CABLE TESTER MANUALS (draft)

The purpose of cable tester is to detect the faults in connectivity of the SCT cables or cable+patch panel assemblies. This document describes the software part of the cable tester setup. For hardware description of the system please have a look at E. Margan's page.

In general there are three tests that can be performed by the software:

- **ID/S test (IDentification/Shield)**. Its purpose is to check is cable lines are connected properly and that there are no shorts between the lines.
- **HV test (High voltage)**. Its purpose is to check that there is no leak between the HV line and other lines.
- **LR test (Line Resistance)**. Its purpose is to determine if the lines (wires) are of the right thickness (resistivity) and also to determine the length of the cables by using specified resistivities. The test applies only to cable tests (not assemblies).

The ID/S test is essentially a loop over all possible combinations of the line pairs. The loop is repeated twice with positive and negative voltage of +/- 2.5 V. In each step of the loop one line is set to bias voltage (set line) and the voltage is measured on all other lines (meas. lines). For the current sensitive lines (Dgnd,Shield,HVret,Agnd) also the currents flowing in those lines are measured. First the positive bias loop is performed and then the negative. At most four measured values are obtained for each set line-meas. line pair: Ufb,Urb,Ifb,Irb.
Ufb: set line at +2.5 V , voltage measured at meas. line.
Urb: set line at -2.5 V , voltage measured at meas. line.
Ifb: set line at +2.5 V, current measured at meas. line.
Ifb: set line at -2.5 V , current measured at meas. line.

The measurements (Ufb,Urb,Ifb,Irb) for all combinations of line pairs are stored in the table (dimension of the table 18x18x4) and later on compared with the reference values (in fact it is a window with upper and lower limit) in the so called acceptance table. In such way it is possible to easily adopt software to different cable+board combinations.

The measured values, of course, depend on the board connected on the other side of the cable. There are only some combinations of line pairs that give non-default values (default value is 0 V or 0 A).

For the Type 4 cable the test in positive direction (+2.5 V) is used to determine if the line in place on both sides of the connector. In the reverse direction (-2.5 V) the diodes placed on the dummy board effectively disconnect the lines and enable to detect the shorts between the lines (<100 kOhm).

The same holds for HV test but in this case the HV is applied to HVline and only the current sensing lines are probed.

The LR test is simply the test of lines' resistances and requires different board at the end of cable. The line resistance depends on its length. Therefore it is more convenient to calculate the ratios of resistances of different line pairs. These values are then compared with expected ones. If for example 0.25 mm^2 line is connected to the Dgnd pin and correspondingly the 4 mm^2 line to Tsense pin the cable would pass ID/S test and fail LR test.

Running software:

To run the cable test software on windows xp/nt/2000 one need to install/run software which enables low level calls to hardware (parallel port) such as AllowIo. On windows 95/98/ME this is not needed. The name of the program is CableTest.exe. The shortcut to the program should be created on the desktop.

