

# **SPX1086**

# 1.5A Low Dropout Voltage Regulator Adjustable & Fixed Output, Fast Response

# **FEATURES**

- Adjustable Output Down To 1.2V
- Fixed Output Voltages 1.5, 2.5, 3.3, 5.0V
- Output Current of 1.5A
- Low Dropout Voltage 1.1V Typ.
- Extremely Tight Load And Line Regulation
- Current & Thermal Limiting
- Standard 3-Terminal Low Cost TO-220, TO-263 & TO-252
- Similar To Industry Standard LT1086/LT1586

# **APPLICATIONS**

- Powering VGA & Sound Card
- Power PC<sup>TM</sup> Supplies
- SMPS Post-Regulator
- High Efficiency "Green" Computer Systems
- High Efficiency Linear Power Supplies
- Portable Instrumentation
- Constant Current Regulators
- Adjustable Power Supplies
- Battery charger

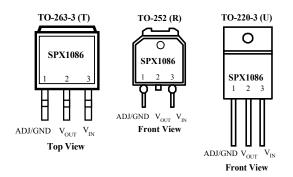
#### PRODUCT DESCRIPTION

The SPX1086 is a low power 1.5A adjustable and fixed voltage regulators that are very easy to use. It requires only 2 external resistors to set the output voltage for adjustable version. The SPX1086 is designed for low voltage applications that offer lower dropout voltage and faster transient response. This device is an excellent choice for use in powering low voltage microprocessor that require a lower dropout, faster transient response to regulate from +2.5V to 3.8V supplies and as a post regulator for switching supplies applications. The SPX1086 features low dropout of a maximum 1.2 volts.

The SPX1086 offers full protection against over-current faults, reversed input polarity, reversed load insertion, and positive and negative transient voltage. On-Chip trimming adjusts the reference voltage to 1%. The  $I_Q$  of this device flows into load which increases efficiency.

The SPX1086 are offered in a 3-pin TO-220, TO-263 & TO-252 packages compatible with other 3 terminal regulators. For a 3A low dropout regulator refer to the SPX1587 data sheet.

# **PIN CONNECTIONS**



# **ABSOLUTE MAXIMUM RATINGS**

Lead Temp. (Soldering, 10 Seconds)	300°C
Storage Temperature Range	65° to +150°C
Operating Junction Temperature Range	
SPX1086 Control Section	45°C +125°C
SPX1086 Power Transistor	-45°C +150°C

