Relationship of Power Output to Input Voltage

Purpose:

In consideration of both the challenge of reducing harmonics and spurs and of gaining confidence that the amplifier is not operating in a saturated mode, the relationship between the power input voltage and the output CW power was measured.

Parts:

uBITX transceiver
MFJ Deluxe Versa Tuner II, Model MFJ-949C
Alinco DM-330 adjustable power supply
homebrew paddle
digital voltmeter

Procedure:

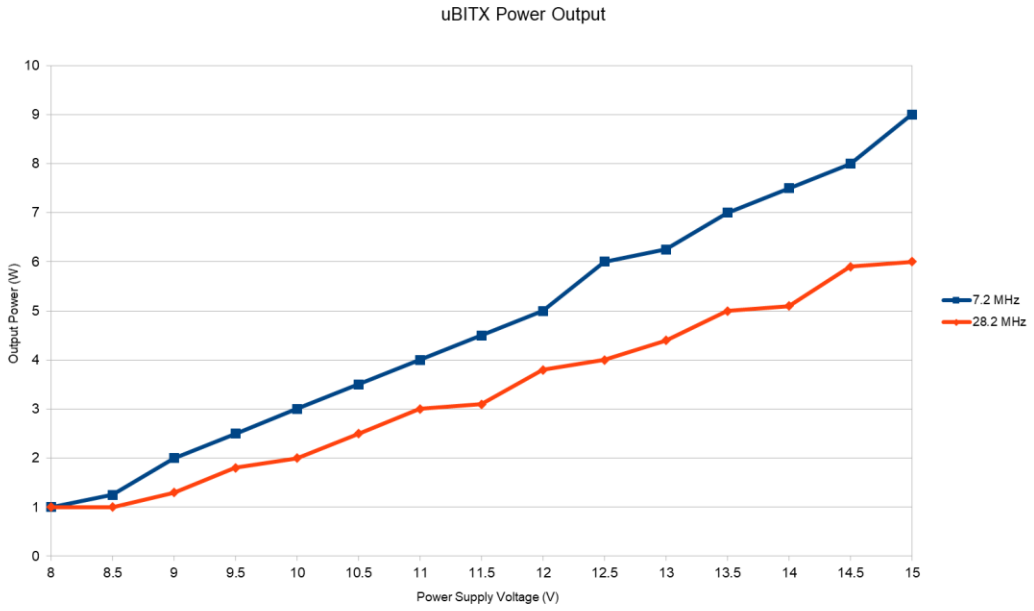
The radio was set to two frequencies, 7.2 MHz and 28.2 MHz, and the output power measured while varying the radio's input voltage. The RF output was fed to the MFJ-949C built-in dummy load and power measured on its meter. The meter had been calibrated using a high-quality power meter borrowed from WO3L and provides readings commensurate with expected power outputs of other radios. While not precise to laboratory standards, it should be reasonable for this work. The dummy load of the MFJ-949C has been swept for RF performance with an AA170 antenna analyzer and verified to be a matched load to past 30 MHz. It is rated for up to 300 Watts. It uses an analog meter with ticks every watt and was set to the 15 Watt scale. A short length of coax was used to connect the uBITX to the MFJ-949C.

Measurements started at 8 Volts to keep clear of the low voltage cut-offs of any 5 Volt regulators which typically are not guaranteed below 7 Volts and stopped at 15 Volts since the Alinco DM-330 would not adjust higher. In addition, the Raduino and 5 Volt regulator's maximum voltages are 16 Volts.

With a digital voltmeter presenting voltages to the hundredth of a volt, the input voltages were adjusted from 8 Volts to 15 Volts in increments of a half-volt. Each voltage measurement was within +- 0.04 volts, except at 13.5 Volts where the power supply detent made the voltage more difficult to set. It was in error by up to 0.06 Volts. Of course, the power measurements from the analog scale are, in cases where decimals are used, visual interpolations.

The data show no rolloff of power with increasing input voltage, indicating no large-scale nonlinearity. However, there appears to be a low-voltage nonlinearity between 8 and 8.5 Volts, indicating a minimum power supply input voltage of 9 Volts. There appeared to be a slightly nonlinear relationship above 12 Volts in the performance of the system at 7.2 MHz. This might reflect a design that was probably done with 12 Volt power in mind.

Input Voltage	7.2 MHz	28.2 MHz
Volts	*Watts*	*Watts*
8	1	1
8.5	1.25	1
9	2	1.3
9.5	2.5	1.8
10	3	2
10.5	3.5	2.5
11	4	3
11.5	4.5	3.1
12	5	3.8
12.5	6	4
13	6.25	4.4
13.5	7	5
14	7.5	5.1
14.5	8	5.9
15	9	6



Next Steps:

To extend this investigation, the power to the final amplifier should be decoupled from the main radio power. Once done, the effect of power amplifier voltage can be safely measured.

A SPICE analysis of the circuit could be performed to look for opportunities to improve the RF transmitter.

Investigate the performance of the transmitter at 160 meters. The original low-band transmit filter is claimed to be from 3.5 to 5 MHz, yet the radio puts out approximately 17 Watts at 1.9 MHz.