Why do I need a Sequencer?

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You certainly don't, if you enjoy replacing preamps, and perhaps climbing towers in the middle of contests.

The rest of us make mistakes and need some assistance so they aren't catastrophic. But mainly, the sequencer serves to protect the preamp and the antenna relay, and possibly the amplifier. That expensive coax relay with 80 dB isolation has much less isolation while switching, so you don't want the amplifier on until it finishes switching. Also, switching with RF on (hot-switching) will burn up the relay contacts, sooner or later. Waveguide switches don't have contacts, but they also have less isolation while switching.

The problem a sequencer attempts to address is that most transceivers put out transmit power immediately, before anything else can switch from TX to RX. This unwanted power can burn out mixers and preamps, as well as coaxial relays that are not meant to hot-switch RF power – it doesn’t take much power to damage a relay contact while it is switching. Another common problem is that many transceivers output a spike of excessively high power until it is reduced by a poorly-designed ALC loop.

Some approaches[1] to dealing with the problem involve trying to delay the transceiver output, either by intercepting the PTT line from the microphone (what about the key) or by controlling an **Inhibit** line to the transceiver. Both of these work well, but need additional connections to the transceiver – rig-specific, and additional points of possible failure.

Another approach is to cross your fingers and hope nothing blows up – strictly for fools!

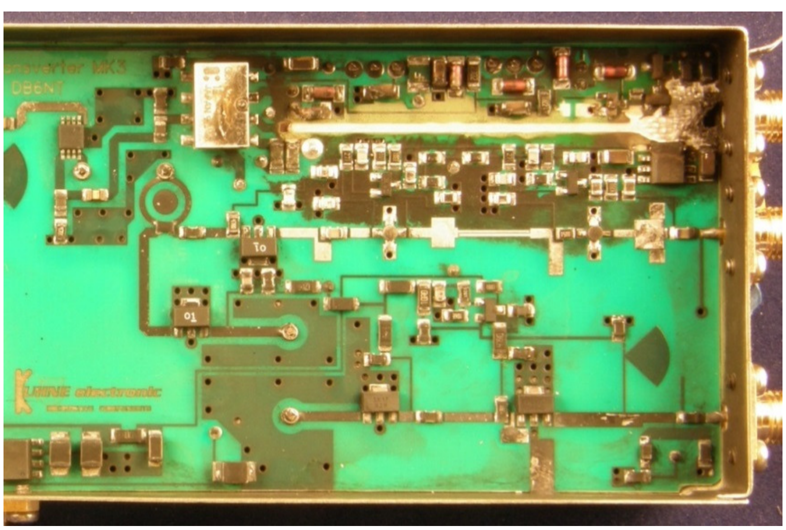

Figure 1 - DB6NT transverter with entire input section vaporized by high power

I prefer to have a single connection from transceiver to transverter, with PTT voltage running up the IF coax. To make this fool-resistant, a PIN diode switch controls the RF flowing to the mixer. This PIN switch has three states: RX, TX, and SAFE. An RF sensor detects any transmitted power and switches to the SAFE state to absorb the power until the sequencer finishes all switching. Of course, this is only fool-resistant – a fool could connect a 100-watt transceiver and burn up the whole PIN diode switch. See Figure 1 for the results.

Dumb sequencers

Most sequencers are just like clockwork mechanisms – once started, they just go thru the sequential steps in order with no further inputs. But what happens when they are interrupted, or if something isn't connected or turned on?

For instance, I recently saw this posting on the EME reflector [edited to remove identity]:

But when I wanted to try and work both Stig's in one QSO (hi!), my foot slipped of the footschwitch causing a timing glitch in my sequencer…. The sudden lack of noise alarmed me and soon it was clear that not only my signals went to the moon, but my preamp as well…

Conditional Sequencers

A conditional sequencer makes additional checks as it goes thru the steps, starting with de-bouncing the PTT (in case thumb or foot slips): has the antenna relay closed? Is the amplifier ready? Etc. And the sequencer takes appropriate action if there is a problem.

When we include some intelligence in the sequencer, we can wait until an operation completes before continuing, and take appropriate action if there is a problem: many coax and waveguide switches have auxiliary contacts to indicate completion, or we could check to make sure an amplifier is ready before applying RF. I call the sequencer that operates intelligently a conditional sequencer.

My previous fool-resistant sequencer[2], the "Even More Fool-resistant Conditional Sequencer," used a lot of discrete parts to provide sensing and an intelligent state machine. It works really well, but requires a large PC board and a whole lot of assembly and soldering. The parts are all cheap and readily available, but it takes a whole bunch. I recently tried to see if I could shrink it and simplify it to essentials, but without much success. So I went to an Arduino microprocessor for the intelligence in the Mark 4 and Mark 5 sequencers.

The condition I'd most like to check is that the antenna is connected before any RF goes out. I haven't solved this one yet, and I've blown up a couple of solid-state amplifiers as a result. I can assure you that the fastest fuse in the world is an expensive RF transistor. One possibility might be to measure VSWR as RF comes on and hope it can be turned off before the amplifier is damaged. Newer RF power FETs are more tolerant of VSWR, so this might work.

A Note on Preamps

For some time, the conventional wisdom for preamplifiers and LNAs is that leaving them powered at all times makes them less susceptible to failure. However, at EME2016, G4DDK[3] presented results of real testing he has done. His conclusion is that "keeping power on during transmit does not confer any advantages." His suspicion is failure is due to relay isolation. I have seen that isolation in some relays and waveguide switches is much lower while switching, a problem addressed by proper sequencing.

Notes

1. Marshall Williams, K5QE, "The Dark Side of Sequencing," *Proceedings of the 2016 VHF Super Conference,* ARRL, 2016.
2. Paul Wade, W1GHZ, "Even More Fool-resistant Conditional Sequencer," [MUD2009]. also www.w1ghz.org
3. Sam Jewell, G4DDK, "*Failure Levels in LNAs*," EME2016 Conference Proceedings, Venice, 2016, pp. 19-26, ISBN 979-12-200-1222-5.