

SPLV low voltage
SP standard
SPJ high current
SPL short circuit protected

Low Noise Low Impedance
Bootstrap Powered
Low Dropout Regulator

FEATURES

- Wide Vout range from 1.2V to 450V
- Very low noise
- Fast dynamic output
- Two output currents—0.5A and 2A
- Unlimited or short circuit protected high current
- Very low output impedance
- Self powered bootstrapped reference
- Low drop-out voltage
- Available as positive or negative output
- LM78xx, LM79xx and LM317 pin out
- Sense connection to sense voltage at the load
- No pre-regulator needed

APPLICATIONS

- High resolution D/A and A/D converters
- Audio DACs, preamps, mixers, microphone amplifiers
- Phono preamps
- Turntable motors
- Anywhere a clean, fast, quiet power supply is needed
- Tube/Valve preamplifiers
- Power amp input stages
- Tubed phono preamps
- Guitar amps

DESCRIPTION

The Superpower regulator is a high performance voltage regulator with a novel circuit design (patent applied for) to internally power its reference circuit with its own regulated output. A floating reference allows any output voltage from 1.2V (SPLV) to 30V (SP and SPJ) to 450V (SPHV) with low noise, low output impedance, high current and fast dynamic performance in a compact circuit that fits a standard IC footprint (except SPHV).

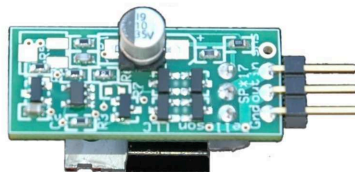
Superpower delivers current to a load with a clean dynamic waveform with minimum ringing or overshoot and settles quickly. Superpower works best *without* a pre-regulator, because a pre-regulator increases overall drop out requirements and may limit the dynamic current available to the load.

With a footprint to match the industry standard TO-220 monolithic regulators, Superpower can be easily retrofit into existing systems or designed into new systems for maximum performance. The design can also be licensed and built into your own products.

[Contact Belleson](#) for more information.



SP

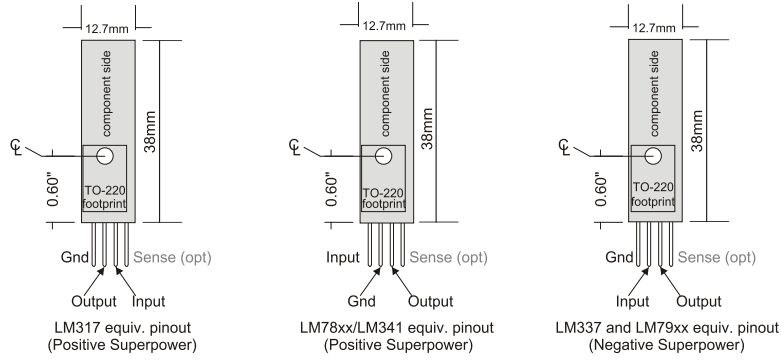


SPJ/SPL



SPHV

PIN CONNECTIONS



Absolute Maximum Ratings

Parameter	Conditions	Value	Units
Input voltage maximum	SPLV SP, SPJ SPL SPHV	12.5 35 70 500	V
Maximum continuous current	SP SPJ SPL SPHV	0.7 8.0 2.0 2.0	A
Total power dissipation	SP at TA = 25°C Derate above 25°C	2.5 25	W mW/°C
Total power dissipation	SPJ, SPL at TA = 25°C Derate above 25°C	60 480	W mW/°C
Thermal Resistance	SP R _{θJA} , Junction-to-Ambient	83	°C/W
Thermal Resistance	SPJ, SPL R _{θJA} , Junction-to-Ambient	63	°C/W

Operation at these limits is not guaranteed. Operation beyond these limits may result in irreversible damage.

