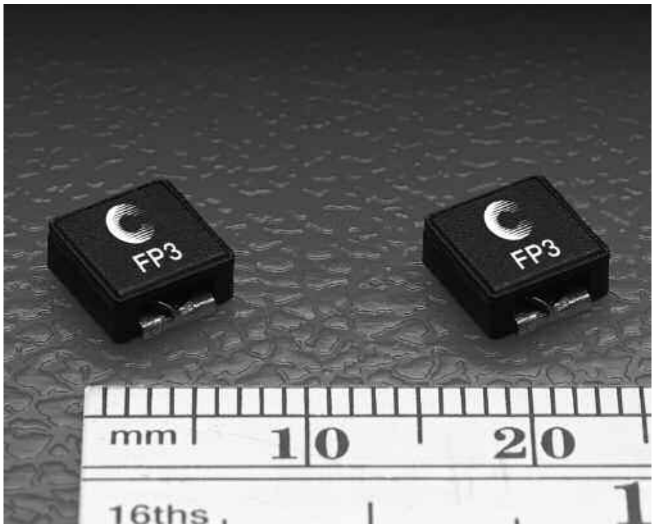
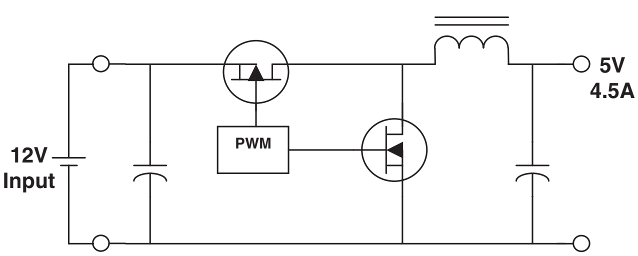
Power Inductors Improve Reliability in High Temperature Designs



The Cooper Coiltronics® brand of High Current FP3™ power inductors from Cooper Bussmann is designed for high density, medium current applications using a high temperature iron powder core material. These inductors do not exhibit the thermal aging issue frequently associated with iron powder core inductors. In fact the FP3 core is rated for 200°C without thermal degradation. The FP3 family is rated for 155°C operation. The calculations below will allow users to take advantage of this high temperature capability.



In this example, a buck regulator will be used to convert a 12V input to a 5V output with a load current of 4.5A. The operating frequency was chosen to be 600 kHz to reduce the size of the filter components, while still maintaining good efficiency. The converter is designed to have 20% ripple current, so a relatively low ESR output filter capacitor will be used, as is typical in switching power supplies.

First calculate the needed inductance value:
V = L * dI/dt where:
V = Vin - Vout (voltage across the inductor)
dT = On time of drive = Vout/Vin/frequency
ΔI = Chosen above to be 20%

Calculate the required inductance:
L = V * dt / ΔI = (12-5)*(12/5/600k)/(0.2*4.5)
L= 4.8 µH
Choose 4.7 µH, the nearest standard value
Recalculate ripple current at 23% using 4.7 µH

Second determine peak to peak flux density, Bp-p:
Bp-p = K * L * ΔI where:

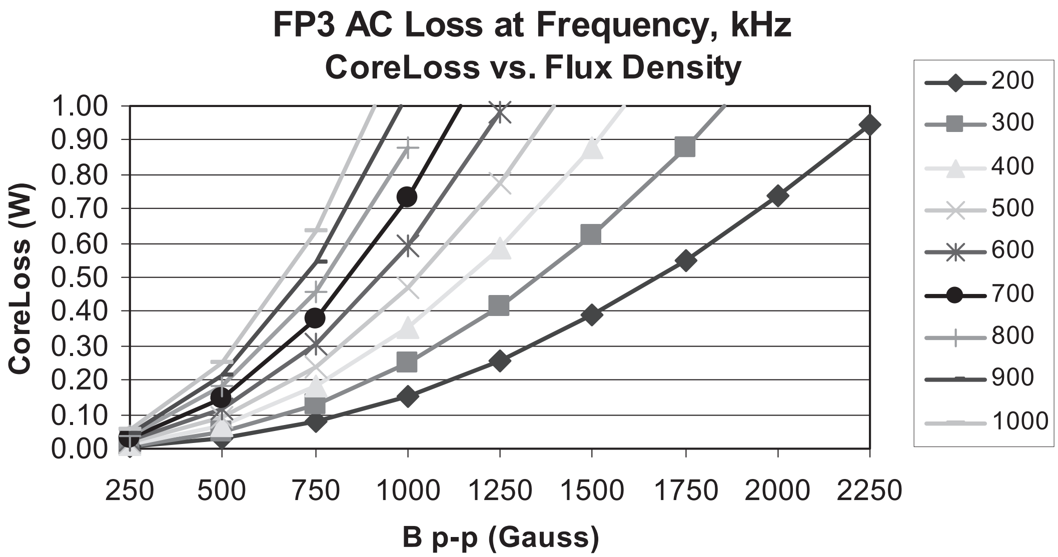
K: K-factor from the adjacent table
L: Inductance µH
ΔI: Peak to peak ripple current (Amps)
Bp-p = 105*4.7*0.23*4.5 = 510 Gauss

