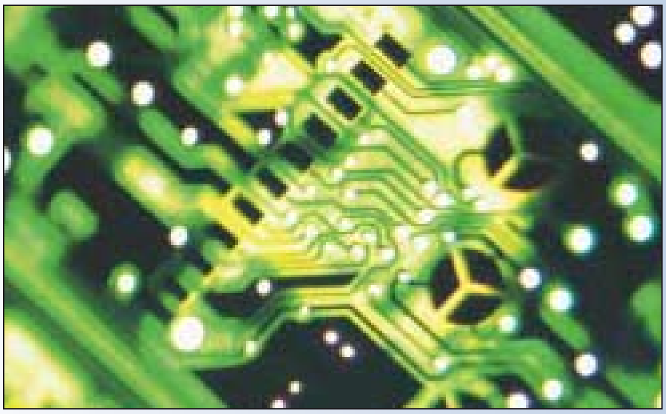
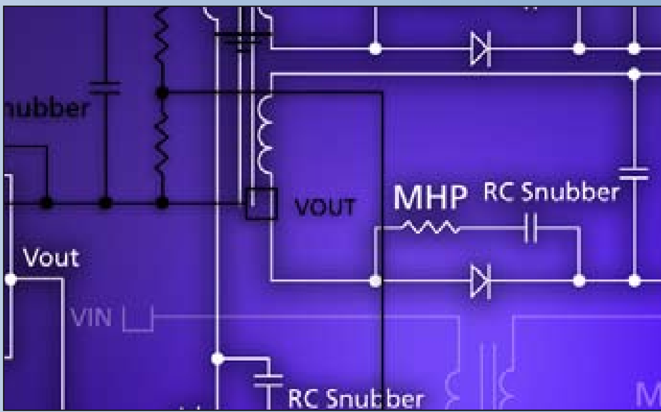
Fixed Resistors

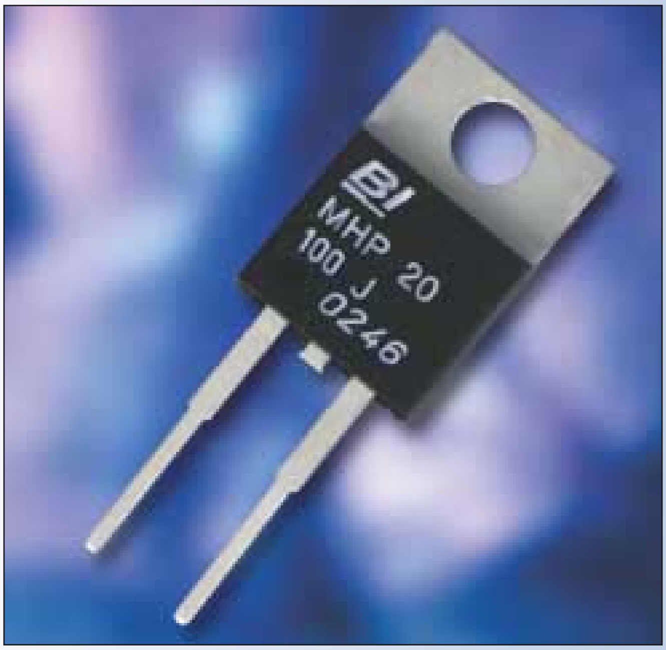
TO220 & TO247 POWER RESISTORS - Application Note





Non-Inductive Planar Thick Film Power Resistor 20 to 140 Watts, TO220 & TO247 Package

Power resistors are now available in compact heatsink mountable packages ideal for thermal management in space-constrained designs. This Application Note describes some of the many applications, which range from current sensing to capacitor inrush and discharge circuits, and the MHP series power resistors which may be used for high power density designs.



Applications

- **Switching power supplies**
- **Snubbers**
- **In-rush / bleeder resistors**
- **Current limiters**

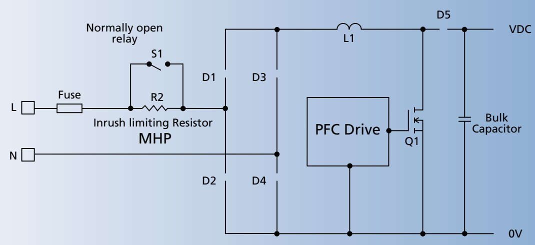
Features

- **High power density**
- **Power is dissipated above circuit board**
- **Low thermal resistance**
- **Non-flammable**
- **Non-Inductive planar**