Typical Performance Characteristics

SPLV Low Voltage 2A Output

Parameter	Conditions	Value	Units
Input voltage maximum		+ or -12	V
Output voltage positive	Standard values (1*)	1.2, 1.5, 2.0, 2.5	V
Output voltage negative	Standard values (1*)	-1.2, -1.5, -2.0, -2.5	V
Output Noise	RMS 20Hz – 20KHz	5	µV
Line Rejection	60Hz, 5V in +1Vpp	115	dB
Continuous current	within power dissipation limit	2	A
Power dissipation (2*)	no heat sink sufficient heat sink	2 2.5	W
Drop-out voltage	<u>Load Current</u> 0.5A 1A 2A	2.1 2.4 2.7	V

SP Standard Voltage Medium Current ½A

Parameter	Conditions	Value	Units
Input voltage maximum		35	V
Output voltage SP78, SP37	Standard values (1*)	3.3, 5, 6.25, 7.5, 9, 10, 12, 15, 18, 24, 30	V
Output voltage SP79	Standard values (1*)	-5, -6.25, -7.5, -9, -10, -12, -15, -18, -24, -30	V
Output Noise	RMS 20Hz – 20KHz	1 to 4	PPM of Vout
Line Rejection	60Hz, 1Vpp	110	dB
Continuous current	within power dissipation limit	0.5	A
Power dissipation (2*)	no heat sink sufficient heat sink	1 2	W
Drop-out voltage	<u>Load Current</u> 50mA 250mA 500mA	0.5 1 2	V

SPJ Standard Voltage High Current 2A

Parameter	Conditions	Value	Units
Input voltage maximum		35	V
Output voltage positive	Standard values (1*)	3.3, 5, 6.25, 7.5, 9, 10, 12, 15, 18, 24, 30	V
Output voltage negative	Standard values (1*)	-5, -6.25, -7.5, -9, -10, -12, -15, -18, -24, -30	V
Output Noise	RMS 20Hz – 20KHz	1 to 4	PPM of Vout
Line Rejection	60Hz, 1Vpp	110	dB
Continuous current	within power dissipation limit	2	A
Power dissipation (2*)	no heat sink sufficient heat sink	2 60	W
Drop-out voltage	<u>Load Current</u> 0.5A 1A 2A	0.6 0.8 1	V

SPL Standard Voltage High Current 2A Output Protected

Parameter	Conditions	Value	Units
Input voltage maximum		60	V
Output voltage positive	Standard values (1*)	3.3, 5, 6.25, 7.5, 9, 10, 12, 15, 18, 24, 30	V
Output voltage negative	Standard values (1*)	-5, -6.25, -7.5, -9, -10, -12, -15, -18, -24, -30	V
Output Noise	RMS 20Hz – 20KHz	3 to 6	PPM of Vout
Line Rejection	60Hz, 1Vpp	110	dB
Continuous current	within power dissipation limit	2	A
Power dissipation (2*)	no heat sink sufficient heat sink	2 60	W
Short Circuit Duration with no heat sink (3*)	<u>Vout</u> 5V 12V 15V 18V 24V 30V	3.5 1.5 1.2 1.0 0.75 0.6	sec
Drop-out voltage	<u>Load Current</u> 0.5A 1A 1.5A 2A	1.5 2.2 3.5 (4*)N/A	V

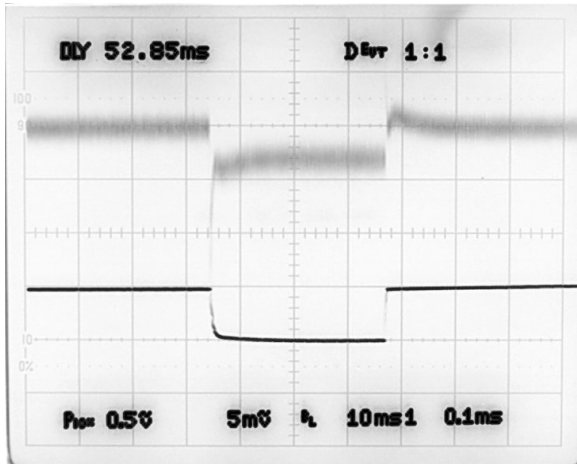
SPHV High Voltage

Parameter	Conditions	Value	Units
Input voltage maximum		480	V
Output voltage	Built to order	maximum 450	V
Output Noise (typ)	RMS 20Hz – 20KHz	1 to 3	PPM of Vout
Line Rejection (typ)	60Hz	110	dB
Maximum continuous current	typical, within power dissipation limit	1	A
Maximum current	<10mV output shift typical (depends on circuit connection)	400	mA
Maximum power dissipation	no heat sink sufficient heat sink	2 >50	W
Drop-out voltage	<u>Load Current</u> 50mA 500mA 1A	0.5 1 2	V
Output Impedance	20Hz – 20KHz	10	mΩ

