SOME NOTES ON INTERFACING WITH AVR-3's

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1. TURNING ON LAMPS

Cold lamps have low resistance. Instant turn-on to full voltage is thermally shocking to the lamp and inductively offensive to other wires near the one driving the lamp. Fig. 1 shows how to reduce this effect. Select R_1 to produce a dull red glow that's dark enough to interpret as "OFF". This will depend on the ambient light and the color and density of the cap. A warm lamp is a happy lamp.

R_2 does two things. It reduces the turn-on surge and lowers the lamp voltage a little (10-20%) which extends life. Select R_2 for "bright enough".

Half watt resistors which are dissipating a half watt tend to unduly pollute the atmosphere. Measure the voltage across R_1 with the lamp off and across R_2 with the lamp on. Do the E^2/R thing to find power and select a power rating four or five times that for carbon resistors and two or three times for wire-wound.

The lamp drivers used on the AVR-3 are integrated circuits designed for that purpose. We rate their output at 100 ma, while the manufacturer says 300 ma. This is to allow for turn-on surges. Even so, it has been known for a cold lamp to offer such a load that the driver's output transistor does not saturate. It is then an amplifier with an antenna attached. By Murphy's Law anything that can oscillate will. Some of them should file for license. The resistive belt-andsuspenders design is comforting. Besides, if the lamp shorts, the resistor may burn out before the lamp driver does.

2. <u>TURNING RELAY ON AND (ESPECIALLY) OFF</u>

The same circuit which turns on a lamp can energize a relay coil. There is no inrush surge, but when the driver turns <u>off</u>, the magnetic field in the coil collapses in a time determined by L/R where L is the inductance of the coil and R is a freshly open collector, which is large; so time is short. Quick collapse and many turns make high voltages. The output transistor resents this and is likely to revert to one of its two ultimately stable states: welded shut or burned open. Besides, high voltage spikes on wires are capacitively repugnant.

Fig. 2 shows the most popular solution. The diode offers a path for the stored energy in the relay coil. Its reverse voltage and current rating must equal or exceed the relay's ratings. The relay now takes longer to drop out because the R in L/R is now mostly the D.C. resistance of the coil. Figure about 2L/R for drop-out delay. If this added delay makes you nervous, you shouldn't be using a relay anyway.

The drivers used in the AVR-3 are rated at 25 volts. With a 24 volt relay supply, the driver voltage is limited to 24.6 volts by the diode when the driver turns off.

There is a popular R-C circuit (from REFERENCE DATA FOR RADIO ENGINEERS) which will create a critically damped resonant circuit with the relay coil. Don't use it with 24 volt relay voltages and 25 volt drivers.

If you must use a relay, consider:

A. For signal circuits and other very low current applications, specify dry-circuit contacts. If you once use dry-circuit contacts for switching a substantial current, i.e., 10 ma, they aren't dry-circuit contacts any more.

B. A detailed description of relay contact closure is somewhat obscene.

C. Capacitors across relay contacts can, indeed, reduce inductive sparking, but consider the poor contacts when they close and suddenly must empty the capacitor. Keep the cap. close to the contacts. Every inch is that much more antenna.

3. SWITCHES

Switch contacts, like relay contacts, should switch either tiny or substantial currents; and like relay contacts there is a frenzy of osculation as they mate. In functions in which the first contact (only) matters, there is no problem. (Play, stop, record, etc.) In electronic push-on, push-off circuits or in any application in which the number of pushes matters, it is best to de-bounce. Fig. 3 shows one kind of de-bounce circuit. It requires a SPDT switch. It also needs a switch whose bounce is not so bad that the swinger flaps back and forth between the contacts. Fortunately, these are rare.

Another approach is shown in Fig. 4. It is useful when you want to use only one wire and a SPST switch. The mating of the contacts must be complete for at least one period of the clock before an output can appear. This method is applied to the major control inputs of the AVR-3. The clock period (recently reduced) is about 1.8 ms.'

