

## RFI Test Report – Generic LM2596 3A DC-DC Buck Converter Module

**Manufacturer:** Generic Chinese

**Model:** LM2596 DC-DC 3A buck converter module (board)

Model number: **None** Item number: **None**

Description: Small circuit board, 1.7 x 0.8 inches, DC-DC converter

Purchased from: Ebay Price: \$3 to \$5 typical

Test equipment: HP 8560A, Tek TDS320A.

Tested by: Gary Johnson, NA6O Date: July 22, 2019

### Summary

Recommend for amateur radio stations: Not without modification, significant RFI generator. See text for modifications.

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

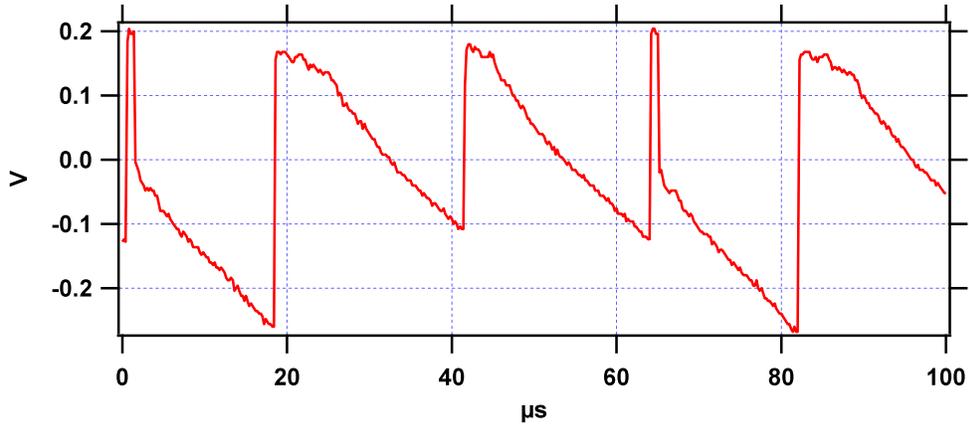


### Observations:

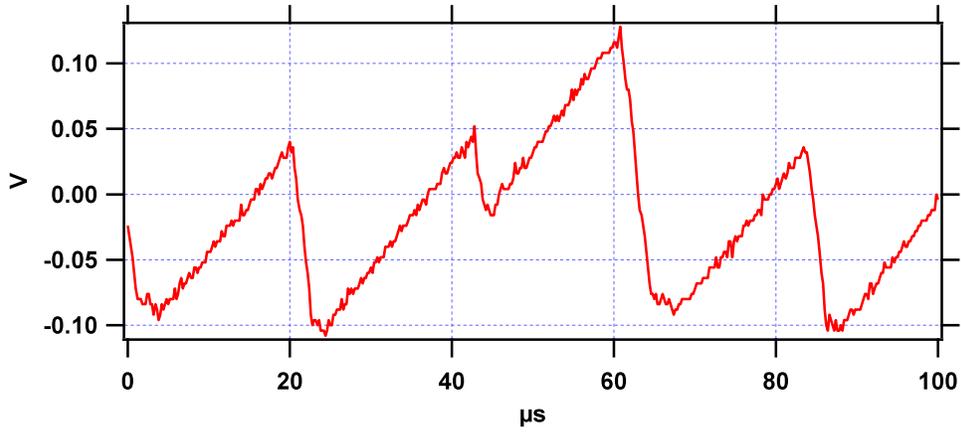
Non-isolated series buck converter with adjustable output voltage. Negative input and output are common. Switching frequency about 50-60 kHz, varies with load. Frequency does not agree with datasheet (150 kHz typical). Test condition: 15 V input, 12 V output, various loads; 450 mA for noise measurements.

Input and output ripple amplitude is proportional to load current. Input ripple amplitude is about 2X output ripple and contains more switching artifacts. Risettime on the steps is about 30 ns. Output ripple filtering is much better, restricting noise bandwidth. At the test current of 450 mA, input conducted emissions exceed FCC Part 15 limits and is easily heard on a portable SW receiver if the board is connected to sufficiently long wires, especially at the input.

