔI_d	Quiescent Current Change	I_o = 20mA to 1A			0.5			0.5			0.5			0.5	mA
		I_o = 20mA			1.3 (V_i = 7 to 25V)			1.3 (V_i = 9.5 to 25V)			1.3 (V_i = 11 to 25V)			1.0 (V_i = 12.5 to 30V)	
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift	I_o = 5mA T_{amb} = 0 to 70°C		− 1.1			− 0.8			− 1			− 1		mV/°C
e_N	Output Noise Voltage	B = 10Hz to 100KHz		40			52			60			65		µV
SVR	Supply Voltage Rejection	f = 120Hz	54			48			47			47			dB
V_i	Operating Input Voltage	$I_o \leq$ 1.5A	8			10.5			12			13			V
R_o	Output Resistance	f = 1KHz		17			16			17			17		mΩ
I_{sc}	Short Circuit Current	V_i = 27V		500			500			500			500		mA
I_{scp}	Short Circ. Peak Current				4			4			4			4	A

ELECTRICAL CHARACTERISTICS L78S00C (continued)

Output Voltage			12			15			18			24			Unit
Input Voltage (unless otherwise specified)			19			23			26			33			
Sym.	Parameter	Test Conditions	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
V_o	Output Voltage		11.5	12	12.5	14.4	15	15.6	17.1	18	18.9	23	24	25	V
		I_o = 1A	11.4	12 (V_i = 14.5V)	12.6	14.25	15 (V_i = 17.5V)	15.75	17	18 (V_i = 20.5V)	19	22.8	24 (V_i = 27V)	25.2	
ΔV_o	Line Regulation				240 (V_i = 14.5 to 30V)			300 (V_i = 17.5 to 30V)			360 (V_i = 20.5 to 30V)			480 (V_i = 27 to 38V)	mV
					120 (V_i = 16 to 22V)			150 (V_i = 20 to 26V)			180 (V_i = 22 to 28V)			240 (V_i = 30 to 36V)	
ΔV_o	Load Regulation	I_o = 20mA to 1.5A			240			300			360			480	mV
		I_o = 2A		150			150			200			300		
I_d	Quiescent Current				8			8			8			8	mA
ΔI_d	Quiescent Current Change	I_o = 20mA to 1A			0.5			0.5			0.5			0.5	mA
		I_o = 20mA			1.0 (V_i = 14.5 to 30V)			1.0 (V_i = 17.5 to 30V)			1.0 (V_i = 20.5 to 30V)			1.0 (V_i = 27 to 38V)	
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift	I_o = 5mA T_{amb} = 0 to 70°C		– 1			– 1			– 1			– 1.5		mV/°C
e_N	Output Noise Voltage	B = 10Hz to 100KHz		75			90			110			170		µV
SVR	Supply Voltage Rejection	f = 120Hz	47			46			43			42			dB
V_i	Operating Input Voltage	$I_o \leq$ 1.5A	15			18			21			27			V
R_o	Output Resistance	f = 1KHz		18			19			22			28		mΩ
I_{sc}	Short Circuit Current	V_i = 27V		500			500			500			500		mA
I_{scp}	Short Circ. Peak Current				4			4			4			4	A

Figure 4 : Dropout Voltage vs. Junction Temperature.

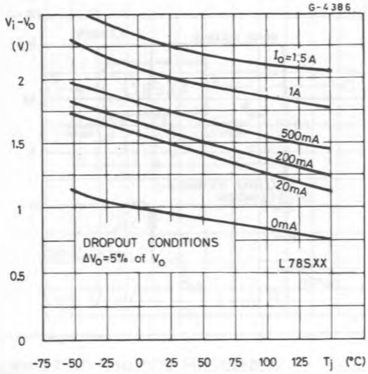


Figure 5 : Peak Output Current vs. Input/Output Differential Voltage.

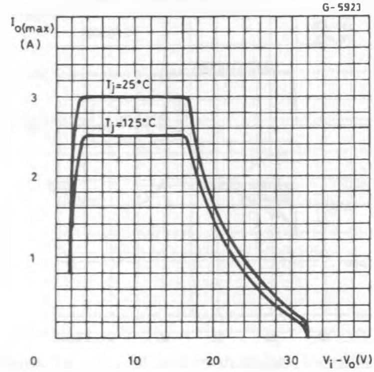


Figure 6 : Supply Voltage Rejection vs. Frequency.

