

# View hysteresis curves

**Fernando Garcia explains how you can display a transformer's hysteresis curve on your digital scope.**

**A** hysteresis curve is a useful graphical display of a transformer's magnetic characteristics. It allows you to view several parameters at a glance, and to determine the presence of manufacturing defects like air gaps, missing laminations, relative quality of the magnetic steel properties, etc.

Unfortunately the equipment needed for displaying a hysteresis curve is expensive. As a result, such equipment is usually only found in specialised laboratories.

If don't need to view a calibrated hysteresis curve though, but rather a relative curve shape, the very simple circuit described here will suffice. You will need a dual channel oscilloscope, but apart from that, only a handful of passive components<sup>1</sup>.

The relative shape is helpful in comparing unknown units against a known good unit. This is particularly useful, for instance, when evaluating the steel lamination from different vendors.

Fortunately, with the newer digital oscilloscopes that incorporate mathematical functions, even that simple circuit is no longer required. The curve may be fully obtained by processing the waveforms with the scope's internal functions.

The basis for the operation lies in the relationships,

$$B = K_1 \times \int E dt$$

where,  $K_1$  is a lumped constant for the frequency, number of turns and core area, and  $E$  is the applied

primary voltage and,

$$H = K_2 \times I$$

where  $K_2$  is a constant for the turns, mean magnetic length and  $I$  is the magnetising current.

Both  $K_1$  and  $K_2$  are assumed constant if you are only comparing a known-good reference device against an identical device whose magnetic properties we are concerned about.

Lastly, the curve's characteristic shape is given by the change of permeability with the rate of change for the flux density and magnetising force. Thus,

$$\Delta\mu = \frac{\Delta B}{\Delta H}$$

**Fig. 1. If you have a digital oscilloscope, all you need to display a transformer's hysteresis is an isolated variable transformer and a few passive components.**

