

A PC-based Auto-testing System for BEPC CAMAC Modules

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1 Introduction

A great deal of CAMAC modules are used in BEPC, however we are without an effective testing system. We imported a CAMAC testing system from SLAC twelve years ago, it played an important role in BEPC construction and operation during the beginning stage, but the system failed several years ago, it is too old to be restored. It is critical to verify that all on-line CAMAC modules are running properly at any time. It is possible for the entire BEPC control system to shutdown if on-line CAMAC modules have trouble. We are required to build a new CAMAC test system for BEPC normal operation.

We designed and developed a PC-based standalone system for testing CAMAC modules since PC is now more popular and less expensive.

All CAMAC modules in the BEPC control system come from abroad. They are IDIM, IDOM, SAM, PSC, 3016, SCC, SBD, 3922, 3388, 3530, trigger, CV and so on. Of them, there are IDIM, IDOM, SAM, PSC, 3016 to be automation testing because they are approximately 80 percent of the whole on-line CAMAC modules in number. The other modules are also tested.

2 Operation characteristics

Operators are able to run this new test system easily. First they turn on the PC, CAMAC crate, auxiliary NIM crate, and digital voltmeter after the cables are connected. The power is supplied to the stand for at least one hour in order for the analog signal measurement to be made. The standard modules with this system have the SAM TESTER at slot 18 in CAMAC crate, IDIM at 4, IDOM at 8, 3016 at 16 using as signal reference sources. DTM-399 at slot 23 can be used to monitor the testing process and to check system security.

The first window has a CAMAC icon in it, by clicking the icon and logging on, you enter the << CAMAC Test System >> window. A hardware connection message about testing can be found in <<information>> and <<help>> menu. When you choose open module option under <<file>> menu, the open module window is displayed[2].

Operators click the crate number, slot number for the module to be tested, and the working mode selections on the open module window to begin the test. We designed 6 working modes for this system: <<general>>, <<3016>>, <<SAM>>, <<IDIM>>, <<IDOM>>, <<PSC>>. The <<General>> mode is supposed to test any CAMAC module with NAF functions by means of various input parameters. Other modes are used for specific module auto - testing after the <<auto>> button is pressed on their

particular windows, or for special item testing when it is selected. The test system can also print or store the test results including the name of the test person and the test time for later use.

Operators sit in front of the instrument and just press the keyboard and mouse buttons to finish testing without other special tools.

3 Hardware configuration

The test system hardware consists of 4 parts: a PC with interface modules KSC-2927 and AX-5488 in the AT slots; a NIM crate with three home-made auxiliary modules A9-15, A9-16, A9-17, a CAMAC crate with a KSC-3922 crate controller and standard test modules: 3016, SAM tester, IDIM, IDOM in the appropriate slots and a 1/2 digital voltmeter HP-3456A, see Fig 1.

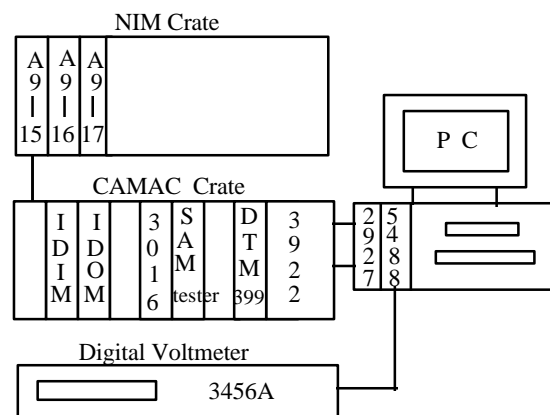


Fig. 1. Testing System for BEPC CAMAC modules

All standard test signal sources come directly from CAMAC modules. The IDOM is selected as a digital test signal reference which has 32 digital channels with flexible and configurable outputs. The SAM tester, which came from SLAC, is the analog signal test reference which is dedicated for testing the SAM module. The SAM tester has 32 channel direct voltage references with good linearity and smooth adjustment in range of -10V to +10V with the high stability of less than +/-0.0001. Its BNC output connector is convenient for the measurement of the SAM tester module output references through the use of the accurate digital voltmeter. 3016 is another analog signal standard module with 16 channel outputs of 16-bit resolution. Its linearity is excellent with +/-0.003%. It is one of ideal analog references. We also use the IDIM as a digital input standard module with 32 digital channels.