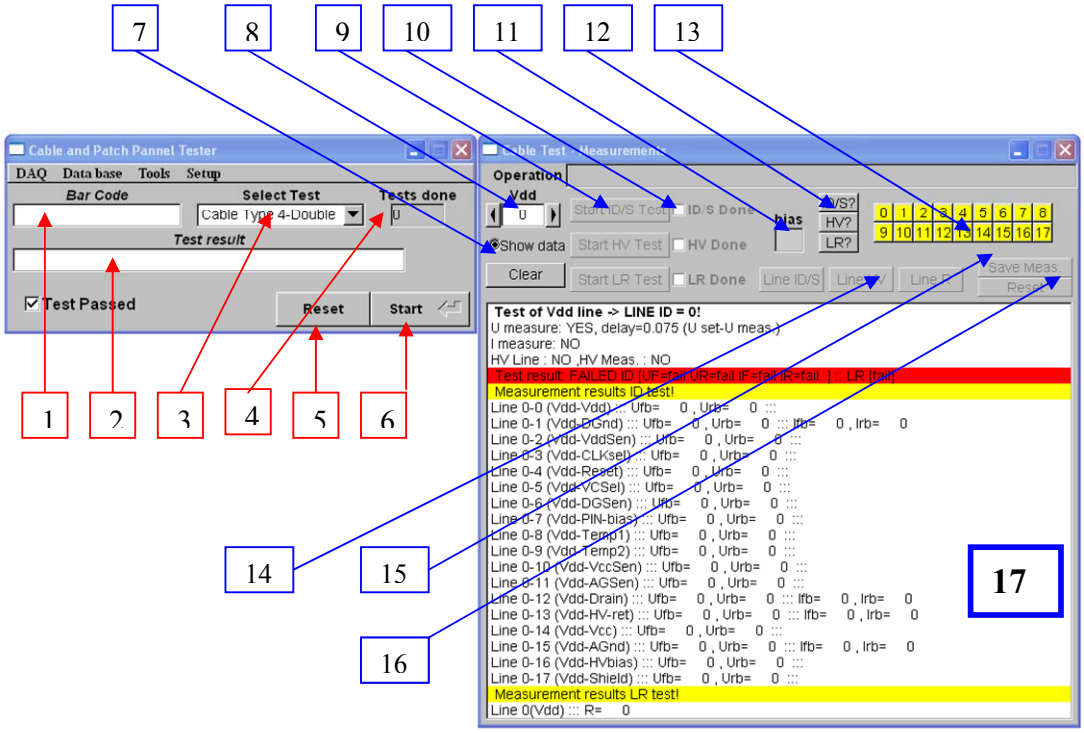
Installing the software:

The current version of the software is available on http://krambi.ijs.si/gregor/downloads/CableTest.zip . The package should be extracted to c:\AllowIO\ . Please always check the version () of the acceptance tables. These are specific for each individual test and have the following name xyz_Cuts.dat , where xyz is the name of the test (CT4_Cuts.dat, CT4 stands for Cable Type 4).
Install procedure in steps:

```
* Unzip file to folder C:\AllowIO
  Create folder C:\CableTest (for output test data)

* Create shortcut on desktop in which 'target' should be:
  C:\AllowIO\AllowIo.exe C:\AllowIO\CableTest.exe /a
  this opens all (/a) ports for the application CableTest.exe

  And in the 'start in' field:
  C:\AllowIO\

* Put the attached xyz_Cuts.dat (CT4_Cuts.dat) into the C:\AllowIO
directory. If the file is already there and newer file is available, just
overwrite the old one.
```

PLEASE NOTE: Some notebook switching power supplies introduce a lot of noise, resulting in fail tests. Don't forget to test that ("confidence test" see below) when you are installing software on new notebook. There should be no problems on desktop PCs.

Interface to the cable test program



1. "Bar Code" - the barcode must be either 7 or 12 digits long. The program checks the format of the barcode and will prompt you again if the form is wrong.
2. "Result window" – success of the test, files written etc. is printed out.
3. "Select Test" menu - select the test you want to perform.
4. "Tests done" – number of tests performed in the current session.
5. "Reset button" – resets the current test. All the measured values are cleared and the test flags removed. The barcode and the type of the test however stay.
6. "Start" – starts the test. After the first step the button changes the label to the appropriate step in testing procedure. For example, Cable Type 4:
   "Start"->"HV Test"->"LR Test".
   After the test is done or reset the button is reset to "Start" again.

7. "Show" and "Clear" - the buttons for the display of the measurements ([16]).
8. "Line No." - The line number of the current set-line.
9. "Start ID Test", "Start HV Test", "Start LR Test" – The buttons which start the individual tests. Starting of the tests is only possible in the so called "Expert mode". In the normal mode the buttons are inactive.
10. "ID/S done", "HV done", "LR done" – indicator showing whether the certain test has been performed or not.
11. "bias" – shows the applied bias polarity
12. "ID/S?", "HV?", "LR?" – Clicking on these buttons shows the results of the tests (see [13]).