TO220 & TO247 POWER RESISTORS - Application Note

1. Inrush Current limiting

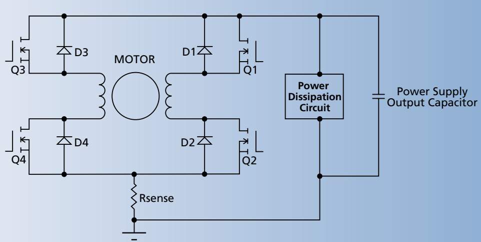
The PFC circuit generates a regulated DC output while controlling the input power factor. The input current is sinusoidal and in-phase with the mains voltage. Due to the large bulk capacitors at the PFC converter output a substantial inrush current can be drawn at power-up. The magnitude of the inrush current depends upon the instant of the AC waveform at which the unit is turned on. Inserting a current limiting resistor in series with the mains supply will control start-up inrush current. The resistor is short-circuited by using a relay once the bulk capacitor is charged.



Inrush current limiting

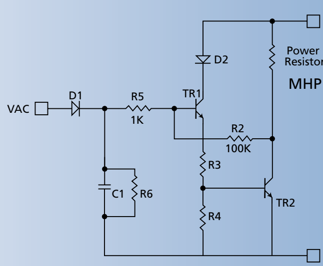
2. Regenerative Power Dissipation

A stepper motor will act like a generator if the shaft is mechanically rotated. Thus inertia energy supplied to the motor during acceleration is returned to the drive during deceleration. This is regeneration and increases the motor current, which could damage the power switches. A current threshold detector in the circuit detects the increased current and momentarily turns off the switches. The regenerated current now has a path back to the supply and charges the bulk capacitor to a higher voltage. Since the power switches have been turned off the current in the threshold detector falls below the threshold and the power switches are turned on again. If the current remains higher than the threshold the drive returns to the regenerative state.



Stepper motor drive circuit

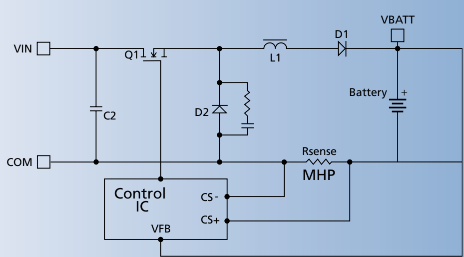
If the power supply capacitor voltage increases to a high enough level then the power switches may be damaged. To avoid this, a regenerative power dissipation circuit can be used. A reference voltage equal to the incoming AC is developed across C1 and under normal conditions will equal the drive circuits bulk capacitor voltage. During regeneration when the bulk capacitor voltage rises above the incoming AC peak the regenerative power dissipation circuit transistor will turn on connecting a power resistor across the bulk capacitor. When this voltage has decreased to the AC peak value the transistor will turn off. The instantaneous regenerative current will be high but the average power dissipation in the resistor will be low due to the short regeneration period. The value and power rating of the power resistor will depend upon the regeneration energy, bulk capacitor value and AC voltage. One or more MHP resistors may be used and the regenerative power dissipation may be considered a temporary overload provided the regenerative energy is dissipated is less than 5 seconds.



Regenerative power dissipation circuit

3. Current Sensing

Non-inductive resistors are suitable for current sensing applications. When switching at high frequencies stray inductance can cause ringing with parasitic capacitances. This may cause the over current sensing to shutdown the power switch prematurely limiting the output power. Even with the correct choice of resistor care must be taken to keep the component leads and PCB traces short to minimize inductance. A buck converter lead acid battery charging application using a current sense resistor is shown opposite.