4. SENDING SOMETHING SOMWHERE

As anyone who has set up a display at NAB or wired a building can tell you, one man's ground is the other man's volt of 60 Hz. Optical isolation has become popular lately (Paul Revere revisited). We use it for communication between the EDM-1 to its VTR's, because we don't know how crummy your power distribution might get. See Fig. 5.

If you have knowledge that your ground potential difference is less than a volt or two, you can use the circuit of Fig. 6.

The signals to pay particular attention to are those whose edges make something happen...clock signals, strobes, etc. A major problem is piping video around, traditionally on coax. Differences in ground potential tend to have low source impedences, which, with the low resistance of the coax shield, can produce some large currents. I have seen (at the Sheraton Park in Washington, D.C.) a volt supered over 2 volts of 60 Hz, coming from a display across the aisle. This effect is in the category of things that shouldn't happen, but do. You have a choice...design so as to accommodate the worst case, or attack and subdue the worst case. The latter is commendable, but too often futile. All it takes is one AC power cord plugged in the wrong way.

5. Every engineer should design at least one black box. It is good for the soul. If it is a box of logic, you will want

to extract some logic signals from the AVR-3. Many remote control lines and status outputs appear on the AVR-3's remote connector.

A. Outputs you can use

1. Straight TTL logic outputs. No interfacing needed to drive your TTL or CMOS, as long as your circuit runs on $\pm$5 volts. If the signals are numbers, a high is a binary 1 and a low is a 0.

2. (Fairly rare) A saturated collector to -12 volts. It is possible to drive a 24 volt lamp (returned to +12) with this output and also derive a logic signal from it. Fig. 7 shows a circuit to use. It is designed to cross the decision threshold at about -7 volts. This circuit could be simpler if there wasn't a lamp present. Design for the lamp now. If you don't, Murphy will install one later.

3. A Saturated collector to ground, designed to drive lamps. Fig. 8 is a way to extract logic signals from it, even if a lamp is attached. If the various wires to your box are bundled together, (they usually are) they will talk to each other. especially when driving lamps. Fig. 9 can be used. Note R1. Large (> .01 uF) capacitors directly across TTL outputs are hard on the transistors and don't do as much good as when combined with a resistor. The slow-down provided by the R-C keeps out the sparks. The positive feedback path via R3

makes sure the input to A2 doesn't linger around the decision level.

Also remember that the AVR-3's driving circuit may well appear as a ground when its power is turned off, and logically may appear to be stopped, playing, cueing, etc. all at once. One way around this is to have your logic monitor the AVR-3's +12 volts. (see Fig. 10)

B. INPUTS

Data inputs are typical TTL. Not to worry. Control inputs are also TTL, but HEAR THIS! The inputs to which a button is likely to be attached are internally pulled up in the AVR-3 by a 220 resistor to +5. This is to make the switch suck up 25 ma or so to keep its contacts clean. If you drive one of these inputs with a logic output you must be sure it has the heft to sink 25 ma. An ordinary gate will usually do it, but no guarantees. A buffer will do it, a lamp driver will do it, and two regular TTL gates (or inverters) with inputs and outputs in parallel will do it.

When parallelling two (or more) TTL devices, use ones which live in the same package. Their turn-on and turn-off delays will more likely match. Otherwise, there can be a few nano-seconds of high-current argument between the outputs. The low-going one usually wins.

CONCLUSION:

As an engineer, you are a certified clever person. You will get the most out of your AVR-3 (or whatever) by using <u>your</u> ingenuity and <u>your</u> intimacy with <u>your</u> operation and <u>your</u> people to optimize <u>your</u> particular man-to-machine interface. Don't be afraid to try. Don't be embarrassed if it doesn't work the first time. (If it does, you were too cautious and took too long, or were just plain lucky.)

Cooperation among engineers is the rule, not the exception. We, like you, want to see our designs put to best use. Maybe we can help. Ask.

