The Slow Control System of the DELPHI Small Angle Tagger (SAT) and Very Small Angle Tagger (VSAT)

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Abstract

This article describes the Slow Control System for the DELPHI Small Angle Tagger, SAT, and Very Small Angle Tagger, VSAT. The two detectors share a single G64 crate to interface to the various types of Slow Controls hardware. The temperatures of the SAT modules and the status of the Fastbus and power supply crates for SAT and VSAT are monitored with standard DELPHI hardware and software. The DC ON/OFF control of the Fastbus crates is also DELPHI standard. In addition to these systems both SAT and VSAT use a voltage bias supply developed at the University of Oslo for silicon diode and photo-diode detectors. The front-end readout of the SAT tracker, a silicon-strip detector, is also monitored and controlled from the G64 crate with non-standard hardware and software.

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1 Introduction

The DELPHI Slow Controls system is designed for controlling certain parts of the hardware, such as high and low voltages, as well as monitoring other systems, e.g. temperatures, gas pressures and status of crates, thus enabling an operator to monitor and control the whole of DELPHI using computer software.

The Slow Controls system consists of a set of programs which are linked together in a chain. First comes the G64 skeleton program which interacts with the hardware, followed by the Elementary Processes, EPs, which enable the operator to communicate with the G64 and report on the current status of the hardware, and ending with two user interfaces, SMI and HIPE. SMI shows the overall hardware status as reported by the EPs and sends selected commands through the EPs to the G64, while HIPE enables the operator to go deeper into the hardware and e.g. to monitor the exact values of voltages or change their settings.

The SAT and VSAT detectors have identical systems regarding bias supplies and Fastbus monitoring/control and thus use the same Slow Controls setup for these systems. In addition the SAT group has an EP for monitoring the temperatures in the calorimeters and tracker system and an EP for control of the silicon tracker. The BIAS system was designed by members of the SAT collaboration [1] and later on adapted to the VSAT.

This article describes the SAT/VSAT Slow Controls system and the software programs used by the detectors. In section 2 the differences of the standard G64 software and SAT/VSAT implementations are outlined, section 3 explains how the Elementary Processes work and the last two sections describe the use of the two interfaces, SMI and HIPE respectively. A more detailed description on how to use the SAT/VSAT systems and the error messages that they generate can be found in [2].

2 The G64 skeleton program.

The differences between the standard DELPHI G64 Skeleton [3] and the SAT/VSAT implementation are:

- Inclusion of the SAT/VSAT specific code, meaning the setting and monitoring of the bias supply and the tracker threshold setting.

- Inclusion of RPC calls for the SAT/VSAT routines.

- Commenting out code and variables not used by SAT/VSAT, such as CAEN etc, in order to gain memory space.

- A different organization of the code on the G64 memory pages for the same reason.

The SAT/VSAT specific RPC routines that have been added to the standard calls will initialize the non-standard data structures, set and read the bias voltages and monitor the bias currents, set tracker thresholds and several other parameters relevant to the performance of the front-end readout chips.
2.1 Error handling.

The monitoring loop of the G64 Skeleton program continuously monitors all channels and compares the readings to the desired values. An alarm message is sent to the VAX when a reading is outside a specified range. The alarm is cancelled by a second message when/if the channel in question goes back to its normal state. The monitoring loop of the G64 program takes about 90 seconds to execute and consists of three subloops:

- Standard control channels; temperature and switch status
- Bias voltage and current monitoring
- Tracker monitoring

3 The Elementary Processes

Each set of channels of a particular type (e.g. the temperature readings of the SAT) are assigned to a separate Elementary Process [4] which executes on a VAXstation in the DELPHI online cluster. The Elementary Processes take care of the communication with the G64 program, report error conditions to the operators, make updates to the database of calibration constants and channel statuses, receive user commands from the HIPE system (described in section 5) and determine a state which summarizes the condition of that component of the system to the State Manager (described in section 4). For the moment the initialisation of the G64 software is done by a separate program but eventually this will be handled by the Elementary Processes using what is specified in the Slow Control tree of the DELPHI data base (see subsection below).

The SAT and VSAT Elementary processes differ from the standard DELPHI version in that additional code has been introduced to control and monitor the bias voltage supplies and tracker parameters. This code has been introduced in detector specific subroutines which are called by the standard DELPHI EP.

3.1 Use of the Data Base

The DELPHI Data Base is divided into a number of trees which each contain a certain type of data, e.g. the 'GEOM' tree contains all geometrical constants, the 'CALB' tree contains all calibration constants etc. Each detector then provides a file for each tree that concerns them with all constants given in the file. For each file the tree is divided into a number of records for each subsystem of the detector, the number depending on how deep into the subsystem one wants to go, e.g. each VSAT module consists of 12 layers with 12 full silicon planes and 3 silicon strip planes with one record for each plane in the data base, giving a total of 15 records. Finally, each record is divided into a number of fields where the constants are written. Thus to find out the values of a certain constant one has to know in which tree, record and field it is written. A description of the structure of the 'GEOM' and 'CALB' trees can be found in [5] and, as an example, the structure for the VSAT is described in detail in [6].
The ‘SLOW’ tree in the DELPHI Data Base contains data for the Slow Control system. As all trees it is divided into records and fields, each containing relevant information for the Elementary Processes, e.g. number of high and/or low voltage channels used by a single EP, the voltages and currents that these channels should be set to when switched on and their tolerances. A detailed description of this Data Base tree can be found in [7].