NOTES

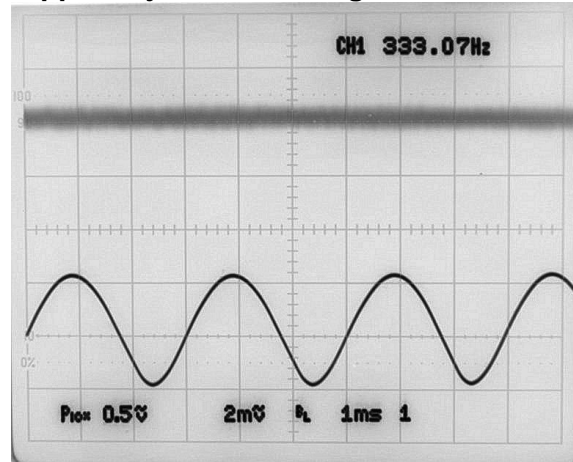
- *1 Other values available, [contact us](#).
- *2 Typical value, maximum depends on ambient temperature, air flow, etc.
- *3 SPL has no thermal protection, which yields an instantaneous power dissipation limit of 36W-sec.
- *4 At 2A, SPL begins to limit Vout so drop-out voltage is not applicable.

Dynamic Performance



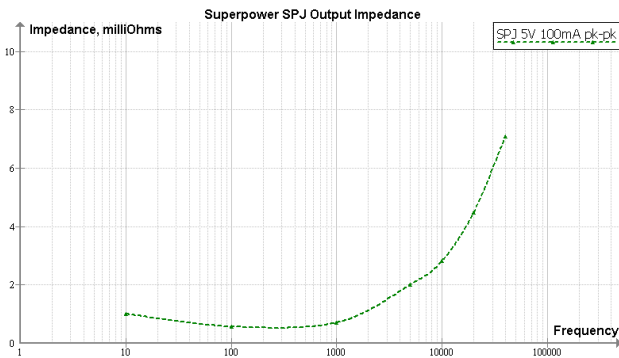
Transient peaks for 1A load change over 50mA static load
 Top: ΔV_{out} , 5mV/div, $V_{out}=12V_{dc}$
 Bottom: Output current through $\frac{1}{2}\Omega$, 1A/div
 Time axis = 100 μ sec/div (delayed sweep)

Ripple Rejection Oscilloscope



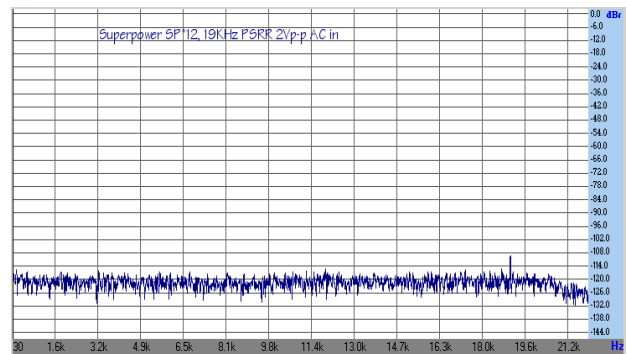
Line Regulation, 333Hz
 Top: V_{out} , 2mV/div, Bottom: V_{in} , 0.5V/div

Output Impedance



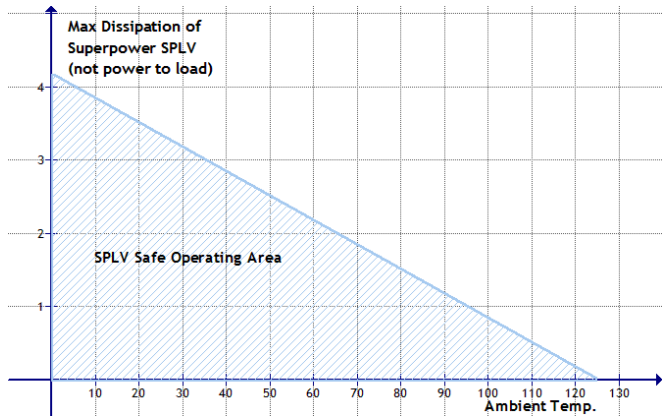
$V_{in}=11.5V$, $V_{out}=5V$
 Voltage across 50 Ω load = $(5V_{DC} - 5V_{pp})$