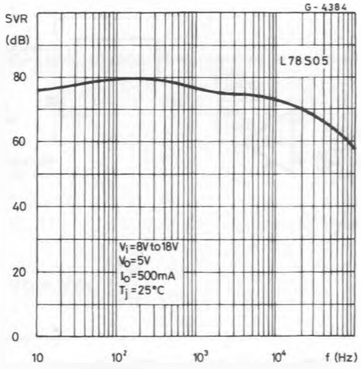


Figure 7 : Output Voltage vs. Junction Temperature.

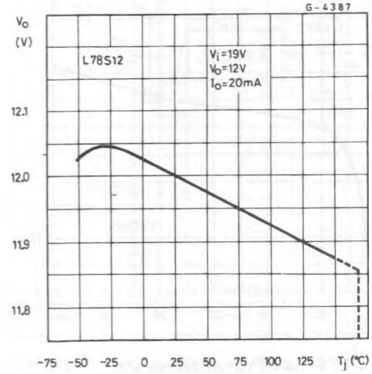


Figure 8 : Output Impedance vs. Frequency.

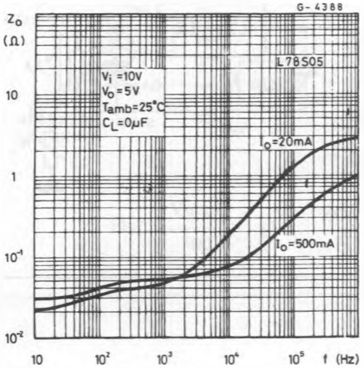


Figure 9 : Quiescent Current vs. Junction Temperature.

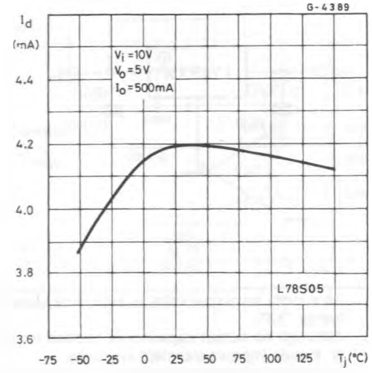


Figure 10 : Load Transient Response.

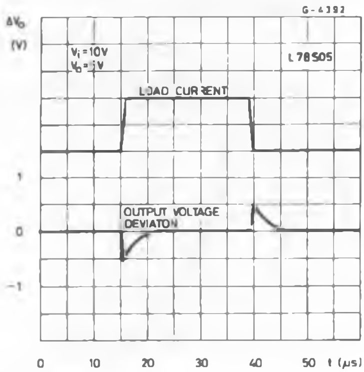


Figure 11 : Line Transient Response.

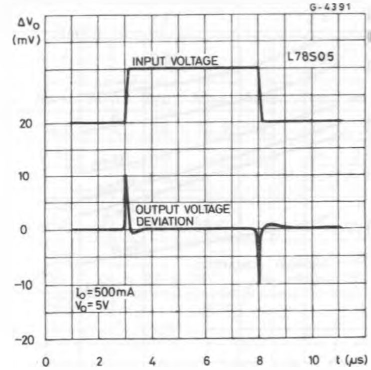


Figure 12 : Quiescent Current vs. Input Voltage.

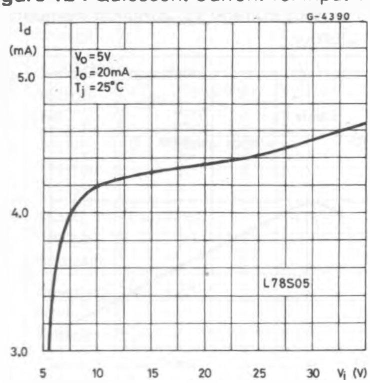
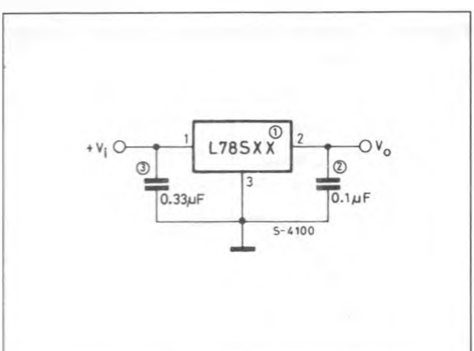


Figure 13 : Fixed Output Regulator.

