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SPECIFICATIONS FOR THE LOCAL/REMOTE CONTROL OF THE POWER SUPPLY FOR THE BTF PULSED DIPOLE MAGNET

INFN-LNF DAFNE PROJECT

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1 Introduction

In order to describe the PS (Power Supply) behavior, here we give some definitions:

1.1 State

A defined set of the digital signals monitored from the PS internal control logic and readable from remote through the communication interface. In this documentation the state names are in uppercase (e.g. STANDBY, ON, ...).

1.2 Mode

Define an operational condition. The possible modes are:

LOCAL and REMOTE. Both in LOCAL and in REMOTE, the PS will follow the same rules regarding States and Commands;

DC and PULSED. When in DC the PS will obey to the software *StartRamp* command. When in PULSED the PS will obey to the hardware triggers (RAMP-UP and RAMP-DOWN).

1.3 Command

A user action that causes the transition of the PS between two States (in particular the two States may coincide) or two Modes. A Command may be issued from remote through the communication interface or locally through the PS front panel or other eventually available inputs. In this documentation the command names are in title-case italic with no blanks (e.g. *Standby*, *On*, ...).

1.4 Event

Something, not determined by a user action, that causes the transition of the PS between two states (in particular the two states may coincide). An Event may be due either to the PS internal control logic (as a consequence of a detected internal wrong condition) or to an external interlock.

2 State diagram

In order to define the PS behavior in terms of States, Commands and Events, a diagram is presented in fig. 1. In such diagram, the bubbles represent all the possible states and the arrows indicate the possible transitions, due to a Command or Event.

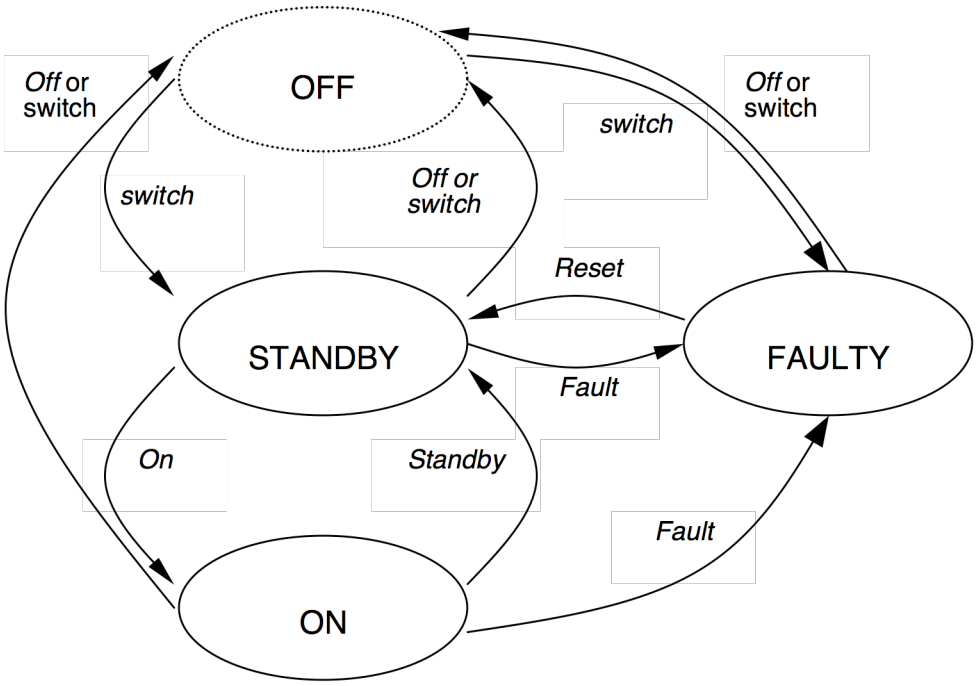

Fig. 1 - State diagram. OFF is not a recognizable state because the PS is not powered and the interface cannot communicate. Nevertheless it is reported in order to understand all the transitions.

Commands
Off
Standby
Reset
On
ModeDC
ModePulsed
PolaPositive
PolaNegative
SetCurrent
StartRamp
States
OFF (*state not recognizable*)
STANDBY
ON
FAULTY

Tab. 1 - List of all commands and states

3 Commands description

It follows a detailed description for each command.

3.1 Off
The *Off* command will shut down the PS. This command is not intended for emergency so that a proper sequence can be accomplished before the actual power off.

3.2 Standby
In the ON state, if the output current is at the reference value or a ramp is in progress, the command *Standby* must produce a ramp to 0 A. When the output is at 0 A the PS will execute a transition ON -> STANDBY. After this sequence, the Current Reference Register stays set to 0.

3.3 Reset
In the FAULTY state the command *Reset* clears all the alarms for which the fault condition does not longer persist and then executes the transition to the STANDBY state (if no faults are still present).

3.4 On
In the STANDBY state the *On* command executes the transition STANDBY -> ON. The Current Reference Register must be reset to 0.
In the FAULTY state the *On* command is ignored.

3.5 ModeDC - ModePulsed
In the STANDBY state the *ModeDC* / *ModePulsed* commands selects the DC or Pulsed modes. The state is not affected by these commands.
In any other states the commands are ignored.

3.6 PolaPositive - PolaNegative
In the STANDBY state the *PolaPositive - PolaNegative* commands select the PS polarity. The state is not affected by these commands.
In any other states the commands are ignored.

3.7 SetCurrent
Whatever is the state the current reference value issued with *SetCurrent* must be latched. The state is not affected by this command.

