ELMB Motherboard v6.5 (v6.6) and v6.5.3 Automated Production Tester for LVPS

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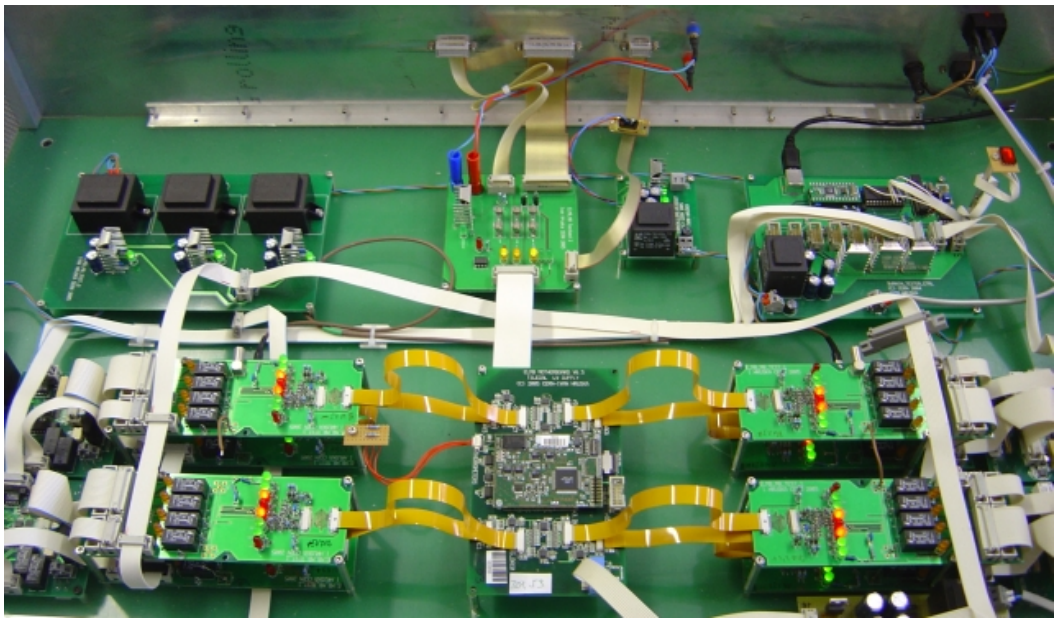


Fig.1: General view on the ELMB_MB tester.

This brief report presents hardware and software configuration of the ELMB motherboard (ELMB_MB) production tester for the LVPS TileCal project. The ELMB_MB v6.5 (v6.5.4) is inside of each LVBOX and sends/receives signals from eight LVPS bricks. The so called ELMB module on the ELMB_MB is digitizing signals and communicates with a host computer via CAN bus.

An automated production tester was designed to evaluate functionality of each ELMB_MB manufactured in 300pcs. The described tester has to check:

- CAN bus communication between ELMB module and a host computer via CAN open protocol.
- Simulated behavior of all connected bricks (3VDIG, 5VDIG, 5VMB, -5MB, 15MB, -15VHV, 15HV, 5HV)
  - = Startup signal on each brick
  - = Three thermometers on bricks
  - = Input/Output brick parameters (Vin, Iin, Vout, Iout)
  - = enable/disable DIG/HV loops
  - = brick Vout DAC Trimming simulation on ELMB_MB motherboard
- simulation of five sense line signals from 3VDIG, 5VDIG, 5VMB, -5VMB, 15VMB
- reading of two heatsink thermometers connected to ELMB_MB
- clock distribution to each brick for possible DC/DC switching synchronization

ELMB_MB v6.5 and v6.5.3, v6.6 differences

Main differences between mentioned versions are the powering of sense line optocouplers, and resistor dividers of five sense lines.

ELMB_MB v6.5 [10, 11] is the original produced motherboard, sense line optocouplers are powered from 5VMB line. Also all sense lines have original resistor divider ratios.

