

## ELMB Test User Guide

This document gives a guide to using the ELMB test box and associated software. The test is designed to ensure all channels; both for analog inputs (if present), and digital inputs/outputs are functioning correctly after production. The ELMB is programmed with the current software, tested and then calibrated.

The following sections explain how to set up the hardware (which should only be required once) and how to run the tests.

NOTE: If any problems or bugs are found, please report them to Jim Cook by e-mail, james.cook@cern.ch

### Hardware Setup

The test box requires some connections to be made before any tests may be run. The connections required are for power, a CAN bus and an RS232 interface. There are four connectors clearly labeled on the back of the test box.



Figure 1: Rear of test box showing connectors

A bar-code reader may also be used, and this is explained at the end of this section.

### Power

A power supply that may supply 1Amp of current, and 12V must be used. Connect the power cable supplied to the power supply and connect the other end to the “POWER MAX 12V” connector on the back of the test box.

### CAN bus

The CAN bus must be connected to the socket labeled “CAN” on the rear of the test box. The other end of the cable must then be connected to the CAN interface card that is installed in the PC to be used for controlling the tests.

## RS232

The RS232 cable must be connected to the socket labeled “RS232 Serial” on the rear of the test box. The other end of this cable must be connected to the serial port labeled “COM2” of the PC.

## Bar-Code Reader

A bar-code reader may be used with the test software in order to read the bar-code serial numbers as supplied on each ELMB. The bar-code reader must be connected to “COM1” of the controlling PC.

## Starting the Application

To start the test software, firstly switch on the power supply. There is an icon on the desktop of the PC called “ELMB Test Software”. Double-click this icon and the test software will start.

## Running the Application

Once the application has started, the dialog shown in Figure 2 will be displayed.

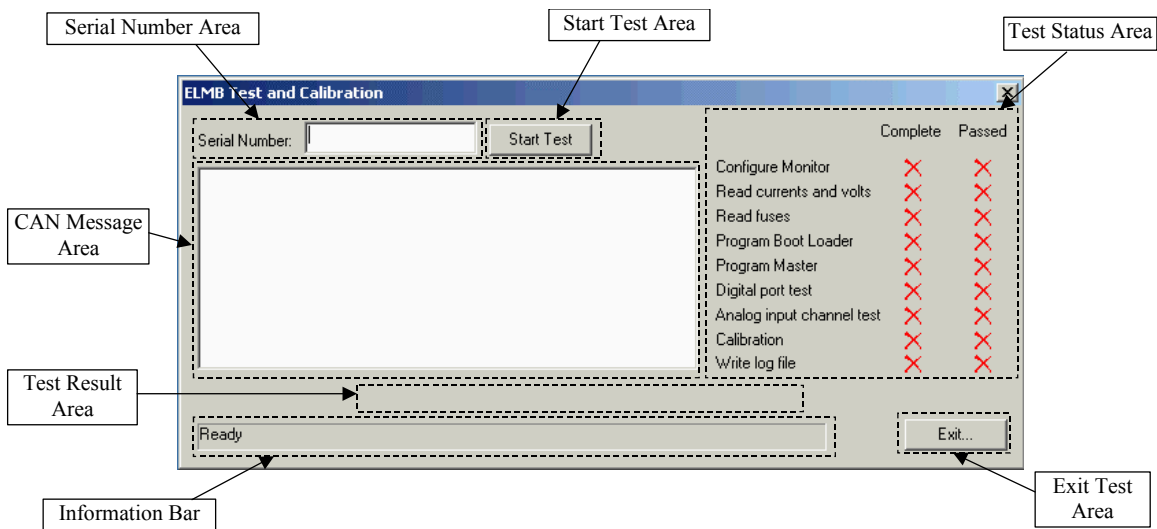


Figure 2: Main dialog of the ELMB Test Software

Below is an explanation of the various sections of the dialog.

**Serial Number Area:** If the bar-code reader is used, the serial number read will be displayed in the text area and the test will start automatically. If the bar-code reader is not used, then the user may enter a serial number manually in the text area.

**Start Test Area:** Clicking the button labeled “Start Test” will initiate a test for an ELMB. This is not necessary if the bar-code reader is used (as once the bar code is read, the test starts automatically). A valid serial number<sup>1</sup> for an ELMB must be entered into the serial number text area before a test will begin.