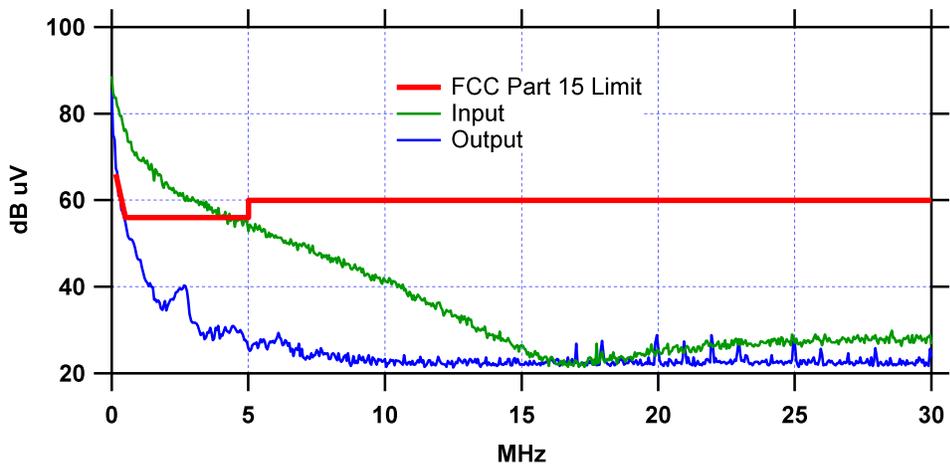
Input Ripple.  $V_{in} = 15.0$ ,  $V_{out} = 12.0$ , load = 450 mA.



Output Ripple.  $V_{in} = 15.0$ ,  $V_{out} = 12.0$ , load = 450 mA.

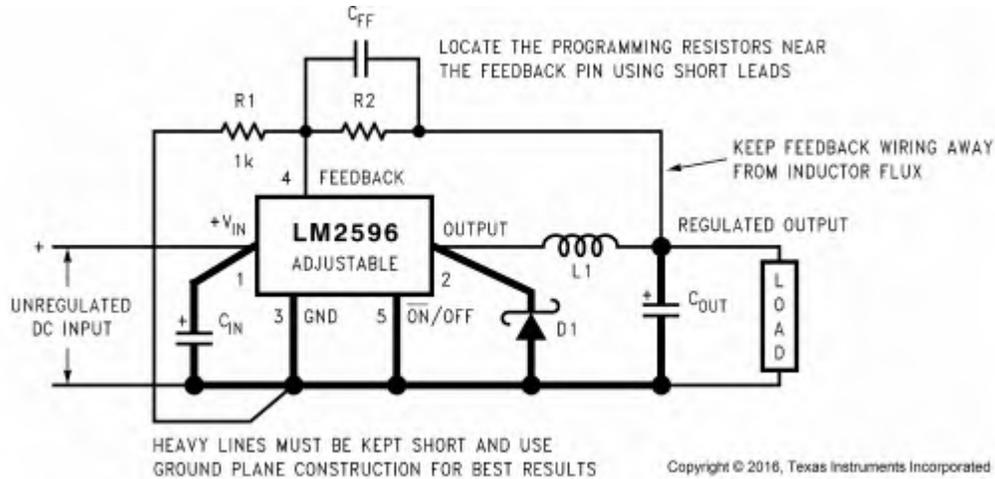


Noise Spectra.  $V_{in} = 15.0$ ,  $V_{out} = 12.0$ , load = 450 mA.



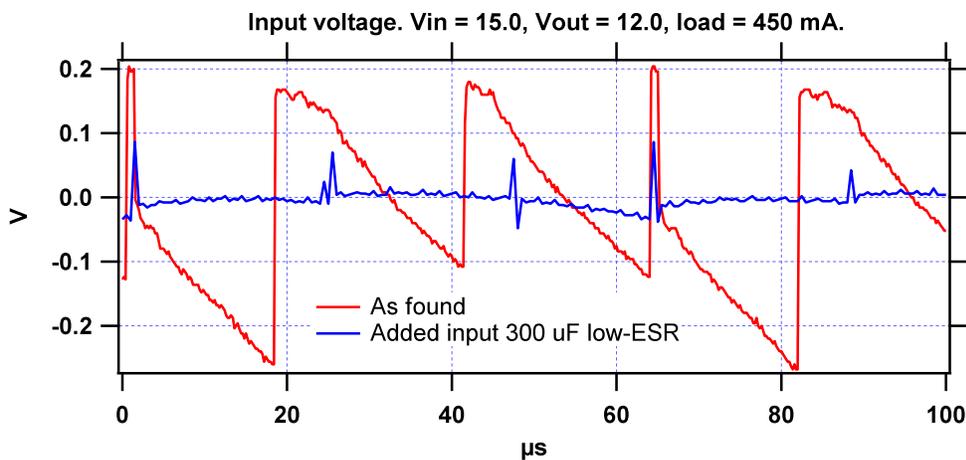
## Modifications

Noise performance of this cheap power supply can be significantly improved at reasonable cost. For reference, here is the nominal schematic from the LM2596 datasheet:

