Antenna Switch:

It's really pretty simple. A clock drives an upcounter. The upcounter outputs each drive s separate relays in sequence to turn the main transmitter off and turn on the auxiliary. Using a 4017 counter, you can get up to 9 separate steps.

For this particular client, the desire was to keep the auxiliary transmitter totally isolated from the outside world until needed…no AC connection, no RF connection, no audio connection. It gives the auxiliary a fighting chance against transients that take down the main transmitter.

For the unit drawn, the following sequence choices were made:

1. Mute/turn off main transmitter
2. Pulse antenna switch to transfer auxiliary transmitter to antenna
3. Enable AC contactor for auxiliary transmitter
4. Turn on auxiliary transmitter
5. Transfer audio from main to auxiliary

Switching back will

1. Mute the auxiliary transmitter
2. Pulse antenna switch to switch the main transmitter to antenna
3. De-energize the AC contactor for the auxiliary transmitter
4. Turn on the main transmitter
5. Transfer audio from auxiliary transmitter to main

NB: Output connections to the counter skip "0" (because that's the quiescent state) and "1" (we just wanted a pause before running the routine). We also skipped a position before initiating the "reset". We did that in case we needed an additional step in the sequence. It's fine to use the step immediately after the last needed step in the sequence.

The clock is a 555 which everyone's worked with. It feeds an AND gate along with a flip/flop. Setting the flip/flop takes Q high, letting the AND gate pass the clock pulses to the upcounter. The outputs of the upcounter each feed buffers which drive the bases of switching transistors. The result is relays that are turned on in sequence, one at a time and they are on for the full period of their count. At the end of the sequence, the count after the last desired action reaches around and resets the flip/flop and the upcounter. The only quirk is the addition of a monostable multivibrator to generate the reset pulse. The IC's are so fast that the reset coming from the upcounter turns itself off so quickly that the reset to the flip/flop isn't reliable. Using the monostable as a pulse stretcher provides reliable reset pulses. To interface the TTL monostable with the CMOS upcounter output, the CMOS output is fed through a section of the 4050 buffers.

It can be built as a unidirectional switch manager – main to auxiliary only – or bidirectional, allowing the ability to switch back, too.

- Looks complicated but isn't. If you only want to switch from a main transmitter to auxiliary, use the single circuit

- The circuit is REALLY simple until it's idiot-proofed. That includes the 2 additional segments of the 4081 which cross-protect the two circuits so that someone can't energize the "aux-to-main" (4081C) while the unit is cycling from "main-to-aux"
- The switches S1 (transfer from main to aux) and S2 (transfer from aux to main) don't need to be debounced. To prevent accidental triggering, you can use a key switch/switches. For one client, we included a time delay instead (see LM339 schematic below main layout) This requires the operator to hold down a switch for a preset amount of time – we set it for 3 seconds – to initiate transfer. Simply adjust the pot for the voltage at which the comparator changes state.
- Yes, CMOS and TTL mixed…have to make sure V+ is well regulated and protected +5V. We used a standard 7805 with heat sink. Include the standard reverse bypass diode (from output back to input) to protect the regulator should the input voltage fall below the output voltage. The actual DC can come from an 8-12VAC transformer secondary into a full wave bridge filtered with 500 uf or so (rate the cap at 50 volts). Switch out the 74121 with a CMOS version and you'll be able to be more flexible in the power supply
- Unit was built from parts on hand. An RS flip/flop would work. Other counters upcounters (1 of 8 or 1 of 10) will work.
- V++ is shown for the relays. Just about any type of dc relay can be used provided the current demand doesn't exceed the parameters of the switching transistor. A 2N2222 will be OK with a max of 50 volts and 500 mA. We advise against using the same supply for relays as the circuit unless the +5 is really stiffened and protected against transients. We chose a separate supply including the transformer just so we could eliminate that concern.
- If you need to trigger some really big relays, use a transistor with higher ratings or an intermediate relay, or a solid state relay driven by the transistor. That'll be determined by the switch requirements and the AC contactor requirements (if you're isolating the auxiliary from the AC line)
- For the 2N2222, a base resistor, Rb of 500 ohms will work unless you need a truckload of current for the relay, in which case, you probably want a higher dissipation transistor than this work horse. You can reduce the base resistor safely to about 100 ohms if you need to (based on the transistor only being on for the length of one count) but 500 ohm resistor will turn on most 2N2222's
- Don't forget the reverse-biased diodes across the relay coil or the back EMF will eat the 2N2222
- Bypass at least every other IC V+ to ground with .01 ceramic as close to device as possible. We did every device
- Rp pulldown resistors for the CMOS devices can be 2k to 3k
- If you use CMOS devices, tie ALL unused inputs to ground or V+ depending on the device e.g., if you're using a 4 input and gate instead of the 4081, the 2 unused inputs need to go to V+ so the device will work. Same way, if you only build half the switch, you'll have unused inputs on the 4081. Tie them *all* to V+
- The 555 clock is set simply with an R/C combination. For about 1.1 seconds, use 100K and 10uf @ 25v. A 250k pot and a 25uf capacitor will give you a nice adjustable clock but leave it vulnerable to dirty contacts changing the timing. We chose a little over a second in case the antenna transfer switch was a little slow. It also makes sure the RF has totally died down from the main transmitter.
- The 74121 is used as a pulse stretcher for the output of whatever "count number" you want to use for resetting the circuit. The speed of the devices is such that if the output of the "count number" is used, the reset cycles that count number back off so quickly that the flip/flop doesn't see it. Select the R/C combination so that the pulse is a decent width – 50K and 1uf works fine
- If you want to add onboard monitoring like an LED, be wary – a CMOS output at 5 volts doesn't like it. Monitor the clock if you like but avoid the rest. If you REALLY want to, you can watch the

