

# Conversion of the TISOL Control System to EPICS

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## Abstract

As part of the preparation for the ISAC radioactive beam facility at TRIUMF, the control system of the small on-line isotope separator TISOL was upgraded using the EPICS toolkit. This upgrade served several purposes: a) to train control personnel on EPICS, b) to familiarize future ISAC users with a prototype of the ISAC control system and c) get an early user feedback on the control system to the controls group. Previously, TISOL was controlled from a PC using custom software and Optomux I/O hardware. The new system maintains the existing I/O hardware and uses an EPICS IOC to drive the Optomux loop. Optomux hardware support was integrated into EPICS and the existing software functionality was recreated using the EPICS tools. The cost and benefits of converting this legacy system to EPICS will be discussed.

## 1 Introduction

TISOL is an on-line isotope separator test facility at TRIUMF which was built in preparation for the ISAC radioactive beam facility, which is currently under construction. TISOL was first commissioned in 1986. It consists of a target ion source and a mass-analysing beam line. A low intensity proton beam (a few  $\mu\text{A}$ ) from the TRIUMF cyclotron produces short-lived radioactive isotopes in a hot massive target by spallation reactions. These isotopes are ionised and extracted from the source at a potential between 10 and 20kV. This ion beam is mass-separated by a dipole magnet and transported to a small experimental area switch-yard. The Control system provides control for the vacuum system, ion source and beam optics. An overview of the TISOL beam line is shown in Fig. 1.

## 2 Original system

### 2.1 Hardware

The existing TISOL control system was built on an extremely low budget using an IBM PC compatible personal computer and Optomux I/O hardware. The Optomux system contains 12 analogue and 17 digital I/O-boards on a multi-drop RS422 line. Each I/O-board accommodates 16 I/O-channels.

### 2.2 Software

TISOL is presently controlled by the TICS software package [1,2]. It runs on the PC under MS-DOS, using an internal multitasking executive. It provides device selection and basic open-loop device control through the numeric keypad. The display uses simple character graphics. The flexibility of the TICS system is derived from the use of an ASCII data base which specifies:

- Device properties
- Conversion tables
- Hardware commands
- Interlocks
- Alarms
- Logging
- Display layout.

Figure 1 shows a TICS database entry for an Ion Gauge with interlock conditions.

```
Gauge IG5
Commands
  On b251 p3 c10
  Off b251 p3 c11
  Condition RV8 off
  Condition GV8 open
  Condition RP4 on
  Read_status b252 p1 c12
  Read_value b255 p1 c37
```

Fig. 1: TICS data base section

## 3 Upgraded system

Since its original design, the TISOL control system has been upgraded several times to accommodate new beam lines and to include new features such as sequencing and Ethernet support for remote control. It has, however, clearly reached its limits and new user requirements made an upgrade necessary. Given our limited resources, it was decided to retain the existing Optomux I/O hardware and to upgrade the software using the EPICS toolkit. EPICS had recently been chosen for the control system of the ISAC accelerator facility. This approach has several advantages:

- a) It facilitates the integration of the upgrade with the ongoing experimental program, because switching back and forth between the old and new system can be achieved in a matter of minutes.
- b) The new TISOL system will provide important feedback for the designers of the ISAC system from the overlapping user community.
- c) The new system will be embedded in the main-stream of TRIUMF control system development, thus providing for integrated maintenance.

### 3.1 Hardware upgrade

The new system will use one VME crate as EPICS input/output controller (IOC), one SUN Sparcstation as application server, and one or more PC's running X-Windows software as operator terminals. As CPU for the EPICS IOC, we chose the MVME162 which is also used for the ISAC control system [3]. The Optomux serial connection