Ripple Rejection Spectrum



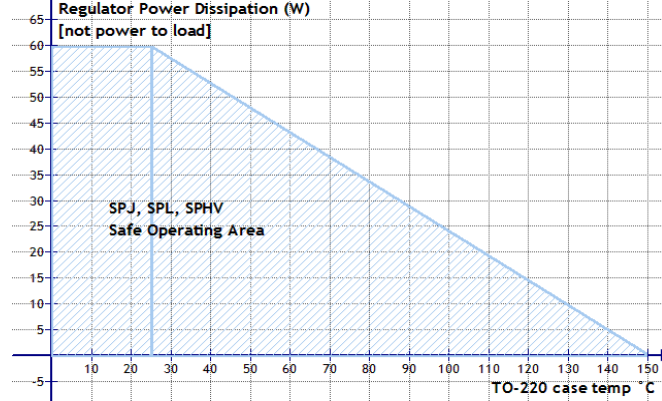
Ripple rejection, SPJ78@12V, $V_{in}=16V_{dc}+2V_{ac}@19KHz$
 Output current = 50mA

SPLV Power Dissipation



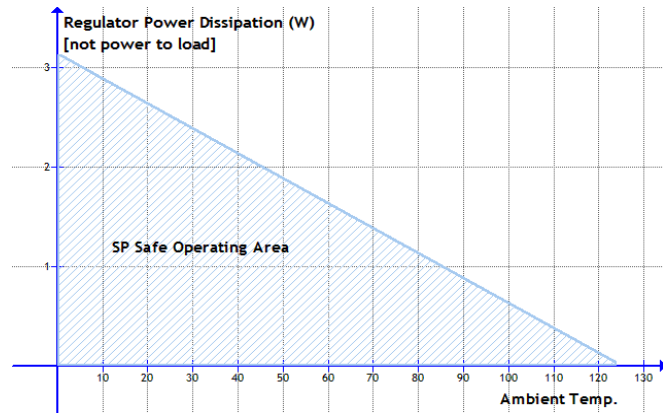
SPLV Power Dissipation vs. Ambient Temperature

SPJ, SPL, SPHV Power Dissipation



SP Power Dissipation vs. Ambient Temperature

SP Power Dissipation



SP Power Dissipation vs. Ambient Temperature

APPLICATION INFORMATION

Superpower provides a breakthrough combination of dynamics and low noise. This provides information to allow you to get the best use from your Superpower.

Output Protection

To deliver maximum current with least drop out voltage, SP and SPJ circuits have no output current limit. Any short circuit of the output to common may destroy the output device and render the circuit useless.

SPL regulators are designed with a special output current limit that does not affect output impedance but does increase drop-out voltage. See the above SPL specifications.

Input Voltage Pre-regulation

Use of a pre-regulator may adversely affect the dynamic response of Superpower by limiting delivery of current. Best performance is obtained by taking Superpower's input directly from a raw rectified and filtered power supply. If you do use a pre-regulator, use a Superpower, that's what we have to use for testing.

Dynamics and Capacitance

Good dynamic response means supplying a lot of current very quickly. A large capacitor (100+ μ F) located near the input pins of Superpower provides reserve storage so Superpower can deliver that current. An input capacitor also decreases output noise.

Superpower has a 10 μ F output capacitor on board, but adding a capacitor near your load may also improve dynamics.

If multi-MHz oscillation is observed, a 0.1 μ F or higher ceramic or film capacitor soldered directly across the IN to GND pins is likely to cure it.

Sense Connection

The sense connection is the 4th (rightmost) pin on the board. It allows the voltage at the *load* to be sensed rather than the voltage at the Superpower output pin. With no sense connection, when load current changes dramatically (e.g. in a circuit with large dynamic range) the voltage drop between the regulator and the load can change as the load current changes—the regulator output will remain constant while the load voltage

changes due to IR losses. Use of the sense connection keeps the load voltage more constant.

