An Audio Tone-Shift Power/SWR Meter

Adjusting a pi network or an antenna-matching system requires visually handicapped amateurs to have a "third hand." This modified SWR indicator is an answer to that need.

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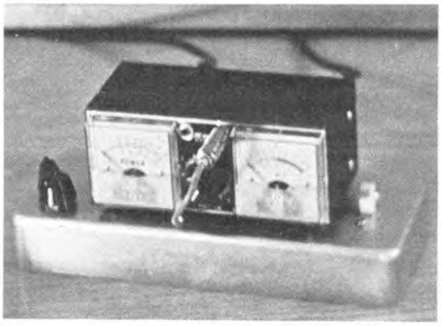
A local visually handicapped amateur, who recently upgraded his license, had a dire need for a dependable tuning aid to assist him in adjusting the pi-network output of his transmitter and the antenna matching system. Much of his operating on the lower frequency bands now involved numerous changes in wavelength. How to help became a matter of concern to me. As we discussed his specific needs, I recalled hearing about devices that produce various audio tones to guide visually handicapped amateurs in making technical adjustments to equipment. Rather than research literature on such accessories, I chose to design a tuning aid from scratch, partly as a means of saving time.

Acquisition of a Swan SWR-1-A power and SWR meter became the first step of the project. This instrument serves to provide the necessary sampling voltages for the power and SWR indications. Because the SWR-1-A is so constructed that there is virtually no unoccupied internal space, any modifications of this Swan unit must be installed outside the device. To house additional components and provide a suitable base for the audio tone-shift meter, a small drawn-aluminum chassis was secured to the bottom of the Swan indicator.

In calling this audio-tone indicator a modified meter, the term "meter" is applied with tongue in cheek. Several factors militate against calibrating the unit well enough to have it deserve the term. For instance, because the sensitivity of the transmission-line coupler is inherently proportional to frequency, it varies drastically from band to band. The forward-power measurement is inaccurate whenever there. is substantial reflected power. Furthermore, no method of measuring the output tone frequency is provided and neither the diode characteristics nor the voltage/tone frequency relationships of the 566 VCO are precisely linear.



This Swan rf bridge is equipped with an audio tone-shift system to aid a visually handicapped radio amateur tune a transmitter pi network and an antenna matching system.

Even though I've provided this set of disclaimers, and you've paused with raised eyebrows, let me hasten to say that indeed this is a most practical device for the visually handicapped amateur. It does permit such an operator to dip and load a transmitter with confidence, knowing that the pi-network output and the antenna matching system can be properly adjusted for optimum performance.

About the Circuit

Simplicity of the design is evident in Fig. 1 showing the VCO and audio stage. Fig. 2 illustrates the minor modifications for adapting the Swan indicator for this purpose.

Because of previously gathered notes on the use of the 566 voltage-controlled oscillator chip, I determined that this IC was well suited to my plan. Although the specifications for the 566 call for a 12-V supply, by playing with a half dozen of them I found that each one provided reliable operation with as little as 7 volts. The 9-V battery indicated in the parts list is a satisfactory compromise.

The audio driver transistor, Q1, was not part of the original arrangement. It was added after attempts to operate the loudspeaker from the square-wave output terminal of the 566 resulted in overloading the IC. The 2N2222 resolved the overloading problem while supplying adequate audio output for the loudspeaker.

You will note in the diagram that R4, the emitter resistor, has a value of 470 ohms. This resistor limits the battery drain to about 18 mA. Where the audio output is more than adequate, R4 can be increased to 1000 ohms, a change that will also serve to reduce the drain to perhaps 12 mA.

Any displacement of the control terminal voltage at pin 5 of the 566 will cause the output frequency to vary as shown in the Table. A 2-V change will cause approximately a three-octave deviation in the output frequency.

For the values chosen and with no input signal, the output frequency of the tone-indicating meter should be close to 150 Hz. Application of a 2-V signal causes the tone to increase to 1200 Hz as pin 5 is driven negatively away from the positive supply voltage. The 566 will not oscillate with pin 5 tied to the positive supply directly, but with the insertion of D1 and the resulting voltage drop, it will produce the 150-Hz tone. Inasmuch as the SWR bridge output will be between zero and perhaps +4 volts at high power on an hf band, a portion of this voltage is applied

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Table
566 VCO Control Characteristic

Voltage A to B	*Output Frequency (Hz)*
0	157
0.5	433
1.0	717
1.5	971
2.0	1157

to the IC by setting the sensitivity control for the desired amount.

Operating Instructions

In use, the sensitivity control is advanced to show a substantial shift in the presence of rf. Without a signal, the audio-output frequency is approximately 150 Hz, and increases to about 1200 Hz with 2 volts of rectified rf applied to the control terminal of the 566 VCO. The plate tuning and loading controls are then adjusted to raise the pitch as much as possible. An intermediate amount of shift should be used initially so that an increase can be noted. With more than two volts of rectified rf, the audio output will stall out somewhat above 1200 Hz.

If the antenna is a reasonably well designed dipole or beam with a respectable match to the transmission line, this is all there is to operating the indicator, for there is nothing available to reduce the SWR anyway. A check of the reflected power will confirm that the SWR is reasonably low, evident by a much smaller frequency shift at the same sensitivity setting.

If the antenna requires a tuner, however, the audio-tone SWR/power indicator will really come into its own. In this case, the reflected power reading is adjusted for minimum pitch change in the presence of rf. Alternating two or three times between forward and reverse measurements may be necessary to get maximum contrast between the two. Once a low reflected power indication is obtained, the final adjustment would be to return to the rig and dip and load it for maximum forward power. This is with the presumption that the tuner was adjusted with less than full output while the tuner is being optimized, which is always a good idea.