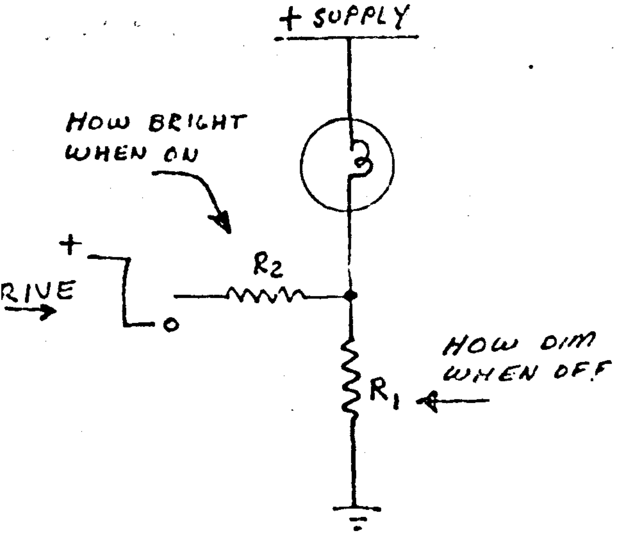
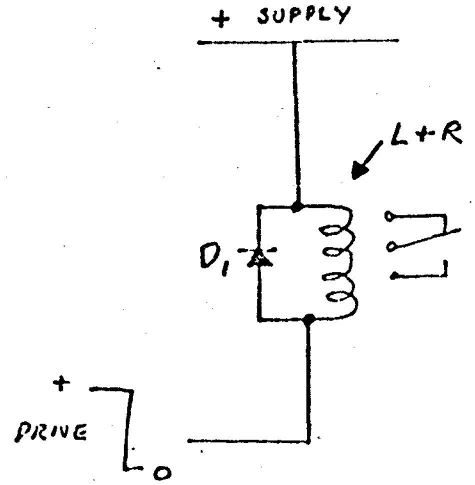


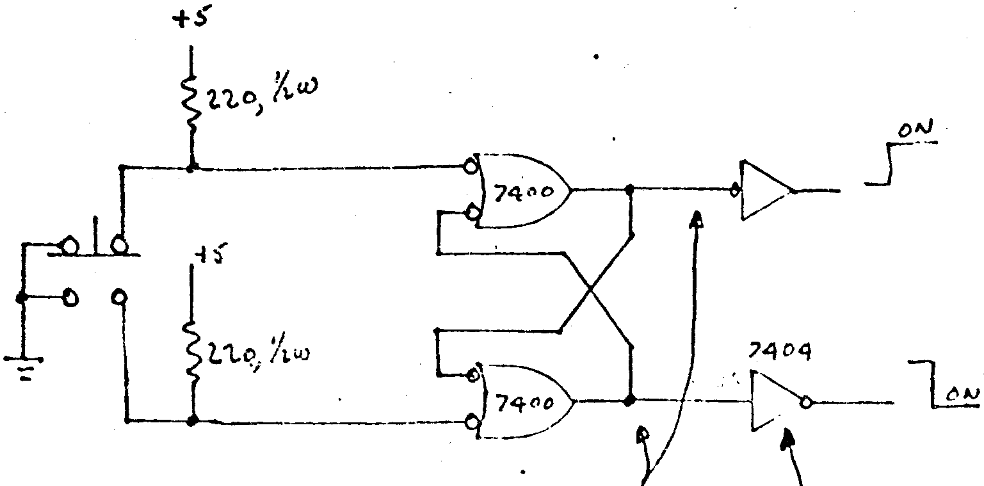
Fig. 1



FOR DIODE - REVERSE VOLTAGE > SUPPLY

CURRENT > $\frac{SUPPLY}{R}$

Fig 2.

