Power Supply Controls for the Tesla Test Facility

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1. Introduction

In the control system for the TESLA Test Facility (TTF) [1] the Experimental Physics and Industrial Control System (EPICS) [2] will be widely used. In particular, it will be used to control power supplies for TTF magnets. The EPICS system places at disposal of a control system developer a collection of, so called, records. There are about 40 various record types in EPICS. By means of the special tool a control system developer can create a control data base using these records as building blocks. Many records in a real data base should be interconnected by means of various type of links (Input links, Output links or Forward links) depending on the actual structure of a control system. In order to control Power Supplies (PS) via EPICS it would be necessary for each PS to combine several types of existing records. In order to concentrate all controlling and diagnostic functions for PS controls in one record a new type of EPICS record was developed called PSC-record type (PSC stands for Power Supply Controller). Usage of this type of records facilitates also a job for a control system developer on creating of the control data base for Power Supply Controls of TTF and on its maintenance.

2. PSC-record functionalities

The PSC-record was developed as a multifunctional record, which gives the user a possibility to perform via it all the necessary operations to control PS. It also carries out a permanent diagnostics of the hardware. Its functions are as follows:

- initialization of software and hardware,
- execution of setpoint operations with PS in various modes,
- stopping of current setpoint operation,
- reset of a PSC,
- switching on and off of a PS,
- performing either an individual or synchronized group controls of PS,
- periodical reading of the hardware status and rising of alarms.

To provide such functionality the PSC-record's software contains an embedded mechanism, based on the final state machine. Every time the PSC-record is activated it analyzes what is the cause of its activation. Depending on its current state and the cause of activation a corresponding function is made and transition to appropriate new state is performed. If it is detected that a cause of activation is vorbidden in current state the record stays in its current state and nothing is done.

2.1. Modes of setpoint operation

A setpoint operation is the most important and complicated function of the PSC-record. During the setpoint operation the required value of a current called setpoint must be set to the PS. The setpoint can be performed in three different modes:

- Instant setpoint.
- Ramping.
- Table's Ramping.

In mode 'Instant setpoint' the setpoint operation is performed as fast as possible. If the setpoint value can be set to PS for one step it is set. But there can be some hardware restrictions for changing of a setpoint value in one step. In such cases the setpoint is set automatically by the PSC-record in several steps. During each step changing of the setpoint value stays within allowed limits. The hardware limits for a maximum allowed step size along with a minimum time delay which is necessary for each step should be set into the record before its activation. An example of two sequentional Instant setpoints which are done both in several steps is represented on Fig.1. These two setpoints differs with the time delay between each step.

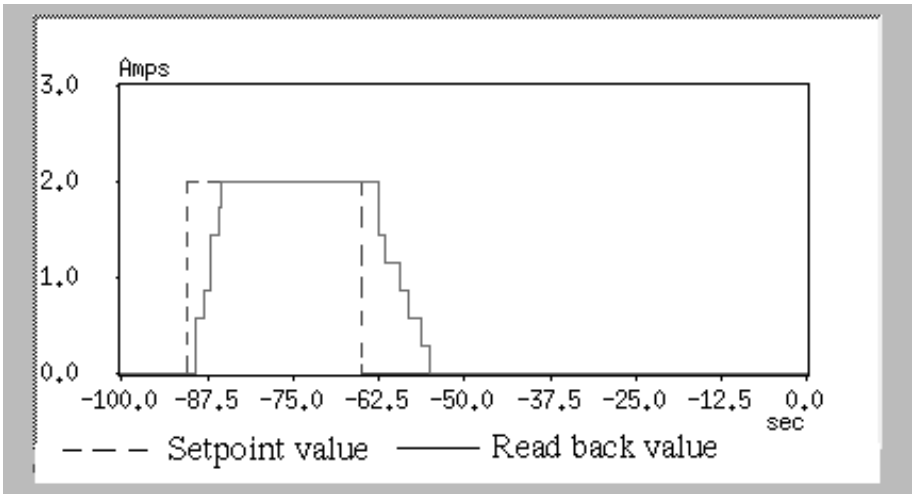

Figure 1: Instant setpoint.