ELMB_MB v6.5.3 (A) is the final production version for LVPS boxes since March 2007 [1]. Sense line optocouplers of all five monitored bricks are powered from 5VDIG line, all resistor dividers have different configuration ratio than in version 6.5.

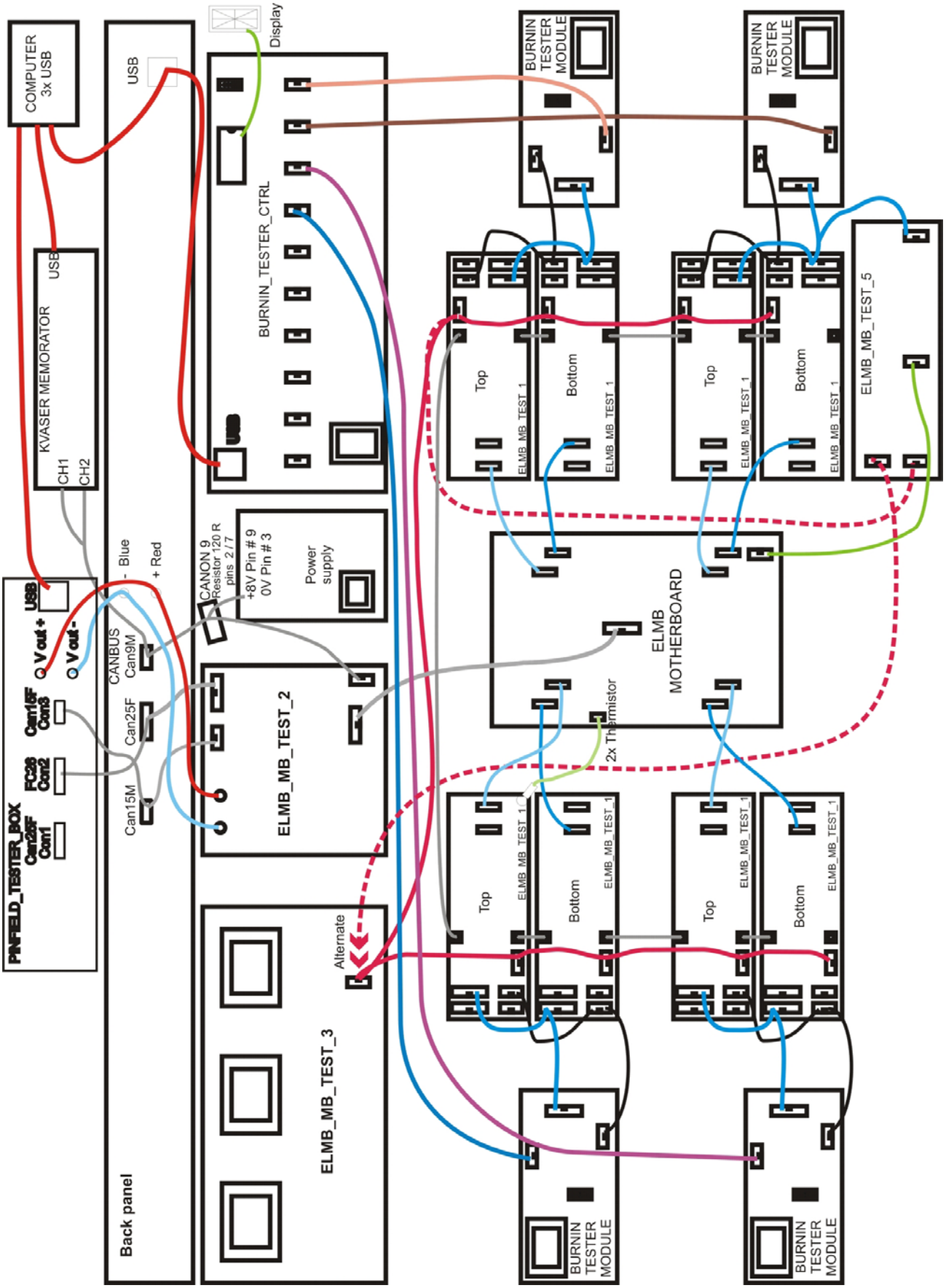
ELMB_MB v6.6 is a prototype version with ALTERA PLD controller chip with additional hardware OverVoltage Protection, OverCurrent Protection, and UnderVoltage Protection for each brick. Complicated design and difficult to test. Finally it has been abandoned for production. The sense lines can be powered either from 5VDIG or 5VMB. The same divider ratios as in version 6.5.

