# Uncertainties of immunity measurements

*DTI-NMSPU project R2.2b1*

*Annex E Description and results of measurement setup (radiated immunity)*

SCHAFFNER

EMC services

## *Radiated immunity dummy EUT tests: measurement setup*

This section describes the method used to investigate the induced signal on a small EUT exposed to a radiated RF field. The EUT described in Figure 1 consists of a small (50 x 50 x 100mm) diecast box with a 1m length of single core wire attached via a 4mm socket on one end and a length of RG58C/U 50 ohm coax via a BNC socket at the other end. The coax could be 1m or 2m length. The "input" wire could be switched to either a high impedance (470R directly into the 50 ohm coax) or low impedance (into a 3R3 to case, the voltage across this feeding via a 47R matching resistor into the 50 ohm coax). The resulting transfer function (output voltage measured with a spectrum analyser for a constant input from a tracking generator) is shown in Figure 2, and demonstrates the impact that stray reactances have even on this simple circuit. The actual shape, of course, is not so important, as long as it stays constant between tests.

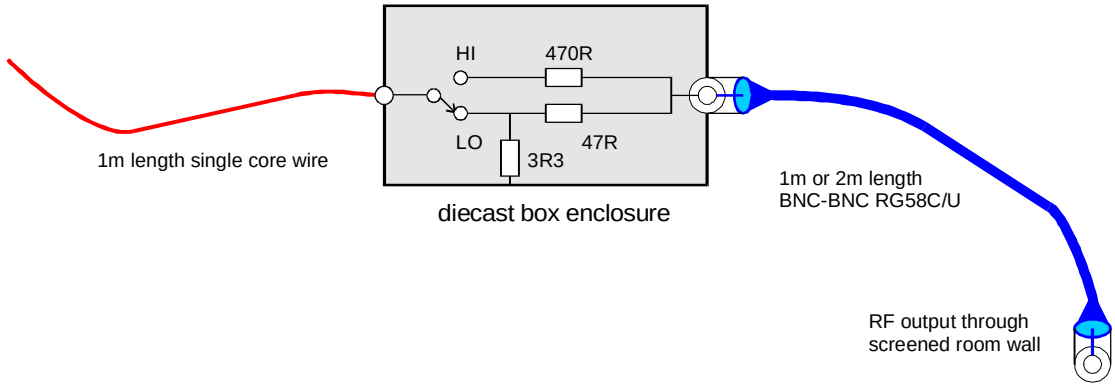



**Figure 1 Dummy EUT construction**

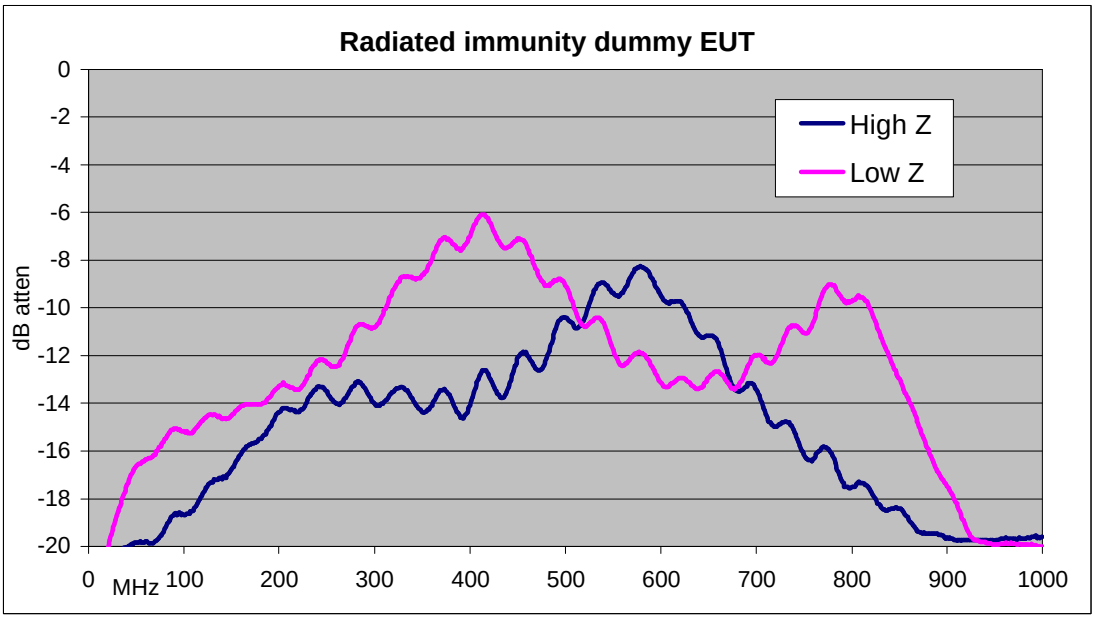



**Figure 2 Dummy EUT transfer versus frequency**

## Test procedure

The EUT was placed in the uniform field plane of Schaffner's radiated immunity test chamber in the configurations shown below. This chamber meets the field uniformity requirement of EN 61000-4-3:1996. The illuminating field level was 3V/m. The cables and EUT were oriented to face the transmitting antenna at a distance of 3m and both horizontal and vertical polarisations were tested. The EUT and cable assembly was not rotated to present other faces: only the front face was tested.

