Electrical resistance measurements on OTE 1 for EndCap C

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Overview

Once the assembly is finished, we did measure the electrical resistances on different OTE areas. Due to its size and geometry it hasn't been possible to use a single conductive material sheet to cover the whole area, so several pieces have been assembled.

Moreover any electrically conductive material must be connected in order to avoid floating masses.

The connection of the external layer (made of Cu-kapton) is obtained by means of a soldered 3.2 mm copper conductive strip [1]. In order to connect the outer Cu-k layer to the inner Al-kapton one some conductive tabs made from Cu-kapton and glued to the surfaces are used. The location and the type of conductive strip used (as two different designs were used) are shown at the "*electrical connection*" [2] document.

The electrical resistance measurement has been done by applying an electrical current between the points of interest, measuring the voltage drop between them and finally the resistance is obtained by dividing both values.

Measurements have been done by applying a voltage of 5 volts and a electrical current of 10.90 mA.

Following, a sketch of the setup is shown:

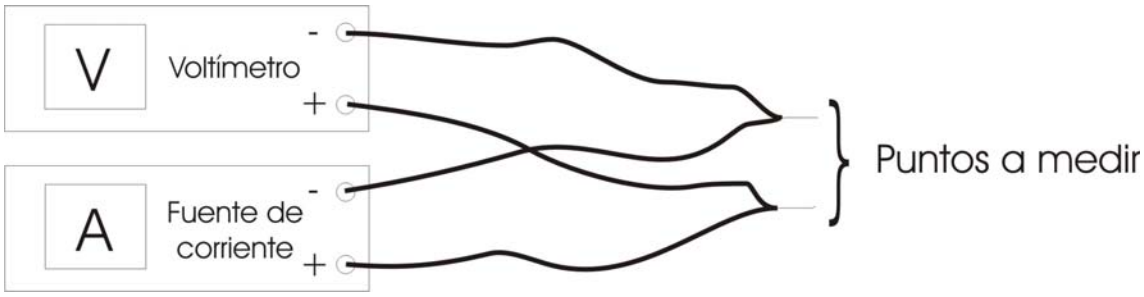

Fig. 1 Sketch of the measurement setup

Ref. [1] Solder.pdf
Ref. [2] Electrical connection.pdf

Test details

First measurements have been done on the external Cu-kapton layer, not only on the cylinder to cylinder side but also on the cylinder to Rear Flange (RF) one. The figure below identifies the measuring points and the values are listed in the attached table.

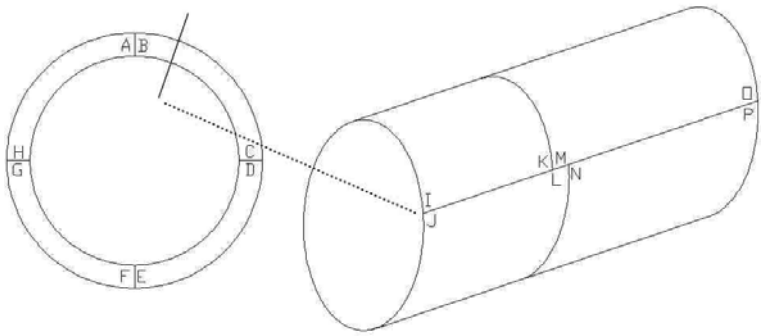

Fig. 2 Location of points of interest

Location	Point of interest	mV	Ohms
	Cables	0.050	0.0045872
RF	A-B	0.065	0.0013761
	C-D	0.064	0.0012844
	E-F	0.066	0.0014679
	G-H	0.072	0.0020183
RF-CIL.	A-A'	0.064	0.0012844
	B-B'	0.063	0.0011927
	C-C'	0.062	0.0011009
	D-D'	0.058	0.0007339
	E-E'	0.064	0.0012844
	F-F'	0.053	0.0002752
	G-G'	0.066	0.0014679
	H-H'	0.066	0.0014679
CIL.	I-J	0.053	0.0002752
	K-L	0.053	0.0002752
	K-M	0.054	0.000367
	M-L	0.052	0.0001835
	M-N	0.053	0.0002752
	O-P	0.060	0.0009174

Tabla 1 Electrical resistance values on the Cu-k layer[3].

Note: points with a prima sign refers to the closest point on the cylinder to the one with the same letter labelled on the RF.

Ref. [3] The electrical resistance values of the table shown the mean measured value at each point once subtracted the cable resistance value.

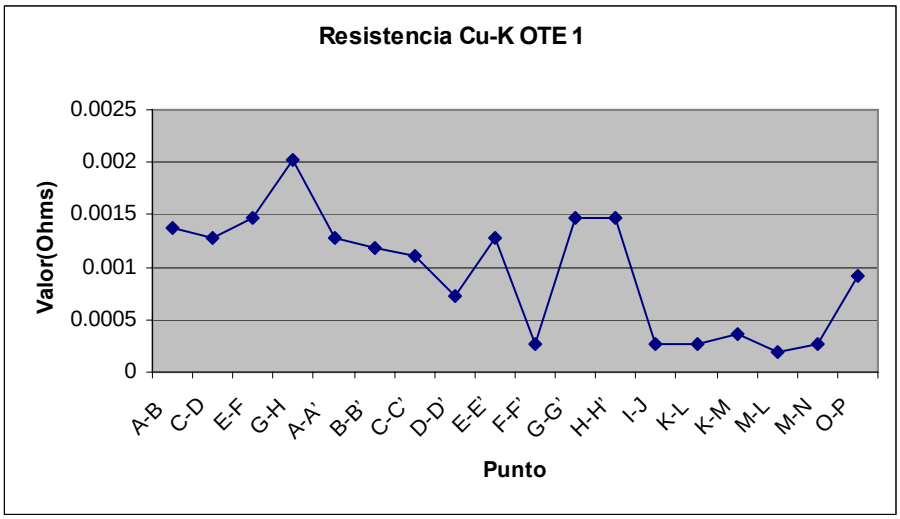

Fig. 3 Graph display of the results from the table above.