ELMB_MB Tester Hardware

The tester is composed of several interconnected functional electronic boards; some of them were already used in other LVPS production testers for bricks:

- ELMB_MB_TEST_1 card 8pcs
- ELMB_MB_TEST_2 card 1pcs
- ELMB_MB_TEST_3 card 1pcs
- ELMB_MB_TEST_5 card 1pcs
- BURNIN_TESTER_MODULE 4pcs
- BURNIN_TESTER_CTRL 1pcs
- PINFIELD_TESTER_BOX 1pcs
- CAN BUS KVASER MEMORATOR (2x serial port to USB, see www.kvaser.com)
- 3 USB (device to PC) cables, interconnection cables PINFIELD/ELMB_MB tester
- PC computer with WIN2000/XP system
  = Winhost+.exe v1.7 diagnostic tool for the CAN bus, it has been created by ATLAS/DCS group with specific functionality for the Embedded Local Monitor Board (ELMB) + Canlib32.dll library
  = Excel 2000 program, Visual Basic for application

Overall interconnection scheme between all boards is shown on next page.


COMPUTER
3x USB
USB
KVASER MEMORATOR
USB
CH1
CH2
Display
BURNIN_TESTER_CTRL
BURNIN
TESTER
MODULE
Top
Bottom
ELMB_MB_TEST_1
ELMB_MB_TEST_5
ELMB
MOTHERBOARD
2x Thermistor
PINFIELD_TESTER_BOX
Can15F
Con3
FC26
Con2
Can25F
Con1
Vout +
Vout -
USB
CANBUS
Can9M
Can25F
Can15M
- Blue
+ Red
CANON 9
Resistor 120 R
pins 2 / 7
+8V Pin # 9
0V Pin # 3
Power
supply
ELMB_MB_TEST_2
ELMB_MB_TEST_3
Alternate
Back panel

ELMB_MB_TEST_1 card *ELMB_MB_TEST_1_scheme.pdf*

TEST_1 card is a plug-in interconnection board (see Fig.2) that is sitting between ELMB_MB under test and BURNIN_TESTER_MODULE board. Simulated parameters (thermometers, voltages, currents) of each virtual LVPS brick are designed, several control LEDs signalize active parameter, several relays switch on/off tested parameters.

Fig.2. The ELMB_MB_TEST_1 plug-in board.

ELMB_MB_TEST_2 card *ELMB_MB_TEST_2_scheme.pdf*

TEST_2 card is also an interconnection board between ELMB_MB under test and the PINFIELD_TESTER_BOX and KVASER CAN bus interface, see Fig.3. The PINFIELD tester delivers several power supply lines for ELMB_MB power (ELMB_MB power 11V, ELMB module power 8V, Startup signal +15V). CAN bus signals are also distributed via this board.

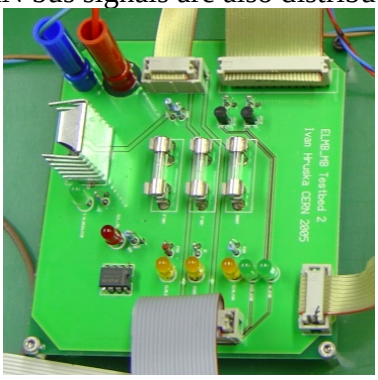


Fig.3. The ELMB_MB_TEST_2 card.

ELMB_MB_TEST_3 card *ELMB_MB_TEST_3_scheme.pdf*

It is a power supply board delivering 2x 5V and -5V voltages for other MB tester cards, see Fig.4.