In mode 'Ramping a setpoint' value must be reached within a defined time interval. A required time interval must be set into reserved field of the record before setting of the desired setpoint value. The whole setpoint operation comprises a sequence of one step setpoints and some delay time between each step. A number of steps, delay time between steps and a step size are calculated in such a way to satisfy a set of conditions:

1. $n \geq N$, where n is a number of steps; N is some predefined number (currently $N=10$);
2. $STEPmin \leq step \leq STEPmax$, where $step$ is the step size, $STEPmin$ and $STEPmax$ are minimum and maximum step sizes respectively defined by hardware restrictions;
3. $Terr \leq Terrmax$,where $Terr$ - the total accumulated time error for the whole operation, $Terrmax$ - predefined maximum value of time error (must be set into reserved field of the record before start of Ramping).

If a setpoint cannot be performed for a required time (for instance, because of too short required setpoint time and too long minimum delay time between steps) it is done for a minimum possible time taking into account the conditions mentioned above. An example of two sequentional setpoints in mode 'Ramping' with two different meanings of the setpoint time is represented on Fig.2.

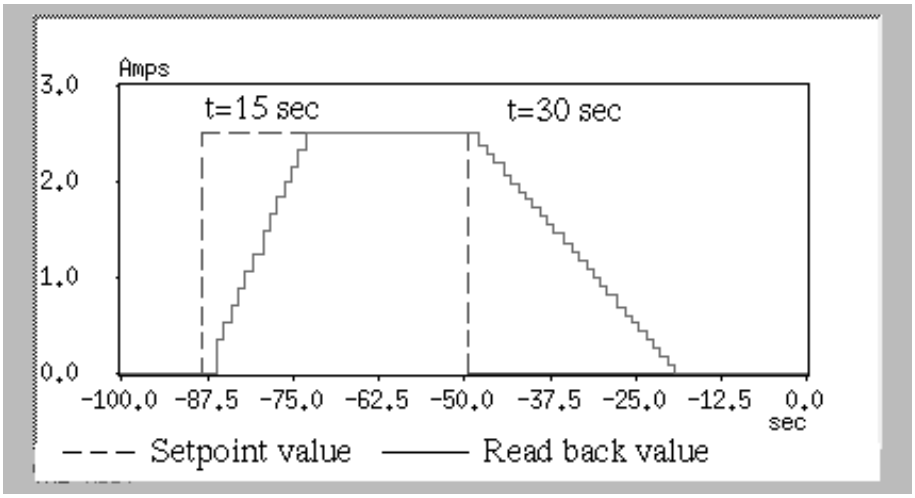

Figure 2: Ramping.

In mode 'Table's Ramping' the PSC-record carries out a set of sequential Rampings. The parameters of these Rampings (the setpoint value and the setpoint time interval for each Ramping) should be preloaded into the appropriate table reserved in the record's local memory. The size of this table can be configured free at the startup time of the computer running the record. An example of "Table's setpoint" is represented on Fig.3.

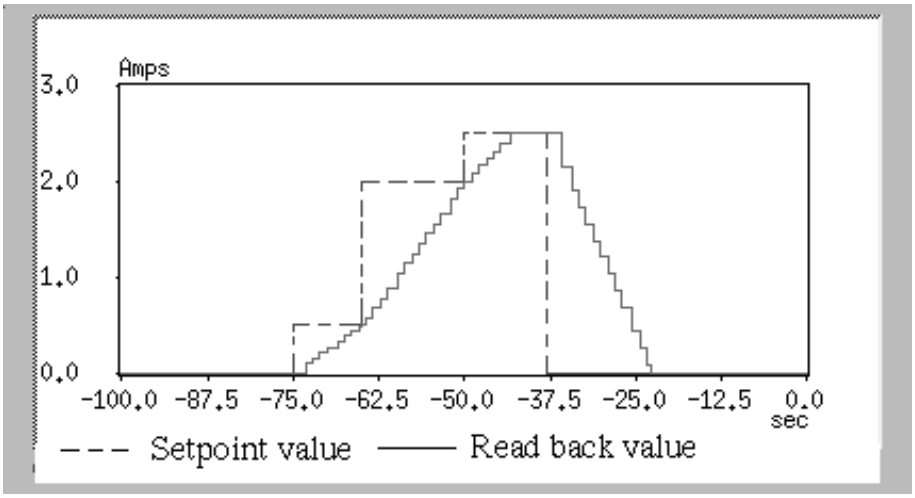

Figure 3: Table's setpoint.