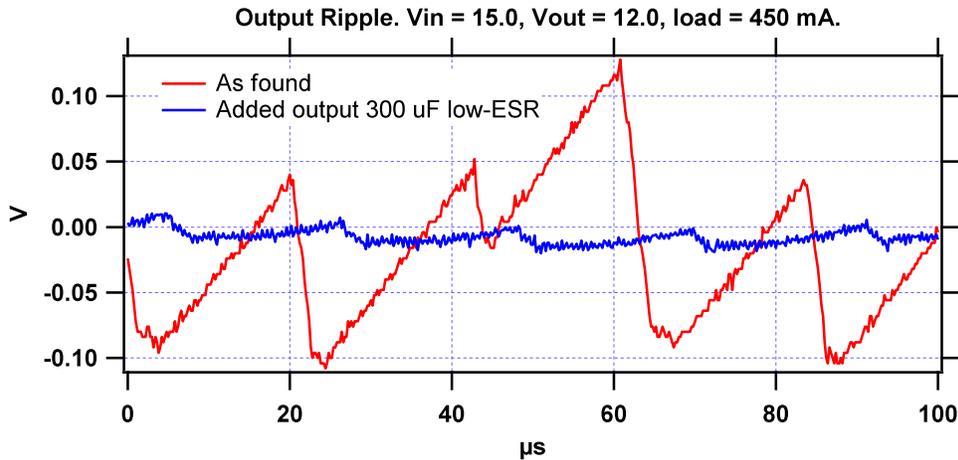


Datasheet recommends a low-ESR 470 to 680  $\mu\text{F}$  35 V (or higher) electrolytic at the input. This board uses 100  $\mu\text{F}$  50 V, maker unknown. Board layout is significantly different from the recommended pattern but it is impossible to determine how it is routed.

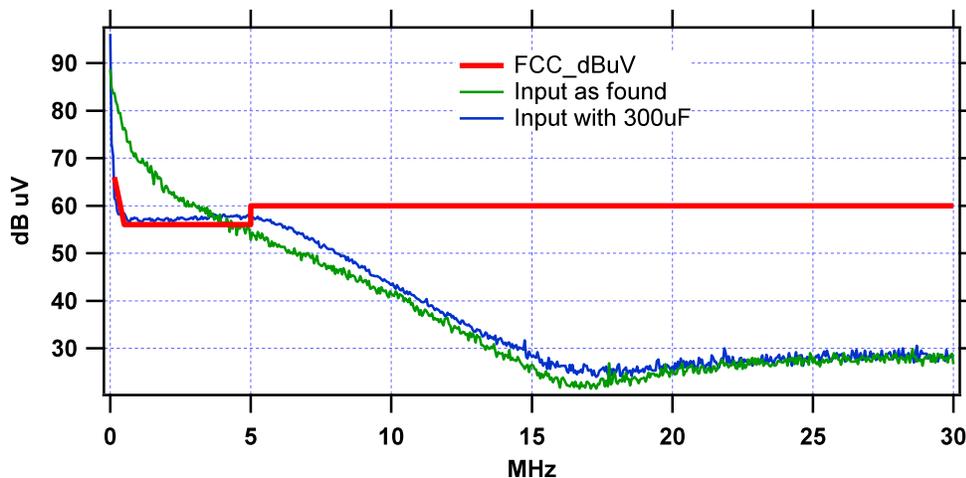
Tacking on a 300  $\mu\text{F}$  50 V low-ESR electrolytic (Panasonic EEU-FR1H331LB) at the input reduced input ripple by more than 20 dB, though there are still some fast transients, around 30 ns FWHM. Clearly the maker did not use a proper input filter capacitor.



The same level of improvement in output ripple is achieved by tacking on the same kind of capacitor at the output.



Even though the waveforms are visibly improved, the RF noise is not much better, at least above 5 MHz, but the device does become just-barely-compliant with FCC Part 15. Tacking on a 100 nF 1206 SMT capacitor at the input improved things above 12 MHz but not much else. The remaining input noise probably cannot be improved further without external filtering. This product is limited by layout issues and of course component selection.



### Adding an Input Filter

A simple LC input filter can eliminate most of the ripple. A series inductor and a capacitor across the input supply is sufficient. The inductor should be at least 10 uH and rated for 3 A DC. The capacitor can be any small ceramic on the order of 100 nF, 50V. 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, this power supply easily meets FCC Part 15 limits and can be used in most amateur radio system applications without RFI consequences.

### Modification Parts List

Input series filter inductor: 10 uH, 2.7A Bourns RLB1314-100ML (\$0.45 ea)

Input shunt capacitor: Any 100 nF 50V ceramic  
Input and output capacitors: 330 uF, 50 V, low ESR, Panasonic EEU-FR1H331LB (\$1.03 ea)  
Common-mode chokes (input and output): 10 turns bifilar around Fair-Rite 2631801202 (1.1" dia type 31), available from Mouser.