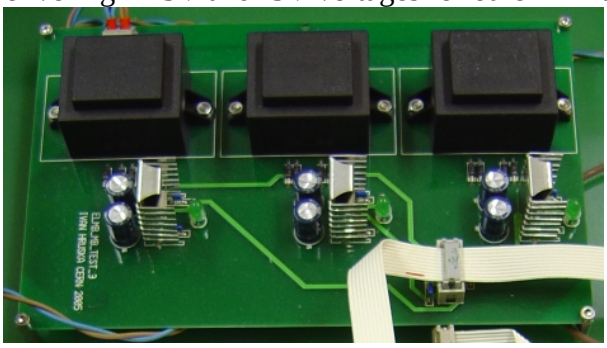


Fig.4. The ELMB_MB_TES_3 power supply board.

ELMB_MB_TEST_5 card *ELMB_MB_TEST_5_scheme.pdf*

It is an active electronic board that simulates five sense power lines (3VDIG, 5VMB, 5VDIG, 15MB) of an LVBOX, see Fig. 5. All sense lines are swept (except of 5VDIG that is stable +5V) via J4 connector from BURNIN-TESTER_MODULE DAC chip. J1 is connected to the ELMB_MB sense line inputs. Additional and optional connectors J5 and J6 can be used in case one 5V power (generated by ELMB_MB_TEST_3 board) need to be trimmed by DAC. It is not used during ELMB_MB v6.5, v6.5.3 tests.

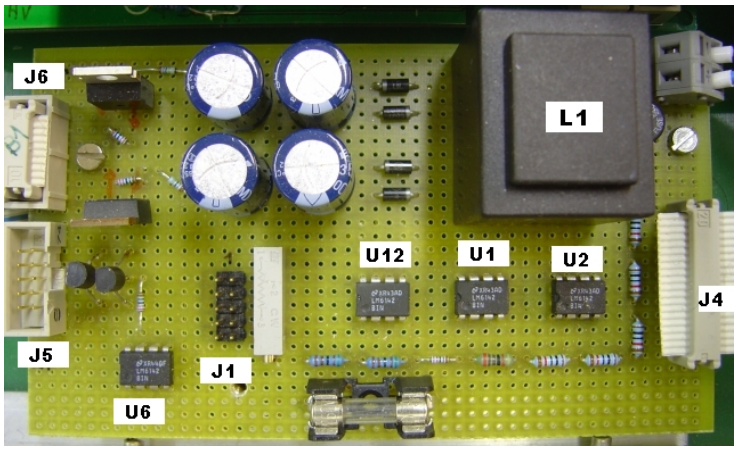


Fig.5. The ELMB-MB_5 board.

BURNIN_TESTER_MODULE board *BURNIN_TESTER_MODULE_scheme.pdf*

This board was developed for BUNIN tester for production testing of LVPS bricks, see Fig.6. It contains PIC16F873 microcontroller with three communication ports. Microcontroller communicates with BURNIN_CTRL board via J11 (opto isolated serial bus communication). A 16channel ADC chip from Linear Technology digitizes analog signal inputs from the brick. The board is connected to ELMB_MB_TEST_1 board via J17.