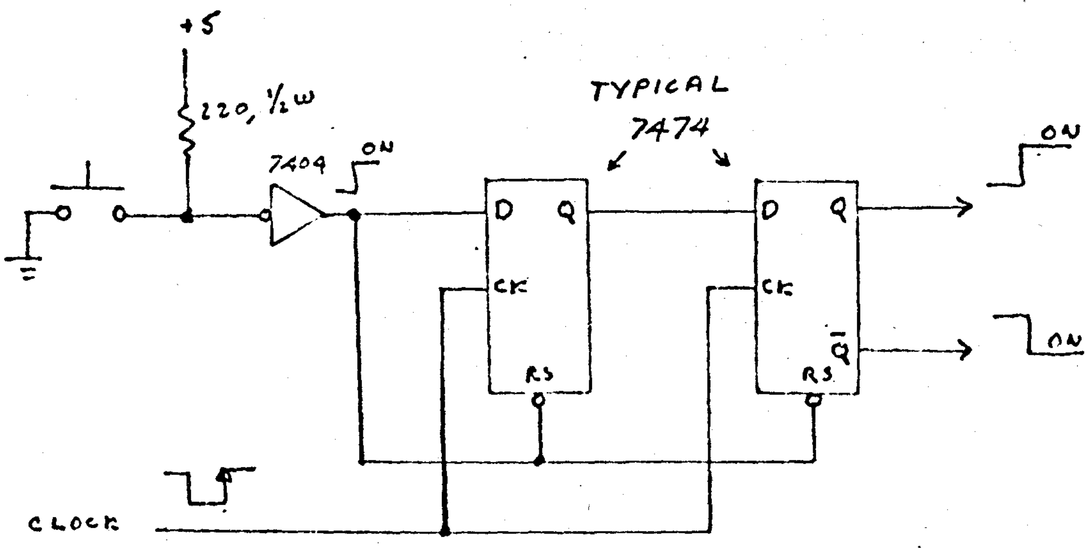


THE 220 Ω PULL-UP RESISTORS KEEP THE SWITCH CONTACTS CLEAN. IT ALSO MEANS THAT SNITS MUST BE MORE POWERFUL TO CAUSE TROUBLE.

IF THIS SIGNAL IS TO LEAVE THE VICINITY, BEST TO BUFFER.

A FLIP-FLOP WITH AN ANTENNA IS A NERVOUS FLIP-FLOP

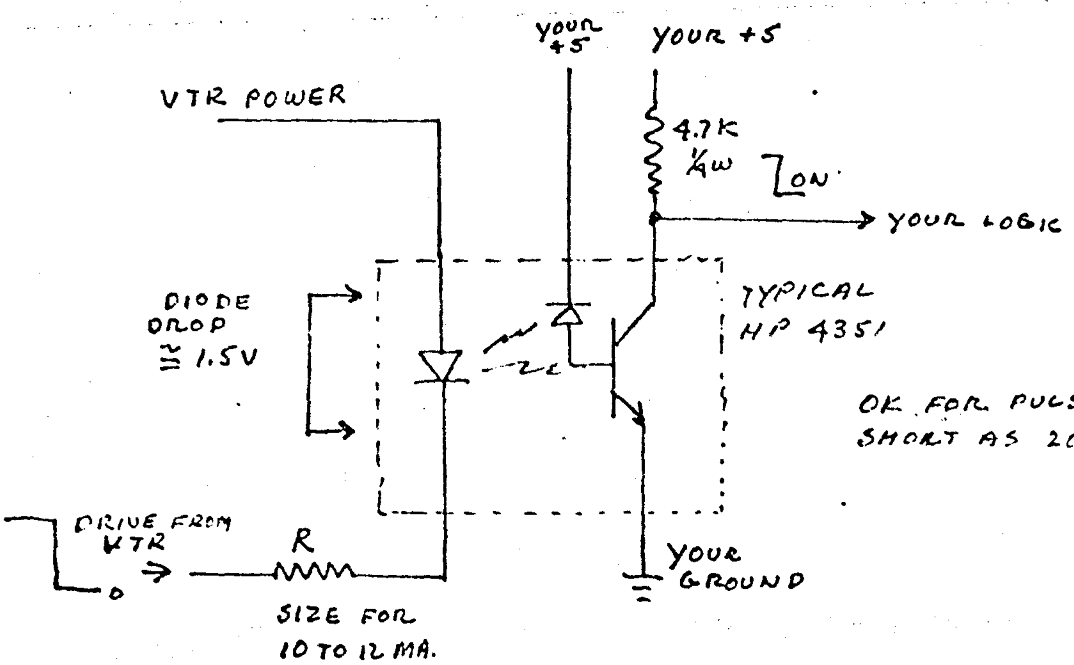
Fig 3.