## Principle of operation

The applied RF field will induce a current in the single core wire and will also induce a current in common mode on the outside of the coax cable. These two currents meet across the EUT impedance, if the size of the EUT case can be neglected; although as the case becomes electrically large with increasing frequency, so the interaction of the cable currents becomes more complex. The voltage across the EUT impedance induced by these currents is then coupled through the coax cable and measured outside the chamber. Provided that the coax cable has a reasonable shielding effectiveness, the common mode current should not directly affect the measured value.

The measured voltage then represents the induced stress at the input of the EUT and since the EUT construction and impedance is invariant, any changes in the induced stress can be attributed entirely to the variations in cable layout and termination. The mechanism of cable termination to the chamber wall or floor is important because the cable lengths resonate across the frequency range; therefore the termination impedance is transformed along the length of the cable and results in a source impedance varying with frequency and electrical length and which, working against the EUT's input impedance and that of the other cable, affects the induced voltage. A low termination impedance therefore should give a quite different result to a high termination impedance, as is indeed shown in the results.

**Test variables:**

Red wire in: position (a) open circuit, position (b) with CDN M1 at end, position (b) with open circuit end, position (b) with direct connection to ground plane

Blue cable in: position (a) (1m) with CDN S1 at end, or with direct connection through ground plane; position (b) (2m) with CDN S1 at end, or with direct connection through ground plane