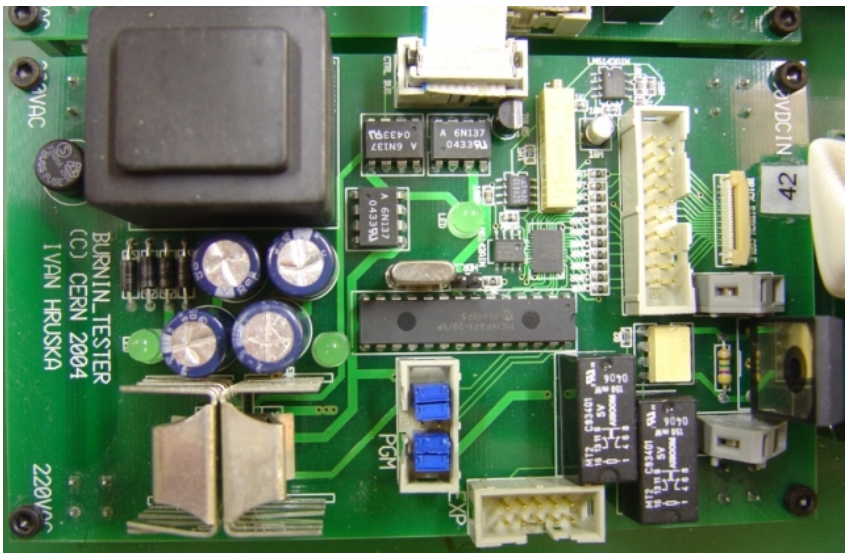


Fig.6. The BURNIN_TESTER_MODULE board.

BURNIN_TESTER_CTRL card *BURNIN_TESTER_CTRL_scheme.pdf*

This board contains PIC16F873 microcontroller that functions as a serial data multiplexer between selected 1 of 10 BURNIN_MODULE boards and UMS2 chip (USB to serial port interface, www.fdti.com). This card was also developed for BURNIN tester of LVPS bricks.

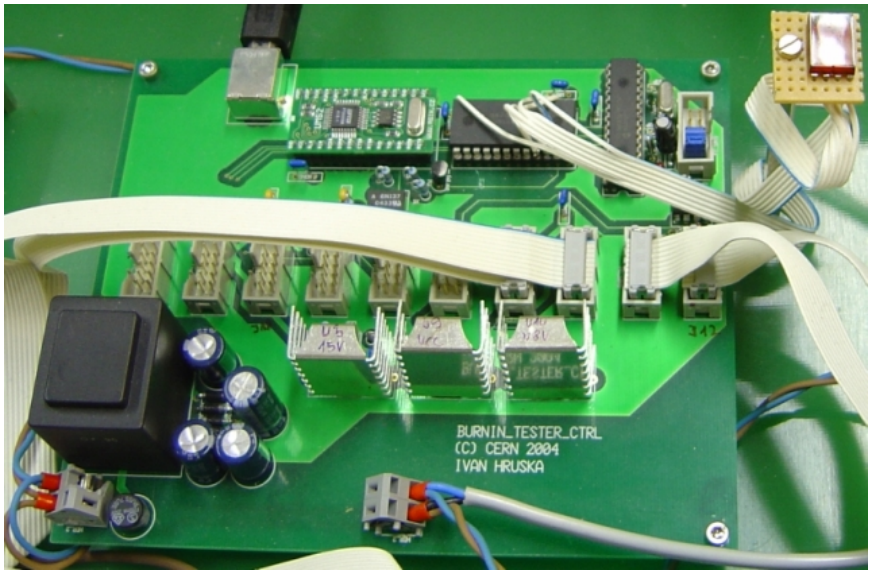


Fig.7. The BURNIN_TESTER_CTRL card.

PINFIELD_TESTER_BOX *PINF_TESTER_CONTROL_scheme.pdf*

Control box for PINFIELD tester was also used in ELMB_MB tester, see Fig.8. At the back side there are three connectors (Con1, Con2, and Con3). Con2 (FC26M) and Con3 (DSUB15F) are interconnected and supply voltages/signals to ELMB_MB_TEST_2 board. An USB to serial interface is used for PC communication.

Fig.8. Front side and backside view of the PINFIELD TESTER BOX.

ELMB_MB Tester Software *ELMB_MB_Tester.xls*

The ELMB_MB tester is automated using a Visual Basic program in an EXCEL file. This program communicates with PINFIELD_TESTER_BOX, BURNIN_TESTER_CONTROL card, and KVASER CAN bus interface by means of 3 USB ports. The ELMB module communicates with a host PC via CAN bus. Eight brick behavior and five sense line voltages are simulated by means of 4 BURNIN-TESTER-MODULEs, 8 ELMB-MB_TEST_1 cards, and ELMB_MB_TEST_5 board.

