EXPERIMENTAL AUTOTUNER FOR SMALL MAGNETIC LOOP ANTENNAS

Andrew Cornwall, VE1COR

The article "Experimental Autotuner for Small Magnetic Loop Antennas" is featured on pages 31-38 of the May-June 2018 issue of The Canadian Amateur magazine. The following provides supplementary information in support of the article.

Supplementary information

Even when the autotuner is turned off the receiver via the sampling antenna is exposed to the full power being transmitted by the small magnetic loop antenna. There is the potential that transmitting high power will cause the current handling capacity of the receiver's 1N34A bridge rectifier diodes, 50 mA, and the 4N35 optocoupler input diode, 60 mA, to be exceeded, destroying them.

Estimating the maximum transmitter power of the small magnetic loop antenna that an autotuner can handle involves these factors:

1) Using the weakest link criteria, the maximum current into the receiver should not be greater than 50 mA (the diodes' limit).

2) The autotuner's red "saturation" LED will blink (or turn on) when a signal level above 875 is encountered. The 875 benchmark is somewhat arbitrary, but has not created any difficulties. Note, the signal level is represented in the autotuner on a scale of 0 to 1,000 as measured by the microcontroller ADC input.

3) A low level tuning signal of known wattage can be used as a maximum power handling guide if saturation is not indicated during auto tuning.

Step 1: Measure the current at the antenna terminals that represents the autotuner's saturation threshold.

This is a bench procedure. The equipment needed includes:

- an autotuner only, not connected to an antenna, running a standard function autotuning program (such as the current versions 5a, 5b or 5c)
- a 12-volt power supply to power the autotuner
- a common 9-volt battery
- a set of resistors, or a variable resistor, with values ranging from about two k-ohms (minimum) to about 100 k-ohms
- a multimeter to measure low milliamps
- various wires with alligator clips to complete a circuit
- optional: a computer, running a Picaxe development program in the terminal mode, and attached to the autotuner via the AXE0027 USB adapter cable. It is fun to "see" what is going on.

A typical 9-volt battery supplies the testing power to the antenna terminals, and varying the series resistance alters its applied current. With the autotuner's sensitivity switch set to "high", the objective is to feed various amounts of current into the autotuner's antenna terminals until the red saturation light turns on. At this point the amount of current, measured by the multimeter, is recorded.

To do the antenna current saturation measurement:

1) Start the autotuner by supplying 12 volts power to it.

2) Do not apply any testing power to the antenna terminals (leave the 9-volt battery disconnected). After a "no signal" reconnaissance sweep, the autotuner enters manual mode. The green LED will light.

3) Connect the testing power circuit to the antenna terminals.

4) Vary the testing circuit resistance while noticing the threshold current that causes the red saturation LED to start blinking. Note, current into the antenna terminals will be in a range of about 0.05 mA (100 k-ohms series resistance) to 3 mA (2 k-ohms) so there is no danger of exceeding the receiver's diodes and optocoupler current limits.

With my autotuner the red LED blinking thershold current is approximately 1.2 milliamps. This is about 2.4% of the maximum 50 mA current that the receiver components can withstand. Alternatively, the 1.2 milliamps represents an overload factor of about 42 (i.e., 50/1.2).

The saturation threshold current and overload factor may be somewhat different for other autotuners because of sensitivity differences inherent in individual optocouplers. Once determined this parameter should not change.

Step 2: Determine maximum power tolerance range.

The next step is in the field, with the autotuner attached to a small magnetic loop antenna and a suitable sampling antenna installed. With the sensitivity switch set to "high", the autotuner is turned on while a known wattage tuning signal is being transmitted (perhaps 5 watts).

If during autotuning the red LED saturation warning does not light, then the setup delivered less than the threshold saturation current to the autotuner's receiver. Multiplying the overload factor times the tuning power estimates the linear extrapolation of the (minimum) tolerable autotuner power handling ability for the given frequency and sampling antenna.

For example, my autotuner has a 1.2 mA saturation threshold current and an overload factor of 42. If the saturation LED does not light when tuning for 7.422 MHz, with a sampling antenna of 14 cm (per leg, and a tuning signal of 5 watts, then the autotuner's power handling estimate is at least 210 watts (i.e., 42 x 5 watts). This estimate is true only for these exact parameters, but it is easy to produce another estimate with different conditions; just tune again in the hope that the red LED light does not turn on.

Note: If saturation is encountered tuning will not be successful anyway.

If the red LED turns on then the strategy is to either reduce the tuning signal or shorten the sampling antenna and extrapolate the maximum power based on the new criteria. By the way, all else being the equal, higher frequency transmission results in a greater tendency for saturation because the small magnetic loop antenna efficiency increases with frequency.

Changing the autotuner sensitivity switch to "low" to avoid a saturation condition does not effect the maximum power condition. Turning the sensitivity switch to low changes the sensitivity of the optocoupler's output transistor, and has no effect on the current going through the receiver's optocoupler input and diodes.

With repeated autotuner experiences, at different frequencies, using different sampling antenna lengths, and transmitting different tuning wattages, an impression builds about an autotuner's routine maximum full tranmission power handling capability. I am fairly confident that my autotuner can withstand at least 150 watts for the range of conditions that I am likely to have. In any case I am unlikely to transmit at this power, because it would cause variable capacitor voltage to exceed the limit placed on it.

Andrew (Andy) Cornwall received his Basic Amateur Radio certification in 1992 (now Basic with Honours) with call sign VE1COR. He also has a General licence in the United States with call sign KB1RSE. His hobby is electronics and radio communications. He is retired from careers as an Economist and as a Director of an information technology section. He lives in Enfield, Nova Scotia.