A NOVEL APPROACH TO ANTENNA SELECTION
by Dennis Andrews, F5VHY

Apart from better weather and cheaper wine, a retirement move to south-west France also meant an end to the constraints of a small UK garden. Our new QTH came with 2½ acres of land and antenna farm dreaming was well in hand before we bade our farewells to Sussex.

Our land is divided in two by a line of trees and bushes and I came to an agreement with Anne that I would leave the half around the house free of wires and have the other 1¼ acres for the antennas. To keep feed and control cables out of the 'garden' part, I ran a large waterproof tube from the basement, under the ground, to the other side of the hedge. I filled this with as many coax lines and multi-core cables as I thought I would ever need, and installed switch boxes for remote selection of the antennas.

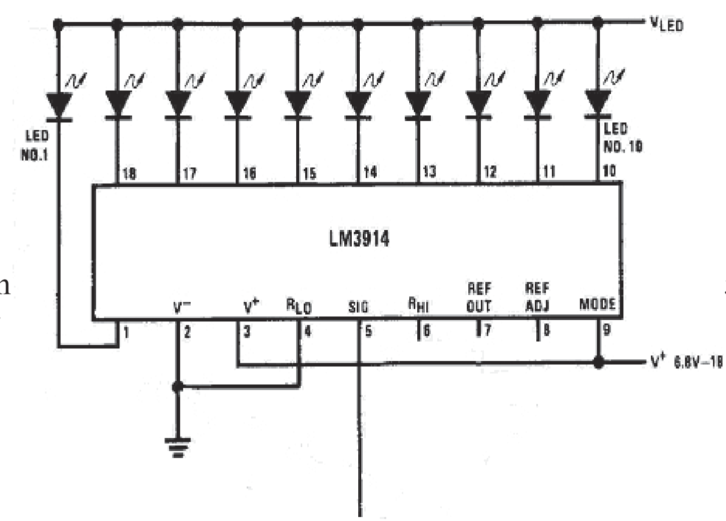
Needless to say, within a couple of years, I had used up all of the switching capacity! It was, in some ways, a welcome problem. The antenna field is heavy clay, with a high water table during the winter months. The 160/80 metre vertical, with just over two miles of radials, has been a joy to use. However, although I don't have a very high local noise level, there are always stations calling who are below it, and so attention quickly turned to improving the receiving antenna setup.

There are those who suggest that receiving antennas need to be precisely installed and aligned to be of value - don't believe them! I currently have a small (300 feet) beverage on Asia, three Pennants in different directions, and shielded loops for 160 and 80 metres. They are all valuable additions to the armoury and each one of them has shown itself capable of pulling in a copyable signal where all else fails, and I have plans for further developments in this area.

So the problem that arose was that of selecting any one of the receiver wires to feed the receiver antenna input of the FT-1000MP.

I could obviously have dug up the garden again and installed some further multi-core cable, but with a long hot summer ahead and a cool basement shack, I thought I would look for a smarter approach.

Enter the LM3914



Now the LM3914N, manufactured by National Semiconductor, turns out to be a very interesting little device. It is normally used in applications such as a volume indicator, where the LEDs sequentially light as the signal strength increases. An increasing voltage on Pin will cause LEDs 1 through 10 to light up either one after the other, or in a cascade with all lit with full signal voltage.

The mode is selected on Pin 9. Investigation showed that the LED pins 1 and 10 through 18 could pass enough current to operate a small five volt relay – about 25mA. So a chain of relays, replacing the LEDs, would form the basis for a 10-way antenna switching box controlled by just one signal line.

Down the garden

Although you don't need to use particularly low-loss coax for receive antennas, you do need to pay some attention to matching. Beverages, Pennants and other wires are likely to have some strange feed impedances.

A feed-line with a high SWR will become part of the antenna, inevitably reintroducing the noise that the antenna itself is designed to minimise. There is plenty of material on the nternet covering design of suitable transformers for interfacing between different receive antennas and 50 ohm line.

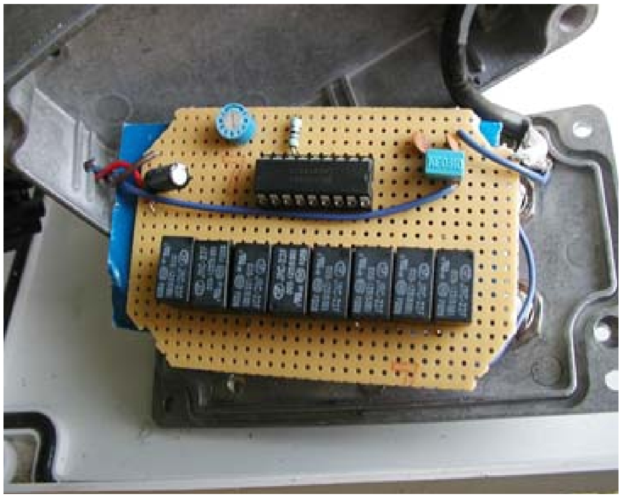
Dennis's antenna switching unit.

I had some concern that high-power RF might cause problems with the logic switching. So the signal line was fed through coax and filtered through the RF choke and two capacitors in the top right hand corner of the board. Even without these precautions, I found no evidence of RF related problems and the switching has been working well for some months. Although the LM3914 can switch up to ten relays, I just made provision for eight.

