USB Power Supply RF analysis
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Five generic cigar-lighter USB power supplies are tested with a Signal Hound USB-SA44B SA scanning the VHF region from 100.0-200.0 MHz. A Baofeng rigid VHF-UHF rubber-duck-ish antenna was used as the sensor. In all images the black trace is the baseline background RF with the cigar-socket bench power supply set to 13.6V output. In all images the traces were an average of 10 sweeps. A Galaxy S7 cell phone was used as the test load for the USB supply output as a battery-charging load. The load current as displayed by the test supplies is noted in the image files names, as the current went down slightly during the tests as the battery level increased.

Three of the test units, UUT1-3, are from two batches of the unit shown in Fig. 1, purchased from Amazon:

https://www.amazon.com/gp/product/B00SWGWILI/ref=oh_aui_detailpage_o01_s01?ie=UTF8&psc=1

Figure 1. First type of power supply under test, with three separate units tested.

The second type of unit tested (UUT 4) is a USB power supply with an integrated Carbon Monoxide detector, also purchased from Amazon:

https://www.amazon.com/Stainless-Monoxide-Detector-Adapter-Emergency/dp/B01G2YJ3ZU/ref=sr_1_3?ie=UTF8&qid=1510872040&sr=8-3&keywords=usb+car+charger+with+carbon+monoxide+detector&dpID=41AiLE9oJIL&preST=_SY300_QL70_&dpSrc=srch

Figure 2. USB power supply with integrated Carbon Monoxide detector.

The third type of unit tested (UUT5) was a generic give-away spiff with Wells Fargo branding. The age and source of this unit are not known. No image is included of this unit.

The Units Under Test are:

1. UUT1, problematic unit that exhibited noise-generation and interference with aviation VHF voice communication radios. This unit was from a first batch purchased from Amazon and has the "Car Charger" label as shown in Fig. 1.
2. UUT2, a second example of the same type as UUT1, from the same batch purchase.
3. UUT3, a third example of the same type as UUT1-UUT2, but from a second batch purchase. This unit does not have the "Car Charger" label.
4. UUT4, an example of the unit shown in Fig. 2.
5. UUT5, the Wells Fargo branded inexpensive give-away spiff.

Test Procedure

The baseline background trace, the black trace shown in the images, was generated with the test fixture cigar socket connected to the bench power supply set to 13.6V output. This simulates a typical aircraft electrical system voltage during flight. It was subsequently observed that the radiated energy from UUT1 increased as the input voltage increased, and increased substantially from a no-load to loaded condition. The background (black) trace is an average of ten sweeps in the SA.

UUT1 was connected first with the Galaxy S7 cell phone used as the output load. The initial load current was shown on the device display as 1.1 Amps. The blue trace, which is also an average of ten sweeps in all Figures, shows the detected energy for this device in Figure 3. It is easily seen that the interference energy from this device is significant, roughly 10-15dB higher than the background energy in the 105-125MHz region occupied by aviation VHF voice traffic.

