The case for Use of a Variac[1] with Some Hickok Testers

For many years, my customers have been offered the option of calibration of some models of Hickok testers for use with or without a Variac. In order to achieve a significant reduction in power dissipation in the tester case and greater repeatability of test results, a tester must be calibrated for such use, and a Variac must be used in the prescribed manner. It is also necessary to replace the type 83 rectifier with a solid state rectifier module (PKH SS83) that closely matches the behavior of the 83, consumes considerably less power and plugs directly into the tester's 83 socket. Operation with a Variac and use of the module reduce the power dissipation in the tester case by approximately 20 watts. The tester may still be used in its originally intended mode without the Variac with increased heat dissipation and reduced accuracy.

A proprietary module, designated the PKH SS83, has been developed to eliminate the adverse effects of aging 83 rectifier tubes, and to reduce the power needed to supply its filament. The 83 was introduced in 1933 as a low loss rectifier tube intended for use in lower power transmitters; it contains mercury as did many transmitting rectifiers of the day. Hickok utilized the type 83 in its testers because of its relatively low and constant voltage drop. Hickok testers do not draw the same current through each side of the rectifier – with age the two sections can become unbalanced and the rectifier can also develop other problems that degrade the long term performance of testers using it. In normal use, this degradation may be gradual and difficult to detect until it becomes severe or catastrophic.

The PKH SS83 module was developed to very closely match the behavior of the 83 tube, with the advantages that the solid state diodes used do not degrade with use and the power consumed by the module is reduced from 15 watts consumed by the tube to just over 4 watts. The SS83 is installed in a recovered 4 pin tube base that is plugged into the tester's existing 83 tube socket. It consists of 8 components in two rectifier elements sealed in epoxy and 2 bridging resistors. The module is only installed in testers when they are repaired and calibrated and are not to be confused with other simpler and less effective diodes. The module can be removed and an 83 substituted for troubleshooting, but if the tester's calibration is to be maintained, the PKH SS83 must remain installed. The module itself can be tested as a type 83 tube on any tube tester.

Almost all models of Hickok testers use power transformers designed for primary supply voltages well below the normal line voltage. For the TV-7 and TV-10, the designed primary voltage is 93V; for the 539 series, it is 100V. These circuits use a wire wound pot (connected as a simple rheostat) that connects a variable resistance in series between the AC line and the

[1] Variac is a registered trade name of the General Radio Company which applies to an adjustable autotransformer. The term "Variac" has become generic in the industry. Similar units which are manufactured by other companies with other trade names (Superior Electric Powerstat, etc.) are equally effective. An autotransformer rated at not less than 2 amps should be used; 5 amp autotransformers are common and are a good choice.

transformer primary. This pot is adjusted so the meter on the tester is at "line test" when the transformer primary is at its design voltage. A TV-7 or TV-10 with no function selected commonly draws about 0.3A from the line; under the heaviest test condition, it can draw around 1A. If the line voltage is 120V, with no tube installed, a TV-7 will require about 27/0.3=90Ω in series with the line for 93V on the primary. Even in this condition, the pot is dissipating 27x27/90=8.1 watts. As the line voltage varies, the amount of series resistance required will vary when the line test setting is made. That power dissipation results in considerable heat in the closed cabinet, contributing to temperature rise. The cabinet and panel can get noticeably hot in the vicinity of the pot after the tester has been in use for extended periods.

In the normal test sequence, the line test setting is first made with the tube being tested in the socket; for a 6L6 commonly adding about 0.06A to the primary current draw. That will slightly reduce the amount of required resistance, but the current being handled increases; dissipation in the pot changes only slightly.

When a tube is tested by pressing the test button, additional current is drawn to conduct the test. In normal operation, the line test pot cannot be readjusted to maintain the designed primary voltage – the only meter on the tester is transferred to the gm test bridge to obtain the quality reading. The reduction in primary voltage also reduces the output of the 83 and 5Y3 rectifier tubes and the filament voltage of the tube being tested.