13. Line buttons - if the test has been successful for a given line the corresponding button turns green, if the test failed the button turns red. If no test is available or performed the button is yellow.
14. “Line ID/S”, “Line HV”, “Line LR” - start certain test for a given line only (only possible in expert mode).
15. “Save Meas.” – prompts for file name and saves the measurements to the disk.
16. “Reset” – resets all the tests and clears the data.
17. Display of the measured data!

Menus:

- **DAQ**
  - Select printer port (select the printer port – default is LPT1)
  - Select report folder (path to the stored files, please remember that the folder name should end with \ ). The default folder is assumed to be “C:\CableTest\”
  - “Expert mode” – mode in which all the features of the program are available.
  - “Float window position” – select if you want to have floating windows on the screen. By default the positions of different windows are fixed with respect to each other.
  - “Auto save files” – automatic file names are created and files are automatically written to the disk once the test has been finished. The file name will be “BarCode_PASS.ctr” if the cable has passed the test and “BarCode_FAIL.ctr” if it has failed.
  - “Exit” – exits the program
- **DATABASE**
  - “Select tester name” – tester name which will go to DB
  - “Select location” – place where tests were made
  - **“**Select URL information” – select the WWW address where more information is available
  - “View last report” – shows the report as it would be when clicking
  - “Auto save DB files” – saves DB files automatically under default name: *cableID.dbe*
- **TOOLS**
  - “Manual test” – Opens the panel for manual test. There it is possible to set voltage and read current/voltage for arbitrary set of two lines. One can select between low and high voltage. This is particularly important in “debugging” the cables.
  - “Thresholds” – opens the panel where thresholds are presented. There are four self-explanatory buttons: “Print cuts”, “Check Cuts”, “Close” and “Clear”. When printing the cuts only the pairs of lines with non-default threshold values are shown. The purpose to check the cuts is to see if they are consistent.
  - “Generate look-up table” – should not be used.
  - “ADC Self-test” – performs the test of ADC. All the voltages in the test-box are checked as well as the gnd. If a certain test fails/passes the box turns red/green. A fail means serious trouble and requires a repair of the test box.
  - “Confidence test” – checks if the used threshold table is appropriate. The program performs the ID/S test many times recording the number of passed and failed test. Ideally there should be no fails, but if the thresholds are too tight wrt noise, there will be also fails.

- **SETUP**
  - "Line resistance test" – switches off/on LR test
  - "Shield on test box side?" – if selected the cable shield is expected to be shortened to the drain wire. Otherwise the cable shield is expected to be floating.
  - "Check connectivity" – if selected an additional button ***"Connect?"*** will appear in *"Cable and Patch Panel Tester"*. Its purpose is to check connectivity (matching of both sides of the cable) for the pulled cables. When pressed VCsel line will be switched on. The dummy patch panel has a LED connected which should be on if both sides of the cables match. In such way it is obvious if the proper connection of the cable has been done before the start of the test (unless the VCsel line is broken of course…). The *"Connect?"* button will turn green and the test can start. If for whatever reason the connection will not be successful you can press *"Connect?"* again to stop the routine looking for the connection and then start the test.
  - "Average over" – number consecutive readings considered for averaging
  - "Fast test" – should not be used.

Testing procedure

It is recommended at the start of all tests to run "ADC Self-test" in "TOOLS" menu and make sure that the ADC works properly.
The test of the Cables/Patch panels will be performed in several steps:

Cable Type IV:

- Select "Cable Type 4 - Cut" or "Cable Type 4 - Double" for uncut cables. In case the Cable Type 4 cable is selected the program will ask you for the second barcode at the end of the test.
- If the connection of the dummy patch panel has been properly done and "Setup/Check connectivity" has been selected (default value for cut/pulled cables) the "Connect?" button should appear in the main window? If connection is successful the LED on the dummy patch panel board should be ON, unless the VCsel line is broken of course. Upon connection the "Connect?" button turns green and the test can start (look into SETUP menu description).
- Enter the barcode of the cable
- Start the test and follow the instructions given by the program. For each step you will be prompted for changing connector to the appropriate test box (board).