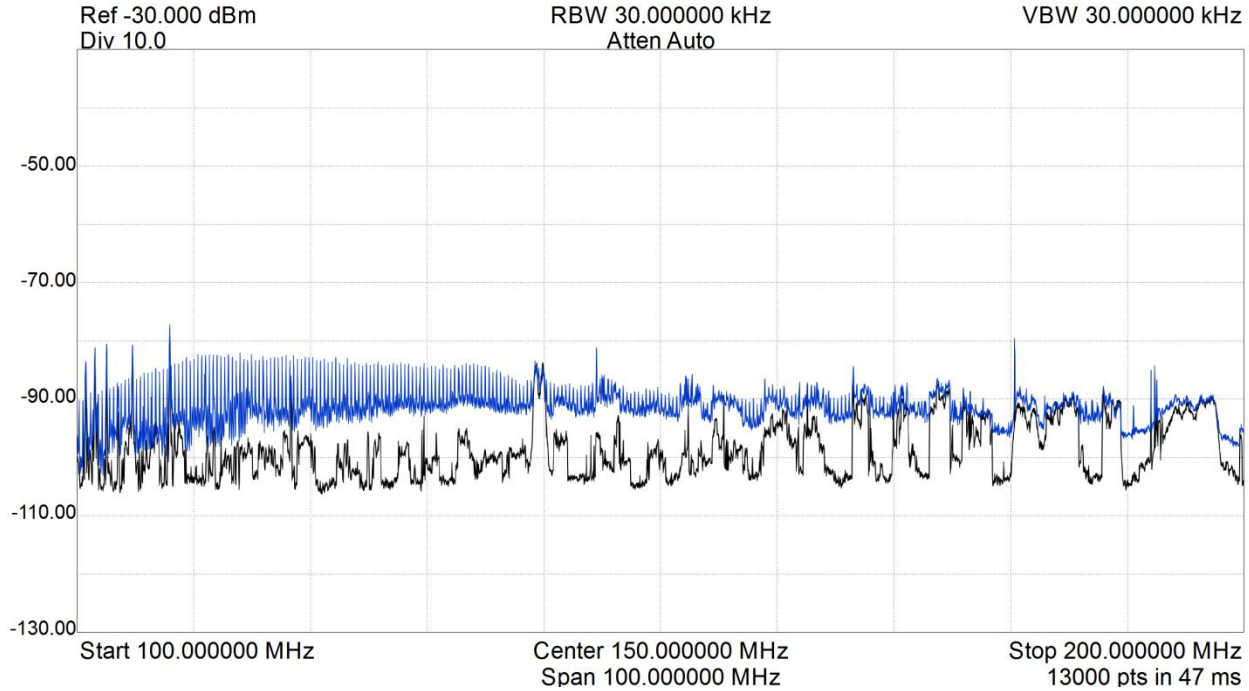

Figure 3. UUT1 output with a 1.1A load. USB_ps_test_13V_1.1A_avg_avg.png

The UUT2 output with the same load is shown in Fig. 4. While the increased energy from the unit (shown in the blue trace) is still significant, it is not as spurious as that from UUT1.

The output of UUT3 in similar conditions (a slightly lower load current) are shown in Fig. 5. This unit was purchased in a different batch than UUT1-UUT2 and is marked slightly differently. Additionally, it shows the ambient temperature in Fahrenheit instead of Celsius (like UUT1-UUT2). The RF energy output appears to be generally significantly lower than UUT1-UUT2, especially in the 105-125 MHz region of interest.

Figure 6 shows the output of UUT4, the silver-finished unit with the integrated CO detector. It is easily observed that the RF energy output from this unit is significantly lower than that of UUT1-UUT3 and could be considered negligible.

The output of UUT5 is shown in Fig. 7 and shows the lowest output levels, with only incremental increases over the background energy in the 105-125MHz region and no noticeable increase at the higher frequencies above 150MHz.