For a more efficient test, we designed and developed three types of NIM auxiliary test modules.

The interface between IDOM and IDIM is the NIM digital module A9-15 which has 32 channel inputs from a IDOM and 32 channel outputs to the IDIM with 32 LEDs on the front panel. IDOMs opto-coupled outputs are not directly routed to the IDIM with opto-coupled inputs. We can check if the IDOM outputs logic is correct via LEDs display.

The NIM module A9-16 is appropriate for analog measurement. The 16 channel analog signals ranging from -10V to +10V go from 3016 to the A9-16 inputs. Only one analog signal is multiplexed to the BNC connector on the front panel which is then connected to the 3456A. A multiplexed analog signal for the A9-16 can reach an accuracy of less than +/-0.005 (including the 3016 error with +/-0.002 between theory values and output values) after analyzing numerous acquired data. Channel selection can be fulfilled through 4 channel IDOM digital inputs. It should be a short connection from 3016 to 3456A through special cable when it is necessary for more accurate report. Test requirements determine whether or not an analog reference from 3016 to SAM is required.

The NIM module A9-17 is dedicated for testing the CAMAC module PSC. PSC is a powerful control module for accelerator main magnet supplies with a 14-bit digital DAC and digital I/O with opto-couplers that are used in our ring control. LEDs on A9-17s front panel display the 14-bit digital DAC output and 6 digital outputs coming from PSC, 8 digital inputs from standard IDOM. There is a BNC connector on its front panel in order to route to oscilloscope COS6100G for 14-bit digital DAC clock test.

Practice proves that these home-made NIM modules are helpful in convenient test.

4 Application software development

The test system software design goals are to implement a current popular graphic man-machine interactive interface for the operator convenience and to auto-test 5 types of CAMAC modules with as many function tests as possible. These modules are employed in great numbers in on-line accelerator control.

Application software is comprised of 5 parts: CAMAC DOS driver, DOS-Windows DOS interface program, MS-Windows CAMAC dynamic link library, MS-Windows GPIB-488 dynamic link library including applications, and man-machine windows interface program package. All of them are developed in-house except for the CAMAC DOS driver. The brief introductions follow. For the application software architecture, see Fig 2.

The CAMAC DOS driver[1] is market available. It operates with the KSC-2927 under MS-DOS. It provides several I/O library functions such as CAOPEN, CACLOS, CAM16, CAM24, CAB16, CAB24, CACTRL, CCSTAT, and so on.

DOS-Windows DOS interface CAMACTSR.C is a TSR program running under MD-DOS. It is programmed using TURBO C 2.0. Actually, it is a interrupt service using a vacant soft interrupt number 0F8. It creates a

2KBYTES common data exchange area in the memory so as to prepare data and the area starting address of real mode for I/O between MS-DOS and MS-Windows.

MS-Windows CAMAC dynamic link library camacDLL.C is designed to provide an interface invoked by Visual Basic as well as a data exchange service with CAMACTSR.C. The program package camacDLL.C is programmed by Visual C++ 1.5. In order to assure data access correction, the right identification to MS-DOS data exchange area is very important. We correctly transformed data area starting address from real mode to virtual mode and made the numbers of data types to minimum for VB usage.

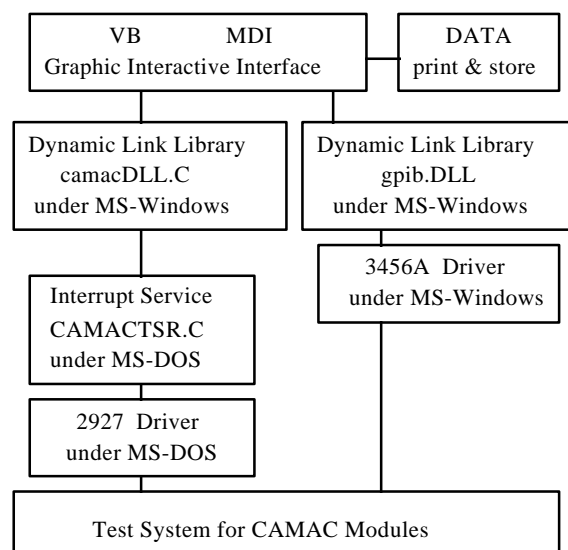


Fig 2. Application Software Architecture

MS-Windows GPIB-488 dynamic link library is market available with 17 interface functions complying with GPIB-488 protocol. First, we set the digital meter GPIB address to 22, then restore it to initiate status, put it to listener, write control words and read the measurement results, and so on.

