Introduction to RCD Testers

Residual circuit breaker testers manufactured by many companies are designed to test and measure the break time of AC mains (RCB) trips at set test currents. To do this they allow a fault current to pass between live phase and earth. The 'fault' current is started by pressing a button on the tester, usually an LCD counter on the tester measures the time in milliseconds until the mains supply is disconnected.

Calibrating RCD Testers

To calibrate an RCD tester, it is necessary to measure the fault current taken by the tester which will normally have several set currents selected by a switch (note : this is a load current taken by the tester - it can be considered as a resistor placed between live and earth and <u>is not</u> a current generated by the tester!). The time reading on the display can be calibrated by disconnecting the supply after a set time interval. Some RCB testers have additional functions such as which half cycle of the mains the fault current started etc. which should be tested as pass/fail tests.

Many of the newer testers, e.g. CM400/500 from Avo-Megger also automatically do a 'no trip' test, first at 1/4, then 1/2 of the fault current to test that a trip is not too sensitive.

Considerations for RCD Testers

There are many different designs of RCB testers which regulate the fault current and perform the measurement of disconnect time in different ways and to calibrate different testers the 2100 calibrator has different modes of operation.

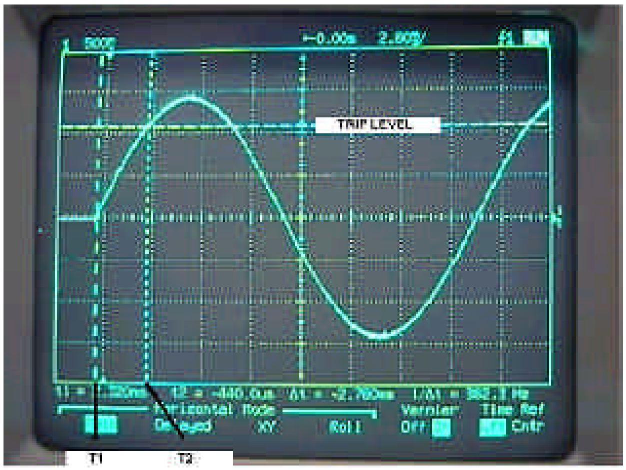
Timing tests are the most complex to understand as the problems and errors are quite different from measuring a DC pulse. The timing period measured by the tester is the time from the start of the fault current to the disconnection of supply. The errors in this measurement are not caused by the accuracy of the counters involved, which are usually crystal controlled and very accurate. Errors are due to the detection of start and stop times on an AC waveform about the zero crossing point.

Simply put, it is impossible for the tester to detect at the zero crossing point of the mains if the mains has been disconnected or not. The same problem exists for the 2100, which has to detect the start of the fault current. Most testers will start their timing at the next zero crossing point after the test button is pressed, but obviously the 2100 can not detect the fault current until a short time later.

2100 Timing Modes

To reduce this error the 2100 has two methods to detect the start of timing.

ZERO CROSSING MODE
Firstly and most used is the zero crossing mode where the 2100 waits until it detects the RCB current selected (this allows pre-test currents to be ignored by the 2100) and then takes its timing from the preceding zero crossing point of the mains.



The diagram above shows the start of the fault current from an RCB tester. The test button would have been pressed at a point in the previous cycle PRECEDING the point T1 - up until then there would either have been no current or with some testers a PRE-TEST current below the trip current level.

The RCB tester will begin its timing at T1 (the zero crossing point preceding the test current). The 2100 has to wait until the current rises to the trip level T2 before it knows this is the FULL trip test (not a pre-test). For accurate timing the 2100 must synchronise itself to the counter running within the RCB tester which started at T1. To do this the 2100 automatically corrects its internal counter using the time interval from the FULL trip point to the zero crossing point, i.e. T2-T1.

IMMEDIATE MODE
Alternatively, mainly for 15th edition IEE testers, the immediate mode starts timing when 5% of the set RCB current is detected - this method will not work with testers which perform pre tests. (See above).

The 2100 uses a fast analogue to digital converter to measure RCB current and the results are stored in memory and processed at the end of a test. Two methods are used to calculate the RCB current. For periods longer than 200ms the RCB current is calculated as true RMS, for periods shorter than 200ms the peak current is taken and divided by 1.414 to give an RMS equivalent value.

2100 Timing Accuracy

In practical terms, the accuracy of the 2100 is far greater than any RCB testers available. The published specification of the 2100 is limited by the method with which it can be realistically verified in a UKAS laboratory, however the theoretical accuracy of the 2100, at 30ppm ± 100us, is far higher.

Calibration Errors Due to Mains Voltage

The mains voltage at which an RCD tester is calibrated affects the current drawn by the tester. Most testers have little or no regulation at all against variation in mains voltage and generally speaking a 10% increase in mains voltage will result in an identical increase in current.

Some manufacturers include the voltage at calibration on the rating plate attached to the instrument, whereas others will include this in the specifications section of the handbook / manual.

Older testers designed for the UK market will have certainly been calibrated for 240VAC whilst units for Europe will be 220VAC. More recently, manufacturers use 230VAC for all testers.

This variation will result very often in an instrument being apparently out of specification if tested at the incorrect mains voltage.

As the relationship for most testers between mains voltage and current is linear, it is possible to use the formula below to correct for the error assuming that the manufacturers specifications for the voltage rating of the tester is known and the mains voltage at the time of calibration is known.

$$\text{CURRENT @ SPEC} = \text{DISPLAYED CURRENT} \times \frac{\text{RCD TESTER MAINS SPEC}}{\text{MEASURED MAINS VOLTAGE}}$$

This formula can be used in ProCal to automatically correct for the difference in mains voltage.

However, some testers do regulate their current to some extent and therefore applying the formula will cause errors.

An alternative approach to solve this problem is to power the 2100 from a variable voltage transformer and set the supply voltage to the correct mains voltage (as specified by the RCD tester manufacturer).

Automating Calibration With ProCal

ProCal can fully control all operations of the 2100 via an optically isolated RS232 connection. Using the built in procedure wizards, procedures can be rapidly created. For installation testers, a combination of tests can be added together to create a comprehensive procedure.