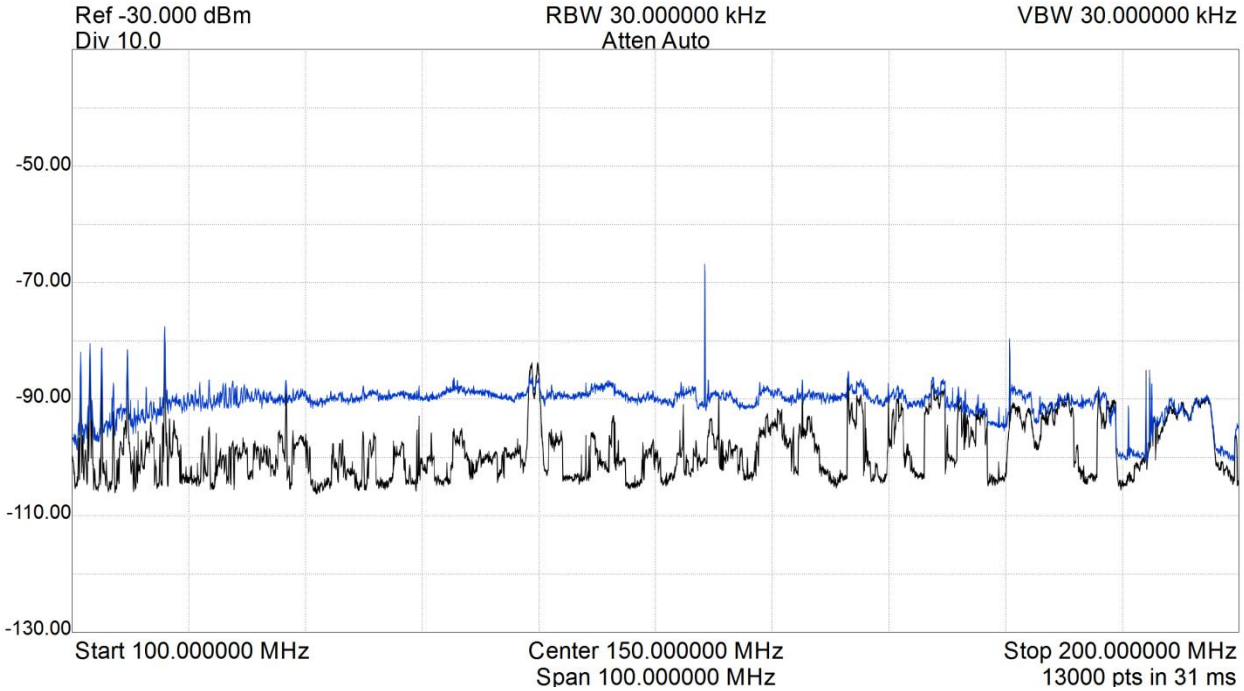

Figure 4. UUT2 output with a 1.1A load. USB_ps_test_13V_1.1A_avg_avg_unit2.png

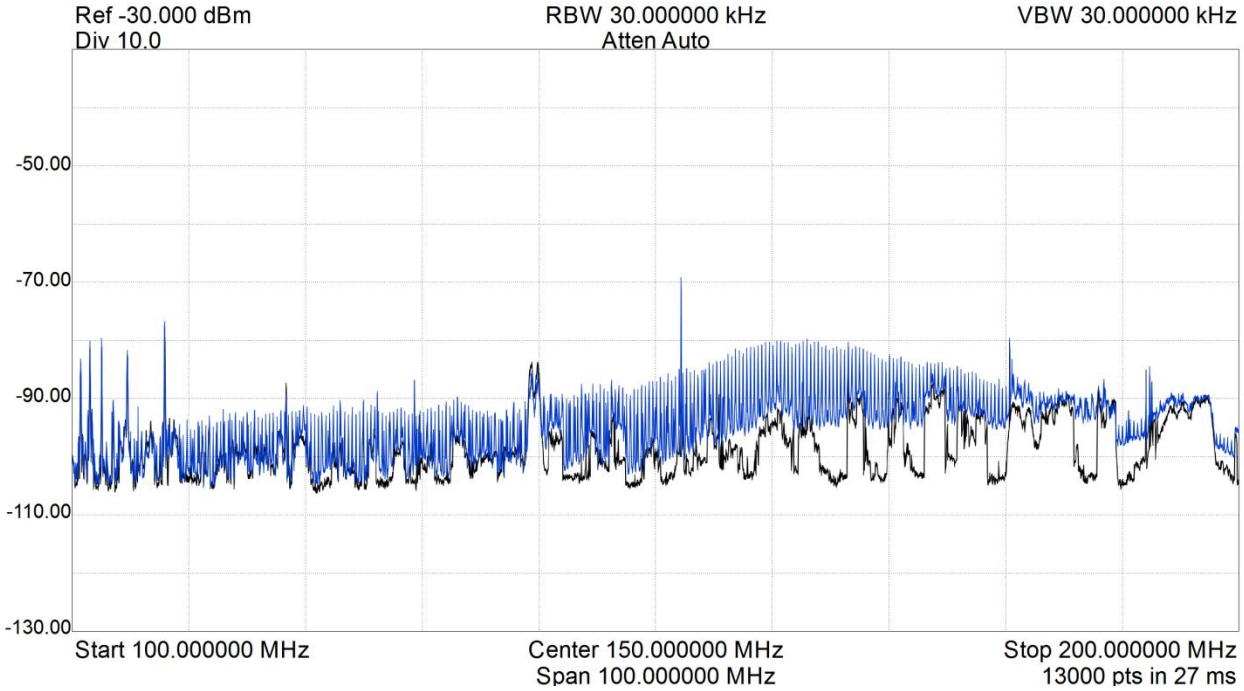