Polarisation: horizontal and vertical

S1: high and low impedance

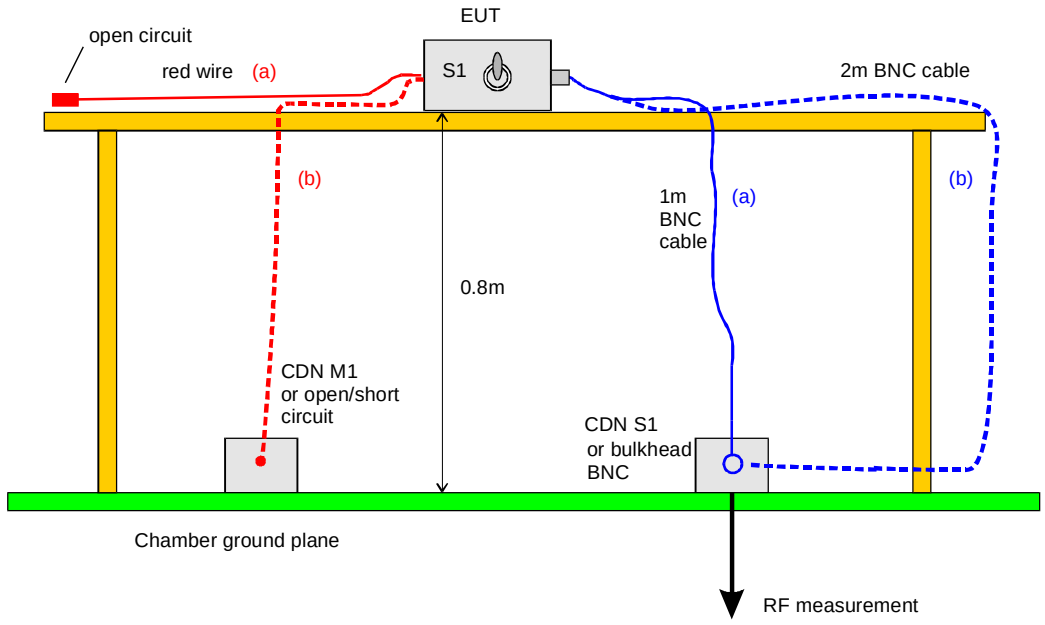
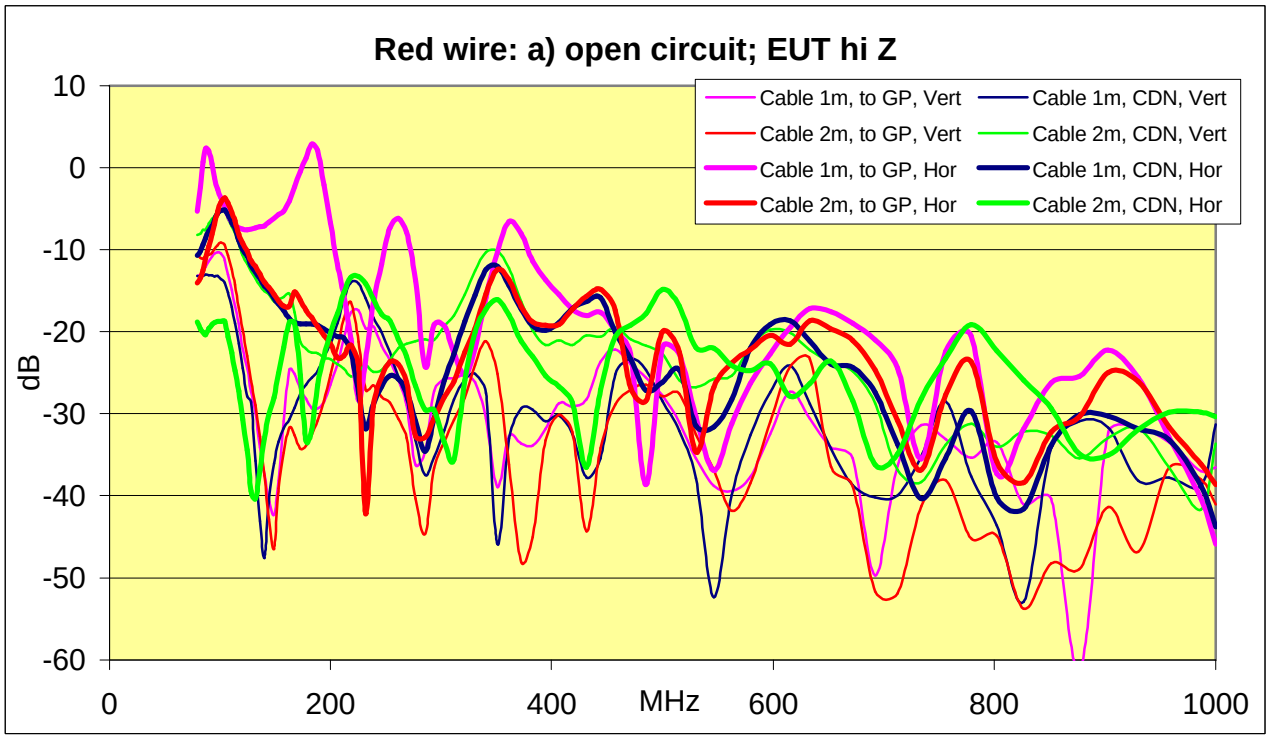
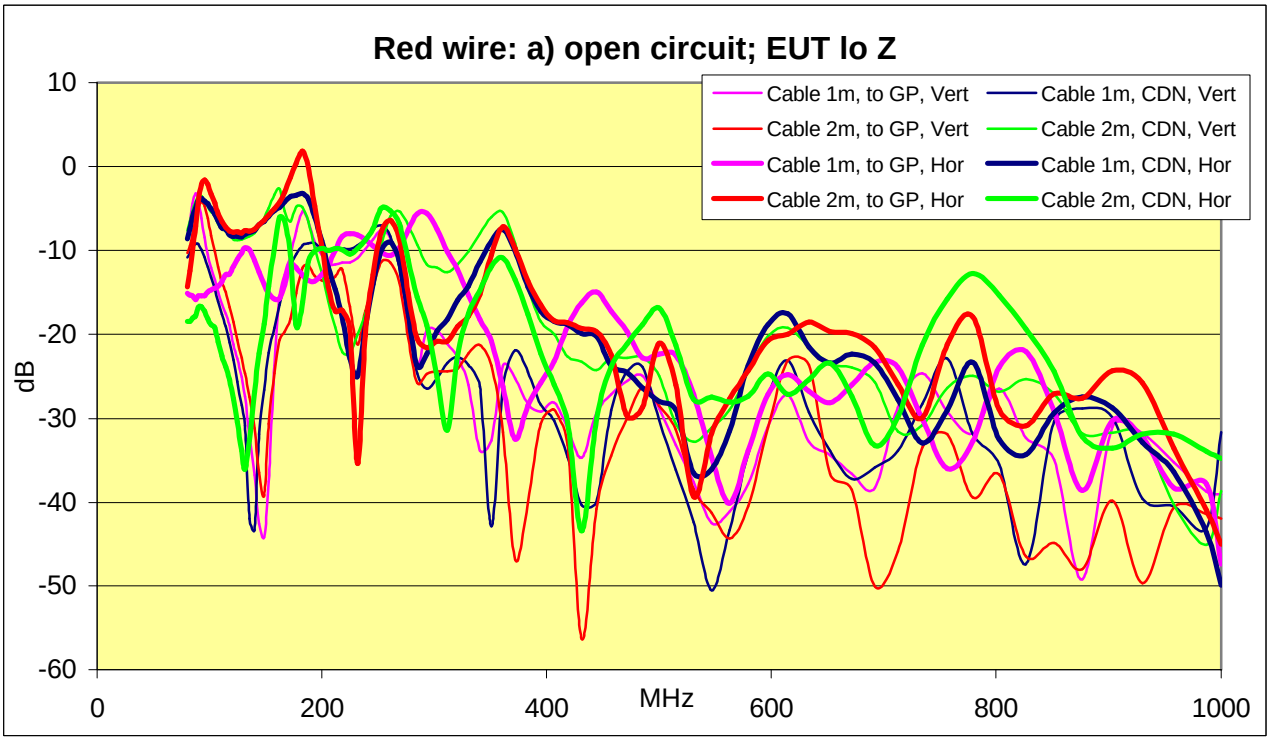


