# 1 Overview of the SPS RF Control model.

The SPS RF Control System follows the 'standard', as established by the SPS Controls group in 1988: 'The LEP/SPS access to equipment.', LEP Controls note 54; version 2.
Our control system was conceived in the early 1990's.

It is thus a 3 layered control system (top->down):

- **The Presentation Layer**, also called at the SPS RF the 'MMI' or 'control application', from which an operator has interactive access to the RF hardware. This layer is executing in HP workstations, running UNIX. Its user interface (X-terminal) communicates, in the RF case, with 'standard' SPS RPC calls to the layer directly underneath:
- **The Process Layer** is implemented in LynxOS running Process Control Assemblies (PCA's). This layer is responsible for de-grouping operator 'logical' commands into RF required procedures for their execution. The PCA layer also provides for secure access control and is therefore considered as the outside world 'entry point' to the RF hardware. It communicates with the 'standard' MIL 1553b protocol to the lower layer:
- **The Equipment Layer** is implemented in 'standard' G-64 computers, the Equipment Control Assemblies (ECA's), that run an AMX kernel ('standard' kernel) based operating system conceived by the SPS RF group, because none was available at that time. This layer has, amongst other, the responsibility of making similar RF hardware of different make seem the same as far as the Process layer concerns: e.g. transmitters of Siemens, Philips or Valvo.

## *1.1 Control Phases.*

The control of SPS RF hardware normally goes in phases, which are called 'Levels'. Each level consists of a logical group of states of sub-systems within the RF hardware. E.g. all sub-systems within the level must be 'ON' in order for the level to which these sub-systems belong is to be considered as 'ON'.

Sometimes these levels have, besides their usual 'OFF' and ON' states, a 'READY' state attribute to the 'OFF' state which indicates the possibility (pre-requisite) of switching to 'ON' whenever that command would be issued.

These levels are chosen to allow for setting-up or testing of the hardware in another than 'fully ON' or 'fully OFF' state.

It also provides for a quick (intermediate) status overview and for problem analysis during switching actions.

Currently the following levels exist for the SPS RF hardware:

- **Level 1.**
  Concerns generally non-HV sub-systems e.g. cooling equipment, filaments etc.
  Pre-requisition is availability of 220/380 mains, primary water etc. (Level 1: 'READY').


Erik Bracke
AB/RF-cs

- **Level 2.**
  Concerns all HV sub-systems (pre-drivers, drivers etc.), but no RF drive possible yet.
  Pre-requisition is the Level 1 'ON' state (Level 2: 'READY').
- **RF drive permitted.**
  Concerns the RF switch at the entry of the RF equipment. Pre-requisition is the Level 2 'ON' state (RF drive permitted: 'READY').

## 1.2 Commands, status, faults and the like.

In the SPS RF Control philosophy we define commonly used names of control signals very rigorously. Are distinguished:

- **Commands.**
  Commands are in general mono-stable signals and are mainly used for initiating switching actions on the SPS RF hardware, provoking a state change of the latter.
  Are defined at SPS RF:
  - Reset faults: A min. 1Sec closing contact.
    This signal is used for resetting buffered faults (see later) and for putting the internal controller of the RF hardware in a state from which it can receive commands from the ECA.
  - Switch 'ON': A min. 1Sec closing contact.
  - Switch 'OFF": A min. 1Sec opening contact.
    Note that a missing cable between ECA and RF hardware will thus always bring the RF equipment in the 'OFF' (inherently safe) state, provided that it is remotely controllable.
- **Status.**
  Generally spoken, these are words consisting of one or more bit signals, each value of the status word has a meaning, i.e. it describes the state of the sub-system/equipment concerned. Most status consist of 1 bit only,having thus 2 states possible; e.g. 'ON' and 'OFF'.
  Some status are 2 bits, coding 4 states altogether. Upon a control action on a (sub-)equipment by the ECA, the latter inspects a corresponding (sub-)equipment status for checking whether the action has succeeded.
  Status _*always*_ follow the state of the sub-system/equipment which they represent and should _*never*_ be memorized by extra electronics. In fact, it is supposed that the RF hardware itself performs the function of signal buffer!
- **Faults.**
  These are one-bit signals, that inhibit the equipment from attaining (or maintaining) a certain state. Faults can be generated internally by the RF equipment itself as well (over temperature e.g.) and create thus an internal command that makes that the equipment undergoes a state change (visible in the status word); most of the time this situation is called 'a trip'.
  Faults thus have only one meaning: if the signal is active, it 'performs' its name. Absence of a fault is not considered to be of importance other than that _ALL_ faults must be absent in order for a control action to be successfull or the current RF hardware

state to be maintained.
Faults are generally buffered which means that, after repair, a command 'Reset faults' is required to extinguish them before a switch command can be honoured. The idea is that an operator at the control interface (near the lamps on the frontpanel and in front of the computer if remote) has a chance to see an intermitted fault to have occurred. The autonomous control logic of the RF hardware would have seen that fault anyhow and would have performed its function accordingly: switch down to a lower (safe) level. This could have made the fault disappear if it were not buffered and thus remain unseen (and: not understood what happened to the hardware and why).

- **Summary status.**
  This is a signal that represents a sub-set of faults. Any fault in the sub-set also activates the Summary status (logical inclusive OR). This name is somewhat confusing with our definition of 'Status'; it is an heritage from a long, almost forgotten past...
  Summary status are used for fast scanning alarm programmes or alarm interrupts (service requests) at the ECA: one Summary status generates in most cases an alarm in the PCR.
  In general, unplugging a cable which carries a Summary status is considered to be equivalent as Summary status 'TRUE' (and so: 'at least one fault is active').
  In 'electrical terms' this would implement the equivalent of an 'open, (floating!) contact' in case of 'at least one fault is active'.
- **Warnings.**
  Some of the SPS RF hardware (notably the RF power amplifiers) produce for certain analogue value faults an extra one-bit signal: the warning. It is a signal that is activated slightly below the analogue value (a temperature e.g.) that would be considered the 'trip' value and that would create the corresponding fault. On the frontpanel of the RF hardware this situation is indicated by the blinking light of the fault lamp; when the 'fault' value would be attained, the light would then become steady 'on'. Warnings are, in contrast to faults, not buffered and they do not initiate a switch action on the RF hardware; they are for information only. The warning can be used for finding 'trends' and determination of 'reasonable' set-values for faults. It was mainly in use during the acceptance tests of the equipment. Currently they are not really used anymore and (probably) not even interfaced to the ECA...

Generally spoken, for the galvanical isolation a convention of the 'signal issuer isolates' is the standard and so is the idea of logical '1' ('TRUE' or signal 'active') equals 'current' in the electrical connection; 'light' in an opto coupler.

The only regular exception to this latter standard is for 'OFF' commands and Summary statys. Here, for security reasons, the rule is that 'no current' (missing or broken cable) switches the equipment 'OFF', or, for the Sumary status, it would mean 'at least one fault is active'.