<sup>1</sup> A valid serial number consists of one *alpha* character followed by three *digits* (e.g. A001)

**CAN Message Area:** This area shows the messages that are present on the CAN bus. This area is mainly used for diagnosis, and in the main, may be ignored.

**Test Status Area:** This area displays the progress of the various parts of the test. A small green tick (✓) will be displayed in the “Complete” column as each part of the test is completed. If the relevant part was successful, another green tick in the “Passed” column will shortly follow this. If the relevant part was unsuccessful, a red cross (✗) will remain visible and the test will be stopped.

**Test Result Area:** This area is only visible once a test has stopped for any reason. The overall result of the test will be displayed, whether a pass or a fail.

**Information Bar:** Various information texts are displayed in this area while a test is being completed.

**Exit Test Area:** Clicking this button allows the user to exit the test application. Confirmation is required before the application will exit.

## Pre-Test Setup

To test an ELMB, the ELMB must first be connected to the test box. A tool is supplied for the purpose of picking up and placing the ELMBs. To pick up an ELMB:

1. Push the orange top of the tool to open the jaws
2. Place the jaws around the ELMB
3. Pull the orange top of the tool to close the jaws around the ELMB

The ELMB may then be placed on the top of the test box with the connectors on the bottom of the ELMB lining up with the connectors on the top of the box. The ELMB must then be pushed firmly down to make a good connection with the test box. To release the ELMB, push again on the orange top of the tool to open the jaws, and remove the tool from the ELMB.



**Figure 3: Placing the ELMB on the test box**

## Starting a Test

Once the ELMB has been connected (see Pre-Test Setup) the test is ready to be started.

If the bar-code reader is being used, the serial number visible on the top of the ELMB should be read using the bar-code reader. This will display the serial number read in the serial number text area and the test will begin.

If the bar-code reader is not being used, the user must enter the serial number of the ELMB manually in the serial number text area. The serial number is displayed in characters at the bottom of the bar-code label on the ELMB. Once the serial number has been entered, the user may click the button labeled “Start Test” and the test will begin.

### **Expected Output During the Test**

When the test begins, many messages will be displayed in the *CAN Message Area*. These messages are used to control the test box and to receive messages from the ELMB under test.

While programming the ELMB, some extra windows will be displayed. These windows will only appear during programming and will close when programming is completed or an error has occurred.

As each part of the test is completed, the red cross (‘×’) in the “Complete” column of the *Test Status Area* will change to a green tick (‘✓’). If an error occurred during execution of the part of the test, the “Complete” status may not change. In these circumstances, the test will be stopped and the result will be displayed as a failure in the *Test Result Area*.

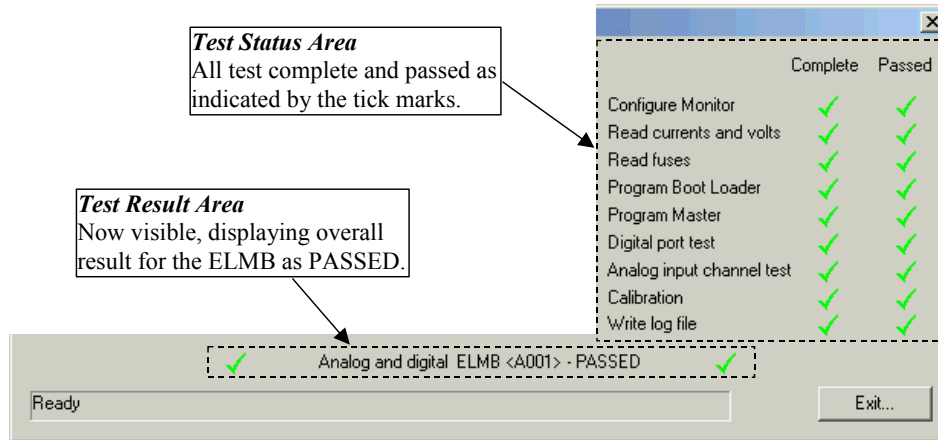
Shortly after each part of the test is completed, the results are analyzed and the pass or fail result will be displayed in the “Passed” column of the *Test Status Area* using the green tick for pass, and the red cross for fail. For most of the parts of the test, if one is completed but fails, the test will be stopped and the result displayed in the *Test Result Area*. The exception to this is the “Digital port test”. If this test fails, the “Analog input channel test” is attempted to give a more clear view of the quality of the ELMB.