The above procedure does not involve the visual meters at all. In fact the panel control of the Swan power/SWR meter is turned all the way down so that no indication is available. Accordingly, there is no danger of burning out the panel meters.

Construction Notes

The aluminum chassis I found for the base of the device measures 3 × 7 × 1-1/4 inches (76 × 178 × 32 mm). It is secured to the base of the Swan indicator by means of two sheet-metal screws. Most of the chassis area under the Swan bridge is cut out to provide an aperture for the loudspeaker. A quarter-inch space between the bridge and the chassis, made possible by the feet on the bridge, allows the sound to be projected unhindered. Because the loudspeaker has no mounting ears, I mounted it permanently with a generous application of two-part epoxy cement.

The snap-slide on/off switch is so mounted that one end serves as a mounting barrier for the 9-V transistor battery which fits snugly in place. At the opposite end is a linear 10-kΩ potentiometer, a couple of square inches of Vectorbord accommodating the 566 and a few discrete components. No point of the circuit should be allowed to touch the chassis, for the input leads from the miniature plug are at potentials differing from the 9-V battery.

Several variations suggest themselves. If matched antennas are available, only relative power need be indicated. A simple diode coupled by a capacitance divider would serve in place of the SWR bridge. Or, if used extensively with an antenna tuner, the unit could incorporate two 566 VCOs with outputs connected to a pair of split stereo headphones. Use with headphones would permit having a VCO unit small enough to be built in the case of an unused microammeter, thus packaging the entire unit in the SWR bridge housing. A 600-ohm dynamic microphone unit could be substituted for the speaker in a similar physical configuration. I have seen several inexpensive bridges at flea markets. These were bargain priced because the meter movements were broken. Having one would be an excellent starting point for such a project.

Know a visually handicapped amateur? He might just like to own one of these tone-indicating meters.

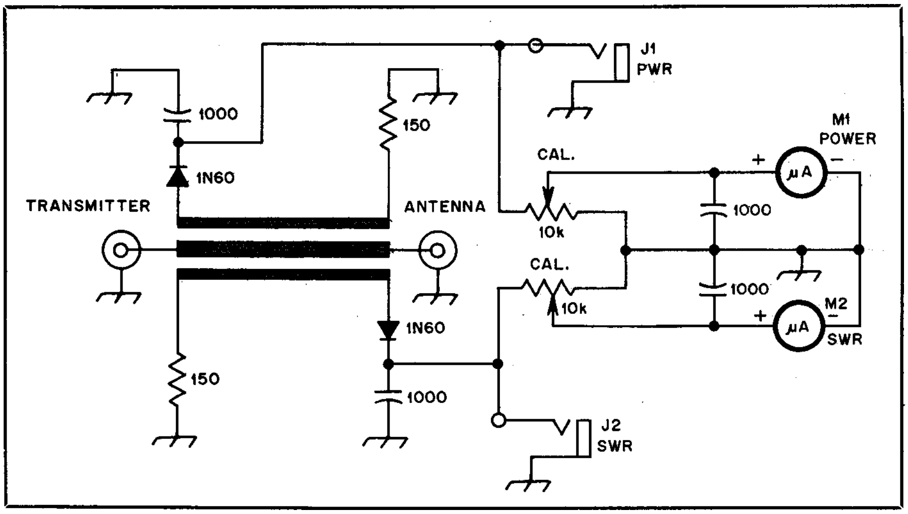

Fig. 1 — The Swan SWR-1-A circuit. The addition of J1 and J2 is the only internal change required to make the N9KV audio tone-shift modification. Capacitances are in pF. Resistances are in ohms.

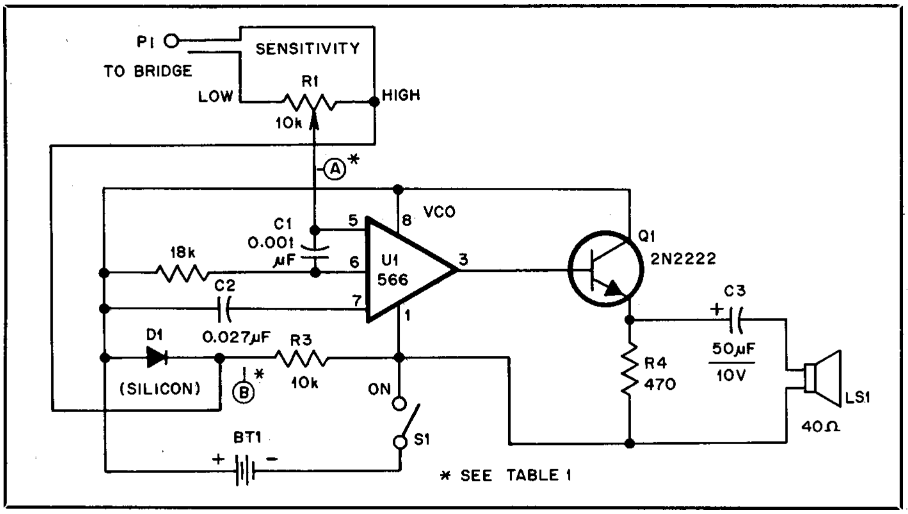

Fig. 2 — The audio tone-shift circuit designed by N9KV for use with the Swan SWR-1-A bridge. A type 566 voltage-controlled oscillator IC serves as the tone generator. The miniature loudspeaker is driven by Q1. Fixed resistors are 1/4 watt with values shown in ohms. R1 is a linear-taper potentiometer. BT1 is a 9-V transistor-radio battery.