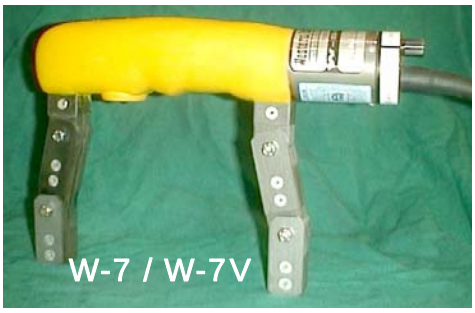
Western Instruments
Established 1965

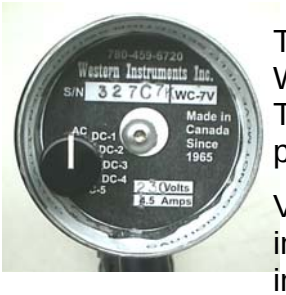
May, 2008

AC/DC Yokes

When the first handheld Yoke was introduced in the 1940's, the output was AC. It was not until the advent of Semiconductors that an AC/DC Yoke was introduced. There are not great technological difficulties with producing the DC circuitry, but more environmental challenges. We have a portable power tool, used in very rugged environments, and we must condition the alternating input voltage (115 or 230 VAC) to provide a DC current to the units coil. This also involves lowering the voltage, so that the lifting power of the Yoke is limited to 50 pounds, thus limiting the heat produced by the internal coil, but producing heat from the circuitry.



When Western Instruments first started to produce Yokes, we introduced the W-7, which was a large frame Yoke. We offered 2 models of this unit; The W-7 with a selection of AC or DC, and the W-7V which offered AC and 5 preset intensities of DC. Our design was innovative for several reasons, but manifested itself as the smallest and lightest AC/DC Yoke on the market. The W-7 was difficult to distinguish from its AC counterpart, the W-6.



The picture to the right shows the controls of a W-7 and the WC-7, with the field selection switch. To the left are the variable models with the AC position, and 5 preset levels of DC.

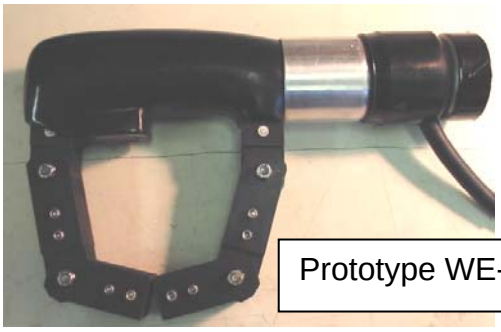
Very soon after introducing the W-7's, Western introduced the more compact WC-Series, which included the WC-7 (AC or DC) and the WC-7V. The WC-7 Yokes went through several different design changes during its 6 year production run, all of which were attempts to remove the heat generated by the DC Circuitry and to eliminate operators inadvertently changing the field from AC to DC while the Yoke was activated. This was not a simple task due to the confined space for the controls, enclosed in the rear Junction Tube. Furthermore, protection was required for both the Detented Toggle Switch on the WC-7, as well as the Rotary Switch on the WC-7V.

Virtually all failures with AC/DC Yokes can be traced to the Field Selection switch being changed, from one position to another, while the Yoke is activated. As an example, if the DC Field is Activated, and suddenly the circuitry is switch to AC, the inrush of AC must attempt to overcome the DC intensity, which is akin to hitting a brick wall. Furthermore, these inadvertent switching's are very hard on

the semiconductors in the control circuitry. AC/DC Yokes, with variable DC have 3 times the switches than an AC Yoke, which can be directly correlated to the chances of failure. The finger activation switch on Yokes are typically environmentally protected, while *Field Selection* and *DC Intensity* are more problematic to protect.

Our latest model of AC/DC Yoke is based on the WE-Series Platform that uses the more standard Licon Series 11 Micro Switch (see write-up on *Yoke Switches*). Here again, the WE-7 went through several design changes before it was released. The first configuration resembled the WC-7 units, but with an extension to the rear Junction Tube (below right). The final configuration used a housing, similar to the WC-9's Battery Pack (below left), which afforded a tremendous amount of room to fit the Controls and Electronics but a much larger heat sink.