"Q" of both flip/flops through buffers to LED's and, of course, the output of the switching transistors to see the parade of relay pulses. If you use the "delay start", you will have two sections of LM339 left over. Each of these can be used to monitor the output of a device – just use the same voltage divider scheme to set one input to a section to midpoint (2.5v) and let the other input swing above and below it. The section will drive an LED through 560 ohms. Note, though that the LED's turning on can cause transients so bypass at the device and the LED. For our two units, we monitored the power supply, clock and the NotQ of the two flip/flops (through the 339). Two additional LED's were fed through the antenna microswitches to confirm position

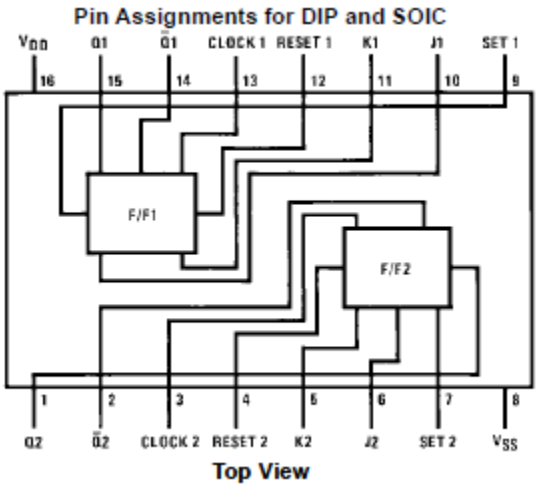
- When laying the unit out, give thought to the voltages you'll need. For example, if your antenna switch needs 120VAC, do that outside the switch box
- For the AC input, route the AC line through a ferrite core and on the inside, add 3 MOV's, line to ground, neutral to ground and line to neutral
- The sequencing will prevent any action from occurring out of the desired order. However, do not neglect the antenna switch interlocks. They should serve as backup protection against a "hot switch". If you still have concerns, check below for more thoughts on protection
- If you need more than 5 steps – maybe adding filament on and off – use the additional outputs of the 4017 in order needed. You will need an additional 4050, tying any unused inputs to V+ and, of course, more switching transistors.
- The prototype used 3 circuit boards – one for the clock, counter, multivibrator and buffer, one for the switching transistors and relays and a third for the power supplies

If you're breadboarding, build the clock first then the flip/flop. Make sure taking "Set" positive flops the "Q" output to high. Take "Reset" high manually to reset. Then wire in the AND gate (don't forget to tie the unused inputs to V+) and connect to the upcounter except for the reset. You can watch the upcounter work with a meter on any of the outputs. Connect the reset pins of the flip/flop and upcounter together. Manually taking that junction high will reset everything for another try. Then connect the 4050 and 74121 and its output pulse back to the resets of the flip/flop and upcounter. Make sure the other inputs on the 4050 go somewhere. If they're open, they can wander all over, causing the device to draw a LOT of current. Watch one of the upcounter outputs. Taking S1 high should take you through a cycle and stop. If there's a problem, check the output of the 74121 with a scope for a healthy reset pulse. If all is well, connect the desired outputs of the upcounter to the 4050. Check again for a cycle, this time at the outputs of the 4050. From there, insert the base resistors, transistors, back-EMF diodes and relays including connection to V++. Check again.