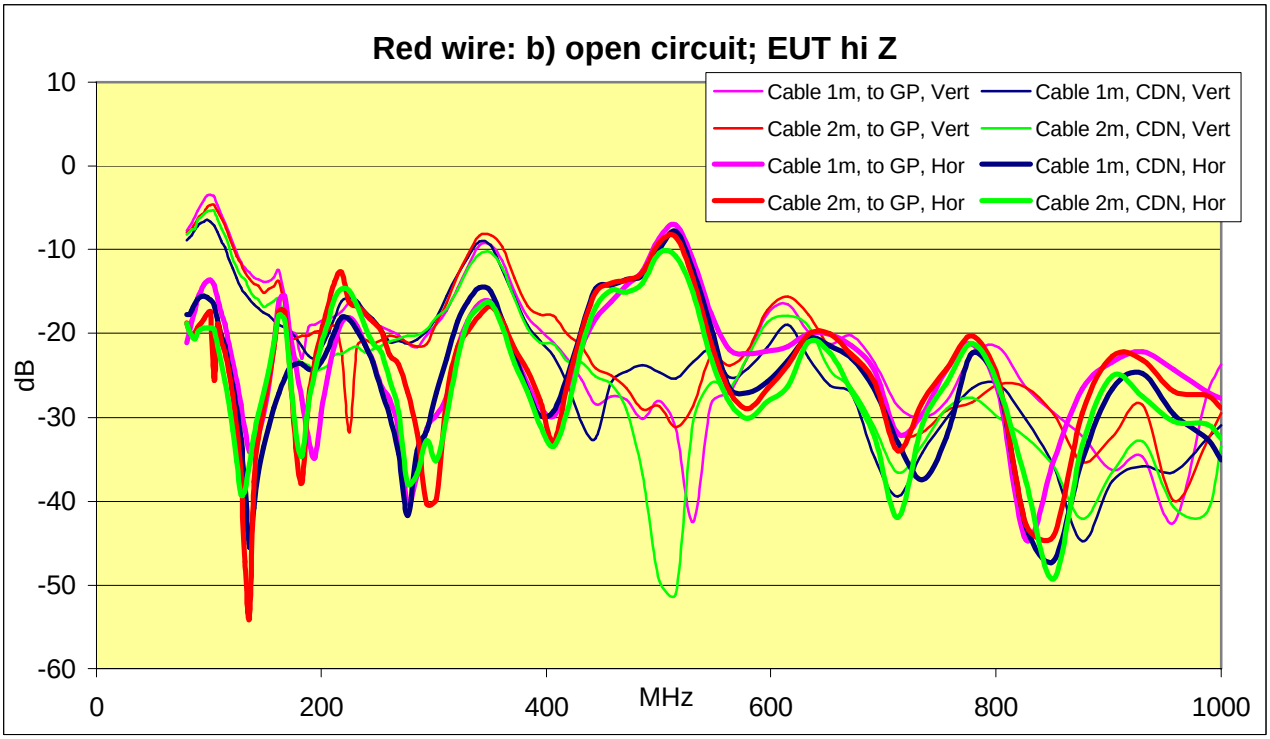

**Figure 3 Test setup**

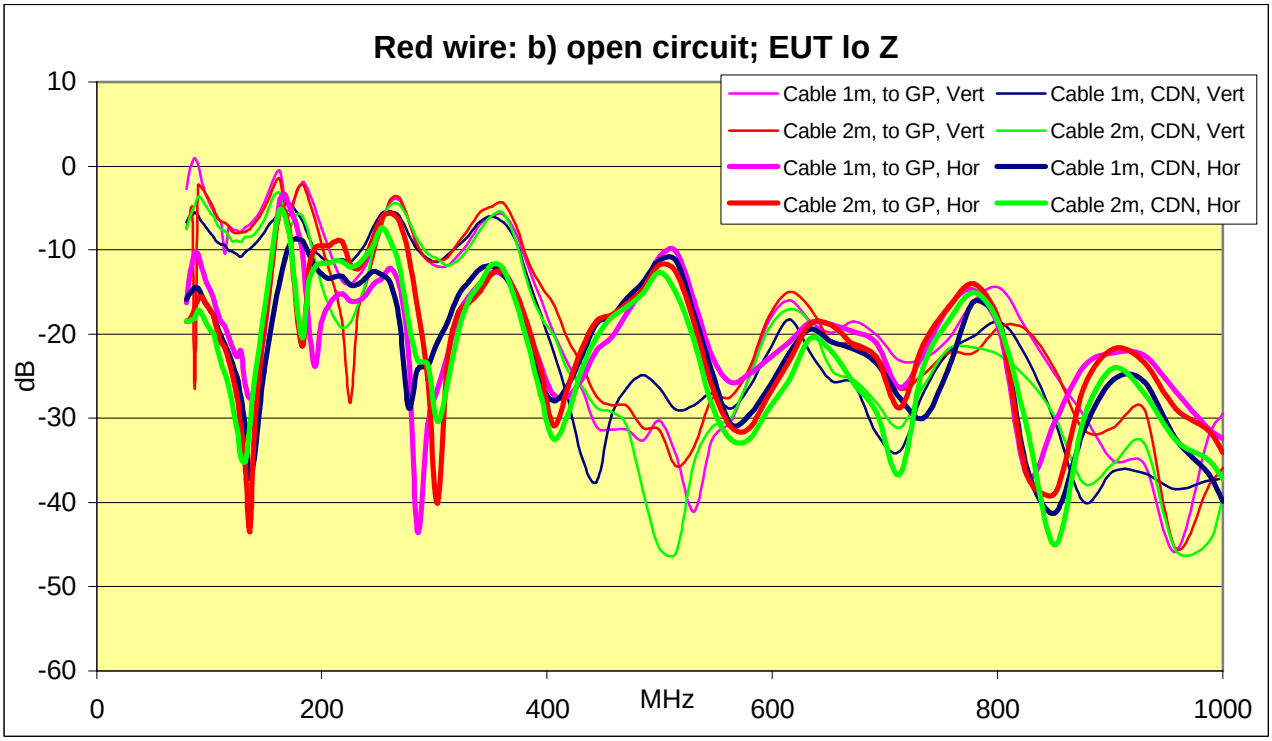
## *Radiated immunity dummy EUT tests: results*

