power lines. Resistor R2 discharges capacitor C2. Charging C2 sets the dual-D flip-flop; the ×10 input is high and the DP1-display is low. As soon as connector S goes low, output from the 3.57-MHz oscillator resets the flip-flop.

The clear plastic front holds momentary contact switch S1. Cut the front piece from ½-inch clear acrylic plastic, which you then glue to the front of the completed black plastic back section of the unit. Sand both pieces with 100-grit sandpaper in a disc sander until you obtain the final shape (see Fig. 6-b). The drawings do not show dimensions since the size depends on the components used. Sand the probe tip with finer-grit paper, stopping at 400 grit.

Once the shape is roughed out, remove the clear plastic section with a razor blade. Drill a 1/16-inch hole through the center to hold the wire probe tip, which is made from 1/8-inch piano wire ground to a point. Wrap AGC No. 10 copper wire once around the back end and silver-solder it using a propane torch. Then, file the copper until the tip resembles a long flathead nail.

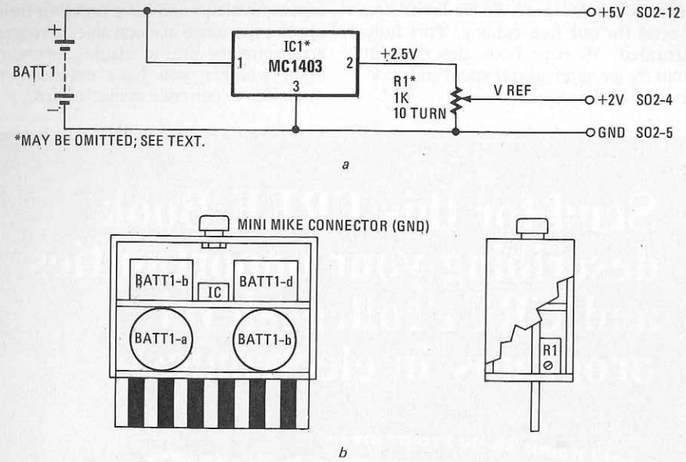


FIG. 5—POWER SUPPLY SCHEMATIC AND PARTS LAYOUT. The MC1403 voltage-regulator IC and the 1K pot are for a 2-volt source used as a reference for accessories not yet completed.

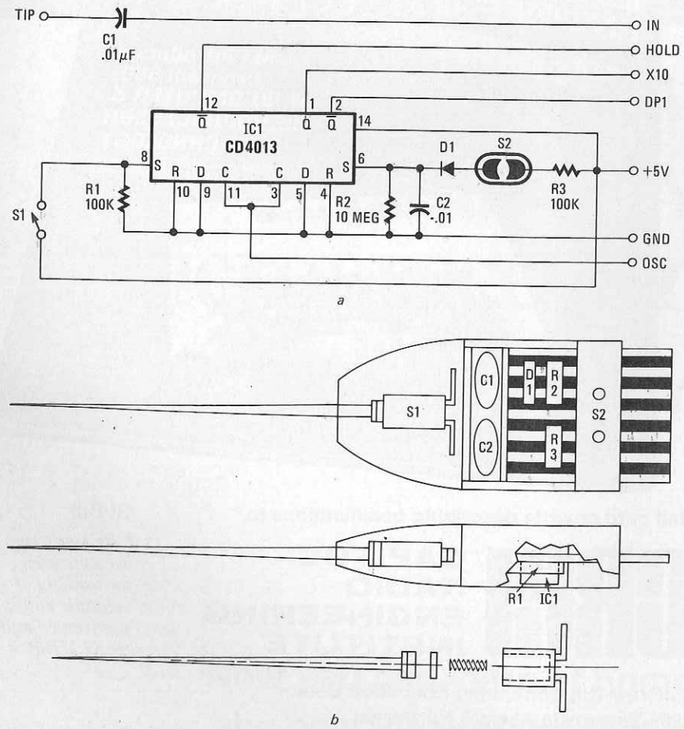


FIG. 6—CONSTRUCTION AND SCHEMATIC DIAGRAM of the probe front-end. The prescaler uses a CD4013 and is turned on by touch switch S2 consisting of two tiny nails.

The 1/8-inch hole in the clear acrylic plastic is drilled out from the back deep enough so that the SPST miniature pushbutton switch fits completely in the clear plastic section. Remove the pushbutton and metal section. Then, remove a white spacer on the red pushbutton to the end of the copper head on the probe tip. Room is hollowed out in the clear plastic to contain the switch lugs, which are bent at right angles to the switch body.

Solder two wires to the copper part of the probe tip. These wires must be flexible; we recommend phonograph pickup wires. Before assembling the switch, glue the clear plastic back on the probe front. Then, to restore the gloss on the plastic, polish the entire unit, using jewelers' rouge on a cloth buffing wheel. Be careful not to let the edges catch in the buffing wheel.

