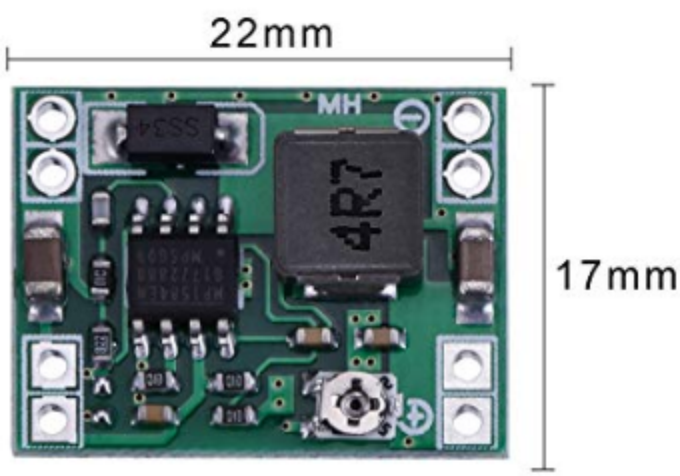
RFI Test Report – Generic MP1584 3A DC-DC Buck Converter Module

Manufacturer: Generic Chinese
Model: MP1584 DC-DC 3A buck converter module (board)

Model number: **None** Item number: **None**
Description: Small circuit board, 22 x 17 mm, DC-DC converter
Purchased from: Amazon (ASIN B01MQGMOKI) Price: 6 for $8

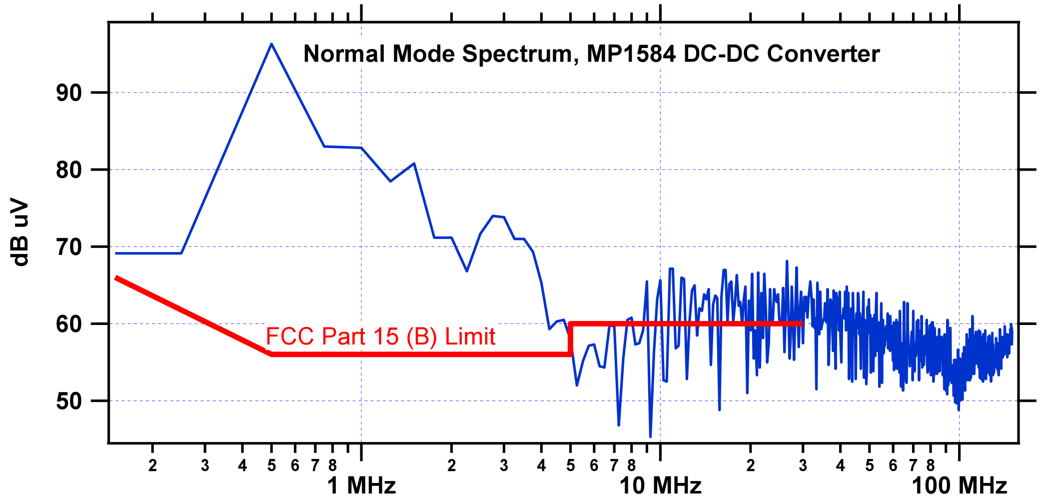
Test equipment: HP 8560A, Tek TDS320A.
Tested by: Gary Johnson, NA6O Date: Aug 13, 2019

Summary
Recommend for amateur radio stations: Maybe; modifications recommended.
FCC Part 15 conducted emissions: (Part 15 regulations do not apply since this device does not connect to the AC mains, but if you use the Part 15 limits as a guideline, it is NON-COMPLIANT without modifications.)
FCC Part 15 labeling: N/A