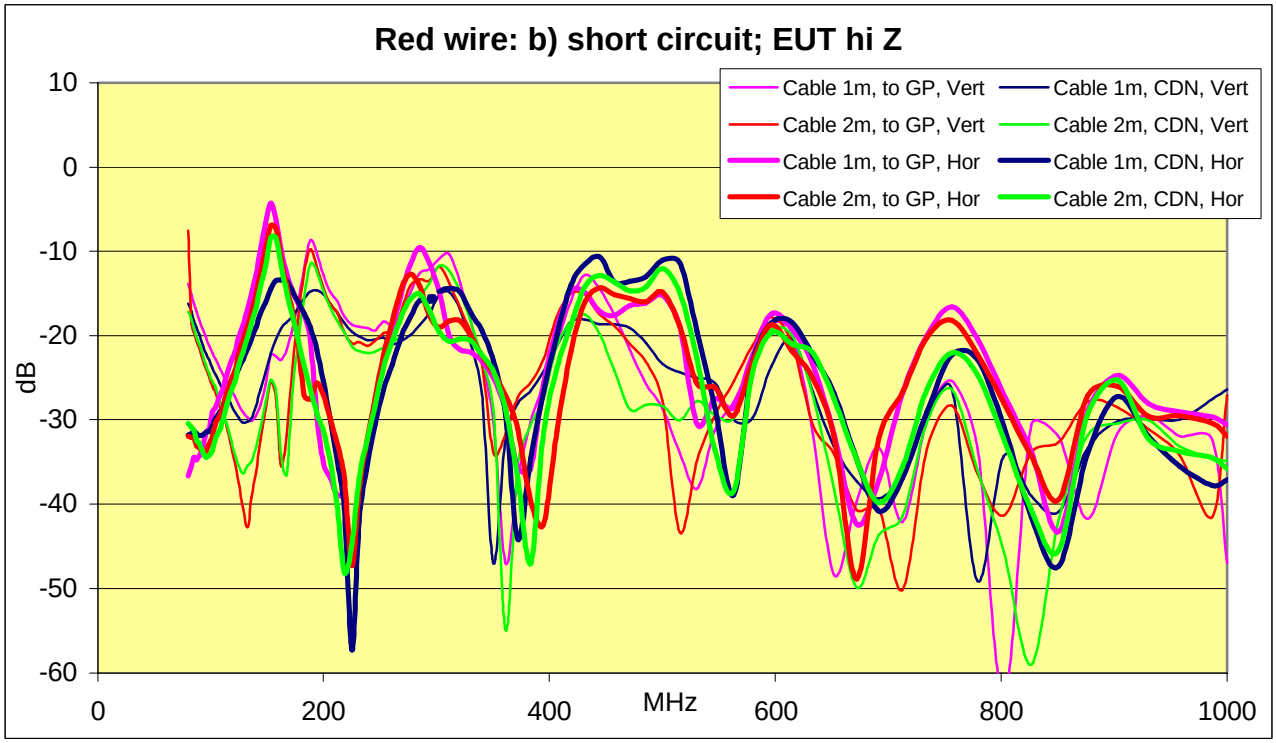
All measurements show dBV for 3V/m applied signal. These next eight graphs show different configurations of BNC cable for a fixed configuration of the single core input wire, with high or low EUT impedance. Horizontal and vertical polarisations are shown on each graph.