WE-7

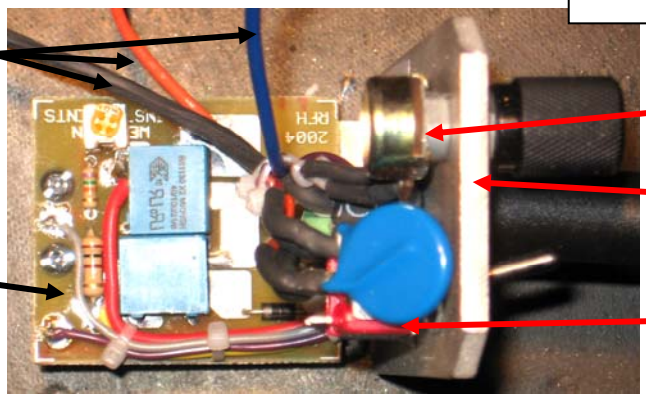


Prototype WE-7

Export voltages vary from lows of 208 to highs over 240V, and while Western Instruments develops its equipment using 50Hz power, variations in voltage often necessitated adjustment of the DC output power from the electronic controls. While adjustments were relatively straight forward, the greatest difficulty was disassembling either the W-7 or the WC-7 without damaging the wiring or the *Field Selection* or *DC Intensity* Switches, while having to deal with the Power Cord/Strain Relief Assembly. All of these components required carful handling as they were all interconnected within the Junction Tube of the Yoke.

WE-7 Controls

Wire Identification;
- Blue - Sensing
- Orange - Common
- Black - Live



DC Intensity Pot

Control Panel

Control Printed Circuit Board

Field Selection Switch

The WE-7 is equipped with tremendous heat dissipation system, where the Printed Circuit Board (PCB) is mounted to a heavy aluminum heat sink, which in turn is mounted to the aluminum Control Panel. Therefore the entire control assembly is exposed to the ambient air and not housed within the Yoke Body. This keeps the controls at a lower temperature

even during prolonged periods of maximum DC operation, which produces the most heat, to both the Yoke Coil/Frame as well as the circuitry.

Secondly, we equipped all WE-Series platforms with an extra electrical connection within the Junction Tube (see *WE Trouble Shooting*), so the controls detect when the field within the coil has fully collapsed. Therefore, when the Field Selection switch is moved, the actual switching is delayed until the electrical current in the coil is zero. This sensing eliminates an opposite field from "hitting a brick wall" within the coil. During laboratory testing, the field intensity switch was rapidly moved back and forth between AC and DC, without failure. It wasn't until the unit was to hot to hold, without a leather glove, that circuitry would fail when switched between AC and DC.

The new WE-7 is only offered with the variable DC, and the 5 preset intensities were replaced with a more traditional potentiometer. These controls are not as linear as the 5 preset DC intensity levels used on the original W-7V or the WC-7V, but are similar to those offered by our competition. Production costs of the WE-7 are every bit as expensive as its predecessor, and typically result in more operator issues. We make no attempt to be competitive in price to other AC/DC Yokes, as end users must pay more for a unit that is 50% lighter, has triple the duty cycle, and is far more comfortable to hold for prolonged periods.

Our market research shows that companies with less experience with the Yoke method purchase AC/DC Yokes, as they think they are basically getting '2 for1'. Company's located in markets where the Yoke method is well accepted know that an AC/DC Yoke is a problem waiting to happen. These well experienced operators predominantly purchase AC Yokes. In the limited number of instances where a DC field is required, one of three alternatives are used; connect a standard AC Yoke (WE-3) to a 6 or 12 Volt Battery, use a DC Yoke with a Voltage Chopper (WC-8), and most often use a Permanent Magnet Yoke (WM-Series).

Distributors should take the advice of experience and promote the use of AC Yokes, and discourage the use of AC/DC Yokes. There are only 2 places where a DC field should be used; areas where metal flow or smear occurs such as on Threads and Bearing surfaces or where fatigue cracks are an issue due to high frequency moments. In conclusion, Magnetic Particle Inspection, with an AC field, is the fastest and most cost affective NDT method available to industry.

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