DAQ/DCS Subsystem State Transitions

This is an attempt to represent the dynamic behaviour of SCT DAQ/DCS subsystems in such a way that their interactions can be examined and possible failure modes identified.

1 . Low Voltage Power Supply System (LV PSS) Card

The following is based on the SCT LV documents [1], [2] as well as e-mails with the designer, Jan Stastny.

The LV PSS is a rather complex object which seems well designed to keep the system safe even without intervention from the DCS. It supplies four different voltages (Vcc, Vdd, Vpin, Vvcsel), two thermistor current sources and two logic levels (SELECT, RESET) to the module. It responds to the state of the module (I, V, temperatures, disconnected sense wires), external commands from DCS and interlocks, and its own state (temperature, communication between microcontrolers, power level).

LV Channel (LV_CHAN) States

Four states are needed to describe the behaviour of a single LV PSS channel:

Stopped Channel relay is open and microcontroller is unpowered.
All voltages are OFF.

LV_Off Channel relay is closed and microcontroller is running.
All voltages are OFF.

LV_On All voltages are ON.

LV_VCSEL All voltages are ON except VCSEL volts because of an interlock condition.

Current sources for module thermistors are always ON and the thermistor volts can be read by DCS even when the LV_CHAN is stopped.

I can't see the value of a separate 'Standby' state for Vcc, since a trip in Vcc shuts off all of the digital voltages as well, and the module loses its configuration. Our experience with SCTLV3 was that Vcc trips could be a problem when switching on. This was because Icc has a negative temperature coefficient and the switching transients could be enough to exceed the trip limit when the module was cold. The LV PSS allows one to set a trip delay which ought to cure this problem, but it still makes sense to wait until both Vcc and Vdd on fully on before trying to configure the module. Another advantage of doing without Vcc 'Standby' is the simplification of the database and of the startup procedure.

The transitions between these states is described by the accompanying state transition table (Table 1) which describes the possible transitions between all four states. The cell at the top left corner, for example, shows the case where the system is initially in the 'Stopped' state and nothing happens, so it stays in that state. The text after the '/' signifies that the 'Hwon' and 'Swon' bits of the channel status byte [1] are left with the value 0. In the next cell to the right something happens: in the 'Stopped' state the system receives a 'Start' command from somewhere and moves into the 'LV_OFF' state, providing that there is no software interlock or DCS interlock condition, and the 'Hwon' bit is set to 1. There is no legal transition from 'Stopped' directly to 'LV_ON' or 'LV_VCSEL'.

2 . SCT High Voltage Power Supply System Card (SCT HV)

The SCT HV documents [3], [4] don't give the same level of detail as the LV PSS ones, and I have not had the time to understand them as fully. For example, I don't know if there is a 'Stopped' state which is distinct from 'HV_OFF'. SCH HV responds to current and voltage trips, external commands, DCS interlock and crate overtemperature interlocks.

HV Channel (HV_CHAN) States:

For the purpose of this discussion, I propose to consider just four states for a single HV channel, leaving open for the moment exaclty how an external system determines which state the channel is in.

HV_OFF Channel HV volts are OFF.

HV_RampUp The channel is ramping up to full volts.

HV_RampDn The channel is ramping down to 0 volts.

HV_ON The channel is stable at full volts.

The ramping states occupy a considerable time (minutes) during which the module is neither fully ON, nor fully sensitive. Trips can occur from both HV_RampUp and HV_RampDn.

3. SCT Module

The state of the module depends on the states of its LV_CHAN and HV_CHAN, and also on whether it has been configured by the DAQ.

Module States:

I reckon that four states are necessary to describe the dynamic behaviour of a module.

MODLV_OFF The module LV is not in the LV_ON state.

MODLV_ON The module LV is in the LV_ON state, but not configured.

Configured The module has been sent its configuration data by the DAQ.

Sensitive The module is fully sensitive.

In the Module State Transition Table (Table 2), 'Config()' means that the DAQ sends configuration data. The module LV must be in the LV_ON state for the module to be configured, but once it is configured, the VCSEL volts can be cut off by an interlock, and the module will retain its configuration data even though it can't communicate with the DAQ.

I don't know if there is a way for the module to lose its configuration data except by the Vdd being cut off. Maybe a data error could do this. If that is the case, a way of quickly detecting that this has happened is needed.

4. DCS and DAQ

Sorry, no time to include these.

References:

[1] Jan Stastny , *Serial com Format,* 12 December 2002.
[2] J. Stastny, *SCT Low Voltage Power Supply Requirements and Specifications,* ATLAS SCT LV Power Supply FDR/2002, 15 November 2002.
[3] SCT Bias Power Supply Specification, v 2.04, February 2001.
http://www-hep2.fzu.cz/Atlas/WorkingGroups/Projects/MSGC/hvspec_01feb26.pdf
[4] SCT HV VME Model HV203 User Manual, Rev. 1.1, May 2002.