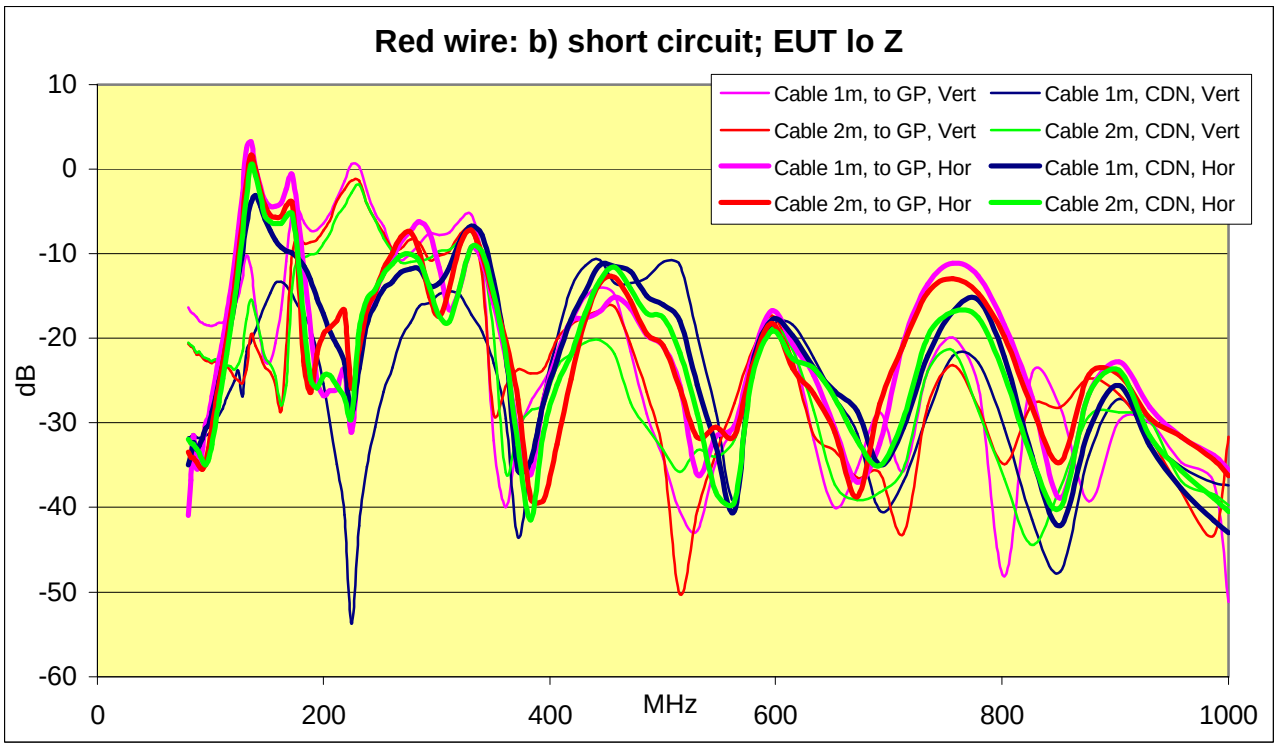



Red wire: b) open circuit; EUT hi Z
Cable 1m, to GP, Vert
Cable 1m, CDN, Vert
Cable 2m, to GP, Vert
Cable 2m, CDN, Vert
Cable 1m, to GP, Hor
Cable 1m, CDN, Hor
Cable 2m, to GP, Hor
Cable 2m, CDN, Hor
10
0
-10
-20
-30
-40
-50
-60
dB
0
200
400
600
800
1000
MHz


Red wire: b) open circuit; EUT lo Z
Cable 1m, to GP, Vert
Cable 1m, CDN, Vert
Cable 2m, to GP, Vert
Cable 2m, CDN, Vert
Cable 1m, to GP, Hor
Cable 1m, CDN, Hor
Cable 2m, to GP, Hor
Cable 2m, CDN, Hor
10
0
-10
-20
-30
-40
-50
-60
dB
0
200
400
600
800
1000
MHz


Red wire: b) short circuit; EUT hi Z
Cable 1m, to GP, Vert
Cable 1m, CDN, Vert
Cable 2m, to GP, Vert
Cable 2m, CDN, Vert
Cable 1m, to GP, Hor
Cable 1m, CDN, Hor
Cable 2m, to GP, Hor
Cable 2m, CDN, Hor
10
0
-10
-20
-30
-40
-50
-60
dB
0
200
400
MHz
600
800
1000