NOTE: while the red light is blinking on the HV test box 500 V is applied – be careful!

What can go wrong!

Every measurement is subjected to the noise and EMI pickup. The acceptance table is chosen in such way that enables reliable detection of faults and provides reasonable robustness to noise/fluctuations. Nevertheless it can happen that certain line(s) turns "bad" in ID/S test. If there is a single line problem one can do the following:

- Repeat the whole test. Please note that if the cable is corrupted it will **always** fail.
- There is a way to avoid lengthy procedure of repeating the whole cable test. At the end of the test answer with "No" to the question "Is the test done". Then one can select (by clicking it) the line with the problem and then choose the Line ID, LineHV or LineR test. If the test is successful the line will turn green and the test for this line will pass. After the tests of individual lines are completed you should press "Done" to store the test or "Reset" if you want to reset the whole test.

It is important to note:

- In case of a fault usually few lines would fail (become "red"). If a single line fails it is most likely, but not necessary, noise problem.
- There is a distinction between the low impedance lines (current sensing lines) and high impedance lines (voltage sensing lines). The current sensing lines would pass the test even without the cable and test board (a feature of the hardware). However all the rest won't. The acceptance thresholds are unique for the dummy board and only if the cable is ok all the lines will pass the test.
- In case of several fails or any other strange behavior of the software please first press reset and if the problems still don't go away restart the program. Also it is worth checking the results to see how far from the measured values were from the specified (acceptance table) ones. The results can be checked either in the report file or clicking the corresponding line.

The form of the measured data for Cable Type 4

The measured data for each individual line are presented within the program and are also stored in the report file. Two examples of a line pass and line fail tests are shown below.

EXAMPLE OF A LINE TEST – PASS

```
Test of DGnd line -> LINE ID = 1!          <-name of the line and its id)
U measure: YES, delay=0.05 (U set-U meas.)  <-measurements to be performed and the proper delays
I measure: YES , delay=0.01 (U set-I meas.)
HV Line : NO ,HV Meas. : NO
Test result: PASSED                        <- result of the test
Measurement results ID test!               <-measurements in the form for each pair of lines Uf[V],Ur[V],If[A],Ir[A]. only non-defaults
Line 1-0 (DGnd-Vdd) ::: Ufb=-0.0001282 , Urb=-0.001459  :::
Line 1-1 (DGnd-DGnd) ::: Ufb=-0.0001434 , Urb=-0.001392  ::: Ifb=-0.001874 , Irb=2.332e-006
Line 1-2 (DGnd-VddSen) ::: Ufb=-0.000119 , Urb=0.0013  :::
Line 1-3 (DGnd-CLKsel) ::: Ufb=-0.001123 , Urb=-0.0005127  :::
Line 1-4 (DGnd-Reset) ::: Ufb=-9.46e-005 , Urb=0.0007538  :::
Line 1-5 (DGnd-VCSel) ::: Ufb=-0.001236 , Urb=-0.0006561  :::
Line 1-6 (DGnd-DGSen) ::: Ufb=-0.0001282 , Urb=0.0006989  :::
Line 1-7 (DGnd-PIN-bias) ::: Ufb=-0.0008423 , Urb=-0.0005524  :::
Line 1-8 (DGnd-Temp1) ::: Ufb=-0.0008148 , Urb=-0.0005127  :::
Line 1-9 (DGnd-Temp2) ::: Ufb=-0.0006348 , Urb=-0.0005188  :::
Line 1-10 (DGnd-VccSen) ::: Ufb=-0.0006561 , Urb=-0.0003265  :::
Line 1-11 (DGnd-AGSen) ::: Ufb=-0.0006653 , Urb=-0.0002655  :::
Line 1-12 (DGnd-Drain) ::: Ufb=-0.001471 , Urb=-0.0005585  ::: Ifb=-1.755e-006 , Irb=1.285e-009
Line 1-13 (DGnd-HV-ret) ::: Ufb=-0.0003082 , Urb=0.0001038  ::: Ifb=3.021e-007 , Irb=-1.617e-010
Line 1-14 (DGnd-Vcc) ::: Ufb=-0.0003723 , Urb=-0.0004883  :::
Line 1-15 (DGnd-AGnd) ::: Ufb=-0.0003571 , Urb=-0.000531  ::: Ifb=-2.386e-006 , Irb=3.021e-009
Line 1-16 (DGnd-HVbias) ::: Ufb=-0.001172 , Urb=-0.001608  :::
Line 1-17 (DGnd-Shield) ::: Ufb=-0.001096 , Urb=-0.001114  :::
Measurement results LR test!                    <-result of the line resistance test
Line 1(DGnd) ::: R=0.2117
```