Input to Output Voltage Differential ........................ 30V

# **ELECTRICAL CHARACTERISTICS** (NOTE 1) at I<sub>OUT</sub> = 10mA, T<sub>a</sub>=25°C, unless otherwise specified.

PX1086-1.5V, $0 \le I_{OUT} \le 1.5A$ , $2.75V \le V_{IN} \le 29V$ PX1086-2.5V, $0 \le I_{OUT} \le 1.5A$ , $4.0V \le V_{IN} \le 29V$ PX1086-3.3V, $0 \le I_{OUT} \le 1.5A$ , $4.75V \le V_{IN} \le 29V$	1.5 1.5 2.5 2.5	1.485 1.470 2.475 2.450	1.515 1.530 2.525 2.550	1.470 1.455	1.530 1.545	V
PX1086-2.5V,0 ≤I <sub>OUT</sub> ≤1.5A, 4.0V≤V <sub>IN</sub> ≤29V	2.5 2.5	<b>1.470</b> 2.475	<b>1.530</b> 2.525	2.450	1.545	
	2.5				2.550	17
	2.5				2.550	17
PX1086-3.3V, $0 \le I_{OUT} \le 1.5A$ , $4.75V \le V_{IN} \le 29V$	3.3			2.425	2.575	V
$PX1086-3.3V$ , $0 \le I_{OUT} \le 1.5A$ , $4.75V \le V_{IN} \le 29V$	3.3				· L	
	3.3	3.270 <b>3.240</b>	3.330 <b>3.360</b>	3.230 <b>3.201</b>	3.370 <b>3.399</b>	V
$PX1086-5.0V, 0 \le I_{OUT} \le 1.5A, 6.5V \le V_{IN} \le 29V$	5.0 <b>5.0</b>	4.95 <b>4.90</b>	5.05 <b>5.10</b>	4.900 <b>4.850</b>	5.100 <b>5.150</b>	V
$V_{IN} \le 7V, P \le P_{MAX}$ $.5V \le (V_{IN}.V_{OUT}) \le 5.75V, 10 \text{ mA} \le I_{OUT} \le 1.5A$	1.250	1.225	1.270	1.225	1.270	V
$.5V \le (V_{IN} . V_{OUT}) \le 5.75V$	5		10		10	mA
.75V≤V <sub>IN</sub> ≤29V, I <sub>OUT</sub> =10mA, T <sub>J</sub> =25°C (Note 3)	0.005		0.2		0.2	%
' <sub>IN</sub> ≤29V, I <sub>OUT</sub> =0mA, T <sub>J</sub> =25°C (Note 2)	0.005		0.2		0.2	%
0mA≤I <sub>OUT</sub> ≤1.5A, (V <sub>IN</sub> -V <sub>OUT</sub> )=3V, T <sub>J</sub> =25°C Note 3)	0.05		0.3		0.3	%
≤I <sub>OUT</sub> ≤1.5A, V <sub>IN</sub> =7V, T <sub>J</sub> =25°C (Note 2)	0.05		0.3		0.3	%
$V_{REF}=1\%$ $I_{OUT} = 1.5 A \text{ (Note 3)}$ $I_{OUT} \le 1.5 A \text{ (Note 2)}$	1.1		1.2		1.2	V
$V_{IN}=7V$ $4V \le (V_{IN}-V_{OUT})$ (Note3)	2.5	1.7		1.7		A
A=125°C, 1000 Hrs.	0.3 (Note 2)		1		1	%
A=25°C, 20 ms pulse	0.01		0.020		0.020	%/W
	0.25					%
0Hz to 10khz T <sub>A</sub> =25°C	0.003					% V <sub>O</sub>
O-220 Junction to Tab Junction to Ambient DD Package Junction to Tab	3.0 60 3.0		3.0 60 3.0		3.0 60 3.0	°C/W
71 0	$I_{N} \le 7V$ , $P \le P_{MAX}$ $5V \le (V_{IN}.V_{OUT}) \le 5.75V$ , $10mA \le I_{OUT} \le 1.5A$ $5V \le (V_{IN}.V_{OUT}) \le 5.75V$ $75V \le V_{IN} \le 29V$ , $I_{OUT} = 10mA$ , $T_{J} = 25^{\circ}C$ (Note 3) $I_{IN} \le 29V$ , $I_{OUT} = 0mA$ , $T_{J} = 25^{\circ}C$ (Note 2) $I_{IM} \le 29V$ , $I_{OUT} = 0mA$ , $I_{J} = 25^{\circ}C$ (Note 2) $I_{IM} \le 1.5A$ , $I_{IM} = 7V$ , $I_{J} = 25^{\circ}C$ (Note 3) $I_{OUT} \le 1.5A$ (Note 3) $I_{OUT} \le 1.5A$ (Note 3) $I_{OUT} \le 1.5A$ (Note 2) $I_{IM} = 7V$ $I_{IM} = 1.5A$ (Note 2) $I_{IM} = 7V$ $I_{IM} = 1.5A$ (Note 3) $I_{IM} = 1.5A$ (Note 3) $I_{IM} = 1.5A$ (Note 2) $I_{IM} = 1.5A$ (Note 3) $I_{IM} = 1.5A$ (Note 3) $I_{$	5.0 $I_{N} \le 7V, P \le P_{MAX}$ $5V \le (V_{IN}, V_{OUT}) \le 5.75V, 10 \text{mA} \le I_{OUT} \le 1.5A$ $5V \le (V_{IN}, V_{OUT}) \le 5.75V$ $75V \le V_{IN} \le 29V, I_{OUT} = 10 \text{mA}, T_{J} = 25^{\circ}\text{C (Note 3)}$ $I_{N} \le 29V, I_{OUT} = 0 \text{mA}, T_{J} = 25^{\circ}\text{C (Note 2)}$ $I_{N} \le 29V, I_{OUT} = 0 \text{mA}, T_{J} = 25^{\circ}\text{C (Note 2)}$ $I_{OUT} \le 1.5A, (V_{IN} - V_{OUT}) = 3V, T_{J} = 25^{\circ}\text{C}$ $I_{OUT} \le 1.5A, V_{IN} = 7V, T_{J} = 25^{\circ}\text{C (Note 2)}$ $I_{N} = 1.5A, I_{OUT} = 1.5A, I_{OUT} \le 1.5A, I_{OUT$	5.0 4.90    Solution   Solution	Instruction       5.0       4.90       5.10         Instruction       5.0       4.90       5.10         Instruction       5.0       4.90       5.10         Instruction       5.0       4.90       5.10         Instruction       5.0       1.250       1.270         5V≤ (V <sub>IN</sub> .V <sub>OUT</sub> )≤5.75V       5       10         75V≤V <sub>IN</sub> ≤29V, I <sub>OUT</sub> =10mA, T <sub>J</sub> =25°C (Note 3)       0.005       0.2         0mA≤I <sub>OUT</sub> ≤1.5A, (V <sub>IN</sub> -V <sub>OUT</sub> )=3V, T <sub>J</sub> =25°C       0.05       0.3         0mA≤I <sub>OUT</sub> ≤1.5A, (V <sub>IN</sub> -V <sub>OUT</sub> )=3V, T <sub>J</sub> =25°C (Note 2)       0.05       0.3         0V <sub>REF</sub> =1%       I <sub>OUT</sub> ≤1.5A (Note 3)       1.1       1.2         1m>7V       4V≤ (V <sub>IN</sub> -V <sub>OUT</sub> ) (Note3)       2.5       1.7         1m=7V       4V≤ (V <sub>IN</sub> -V <sub>OUT</sub> ) (Note3)       2.5       1.7         1m=25°C, 1000 Hrs.       0.3       0.3       0.003         1m=25°C, 20 ms pulse       0.01       0.020         0Hz to 10khz       T <sub>A</sub> =25°C       0.003         0-220       Junction to Tab       3.0       3.0         0-220       Junction to Ambient       60       60         0-220       Junction to Tab       3.0       3.0	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$