The sense pin is internally connected via a 1 Ω resistor. To use the sense connection, make a connection from the sense pin/pad directly to the load. The connection resistance to the load is in parallel with the internal 1 Ω , so keep the sense connection below 0.1 Ω , the lower the better. If the sense connection is longer than 10-15 centimeters, check stability as inductance may influence circuit behavior.

Sense connection is most useful for a single load; for a distributed load, find either a central point or a point where the most load current flows.

SPLV does not have a sense connection.

SPHV Vout Sense and Ground Ref

This applies only to SPHV high voltage regulator.

Vout sense and Ref Ground connections are labelled on the board. They allow the voltage at the *load* to be sensed rather than the voltage at the Superpower output pin. With no sense connection, when load current changes dramatically (e. g. in a circuit with large dynamic range) the voltage drop between the regulator and the load will change as the load current changes — the regulator output will remain constant while the load voltage changes due to IR losses. Use of the sense connection keeps the load voltage more constant.

The Vout and Vout sense terminals must be connected together at either the PCB or at the load. Connect For typical low current applications (<50mA), a jumper on the PCB is fine. If the sense connection is longer than 10-15 centimeters, check stability as inductance may influence circuit behavior.

Ref Gnd and Pwr Gnd terminals must be connected together at either the PCB or at the star ground point of the system. For low current applications (<50mA), connection at the PCB is fine. Connecting them individually to system star ground prevents load current from affecting the Superpower's reference voltage.

Heat Sinks and Power Dissipation

This discussion pertains to the power dissipation in the regulator itself, not power delivered from a regulator to a load. This is calculated as

$$\frac{V_{in} - V_{out}}{I_{load} + 10mA}$$

Superpower can dissipate approximately 1W without heat sinking depending on ambient temperature and air flow. You can minimize regulator power dissipation by taking advantage of the low drop-out voltage, i. e. setting input voltage slightly higher than output voltage + drop-out. See our transformer calculator web page at <http://www.belleson.com/xfcalc.php>.

To dissipate more than 1W, attach Superpower to a heat sink or a heat conductive chassis. Use an insulating thermal pad or mica insulator with thermal paste and, for best results, electrically connect the heat sink to a stable, quiet ground point.

SP and SPLV regulators use surface mounted output transistors and their power dissipation is limited by the thermal resistance of the PCB, through which heat must pass to get to a heat sink. Power dissipation for SP should not exceed 2.5W at room temperature (25°C) and for SPLV should not exceed 3.2W at 25°C. See power dissipation vs. ambient temperature curves for more information.

If you have any concerns about power dissipation we recommend you use SPJ or SPL with output device that can be mounted directly to a heat sink.

Line Rejection and Drop Out Voltage

(This section does not apply when V_{in} is supplied by a switched mode power supply, only to a linear rectified power supply.)

As current increases, the minimum value of input ripple goes down and the regulator drop-out voltage goes up. If they meet or overlap, line regulation degrades rapidly. Ripple on the output of a full wave rectifier is calculated as

$$Vr = \frac{Idc}{2fC} \text{ where } Vr \text{ is the peak to peak ripple voltage.}$$

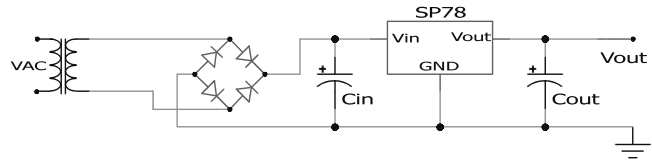


Figure 1: Typical regulated power supply

For example, consider a 5V regulator circuit as seen in Figure 1 using a 100uF filter capacitor. At 400mA, the ripple for a 60Hz AC input =

$$\frac{0.4}{2 \times 60 \times (100 \times 10^{-6})} = 33V (!)$$

Clearly 100µF is not enough capacitance for this circuit.

The same calculation with 4700µF results in a more tolerable 0.7V ripple. If the minimum point of the rectified voltage must be 5V, the DC + ripple at Cin must have a peak of at least 5.7V to deliver 5V out.