The Elemenetary Processes can also write updates to another tree of the data base, the ‘STAT’ tree, if it is requested to do that. The contents of this tree was previously in the ‘CALB’ tree, but because of the amount of data written by the slow control EP’s of different detectors, the constants concerned by the slow controls were taken out of ‘CALB’ and put into the newly created ‘STAT’ tree. Unfortunately there is one field in this tree that is also called ‘STAT’ but this should not to be confused with the tree name itself. The change is completely transparent to the EP’s. The request to write updates is specified in the ‘SLOW’ tree of the data base where the correct record name, field name and word number is specified for each channel. By requesting to write updates when DELPHI is taking data, one will be able to find out if a specific detector was working correctly at a certain point of data taking, by forcing the analysis program, DELANA, to read the ‘STAT’ tree information.

4 State Management Interface, SMI

As described in the previous section, the Elementary Processes communicate with the G64 program, report on hardware status and enable the user to send commands to the G64. The EP is, however, a batch process and the operator needs an interface with which to communicate with the EP. The most general interface used in DELPHI for such purposes is called State Management Interface, SMI.

Each sub-detector has an SMI-process for the Slow Controls, SMI<detector-name>_SC, e.g. SMI_SAT_SC, to which all the Elementary Processes are linked.

SMI is written in a special language called State Manager Language, SML. Each sub-detector has provided code for their own SMI. A set of objects and the states these objects can obtain are defined in the SMI code and so are the lists of commands to which each object can react to in a particular state. Also since the SMI can be subject to either LOCAL or CENTRAL control it is possible to code it so that it reacts to certain commands if only in LOCAL/CENTRAL state.

For the SAT and VSAT detectors, the SMI is very simple. It consists of seven objects for SAT and five for VSAT. These objects are:

- CL, which stands for CENTRAL/LOCAL, shows if the detector SMI is under central or local control.
- SC, which means Slow Control, shows the current overall SMI state of the detector taking into account all other objects but CL.
- BIAS shows the status of the bias supplies.
- SWST, which means SWitch STatus, shows the status of the bias crates.
• FB, which shows the state of the Fastbus crates and enables the user to switch on or off the DC power to the crates.

• TEMP shows the status of the temperatures in the detector. (Only present for SAT.)

• TRCK shows the status of the tracker. (Only present for SAT.)

Apart from CL and SC, each of these objects represent the state of an Elementary Process.

The SAT and VSAT groups have programmed their local SMIs in such a way that if they have one or more bias channels that are not at nominal voltages, the central operator can switch the faulty channels on. Also if one or more Fastbus crates are OFF, they can be switched on from the central SMI. All other central commands are discarded and do not alter the SMI state. This is because the detectors remain on regardless of changes in the beam conditions.

5 Human Interactive system for the Elementary Processes, HIPE

The HIPE system provides an interface between the user and the Slow Controls Elementary Processes. With HIPE the user is able to read the values for all channels inside the EPs, and also to change the values of individual channels, which in turn will change values for those channels in the G64. Unlike the EPs, which need to run all the time, HIPE is an interactive program which is started only when needed. It can connect to several EPs and in this way change and read values of different types of channels, e.g. voltages and temperatures.

The main difference between the SMI and HIPE is that SMI works on the whole set of channels that are defined for each EP, while with HIPE a user can monitor/control individual channels. HIPE does not show an overall state of the EP’s connected to it, but instead display the actual readings of e.g. voltage channels or temperature channels. One can thus use HIPE as an error checking tool to see which channel(s) are outside their tolerances and is a useful tool for correcting the settings of individual channels.

Each detector has to provide a configuration file which describes the Slow Controls environment and is interpreted by HIPE. For more details about this file, see [8]. When invoking HIPE, the configuration file is read first and then one enters a menu driven program from which one selects the group of channels of interest.

Normally a detector group only supplies a small part of the configuration file which tells HIPE how to display the menus. However, because of the non-standard bias supplies used by SAT and VSAT and the the SAT tracker, we have had our own version of HIPE.EXE and a non-standard configuration file.
6 Summary

The Slow Controls systems for SAT and VSAT has, with one exception, been working reliably since they were implemented into the DELPHI central control. It has shown that the BIAS supplies have been very stable with only a few trips in the total time of running. Furthermore the SAT TEMP EP has worked well reacting immediately to any temperature changes that leads to values outside range. The Fastbus was implemented only after the end of running in 1993 and have thus not been tested “in real life”, but sufficient tests were made after the implementation and the results were good. However, the SAT TRCK was never successfully implemented into the DELPHI environment due to difficulty of systems development during running. The tracker was controlled and monitored (infrequently) from a stand-alone IBM compatible PC in D2.

The only problem we had with the Slow Controls was due to the G64 program loosing connection with the EP’s and/or the hardware and thus needing to be reset. This was, however, not a specific SAT/VSAT problem but affected all G64 systems in DELPHI. It can be said that the SAT/VSAT G64 has been one of the most stable throughout the years of running.

References