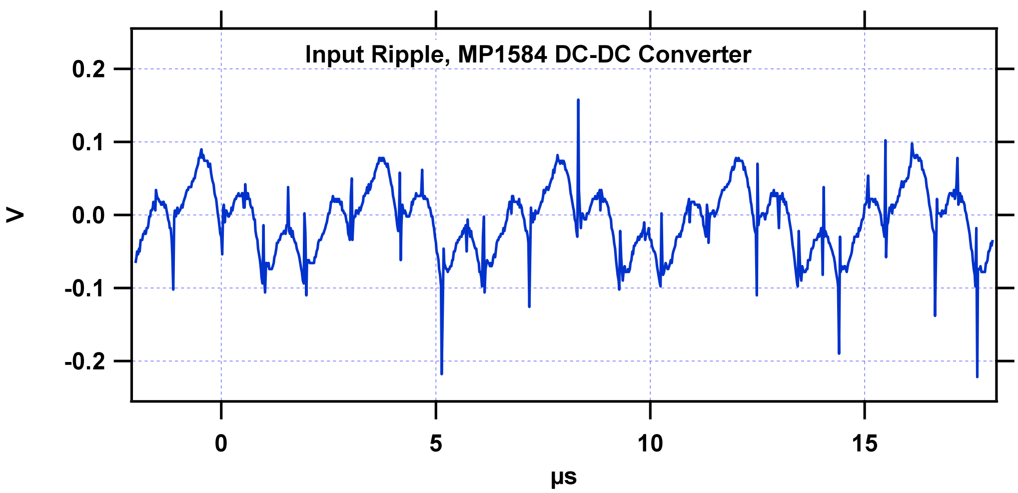


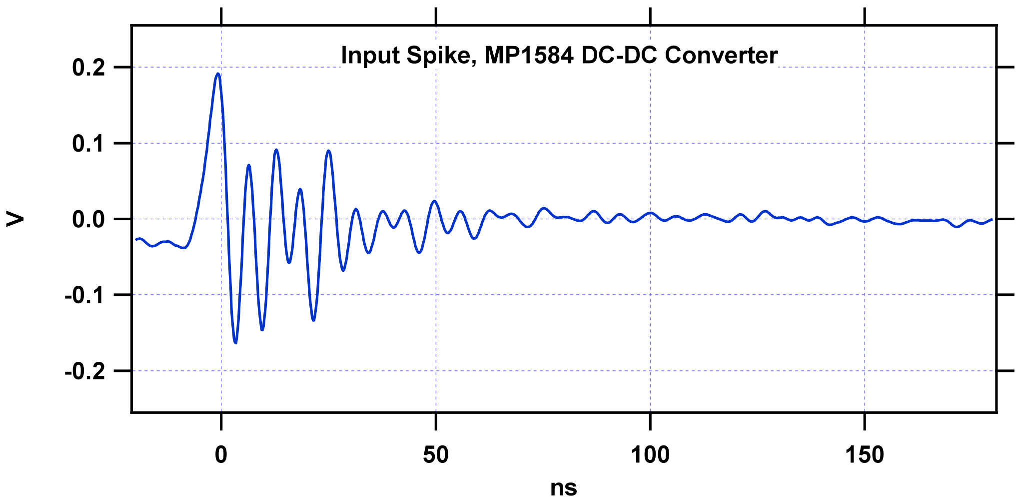
Observations:
Non-isolated series buck converter with adjustable output voltage. Negative input and output are common. Switching frequency 243 kHz and is stable with load. The manufacturer quotes the switching frequency as 1 MHz typical but clearly my sample was different. Test condition: 12 V input, 5 V output, various loads; 500 mA for noise measurements.

Input and output ripple amplitude is proportional to load current. Input ripple amplitude is about 20 dB greater than output ripple and contains more switching artifacts. At the test current of 450 mA, input conducted emissions at the input exceed FCC Part 15 limits. It is easily heard on a portable shortwave receiver, and via a dipole 20 ft away, appearing as a low-level "growler" about 4 kHz wide. The good news is that noise energy only appears at discrete 243 kHz multiples. This device may cause interference around an amateur radio station if used without additional filtering.

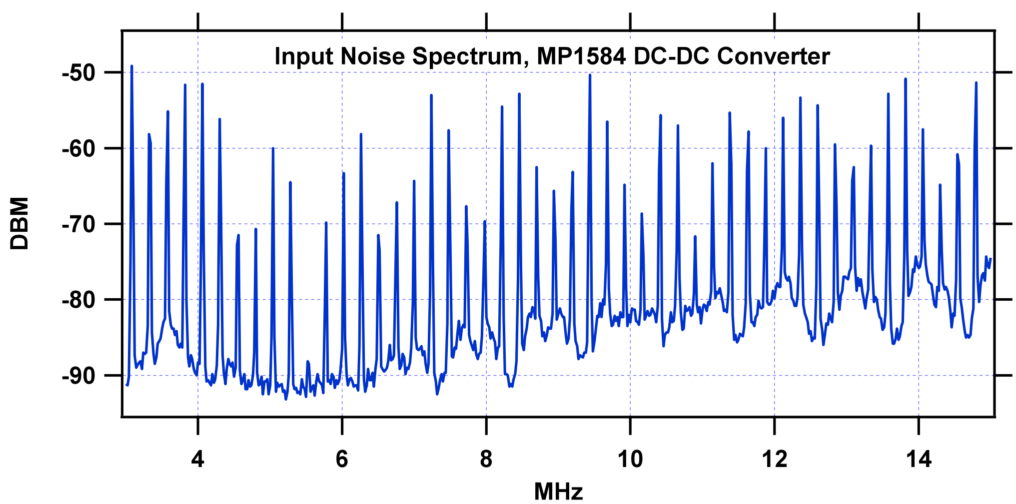


Looking at the input ripple, it contains fast spikes at the 243 kHz switching frequency and also some lower-frequency modulation. Spikes are 5 ns FWHM and ring down at about 150 MHz; additional spectrum analysis showed energy there.