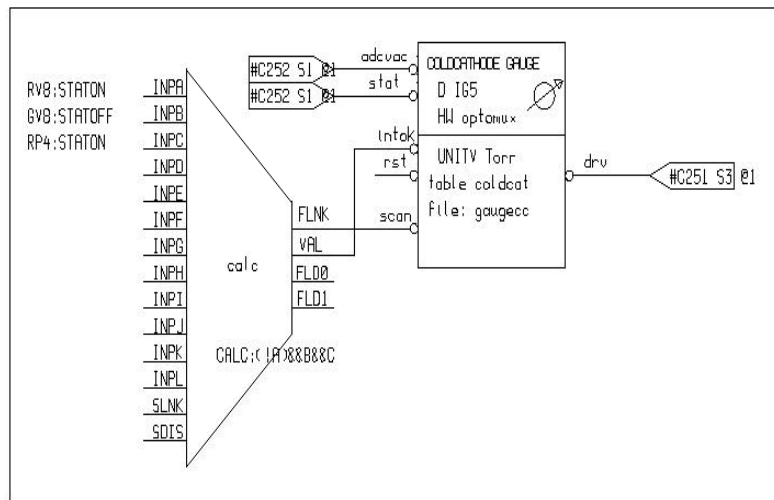


Fig. 2: Section of CAPFAST schematics

will initially be connected to the second serial port of the MVME162. Future performance enhancements are possible by changing the Optomux topology from one to multiple independent loops using, for example, industry packs with multiple serial ports.

### 3.2 Software upgrade (EPICS)

The software upgrade consisted of the following tasks:

- Writing C code for integrating the Optomux system into EPICS.
- Using EPICS tools to convert the TICS database to EPICS databases
- Using EPICS tools to replace the TICS operator interface screens with EPICS screens.

#### 3.2.1 Optomux integration

EPICS device and driver support for the Optomux hardware was developed using the C language. The Optomux serial communication is very slow (In our old installation we are limited to 19200 baud.). Instead of writing asynchronous EPICS device support with call-back functions, we opted for a separate polling task which is spawned when the EPICS driver level is initialised. This task polls the Optomux system using the vxWorks serial port driver and interacts with the EPICS device support via memory-resident data structures.

#### 3.2.2 EPICS database

We use the CAPFAST schematic drawing package [4] as the primary tool to build EPICS databases. Drawing on the experience from our first EPICS project [3] and the ongoing work for the ISAC control system, we use a schematic hierarchy of the form

Sub-system >> device >> component >> EPICS primitives.

In this scheme, device functionality is constructed from reusable components wherever possible. Macro substitution is used to define device specific operating parameters,

hardware type, etc. at the device symbol level. This approach allowed us to very quickly convert the TICS database of 170 devices. As an example, figure 2 shows a section of a CAPFAST sub-system schematic drawing which corresponds to the TICS database section shown in figure 1. A calculation record is used to describe the interlock conditions for an ion gauge.

#### 3.2.3 Operator interface

Because of their high performance, the EPICS tools edd/dm were selected over medm for creating and displaying operator screens. Standard open-loop device control is done from synoptic displays of the different sub-systems, such as vacuum, beam optics, etc. In addition, for each device a detailed control panel can be called up which shows all device parameters and all interlock information. In order to bypass the tedious process of interactively constructing many of these panels, a utility was written which generates panel instances using template files and instance specifications contained in a spread-sheet.

## 4 Project status

The Optomux driver and its integration into EPICS are completed and were tested on a small system under laboratory conditions. Conversion of the TICS data base into a working EPICS function block data base is 90% complete. A first set of operator interface screens has been completed and is currently being tested together with the data base in simulation mode. Installation and testing on TISOL will begin early next year. As a by-product of the conversion to EPICS, improvements to the existing functionality, such as better mass-scanning, improved sequencing capabilities, and remote access to the control system will now be possible with little effort.

## 5 Conclusion

This conversion project proceeded at low priority in

parallel with the ongoing development of the ISAC control system, which supplied some usable screen templates and, above all, debugged EPICS data base components. Because of this and the seamless integration of the existing controls hardware very few resources were needed to produce the upgraded system which is ready for testing. Up to now, two man-weeks each were spent on screen design and the development an EPICS data base which reflects most the TICS functionality. Optomux driver development and integration into EPICS consumed approximately five man-weeks. Although there is still work left in the areas of alarming and login, our present experience with this upgrade encourages us to consider converting other TICS based systems to EPICS in the future, especially the CAMAC based secondary channel control system.

### **Acknowledgements**

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### **References**

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