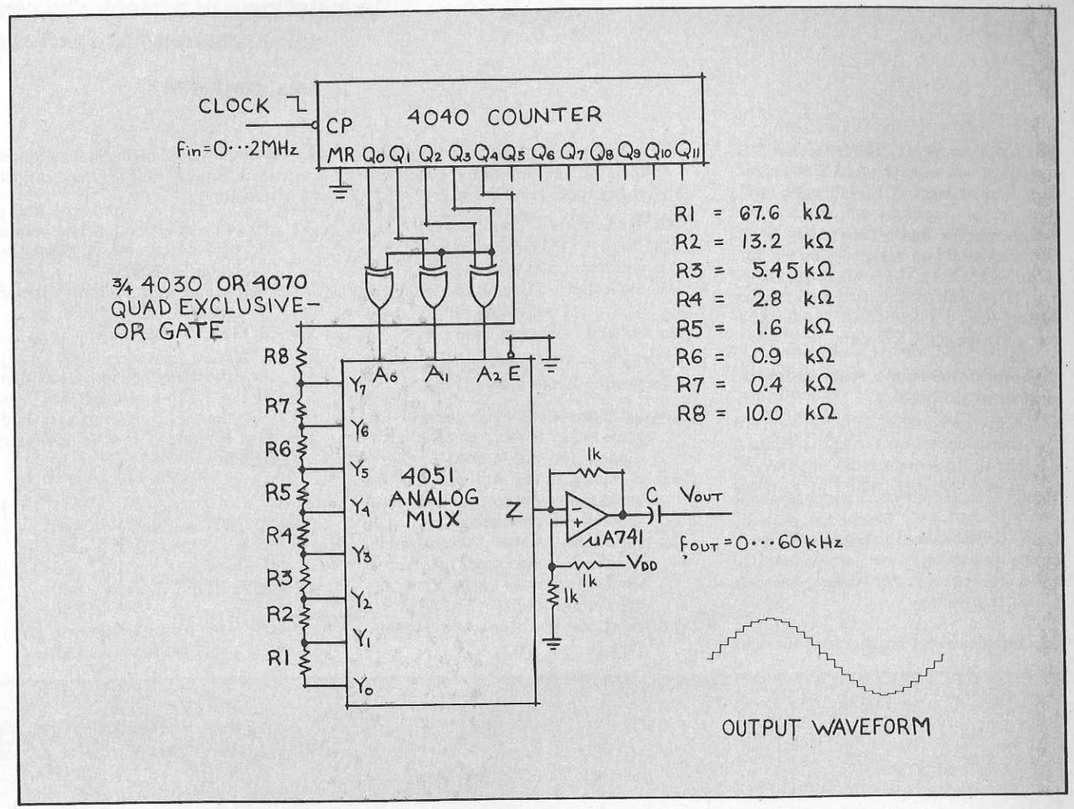
Calibration is the next step

After the probe tip is polished, you can assemble it. Unglue the clear plastic section again and file off the old glue from both sections. Push the probe tip through the 1/8-inch hole that was drilled in the clear plastic section. Insert first the spring and then the flat contact disc into the switch body. Place the switch assembly in the back of the clear plastic section and glue it in place. There should be sufficient room at the front of the switch body to allow the wires on the probe tip to move. Check the switch to make sure that it closes when the probe tip is pushed in. When the switch is finished, connect the wires to the switch, and the probe tip wires to the input capacitor. The clear plastic section is now glued to the front permanently. Any glue that appears on the surface can be removed with the buffing wheel. Be especially careful of the sharp point waiting to get you if it catches in the wheel!

When the tip is pushed in, the meter will convert until it is removed. The count will be held as long as the tip is not pushed in. When the prescalers are added you insert them between the probe tip and the meter body.

The usefulness of the basic frequency probe can be greatly expanded by accessories that plug into the main body. You can add a 5-volt calculator battery eliminator so that the meter can function off the AC power line. You can also construct a new front section so that you can use the probe as a normal bench meter. You can also add a 20-MHz to 125-MHz prescaler. Due to the construction of the main body, the number of accessories you can add is almost unlimited. **R-E**

CIRCUIT IDEAS



DIGITALLY CONTROLLED SINE WAVE GENERATOR

PETER ALFKE

Digitally derived sine waves are ideal in instruments that cover a wide frequency range, and in frequency shift keying, e.g., for data storage on audio cassette. Conventionally, these sine waves are created by filtering symmetrical square waves through low-pass filters. Such filters require several precision components (capacitors, resistors, or even inductors) and work properly only over a limited frequency range.

The approach used here eliminates the filtering and the frequency-sensitive components by generating a staircase approximation of a sine wave (of arbitrary frequency) through a specialized digital-to-analog converter.

The counter, with outputs Q_0 through Q_4, counts clock pulses at 32 times the rate of the sine wave frequency to be generated (a 1-kHz sine wave requires a 32-kHz clock rate).

The three least significant counter outputs are fed through three exclusive-OR gates into the address inputs of an 8-input analog multiplexer. The next counter output (Q_3) controls the exclusive-OR gates so that the address inputs to the multiplexer first count up (0...7), then count down (7...0), then count up again.

The inputs of the analog multiplexer are connected to a resistor chain, and the multiplexer output feeds into the inverting input of an operational amplifier. The non-inverting op amp input is connected to 50% of the supply voltage, e.g., 2.5 V in a 5 V system.

Address 0 connects the highest, and address 7 the lowest, resistor value to the op amp input. The other end of the resistor chain is tied to the most significant counter output, so that it alternates between sourcing current into the amplifier and sinking current from the amplifier. By proper choice of the eight resistor values, the amplifier output is a 32-step approximation of a sine wave with a dc component equal to half the CMOS supply voltage. **R-E**

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