The Bold specifications apply to the full operating temperature range.

Note 1: Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 2: Fixed Version Only Note 3: Adjustable Version Only

# APPLICATION HINTS

The SPX1086 incorporates protection against over-current faults, reversed load insertion, over temperature operation, and positive and negative transient voltage. However, the use of an output capacitor is required in order to insure the stability and the performances.

#### **Stability**

The output capacitor is part of the regulator's frequency compensation system. Either a  $220\mu F$  aluminum electrolytic capacitor or a  $47\mu F$  solid tantalum capacitor between the output terminal and ground guarantees stable operation for all operating conditions.

However, in order to minimize overshoot and undershoot, and therefore optimize the design, please refer to the section 'Ripple Rejection'.

# **Ripple Rejection**

Ripple rejection can be improved by adding a capacitor between the ADJ pin and ground. When ADJ pin bypassing is used, the value of the output capacitor required increases to its maximum (220  $\mu F$  for an aluminum electrolytic capacitor, or 47  $\mu F$  for a solid tantalum capacitor). If the ADJ pin is not bypass, the value of the output capacitor can be lowered to  $100 \mu F$  for an electrolytic aluminum capacitor or  $15 \mu F$  for a solid tantalum capacitor.

However the value of the ADJ-bypass capacitor should be chosen with respect to the following equation:

$$C = 1 / (6.28 * F_R * R_1)$$

Where C = value of the capacitor in Farads (select an equal or larger standard value),

F<sub>R</sub> = ripple frequency in Hz, R<sub>1</sub> = value of resistor R<sub>1</sub> in Ohms.

 $R_1$  = value of resistor  $R_1$  in Ohms

If an ADJ-bypass capacitor is use, the amplitude of the output ripple will be independent of the output voltage. If an ADJ-bypass capacitor is not used, the output ripple will be proportional to the ratio of the output voltage to the reference voltage:

$$M = V_{OUT} / V_{REF}$$

Where M = multiplier for the ripple seen when the ADJ pin is optimally bypassed.

$$V_{REF}$$
 = Reference Voltage

#### Reducing parasitic resistance and inductance

One solution to minimize parasitic resistance and inductance is to connect in parallel capacitors. This arrangement will improve the transient response of the power supply if your system requires rapidly changing current load condition.