The table of parameters for this setpoint is shown on Tbl.1.

Table 1:

Setpoint value (amps)	0.5	2.0	2.5	2.5	0.0
Setpoint time (sec)	10	15	7	5	15

2.2. Another control operations

There are a number of control operations along with the setpoint which are necessary and can be done via PSC-record. They are as follows:

- Stop current setpoint
- Reset PSC
- PS ON or OFF

'Stop' operation stops entire setpoint operation, i.e. for 'Ramping' mode it stops whole sequence of steps and for 'Table's ramping' mode it stops whole sequence of Rampings, fixing the state of PS as it was at the moment when 'Stop' commant has come.

'Reset PSC' operation performs at first 'Stop' operation and then executes a reset of PSC. 'Switch PS OFF' operation also performs at first 'Stop' operation, then stops a process of periodical reading of status information (see p.2.4) and then transfers the record into 'sleeping' state. In this state the record ignores all commands but 'Switch PS ON'. On coming 'Switch PS ON' command the necessary initialization is done and the process of status reading is restarted as well.

2.3. Individual and group controls

All operations described above can be done both with an individual PSC-record and with a group of records simultaneously. For group synchronization of PSC-records the event-driven mechanism of EPICS records activation is used. For every EPICS record type there is the special field, where the event number should be placed for event-driven mode of a record activation (Event Number field). Writing of a nonzero value into this field of the PSC-record transfers it into the event-driven mode of activation. In this mode activation of the records having the same Event Number will happen only on coming of the event with this Event Number. Writing 0 into the Event Number field transfers the PSC-record into, so called, 'Passive' mode of activation, which allows to control each PSC-record individually. So, the Event Number field for PSC-record is used as a switch to select either the individual controls mode or mode for the synchronized group controls.

2.4. Periodical diagnostics of the hardware

The PSC-record performs periodical reading of some status information from the hardware along with reading back of controlled value. There is the special field in the PSC-record where the time period for reading of status information should be set. Initially it can be set during the process of a data base creation. At run time this parameter can be changed at any moment by an operator. Process of status reading is started when 'Switch PS ON' operation is done and is stopped after 'Switch PS OFF' operation. This process is supported automatically by the PSC-record in parallel with executing of setpoints and

other control actions. There is the field in the PSC-record where should be set the mask for specified bits in received status. On receiving the status where the specified bits were set corresponding alarms are raised. If during setpoint operation an error of a hardware interface to PSC is detected the current setpoint is stopped and the next one is blocked until recovering. An error, is considered, to be recovered when next read status operation is completed successfully.

2.5. Support for different hardware

The PSC-record provides full functionality described above when it is used as an interface to connect to PSC through SEDAC [3]. Currently two PSC types, developed in DESY to control different types of PS, are supported: COPC 1 - Correction Power Supply Controller [4] and the PSC developed by W. Vagt [5]. In order to control a PSC using another type of interface the PSC-record needs to be linked to a definite collection of additional EPICS records (Analog input, Analog output etc.) supporting this particular interface. In this case the PSC-record supports reduced functionality, providing only "Instant setpoint" mode of setpoint operation.To provide the full functionallity for any other interface but SEDAC it is necessary to develop for every particular case the interface level library (Device Support library) having the similar capabilities on executing of a complex asynchronous input/output requests as in the current SEDAC Device Support library.

3. Conclusion

Development of the PSC-record was done partially by using simulators of PS and a test data base. So, some features of the PSC-record functioning remained untested. At present, for Power Supply Controls for the TTF using developed PSC-record the real control data base is created. After all the hardware will be installed an ultimate testing of the PSC-record functionality will be done on the actual equipment.

References

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[3] G.Hochweller, et al. ¨Padac Multi-Microcomputers, Basic Building Blocks for Future Control Systems¨, IEEE-NS-28, 3, 1981.

[4] P.Nommensen, J.Sachse. ¨Eigenschaften der Korrekturmagnetsteuerung bei folgenden Beschleunigern¨, Internal Report DESY M-94-01, July 1994.

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