MAX. DELAY = 2 CLOCK CYCLES
MIN. " = 1 " CYCLE

CLOCK FREQ ≪ 600 Hz THE NASTIER THE SWITCH IS, THE SLOWER THE CLOCK SHOULD BE.

FIG. 4



OK FOR PULSES AS SHORT AS 20μSEC OR SO

OPTICAL ISOLATORS ARE GREAT TO USE BETWEEN MOBILE TRUCKS, WHICH ARE NOTORIOUS FOR HAVING GROUNDING PROBLEMS.

FIG. 5

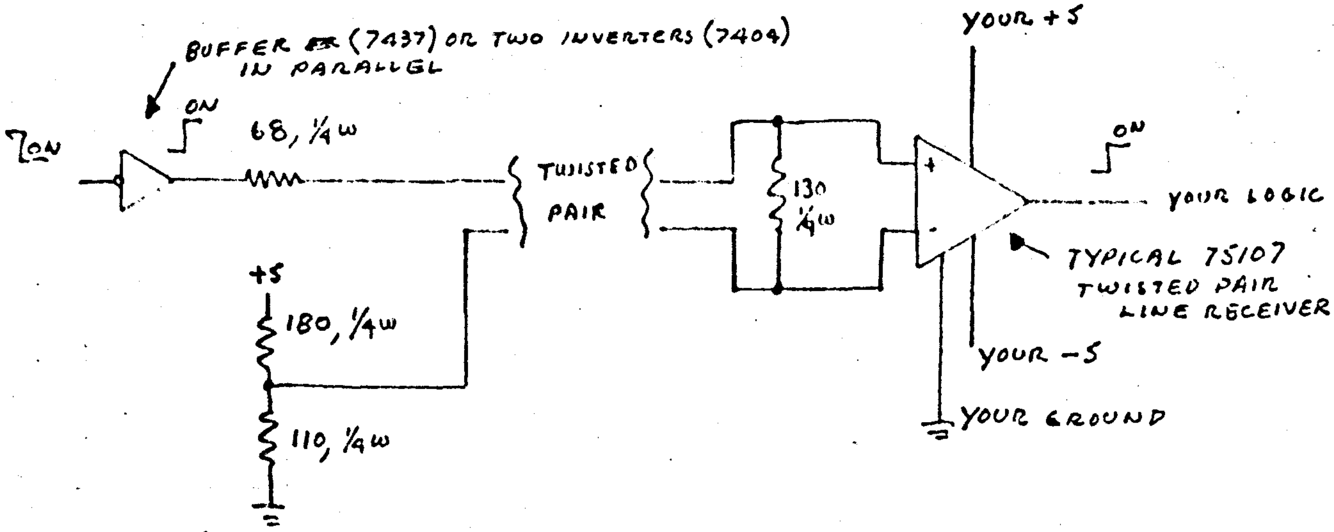
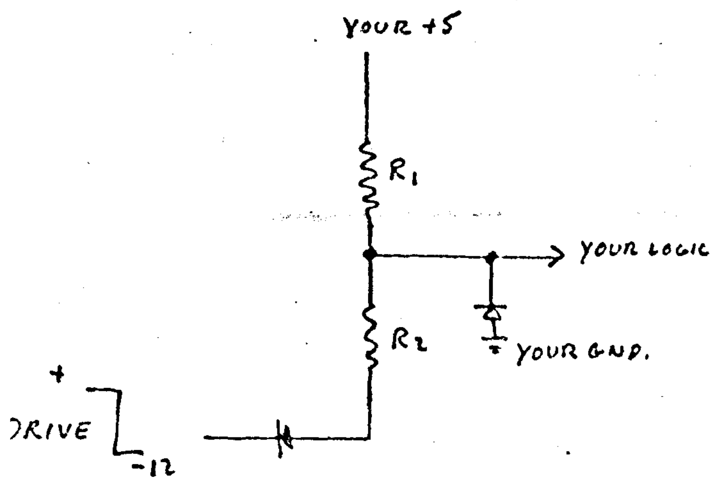