To calculate the capacitance required for a given ripple voltage and output current, use

$$C = \frac{Idc}{2fVr}$$

However, this does not consider the regulator drop out voltage—the voltage to operate a standard SP Superpower is almost 2V of drop out "head-room" at 400mA. The minimum point of ripple must then be 5V $V_{out} + 2V$ drop out and V_{in} must peak at least 0.7V above that. So the absolute minimum voltage supplied by the rectifier at full load must be 7.7V(DC + ripple) to get 5V out and meet the SP specification for line regulation. It is best to allow for other factors and supply something higher than minimum, for this example 9V. Use an SPJ for lower drop out voltage of 1V at 2A.

The required trade off is increased power dissipation in the regulator. But keep in mind that lost power is due to a constant DC value plus the RMS value of ripple magnitude.

Replacing Existing Regulators

Superpower regulators are designed to make it easy to replace lesser regulators in your equipment. They are built as a direct replacement for some pin outs or can be externally mounted or chassis mounted and wired into PC boards where there is not enough space or where you are replacing a surface mount regulator.

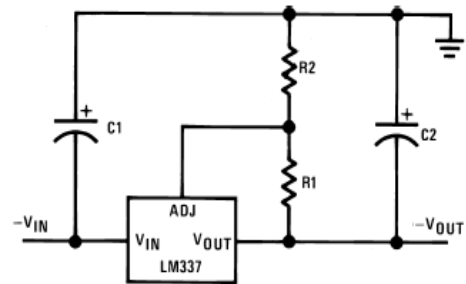
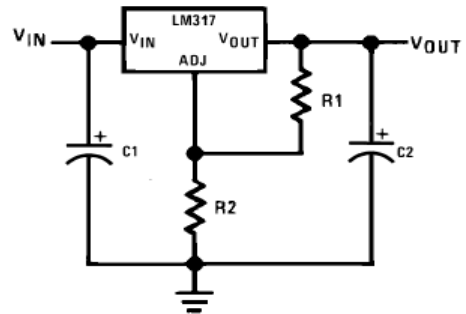
LM78x and LM79x Regulators

SP78, SP79, SPJ78 and SPJ79 regulators are direct drop-in replacements for TO-220 packaged LM78x and LM79x type regulators. Unsolder and remove the existing regulator, insert and resolder the same voltage Superpower. You can keep or remove any existing input and/or output capacitors. For best performance, use a 100 μ F capacitor directly at the Superpower input to ground.