Tubes of the same type being tested will normally exhibit various degrees of merit. A new tube can be expected to draw more current than one with a long service life. Because of the pot's series resistance in the line, the better tube's additional current draw will reduce the voltage on the transformer more than will a tube with lesser emission. The effect is to compress the difference in readings between different examples of tubes of the same type. Better tubes test less than they should and poorer tubes test better than they should.

Appropriate use of a Variac can significantly reduce these effects. The basic procedure is to turn the line test pot all the way up – which becomes a short, no input resistance – and use a lower than line voltage setting on the Variac to adjust the line test reading on the meter. When that is done, the transformer's primary voltage is not changed by testing any tube; variations in test results as a result of a series resistance in the line are eliminated. No transformer is perfect, so some voltage drop on the output terminals is still to be expected, but the effect of the series line resistance is eliminated. The only need to make adjustments on the Variac is to compensate for line voltage variations.

Some more elaborate of Hickok's testers used separate line set meters, which allow resetting the line test during the time a tube is being tested. Operation with the Variac with these testers will not change the test results, but will eliminate fussing with the bias and line set readings as a tube is tested. The beneficial effects on lowering the temperature rise in the tester box are also

realized. Testers with separate meters for the line test function don't need to be calibrated differently depending on whether they are used with or without a Variac, but they also require installation of the PKH SS83 module.

There are some downsides to operating a tester this way. If the tester is turned on with the line test pot all the way up, even with the Variac left as set when the tester was shut down, there is little resistance in the primary circuit. If the 60 Hz line voltage happens to be at its peak at the instant the tester is turned on, a current surge can occur that could blow the fuse lamp. Also, if a rectifier tube is being tested, and the operator mistakenly presses the gm button (we have all done that), a large current will flow which can blow the fuse lamp. To assist in minimizing these effects, a small value power resistor is installed in series with the line and a #87 fuse lamp is installed instead of the normal #81. These changes assist in minimizing these effects, but have no effect on the test readings. Mistakes will still be made – always turn the line test pot down before turning off a tester being used with a Variac. Once the tester power is turned back on, the pot can be advanced to its full up position and left full up for the duration of testing.

The effects of the series primary resistance on test results for small signal tubes when operating the tester in its stock mode are quite small. Tubes that draw larger amounts of power from a 6V6 and up will exhibit the most benefit from using the Variac mode. The more current the tube being tested draws, the more benefit is realized from operation in the Variac mode.

Operation with the Variac and the PKH SS83 will result in significantly reduced internal temperatures no matter what types of tubes are tested. If a tester is inadvertently left on overnight, or in the event of a long testing session, the case can get very hot which can hasten failure of many components in the tester. Not the least of these is the power transformer, which is also not generating as much internal heat due to the decreased load on the filament winding of the 83.

Caution is required; if a tester is turned on with the plug inserted in an AC outlet and the line set pot all the way up, the fuse bulb will fail in a bright flash and the tester may be damaged. A complete set of operating instructions and cautions is provided with any tester calibrated for use with a Variac.

None of these measures change the basic characteristics of these testers. The military testers were intended to make quick readings to determine if tubes are fit for further use. They utilize relatively basic circuitry to accomplish that need with relative ease of operation and maintenance. In the current environment, these testers have come to be expected to provide levels of accuracy and validity that they cannot provide and for which they were never intended. These testers are not laboratory instruments by any stretch of the imagination.

Calibration and operation of these testers as described using procedures that go beyond the methods provided to the military when they were produced provide the best options for utilization of these instruments. As designed and intended, they provided excellent utility for testing tubes in all sorts of environments; these new conditions provide greater accuracy and uniformity of results. Testers built for the military are mechanically rugged; they have proven their durability. They can be most effectively used and preserved today when these enhanced conditions of preparation and operation are implemented and their limitations are well understood.

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