Fig. 6



DIODES ARE SILICON, RESIS = 1/4 W

FOR REGULAR TTL, R1 = 330, R2 = 620

FOR LS TTL, R1 = 1500, R2 = 2700

WILL DRIVE TWO LOGIC INPUTS

Fig. 7

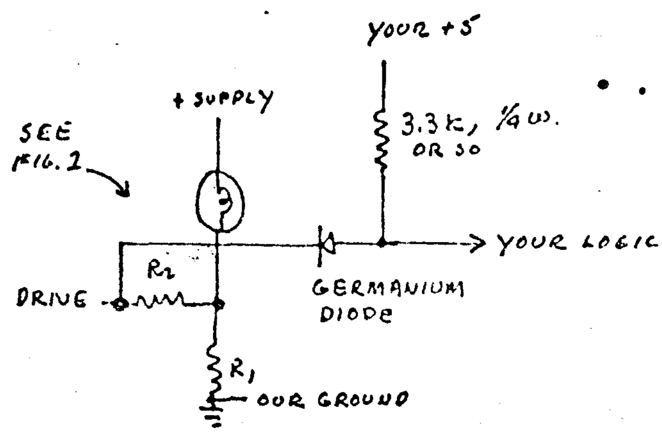


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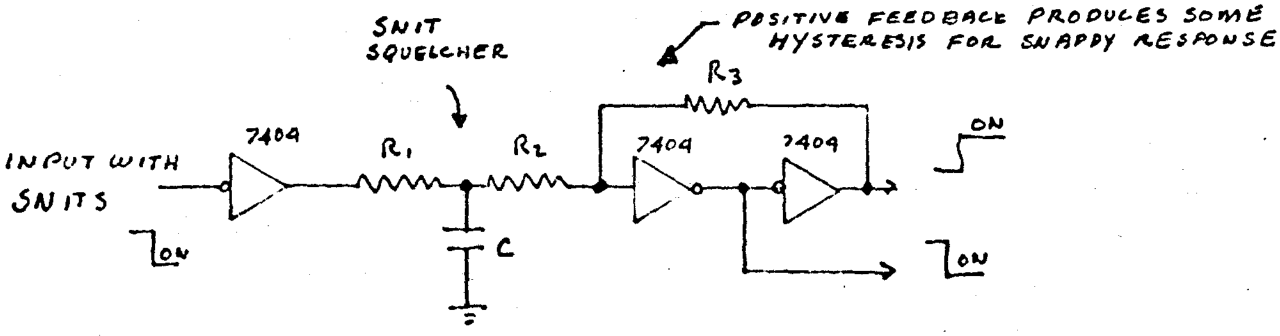
Fig. 8



