



IMD Tester Construction

INTRODUCTION

The requirements for the Insulation Monitoring Device are defined in the Formula-Hybrid rules in Section EV5.9. They state that *“The response value of the IMD needs to be set to no less than 500 ohm/volt, related to the maximum tractive system operation voltage.”*

The IMD test is described in EV7.1.2: *“The test is passed if the IMD shuts down the tractive system within 30 seconds at a fault resistance of 250 ohm/volt (50% below the response value).”*

The IMD test is performed by connecting a suitable value resistor between either the positive or negative *Tractive System Measuring Point (TSMP – EV4.4)* and ground.

As connections are made to potentially hazardous tractive system voltage levels, the test resistors should be constructed to provide adequate voltage isolation, and also sufficient power handling capability in case they are subject to full pack voltage. (This could happen if say TS(+) to ground is tested while there is an active TS(-) ground fault, and the IMD fails to trip).

CONNECTION LEADS

We highly recommend the use of Fluke brand banana plug multimeter test leads for connection leads. Model TL224 has straight plugs at one end and right angle plugs at the other. They cost about \$30.

The Fluke TL220 test lead set includes two insulated alligator clips and two point probes as well and costs about \$80.



Resistor Rating

The resistors used must have a total power rating sufficient to carry sustained full pack voltage. A test resistor value of 250 Ohms/Volt ($R = 250 \text{ V}$) means that the resistor power rating must be at least:

$$P = V^2 / R = V^2 / (250 \cdot V) = V/250 \text{ Watts}$$

Applying a 50% derate, ideally the power rating should be $P = V / 125 \text{ Watts}$.

Thus a resistor for a 100 – 125V system should be rated at 1 Watt.

A 75 kOhm resistor for a 300V system should be rated 2.4 Watts minimum.

The power rating applies to the sum of component power ratings if multiple resistors are used.

Finally, any resistors used should have sufficient voltage rating for the application. Small surface mount resistors in particular may be rated at 150V or less. Leaded wire-wound resistors are probably the best choice for this application – but it is still important to check their data sheet for voltage rating.

Fixed Resistor Boxes

If you know your tractive system voltage and don't want to test at other than the required sensitivity (250 ohms/volt), then a fixed resistor test box is adequate (Figure 1).



Figure 1 - Fixed Resistor Box

This is a 40 kOhm fixed-value box that uses four x 10 k Ω 5 Watt resistors in series (20 W total rating). Even though it is a suitable test value for 160 V, it might be used at 300V in the event, and so it is conservatively rated. (Rated power $P = 2V^2/R = 2 \cdot 300^2/40K = 4.5 \text{ W}$). In fact a single 40K Ω 5W resistor would have been adequate.

The resistors for this test box were assembled on some blank (no copper) FR4 insulating board with holes drilled for the leads. The assembly is enclosed in a Bud clear front box (Bud PN-1321-C. Mouser 563-PN1321C - \$11). Fluke leads were used with one end removed and leads soldered to the resistors. The leads were secured in the box with a strain relief (e.g. Heyco M4518 or similar, Mouser 836-M4518).

Adjustable Resistor Boxes

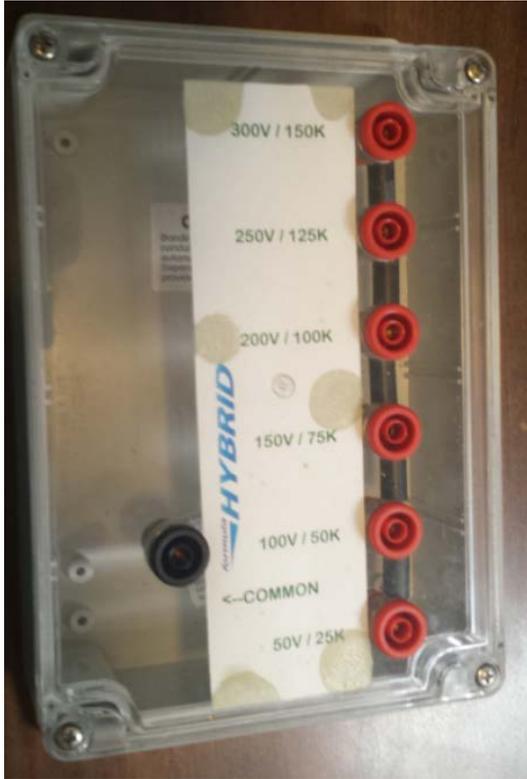


Figure 2 – Stepped Resistor Box

These are mounted in a BUD PN-1324-CMB box with a clear cover (Mouser 563-PN-1324-CMB, about \$18). The shielded banana sockets are made by Pomona (Mouser 565-72912-0 Black and 565-72912-2 Red). 5 Watt resistors were chosen as it is possible that an inadvertent connection could be made to a single resistor at full allowed voltage (300V). In this case, the dissipation would be $300^2 / 25K\Omega = 3.6$ Watts.

As Formula Hybrid has vehicles with system voltages ranging from 50 to 300V, different values are required for testing based on the 250 Ohms/Volt test requirement. To address this, we have built adjustable resistor boxes (Figure 2).

These boxes contain six x 25k Ω resistors in series with shielded banana sockets providing the means to tap at each junction (Figure 2). Note that the voltage values shown are the trip limit, not the test value (in fact, 75K Ω would be used to test a 300V battery IMD).

Construction is simple – six Ohmite WHE25KFET resistors (25 k Ω , 5W – Mouser 588-WHE25KFET)



Figure 3 - Construction



Figure 4 - Construction detail