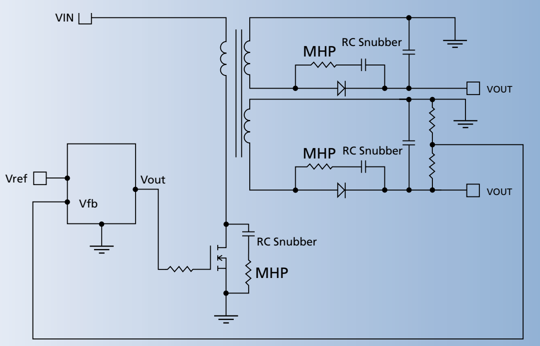


Switchmode lead acid battery charger

TO220 & TO247 POWER RESISTORS - Application Note

4. Snubber Circuits

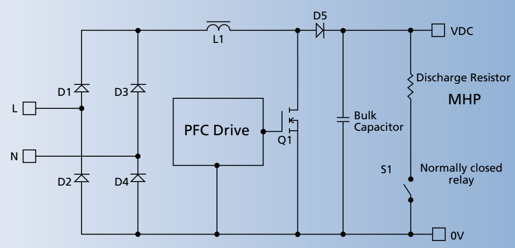
The low inductive properties of the MHP power resistors make them ideal for high frequency snubbing applications. This example shows a flyback converter with snubbing circuits on the primary switch and output diodes. Leakage inductances in the circuit are unclamped and responsible for voltage spikes at the drain of the power switch as well as the secondary output diodes during the switching transitions. The RC snubber network dampens circuit resonance, caused by component parasitics; this limits the voltage stress on the devices, improves circuit efficiency and reduces radiated EMI. RC snubber circuit components that have extremely low parasitic inductance should be chosen to avoid unwanted resonance in the circuit. Ceramic capacitors are available with low ESR and ESL values. Wire wound resistors often have too much inductance and will cause ringing and voltage overshoots.



Flyback converter with RC snubbers

5. Capacitor Discharge

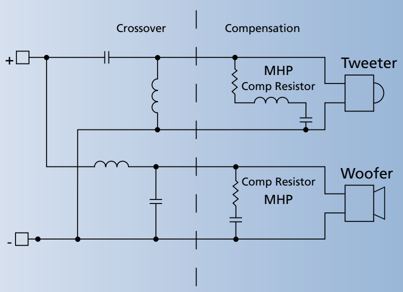
An important aspect in power supply design is the provision of a quick safe discharge of the bulk capacitors at turn off. The electrolytic capacitors can hold large charges, which if left to self-discharge allow dangerous voltages to remain for long periods of time presenting potential safety hazards for service personnel. The discharge of 0.25J of stored energy to the human body can provide a heavy shock and 10J can be fatal. Thus a discharge resistor is required. The energy stored by the input capacitors is equal to $1/2CV^2$ where V is the PFC output voltage. The discharge resistor must be chosen to provide a quick discharge to a safe voltage when the unit is turned off. Using $V = Vse^{-t/RC}$, the RC time constant is calculated. If the resistor continuously dissipated power it would represent an unacceptably high loss. It is only switched into the circuit when needed therefore reducing the required resistor power rating. The capacitor discharge may be considered a temporary overload condition.



Capacitor Discharge Circuit

6. Audio Crossover Circuits

Loud speakers are optimised to reproduce sound within specific frequency bands. A crossover circuit in the speaker system splits the audio signal into multiple signals. So the signal going to the bass (or woofer) has just the low frequencies in it. The signal to the mid-range has the middle frequencies, and the signal to the tweeter has the high frequencies. The goal of the audio system is to generate an accurate response to the input signal over the complete audio spectrum however the frequency response of the individual speakers is not always flat through the crossover region. Thus a compensation network is required to correct for the impedance variations of the speakers. Non-inductive resistors are suitable for this application.



40dB/Decade passive crossover circuit

TO220 & TO247 POWER RESISTORS - Application Note

Electrical Data

	MHP20	MHP35	MHP50	MHP100	MHP140
Power rating @ 25˚C flange (W)	20	35	50	100	140
Thermal impedance Hot-spot to tab (˚C/W)	5.9	3.3	2.3	1.3	0.9
Package style	TO220			TO247	
Limiting element voltage (V)	500			700	
Dielectric voltage (V dc/rms)	2000			2500	
Resistance range (ohms)	0R01 – 51K				
Tolerance (%)	1, 5				

Environmental

Test	Stability	Condition
Load Life ΔR	+/-(1.0 %+0.05 Ω)	25 °C, 90 min. ON, 30 min. OFF, 1000 hours.
Humidity ΔR	+/- (1.0 %+0.05 Ω)	40°C, 90-95% RH, DC 0.1 W, 1000 hours.
Temp. Cycle ΔR	+/- (0.25 %+0.05 Ω)	-55 °C,30 min.,+155 °C,30 min., 5 cycles
Soldering Heat (Max) ΔR	+/- (0.1 %+0.05 Ω)	250+/-5 °C, 3 seconds
Solderability	Over 95% of surface	230+/-5 °C, 3 seconds
Insulation Resistance	Over 1,000 MΩ	Between terminals and tab
Vibration ΔR	+/- (0.25 %+0.05 Ω)	10g, 10 to 500Hz