The graph below shows the noise carriers with 243 kHz spacing. This reduces the likelihood that it will interfere with communications, but note that each carrier has a bandwidth of 4 kHz or so and is somewhat unstable. This is certainly better than having a very low switching frequency.



Suggested Modifications

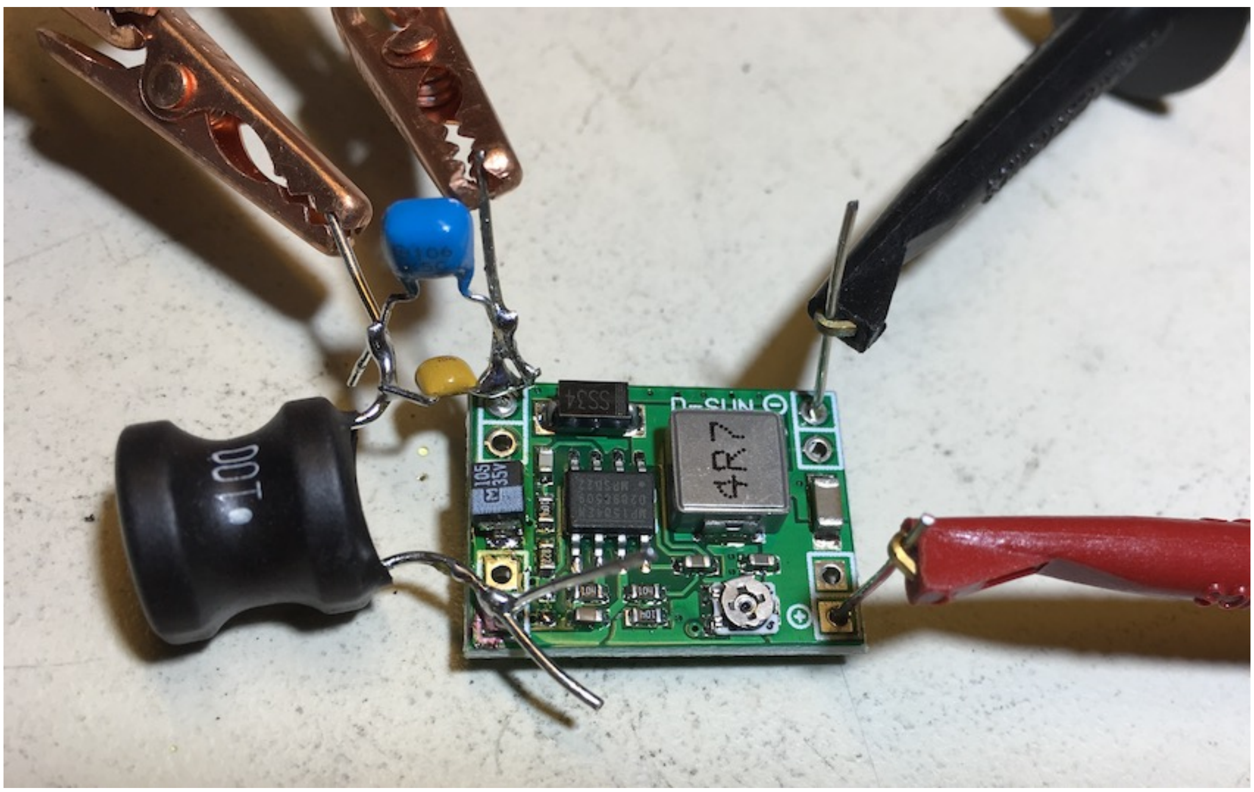
Noise performance of this cheap power supply can be significantly improved at reasonable cost. A simple LC input filter can eliminate most of the ripple that leads to conducted emissions. A series inductor and a capacitor across the input supply is sufficient. The inductor should be between 3.3 and 10 uH and rated for 3 A DC, with a high self-resonant frequency. The capacitors should be a small ceramic on the order of 100 nF, 35V, and a larger monolithic ceramic or tantalum 10 uF, 35V. The parts need to be as close as possible to the board's input terminals and leads must be very short.