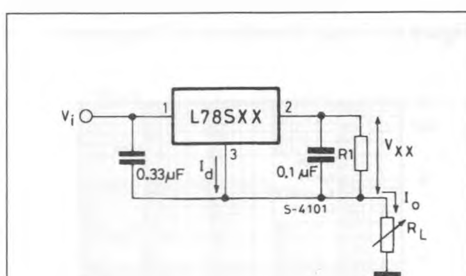


Notes : 1. To specify an output voltage, substitute voltage value for "XX".

2. Although no output capacitor is needed for stability, it does improve transient response.

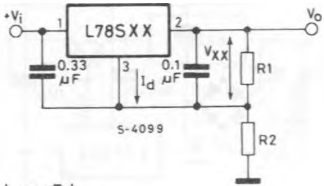
3. Required if regulator is located an appreciable distance from power supply filter.

Figure 14 : Constant Current Regulator.



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

Figure 15 : Circuit for Increasing Output Voltage.



$I_{R1} \geq 5\, I_d$

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

Figure 16 : Adjustable Output Regulator (7 to 30V).

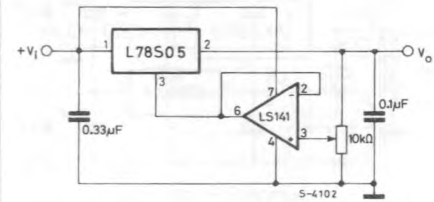
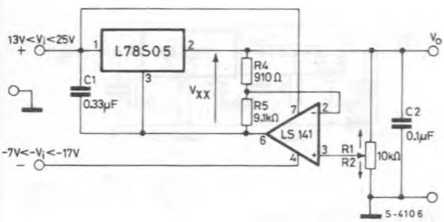
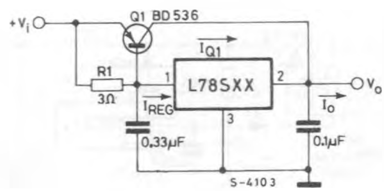


Figure 17 : 0.5 to 10V Regulator.



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

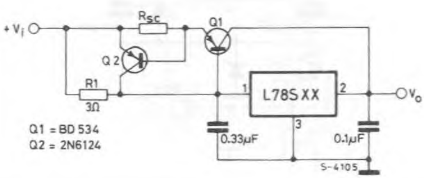
Figure 18 : High Current Voltage Regulator.



$$R_1 = \frac{V_{BEQ1}}{I_{REG} - \frac{I_{Q1}}{\beta_{Q1}}}$$

$$I_O = I_{REG} + Q_1\left[I_{REG} - \frac{V_{BEQ1}}{R_1}\right]$$

Figure 19 : High Output Current with Short Circuit Protection.



$$R_{SC} = \frac{V_{BEQ2}}{I_{SC}}$$

Figure 20 : Tracking Voltage Regulator.

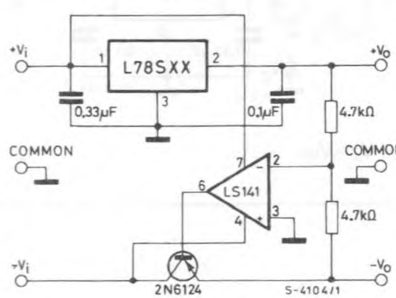
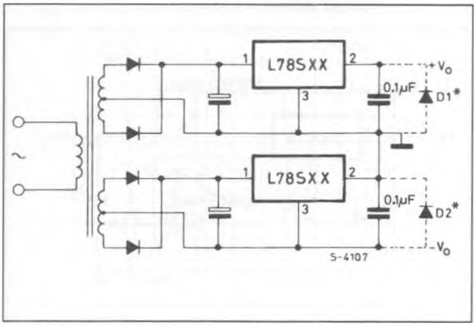


Figure 21 : Positive and Negative Regulator.



(*) D_1 and D_2 are necessary if the load is connected between + V_0 and – V_0.

Figure 22 : Negative Output Voltage Circuit.

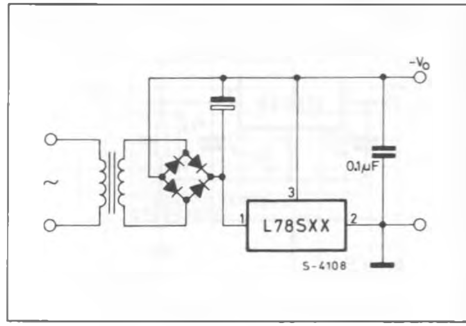


Figure 23 : Switching Regulator.