Figure 5. UUT3 output with a 0.71A load. USB_ps_test_13V_0.71A_avg_avg_unit3.png

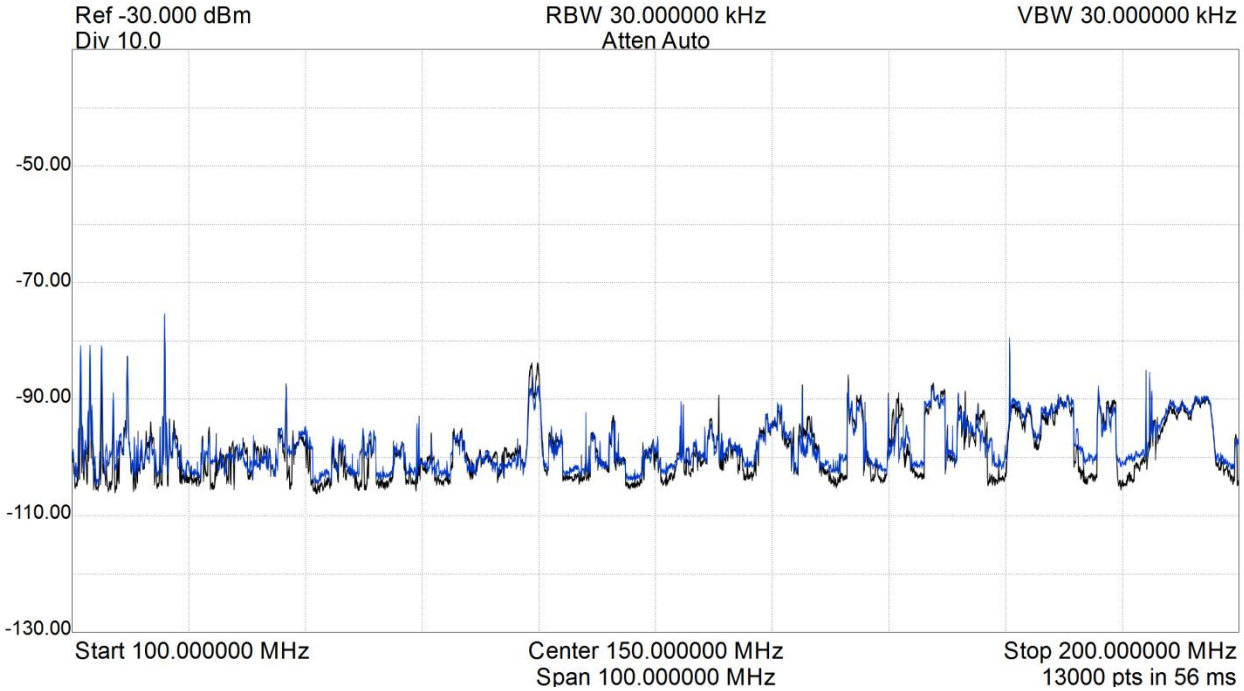

Figure 6. UUT4 output with a 0.71A load. USB_ps_test_13V_0.71A_avg_avg_COunit.png