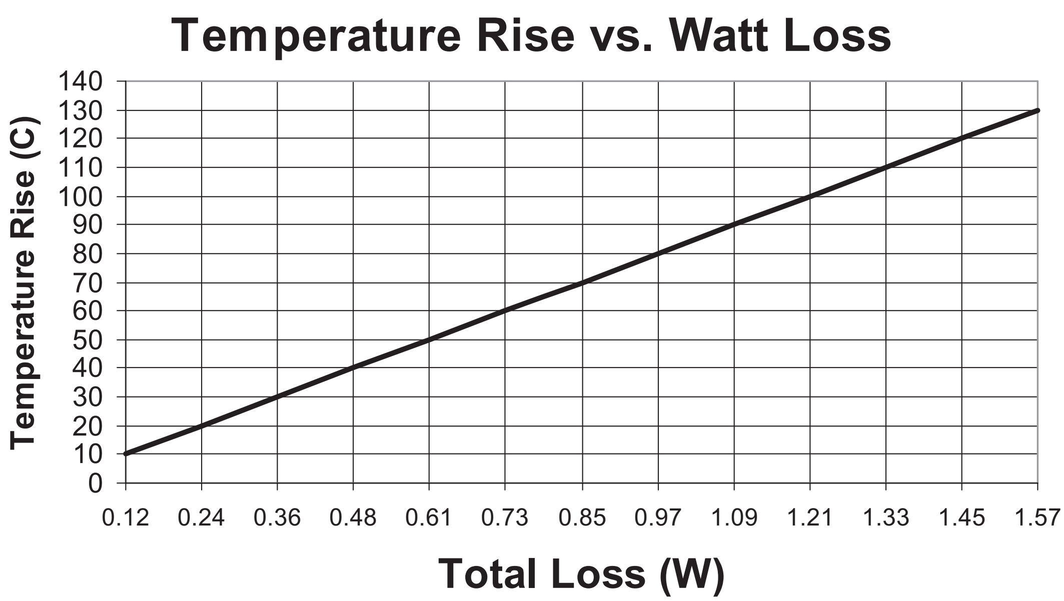
Part Number	K-factor
FP3-R10-R	803
FP3-R20-R	482
FP3-R47-R	344
FP3-R68-R	268
FP3-1R0-R	219
FP3-1R5-R	185
FP3-2R0-R	161
FP3-3R3-R	127
FP3-4R7-R	105
FP3-8R2-R	78
FP3-150-R	59

Next determine the total losses in the inductor:
Total losses = DC loss + AC loss
DC loss = I^2 *DCR = 4.5^2 * 0.040 = 0.81 W
(DCR from FP3 datasheet)
AC loss from table at Bp-p of 510 = 0.15 W
Total Loss = DC loss + AC loss = 0.96W

Finally determine the temperature rise.
Total loss = 0.96W, using the table,
Temperature rise is 80°C
Assuming an ambient temperature of 70°C,
The temperature of the inductor is
T = 70 +75 = 150°C

Note the data assumes no cooling airflow. Cooling will reduce the temperature of the inductor.
The FP3 is rated for 155°C operation.





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