If *any* of the parts of the test fail, the overall result for the ELMB will be a failure.

Once the test has stopped for any reason, the overall result of the ELMB will be displayed.

### **Expected Result from a Test**

Figure 4 shows the *Test Status Area* and the *Test Result Area*, as they would be displayed if an ELMB is programmed successfully and passes all subsequent tests.



**Figure 4: Test Status Area and Test Result Area as shown if test completed without fault**

The last operation completed by the test is to output a text file containing information on the various parts of the test. Any failures are recorded here with more details indicating the reason for the failure.

## Post-Test Setup

Once a test has been completed, the ELMB must be removed from the test box.

If a re-test is required, the ELMB may be left in the test box and a new test started (with the old ELMB) as detailed in the section “Running a New Test”. In this case, once the serial number has been entered (either by reading the bar-code or by entering the serial number manually and clicking “Start Test”), a question will be displayed for confirmation. This confirmation is used to ensure that all serial numbers are unique, and serves as an aid to warn of duplicate serial numbers. Answering “Yes” to the confirmation question will result in another question, requesting whether re-programming is required. Answering “Yes” to this question will run the full test again with the same serial number. If re-programming is not required, answer “No” and only the testing and calibration part of the test are performed. The output log file from the previous test is not overwritten, but kept to show the history of the ELMB.

Once an ELMB has been tested satisfactorily, it must be removed from the test box. Using the tool provided, push the orange top to open the jaws. Place the tool around the ELMB and pull the orange top upwards to close the jaws around the ELMB (as shown in Figure 5).



**Figure 5: Removing the ELMB from the test box**

The ELMB may then be removed using the tool.

### **Running a New Test**

To initiate a new test after a previous test has completed and the ELMB removed from the test box, a new ELMB must be connected to the top of the test box. To start the new test, two choices are available:

1. The user reads the serial number of the new ELMB using the bar-code reader. This automatically starts the new test.
2. The user enters the serial number of the new ELMB manually and the button labeled “Start Test” is clicked. The test begins when the button is clicked.

At the start of a test, all status marks are initialized to show that no parts are complete or passed, and the overall result is shown.

### **Stopping the Application**

To exit the test software application, the button labeled “Exit...” may be clicked. A confirmation question is displayed to stop the test being exited accidentally. If the user answers “Yes” to the confirmation question, the application ends and the dialog will close.

## **Software Process Description**

### **Tests Completed**

There are a number of ‘parts’ to the ELMB test. These are detailed below:

- Currents and voltages are measured
- Programming of fuses for processor
- Programming boot sector of the processor
- Programming main sector of the processor

- Test of digital ports
- Test of analog inputs
- Calibration of all analog input voltage ranges

In the following sections, the process executed during each part of the test is explained.

## Measuring Currents and Voltages

The ELMB situated within the test box (which is not visible) is configured and a SYNC is sent to the CAN bus. The ELMB responds with 11 channels containing the data described in Table 1.

**Table 1: Value descriptions for ELMB situated within the Test Box**

<i>Channel Number</i>	<i>Value Given</i>
0	Digital Voltage
1	Digital Current
2	CAN Voltage
3	CAN Current
4	Analog Voltage
5	Analog Current
6	3.3V Digital Regulator
7	5V CAN Regulator
8	5V Analog Positive Regulator
9	5V Analog Negative Regulator
10	2.5V Voltage Reference

These values are analysed and if they are outside specific limits, the power to the ELMB being tested is switched off (to ensure the minimum amount of damage to the ELMB) and the test is stopped.

## Programming Fuses

The microprocessor on the ELMB requires certain fuses to be set to allow for compatibility with an older processor of the same family (this is required due to hardware restrictions).

To program the fuses, a command-line program is called. This checks for the presence of the programming hardware connected to a serial port, and ensures that the correct type of microprocessor is connected<sup>2</sup>. While this command line program is running, a DOS window will flash up on the screen for a short amount of time. If the correct hardware and microprocessor has been found, the fuses are programmed, therefore allowing the software to be loaded into the ELMB.

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<sup>2</sup> Older versions of the ELMB used a different microprocessor. The check ensures that incompatible software is not loaded onto the wrong version.