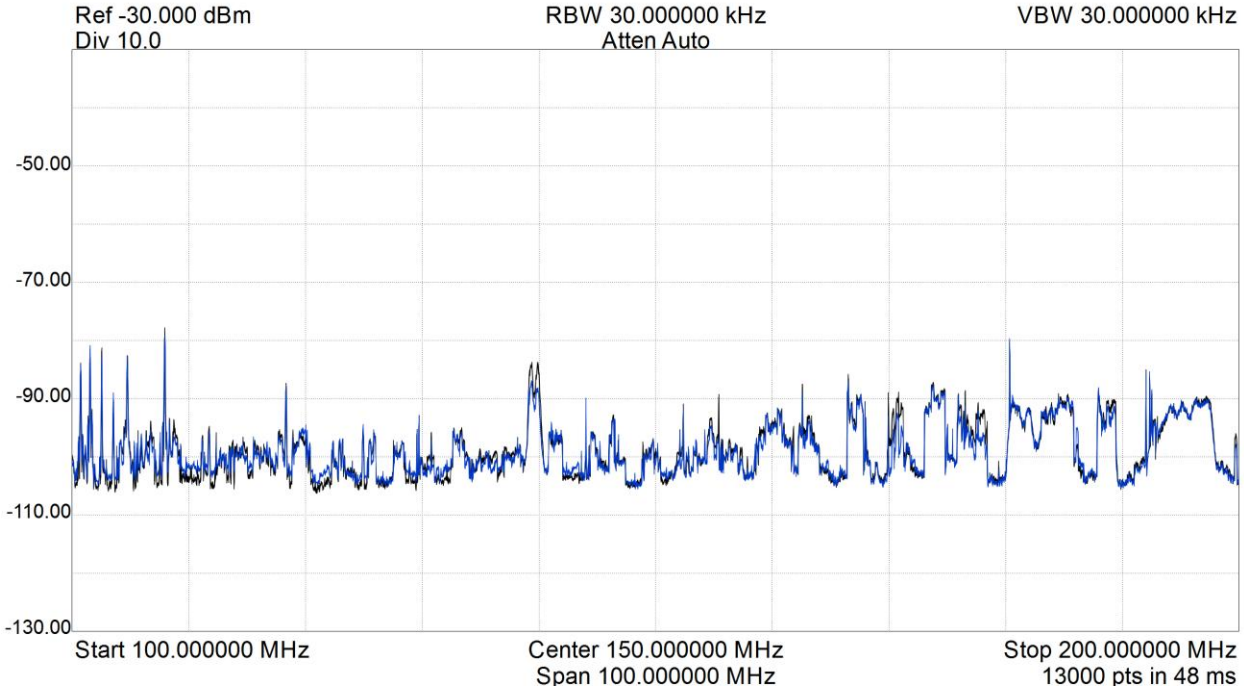

Figure 7. UUT5 output with a 0.71A load. USB_ps_test_13V_0.71A_avg_avg_WFunit.png

Conclusion

A significant variance exists in the RF emissions of common automotive-style plug-in USB chargers in the 105-150 MHz region and above. Interference with aviation VHF voice or navigation systems may be mitigated by unplugging a USB charger and potentially replacing it with one with lower RF emissions. Without measurement information, whether a particular charger is an RF interference hazard or not is difficult to determine. Low-cost chargers may have minimal emissions and variance among individual chargers of a particular type may be significant. Without RF measurement equipment trial-and-error may be required to determine if a particular charger is sufficiently quiet for reliable use around VHF communication or navigation equipment.

It was observed that the RF emission levels of particular units varied with both input voltage level and load current. This means that potential for interference with VHF systems may change as the electrical load of the aircraft system changes and/or the electrical load on the USB charger changes. If interference from the USB charger is suspected, unplugging the charger from the aircraft electrical system during the interference event may reveal whether the unit is responsible for the interference.