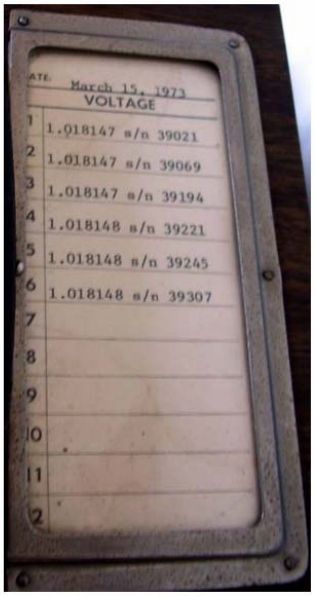
Guildline 9152-T6 - Primary Voltage Standard



The Weston cell was first devised in 1893 and accepted as primary voltage standard since 1911. Still today it is in semi-clandestine use to check solid state voltage references. Due to environmental restrictions for its major components, mercury and cadmium, its use is very limited and secret today. Unfortunately, even the documentation and the same datasheets have been removed from the Web, probably fearing mercury contamination of the keyboards!

This instrument, made by Canadian Guildline, includes six Weston cells in a thermostated enclosure with a thermomenter on the front side. Temperature is mantained at 30º C nominal and can be adjusted within ±0.02ºC around this value. It was intended as primary voltage reference in a metrology laboratory. In origin Guildline was the Canadian distributor of the British Tinsley.

Some notes on the Weston cell

Weston reference cells are very high precision batteries, built until today with the same care and the same chemical elements and compounds as in 1892, when the first cell was built by Edward Weston: platinum, mercury, mercury sulfate solution, cadmium sulfate saturated solution, 12,5% cadmium and mercury amalgam, platinum. The Weston cell was derived from the Latimer-Clark one, which was in use since 1893 as an absolute reference cell, giving an output voltage of 1,4328 V at 15° C. The Weston standard cell give an output voltage of 1,01830 V at 20° C, granting a very, very low temperature coefficient.

People today, if asked for a precision voltage reference, can imagine a complex measuring system, with a lot of microcontrollers and of computers, all exchanging gigabyte of data to do nothing else that generating a simple voltage. People of yesterday, having no computers but their brains, had to rely upon simple, yet dependable, solutions. For almost a century, since the Berlin Conference in 1905, when the Weston cell was accepted as the absolute voltage standard, up to the nineties it was the voltage primary standard, against which comparing all other voltage sources. Either putting it inside a simple temperature controlled oven, or computing the voltage deviation at any given temperature, its output voltage was the true voltage reference. And in the past even the measure of any voltage source against this reference was very, very simple and accurate, based upon balancing a voltage derived through a potentiometer from the unknown, against the cell itself. To measure any voltage with unsurpassed precision you just needed the Weston cell, any suitable potentiometric voltage divider and a sensitive galvanometer, to read the balance condition, or the zero current condition. Such measuring technique, based upon the current nulling, was simple, yet independent of the cell internal resistance.

At any temperature, other than 20°C, the output voltage of the Weston standard cell could be computed according to the formula:

$$V(t) = 1{,}01830 - 0{,}0000406*(t - 20) - 0{,}00000095*(t - 20)^2 + 0{,}00000001*(t - 20)^3$$

where t is the actual room temperature.