The man-machine windows interface program package is created by Visual Basic which is an object-oriented programming tool. The man-machine interface is a multi-pages and multi-windows with MDI style.

For more information about the application software introduction, see[2].

5 Test functions

The overall considerations are to test automatically for 5 types of IDIM, IDOM, PSC, 3016, SAM. Other types of CAMAC modules are tested manually.

The tests for IDIM are Q/X response, single digital input scan, random digital input scan and status level transition test. Digital reference signals come from standard IDOM, but status level signals are obtained from standard 3016.

The tests for IDOM are Q/X response, single digital output scan, random digital output scan, selective bit

set/clear and bit pulse on/off. All the test processes are displayed using LEDs on the front panel of the A9-15 or are read by the computer using the A9-15 and standard IDIM.

The tests for PSC are Q/X response, ramping rate time, digital output scan and digital input scan. PSC can run in one of seven ramping rates by means of code control. We can test these seven ramping rates separately within ± 0.5 second or observe its digital DAC LEDs change rate on the A9-17s front panel. The digital output and input logic also displays on the front panel of A9-17. Testing the correction of digital inputs needs standard IDOMs reference signals.

In respect to 3016, we test its output nonlinearity for each channel besides Q/X response. We generally use the A9-16 and IDOM as standard test modules to perform the automatic measurement. The graphic from the nonlinearity results can display on 3016 test windows because the 3016 outputs data can be read back from digital meter 3456A through GPIB-488. If more accurate data are needed then a direct link between the 3016 output channel and the 3456A is necessary. However, we thought that 3016 outputs can be directly connected to standard SAM inputs for testing 3016, but it is not yet adopted.

SAM has two working modes: normal scan mode and fast scan mode. We concentrate on the performance test under the normal scan mode that is our working mode in practice. The test items have Q/X response, linearity and AC function. The standard SAM tester module is selected as an adjustable analog signal reference. It has 32 channel outputs which adapt coincidentally to the 32 channel inputs of the SAM. In parallel, one of the outputs can be connected to a digital voltmeter for SAMs linearity measurement. Its result will be shown on SAM test windows in graphic form. AC function test is an important index for SAM to see if the SAM can reject 60 Hz noise signal.

Other CAMAC modules like SBD, SCC, CV, etc., can also be tested by this system by selecting <<general>> button on the open module window. By choosing the NAF for a particular module you can read/write data from/to the module in three models: Q/X responses, single data transfers and

block data transfers according to your interest.

6 Questions and considerations

It took us about one year to build this CAMAC test system. Its design aims at keeping BEPC on-line CAMAC modules in good condition. It does not try to make an overall performance test for every CAMAC module.

This new test system has been in operation since June of this year. We plan to verify all CAMAC modules which are used as spare parts and fix all broken modules during BEPC shutdown by using this new test system. Now, the system works well in spite of need for more practice to develop its potential.

Correct operation for the system is very important. It relies on two aspects. Firstly, every standard module including three NIM and five CAMAC work well, therefore we must find solution to assure these standard modules are robust each time test begins. Besides this, We should make reliable connections for each tested type of CAMAC modules, and should minimize changes in measurement cables.

Determining the exact malfunction locations is significant if the module to be tested fails. The question is which instrumentation card can collect such information that can be accessed by the computer. This is our next challenge.

This system is an off-line standalone one. We think that the better way to find malfunctions for CAMAC modules is on-line test in a regular period through some application software when times are feasible. It is particularly important for analog modules like the 3016 and the SAM. This test procedure allows us to detect a problem with linear response timely and avoid any problem to operations.

References

- [1] Kinetic System Corporation. Model 2927 CAMAC/IBM PC Interface and 6110G Software, Release 1.1, 1992.
- [2] H.Zhang, J.J.Xu, <<Software Design of Auto-testing system for CAMAC Modules>>, proceedings on The China 9th Symposium on Computer Application in Modern Science & Technology, p405-410, 1997.