3.8 StartRamp
When in the ON status and in the PULSED mode, the command *StartRamp* will charge the booster capacitor until the suitable level related to the current set. After this the actual current delivery will follows the start and stop triggers. For further details on the pulsed mode, see specs **SR 20050419**.
When in the ON status and in the DC mode, the command *StartRamp* will start the output current ramp toward the reference value. This command is equivalent to a trigger pulse. The Time delay from the reception of a software *StartRamp* command and the actual beginning of current variation must be ≤ 20 [ms] (the time delay is calculated from the last stop bit of the command).
All the readbacks must be available during a ramp. This means that it must be possible to check continuously the PS state and to track the analog values in real-time.

All the commands must be accepted during a ramp. This means also that it must be possible to write a new "Current Reference" value and to send a new *StartRamp*. This will abort the ramp in progress and will start a new ramp toward the new "Current Reference" (see fig. 3). The state is not affected by this command.

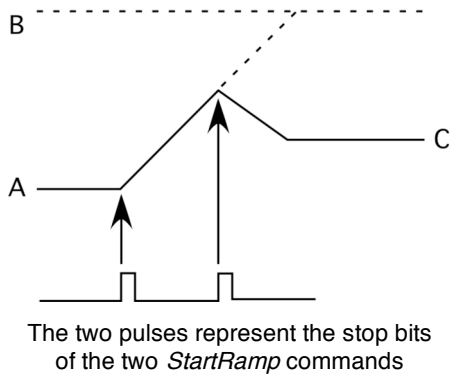

Fig. 3 - Example: the PS output is A; a subsequent command sets the "Current Reference" to B. At the first *StartRamp* the PS initiates the ramp toward B. During the ramp the new "Current Reference" C is set. At the next *StartRamp* the PS stops its original ramp and starts the new one.

4 PS behavior

At the startup (manual power on) the PS automatically go in the STANDBY state or eventually in the FAULTY state.

The emergency stop push button must shut down immediately the PS without executing any procedure.

The LOCAL or REMOTE mode selection must be operable only from the PS front panel. There is no command for setting the LOCAL or REMOTE mode from remote.

When in LOCAL mode, the PS internal database must be accessible for read operations (see 4.1).

When in LOCAL mode, any command issued through the interface will be ignored even though the slave will respond with the regular answer.

5 Database

5.1 Introduction

Here we refer to the MODBUS database structure, as defined in the document **CS-20051109**.
All the 16-bit registers of the read area of the slave internal database must be always updated at the requested refresh rate and must be readable through the interface, regardless the PS LOCAL/REMOTE mode and/or the persistence of the PS into a FAULTY state. It must be possible to read the command area.

5.2 Refresh rate

The Current and Voltage values (that is the rate at which the interface updates the holding registers readable through serial link) must be ≥ 20 Hz.

5.3 Database structure

It is reported the slave internal database structure. In order to ensure the compatibility with other already implemented MODBUS slaves, the command and readback addresses as well as the bit positions for each register are mandatory. The last valid address is 0x003F. The address indicates the word number (i.e. address 0x0000 locates the first 16-bit word, address 0x0001 the second 16-bit word and so on).

COMMAND AREA (Read/Write)		
LOCAL ADDRESS	BIT	DESCRIPTION
		Commands
0x0000	0	*Standby*
	1	*On*
	2	*Off*
	3	*Reset*
	4	*StartRamp*
	5	*ModeDC*
	6	*ModePulsed*
	7	*PolaPositive*
	8	*PolaNegative*
	9-15	Not Used
		Write Registers
0x0001	0-15	Current Reference Register
		Padding Area
0x0002-0x001F		For spare commands... (all words must be set to zero)

Tab. 2 - All the write registers in the COMMAND AREA must be also readable through the Modbus Read function.

READBACK AREA (Read only)		
LOCAL ADDRESS	BIT	DESCRIPTION
		Faults
0x0020	0	Input AC line fuse failure (if used)
	1	Phase unbalance / loss / reversal
	2	AC over current
	3	DC over current
	4	Cooling system failure
	5	Rectifier transformer over temperature
	6	Rectifier over temperature
	7	Filter choke over temperature
	8	Filter capacitor fuse failure
	9	Resonant Capacitor failure
	10	Rectifier failure
	11	Booster switches failure
	12	Booster switches over temperature
	13	Chopper switches failure
	14	Chopper switches over temperature
	15	DCCT failure
0x0021	0	Excessive current ripple alarm (*)
	1	Maximum DC ground current
	2	Cabinet over temperature
	3	Cabinet door open
	4	External interlock 1
	5	External interlock 2
	6-15	Not used
		States & Modes
0x0022	0	0 = Remote, 1 = Local
	1	Standby
	2	On
	3	Fault Sum (logical OR of all faults)
	4	0 = DC, 1 = Pulsed
	5	0 = Pol. Positive, 1 = Pol. Negative
	6 - 15	Not Used
		Readout Registers
0x0023	0 - 15	Current Reference readback
0x0024	0 - 15	Output current readback
0x0025	0 - 15	Output voltage readback
0x0026	0 - 15	Ground current readback
		Padding Area
0x0027-0x003F		*For spare readouts...*

Tab. 4 - The "Current Reference readback" must contain the last value written into the "Current Reference Register" of the COMMAND AREA.
Items marked with a "*" are warnings and do not cause a transition to the FAULTY status

6 System Acceptance

The only acceptable method for INFN-LNF, to determine if the whole HW and SW interface system and control logic are compliant to the above specifications, is to establish a reliable connection between the PS and a INFN-LNF master computer using INFN-LNF applications. Then, all the acceptance tests will be performed using this setup.