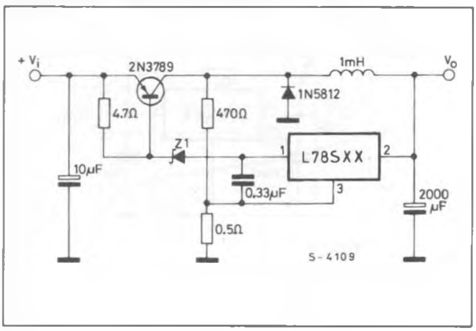
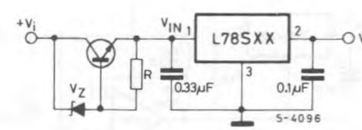
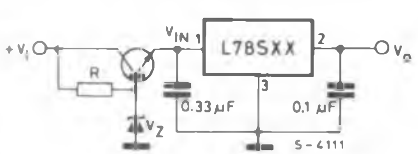


Figure 24 : High Input Voltage Circuit.



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

Figure 25 : High Input Voltage Circuit.



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

Figure 26 : High Output VoltageRegulator.

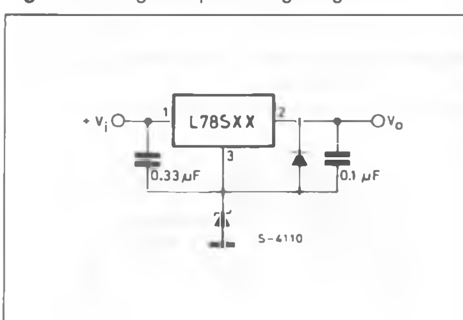
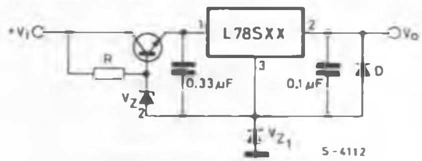
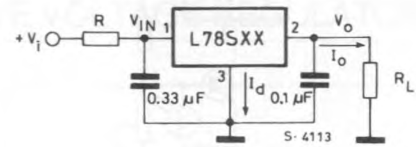


Figure 27 : High Input and Output Voltage.



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

Figure 28 : Reducing Power Dissipation with Dropping Resistor.



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

Figure 29 : Remote Shuntdown.

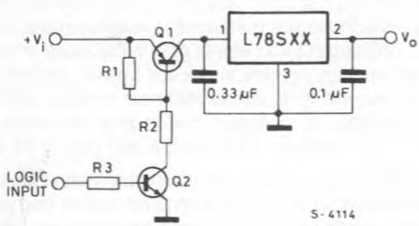
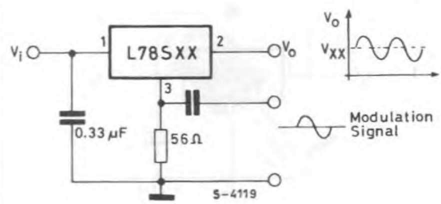
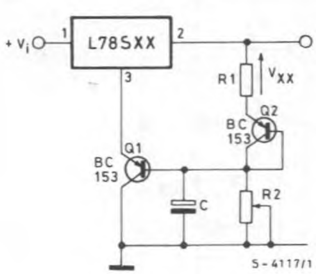


Figure 30 : Power AM Modulator (unity voltage gain, Io ≤ 1A).



Note : The circuit performs well up to 100KHz.

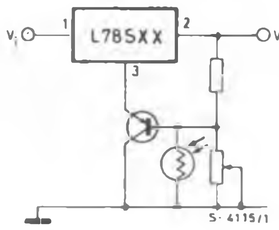
Figure 31 : Adjustable Output Voltage with Temperature Compensation.



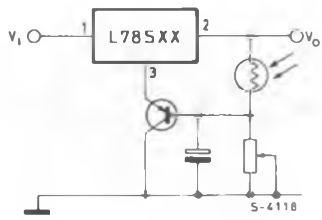
$$V_O = V_{XX}\left(1 + \frac{R_2}{R_1}\right) + V_{BE}$$

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

Figure 32 : Light Controllers ($V_{O\,min} = V_{xx} + V_{BE}$).

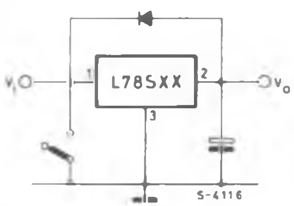


V_O falls when the light goes up



V_O rises when the light goes up

Figure 33 : 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. 33) 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.