EXAMPLE OF A LINE TEST - FAIL

```
Test of Temp2 line -> LINE ID = 9!
U measure: YES, delay=0.075 (U set-U meas.)
I measure: NO
HV Line : NO ,HV Meas. : NO
Test result: FAILED ID [UF=fail UR=ok IF=ok IR=ok  ] :: LR [fail]  <-ID test failed during pos. bias loop UF=fail and for LR test
Measurement results ID test!
```

Line 9-0 (Temp2-Vdd) ::: Ufb=-0.0008453 , Urb=-0.004727 :::
Line 9-1 (Temp2-DGnd) ::: Ufb=-0.0009735 , Urb=-0.004898 ::: Ifb=-0.0001851 , Irb=9.589e-009
Line 9-2 (Temp2-VddSen) ::: Ufb=-0.0007965 , Urb=-0.00481 :::
Line 9-3 (Temp2-CLKsel) ::: Ufb=0.01737 , Urb=0.01784 :::
Line 9-4 (Temp2-Reset) ::: Ufb=-0.0008575 , Urb=-0.004663 :::
Line 9-5 (Temp2-VCSel) ::: Ufb=0.01868 , Urb=0.01902 :::
Line 9-6 (Temp2-DGSen) ::: Ufb=-0.000824 , Urb=-0.004776 :::
Line 9-7 (Temp2-PIN-bias) ::: Ufb=0.01599 , Urb=0.01815 :::
Line 9-8 (Temp2-Temp1) ::: Ufb=0.01617 , Urb= 0.019 :::
Line 9-9 (Temp2-Temp2) ::: Ufb= 2.084 , Urb=-2.555 ::: <-value out of the acceptance window [1.97,2.08] – noise problem
Line 9-10 (Temp2-VccSen) ::: Ufb=0.002325 , Urb=-0.00625 :::
Line 9-11 (Temp2-AGSen) ::: Ufb=0.002209 , Urb=-0.006302 :::
Line 9-12 (Temp2-Drain) ::: Ufb=0.0008179 , Urb=-0.003546 ::: Ifb=8.484e-007 , Irb=1.294e-008
Line 9-13 (Temp2-HV-ret) ::: Ufb=-0.0004456 , Urb=-0.0004974 ::: Ifb=-1.377e-005 , Irb=-1.009e-008
Line 9-14 (Temp2-Vcc) ::: Ufb=0.001987 , Urb=-0.006229 :::
Line 9-15 (Temp2-AGnd) ::: Ufb=0.001605 , Urb=-0.006094 ::: Ifb=1.965e-006 , Irb=2.336e-008
Line 9-16 (Temp2-HVbias) ::: Ufb=0.02375 , Urb=0.02336 :::
Line 9-17 (Temp2-Shield) ::: Ufb=-0.001895 , Urb=-0.001877 :::
Measurement results LR test!
Line 9(Temp2) ::: R= 21.38 <-overflow value (the maximum resistance that can be measured should be below 20 Ohm.

To be continued …