No output is shown in the DOS window, as the output is directed to a file. The file produced is then analysed and any errors will stop further execution of the ELMB test.

### **Programming the Boot Sector**

The microprocessor on the ELMB utilizes a boot sector. This may be used to allow for certain operations to be performed, such as programming of the main sector of the processor while the ELMB is on any bus, and to allow for a 'watchdog' process which may perform a soft reset of the ELMB if the main program has been interrupted (for example, due to SEE in radiation).

To program the boot sector, the same command-line program is called as for programming the fuses. The program checks the programming hardware is connected to a serial port of the PC and then downloads an image of the boot sector to the ELMB. While the program is running, a DOS window is displayed for approximately 10 seconds. No output is shown in the DOS window, as the output is directed to a file. The file produced is then analysed and any errors will stop further execution of the ELMB test.

### **Programming the Main Sector**

The main sector of the microprocessor contains the main program for the ELMB. The main program executes the majority of the ELMB's functionality.

To program the main sector, the same command-line program is called as for programming the fuses. The program checks the programming hardware is connected to a serial port of the PC and then downloads an image of the main sector to the ELMB. While the program is running, a DOS window is displayed for approximately 10 seconds. No output is shown in the DOS window, as the output is directed to a file. The file produced is then analysed and any errors will stop further execution of the ELMB test.

### **Digital Port Test**

The ELMB contains four digital ports. When the ELMB under test is connected to the test box, the hardware inside the test box connects the digital ports in a specific pattern. This pattern is used with some internal software of the ELMB to test all bits of each port when a pre-defined command is given to the ELMB. The results from this test are encoded and sent (via the CAN bus) to the PC. When the PC receives the result, it is analysed and a pass or fail verdict is assigned.

If the ELMB fails this test, the *test does not stop*. Any following tests would still be completed to give a clearer picture of any faults on the ELMB.

### **Analog Input Test**

The ELMB contains 64 analog input channels. When the ELMB under test is connected to the test box, the analog input channels are connected to a network of resistors giving known voltage values for each channel. The analog inputs are first configured for a specified voltage range, conversion rate and mode (bi-polar or uni-polar). The number of channels sent from the ELMB is also set to be the full 64 channels.

The purpose of this test is twofold:

1. To ensure all 64 channels are correctly connected and give valid voltage values

2. To perform a calibration for the specified voltage range (see the section ‘Calibration’ for details)

A SYNC message is sent to the CAN bus and the ELMB should respond by sending all 64 channels to the PC. The test completes when one of two possibilities occurs:

1. All 64 channels are received
2. A timeout elapses

The timeout period is set such that all 64 channels will be received before it elapses if the ELMB is functioning correctly.

For the test to pass, all 64 channels must be received within the timeout period. The values received must also be within specified limits of the expected values (given by the resistor network in the test box).

If the test fails, no calibration will take place, though any other following tests will be performed.

## **Calibration**

If the analog test is successful, the remaining voltage ranges (that is, all ranges apart from the one used for the Analog Input Test) are calibrated. The calibration is performed by sending a SYNC to the CAN bus, and only the first 16 channels are received. The resistor network contained in the test box has 16 different values. Therefore, only these channels are required for a full calibration, and this also decreases the time needed for this procedure.

Once all 16 channels have been received, a calculation is performed on the values obtained that give four values for gain registers within the ELMB. These four values are loaded into the EEPROM of the ELMB and are then used each time the ELMB is powered up.

## **Log File Output**

After every test (whether the result is pass or fail), a log file is produced containing information regarding the test. This includes information such as the results from each of the tests detailed above, the values obtained during the Analog Input Test, Digital Port Test and the Reading of Currents and Voltages, and the calibration constants calculated for each of the ranges. This gives a permanent record of the tests for each ELMB.

## Quick Reference

Below is a quick step-by-step guide for ELMB testing.

1. Using the tool provided, place the ELMB onto the top of the test box.
2. Either,
  - a. Read the bar-code serial number on the ELMB.
  - b. Enter the serial number in the text field and click the button labeled “Start Test”.
3. The test will run, giving status information at each step.
4. Once the test is complete, the result will be shown on the main dialog.
5. Either,
  - a. Remove the ELMB using the tool provided.
  - b. If the ELMB failed, the test may be performed again (this may also be done at a later time).