Red wire: b) short circuit; EUT lo Z
Cable 1m, to GP, Vert
Cable 1m, CDN, Vert
Cable 2m, to GP, Vert
Cable 2m, CDN, Vert
Cable 1m, to GP, Hor
Cable 1m, CDN, Hor
Cable 2m, to GP, Hor
Cable 2m, CDN, Hor
10
0
-10
-20
-30
-40
-50
-60
dB
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MHz
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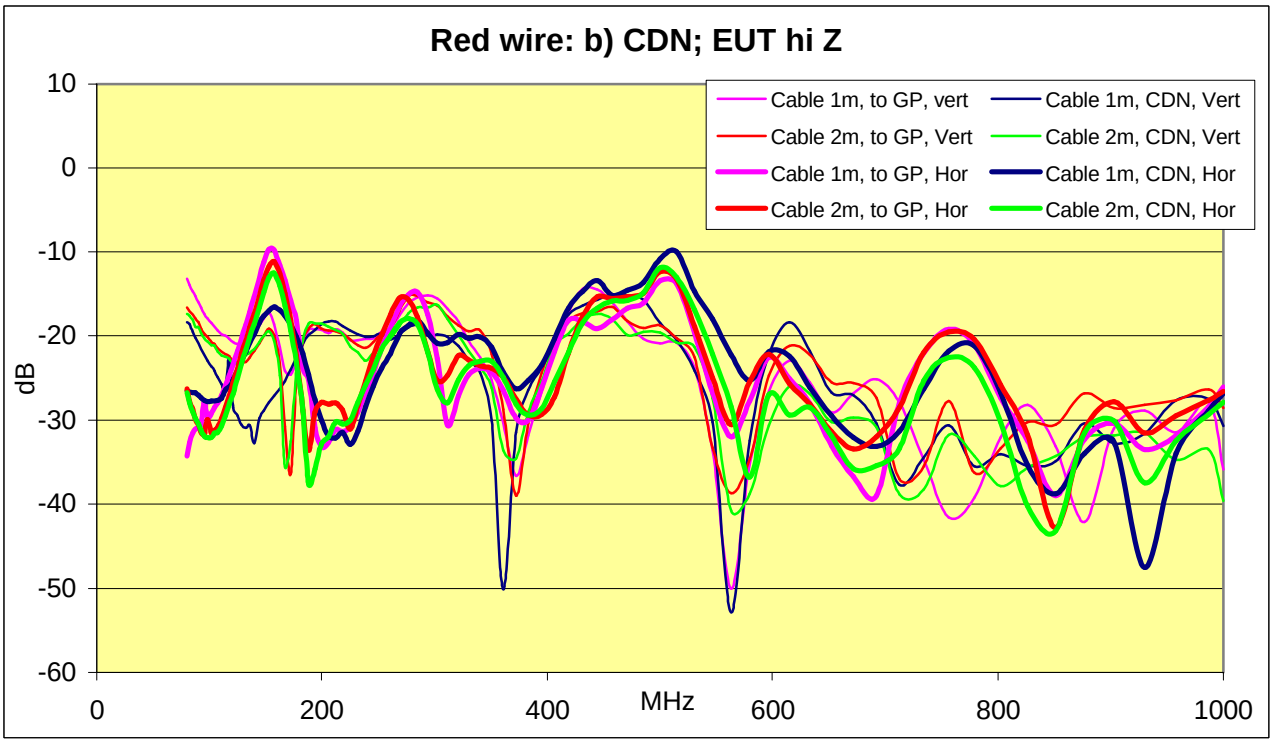
Red wire: b) CDN; EUT hi Z
Cable 1m, to GP, vert
Cable 1m, CDN, Vert
Cable 2m, to GP, Vert
Cable 2m, CDN, Vert
Cable 1m, to GP, Hor
Cable 1m, CDN, Hor
Cable 2m, to GP, Hor
Cable 2m, CDN, Hor
10
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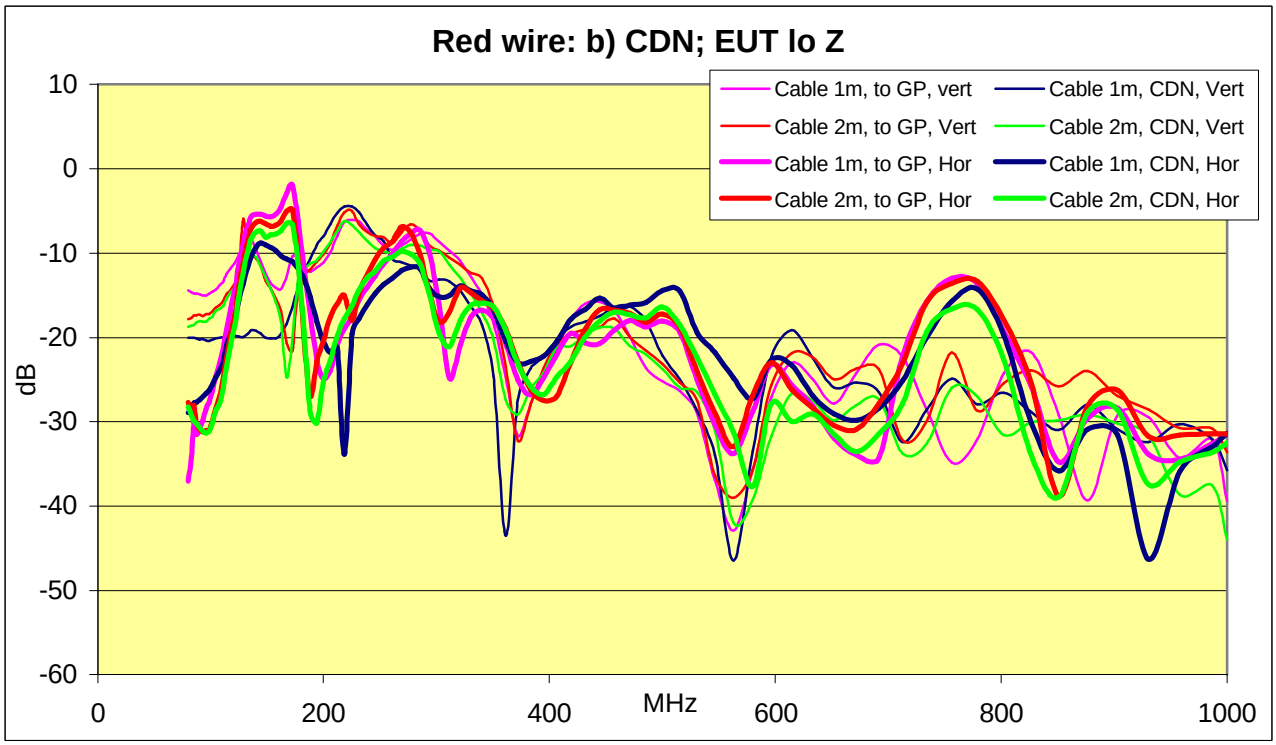
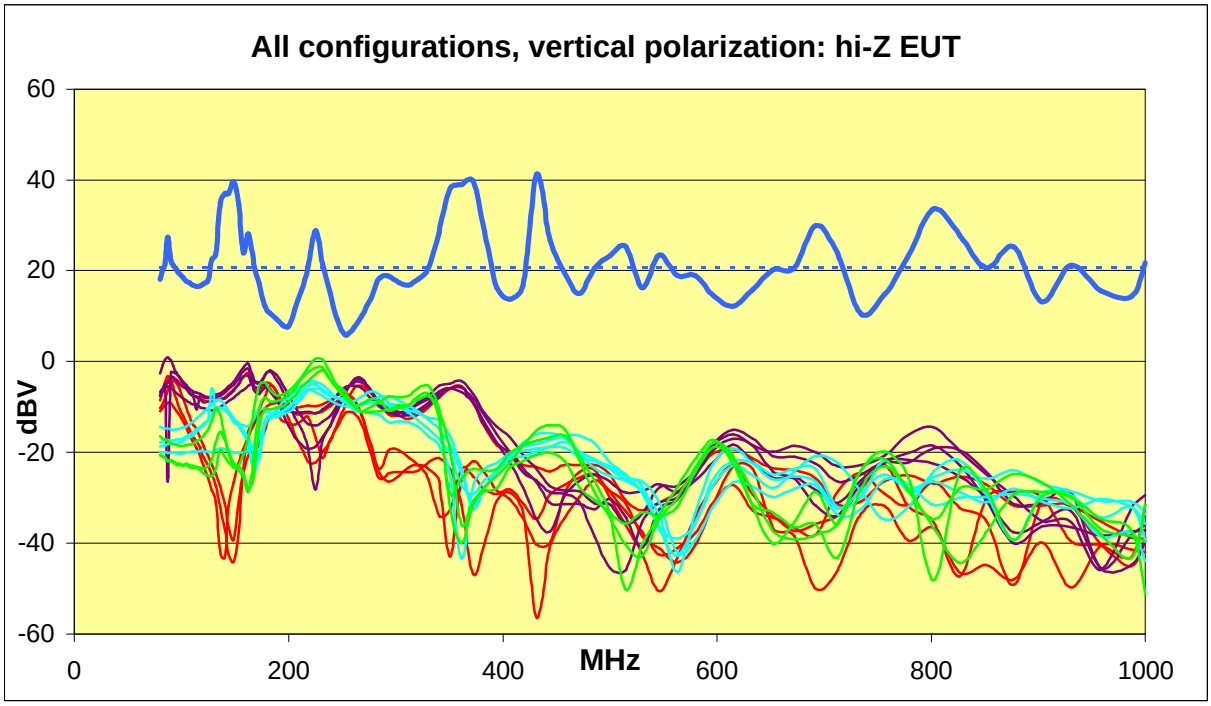
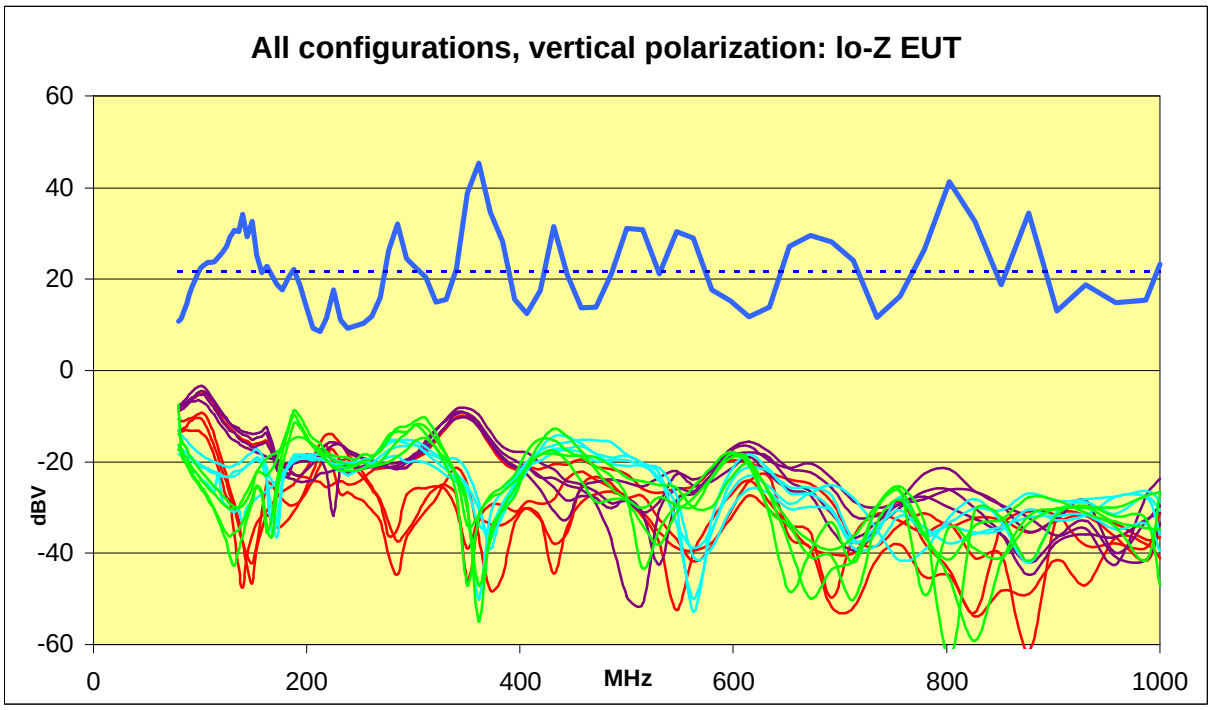

Red wire: b) CDN; EUT lo Z
Cable 1m, to GP, vert
Cable 1m, CDN, Vert
Cable 2m, to GP, Vert
Cable 2m, CDN, Vert
Cable 1m, to GP, Hor
Cable 1m, CDN, Hor
Cable 2m, to GP, Hor
Cable 2m, CDN, Hor
10
0
-10
-20
-30
-40
-50
-60
dB
0
200
400
600
800
1000
MHz

## *Radiated immunity dummy EUT tests: results*

### Comparison of all configurations for different EUT impedances and polarisations

The next four graphs show all cable configurations, for the two EUT impedances and for horizontal and vertical polarisation separately. See overleaf for the colour key for these graphs.



**Colour key:** blue solid – maximum spread of values; blue dotted: mean of spread

| | | |
|---|---|---|
| Red | Series 1-4 | Red wire: a) open circuit |
| Purple | Series 5-8 | Red wire: b) open circuit |
| Cyan | Series 9-12 | Red wire: b) CDN |
| Green | Series 13-16 | Red wire: b) short circuit |