ELMB_MB tester - Short Users Manual

1) Start PC computer
2) Start ELMB_MB test bed + switch on PINFIELD_TESTER_BOX.
3) Start Excel sheet *ELMB_MB_Tester.xls* with prepared table and visual basic code inside.
4) Start ELMB_MB tester panel by "CTRL-S", see displayed menu in Fig.9.

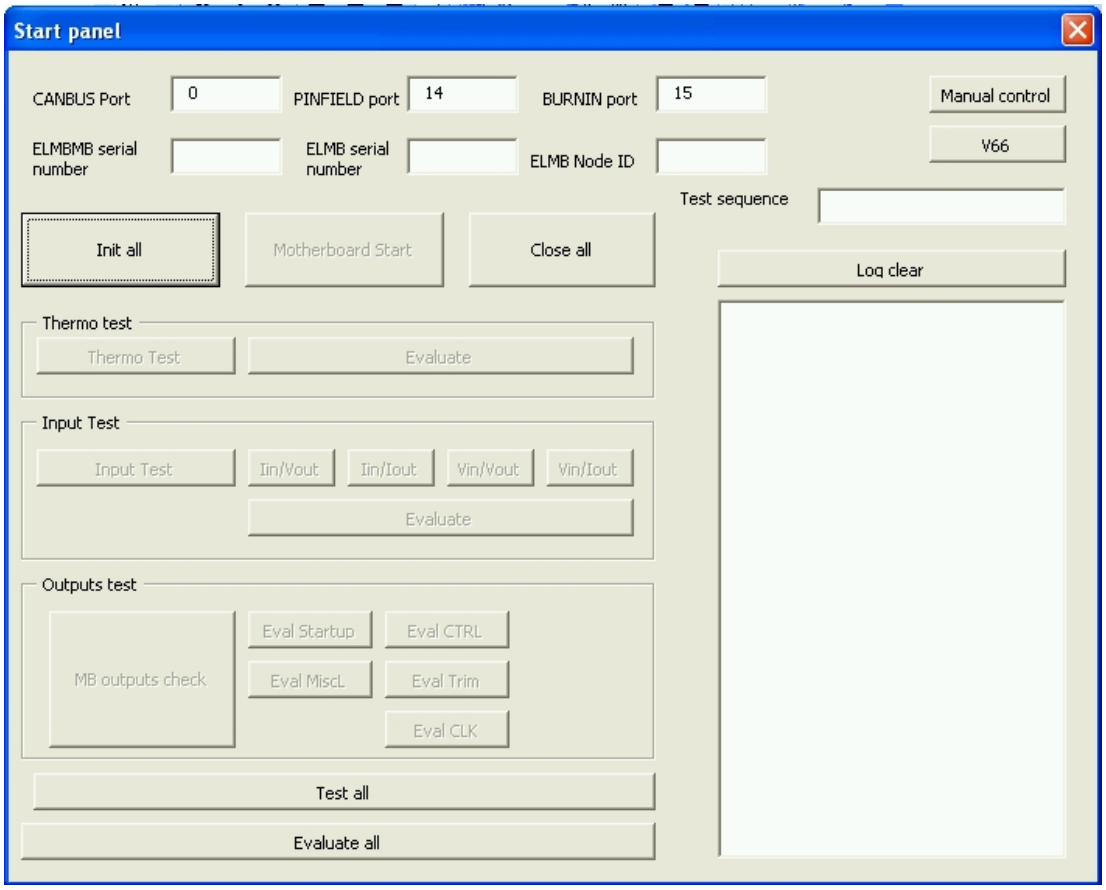


Fig.9. ELMB_MB tester Start Panel in the *ELMB_MB_Tester.xls* sheet.