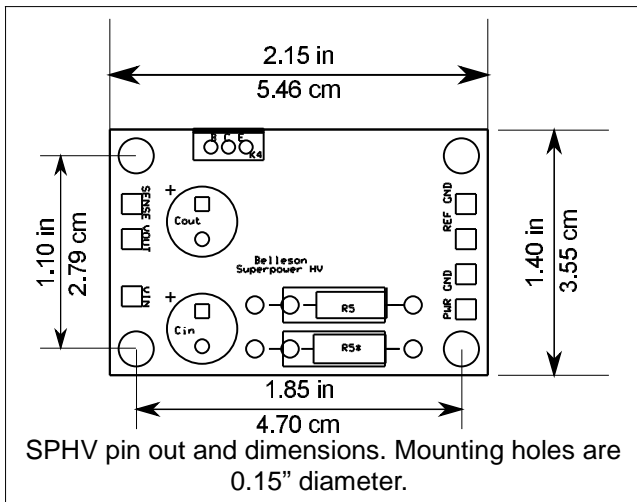
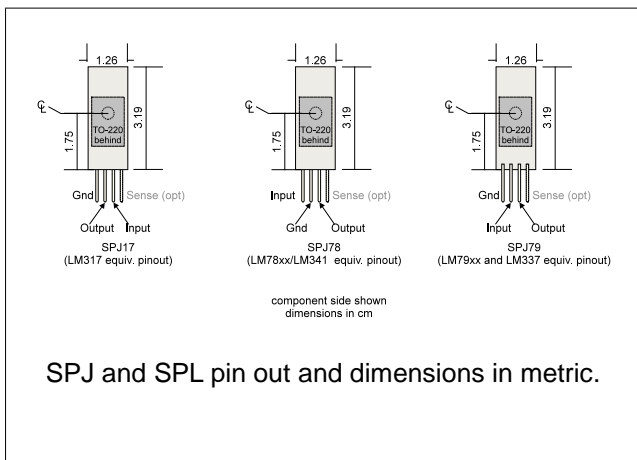
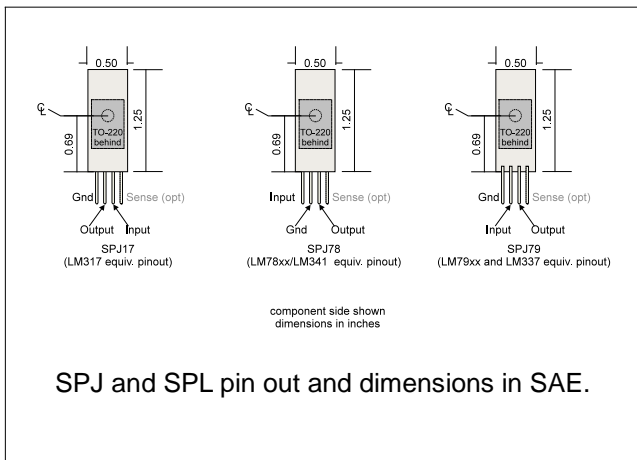
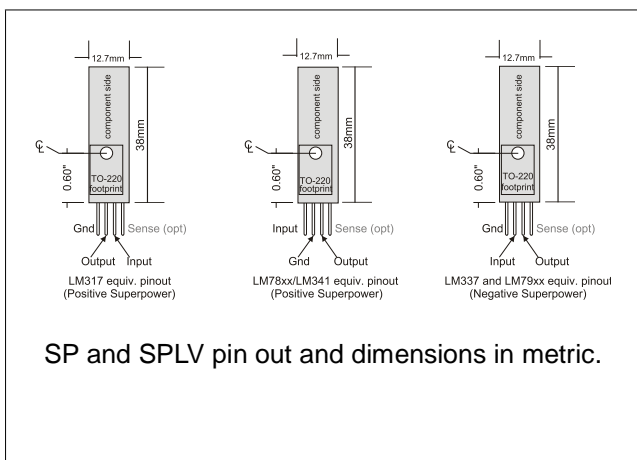
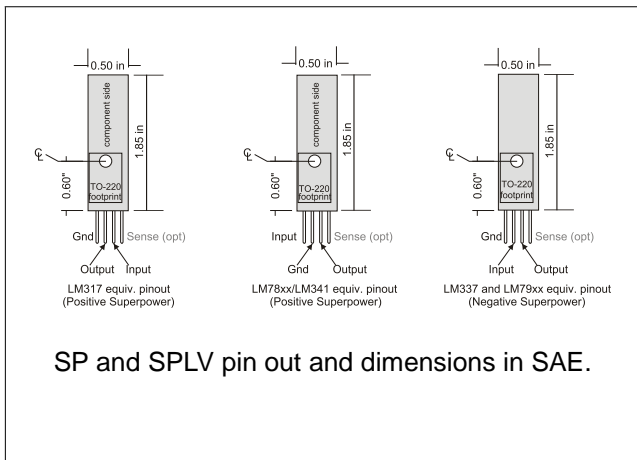
Replacing LM317 and LM337 Regulators

Superpower regulators are fixed output, LM317 and LM337 regulators are adjustable. To replace the adjustable regulators, circuit modifications must be made. To replace LM317/LM337/LM1117, etc., make the following circuit changes:

1. Replace R2 (goes from ADJ to ground) with a wire or short R2 to ground.
2. Remove R1 (goes from Vout to ADJ) because now it has the full Vout across it (instead of 1.2V) and will overheat.
3. If there is a capacitor at the ADJ adjustment pin, it can stay or be removed as it now has both ends grounded.
4. An input capacitor C1 of 100 μ F is recommended for better performance. C2 can remain or can be removed.



MECHANICAL SPECIFICATIONS



External dimensions may vary by ±5%, mounting hole dimensions by ±0.5%.

Legal Information

By using Belleson Superpower regulators, you agree that SP and SPJ devices have no output protection and a short circuit of the output to ground can damage or destroy the regulator. All devices are tested prior to shipment and damaged devices will not be replaced.

You also agree that misuse or misapplication of Belleson products may cause damage where attempted use or application occurs and you as user of the product(s) accept all responsibility for all consequences of use or application of Belleson product(s) and will not hold Belleson responsible for any damage nor injury as a result of use or attempted use of Belleson products.

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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