	R_1	R_2	R_3	
REG. TTL	270	100	3300	ALL 1/4 W.
LS TTL	1200	430	15K	

MEASURE DURATION OF BIGGEST INPUT SNIT WITH A SCOPE. MAKE $R_1 \times C$ = 10 SNITS

$$C = \frac{10\ \text{SNITS}}{R_1}$$

Fig. 9

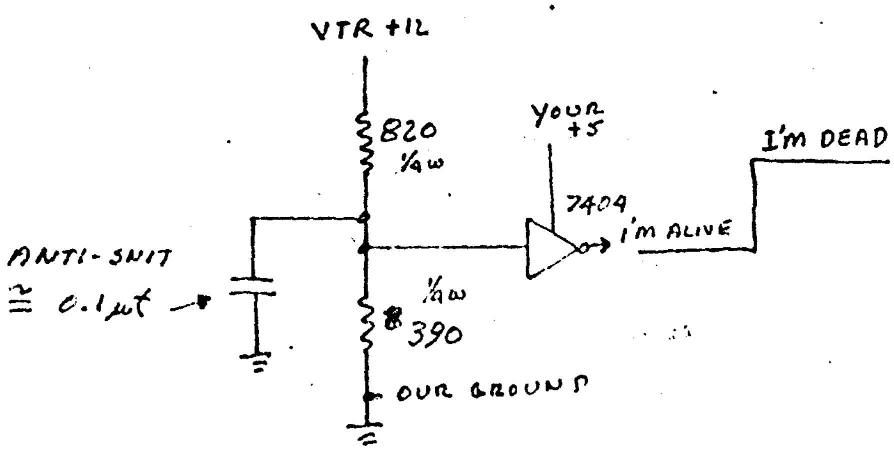
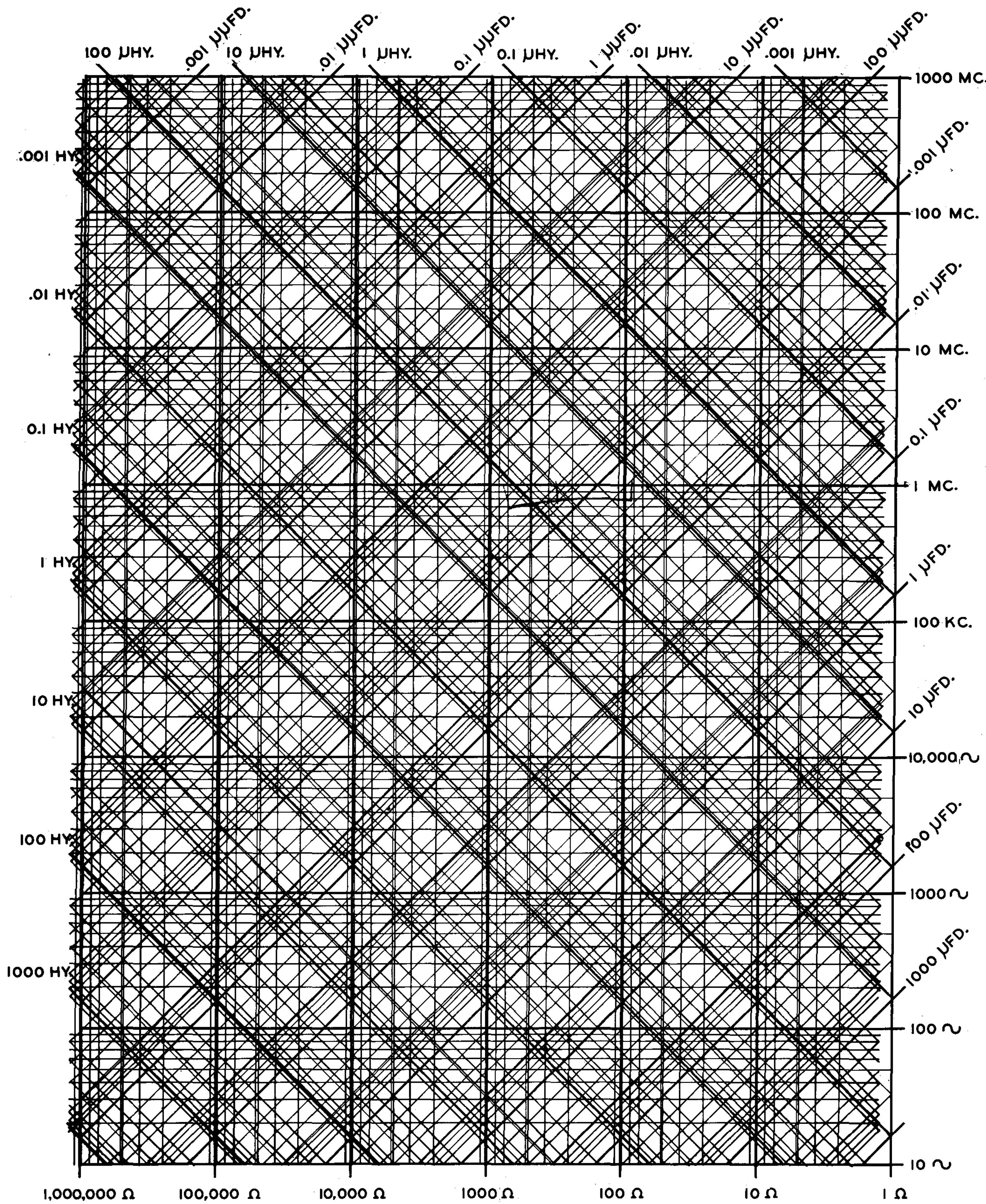


Fig. 10

Reactance Chart



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