6) Set proper port numbers (default CANBUS=0, PINFIELD=14, BURNIN=15), you need to verify COM ports in Windows menu "My Computer – Properties – Hardware – Device Manager – Serial Ports (COM-LPT) – USB Serial Port and number"
7) Push button "Init all" (initialization command are sent to CAN controller and PINFIELD BOX controller)

8) Wait for a response in the status window (3 times "CAN: No error").
9) Push button "Motherboard Start".
10) Program asks for ELMB_MB ID name (102xxx) and ELMB chip ID (Bxxx, Cxxx, Dxxx, Exxx).
11) Tester starts to power ELMB_MB and searches for ELMB CAN bus node. Then it returns node number and init of ADC. Wait for response in status window that program recognized the ELMB chip and communication started.
11) Push button "Test All" and click to status window to see the data communication progress.
12) Window "Test sequence" shows actual test procedure and indicates Test finished.
13) Evaluation of results is automatically started after full test and in case of any error a new window with PCB picture is displayed. Orange dot indicates position of the problem. Errors could also be seen in the table by showing the wrong measured values in red.
14) Program finally stores the whole sheet under the tested ELMB motherboard name (102xxx.xls) into a standard xls file.

EXCEL TABLE COLOR SCHEME

GREEN - Value within tolerance - GOOD
CYAN - Table background
RED - bad value (out of tolerance)
YELLOW - field to set reference values and tolerances (in %)
OTHER COLORS - to indicate blocks or comments

DESCRIPTION OF PERFORMED TESTS

The ELMB MB tester simulates a real operation of motherboard and associated eight bricks including CAN bus communication with a host PC.

1) Thermometer input test

Three thermometers on the brick are simulated by resistors switched by relays. Readout values are then varied to see a crosstalk between channels. There are two fixed values of resistors simulating 20 and 60 deg of Celsius.

2) Input test

The program checks four input readouts (Vin, Vout, Iin and Iout) of each brick. Brick values are simulated by using resistor dividers and relays. Sequence has four simulated states; values are then saved and checked in the table. There is also possible to switch any of relay combination manually to re-measure values by DVM directly on the board and eliminate contacting problems.

3) StartUp Test

Test of StartUp signal connectivity between ELMB_MB and individual bricks via ribbon cables.

4) ON/OFF test

Test simulates current loops for remote control and then checks the whole chain from the current loop until the control input of brick in both "switch" positions.

5) Miscellaneous functions test

Behavior of additional ELMB_MB sub-circuits.

MISC_ELMB_MB_VIN verifies the voltage of ELMB motherboard power
MISC_HEATSINK_IN - temperature of water input (simulated by a fixed resistor)
MISC_HEATSINK_OUT - temperature of water output (fixed resistor)

Following testes verify the functionality of five sense line voltages and proper behavior of isolation amplifiers on ELMB_MB:

MISC_SENS_15VDIG
MISC_SENS_33DIG
MISC_SENS_5VDIG
MISC_SENS_5VMB
MISC_SENS_M5VMB

These sense lines are ramped up by an external DAC circuit to see the transfer function; it is displayed in the excel graph and table.

6) DAC trimming test
Test is to verify the functionality of all DACs on motherboard; it is used for brick output voltage trimming. Two trimming values (MAX/MIN) are sent and measured by an external ADC.

7) CLOCK test
Test checks path of the signal chain for brick synchronized switching clock distribution. An external differential driver sends two logic states to ELMB_MB, clock inputs of each individual brick are then measured.

REFERENCES:

[1] B.Palan, A.Tikhonov: Manual of ELMB_MB v.6.5.3A modifications for technicians, CERN internal report, ATLAS/TileCal/LVPS/02-2007, 13 March 2007.
[2] *ELMB_MB_TEST_1_scheme.pdf*
[3] *ELMB_MB_TEST_2_scheme.pdf*
[4] *ELMB_MB_TEST_3_scheme.pdf*
[5] *ELMB_MB_TEST_5_scheme.pdf*
[6] *BURNIN_TESTER_MODULE_scheme.pdf*
[7] *BURNIN_TESTER_CTRL_scheme.pdf*
[8] *PINF_TESTER_CONTROL_scheme.pdf*
[9] *ELMB_MB_Tester.xls*
[10] *ELMB_firmware.pdf*
[11] *ELMB_MB_V65_scheme.pdf*