#### **Thermal Consideration**

Although the SPX1086 offers some limiting circuitry for overload conditions, it is necessary not to exceed the maximum junction temperature, and therefore to be careful about thermal resistance. The heat flow will follow the lowest resistance path, which is the Junction-to-case thermal resistance. In order to insure the best thermal flow of the component, a proper mounting is required. Note that the case of the device is electrically connected to the output. In case the case has to be electrically isolated, a thermally conductive spacer can be used. However do not forget to consider its contribution to thermal resistance.

#### Assuming:

$$V_{IN} = 10V$$
,  $V_{OUT} = 5V$ ,  $I_{OUT} = 1.5A$ ,  $T_A = 50$ °C/W,  $\theta_{Heatsink\ Case} = 6$ °C/W,  $\theta_{Heatsink\ Case} = 0.5$ °C/W,  $\theta_{JC} = 3$ °C/W

Power dissipation under this condition  $P_D = (V_{IN} - V_{OUT}) * I_{OUT} = 7.5W$ 

Junction Temperature  $T_{J} = T_{A} + P_{D} * (\theta_{Case-HS} + \theta_{HS} + \theta_{JC})$ 

For the Control Sections  $T_J = 50 + 7.5*(0.5+6=3) = 121.25$ °C 121.25°C  $< T_{J(max)}$  for the Control & Power Sections.

In both case reliable operation is insured by adequate junction temperature.

# **Basic Adjustable Regulator**

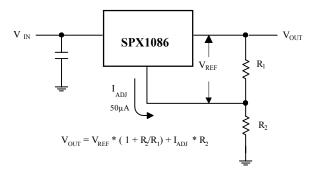


Fig.2 Basic Adjustable Regulator

# **Output Voltage**

Consider Figure 2. The resistance  $R_1$  generates a constant current flow, normally the specified load current of 10mA. This current will go through the resistance  $R_2$  to set the overall output voltage. The current  $I_{ADJ}$  is very small and constant. Therefore its contribution to the overall output voltage is very small and can generally be ignored

# **Load Regulation**

Parasitic line resistance can degrade load regulation. In order not to affect the behavior of the regulator, it is best to connect directly the  $R_1$  resistance from the resistor divider to the case, and not to the load. For the same reason, it is best to connect the resistor  $R_2$  to the Negative side of the load.

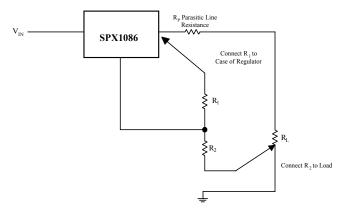


Fig.3 Basic Adjustable Regulator

# TYPICAL APPLICATIONS

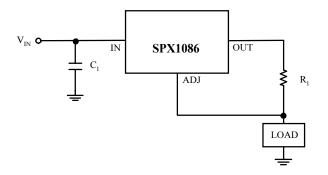


Fig. 4 1.5A Current output Regulator

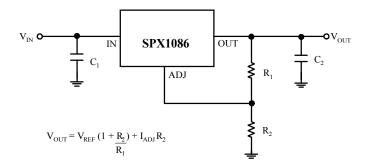


Fig. 5 Typical Adjustable Regulator

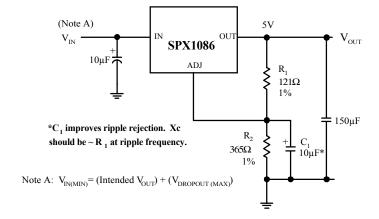


Fig. 6 Improving Ripple Rejection

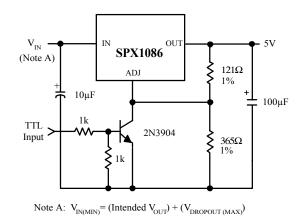
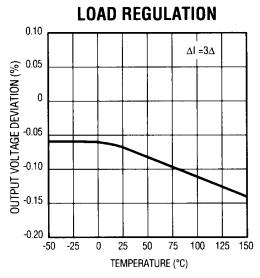
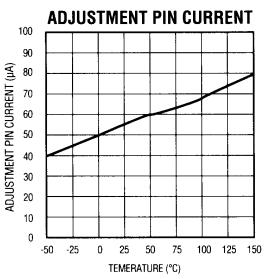
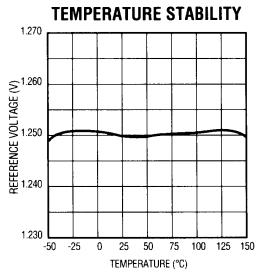