The coils of the eight five volt relays connect to the appropriate pins of the LM3914N and to the 12 volt line. The 500 ohm potentiometer is adjusted so that the current flow through the selected port on the LM3914N produces five volts across the relay coil. Pin 9 selects the operating mode of the chip and, for this application, is left floating. Pins 11 and 12 could be used for two further relays with suitable adjustment of the steps in the control voltage.

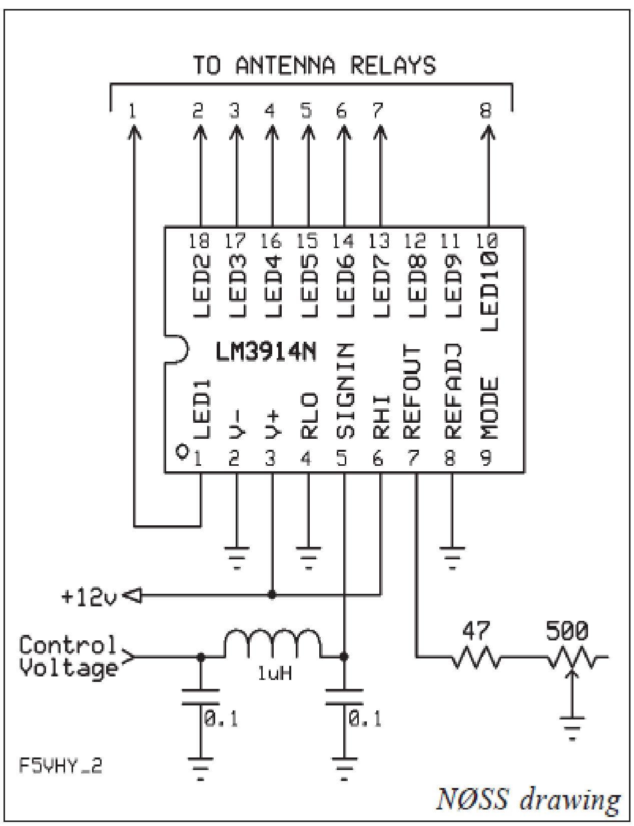
The picture above shows the switching unit which is located outside in a (hopefully) weatherproof box. In addition to the circuit board holding the relays and the LM3914, it contains the receive antenna amplifier – in this case, the PRE-2 from K9AY that can provide around 12dB gain. The PRE-2 includes a shack-end splitter that allows the 12 volts for the amplifier to be fed down the coax. An amplifier is essential with a Pennant; for as well as being a low noise antenna, its signal pick-up is relatively small. Mounting it with the switch unit allows the amplifier to be used in conjunction with any of the receive antennas. The circuit board is mounted in a shielded box with BNC connectors for the incoming antennas. The switched output goes to the input of the AY amplifier. The only other connections are the 12 volts supply and the signal voltage.

Internal view of the switching unit.

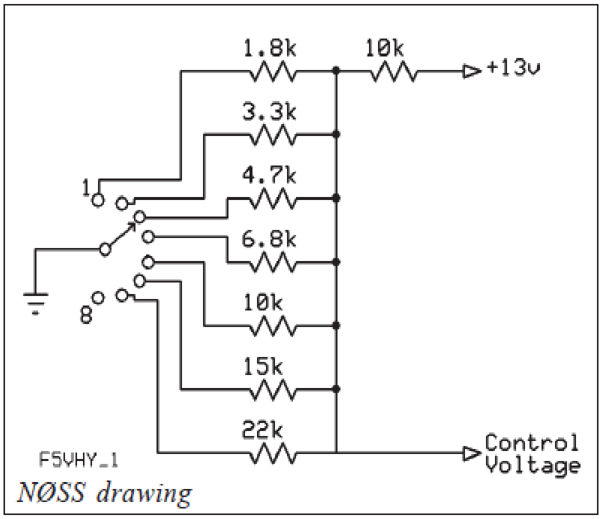


The circuit board inside the shielded box.

In the shack
At the operating position, you need to arrange to provide the appropriate voltage level to select the required receive antenna. The simplest way to achieve this would be with a rotary switch and a chain of resistors. Switch position 8 has no connected resistor which allows the control voltage line to rise to almost the full input voltage and selects the last LED port on pin 10 of the LM3914N.
The table shows the mid-value voltage, measured with a digital voltmeter, for the level on the signal line (pin 5) of the LM3914 required to select the different channels.



Circuit diagram of the circuit board inside the shielded box.



Circuit diagram of the switching.

Channel	1	2	3	4	5	6	7	8
Pin	1	18	17	16	15	14	13	10
Voltage	2.69	3.95	4.89	6	7.26	8.58	9.77	12.8

A further development can eliminate the rotary switch and use some solid state logic to perform the selection. The left-hand box has eight red push buttons for selecting the antennas. The black push button toggles the antenna amplifier on and off. The buttons operate a system of latches (74HCT75) that feed drivers (ULN2803A) that then perform the same function as the rotary switch.
The latches are connected so that pushing one of the red buttons selects an antenna and, at the same time, cancels any other selection.

The two control boxes in the shack.

The logic also drives small LEDs to indicate the selected antenna. This system makes it very easy to quickly scan around the various receive antennas to find the best incoming signal. The right-hand box uses similar logic to control the 40 metre four-square array, with the four buttons selecting NW, NE, SE and SW.

Trial & Error mode

I should emphasise that I am not an experienced design engineer. The component values were arrived at by the trusted T&E method - so might need some adjustment in other situations.