A second set of measurements are done on the connection between the external Cu-kapton layer to the internal Al-kapton layer and also the ones to connect the external Al-k layer of the Rear Flange to the internal layer of the same material. They are connected by using Cu-kapton tabs made from a 20mm width Cu-kapton piece, 48 mm length for the ones used at the Front Flange (FF) and 50 mm for the others as they are used on the sloped edge at the Rear Flange of the OTE. A chrome dented strip is soldered to the Cu side of the strip and the remaining surface is filled with non electrically conductive glue, as described at *" test ground v0.1. pdf "* [4] document.

All the tabs are type 1 except the ones used to connect the aluminised side of the RF to the inner diameter of the barrel, also with Al-kapton where type 2 tabs were used.

The following table shows the results from measurements of the different OTE electrical surfaces.

Point	1	2	3	4	5	6	7	8
FF (Cu-Al) (mV)	24	11.3	4.3	11.5	10.5	10.5	9.5	21.4
FF (Cu-Al) (Ohms)	2.197	1.032	0.390	1.050	0.959	0.959	0.867	1.959
RF(Ext) (Al-Al) (mV)	11.5	13	9	9.5	15.5	11	10	12.5
RF(Ext) (Al-Al)	1.050	1.188	0.821	0.867	1.417	1.005	0.913	1.142
RF(Int) (Al-Cu) (mV)	26.5	29.5	27.5	27	30	29.5	21	16.4
RF(Int) (Al-Cu)	2.427	2.702	2.518	2.472	2.748	2.702	1.922	1.500

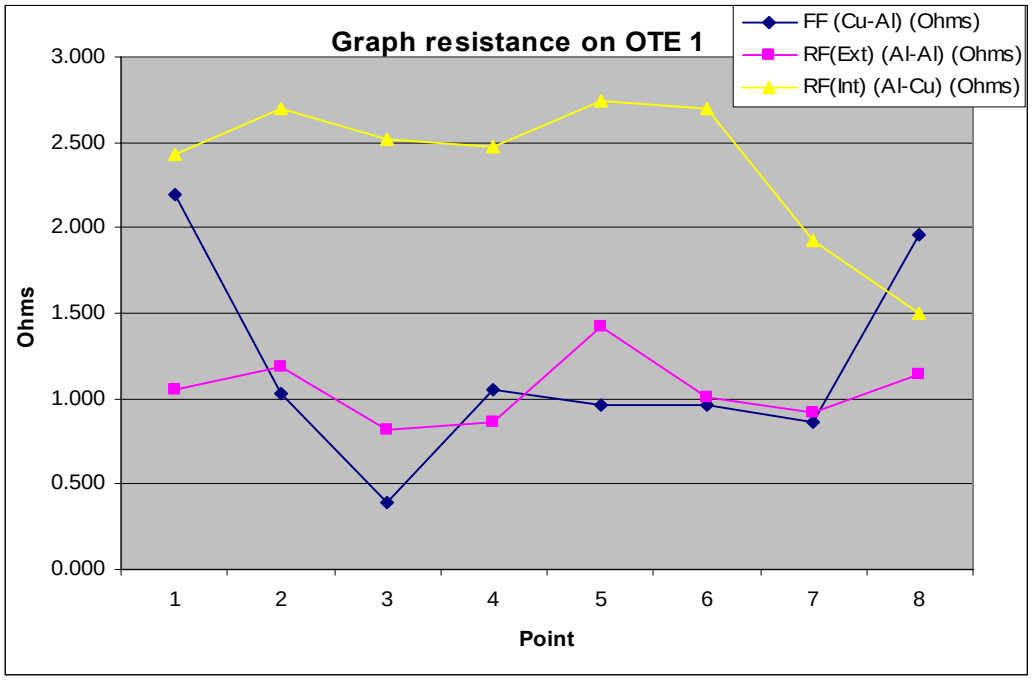

Fig. 4 Electrical resistance at different OTE layers.

Conclusions

As shown on the above figure there are three different results:

1. Measurements between the Al-kapton on the RF and one on the inner side of the cylinder (■)

These should present the highest values as we are connecting two Al layers with higher electrical resistance than the Cu ones but as we used the new type 2 tabs values are low and quite uniform.

2. Measurements between the outer Cu side of the cylinder and the inner one at the RF side (▲)

It presents the highest resistances as we used type 1 tabs and the conductive glue has a poorer performance.

3. Measurements between the outer cylinder side and the inner one at the FF side (♦)

It is connecting the same materials and with identical tab design as previous one, but results are much better. That can be explained due to the Carbon Fibre ring that is located at the inner diameter of the cylinder pressing the tab against the material and thus improving the contact.