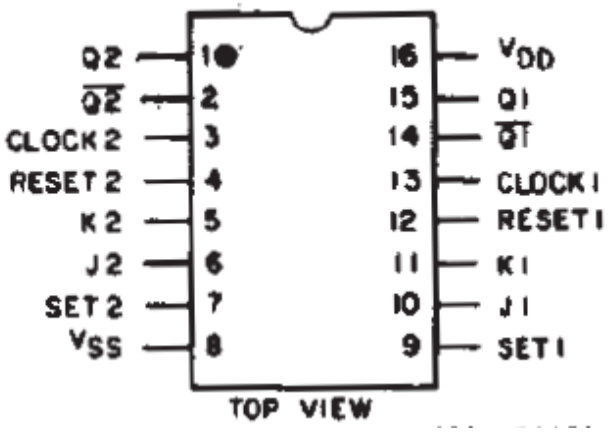
- If you're building the bidirectional version, build the second side and make sure it's working the same way. Then wire the cross-protection by using the two sections of the 4081, removing whatever jumpers to HI you've installed earlier

More thoughts on protection: If there's concern about a hot switch (like, somehow, a jock will manage it), here are a couple of thoughts. Apply them based on your particular installation:

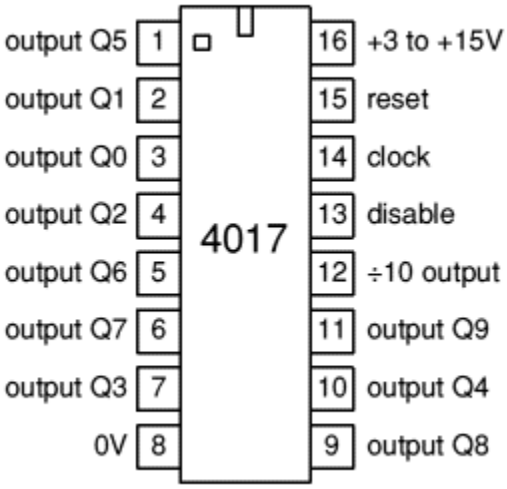
- Use an external pair of relay contacts to ground the base of the 2N2222 that fires the antenna transfer switch unless the appropriate transmitter is truly off. Relay can be operated from the filament supply, an indicator supply ("plate on" or "transmitter on" lamp or LED), Have it ground the base of the transistor that turns on the auxiliary, too.
- Really paranoid? Sample a little of the RF with a coil, rectify it to a negative voltage and use it to reverse bias the base of the appropriate switching transistor(s), (see drawing below)



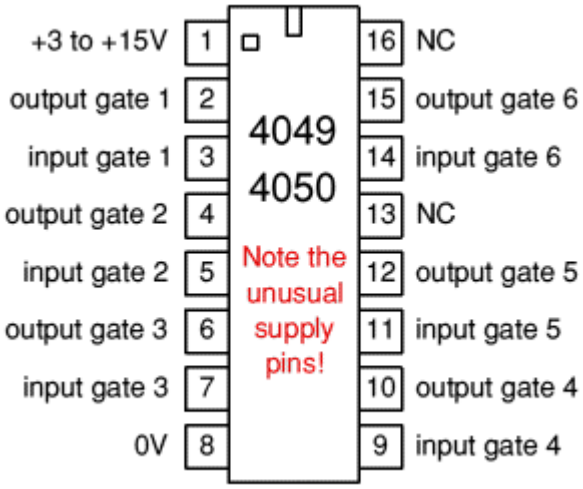
4027 Dual Flip/Flop



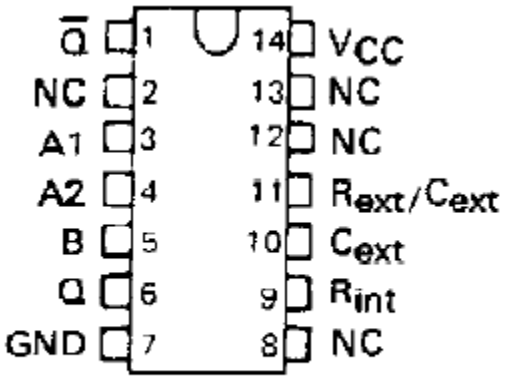
4027 Dual Flip/Flop



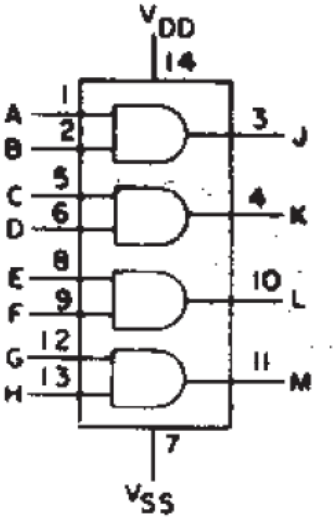
4017 Upcounter



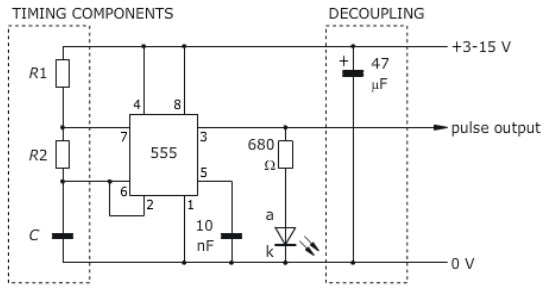
4050 Hex Buffer



74121 Monostable Multivibrator



4081 Quad AND gate

	
555 connections	