ISCE

The Institute of Sound and Communications Engineers

Engineering Note 28.1

Finding the earth fault on an induction loop

J M Woodgate *FInstSCE*

Finding the earth fault on an induction loop

What is this about?

Almost all induction-loop amplifiers these days are 'current-drive', which means that they have an output source impedance of several ohms or tens of ohms, defined by a combination of voltage and current feedback. Current feedback means that a voltage proportional to the output current is fed back to an earlier stage in the amplifier, with polarity opposite to the signal at that point.

This voltage is normally obtained by including a very low-value current-sensing resistor (maybe 0.1 Ω) in series with the 'cold' output terminal - the 'black' one, that one you would expect to be connected to the 0 V line inside the amplifier. This results in an earth fault on the loop cable anywhere having an effect on the feedback. If the fault is very close to the 'black' amplifier terminal, so that it more or less short-circuits the current-sensing resistor, then you no longer have a current-drive amplifier but a conventional voltage-drive amplifier (with a very low output source impedance) and one with a lot more gain that you expect. Not a good situation. Even worse is an earth fault close to the 'red' output terminal, which, because it greatly reduces the load impedance, increases the feedback, maybe so much that the amplifier oscillates and may smoke, or at least forces it into a very low gain condition.

Of course, the Law of Cussedness dictates that the earth fault only appears after the loop is embedded in the building, so it is essential to find out where in the loop it is, to minimise cutting into the floor-covering or even the screed. Figure 1 shows the essential parts of the circuitry.

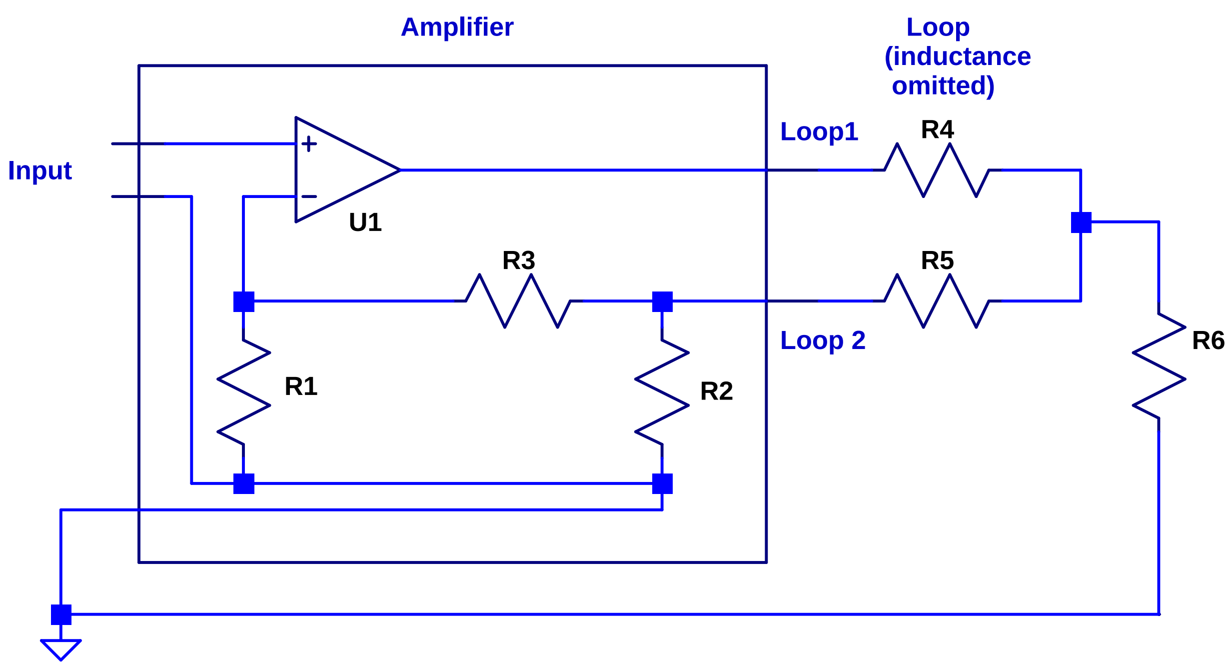

Figure 1 Amplifier and loop showing an earth fault at the junction of R4, R5 and R6

In Figure 1, U1 is the amplifier IC (such as a TDA2050) or discrete transistor equivalent. R2 is the current-sensing resistor in series with the loop. The voltage developed across it, proportional to the loop current, is applied to the potential divider formed by R3 and R1, so that the feedback voltage Vf is:

$$Vf = IL.R2 \times R1/(R1 + R3)$$

Assuming that U1 has a very high gain without feedback, the 'gain' (transconductance) Gt of the amplifier is IL/Vf, i.e.:

$$Gt = R2.R1/(R1+R3)$$

in amps per volt, or siemens.

The loop is represented by R4 and R5 in series, and R6 is the resistance between the earth fault point and the earthed end of R2, although measuring to the safety earth point on the amplifier may be close enough.

Finding the break

Measure the resistances of the loop wire, R4 and R5, and the earth fault path R6.

This needs to be done with DC or 50 Hz and ACCURATE);

Loop1 to Earth = R4 + R6 Call this RA

Loop2 to Earth = R5 + R6 Call this RB

Loop1 to Loop2 = R4 + R5 Call this RC

Then calculate:

R6 = ½(RA + RB - RC)

R4 = RA - R6

R5 = RB - R6

Loop length x R4/RC = Distance of fault from Loop1

Loop length x R5/RC = Distance of fault from Loop 2

The two distances must add up to (nearly) equal to the loop length, otherwise the measurements are not accurate enough. Get digging!