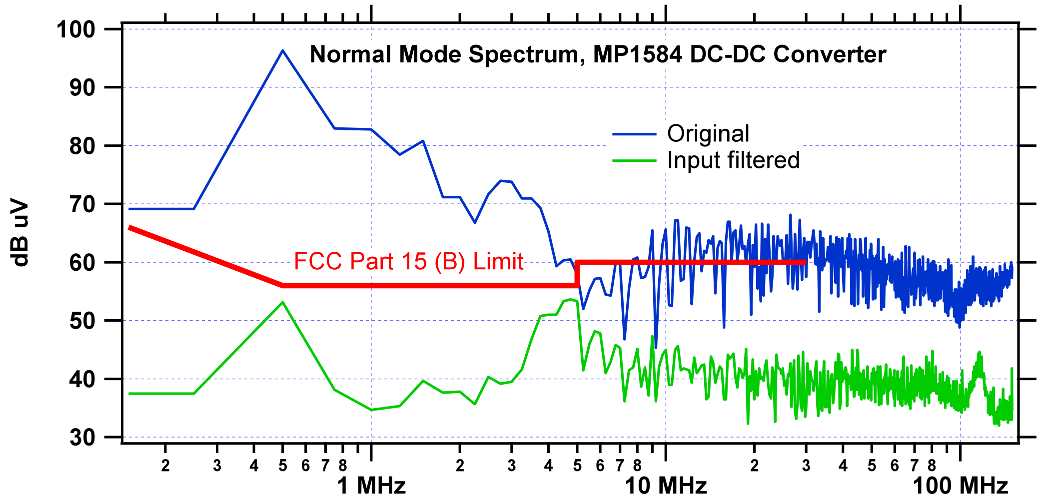
Another improvement is to add a surface-mount 10 uF 35V tantalum capacitor in parallel with the input ceramic capacitor on the board. It appears that the manufacturer did not follow the datasheet recommendations and used an undersized capacitor here. You can see it in the photo below. If SMT soldering is beyond your skill level, it’s ok to skip this component.

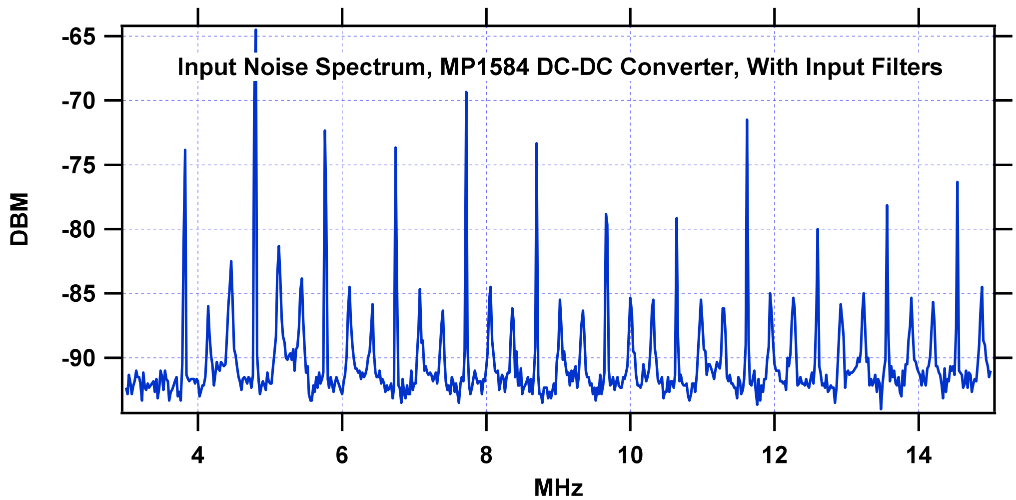
Everything should be installed inside a closed metal enclosure. Common-mode chokes may be needed on both input and output leads.

With the modifications discussed here, conducted emissions at the input are reduced by 20 dB typically, and this power supply meets FCC Part 15 (B) limits.

Modification Parts List
Input series filter inductor: 10 uH, 2.7A Bourns RLB1314-100ML ($0.45 ea)
Input shunt capacitor: Any 100 nF 35V ceramic
Input shunt capacitor: 10 uF 35V low ESR tantalum or monolithc ceramic.
Common-mode chokes (input and output): 10 turns bifilar around Fair-Rite 2631801202 (1.1" dia type 31), available from Mouser.




Normal Mode Spectrum, MP1584 DC-DC Converter
Original
Input filtered
FCC Part 15 (B) Limit
dB uV
100
90
80
70
60
50
40
30
1 MHz
10 MHz
100 MHz


Input Noise Spectrum, MP1584 DC-DC Converter, With Input Filters
DBM
-65
-70
-75
-80
-85
-90
4
6
8
10
12
14
MHz