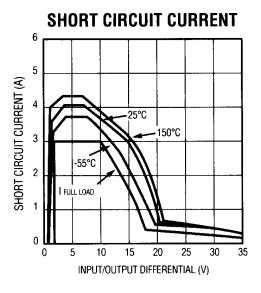
Fig. 7 5V Regulator with Shutdown

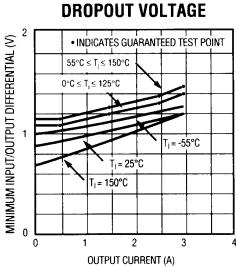
# TYPICAL CHARACTERISTICS

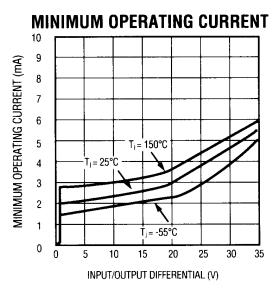












# **ORDERING INFORMATION**

Ordering No.	Precision	Output Voltage	Packages		
SPX1086U	2%	Adj	3 Lead TO-220		
SPX1086U-1.5	2%	1.5V	3 Lead TO-220		
SPX1086U-2.5	2%	2.5V	3 Lead TO-220		
SPX1086U-3.3	2%	3.0V	3 Lead TO-220		
SPX1086U-5.0	2%	5.0V	3 Lead TO-220		
SPX1086AU	1%	Adj	3 Lead TO-220		
SPX1086AU-1.5	1%	1.5V	3 Lead TO-220		
SPX1086AU-2.5	1%	2.5V	3 Lead TO-220		
SPX1086AU-3.3	1%	3.0V	3 Lead TO-220		
SPX1086AU-5.0	1%	5.0V	3 Lead TO-220		
SPX1086T	2%	Adj	3 Lead TO-263		
SPX1086T-1.5	2%	1.5V	3 Lead TO-263		
SPX1086T-2.5	2%	2.5V	3 Lead TO-263		
SPX1086T-3.3	2%	3.0V	3 Lead TO-263		
SPX1086T-5.0	2%	5.0V	3 Lead TO-263		
SPX1086AT	1%	Adj	3 Lead TO-263		
SPX1086AT-1.5	1%	1.5V	3 Lead TO-263		
SPX1086AT-2.5	1%	2.5V	3 Lead TO-263		
SPX1086AT-3.3	1%	3.0V	3 Lead TO-263		
SPX1086AT-5.0	1%	5.0V	3 Lead TO-263		
SPX1086R	2%	Adj	3 Lead TO-252		
SPX1086R-1.5	2%	1.5V	3 Lead TO-252		
SPX1086R-2.5	2%	2.5V	3 Lead TO-252		
SPX1086R-3.3	2%	3.0V	3 Lead TO-252		
SPX1086R-5.0	2%	5.0V	3 Lead TO-252		
SPX1086AR	1%	Adj	3 Lead TO-252		
SPX1086AR-1.5	1%	1.5V	3 Lead TO-252		
SPX1086AR-2.5	1%	2.5V	3 Lead TO-252		
SPX1086AR-3.3	1%	3.0V	3 Lead TO-252		
SPX1086AR-5.0	1%	5.0V	3 Lead TO-252		



SIGNAL PROCESSING EXCELLENCE

# **Sipex Corporation**

Headquarters and Main Offices: 22 Linnell Circle Billerica, MA 01821 TEL: (978) 667-8700 FAX: (978) 670-9001 e-mail: sales@sipex.com

233 South Hillview Drive Milpitas, CA 95035 TEL: (408) 935-7600 FAX: (408) 934-7500

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